Iodine(III) Promoted Ring-Rearrangement Reaction of 1-Arylamino-2-oxocyclopentane-1-carbonitriles to Synthesize N-Aryl-δ-valerolactams

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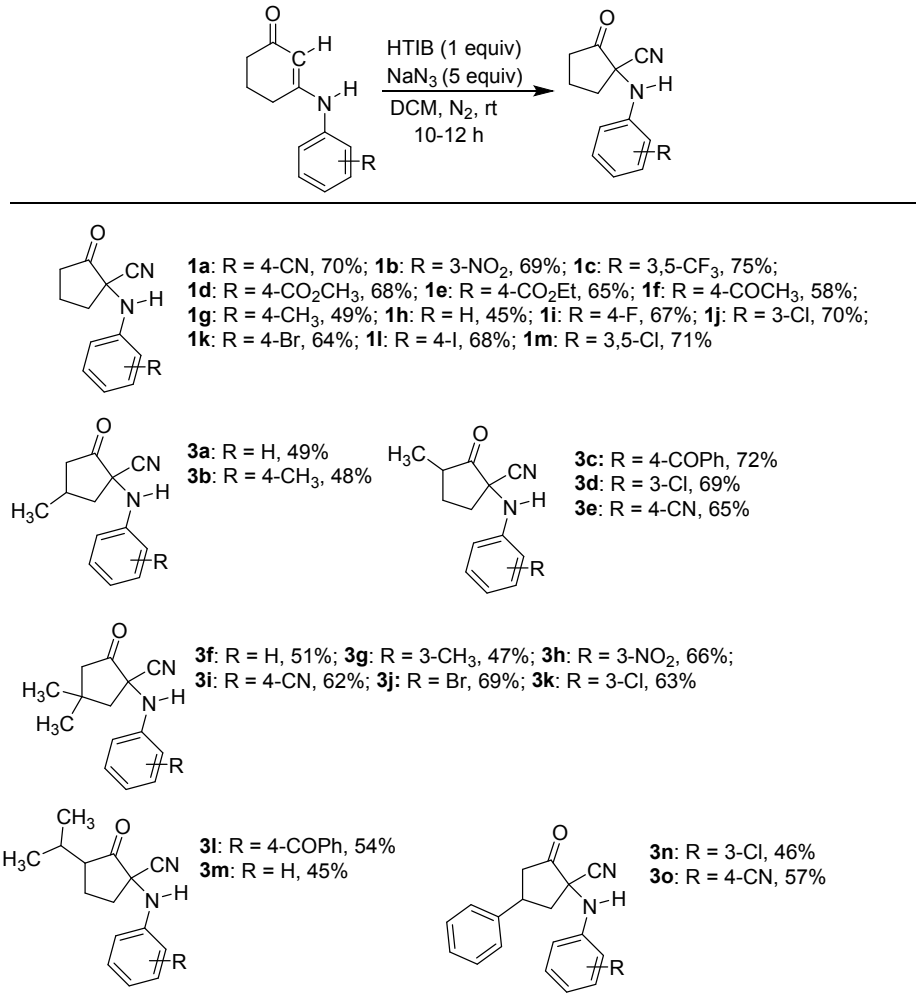
(A) General methods

Reagents of high quality were purchased from Sigma Aldrich and TCI chemicals. Silica gel (60-120 and 230-400 mesh size) for column chromatography was procured from Sd Fine-chem Ltd. Commercial reagents and solvents were of analytical grade and were purified by standard procedures prior to use. Thin layer chromatography was performed using precoated silica gel plates 60 F_{254} (Merck) in UV light detector. ESI-MS spectra were analyzed using micro mass Q-TOF ultima spectrometer. ^{1}H , ^{13}C NMR spectra were recorded using a Bruker Advance 300 and 600 spectrometer operating at 300 MHz and 600 MHz for ^{1}H, 75 MHz and 150 MHz ^{13}C. Spectra were recorded at 25 °C in $CDCl_3$ [residual $CHCl_3$ (δ_H 7.26 ppm) or $CDCl_3$ (δ_C 77.00 ppm) and CD_3OD (δ_H 3.30, 4.78 ppm) or CD_3OD (δ_C 49.00 ppm) as international standard] with TMS as internal standard. Chemical shifts were recorded in δ (ppm) relative to the TMS and $CDCl_3$ signal, coupling constants (J) are given in Hz and multiplicities of signals are reported as follows: s, singlet; d, doublet; t, triplet; m, multiplet; brs, broad singlet; qt, quartet. IR spectra were carried out using Shimadzu IR Prestige-21 FT-IR spectrophotometer. The melting point of the solid compounds was recorded using Visual melting range apparatus (MR VIS^{+}).

(B) Table S1: Synthesis of 1-arylamino-2-oxocyclopentane-1-carbonitrile derivatives [a*]

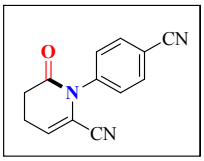


[a]**isolated yields**

***Compounds were synthesized as per procedure in reference 1**

(C) Synthesis and characterization data for the products (Table 1-2)

1-(4-Cyanophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 1, 2a)



Prepared as described for GP-II, starting from **1a** (50 mg, 0.2222 mmol) gave, after purification with silica gel column chromatography (50% EtOAc in n-Hexane) **2a** as light brown solid (41 mg, 82.7%). Melting point: 137-139 °C.

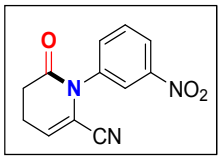
^{1}H NMR (600 MHz; $CDCl_3$) *δ (ppm)* 2.67-2.70 (m, 2H), 2.80 (t, *J* = 7.74 Hz, 2H), 6.40 (t, *J* = 5.04 Hz, 1H), 7.42 (d, *J* = 8.34 Hz, 2H), 7.80 (d, *J* = 8.34 Hz, 2H).

^{13}C NMR (150 MHz; $CDCl_3$) *δ (ppm)* 20.91, 30.45, 112.59, 112.66, 117.62, 117.83, 125.24, 128.72, 133.19, 140.63, 167.58.

ESI-MS $(M+H)^+$ calcd. for $C_{13}H_{10}N_3O^+$ is 224.0818 obsd. 224.0816.

IR (neat) 3082, 3065, 2232, 1699 cm^{-1}.

1-(3-Nitrophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2b)



Prepared as described for GP-II, starting from **1b** (50 mg, 0.2040 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **2b** as dark yellow solid (44.5 mg, 89.6%).

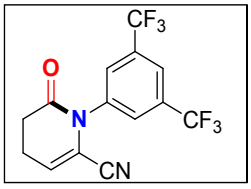
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.69-2.72 (m, 2H), 2.79-2.83 (m, 2H), 6.38 (m, 1H), 7.61-7.72 (m, 2H), 8.29 (s, 1H), 8.30 (d, J = 8.1 Hz, 1H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 20.98, 30.38, 112.65, 117.76, 123.51, 123.74, 124.86, 130.24, 134.14, 137.82, 148.67, 167.76.

ESI-MS $(M+H)^+$ calcd. for $C_{12}H_{10}N_3O_3^+$ is 244.0717 obsd. 244.0720.

IR (neat) 3084, 2230, 1697 cm^{-1}.

1-(3,5-Bis(trifluoromethyl)phenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2c)



Prepared as described for GP-II, starting from **1c** (50 mg, 0.1488 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **2c** as off white solid (44.2 mg, 89.1%). Melting point: 112.6-114.5 °C.

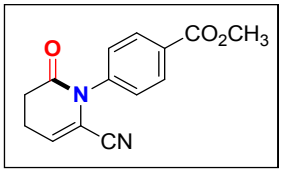
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.67-2.73 (m, 2H), 2.79-2.85 (m, 2H), 6.41 (t, J = 5.07 Hz, 1H), 7.76 (s, 2H), 7.94 (s, 1H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 20.95, 30.37, 112.45, 117.56, 122.71 ($J_{C\text{-}F}$ = 3.6 Hz), 124.46, 125.32 ($J_{C\text{-}F}$ = 1.7 Hz), 128.53 ($J_{C\text{-}F}$ = 2.5 Hz), 132.95 ($J_{C\text{-}F}$ = 34.2 Hz), 138.14, 167.66.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_9F_6N_2O^+$ is 335.0614 obsd. 335.0618.

IR (neat) 3082, 2968, 2230, 1705 cm^{-1}.

Methyl 4-(6-cyano-2-oxo-3,4-dihydropyridin-1(2H)-yl)benzoate (Table 2, 2d)



Prepared as described for GP-II, starting from **1d** (50 mg, 0.1937 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2d** as light brown solid (36.7 mg, 74%). Melting point: 134-136 °C.

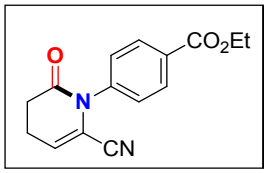
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.62-2.80 (m, 4H), 3.95 (s, 3H), 6.33 (t, *J* = 4.89 Hz, 1H), 7.35 (d, *J* = 8.4 Hz, 2H), 8.17 (d, *J* = 8.4 Hz, 2H)

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 20.98, 30.55, 52.27, 112.81, 118.18, 124.31, 127.89, 130.45, 130.74, 140.76, 166.02, 167.67.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{13}N_2O_3^+$ is 257.0921 obsd. 257.0930.

IR (neat) 3078, 3013, 2955, 2228, 1732, 1703 cm^{-1}.

Ethyl 4-(6-cyano-2-oxo-3,4-dihydropyridin-1(2H)-yl)benzoate (Table 2, 2e)



Prepared as described for GP-II, starting from **1e** (50 mg, 0.1838 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2e** as brown semi-solid (38.2 mg, 77%).

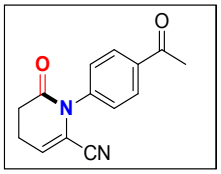
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.41 (t, *J* = 7.11 Hz, 3H), 2.64-2.68 (m, 2H), 2.75-2.80 (m, 2H), 4.41 (q, *J* = 14.22 Hz, 2H), 6.32 (t, *J* = 5.04 Hz, 1H), 7.35 (d, *J* = 8.46 Hz, 2H), 8.16 (d, *J* = 8.46 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 14.24, 20.97, 30.53, 61.22, 112.82, 118.18, 124.26, 127.84, 130.70, 130.81, 140.69, 165.52, 167.67.

ESI-MS $(M+H)^+$ calcd. for $C_{15}H_{15}N_2O_3^+$ is 271.1077 obsd. 271.1083.

IR (neat) 3075, 2982, 2230, 1703 cm^{-1}.

1-(4-Acetylphenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2f)



Prepared as described for GP-II, starting from **1f** (50 mg, 0.2066 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2f** as brown solid (38.7 mg, 78%). Melting point: 101.7-103.9 °C.

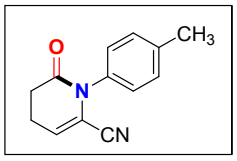
^{1}H NMR (600 MHz; $CDCl_3$) *δ (ppm)* 2.64 (s, 3H), 2.66-2.69 (m, 2H), 2.75-2.80 (m, 2H), 6.35 (t, *J* = 5.04 Hz, 1H), 7.39 (d, *J* = 8.4 Hz, 2H), 8.08 (d, *J* = 8.4 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 21.00, 26.62, 30.56, 112.86, 118.12, 124.46, 128.12, 129.43, 137.07, 140.90, 167.72, 196.82.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{13}N_2O_2^+$ is 241.0972 obsd. 241.0980.

IR (neat) 3061, 2924, 2224, 1678 cm^{-1}.

6-Oxo-1-(p-tolyl)-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2g)



Prepared as described for GP-II, starting from **1g** (50 mg, 0.2336 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2g** as white solid (35.6 mg, 72%). Melting point: 108-110.8 °C.

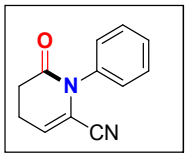
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.40 (s, 3H), 2.61-2.66 (m, 2H), 2.73-2.78 (m, 2H), 6.23 (t, *J* = 5.07 Hz, 1H), 7.14 (d, *J* = 8.28 Hz, 2H), 7.28 (d, *J* = 8.05 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 21.04, 21.18, 30.53, 113.07, 118.95, 122.85, 127.70, 130.15, 134.34, 139.05, 167.95.

ESI-MS $(M+H)^+$ calcd. for $C_{13}H_{13}N_2O^+$ is 213.1022 obsd. 213.1030.

IR (neat) 3046, 2949, 2226, 1688 cm^{-1}.

6-Oxo-1-phenyl-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2h)



Prepared as described for GP-II, starting from **1h** (50 mg, 0.25 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2h** as brown solid (32.7 mg, 66%). Melting point: 93-96 °C.

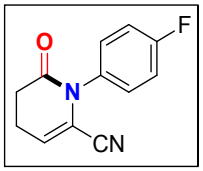
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.60-2.67 (m, 2H), 2.75-2.80 (m, 2H), 6.26 (t, *J* = 5.01 Hz, 1H), 7.27 (d, *J* = 6.96 Hz, 2H), 7.41-7.52 (m, 3H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 21.04, 30.55, 113.00, 118.80, 123.20, 127.99, 129.01, 129.48, 136.96, 167.89.

ESI-MS $(M+H)^+$ calcd. for $C_{12}H_{11}N_2O^+$ is 199.0866 obsd. 199.0881.

IR (neat) 3076, 2947, 2226, 1697 cm^{-1}.

1-(4-Fluorophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2i)



Prepared as described for GP-II, starting from **1i** (50 mg, 0.2293 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2i** as white solid (31.7 mg, 64%). Melting point: 109-111.1 °C.

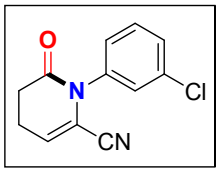
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.55-2.60 (m, 2H), 2.66-2.71 (m, 2H), 6.19 (t, J = 4.86 Hz, 1H), 7.06-7.19 (m, 4H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 21.05, 30.51, 112.91, 116.57 ($J_{C\text{-}F}$ = 23.1 Hz), 118.75, 123.26, 129.94 ($J_{C\text{-}F}$ = 9.0 Hz), 132.84 ($J_{C\text{-}F}$ = 3.5 Hz), 162.51 ($J_{C\text{-}F}$ = 249.2 Hz), 167.96.

ESI-MS $(M+H)^+$ calcd. for $C_{12}H_{10}FN_2O^+$ is 217.0772 obsd. 217.0760.

IR (neat) 3063, 2970, 2222, 1693 cm^{-1}.

1-(3-Chlorophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2j)



Prepared as described for GP-II, starting from **1j** (50 mg, 0.2136 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2j** as white solid (34.2 mg, 69%). Melting point: 130.8-134.6 °C.

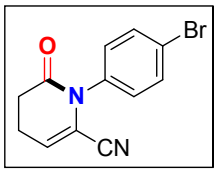
^{1}H NMR (600 MHz; $CDCl_3$) *δ (ppm)* 2.62-2.65 (m, 2H), 2.77 (t, J = 7.8 Hz, 2H), 6.28 (t, J = 5.04 Hz, 1H), 7.16-7.18 (m, 1H), 7.30 (s, 1H), 7.42-7.43 (m, 2H).

^{13}C NMR (150 MHz; $CDCl_3$) *δ (ppm)* 20.95, 30.43, 112.78, 118.26, 123.89, 126.25, 128.48, 129.27, 130.34, 134.92, 137.89, 167.71.

ESI-MS $(M+H)^+$ calcd. for $C_{12}H_{10}ClN_2O^+$ is 233.0476 obsd. 233.0482.

IR (neat) 3071, 2963, 2224, 1693 cm^{-1}.

1-(4-Bromophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2k)



Prepared as described for GP-II, starting from **1k** (50 mg, 0.1798 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2k** as brown solid (31.3 mg, 63%). Melting point: 102.0-104.8 °C.

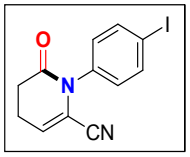
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.61-2.79 (m, 4H), 6.29 (t, *J* = 4.89 Hz, 1H), 7.15(d, *J* = 8.52 Hz, 2H), 7.62 (d, *J* = 8.52 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 21.00, 30.48, 112.85, 118.35, 122.99, 123.75, 129.62, 132.71, 135.86, 167.76.

ESI-MS $(M+H)^+$ calcd. for $C_{12}H_{10}BrN_2O^+$ is 276.9971 obsd. 276.9979.

IR (neat) 3059, 2957, 2226, 1688 cm^{-1}.

1-(4-Iodophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2l)



Prepared as described for GP-II, starting from **1l** (50 mg, 0.1533 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2l** as brown solid (32.8 mg, 66%). Melting point: 107.3-110 °C.

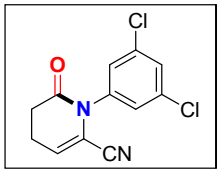
^{1}H NMR (600 MHz; $CDCl_3$) *δ (ppm)* 2.63-2.66 (m, 2H), 2.76 (t, *J* = 7.86 Hz, 2H), 6.30 (t, *J* = 5.04 Hz, 1H), 7.02 (d, *J* = 8.54 Hz, 2H), 7.81 (d, *J* = 8.52 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 20.97, 30.44, 94.54, 112.84, 118.23, 123.84, 129.76, 136.56, 138.64, 167.70.

ESI-MS $(M+H)^+$ calcd. for $C_{12}H_{10}IN_2O^+$ is 324.9832 obsd. 324.9828.

IR (neat) 2947, 2891, 2230, 1682 cm^{-1}.

1-(3,5-Dichlorophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 2, 2m)



Prepared as described for GP-II, starting from **1m** (50 mg, 0.1865 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **2m** as brown solid (39.2 mg, 79%). Melting point: 129-132 °C.

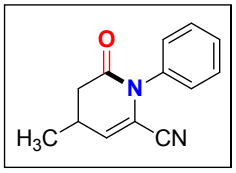
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.61-2.80 (m, 4H), 6.32 (t, *J* = 5.01 Hz, 1H), 7.19-7.20 (m, 2H), 7.43-7.44 (m, 1H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 20.97, 30.44, 112.59, 117.96, 124.41, 126.94, 129.43, 135.63, 138.48, 167.59.

ESI-MS $(M+H)^+$ calcd. for $C_{12}H_9Cl_2N_2O^+$ is 267.0086 obsd. 267.0090.

IR (neat) 3186, 3070, 2224, 1680 cm^{-1}.

4-Methyl-6-oxo-1-phenyl-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4a)



Prepared as described for GP-II, starting from **3a** (50 mg, 0.2336 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **4a** as white solid (33.7 mg, 68%). Melting point: 102.2-103.7 °C.

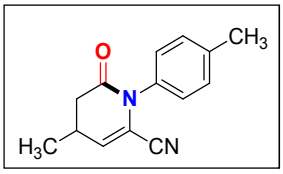
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.26 (d, *J* = 6.96 Hz, 3H), 2.49-2.57 (m, 1H), 2.78-2.92 (m, 2H), 6.16 (d, *J* = 4.23 Hz, 1H), 7.24-7.27 (m, 2H), 7.43-7.52 (m, 3H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 18.82, 27.75, 38.59, 113.04, 117.62, 127.93, 129.0, 129.14, 129.49, 136.84, 167.74.

ESI-MS $(M+H)^+$ calcd. for $C_{13}H_{13}N_2O^+$ is 213.1022 obsd. 213.1031.

IR (neat) 3069, 2959, 2228, 1691 cm^{-1}.

4-Methyl-6-oxo-1-(p-tolyl)-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4b)



Prepared as described for GP-II, starting from **3b** (50 mg, 0.2212 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **4b** as light yellow solid (32.5 mg, 65%). Melting point: 82-84 °C.

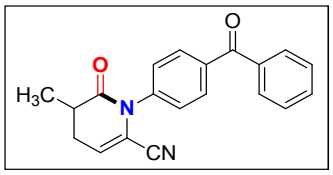
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.25 (d, *J* = 6.96 Hz, 3H), 2.40 (s, 3H), 2.51-2.56 (m, 1H), 2.78-2.85 (m, 2H), 6.14 (d, *J* = 4.23 Hz, 1H), 7.12 (d, *J* = 8.28 Hz, 2H), 7.28 (d, *J* = 8.07 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 18.87, 21.20, 27.80, 38.64, 113.13, 117.87, 127.68, 128.74, 130.19, 134.27, 139.09, 167.83.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{15}N_2O^+$ is 227.1179 obsd. 227.1185.

IR (neat) 3053, 2976, 2230, 1688 cm^{-1}.

1-(4-Benzoylphenyl)-5-methyl-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4c)



Prepared as described for GP-II, starting from **3c** (50 mg, 0.1572 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **4c** as light brown solid (42.2 mg, 85%). Melting point: 128-130 °C.

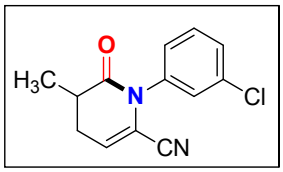
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.35 (d, *J* = 6.81 Hz, 3H), 2.43-2.50 (m, 1H), 2.64-2.84 (m, 2H), 6.32-6.35 (m, 1H), 7.39 (d, *J* = 8.46 Hz, 2H), 7.51 (t, *J* = 7.59 Hz, 2H), 7.62 (t, *J* = 7.59 Hz, 1H), 7.82-7.85 (m, 2H), 7.92 (d, *J* = 8.43 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 15.32, 28.73, 34.97, 112.92, 117.78, 123.89, 127.78, 128.37, 129.98, 131.05, 132.61, 137.23, 137.51, 140.60, 170.95, 195.44.

ESI-MS $(M+H)^+$ calcd. for $C_{20}H_{17}N_2O_2^+$ is 317.1285 obsd. 317.1290.

IR (neat) 3061, 2984, 2232, 1695 cm^{-1}.

1-(3-Chlorophenyl)-5-methyl-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4d)



Prepared as described for GP-II, starting from **3d** (50 mg, 0.2016 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **4d** as brown solid (37.7 mg, 76%). Melting point: 117.5-120 °C.

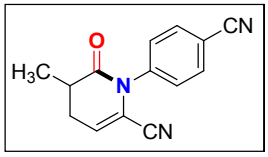
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.33 (d, *J* = 6.81 Hz, 3H), 2.36-2.47 (m, 1H), 2.62-2.81 (m, 2H), 6.26-6.30 (m, 1H), 7.14-7.18 (m, 1H), 7.28 (s, 1H), 7.41-7.43 (m, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 15.36, 28.74, 34.92, 112.85, 117.98, 123.22, 126.25, 128.53, 129.22, 130.32, 134.94, 138.22, 170.95.

ESI-MS $(M+H)^+$ calcd. for $C_{13}H_{12}ClN_2O^+$ is 247.0633 obsd. 247.0637.

IR (neat) 3080, 3061, 2226, 1686 cm^{-1}.

1-(4-Cyanophenyl)-5-methyl-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4e)



Prepared as described for GP-II, starting from **3e** (50 mg, 0.2092 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **4e** as off white solid (34.2 mg, 69%). Melting point: 112-114 °C.

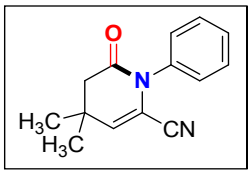
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.34 (d, *J* = 6.78 Hz, 3H), 2.43-2.50 (m, 1H), 2.64-2.83 (m, 2H), 6.35-6.38 (m, 1H), 7.39 (d, *J* = 8.16 Hz, 2H), 7.78 (d, *J* = 8.13 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 15.25, 28.67, 34.95, 112.57, 112.73, 117.31, 117.88, 124.65, 128.73, 133.18, 140.97, 170.80.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{12}N_3O^+$ is 238.0975 obsd. 238.0983.

IR (neat) 3098, 3065, 3044, 2235, 1703 cm^{-1}.

4,4-Dimethyl-6-oxo-1-phenyl-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4f)



Prepared as described for GP-II, starting from **3f** (50 mg, 0.2192 mmol) gave, after purification with silica gel column chromatography (20% EtOAc in n-Hexane) **4f** as white solid (30.7 mg, 62%). Melting point: 116-118 °C.

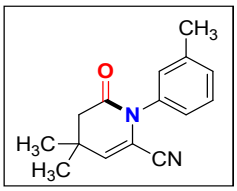
^{1}H NMR (600 MHz; $CDCl_3$) *δ (ppm)* 1.27 (s, 6H), 2.62 (s, 2H), 6.10 (s, 1H), 7.25-7.26 (m, 2H), 7.44-7.45 (m, 1H), 7.49 (t, *J* = 7.86 Hz, 2H).

^{13}C NMR (150 MHz; $CDCl_3$) *δ (ppm)* 26.77, 32.87, 45.28, 113.09, 116.49, 127.87, 129.01, 129.51, 133.57, 136.77, 167.71.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{15}N_2O^+$ is 227.1179 obsd. 227.1184.

IR (neat) 3055, 2963, 2228, 1701 cm^{-1}.

4,4-Dimethyl-6-oxo-1-(m-tolyl)-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4g)



Prepared as described for GP-II, starting from **3g** (50 mg, 0.2066 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4g** as brown solid (37 mg, 75%). Melting point: 93-95.3 °C.

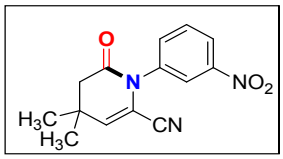
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.25 (s, 6H), 2.41 (s, 3H), 2.60 (s, 2H), 6.07 (s, 1H), 7.05 (m, 2H), 7.25-7.37 (m, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 21.25, 26.75, 32.82, 45.27, 113.10, 116.57, 124.81, 128.43, 129.25, 129.87, 133.31, 136.67, 139.53, 167.70.

ESI-MS $(M+H)^+$ calcd. for $C_{15}H_{17}N_2O^+$ is 241.1335 obsd. 241.1336.

IR (neat) 3067, 2965, 2226, 1699 cm^{-1}.

4,4-Dimethyl-1-(3-nitrophenyl)-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4h)



Prepared as described for GP-II, starting from **3h** (50 mg, 0.1831 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4h** as yellow semi-solid (33.2 mg, 67%).

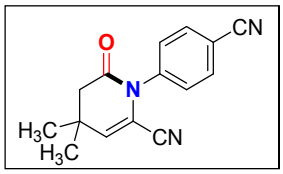
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.28 (s, 6H), 2.64 (s, 2H), 6.21 (s, 1H), 7.59-7.69 (m, 2H), 8.14-8.15 (m, 1H), 8.28-8.31 (m, 1H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 26.72, 32.98, 45.01, 112.69, 115.33, 123.29, 123.70, 130.24, 133.99, 135.13, 137.64, 148.66, 167.59.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{14}N_3O_3^+$ is 272.1030 obsd. 272.1030.

IR (neat) 3092, 2965, 2230, 1697 cm^{-1}.

1-(4-Cyanophenyl)-4,4-dimethyl-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4i)



Prepared as described for GP-II, starting from **3i** (50 mg, 0.1976 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4i** as light yellow solid (36.2 mg, 73%). Melting point: 119-122°C.

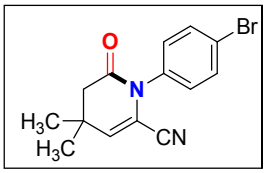
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.25 (s, 6H), 2.60 (s, 2H), 6.21 (s, 1H), 7.37-7.40 (m, 2H), 7.76-7.79 (m, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 26.64, 32.91, 45.07, 112.58, 112.71, 115.22, 117.81, 128.56, 133.19, 135.52, 140.44, 167.42.

ESI-MS $(M+H)^+$ calcd. for $C_{15}H_{14}N_3O^+$ is 252.1131 obsd. 252.1140.

IR (neat) 3099, 2980, 2230, 1701 cm^{-1}.

1-(4-Bromophenyl)-4,4-dimethyl-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4j)



Prepared as described for GP-II, starting from **3j** (50 mg, 0.1633 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4j** as white solid (33.8 mg, 68%). Melting point: 172.3-175.9 °C.

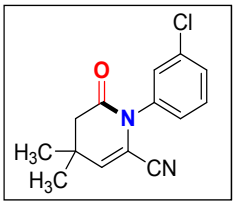
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.25 (s, 6H), 2.60 (s, 2H), 6.12 (s, 1H), 7.12 (d, *J* = 8.58 Hz, 2H), 7.62 (d, *J* = 8.58 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 26.77, 32.89, 45.19, 112.93, 116.02, 122.97, 129.48, 132.73, 134.09, 135.71, 167.58.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{14}BrN_2O^+$ is 305.0284 obsd. 305.0291.

IR (neat) 3067, 2957, 2228, 1697 cm^{-1}.

1-(3-Chlorophenyl)-4,4-dimethyl-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4k)



Prepared as described for GP-II, starting from **3k** (50 mg, 0.1908 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4k** as yellow solid (37.7 mg, 76%). Melting point: 107-109.2 °C.

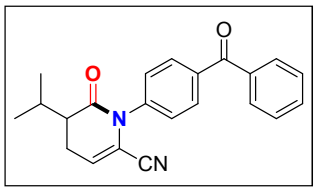
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.26 (s, 6H), 2.61 (s, 2H), 6.13 (s, 1H), 7.14-7.15 (m, 1H), 7.27 (s, 1H), 7.42-7.43 (m, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 26.75, 32.91, 45.17, 112.86, 116.00, 126.15, 128.36, 129.33, 130.40, 134.19, 135.01, 137.74, 167.59.

ESI-MS $(M+H)^+$ calcd. for $C_{14}H_{14}ClN_2O^+$ is 261.0789 obsd. 261.0793.

IR (neat) 3063, 2967, 2234, 1697 cm^{-1}.

1-(4-Benzoylphenyl)-5-isopropyl-6-oxo-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4l)



Prepared as described for GP-II, starting from **3l** (50 mg, 0.1445 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4l** as brown solid (38.3 mg, 77%). Melting point: 89-93 °C.

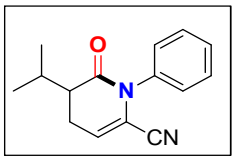
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.01 (d, *J* = 6.87 Hz, 3H), 1.10 (d, *J* = 6.87 Hz, 3H), 2.34-2.40 (m, 1H), 2.53-2.70 (m, 3H), 6.32-6.36 (m, 1H), 7.38 (d, *J* = 8.46 Hz, 2H), 7.48-7.53 (m, 2H), 7.59-7.65 (m, 1H), 7.82-7.84 (m, 2H), 7.93 (d, *J* = 8.49 Hz, 2H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 18.87, 20.53, 22.66, 27.05, 46.14, 112.94, 117.47, 124.10, 127.82, 128.36, 129.98, 131.04, 132.59, 137.27, 137.49, 140.66, 169.86, 195.42.

ESI-MS $(M+H)^+$ calcd. for $C_{22}H_{21}N_2O_2^+$ is 345.1598 obsd. 345.1611.

IR (neat) 3075, 2959, 2228, 1692, 1651 cm^{-1}.

5-Isopropyl-6-oxo-1-phenyl-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4m)



Prepared as described for GP-II, starting from **3m** (50 mg, 0.2066 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4m** as brown solid (35.7 mg, 72%). Melting point: 57-60 °C.

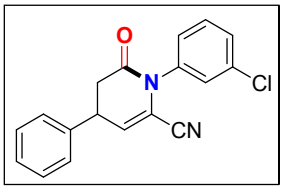
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 1.01 (d, *J* = 6.69 Hz, 3H), 1.08 (d, *J* = 6.87 Hz, 3H), 2.32-2.36 (m, 1H), 2.49-2.64 (m, 3H), 6.24 (t, *J* = 4.89 Hz, 1H), 7.24 (d, *J* = 7.71 Hz, 2H), 7.41-7.51 (m, 3H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 18.88, 20.52, 22.66, 27.03, 46.04, 113.09, 118.00, 122.82, 127.98, 128.80, 129.39, 137.26, 169.92.

ESI-MS $(M+H)^+$ calcd. for $C_{15}H_{17}N_2O^+$ is 241.1335 obsd. 241.1340.

IR (neat) 3053, 2966, 2878, 2230, 1676 cm^{-1}.

1-(3-Chlorophenyl)-6-oxo-4-phenyl-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4n)



Prepared as described for GP-II, starting from **3n** (50 mg, 0.1612 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4n** as brown solid (31.8 mg, 64%). Melting point: 106.4-108.4 °C.

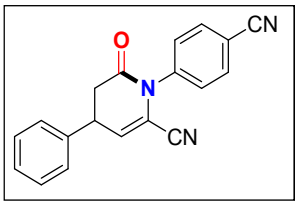
^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.91-3.12 (m, 2H), 4.05-4.12 (m, 1H), 6.39 (d, *J* = 4.32 Hz, 1H), 7.18-7.46 (m, 9H).

^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 38.63, 38.71, 112.71, 118.12, 112.26, 126.81, 127.06, 128.03, 128.54, 129..41, 129.51, 130.46, 135.11, 137.72, 139.46, 166.94.

ESI-MS $(M+H)^+$ calcd. for $C_{18}H_{14}ClN_2O^+$ is 309.0789 obsd. 309.0794.

IR (neat) 3067, 3032, 2230, 1701 cm^{-1}.

1-(4-Cyanophenyl)-6-oxo-4-phenyl-1,4,5,6-tetrahydropyridine-2-carbonitrile (Table 3, 4o)



Prepared as described for GP-II, starting from **3o** (50 mg, 0.1661 mmol) gave, after purification with silica gel column chromatography (30% EtOAc in n-Hexane) **4o** as light yellow solid (35.3 mg, 71%). Melting point: 146-149 °C.

^{1}H NMR (300 MHz; $CDCl_3$) *δ (ppm)* 2.94-3.13 (m, 2H), 4.07-4.12 (m, 1H), 6.48 (d, *J* = 4.44 Hz, 1H), 7.27 (d, *J* = 7.35 Hz, 2H), 7.34-7.45 (m, 5H), 7.80 (d, *J* = 8.43 Hz, 2H).

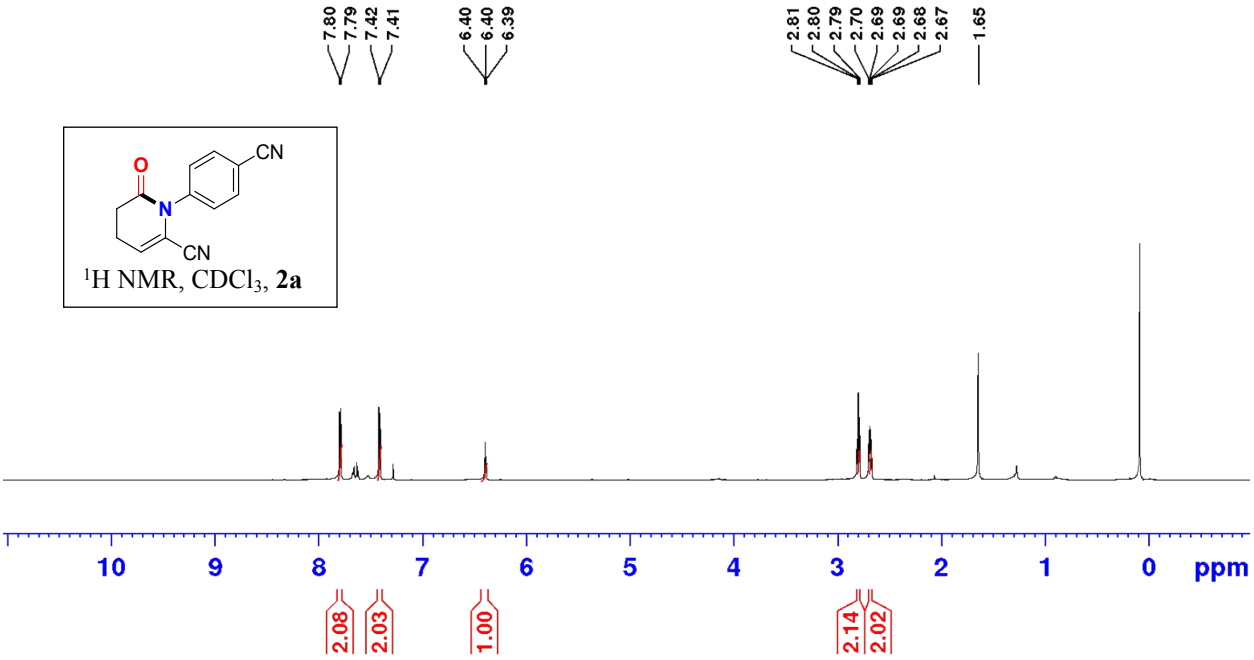
^{13}C NMR (75 MHz; $CDCl_3$) *δ (ppm)* 38.51, 38.64, 112.58, 112.89, 117.38, 117.77, 126.74, 128.13, 128.43, 128.76, 129.45, 133.30, 139.09, 140.42, 166.83.

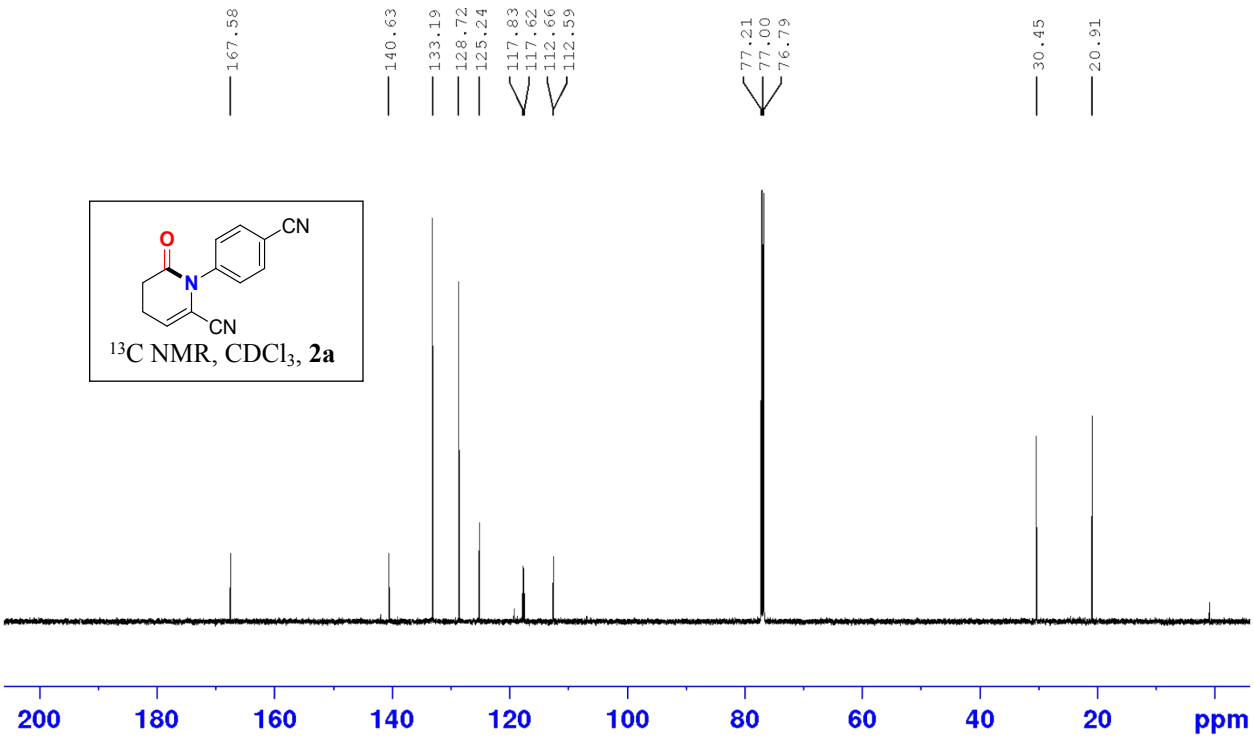
ESI-MS $(M+H)^+$ calcd. for $C_{19}H_{14}N_3O^+$ is 300.1131 obsd. 300.1138.

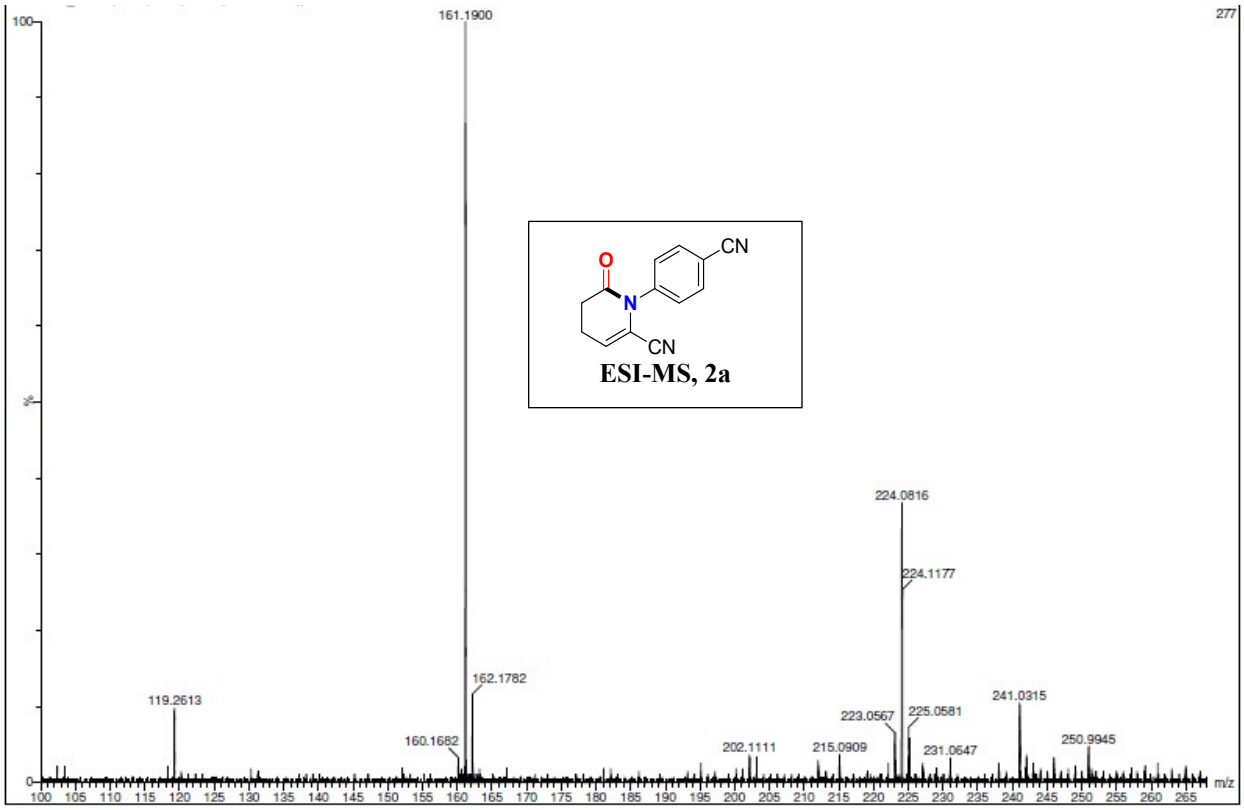
IR (neat) 3059, 3026, 2226, 1703 cm^{-1}.

#Note: In most of the ^{1}H NMR mentioned below, we have noticed minor peaks at aromatic region may be due to the corresponding rotational isomers of the compound (present in different plans).

D. Spectral data (^{1}H, ^{13}C, HRMS-ESI) for synthesized compounds (2a-m, 4a-o).



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202.1111
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231.0647
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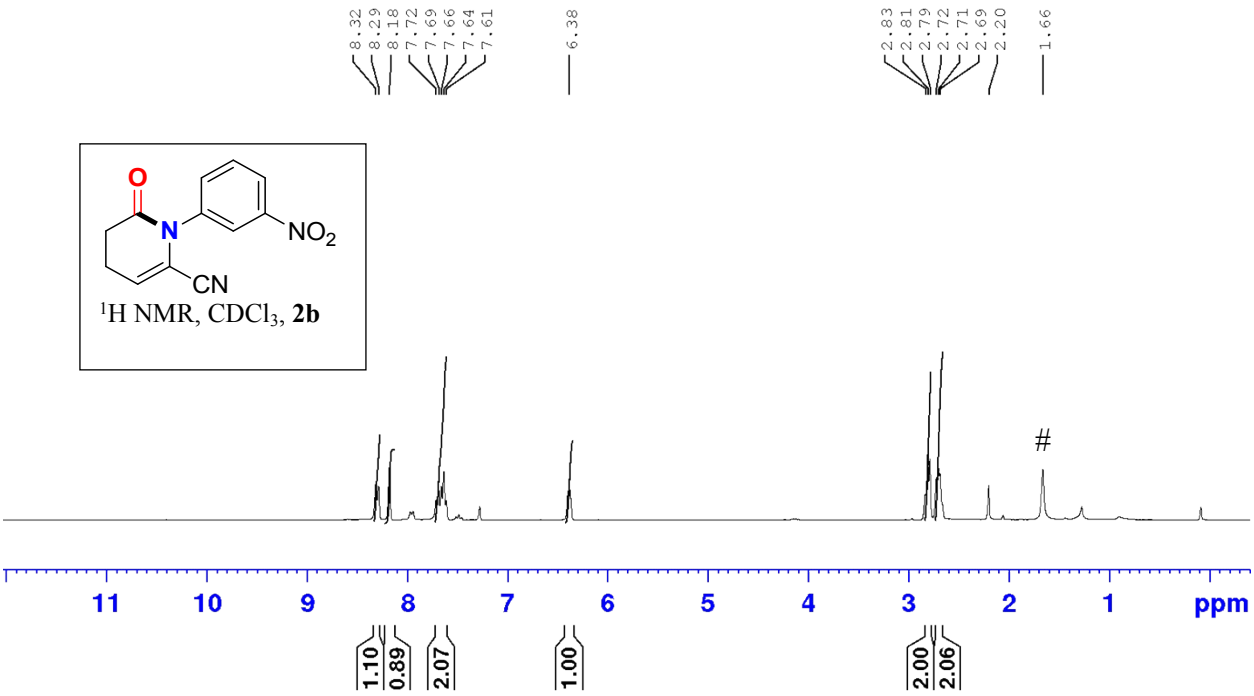
m/z
ESI-MS, 2a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7.72
7.69
7.66
7.64
7.61
6.38
2.83
2.81
2.79
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2.71
2.69
2.20
1.66
#
11
10
9
8
7
6
5
4
3
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1
ppm
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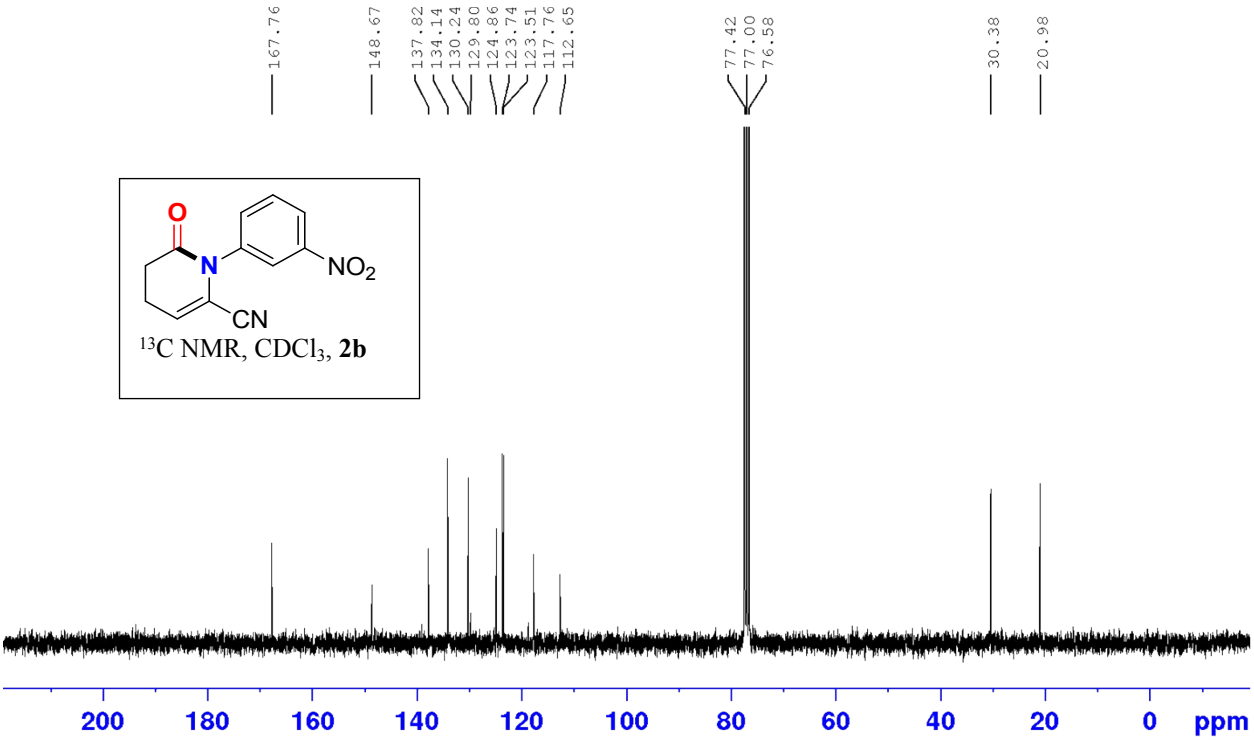
2.07
1.00
2.00
2.06
^{1}H NMR, $CDCl_3$, **2b**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117.76
112.65
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20.98
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N
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13C NMR, CDCl3, 2b
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140
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40
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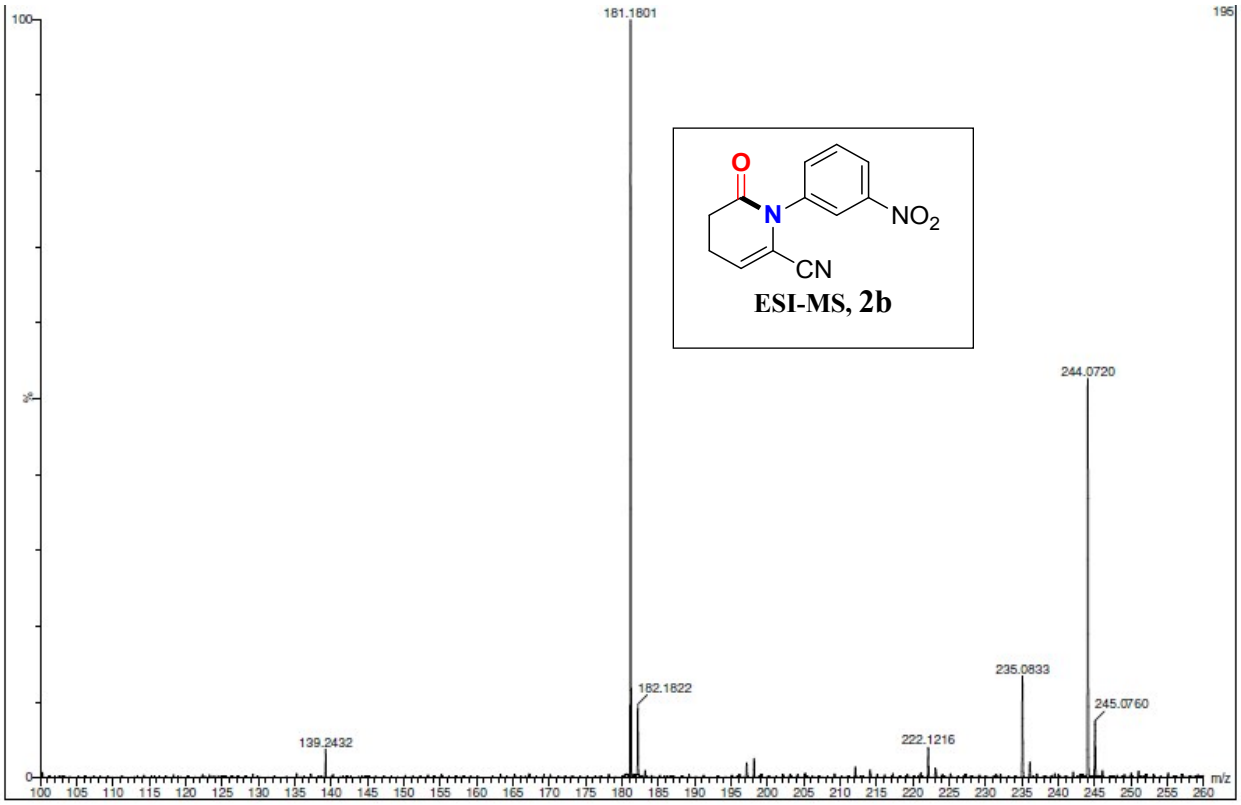
ppm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%
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245.0760
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0
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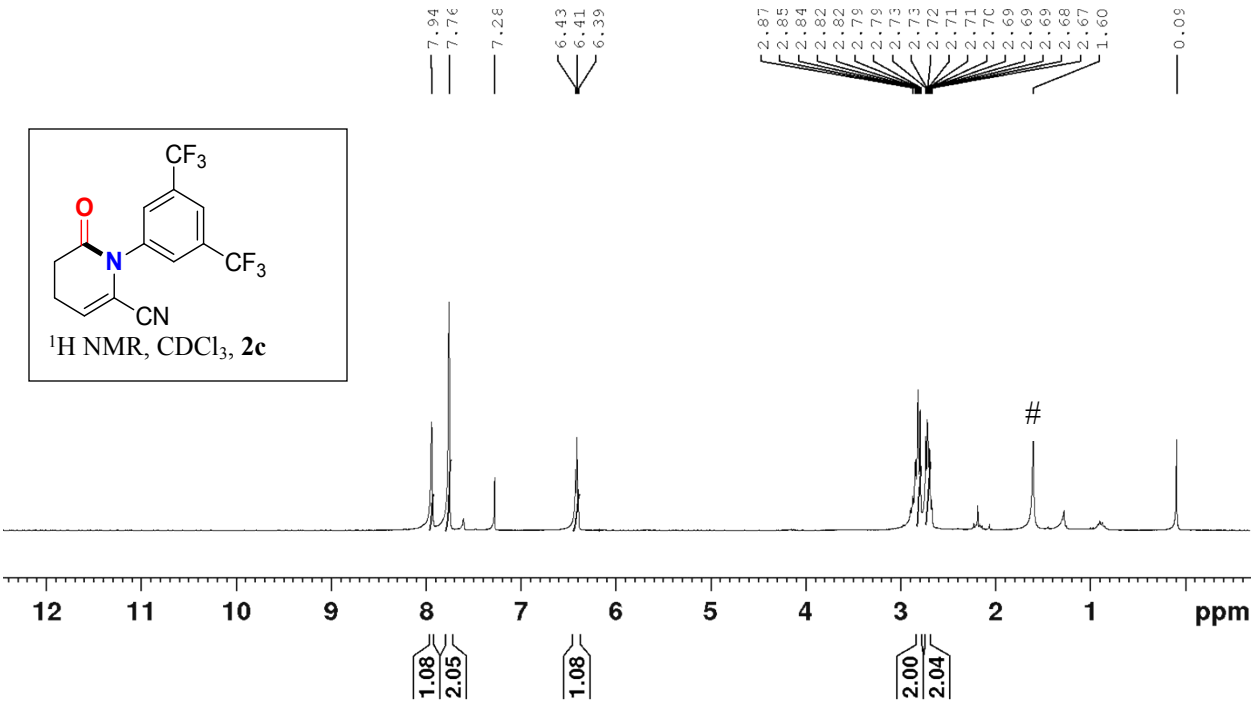
m/z
O
N
NO2
CN
ESI-MS, 2b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7.28
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6.41
6.39
2.87
2.85
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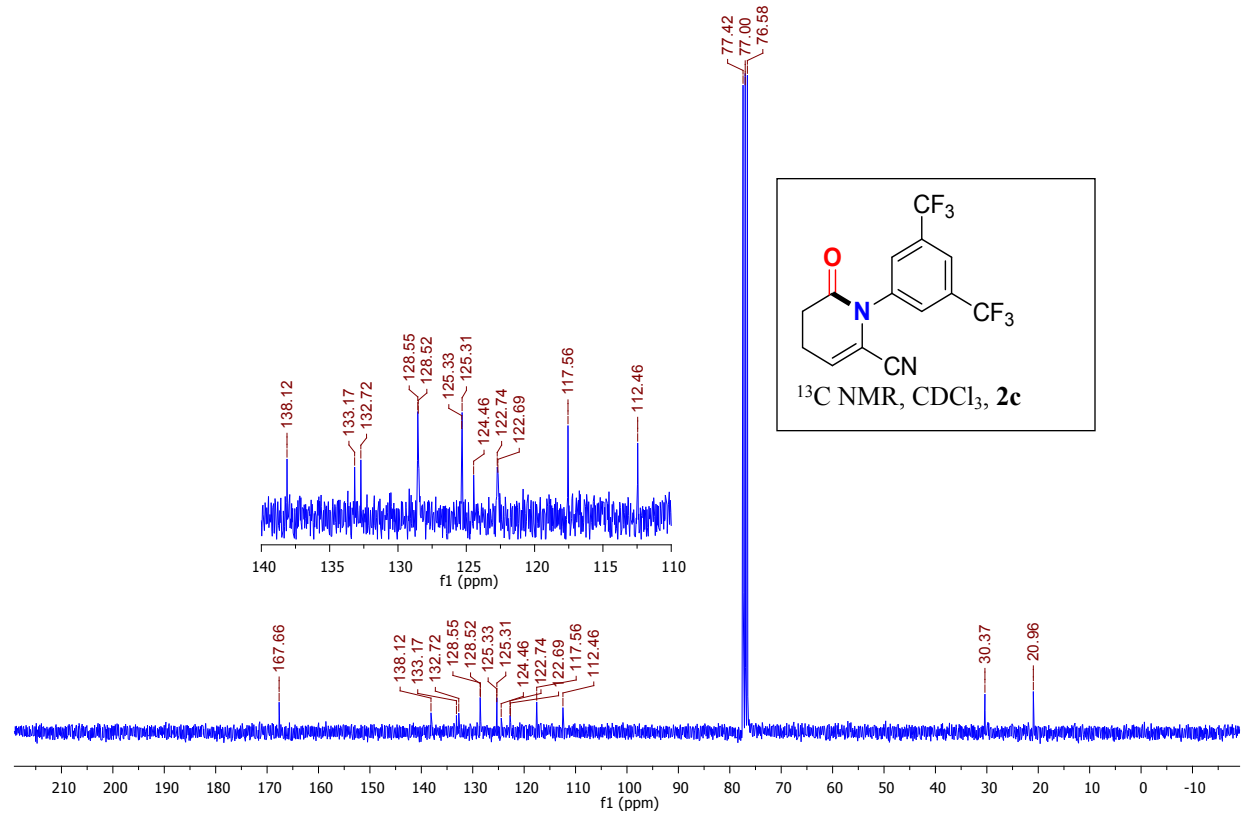
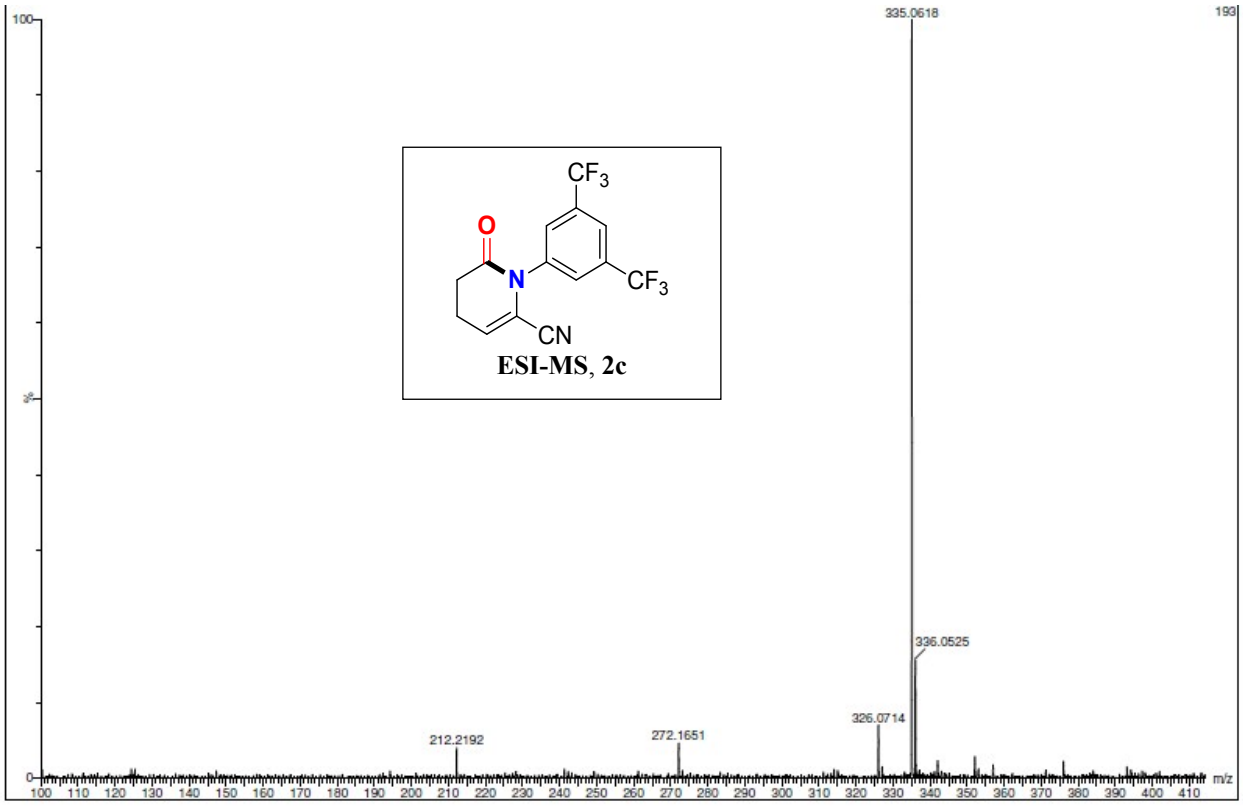
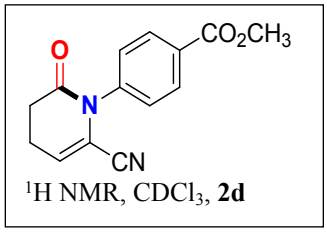
N
CF3
CN
1H NMR, CDCl3, 2c
#
12
11
10
9
8
7
6
5
4
3
2
1
ppm
1.08
2.05
1.08
2.00
2.04

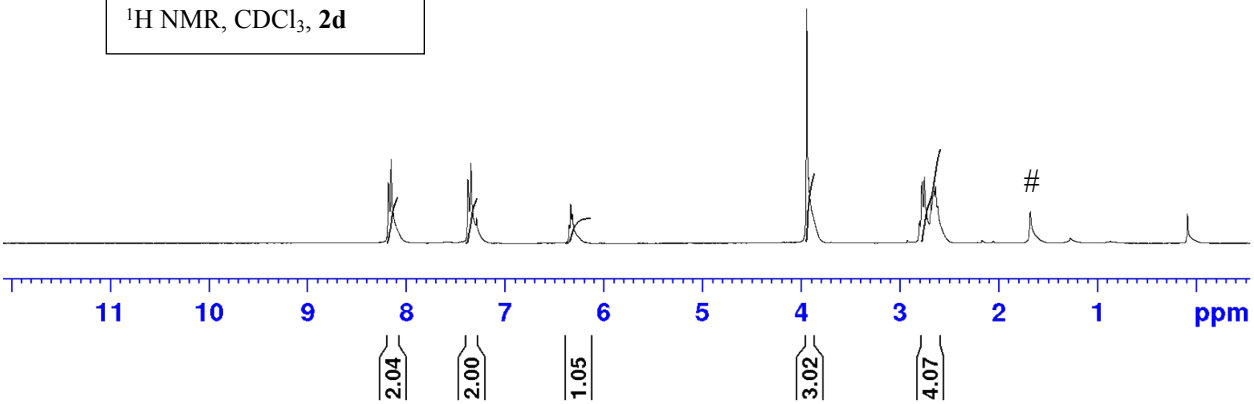

77.42
77.00
76.58
CF3
O
N
CF3
CN
13C NMR, CDCl3, 2c
138.12
133.17
132.72
128.55
128.52
125.33
125.31
124.46
122.74
122.69
117.56
112.46
140
135
130
125
120
115
110
f1 (ppm)
167.66
138.12
133.17
132.72
128.55
128.52
125.33
125.31
124.46
122.74
122.69
117.56
112.46
30.37
20.96
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

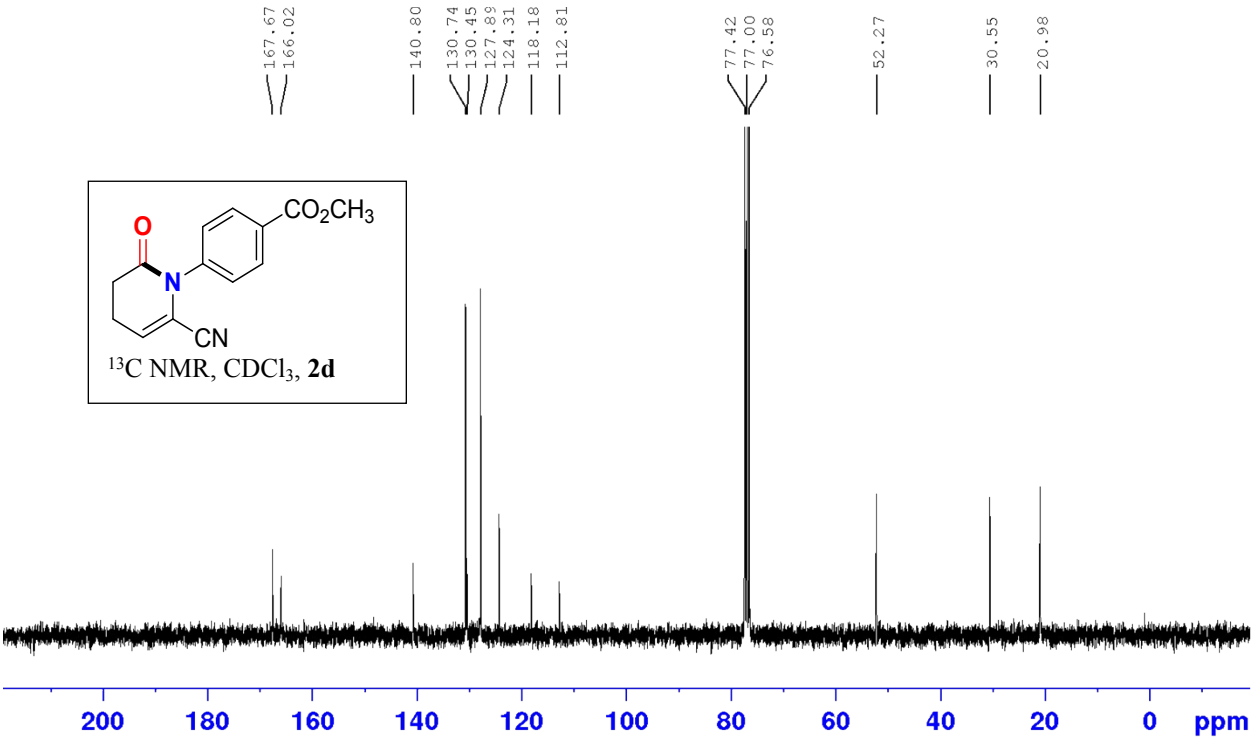


ESI-MS, **2c**

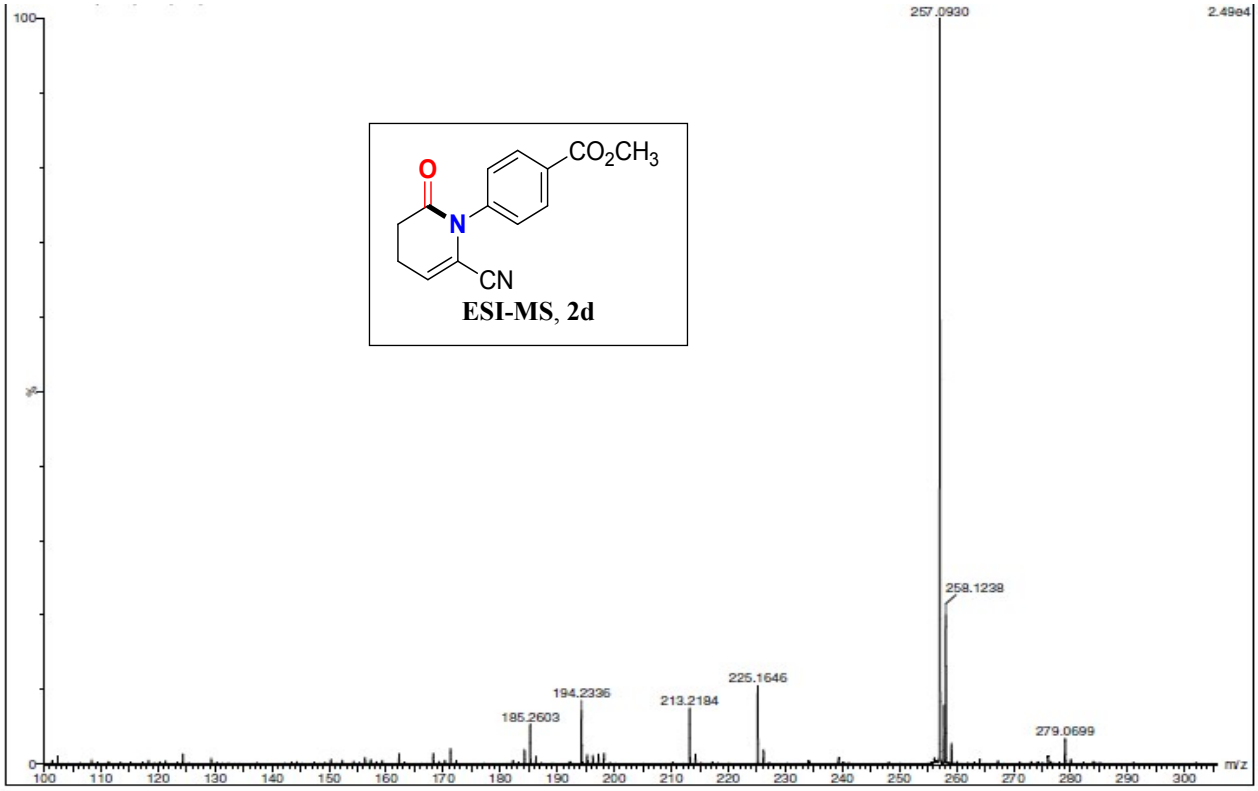


^{1}H NMR, $CDCl_3$, **2d**

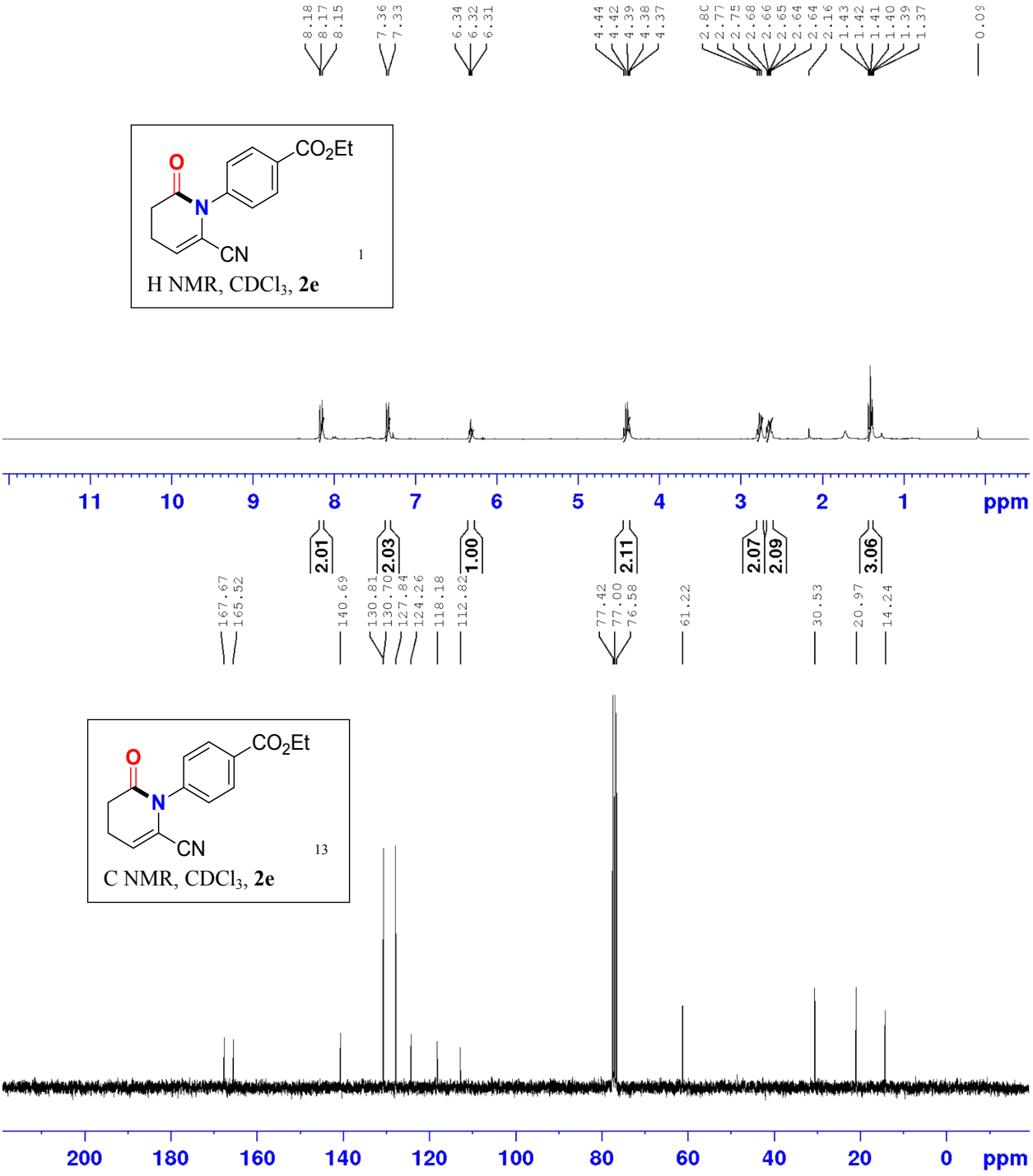


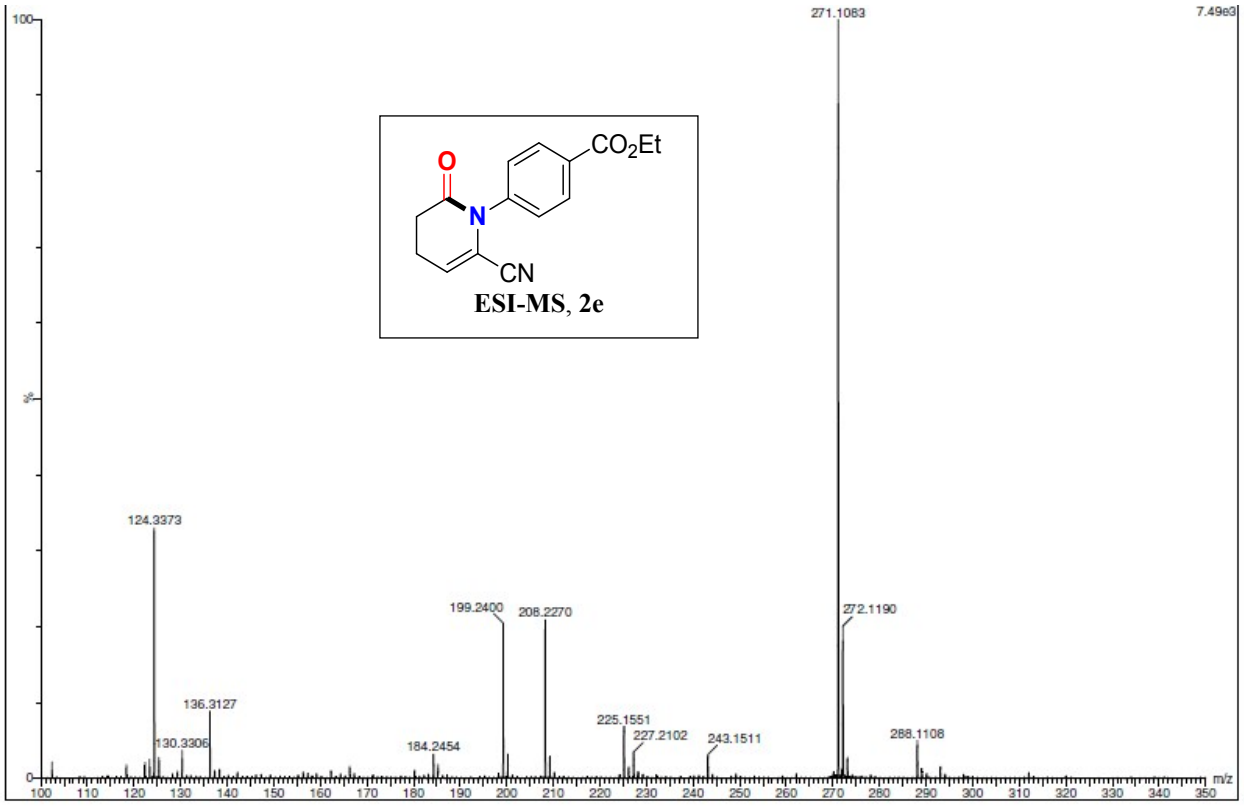


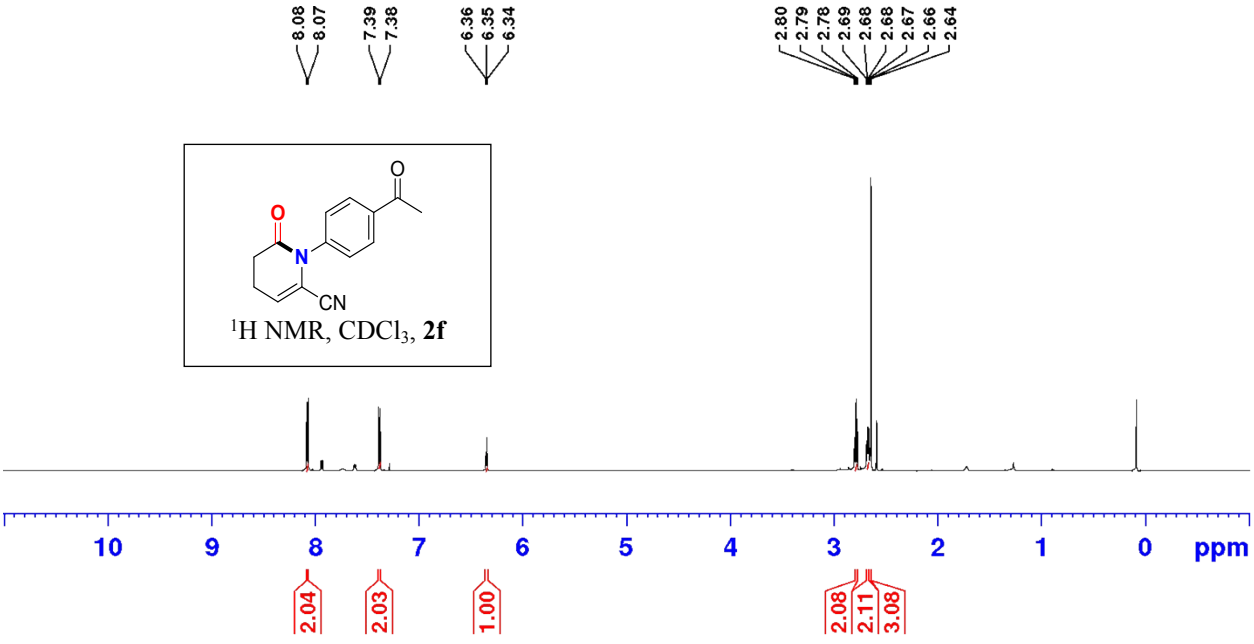
^{13}C NMR, $CDCl_3$, **2d**

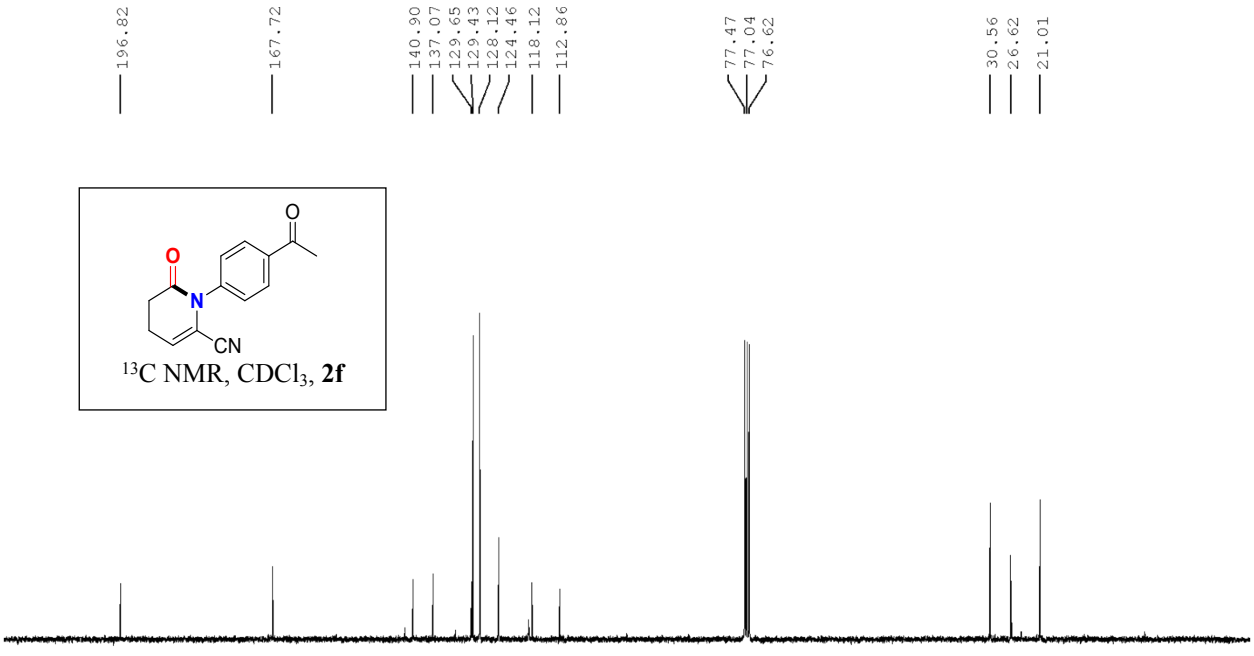


ESI-MS, **2d**

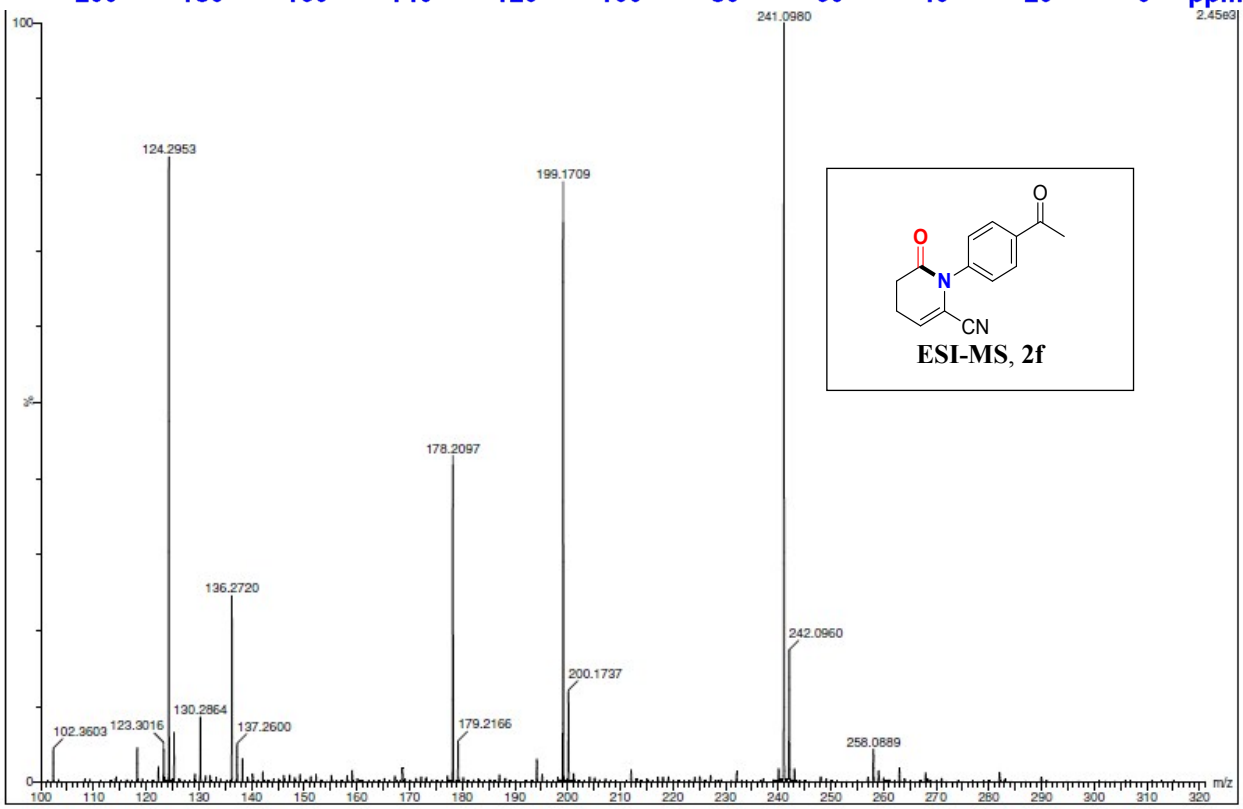

8.18
8.17
8.15
7.36
7.33
6.34
6.32
6.31
4.44
4.42
4.39
4.38
4.37
2.80
2.77
2.75
2.68
2.66
2.65
2.64
2.64
2.16
1.43
1.42
1.41
1.40
1.39
1.37
0.09
CO2Et
O
N
CN
1
H NMR, CDCl3, 2e
11
10
9
8
7
6
5
4
3
2
1
ppm
2.01
2.03
1.00
2.11
2.07
2.09
3.06
167.67
165.52
140.69
130.81
130.70
127.84
124.26
118.18
112.82
77.42
77.00
76.58
61.22
30.53
20.97
14.24
CO2Et
O
N
CN
13
C NMR, CDCl3, 2e
200
180
160
140
120
100
80
60
40
20
0
ppm


271.1083
7.49e3
100
%
0
CO2Et
O
N
CN
ESI-MS, 2e
124.3373
199.2400
208.2270
272.1190
136.3127
130.3306
184.2454
225.1551
227.2102
243.1511
288.1108
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350
m/z

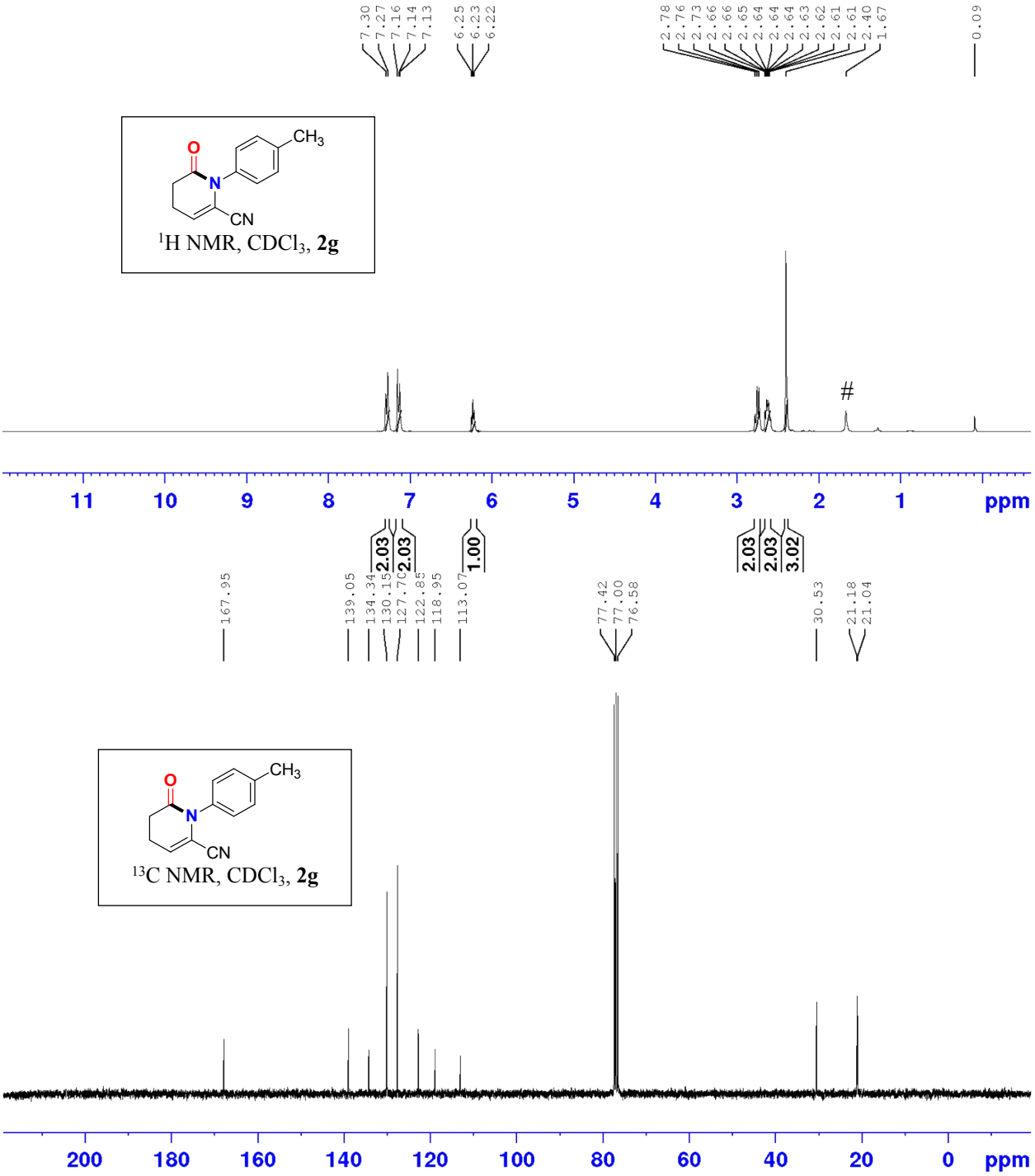

8.08
8.07
7.39
7.38
6.36
6.35
6.34
2.80
2.79
2.78
2.69
2.68
2.68
2.67
2.66
2.64
O
O
N
CN
1H NMR, CDCl3, 2f
10 9 8 7 6 5 4 3 2 1 0 ppm
2.04
2.03
1.00
2.08
2.11
3.08

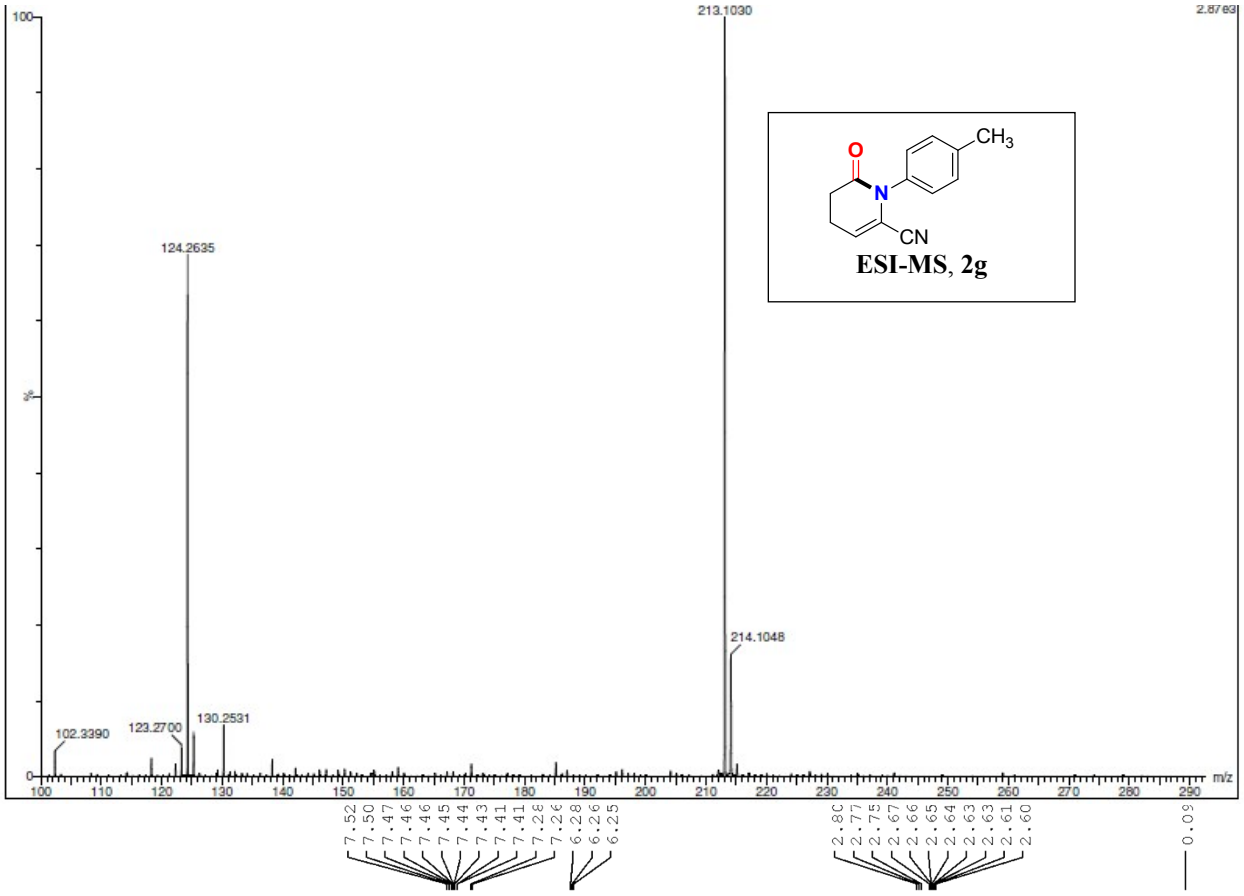


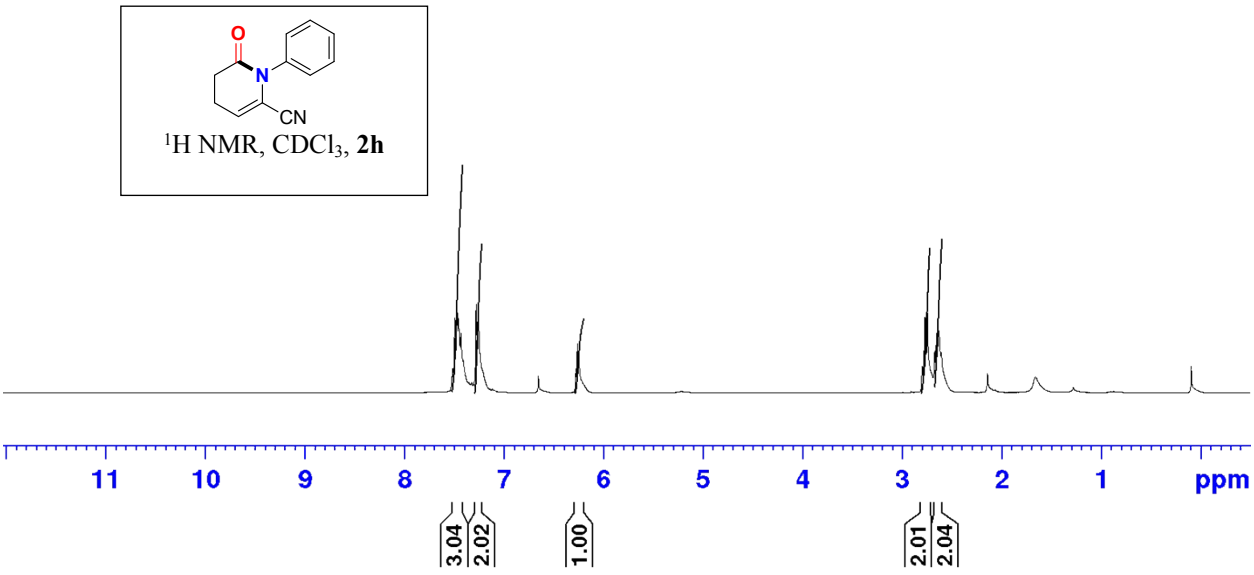
^{13}C NMR, $CDCl_3$, **2f**

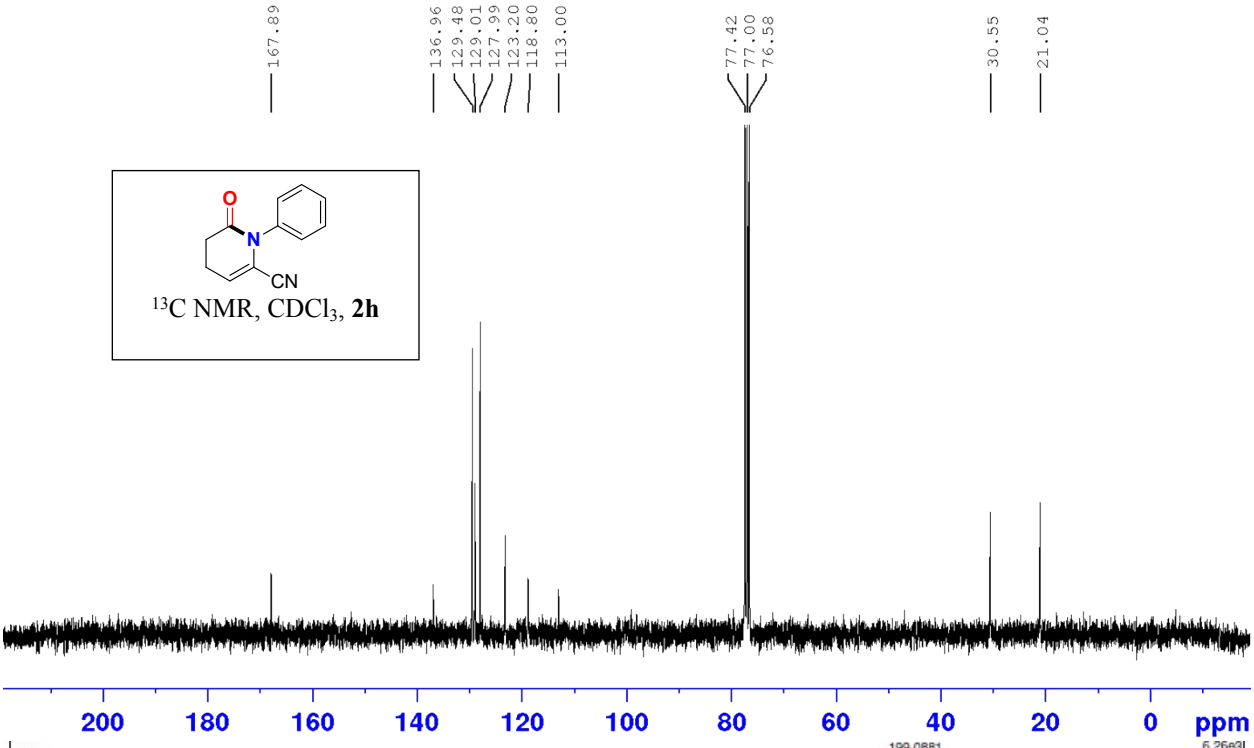


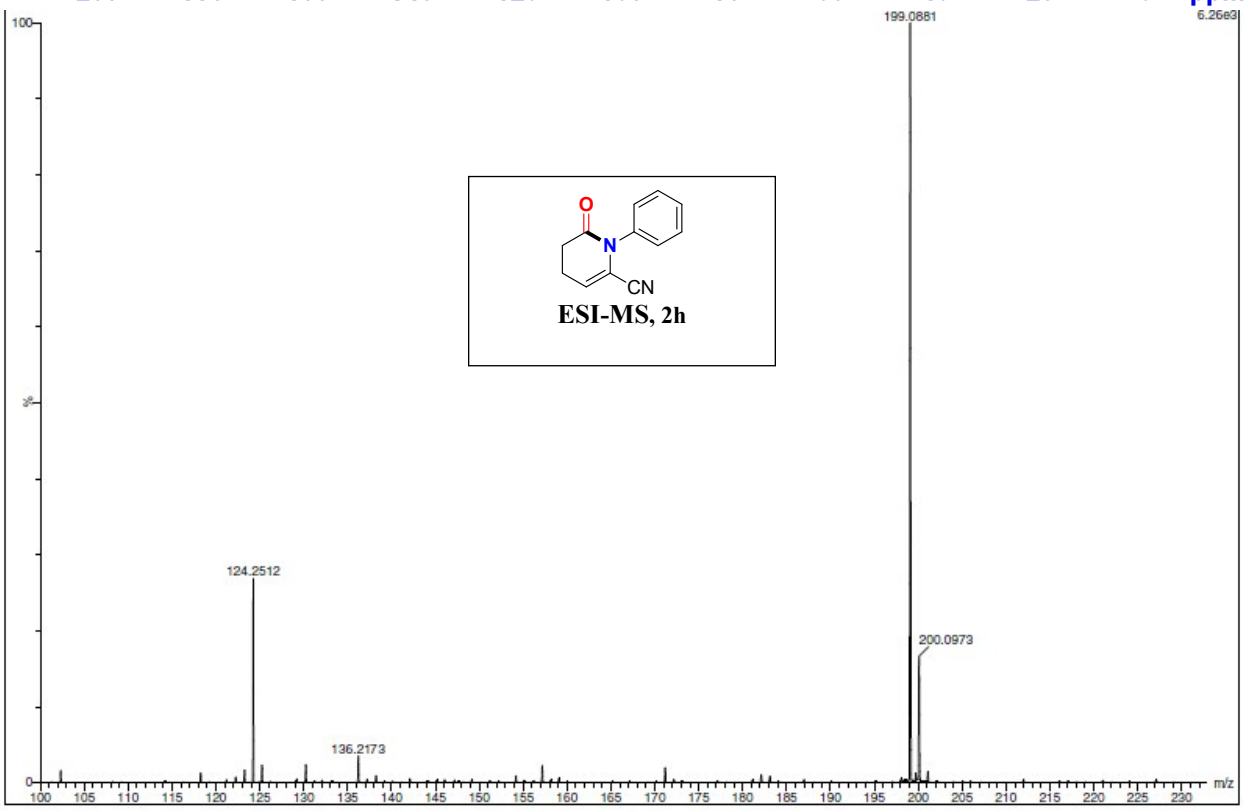
ESI-MS, **2f**

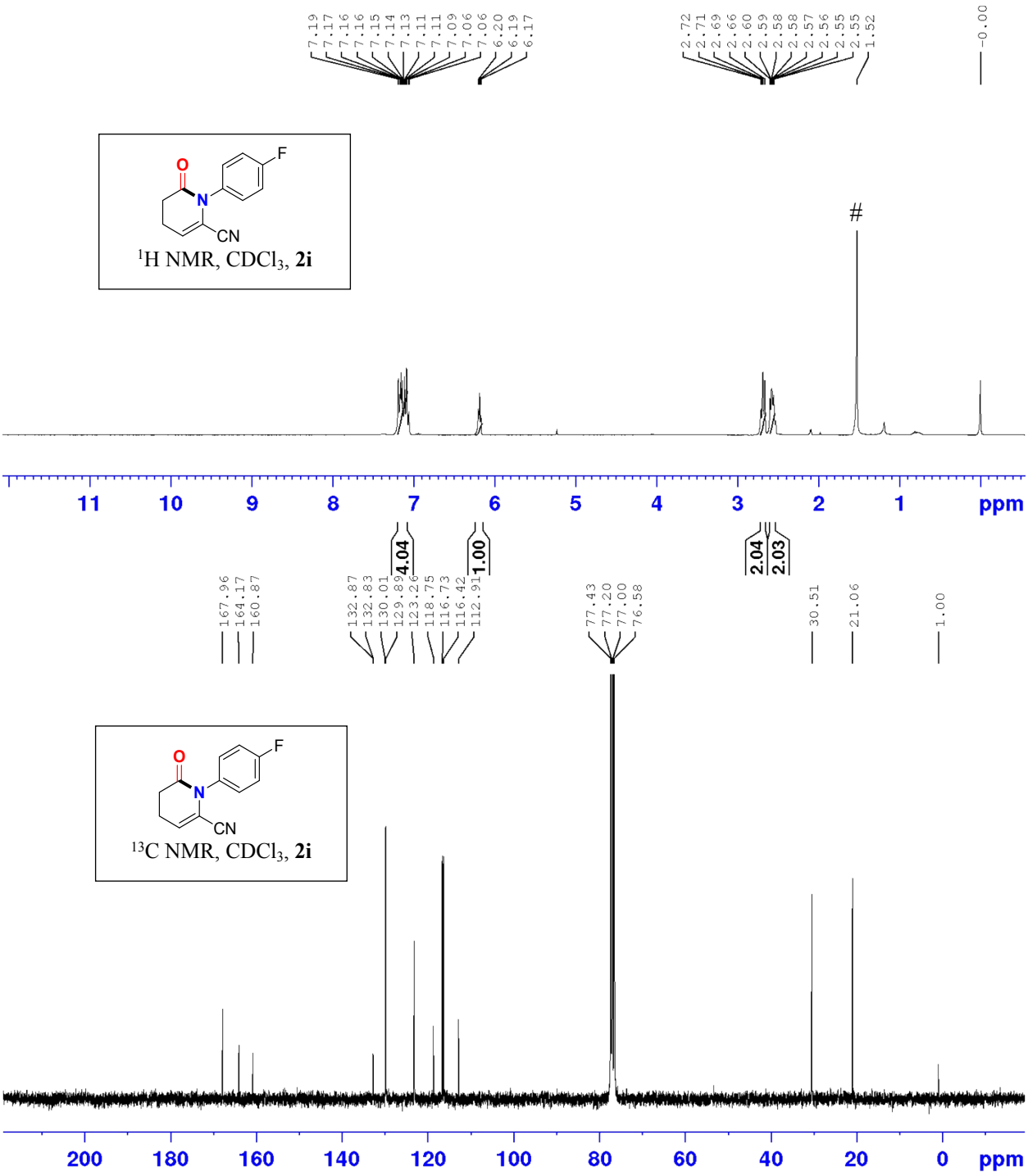

7.30
7.27
7.16
7.14
7.13
6.25
6.23
6.22
2.78
2.76
2.73
2.66
2.66
2.65
2.64
2.64
2.64
2.63
2.62
2.61
2.61
2.40
1.67
0.09
CH3
O
N
CN
1H NMR, CDCl3, 2g
#
11
10
9
8
7
6
5
4
3
2
1
ppm
167.95
139.05
134.34
130.15
127.76
122.85
118.95
113.07
77.42
77.00
76.58
30.53
21.18
21.04
2.03
2.03
2.03
1.00
2.03
2.03
3.02
CH3
O
N
CN
13C NMR, CDCl3, 2g
200
180
160
140
120
100
80
60
40
20
0
ppm


213.1030
124.2635
214.1048
102.3390
123.2700
130.2531
m/z
ESI-MS, 2g


^{1}H NMR, $CDCl_3$, **2h**
11
10
9
8
7
6
5
4
3
2
1
ppm
3.04
2.02
1.00
2.01
2.04

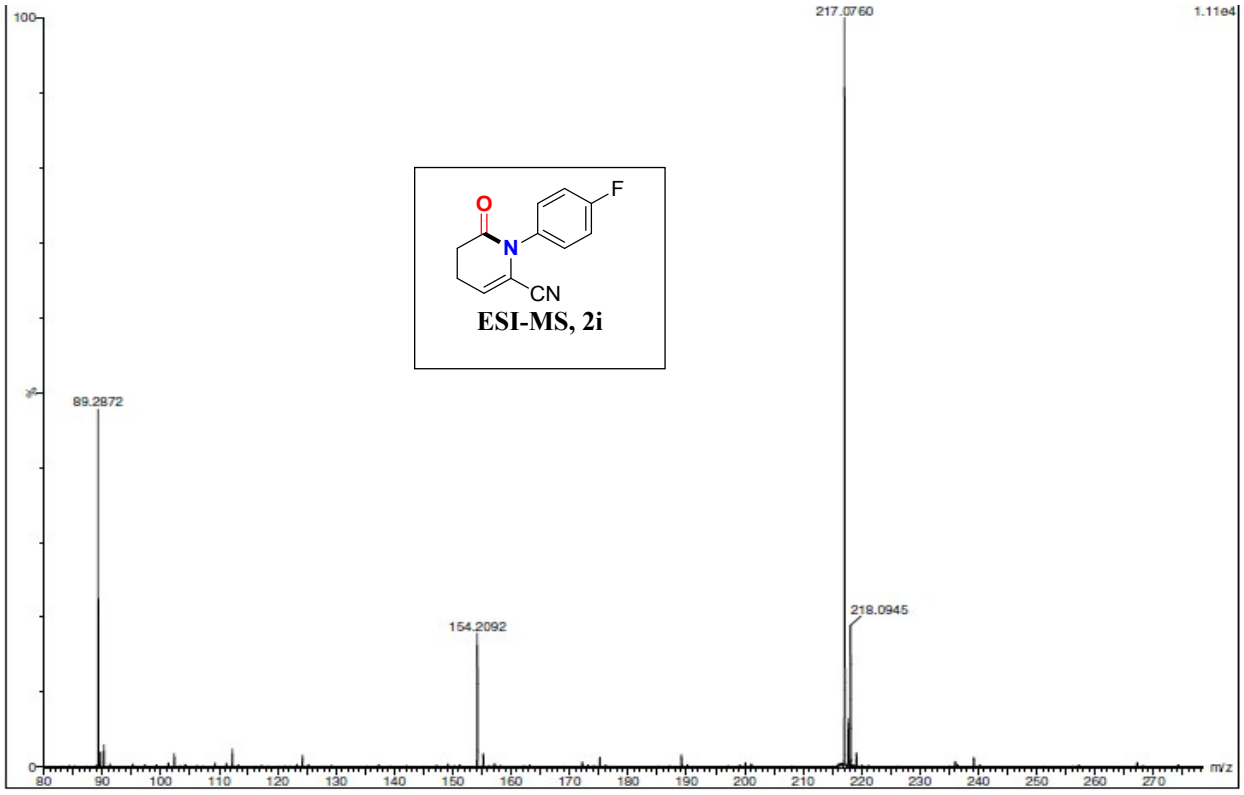

167.89
136.96
129.48
129.01
127.99
123.20
118.80
113.00
77.42
77.00
76.58
30.55
21.04
O
N
CN
^{13}C NMR, $CDCl_3$, **2h**
200
180
160
140
120
100
80
60
40
20
0
ppm


100
%
0
199.0881
6.26e3
124.2512
200.0973
136.2173
O
N
CN
ESI-MS, 2h
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
m/z

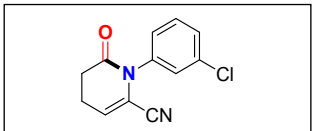


^{1}H NMR, $CDCl_3$, **2i**

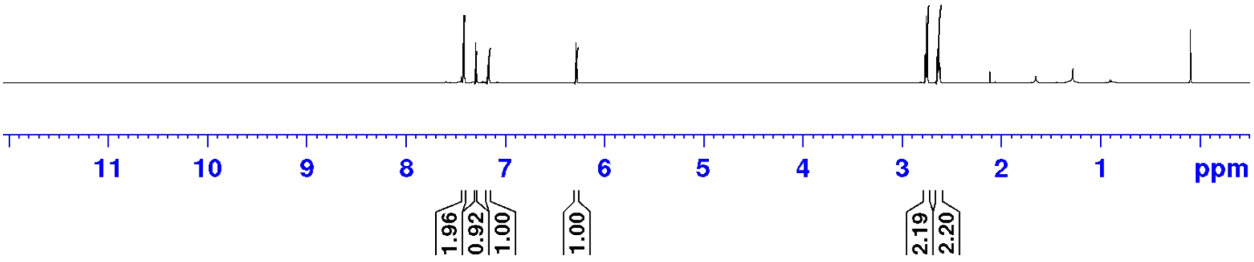
^{13}C NMR, $CDCl_3$, **2i**

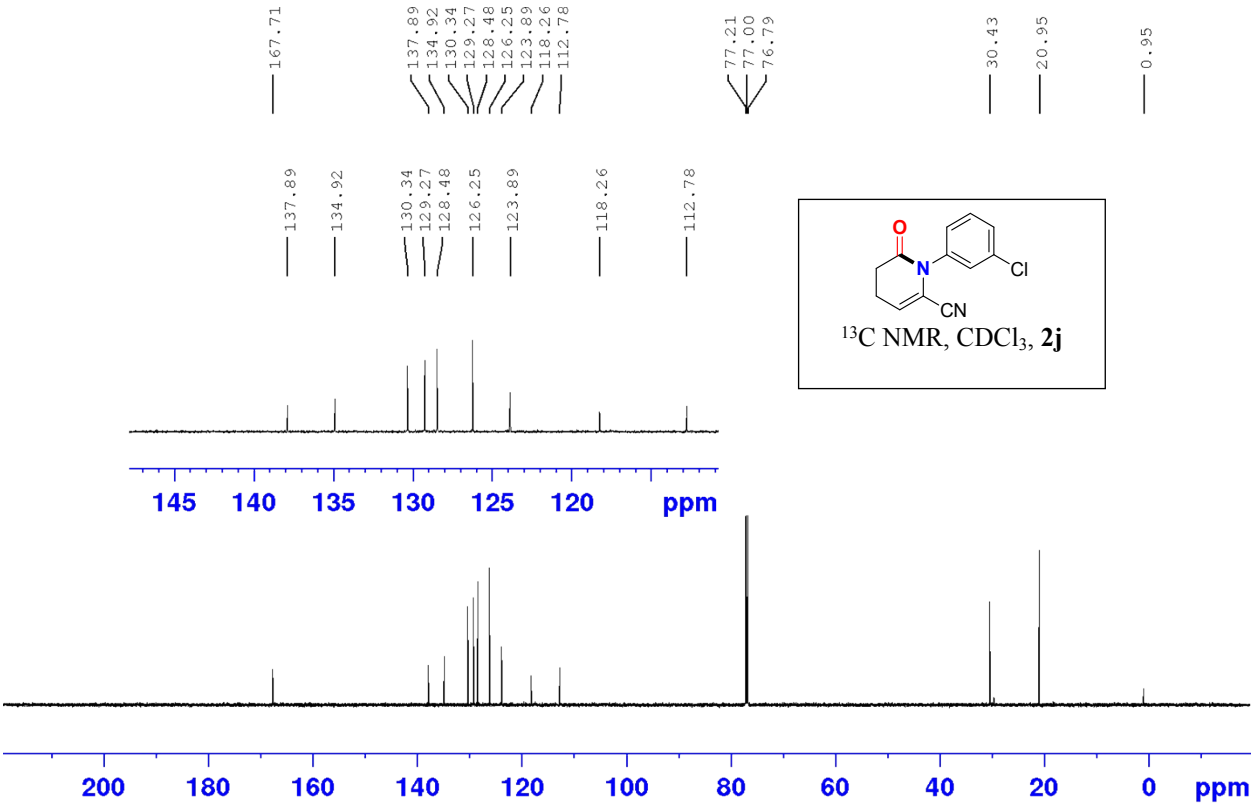


ESI-MS, 2i

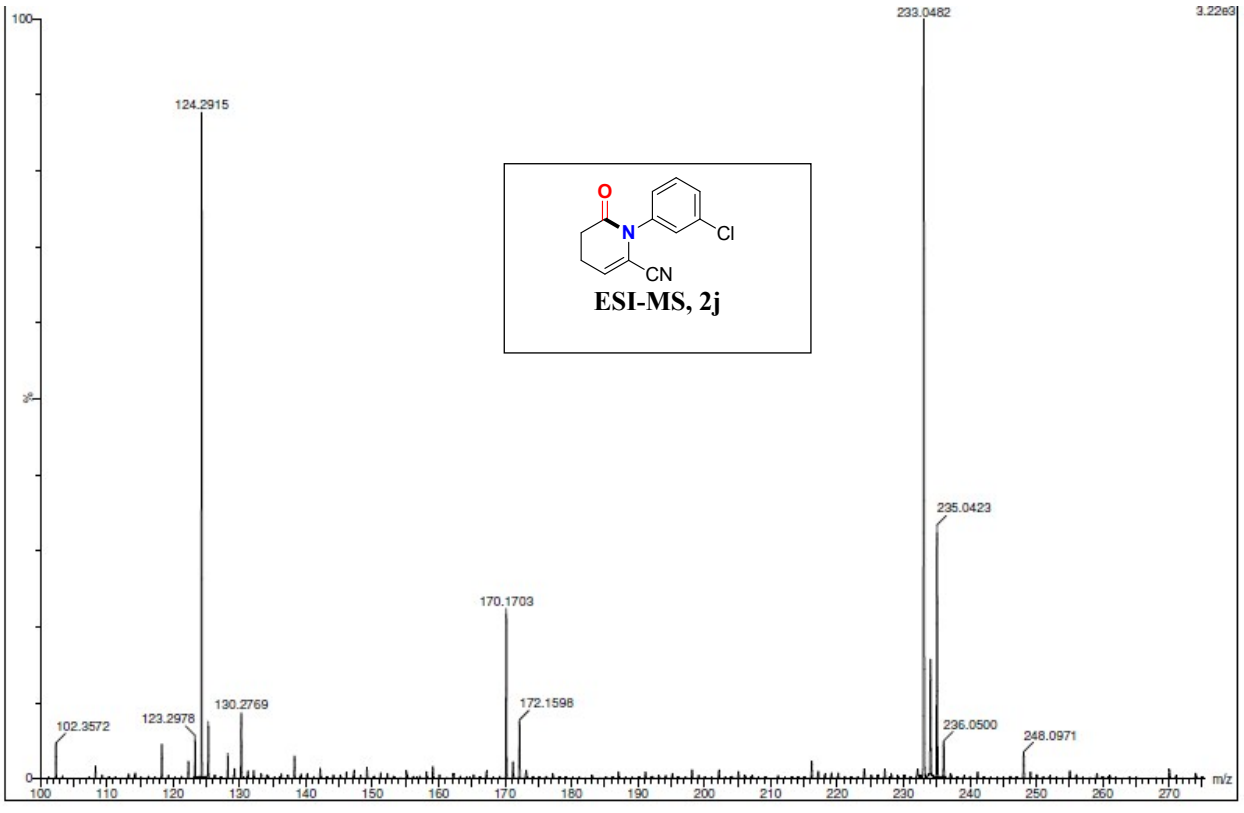


^{1}H NMR, $CDCl_3$, **2j**

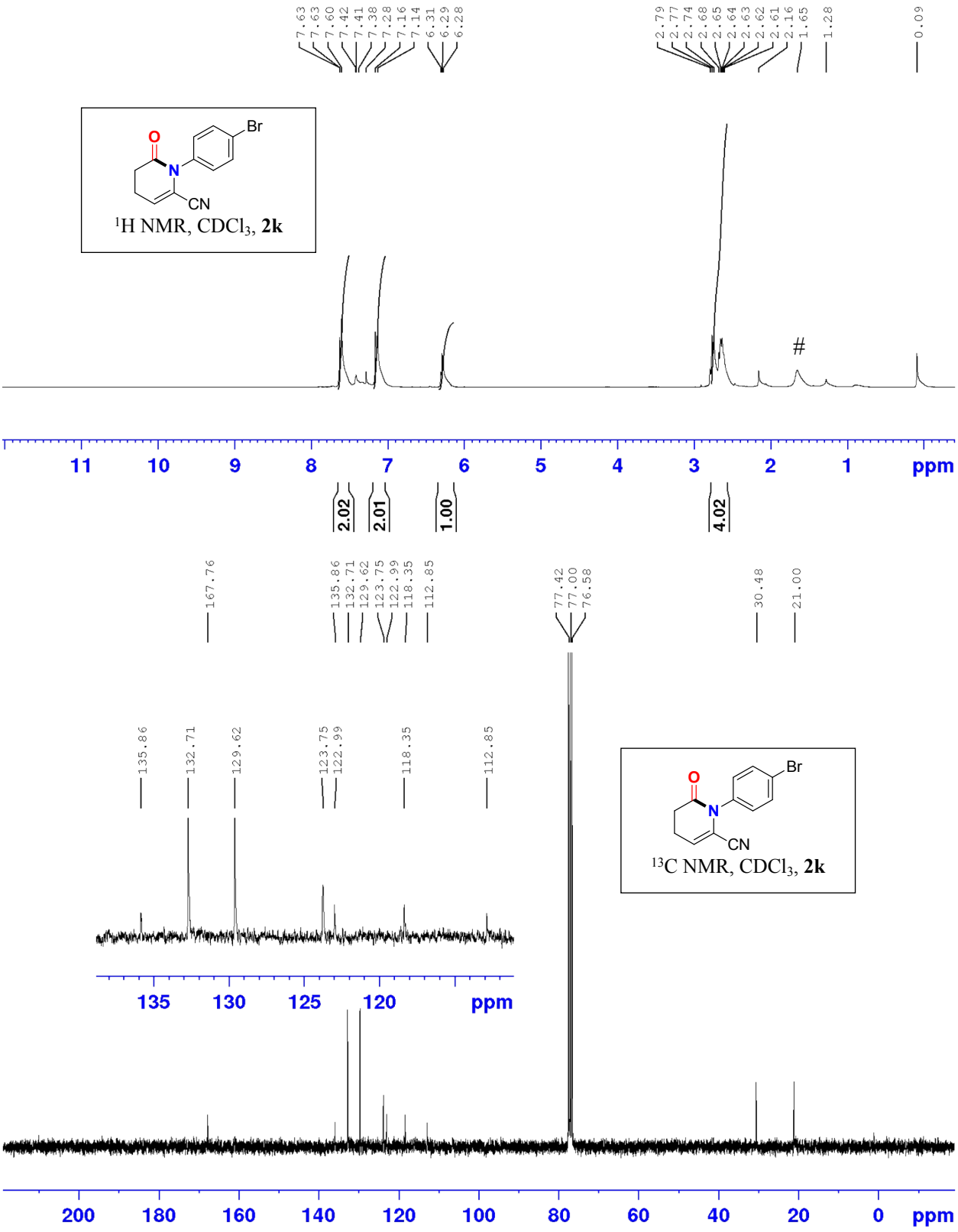


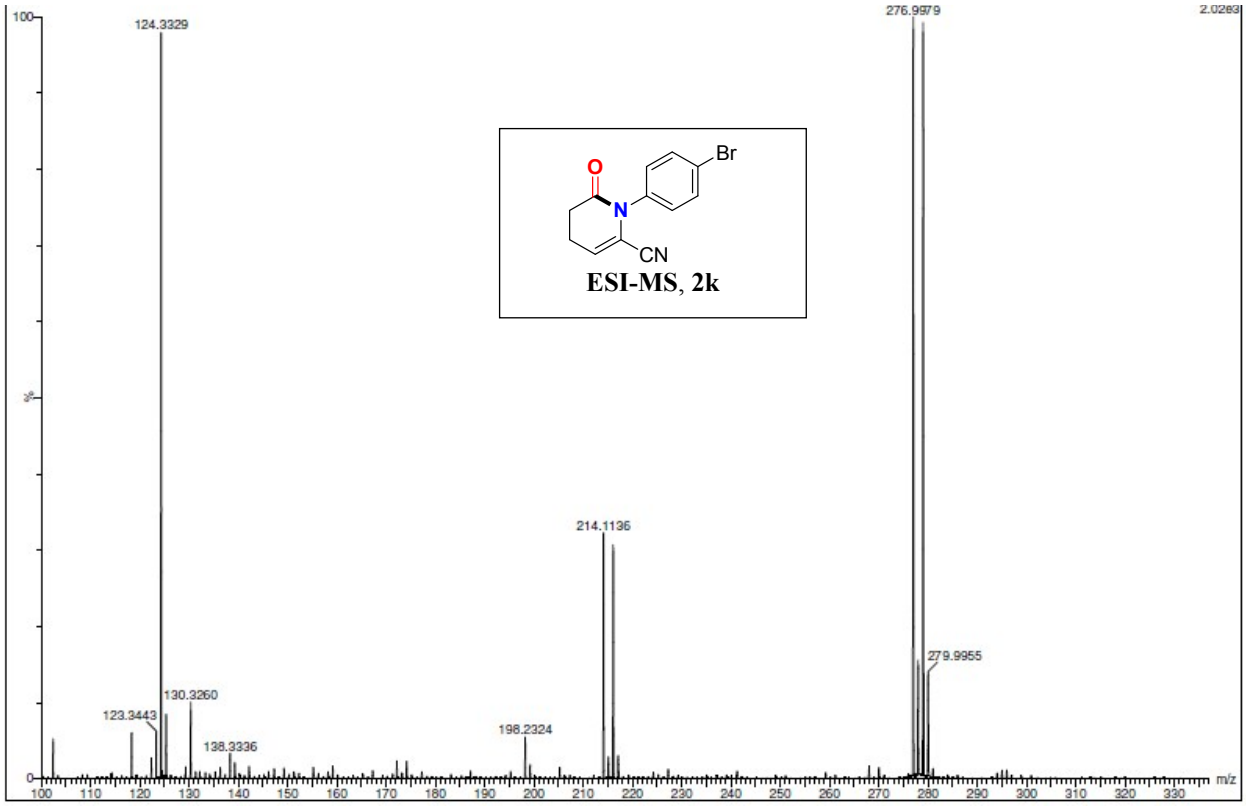


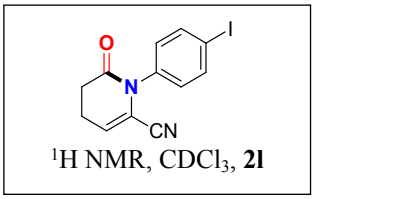
^{13}C NMR, $CDCl_3$, **2j**



ESI-MS, 2j

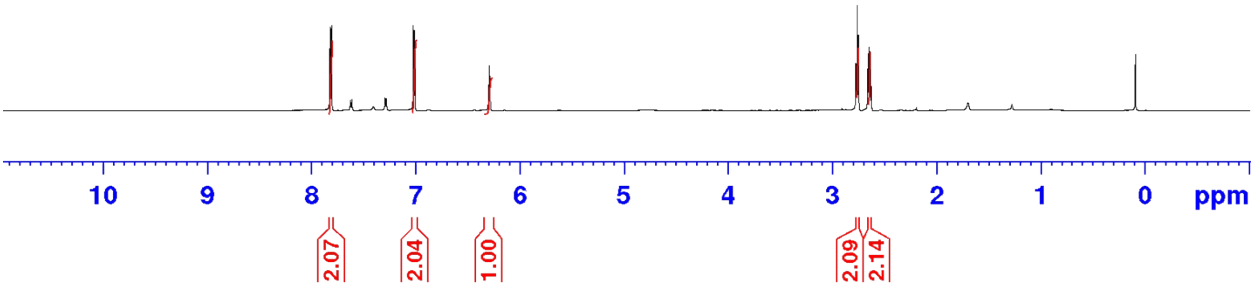

7.63
7.63
7.60
7.42
7.41
7.38
7.28
7.16
7.14
6.31
6.29
6.28
2.79
2.77
2.74
2.68
2.65
2.64
2.63
2.62
2.61
2.16
1.65
1.28
0.09
Br
O
N
CN
^{1}H NMR, $CDCl_3$, **2k**
#
11
10
9
8
7
6
5
4
3
2
1
ppm
2.02
2.01
1.00
4.02
167.76
135.86
132.71
129.62
123.75
122.99
118.35
112.85
77.42
77.00
76.58
30.48
21.00
^{13}C NMR, $CDCl_3$, **2k**
135
130
125
120
ppm
200
180
160
140
120
100
80
60
40
20
0
ppm

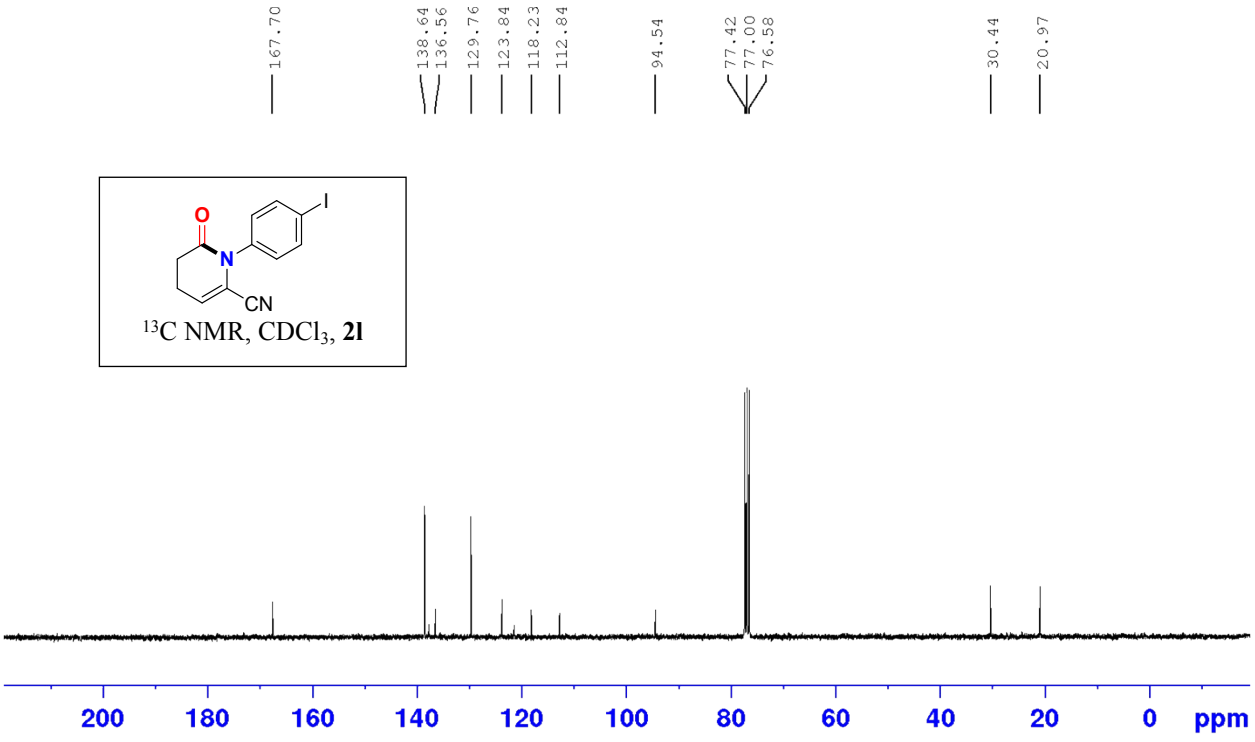




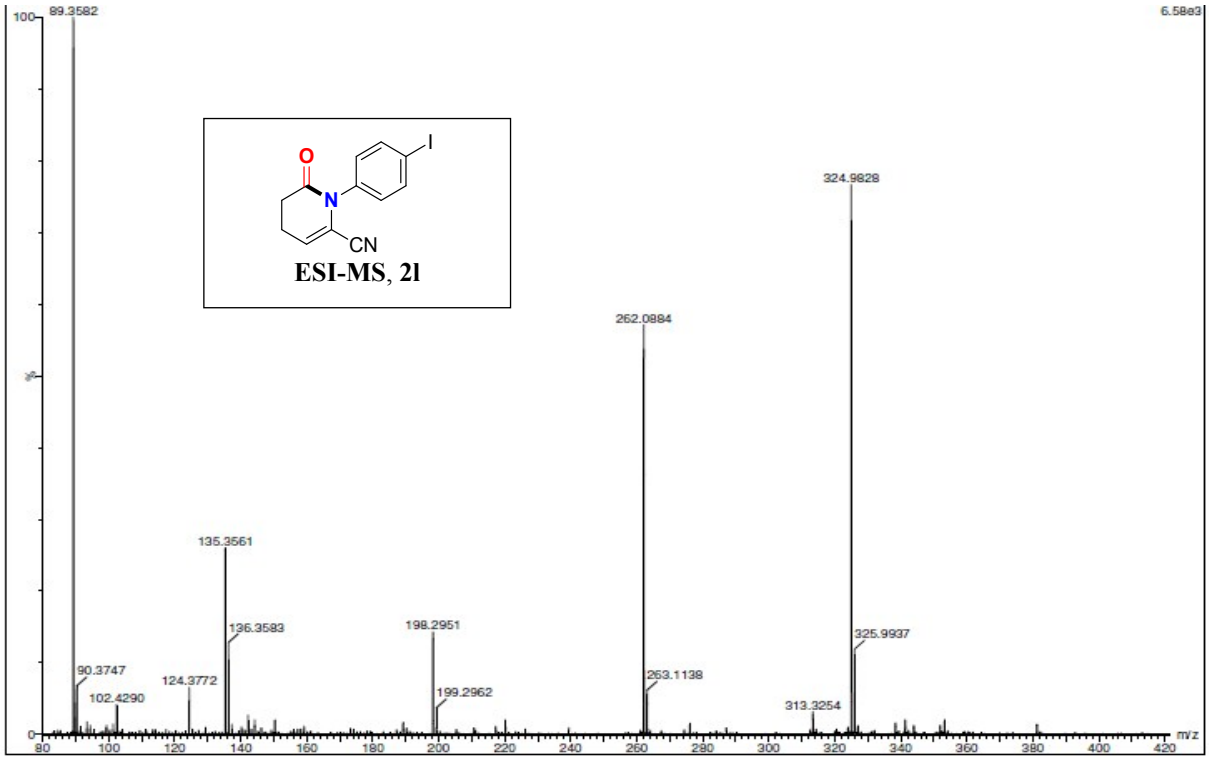
ESI-MS, 2k

^{1}H NMR, $CDCl_3$, **2l**

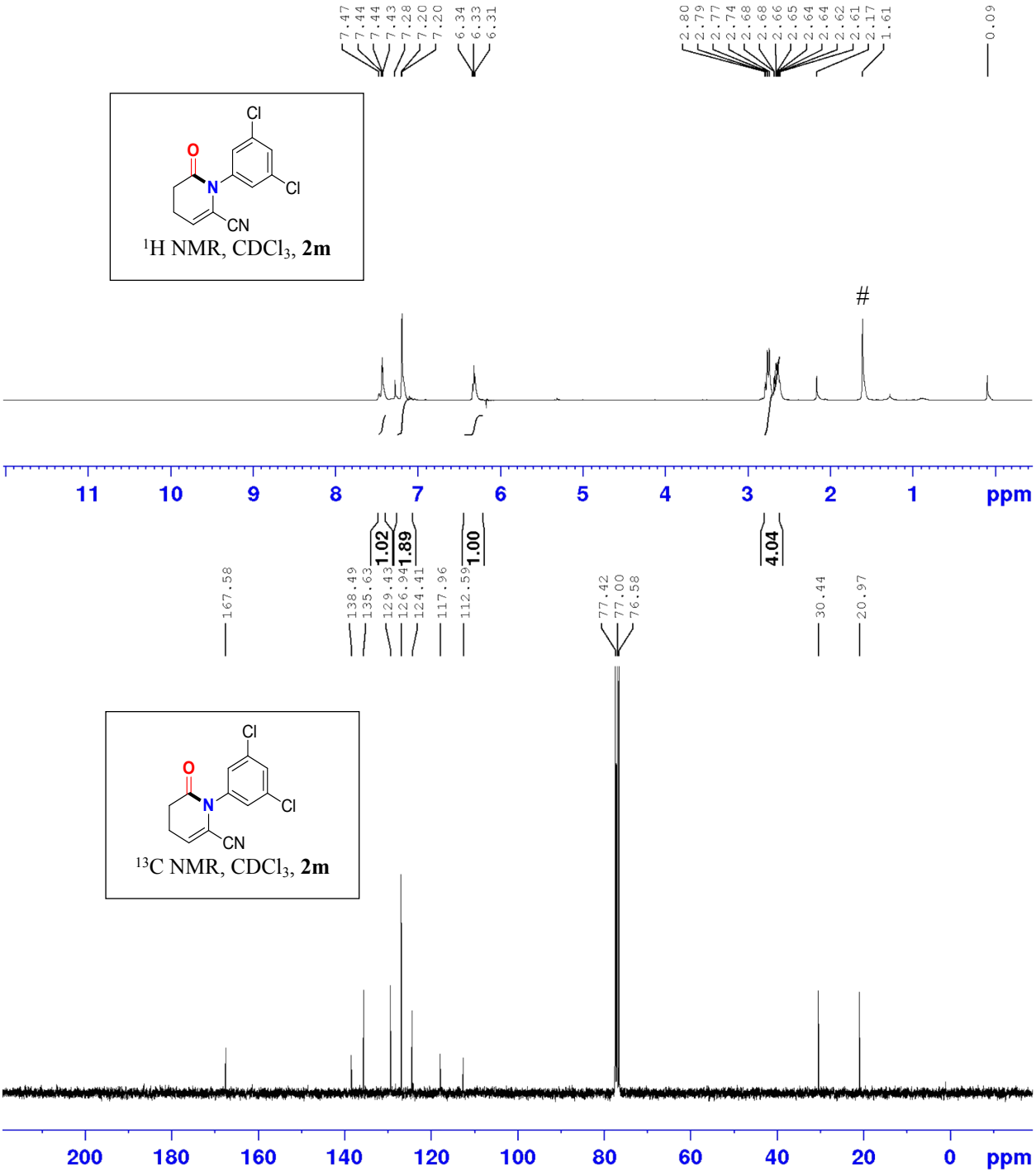


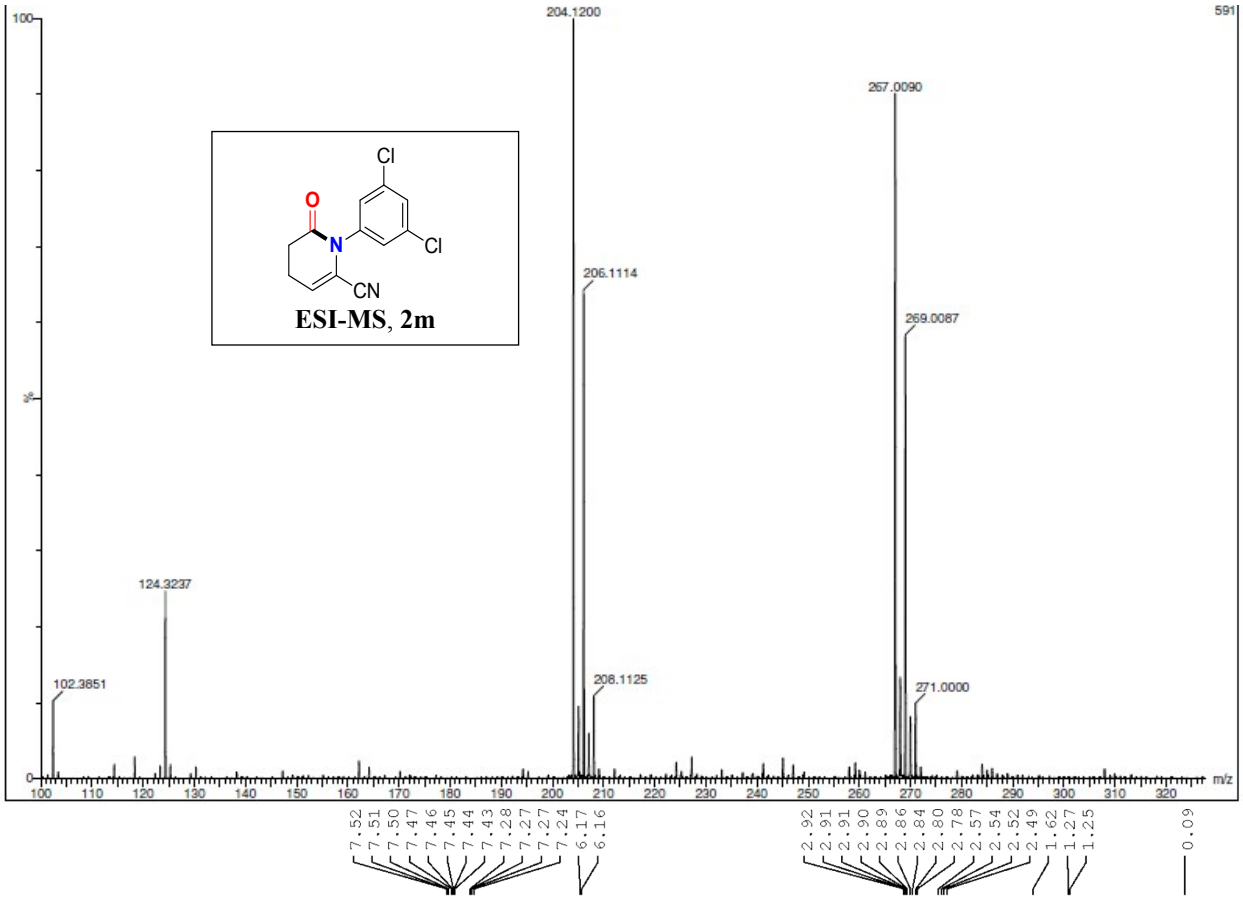


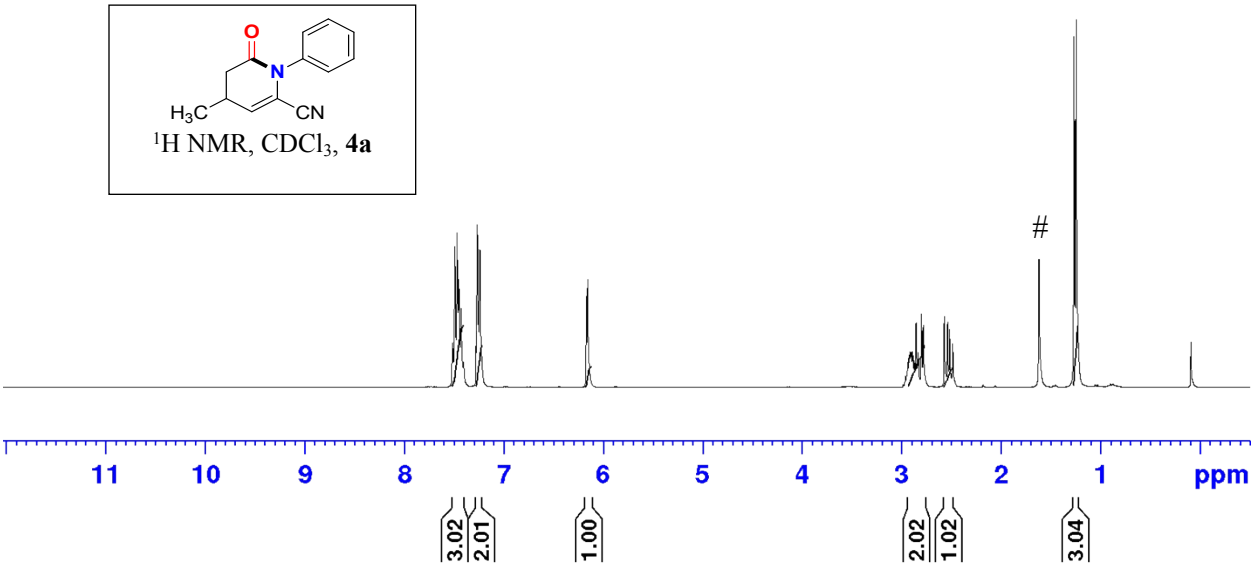
^{13}C NMR, $CDCl_3$, **2l**

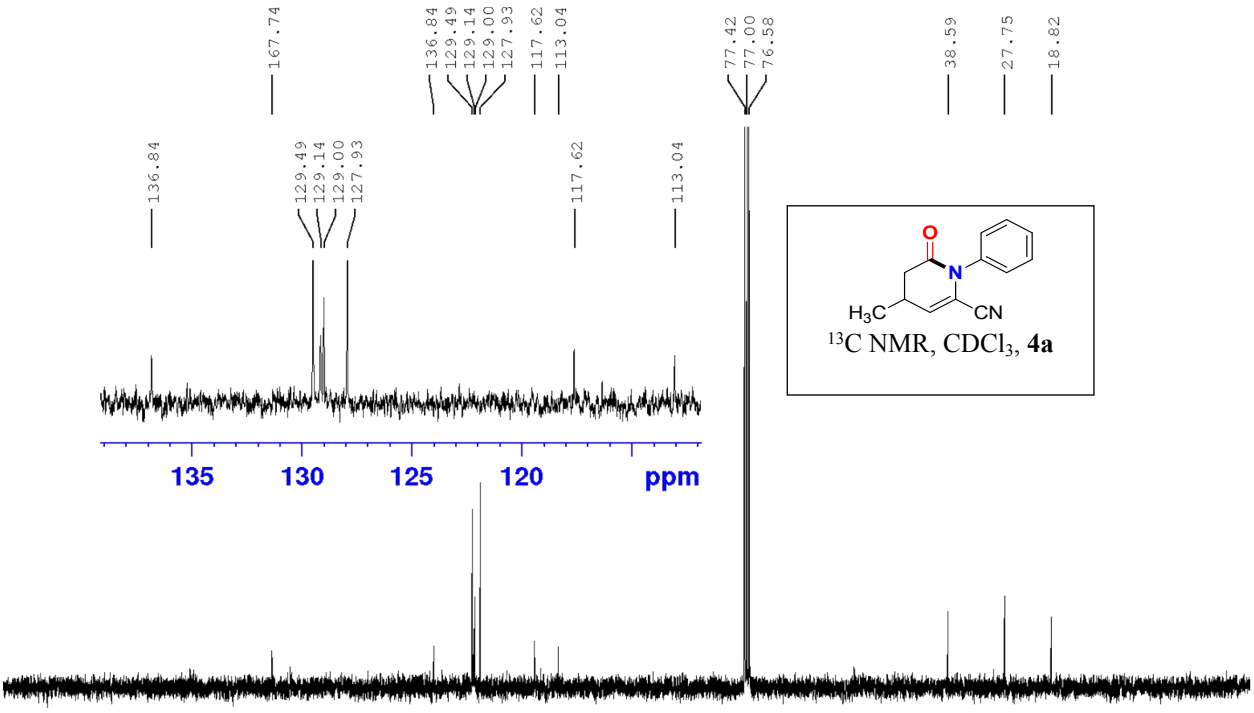


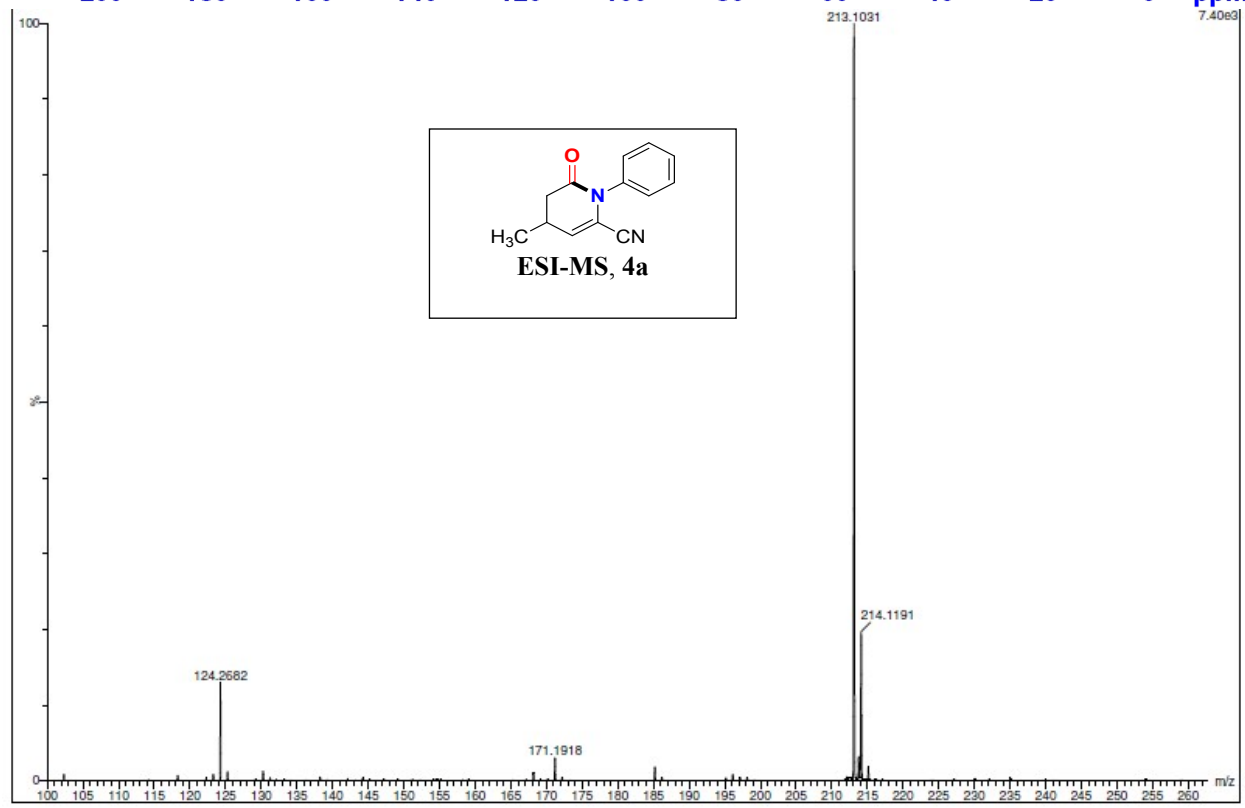
ESI-MS, **2l**

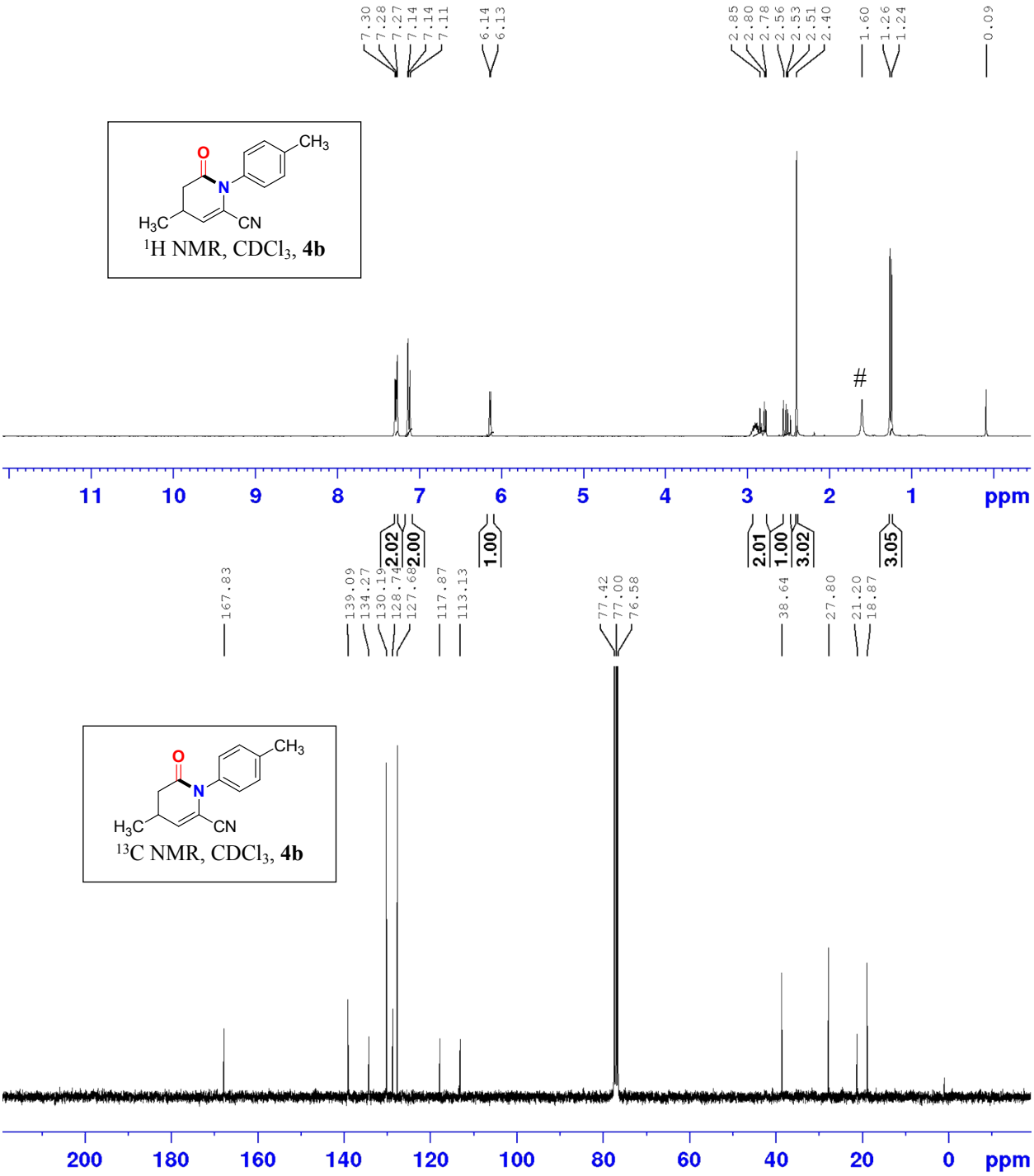

7.47
7.44
7.44
7.43
7.28
7.20
7.20
6.34
6.33
6.31
2.80
2.79
2.77
2.74
2.68
2.68
2.66
2.65
2.64
2.64
2.62
2.61
2.17
1.61
0.09
Cl
O
N
Cl
CN
1H NMR, CDCl3, 2m
#
11
10
9
8
7
6
5
4
3
2
1
ppm
1.02
1.89
1.00
4.04
167.58
138.49
135.63
129.43
126.94
124.41
117.96
112.59
77.42
77.00
76.58
30.44
20.97
Cl
O
N
Cl
CN
13C NMR, CDCl3, 2m
200
180
160
140
120
100
80
60
40
20
0
ppm

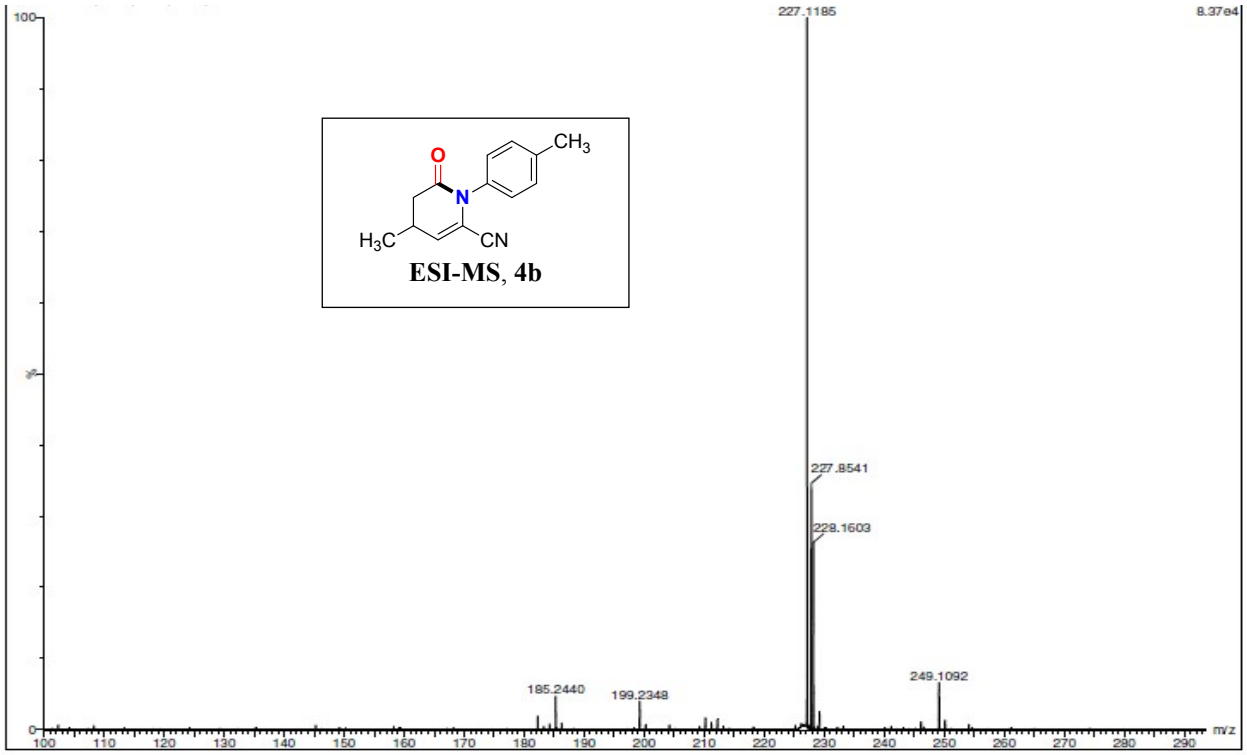

ESI-MS, 2m
204.1200
267.0090
206.1114
269.0087
124.3237
102.3851
208.1125
271.0000
m/z


^{1}H NMR, CDCl$_3$, 4a
#
11
10
9
8
7
6
5
4
3
2
1
ppm
3.02
2.01
1.00
2.02
1.02
3.04

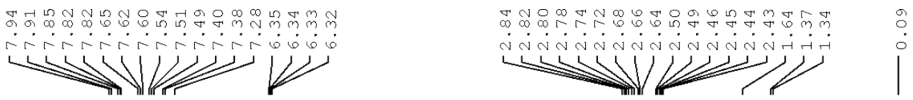

167.74
136.84
129.49
129.14
129.00
127.93
117.62
113.04
77.42
77.00
76.58
38.59
27.75
18.82
135
130
125
120
ppm
200
180
160
140
120
100
80
60
40
20
0
ppm
^{13}C NMR, $CDCl_3$, **4a**

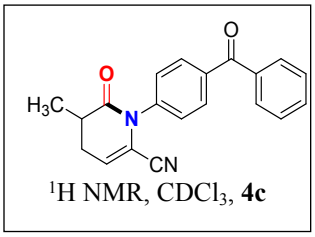

213.1031
7.40e3
214.1191
124.2682
171.1918
%
m/z
ESI-MS, 4a


7.30
7.28
7.27
7.14
7.14
7.11
6.14
6.13
2.85
2.80
2.78
2.56
2.53
2.51
2.40
1.60
1.26
1.24
0.09
CH3
O
N
H3C
CN
1H NMR, CDCl3, 4b
#
11
10
9
8
7
6
5
4
3
2
1
ppm
2.02
2.00
1.00
2.01
1.00
3.02
3.05
167.83
139.09
134.27
130.19
128.74
127.68
117.87
113.13
77.42
77.00
76.58
38.64
27.80
21.20
18.87
13C NMR, CDCl3, 4b
200
180
160
140
120
100
80
60
40
20
0
ppm

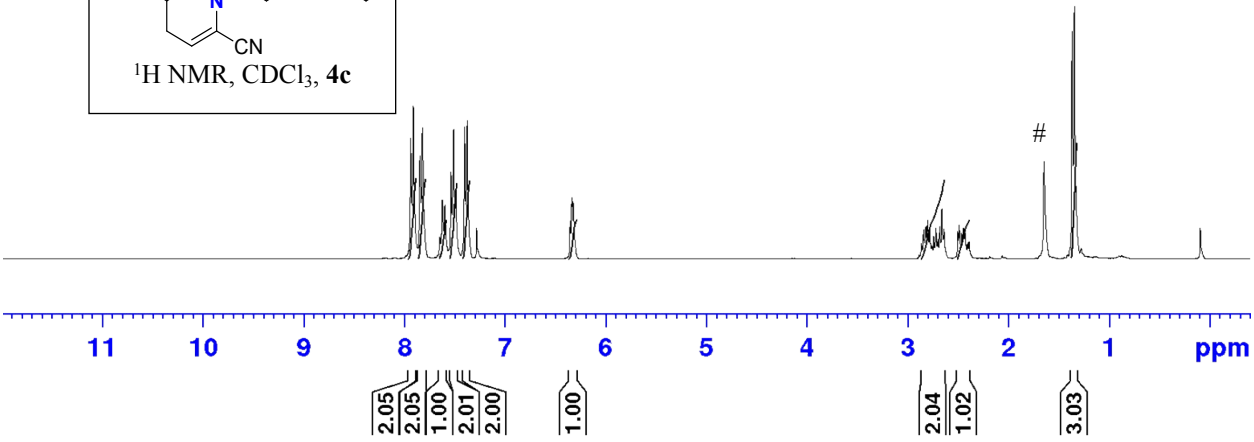


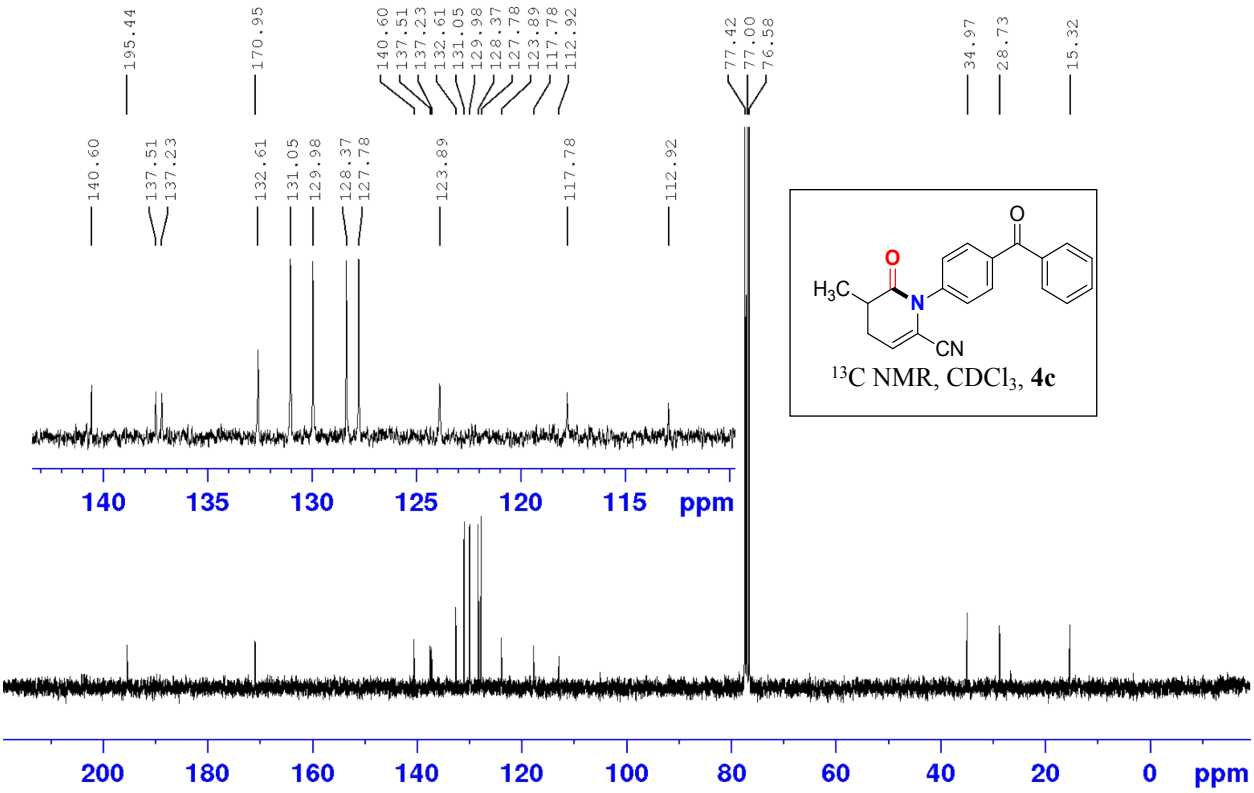
ESI-MS, 4b

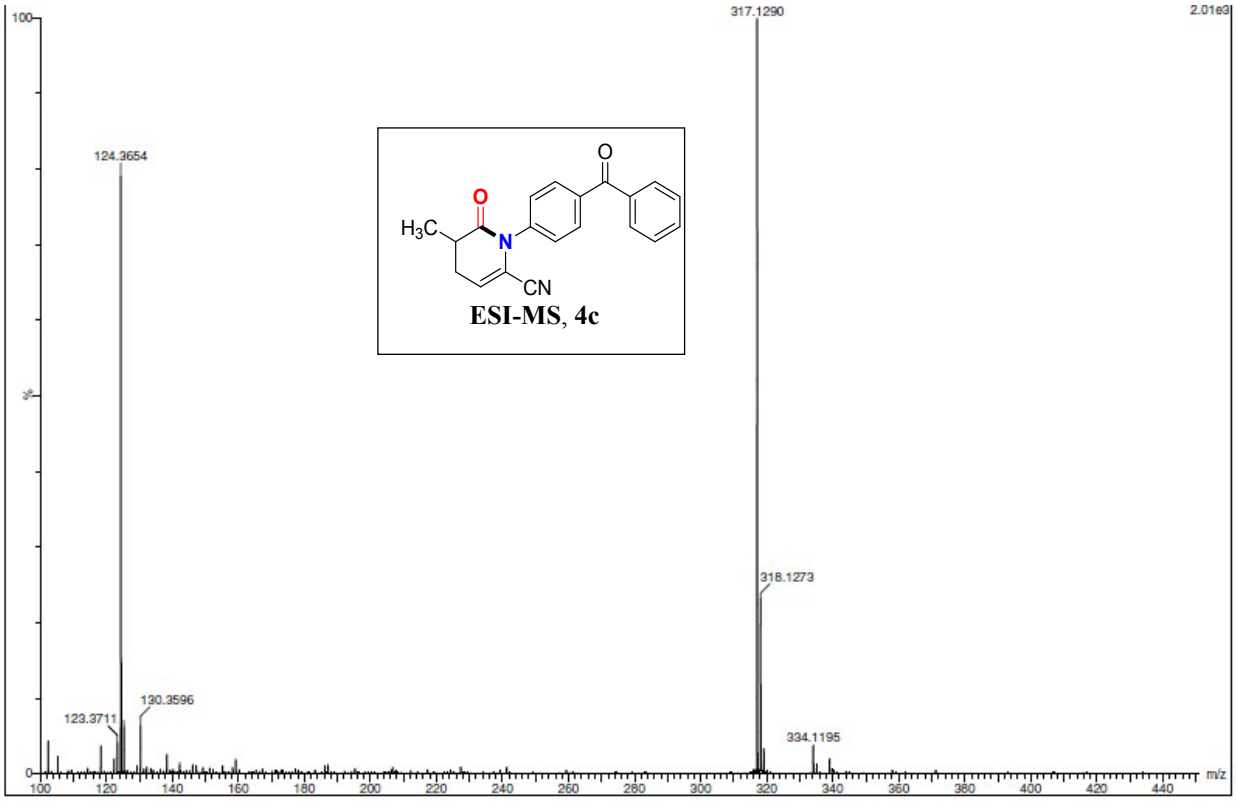


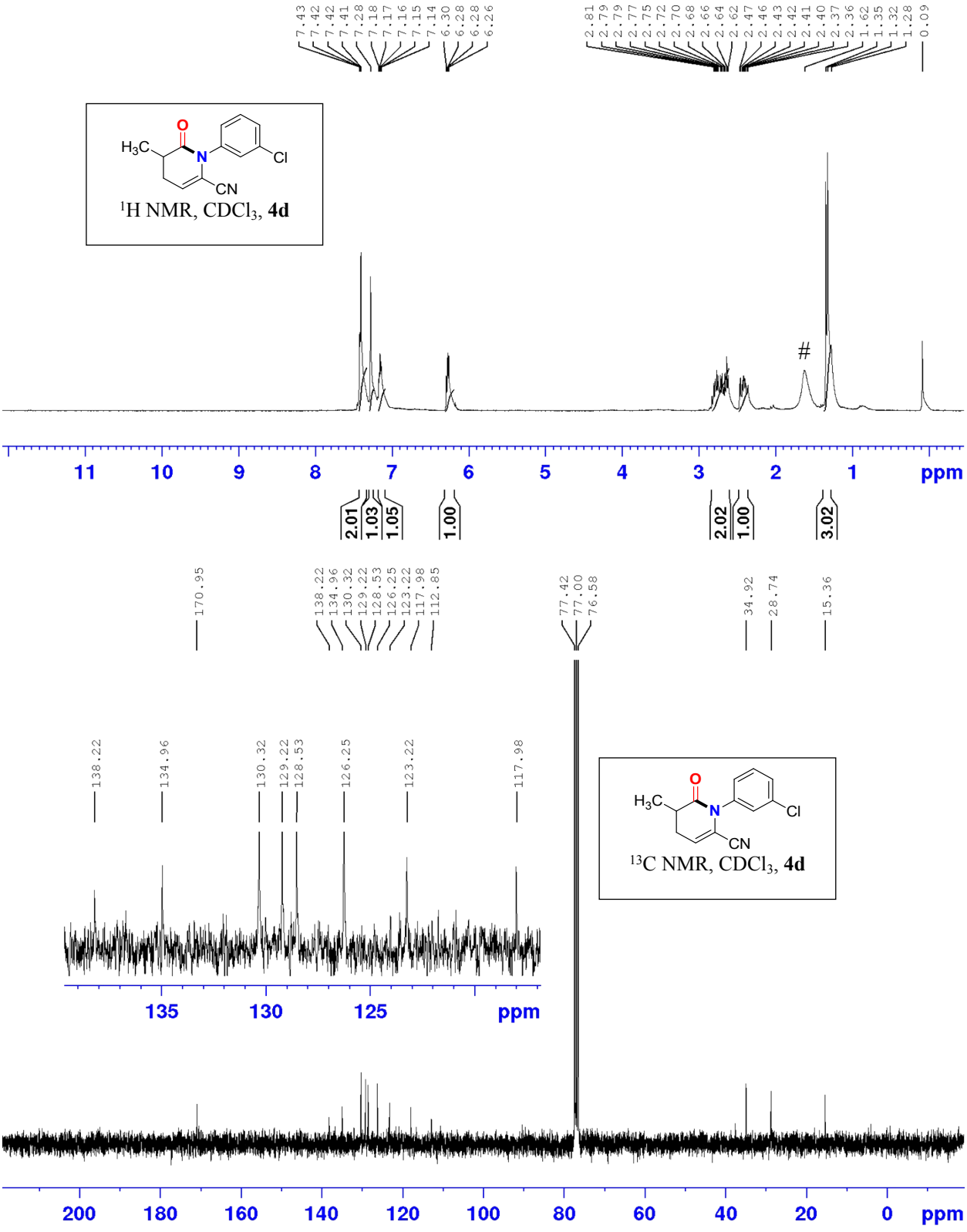


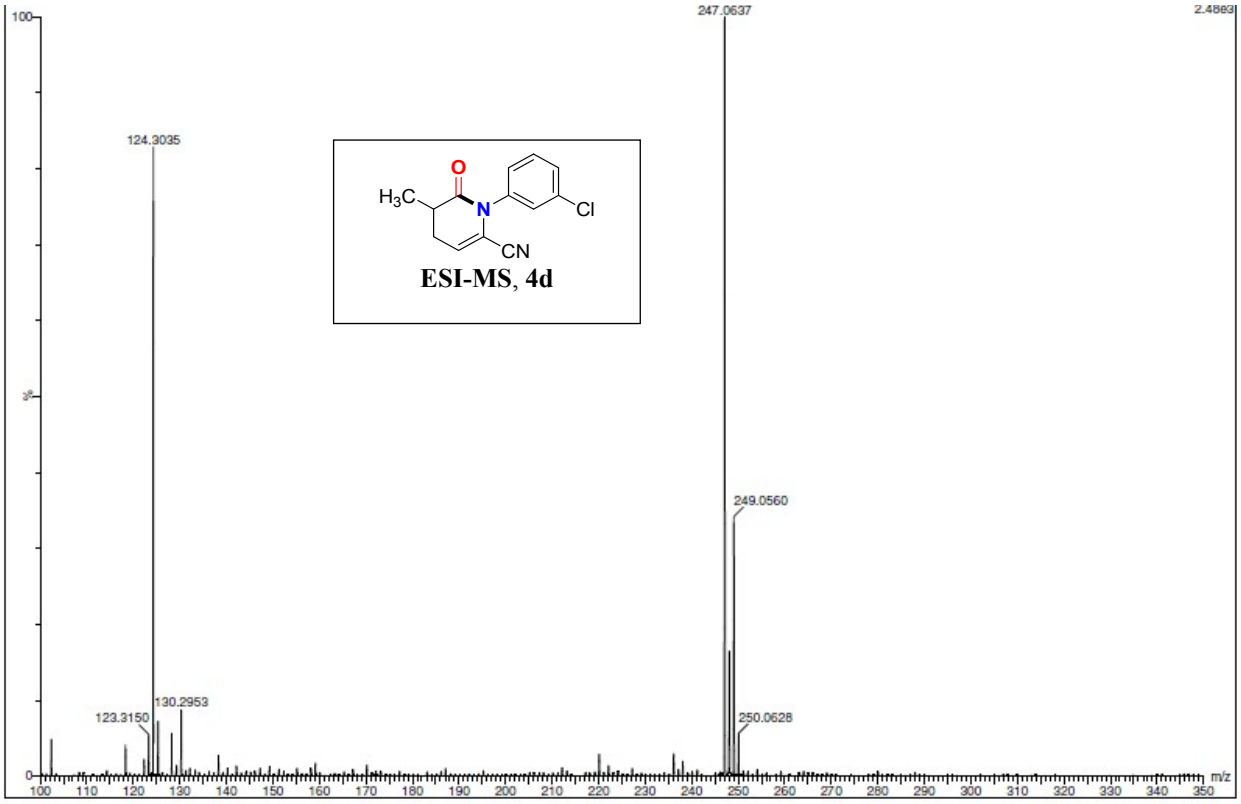
^{1}H NMR, $CDCl_3$, **4c**

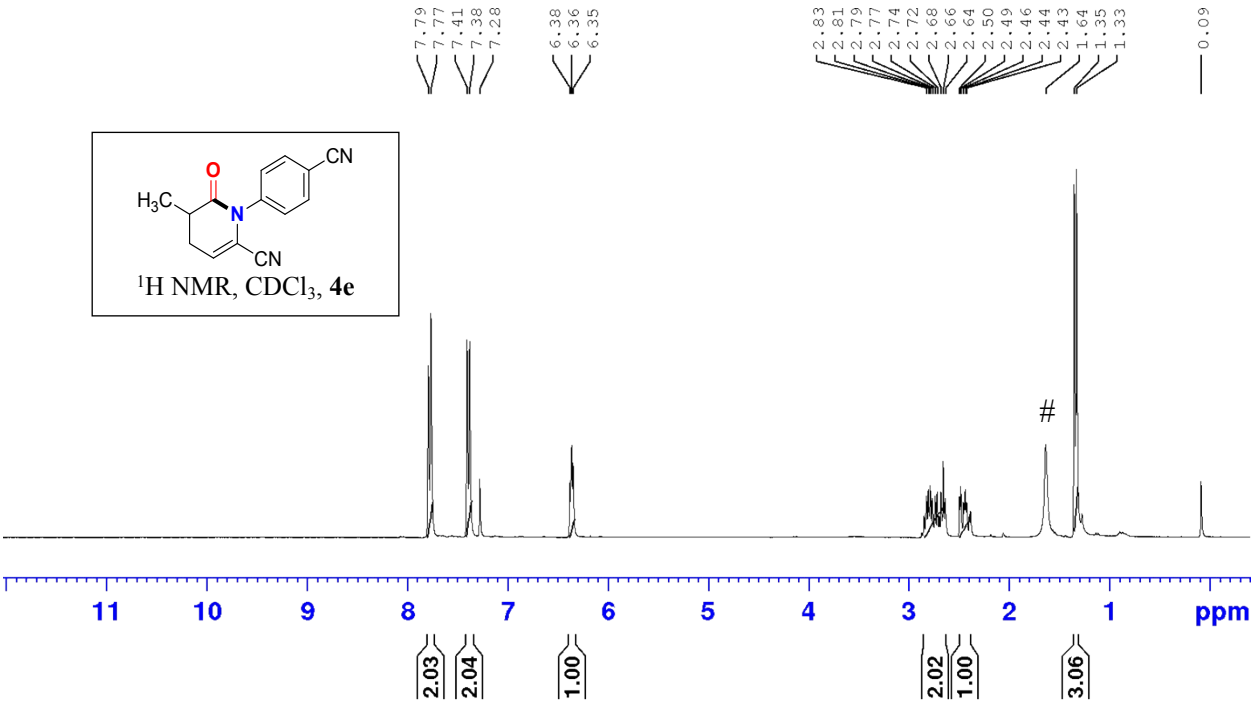


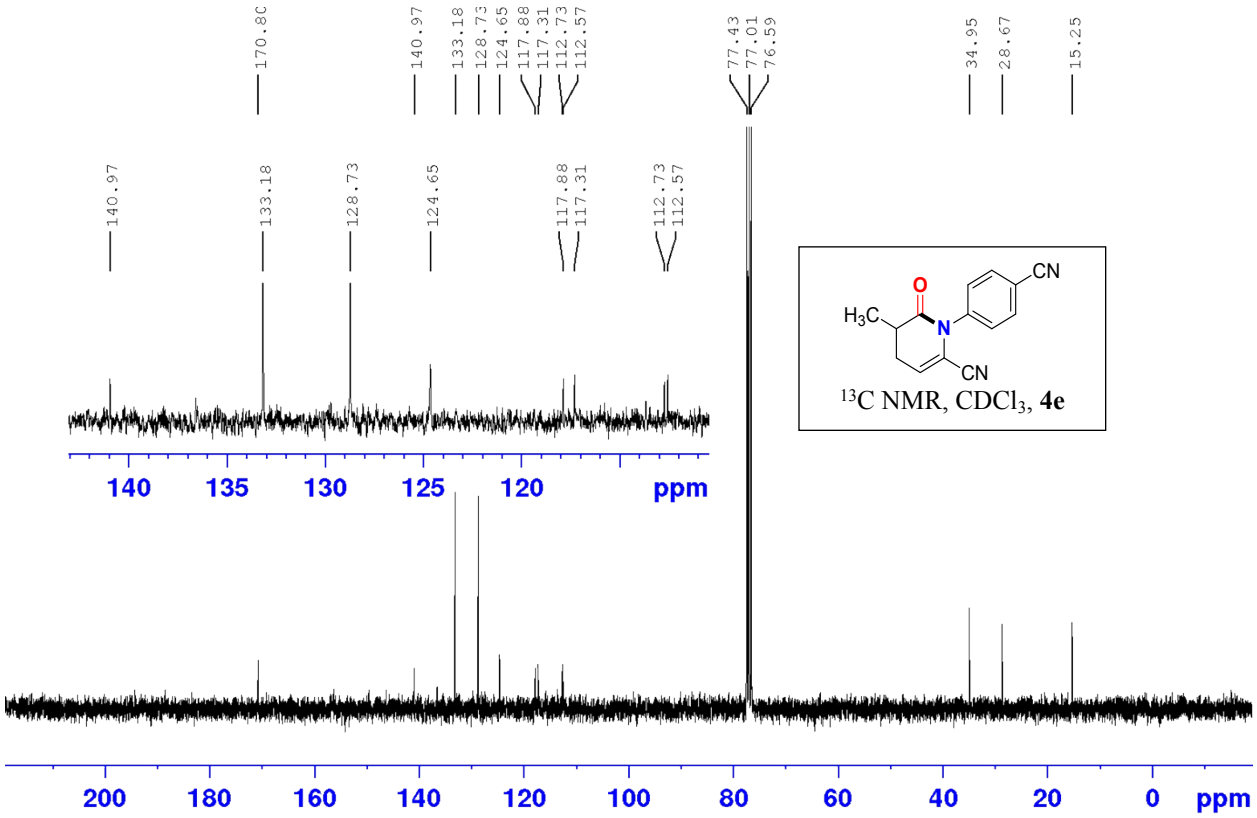

195.44
170.95
140.60
137.51
137.23
132.61
131.05
129.98
128.37
127.78
123.89
117.78
112.92
77.42
77.00
76.58
34.97
28.73
15.32
O
O
H3C
N
CN
13C NMR, CDCl3, 4c
140
135
130
125
120
115
ppm
200
180
160
140
120
100
80
60
40
20
0
ppm

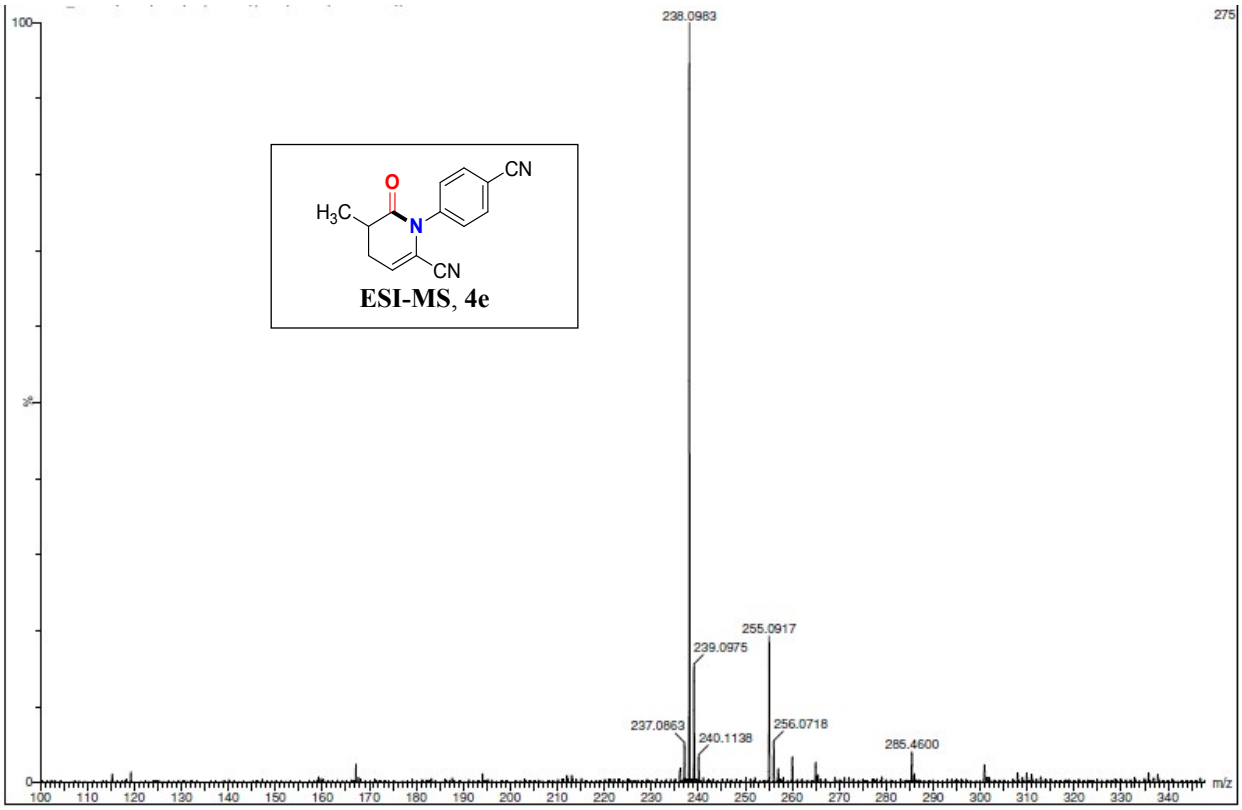

100
%
317.1290
2.01e3
124.3654
318.1273
130.3596
123.3711
334.1195
m/z
O
O
H3C
N
CN
ESI-MS, 4c


7.43
7.42
7.42
7.41
7.28
7.18
7.17
7.16
7.15
7.14
6.30
6.28
6.28
6.26
2.81
2.79
2.79
2.77
2.75
2.72
2.70
2.68
2.66
2.64
2.62
2.47
2.46
2.43
2.42
2.41
2.40
2.37
2.36
1.62
1.35
1.32
1.28
0.09
H3C
O
N
Cl
CN
1H NMR, CDCl3, 4d
#
11
10
9
8
7
6
5
4
3
2
1
ppm
2.01
1.03
1.05
1.00
2.02
1.00
3.02
170.95
138.22
134.96
130.32
129.22
128.53
126.25
123.22
117.98
112.85
77.42
77.00
76.58
34.92
28.74
15.36
138.22
134.96
130.32
129.22
128.53
126.25
123.22
117.98
135
130
125
ppm
13C NMR, CDCl3, 4d
200
180
160
140
120
100
80
60
40
20
0
ppm


247.0637
2.4869
124.3035
249.0560
130.2953
123.3150
250.0628
m/z
ESI-MS, 4d


7.79
7.77
7.41
7.38
7.28
6.38
6.36
6.35
2.83
2.81
2.79
2.77
2.74
2.72
2.68
2.66
2.64
2.50
2.49
2.46
2.44
2.43
1.64
1.35
1.33
0.09
#
11
10
9
8
7
6
5
4
3
2
1
ppm
2.03
2.04
1.00
2.02
1.00
3.06
1H NMR, CDCl3, 4e


170.80
140.97
133.18
128.73
124.65
117.88
117.31
112.73
112.57
77.43
77.01
76.59
34.95
28.67
15.25
140.97
133.18
128.73
124.65
117.88
117.31
112.73
112.57
140
135
130
125
120
ppm
200
180
160
140
120
100
80
60
40
20
0
ppm
O
CN
H3C
N
CN
13C NMR, CDCl3, 4e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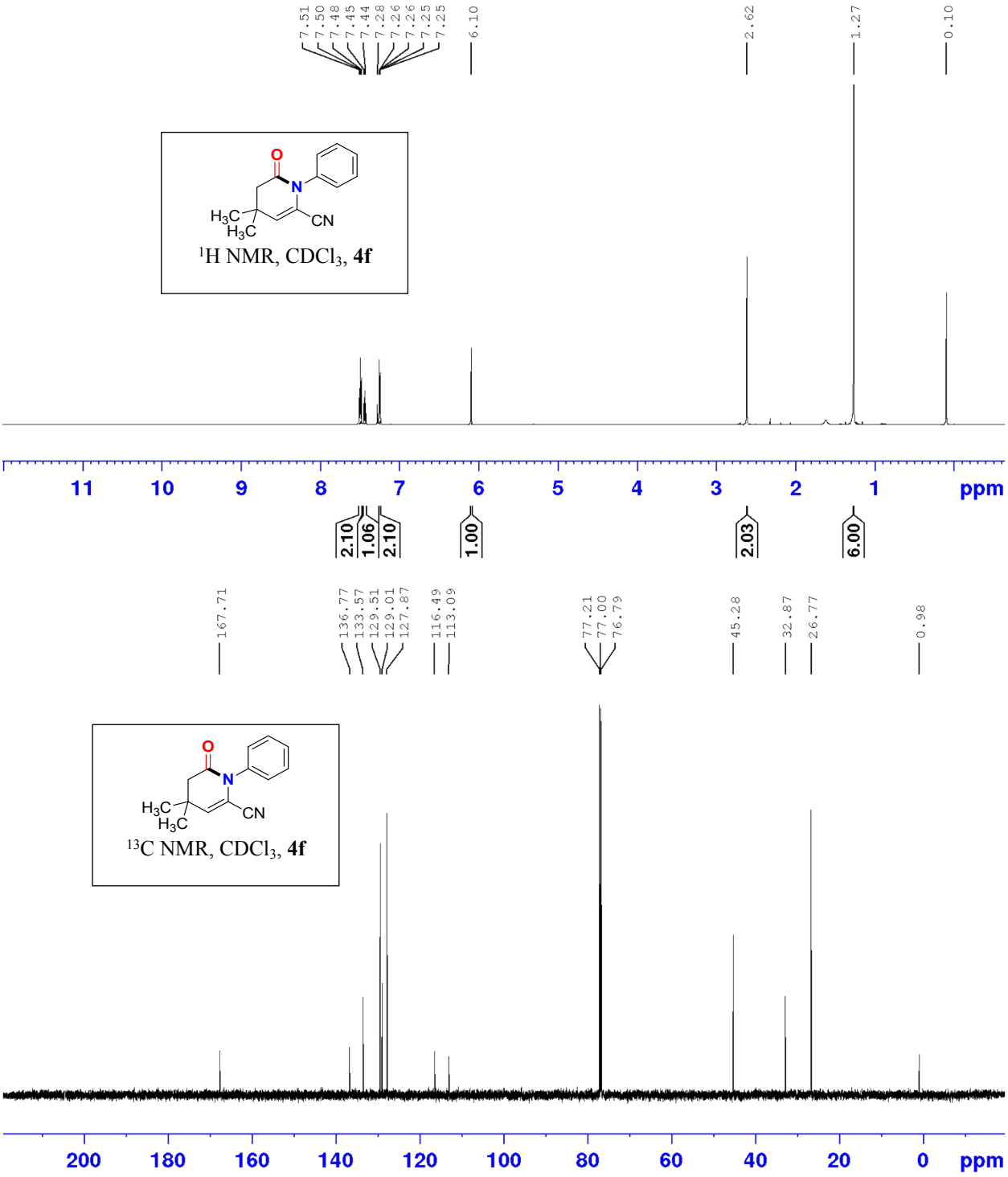
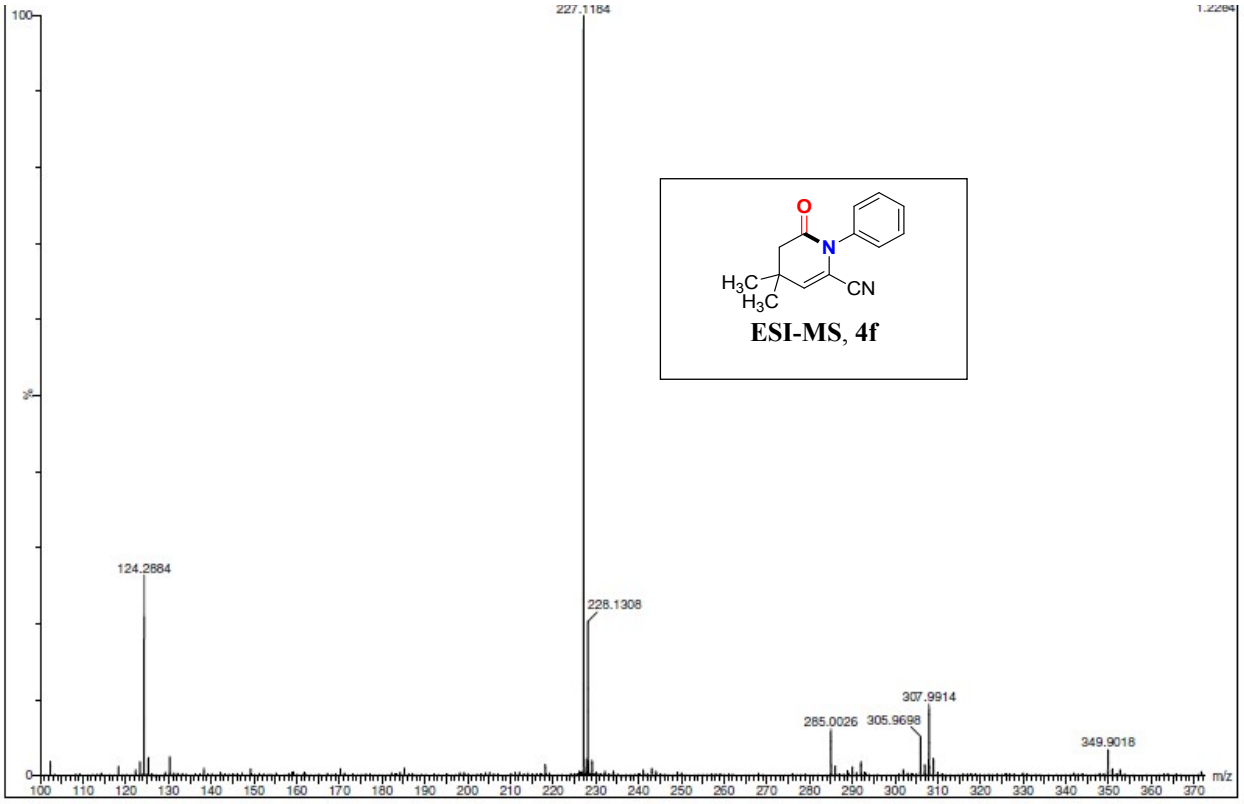
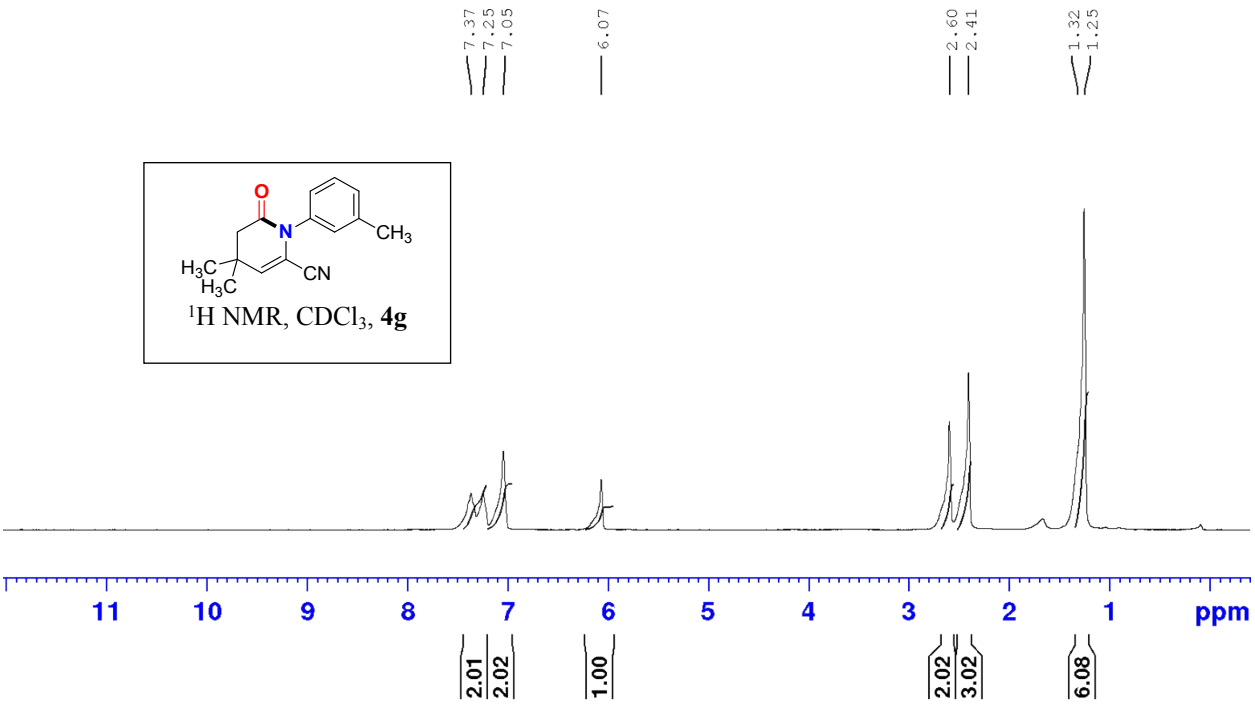
%
0
238.0983
275
255.0917
239.0975
237.0863
240.1138
256.0718
285.4600
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
m/z
O
CN
H3C
N
CN
ESI-MS, 4e

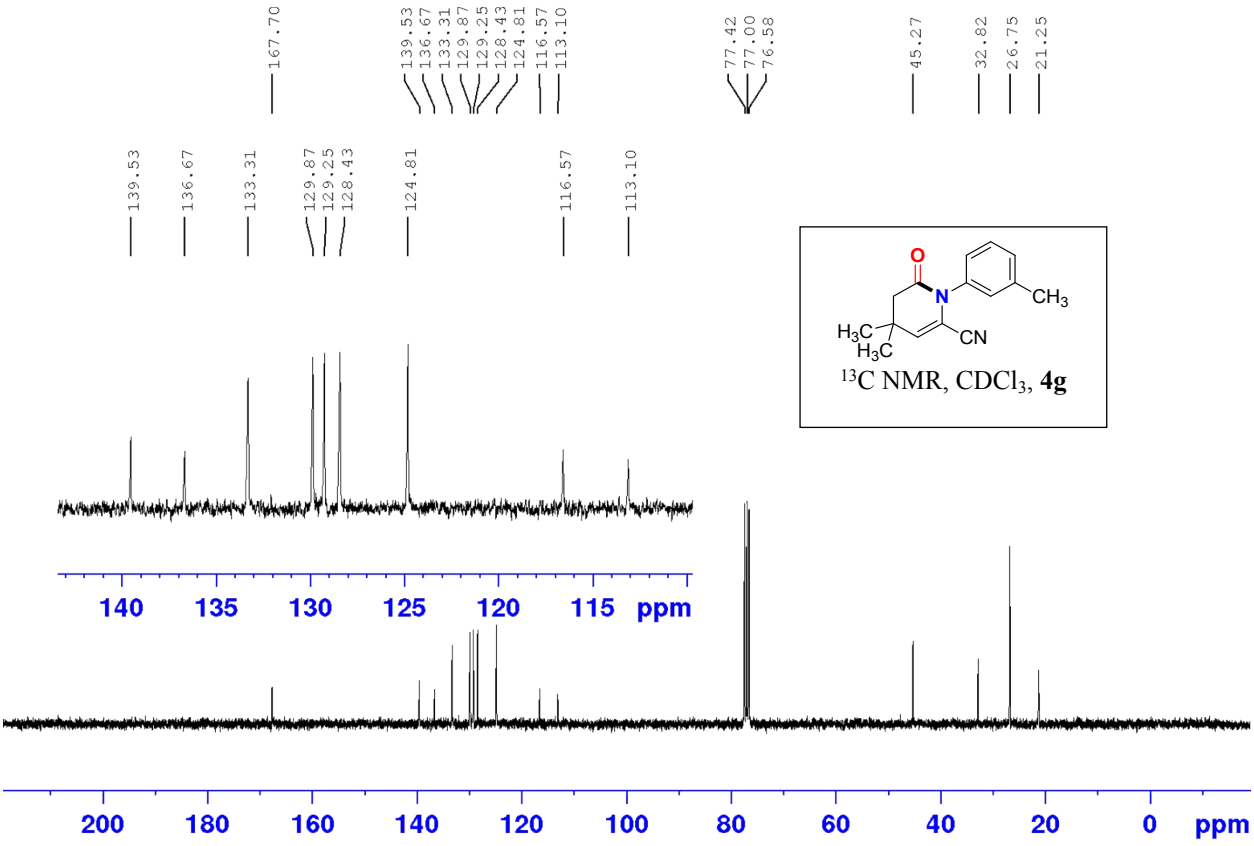

7.51
7.50
7.48
7.45
7.44
7.28
7.26
7.26
7.25
7.25
6.10
2.62
1.27
0.10
O
N
CN
H3C
H3C
1H NMR, CDCl3, 4f
11
10
9
8
7
6
5
4
3
2
1
ppm
2.10
1.06
2.10
1.00
2.03
6.00
167.71
136.77
133.57
129.51
129.01
127.87
116.49
113.09
77.21
77.00
76.79
45.28
32.87
26.77
0.98
O
N
CN
H3C
H3C
13C NMR, CDCl3, 4f
200
180
160
140
120
100
80
60
40
20
0
ppm



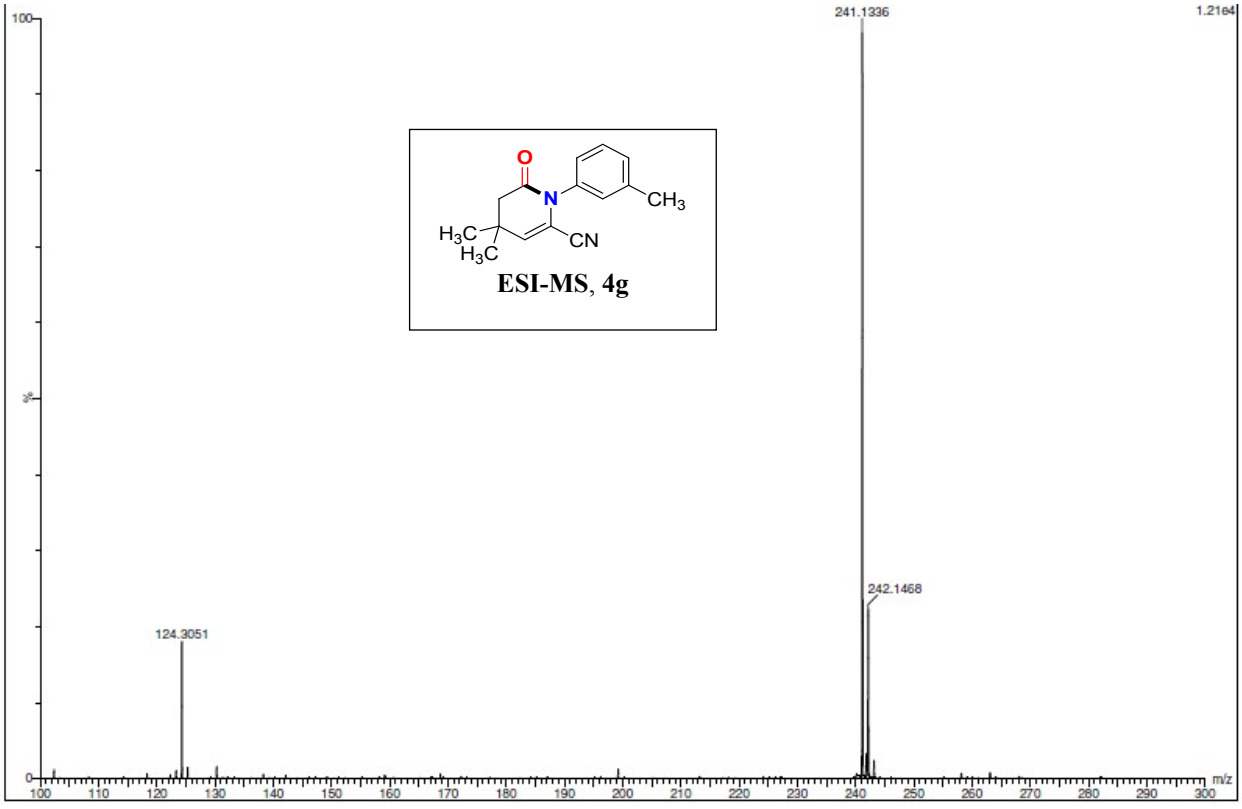
ESI-MS, 4f



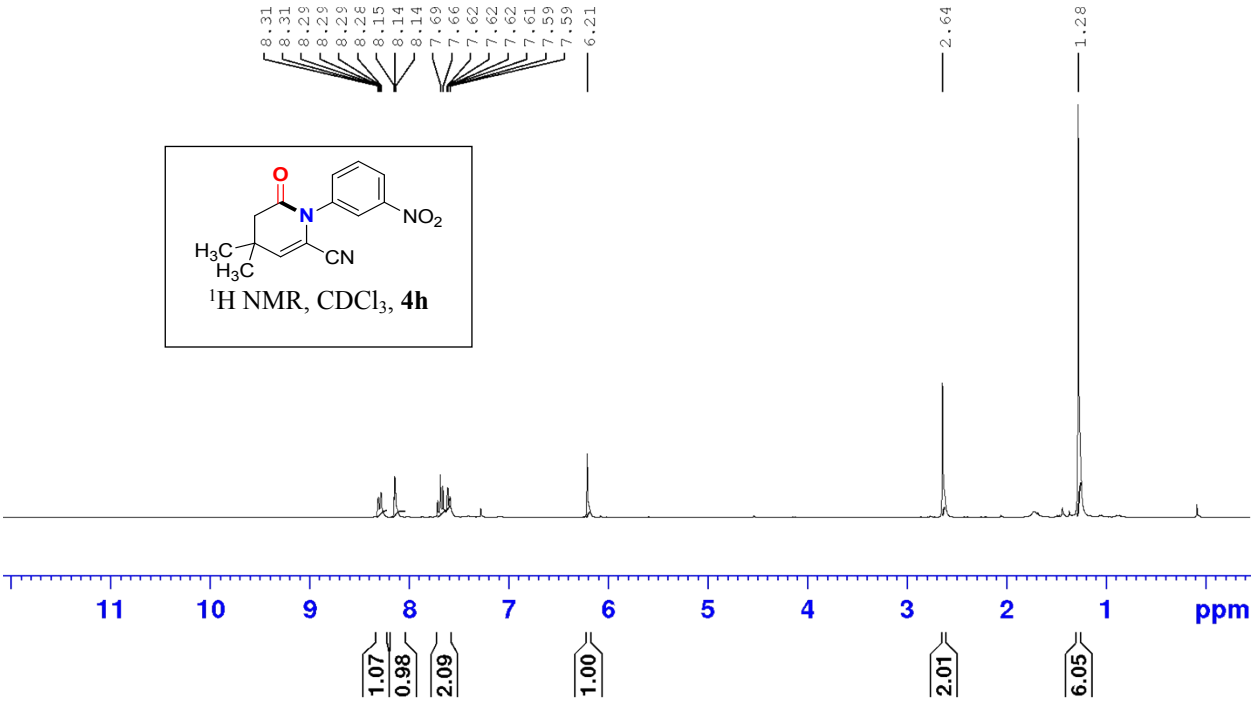
^{1}H NMR, $CDCl_3$, **4g**

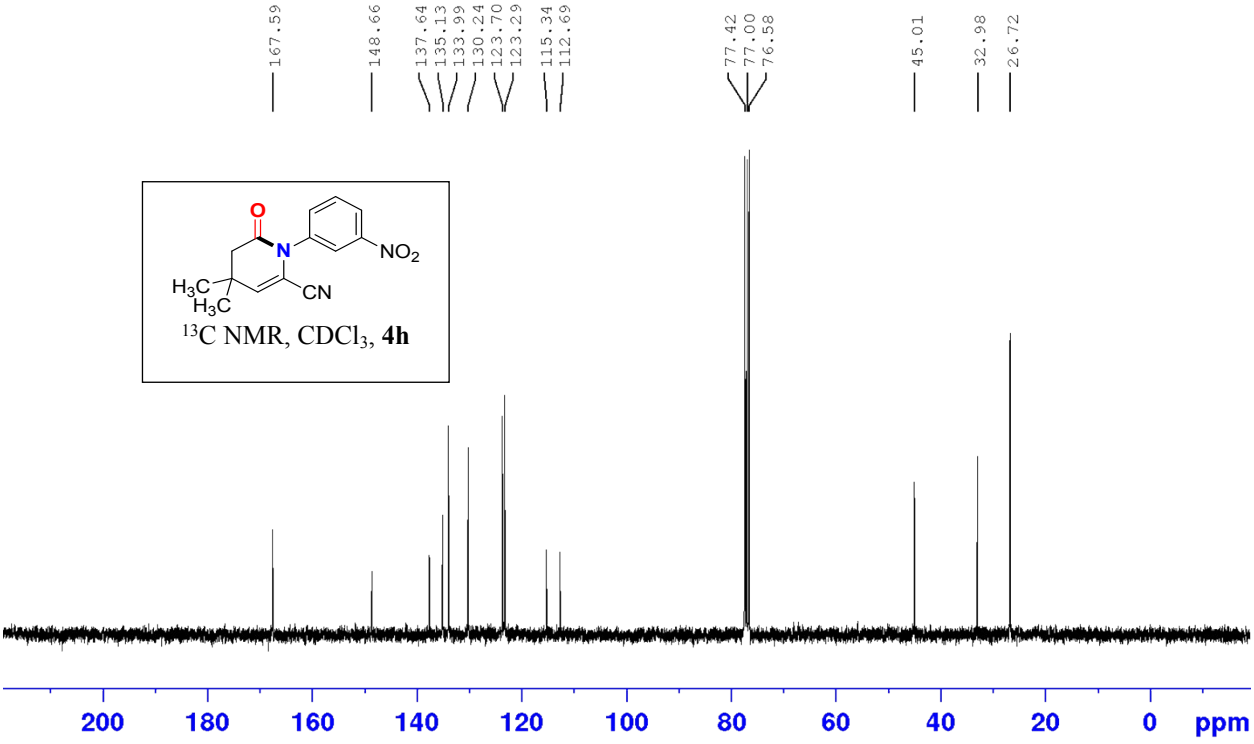


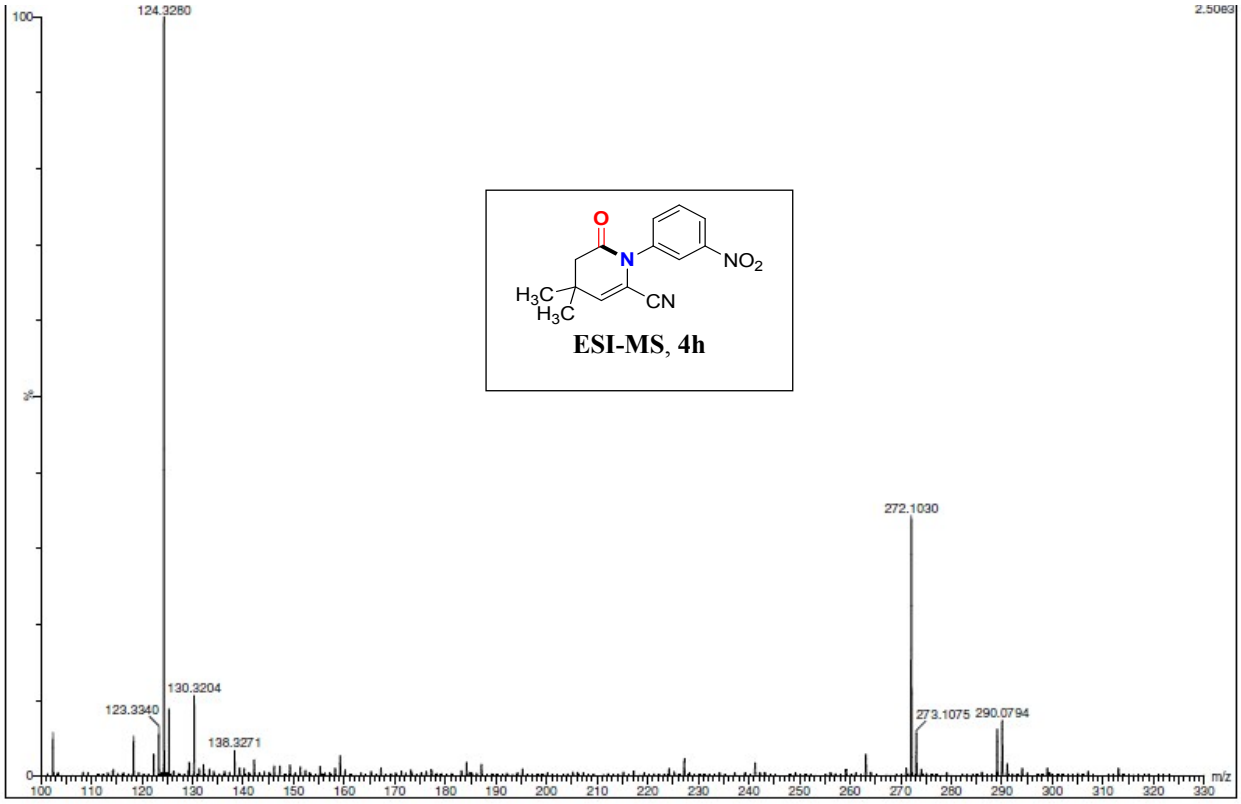
^{13}C NMR, $CDCl_3$, **4g**



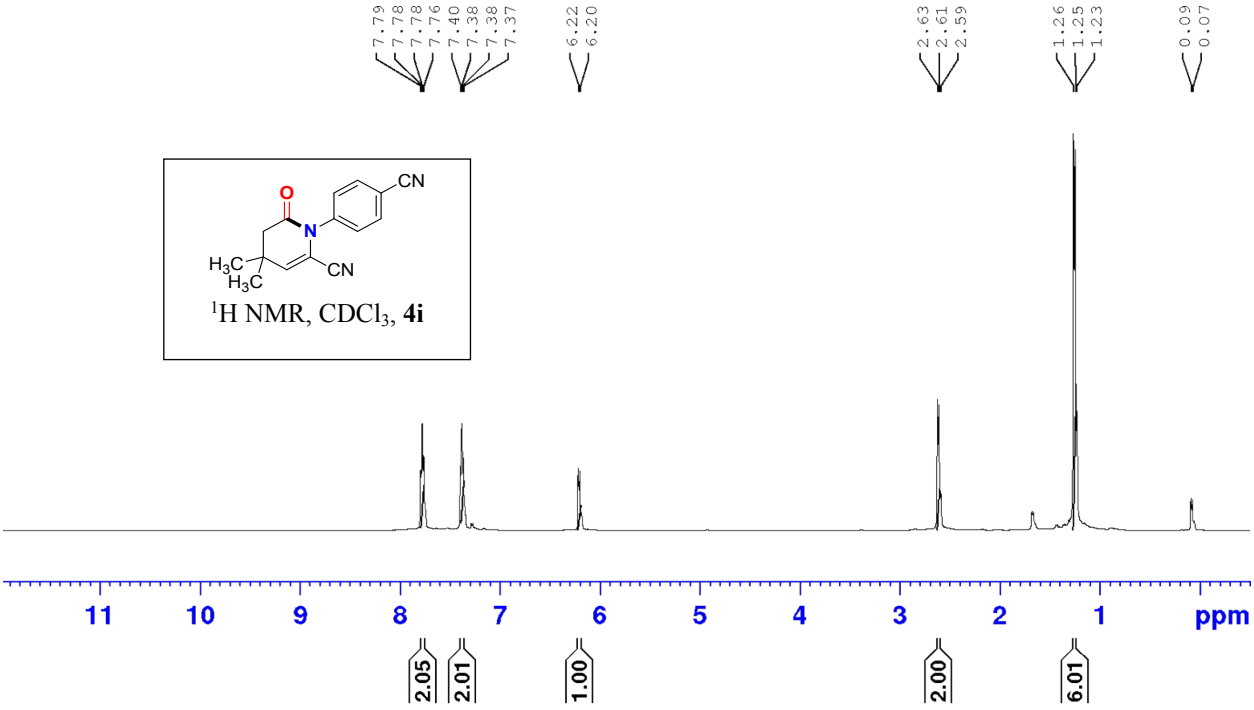
ESI-MS, **4g**


8.31
8.31
8.29
8.29
8.29
8.28
8.15
8.14
8.14
7.69
7.66
7.62
7.62
7.62
7.61
7.59
7.59
6.21
2.64
1.28
O
N
NO2
H3C
H3C
CN
1H NMR, CDCl3, 4h
11
10
9
8
7
6
5
4
3
2
1
ppm
1.07
0.98
2.09
1.00
2.01
6.05

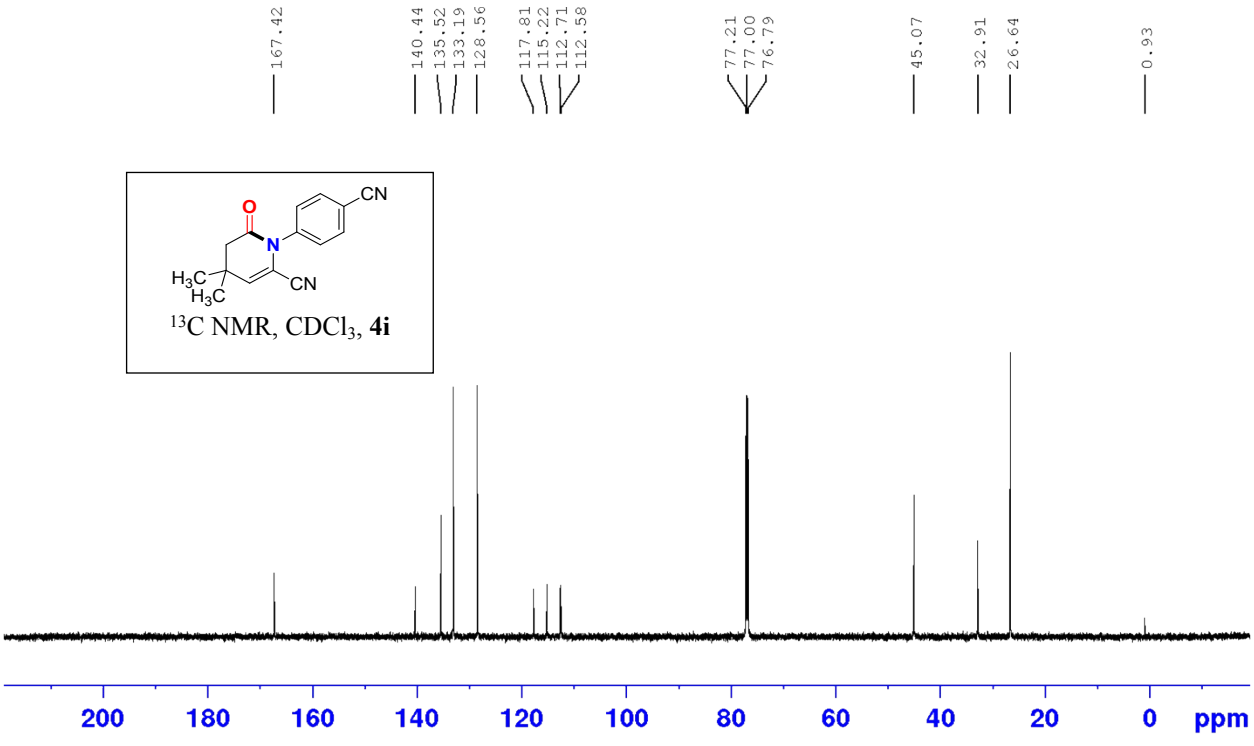

167.59
148.66
137.64
135.13
133.99
130.24
123.70
123.29
115.34
112.69
77.42
77.00
76.58
45.01
32.98
26.72
O
N
NO2
H3C
H3C
CN
13C NMR, CDCl3, 4h
200
180
160
140
120
100
80
60
40
20
0
ppm



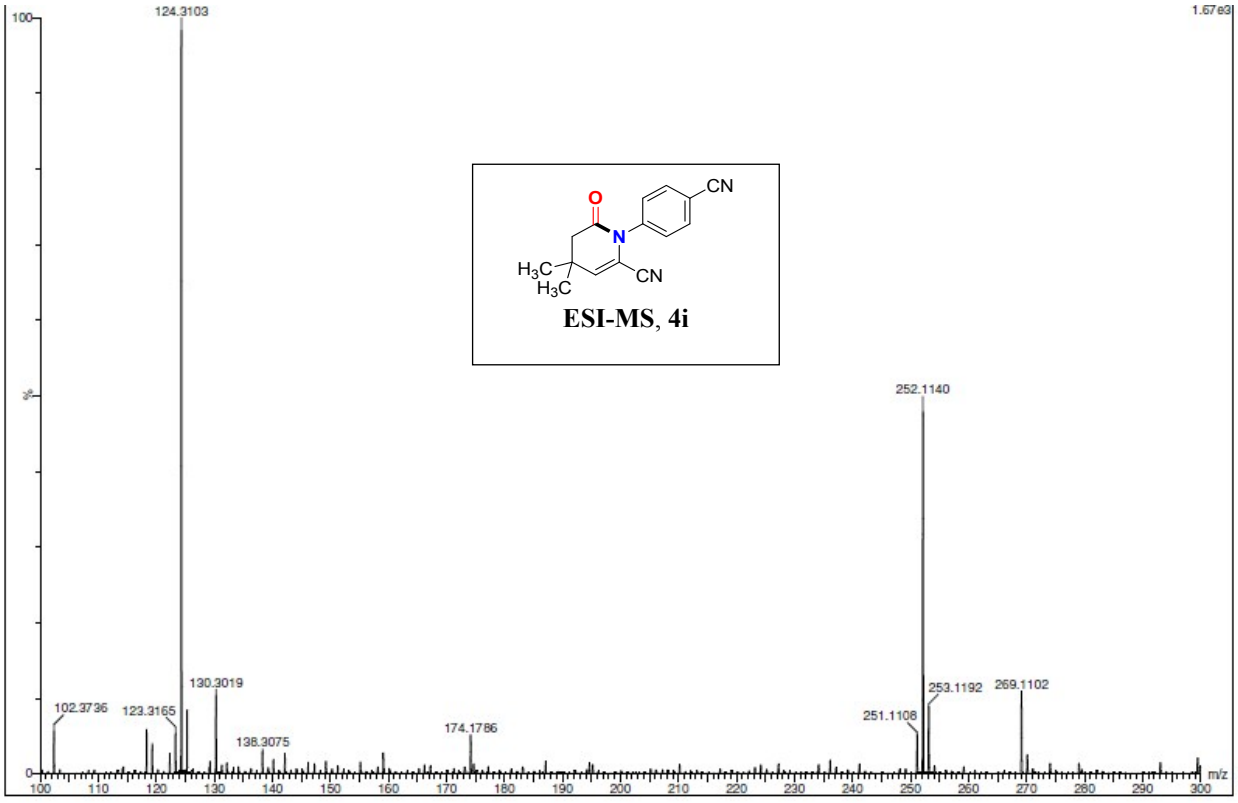
ESI-MS, **4h**



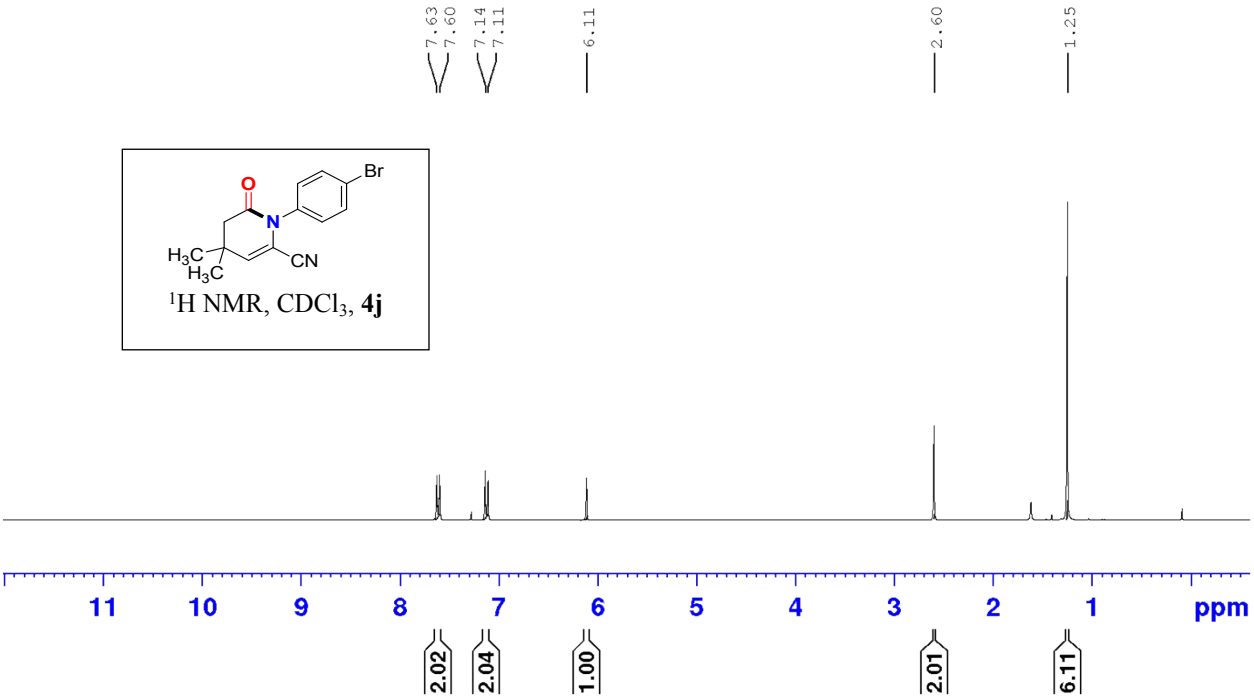
^{1}H NMR, $CDCl_3$, **4i**



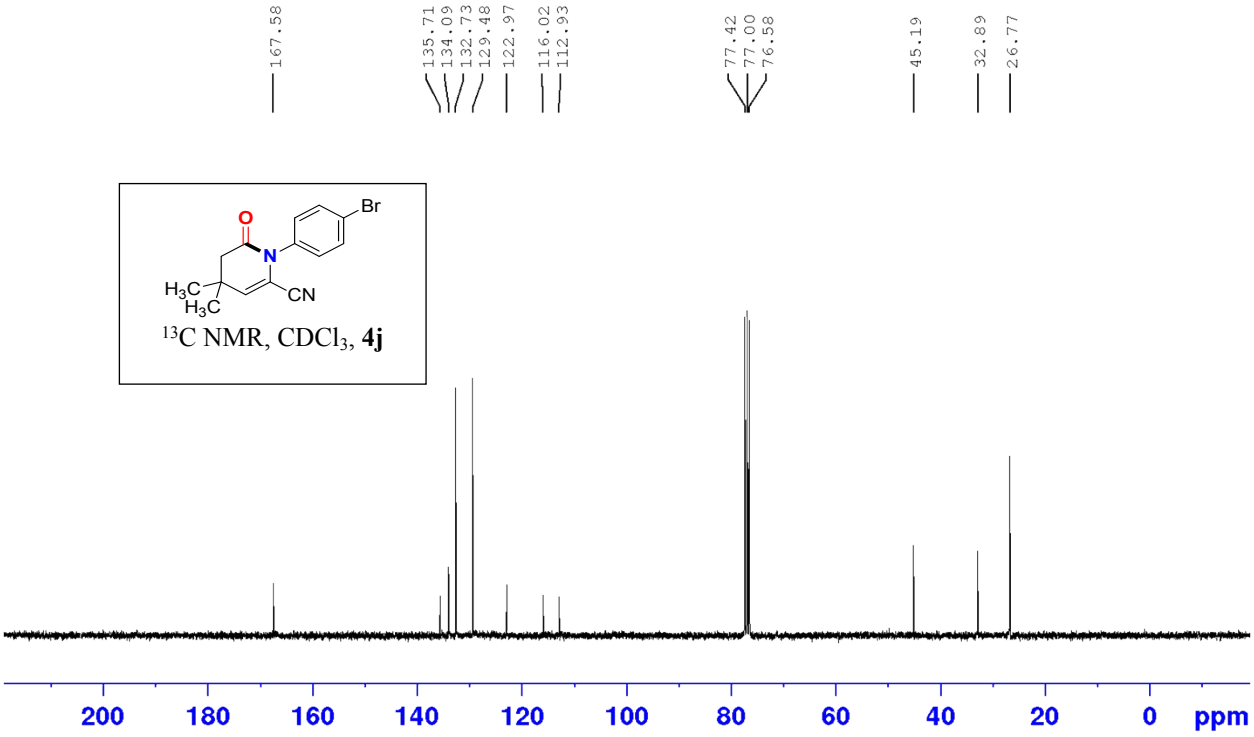
^{13}C NMR, $CDCl_3$, **4i**



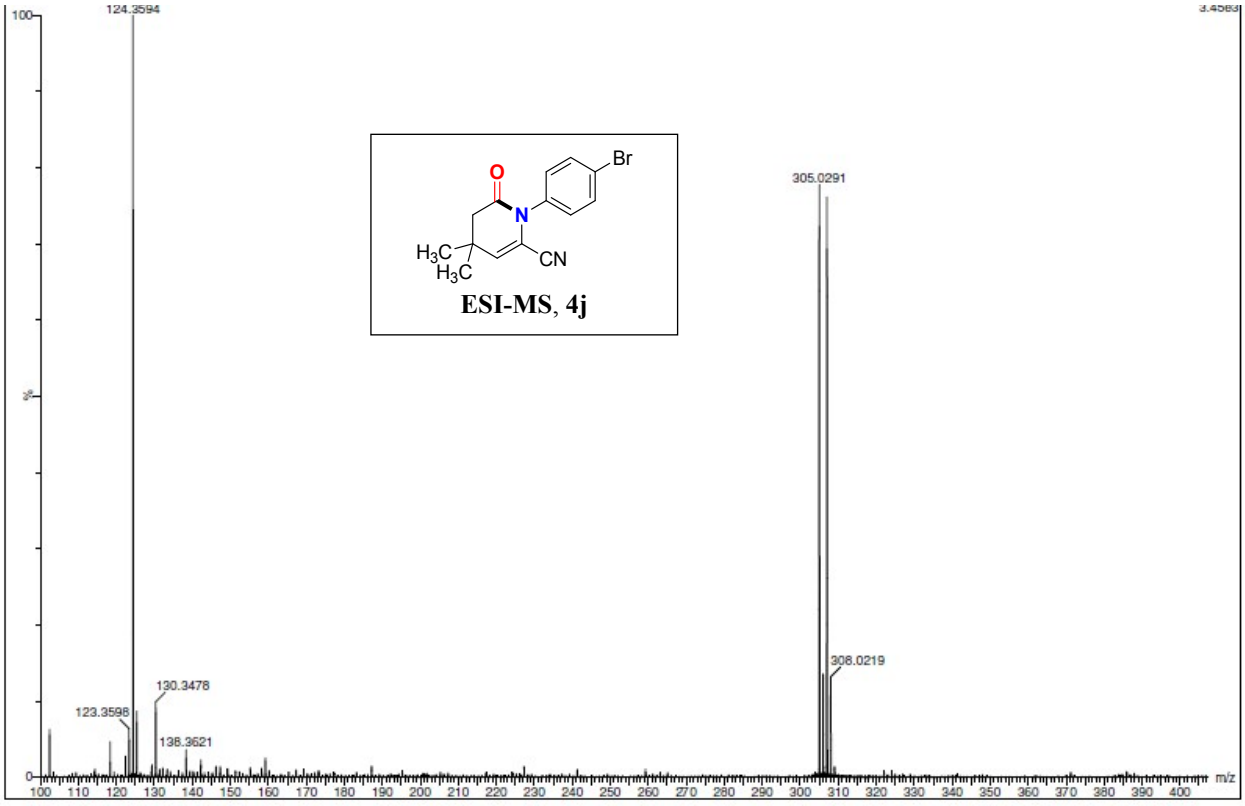
ESI-MS, **4i**

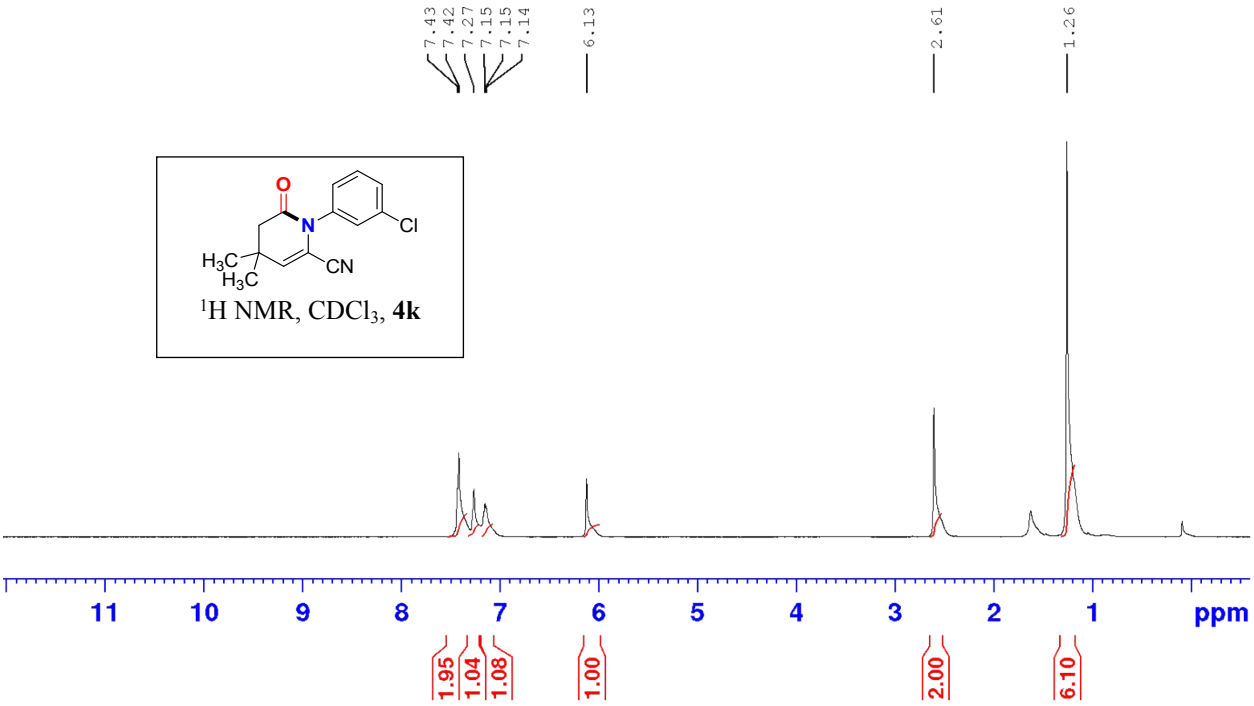


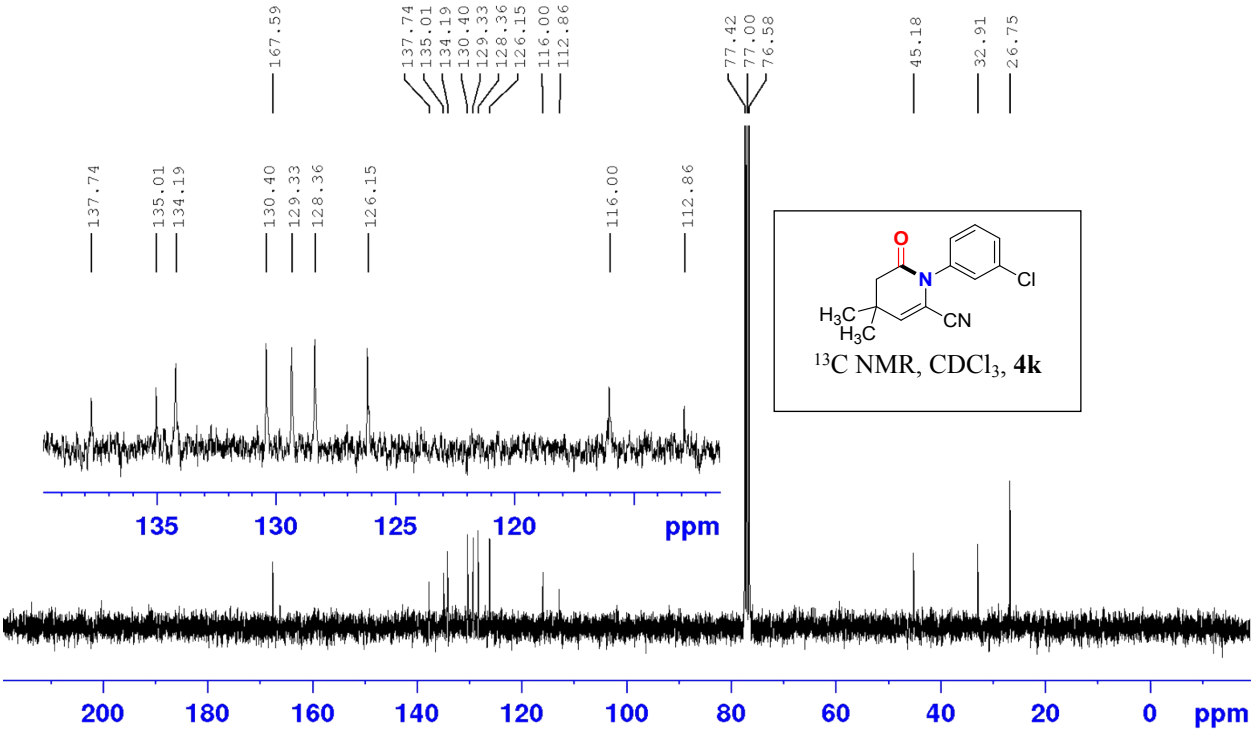
^{1}H NMR, $CDCl_3$, **4j**

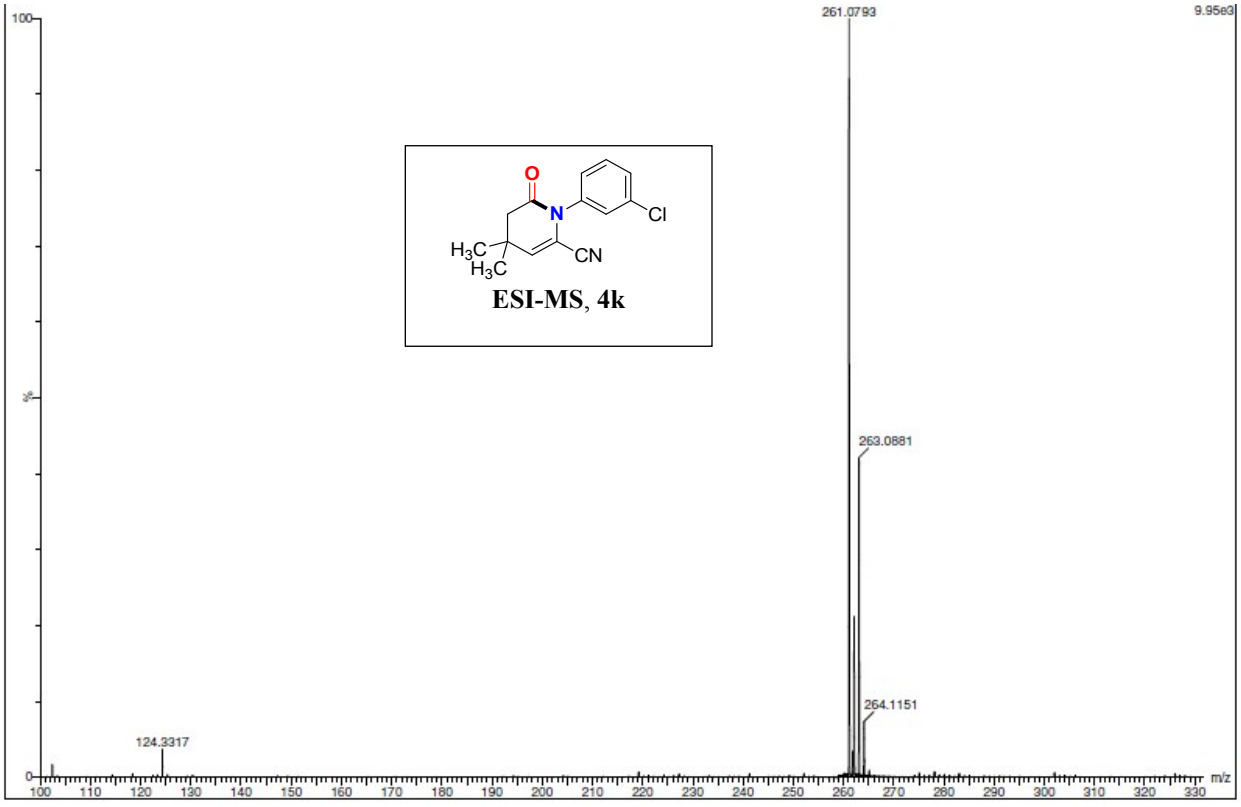


^{13}C NMR, $CDCl_3$, **4j**


124.3594
305.0291
308.0219
130.3478
123.3598
138.3621
Br
O
N
CN
H3C
H3C
ESI-MS, 4j


7.43
7.42
7.27
7.15
7.15
7.14
6.13
2.61
1.26
Cl
O
N
CN
H3C
H3C
1H NMR, CDCl3, 4k
11
10
9
8
7
6
5
4
3
2
1
ppm
1.95
1.04
1.08
1.00
2.00
6.10


167.59
137.74
135.01
134.19
130.40
129.33
128.36
126.15
116.00
112.86
77.42
77.00
76.58
45.18
32.91
26.75
135
130
125
120
ppm
200
180
160
140
120
100
80
60
40
20
0
ppm
O
N
Cl
H3C
H3C
CN
13C NMR, CDCl3, 4k


100
%
0
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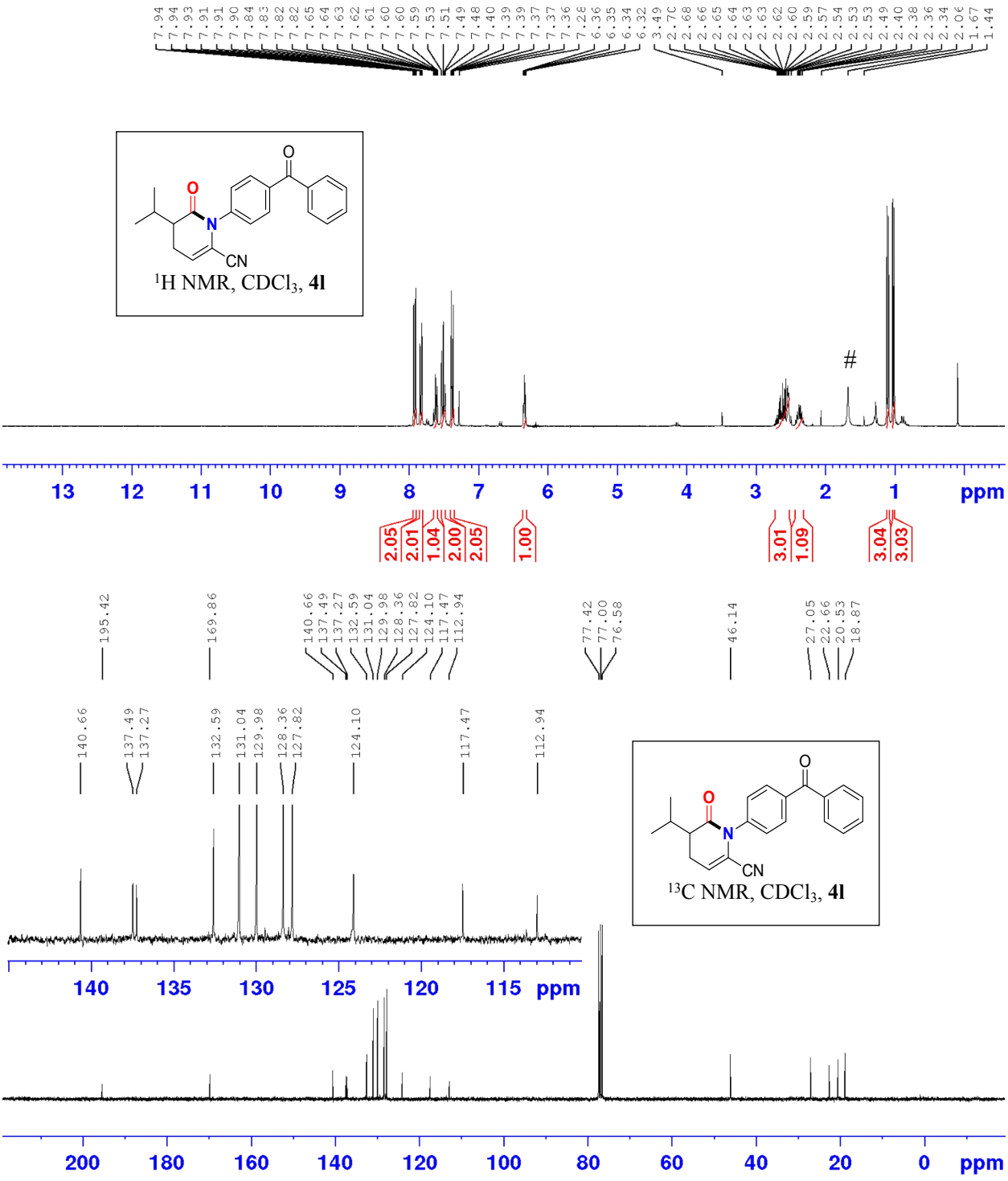
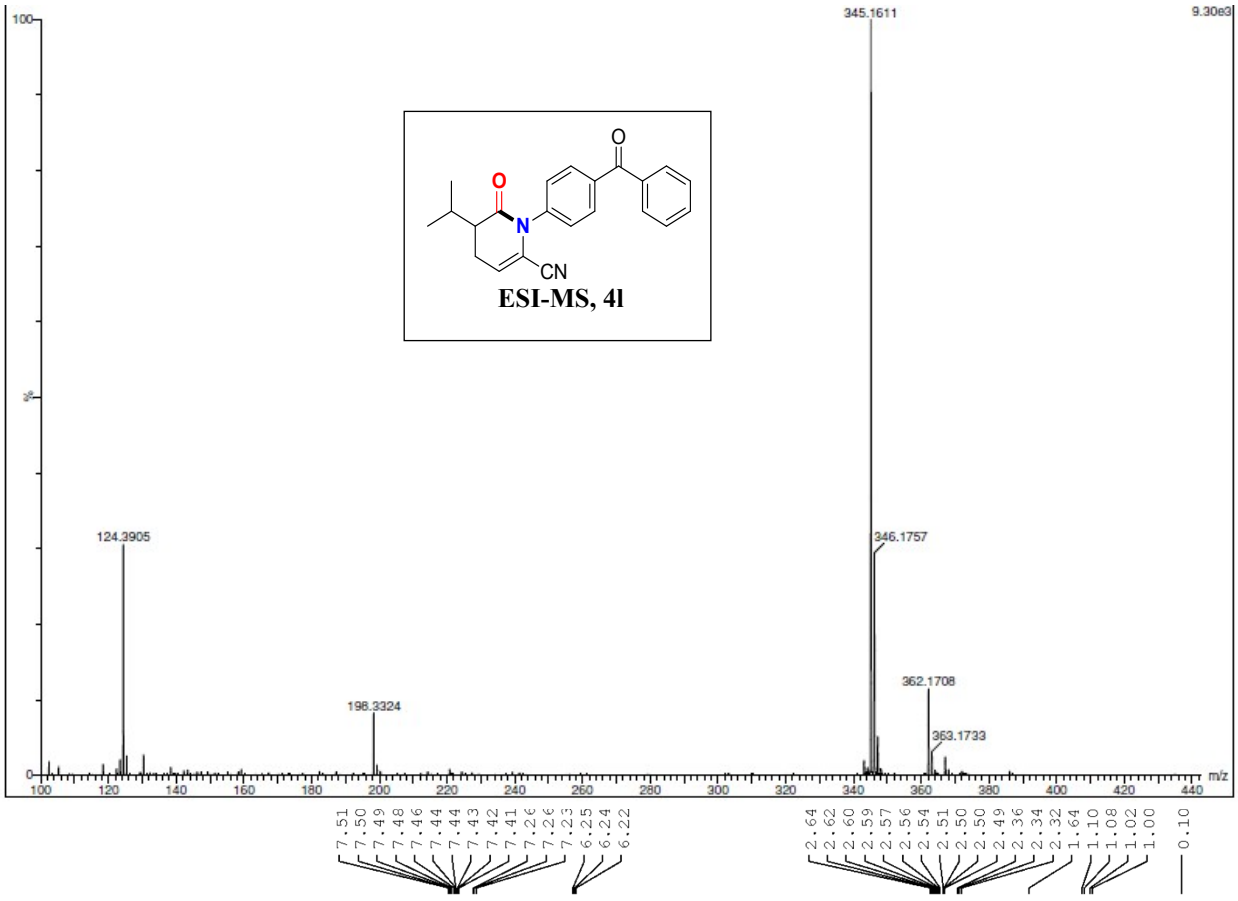
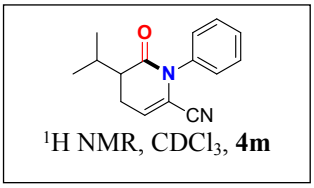
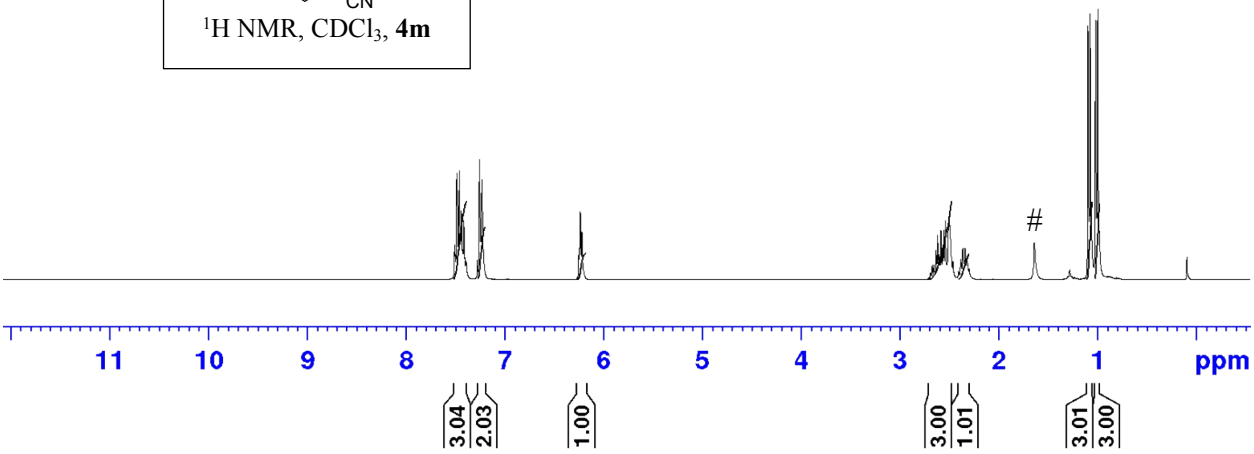
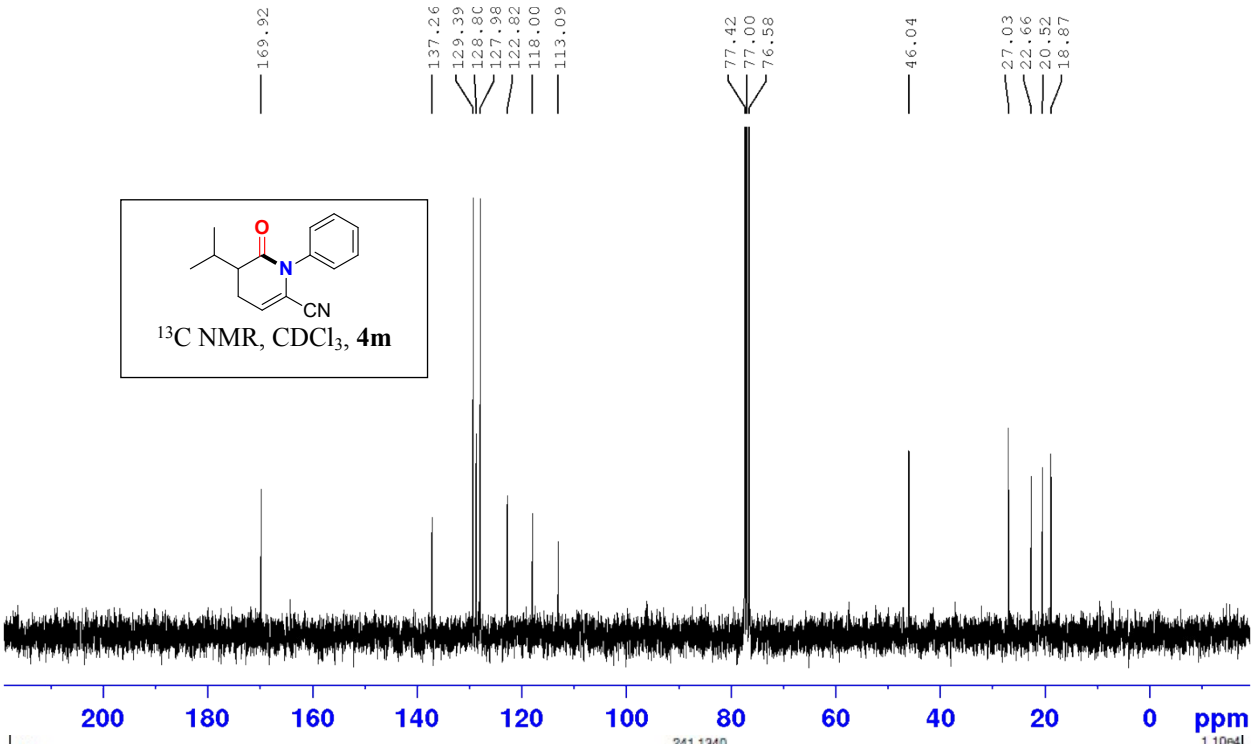
9.95e3
263.0881
264.1151
124.3317
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
m/z
O
N
Cl
H3C
H3C
CN
ESI-MS, 4k


7.94 7.94 7.93 7.91 7.91 7.90 7.84 7.83 7.82 7.82 7.65 7.64 7.63 7.62 7.61 7.60 7.60 7.59 7.53 7.51 7.49 7.48 7.40 7.39 7.39 7.37 7.37 7.36 7.28 6.36 6.35 6.34 6.32 3.49 2.70 2.68 2.66 2.65 2.64 2.63 2.63 2.62 2.60 2.59 2.57 2.54 2.53 2.53 2.49 2.40 2.38 2.36 2.34 2.06 1.67 1.44
O
O
N
CN
^{1}H NMR, $CDCl_3$, **4l**
#
13 12 11 10 9 8 7 6 5 4 3 2 1 ppm
2.05 2.01 1.04 2.00 2.05 1.00 3.01 1.09 3.04 3.03
195.42 169.86 140.66 137.49 137.27 132.59 131.04 129.98 128.36 127.82 124.10 117.47 112.94 77.42 77.00 76.58 46.14 27.05 22.66 20.53 18.87
140.66 137.49 137.27 132.59 131.04 129.98 128.36 127.82 124.10 117.47 112.94
O
O
N
CN
^{13}C NMR, $CDCl_3$, **4l**
140 135 130 125 120 115 ppm
200 180 160 140 120 100 80 60 40 20 0 ppm

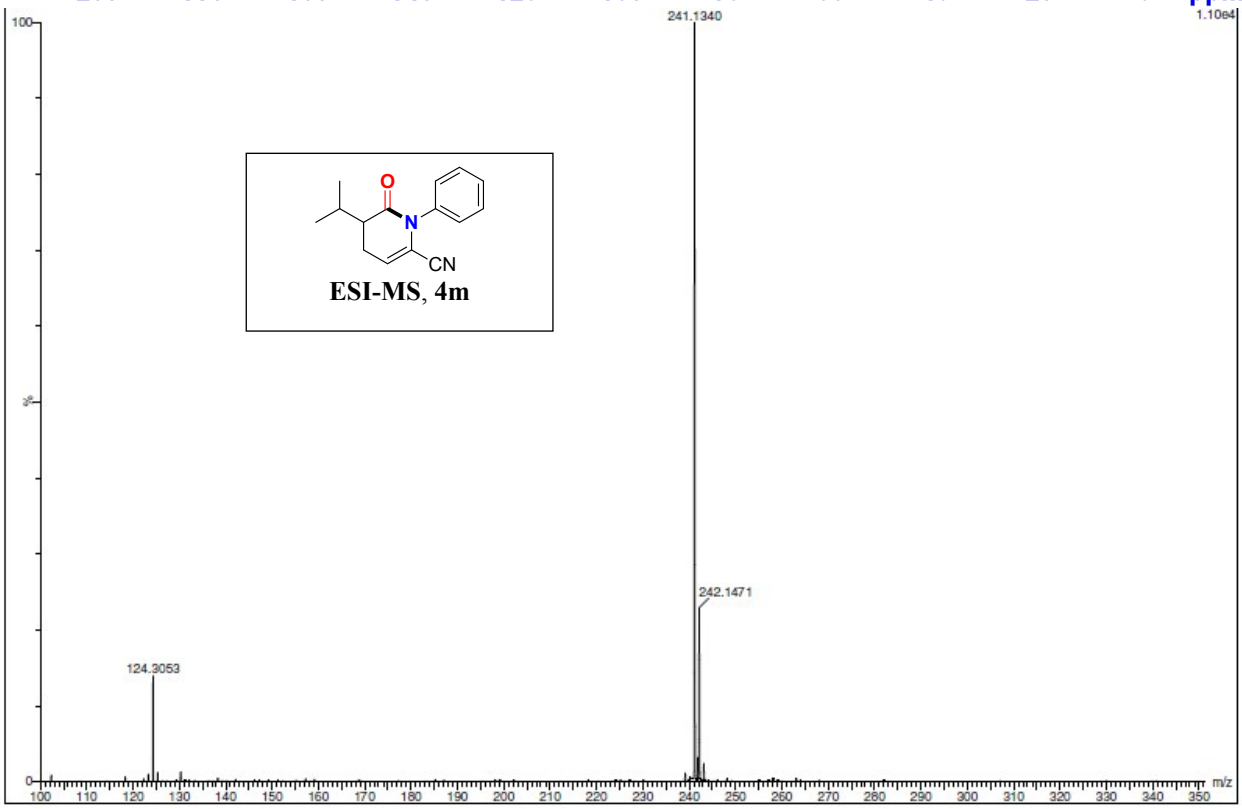

345.1611
9.30e3
124.3905
346.1757
198.3324
362.1708
363.1733
m/z
ESI-MS, 4l


^{1}H NMR, $CDCl_3$, **4m**

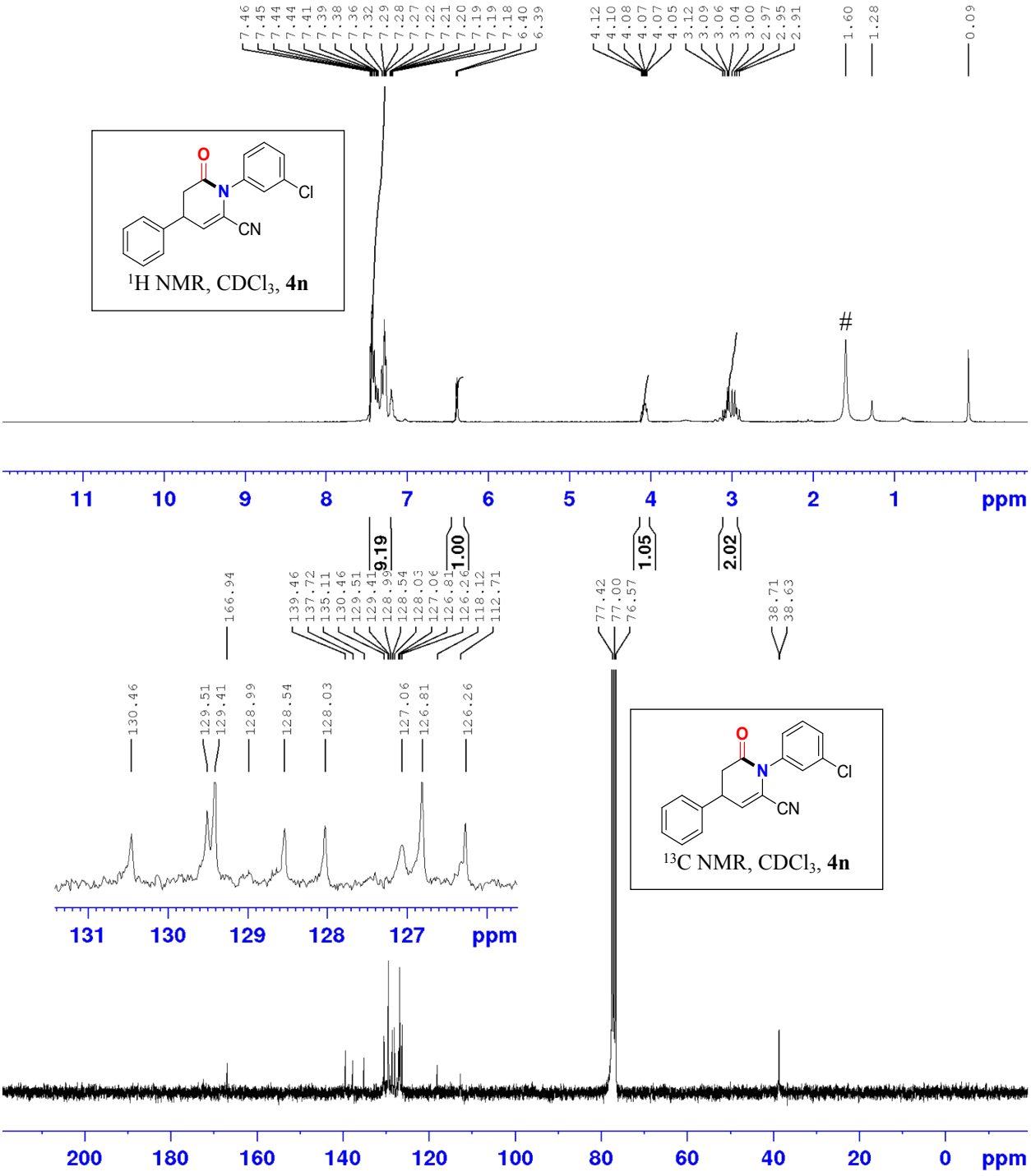

#
ppm
3.04
2.03
1.00
3.00
1.01
3.01
3.00

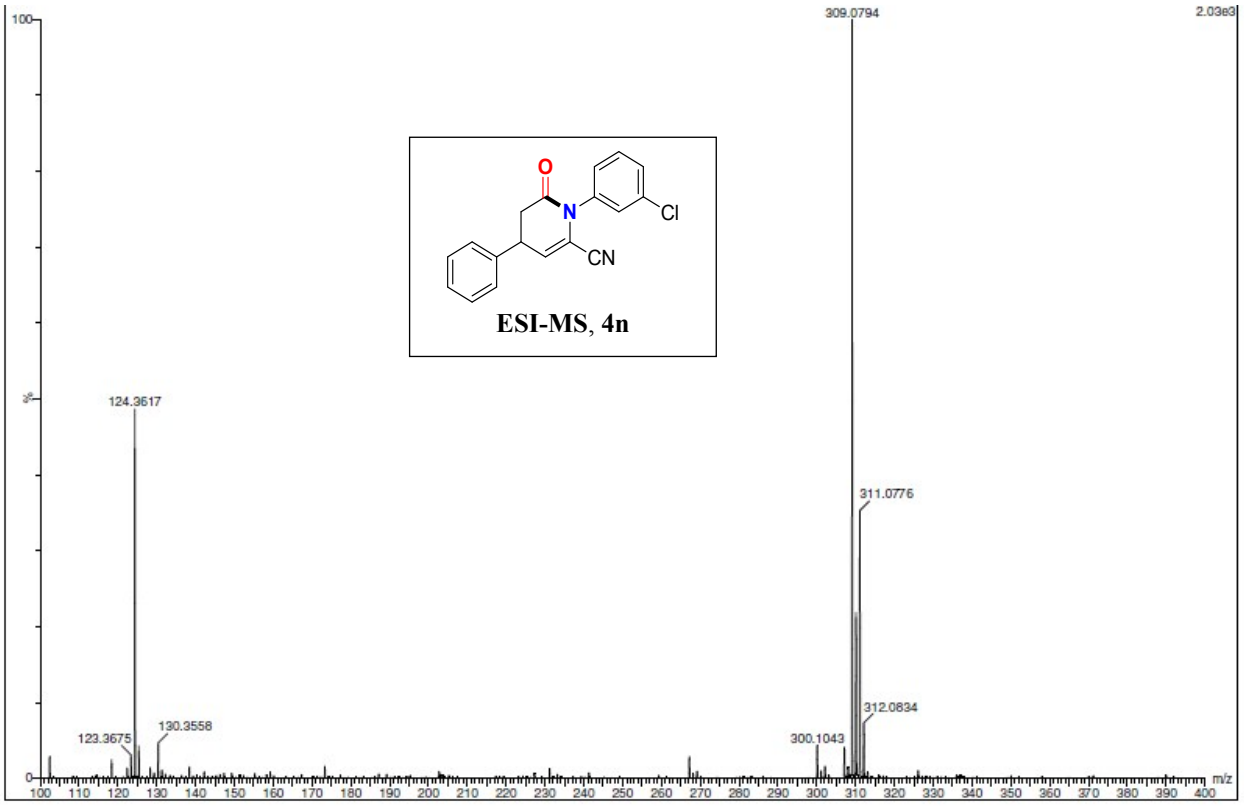


^{13}C NMR, $CDCl_3$, **4m**

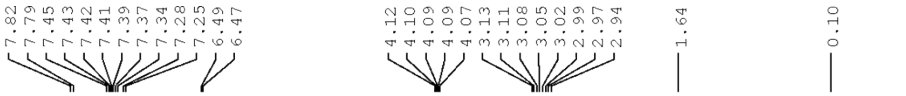


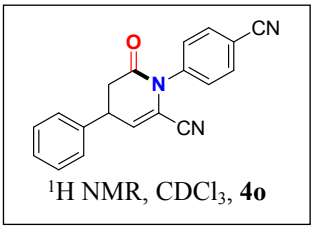
ESI-MS, **4m**


7.46
7.45
7.44
7.44
7.41
7.39
7.38
7.36
7.32
7.29
7.28
7.27
7.22
7.21
7.20
7.19
7.19
7.18
6.40
6.39
4.12
4.10
4.08
4.07
4.07
4.05
3.12
3.09
3.06
3.04
3.00
2.97
2.95
2.91
1.60
1.28
0.09
O
N
Cl
CN
^{1}H NMR, $CDCl_3$, **4n**
#
11
10
9
8
7
6
5
4
3
2
1
ppm
9.19
1.00
1.05
2.02
166.94
139.46
137.72
135.11
130.46
129.51
129.41
128.99
128.54
128.03
127.06
126.81
126.26
118.12
112.71
77.42
77.00
76.57
38.71
38.63
130.46
129.51
129.41
128.99
128.54
128.03
127.06
126.81
126.26
131
130
129
128
127
ppm
^{13}C NMR, $CDCl_3$, **4n**
200
180
160
140
120
100
80
60
40
20
0
ppm

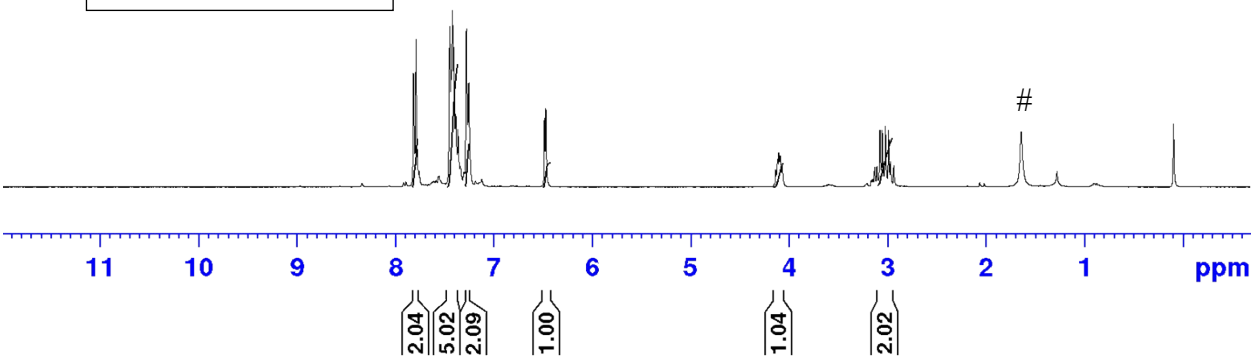


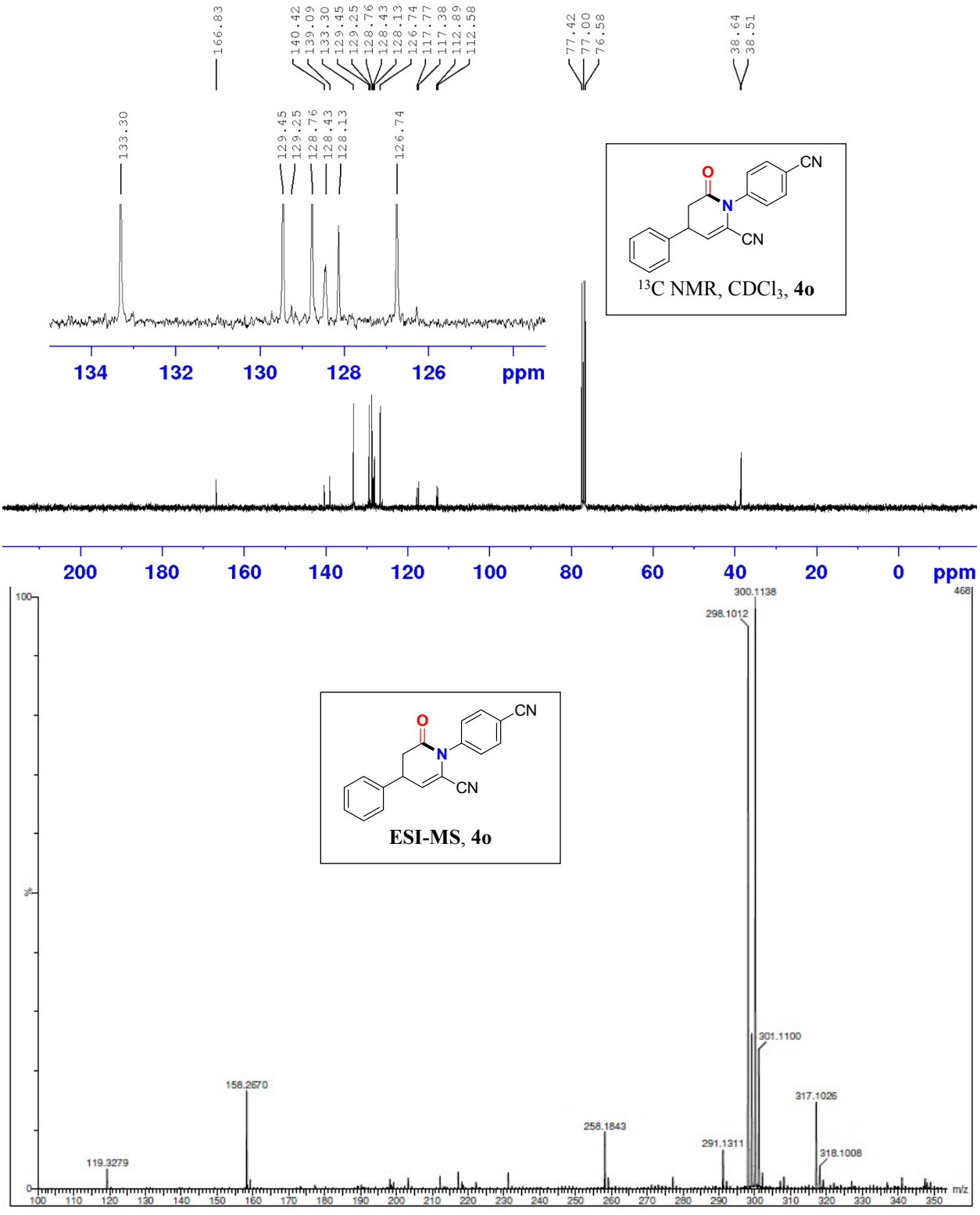
ESI-MS, 4n

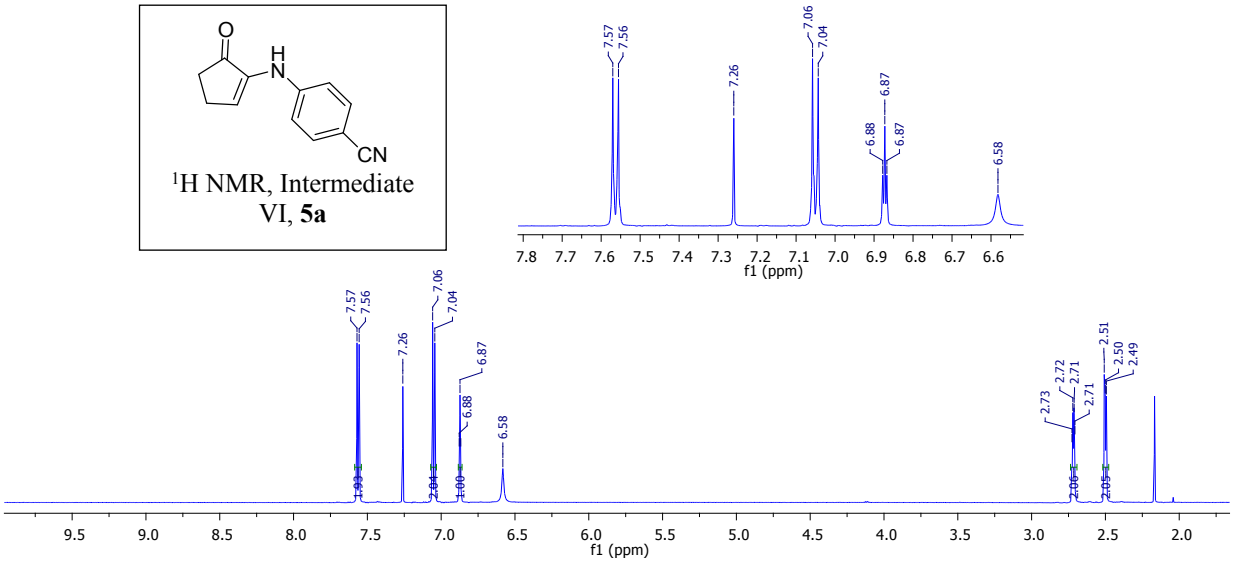


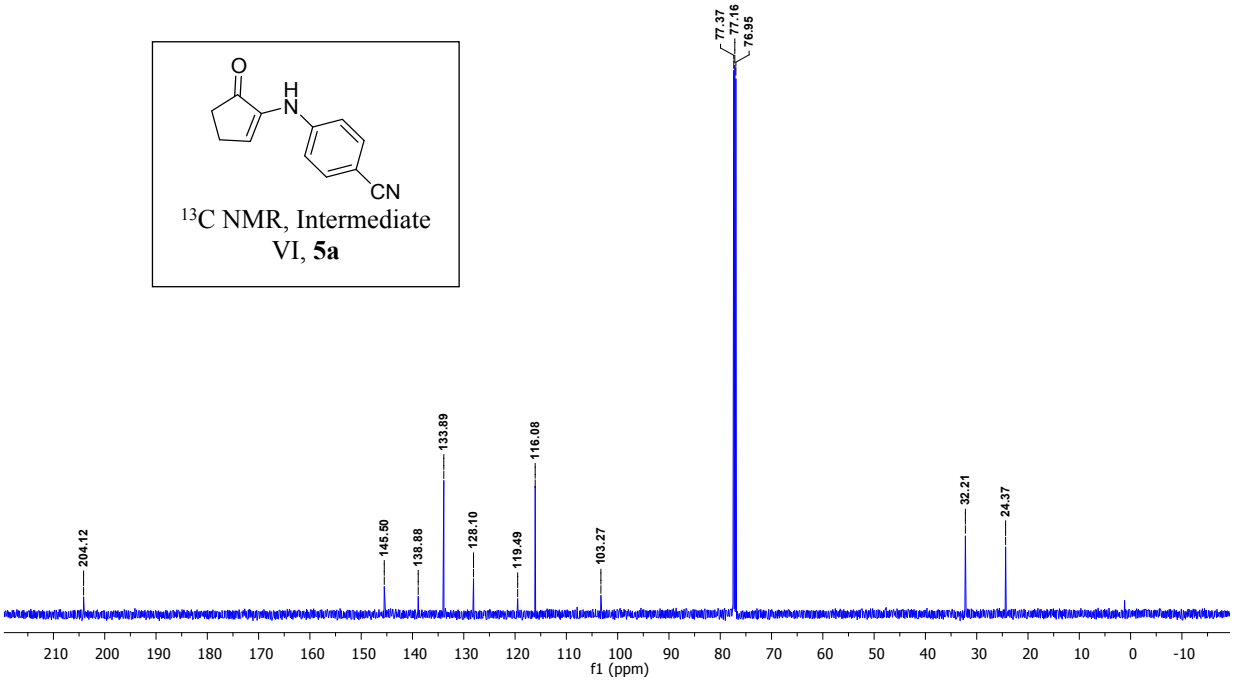


^{1}H NMR, $CDCl_3$, **4o**

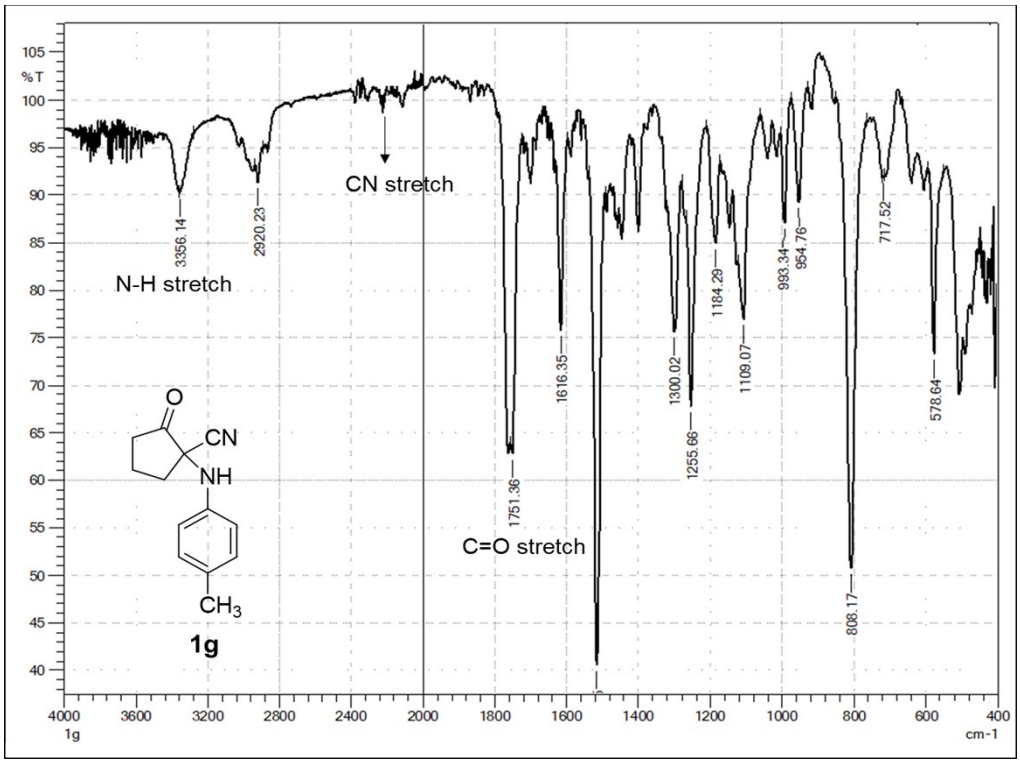


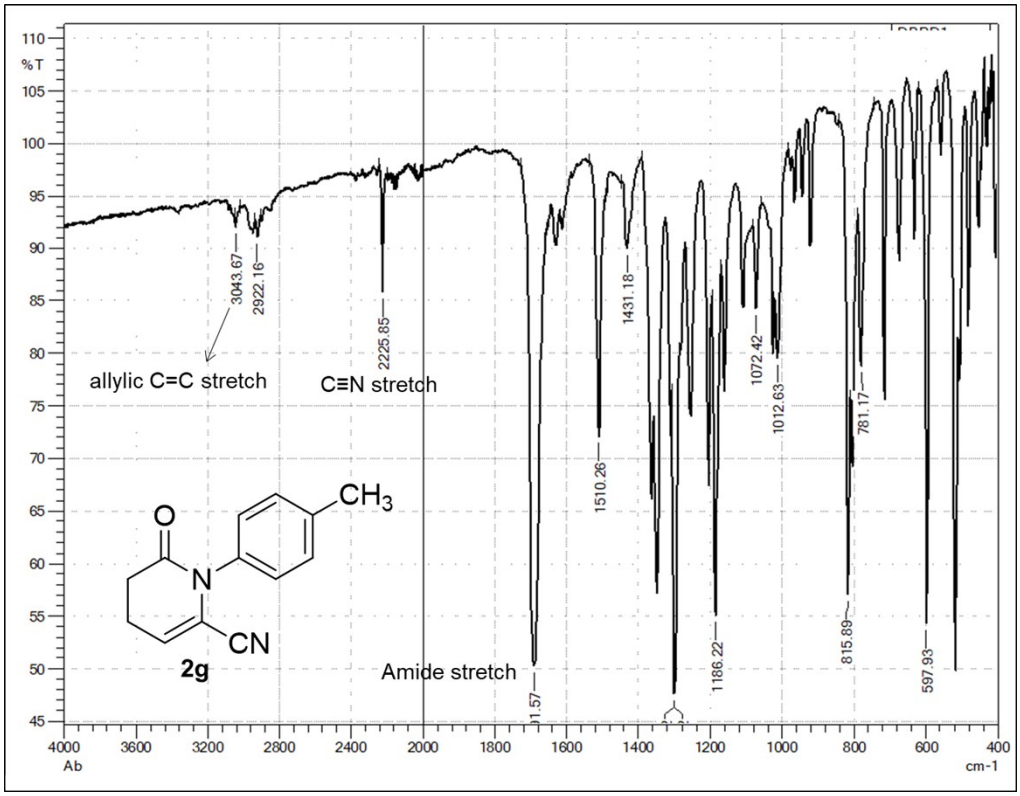

166.83
140.42
139.09
133.30
129.45
129.25
128.76
128.43
128.13
126.74
117.77
117.38
112.89
112.58
77.42
77.00
76.58
38.64
38.51
133.30
129.45
129.25
128.76
128.43
128.13
126.74
134
132
130
128
126
ppm
O
N
CN
CN
13C NMR, CDCl3, 4o
200
180
160
140
120
100
80
60
40
20
0
ppm
100
%
0
300.1138
298.1012
301.1100
317.1026
318.1008
291.1311
258.1843
158.2670
119.3279
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
m/z
ESI-MS, 4o

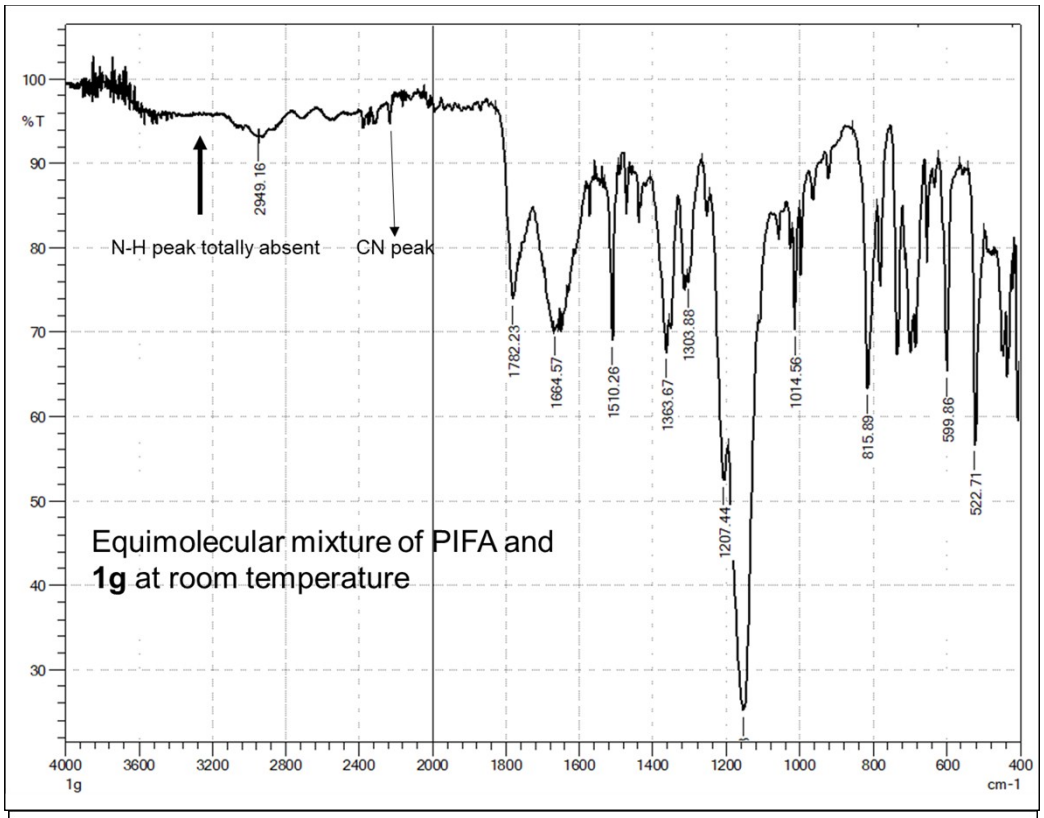


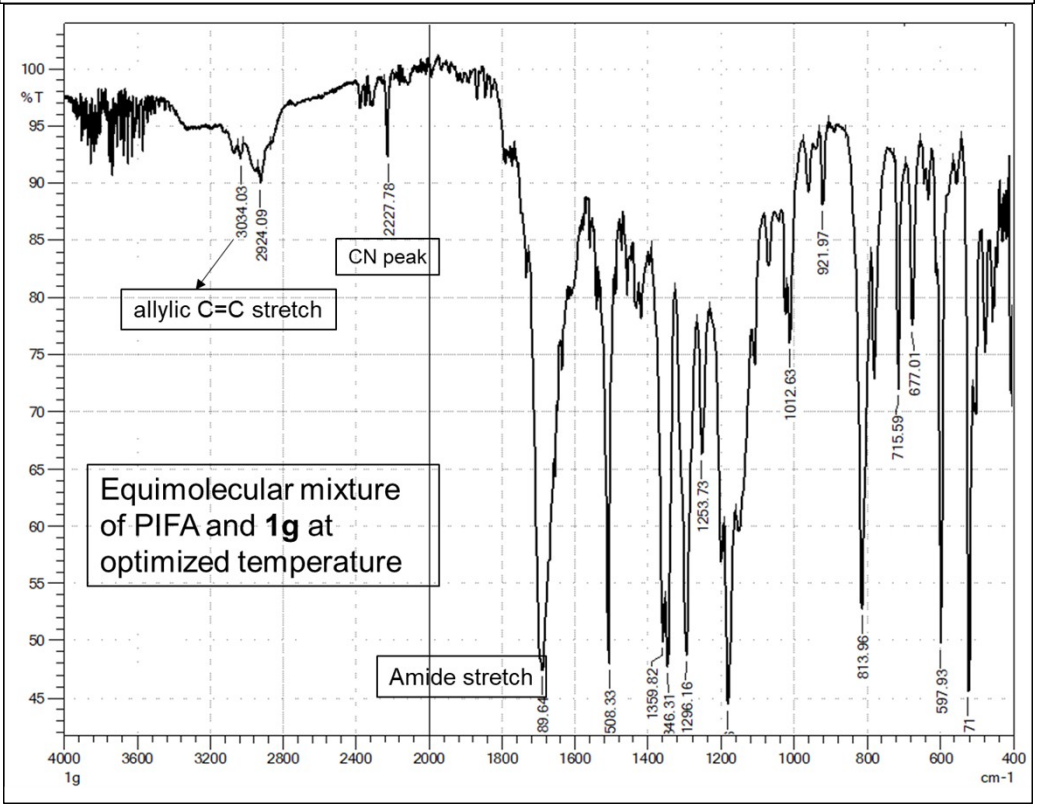


(E) Spectral data (IR and NMR) for reaction intermediates.

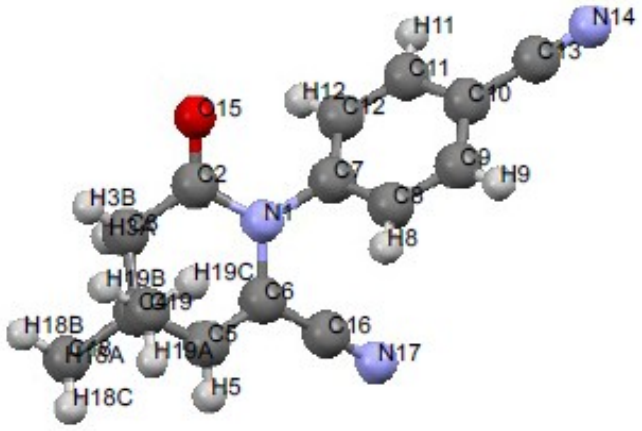

%T
3356.14
2920.23
CN stretch
N-H stretch
1751.36
1616.35
1300.02
1255.66
1184.29
1109.07
993.34
954.76
808.17
717.52
578.64
C=O stretch
O
CN
NH
CH3
1g
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
600
400
cm-1


%T
3043.67
2922.16
2225.85
allylic C=C stretch
C≡N stretch
1510.26
1431.18
1072.42
1012.63
815.89
781.17
597.93
1186.22
1571.57
Amide stretch
CH3
O
N
CN
2g
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
600
400
cm-1


%T
2949.16
N-H peak totally absent
CN peak
1782.23
1664.57
1510.26
1363.67
1303.88
1207.44
1014.56
815.89
599.86
522.71
Equimolecular mixture of PIFA and
1g at room temperature
1g
cm-1


%T
3034.03
2924.09
2227.78
CN peak
allylic C=C stretch
921.97
1012.63
715.59
677.01
1253.73
Equimolecular mixture
of PIFA and 1g at
optimized temperature
Amide stretch
89.64
508.33
1359.82
1346.31
1296.16
813.96
597.93
71
1g
cm-1

(F) Crystallographic Data for compound 4i (CCDC1861158).



Compound 4i

```
Bond precision:  C-C = 0.0074 A          Wavelength=1.54184

Cell:            a=7.5028(10)     b=10.3065(10)       c=17.339(2)
                 alpha=90         beta=93.209(11)     gamma=90
Temperature:     293 K

                 Calculated                Reported
Volume           1338.7(3)                 1338.7(3)
Space group      P 21/c                    P 1 21/c 1
Hall group       -P 2ybc                   -P 2ybc
Moiety formula   C15 H13 N3 O              C15 H13 N3 O
Sum formula      C15 H13 N3 O              C15 H13 N3 O
Mr               251.28                    251.28
Dx,g cm-3        1.247                     1.247
Z                4                         4
Mu (mm-1)        0.651                     0.651
F000             528.0                     528.0
F000'            529.54
h,k,lmax         8,12,20                   8,12,20
Nref             2379                      2259
Tmin,Tmax        0.787,0.912               0.453,1.000
Tmin'            0.787

Correction method= # Reported T Limits: Tmin=0.453 Tmax=1.000
AbsCorr = GAUSSIAN

Data completeness= 0.950          Theta(max)= 66.930

R(reflections)= 0.0934( 1466)     wR2(reflections)= 0.4097( 2259)

S = 1.639                 Npar= 174
```

Table S2. Crystal data and structure refinement for compound 4i.	
Identification code	4i
Empirical formula	$C_{15}H_{13}N_3O$
Formula weight	251.28
Temperature/K	293(2)
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	7.5028(10)
b/Å	10.3065(10)
c/Å	17.339(2)
α/°	90
β/°	93.209(11)
γ/°	90
Volume/Å^3	1338.7(3)
Z	4
ρ_{calc}g/cm^3	1.247
μ/mm^{-1}	0.651
F(000)	528
Crystal size/mm^3	0.367 × 0.333 × 0.141
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	9.98 to 133.86
Index ranges	$-8 \le h \le 8$, $-10 \le k \le 12$, $-20 \le l \le 18$
Reflections collected	3969
Independent reflections	2259 [R_{int} = 0.0287, R_{sigma} = 0.0316]
Data/restraints/parameters	2259/0/174
Goodness-of-fit on F^2	1.639
Final R indexes [I>=2σ (I)]	R_1 = 0.0934, wR_2 = 0.2885
Final R indexes [all data]	R_1 = 0.1436, wR_2 = 0.4097
Largest diff. peak/hole / e Å^{-3}	0.39/-0.52

Table S3. Displacement Parameters (Å2×103) for 4i. Ueq is defined as 1/3 of of the trace of the orthogonalised UIJ tensor.				
Atom	x	y	z	U(eq)
O15	2603(5)	2678(3)	2244(2)	75.4(12)
N1	3088(5)	519(3)	2106(2)	58.5(11)
C2	2246(7)	1576(4)	2439(3)	59.6(12)
C16	3299(7)	-1815(4)	1924(3)	63.7(13)
C9	7454(7)	387(5)	1211(3)	69.7(15)
C6	2761(6)	-746(4)	2384(3)	57.3(12)
C13	8536(8)	1381(5)	49(4)	78.1(17)
C8	6137(7)	195(4)	1720(3)	64.0(13)
C12	4109(7)	1457(5)	916(3)	68.3(14)
C7	4452(7)	732(4)	1566(3)	60.2(13)
C5	1964(7)	-965(5)	3036(3)	68.0(14)
C11	5427(7)	1664(5)	414(3)	71.3(15)
C10	7123(7)	1136(5)	563(4)	67.1(14)
N17	3682(7)	-2686(4)	1556(3)	85.0(16)
C4	1337(7)	113(5)	3540(3)	63.7(13)
C19	2810(8)	463(6)	4137(3)	79.0(17)
C3	885(8)	1260(5)	3007(3)	69.5(14)
C18	-349(8)	-281(6)	3943(4)	84.5(19)
N14	9684(8)	1594(6)	-340(4)	109(2)

Table S4. Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for 4i. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\ldots]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
O15	106(3)	40.7(18)	80(3)	4.1(16)	13(2)	8.9(16)
N1	73(3)	38.7(19)	66(2)	2.8(16)	16(2)	5.2(15)
C2	78(3)	49(2)	52(3)	-0.2(19)	11(2)	6.9(19)
C16	77(3)	46(2)	70(3)	0(2)	15(2)	-0.9(19)
C9	70(3)	51(2)	89(4)	3(2)	13(3)	7(2)
C6	71(3)	42(2)	60(3)	1.9(19)	13(2)	-0.5(18)
C13	87(4)	63(3)	87(4)	13(3)	27(3)	10(3)
C8	72(3)	47(2)	74(3)	6(2)	11(2)	4.9(19)
C12	74(3)	56(3)	76(3)	8(2)	9(3)	10(2)
C7	73(3)	38(2)	71(3)	0.2(19)	15(2)	4.7(18)
C5	88(3)	44(2)	74(3)	-1(2)	18(3)	-8(2)
C11	83(4)	59(3)	73(3)	14(2)	19(3)	8(2)
C10	72(3)	46(2)	85(4)	-1(2)	20(3)	4(2)
N17	100(4)	58(3)	99(4)	-19(3)	24(3)	4(2)
C4	79(3)	56(3)	58(3)	-8(2)	12(2)	-9(2)
C19	92(4)	78(4)	67(4)	-4(3)	11(3)	-17(3)
C3	82(3)	62(3)	66(3)	-10(2)	16(3)	10(2)
C18	88(4)	81(4)	87(4)	-22(3)	26(3)	-25(3)
N14	105(4)	93(4)	134(5)	40(4)	63(4)	22(3)

Table S5. Bond Lengths for 4i.

Atom	Atom	Length/Å		Atom	Atom	Length/Å
O15	C2	1.219(6)		C13	C10	1.445(7)
N1	C2	1.400(6)		C13	N14	1.145(7)
N1	C6	1.417(5)		C8	C7	1.391(7)
N1	C7	1.442(6)		C12	C7	1.366(7)
C2	C3	1.493(7)		C12	C11	1.370(7)
C16	C6	1.431(6)		C5	C4	1.505(7)
C16	N17	1.147(7)		C11	C10	1.395(8)
C9	C8	1.376(7)		C4	C19	1.515(8)
C9	C10	1.374(8)		C4	C3	1.526(8)
C6	C5	1.328(7)		C4	C18	1.534(7)

Table S6. Bond Angles for 4i.

Atom	Atom	Atom	Angle/°		Atom	Atom	Atom	Angle/°
C2	N1	C6	119.0(4)		C12	C7	N1	120.7(4)
C2	N1	C7	120.2(4)		C12	C7	C8	120.2(5)
C6	N1	C7	120.2(4)		C6	C5	C4	122.6(4)
O15	C2	N1	119.9(4)		C12	C11	C10	120.3(5)
O15	C2	C3	123.7(4)		C9	C10	C13	119.8(5)
N1	C2	C3	116.3(4)		C9	C10	C11	119.5(5)
N17	C16	C6	178.0(6)		C11	C10	C13	120.7(5)
C10	C9	C8	120.1(5)		C5	C4	C19	109.4(5)
N1	C6	C16	117.4(4)		C5	C4	C3	106.7(4)
C5	C6	N1	122.7(4)		C5	C4	C18	111.2(4)
C5	C6	C16	119.9(4)		C19	C4	C3	111.0(4)
N14	C13	C10	178.0(8)		C19	C4	C18	109.9(4)
C9	C8	C7	119.8(5)		C3	C4	C18	108.6(5)

Table S7. Torsion Angles for 4i.

A	B	C	D	Angle/°	A	B	C	D	Angle/°
O15	C2	C3	C4	−143.8(5)	C8	C9	C10	C11	-2.1(8)
N1	C2	C3	C4	38.5(6)	C12	C11	C10	C9	1.1(8)
N1	C6	C5	C4	-0.1(9)	C12	C11	C10	C13	−178.1(5)
C2	N1	C6	C16	166.0(5)	C7	N1	C2	O15	3.7(8)
C2	N1	C6	C5	-12.8(8)	C7	N1	C2	C3	−178.4(4)
C2	N1	C7	C8	123.0(5)	C7	N1	C6	C16	-22.6(7)
C2	N1	C7	C12	-56.5(7)	C7	N1	C6	C5	158.5(5)
C16	C6	C5	C4	−179.0(5)	C7	C12	C11	C10	0.1(8)
C9	C8	C7	N1	179.9(4)	C5	C4	C3	C2	-46.8(6)
C9	C8	C7	C12	-0.6(7)	C11	C12	C7	N1	179.2(5)
C6	N1	C2	O15	175.1(5)	C11	C12	C7	C8	-0.3(8)
C6	N1	C2	C3	-7.1(7)	C10	C9	C8	C7	1.8(8)
C6	N1	C7	C8	-48.2(7)	N17	C16	C6	N1	-127(18)
C6	N1	C7	C12	132.3(5)	N17	C16	C6	C5	52(18)
C6	C5	C4	C19	-91.2(7)	C19	C4	C3	C2	72.4(6)
C6	C5	C4	C3	29.0(7)	C18	C4	C3	C2	−166.7(4)
C6	C5	C4	C18	147.3(6)	N14	C13	C10	C9	-61(17)
C8	C9	C10	C13	177.2(5)	N14	C13	C10	C11	119(17)

Table S8. Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for 4i.

Atom	*x*	*y*	*z*	U(eq)
H9	8570	8	1305	84
H8	6371	-291	2166	77
H12	2980	1810	813	82
H5	1785	-1819	3187	82
H11	5190	2159	-29	86
H19A	3049	-265	4473	119
H19B	2443	1190	4435	119
H19C	3871	684	3882	119
H3A	-240	1080	2724	83
H3B	711	2020	3324	83
H18A	-1236	-584	3565	127
H18B	-804	456	4208	127
H18C	-63	-960	4308	127

(G) References:

(a) D. Bhattacherjee, V. Thakur, S. Sharma, S. Kumar, R. Bharti, C. B. Reddy and P. Das, *Adv. Synth. Catal.* **2017**, *359*, 2209-2214.

[#]In proton NMR spectra refers peak of H_2O in $CDCl_3$ as impurities and it is not taken into account in the yield calculations of final products.