Reassembly and Functionalization of *N*-CF_3 Pyridinium Salts: Synthesis of Nicotinaldehydes

Xiaowei Liu,[‡a] Shuang Wang,[‡b] Chi Gao,[a] Wei Guan*[,b] and Mang Wang*[,a]

[a]Jilin Province Key Laboratory of Organic Functional Molecular Design & Synthesis, College of Chemistry, Northeast Normal University, Changchun 130024, China

[b]Institute of Functional of Material, Faculty of Chemistry, Northeast Normal University, Changchun 130024, China

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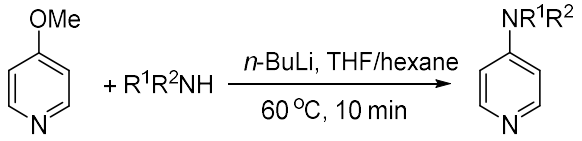
1. General Information.

All reagents were purchased from commercial sources and used without treatment, unless otherwise indicated. The products were purified by column chromatography over silica gel (particle size 300-400 mesh ASTM, purchased from Taizhou, China). ^{1}H NMR and ^{13}C NMR spectra were recorded at 25 ºC on a Bruker 600 MHz or Varian 500 MHz, 400 MHz, and 151 MHz or 125 MHz spectrometer, respectively by using TMS as internal standard. ^{19}F NMR were recorded at 25 ºC on a Bruker 565 MHz or Varian 470 MHz spectrometer. Data for ^{1}H, ^{13}C, ^{19}F were recorded as follows: chemical shift (δ, ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublets, ddd = doublet of doublet of doublets, dt = doublet of triplets, dq = doublet of quartets, td = triplet of doublets). High-resolution mass spectra (HRMS) were obtained using a Bruker micro TOF II focus spectrometer (ESI).

2. Experimental Data for *N*-CF_3 Pyridinium Preparation

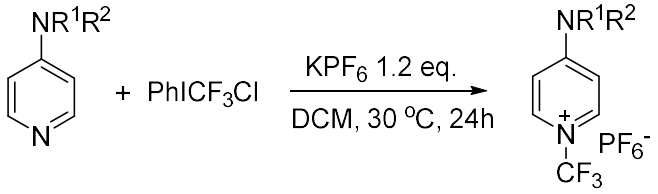
Preparation of 4-dialkylamino-pyridins.[1]



A round-bottomed flask reaction tube (50 mL) was equipped with a magnetic stir bar, and the reaction tube was vacuumed and filled with N_2 three times at -78 °C. Then the aliphatic amine (10 mmol) was added under N_2 atmosphere, followed by THF (6.2 mL) and *n*-BuLi (11 mmol, 4.4 mL, 2.5 M in hexane) by syringe at -78 °C. The round-bottomed flask was stirred at room temperature for 10 min. Then 4-methoxypyridine (16 mmol) was added quickly by syringe. The reaction mixture was stirred in a 60 °C oil bath for 10 min. The reaction mixture was then allowed to cool to room temperature, quenched by water (36 mL), and then extracted with DCM (3 × 20 mL). The solvent layer was dried with dried Na_2SO_4. The crude mixture was concentrated in vacuo and purified by flash column chromatography eluting with EtOAc (1% Et_3N) to give the target compound.

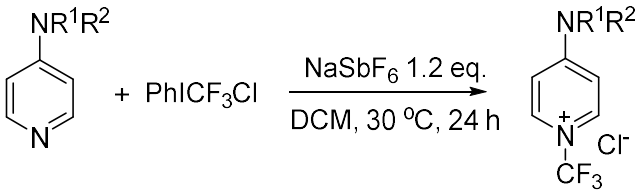
Trifluoromethylation of 4-alkylamino-pyridine

Method A:



A dry Schlenk tube (20 mL) under N_2 equipped with a magnetic stirring bar and a rubber septum was charged with $PhICF_3Cl$ (1.1 mmol, 1.1 equiv.), KPF_6 (1.2 mmol, 1.2 equiv.) and solution of 4-substituted-pyridine in DCM (1.0 mmol, 1.0 mL) was added with a syringe. The resulting mixture was stirred for 24 h at 30 °C, a saturated aqueous solution of NaCl (30 mL) was added, aqueous phase was extracted with DCM (3 × 10 mL). The combined organic extracts were dried over anhydrous $MgSO_4$, filtered and concentrated under reduced pressure to yield the crude product, which was purified by silica gel chromatography or recrystallization to give *N*-CF_3 pyridinium salt **1a-f**.

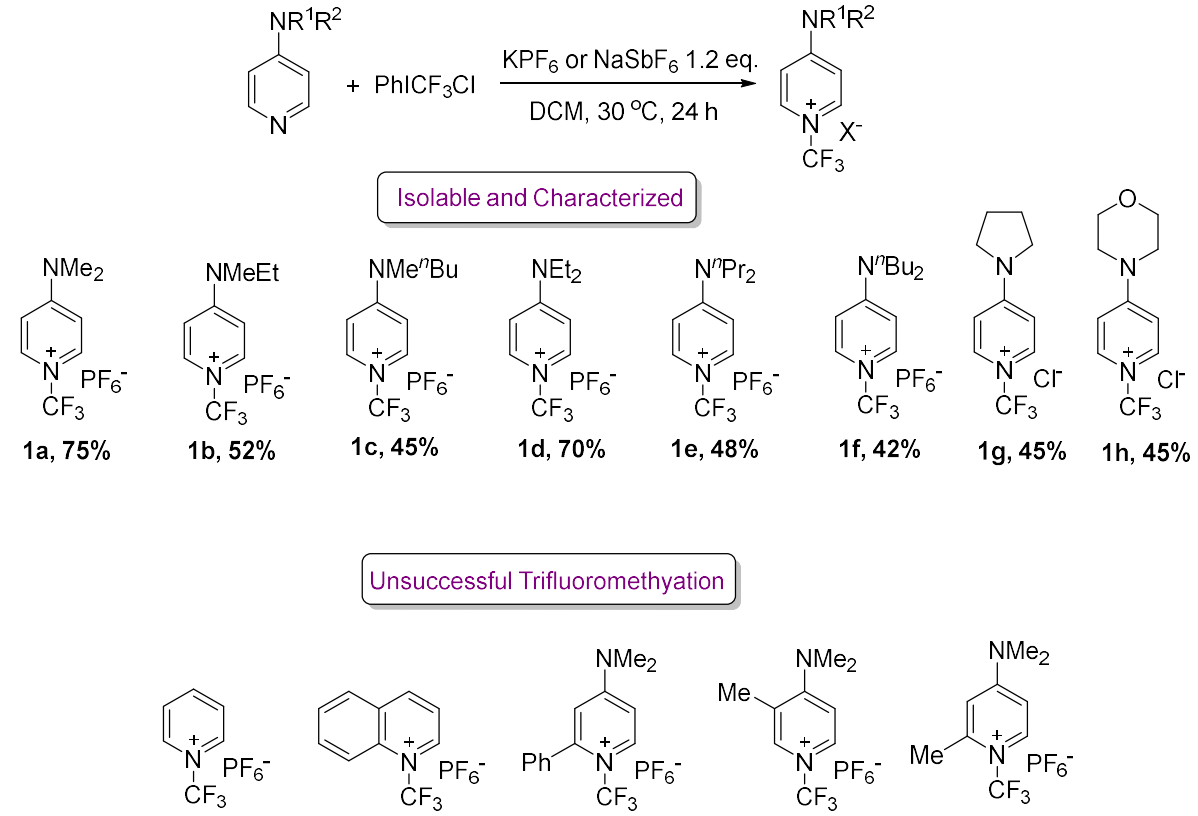
Method B:



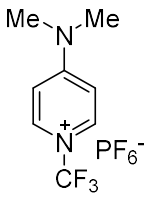
A dry Schlenk tube (20 mL) under N_2 equipped with a magnetic stirring bar and a rubber septum was charged with $PhICF_3Cl$ (1.1 mmol, 1.1 equiv.), $NaSbF_6$ (1.2 mmol, 1.2 equiv.) and solution

of 4-substituted-pyridine in DCM (1.0 mmol, 1.0 mL) was added with a syringe. The resulting mixture was stirred for 24 h at 30 °C, a saturated aqueous solution of NaCl (30 mL) was added, aqueous phase was extracted with DCM (3 × 10 mL). The combined organic extracts were dried over anhydrous $MgSO_4$, filtered and concentrated under reduced pressure to yield the crude product, which was purified by silica gel chromatography or recrystallization to give *N*-CF_3 pyridinium salt **1g** and **1h**.

Table S1. Scope of Trifluoromethylation of Pyridine.

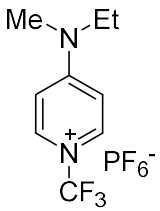


4-(dimethylamino)-1-(trifluoromethyl)pyridin-1-ium hexafluorophosphate(V) (1a)



Yellow solid. mp: 134.4-134.8 °C. **^{1}H NMR** (600 MHz, DMSO-d_6) δ 8.70 (d, J = 8.2 Hz, 2H), 7.21 (d, J = 8.1 Hz, 2H), 3.36 (s, 6H). **^{13}C NMR** (151 MHz, DMSO-d_6) δ 157.8, 136.3, 136.2, 118.7 (q, J = 268.8 Hz, 1C), 108.5 (2C), 41.3 (2C). **^{19}F NMR** (470 MHz, DMSO-d_6) δ -55.0 (s, 3F, CF_3), -65.4 (d, J = 228.0 Hz, 6F, PF_6). **HRMS** (ESI-TOF) calcd for $C_8H_{10}F_3N_2^+$ ([M]$^+$) 191.0791, found 191.0795.

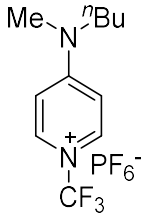
4-(ethyl(methyl)amino)-1-(trifluoromethyl)pyridin-1-ium hexafluorophosphate(V) (1b)



Yellow solid. mp: 78.3-78.6 °C. **^{1}H NMR** (600 MHz, Acetone-d_6) δ 8.62 (dd, J = 8.0 Hz, 2.4 Hz, 1H), 8.59 (dd, J = 8.1 Hz, 2.3 Hz, 1H), 7.43 (dd, J = 8.1 Hz, 3.1 Hz, 1H), 7.32 (dd, J = 8.1 Hz, 3.1 Hz, 1H), 3.94 (q, J = 7.2 Hz, 2H), 3.52 (s, 3H), 1.37 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (151 MHz, Acetone-d_6) δ 157.5, 135.8 (d, J = 3.0 Hz, 1C), 135.7 (d, J = 3.0 Hz, 1C), 118.7 (q, J = 268.8 Hz, 1C), 108.6,

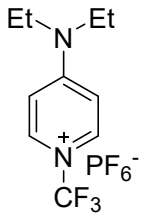
108.06, 48.5, 38.5, 10.8. **^{19}F NMR** (471 MHz, Acetone-d_6) δ -56.6 (s, 3F, CF_3), -67.5 (d, J = 228.0 Hz, 6F, PF_6). **HRMS** (ESI-TOF) calcd for $C_9H_{12}F_3N_2^+$ ([M]$^+$) 205.0947, found 205.0954.

4-(butyl(methyl)amino)-1-(trifluoromethyl)pyridin-1-ium hexafluorophosphate(V) (1c)



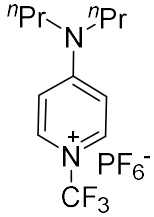
Yellow solid. mp: 37.2-37.5 °C. **^{1}H NMR** (600 MHz, Acetone-d_6) δ 8.62 (dd, J = 8.1 Hz, 2.4 Hz, 1H), 8.56 (dd, J = 8.2 Hz, 2.4 Hz, 1H), 7.44 (dd, J = 8.2 Hz, 3.1 Hz, 1H), 7.32 (dd, J = 8.1 Hz, 3.1 Hz, 1H), 3.89 (t, J = 7.2 Hz, 2H), 3.53 (s, 3H), 1.83 - 1.76 (m, 2H), 1.48 - 1.41 (m, 2H), 0.98 (t, J = 7.4 Hz, 3H). **^{13}C NMR** (151 MHz, Acetone-d_6) δ 157.7, 135.8 (d, J = 3.0 Hz, 1C), 135.6 (d, J = 3.0 Hz, 1C), 118.7 (q, J = 268.8 Hz, 1C), 108.5, 108.2, 53.3, 39.2, 28.5, 19.5, 13.1. **^{19}F NMR** (471 MHz, Acetone-d_6) δ -56.6 (s, 3F, CF_3), -67.5 (d, J = 228.0 Hz, 6F, PF_6). **HRMS** (ESI-TOF) calcd for $C_{11}H_{16}F_3N_2^+$ ([M]$^+$) 233.1260, found 233.1267.

4-(diethylamino)-1-(trifluoromethyl)pyridin-1-ium hexafluorophosphate(V) (1d)



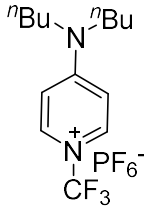
Yellow solid. mp: 82.1-82.5 °C. **^{1}H NMR** (600 MHz, Acetone-d_6) δ 8.57 (d, J = 8.2 Hz, 2H), 7.37 (d, J = 8.2 Hz, 2H), 3.91 (q, J = 7.2 Hz, 4H), 1.37 (t, J = 7.2 Hz, 6H). **^{13}C NMR** (151 MHz, Acetone-d_6) δ 156.9, 135.9 (q, J = 3.0 Hz, 2C), 118.7 (q, J = 268.8 Hz, 1C), 108.3 (2C), 46.5 (2C), 11.3 (2C). **^{19}F NMR** (471 MHz, Acetone-d_6) δ -56.6 (s, 3F, CF_3), -67.5 (d, J = 228.0 Hz, 6F, PF_6). **HRMS** (ESI-TOF) calcd for $C_{10}H_{14}F_3N_2^+$ ([M]$^+$) 219.1104, found 219.1096.

4-(dipropylamino)-1-(trifluoromethyl)pyridin-1-ium hexafluorophosphate(V) (1e)



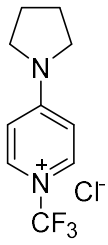
Yellow solid. mp: 130.0-130.5 °C. **^{1}H NMR** (600 MHz, Acetone-d_6) δ 8.56 (d, J = 8.2 Hz, 2H), 7.40 (d, J = 8.2 Hz, 2H), 3.83 (t, J = 7.2 Hz, 4H), 1.85 - 1.81 (m, 4H), 1.03 (t, J = 7.4 Hz, 6H). **^{13}C NMR** (151 MHz, Acetone-d_6) δ 157.4, 135.8 (q, J = 3.0 Hz, 2C), 118.7 (q, J = 268.8 Hz, 1C), 108.5 (2C), 53.3 (2C), 19.9 (2C), 10.1 (2C). **^{19}F NMR** (471 MHz, Acetone-d_6) δ -56.6 (s, 3F, CF_3), -67.5 (d, J = 228.0 Hz, 6F, PF_6). **HRMS** (ESI-TOF) calcd for $C_{12}H_{18}F_3N_2^+$ ([M]$^+$) 247.1417, found 247.1419.

4-(dibutylamino)-1-(trifluoromethyl)pyridin-1-ium hexafluorophosphate(V) (1f)



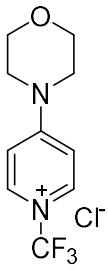
Yellow solid. mp: 100.5-100.8 °C. **^{1}H NMR** (600 MHz, Acetone-d_6) δ 8.54 (d, J = 7.8 Hz, 2H), 7.36 (d, J = 8.4 Hz, 2H), 3.85 (t, J = 7.8 Hz, 4H), 1.81 - 1.75 (m, 4H), 1.48 (m, 4H), 0.98 (t, J = 7.4 Hz, 6H). **^{13}C NMR** (151 MHz, Acetone-d_6) δ 157.2, 135.8 (q, J = 3.0 Hz, 2C), 118.7 (q, J = 268.8 Hz, 1C), 108.5 (2C), 51.8 (2C), 28.7, 19.5 (2C), 13.1 (2C). **^{19}F NMR** (471 MHz, Acetone-d_6) δ -56.6 (s, 3F, CF_3), -67.5 (d, J = 228.0 Hz, 6F, PF_6). **HRMS** (ESI-TOF) calcd for $C_{14}H_{22}F_3N_2^+$ ([M]$^+$) 275.1730, found 275.1736.

4-(pyrrolidin-1-yl)-1-(trifluoromethyl)pyridin-1-ium chloride (1g)



Yellow solid (22.7 mg, 45%), mp: 133.3-133.8 °C. **^{1}H NMR** (500 MHz, Acetone-d_6) δ 8.62 (d, J = 8.1 Hz, 2H), 7.22 (d, J = 8.1 Hz, 2H), 3.88 (t, J = 7.0 Hz, 4H), 2.24 - 2.16 (m, 4H). **^{13}C NMR** (151 MHz, Acetone-d_6) δ 155.1, 136.5, 135.4, 118.8 (q, J = 268.2 Hz, 1C), 109.0 (2C), 50.0 (2C), 24.7 (2C). **^{19}F NMR** (565 MHz, Acetone-d_6) δ -61.8 (s, 3F). **HRMS** (ESI-TOF) calcd for $C_{10}H_{12}F_3N_2^+$ ($[M]^+$) 217.0947, found 217.0955.

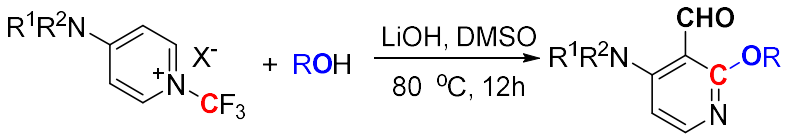
4-morpholino-1-(trifluoromethyl)pyridin-1-ium chloride (1h)



Yellow solid (24.2 mg, 45%), mp: 158.4-158.7 °C. **^{1}H NMR** (500 MHz, DMSO-d_6) δ 8.76 (d, J = 7.7 Hz, 2H), 7.40 (d, J = 7.7 Hz, 2H), 3.91 (t, J = 4.8 Hz, 4H), 3.77 (t, J = 4.8 Hz, 4H). **^{13}C NMR** (151 MHz, DMSO-d_6) δ 157.2, 137.1, 137.1, 118.7 (q, J = 269.3 Hz, 1C), 108.5 (2C), 66.0 (2C), 48.2 (2C). **^{19}F NMR** (565 MHz, DMSO-d_6) δ -59.8 (s, 3F). **HRMS** (ESI-TOF) calcd for $C_{10}H_{12}F_3N_2O^+$ ($[M]^+$) 233.0896, found 233.0895.

3. Synthetic Procedures/Analytical Data of Compounds 3.

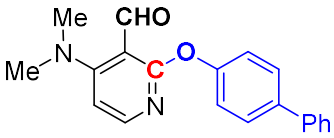
General procedure for the synthesis of compounds **3.**



1 **2** **3**

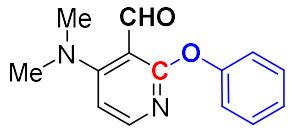
1 (0.2 mmol), ROH (0.3 mmol, 1.5 eq.), LiOH (0.7 mmol, 3.5 eq.) and DMSO (2 mL) were added in a glass tube in sequence. The reaction mixture was stirred at 80 °C for 12 h, and a saturated aqueous solution of NaCl (30 mL) was added. Aqueous phase was extracted with EtOAc (3 × 10 mL), the combined organic extracts were washed with a saturated aqueous solution of NaCl (3 × 30 mL), then the organic extracts were dried over anhydrous $MgSO_4$, filtered and concentrated under reduced pressure to yield the crude product, which was purified by silica gel chromatography (petroleum ether/ethyl acetate: 20/1, v/v) to give **3**.

2-([1,1'-biphenyl]-4-yloxy)-4-(dimethylamino)nicotinaldehyde (3a)



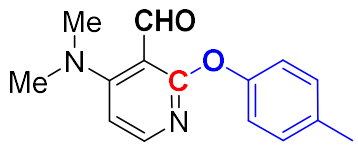
White solid (61.1 mg, 96%), mp: 112.1-112.9 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.50 (s, 1H), 7.87 (d, *J* = 6.2 Hz, 1H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 7.6 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 7.3 Hz, 1H), 7.22 (d, *J* = 8.4 Hz, 2H), 6.49 (d, *J* = 6.2 Hz, 1H), 3.04 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.5, 167.6, 158.1, 153.3, 149.7, 140.6, 138.0, 128.8 (2C), 128.4 (2C), 127.2, 127.1 (2C), 121.8 (2C), 106.7, 106.4, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{20}H_{19}N_2O_2^+$ ($[M+H]^+$) 319.1436, found 319.1441.

3-(dimethylamino)-2-phenoxynicotinaldehyde (3b)



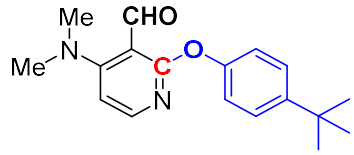
White solid (40.2 mg, 83%), mp: 72.1-72.4 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.47 (s, 1H), 7.84 (d, *J* = 6.3 Hz, 1H), 7.41 (t, *J* = 7.5 Hz, 2H), 7.21 (t, *J* = 7.4 Hz, 1H), 7.15 (d, *J* = 7.4 Hz, 2H), 6.47 (d, *J* = 6.3 Hz, 1H), 3.04 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.5, 167.6, 158.1, 153.8, 149.7, 129.6 (2C), 124.9, 121.5 (2C), 106.6, 106.6, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{14}H_{15}N_2O_2^+$ ($[M+H]^+$) 243.1135, found 243.1128.

4-(dimethylamino)-2-(p-tolyloxy)nicotinaldehyde (3c)



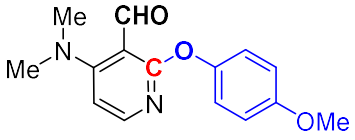
Yellow solid (43.6 mg, 85%), mp: 88.1-88.3 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.48 (s, 1H), 7.83 (d, *J* = 6.3 Hz, 1H), 7.20 (d, *J* = 8.1 Hz, 2H), 7.03 (d, *J* = 8.4 Hz, 2H), 6.46 (d, *J* = 6.3 Hz, 1H), 3.03 (s, 6H), 2.35 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.6, 167.9, 158.1, 151.4, 149.8, 134.5 (2C), 130.1 (2C), 121.4, 106.4, 106.3, 43.6 (2C), 20.9. **HRMS** (ESI-TOF) calcd for $C_{15}H_{17}N_2O_2^+$ ($[M+H]^+$) 257.1286, found 257.1285.

2-(4-(tert-butyl)phenoxy)-4-(dimethylamino)nicotinaldehyde (3d)



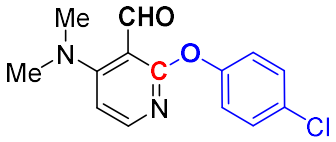
Yellow solid (47.7 mg, 80%), mp: 94.1-94.5 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.46 (s, 1H), 7.85 (d, *J* = 6.3 Hz, 1H), 7.41 (d, *J* = 8.7 Hz, 2H), 7.07 (d, *J* = 8.7 Hz, 2H), 6.47 (d, *J* = 6.3 Hz, 1H), 3.03 (s, 6H), 1.33 (s, 9H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.6 (d, *J* = 2.6 Hz, 1C), 167.7, 158.1, 151.4, 149.7, 147.4, 126.5 (2C), 120.8 (2C), 106.5, 106.4, 43.6 (2C), 34.4, 31.5 (3C). **HRMS** (ESI-TOF) calcd for $C_{18}H_{23}N_2O_2^+$ ($[M+H]^+$) 299.1758, found 299.1754.

4-(dimethylamino)-2-(4-methoxyphenoxy)nicotinaldehyde (3e)



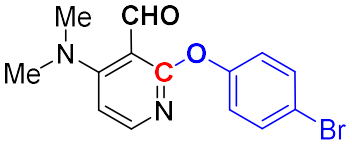
Orange solid (45.7 mg, 84%), mp: 97.9-98.1 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.48 (s, 1H), 7.83 (d, *J* = 6.2 Hz, 1H), 7.07 (d, *J* = 8.9 Hz, 2H), 6.93 (d, *J* = 9.0 Hz, 2H), 6.46 (d, *J* = 6.3 Hz, 1H), 3.81 (s, 3H), 3.03 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.6 (d, *J* = 3.3 Hz, 1C), 167.9, 158.1, 156.7, 149.7, 147.0, 122.6 (2C), 114.7 (2C), 106.4, 106.1, 55.6, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{15}H_{17}N_2O_3^+$ ($[M+H]^+$) 273.1204, found 273.1234.

2-(4-chlorophenoxy)-4-(dimethylamino)nicotinaldehyde (3f)



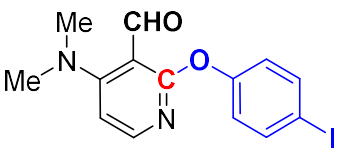
White solid (48.7 mg, 88%), mp: 117.6-117.9 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.45 (s, 1H), 7.82 (d, *J* = 6.2 Hz, 1H), 7.36 (d, *J* = 8.7 Hz, 2H), 7.09 (d, *J* = 8.5 Hz, 2H), 6.49 (d, *J* = 6.3 Hz, 1H), 3.04 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.2 (d, *J* = 2.8 Hz, 1C), 167.2, 158.1, 152.2, 149.4, 130.2, 129.6 (2C), 123.0 (2C), 106.9, 106.2, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{14}H_{14}ClN_2O_2^+$ ($[M+H]^+$) 277.0735, found 277.0738.

2-(4-bromophenoxy)-4-(dimethylamino)nicotinaldehyde (3g)



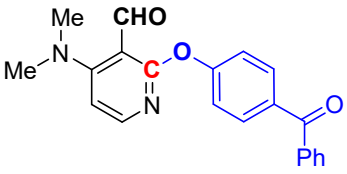
White solid (54.6 mg, 85%), mp: 117.9-118.3 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.45 (s, 1H), 7.82 (d, *J* = 6.3 Hz, 1H), 7.51 (d, *J* = 8.9 Hz, 2H), 7.05 (d, *J* = 8.8 Hz, 2H), 6.50 (d, *J* = 6.3 Hz, 1H), 3.04 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.2 (d, *J* = 3.0 Hz, 1C), 167.1, 158.1, 152.8, 149.4, 132.6 (2C), 123.5 (2C), 117.9, 106.9, 106.3, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{14}H_{14}BrN_2O_2^+$ ($[M+H]^+$) 321.0235, found 321.0233.

4-(dimethylamino)-2-(4-iodophenoxy)nicotinaldehyde (3h)



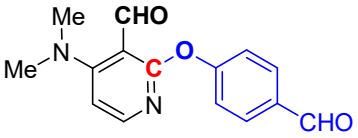
White solid (59.6 mg, 81%), mp: 131.8-132.0 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.43 (s, 1H), 7.82 (d, *J* = 6.3 Hz, 1H), 7.69 (d, *J* = 8.7 Hz, 2H), 6.92 (d, *J* = 8.8 Hz, 2H), 6.49 (d, *J* = 6.3 Hz, 1H), 3.03 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.2 (d, *J* = 3.3 Hz, 1C), 167.1, 158.1, 153.6, 149.4, 138.5 (2C), 123.9 (2C), 106.9, 106.3, 88.8, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{14}H_{14}IN_2O_2^+$ ($[M+H]^+$) 369.0069, found 369.0095.

2-(4-benzoylphenoxy)-4-(dimethylamino)nicotinaldehyde (3i)



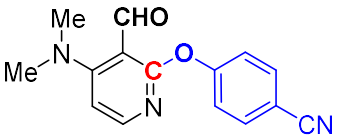
White solid (61.7 mg, 89%), mp: 106.7-107.1 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.46 (s, 1H), 7.90 (d, *J* = 8.7 Hz, 2H), 7.87 (d, *J* = 6.3 Hz, 1H), 7.81 (d, *J* = 7.5 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.7 Hz, 2H), 7.26 (d, *J* = 8.5 Hz, 2H), 6.55 (d, *J* = 6.3 Hz, 1H), 3.05 (s, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 195.5, 187.1 (d, *J* = 2.8 Hz, 1C), 166.8, 158.1, 157.6, 149.4, 137.8, 133.8, 132.3, 132.0 (2C), 129.9 (2C), 128.3 (2C), 121.0 (2C), 107.3, 106.7, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{21}H_{19}N_2O_3^+$ ($[M+H]^+$) 347.1393, found 347.1390.

4-(dimethylamino)-2-(4-formylphenoxy)nicotinaldehyde (3j)



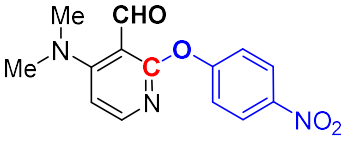
Yellow solid (42.2 mg, 78%), mp: 109.4-111.3 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.44 (s, 1H), 9.99 (s, 1H), 7.94 (d, *J* = 8.7 Hz, 2H), 7.85 (d, *J* = 6.3 Hz, 1H), 7.31 (d, *J* = 8.6 Hz, 2H), 6.55 (d, *J* = 6.2 Hz, 1H), 3.06 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 190.9, 187.0 (d, *J* = 2.8 Hz, 1C), 166.6, 159.0, 158.1, 149.4, 133.0, 131.5 (2C), 121.8 (2C), 107.5, 106.7, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{15}H_{15}N_2O_3^+$ ($[M+H]^+$) 271.1084, found 271.1077.

4-((4-(dimethylamino)-3-formylpyridin-2-yl)oxy)benzonitrile (3k)



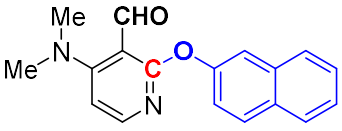
Yellow solid (26.7 mg, 50%), mp: 134.3-134.6 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.41 (s, 1H), 7.83 (d, *J* = 6.3 Hz, 1H), 7.70 (d, *J* = 8.7 Hz, 2H), 7.27 (d, *J* = 8.8 Hz, 2H), 6.56 (d, *J* = 6.3 Hz, 1H), 3.06 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 186.8 (d, *J* = 2.9 Hz, 1C), 166.3, 158.1, 157.4, 149.2, 133.8 (2C), 122.3 (2C), 118.6, 108.3, 107.6, 106.6, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{15}H_{13}N_3NaO_2^+$ ($[M+Na]^+$) 290.0905, found 290.0900.

4-(dimethylamino)-2-(4-nitrophenoxy)nicotinaldehyde (3l)



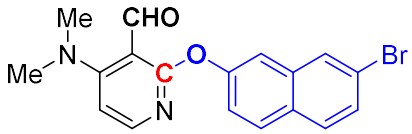
White solid (27.0 mg, 47%), mp: 137.5-138.0 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.42 (s, 1H), 8.29 (d, *J* = 9.2 Hz, 2H), 7.84 (d, *J* = 6.3 Hz, 1H), 7.30 (d, *J* = 9.1 Hz, 2H), 6.58 (d, *J* = 6.2 Hz, 1H), 3.07 (s, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 186.8 (d, *J* = 3.0 Hz, 1C), 166.2, 159.0, 158.2, 149.2, 144.4, 125.5 (2C), 121.8 (2C), 107.8, 106.6, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{14}H_{14}N_3O_4^+$ ($[M+H]^+$) 288.0967, found 288.0979.

4-(dimethylamino)-2-(naphthalen-2-yloxy)nicotinaldehyde (3m)



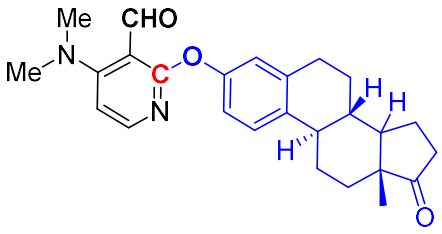
Orange solid (52.0 mg, 89%), mp: 112.1-112.9 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.54 (s, 1H), 7.87 (d, *J* = 8.8 Hz, 1H), 7.85-7.83 (m, 2H), 7.79 (d, *J* = 8.1 Hz, 1H), 7.58 (s, 1H), 7.48-7.42 (m, 2H), 7.31 (d, *J* = 11.1 Hz, 1H), 6.49 (d, *J* = 6.3 Hz, 1H), 3.06 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.5, 167.7, 158.1, 151.5, 149.7, 134.2, 131.1, 129.5, 127.8, 127.5, 126.4, 125.3, 121.7, 118.0, 106.7, 106.4, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{18}H_{17}N_2O_2^+$ ($[M+H]^+$) 293.1281, found 293.1285.

4-((7-bromonaphthalen-2-yl)oxy)-4-(dimethylamino)nicotinaldehyde (3n)



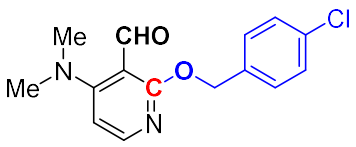
Orange solid (60.9 mg, 82%), mp: 175.9-176.5 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.53 (d, *J* = 0.9 Hz, 1H), 7.95 (d, *J* = 1.9 Hz, 1H), 7.84 (dd, *J* = 7.6 Hz, 4.6 Hz, 2H), 7.70 (d, *J* = 8.7 Hz, 1H), 7.51 (dd, *J* = 8.6 Hz, 2.0 Hz, 2H), 7.33 (dd, *J* = 8.8 Hz, 2.3 Hz, 1H), 6.51 (d, *J* = 6.2 Hz, 1H), 3.06 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.4 (d, *J* = 1.5 Hz, 1C), 167.4, 158.1, 152.3, 149.5, 135.3, 129.4 (4C), 128.7, 122.2, 120.6, 117.1, 106.9, 106.4, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{18}H_{16}BrN_2O_2^+$ ($[M+H]^+$) 371.0378, found 371.0390.

5-(dimethylamino)-2-(((8R,9S,13S,14S)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[a]phenanthren-2-yl)oxy)nicotinaldehyde (3o)



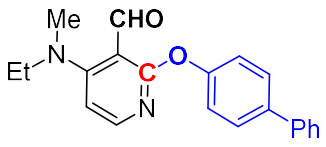
Yellow solid (79.5 mg, 95%), mp: 196.5-197.0 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.45 (s, 1H), 7.85 (d, *J* = 6.3 Hz, 1H), 7.31 (d, *J* = 8.5 Hz, 1H), 6.93 (dd, *J* = 8.5 Hz, 2.6 Hz, 1H), 6.88 (d, *J* = 2.5 Hz, 1H), 6.47 (d, *J* = 6.3 Hz, 1H), 3.04 (s, 6H), 2.95-2.91 (m, 2H), 2.51 (dd, *J* = 19.1 Hz, 8.7 Hz, 1H), 2.44-2.40 (m, 1H), 2.33-2.28 (m, 1H), 2.20-1.92 (m, 4H), 1.69-1.57 (m, 2H), 1.58-1.41 (m, 4H), 0.91 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 220.8, 187.6 (d, *J* = 3.0 Hz, 1C), 167.8, 158.1,151.6, 149.8, 138.1, 136.4, 126.5, 121.5, 118.9, 106.5, 106.4, 50.5, 48.0, 44.2, 43.6 (2C), 38.0, 35.9, 31.6, 29.5, 26.4, 25.8, 21.6, 13.9. **HRMS** (ESI-TOF) calcd for $C_{26}H_{31}N_2O_3^+$ ($[M+H]^+$) 419.2323, found 419.2329.

2-((4-chlorobenzyl)oxy)-4-(dimethylamino)nicotinaldehyde (3p)



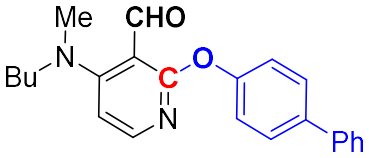
White solid (25.0 mg, 43%), mp: 63.5-63.9 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.33 (s, 1H), 7.86 (d, *J* = 6.6 Hz, 1H), 7.39 (d, *J* = 8.2 Hz, 2H), 7.34 (d, *J* = 8.3 Hz, 2H), 6.43 (d, *J* = 6.3 Hz, 1H), 5.42 (s, 2H), 2.99 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.4 (d, *J* = 3.0 Hz, 1C), 167.1, 158.1, 149.3, 135.6, 133.7, 129.2 (2C), 128.6 (2C), 128.2, 105.8, 67.2, 43.5 (2C). **HRMS** (ESI-TOF) calcd for $C_{15}H_{16}ClN_2O_2$ ($[M+H]^+$) 291.0895, found 291.0902.

2-([1,1'-biphenyl]-4-yloxy)-4-(ethyl(methyl)amino)nicotinaldehyde (3q)



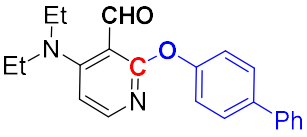
White solid (51.1 mg, 77%), mp: 124.1-124.5 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.47 (s, 1H), 7.85 (d, *J* = 6.6 Hz, 1H), 7.62 (d, *J* = 8.5 Hz, 2H), 7.59 (d, *J* = 6.6 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.6 Hz, 1H), 7.22 (d, *J* = 8.4 Hz, 2H), 6.51 (d, *J* = 6.3 Hz, 1H), 3.46 (q, *J* = 7.1 Hz, 2H), 2.96 (s, 3H), 1.29 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.5, 167.6, 157.6, 153.3, 149.5, 140.7, 138.0, 128.7 (2C), 128.4 (2C), 127.1 (3C), 121.8 (2C), 107.1, 106.7, 49.0, 41.1, 12.2. **HRMS** (ESI-TOF) calcd for $C_{21}H_{20}N_2NaO_2^+$ ($[M+Na]^+$) 355.1417, found 355.1415.

2-([1,1'-biphenyl]-4-yloxy)-4-(butyl(methyl)amino)nicotinaldehyde (3r)



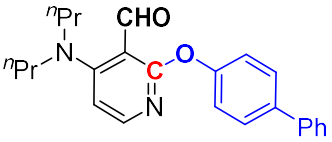
White solid (51.9 mg, 72%), mp: 82.8-83.3 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.47 (s, 1H), 7.85 (d, *J* = 6.3 Hz, 1H), 7.63 (d, *J* = 8.5 Hz, 2H), 7.59 (d, *J* = 7.0 Hz, 2H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.34 (t, *J* = 7.5 Hz, 1H), 7.23 (d, *J* = 8.5 Hz, 2H), 6.51 (d, *J* = 6.4 Hz, 1H), 3.40 (t, *J* = 7.5 Hz, 2H), 2.97 (s, 3H), 1.71-1.65 (m, 2H), 1.39-1.32 (m, 2H), 0.96 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.3 (d, *J* = 9.1 Hz, 1C), 167.6, 157.7, 153.4, 149.4, 140.7, 138.0, 128.8 (2C), 128.4 (2C), 127.1 (3C), 121.8 (2C), 107.2, 106.7, 54.3, 42.2, 29.2, 20.0, 13.8. **HRMS** (ESI-TOF) calcd for $C_{23}H_{24}N_2NaO_2^+$ ([M+Na]$^+$) 383.1730, found 383.1734.

2-([1,1'-biphenyl]-4-yloxy)-4-(diethylamino)nicotinaldehyde (3s)



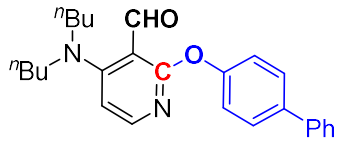
Yellow solid (59.5 mg, 86%), mp: 107.1-107.4 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.43 (s, 1H), 7.87 (d, *J* = 6.3 Hz, 1H), 7.61 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 7.2 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.34 (d, *J* = 7.4 Hz, 1H), 7.21 (d, *J* = 9.0 Hz,, 2H), 6.53 (d, *J* = 6.3 Hz, 1H), 3.44 (q, *J* = 7.1 Hz, 4H), 1.23 (t, *J* = 7.1 Hz, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.3, 167.4, 157.3, 153.4, 149.8, 140.7, 138.0, 128.7 (2C), 128.3 (2C), 127.1 (3C), 121.8 (2C), 108.4, 107.9, 46.9 (2C), 12.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{22}H_{23}N_2O_2^+$ ([M+H]$^+$) 347.1754, found 347.1763.

2-([1,1'-biphenyl]-4-yloxy)-4-(dipropylamino)nicotinaldehyde (3t)



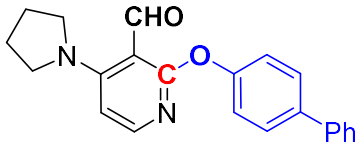
Yellow solid (52.4 mg, 70%), mp: 119.4-119.9 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.41 (s, 1H), 7.86 (d, *J* = 6.2 Hz, 1H), 7.62 (d, *J* = 8.6 Hz, 2H), 7.58 (d, *J* = 7.4 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.4 Hz, 1H), 7.23 (d, *J* = 8.6 Hz, 2H), 6.53 (d, *J* = 6.3 Hz, 1H), 3.33 (t, *J* = 7.2 Hz, 4H), 1.66-1.60 (m, 4H), 0.88 (t, *J* = 7.4 Hz, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 186.9, 167.5, 158.0, 153.4, 149.8, 140.7, 138.0, 128.8 (2C), 128.4 (2C), 127.1 (3C), 121.8 (2C), 108.5, 107.9, 54.6 (2C), 20.8 (2C), 11.3 (2C). **HRMS** (ESI-TOF) calcd for $C_{24}H_{26}N_2NaO_2^+$ ([M+Na]$^+$) 397.1886, found 397.1892.

2-([1,1'-biphenyl]-4-yloxy)-4-(dibutylamino)nicotinaldehyde (3u)



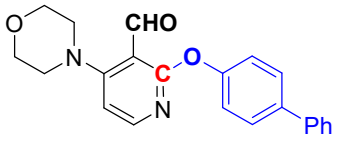
Green solid (60.3 mg, 75%), mp: 55.3-55.7 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.41 (s, 1H), 7.86 (d, *J* = 6.2 Hz, 1H), 7.61 (d, *J* = 8.5 Hz, 2H), 7.58 (d, *J* = 7.2 Hz, 2H), 7.42 (t, *J* = 7.7 Hz, 2H), 7.33 (t, *J* = 7.2 Hz, 1H), 7.22 (d, *J* = 8.5 Hz, 2H), 6.52 (d, *J* = 6.3 Hz, 1H), 3.36 (t, *J* = 7.3 Hz, 4H), 1.59-1.56 (m, 4H), 1.31-1.27 (m, 4H), 0.91 (t, *J* = 7.4 Hz, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 186.8 (d, *J* = 1.5 Hz, 1C), 167.5, 158.0, 153.4, 149.7, 140.7, 137.9, 128.8 (2C), 128.3 (2C), 127.2, 127.1 (2C), 121.8 (2C), 108.6, 108.0, 52.7 (2C), 29.6 (2C), 20.1 (2C), 13.9 (2C). **HRMS** (ESI-TOF) calcd for $C_{26}H_{30}N_2NaO_2^+$ ([M+Na]$^+$) 425.2199, found 425.2199.

2-([1,1'-biphenyl]-4-yloxy)-4-(pyrrolidin-1-yl)nicotinaldehyde (3v)



White solid (58.5 mg, 85%), mp: 189.8-190.5 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.54 (s, 1H), 7.82 (d, *J* = 6.2 Hz, 1H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.58 (d, *J* = 7.7 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 7.4 Hz, 1H), 7.23 (d, *J* = 8.5 Hz, 2H), 6.41 (d, *J* = 6.3 Hz, 1H), 3.31 (t, *J* = 6.5 Hz, 4H), 2.02 - 1.98 (m, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.3, 166.9, 154.1, 153.3, 148.8, 140.7, 137.9, 128.8 (2C), 128.3 (2C), 127.1 (2C), 121.8 (2C), 106.2, 106.1, 52.4 (2C), 25.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{22}H_{20}N_2NaO_2^+$ ([M+Na]$^+$) 367.1417, found 367.1410.

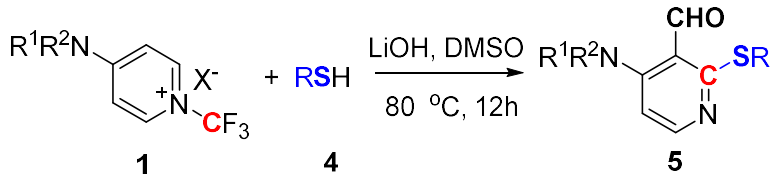
2-([1,1'-biphenyl]-4-yloxy)-4-morpholinonicotinaldehyde (3w)



White solid (59.1 mg, 82%), mp: 211.7-212.1 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.48 (s, 1H), 8.00 (d, *J* = 6.0 Hz, 1H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 7.3 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 7.3 Hz, 1H), 7.21 (s, 2H), 6.54 (d, *J* = 6.1 Hz, 1H), 3.93 (t, *J* = 4.6 Hz, 4H), 3.32 (t, *J* = 4.6 Hz, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.1, 167.9, 158.9, 153.0, 151.6, 140.5, 138.3, 128.8 (2C), 128.4 (2C), 127.2, 127.1 (2C), 121.8 (2C), 108.4, 108.0, 66.7 (2C), 52.0 (2C). **HRMS** (ESI-TOF) calcd for $C_{22}H_{20}N_2NaO_3^+$ ([M+Na]$^+$) 383.1366, found 383.1361.

4. Synthetic Procedures/Analytical Data of Compounds 5

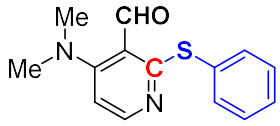
General procedure for the synthesis of compounds **5.**



1 **4** **5**

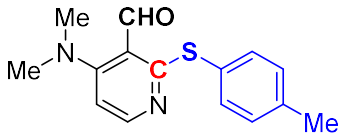
1 (0.2 mmol), RSH (0.3 mmol, 1.5 eq.), LiOH (0.7 mmol, 3.5 eq.) and DMSO (2 mL) were added in a glass tube in sequence. The reaction mixture was stirred at 80 °C for 12 h, and a saturated aqueous solution of NaCl (30 mL) was added. Aqueous phase was extracted with EtOAc (3 × 10 mL), the combined organic extracts were washed with a saturated aqueous solution of NaCl (3 × 30 mL), then the organic extracts were dried over anhydrous $MgSO_4$, filtered and concentrated under reduced pressure to yield the crude product, which was purified by silica gel chromatography (petroleum ether/ethyl acetate: 20/1, v/v) to give **5.**

4-(dimethylamino)-2-(phenylthio)nicotinaldehyde (5a)



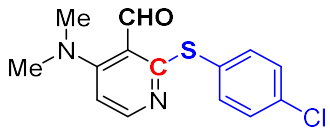
Brown solid (38.8 mg, 75%), mp: 110.3-110.7 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.34 (s, 1H), 8.02 (d, *J* = 6.0 Hz, 1H), 7.52 (dd, *J* = 7.8 Hz, 1.7 Hz, 2H), 7.40-7.34 (m, 3H), 6.55 (d, *J* = 6.0 Hz, 1H), 3.04 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.4 (d, *J* = 1.5 Hz, 1C), 164.6, 159.5, 151.2, 134.7 (2C), 131.6, 129.0 (2C), 128.5, 116.5, 107.8, 44.1 (2C). **HRMS** (ESI-TOF) calcd for $C_{14}H_{15}N_2OS^+$ ($[M+H]^+$) 259.0893, found 259.0900.

4-(dimethylamino)-2-(p-tolylthio)nicotinaldehyde (5b)



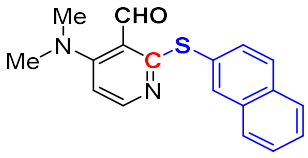
Orange solid (53.9 mg, 99%), mp: 138.6-139.2 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.33 (s, 1H), 8.02 (d, *J* = 6.0 Hz, 1H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.19 (d, *J* = 7.8 Hz, 2H), 6.53 (d, *J* = 6.0 Hz, 1H), 3.03 (s, 6H), 2.37 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.4, 165.1, 159.6, 151.3, 138.7, 134.9 (2C), 129.9 (2C), 127.7, 116.3, 107.6, 44.1 (2C), 21.4. **HRMS** (ESI-TOF) calcd for $C_{15}H_{17}N_2OS^+$ ($[M+H]^+$) 273.1066, found 273.1056.

2-((4-chlorophenyl)thio)-4-(dimethylamino)nicotinaldehyde (5c)



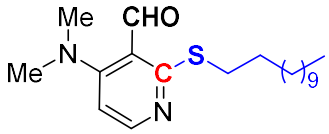
Orange solid (49.8 mg, 85%), mp: 94.8-95.0 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.29 (s, 1H), 8.01 (d, *J* = 6.0 Hz, 1H), 7.45 (d, *J* = 8.5 Hz, 2H), 7.35 (d, *J* = 8.5 Hz, 2H), 6.56 (d, *J* = 6.0 Hz, 1H), 3.06 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.3 (d, *J* = 3.0 Hz, 1C), 163.8, 159.9, 151.2, 136.3 (2C), 134.8, 129.8, 129.2 (2C), 116.3, 107.9, 44.2 (2C). **HRMS** (ESI-TOF) calcd for $C_{14}H_{14}ClN_2OS^+$ ($[M+H]^+$) 293.0507, found 293.0510.

4-(dimethylamino)-2-(naphthalen-2-ylthio)nicotinaldehyde (5d)



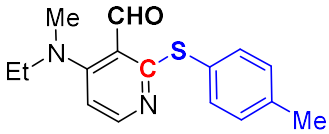
White solid (58.0 mg, 94%), mp: 117.6-120.2 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.30 (s, 1H), 7.99 (d, J = 1.7 Hz, 1H), 7.93 (d, J = 6.0 Hz, 1H), 7.80-7.70 (m, 3H), 7.49-7.36 (m, 3H), 6.48 (d, J = 6.0 Hz, 1H), 2.98 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.4, 164.6, 159.6, 151.2, 133.8, 133.6, 133.0, 131.9, 129.1, 128.3, 127.9, 127.8, 126.7, 126.3, 116.5, 107.9, 44.1 (2C). **HRMS** (ESI-TOF) calcd for $C_{18}H_{17}N_2OS^+$ ([M+H]$^+$) 309.1035, found 309.1056.

4-(dimethylamino)-2-(propylthio)nicotinaldehyde (5e)



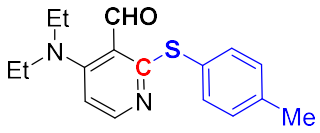
Orange solid (8.4 mg, 12%), mp: 42.0-42.5 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.23 (s, 1H), 8.13 (d, J = 6.0 Hz, 1H), 6.52 (d, J = 6.0 Hz, 1H), 3.19 (t, J = 7.5 Hz, 2H), 3.02 (s, 6H), 1.69 (p, J = 7.5 Hz, 2H), 1.43 (q, J = 7.7 Hz, 2H), 1.32 - 1.25 (m, 16H), 0.87 (t, J = 7.0 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.2 (d, J = 2.3 Hz, 1C), 165.3, 159.6, 150.7, 116.5, 106.9, 44.1 (2C), 31.9, 30.3, 29.7, 29.6, 29.6, 29.5, 29.4, 29.3, 29.1, 29.0, 22.7, 14.1. **HRMS** (ESI-TOF) calcd for $C_{20}H_{35}N_2OS^+$ ([M+H]$^+$) 351.2465, found 351.2457.

4-(ethyl(methyl)amino)-2-(p-tolylthio)nicotinaldehyde (5f)



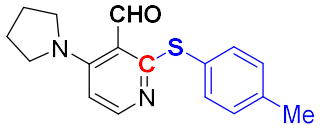
Yellow solid (37.8 mg, 66%), mp: 113.9-114.3 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.25 (s, 1H), 8.03 (d, J = 6.0 Hz, 1H), 7.42 (d, J = 8.1 Hz, 2H), 7.20 (d, J = 7.8 Hz, 2H), 6.56 (d, J = 6.0 Hz, 1H), 3.38 (q, J = 7.1 Hz, 2H), 2.96 (s, 3H), 2.38 (s, 3H), 1.26 (t, J = 7.1 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.5, 164.8, 159.8, 151.38, 138.7, 135.1 (2C), 129.8 (2C), 127.7, 117.0, 108.2, 51.0, 40.4, 21.4, 12.4. **HRMS** (ESI-TOF) calcd for $C_{16}H_{19}N_2OS^+$ ([M+H]$^+$) 287.1213, found 287.1219.

4-(diethylamino)-2-(p-tolylthio)nicotinaldehyde (5g)



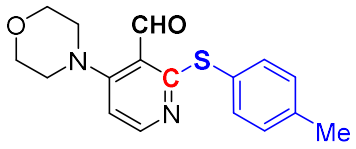
Yellow solid (33.6 mg, 56%), mp: 102.2-102.5 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.16 (s, 1H), 8.07 (d, J = 5.9 Hz, 1H), 7.42 (d, J = 8.0 Hz, 2H), 7.21 (d, J = 7.9 Hz, 2H), 6.60 (d, J = 5.9 Hz, 1H), 3.37 (q, J = 7.1 Hz, 4H), 2.38 (s, 3H), 1.19 (t, J = 7.1 Hz, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.8, 164.2, 160.1, 151.5, 138.7, 135.3 (2C), 129.8 (2C), 127.6, 118.5, 109.6, 47.6 (2C), 21.4, 12.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{17}H_{21}N_2OS^+$ ([M+H]$^+$) 301.1369, found 301.1375.

4-(pyrrolidin-1-yl)-2-(p-tolylthio)nicotinaldehyde (5h)



Yellow solid (45.3 mg, 76%), mp: 159.1-159.7 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 10.49 (s, 1H), 7.93 (d, J = 6.2 Hz, 1H), 7.39 (d, J = 8.0 Hz, 2H), 7.17 (d, J = 7.8 Hz, 2H), 6.41 (d, J = 6.1 Hz, 1H), 3.32 (t, J = 6.5 Hz, 4H), 2.35 (s, 3H), 2.00 - 1.93 (m, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.6, 164.1, 154.0, 150.2, 138.5, 134.5 (2C), 129.9 (2C), 128.1, 115.8, 106.8, 52.6 (2C), 25.8 (2C), 21.3. **HRMS** (ESI-TOF) calcd for $C_{17}H_{18}N_2NaOS^+$ ([M+Na]$^+$) 321.1032, found 321.1029.

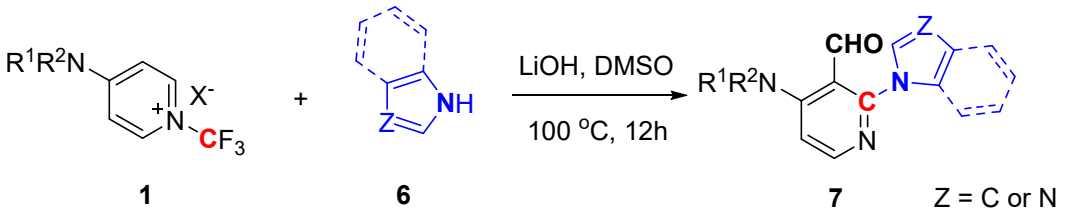
4-morpholino-2-(p-tolylthio)nicotinaldehyde (5i)



Yellow solid (44.0 mg, 70%), mp: 168.2-168.8 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 10.32 (s, 1H), 8.20 (d, *J* = 5.7 Hz, 1H), 7.41 (d, *J* = 7.9 Hz, 2H), 7.21 (d, *J* = 7.8 Hz, 2H), 6.61 (d, *J* = 5.7 Hz, 1H), 3.89 (t, *J* = 7.8 Hz, 4H), 3.22 (t, *J* = 7.8 Hz, 4H), 2.38 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.5, 165.0, 161.0, 153.0, 139.0, 135.3 (2C), 129.9 (2C), 127.1, 118.5, 108.8, 66.6 (2C), 53.1 (2C), 21.4. **HRMS** (ESI-TOF) calcd for $C_{17}H_{18}N_2NaO_2S^+$ ($[M+Na]^+$) 337.0981, found 337.0976.

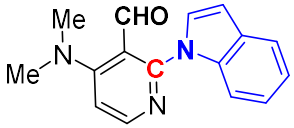
5. Synthetic Procedures/Analytical Data of Compounds 7

General procedure for the synthesis of compounds **7.**



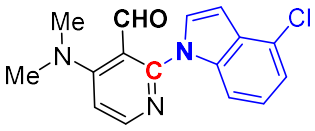
1 (0.2 mmol), **6** (0.3 mmol, 1.5 eq.), LiOH (0.7 mmol, 3.5 eq.) and DMSO (2 mL) were added in a glass tube in sequence. The reaction mixture was stirred at 100 °C for 12 h, and a saturated aqueous solution of NaCl (30 mL) was added. Aqueous phase was extracted with EtOAc (3 × 10 mL), the combined organic extracts were washed with a saturated aqueous solution of NaCl (3 × 30 mL), then the organic extracts were dried over anhydrous $MgSO_4$, filtered and concentrated under reduced pressure to yield the crude product, which was purified by silica gel chromatography (petroleum ether/ethyl acetate: 10/1, v/v) to give **7.**

4-(dimethylamino)-2-(1H-indol-1-yl)nicotinaldehyde (7a)



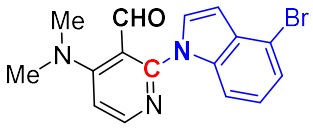
Orange solid (35.0 mg, 66%), mp: 157.8-158.5 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.42 (s, 1H), 8.20 (d, *J* = 6.1 Hz, 1H), 7.70 (d, *J* = 8.1 Hz, 1H), 7.66 (d, *J* = 7.7 Hz, 1H), 7.61 (d, *J* = 3.4 Hz, 1H), 7.25 - 7.18 (m, 2H), 6.73 (d, *J* = 3.4 Hz, 1H), 6.67 (d, *J* = 6.2 Hz, 1H), 3.17 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.9, 157.9, 157.5, 151.2, 137.2, 130.2, 129.1, 123.3, 121.6, 121.3, 111.4, 110.7, 108.2, 105.8, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{16}H_{16}N_3O^+$ ($[M+H]^+$) 266.1282, found 266.1288.

2-(4-chloro-1H-indol-1-yl)-4-(dimethylamino)nicotinaldehyde (7b)



Brown solid (53.8 mg, 90%), mp: 158.5-159.1 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.39 (s, 1H), 8.20 (d, *J* = 6.2 Hz, 1H), 7.63 (d, *J* = 3.4 Hz, 1H), 7.60 (d, *J* = 8.1 Hz, 1H), 7.20 (dd, *J* = 7.7 Hz, 1.0 Hz, 1H), 7.15 (t, *J* = 7.9 Hz, 1H), 6.85 (d, *J* = 3.5, 1H), 6.71 (d, *J* = 6.2, 1H), 3.18 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.5, 157.9, 157.2, 151.0, 137.8, 129.7, 128.8, 126.4, 123.9, 121.3, 110.8, 110.2, 108.7, 104.0, 43.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{16}H_{15}ClN_3O^+$ ($[M+H]^+$) 300.0899, found 300.0898.

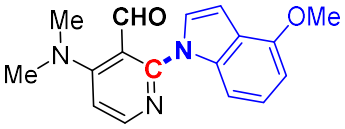
2-(4-bromo-1H-indol-1-yl)-4-(dimethylamino)nicotinaldehyde (7c)



Orange solid (44.6 mg, 65%), mp: 147.5-147.9 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.38 (s, 1H), 8.19 (d, *J* = 6.2 Hz, 1H), 7.66-7.64 (m, 2H), 7.37 (d, *J* = 7.6 Hz, 1H), 7.10 (t, *J* = 8.0 Hz, 1H), 6.80 (d, *J* = 3.2 Hz, 1H), 6.71 (d, *J* = 6.0 Hz, 1H), 3.17 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.5, 157.9, 157.2, 151.0, 137.4, 130.7, 129.7, 124.5, 124.2, 115.0, 110.8,

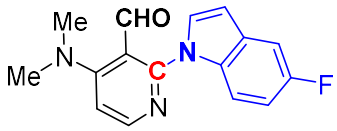
110.8, 108.7, 105.7, 43.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{16}H_{15}BrN_3O^+$ ([M+H]$^+$) 344.0403, found 344.0393.

4-(dimethylamino)-2-(4-methoxy-1H-indol-1-yl)nicotinaldehyde (7d)



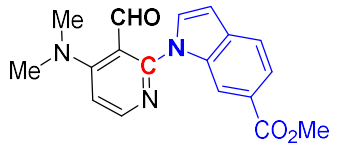
Brown solid (40.1 mg, 68%), mp: 129.1-129.5 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.40 (s, 1H), 8.19 (d, *J* = 6.2 Hz, 1H), 7.52 (d, *J* = 3.4 Hz, 1H), 7.29 (d, *J* = 8.3 Hz, 1H), 7.16 (t, *J* = 8.1 Hz, 1H), 6.85 (d, *J* = 3.4 Hz, 1H), 6.67 (dd, *J* = 6.2 Hz, 1.0 Hz, 1H), 6.62 (d, *J* = 7.8 Hz, 1H), 3.97 (s, 3H), 3.17 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.9, 157.8, 157.6, 153.4, 151.1, 138.6, 127.6, 124.2, 120.6, 110.8, 108.3, 104.6, 102.8, 101.6, 55.4, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{17}H_{18}N_3O_2^+$ ([M+H]$^+$) 296.1401, found 296.1394.

3-(dimethylamino)-2-(5-fluoro-1H-indol-1-yl)nicotinaldehyde (7e)



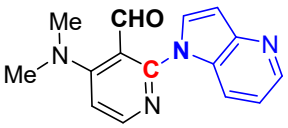
Orange solid (40.2 mg, 71%), mp: 156.9-157.3 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.41 (d, *J* = 0.9 Hz, 1H), 8.20 (d, *J* = 6.2 Hz, 1H), 7.68 (dd, *J* = 9.0 Hz, 4.5 Hz, 1H), 7.61 (d, *J* = 3.4 Hz, 1H), 7.31 (dd, *J* = 9.1 Hz, 2.6 Hz, 1H), 6.99 (td, *J* = 9.1, 2.5 Hz, 1H), 6.70 (dd, *J* = 2.4 Hz, 0.9 Hz, 1H), 6.69 (s, 1H), 3.19 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.6, 159.5 (d, *J* = 237.1 Hz, 1C), 158.0, 157.4, 151.1, 133.6, 130.8, 130.7 (d, *J* = 10.6 Hz, 1C), 112.6 (d, *J* = 9.1 Hz, 1C), 111.4 (d, *J* = 27.2 Hz, 1C), 110.5, 108.4, 106.2 (d, *J* = 22.6 Hz, 1C), 105.6 (d, *J* = 4.5 Hz, 1C), 43.7 (2C). **^{19}F NMR** (471 MHz, $CDCl_3$) δ (-122.40) - (-122.45) (m, 1F). **HRMS** (ESI-TOF) calcd for $C_{16}H_{15}FN_3O^+$ ([M+H]$^+$) 284.1200, found 284.1194.

methyl 1-(4-(dimethylamino)-3-formylpyridin-2-yl)-1H-indole-6-carboxylate (7f)



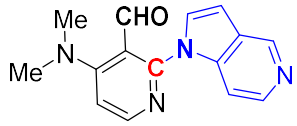
Yellow solid (54.9 mg, 85%), mp: 169.1-169.4 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.38 (s, 1H), 8.43 (s, 1H), 8.21 (d, *J* = 6.1 Hz, 1H), 7.89 (dd, *J* = 8.3 Hz, 1.4 Hz, 1H), 7.76 (d, *J* = 3.4 Hz, 1H), 7.69 (d, *J* = 8.2 Hz, 1H), 6.78 (dd, *J* = 3.4 Hz, 0.9 Hz, 1H), 6.73 (dd, *J* = 6.3 Hz, 0.9 Hz, 1H), 3.89 (s, 3H), 3.20 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.4, 167.7, 157.9, 156.7, 151.1, 136.7, 133.7, 132.0, 125.0, 122.6, 120.9, 113.7, 110.9, 108.7, 105.7, 52.0, 43.6 (2C). **HRMS** (ESI-TOF) calcd for $C_{18}H_{18}N_3O_3^+$ ([M+H]$^+$) 324.1345, found 324.1343.

4-(dimethylamino)-2-(1H-pyrrolo[3,2-b]pyridin-1-yl)nicotinaldehyde (7g)



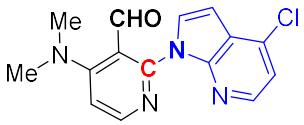
Orange solid (42.0 mg, 79%), mp: 157.9-158.4 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.42 (s, 1H), 8.54 (d, *J* = 4.5 Hz, 1H), 8.19 (d, *J* = 6.2 Hz, 1H), 8.03 (d, *J* = 8.3 Hz, 1H), 7.82 (d, *J* = 3.5 Hz, 1H), 7.18 (dd, *J* = 8.3 Hz, 4.7 Hz, 1H), 6.94 (d, *J* = 2.9 Hz, 1H), 6.71 (d, *J* = 6.3 Hz, 1H), 3.19 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.1, 158.1, 156.9, 151.0, 148.4, 145.0, 132.4, 130.2, 119.4, 118.0, 110.2, 108.6, 106.7, 43.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{15}H_{15}N_4O^+$ ([M+H]$^+$) 267.1244, found 267.1240.

4-(dimethylamino)-2-(1H-pyrrolo[3,2-c]pyridin-1-yl)nicotinaldehyde (7h)



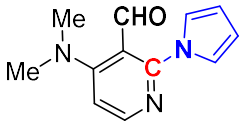
Orange solid (42.6 mg, 80%), mp: 163.6-164.3 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.40 (s, 1H), 8.99 (s, 1H), 8.39 (d, *J* = 5.8 Hz, 1H), 8.21 (d, *J* = 6.2 Hz, 1H), 7.64 (d, *J* = 3.4 Hz, 1H), 7.55 (d, *J* = 5.8 Hz, 1H), 6.83 (d, *J* = 3.4 Hz, 1H), 6.75 (d, *J* = 6.2 Hz, 1H), 3.20 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.0, 157.9, 156.4, 151.0, 144.3, 142.7, 140.9, 130.0, 126.6, 110.7, 109.0, 106.8, 104.5, 43.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{15}H_{15}N_4O^+$ ($[M+H]^+$) 267.1247, found 267.1240.

4-(4-chloro-1H-indol-1-yl)-4-(dimethylamino)nicotinaldehyde (7i)



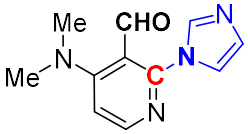
Yellow solid (49.0 mg, 82%), mp: 144.9-150.1 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.44 (s, 1H), 8.18 (d, *J* = 6.1 Hz, 1H), 8.15 (d, *J* = 5.2 Hz, 1H), 7.94 (d, *J* = 3.8 Hz, 1H), 7.18 (d, *J* = 5.2 Hz, 1H), 6.80 (d, *J* = 3.8 Hz, 1H), 6.73 (dd, *J* = 6.2 Hz, 1.0 Hz, 1H), 3.19 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 186.1, 157.6, 154.4, 150.5, 149.0, 144.2, 136.4, 129.2, 121.3, 117.9, 112.0, 109.0, 101.6, 43.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{15}H_{14}ClN_4O^+$ ($[M+H]^+$) 301.0849, found 301.0851.

4-(dimethylamino)-2-(1H-pyrrol-1-yl)nicotinaldehyde (7j)



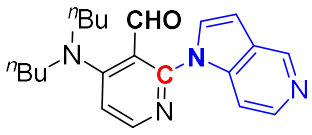
Yellow solid (26.7 mg, 62%), mp: 124.5-123.0 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.48 (s, 1H), 8.11 (d, *J* = 6.2 Hz, 1H), 7.24 (t, *J* = 2.2 Hz, 2H), 6.63 (d, *J* = 6.2 Hz, 1H), 6.39 (t, *J* = 2.2 Hz, 2H), 3.14 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 185.9, 158.4, 158.0, 150.7, 122.7, 111.4, 109.7, 108.0, 43.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{12}H_{13}N_3NaO^+$ ($[M+Na]^+$) 238.0951, found 238.0956.

4-(dimethylamino)-2-(1H-imidazol-1-yl)nicotinaldehyde (7k)



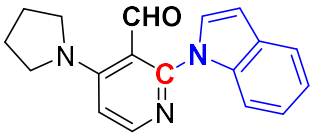
Yellow solid (20.2 mg, 44%), mp: 101.8-102.5 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.85 (s, 1H), 8.34 (d, *J* = 2.5 Hz, 1H), 8.09 (d, *J* = 6.1 Hz, 1H), 7.83 - 7.77 (m, 1H), 6.70 (dd, *J* = 6.2 Hz, 0.9 Hz, 1H), 6.54 - 6.48 (m, 1H), 3.12 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.7, 157.7, 156.5, 149.5, 142.9, 130.4, 110.4, 109.1, 107.9, 43.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{11}H_{13}N_4O^+$ ($[M+H]^+$) 217.1084, found 217.1088.

4-(dibutylamino)-2-(1H-pyrrolo[3,2-c]pyridin-1-yl)nicotinaldehyde (7l)



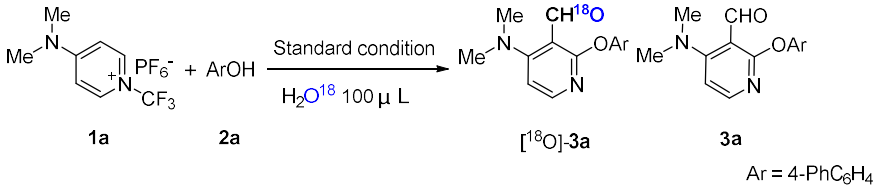
Yellow oil. (49.7 mg, 71%). **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.30 (s, 1H), 8.97 (s, 1H), 8.38 (d, *J* = 5.8 Hz, 1H), 8.19 (d, *J* = 6.2 Hz, 1H), 7.60 (d, *J* = 3.5 Hz, 1H), 7.50 (d, *J* = 5.8 Hz, 1H), 6.81 (d, *J* = 3.5 Hz, 1H), 6.76 (d, *J* = 6.3 Hz, 1H), 3.49 (t, *J* = 7.3 Hz, 4H), 1.70 - 1.59 (m, 4H), 1.32 (q, *J* = 7.5 Hz, 4H), 0.92 (t, *J* = 7.4 Hz, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 184.2, 157.7, 156.5, 151.1, 144.2, 142.6, 141.0, 130.1, 126.7, 112.1, 110.5, 106.8, 104.4, 53.0 (2C), 29.9 (2C), 20.1 (2C), 13.8 (2C). **HRMS** (ESI-TOF) calcd for $C_{21}H_{27}N_4O^+$ ($[M+H]^+$) 351.2179, found 351.2181.

2-(1H-indol-1-yl)-4-(pyrrolidin-1-yl)nicotinaldehyde (7m)



Yellow solid (39.6 mg, 68%), mp: 138.1-138.5 °C. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.53 (s, 1H), 8.15 (d, *J* = 6.2 Hz, 1H), 7.23 (d, *J* = 7.3 Hz, 1H), 7.19 (t, *J* = 7.2 Hz, 1H), 6.73 (d, *J* = 3.3 Hz, 1H), 6.61 (d, *J* = 6.2 Hz, 1H), 3.47 (t, *J* = 6.5 Hz, 4H), 2.10-2.04 (m, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 187.1, 156.5, 154.4, 150.4, 137.1, 130.0, 129.1, 123.2, 121.4, 121.2, 111.5, 110.6, 108.1, 105.4, 52.4 (2C), 25.7 (2C). **HRMS** (ESI-TOF) calcd for $C_{18}H_{18}N_3O^+$ ($[M+H]^+$) 292.1445, found 292.1450.

6. Mechanistic Studies



1a (0.2 mmol), **2a** (0.3 mmol, 1.5 eq.), LiOH (0.7 mmol, 3.5 eq.), DMSO (2 mL) and H_2O^{18} 100 μL were added in a glass tube in sequence. The reaction mixture was stirred at 80 °C for 12 h, and a saturated aqueous solution of NaCl (30 mL) was added. Aqueous phase was extracted with EtOAc (3 × 10 mL), the combined organic extracts were washed with a saturated aqueous solution of NaCl (3 × 30 mL), then the organic extracts were dried over anhydrous $MgSO_4$, filtered and concentrated under reduced pressure to yield the crude product, which was purified by silica gel chromatography (petroleum ether/ethyl acetate: 20/1, v/v) to give **3a** (31.8 mg, 50%).

To trace the source of oxygen in the CHO of product, $H_2{}^{18}O$ was added in the reaction mixture, isotope labeling experiments led to the formation of [^{18}O]-**3a** and **3a**, and this result was unambiguously confirmed by mass spectrometry (Figure S1). This provided direct evidence of the fact that the O atom originates from aqueous reaction mixture.

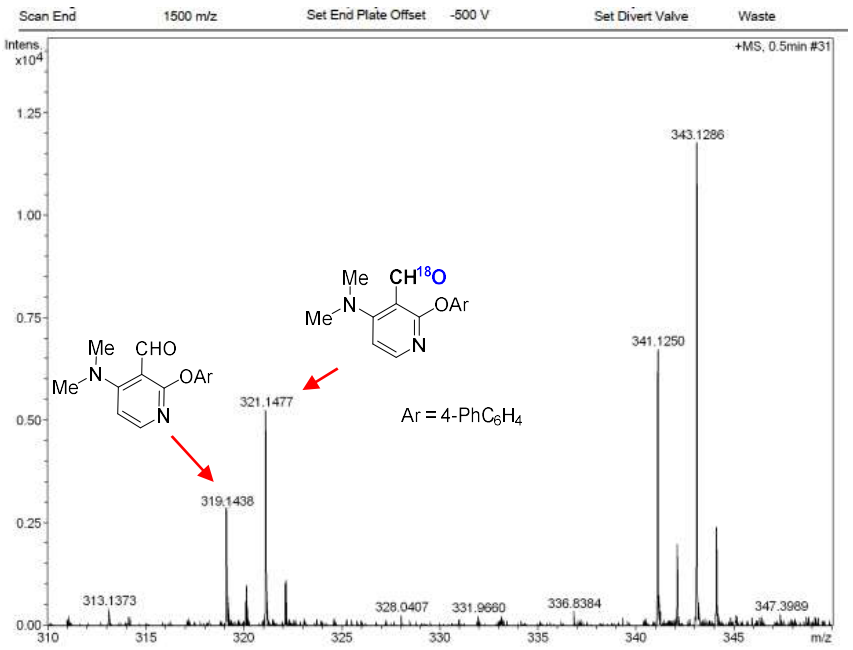
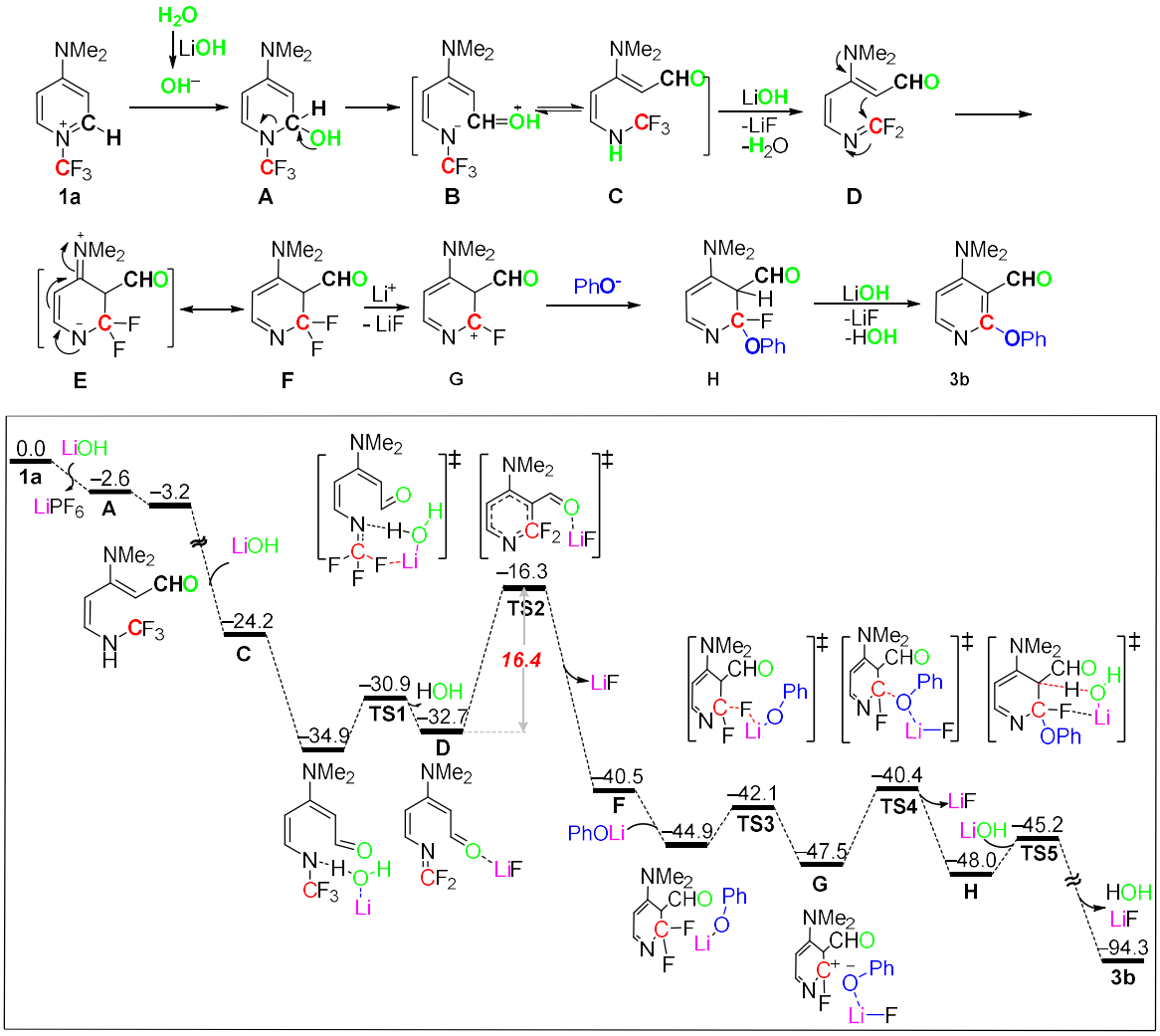


Figure S1 ^{18}O labelling experiment and HRMS analysis

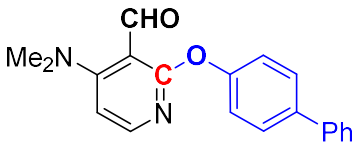
DFT Calculations All density functional theory (DFT) calculations were carried out with the Gaussian 16 package.[2] The M06[3] method was used for all calculations. The 6-31G(d) basis set

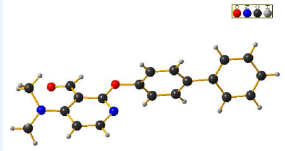
was used for optimization of molecular geometries. Frequency analyses were calculated to ensure whether it is a saddle point or minimum at 353.15 K and 1 atm at the same level. Intrinsic reaction coordinate (IRC)[4] calculations were calculated to confirm that the transition states indeed lead to the right reactants and products. The single-point energies of all stationary points were performed at the M06/6-311++G(d, p) level. Both geometry optimizations and single-point energies were considered the solvent effects with the SMD[5] model in dimethyl sulfoxide (DMSO) solvent. In addition, the translational entropy was corrected with the method developed by Whitesides et al.[6] In all the energy changes and profiles, the calculated relative Gibbs free energies (in kcal/mol) are presented.



Scheme S1. Gibbs energy profile of the progress from **1a** to **3b**.

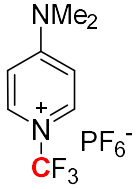
7. Crystal data and ORTEP drawing of compound 3a





CCDC	2005775
Empirical formula	$C_{80}H_{72}N_8O_8$
Formula weight	1273.45
Temperature/K	293(2)
Crystal system	triclinic
Space group	P-1
a/Å	11.2393(8)
b/Å	15.5045(10)
c/Å	19.5700(13)
α/°	102.996(6)
β/°	90.040(6)
γ/°	100.425(6)
Volume/Å^3	3265.0(4)
Z	2
ρ_{calc}g/cm^3	1.295
μ/mm^{-1}	0.085
F(000)	1344.0
Crystal size/mm^3	0.320 × 0.300 × 0.280
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	7.068 to 58.802
Index ranges	-14 ≤ h ≤ 15, -21 ≤ k ≤ 15, -23 ≤ l ≤ 26
Reflections collected	24544
Independent reflections	14992 [R_{int} = 0.0240, R_{sigma} = 0.0584]
Data/restraints/parameters	14992/3/963
Goodness-of-fit on F^2	0.996
Final R indexes [I>=2σ (I)]	R_1 = 0.0765, wR_2 = 0.1798
Final R indexes [all data]	R_1 = 0.1665, wR_2 = 0.2502
Largest diff. peak/hole / e Å^{-3}	0.41/-0.28

8. Cartesian coordinates of optimized structures



C	3.07198100	-0.45179400	-0.43471600
C	3.08812100	0.90519100	-0.43218100
C	1.97984400	1.64673000	0.07609300
C	0.88667000	0.88798600	0.58836000
C	0.92158300	-0.46600300	0.56983100
N	1.99895900	-1.13884700	0.06050500
H	3.89398500	-1.04038700	-0.82540000
H	3.96232200	1.40042500	-0.84031200
H	-0.00273700	1.35812000	0.99102800
H	0.09915500	-1.06587900	0.94528100
C	1.93964900	-2.58144600	0.05948000
F	0.88727700	-2.98856400	-0.63463400
F	1.81073700	-3.02899100	1.29925800
F	3.03318500	-3.08823300	-0.47222900
N	1.96184800	2.97864300	0.06800000
C	0.78713200	3.70105200	0.54464400
H	0.64477100	3.55323200	1.62281500
H	0.92465500	4.76620600	0.35218100
H	-0.11425400	3.36783700	0.01663500
C	3.11318600	3.73032000	-0.41799600
H	3.28388600	3.54072900	-1.48533200
H	2.92443000	4.79588800	-0.27865300
H	4.01754500	3.46360400	0.14222600
P	-2.81244600	0.00955000	-0.09939000
F	-1.65236300	-0.84024100	-0.85726400
F	-2.02196000	1.38907800	-0.44232400
F	-3.63609600	0.13216300	-1.48791100
F	-3.95750600	0.85961600	0.66957100
F	-1.97396600	-0.11108600	1.29722500
F	-3.58949800	-1.36750000	0.25383400

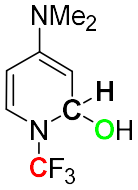
LiOH

O	0.07035200	-0.38485200	0.00000000
H	-0.77386900	-0.84564100	0.00000000
Li	0.07035200	1.30815100	0.00000000

$LiPF_6$

P	-0.16754100	-0.00002300	0.00000200

F	1.06765400	-1.14083700	-0.00374900
F	-1.25964600	-1.16592400	-0.00255300
F	-0.10273100	0.00452100	-1.60495700
F	-1.25967700	1.16591400	0.00377200
F	-0.10103400	-0.00453600	1.60491200
F	1.06778600	1.14102300	0.00252900
Li	2.60065200	-0.00037400	0.00012700



C	-0.39306700	1.21383600	0.44011100
C	0.93787500	1.18171700	0.60828900
C	1.70555900	0.05575700	0.09462400
C	1.02695900	-1.02353300	-0.38202800
C	-0.44766600	-1.15724400	-0.22544400
N	-1.06457500	0.17999400	-0.20625200
H	-1.00538300	2.04134300	0.78989200
H	1.42148500	1.99709400	1.13659200
H	1.53358400	-1.89143200	-0.79414900
C	-2.46602600	0.25656800	-0.20354700
F	-3.00009100	-0.71755900	-0.93453400
F	-2.87762500	1.42713500	-0.70578000
F	-3.00695500	0.17264400	1.02475100
N	3.09273500	0.13016200	0.15666200
C	3.83605700	-1.03189600	-0.27752900
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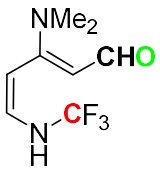
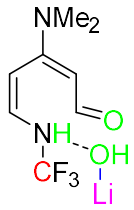
C	3.74272500	1.37481100	-0.22217600
H	3.20436800	2.24458200	0.16285400
H	4.75674500	1.39420900	0.19518000
H	3.82052100	1.47778100	-1.31900800
H	-0.88214900	-1.69902200	-1.07066600
O	-0.82617400	-1.90833500	0.91295200
H	-0.26141000	-1.60590500	1.64430500



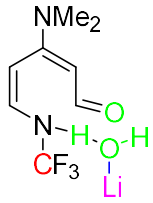
C	-0.65330900	-0.52531400	1.04270000
C	0.67900800	-0.56935400	1.19891100

C	1.67675600	-0.02162500	0.26675000
C	1.62408600	1.28691700	-0.18546600
C	0.81041100	2.30447700	0.40891700
N	-1.34581500	0.08327400	0.00651000
H	-1.29631200	-0.99154200	1.78783500
H	1.05240400	-1.11126300	2.06652400
H	2.29256400	1.62006300	-0.97838300
C	-2.65562000	-0.31525400	-0.26599300
F	-3.43729200	-0.17203400	0.80830000
F	-2.77191400	-1.60508500	-0.63526500
F	-3.14917700	0.42216000	-1.25662700
N	2.67171600	-0.86267300	-0.10853400
C	3.79992400	-0.37991200	-0.87956100
H	4.16728400	0.56896900	-0.47171400
H	4.60705100	-1.11739800	-0.82053100
H	3.54206400	-0.23115100	-1.93916900
C	2.61605500	-2.30379300	0.06041700
H	2.78144600	-2.79380900	-0.90889700
H	3.39413100	-2.64703400	0.75632000
H	1.63902800	-2.61536800	0.43584400
H	-0.81675600	0.37422600	-0.81420800
O	0.74652800	3.46881800	0.02105100
H	0.22514100	1.98734000	1.30442200



C	0.36929100	-1.36079100	-0.61191100
C	-0.95868000	-1.23232600	-0.84586300
C	-1.83505300	-0.17843100	-0.34966900
C	-1.44845700	1.16625900	-0.39791900
C	-0.36093700	1.61966600	-1.16016600
N	1.15622100	-0.66127100	0.26168700
H	0.88415100	-2.16870200	-1.13375100
H	-1.41781800	-2.01228400	-1.45239900
H	-1.96000200	1.90478000	0.22097200
C	2.52500400	-0.61641400	0.06788800
F	3.03293500	-1.73923400	-0.45787400
F	3.15920400	-0.38773500	1.22539200
F	2.91241900	0.38610900	-0.76190500
N	-3.04001700	-0.53407700	0.13416900
C	-4.05293100	0.46047800	0.43679600

H	-4.04972100	1.25111500	-0.32118900
H	-5.03446000	-0.02448500	0.43070900
H	-3.89448300	0.91474800	1.42579700
C	-3.39033600	-1.90109900	0.47934100
H	-3.85887900	-1.91243600	1.47157200
H	-4.10279200	-2.31977600	-0.24482700
H	-2.49843400	-2.53106900	0.51228100
H	0.83698000	0.16104700	0.93900400
O	0.18440300	2.74558500	-1.03039600
H	0.03126600	0.93560700	-1.93866200
O	0.76947300	1.33324000	1.87183800
H	1.56062500	1.23478100	2.41545700
Li	0.67690300	2.74239500	0.80367000



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C	-1.83719800	-0.26206300	-0.27585100
C	-1.54638700	1.12101300	-0.29743400
C	-0.59344900	1.66156000	-1.15816100
N	1.24807700	-0.34865800	0.03527000
H	0.96520900	-2.12702300	-1.01676700
H	-1.31847600	-2.16118100	-1.16706900
H	-2.08166900	1.80433300	0.36551300
C	2.58076100	-0.64602700	0.03425100
F	2.91922700	-1.82952700	0.62109900
F	3.27939000	0.29823700	0.70423800
F	3.15302700	-0.71613600	-1.19978600
N	-3.03789200	-0.68223400	0.18376900
C	-4.13608500	0.23916600	0.41034300
H	-4.09701000	1.06434100	-0.30782600
H	-5.08167900	-0.29655300	0.27049400
H	-4.12067500	0.65369800	1.42936100
C	-3.31147400	-2.06715300	0.52343100
H	-3.96458700	-2.09479400	1.40390300
H	-3.81750300	-2.59495300	-0.29811600
H	-2.38366600	-2.59287600	0.76516200
H	0.94189800	0.97892700	1.17903200
O	-0.15349900	2.84684200	-1.11539300
H	-0.21129000	0.99798600	-1.95705200

O	0.95262500	1.79442600	1.76289900
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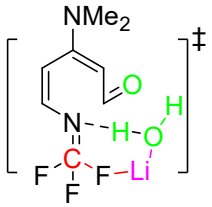
Li	0.30813400	3.17672100	0.64514600



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C	-1.34357000	1.19744600	-0.37661900
C	-0.21528700	1.54903100	-1.14188700
N	0.98726000	-0.87852400	0.32778400
H	0.66249300	-2.35077000	-1.15579000
H	-1.60297000	-1.90348700	-1.57575100
H	-1.80521300	1.98081600	0.22507600
C	2.26203600	-0.94411500	0.23304100
F	2.99216600	-0.76323700	1.31277700
F	2.85539000	0.63213900	-0.55581300
F	2.90665700	-1.73000400	-0.60691900
N	-3.06677000	-0.37646800	0.14827100
C	-3.97396800	0.68902700	0.53470700
H	-3.95420400	1.49607100	-0.20584800
H	-4.99004400	0.28493100	0.58266600
H	-3.71634500	1.10376100	1.52013100
C	-3.52481500	-1.72252200	0.44883100
H	-3.93871600	-1.74361400	1.46493900
H	-4.31077500	-2.03436500	-0.25237500
H	-2.69622900	-2.43282200	0.40062300
H	0.24632600	2.11164500	1.77008700
O	0.43665400	2.61252200	-1.02443800
H	0.11350100	0.81183300	-1.90251700
O	1.07882500	1.61232000	1.77402200
H	0.81168400	0.70681100	1.49263400
Li	1.96603700	2.02769500	0.04186500

H_2O

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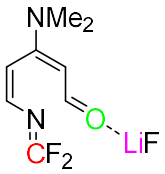
H	0.00000000	0.75756400	-0.48072500
H	0.00000000	-0.75756400	-0.48072500



C	0.60041100	-1.94579500	1.17167900
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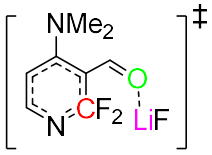
C	1.21599100	0.40380500	0.56512900
C	0.05004000	1.13550800	0.78043700
C	-0.90025800	0.79674800	1.76536900
N	-0.66197700	-1.98706100	0.57540600
H	0.86035300	-2.86407500	1.69665400
H	2.38223200	-1.03737100	1.74145300
H	-0.18080300	1.99147700	0.14486400
C	-0.85925800	-1.67167800	-0.60992700
F	0.02935900	-1.32567600	-1.51023600
F	-3.14137800	1.66117600	-1.47785700
F	-2.04760600	-1.64545700	-1.14500300
N	2.18134000	0.84216100	-0.25752500
C	2.11877600	2.17192500	-0.83848300
H	1.83450900	2.90837400	-0.07918900
H	3.10971500	2.43121600	-1.22295200
H	1.39754700	2.21444200	-1.66761000
C	3.23594200	-0.01054500	-0.78284500
H	3.22184600	0.03687000	-1.87964300
H	4.21818200	0.33158100	-0.43222000
H	3.08629400	-1.04986400	-0.48282400
O	-2.05248900	1.28051600	1.83267700
H	-0.59704500	0.06353900	2.53680200
Li	-2.83740200	1.55198500	0.12018600



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C	1.70632800	-1.21074900	0.70598500
C	1.30487500	0.15369700	0.41833800
C	-0.08793500	0.49903800	0.53314200
C	-0.83536100	0.11786900	1.67808300
N	-0.33929200	-2.23499900	-0.12746100
H	1.30253700	-3.28193600	0.58350200
H	2.68660400	-1.40274800	1.13435900
H	-0.47818800	1.33505200	-0.05135700
C	-0.73596700	-1.18829600	-0.74207200

F	-0.16994300	-0.68261400	-1.82909400
F	-3.77183000	1.80905700	-0.72246800
F	-2.03817100	-0.92990700	-0.81351500
N	2.18883900	1.02307100	-0.04152500
C	1.87689800	2.43645900	-0.22113300
H	1.11530000	2.75574900	0.49370700
H	2.79129700	3.01207800	-0.04590800
H	1.52884600	2.62705700	-1.24429500
C	3.54390700	0.64868500	-0.43022200
H	3.81025700	1.21239700	-1.33074200
H	4.25159500	0.90415600	0.36832100
H	3.60238300	-0.41815700	-0.65291500
O	-2.03281000	0.40328800	1.86169100
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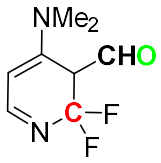
Li	-3.11541400	0.73046200	0.31399500



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C	-0.88633700	-0.45423500	-0.11020900
C	0.33915300	0.33936700	-0.55703800
C	1.60231000	-0.27423900	0.02395700
N	1.75805200	-1.66278200	-0.17272500
H	0.74028200	-3.42306000	-0.15939300
H	-1.47922200	-2.49750700	0.23968800
N	-2.11436400	0.10034100	-0.05318100
C	-2.38460600	1.49862200	0.25009500
H	-2.60765300	2.08259000	-0.65307300
H	-3.25345800	1.54620800	0.91574500
H	-1.55556400	1.95843800	0.79425100
C	-3.28096700	-0.76789600	-0.01383000
H	-3.42434400	-1.21489900	0.98104400
H	-4.16572900	-0.17489200	-0.26318600
H	-3.18453300	-1.56984800	-0.75362300
C	0.32788700	1.85887300	-0.50597300
O	1.01918500	2.53490700	0.21536100
H	-0.34060400	2.32337900	-1.26322400
F	2.67799300	0.35669600	-0.52480600
H	0.38956900	0.12057900	-1.64110400
F	1.66074000	-0.00736000	1.36911400

PhOLi

C	0.08226500	1.19507400	0.00115000
C	0.80832500	-0.02334300	0.00192600
C	0.03865700	-1.21464300	0.00095000
C	-1.34987000	-1.18275100	-0.00087400
C	-2.04294300	0.02858000	-0.00165100
C	-1.30631600	1.21411500	-0.00066600
H	0.65038100	2.12714200	0.00199100
H	0.57297500	-2.16635600	0.00146500
H	-1.90376600	-2.12295400	-0.00160800
H	-3.13177600	0.04815600	-0.00316500
H	-1.82575600	2.17379100	-0.00124800
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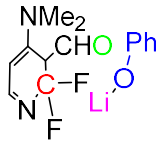
Li	3.80887100	0.07208100	-0.01073100



C	-2.24887100	-1.41446500	1.78871700
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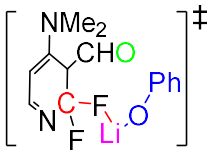
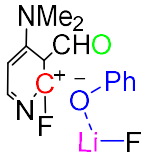
C	-0.94042000	0.47097800	1.03247200
C	-2.13164600	0.79687400	0.15095700
C	-2.94479600	-0.47175600	-0.13242700
N	-3.23067300	-1.31015000	0.92857900
H	-2.39235700	-2.14854200	2.58619800
H	-0.31171000	-0.89642200	2.57664600
N	0.09327500	1.31937900	1.09686500
C	0.08865300	2.67610200	0.57126500
H	-0.91823400	3.01202900	0.30471800
H	0.44263500	3.35548300	1.35553800
H	0.75594200	2.76653300	-0.29657400
C	1.23519500	0.99046800	1.93836100
H	1.57886900	-0.03099000	1.73532900
H	2.05090300	1.68031100	1.70497400
H	0.97942200	1.08706100	3.00331100
C	-1.83615000	1.47341500	-1.17102300
O	-1.03539800	1.03537400	-1.97610100
H	-2.42463000	2.37916000	-1.40248100
F	-4.07056300	-0.10742700	-0.78707400
H	-2.80491300	1.45167700	0.72781400
F	-2.23336300	-1.23156700	-1.11328900
C	2.60349000	0.27547700	-1.23162600
C	2.17280200	-1.02027200	-0.83398600
C	3.03641900	-1.71634600	0.05349100

C	4.22127800	-1.15309600	0.51183200
C	4.61515300	0.12573100	0.11404100
C	3.78964500	0.82833400	-0.76687100
H	1.97319000	0.83405600	-1.92859600
H	2.73934500	-2.71817500	0.36892300
H	4.85272600	-1.72523400	1.19374400
H	5.54571200	0.56106900	0.47509800
H	4.07798700	1.82714000	-1.09972600
O	1.06360100	-1.54215400	-1.25447900
Li	-0.44398900	-0.86179400	-1.86419000



C	-1.84466100	-1.36096400	1.84229300
C	-0.75736300	-0.52137100	1.71084700
C	-0.85916800	0.62671400	0.90404600
C	-2.12333400	0.80046900	0.10391800
C	-3.02868000	-0.40482800	0.21075000
N	-3.01146500	-1.28562300	1.17226900
H	-1.78527100	-2.16312000	2.57917000
H	0.11506100	-0.69728300	2.33036100
N	0.06712600	1.56996300	0.89575100
C	-0.05920800	2.86191700	0.23441400
H	-1.08212100	3.06188400	-0.08926500
H	0.22398700	3.64096400	0.95047700
H	0.61894900	2.90618900	-0.62682300
C	1.29219600	1.40677400	1.67828900
H	1.75213700	0.43330800	1.47154500
H	1.99284700	2.19299600	1.38788900
H	1.07279300	1.49746600	2.74974400
C	-1.92920600	1.08813800	-1.38313300
O	-0.87620300	0.95444900	-1.96625100
H	-2.84544900	1.43474700	-1.89643100
F	-4.20293100	-0.18478400	-0.35538800
H	-2.70197900	1.64221500	0.52700000
F	-2.29923900	-1.30066900	-1.23580600
C	2.60252400	0.04435000	-1.34714300
C	2.11061300	-1.15259200	-0.75523600
C	2.87725900	-1.67194100	0.32359100
C	4.03789300	-1.04718000	0.76423900
C	4.49980700	0.12511000	0.16293600
C	3.76476700	0.65824500	-0.89874400

H	2.04233900	0.46562400	-2.18482900
H	2.52677700	-2.59079900	0.79782300
H	4.59571300	-1.48504200	1.59392800
H	5.41183500	0.60890500	0.50945000
H	4.10680300	1.57187100	-1.38854900
O	1.03688500	-1.74304600	-1.17223100
Li	-0.56687100	-1.18316800	-1.68847600



C	-1.88829800	-1.16338400	1.95369900
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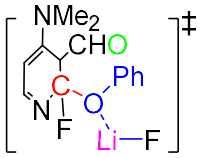
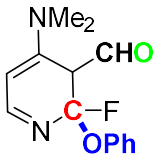
C	-0.92260200	0.72368400	0.80940100
C	-2.16602900	0.79208700	-0.02267000
C	-3.18623800	-0.19365700	0.41342000
N	-3.11538400	-1.06441300	1.33570100
H	-1.81429000	-1.95632500	2.69610100
H	0.09323900	-0.52061600	2.30149400
N	0.02096700	1.62889800	0.69586900
C	-0.05674300	2.82740600	-0.13220700
H	-1.01921900	2.92822400	-0.63150800
H	0.10355100	3.69646800	0.51566800
H	0.73951700	2.79119700	-0.88422500
C	1.23048800	1.55528100	1.52348500
H	1.72696800	0.58726800	1.39190900
H	1.91226700	2.34611400	1.20504800
H	0.96923200	1.70501300	2.57747000
C	-1.90014900	0.58059600	-1.54661100
O	-0.78486200	0.65948700	-2.02360500
H	-2.82497100	0.62654700	-2.14327600
F	-4.32427600	-0.06732500	-0.23613700
H	-2.63047700	1.79089300	0.04753700
F	-2.15599900	-1.45437000	-1.37426700
C	2.59979500	-0.11036100	-1.29808300
C	2.17305600	-1.23713100	-0.53927500
C	2.98125500	-1.56760300	0.58408100
C	4.11573100	-0.83416700	0.91204600
C	4.51087300	0.26610500	0.14860300
C	3.73572700	0.61329700	-0.96074800
H	2.00665800	0.16960600	-2.17163200
H	2.68425500	-2.42978900	1.18463100
H	4.70628300	-1.12883600	1.78149700

H	5.40220600	0.83545700	0.40837600
H	4.02443700	1.46764600	-1.57619100
O	1.12217900	-1.92464000	-0.84955300
Li	-0.42500600	-1.46611700	-1.62867000

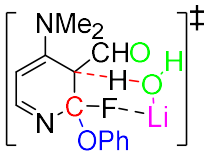


C	-1.47283200	2.32048200	0.22436600
C	-2.47115600	1.51605300	-0.27345800
C	-2.51336000	0.15534500	0.09263300
C	-1.34592900	-0.39627300	0.85562900
C	-0.28231900	0.63139900	1.12064100
N	-0.41042800	1.93037500	0.97101300
H	-1.52221600	3.39199400	0.02759000
H	-3.28078200	1.97677300	-0.82787800
N	-3.54710200	-0.61572200	-0.18917600
C	-3.78774900	-1.93981100	0.37185800
H	-3.06509100	-2.19661400	1.14618000
H	-4.78829500	-1.93771400	0.81978200
H	-3.75381500	-2.69276900	-0.42260800
C	-4.63921100	-0.11222800	-1.02072800
H	-4.24447300	0.35773600	-1.92620900
H	-5.26623300	-0.95815400	-1.31091800
H	-5.24713700	0.61139900	-0.46361800
C	-0.67918100	-1.60786100	0.17451800
O	-1.11741900	-2.16472900	-0.79635900
H	0.21501400	-1.96188800	0.72377500
F	0.57552000	0.23146400	2.04385100
H	-1.67590400	-0.75068500	1.84933000
F	1.64563000	3.41981500	-1.47628800
C	2.46848200	-1.49113900	-0.89732800
C	2.09089700	-0.27245800	-0.30516400
C	3.06245000	0.44479600	0.41830100
C	4.36407800	-0.03405000	0.52715600
C	4.72887900	-1.23621100	-0.07300800
C	3.77146600	-1.95852200	-0.78503500
H	1.71950000	-2.04872800	-1.45968600
H	2.78591400	1.38052400	0.91118800
H	5.09905100	0.54036800	1.09015900
H	5.74843900	-1.60776000	0.01251300
H	4.04397900	-2.90012700	-1.26114500
O	0.84913200	0.19965000	-0.46677700

Li	1.10787000	2.11168900	-0.65552400



C	0.21176900	-0.89074900	-2.32019000
C	0.17068100	0.49580000	-1.98865800
C	0.77596000	0.93281000	-0.83414900
C	1.62703900	-0.12819900	-0.14331300
C	1.02259700	-1.53403000	-0.25417000
N	0.61320400	-1.87506700	-1.57496800
H	-0.17175600	-1.16926000	-3.30802300
H	-0.37938200	1.16441300	-2.64282800
N	0.77337900	2.22791100	-0.44500400
C	0.93762200	2.70756200	0.91928000
H	1.85621500	3.29957200	1.02780600
H	0.08006100	3.34404600	1.17429300
H	0.94358100	1.89442400	1.64686600
C	0.19912900	3.22060400	-1.33816000
H	-0.90077700	3.16316800	-1.35139400
H	0.49502500	4.21508100	-0.99048200
H	0.57589200	3.08535500	-2.35757600
C	2.30061100	0.19096300	1.17576700
O	2.14227300	-0.40008300	2.21681400
H	3.04970600	1.01083900	1.09269400
O	0.01403100	-1.83534700	0.68249900
C	-1.14564500	-1.09524800	0.63966300
C	-1.27965000	-0.00669000	1.49695100
C	-2.18654500	-1.46530300	-0.20797400
C	-2.43587000	0.76589500	1.45074300
H	-0.47102300	0.21983300	2.19050300
C	-3.34055800	-0.68929200	-0.24516600
H	-2.07037400	-2.34178200	-0.84170700
C	-3.46226100	0.43469700	0.56937700
H	-2.53515600	1.62632500	2.11110800
H	-4.15207700	-0.96620400	-0.91629500
H	-4.36545600	1.04111600	0.53082700
F	2.02464000	-2.40155500	0.09843200
H	2.49796800	-0.19232300	-0.82638700



C	0.85839800	-0.60352900	-2.17414300
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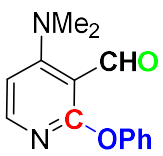
C	0.44731300	1.14915800	-0.57764300
C	1.17585400	0.26012400	0.37428800
C	1.01854600	-1.21871200	0.06830800
N	1.19964600	-1.53606900	-1.31217900
H	0.93562100	-0.89271200	-3.22669000
H	-0.02614800	1.28705500	-2.69433600
N	0.00011800	2.37633300	-0.23334100
C	-0.50379400	2.75108700	1.08031800
H	0.12453300	3.52026300	1.54877100
H	-1.51797400	3.15547000	0.95989700
H	-0.58204700	1.89034100	1.74714200
C	-0.37115300	3.32120500	-1.27527200
H	-1.35770800	3.08719500	-1.70327000
H	-0.41001700	4.32290400	-0.83547400
H	0.37595600	3.32677000	-2.07513600
C	1.36386800	0.64825300	1.79309100
O	1.32817600	-0.09255500	2.75474000
H	1.67124900	1.71200300	1.92016900
O	-0.08372200	-1.88409700	0.62273200
C	-1.33316700	-1.36543300	0.36021100
C	-1.91727700	-0.51976000	1.29815200
C	-2.02045800	-1.73744200	-0.79224400
C	-3.18452100	0.00141500	1.05502300
H	-1.36779100	-0.28592500	2.20910100
C	-3.28787700	-1.21330100	-1.02523500
H	-1.55391100	-2.42633000	-1.49363900
C	-3.86776000	-0.33687500	-0.11026400
H	-3.63965700	0.67117700	1.78332000
H	-3.82748800	-1.49481300	-1.92809900
H	-4.85885000	0.07157700	-0.29978200
F	2.08530500	-1.87687500	0.71489900
H	2.33212500	0.40002200	-0.03514900
O	3.70926800	0.21216500	-0.63332200
H	4.29180100	0.39053600	0.11672700
Li	3.33143100	-1.52628700	-0.89090200



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C	2.54407700	1.53039400	0.36009300

C	2.12581900	0.20845800	0.06843000
C	0.82831700	0.06999600	-0.52097000
C	0.00999900	1.22041400	-0.52743200
N	0.36916100	2.43166500	-0.16936400
H	1.96490000	3.57744500	0.48494700
H	3.53399400	1.73287000	0.75746500
N	2.92145500	-0.84843700	0.35009000
C	2.39268200	-2.14622300	0.73494400
H	2.58336300	-2.91047600	-0.02619300
H	2.87345400	-2.44401900	1.67665800
H	1.31476400	-2.08669700	0.91017900
C	4.31891100	-0.64874300	0.69345100
H	4.44702200	-0.33253300	1.74026900
H	4.84563200	-1.59828700	0.55173400
H	4.78094400	0.09275500	0.03432200
O	-1.26977800	1.12295300	-1.01261700
C	-2.21032900	0.44782500	-0.27018000
C	-2.09716800	0.27320600	1.10636900
C	-3.31983000	-0.02672900	-0.96447300
C	-3.11214500	-0.39485700	1.78615700
H	-1.23368600	0.66124100	1.64426300
C	-4.32709300	-0.68549000	-0.26980300
H	-3.37646400	0.12833600	-2.04067600
C	-4.22711600	-0.87617400	1.10676900
H	-3.02670200	-0.53277600	2.86283700
H	-5.19469600	-1.05721700	-0.81246000
H	-5.01575600	-1.39617600	1.64707800
C	0.43112800	-1.05512200	-1.36850100
O	1.14595900	-1.97769000	-1.72181400
H	-0.59946700	-0.97394200	-1.77321100

9. References

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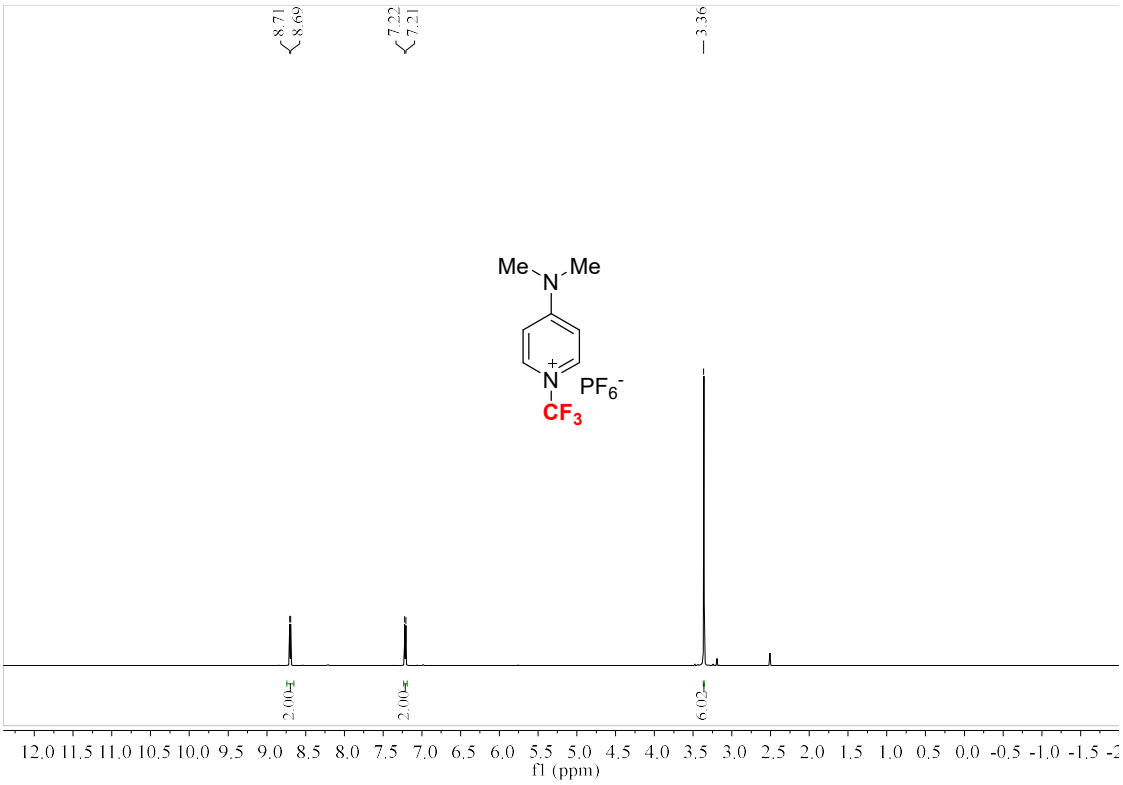
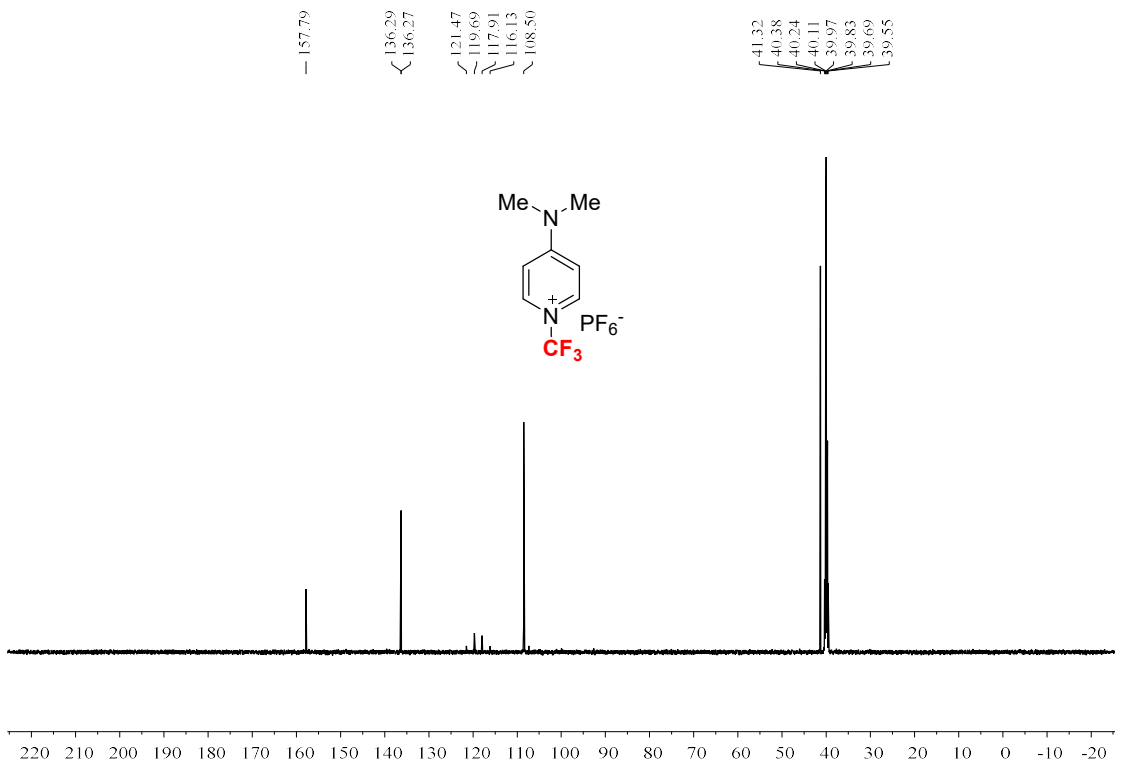
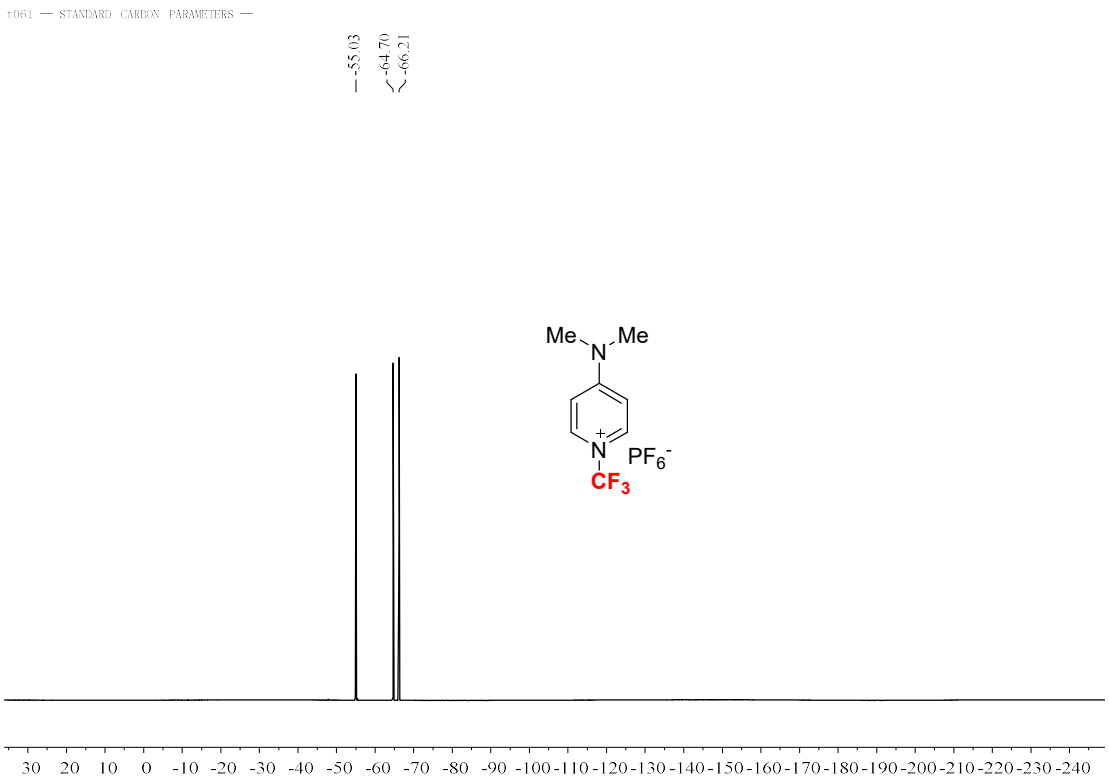
10. Copies of the NMR Spectra of New Compounds.

Compound 1a






t061 — STANDARD CARBON PARAMETERS —
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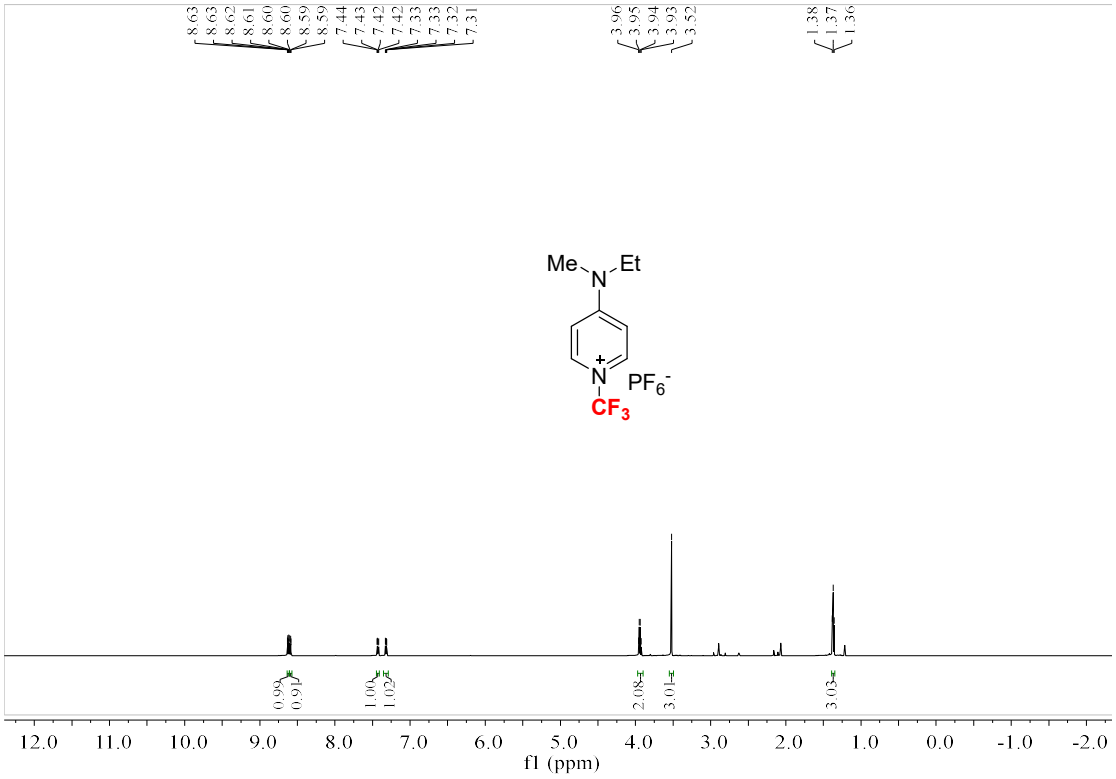
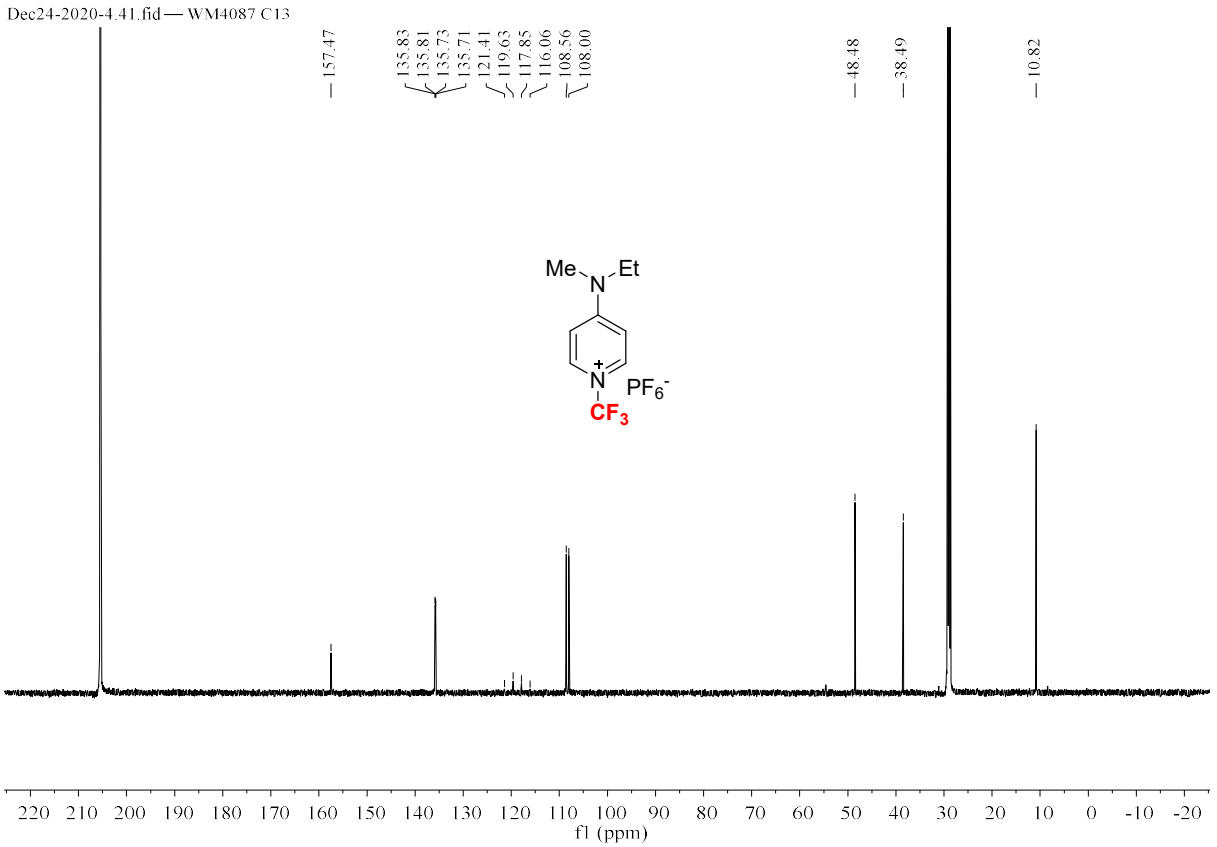
-64.70
-66.21
Me
N
Me
N
PF6-
CF3
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220 -230 -240

Compound 1b


8.63
8.63
8.62
8.61
8.60
8.60
8.59
8.59
7.44
7.43
7.42
7.42
7.33
7.33
7.32
7.31
3.96
3.95
3.94
3.93
3.52
1.38
1.37
1.36
Me
N
Et
N
PF6-
CF3
0.99
0.91
1.00
1.02
2.08
3.01
3.03
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0 -2.0
f1 (ppm)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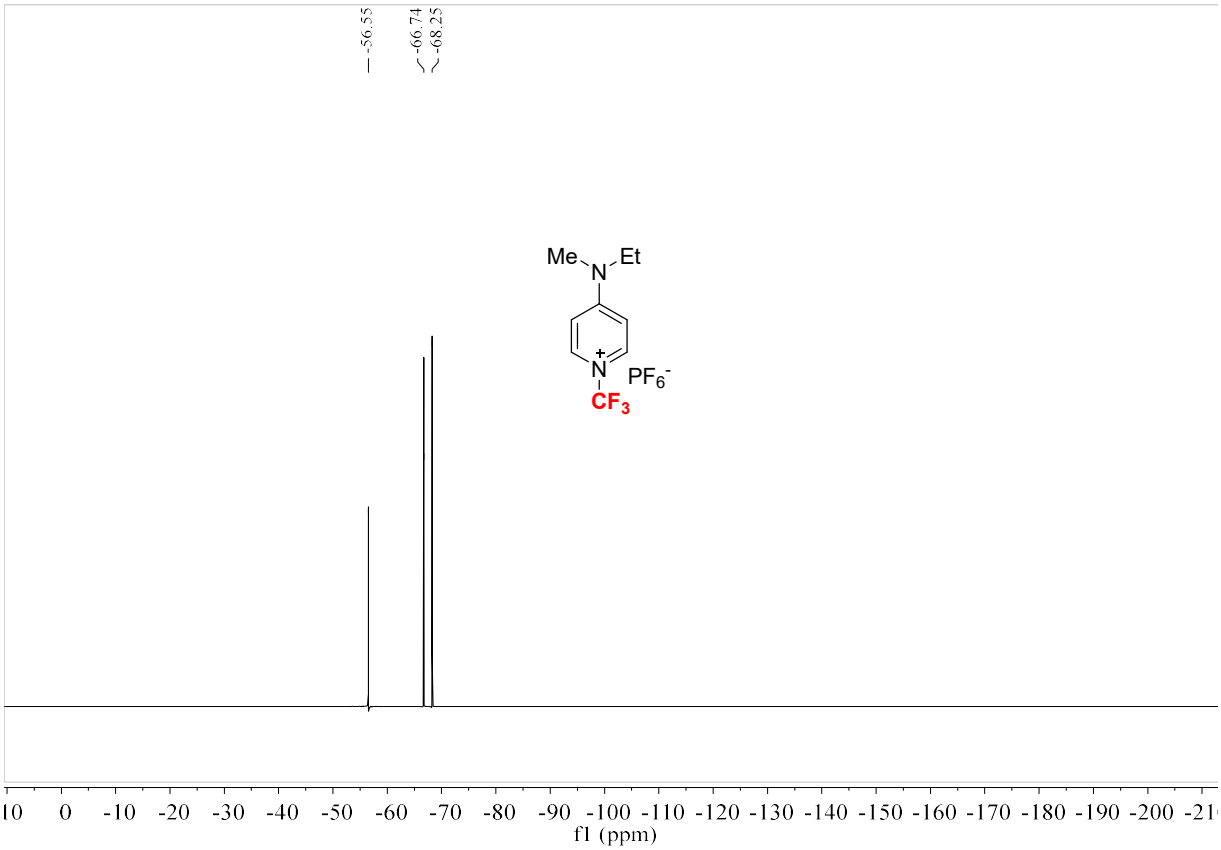
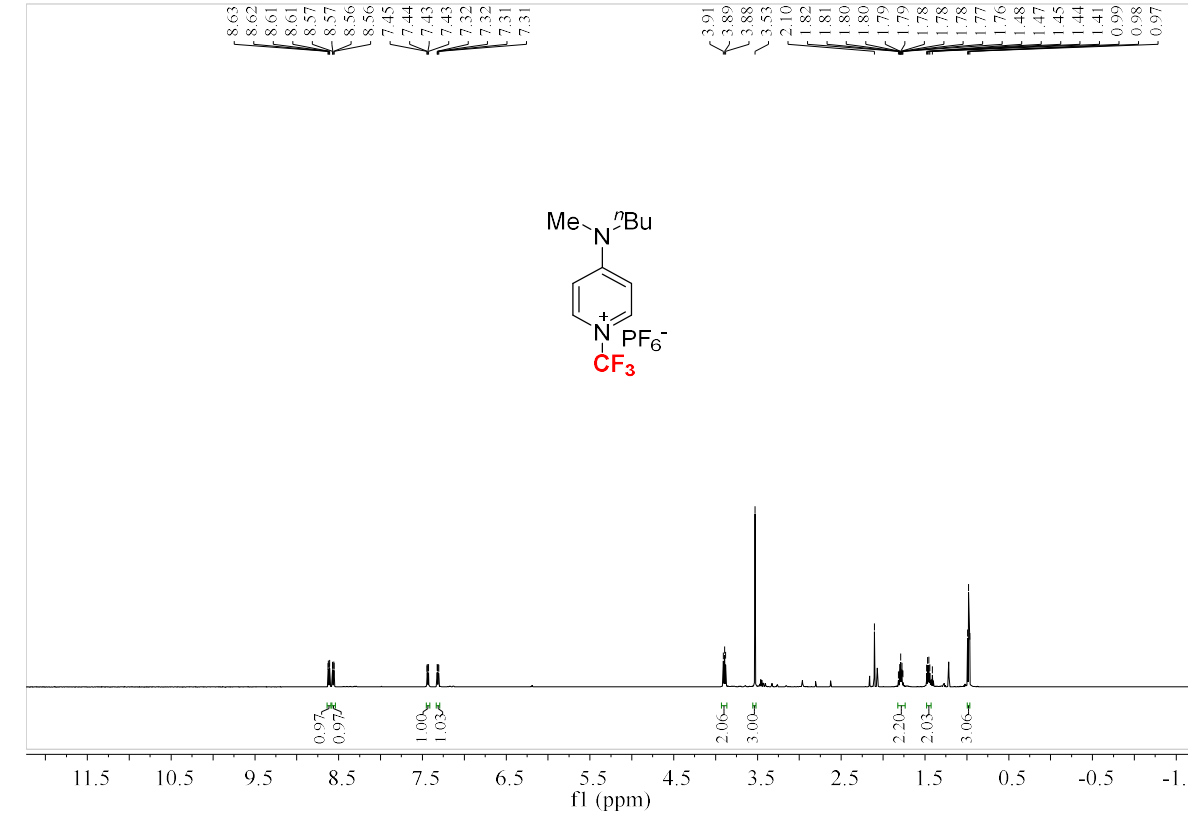
135.83
135.81
135.73
135.71
121.41
119.63
117.85
116.06
108.56
108.00
48.48
38.49
10.82
Me
N
Et
N
PF6-
CF3
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)


-56.55
-66.74
-68.25
Me
N
Et
N
PF6-
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -21
f1 (ppm)

Compound 1c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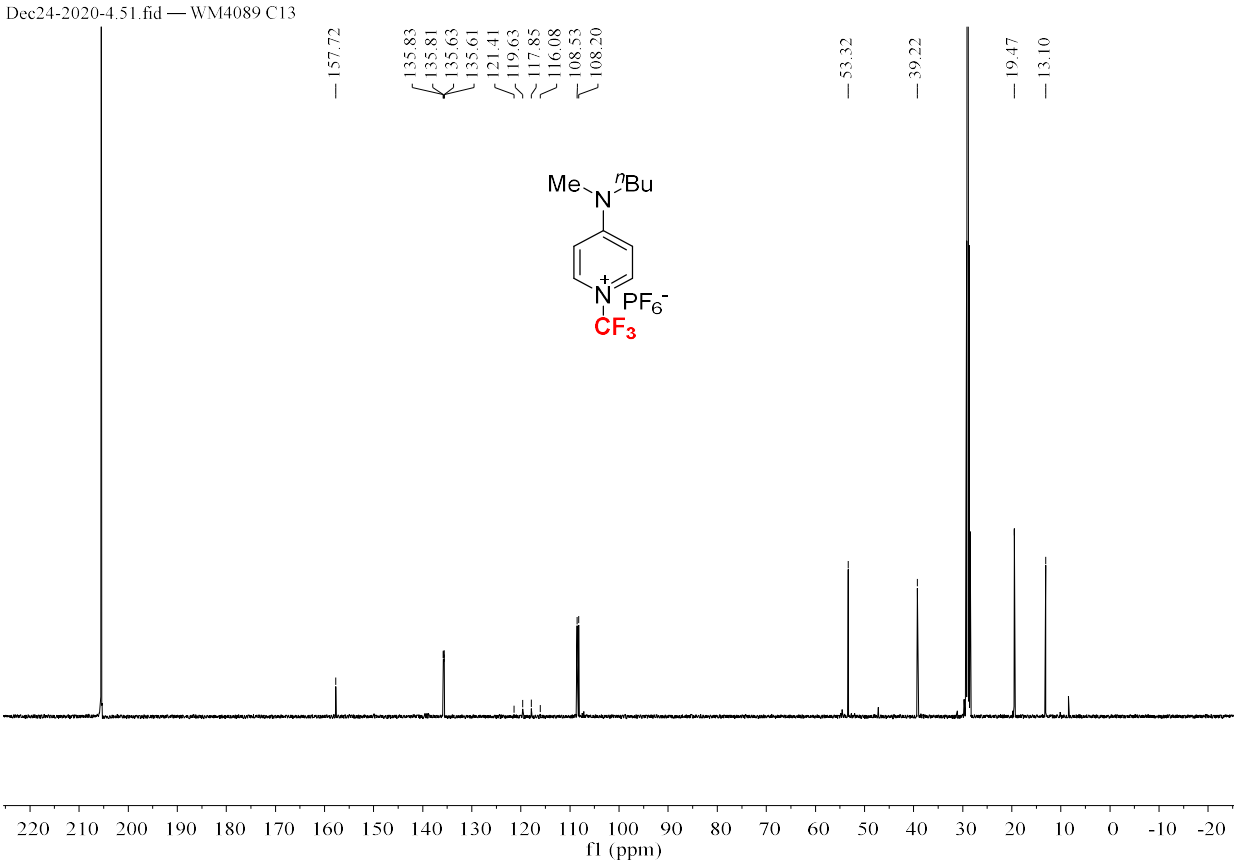
8.62
8.61
8.61
8.57
8.57
8.56
8.56
7.45
7.44
7.43
7.43
7.32
7.32
7.31
7.31
3.91
3.89
3.88
3.53
2.10
1.82
1.81
1.80
1.80
1.79
1.79
1.78
1.78
1.78
1.77
1.76
1.48
1.47
1.45
1.44
1.41
0.99
0.98
0.97
Me
nBu
N
PF6-
CF3
0.97
0.97
1.00
1.03
2.06
3.00
2.20
2.03
3.06
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.
f1 (ppm)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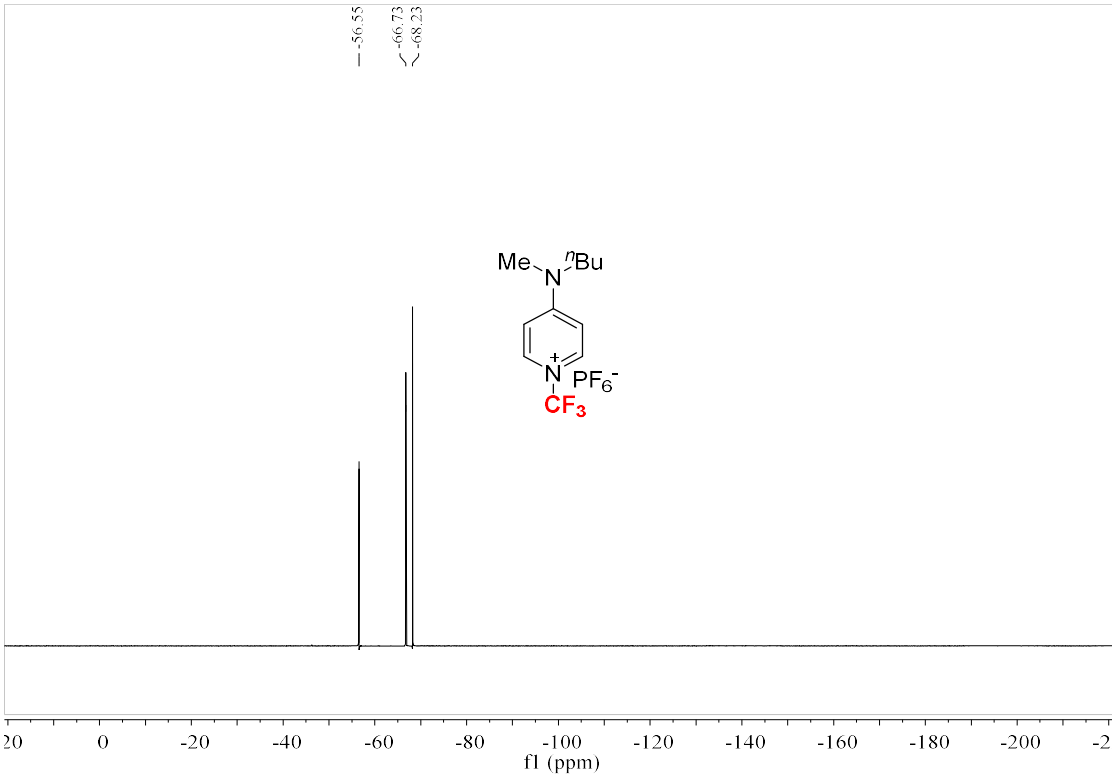
135.81
135.63
135.61
121.41
119.63
117.85
116.08
108.53
108.20
53.32
39.22
19.47
13.10
Me
nBu
N
PF6-
CF3
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)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-66.73
-68.23
Me
nBu
N
PF6-
CF3
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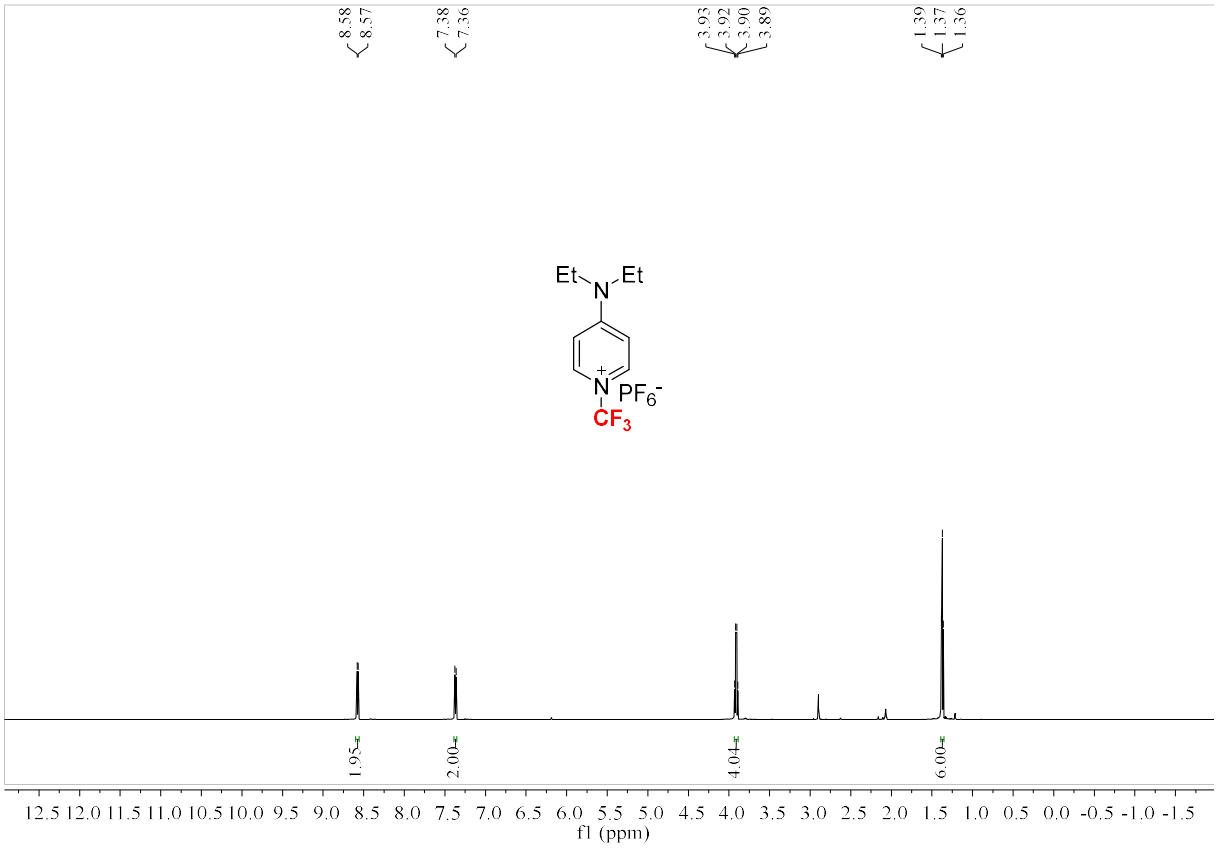
f1 (ppm)

Compound 1d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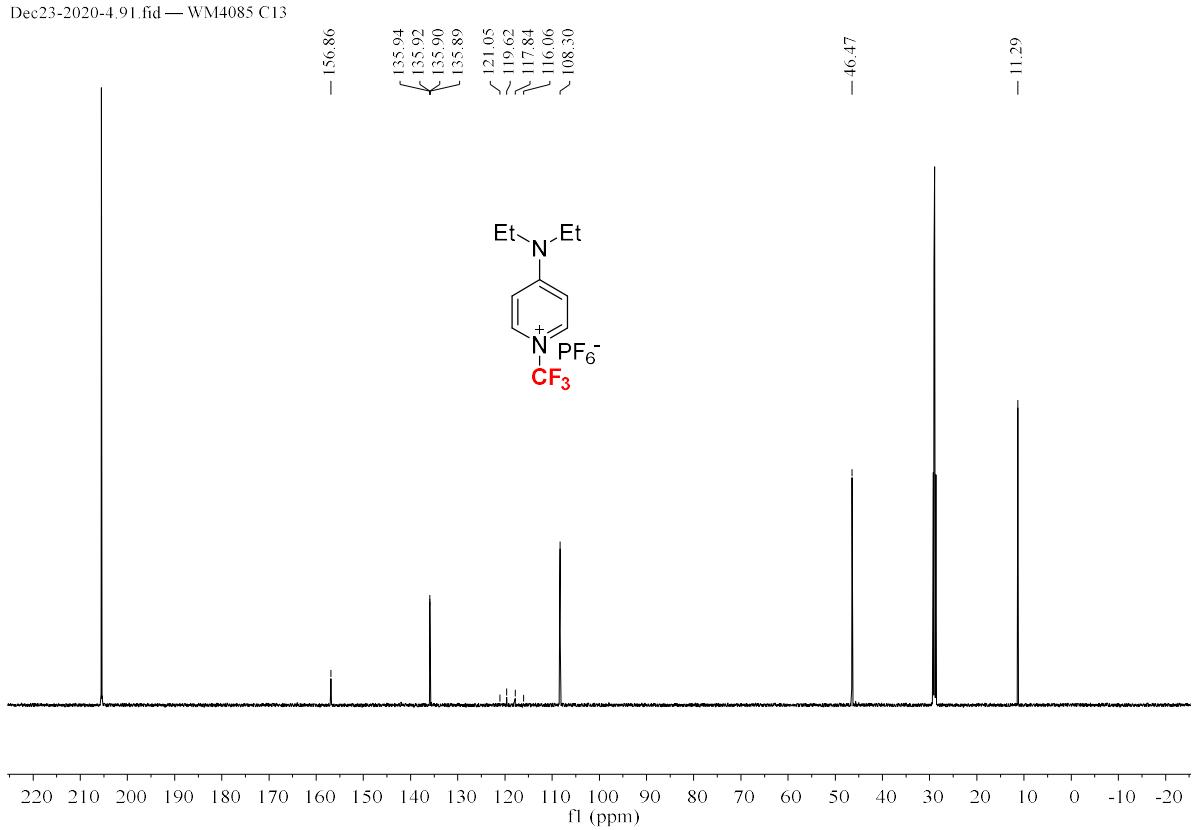
8.57
7.38
7.36
3.93
3.92
3.90
3.89
1.39
1.37
1.36
Et
Et
N
PF6-
CF3
1.95
2.00
4.04
6.00
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)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121.05
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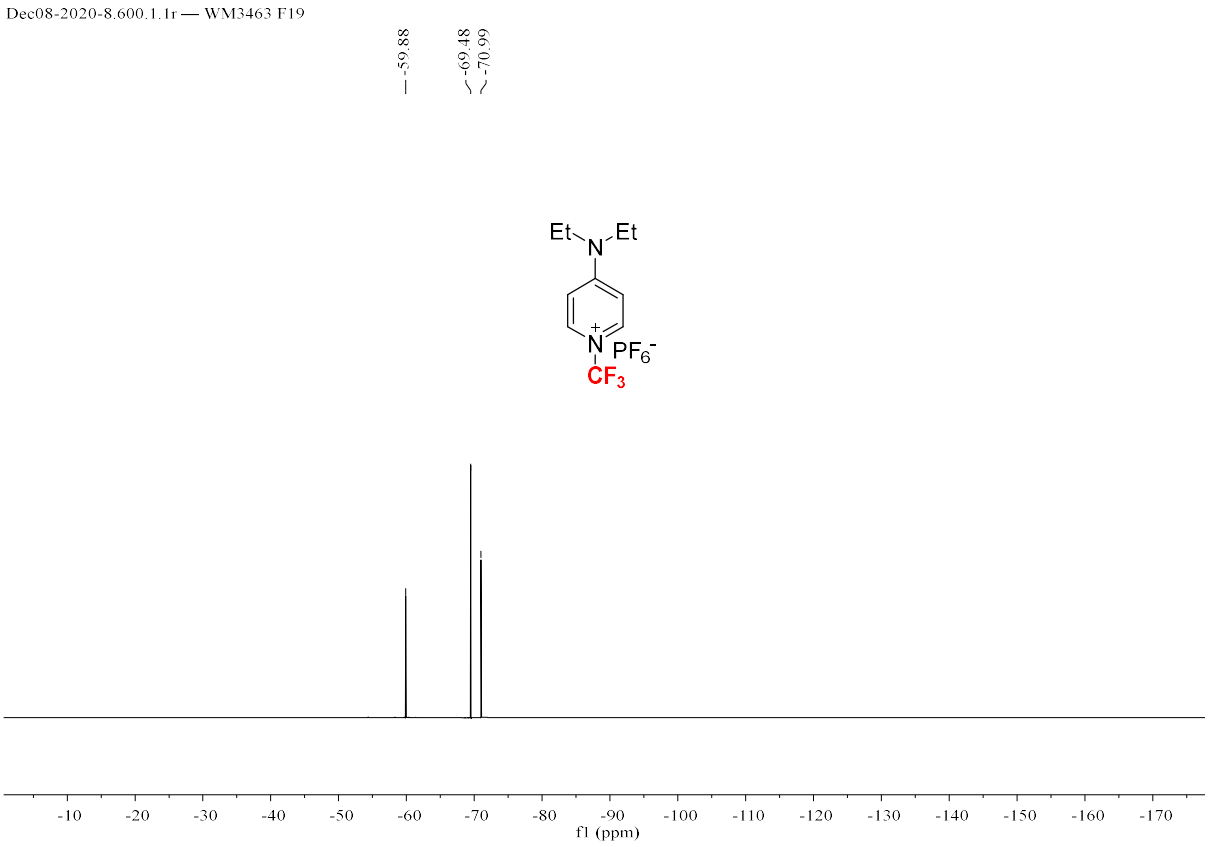
116.06
108.30
46.47
11.29
Et
N
Et
N
PF6-
CF3
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)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Et
N
Et
N
PF6-
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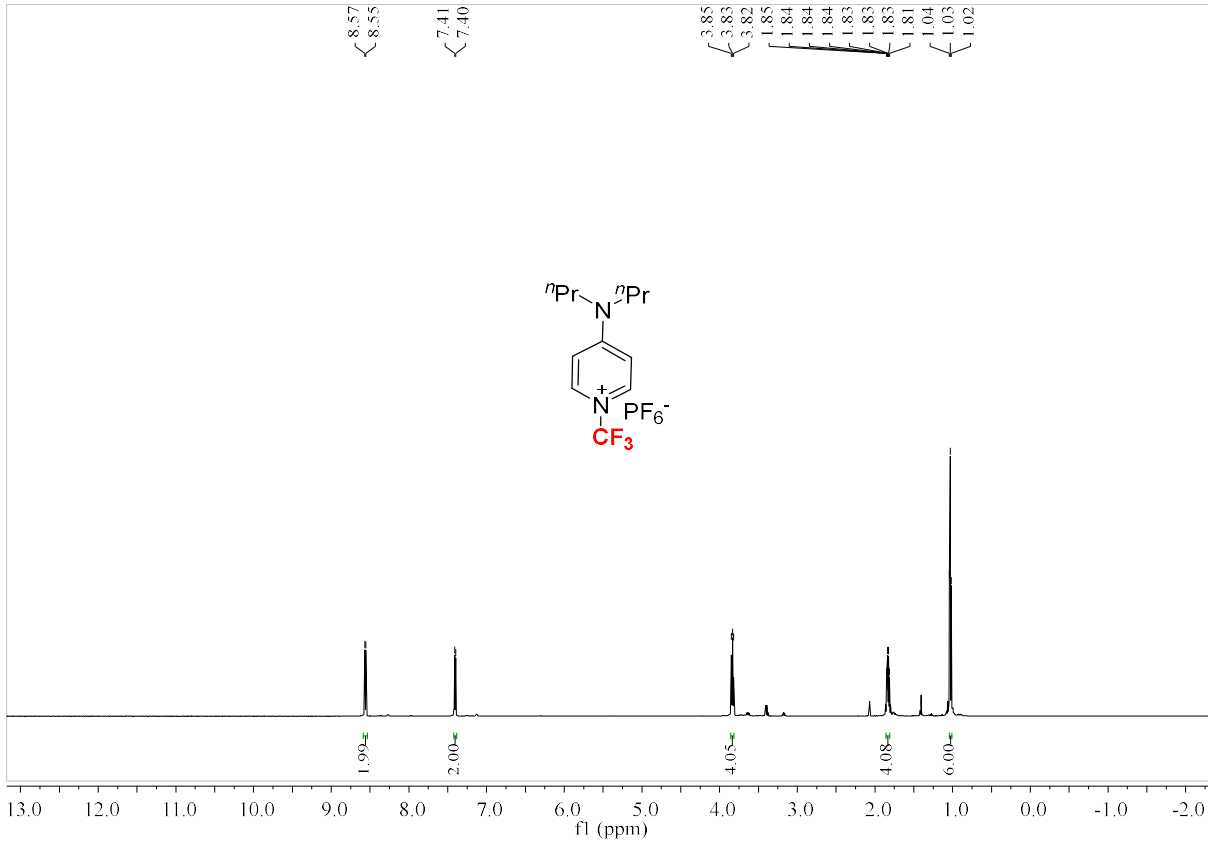
f1 (ppm)

Compound 1e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3.83
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1.84
1.84
1.83
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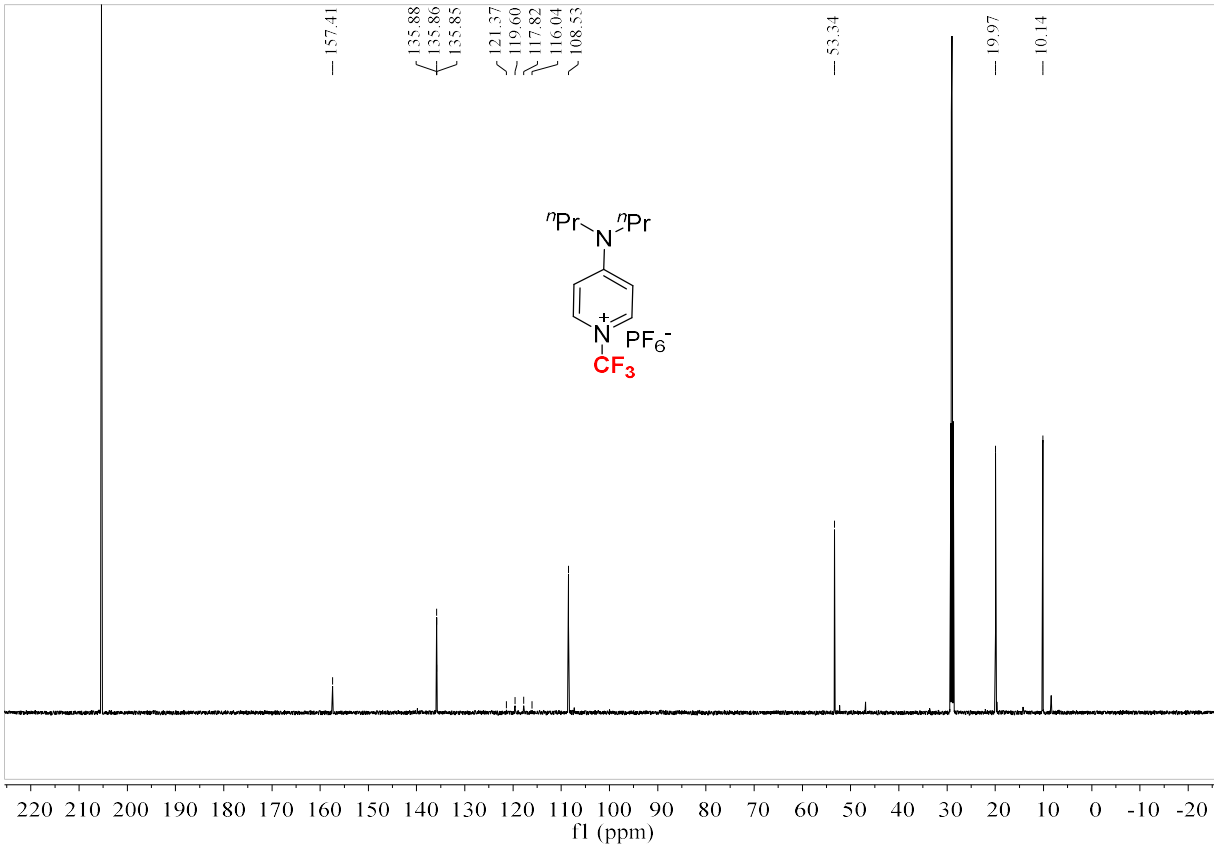
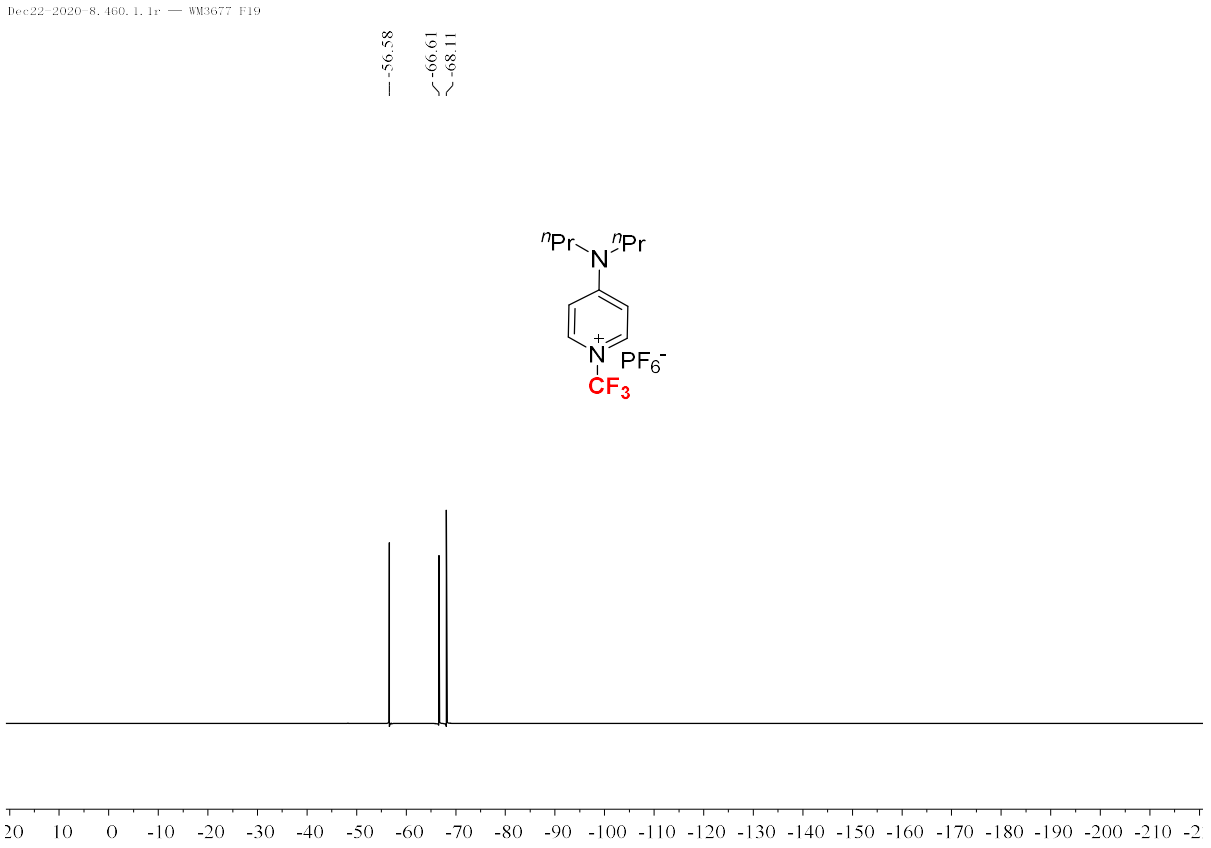
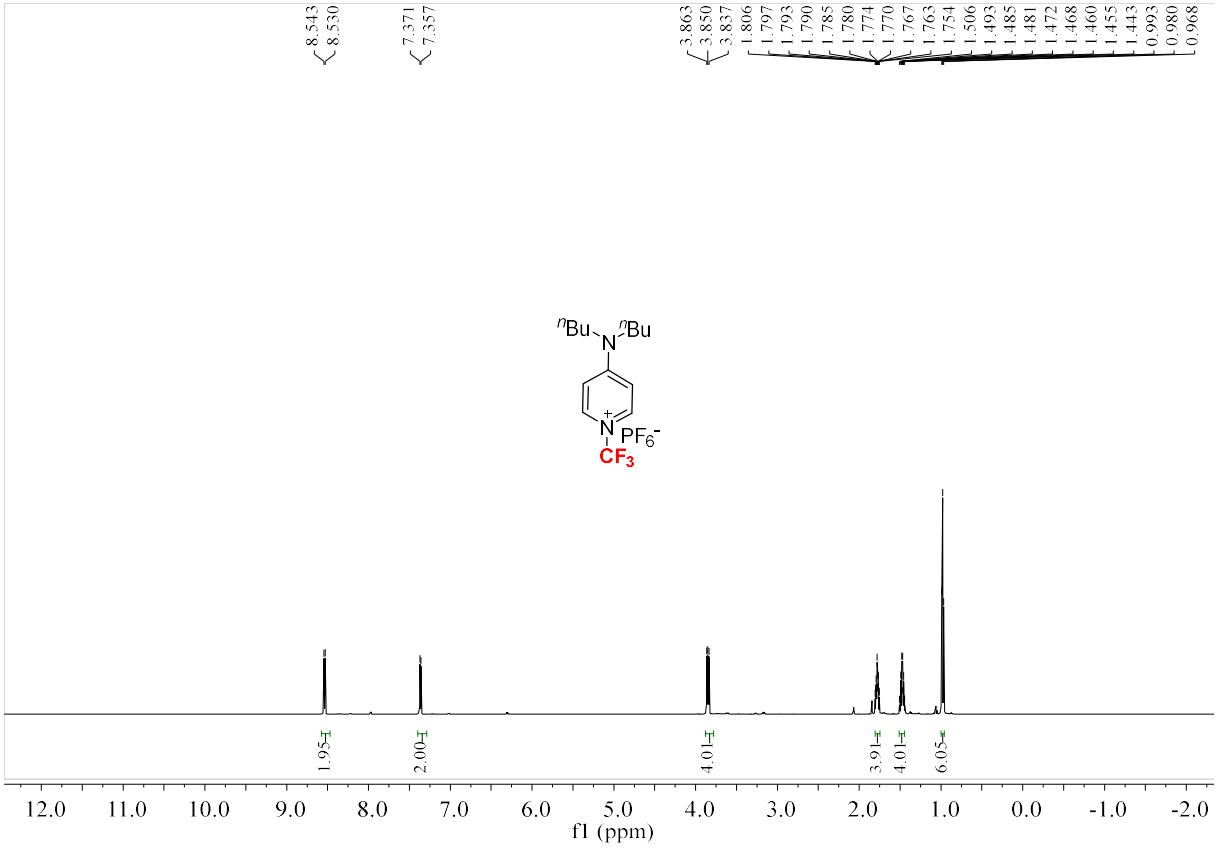
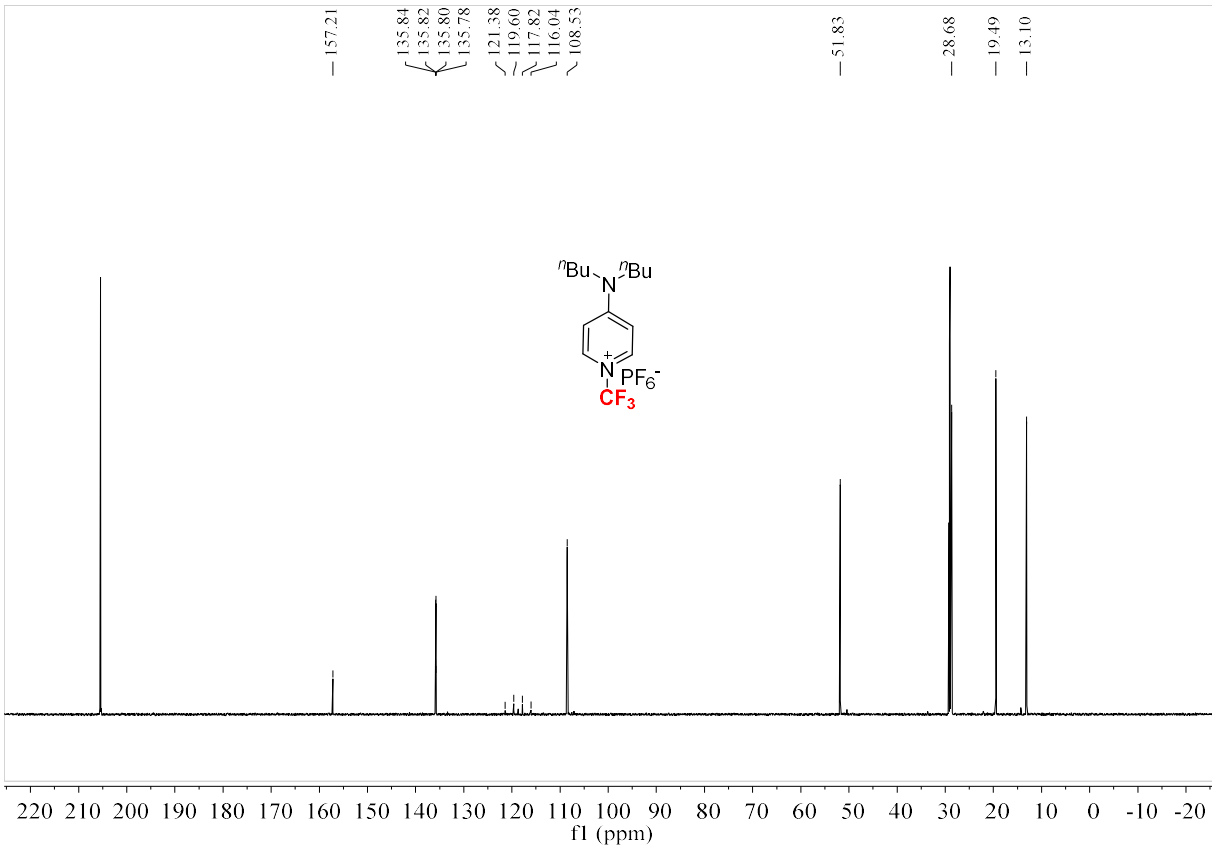
1.81
1.04
1.03
1.02
nPr
nPr
N
N
PF6-
CF3
1.99
2.00
4.05
4.08
6.00
13.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0 -2.0
f1 (ppm)

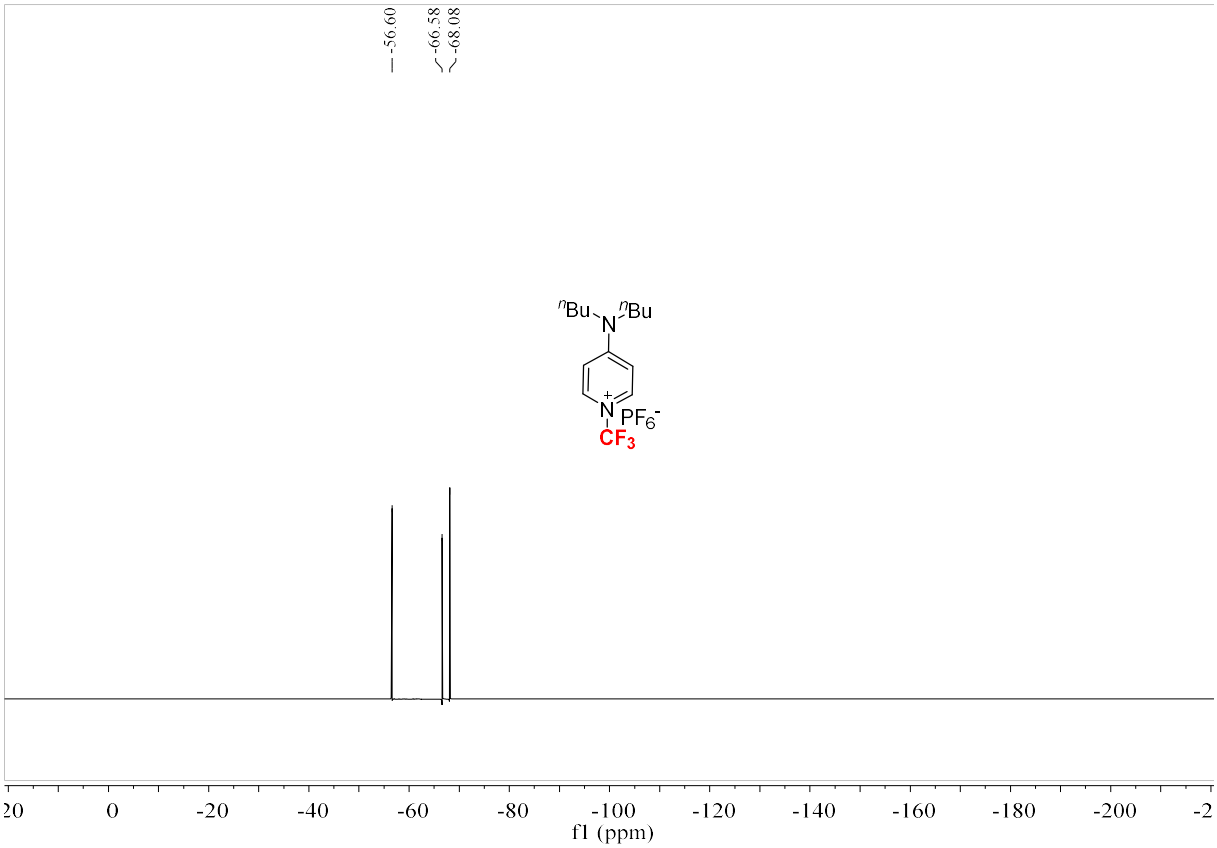

157.41
135.88
135.86
135.85
121.37
119.60
117.82
116.04
108.53
53.34
19.97
10.14
nPr
nPr
N
N
PF6-
CF3
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)


Dec22-2020-8.460.1.1r — WM3677 F19
-56.58
-66.61
-68.11
nPr
nPr
N
N
PF6-
CF3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -2

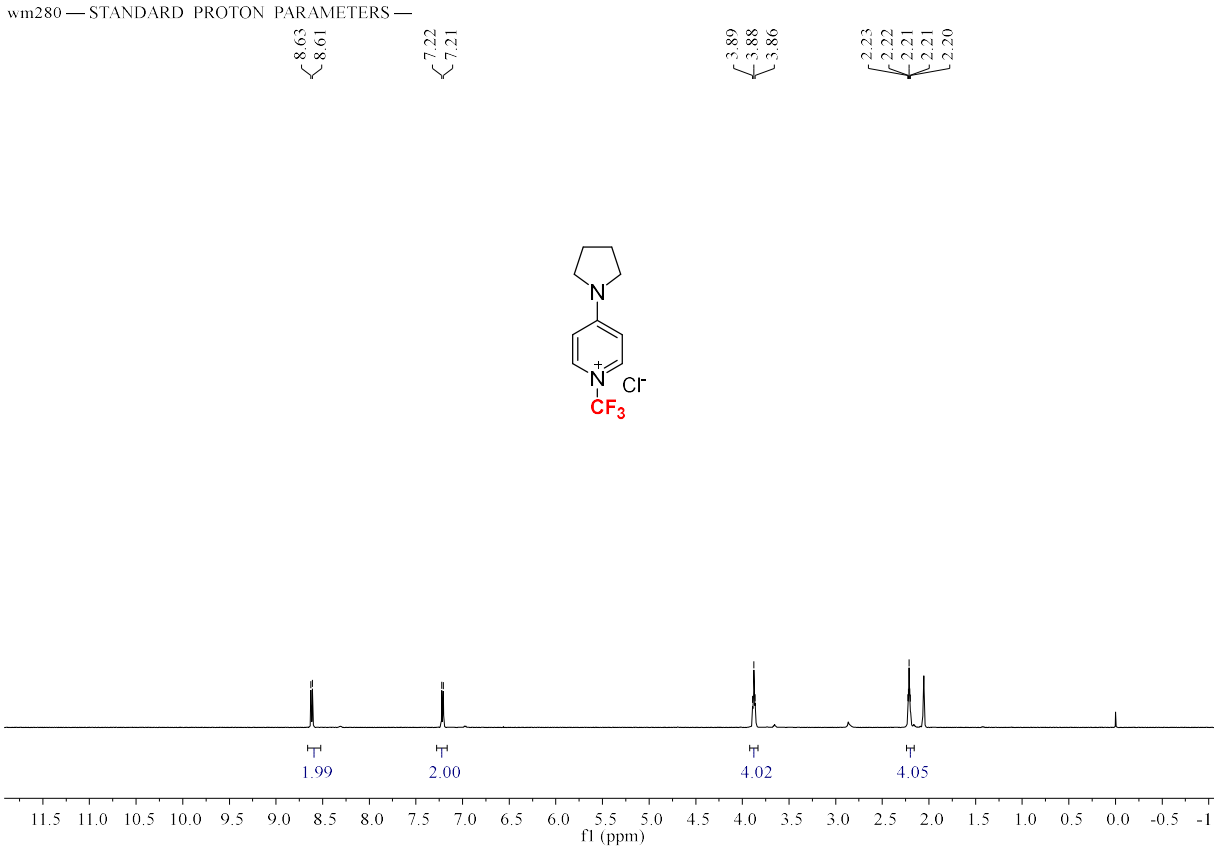
Compound 1f

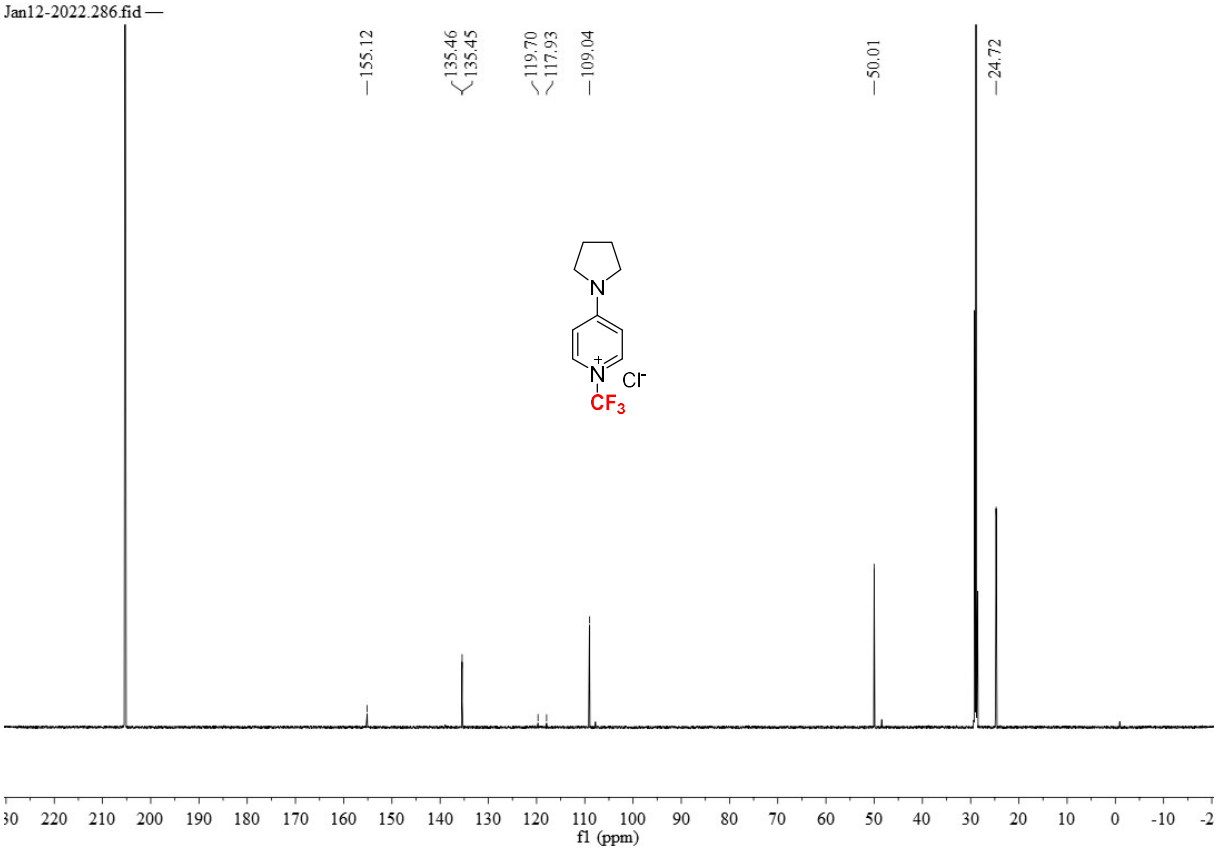

8.543
8.530
7.371
7.357
3.863
3.850
3.837
1.806
1.797
1.793
1.790
1.785
1.780
1.774
1.770
1.767
1.763
1.754
1.506
1.493
1.485
1.481
1.472
1.468
1.460
1.455
1.443
0.993
0.980
0.968
nBu
nBu
N
N
PF6-
CF3
1.95
2.00
4.01
3.91
4.01
6.05
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0 -2.0
f1 (ppm)

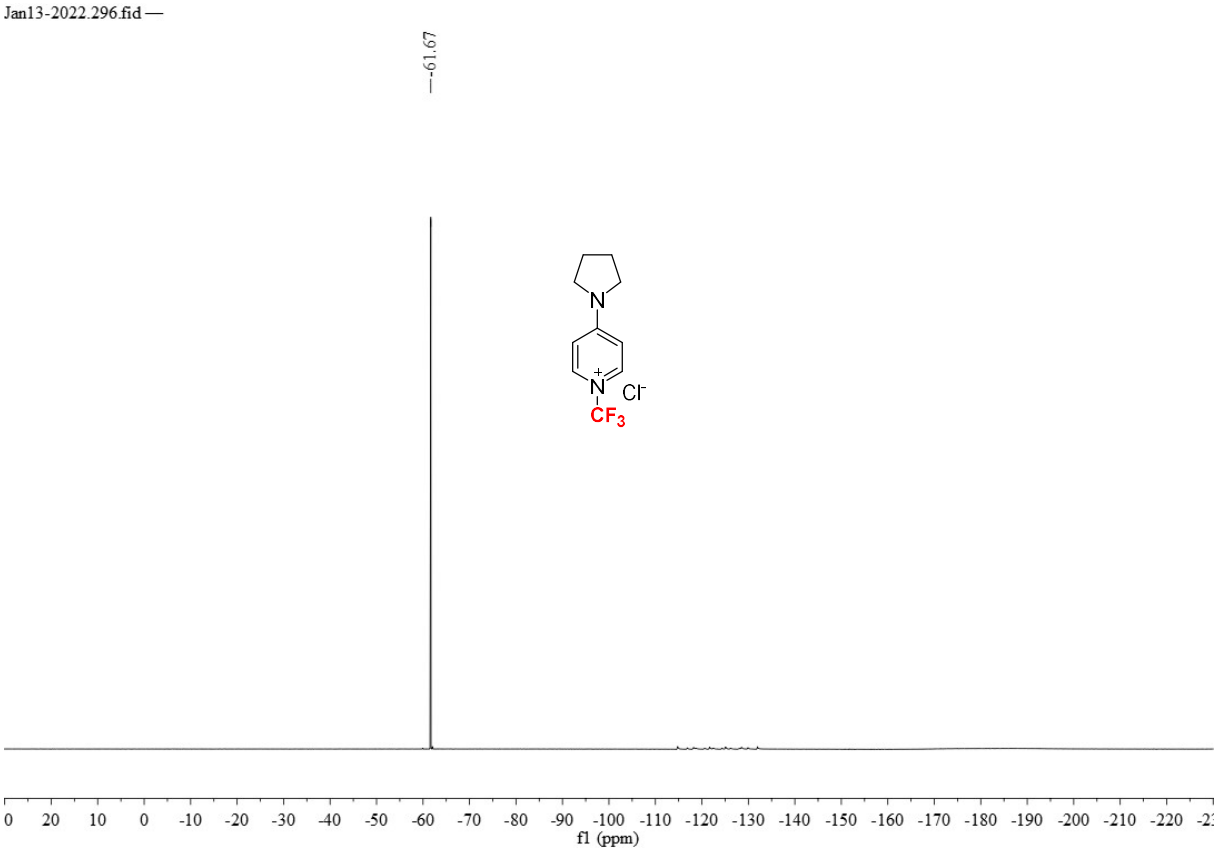

157.21
135.84
135.82
135.80
135.78
121.38
119.60
117.82
116.04
108.53
51.83
28.68
19.49
13.10
nBu
nBu
N
N
PF6-
CF3
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)


-56.60
-66.58
-68.08
nBu
nBu
N
N
PF6-
CF3
20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -2
f1 (ppm)

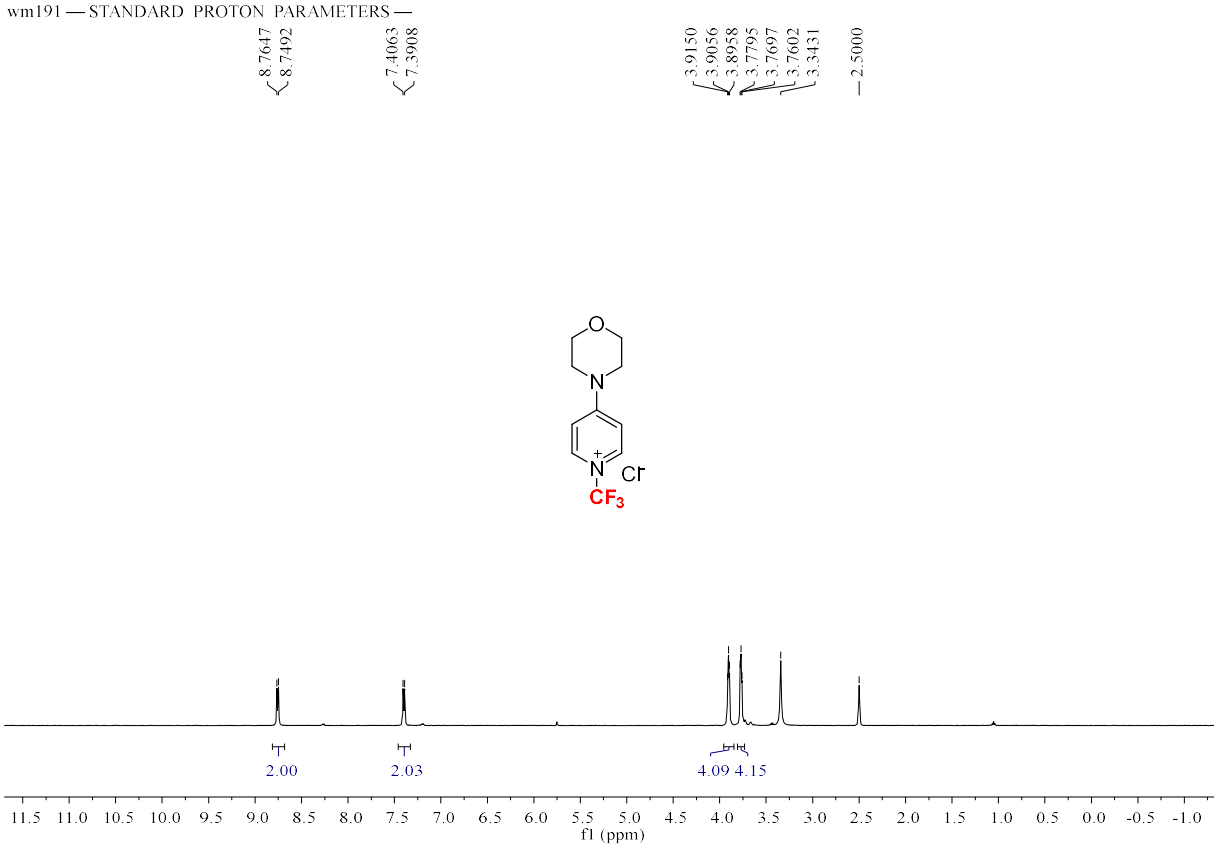
Compound 1g


wm280 — STANDARD PROTON PARAMETERS —
8.63
8.61
7.22
7.21
3.89
3.88
3.86
2.23
2.22
2.21
2.21
2.20
N
N
Cl
CF3
1.99
2.00
4.02
4.05
f1 (ppm)

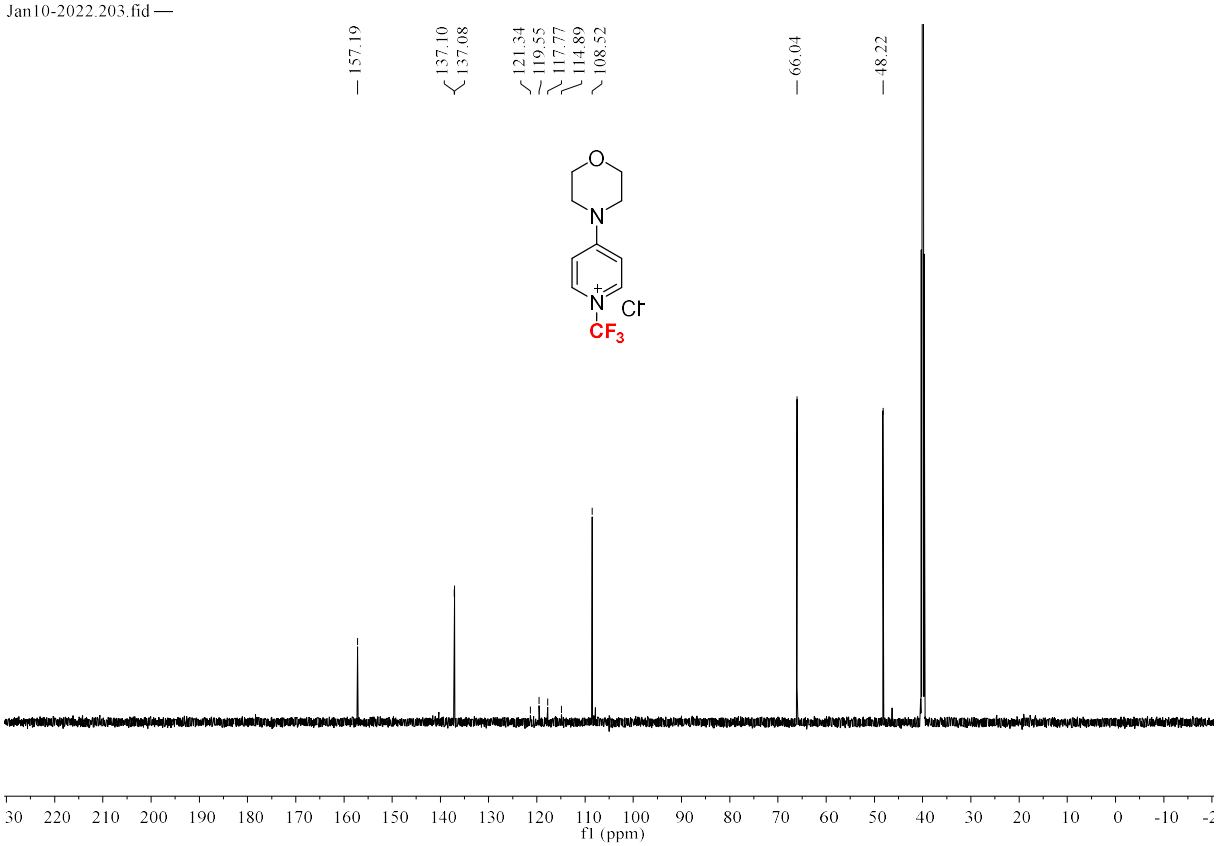

Jan12-2022.286.fid —
155.12
135.46
135.45
119.70
117.93
109.04
50.01
24.72
N
N
Cl
CF3
f1 (ppm)


Jan13-2022.296.fid
-61.67
N
N
Cl
CF3
0 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220
f1 (ppm)

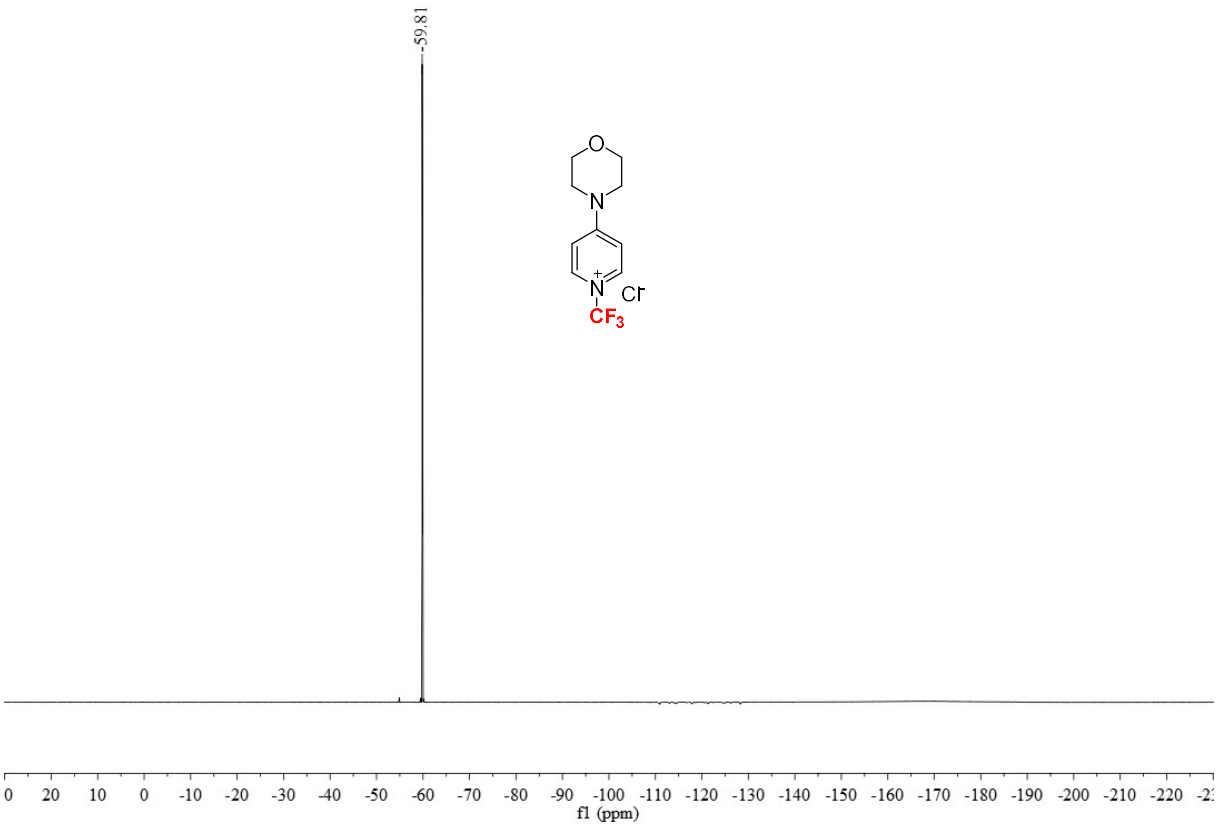
Compound 1h


wm191 — STANDARD PROTON PARAMETERS
8.7647
8.7492
7.4063
7.3908
3.9150
3.9056
3.8958
3.7795
3.7697
3.7602
3.3431
2.5000
O
N
N
Cl
CF3
2.00
2.03
4.09 4.15
11.5 11.0 10.5 10.0 9.5 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 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

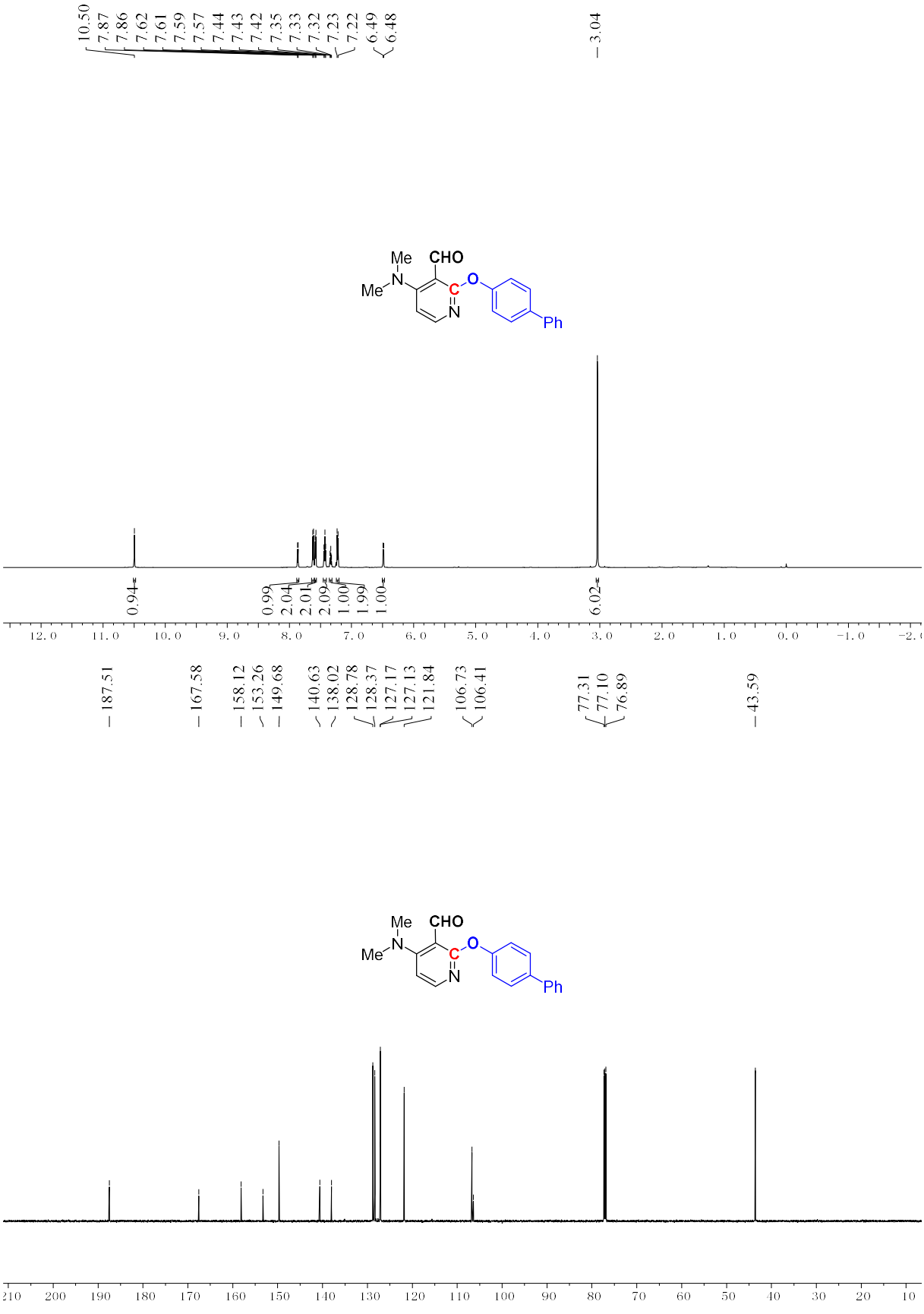
Jan10-2022.203.fid —



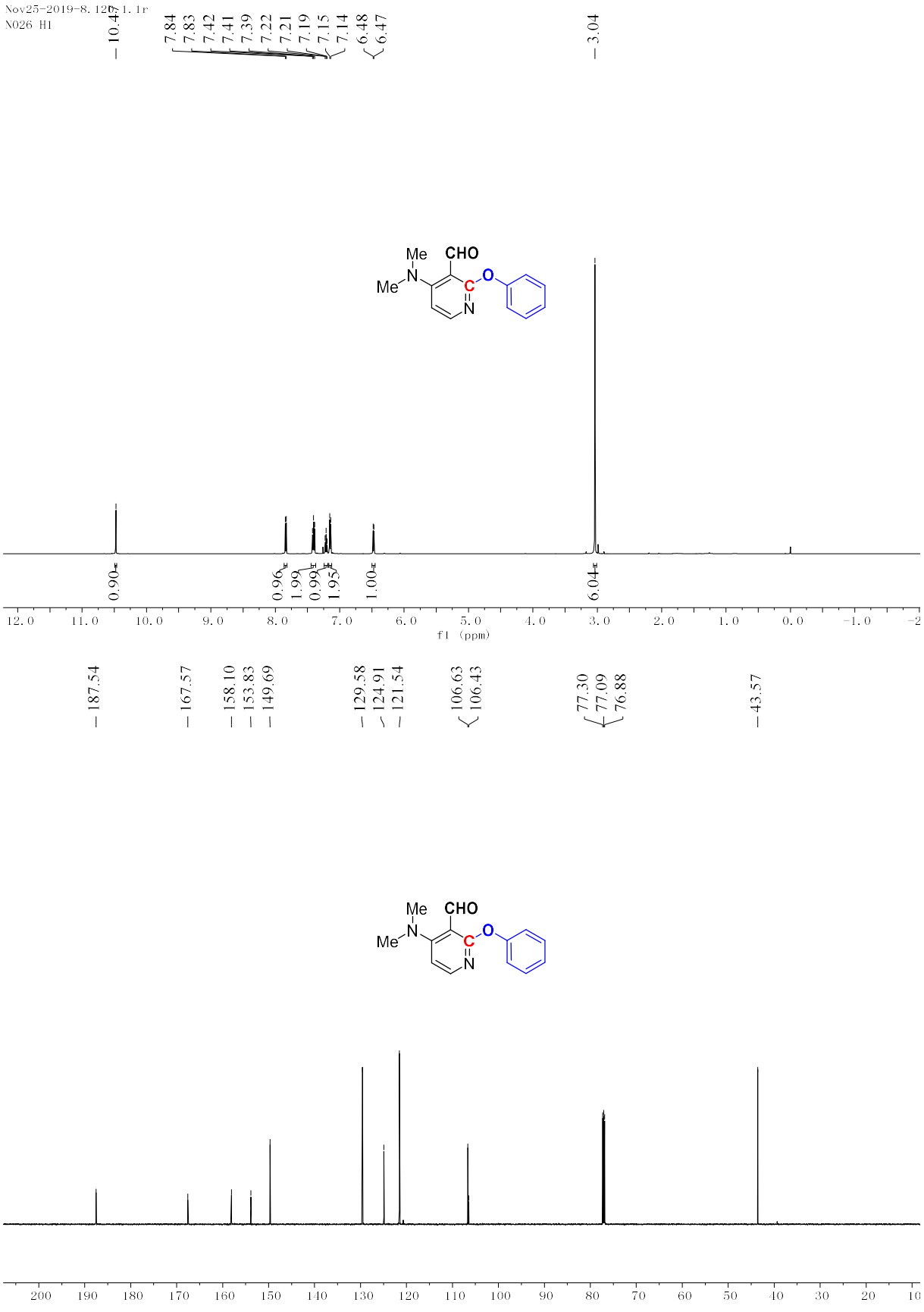
Jan10-2022.204.fid —



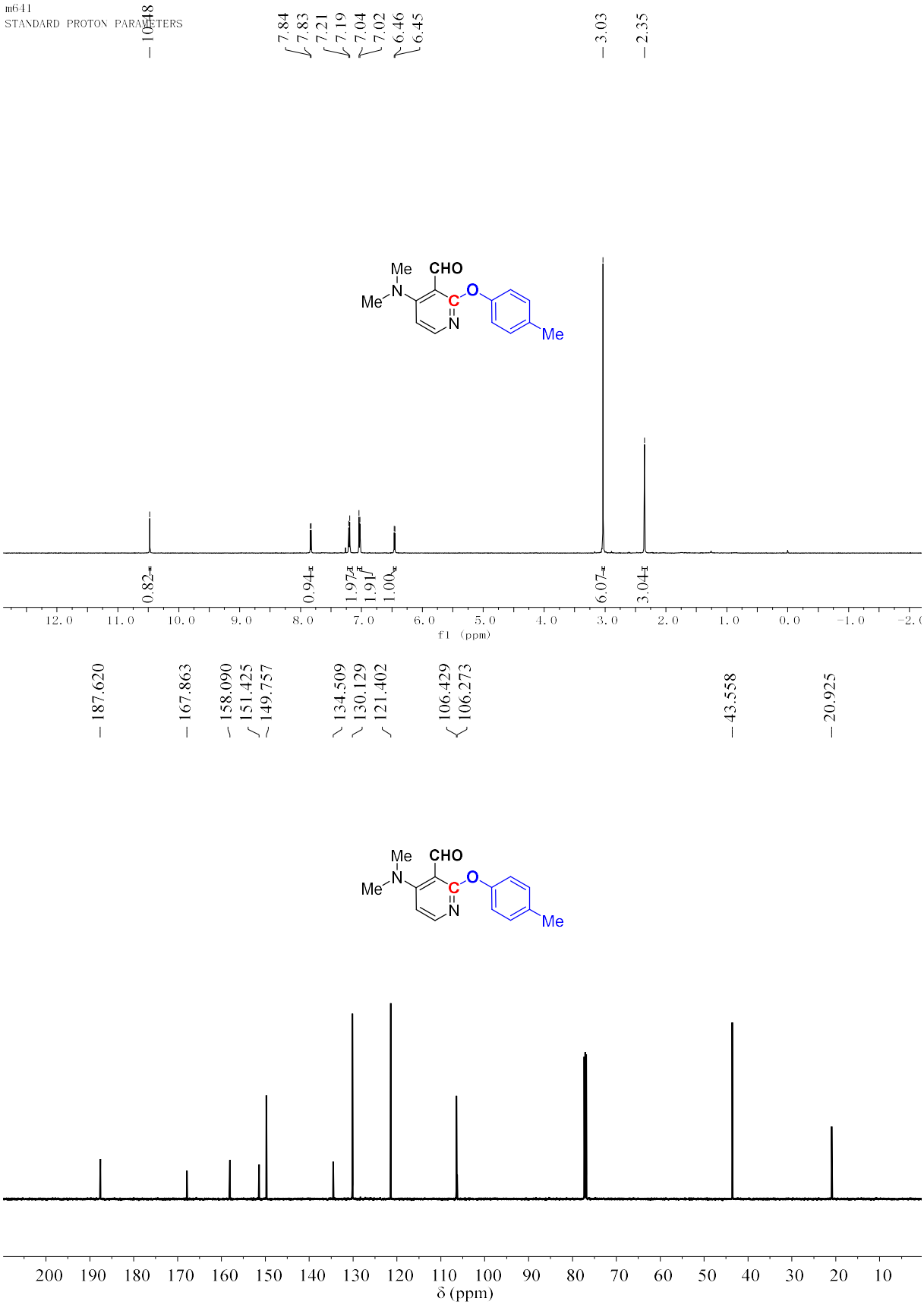
Compound 3a


10.50
7.87
7.86
7.62
7.61
7.59
7.57
7.44
7.43
7.42
7.35
7.33
7.32
7.23
7.22
6.49
6.48
3.04
Me
CHO
Me
N
C
O
N
Ph
0.94
0.99
2.04
2.01
2.09
1.00
1.99
1.00
6.02
187.51
167.58
158.12
153.26
149.68
140.63
138.02
128.78
128.37
127.17
127.13
121.84
106.73
106.41
77.31
77.10
76.89
43.59

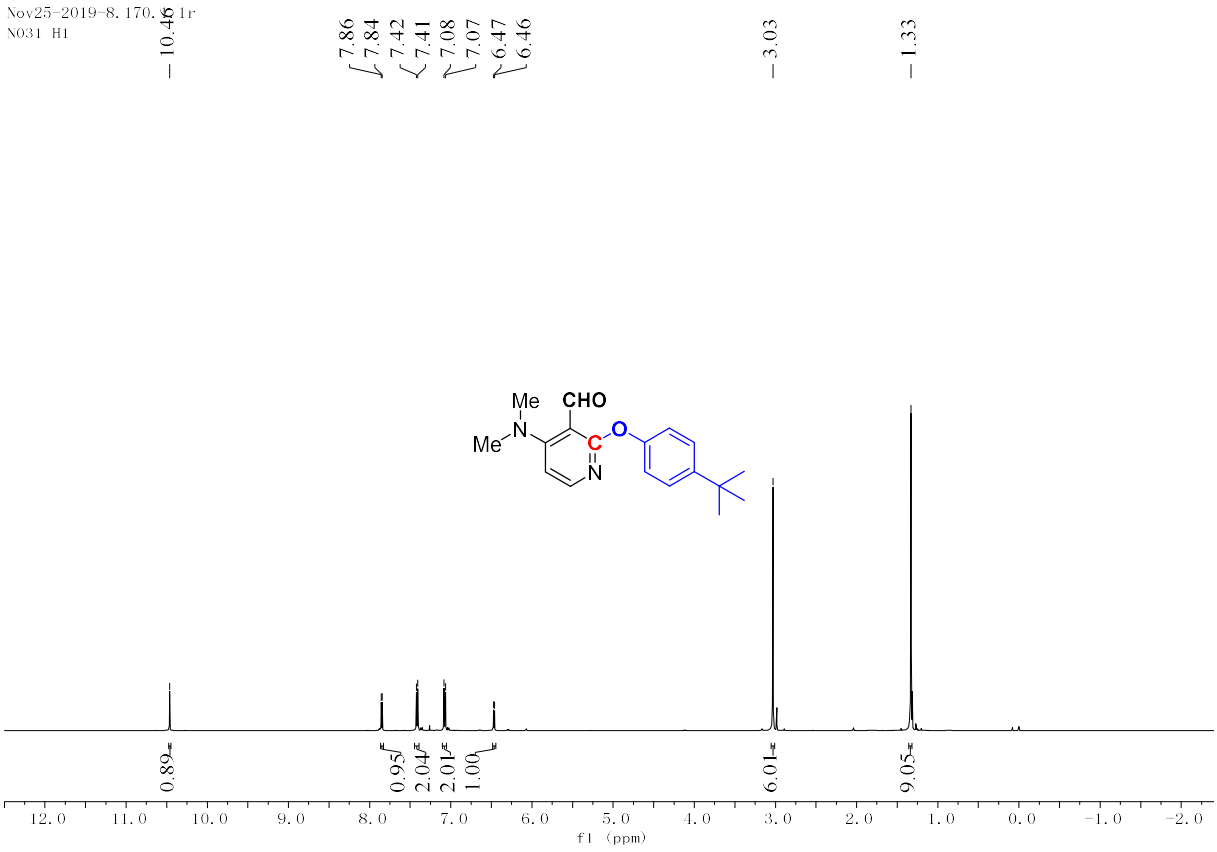
Compound 3b

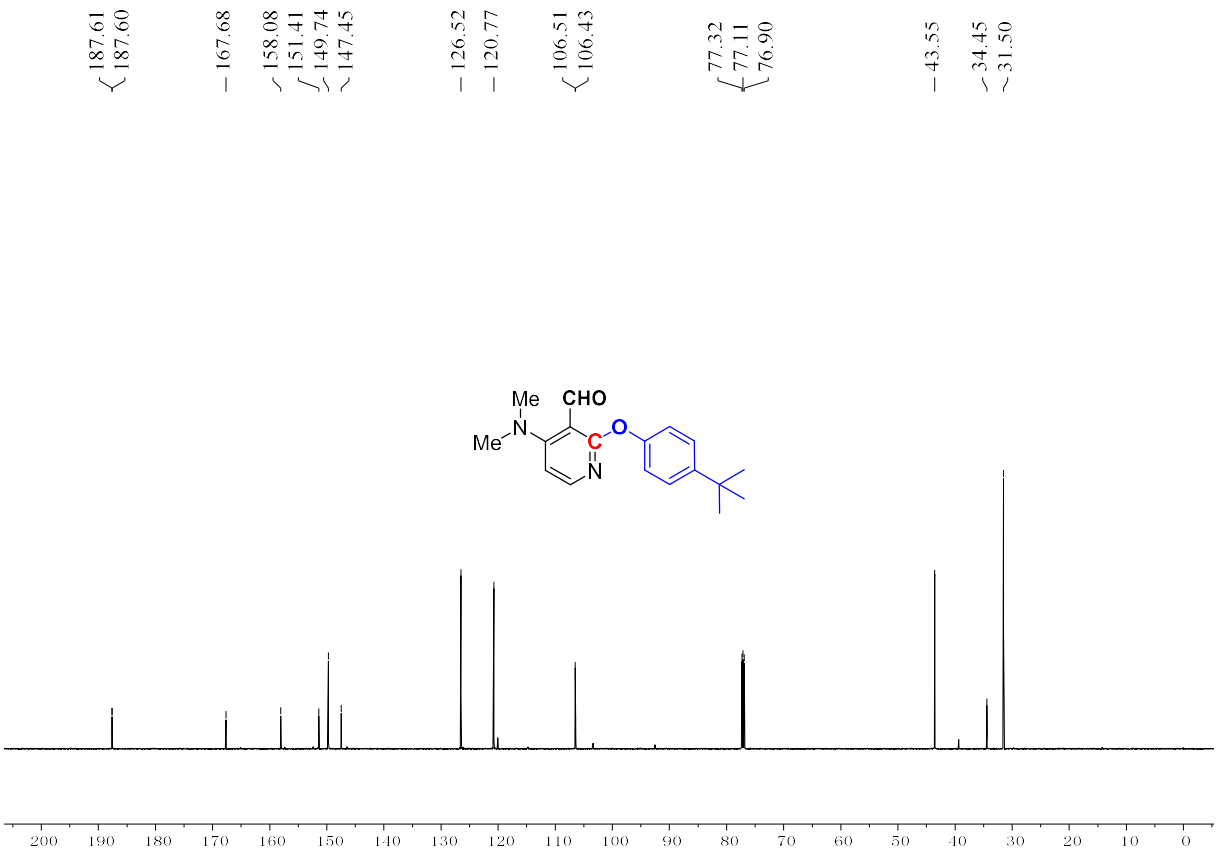

Nov25-2019-8.12611.1r
N026 H1
10.47
7.84
7.83
7.42
7.41
7.39
7.22
7.21
7.19
7.15
7.14
6.48
6.47
3.04
Me
CHO
Me
N
C
O
N
0.90
0.96
1.99
0.99
1.95
1.00
6.04
f1 (ppm)
187.54
167.57
158.10
153.83
149.69
129.58
124.91
121.54
106.63
106.43
77.30
77.09
76.88
43.57

Compound 3c

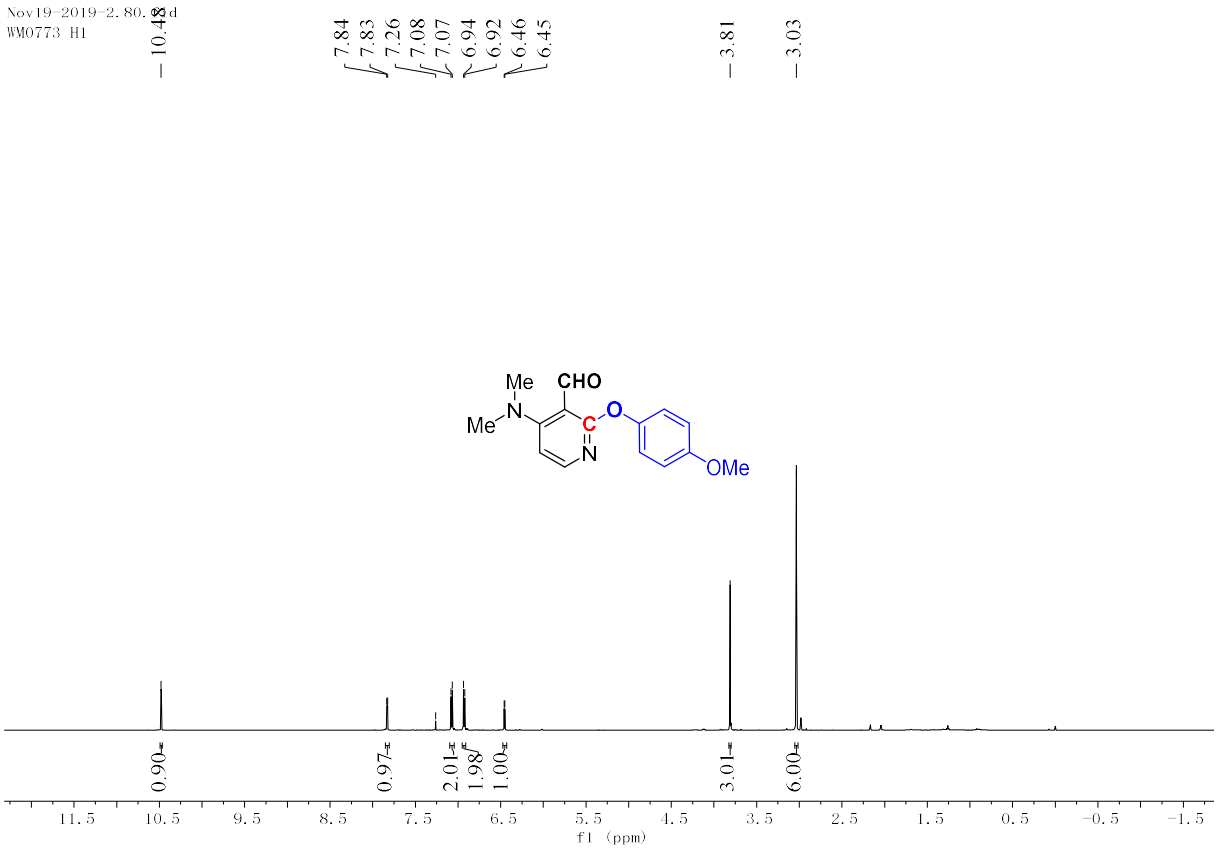

m641
STANDARD PROTON PARAMETERS
10.48
7.84
7.83
7.21
7.19
7.04
7.02
6.46
6.45
3.03
2.35
Me
CHO
Me
N
C
O
N
Me
0.82
0.94
1.97
1.91
1.00
6.07
3.04
f1 (ppm)
187.620
167.863
158.090
151.425
149.757
134.509
130.129
121.402
106.429
106.273
43.558
20.925
δ (ppm)

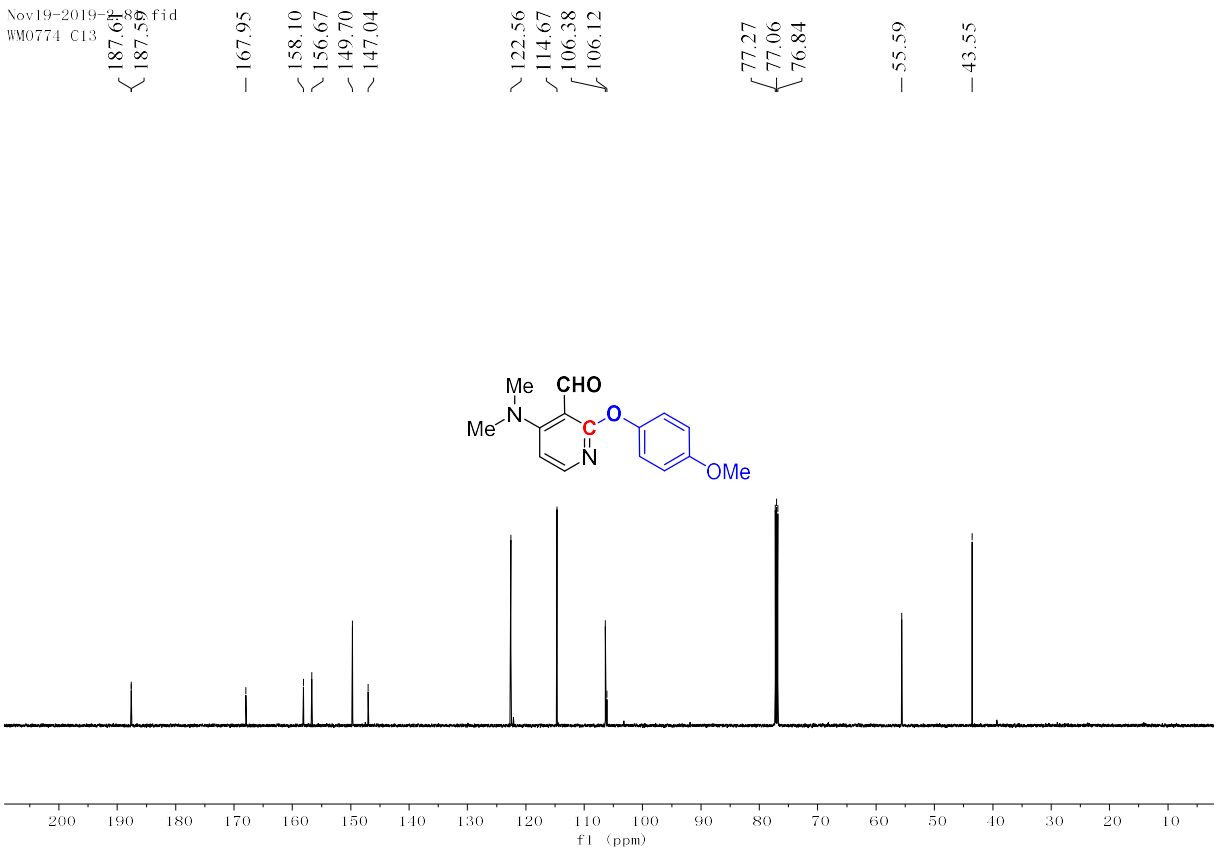
Compound 3d


Nov25-2019-8.170.1r
N031 H1
10.46
7.86
7.84
7.42
7.41
7.08
7.07
6.47
6.46
3.03
1.33
Me
CHO
N
Me
C
O
N
0.89
0.95
2.04
2.01
1.00
6.01
9.05
f1 (ppm)

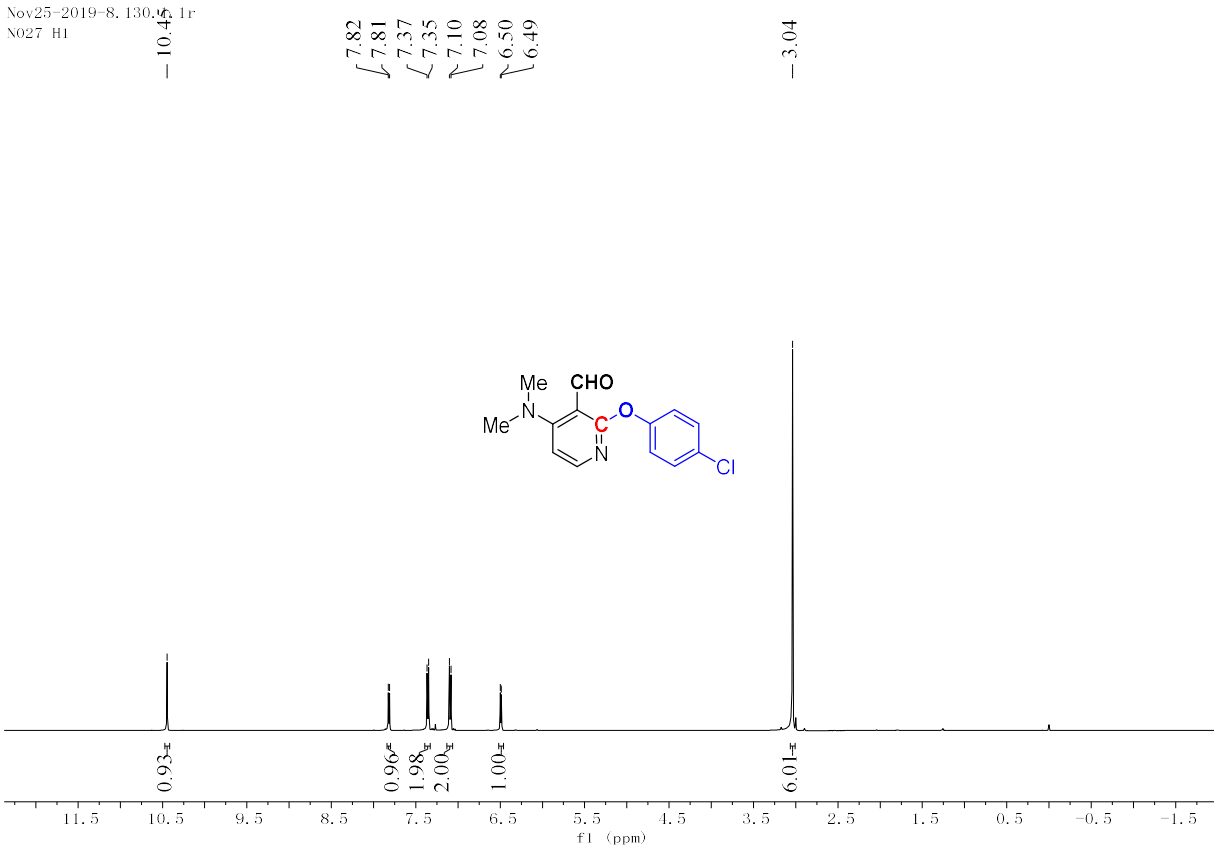

187.61
187.60
167.68
158.08
151.41
149.74
147.45
126.52
120.77
106.51
106.43
77.32
77.11
76.90
43.55
34.45
31.50
Me
CHO
N
Me
C
O
N

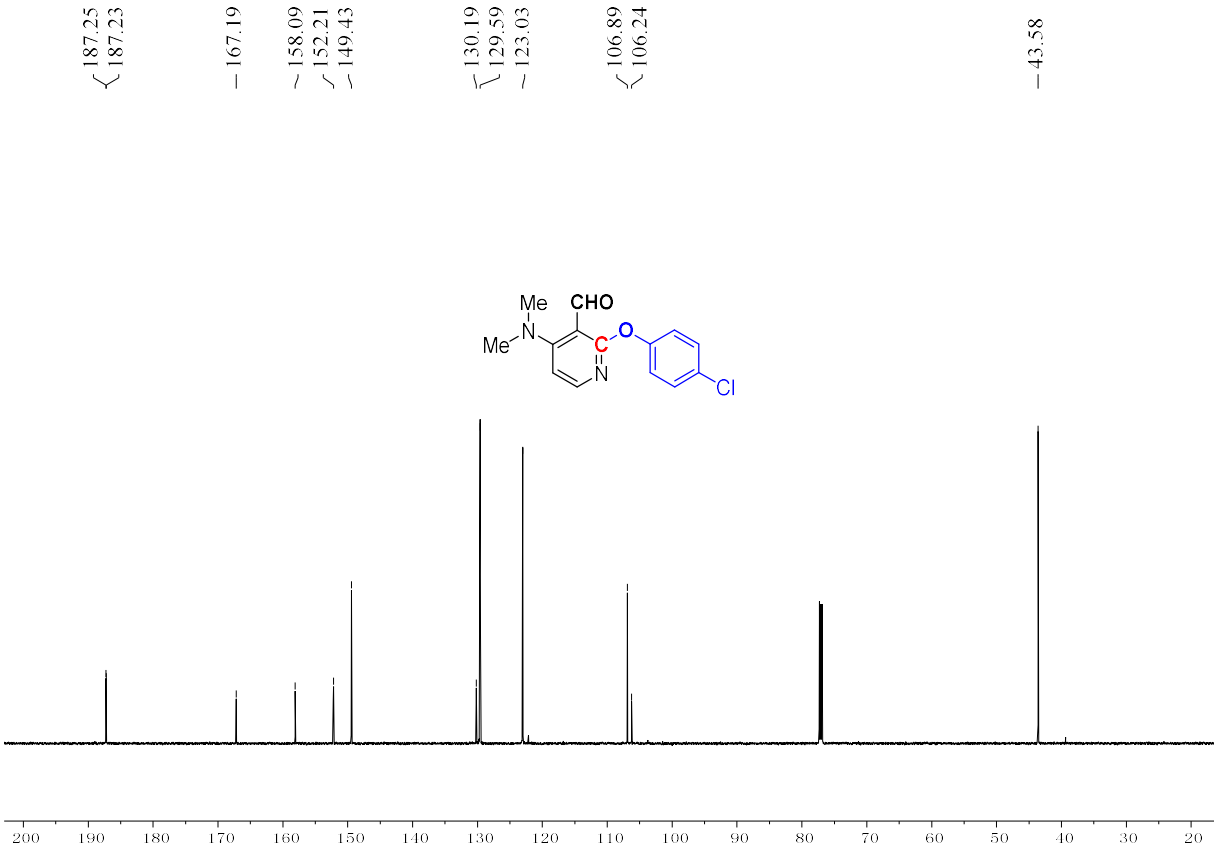
Compound 3e


Nov19-2019-2.80.1.fid
WM0773 H1
10.48
7.84
7.83
7.26
7.08
7.07
6.94
6.92
6.46
6.45
3.81
3.03
Me
CHO
Me
N
C
O
N
OMe
0.90
0.97
2.01
1.98
1.00
3.01
6.00
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
f1 (ppm)

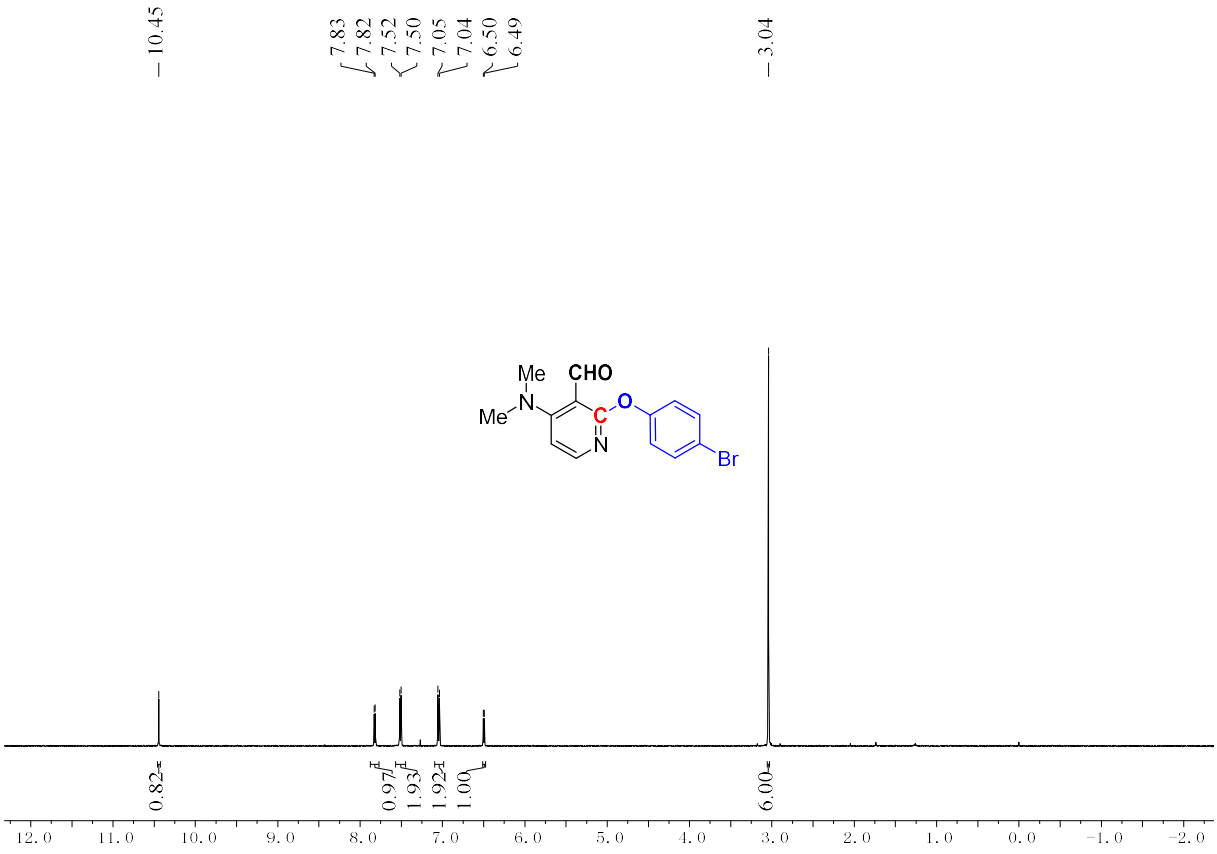

Nov19-2019-2.80.2.fid
WM0774 C13
187.61
187.59
167.95
158.10
156.67
149.70
147.04
122.56
114.67
106.38
106.12
77.27
77.06
76.84
55.59
43.55
Me
CHO
Me
N
C
O
N
OMe
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

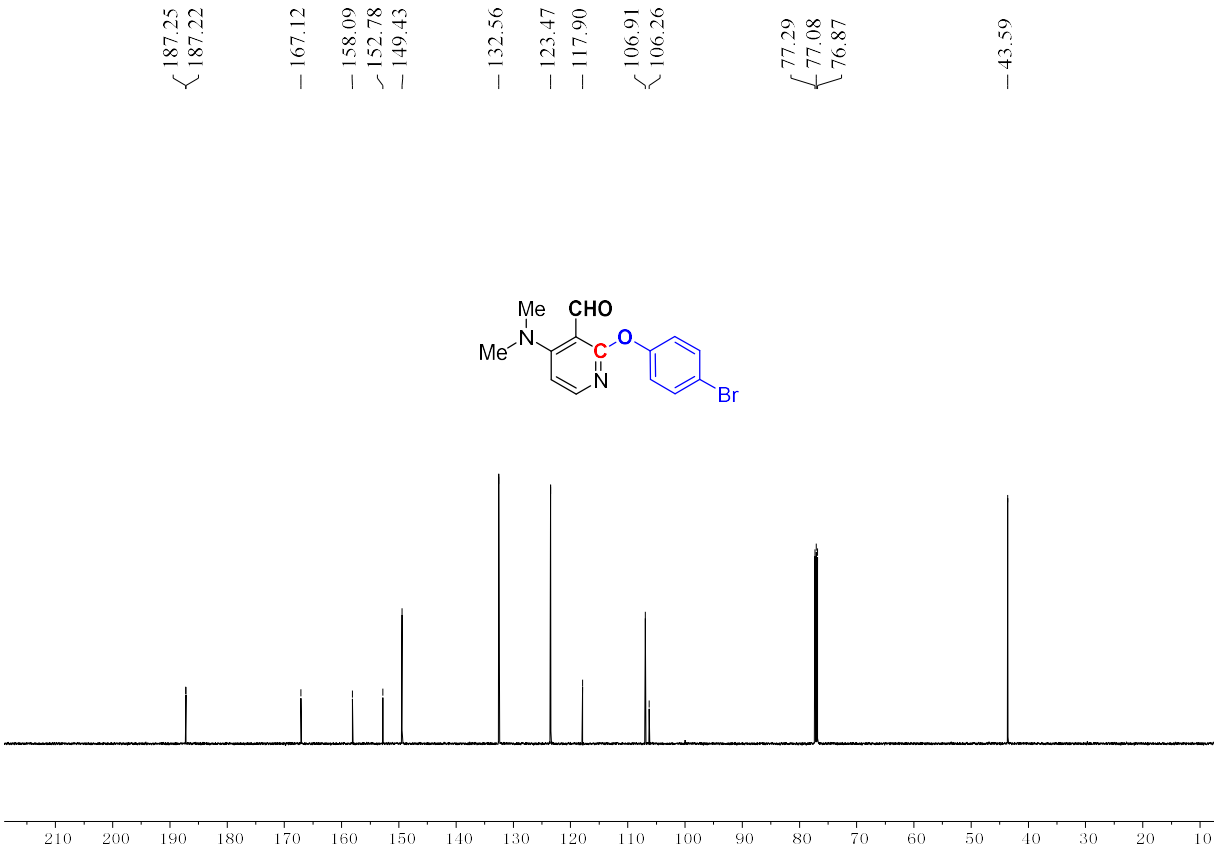
Compound 3f


Nov25-2019-8.130.5.1r
N027 H1
10.45
7.82
7.81
7.37
7.35
7.10
7.08
6.50
6.49
3.04
Me
CHO
Me
N
C
O
N
Cl
0.93
0.96
1.98
2.00
1.00
6.01
f1 (ppm)

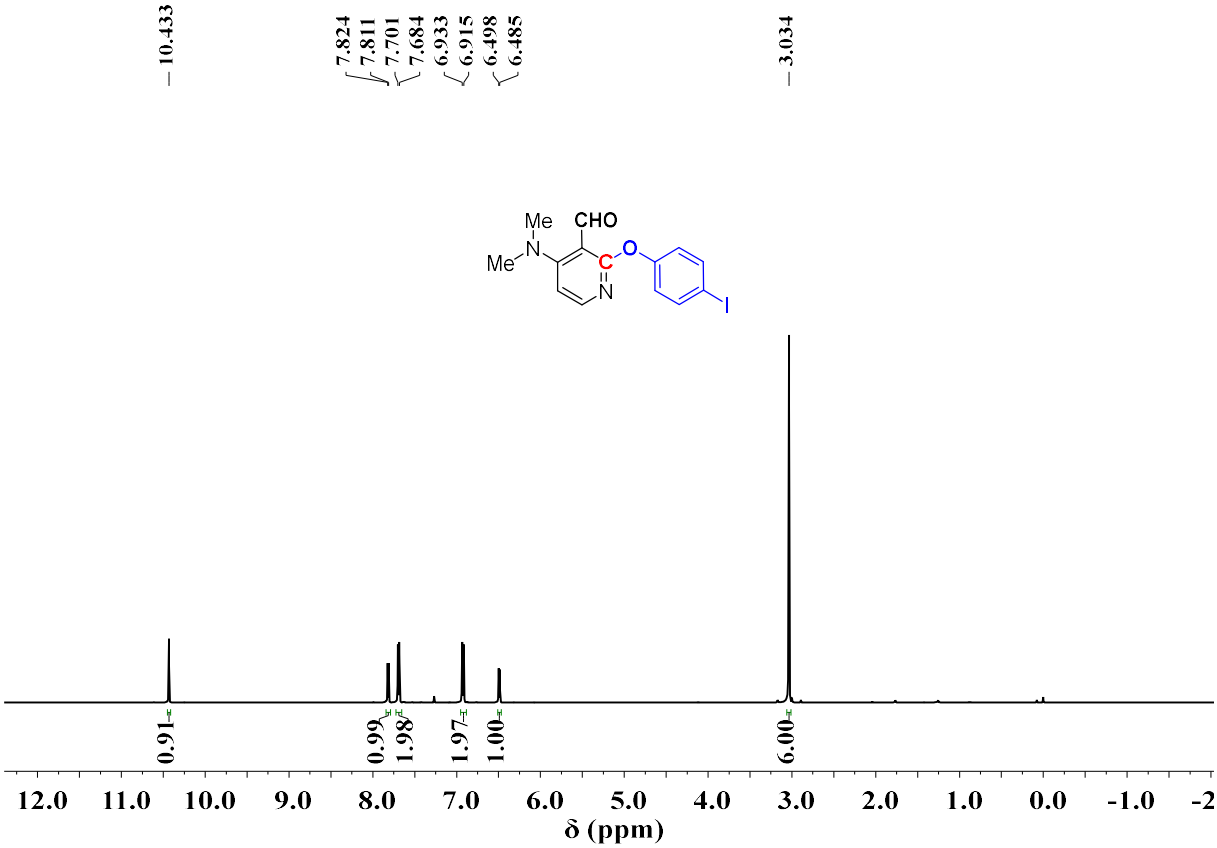

187.25
187.23
167.19
158.09
152.21
149.43
130.19
129.59
123.03
106.89
106.24
43.58
Me
CHO
Me
N
C
O
N
Cl

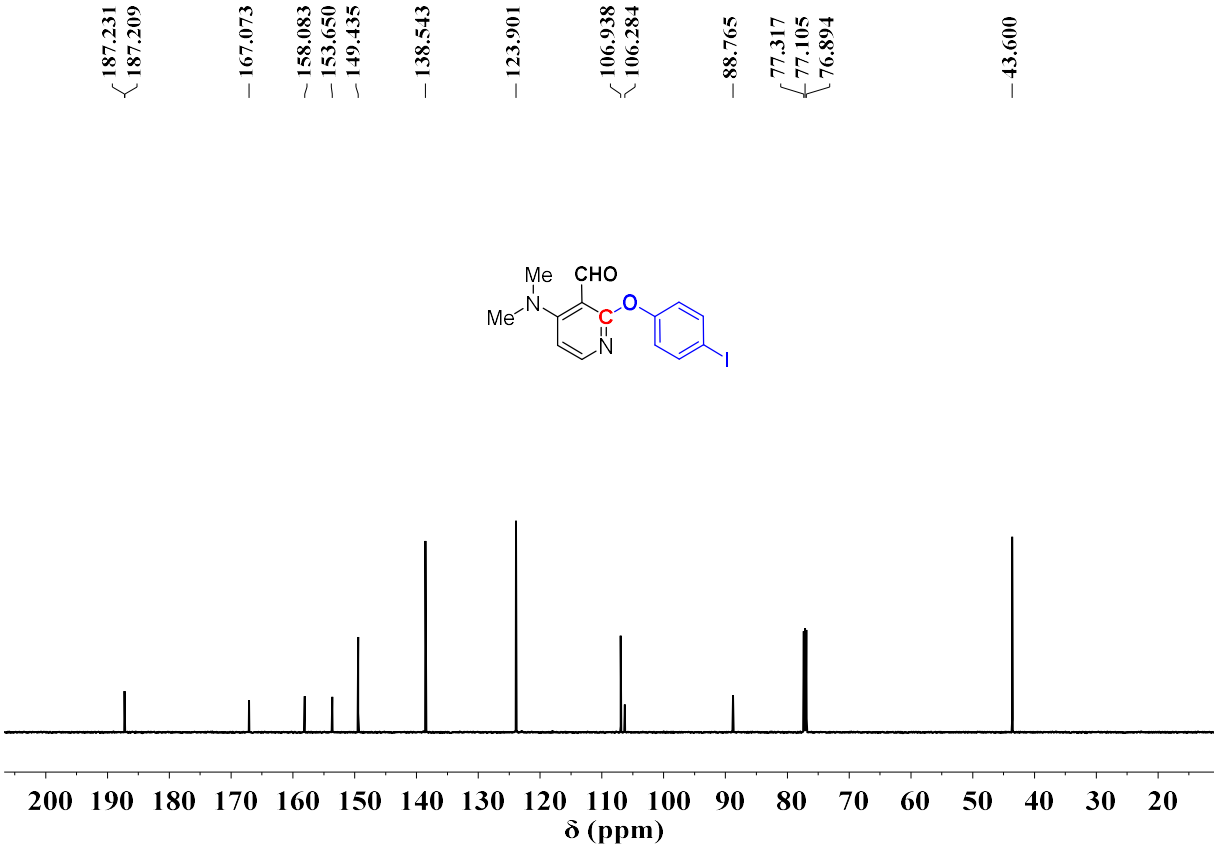
Compound 3g


10.45
7.83
7.82
7.52
7.50
7.05
7.04
6.50
6.49
3.04
Me
CHO
Me
N
C
O
N
Br
0.82
0.97
1.93
1.92
1.00
6.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0

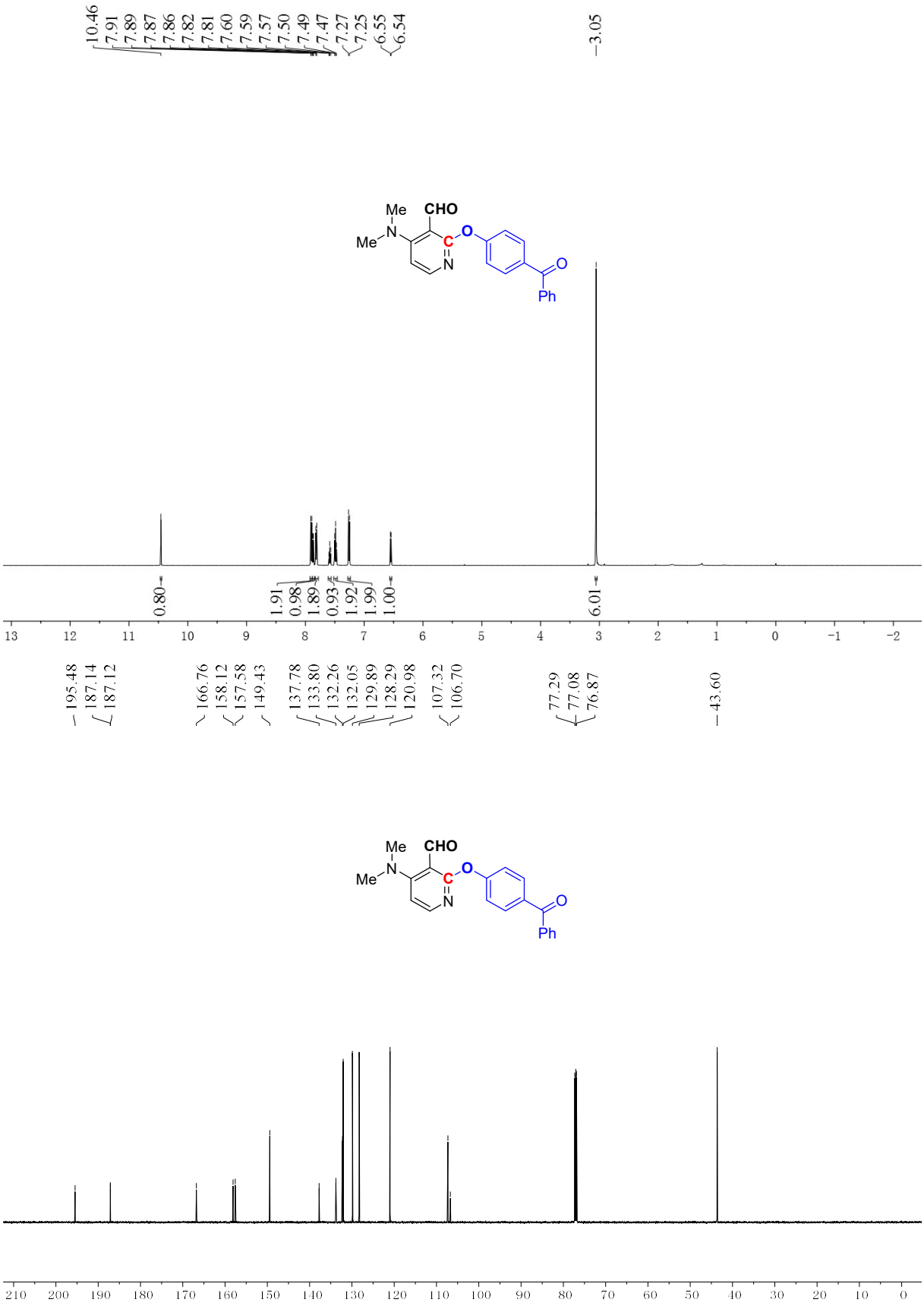

187.25
187.22
167.12
158.09
152.78
149.43
132.56
123.47
117.90
106.91
106.26
77.29
77.08
76.87
43.59
Me
CHO
Me
N
C
O
N
Br
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

Compound 3h

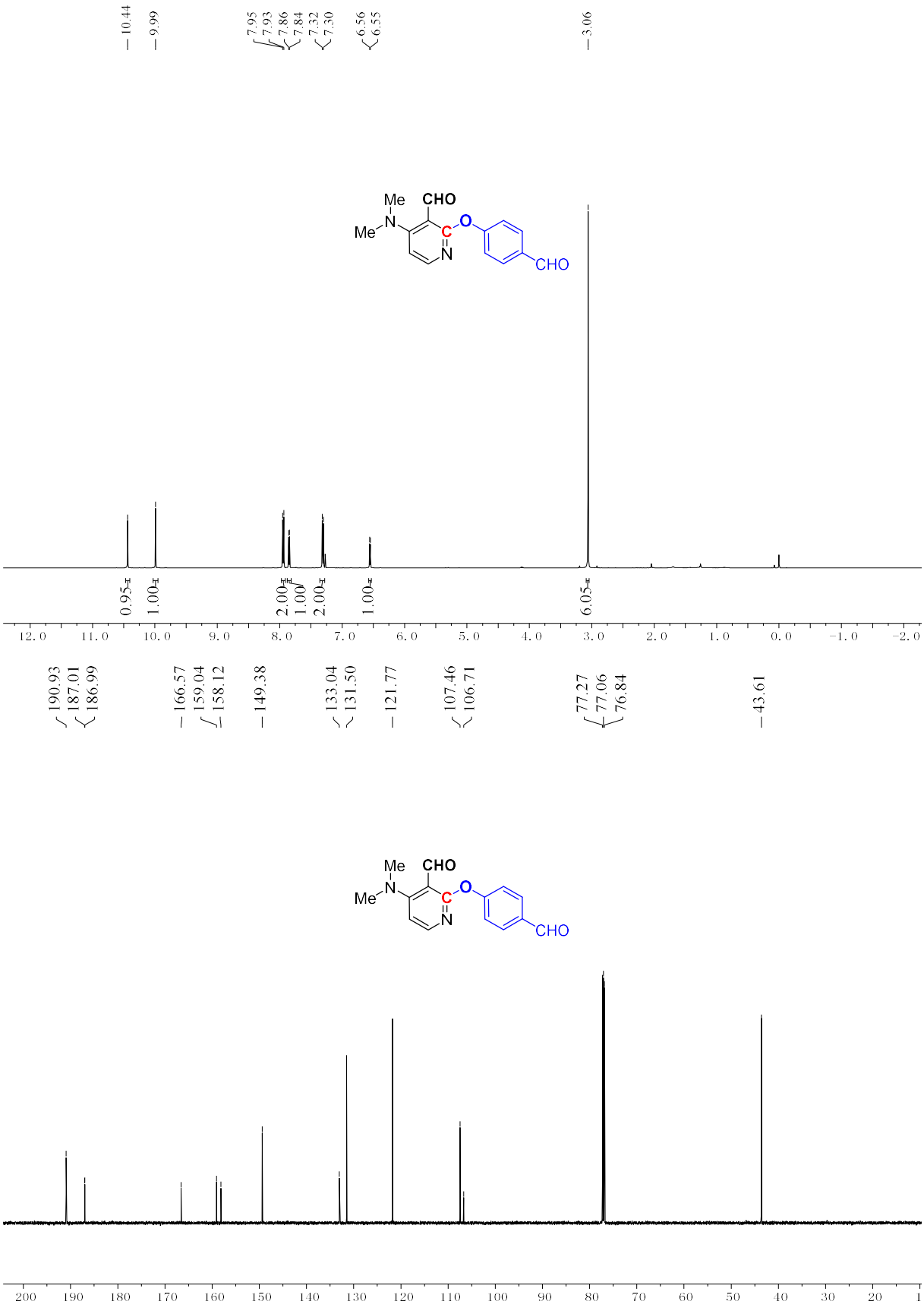

10.433
7.824
7.811
7.701
7.684
6.933
6.915
6.498
6.485
3.034
Me
CHO
Me
N
O
C
N
I
0.91
0.99
1.98
1.97
1.00
6.00
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0 -2
δ (ppm)


187.231
187.209
167.073
158.083
153.650
149.435
138.543
123.901
106.938
106.284
88.765
77.317
77.105
76.894
43.600
Me
CHO
Me
N
O
C
N
I
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20
δ (ppm)

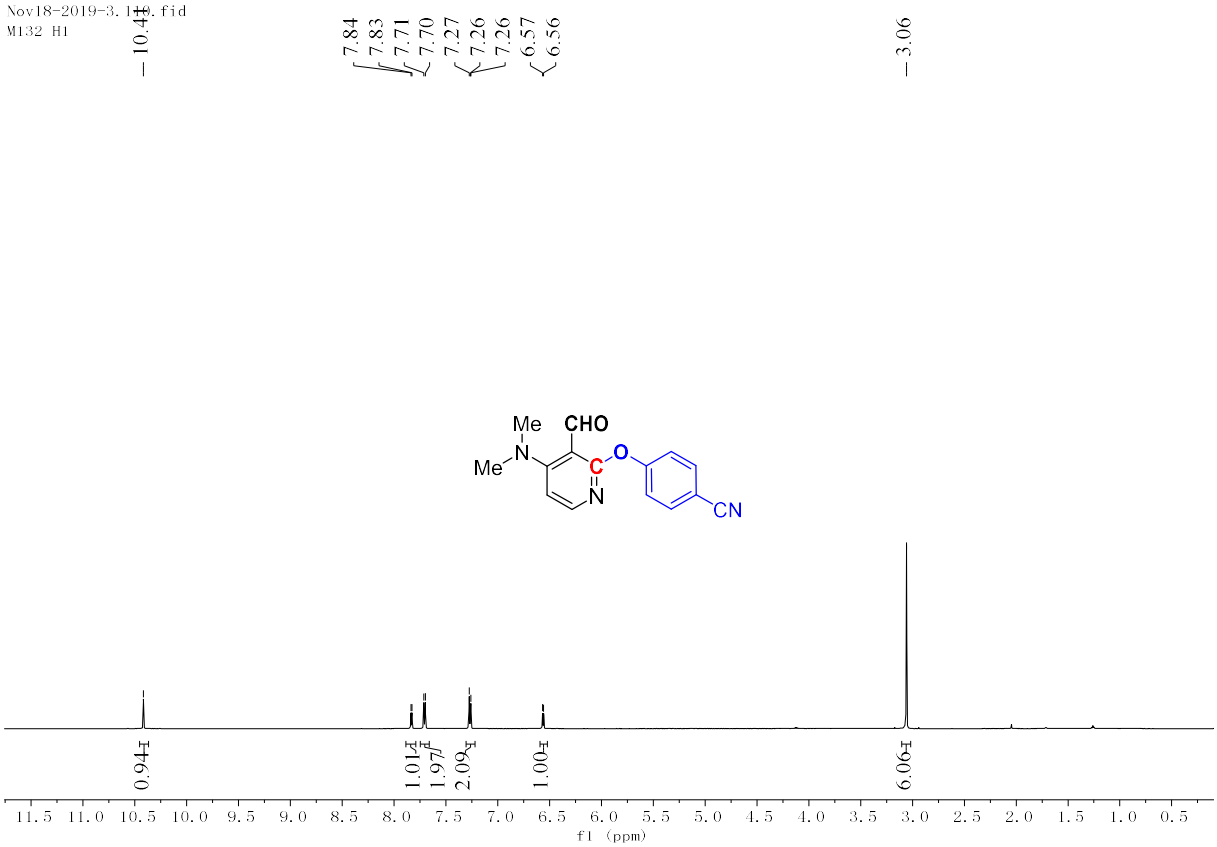
Compound 3i

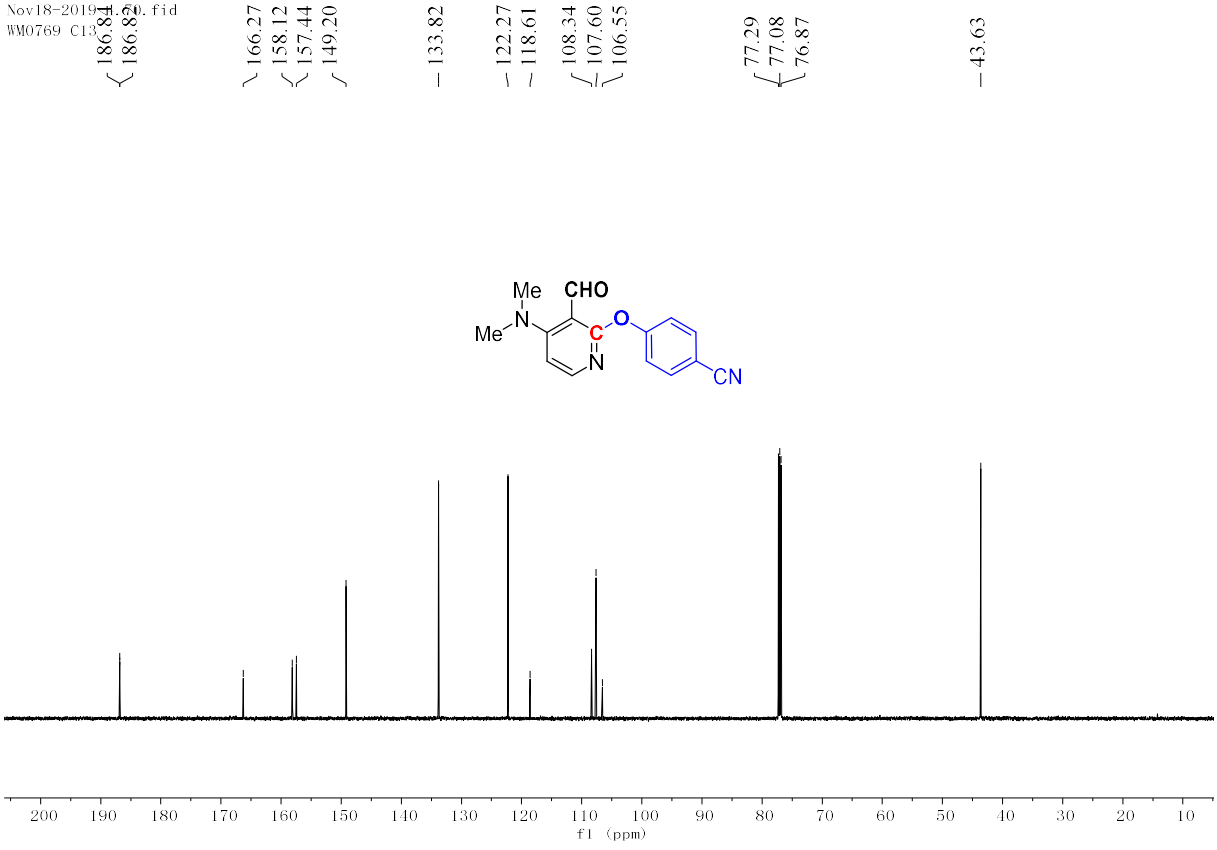

10.46
7.91
7.89
7.87
7.86
7.82
7.81
7.60
7.59
7.57
7.50
7.49
7.47
7.27
7.25
6.55
6.54
3.05
Me
CHO
Me
N
C
O
N
O
Ph
0.80
1.91
0.98
1.89
0.93
1.92
1.99
1.00
6.01
195.48
187.14
187.12
166.76
158.12
157.58
149.43
137.78
133.80
132.26
132.05
129.89
128.29
120.98
107.32
106.70
77.29
77.08
76.87
43.60

Compound 3j

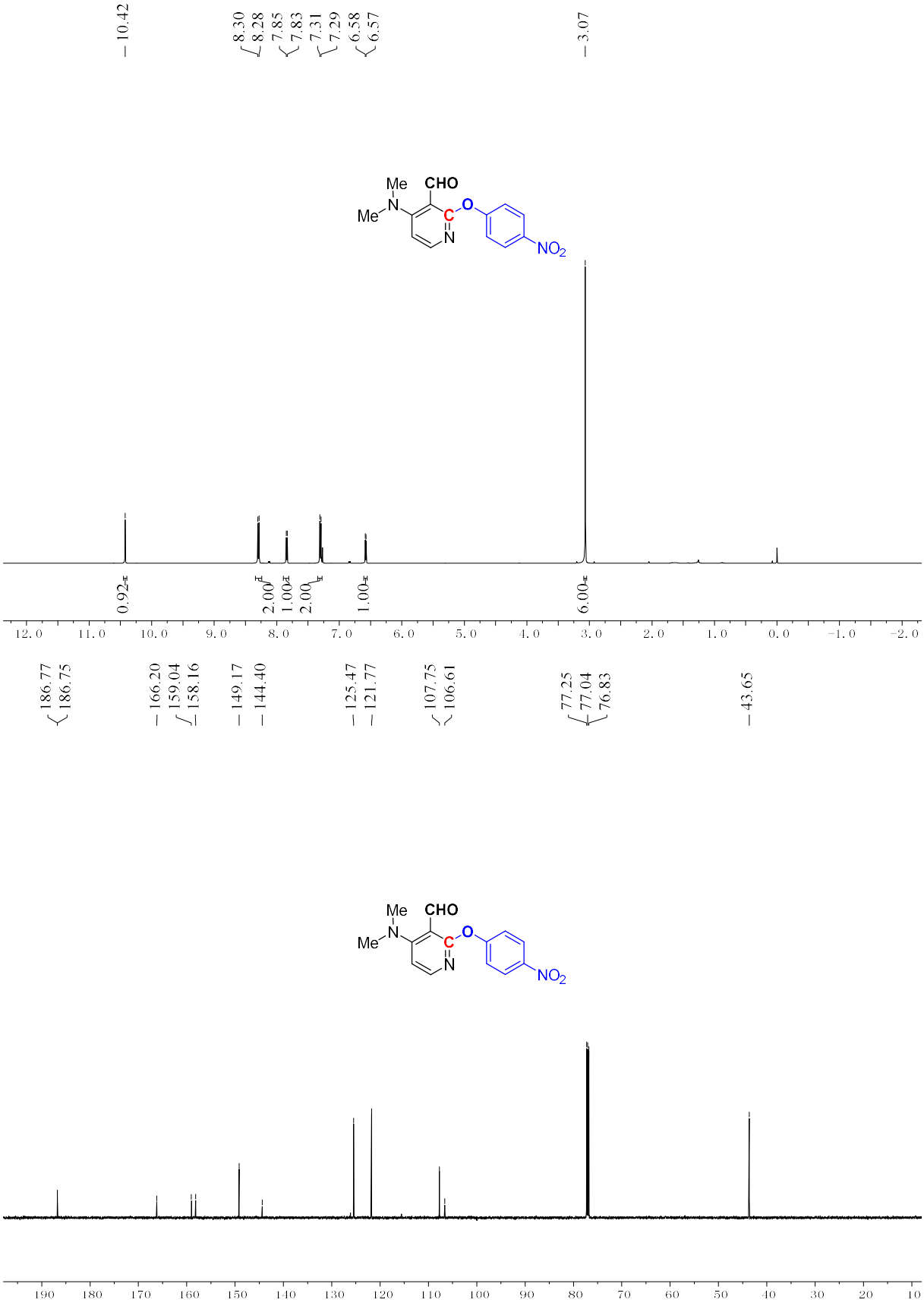

10.44
9.99
7.95
7.93
7.86
7.84
7.32
7.30
6.56
6.55
3.06
Me
CHO
Me
N
C
O
N
CHO
0.95
1.00
2.00
1.00
2.00
1.00
6.05
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
190.93
187.01
186.99
166.57
159.04
158.12
149.38
133.04
131.50
121.77
107.46
106.71
77.27
77.06
76.84
43.61
Me
CHO
Me
N
C
O
N
CHO
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
1

Compound 3k

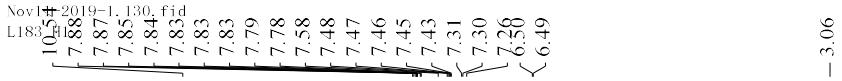

Nov18-2019-3.1
M132 H1
10.44
7.84
7.83
7.71
7.70
7.27
7.26
7.26
6.57
6.56
3.06
Me
CHO
Me
N
C
O
N
CN
0.94
1.01
1.97
2.09
1.00
6.06
f1 (ppm)

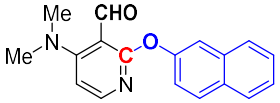

Nov18-2019-1.50.fid
WM0769 C13
186.84
186.82
166.27
158.12
157.44
149.20
133.82
122.27
118.61
108.34
107.60
106.55
77.29
77.08
76.87
43.63
Me
CHO
Me
N
C
O
N
CN
f1 (ppm)

Compound 3l


10.42
8.30
8.28
7.85
7.83
7.31
7.29
6.58
6.57
3.07
Me
CHO
Me
N
C
O
N
NO2
0.92
2.00
1.00
2.00
1.00
6.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
186.77
186.75
166.20
159.04
158.16
149.17
144.40
125.47
121.77
107.75
106.61
77.25
77.04
76.83
43.65
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

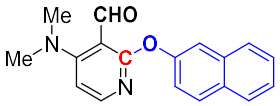
Compound 3m

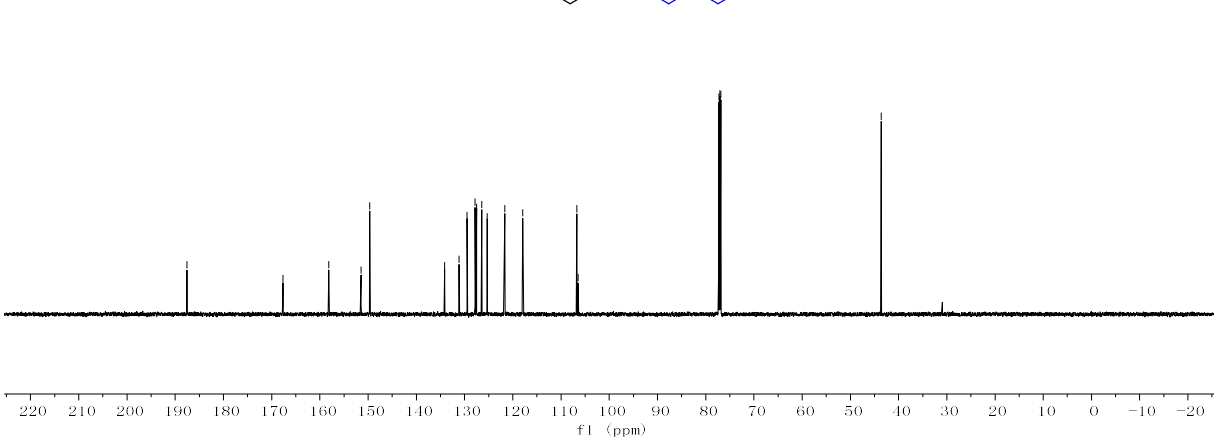

10.54
7.88
7.87
7.85
7.84
7.83
7.83
7.83
7.79
7.78
7.58
7.48
7.47
7.46
7.45
7.43
7.31
7.30
7.26
6.50
6.49
3.06


Me
CHO
N
Me
C
O
N

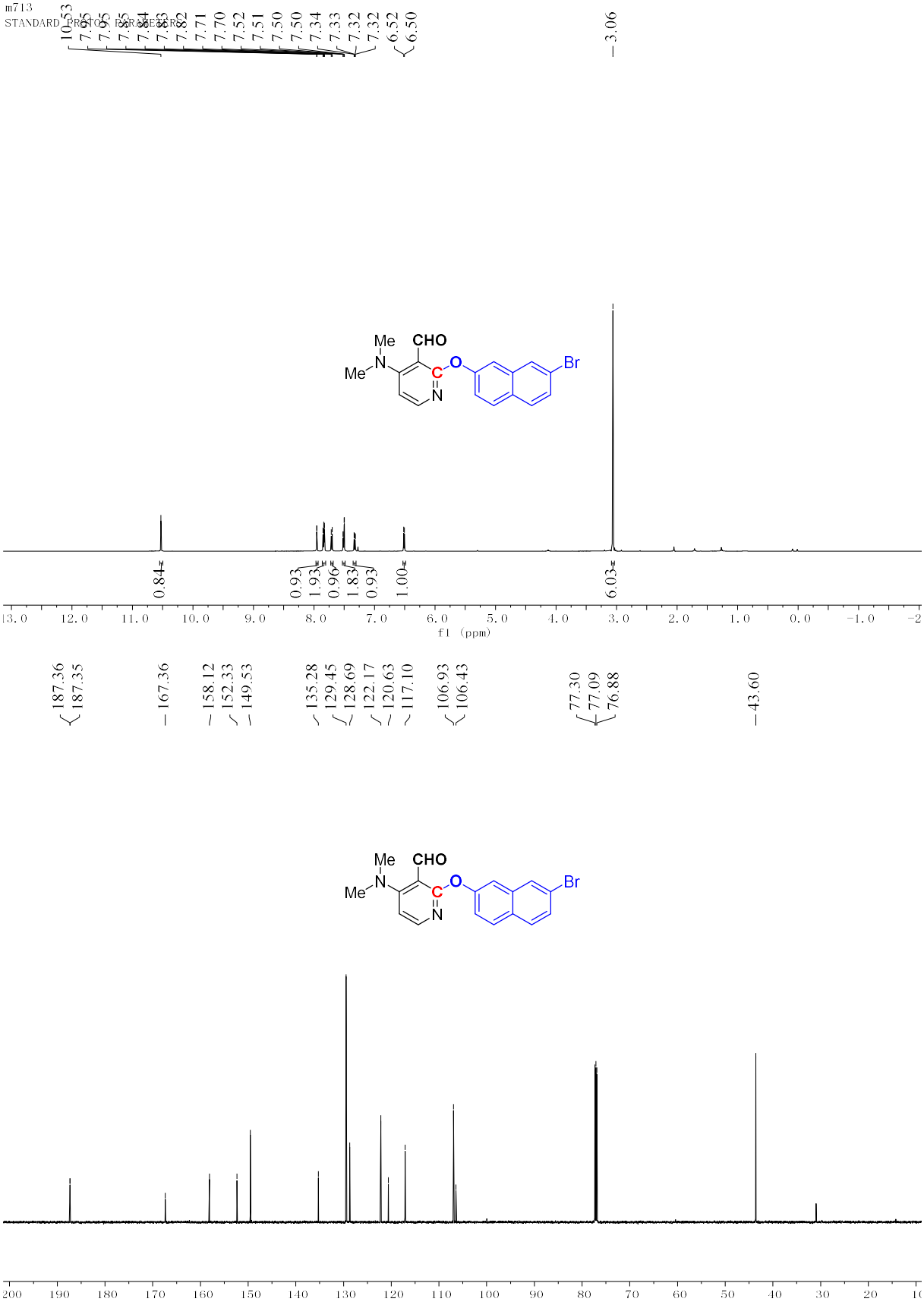
0.92
1.04
1.92
0.98
0.94
1.99
0.95
1.00
6.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)


Nov21-2019-1.51.fid
WM0805 C13
187.54
167.68
158.13
151.47
149.68
134.15
131.12
129.46
127.82
127.53
126.43
125.31
121.68
117.96
106.72
106.43
77.28
77.07
76.86
43.60

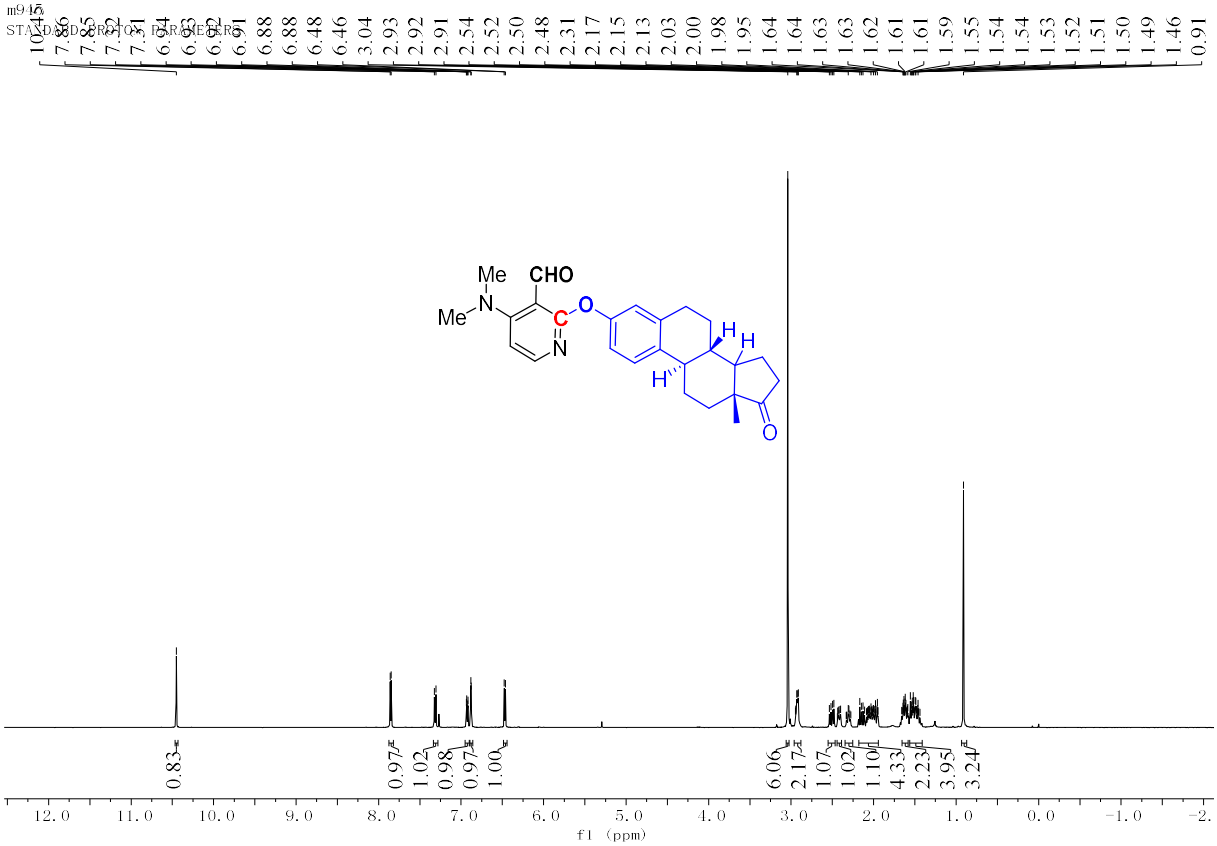

Me
CHO
N
Me
C
O
N

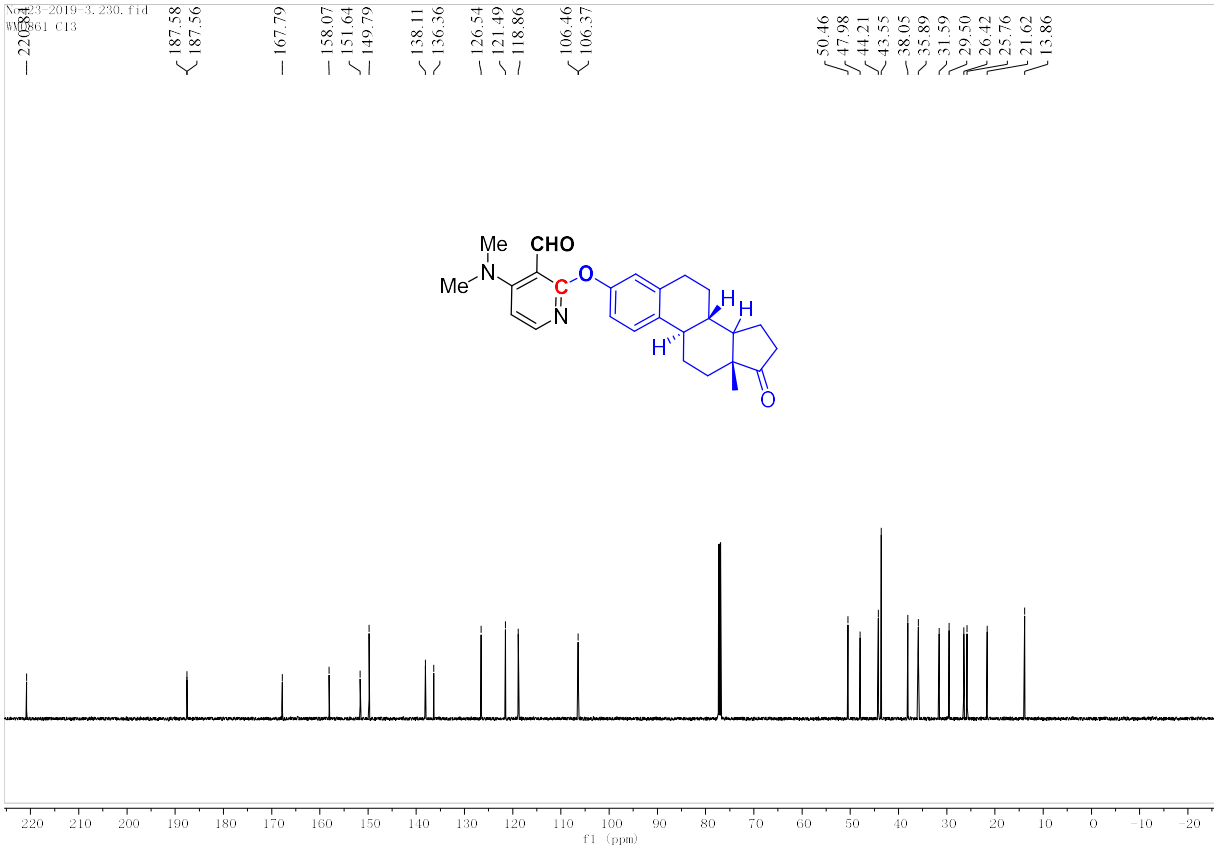

220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

Compound 3n

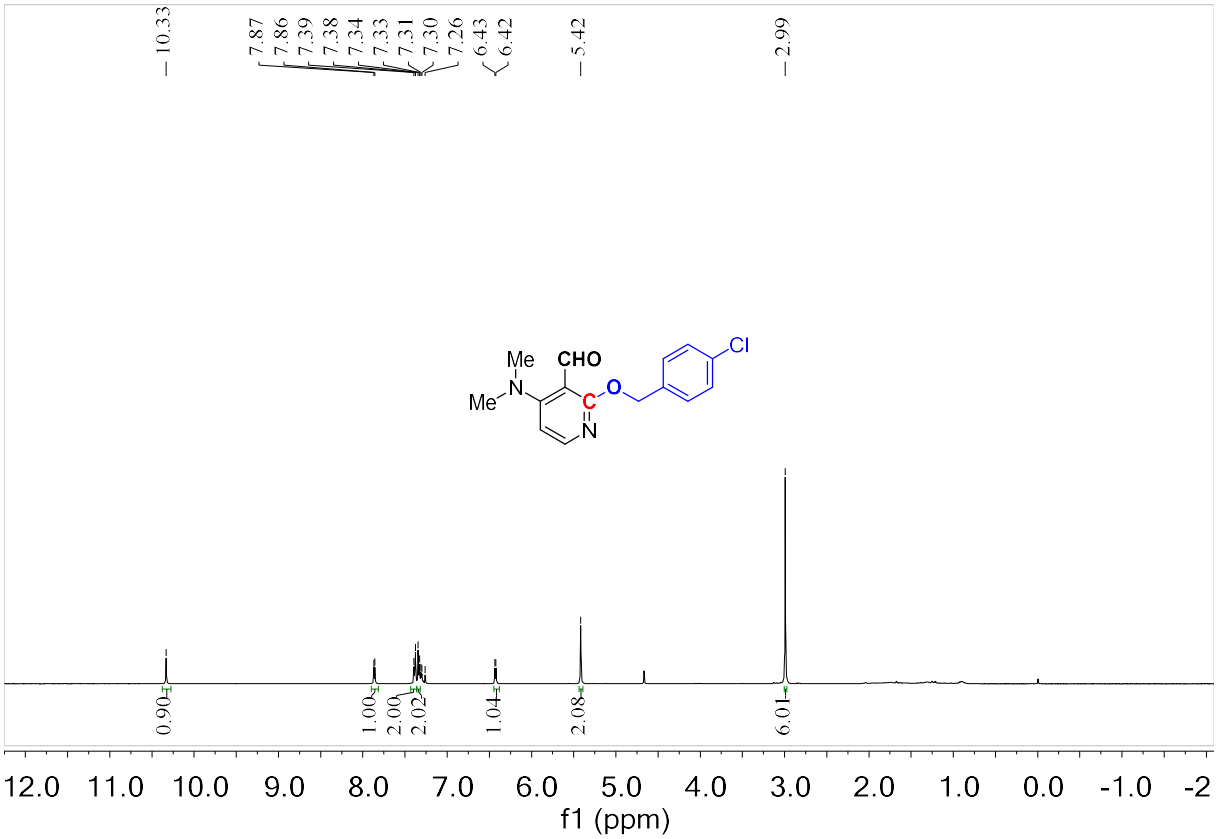

m713
STANDARD PROTON PARAMETER
10.53
7.95
7.85
7.84
7.83
7.82
7.71
7.70
7.52
7.51
7.50
7.50
7.34
7.33
7.32
7.32
6.52
6.50
3.06
Me
CHO
N
Me
C
O
Br
N
0.84
0.93
1.93
0.96
1.83
0.93
1.00
6.03
f1 (ppm)
187.36
187.35
167.36
158.12
152.33
149.53
135.28
129.45
128.69
122.17
120.63
117.10
106.93
106.43
77.30
77.09
76.88
43.60

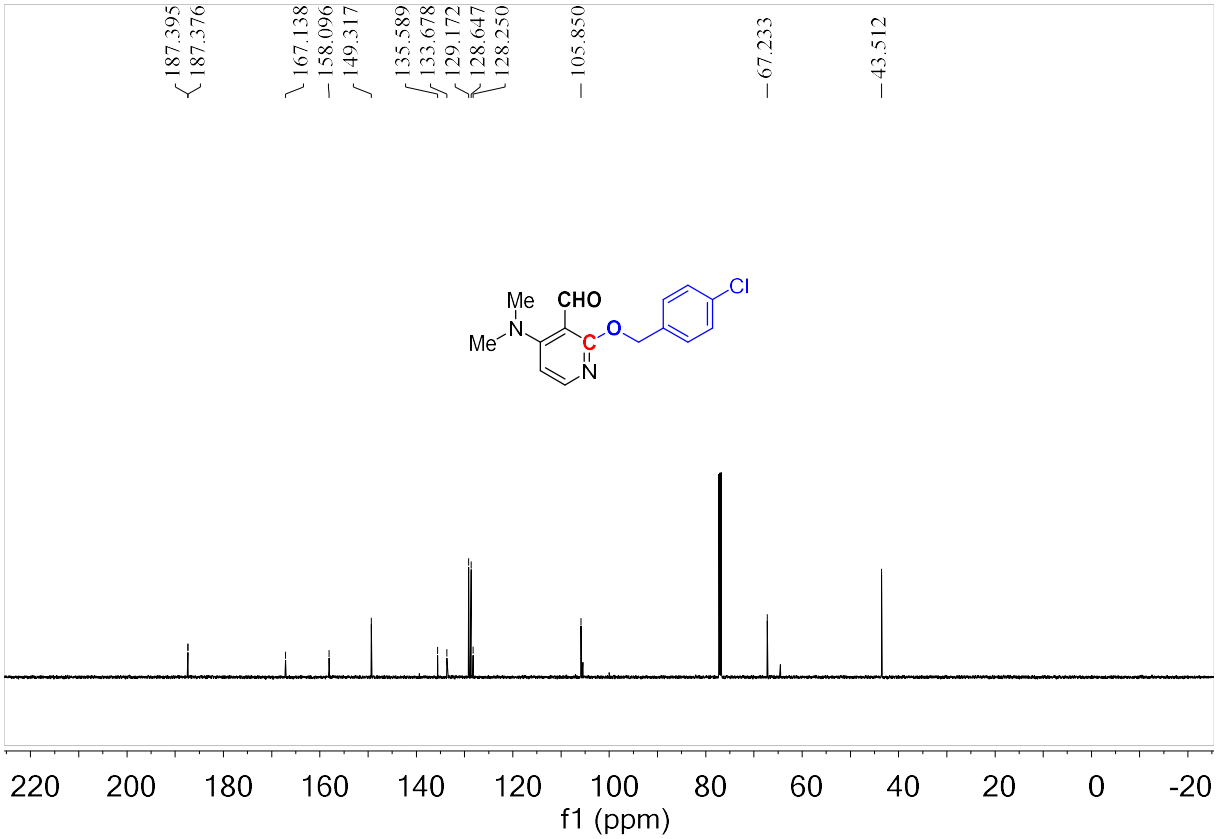
Compound 3o


m9-15
STANDARD_PROTON_PARAMETER_1
10.15
7.86
7.85
7.82
7.31
6.64
6.63
6.62
6.61
6.88
6.88
6.48
6.46
3.04
2.93
2.92
2.91
2.54
2.52
2.50
2.48
2.31
2.17
2.15
2.13
2.03
2.00
1.98
1.95
1.64
1.64
1.63
1.63
1.62
1.61
1.61
1.59
1.55
1.54
1.54
1.53
1.52
1.51
1.50
1.49
1.46
0.91
Me
CHO
N
Me
C
O
N
H
H
H
O
0.83
0.97
1.02
0.98
0.97
1.00
6.06
2.17
1.07
1.02
1.10
4.33
2.23
3.95
3.24
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.
f1 (ppm)

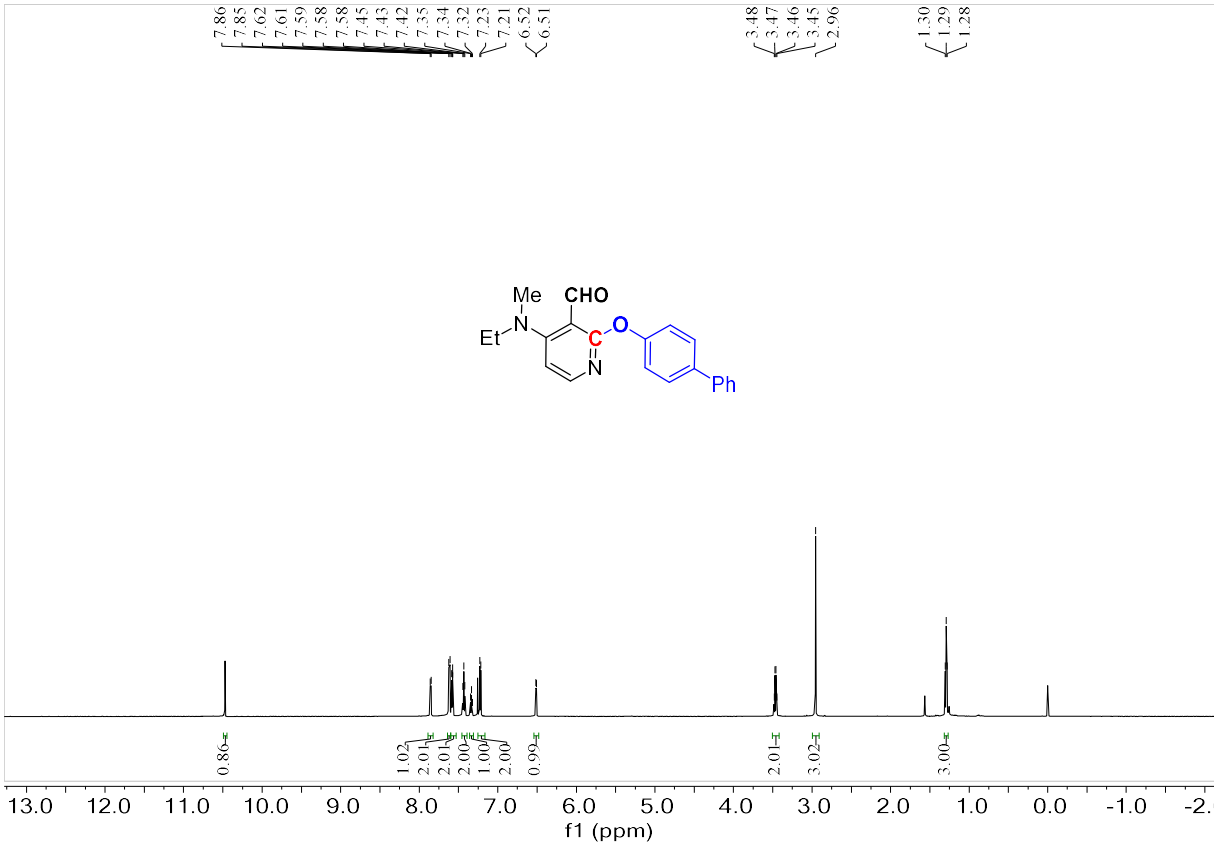

220.83
187.58
187.56
167.79
158.07
151.64
149.79
138.11
136.36
126.54
121.49
118.86
106.46
106.37
50.46
47.98
44.21
43.55
38.05
35.89
31.59
29.50
26.42
25.76
21.62
13.86
Me
CHO
N
Me
C
O
N
H
H
H
O
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

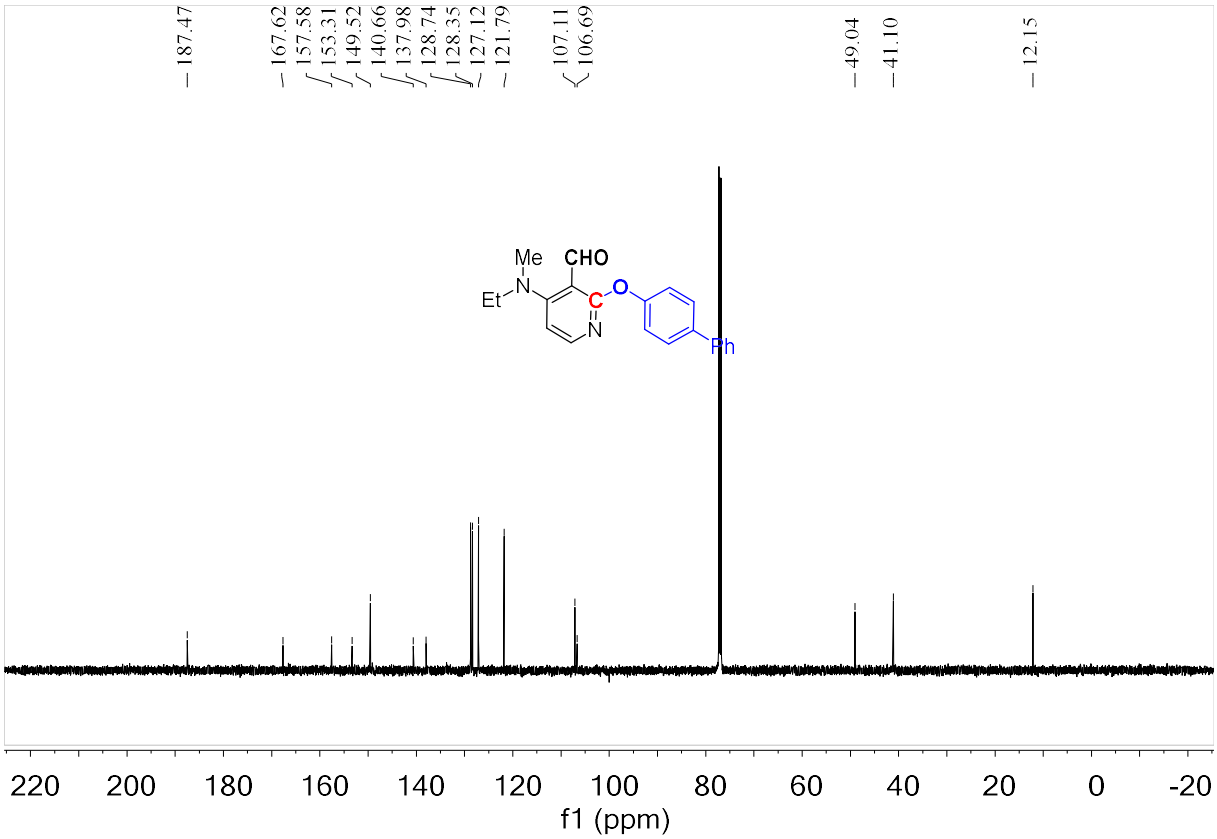
Compound 3p


10.33
7.87
7.86
7.39
7.38
7.34
7.33
7.31
7.30
7.26
6.43
6.42
5.42
2.99
Me
CHO
Me
N
O
C
N
Cl
0.90
1.00
2.00
2.02
1.04
2.08
6.01
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0 -2
f1 (ppm)

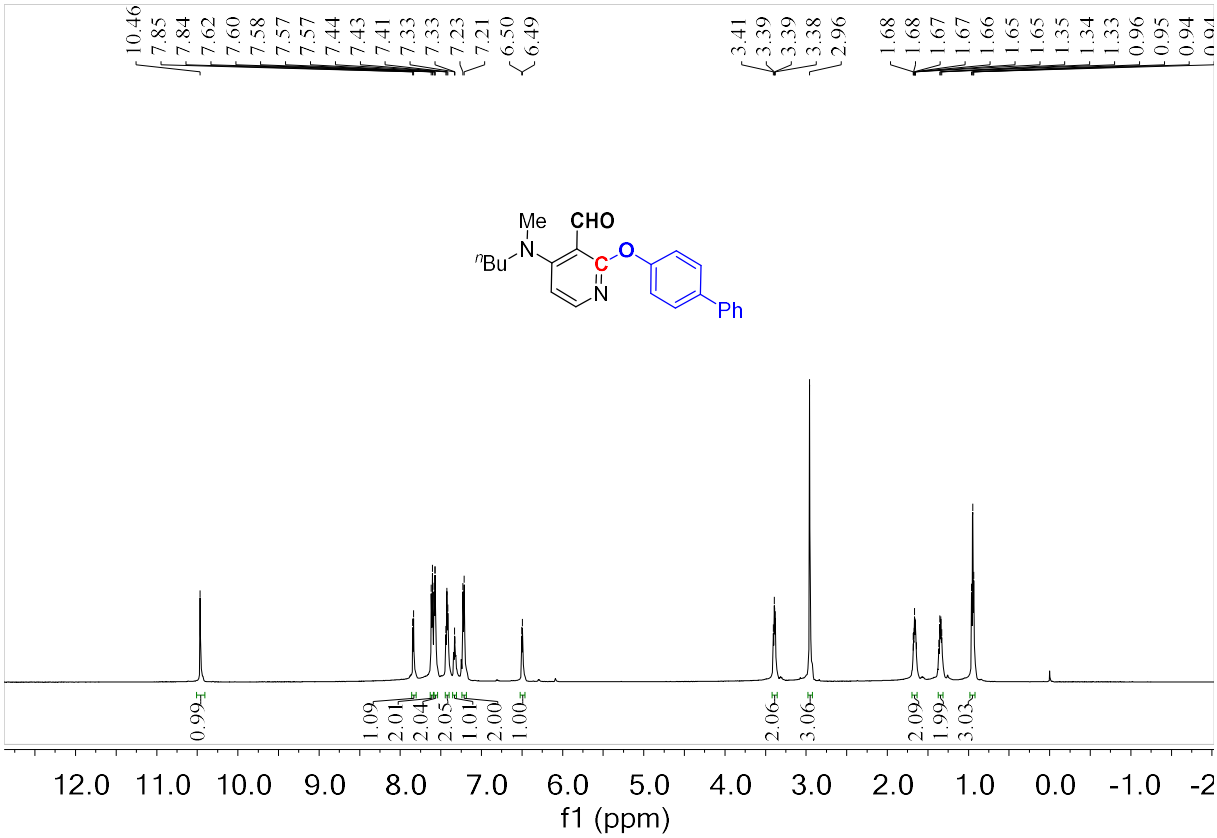

187.395
187.376
167.138
158.096
149.317
135.589
133.678
129.172
128.647
128.250
105.850
67.233
43.512
Me
CHO
Me
N
O
C
N
Cl
220 200 180 160 140 120 100 80 60 40 20 0 -20
f1 (ppm)

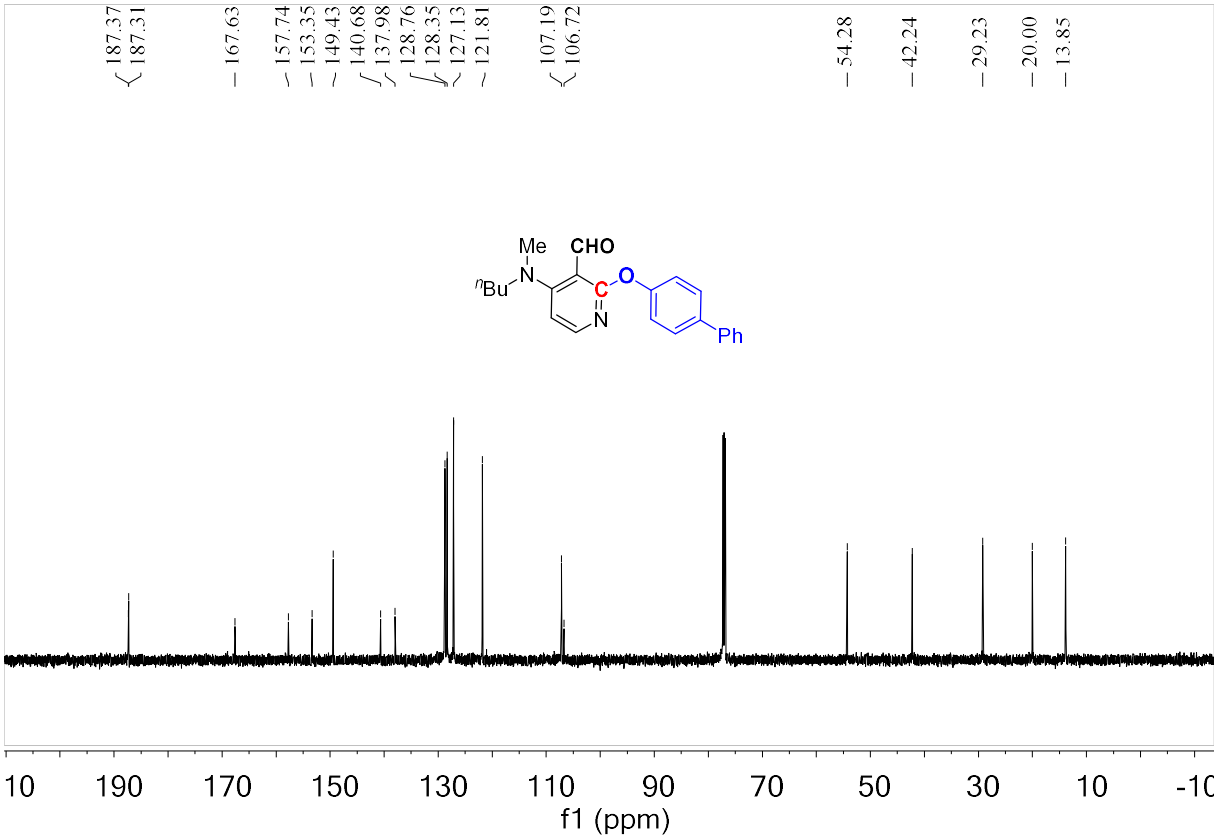
Compound 3q


7.86
7.85
7.62
7.61
7.59
7.58
7.58
7.45
7.43
7.42
7.35
7.34
7.32
7.23
7.21
6.52
6.51
3.48
3.47
3.46
3.45
2.96
1.30
1.29
1.28
Me
CHO
Et
N
C
O
N
Ph
0.86
1.02
2.01
2.01
2.00
1.00
2.00
0.99
2.01
3.02
3.00
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.
f1 (ppm)


187.47
167.62
157.58
153.31
149.52
140.66
137.98
128.74
128.35
127.12
121.79
107.11
106.69
49.04
41.10
12.15
Me
CHO
Et
N
C
O
N
Ph
220
200
180
160
140
120
100
80
60
40
20
0
-20
f1 (ppm)

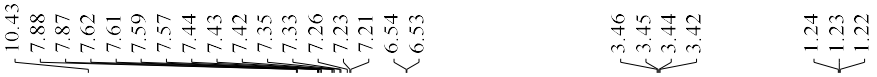
Compound 3r

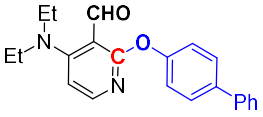

10.46
7.85
7.84
7.62
7.60
7.58
7.57
7.57
7.44
7.43
7.41
7.33
7.33
7.23
7.21
6.50
6.49
3.41
3.39
3.39
3.38
2.96
1.68
1.68
1.67
1.67
1.66
1.65
1.65
1.35
1.34
1.33
0.96
0.95
0.94
Me
CHO
nBu
N
C
O
N
Ph
0.99
1.09
2.01
2.04
2.05
1.01
2.00
1.00
2.06
3.06
2.09
1.99
3.03
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0 -2
f1 (ppm)

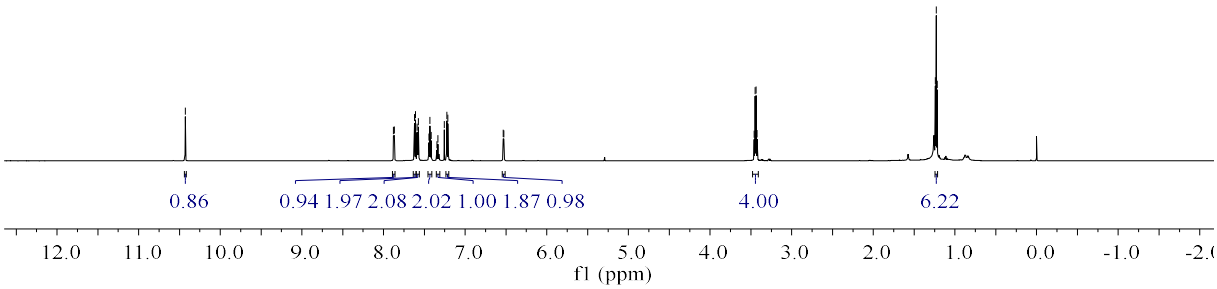

187.37
187.31
167.63
157.74
153.35
149.43
140.68
137.98
128.76
128.35
127.13
121.81
107.19
106.72
54.28
42.24
29.23
20.00
13.85
Me
CHO
nBu
N
C
O
N
Ph
10 190 170 150 130 110 90 70 50 30 10 -10
f1 (ppm)

Compound 3s

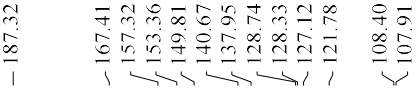
Dec07-2020-6.20.fid — WM3925 H1

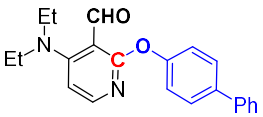


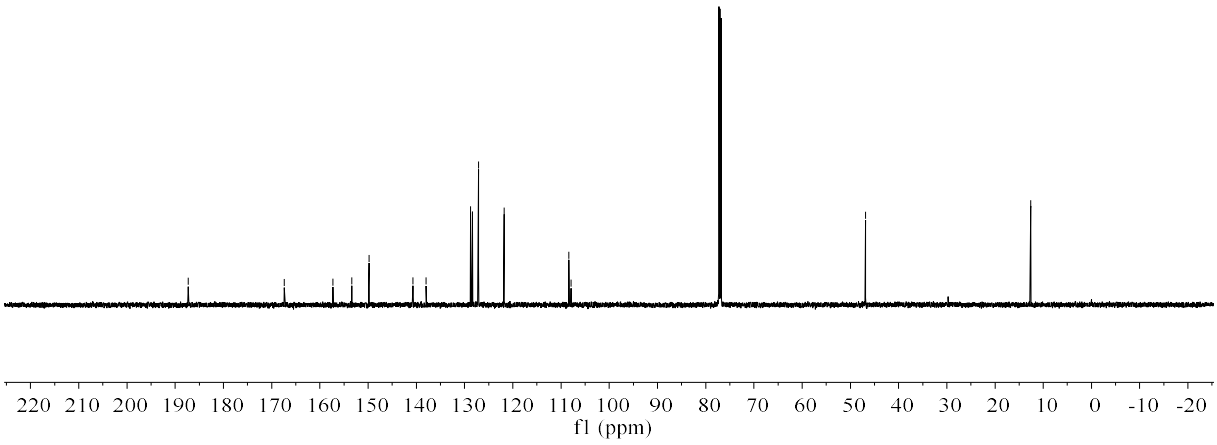




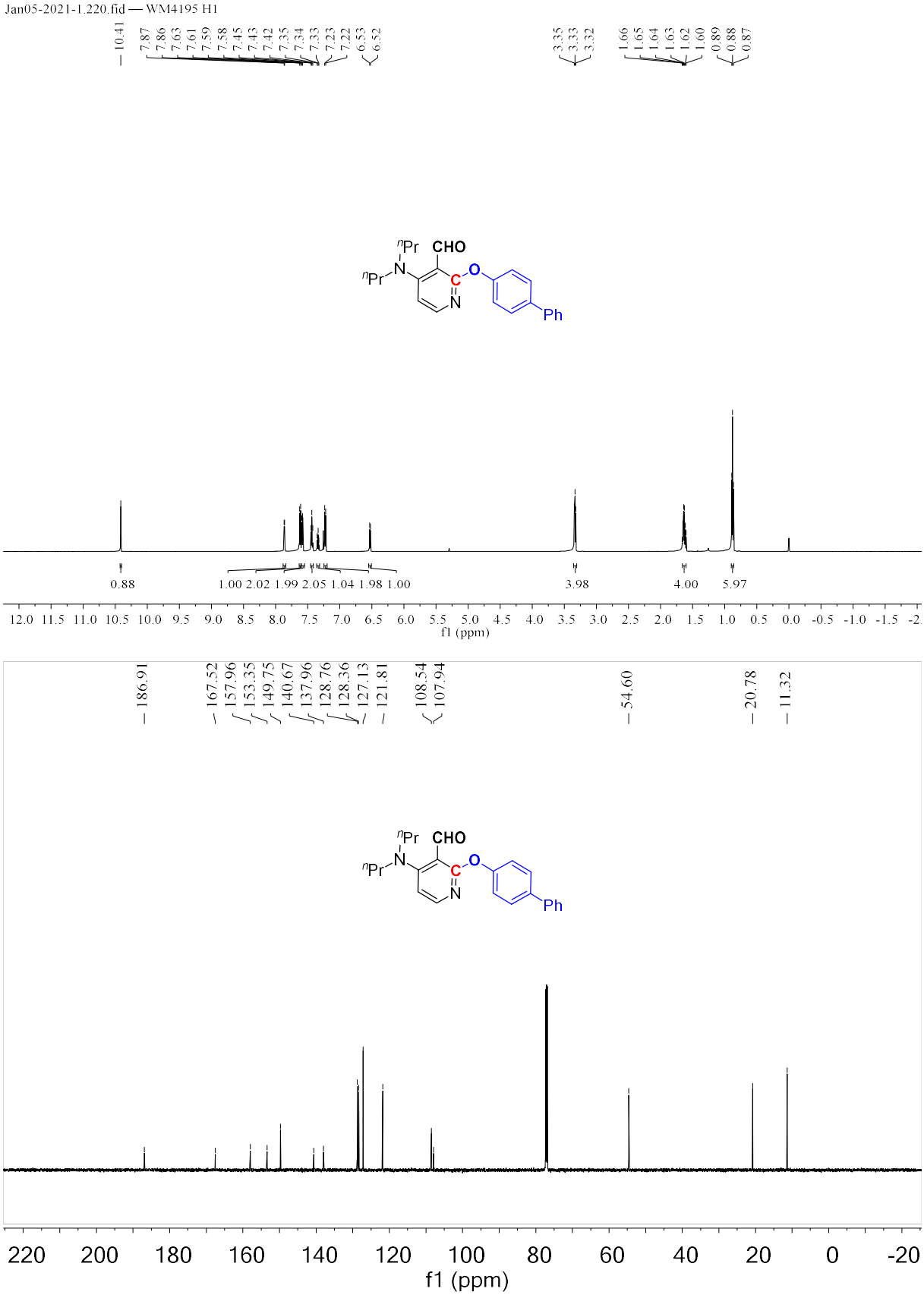
Dec07-2020-6.21.fid — WM3926 C13



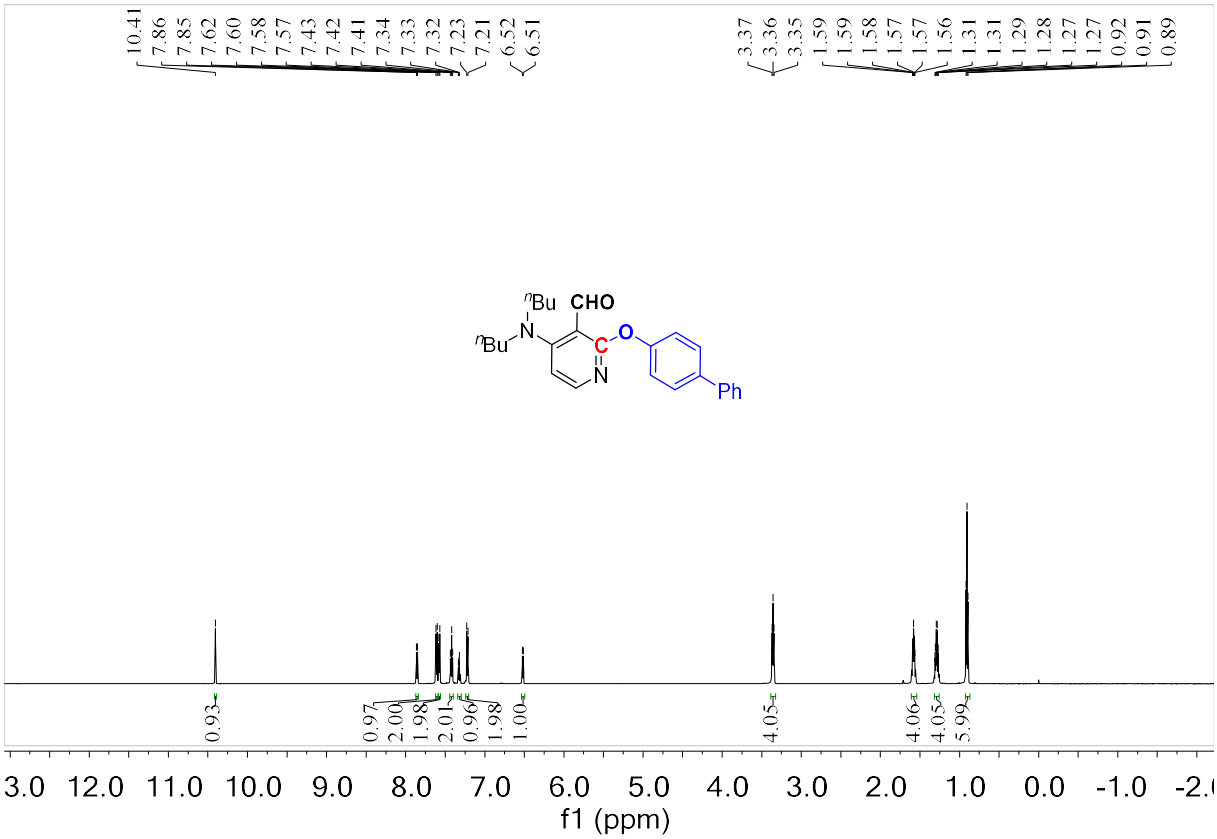


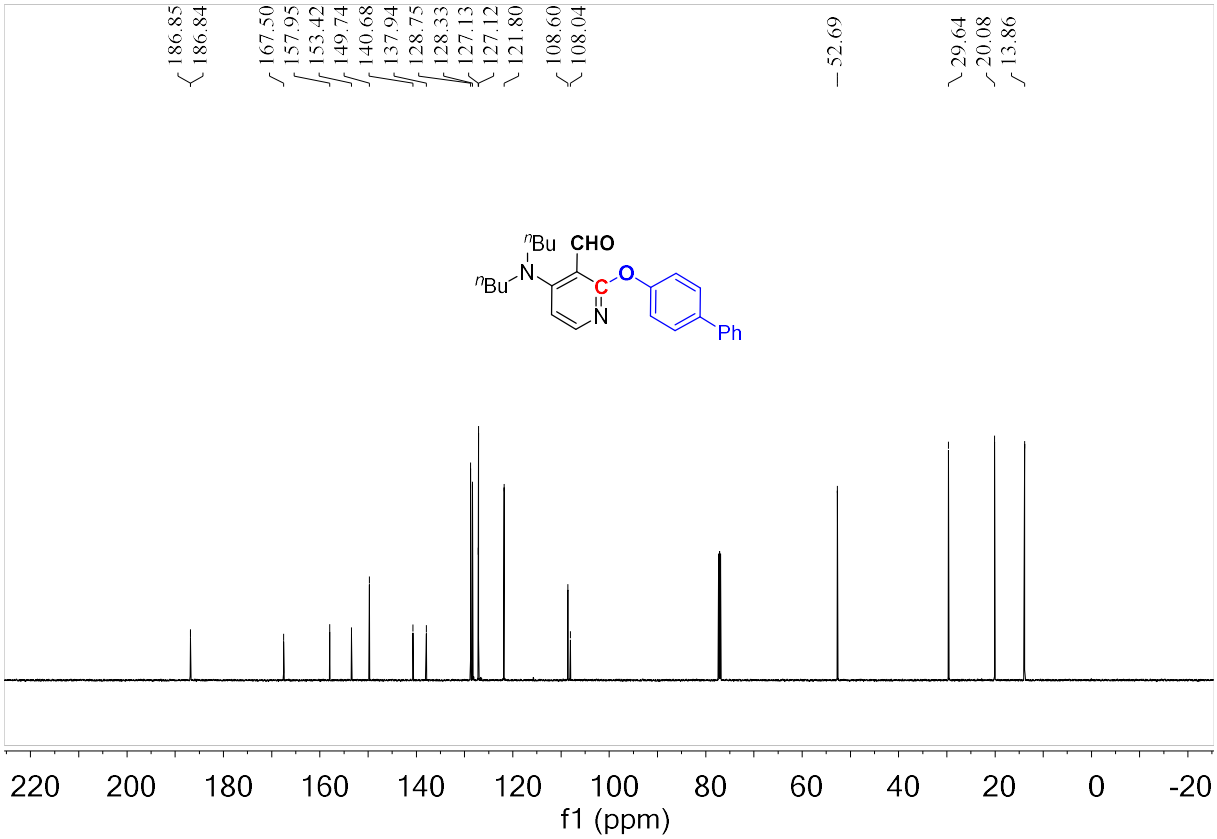


Compound 3t

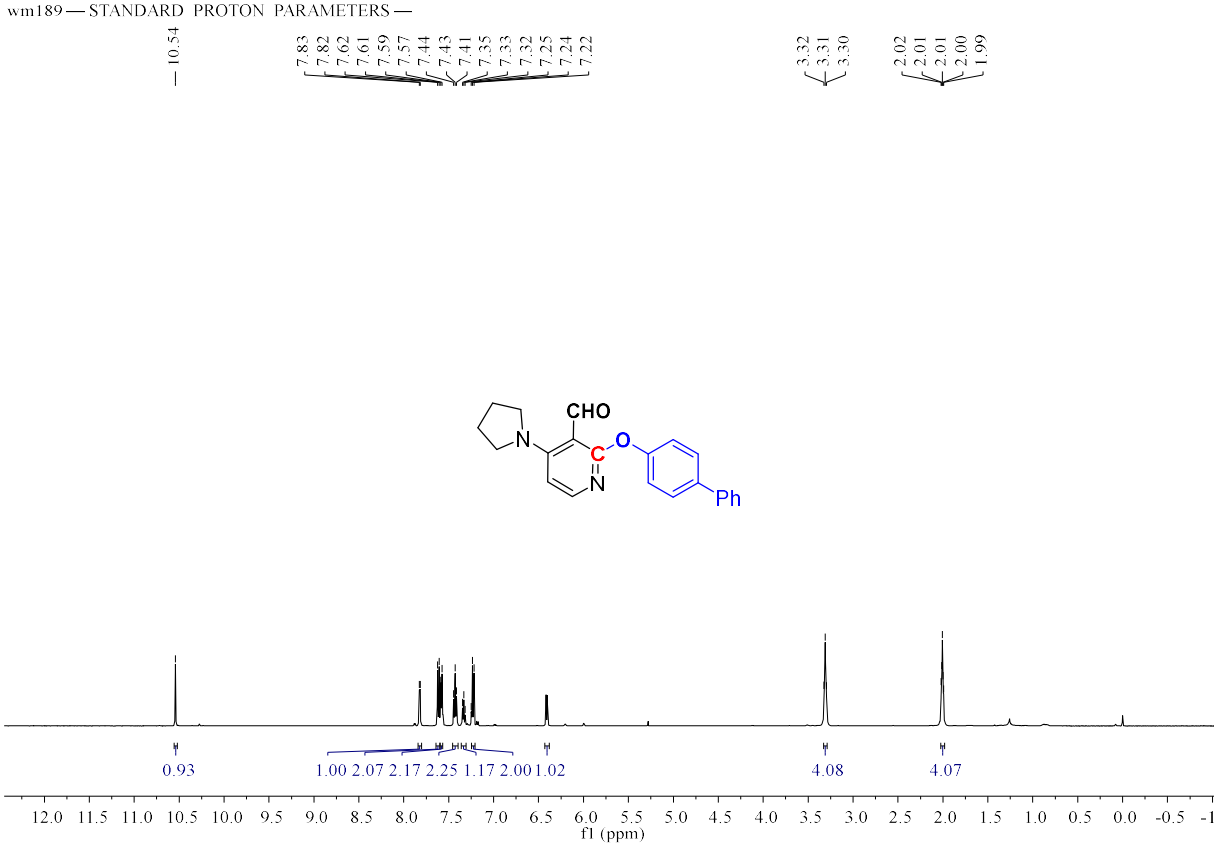

Jan05-2021-1.220.fid — WM4195 H1
10.41
7.87
7.86
7.63
7.61
7.59
7.58
7.45
7.43
7.42
7.35
7.34
7.33
7.23
7.22
6.53
6.52
3.35
3.33
3.32
1.66
1.65
1.64
1.63
1.62
1.60
0.89
0.88
0.87
nPr
CHO
nPr
N
C
O
N
Ph
0.88
1.00
2.02
1.99
2.05
1.04
1.98
1.00
3.98
4.00
5.97
f1 (ppm)
186.91
167.52
157.96
153.35
149.75
140.67
137.96
128.76
128.36
127.13
121.81
108.54
107.94
54.60
20.78
11.32
f1 (ppm)

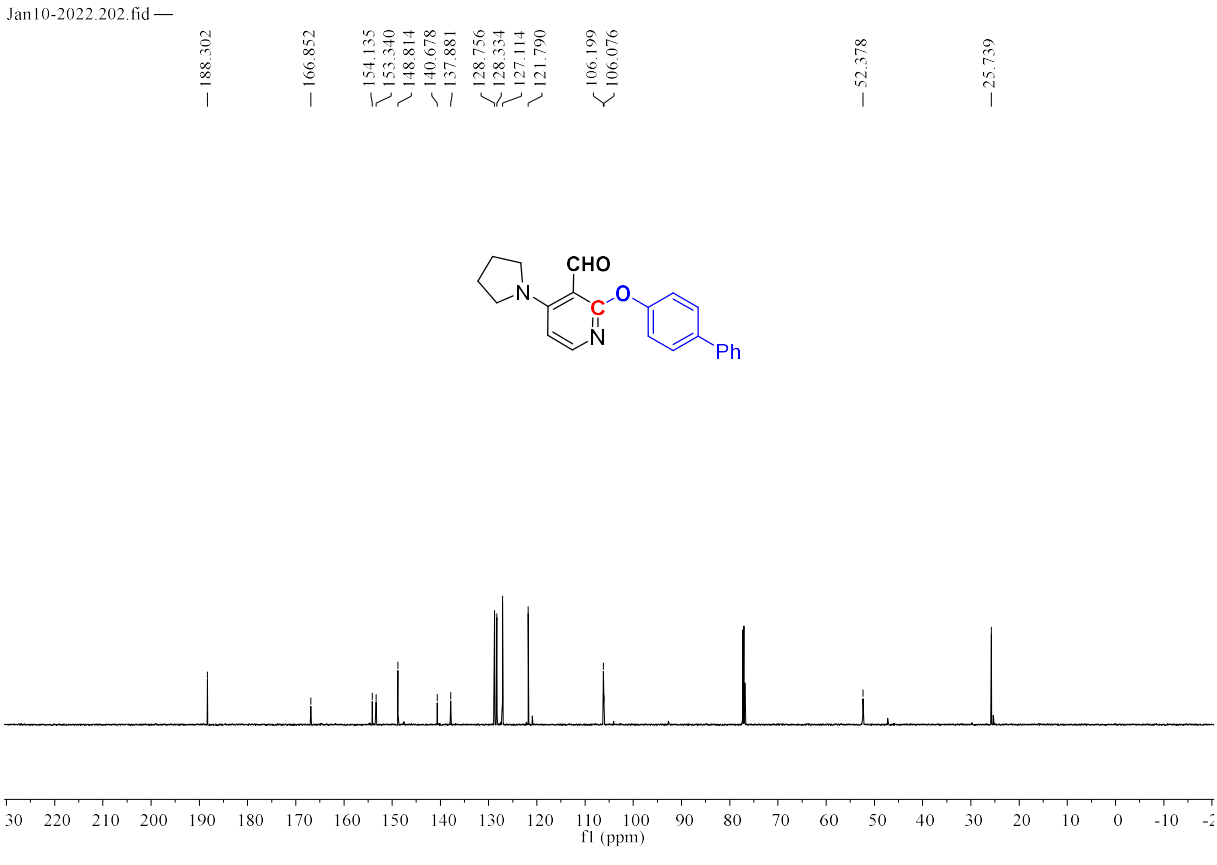
Compound 3u


10.41
7.86
7.85
7.62
7.60
7.58
7.57
7.43
7.42
7.41
7.34
7.33
7.32
7.23
7.21
6.52
6.51
3.37
3.36
3.35
1.59
1.59
1.58
1.57
1.57
1.56
1.31
1.31
1.29
1.28
1.27
1.27
0.92
0.91
0.89
nBu
CHO
nBu
N
C
O
N
Ph
0.93
0.97
2.00
1.98
2.01
0.96
1.98
1.00
4.05
4.06
4.05
5.99
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

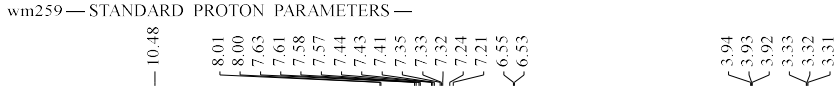

186.85
186.84
167.50
157.95
153.42
149.74
140.68
137.94
128.75
128.33
127.13
127.12
121.80
108.60
108.04
52.69
29.64
20.08
13.86
nBu
CHO
nBu
N
C
O
N
Ph
220
200
180
160
140
120
100
80
60
40
20
0
-20
f1 (ppm)

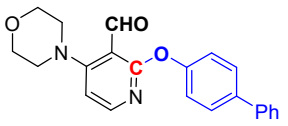
Compound 3v

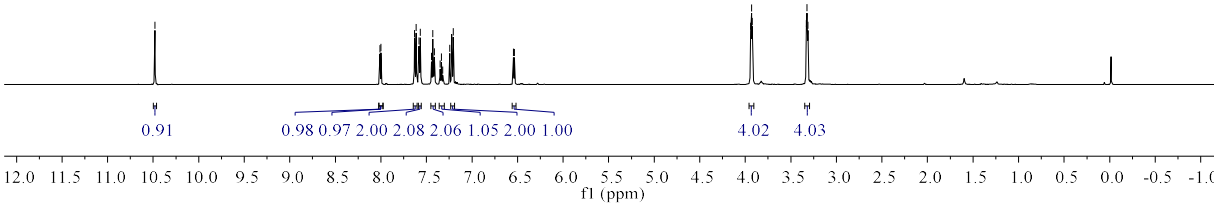

wm189 — STANDARD PROTON PARAMETERS —
10.54
7.83
7.82
7.62
7.61
7.59
7.57
7.44
7.43
7.41
7.35
7.33
7.32
7.25
7.24
7.22
3.32
3.31
3.30
2.02
2.01
2.01
2.00
1.99
CHO
N
O
C
N
Ph
0.93
1.00
2.07
2.17
2.25
1.17
2.00
1.02
4.08
4.07
f1 (ppm)

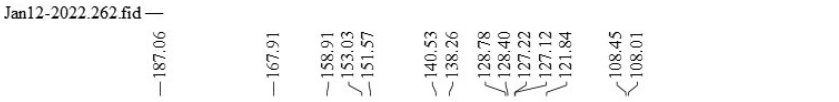

Jan10-2022.202.fid —
188.302
166.852
154.135
153.340
148.814
140.678
137.881
128.756
128.334
127.114
121.790
106.199
106.076
52.378
25.739
CHO
N
O
C
N
Ph
f1 (ppm)

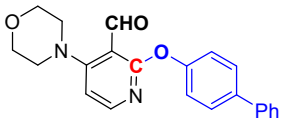
Compound 3w

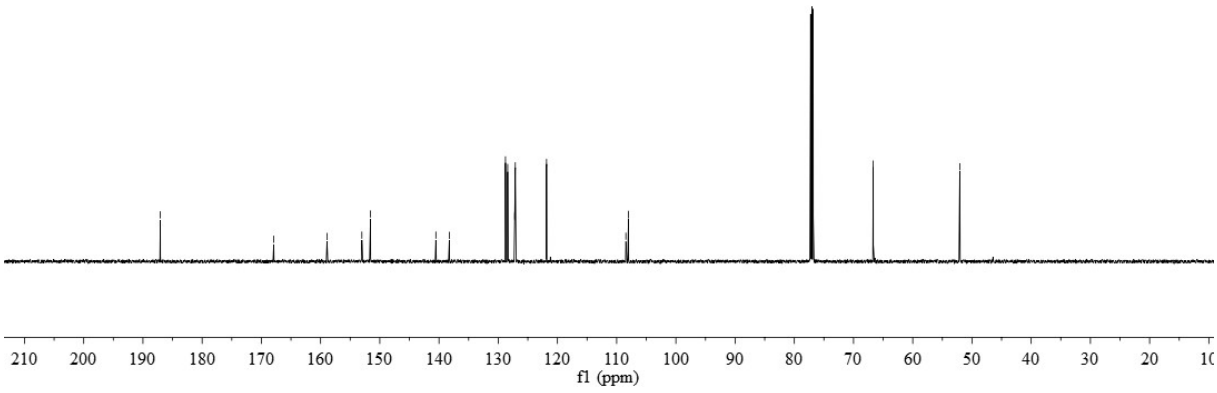

wm259 — STANDARD PROTON PARAMETERS —
10.48
8.01
8.00
7.63
7.61
7.58
7.57
7.44
7.43
7.41
7.35
7.33
7.32
7.24
7.21
6.55
6.53
3.94
3.93
3.92
3.33
3.32
3.31


O
N
CHO
C
O
N
Ph

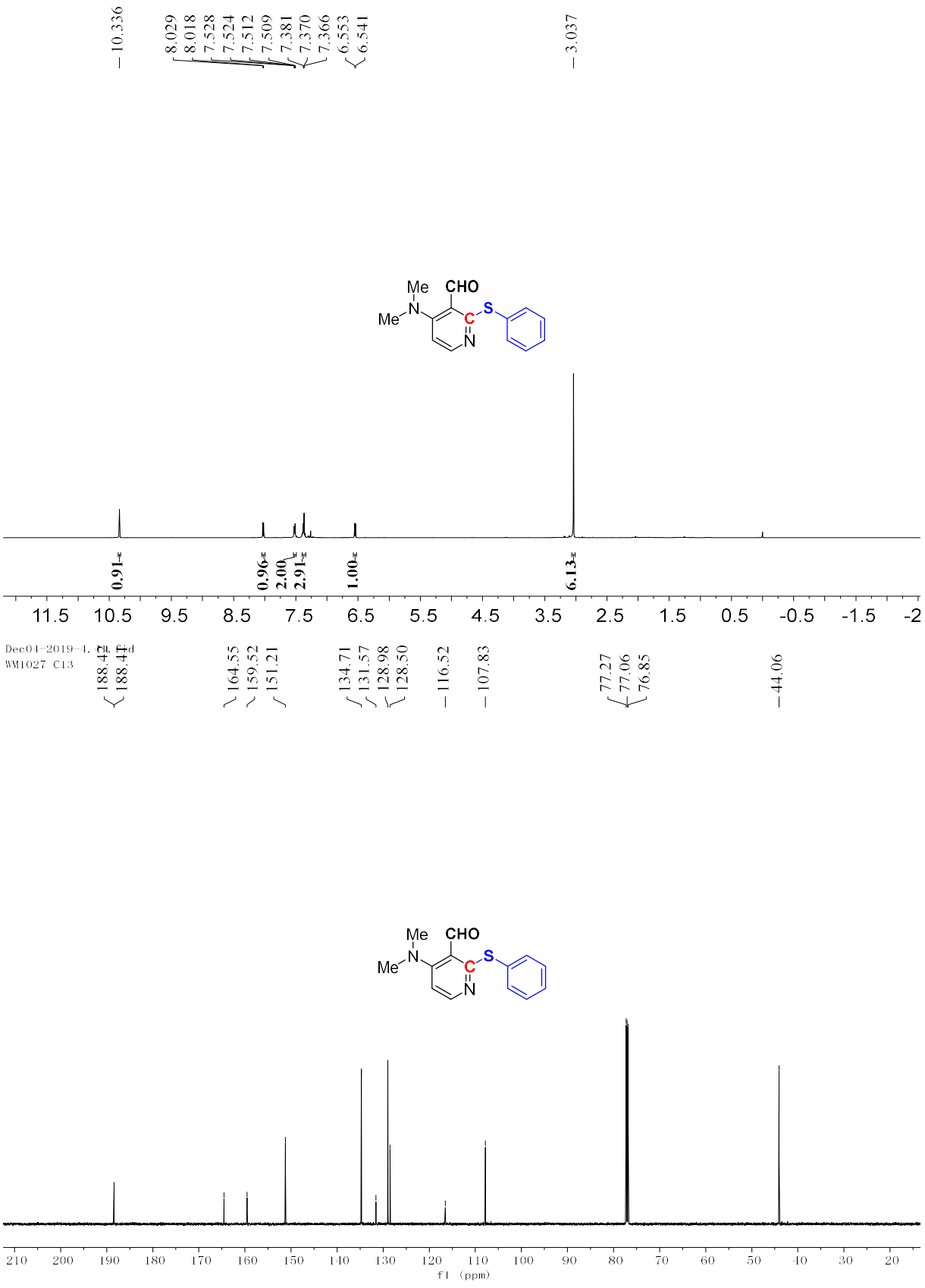

0.91
0.98 0.97 2.00 2.08 2.06 1.05 2.00 1.00
4.02
4.03
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


Jan12-2022.262.fid —
187.06
167.91
158.91
153.03
151.57
140.53
138.26
128.78
128.40
127.22
127.12
121.84
108.45
108.01
66.67
52.05

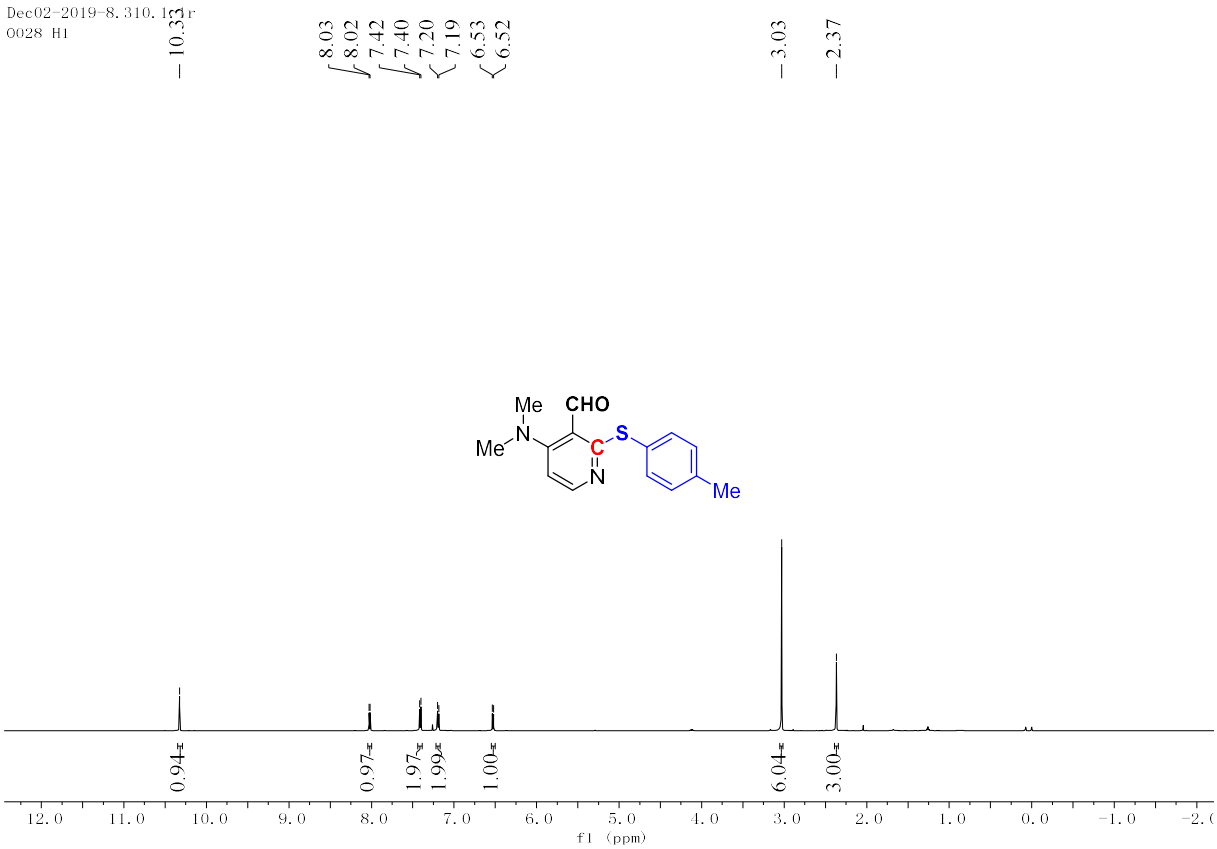

O
N
CHO
C
O
N
Ph

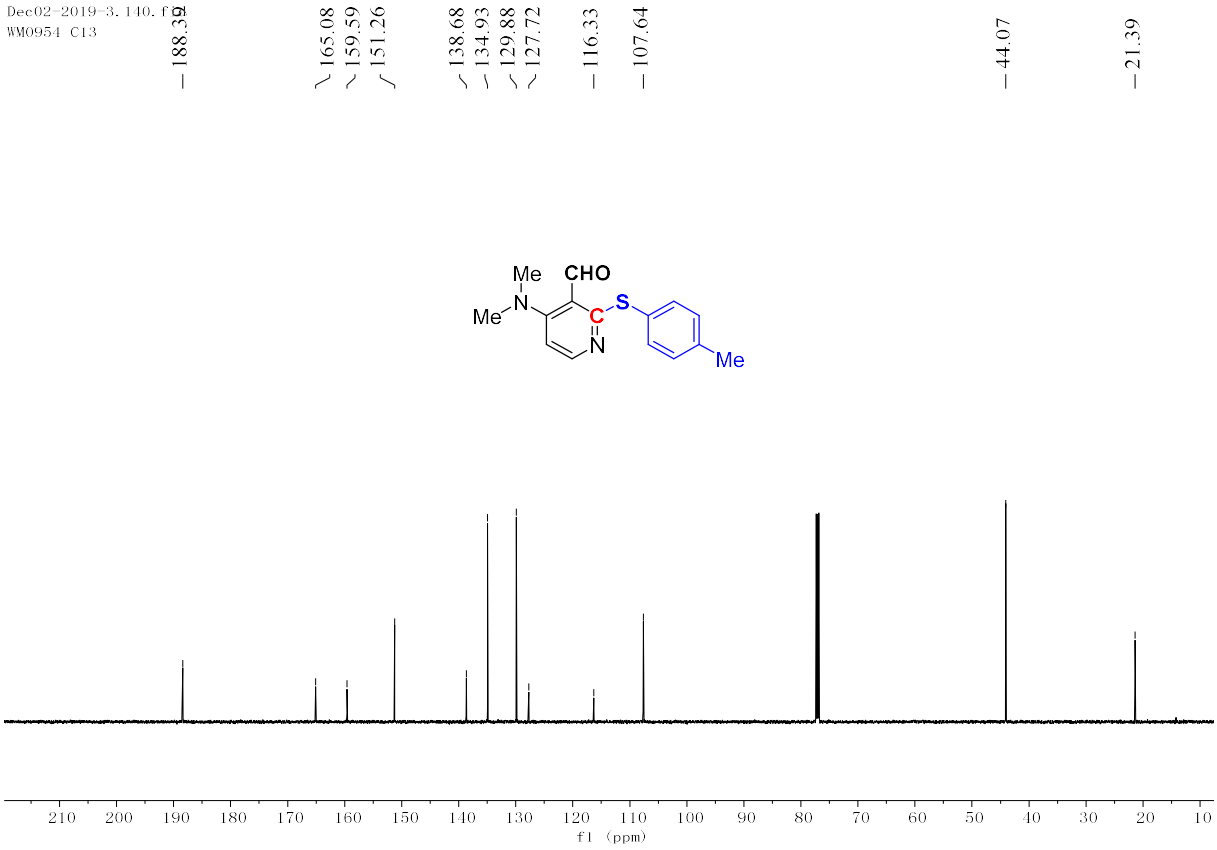

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20
f1 (ppm)

Compound 5a


Dec03-2019-8.80.1.1r — 0184 H1
10.336
8.029
8.018
7.528
7.524
7.512
7.509
7.381
7.370
7.366
6.553
6.541
3.037
Me
CHO
Me
N
C
S
N
0.91
0.96
2.00
2.91
1.00
6.13
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
-2
Dec04-2019-4.
WM1027 C13
188.42
188.41
164.55
159.52
151.21
134.71
131.57
128.98
128.50
116.52
107.83
77.27
77.06
76.85
44.06
Me
CHO
Me
N
C
S
N
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

Compound 5b

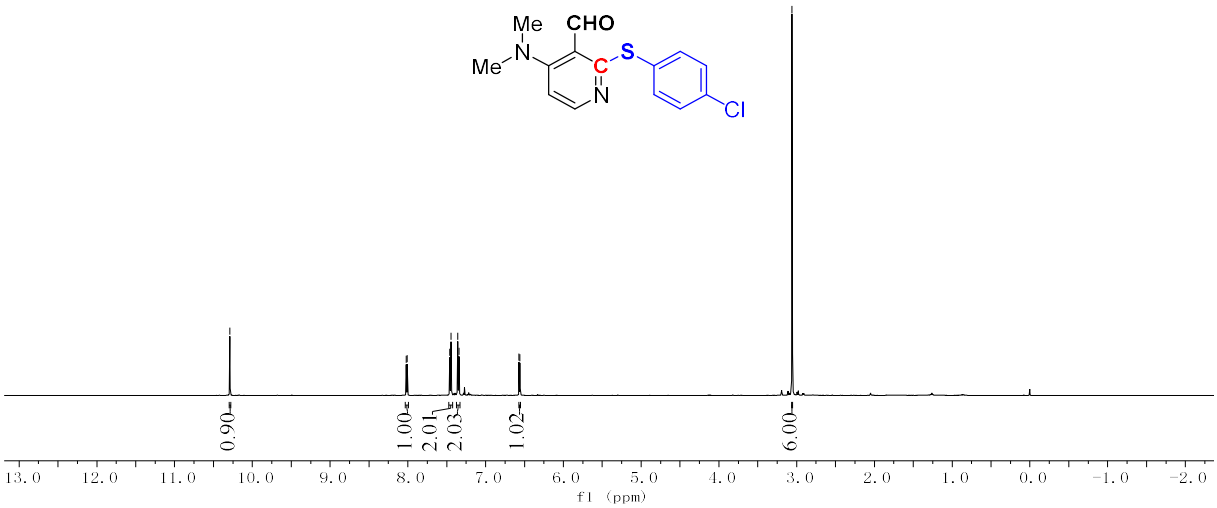

Dec02-2019-8.310.1r
0028 H1
10.33
8.03
8.02
7.42
7.40
7.20
7.19
6.53
6.52
3.03
2.37
Me
CHO
Me
N
S
C
N
Me
0.94
0.97
1.97
1.99
1.00
6.04
3.00
f1 (ppm)


Dec02-2019-3.140.fid
WM0954 C13
188.39
165.08
159.59
151.26
138.68
134.93
129.88
127.72
116.33
107.64
44.07
21.39
Me
CHO
Me
N
S
C
N
Me
f1 (ppm)

Compound 5c

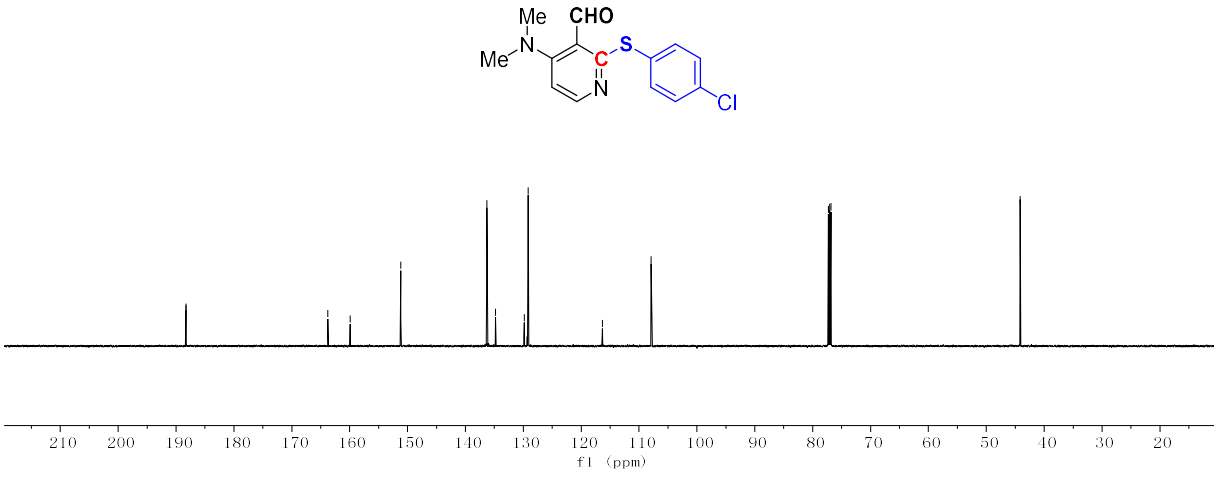
o196
STANDARD PROTON PARAMETERS

10.29
8.02
8.01
7.46
7.44
7.36
7.34
6.57
6.56
3.06

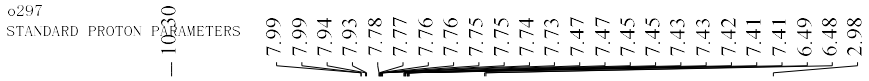


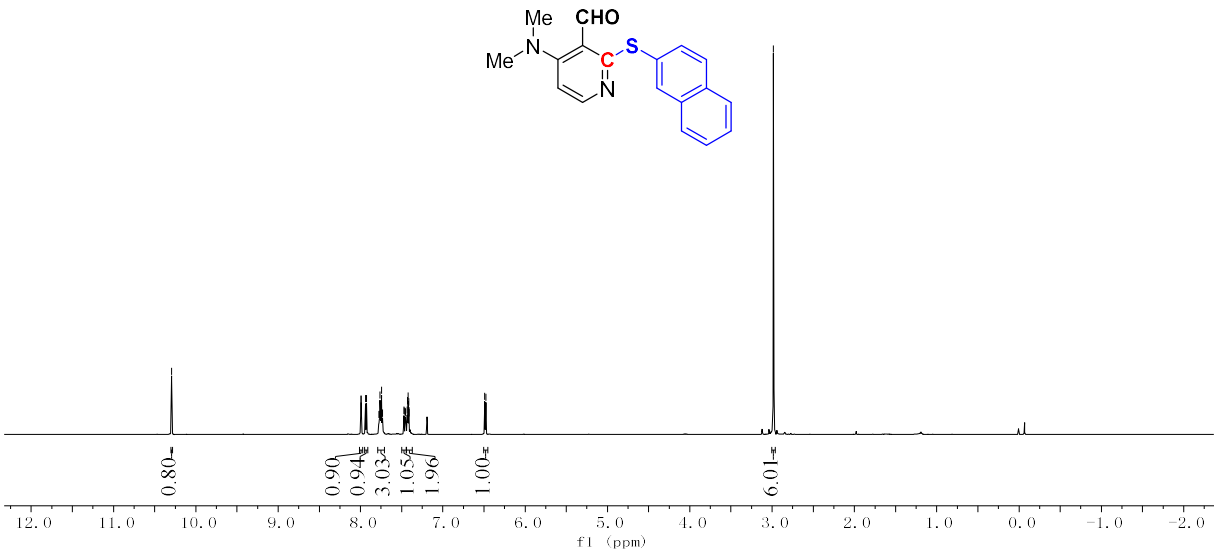
Dec03-2019-2.120.9dd
WM1002 C13

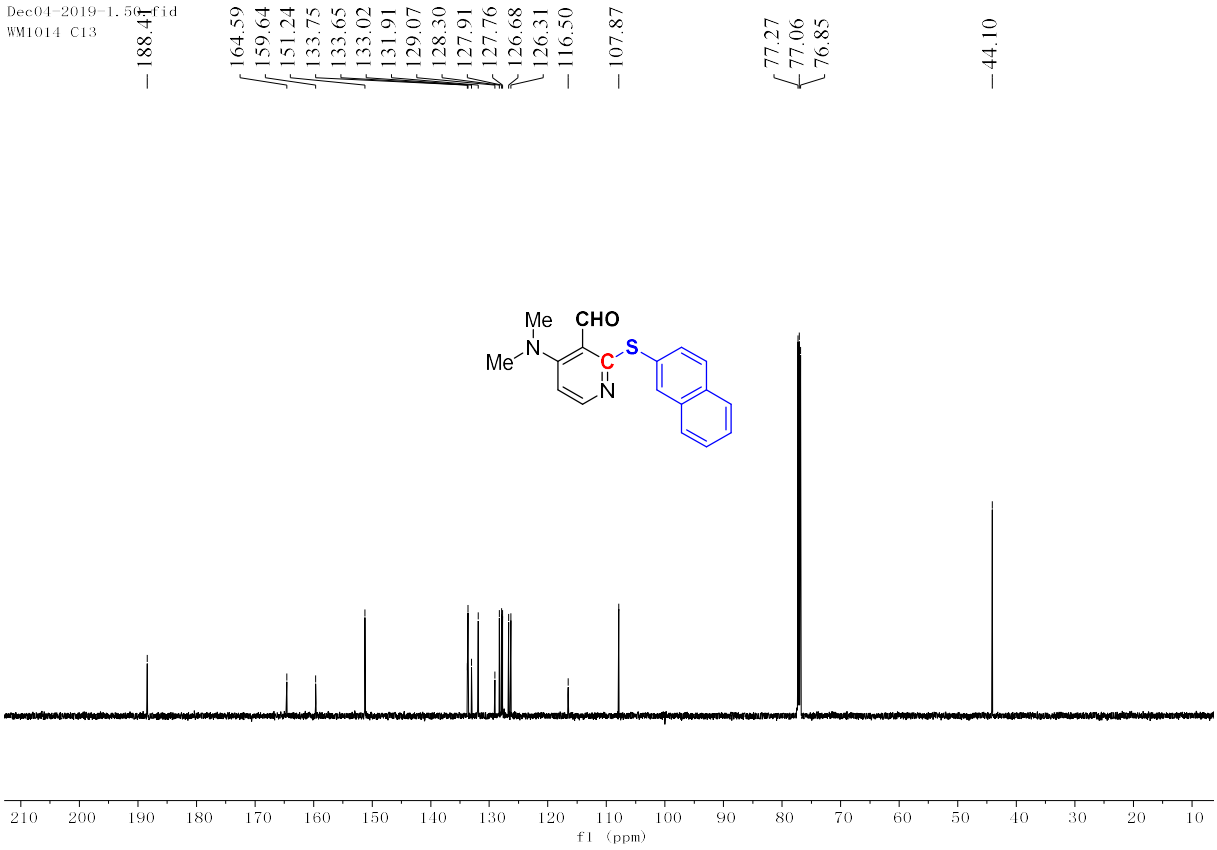
188.29
188.28
163.77
159.92
151.19
136.27
134.83
129.83
129.16
116.34
107.91
77.29
77.08
76.87
44.15



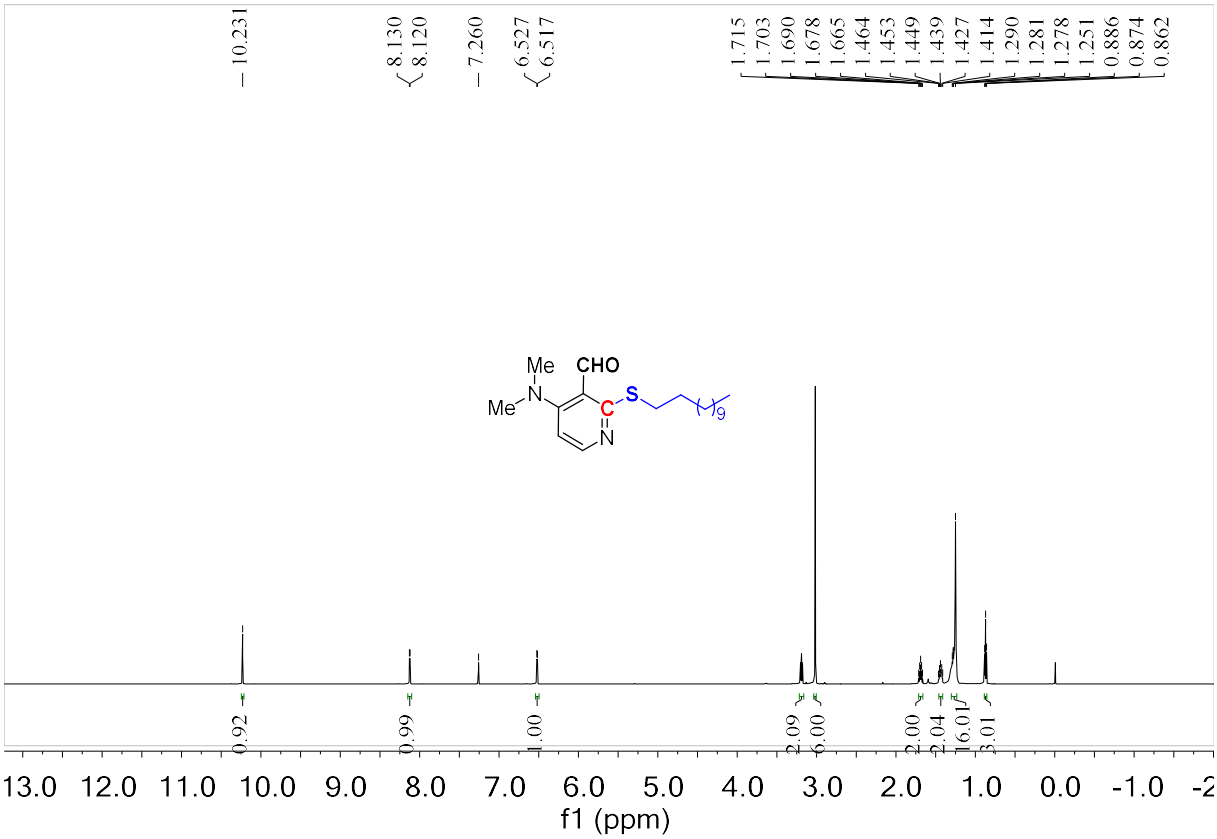
Compound 5d

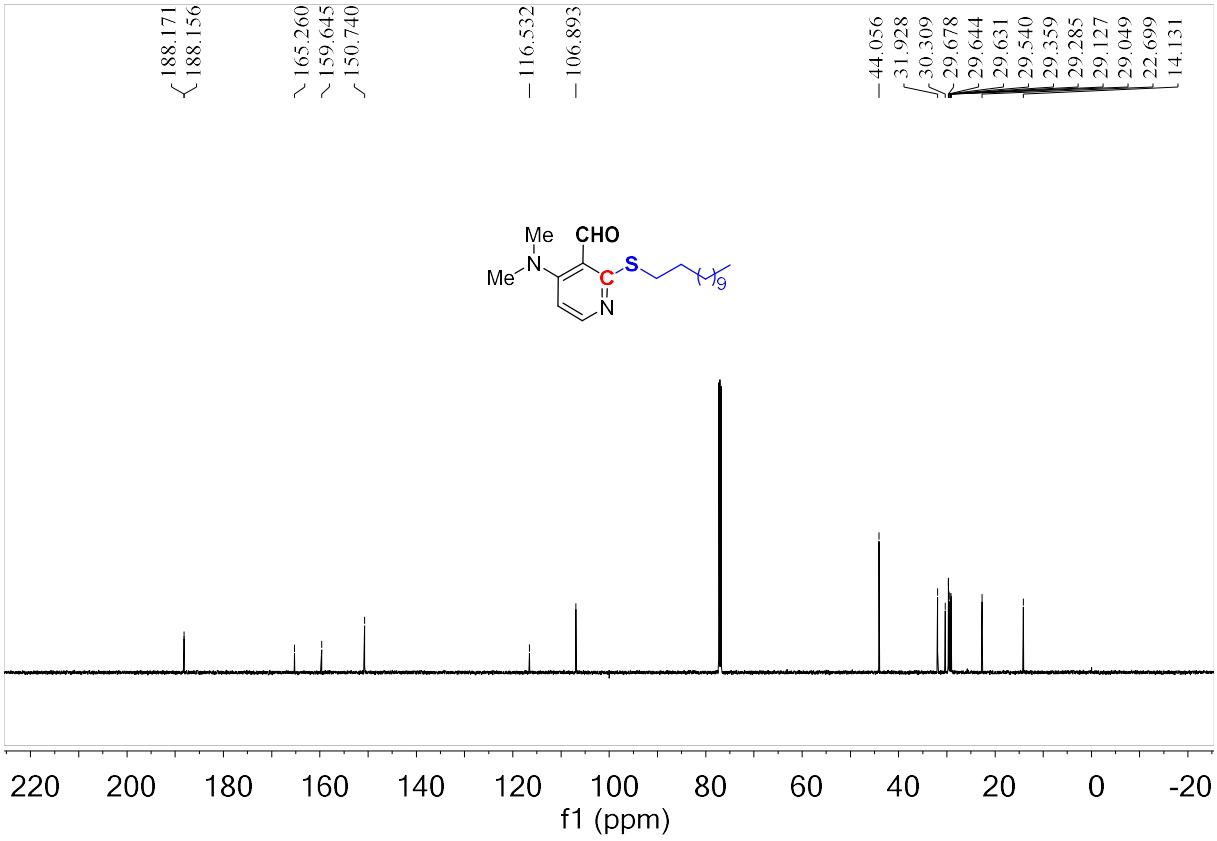

o297
STANDARD PROTON PARAMETERS
10330
7.99
7.99
7.94
7.93
7.78
7.77
7.76
7.76
7.75
7.75
7.74
7.73
7.47
7.47
7.45
7.45
7.43
7.43
7.42
7.41
7.41
6.49
6.48
2.98


Me
CHO
N
Me
C
S
N
0.80
0.90
0.94
3.03
1.05
1.96
1.00
6.01
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
f1 (ppm)

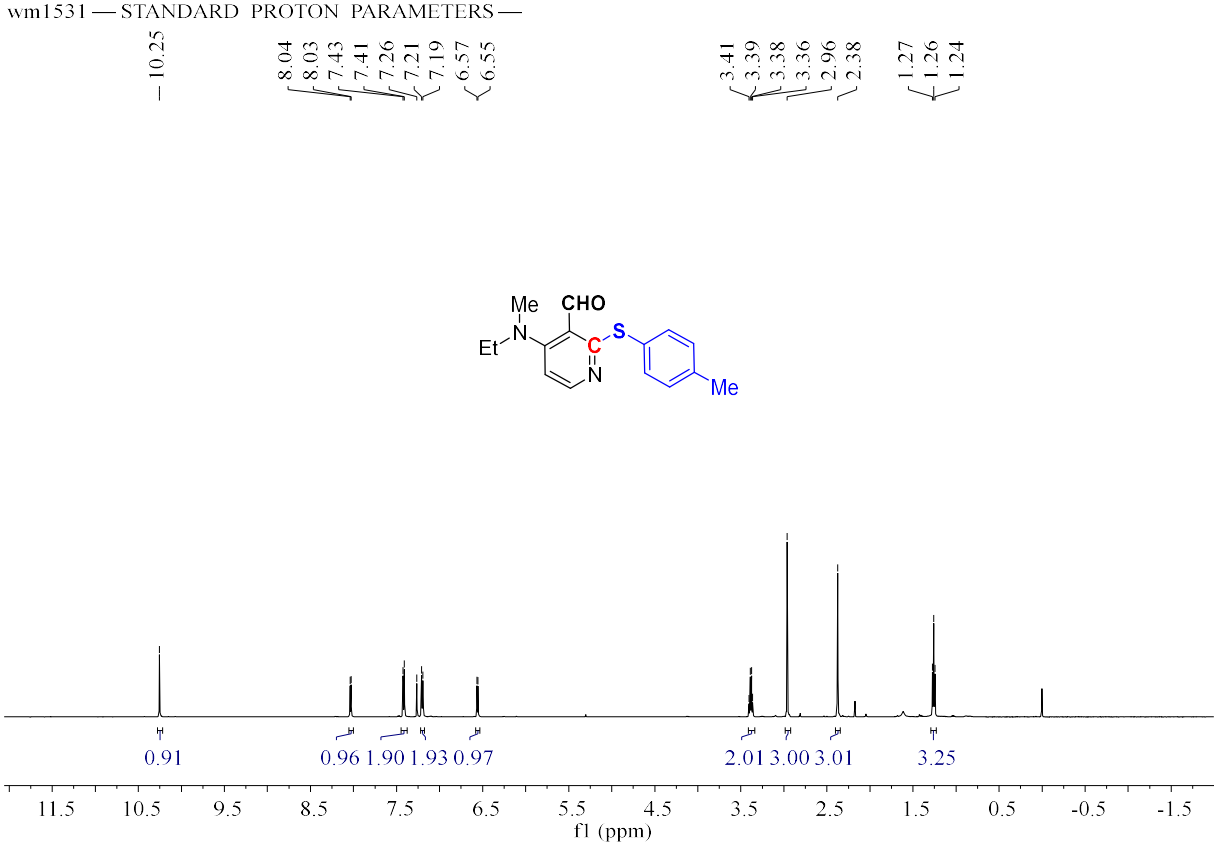

Dec04-2019-1.5.fid
WM1014 C13
188.41
164.59
159.64
151.24
133.75
133.65
133.02
131.91
129.07
128.30
127.91
127.76
126.68
126.31
116.50
107.87
77.27
77.06
76.85
44.10
Me
CHO
N
Me
C
S
N
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

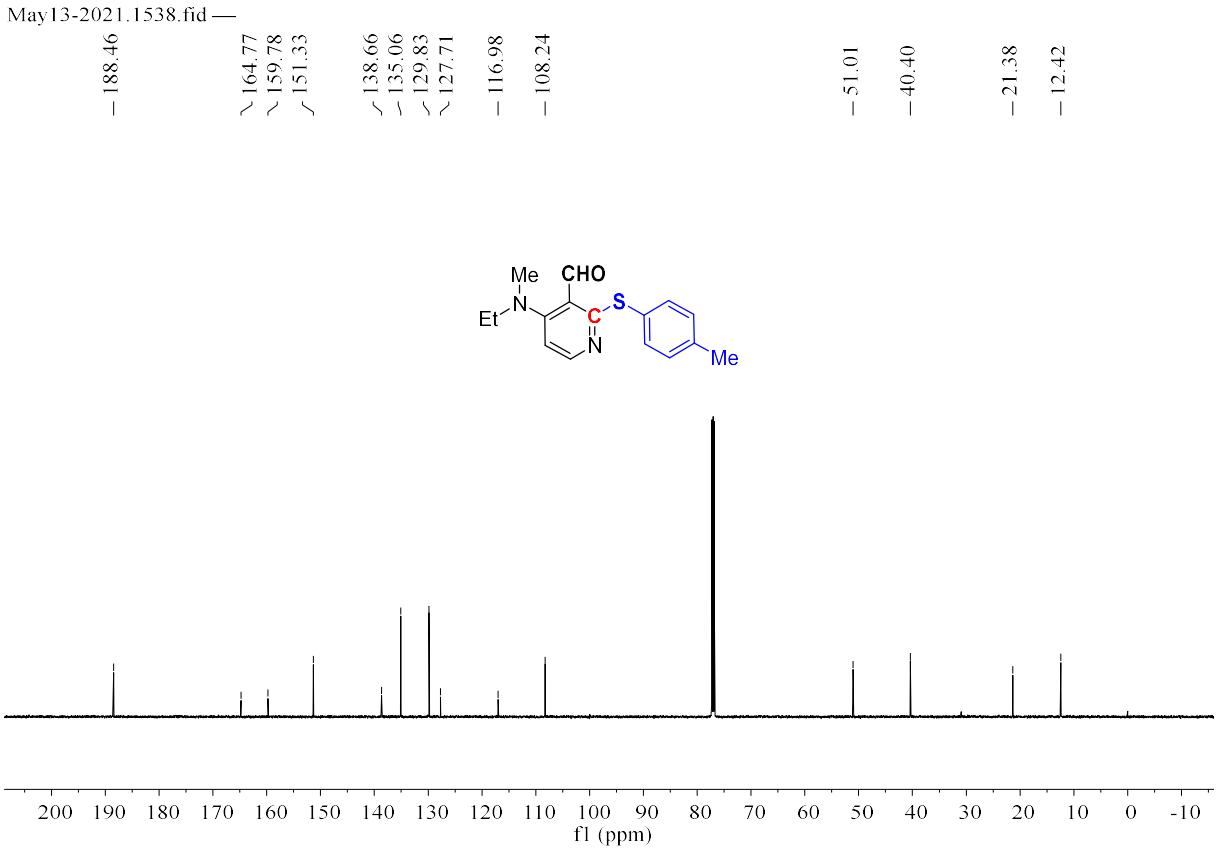
Compound 5e


10.231
8.130
8.120
7.260
6.527
6.517
1.715
1.703
1.690
1.678
1.665
1.464
1.453
1.449
1.439
1.427
1.414
1.290
1.281
1.278
1.251
0.886
0.874
0.862
Me
CHO
Me
N
S
C
N
g
0.92
0.99
1.00
2.09
6.00
2.00
2.04
16.01
3.01
13.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0 -2
f1 (ppm)

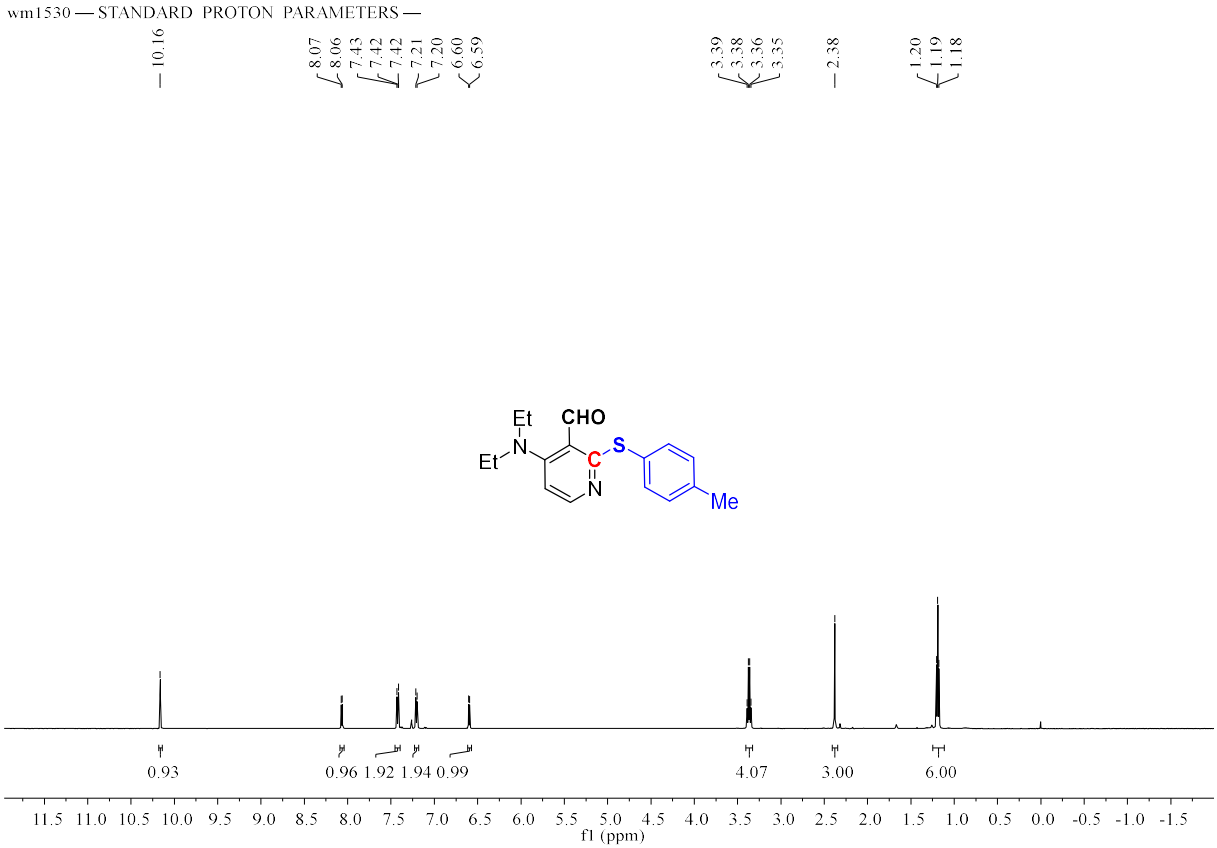

188.171
188.156
165.260
159.645
150.740
116.532
106.893
44.056
31.928
30.309
29.678
29.644
29.631
29.540
29.359
29.285
29.127
29.049
22.699
14.131
Me
CHO
Me
N
S
C
N
g
220 200 180 160 140 120 100 80 60 40 20 0 -20
f1 (ppm)

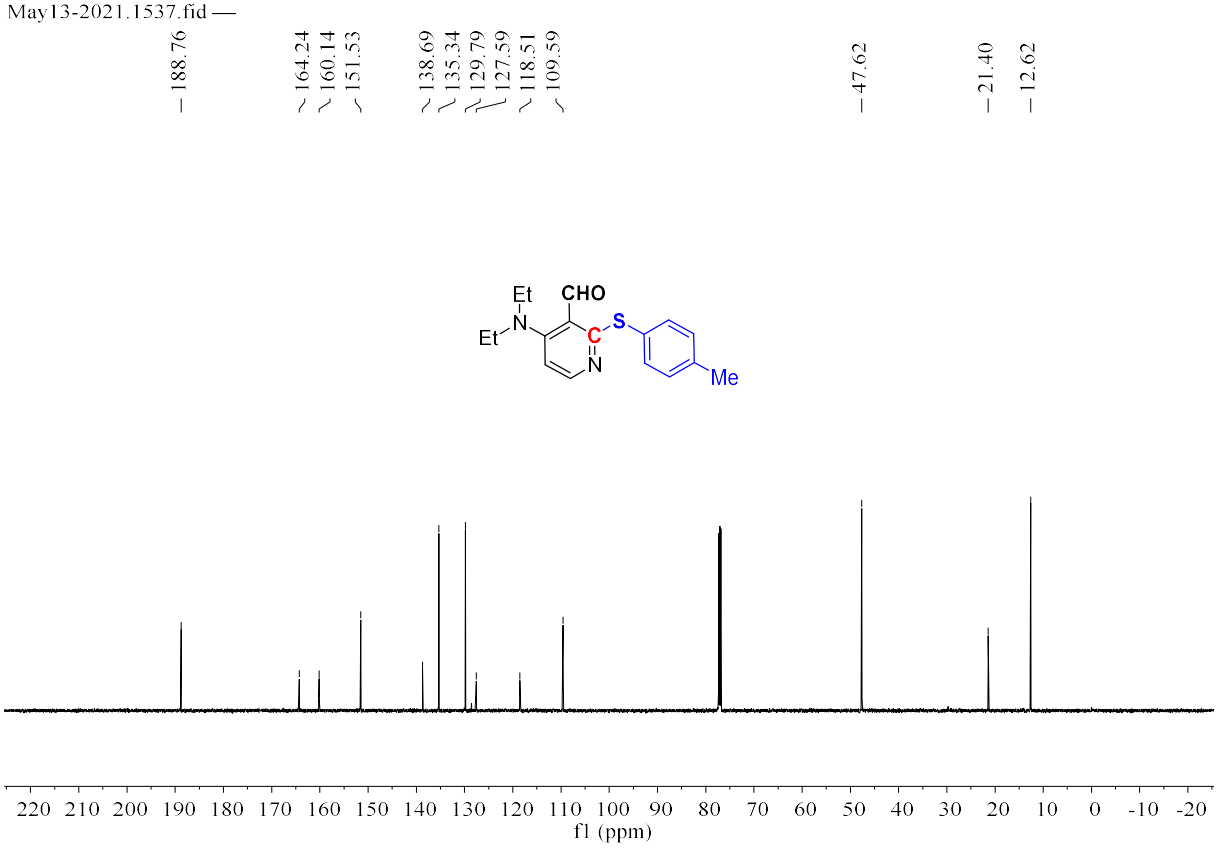
Compound 5f


wm1531 — STANDARD PROTON PARAMETERS —
10.25
8.04
8.03
7.43
7.41
7.26
7.21
7.19
6.57
6.55
3.41
3.39
3.38
3.36
2.96
2.38
1.27
1.26
1.24
Me
CHO
Et
N
C
S
N
Me
0.91
0.96
1.90
1.93
0.97
2.01
3.00
3.01
3.25
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
f1 (ppm)

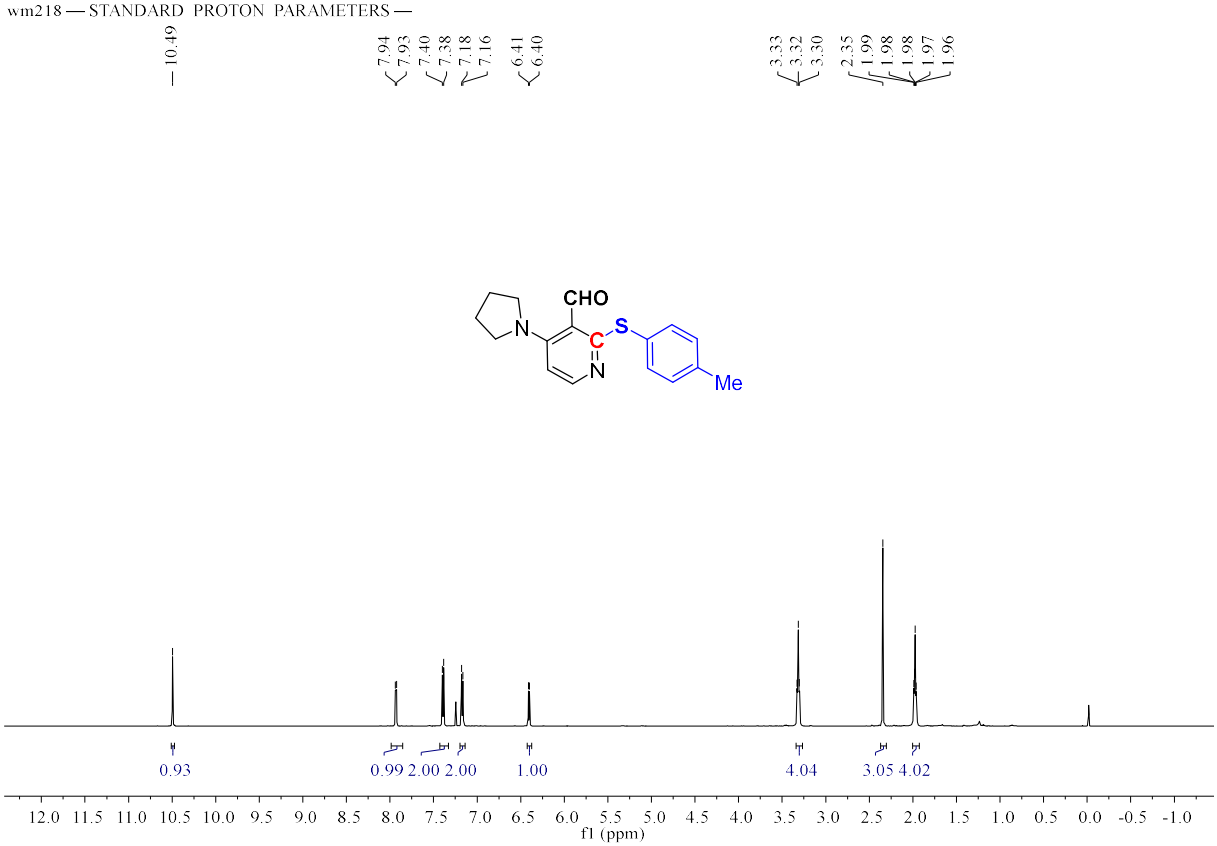

May13-2021.1538.fid —
188.46
164.77
159.78
151.33
138.66
135.06
129.83
127.71
116.98
108.24
51.01
40.40
21.38
12.42
Me
CHO
Et
N
C
S
N
Me
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

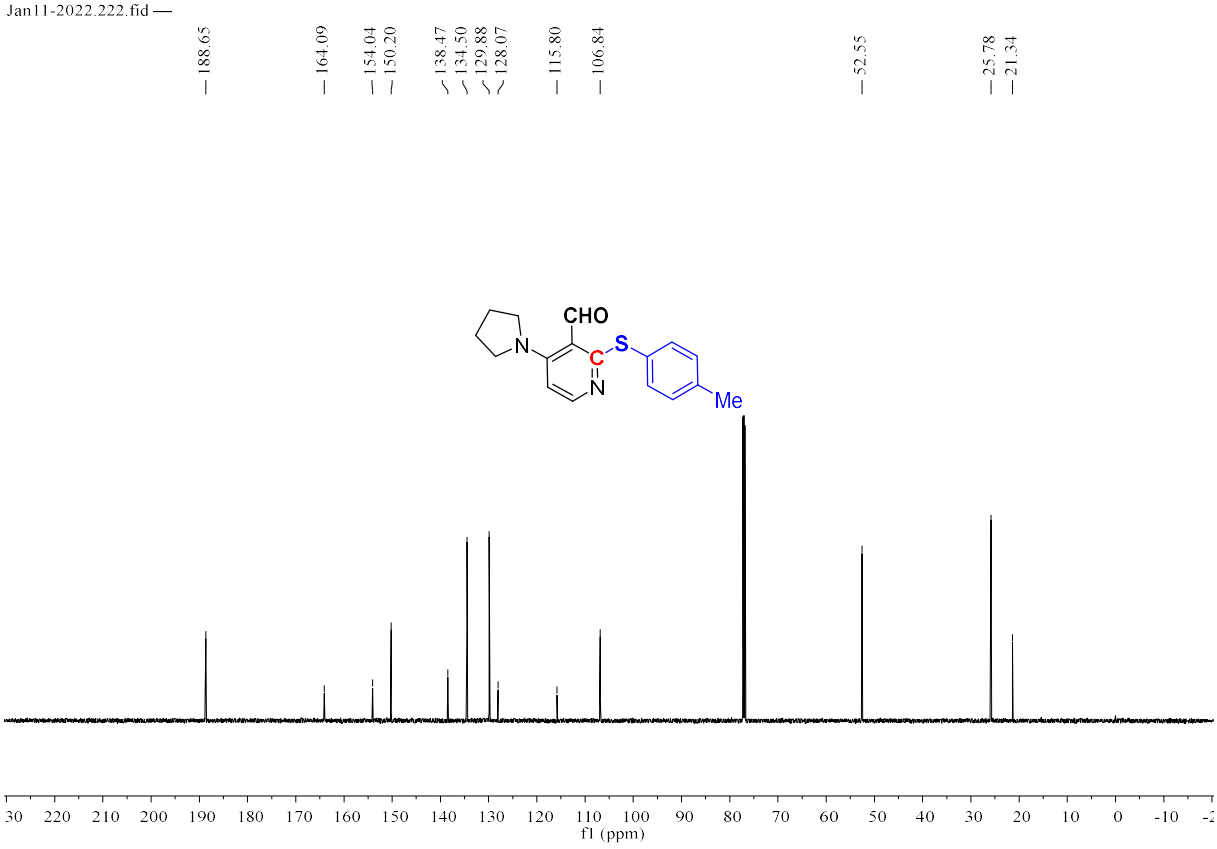
Compound 5g


wm1530 — STANDARD PROTON PARAMETERS —
10.16
8.07
8.06
7.43
7.42
7.42
7.21
7.20
6.60
6.59
3.39
3.38
3.36
3.35
2.38
1.20
1.19
1.18
Et
CHO
N
Et
C
S
N
Me
0.93
0.96
1.92
1.94
0.99
4.07
3.00
6.00
11.5 11.0 10.5 10.0 9.5 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 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)


May13-2021.1537.fid —
188.76
164.24
160.14
151.53
138.69
135.34
129.79
127.59
118.51
109.59
47.62
21.40
12.62
Et
CHO
N
Et
C
S
N
Me
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

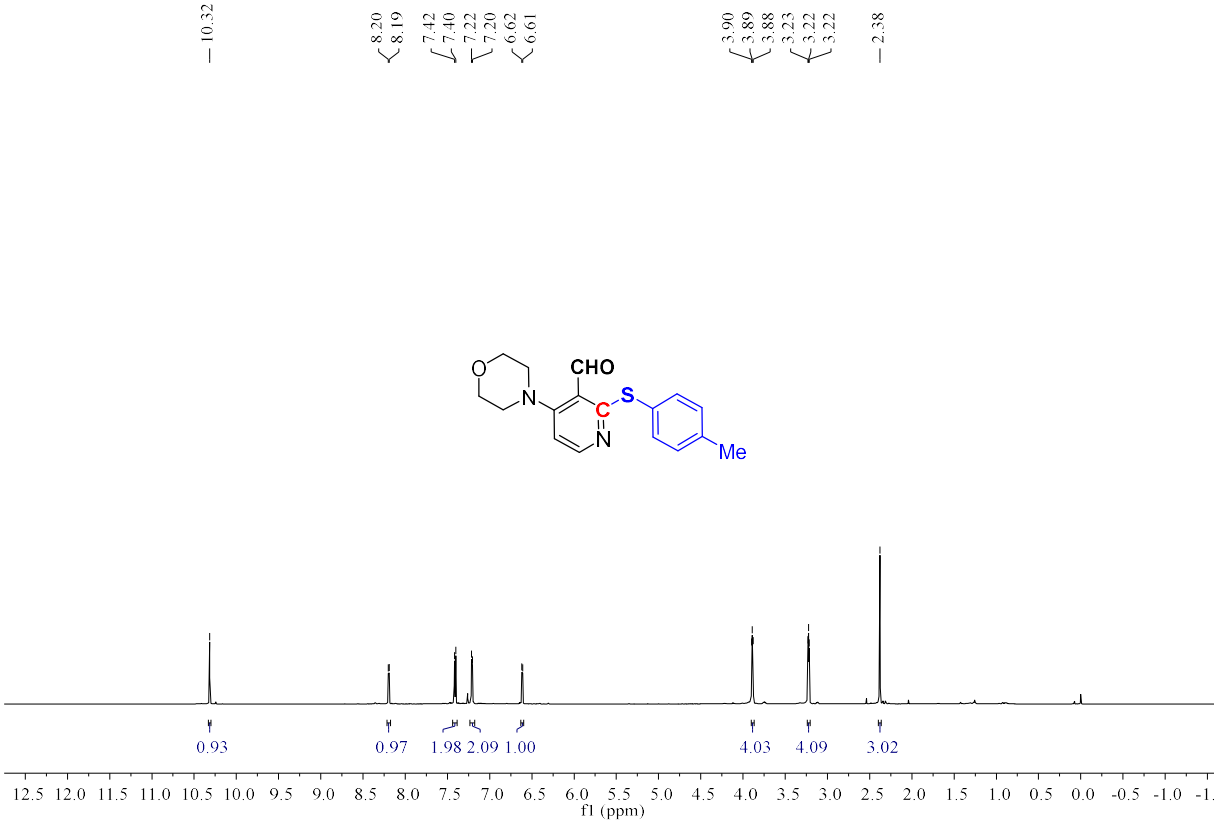
Compound 5h


wm218 — STANDARD PROTON PARAMETERS —
10.49
7.94
7.93
7.40
7.38
7.18
7.16
6.41
6.40
3.33
3.32
3.30
2.35
1.99
1.98
1.98
1.97
1.96
CHO
N
C
S
N
Me
0.93
0.99
2.00
2.00
1.00
4.04
3.05
4.02
f1 (ppm)

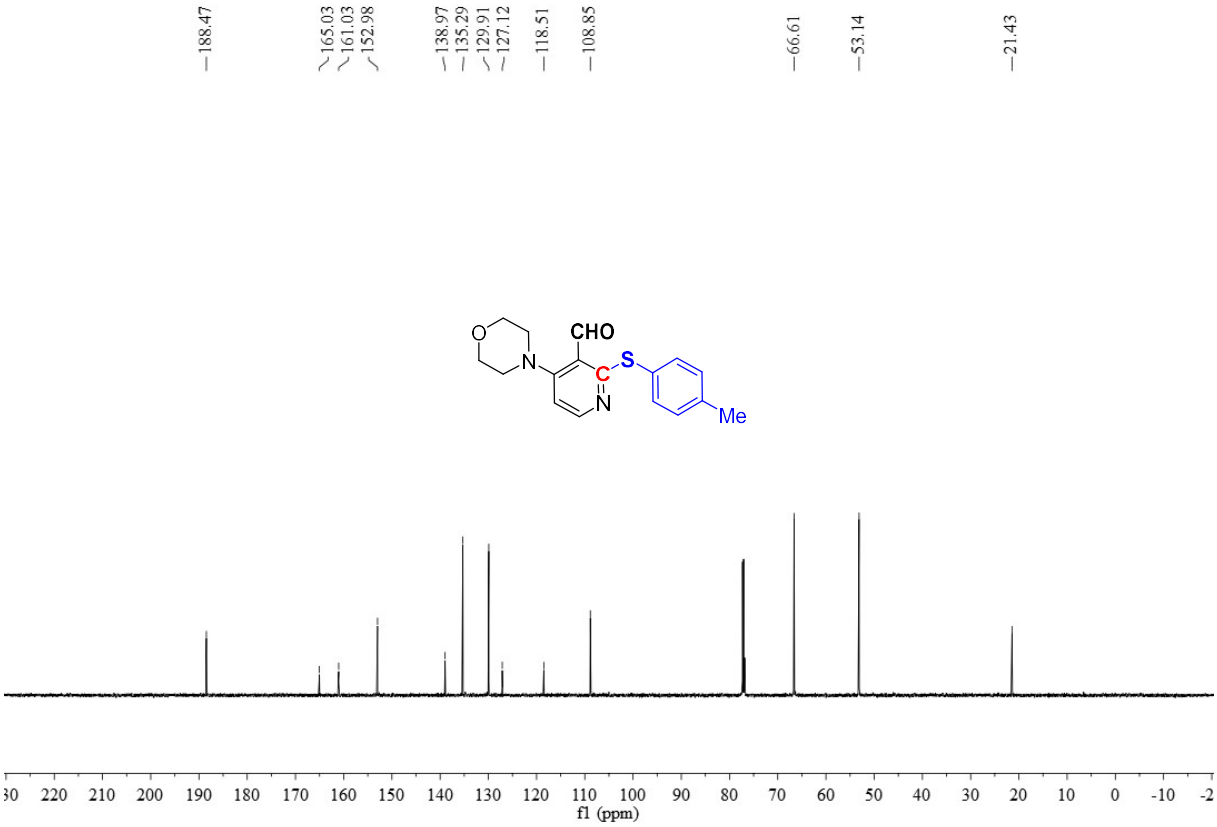

Jan11-2022.222.fid —
188.65
164.09
154.04
150.20
138.47
134.50
129.88
128.07
115.80
106.84
52.55
25.78
21.34
CHO
N
C
S
N
Me
f1 (ppm)

Compound 5i

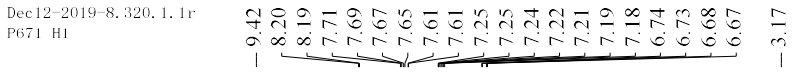
Jan12-2022.285.fid —

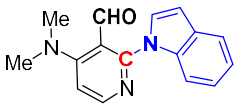


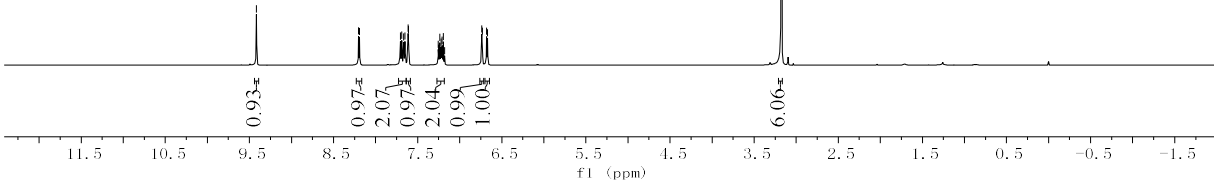
Jan12-2022.287.fid —



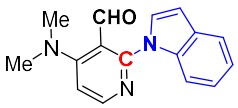
Compound 7a

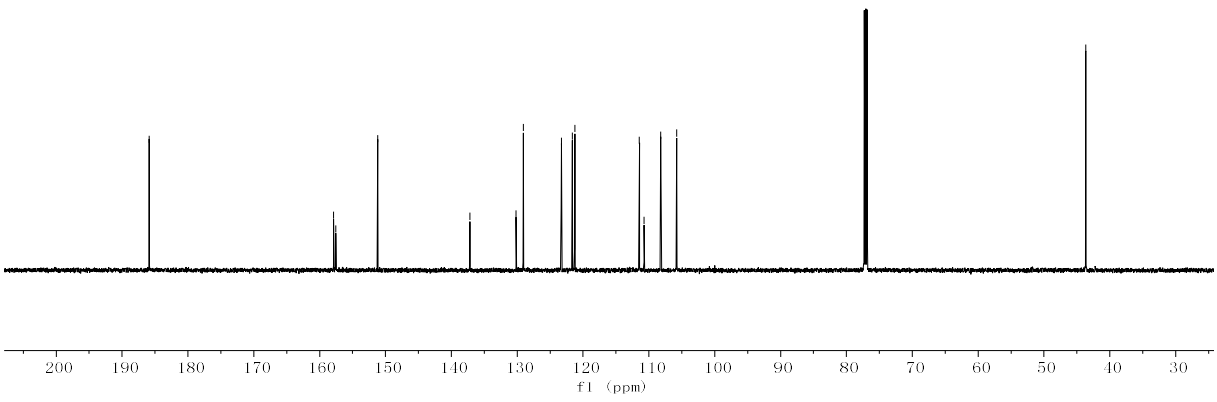

Dec12-2019-8.320.1.1r
P671 H1
9.42
8.20
8.19
7.71
7.69
7.67
7.65
7.61
7.61
7.25
7.25
7.24
7.22
7.21
7.19
7.18
6.74
6.73
6.68
6.67
3.17


Me
CHO
Me
N
C
N
N

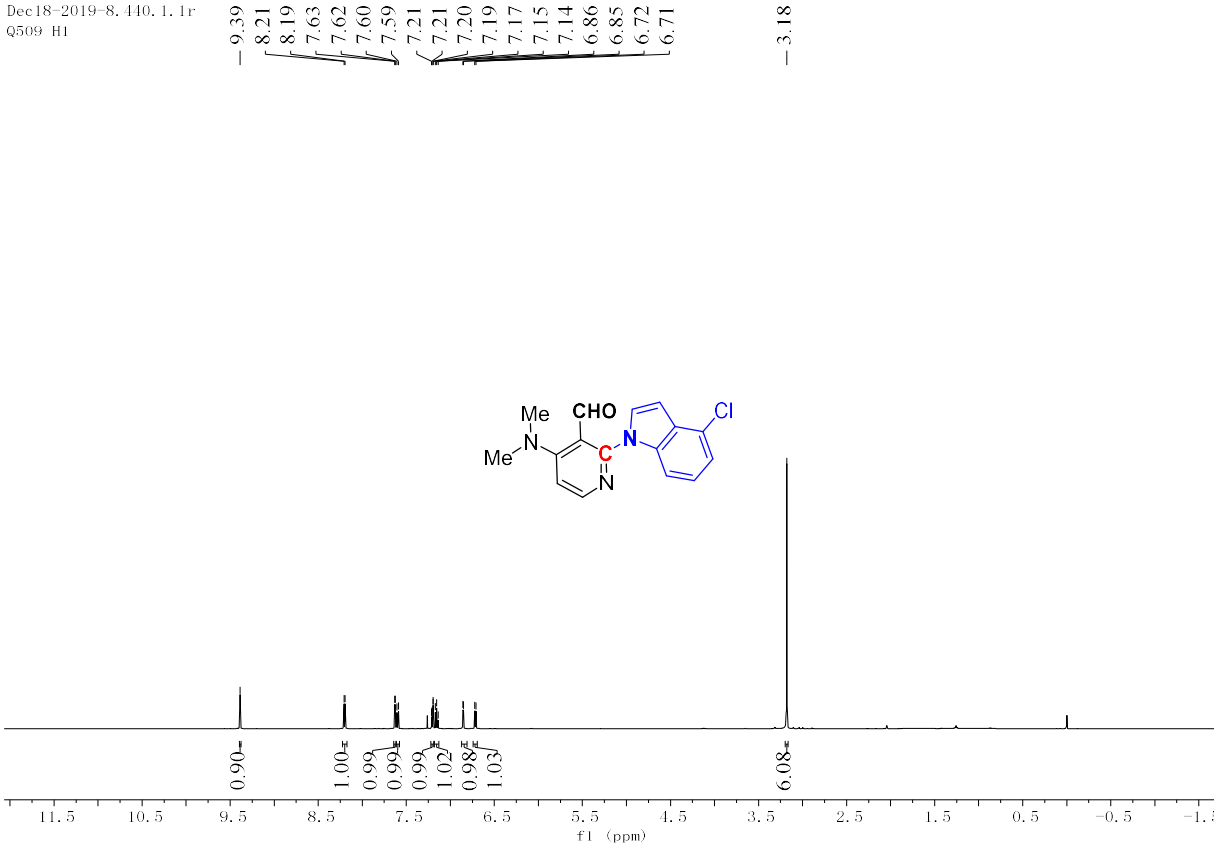

0.93
0.97
2.07
0.97
2.04
0.99
1.00
6.06
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
f1 (ppm)

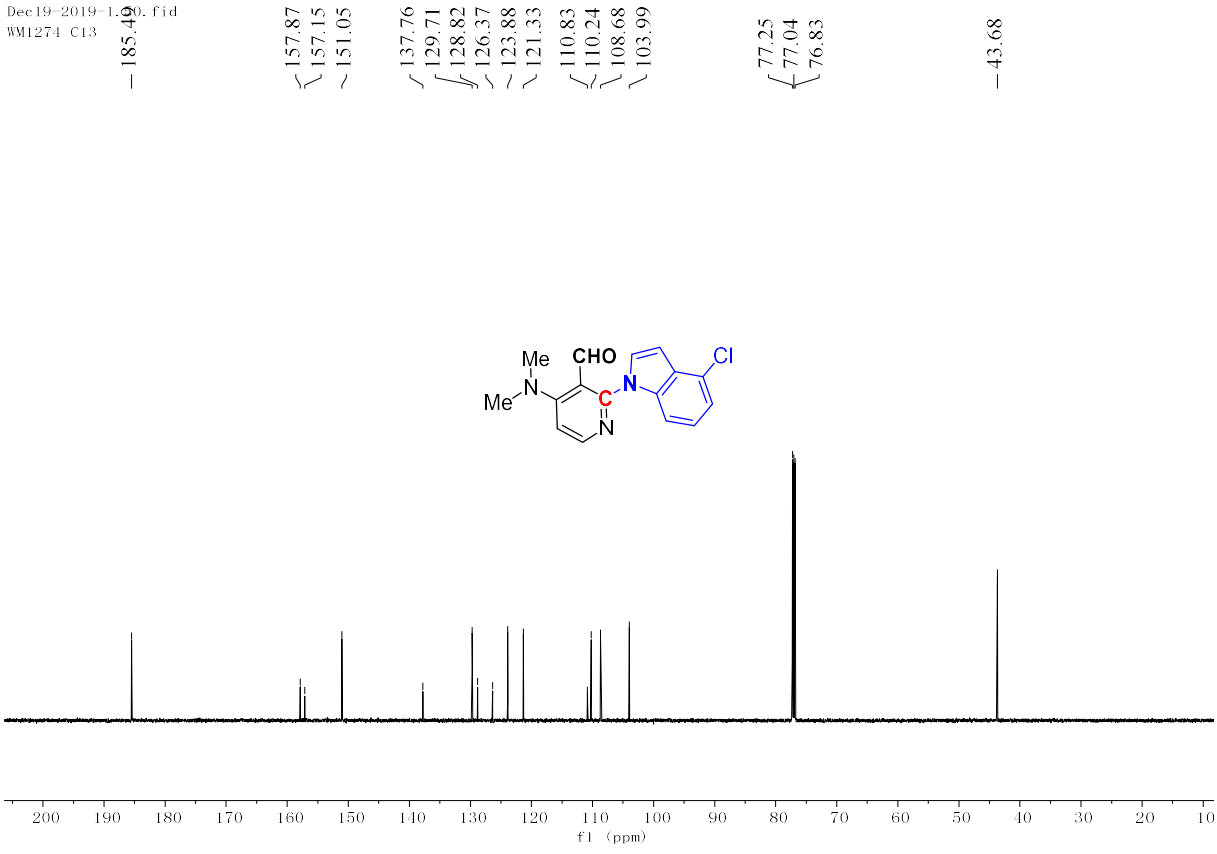

Dec12-2019-2.240.1.fid
WM1203 C13
185.88
157.87
157.54
151.18
137.19
130.16
129.08
123.30
121.61
121.26
111.44
110.72
108.23
105.77
43.64


Me
CHO
Me
N
C
N
N

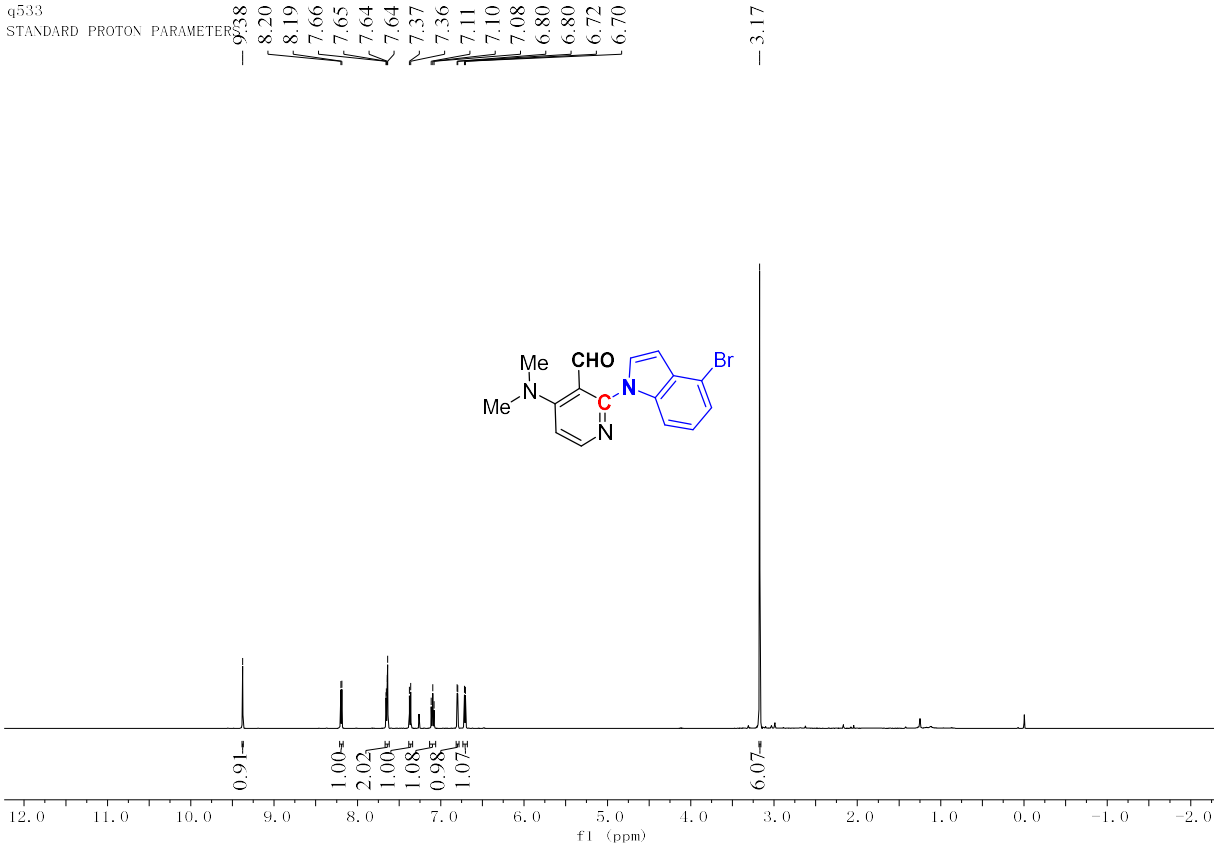

200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
f1 (ppm)

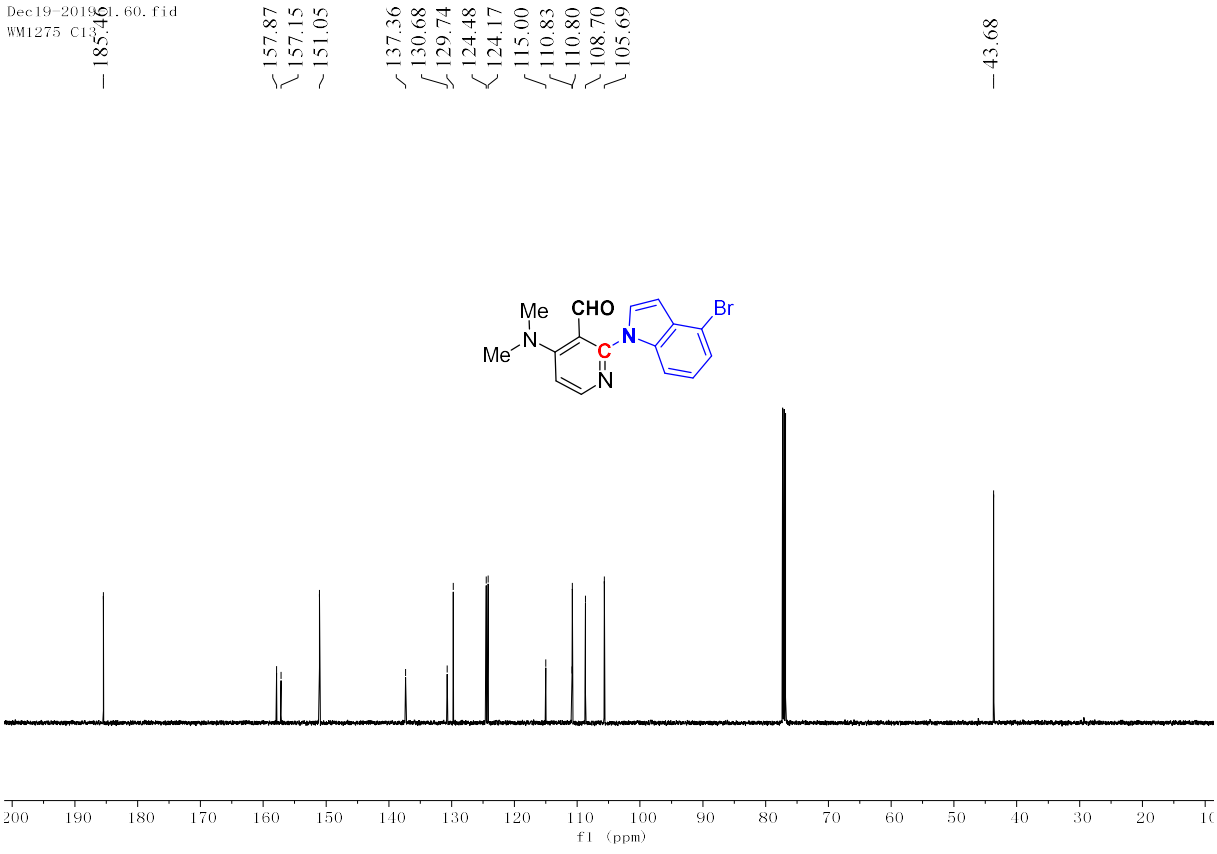
Compound 7b


Dec18-2019-8.440.1.1r
Q509 H1
9.39
8.21
8.19
7.63
7.62
7.60
7.59
7.21
7.21
7.20
7.19
7.17
7.15
7.14
6.86
6.85
6.72
6.71
3.18
Me
CHO
Cl
N
Me
C
N
0.90
1.00
0.99
0.99
0.99
1.02
0.98
1.03
6.08
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

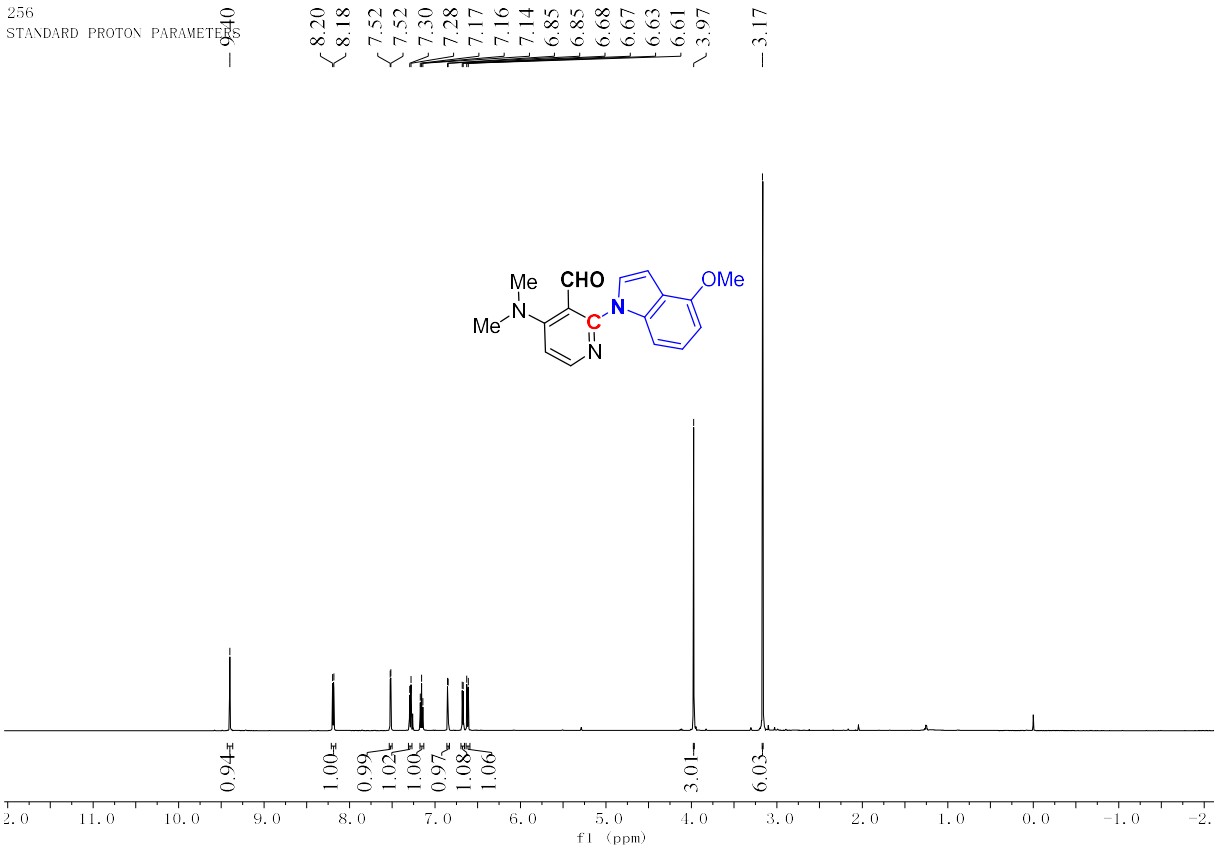

Dec19-2019-1.90.fid
WM1274 C13
185.49
157.87
157.15
151.05
137.76
129.71
128.82
126.37
123.88
121.33
110.83
110.24
108.68
103.99
77.25
77.04
76.83
43.68
Me
CHO
Cl
N
Me
C
N
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

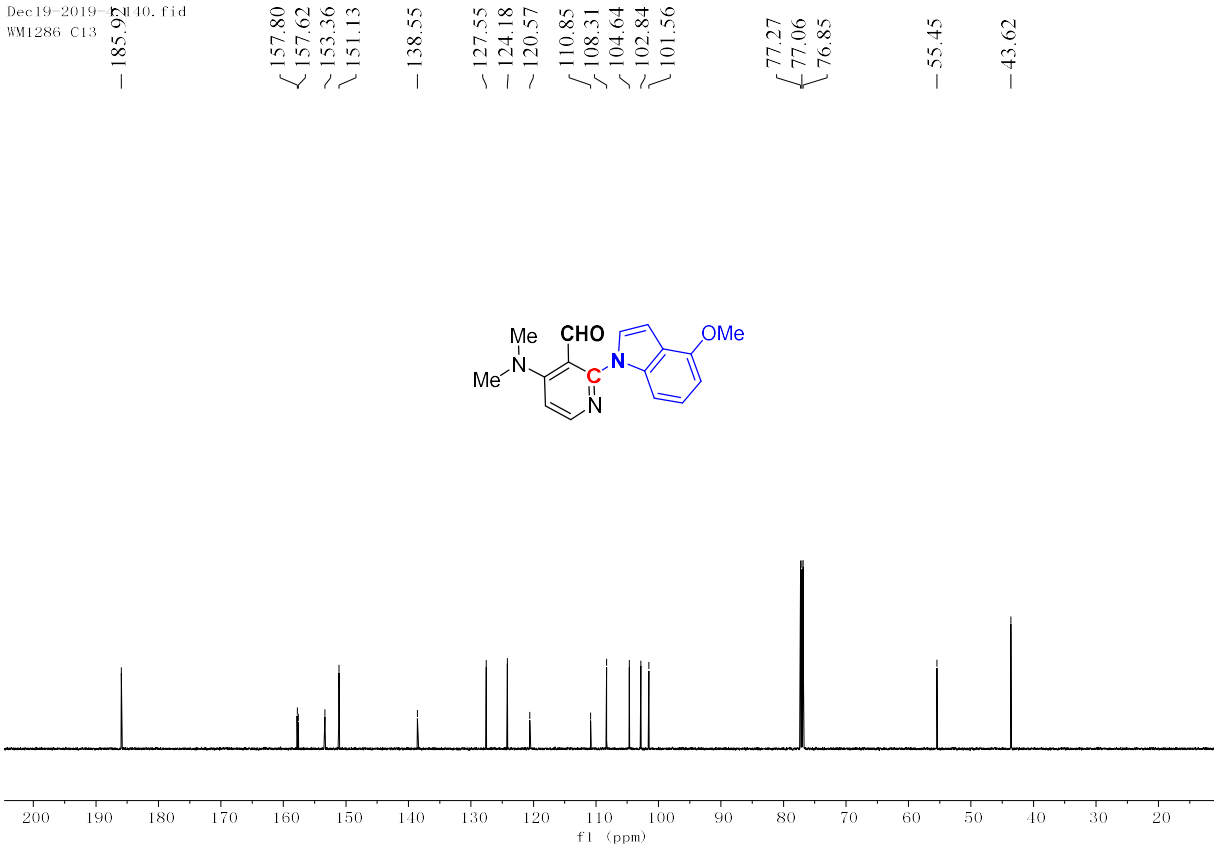
Compound 7c


q533
STANDARD PROTON PARAMETERS
9.38
8.20
8.19
7.66
7.65
7.64
7.64
7.37
7.36
7.11
7.10
7.08
6.80
6.80
6.72
6.70
3.17
Me
CHO
Br
N
Me
C
N
0.91
1.00
2.02
1.00
1.08
0.98
1.07
6.07
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
f1 (ppm)

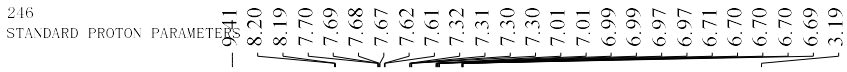

Dec19-2019-1.60.fid
WM1275 C13
185.46
157.87
157.15
151.05
137.36
130.68
129.74
124.48
124.17
115.00
110.83
110.80
108.70
105.69
43.68
Me
CHO
Br
N
Me
C
N
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

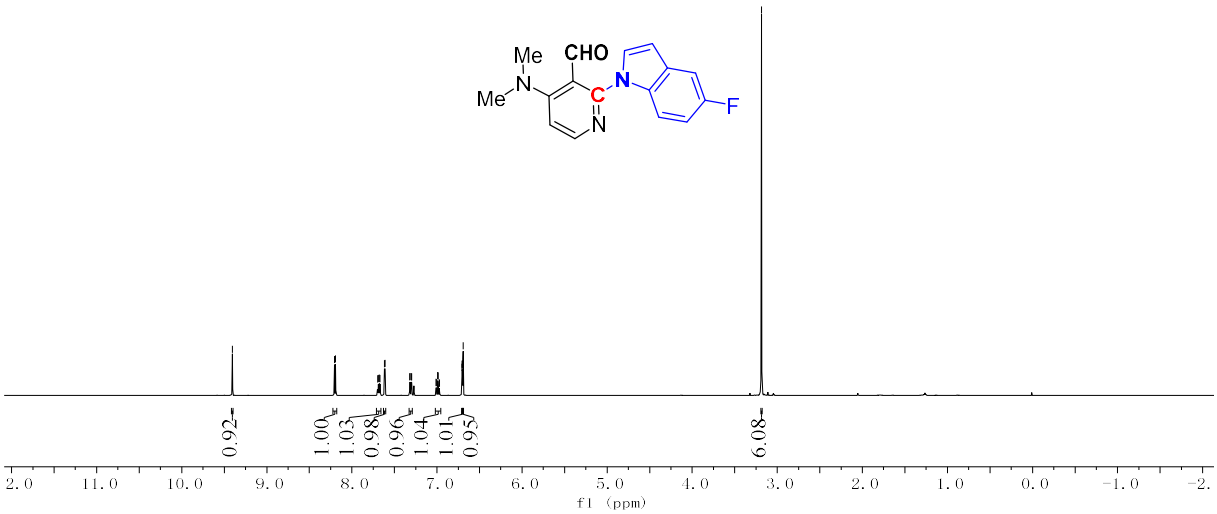
Compound 7d

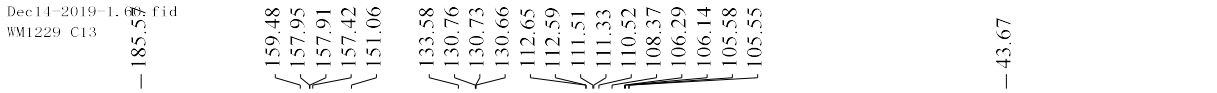

256
STANDARD PROTON PARAMETERS
9.40
8.20
8.18
7.52
7.52
7.30
7.28
7.17
7.16
7.14
6.85
6.85
6.68
6.67
6.63
6.61
3.97
3.17
Me
CHO
OMe
N
Me
C
N
0.94
1.00
0.99
1.02
1.00
0.97
1.08
1.06
3.01
6.03
2.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.
f1 (ppm)

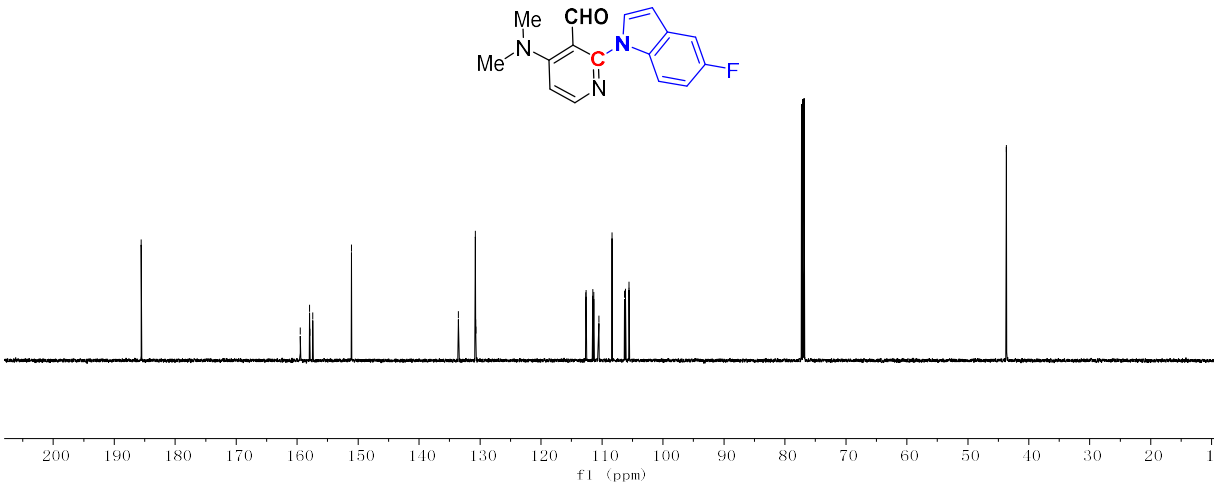

Dec19-2019-WM40.fid
WM1286 C13
185.92
157.80
157.62
153.36
151.13
138.55
127.55
124.18
120.57
110.85
108.31
104.64
102.84
101.56
77.27
77.06
76.85
55.45
43.62
Me
CHO
OMe
N
Me
C
N
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

Compound 7e


246
STANDARD PROTON PARAMETERS
9.41
8.20
8.19
7.70
7.69
7.68
7.67
7.62
7.61
7.32
7.31
7.30
7.30
7.01
7.01
6.99
6.99
6.97
6.97
6.71
6.70
6.70
6.70
6.69
3.19

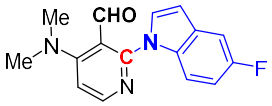

Me
CHO
Me
N
C
N
N
F
0.92
1.00
1.03
0.98
0.96
1.04
1.01
0.95
6.08
f1 (ppm)

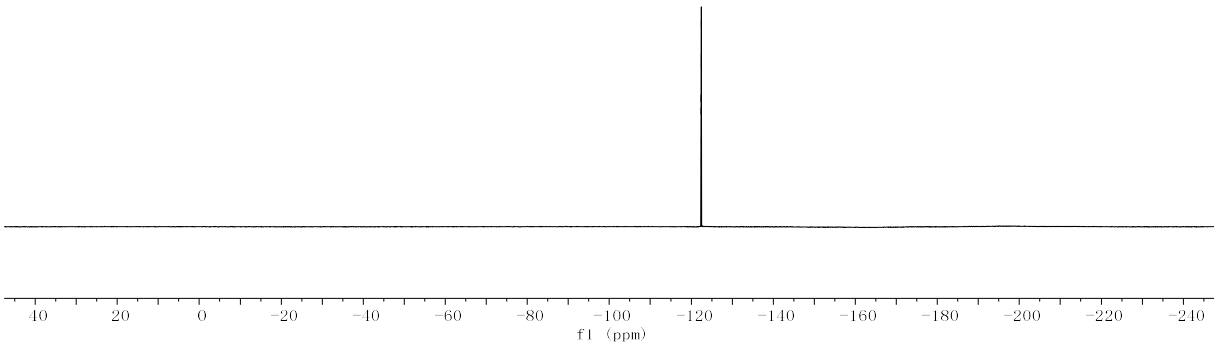

Dec14-2019-1.60.fid
WM1229 C13
185.57
159.48
157.95
157.91
157.42
151.06
133.58
130.76
130.73
130.66
112.65
112.59
111.51
111.33
110.52
108.37
106.29
106.14
105.58
105.55
43.67


Me
CHO
Me
N
C
N
N
F
f1 (ppm)

Dec14-2019-8.60.1.1r
WM1347 F19

-122.40
-122.41
-122.42
-122.42
-122.43
-122.44
-122.45

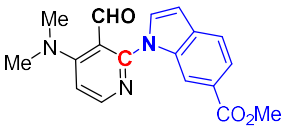


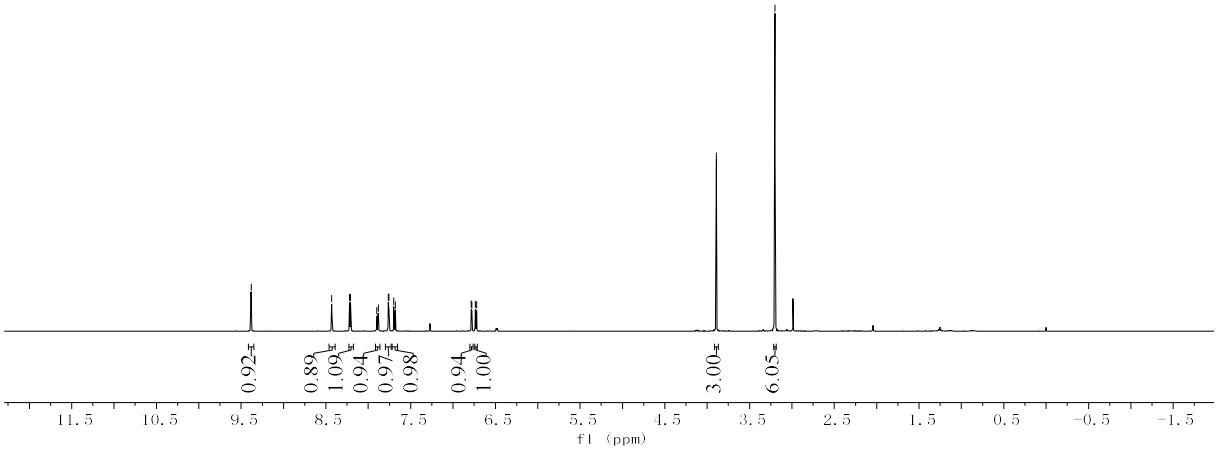


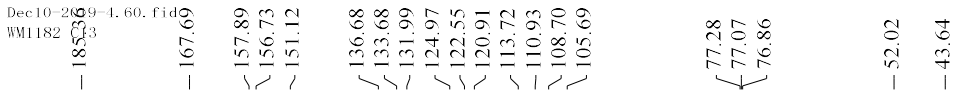
Compound 7f

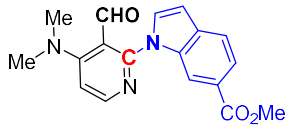
p373
STANDARD PROTON PARAMETERS

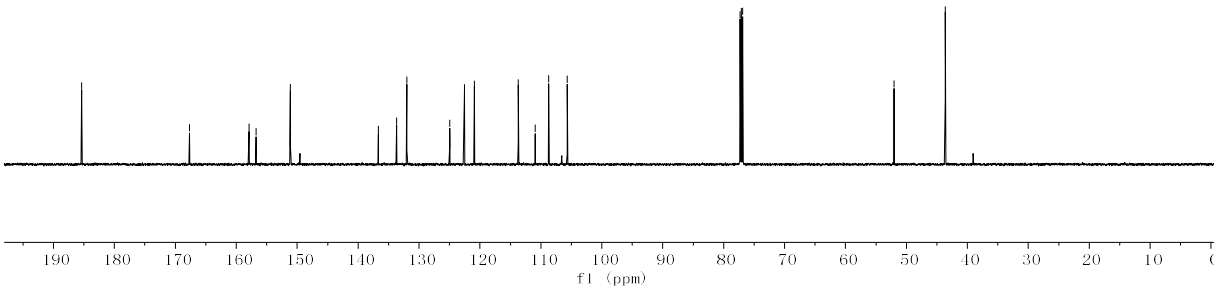
9.38
8.43
8.22
8.21
7.90
7.88
7.76
7.76
7.70
7.68
6.78
6.78
6.73
6.72
3.89
3.20



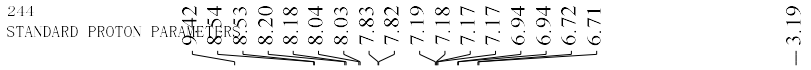


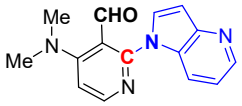

Dec10-2009-4.60.fid
WM1182 13
185.23
167.69
157.89
156.73
151.12
136.68
133.68
131.99
124.97
122.55
120.91
113.72
110.93
108.70
105.69
77.28
77.07
76.86
52.02
43.64

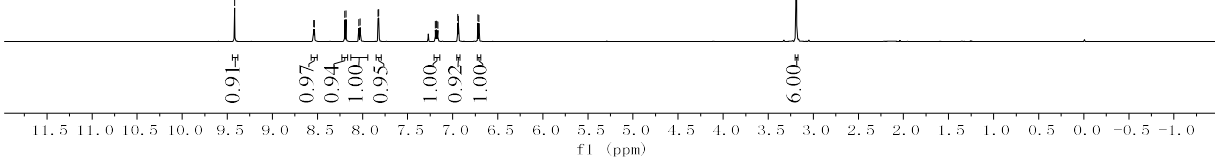

Me
CHO
N
Me
C
N
N
CO2Me

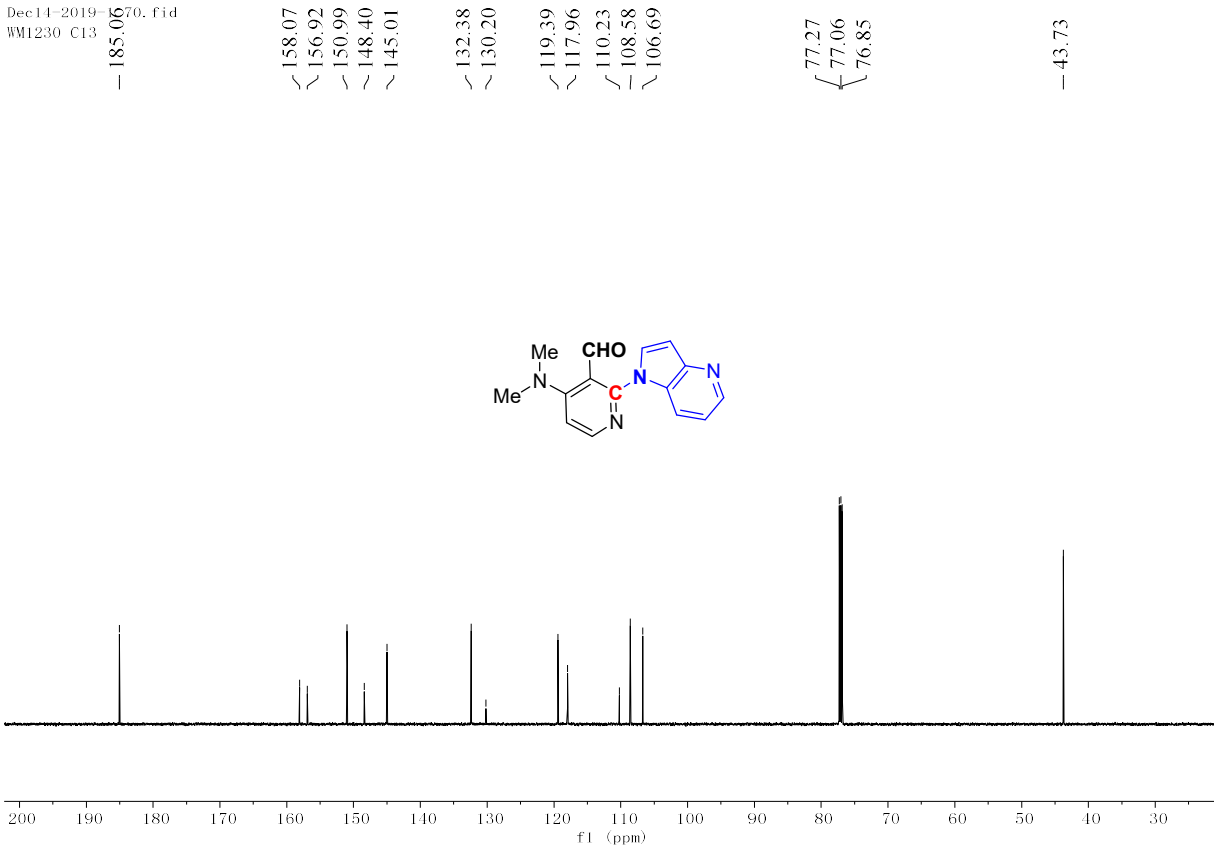

190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

Compound 7g

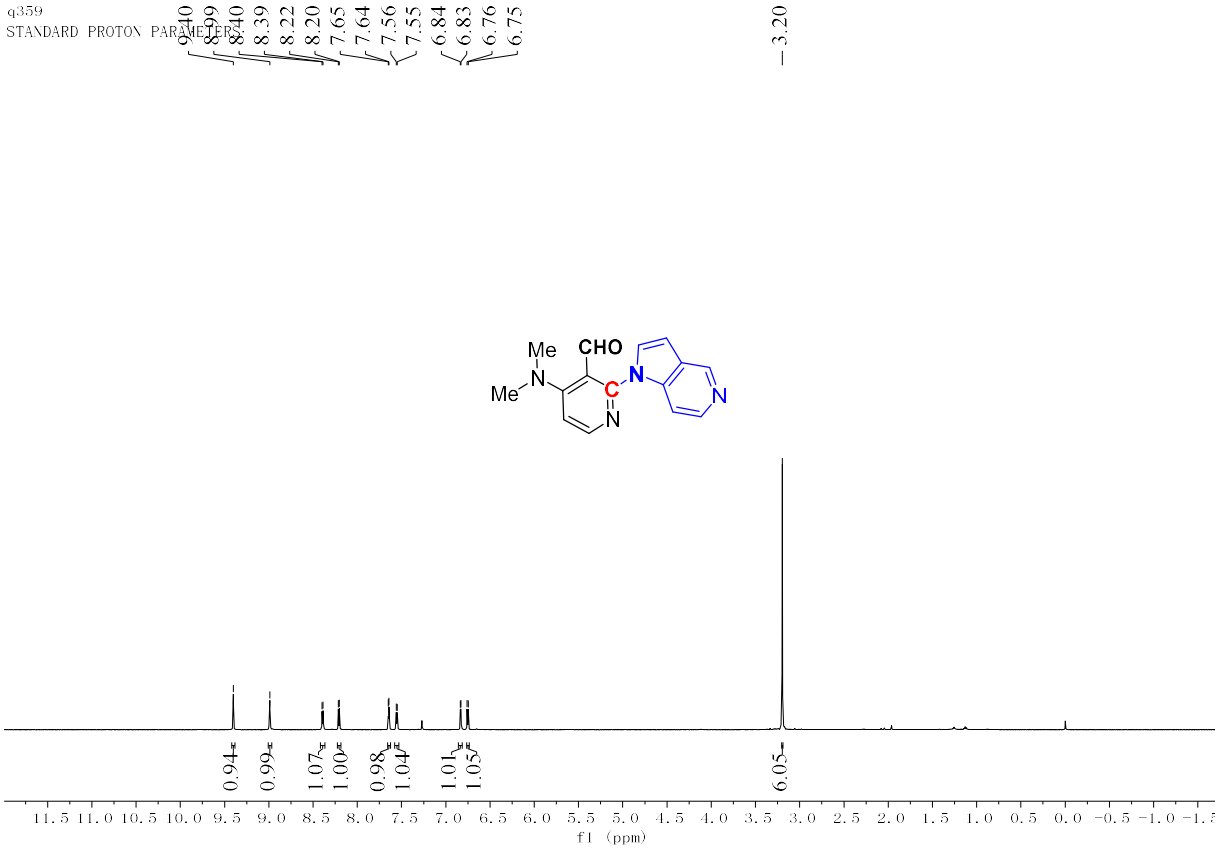

244
STANDARD PROTON PARAMETER
9.42
8.54
8.53
8.20
8.18
8.04
8.03
7.83
7.82
7.19
7.18
7.17
7.17
6.94
6.94
6.72
6.71
3.19

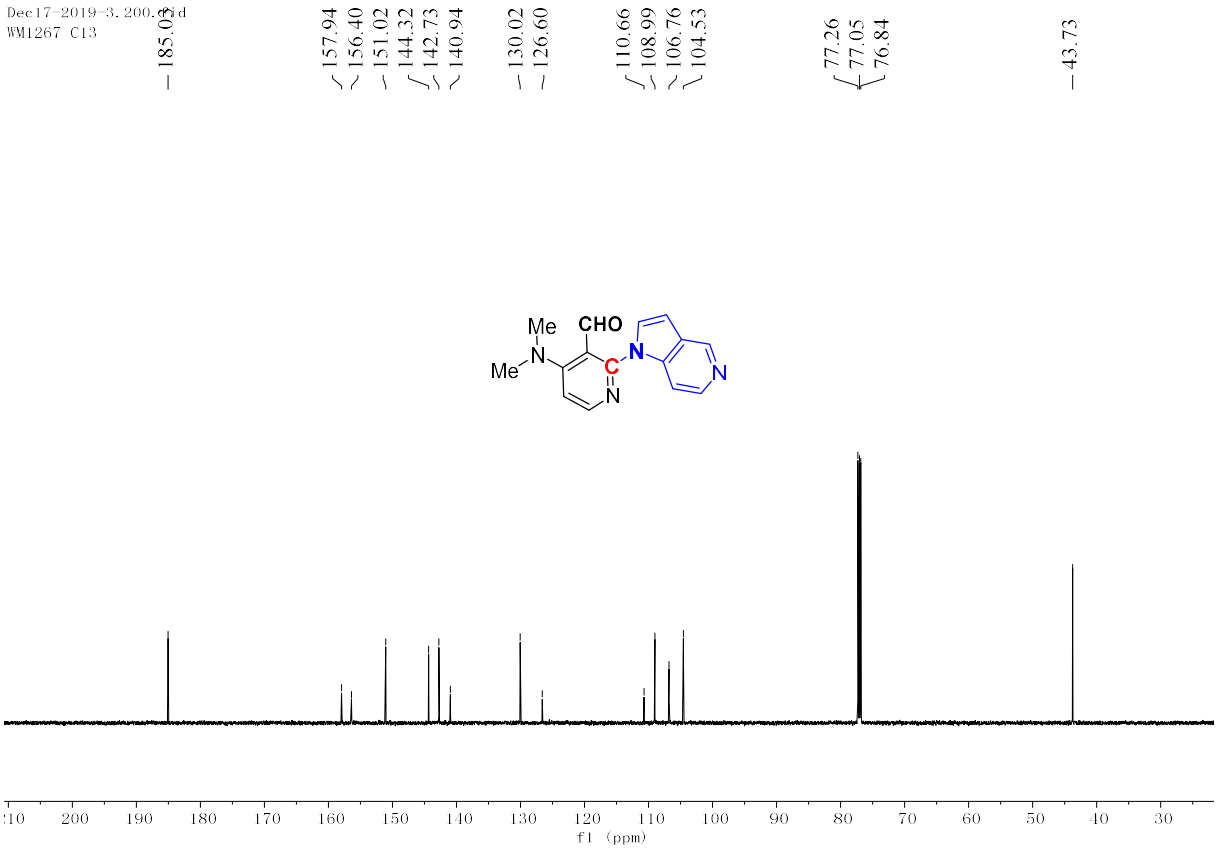

Me
CHO
N
Me
C
N
N
N


0.91
0.97
0.94
1.00
0.95
1.00
0.92
1.00
6.00
11.5 11.0 10.5 10.0 9.5 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 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

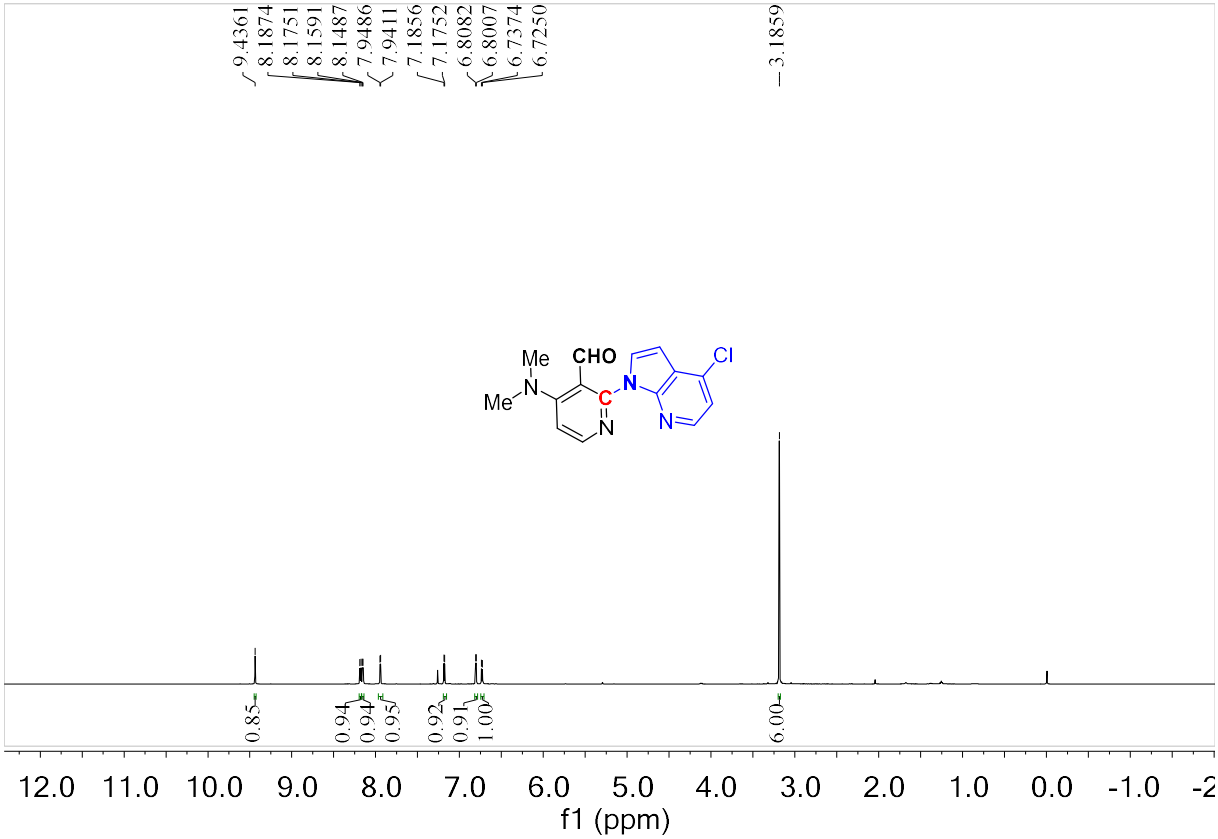

Dec14-2019-1670.fid
WM1230 C13
185.06
158.07
156.92
150.99
148.40
145.01
132.38
130.20
119.39
117.96
110.23
108.58
106.69
77.27
77.06
76.85
43.73
Me
CHO
N
Me
N
C
N
N
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30
f1 (ppm)

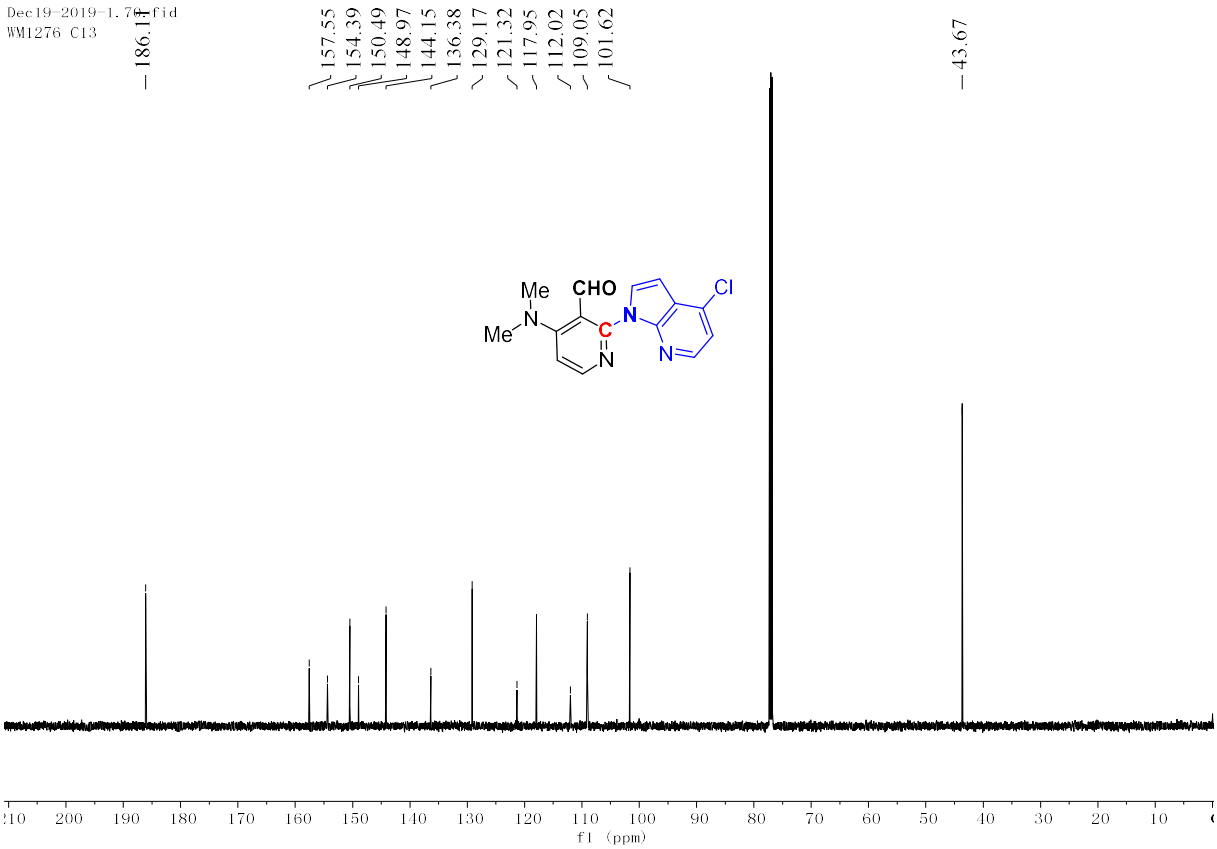
Compound 7h


q359
STANDARD PROTON PARAMETER
9.40
8.99
8.40
8.39
8.22
8.20
7.65
7.64
7.56
7.55
6.84
6.83
6.76
6.75
3.20
Me
CHO
N
Me
N
C
N
N
0.94
0.99
1.07
1.00
0.98
1.04
1.01
1.05
6.05
11.5 11.0 10.5 10.0 9.5 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 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

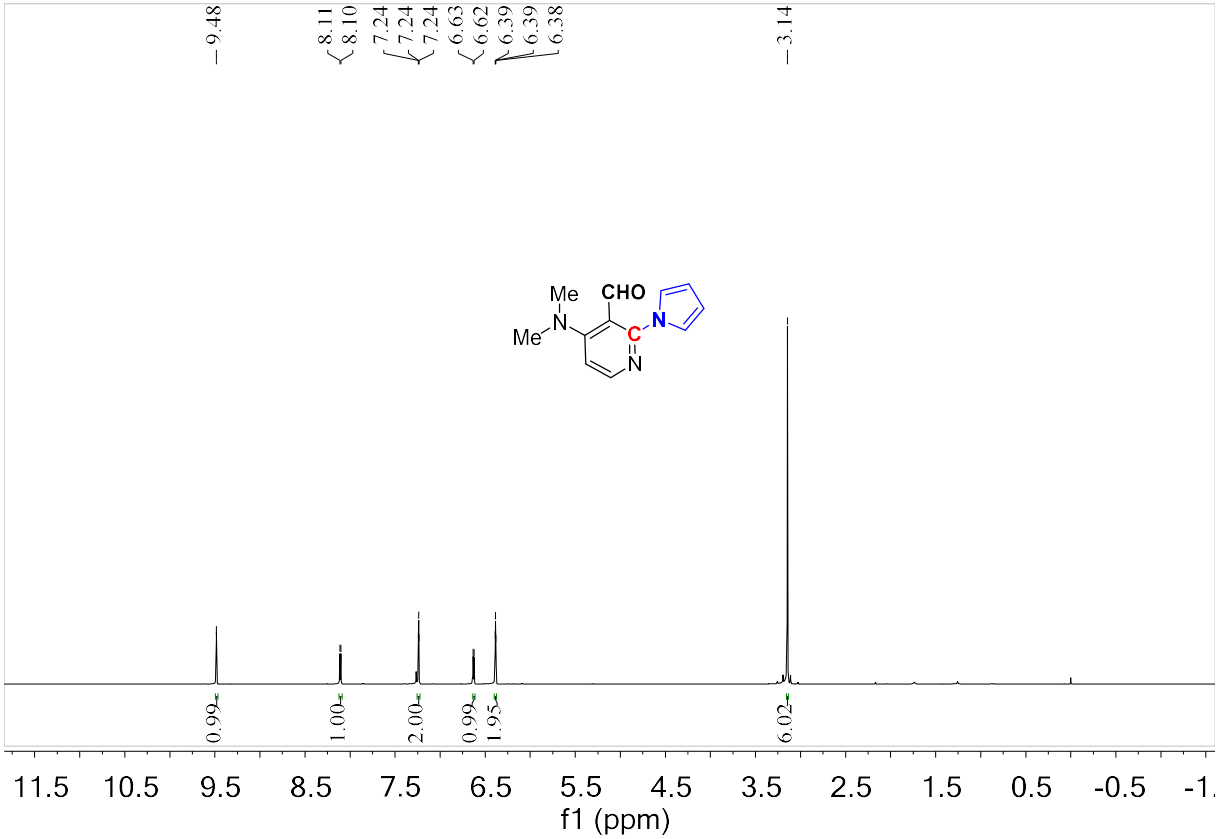

Dec17-2019-3.200.1d
WM1267 C13
185.03
157.94
156.40
151.02
144.32
142.73
140.94
130.02
126.60
110.66
108.99
106.76
104.53
77.26
77.05
76.84
43.73
Me
CHO
N
Me
C
N
N
f1 (ppm)

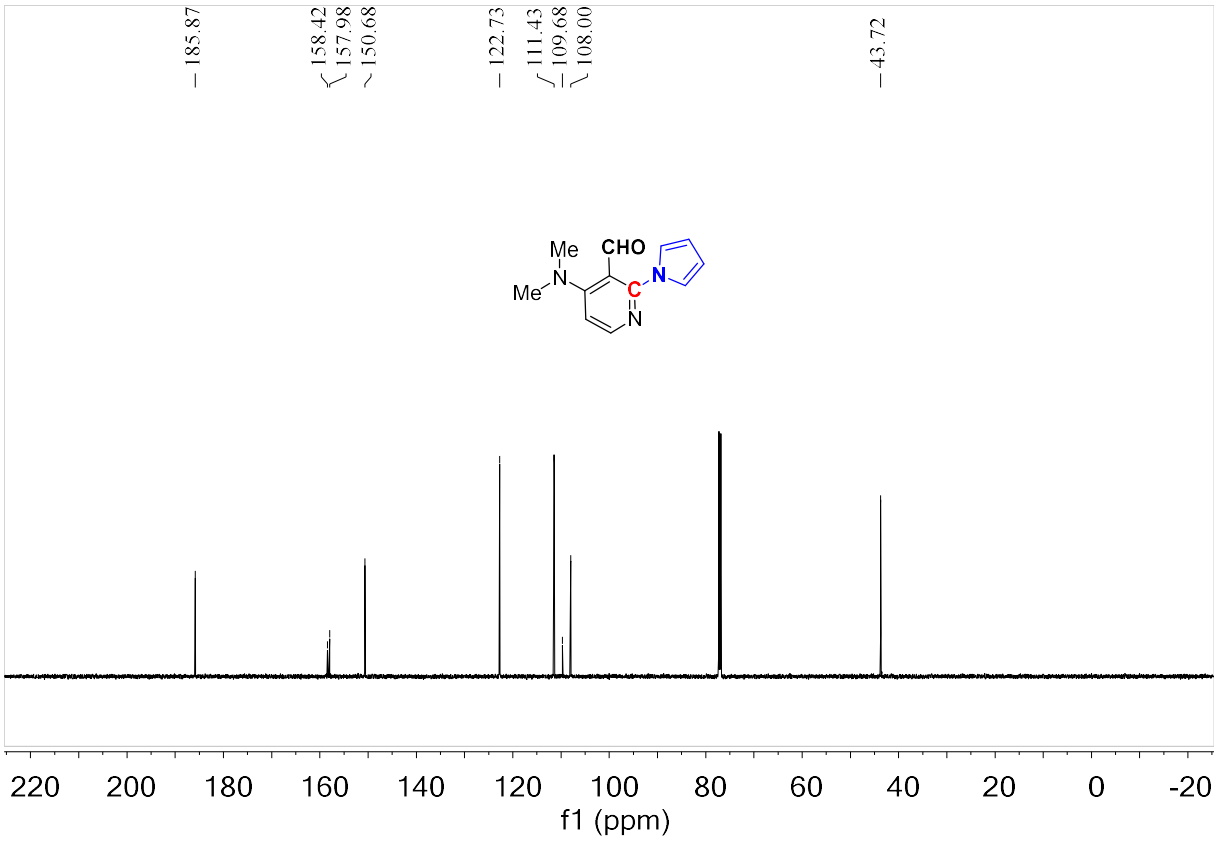
Compound 7i


9.4361
8.1874
8.1751
8.1591
8.1487
7.9486
7.9411
7.1856
7.1752
6.8082
6.8007
6.7374
6.7250
3.1859
Me
CHO
Cl
N
Me
C
N
N
0.85
0.94
0.94
0.95
0.92
0.91
1.00
6.00
f1 (ppm)

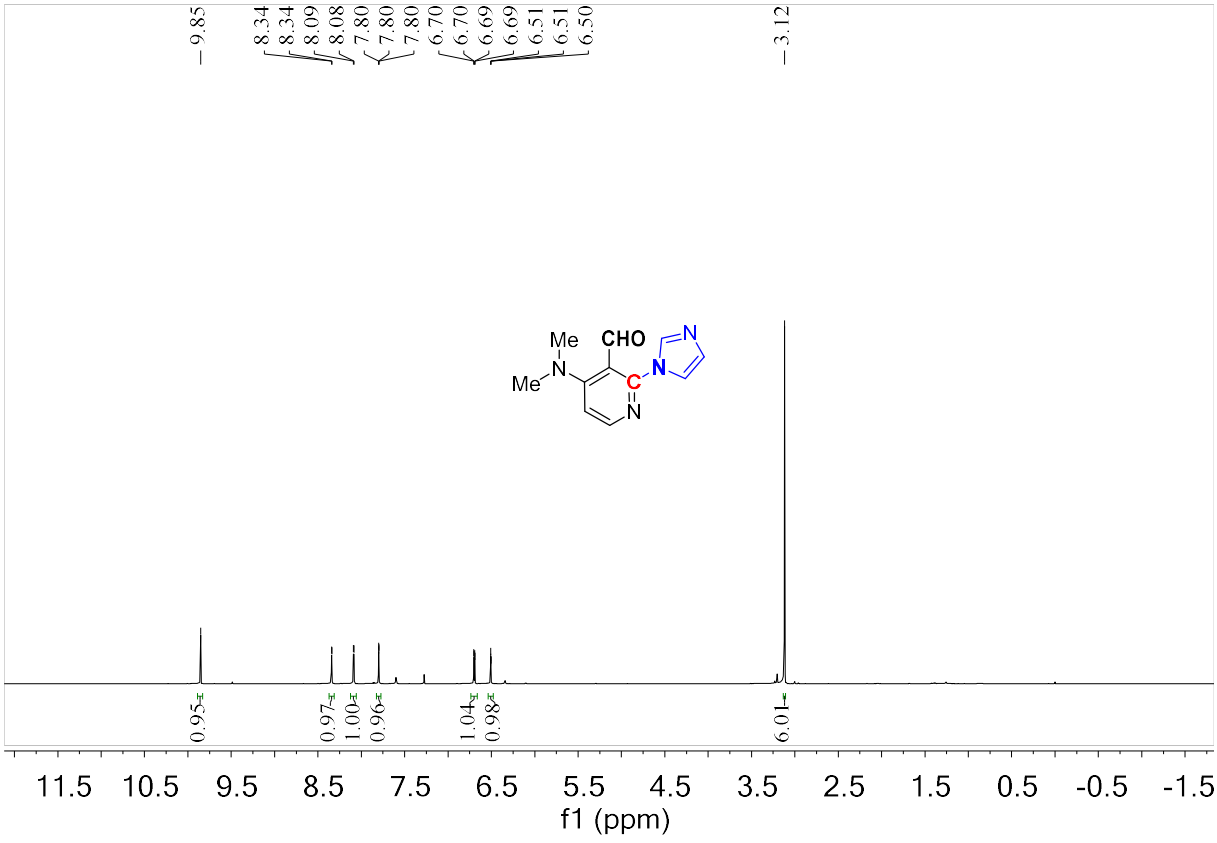

Dec19-2019-1.7f.fid
WM1276 C13
186.14
157.55
154.39
150.49
148.97
144.15
136.38
129.17
121.32
117.95
112.02
109.05
101.62
43.67
Me
CHO
Me
N
C
N
N
Cl
f1 (ppm)

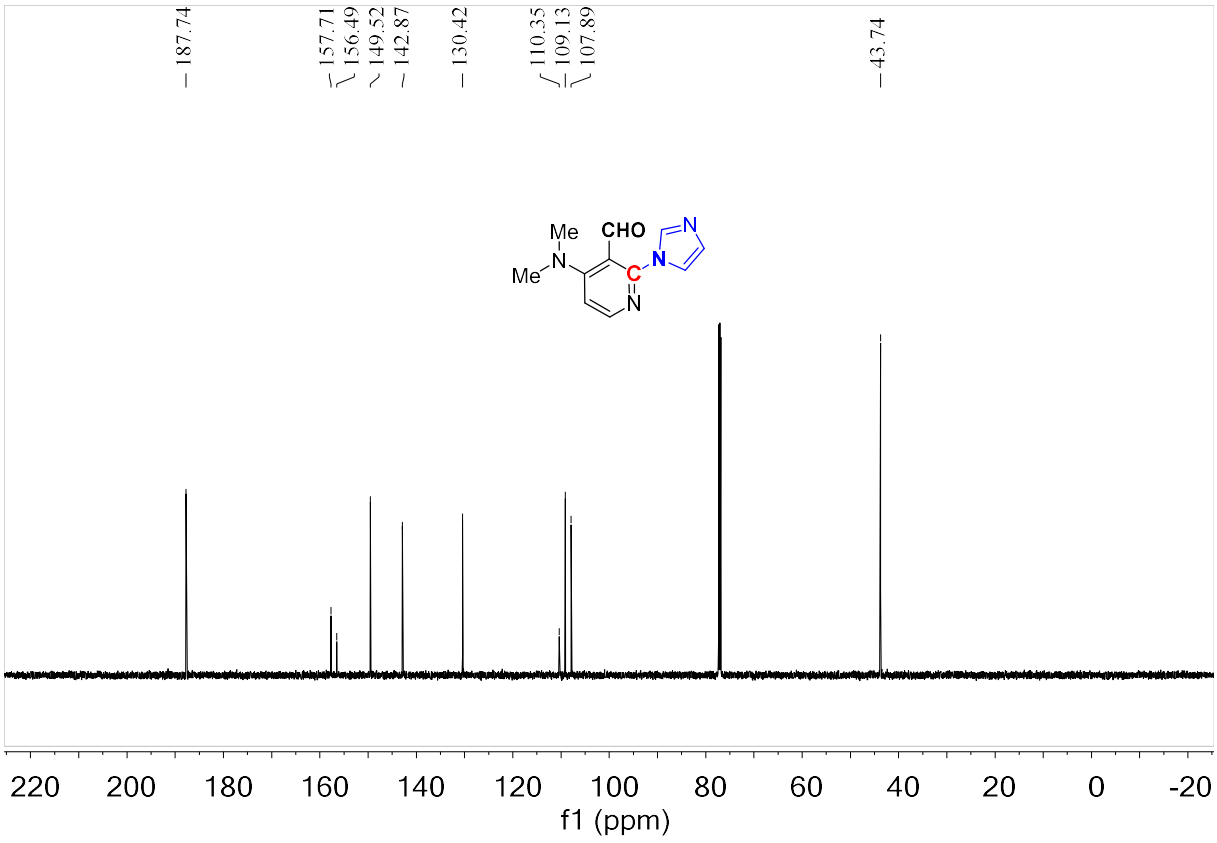
Compound 7j


9.48
8.11
8.10
7.24
7.24
7.24
6.63
6.62
6.39
6.39
6.38
3.14
Me
CHO
Me
N
C
N
N
0.99
1.00
2.00
0.99
1.95
6.02
f1 (ppm)

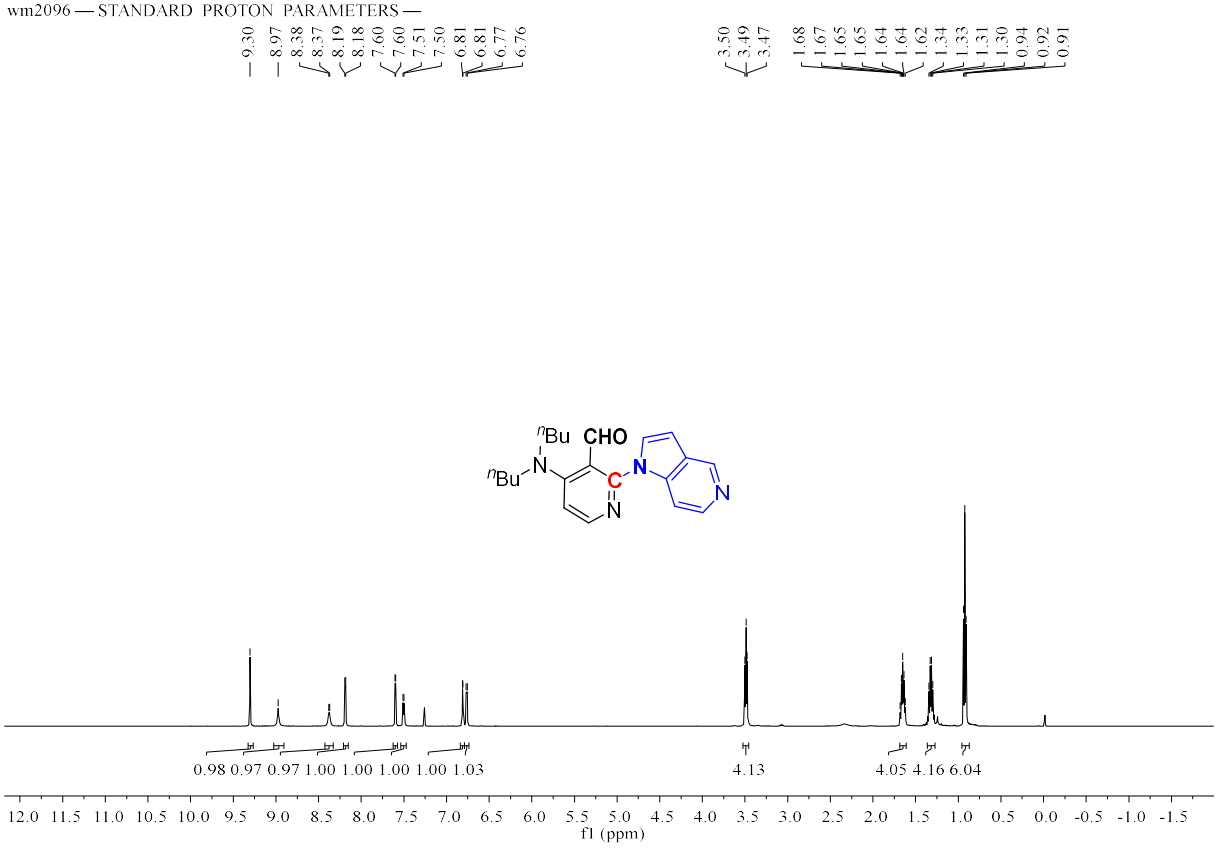

185.87
158.42
157.98
150.68
122.73
111.43
109.68
108.00
43.72
Me
CHO
N
Me
N
C
N
220
200
180
160
140
120
100
80
60
40
20
0
-20
f1 (ppm)

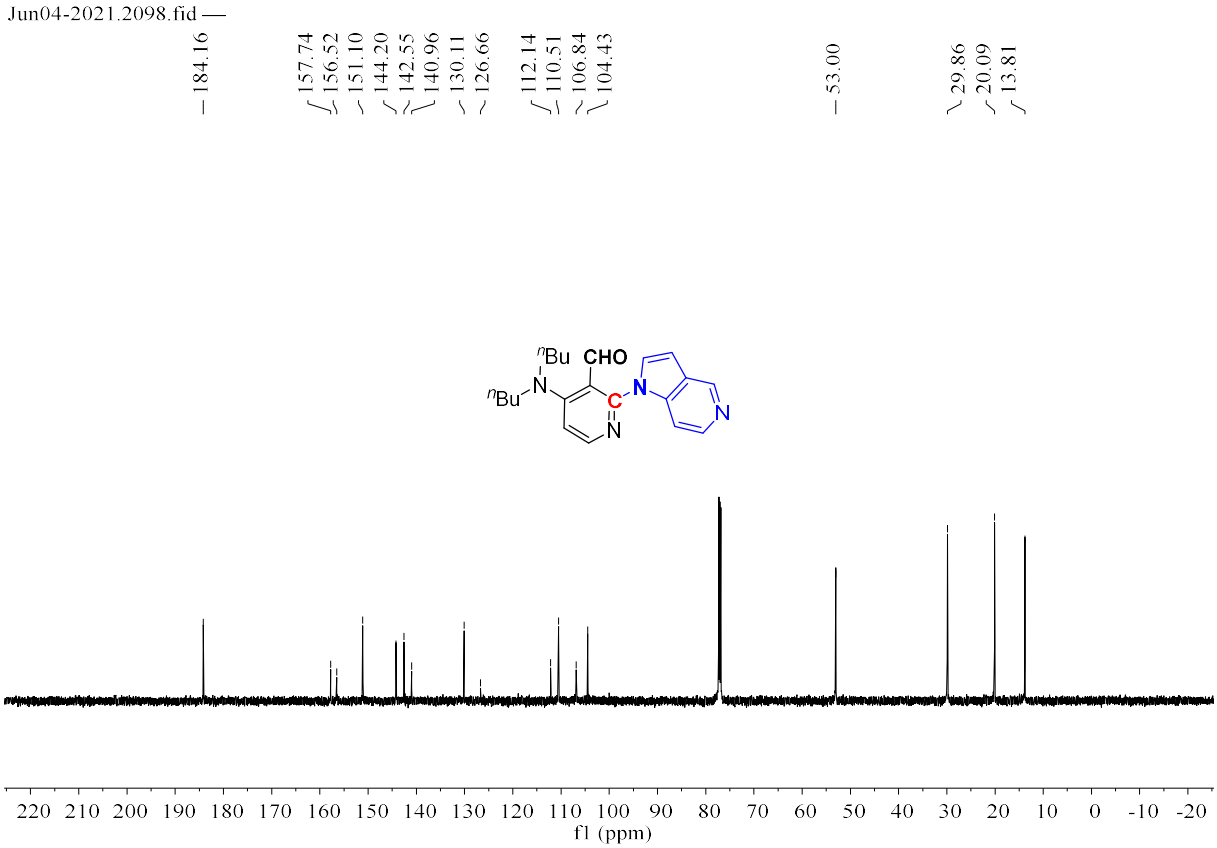
Compound 7k


9.85
8.34
8.34
8.09
8.08
7.80
7.80
7.80
6.70
6.70
6.69
6.69
6.51
6.51
6.50
3.12
Me
CHO
N
Me
N
C
N
0.95
0.97
1.00
0.96
1.04
0.98
6.01
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
f1 (ppm)

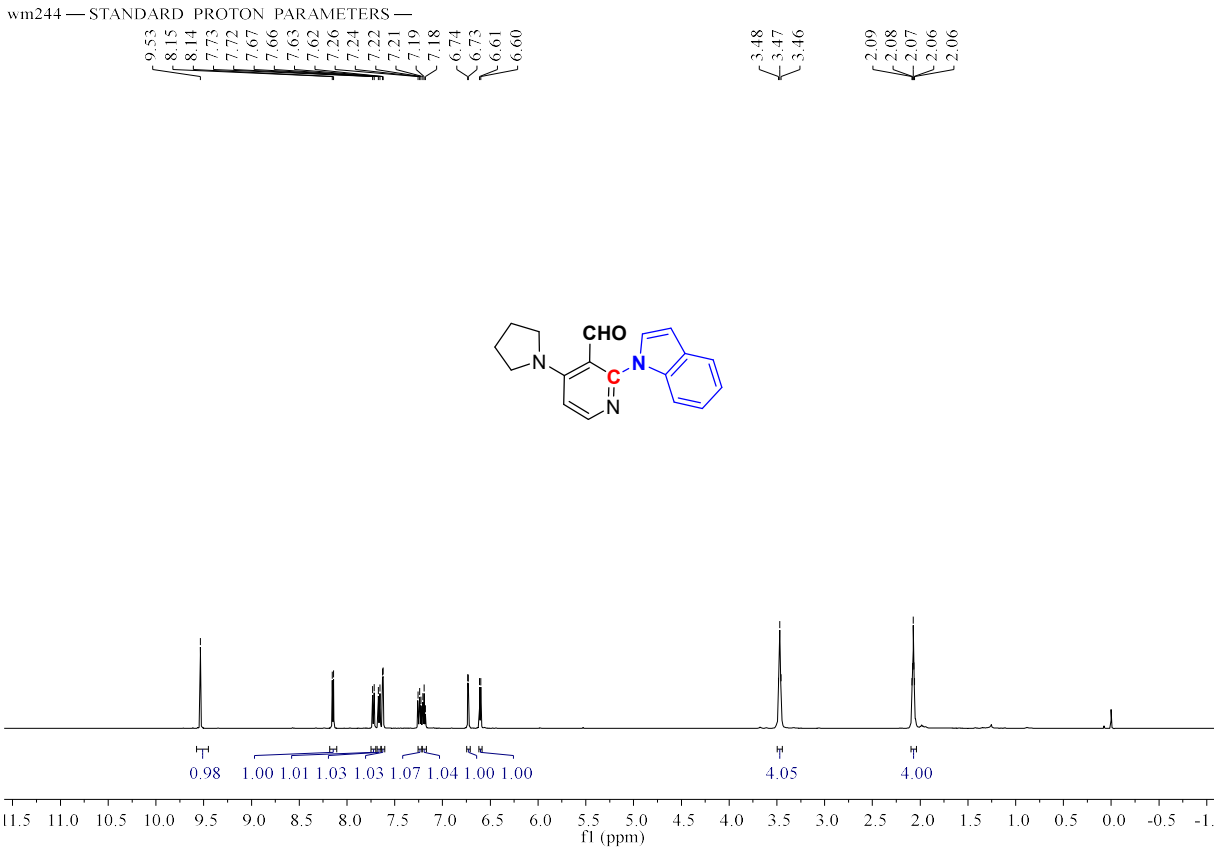

187.74
157.71
156.49
149.52
142.87
130.42
110.35
109.13
107.89
43.74
Me
CHO
N
Me
N
N
C
N
220
200
180
160
140
120
100
80
60
40
20
0
-20
f1 (ppm)

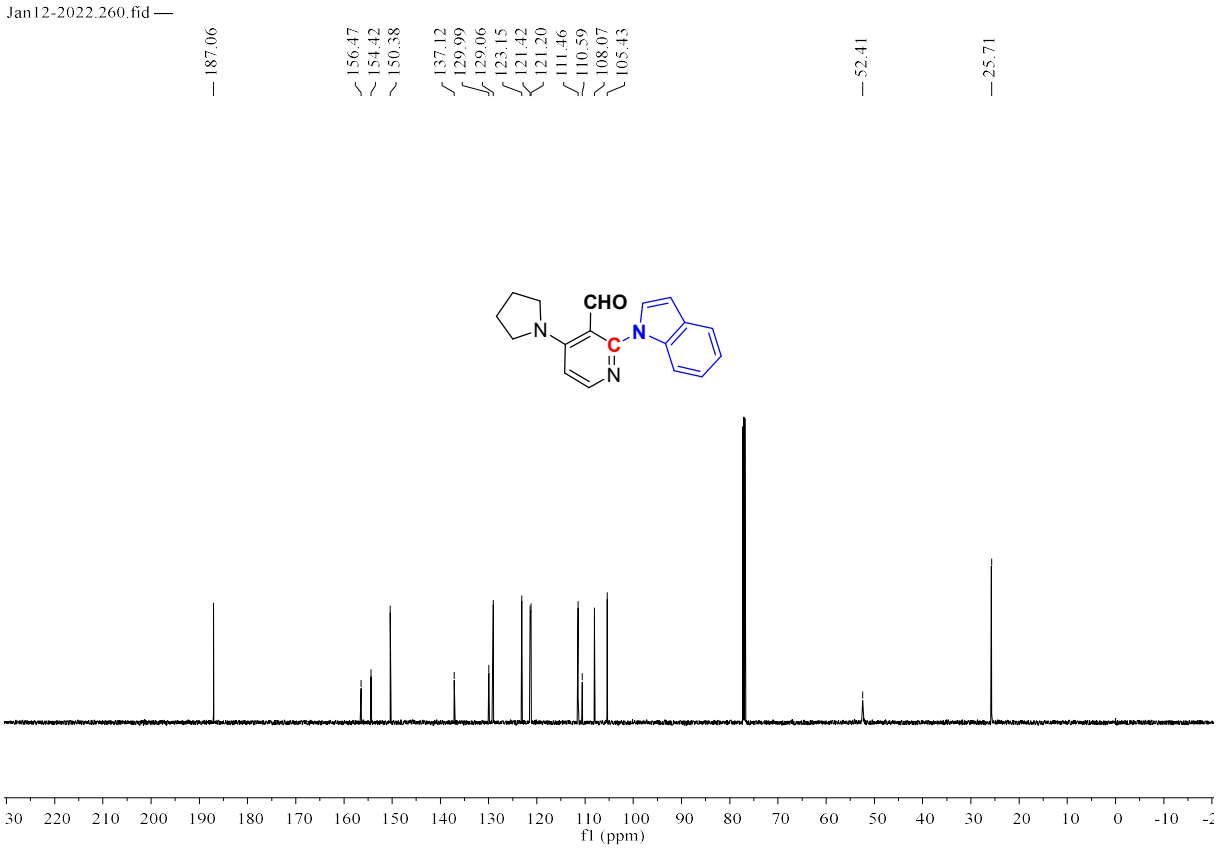
Compound 7l


wm2096 — STANDARD PROTON PARAMETERS —
9.30
8.97
8.38
8.37
8.19
8.18
7.60
7.60
7.51
7.50
6.81
6.81
6.77
6.76
3.50
3.49
3.47
1.68
1.67
1.65
1.65
1.64
1.64
1.62
1.34
1.33
1.31
1.30
0.94
0.92
0.91
nBu
CHO
nBu
N
N
C
N
N
0.98 0.97 0.97 1.00 1.00 1.00 1.00 1.03
4.13
4.05 4.16 6.04
12.0 11.5 11.0 10.5 10.0 9.5 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 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)


Jun04-2021.2098.fid
184.16
157.74
156.52
151.10
144.20
142.55
140.96
130.11
126.66
112.14
110.51
106.84
104.43
53.00
29.86
20.09
13.81
nBu
CHO
nBu
N
C
N
N
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

Compound 7m


wm244 — STANDARD PROTON PARAMETERS —
9.53
8.15
8.14
7.73
7.72
7.67
7.66
7.63
7.62
7.26
7.24
7.22
7.21
7.19
7.18
6.74
6.73
6.61
6.60
3.48
3.47
3.46
2.09
2.08
2.07
2.06
2.06
CHO
N
N
C
N
0.98
1.00 1.01 1.03 1.03 1.07 1.04 1.00 1.00
4.05
4.00
11.5 11.0 10.5 10.0 9.5 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 2.0 1.5 1.0 0.5 0.0 -0.5 -1.
f1 (ppm)


Jan12-2022.260.fid
187.06
156.47
154.42
150.38
137.12
129.99
129.06
123.15
121.42
121.20
111.46
110.59
108.07
105.43
52.41
25.71
CHO
N
N
C
N
30 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)