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SUPPORTING INFORMATION

Magnetically Recoverable Nickel-Palladium Alloy Nanocatalysts for the C-H Arylation Reactions

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Experimental details

Materials

Oleylamine (OAm) (>70%), 1-octadecene (ODE, 90%), palladium (II) acetylacetonate ($Pd(acac)_2$, 99%), nickel(II) acetylacetonate($Ni(acac)_2$ 97%), Cobalt(II) acetylacetonate ($Co(acac)_2$, 97%), ıron(III) acetylacetonate ($Fe(acac)_3$, 97%), benzyl ether (BE, 99%), 1,2-tetradecanediol (1,2-TDD,97%), borane-tert-bütylamine (BTB, 97%), hexanes (99%), ethanol (99%), acetone (97%), Phosphorus pentoxide (P_2O_5, 95%), Potassium peroxodisulfate ($K_2S_2O_8$, 95%), potassium permanganate ($KMnO_4$), hydrogen peroxide (H_2O_2, 30%), sodium nitrate ($NaNO_3$, 99%), sulfuric acid (H_2SO_4, 98%), dimethylformamide (DMF, >99%) and were purchased from Sigma-Aldrich ® used as received. Natural graphite flakes (average particle size: 325 mesh) were purchased from Alfa-Aesar. All organic compounds received from commercially sources. A deionized water was distilled using a Milli-Q water purification system.

Instrumentation

All low-resolution transmission electron microscope (TEM)images were recorded on a Hitachi HT7700 TEM instrument equipped with the EXALENS HR-TEM lens operated at 120 kV. X-ray diffraction (XRD) patterns were recorded on a Panalytical Empyrean diffractometer with Cu-Kα radiation (40 kV, 15 mA, 1.54051 A°) over a 2θ range from 10°- 90° at room temperature. Elemental analysis measurements were carried out on an Agilent Technologies 7700x inductively coupled plasma-mass spectroscopy (ICP-MS) after each sample was completely dissolved in aqua-regia (HCl/HNO_3: 3/1 v/v ratio). X-ray photoelectron spectra (XPS) were recorded on Thermo Scientific K-Alpha spectrometer using anAl Kα(hŭ:1486.6 eV) radiation. ^{1}H NMR and ^{13}C NMR experiments were performed on either 400 MHz Varian and 400 MHz Bruker Avance II instruments using $CDCl_3$, DMSO-d_6, MeOD, Acetone-d_6 as the solvent with tetramethylenesilane (TMS) as internal standard at room temperature, and the coupling constants *J* are given in hertz. The multiplicity is designated as s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, m = multiplet.

Compound Characterization

3-Phenylimidazo[1,2-*a*]pyridine (3a).[1] Light yellow crystal, 94 mg from bromobenzene (97% yield, 30:70 EtOAc/hexane) and 93 mg from iodobenzene (96% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.18 (d, *J* = 6.9 Hz, 1H), 7.59 – 7.50 (m, 2H), 7.45 – 7.33 (m, 4H), 7.32 – 7.24 (m, 1H), 7.09 – 6.99 (m, 1H), 6.65 (t, *J* = 6.9 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 146.0, 132.3, 129.2, 129.2, 128.2, 128.0, 125.7, 124.3, 123.3, 118.1, 112.6.

3-(4-Nitrophenyl)imidazo[1,2-*a*]pyridine (3b).[1] Yellow solid, 116 mg from 1-bromo-4-nitrobenzene (97% yield, 30:70 EtOAc/hexane) and 115 mg from 1-iodo-4-nitrobenzene (96% yield**). ^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.35 (d, *J* = 7.0 Hz, 1H), 8.33 – 8.26 (m, 2H), 7.79 (s, 1H), 7.73 – 7.64 (m, 3H), 7.28 – 7.20

(m, 1H), 6.87 (t, *J* = 6.8 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 147.3, 146.8, 135.9, 134.7, 127.5, 125.5, 124.8, 123.7, 123.2, 118.8, 113.6.

4-(Imidazo[1,2-*a*]pyridin-3-yl)benzonitrile (3c).[1] Light yellow solid, 105 mg from 4-bromobenzonitrile (96% yield, 30:70 EtOAc/hexane) and 107 mg from 4-iodobenzonitrile (97% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.30 (d, *J* = 7.0 Hz, 1H), 7.74 – 7.68 (m, 3H), 7.66 – 7.58 (m, 3H), 7.24 – 7.15 (m, 1H), 6.83 (t, *J* = 7.4 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 147.0, 134.1, 133.9, 133.1, 127.6, 125.3, 124.0, 123.2, 118.6, 118.5, 113.5, 111.2.

4-(Imidazo[1,2-*a*]pyridin-3-yl)benzaldehyde (3d).[1] Light yellow solid, 106 mg from 4-bromobenzaldehyde (95% yield, 30:70 EtOAc/hexane) and 108 mg from 4-iodobenzaldehyde (97% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.92 (s, 1H), 8.31 (d, *J* = 6.8 Hz, 1H), 7.88 (d, *J* = 8.1 Hz, 2H), 7.70 (s, 1H), 7.63 – 7.57 (m, 3H), 7.19 – 7.08 (m, 1H), 6.78 (t, *J* = 6.8 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 191.3, 146.9, 135.3, 135.2, 134.0, 130.6, 127.4, 125.1, 124.5, 123.4, 118.4, 113.3.

1-(4-(Imidazo[1,2-*a*]pyridin-3-yl)phenyl)ethan-1-one (3e).[1] Light yellow solid, 115 mg from 1-(4-bromophenyl)ethan-1-one (97% yield, 30:70 EtOAc/hexane) and 114 mg from 1-(4-iodophenyl)ethan-1-one (96% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.32 (d, *J* = 7.1 Hz, 1H), 8.01 (d, *J* = 8.4 Hz, 2H), 7.71 (s, 1H), 7.65 – 7.55 (m, 3H), 7.23 – 7.11 (m, 1H), 6.79 (t, *J* = 7.1 Hz, 1H), 2.57 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 197.2, 146.8, 136.2, 134.0, 133.8, 129.3, 127.3, 124.9, 124.7, 123.4, 118.5, 113.1, 26.6.

Methyl 4-(imidazo[1,2-*a*]pyridin-3-yl)benzoate (3f).[2] White solid, 106 mg from methyl 4-bromobenzoate (84% yield, 30:70 EtOAc/hexane) and 109 mg from methyl 4-iodobenzoate (86% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.33 (d, *J* = 6.9 Hz, 1H), 8.11 (d, *J* = 8.3 Hz, 2H), 7.72 (s, 1H), 7.65 – 7.58 (m, 3H), 7.22 – 7.10 (m, 1H), 6.81 (t, *J* = 6.9 Hz, 1H), 3.89 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 166.6, 146.8, 133.9, 133.6, 130.6, 129.4, 127.2, 124.8, 123.4, 118.5, 115.6, 113.1, 52.3.

3-(4-(Trifluoromethyl)phenyl)imidazo[1,2-*a*]pyridine (3g).[1] Light yellow solid, 121 mg from 1-iodo-4-(trifluoromethyl)benzene (92% yield, 30:70 EtOAc/hexane). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.27 (d, *J* = 7.0 Hz, 1H), 7.69 (t, *J* = 4.1 Hz, 3H), 7.62 (t, *J* = 7.4 Hz, 3H), 7.23 – 7.10 (m, 1H), 6.79 (t, *J* = 7.4 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 146.7, 133.4, 133.0, 130.1, 129.8, 127.8, 126.4-126.2 (m, 1C), 124.9, 124.3, 123.2, 118.5, 113.1.

3-(3-Nitrophenyl)imidazo[1,2-*a*]pyridine (3h).[3] Brownish solid, 113 mg from 1-bromo-3-nitrobenzene (94% yield, 30:70 EtOAc/hexane) and 111 mg from 1-iodo-3-nitrobenzene (93% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.37 (m, 1H), 8.30 – 8.25 (m, 1H), 8.19 – 8.17 (m, 1H), 7.87 – 7.80 (m, 1H), 7.74 (m, 1H), 7.66 – 7.62 (m, 2H), 7.25 – 7.17 (m, 1H), 6.84 (t, *J* = 6.8 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 148.9, 146.8, 133.9, 133.5, 131.2, 130.4, 125.1, 123.3, 122.9, 122.7, 122.1, 118.7, 113.4.

3-(Imidazo[1,2-*a*]pyridin-3-yl)benzonitrile (3i).[2] Light brownish solid, 108 mg from 3-bromobenzonitrile (98% yield, 30:70 EtOAc/hexane) and 106 mg from 3-iodoobenzonitrile (97% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.22 (d, *J* = 7.0 Hz, 1H), 7.76 (s, 1H), 7.73 – 7.70 (m, 1H), 7.65 (s, 1H), 7.62 – 7.52 (m, 3H), 7.19 – 7.12 (m, 1H), 6.80 (t, *J* = 7.3 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 146.7, 133.6, 131.9, 131.3, 130.9, 130.8, 130.3, 125.0, 123.4, 122.9, 118.5, 118.3, 113.6, 113.3.

3-(Imidazo[1,2-*a*]pyridin-3-yl)benzaldehyde (3j).[2] Light yellow solid, 106 mg from 3-bromobenzaldehyde (95% yield, 30:70 EtOAc/hexane) and 102 mg from 3-iodoobenzaldehyde (92% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.07 (s, 1H), 8.33 (d, *J* = 7.0 Hz, 1H), 8.06 (s, 1H), 7.93 – 7.86 (m, 1H), 7.84 – 7.78 (m, 1H), 7.75 (s, 1H), 7.72 – 7.63 (m, 2H), 7.27 – 7.17 (m, 1H), 6.85 (t, *J* = 7.3 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 191.8, 146.5, 137.2, 133.6, 133.2, 130.4, 130.1, 129.5, 128.2, 124.8, 124.3, 123.1, 118.4, 113.1.

2-(Imidazo[1,2-*a*]pyridin-3-yl)benzaldehyde (3k).[2] Brownish oil, 102 mg from 2-bromobenzaldehyde (92% yield, 30:70 EtOAc/hexane) and 105 mg from 2-iodoobenzaldehyde (94% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.80 (s, 1H), 8.02 (d, *J* = 7.8 Hz, 1H), 7.87 (d, *J* = 6.9 Hz, 1H), 7.71 – 7.62 (m, 2H), 7.62 (s, 1H), 7.58 – 7.44 (m, 2H), 7.25 – 7.13 (m, 1H), 6.77 (t, *J* = 6.9 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 191.1, 146.2, 134.8, 134.7, 134.5, 131.3, 131.1, 129.5, 129.4, 125.5, 123.4, 120.9, 118.1, 113.4.

3-(*p*-Tolyl)imidazo[1,2-*a*]pyridine (3l).[1] Brownish solid, 76 mg from 1-bromo-4-methylbenzene (73% yield, 30:70 EtOAc/hexane) and 78 mg from 1-iodo-4-methylbenzene (75% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.16 (d, *J* = 6.9 Hz, 1H), 7.54 (d, *J* = 7.9 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 7.18 (d, *J* = 8.0 Hz, 2H), 7.06 – 7.00 (m, 1H), 6.64 (t, *J* = 6.9 Hz, 1H), 2.30 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 145.9, 138.1, 132.2, 129.9, 128.0, 126.3, 125.7, 124.0, 123.4, 118.1, 112.4, 21.3.

3-(4-Methoxyphenyl)imidazo[1,2-*a*]pyridine (3m).[1] Light yellow solid, 89 mg from 1-bromo-4-methoxybenzene (79% yield, 30:70 EtOAc/hexane) and 90 mg from 1-iodo-4-methoxybenzene (80% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.16 (d, *J* = 7.0 Hz, 1H), 7.58 – 7.55 (m, 2H), 7.44 – 7.31 (m, 2H), 7.13 – 7.05 (m, 1H), 7.01 – 6.90 (m, 2H), 6.69 (t, *J* = 6.8 Hz, 1H), 3.79 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 159.6, 145.8, 132.0, 129.6, 125.5, 123.9, 123.3, 121.6, 118.2, 114.7, 112.3, 55.4.

3-(*m*-Tolyl)imidazo[1,2-*a*]pyridine (3n).[4] Light yellow oil, 75 mg from 1-bromo-3-methylbenzene (72% yield, 30:70 EtOAc/hexane) and 83 mg from 1-iodo-3-methylbenzene (80% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.31 (d, *J* = 7.0 Hz, 1H), 7.66 (s, 1H), 7.64 (d, *J* = 9.1 Hz, 1H), 7.45 – 7.30 (m, 3H), 7.23 – 7.13 (m, 2H), 6.77 (t, *J* = 7.4 Hz, 1H), 2.41 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 146.1, 139.0, 132.5, 129.2, 129.1, 129.0, 128.7, 125.9, 125.0, 124.1, 123.4, 118.2, 112.4, 21.5.

3-(3-Methoxyphenyl)imidazo[1,2-*a*]pyridine (3o).[5] Light yellow solid, 80 mg from 1-bromo-3-methoxybenzene (71% yield, 30:70 EtOAc/hexane) and 83 mg from 1-iodo-3-methoxybenzene (74% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.30 (d, *J* = 6.9 Hz, 1H), 7.65 (s, 1H), 7.62 (d, *J* = 9.1 Hz, 1H), 7.36 (t, *J* = 7.9 Hz, 1H), 7.17 – 7.00 (m, 3H), 6.89 (dd, *J* = 8.3, 2.5 Hz, 1H), 6.74 (t, *J* = 6.8 Hz, 1H), 3.80 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 160.4, 146.2, 132.5, 130.6, 130.5, 125.8, 124.6, 123.7, 120.4, 118.3, 113.9, 113.7, 112.9, 55.6.

3-(*o*-Tolyl)imidazo[1,2-*a*]pyridine (3p).[6] Light yellow oil, 70 mg from 1-bromo-2-methylbenzene (67% yield, 30:70 EtOAc/hexane) and 82 mg from 1-iodo-2-methylbenzene (79% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.66 (d, *J* = 6.8 Hz, 1H), 7.60 (d, *J* = 9.2 Hz, 1H), 7.53 (s, 1H), 7.32 – 7.18 (m, 4H), 7.12 – 7.08 (m, 1H), 6.67 (t, *J* = 6.4 Hz, 1H), 2.07 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 145.5, 138.3, 132.8, 131.1, 130.7, 129.2, 128.2, 126.2, 124.6, 124.0, 123.6, 118.0, 112.2, 19.7.

3-(Pyridin-2-yl)imidazo[1,2-*a*]pyridine (3q).[2] Light Brownish solid, 56 mg from 2-bromopyridine (57% yield, 30:70 EtOAc/ hexane) and 50 mg from 2-iodopyridine (51% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.94 (d, *J* = 7.1 Hz, 1H), 8.65 (d, *J* = 4.9 Hz, 1H), 8.14 (s, 1H), 7.77 – 7.63 (m, 3H), 7.41 – 7.20 (m, 1H), 7.22 – 7.09 (m, 1H), 6.93 (t, *J* = 6.4 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 150.7, 148.7, 147.6, 136.5, 134.7, 128.1, 125.5, 123.7, 120.9, 120.4, 117.6, 112.9.

3-(Pyridin-3-yl)imidazo[1,2-*a*]pyridine (3r).[1] Light yellow solid, 84 mg from 3-bromopyridine (86% yield, 30:70 EtOAc/ hexane) and 87 mg from 3-iodopyridine (89% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.75 (d, *J* = 4.3 Hz, 1H), 8.56 – 8.55 (m, 1H), 8.19 (d, *J* = 7.0 Hz, 1H), 7.82 – 7.73 (m, 1H), 7.66 (s, 1H), 7.60 (d, *J* = 9.1 Hz, 1H), 7.38 – 7.34 (m, 1H), 7.17 – 7.12 (m, 1H), 6.79 – 6.75 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 149.2, 148.8, 146.6, 135.1, 133.3, 125.6, 124.8, 123.9, 123.0, 122.3, 118.4, 113.1.

3-(Naphthalen-1-yl)imidazo[1,2-*a*]pyridine (3s).[1] Light yellow oil, 93 mg from 1-iodonaphthalene (76% yield, 30:70 EtOAc/hexane). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.89 – 7.84 (m, 2H), 7.73 (s, 1H), 7.69 (d, *J* = 9.1 Hz, 1H), 7.59 (d, *J* = 6.8 Hz, 1H), 7.49 (d, *J* = 4.9 Hz, 2H), 7.47 – 7.40 (m, 2H), 7.33 – 7.28 (m, 1H), 7.16 – 7.08 (m, 1H), 6.57 (t, *J* = 6.7 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 146.0, 134.1, 133.9, 132.2, 129.8, 129.3, 128.9, 127.2, 126.6, 126.4, 125.8, 125.3, 124.6, 124.3, 123.9, 118.1, 112.5.

1,2-Dimethyl-5-phenyl-1H-imidazole (4a).[7] Light yellow solid, 78 mg from bromobenzene (91% yield, 60:40 EtOAc/hexane) and 74 mg from iodobenzene (86% yield). **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.31 – 7.26 (m, 2H), 7.25 – 7.20 (m, 3H), 6.83 (s, 1H), 3.38 (s, 3H), 2.31 (s, 3H). **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 145.9, 133.5, 130.5, 128.6, 128.5, 127.6, 125.7, 31.3, 13.6.

1,2-Dimethyl-5-(4-nitrophenyl)-1H-imidazole (4b).[7] Yellow solid, 100 mg from 1-bromo-4-nitrobenzene (92% yield, 60:40 EtOAc/hexane) and 92 mg from 1-iodo-4-nitrobenzene (85% yield). **^{1}H-**

NMR (400 MHz, $CDCl_3$): δ 8.24 – 8.20 (m, 2H), 7.48 – 7.45 (m, 2H), 7.06 (s, 1H), 3.55 (s, 3H), 2.42 (s, 3H). **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 153.7, 148.0, 146.7, 136.9, 131.4, 128.2, 124.2, 31.8, 13.8.

4-(1,2-Dimethyl-1H-imidazol-5-yl)benzonitrile (4c).[7] White solid, 86 mg from 4-bromobenzonitrile (87% yield, 60:40 EtOAc/hexane) and 82 mg from 4-iodobenzonitrile (83% yield). **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.64 (d, *J* = 8.3 Hz, 2H), 7.40 (d, *J* = 8.3 Hz, 2H), 7.00 (s, 1H), 3.51 (s, 3H), 2.40 (s, 3H). **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 147.7, 135.1, 132.6, 131.9, 128.3, 127.9, 118.7, 110.8, 31.5, 13.9.

5-(4-methoxyphenyl)-1,2-dimethyl-1H-imidazole (4d).[7] White solid, 55 mg from 1-bromo-4-methoxybenzene (54% yield, 60:40 EtOAc/hexane) and 63 mg from 1-iodo-4-methoxybenzene (62% yield). **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.18 (d, *J* = 8.6 Hz, 2H), 6.87 (d, *J* = 8.7 Hz, 2H), 6.80 (s, 1H), 3.75 (s, 3H), 3.39 (s, 3H), 2.35 (s, 3H) **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 159.3, 145.4, 133.3, 130.1, 125.1, 122.9, 114.1, 55.3, 31.2, 13.7.

2,3-Diphenylindolizine (4e).[8] Brown oil, 118 mg from bromobenzene (85% yield, 5:95 EtOAc/hexane) and 126 mg from iodobenzene (90% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.86 (d, *J* = 7.4 Hz, 1H), 7.40 – 7.27 (m, 6H), 7.26 – 7.21 (m, 2H), 7.19 – 7.06 (m, 3H), 6.64 – 6.56 (m, 2H), 6.38 – 6.28 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 136.1, 132.7, 131.9, 131.0, 129.1, 128.9, 128.2, 127.9, 127.8, 126.1, 122.3, 121.5, 119.1, 117.5, 110.5, 99.4.

3-(4-Nitrophenyl)-2-phenylindolizine (4f).[9] Orange solid, 153 mg from 1-bromo-4-nitrobenzene (94% yield, 6:94 EtOAc/hexane) and 156 mg from 1-iodo-4-nitrobenzene (96% yield). **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 8.17 (d, *J* = 9.1 Hz, 2H), 8.05 – 8.01 (m, 1H), 7.47 (d, *J* = 9.1 Hz, 2H), 7.38 (d, *J* = 9.0 Hz, 1H), 7.24 – 7.13 (m, 5H), 6.77 – 6.65 (m, 1H), 6.62 (s, 1H), 6.52 – 6.43 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)**: δ 146.4, 138.5, 135.4, 134.1, 130.8, 130.1, 129.2, 128.5, 126.8, 124.3, 121.8, 119.5, 119.2, 118.9, 111.6, 101.3.

4-(2-Phenylindolizin-3-yl)benzonitrile (4g). Light brown solid, 122 mg from 4-bromobenzonitrile (80% yield, mp 126.0−127.0 °C, 5:95 EtOAc/hexane) and 142 mg from 4-iodobenzonitrile (93% yield). **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 8.07 (d, *J* = 7.0 Hz, 1H), 7.71 (d, *J* = 8.3 Hz, 2H), 7.51 (d, *J* = 8.3 Hz, 2H), 7.47 (d, *J* = 9.0 Hz, 1H), 7.35 – 7.24 (m, 5H), 6.83 – 6.73 (m, 1H), 6.72 (s, 1H), 6.58 – 6.50 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 136.5, 135.4 (2C), 133.8, 132.7, 131.0, 129.6, 129.2, 128.5, 126.7, 121.8, 119.4, 118.9, 118.6, 111.4, 110.7, 100.9. **HRMS (ESI-TOF) m/z:** $[M + H]^+$ calcd for $C_{21}H_{15}N_2$, 295.1230; found 295.1225.

2-Phenyl-3-(*p*-tolyl)indolizine (4h).[8] Brown oil, 110 mg from 1-bromo-4-methylbenzene (75% yield, 4:96 EtOAc/hexane) and 136 mg from 1-iodo-4-methylbenzene (93% yield). **^{1}H NMR (400 MHz, $CDCl_3$):**

δ 7.86 – 7.78 (m, 1H), 7.31 (d, *J* = 9.0 Hz, 1H), 7.27 – 7.22 (m, 2H), 7.22 – 7.11 (m, 6H), 7.11 – 7.04 (m, 1H), 6.64 – 6.53 (m, 2H), 6.37 – 6.25 (m, 1H), 2.33 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 137.6, 136.2, 132.6, 130.9, 129.9, 128.9, 128.2 (2C), 127.7, 126.1, 122.4, 121.6, 119.1, 117.3, 110.4, 99.3, 21.4.

5-Phenylfuran-2-carbonitrile (4i).[10] White solid, 64 mg from bromobenzene (70% yield, 2:98 EtOAc/hexane) and 69 mg from iodobenzene (75% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.77 – 7.71 (m, 2H), 7.51 – 7.37 (m, 3H), 7.19 (d, *J* = 3.7 Hz, 1H), 6.75 (d, *J* = 3.7 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 158.7, 129.5, 129.0, 128.7, 125.1, 124.9, 124.0, 111.9, 106.0.

5-(4-Acetylphenyl)furan-2-carbonitrile (4j).[11] White solid, 103 mg from 4'-bromoacetophenone (91% yield, 7:93 EtOAc/hexane) and 93 mg from 4'-iodoacetophenone (82% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.05 (d, *J* = 8.5 Hz, 2H), 7.83 (d, *J* = 8.5 Hz, 2H), 7.22 (d, *J* = 3.7 Hz, 1H), 6.89 (d, *J* = 3.7 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 197.1, 157.3, 137.3, 132.5, 129.1, 126.1, 124.9, 123.9, 111.5, 108.0, 26.7.

5-(4-Cyanophenyl)furan-2-carbonitrile (4k).[12] White solid, 91 mg from 4-bromobenzonitrile (87% yield, 3:97 EtOAc/hexane) and 96 mg from 4-iodobenzonitrile (92% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.75 (d, *J* = 8.5 Hz, 2H), 7.66 (d, *J* = 8.5 Hz, 2H), 7.14 (d, *J* = 3.7 Hz, 1H), 6.83 (d, *J* = 3.7 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 156.2, 132.9, 132.3, 126.6, 125.2, 123.9, 118.2, 112.8, 111.3, 108.7.

5-(*p*-Tolyl)furan-2-carbonitrile (4l).[13] White-off solid, 45 mg from 1-bromo-4-methylbenzene (45% yield, 2:98 EtOAc/hexane) and 62 mg from 1-iodo-4-methylbenzene (63% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.63 (d, *J* = 8.2 Hz, 2H), 7.27 (d, *J* = 8.2 Hz, 2H), 7.17 (d, *J* = 3.7 Hz, 1H), 6.69 (d, *J* = 3.7 Hz, 1H), 2.42 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 159.0, 139.8, 129.7, 126.1, 124.8, 124.8, 124.0, 112.1, 105.3, 21.4.

2-(4-(Methylsulfonyl)phenyl)-3-phenylimidazo[1,2-*a*]pyridine (6a).[14] Light Brown solid, from bromobenzene (trace) and 168 mg from iodobenzene (96% yield, 10:90 EtOAc/hexane). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.84 (d, *J* = 6.9 Hz, 1H), 7.78 (d, *J* = 8.5 Hz, 2H), 7.73 (d, *J* = 8.5 Hz, 2H), 7.59 (d, *J* = 9.1 Hz, 1H), 7.52 – 7.41 (m, 3H), 7.37 – 7.32 (m, 2H), 7.19 – 7.11 (m, 1H), 6.69 (t, *J* = 6.8 Hz, 1H), 2.95 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 145.0, 140.1, 139.9, 138.8, 130.6, 129.9, 129.5, 129.1, 128.5, 127.3, 125.5, 123.6, 122.7, 117.7, 112.9, 44.5.

2-(4-(Methylsulfonyl)phenyl)-3-(4-nitrophenyl)imidazo[1,2-*a*]pyridine (6b). Yellow solid, 173 mg from 1-bromo-4-nitrobenzene (88% yield, mp 123.0-124.0 °C, 10:90 EtOAc/hexane) and 182 mg from 1-iodo-4- nitrobenzene (93% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.33 (d, *J* = 8.7 Hz, 2H), 7.97 (d, *J* = 7.0 Hz, 1H), 7.80 (d, *J* = 8.5 Hz, 2H), 7.72 (d, *J* = 8.5 Hz, 2H), 7.65 (d, *J* = 9.1 Hz, 1H), 7.59 (d, *J* = 8.7 Hz, 2H), 7.32 – 7.22 (m, 1H), 6.86 – 6.77 (m, 1H), 2.99 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 147.9, 145.8, 141.9,

139.7, 139.2, 135.9, 131.3, 129.0, 127.6, 126.4, 125.0, 123.1, 120.1, 118.2, 113.8, 44.5. **HRMS (ESI-TOF) m/z:** $[M + H]^+$ calcd for $C_{20}H_{16}N_3O_4S$, 394.0856; found 394.0857.

4-(2-(4-(Methylsulfonyl)phenyl)imidazo[1,2-*a*]pyridin-3-yl)benzonitrile (6c). White-off solid, 150 mg from 4-bromobenzonitrile (80% yield, mp 242.0-243.0 °C, 10:90 EtOAc/hexane) and 155 mg from 4-iodobenzonitrile (83% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.93 (d, *J* = 6.9 Hz, 1H), 7.83 – 7.86 (m, 4H), 7.72 (d, *J* = 8.3 Hz, 2H), 7.66 (d, *J* = 9.1 Hz, 1H), 7.53 (d, *J* = 8.3 Hz, 2H), 7.29 – 7.22 (m, 1H), 6.80 (t, *J* = 6.7 Hz, 1H), 2.99 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 145.7, 141.6, 139.6, 139.2, 134.0, 133.5, 131.1, 128.9, 127.6, 126.2, 123.0, 120.4, 118.2, 118.1, 113.6, 113.1, 44.5. **HRMS (ESI-TOF) m/z:** $[M + H]^+$ calcd for $C_{21}H_{16}N_3O_2S$, 374.0958; found 374.0954.

2-(4-(Methylsulfonyl)phenyl)-3-(*p*-tolyl)imidazo[1,2-*a*]pyridine (6d). yellow solid, from 1-bromo-4-methylbenzene (trace) and 149 mg from 1-iodo-4-methylbenzene (82% yield, mp 178.9-179.9 °C, 8:92 EtOAc/hexane). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.83 (d, *J* = 7.0 Hz, 1H), 7.80 (d, *J* = 8.6 Hz, 2H), 7.74 (d, *J* = 8.6 Hz, 2H), 7.58 (d, *J* = 9.1 Hz, 1H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.17 – 7.12 (m, 1H), 6.70 – 6.65 (m, 1H), 2.95 (s, 3H), 2.39 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 144.9, 140.0, 139.96, 139.6, 138.7, 130.6, 130.5, 128.4, 127.3, 126.0, 125.4, 123.6, 122.8, 117.7, 112.7, 44.5, 21.5. **HRMS (ESI-TOF) m/z:** $[M + H]^+$ calcd for $C_{21}H_{18}N_2O_2S$, 363.1162; found 363.1158.

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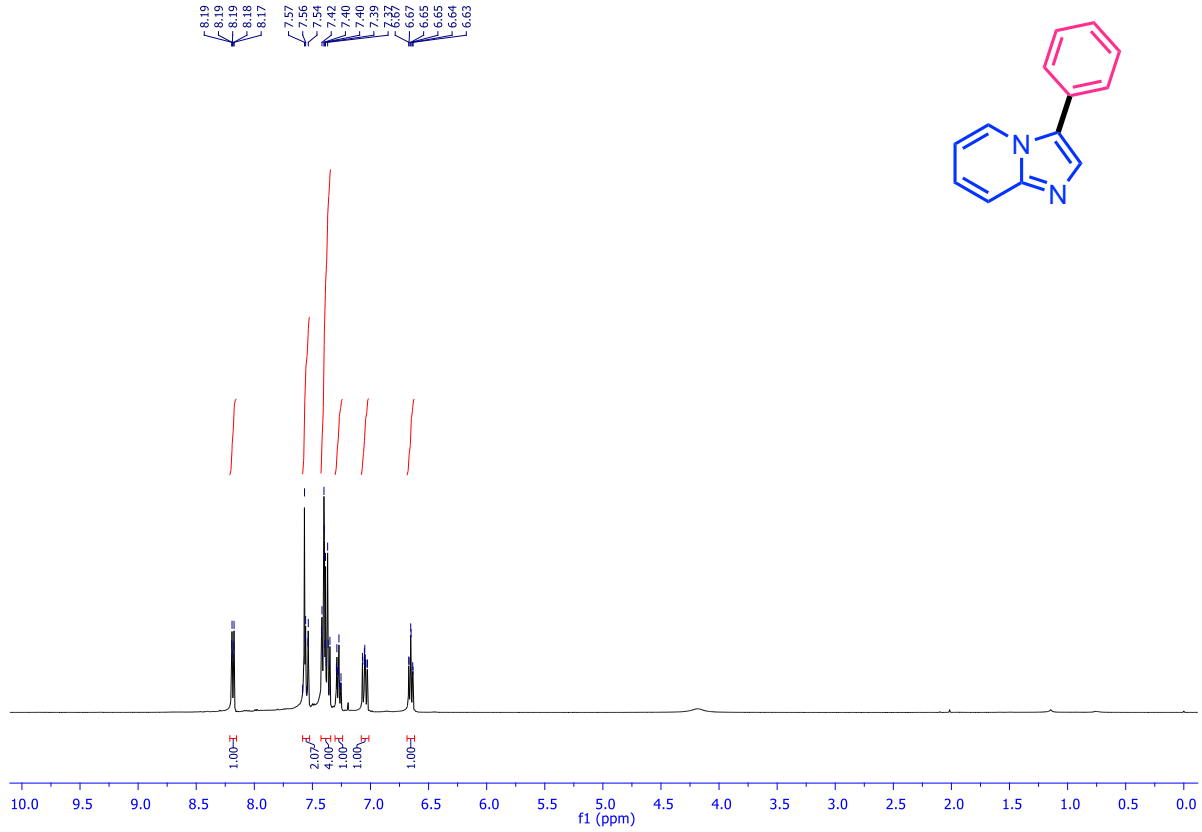
NMR Spectra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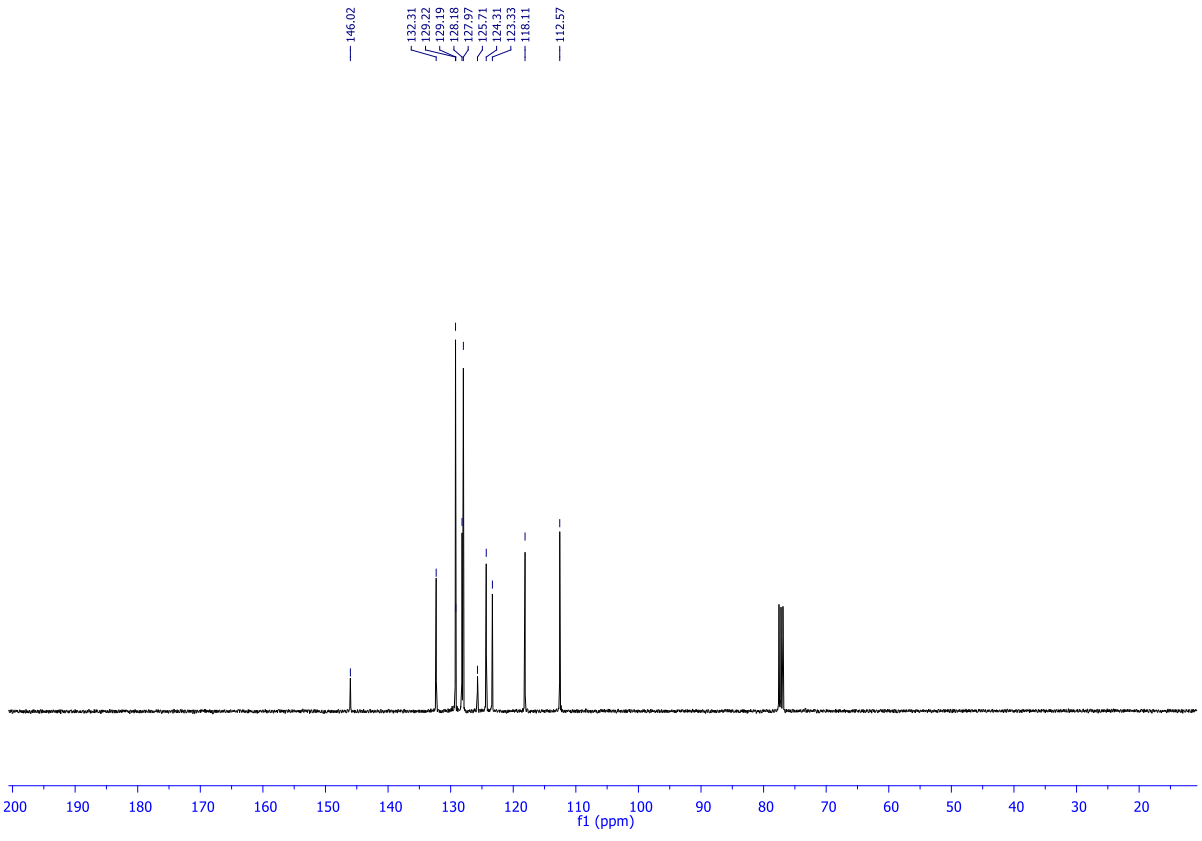
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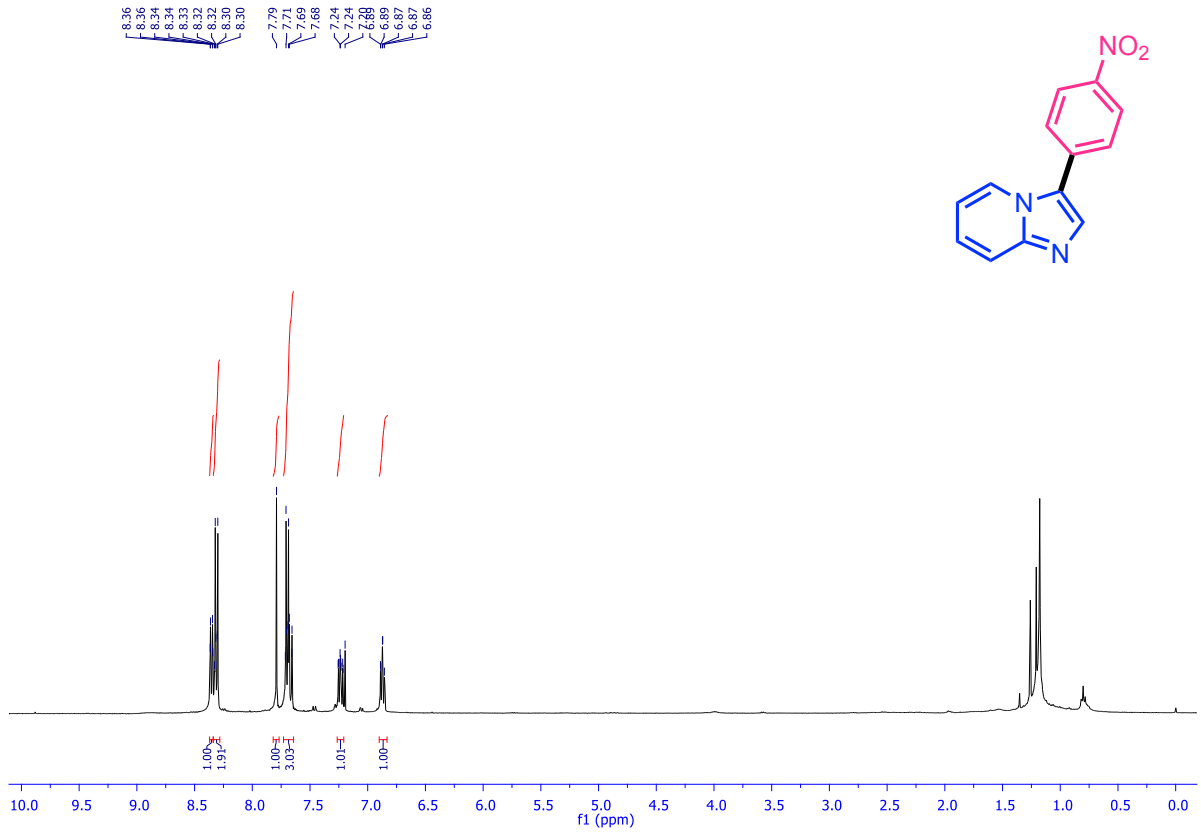
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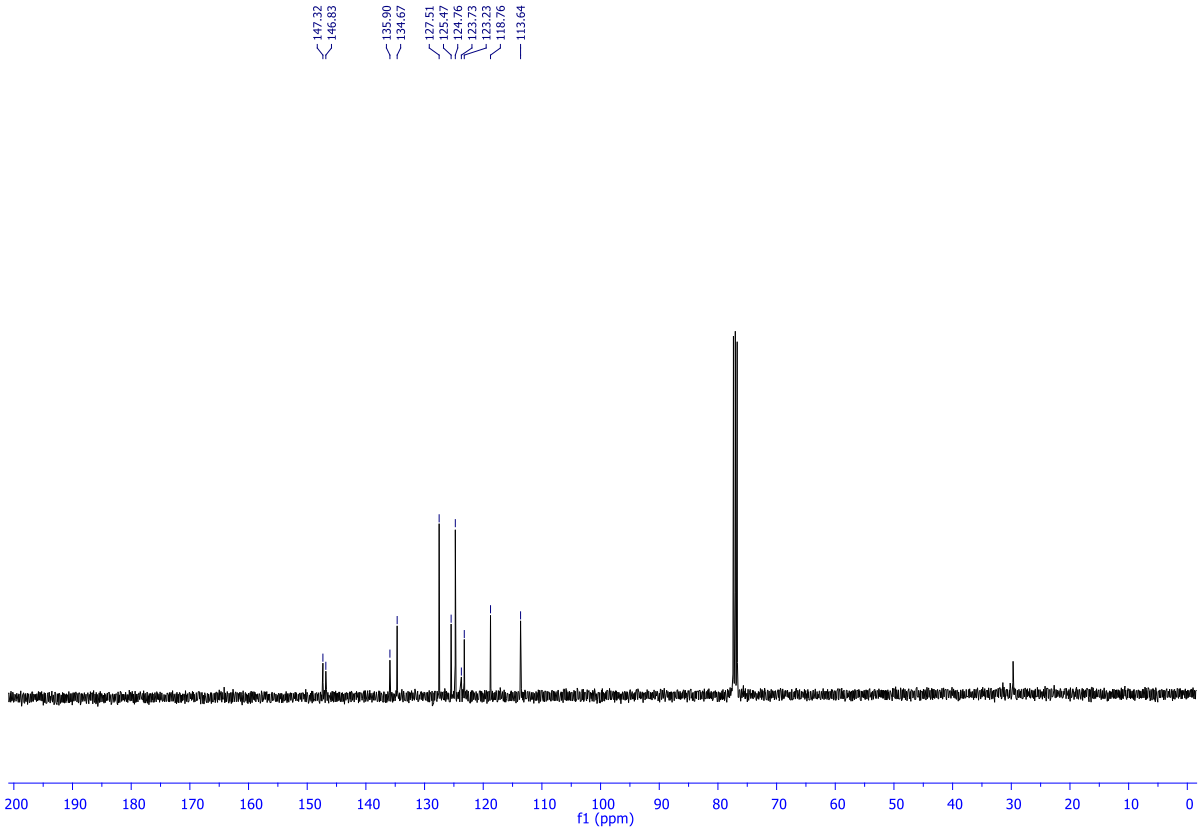
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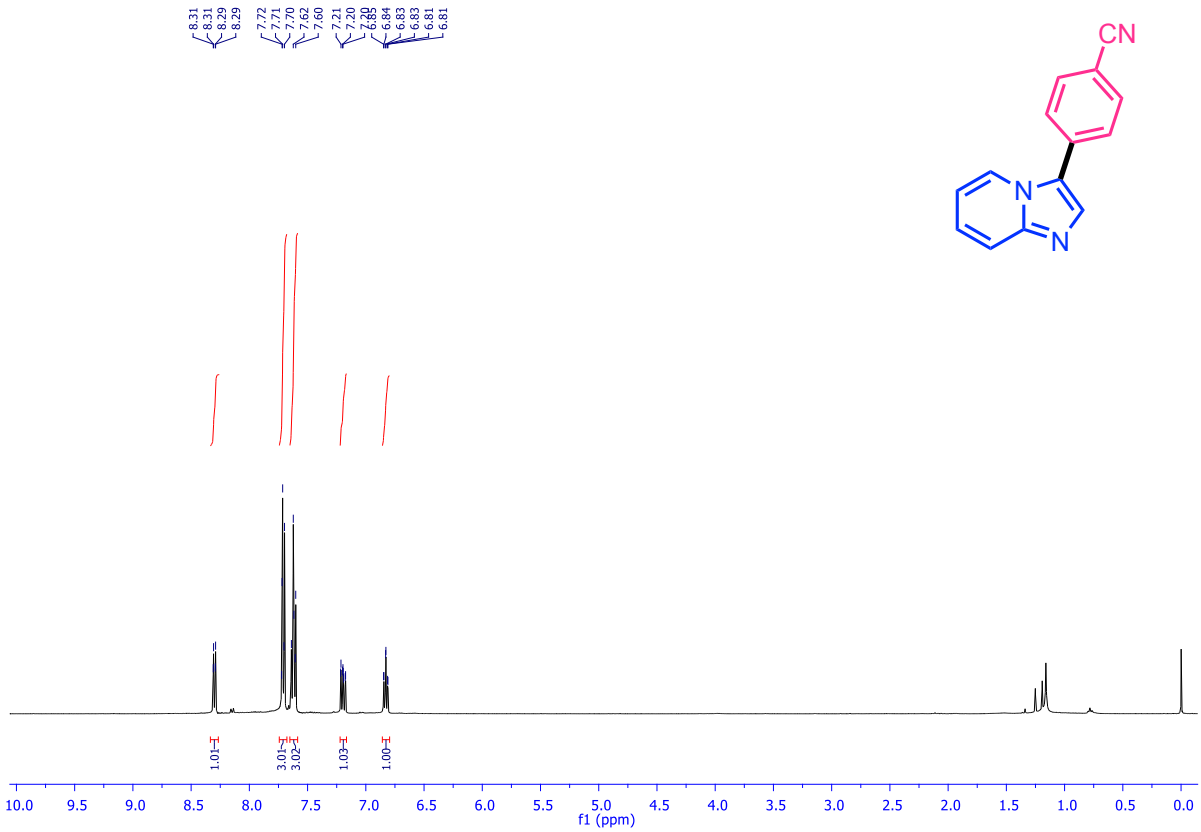
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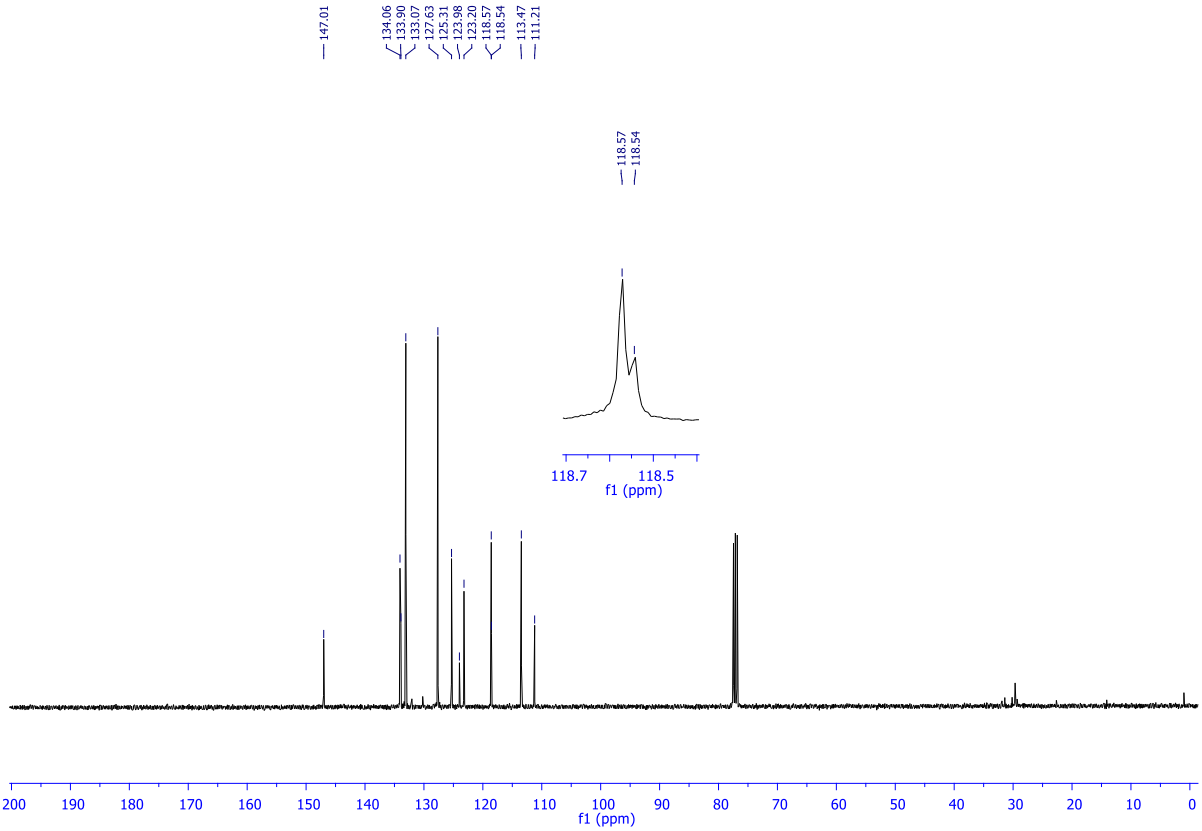
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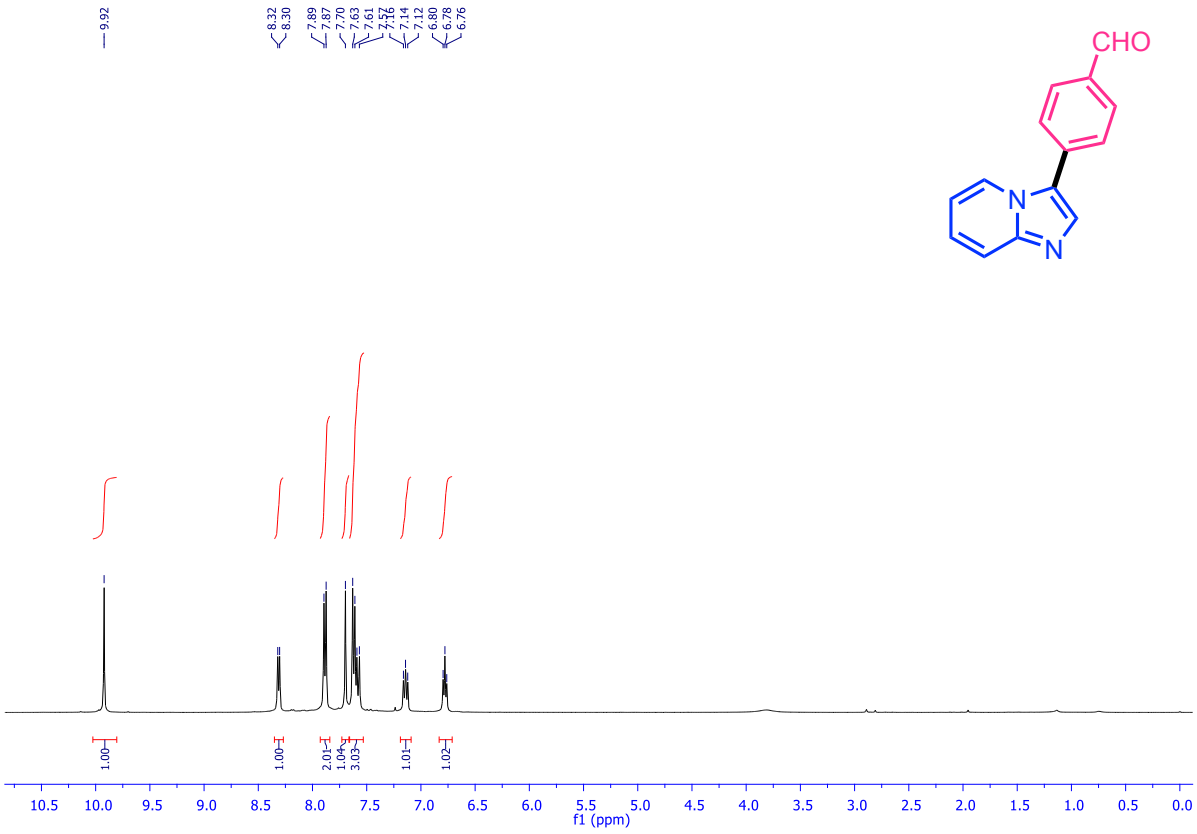
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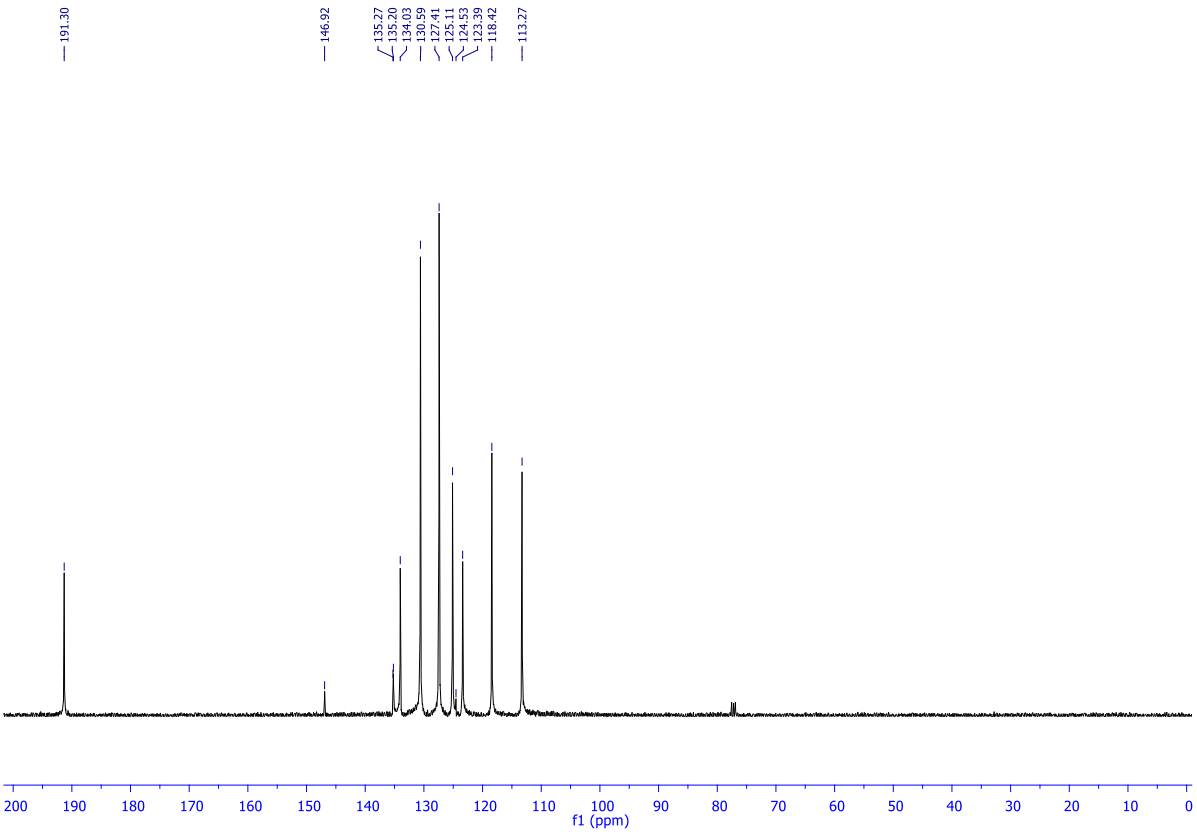
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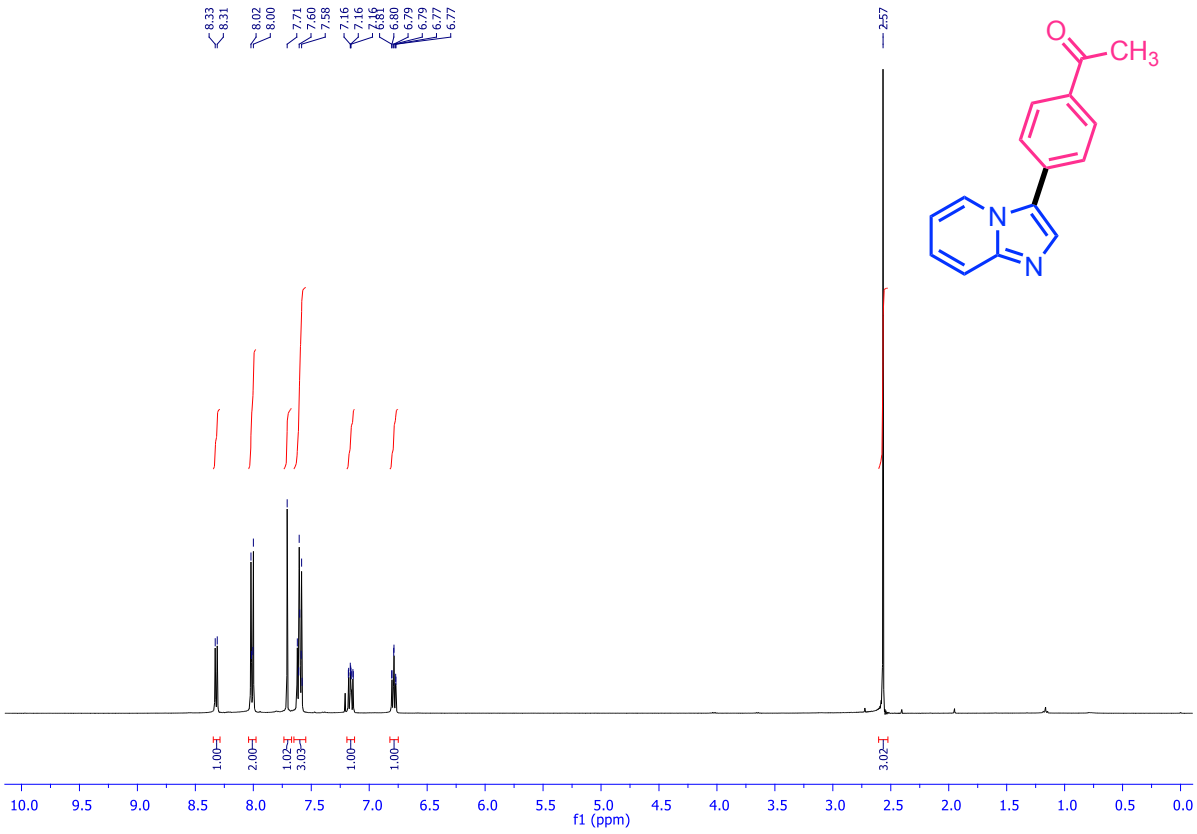
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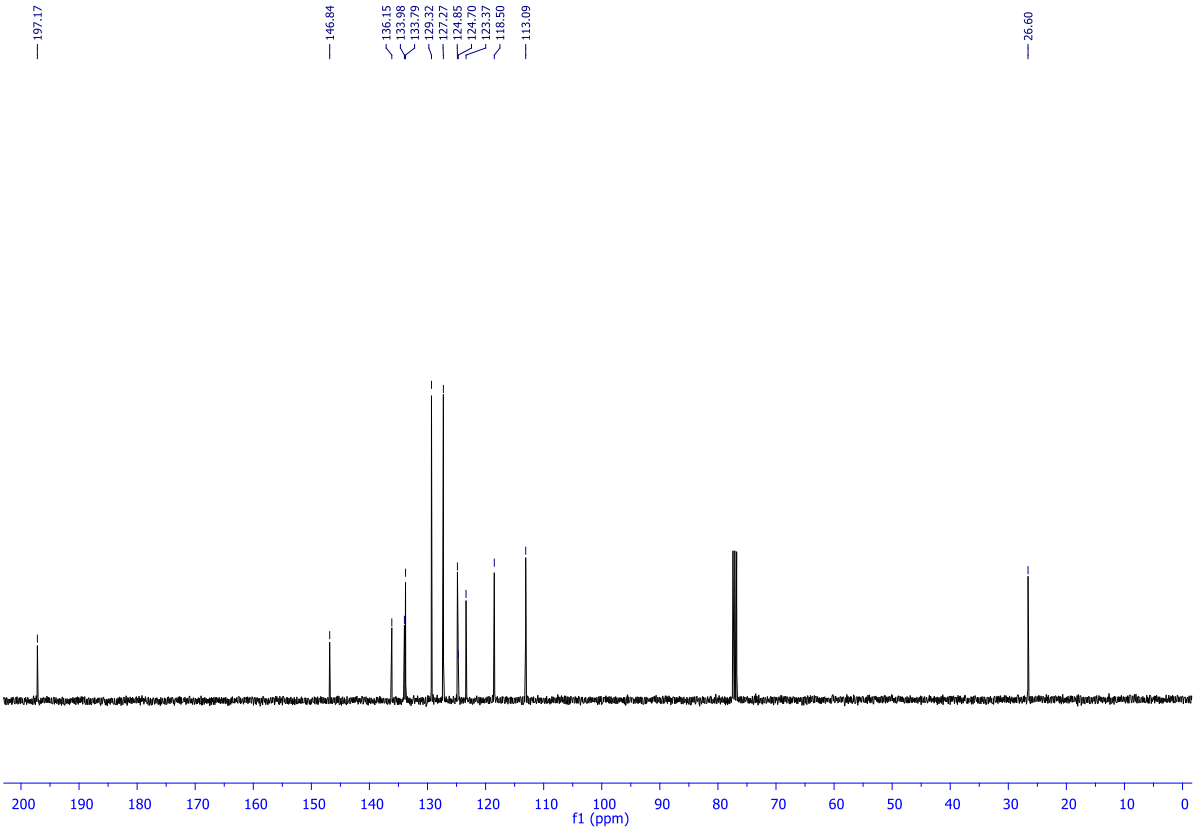
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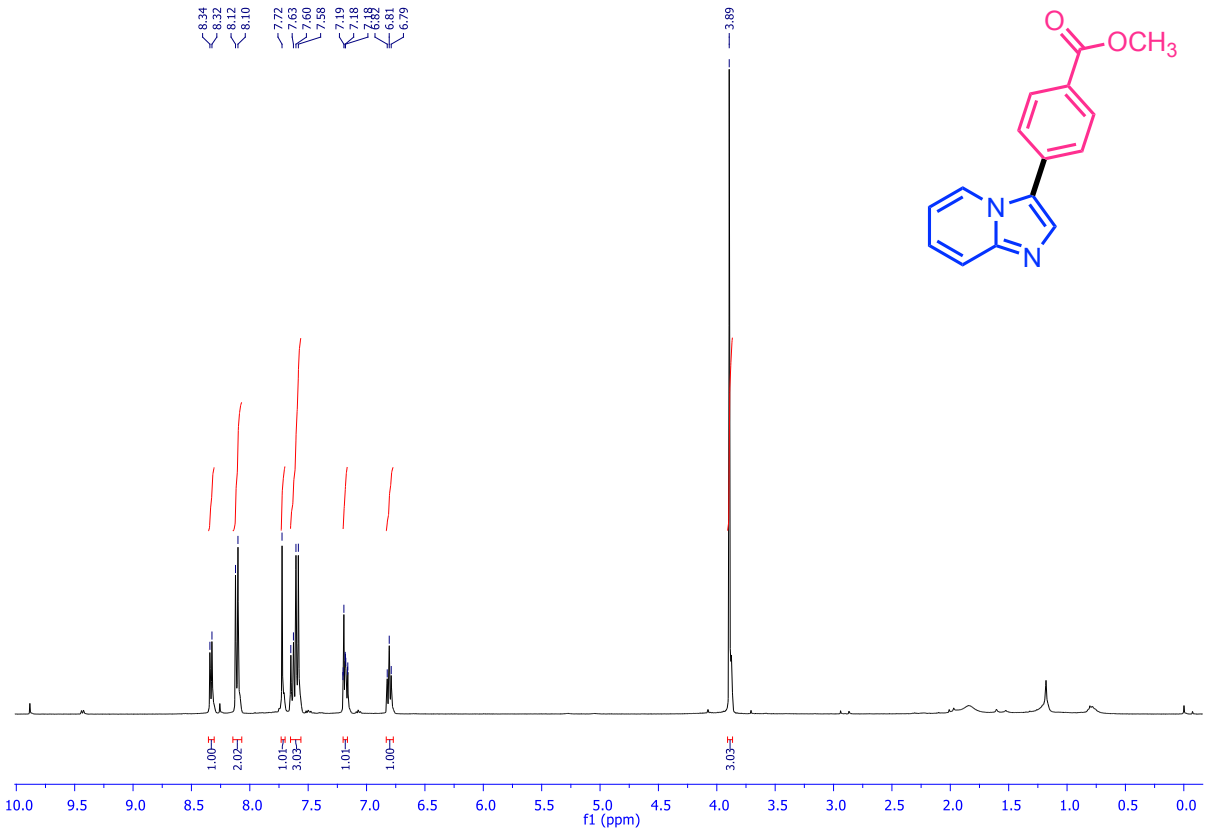
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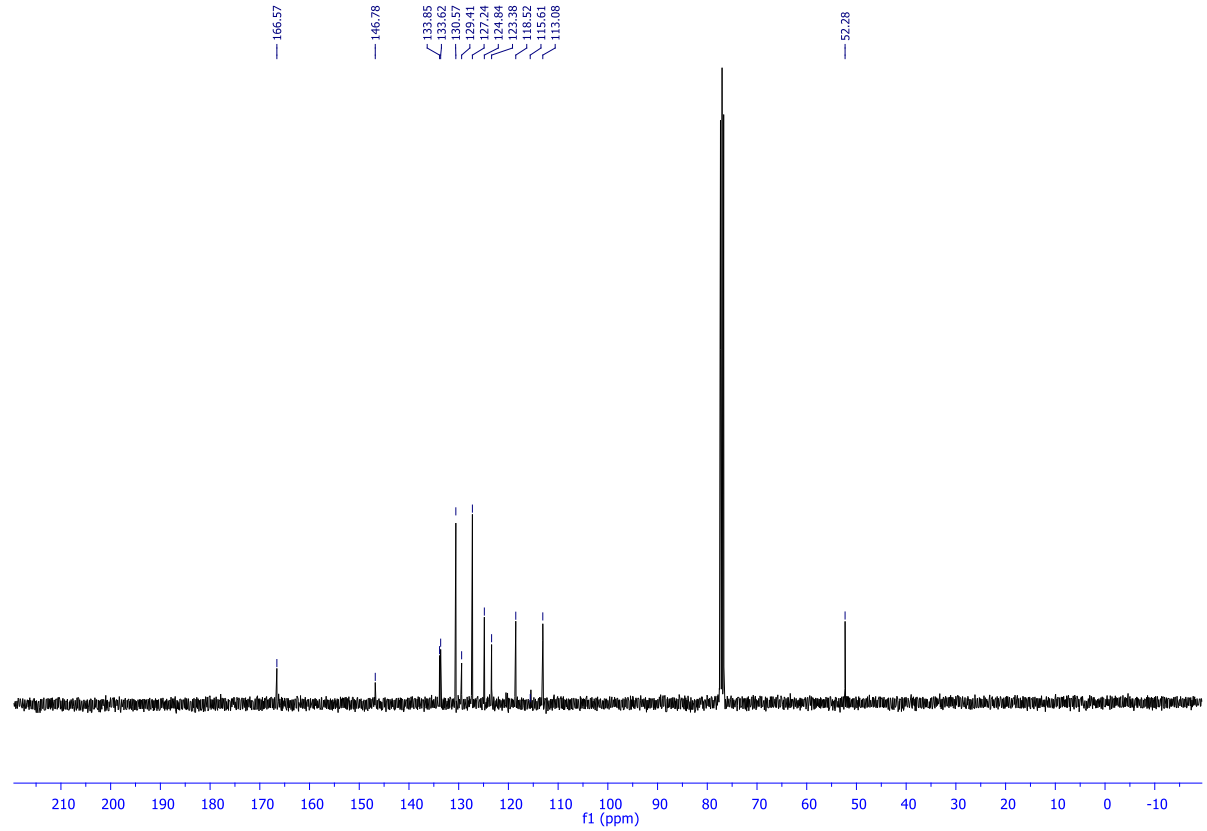
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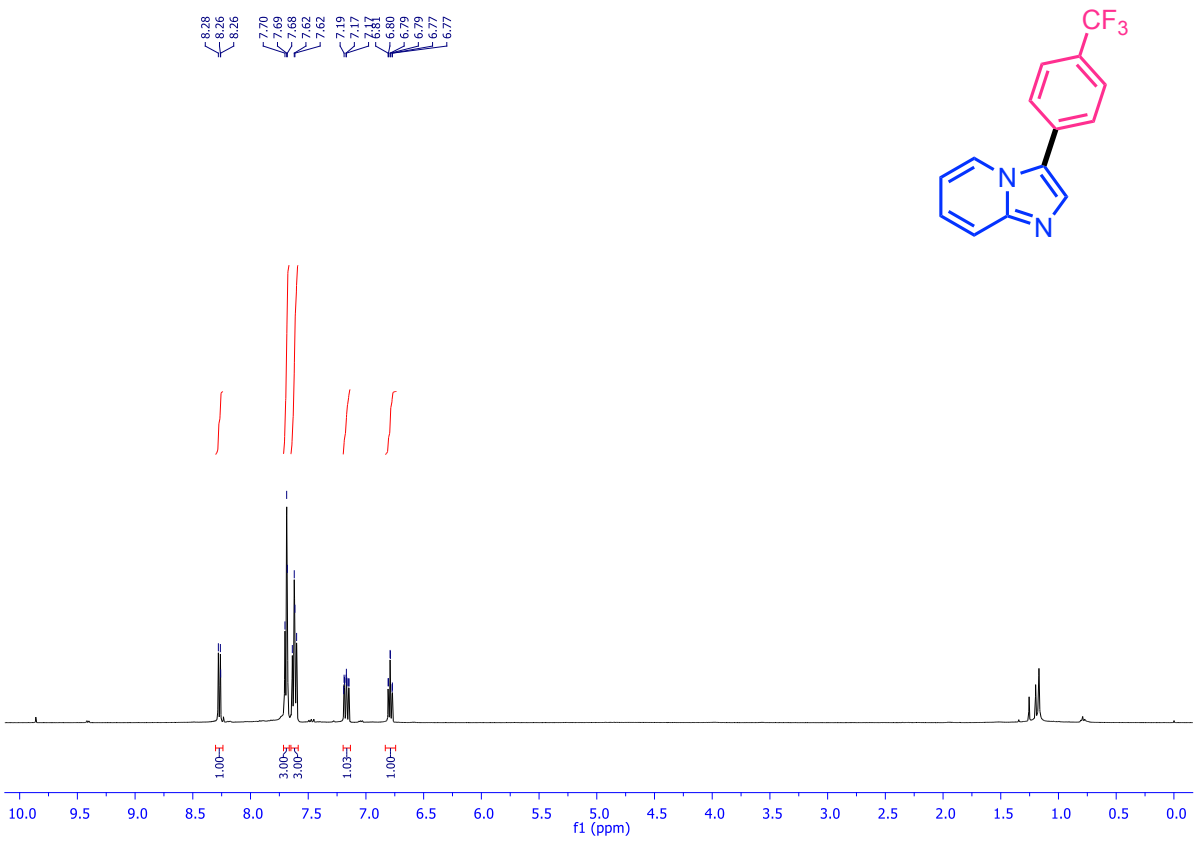
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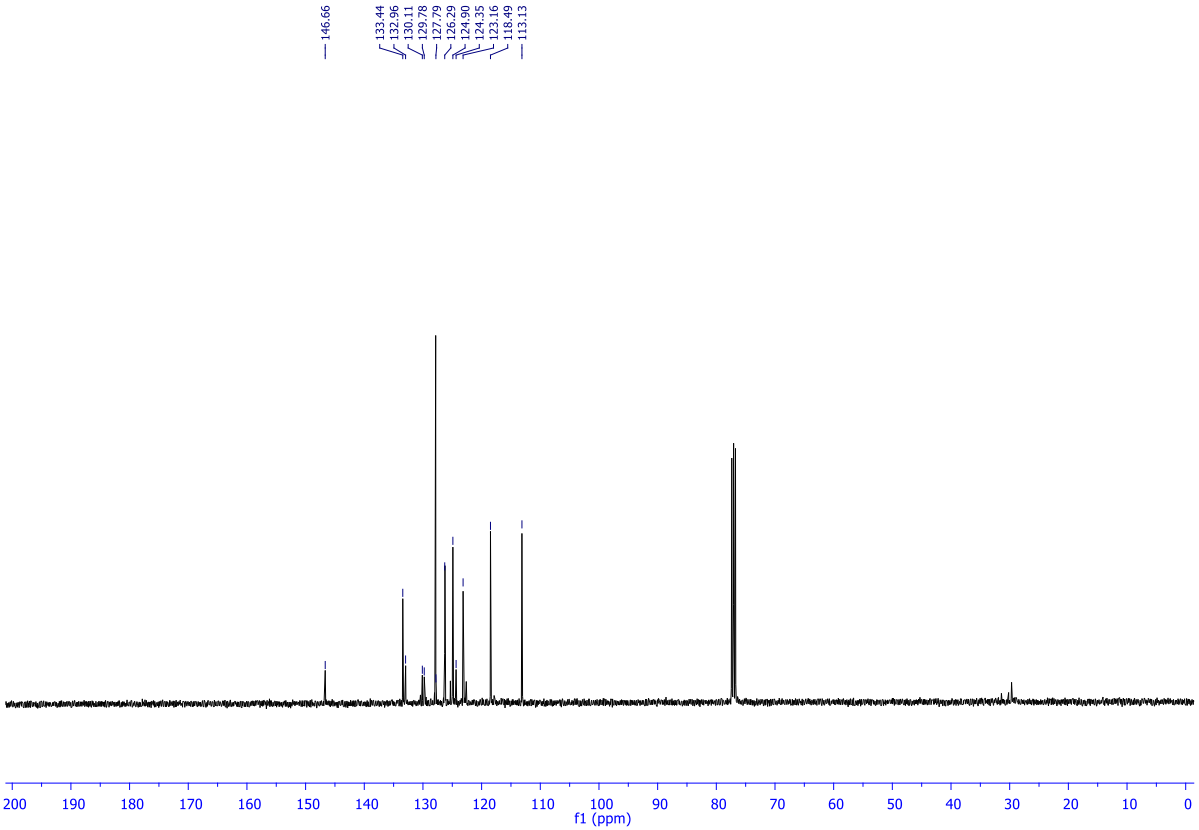
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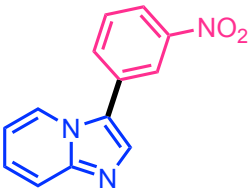
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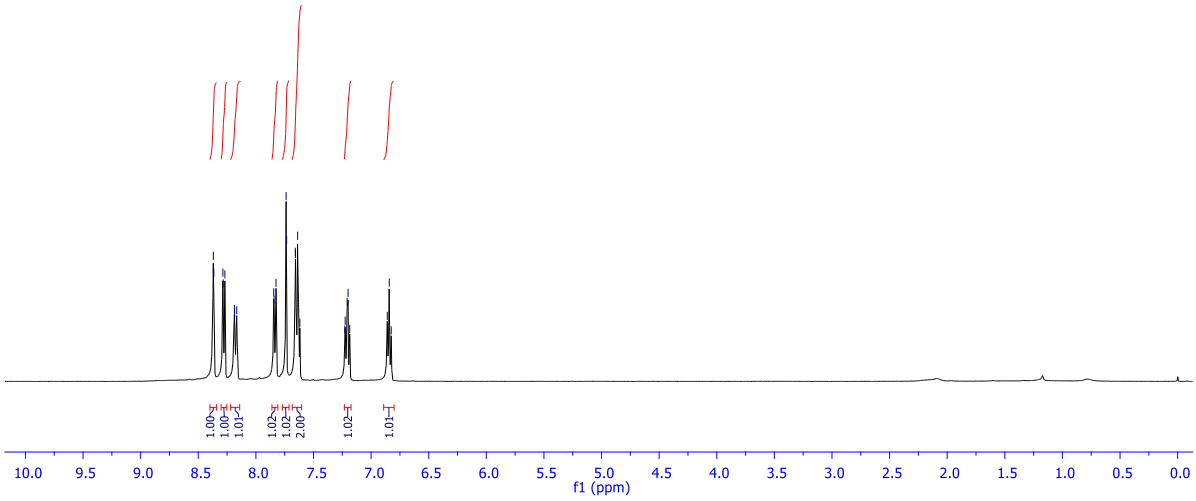
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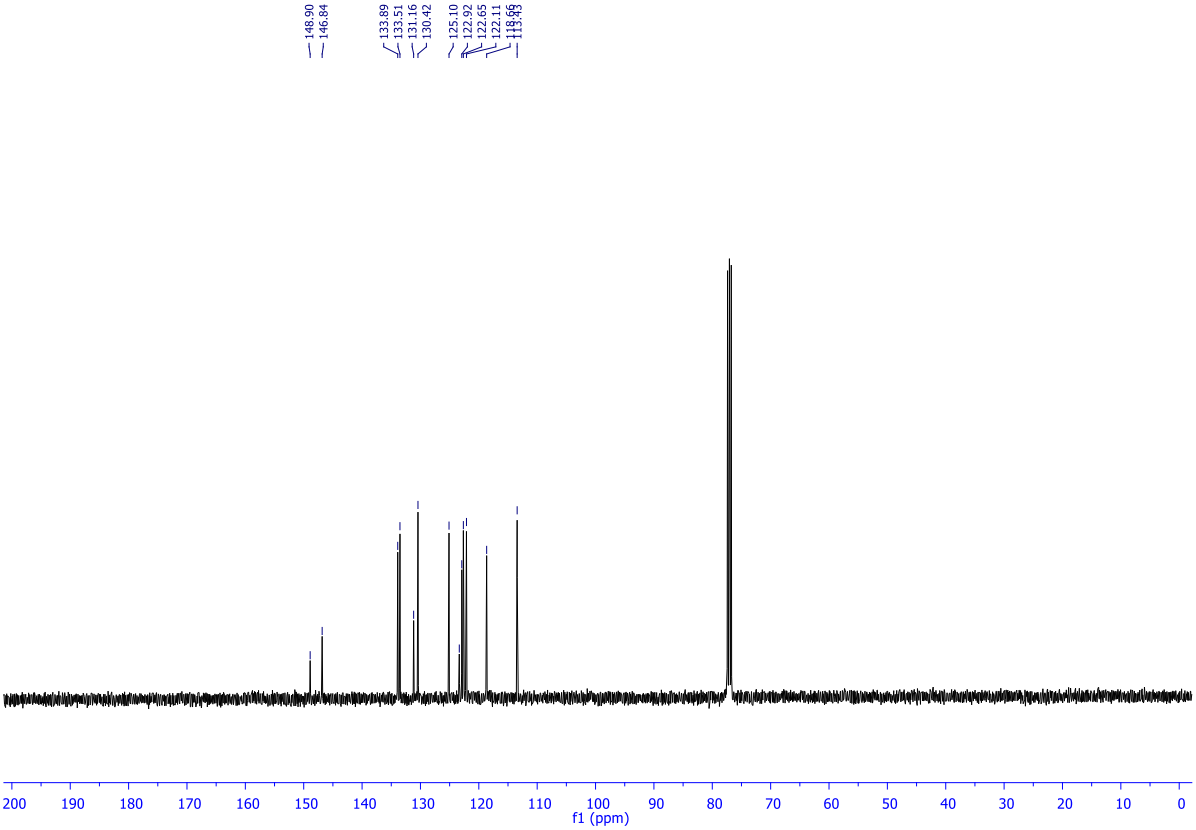
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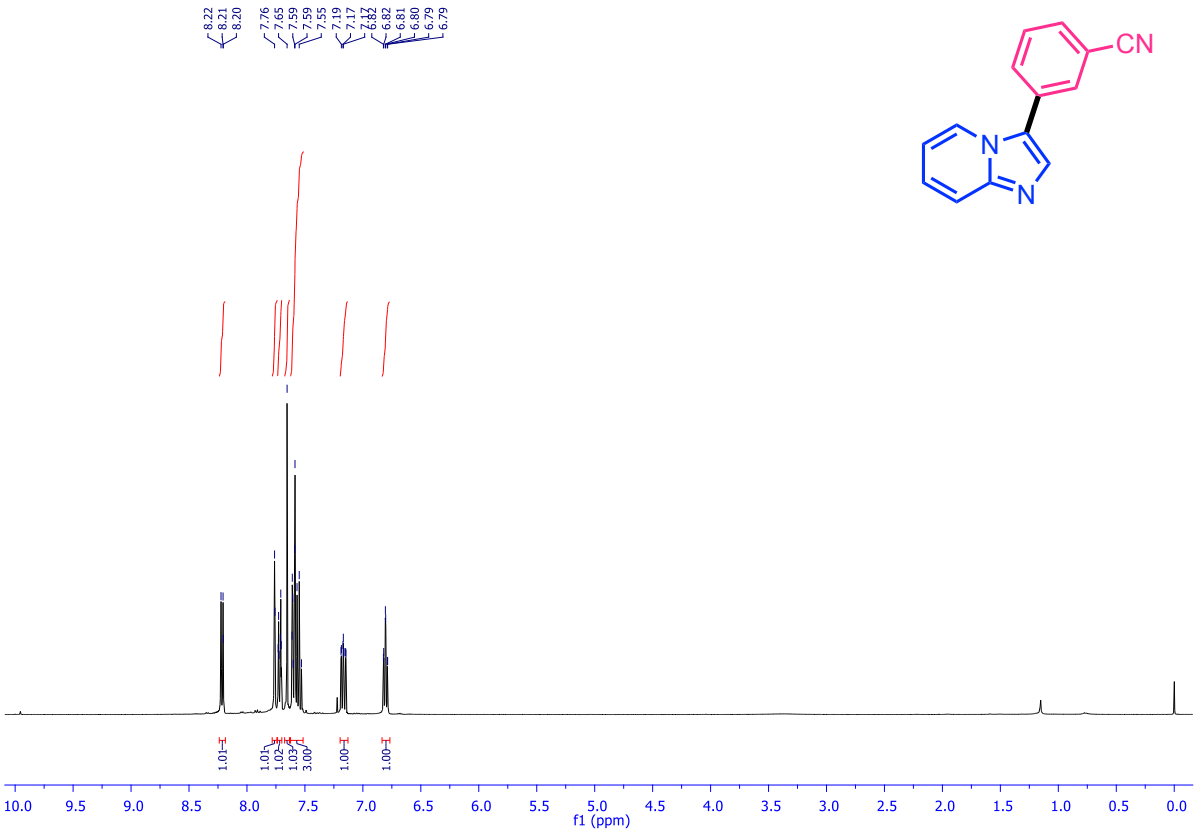
f1 (ppm)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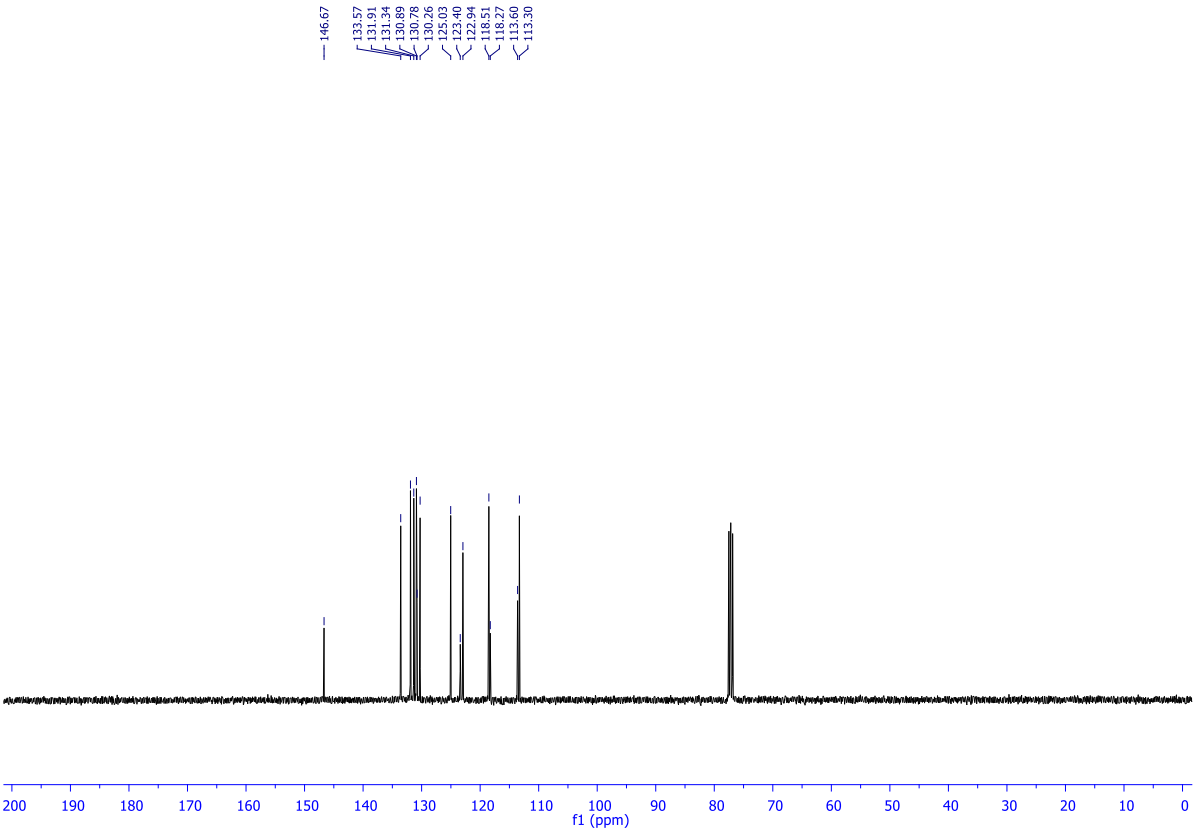
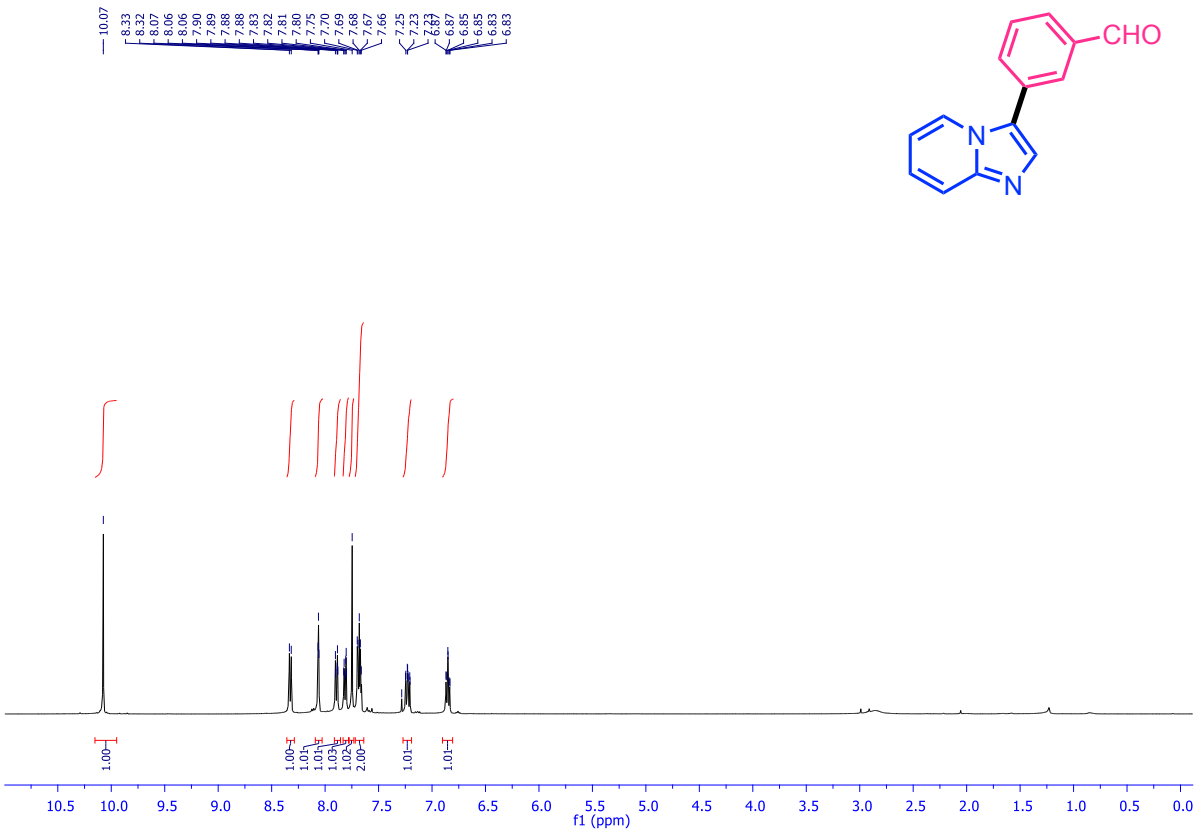
8.21
8.20
7.76
7.65
7.59
7.59
7.55
7.19
7.17
6.82
6.82
6.81
6.80
6.79
6.79
CN
N
N
1.01
1.01
1.02
1.03
3.00
1.00
1.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


146.67
133.57
131.91
131.34
130.89
130.78
130.26
125.03
123.40
122.94
118.51
118.27
113.60
113.30
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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8.32
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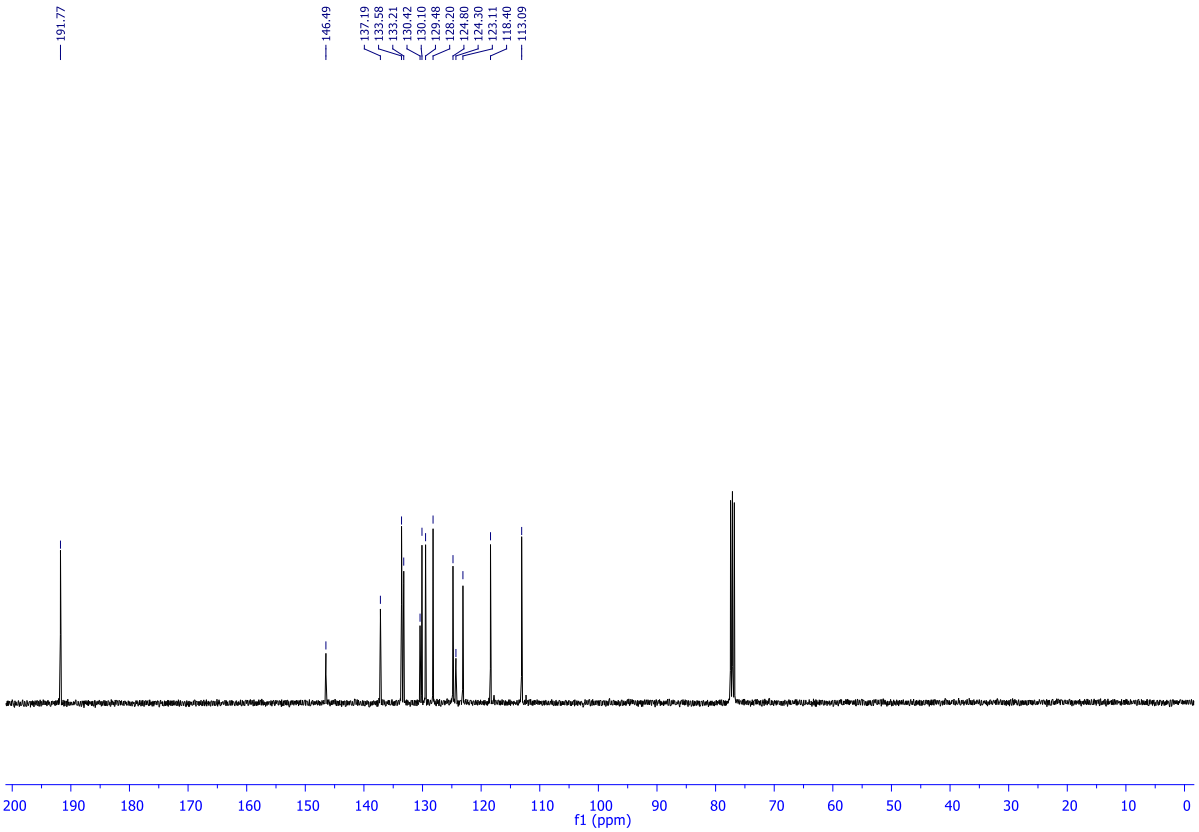
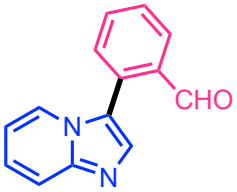
8.06
8.06
7.90
7.89
7.88
7.88
7.83
7.82
7.81
7.80
7.75
7.70
7.69
7.68
7.67
7.66
7.25
7.23
6.87
6.85
6.85
6.83
6.83
CHO
N
N
1.00
1.00
1.01
1.01
1.03
1.02
2.00
1.01
1.01
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


191.77
146.49
137.19
133.58
133.21
130.42
130.10
129.48
128.20
124.80
124.30
123.11
118.40
113.09
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


9.80
8.03
8.02
8.01
8.00
7.88
7.86
7.71
7.69
7.69
7.68
7.68
7.67
7.66
7.65
7.62
7.56
7.54
7.50
7.48
6.77
6.76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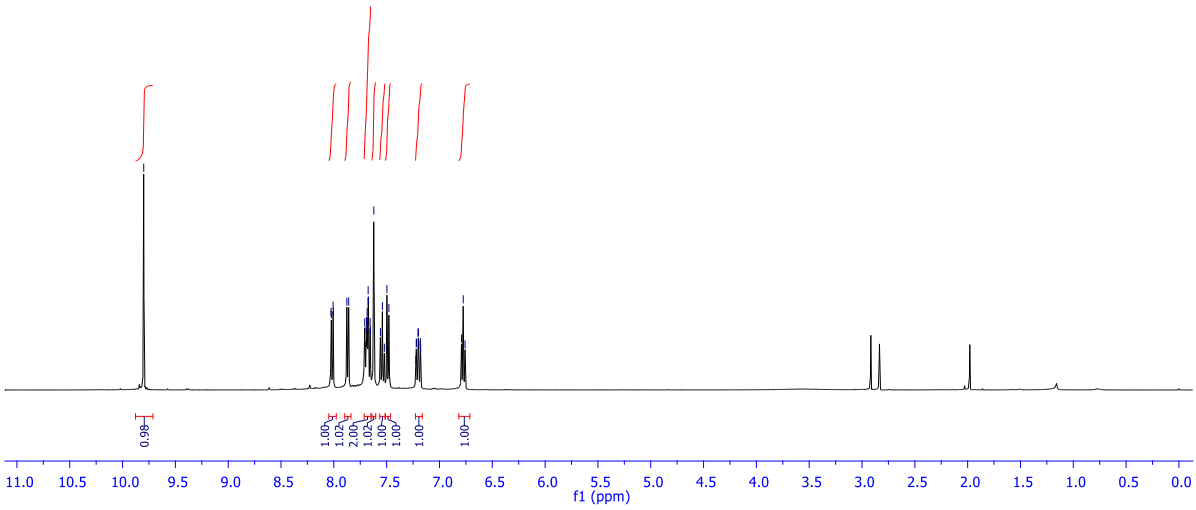
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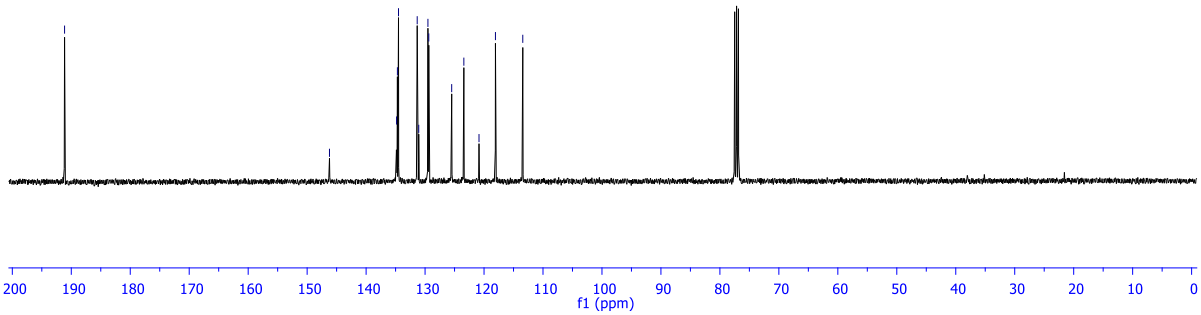
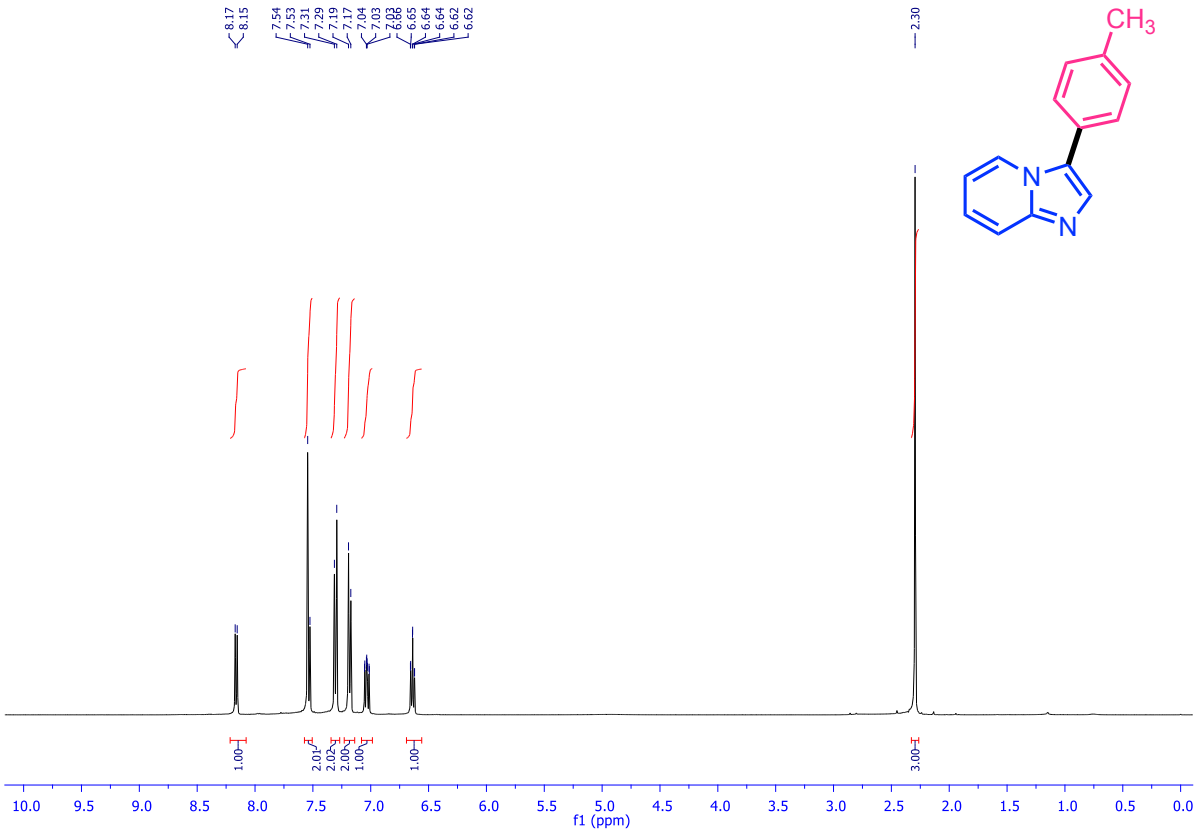
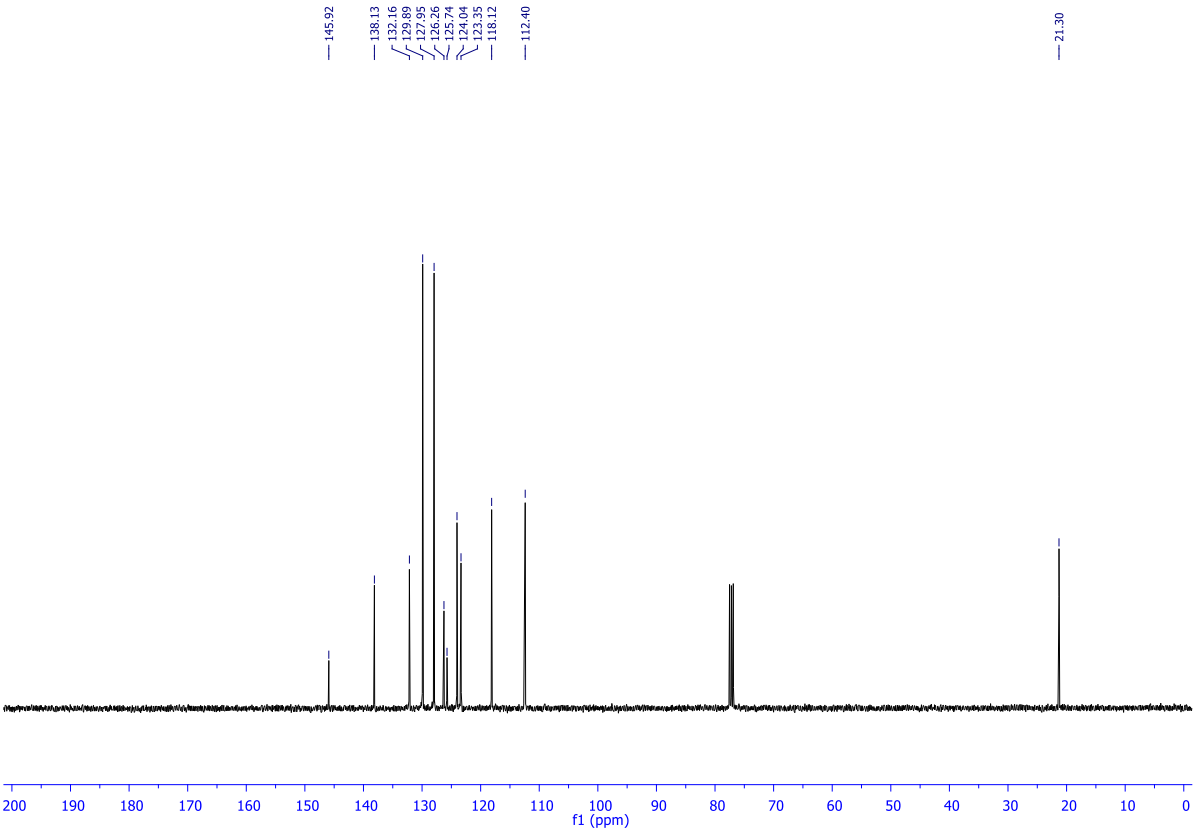
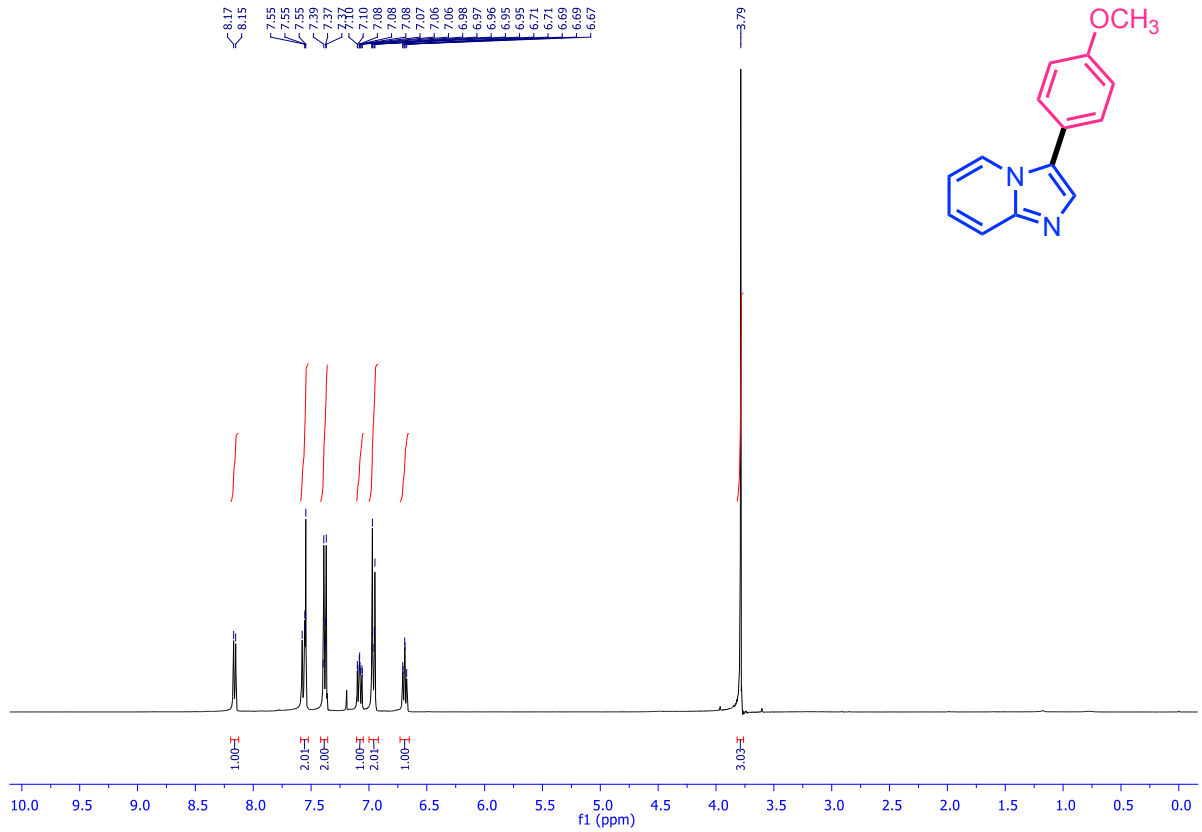
1.00
1.02
2.00
1.02
1.00
1.00
1.00
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

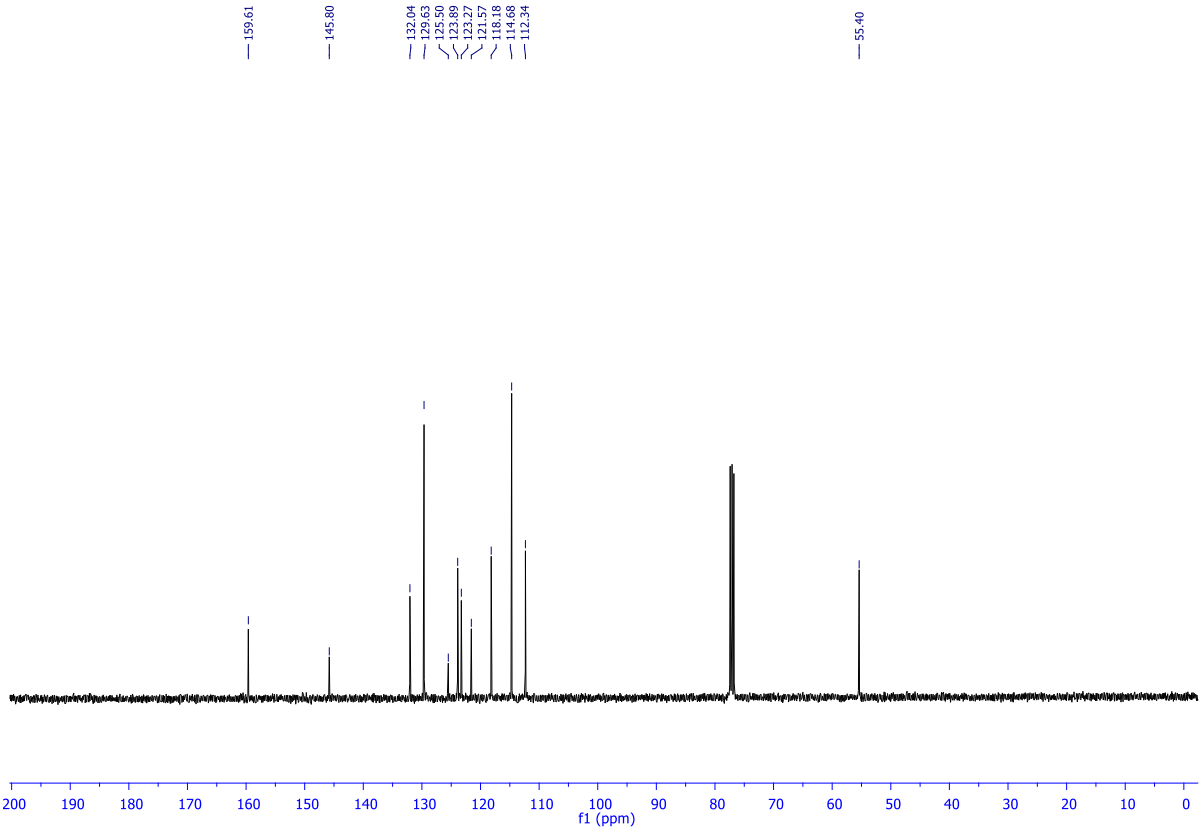

191.14
146.21
134.83
134.69
134.50
131.34
131.07
129.52
129.37
125.49
123.42
120.85
118.06
113.43

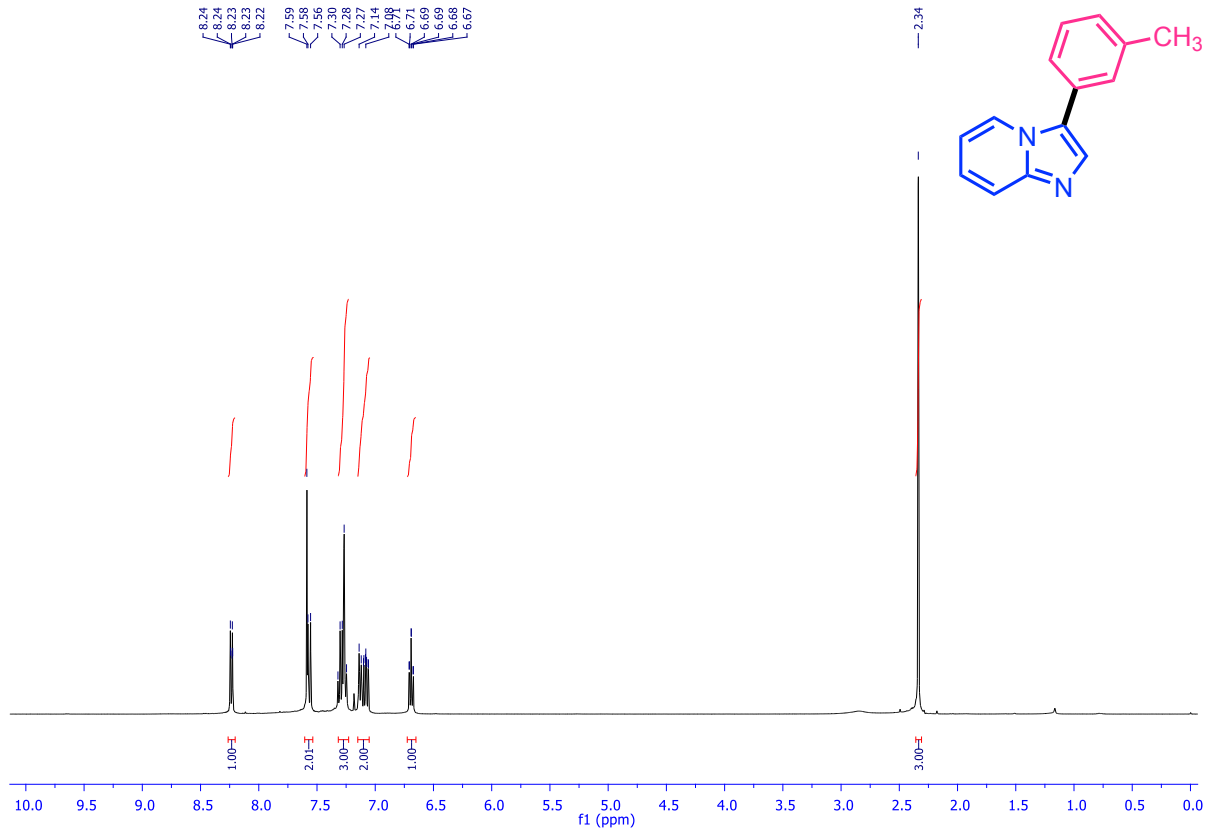

200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.17
8.15
7.54
7.53
7.31
7.29
7.19
7.17
7.04
7.03
6.65
6.64
6.64
6.62
6.62
2.30
CH3
N
N
1.00
2.01
2.02
2.06
1.06
1.00
3.00
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
f1 (ppm)


145.92
138.13
132.16
129.89
127.95
126.26
125.74
124.04
123.35
118.12
112.40
21.30
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.17
8.15
7.55
7.55
7.55
7.39
7.37
7.37
7.10
7.08
7.08
7.08
7.07
7.06
7.06
6.98
6.97
6.96
6.95
6.95
6.71
6.69
6.69
6.67
3.79
OCH3
N
N
1.00
2.01
2.00
1.00
2.01
1.00
3.03
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
f1 (ppm)


159.61
145.80
132.04
129.63
125.50
123.89
123.27
121.57
118.18
114.68
112.34
55.40
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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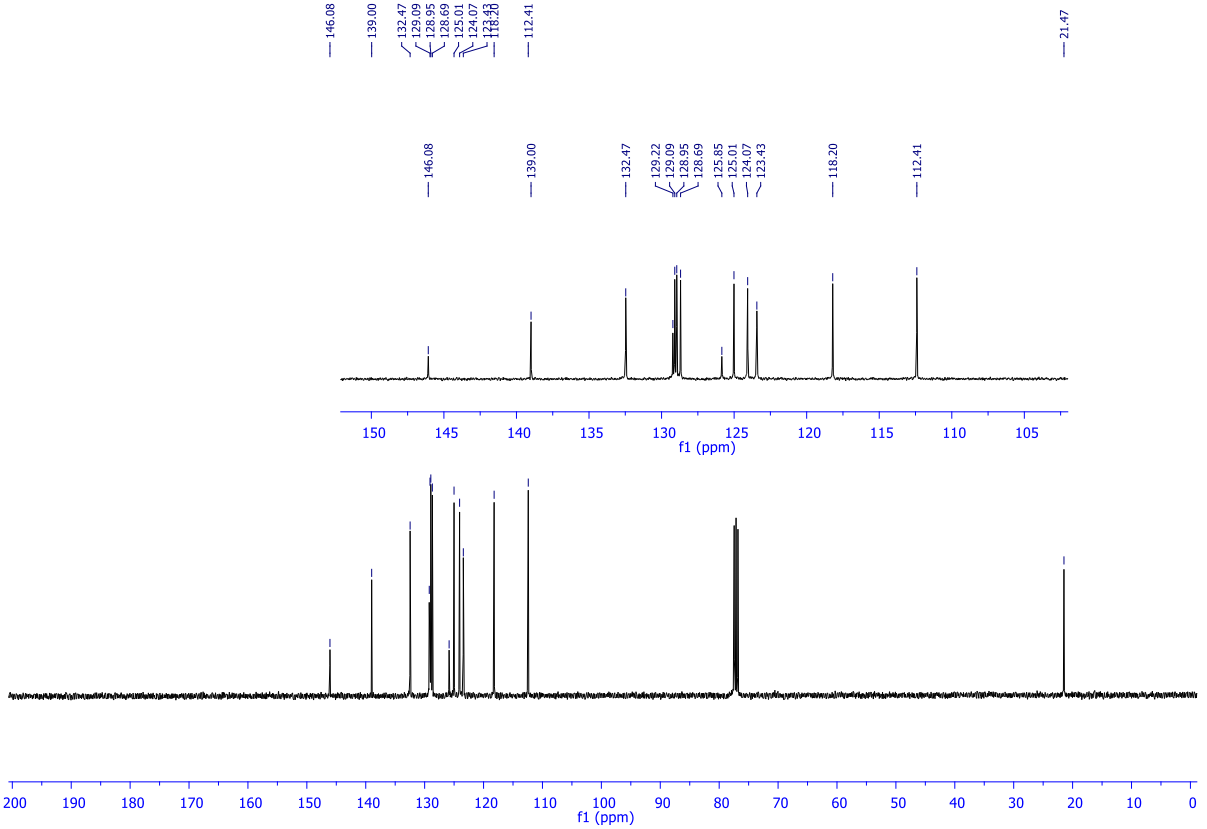
8.24
8.23
8.23
8.22
7.59
7.58
7.56
7.30
7.28
7.27
7.14
7.08
6.71
6.69
6.69
6.68
6.67
2.34
CH3
N
N
1.00
2.01
3.00
2.00
1.00
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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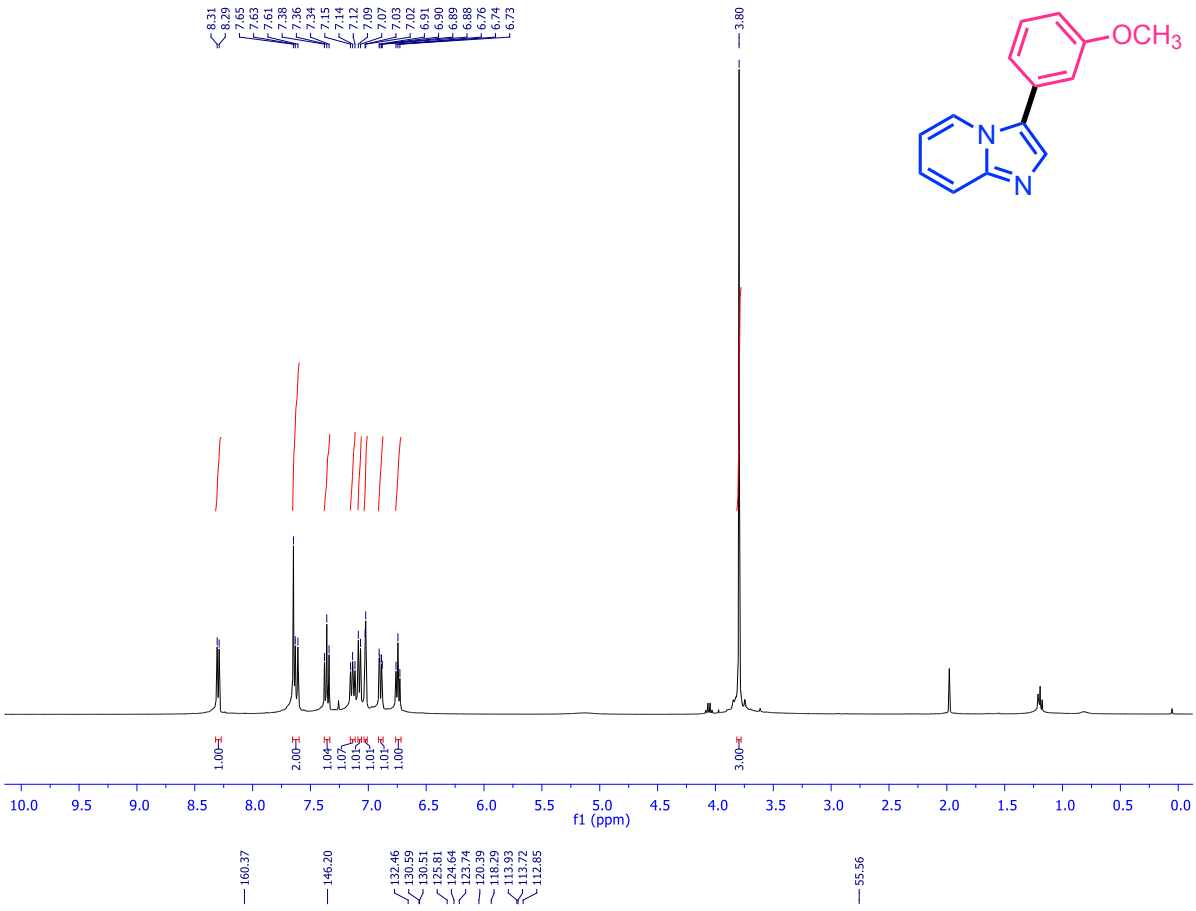
139.00
132.47
129.09
128.95
128.69
125.01
124.07
123.43
118.20
112.41
21.47
146.08
139.00
132.47
129.22
129.09
128.95
128.69
125.85
125.01
124.07
123.43
118.20
112.41
150 145 140 135 130 125 120 115 110 105
f1 (ppm)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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8.29
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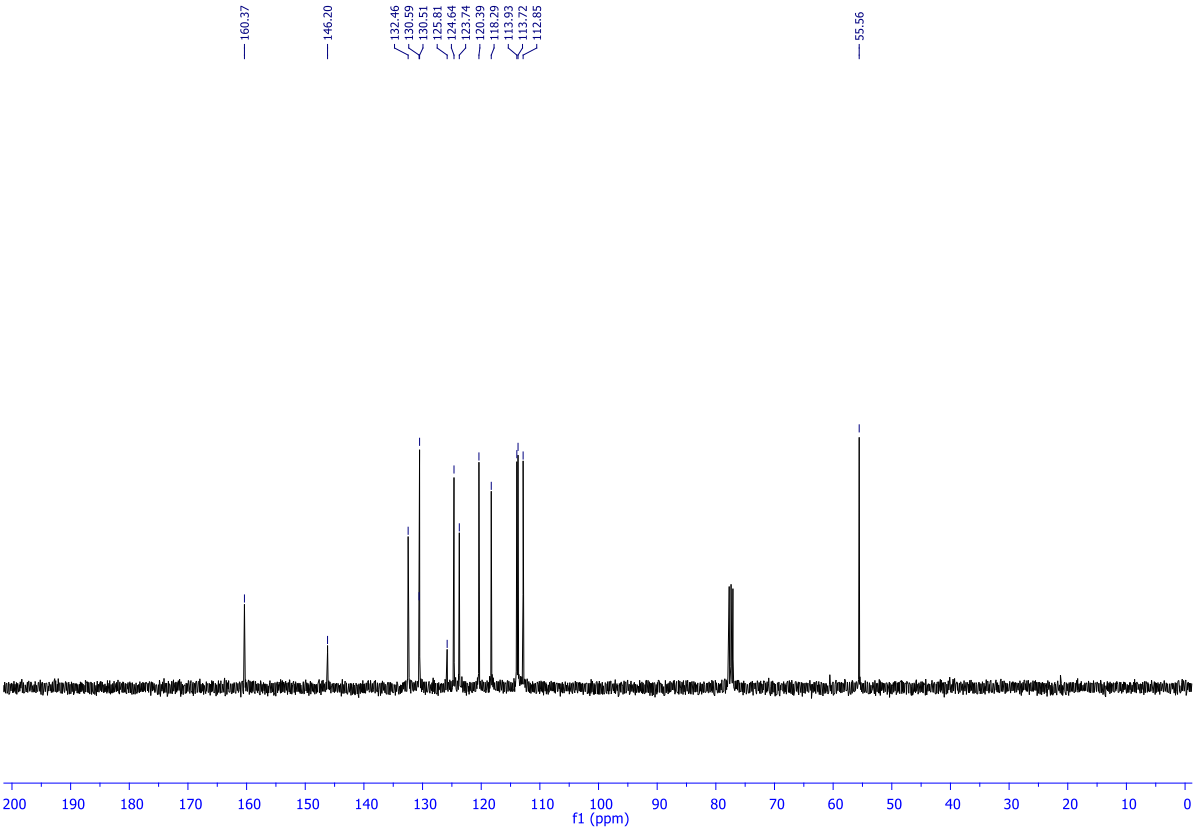
7.63
7.61
7.38
7.36
7.34
7.15
7.14
7.12
7.09
7.07
7.03
7.02
6.91
6.90
6.89
6.88
6.76
6.74
6.73
3.80
OCH3
N
N
1.00
2.00
1.04
1.07
1.01
1.01
1.01
1.00
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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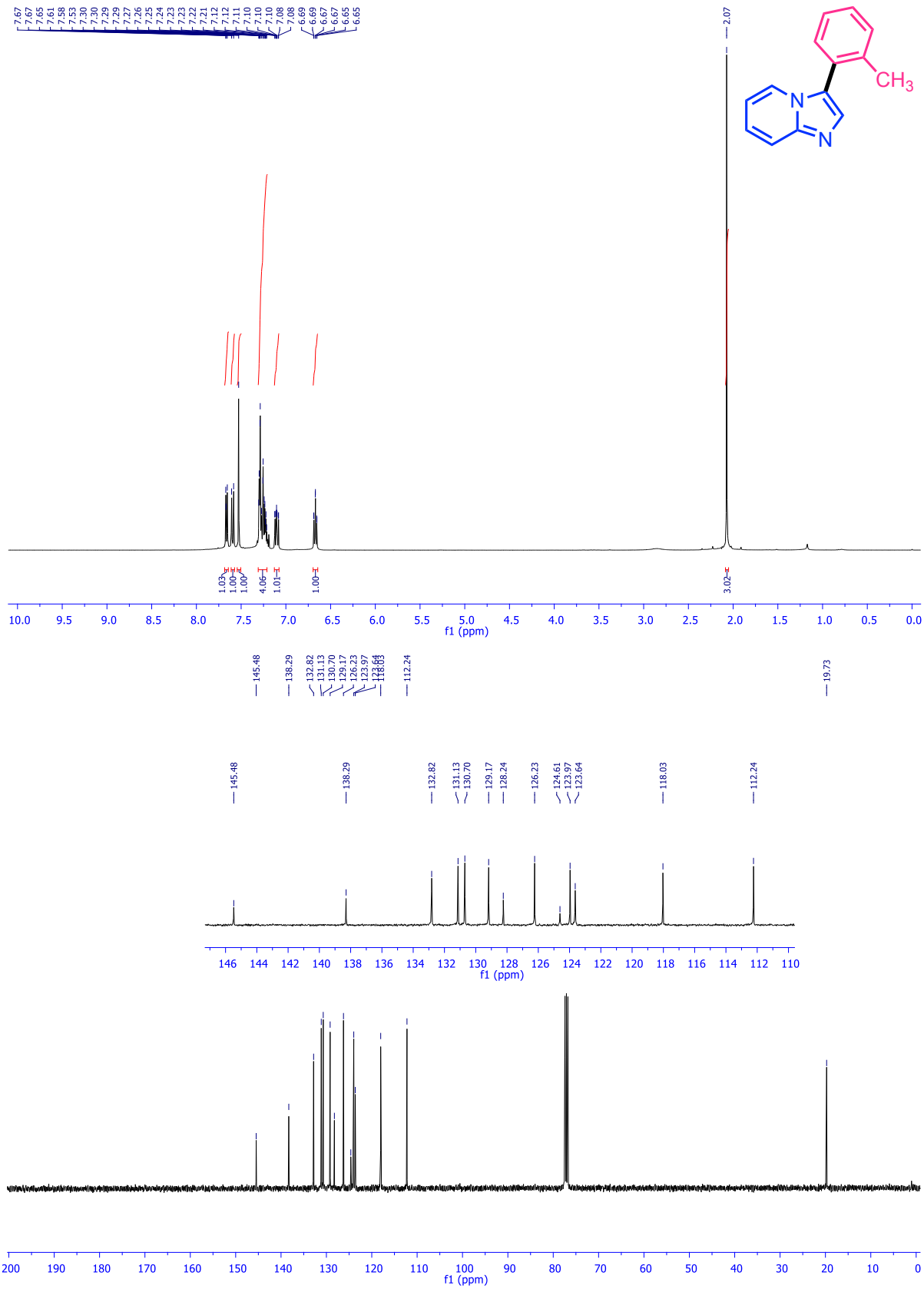
146.20
132.46
130.59
130.51
125.81
124.64
123.74
120.39
118.29
113.93
113.72
112.85
55.56
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.67
7.67
7.65
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7.58
7.53
7.30
7.29
7.29
7.27
7.26
7.25
7.24
7.23
7.23
7.22
7.21
7.12
7.11
7.10
7.10
7.10
7.08
7.08
6.69
6.69
6.67
6.67
6.65
6.65
2.07
CH3
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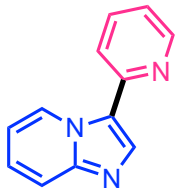
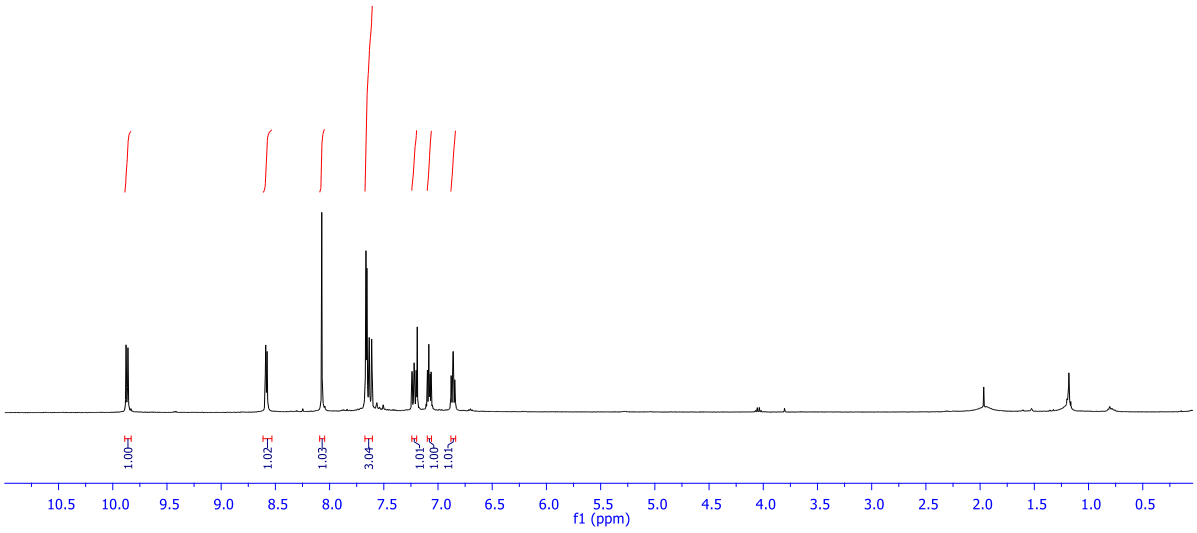
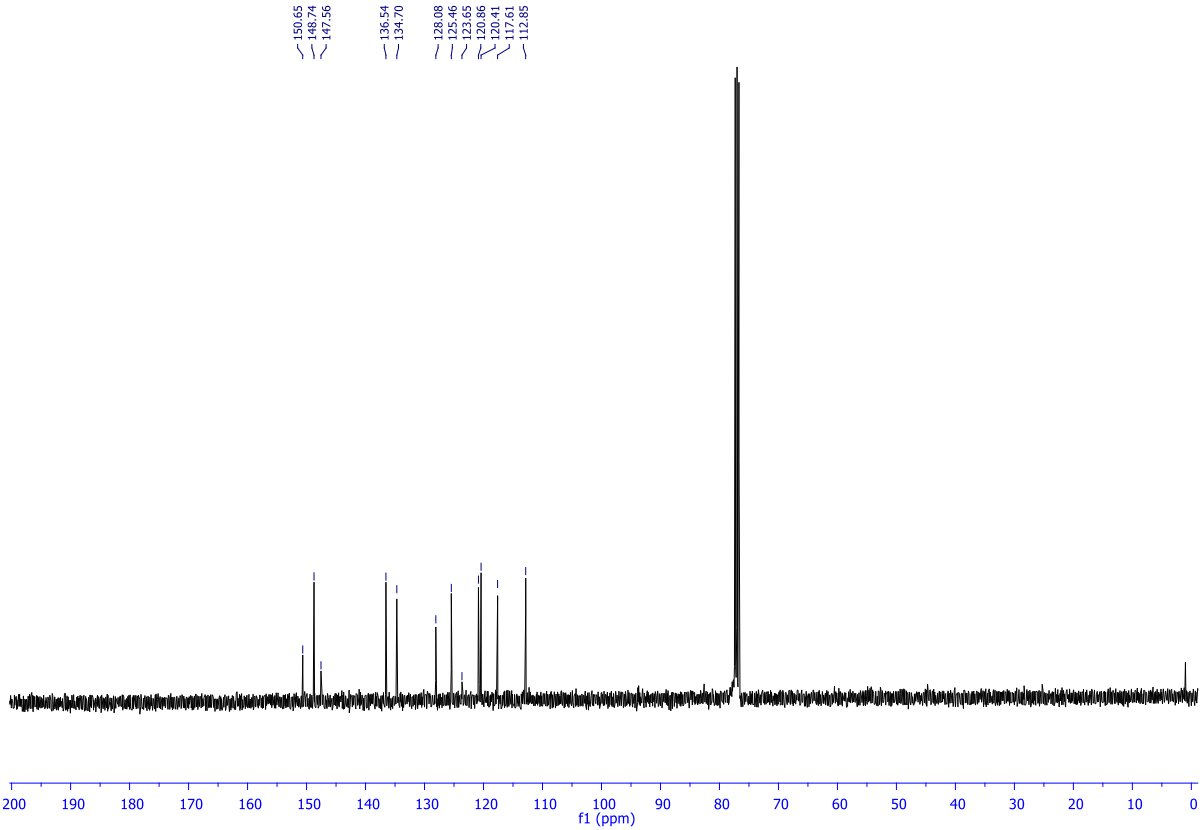
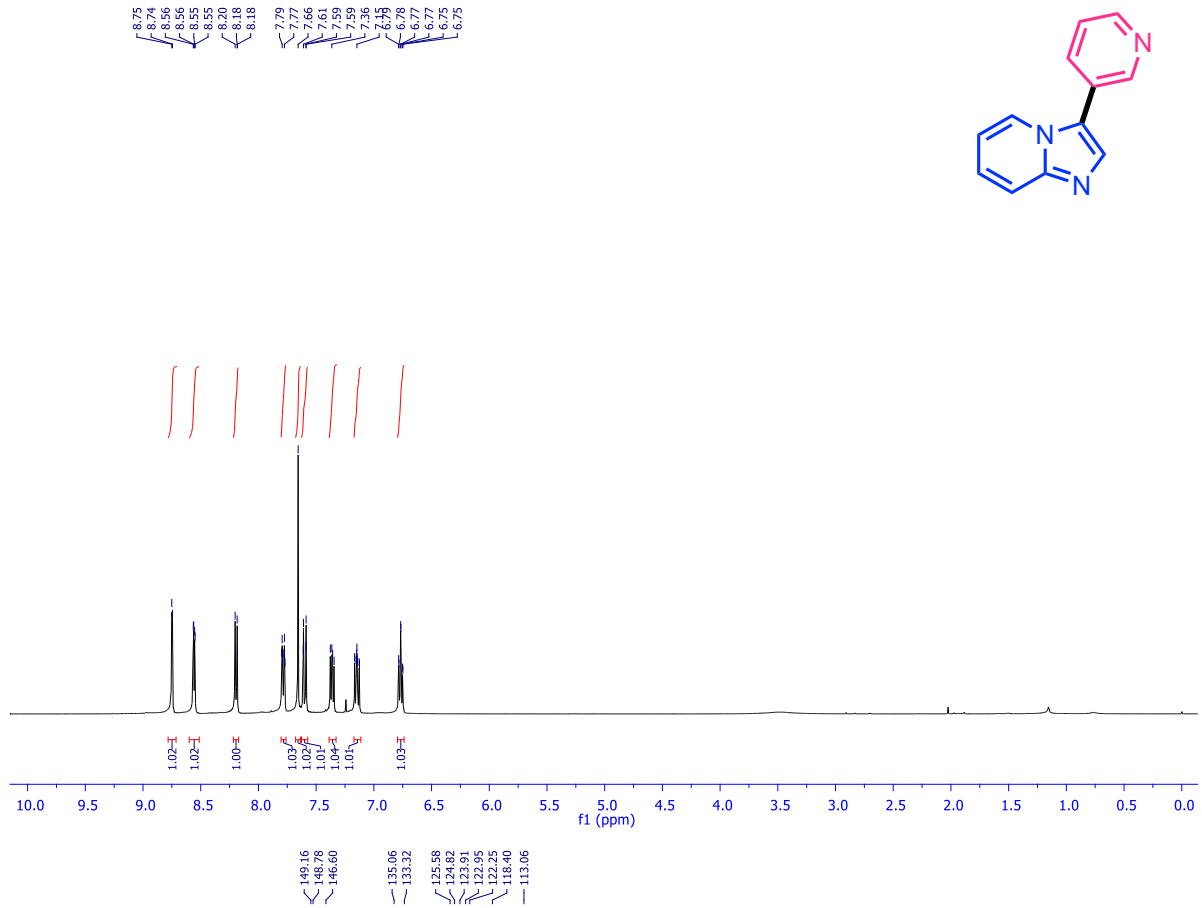
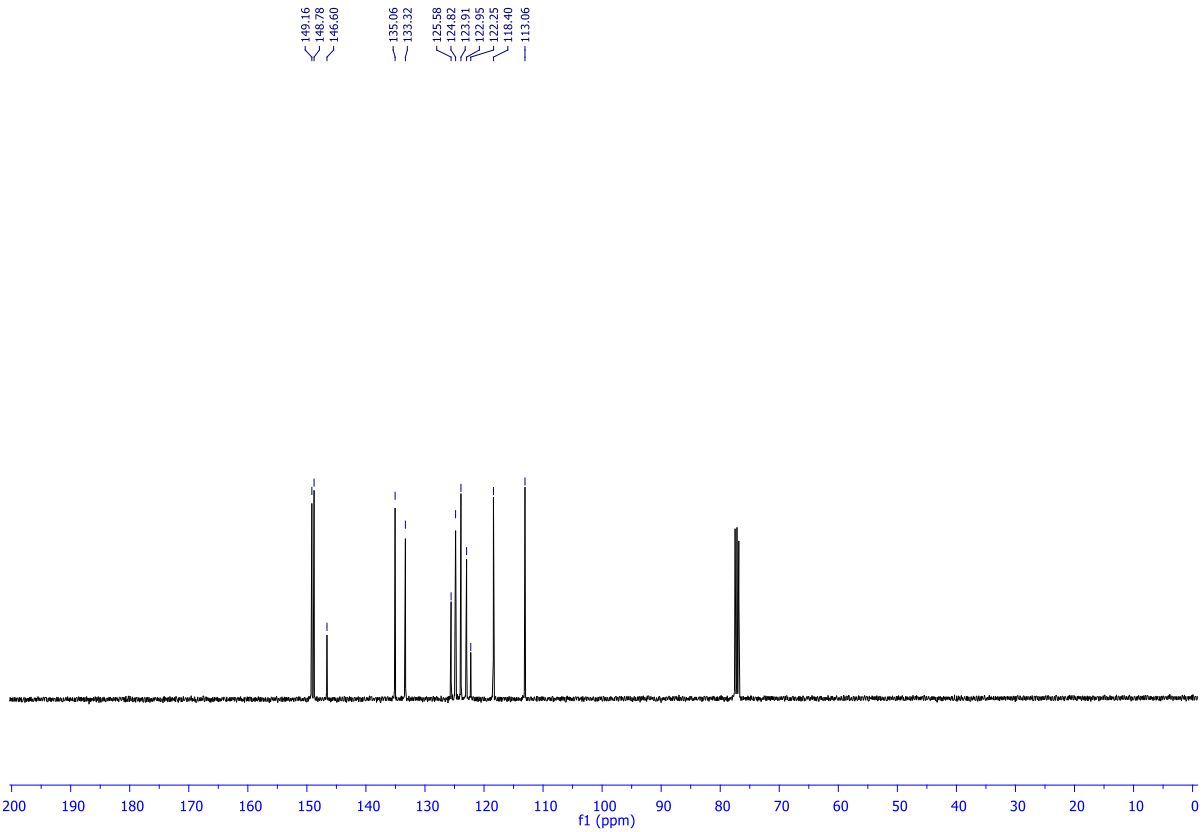
1.03
1.00
1.00
4.06
1.01
1.00
3.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
145.48
138.29
132.82
131.13
130.70
129.17
126.23
123.97
123.64
118.03
112.24
19.73
146 144 142 140 138 136 134 132 130 128 126 124 122 120 118 116 114 112 110
f1 (ppm)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


N
N
N


1.00
1.02
1.03
3.04
1.01
1.00
1.01
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
f1 (ppm)


150.65
148.74
147.56
136.54
134.70
128.08
125.46
123.65
120.86
120.41
117.61
112.85
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.75
8.74
8.56
8.56
8.55
8.55
8.20
8.18
8.18
7.79
7.77
7.66
7.61
7.59
7.59
7.36
7.15
6.78
6.77
6.77
6.75
6.75
N
N
N
1.02
1.02
1.00
1.03
1.02
1.01
1.04
1.01
1.03
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
f1 (ppm)


149.16
148.78
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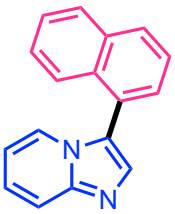
135.06
133.32
125.58
124.82
123.91
122.95
122.25
118.40
113.06
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.90
7.88
7.87
7.85
7.73
7.70
7.68
7.60
7.59
7.49
7.48
7.46
7.45
7.43
7.42
7.33
7.31
7.29
7.14
7.12
7.10
6.58
6.57
6.55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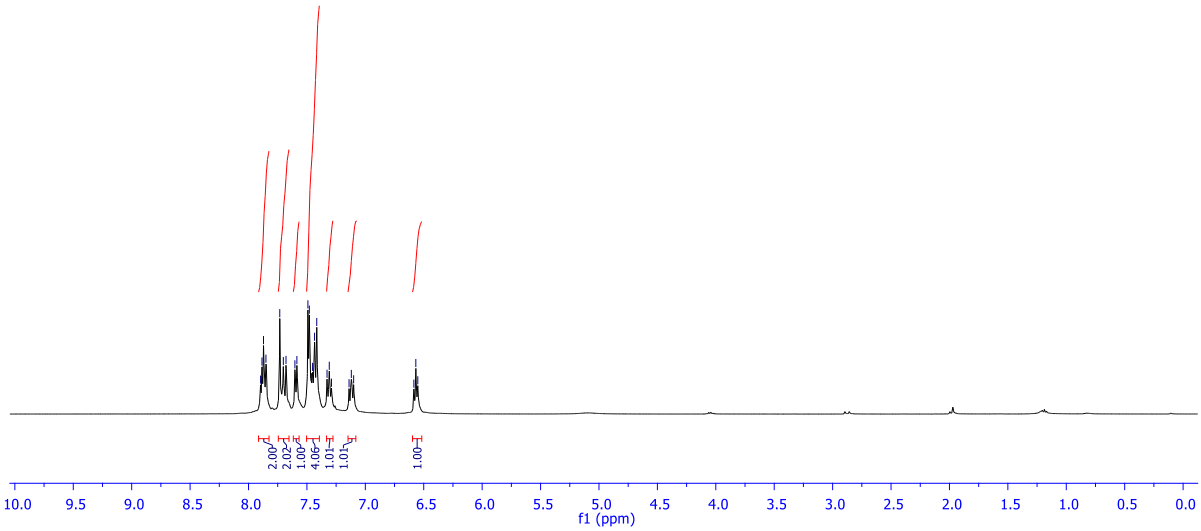
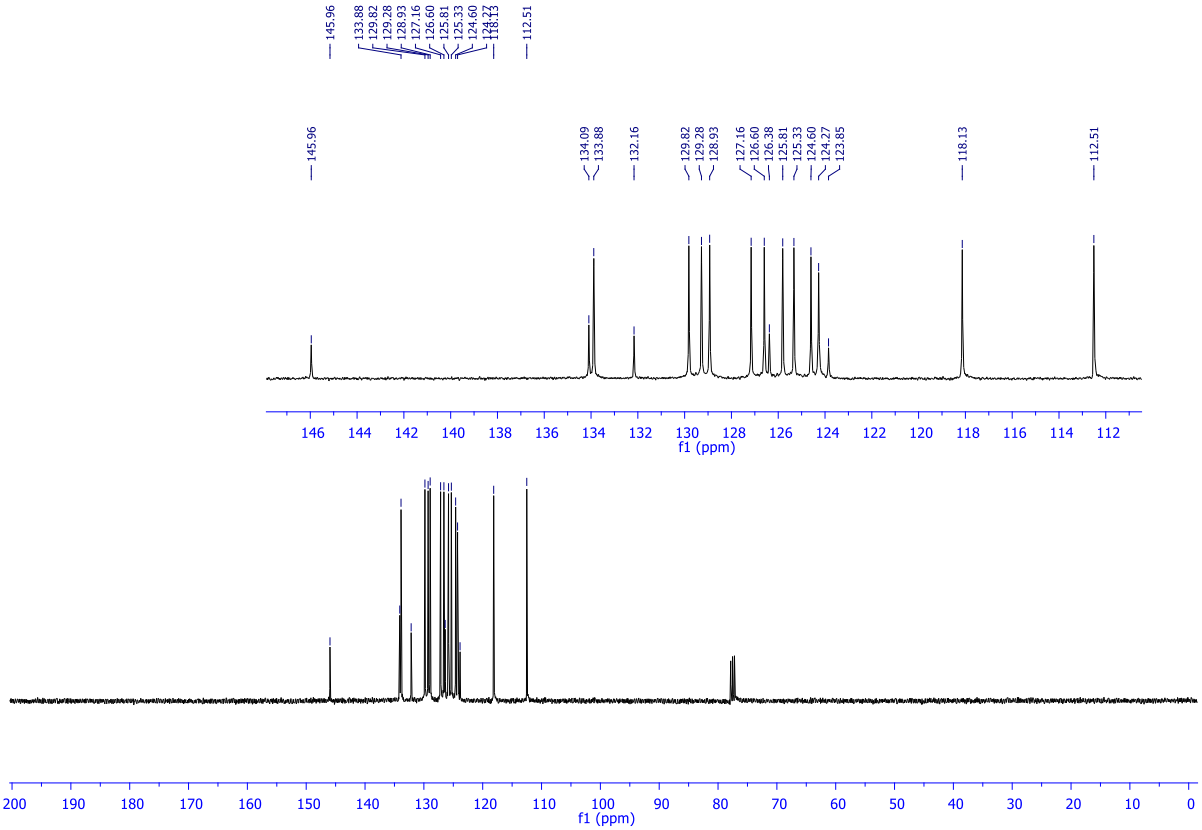
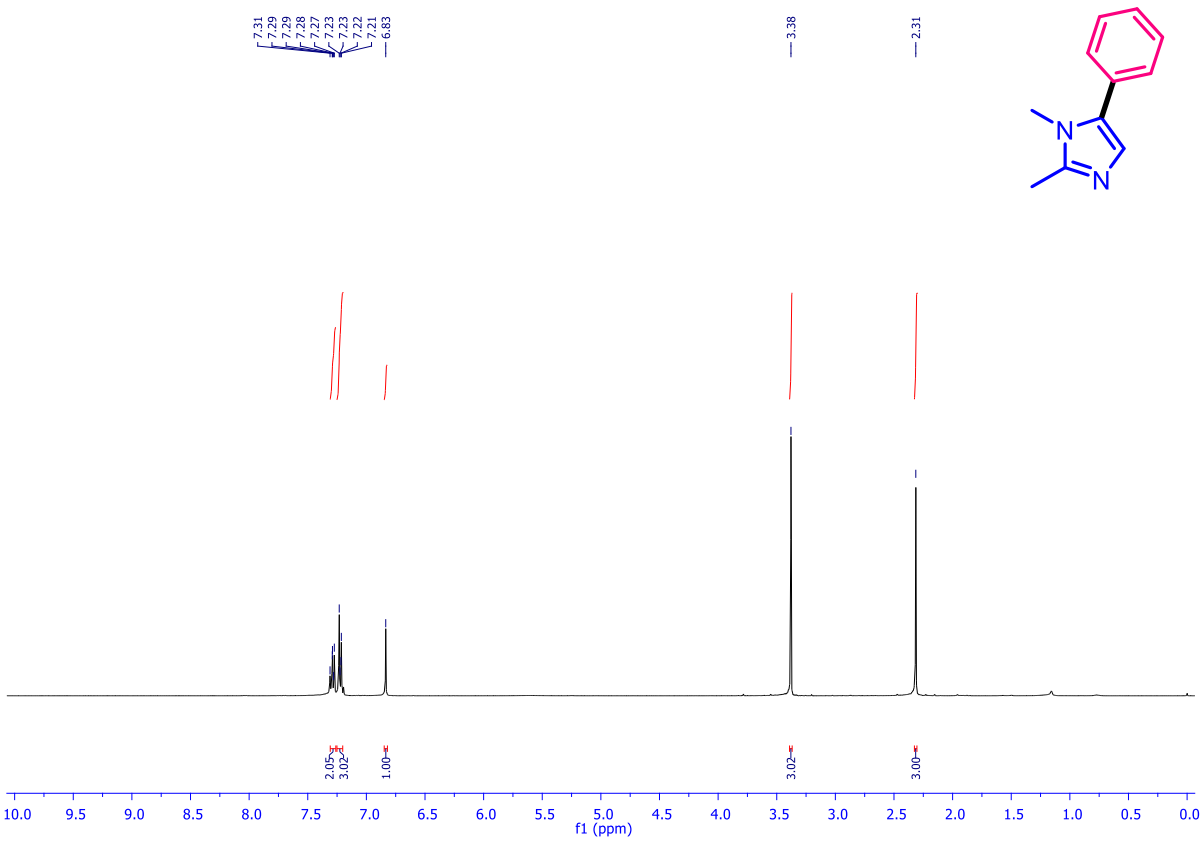
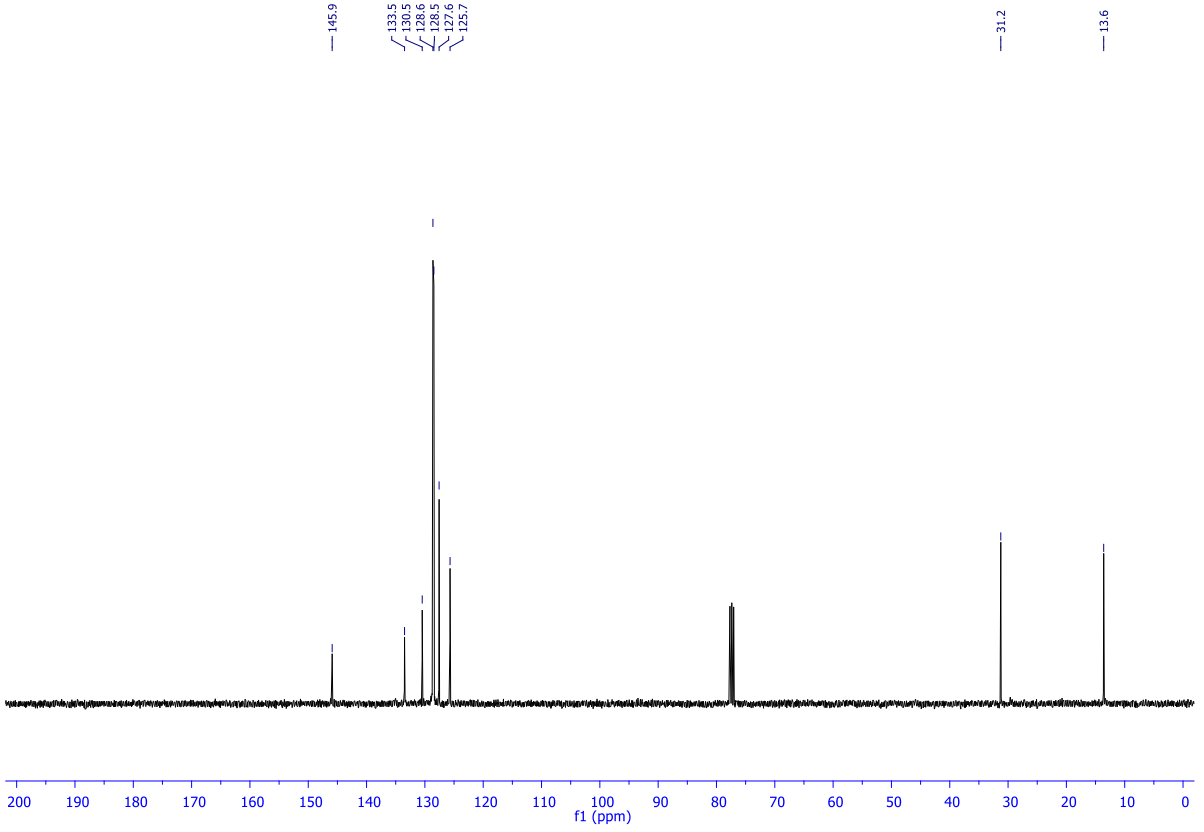
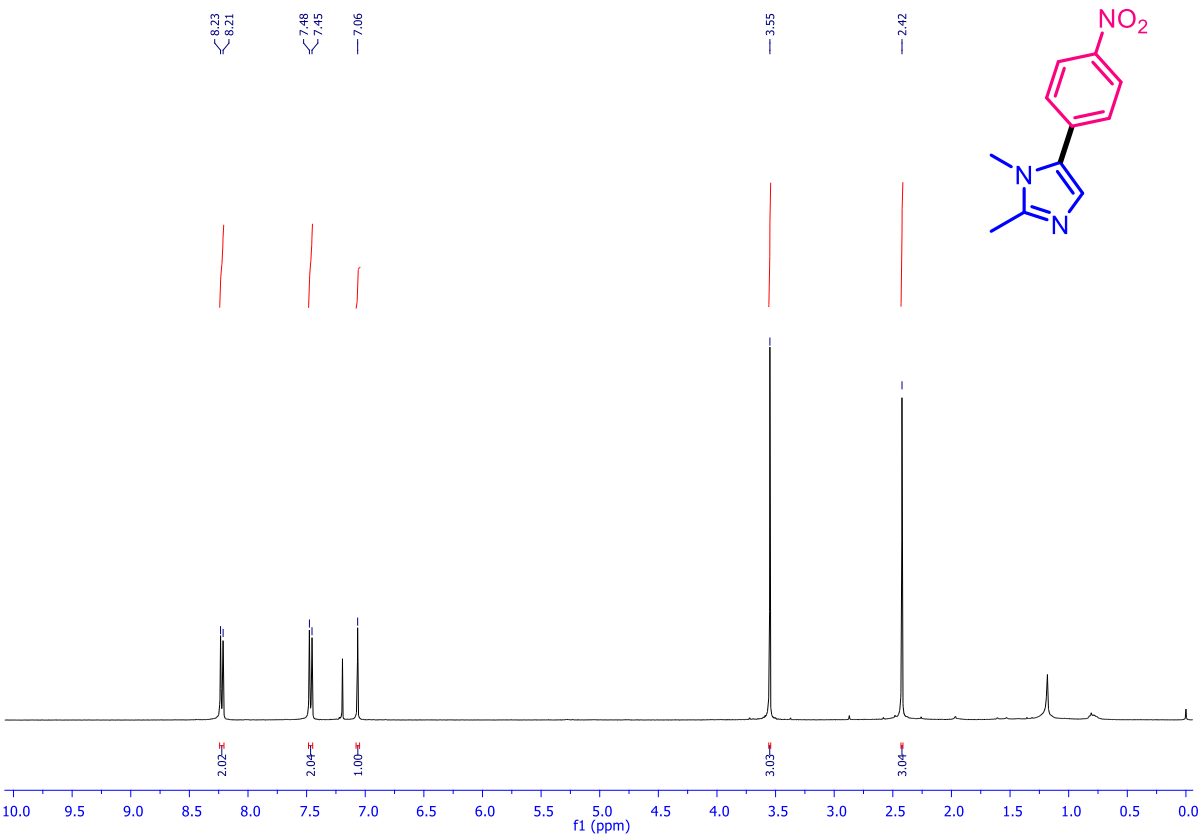
N

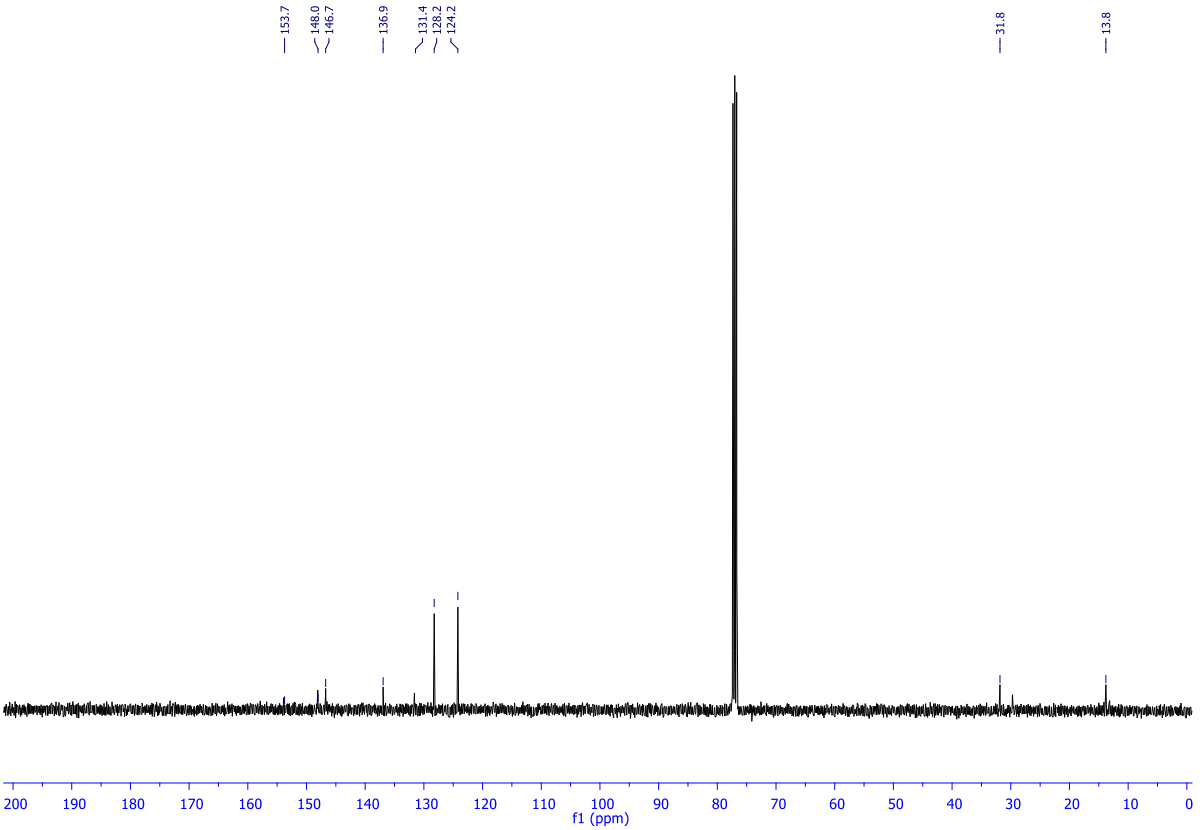

2.00
2.02
1.00
4.06
1.01
1.01
1.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

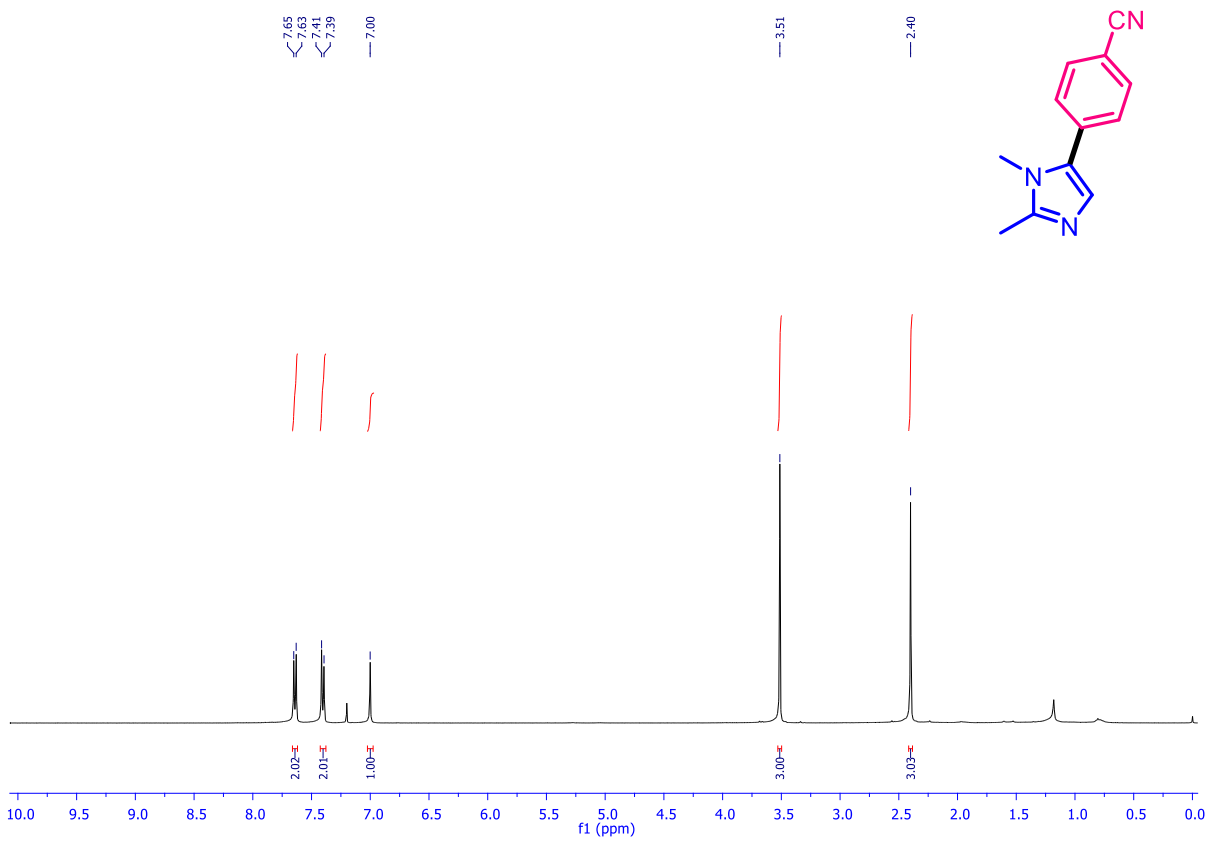

145.96
133.88
129.82
129.28
128.93
127.16
126.60
125.81
125.33
124.60
124.27
118.13
112.51
146 144 142 140 138 136 134 132 130 128 126 124 122 120 118 116 114 112
f1 (ppm)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.31
7.29
7.29
7.28
7.27
7.23
7.23
7.22
7.21
6.83
3.38
2.31
N
N
2.05
3.02
1.00
3.02
3.00
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
f1 (ppm)


145.9
133.5
130.5
129.5
128.6
128.5
127.6
125.7
31.2
13.6
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.23
8.21
7.48
7.45
7.06
3.55
2.42
NO2
N
N
2.02
2.04
1.00
3.03
3.04
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
f1 (ppm)


153.7
148.0
146.7
136.9
131.4
128.2
124.2
31.8
13.8
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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3.51
2.40
CN
N
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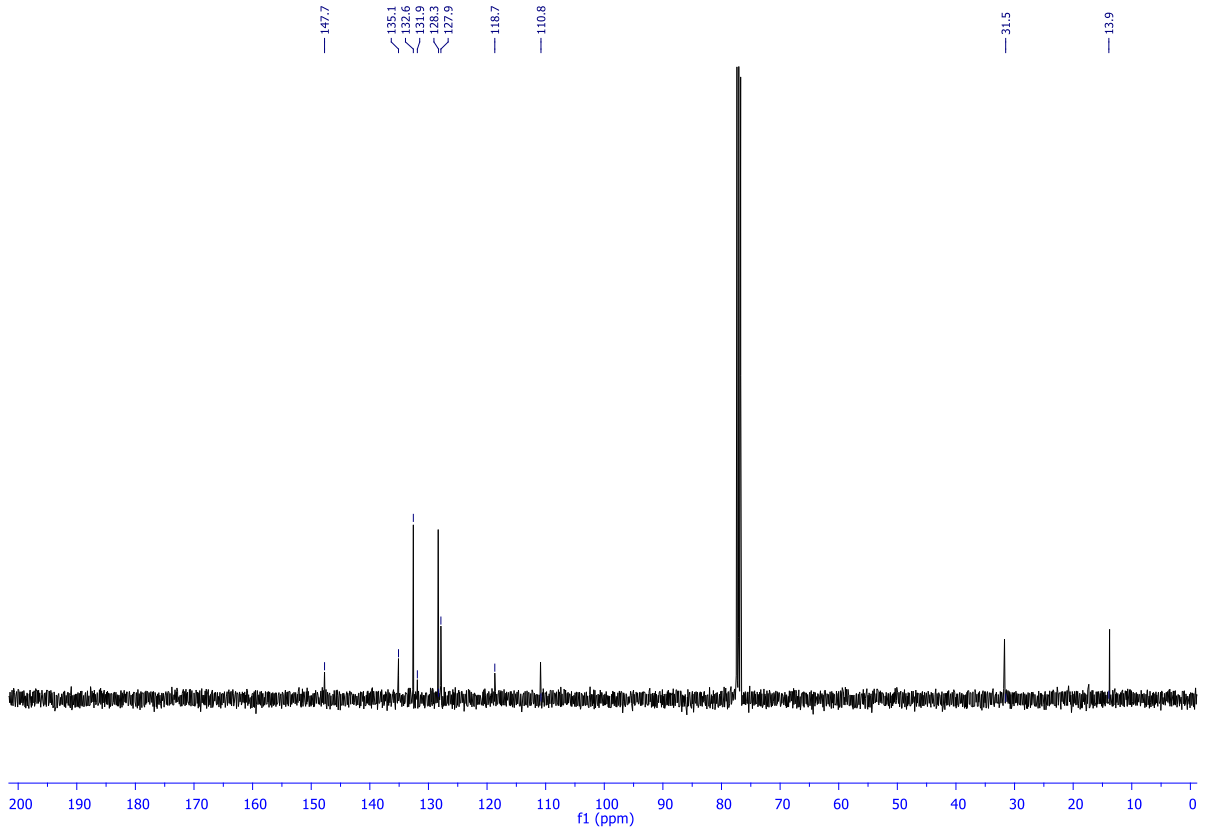
2.02
2.01
1.00
3.00
3.03
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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135.1
132.6
131.9
128.3
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118.7
110.8
31.5
13.9
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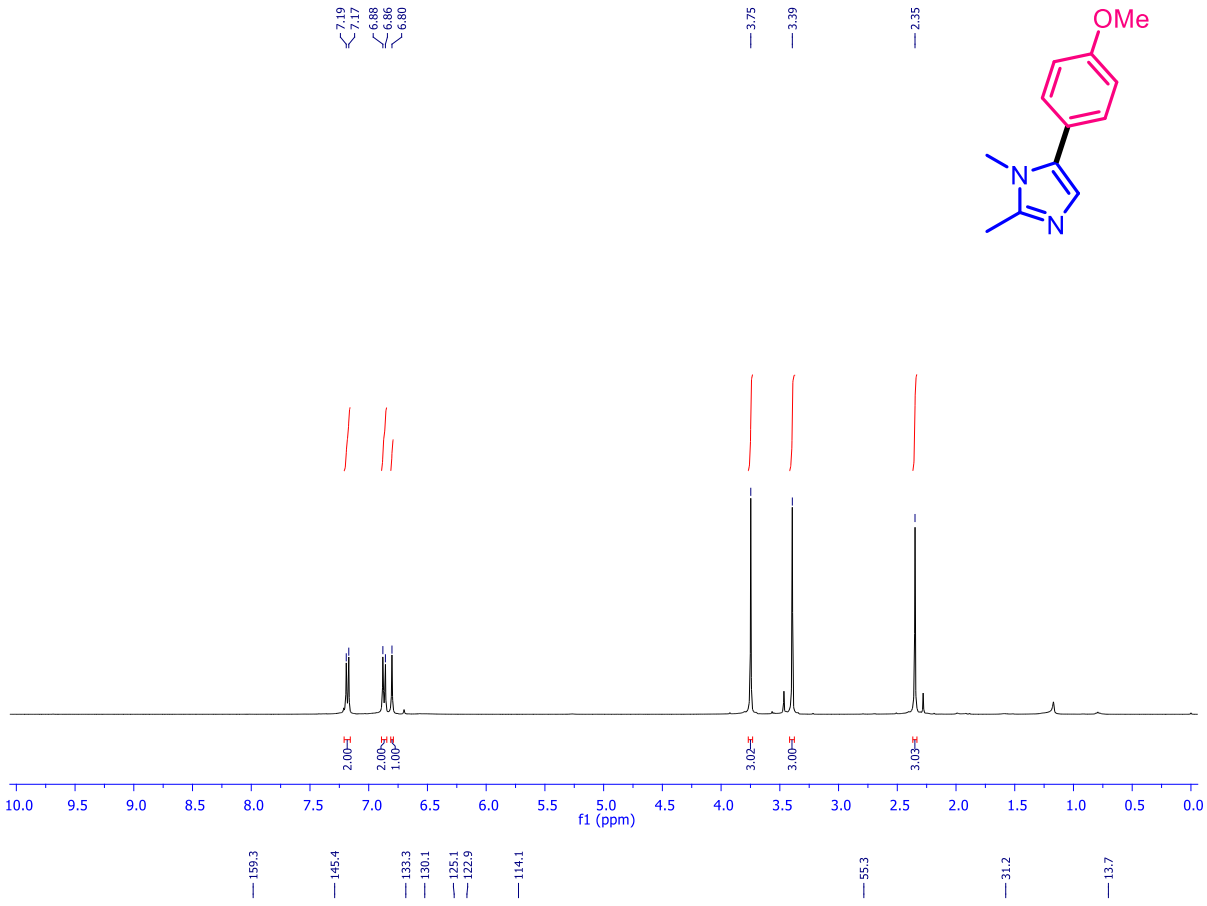
f1 (ppm)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7.17
6.88
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6.80
3.75
3.39
2.35
OMe
N
N
2.00
2.00
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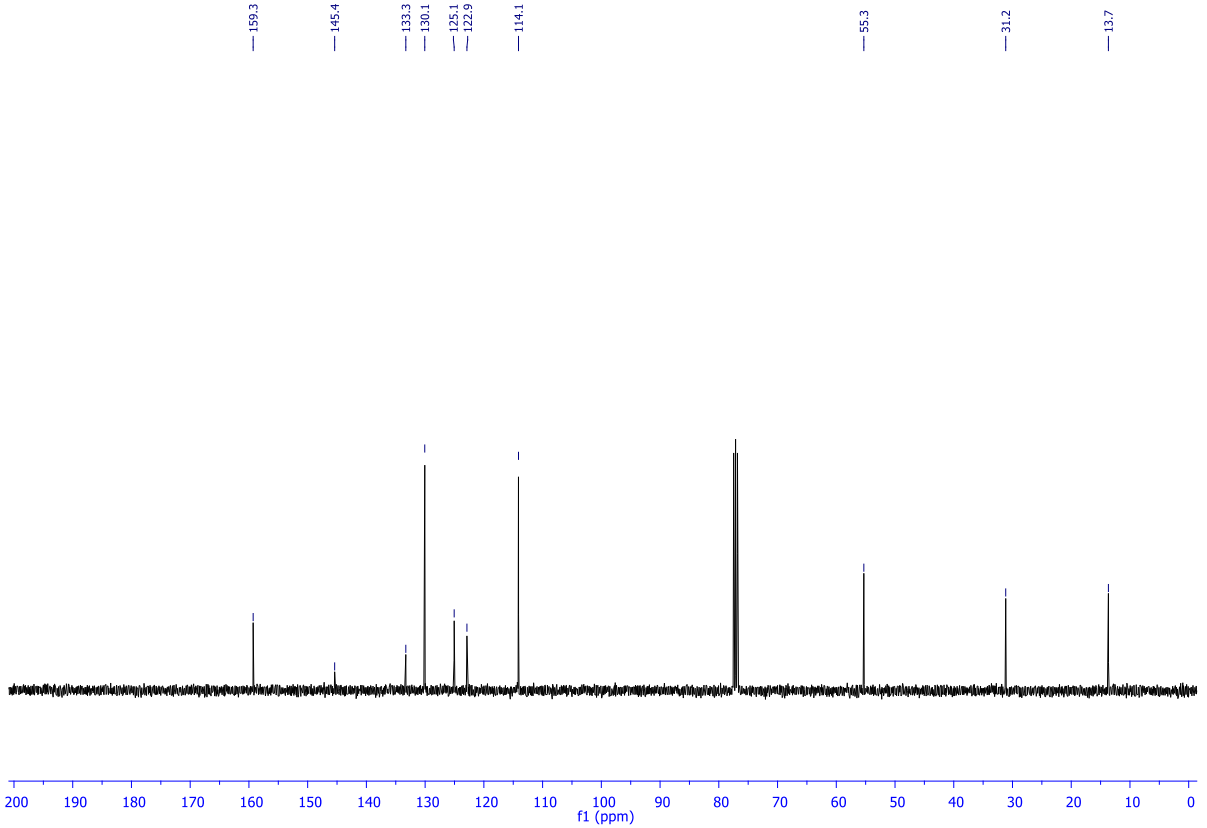
3.02
3.00
3.03
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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133.3
130.1
125.1
122.9
114.1
55.3
31.2
13.7
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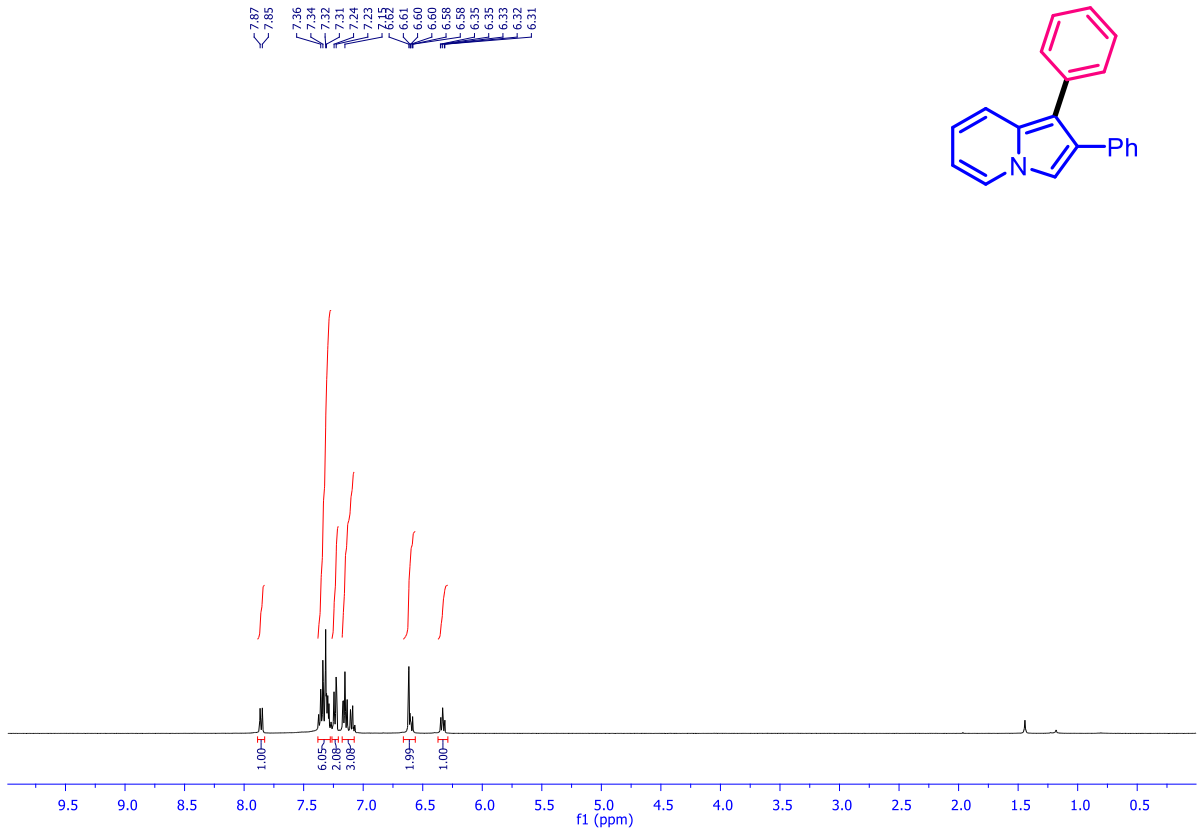
f1 (ppm)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7.23
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6.60
6.60
6.58
6.58
6.35
6.35
6.33
6.32
6.31
Ph
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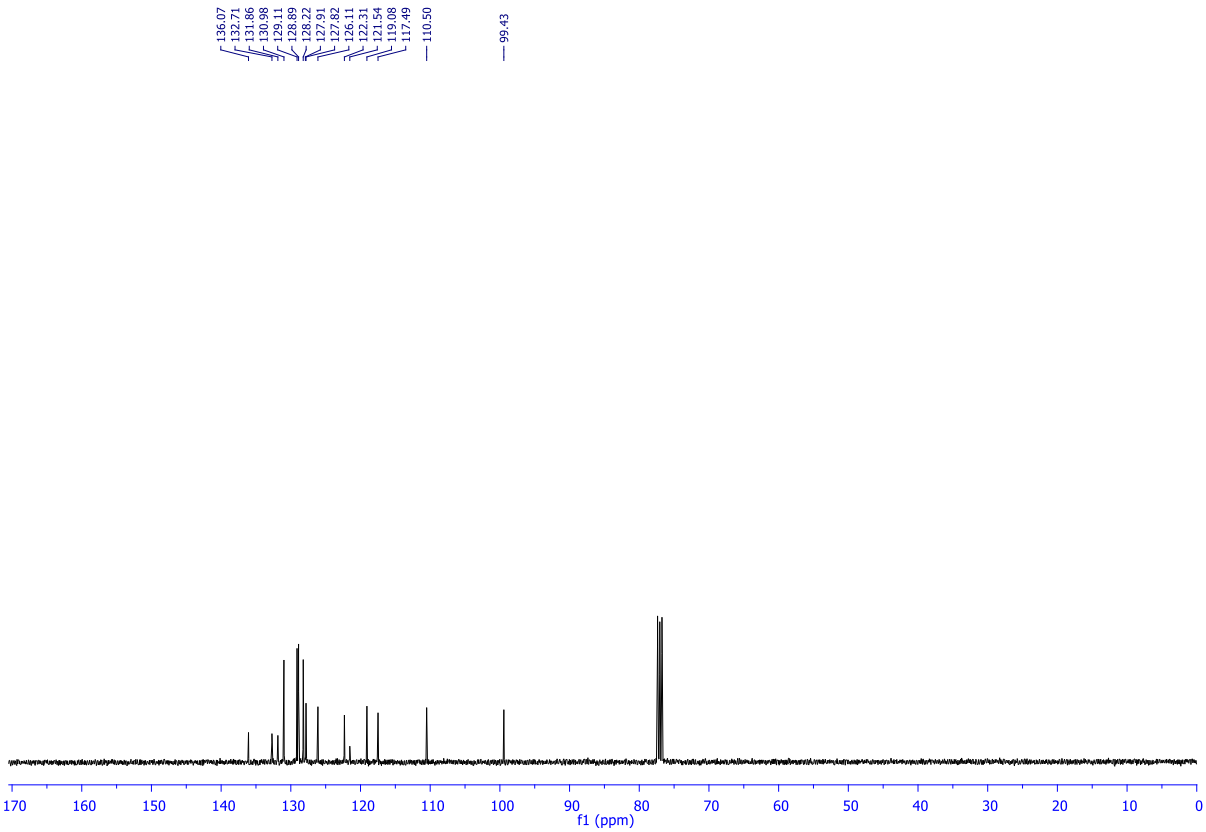
6.05
2.08
3.08
1.99
1.00
f1 (ppm)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129.11
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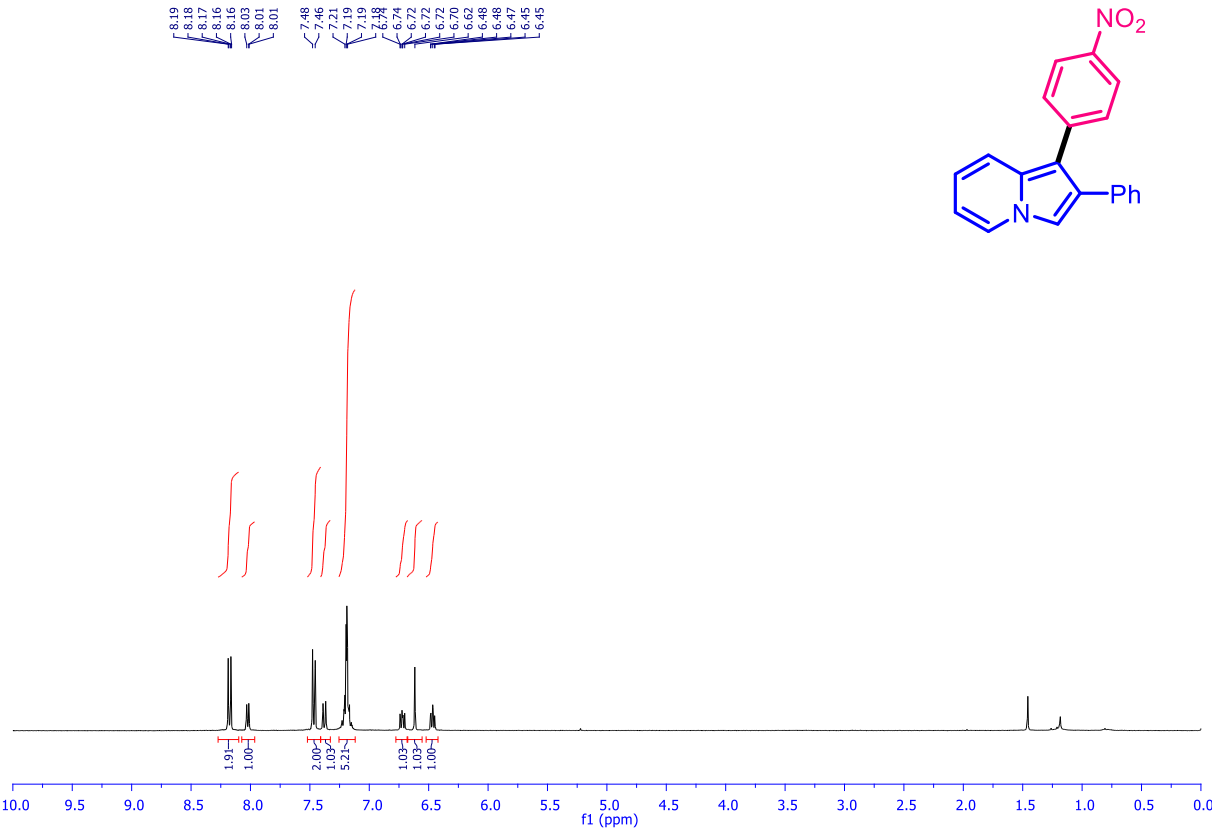
127.82
126.11
122.31
121.54
119.08
117.49
110.50
99.43
f1 (ppm)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8.03
8.01
8.01
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7.19
7.19
7.18
6.74
6.72
6.72
6.72
6.70
6.62
6.48
6.47
6.45
6.45
NO2
Ph
N
1.91
1.00
2.00
1.03
5.21
1.03
1.03
1.00
10.0
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
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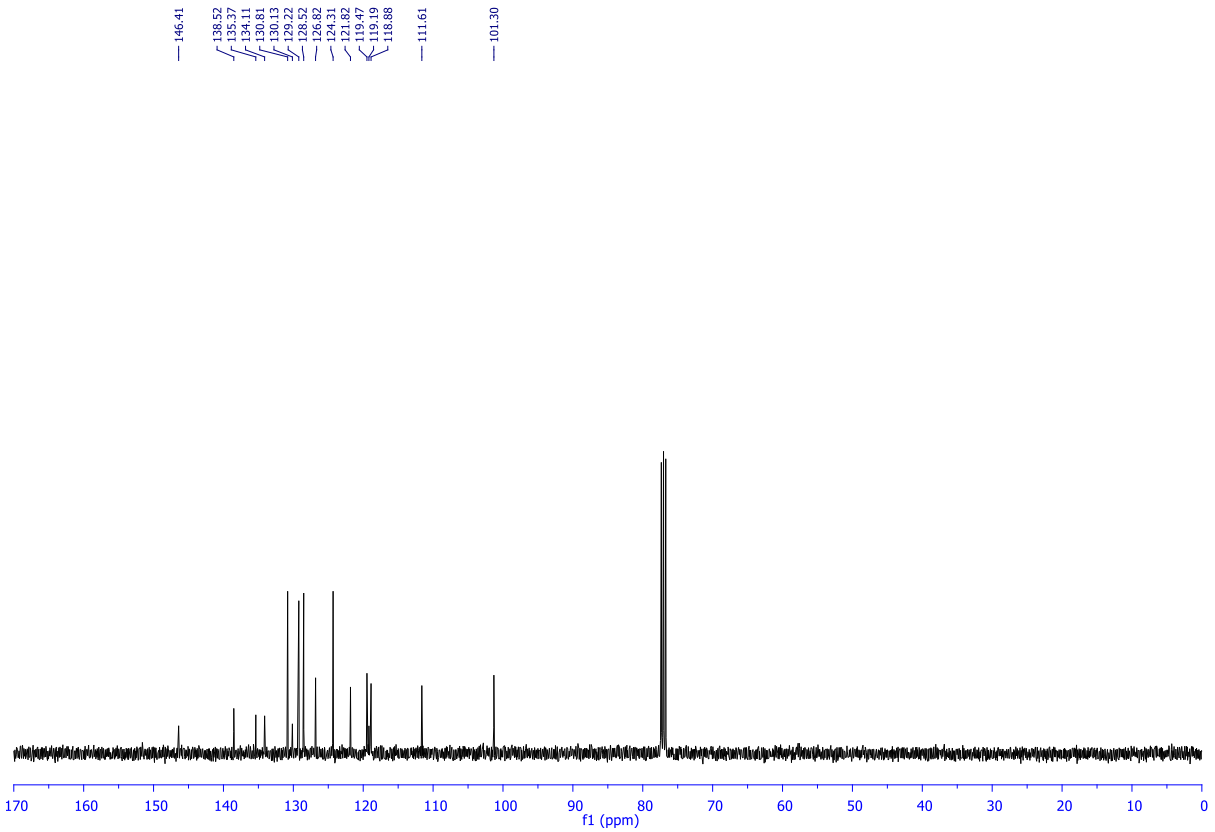
0.0
f1 (ppm)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130.13
129.22
128.52
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124.31
121.82
119.47
119.19
118.88
111.61
101.30
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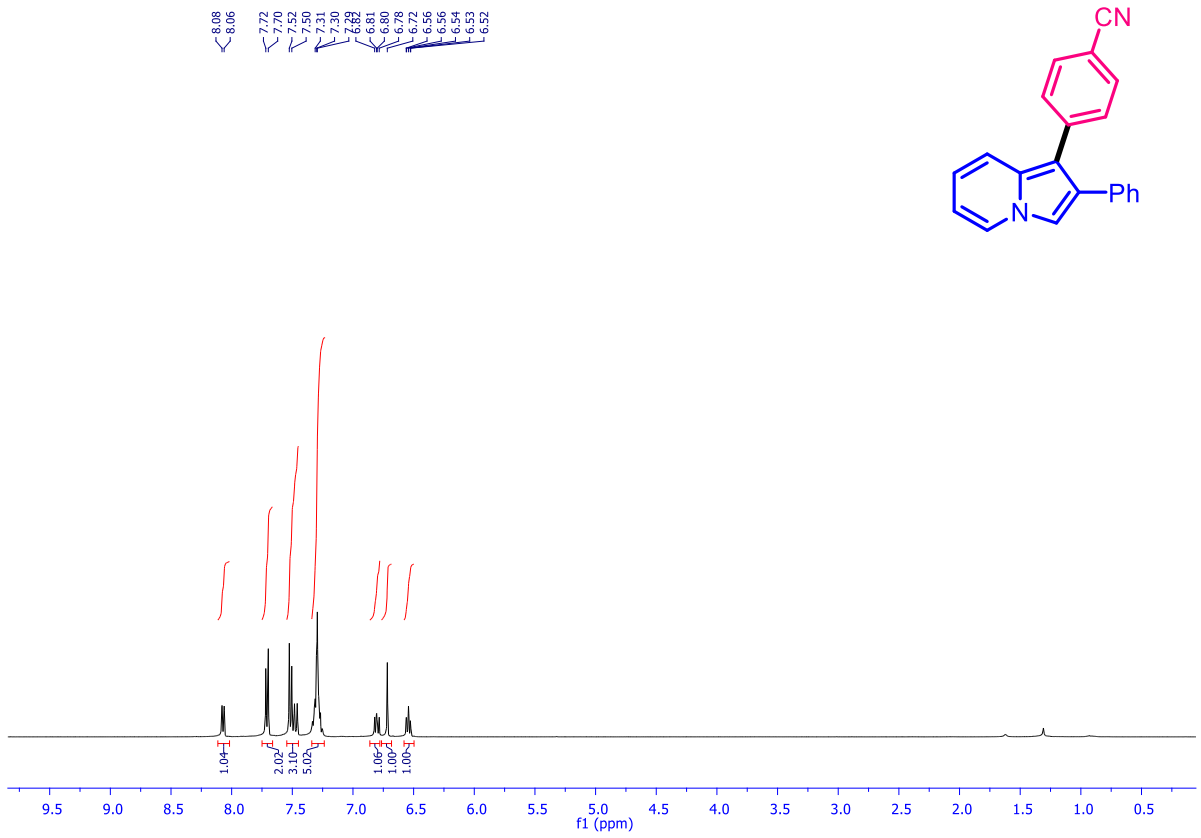
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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8.06
7.72
7.70
7.52
7.50
7.31
7.30
7.29
6.82
6.81
6.80
6.78
6.72
6.56
6.54
6.53
6.52
CN
Ph
N
1.04
2.02
3.10
5.02
1.06
1.00
1.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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5.0
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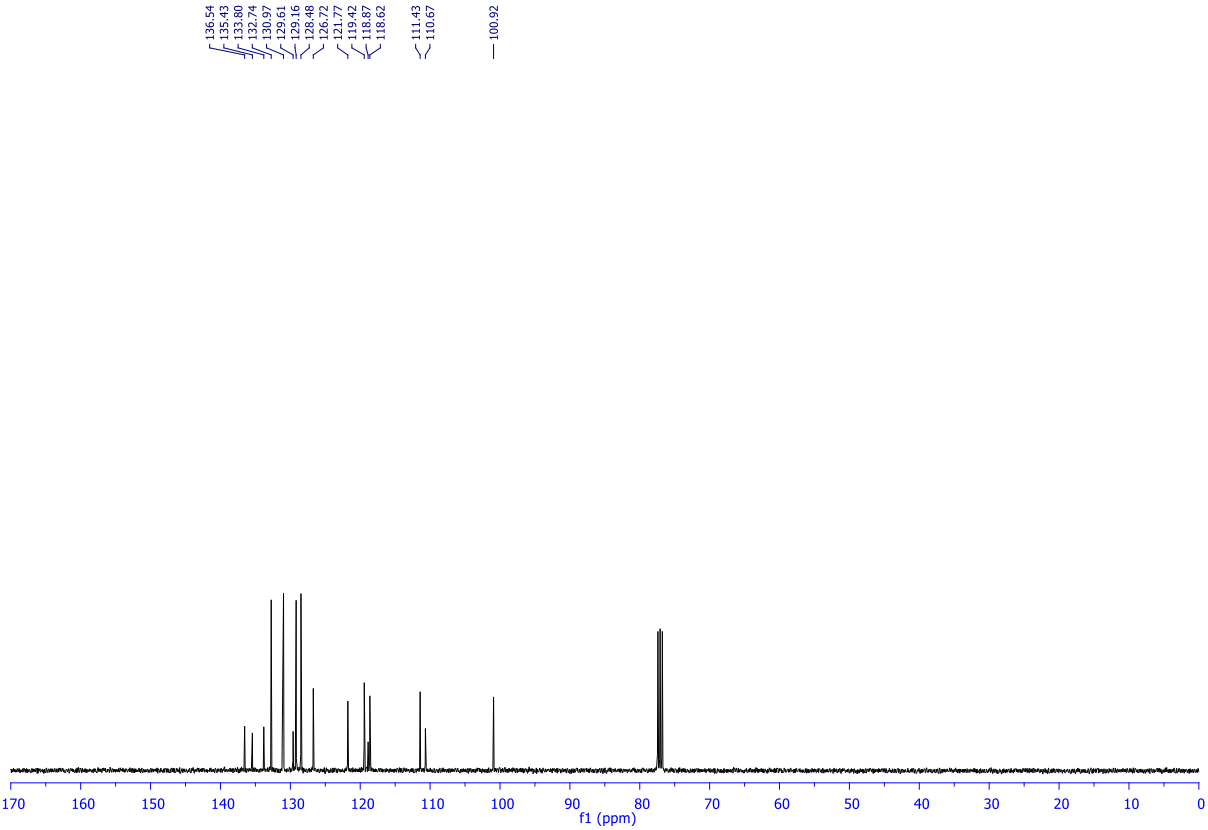
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)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133.80
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129.61
129.16
128.48
126.72
121.77
119.42
118.87
118.62
111.43
110.67
100.92
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130
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110
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90
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70
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50
40
30
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10
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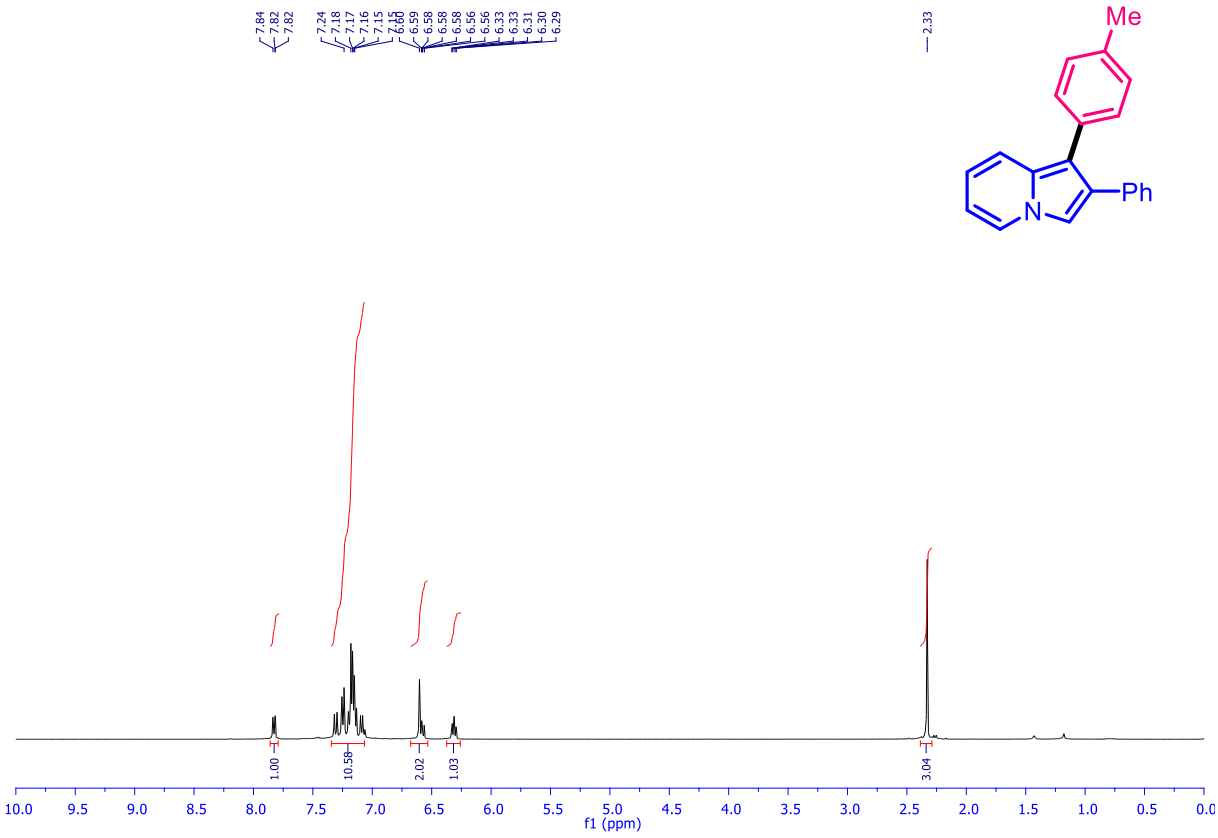
f1 (ppm)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7.82
7.82
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7.17
7.16
7.15
6.59
6.58
6.58
6.56
6.56
6.33
6.31
6.30
6.29
2.33
Me
Ph
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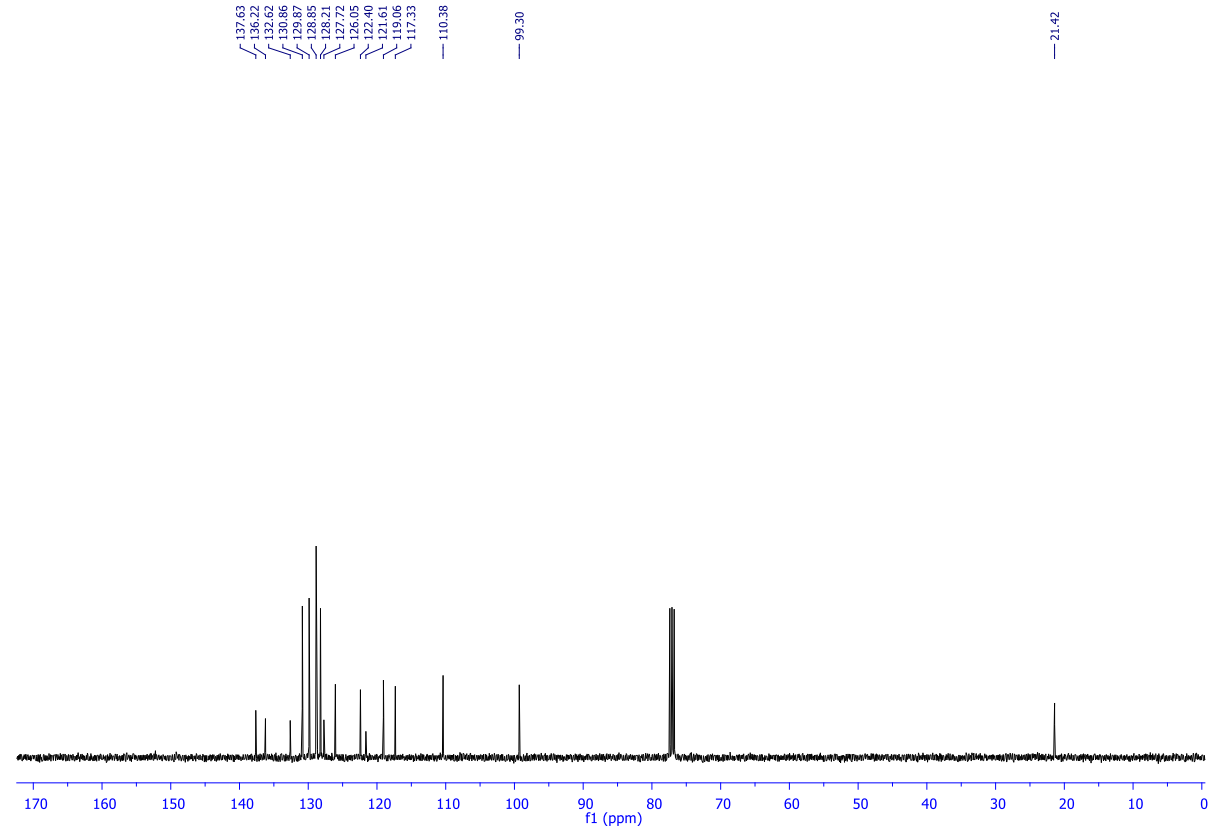
1.00
10.58
2.02
1.03
3.04
f1 (ppm)


137.63
136.22
132.62
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129.87
128.85
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121.61
119.06
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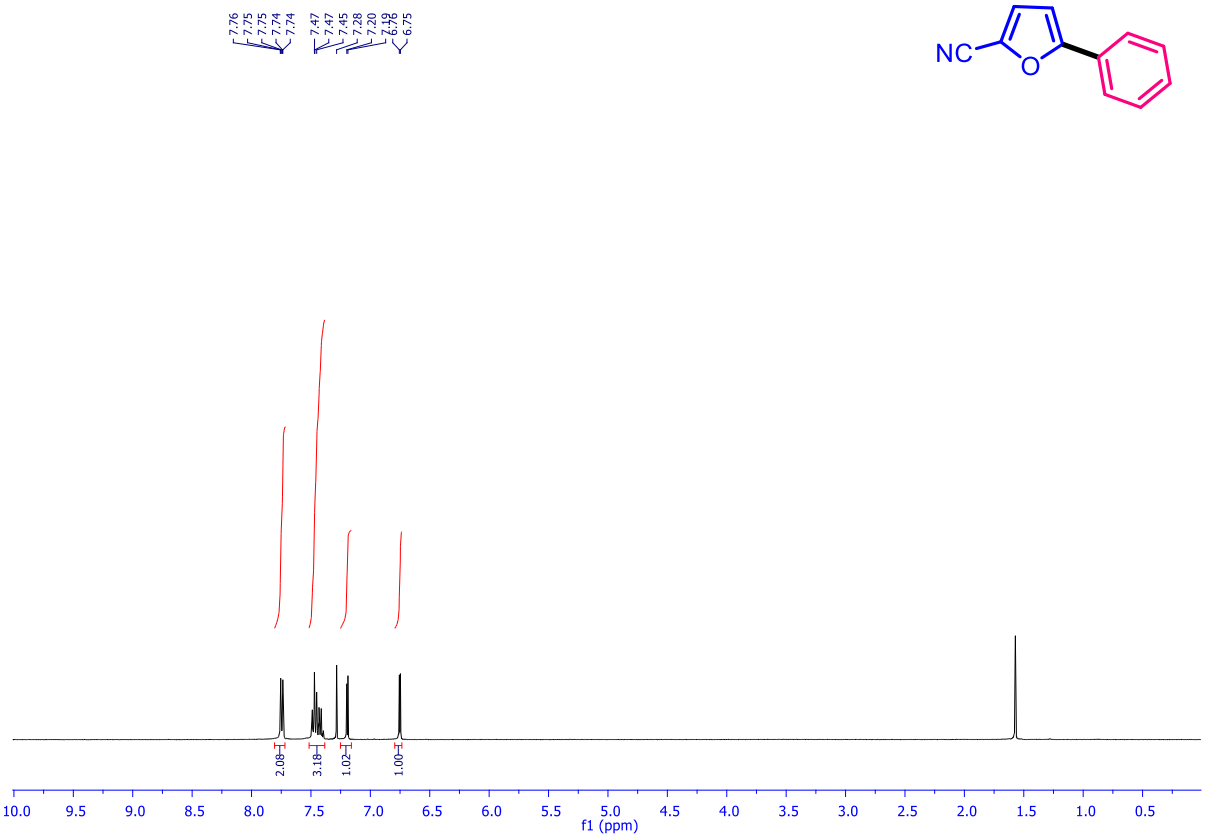
110.38
99.30
21.42
f1 (ppm)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7.47
7.45
7.28
7.20
6.78
6.75
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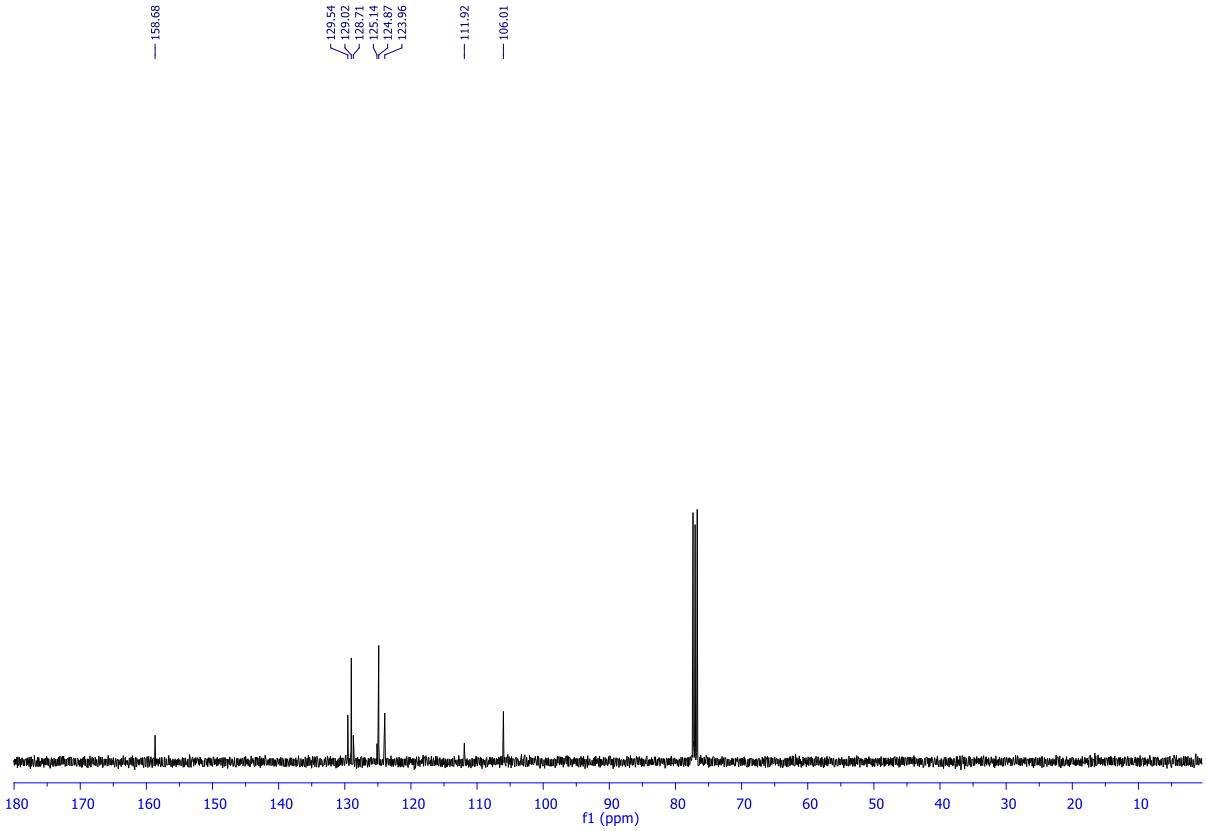
2.08
3.18
1.02
1.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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129.54
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128.71
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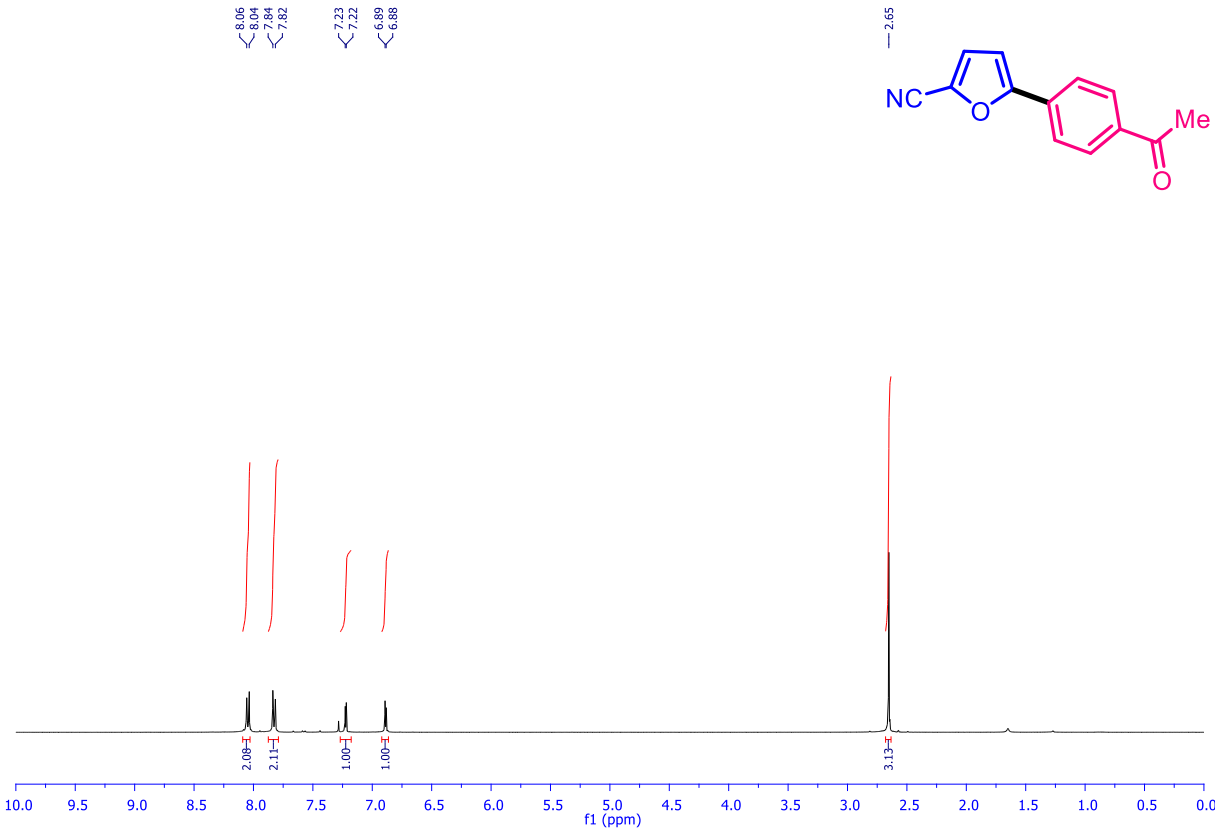
124.87
123.96
111.92
106.01
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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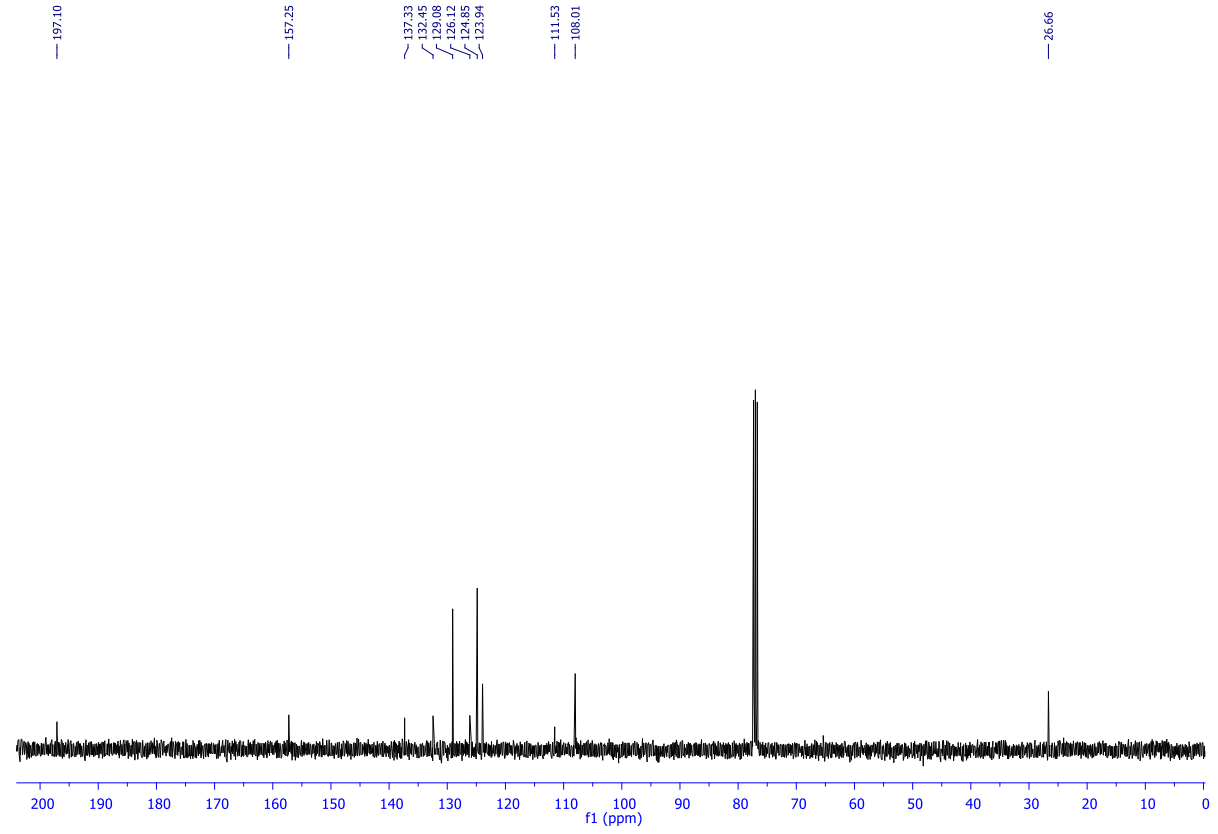
8.04
7.84
7.82
7.23
7.22
6.89
6.88
2.65
NC
O
Me
O
2.08
2.11
1.00
1.00
3.13
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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137.33
132.45
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123.94
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108.01
26.66
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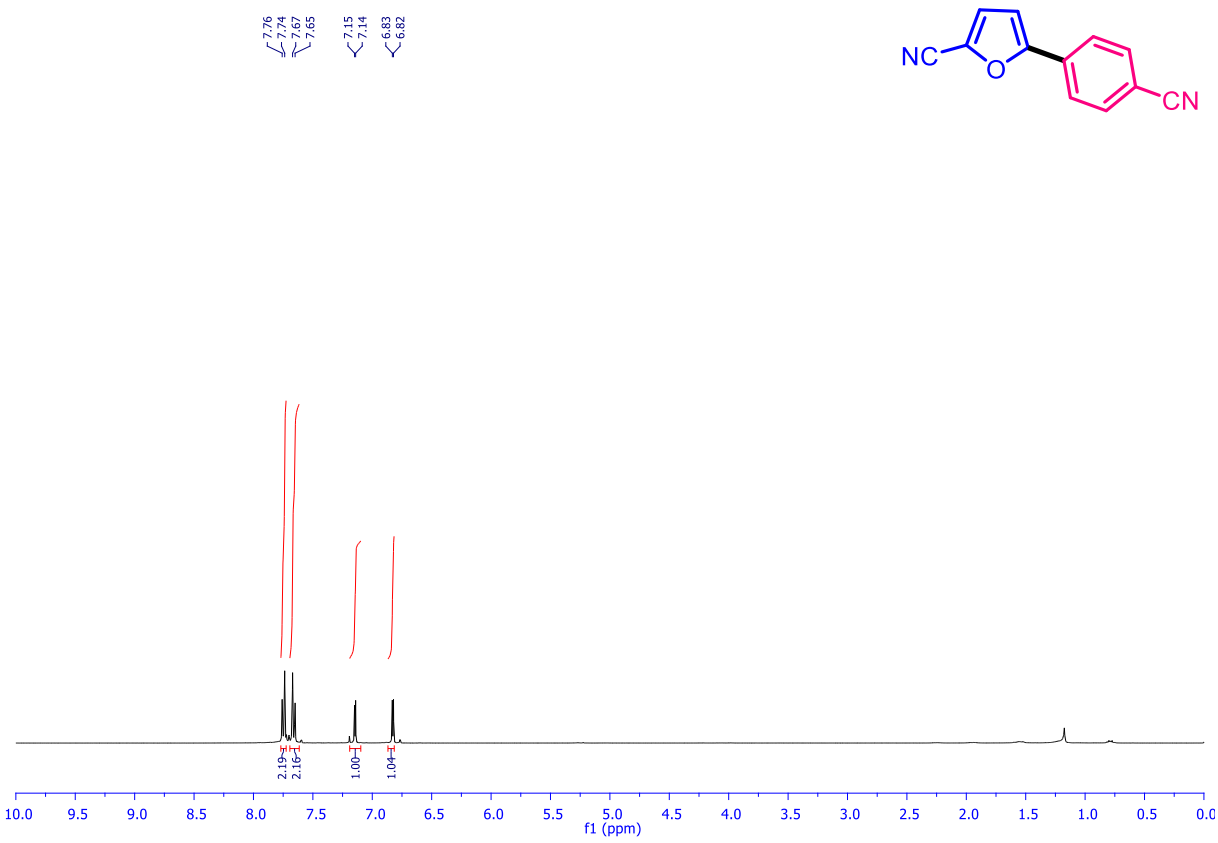
f1 (ppm)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7.14
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6.82
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O
CN
2.19
2.16
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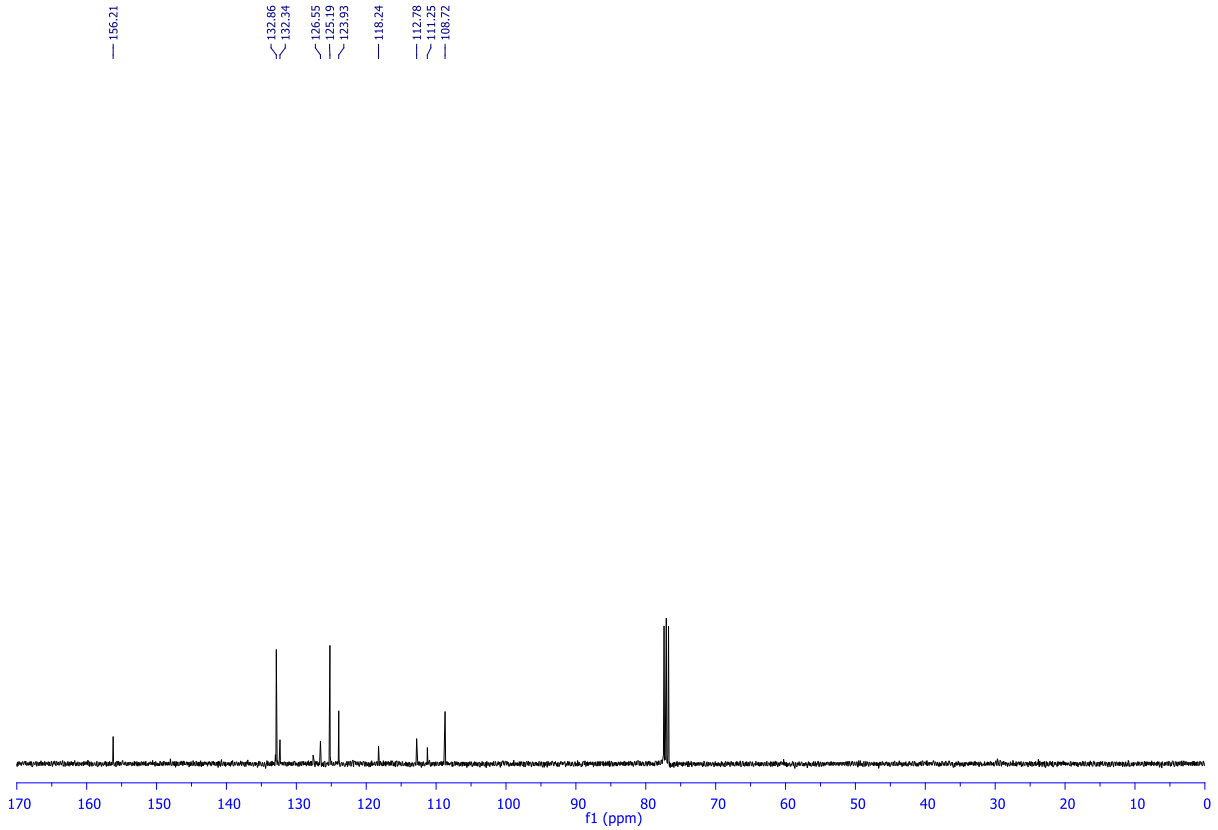
1.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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108.72
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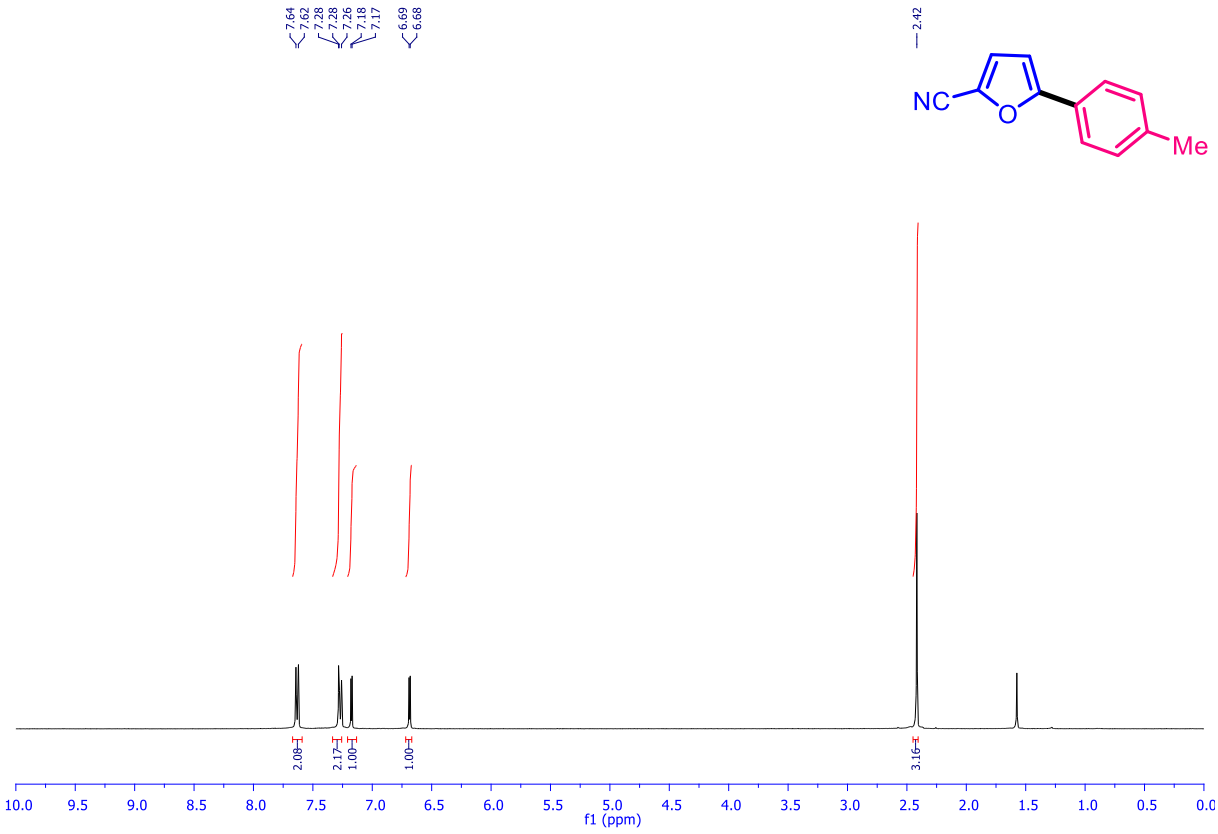
f1 (ppm)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7.28
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7.18
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6.68
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O
Me
2.08
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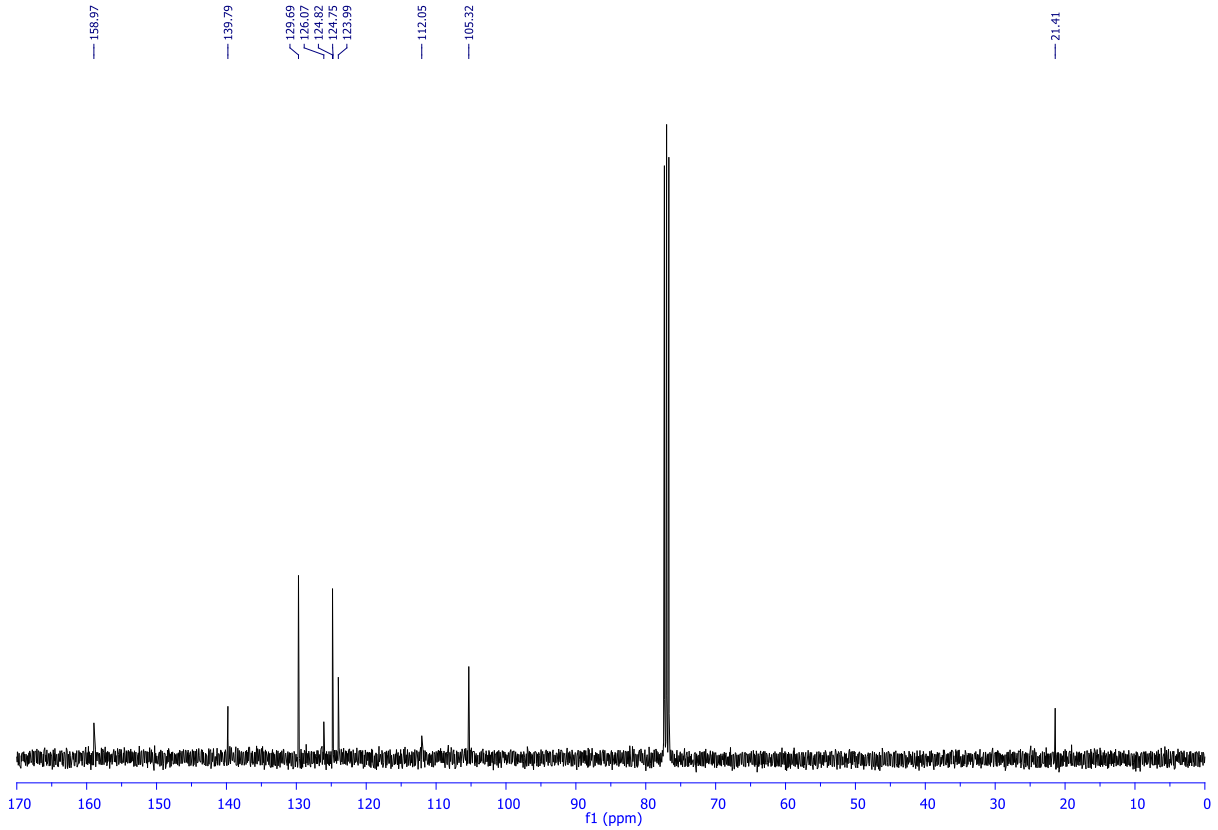
1.00
1.00
3.16
f1 (ppm)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21.41
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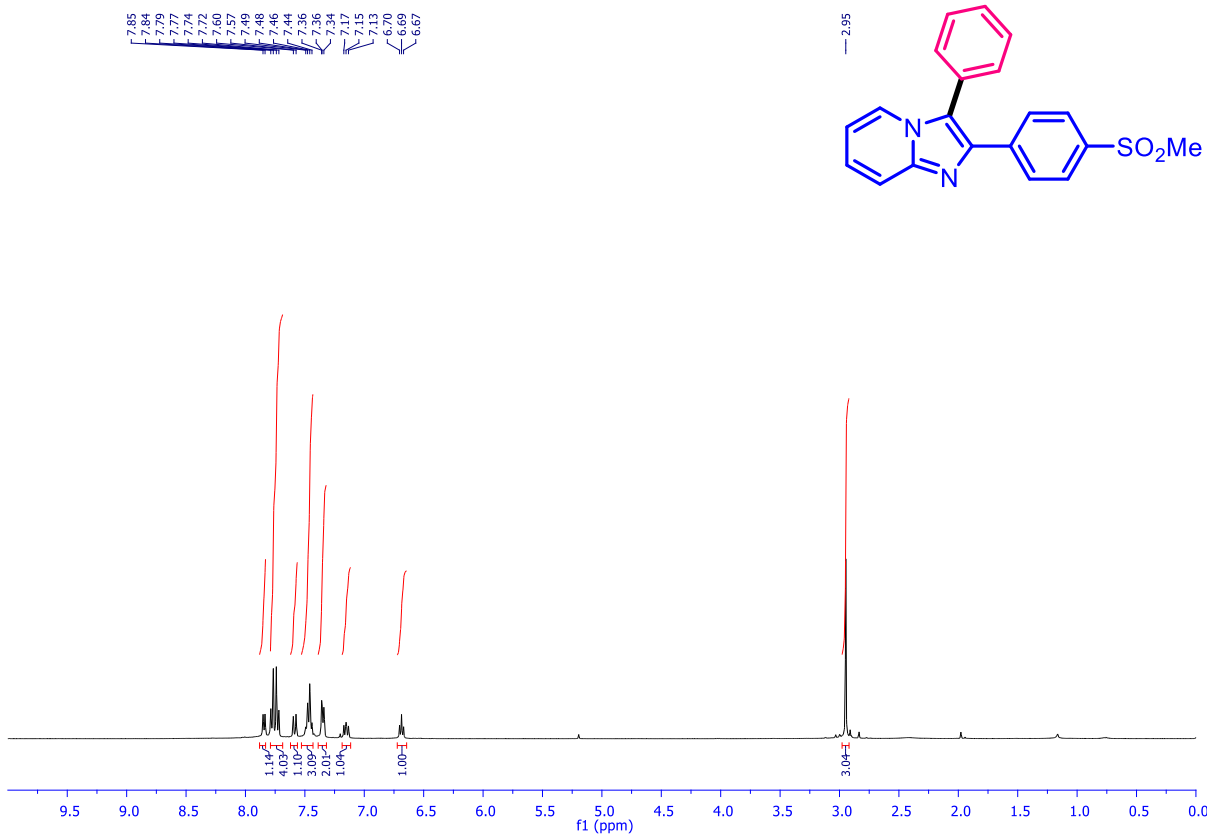
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7.36
7.34
7.17
7.15
7.13
6.70
6.69
6.67
2.95
N
N
SO2Me
1.14
4.03
1.10
3.09
2.01
1.04
1.00
3.04
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.5
3.0
2.5
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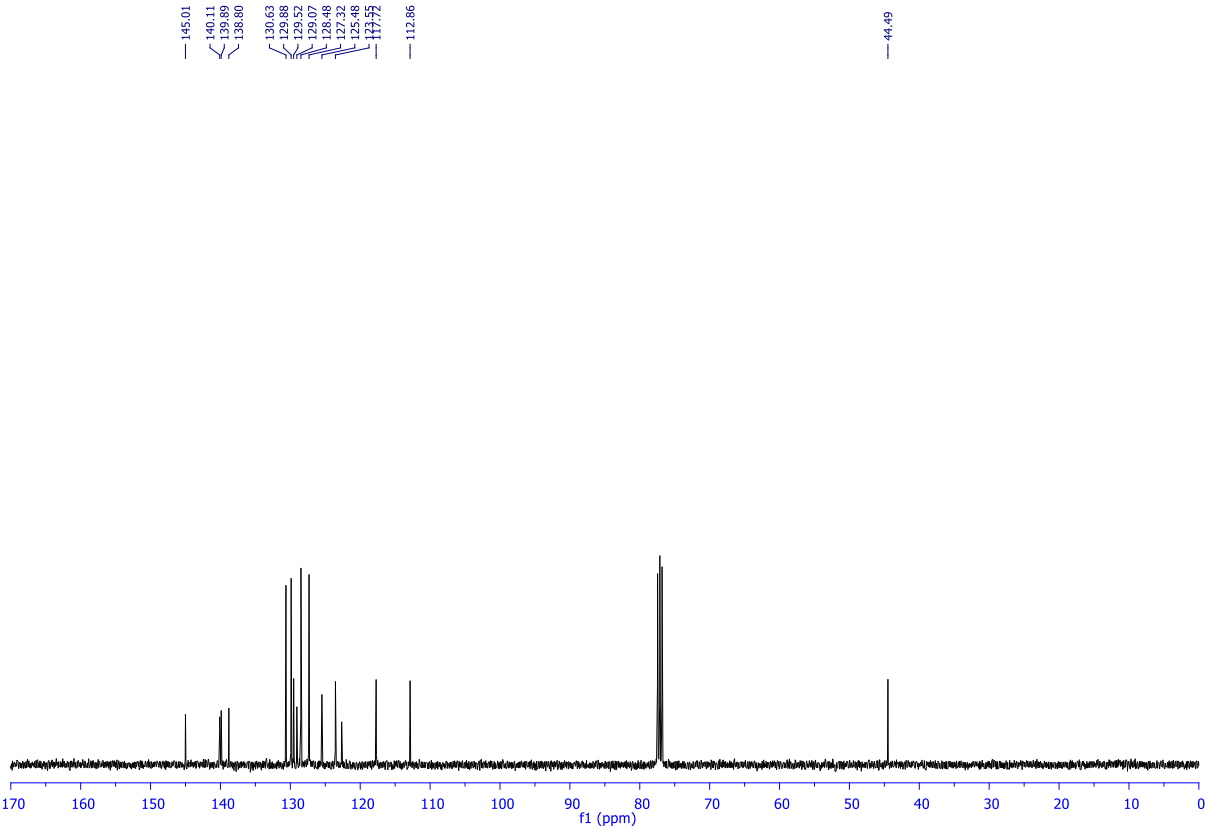
f1 (ppm)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127.32
125.48
112.86
44.49
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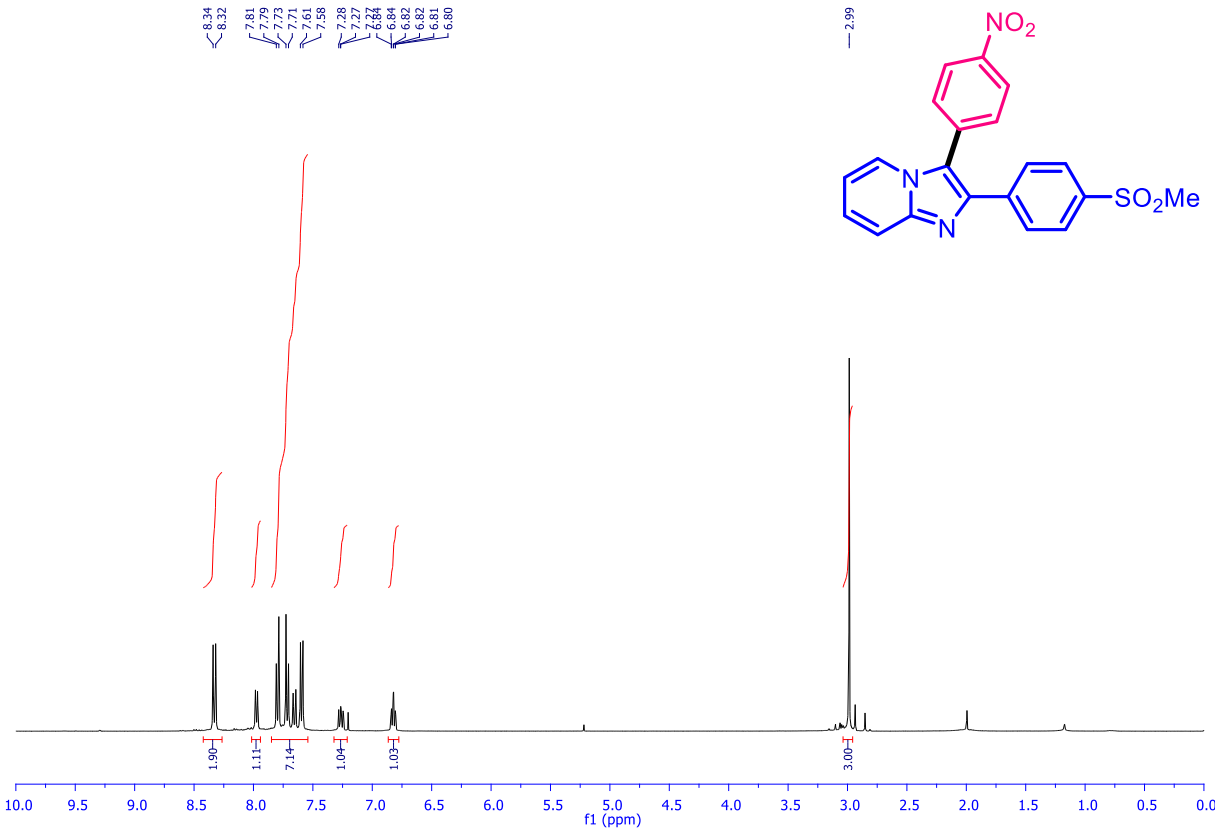
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.22
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6.82
6.82
6.81
6.80
2.99
NO2
SO2Me
N
N
1.90
1.11
7.14
1.04
1.03
3.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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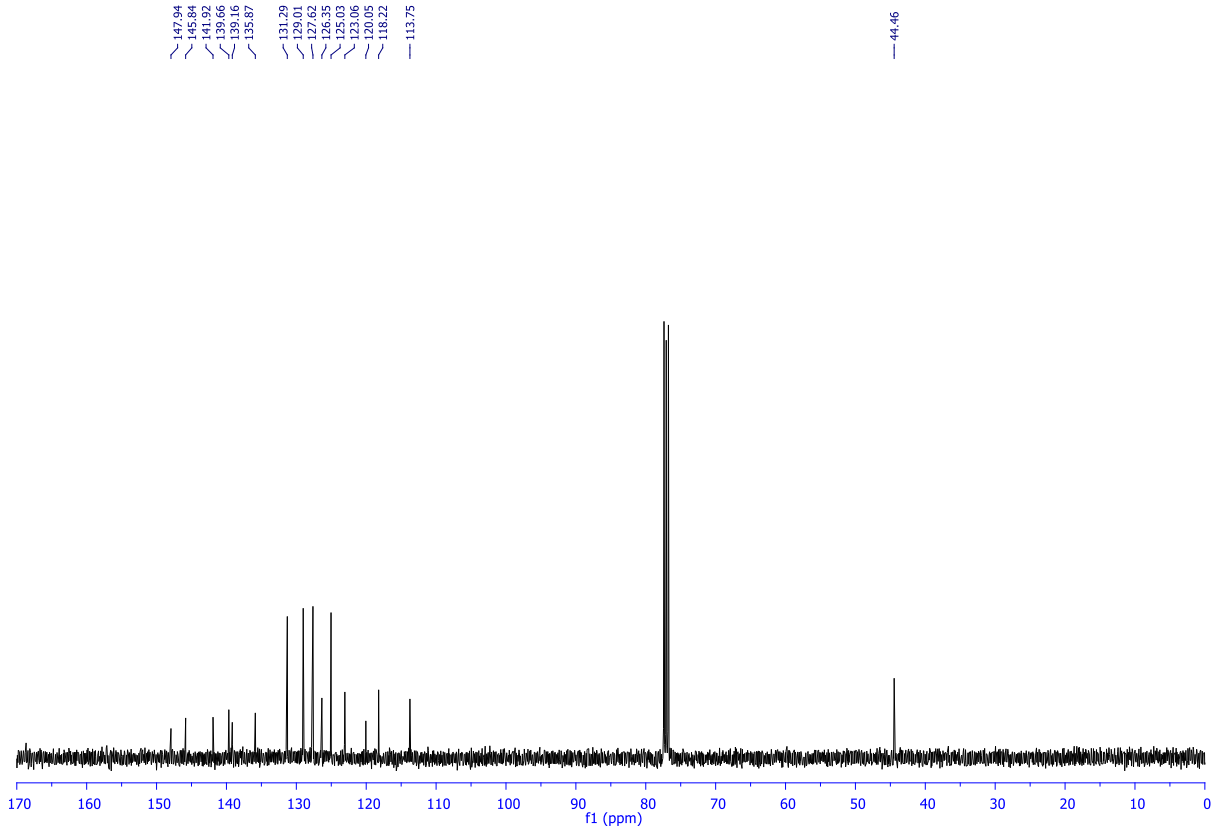
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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113.75
44.46
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50
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10
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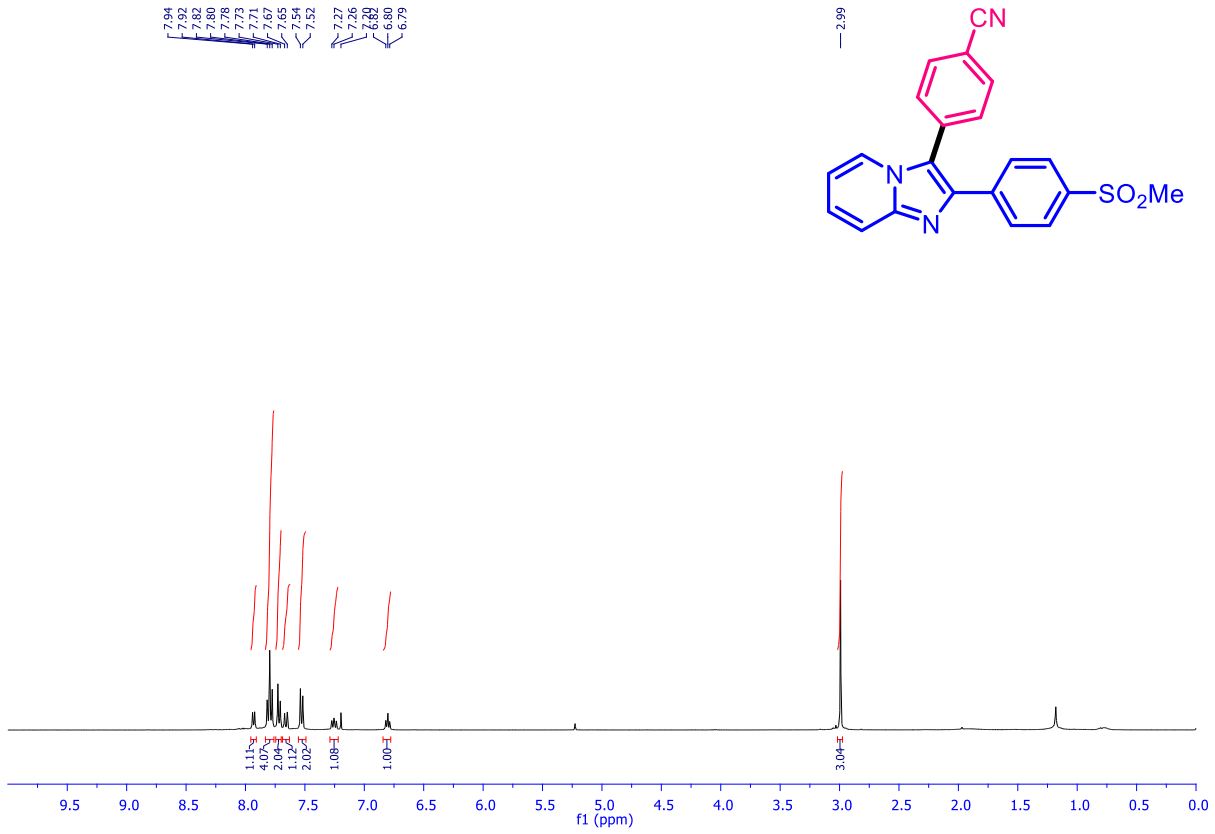
f1 (ppm)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7.26
6.82
6.80
6.79
2.99
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1.12
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1.08
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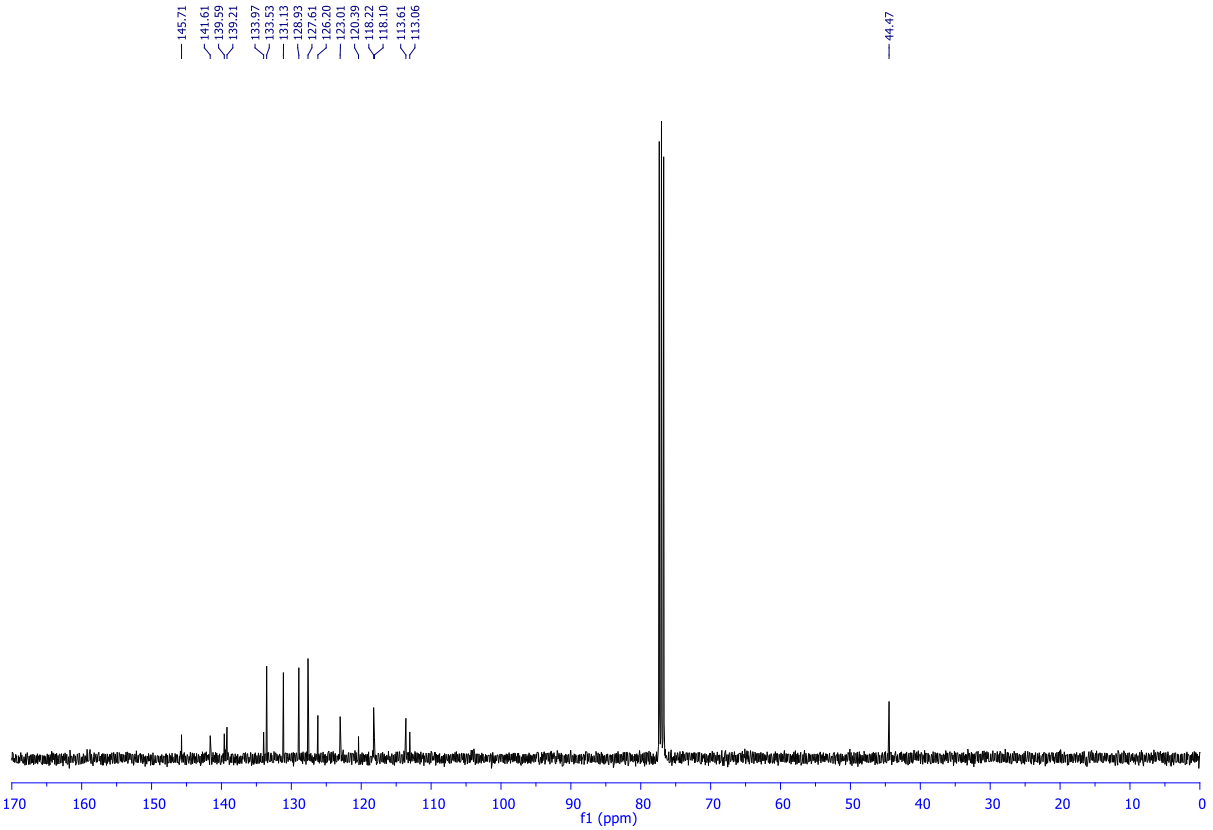
f1 (ppm)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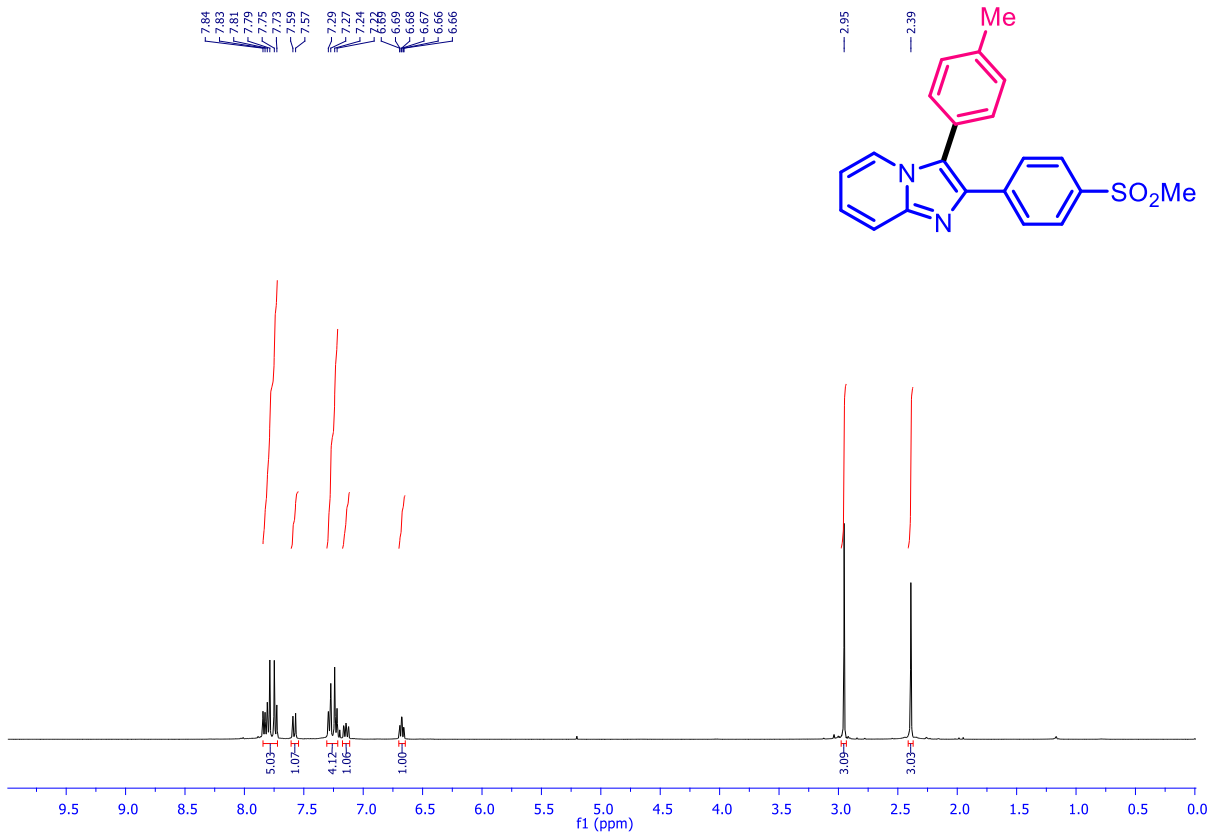
113.61
113.06
44.47
f1 (ppm)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7.24
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6.68
6.67
6.66
6.66
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2.39
Me
N
N
SO2Me
5.03
1.07
4.12
1.06
1.00
3.09
3.03
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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3.5
3.0
2.5
2.0
1.5
1.0
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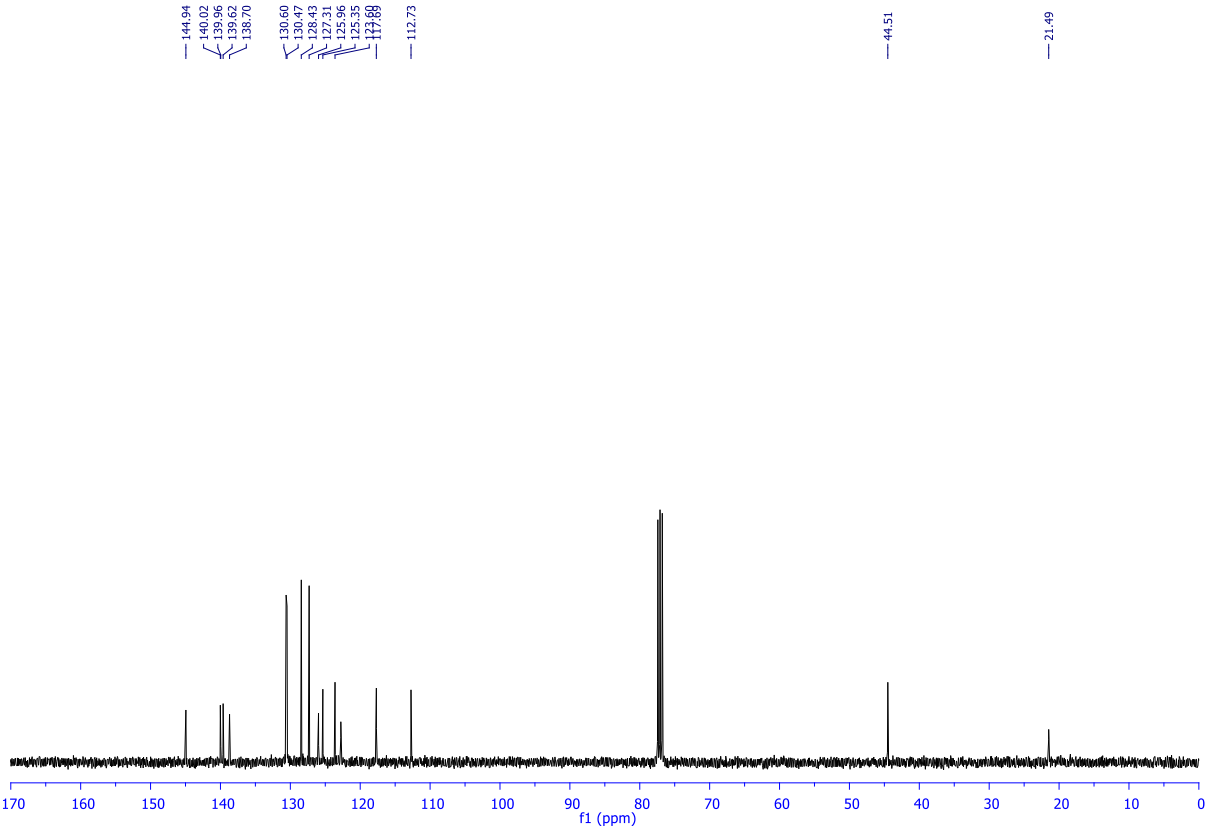
0.0
f1 (ppm)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125.35
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170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)