Pyrrole-2-Carboxylic Acid as a Ligand for the Cu-Catalyzed Reactions of Primary Anilines with Aryl Halides

*Ryan A. Altman, Kevin W. Anderson and Stephen L. Buchwald**

Department of Chemistry, Massachusetts Institute of Technology

Cambridge, MA 02139

sbuchwal@mit.edu

Supporting Information

Table of Contents:

General Considerations

All reactions were carried out in resealable test tubes with teflon septa under an argon or nitrogen atmosphere. Copper(I) iodide (98%) was purchased from Strem. Pyrrole-2-carboxylic acid was purchased from Aldrich. Finely milled K_3PO_4 was purchased from Fluka. The base was flame-dried under vacuum and cooled under nitrogen immediately prior to usage. The base is hygroscopic and excessive amounts of water lead to the formation of phenol and diaryl ether byproducts. Anilines were purchased from commercial sources and, when necessary, purified by distillation or sublimation. Aryl halides were purchased from commercial sources and, when necessary, were distilled or filtered through a plug of alumina before use. Anhydrous dimethylsulfoxide (DMSO) and *N,N'*-dimethylformamide (DMF) were purchased from Aldrich in SureSeal® bottles and used as received. Flash column chromatography was performed using a Biotage SP4 Flash Purification System using SNAP 10g silica cartridges. In all cases, dichloromethane was used to transfer the crude reaction material onto the silica gel samplet. The samplet was then air-dried before usage. A gradient elution using hexanes and ethyl acetate was performed, based on the recommendation from the Biotage TLC Wizard.

Yields reported in the publication are of isolated material and represent an average of at least two independent runs. Yields reported in the supporting information refer to a single experiment. Compounds described in the literature were characterized by comparing their ^{1}H NMR and ^{13}C NMR spectra, and melting points (m.p.) to the previously reported data; their purity was confirmed by gas chromatography (GC) or elemental analysis. GC analyses were performed on a Hewlett Packard 6890 instrument with an FID detector and a Hewlett Packard 10 m x 0.2 mm i.d. HP-1 capillary column using dodecane as an internal standard. Elemental analyses were performed by Atlantic Microlabs, Inc., Norcross, GA. Previously unknown

compounds were synthesized, purified and analyzed from a single run and the reactions used to form them were then repeated to determine an average yield. They were characterized by ^{1}H NMR, ^{13}C NMR, m.p., IR and elemental analysis. ^{1}H NMR and ^{13}C NMR spectra were recorded on Varian 500 MHz instruments with chemical shifts reported relative to the deuterated solvent or TMS. IR spectra were recorded on a Perkin-Elmer System 2000 FT-IR instrument for all previously unknown compounds (KBr disc). Melting points (uncorrected) were obtained on a Mel-Temp II capillary melting point apparatus.

General procedure for the Cu-catalyzed cross-coupling of anilines with aryl halides

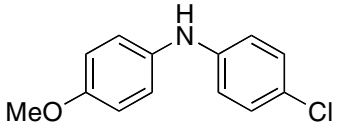
An oven-dried screw-cap test tube was charged with K_3PO_4 (424 mg, 2.0 mmol). The tube was sealed and the base was flame-dried under vacuum, and cooled under a purge of N_2. CuI (19 mg, 0.10 mmol), Pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), aryl halide (1.0 mmol, if solid), amine (2.0 mmol, if solid) and a magnetic stir bar were added to the cooled vessel. The tube was then evacuated and back-filled with nitrogen. The evacuation/backfill sequence was repeated two additional times. Aryl halide (1.0 mmol, if liquid), amine (2.0 mmol, if liquid) and DMSO (0.50 mL) were then added by syringe. The vessel was immersed in a preheated oil bath and the reaction mixture was stirred vigorously until TLC and/or GC analysis of the crude reaction mixture indicated that the aryl halide had been completely consumed. The reaction mixture was cooled to room temperature. Ethyl acetate (15 mL), $NH_4Cl_{(aq)}$ (2 mL), and H_2O (1mL) were added and the mixture was stirred. The organic layer was separated, and filtered through a plug of silica. The aqueous layer was extracted twice more with ethyl acetate (10 mL), and each extract was sequentially filtered through the pad of silica gel. The filtrate was concentrated and the resulting residue was purified by flash chromatography (hexanes/ethyl

acetate, gradient elution) to provide the desired product.

Experimental procedure for the reactions described in Table 1

An oven-dried screw-cap test tube was charged with CuI (9.5 mg, 0.050 mmol), ligand (0.20 mmol, if solid), and a magnetic stir bar. The tubes were transferred into a nitrogen-filled glove box where flame-dried anhydrous K_3PO_4 (212 mg, 1.0 mmol) was added. The tubes were sealed with a Teflon septum and removed from the glovebox, where iodobenzene (56 μL, 0.5 mmol), aniline (92 mL, 1.0 mmol) and DMSO (0.25 mL) were successfully added by syringe. The vessel was immersed in a preheated oil bath and the reaction mixture was stirred vigorously for 12 h at 80 °C. The reaction mixture was cooled to room temperature. Dodecane (112 μL), ethyl acetate (15 mL), $NH_4Cl_{(aq)}$ (2 mL), and H_2O (1mL) were added, and the mixture was stirred. The organic layer was sampled and analyzed by GC.

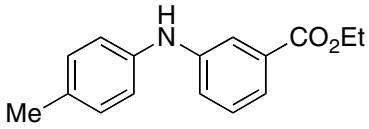
Experimental procedures for compounds in Table 2



4-chloro-*N*-(4-methoxyphenyl)aniline (Entry 1)

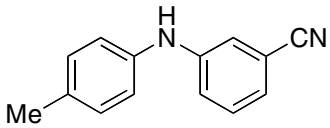
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 4-chloroiodobenzene (238 mg, 1.00 mmol), and *p*-anisidine (182 mg, 1.5 mmol) with DMSO (0.50 mL) as solvent for 20 h at 80 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as an off-white solid (188 mg, 81 %). m.p. 49-50.5 °C (lit. 50-51°C).[i] ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.18-7.13 (2H, m), 7.09-7.03 (2H, m), 6.90-6.80 (m, 4H), 5.48 (1H, bs), 3.81 (3H, s).

^{13}C NMR (125 MHz, $CDCl_3$) δ 155.8, 144.1, 135.4, 129.4, 124.5, 122.7, 116.8, 114.9, 55.8.



ethyl 3-(*p*-tolylamino)benzoate (Entry 2)

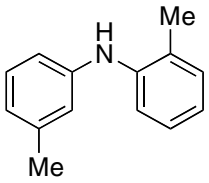
The general procedure was followed using CuI (9.5 mg, 0.05 mmol), pyrrole-2-carboxylic acid (11 mg, 0.10 mmol), K_3PO_4 (424 mg, 2.0 mmol), ethyl-3-iodobenzoate (167 μL, 1.00 mmol), and *p*-toluidine (214 mg, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 80 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a tan solid (199 mg, 78 *%)*. m.p. 95-96 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66 (1H, dd, *J* = 1.8, 2.0 Hz), 7.54 (1H, ddd, *J* = 1.1, 1.5, 7.6 Hz), 7.29 (1H, t, *J* = 7.8 Hz), 7.20 (1H, ddd, *J* = 0.9, 2.5, 8.1 Hz), 7.13-7.11 (2H, m), 7.04-7.01 (2H, m), 5.73 (1H, bs), 4.37 (2H, q, *J* = 7.1 Hz), 2.33 (3H, s), 1.39 (3H, t, *J* = 7.1 Hz). ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.9, 144.4, 139.8, 131.8, 130.2, 120.4, 121.2, 120.6, 119.5, 117.5, 61.1, 20.9, 14.5. IR (KBr disc, cm^{-1}) 3356, 1701, 1604, 1589, 1526, 1487, 1367, 1280, 1219, 1106, 1025, 829, 801, 752. Anal. Calc. for $C_{16}H_{17}NO_2$: C 75.27, H 6.71. Found: C 75.51, H 6.74.



3-(*p*-tolylamino)benzonitrile (Entry 3)[ii]

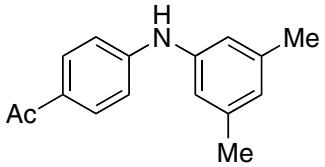
The general procedure was followed using CuI (9.5 mg, 0.05 mmol), pyrrole-2-carboxylic acid (11 mg, 0.10 mmol), K_3PO_4 (424 mg, 2.0 mmol), 3-iodobenzonitrile (229 mg, 1.00 mmol), and *p*-toluidine (214 mg, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 90 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as an tan solid (150mg, 72 *%)*. m.p. 71-73°C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.30-7.28 (1H, m),

7.20-7.15 (2H, m), 7.13 (1H, ddd, J = 0.9, 2.4, 7.4 Hz), 7.09 (1H, ddd, J = 1.1, 1.4, 7.5 Hz), 7.05-7.02 (2H, m), 5.78 (1H, bs), 2.35 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 145.5, 138.4, 133.3, 130.4, 130.3, 123.1, 120.1, 119.3, 118.1, 113.2, 21.0. IR (KBr disc, cm^{-1}) 3398, 2226, 1598, 1523, 1489, 1312, 996, 867, 818, 780, 681. Anal. Calc. for $C_{14}H_{12}N_2$: C 80.74, H 5.81. Found: C 80.49, H 5.74.



2-methyl-*N*-*m*-tolylaniline (Entry 4)[iii]

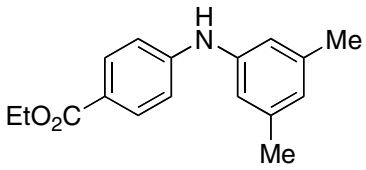
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 2-iodotoluene (127 μL, 1.00 mmol), and *m*-toluidine (216 μL, 2.0 mmol) with DMSO (0.50 mL) as solvent for 30 h at 80 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a tan oil (144 mg, 75 *%).* ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26 (1H, d, J = 6.9 Hz), 7.22 (1H, d, J = 7.5 Hz), 7.17 (2H, m), 6.97-6.94 (1H, m), 6.81-6.75 (m, 3H), 5.36 (1H, bs), 2.33 (3H, s), 2.28 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 144.0, 141.5, 139.3, 131.1, 129.3, 128.3, 126.9, 122.0, 122.5, 118.9, 118.3, 114.7, 21.7, 18.1.



1-(4-(3,5-dimethylphenylamino)phenyl)ethanone (Entry 5)

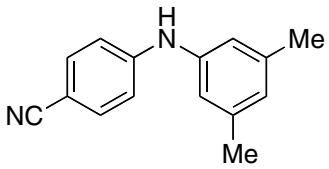
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 5-iodo-*m*-xylene (144 μL, 1.00 mmol), and 1-

(4-aminophenyl)ethanone (270 mg, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 90 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a yellow solid (136 mg, 57 %). m.p. 131-134 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90-7.86 (2H, m), 7.01-6.97 (2H, m), 6.81 (2H, s), 6.74 (1H, s), 6.02 (1H, bs), 2.54 (3H, s), 2.32 (6H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 196.6, 148.8, 140.6, 139.5, 130.8, 129.0, 125.4, 118.7, 114.6, 26.4, 21.6. IR (KBr disc, cm^{-1}) 3331, 1653, 1570, 1342, 1274, 1181, 1168, 827. Anal. Calc. for $C_{16}H_{17}NO$: C 80.30, H 7.16. Found: C 80.22, H 7.18.



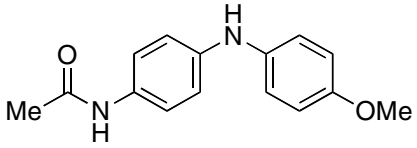
ethyl 4-(3,5-dimethylphenylamino)benzoate (Entry 6)

The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 5-iodo-*m*-xylene (144 μL, 1.00 mmol), and ethyl-4-aminobenzoate (330 mg, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 90 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a white solid (138 mg, 51%). m.p. 119-120 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94-7.91 (2H, m), 7.00-6.96 (2H, m), 6.81 (2H, m), 6.72 (1H, m), 5.96 (1H, s), 4.35 (2H, q, *J* = 7.1 Hz), 2.31 (3H, s), 1.38 (3H, t, *J* = 7.1 Hz). ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.7, 148.3, 141.0, 139.4, 131.6, 125.1, 121.4, 118.3, 114.8, 60.6, 21.6, 14.6. IR (KBr disc, cm^{-1}) 2241, 1697, 1595, 1509, 1352, 1285, 1170, 830, 769. Anal. Calc. for $C_{17}H_{19}NO_2$: C 75.81, H 7.11. Found: C 76.13, H 6.94.



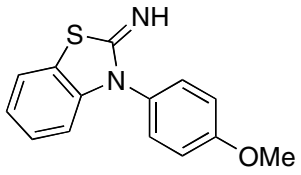
4-(3,5-dimethylphenylamino)benzonitrile (Entry 7)[iv]

The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 5-iodo-*m*-xylene (144 μL, 1.00 mmol), and 4-aminobenzonitrile (236 mg, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 90 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a yellow solid (113 mg, 51%). m.p. 154-155 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 2.32 (3H, S)7.49-7.46 (2H, m), 6.97-6.94 (2H, m), 6.80 (2H, s), 6.77 (1H, s), 6.00 (1H, bs). ^{13}C NMR (125 MHz, $CDCl_3$) δ 148.1, 139.7, 139.4, 133.7, 125.7, 120.0, 118.9, 114.8, 101.1, 21.3. IR (KBr disc, cm^{-1}) 3335, 2214, 1591, 1532, 1350, 1170, 826. Anal. Calc. for $C_{15}H_{14}N_2$: C 81.05, H 6.35. Found: C 80.76, H 6.33.



N-(4-(4-methoxyphenylamino)phenyl)acetamide (Entry 8)

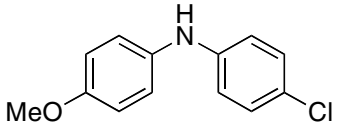
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 4-iodoanisole (234 mg, 1.00 mmol), and *N*-(4-aminophenyl)acetamide (300 mg, 2.0 mmol) with DMSO (0.70 mL) as solvent for 24 h at 80 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a white solid (212 mg, 83 %). m.p. 138-139 °C (lit. 138 °C).[v] ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33-7.30 (2H, m), 7.16 (1H, bs), 7.10-7.02 (2H, m), 6.90-.84 (m, 4H), 5.47 (1H, bs), 3.80 (3H, s), 2.15 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.4, 155.2, 142.1, 136.3, 130.4, 122.2, 121.7, 116.7, 114.9, 55.8, 24.6. IR (KBr disc, cm^{-1}) 3270, 1653, 1512, 1297, 1248, 1035, 819. Anal. Calc. for $C_{15}H_{16}N_2O_2$: C 70.29, H 6.29. Found: C 70.55, H 6.32.



3-(4-methoxyphenyl)benzo[*d*]thiazol-2(3*H*)-imine (Entry 9)

The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_2CO_3 (280 mg, 2.0 mmol), 4-iodoanisole (234 mg, 1.00 mmol), and 2-aminobenzothiazole (298 mg, 2.0 mmol) with DMSO (0.80 mL) as solvent for 24 h at 90 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a white solid (169 mg, 66 %). m.p. 91.5-92 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (1H, td, *J* = 0.6, 7.8 Hz), 7.-7.41 (1H, m), 7.31 (1H, dd, *J* = 0.6, 8.2 Hz), 7.13-7.07 (3H, m), 6.07 (1H, bs), 6.84-6.82 (2H, bs), 3.78 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.3, 139.0, 136.6, 131.2, 130.7, 125.0, 124.2, 119.9, 115.4, 115.3, 110.4, 55.6. IR (KBr disc, cm^{-1}) 3220, 2235, 1591, 1580, 1493, 1404, 1289, 1246, 1175, 1021, 824, 753. Anal. Calc. for $C_{14}H_{12}N_2OS$: C 65.60, H 4.72. Found: C 65.64, H 4.75.

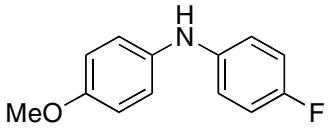
Experimental procedures for compounds in Table 3



4-chloro-*N*-(4-methoxyphenyl)aniline (Entry 1)

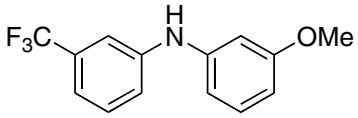
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 1-bromo-4-chlorobenzene (191 mg, 1.00 mmol), and *p*-anisidine (248 mg, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 100 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title

compound as a tan solid (180 mg, 77 %). m.p. 50-51 °C (lit. 50-51°C).[vi] ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.18-7.13 (2H, m), 7.09-7.03 (2H, m), 6.90-6.80 (m, 4H), 5.48 (1H, bs), 3.81 (3H, s).



4-fluoro-*N*-(4-methoxyphenyl)aniline (Entry 2)

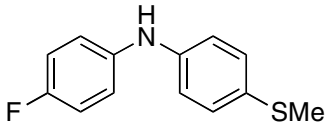
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 1-bromo-4-fluorobenzene (109 μL, 1.00 mmol), and *p*-anisidine (248 mg, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 80 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a tan solid (155 mg, 71 %). m.p. 57-59 °C (lit. 59 °C).[vii] ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.03-7.00 (2H, m), 6.96-6.85 (6H, m), 5.40 (1H, bs), 3.81 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.3, 155.2, 141.3 (d), 136.7, 121.4, 117.9 (d), 116.1, 115.9, 114.9, 55.8.



3-methoxy-*N*-(3-(trifluoromethyl)phenyl)aniline (Entry 3)[viii]

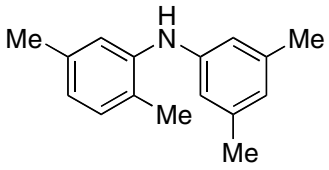
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 3-bromoanisole (127 μL, 1.00 mmol), and 3-aminobenzotrifluoride (250 μL, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 100 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as an orange oil (153 mg, 57%). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (1H, t, *J* = 7.9 Hz), 7.30 (1H, s), 7.26-7.20 (2H, m), 7.16 (1H, d, *J* = 7.8 Hz), 6.70 (1H, dd, *J* = 1.2, 8.1 Hz), 6.67 (1H, s), 6.59 (1H, d, *J* = 8.2 Hz), 5.85 (1H, bs), 3.81 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 160.9, 143.9, 143.4, 132.1, 130.5, 130.0, 129.9, 120.4, 117.3 (q), 113.0 (t), 111.4 (d), 107.6 (d),

104.7, 55.4.



4-fluoro-*N*-(4-(methylthio)phenyl)aniline (Entry 4)

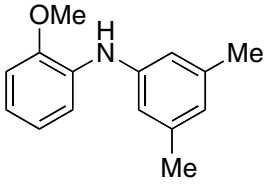
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 4-bromothioanisole (203 mg, 1.00 mmol), and 4-fluoroaniline (189 μL, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 100 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a brown oil (170 mg, 73 %). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.21-7.17 (2H, m), 7.02-6.92 (4H, m), 6.89-6.86 (2H, m), 5.56 (1H, bs), 2.41 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.2, 142.4, 139.0 (d), 130.3, 129.7, 120.6 (d), 117.7, 116.1 (d), 18.2. IR (KBr disc, cm^{-1}) 3396, 1595, 1508, 1314, 1223, 817, 506. Anal. Calc. for $C_{13}H_{12}FNS$: C 66.93, H 5.18. Found: C 67.16, H 5.20.



N-(3,5-dimethylphenyl)-2,5-dimethylaniline (Entry 5)

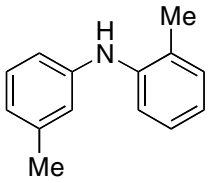
The general procedure was followed using CuI (19 mg, 0.10 mmol), 2-isobutyrylcyclohexanone (33 μL, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 5-bromo-*m*-xylene (136 μL, 1.00 mmol), and 2,5-dimethylaniline (249 μL, 2.0 mmol) with DMF (0.50 mL) as solvent for 24 h at 110 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a yellow oil (166 mg, 74 %). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.05-7.02 (2H, s), 6.72 (1H, td, J = 0.4, 7.6 Hz), 6.56 (2H, d, J = 0.6 Hz), 6.53 (1H, t, J = 0.6 Hz), 5.22 (1H, bs), 2.26

(3H, s), 2.23 (6H, s), 2.17 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 144.2, 141.3, 139.2, 136.6, 130.9, 125.4, 122.8, 122.4, 119.9, 116.8, 115.4, 21.6, 21.4, 17.7. IR (KBr disc, cm^{-1}) 3383, 3020, 2919, 1601, 1578, 1522, 1466, 1221, 1177, 829, 802. Anal. Calc. for $C_{14}H_{12}F_3NO$: C 62.92, H 4.53. Found: C 63.13, H 4.46.



N-(2-methoxyphenyl)-3,5-dimethylaniline (Entry 6)[ix]

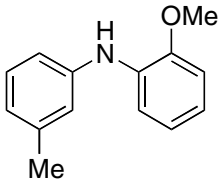
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 5-bromo-*m*-xylene (136 μL, 1.00 mmol), and *o*-anisidine (225 μL, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 100 °C. Workup and chromatographic purification (hexanes / ethyl acetate 4:1 → 1:0) afforded the title compound as an orange oil (155 mg, 68%). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33-7.31 (1H, m), 6.91-6.84 (3H, m), 6.81 (2H, d, *J* = 0.6 Hz), 6.62 (1H, t, *J* = 0.6 Hz), 6.10 (1H, s), 3.89 (3H, s), 2.30 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 148.4, 142.8, 139.1, 123.2, 121.0, 119.8, 118.7, 116.5, 115.0, 110.6, 55.8, 21.6.



2-methyl-*N*-*m*-tolylaniline (Entry 7)[3]

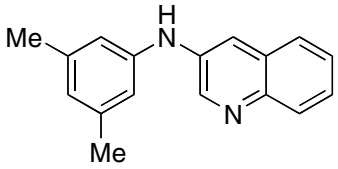
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 2-bromotoluene (120 μL, 1.00 mmol), and *m*-toluidine (216 μL, 2.0 mmol) with DMSO (0.50 mL) as solvent for 30 h at 100 °C. Workup and

chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as a tan oil (129 mg, 66 %). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26 (1H, d, *J* = 6.9 Hz), 7.22 (1H, d, *J* = 7.5 Hz), 7.17 (2H, m), 6.97-6.94 (1H, m), 6.81-6.75 (3H, m), 5.36 (1H, bs), 2.33 (3H, s), 2.28 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 144.0, 141.5, 139.3, 131.1, 139.3, 128.3, 126.9, 122.0, 122.5, 118.9, 118.3, 114.7, 21.7, 18.1.



2-methoxy-*N*-*m*-tolylaniline (Entry 8)[x]

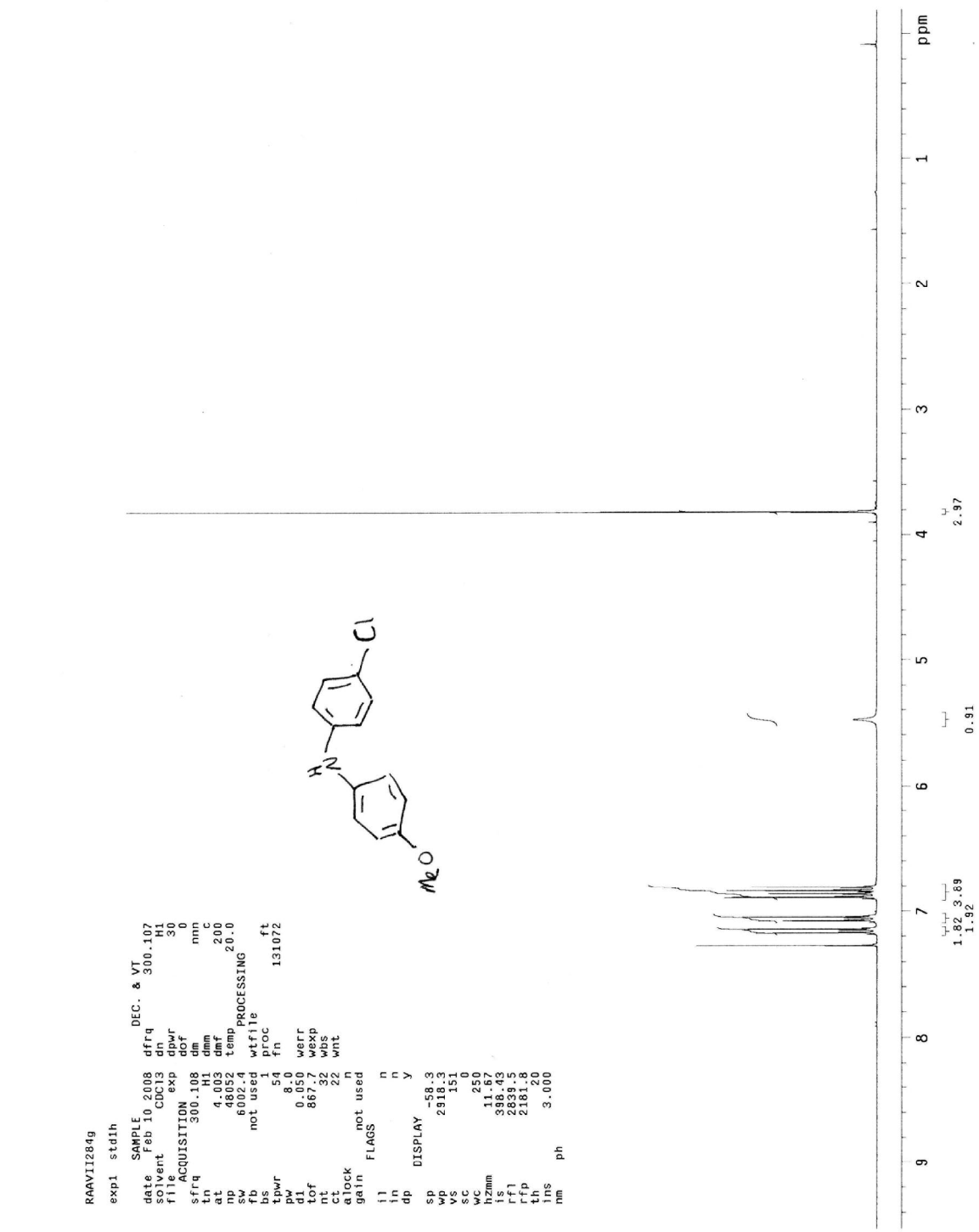
The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 2-bromoanisole (125 μL, 1.00 mmol), and *m*-toluidine (216 μL, 2.0 mmol) with DMSO (0.50 mL) as solvent for 30 h at 100 °C. Workup and chromatographic purification (hexanes / ethyl acetate 1:0 → 4:1) afforded the title compound as an orange oil (142 mg, 66%). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36-7.33 (1H, m), 7.23-7.18 (1H, m), 7.02-6.87 (5H, m), 6.81 (1H, d, *J* = 7.5 Hz), 6.16 (1H, bs), 3.29 (3H, s), 2.36 (3H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 148.4, 142.8, 139.3, 133.2, 129.3, 122.2, 121.0, 119.9, 119.4, 115.8, 114.9, 110.6, 55.8, 21.7.

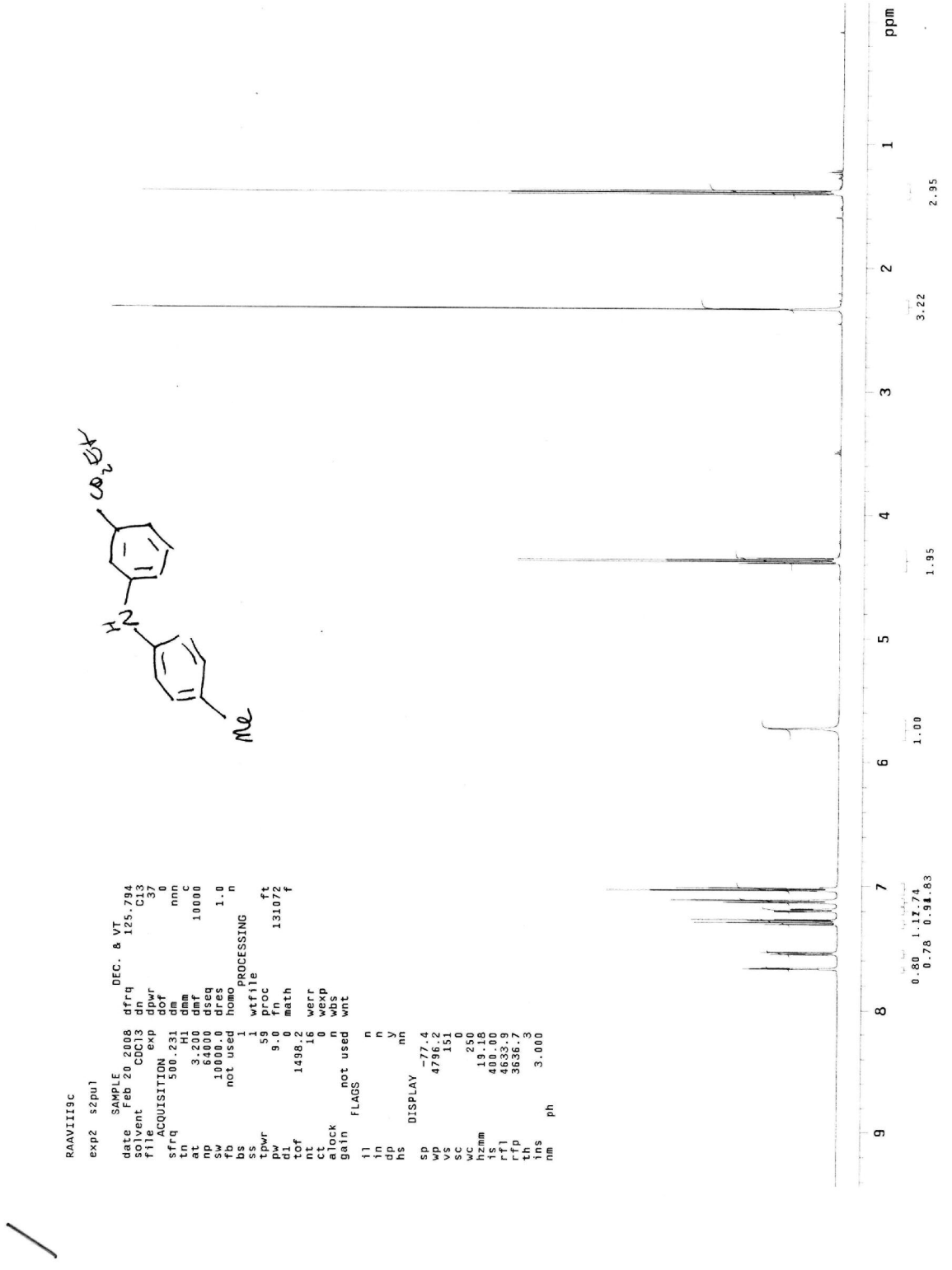


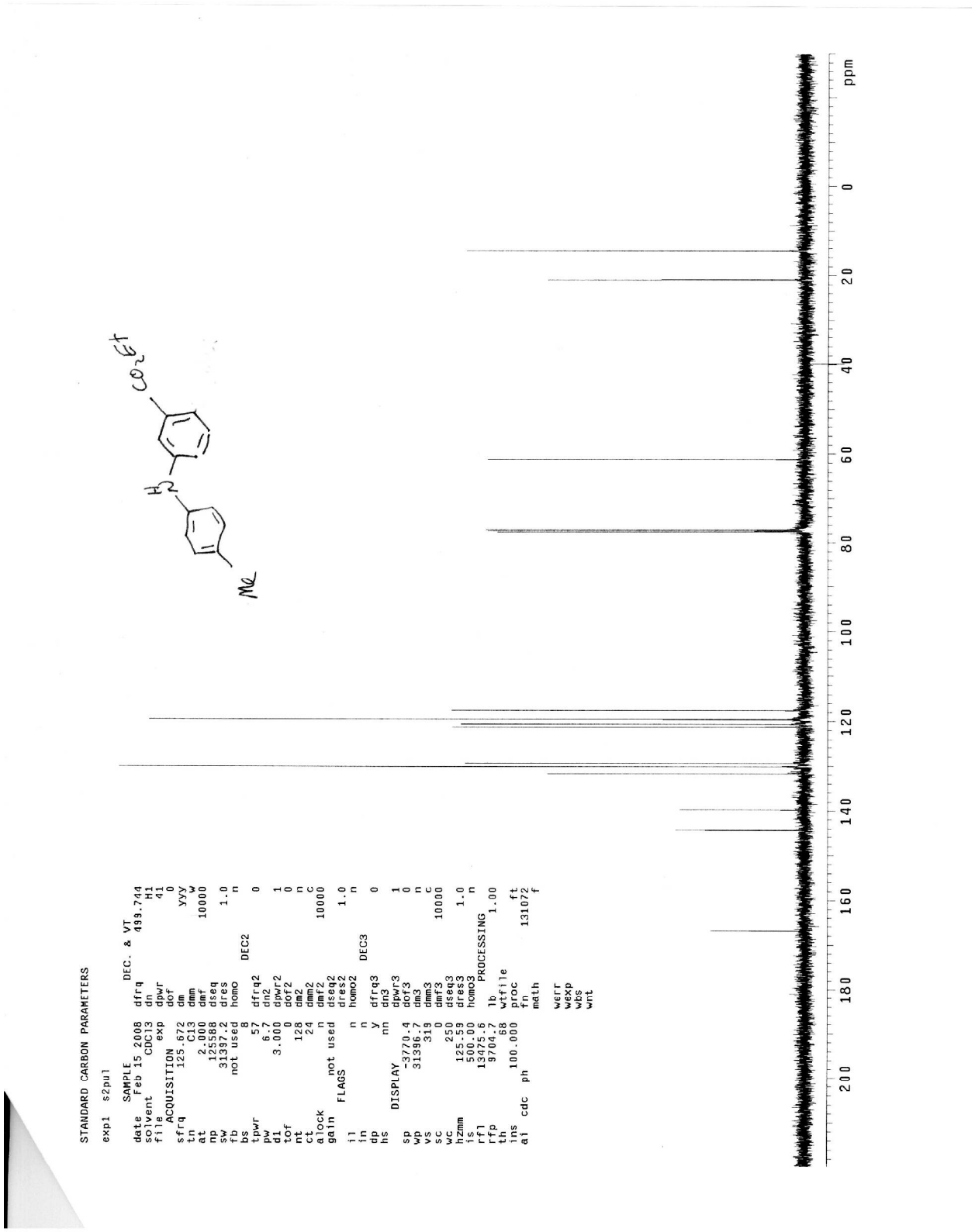
N-(3,5-dimethylphenyl)quinolin-3-amine (Entry 9)

The general procedure was followed using CuI (19 mg, 0.10 mmol), pyrrole-2-carboxylic acid (22 mg, 0.20 mmol), K_3PO_4 (424 mg, 2.0 mmol), 3-bromoquinoline (136 μL, 1.00 mmol), and

3,5-dimethylaniline (248 μL, 2.0 mmol) with DMSO (0.50 mL) as solvent for 24 h at 100 °C. Workup and chromatographic purification (hexanes / ethyl acetate 4:1 → 1:0) afforded the title compound as a green oil (135 mg, 54 *%).* ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.72 (1H, d, *J* = 2.8 Hz), 8.02 (1H, dd, *J* = 0.6, 8.2 Hz), 7.70 (1H, d, *J* = 2.8 Hz), 7.65 (1H, dd, *J* = 1.2, 8.1 Hz), 7.54-7.46 (2H, m), 6.82 (2H, s), 6.71 (1H, d, *J* = 0.6 Hz), 6.12 (1H, s), 2.32 (6H, s). ^{13}C NMR (125 MHz, $CDCl_3$) δ 145.3, 143.7, 141.9, 139.6, 137.4, 120.2, 129.1, 127.2, 126.6, 126.5, 124.4, 117.2, 116.5, 21.6. IR (KBr disc, cm^{-1}) 3265, 3038, 1596, 1491, 1470, 1361, 1215, 1140, 908, 834, 781, 749, 732.


RAAVII284g
exp1 std1h
SAMPLE
date Feb 10 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 300.108
tn H1
at 4.003
np 48052
sw 6002.4
fb not used
bs
tpwr 54
pw 8.0
d1 0.050
tof 867.7
nt 32
ct 22
alock n
gain not used
FLAGS
il n
in n
dp y
DISPLAY
sp -58.3
wp 2918.3
vs 151
sc 0
wc 250
hzmm 11.67
is 388.43
rfl 2839.5
rfp 2181.8
th 20
ins 3.000
nm ph
DEC. & VT
dfrq 300.107
dn H1
dpwr 30
dof 0
dm nnn
dmm c
dmf 200
temp 20.0
PROCESSING
wtfile
proc ft
fn 131072
werr
wexp
wbs
wnt
MeO
Cl
1.82 3.68
1.92
0.91
2.97
9 8 7 6 5 4 3 2 1 ppm

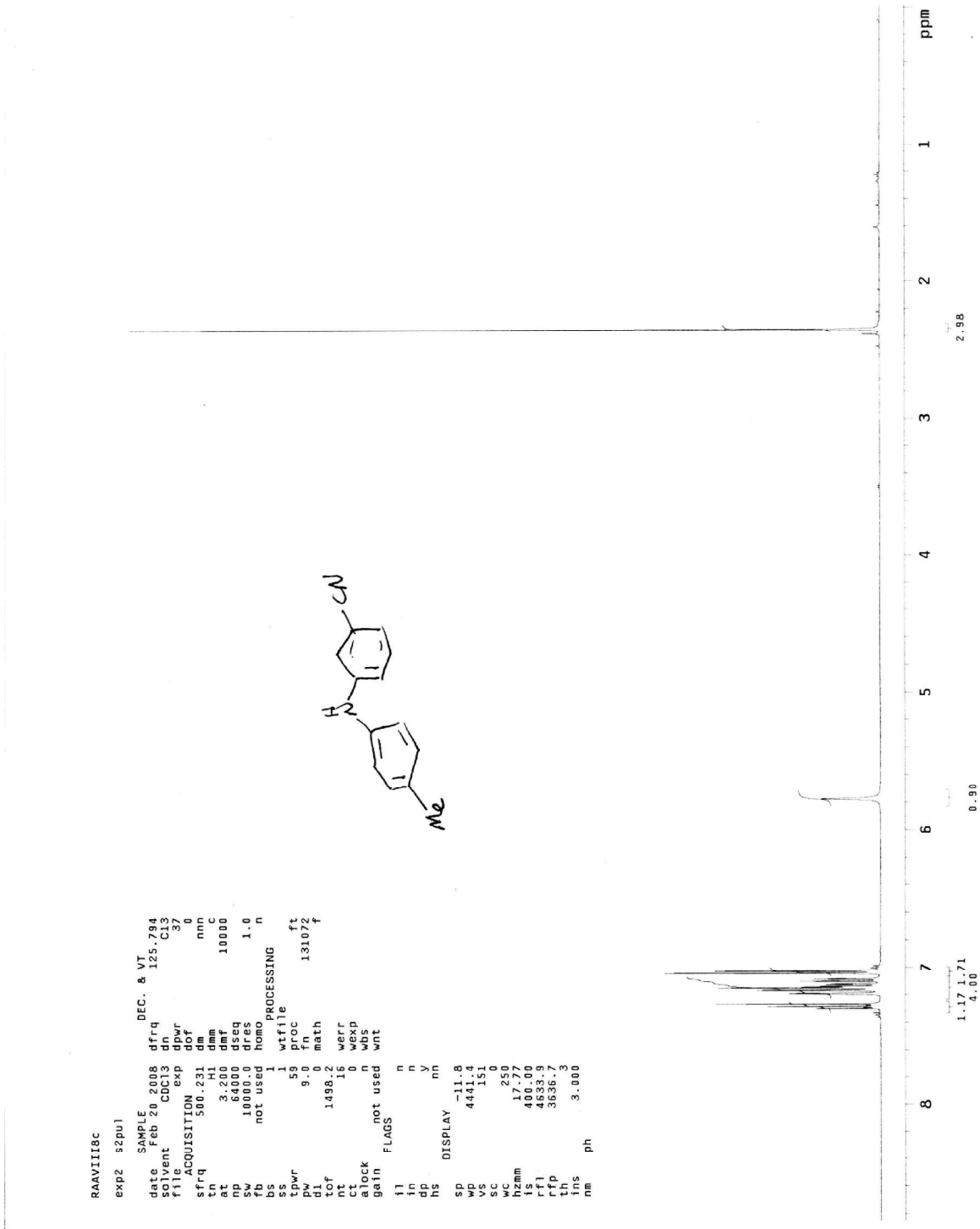

RAAVII9c
exp2 s2pul
SAMPLE
date Feb 20 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 500.231
tn H1
at 3.200
np 64000
sw 10000.0
fb not used
bs 1
ss 1
tpwr 59
pw 9.0
d1 1498.2
tof 16
nt 0
ct n
alock not used
gain FLAGS
DEC. & VT
dfrq 125.794
dn C13
dpwr 37
dof 0
dm nnn
dmm c
dmf 10000
dseq
dres 1.0
homo n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
sp -77.4
wp 4796.2
vs 151
sc 0
wc 250
hzmm 19.18
is 400.00
rfl 4633.9
rfp 3636.7
th 3
ins 3.000
nm ph
1.00
1.95
3.22
2.95
0.80 1.17.74
0.78 0.91.83
ppm



STANDARD CARBON PARAMETERS

exp1 s2pul

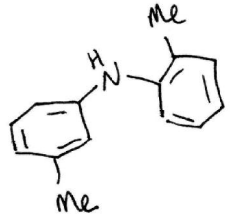
	SAMPLE	DEC. & VT	
date	Feb 15 2008	dfrq	499.744
solvent	CDCl3	dn	H1
file	exp	dpwr	41
	ACQUISITION	dof	0
sfrq	125.672	dm	yyy
tn	C13	dmm	w
at	2.003	dmf	10000
np	125588	dseq	
sw	31397.2	dres	1.0
fb	not used	homo	n
bs	8	DEC2	
tpwr	57	dfrq2	0
pw	6.7	dn2	
d1	3.000	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	24	dmm2	c
alock	n	dmf2	10000
gain	not used	dseq2	
	FLAGS	dres2	1.0
il	n	homo2	n
in	n	DEC3	
dp	y	dfrq3	
hs	nn	dn3	0
	DISPLAY	dpwr3	
sp	-3770.4	dof3	1
wp	31396.7	dm3	0
vs	319	dmm3	n
sc	0	dmf3	c
wc	250	dseq3	10000
hzmm	125.59	dres3	
is	500.00	homo3	1.0
rfl	13475.6		n
rfp	9704.7	PROCESSING	
th	68	lb	1.00
ins	100.000	wtfile	
ai	cdc ph	proc	ft
		fn	131072
		math	f
		werr	
		wexp	
		wbs	
		wnt	

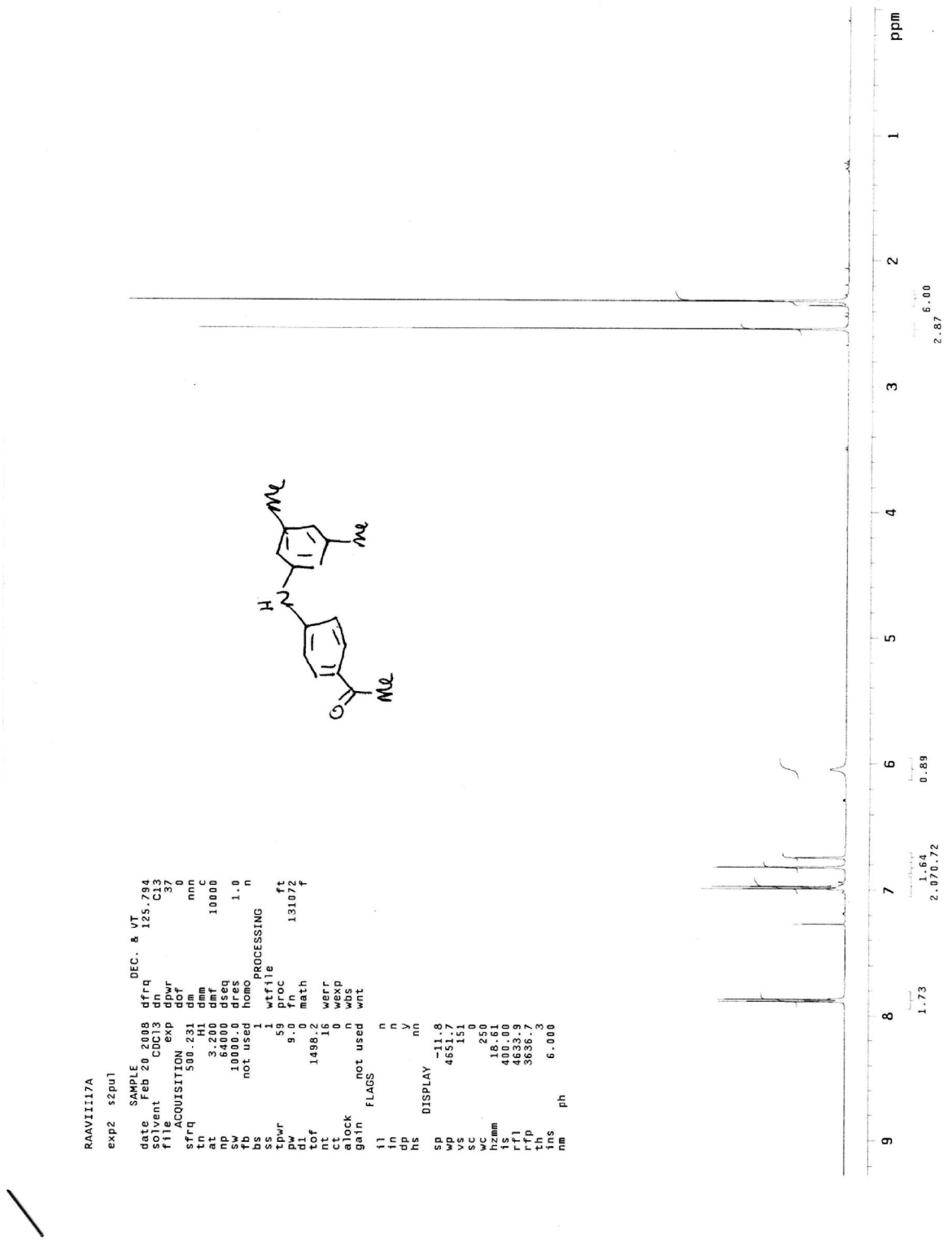

RAAVIII8c
exp2 s2pul
SAMPLE
date Feb 20 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 500.231
tn H1
at 3.200
np 64000
sw 10000.0
fb not used
bs 1
ss 59
tpwr 9.0
pw 0
d1 1498.2
tof 16
nt 0
ct n
alock not used
gain
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -11.8
wp 4441.4
vs 151
sc 0
wc 250
hzmm 17.77
is 400.00
rl 4633.9
rfp 3636.7
th 3
ins 3.000
nm ph
DEC. & VT
dfrq 125.794
dn C13
dpwr 37
dof 0
dm nnn
dmm c
dmf 10000
dseq
dres 1.0
homo n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
Me
8
7
6
5
4
3
2
1
ppm
1.17 1.71
4.00
0.90
2.98

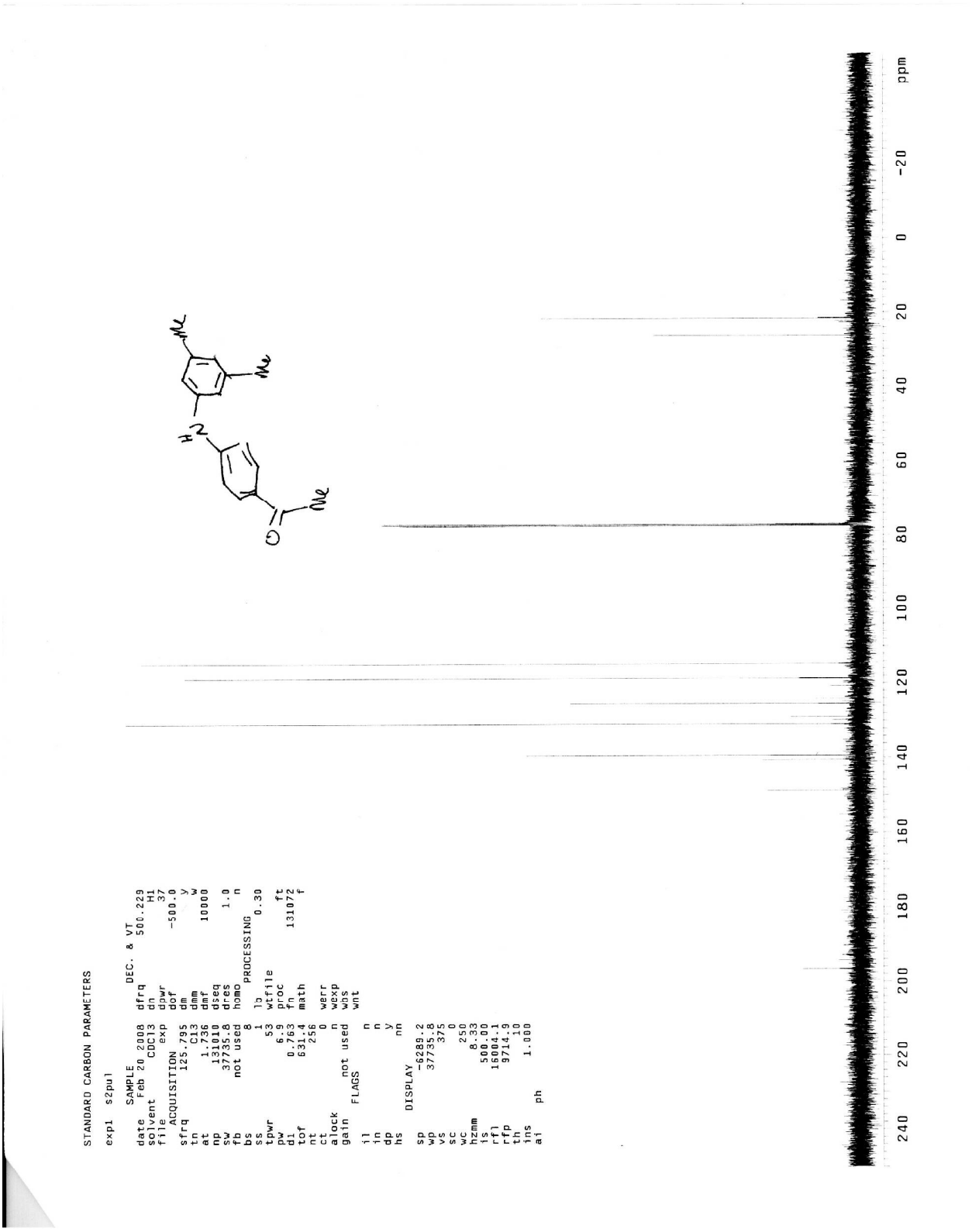
RAAVIII46b

exp1 s2pul

SAMPLE		DEC. & VT	
date	Mar 6 2008	dfrq	125.794
solvent	CDCl3	dn	C13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.231	dm	nnn
tn	H1	dmm	c
at	3.200	dmf	10000
np	64000	dseq	
sw	10000.0	dres	1.0
fb	not used	homo	n
bs	2	PROCESSING	
ss	1	wtfile	
tpwr	59	proc	ft
pw	9.0	fn	131072
dl	0	math	f
tof	1498.2		
nt	16	werr	
ct	16	wexp	
alock	n	wbs	
gain	not used	wnt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-536.8		
wp	5177.4		
vs	151		
sc	0		
wc	250		
hzmm	20.71		
is	100.00		
rfl	4633.4		
rfp	3636.7		
th	7		
ins	3.000		
nm	ph		



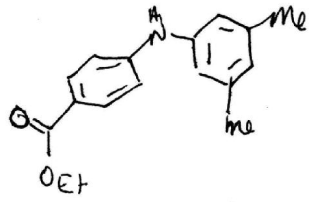

RAAVIII17A
exp2 s2pul
SAMPLE
date Feb 20 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 500.231
tn H1
at 3.200
np 64000
sw 10000.0
fb not used
bs 1
ss 59
tpwr 9.0
pw 0
dl 1498.2
tof 16
nt 0
ct 0
alock not used
gain FLAGS
DEC. & VT
dfrq 125.794
dn C13
dpwr 37
dof 0
dm nnn
dmm c
dmf 10000
dseq
dres 1.0
homo n
1
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
n
n
y
nn
DISPLAY
sp -11.8
wp 4651.7
vs 151
sc 0
wc 250
hzmm 18.61
is 400.00
rfl 4633.9
rfp 3636.7
th 3
ins 6.000
nm ph
Me
Me
Me
H
N
O
9
8
7
6
5
4
3
2
1
ppm
1.73
1.64
2.070.72
0.89
2.87
6.00

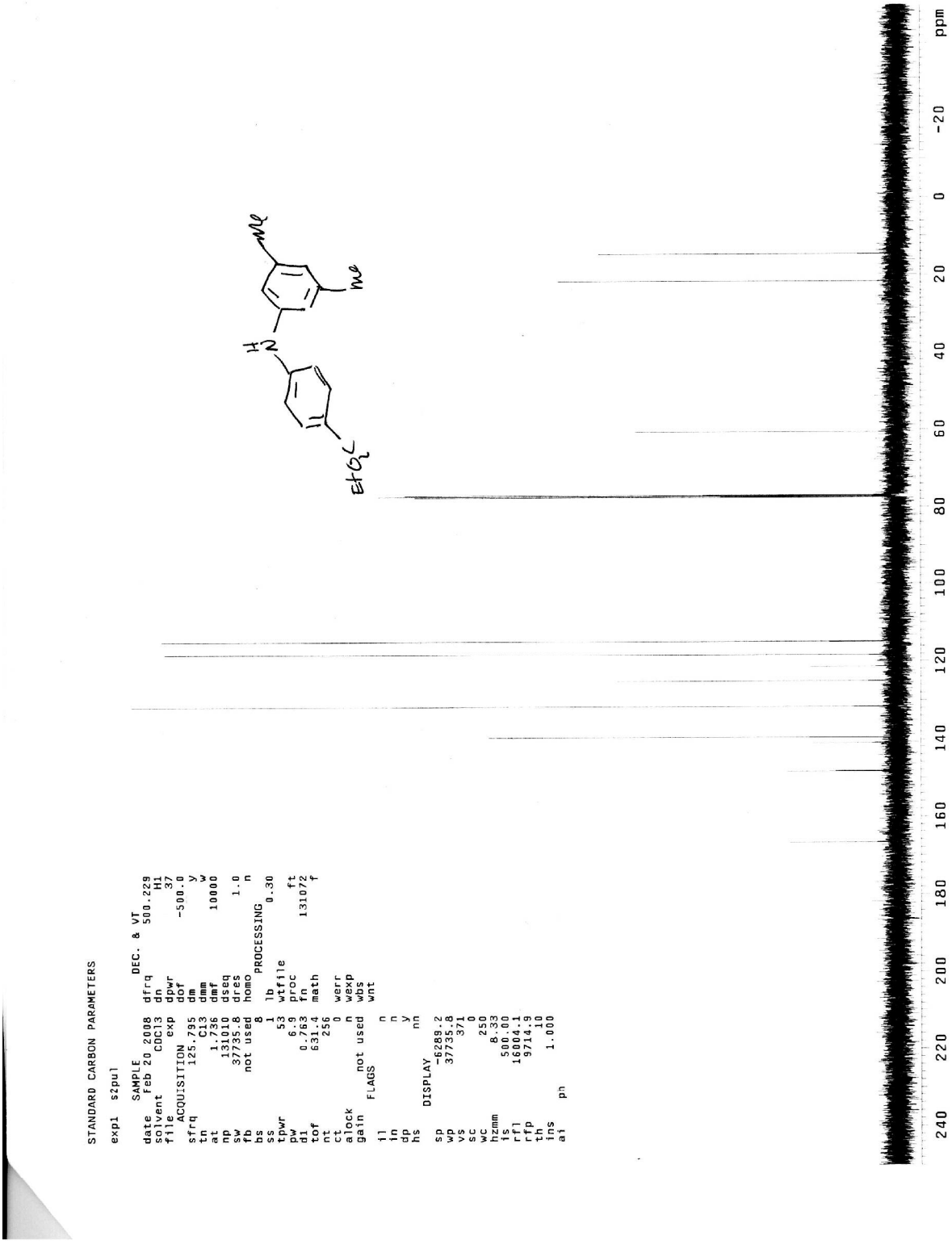

STANDARD CARBON PARAMETERS
exp1 s2pul
SAMPLE DEC. & VT
date Feb 20 2008 dfrq 500.229
solvent CDCl3 dn H1
file exp dpwr 37
ACQUISITION dof -500.0
sfrq 125.795 dm y
tn C13 dmm w
at 1.736 dmf 10000
np 131010 dseq
sw 37735.8 dres 1.0
fb not used homo n
bs 8 PROCESSING
ss 1 lb 0.30
tpwr 53 wtfile ft
pw 6.9 proc
d1 0.763 fn 131072
tof 631.4 math f
nt 256
ct 0 werr
alock n wexp
gain not used wbs
FLAGS wnt
il n
in n
dp y
hs nn
DISPLAY
sp -6289.2
wp 37735.8
vs 375
sc 0
wc 250
hzmm 8.33
is 500.00
rfl 16004.1
rfp 9714.9
th 10
ins 1.000
ai ph
240 220 200 180 160 140 120 100 80 60 40 20 0 -20 ppm

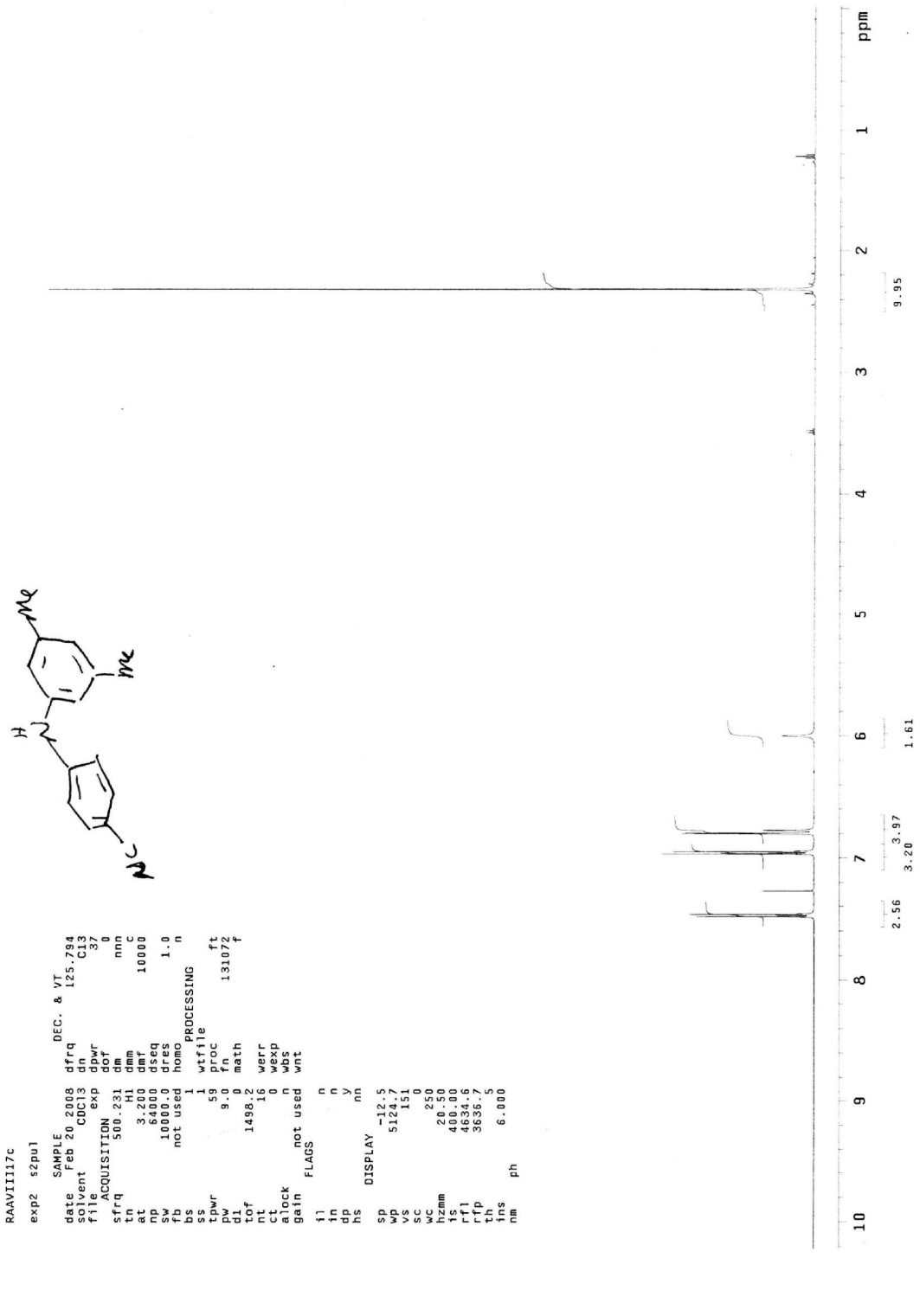
RAAVIII17b

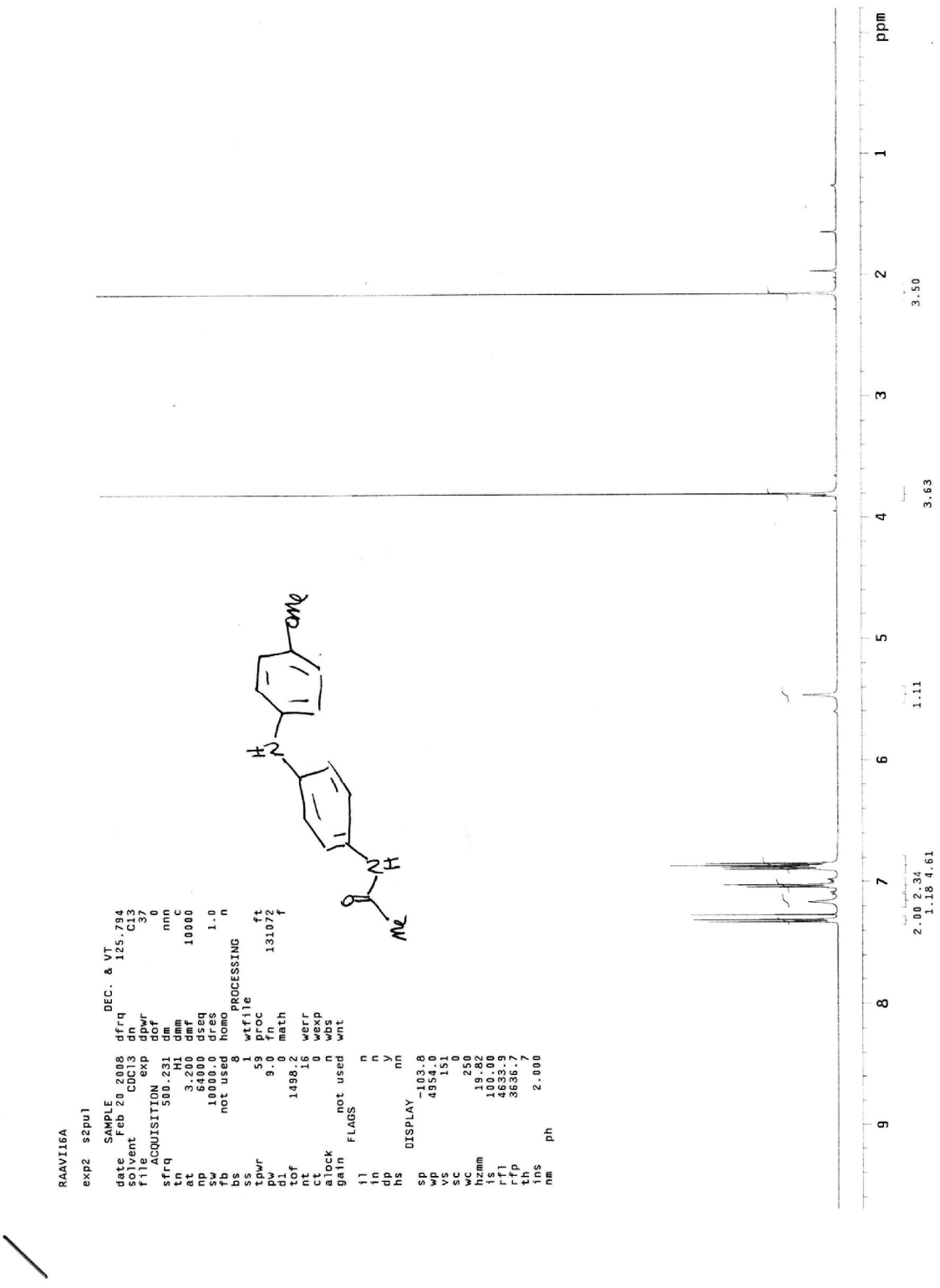
exp2 s2pul

SAMPLE		DEC. & VT	
date	Feb 20 2008	dfrq	125.794
solvent	CDCl3	dn	C13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.231	dm	nnn
tn	H1	dmm	c
at	3.200	dmf	10000
np	64000	dseq	
sw	10000.0	dres	1.0
fb	not used	homo	n
bs	1	PROCESSING	
ss	1	wtfile	
tpwr	59	proc	ft
pw	9.0	fn	131072
d1	0	math	f
tof	1498.2		
nt	16	werr	
ct	0	wexp	
alock	n	wbs	
gain	not used	wnt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-261.4		
wp	4783.1		
vs	151		
sc	0		
wc	250		
hzmm	19.13		
is	400.00		
rfl	4633.9		
rfp	3636.7		
th	3		
ins	6.000		
nm	ph		




STANDARD CARBON PARAMETERS
exp1 s2pul
SAMPLE DEC. & VT
date Feb 20 2008 dfrq 500.229
solvent CDCl3 dn H1
file exp dpwr 37
ACQUISITION -500.0 dof y
sfrq 125.795 dm w
tn C13 dmm 10000
at 1.736 dmf
np 131010 dseq 1.0
sw 37735.8 dres n
fb not used homo PROCESSING
bs 8 0.30
ss 1 lb
tpwr 53 wtfile ft
pw 6.9 proc 131072
d1 0.763 fn f
tof 631.4 math
nt 256
ct 0 werr
alock n wexp
gain not used wbs
FLAGS wnt
il n
in n
dp y
hs nn
DISPLAY
sp -6289.2
wp 37735.8
vs 371
sc 0
wc 250
hzmm 8.33
is 500.00
rfl 16004.1
rfp 9714.9
th 10
ins 1.000
ai ph
EtO2C
Me
Me
H2N
240 220 200 180 160 140 120 100 80 60 40 20 0 -20 ppm

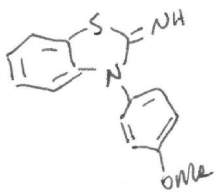

RAAVII117c
exp2 s2pul
SAMPLE
date Feb 20 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 500.231
tn H1
at 3.200
np 64000
sw 10000.0
fb not used
bs 1
ss 1
tpwr 59
pw 9.0
d1 0
tof 1498.2
nt 16
ct 0
alock n
gain not used
FLAGS
DISPLAY
sp -12.5
wp 5124.7
vs 151
sc 0
wc 250
hzmm 20.50
is 400.00
rfl 4634.6
rfp 3636.7
th 5
ins 6.000
nm ph
DEC. & VT
dfrq 125.794
dn C13
dpwr 37
dof 0
dm nnn
dmm c
dmf 10000
dseq
dres 1.0
homo n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
n
n
y
nn
Me
Me
N
H
ppm
2.56
3.97
3.20
1.61
9.95

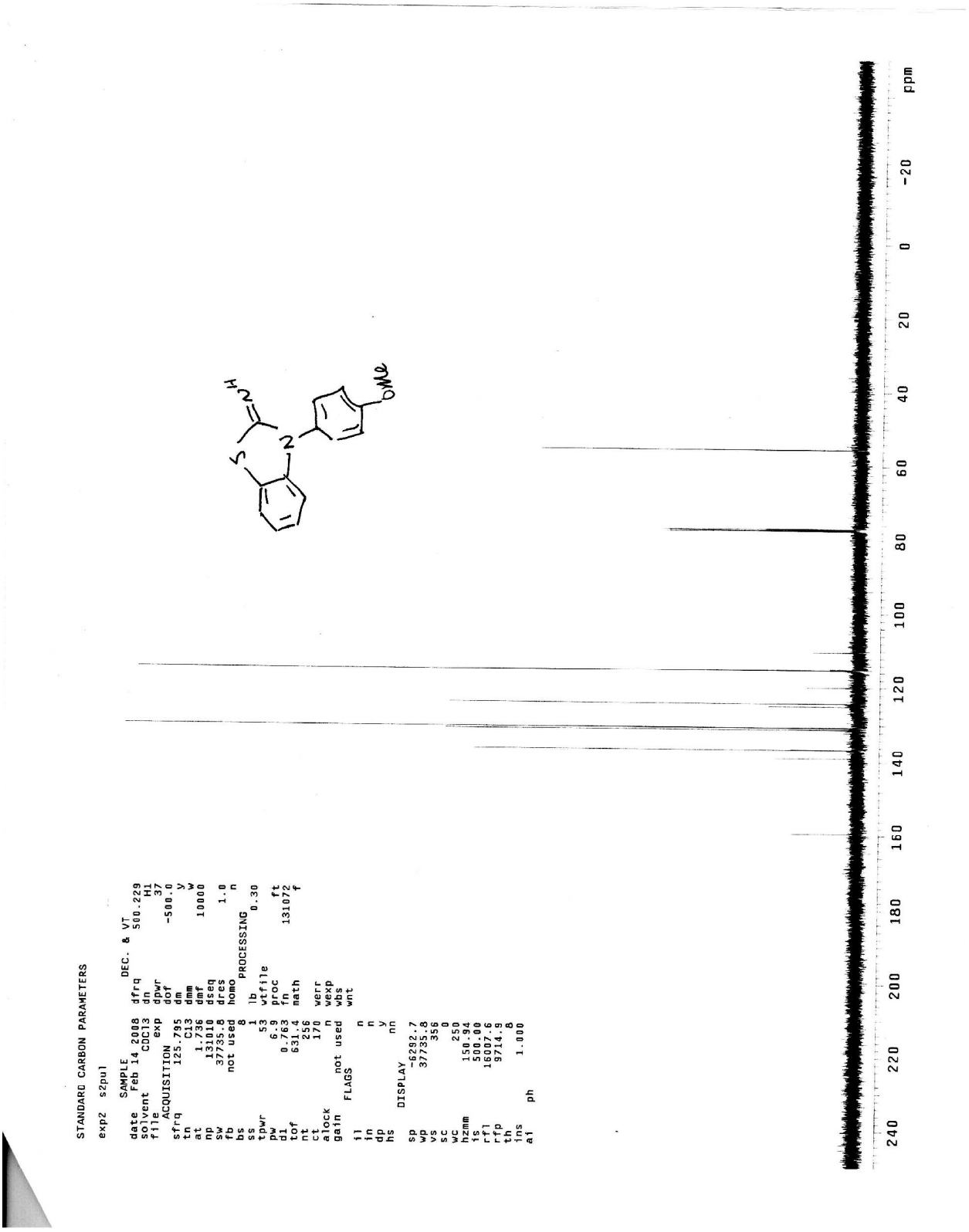

RAAVI16A
exp2 s2pul
SAMPLE
date Feb 20 2008
solvent CDCl3
file ACQUISITION
sfrq 500.231
tn H1
at 3.200
np 64000
sw 10000.0
fb not used
bs 8
ss 1
tpwr 59
pw 9.0
d1 1498.2
tof 16
nt 0
ct n
alock not used
gain FLAGS
tl n
in n
dp y
hs nn
DISPLAY
sp -103.8
wp 4954.0
vs 151
sc 0
wc 250
hzmm 19.82
is 100.00
rfl 4633.9
rfp 3636.7
th 7
ins 2.000
nm ph
DEC. & VT
dfrq 125.794
dn C13
dpwr 37
dof 0
dm nnn
dmm C
dmf 10000
dseq
dres 1.0
homo n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
Me
NH
NH2
Me
9
8
7
6
5
4
3
2
1
ppm
2.00 2.34
1.18 4.61
1.11
3.63
3.50

RAAVIII25B

exp2 s2pul

SAMPLE		DEC. & VT	
date	Feb 25 2008	dfrq	125.672
solvent	CDCl3	dn	C13
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.746	dm	nnn
tn	H1	dmm	w
at	3.001	dmf	10000
np	63050	dseq	
sw	10504.2	dres	1.0
fb	not used	homo	n
bs	1	DEC2	
tpwr	59	dfrq2	0
pw	8.6	dn2	
d1	2.000	dpwr2	1
tof	1519.5	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	not used	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	DEC3	
dp	y	dfrq3	0
hs	nn	dn3	
DISPLAY		dpwr3	1
sp	-85.2	dof3	0
wp	4595.5	dm3	n
vs	34	dmm3	c
sc	0	dmf3	200
wc	250	dseq3	
hzmm	18.38	dres3	1.0
is	33.57	homo3	n
rfl	4864.1	PROCESSING	
rfp	3633.1	wtfile	
th	7	proc	ft
ins	3.000	fn	262144
ai cdc ph		math	f
		werr	
		wexp	
		wbs	
		wnt	wft

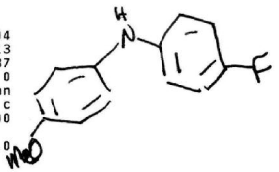


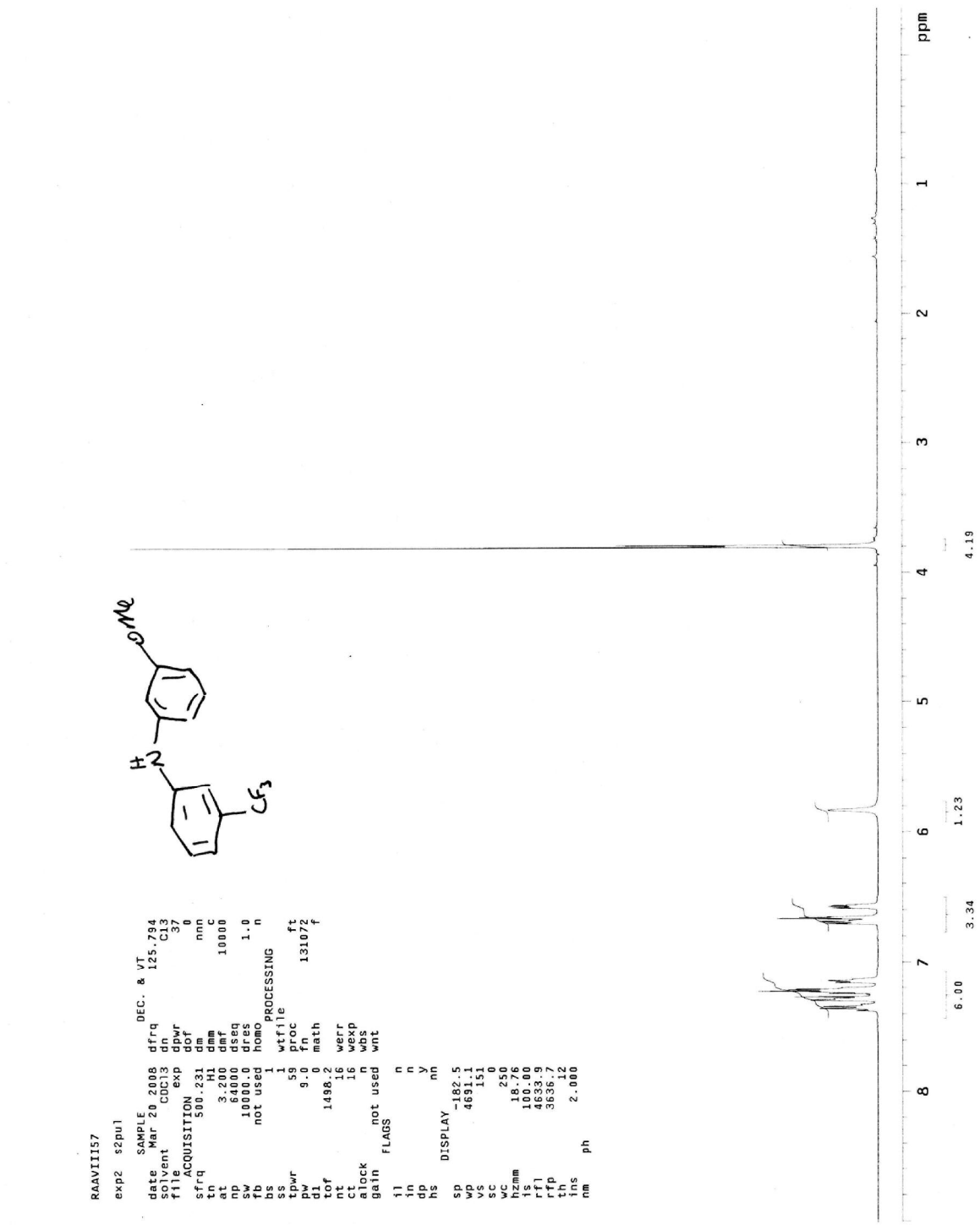

STANDARD CARBON PARAMETERS
exp2 s2pul
SAMPLE
date Feb 14 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 125.795
tn C13
at 1.736
np 131016
sw 37735.8
fb not used
bs 8
ss 1
tpwr 53
pw 6.9
d1 0.763
tof 631.4
nt 256
ct 170
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -6292.7
wp 37735.8
vs 356
sc 0
wc 250
hzmm 150.94
is 500.00
rfl 16007.6
rfp 9714.9
th 8
ins 1.000
ai ph
DEC. & VT
dfrq 500.229
dn H1
dpwr 37
dof -500.0
dm y
dmm w
dmf 10000
dres 1.0
homo n
PROCESSING
lb 0.30
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
OMe
ppm

RAAVII246

expl s2pul

SAMPLE		DEC. & VT	
date	Feb 2 2008	dfrq	125.794
solvent	CDCl3	dn	C13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.231	dm	nnn
tn	H1	dmm	c
at	3.200	dmf	10000
np	64000	dseq	
sw	10000.0	dres	1.0
fb	not used	homo	
bs	8	PROCESSING	
ss	1	wtfile	
tpwr	59	proc	ft
pw	9.0	fn	131072
dl	0	math	f
tof	1498.2		
nt	16	werr	
ct	16	wexp	
alock	n	wbs	
gain	not used	wnt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-143.7		
wp	4638.6		
vs	151		
sc	0		
wc	250		
hzmm	18.55		
is	100.00		
rfl	4634.5		
rfp	3636.7		
th	7		
ins	3.000		
nm	ph		

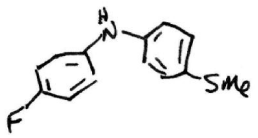



RAAVIII57
exp2 s2pul
SAMPLE
date Mar 20 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 500.231
tn H1
at 3.200
np 64000
sw 10000.0
fb not used
bs 1
ss 1
tpwr 59
pw 9.0
d1 0
tof 1498.2
nt 16
ct 16
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -182.5
wp 4691.1
vs 151
sc 0
wc 250
hzmm 18.76
is 100.00
rfl 4633.9
rfp 3636.7
th 12
ins 2.000
nm ph
DEC. & VT
dfrq 125.794
dn C13
dpwr 37
dof 0
dm nnn
dmm c
dmf 10000
dseq
dres 1.0
homo n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
OMe
NH2
CF3
8
7
6
5
4
3
2
1
ppm
6.00
3.34
1.23
4.19

RAAVIII56

exp2 s2pul

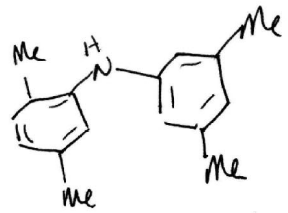
SAMPLE		DEC. & VT	
date	Mar 20 2008	dfrq	125.794
solvent	CDCl3	dn	C13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.231	dm	nnn
tn	H1	dmm	c
at	3.200	dmf	10000
np	64000	dseq	
sw	10000.0	dres	1.0
fb	not used	homo	n
bs	1	PROCESSING	
ss	1	wtfile	
tpwr	59	proc	ft
pw	9.0	fn	131072
d1	0	math	f
tof	1498.2		
nt	16	werr	
ct	16	wexp	
alock	n	wbs	
gain	not used	wnt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-169.4		
wp	5045.9		
vs	151		
sc	0		
wc	250		
hzmm	20.18		
is	100.00		
rfl	4633.9		
rfp	3636.7		
th	7		
ins	2.000		
nm	ph		

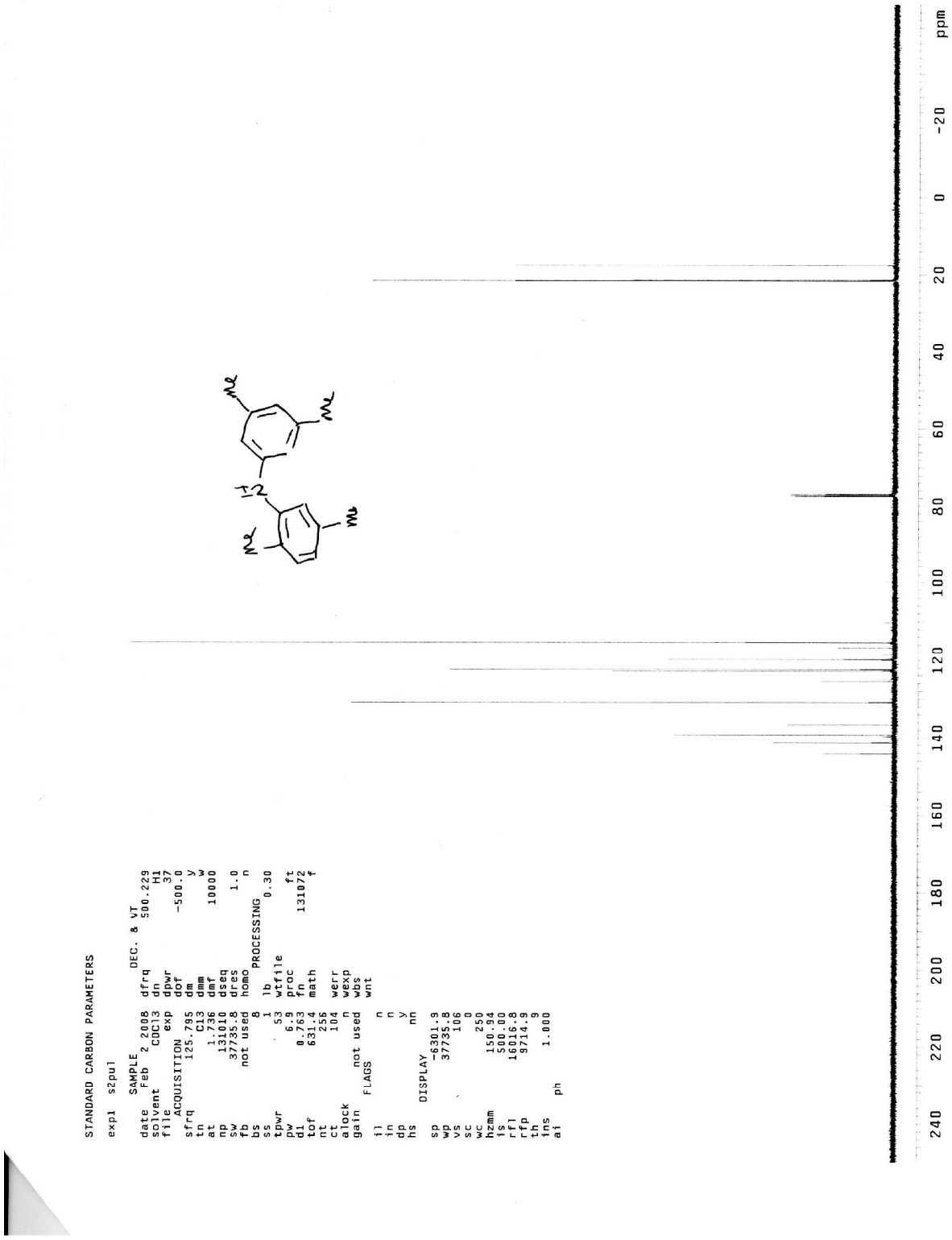


RAAVII254a

exp2 s2pul

SAMPLE		DEC. & VT	
date	Feb 2 2008	dfrq	125.794
solvent	CDCl3	dn	C13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.231	dm	nnn
tn	H1	dmm	c
at	3.200	dmf	10000
np	64000	dseq	
sw	10000.0	dres	1.0
fb	not used	homo	n
bs	8	PROCESSING	
ss	1	wtfile	
tpwr	59	proc	ft
pw	9.0	fn	131072
d1	0	math	f
tof	1498.2		
nt	16	werr	
ct	16	wexp	
alock	n	wbs	
gain	not used	wnt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-118.3		
wp	4704.2		
vs	151		
sc	0		
wc	250		
hzmm	18.82		
is	100.00		
rfl	4635.2		
rfp	3636.7		
th	7		
ins	1.000		
nm	ph		

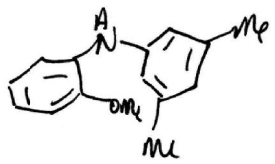


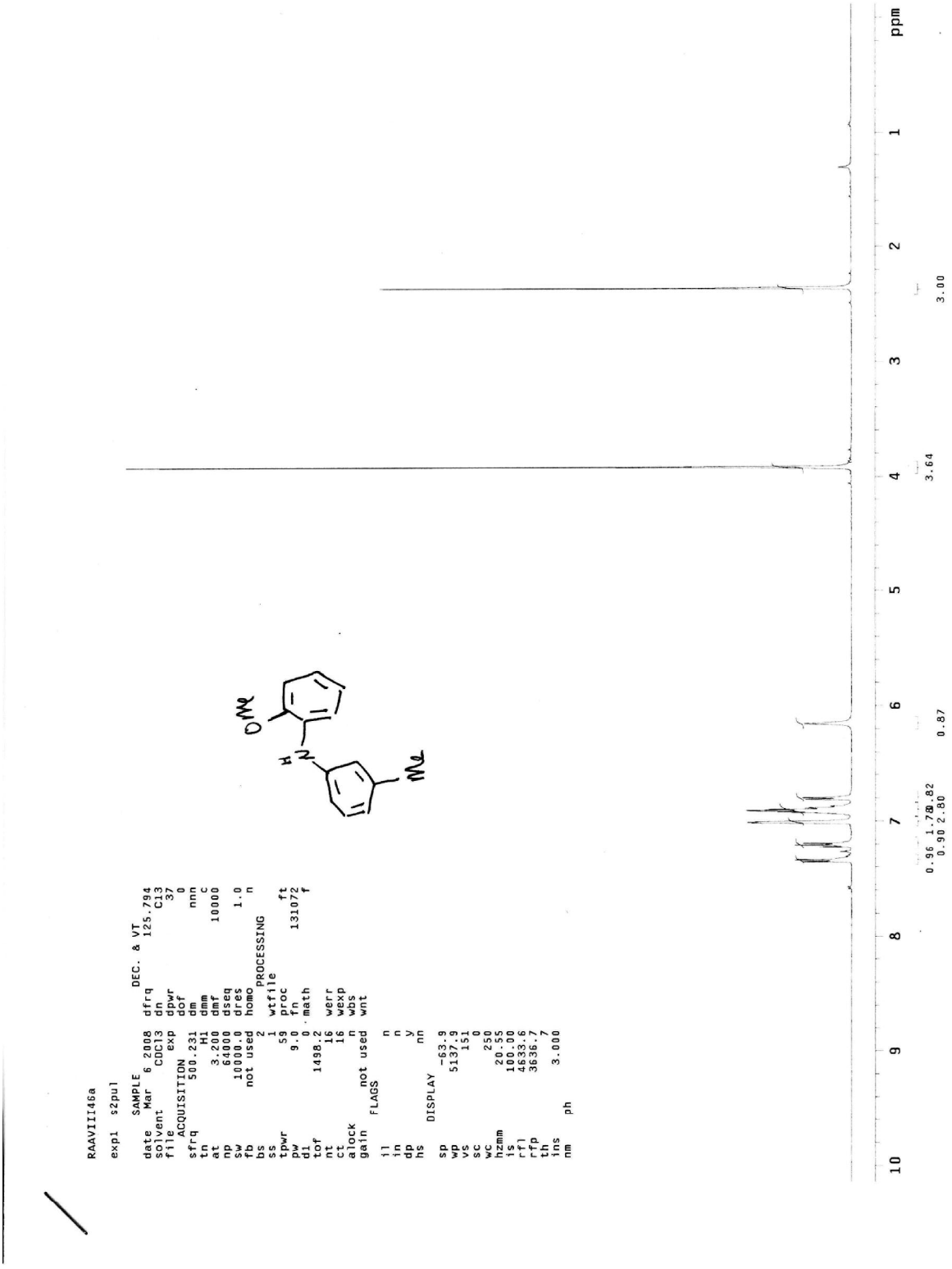

STANDARD CARBON PARAMETERS
exp1 s2pul
SAMPLE DEC. & VT
date Feb 2 2008 dfrq 500.229
solvent CDCl3 dn H1
file exp dpwr 37
ACQUISITION dof -500.0
sfrq 125.795 dm y
tn C13 dmm w
at 1.736 dmf 10000
np 131010 dseq
sw 37735.8 dres 1.0
fb not used homo n
bs 8 PROCESSING
ss 1 lb 0.30
tpwr 53 wrfile
pw 6.9 proc ft
dl 0.763 fn 131072
tof 631.4 math f
nt 256
ct 104 werr
alock n wexp
gain not used wbs
FLAGS wnt
il n
in n
dp y
hs nn
DISPLAY
sp -6301.9
wp 37735.8
vs 106
sc 0
wc 250
hzmm 150.94
is 500.00
rfl 16016.8
rfp 9714.9
th 9
ins 1.000
ai ph
240 220 200 180 160 140 120 100 80 60 40 20 0 -20 ppm

RAAVIII63

exp2 s2pul

SAMPLE		DEC. & VT	
date	Mar 20 2008	dfrq	125.794
solvent	CDCl3	dn	C13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.231	dm	nnn
tn	H1	dmm	c
at	3.200	dmf	10000
np	64000	dseq	
sw	10000.0	dres	1.0
fb	not used	homo	n
bs	1	PROCESSING	
ss	1	wtfile	
tpwr	59	proc	ft
pw	9.0	fn	131072
dl	0	math	f
tof	1498.2		
nt	64	werr	
ct	26	wexp	
alock	n	wbs	
gain	not used	wnt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-64.4		
wp	4783.1		
vs	151		
sc	0		
wc	250		
hzmm	19.13		
is	100.00		
rfl	4634.0		
rfp	3636.7		
th	4		
ins	6.000		
nm	ph		

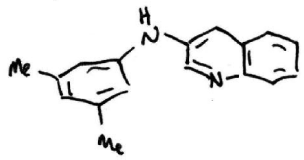


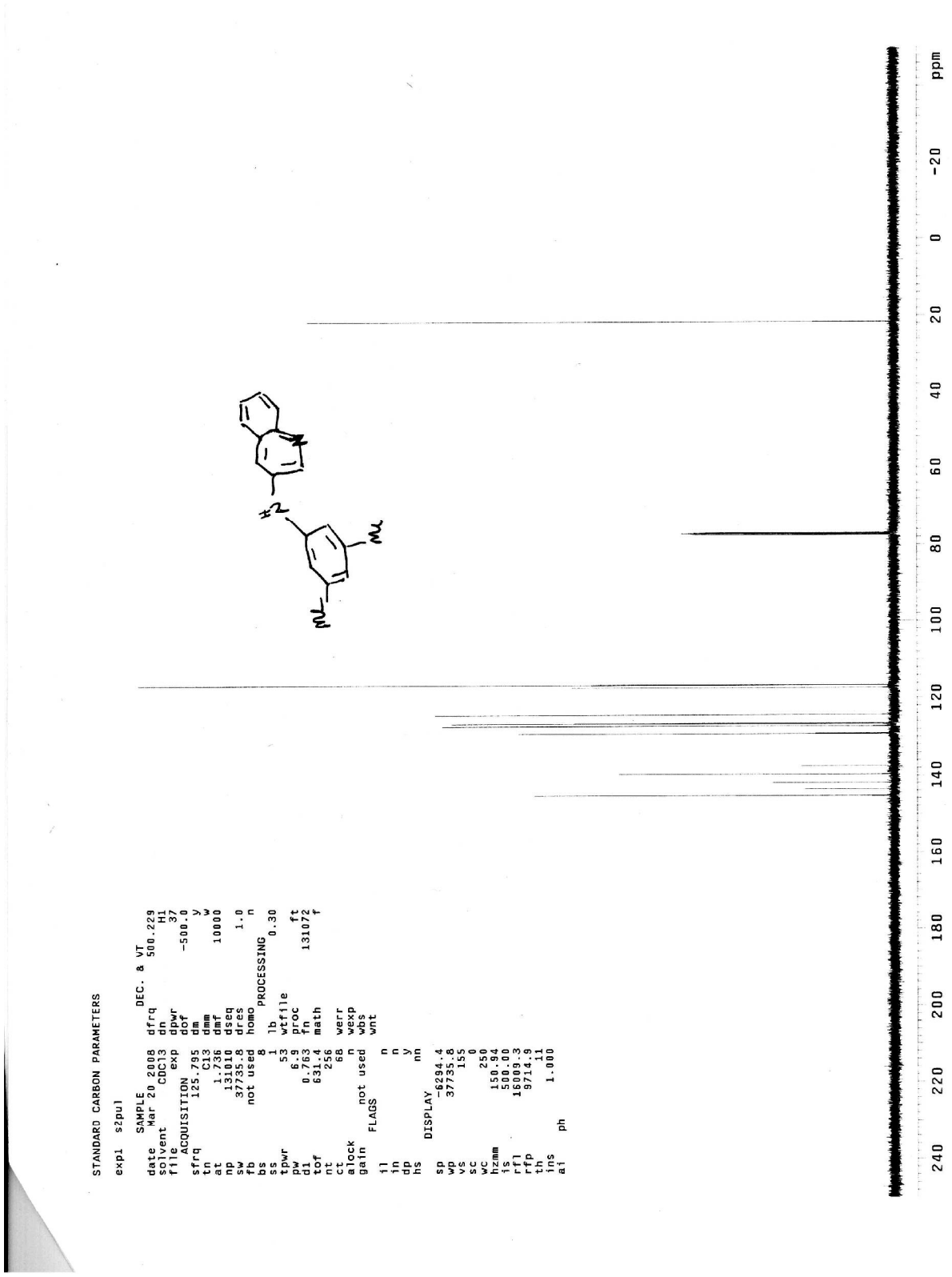

RAAVII46a
expl s2pul
SAMPLE
date Mar 6 2008
solvent CDCl3
file exp
ACQUISITION
sfrq 500.231
tn H1
at 3.200
np 64000
sw 10000.0
fb not used
bs 2
ss 1
tpwr 59
pw 9.0
d1 1498.2
tof 16
nt 16
ct
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -63.9
wp 5137.9
vs 151
sc 0
wc 250
hzmm 20.55
is 100.00
rf1 4633.6
rfp 3638.7
th
ins 3.000
nm ph
DEC. & VT
dfrq 125.794
dn C13
dpwr 37
dof 0
dm nnn
dmm c
dmf 10000
dseq
dres 1.0
homo n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt
0.96 1.78 0.82
0.90 2.80
0.87
3.64
3.00
ppm

RAAVIII58

exp2 s2pul

SAMPLE		DEC. & VT	
date	Mar 20 2008	dfrq	125.794
solvent	CDCl3	dn	C13
file	exp	dpwr	37
ACQUISITION		dof	0
sfrq	500.231	dm	nnn
tn	H1	dmm	c
at	3.200	dmf	10000
np	64000	dseq	
sw	10000.0	dres	1.0
fb	not used	homo	n
bs	1	PROCESSING	
ss	1	wtfile	
tpwr	59	proc	ft
pw	9.0	fn	131072
d1	0	math	f
tof	1498.2		
nt	16	werr	
ct	16	wexp	
alock	n	wbs	
gain	not used	wnt	
FLAGS			
il	n		
in	n		
dp	y		
hs	nn		
DISPLAY			
sp	-116.9		
wp	5269.2		
vs	151		
sc	0		
wc	250		
hzmm	21.08		
is	100.00		
rfl	4633.9		
rfp	3636.7		
th	5		
ins	6.000		
nm	ph		




STANDARD CARBON PARAMETERS
expl s2pul
SAMPLE DEC. & VT
date Mar 20 2008 dfrq 500.229
solvent CDCl3 dn H1
file exp dpwr 37
ACQUISITION dof -500.0
sfrq 125.795 dm y
tn C13 dmm y
at 1.736 dmf 10000
np 131010 dseq
sw 37735.8 dres 1.0
fb not used homo n
bs 8 PROCESSING
ss 1 lb 0.30
tpwr 53 wtfile
pw 6.9 proc ft
d1 0.763 fn 131072
tof 631.4 math f
nt 256
ct 68 werr
alock n wexp
gain not used wbs
wnt
fl n
in n
dp y
hs nn
DISPLAY
sp -6294.4
wp 37735.8
vs 155
sc 0
wc 250
hzmm 150.94
is 500.00
rfl 16009.3
rfp 9714.9
th 11
ins 1.000
ai ph
240 220 200 180 160 140 120 100 80 60 40 20 0 -20 ppm

References

[i] Nordiff, E. A.; Hausman, M. *J. Org. Chem.* **1964**, *29*, 2453.
[ii] Toyama, T.; Toyama, I.; Nimura, M.; Kamiyama, N.; Yokota, M. Biaryl compounds and diaryl ethers as uricosuric agents. Jpn. Kokai Tokkyo Koho, JP/2000001431 A 20000107, 2000.
[iii] Spagnolo, P.; Zanirato, P. *Tetrahedron Lett.* **1987**, *28*, 961.
[iv] Buchwald, S. L.; Klapars, A.; Antilla, J. C.; Job, G. E.; Wolter, M.; Kwong, F. Y.; Nordmann, G.; Hennessy, E. J. Copper-catalyzed formation of carbon-heteroatom and carbon-carbon bonds by arylation and vinylation of amines, amides, hydrazides, heterocycles, alcohols, enolates, and malonates, using aryl, heteroaryl, and vinyl halides and analogs. WO/2002085838 A1, 2002.
[v] Erdley, et Al. *Acta Chim. Acad. Sci Hung.* **1957**, *12*, 251.
[vi] Zhang, Hui; Cai, Qian; Ma, D. *J. Org. Chem.* **2005**, *70*, 5164.
[vii] Thu-Cuc, T., et al. *J. Heterocycl. Chem.* **1964**, *1*, 28.
[viii] Nodiff, E. A.; Craig, P. N. *J. Org. Chem.* **1961**, *26*, 824.
[ix] Zhang, X. X.; Harris, M. C.; Sadighi, J. P.; Buchwald, S. L. *Can. J. Chem.* **2001**, *79*, 1799.
[x] Sridharan, V.; Karthikeyan, K.; Muthusubramanian, S. *Tetrahedron Lett.* **2006**, *47*, 4221.