Intramolecular cyclization of diarylmethanols to α,β-unsaturated amides promoted by KO*t*-Bu/DMF: a metal-free approach towards 3,4-disubstituted quinolinones

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Supporting Information

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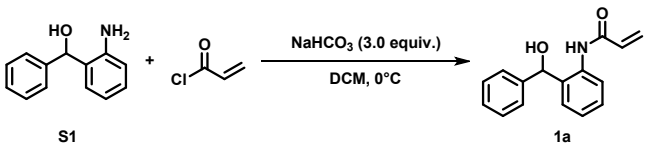
General Information

^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker AVANCE 400 spectrometer. Melting points were measured on a WRS-2A melting point apparatus and are uncorrected. Chemical shifts of protons are reported in parts per million downfield from tetramethylsilane and are referenced to residual protium in the NMR solvent ($CDCl_3$: δ 7.26; DMSO: δ 2.50). Chemical shifts of carbon are referenced to the carbon resonances of the solvent ($CDCl_3$: δ 77.0; DMSO: δ 39.5). Peaks are labeled as singlet (s), broad singlet (br), doublet (d), triplet (t), double doublet (dd), multiplet (m). Infrared spectra were recorded on a Nicolet 6700-Contium spectrometer. All products were further characterized by HRMS (high resolution mass spectra). Copies of their ^{1}H NMR and ^{13}C NMR spectra were provided. GC spectra were taken on an Agilent-6890A instrument. The normal and 99.99% purity of KO*t*-Bu were purchased from J&K chemical company and Sigma-Aldrich chemical company respectively and used without further purification. DMF (*N,N*-dimethylformamide) and THF (tetrahydrofuran) were dried and redistilled according to standard methods. DMSO (dimethyl sulfoxide) was dried over 4Å molecular sieves.

General procedures

2.1 Synthesis of the starting materials[1]

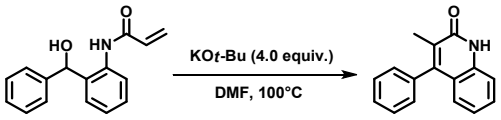


S1 1a

To a solution of (2-aminophenyl)(phenyl)methanol **S1** (398.5 mg, 2.0 mmol) and sodium bicarbonate (504.0 mg, 6.0 mmol) in dry DCM (20 mL) was added a solution of acryloyl chloride (199.1 mg, 2.2 mmol) in dry DCM (2 mL) dropwise at 0°C. The mixture was allowed to stir at this temperature for 2 hours. Upon completion (judged by TLC), water (20 mL) was added to quench the reaction. The organic phase was separated and evaporated to dryness. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 5:2) to give **1a** (480.0 mg, 95% yield).

The diphenylmethanol **S1** was synthesized according to known literatures.[2]

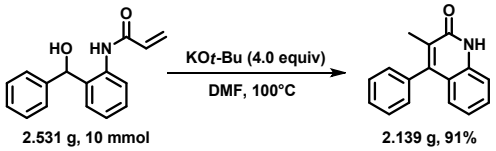
2.2 Representative experiment procedure



1a 2a

To a 25 mL dried reaction tube was added **1a** (63.4 mg, 0.25 mmol), KO*t*-Bu (112.3 mg, 1.0 mmol) and dry DMF (2.5 mL). The mixture was stirred at 100°C for 2 hours under argon atmosphere. After cooled down to room temperature, the reaction mixture was quenched with saturated NH_4Cl solution (1 mL) and was extracted with ethyl acetate (10 mL × 3). The combined organic layers was then washed with brine (5 mL) and dried over anhydrous $MgSO_4$. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 10:3) to give **2a** as a white solid (53.1 mg, 90% yield).

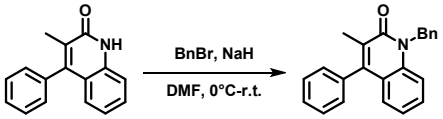
2.3 Gram-scale experiment



2.531 g, 10 mmol 2.139 g, 91%

To a 100 mL dried flask was added the mixture of **1a** (2.351 g, 10.0 mol), KO*t*-Bu (4.492 g, 40.0 mmol) and dry DMF (100.0 mL). The mixture was stirred at 100°C for 2 hours under argon atmosphere. After cooled down to room temperature, the mixture was poured into 500 mL ice water and stirred for 5 minutes. The precipitated solid was collected by filtration and further purified by recrystallization (petroleum ether/ethyl acetate) to afford **2a** as a pale solid (2.139 g, 91% yield).

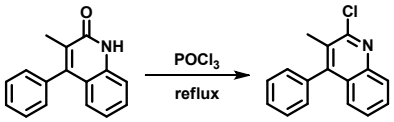
2.4 Synthesis of 5a



2a 5a

Under argon atmosphere, NaH (60.0 mg, 1.5 mmol, 60% in mineral) was added to a mixture of **2a** (235.3 mg, 1.0 mmol) in dry DMF (10 mL) at 0°C in portions and stirred at this temperature for 2 hours. BnBr (205.3 mg, 1.2 mmol) was added to the mixture slowly and then warm up to room temperature. After 10 hours, the mixture was quenched with saturated NH_4Cl solution (5 mL) and was extracted with ethyl acetate (10 mL × 3). The combined organic layers was then washed with brine (5 mL) and dried over anhydrous $MgSO_4$. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 20:1) to give **5a** as a white solid (289.2 mg, 89% yield).

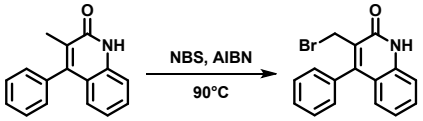
2.5 Synthesis of 5b



2a 5b

A mixture of **2a** (235.3 mg, 1.0 mmol) and 5 mL freshly distilled $POCl_3$ was refluxed for 5 hours. The mixture was poured into ice water (50 mL). Saturated Na_2CO_3 was added to adjust pH=7. The mixture was extracted with ethyl acetate (10 mL × 3). The combined organic layers was then washed with brine (5 mL) and dried over anhydrous $MgSO_4$. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 100:1) to give **5b** as a white solid (233.4 mg, 92% yield).

2.6 Synthesis of 5c

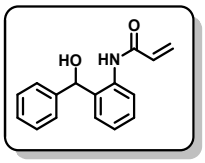


2a 5c

A mixture of **2a** (235.3 mg, 1.0 mmol), *N*-bromosuccinimide (267.0 mg, 1.5 mmol), azodiisobutyronitrile (33.0 mg, 0.2 mmol) in CCl_4 (10 mL) was heated at 90°C for 7 hours. The mixture was washed with water (20 mL) and brine (5 mL). The organic layer was dried over anhydrous $MgSO_4$. The residue was purified by column chromatography (petroleum ether/EtOAc = 10:1) to give **5c** as a white solid (265.8 mg, 85% yield).

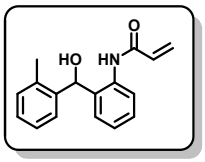
3. Characterization data

***N*-(2-(hydroxy(phenyl)methyl)phenyl)acrylamide (1a)**



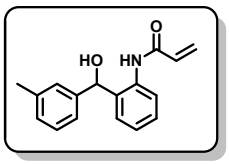
White solid. M.p.:110.1–113.5°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.06 (br, 1H), 8.03 (d, *J* = 8.2 Hz, 1H), 7.33–7.17 (m, 6H), 7.06–6.98 (m, 2H), 6.10 (d, *J* = 17.0 Hz, 1H), 5.97 (dd, *J* = 17.0, 10.1 Hz, 1H), 5.80 (s, 1H), 5.55 (d, *J* = 10.1 Hz, 1H), 4.49 (br, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.0, 141.5, 136.5, 132.5, 131.6, 128.9, 128.7, 128.5, 127.6, 127.1, 126.2, 124.4, 122.9, 75.3. **IR (thin film):** ν(cm^{-1}) 3344, 3265, 3054, 1662, 1627, 1583, 1533, 1444, 1400, 1018(s), 758. **HRMS** (ESI) calculated for $C_{16}H_{15}NO_2Na$ [M+Na]$^+$: 276.0995, found: 276.0984.

***N*-(2-(hydroxy(*o*-tolyl)methyl)phenyl)acrylamide (1b)**



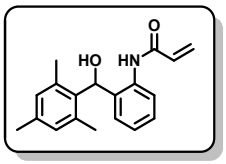
White solid. M.p.: 136.2–138.1°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.92 (br, 1H), 8.03 (d, *J* = 8.2 Hz, 1H), 7.44 (dd, *J* = 5.4, 4.0 Hz, 1H), 7.31–7.21 (m, 3H), 7.19–7.15 (m, 1H), 7.01 (t, *J* = 7.7 Hz, 1H), 6.80 (d, *J* = 7.8 Hz, 1H), 6.31 (d, *J* = 16.9 Hz, 1H), 6.18 (dd, *J* = 16.9, 10.0 Hz, 1H), 6.02 (d, *J* = 2.1 Hz, 1H), 5.70 (d, *J* = 10.2 Hz, 1H), 3.54 (br, 1H), 2.13 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.2, 139.1, 136.7, 135.8, 132.0, 131.6, 130.7, 128.8, 128.3, 128.0, 127.5, 126.4, 126.3, 124.8, 123.2, 71.7, 19.4. **IR (thin film):** ν(cm^{-1}) = 3465, 3237, 3018, 1643, 1591, 1517, 144, 1400, 1022, 767, 744. **HRMS** (ESI) calculated for $C_{17}H_{17}NO_2Na$ [M+Na]$^+$: 290.1152, found: 290.1149.

***N*-(2-(hydroxy(*m*-tolyl)methyl)phenyl)acrylamide (1c)**



White solid. M.p.: 97.8–98.4°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.84 (br, 1H), 8.13 (d, *J* = 8.3 Hz, 1H), 7.33–7.27 (m, 1H), 7.20 (t, *J* = 7.7 Hz, 1H), 7.15–7.03 (m, 5H), 6.18 (dd, *J* = 17.0, 0.8 Hz, 1H), 6.05 (dd, *J* = 17.0, 10.2 Hz, 1H), 5.85 (d, *J* = 3.1 Hz, 1H), 5.62 (dd, *J* = 10.2, 1.2 Hz, 1H), 3.50 (br, 1H), 2.30 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 163.8, 141.2, 138.2, 136.6, 132.1, 131.8, 128.8, 128.6, 128.5(0), 128.4(5), 126.9, 126.8, 124.3, 123.3, 122.9, 75.6, 21.5. **IR (thin film):** ν(cm^{-1}) 3347, 3052 , 2873, 1664, 1604, 1591, 1533, 1326 , 1270, 755. **HRMS** (ESI) calculated for $C_{17}H_{17}NO_2Na$ [M+Na]$^+$: 290.1152, found: 290.1146.

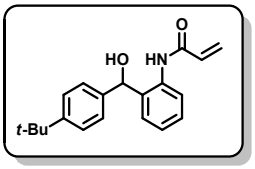
***N*-(2-(hydroxy(mesityl)methyl)phenyl)acrylamide (1d)**



Vicious oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.55 (br, 1H), 8.33 (d, *J* = 8.3 Hz, 1H), 7.30 (d, *J* = 7.8 Hz, 1H), 6.97–6.90

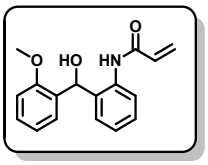
(m, 3H), 6.71 (d, J = 7.9 Hz, 1H), 6.43–6.37 (m, 2H), 6.26 (dd, J = 17.0, 10.2 Hz, 1H), 5.75 (d, J = 10.2 Hz, 1H), 2.41 (br, 1H), 2.32 (s, 3H), 2.25 (s, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.0, 137.6, 137.4, 137.3, 134.3, 132.2, 130.2, 130.0, 128.1, 127.4, 126.7, 124.0, 122.1, 71.1, 20.9, 20.8. **IR (thin film):** ν(cm^{-1}) 3380, 3237, 3025, 2925, 2848, 1672, 1585, 1521, 1444, 1317, 1039, 755. **HRMS** (ESI) calculated for $C_{19}H_{21}NO_2Na$ [M+Na]$^+$: 318.1465, found: 318.1461.

***N*-(2-((4-(*tert*-butyl)phenyl)(hydroxy)methyl)phenyl)acrylamide (1e)**



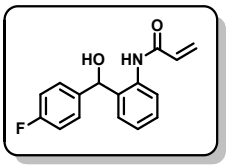
White solid. M.p.: 156.2–159.3°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.87 (s, 1H), 8.20 (d, J = 8.3 Hz, 1H), 7.36 – 7.29 (m, 3H), 7.23 (d, J = 8.3 Hz, 2H), 7.12 – 7.03 (m, 2H), 6.18 (d, J = 16.8 Hz, 1H), 6.05 (dd, J = 17.0, 10.1 Hz, 1H), 5.90 (s, 1H), 5.62 (d, J = 10.2 Hz, 1H), 3.21 (br, 1H), 1.29 (s, 9H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 163.7, 150.9, 138.1, 136.7, 131.9, 131.8, 128.8(4), 128.7(7), 126.8, 126.0, 125.5, 124.2, 122.8, 75.7, 34.6, 31.3. **IR (thin film):** ν(cm^{-1}) 3334, 3230, 3072, 2960, 2942, 1662, 1610, 1585, 1403, 1332, 1288, 757. **HRMS** (ESI) calculated for $C_{20}H_{23}NO_2Na$ [M+Na]$^+$: 332.1621, found: 332.1614.

***N*-(2-(hydroxy(2-methoxyphenyl)methyl)phenyl)acrylamide (1f)**



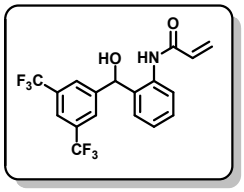
White solid. M.p.: 146.3–149.2°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.34 (br, 1H), 8.29 (d, J = 8.3 Hz, 1H), 7.31 (m, 2H), 7.07–6.89 (m, 5H), 6.27 (d, J = 16.9 Hz, 1H), 6.21–6.08 (m, 2H), 5.65 (d, J = 10.0 Hz, 1H), 4.05 (br, 1H), 3.87 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 163.7, 156.9, 137.3, 132.2, 130.2, 129.4, 128.9, 128.6, 128.3, 128.2, 126.6, 124.0, 122.5, 121.3, 110.8, 72.8, 55.6. **IR (thin film):** 3407(s), 3367, 2991, 2908, 2832, 1672, 1631, 1585, 1452, 1405, 1284, 1045, 754. **HRMS** (ESI) calculated for $C_{17}H_{17}NO_3Na$ [M+Na]$^+$: 306.1101, found: 306.1095.

***N*-(2-((4-fluorophenyl)(hydroxy)methyl)phenyl)acrylamide (1g)**



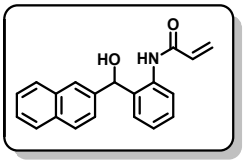
White solid. M.p.: 96.0–100.3°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.97 (s, 1H), 8.02 (d, J = 8.3 Hz, 1H), 7.29–7.18 (m, 3H), 7.09–7.01 (m, 2H), 6.95 (d, J = 8.3 Hz, 2H), 6.13 (d, J = 17.0 Hz, 1H), 5.99 (dd, J = 16.9, 10.3 Hz, 1H), 5.81 (s, 1H), 5.59 (d, J = 10.2 Hz, 1H), 4.31 (s, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.0, 162.1 ($^1J_{C\text{-}F}$ = 244.2 Hz), 137.2 ($^4J_{C\text{-}F}$ = 3.0 Hz), 136.4, 132.3, 131.5, 128.9, 127.9 ($^3J_{C\text{-}F}$ = 8.0 Hz), 127.1, 124.6, 123.2, 115.3 ($^2J_{C\text{-}F}$ = 21.2 Hz), 74.8. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -114.87. **IR (thin film):** ν(cm^{-1}) 3365, 3293, 3072, 2875, 2832, 1668, 1608, 1572, 1452, 1405, 1222, 1060, 767. **HRMS** (ESI) calculated for $C_{16}H_{14}NO_2FNa$ [M+Na]$^+$: 294.0901, found: 294.0893.

***N*-(2-((3,5-bis(trifluoromethyl)phenyl)(hydroxy)methyl)phenyl)acrylamide (1h)**



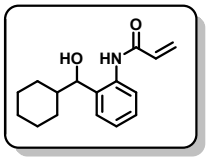
White solid. M.p.: 94.6–100.5°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.49 (br, 1H), 7.84 (d, *J* = 8.2 Hz, 1H), 7.77 (s, 3H), 7.33 (dd, *J* = 9.6, 1.8 Hz, 1H), 7.22–7.11 (m, 2H), 6.21 (dd, *J* = 17.0, 1.1 Hz, 1H), 6.05 (dd, *J* = 17.0, 10.3 Hz, 1H), 5.94 (d, *J* = 2.4 Hz, 1H), 5.68 (dd, *J* = 10.2, 0.8 Hz, 1H), 4.35 (br, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.4, 144.4, 135.8, 132.7, 131.6 (q, *J* = 34.0 Hz), 130.7, 129.7, 129.2, 127.9, 126.1, 125.6, 124.6, 124.4, 121.9, 121.4 74.0. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.9. **IR (thin film):** ν(cm^{-1}) 3344, 3072, 3089, 3060, 1673, 1612, 1519, 1450, 1278, 1128, 754. **HRMS** (ESI) calculated for $C_{18}H_{13}NO_2F_6Na$ [M+Na]$^+$: 412.0743, found: 412.0735.

***N*-(2-(hydroxy(naphthalen-2-yl)methyl)phenyl)acrylamide (1i)**



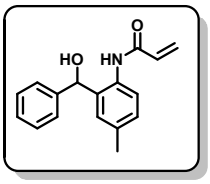
White solid. M.p.: 169.9–172.7°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.90 (br, 1H), 8.12 (d, *J* = 8.4 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.85 (d, *J* = 8.3 Hz, 2H), 7.57 (d, *J* = 7.1 Hz, 1H), 7.48 (t, *J* = 7.3 Hz, 2H), 7.42 (t, *J* = 7.2 Hz, 1H), 7.31 (t, *J* = 7.7 Hz, 1H), 6.97 (t, *J* = 7.7 Hz, 1H), 6.86 (d, *J* = 7.7 Hz, 1H), 6.61 (s, 1H), 6.33 (d, *J* = 17.0 Hz, 1H), 6.17 (dd, *J* = 16.9, 10.3 Hz, 1H), 5.69 (d, *J* = 10.3 Hz, 1H), 3.34 (br, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.2, 136.6, 136.3, 133.9, 132.1, 131.6, 130.7, 129.0, 128.9(4), 128.8(9), 128.74, 127.4, 126.4, 125.9, 125.4, 124.9, 123.9, 123.3, 72.3. (One carbon was missing due to overlapping) **IR (thin film):** ν(cm^{-1}) 3492, 3363, 3054, 2863, 1673, 1585, 1510, 1446, 1405, 1287, 1186, 975, 794. **HRMS** (ESI) calculated for $C_{20}H_{17}NO_2Na$ [M+Na]$^+$: 326.1152, found: 326.1143.

***N*-(2-(cyclohexyl(hydroxy)methyl)phenyl)acrylamide (1j)**



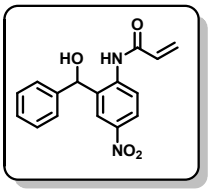
White solid. M.p.: 120.8–123.1°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.43 (br, 1H), 8.33 (d, *J* = 8.3 Hz, 1H), 7.29 (ddd, *J* = 8.6, 6.5, 2.2 Hz, 1H), 7.08–6.97 (m, 2H), 6.36 (dd, *J* = 17.0, 1.3 Hz, 1H), 6.24 (dd, *J* = 17.0, 10.0 Hz, 1H), 5.74 (dd, *J* = 10.1, 1.4 Hz, 1H), 4.43 (dd, *J* = 8.7, 3.3 Hz, 1H), 2.55 (d, *J* = 2.7 Hz, 1H), 2.17–2.08 (m, 1H), 1.82–1.72 (m, 2H), 1.67–1.59 (m, 2H), 1.27–1.17 (m, 2H), 1.15–1.07 (m, 2H), 1.06–0.98 (m, 1H), 0.91–0.82 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 163.7, 136.8, 132.2, 130.8, 128.9, 128.1, 126.5, 123.6, 122.2, 81.3, 43.0, 29.8, 29.6, 26.2, 25.8(7), 25.8(5). **IR (thin film)**: ν(cm^{-1}) 3398, 3288, 3048, 2919, 2850, 1662, 1612, 1589, 1533, 1446, 140, 1193, 1014, 748. **HRMS** (ESI) calculated for $C_{16}H_{21}NO_2Na$ [M+Na]$^+$: 282.1465, found: 282.1452.

***N*-(2-(hydroxy(phenyl)methyl)-4-methylphenyl)acrylamide (1k)**



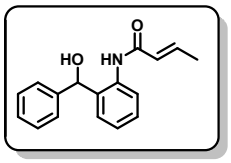
White solid. M.p.: 130.1–132.9°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.82 (br, 1H), 7.89 (d, *J* = 8.3 Hz, 1H), 7.32–7.17 (m, 5H), 7.05 (d, *J* = 8.3 Hz, 1H), 6.86 (s, 1H), 6.10 (d, *J* = 17.0 Hz, 1H), 5.97 (dd, *J* = 16.8, 10.1 Hz, 1H), 5.77 (s, 1H), 5.54 (d, *J* = 10.2 Hz, 1H), 4.20 (br, 1H), 2.25 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.0, 141.6, 134.2, 133.8, 132.7, 131.6, 129.5, 129.2, 128.4, 127.6, 126.7, 126.2, 123.2, 75.3, 21.0. **IR (thin film):** ν(cm^{-1}) 3365, 3309, 3027, 2879, 2730, 1666, 1619, 1519, 1452, 1446, 1282, 1037, 950, 719 . **HRMS** (ESI) calculated for $C_{17}H_{17}NO_2Na$ $[M+Na]^+$: 290.1152, found: 290.1146.

***N*-(2-(hydroxy(phenyl)methyl)-4-nitrophenyl)acrylamide (1l)**



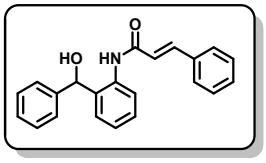
Yellow solid. M.p.: 120.9–124.1°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.36 (br, 1H), 8.54 (d, *J* = 9.0 Hz, 1H), 8.17 (dd, *J* = 9.1, 2.6 Hz, 1H), 8.00 (d, *J* = 2.6 Hz, 1H), 7.42–7.29 (m, 5H), 6.25 (dd, *J* = 17.0, 0.7 Hz, 1H), 6.08 (dd, *J* = 17.0, 10.3 Hz, 1H), 6.01 (s, 1H), 5.74 (dd, *J* = 10.3, 0.7 Hz, 1H), 3.68 (br, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 163.8, 143.0, 142.9, 139.7, 131.4, 131.3, 129.0, 128.6, 128.3, 126.0, 124.6, 124.2, 121.8, 75.7. **IR (thin film):** ν(cm^{-1}) 3369, 3264, 3058, 2852, 2730, 1679, 1618, 1585, 1513, 1446, 1336, 1215, 975, 698 . **HRMS** (ESI) calculated for $C_{16}H_{14}N_2O_4Na$ $[M+Na]^+$: 321.0846, found: 321.0835.

***N*-(2-(hydroxy(phenyl)methyl)phenyl)but-2-enamide (3a)**



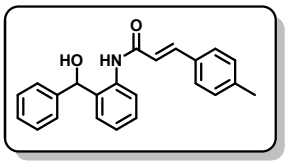
White solid. M.p.: 144.7–148.7°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.63 (br, 1H), 8.09 (s, 1H), 7.32–7.24 (m, 6H), 7.08–7.02 (m, 2H), 6.77–6.68 (m, 1H), 5.88 (s, 1H), 5.73 (dq, *J* = 15.2, 1.5 Hz, 1H), 3.63 (br, 1H), 1.80 (dd, *J* = 6.9, 1.6 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.3, 141.4, 140.8, 136.8, 128.8, 128.5, 127.7, 126.3, 125.8, 124.1, 123.1, 75.4, 17.7. (Some carbons were missing due to overlapping) **IR (thin film):** ν(cm^{-1}) 3322, 3201, 2910, 2723, 2642, 1670, 1633, 1585, 1452, 1533, 1456, 1290, 1027, 755. **HRMS** (ESI) calculated for $C_{17}H_{17}NO_2Na$ $[M+Na]^+$: 290.1152, found: 290.1141.

***N*-(2-(hydroxy(phenyl)methyl)phenyl)cinnamamide (3b)**



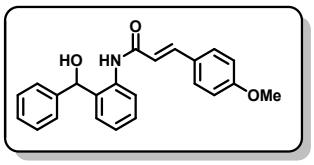
White solid. M.p.: 145.6–148.3°C. **^{1}H NMR** (400 MHz, DMSO) δ 9.68 (br, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.66 (d, *J* = 7.5 Hz, 2H), 7.52 (d, *J* = 15.7 Hz, 1H), 7.47–7.40 (m, 4H), 7.35 (d, *J* = 7.5 Hz, 2H), 7.27 (m, 3H), 7.20–7.14 (m, 2H), 6.88 (d, *J* = 15.7 Hz, 1H), 6.29 (d, *J* = 3.3 Hz, 1H), 6.03 (d, *J* = 3.1 Hz, 1H). **^{13}C NMR** (100 MHz, DMSO) δ 163.5, 143.9, 140.2, 136.5, 135.6, 134.7, 129.7, 128.9, 127.9, 127.8, 127.7, 127.3, 126.7, 126.2, 124.6, 124.0, 122.2, 71.3. **IR (thin film):** ν(cm^{-1}) 3322, 3216, 3020, 1656, 1680, 1581, 1531, 1456, 985, 763. **HRMS** (ESI) calculated for $C_{22}H_{19}NO_2Na$ $[M+Na]^+$: 352.1308, found: 352.1297.

***N*-(2-(hydroxy(phenyl)methyl)phenyl)-3-(*p*-tolyl)acrylamide (3c)**



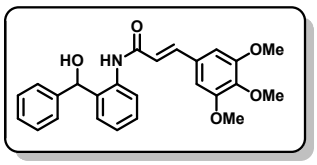
White solid. M.p.: 181.6–185.2°C. **^{1}H NMR** (400 MHz, DMSO) δ 9.64 (br, 1H), 7.78 (d, *J* = 8.4 Hz, 1H), 7.54 (d, *J* = 8.0 Hz, 2H), 7.48 (d, *J* = 15.7 Hz, 1H), 7.40 (d, *J* = 7.9 Hz, 1H), 7.34 (d, *J* = 7.5 Hz, 2H), 7.31–7.21 (m, 5H), 7.20–7.13 (m, 2H), 6.81 (d, *J* = 15.7 Hz, 1H), 6.28 (br, 1H), 6.02 (s, 1H), 2.34 (s, 3H). **^{13}C NMR** (100 MHz, DMSO) δ 163.6, 143.9, 140.1, 139.5, 136.4, 135.7, 131.9, 129.5, 127.9, 127.8, 127.6, 127.3, 126.7, 126.2, 124.5, 123.9, 121.2, 71.3, 20.9. **IR (thin film):** ν(cm^{-1}) 3334, 3290, 3021, 2861, 2736, 1658, 1602, 1528, 1448, 1336, 975, 744. **HRMS** (ESI) calculated for $C_{23}H_{21}NO_2Na$ $[M+Na]^+$: 366.1465, found: 366.1453.

***N*-(2-(hydroxy(phenyl)methyl)phenyl)-3-(4-methoxyphenyl)acrylamide (3d)**



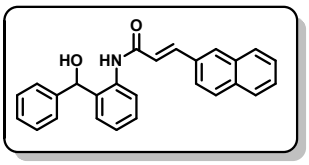
White solid. M.p.: 180.8–184.2°C. **^{1}H NMR** (400 MHz, DMSO) δ 9.65 (br, 1H), 7.79 (d, *J* = 8.0 Hz, 1H), 7.61 (d, *J* = 8.7 Hz, 2H), 7.47 (d, *J* = 15.7 Hz, 1H), 7.41–7.31 (m, 3H), 7.31–7.22 (m, 3H), 7.20–7.11 (m, 2H), 7.00 (d, *J* = 8.7 Hz, 2H), 6.76 (d, *J* = 15.7 Hz, 1H), 6.31 (br, 1H), 6.03 (s, 1H), 3.80 (s, 3H). **^{13}C NMR** (100 MHz, DMSO) δ 163.8, 160.6, 143.9, 139.9, 136.4, 135.8, 129.4, 127.9(2), 127.8(6), 127.7, 127.3, 127.2, 126.7, 126.2, 124.3, 123.8, 119.7, 114.4, 71.2, 55.3. **IR (thin film):** ν(cm^{-1}) 3322, 3249, 2998, 2829, 1656, 1596, 1519, 1444, 1249, 1024, 736. **HRMS** (ESI) calculated for $C_{23}H_{21}NO_3Na$ $[M+Na]^+$: 382.1414, found: 382.1406.

***N*-(2-(hydroxy(phenyl)methyl)phenyl)-3-(3,4,5-trimethoxyphenyl)acrylamide (3e)**



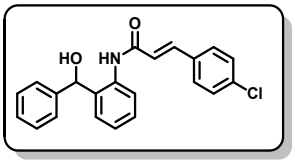
White solid. M.p.: 116.3–119.7°C. **^{1}H NMR** (400 MHz, DMSO) δ 9.64 (br, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.46 (d, *J* = 15.6 Hz, 1H), 7.39–7.34 (m, 3H), 7.30–7.24 (m, 3H), 7.21–7.17 (m, 1H), 7.14 (t, *J* = 7.5 Hz, 1H), 6.99 (s, 2H), 6.83 (d, *J* = 15.7 Hz, 1H), 6.31 (d, *J* = 4.4 Hz, 1H), 6.02 (s, 1H), 3.85 (s, 6H), 3.71 (s, 3H). **^{13}C NMR** (100 MHz, DMSO) δ 163.6, 153.1, 143.9, 140.5, 139.1, 136.4, 135.8, 130.3, 127.9, 127.8, 127.3, 126.7, 126.2, 124.5, 124.0, 121.4, 105.5, 71.4, 60.1, 56.0. **IR (thin film):** ν(cm^{-1}) 3378, 3300, 2927, 2836, 1664, 1583, 1519, 1448,1319, 1121, 755. **HRMS** (ESI) calculated for $C_{25}H_{25}NO_5$ $[M+Na]^+$: 442.1625, found: 442.1611.

***N*-(2-(hydroxy(phenyl)methyl)phenyl)-3-(naphthalen-2-yl)acrylamide (3f)**



White solid. M.p.: 166.5–170.3°C. **^{1}H NMR** (400 MHz, DMSO) δ 9.80 (br, 1H), 8.28 (d, *J* = 15.6 Hz, 1H), 8.20 (d, *J* = 8.6 Hz, 1H), 8.06–7.97 (m, 2H), 7.90 (d, *J* = 6.6 Hz, 1H), 7.80 (d, *J* = 6.4 Hz, 1H), 7.68–7.57 (m, 3H), 7.46 (d, *J* = 8.4 Hz, 1H), 7.39–7.33 (m, 2H), 7.31–7.25 (m, 3H), 7.21–7.16 (m, 2H), 6.94 (d, *J* = 15.7 Hz, 1H), 6.30 (s, 1H), 6.06 (s, 1H). **^{13}C NMR** (100 MHz, DMSO) δ 163.9, 144.5, 137.3, 137.0, 136.0, 133.8, 132.2, 131.3, 130.4, 129.2, 128.4, 128.1, 127.8, 127.5, 127.3, 126.8, 126.3, 125.7, 125.3, 125.2, 124.7, 123.6, 71.7. (One carbon was missing due to overlapping) **IR (thin film):** ν(cm^{-1}) 2996, 2871, 1639, 1592, 1548, 1417,1380, 755. **HRMS** (ESI) calculated for $C_{26}H_{21}NO_2Na$ $[M+H]^+$: 402.1465, found: 402.1457.

3-(4-chlorophenyl)-*N*-(2-(hydroxy(phenyl)methyl)phenyl)acrylamide (3g)

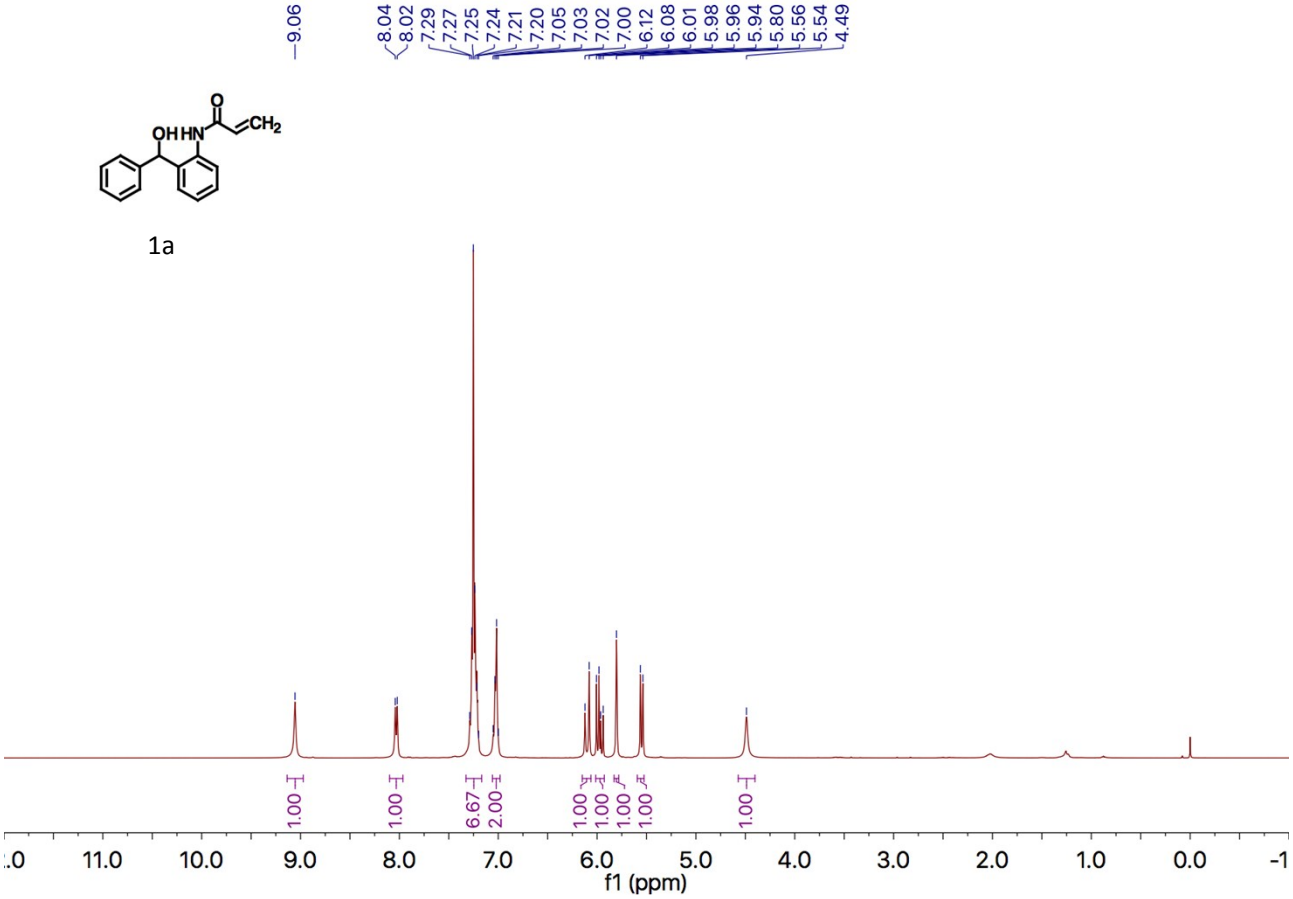


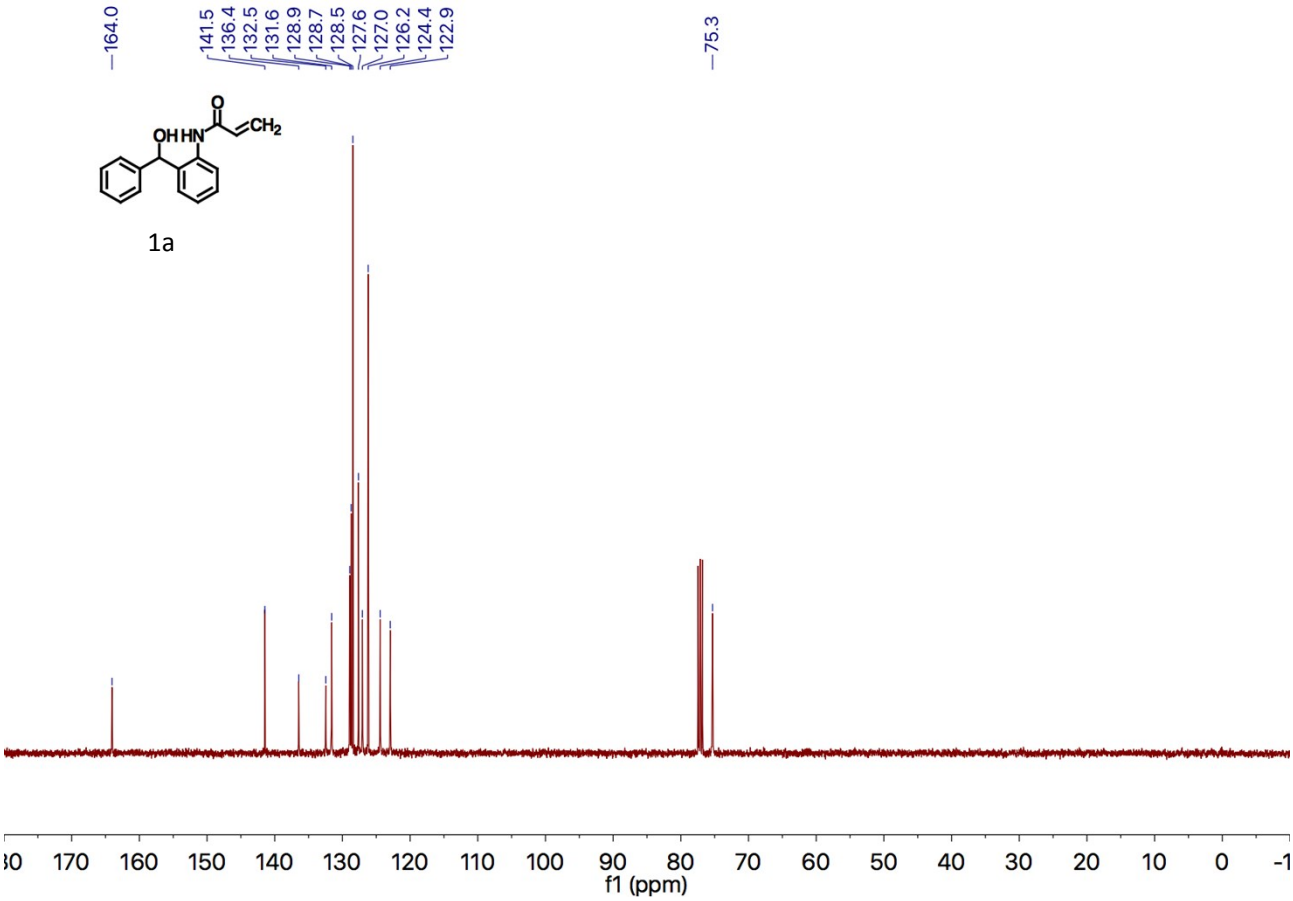
White solid. M.p.: 201.8–205.8°C. **^{1}H NMR** (400 MHz, DMSO) δ 9.71 (br, 1H), 7.79 (d, *J* = 8.0 Hz, 1H), 7.70 (d, *J* = 8.2 Hz, 2H), 7.57–7.47 (m, 3H), 7.43 (d, *J* = 7.7 Hz, 1H), 7.36 (d, *J* = 7.8 Hz, 2H), 7.28 (d, *J* = 7.5 Hz, 3H), 7.21–7.14 (m, 2H), 6.92 (d, *J* = 15.8 Hz, 1H), 6.31 (br, 1H), 6.03 (s, 1H). **^{13}C NMR** (100 MHz, DMSO) δ 163.3, 143.9, 138.8, 136.5, 135.6, 134.2, 133.7, 129.5, 128.9, 127.9, 127.8, 127.7, 127.3, 126.7, 126.2, 124.6, 124.0, 123.1, 71.3. **IR (thin film):** ν(cm^{-1}) 3293, 3031, 1656, 1618, 1527, 1444,1336, 1089, 754. **HRMS** (ESI) calculated for $C_{22}H_{18}NO_2ClNa$ $[M+H]^+$: 386.0918, found: 386.0902.

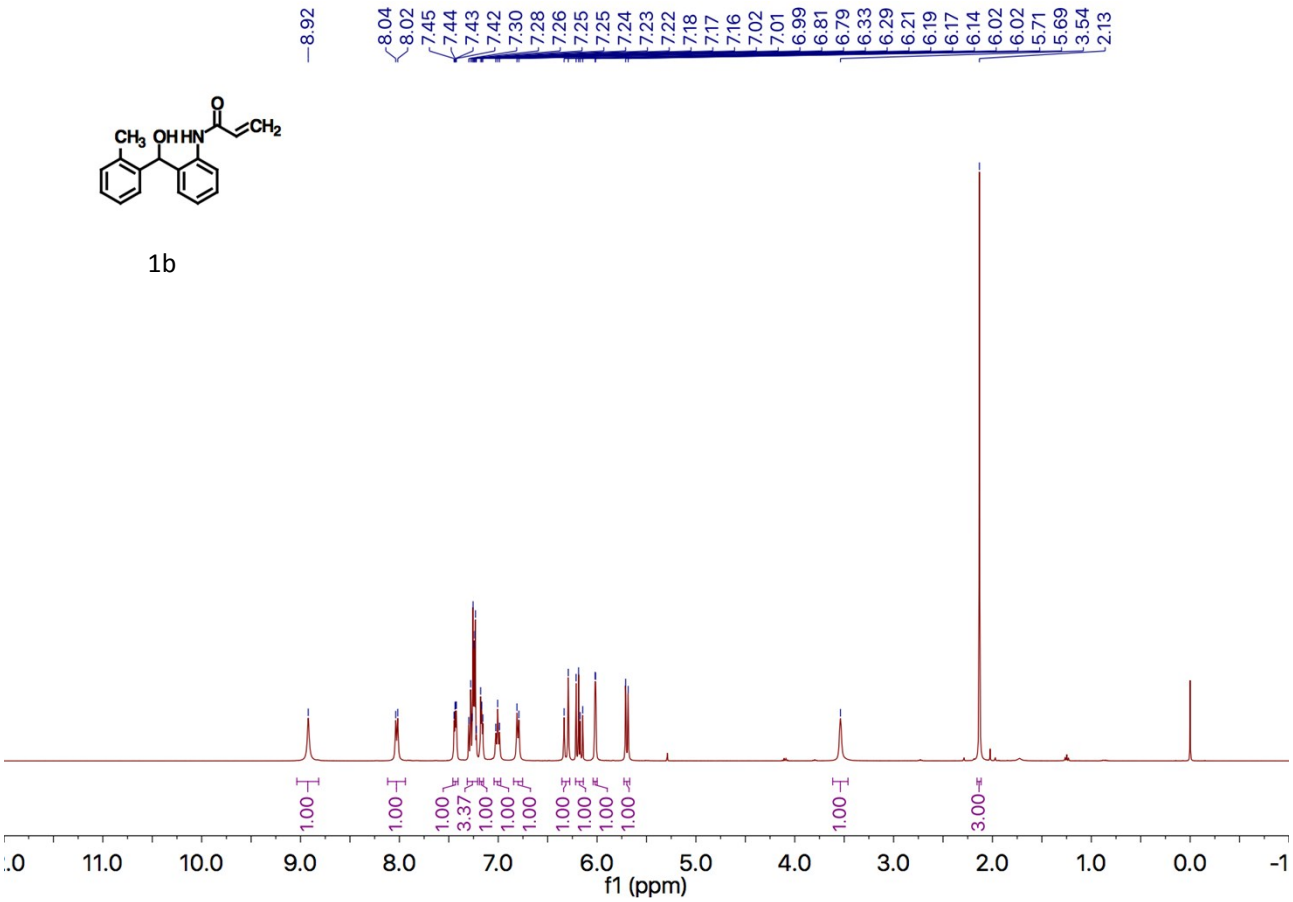
4. References

1. Miki, T.; Kori, M.; Mabuchi, H.; Banno, H.; Tozawa, R.-I.; Nakamura, M.; Itokawa, S.; Sugiyama, Y.; Yukimasa, H. *Bioorga. Med. Chem.*, **2002**, *10*, 401.
2. Chen, J.-H.; Chen, Z.-C.; Zhao, H.; Zhang, T.; Wang, W.-J.; Zou, Y.; Zhang, X.-J.; Yan, M. *Org. Biomol. Chem.*, **2016**, *14*, 4071.

5. NMR Spectra



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7.45
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7.43
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7.30
7.28
7.26
7.25
7.25
7.24
7.23
7.22
7.18
7.17
7.16
7.02
7.01
6.99
6.81
6.79
6.33
6.29
6.21
6.19
6.17
6.14
6.02
6.02
5.71
5.69
3.54
2.13
CH3 OH HN
CH2
1b
1.00
1.00
1.00
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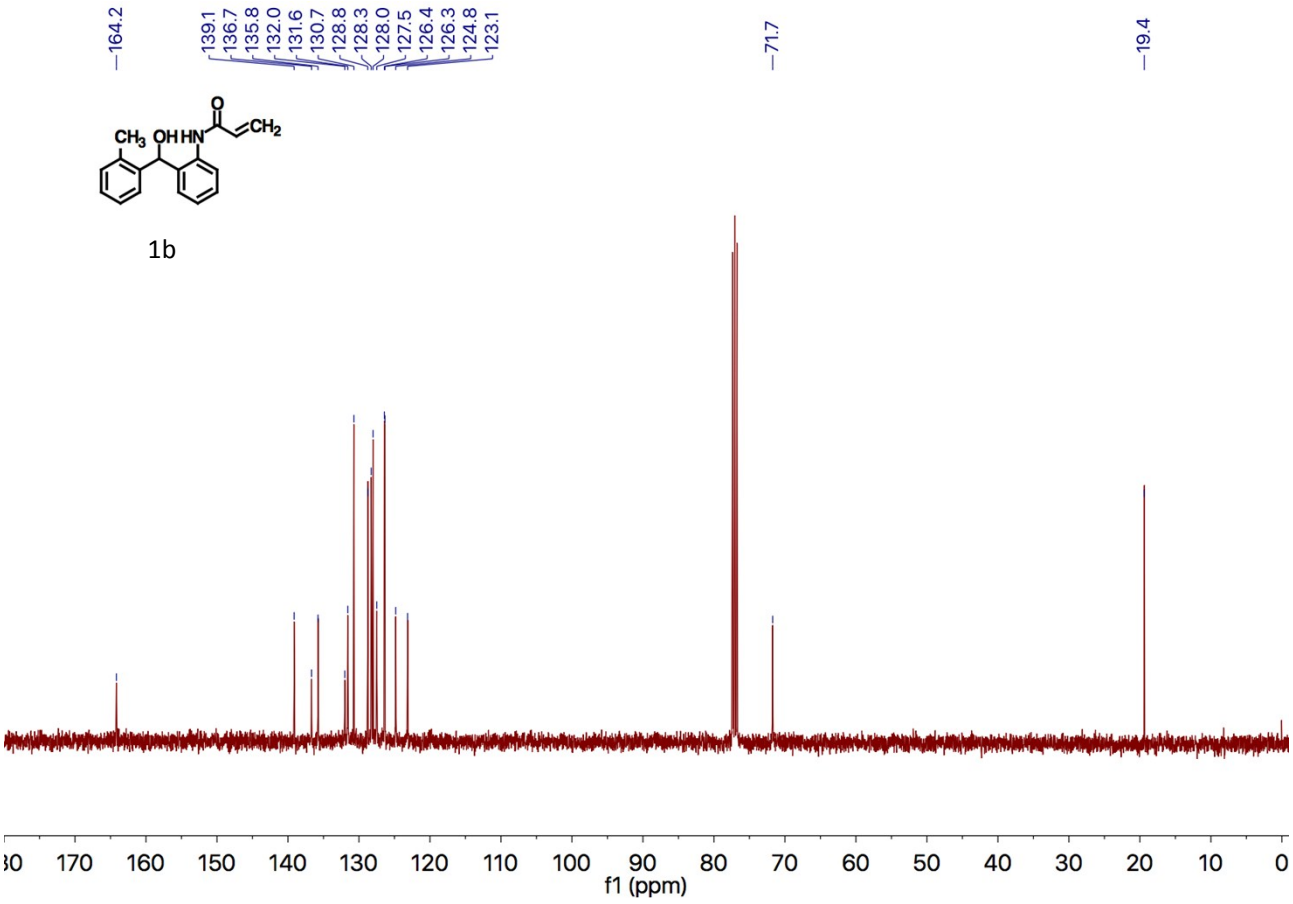
1.00
1.00
1.00
1.00
1.00
1.00
1.00
3.00
f1 (ppm)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131.6
130.7
128.8
128.3
128.0
127.5
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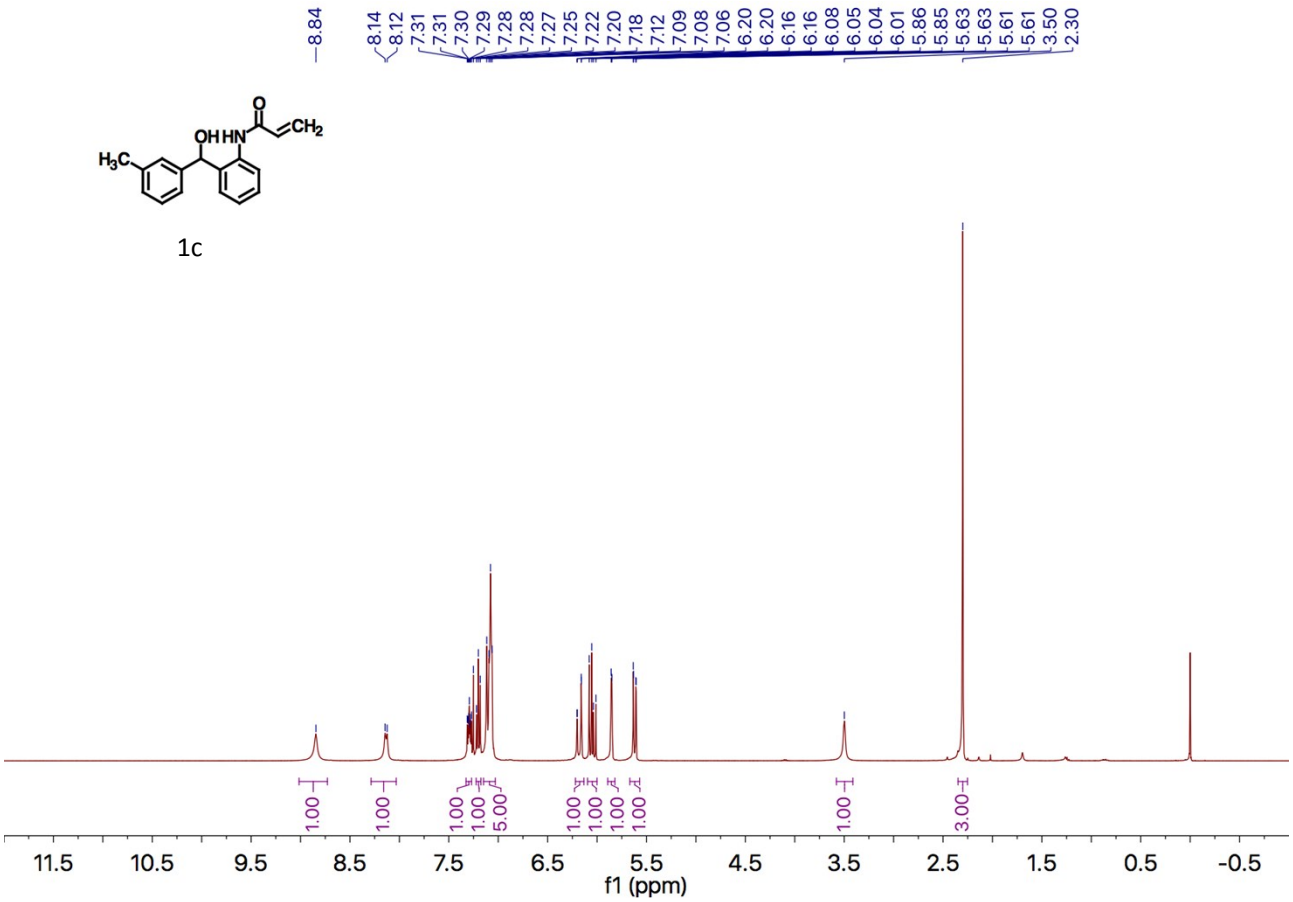
126.3
124.8
123.1
71.7
19.4
CH3 OH HN
CH2
1b
f1 (ppm)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7.20
7.18
7.12
7.09
7.08
7.06
6.20
6.20
6.16
6.08
6.05
6.04
6.01
5.86
5.85
5.63
5.63
5.61
5.61
3.50
2.30
OH HN
CH2
H3C
1c
1.00
1.00
1.00
1.00
5.00
1.00
1.00
1.00
1.00
1.00
3.00
11.5
10.5
9.5
8.5
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5.5
4.5
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2.5
1.5
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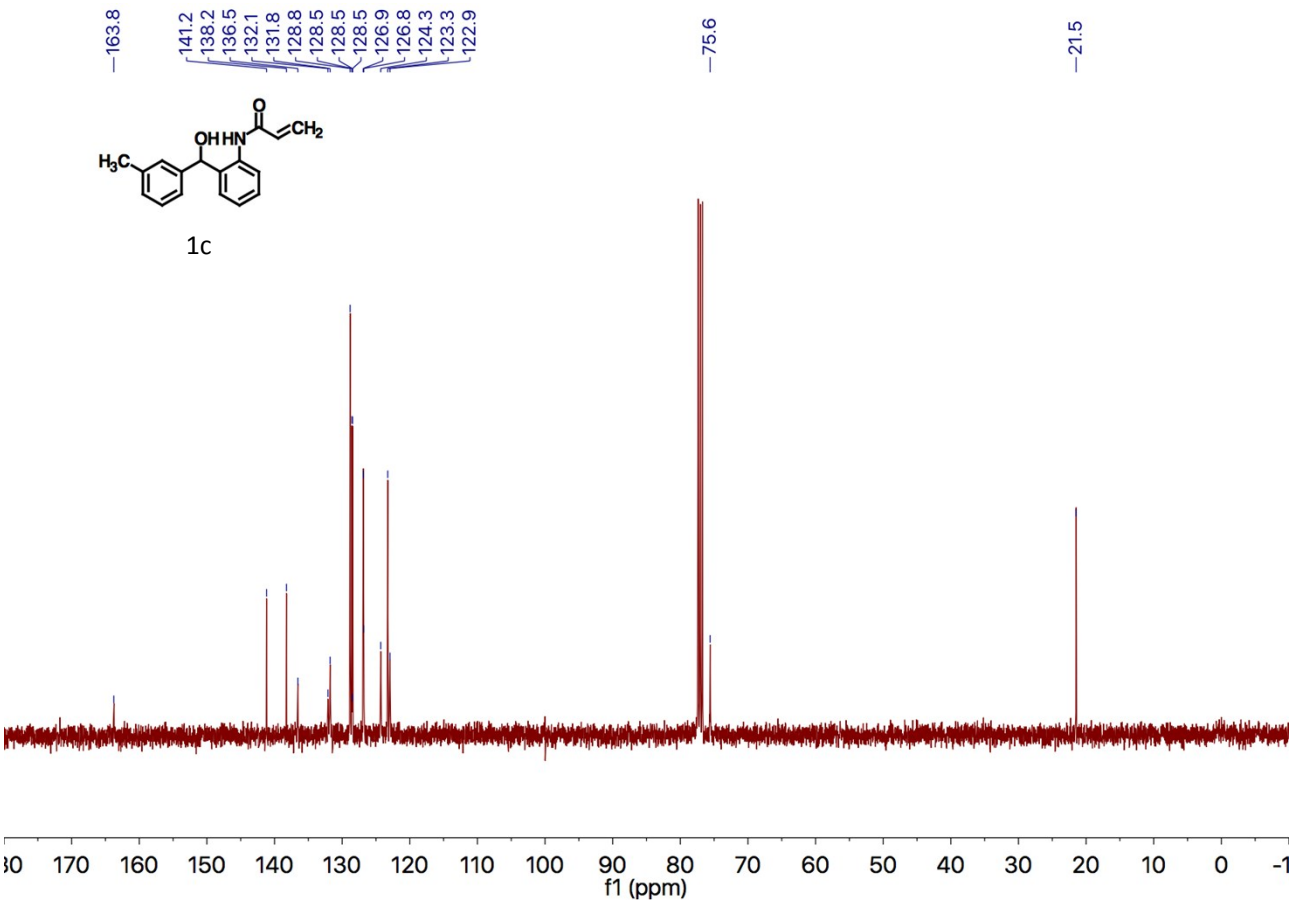
f1 (ppm)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141.2
138.2
136.5
132.1
131.8
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128.5
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126.9
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124.3
123.3
122.9
75.6
21.5
OH HN
CH2
H3C
1c
170
160
150
140
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120
110
100
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80
70
60
50
40
30
20
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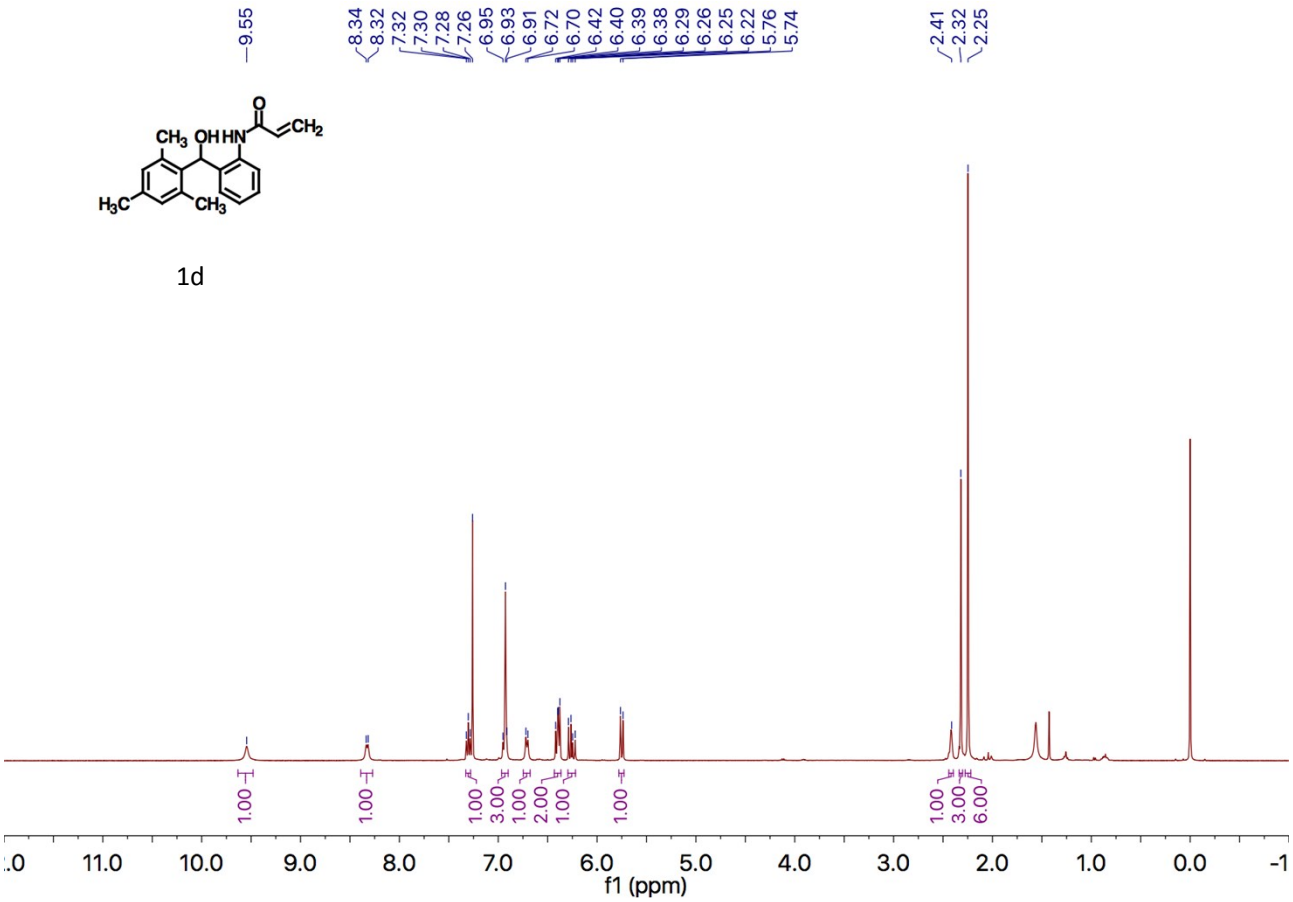
-1
f1 (ppm)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6.95
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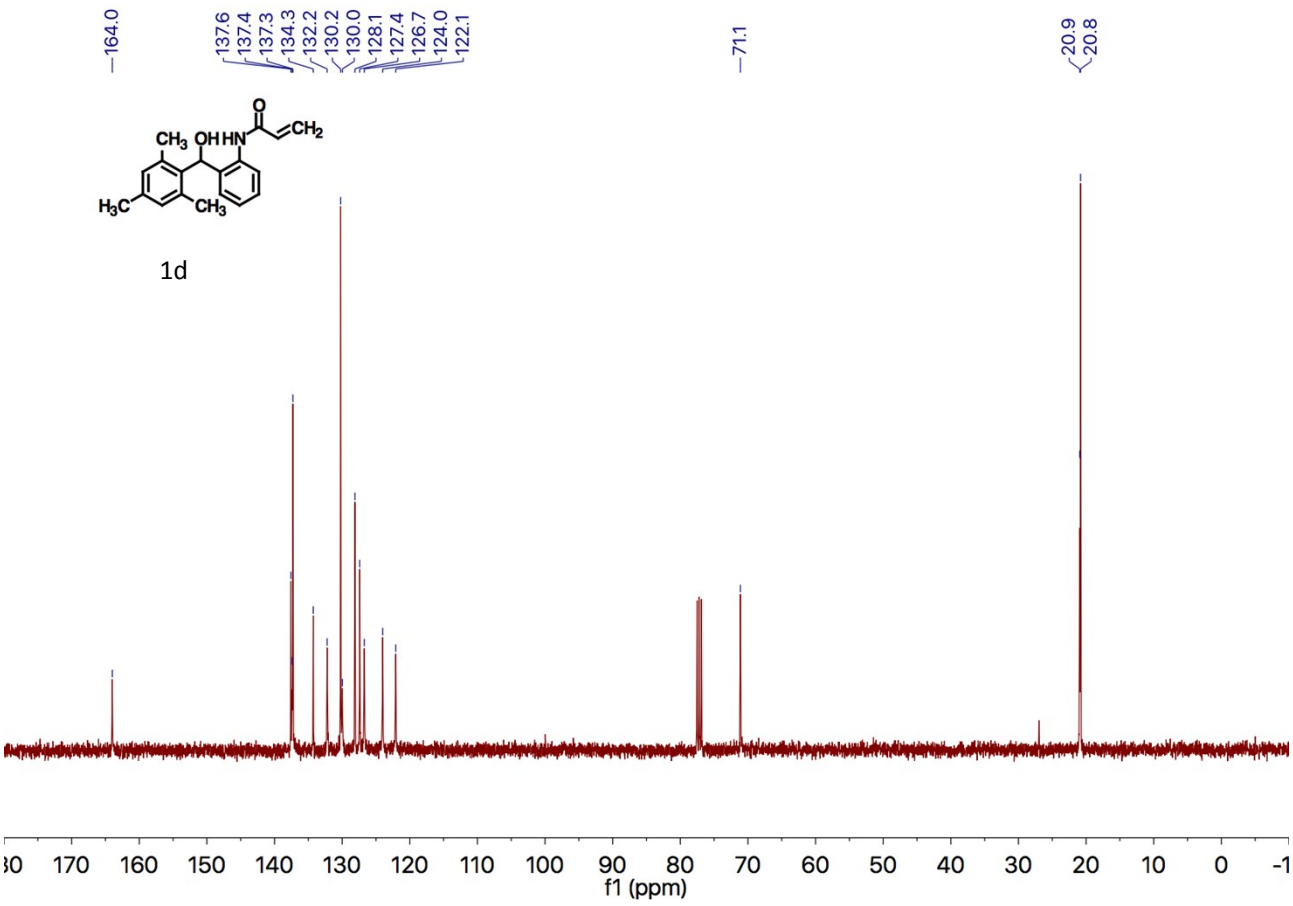
1.00
3.00
6.00
f1 (ppm)

1d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137.6
137.4
137.3
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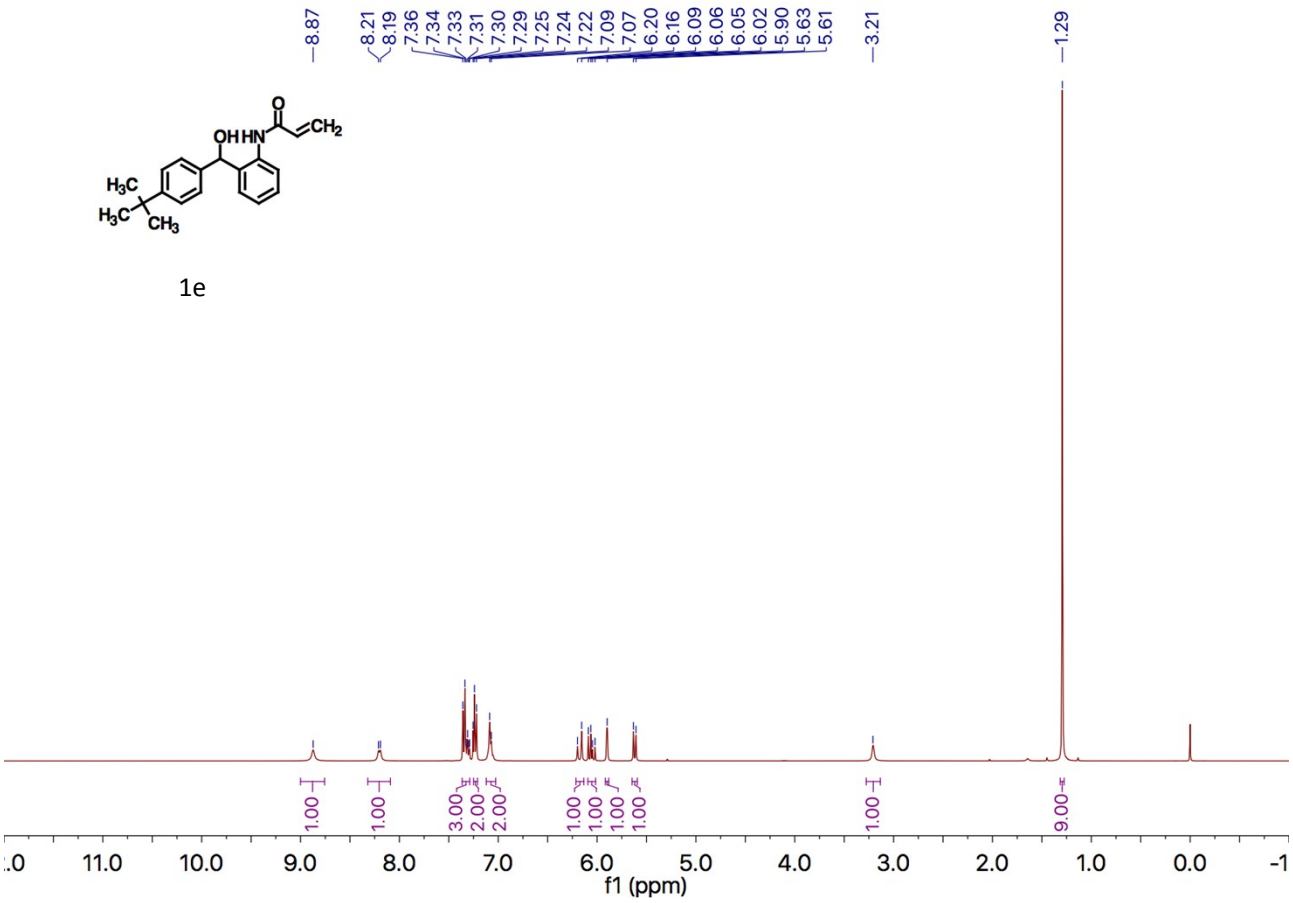
132.2
130.2
130.0
128.1
127.4
126.7
124.0
122.1
71.1
20.9
20.8
f1 (ppm)

1d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7.30
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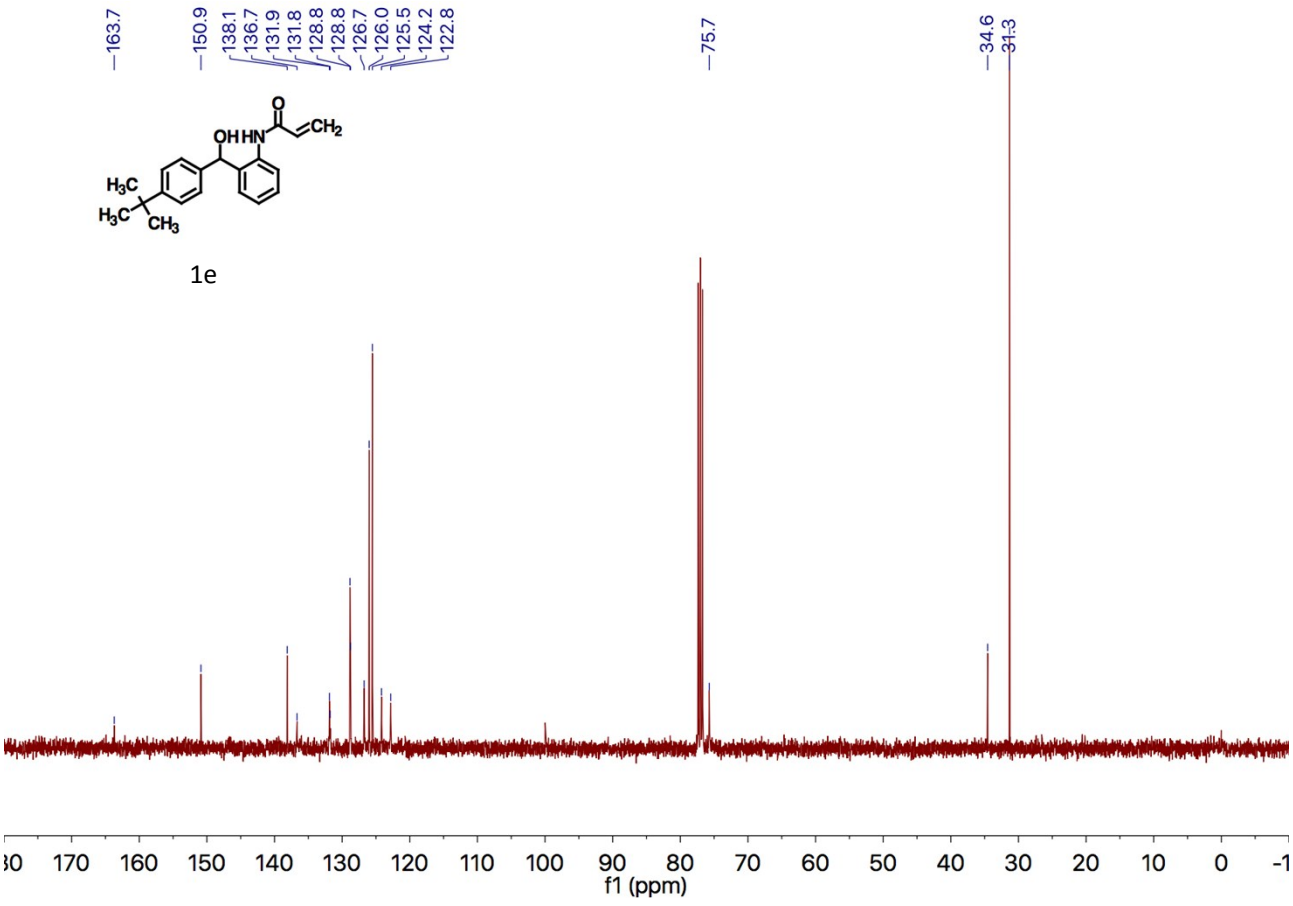
7.25
7.24
7.22
7.09
7.07
6.20
6.16
6.09
6.06
6.05
6.02
5.90
5.63
5.61
3.21
1.29
OH HN
O
CH2
H3C
H3C
CH3
1.00
1.00
3.00
2.00
2.00
1.00
1.00
1.00
1.00
9.00
f1 (ppm)

1e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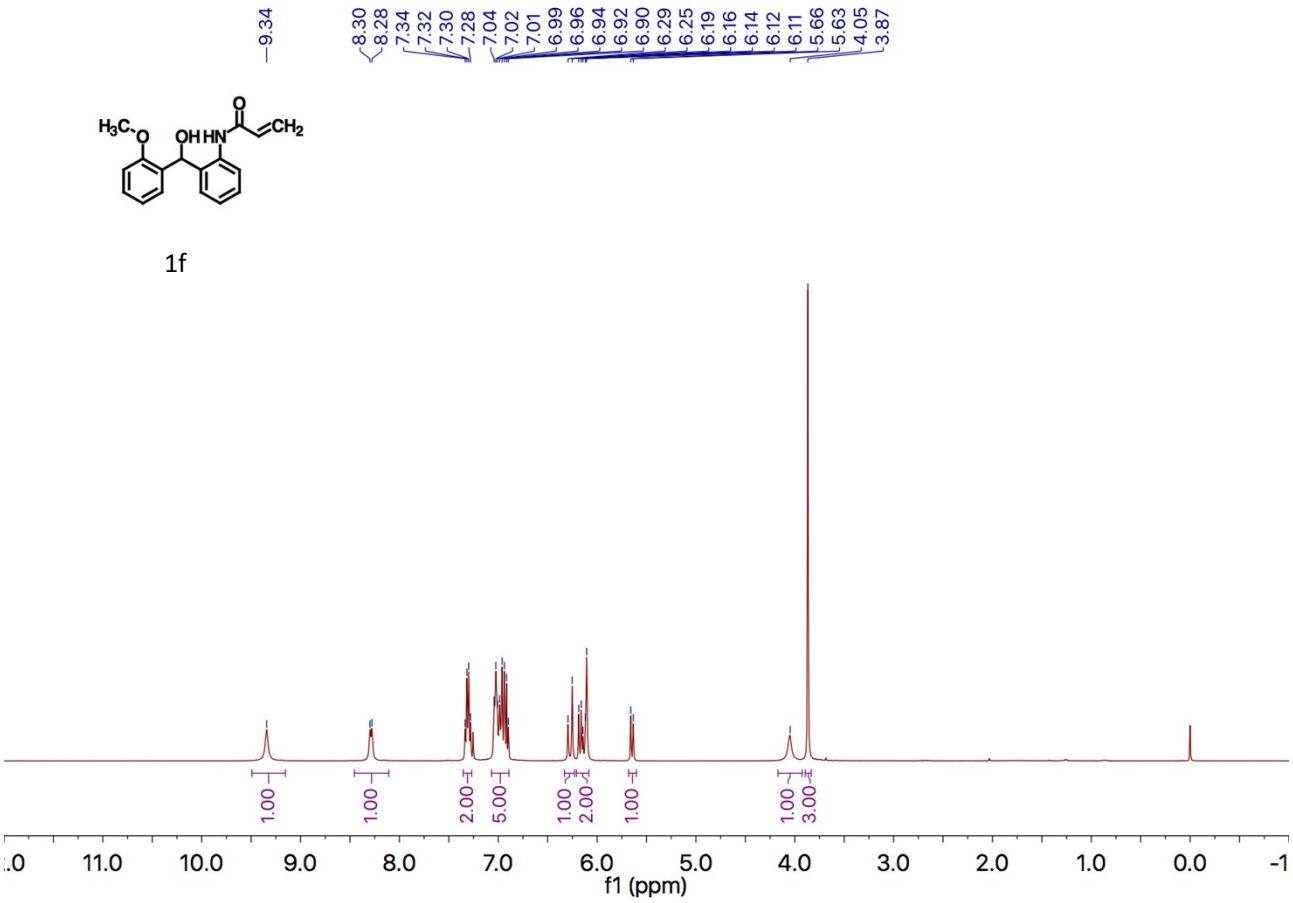
150.9
138.1
136.7
131.9
131.8
128.8
128.8
126.7
126.0
125.5
124.2
122.8
75.7
34.6
31.3
OH HN
O
CH2
H3C
H3C
CH3
f1 (ppm)

1e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6.92
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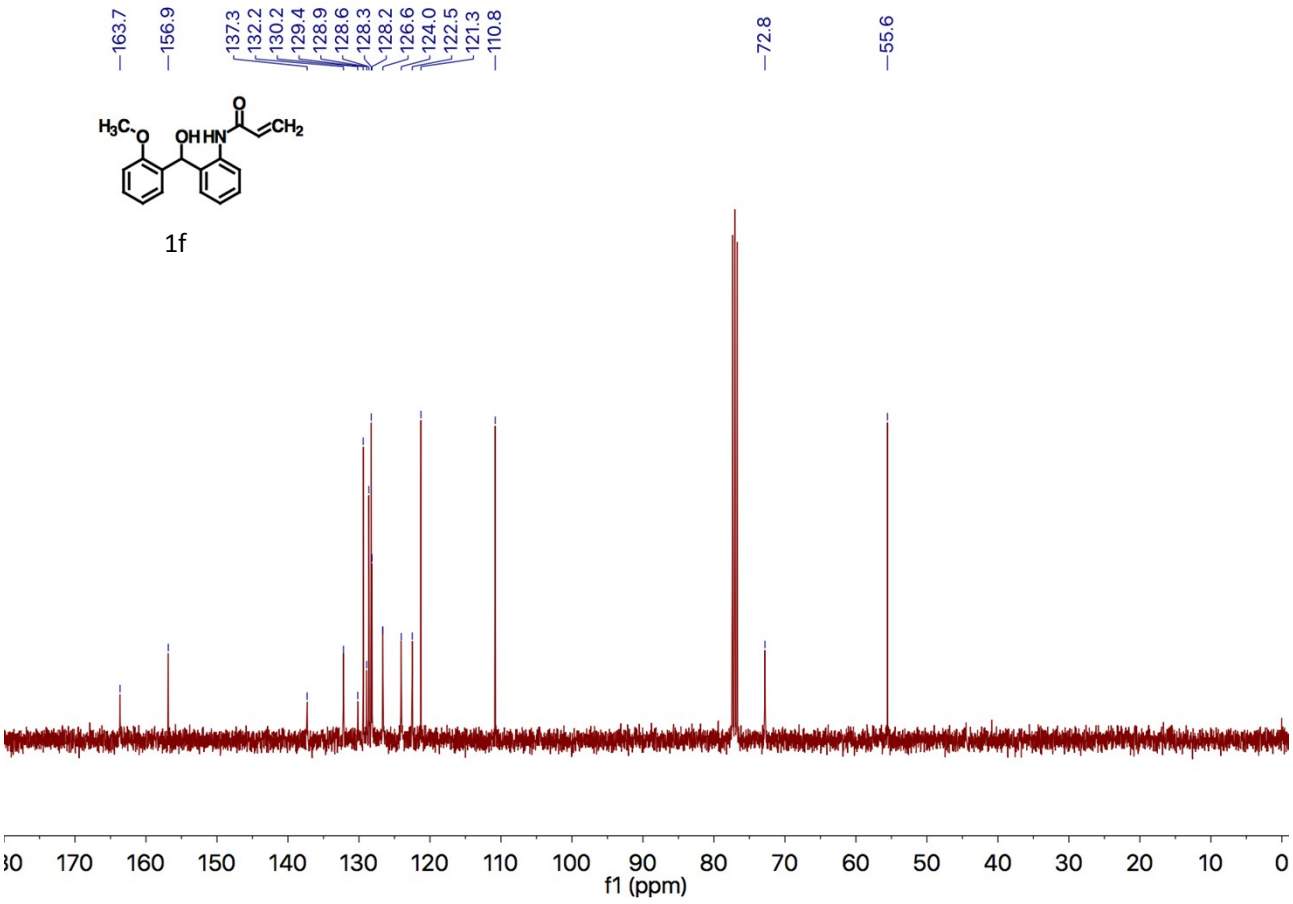
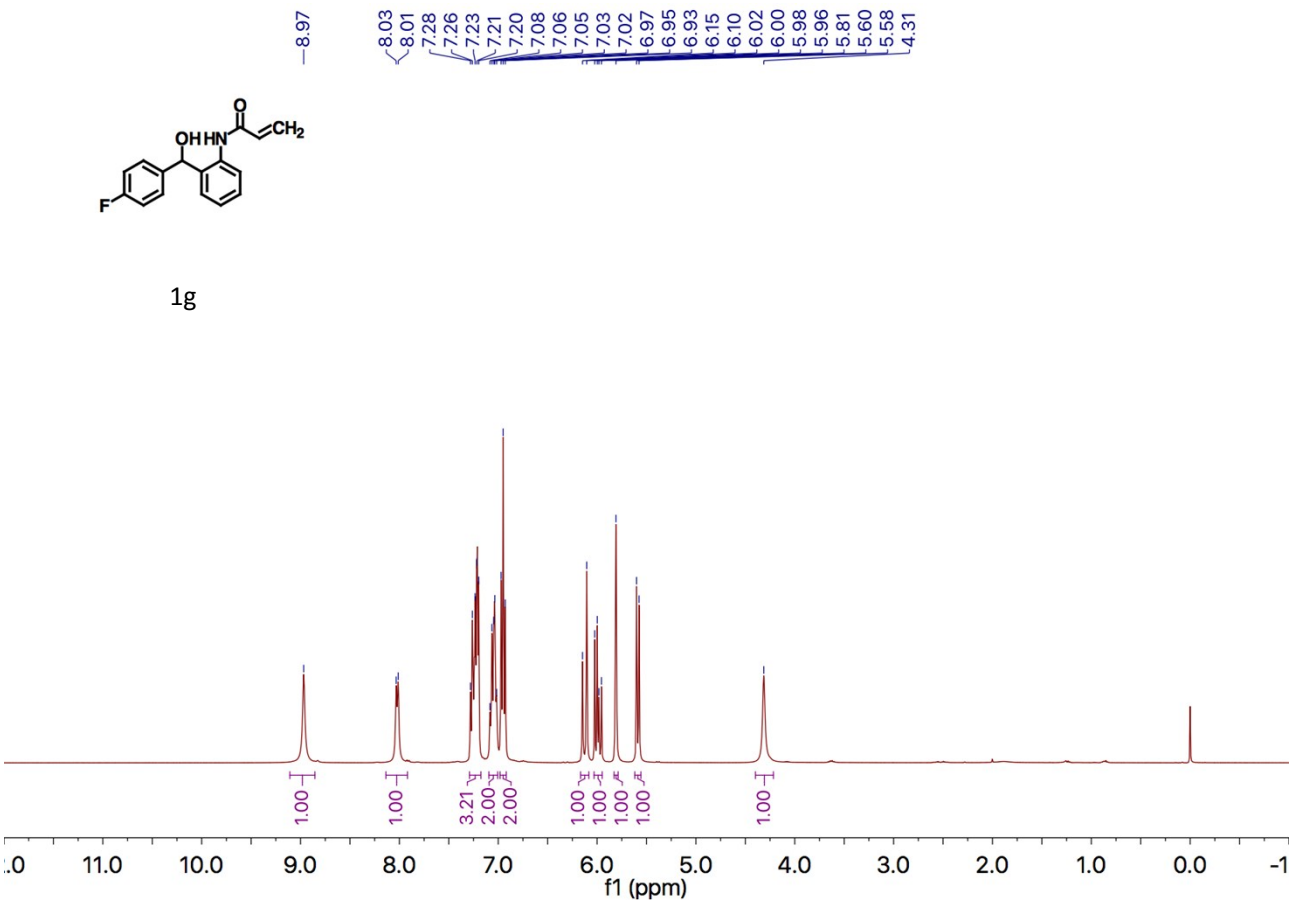
6.29
6.25
6.19
6.16
6.14
6.12
6.11
5.66
5.63
4.05
3.87
H3C
O
OH HN
O
CH2
1.00
1.00
2.00
5.00
1.00
2.00
1.00
1.00
3.00
f1 (ppm)

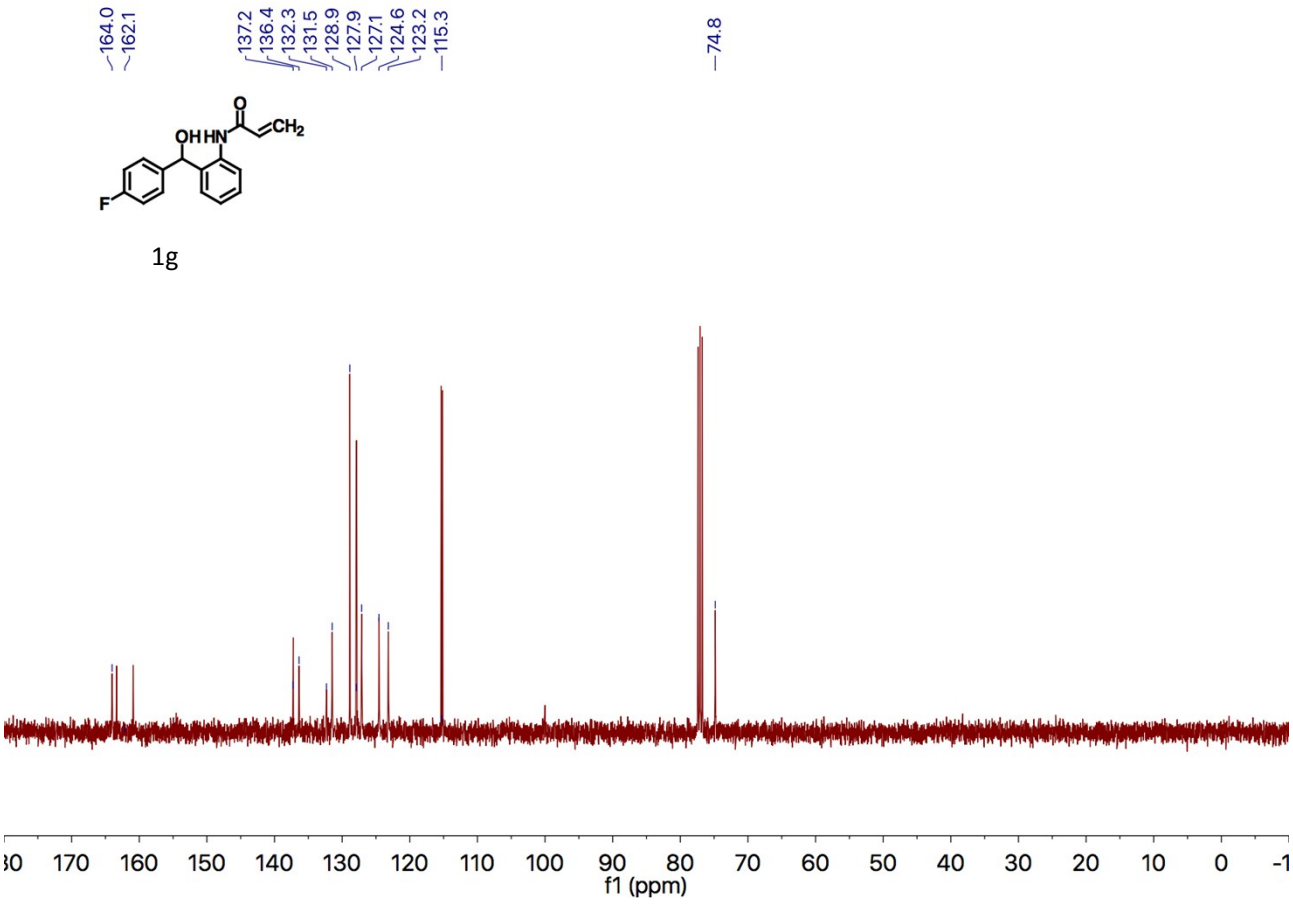
1f


163.7
156.9
137.3
132.2
130.2
129.4
128.9
128.6
128.3
128.2
126.6
124.0
122.5
121.3
110.8
72.8
55.6
H3C
O
OH HN
O
CH2
f1 (ppm)

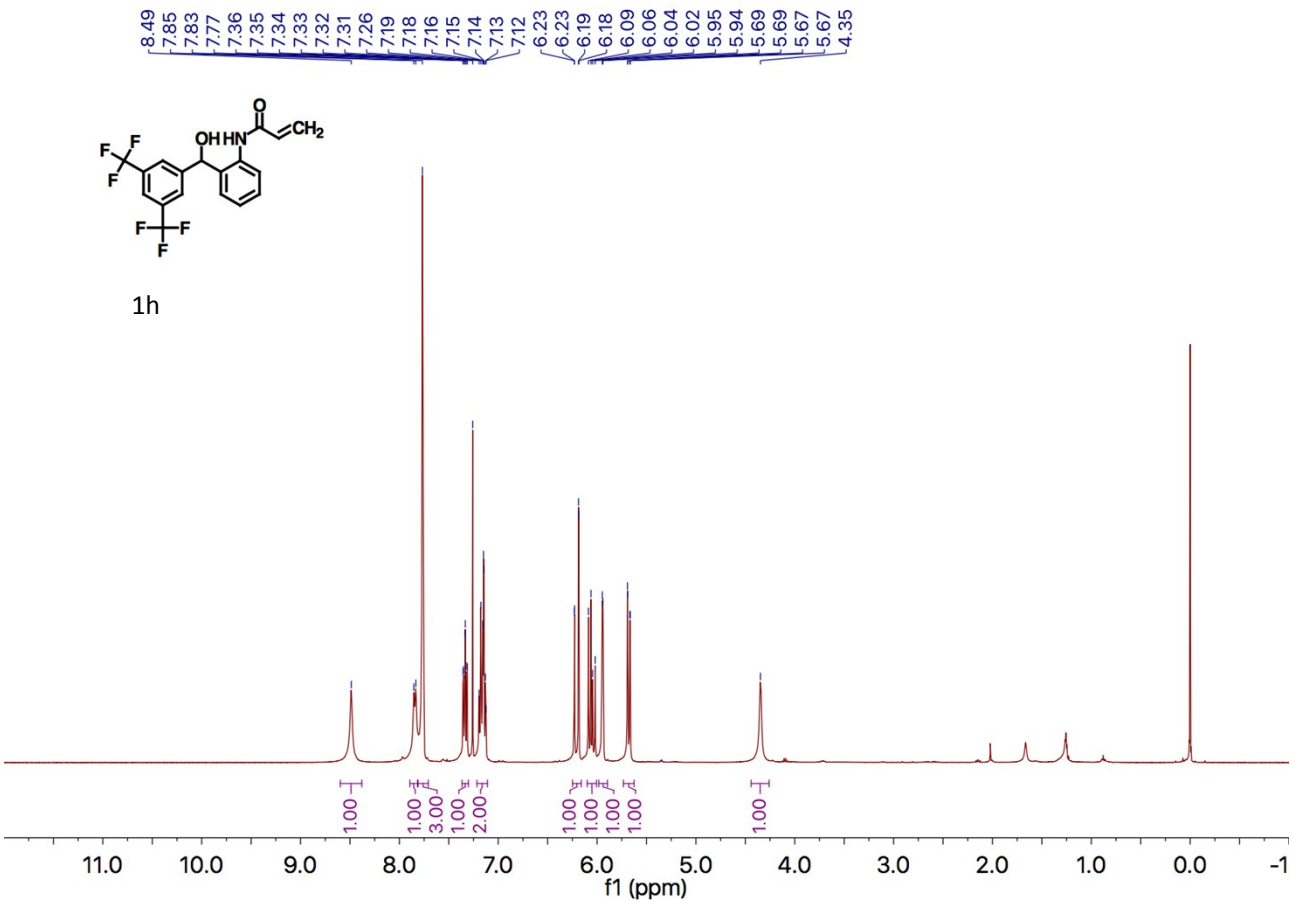
1f


8.97
8.03
8.01
7.28
7.26
7.23
7.21
7.20
7.08
7.06
7.05
7.03
7.02
6.97
6.95
6.93
6.15
6.10
6.02
6.00
5.98
5.96
5.81
5.60
5.58
4.31
OH HN
CH2
F
1.00
1.00
3.21
2.00
2.00
1.00
1.00
1.00
1.00
1.00
f1 (ppm)

1g


164.0
162.1
137.2
136.4
132.3
131.5
128.9
127.9
127.1
124.6
123.2
115.3
74.8
OH HN
CH2
F
f1 (ppm)

1g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7.85
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7.77
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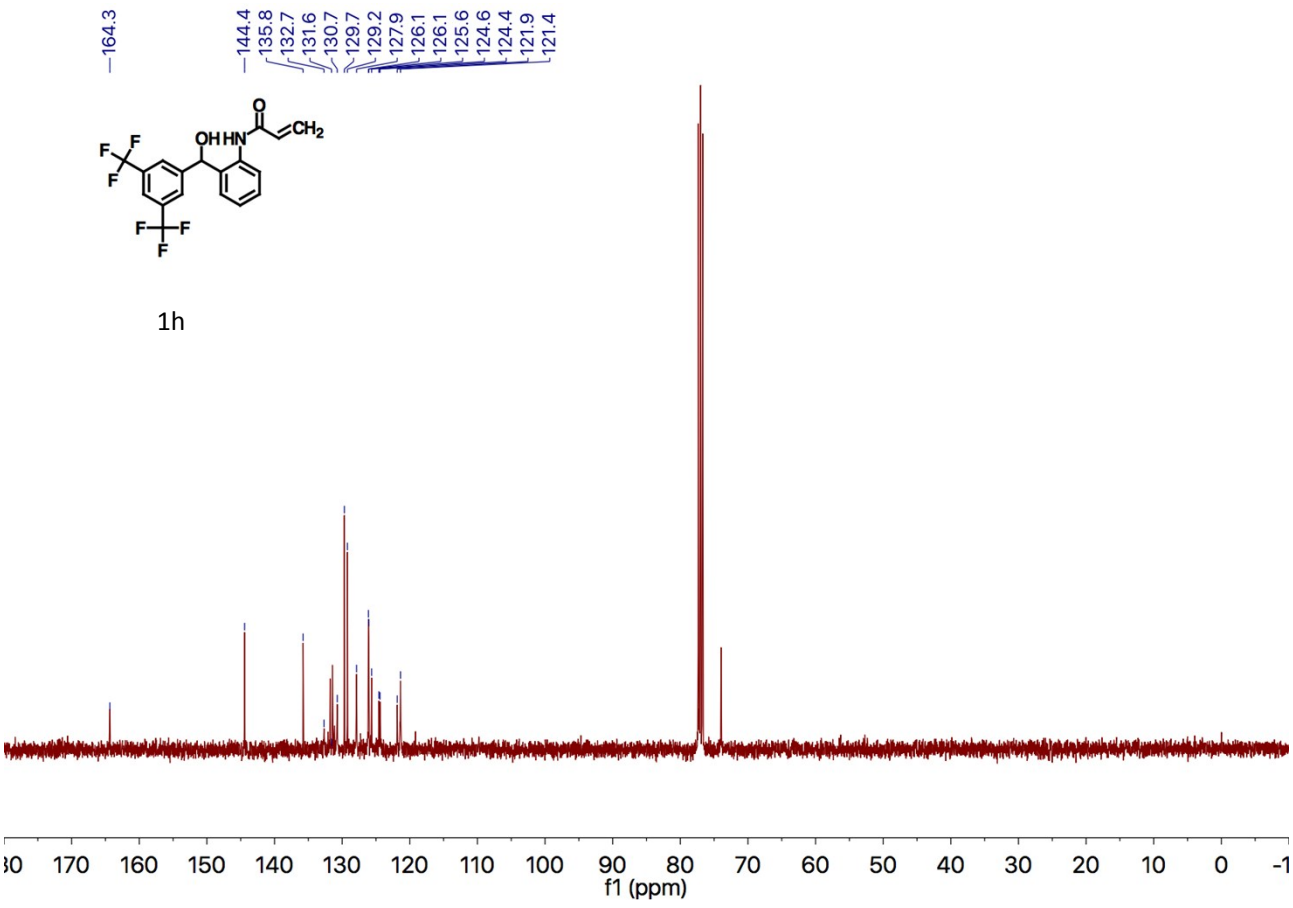
7.35
7.34
7.33
7.32
7.31
7.26
7.19
7.18
7.16
7.15
7.14
7.13
7.12
6.23
6.23
6.19
6.18
6.09
6.06
6.04
6.02
5.95
5.94
5.69
5.69
5.67
5.67
4.35
OH
HN
O
CH2
F
F
F
F
F
F
1h
1.00
1.00
3.00
1.00
2.00
1.00
1.00
1.00
1.00
1.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1
f1 (ppm)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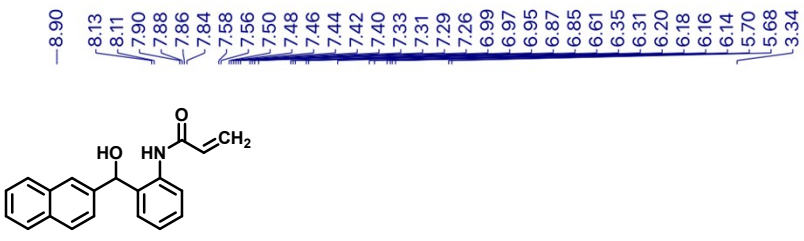
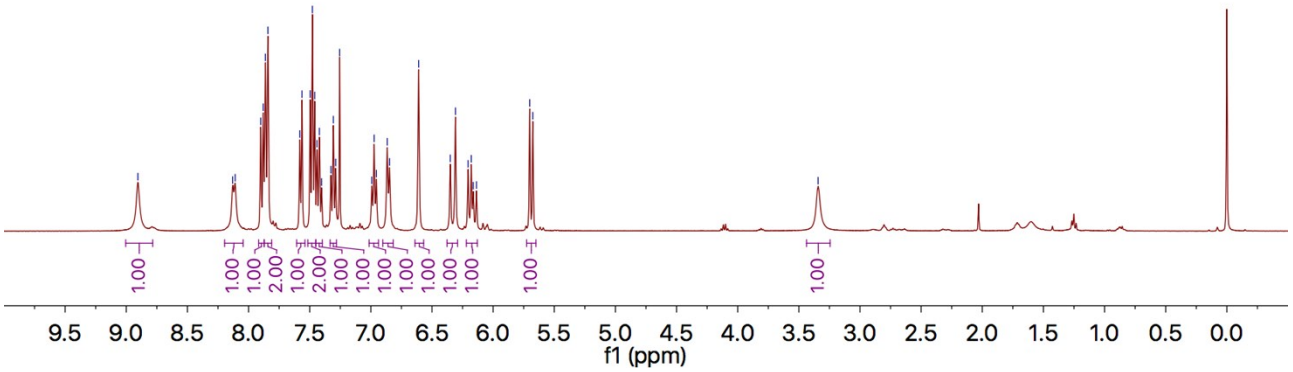
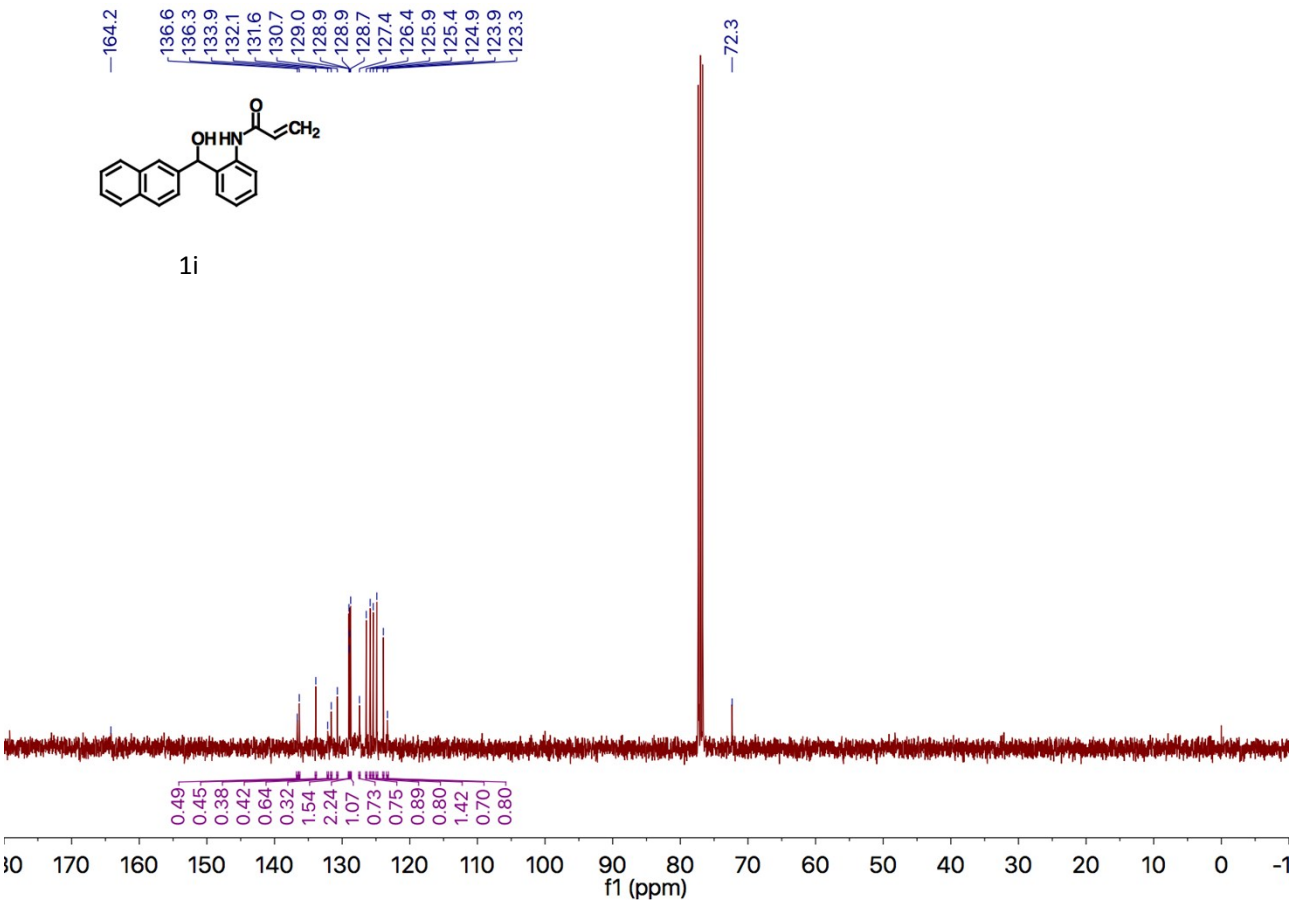
144.4
135.8
132.7
131.6
130.7
129.7
129.2
127.9
126.1
126.1
125.6
124.6
124.4
121.9
121.4
OH
HN
O
CH2
F
F
F
F
F
F
1h
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

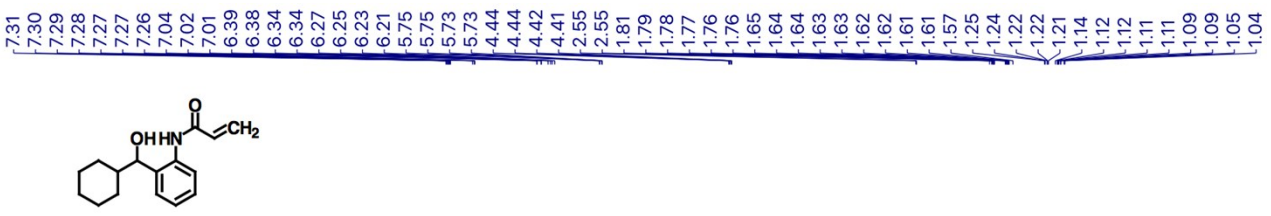

8.90
8.13
8.11
7.90
7.88
7.86
7.84
7.58
7.56
7.50
7.48
7.46
7.44
7.42
7.40
7.33
7.31
7.29
7.26
6.99
6.97
6.95
6.87
6.85
6.61
6.35
6.31
6.20
6.18
6.16
6.14
5.70
5.68
3.34
HO
HN
O
CH2

1i


1.00
1.00
2.00
1.00
2.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
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)

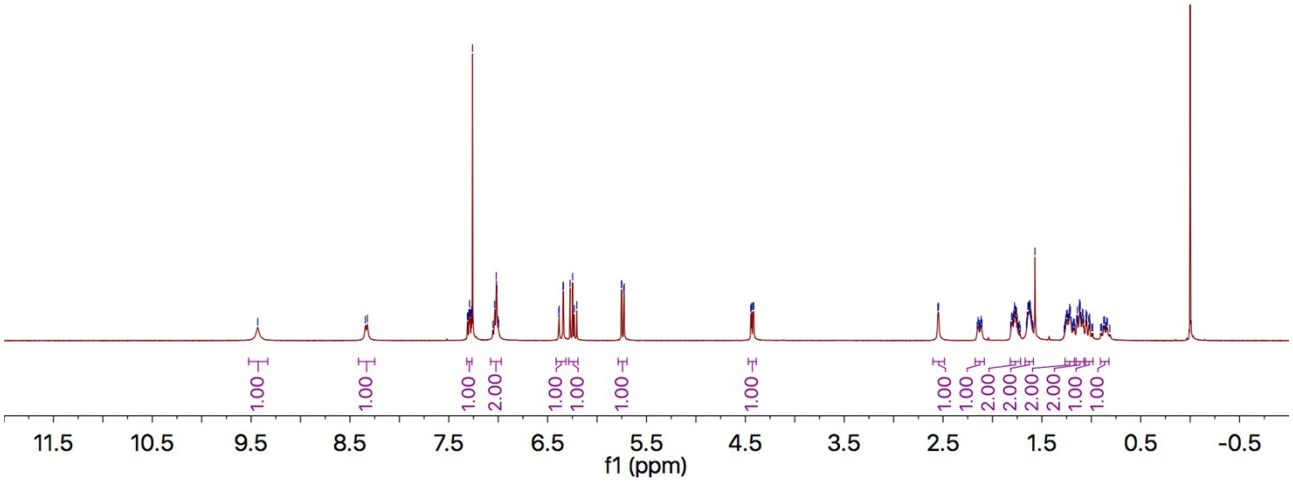

164.2
136.6
136.3
133.9
132.1
131.6
130.7
129.0
128.9
128.9
128.7
127.4
126.4
125.9
125.4
124.9
123.9
123.3
72.3
OH
HN
O
CH2
0.49
0.45
0.38
0.42
0.64
0.32
1.54
2.24
1.07
0.73
0.75
0.89
0.80
1.42
0.70
0.80
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

1i

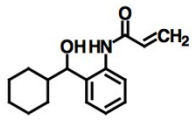

7.31
7.30
7.29
7.28
7.27
7.27
7.26
7.04
7.02
7.01
6.39
6.38
6.34
6.34
6.27
6.25
6.23
6.21
5.75
5.75
5.73
5.73
4.44
4.44
4.42
4.41
2.55
2.55
1.81
1.79
1.78
1.77
1.76
1.76
1.65
1.64
1.64
1.63
1.63
1.62
1.62
1.61
1.61
1.57
1.25
1.24
1.22
1.22
1.21
1.14
1.12
1.12
1.11
1.11
1.09
1.09
1.05
1.04

OH
HN
O
CH2

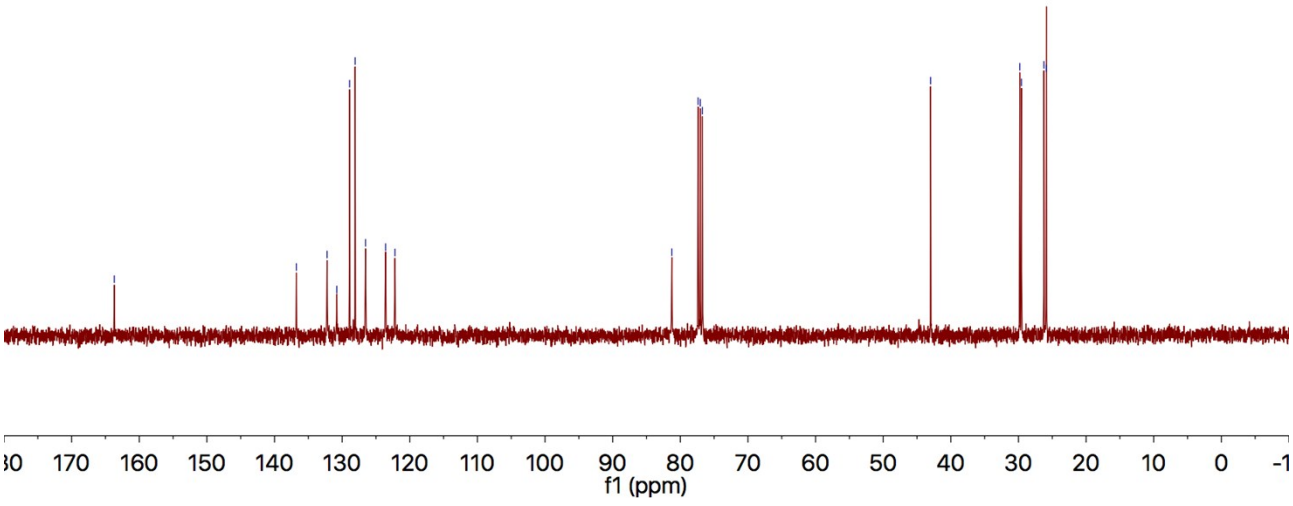
1j

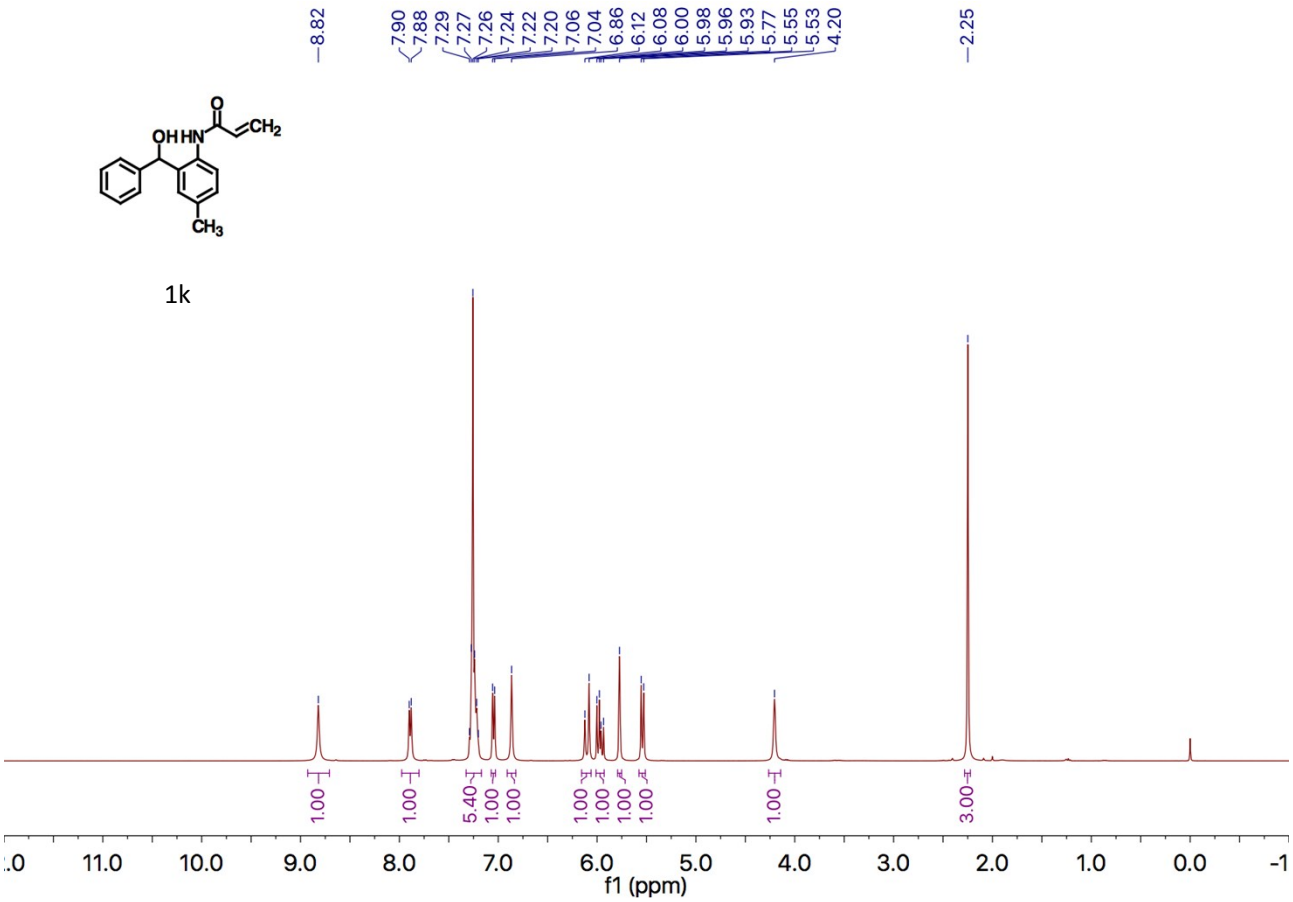

1.00
1.00
1.00
2.00
1.00
1.00
1.00
1.00
1.00
1.00
2.00
2.00
2.00
1.00
1.00
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)


163.7
136.8
132.2
130.8
128.9
128.1
126.5
123.6
122.2
81.3
77.4
77.0
76.7
43.0
29.8
29.6
26.2
25.9

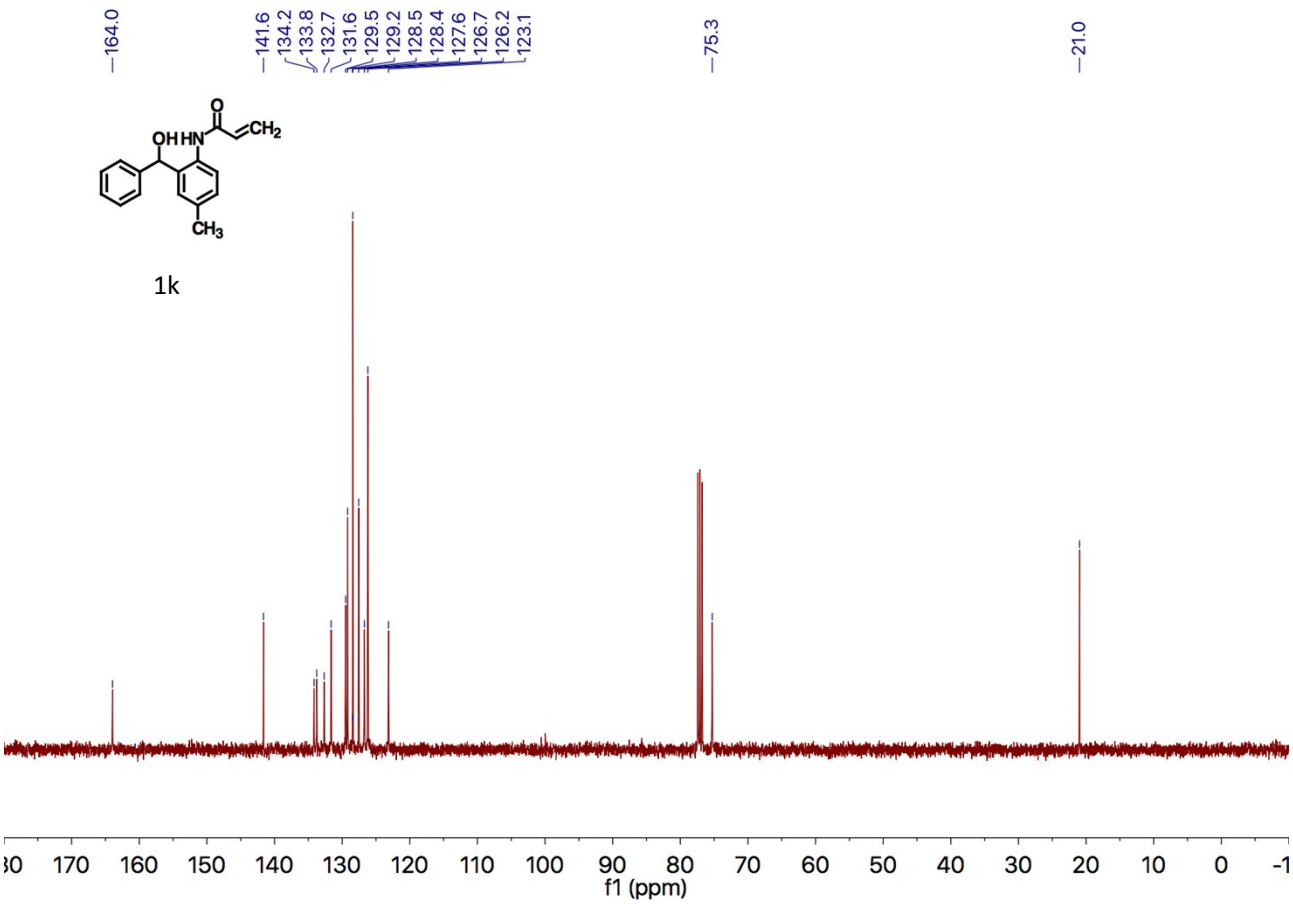

OH
HN
O
CH2

1j

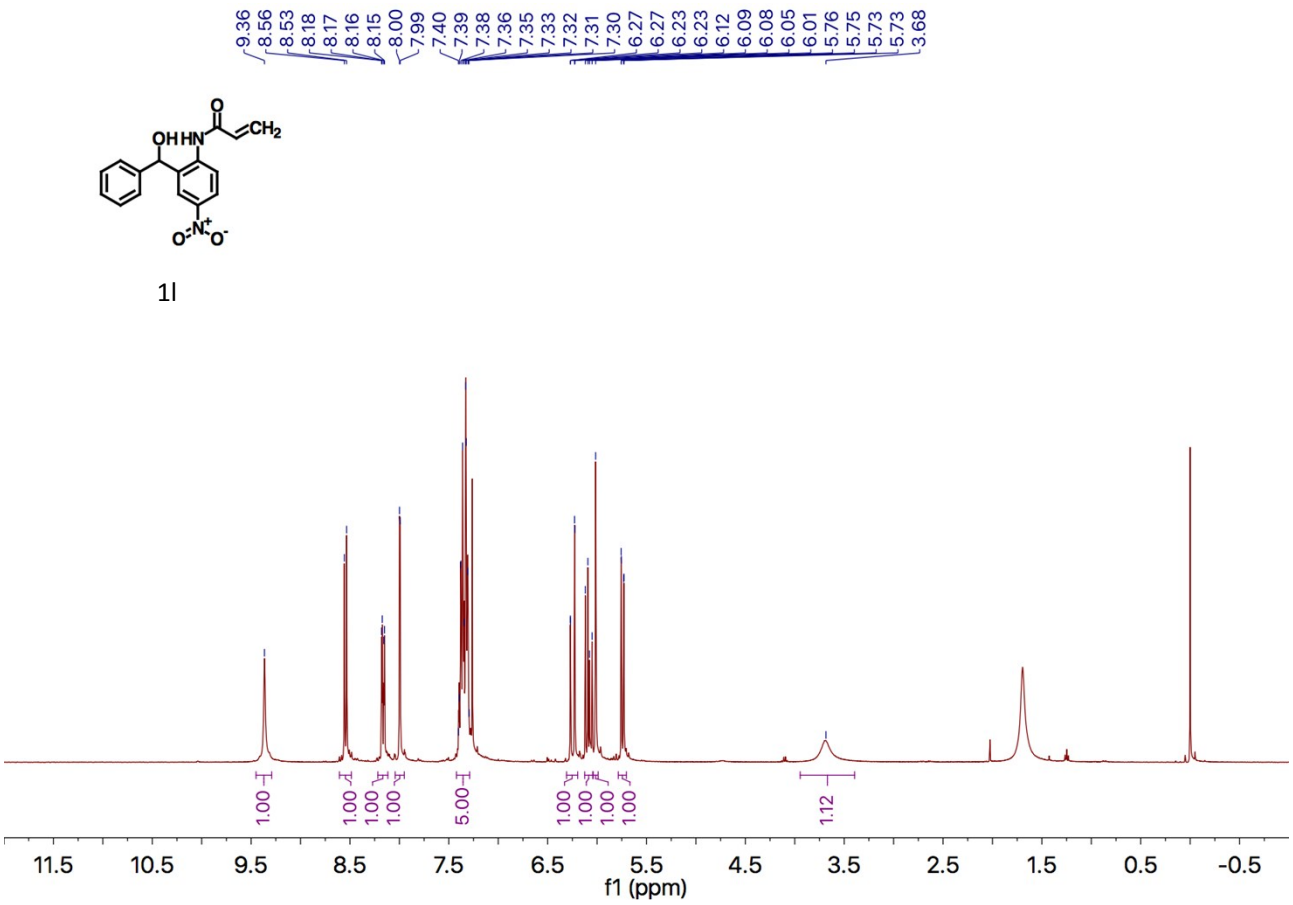

170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

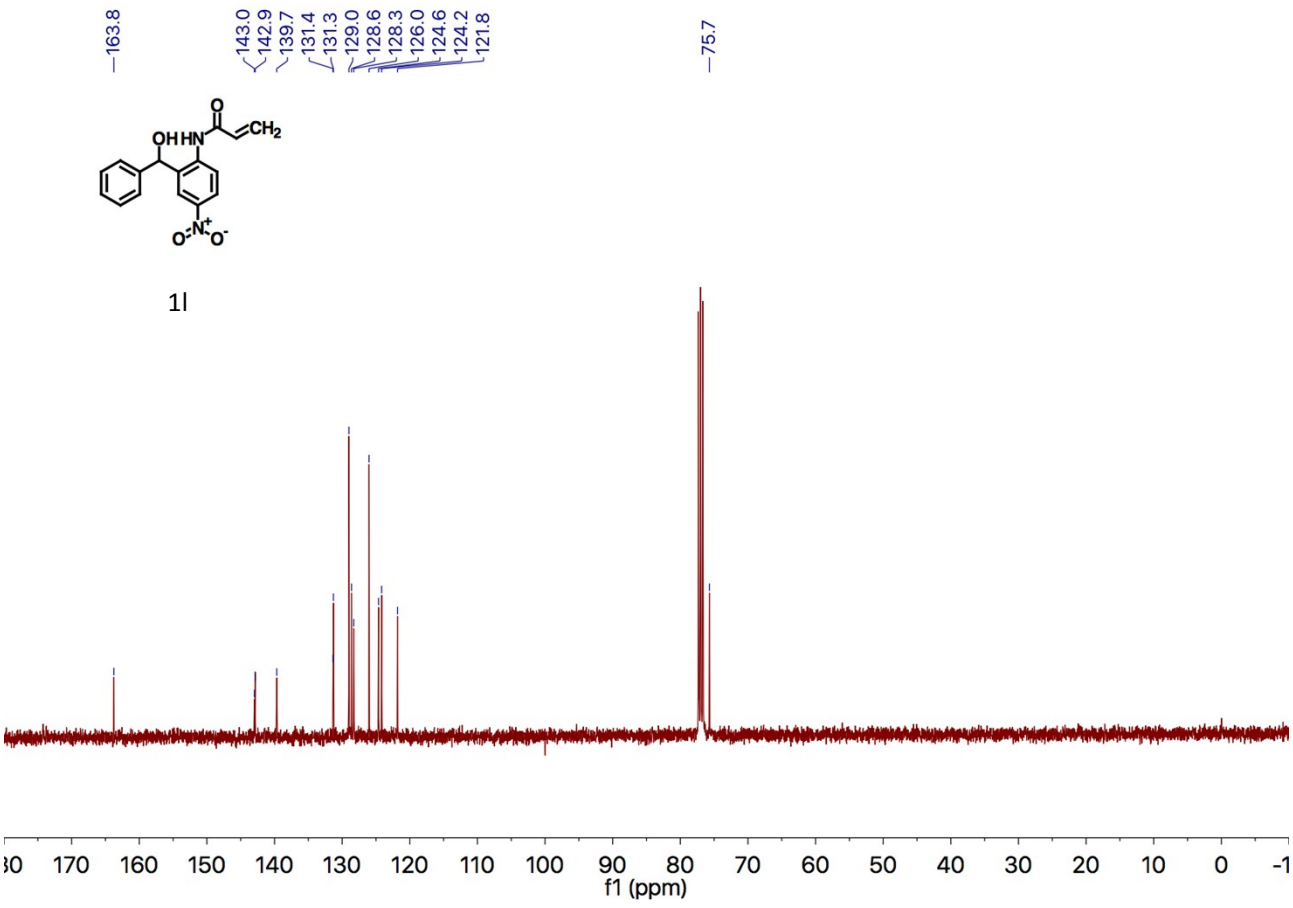

8.82
7.90
7.88
7.29
7.27
7.26
7.24
7.22
7.20
7.06
7.04
6.86
6.12
6.08
6.00
5.98
5.96
5.93
5.77
5.55
5.53
4.20
2.25
OH
HN
O
CH2
CH3
1.00
1.00
5.40
1.00
1.00
1.00
1.00
1.00
1.00
3.00
f1 (ppm)

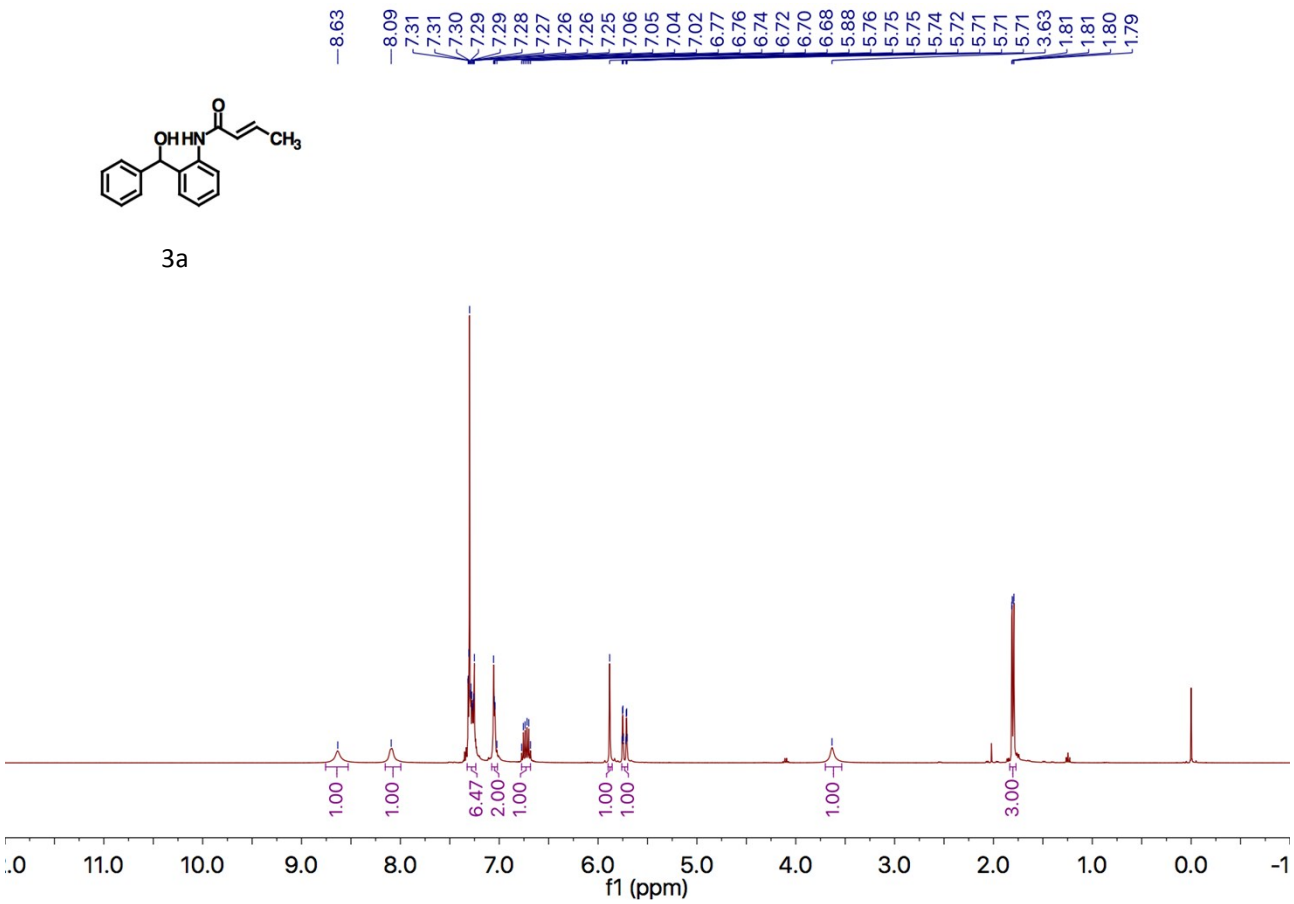
1k

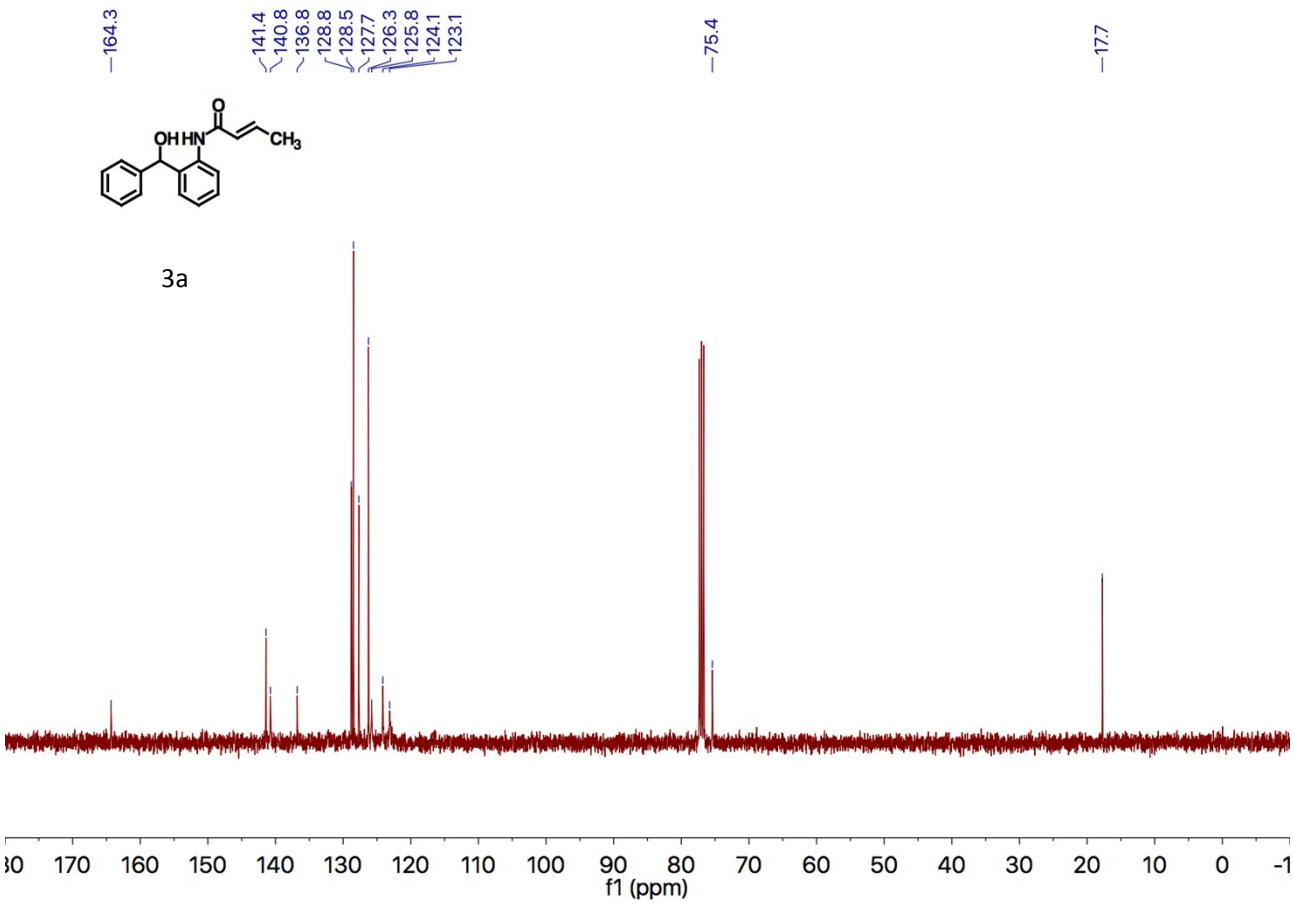

164.0
141.6
134.2
133.8
132.7
131.6
129.5
129.2
128.5
128.4
127.6
126.7
126.2
123.1
75.3
21.0
OH
HN
O
CH2
CH3
f1 (ppm)

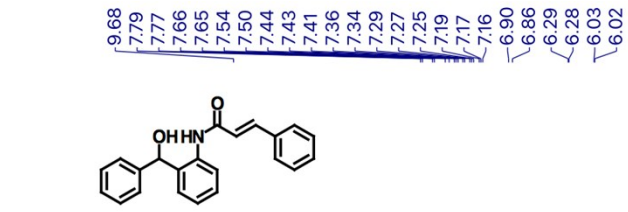
1k


9.36
8.56
8.53
8.18
8.17
8.16
8.15
8.00
7.99
7.40
7.39
7.38
7.36
7.35
7.33
7.32
7.31
7.30
6.27
6.27
6.23
6.23
6.12
6.09
6.08
6.05
6.01
5.76
5.75
5.73
5.73
3.68
OH
HN
O
CH2
O2N+
O-
1l
1.00
1.00
1.00
1.00
5.00
1.00
1.00
1.00
1.00
1.12
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

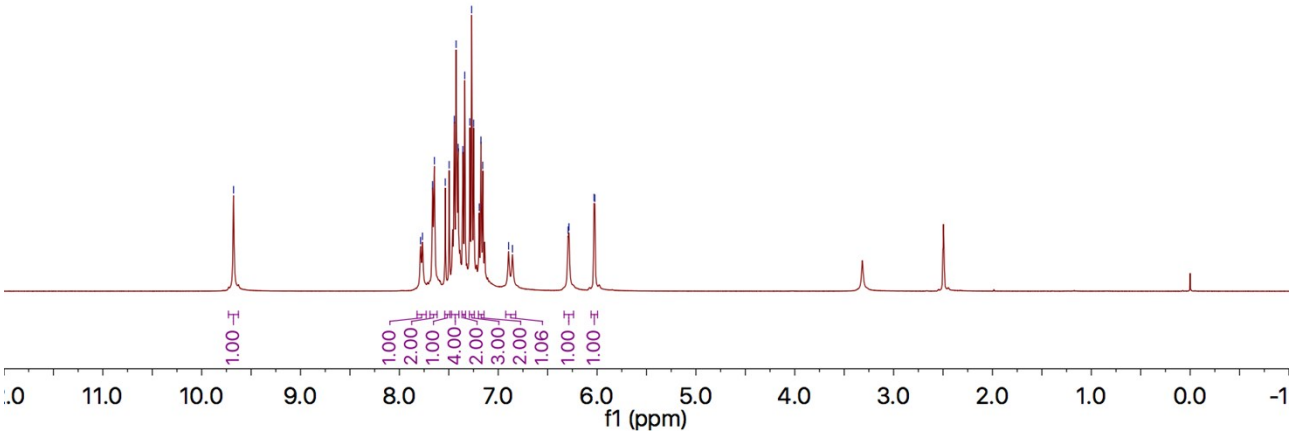

163.8
143.0
142.9
139.7
131.4
131.3
129.0
128.6
128.3
126.0
124.6
124.2
121.8
75.7
OH
HN
O
CH2
O2N+
O-
1l
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

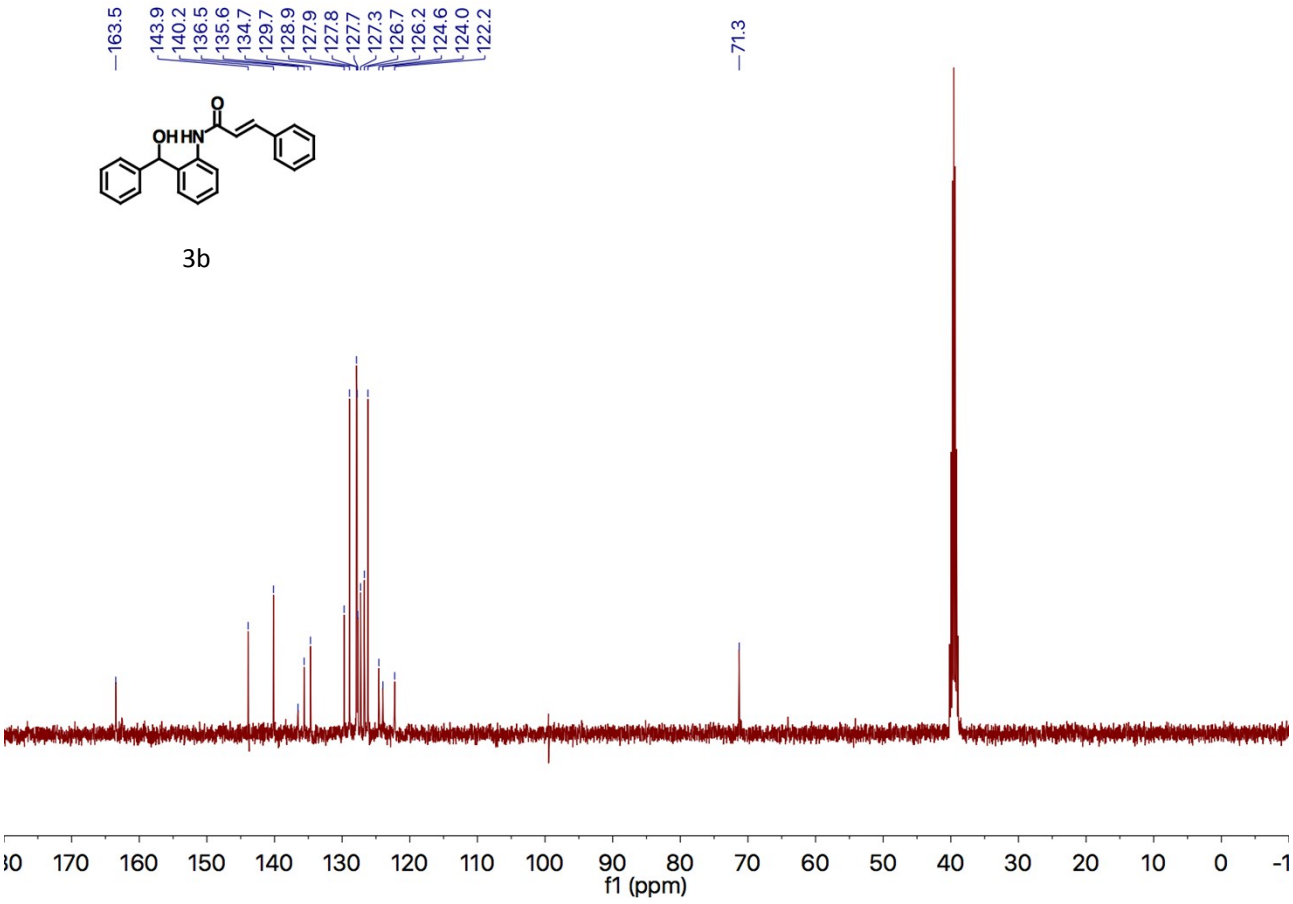

8.63
8.09
7.31
7.31
7.30
7.29
7.29
7.28
7.27
7.26
7.26
7.25
7.06
7.05
7.04
7.02
6.77
6.76
6.74
6.72
6.70
6.68
5.88
5.76
5.75
5.75
5.74
5.72
5.71
5.71
5.71
3.63
1.81
1.81
1.80
1.79
OH
HN
O
CH3
3a
1.00
1.00
6.47
2.00
1.00
1.00
1.00
1.00
3.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


164.3
141.4
140.8
136.8
128.8
128.5
127.7
126.3
125.8
124.1
123.1
75.4
17.7
OH
HN
O
CH3
3a
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

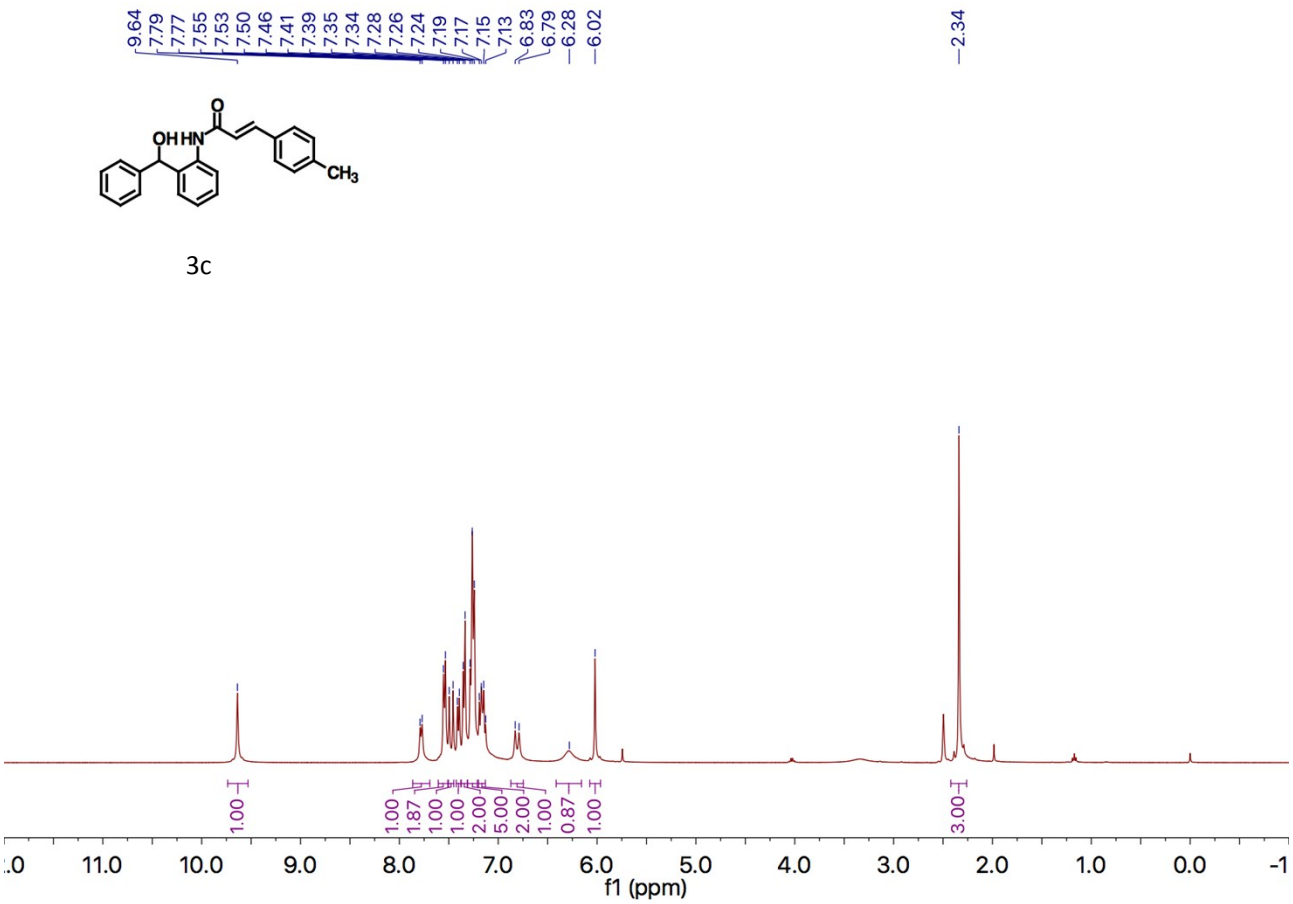

9.68
7.79
7.77
7.66
7.65
7.54
7.50
7.44
7.43
7.41
7.36
7.34
7.29
7.27
7.25
7.19
7.17
7.16
6.90
6.86
6.29
6.28
6.03
6.02
OH
HN
O

3b

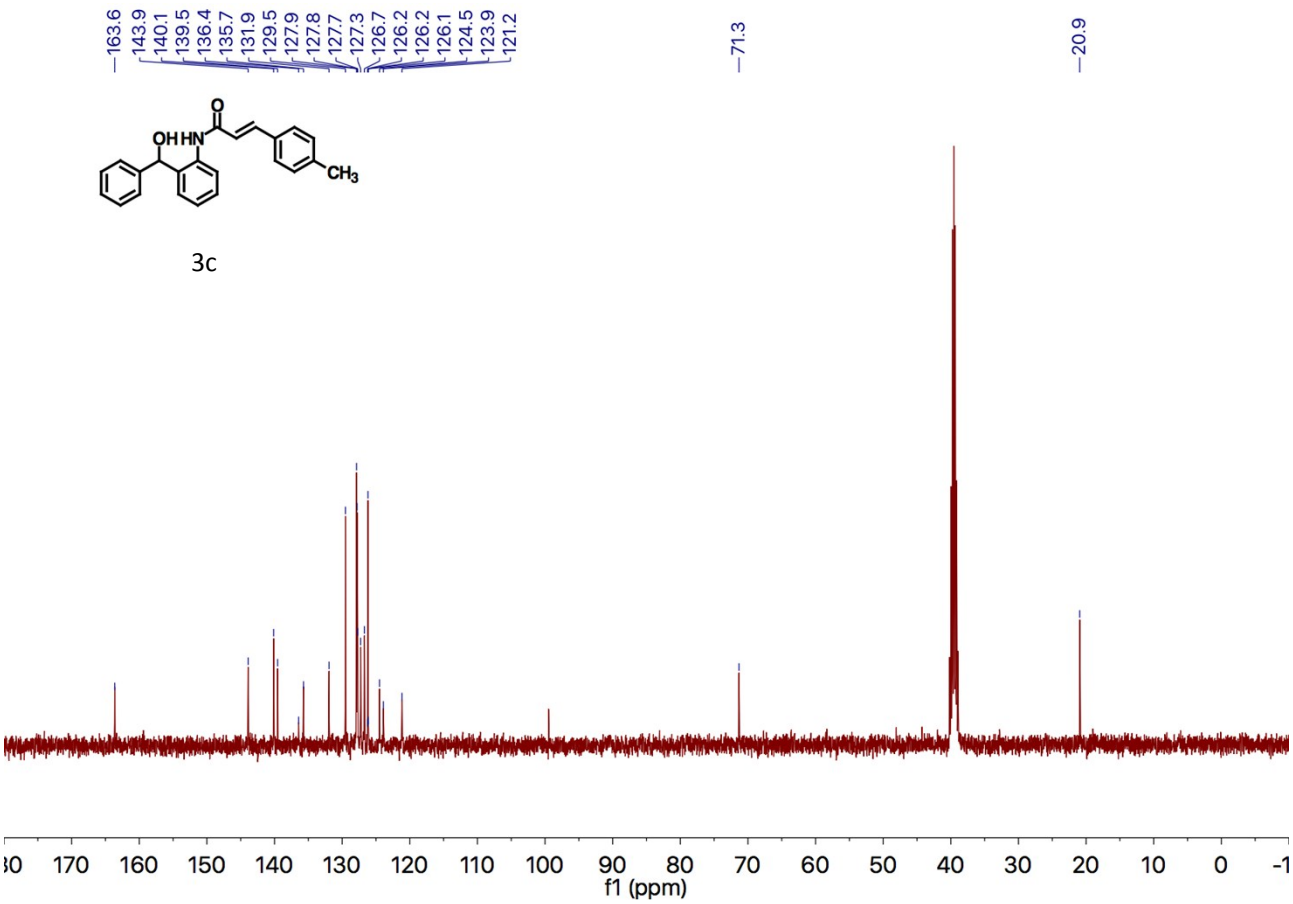

1.00
1.00
2.00
1.00
4.00
2.00
3.00
2.00
1.06
1.00
1.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


163.5
143.9
140.2
136.5
135.6
134.7
129.7
128.9
127.9
127.8
127.7
127.3
126.7
126.2
124.6
124.0
122.2
71.3
OH
HN
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

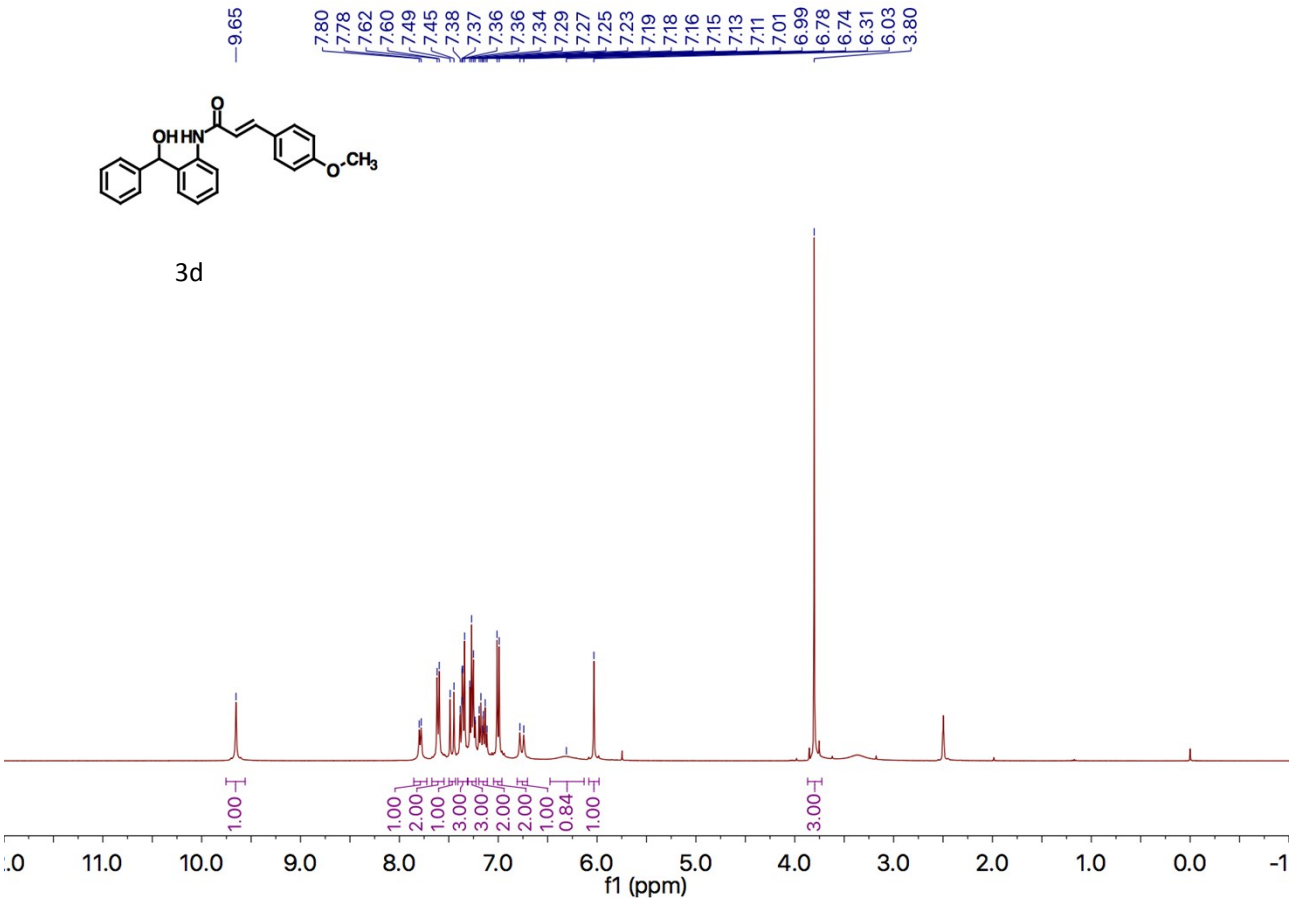
3b


9.64
7.79
7.77
7.55
7.53
7.50
7.46
7.41
7.39
7.35
7.34
7.28
7.26
7.24
7.19
7.17
7.15
7.13
6.83
6.79
6.28
6.02
2.34
OH
HN
O
CH3
1.00
1.00
1.87
1.00
1.00
2.00
5.00
2.00
1.00
0.87
1.00
3.00
f1 (ppm)

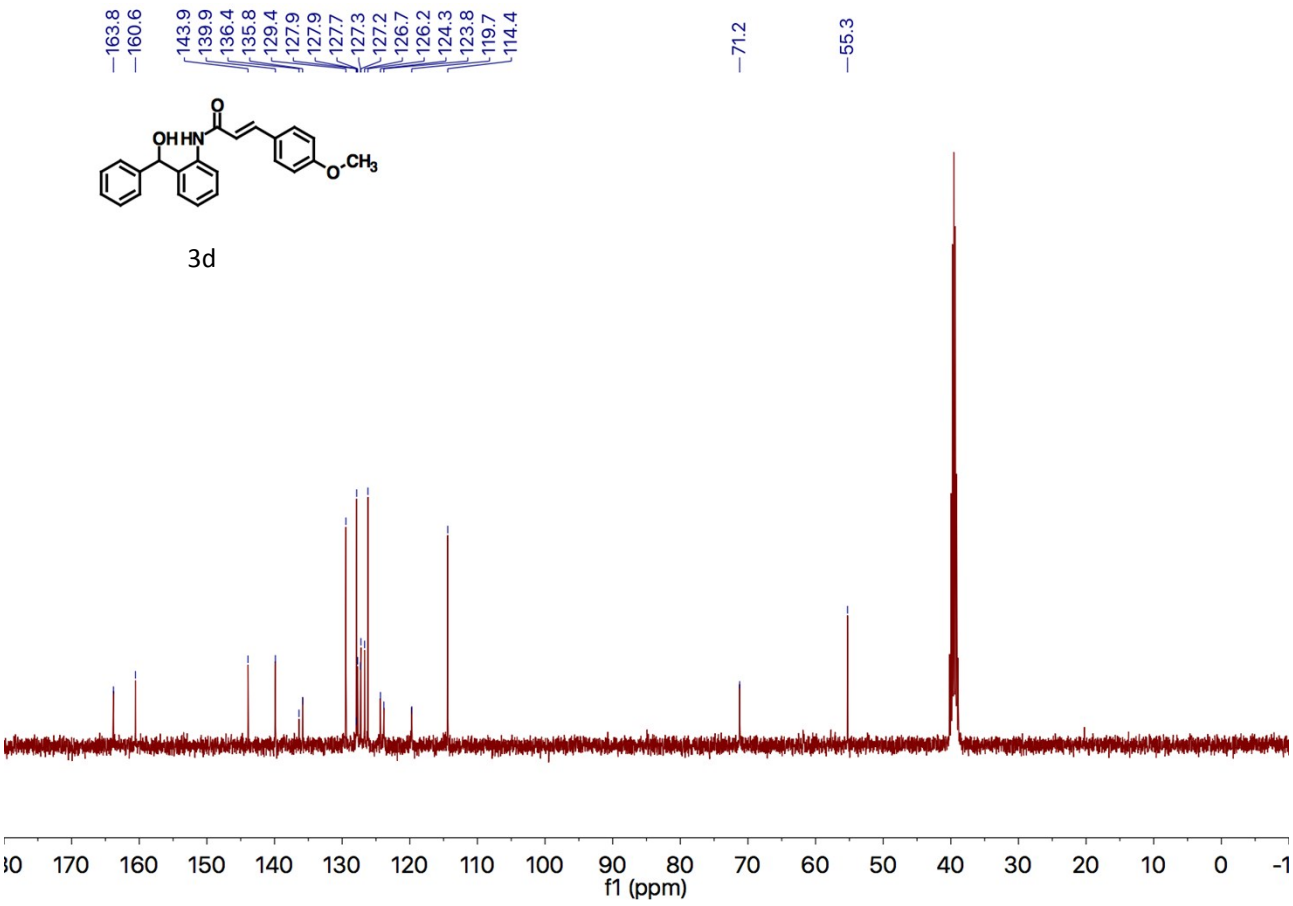
3c


163.6
143.9
140.1
139.5
136.4
135.7
131.9
129.5
127.9
127.8
127.7
127.3
126.7
126.2
126.2
126.1
124.5
123.9
121.2
71.3
20.9
OH
HN
O
CH3
f1 (ppm)

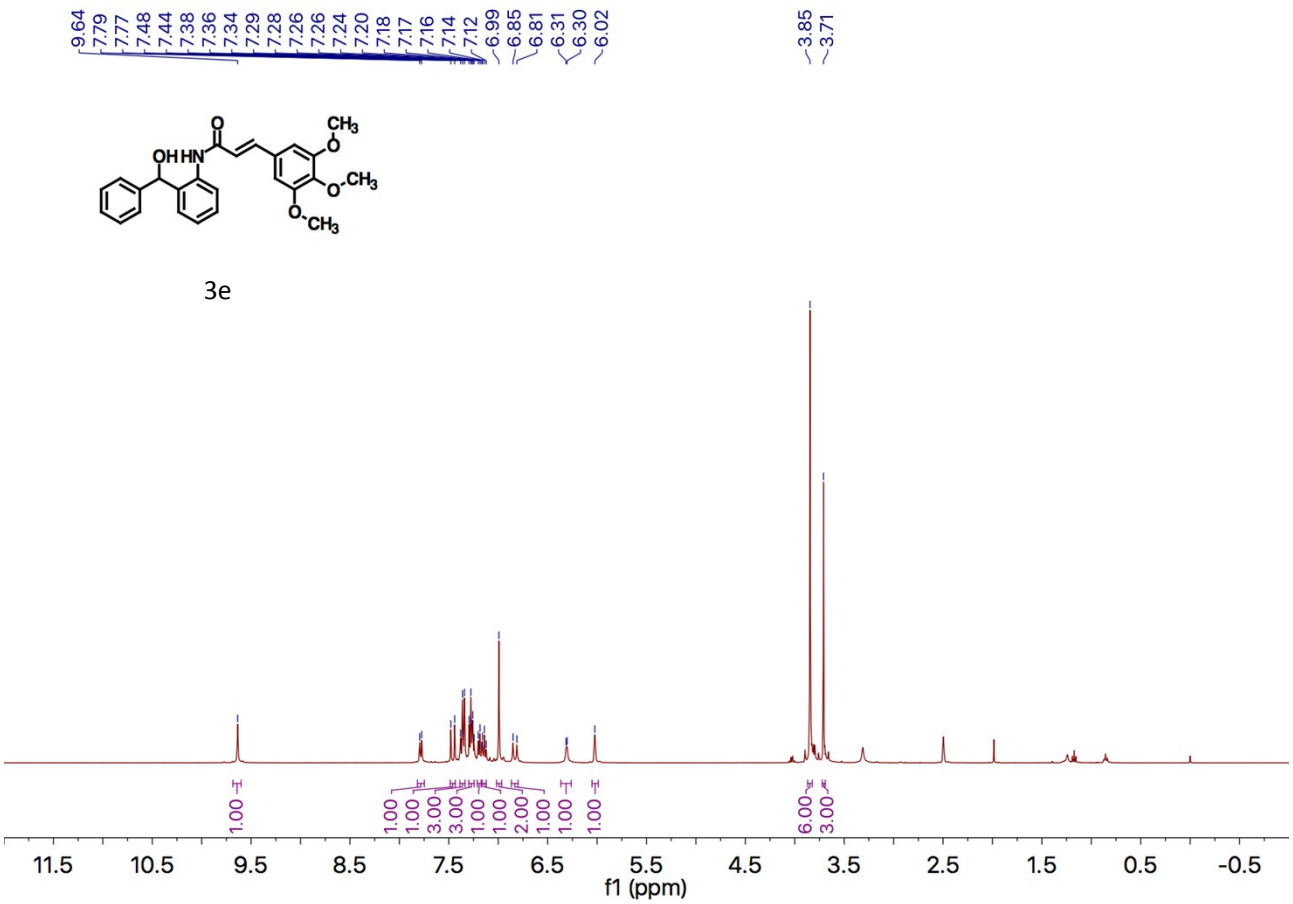
3c


9.65
7.80
7.78
7.62
7.60
7.49
7.45
7.38
7.37
7.36
7.36
7.34
7.29
7.27
7.25
7.23
7.19
7.18
7.16
7.15
7.13
7.11
7.01
6.99
6.78
6.74
6.31
6.03
3.80
OH
HN
O
O
CH3
1.00
1.00
2.00
1.00
3.00
3.00
2.00
2.00
1.00
0.84
1.00
3.00
f1 (ppm)

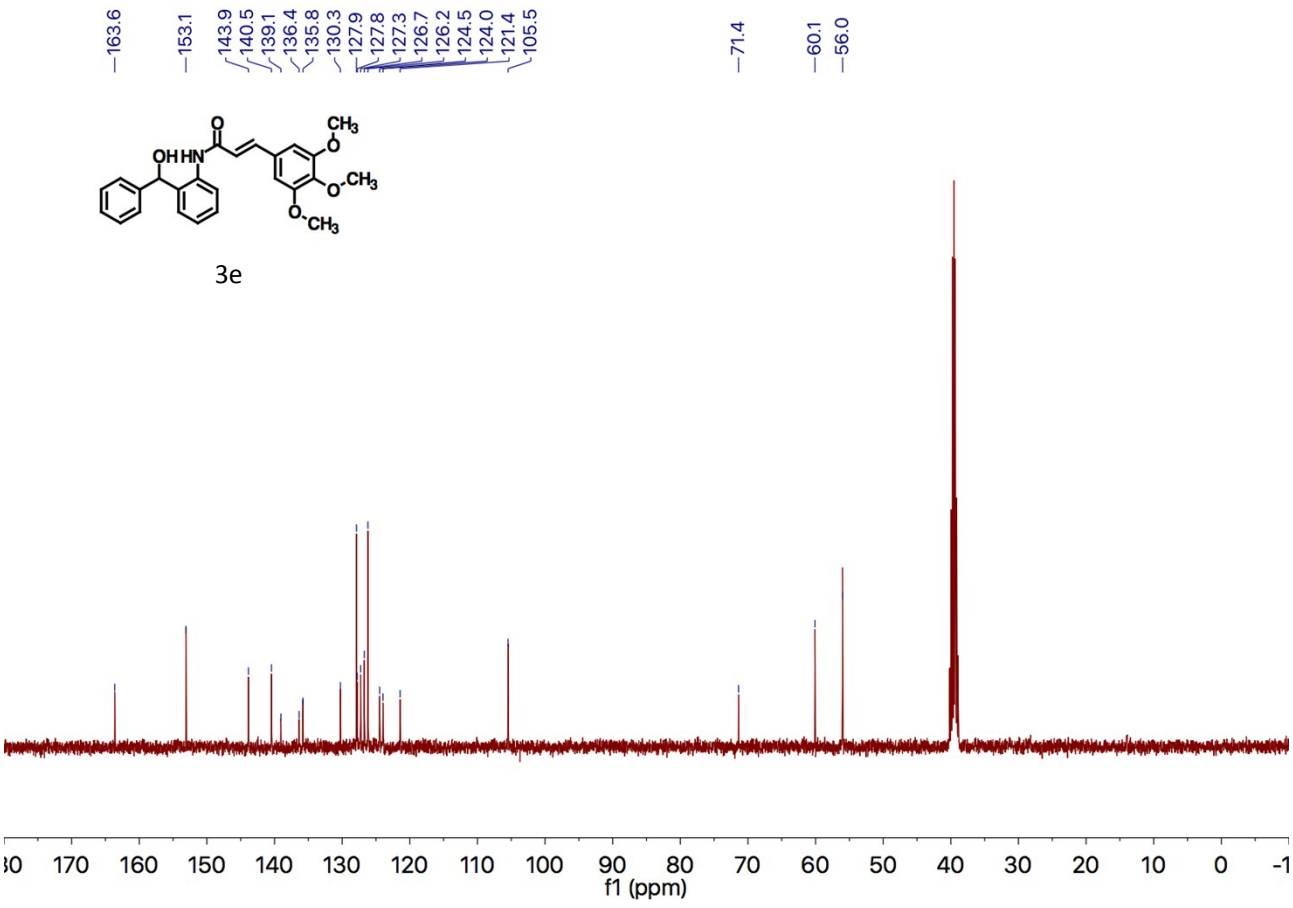
3d


163.8
160.6
143.9
139.9
136.4
135.8
129.4
127.9
127.9
127.7
127.3
127.2
126.7
126.2
124.3
123.8
119.7
114.4
71.2
55.3
OH
HN
O
O
CH3
f1 (ppm)

3d


9.64
7.79
7.77
7.48
7.44
7.38
7.36
7.34
7.29
7.28
7.26
7.26
7.24
7.20
7.18
7.17
7.16
7.14
7.12
6.99
6.85
6.81
6.31
6.30
6.02
3.85
3.71
OH HN
O
CH3
O
CH3
O
CH3
1.00
1.00
1.00
3.00
3.00
1.00
1.00
2.00
1.00
1.00
1.00
6.00
3.00
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

3e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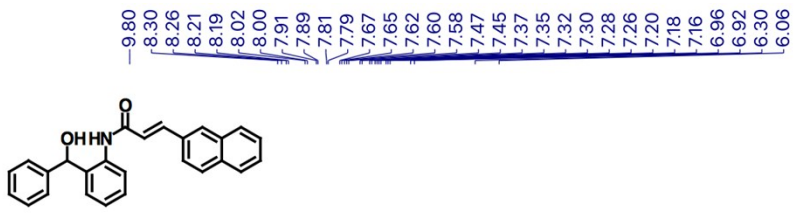
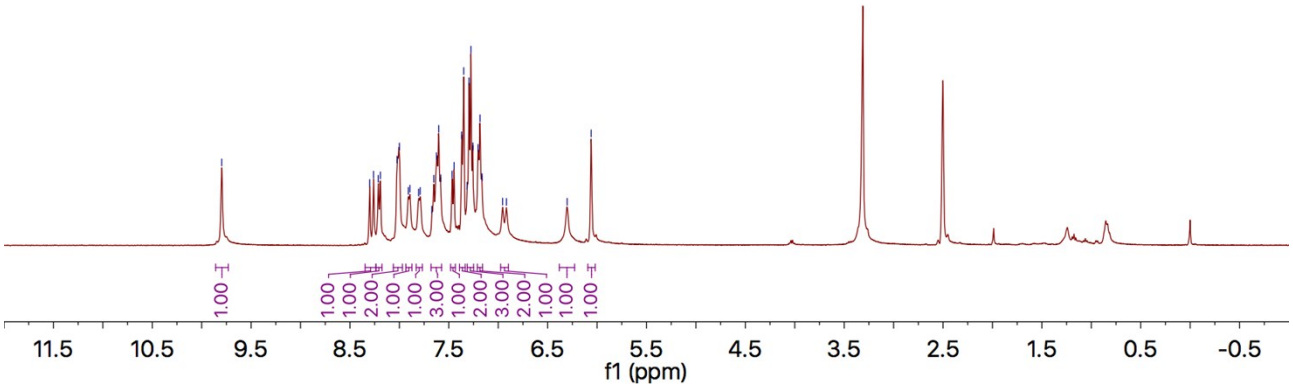
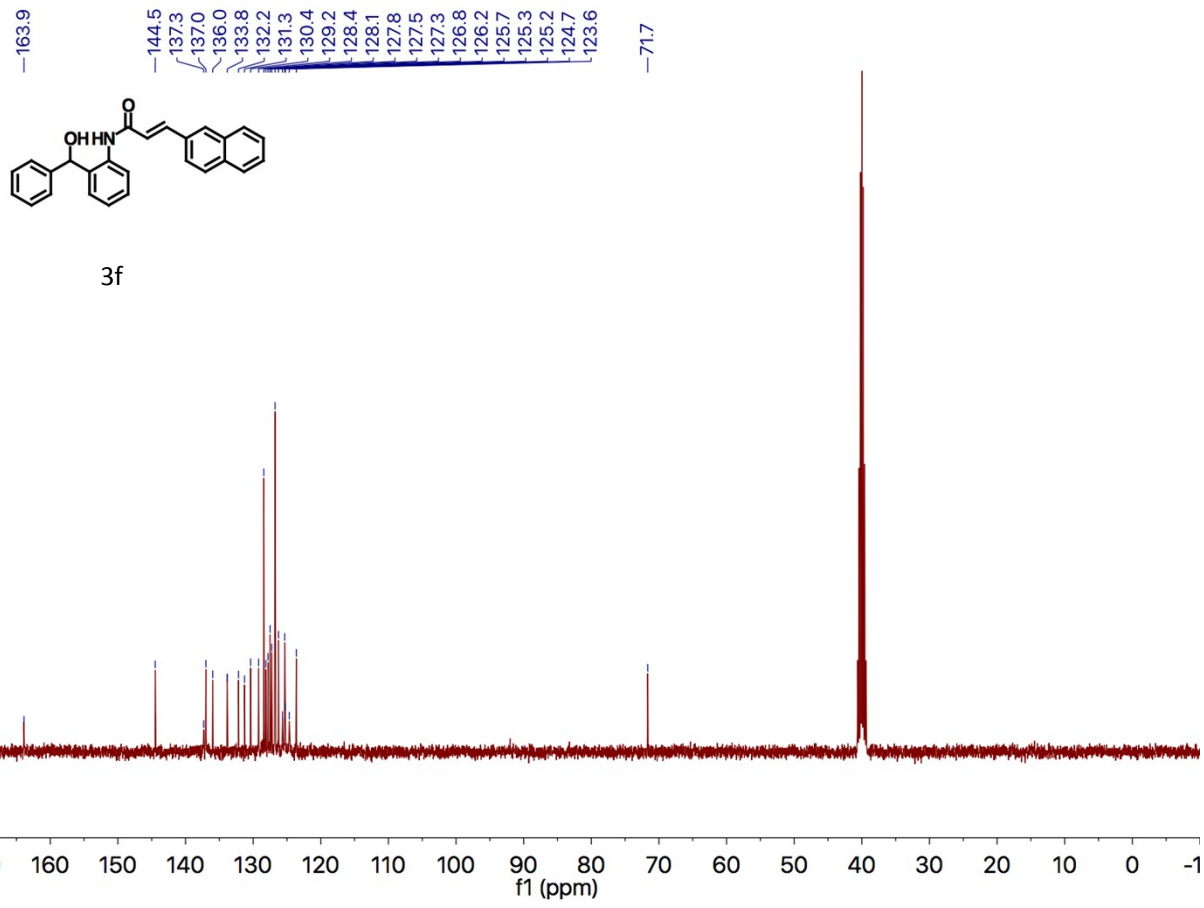
153.1
143.9
140.5
139.1
136.4
135.8
130.3
127.9
127.8
127.3
126.7
126.2
124.5
124.0
121.4
105.5
71.4
60.1
56.0
OH HN
O
CH3
O
CH3
O
CH3
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

3e


9.80
8.30
8.26
8.21
8.19
8.02
8.00
7.91
7.89
7.81
7.79
7.67
7.65
7.62
7.60
7.58
7.47
7.45
7.37
7.35
7.32
7.30
7.28
7.26
7.20
7.18
7.16
6.96
6.92
6.30
6.06
OH
HN
O

3f


1.00
1.00
1.00
2.00
1.00
1.00
3.00
1.00
2.00
3.00
2.00
1.00
1.00
1.00
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)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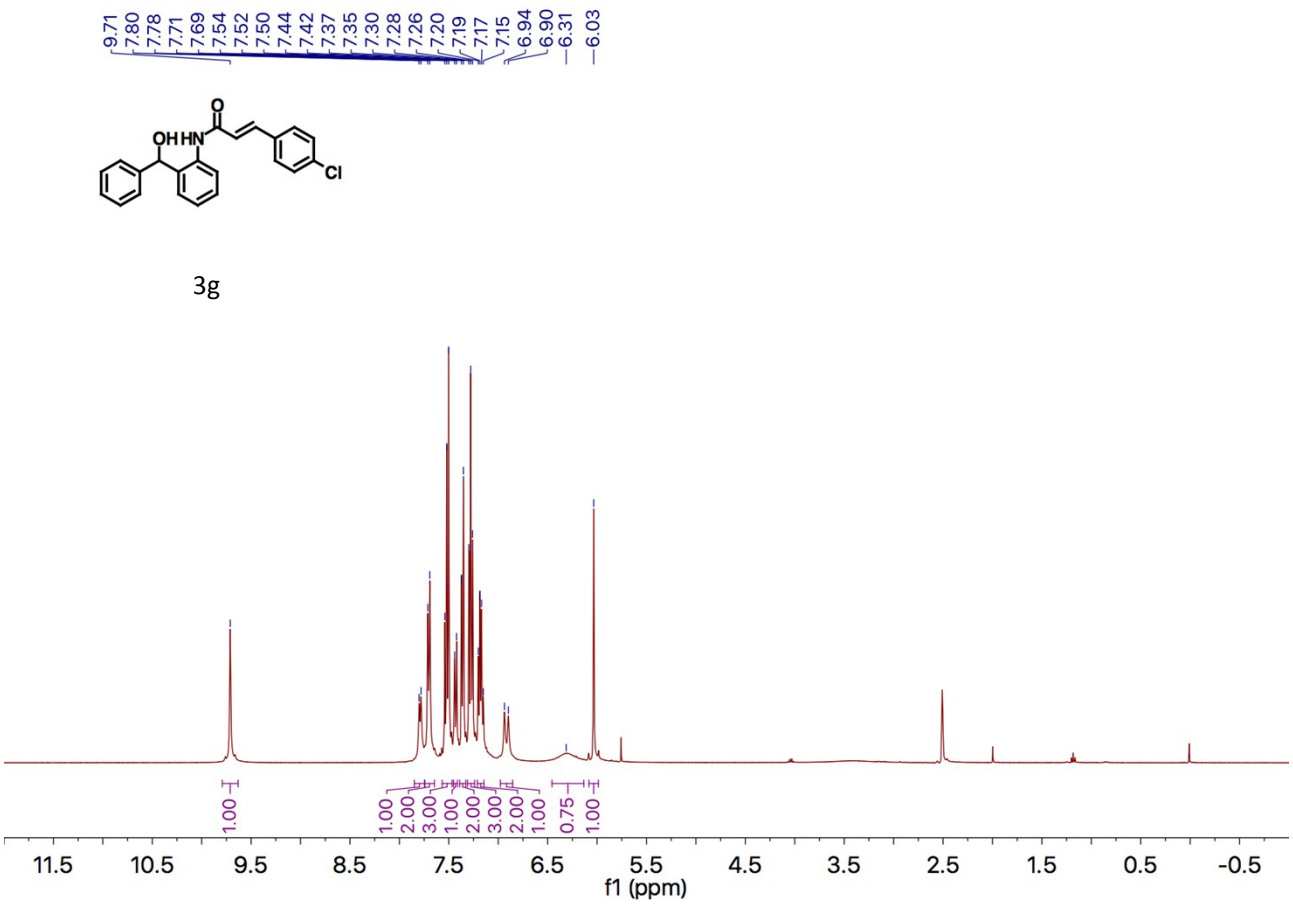
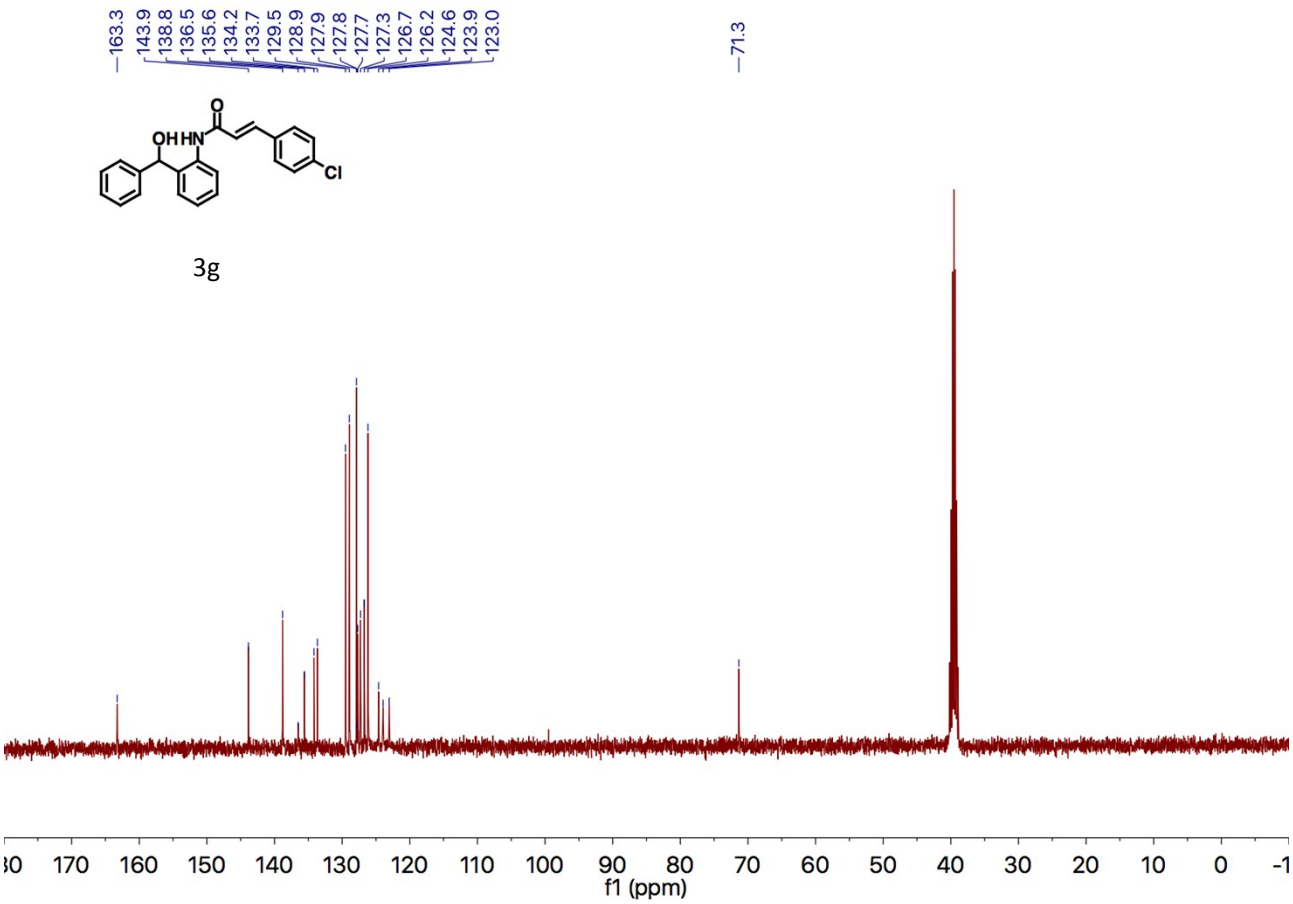
144.5
137.3
137.0
136.0
133.8
132.2
131.3
130.4
129.2
128.4
128.1
127.8
127.5
127.3
126.8
126.2
125.7
125.3
125.2
124.7
123.6
71.7
OH
HN
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

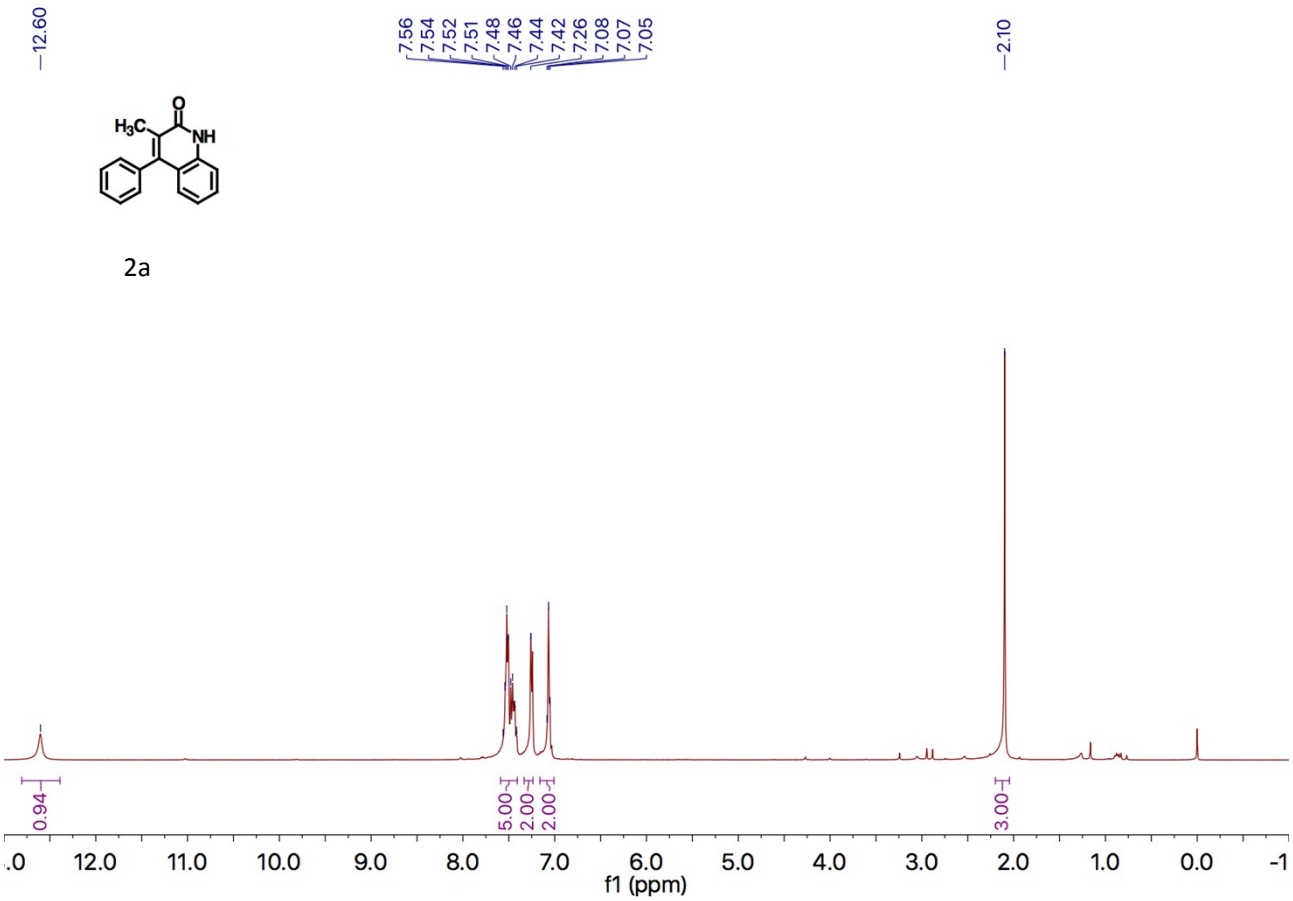
3f


9.71
7.80
7.78
7.71
7.69
7.54
7.52
7.50
7.44
7.42
7.37
7.35
7.30
7.28
7.26
7.20
7.19
7.17
7.15
6.94
6.90
6.31
6.03
OH
HN
O
Cl
1.00
2.00
3.00
1.00
2.00
3.00
2.00
1.00
0.75
1.00
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

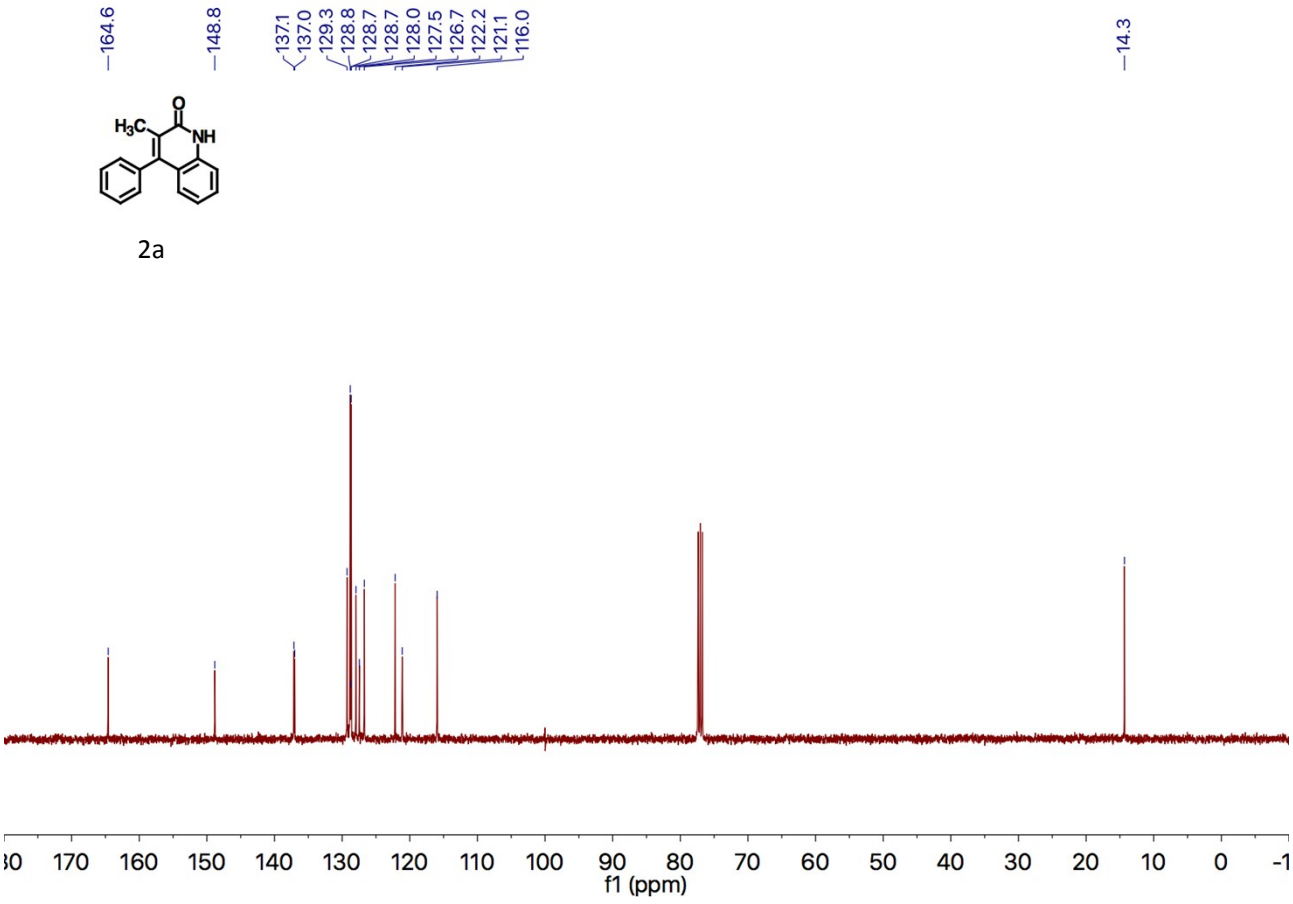
3g


163.3
143.9
138.8
136.5
135.6
134.2
133.7
129.5
128.9
127.9
127.8
127.7
127.3
126.7
126.2
124.6
123.9
123.0
71.3
OH
HN
O
Cl
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

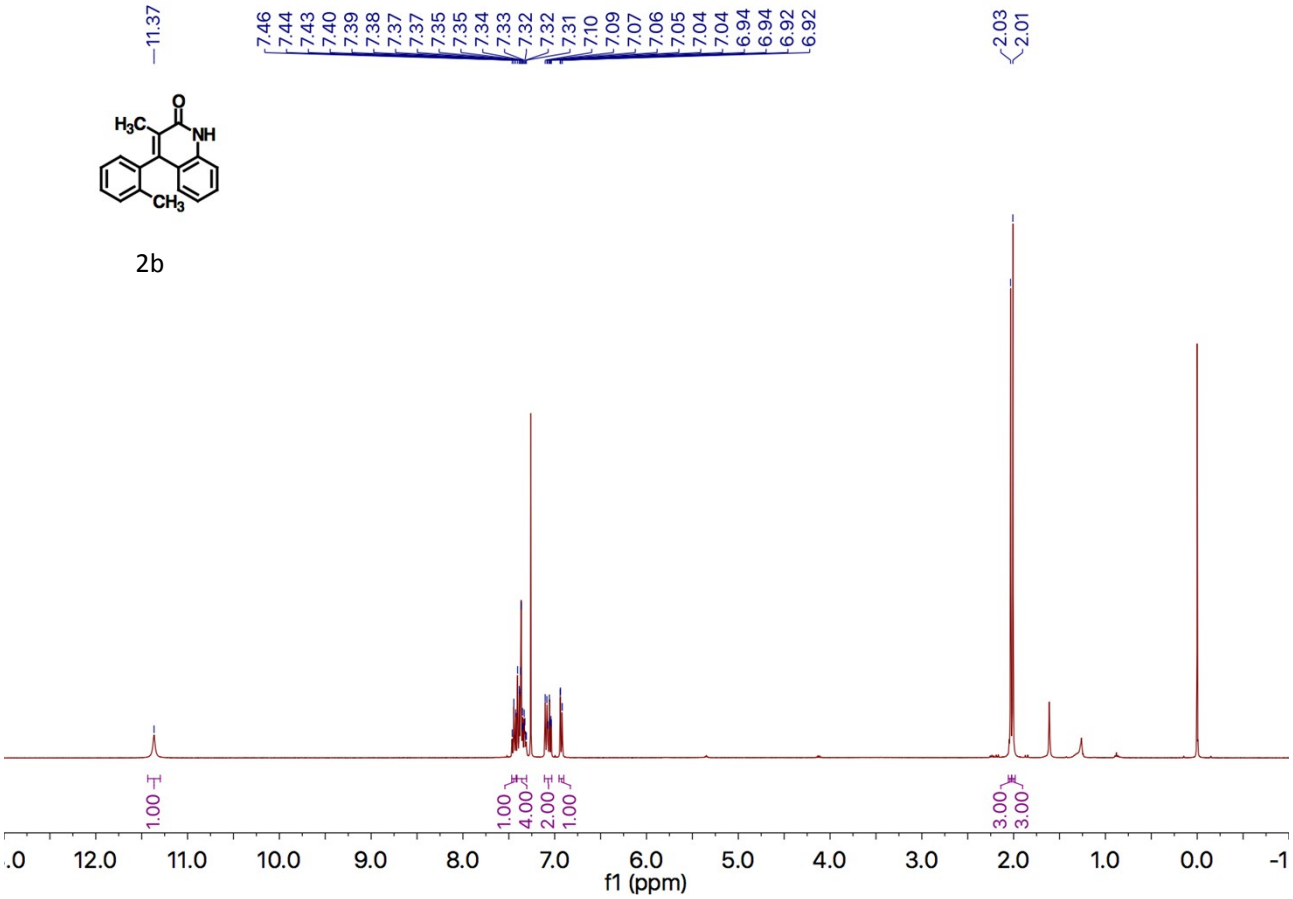
3g


12.60
7.56
7.54
7.52
7.51
7.48
7.46
7.44
7.42
7.26
7.08
7.07
7.05
2.10
H3C
O
NH
0.94
5.00
2.00
2.00
3.00
f1 (ppm)

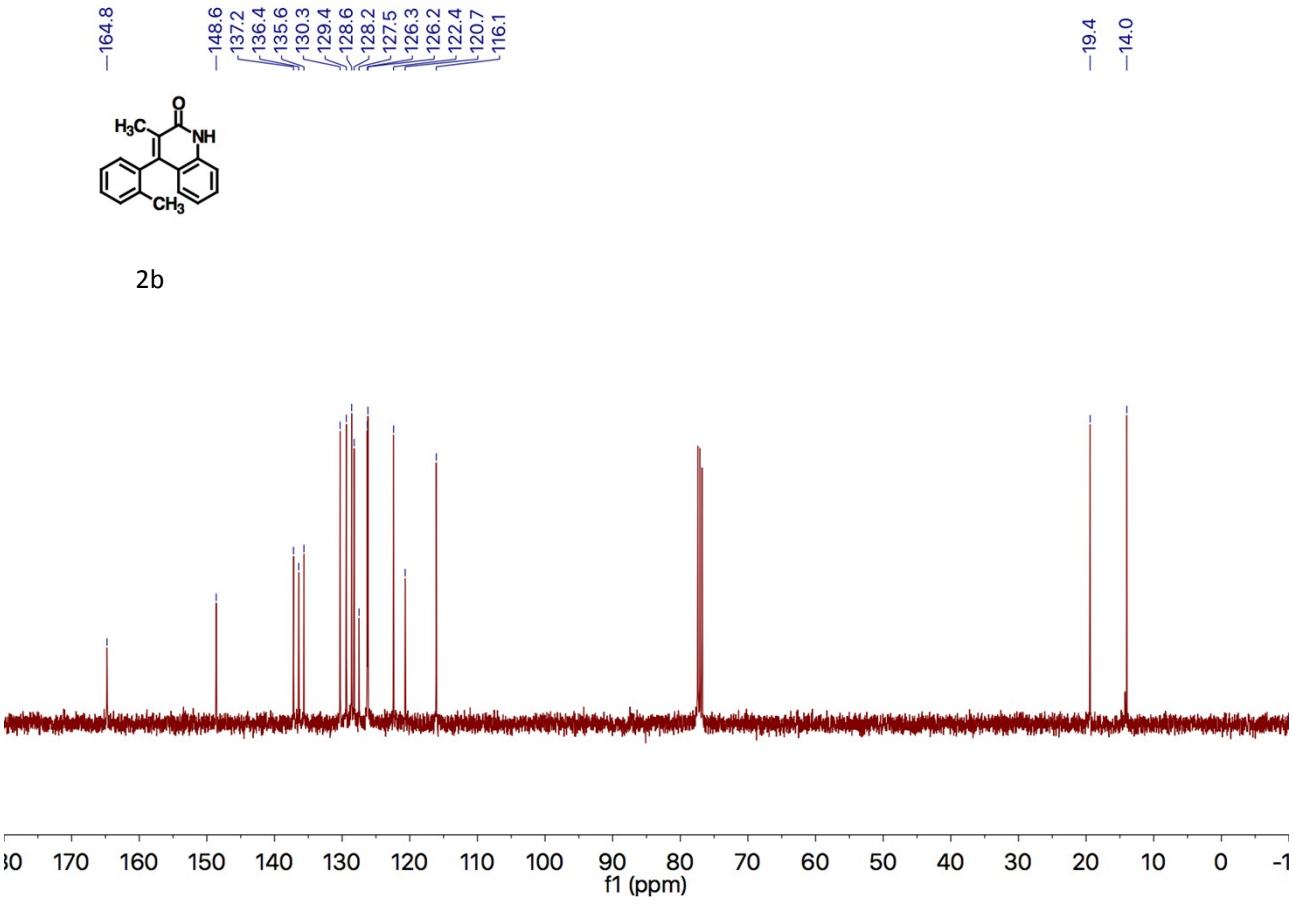
2a


164.6
148.8
137.1
137.0
129.3
128.8
128.7
128.7
128.0
127.5
126.7
122.2
121.1
116.0
14.3
H3C
O
NH
f1 (ppm)

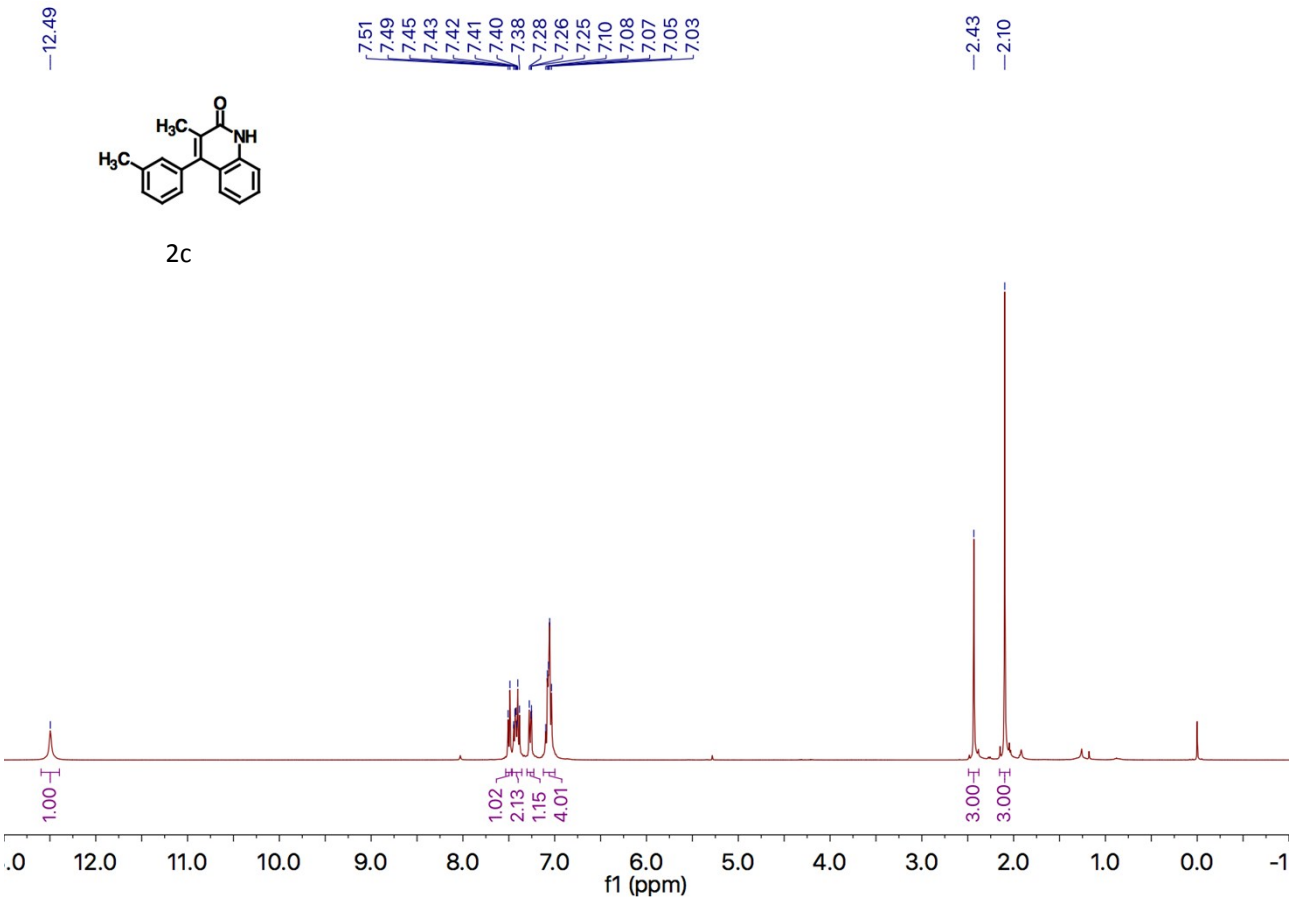
2a


11.37
7.46
7.44
7.43
7.40
7.39
7.38
7.37
7.37
7.35
7.35
7.34
7.33
7.32
7.32
7.31
7.10
7.09
7.07
7.06
7.05
7.04
7.04
6.94
6.94
6.92
6.92
2.03
2.01
H3C
NH
CH3
1.00
1.00
4.00
2.00
1.00
3.00
3.00
f1 (ppm)

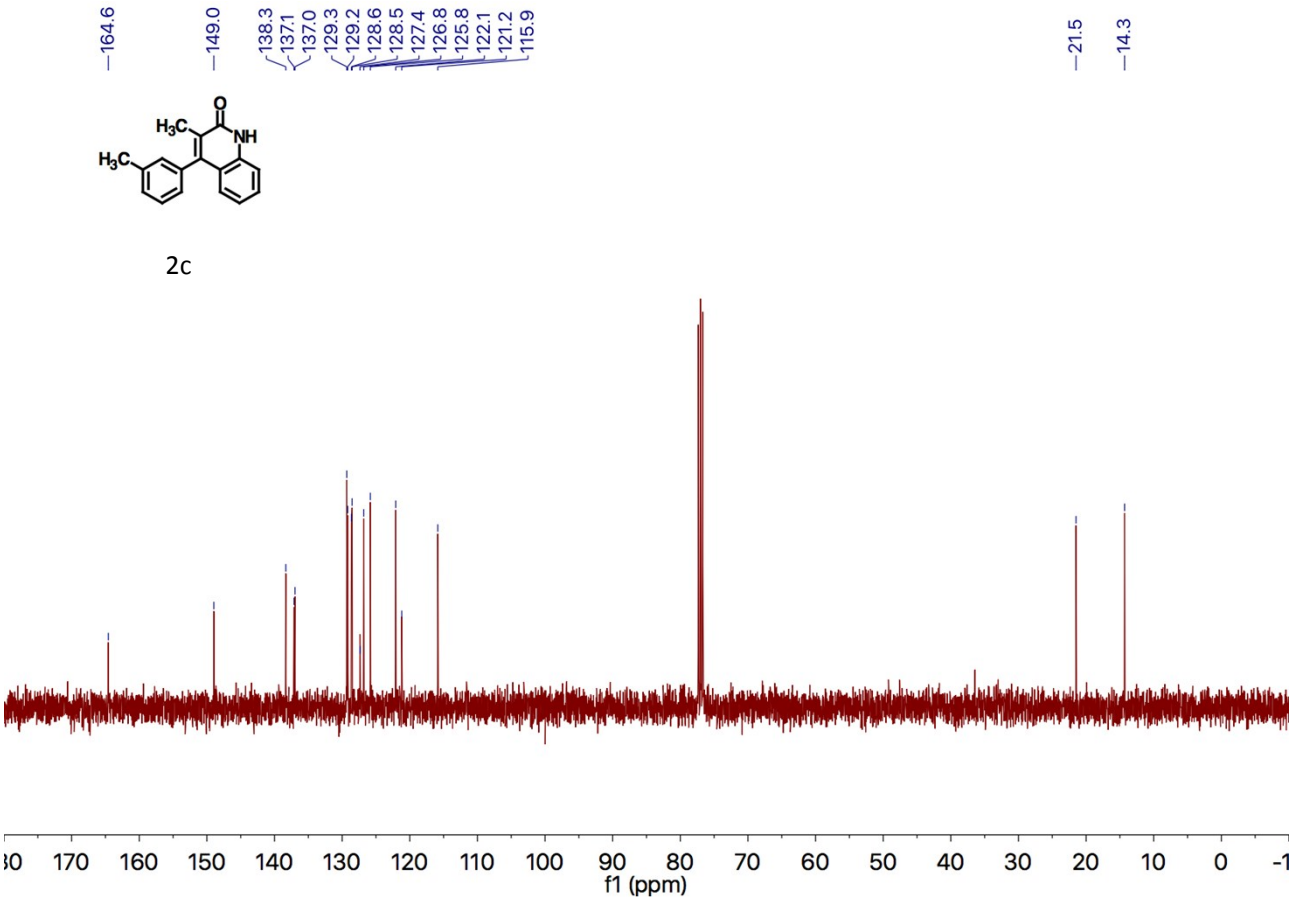
2b


164.8
148.6
137.2
136.4
135.6
130.3
129.4
128.6
128.2
127.5
126.3
126.2
122.4
120.7
116.1
19.4
14.0
H3C
NH
CH3
f1 (ppm)

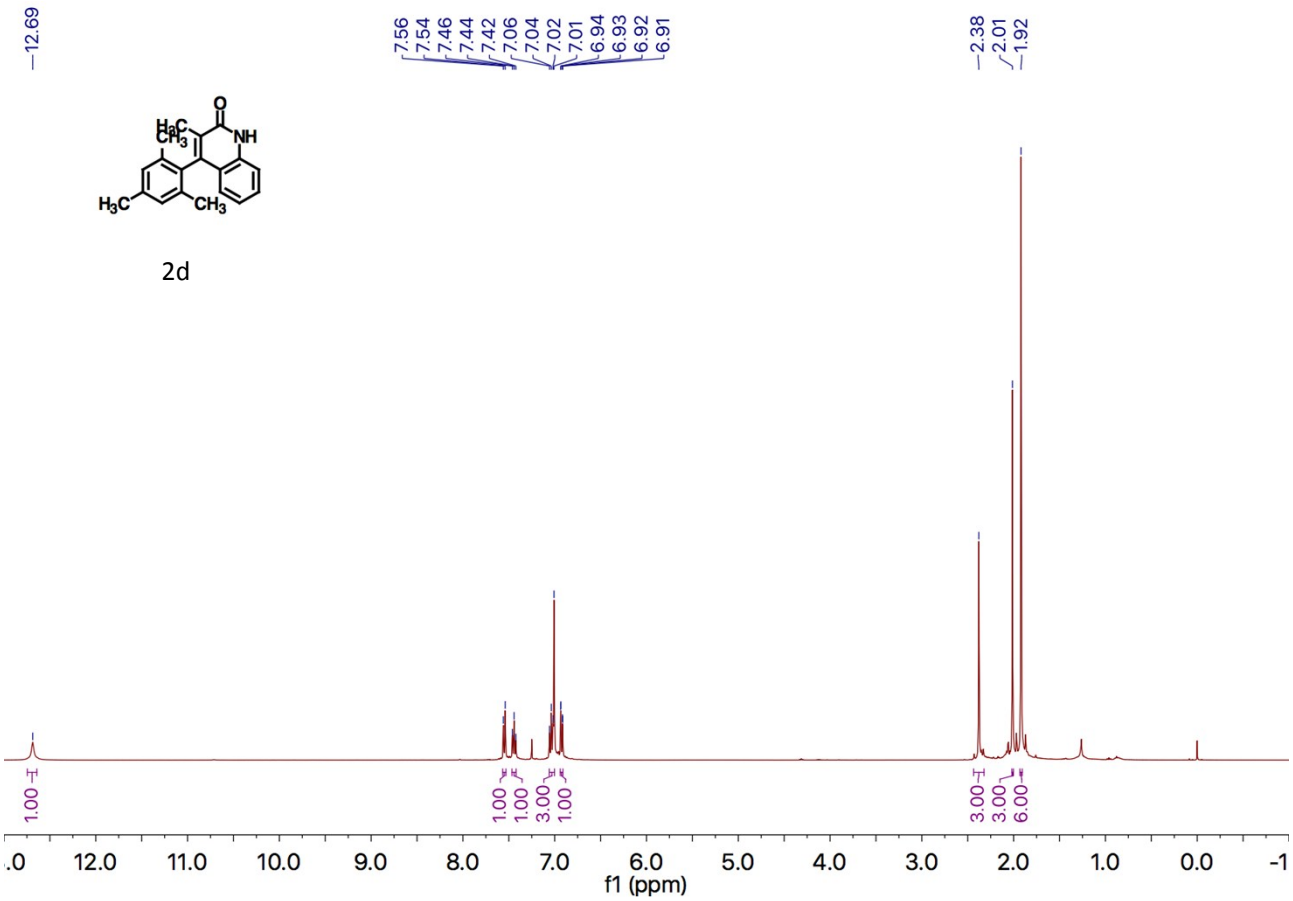
2b


12.49
7.51
7.49
7.45
7.43
7.42
7.41
7.40
7.38
7.28
7.26
7.25
7.10
7.08
7.07
7.05
7.03
2.43
2.10
H3C
O
NH
H3C
1.00
1.02
2.13
1.15
4.01
3.00
3.00
f1 (ppm)

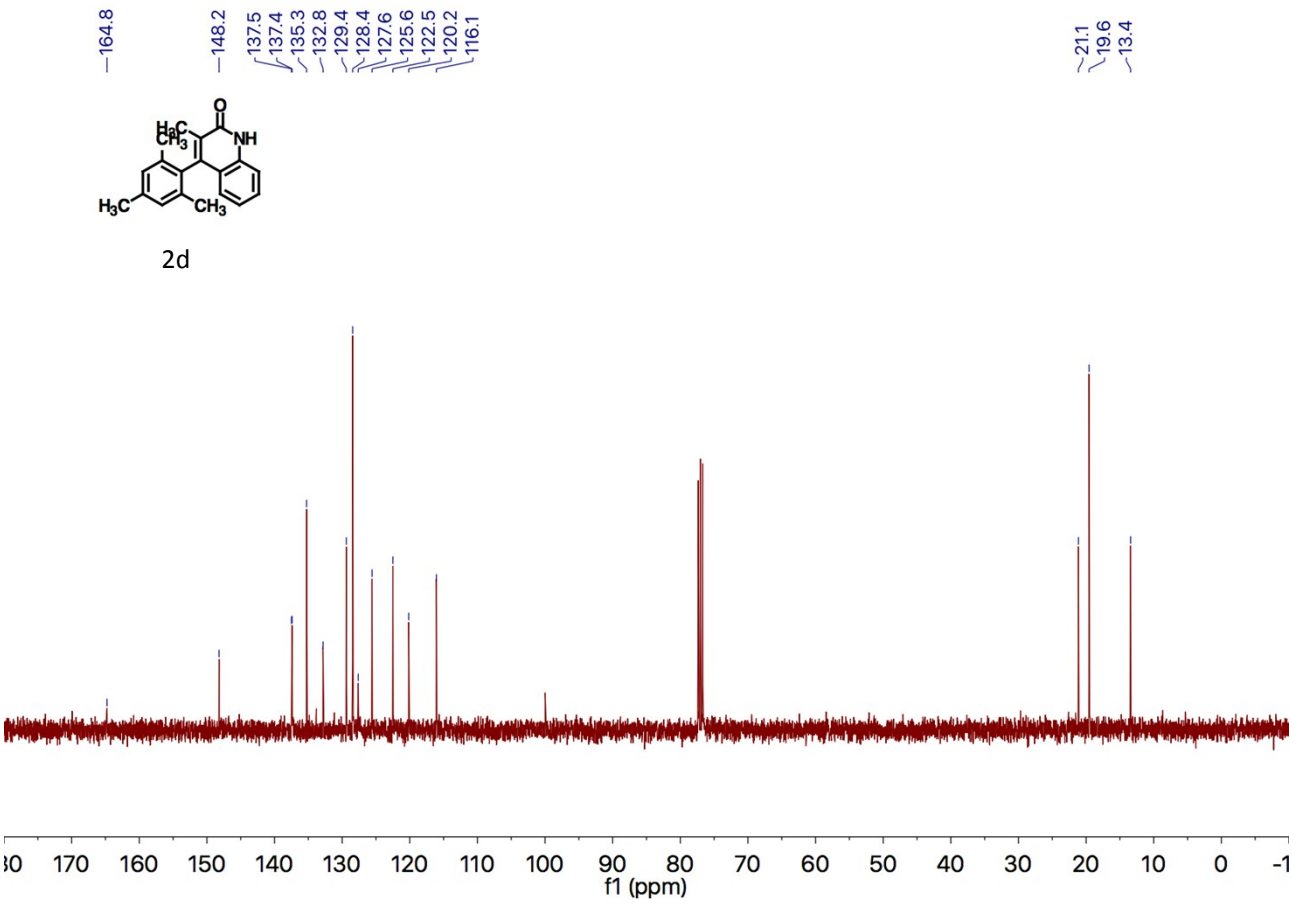
2c


164.6
149.0
138.3
137.1
137.0
129.3
129.2
128.6
128.5
127.4
126.8
125.8
122.1
121.2
115.9
21.5
14.3
H3C
O
NH
H3C
f1 (ppm)

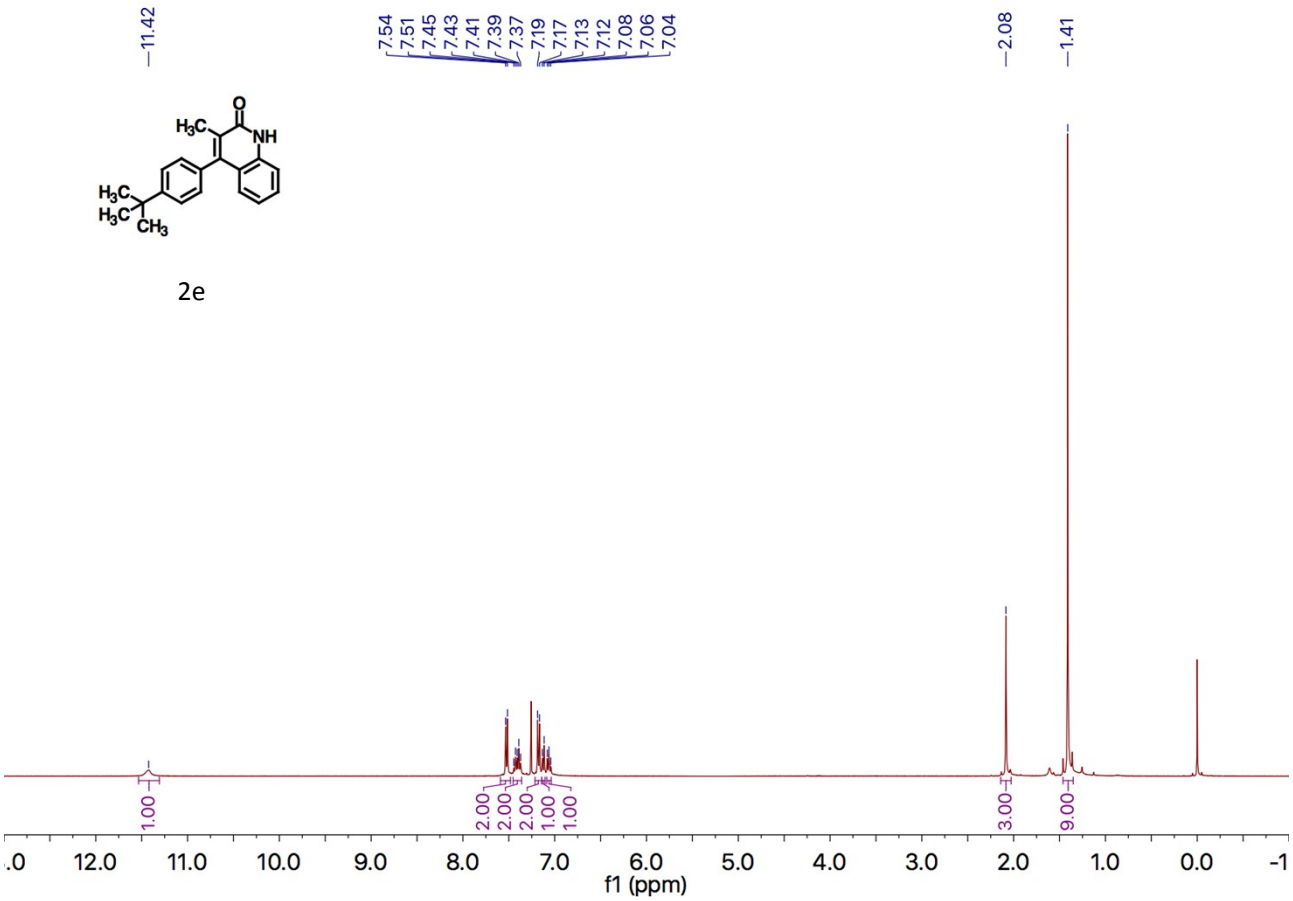
2c


12.69
7.56
7.54
7.46
7.44
7.42
7.06
7.04
7.02
7.01
6.94
6.93
6.92
6.91
2.38
2.01
1.92
1.00
1.00
1.00
3.00
1.00
3.00
3.00
6.00
f1 (ppm)

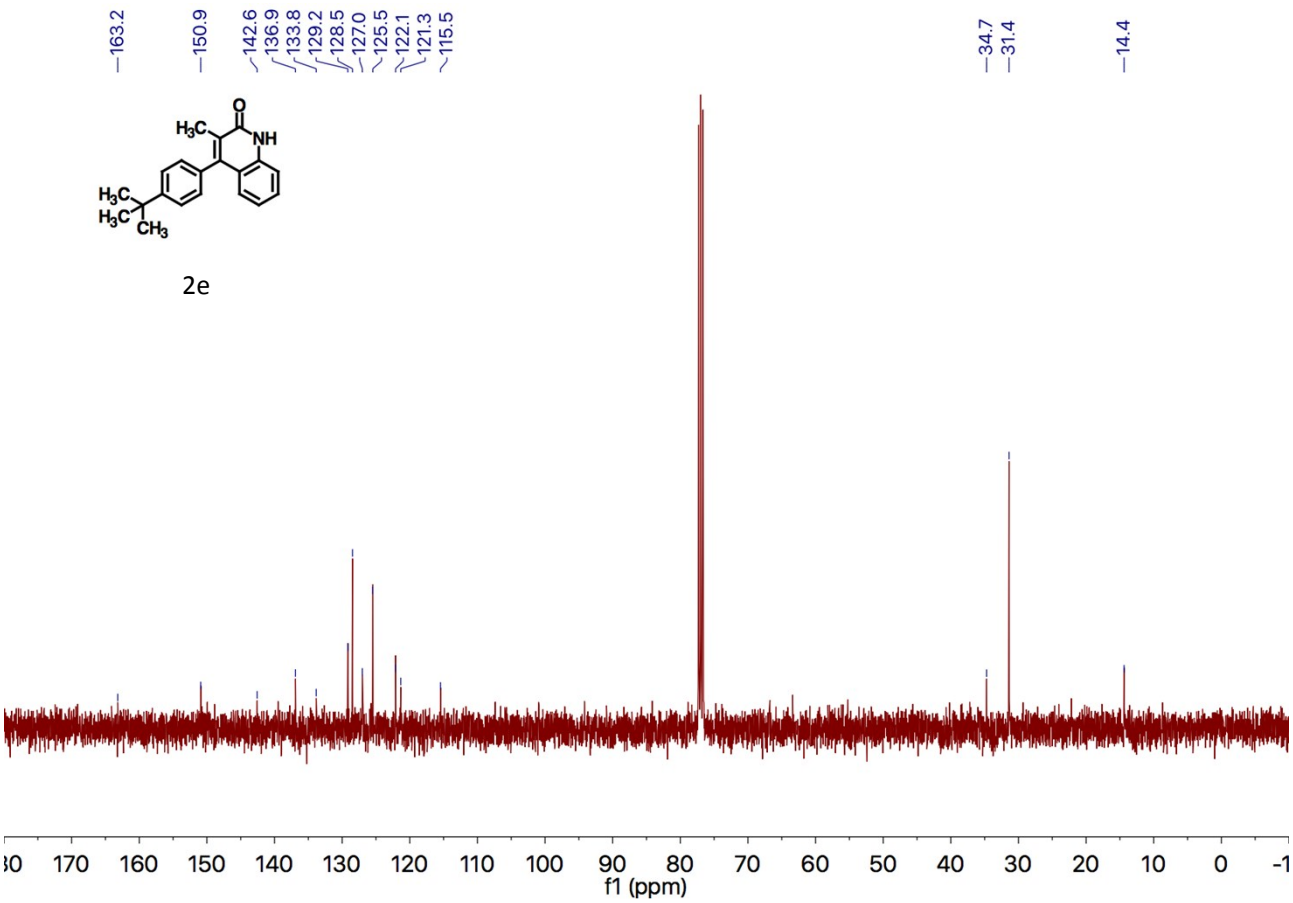
2d


164.8
148.2
137.5
137.4
135.3
132.8
129.4
128.4
127.6
125.6
122.5
120.2
116.1
21.1
19.6
13.4
f1 (ppm)

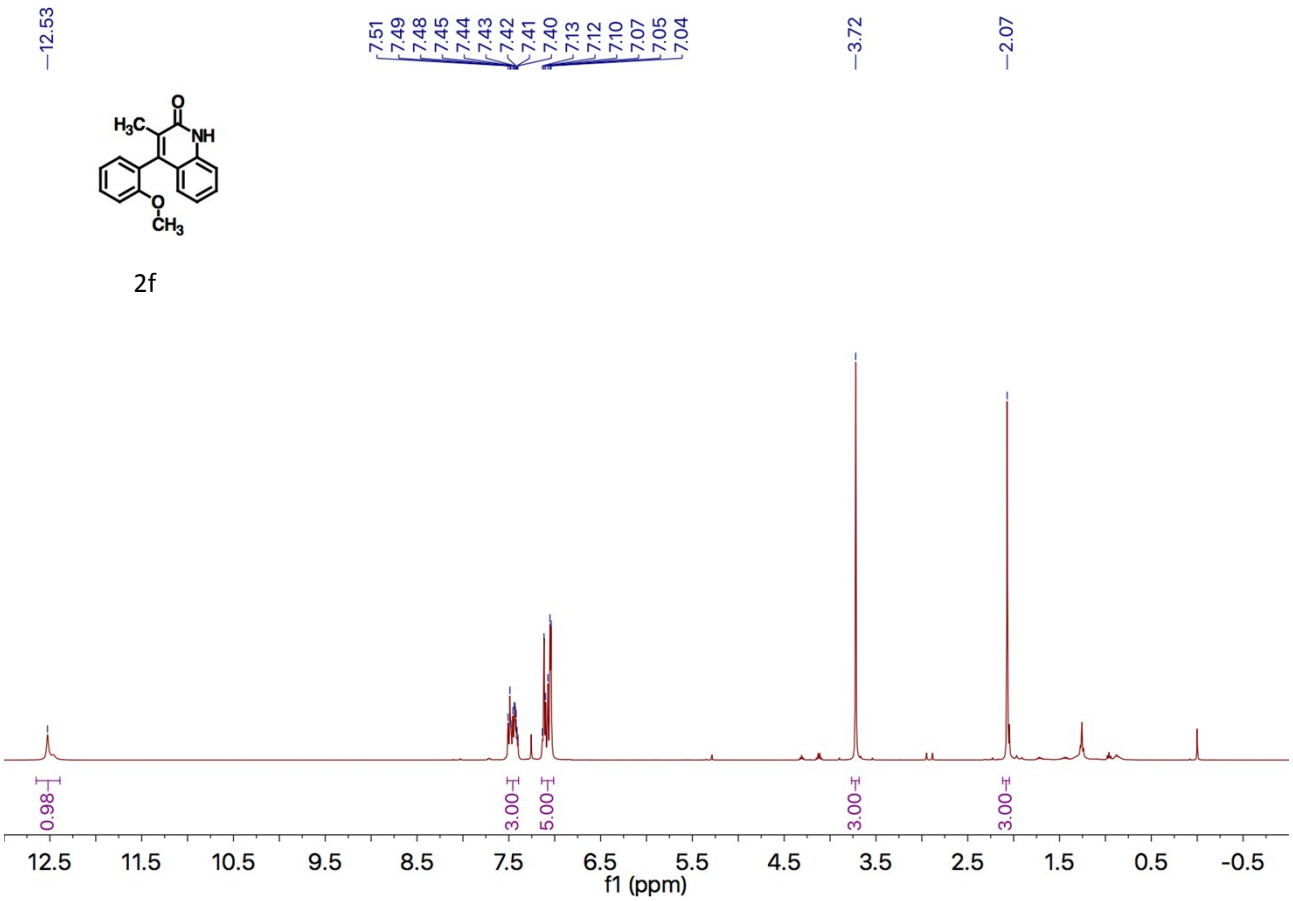
2d


11.42
7.54
7.51
7.45
7.43
7.41
7.39
7.37
7.19
7.17
7.13
7.12
7.08
7.06
7.04
2.08
1.41
1.00
2.00
2.00
2.00
1.00
1.00
3.00
9.00
f1 (ppm)

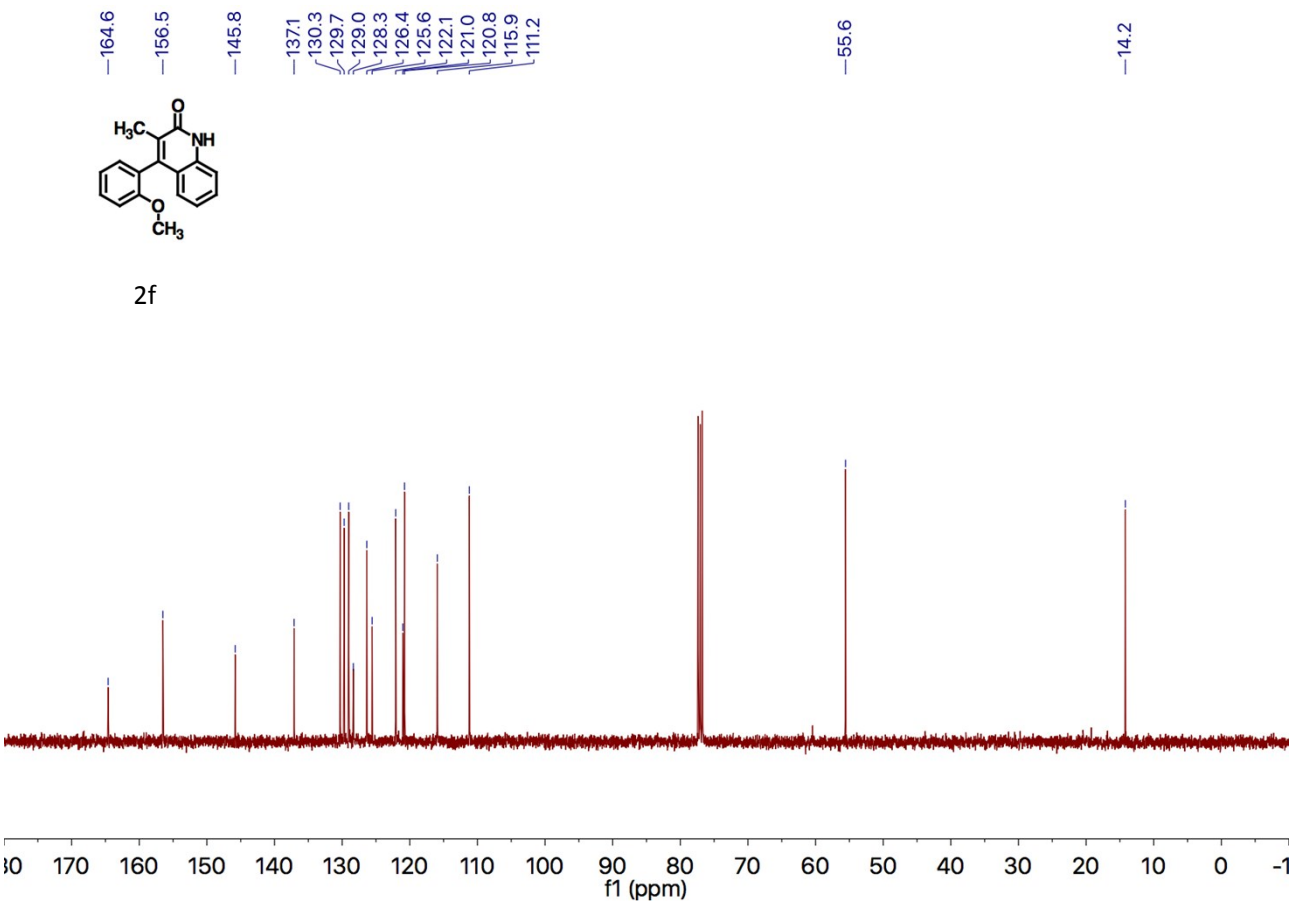
2e


163.2
150.9
142.6
136.9
133.8
129.2
128.5
127.0
125.5
122.1
121.3
115.5
34.7
31.4
14.4
f1 (ppm)

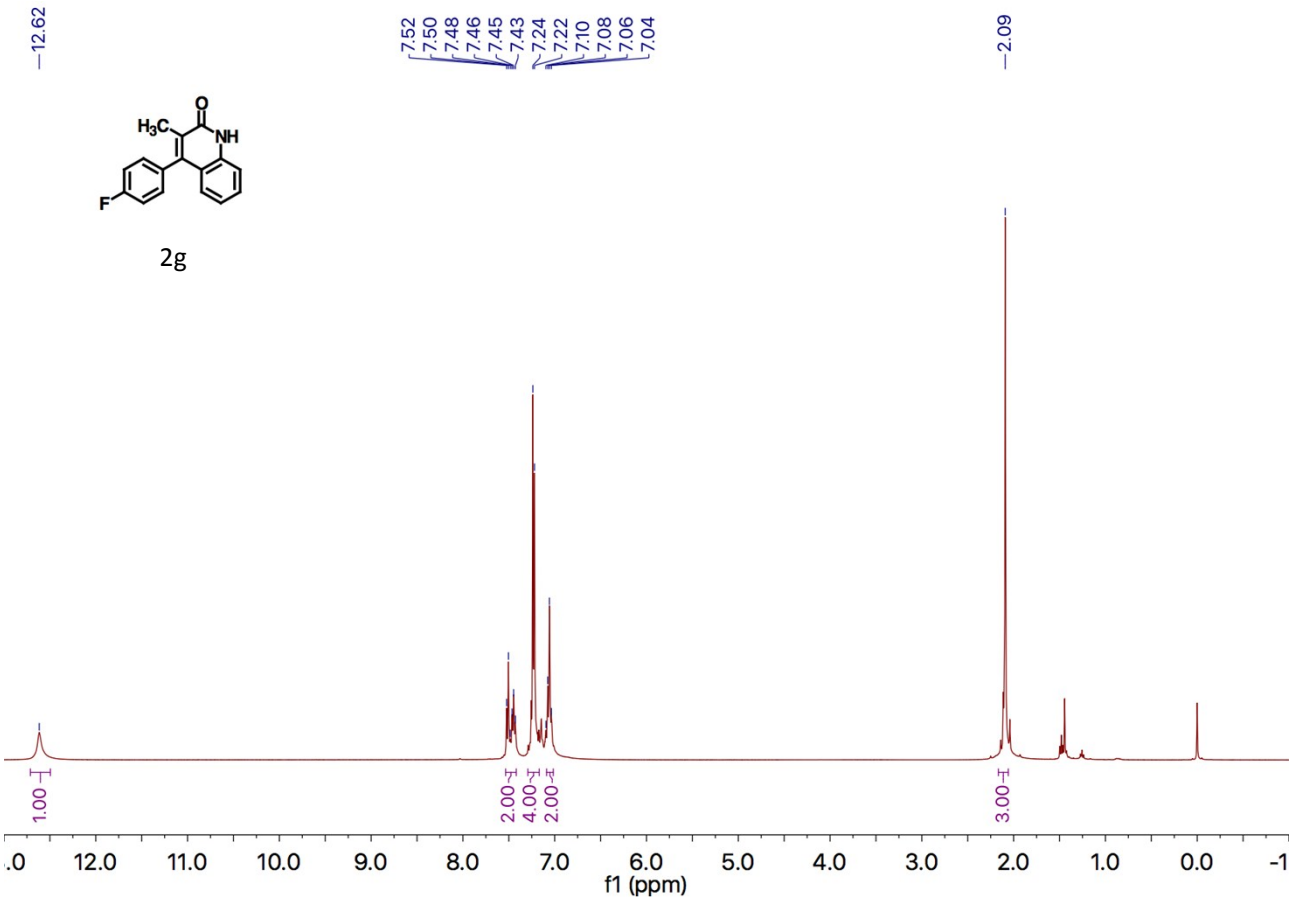
2e


12.53
7.51
7.49
7.48
7.45
7.44
7.43
7.42
7.41
7.40
7.13
7.12
7.10
7.07
7.05
7.04
3.72
2.07
0.98
3.00
5.00
3.00
3.00
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

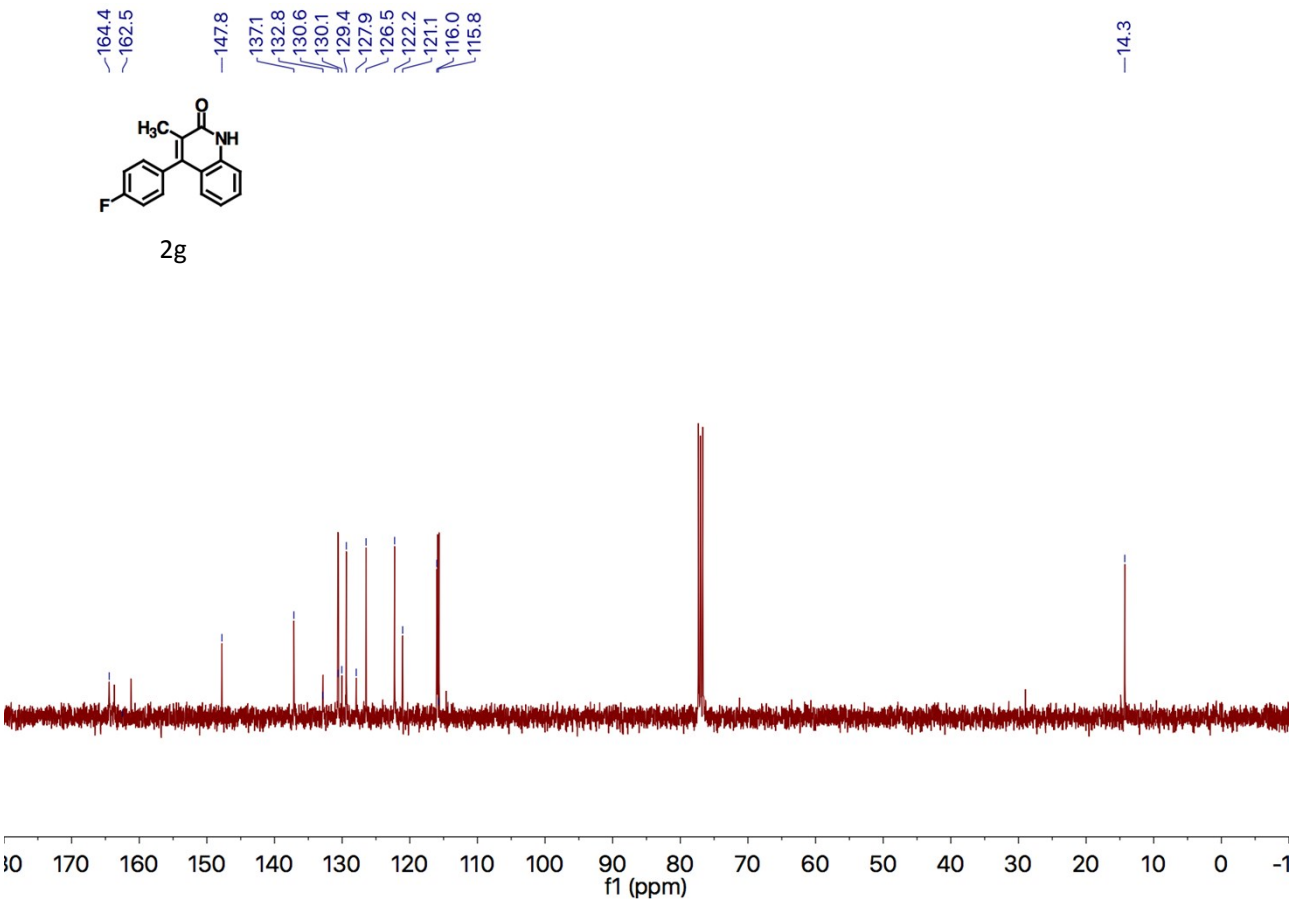
2f


164.6
156.5
145.8
137.1
130.3
129.7
129.0
128.3
126.4
125.6
122.1
121.0
120.8
115.9
111.2
55.6
14.2
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

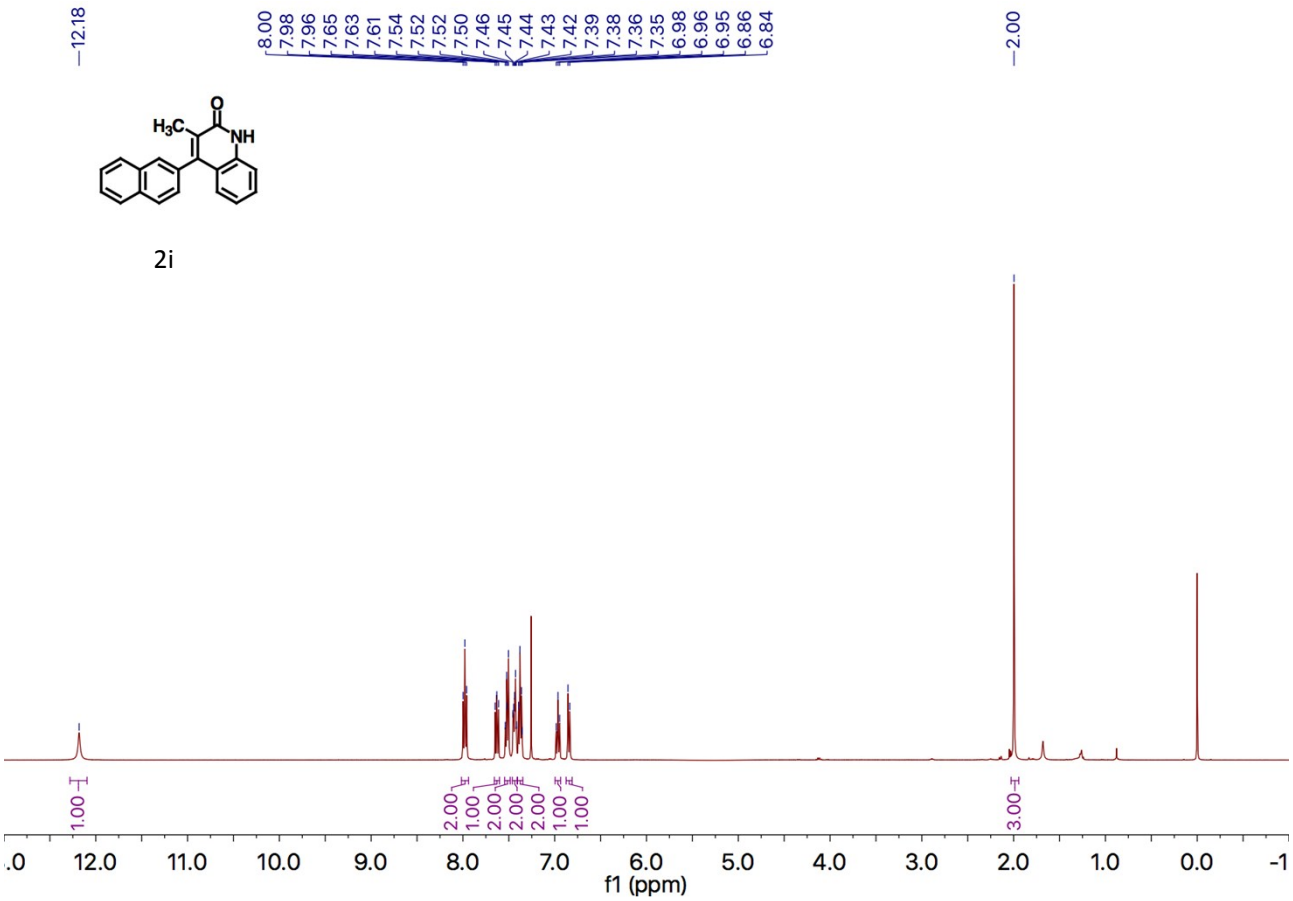
2f


12.62
7.52
7.50
7.48
7.46
7.45
7.43
7.24
7.22
7.10
7.08
7.06
7.04
2.09
1.00
2.00
4.00
2.00
3.00
f1 (ppm)

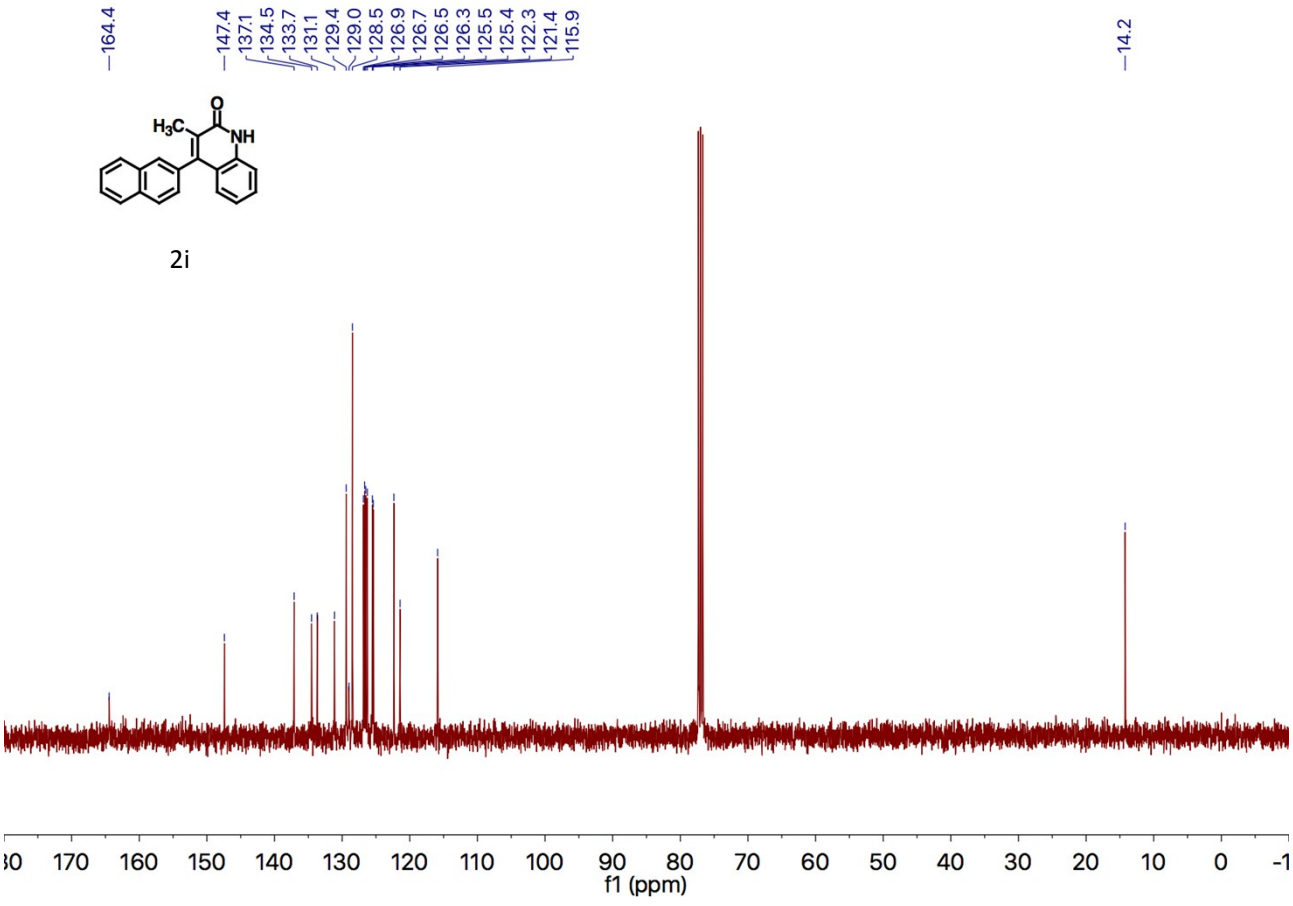
2g


164.4
162.5
147.8
137.1
132.8
130.6
130.1
129.4
127.9
126.5
122.2
121.1
116.0
115.8
14.3
f1 (ppm)

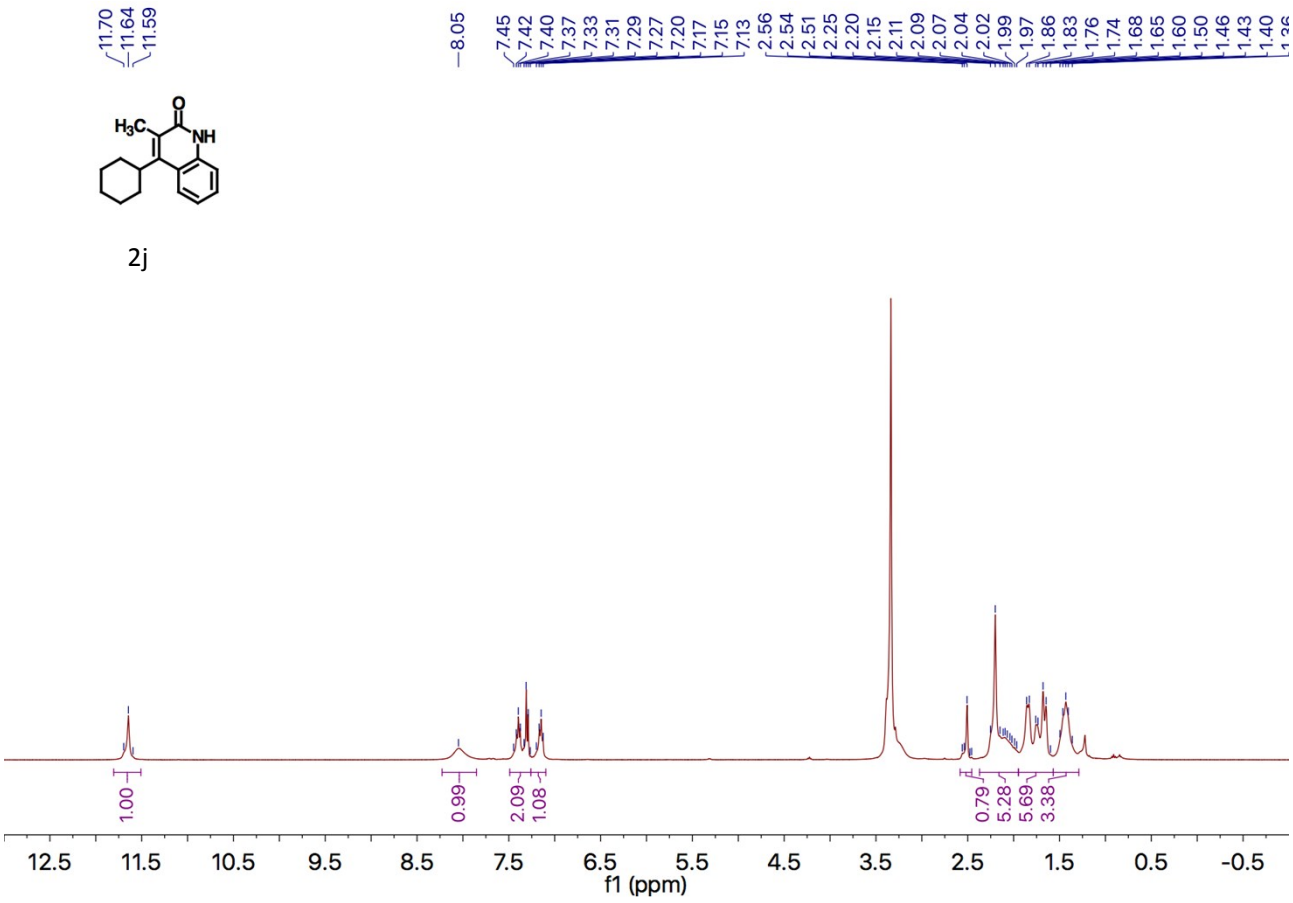
2g


12.18
8.00
7.98
7.96
7.65
7.63
7.61
7.54
7.52
7.52
7.50
7.46
7.45
7.44
7.43
7.42
7.39
7.38
7.36
7.35
6.98
6.96
6.95
6.86
6.84
2.00
H3C
O
NH
1.00
2.00
1.00
2.00
2.00
2.00
1.00
1.00
3.00
f1 (ppm)

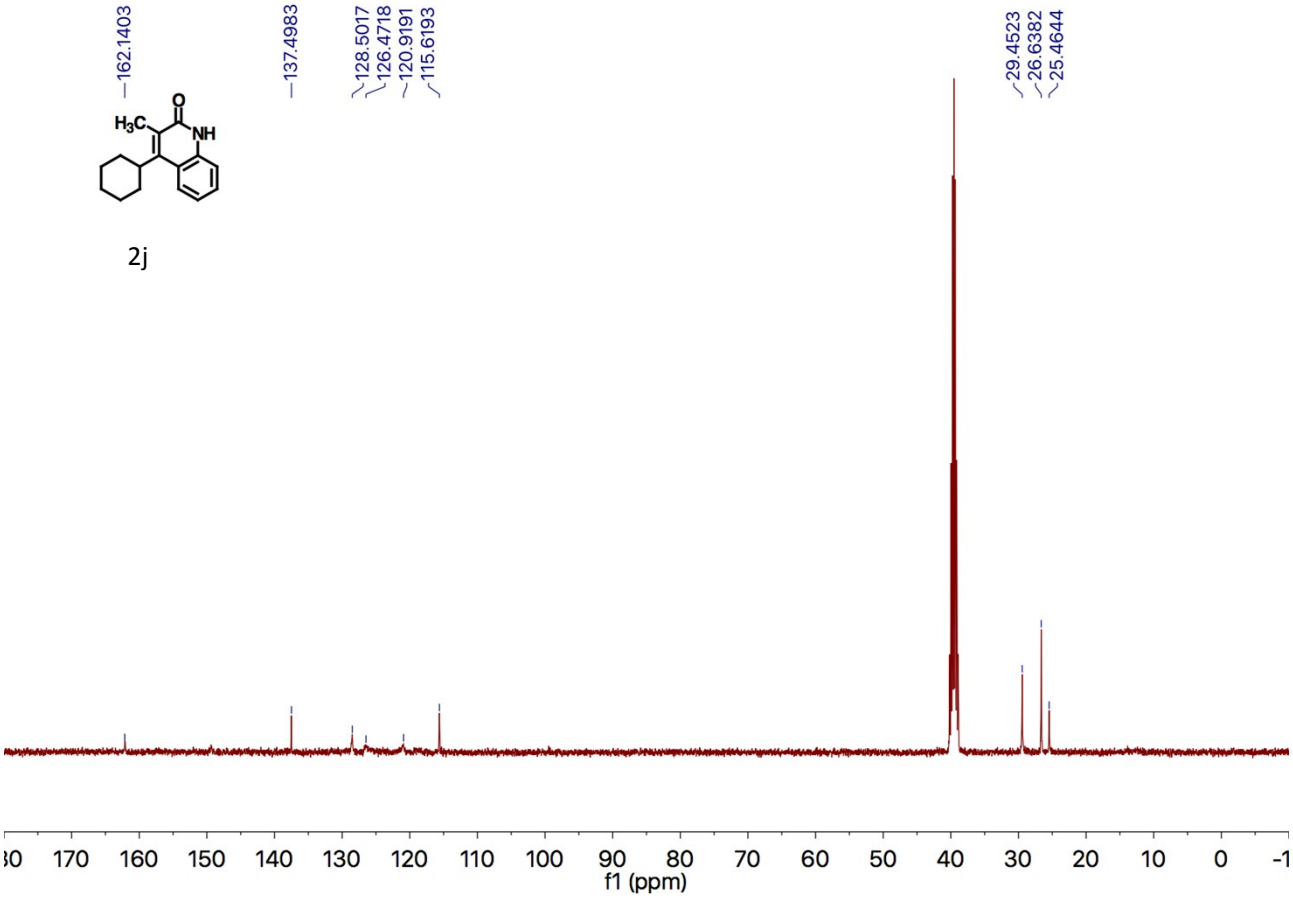
2i


164.4
147.4
137.1
134.5
133.7
131.1
129.4
129.0
128.5
126.9
126.7
126.5
126.3
125.5
125.4
122.3
121.4
115.9
14.2
H3C
O
NH
f1 (ppm)

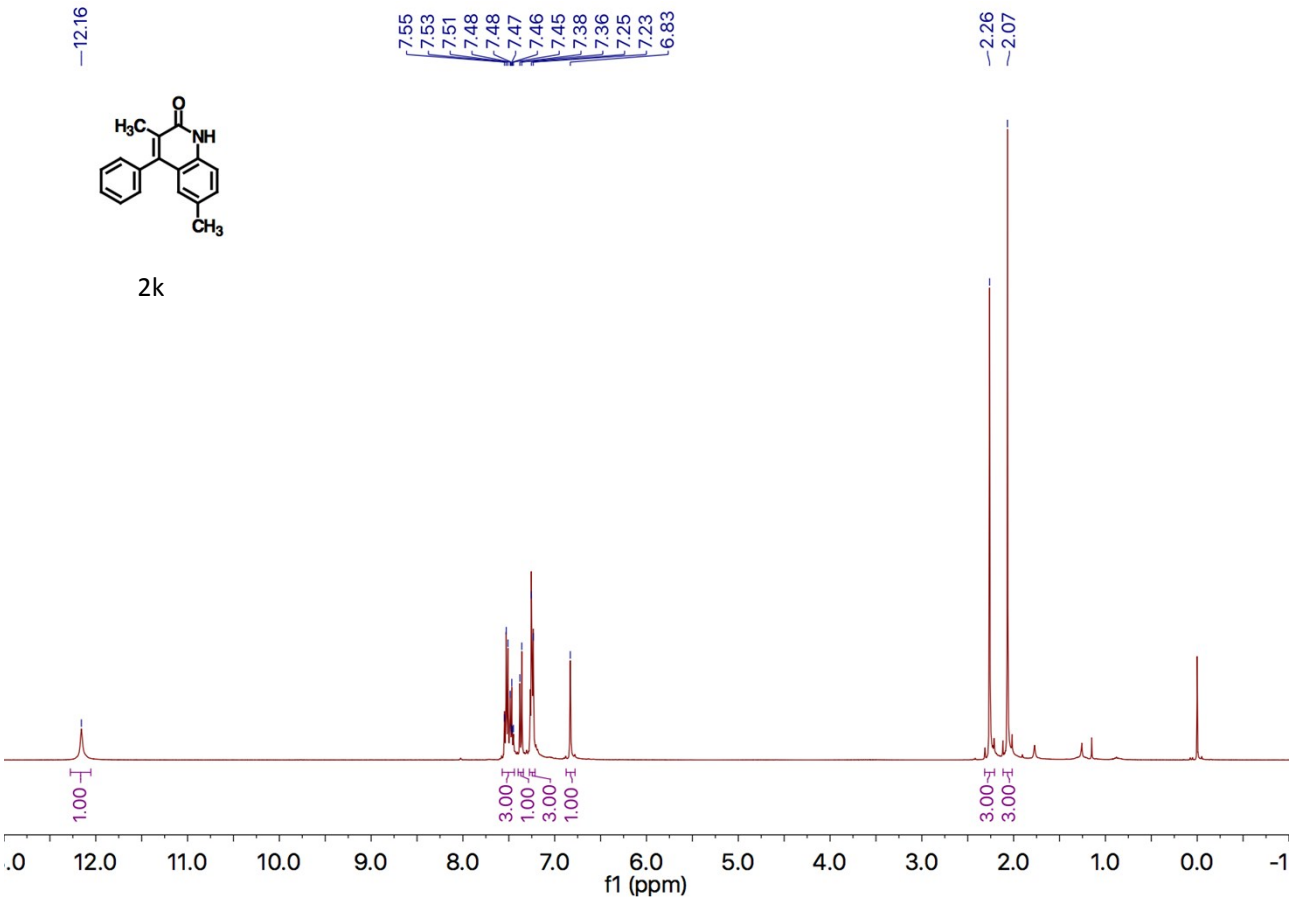
2i

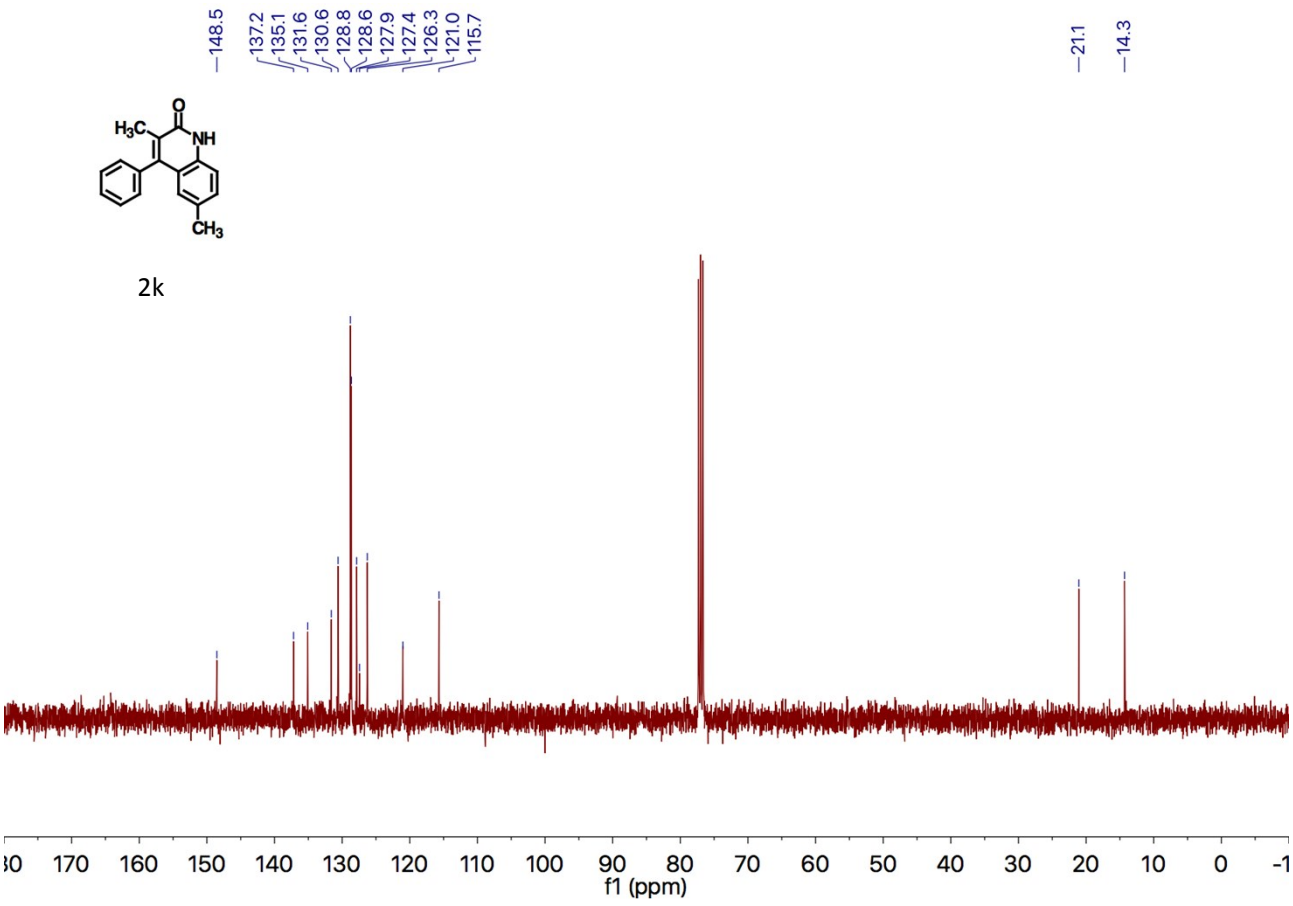

11.70
11.64
11.59
8.05
7.45
7.42
7.40
7.37
7.33
7.31
7.29
7.27
7.20
7.17
7.15
7.13
2.56
2.54
2.51
2.25
2.20
2.15
2.11
2.09
2.07
2.04
2.02
1.99
1.97
1.86
1.83
1.76
1.74
1.68
1.65
1.60
1.50
1.46
1.43
1.40
H3C
O
NH
1.00
0.99
2.09
1.08
0.79
5.28
5.69
3.38
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

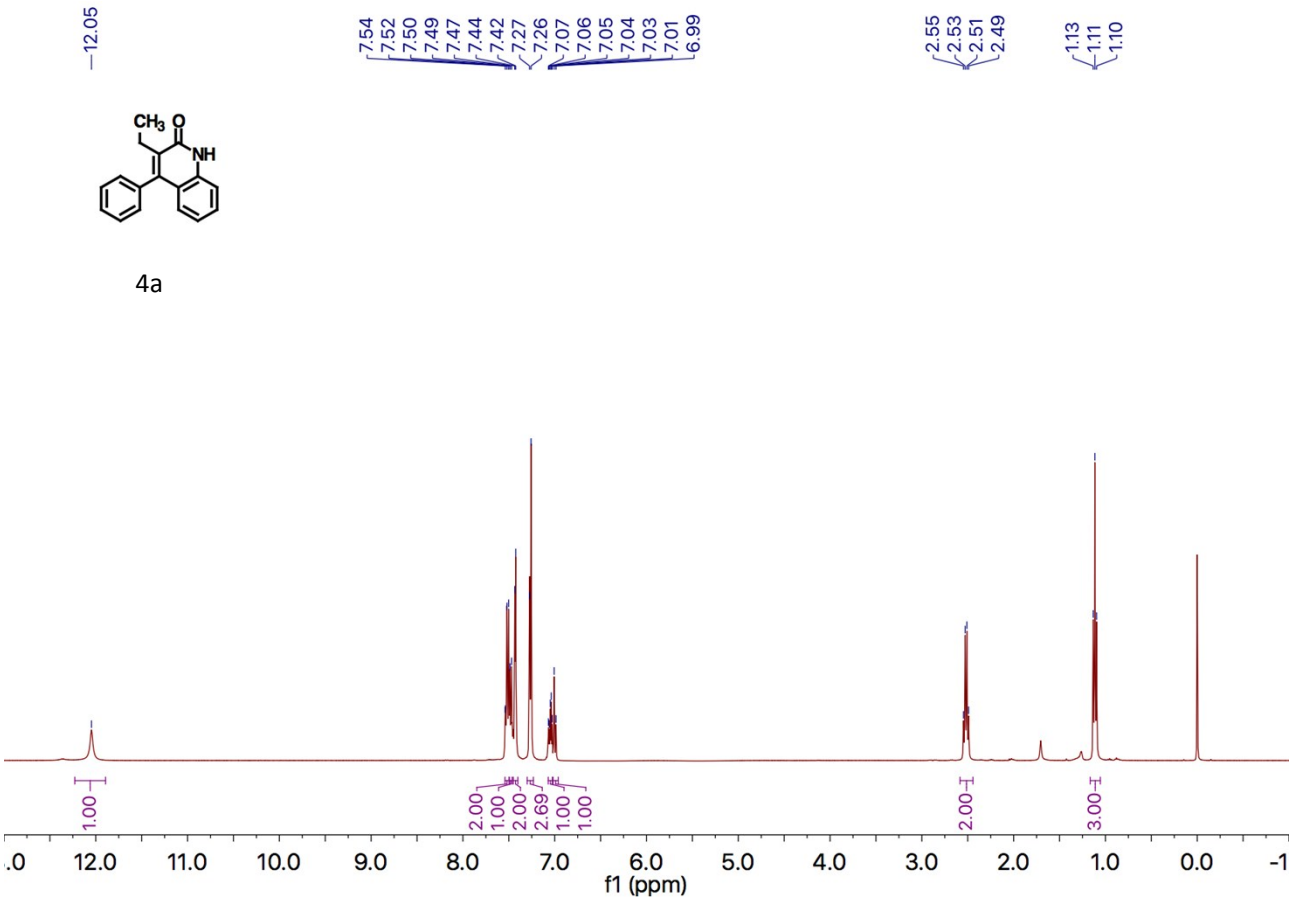
2j


162.1403
137.4983
128.5017
126.4718
120.9191
115.6193
29.4523
26.6382
25.4644
H3C
O
NH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

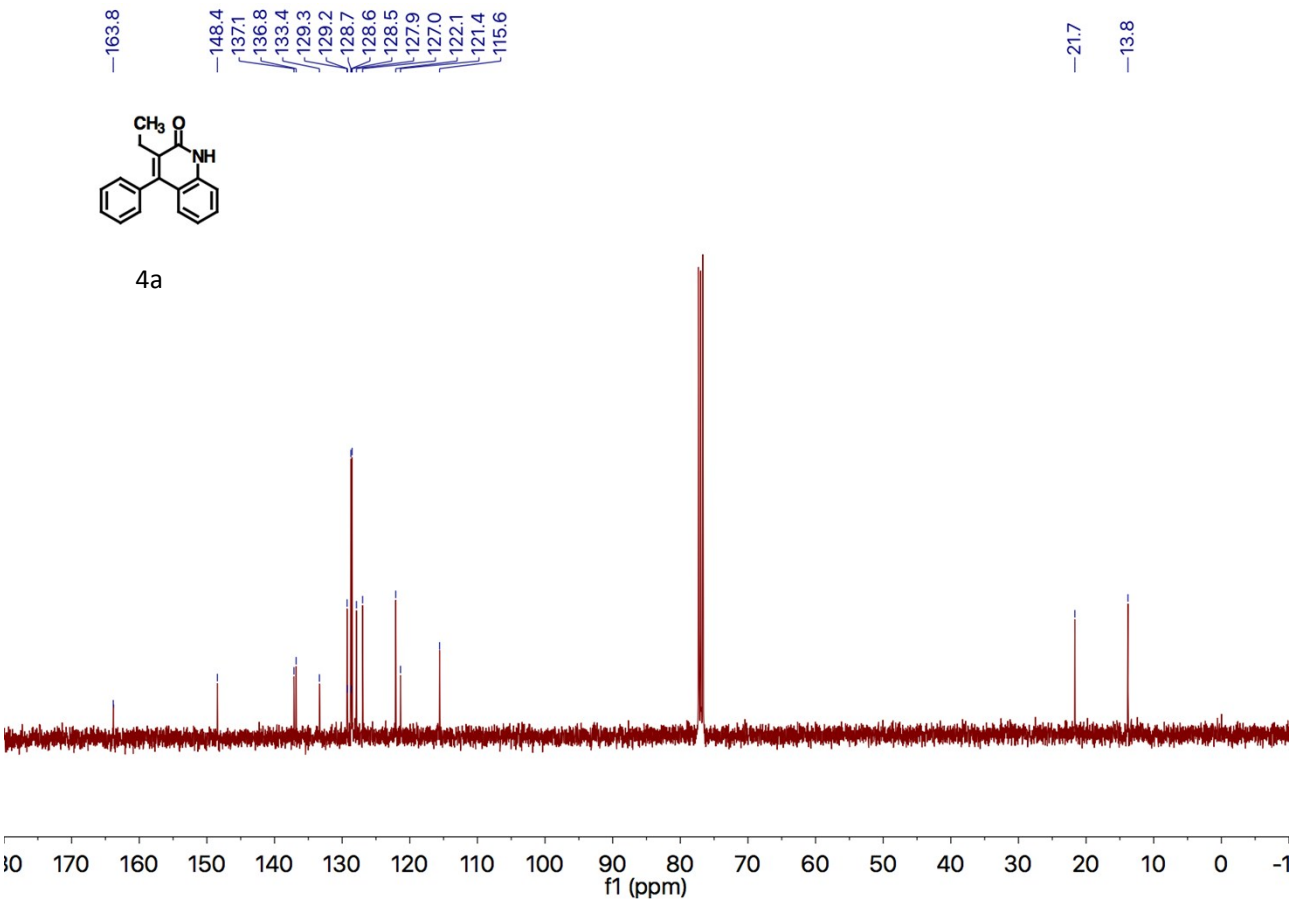
2j


12.16
7.55
7.53
7.51
7.48
7.48
7.47
7.46
7.45
7.38
7.36
7.25
7.23
6.83
2.26
2.07
H3C
NH
CH3
2k
1.00
3.00
1.00
3.00
1.00
3.00
3.00
f1 (ppm)

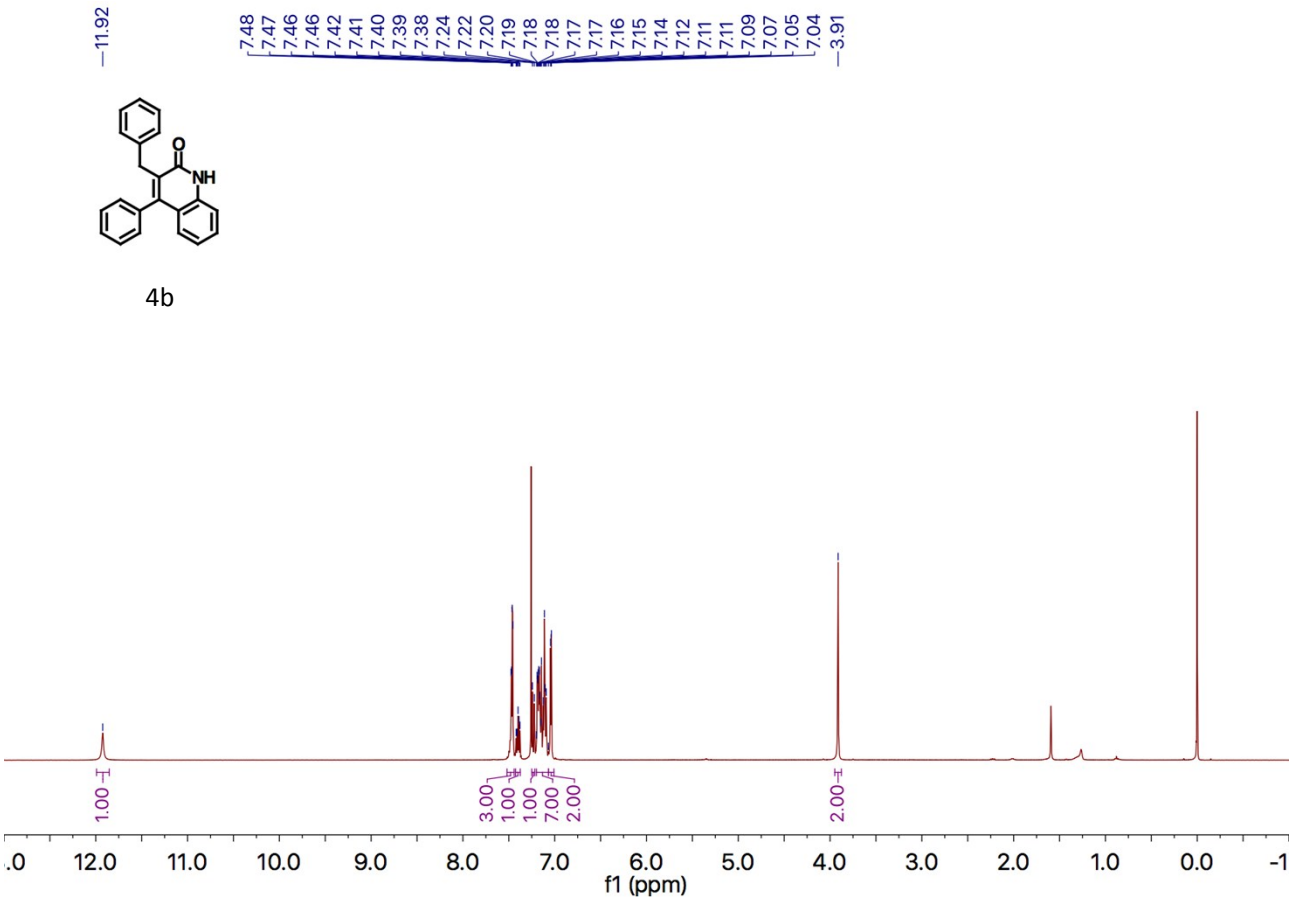

148.5
137.2
135.1
131.6
130.6
128.8
128.6
127.9
127.4
126.3
121.0
115.7
21.1
14.3
H3C
NH
CH3
2k
f1 (ppm)

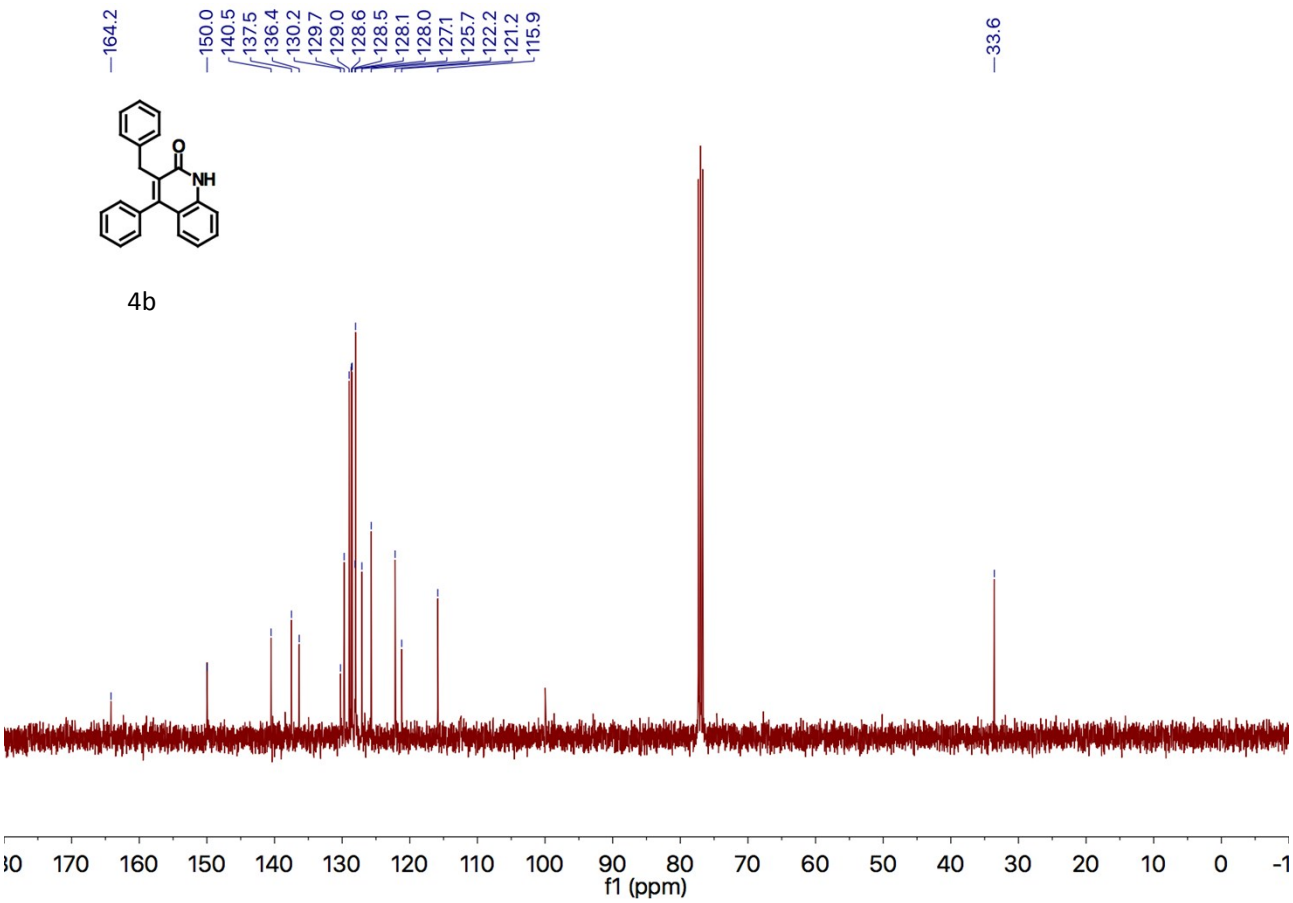

12.05
7.54
7.52
7.50
7.49
7.47
7.44
7.42
7.27
7.26
7.07
7.06
7.05
7.04
7.03
7.01
6.99
2.55
2.53
2.51
2.49
1.13
1.11
1.10
CH3
O
NH
1.00
2.00
1.00
2.00
2.69
1.00
1.00
2.00
3.00
f1 (ppm)

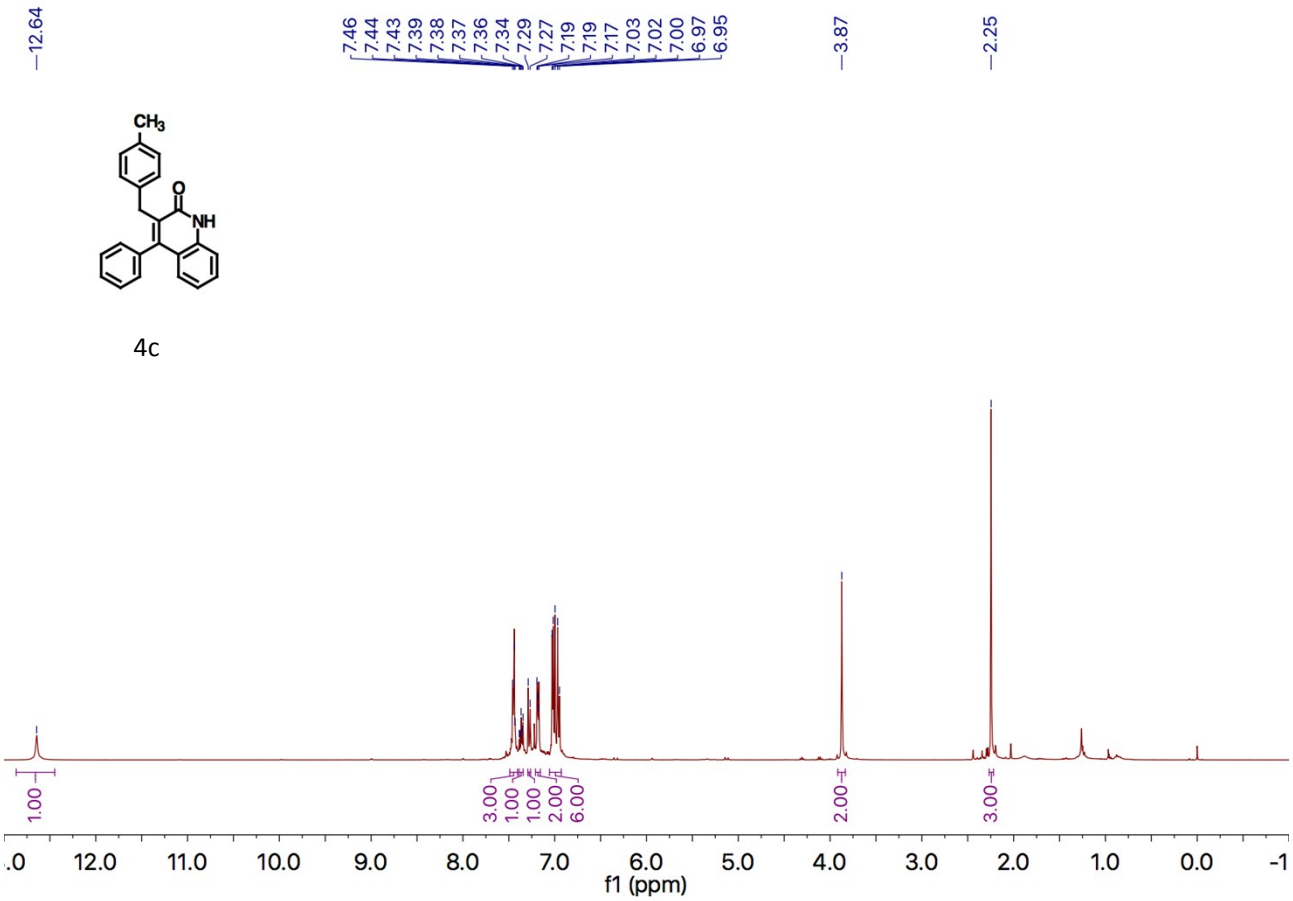
4a


163.8
148.4
137.1
136.8
133.4
129.3
129.2
128.7
128.6
128.5
127.9
127.0
122.1
121.4
115.6
21.7
13.8
CH3
O
NH
f1 (ppm)

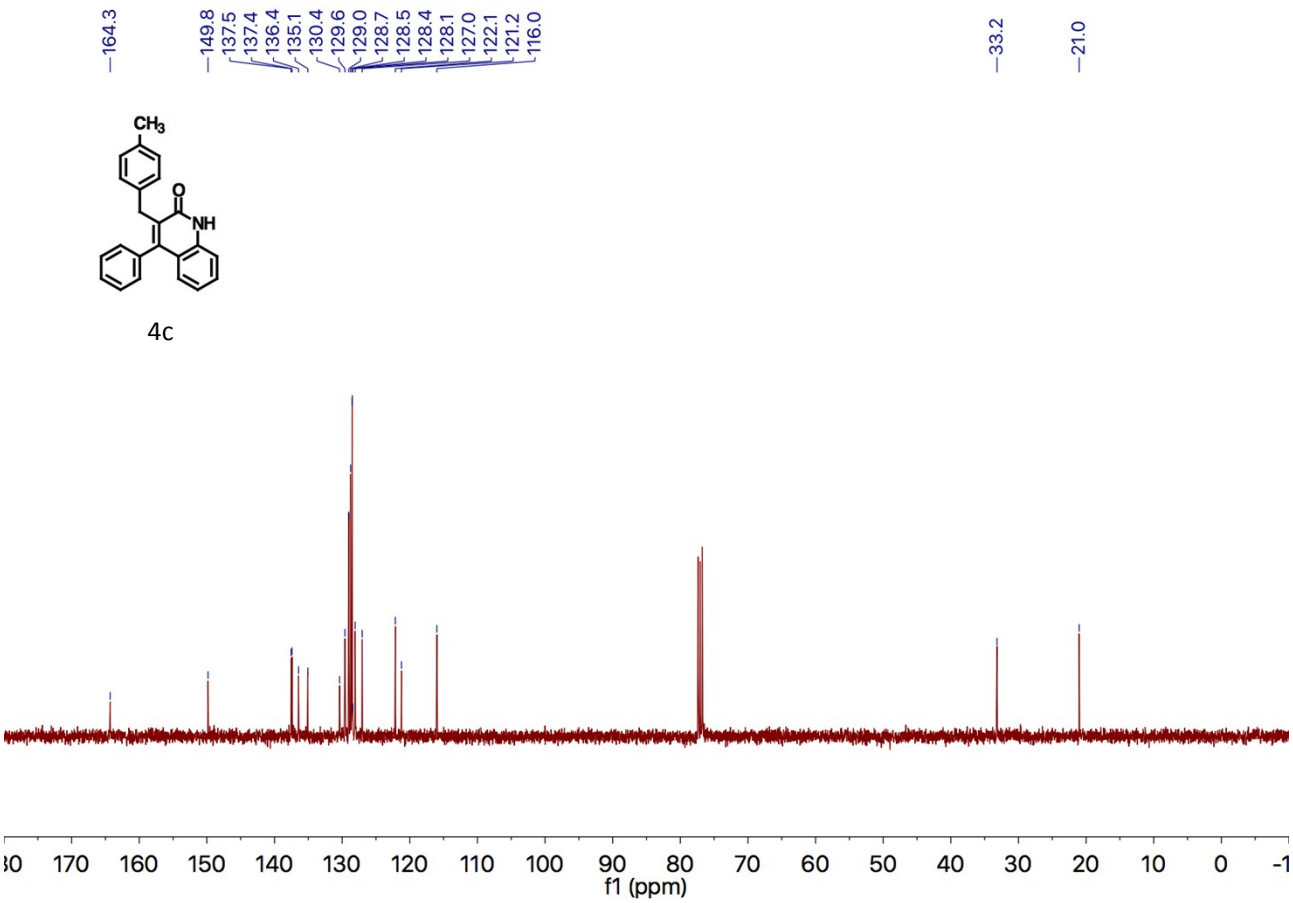
4a


11.92
7.48
7.47
7.46
7.46
7.42
7.41
7.40
7.39
7.38
7.24
7.22
7.20
7.19
7.18
7.18
7.17
7.17
7.16
7.15
7.14
7.12
7.11
7.11
7.09
7.07
7.05
7.04
3.91
NH
O
4b
1.00
3.00
1.00
1.00
7.00
2.00
2.00
f1 (ppm)

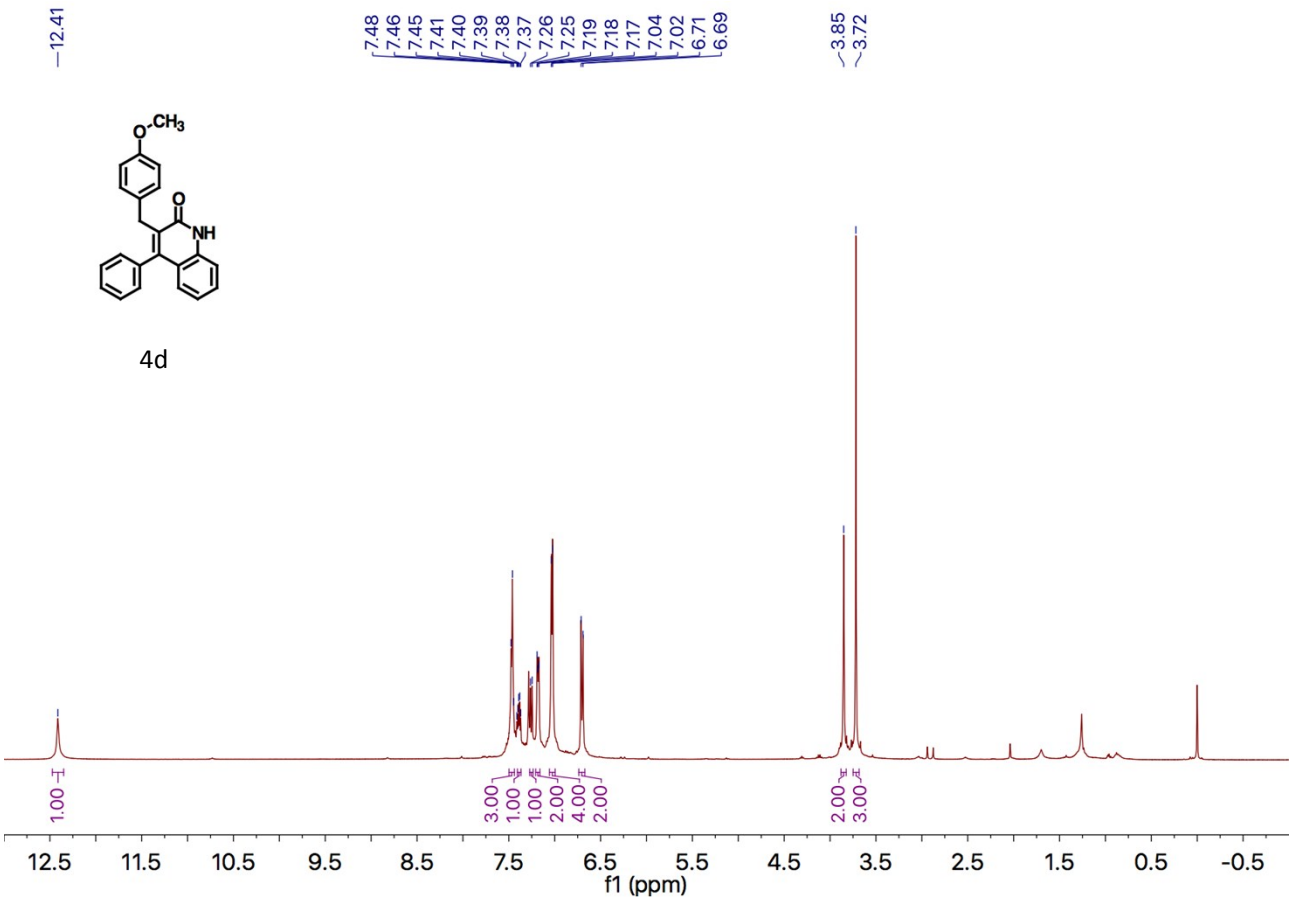

164.2
150.0
140.5
137.5
136.4
130.2
129.7
129.0
128.6
128.5
128.1
128.0
127.1
125.7
122.2
121.2
115.9
33.6
NH
O
4b
f1 (ppm)


12.64
7.46
7.44
7.43
7.39
7.38
7.37
7.36
7.34
7.29
7.27
7.19
7.19
7.17
7.03
7.02
7.00
6.97
6.95
3.87
2.25
CH3
O
NH
1.00
3.00
1.00
1.00
2.00
6.00
2.00
3.00
f1 (ppm)

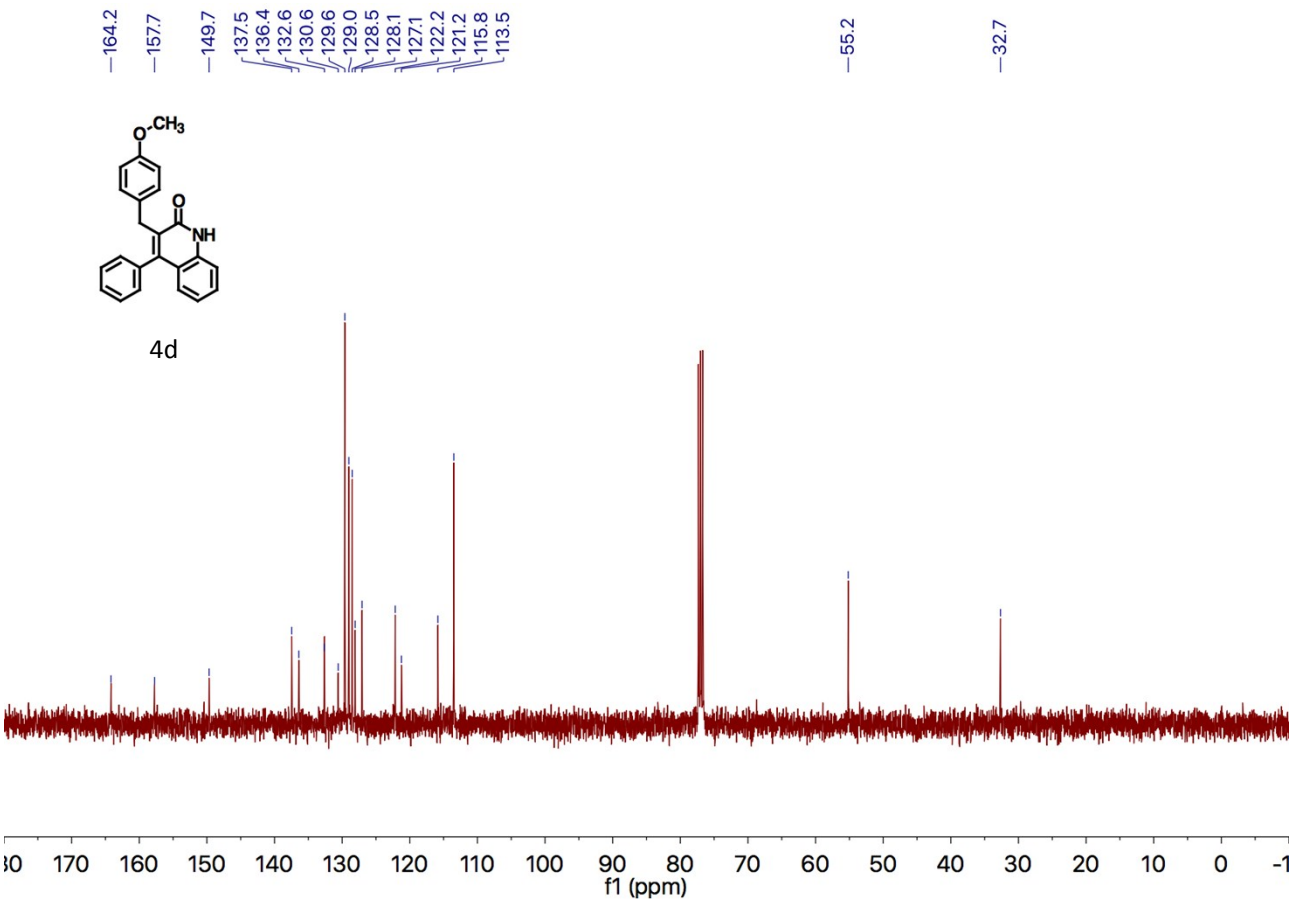
4c


164.3
149.8
137.5
137.4
136.4
135.1
130.4
129.6
129.0
128.7
128.5
128.4
128.1
127.0
122.1
121.2
116.0
33.2
21.0
CH3
O
NH
f1 (ppm)

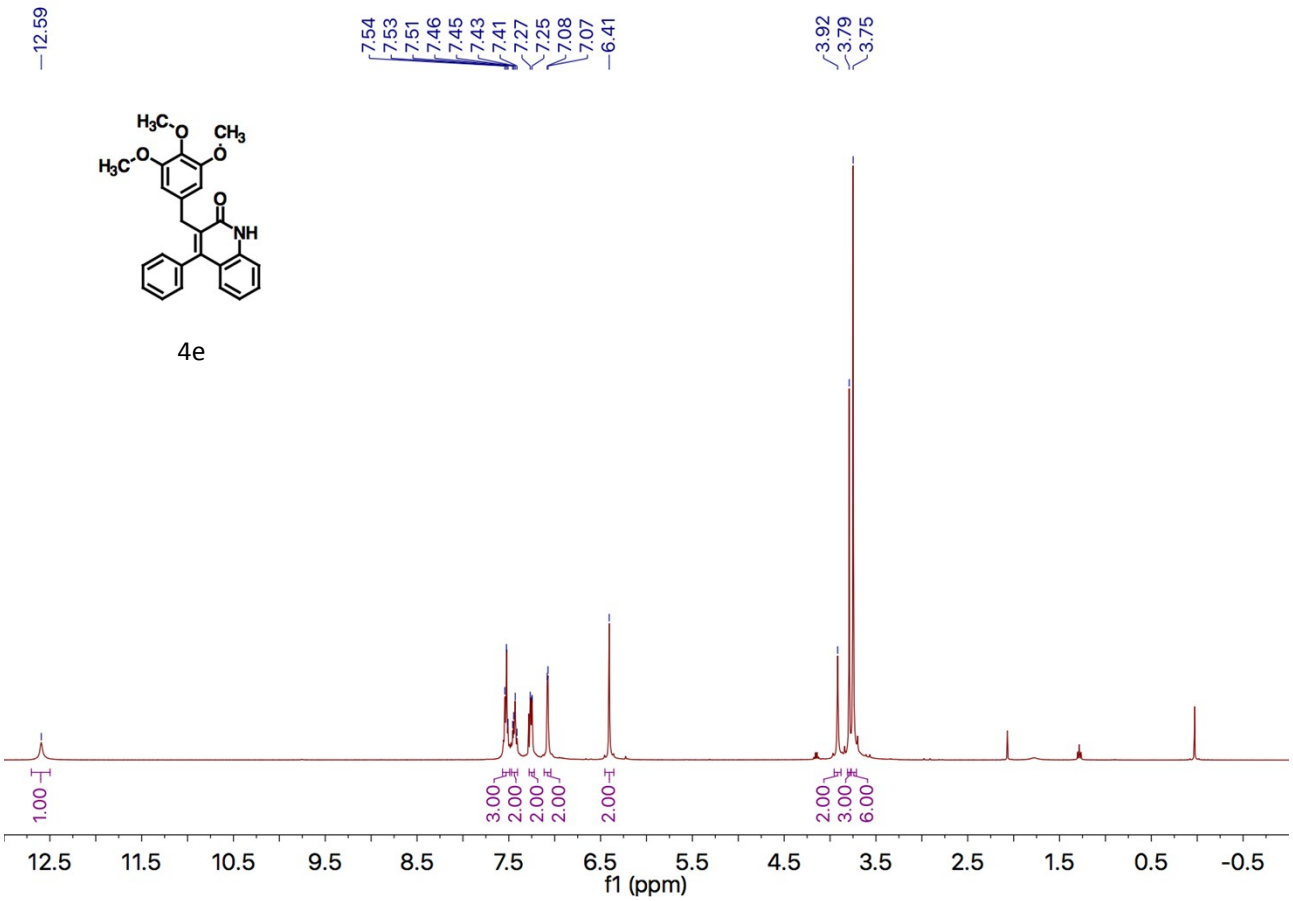
4c


12.41
7.48
7.46
7.45
7.41
7.40
7.39
7.38
7.37
7.26
7.25
7.19
7.18
7.17
7.04
7.02
6.71
6.69
3.85
3.72
O
CH3
O
NH
1.00
3.00
1.00
1.00
2.00
4.00
2.00
2.00
3.00
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

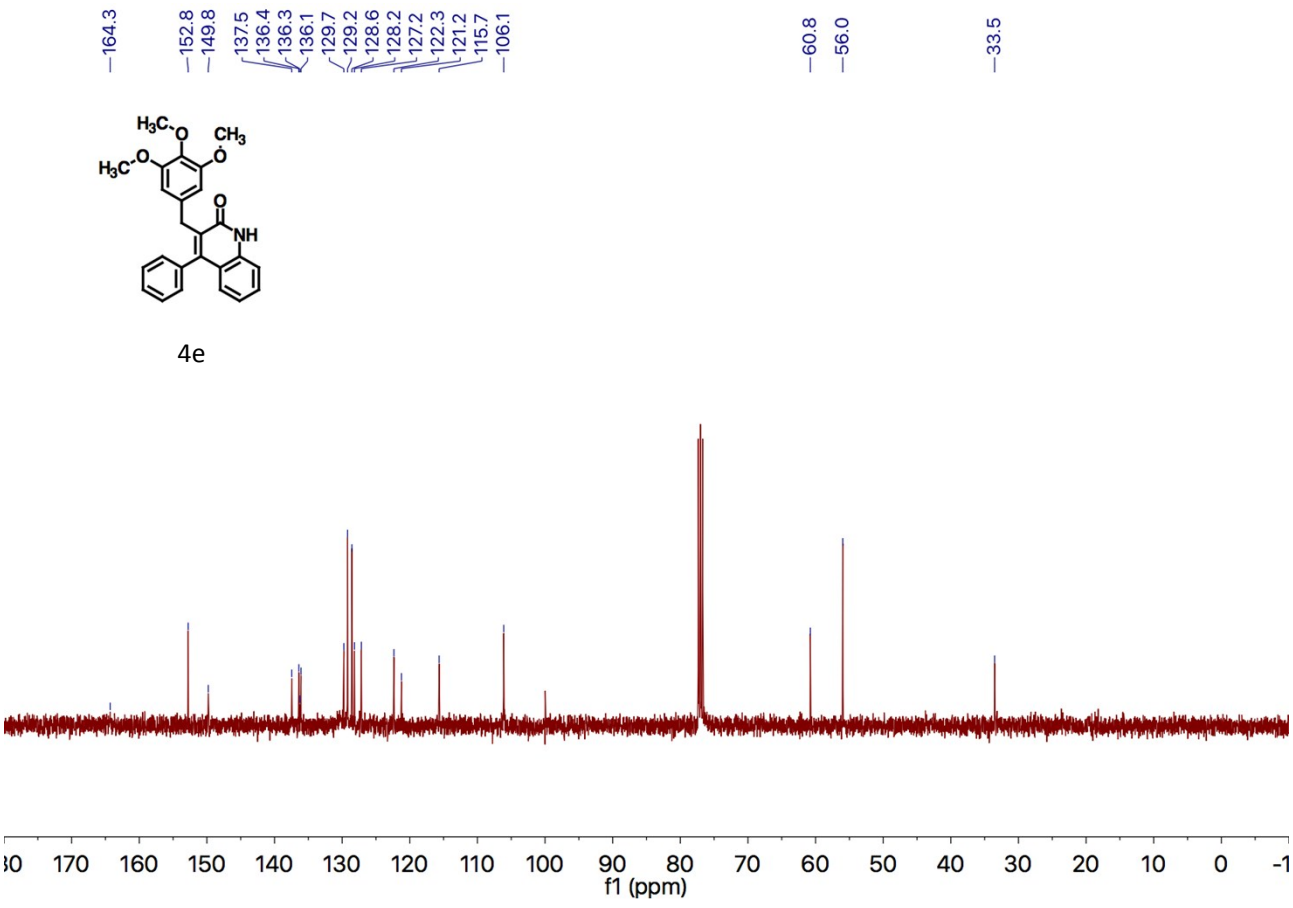
4d


164.2
157.7
149.7
137.5
136.4
132.6
130.6
129.6
129.0
128.5
128.1
127.1
122.2
121.2
115.8
113.5
55.2
32.7
O
CH3
O
NH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

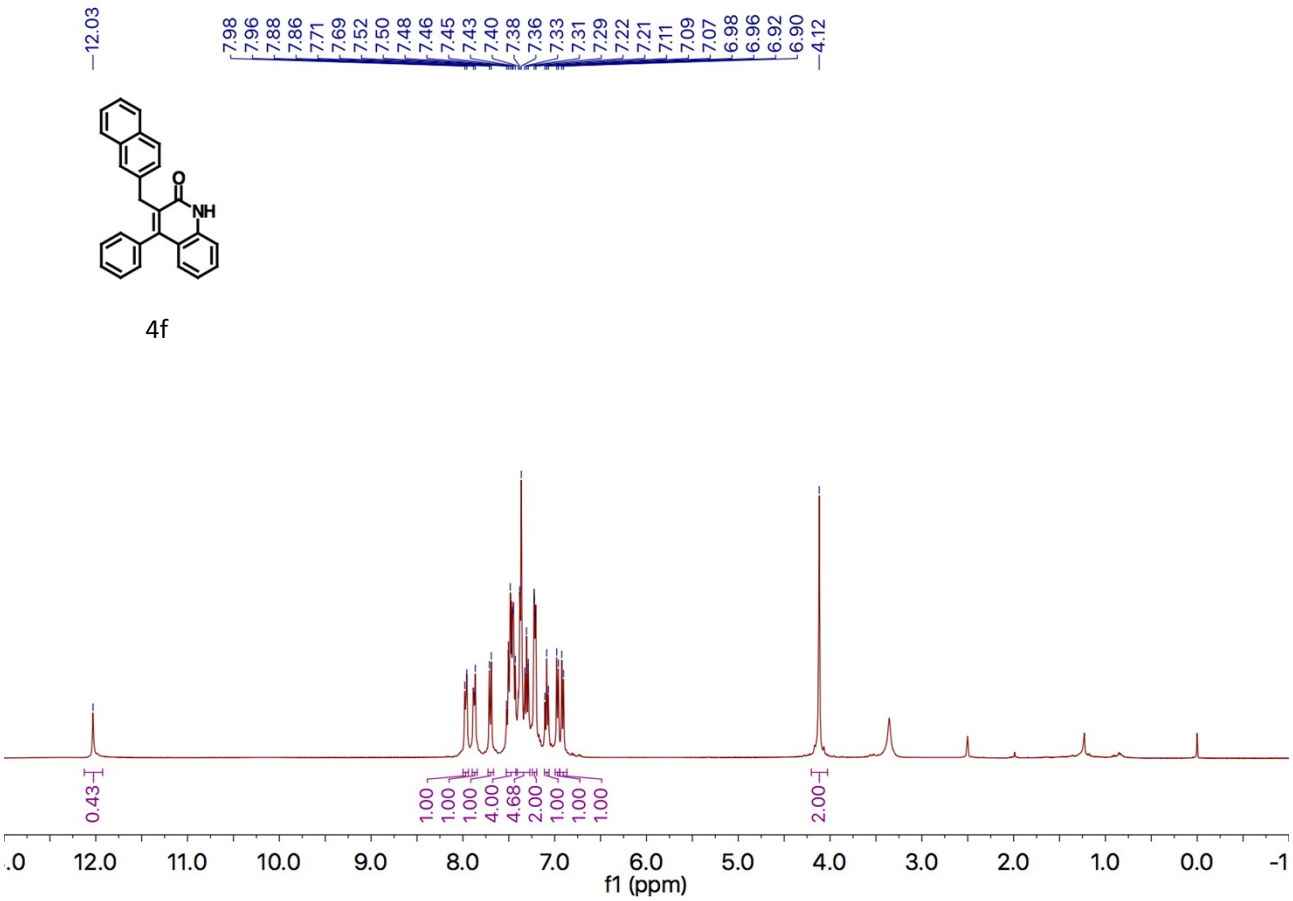
4d


12.59
7.54
7.53
7.51
7.46
7.45
7.43
7.41
7.27
7.25
7.08
7.07
6.41
3.92
3.79
3.75
1.00
3.00
2.00
2.00
2.00
2.00
2.00
3.00
6.00
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

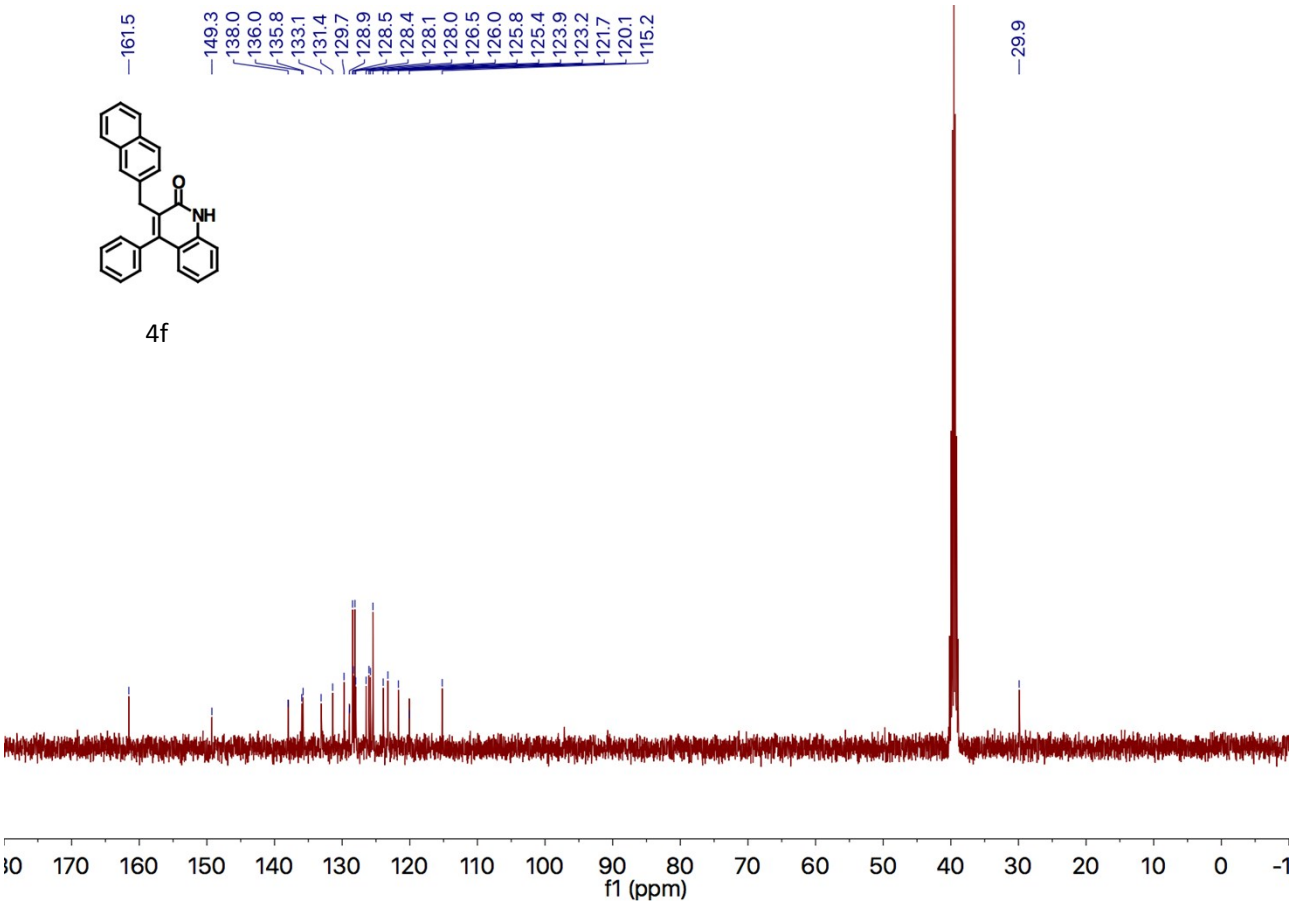
4e


164.3
152.8
149.8
137.5
136.4
136.3
136.1
129.7
129.2
128.6
128.2
127.2
122.3
121.2
115.7
106.1
60.8
56.0
33.5
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

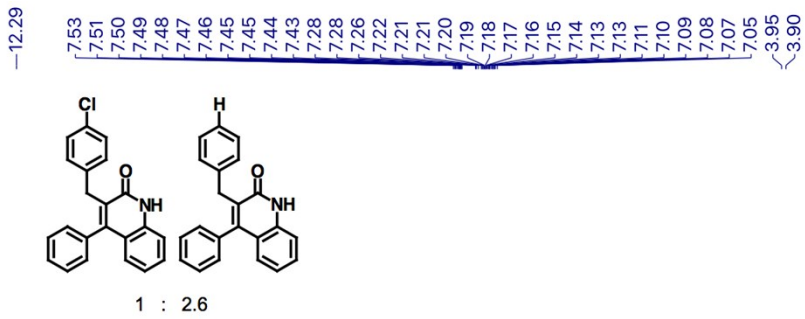
4e


12.03
7.98
7.96
7.88
7.86
7.71
7.69
7.52
7.50
7.48
7.46
7.45
7.43
7.40
7.38
7.36
7.33
7.31
7.29
7.22
7.21
7.11
7.09
7.07
6.98
6.96
6.92
6.90
4.12
O
NH
0.43
1.00
1.00
1.00
4.00
4.68
2.00
1.00
1.00
2.00
f1 (ppm)

4f

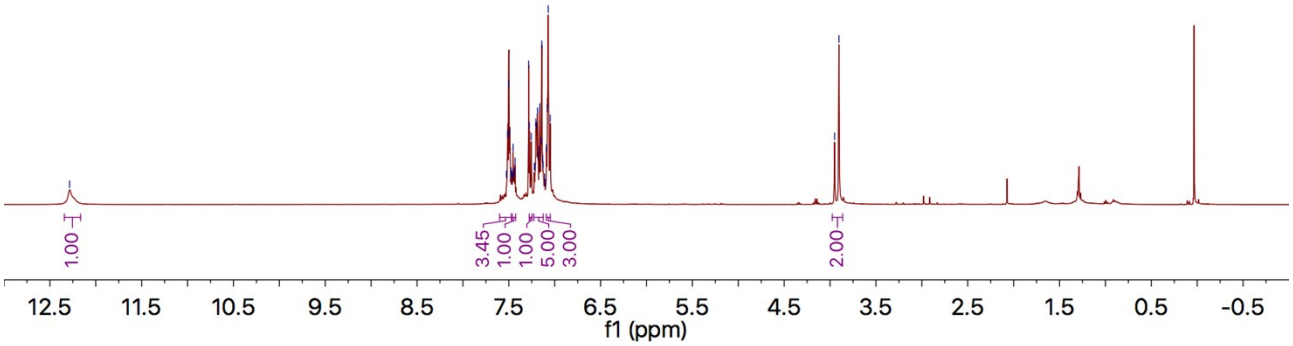

161.5
149.3
138.0
136.0
135.8
133.1
131.4
129.7
128.9
128.5
128.4
128.1
128.0
126.5
126.0
125.8
125.4
123.9
123.2
121.7
120.1
115.2
29.9
O
NH
f1 (ppm)

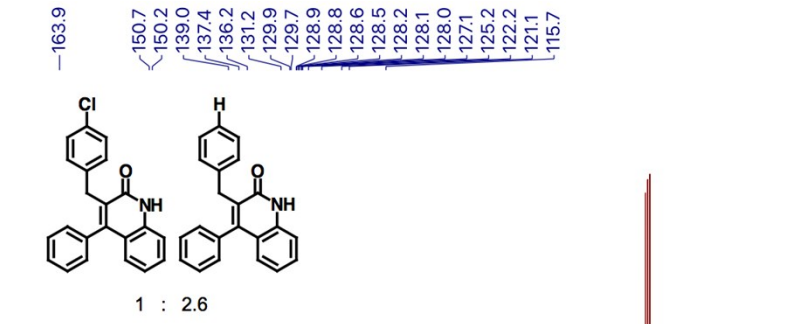
4f



1 : 2.6

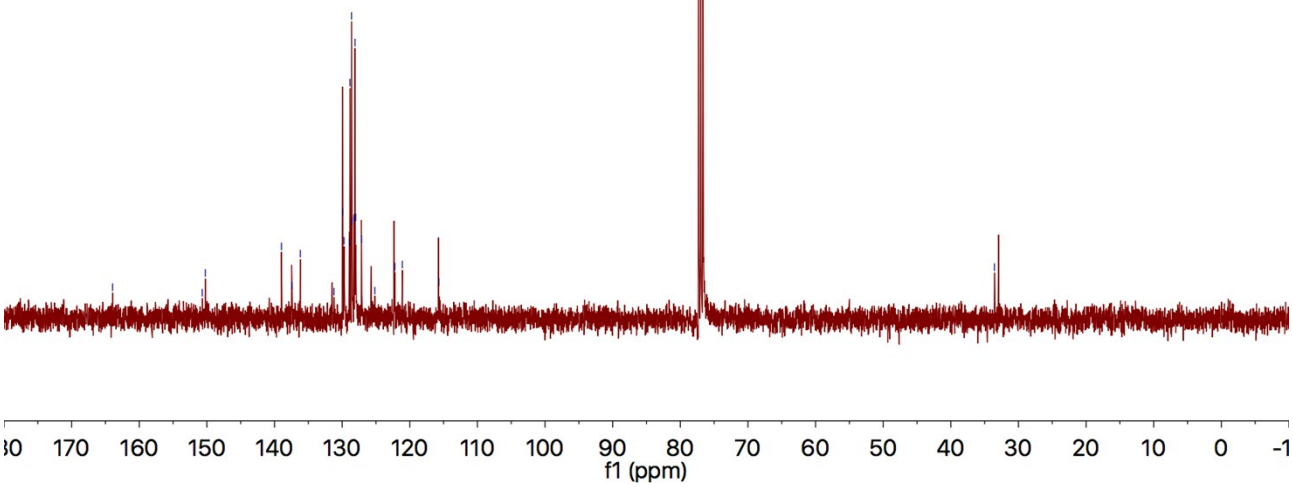
4g+4b

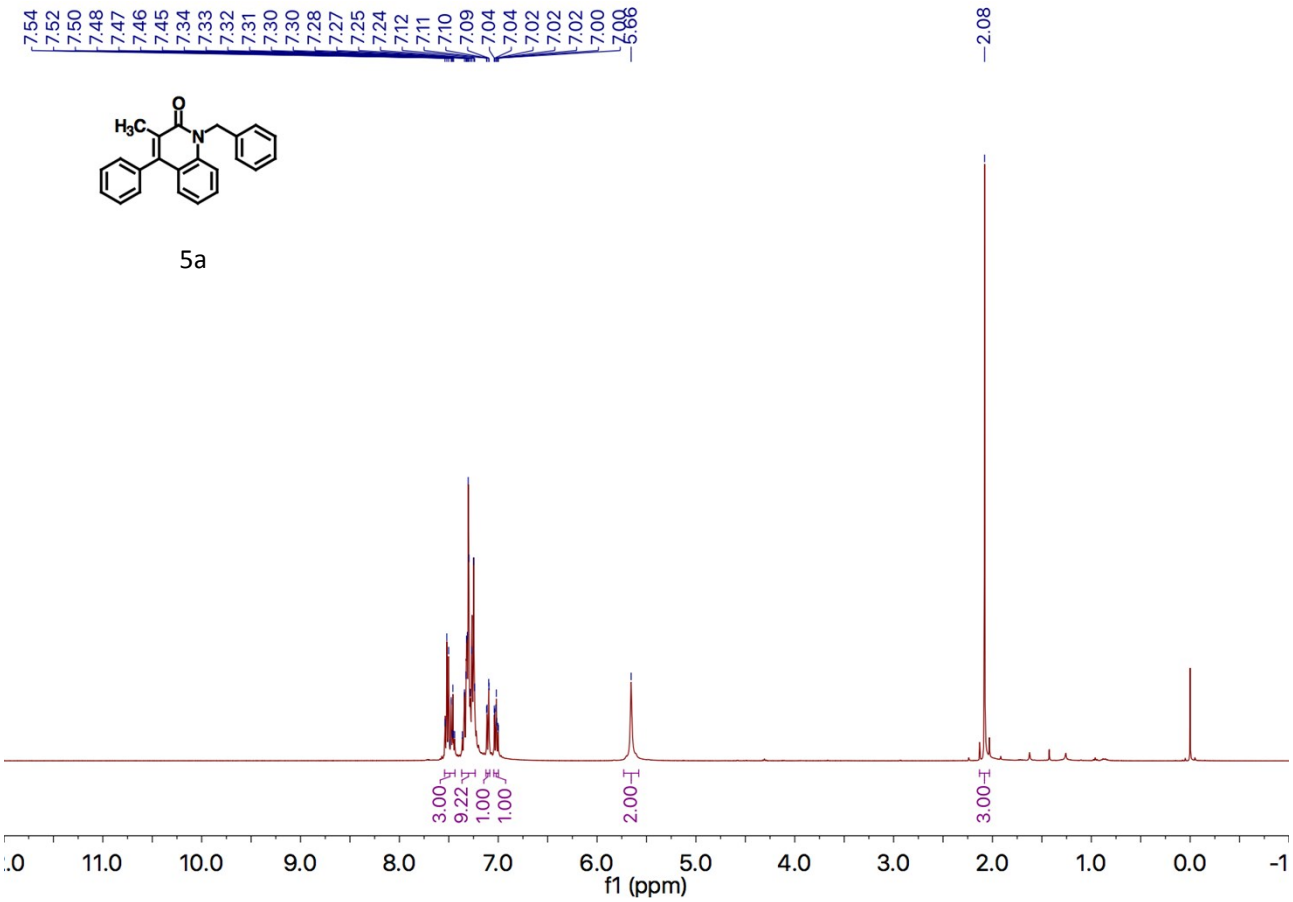




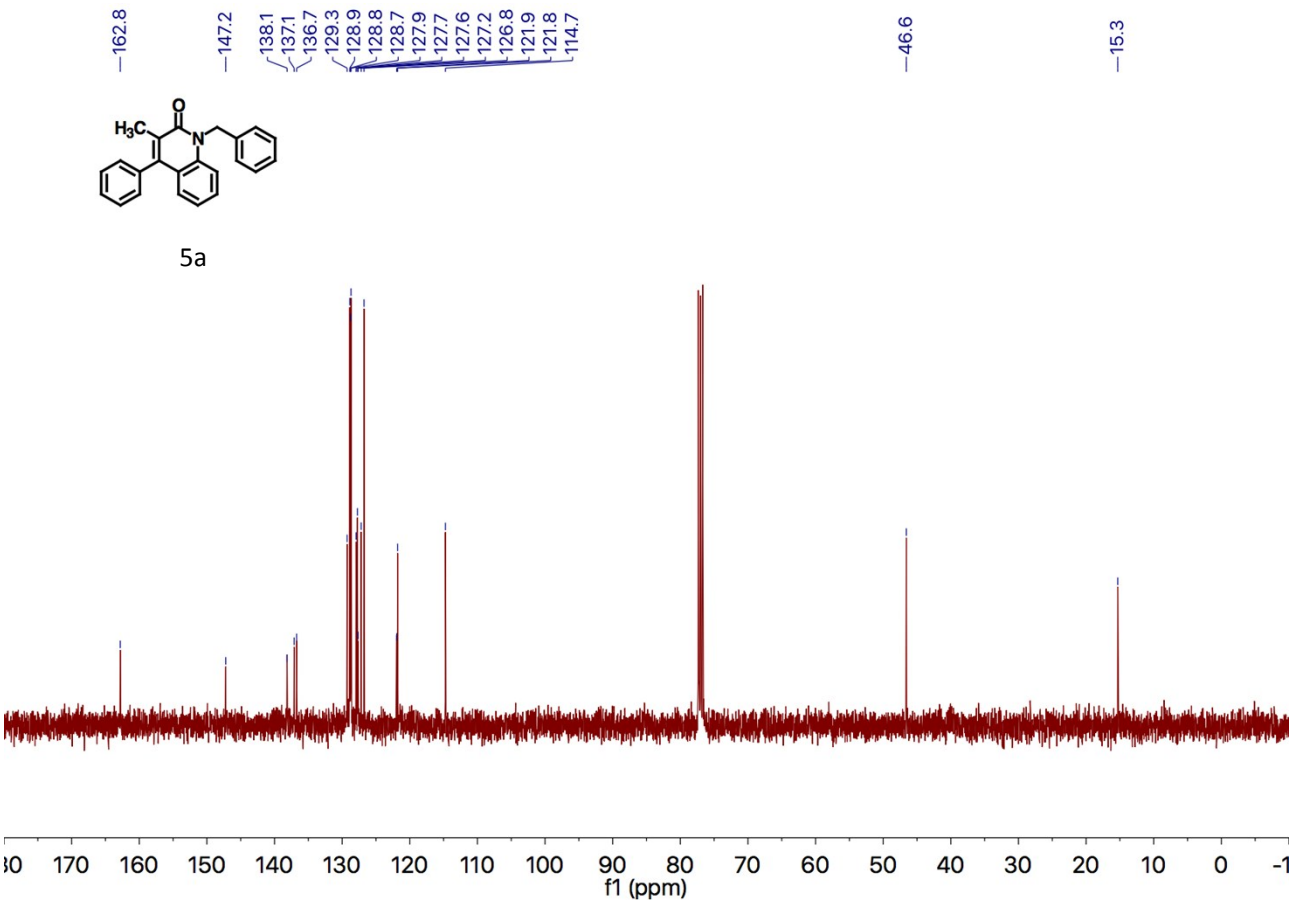
1 : 2.6

4g+4b




7.54
7.52
7.50
7.48
7.47
7.46
7.45
7.34
7.33
7.32
7.31
7.30
7.30
7.28
7.27
7.25
7.24
7.12
7.11
7.10
7.09
7.04
7.04
7.02
7.02
7.02
7.00
7.00
5.66
2.08
H3C
O
N
3.00
9.22
1.00
1.00
2.00
3.00
f1 (ppm)

5a


162.8
147.2
138.1
137.1
136.7
129.3
128.9
128.8
128.7
127.9
127.7
127.6
127.2
126.8
121.9
121.8
114.7
46.6
15.3
H3C
O
N
f1 (ppm)

5a


8.04
8.02
7.66
7.66
7.65
7.64
7.64
7.62
7.62
7.56
7.56
7.55
7.55
7.54
7.53
7.53
7.52
7.51
7.51
7.51
7.50
7.49
7.48
7.48
7.47
7.47
7.41
7.40
7.39
7.39
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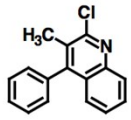
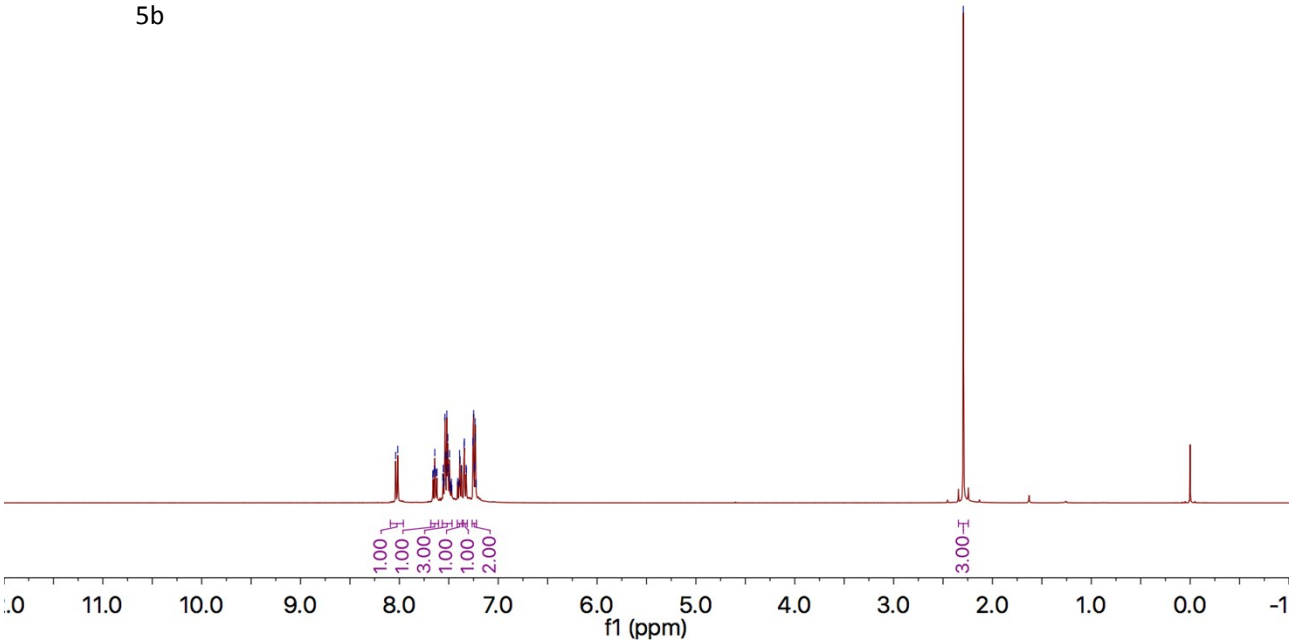
7.24
7.24
7.23
7.23
7.22
2.29


Cl
H3C
N

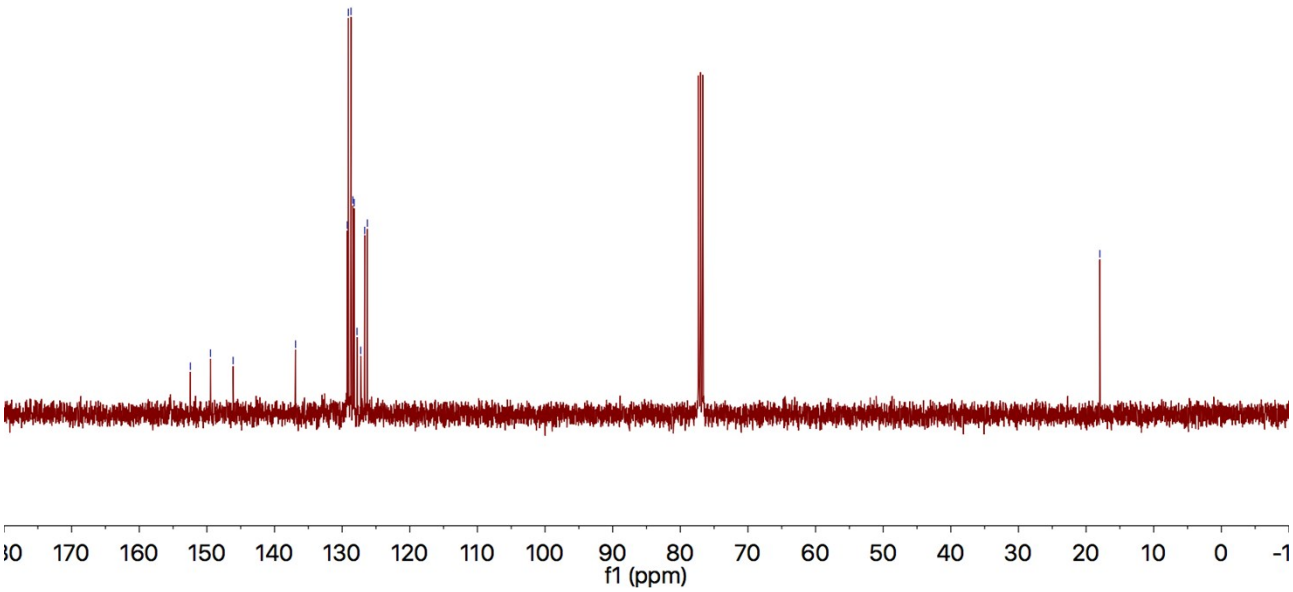
5b

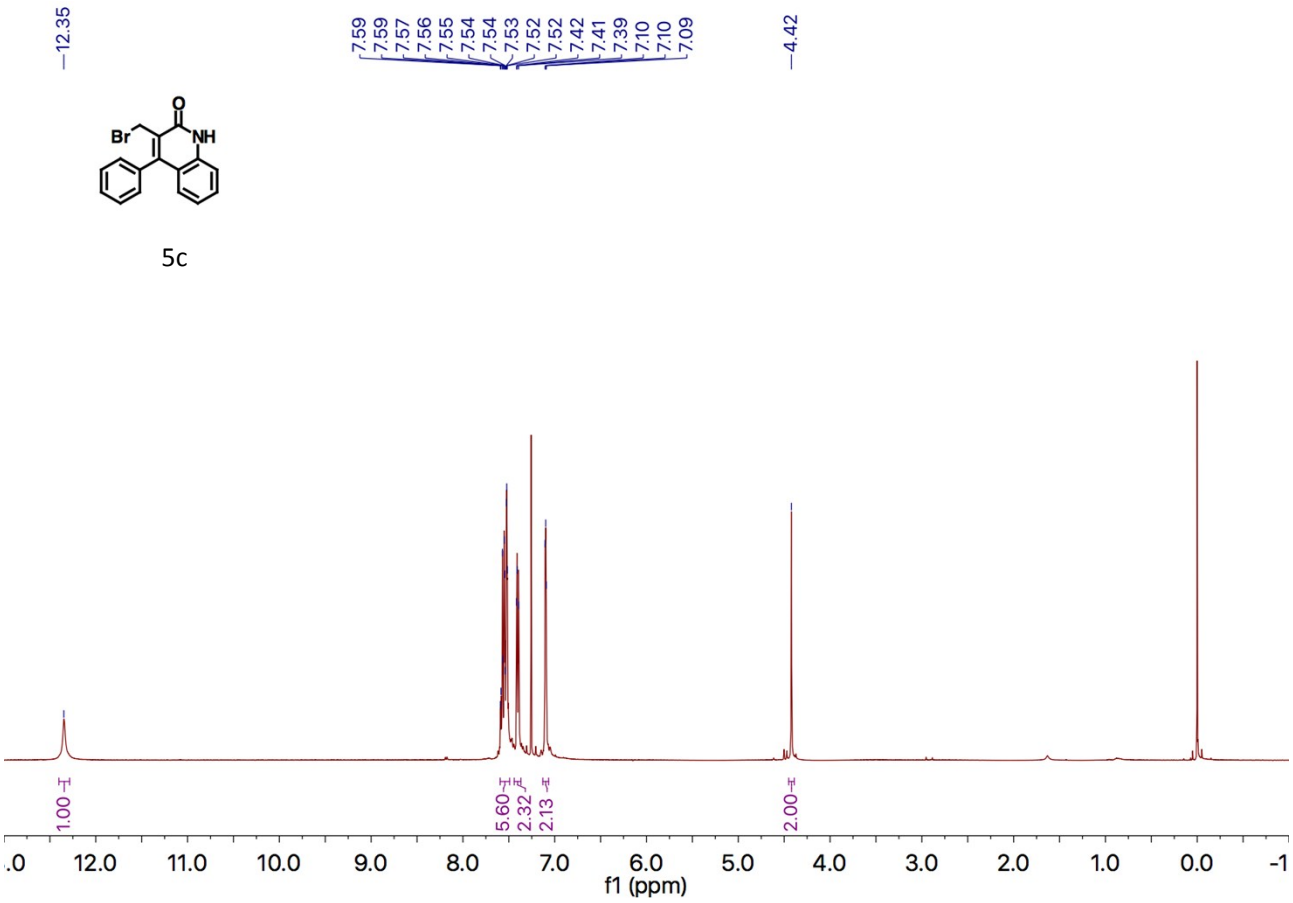

1.00
1.00
3.00
1.00
1.00
2.00
3.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


152.4
149.5
146.1
136.9
129.2
129.1
128.7
128.4
128.2
127.8
127.3
126.7
126.3
18.0

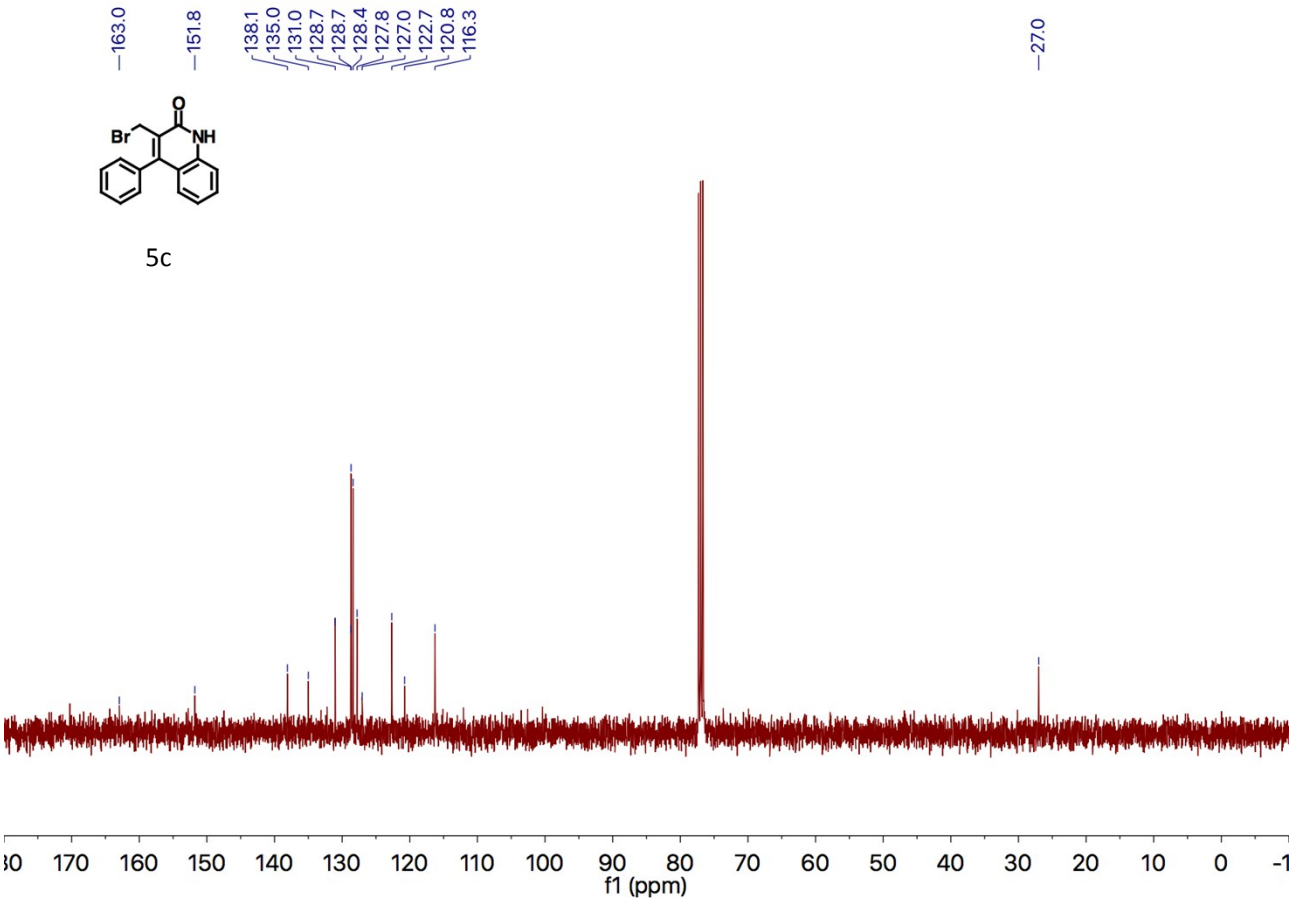
Cl
H3C
N

5b


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


12.35
7.59
7.59
7.57
7.56
7.55
7.54
7.54
7.53
7.52
7.52
7.42
7.41
7.39
7.10
7.09
4.42
Br
NH
O
1.00
5.60
2.32
2.13
2.00
f1 (ppm)

5c


163.0
151.8
138.1
135.0
131.0
128.7
128.7
128.4
127.8
127.0
122.7
120.8
116.3
27.0
Br
NH
O
f1 (ppm)

5c