Supplementary Material (ESI) for Chemical Communications

Supporting Information

Enantioselective Organocatalyzed Henry Reaction with Fluoromethyl Ketones

Marco Bandini,* Riccardo Sinisi, Achille Umani-Ronchi*

Dipartimento di Chimica Organica "G. Ciamician", Università di Bologna

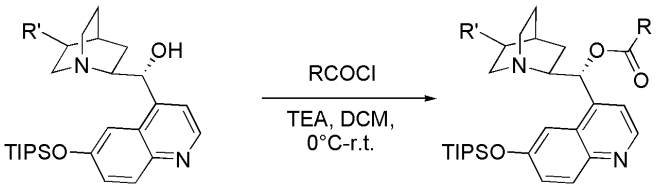
Via Selmi 2, 40126 Bologna (Italy)

**E-mail: marco.bandini@unibo.it, achille.umanironchi@unibo.it*

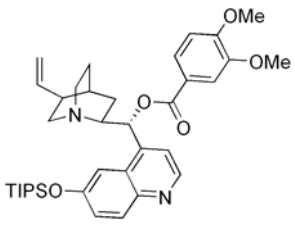
General Methods. ^{1}H-NMR spectra were recorded on Varian 200 (200 MHz), Varian 300 (300 MHz) spectrometers. Chemical shifts are reported in ppm from TMS with the solvent resonance as the internal standard (deuterochloroform: δ 7.27 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = duplet, pd = pseudo duplet, t = triplet, q = quartet, br = broad, br s = broad singlet, m = multiplet), coupling constants (Hz). ^{13}C-NMR spectra were recorded on a Varian 200 (50 MHz), Varian 300 (75 MHz) spectrometers with complete proton decoupling. Chemical shifts are reported in ppm from TMS with the solvent as the internal standard (deuterochloroform: δ 77.0 ppm). GC-MS spectra were taken by EI ionization at 70 eV on a Hewlett-Packard 5971 with GC injection. They are reported as: *m/z* (rel. intense). LC-electrospray ionization mass spectra were obtained with Agilent Technologies MSD1100 single-quadrupole mass spectrometer. Chromatographic purification was done with 240-400 mesh silica gel. IR analysis was performed with a FT-IR NICOLET 380 spectrophotometer and the spectra are expressed by wavenumber (cm^{-1}). Elemental analyses were carried out by using a EACE 1110 CHNOS analyzer. Analytical high performance liquid chromatography (HPLC) was performed on a liquid chromatograph equipped with a variable wave-length UV detector (deuterium lamp 190-600 nm), using a Daicel Chiracel^{TM} OD, AD, OF or OJ column (0.46 cm I.D. x 25 cm) (Daicel Inc. HPLC grade isopropanol and hexane were used as the eluting solvents. Separation via preparative HPLC was performed on a Agilent Technologies MSD 1100 liquid chromatograph using a Zorbax Eclipse SDB-C18 column (21.2 x 150 mm) with acetonitrile and milliQ-H_2O as eluents. Optical rotations were determined in a 1 ml cell with a path length of 10 mm (Na_D line). Melting points were determined with Bibby Stuart Scientific Melting Point Apparatus SMP 3 and are not corrected. ^{19}F-NMR spectra were referred to CF_3CO_2H in $CDCl_3$ (-76.6 ppm).

Materials. Racemic nitroalcohols **2** were synthesized with TEA (20 mol%) in CH_2Cl_2. Reagent grade solvents and $MeNO_2$ were used in the asymmetric Henry reaction. Commercially available ketones **1a-g**, **i-k** were used as received. Catalysts **3a-c** were synthesized following known protocols.[1]

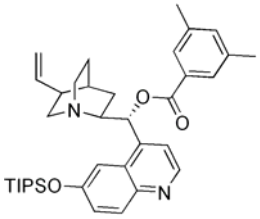
Synthesis of catalysts 3



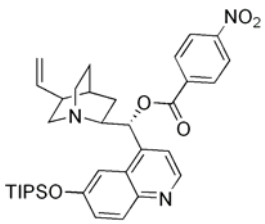
To a solution of 6'-OTIPS quinine derivative[1] (2 mmol) in anhydrous CH_2Cl_2 (12 ml) were added 4 mmol of Et_3N and the mixture was cooled to 0 °C with an ice bath. Then a solution of the desired acidic chloride (2.0 mmol) in 5 ml of CH_2Cl_2 was added dropwise. The ice bath was removed and the mixture stirred for 4 h. The reaction was quenched with water (10 ml) the phases separated and the aqueous layer extracted with CH_2Cl_2 (3 x 8 ml). The combined organic phases were dried over Na_2SO_4 and evaporated under reduced pressure. Pure **3-TIPS** catalysts were obtained by flash chromatography from pure AcOEt.



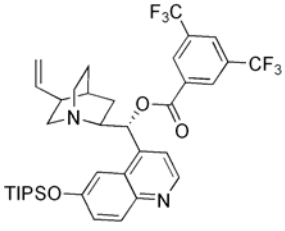
3d-TIPS. Pale yellow solid. Yield = 67%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.15 (d, J = 6.6 Hz, 18H), 1.23-1.41 (m, 3H), 1.61 (br, 2H), 1.81 (br, 1H), 2.29 (br, 1H), 2.58 (br, 1H), 3.04 (br, 2H), 3.39 (q, J = 8.0 Hz, 1H), 3.79 (s, 3H), 3.87 (s, 3H), 4.96-5.03 (m, 2H), 5.70-5.80 (m, 1H), 6.74 (s, 1H), 6.81 (s, 1H), 7.16 (s, 1H), 7.35 (d, J = 9.2 Hz, 1H), 7.58 (br, 1H), 8.0 (d, J = 9.2 Hz, 1H), 8.66 (d, J = 4.4 Hz, 1H).



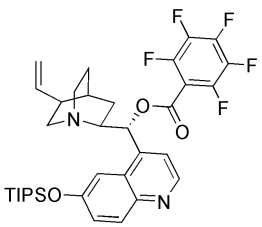
3e-TIPS. Pale yellow solid. Yield = 60%. ^{1}H-NMR (300 MHz, $CDCl_3$): δ 1.15 (d, J= 6.8 18H), 1.21-1.41 (m, 3H), 1.64-1.99 (m, 5H), 2.37 (br, 8H), 2.67-2.77 (m, 1H), 3.15-3.29 (m, 2H), 3.58 (q, J=7.8, 1H), 5.00-5.06 (m, 2H), 5.76-5.87 (m, 1H), 6.68 (br, 1H), 7.22 (br, 1H), 7.35 (dd, J = 2.2, 9.3 Hz, 1H), 7.42 (d, J= 4.5 Hz, 1H), 7.67 (s, 3H), 8.02 (d, J = 9.0 Hz, 1H), 8.73 (d, J = 4.5 Hz, 1H).



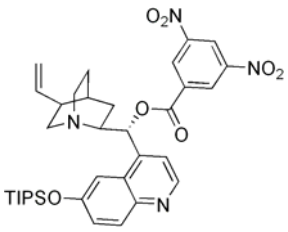
3f-TIPS. Pale yellow solid. Yield = 77%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.16 (d, J = 7.0 Hz, 18H), 1.23-1.44 (m, 3H), 1.63 (br, 3H), 1.92 (br, 1H), 2.05 (br, 1H), 2.32 (br, 1H), 2.66 (br, 2H), 3.02-3.14 (br, 2H), 3.67 (q, J = 8.0 Hz, 1H), 5.01-5.09 (m, 2H), 5.79-5.97 (m, 1H), 6.69 (d, J = 8.6 Hz, 1H), 7.37 (dd, J = 2.6, 9.2 Hz, 1H), 7.43 (d, J = 4.8 Hz, 2H), 7.65 (d, J = 2.6 Hz, 1H), 8.03 (d, J = 9.2 Hz, 1H), 8.09 (s, 1H), 8.48 (s, 2H), 8.77 (d, J = 4.8 Hz, 1H).



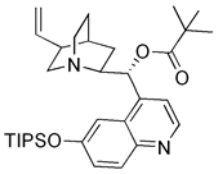
3g-TIPS. Pale yellow solid. Yield = 87%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.16 (d, J = 7.0 Hz, 18H), 1.23-1.44 (m, 3H), 1.53-1.73 (m, 3H), 1.92 (br, 1H), 1.95-2.13 (m, 1H), 2.32 (br, 1H), 2.59-2.75 (m, 2H), 3.02-3.14 (m, 2H), 3.67 (q, J = 8.0 Hz, 1H), 5.01-5.09 (m, 2H), 5.79-5.97 (m, 1H), 6.69 (d, J = 8.6 Hz, 1H), 7.37 (dd, J = 2.6, 9.2 Hz, 1H), 7.43 (d, J = 4.8 Hz, 1H), 7.65 (d, J = 2.6 Hz, 1H), 8.03 (d, J = 9.2 Hz, 1H), 8.09 (s, 1H), 8.48 (s, 2H), 8.77 (d, J = 4.8 Hz, 1H).



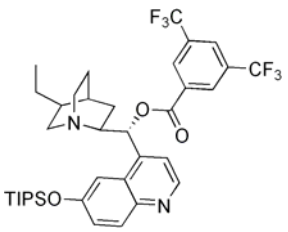
3h-TIPS. Pale green solid. Yield = 79%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.14 (d, J = 6.6 Hz, 18H), 1.23-1.38 (m, 3H), 1.47-1.79 (m, 3H), 1.89 (br, 1H), 1.97-2.09 (m, 1H), 2.28 (br, 1H), 2.51-2.71 (m, 2H), 2.97-3.18 (m, 2H), 3.54 (q, J = 8.4 Hz, 1H), 4.98-5.06 (m, 2H), 5.75-5.93 (m, 1H), 6.56 (d, J = 8.4 Hz, 1H), 7.38 (s, 1H), 7.40 (d, J = 2.4 Hz, 1H), 7.58 (d, J = 2.6 Hz, 1H), 8.03 (d, J = 9.2 Hz, 1H), 8.76 (d, J = 4.4 Hz, 1H).



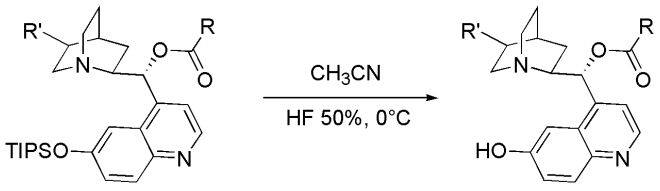
3i-TIPS. Pale yellow solid. Yield = 65%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.16 (d, J = 6.6 Hz, 18H), 1.27-1.41 (m, 3H), 1.43-1.80 (m, 3H), 1.93 (br, 1H), 2.01-2.13 (m, 1H), 2.31 (br, 1H), 2.59-2.73 (m, 2H), 3.02-3.13 (m, 2H), 3.65 (q, J = 8.4 Hz, 1H), 5.02-5.09 (m, 2H), 5.81-5.94 (m, 1H), 6.68 (d, J = 8.4 Hz, 1H), 7.37 (dd, J = 2.6, 7.0 Hz, 1H), 7.44 (d, J = 4.4 Hz, 1H), 7.64 (d, J= 2.6 Hz, 1H), 8.03 (d, J = 9.2 Hz, 1H), 8.77 (d, J = 4.4 Hz, 1H), 9.14 (d, J = 2.2 Hz, 2H), 9.24 (d, J = 2.2 Hz, 1H).



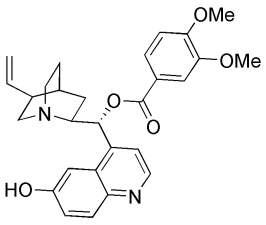
3j-TIPS. Pale yellow solid. Yield = 87%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.13-1.21 (m, 27H), 1.32-1.44 (m, 5H), 1.71 (br, 3H), 2.27 (br, 1H), 2.49-2.75 (m, 2H), 2.97-3.26 (m, 2H), 3.40-3.49 (m, 1H), 4.96-5.05 (m, 2H), 5.74-5.92 (m, 1H), 6.31 (d, J = 8.0 Hz, 1H), 7.29-7.37 (m, 2H), 7.59 (d, J = 2.2 Hz, 1H), 8.0 (d, J = 9.0 Hz, 1H), 8.72 (d, J = 4.4 Hz, 1H).



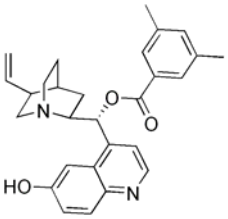
3k-TIPS. Pale yellow solid. Yield = 56%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 0.89 (t, J = 7.0 Hz, 3H), 1.16 (d, J = 7.0 Hz, 18H), 1.26-1.59 (m, 8H), 1.68-1.81 (m, 1H), 1.88 (br, 1H), 1.94 (br, 1H), 2.30-2.37 (m, 1H), 2.57-2.71 (m, 1H), 2.99-3.19 (m, 2H), 3.62 (q, J = 8.4 Hz, 1H), 6.62 (d, J = 7.8 Hz, 1H), 7.36 (dd, J = 2.4, 9.0 Hz, 1H), 7.42 (d, J = 4.8 Hz, 1H), 7.64 (d, J = 2.6 Hz, 1H), 8.02 (d, J = 9.2 Hz, 1H), 8.09 (s, 1H), 8.48 (s, 2H), 8.76 (d, J = 4.4 Hz, 1H).



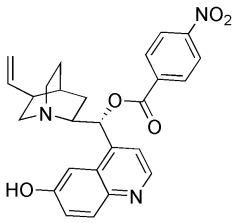
A solution of **3-TIPS** (0.5 mmol) in CH_3CN (10 ml) was cooled to 0 °C, then 10 drops of an aqueous solution of HF (50%) were added. After 10 min stirring at the same temperature, the reaction was quenched with a saturated solution of $NaHCO_3$ (5 ml) and diluted with AcOEt (5 ml). After separation, the organic phase was washed with $NaHCO_3$ (sat) and brine. After dryness, the volatiles were removed under reduced pressure and rude purified by repeated washings with *n*-pentane (chemical purity > 98% by LC-MS).



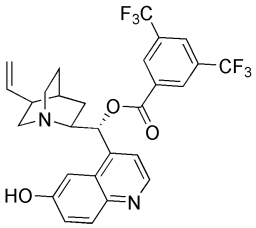
3d. Pale white solid. Yield = 83 %. Mp = 115 - 117 °C. $[\alpha]_D$ = - 21.9 (*c* = 0.94, $CHCl_3$). ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.62-1.81 (m, 3H), 1.91 (br, 1H), 2.45 (br, 1H), 2.87-2.94 (m, 2H), 3.15-3.32 (m, 2H), 3.39 (m, 2H), 3.89 (3, 3H), 3.84 (3, 3H), 4.86 (br, 1H), 4.95-5.04 (m, 2H), 5.54-5.72 (m, 1H), 6.81 (s, 2H), 6.85 (s, 2H), 6.98 (d, J = 4.4 Hz, 1H), 7.35 (d, J = 9.2 Hz, 1H), 7.75 (br, 1H), 7.99 (d, J = 8.8 Hz, 1H), 8.58 (d, J = 4.8 Hz, 1H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 21.3, 26.0, 27.1, 38.2, 41.3, 42.8, 55.7, 55.9, 58.4, 72.8, 104.7, 111.2, 112.2, 115.7, 117.2, 121.5, 122.7, 125.6, 126.3, 131.5, 139.4, 141.6, 143.6, 146.1, 148.3, 149.0, 156.5, 169.6. IR (neat): υ 3388, 2935, 2644, 2279, 1740, 1619, 1592, 1514, 1465, 1420, 1263, 1238, 1142, 1026, 855, 735. ESI-MS: (M+1): 475. Anal. calcd for ($C_{28}H_{30}N_2O_5$: 474.22): C, 70.87; H, 6.37; N, 5.90. Found: C, 70.80; H, 6.32; N, 5.88.



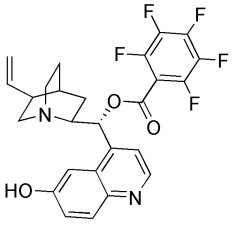
3e. Pale white solid. Yield = 97 %. Mp = 146 - 147 °C. $[\alpha]_D$ = + 119.0 (*c* = 0.91, $CHCl_3$). ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.51-1.72 (m, 1H), 1.75-1.99 (m, 4H), 2.38 (br, 7H), 2.67-2.81 (m, 2H), 3.09-3.44 (m, 3H), 4.94-5.03 (m, 2H), 5.69-5.86 (m, 1H), 6.85 (d, J= 4.4, 1H), 7.23 (br, 1H), 7.28 (d, J = 2.6 Hz, 1H), 7.39 (d, J = 4.4 Hz, 1H), 7.70 (s, 2H), 7.83 (d, J = 2.2 Hz, 1H), 7.97 (d, J = 8.8 Hz, 1H), 8.67 (d, J = 6.6 Hz, 1H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 21.1 (2C), 23.0, 27.3, 27.5, 39.3, 42.5, 56.4, 59.0, 73.8, 105.6, 114.7, 117.9, 122.8, 127.3 (2C), 129.5, 130.9, 134.9, 135.0, 138.2 (2C), 140.9, 143.3, 143.6, 145.9, 156.6, 165.4. IR (neat): υ 33240, 2940, 1721, 1618, 1512, 1455, 1311, 1208, 1112, 1072, 996, 917, 852, 767, 736. ESI-MS: (M+1): 443. Anal. calcd for ($C_{28}H_{30}N_2O_3$: 442.55): C, 75.99; H, 6.83; N, 6.33. Found: C, 75.91; H, 6.80; N, 6.28.



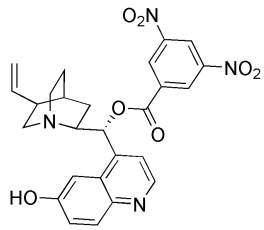
3f. Pale white solid. Yield = 91 %. Mp = 232 - 234 °C. $[\alpha]_D$ = + 132.3 (*c* = 1.79, $CHCl_3$). ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.80 (m, 3H), 1.93 (br, 2H), 2.35 (br, 1H), 2.65-2.72 (m, 2H), 3.01-3.20 (m, 2H), 3.49 (q, J = 5.0 Hz, 1H), 4.96-5.05 (m, 2H), 5.70-5.87 (m, 1H), 6.82 (d, J = 5.2 Hz, 1H), 7.23-7.27 (m, 1H), 7.39 (d, J = 4.4 Hz, 1H), 7.81 (d, J = 2.0 Hz, 1H), 7.99 (d, J = 8.8 Hz, 1H), 8.24 (q, J = 8.2 Hz, 4H), 8.69 (d, J =4.4 Hz, 2H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 23.6, 27.4(2C), 39.2, 42.5, 56.4, 59.0, 75.3, 105.9, 115.1, 118.4, 122.6, 123.7(2C), 127.2, 130.7(), 131.3, 134.9, 140.8, 142.8, 143.6, 146.3, 150.7, 156.4, 163.5. IR (neat): υ 3414, 3055, 2986, 2360, 2342, 1738, 1710, 1617, 1547, 1466, 1420, 1342, 1284, 1180, 1075, 921, 896, 763, 748. ESI-MS: (M-1): 458. Anal. calcd for ($C_{26}H_{25}N_3O_5$: 459.49): C, 67.96; H, 5.48; N, 9.14. Found: C, 67.94; H, 5.45; N, 9.10.



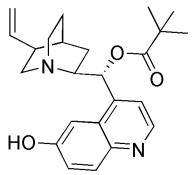
3g. Pale white solid. Yield = 74%. Mp = 195 - 197 °C. $[\alpha]_D$ = + 69.3 (*c* = 3.34, $CHCl_3$). ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.68-1.82 (m, 3H), 1.96 (br, 2H), 2.38 (br, 1H), 2.70-2.80 (m, 2H), 3.12-3.25 (m, 2H), 3.52 (br, 1H), 4.99-5.05 (m, 2H), 5.74-5.86 (m, 1H), 6.89 (d, J = 3.0 Hz, 1H), 7.25 (d, J = 7.0 Hz, 1H), 7.40 (d, J = 3.0 Hz, 1H), 7.87 (s, 1H), 7.98 (d, J = 6.0 Hz, 1H), 8.12 (s, 1H), 8.51 (s, 2H), 8.71 (d, J = 3.2 Hz, 1H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 20.2, 24.6, 26.5, 36.4, 44.2, 55.3, 58.6, 72.2, 103.9, 116.2, 117.6, 122.5 (q, $^1J_{C\text{-}F}$ = 271,2 Hz, 2C), 123.1, 125.5, 127.4, 129.3(2C), 131.1, 131.8 (br), 132.8 (q, $^2J_{C\text{-}F}$ = 33.9 Hz, 2C), 136.4, 138.6, 143.8, 146.1, 157.2, 161.7. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -63.8. IR (neat): υ 3077, 2926, 2867, 2331, 1732, 1651, 1573, 1469, 1279, 1244, 1182, 1140, 989, 912, 847, 746, 740, 700, 682. ESI-MS: (M+1): 551. Anal. calcd for ($C_{28}H_{24}F_6N_2O_3$: 550.17): C, 61.09; H, 4.39; N, 5.09. Found: C, 61.00; H, 4.31; N, 5.08.



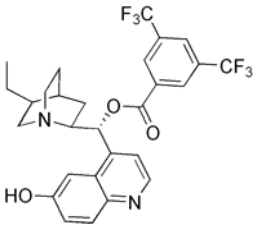
3h. Pale white solid. Yield = 74 %. Mp = 205 - 207 °C. $[\alpha]_D$ = + 56.2 (*c* = 0.92, $CHCl_3$). ^{1}H-NMR (200 MHz, $CDCl_3$): δ 1.58-1.90 (m, 5H), 2.34 (br, 1H), 2.64-2.82 (m, 2H), 3.06-3.40 (m, 3H), 4.95-5.04 (m, 2H), 5.67-5.84 (m, 1H), 6.84 (d, J = 4.8 Hz, 1H), 7.32-7.40 (m, 2H), 7.78 (d, J = 2.2 Hz, 1H), 8.02 (d, J = 9.2 Hz, 1H), 8.73 (d, J = 4.4 Hz, 1H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 24.2, 27.3, 29.4, 39.3, 42.3, 56.4, 59.1, 76.5, 77.2, 104.5, 114.5, 118.4, 122.1, 126.9, 131.5, 135.0 (m, 1C), 140.0 (m, 1C), 141.2, 141.7, 143.0 (m, 1C), 143.8, 145.8 (m, 1C), 146.4, 148.0 (m, 1C), 156.1, 157.9 (br). ^{19}F-NMR (282 MHz, $CDCl_3$): δ -133.6(2F), -143.5, -156.1(2F). IR (neat): υ 3054, 2986, 2685, 2521, 2410, 2305, 1742, 1712, 1651, 1620, 1524, 1499, 1421, 1361, 1330, 1265, 1224, 1102, 1006, 896, 854, 738, 705. ESI-MS: (M+1): 505. Anal. calcd for ($C_{26}H_{21}F_5N_2O_3$: 504.15): C, 61.90; H, 4.20; N, 5.55. Found: C, 69.40; H, 4.18; N, 5.50.



3i. Pale white solid. Yield = 85%. Mp = 243 - 245 °C. $[\alpha]_D$ = + 139 (*c* = 2.55, DMSO). ^{1}H-NMR (300 MHz, DMSO): δ 1.52-1.70 (m, 3H), 1.80 (br, 2H), 1-98-2.07 (m, 1H), 2.25 (br, 1H), 2.43-2.51 (m, 2H), 2.89 (t, J= 10.0 Hz, 1H), 3.12 (br, 1H), 3.60 (q, J = 7.5 Hz, 1H), 4.98-5.06 (m, 2H), 5.93-6.05 (m, 1H), 6.50 (d, J = 7.8 Hz, 1H), 7.33 (d, J = 9.0 Hz, 1H), 7.57 (s, 1H), 7.64 (d, J = 4.5 Hz, 1H), 7.88 (d, J = 9.0 Hz, 1H), 9.00 (s, 2H), 10.18 (s, 1H). ^{13}C-NMR (50 MHz, DMSO): δ 24.9, 27.2, 27.3, 39.1, 40.7, 56.0, 59.3, 76.2, 104.3, 114.4, 119.2, 121.7, 122.9, 126.9, 129.1(2C), 131.4, 132.0, 142,3, 142.6, 143.2, 146.7, 148.5(2C), 155.8, 162.1. IR (neat): υ 3082, 3054, 2986, 2938, 2870, 2685, 2522, 2410, 2385, 1738, 1614, 1595, 1548, 1536, 1466, 1421, 1340, 1265, 1165, 922, 896, 738. ESI-MS: (M+1): 505. Anal. calcd for ($C_{26}H_{24}N_4O_7$: 504,49): C, 61.90; H, 4.80; N, 11.11. Found: C, 61.89; H, 4.75; N, 11.04.



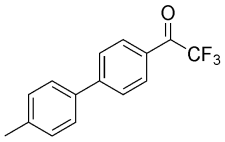
3j. Pale white solid. Yield = 98%. Mp = 203-205 °C. $[\alpha]_D$ = - 68.7 (*c* = 3.04, $CHCl_3$). ^{1}H-NMR (300 MHz, $CDCl_3$): δ 1.24-1.32 (m, 9H), 1.60 (br, 1H), 1.75-1.84 (m, 3H), 1.88 (br, 1H), 2.32 (br, 1H), 2.62 (br, 1H), 2.69-2.78 (m, 1H), 3.10 (t, J = 10.5 Hz, 1H), 3.27 (br, 2H), 4.94-5.01 (m, 2H), 5.68-5.80 (m, 1H), 6.53 (d, J = 3.3 Hz, 1H), 7.23-7.28 (m, 2H), 7.73 (s, 1H), 7.97 (d, J = 9.0 Hz, 1H), 8.68 (d, J = 4.2 Hz, 1H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 23.4, 26.9, 27.3(3C), 27.5, 38.7, 39.4, 42,3, 56.4, 59.1, 73.8, 106,2, 114.8, 118.1, 122.7, 127.3, 130.8, 141.1, 143.4, 144.1, 146.0, 156.3, 176.8. IR (neat): υ 3418, 3054, 2081, 2871, 2305, 1731, 1620, 1512, 1469, 1478, 1421, 1364, 1265, 1146, 1095, 1073, 1033, 991, 918, 895, 853, 745, 704. ESI-MS: (M+1): 395. Anal. calcd for ($C_{24}H_{30}N_2O_3$: 394.51): C, 73.07; H, 7.66; N, 7.10;. Found: C, 73.05; H, 7.61; N, 7.08.



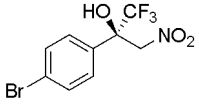
3k. Pale white solid. Yield = 66 %. Mp = 130 - 132 °C. $[\alpha]_D$ = + 96.3 (*c* = 1.91, $CHCl_3$). ^{1}H-NMR (300 MHz, $CDCl_3$): δ 0.84 (t, J= 7.5, 3H), 1.08 (d, J= 7.8, 2H), 1.26-1.37 (m, 1H), 1.53-1.67 (m, 2H), 1.77-1.89 (m, 3H), 1.96 (br, 1H), 2.45-2.48 (m, 1H), 2.79-2.89 (m, 1H), 3.13-3.33 (m, 2H), 6.93 (d, J=4.5, 1H), 7.24 (d, J=8.7, 1H), 7.37 (d, J=4.5, 1H), 7.86 (s, 1H), 7.97 (d, J=9.0, 1H), 8.12 (s, 1H), 8.52 (s, 2H), 8.70 (d, J=4.5, 1H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 23.1, 25.0, 27.4, 27.9, 30.2, 36.8, 42.7, 58.0, 58.7, 75.3, 105.5, 117.9, 122.6 (q, J= 271,6, 2C), 122.9 (br), 126.8, 127.2, 129.6 (2C), 131.1, 132.5 (q, ^{1}J= 34.0, 2C), 142.5, 143.4, 145.9, 156.8, 162.7. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -59.1. IR (neat): υ 3415, 3056, 2958, 2873, 1736, 1712, 1620, 1513, 1468, 1421, 1365, 1280, 1245, 1141, 913, 851, 739, 700,

682. ESI-MS: (M+1): 553. Anal. calcd for ($C_{28}H_{26}F_6N_2O_3$: 552.51): C, 60.87; H, 4.74; F, 20.63; N, 5.07. Found: C, 60.80; H, 4.69; F, 20.61; N, 5.04.

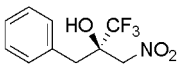
Synthesis of ketone 1h.[2]



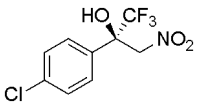
To a mixture of H_2O and acetone (3 mL, 1.2:1) were added in sequence 4'-bromo-2,2,2-trifluoroacetophenone **2b** (127 mg, 0.5 mmol), 136 mg of 4-methylphenylboronic acid (1 mmol), 106 mg of Na_2CO_3 (1 mmol) and 1 mg of $Pd(OAc)_2$ (5 mol%). The mixture was stirred at rt for 2 h, then the aqueous phase extracted with DCM (3 x 5 mL), the organic phases collected, dried under Na_2SO_4 and evaporated under reduced pressure. Pure **1h** was obtained by flash chromatography (*c*-Hex).Yellow viscous oil. Yield = 83%. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 2.32 (s, 3H), 7.23 - 7.35 (m, 4H), 7.54 (d, J = 8.6 Hz, 2H), 8.16 (d, J = 8.6 Hz, 2H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 20.3, 115.6 (q, $^1J_{C\text{-}F}$ = 289.8 Hz), 126.1(2C), 128.3(2C), 129.4 (2C), 130.1(2C), 130.7, 135.1, 140.0, 149.5, 180.0 (q, $^2J_{C\text{-}F}$ = 37.5 Hz). ^{19}F-NMR (282 MHz, $CDCl_3$): δ -72.1. GC-MS (*m/z*): 51(5), 63(7), 82(9), 97(10), 115(12), 152(45), 165(52), 195(100), 264(31).



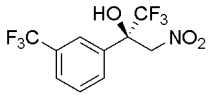
(*R*)-**2a**. Pale yellow oil. Yield = 95%. Ee = 90%. $[\alpha]_D$ = - 2.1 (*c* = 5.3, $CHCl_3$). HPLC analysis: OJ column (214 nm), 40 °C, method: *n*-Hex:IPA = 90:10, flow 0.8 ml/min, $t_{(S)}$ = 17.4 min, $t_{(R)}$ = 21.0 min. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 4.33 (s, 1H), 4.99 (d, J = 13.6 Hz, 1H), 5.07 (d, J = 13.6 Hz, 1H), 7.47 (d, J = 8.8 Hz, 1H), 7.58 (d, J = 8.8 Hz, 1H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 75.1, 75.6, 76.2, 76.8 (q, $^2J_{C\text{-}F}$ = 29.5 Hz), 76.3, 124.5, 127.9(2C), 132.1(2C), 132.5. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -79.7. GC-MS (*m/z*): 50(6), 75(9), 91(13), 140(19), 157(22), 159(23), 169(6), 171(8), 183(98), 185(100), 201(15), 203(17), 246(24), 248(26), 313(89), 315(91).



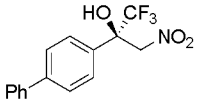
(*R*)-**2b**. Pale yellow oil. Yield = 70%. Ee = 92%. $[\alpha]_D$ = +2.4 (*c* = 2.9, $CHCl_3$). HPLC analysis: AD column (214 nm), 30 °C, method: *n*-Hex:IPA = 99:1, flow 1.0 ml/min, $t_{(S)}$ = 28.7 min, $t_{(R)}$ = 32.3 min. ^{1}H-NMR (300 MHz, $CDCl_3$): δ 2.75 (d, J = 14.4 Hz, 1H), 3.30 (d, J = 14.4 Hz, 1H), 4.24 (d, J = 13.5 Hz, 1H), 4.34 (s, 1H), 4.65 (d, J = 13.5 Hz, 1H), 7.27–7.36 (m, 3H), 7.37–7.38 (m, 2H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 38.2, 74.5 (q, $^2J_{C\text{-}F}$ = 28.6 Hz), 75.7, 124.8 (q, $^1J_{C\text{-}F}$ = 285.2 Hz), 128.1 128.8(2C), 130.8(2C), 131.9. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -80.7. GC-MS (*m/z*): 65(13), 91(100), 107(8), 133(3), 188(21), 231(3), 249(5).



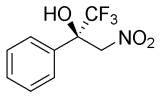
(*R*)-**2c**. Pale yellow oil. Yield = 80%. Ee = 92%. $[\alpha]_D$ = - 2.3 (*c* = 3.5, $CHCl_3$). HPLC analysis: OJ column (214 nm), 30 °C, method: *n*-Hex:IPA = 90:10, flow 0.5 ml/min, $t_{(S)}$ = 35.6 min, $t_{(R)}$ = 44.4 min. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 4.70 (s, 1H), 5.02 (d, J = 13.6 Hz, 1H), 5.07 (d, J = 13.6 Hz, 1H), 7.43 (d, J = 8.8 Hz, 2H), 7.55 (d, J = 8.8 Hz, 2H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 76.4 (q, $^2J_{C\text{-}F}$ = 29.7 Hz), 75.7, 124.8 (t, $^1J_{C\text{-}F}$ = 285.2 Hz), 128.1 128.8(2C), 130.8(2C), 131.9. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -79.7. GC-MS (*m/z*): 50(10), 75(19), 91(8), 111(31), 139(100), 157(15), 200(8), 209(9), 269(41).



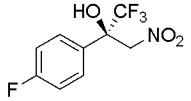
(*R*)-**2d**. Pale yellow oil. Yield = 86%. Ee = 96%. $[\alpha]_D$ = - 5.3 (*c* = 3.7, $CHCl_3$). HPLC analysis: OJ column (215 nm), 30 °C, method: *n*-Hex:IPA = 90:10, flow 1.0 ml/min, $t_{(S)}$ = 26.1 min, $t_{(R)}$ = 31.1 min. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 4.79 (s, 1H), 5.07 (d, J = 13.8 Hz, 1H), 5.12 (d, J = 13.8 Hz, 1H), 7.61 (t, J = 7.8 Hz, 1H), 7.76 (t, J = 7.8 Hz, 2H), 7.92 (s, 1H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 76.0 (q, $^2J_{C\text{-}F}$ = 30.0 Hz), 77.2, 123.1 (q, $^1J_{C\text{-}F}$ = 285.0 Hz), 123.4 (d, $^3J_{C\text{-}F}$ = 3.05 Hz), 123.8 (q, $^1J_{C\text{-}F}$ = 271.2 Hz), 127.0 (q, $J_{3C\text{-}F}$ = 3.4 Hz), 129.5, 129.6, 131.6 (q, $^2J_{C\text{-}F}$ = 32.7 Hz), 134.2. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -63.6, -79.5. GC-MS (*m/z*): 50(7), 95(11), 127(13), 145(59), 159(30), 173(100), 191(22), 209(11), 234(16), 284(10), 303(5).



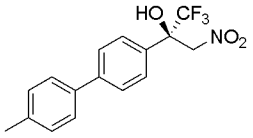
(*R*)-**2e**. Pale yellow oil. Mp = 107 - 109 °C. Yield = 99%. Ee = 96%. $[\alpha]_D$ = + 3.2 (*c* = 1.12, $CHCl_3$). HPLC analysis: OF column (210 nm), 30 °C, method: *n*-Hex:IPA = 96:4, flow 0.6 ml/min, $t_{(S)}$ = 27.7min, $t_{(R)}$ = 30.3 min. ^{1}H-NMR (300 MHz, $CDCl_3$): δ 4.80 (br s, 1H), 5.04 (d, J = 13.5 Hz, 1H), 5.15 (d, J = 13.5 Hz, 1H), 7.45-7.54 (m, 4H), 7.66-7.67 (m, 5H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 76.4 (q, $^2J_{C\text{-}F}$ = 29.8 Hz), 119.5 (q, $^1J_{C\text{-}F}$ = 289.5 Hz), 126.6(2C), 127.1(2C), 127.5(2C), 128.7(2C), 130.7, 130.8, 137.1, 139.7. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -79.5.



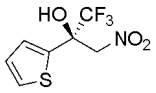
(*R*)-**2f**. White wax. Yield = 85%. Ee = 99%. $[\alpha]_D$ = - 67.0 (*c* = 1.54, MeOH), (lit. $[\alpha]_D$ = + 41.8 (*c* = 1.7, MeOH, (*S*)-**2f** *ee* = 96%)).[3] HPLC analysis: OJ column (210 nm), 30 °C, method: *n*-Hex:IPA = 90:10, flow 1.0 ml/min, $t_{(S)}$ = 28.9 min, $t_{(R)}$ = 30.5 min. ^{1}H-NMR (300 MHz, $CDCl_3$): δ 4.66 (s, 1H), 5.02 (d, J = 13.8 Hz, 1H), 5.12 (d, J = 13.8 Hz, 1H), 7.45-7.48 (m, 3H), 7.57-7.62 (m, 2H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 75.5, 75.9, 76.3, 76.7 (q, $^2J_{C\text{-}F}$ = 29.7 Hz), 77.2, 117.7, 121.5, 125.3, 129.0 (q, $^1J_{C\text{-}F}$ = 283.9 Hz), 126.1 128.9(2C), 129.9(2C), 132.9. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -79.6. GC-MS (*m/z*): 51(12), 77(45), 91(62), 105(100), 123(13), 141(32), 166(20), 235(23).



(*R*)-**2g**. Pale yellow oil. Yield = 82%. Ee = 96%. $[\alpha]_D$ = - 4.0 (*c* = 2.74, $CHCl_3$), (lit. $[\alpha]_D$ = + 15.0 (*c* = 0.80, $CHCl_3$, (*S*)-**2g** *ee* = 97.0%))[1]. HPLC analysis: OJ column (215 nm), 40 °C, method: *n*-Hex:IPA = 90:10, flow 1.0 ml/min, $t_{(S)}$ = 14.5 min, $t_{(R)}$ = 15.7 min. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 4.80 (br s, 1H), 5.01 (d, J = 13.6 Hz, 1H), 5.09 (d, J = 13.6 Hz, 1H), 7.14 (pt, J = 8.4 Hz, 2H), 7.59 (dd, J = 5.2, 8.4 Hz, 2H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 75.7 (t, $^2J_{C\text{-}F}$ = 30.0 Hz), 77.5, 116.0 (d, $^2J_{C\text{-}F}$ = 22.0 Hz, 2C), 123.5 (q, $^1J_{C\text{-}F}$ = 284.0 Hz), 128.3 (d, $^3J_{C\text{-}F}$ = 8.4.0 Hz, 2C), 163.2 (d, $^1J_{C\text{-}F}$ = 248.9 Hz). ^{19}F-NMR (282 MHz, $CDCl_3$): δ -79.8, -111.9. GC-MS (*m/z*): 75(3), 75(9), 95(31), 109(38), 123(100), 141(15), 159(23), 184(13), 207(5), 253(11).

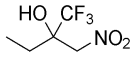


(*R*)-**2h**. Pale colorless oil. Yield = 85%. Ee = 90%. $[\alpha]_D$ = + 4.1 (*c* = 1.50, $CHCl_3$). HPLC analysis: AD column (210 nm), 40 °C, method: *n*-Hex:IPA = 99:1, flow 1.2 ml/min, $t_{(S)}$ = 21.4 min, $t_{(R)}$ = 26.6 min. ^{1}H-NMR (300 MHz, $CDCl_3$): δ 2.27 (s, 3H), 4.34 (s, 1H), 5.10 (d, J = 13.8 Hz, 1H), 5.19 (d, J = 13.8 Hz, 1H), 7.21-7.30 (m, 4H), 7.40 (d, J = 8.2 Hz, 2H), 7.64 (d, J = 8.2 Hz, 2H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ 20.3, 76.1 (t, $^2J_{C\text{-}F}$ = 29.8 Hz), 77.4, 117.0 (q, $^1J_{C\text{-}F}$ = 289.4 Hz), 125.8(2C, 125.9(2C), 127.7, 128.3, 129.3(2C), 129.7(2C), 130.1, 139.0. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -79.4.

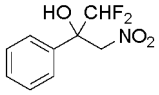


(*R*)-**2i**. Pale yellow oil. Yield = 79%. Ee = 76%. $[\alpha]_D$ = + 4.9 (*c* = 1.44, $CHCl_3$). HPLC analysis: OJ column (220 nm), 30 °C, method: *n*-Hex:IPA = 90:10, flow 0.9 ml/min, $t_{(S)}$ = 33.2 min, $t_{(R)}$ = 35.3 min. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 5.01 (s, 2H), 5.03 (s, 1H), 7.07 (dd, J = 3.6, 5.2 Hz, 1H), 7.17-7.18 (m, 1H), 7.50 (dd, J = 1.0, 5.2 Hz, 1H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 74.8, 75.2, 75.6, 76.0 (q, $J_{2H\text{-}F}$ = 30.9 Hz), 77.2, 117.2, 120.9, 124.7,

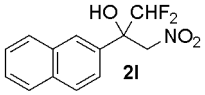
128.5 (q, J_{1C-F} = 283.9 Hz), 127.6 127.9, 129.1. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -80.5. GC-MS (*m/z*): 50(5), 69(9), 84(10), 97(42), 111(100), 126(33), 147(25), 181(14), 241(39).



2j. Pale yellow oil. Yield = 67%. Ee = 93%. $[\alpha]_D$ = + 5.52 (*c* = 1.16, $CHCl_3$). HPLC analysis: OJ column (210 nm), 30 °C, method: *n*-Hex:IPA = 96:4, flow 0.6 ml/min, $t_{(S)}$ = 25.2 min, $t_{(R)}$ = 27.9 min. ^{1}H-NMR (300 MHz, $CDCl_3$): δ 1.01 (t, J = 11.0 Hz, 3H), 1.81-1.93 (m, 2H), 4.55-4.62 (m, 2H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 8.3, 25.6, 74.6 (q, $^2J_{C-F}$ = 28.5 Hz), 76.0, 124.5 (q, $^1J_{C-F}$ = 285.6 Hz). ^{19}F-NMR (282 MHz, $CDCl_3$): δ -80.2. GC-MS (*m/z*): 51(10), 57(100), 69(39), 75(85), 91(29), 103 (60), 123(68), 158(65), 170(5).



2k. White solid. Yield = 77%. Ee = 99%. $[\alpha]_D$ = - 2.54 (*c* = 2.7, $CHCl_3$). HPLC analysis: OD column (210 nm), 30 °C, method: *n*-Hex:IPA = 85:15, flow 1.2 ml/min, $t_{(minor)}$ = 23.4 min, $t_{(major)}$ = 23.4 min. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 4.94 (d, J = 13.2 Hz, 1H), 5.05 (d, J = 13.2 Hz, 1H), 5.85 (t, $^2J_{H-F}$ = 54.8 Hz, 1H), 7.39–7.49 (m, 3H), 7.50-7.47 (m, 2H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 75.5 (t, $^2J_{H-F}$ = 22.7 Hz), 76.3, 115.0 (t, $^1J_{C-F}$ = 248.9 Hz), 125.8 129.0(2C), 129.5(2C), 134.8. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -129.2 (dd, $^2J_{H-F}$ = 55.2 Hz, $^2J_{H-F}$ = 282.0 Hz, 1H), -130.9 (dd, $^2J_{H-F}$ = 55.2 Hz, $^2J_{H-F}$ = 282.0 Hz, 1H). IR (CH_2Cl_2): 3442, 3020, 2926, 1636, cm^{-1}. GC-MS (*m/z*): 51(31), 77(60), 91(21), 105(100), 123(26), 166(29), 217(3).



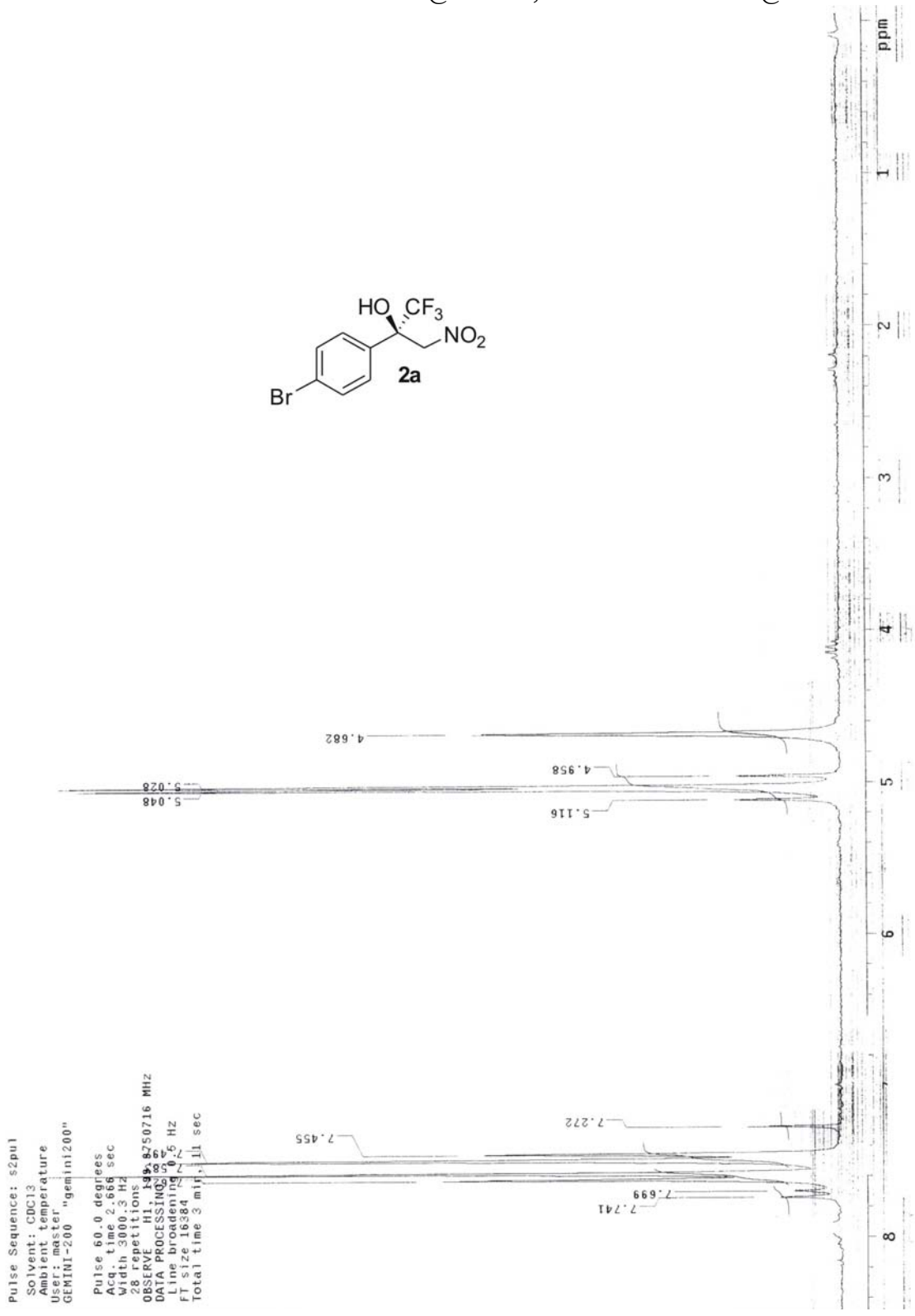
2l. Pale yellow solid. Yield = 71%. Ee = 92%. $[\alpha]_D$ = - 2.54 (*c* = 2.7, $CHCl_3$). HPLC analysis: AD column (210 nm), 30 °C, method: *n*-Hex:IPA = 85:15, flow 0.6 ml/min, $t_{(minor)}$ = 22.8 min, $t_{(major)}$ = 25.5 min. ^{1}H-NMR (200 MHz, $CDCl_3$): δ 5.07 (d, J = 14.0 Hz, 1H), 5.17 (d, J = 14.0 Hz, 1H), 5.94 (t, $^2J_{H-F}$ = 55.2 Hz, 1H), 7.53–7.68 (m, 3H), 7.88-7.93 (m, 3H), 8.07 (br s, 1H). ^{13}C-NMR (50 MHz, $CDCl_3$): δ 75.5 (t, $^2J_{H-F}$ = 22.7 Hz), 76.3, 115.0 (t, $^1J_{C-F}$ = 248.9 Hz), 125.8 129.0(2C), 129.5(2C), 134.8. ^{19}F-NMR (282 MHz, $CDCl_3$): δ -129.2 (dd, $^2J_{H-F}$ = 55.2 Hz, $^2J_{H-F}$ = 282.0 Hz, 1H), -130.9 (dd, $^2J_{H-F}$ = 55.2 Hz, $^2J_{H-F}$ = 282.0 Hz, 1H). IR (CH_2Cl_2): 3442, 3020, 2926, 1636, cm^{-1}. ESI-MS: (M+1): 268, (M+Na): 299.

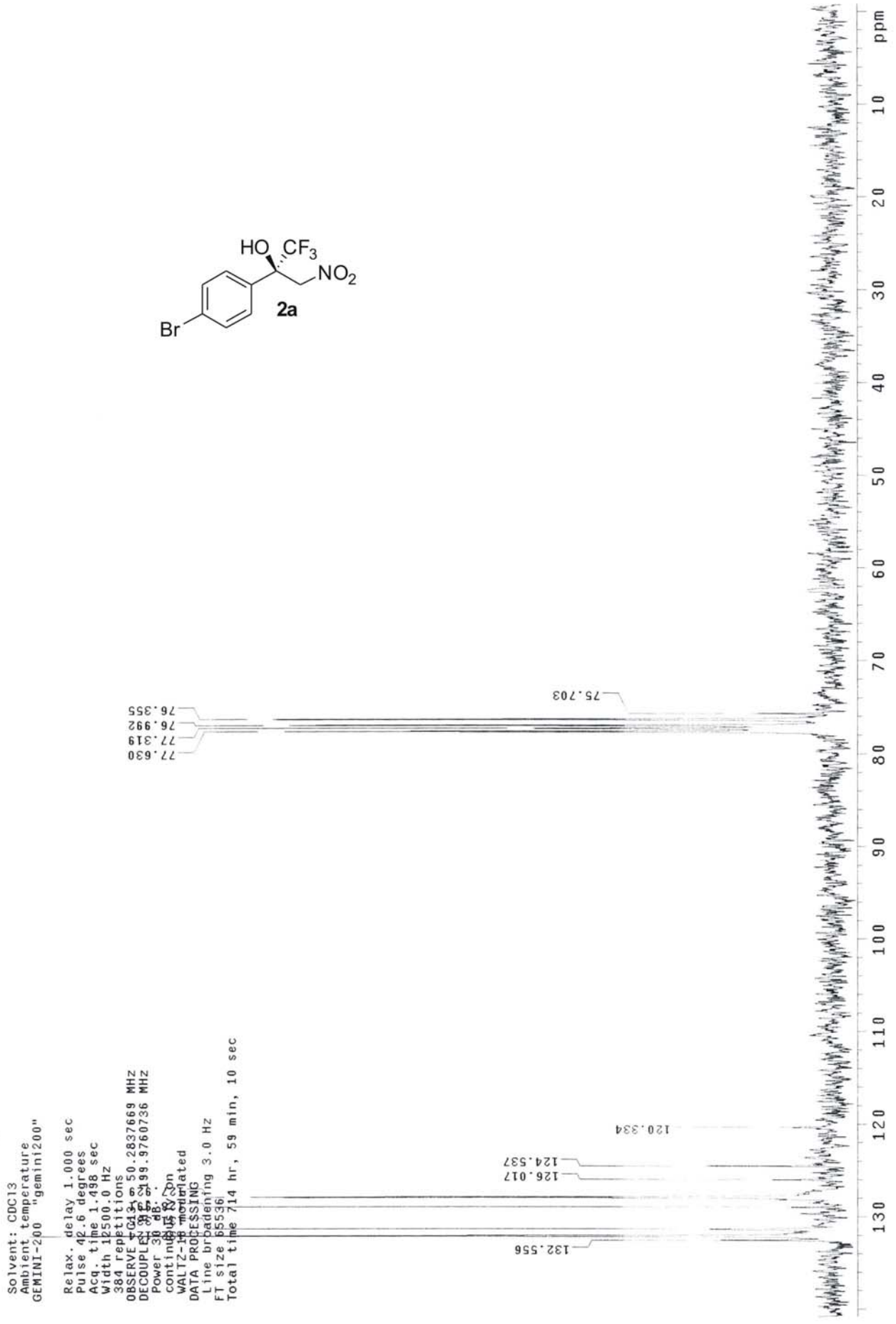
[1] H. Li, B. Wang, L. Deng, *J. Am. Chem. Soc.* **2006**, *128*, 732 – 733.

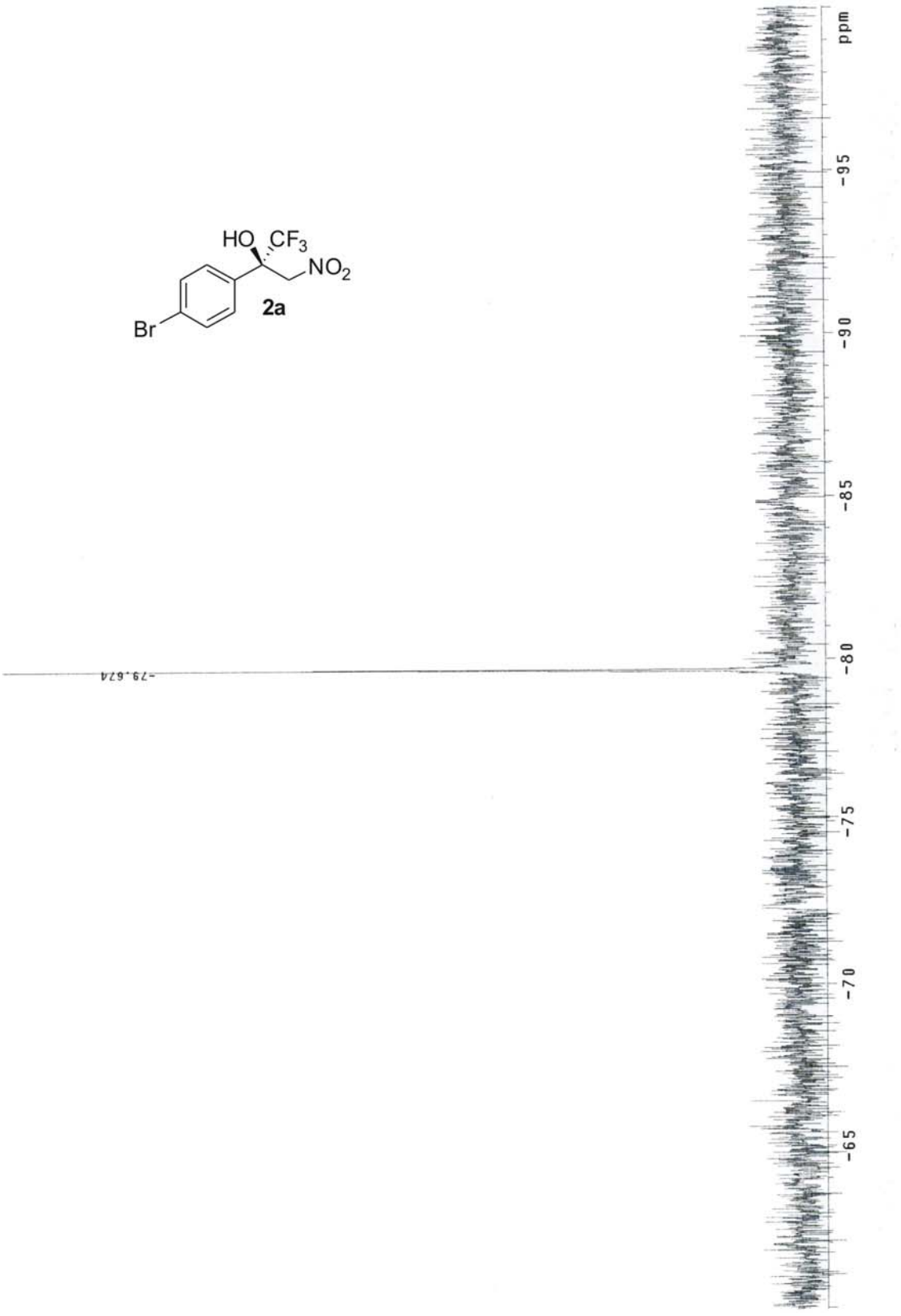
[2] L. Liu, Y. Zhang, B. Xin, *J.Org.Chem.* **2006**, *71*, 3994-3997.

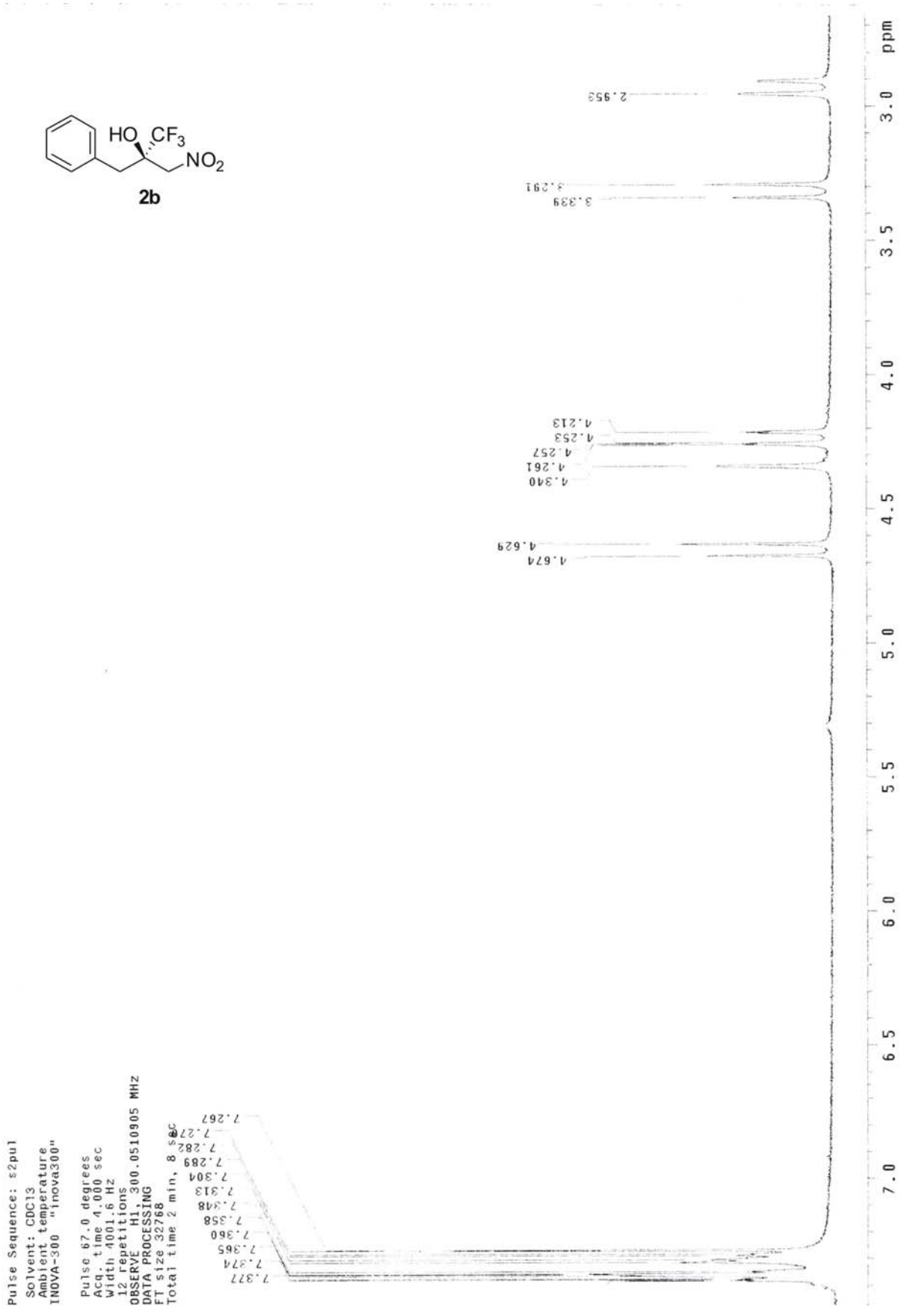
[3] F. Tur, J. M. Saa, *Org.Lett.* **2007**, *9*, 5079-5082.

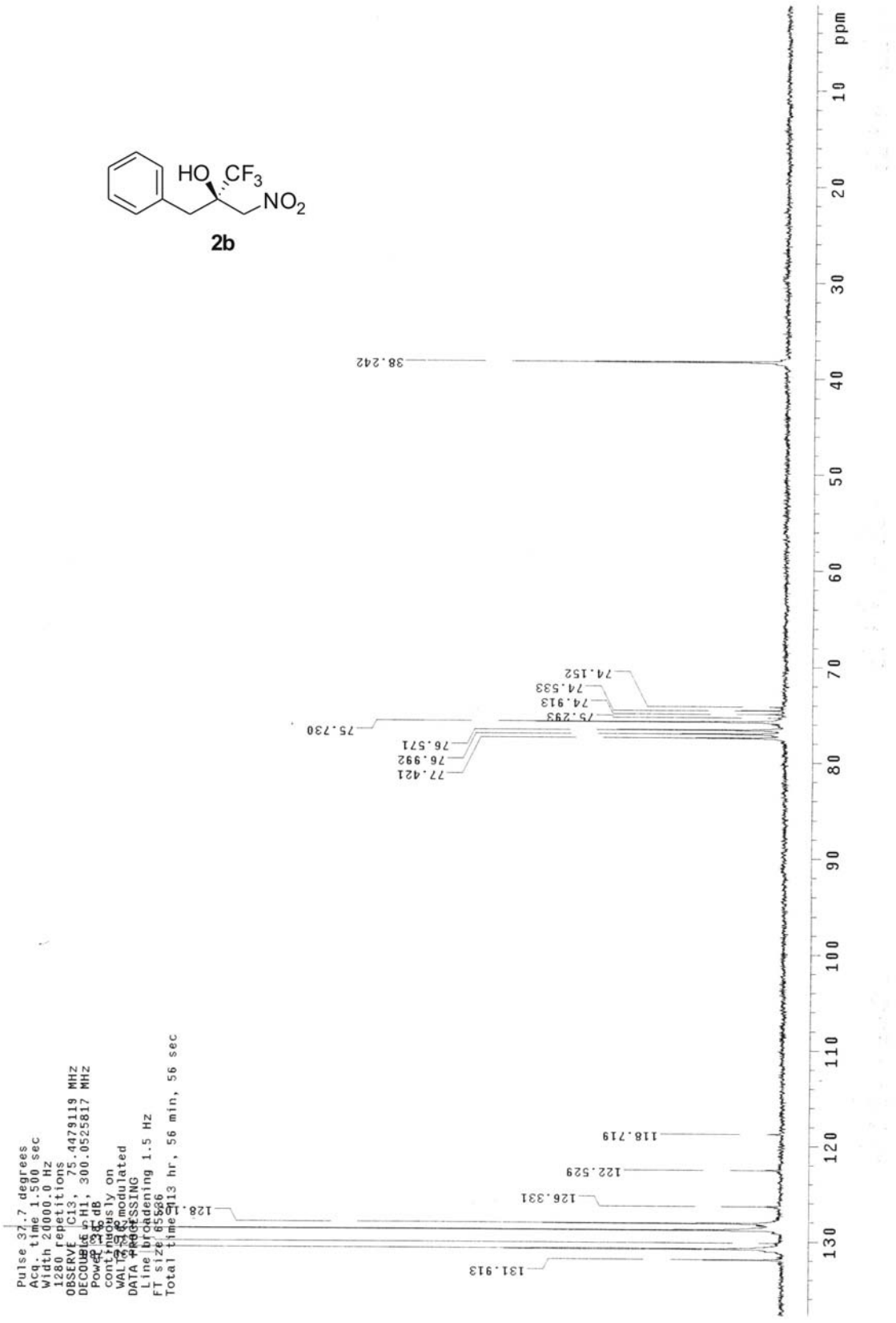
**E-mail: marco.bandini@unibo.it, achille.umanironchi@unibo.it*

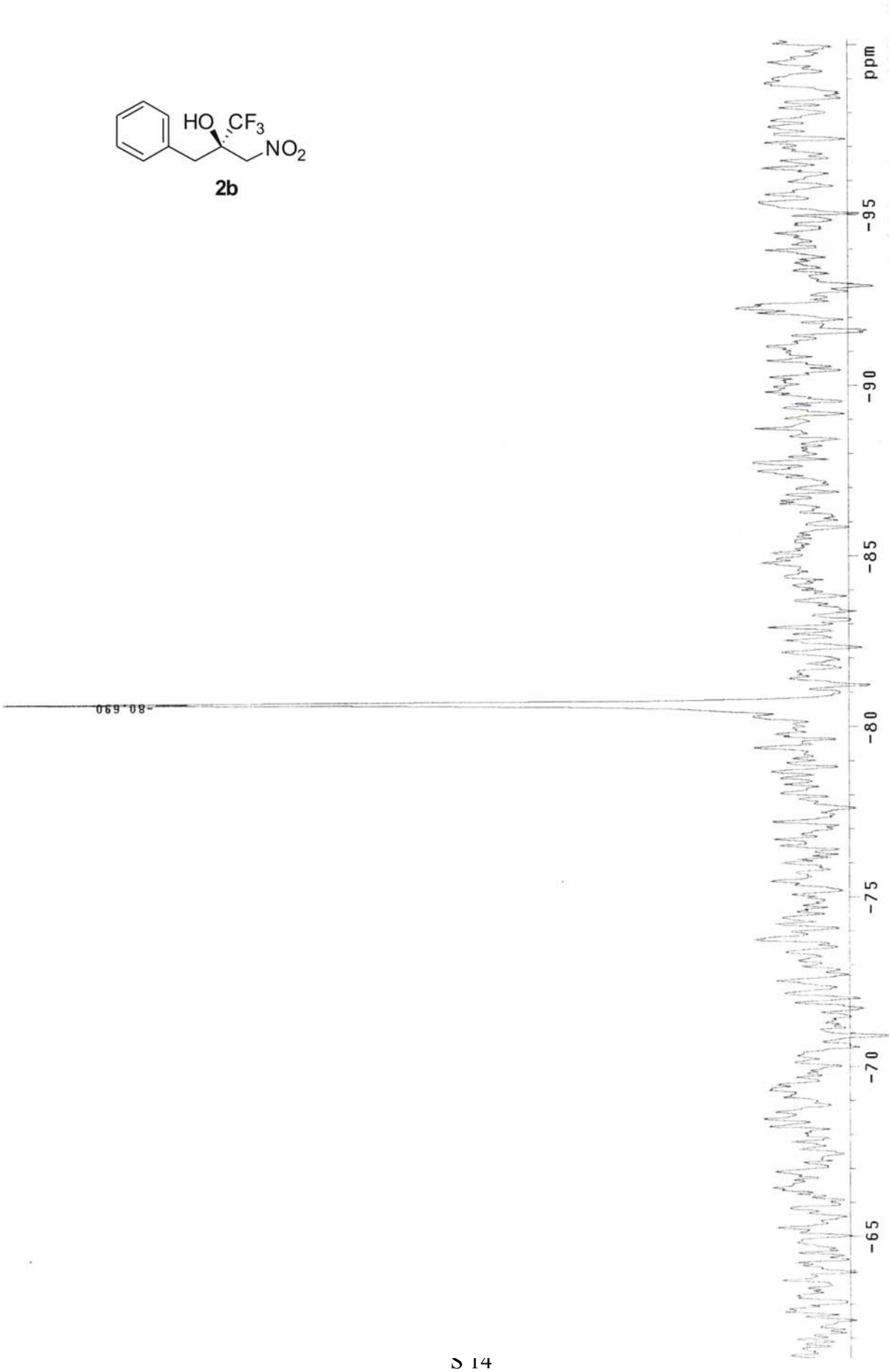


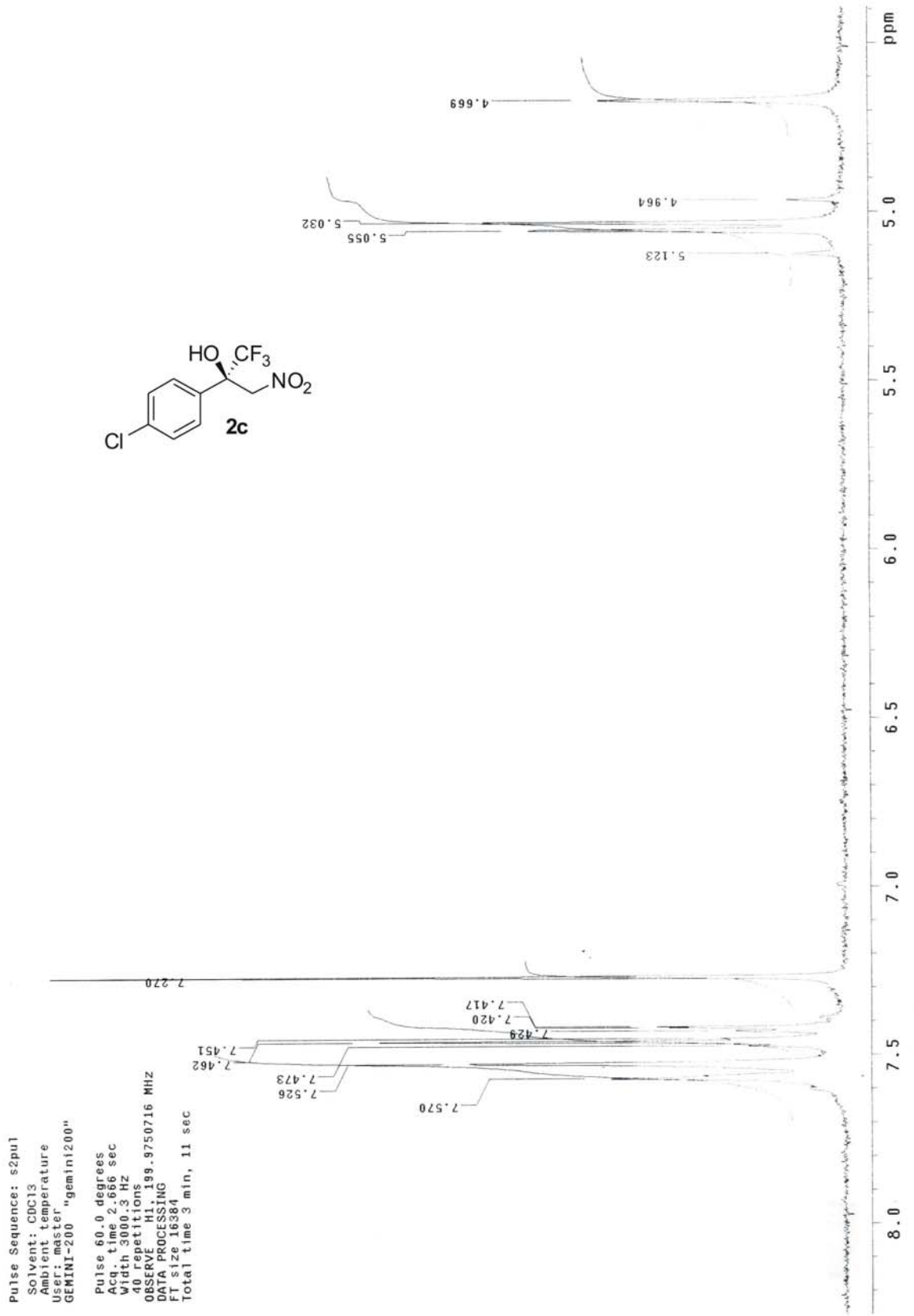

HO
CF3
NO2
Br
2a
ppm
10
20
30
40
50
60
70
80
90
100
110
120
130
75.703
76.355
76.992
77.319
77.630
120.334
124.537
126.017
132.556
Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
384 repetitions
OBSERVE C13, 50.2837669 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 3.0 Hz
FT size 65536
Total time 714 hr, 59 min, 10 sec

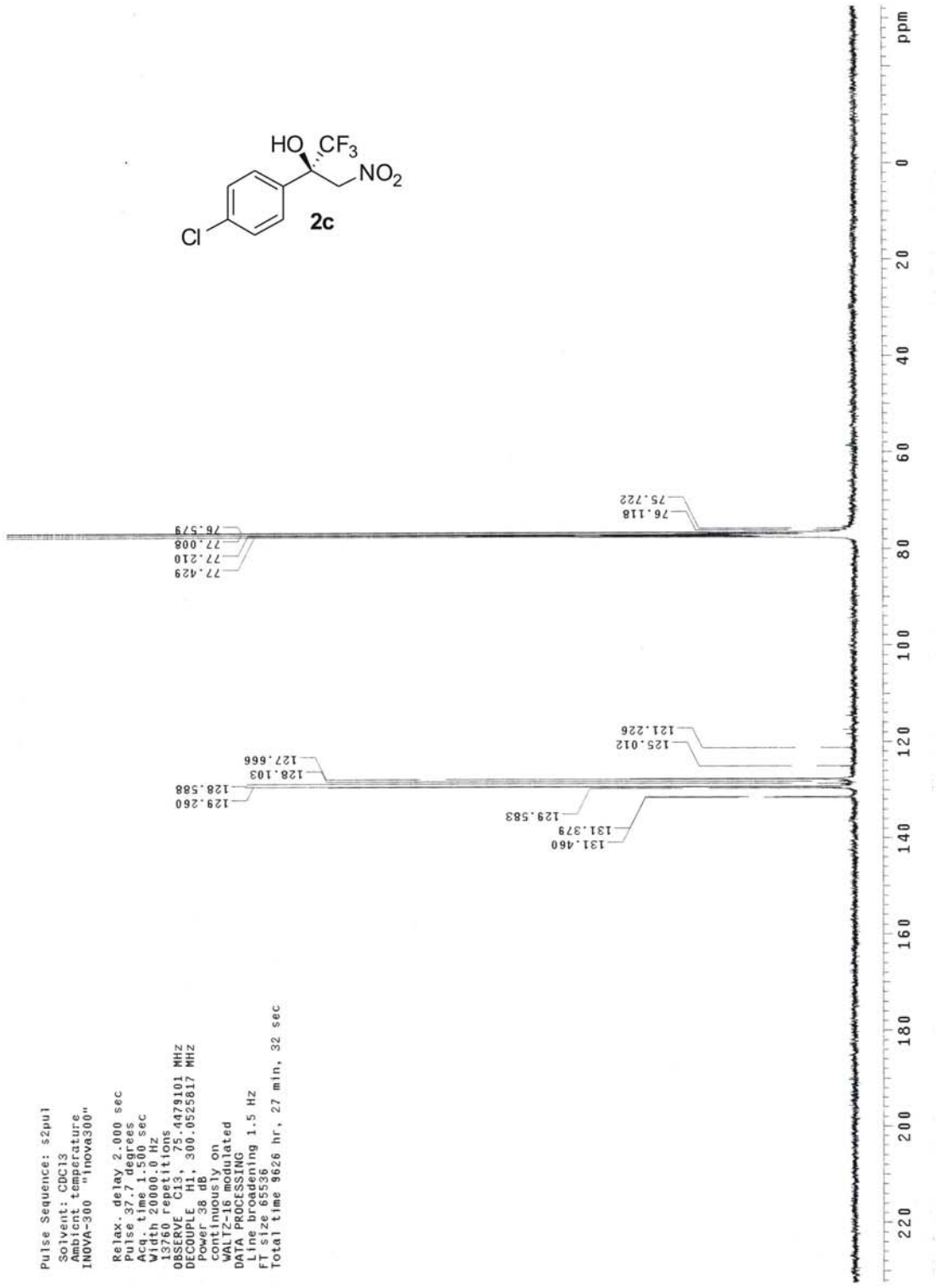

HO
CF3
NO2
Br
2a
-79.624
ppm
-95
-90
-85
-80
-75
-70
-65

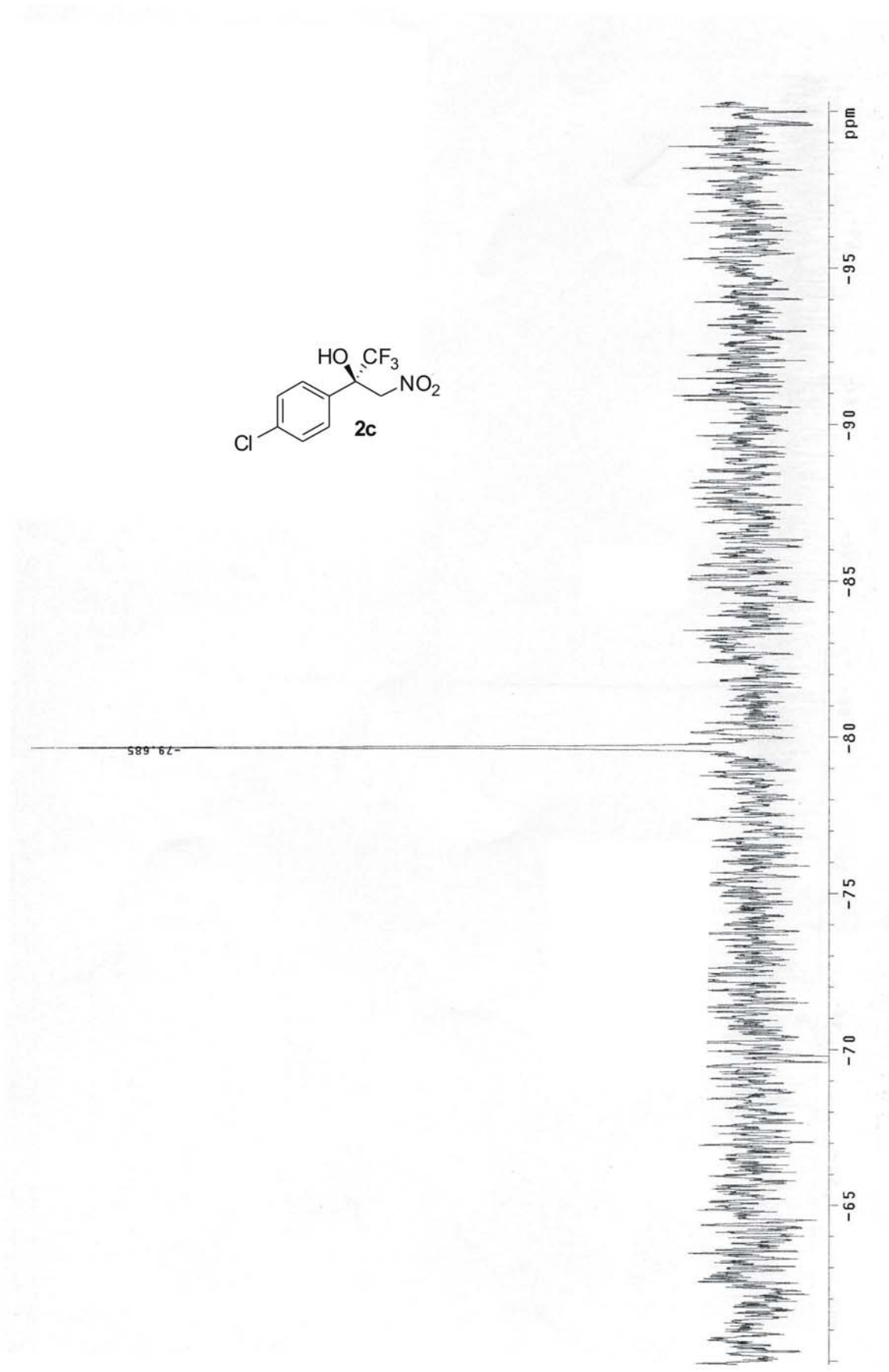

HO
CF3
NO2
2b
2.958
3.291
3.339
4.213
4.253
4.257
4.261
4.340
4.629
4.674
7.267
7.272
7.282
7.289
7.304
7.313
7.348
7.358
7.360
7.365
7.374
7.377
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 sec
Width 4001.6 Hz
12 repetitions
OBSERVE H1, 300.0510905 MHz
DATA PROCESSING
FT size 32768
Total time 2 min, 8 sec
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
ppm

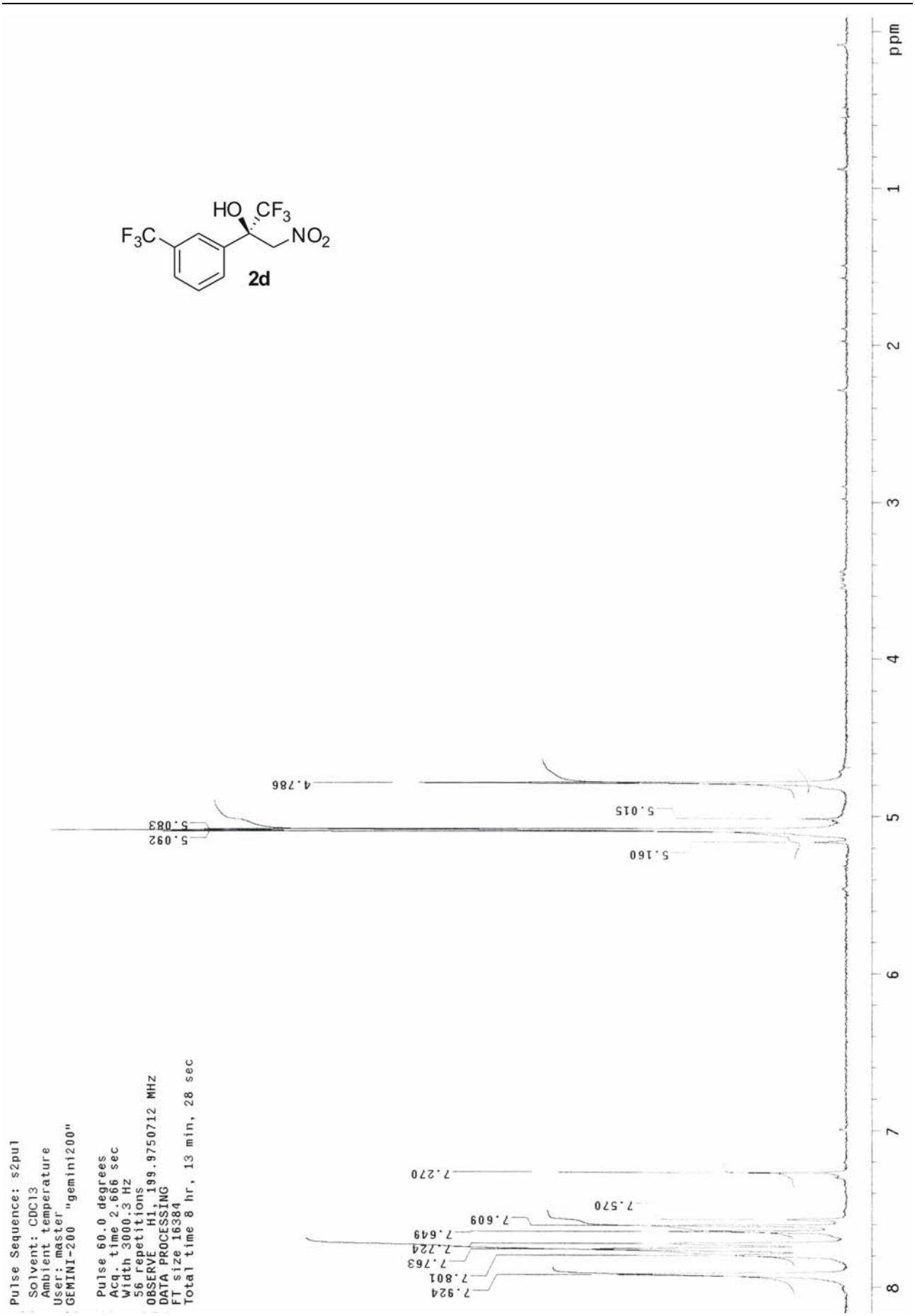

HO
CF3
NO2
2b
38.242
75.730
74.152
74.533
74.913
75.293
76.571
76.992
77.421
118.719
122.529
126.331
128.
131.913
ppm

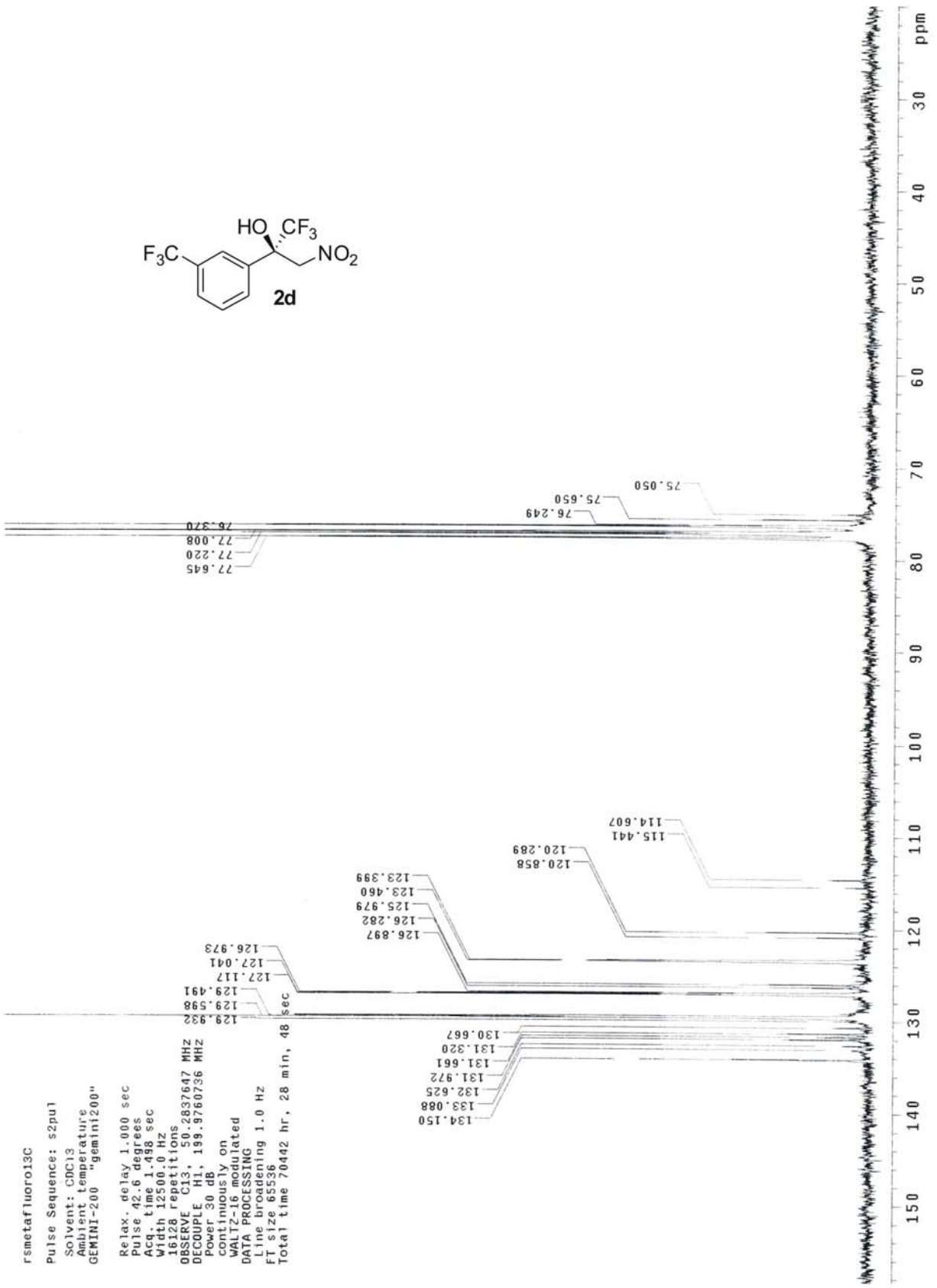

HO
CF3
NO2
2b
ppm
-95
-90
-85
-80
-75
-70
-65
-80.690

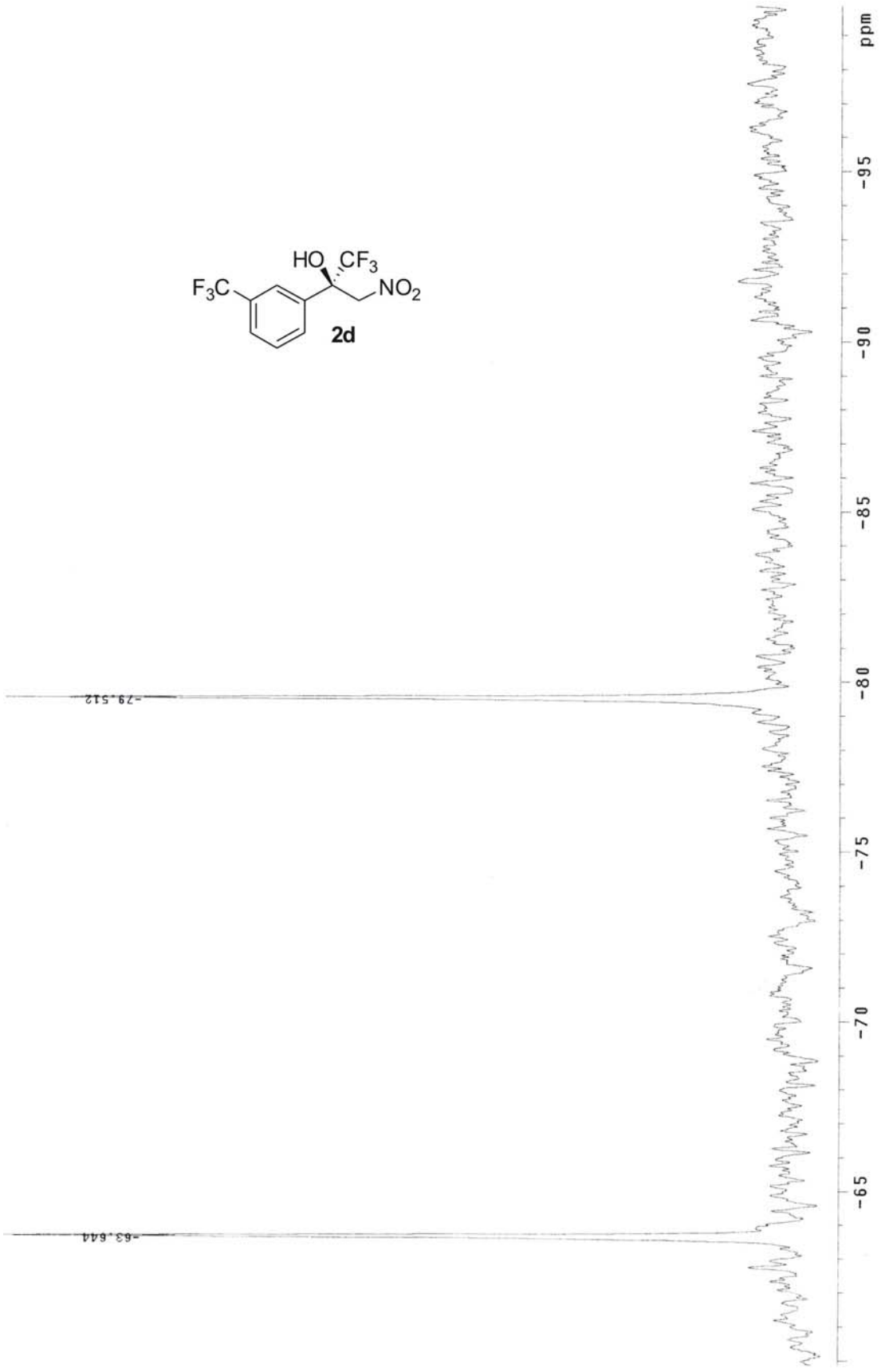

HO
CF3
NO2
Cl
2c
4.669
4.964
5.032
5.055
5.123
7.220
7.417
7.420
7.429
7.451
7.462
7.473
7.526
7.570
ppm
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
User: master "gemini200"
Pulse 60.0 degrees
Acq. time 2.666 sec
Width 3000.3 Hz
40 repetitions
OBSERVE H1, 199.9750716 MHz
DATA PROCESSING
FT size 16384
Total time 3 min, 11 sec

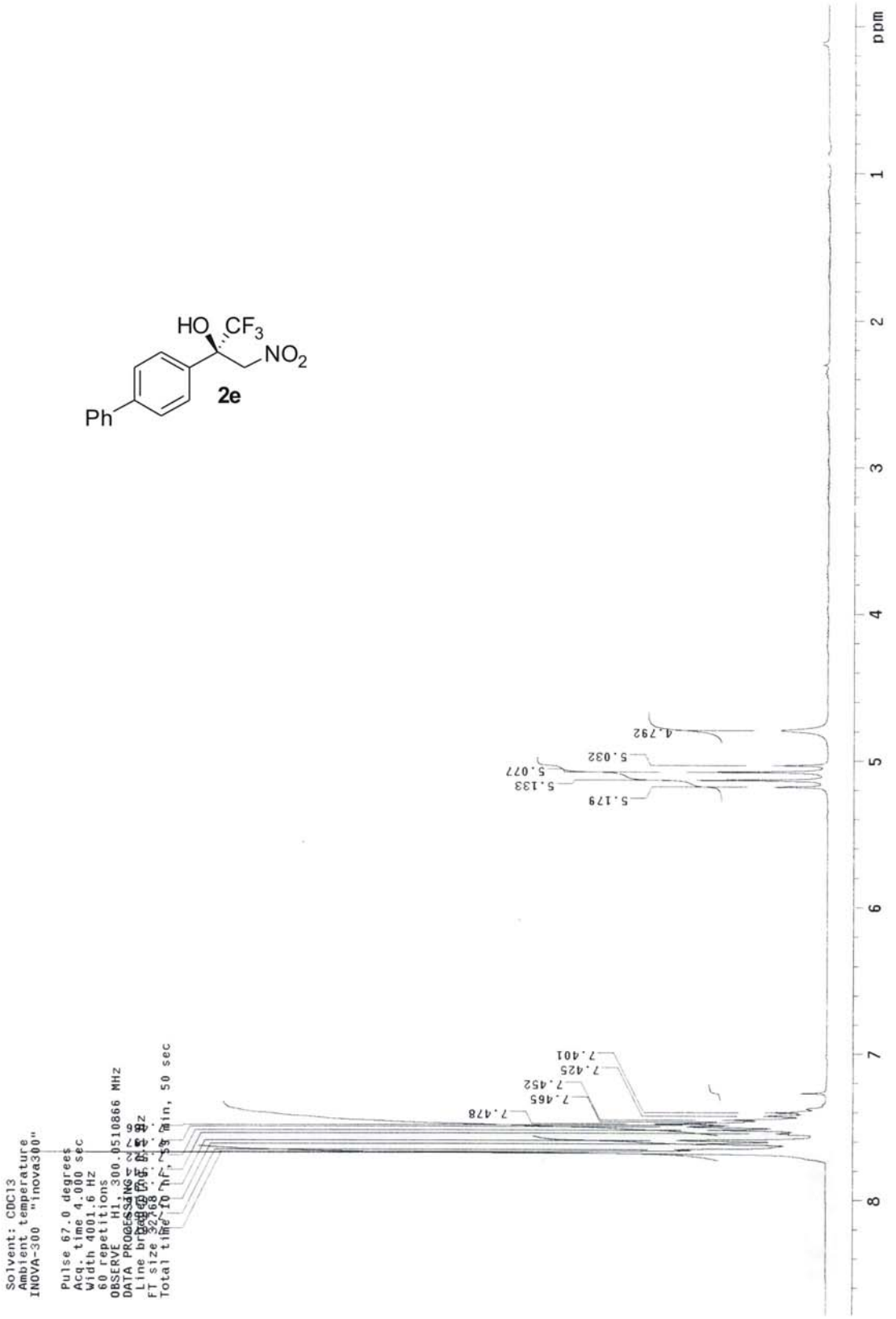

HO
CF3
NO2
Cl
2c
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
INOVA-300 "Inova300"
Relax. delay 2.000 sec
Pulse 37.7 degrees
Acq. time 1.500 sec
Width 20000.0 Hz
13760 repetitions
OBSERVE C13, 75.4479101 MHz
DECOUPLE H1, 300.0525817 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.5 Hz
FT size 65536
Total time 9626 hr, 27 min, 32 sec
76.579
77.008
77.210
77.429
75.722
76.118
121.226
125.012
127.666
128.103
128.588
129.260
129.583
131.379
131.460
ppm

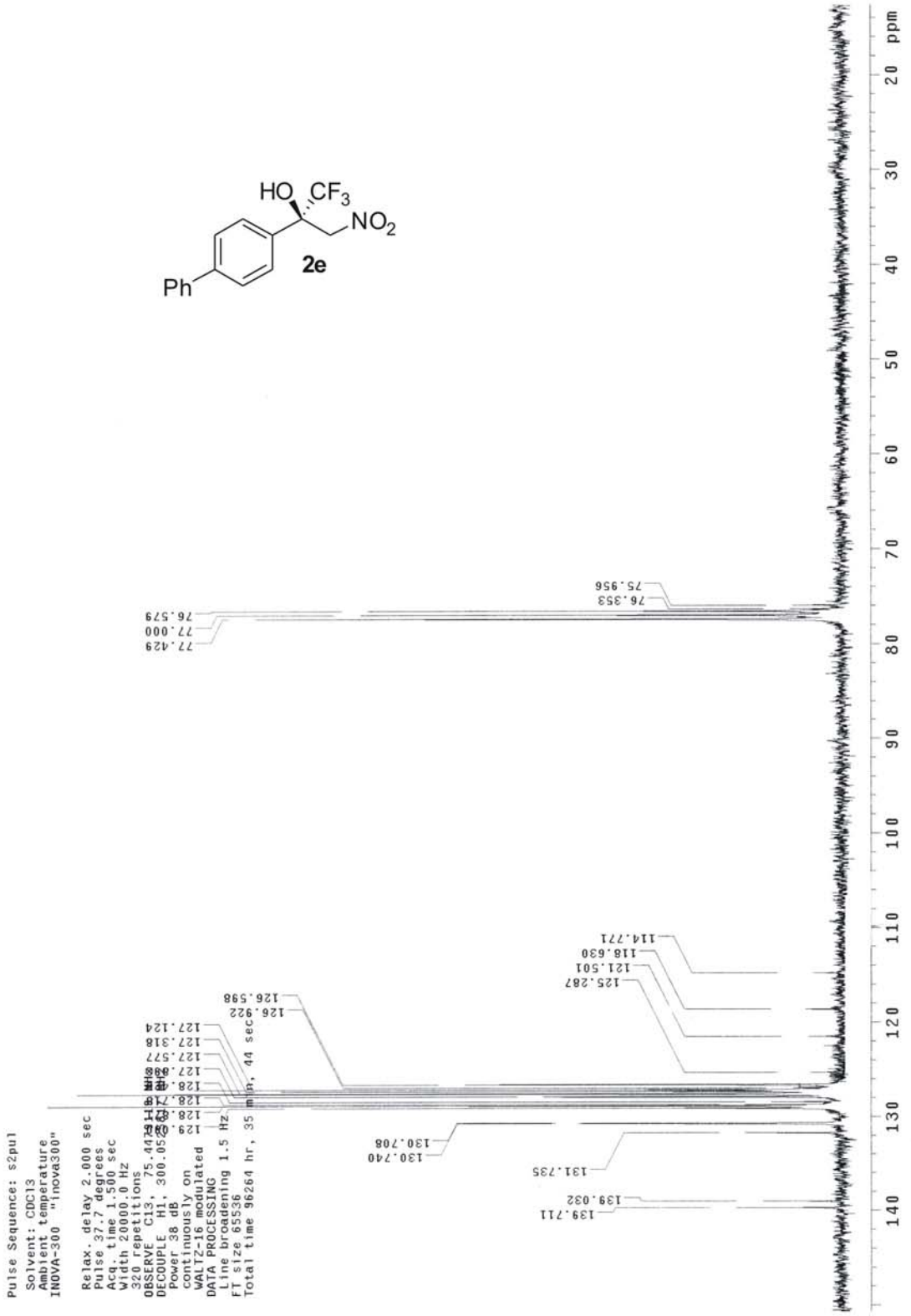

HO
CF3
NO2
Cl
2c
-79.685
ppm
-95
-90
-85
-80
-75
-70
-65

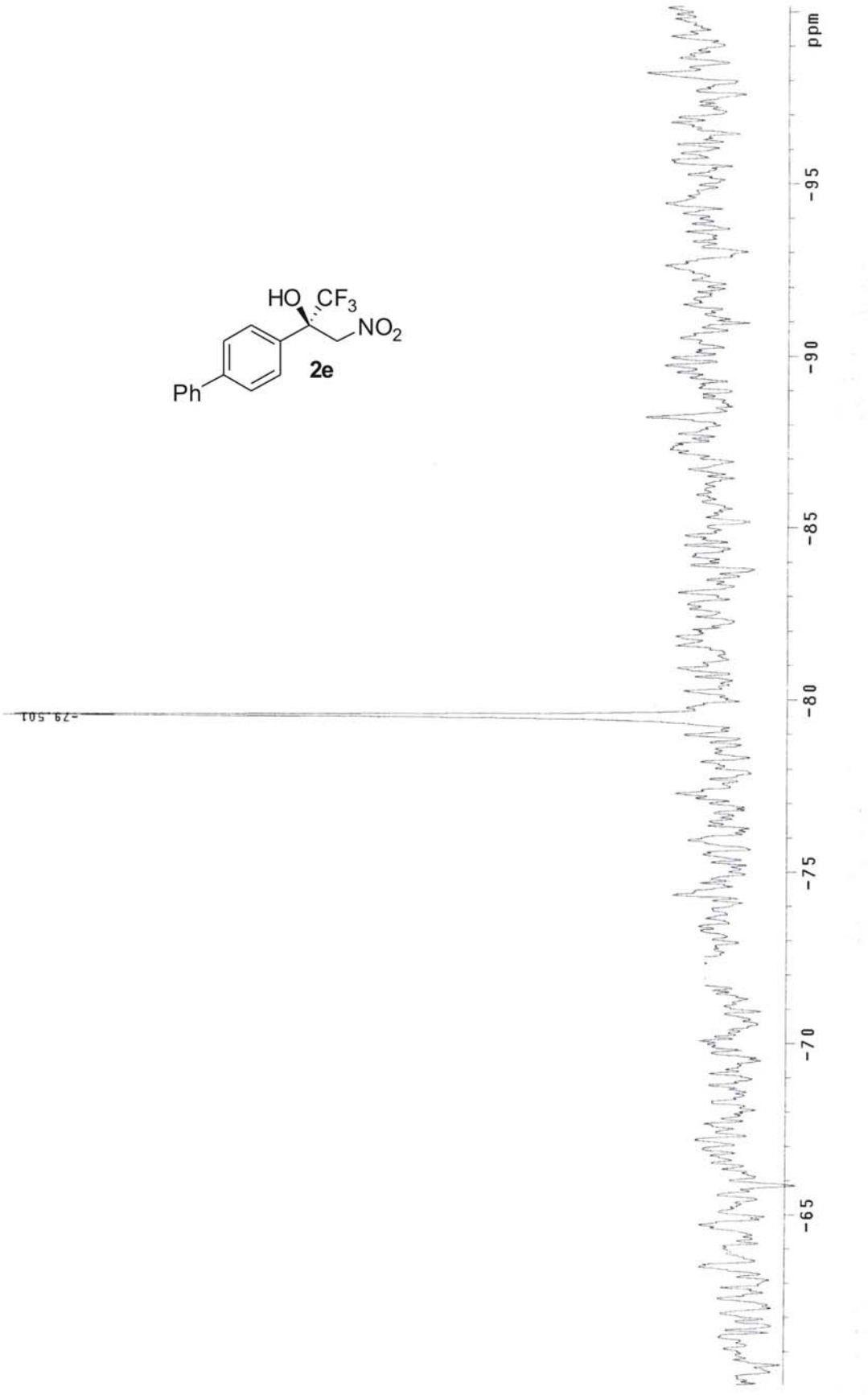

HO
CF3
F3C
NO2
2d
4.786
5.015
5.092
5.083
5.160
7.270
7.570
7.609
7.649
7.724
7.763
7.801
7.924
ppm
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
User: master
GEMINI-200 "gemini200"
Pulse 60.0 degrees
Acq. time 2.666 sec
Width 3000.3 Hz
56 repetitions
OBSERVE H1 199.9750712 MHz
DATA PROCESSING
FT size 16384
Total time 8 hr, 13 min, 28 sec

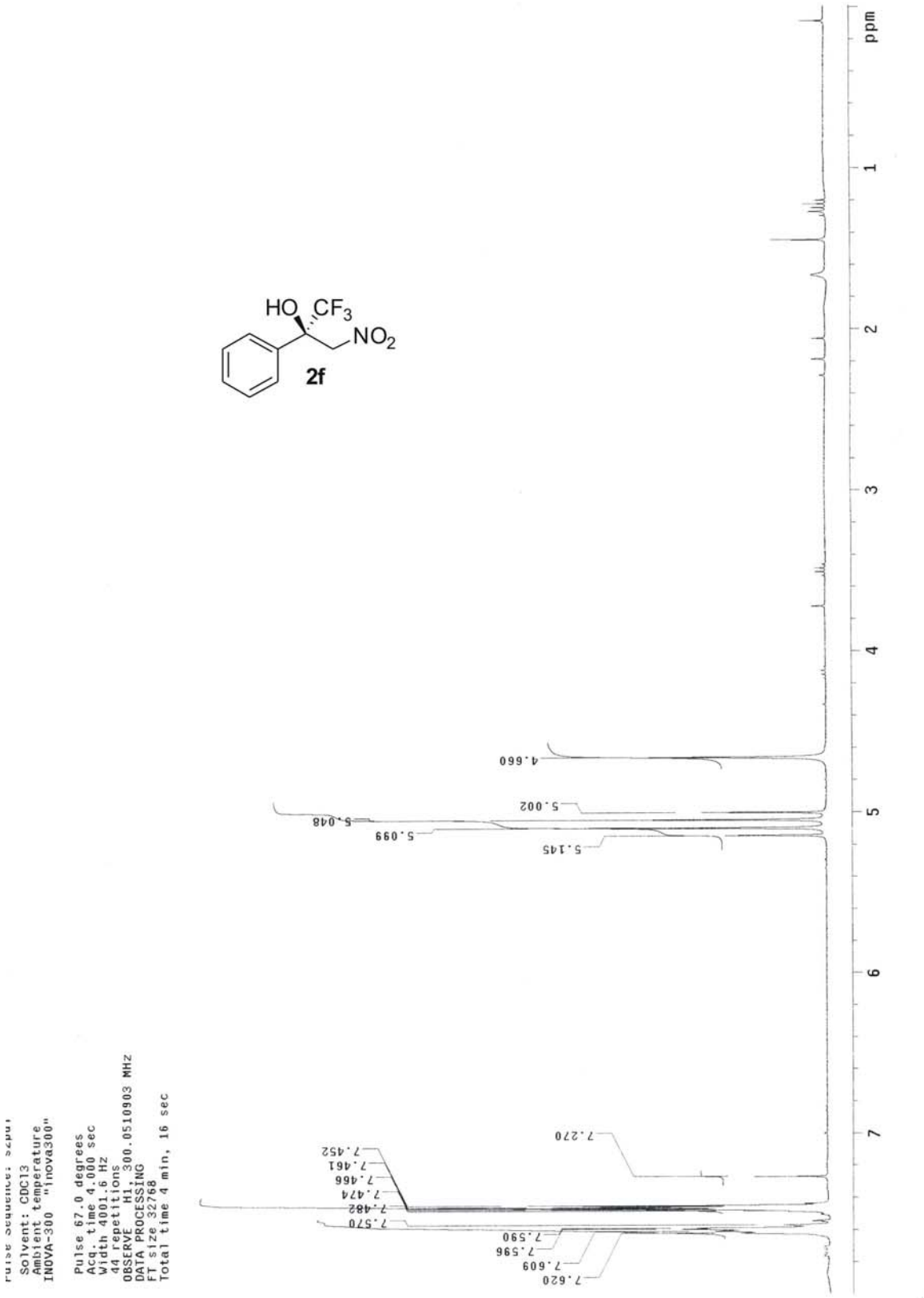

HO
CF3
F3C
NO2
2d
ppm
rsmetafluoro13C
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
16128 repetitions
OBSERVE C13, 50.2837647 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 65536
Total time 70442 hr, 28 min, 48 sec

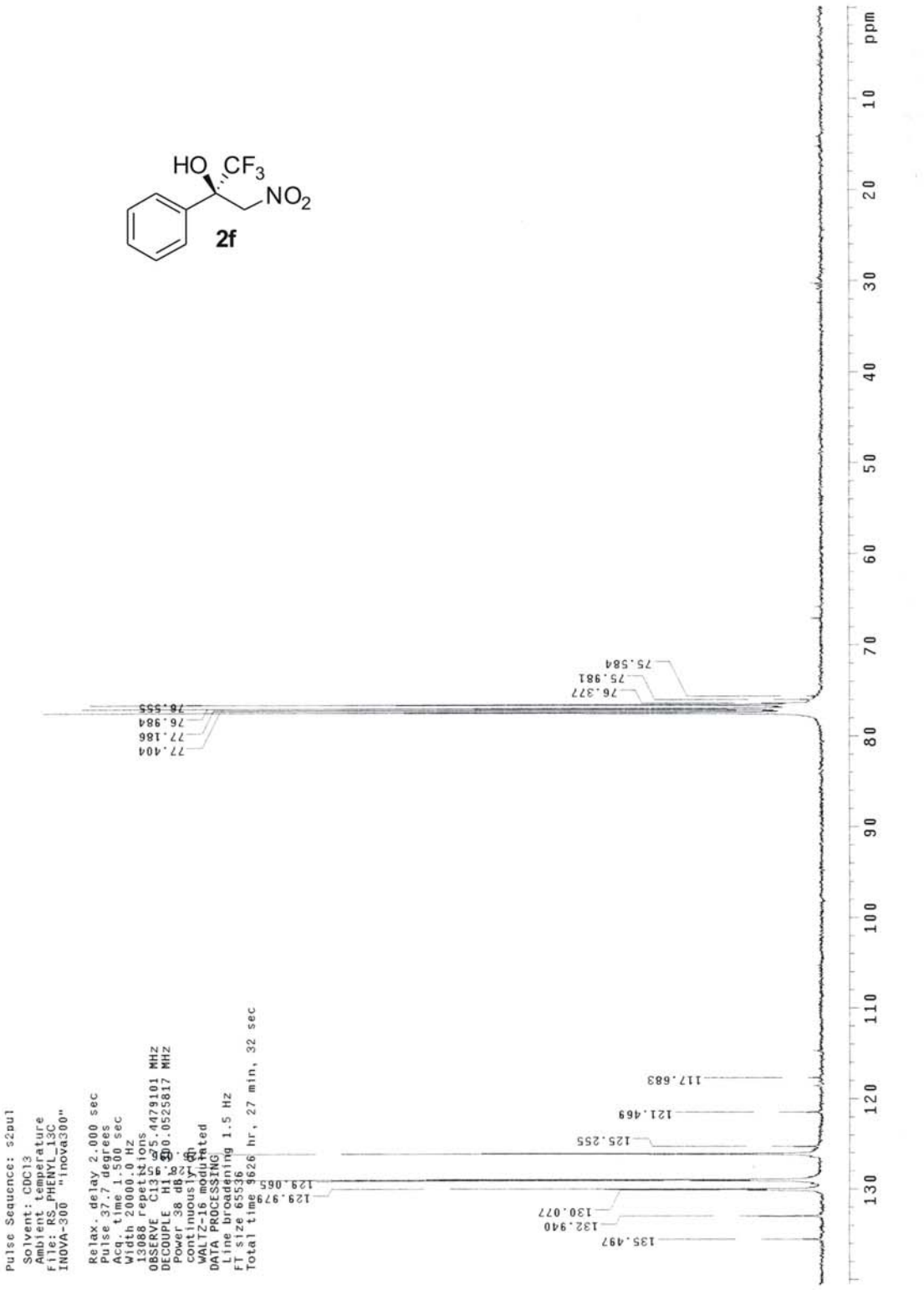

HO
CF3
F3C
NO2
2d
-79.512
-63.644
ppm
-95
-90
-85
-80
-75
-70
-65

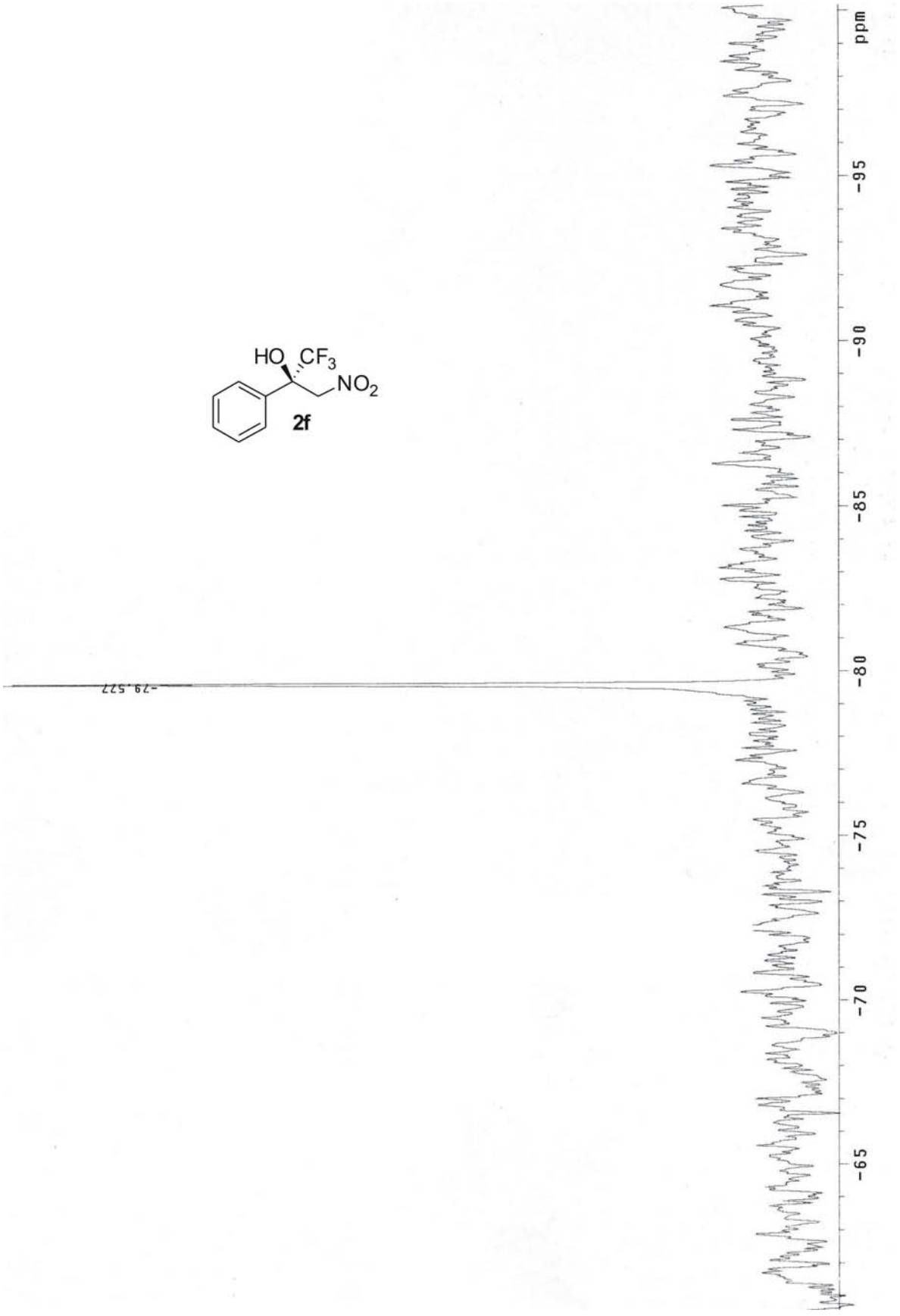

HO
CF3
NO2
Ph
2e
4.792
5.032
5.077
5.133
5.179
7.401
7.425
7.452
7.465
7.478
ppm
1
2
3
4
5
6
7
8
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 sec
Width 4001.6 Hz
60 repetitions
OBSERVE H1, 300.0510866 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 10 hr, 13 min, 50 sec

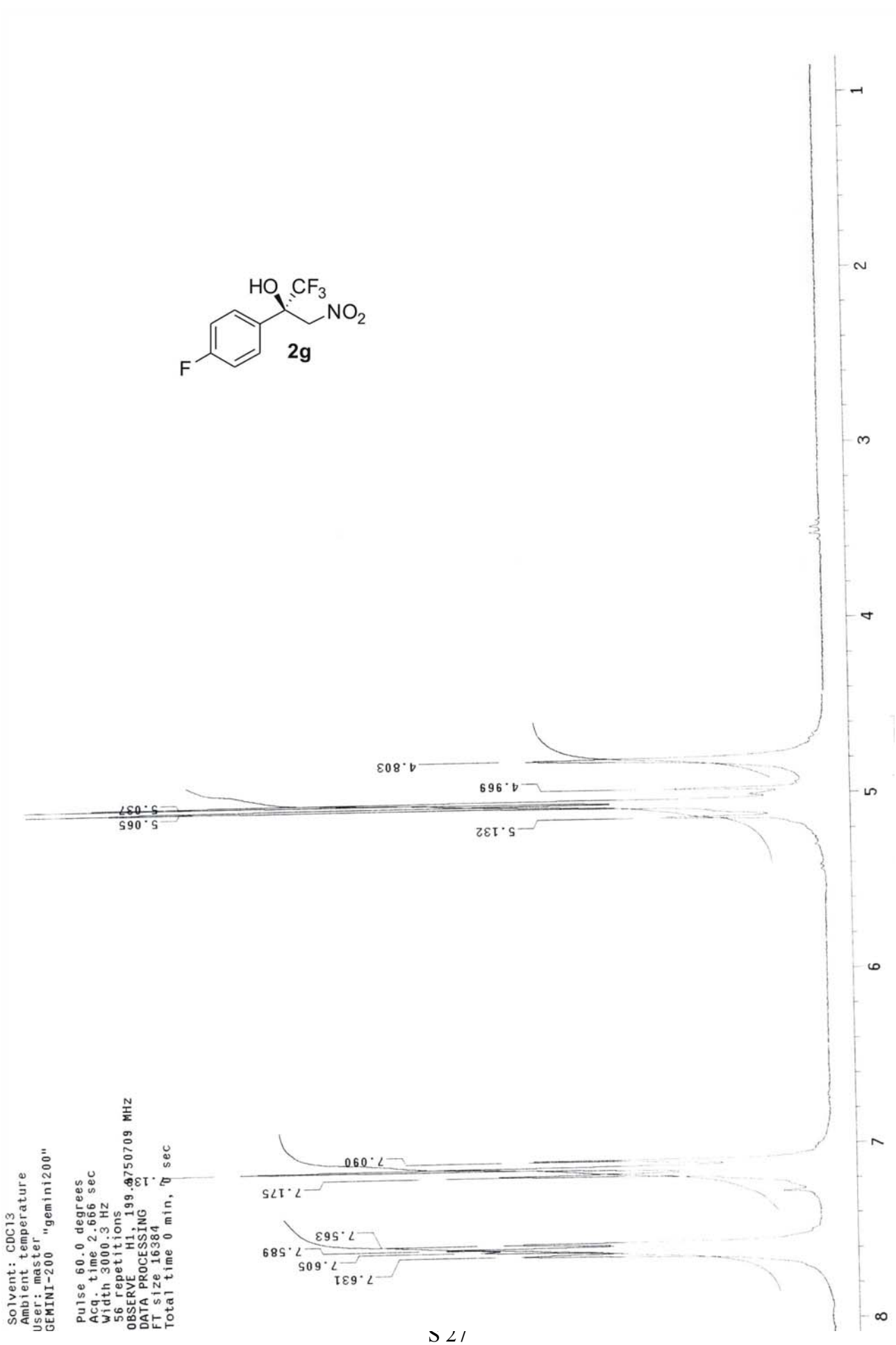

HO
CF3
NO2
Ph
2e
ppm
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Relax. delay 2.000 sec
Pulse 37.7 degrees
Acq. time 1.500 sec
Width 20000.0 Hz
320 repetitions
OBSERVE C13, 75.4478
DECOUPLE H1, 300.052
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.5 Hz
FT size 65536
Total time 96264 hr, 35 min, 44 sec
77.429
77.000
76.579
75.956
76.353
114.771
118.630
121.501
125.287
126.598
126.922
127.124
127.318
127.577
130.708
130.740
131.735
139.032
139.711

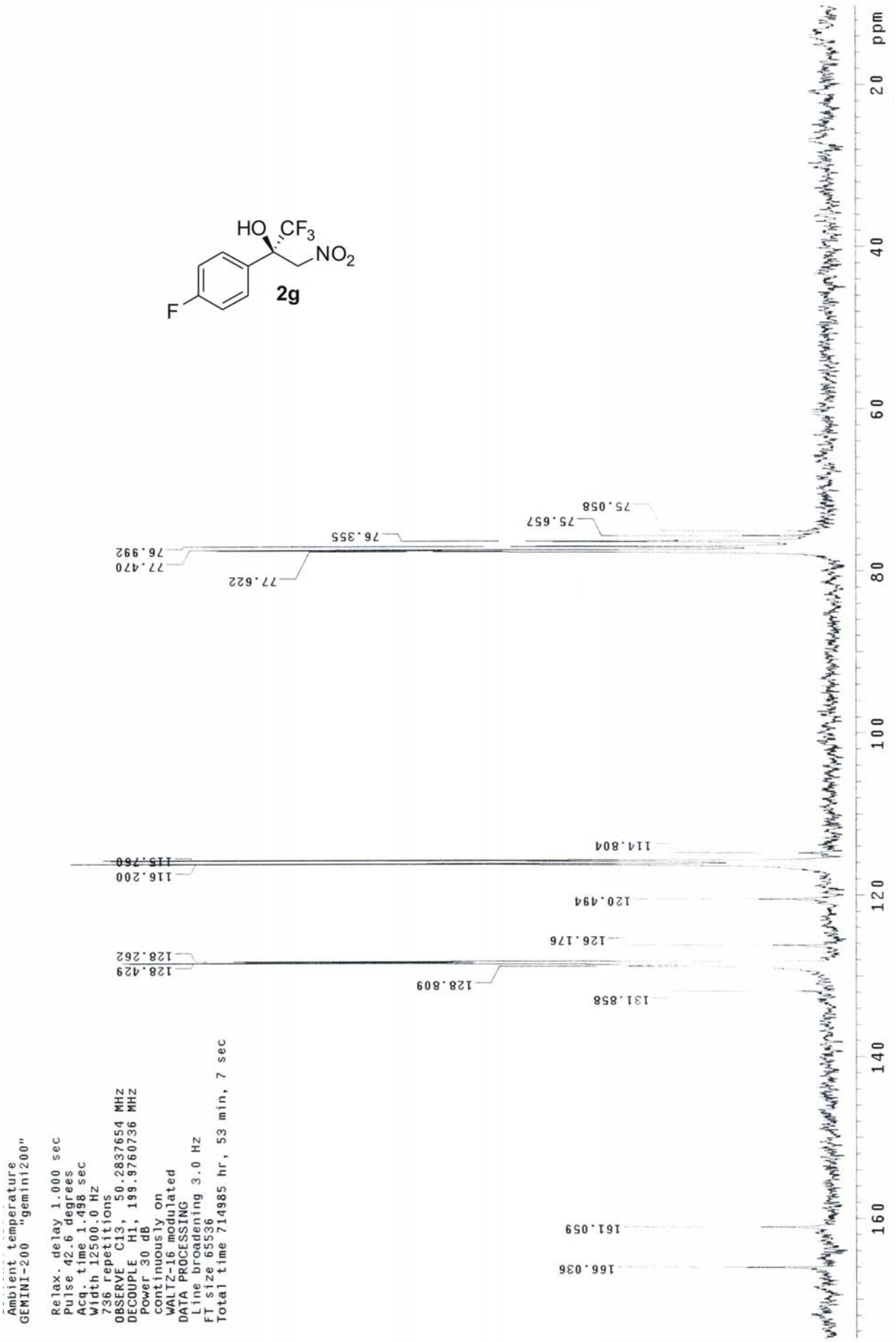

HO
CF3
NO2
Ph
2e
ppm
-95
-90
-85
-80
-75
-70
-65
-79.501

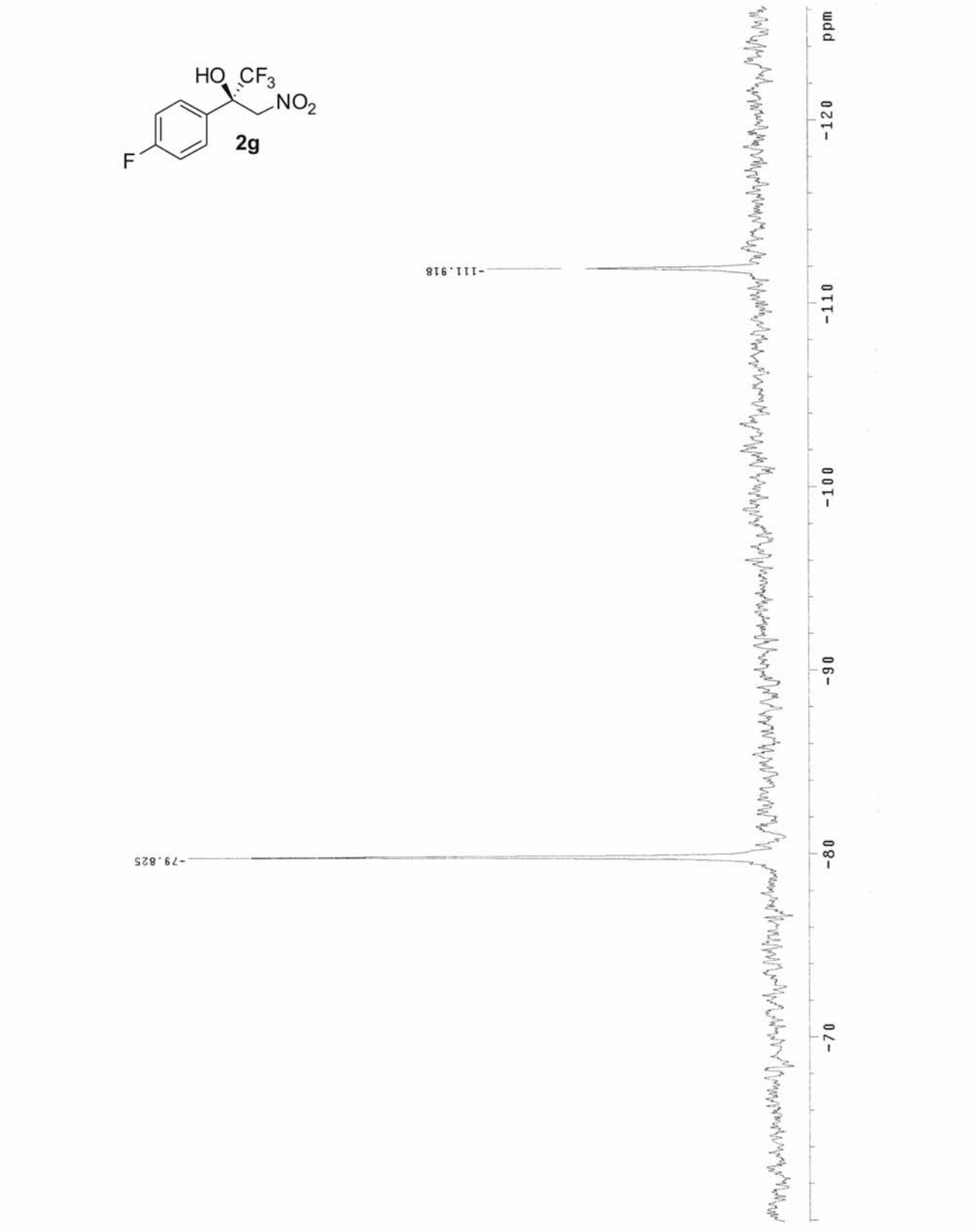

HO
CF3
NO2
2f
4.660
5.002
5.048
5.099
5.145
7.270
7.452
7.461
7.466
7.474
7.482
7.570
7.590
7.596
7.609
7.620
ppm
1
2
3
4
5
6
7
Pulse sequence: s2pul
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 sec
Width 4001.6 Hz
44 repetitions
OBSERVE H1, 300.0510903 MHz
DATA PROCESSING
FT size 32768
Total time 4 min, 16 sec

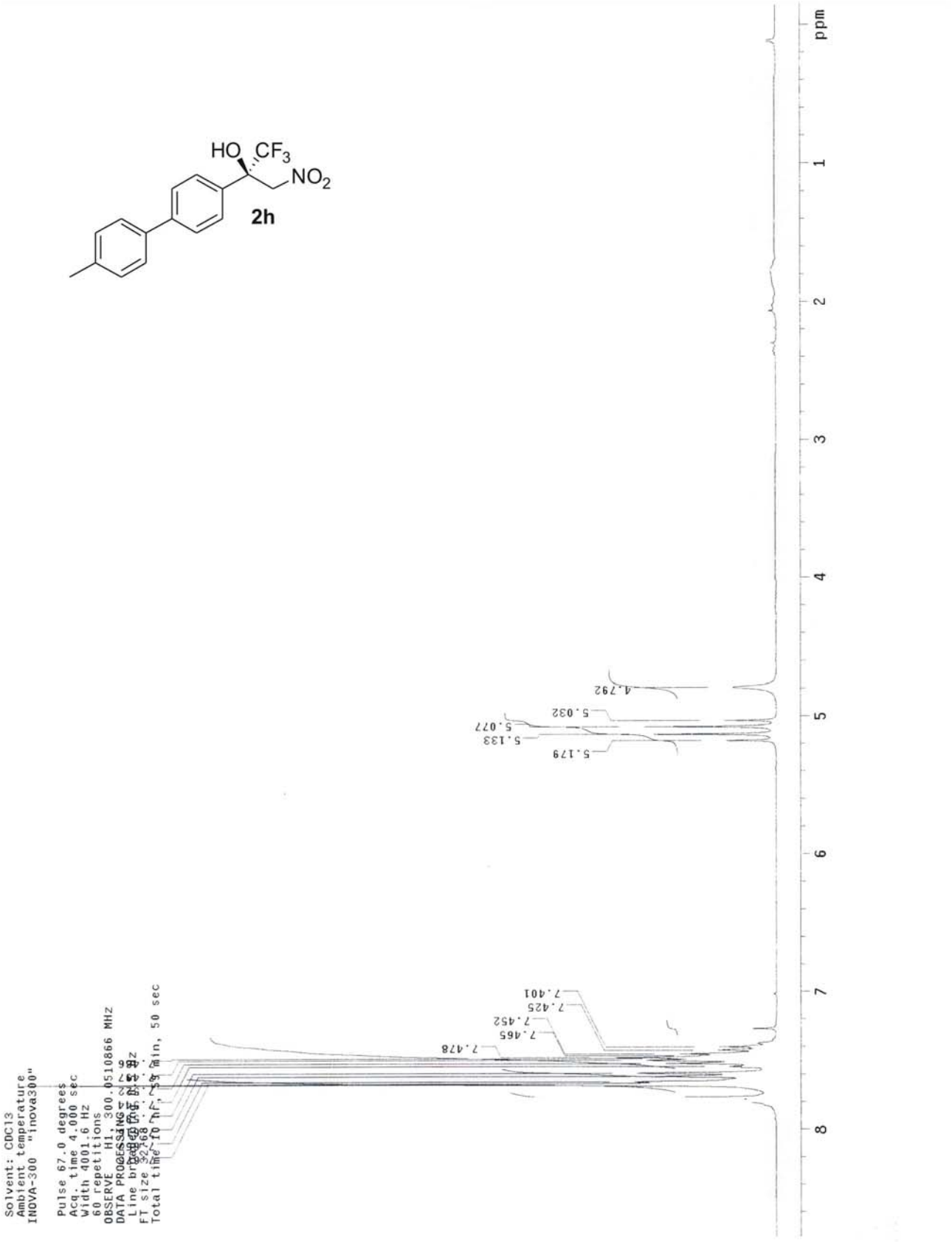

HO
CF3
NO2
2f
ppm
10
20
30
40
50
60
70
80
90
100
110
120
130
75.584
75.981
76.377
76.555
76.984
77.186
77.404
117.683
121.469
125.255
129.065
129.979
130.077
132.940
135.497
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: RS_PHENYL_13C
INOVA-300 "inova300"
Relax. delay 2.000 sec
Pulse 37.7 degrees
Acq. time 1.500 sec
Width 20000.0 Hz
13088 repetitions
OBSERVE C13 75.4479101 MHz
DECOUPLE H1 300.0525817 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.5 Hz
FT size 65536
Total time 9626 hr, 27 min, 32 sec

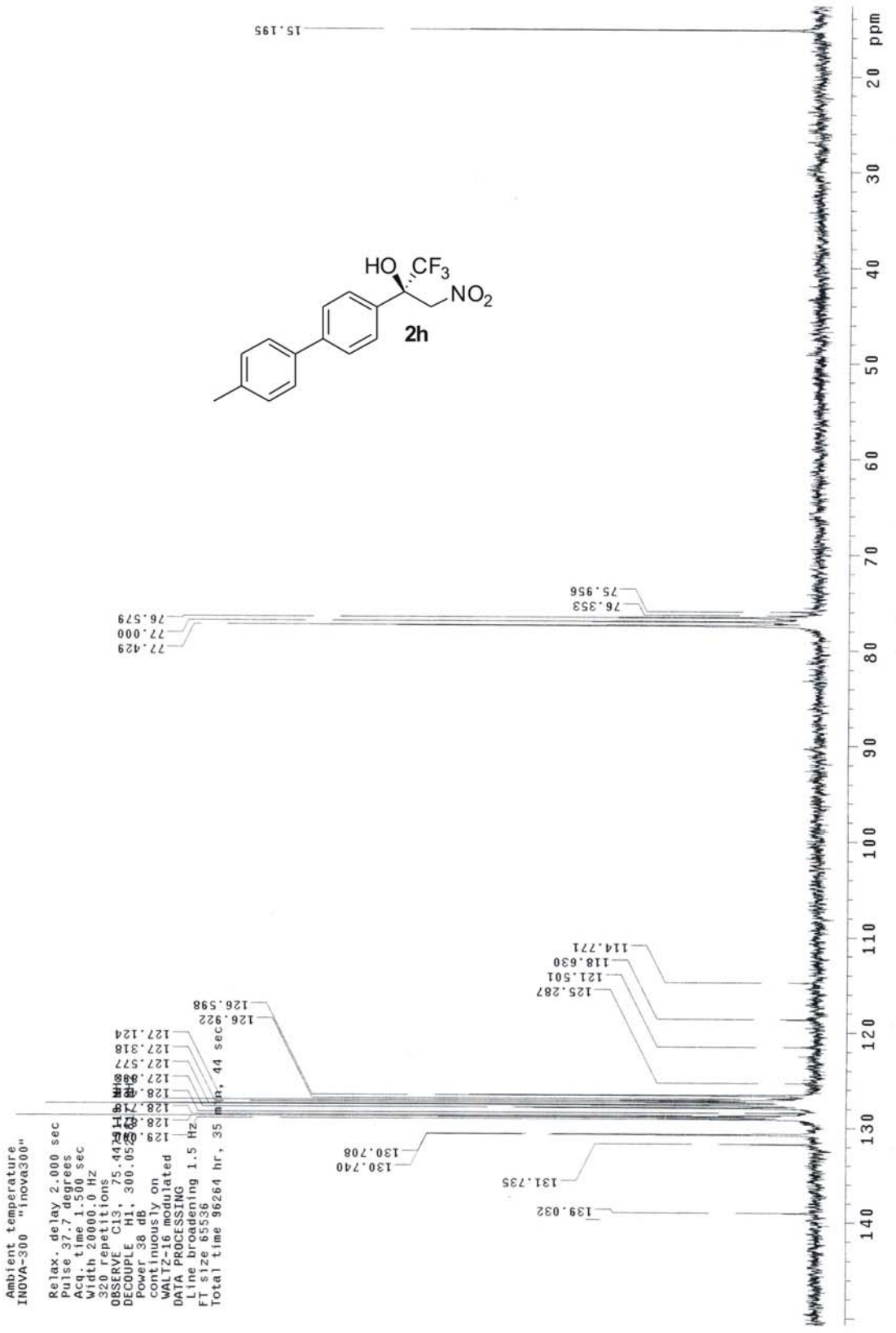

HO
CF3
NO2
2f
-79.527
ppm
-95
-90
-85
-80
-75
-70
-65

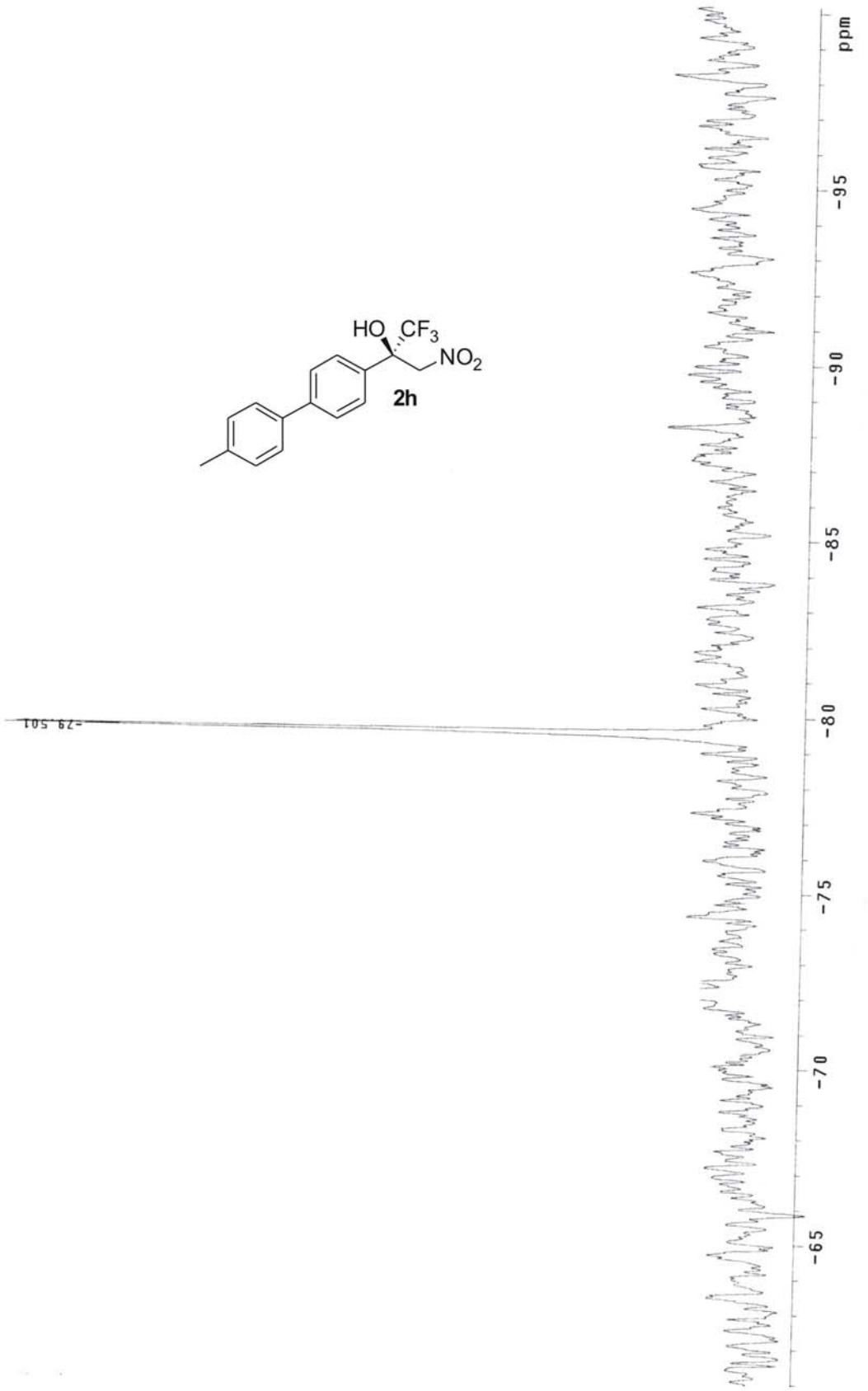

HO
CF3
NO2
F
2g
4.803
4.969
5.057
5.065
5.132
7.090
7.175
7.563
7.589
7.605
7.631
Solvent: CDCl3
Ambient temperature
User: master
GEMINI-200 "gemini200"
Pulse 60.0 degrees
Acq. time 2.666 sec
Width 3000.3 Hz
56 repetitions
OBSERVE H1, 199.9750709 MHz
DATA PROCESSING
FT size 16384
Total time 0 min, 0 sec

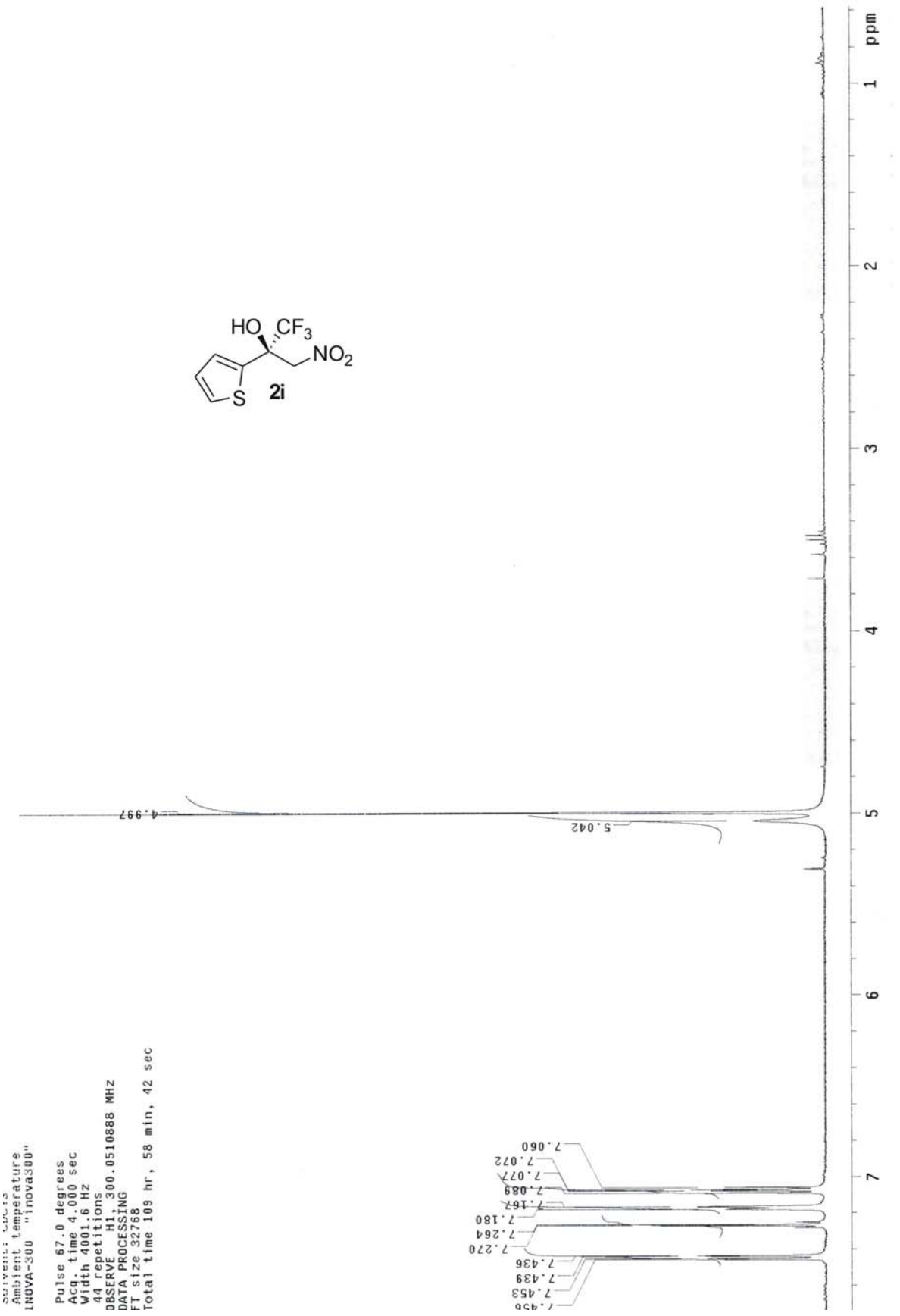

HO
CF3
NO2
F
2g
ppm
20
40
60
80
100
120
140
160
75.058
75.657
76.355
76.992
77.470
77.622
114.804
116.200
116.760
120.494
126.176
128.262
128.429
128.809
131.858
161.059
166.036
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
736 repetitions
OBSERVE C13, 50.2837654 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 3.0 Hz
FT size 65536
Total time 714985 hr, 53 min, 7 sec

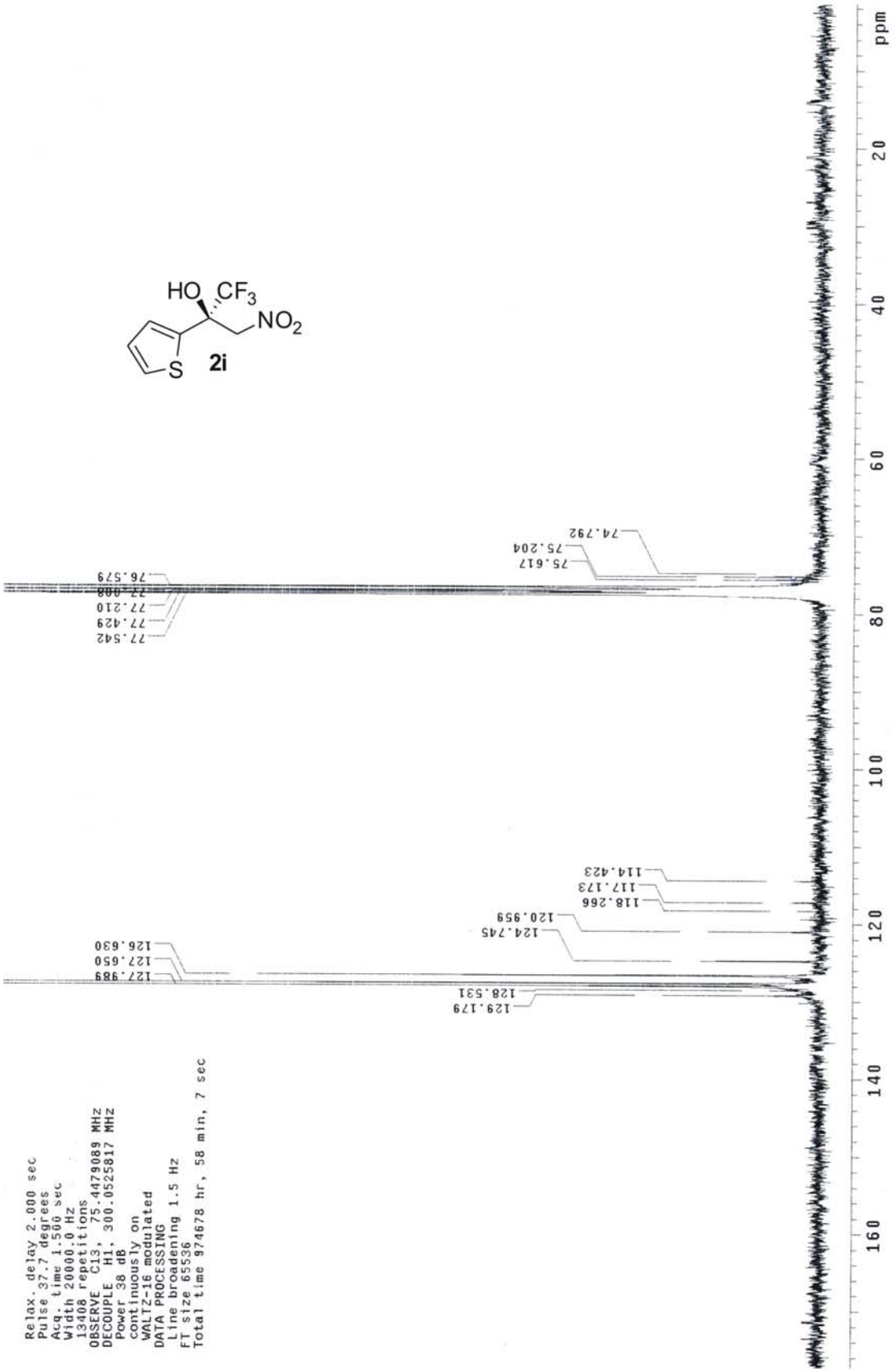

HO
CF3
NO2
F
2g
-111.918
-79.825
ppm
-120
-110
-100
-90
-80
-70

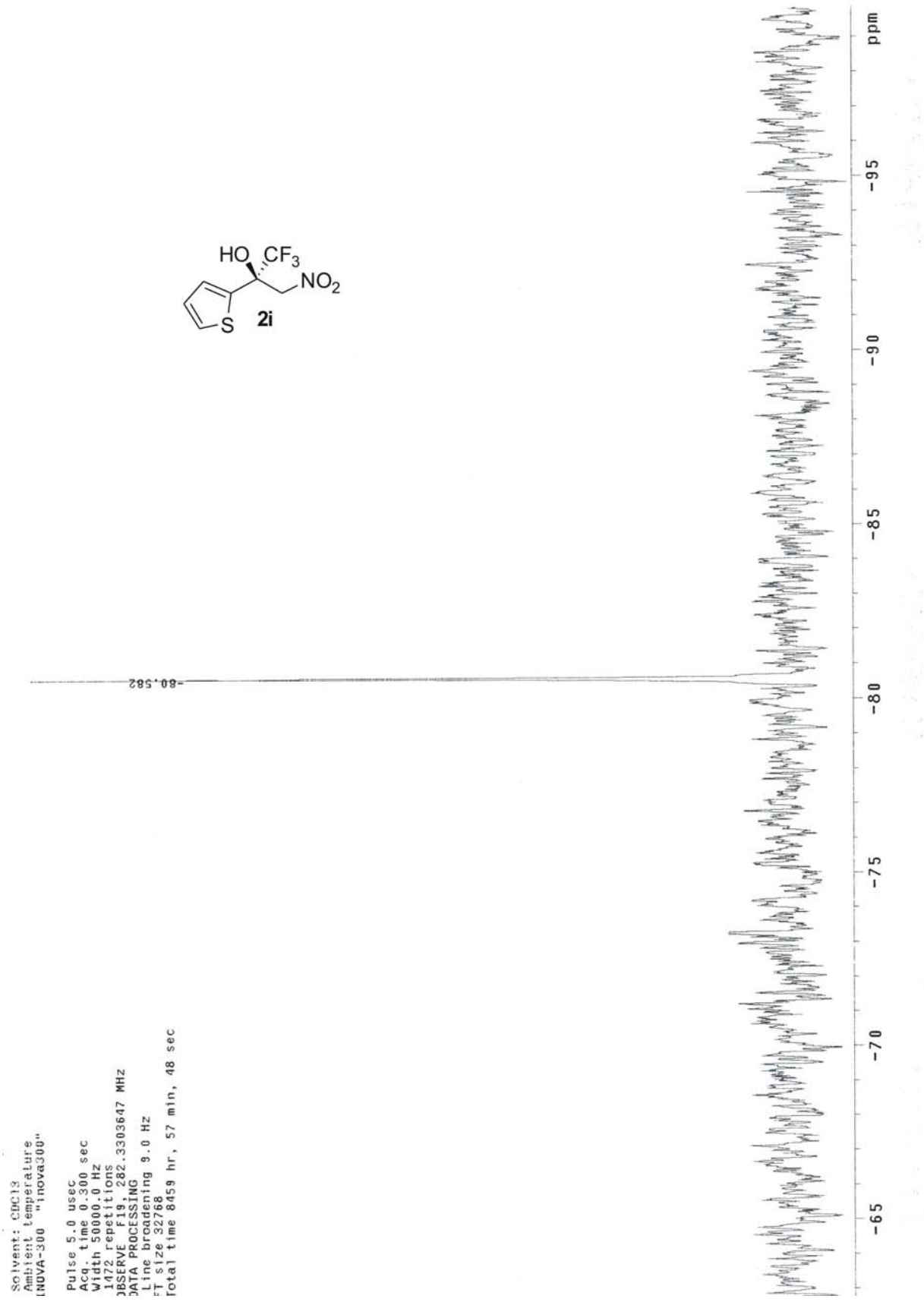

HO
CF3
NO2
2h
4.792
5.032
5.077
5.133
5.179
7.401
7.425
7.452
7.465
7.478
ppm
1
2
3
4
5
6
7
8
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 sec
Width 4001.6 Hz
60 repetitions
OBSERVE H1, 300.0510866 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 10 hr, 58 min, 50 sec

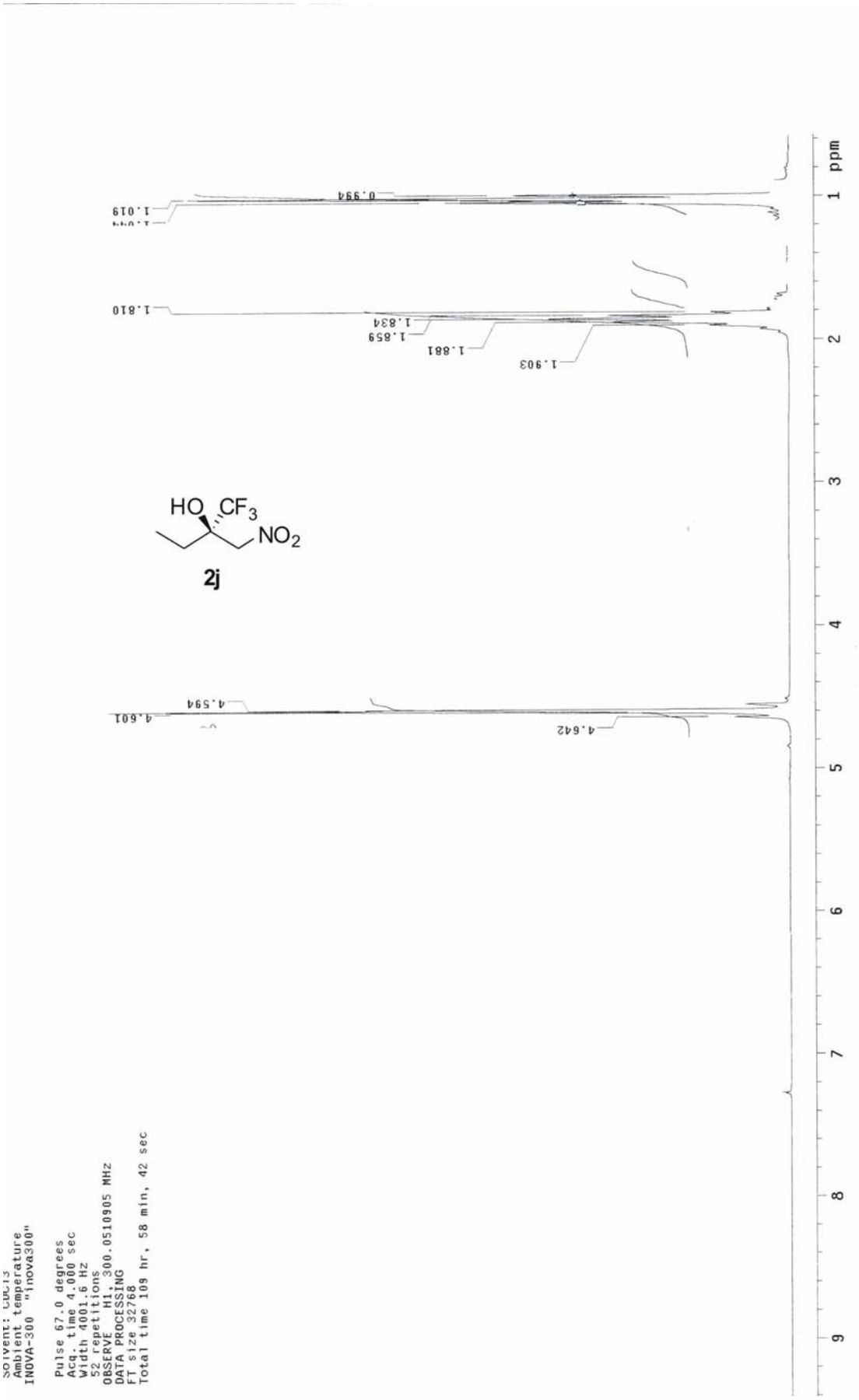

HO
CF3
NO2
2h
15.195
75.956
76.353
76.579
77.000
77.429
114.771
118.630
121.501
125.287
126.598
126.922
127.124
127.318
127.577
128.716
129.040
130.708
130.740
131.735
139.032
Ambient temperature
INOVA-300 "inova300"
Relax. delay 2.000 sec
Pulse 37.7 degrees
Acq. time 1.500 sec
Width 20000.0 Hz
320 repetitions
OBSERVE C13, 75.44
DECOUPLE H1, 300.05
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.5 Hz
FT size 65536
Total time 96264 hr, 35 min, 44 sec
ppm

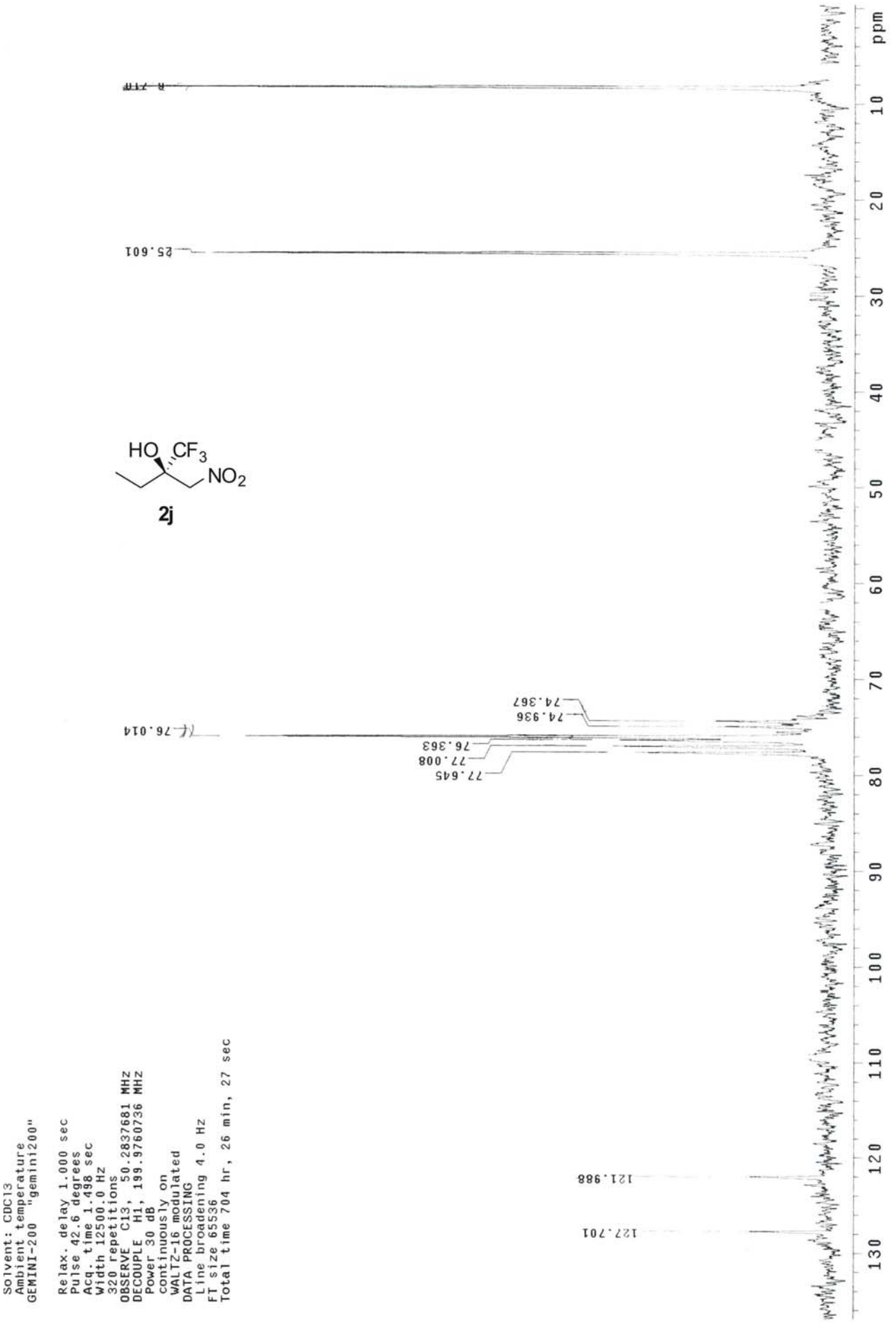

HO
CF3
NO2
2h
ppm
-95
-90
-85
-80
-75
-70
-65
-79.501

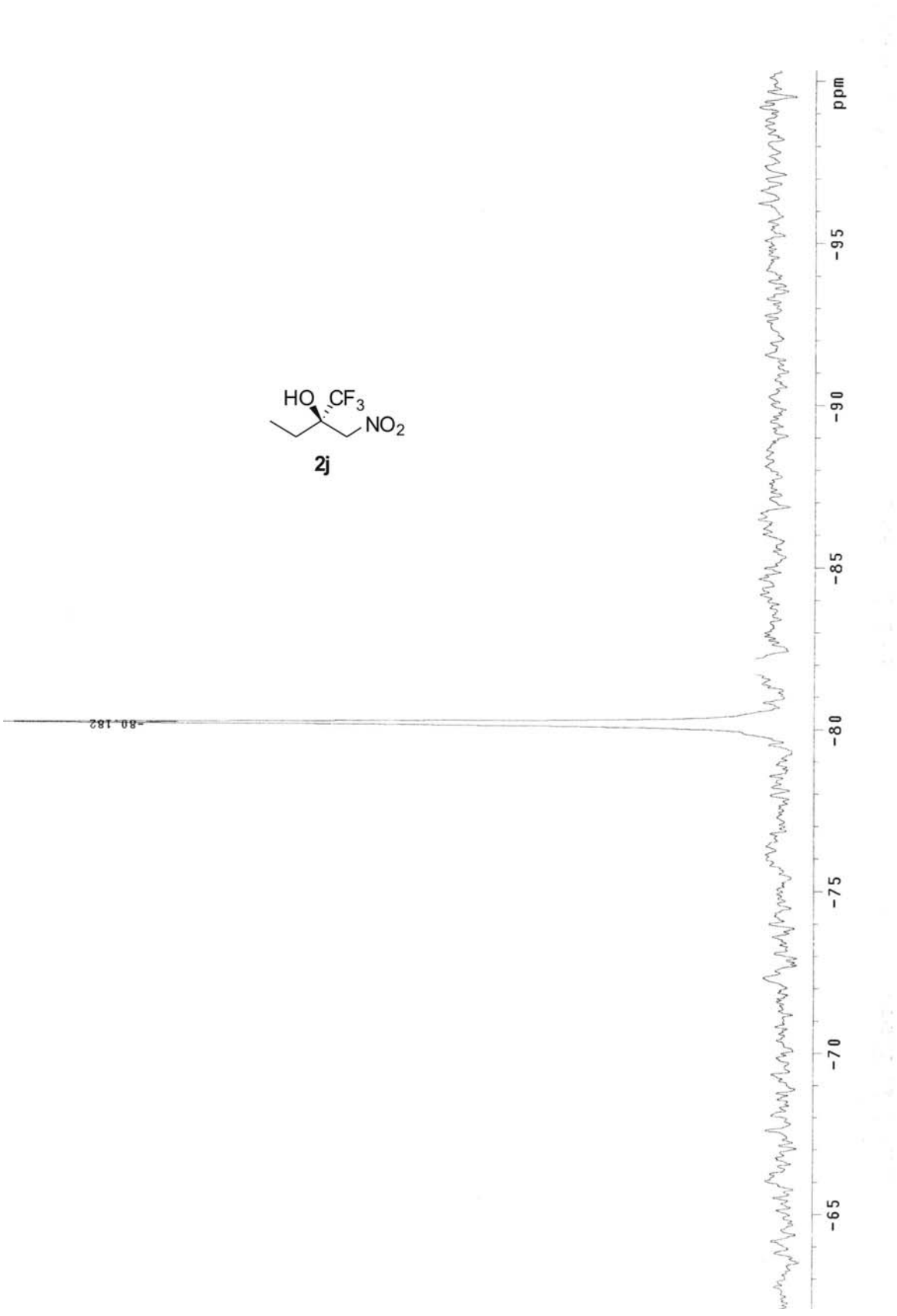

HO
CF3
NO2
S
2i
4.997
5.042
7.060
7.072
7.077
7.089
7.167
7.180
7.264
7.270
7.436
7.439
7.453
ppm
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 sec
Width 4001.6 Hz
44 repetitions
OBSERVE H1, 300.0510888 MHz
DATA PROCESSING
FT size 32768
Total time 109 hr, 58 min, 42 sec

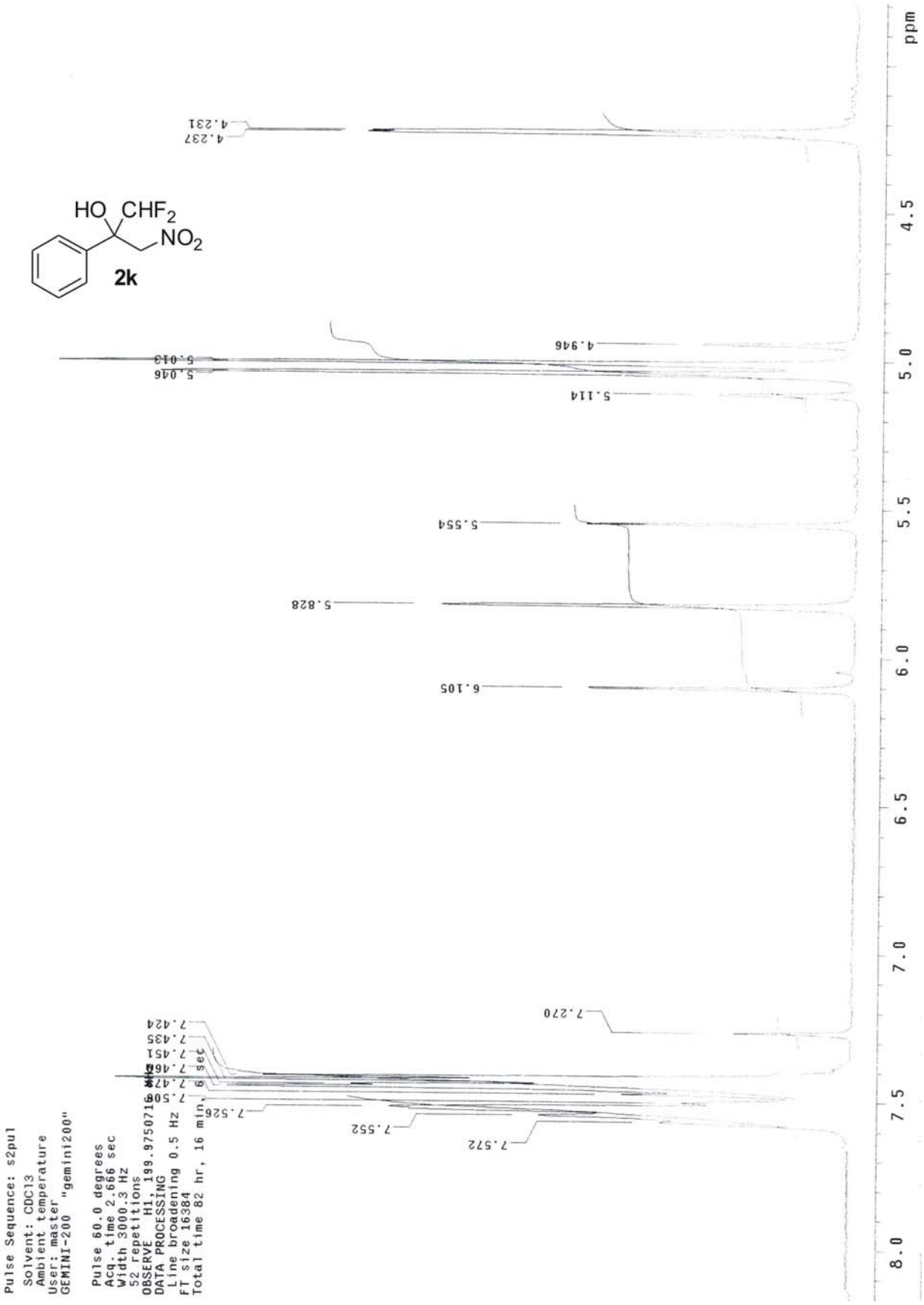

HO
CF3
NO2
S
2i
74.792
75.204
75.617
76.579
77.008
77.210
77.429
77.542
114.423
117.173
118.266
120.959
124.745
126.630
127.650
127.989
128.531
129.179
ppm
20
40
60
80
100
120
140
160
Relax. delay 2.000 sec
Pulse 37.7 degrees
Acq. time 1.500 sec
Width 20000.0 Hz
13408 repetitions
OBSERVE C13, 75.4479089 MHz
DECOUPLE H1, 300.0525817 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.5 Hz
FT size 65536
Total time 974678 hr, 58 min, 7 sec

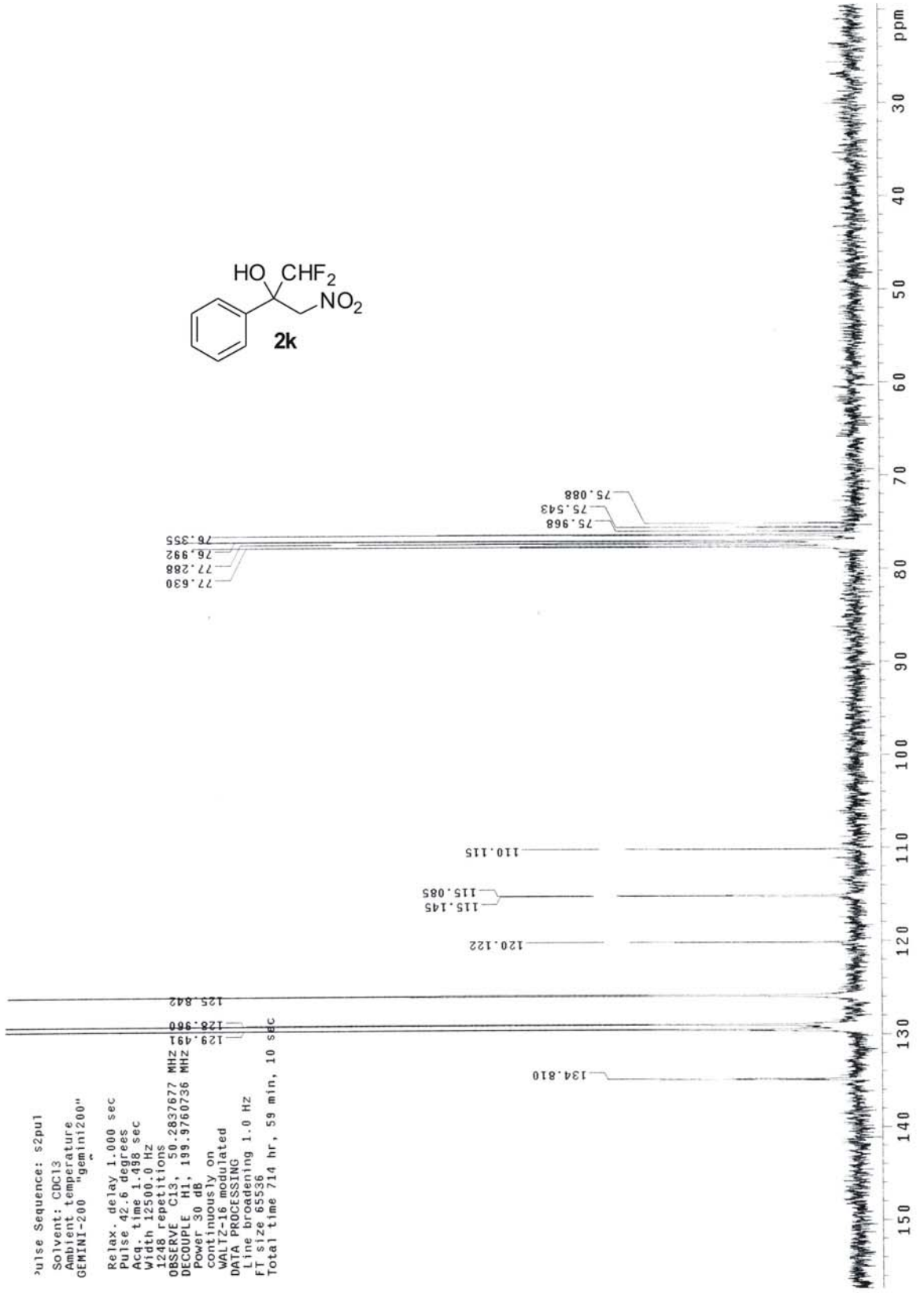

HO
CF3
NO2
S
2i
-80.582
ppm
-65
-70
-75
-80
-85
-90
-95
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 5.0 usec
Acq. time 0.300 sec
Width 50000.0 Hz
1472 repetitions
OBSERVE F19, 282.3303647 MHz
DATA PROCESSING
Line broadening 9.0 Hz
FT size 32768
Total time 8459 hr, 57 min, 48 sec

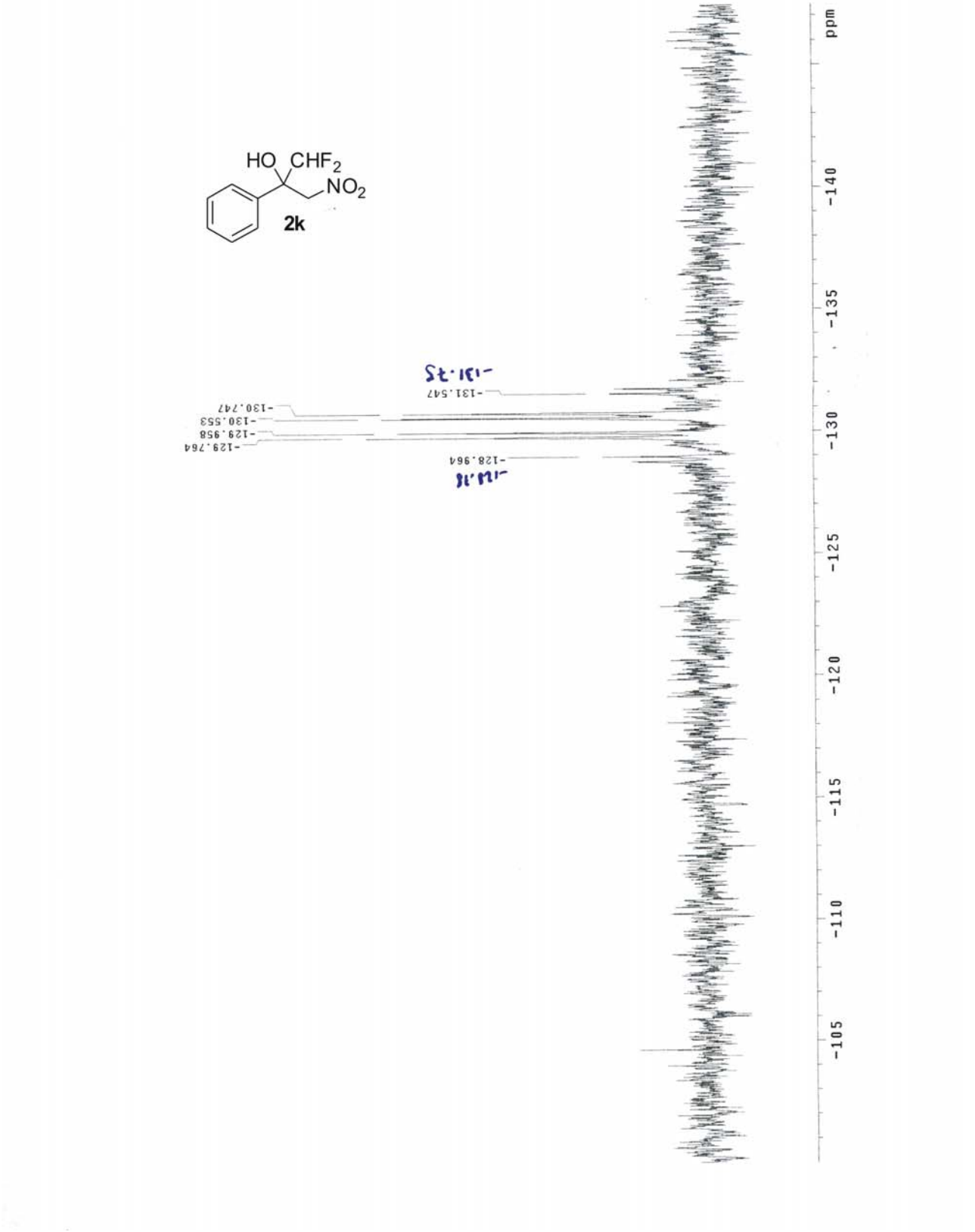

HO
CF3
NO2
2j
0.994
1.019
1.810
1.834
1.859
1.881
1.903
4.594
4.601
4.642
1 ppm
2
3
4
5
6
7
8
9
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 sec
Width 401.6 Hz
52 repetitions
OBSERVE H1, 300.0510905 MHz
DATA PROCESSING
FT size 32768
Total time 109 hr, 58 min, 42 sec

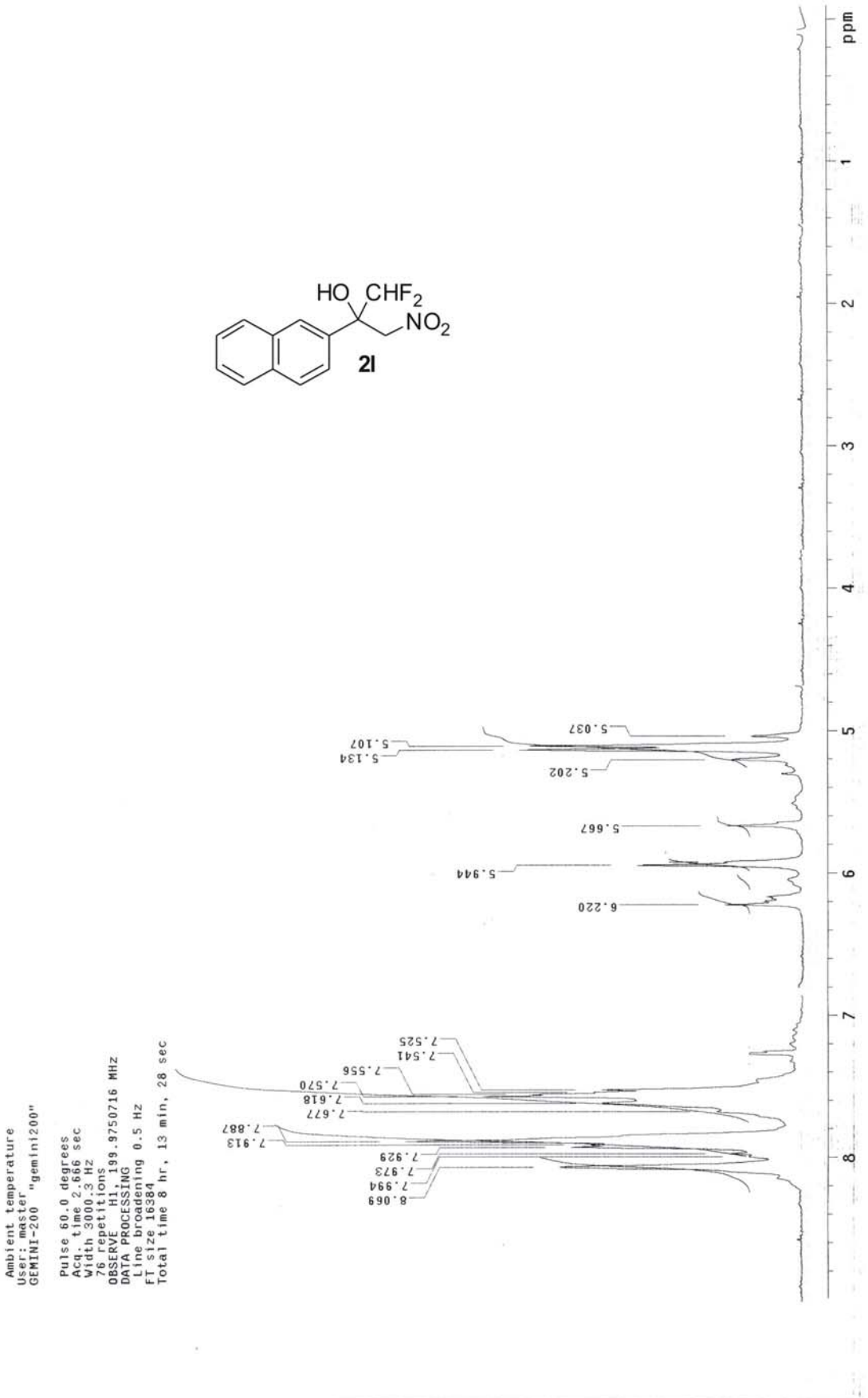

HO CF3
NO2
2j
25.601
74.367
74.936
76.014
76.363
77.008
77.645
121.988
127.701
ppm
10
20
30
40
50
60
70
80
90
100
110
120
130
Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
320 repetitions
OBSERVE C13, 50.2837681 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 4.0 Hz
FT size 65536
Total time 704 hr, 26 min, 27 sec

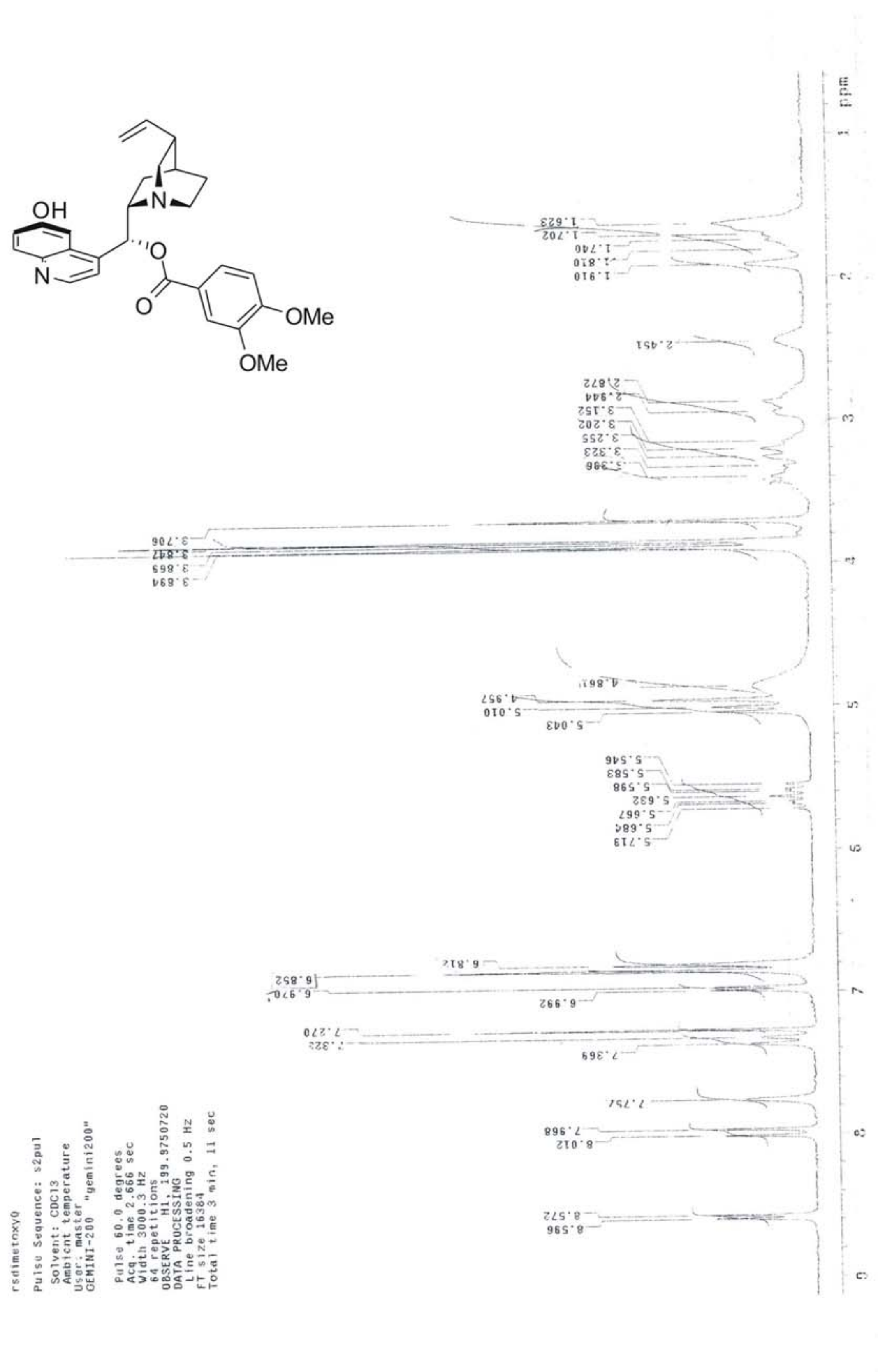

HO
CF3
NO2
2j
-80.182
ppm
-95
-90
-85
-80
-75
-70
-65

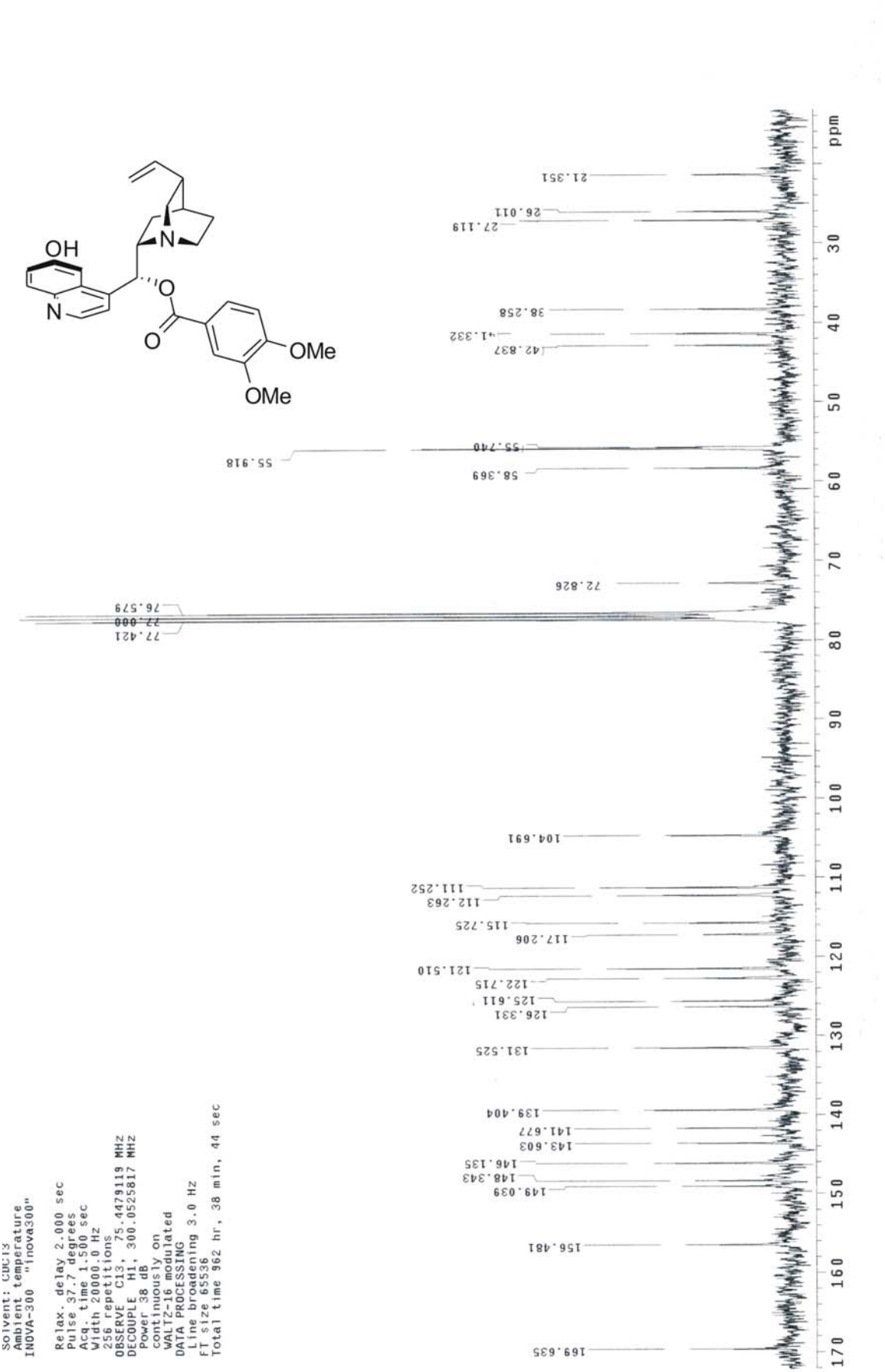

HO CHF2
NO2
2k
4.231
4.237
4.946
5.013
5.046
5.114
5.554
5.828
6.105
7.270
7.424
7.435
7.451
7.468
7.472
7.508
7.526
7.552
7.572
ppm
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
User: master
GEMINI-200 "gemini200"
Pulse 60.0 degrees
Acq. time 2.666 sec
Width 3000.3 Hz
52 repetitions
OBSERVE H1, 199.9750716
DATA PROCESSING
Line broadening 0.5 Hz
FT size 16384
Total time 82 hr, 16 min,

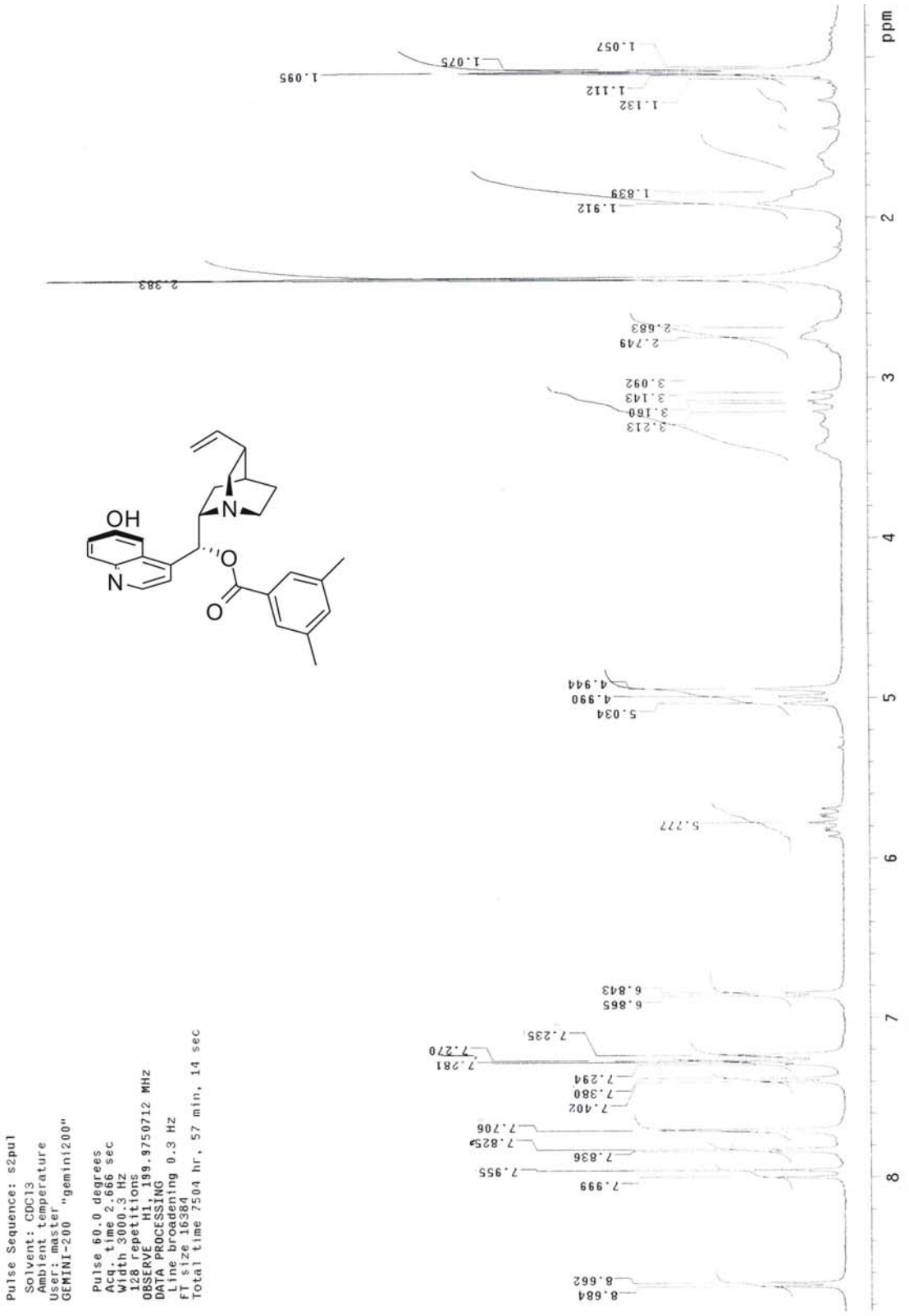

HO
CHF2
NO2
2k
ppm
75.088
75.543
75.968
76.355
76.992
77.288
77.630
110.115
115.085
115.145
120.122
125.842
128.960
129.491
134.810
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
1248 repetitions
OBSERVE C13, 50.2837677 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 65536
Total time 714 hr, 59 min, 10 sec

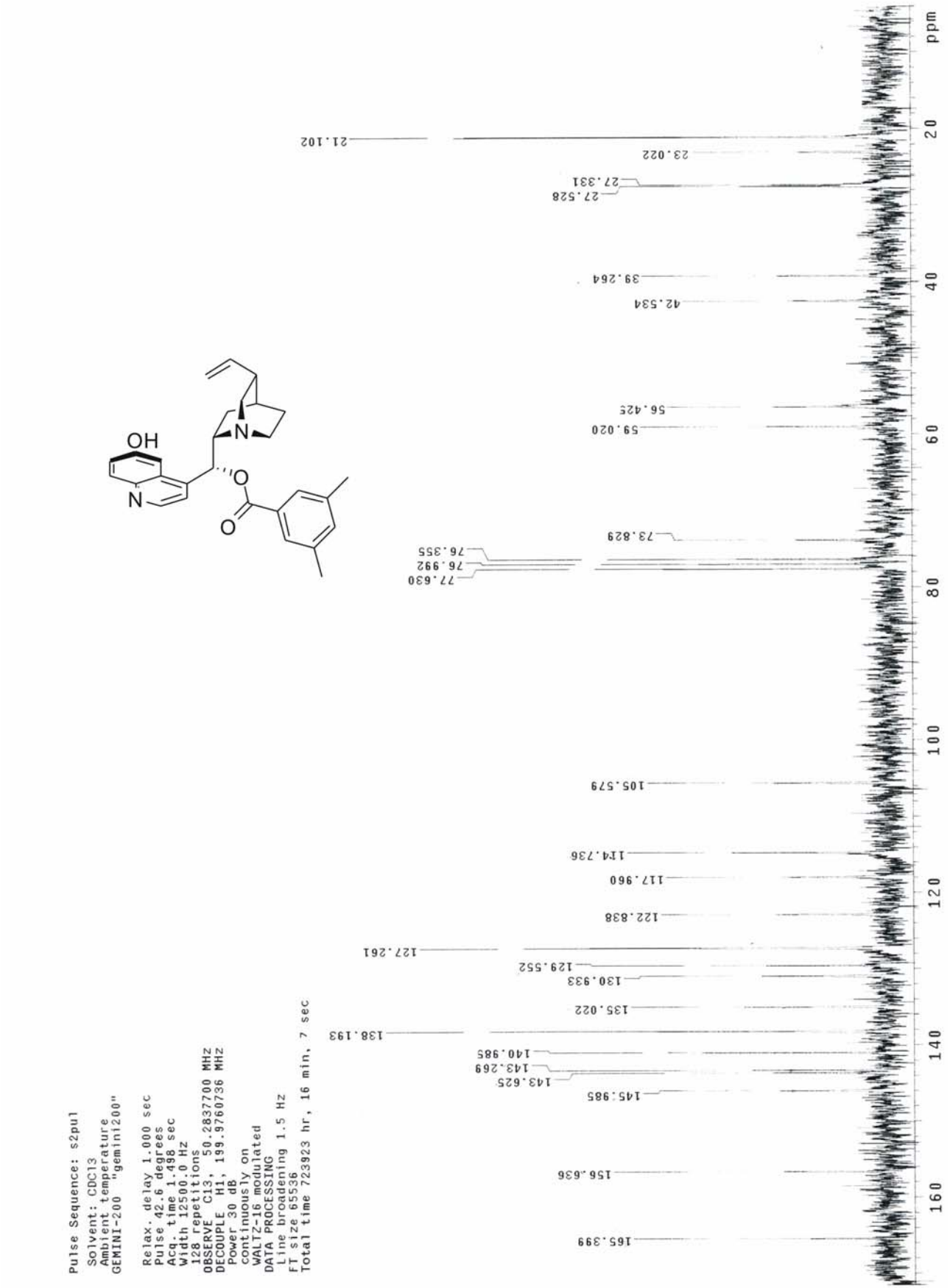

HO
CHF2
NO2
2k
-131.547
-130.747
-130.553
-129.958
-129.764
-128.964
ppm
-105
-110
-115
-120
-125
-130
-135
-140

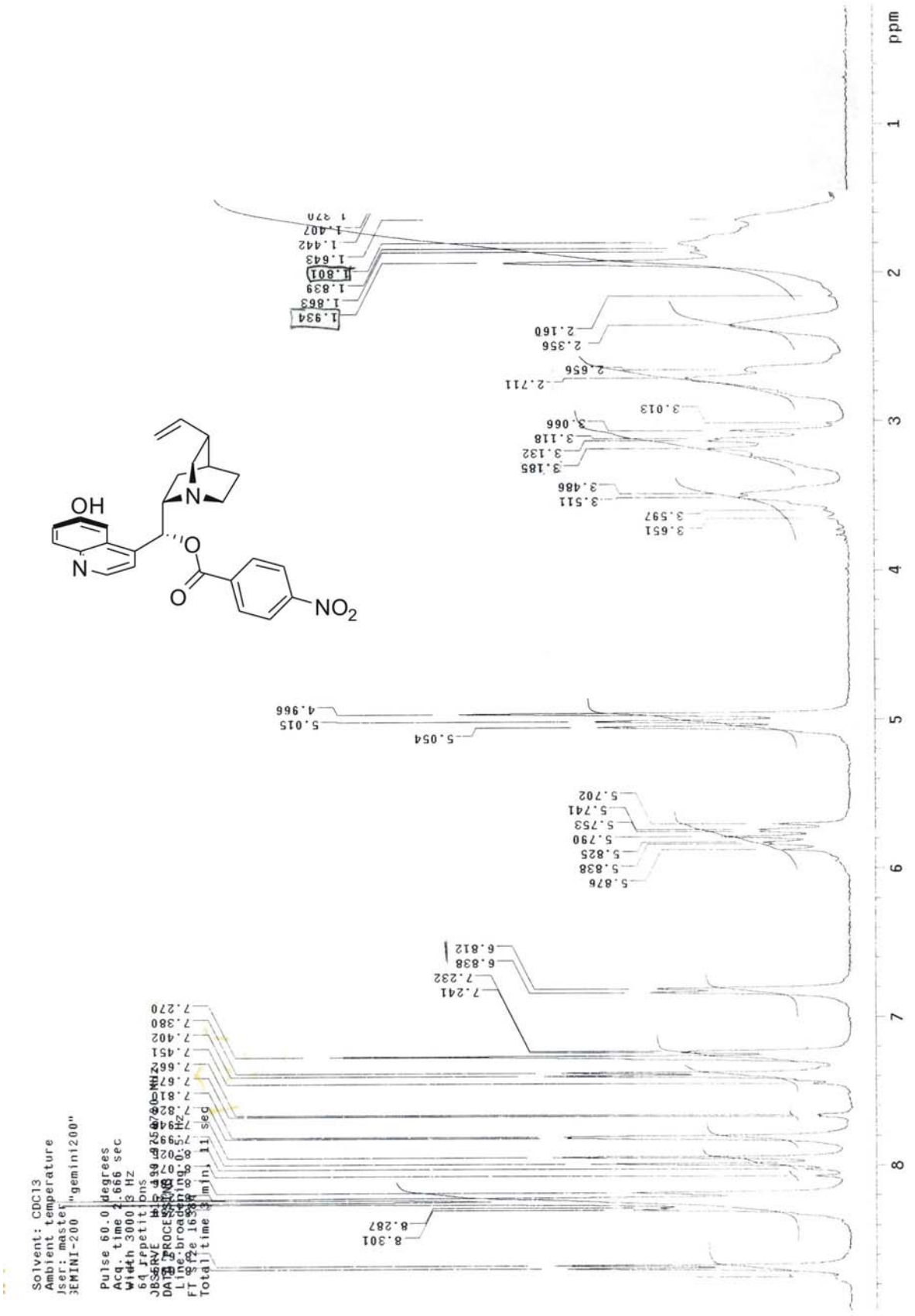

HO
CHF2
NO2
2l
ppm
1
2
3
4
5
6
7
8
5.037
5.107
5.134
5.202
5.667
5.944
6.220
7.525
7.541
7.556
7.570
7.618
7.677
7.887
7.913
7.929
7.973
7.994
8.069
Ambient temperature
User: master
GEMINI-200 "gemini200"
Pulse 60.0 degrees
Acq. time 2.666 sec
Width 3000.3 Hz
76 repetitions
OBSERVE H1, 199.9750716 MHz
DATA PROCESSING
Line broadening 0.5 Hz
FT size 16384
Total time 8 hr, 13 min, 28 sec

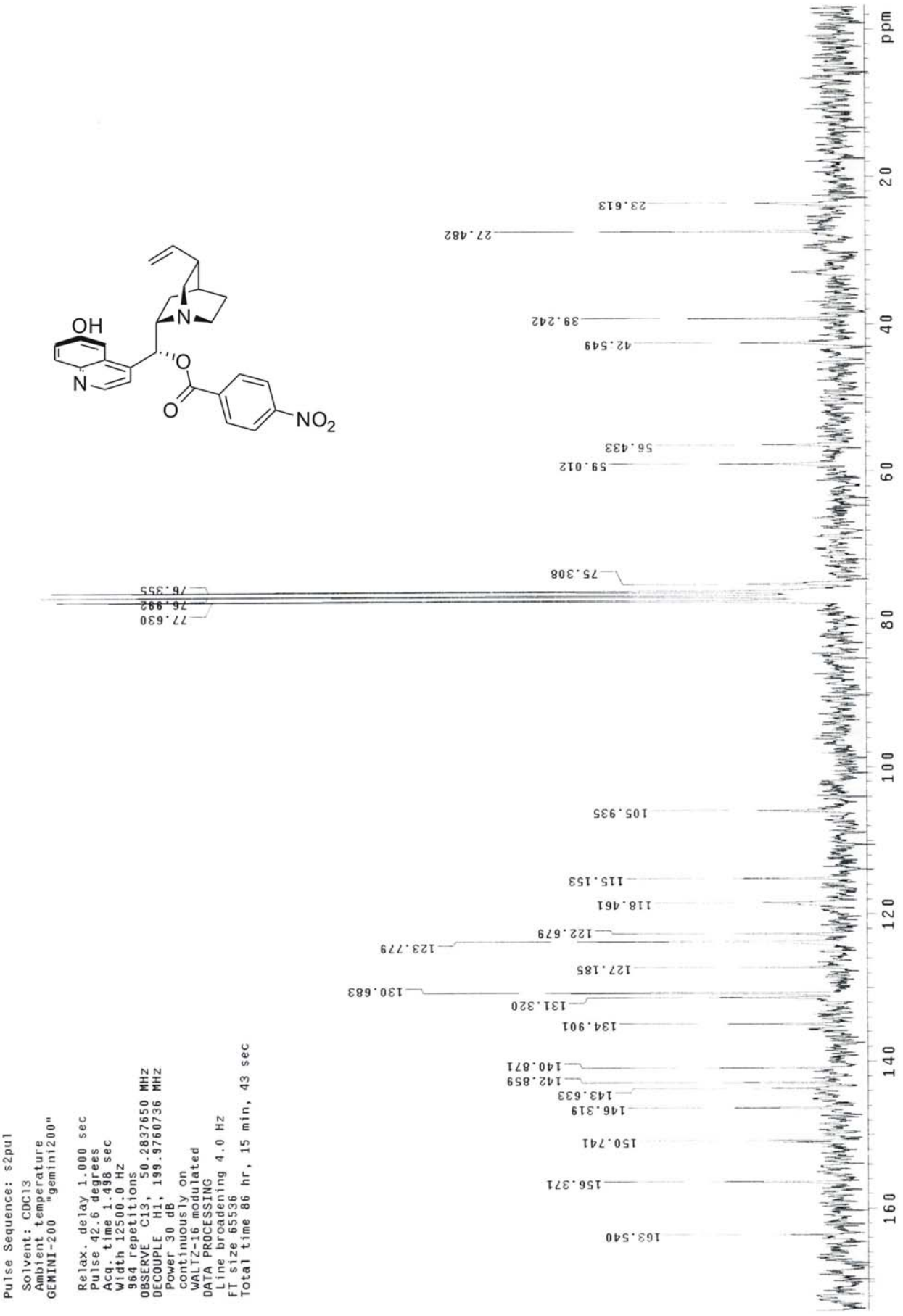

OH
N
O
O
OMe
OMe

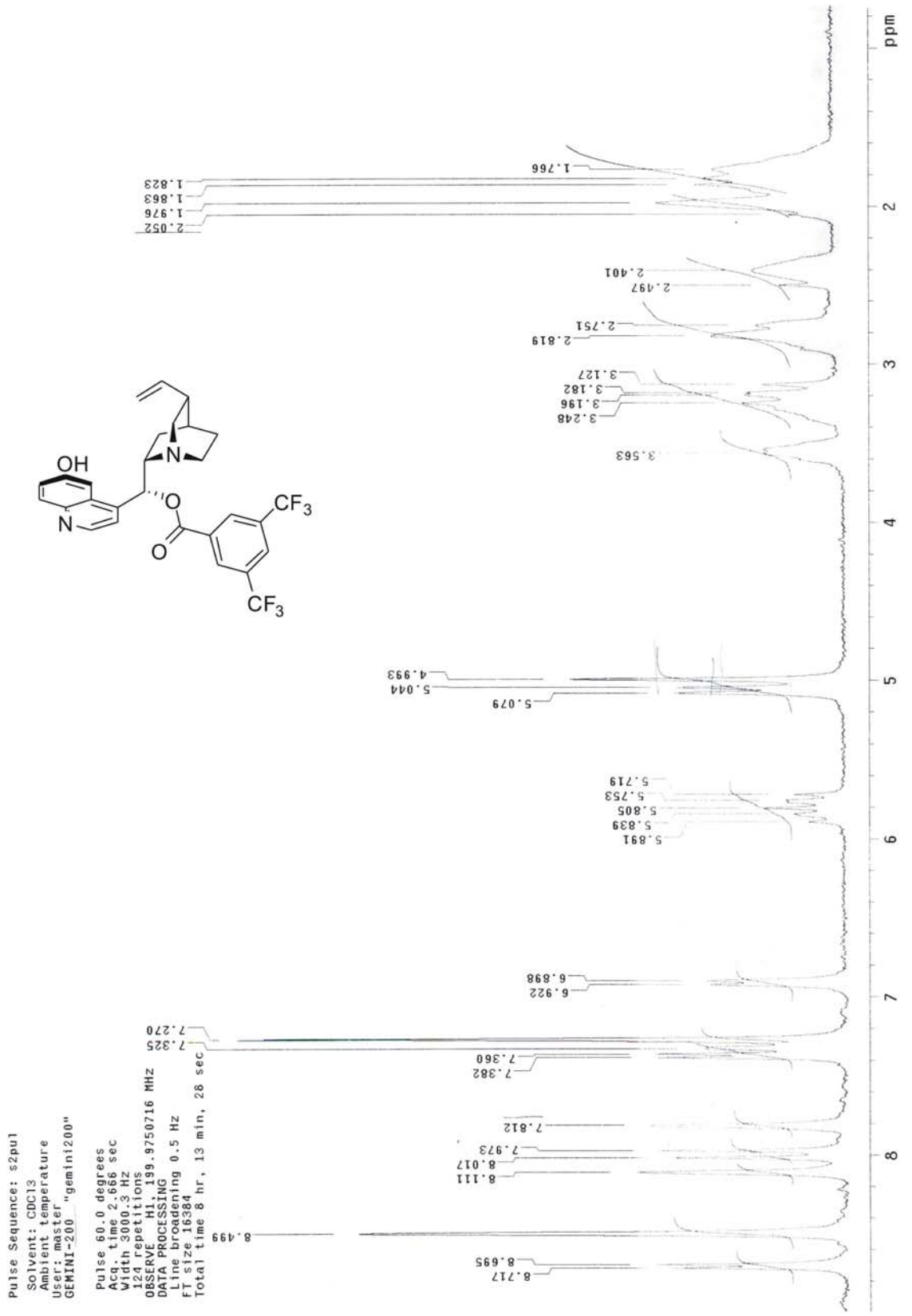

OH
N
N
O
O
OMe
OMe
21.351
26.011
27.119
38.258
41.332
42.837
55.740
55.918
58.369
72.826
76.579
77.000
77.421
104.691
111.252
112.263
115.725
117.206
121.510
122.715
125.611
126.331
131.525
139.404
141.677
143.603
146.135
148.343
149.039
156.481
169.635
ppm
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Relax. delay 2.000 sec
Pulse 37.7 degrees
Acq. time 1.500 sec
Width 20000.0 Hz
256 repetitions
OBSERVE C13, 75.4479119 MHz
DECOUPLE H1, 300.0525817 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 3.0 Hz
FT size 65536
Total time 962 hr, 38 min, 44 sec

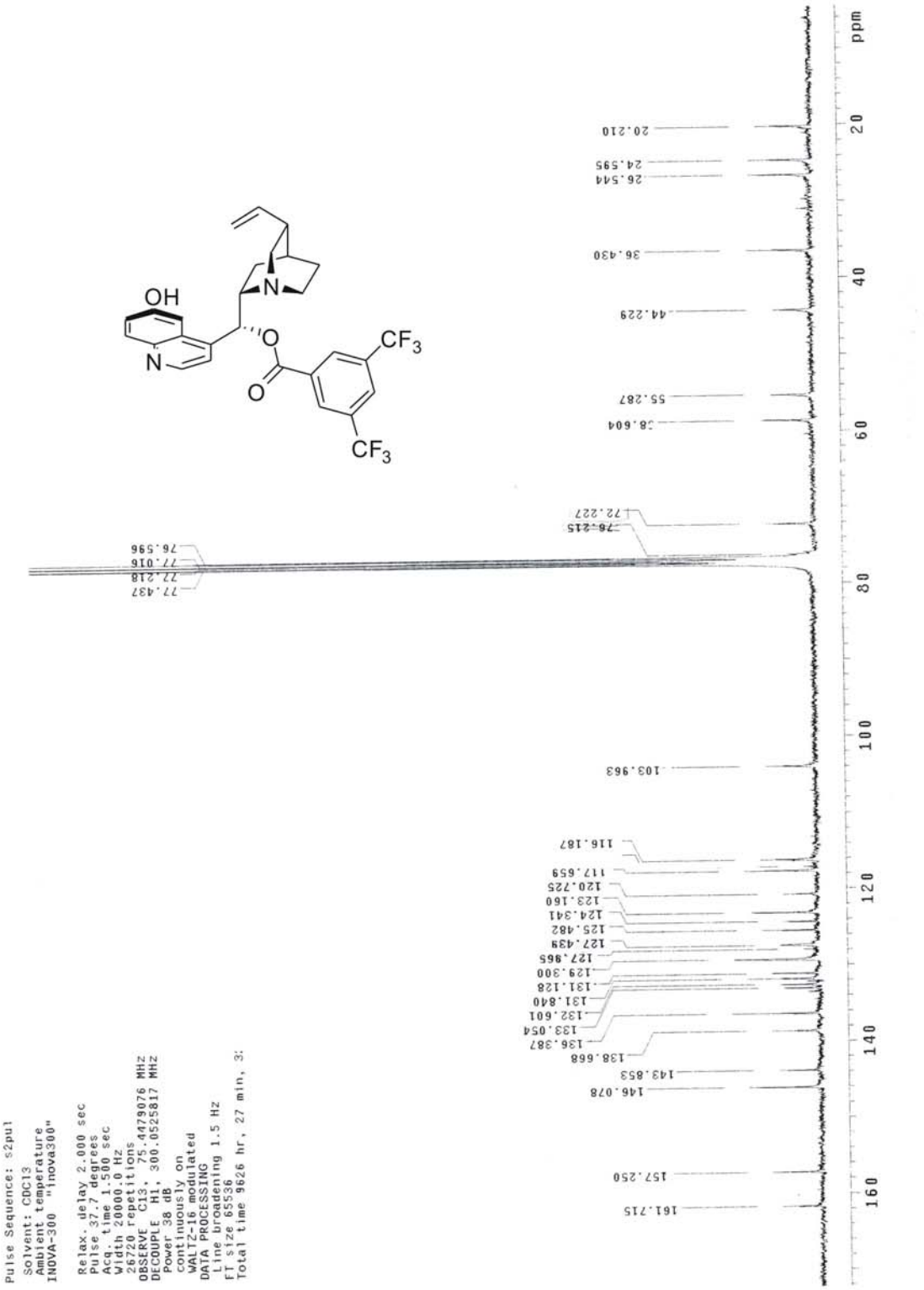

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
User: master "gemini200"
GEMINI-200
Pulse 60.0 degrees
Acq. time 2.666 sec
Width 3000.3 Hz
128 repetitions
OBSERVE H1, 199.9750712 MHz
DATA PROCESSING
Line broadening 0.3 Hz
FT size 16384
Total time 7504 hr, 57 min, 14 sec
OH
N
O
O
N
ppm

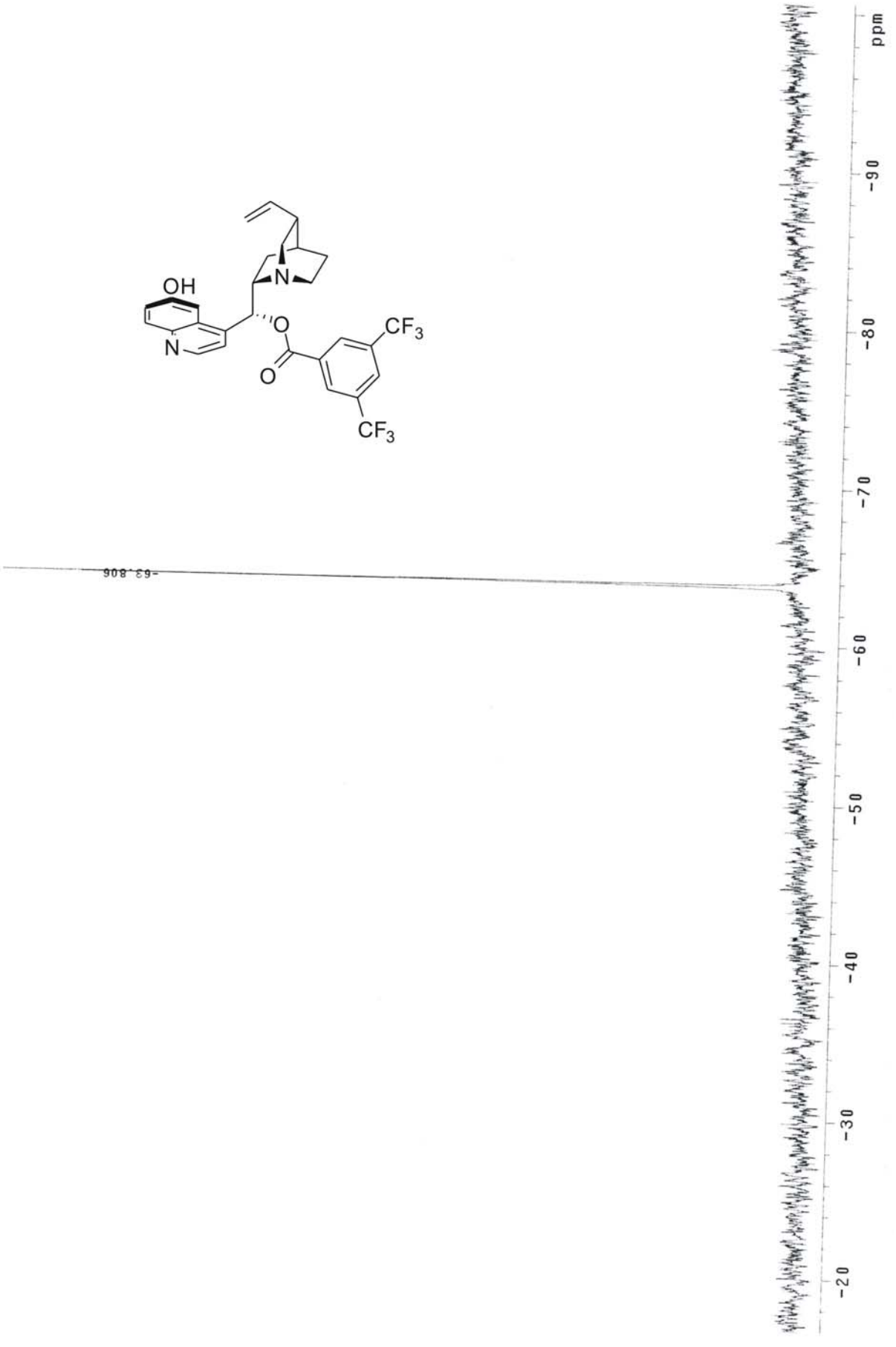

OH
N
O
O
N
21.102
23.022
27.331
27.528
39.264
42.534
56.425
59.020
73.829
76.355
76.992
77.630
105.579
114.736
117.960
122.838
127.261
129.552
130.933
135.022
138.193
140.985
143.269
143.625
145.985
156.636
165.399
ppm
20
40
60
80
100
120
140
160
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
128 repetitions
OBSERVE C13, 50.2837700 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.5 Hz
FT size 65536
Total time 723923 hr, 16 min, 7 sec

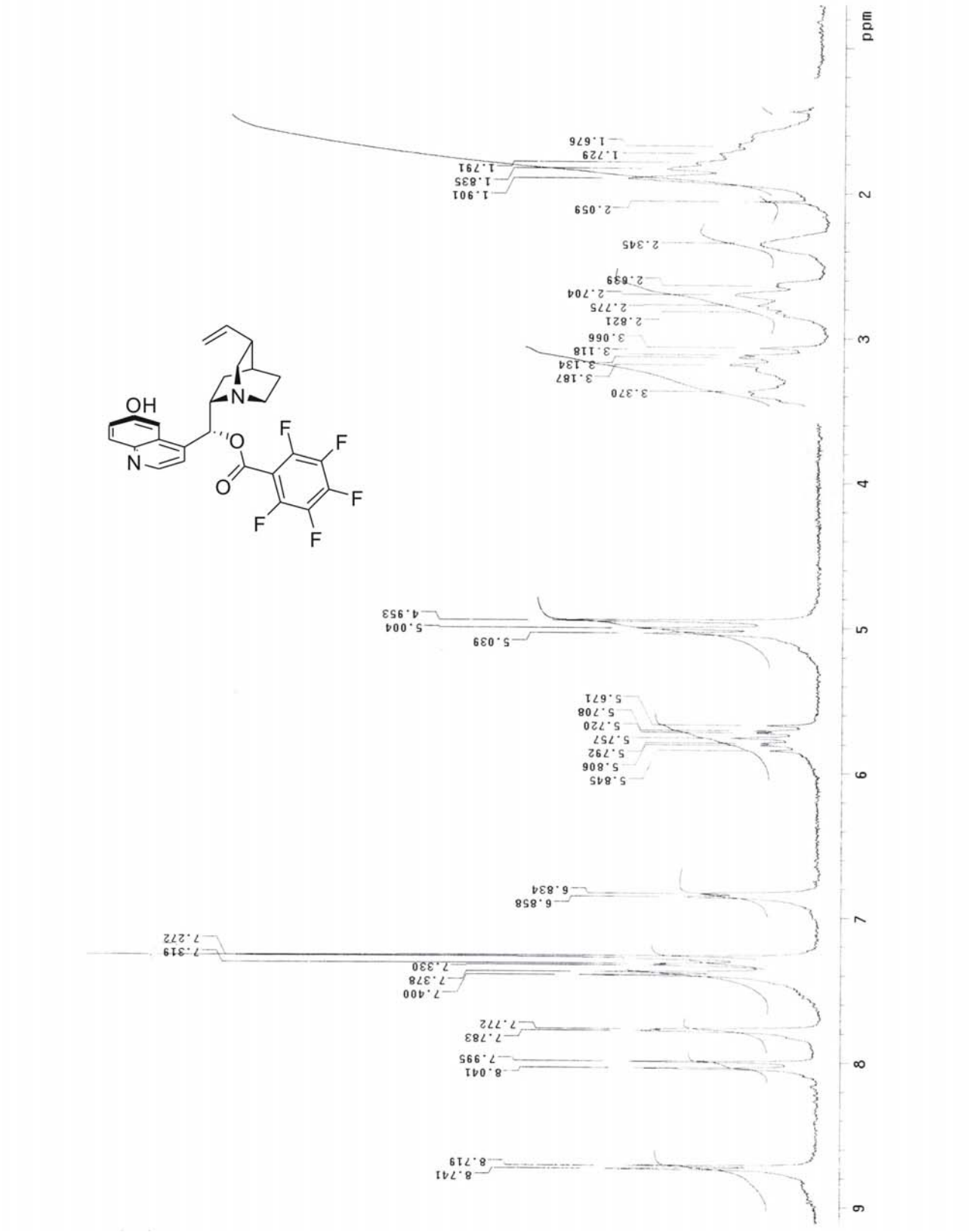

OH
N
O
O
NO2
ppm

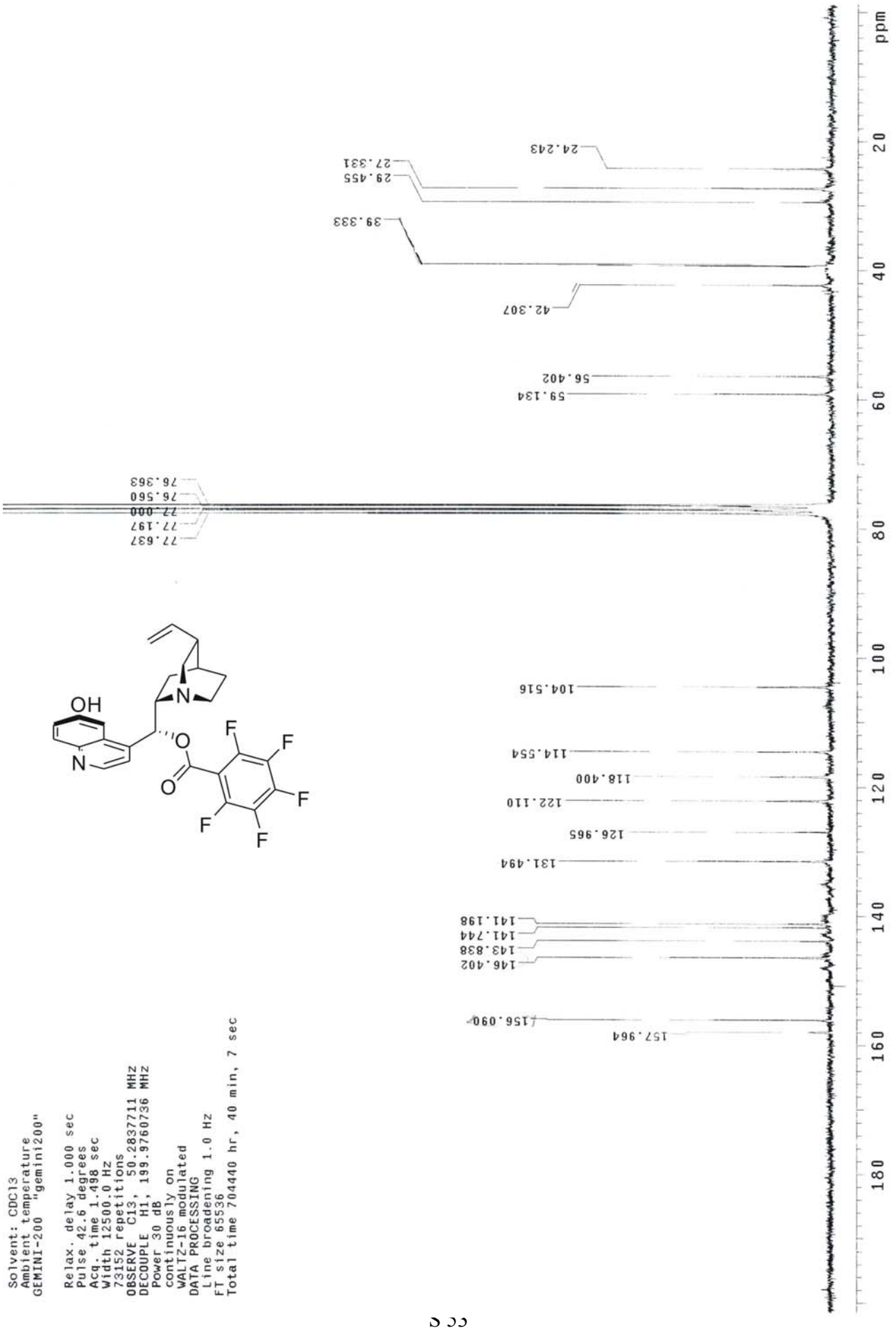

OH
N
O
O
N
NO2
ppm
20
40
60
80
100
120
140
160
23.613
27.482
39.242
42.549
56.433
59.012
75.308
77.630
105.935
115.153
118.461
122.679
123.779
127.185
130.683
131.320
134.901
140.871
142.859
143.633
146.319
150.741
156.371
163.540
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
964 repetitions
OBSERVE C13, 50.2837650 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 4.0 Hz
FT size 65536
Total time 86 hr, 15 min, 43 sec

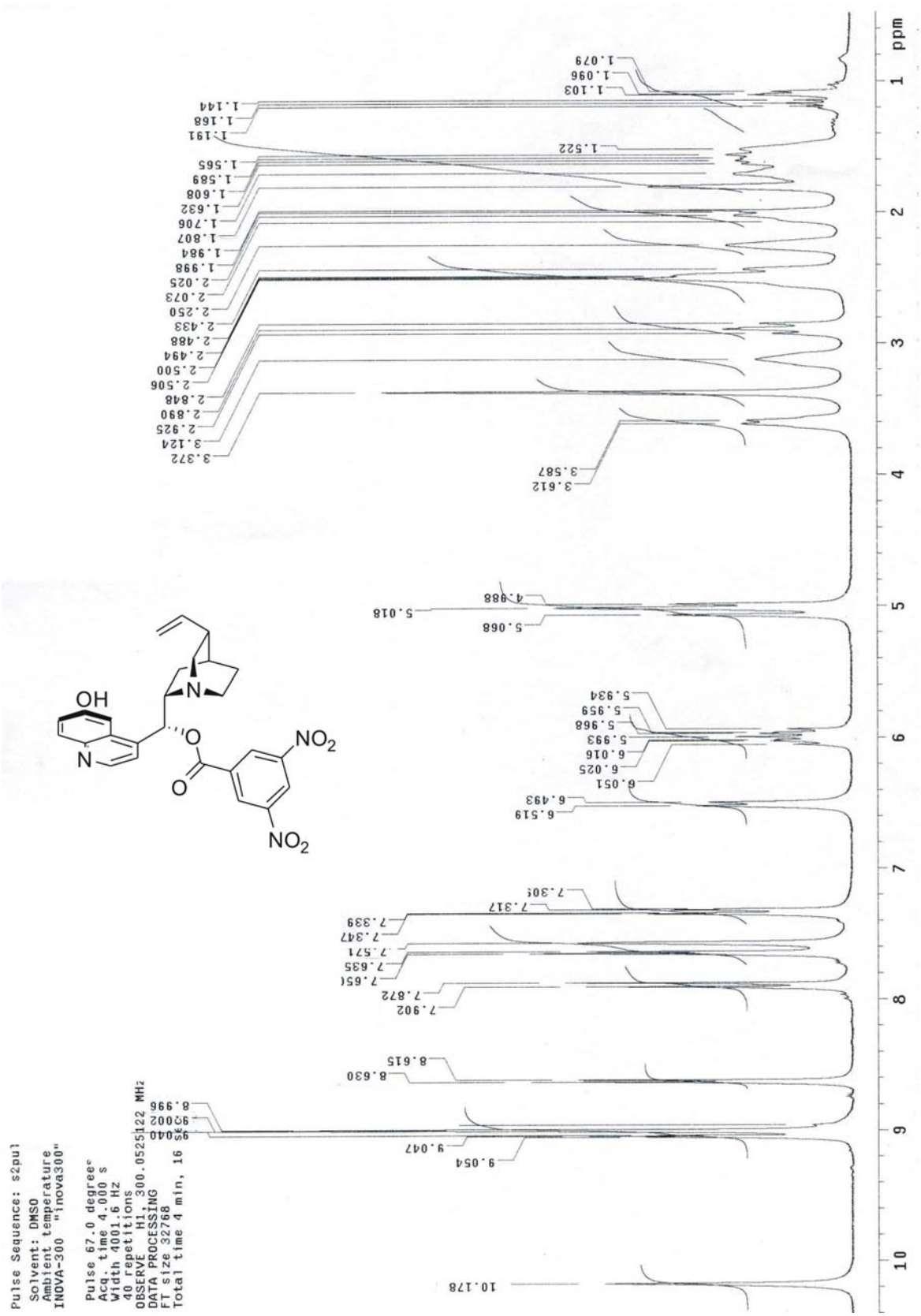

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
User: master
GEMINI-200 "gemini200"
Pulse 60.0 degrees
Acq. time 2.666 sec
Width 3000.3 Hz
124 repetitions
OBSERVE H1, 199.9750716 MHz
DATA PROCESSING
Line broadening 0.5 Hz
FT size 16384
Total time 8 hr, 13 min, 28 sec
OH
N
O
O
CF3
CF3
ppm

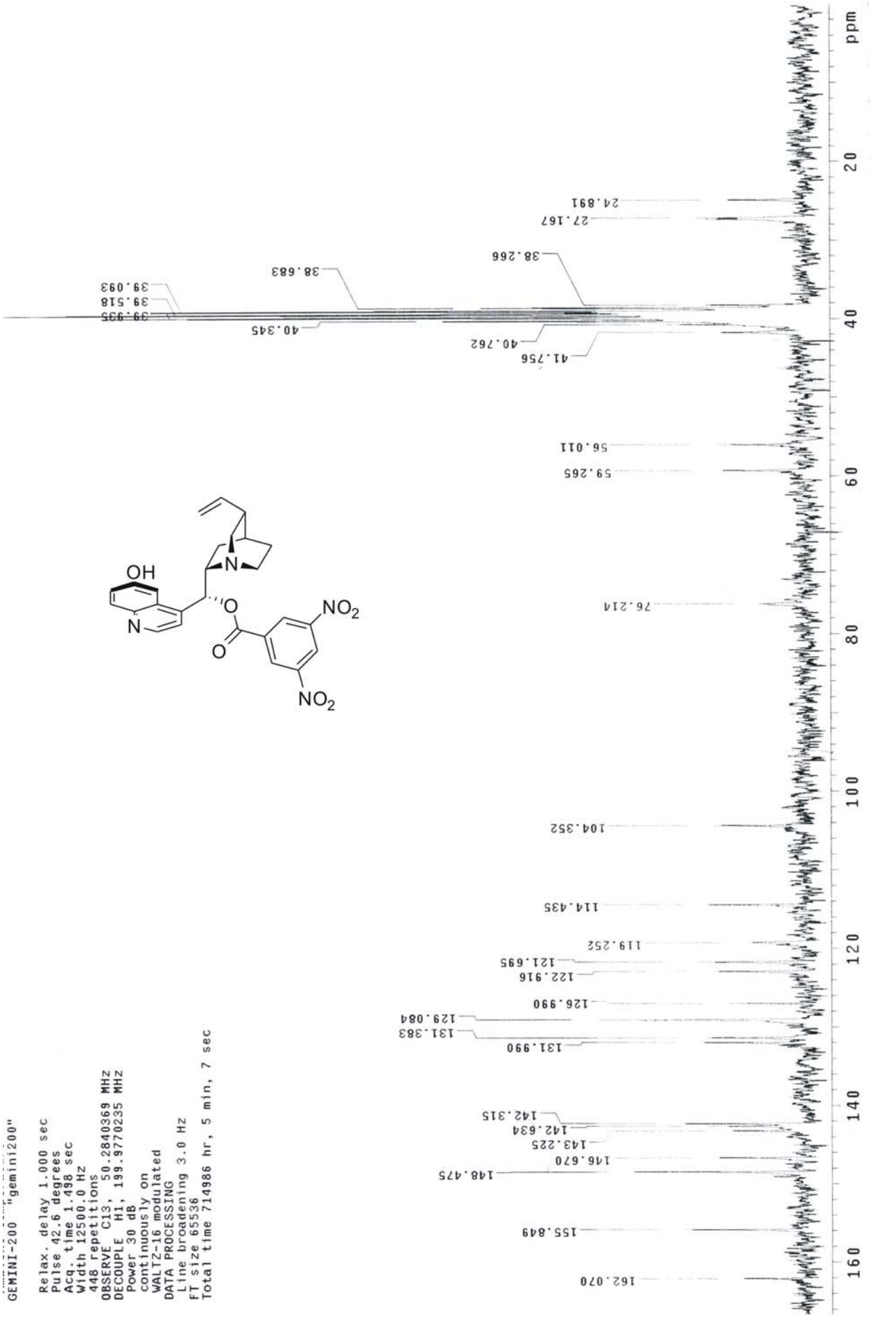

OH
N
O
O
CF3
CF3
N
20.210
24.595
26.544
36.430
44.229
55.287
58.604
72.227
76.215
76.596
77.016
77.218
77.437
103.963
116.187
117.659
120.725
123.160
124.341
125.482
127.439
127.865
129.300
131.128
131.840
132.601
133.054
136.387
138.668
143.853
146.078
157.250
161.715
ppm
20
40
60
80
100
120
140
160
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Relax. delay 2.000 sec
Pulse 37.7 degrees
Acq. time 1.500 sec
Width 20000.0 Hz
26720 repetitions
OBSERVE C13, 75.4479076 MHz
DECOUPLE H1, 300.0525817 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.5 Hz
FT size 65536
Total time 9626 hr, 27 min, 3

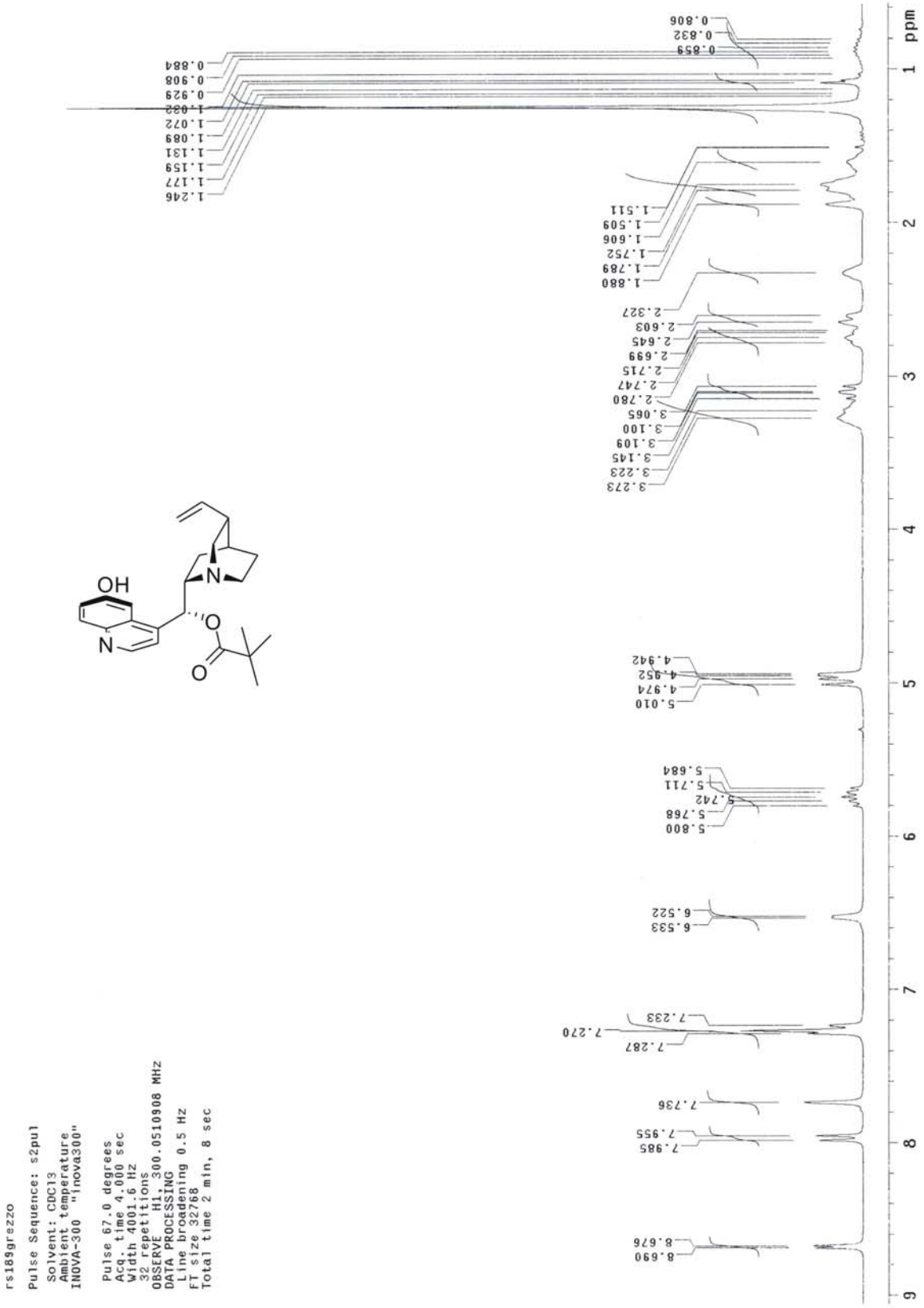

OH
N
O
O
N
CF3
CF3
-63.806
ppm
-90
-80
-70
-60
-50
-40
-30
-20

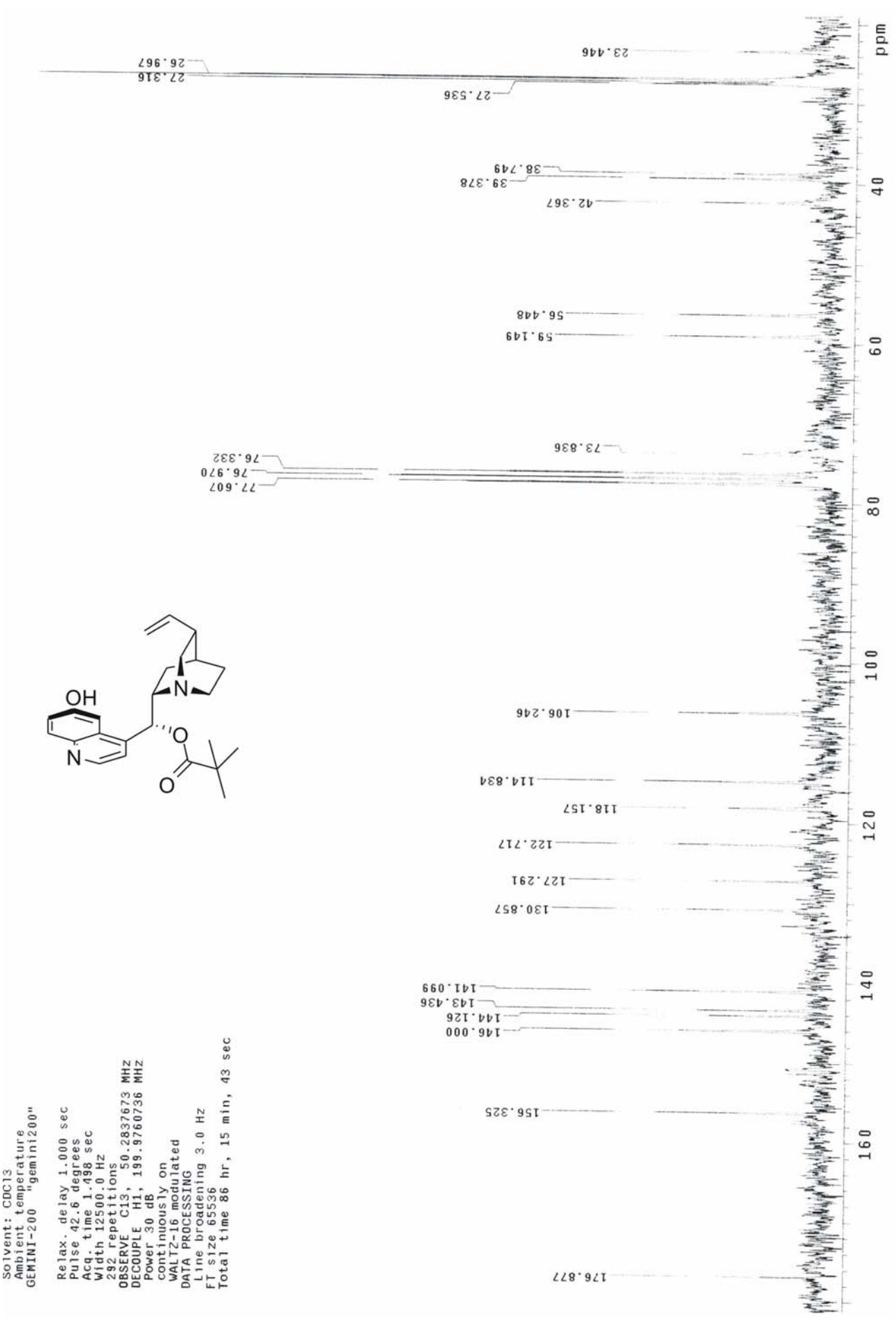

OH
N
O
O
F
F
F
F
F
ppm
1.676
1.729
1.791
1.835
1.901
2.059
2.345
2.689
2.704
2.775
2.821
3.066
3.118
3.134
3.187
3.370
4.953
5.004
5.039
5.671
5.708
5.720
5.757
5.792
5.806
5.845
6.834
6.858
7.272
7.319
7.330
7.378
7.400
7.772
7.783
7.995
8.041
8.719
8.741


Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
73152 repetitions
OBSERVE C13, 50.2837711 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 65536
Total time 704440 hr, 40 min, 7 sec
24.243
27.331
29.455
39.333
42.307
56.402
59.134
76.363
76.560
77.000
77.197
77.637
104.516
114.554
118.400
122.110
126.965
131.494
141.198
141.744
143.838
146.402
156.090
157.964
OH
N
O
O
F
F
F
F
F
ppm
20
40
60
80
100
120
140
160
180


OH
N
N
O
O
NO2
NO2
1.079
1.096
1.103
1.144
1.168
1.191
1.522
1.565
1.589
1.608
1.632
1.706
1.807
1.984
1.998
2.025
2.073
2.250
2.433
2.488
2.494
2.500
2.506
2.848
2.890
2.925
3.124
3.372
3.587
3.612
4.888
5.018
5.068
5.934
5.959
5.968
5.993
6.016
6.025
6.051
6.493
6.519
7.305
7.317
7.339
7.347
7.571
7.635
7.650
7.872
7.902
8.615
8.630
8.996
9.002
9.040
9.047
9.054
10.178
Pulse Sequence: s2pul
Solvent: DMSO
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 s
Width 4001.6 Hz
40 repetitions
OBSERVE H1, 300.0525122 MHz
DATA PROCESSING
FT size 32768
Total time 4 min, 16
ppm


GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
448 repetitions
OBSERVE C13, 50.2840369 MHz
DECOUPLE H1, 199.9770235 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 3.0 Hz
FT size 65536
Total time 714986 hr, 5 min, 7 sec
OH
N
O
O
NO2
NO2
N
24.891
27.167
38.266
38.683
39.093
39.518
39.935
40.345
40.762
41.756
56.011
59.265
76.214
104.352
114.435
119.252
121.695
122.916
126.990
129.084
131.383
131.990
142.315
142.634
143.225
146.670
148.475
155.849
162.070
ppm
20
40
60
80
100
120
140
160


rs189grezzo
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
INOVA-300 "inova300"
Pulse 67.0 degrees
Acq. time 4.000 sec
Width 4001.6 Hz
32 repetitions
OBSERVE H1, 300.0510908 MHz
DATA PROCESSING
Line broadening 0.5 Hz
FT size 32768
Total time 2 min, 8 sec
OH
N
O
O
N
ppm


Solvent: CDCl3
Ambient temperature
GEMINI-200 "gemini200"
Relax. delay 1.000 sec
Pulse 42.6 degrees
Acq. time 1.498 sec
Width 12500.0 Hz
292 repetitions
OBSERVE C13, 50.2837673 MHz
DECOUPLE H1, 199.9760736 MHz
Power 30 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 3.0 Hz
FT size 65536
Total time 86 hr, 15 min, 43 sec
OH
N
O
O
N
ppm
23.446
26.967
27.316
27.536
38.749
39.378
42.367
56.448
59.149
73.836
76.332
76.970
77.607
106.246
114.834
118.157
122.717
127.291
130.857
141.099
143.436
144.126
146.000
156.325
176.877