Supporting Information

A Synthesis of Strychnine by a Longest Linear Sequence of Six Steps

David B. C. Martin and Christopher D. Vanderwal*

1102 Natural Sciences II, Department of Chemistry, University of California, Irvine,
Irvine, CA, 92697-2025

cdv@uci.edu

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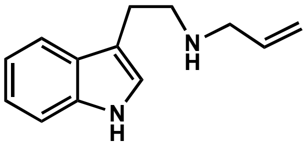
I. General Methods:

All reactions were carried out under an inert atmosphere of nitrogen or argon in oven-dried or flame-dried glassware with magnetic stirring, unless otherwise noted. Solvents were dried by passage through columns of activated alumina. THF (for anionic bicyclization reactions) and acetone (for hydrosilylation reactions) were degassed by three cycles of freeze/pump/thaw. Pyridine, diisopropylethylamine, triethylamine and *N*-methyl-2-pyrrolidinone (NMP) were distilled from calcium hydride prior to use. 5-Methyl Meldrum's acid was recrystallized from acetone/water.[1] $[Cp^{\star}Ru(CH_3CN)_3]PF_6$ was purchased from Strem and stored in a glovebox at –20 °C. All other reagents were prepared by known literature procedures or used as obtained from commercial sources, unless otherwise indicated. Reactions were monitored by thin-layer chromatography (TLC) carried out on 0.25 mm coated commercial silica gel plates (Dynamic Adsorbents, F254 precoated glass plates) using UV light as visualizing agent and $KMnO_4$ and heat as a developing agent. Flash chromatography was performed on silica gel (Dynamic Adsorbents, 230-400 mesh). Melting points were determined on a Mel-Temp apparatus and are uncorrected. ^1H and ^{13}C NMR spectra were obtained on a Bruker Avance 500 MHz or 600 MHz spectrometer at 298 K, unless otherwise indicated. Abbreviations for multiplicity are as follows: app indicates apparent, br indicates broad, d indicates doublet, t indicates triplet, q indicates quartet, m indicates multiplet. Chemical shifts are reported in ppm referenced to the internal solvent residual of $CDCl_3$ or DMSO-d_6 at 7.27 ppm and 2.50 ppm for ^1H NMR and 77.1 ppm and 39.5 ppm for ^{13}C NMR, respectively. IR spectra were obtained on a Perkin-Elmer Spectrum RX 1 FT-IR spectrophotometer using NaCl plates. High-resolution mass spectrometry data were obtained on a Waters LCT Premier spectrometer (for LC-ESI) or Waters GCT Premier spectrometer (for GC-CI).

Note: Chromatographic purification of Zincke aldehydes usually yields a brown semisolid that appears pure by ^1H- and ^{13}C-NMR analysis. Further purification by treatment with activated charcoal in CH_2Cl_2 yields a yellow solid. This additional purification was critical for the success of the anionic bicyclization reaction.

II. Experimental Procedures and Characterization Data

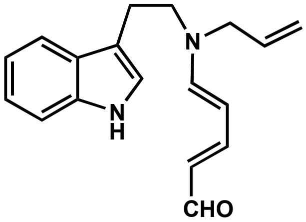


N_b-Allyltryptamine (9)

This reaction is a modification of the procedure of Martin et al.[2] Tryptophyl bromide (16.0 g, 71.2 mmol) was added to allylamine (134 mL, 1.78 mol, 25 equiv) and the resulting mixture was stirred at rt for 44 h. The reaction mixture was diluted with EtOAc/hexanes (60:40, 1.0 L) and the resulting solution was washed successively with water (4 x 200 mL) and brine (100 mL), then dried over Na_2SO_4. The solvent was removed *in vacuo* to give the title compound as a yellow oil (14.26 g, 100 %) that was used without further purification.

R_f = 0.15 (1:9:90 NH_4OH/MeOH/CH_2Cl_2);

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (br s, 1H, N_a-*H*), 7.65 (d, *J* = 7.6 Hz, 1H, indole C4-*H*), 7.38 (d, *J* = 7.6 Hz, 1H, indole C7-*H*), 7.21 (t, *J* = 7.6 Hz, 1H, indole C6-*H*), 7.13 (t, *J* = 7.6 Hz, 1H, indole C5-*H*), 7.06 (d, *J* = 2.0 Hz, 1H, indole C2-*H*), 5.90 (ddt, *J* = 17.1, 10.3, 6.0 Hz, 1H, C*H*=CH_2), 5.15 (dd, *J* = 17.1, 1.4 Hz, 1H, *E*-C*H*), 5.07 (dd, *J* = 10.3, 1.4 Hz, 1H, *Z*-C*H*), 3.29 (d, *J* = 6.0 Hz, 2H, N_bCH_2), 2.95–3.03 (m, 4H, CH_2CH_2), 1.61 (br s, 1H, N_b-*H*).



(2*E*,4*E*)-5-{Allyl-[2-(3-indolyl)-ethyl]-amino}-penta-2,4-dienal (11)

To a solution of N_b-allyltryptamine (**9**) (14.25 g, 71.15 mmol, 2.10 equiv) in EtOH (85 mL) was added 1-(2,4-dinitrophenyl)-pyridinium chloride (**10**)[3] (9.54 g, 33.9 mmol). After stirring for 30 min at rt, the red mixture was heated to 80 °C for 2 h 45 min, then cooled to rt. The reaction mixture was quenched with 2 M NaOH (90 mL) and stirred at rt for 30 min, then diluted with EtOAc (350 mL) and water (250 mL). The aqueous layer was separated and extracted with EtOAc (100 mL). The combined organic extracts were washed successively with 2 M NaOH (60 mL) and brine (100 mL), then dried over Na_2SO_4. The solvent was evaporated *in vacuo* and the crude material was purified by column chromatography (SiO_2, 0.1:0.9:99 → 0.5:4.5:95 $NH_4OH/MeOH/CH_2Cl_2$) to yield the desired product as a red–brown solid (7.67 g, 81% based on **10**) along with recovered N_b-allyltryptamine (7.55 g, 100% recovery of excess). Further purification by column chromatography (SiO_2, 5:4:1 → 6:3:1 EtOAc:hexanes:CH_2Cl_2) and treatment with activated charcoal (~ 8 g) in CH_2Cl_2 for 1 h, followed by filtration and solvent removal gave a yellow solid.

m.p. = 104–106 °C;

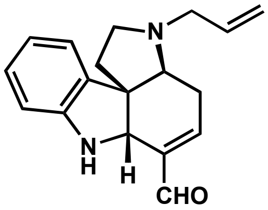
$R_f = 0.3$ (0.5:4.5:95 $NH_4OH/MeOH/CH_2Cl_2$);

^{1}H NMR (500 MHz, $CDCl_3$) δ 9.29 (d, J = 8.3 Hz, 1H, C*H*O), 8.31 (br s, 1H, N_a-*H*), 7.57 (d, J = 7.6 Hz, 1H, indole C4-*H*), 7.40 (d, J = 7.6 Hz, 1H, indole C7-*H*), 7.23 (t, J = 7.6 Hz, 1H, indole C6-*H*), 7.16 (t, J = 7.6 Hz, 1H, indole C5-*H*), 7.05 (t, J = 12.0 Hz, 1H, ZA [Zincke aldehyde] β-C*H*), 7.02 (s, 1H, indole C2-*H*), 6.74 (d, J = 12.0 Hz, 1H, ZA δ-C*H*), 5.85 (dd, J = 14.0, 8.3 Hz, 1H, ZA α-C*H*), 5.76 (ddt, J = 17.1, 10.2, 5.4 Hz, 1H, C*H*=CH_2), 5.38 (app t, J = 12.0 Hz, 1H, ZA γ-C*H*), 5.24 (d, J = 10.2 Hz, 1H, *E*-C*H*), 5.18 (d, J = 17.1 Hz, 1H, *Z*-C*H*), 3.74 (br s, 2H, N_b-CH_2), 3.52 (t, J = 7.2 Hz, 2H, Ar-CH_2), 3.05 (t, J = 7.2 Hz, 2H, CH_2-N_b);

^{13}C NMR (125 MHz, DMSO, 373 K) δ 189.7, 155.7, 151.5, 136.0, 132.6, 126.7, 233.5, 120.4, 118.2, 117.8, 117.5, 116.9, 110.9, 110.5, 96.6, 53.1, 51.9, 23.0;

IR (thin film) ν 3215, 3039, 2921, 1574, 1557, 1148, 742 cm^{-1};

HRMS (LC-ESI) m / z calcd for $C_{18}H_{21}N_2O$ $(M + H)^+$ 281.1654, found 281.1654.

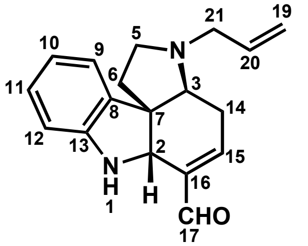


Tetracycle 12

To a solution of Zincke aldehyde **11** (207 mg, 0.738 mmol) in THF (36 mL, 0.02 M) in a sealed tube temporarily capped with a septum was added KO*t*-Bu (0.775 mL, 1.0 M in THF, 0.78 mmol, 1.05 equiv), yielding a light brown, slightly cloudy solution. The tube was tightly sealed and heated to 80 °C for 3 h 15 min, then cooled to rt. A saturated aqueous solution of $NaHCO_3$ (25 mL) was added, followed by EtOAc (60 mL) and water (25 mL). The aqueous layer was extracted with EtOAc (25 mL), and the combined organics were washed with brine (25 mL), then dried over Na_2SO_4. The solvent was evaporated *in vacuo* and the crude material was purified by column chromatography (SiO_2, 0.1:0.9:99 → 0.2:1.8:98 $NH_4OH/MeOH/CH_2Cl_2$) to yield the desired product as a yellow solid (133 mg, 64%). A reaction performed on 760 mg of **11** yielded 453 mg of product (60%).

m.p. = 91–93 °C;

R_f = 0.3 (0.5:4.5:95 $NH_4OH/MeOH/CH_2Cl_2$);



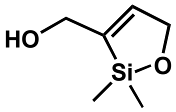
(Strychnine numbering)

^{1}H NMR (500 MHz, $CDCl_3$) δ 9.48 (s, 1H, C17-*H*), 7.06 (d, *J* = 7.5 Hz, 1H, C9-*H*), 7.03 (t, *J* = 7.5 Hz, 1H, C11-*H*), 6.82 (dd, *J* = 5.2, 2.5 Hz, 1H, C15-*H*), 6.71 (t, *J* = 7.5 Hz, 1H, C10-*H*), 6.56 (d, *J* = 7.5 Hz, 1H, C12-*H*), 5.91 (dddd, *J* = 17.1, 10.2, 7.2, 5.3 Hz, 1H, C20-*H*), 5.23 (d, *J* = 17.1 Hz, 1H, *Z*-C19-*H*), 5.15 (d, *J* = 10.2 Hz, 1H, *E*-C19-*H*), 4.51 (br s, 1H, NH), 4.33 (s, 1H, C2-*H*), 3.47 (dd, *J* = 14.0, 5.3 Hz, 1H, C21-*H*), 3.15–3.21 (m, 1H, C5-*H*), 3.12 (appar d, *J* = 2.9 Hz, 1H, C3-*H*), 3.03 (dd, *J* = 14.0, 7.2 Hz, 1H, C21-*H*), 2.68 (ddd, *J* = 10.2, 10.0, 5.1 Hz, 1H, C5-*H*), 2.62 (dd, *J* = 19.3, 5.4 Hz, 1H, C14-*H*), 2.40 (appar d, *J* = 19.3 Hz, 1H, C14-*H*), 2.21 (ddd, *J* = 13.0, 8.2, 5.1 Hz, 1H, C6-*H*), 1.93 (ddd, *J* = 13.0, 10.0, 6.5 Hz, 1H, C6-*H*);

^{13}C NMR (125 MHz, $CDCl_3$) δ 194.9 (C17), 150.6 (C15), 150.4 (C13), 140.8 (C16), 135.2 (C20), 132.0 (C8), 128.3 (C11), 122.8 (C9), 118.6 (C10), 117.4 (C19), 109.3 (C12), 63.8 (C3), 59.7 (C2), 56.6 (21), 53.5 (C7), 51.0 (C5), 38.0 (C6), 26.0 (C14);

IR (thin film) ν 3398, 2917, 2809, 1679, 1485, 1464, 1184, 921, 744 cm^{-1};

HRMS (LC-ESI) *m* / *z* calcd for $C_{18}H_{21}N_2O$ $(M + H)^+$ 281.1654, found 281.1649.



Siloxacycle 14

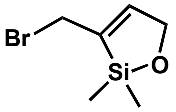
This reaction is a modification of the procedure of Trost and Ball.[4] To a solution of 1,4-butynediol (1.40 g, 16.3 mmol) and $Me_2SiH(OEt)$ (2.69 mL, 19.5 mmol, 1.2 equiv) in degassed acetone (33 mL, 0.5 M) at 0 °C was added $[Cp^{*}Ru(CH_3CN)_3]PF_6$ (22 mg, 0.044 mmol, 0.27 mol%). The solution was stirred at 0 °C for 5 min, warmed to rt for 30 min. A second portion of catalyst (22 mg, 0.044 mmol, 0.27 mol%) was added and the reaction was stirred at rt for 2 h, at which point ^{1}H NMR analysis of an aliquot indicated consumption of 1,4-butynediol. The solvent was removed *in vacuo* to give the desired product as a light yellow oil (2.64 g, ~90% pure by ^{1}H NMR) that was used without further purification. Siloxacycle **14** decomposed rapidly on silica gel.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.63 (s, 1H, vinyl C*H*), 4.60 (s, 2H, C*H*$_2$OSi), 4.44 (s, 2H, C*H*$_2$OH), 1.60 (br s, 1H, O*H*), 0.29 (s, 6H, SiC*H*$_3$);

^{13}C NMR (125 MHz, $CDCl_3$) δ 142.1 (vinyl CSi), 140.5 (vinyl CH), 72.0 (CH_2OSi), 62.5 (CH_2OH), 0.5 (CH_3Si);

IR (thin film) ν 3272, 2961, 2856, 1254, 1075, 1025, 858, 815, 784 cm^{-1};

HRMS (GC-CI) *m / z* calcd for $C_6H_{13}O_2Si$ $(M + H)^+$ 145.0685, found 145.0687.



Allylic bromide S1

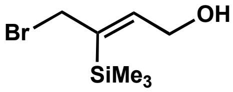
To a solution of crude siloxacycle **14** (2.64 g, <16.3 mmol) and NEt_3 (3.16 mL, 22.8 mmol, 1.4 equiv) in THF (65 mL, 0.25 M) at –25 °C was added methanesulfonyl chloride (1.51 mL, 19.5 mmol, 1.2 equiv). The solution was stirred at –25 °C for 1 h, then LiBr (3.95 g, 45.5 mmol, 2.8 equiv) was added and the reaction mixture was warmed to rt for 4 h. The reaction was diluted with Et_2O (50 mL), quenched with water (50 mL), then further diluted with Et_2O (50 mL) and water (30 mL). The layers were separated and the aqueous layer was extracted with Et_2O (50 mL). The combined organic extracts were washed with saturated aqueous NH_4Cl (2 x 50 mL) and dried over $MgSO_4$. The solvent was removed *in vacuo* to give the desired product as an orange oil (3.40 g, ~60–70% pure by ^{1}H NMR) that was used without further purification. Bromide **S1** decomposed on silica gel.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.72 (s, 1H, vinyl C*H*), 4.61 (s, 2H, C*H*$_2$OSi), 4.24 (s, 2H, C*H*$_2$Br), 0.33 (s, 6H, SiC*H*$_3$);

^{13}C NMR (125 MHz, $CDCl_3$) δ 146.0 (vinyl CH), 138.2 (vinyl CSi), 71.3 (CH_2OSi), 31.5 (CH_2Br), 0.6 (CH_3Si);

IR (thin film) ν 2960, 2854, 1259, 1075, 1039, 799 cm^{-1};

HRMS (GC-CI) *m / z* calcd for $C_6H_{15}NOSiBr$ $(M + NH_4)^+$ 224.0106, found 224.0106.



Vinylsilane 15

To a solution of crude siloxacycle **S1** (3.40 g, <16.3 mmol) in Et_2O (90 mL, 0.18 M) at –78 °C was added methylmagnesium bromide (5.51 mL, 3.10 M in Et_2O, 17.1 mmol, ~1.05 equiv) over 5 min. After stirring for 30 min at –78 °C, the reaction was quenched with half-saturated aqueous NH_4Cl (25 mL) and warmed to rt. The reaction mixture was diluted with Et_2O (50 mL) and half-saturated aqueous NH_4Cl (100 mL). The layers were separated, and the aqueous layer was extracted with Et_2O (50 mL). The combined organic extracts were washed with saturated aqueous NH_4Cl (50 mL) and dried over $MgSO_4$. The solvent was evaporated *in vacuo* and the crude material was purified by column chromatography (SiO_2, 25:75 → 30:70 Et_2O/hexanes) to yield the desired product as a colorless oil (1.70 g, 47% over 3 steps).

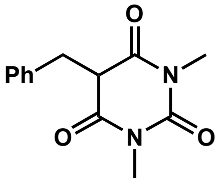
R_f = 0.3 (2:3 Et_2O:hexanes);

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.45 (t, *J* = 6.5 Hz, 1H, vinyl C*H*), 4.26 (d, *J* = 6.5 Hz, 2H, CH_2OH), 4.10 (s, 2H, CH_2Br), 1.51 (br s, 1H, O*H*), 0.26 (s, 9H, SiCH_3);

^{13}C NMR (125 MHz, $CDCl_3$) δ 145.9 (vinyl CH), 139.9 (vinyl CSi), 61.7 (CH_2O), 39.9 (CH_2Br), 0.0 (CH_3Si);

IR (thin film) ν 3329, 2957, 1251, 1204, 1072, 1010, 841, 760 cm^{-1};

HRMS (GC-CI) *m* / *z* calcd for $C_7H_{19}NOSiBr$ $(M + NH_4)^+$ 240.0419, found 240.0423.

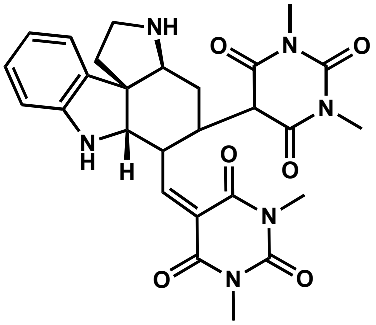


5-Benzyl-*N,N'*-dimethylbarbituric acid (S2)

This reaction is a modification of the procedure of Ramachary et al.[5] To a solution of *N,N'*-dimethylbarbituric acid (8.00 g, 51.2 mmol) in EtOH (128 mL, 0.4 M) was added sequentially benzaldehyde (5.75 mL, 56.4 mmol, 1.1 equiv), Hantzsch ester [diethyl 2,6-dimethyl-1,4-dihydropyridine-3,5-dicarboxylate] (15.4 g, 56.4 mmol, 1.1 equiv) and piperidine (0.51 mL, 5.1 mmol, 0.1 equiv). The resulting thick suspension was stirred at rt for 15 h. Most of the EtOH was removed *in vacuo*, 1M HCl (50 mL) was added, and the resulting mixture was diluted with EtOAc (150 mL) and water (150 mL). The layers were separated and the aqueous layer was extracted with

EtOAc (150 mL). The combined organic extracts were washed successively with water (60 mL) and brine (60 mL), then dried over $MgSO_4$. Most of the solvent was evaporated *in vacuo* and the product could be collected directly by filtration, rinsing with EtOAc:hexanes (20:80, 100 mL) to give a pale orange, crystalline solid (7.0 g, 56%). Spectral data were consistent with literature values.[5]

$R_f = 0.4$ (1:3 EtOAc/hexanes).



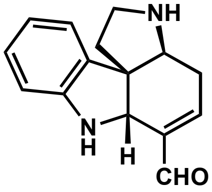
Barbituric acid adduct 8

To a solution of **12** (16.7 mg, 59.6 µmol) and *N,N'*-dimethylbarbituric acid (27.9 mg, 179 µmol, 3 equiv) in CH_2Cl_2 (0.6 mL, 0.1 M) at rt was added $Pd(PPh_3)_4$ (3.4 mg, 3.0 µmol, 5 mol%). The reaction mixture was stirred at rt for 1.75 h. The reaction mixture was concentrated *in vacuo*. NMR analysis of the crude residue indicated clean formation of **8**, which was contaminated with excess **S2** and allylated variants thereof. Column chromatography (SiO_2, 0.5:4.5:95 → 1:9:90 $NH_4OH/MeOH/CH_2Cl_2$) afforded a pure sample of title compound as a clear oil (6.6 mg, 21%).

$R_f = 0.4$ (1:9:90 $NH_4OH/MeOH/CH_2Cl_2$);

^1H NMR (500 MHz, $CDCl_3$) δ 7.30–7.36 (m, 1H), 7.16 (t, J = 7.5 Hz, 1H), 7.10 (d, J = 7.5 Hz, 1H), 6.78 (t, J = 7.5 Hz, 1H), 6.67 (d, J = 7.5 Hz, 1H), 4.57 (d, J = 3.7 Hz, 1H), 4.20 (d, J = 10.5 Hz, 1H), 4.09–4.15 (m, 2H), 3.45 (q, J = 9.7 Hz, 1H), 3.28 (s, 6H), 3.20–3.29 (m, 1H), 3.21 (s, 3H), 3.19 (s, 3H), 2.80–2.84 (m, 1H), 2.72–2.80 (m, 1H), 2.20–2.37 (m, 3H), 1.88 (dd, J = 14.8, 7.7 Hz, 1H);

LRMS (LC-ESI) m / z calcd for $C_{27}H_{31}N_6O_6$ $(M + H)^+$ 535.23, found 535.19; m / z calcd for $C_{27}H_{30}N_6O_6Na$ $(M + Na)^+$ 557.21, found 557.15.



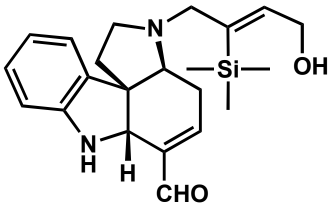
Tetracycle 7

To a solution of **12** (44.7 mg, 0.159 mmol) and 5-benzyl-*N,N'*-dimethylbarbituric acid **S2** (47.1 mg, 0.191 mmol, 1.2 equiv) in CH_2Cl_2 (0.8 mL, 0.2 M) at rt was added $Pd(PPh_3)_4$ (9.2 mg, 0.008 mmol, 5 mol%). The reaction mixture was stirred at rt for 1.5 h. The reaction mixture was concentrated *in vacuo* and the crude material was purified by column chromatography (SiO_2, 0.2:1.8:98 → 0.8:7.2:92 $NH_4OH/MeOH/CH_2Cl_2$) to yield the desired product as a clear oil (21.9 mg, 57%). Tetracycle **7** was unstable in concentrated form.

$R_f = 0.3$ (1:9:90 $NH_4OH/MeOH/CH_2Cl_2$);

^{1}H NMR (500 MHz, $CDCl_3$) δ 9.52 (s, 1H), 7.05 (t, *J* = 7.6 Hz, 1H), 7.02 (d, *J* = 7.6 Hz, 1H), 6.87 (t, *J* = 4.0 Hz, 1H), 6.73 (t, *J* = 7.6 Hz, 1H), 6.58 (d, *J* = 7.6 Hz, 1H), 4.58 (br s, 1H), 4.36 (s, 1H), 3.58 (t, *J* = 4.6 Hz, 1H), 3.23–3.29 (m, 1H), 3.14–3.21 (m, 1H), 2.48–2.61 (m, 2H), 2.25 (ddd, *J* = 13.1, 8.3, 4.5 Hz, 1H), 2.07 (ddd, *J* = 13.1, 9.6, 7.0 Hz, 1H);

HRMS (LC-ESI) *m* / *z* calcd for $C_{15}H_{17}N_2O$ $(M + H)^+$ 241.1341, found 241.1335.

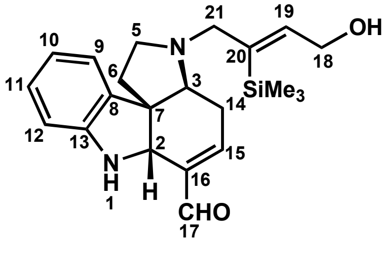


Tetracycle 16

To a solution of **12** (280 mg, 0.999 mmol) and 5-methyl Meldrum's acid (347 mg, 2.20 mmol, 2.2 equiv) in $CDCl_3$ (5.0 mL, 0.2 M) at 0 °C was added $Pd(PPh_3)_4$ (57.7 mg, 50.0 μmol, 5 mol%). The reaction mixture was stirred at 0 °C for 1 h, at which point ^{1}H NMR analysis of an aliquot indicated complete deallylation. To the reaction mixture was added diisopropylethylamine (610 μL, 3.50 mmol, 3.5 equiv) and bromide **15** (493 mg, 2.20 mmol, 2.2 equiv) as a solution in CH_3CN, rinsing with CH_3CN (5.0 mL total). The resulting solution was stirred at 0 °C for 2.5 h, diluted with EtOAc (10 mL) and saturated aqueous $NaHCO_3$ (10 mL), and warmed to rt. The mixture was diluted with EtOAc (20 mL) and water (10 mL). The layers were separated and the aqueous layer was extracted with EtOAc (20 mL). The combined organic extracts were washed with aqueous $NaHCO_3$ (20 mL) and brine (20 mL), then dried over Na_2SO_4. The solvent was evaporated *in vacuo* and the crude material was purified by column chromatography (SiO_2, 1:4 → 1:3 EtOAc:CH_2Cl_2) to yield the desired product as a yellow solid. The purified product was dissolved in Et_2O (10 mL) and filtered through Celite to remove traces of Ph_3PO, then concentrated to give the desired product as a pale yellow solid (265 mg, 69%).

m.p. = 115–117 °C;

$R_f = 0.3$ (1:3 EtOAc:CH_2Cl_2);



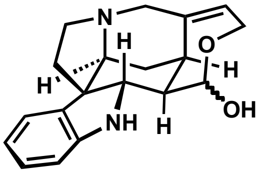
(Strychnine numbering)

^{1}H NMR (500 MHz, $CDCl_3$) δ 9.48 (s, 1H, C17-*H*), 7.06 (d, *J* = 7.5 Hz, 1H, C9-*H*), 7.03 (t, *J* = 7.5 Hz, 1H, C11-*H*), 6.81 (dd, *J* = 5.2, 2.9 Hz, 1H, C15-*H*), 6.71 (t, *J* = 7.5 Hz, 1H, C10-*H*), 6.56 (d, *J* = 7.5 Hz, 1H, C12-*H*), 6.31 (t, *J* = 6.6 Hz, 1H, C19-*H*), 4.50 (br s, 1H, N*H*), 4.26 (s, 1H, C2), 4.19–4.27 (m, 2H, C18-*H*), 3.66 (d, *J* = 11.7 Hz, 1H, C21-*H*), 2.96–3.02 (m, 2H, C3-*H* and C5-*H*), 2.76 (d, *J* = 11.7 Hz, 1H, C21-*H*), 2.60 (appar dd, *J* = 19.9, 3.8 Hz, 1H, C14-*H*), 2.50 (td, *J* = 10.2, 5.1 Hz, 1H, C5-*H*), 2.16 (ddd, *J* = 12.8, 8.8, 5.1 Hz, 1H, C6-*H*), 1.88 (ddd, *J* = 12.8, 10.3, 6.1 Hz, 1H, C6-*H*), 1.40 (br s, O*H*), 0.10 (s, 9H, SiC*H*$_3$);

^{13}C NMR (125 MHz, $CDCl_3$) δ 194.8 (C17), 150.8 (C15), 150.1 (C13), 142.5 (C19), 141.4 (C20), 140.6 (C16), 132.0 (C8), 128.1 (C11), 122.8 (C9), 118.5 (C10), 109.2 (C12), 63.8 (C3), 62.9 (C), 61.8 (C), 59.7 (C2), 53.3 (C7), 50.8 (C5), 36.9 (C6), 25.6 (C14), 0.1 (CH_3Si);

IR (thin film) ν 3380, 2952, 2807, 1679, 1485, 1246, 840, 743 cm^{-1};

HRMS (LC-ESI) *m* / *z* calcd for $C_{22}H_{31}N_2O_2Si$ $(M + H)^+$ 383.2155, found 383.2158.



Wieland–Gumlich aldehyde (2)

To a solution of **16** (38.2 mg, 100 μmol) in NMP (1.43 mL) at 0 °C was added NaHMDS (180 μL, 1.0 M in THF, 180 μmol, 1.8 equiv). After 15 min stirring at 0 °C, a suspension of $CuBr•SMe_2$ (1.44 mL, 0.120 M in NMP, 180 μmol, 1.8 equiv) was added. The resulting solution was stirred for 10 min at 0 °C, then warmed to rt for 5 min, then heated to 65 °C for 75 min. The reaction was cooled to rt, quenched with water (~5 drops), and diluted with EtOAc (20 mL) and 10% aqueous NH_3 (10 mL). The layers were separated and the aqueous layer was extracted with EtOAc (10 mL). The combined organic extracts were washed successively with 10% aqueous NH_3 (4 mL), water (2 x 4 mL), and brine (4 mL), and dried over Na_2SO_4. The solvent was evaporated *in vacuo* and the crude material was purified by two iterations of column chromatography (1. SiO_2, 1:9:90 → 1:9:90 NH_4OH/MeOH/$CHCl_3$; 2. SiO_2, 1:9:90 → 1:9:90 NEt_3/MeOH/CH_2Cl_2) to give the Wieland–Gumlich aldehyde as a light yellow solid (3.8 mg, ~80% pure by NMR, 10% yield).

The product Wieland–Gumlich aldehyde is an inseparable (likely equilibrating) mixture of hemiacetal epimers (typically 4:1 to 8:1). This compound is notoriously difficult to purify, and especially so from a crude reaction mixture containing only about 10% desired product. Spectral data were consistent with literature values (although variable depending upon preparation and purification method),[6] and synthetic Wieland–Gumlich aldehyde behaved identically by TLC to a sample prepared by degradation of natural strychnine.[7] Synthetic Wieland–Gumlich aldehyde was successfully converted to strychnine using the procedure of Overman.[8] Synthetic strychnine behaved identically by TLC to a commercially procured sample. Spectral data of synthetic strychnine were consistent with literature values, but due to minor differences in chemical shift, a titration experiment was performed by adding 0.1 mg portions of commercially procured strychnine to an NMR sample containing our synthetic strychnine. Analysis of the mixtures by ^1H NMR confirmed that our synthetic sample was in fact strychnine.

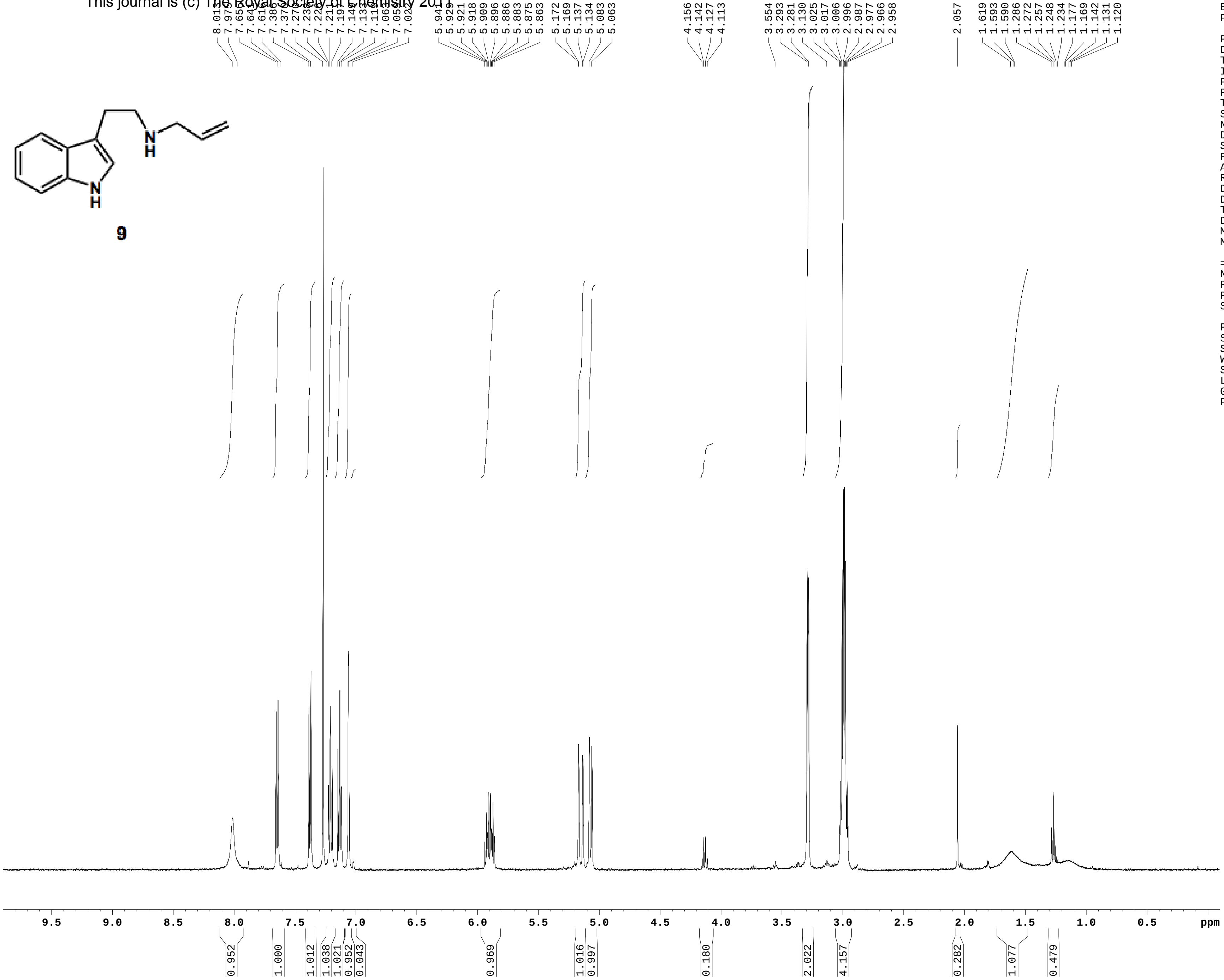
III. References:

1. Danheiser, R. L.; Renslo, A. R.; Amos, D. T.; Wright, G. T. *Organic Syntheses* **2003**, *80*, 133–143.
2. Martin, S. F.; Williamson, S. A.; Gist, R. P.; Smith, K. M. *J. Org. Chem.* **1983**, *48*, 5170–5180.
3. Zincke, T. *Liebigs Ann. Chem.* **1903**, *330*, 361–374.
4. Trost, B. M.; Ball, Z. T. *J. Am. Chem. Soc.* **2005**, *127*, 17644–17655.
5. Ramachary, D. B.; Kishor, M.; Reddy, Y. V. *Eur. J. Org. Chem.* **2008**, 975–993.
6. NMR spectra of Wieland–Gumlich aldehyde: Kuehne, M. E.; Xu, Feng *J. Org. Chem.* **1998**, *63*, 9427–9433.
7. Degradation of strychnine to Wieland–Gumlich aldehyde: Zlotos, D. P.; Buller, S.; Stiefl, N.; Baumann, K.; Mohr, K. *J. Med. Chem.* **2004**, *47*, 3561–3571.
8. Knight, S. D.; Overman, L. E.; Pairaudeau, G. *J. Am. Chem. Soc.* **1995**, *117*, 5776–5788.

IV. ^{1}H and ^{13}C NMR Spectra

dm-iv-136cr 1 - crude N-allyl tryptamine
1H spectrum

9



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EXPNO                  1
PROCNO                 1

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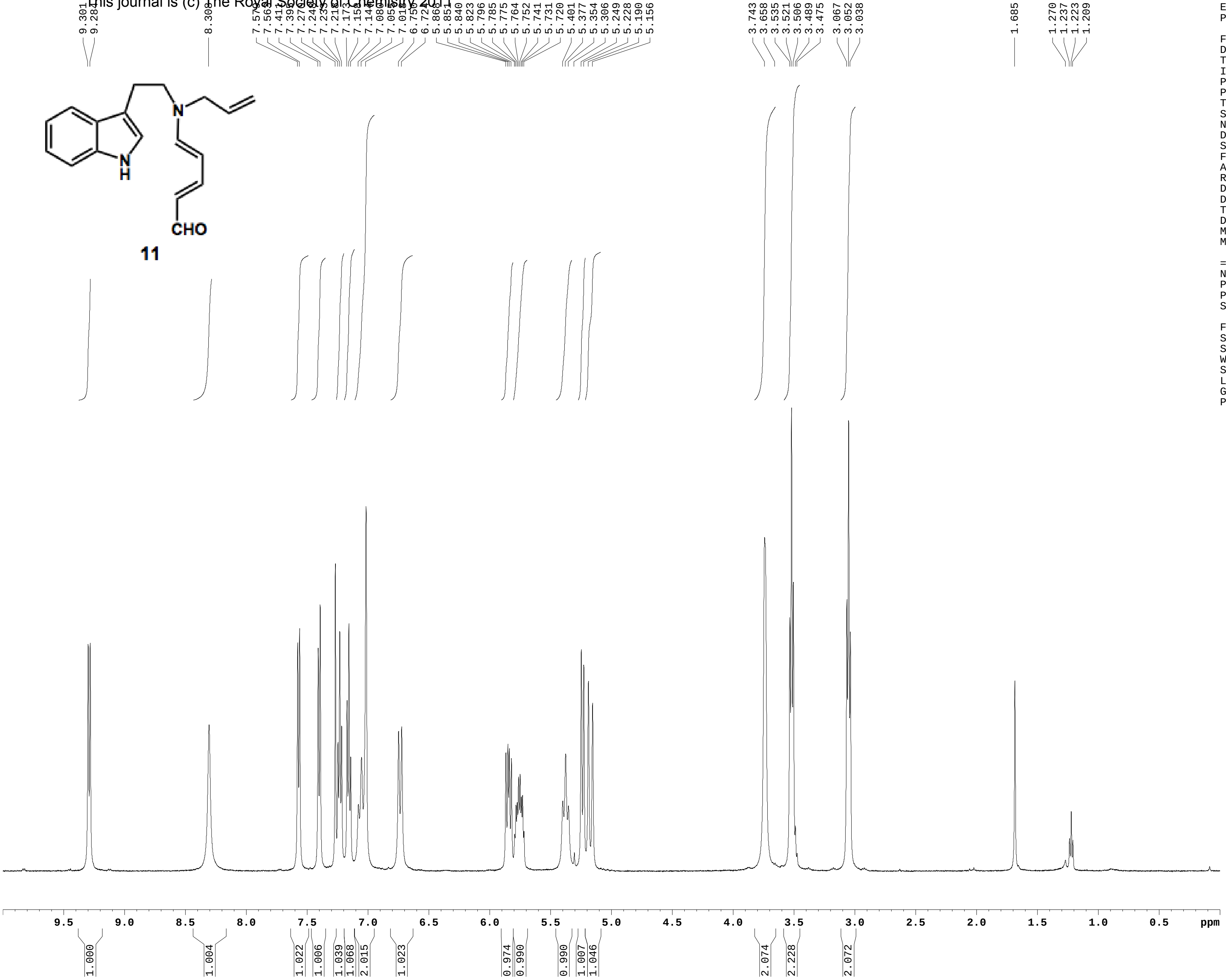
INSTRUM            gn500
PROBHD   5 mm broadband
PULPROG             zg30
TD                 48074
SOLVENT           CDCl3T
NS                     8
DS                     2
SWH             8012.820 Hz
FIDRES          0.166677 Hz
AQ             2.9999299 se
RG                1625.5
DW                62.400 us
DE                  6.00 us
TE                 297.9 K
D1            0.10000000 se
MCREST        0.00000000 se
MCWRK         0.01500000 se

======== CHANNEL f1 ======
NUC1                  1H
P1                 12.00 us
PL1                -3.00 dB
SFO1         499.6234973 MH

F2 - Processing parameters
SI                 65536
SF           499.6200239 MH
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```

```
dm-iv-144p       12 - pure N-allyl ZA
1H spectrum
```



11

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Current Data Parameters
USER                davebm
NAME             dm-iv-144p
EXPNO                    12
PROCNO                    1

F2 - Acquisition Parameter
Date_              20100109
Time                  16.12
INSTRUM               gn500
PROBHD   5 mm broadband
PULPROG                zg30
TD                    48074
SOLVENT               CDCl3T
NS                        8
DS                        2
SWH              8012.820 Hz
FIDRES           0.166677 Hz
AQ              2.9999299 se
RG                   645.1
DW                  62.400 us
DE                    6.00 us
TE                   298.0 K
D1             0.10000000 se
MCREST         0.00000000 se
MCWRK          0.01500000 se

======== CHANNEL f1 ======
NUC1                     1H
P1                   12.00 us
PL1                  -3.00 dB
SFO1         499.6234973 MH

F2 - Processing parameters
SI                    65536
SF           499.6200242 MH
WDW                      EM
SSB                       0
LB                    0.30 Hz
GB                        0
PC                     1.00
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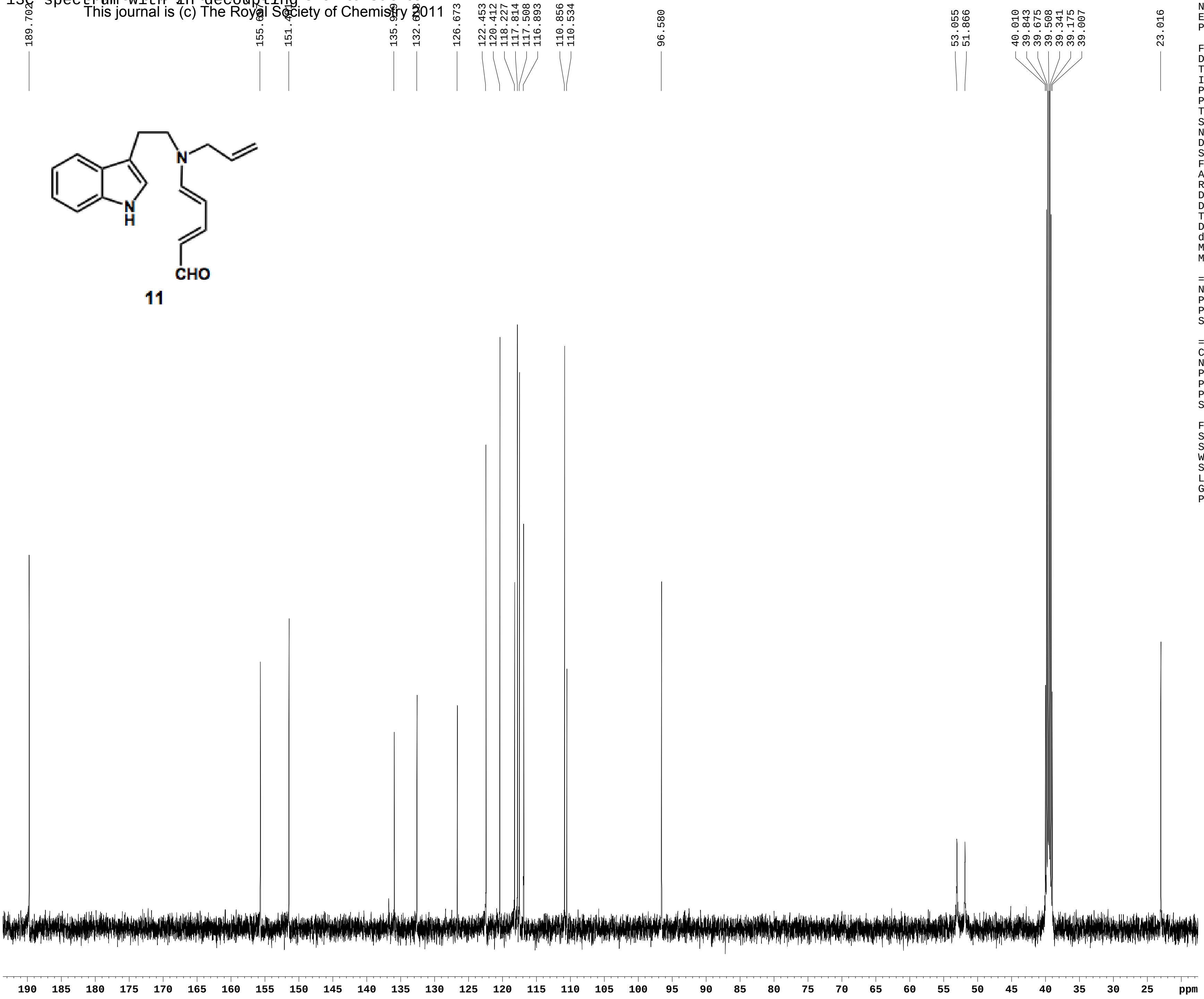
dm-iv-144p 43 - allyl-ZA in DMSO at 373K
13C spectrum with 1H decoupling



11

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Current Data Parameters
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NAME            dm-iv-144p
EXPNO                   43
PROCNO                   1

F2 - Acquisition Parameter
Date_             20100910
Time                 21.02
INSTRUM              gn500
PROBHD   5 mm broadband
PULPROG            zgdc30
TD                   65536
SOLVENT              CDCl3
NS                     864
DS                       4
SWH          30303.031 Hz
FIDRES        0.462388 Hz
AQ           1.0814105 se
RG                   32768
DW              16.500 us
DE                4.50 us
TE               373.0 K
D1          1.00000000 se
d11         0.03000000 se
MCREST      0.00000000 se
MCWRK       0.01500000 se

======== CHANNEL f1 =====
NUC1                   13C
P1                 7.50 us
PL1                0.00 dB
SFO1       125.6433683 MH

======== CHANNEL f2 =====
CPDPRG2            waltz16
NUC2                    1H
PCPD2             80.00 us
PL2               -3.00 dB
PL12              13.00 dB
SFO2       499.6224981 MH

F2 - Processing parameters
SI                   65536
SF         125.6296840 MH
WDW                     EM
SSB                      0
LB                 1.00 Hz
GB                       0
PC                    1.00
```
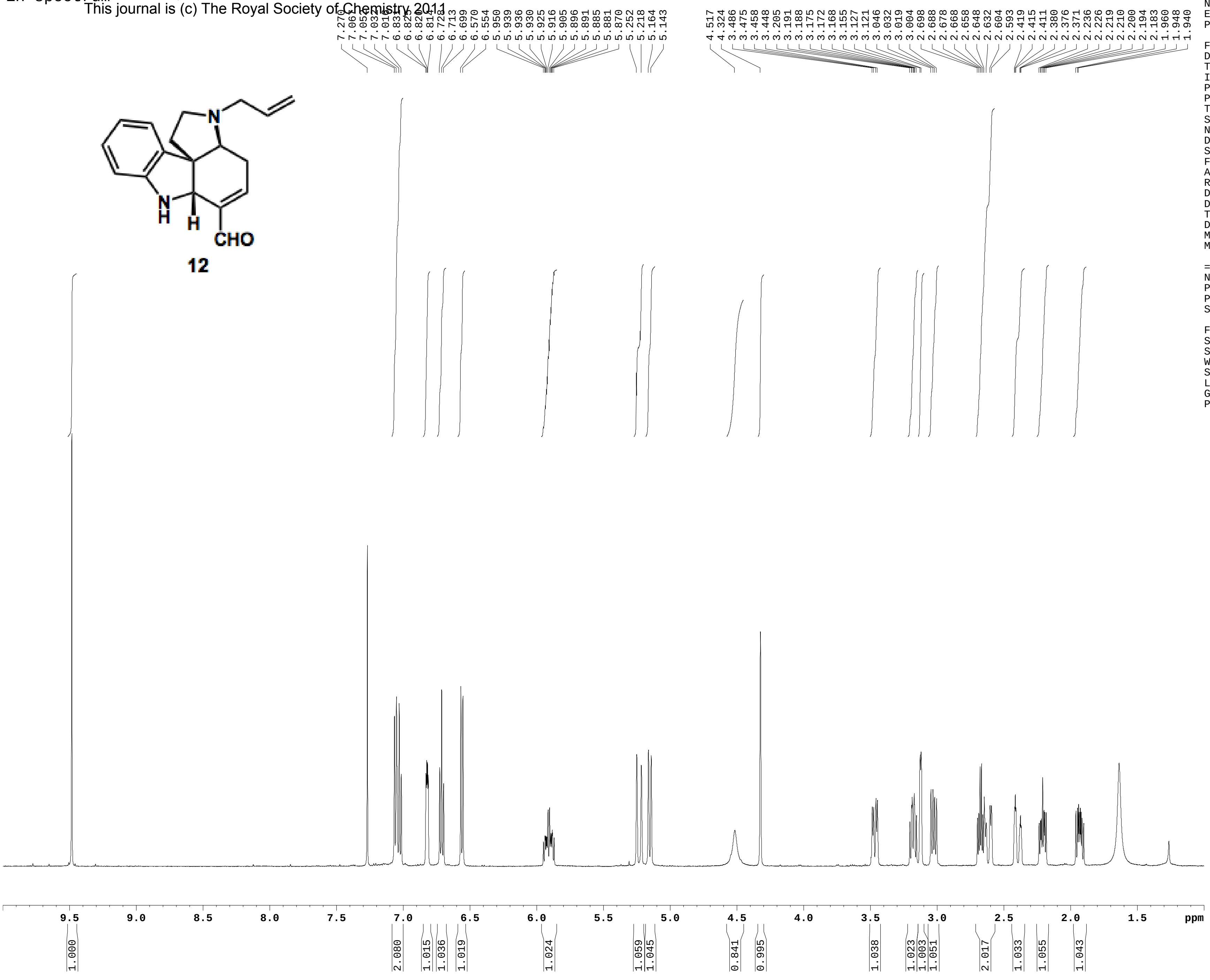
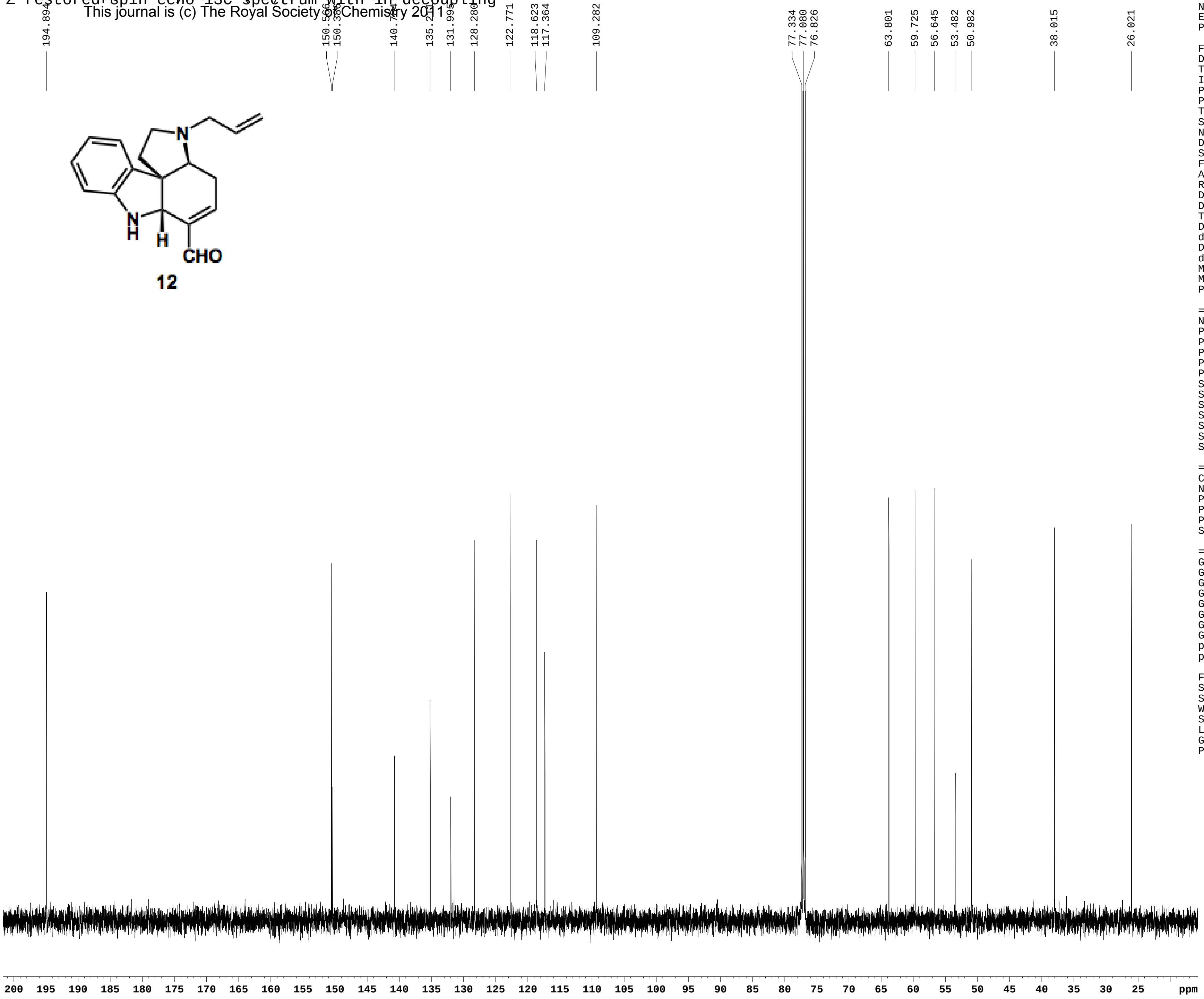

dm-iv-57p 11 - pure N-allyl core
1H spectrum



12

```
Current Data Parameters
USER                davebm
NAME             dm-iv-57p
EXPNO                   11
PROCNO                   1

F2 - Acquisition Parameter
Date_             20091019
Time                 17.04
INSTRUM            cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG               zg30
TD                   81728
SOLVENT              CDCl3
NS                       8
DS                       2
SWH             8012.820 Hz
FIDRES          0.098043 Hz
AQ             5.0999398 se
RG                     6.3
DW                  62.400 us
DE                    6.00 us
TE                   298.0 K
D1            0.10000000 se
MCREST        0.00000000 se
MCWRK         0.01500000 se

======== CHANNEL f1 ======
NUC1                    1H
P1                    7.50 us
PL1                   1.60 dB
SFO1         500.2235015 MH

F2 - Processing parameters
SI                   65536
SF           500.2200263 MH
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    4.00
```

dm-iv-57p 15 - pure N-allyl core
Z-restored spin-echo 13C spectrum with 1H decoupling



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USER                davebm
NAME            dm-iv-57p
EXPNO                  15
PROCNO                  1

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Date_            20091019
Time                17.38
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PROBHD   5 mm CPTCI 1H-
PULPROG  SpinEchopg30gp.pr
TD                  65536
SOLVENT             CDCl3
NS                    200
DS                     16
SWH          30303.031 Hz
FIDRES        0.462388 Hz
AQ           1.0813940 se
RG                 7298.2
DW             16.500 us
DE               6.00 us
TE              298.0 K
D1          0.25000000 se
d11         0.03000000 se
D16         0.00020000 se
d17         0.00019600 se
MCREST      0.00000000 se
MCWRK       0.01500000 se
P2              31.00 us

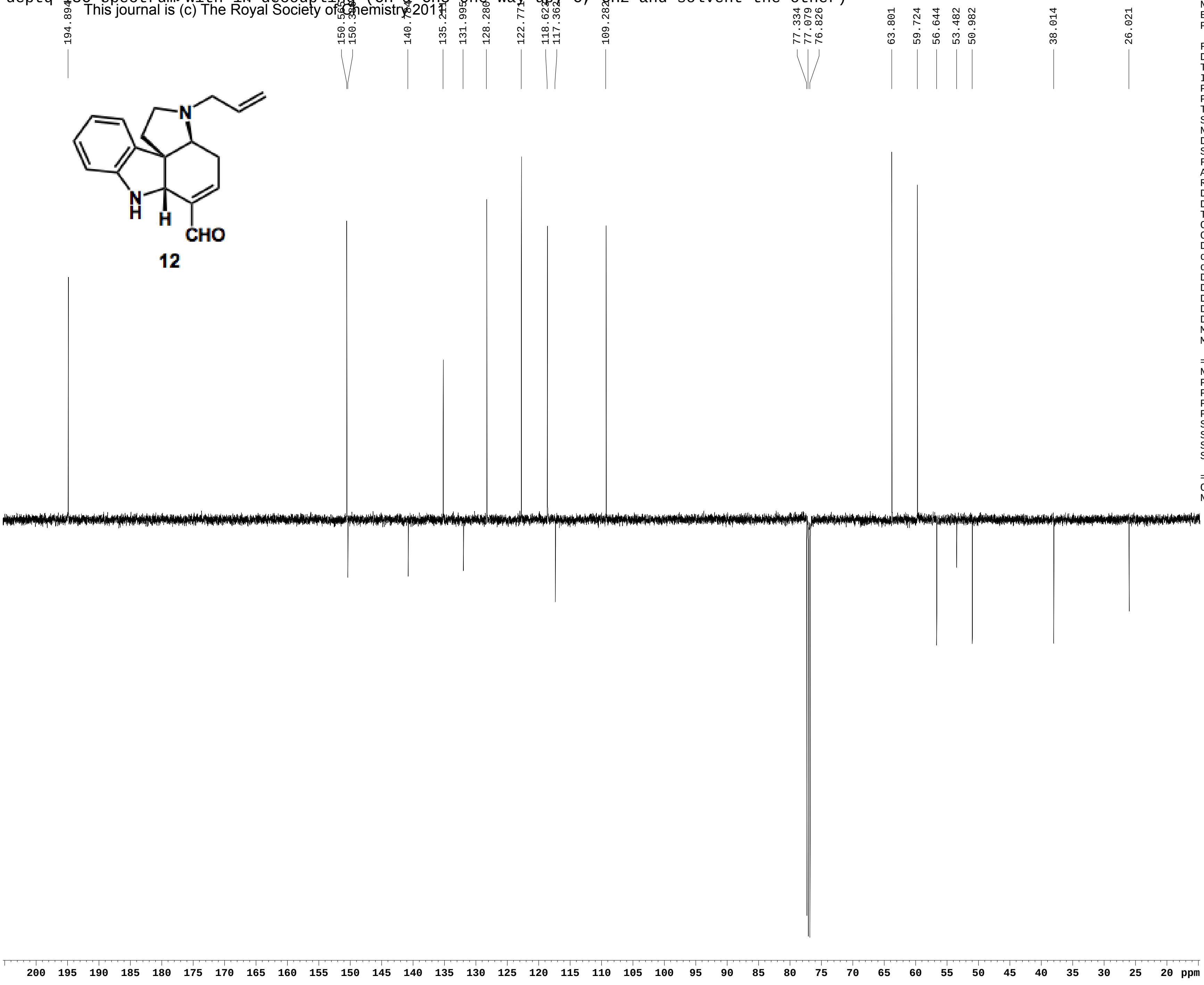
======== CHANNEL f1 ======
NUC1                  13C
P1              15.50 us
P11            500.00 us
P12           2000.00 us
PL0            120.00 dB
PL1             -1.00 dB
SFO1      125.7942548 MH
SP1              3.20 dB
SP2              3.20 dB
SPNAM1   Crp60,0.5,20.1
SPNAM2      Crp60comp.4
SPOFF1           0.00 Hz
SPOFF2           0.00 Hz

======== CHANNEL f2 ======
CPDPRG2           waltz16
NUC2                   1H
PCPD2          100.00 us
PL2              1.60 dB
PL12            24.60 dB
SFO2      500.2225011 MH

====== GRADIENT CHANNEL ==
GPNAM1          SINE.100
GPNAM2          SINE.100
GPX1              0.00 %
GPX2              0.00 %
GPY1              0.00 %
GPY2              0.00 %
GPZ1             30.00 %
GPZ2             50.00 %
p15             500.00 us
p16            1000.00 us

F2 - Processing parameters
SI                  65536
SF        125.7804190 MH
WDW                    EM
SSB                     0
LB               1.00 Hz
GB                      0
PC                   2.00
```

dm-iv-57p 12 - pure N-allyl core
deptq 13C spectrum with 1H decoupling (CH & CH3 one way up: C, CH2 and solvent the other)



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Current Data Parameters
USER                 davebm
NAME              dm-iv-57p
EXPNO                    12
PROCNO                    1

F2 - Acquisition Parameter
Date_              20091019
Time                  17.06
INSTRUM             cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG           deptqgpsp
TD                    65536
SOLVENT               CDCl3
NS                      240
DS                        8
SWH              30303.031 Hz
FIDRES            0.462388 Hz
AQ               1.0814105 se
RG                  10321.3
DW                   16.500 us
DE                     6.00 us
TE                    298.0 K
CNST2           145.0000000
CNST12            1.5000000
D1               1.00000000 se
d2               0.00344828 se
d12              0.00002000 se
D16              0.00020000 se
DELTA            0.00001574 se
DELTA1           0.00227878 se
DELTA2           0.00226378 se
DELTA3           0.00224828 se
MCREST           0.00000000 se
MCWRK            0.01500000 se

======== CHANNEL f1 ======
NUC1                    13C
P1                    15.50 us
P12                 2000.00 us
PL0                  120.00 dB
PL1                   -1.00 dB
SFO1            125.7942548 MH
SP2                    3.20 dB
SPNAM2          Crp60comp.4
SPOFF2                 0.00 Hz

======== CHANNEL f2 ======
CPDPRG2             waltz16
NUC2                     1H
```
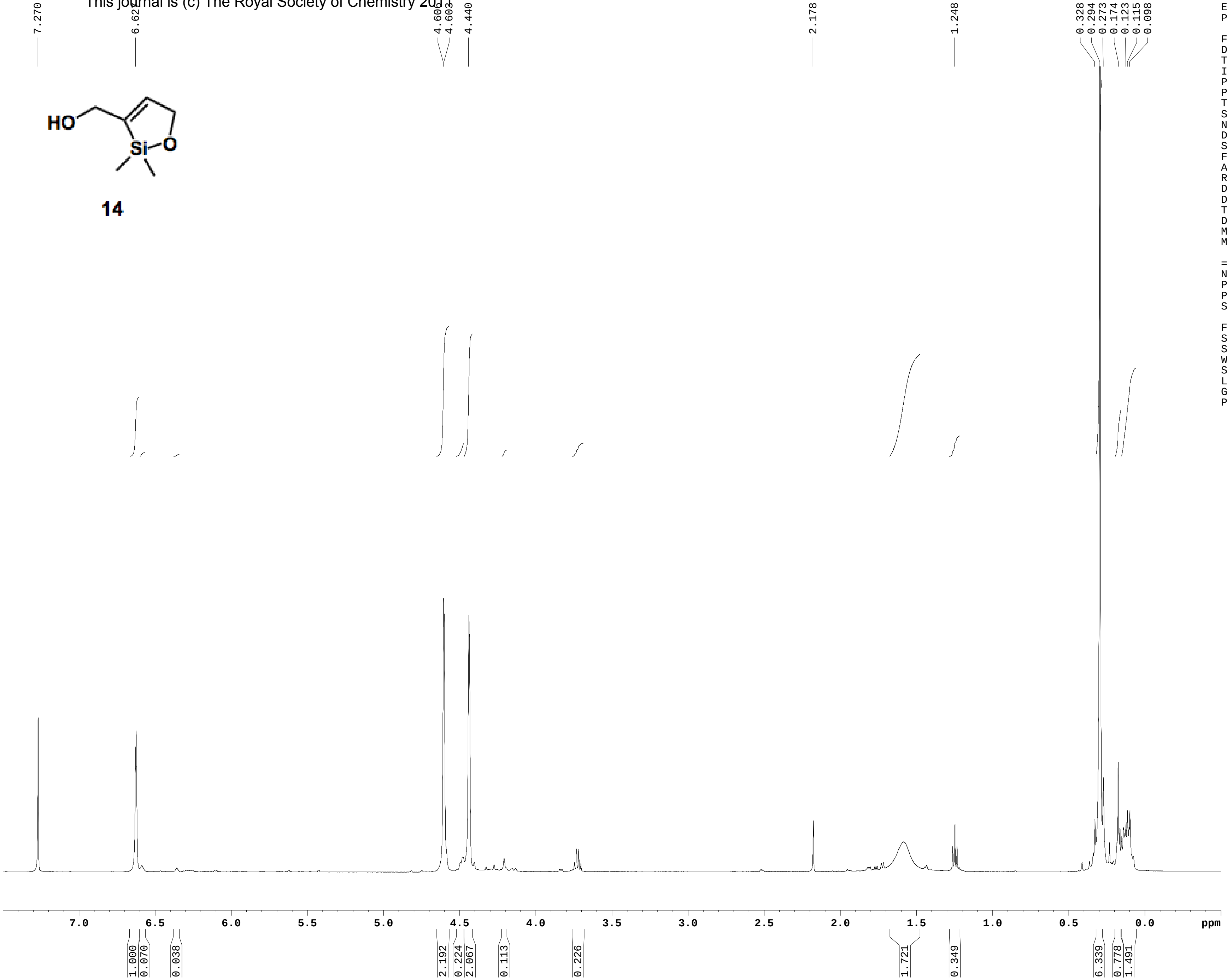
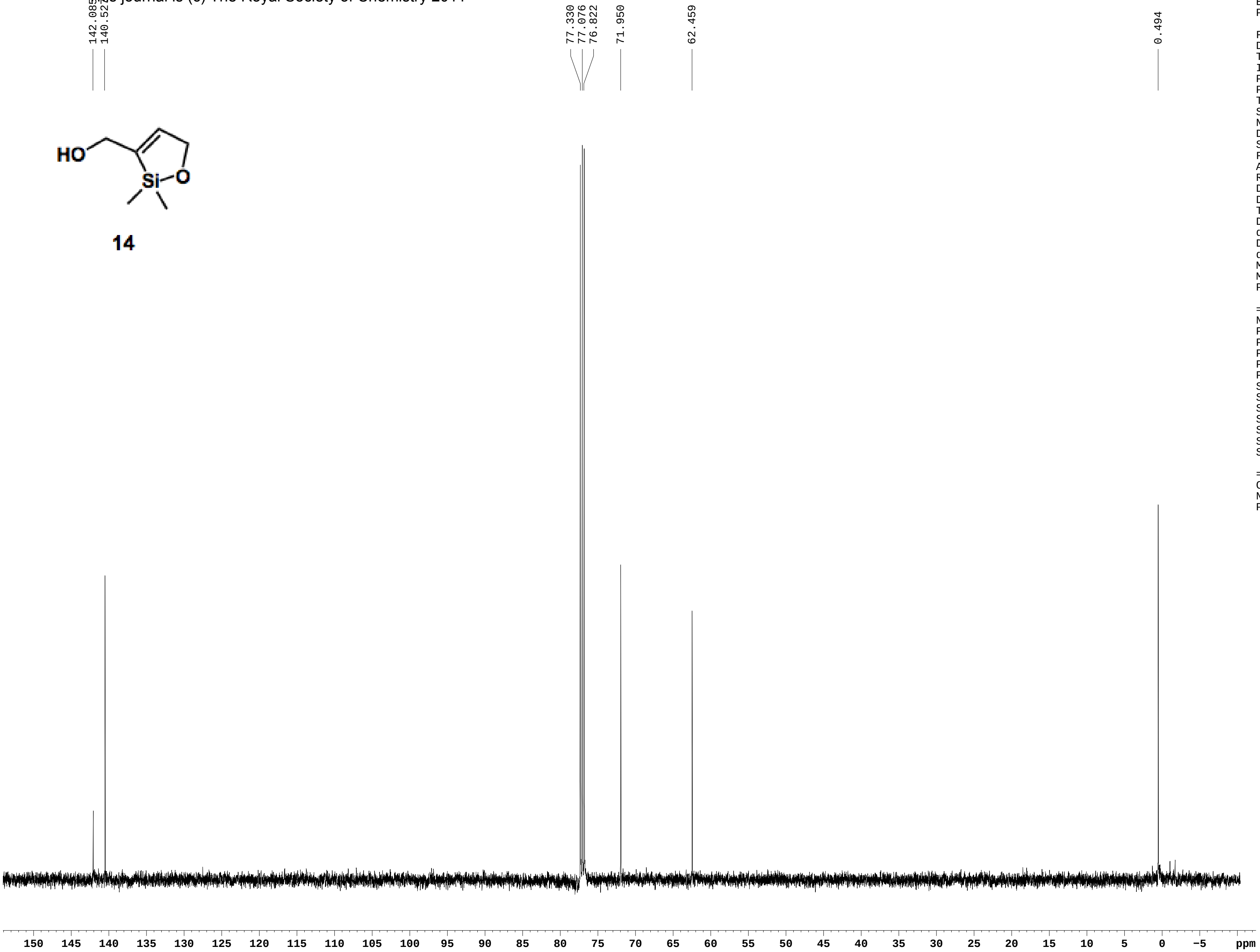

dm-iv-141cr 11 - unpurified silacycle
1H spectrum



14

```
Current Data Parameters
USER             davebm
NAME        dm-iv-141cr
EXPNO                11
PROCNO                1

F2 - Acquisition Parameter
Date_          20091222
Time              16.56
INSTRUM         cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG            zg30
TD                81728
SOLVENT           CDCl3
NS                    8
DS                    2
SWH          8012.820 Hz
FIDRES       0.098043 Hz
AQ          5.0999398 se
RG                  4.5
DW               62.400 us
DE                6.00 us
TE               298.0 K
D1          0.10000000 se
MCREST      0.00000000 se
MCWRK       0.01500000 se

======== CHANNEL f1 ======
NUC1                 1H
P1                 7.50 us
PL1                1.60 dB
SFO1        500.2235015 MH

F2 - Processing parameters
SI                65536
SF          500.2200273 MH
WDW                  EM
SSB                   0
LB                 0.30 Hz
GB                    0
PC                 4.00
```

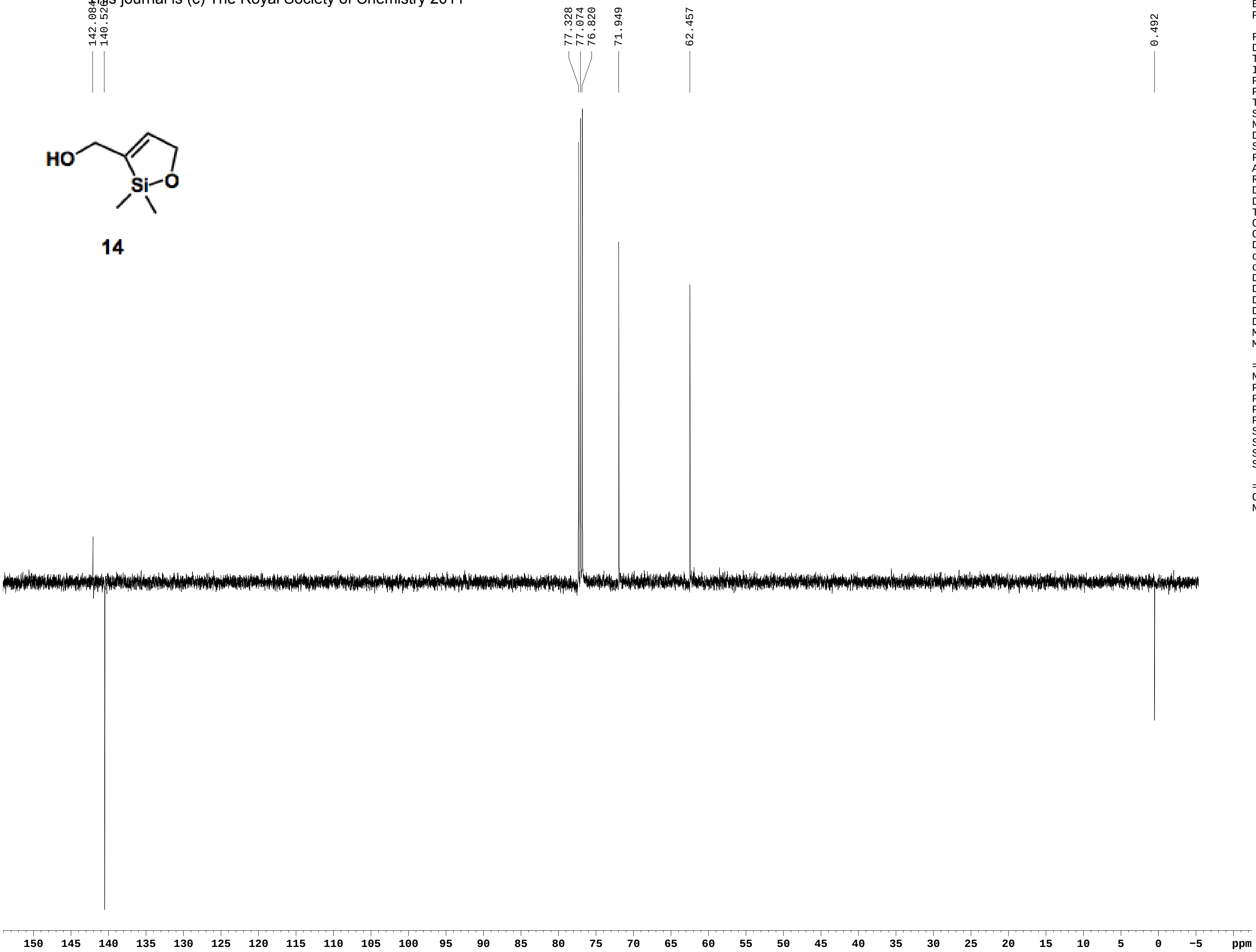
dm-iv-141cr 12 - unpurified silacycle
Z-restored spin-echo 13C spectrum with 1H decoupling



14

```
Current Data Parameters
USER              davebm
NAME         dm-iv-141cr
EXPNO                 12
PROCNO                 1

F2 - Acquisition Parameter
Date_           20091222
Time               17.00
INSTRUM          cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG  SpinEchopg30gp.pr
TD                 65536
SOLVENT            CDCl3
NS                   293
DS                    16
SWH            30303.031 Hz
FIDRES          0.462388 Hz
AQ             1.0814105 se
RG                 13004
DW                16.500 us
DE                  6.00 us
TE                 298.0 K
D1            0.25000000 se
d11           0.03000000 se
D16           0.00020000 se
d17           0.00019600 se
MCREST        0.00000000 se
MCWRK         0.01500000 se
P2                 31.00 us

======== CHANNEL f1 ======
NUC1                 13C
P1                 15.50 us
P11               500.00 us
P12              2000.00 us
PL0               120.00 dB
PL1                -1.00 dB
SFO1         125.7942548 MH
SP1                 3.20 dB
SP2                 3.20 dB
SPNAM1   Crp60,0.5,20.1
SPNAM2      Crp60comp.4
SPOFF1              0.00 Hz
SPOFF2              0.00 Hz

======== CHANNEL f2 ======
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 us
```

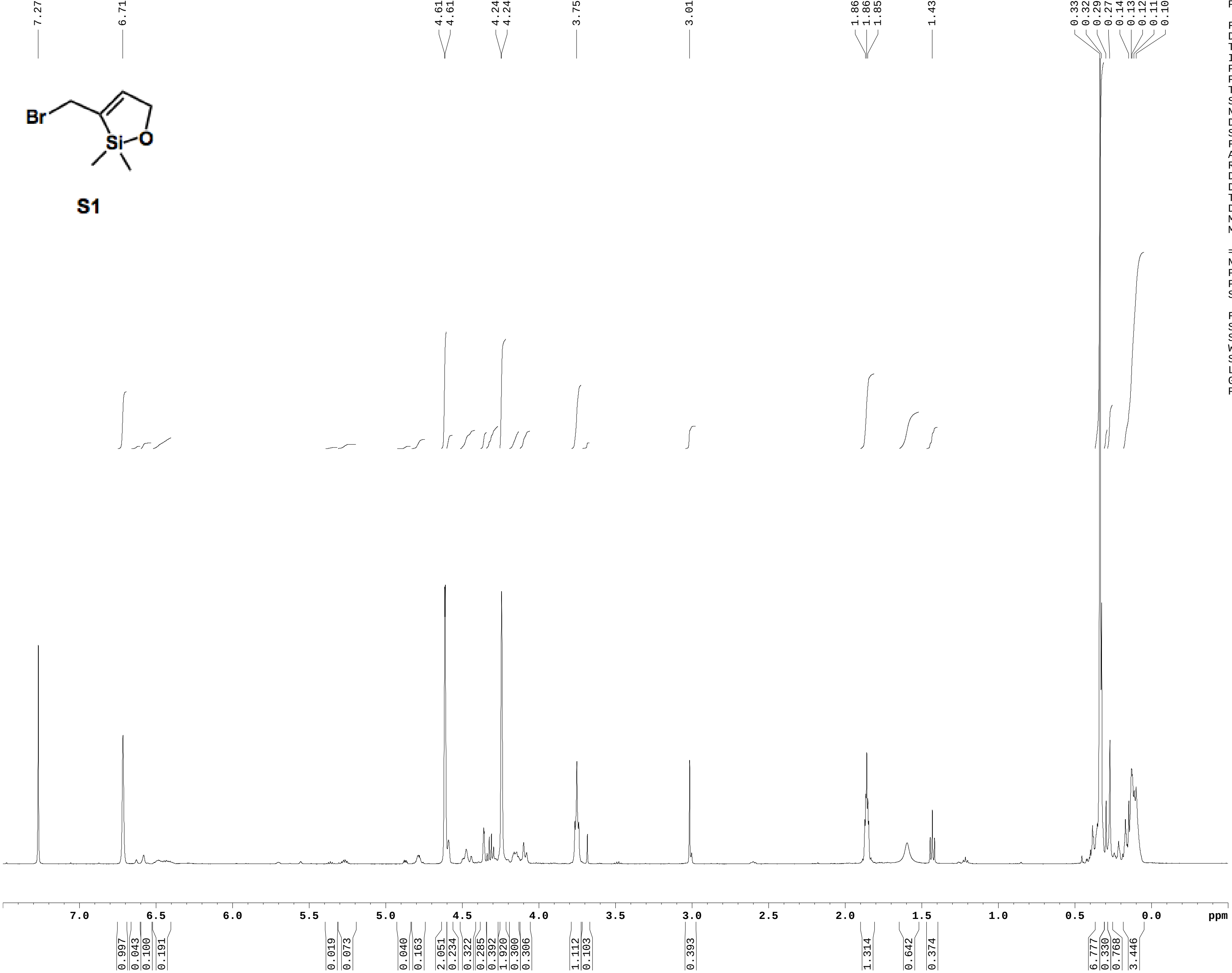
deptq 13C spectrum with 1H decoupling (CH & CH3 one way up; C, CH2 and solvent the other)



14

```
Current Data Parameters
USER              davebm
NAME        dm-iv-141cr
EXPNO                13
PROCNO                1

F2 - Acquisition Parameter
Date_          20091222
Time              17.07
INSTRUM         cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG       deptqgpsp
TD                65536
SOLVENT           CDCl3
NS                  188
DS                    8
SWH           20833.334 Hz
FIDRES         0.317891 Hz
AQ            1.5729380 se
RG               5792.6
DW               24.000 us
DE                 6.00 us
TE                298.0 K
CNST2       145.0000000
CNST12        1.5000000
D1           1.00000000 se
d2           0.00344828 se
d12          0.00002000 se
D16          0.00020000 se
DELTA        0.00001574 se
DELTA1       0.00227878 se
DELTA2       0.00226378 se
DELTA3       0.00224828 se
MCREST       0.00000000 se
MCWRK        0.01500000 se

======== CHANNEL f1 ======
NUC1                13C
P1                15.50 us
P12             2000.00 us
PL0              120.00 dB
PL1               -1.00 dB
SFO1        125.7901555 MH
SP2                3.20 dB
SPNAM2      Crp60comp.4
SPOFF2             0.00 Hz

======== CHANNEL f2 ======
CPDPRG2         waltz16
NUC2                 1H
```

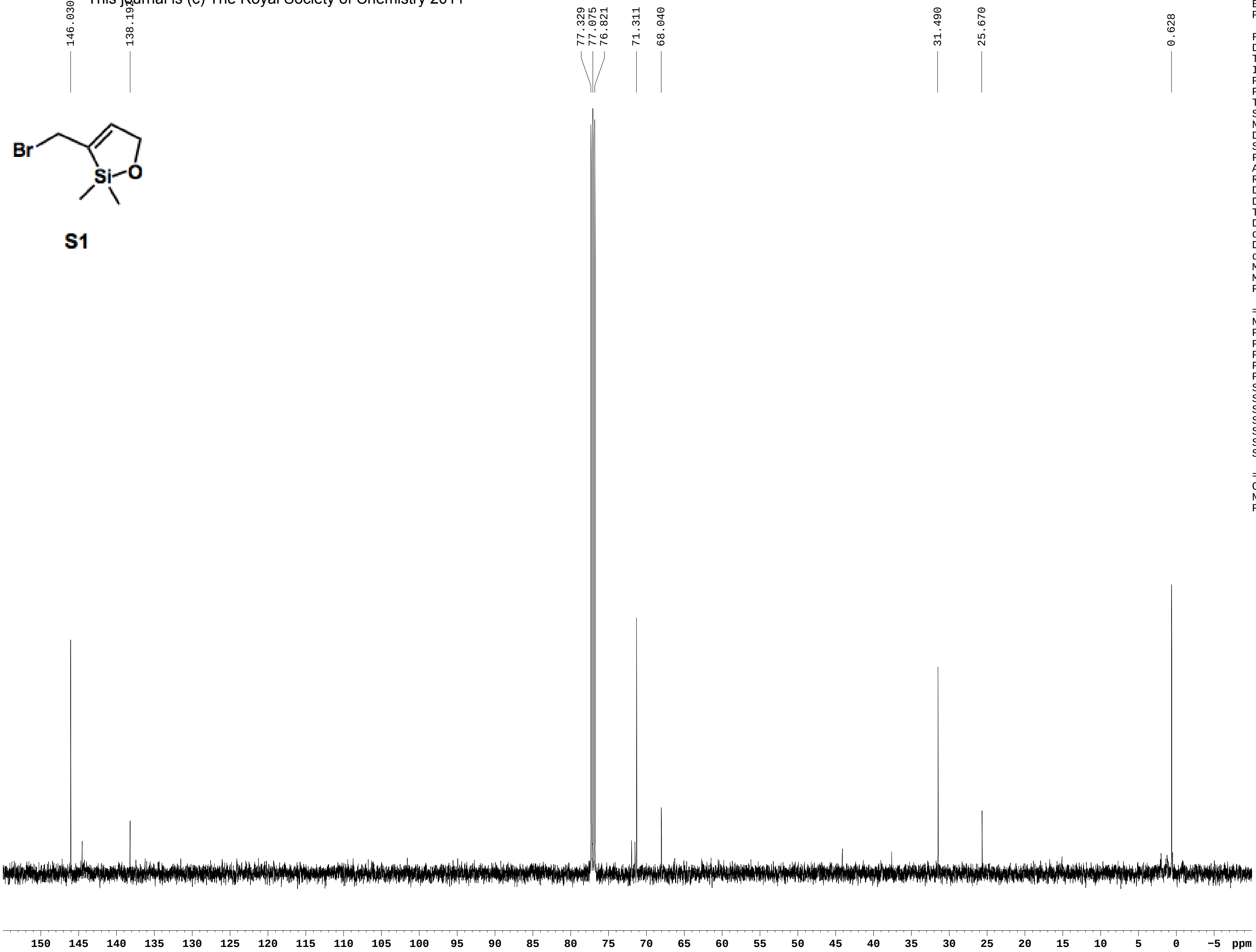
dm-iv-145cr 11 - unpurified bromo-silacycle
1H spectrum



S1

```
Current Data Parameters
USER              davebm
NAME         dm-iv-145cr
EXPNO                 11
PROCNO                 1

F2 - Acquisition Parameter
Date_           20091222
Time               17.24
INSTRUM          cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG             zg30
TD                 81728
SOLVENT            CDCl3
NS                     8
DS                     2
SWH           8012.820 Hz
FIDRES        0.098043 Hz
AQ           5.0999398 se
RG                     5
DW              62.400 us
DE                6.00 us
TE               298.0 K
D1          0.10000000 se
MCREST      0.00000000 se
MCWRK       0.01500000 se

======== CHANNEL f1 ======
NUC1                  1H
P1                7.50 us
PL1               1.60 dB
SFO1       500.2235015 MH

F2 - Processing parameters
SI                 65536
SF         500.2200273 MH
WDW                   EM
SSB                    0
LB                0.30 Hz
GB                     0
PC                  4.00
```

dm-iv-145cr 12 - unpurified bromo-silacycle
Z-restored spin-echo 13C spectrum with 1H decoupling



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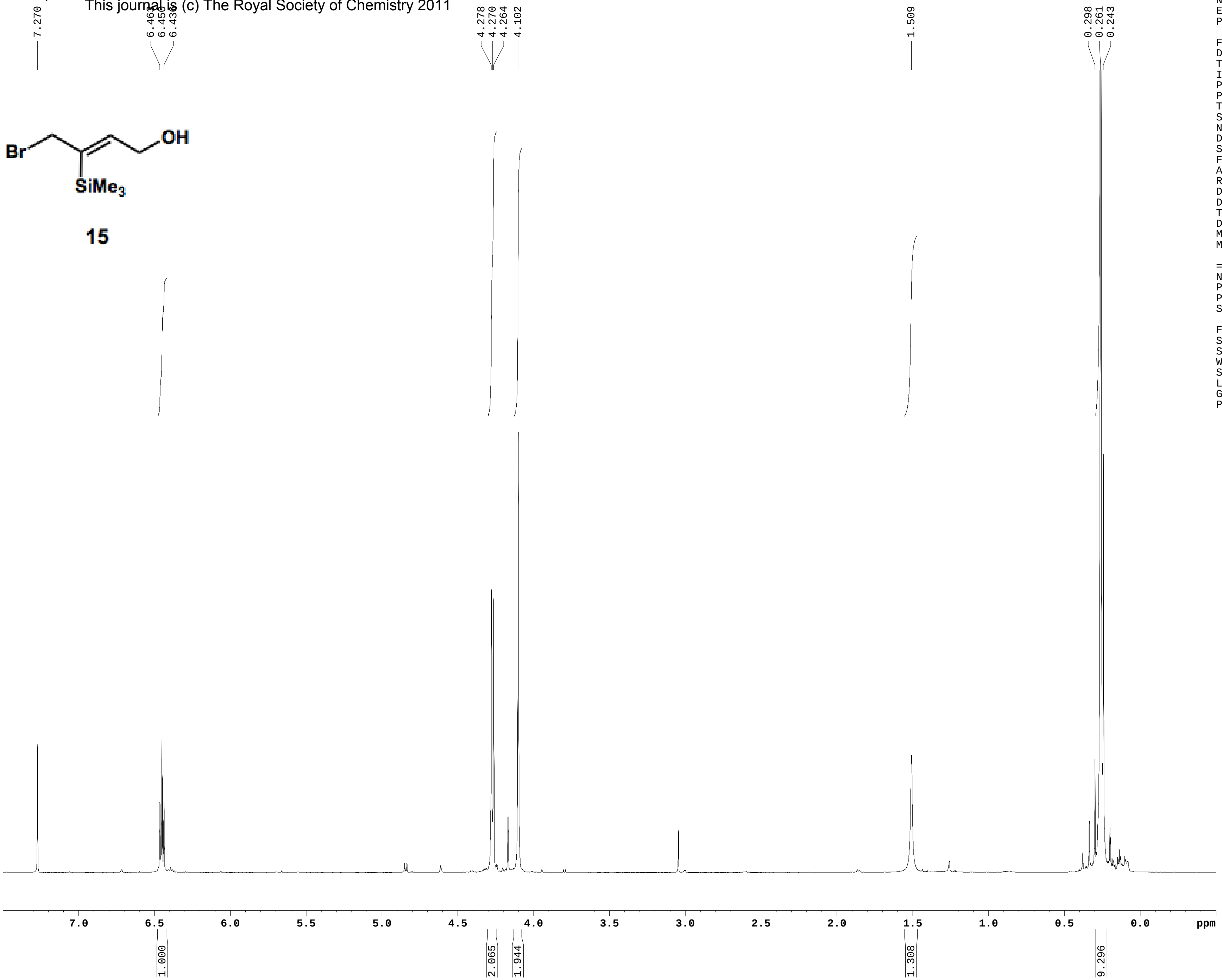
Current Data Parameters
USER              davebm
NAME         dm-iv-145cr
EXPNO                 12
PROCNO                 1

F2 - Acquisition Parameter
Date_           20091222
Time               17.29
INSTRUM          cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG  SpinEchopg30gp.pr
TD                 65536
SOLVENT            CDCl3
NS                   141
DS                    16
SWH            30303.031 Hz
FIDRES          0.462388 Hz
AQ             1.0814105 se
RG                  8192
DW                16.500 us
DE                  6.00 us
TE                 298.0 K
D1            0.25000000 se
d11           0.03000000 se
D16           0.00020000 se
d17           0.00019600 se
MCREST        0.00000000 se
MCWRK         0.01500000 se
P2                 31.00 us

======== CHANNEL f1 =====
NUC1                 13C
P1                 15.50 us
P11               500.00 us
P12              2000.00 us
PL0               120.00 dB
PL1                -1.00 dB
SFO1         125.7942548 MH
SP1                 3.20 dB
SP2                 3.20 dB
SPNAM1   Crp60,0.5,20.1
SPNAM2      Crp60comp.4
SPOFF1              0.00 Hz
SPOFF2              0.00 Hz

======== CHANNEL f2 =====
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 us
```

dm-iv-124p 11 - pure silane on cryo
1H spectrum



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Current Data Parameters
USER              davebm
NAME          dm-iv-124p
EXPNO                 11
PROCNO                 1

F2 - Acquisition Parameter
Date_           20091208
Time               15.51
INSTRUM          cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG             zg30
TD                 81728
SOLVENT            CDCl3
NS                     8
DS                     2
SWH             8012.820 Hz
FIDRES          0.098043 Hz
AQ             5.0998774 se
RG                   4.5
DW                62.400 us
DE                  6.00 us
TE                 298.0 K
D1            0.10000000 se
MCREST        0.00000000 se
MCWRK         0.01500000 se

======== CHANNEL f1 ======
NUC1                  1H
P1                  7.50 us
PL1                 1.60 dB
SFO1         500.2235015 MH

F2 - Processing parameters
SI                 65536
SF           500.2200261 MH
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  4.00
```
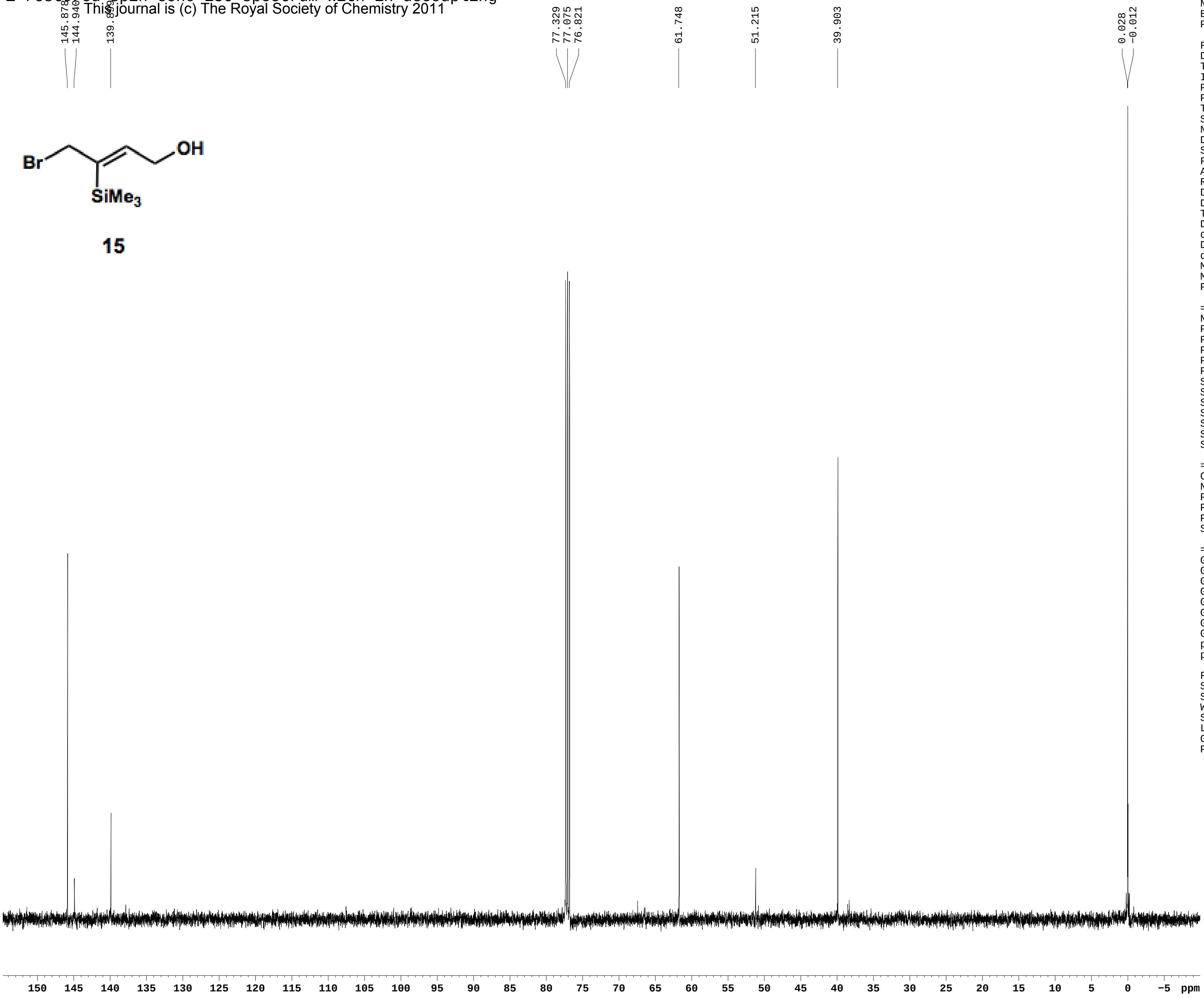
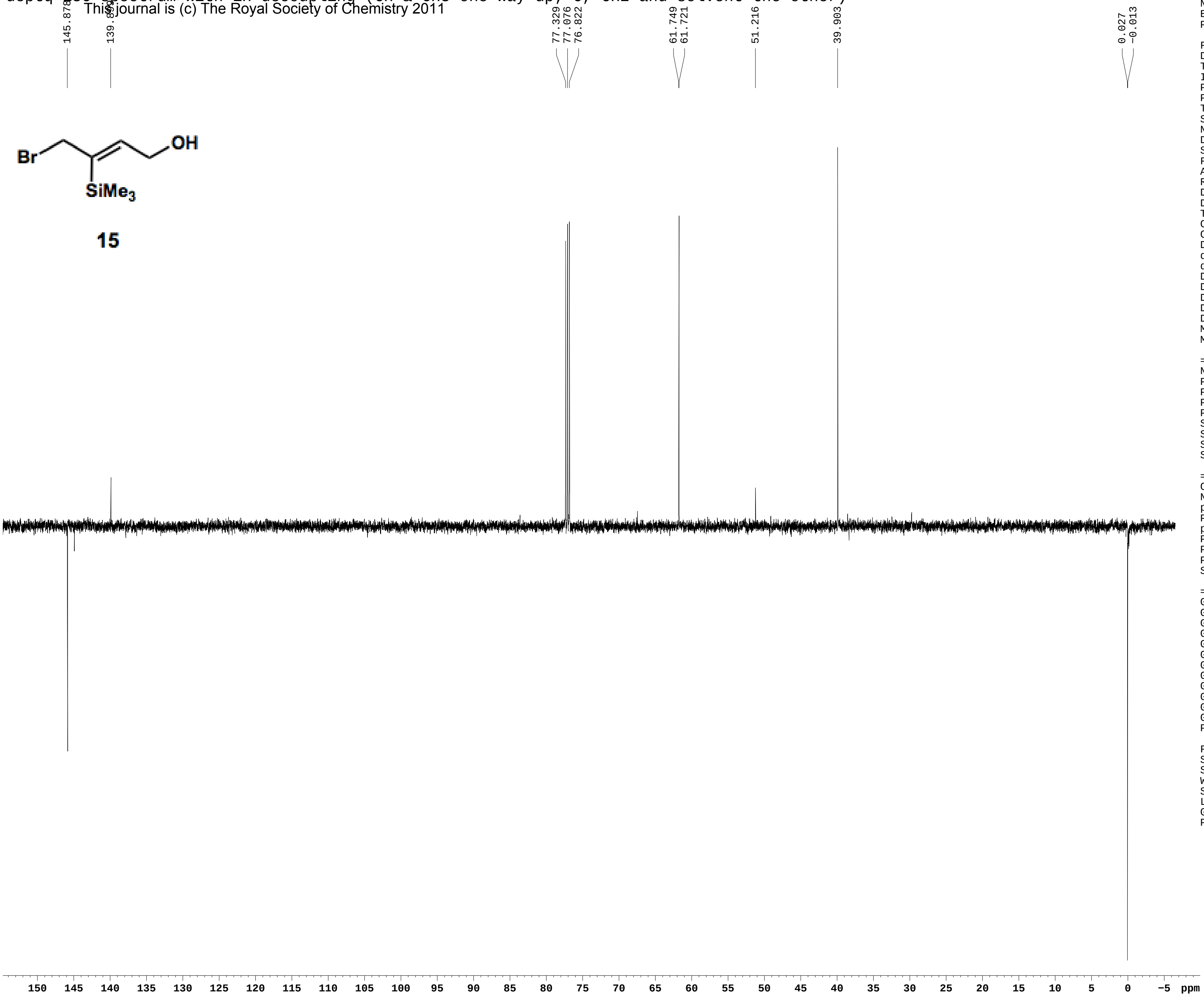

dm-iv-124p 12 - purified silane
Z-restored spin-echo 13C spectrum with 1H decoupling



```
Current Data Parameters
USER              davebm
NAME          dm-iv-124p
EXPNO                 12
PROCNO                 1

F2 - Acquisition Parameter
Date_           20091208
Time               15.55
INSTRUM          cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG  SpinEchopg30gp.pr
TD                 65536
SOLVENT            CDCl3
NS                   192
DS                    16
SWH            30303.031 Hz
FIDRES          0.462388 Hz
AQ             1.0814105 se
RG                7298.2
DW                16.500 us
DE                  6.00 us
TE                 298.0 K
D1            0.25000000 se
d11           0.03000000 se
D16           0.00020000 se
d17           0.00019600 se
MCREST        0.00000000 se
MCWRK         0.01500000 se
P2                 31.00 us

======== CHANNEL f1 ======
NUC1                 13C
P1                 15.50 us
P11               500.00 us
P12              2000.00 us
PL0               120.00 dB
PL1                -1.00 dB
SFO1         125.7942548 MH
SP1                 3.20 dB
SP2                 3.20 dB
SPNAM1   Crp60,0.5,20.1
SPNAM2      Crp60comp.4
SPOFF1              0.00 Hz
SPOFF2              0.00 Hz

======== CHANNEL f2 ======
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 us
PL2                 1.60 dB
PL12               24.60 dB
SFO2         500.2225011 MH

====== GRADIENT CHANNEL ==
GPNAM1          SINE.100
GPNAM2          SINE.100
GPX1                0.00 %
GPX2                0.00 %
GPY1                0.00 %
GPY2                0.00 %
GPZ1               30.00 %
GPZ2               50.00 %
p15               500.00 us
p16              1000.00 us

F2 - Processing parameters
SI                 65536
SF           125.7804190 MH
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  2.00
```

dm-iv-124p 13 - purified silane
deptq 13C spectrum with 1H decoupling (CH & CH3 one way up; C, CH2 and solvent the other)



```
Current Data Parameters
USER              davebm
NAME          dm-iv-124p
EXPNO                 13
PROCNO                 1

F2 - Acquisition Parameter
Date_           20091208
Time               16.06
INSTRUM          cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG        deptqgpsp
TD                 65536
SOLVENT            CDCl3
NS                    49
DS                     8
SWH            20661.156 Hz
FIDRES          0.315264 Hz
AQ             1.5860454 se
RG                5160.6
DW                24.200 us
DE                  6.00 us
TE                 298.0 K
CNST2        145.0000000
CNST12         1.5000000
D1            1.00000000 se
d2            0.00344828 se
d12           0.00002000 se
D16           0.00020000 se
DELTA         0.00001574 se
DELTA1        0.00227878 se
DELTA2        0.00226378 se
DELTA3        0.00224828 se
MCREST        0.00000000 se
MCWRK         0.01500000 se

======== CHANNEL f1 ======
NUC1                 13C
P1                 15.50 us
P12              2000.00 us
PL0               120.00 dB
PL1                -1.00 dB
SFO1         125.7899237 MH
SP2                 3.20 dB
SPNAM2      Crp60comp.4
SPOFF2              0.00 Hz

======== CHANNEL f2 ======
CPDPRG2          waltz16
NUC2                  1H
p0                 11.25 us
P3                  7.50 us
p4                 15.00 us
PCPD2             100.00 us
PL2                 1.60 dB
PL12               24.60 dB
SFO2         500.2225011 MH

====== GRADIENT CHANNEL ==
GPNAM1          SINE.100
GPNAM2          SINE.100
GPNAM3          SINE.100
GPX1                0.00 %
GPX2                0.00 %
GPX3                0.00 %
GPY1                0.00 %
GPY2                0.00 %
GPY3                0.00 %
GPZ1               31.00 %
GPZ2               31.00 %
GPZ3               31.00 %
P16              1000.00 us

F2 - Processing parameters
SI                 65536
SF           125.7804190 MH
WDW                   no
SSB                    0
LB                  0.00 Hz
GB                     0
PC                  2.00
```

dm-iv-31p 3 - purified double barbituric acid adduct
1H spectrum

Supplementary Material (ESI) for Chemical Science
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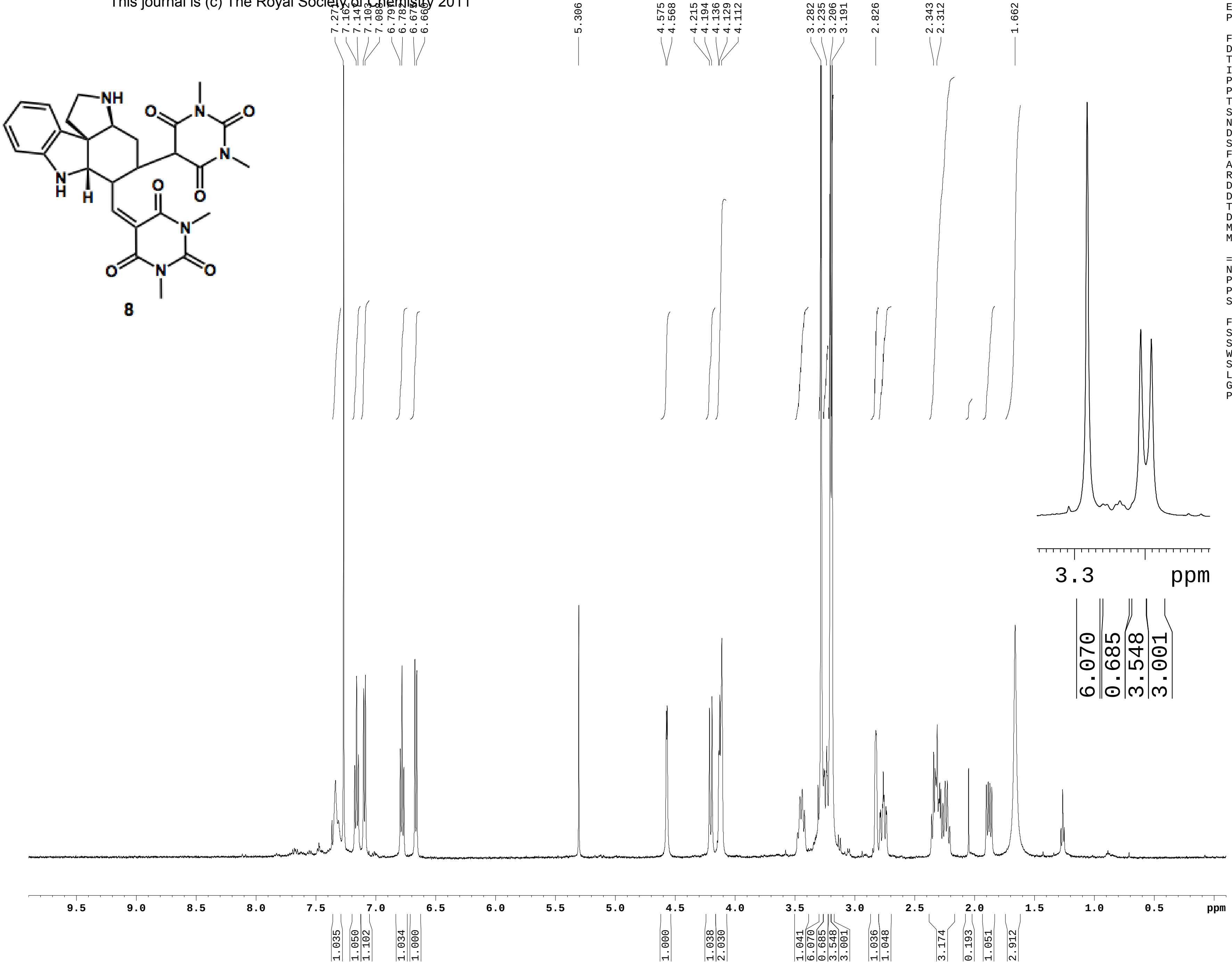
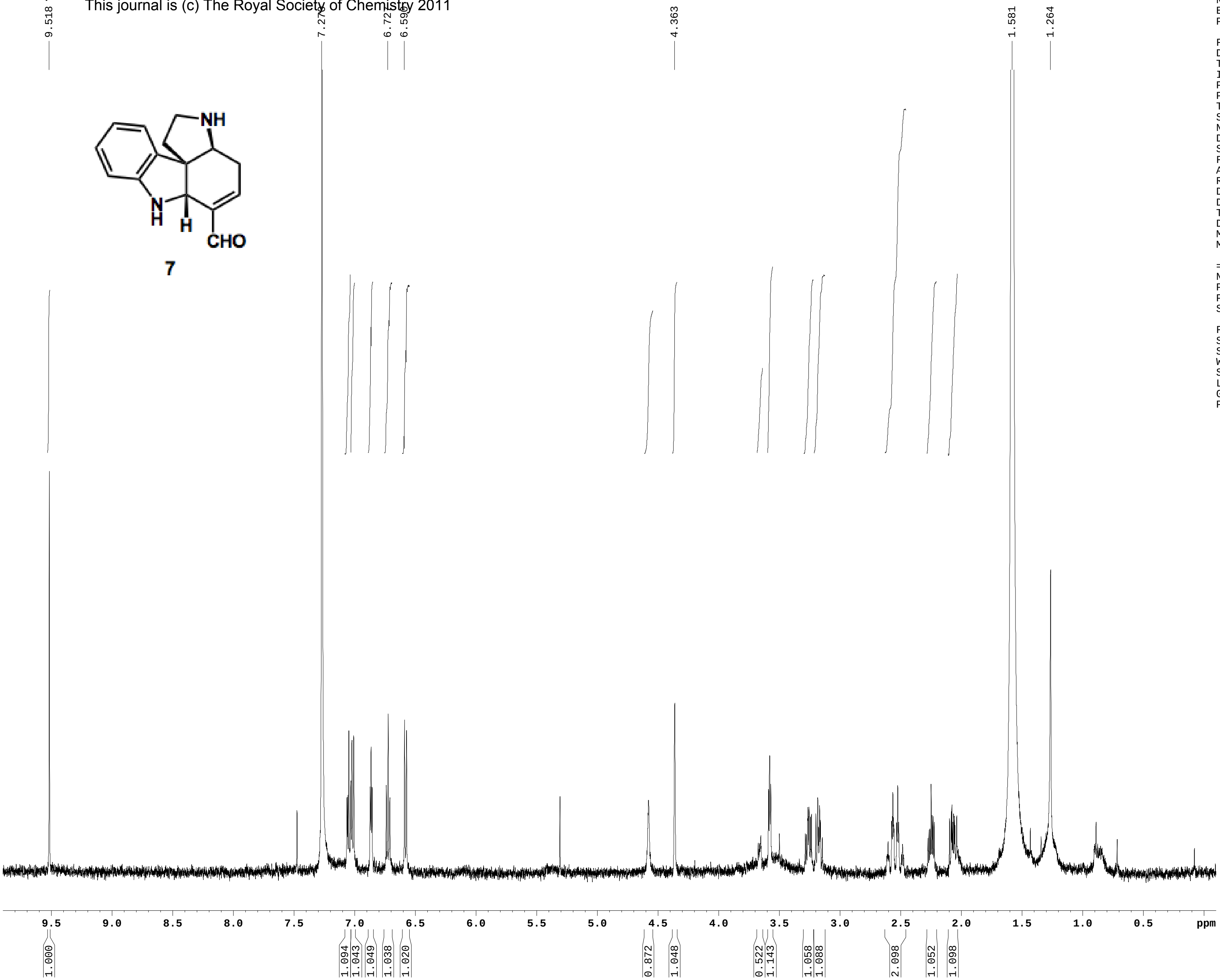

8

```
Current Data Parameters
USER              davebm
NAME           dm-iv-31p
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameter
Date_           20091001
Time               16.38
INSTRUM            gn500
PROBHD   5 mm broadband
PULPROG             zg30
TD                 48074
SOLVENT           CDCl3T
NS                     8
DS                     2
SWH          8012.820 Hz
FIDRES       0.166677 Hz
AQ          2.9998677 se
RG                1149.4
DW                62.400 us
DE                 6.00 us
TE                298.0 K
D1          0.10000000 se
MCREST      0.00000000 se
MCWRK       0.01500000 se

======== CHANNEL f1 ======
NUC1                  1H
P1                 12.00 us
PL1                -3.00 dB
SFO1        499.6234973 MH

F2 - Processing parameters
SI                 65536
SF          499.6200238 MH
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```

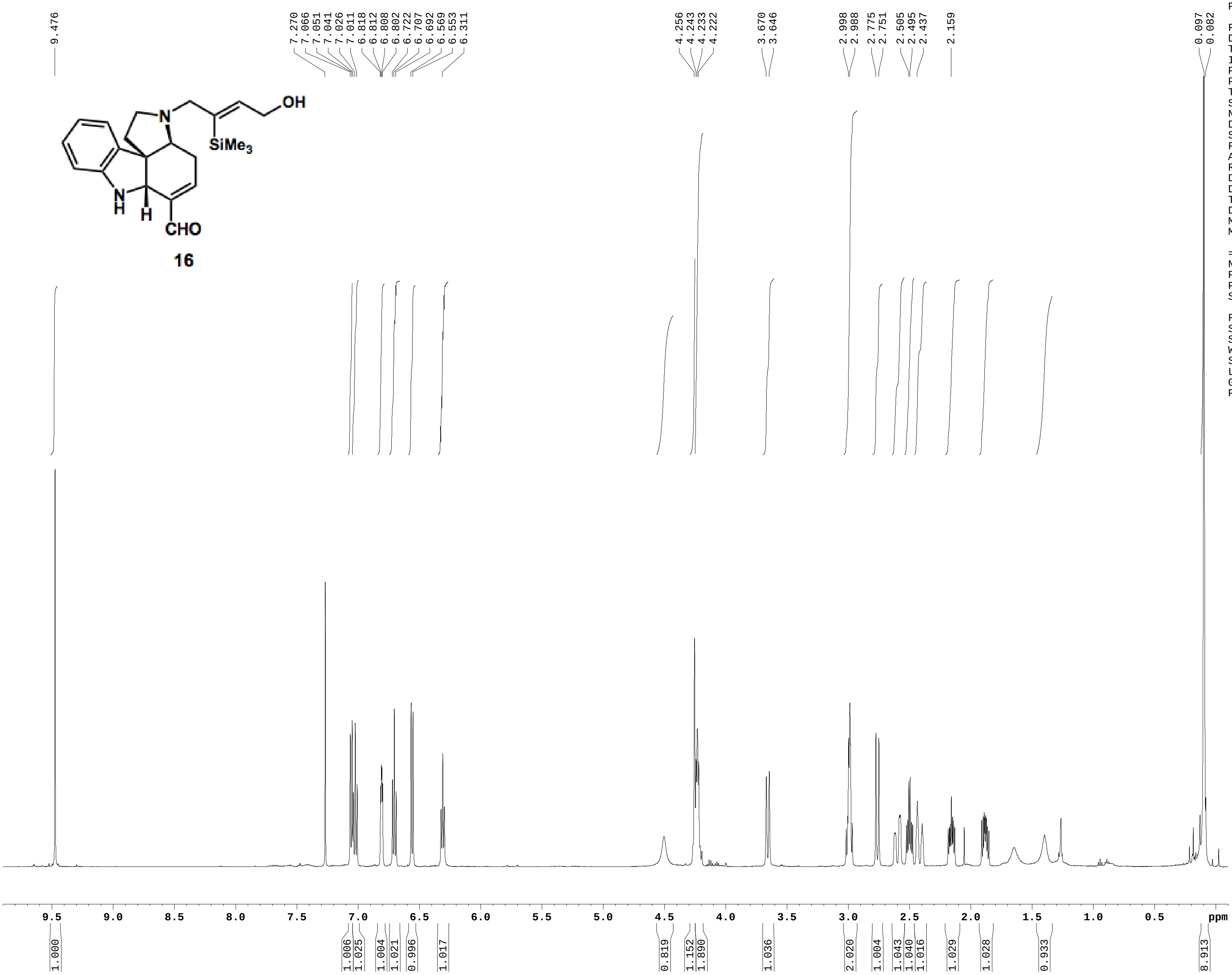
dm-iii-288p 2 - purified NH tetracycle
1H spectrum



7

```
Current Data Parameters
USER            davebm
NAME        dm-iii-288p
EXPNO                 2
PROCNO                1

F2 - Acquisition Parameter
Date_          20090916
Time              14.15
INSTRUM           gn500
PROBHD   5 mm broadband
PULPROG            zg30
TD                81728
SOLVENT           CDCl3T
NS                   16
DS                    2
SWH            8012.820 Hz
FIDRES         0.098043 Hz
AQ            5.0999398 se
RG                 2048
DW               62.400 us
DE                 6.00 us
TE                298.0 K
D1           0.10000000 se
MCREST       0.00000000 se
MCWRK        0.01500000 se

======== CHANNEL f1 ======
NUC1                 1H
P1                12.00 us
PL1               -3.00 dB
SFO1        499.6234973 MH

F2 - Processing parameters
SI                65536
SF          499.6199685 MH
WDW                  EM
SSB                   0
LB                 0.30 Hz
GB                    0
PC                 1.00
```

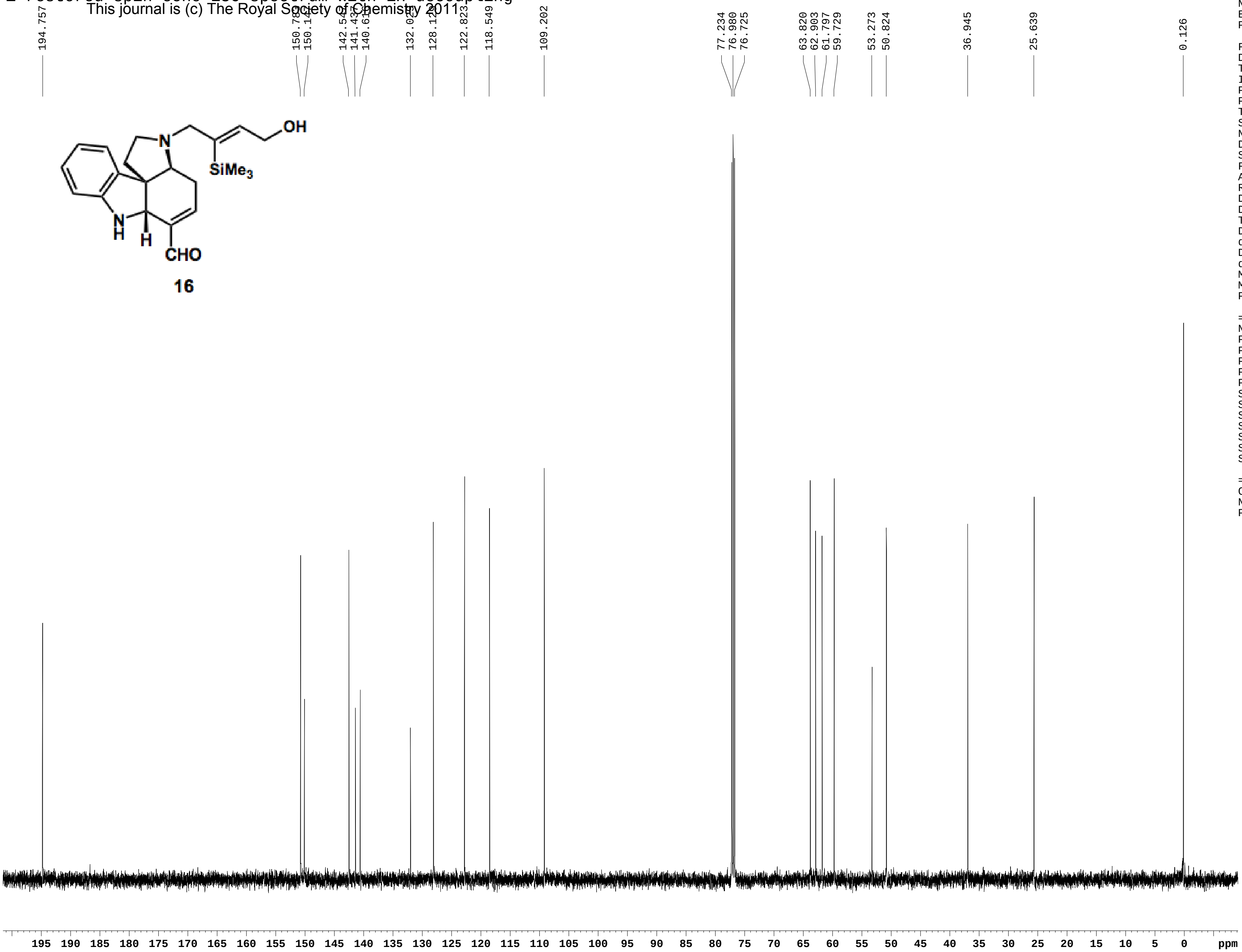
dm-v-97p 11 - pure core-vinyl-TMS
1H spectrum



16

```
Current Data Parameters
USER                davebm
NAME              dm-v-97p
EXPNO                   11
PROCNO                   1

F2 - Acquisition Parameter
Date_             20100804
Time                 18.34
INSTRUM            cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG               zg30
TD                   48074
SOLVENT              CDCl3
NS                       8
DS                       2
SWH              8012.820 Hz
FIDRES           0.166677 Hz
AQ              2.9999299 se
RG                       8
DW                  62.400 us
DE                    6.00 us
TE                   298.0 K
D1             0.10000000 se
MCREST         0.00000000 se
MCWRK          0.01500000 se

======== CHANNEL f1 ======
NUC1                    1H
P1                    7.50 us
PL1                   1.60 dB
SFO1           500.2235015 MH

F2 - Processing parameters
SI                   65536
SF             500.2199714 MH
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    4.00
```

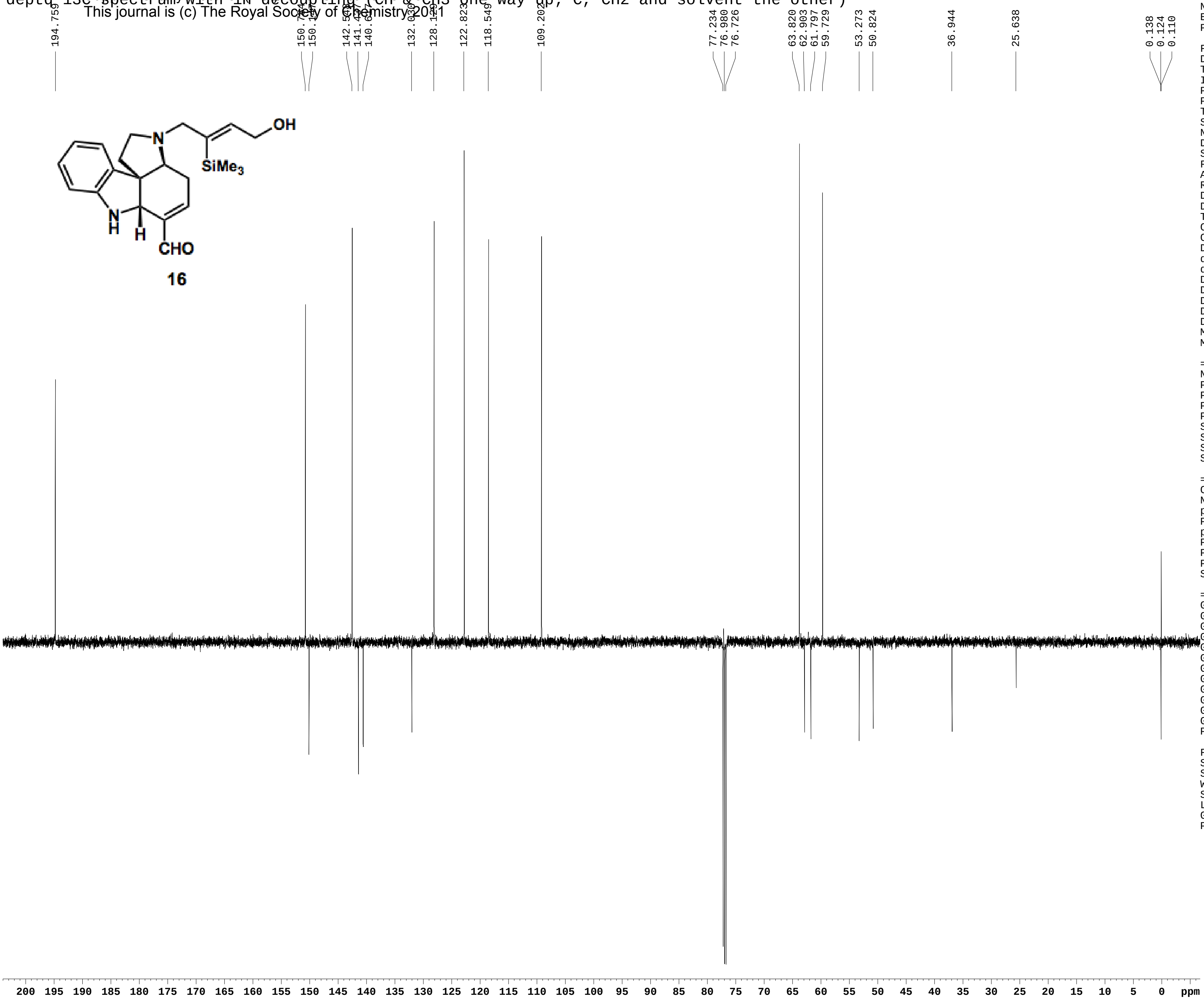
Z-restored spin-echo 13C spectrum with 1H decoupling



16

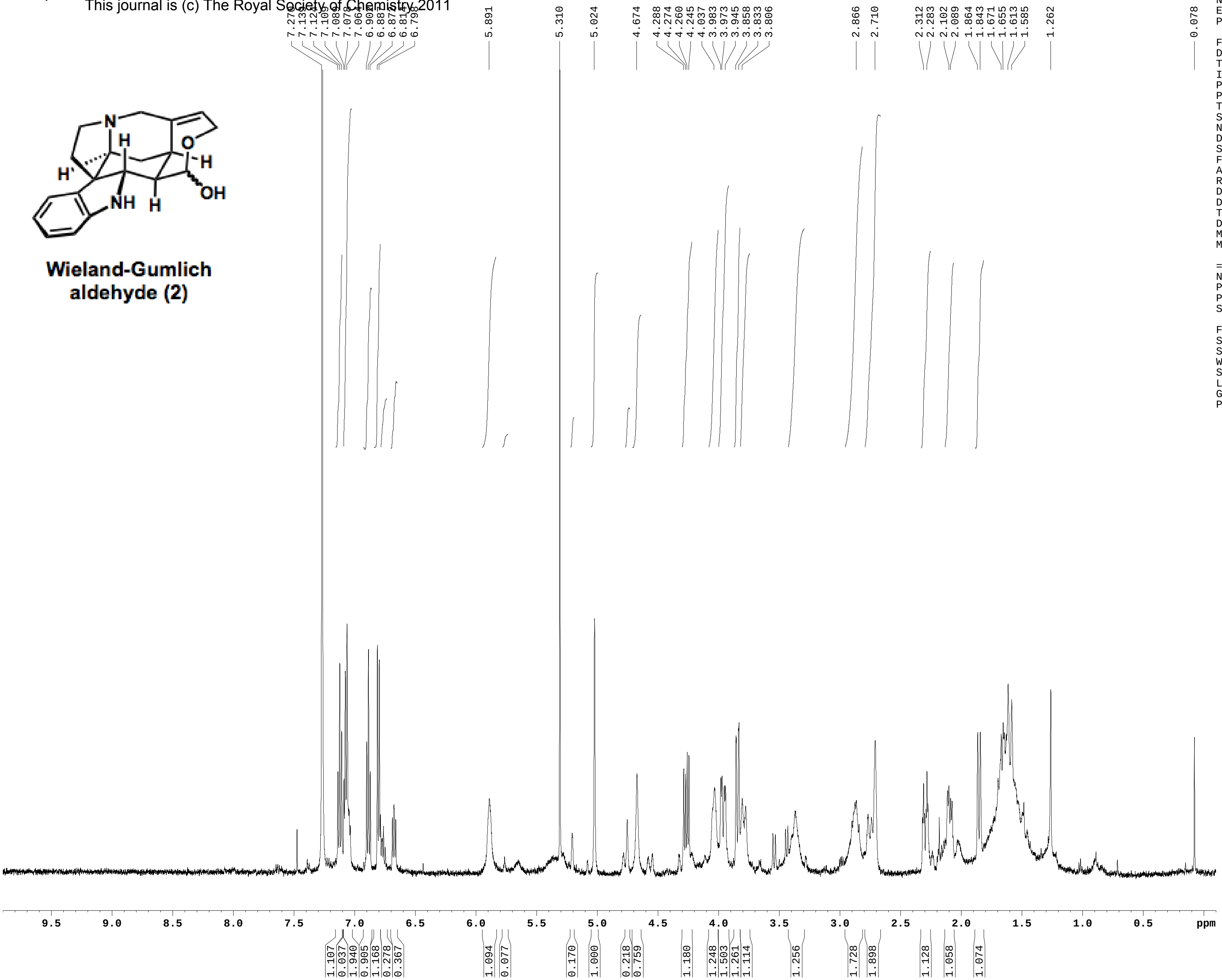
```
Current Data Parameters
USER              davebm
NAME            dm-v-97p
EXPNO                 12
PROCNO                 1

F2 - Acquisition Parameter
Date_           20100804
Time               18.38
INSTRUM          cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG  SpinEchopg30gp.pr
TD                 65536
SOLVENT            CDCl3
NS                   160
DS                    16
SWH            30303.031 Hz
FIDRES          0.462388 Hz
AQ             1.0814105 se
RG                5792.6
DW                16.500 us
DE                  6.00 us
TE                 298.0 K
D1            0.25000000 se
d11           0.03000000 se
D16           0.00020000 se
d17           0.00019600 se
MCREST        0.00000000 se
MCWRK         0.01500000 se
P2                 31.00 us

======== CHANNEL f1 =====
NUC1                 13C
P1                 15.50 us
P11               500.00 us
P12              2000.00 us
PL0               120.00 dB
PL1                -1.00 dB
SFO1         125.7942548 MH
SP1                 3.20 dB
SP2                 3.20 dB
SPNAM1   Crp60,0.5,20.1
SPNAM2      Crp60comp.4
SPOFF1              0.00 Hz
SPOFF2              0.00 Hz

======== CHANNEL f2 =====
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 us
```

deptq 13C spectrum with 1H decoupling (CH & CH3 one way up; C, CH2 and solvent the other)



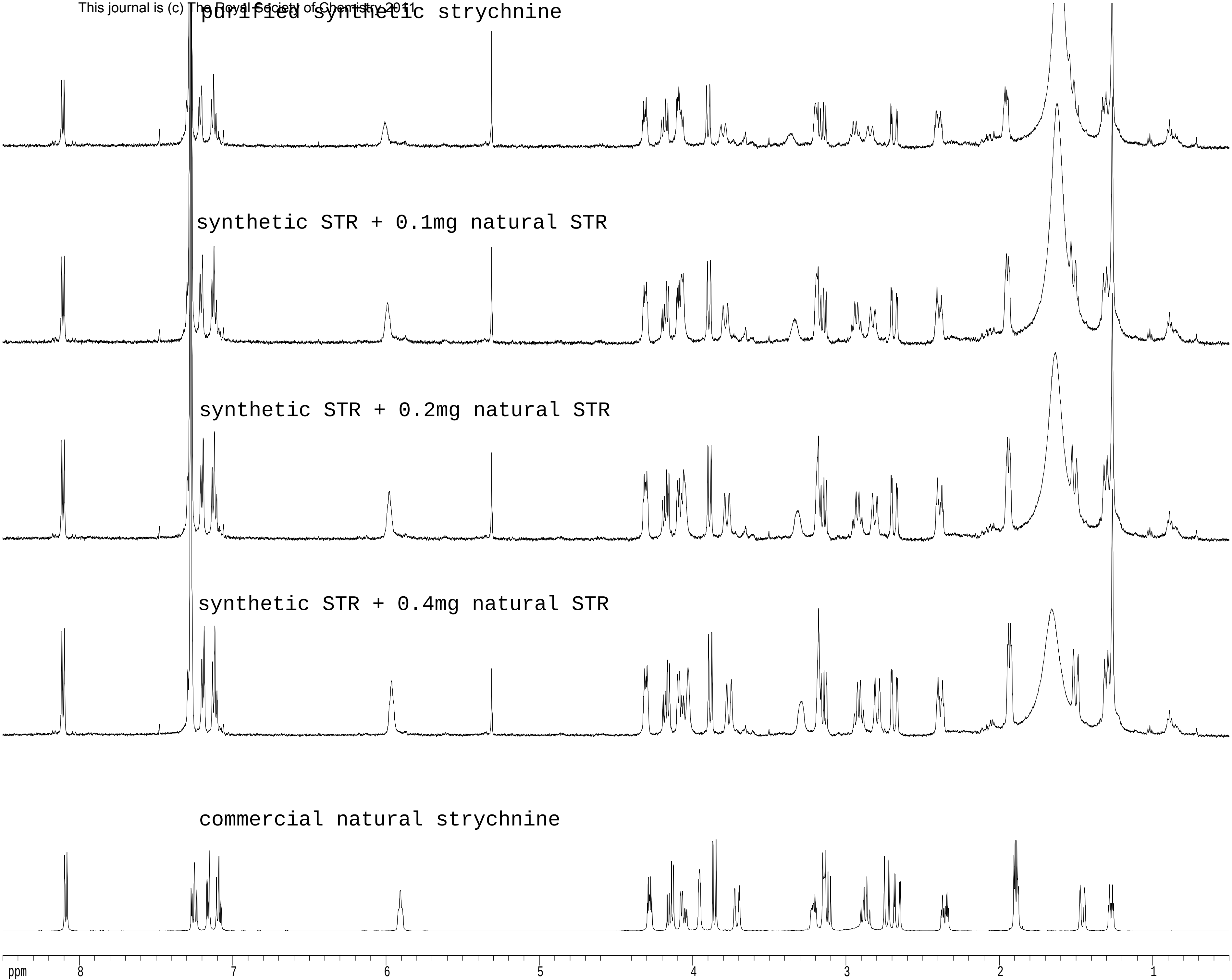
```
Current Data Parameters
USER              davebm
NAME           dm-v-97p
EXPNO                13
PROCNO                1

F2 - Acquisition Parameter
Date_          20100804
Time              18.41
INSTRUM         cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG       deptqgpsp
TD                65536
SOLVENT           CDCl3
NS                  200
DS                    8
SWH           30303.031 Hz
FIDRES         0.462388 Hz
AQ            1.0813940 se
RG                 2048
DW               16.500 us
DE                 6.00 us
TE                298.0 K
CNST2       145.0000000
CNST12        1.5000000
D1           1.00000000 se
d2           0.00344828 se
d12          0.00002000 se
D16          0.00020000 se
DELTA        0.00001574 se
DELTA1       0.00227878 se
DELTA2       0.00226378 se
DELTA3       0.00224828 se
MCREST       0.00000000 se
MCWRK        0.01500000 se

======== CHANNEL f1 ======
NUC1                13C
P1                15.50 us
P12             2000.00 us
PL0              120.00 dB
PL1               -1.00 dB
SFO1        125.7942548 MH
SP2                3.20 dB
SPNAM2      Crp60comp.4
SPOFF2             0.00 Hz

======== CHANNEL f2 ======
CPDPRG2         waltz16
NUC2                 1H
p0                11.25 us
P3                 7.50 us
p4                15.00 us
PCPD2            100.00 us
PL2                1.60 dB
PL12              24.60 dB
SFO2        500.2225011 MH

====== GRADIENT CHANNEL ==
GPNAM1         SINE.100
GPNAM2         SINE.100
GPNAM3         SINE.100
GPX1               0.00 %
GPX2               0.00 %
GPX3               0.00 %
GPY1               0.00 %
GPY2               0.00 %
GPY3               0.00 %
GPZ1              31.00 %
GPZ2              31.00 %
GPZ3              31.00 %
P16             1000.00 us

F2 - Processing parameters
SI                65536
SF          125.7804190 MH
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 2.00
```

dm-v-175p 4 - purified Wieland-Gumlich aldehyde, ~80% purity, mix of diastereomers
1H spectrum



Wieland-Gumlich aldehyde (2)

```
Current Data Parameters
USER                davebm
NAME             dm-v-175p
EXPNO                    4
PROCNO                   1

F2 - Acquisition Parameter
Date_             20101104
Time                 22.21
INSTRUM            cryo500
PROBHD   5 mm CPTCI 1H-
PULPROG               zg30
TD                   48074
SOLVENT              CDCl3
NS                      24
DS                       2
SWH             8012.820 Hz
FIDRES          0.166677 Hz
AQ             2.9998677 se
RG                       8
DW                62.400 us
DE                  6.00 us
TE                 298.0 K
D1            0.10000000 se
MCREST        0.00000000 se
MCWRK         0.01500000 se

======== CHANNEL f1 ======
NUC1                    1H
P1                  7.50 us
PL1                 1.60 dB
SFO1        500.2235015 MH

F2 - Processing parameters
SI                   65536
SF          500.2200273 MH
WDW                     EM
SSB                      0
LB                  0.30 Hz
GB                       0
PC                    4.00
```


purified synthetic strychnine
synthetic STR + 0.1mg natural STR
synthetic STR + 0.2mg natural STR
synthetic STR + 0.4mg natural STR
commercial natural strychnine
ppm
8
7
6
5
4
3
2
1