

**Concise Copper-Catalyzed Synthesis of Tricyclic Biaryl Ether-Linked Aza-Heterocyclic Ring Systems**

Paola Mestichelli,<sup>†</sup> Matthew J. Scott,<sup>†</sup> Warren R. J. D. Galloway,<sup>†</sup> Jamie Selwyn,<sup>†</sup> Jeremy S. Parker,<sup>‡</sup> and David R. Spring<sup>\*,†</sup>

*Department of Chemistry, University of Cambridge, Lensfield Road, Cambridge, CB2 1EW, U. K., and AstraZeneca, Pharmaceutical Development, Charter Way, Silk Road Business Park, Macclesfield, Cheshire, SK10 2NA, U.K.*

<sup>†</sup> University of Cambridge.

<sup>‡</sup> AstraZeneca, Pharmaceutical Development.

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## General experimental details

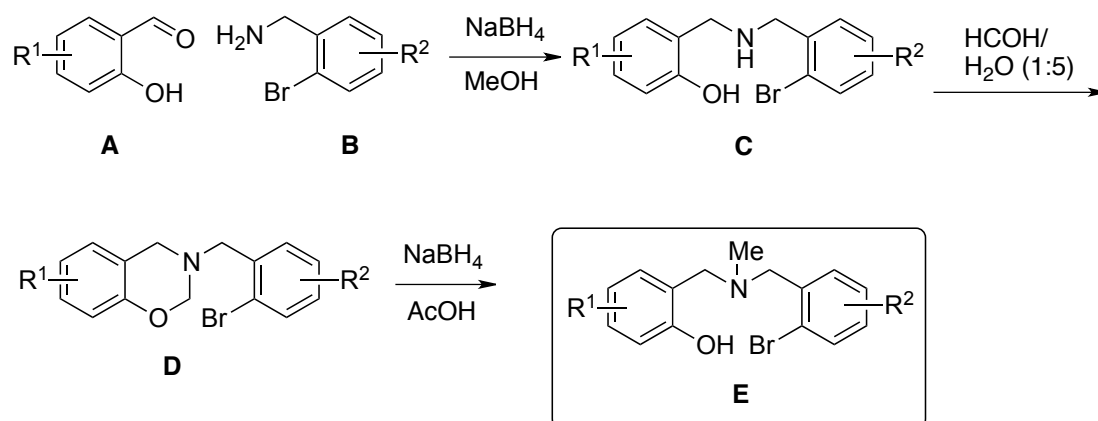
Reactions were performed using oven-dried glassware under an atmosphere of nitrogen with anhydrous, freshly distilled solvents unless otherwise stated. Dichloromethane, ethyl acetate, methanol, *n*-hexane, acetonitrile and toluene were distilled from calcium hydride. Diethyl ether was distilled over a mixture of lithium aluminium hydride and calcium hydride. Petroleum ether was distilled before use and refers to the fraction between 40-60 °C. All other reagents were used as obtained from commercial sources. Tetrahydrofuran was dried over Na wire and distilled from a mixture of lithium aluminium hydride and calcium hydride. Unless otherwise stated reactions were carried out at room temperature (ambient temperature) and temperatures of addition were at room temperature. Temperatures of 0°C were maintained using an ice-water bath and temperatures below 0°C were maintained using an acetone-cardice bath. Reactions involving microwave irradiation were performed in 10 cm<sup>3</sup> or 30 cm<sup>3</sup> microwave tubes with clip lids using CEM Discover® microwave apparatus. Yields refer to chromatographically and spectroscopically pure compounds unless otherwise stated. All flash chromatography was carried out using slurry-packed Merck 9325 Keisegel 60 silica gel. Where possible, reactions were monitored by thin layer chromatography (TLC) performed on commercially prepared glass plates pre-coated with Merck silica gel 60 F254 or aluminium oxide 60 F254. Visualisation was by the quenching of UV fluorescence ( $\nu_{max}$  = 254 nm) or by staining with ceric ammonium molybdate, potassium permanganate or Dragendorff's reagent (0.08% w/v bismuth subnitrate and 2% w/v KI in 3M aq. AcOH). Infrared spectra were recorded neat or as a solution in the designated solvent on a Perkin-Elmer Spectrum One spectrometer with internal referencing. Selected absorption maxima ( $\nu_{max}$ ) are reported in wavenumbers (cm<sup>-1</sup>) and the following abbreviations are used: w, weak; m, medium; st, strong; br, broad. Melting points were obtained using a Büchi® melting point apparatus (model B-545) and are uncorrected. Proton magnetic resonance spectra (<sup>1</sup>H NMR) were recorded using an internal deuterium lock at ambient probe temperatures (unless otherwise stated) on the following instruments: Bruker DPX-400 (400 MHz), Bruker Avance 400 QNP (400 MHz) Bruker Avance 500 BB ATM (500 MHz) and Bruker Avance 500 Cryo Ultrashield (500 MHz). Chemical shifts ( $\delta_H$ ) are quoted in ppm, to the nearest 0.01 ppm, and are referenced to the residual non-deuterated solvent peak. Coupling constants (*J*) are

reported in Hertz to the nearest 0.1 Hz. Data are reported as follows: chemical shift, integration, multiplicity [br, broad; s, singlet; d, doublet; t, triplet; q, quartet; quint, quintet; sextet; sept, septet; m, multiplet; or as a combination of these (*e.g.* dd, dt, *etc.*)], coupling constant(s) and assignment. Proton assignments were determined either on the basis of unambiguous chemical shift or coupling pattern, by patterns observed in 2D experiments ( $^1\text{H}$ - $^1\text{H}$  COSY, HMBC and HMQC) or by analogy to fully interpreted spectra for related compounds. Carbon magnetic resonance spectra ( $^{13}\text{C}$  NMR) were recorded by broadband proton spin decoupling at ambient probe temperatures (unless otherwise stated) using an internal deuterium lock on the following instruments: Bruker DPX-400 (100 MHz), Bruker Avance 400 QNP (100 MHz) and Bruker Avance 500 BB ATM (125 MHz) and Bruker Avance 500 Cryo Ultrashield (125 MHz). Chemical shifts ( $\delta_{\text{C}}$ ) are quoted in ppm, to the nearest 0.1 ppm, and are referenced to the residual non-deuterated solvent peak. Where appropriate, coupling constants are reported in Hertz to the nearest 0.1 Hz and data are reported as for proton magnetic resonance spectra without integration. Assignments were supported by DEPT editing and determined either on the basis of unambiguous chemical shift or coupling pattern, by patterns observed in 2D experiments (HMBC and HMQC) or by analogy to fully interpreted spectra for related compounds. Phosphorous magnetic resonance spectra ( $^{31}\text{P}$  NMR) were recorded on Bruker DPX-400 (162 MHz) and Bruker Avance 500 BB-ATM (202 MHz) instruments. Chemical shifts ( $\delta_{\text{P}}$ ) are quoted in ppm to the nearest 0.01 ppm and are referenced to  $\text{H}_3\text{PO}_4$  (external). Where appropriate, coupling constants are reported in Hertz to the nearest 0.5 Hz and data are reported as for proton magnetic resonance spectra without integration. Liquid chromatography mass spectrometry (LCMS) spectra were recorded on an HP/Agilent LCMS APCI 120-1000 full gradient machine. The ionisation technique used was electron ionisation (EI). High resolution mass spectroscopy measurements were recorded in-house using a Waters LCT Premier Mass Spectrometer or a Micromass Quadrupole-Time of Flight (Q-ToF) spectrometer. Mass values are reported within the error limits of  $\pm 5$  ppm mass units. The ionisation technique used was electrospray ionization (ESI).

## Experimental procedures and characterization data

### General procedure 1: Synthesis of N-methyl-dibenzylamines

General synthetic route outlined in **Scheme 1**.



**Scheme 1:** Synthetic route towards N-methyl-dibenzylamines

Based on from the method of Wei *et al.*<sup>1</sup> A solution of the appropriate salicylaldehyde derivative **A** (1 equivalent) and the appropriate 2-bromobenzylamine derivative **B** (1 equivalent) in MeOH (0.409 M) was stirred overnight at 50 °C. The reaction mixture was then cooled to 0 °C and  $\text{NaBH}_4$  (2 equivalents) was added slowly. The reaction mixture was then allowed to reach room temperature and stirred for 6 hours. 2 M aqueous NaOH solution (0.571 M) was added, the aqueous and organic layers separated and the aqueous later extracted with EtOAc (3 times). The combined organic layers were washed with brine, dried ( $\text{K}_2\text{CO}_3$ ) and the solvent removed under reduced pressure to yield intermediates of the form **C**. Intermediate **C** was consistently greater than 90% pure (by  $^1\text{H}$  NMR) after work-up and was used directly in the next synthetic step without further purification (attempted purification of the intermediate amines **C** by column chromatography on  $\text{SiO}_2$  was not possible due to extensive streaking). To a sample of the crude intermediate **C** (1 equivalent) in THF (0.571 M) was added 35% aqueous formaldehyde (1.2 equivalents) and the mixture was stirred at room temperature until TLC analysis indicated complete consumption of **C** (typically overnight) to yield **D**. The solvent was removed under reduced pressure. The residue was re-dissolved in THF (0.571 M), cooled to 0 °C and  $\text{NaBH}_4$  (2 equivalents) was added. The solution was vigorously stirred, and a solution of AcOH (1 mmol) in THF (0.666 mmol) was slowly added to the flask. After the



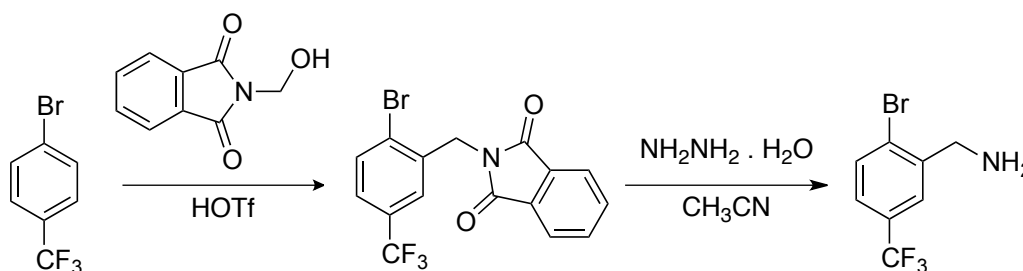
addition, the mixture was warmed up to room temperature and allowed to stir at room temperature until TLC analysis indicated complete consumption of cyclic intermediate **D** (typically 0.5 hours). Saturated  $\text{Na}_2\text{CO}_3$  was added. When the emission of  $\text{CO}_2$  ceased, the organic layer was extracted with  $\text{CH}_2\text{Cl}_2$ , dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent removed under reduced pressure. The residue was purified by column chromatography to afford the desired *N*-methyl-dibenzylamine derivative **E**. The overall yields given for the formation of products **E** are calculated over two- or three-steps (as stated) assuming pure **C**.

### Salicylaldehyde derivatives and 2-bromobenzylamine derivatives

All the substituted salicylaldehyde derivatives used were obtained directly from commercial sources.

(2-bromo-5-(trifluoromethyl)phenyl)methanamine and 2-hydroxy-benzylamine were prepared as detailed below. All other 2-bromobenzylamine derivatives used were obtained directly from commercial sources.

#### (2-bromo-5-(trifluoromethyl)phenyl)methanamine



Synthesis of 2-(2-bromo-5-(trifluoromethyl)benzyl)isoindoline-1,3-dione by the method of Paunescu *et al.*<sup>2</sup> To a suspension of 2-(hydroxymethyl)isoindoline-1,3-dione (1 equivalent, 0.394 g, 2.22 mmol) in HOTf (3.92 mL) at 0 °C was added 1-bromo-4-(trifluoromethyl)benzene (2 equivalents, 1.00g, 4.44 mmol). After stirring the mixture at room temperature overnight, the reaction medium was added drop-wise to cold water (29.5 mL). A white solid precipitated. The aqueous layer was extracted with EtOAc (3 times). The organic layers were combined, dried ( $\text{MgSO}_4$ ), and the solvent was removed under reduced pressure. The residue was purified by column

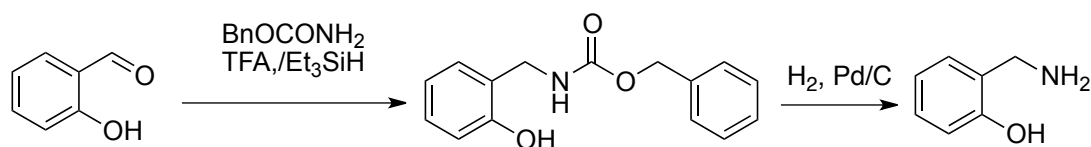
chromatography (SiO<sub>2</sub>, CH<sub>2</sub>Cl<sub>2</sub>) to afford 2-(2-bromo-5-(trifluoromethyl)benzyl)isoindoline-1,3-dione as a white solid (600 mg, 75%).

Analytical data for 2-(2-bromo-5-(trifluoromethyl)benzyl)isoindoline-1,3-dione:

**Mp:** 154.0-155.4 °C. **IR:**  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 2928 w (aromatic C-H), 1704 st (C=O), 1593 m (aromatic C=C), 1466 m (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 7.91-7.87 (2H, m, aryl CH), 7.78-7.74 (2H, m, aryl CH), 7.70-7.69 (1H, m, aryl CH), 7.39-7.37 (2H, m, aryl CH), 4.98 (2H, s, CH<sub>2</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, CDCl<sub>3</sub>) = 167.8 (C), 136.2 (C), 134.4 (CH), 133.6 (CH), 131.8 (C), 130.5 (C), 130.3 (C), 130.0 (C), 129.7 (C), 126.8 (C), 126.8 (C), 125.9 (CH), 125.87 (CH), 125.85 (CH), 125.8 (CH), 125.4 (CH), 125.32 (CH), 125.29 (CH), 125.3 (CH), 124.6 (C), 123.7 (CH), 122.5 (C), 41.7 (CH<sub>2</sub>) ppm. **<sup>19</sup>F NMR :**  $\delta_{\text{F}}$  (400 MHz, CDCl<sub>3</sub>) = - 63.13 ppm.

To a suspension of 2-(2-bromo-5-(trifluoromethyl)benzyl)isoindoline-1,3-dione (1 equivalent, 500mg, 1.375 mmol) in CH<sub>3</sub>CN (45 mL) was added NH<sub>2</sub>NH<sub>2</sub>·H<sub>2</sub>O (5 equivalents, 6.865 mmol) and the mixture was stirred at reflux for 22 hours. A white solid precipitated. The reaction medium was cooled to 0 °C, filtered, and the filtrate was concentrated under reduced pressure to yield (2-bromo-5-(trifluoromethyl)phenyl)methanamine as a yellow oil (200 mg, 60%) which was used without characterization or further purification.

### Synthesis of 2-hydroxy-benzylamine



Synthesis of protected intermediate based by the method of Dubé *et al.*<sup>3</sup> A solution of salicylaldehyde (**9**, 1 equivalent, 8.188 mmol), benzylcarbamate (3 equivalents, 24.564 mmol), triethylsilane (3 equivalents, 24.564 mmol), and TFA (2 equivalents, 16.376 mmol) in CH<sub>3</sub>CN (40 mL) was stirred at room temperature for 18 hours. The mixture was diluted with Et<sub>2</sub>O, washed with saturated NaHCO<sub>3</sub> solution and brine. The organic layer was dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent removed under reduced

pressure. The residue was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether : Et<sub>2</sub>O, 70:30) to afford the protected intermediate as a colourless oil (90%).

Analytical data for protected intermediate:

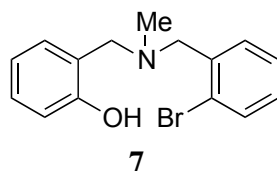
**IR:**  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 3325 m (aromatic C-H), 1666 st (C=O), 1538 m (aromatic C=C), 1489 m (aromatic C=C), 1446 m (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 8.50 (1H, br, OH or NH), 7.36-7.29 (5H, m, aryl CH), 7.22 (1H, t,  $J$  = 7.3 Hz, aryl CH), 7.08 (1H, dd,  $J$  = 7.5, 1.5 Hz, aryl CH), 6.93 (1H, d,  $J$  = 8.0 Hz, aryl CH), 6.85-6.82 (1H, td,  $J$  = 7.5, 1.0 Hz, aryl CH), 5.57 (1H, br s, OH or NH), 5.10 (2H, s, OCH<sub>2</sub>), 4.28 (2H, d,  $J$  = 6.5 Hz, CH<sub>2</sub>N) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, CDCl<sub>3</sub>) = 158.6 (C), 155.3 (C), 135.8 (C), 130.6 (CH), 129.9 (CH), 128.6 (CH), 128.4 (CH), 128.3 (CH), 124.6 (C), 120.2 (CH), 117.6 (CH), 67.7 (CH<sub>2</sub>), 41.4 (CH<sub>2</sub>) ppm.

This data is consistent with that previously reported.<sup>4</sup>

To a solution of the protected intermediate (1.83 g) in EtOAc (10 mL) was added 10% Pd/C 10% (40 mg). This suspension was stirred under an atmosphere of hydrogen gas (balloon) for 18 hours. The reaction mixture was filtered through Celite<sup>®</sup> and the solvent removed under reduced pressure to yield the title compound as a white solid (Yield: 95 %) which was used without characterization or purification

## Synthesis of acyclic precursors to cyclic compounds 12-21

### 2-(((2-bromobenzyl)(methyl)amino)methyl)phenol (7)

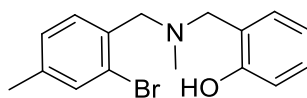


Prepared by general procedure 1 using 2-hydroxybenzaldehyde (**9**, 4.09 mmol) and (2-bromophenyl)methanamine (**8**). The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow oil (1.1 g, 92% crude yield). 0.200 g of this crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The

crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 95:5) to yield the title compound **7** as a white solid (0.200 g, 95% over two step sequence from intermediate free amine derivative).

**Mp:** 90.9-91.4 °C, **IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2976 w (aromatic C-H), 2943 w (aromatic C-H), 2900 br m (O-H), 2846 m (C-H), 1587 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (400 MHz, CDCl<sub>3</sub>) 10.69 (1H, br s, OH), 7.60 (1H, dd,  $J$  = 8.0, 1.2 Hz, aryl CH), 7.38 (1H, dd,  $J$  = 7.6 Hz, 1.6 Hz, aryl CH), 7.31 (1H, td,  $J$  = 7.6, 1.2 Hz, aryl CH), 7.17 (2H, td,  $J$  = 7.8, 1.5 Hz, aryl CH), 7.01 (1H, d,  $J$  = 7.2 Hz, aryl CH), 6.83 (1H, d,  $J$  = 8.0 Hz, aryl CH), 6.79 (1H, td,  $J$  = 7.4 Hz, 0.9 Hz, aryl CH), 3.78 (4H, apparent d,  $J$  = 13.6 Hz, CH<sub>2</sub>N(CH<sub>3</sub>)CH<sub>2</sub>), 2.28 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (100 MHz, CDCl<sub>3</sub>) = 157.5 (C), 136.1 (C), 133.3 (CH), 131.7 (CH), 129.5 (CH), 128.9 (CH), 128.7 (CH), 127.6 (CH), 125.3 (C), 121.7 (C), 119.2 (CH), 116.2 (CH), 61.4 (CH<sub>2</sub>), 60.6 (CH<sub>2</sub>), 41.2 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>):  $m/z$  found  $[M+H]^+$  306.0499 ( $\Delta$  = 1.6 ppm), C<sub>15</sub>H<sub>17</sub>NO<sup>79</sup>Br<sup>+</sup> requires 306.0494.

## 2-(((2-bromo-4-methylbenzyl)(methyl)amino)methyl)phenol

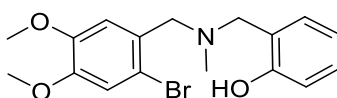


Prepared by general procedure 1 using 2-bromo-4-methylbenzaldehyde (2.512 mmol) and 2-hydroxy-benzylamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow oil (0.760 g, 99% crude yield). 0.760 g of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 90:10) to yield the title compound as a colourless oil (500 mg, 62% over two step sequence from intermediate free amine derivative).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2978 w (aromatic C-H), 2947 w (aromatic C-H), 2900 br m (O-H), 2878 w (C-H), 2834 w (C-H), 1586 m (aromatic C=C), 1489 st (aromatic C=C), 1453 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (400 MHz, CDCl<sub>3</sub>) = 10.77 (1H, br s, OH), 7.41 (1H, s, aryl CH), 7.22 (1H, d,  $J$  = 6.9 Hz, aryl CH), 7.15 (1H, td,  $J$  = 7.6, 1.3 Hz, aryl CH), 7.09 (1H, dd,  $J$  = 7.7, 0.9 Hz, aryl CH), 6.95 (1H, dd,  $J$  = 7.4, 1.4 Hz, aryl CH), 6.81 (1H, dd,  $J$  = 8.2, 1.0 Hz, aryl CH), 6.77 (1H, td,  $J$  = 7.4, 1.1 Hz, aryl CH),

3.71 (4H, apparent d,  $J = 23.2$  Hz,  $\text{CH}_2(\text{NCH}_3)\text{CH}_2$ ), 2.30 (3H, s,  $\text{CH}_3$ ), 2.24 (3H, s,  $\text{CH}_3$ ) ppm.  $^{13}\text{C}$  NMR:  $\delta_{\text{C}}$  (100 MHz,  $\text{CDCl}_3$ ) = 157.6 (C), 139.6 (C), 133.7 (CH), 133.1 (C), 131.4 (CH), 128.8 (CH), 128.6 (CH), 128.3 (CH), 125.0 (C), 121.9 (C), 119.1 (CH), 116.0 (CH), 61.2 ( $\text{CH}_2$ ), 60.4 ( $\text{CH}_2$ ), 41.1 ( $\text{CH}_3$ ), 20.7 ( $\text{CH}_3$ ) ppm. HRMS (ESI+):  $m/z$  found  $[\text{M}+\text{H}]^+$  320.0664,  $\text{C}_{16}\text{H}_{19}\text{NO}^{79}\text{Br}^+$  required 320.0650 ( $\Delta = 4.4$  ppm).

## 2-(((2-bromo-4,5-dimethoxybenzyl)(methyl)amino)methyl)phenol

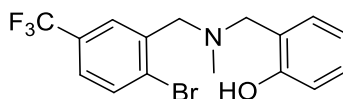


Prepared by general procedure 1 using 2-bromo-4,5-dimethoxybenzaldehyde (3.086 mmol) and 2-hydroxy-benzylamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a green oil (980 mg, 90% crude yield). 980 mg of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography ( $\text{SiO}_2$ , Petroleum Ether:  $\text{Et}_2\text{O}$ , 80:20) to yield the title compound as a white solid (500 mg, 50% over two step sequence from intermediate free amine derivative).

**Mp**: 91.0-92.3 °C. **IR**:  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  3000 w (aromatic C-H), 2948 w (aromatic C-H), 2900 br m (O-H), 2842 w (C-H), 1586 m (aromatic C=C), 1505 st (aromatic C=C).  $^1\text{H}$  NMR:  $\delta_{\text{H}}$  (400 MHz,  $\text{CDCl}_3$ ) = 10.65 (1H, br s, OH), 7.15 (1H, td,  $J = 7.8$ , 1.3 Hz, aryl CH), 7.02-6.99 (2H, m, aryl CH), 6.86 (1H, s, aryl CH), 6.20 (1H, dd,  $J = 8.2$ , 1.0 Hz), 6.77 (1H, td,  $J = 7.4$ , 0.9 Hz), 3.88 (3H, s,  $\text{OCH}_3$ ), 3.85 (3H, s,  $\text{OCH}_3$ ), 3.76 (2H, s,  $\text{CH}_2$ ), 3.66 (2H, s,  $\text{CH}_2$ ), 2.27 (3H, s,  $\text{NCH}_3$ ) ppm.  $^{13}\text{C}$  NMR:  $\delta_{\text{C}}$  (100 MHz,  $\text{CDCl}_3$ ) = 157.6 (C), 149.1 (C), 148.5 (C), 128.9 (CH), 128.7 (CH), 128.3 (C), 121.9 (C), 119.2 (CH), 116.1 (CH), 115.5 (C), 115.2 (CH), 113.9 (CH), 60.8 ( $\text{CH}_2$ ),

60.5 (CH<sub>2</sub>), 56.2 (CH<sub>3</sub>), 56.1 (CH<sub>3</sub>), 41.3 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 366.0710, C<sub>17</sub>H<sub>21</sub>NO<sub>3</sub><sup>79</sup>Br<sup>+</sup> required 366.0705 (Δ= 1.4 ppm).

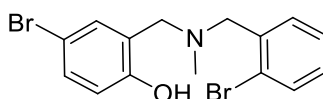
#### 2-(((2-bromobenzyl)(methyl)amino)methyl)-4-(trifluoromethyl)phenol



Prepared by general procedure 1 using 2-hydroxybenzaldehyde (0.630mmol) and (2-bromo-5-(trifluoromethyl)phenyl)methanamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow solid (220 mg, 96% crude yield). 210 mg of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to yield the title compound as a colourless oil (210 mg, 92% over two step sequence from intermediate free amine derivative).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2959 w (aromatic C-H), 2900 br m (O-H), 2874 w (C-H), 1588 m (aromatic C=C), 1488 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 10.24 (1H, br s, OH), 7.72 (1H, d, *J* = 8.5 Hz, aryl CH), 7.60 (1H, s, aryl CH), 7.41 (1H, dd, *J* = 8.5, 2.0 Hz, aryl CH), 7.18 (1H, td, *J* = 7.8, 1.3 Hz, aryl CH), 7.02 (1H, dd, *J* = 7.3, 1.3 Hz, aryl CH), 6.82 (1H, d, *J* = 8.0 Hz, aryl CH), 6.80 (1H, td, *J* = 7.5, 1.0 Hz, aryl CH), 3.78 (4H, apparent d, *J* = 2.5 Hz, CH<sub>2</sub>(NCH<sub>3</sub>)CH<sub>2</sub>), 2.29 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, CDCl<sub>3</sub>) = 157.7 (C), 137.4 (C), 134.4 (CH), 130.9 (C), 130.7 (C), 130.4 (C), 130.1 (C), 129.6 (CH), 129.59 (C), 129.58 (C), 129.3 (CH), 128.82 (CH), 128.79 (CH), 127.2 (C), 126.7 (CH), 126.6 (CH), 125.1 (C), 122.9 (C), 121.5 (C), 120.7 (C), 119.8 (CH), 116.7 (CH), 61.7 (CH<sub>2</sub>), 60.9 (CH<sub>2</sub>), 41.6 (CH<sub>3</sub>) ppm. **<sup>19</sup>F NMR:**  $\delta_{\text{F}}$  (400 MHz, CDCl<sub>3</sub>) = - 63.13 ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 374.0373, C<sub>16</sub>H<sub>16</sub>NO<sup>19</sup>F<sub>3</sub><sup>79</sup>Br<sup>+</sup> required 374.0367 (Δ= 1.6 ppm).

#### 4-bromo-2-(((2-bromobenzyl)(methyl)amino)methyl)phenol

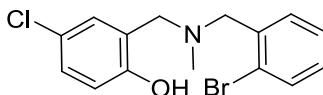


Prepared by general procedure 1 using 5-bromo-2-hydroxybenzaldehyde (4.98 mmol) and (2-bromophenyl)methanamine. The intermediate free amine derivative (**C**,

Scheme 1) was obtained as a yellow solid (1.74 g, 94% crude yield). 1.74 g of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to yield the title compound as a white solid (1.20 g, 66% over two step sequence from intermediate free amine derivative).

**Mp**: 147.0-147.8 °C. **IR**:  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3130 w (aromatic C-H), 2900 br m (O-H), 2848 m (C-H), 1576 m (aromatic C=C), 1469 st (aromatic C=C). **<sup>1</sup>H NMR**:  $\delta_{\text{H}}$  (500 MHz, *d*<sub>6</sub>-DMSO) = 10.23 (1H, br s, OH), 7.61 (1H, dd, *J* = 8.0, 1.0 Hz, aryl CH), 7.48 (1H, dd, *J* = 7.6, 1.6 Hz, aryl CH), 7.40 (1H, td, *J* = 7.5, 1.0 Hz, aryl CH), 7.24-7.21 (2H, m, aryl CH), 7.09 (1H, dd, *J* = 8.6, 2.7 Hz, aryl CH), 6.73 (1H, d, *J* = 8.6 Hz, aryl CH), 3.63 (4H, apparent d, *J* = 12.2 Hz, CH<sub>2</sub>N(CH<sub>3</sub>)CH<sub>2</sub>), 2.13 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR**:  $\delta_{\text{C}}$  (125 MHz, *d*<sub>6</sub>-DMSO) = 155.3 (C), 137.2 (C), 132.8 (CH), 131.5 (CH), 129.5 (CH), 128.8 (CH), 127.8 (CH), 127.7 (CH), 125.7 (C), 124.2 (C), 122.4 (C), 116.8 (CH), 60.7 (CH<sub>2</sub>), 56.4 (CH<sub>2</sub>), 41.4 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 383.9585, C<sub>15</sub>H<sub>16</sub>NO<sup>79</sup>Br<sub>2</sub><sup>+</sup> requires 383.9593 ( $\Delta$  = -2.04 ppm).

## 2-(((2-bromobenzyl)(methyl)amino)methyl)-4-chlorophenol

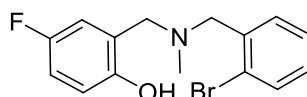


Prepared by general procedure 1 using 5-chloro-2-hydroxybenzaldehyde (6.387 mmol) and (2-bromophenyl)methanamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow solid (2 g, 95% crude yield). 2.00 g of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to yield the title compound as a white solid (1.50 g, 72% over two step sequence from intermediate free amine derivative).

**Mp**: 134.8-135.8 °C. **IR**:  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2979 w (aromatic C-H), 2939 w (aromatic C-H), 2900 br m (O-H), 2847 m (C-H), 1581 m (aromatic C=C), 1479 st (aromatic C=C). **<sup>1</sup>H NMR**:  $\delta_{\text{H}}$  (500 MHz, *d*<sub>6</sub>-DMSO) = 10.26 (1H, br, OH), 7.61 (1H, dd, *J* = 8.0, 1.1 Hz, aryl CH), 7.48 (1H, dd, *J* = 7.6, 1.7 Hz, aryl CH), 7.8 (1H, td, *J* = 7.4, 1.3 Hz, aryl CH), 7.34 (1H, d, *J* = 2.6 Hz, aryl CH), 7.24-7.20 (2H, m, aryl CH), 6.69 (1H, d, *J* = 8.6 Hz, aryl CH), 3.63 (4H, apparent d, *J* = 9.4 Hz, CH<sub>2</sub>N(CH<sub>3</sub>)CH<sub>2</sub>), 2.13

(3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:** δ<sub>C</sub> (125 MHz, *d*<sub>6</sub>-DMSO) = 155.7 (C), 137.2 (C), 132.8 (CH), 131.7 (CH), 131.5 (CH), 130.6 (CH), 129.5 (CH), 127.8 (CH), 126.2 (C), 124.3 (C), 117.4 (CH), 110.0 (C), 60.7 (CH<sub>2</sub>), 56.3 (CH<sub>2</sub>), 41.3 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 340.0089, C<sub>15</sub>H<sub>16</sub>NO<sup>79</sup>Br<sup>35</sup>Cl<sup>+</sup> required 340.0098 (Δ= -2.68 ppm).

## 2-(((2-bromobenzyl)methyl)amino)methyl)-4-fluorophenol

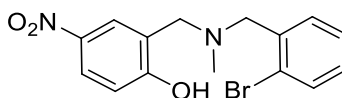


Prepared by general procedure 1 using 5-fluoro-2-hydroxybenzaldehyde (3.568 mmol) and (2-bromophenyl)methanamine. The intermediate free amine derivative (C, Scheme 1) was obtained in a 98% crude yield. 1.242 g of the crude intermediate free amine derivative (C, Scheme 1) was taken used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 90:10) to yield the title compound as a white solid (1.16 g, 90% over two step sequence from intermediate free amine derivative).

**Mp:** 132.0-133.1 °C. **IR:** ν<sub>max</sub> (neat)/cm<sup>-1</sup> 2959 w (aromatic C-H), 2900 br m (O-H), 2883 m (C-H), 2816 m (C-H), 1511 m (aromatic C=C), 1567 m (aromatic C=C), 1490 st (aromatic C=C). **<sup>1</sup>H NMR:** δ<sub>H</sub> (400 MHz, CDCl<sub>3</sub>) = 10.46 (1H, br, OH), 7.59 (1H, dd, *J* = 8.0, 1.0 Hz, aryl CH), 7.36 (1H, dd, *J* = 7.6, 1.6 Hz, aryl CH), 7.31 (1H, td, *J* = 7.4, 1.2 Hz, aryl CH), 7.18 (1H, td, *J* = 7.4, 1.7 Hz, aryl CH), 6.85 (1H, td, *J* = 8.6, 2.8 Hz, aryl CH), 3.74 (4H, apparent d, *J* = 3.9 Hz, CH<sub>2</sub>N(CH<sub>3</sub>)CH<sub>2</sub>), 2.26 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:** δ<sub>C</sub> (100 MHz, CDCl<sub>3</sub>) = 157.2 (C), 154.9 (C), 153.5 (C), 153.5 (C), 135.9 (C), 133.4 (CH), 131.7 (CH), 129.6 (CH), 127.6 (CH), 125.3 (C), 122.6 (C), 122.6 (C), 116.9 (CH), 116.8 (CH), 115.2 (CH), 115.2 (CH), 115.0 (CH), 114.95 (CH), 61.5 (CH<sub>2</sub>), 60.2 (CH<sub>2</sub>), 41.2 (CH<sub>3</sub>) ppm. **<sup>19</sup>F NMR:** δ<sub>F</sub> (400 MHz, CDCl<sub>3</sub>) -125.94 ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 324.0411, C<sub>15</sub>H<sub>16</sub>NO<sup>19</sup>F<sup>79</sup>Br<sup>+</sup> required 324.0399 (Δ= 3.7 ppm).



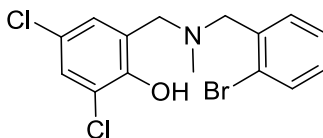
## 2-(((2-bromobenzyl)(methyl)amino)methyl)-4-nitrophenol



Prepared by general procedure 1 using 2-hydroxy-5-nitro-benzaldehyde (5.984 mmol) and (2-bromophenyl)methanamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as an orange oil (1.60 g, 98% crude yield). 1.60 g of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to yield the title compound as a yellow solid (1.25 g, 75% over two step sequence from intermediate free amine derivative).

**Mp**: 113.4-114.5 °C. **IR**:  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 2900 br m (O-H), 2840 w (C-H), 1614 st (aromatic C=C), 1585 st (aromatic C=C), 1468 st (aromatic NO<sub>2</sub>), 1341 st (aromatic NO<sub>2</sub>). **<sup>1</sup>H NMR**:  $\delta_{\text{H}}$  (400 MHz, *d*<sub>6</sub>-DMSO) = 8.18 (1H, d, *J* = 2.9 Hz, aryl CH), 8.03 (1H, dd, *J* = 11.9, 2.9 Hz, aryl CH), 7.63 (1H, dd, *J* = 8.0, 1.0 Hz, aryl CH), 7.52 (1H, dd, *J* = 7.6, 1.6 Hz, aryl CH), 7.40 (1H, td, *J* = 7.4, 1.1 Hz, aryl CH), 7.24 (1H, td, *J* = 7.6, 1.6 Hz, aryl CH), 6.92 (1H, d, *J* = 9.0 Hz, aryl CH), 3.72 (4H, apparent d, *J* = 8.9 Hz, CH<sub>2</sub>(NCH<sub>3</sub>)CH<sub>2</sub>), 2.19 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR**:  $\delta_{\text{C}}$  (100 MHz, CDCl<sub>3</sub>) = 163.0 (C), 139.5 (C), 137.1 (C), 132.9 (CH), 131.5 (CH), 129.5 (CH), 127.8 (CH), 125.4 (CH), 124.9 (C), 124.7 (CH), 124.3 (C), 115.6 (CH), 60.7 (CH<sub>2</sub>), 55.8 (CH<sub>2</sub>), 41.5 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 351.0360, C<sub>15</sub>H<sub>16</sub>N<sub>2</sub>O<sub>3</sub><sup>79</sup>Br<sup>+</sup> required 351.0344 ( $\Delta$  = 4.6 ppm).

## 2-(((2-bromobenzyl)methyl)amino)methyl)-4,6-dichlorophenol

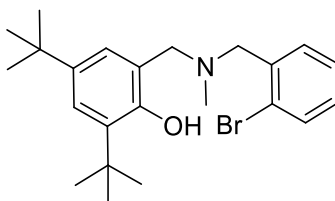


Prepared by general procedure 1 using 3,5-dichloro-2-hydroxybenzaldehyde (5.234 mmol) and (2-bromophenyl)methanamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow solid (1.80 g, 95% crude yield). 1.88 g of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>,

Petroleum Ether: Et<sub>2</sub>O, 80:20) to yield the title compound as a white solid (1.75 g, 89% over two step sequence from intermediate free amine derivative).

**Mp:** 106.1-108.0 °C. **IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2993 w (aromatic C-H), 2944 w (aromatic C-H), 2900 br m (O-H), 2848 w (C-H), 1593 m (aromatic C=C), 1568 m (aromatic C=C), 1455 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (400 MHz, *d*<sub>6</sub>-DMSO) = 7.67 (1H, d, *J* = 7.9 Hz, aryl CH), 7.49 (1H, dd, *J* = 7.6, 1.6 Hz, aryl CH), 7.42 (1H, t, *J* = 7.6 Hz, aryl CH), 7.38 (1H, d, *J* = 2.4 Hz, aryl CH), 7.28 (1H, td, *J* = 7.6 Hz, 1.6 Hz, aryl CH), 7.20 (1H, d, *J* = 2.4 Hz, aryl CH), 3.77 (4H, apparent d, *J* = 21.7, CH<sub>2</sub>N(CH<sub>3</sub>)CH<sub>2</sub>), 2.17 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (100 MHz, *d*<sub>6</sub>-DMSO) = 152.1 (C), 136.1 (C), 133.0 (CH), 132.1 (CH), 130.0 (CH), 128.0 (CH), 127.8 (CH), 127.4 (CH), 125.8 (C), 124.6 (C), 122.4 (C), 120.4 (C), 60.6 (CH<sub>2</sub>), 58.2 (CH<sub>2</sub>), 40.9 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 373.9724, C<sub>15</sub>H<sub>15</sub>NO<sup>35</sup>Cl<sub>2</sub><sup>79</sup>Br<sup>+</sup> required 373.9714 ( $\Delta$  = 2.7 ppm).

#### 2-(((2-bromobenzyl)(methyl)amino)methyl)-4,6-di-*tert*-butylphenol



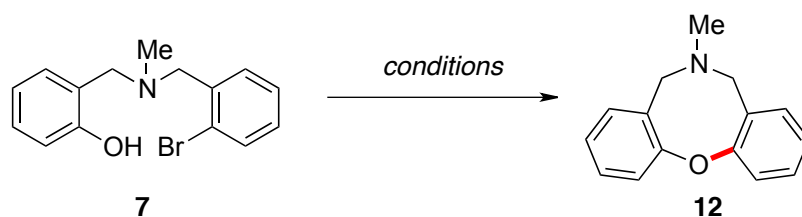
Prepared by general procedure 1 using 3,5-di-*tert*-butyl-2-hydroxybenzaldehyde (4.267 mmol) and (2-bromophenyl)methanamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow solid (1.56 g, 90% crude yield). 1.56 g of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 90:10) to yield the title compound as a colourless oil (1.10 g, 68% over two step sequence from intermediate free amine derivative).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2950 w (aromatic C-H), 2902 w (aromatic C-H), 2900 br m (O-H), 1568 m (aromatic C=C), 1464 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 10.65 (1H, br, OH), 7.56 (1H, d, *J* = 8.0 Hz, aryl CH), 7.38 (1H, d, *J* = 7.5 Hz, aryl CH), 7.29 (1H, t, *J* = 7.3 Hz, aryl CH), 7.21 (1H, s, aryl CH), 7.13 (1H, td, *J* = 7.7, 1.0 Hz, aryl CH), 6.87 (1H, d, aryl CH), 3.75 (4H, apparent d, *J* = 30.5 Hz,

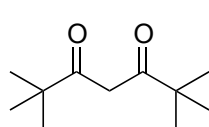
$\text{CH}_2\text{N}(\text{CH}_3)\text{CH}_2$ ), 2.27 (3H, s,  $\text{NCH}_3$ ), 1.43 (9H, s,  $(\text{CH}_3)_3$ ), 1.30 (9H, s,  $(\text{CH}_3)_3$ ) ppm.  **$^{13}\text{C}$  NMR:**  $\delta_{\text{C}}$  (125 MHz,  $\text{CDCl}_3$ ) = 154.0 (C) 140.6 (C), 136.7 (C), 135.5 (C), 133.0 (CH), 131.5 (CH), 129.0 (CH), 127.5 (CH), 125.1 (C), 123.5 (CH), 123.0 (CH), 121.2 (C), 62.1 ( $\text{CH}_2$ ), 60.4 ( $\text{CH}_2$ ), 41.2 ( $\text{CH}_3$ ), 34.9 (C), 34.1 (C), 31.7 ( $\text{CH}_3$ ), 29.6 ( $\text{CH}_3$ ) ppm. **HRMS** (ESI+):  $m/z$  found  $[\text{M}+\text{H}]^+$  418.1747,  $\text{C}_{23}\text{H}_{33}\text{NO}^{79}\text{Br}^+$  required 418.17464 ( $\Delta$ = 0.2 ppm).

## Cyclization reactions: optimization studies

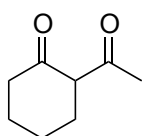
Reaction investigated:



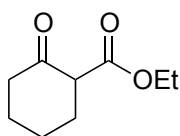
Ligands examined:



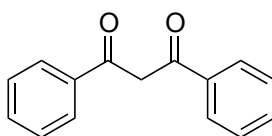
**L1**



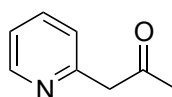
**L2**



**L3**



**L4**



**L5**

Standard procedure for screening: Acyclic substrate (1 equivalent) mixed with base, solvent, ligand and additive (equivalents as listed) and internal standard (meta-terphenyl) in either an oven-dried round-bottomed flask (thermal heating) or an oven-dried microwave vial. Yields were based on HPLC analysis using meta-terphenyl as an internal standard. Selected key screening data are shown in **Table 1**.

Entry	Catalyst (mol %)	Ligand	Solvent	Base	Additive (mol %)	Temp (°C)	Time (h)	Yield (%)
1	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	74
2	CuI (5%)	L2	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	63
3	CuI (5%)	L3	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	38
4	CuI (5%)	L4	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	20
5	CuI (5%)	L5	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	0
6	CuBr 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	73
7	CuCl 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	70
8	CuOAc 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	38
9	Cu(OAc) <sub>2</sub>	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	71
10	Cu <sub>2</sub> O 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	30
11	CuCl <sub>2</sub> 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	75
12	CuBr <sub>2</sub> 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	62
13	CuO 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	32
14	Cu(CF <sub>3</sub> SO <sub>3</sub> ) <sub>2</sub> 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	60
15	Cu(AcAc) <sub>2</sub> 5%	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	71
16	CuI (5%)	L1	MeCN	K <sub>3</sub> PO <sub>4</sub>	-	80	5	67
17	CuI (5%)	L1	MeCN	K <sub>3</sub> PO <sub>4</sub>	-	80	22	81
18	CuI (5%)	L1	MeCN	K <sub>2</sub> CO <sub>3</sub>	-	80	5	28
19	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	100	5	76
20	CuI (10%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	100	5	75
21	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	74
22	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	24	80
23	CuI (5%)	L1	BuCN	Cs <sub>2</sub> CO <sub>3</sub>	-	100	5	69
24	CuI (5%)	L1	MeCN	K <sub>3</sub> PO <sub>4</sub>	Sodium Ascorbate (10%)	80	24	82
25	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	Iron(III)Chloride (10%)	80	5	58
26	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	Sodium Ascorbate (10%)	80	5	83
27	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	Sodium Ascorbate (100%)	80	5	85
28	CuI (5%)	L1	MeCN	K <sub>3</sub> PO <sub>4</sub>	Sodium Ascorbate (10%)	80	24	82
29	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	120 (μW)	5	80
30	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	120 (μW)	1	34
31	CuI (5%)	L1	DMF	Cs <sub>2</sub> CO <sub>3</sub>	-	150 (μW)	5	49
32	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	Sodium Ascorbate (10%) 4A molecular sieves	120 (μW)	5	76
33	CuI (5%)	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	Sodium Ascorbate (10%) MgSO <sub>4</sub> (200%)	120 (μW)	5	62
<b>34</b>	<b>CuI (5%)</b>	<b>L1</b>	<b>MeCN</b>	<b>Cs<sub>2</sub>CO<sub>3</sub></b>	<b>Sodium Ascorbate (10%) Na<sub>2</sub>SO<sub>4</sub> (200%)</b>	<b>120 (μW)</b>	<b>5</b>	<b>85</b>
35	PdCl <sub>2</sub> (5%)	P(Ph) <sub>3</sub>	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	0
36	-	L1	MeCN	Cs <sub>2</sub> CO <sub>3</sub>	-	80	5	0

**Table 1:** Selected key screening data for the ring-closure of acyclic precursor **7** to form **12**. Yields were based on HPLC analysis using meta-terphenyl as an internal standard. Substrate concentration of 0.2 M in all cases.

Entries 1-5 examined the use of different ligands. L1 was found to be optimal (entry 1). Entries 6-15 examined the effect of varying copper sources. Copper (I) iodide was found to be optimal (that is, there was no improvement in the product yield compared to that obtained using the reaction conditions listed in entry 1). Entries 16-18 examined the effect of using alternative bases to cesium carbonate; all were found to be inferior. Entries 19-23 explored variations in temperature, reaction time and catalyst loading in an attempted to improve the yield of the product. Entries 24-28 explored the effect of additives on the reaction, with sodium ascorbate found to have a beneficial impact upon product yield. It was observed that microwave heating for 5 h (in the absence of additives, entry 29) also gave an increase in yield (relative to entry 1). Entries 32-34 explored the combination of sodium ascorbate and microwave irradiation, in addition to the use of different drying agents. The conditions listed in entry 34 were found to reliably provide the highest yield of the desired product and thus constituted the optimized conditions. Entries 35-36 were control reactions.

## General procedure 2: Intramolecular C-O bond formation

CuI (0.05 equivalents), sodium ascorbate (0.1 equivalents), Na<sub>2</sub>SO<sub>4</sub> (2 equivalents), the acyclic substrate (1 equivalent), 2,2,6,6-Tetramethyl-3,5-heptanedione (0.1 equivalent), Cs<sub>2</sub>CO<sub>3</sub> (2 equivalent) and CH<sub>3</sub>CN (0.190 mmol) were added sequentially to an oven-dried microwave tube. The mixture was then heated to 120 °C in the microwave (using the ‘Standard method’) for 5 hours. The mixture was filtered through a plug of Celite<sup>®</sup> (eluting with CH<sub>2</sub>Cl<sub>2</sub>). The organic layer was washed with water and 1M NaOH solution, dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent removed under reduced pressure. The residue was purified by column chromatography to afford the cyclic product.

Settings corresponding to the use of the ‘Standard method’ on the Discover microwave apparatus (with a temperature of 120 °C and a time of 5 hours):

Temperature type:	Infrared
Release limits:	60 °C, 2.8 bar
Hold time:	30 min
Ramp time:	10 min
Temperature:	200 °C
Microwave power:	150 Watt
Stirring:	On
Premix time:	Off
Pressure:	17.2 bar
Cooling time:	20 min
PowerMax:	Off

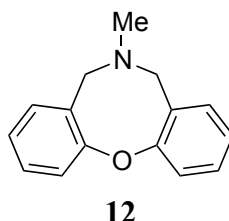
## Note on the characterization of the cyclic compounds:

The majority of the cyclic products reported here appeared dynamic on the NMR timescale at room temperature; frequently, broad peaks were observed when spectra were obtained at room temperature, which then resolved when the spectra were

obtained under high temperature conditions. Due to issues with instrument selectivity when obtaining  $^{13}\text{C}$  NMR spectra at high temperatures, some carbon resonances are absent in the  $^{13}\text{C}$  NMR data for several compounds.

### Synthesis of cyclic compound 12-21

#### 6-methyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (12)

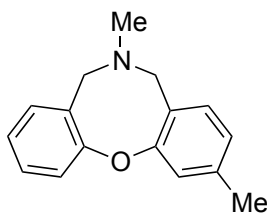


Prepared by general procedure 2 using 2-(((2-bromobenzyl)(methyl)amino)methyl)phenol (**7**, 0.200 g). The crude product material was purified by column chromatography ( $\text{SiO}_2$ , Petroleum Ether:  $\text{Et}_2\text{O}$  80:20) to give the title compound **12** as a white solid (84%).

**Mp**: 85.0-85.3 °C. **IR**:  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  3058 m (aromatic C-H), 2895 st (C-H), 1601 st (aromatic C=C), 1577 st (aromatic C=C).  **$^1\text{H}$  NMR**:  $\delta_{\text{H}}$  (500 MHz, 120 °C,  $d_6$ -DMSO) = 7.33 (2H, dd,  $J$  = 7.75, 1.5 Hz, aryl CH), 7.29 (2H, td,  $J$  = 7.5, 1.5 Hz, aryl CH), 7.17 (2H, dd,  $J$  = 7.3, 1.8 Hz, aryl CH), 7.08 (2H, td,  $J$  = 7.3, 1.3 Hz, aryl CH), 3.90 (4H, s, 2 x  $\text{CH}_2$ ), 2.09 (s, 3H,  $\text{CH}_3$ ) ppm.  **$^{13}\text{C}$  NMR**:  $\delta_{\text{C}}$  (125 MHz, 120 °C  $d_6$ -DMSO) = 158.6 ( $\underline{\text{C}}$ ), 132.6 ( $\underline{\text{CH}}$ ), 129.6 ( $\underline{\text{CH}}$ ), 129.4 ( $\underline{\text{C}}$ ), 124.5 ( $\underline{\text{CH}}$ ), 121.6 ( $\underline{\text{CH}}$ ), 57.0 ( $\underline{\text{CH}_2}$ ), 39.6 ( $\underline{\text{CH}_3}$ ) ppm. **HRMS** (ESI+):  $m/z$  found  $[M+\text{H}]^+$  226.1235,  $\text{C}_{15}\text{H}_{16}\text{NO}^+$  required 226.1232 ( $\Delta$  = 1.3 ppm).



**2,6-dimethyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (13)**

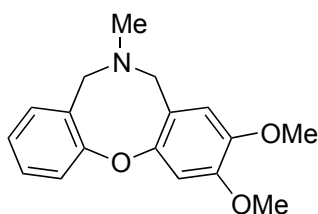


**13**

Prepared by general procedure 2 using 2 2-(((2-bromo-4-methylbenzyl)(methyl)amino)methyl)phenol (0.200 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to give the title compound **13** as a white solid (93%).

**Mp**: 106-106.5 °C. **IR**:  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 2955 w (aromatic C-H), 2924 w (aromatic C-H), 2893 st (C-H), 1613 m (aromatic C=C), 1572 m (aromatic C=C), 1499 m (aromatic C=C), 1485 st (aromatic C=C). **<sup>1</sup>H NMR**:  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.32-7.27 (2H, m, aryl CH), 7.16-1.14 (2H, m, aryl CH), 7.09-7.07 (1H, m, aryl CH), 7.03 (1H, d, *J* = 7.5 Hz, aryl CH), 6.89 (1H, d, *J* = 2.5 Hz, aryl CH), 3.85 (4H, apparent d, *J* = 20.5 Hz, 2 x CH<sub>2</sub>), 2.32 (3H, s, CH<sub>3</sub>), 2.08 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR**:  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 158.5 (C), 158.4 (C), 139.4 (CH), 132.6 (C), 132.4 (CH), 129.5 (CH), 129.4 (C), 126.1 (C), 125.0 (CH), 124.3 (CH), 122.0 (CH), 121.6 (CH), 56.9 (CH<sub>2</sub>), 56.6 (CH<sub>2</sub>), 39.7 (CH<sub>3</sub>), 20.8 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 240.1374, C<sub>16</sub>H<sub>18</sub>NO<sup>+</sup> required 240.1383 ( $\Delta$  = -3.75 ppm).

**3,4-dimethoxy-6-methyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (14)**



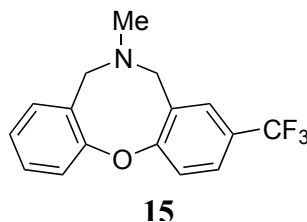
**14**

Prepared by general procedure 2 using 2-(((2-bromo-4,5-dimethoxybenzyl)(methyl)amino)methyl)phenol (0.200 g). The crude product

material was purified by column chromatography (SiO<sub>2</sub>, CH<sub>2</sub>Cl<sub>2</sub>: MeOH, 99:1) to give the title compound **14** as a colourless oil (90%).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3065 w (aromatic C-H), 3000 w (aromatic C-H), 2933 m (aromatic C-H), 2834 m (C-H), 1607 m (aromatic C=C), 1581 w (aromatic C=C), 1509 st (aromatic C=C), 1484 st (aromatic C=C), 1439 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.33 (1H, dd, *J* = 8.0, 1.0 Hz, aryl CH), 7.28 (1H, td, *J* = 7.3, 1.7 Hz, aryl CH), 7.14 (1H, dd, *J* = 7.5, 2.0 Hz, aryl CH), 7.06 (1H, td, *J* = 7.3, 1.3 Hz, aryl CH), 6.97 (1H, s, aryl CH), 6.75 (1H, s, aryl CH), 3.90 (2H, s, CH<sub>2</sub>), 3.82 (5H, apparent br s, CH<sub>2</sub> and OCH<sub>3</sub>), 3.75 (3H, br s, OCH<sub>3</sub>), 2.09 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 158.9 (C), 152.4 (C), 150.3 (C), 146.4 (C), 132.7 (CH), 129.5 (CH), 129.3 (C), 124.2 (CH), 121.6 (CH), 117.6 (CH), 107.8 (CH), 57.4 (CH<sub>3</sub>), 57.1 (CH<sub>2</sub>), 57.0 (CH<sub>3</sub>), 56.8 (CH<sub>2</sub>), 39.6 (CH<sub>3</sub>) ppm. Missing one signal corresponding to 1 x (C). **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 286.1454, C<sub>17</sub>H<sub>20</sub>NO<sub>3</sub><sup>+</sup> required 286.1443 ( $\Delta$  = 3.8 ppm).

#### 6-methyl-4-(trifluoromethyl)-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (**15**)

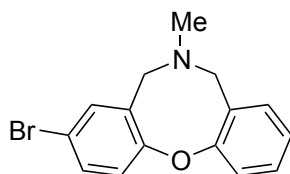


Prepared by general procedure 2 using 2-(((2-bromobenzyl)(methyl)amino)methyl)-4-(trifluoromethyl)phenol (0.185 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to give the title compound **15** as a white solid (82%).

**Mp:** 88.5-88.9 °C. **IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3061 w (aromatic C-H), 2944 m (aromatic C-H), 1608 m (aromatic C=C), 1595 m (aromatic C=C), 1582 m (aromatic C=C), 1485 st (aromatic C=C), 1447 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.63 (1H, d, *J* = 8.5 Hz, aryl CH), 7.53-7.51 (2H, m, aryl CH), 7.37-7.32 (2H, m, aryl CH), 7.22-7.13 (2H, m, aryl CH), 3.90 (4H, apparent d, *J* = 7 Hz, 2 x CH<sub>2</sub>), 2.11 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 161.3

(C), 157.6 (C), 132.7 (CH), 129.9 (CH), 129.6 (C), 128.9 (C), 127.8 (C), 126.8 (CH), 126.8 (CH), 125.7 (C), 125.4 (C), 125.1 (CH), 123.5 (C), 122.4 (CH), 121.4 (CH), 56.4 (CH<sub>2</sub>), 56.0 (CH<sub>2</sub>), 39.8 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 294.1094, C<sub>16</sub>H<sub>15</sub>NO<sup>19</sup>F<sub>3</sub><sup>+</sup> required 294.1106 (Δ= -4.1 ppm).

### 3-bromo-6-methyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (**16**)

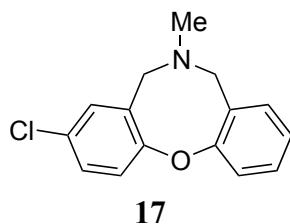


**16**

Prepared by general procedure 2 using 4-bromo-2-(((2-bromobenzyl)(methyl)amino)methyl)phenol (0.200 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 90:10) to give the title compound **16** as a white solid (64%).

**Mp**: 110-111 °C. **IR**:  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3055 w (aromatic C-H), 2950 m (aromatic C-H), 2924 m (C-H), 1601 m (aromatic C=C), 1584 m (aromatic C=C), 1475 s (aromatic C=C). **<sup>1</sup>H NMR**:  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.44 (1H, dd, *J* = 8.5, 2.5 Hz, aryl CH), 7.36-7.29 (4H, m, aryl CH), 7.18 (1H, dd, *J* = 7.5, 1.5 Hz, aryl CH), 7.11 (1H, td, *J* = 7.3, 1.3 Hz, aryl CH), 3.90 (4H, apparent d, *J* = 17 Hz, 2 x CH<sub>2</sub>), 2.09 (3H, s, CH<sub>3</sub>). **<sup>13</sup>C NMR**:  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 158.3 (C), 158.0 (C), 134.8 (CH), 132.6 (CH), 132.3 (CH), 129.7 (CH), 124.9 (CH), 124.0 (CH), 121.6 (CH), 116.4 (C), 57.1 (CH<sub>2</sub>), 56.6 (CH<sub>2</sub>), 39.4 (CH<sub>3</sub>) ppm. Missing three signals corresponding to 3 x (C). **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 304.0349, C<sub>15</sub>H<sub>15</sub>NO<sup>79</sup>Br<sup>+</sup> required 304.0337 (Δ= 3.9 ppm).

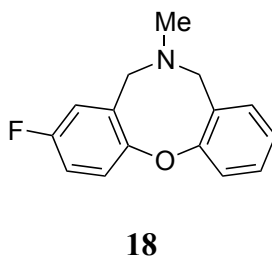
### Synthesis of 3-chloro-6-methyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (17)



Prepared by general procedure 2 using 2-(((2-bromobenzyl)(methyl)amino)methyl)-4-chlorophenol (0.200 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, gradient 95:5 to 80:20) to give the title compound **17** as a white solid (62%).

**Mp:** 107.8-108.8 °C. **IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3052 w (aromatic C-H), 2952 m (aromatic C-H), 2917 m (C-H), 2891 m (C-H), 1601 m (aromatic C=C), 1584 m (aromatic C=C), 1476 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.38-7.29 (4H, m, aryl CH), 7.23 (1H, d, *J* = 2.5 Hz, aryl CH), 7.18 (1H, dd, *J* = 7.3, 1.8 Hz, aryl CH), 7.12 (1H, td, *J* = 7.3, 1.5 Hz, aryl CH), 3.91 (4H, apparent d, *J* = 14.5 Hz, 2 x CH<sub>2</sub>), 2.09 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 158.3 (C), 157.5 (C), 132.6 (CH), 131.9 (CH), 129.7 (CH), 129.3 (CH), 128.6 (C), 124.9 (CH), 123.5 (CH), 121.7 (CH), 57.1 (CH<sub>2</sub>), 56.7 (CH<sub>2</sub>), 39.4 (CH<sub>3</sub>) ppm. Missing two signals corresponding to 2 x (C) **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 260.0829, C<sub>15</sub>H<sub>15</sub>NO<sup>35</sup>Cl<sup>+</sup> required 260.0837 ( $\Delta$  = -3.15 ppm).

### 3-fluoro-6-methyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (18)

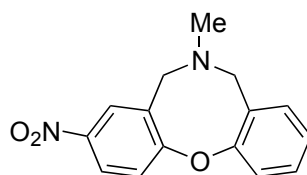


Prepared by general procedure 2 using 2-(((2-bromobenzyl)methyl)amino)methyl)-4-fluorophenol (0.200 g). The crude product material was purified by column

chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to give the title compound **18** as a colourless oil (80%).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3052 w (aromatic C-H), 2954 m (aromatic C-H), 2895 m (C-H), 1592 m (aromatic C=C), 1483 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.40-7.45 (2H, m, aryl CH), 7.31-7.28 (1H, m, aryl CH), 7.17 (1H, d, *J* = 7.2 Hz, aryl CH), 7.11-7.04 (2H, m, aryl CH), 6.99 (1H, dd, *J* = 9.0, 3.0 Hz, aryl CH), 3.95-3.94 (4H, m, 2 x CH<sub>2</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 159.0 (d, *J* = 237.5 Hz, C), 158.8 (C), 154.9 (d, *J* = 2.5 Hz, C), 132.7 (C), 132.5 (CH), 130.2 (C), 129.6 (CH), 124.7 (CH), 123.4 (d, *J* = 8.8 Hz, CH), 121.8 (CH), 118.4 (d, *J* = 22.5 Hz, CH), 115.7 (d, *J* = 23.9 Hz, CH), 57.5 (CH<sub>2</sub>), 57.2 (CH<sub>2</sub>), 39.1 (CH<sub>3</sub>) ppm. **HRMS** (ESI+): *m/z* found [*M*+H]<sup>+</sup> 244.1124, C<sub>15</sub>H<sub>15</sub>NO<sup>19</sup>F<sup>+</sup> required 244.1132 ( $\Delta$  = -3.23 ppm).

#### Synthesis of 6-methyl-3-nitro-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (**19**)



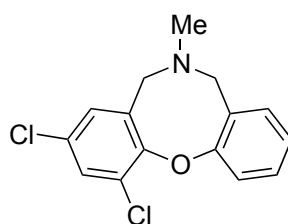
**19**

Prepared by general procedure 2 using 2-(((2-bromobenzyl)(methyl)amino)methyl)-4-nitrophenol (0.200 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, gradient 80:20 to 70:30) to give the title compound **19** as a yellow oil (65%).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3079 w (aromatic C-H), 2952 m (aromatic C-H), 2851 w (C-H), 2813 m (C-H), 1615 m (aromatic C=C), 1586 m (aromatic C=C), 1574 m (aromatic C=C), 1513 st (aromatic NO<sub>2</sub>), 1335 st (aromatic NO<sub>2</sub>). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 8.15 (1H, dd, *J* = 8.8, 2.8 Hz, aryl CH), 8.07 (1H, d, *J* = 2.0 Hz, aryl CH), 7.52 (1H, d, *J* = 9.0 Hz, aryl CH), 7.35 (2H, d, *J* = 3.5 Hz, aryl CH), 7.24 (1H, d,

$J = 7.0$  Hz, aryl CH), 7.19-7.16 (1H, m, aryl CH), 3.86 (4H, apparent d,  $J = 5.5$  Hz, 2 x CH<sub>2</sub>), 2.15 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_C$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 163.2 (C), 156.9 (C), 144.0 (C), 132.7 (CH), 130.0 (CH), 128.2 (CH), 125.5 (CH), 125.2 (CH), 122.4 (CH), 121.2 (CH), 55.9 (CH<sub>2</sub>), 55.4 (CH<sub>2</sub>), 40.2 (CH<sub>3</sub>, obscured by solvent peak) ppm. Missing two signals corresponding to 2 x (C).

**1,3-dichloro-6-methyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (20)**

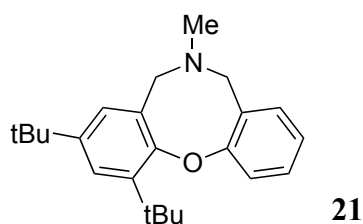


**20**

Prepared by general procedure 2 using 2-(((2-bromobenzyl)methyl)amino)methyl)-4,6-dichlorophenol (0.400 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 90:10) to give the title compound **20** as a colourless oil (38%).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2966 w (aromatic C-H), 2940 w (aromatic C-H), 2833 w (C-H), 1603 m (aromatic C=C), 1567 m (aromatic C=C), 1484 st (aromatic C=C), 1440 m (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_H$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.55 (1H, d,  $J = 3.0$  Hz, aryl CH), 7.39 (1H, d,  $J = 7.0$  Hz, aryl CH), 7.34 (1H, td,  $J = 7.6, 1.7$  Hz, aryl CH), 7.26 (1H, d,  $J = 2.5$  Hz, aryl CH), 7.22 (1H, dd,  $J = 7.5, 2.0$  Hz, aryl CH), 7.15 (1H, td,  $J = 7.3, 1.2$  Hz, aryl CH), 3.73 (4H, apparent d,  $J = 12.0$  Hz, 2 x CH<sub>2</sub>), 2.24 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_C$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 156.8 (C), 151.8 (C), 133.1 (CH), 131.1 (CH), 130.0 (CH), 129.9 (CH), 129.7 (C), 128.5 (C), 126.6 (C), 124.9 (CH), 121.1 (CH), 55.2 (CH<sub>2</sub>), 55.0 (CH<sub>2</sub>), 41.1 (CH<sub>3</sub> obscured by solvent). ppm Missing two signals corresponding to 2 x (C). **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 294.0463, C<sub>15</sub>H<sub>14</sub>NO<sup>35</sup>Cl<sub>2</sub><sup>+</sup> required 294.0452 ( $\Delta = 3.7$  ppm).

### 1,3-di-tert-butyl-6-methyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (21)

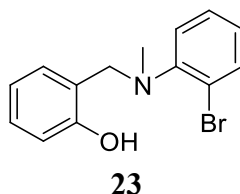


Prepared by general procedure 2 using 2-(((2-bromobenzyl)(methyl)amino)methyl)-4,6-di-tert-butylphenol (0.200 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to give the title compound **21** as a colourless oil (37%).

**IR:**  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 2952 st (aromatic C-H), 1606 m (aromatic C=C), 1575 m (aromatic C=C), 1475 st (aromatic C=C), 1439 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.37 (1H, d, *J* = 3 Hz, aryl CH), 7.33-7.30 (1H, m, aryl CH), 7.12-7.07 (3H, m, aryl CH), 7.01-6.97 (1H, m, aryl CH), 3.57 (2H, s, CH<sub>2</sub>), 3.40 (2H, s, CH<sub>2</sub>), 2.19 (3H, s, CH<sub>3</sub>), 1.40 (9H, s, (CH<sub>3</sub>)<sub>3</sub>), 1.34 (9H, s, (CH<sub>3</sub>)<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 158.0 (C), 151.9 (C), 146.1 (C), 142.7 (C), 139.7 (C), 134.3 (CH), 129.6 (CH), 127.4 (CH), 123.7 (CH), 122.1 (CH), 119.1 (CH), 53.9 (CH<sub>2</sub>), 53.4 (CH<sub>2</sub>), 42.2 (CH<sub>3</sub>), 35.2 (C), 34.5 (C), 31.7 (CH<sub>3</sub>), 30.9 (CH<sub>3</sub>) ppm. Missing one signal corresponding to 1 x (C) **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 338.2499, C<sub>23</sub>H<sub>32</sub>NO<sup>+</sup> required 338.2484 ( $\Delta$  = 4.4 ppm).

### Route towards compound 22

#### 2-(((2-bromophenyl)(methyl)amino)methyl)phenol (23)

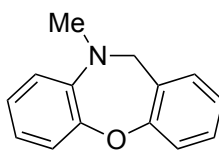


Prepared by general procedure 1 using salicylaldehyde (**9**, 5.813 mmol) and 2-bromoaniline. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow oil (1.60 g, 99% crude yield). 1.60 g of the crude intermediate free amine

derivative (**C**, Scheme 1) was taken forward. The crude title compound material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 95:5) to yield the title compound **23** as a colourless oil (1.30 g, 76% over two step sequence from intermediate free amine derivative).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2989 m (aromatic C-H), 2900 br m (O-H), 1587 st (aromatic C=C), 1491 st (aromatic C=C), 1478 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 9.83 (1H, br s, OH), 7.63 (1H, dd,  $J$  = 8.0, 1.4 Hz, aryl CH), 7.37 -7.30 (2H, m, aryl CH), 7.21 (1H, td,  $J$  = 7.8, 1.7 Hz, aryl CH), 7.10-7.04 (2H, m, aryl CH), 6.90 (1H, dd,  $J$  = 8.1, 1.0 Hz, aryl CH), 6.84 (1H, td,  $J$  = 7.4, 1.2 Hz, aryl CH), 4.24 (2H, s, CH<sub>2</sub>), 2.66 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, CDCl<sub>3</sub>) = 157.2 (C), 149.8 (C), 133.9 (CH), 129.2 (CH), 129.1 (CH), 128.6 (CH), 126.7 (CH), 122.3 (CH), 120.99 (C), 120.97 (C), 119.4 (CH), 116.4 (CH), 59.6 (CH<sub>2</sub>), 42.7 (CH<sub>3</sub>). ppm. **HRMS** (ESI+):  $m/z$  found  $[M+H]^+$  292.0345, C<sub>14</sub>H<sub>15</sub>NO<sup>79</sup>Br<sup>+</sup> required 292.0337 ( $\Delta$  = 2.7 ppm).

**10-methyl-10,11-dihydrodibenzo[b,f][1,4]oxazepine (22)**



**22**

Prepared by general procedure 2 using 2-(((2-bromophenyl)(methyl)amino)methyl)phenol (**23**, 0.200 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 95:5) to give the title compound **22** as a colourless oil (84%).

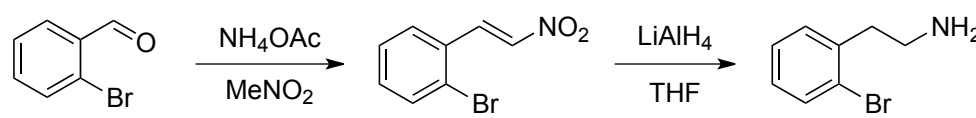
**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3064 m (aromatic C-H), 2872 m (C-H), 2808 m (C-H), 1601 m (aromatic C=C), 1486 st (aromatic C=C), 1451 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 7.27-7.24 (1H, m, aryl CH), 7.20 (1H, dd,  $J$  = 8.0, 1.0 Hz, aryl CH), 7.16-7.14 (2H, m, aryl CH), 7.06 (1H, td,  $J$  = 7.3, 1.3 Hz, aryl CH), 7.04-7.00 (1H, m, aryl CH), 6.91 (1H, dd,  $J$  = 8.3, 1.3 Hz, aryl CH), 6.84 (1H, td,  $J$  = 7.6, 1.5 Hz, aryl



CH), 4.38 (2H, s, CH<sub>2</sub>), 2.96 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:** δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) = 157.3 (C), 148.9 (C), 142.4 (C), 129.4 (C), 128.7 (CH), 128.6 (CH), 124.5 (CH), 123.6 (CH), 121.7 (CH), 121.1 (CH), 120.3 (CH), 120.0 (CH), 56.5 (CH<sub>3</sub>), 43.0 (CH<sub>2</sub>) ppm. **HRMS** (ESI+): *m/z* found [M+H]<sup>+</sup> 210.1081, C<sub>14</sub>H<sub>14</sub>NO<sup>+</sup> required 212.1075 (Δ = 2.8 ppm).

## Route towards compound 24

### 2-(2-bromophenyl)ethanamine



Synthesis of 1-bromo-2-(2-nitrovinyl)benzene based on the method of Chang <sup>5</sup>. 2-bromo-benzaldehyde (1 equivalent, 5.404 mmol) was added to a mixture of NH<sub>4</sub>OAc (15 mL) and AcOH (1 mL) at room temperature. Then CH<sub>3</sub>NO<sub>2</sub> (1 mL) was added (slowly) with stirring for 5 minutes. The resulting mixture was heated to reflux at 120 °C for 4 hours, then quenched by addition of ice water and extracted with CH<sub>2</sub>Cl<sub>2</sub>. The organic layers were combined and the solvent was removed under reduced pressure. The residue was purified by column chromatography (SiO<sub>2</sub>: Petroleum Ether : Et<sub>2</sub>O, 20:80) to yield 1-bromo-2-(2-nitrovinyl)benzene as a yellow solid. (Yield: 95%).

**IR:** ν<sub>max</sub> (neat)/cm<sup>-1</sup> 3120 m (aromatic C-H), 1633 st (aliphatic NO<sub>2</sub>), 1584 w (aromatic C=C), 1498 st (aromatic C=C), 1337 st (aliphatic NO<sub>2</sub>). **<sup>1</sup>H NMR:** δ<sub>H</sub> (500 MHz, CDCl<sub>3</sub>) = 8.37 (1H, d, *J* = 14.0 Hz, CH=CHNO<sub>2</sub>), 7.67 (1H, dd, *J* = 8.0, 1.5 Hz, aryl CH), 7.58 (1H, dd, *J* = 7.8, 1.8 Hz, aryl CH), 7.53 (1H, d, *J* = 14 Hz, CH=CHNO<sub>2</sub>), 7.39 (1H, td, *J* = 7.5, 1.0 Hz, aryl CH), 7.34 (1H, td, *J* = 7.4, 1.6 Hz, aryl CH) ppm. **<sup>13</sup>C NMR:** δ<sub>C</sub> (125 MHz, CDCl<sub>3</sub>) = 138.8 (CH), 137.6 (CH), 134.0 (CH), 132.9 (CH), 130.4 (C), 128.5 (CH), 128.1 (CH), 126.3 (C) ppm.

This data is consistent with that previously reported.<sup>5</sup>

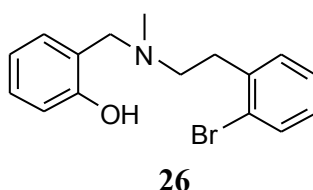
Based on the method of Bradsher *et al.*<sup>6</sup> 1-bromo-2-(2-nitrovinyl)benzene (1 equivalent, 4.385 mmol) was dissolved in anhydrous Et<sub>2</sub>O (28 mL) and added drop-

wise to  $\text{LiAlH}_4$  (4 equivalents, 17.54 mmol) in anhydrous  $\text{Et}_2\text{O}$  (47.5 mL), and the mixture was stirred at 0-5 °C for 5 hours. After this time water (3 mL), 20% aqueous NaOH solution (3 mL) and water (6.5 mL) again were added in sequence. The precipitate was filtered off and washed with diethyl ether. The combined filtrates were dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent removed under reduced pressure to yield 2-(2-bromophenyl)ethanamine as yellow oil (Yield: 80%).

**IR:**  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  2928 m (aromatic C-H), 1470 st (aromatic C=C), 1439 st (aromatic C=C), 1023 st (N-H), 747 (C-N).  **$^1\text{H}$  NMR:**  $\delta_{\text{H}}$  (500 MHz,  $\text{CDCl}_3$ ) = 7.53 (1H, d,  $J$  = 8.0 Hz, aryl CH), 7.16-7.13 (2H, m, aryl CH), 7.05-7.00 (1H, m, aryl CH), 2.94-2.84 (4H, m, 2 x  $\text{CH}_2$ ), 2.14 (2H, br s,  $\text{NH}_2$ ) ppm.  **$^{13}\text{C}$  NMR:**  $\delta_{\text{C}}$  (125 MHz,  $\text{CDCl}_3$ ) = 138.8 (C), 132.8 (CH), 130.8 (CH), 127.8 (CH), 127.3 (CH), 124.5 (C), 41.8 ( $\text{CH}_2$ ), 39.9 ( $\text{CH}_2$ ) ppm.

This data is consistent with that previously reported.<sup>5</sup>

### 2-(((2-bromophenethyl)(methyl)amino)methyl)phenol (**26**)

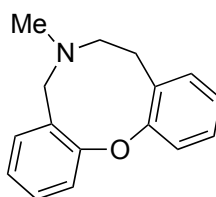


Prepared by general procedure 1 using salicylaldehyde (**9**, 3.5 mmol) and 2-(2-bromophenyl)ethanamine. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a yellow oil (1.06 g, 99% crude yield). 1.06 g of the crude intermediate free amine derivative (**C**, Scheme 1) was used in subsequent steps. The crude title compound material was purified by column chromatography ( $\text{SiO}_2$ , Petroleum Ether:  $\text{Et}_2\text{O}$ , 80:20) to yield the title compound **26** as a yellow oil (500 mg, 45% over two step sequence from intermediate free amine derivative).

**IR:**  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  3054 w (aromatic C-H), 2960 w (aromatic C-H) 2900 br m (O-H), 2850 w (C-H), 1588 st (aromatic C=C), 1470 st (aromatic C=C).  **$^1\text{H}$  NMR:**  $\delta_{\text{H}}$  (500 MHz,  $\text{CDCl}_3$ ) = 10.73 (1H, br, OH), 7.55 (1H, dd,  $J$  = 10.0, 1.5 Hz, aryl CH), 7.27 (1H, d,  $J$  = 7.5 Hz, aryl CH), 7.25-7.18 (2H, m, aryl CH), 7.11 (1H, td,  $J$  = 7.8, 1.7 Hz, aryl CH), 7.00 (1H, d,  $J$  = 2.0 Hz, aryl CH), 6.85 (1H, d,  $J$  = 7.5 Hz, aryl CH),

6.80 (1H, td,  $J = 7.4, 1.0$  Hz, aryl CH), 3.82 (2H, s, CH<sub>2</sub>), 3.07-3.03 (2H, m, CH<sub>2</sub>), 2.82-2.78 (2H, m, CH<sub>2</sub>), 2.44 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_C$  (125 MHz, CDCl<sub>3</sub>) = 157.9 (C), 138.5 (C), 133.0 (CH), 130.7 (CH), 128.8 (CH), 128.6 (CH), 128.2 (CH), 127.7 (CH), 124.4 (C), 121.6 (C), 119.1 (CH), 116.2 (CH), 61.1 (CH<sub>2</sub>), 56.6 (CH<sub>2</sub>), 41.2 (CH<sub>3</sub>), 33.6 (CH<sub>2</sub>) ppm. **HRMS** (ESI<sup>+</sup>):  $m/z$  found  $[M+H]^+$  320.0646, C<sub>16</sub>H<sub>19</sub>NO<sup>79</sup>Br<sup>+</sup> required 320.0650 ( $\Delta = -1.2$  ppm).

#### 6-methyl-5,6,7,8-tetrahydrodibenzo[b,h][1,5]oxazonine (**24**)



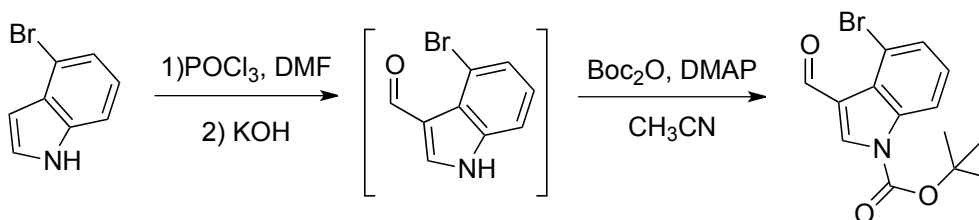
**24**

Prepared by general procedure 2 using 2-(((2-bromophenethyl)(methyl)amino)methyl)phenol (**26**, 0.270 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 80:20) to give the title compound **24** as a colourless oil (50%).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 2972 st (aromatic C-H), 2901 st (C-H), 1579 m (aromatic C=C), 1478 st (aromatic C=C), 1449 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_H$  (500 MHz, CDCl<sub>3</sub>) = 7.31-7.02 (8H, m, aryl CH), 3.63 (2H, s, CH<sub>2</sub>N(CH<sub>3</sub>)CH<sub>2</sub>CH<sub>2</sub>), 2.94 (2H, t,  $J = 5.5$  Hz, CH<sub>2</sub>), 2.85 (2H, t,  $J = 5.5$  Hz, CH<sub>2</sub>), 2.28 (3H, s, CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_C$  (125 MHz, CDCl<sub>3</sub>) = 157.6 (C), 157.2 (C), 134.2 (C), 132.6 (C), 130.9 (CH), 130.5 (CH), 128.6 (CH), 127.4 (CH), 124.1 (CH), 124.0 (CH), 122.2 (CH), 120.2 (CH), 57.3 (CH<sub>2</sub>), 55.6 (CH<sub>2</sub>), 43.9 (CH<sub>3</sub>), 29.9 (CH<sub>2</sub>) ppm. **HRMS** (ESI<sup>+</sup>):  $m/z$  found  $[M+H]^+$  240.1390, C<sub>16</sub>H<sub>18</sub>NO<sup>+</sup> required 240.1388 ( $\Delta = 0.8$  ppm).

## Route towards compound 25

### *tert*-Butyl 4-bromo-3-formyl-1H-indole-1-carboxylate

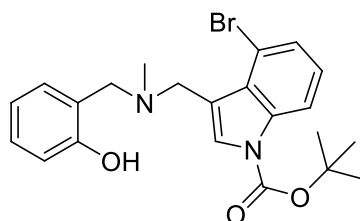


Synthesis of 4-bromo-1H-indole-3-carbaldehyde based on the method of Muratore *et al.*<sup>7</sup> POCl<sub>3</sub> (2.5 equivalents, 12.75 mmol) was added drop-wise to anhydrous DMF (6 mL) at 0 °C (ice-bath cooling). The mixture was stirred for 5 minutes at this temperature, then a solution of 4-bromoindole (1 equivalents, 5.1 mmol) in anhydrous DMF (12 mL) was added dropwise. The mixture was then allowed to warm to room temperature and stirred for 3 hours (note that the reaction became a heavy suspension that required vigorous stirring). 3.8 M aqueous potassium hydroxide (1.34 mL) was added via a dropping funnel and the mixture was heated to reflux and stirred at reflux overnight. After this time the reaction mixture was cooled to room temperature. Saturated aqueous NaHCO<sub>3</sub> and EtOAc were added until the mixture became clear and the organic layer separated. The aqueous layer was extracted with EtOAc. The combined organic layers were dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent removed under reduced pressure to furnish 4-bromo-1H-indole-3-carbaldehyde as a red solid (Yield: 96%) that required no further purification and was used in the next reaction without characterization. To a stirred solution of 4-bromo-1H-indole-3-carbaldehyde (1 equivalent, 4.9 mmol), and Boc-anhydride (1.12 equivalents, 5.488 mmol), in CH<sub>3</sub>CN (8.5 mL) was added DMAP (0.087 equivalents, 0.426 mmol). The resulting solution was stirred overnight and the solvent was removed under reduced pressure. The solid residue was dissolved in CH<sub>2</sub>Cl<sub>2</sub> and washed with a saturated NaHCO<sub>3</sub> solution. The aqueous layer was extracted with CH<sub>2</sub>Cl<sub>2</sub> and the combined organic extracts were washed with saturated NH<sub>4</sub>Cl solution, water and brine and dried (MgSO<sub>4</sub>). The solvent was removed under reduced pressure and the crude product was purified by column chromatography (SiO<sub>2</sub>: Petroleum Ether : Et<sub>2</sub>O, 90:10) to afford the title compound as a white solid. (Yield: 80%).

**IR:**  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  2979 w (aromatic C-H), 1747 st (C=O), 1668 st (C=O), 1528 st (aromatic C=C), 1427 st (aromatic C=C).  **$^1\text{H}$  NMR:**  $\delta_{\text{H}}$  (500 MHz,  $\text{CDCl}_3$ ) = 10.98 (1H, s, C(=O)H), 8.39 (1H, s, CHN), 8.28 (1H, d,  $J$  = 8.5 Hz, aryl CH), 7.56 (1H, d,  $J$  = 7.5 Hz, aryl CH), 7.26-7.23 (1H, m, aryl CH), 1.68 (9H, s,  $(\text{CH}_3)_3$ ) ppm.  **$^{13}\text{C}$  NMR:**  $\delta_{\text{C}}$  (125 MHz,  $\text{CDCl}_3$ ) = 187.0 (CH), 148.3 (C), 137.3 (C), 132.0 (CH), 128.5 (CH), 126.9 (C), 126.0 (CH), 121.1 (C), 114.8 (CH), 113.5 (C), 86.2 (C), 28.0 ( $\text{CH}_3$ ) ppm.

This data is consistent with that previously reported.<sup>8</sup>

***tert*-butyl 4-bromo-3-(((2-hydroxybenzyl)(methyl)amino)methyl)-1H-indole-1-carboxylate (27)**



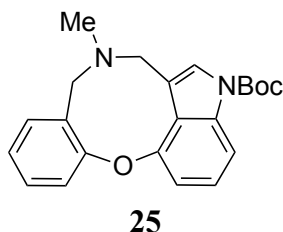
**27**

Prepared by general procedure 1 using 2-hydroxy-benzylamine (0.309 mmol) and *tert*-butyl 4-bromo-3-formyl-1H-indole-1-carboxylate. The intermediate free amine derivative (**C**, Scheme 1) was obtained as a colourless oil (0.117 g, 87% crude yield). 0.117 g of the crude intermediate free amine derivative (**C**, Scheme 1) was taken forward. The crude title compound material was purified by column chromatography ( $\text{SiO}_2$ , Petroleum Ether:  $\text{Et}_2\text{O}$ , 90:10) to yield the title compound **27** as a white solid (400 mg, 54% over two step sequence from intermediate free amine derivative).

**Mp:** 58.8-60.0°C. **IR:**  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  2981 w (aromatic C-H), 2900 br m (O-H), 1733 st (C=O), 1588 m (aromatic C=C), 1419 st (aromatic C=C).  **$^1\text{H}$  NMR:**  $\delta_{\text{H}}$  (500 MHz,  $\text{CDCl}_3$ ) = 10.74 (1H, br s, CH), 8.16 (1H, d,  $J$  = 5 Hz, CH), 7.60 (1H, s, CH), 7.45 (1H, d,  $J$  = 10 Hz, CH), 7.17-7.10 (2H, m, CH), 6.99 (1H, d,  $J$  = 5 Hz, CH), 6.77-6.73 (2H, m, CH), 3.95 (2H, s,  $\text{CH}_2$ ), 3.78 (2H, s,  $\text{CH}_2$ ), 3.37 (3H, s,  $\text{NCH}_3$ ), 1.67 (9H, s,  $(\text{CH}_3)_3$ ) ppm.  **$^{13}\text{C}$  NMR:**  $\delta_{\text{C}}$  (125 MHz,  $\text{CDCl}_3$ ) = 157.5 (C), 149.0 (C), 137.2 (C), 128.54 (CH), 128.48 (CH), 128.0 (C), 127.62 (CH), 127.55 (CH), 125.5 (CH), 121.9 (C), 118.9 (CH), 116.4 (C), 116.0 (CH), 114.6 (CH), 113.9 (C), 84.6 (C),

59.3 (CH<sub>2</sub>), 53.8 (CH<sub>2</sub>), 41.7 (CH<sub>3</sub>), 28.1 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 445.1139, C<sub>22</sub>H<sub>26</sub>N<sub>2</sub>O<sub>3</sub><sup>79</sup>Br<sup>+</sup> required 445.1127 ( $\Delta$  = 2.7 ppm).

***tert*-Butyl 7-methyl-7,8-dihydrobenzo[2,3][1,5]oxazonino[7,8,9-*cd*]indole-4(6*H*)-carboxylate (25)**

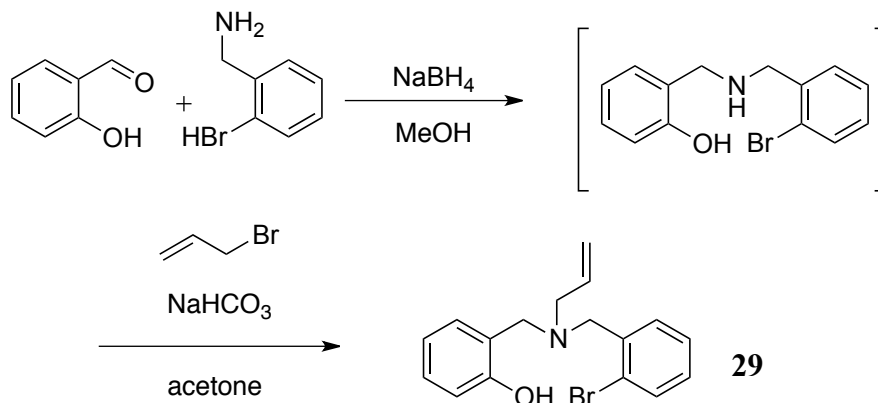


Prepared by general procedure 2 using *tert*-butyl 4-bromo-3-(((2-hydroxybenzyl)(methyl)amino)methyl)-1*H*-indole-1-carboxylate (**27**, 0.270 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O, 50:50) to give the title compound **25** as a colourless oil (23%).

$\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 2980 m (aromatic C-H), 2934 m (aromatic C-H), 1732 st (C=O), 1609 m (aromatic C=C), 1567 st (aromatic C=C), 1479 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (400 MHz, CDCl<sub>3</sub>) = 7.99 (1H, d, *J* = 8.0 Hz, aryl CH), 7.50 (1H, s, aryl CH), 7.38 (1H, d, *J* = 7.6 Hz, aryl CH), 7.31-7.27 (3H, m, aryl CH), 7.17 (1H, dd, *J* = 7.2, 2.0 Hz, aryl CH), 7.09 (1H, t, *J* = 7.2 Hz, aryl CH), 4.06-3.90 (4H, br m, 2 x CH<sub>2</sub>), 2.42 (3H, s, CH<sub>3</sub>), 1.69 (9H, s, (CH<sub>3</sub>)<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, CDCl<sub>3</sub>) = 157.8, 151.4, 149.5, 137.2, 133.4, 130.7, 129.1, 125.1, 124.2, 122.1, 117.3, 115.9, 112.3, 83.8, 55.1, 50.5, 42.1, 28.2 ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [M+H]<sup>+</sup> 365.1879, C<sub>22</sub>H<sub>25</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> required 365.1865 ( $\Delta$  = 3.8 ppm).

## Route towards compound 28

### Synthesis of 2-((allyl(2-bromobenzyl)amino)methyl)phenol (**29**)

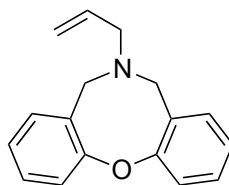


Salicylaldehyde (**9**, 1 equivalent, 0.179 mL, 1.712 mmol) and 2-bromobenzylamine (**8**, 1 equivalent, 0.215 mL, 1.712 mmol) were added to a stirring solution of methanol (3 mL) at room temperature. The reaction mixture was heated to 50 °C and stirred at this temperature overnight. The reaction was then cooled to 0 °C and sodium borohydride (2 equivalents, 0.129 g, 3.424 mmol) was added slowly. The reaction mixture was then allowed to reach room temperature and stirred at this temperature for 6 hours. 2M aqueous sodium hydroxide solution (5 mL) was added and the product extracted using EtOAc (3 x 5 mL). The combined organic layers were washed with brine, dried (K<sub>2</sub>CO<sub>3</sub>), and the solvent removed under reduced pressure. The resulting crude intermediate, allyl bromide (1.5 equivalents 0.310 g, 2.568 mmol), and sodium hydrogen carbonate (2 equivalents, 0.288 g, 3.425 mmol) were added to acetone (10 mL) at room temperature, heated to 56 °C (reflux) and left to stir at this temperature overnight. The reaction mixture was allowed to cool to room temperature, washed with water (2 x 5 mL), dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent removed under reduced pressure. The crude product was purified by column chromatography (SiO<sub>2</sub>, Petroleum Ether: Et<sub>2</sub>O 98:2) to give the title compound **29** as a colourless oil (0.380 g, 1.144 mmol, 67% over 2 steps).

**IR:**  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 3013 w (aromatic C-H), 2900 br m (O-H), 2819 w (C-H), 1588 st (aromatic C=C), 1488 st (aromatic C=C), 1472 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 10.53 (1H, br s, OH), 7.58 (1H, dd,  $J$  = 8.0, 1.0 Hz, aryl CH), 7.39 (1H, dd,  $J$  = 7.5, 1.5 Hz, aryl CH), 7.31 (1H, td,  $J$  = 7.4, 1.5 Hz, aryl CH), 7.30-7.13

(2H, m, aryl CH), 6.98 (1H, dd,  $J = 7.5, 1.5$  Hz, aryl CH), 6.81 (1H, dd,  $J = 8.5, 1.0$  Hz, aryl CH), 6.77 (1H, td,  $J = 7.4, 1.3$  Hz, aryl CH), 6.03-5.95 (1H, m, alkene), 5.29-5.20 (2H, m, alkene), 3.79 (4H, apparent d,  $J = 4$  Hz,  $\text{CH}_2\text{N}(\text{CH}_2\text{CH}=\text{CH}_2)\text{CH}_2$ ), 3.20 (2H, d,  $J = 7$  Hz,  $\text{CH}_2\text{N}(\text{CH}_2\text{CH}=\text{CH}_2)\text{CH}_2$ ) ppm.  $^{13}\text{C}$  NMR:  $\delta_{\text{C}}$  (125 MHz,  $\text{CDCl}_3$ ) = 157.5 (C), 136.4 (C), 133.3 (CH), 132.8 (CH), 131.8 (CH), 129.4 (CH), 128.9 (CH), 128.8 (CH), 127.6 (CH), 125.2 (C), 121.6 (C), 120.1 ( $\text{CH}_2$ ), 119.3 (CH), 116.1 (CH), 57.7 ( $\text{CH}_2$ ), 56.4 ( $\text{CH}_2$ ), 56.0 ( $\text{CH}_2$ ) ppm. HRMS (ESI+):  $m/z$  found  $[M+H]^+$  332.0650,  $\text{C}_{17}\text{H}_{19}\text{NO}^{79}\text{Br}^+$  required 332.0650 ( $\Delta = 0.0$  ppm).

### 6-allyl-6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (30)



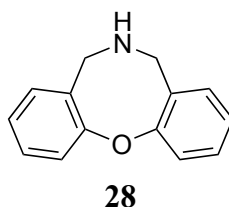
**30**

Prepared by general procedure 2 using 2-((allyl(2-bromobenzyl)amino)methyl)phenol (**29**, 0.290 g). The crude product material was purified by column chromatography ( $\text{SiO}_2$ , Petroleum Ether:  $\text{Et}_2\text{O}$ , 80:20) to give the title compound **30** as a white solid (64%).

**Mp**: 71.8-72.8 °C. **IR**:  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  3056 w (aromatic C-H), 2978 m (aromatic C-H), 2900 st (aromatic C-H), 1642 m (aromatic C=C), 1600 m (aromatic C=C), 1578 m (aromatic C=C), 1481 st (aromatic C=C).  $^1\text{H}$  NMR:  $\delta_{\text{H}}$  (500 MHz, 120 °C,  $d_6$ -DMSO) = 7.35 (2H, d,  $J = 7.5$  Hz, aryl CH), 7.30 (2H, t,  $J = 7.8$  Hz, aryl CH), 7.14 (2H, d,  $J = 7.5$  Hz, aryl CH), 7.08 (2H, t,  $J = 7.3$ , aryl CH), 5.91-5.83 (1H, m, alkene CH), 5.14-5.09 (2H, m, 2 x alkene CH), 3.96 (4H, s,  $\text{CH}_2\text{N}(\text{CH}_2\text{CH}=\text{CH}_2)\text{CH}_2$ ), 2.88 (2H, d,  $J = 5.5$  Hz,  $\text{CH}_2\text{N}(\text{CH}_2\text{CH}=\text{CH}_2)\text{CH}_2$ ) ppm.  $^{13}\text{C}$  NMR:  $\delta_{\text{C}}$  (125 MHz, 120 °C,  $d_6$ -DMSO) = 158.7 (C), 136.7 (CH), 132.5 (CH), 129.8 (C), 129.6 (CH), 124.5 (CH), 121.7 (CH), 116.9 ( $\text{CH}_2$ ), 55.1 ( $\text{CH}_2$ ), 54.8 ( $\text{CH}_2$ ) ppm. HRMS (ESI+):  $m/z$  found  $[M+H]^+$  252.1399,  $\text{C}_{17}\text{H}_{18}\text{NO}^+$  required 252.1388 ( $\Delta = 4.4$  ppm).



**6,7-dihydro-5H-dibenzo[b,g][1,5]oxazocine (28)**



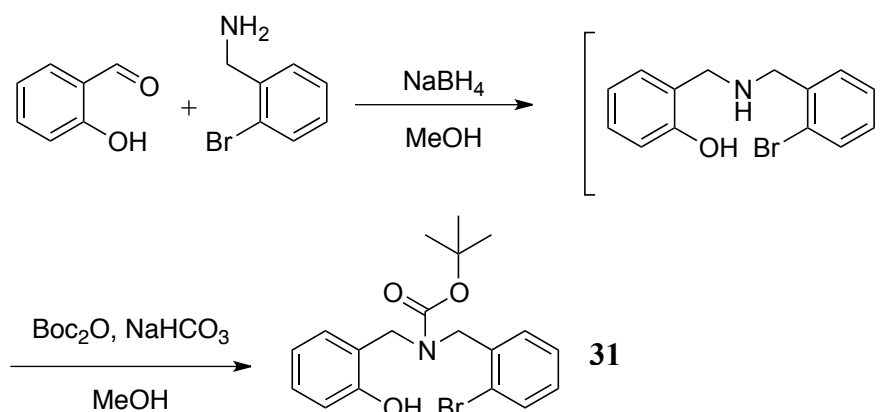
Wilkinson's catalyst (0.05 eq, 0.010 g) was added to a solution of 6-allyl-6,7-dihydro-5H-dibenzo [b,g][1,5]oxazocine (**30**, 1 equivalent, 0.055 g) in CH<sub>3</sub>CN-H<sub>2</sub>O (2.35 ml-0.45 ml). The reaction mixture was purged with nitrogen for 10 min and then stirred at 100 °C for 4 hours. Water (5 ml) was added and the aqueous layer was extracted 3 times with Et<sub>2</sub>O (3 x 5 ml). The combined organic layers were dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent removed under reduce pressure. The residue was purified by chromatographic column (SiO<sub>2</sub>: CH<sub>2</sub>Cl<sub>2</sub>: MeOH, 98:2) to yield the title compound as a white solid (87%).

**Mp:** 121.0-122°C. **IR:**  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 3202 st (N-H), 2992 w (aromatic C-H), 2934 w (aromatic C-H), 2893 w (C-H), 1578 st (aromatic C=C), 1481 st (aromatic C=C), 1448 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 90 °C, *d*<sub>6</sub>-DMSO) = 7.39 (2H, d, *J* = 8.0 Hz, aryl CH), 7.27 (2H, td, *J* = 7.6, 1.7 Hz, aryl CH), 7.16 (2H, dd, *J* = 7.5, 1.5 Hz, aryl CH), 7.08 (2H, td, *J* = 7.5, 1.0 Hz, aryl CH), 3.98 (4H, s, 2 x CH<sub>2</sub>), 2.91 (1H, s, NH, overlaps with residual water in solvent) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, 90 °C, *d*<sub>6</sub>-DMSO) = 158.9 (C), 134.2 (C), 131.2 (CH), 129.2 (CH), 125.0 (CH), 122.2 (CH), 51.5 (CH<sub>2</sub>) ppm.

The synthesis of this compound has previously been reported.<sup>9</sup>

### Route to compound 33

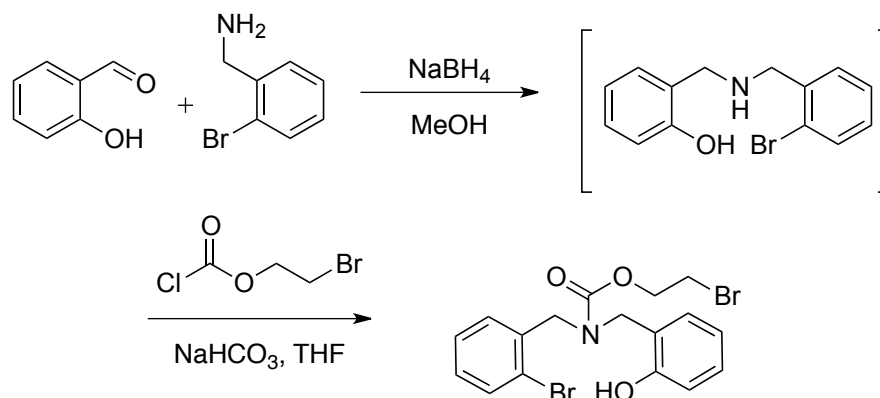
#### *tert*-Butyl 2-bromobenzyl(2-hydroxybenzyl)carbamate (**31**)



Salicylaldehyde (**9**, 1 equivalent, 0.179 mL, 1.712 mmol) and 2-bromobenzylamine) (1 eq, 0.215 mL, 1.712 mmol) were added to a stirring solution of methanol (3 mL) at room temperature, heated to 50 °C and left stirring at this temperature overnight. The reaction was then cooled to 0 °C and sodium borohydride (2 equivalents, 0.129 g, 3.424 mmol,) was added slowly. The reaction mixture was then allowed to reach room temperature and stirred at this temperature for 6 hours. 2M aqueous sodium hydroxide solution (5 mL) was added and the product extracted using EtOAc (3 x 5 mL). The combined organic layers were washed with brine, dried ( $\text{K}_2\text{CO}_3$ ) and the solvent removed under reduced pressure. The crude residue was dissolved in in MeOH (14 mL) sodium hydrogen carbonate (2 equivalents 0.144 g, 1.712 mmol) was added. After stirring for 5 minutes, Boc-anhydride (1 equivalent, 0.373 g, 1.712 mmol) was added and the reaction mixture was stirred at room temperature for 18 hours. The solvent was removed under reduced pressure. The crude product was purified by column chromatography ( $\text{SiO}_2$ , Petroleum Ether:  $\text{Et}_2\text{O}$ , 90:10) to give the title compound **31** as a colourless oil (70 % over two steps). Protection step based on the method of Woods *et al.*<sup>10</sup>

**IR:**  $\nu_{\text{max}}$  (neat)/ $\text{cm}^{-1}$  3134 m (aromatic C-H), 2980 w (aromatic C-H), 2900 br m (O-H), 1655 st (C=O), 1466 m (aromatic C=C), 1456 m (aromatic C=C), 1438 m (aromatic C=C), 1417 m (aromatic C=C).  **$^1\text{H}$  NMR:**  $\delta_{\text{H}}$  (400 MHz,  $\text{CDCl}_3$ ) = 9.32 (1H, br s, OH), 7.57 (1H, dd,  $J = 7.9, 1.0$  Hz, aryl CH), 7.30 (1H, td,  $J = 7.5, 1.1$  Hz, aryl CH), 7.23 (1H, td,  $J = 7.8, 1.5$  Hz, aryl CH), 7.18-7.13 (2H, m, aryl CH), 7.00 (1H, dd,  $J = 7.4, 1.6$  Hz, aryl CH), 6.96 (1H, dd,  $J = 8.2, 0.9$  Hz, aryl CH), 6.77 (1H, td,  $J = 7.4, 1.1$  Hz, aryl CH), 4.51 (2H, s,  $\text{CH}_2$ ), 4.32 (2H, s,  $\text{CH}_2$ ), 1.43 (9H, s,  $(\text{CH}_3)_3$ ) ppm.  **$^{13}\text{C}$  NMR:**  $\delta_{\text{C}}$  (100 MHz,  $\text{CDCl}_3$ ) = 158.1 (C), 156.3 (C), 136.2 (C), 133.0 (CH), 131.5 (CH), 130.2 (CH), 128.8 (CH), 127.7 (CH), 127.7 (CH), 123.0 (C), 122.3 (C), 119.4 (CH), 117.6 (CH), 82.3 (C), 50.2 ( $\underline{\text{CH}_2}$ ), 47.4 ( $\underline{\text{CH}_2}$ ), 28.3 ( $\underline{\text{CH}_3}$ ) ppm. **HRMS** (ESI+):  $m/z$  found  $[M+\text{H}]^+$  392.0866,  $\text{C}_{19}\text{H}_{23}\text{NO}_3^{79}\text{Br}^+$  required 392.0861, ( $\Delta = 1.3$  ppm).

### Synthesis of 2-bromoethyl 2-bromobenzyl(2-hydroxybenzyl)carbamate

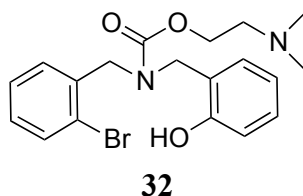


Salicylaldehyde (1 equivalent, 0.213 mL, 2.031 mmol) and 2-bromobenzylamine (1 equivalent, 0.255 mL, 2.031 mmol) were added to a stirring solution of methanol (4 mL) at room temperature. The reaction mixture was heated to 50 °C and stirred at this temperature overnight. The reaction was then cooled to 0 °C and sodium borohydride (2 equivalents, 0.154 g, 4.062 mmol) was added slowly. The reaction mixture was then allowed to reach room temperature and stirred at this temperature for 6 hours. 2M aqueous sodium hydroxide solution (5 mL) was added and the product extracted using EtOAc (3 x 5 mL). The combined organic layers were washed with brine, dried (K<sub>2</sub>CO<sub>3</sub>) and the solvent removed under reduced pressure. To a solution of the crude intermediate in THF (15 mL) at room temperature was added 2-bromoethyl carbonochloridate (1 equivalent, 0.212 mL) and NaHCO<sub>3</sub> (1 eq, 0.171g). The reaction mixture was stirred for 2 hours at room temperature. CH<sub>2</sub>Cl<sub>2</sub> (20 mL) was added and the organic layer was removed and washed with water. The organic layer was dried (Na<sub>2</sub>SO<sub>4</sub>), and the solvent removed under reduced pressure. The crude product was purified by column chromatography (SiO<sub>2</sub>, Pet Ether : Ethyl Ether, 9:1) to give the title compound as a colourless oil (Yield: 92%).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3134 br m (O-H), 2962 w (aromatic C-H), 2852 w (C-H), 1656 st (C=O), 1582 m (aromatic C=C), 1484 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, CDCl<sub>3</sub>) = 8.89 (1H, s, OH), 7.60 (1H, dd,  $J$  = 8.0, 1.0 Hz, aryl CH), 7.32 (1H, td,  $J$  = 8.5, 1.0 Hz, aryl CH), 7.24-7.17 (3H, m, aryl CH), 7.05 (1H, d,  $J$  = 12.0 Hz, aryl CH), 6.96 (1H, d,  $J$  = 8.0 Hz, aryl CH), 6.81 (1H, t,  $J$  = 7 Hz, aryl CH), 4.62 (2H, s, CH<sub>2</sub>NCH<sub>2</sub>), 4.48 (2H, t,  $J$  = 6.0 Hz, OCH<sub>2</sub>), 4.37 (2H, s, CH<sub>2</sub>NCH<sub>2</sub>), 3.49 (2H, t,  $J$  = 6.0 Hz, CH<sub>2</sub>Br) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, CDCl<sub>3</sub>) = 158.1 (C), 156.0 (C), 135.3

(C), 133.1 (CH), 131.6 (CH), 130.4 (CH), 129.2 (CH), 128.1 (CH), 127.8 (CH), 123.1 (C), 121.7 (C), 119.8 (CH), 117.7 (CH), 66.0 (CH<sub>2</sub>), 50.0 (CH<sub>2</sub>), 47.6 (CH<sub>2</sub>), 28.8 (CH<sub>2</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found  $[M+H]^+$  441.9667, C<sub>17</sub>H<sub>18</sub>NO<sub>3</sub><sup>79</sup>Br<sub>2</sub><sup>+</sup> required 441.9653 ( $\Delta$  = 3.2 ppm).

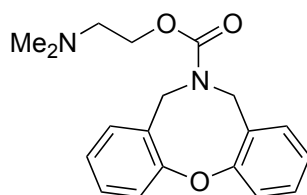
**2-(dimethylamino)ethyl 2-bromobenzyl(2-hydroxybenzyl)carbamate (32)**



2-bromoethyl 2-bromobenzyl(2-hydroxybenzyl)carbamate (1 equivalent, 1.309 mmol) and NaHCO<sub>3</sub> (1 equivalent, 1.309 mmol) were added to diethyl amine (14 mL, 2M solution in THF) at room temperature. The reaction mixture was heated to 60°C and stirred at this temperature for 6 hours. The reaction mixture was allowed to cool to room temperature and EtOAc (10 mL) was added. The organic layer was washed with water and brine. The organic layer was dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent removed under pressure. The crude product was purified by column chromatography (SiO<sub>2</sub>, CH<sub>2</sub>Cl<sub>2</sub> : MeOH, 98:2) to give the title compound **32** as a colourless oil (Yield 75%).

**IR:**  $\nu_{\max}$  (neat)/cm<sup>-1</sup> 3134 br m (O-H), 2951 w (aromatic C-H), 2822 m (C-H), 1698 s (C=O), 1597 m (aromatic C=C), 1456 s (aromatic C=C), 1232 s (C-N). **<sup>1</sup>H NMR:**  $\delta_H$  (400 MHz, CDCl<sub>3</sub>) = 9.12 (1H, br, OH), 7.57 (1H, d, *J* = 7.9 Hz, aryl CH), 7.29 (1H, td, *J* = 8.0, 1.0 Hz, aryl CH), 7.20-7.13 (3H, m, aryl CH), 6.98 (2H, dd, *J* = 8.0, 3.2 Hz, aryl CH), 6.79 (1H, t, *J* = 6.8 Hz, aryl CH), 4.57 (2H, s, CH<sub>2</sub>), 4.36 (2H, s, CH<sub>2</sub>), 4.27 (2H, t, *J* = 5.8 Hz, CH<sub>2</sub>), 2.53 (2H, s, CH<sub>2</sub>), 2.20 (6H, s, 2 x CH<sub>3</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_C$  (100 MHz, CDCl<sub>3</sub>) = 158.7 (C), 156.1 (C), 135.7 (C), 133.0 (CH), 131.6 (CH), 130.3 (CH), 129.0 (CH), 127.9 (CH), 127.8 (CH), 123.0 (C), 122.0 (C), 119.2 (CH), 117.7 (CH), 64.8 (CH<sub>2</sub>), 57.8 (CH<sub>2</sub>), 50.0 (CH<sub>2</sub>), 47.6 (CH<sub>2</sub>), 45.6 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found  $[M+H]^+$  407.0988, C<sub>19</sub>H<sub>24</sub>N<sub>2</sub>O<sub>3</sub><sup>79</sup>Br<sup>+</sup> required 407.0970 ( $\Delta$  = 4.4 ppm).

**2-(dimethylamino)ethyl 5H-dibenzo[b,g][1,5]oxazocine-6(7H)-carboxylate (33)**



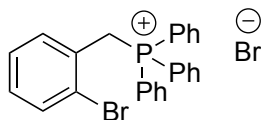
**33**

Prepared by general procedure 2 using 2-(dimethylamino)ethyl 2-bromobenzyl(2-hydroxybenzyl)carbamate (**32**, 0.236 g). The crude product material was purified by column chromatography (SiO<sub>2</sub>, CH<sub>2</sub>Cl<sub>2</sub>: MeOH, 95:5) to give the title compound as a colourless oil (43%).

**IR:**  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 3061 w (aromatic C-H), 2943 m (aromatic C-H), 2818 m (C-H), 1698 st (C=O), 1603 (aromatic C=C), 1579 m (aromatic C=C), 1483 st (aromatic C=C), 1451 st (aromatic C=C), 1227 st (C-N). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (500 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 7.49 (2H, d, *J* = 8.0 Hz, aryl CH), 7.33-7.29 (4H, m, aryl CH), 7.13 (2H, td, *J* = 7.3, 1.0 Hz, aryl CH), 4.62 (4H, s, 2 x CH<sub>2</sub>), 4.00 (2H, t, *J* = 1.0 Hz, CH<sub>2</sub>), 2.48 (2H, t, *J* = 1.0 Hz, CH<sub>2</sub>), 2.19 (6H, s, N(CH<sub>3</sub>)<sub>2</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, 120 °C, *d*<sub>6</sub>-DMSO) = 158.8 (C), 155.4 (C), 132.5 (C), 131.6 (CH), 129.7 (CH), 125.1 (CH), 122.9 (CH), 63.3 (CH<sub>2</sub>), 58.1 (CH<sub>2</sub>), 50.9 (CH<sub>2</sub>), 45.4 (CH<sub>3</sub>) ppm. **HRMS** (ESI<sup>+</sup>): *m/z* found [*M*+H]<sup>+</sup> 327.1709, C<sub>19</sub>H<sub>23</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> required 327.1709 ( $\Delta$  = 0.0 ppm).

## Route towards an acyclic precursor with all-carbon chain (no 'templating' nitrogen)

### (2-bromobenzyl)triphenylphosphonium bromide

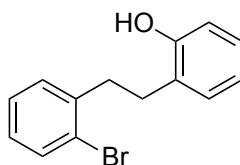


Based on the procedure of Wyatt *et al.*<sup>11</sup> 2-Bromo-benzylbromide (1 equivalents, 8.0 mmol) was dissolved in anhydrous DMF (4.5 mL). PPh<sub>3</sub> (1.1 equivalents, 8.8 mmol) was added to the solution and the reaction vigorously stirred at room temperature overnight. The mixture was poured in toluene (10 mL) and the suspension filtered. The solid product was dissolved in CH<sub>2</sub>Cl<sub>2</sub> (7.5 mL) and re-precipitated by addition of Et<sub>2</sub>O (10 mL). The precipitate was isolated by vacuum filtration to yield the phosphonium salt **17** as a fine white powder (Yield: 92%).

**IR:**  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 3049 m (aromatic C-H), 2840 m (C-H), 2770 m (C-H), 1586 m (aromatic C=C), 1436 st (aromatic C=C). **<sup>1</sup>H NMR:**  $\delta_{\text{H}}$  (400 MHz, CDCl<sub>3</sub>) = 7.80-7.78 (3H, m, aryl CH), 7.70-7.60 (12H, m, aryl CH), 7.56-7.53 (1H, m, aryl CH), 7.35 (1H, d,  $J$  = 8 Hz, aryl CH), 7.20-7.17 (1H, m, aryl CH), 7.12 (1H, tt,  $J$  = 7.8, 2.0 Hz, aryl CH), 5.64 (2H, d,  $J$  = 14.0 Hz, CH<sub>2</sub>) ppm. **<sup>13</sup>C NMR:**  $\delta_{\text{C}}$  (125 MHz, CDCl<sub>3</sub>) = 135.14 (CH), 135.12 (CH), 134.4 (CH), 134.3 (CH), 133.32 (CH), 133.28 (CH), 132.93 (CH), 132.90 (CH), 130.3 (CH), 130.24 (CH), 130.21 (CH), 130.2 (CH), 128.54 (CH), 128.51 (CH), 127.73 (C), 127.7 (C), 127.22 (C), 127.2 (C), 117.8 (C), 117.1 (C), 31.1 (CH<sub>2</sub>), 30.7 (CH<sub>2</sub>) ppm. **<sup>31</sup>P NMR:**  $\delta_{\text{P}}$  (500 MHz, CDCl<sub>3</sub>) = 23.31 ppm.

This data is consistent with that previously reported.<sup>12</sup>

## 2-(2-bromophenethyl)phenol



Based on the method of Colabufo *et al.*<sup>13</sup> A solution of DBU (1.03 equivalents, 7.7 mmol), 2-hydroxybenzaldehyde (1 equivalent, 7.45 mmol) and (2-bromobenzyl)triphenylphosphonium bromide (1 eq, 7.45 mmol) in CH<sub>3</sub>CN (12mL) was stirred for 12 hours at reflux. The solvent was removed under reduce pressure and the residue was diluted with CHCl<sub>3</sub> and washed with water, 1N HCl and brine. The organic layer was dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent removed under reduced pressure to afford a mixture *cis/trans*-stilbene derivatives as a yellow oil. This crude mixture was dissolved in EtOH (60 mL) and 10% Pd/C (0.225 g) was added. This suspension was stirred under an atmosphere of hydrogen gas (approximately 1 atmosphere) for 12 hours. The reaction mixture was filtered and the solvent removed under reduced pressure. The residual material was purified by column chromatography (SiO<sub>2</sub>: Petroleum Ether : Et<sub>2</sub>O 50:50) to afford the title compound as light yellow solid. (Yield over 2 steps: 43%). **Mp**: 79.0-80.6 °C. **IR**:  $\nu_{\text{max}}$  (neat)/cm<sup>-1</sup> 3031 m (aromatic C-H), 2922 m (aromatic C-H), 2900 br m (O-H), 2857 m (C-H), 1591 st (aromatic C=C), 1500 st (aromatic C=C), 1453 st (aromatic C=C). **<sup>1</sup>H NMR**:  $\delta_{\text{H}}$  (400 MHz, CDCl<sub>3</sub>) = 7.34-7.31 (2H, m, aryl CH), 7.25-7.21 (2H, m, aryl CH), 7.14-7.10 (2H, m, aryl CH), 6.89 (1H, td,  $J$  = 6.0, 0.8 Hz, aryl CH), 6.76 (1H, dd,  $J$  = 7.0, 1.0Hz, aryl CH), 4.55 (1H, s, OH), 2.95 (4H, s, 2 x CH<sub>2</sub>) ppm. **<sup>13</sup>C NMR**:  $\delta_{\text{C}}$  (100 MHz, CDCl<sub>3</sub>) = 153.6 (C), 142.0 (C), 130.3 (CH), 128.5 (CH), 128.4 (CH), 127.8 (C), 127.3 (CH), 126.0 (CH), 120.9 (CH), 115.4 (CH), 36.2 (CH<sub>2</sub>), 32.3 (CH<sub>2</sub>) ppm. **HRMS** (ESI<sup>+</sup>):  $m/z$  found [M+Na]<sup>+</sup> 299.1471, C<sub>14</sub>H<sub>13</sub><sup>79</sup>BrONa<sup>+</sup> required 299.1471; found: ( $\Delta$  = -2.0 ppm).



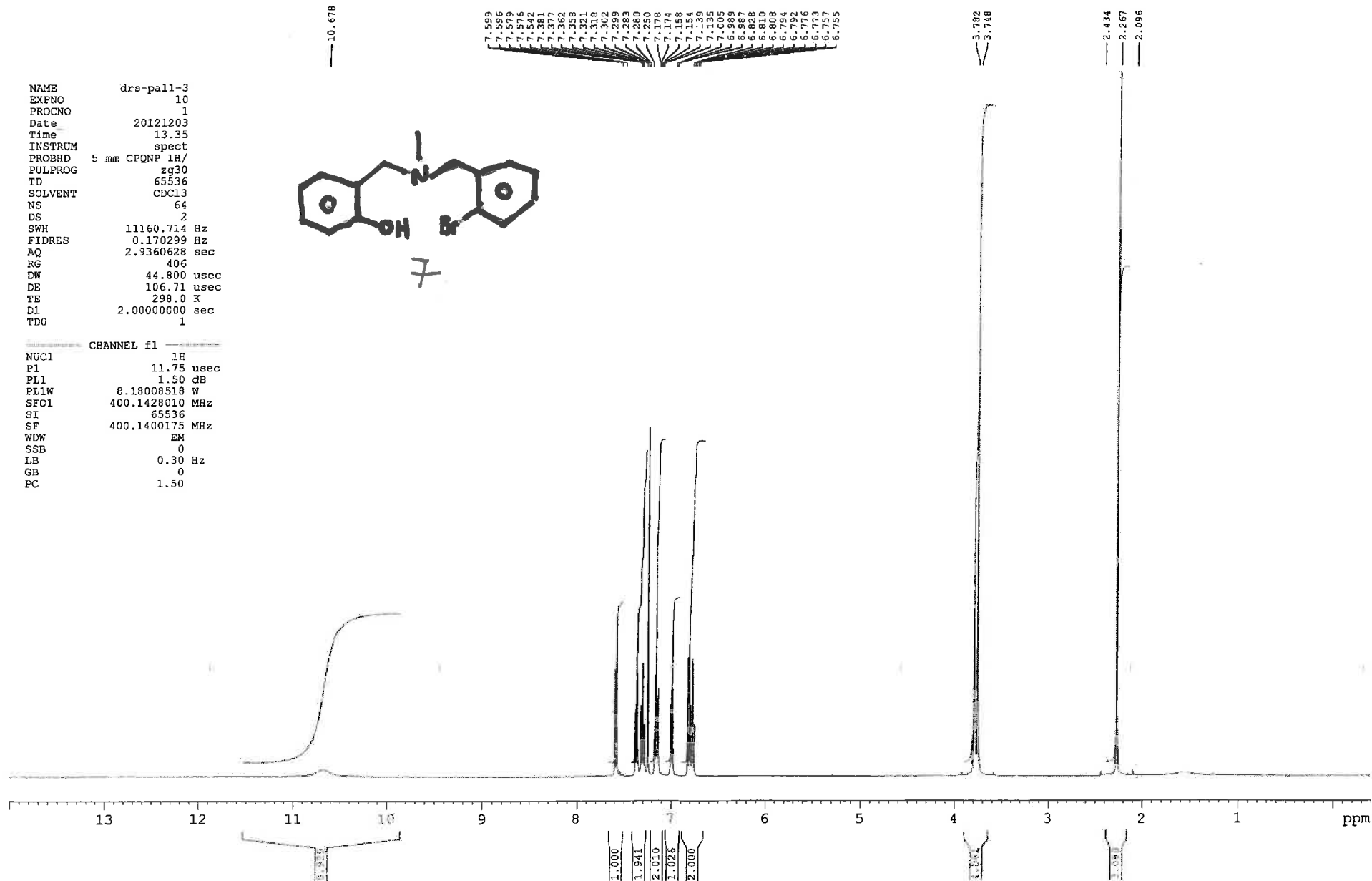
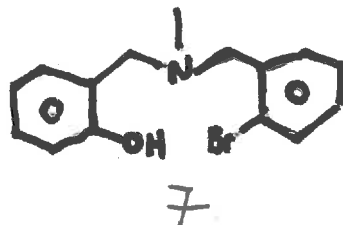
## References

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## NMR spectra

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NS 64  
DS 2  
SWH 11160.714 Hz  
FIDRES 0.170299 Hz  
AQ 2.9360628 sec  
RG 406  
DW 44.800 usec  
DE 106.71 usec  
TE 298.0 K  
D1 2.00000000 sec  
TD0 1

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SFO1 400.1428010 MHz  
SI 65536  
SF 400.1400175 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50



Compound 7

NAME drs-pall-3  
EXPNO 6011  
PROCNO 1  
Date\_ 20121203  
Time 14.14  
INSTRUM spect  
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PULPROG zgpg30  
TD 65384  
SOLVENT CDC13  
NS 640  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TD0 1

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SFO1 100.6263497 MHz

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PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
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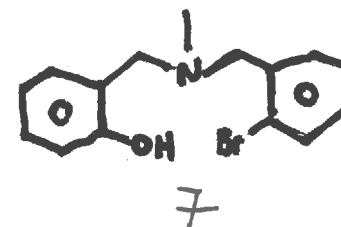
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131.689  
129.464  
128.929  
128.733  
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125.263  
121.689  
119.216  
116.171

77.349  
77.236  
77.032  
76.714

61.445  
60.547

41.153



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Compound 7

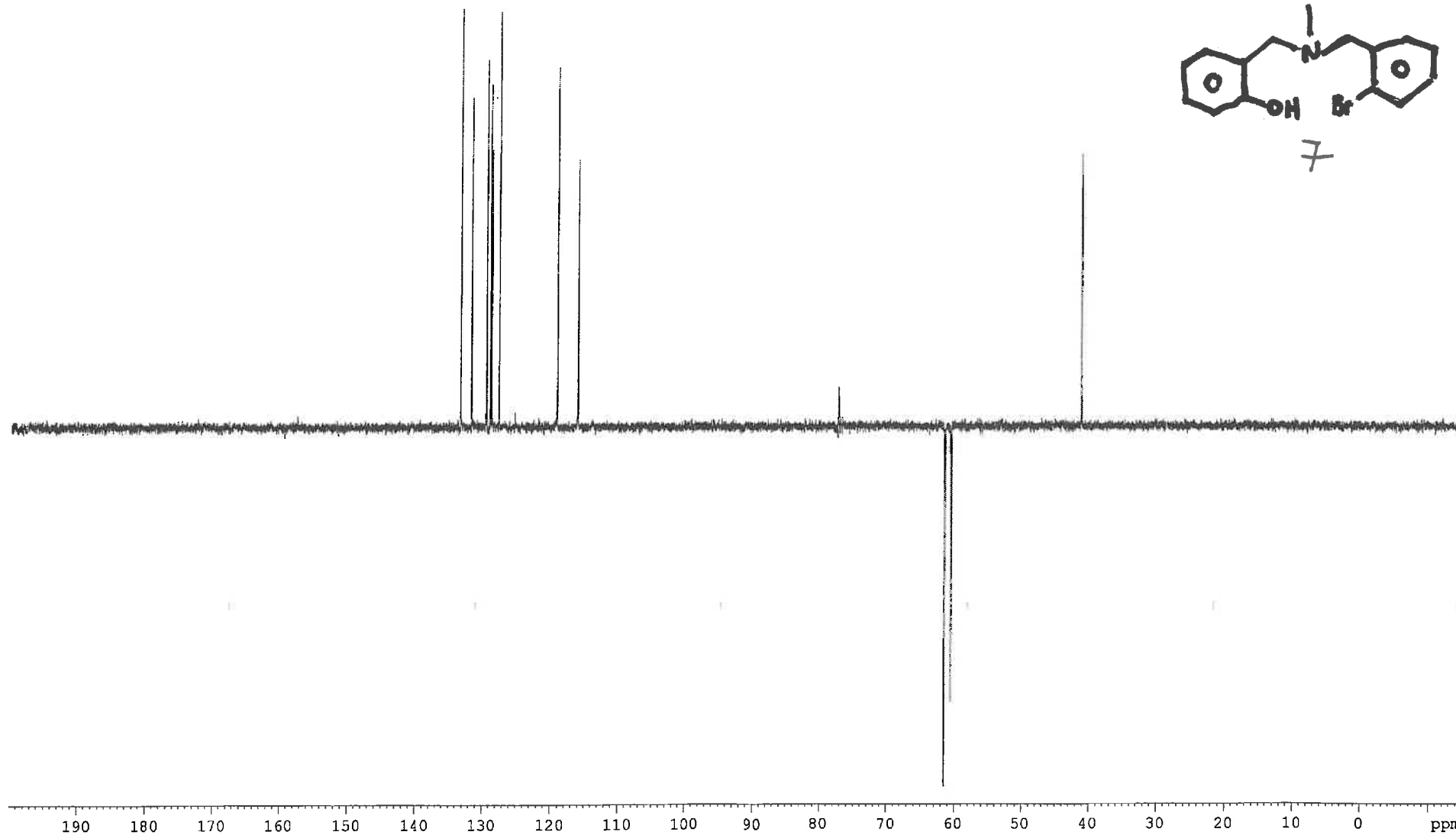
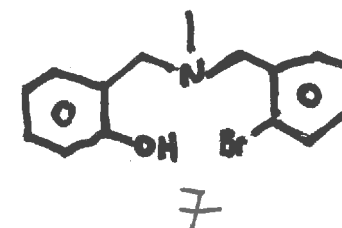
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77.215

61.423  
60.527

41.132



Compound 7

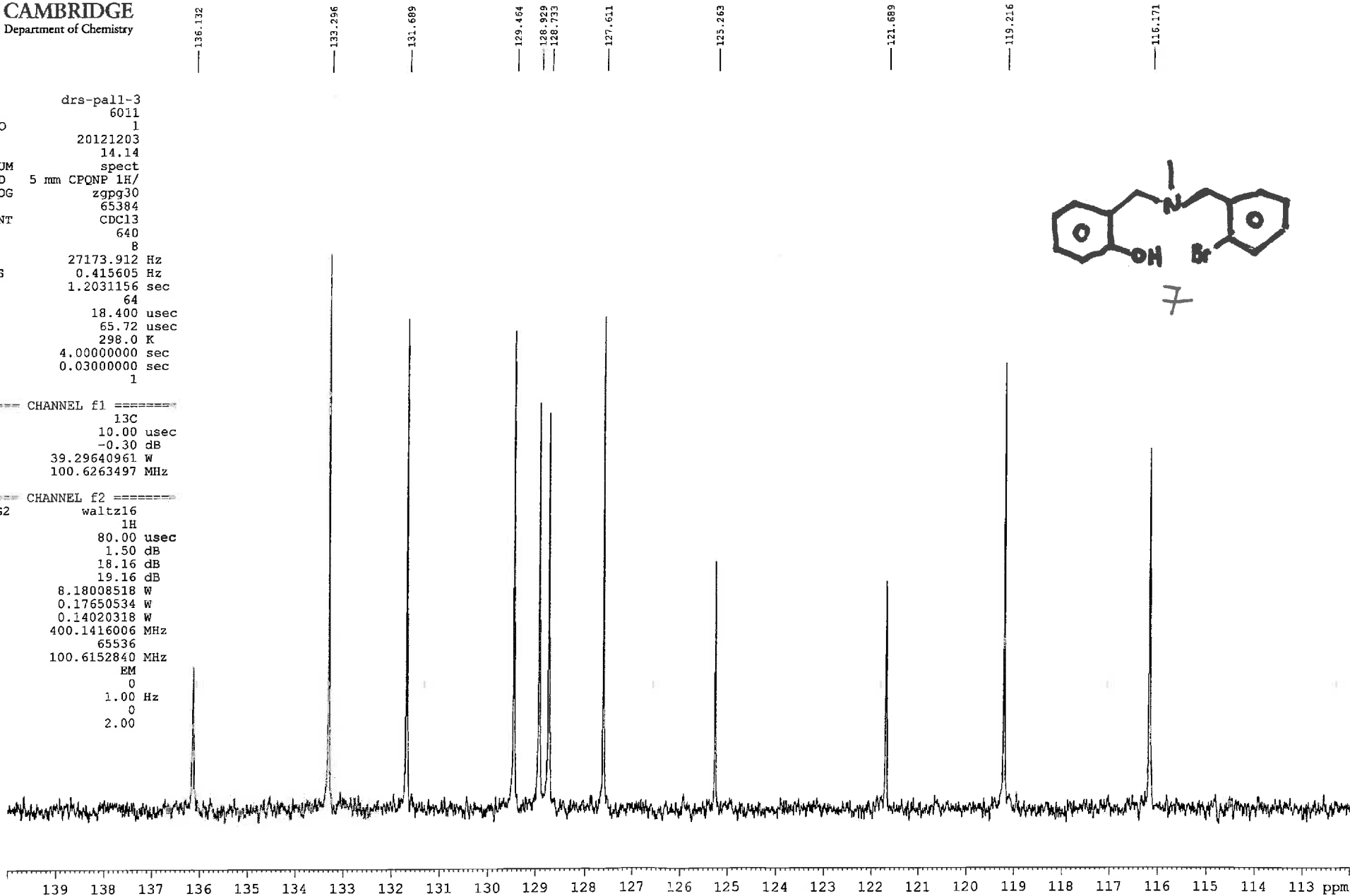
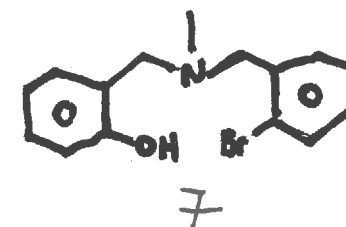


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Data has been converted to analogue. Backwards predicted 16 points to remove cryoprobe baseline roll.

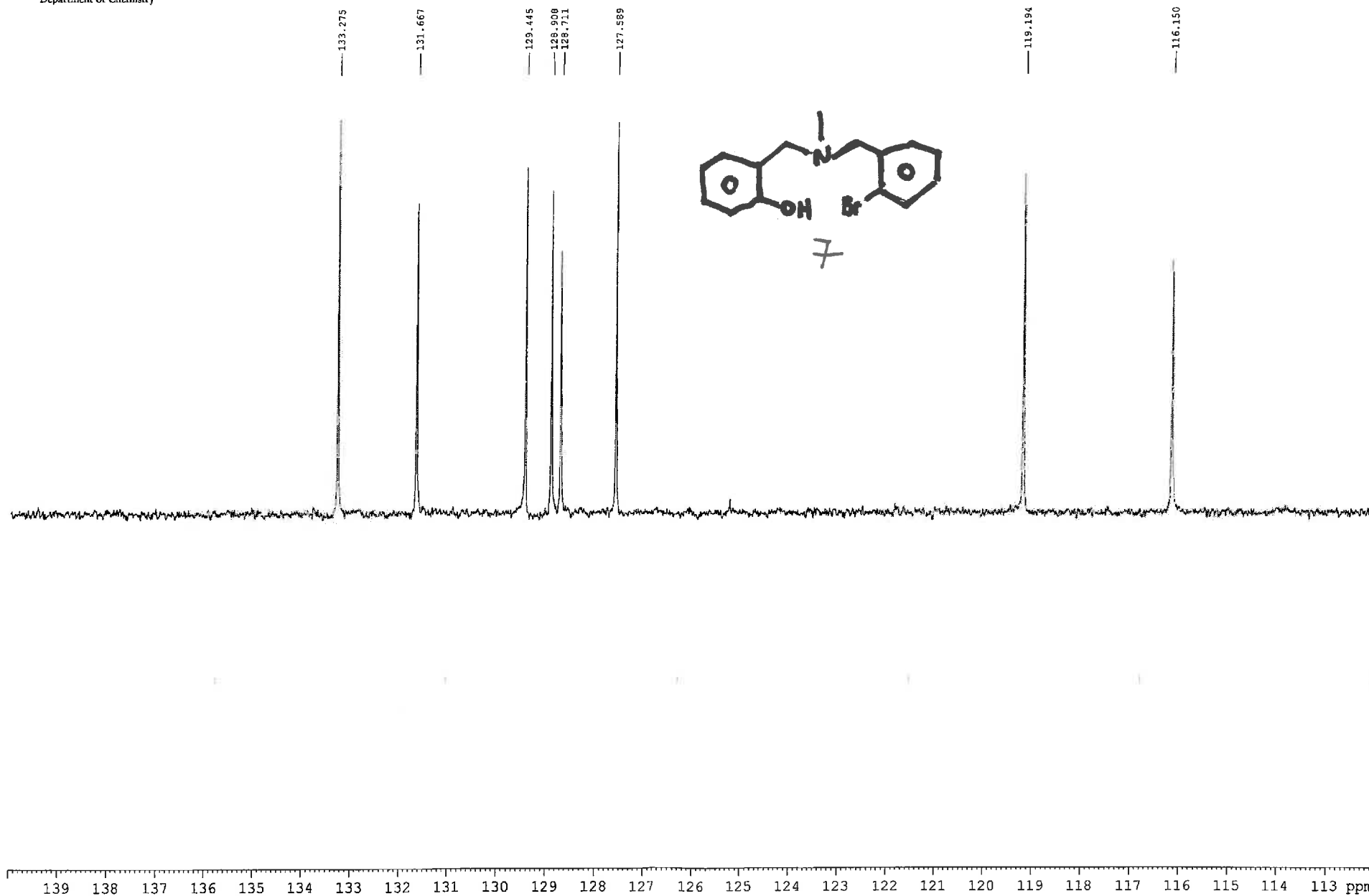
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Date\_ 20121203  
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PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 640  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TDO 1

===== CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
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PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
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WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00



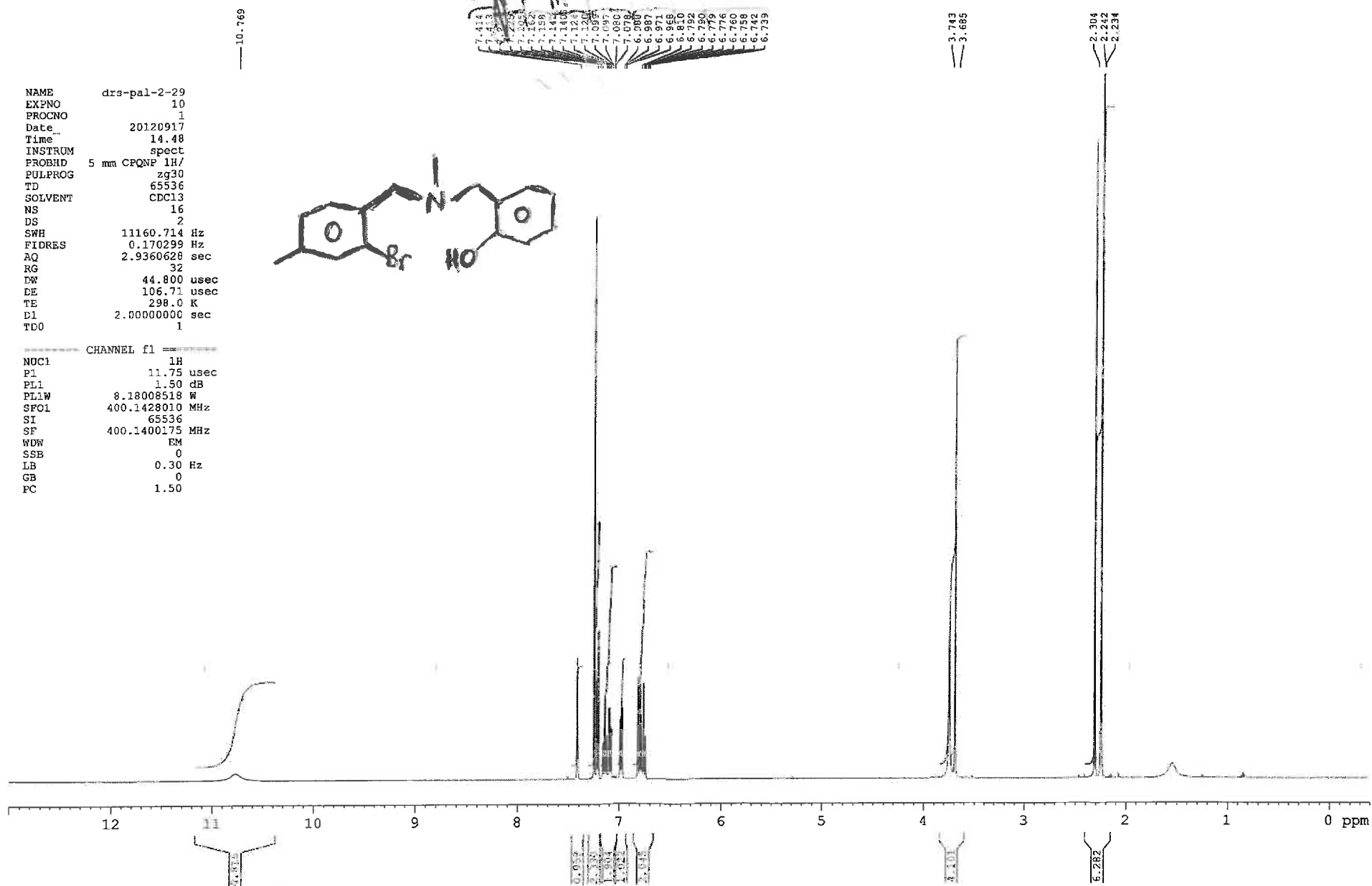
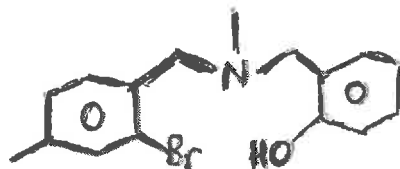
Compound 7



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PC                  1.50

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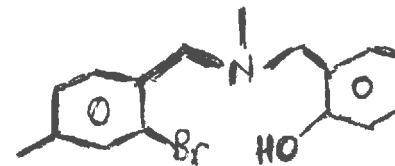
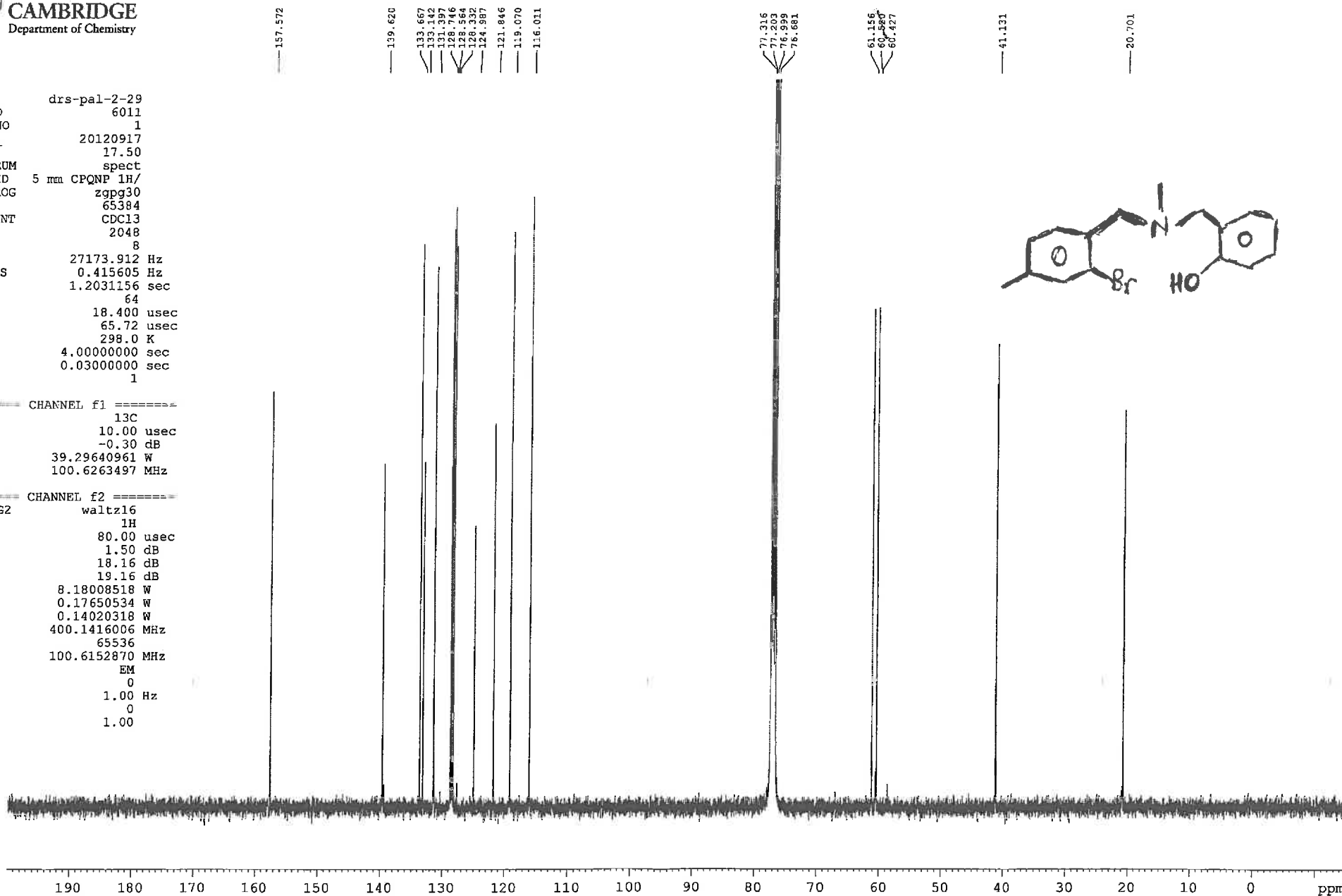


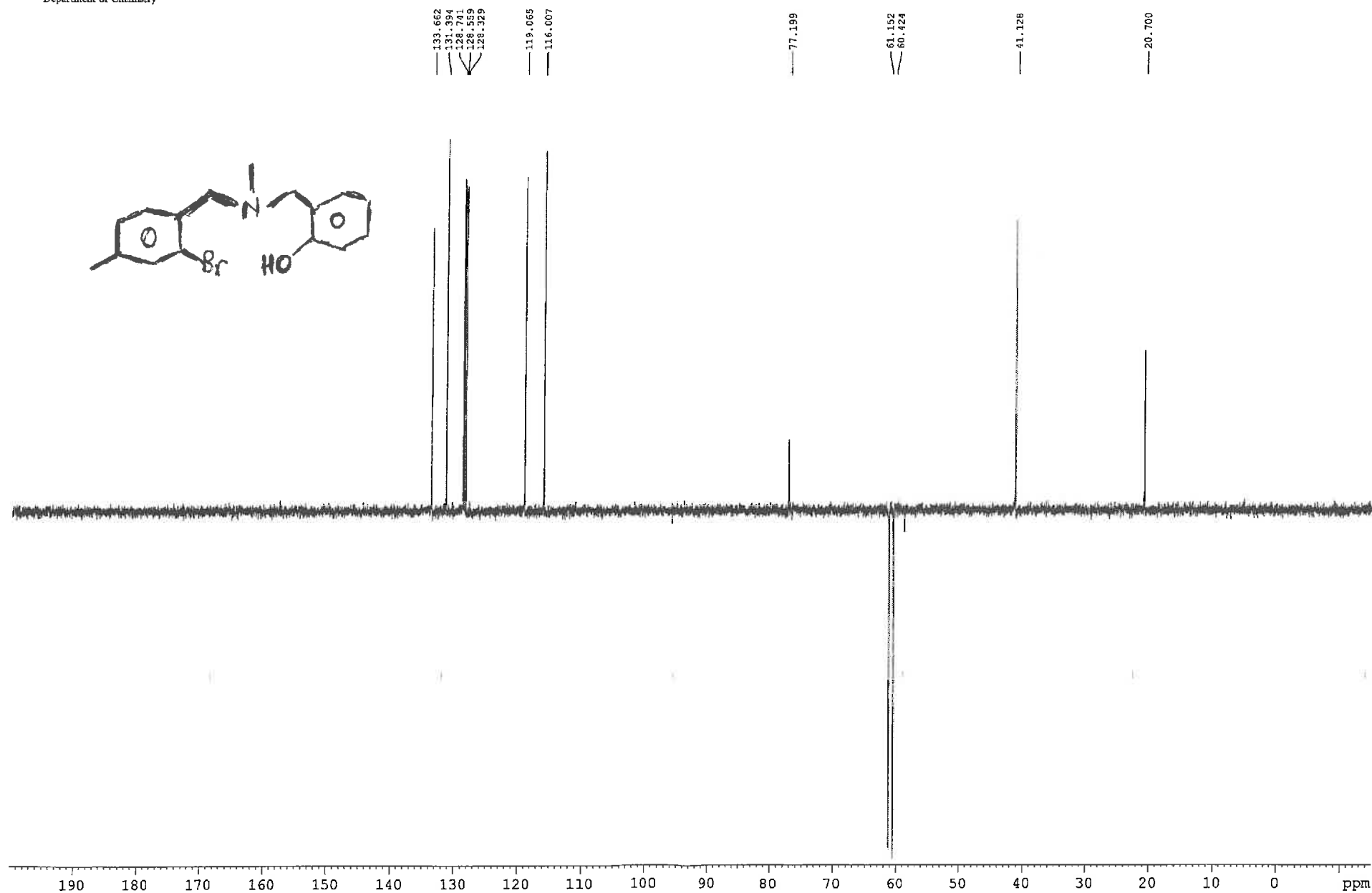
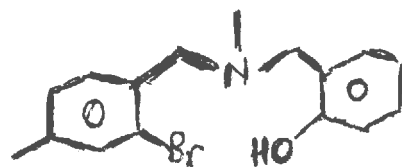


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SOLVENT CDCl3  
NS 2048  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

===== CHANNEL f2 =====  
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NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
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PC 1.00

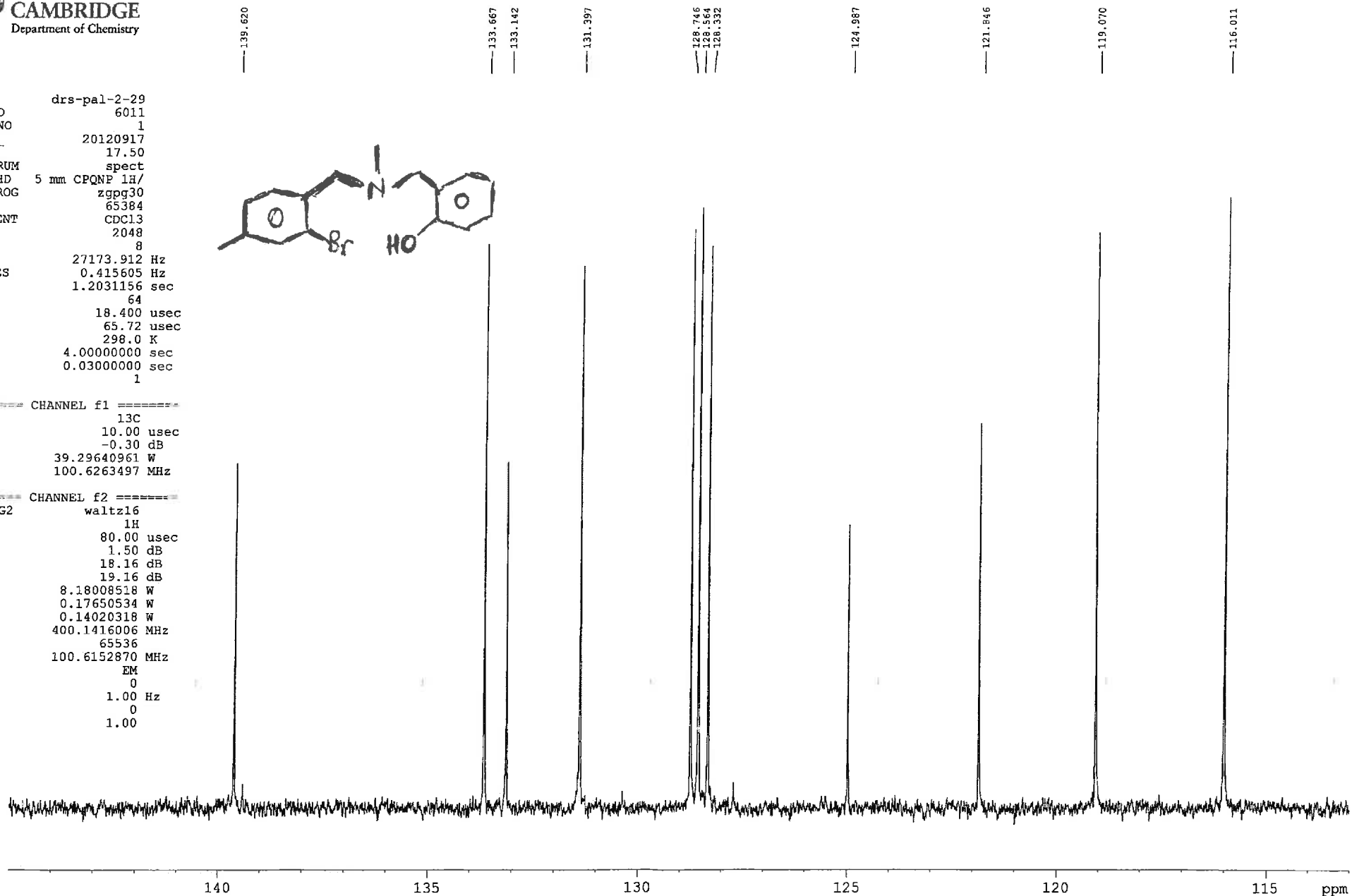
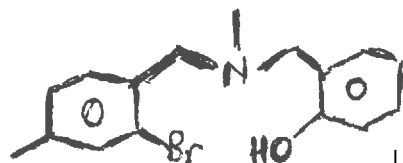


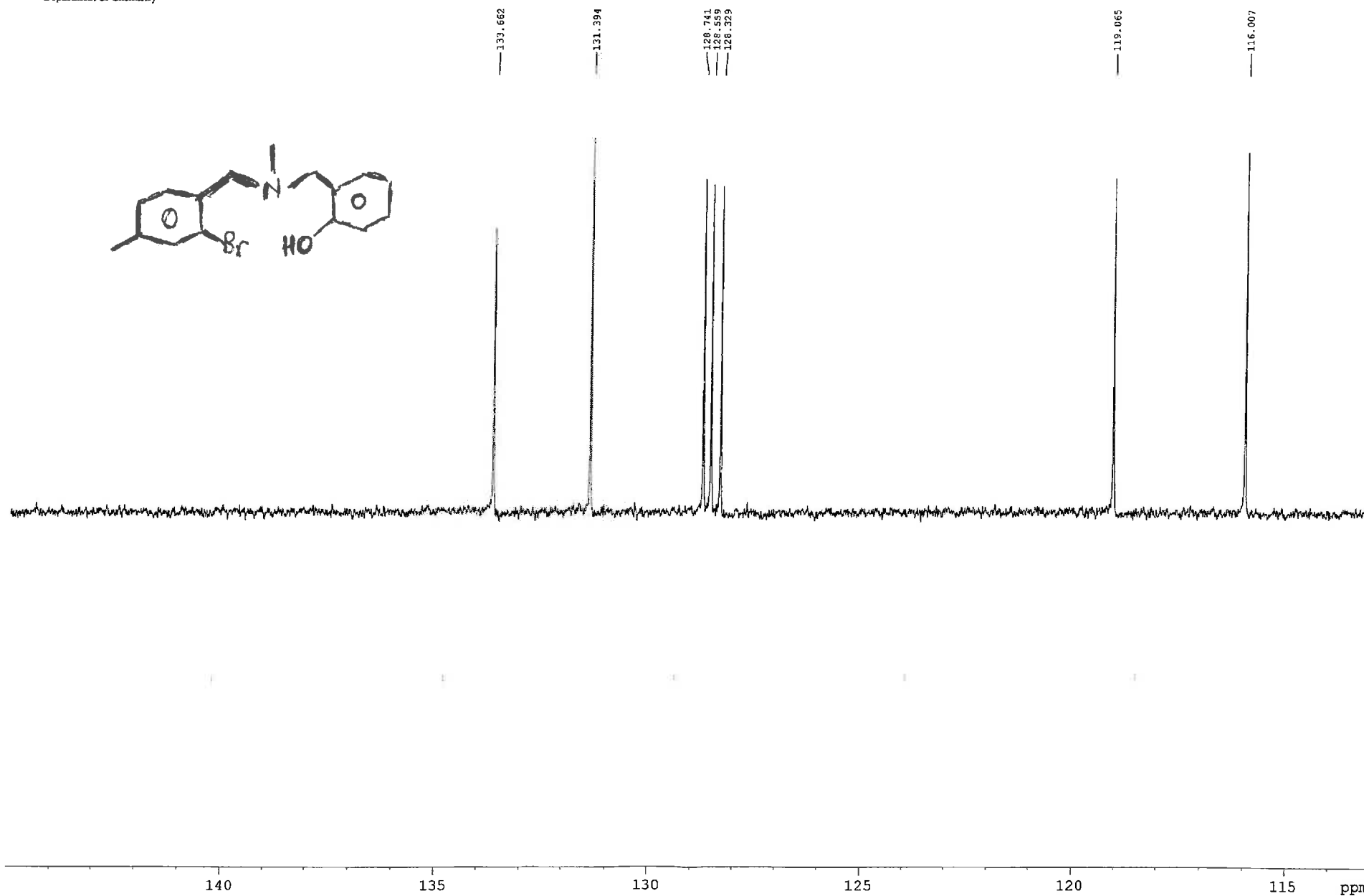
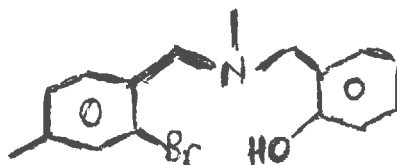


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TD 65384  
SOLVENT CDCl3  
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AQ 1.2031156 sec  
RG 64  
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DE 65.72 usec  
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D11 0.03000000 sec  
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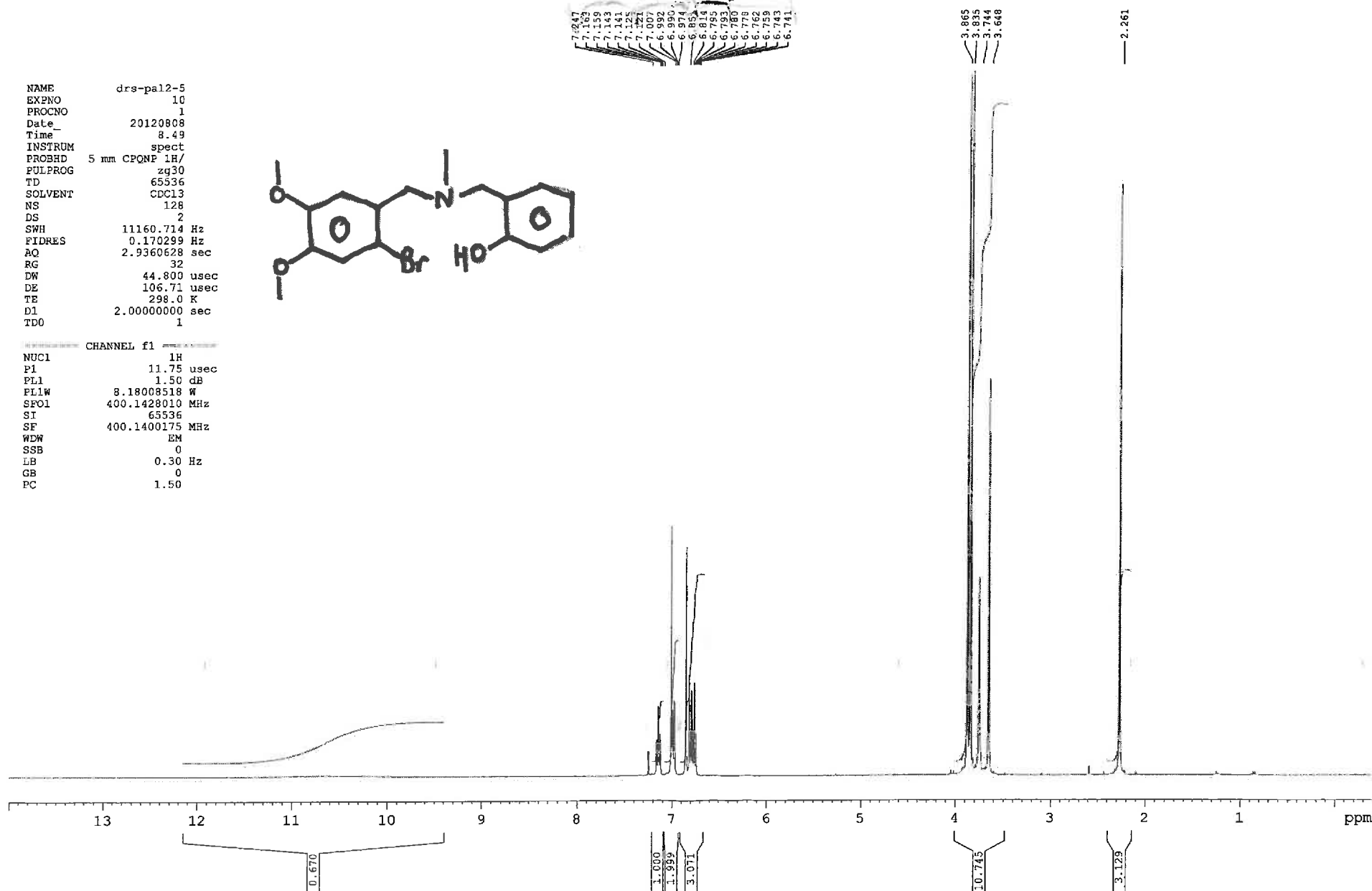
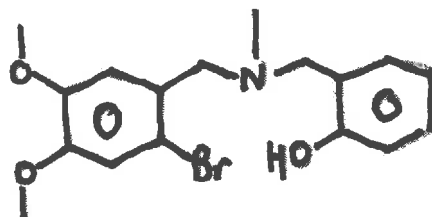
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PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6152870 MHz  
WDW EM  
SSB 0  
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PC 1.00





NAME drs-pal2-5  
EXPNO 10  
PROCNO 1  
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AQ 2.9360628 sec  
RG 32  
DW 44.800 usec  
DE 106.71 usec  
TE 298.0 K  
D1 2.00000000 sec  
TDO 1

CHANNEL f1  
NUC1 1H  
P1 11.75 usec  
PL1 1.50 dB  
PL1W 8.18008518 W  
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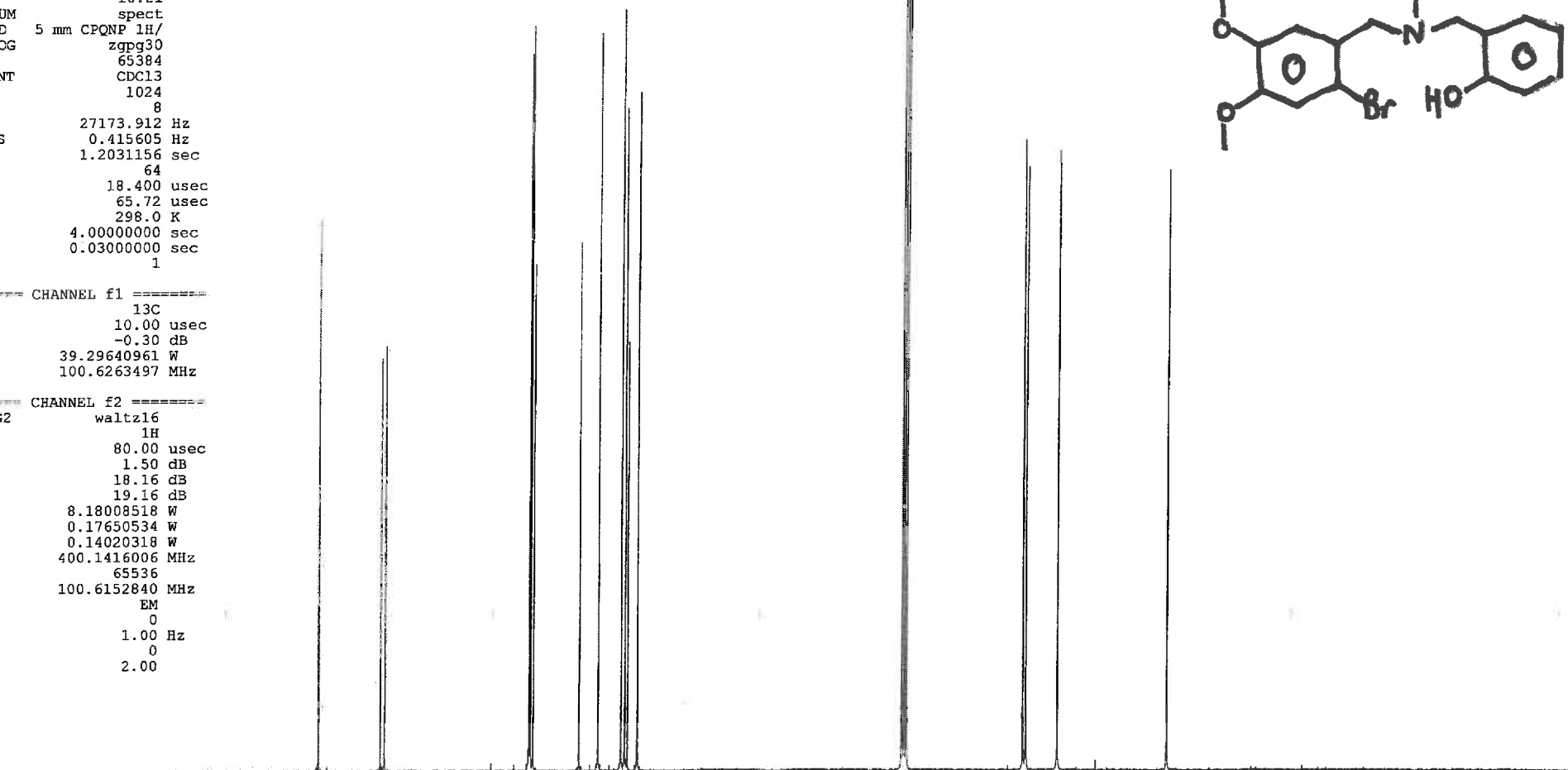
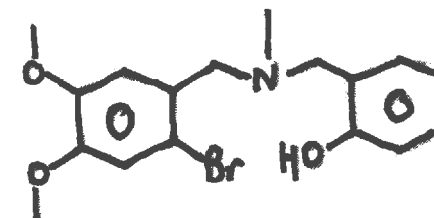


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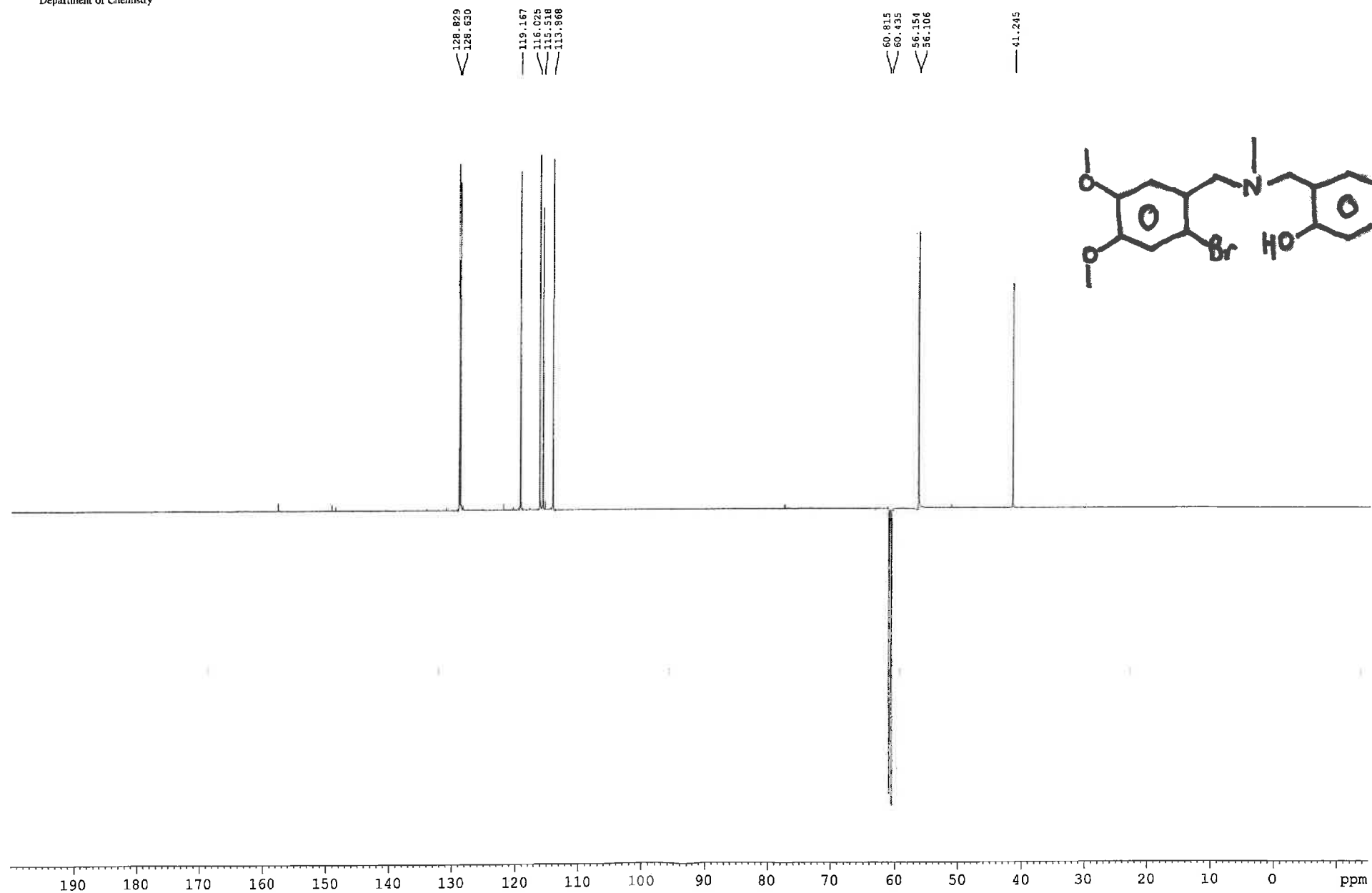
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SFO1 100.6263497 MHz

===== CHANNEL f2 =====  
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NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6152840 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00

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148.525  
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41.267



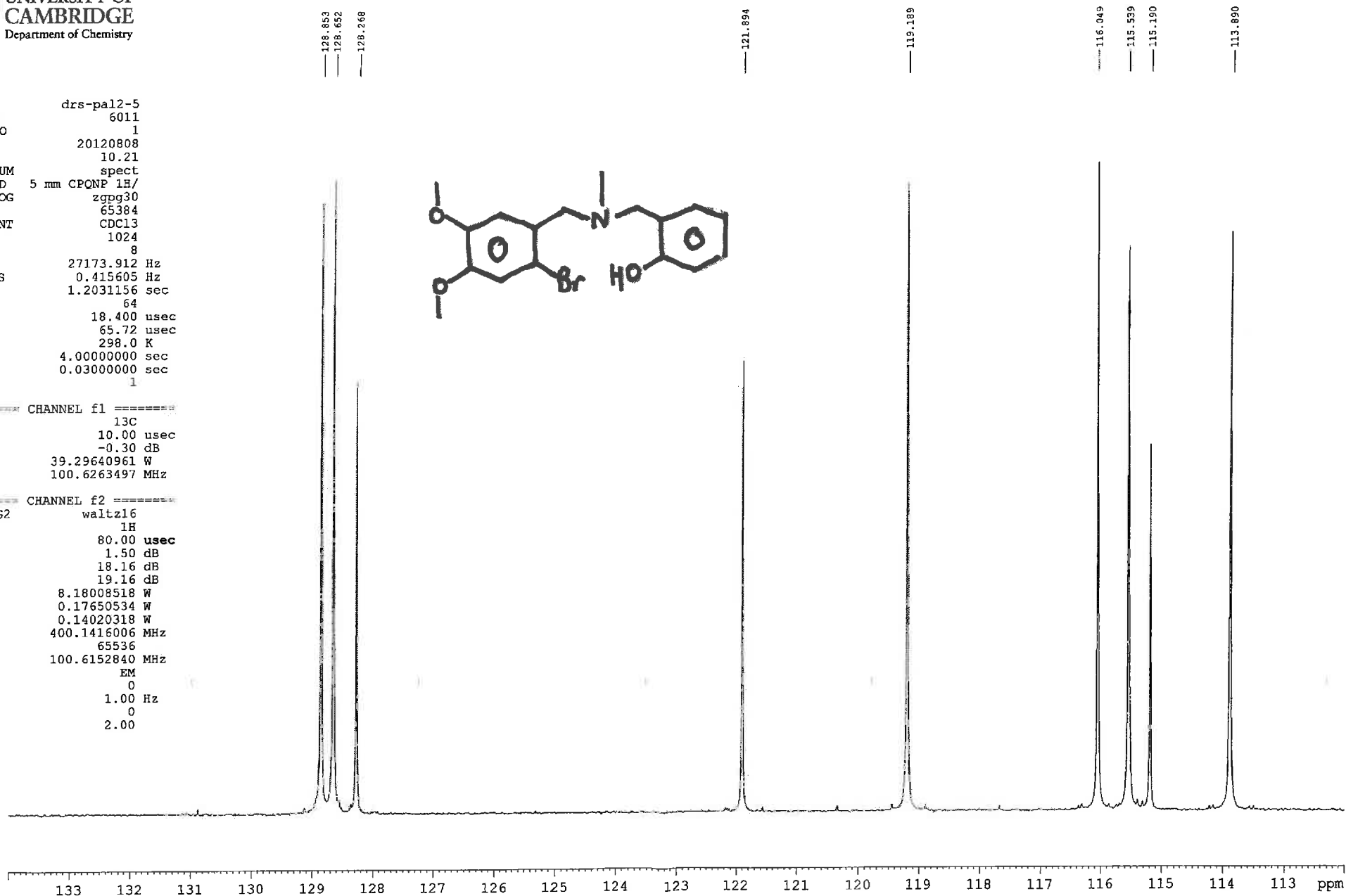
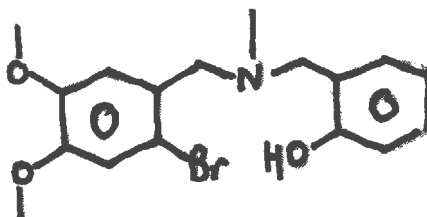
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PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 1024  
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FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
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DW 18.400 usec  
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TE 298.0 K  
D1 4.00000000 sec  
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TD0 1

CHANNEL f1 =====  
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PL1 -0.30 dB  
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PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
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SF 100.6152840 MHz  
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SSB 0  
LB 1.00 Hz  
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PC 2.00







NAME drs-pal2-5  
EXPNO 6011  
PROCNO 1  
Date\_ 20120808  
Time\_ 10.21  
INSTRUM spect  
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PULPROG zgpg30  
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SOLVENT CDCl3  
NS 1024  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
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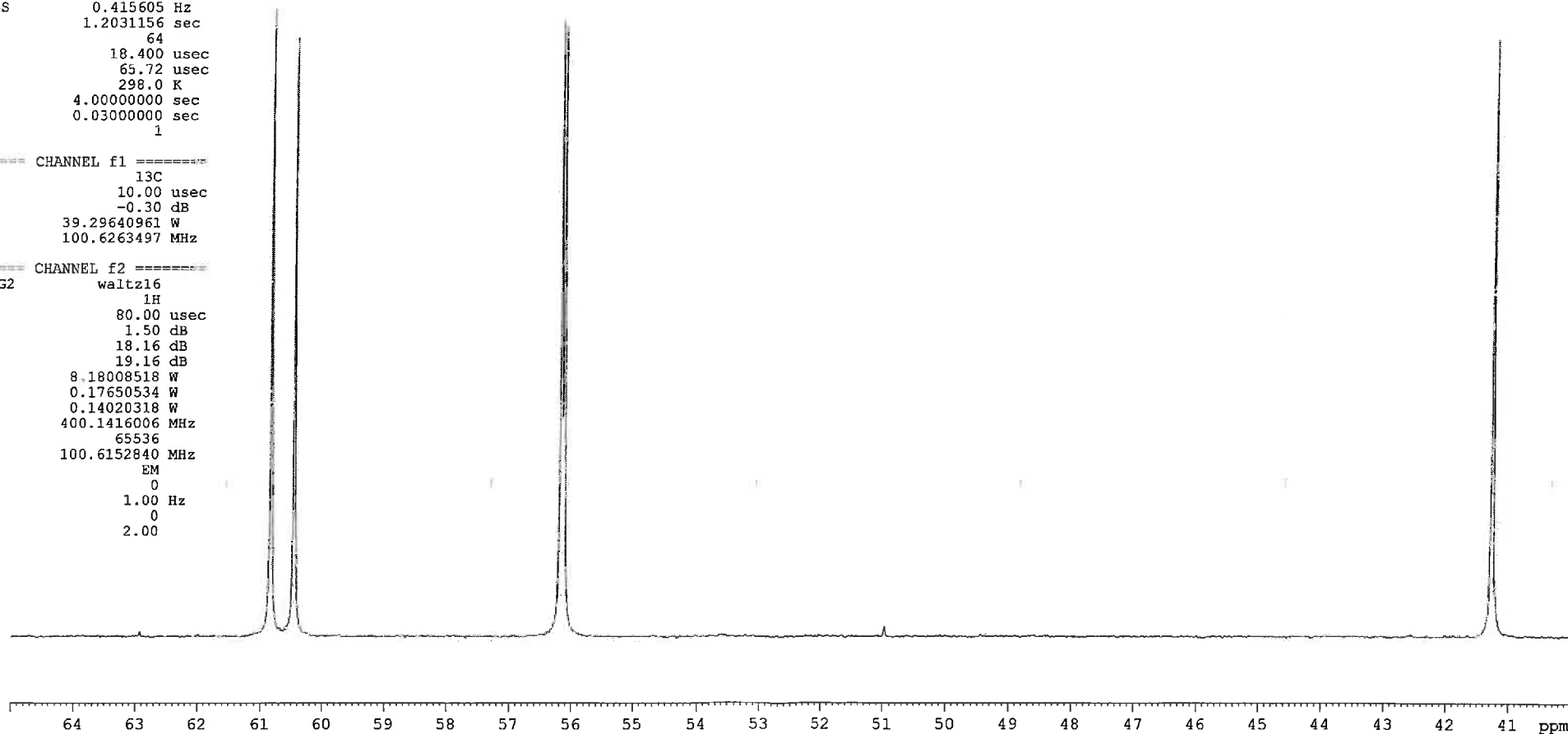
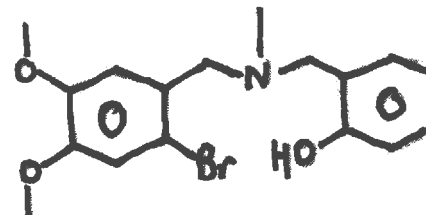
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NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
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60.459

56.178  
56.129

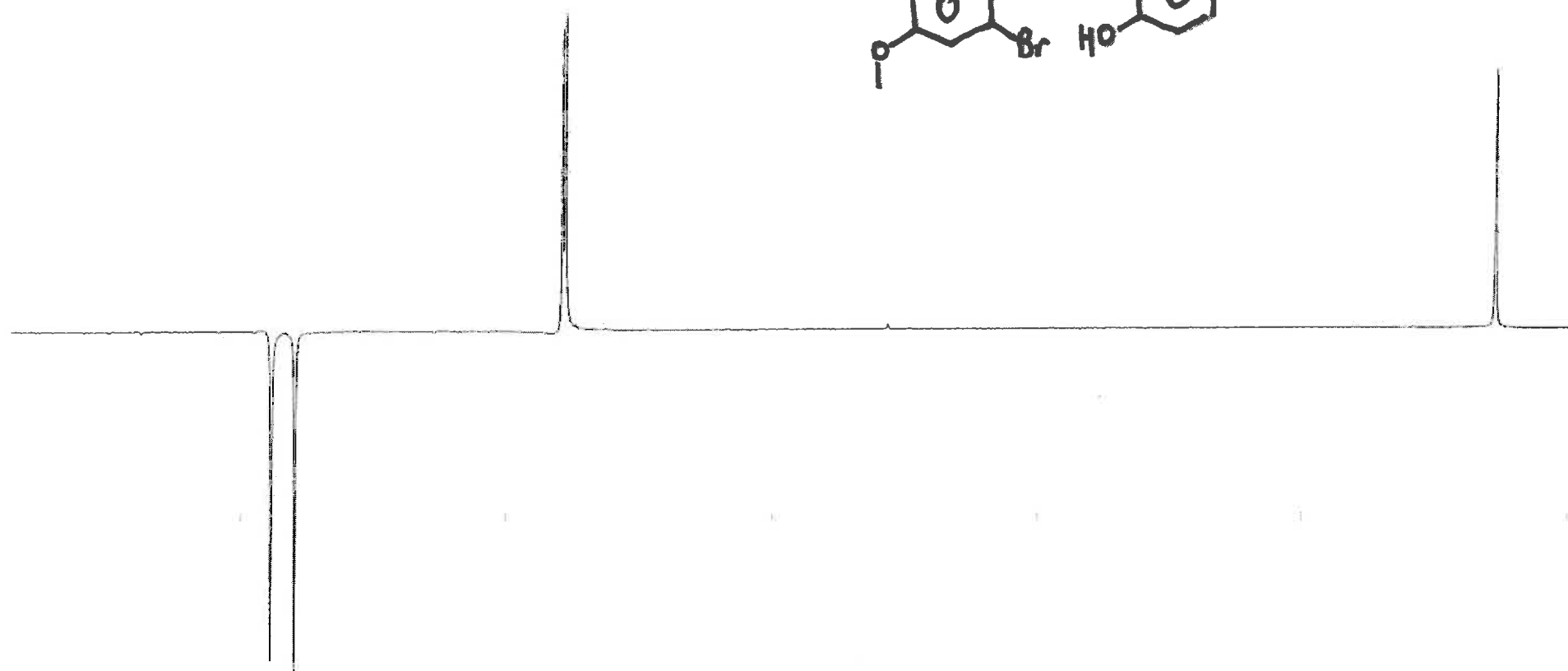
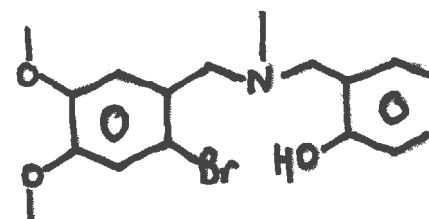
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41.245



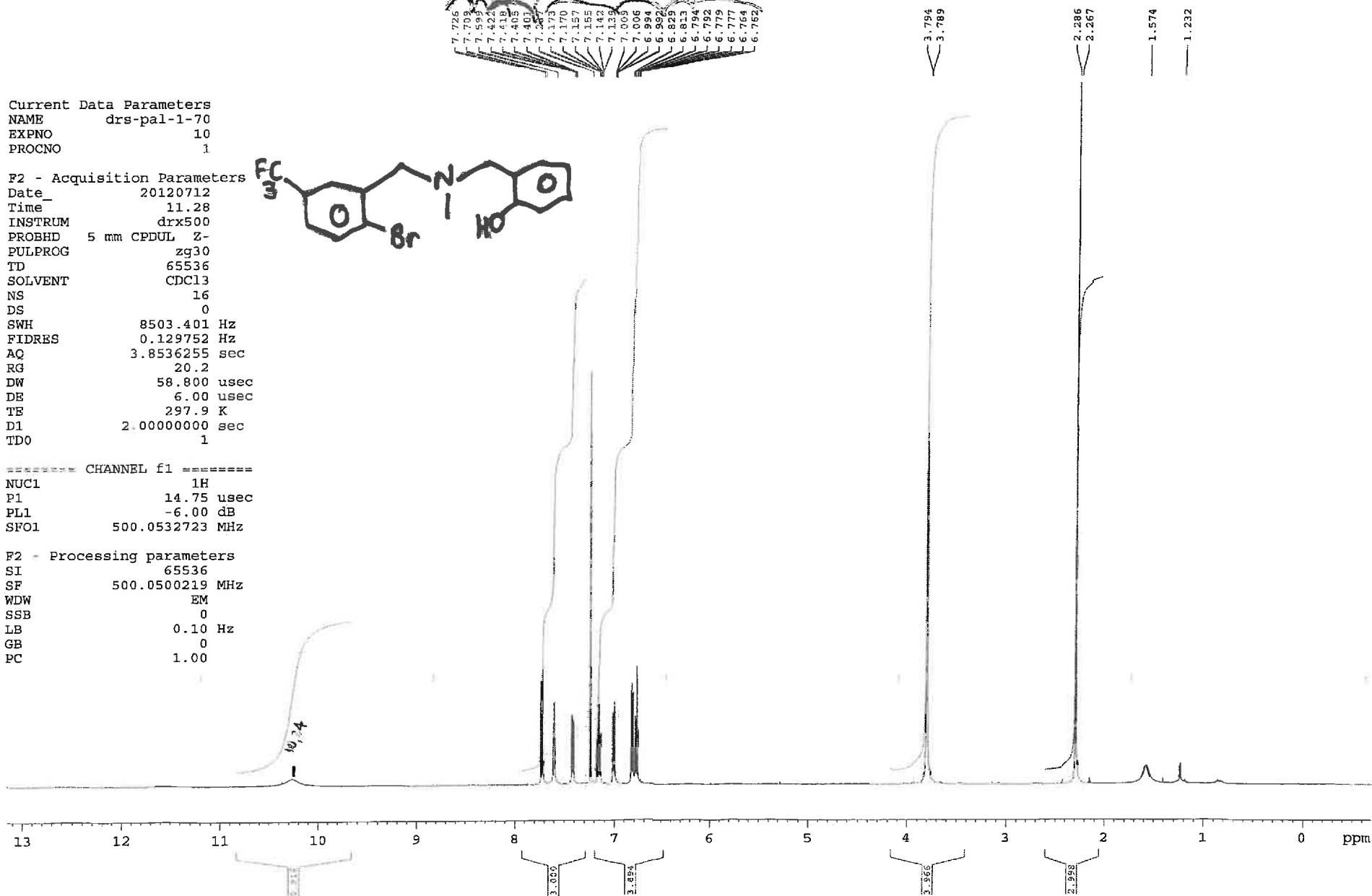
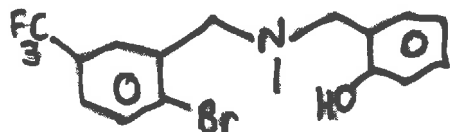
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 DS 0  
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 FIDRES 0.129752 Hz  
 AQ 3.8536255 sec  
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 DE 6.00 usec  
 TE 297.9 K  
 D1 2.00000000 sec  
 TD0 1

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 PL1 -6.00 dB  
 SFO1 500.0532723 MHz

F2 - Processing parameters  
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 WDW EM  
 SSB 0  
 LB 0.10 Hz  
 GB 0  
 PC 1.00



500 MHz Cryoprobe 'Aberlour'

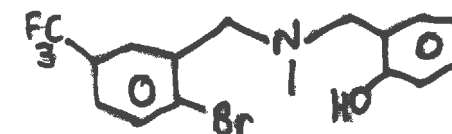
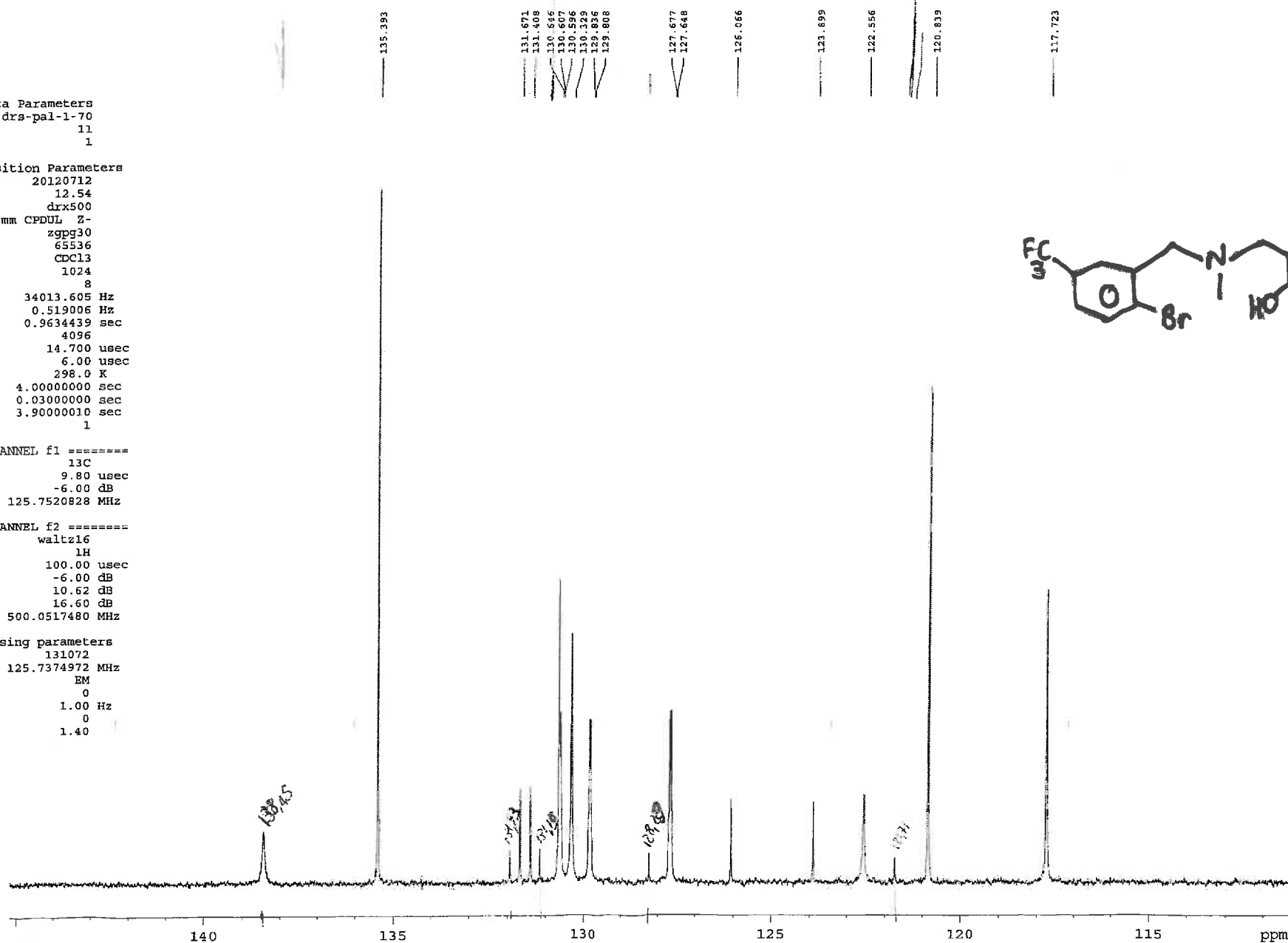
Current Data Parameters  
NAME drs-pal-1-70  
EXPNO 11  
PROCNO 1

F2 - Acquisition Parameters  
Date 20120712  
Time 12.54  
INSTRUM drx500  
PROBHD 5 mm CPDUL Z-  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 1024  
DS 8  
SWH 34013.605 Hz  
FIDRES 0.519006 Hz  
AQ 0.9634439 sec  
RG 4096  
DW 14.700 usec  
DE 6.00 usec  
TE 298.0 K  
D1 4.00000000 sec  
d11 0.03000000 sec  
DELTA 3.90000010 sec  
TDO 1

===== CHANNEL f1 =====  
NUC1 13C  
P1 9.80 usec  
PL1 -6.00 dB  
SFO1 125.7520828 MHz

===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 100.00 usec  
PL2 -6.00 dB  
PL12 10.62 dB  
PL13 16.60 dB  
SFO2 500.0517480 MHz

F2 - Processing parameters  
SI 131072  
SF 125.7374972 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 1.40





Current Data Parameters  
 NAME drs-pal-1-70  
 EXPNO 11  
 PROCNO 1

## F2 - Acquisition Parameters

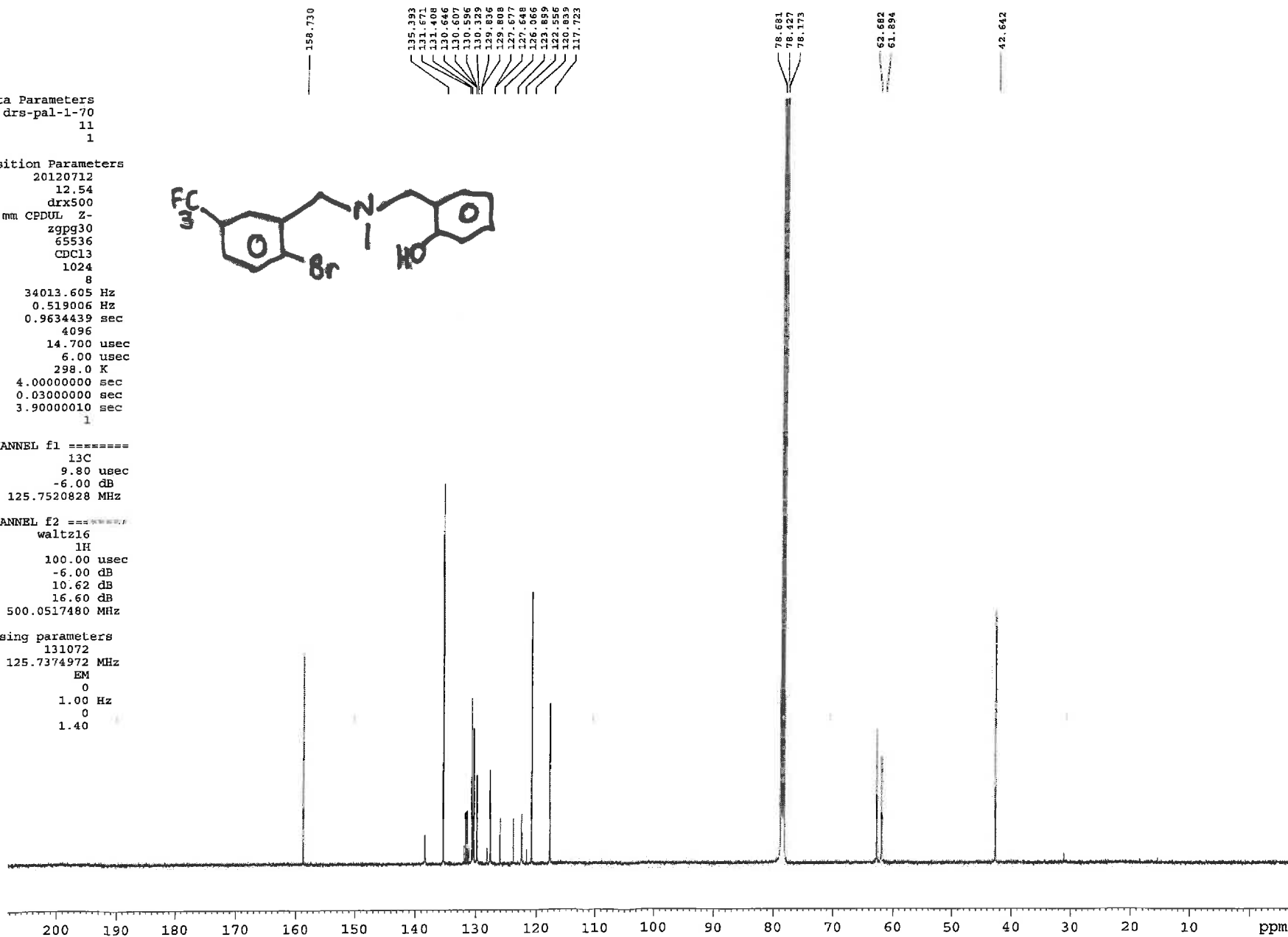
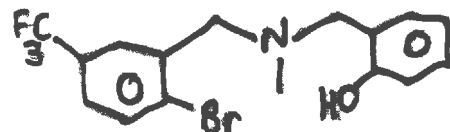
Date 20120712  
 Time 12.54  
 INSTRUM drx500  
 PROBHD 5 mm CPDUL Z-  
 PULPROG zgpg30  
 TD 65536  
 SOLVENT CDCl3  
 NS 1024  
 DS 8  
 SWH 34013.605 Hz  
 FIDRES 0.519006 Hz  
 AQ 0.9634439 sec  
 RG 4096  
 DW 14.700 usec  
 DE 6.00 usec  
 TE 298.0 K  
 D1 4.00000000 sec  
 d11 0.03000000 sec  
 DELTA 3.90000010 sec  
 TDO 1

===== CHANNEL f1 =====  
 NUC1 13C  
 P1 9.80 usec  
 PL1 -6.00 dB  
 SFO1 125.7520828 MHz

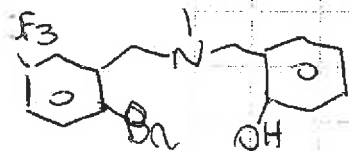
===== CHANNEL f2 =====  
 CPDPRG2 waltz16  
 NUC2 1H  
 PCPD2 100.00 usec  
 PL2 -6.00 dB  
 PL12 10.62 dB  
 PL13 16.60 dB  
 SFO2 500.0517480 MHz

## F2 - Processing parameters

SI 131072  
 SF 125.7374972 MHz  
 WDW EM  
 SSB 0  
 LB 1.00 Hz  
 GB 0  
 PC 1.40

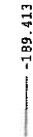
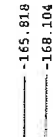
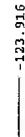
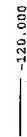
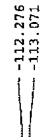
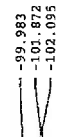
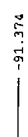
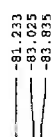
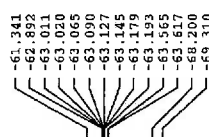


drs-pal-1-70





V214943  
DRS/PAL1-70FLUORO  
paola  
19FCPD



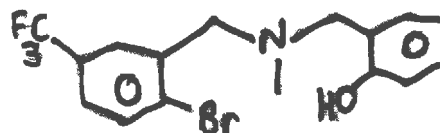
Current Data Parameters  
NAME V214943  
EXPNO 10  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120713  
Time 12.17  
INSTRUM dpx400  
PROBHD 5 mm QNP 1H/1  
PULPROG zgpg30  
TD 131072  
SOLVENT CDCl3  
NS 32  
DS 4  
SWH 75187.969 Hz  
FIDRES 0.573639 Hz  
AQ 0.8716788 sec  
RG 1024  
DW 6.650 usec  
DE 6.00 usec  
TE 300.2 K  
D1 1.00000000 sec  
d11 0.03000000 sec  
d12 0.00002000 sec  
TD0 1

\*\*\*\*\* CHANNEL f1 \*\*\*\*\*  
NUC1 19F  
P1 14.80 usec  
PL1 -3.00 dB  
SFO1 376.4533542 MHz

\*\*\*\*\* CHANNEL f2 \*\*\*\*\*  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 100.00 usec  
PL2 0.00 dB  
PL12 20.00 dB  
SFO2 400.1316005 MHz

F2 - Processing parameters  
SI 65536  
SF 376.4985340 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.00



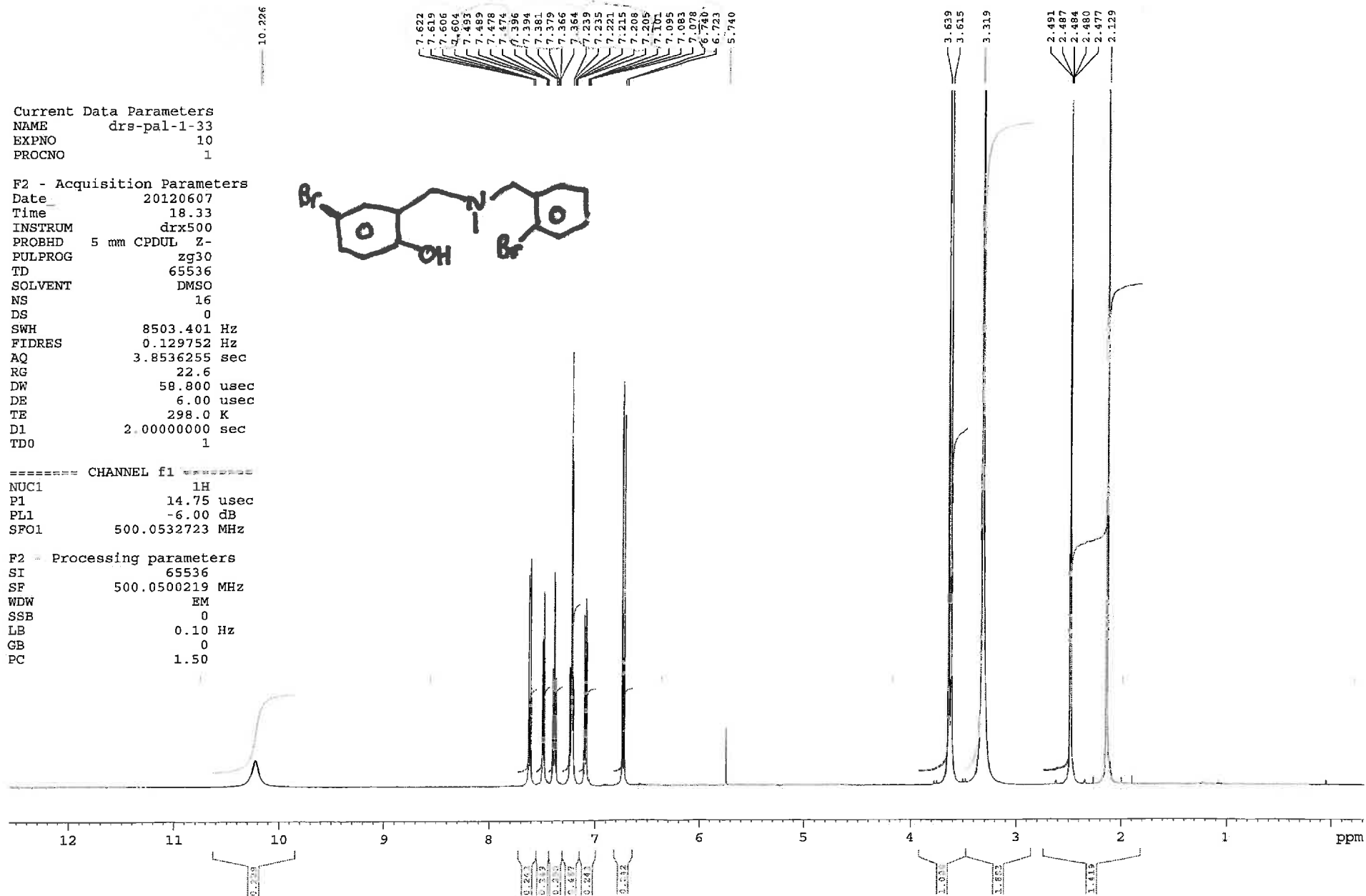
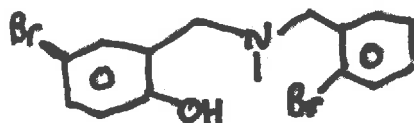
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 ppm

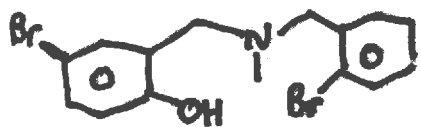
Current Data Parameters  
 NAME drs-pal-1-33  
 EXPNO 10  
 PROCNO 1

F2 - Acquisition Parameters  
 Date 20120607  
 Time 18.33  
 INSTRUM drx500  
 PROBHD 5 mm CPDUL Z-  
 PULPROG zg30  
 TD 65536  
 SOLVENT DMSO  
 NS 16  
 DS 0  
 SWH 8503.401 Hz  
 FIDRES 0.129752 Hz  
 AQ 3.8536255 sec  
 RG 22.6  
 DW 58.800 usec  
 DE 6.00 usec  
 TE 298.0 K  
 D1 2.00000000 sec  
 TD0 1

===== CHANNEL f1 =====  
 NUC1 1H  
 P1 14.75 usec  
 PL1 -6.00 dB  
 SFO1 500.0532723 MHz

F2 - Processing parameters  
 SI 65536  
 SF 500.0500219 MHz  
 WDW EM  
 SSB 0  
 LB 0.10 Hz  
 GB 0  
 PC 1.50





Current Data Parameters  
 NAME drs-pal-1-33  
 EXPNO 11  
 PROCNO 1

## F2 - Acquisition Parameters

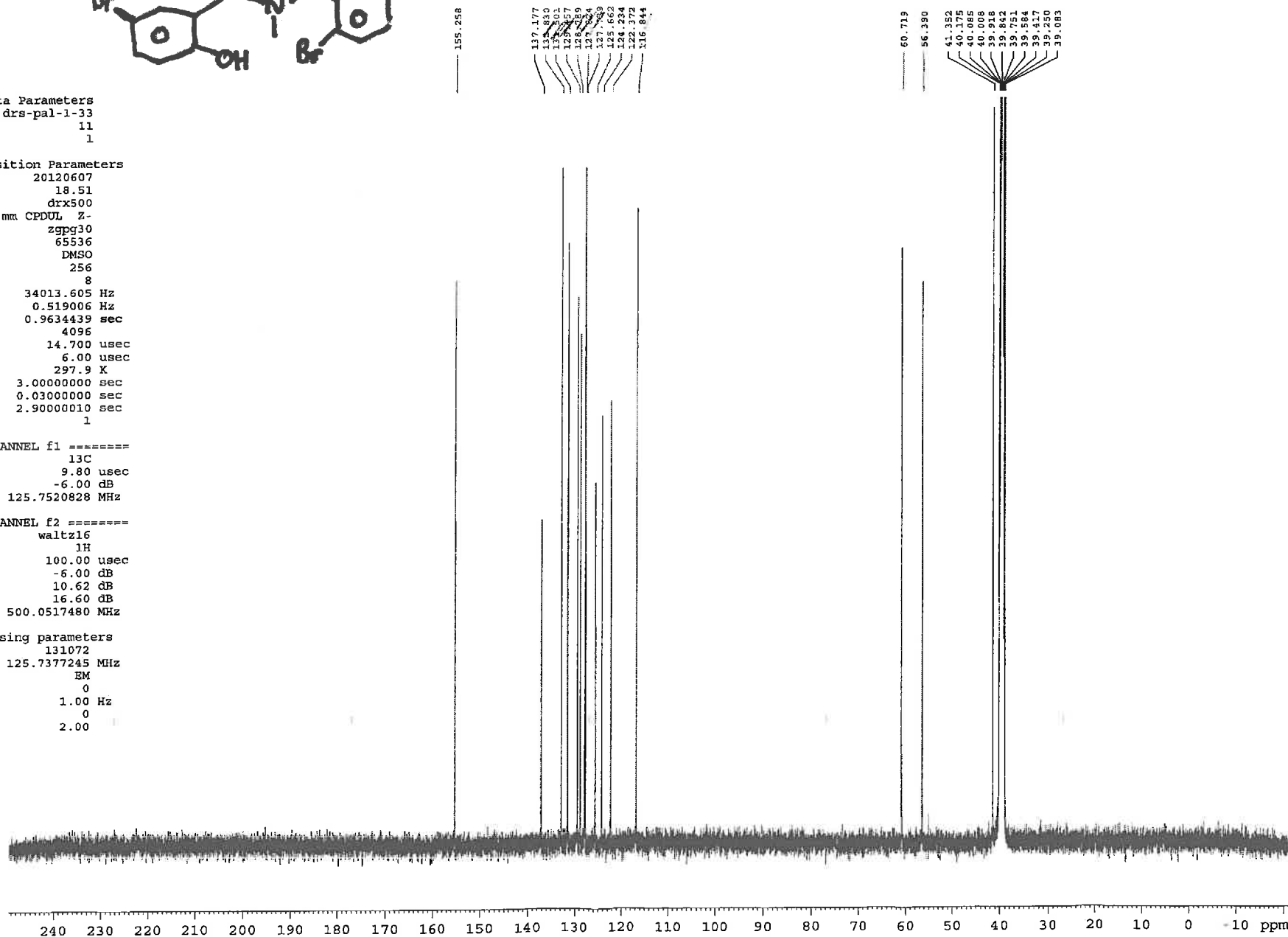
Date 20120607  
 Time 18.51  
 INSTRUM drx500  
 PROBHD 5 mm CPDUL Z-  
 PULPROG zgpg30  
 TD 65536  
 SOLVENT DMSO  
 NS 256  
 DS 8  
 SWH 34013.605 Hz  
 FIDRES 0.519006 Hz  
 AQ 0.9634439 sec  
 RG 4096  
 DW 14.700 usec  
 DE 6.00 usec  
 TE 297.9 K  
 D1 3.00000000 sec  
 d11 0.03000000 sec  
 DELTA 2.90000010 sec  
 TD0 1

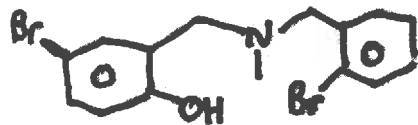
===== CHANNEL f1 =====  
 NUC1 13C  
 P1 9.80 usec  
 PL1 -6.00 dB  
 SFO1 125.7520828 MHz

===== CHANNEL f2 =====  
 CPDPRG2 waltz16  
 NUC2 1H  
 PCPD2 100.00 usec  
 PL2 -6.00 dB  
 PL12 10.62 dB  
 PL13 16.60 dB  
 SFO2 500.0517480 MHz

## F2 - Processing parameters

SI 131072  
 SF 125.7377245 MHz  
 WDW EM  
 SSB 0  
 LB 1.00 Hz  
 GB 0  
 PC 2.00





500 MHz Cryoprobe 'Aberlour'

## Current Data Parameters

NAME drs-pal-1-33  
EXPNO 11  
PROCNO 1

## F2 - Acquisition Parameters

Date 20120607  
Time 18.51  
INSTRUM drx500  
PROBHD 5 mm CPDUL Z-  
PULPROG zgpg30  
TD 65536  
SOLVENT DMSO  
NS 256  
DS 8  
SWH 34013.605 Hz  
FIDRES 0.519006 Hz  
AQ 0.9634439 sec  
RG 4096  
DW 14.700 usec  
DE 6.00 usec  
TE 297.9 K  
D1 3.00000000 sec  
d11 0.03000000 sec  
DELTA 2.90000010 sec  
TDO 1

## ===== CHANNEL f1 =====

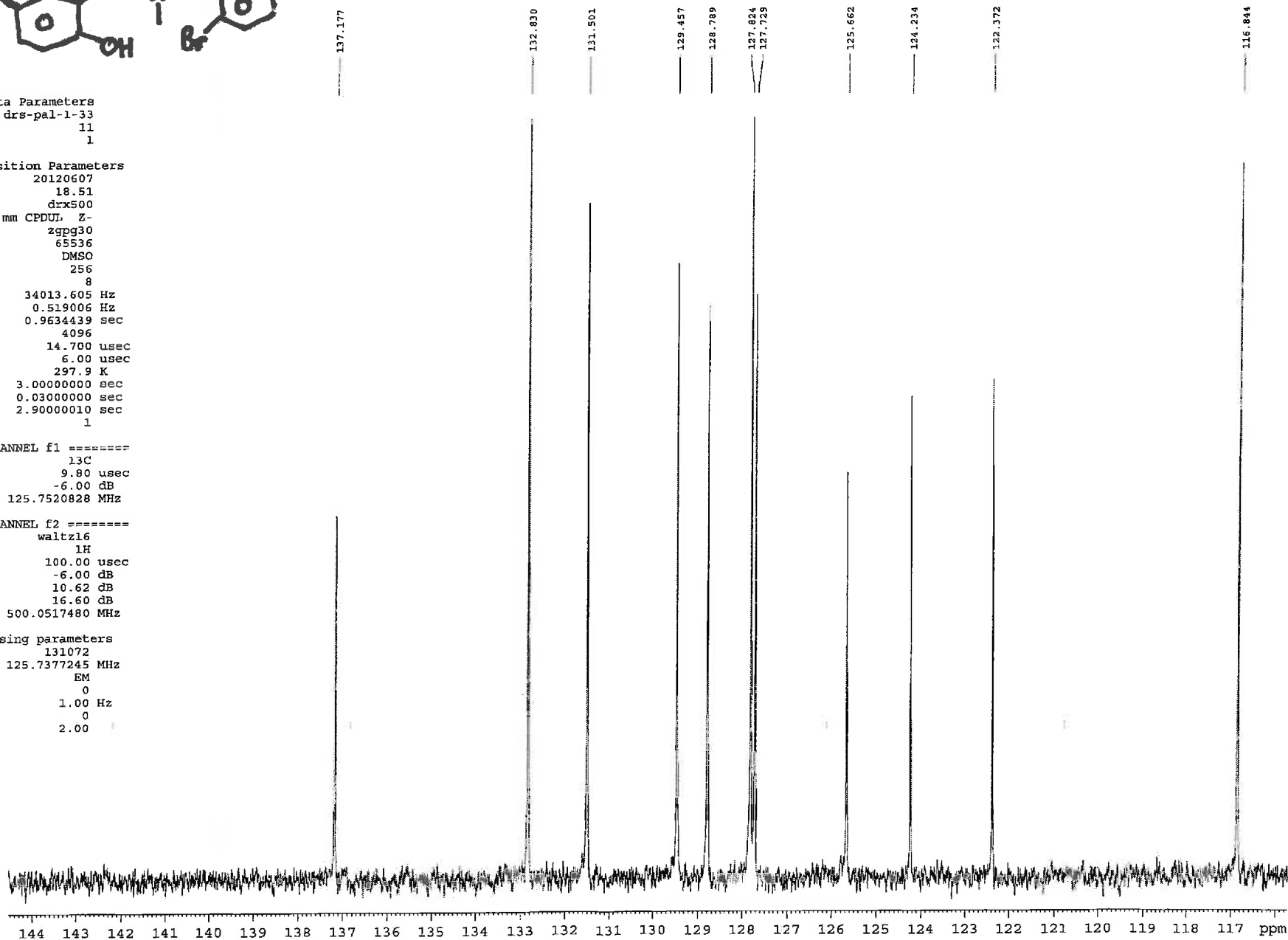
NUC1 13C  
P1 9.80 usec  
PL1 -6.00 dB  
SFO1 125.7520828 MHz

## ===== CHANNEL f2 =====

CPDPRG2 waltz16  
NUC2 1H  
PCPD2 100.00 usec  
PL2 -6.00 dB  
PL12 10.62 dB  
PL13 16.60 dB  
SFO2 500.0517480 MHz

## F2 - Processing parameters

SI 131072  
SF 125.7377245 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00



Current Data Parameters  
NAME: dcp-pa1-1-13  
EXPNO: 12  
PROCNO: 1

F2 - Acquisition Parameters  
Date\_: 20120607  
Time: 19.01  
INSTRUM: cryo500  
PROBHD: 5 mm CPDCL 2-  
PULPROG: zgpg30  
TD: 65536  
SOLVENT: DMSO  
NS: 128  
DS: 4  
SWH: 23446.541 Hz  
FIDRES: 0.478835 Hz  
AQ: 1.8420583 sec  
RG: 1096  
DW: 15.900 usec  
DE: 6.80 usec  
TE: 298.2 K  
CNSF2: 145.000000  
D1: 3.50000000 sec  
d2: 0.90144828 sec  
d12: 0.30061300 sec  
DELTA: 0.90601240 sec  
TD0: 1

===== CHANNEL f1 =====  
NUC1: 13C  
P1: 9.80 usec  
PC: 19.00 usec  
PL1: -6.00 dB  
SFO1: 125.7603778 MHz

===== CHANNEL f2 =====  
CPDPRG2: waltz16  
NUC2: 1H  
P2: 14.75 usec  
PC: 22.50 usec  
PL2: 100.00 usec  
PL12: -6.00 dB  
PL12: 10.00 dB  
SFO2: 500.1361980 MHz

F1 - Acquisition parameters  
ND0: 1  
TD: 256  
SFO1: 125.7603778 MHz  
FIDRES: 3.906250 Hz  
SW: 7.500 MHz  
FREQOUT: 0

F2 - Processing parameters  
SI: 65536  
SF: 125.7677045 MHz  
WDW: EM  
SSB: 0  
LB: 1.00 Hz  
GB: 0  
PC: 2.00

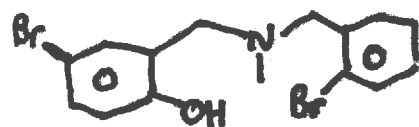
132.830  
131.501  
129.456  
128.788  
127.824  
127.729

116.844

60.719  
56.390

41.352  
40.172  
40.010  
39.842  
39.675  
39.506

1



220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

## F2 - Acquisition Parameters

```

Date_                20120607
Time                 19.09
INSTRUM              drx500
PROBHD               5 mm CPDUL Z-
PULPROG              zg30
TD                   65536
SOLVENT              DMSO
NS                   16
DS                   0
SWH                  8503.401 Hz
FIDRES               0.129752 Hz
AQ                   3.8536255 sec
RG                   22.6
DW                   58.800 usec
DE                   6.00 usec
TE                   298.0 K
D1                   2.00000000 sec
TD0                  1

```

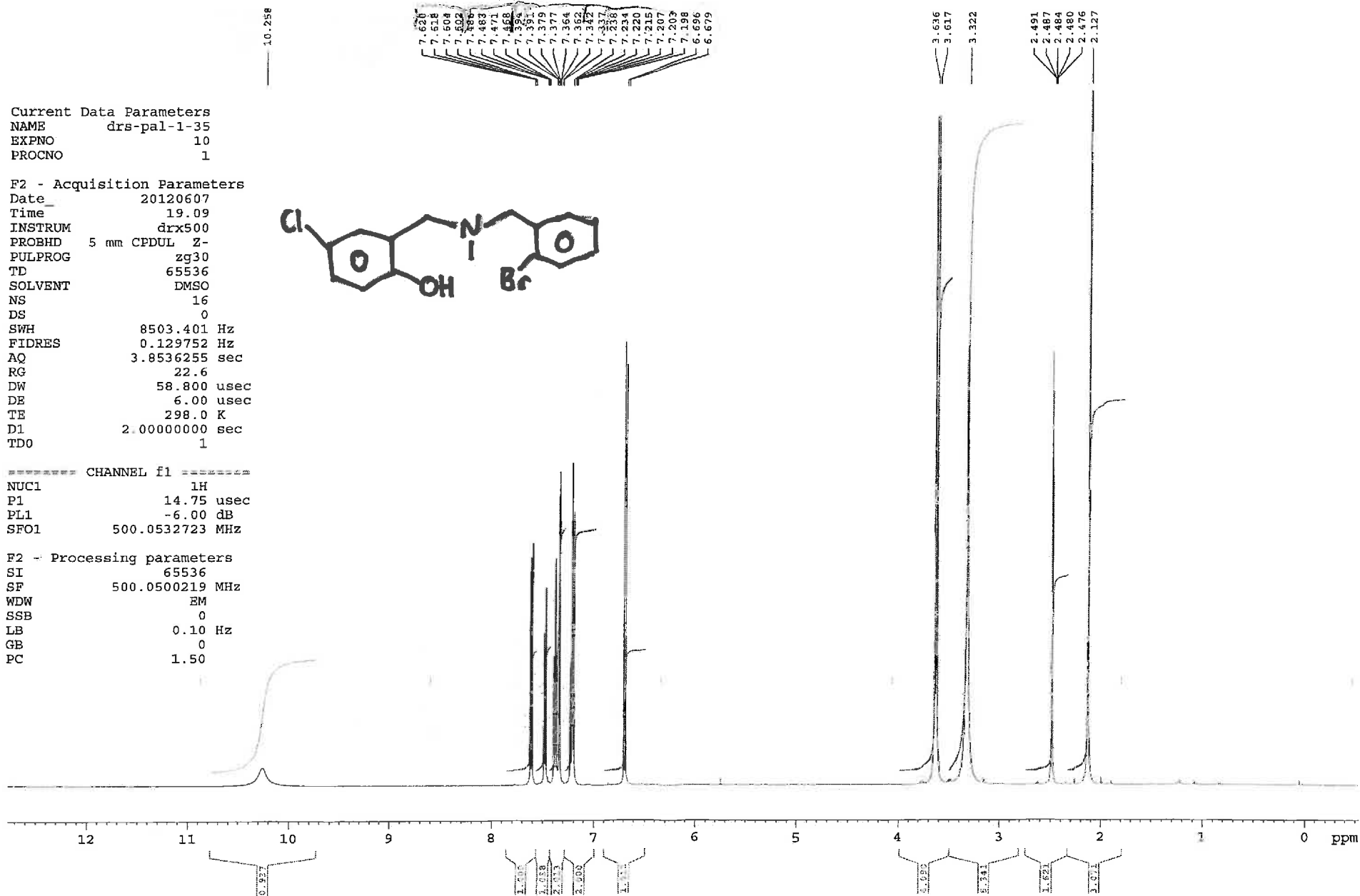
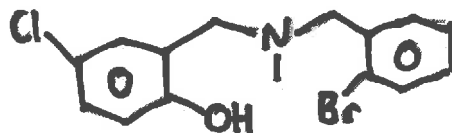
```
===== CHANNEL f1 =====
```

NUC1	1H
P1	14.75 usec
PL1	-6.00 dB
SFO1	500.0532723 MHz

```

F2 - Processing parameters
SI          65536
SF          500.0500219 MHz
WDW          EM
SSB          0
LB          0.10 Hz
GB          0
PC          1.50

```



Current Data Parameters  
 NAME drs-pal-1-35  
 EXPNO 11  
 PROCNO 1

## F2 - Acquisition Parameters

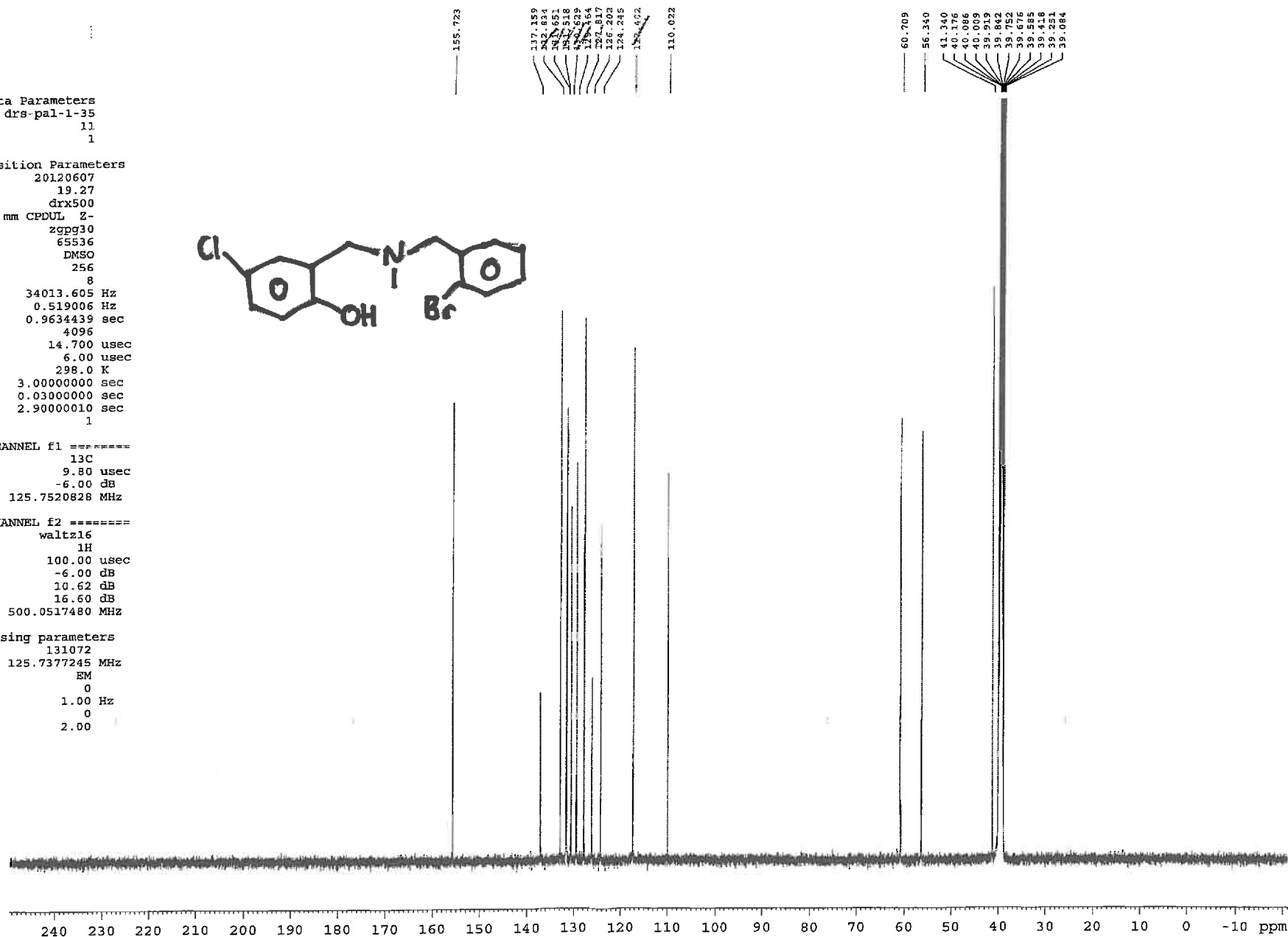
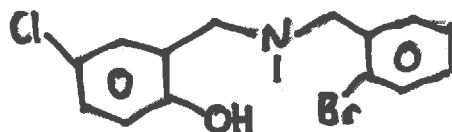
Date\_ 20120607  
 Time 19.27  
 INSTRUM drx500  
 PROBHD 5 mm CPDUL 2-  
 PULPROG zgpg30  
 TD 65536  
 SOLVENT DMSO  
 NS 256  
 DS 8  
 SWH 34013.605 Hz  
 FIDRES 0.519006 Hz  
 AQ 0.9634439 sec  
 RG 4096  
 DW 14.700 usec  
 DE 6.00 usec  
 TE 298.0 K  
 D1 3.00000000 sec  
 d11 0.03000000 sec  
 DELTA 2.90000010 sec  
 TD0 1

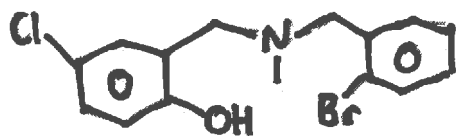
===== CHANNEL f1 =====  
 NUC1 13C  
 P1 9.80 usec  
 PL1 -6.00 dB  
 SFO1 125.7520828 MHz

===== CHANNEL f2 =====  
 CPDPRG2 waltz16  
 NUC2 1H  
 PCPD2 100.00 usec  
 PL2 -6.00 dB  
 PL12 10.62 dB  
 PL13 16.60 dB  
 SFO2 500.0517480 MHz

## F2 - Processing parameters

SI 131072  
 SF 125.7377245 MHz  
 WDW EM  
 SSB 0  
 LB 1.00 Hz  
 GB 0  
 PC 2.00





500 MHz Cryoprobe 'Aberlour'

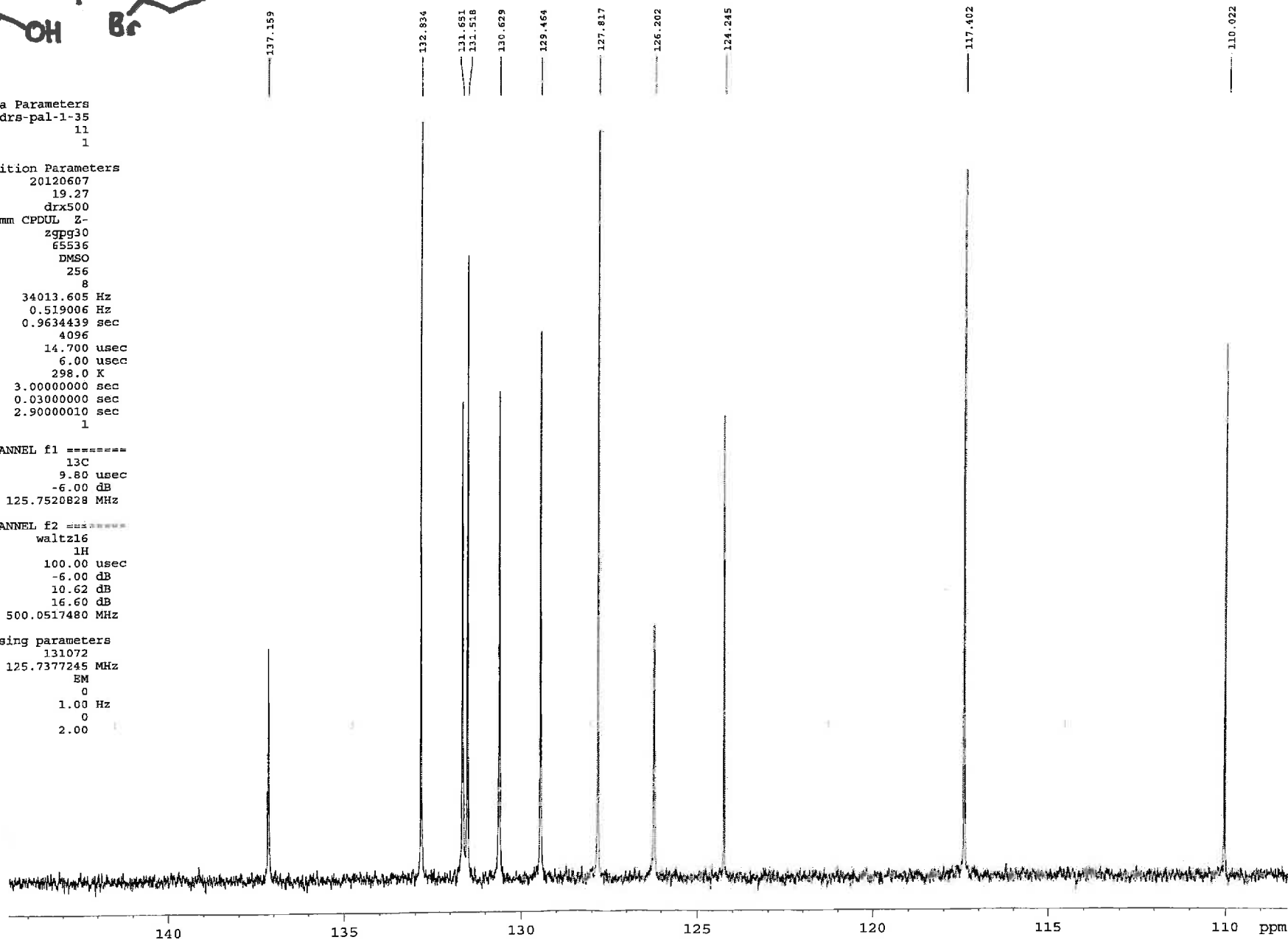
Current Data Parameters  
NAME drs-pal-1-35  
EXPNO 11  
PROCNO 1

F2 - Acquisition Parameters  
Date 20120607  
Time 19.27  
INSTRUM drx500  
PROBHD 5 mm CPDUL Z-  
PULPROG zgpg30  
TD 65536  
SOLVENT DMSO  
NS 256  
DS 8  
SWH 34013.605 Hz  
FIDRES 0.519006 Hz  
AQ 0.9634439 sec  
RG 4096  
DW 14.700 usec  
DE 6.00 usec  
TE 298.0 K  
D1 3.00000000 sec  
d11 0.03000000 sec  
DELTA 2.90000010 sec  
TDO 1

===== CHANNEL f1 =====  
NUC1 13C  
P1 9.80 usec  
PL1 -6.00 dB  
SFO1 125.7520828 MHz

===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 100.00 usec  
PL2 -6.00 dB  
PL12 10.62 dB  
PL13 16.60 dB  
SFO2 500.0517480 MHz

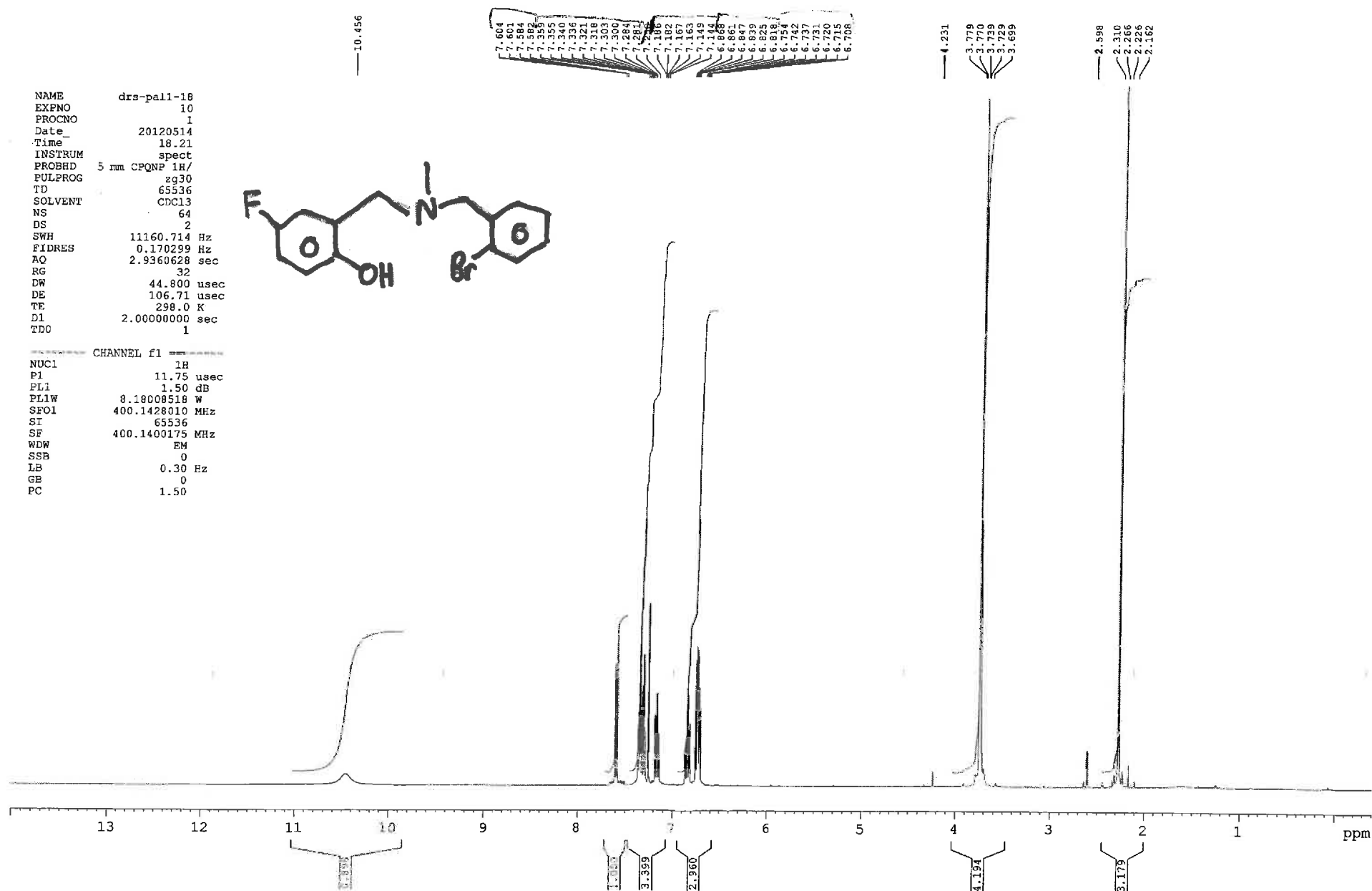
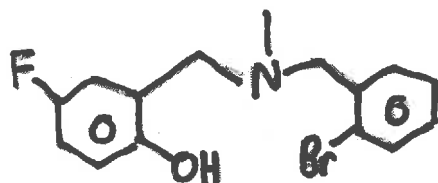
F2 - Processing parameters  
SI 131072  
SF 125.7377245 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00





NAME dra-pall-18  
EXPNO 10  
PROCNO 1  
Date 20120514  
Time 18.21  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zg30  
TD 65536  
SOLVENT CDC13  
NS 64  
DS 2  
SWH 11160.714 Hz  
FIDRES 0.170299 Hz  
AQ 2.9360628 sec  
RG 32  
DW 44.800 usec  
DE 106.71 usec  
TE 298.0 K  
D1 2.00000000 sec  
TD0 1

CHANNEL f1  
NUC1 1H  
P1 11.75 usec  
PL1 1.50 dB  
PL1W 8.180008518 W  
SFO1 400.1428010 MHz  
SI 65536  
SF 400.1400175 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GE 0  
PC 1.50

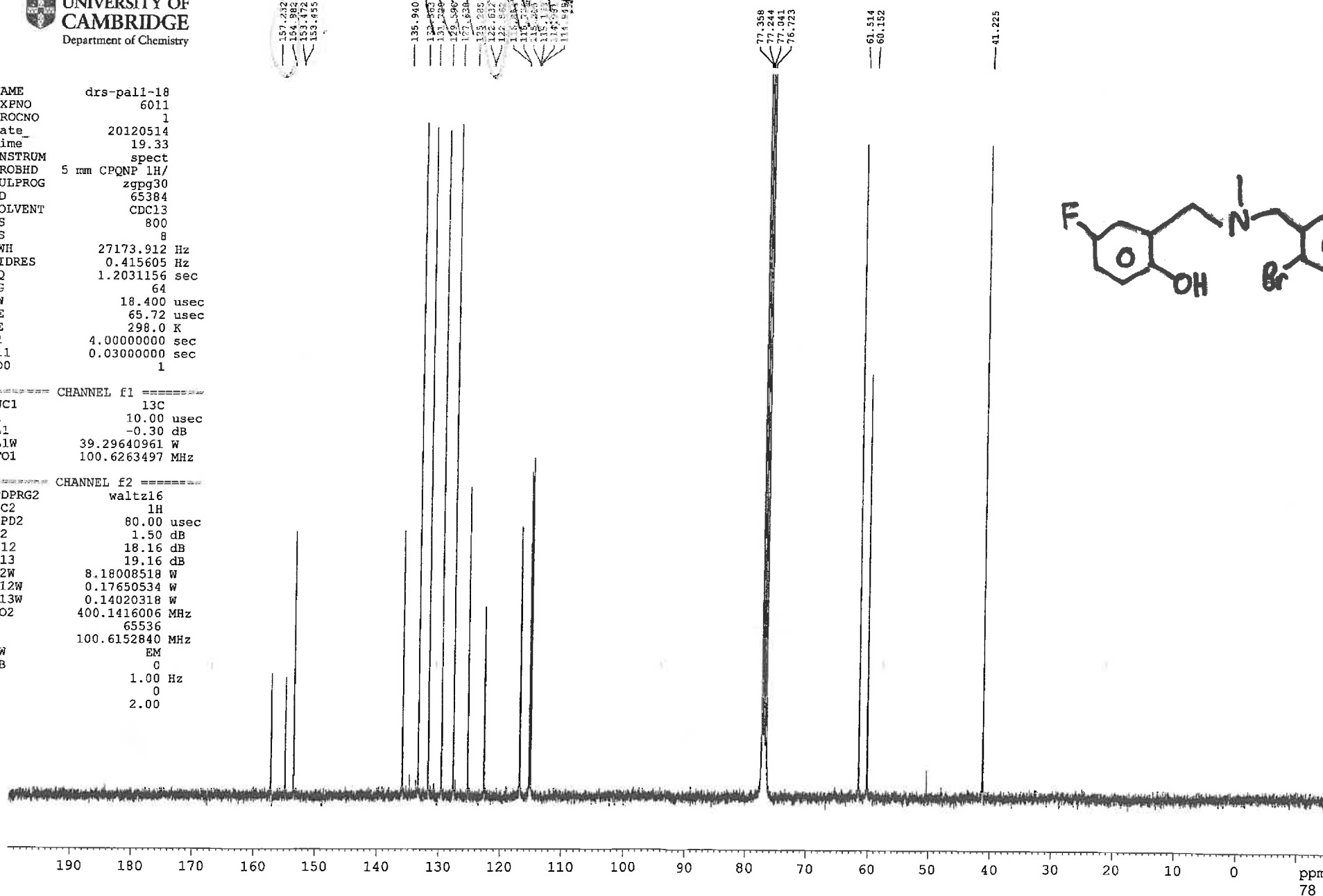


NAME drs-pal1-18  
EXPNO 6011  
PROCNO 1  
Date\_ 20120514  
Time\_ 19.33  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDC13  
NS 800  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TD0 1

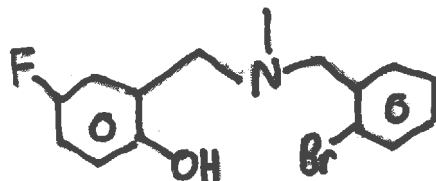
CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6152840 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00

Data has been converted to analogue. Backwards predicted 16 points to remove cryoprobe baseline roll. PAL 1-18

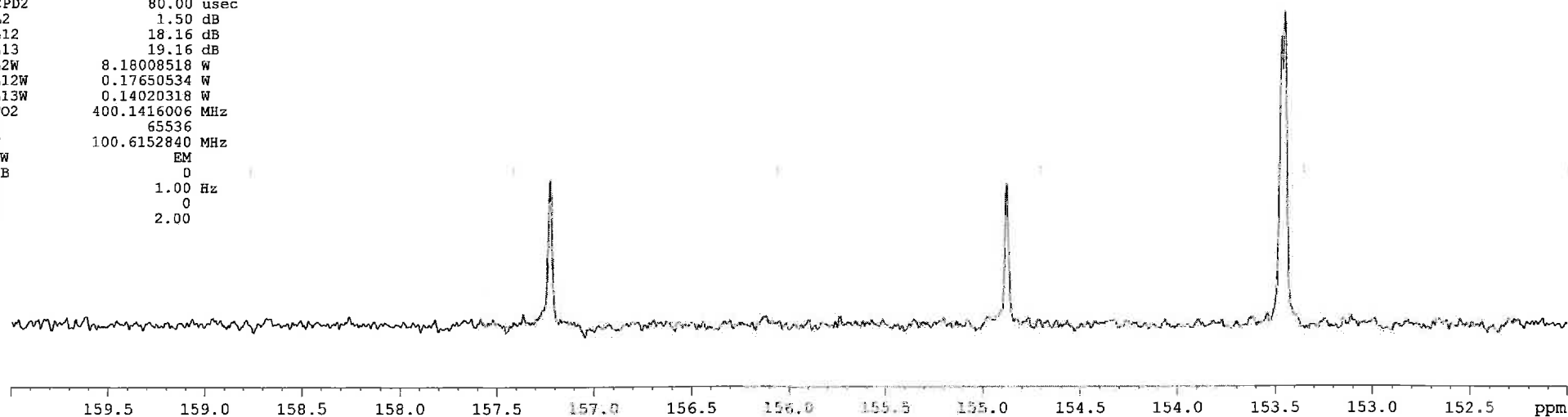


NAME drs-pall-18  
EXPNO 6011  
PROCNO 1  
Date\_ 20120514  
Time\_ 19.33  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDC13  
NS 800  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TDO 1



===== CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

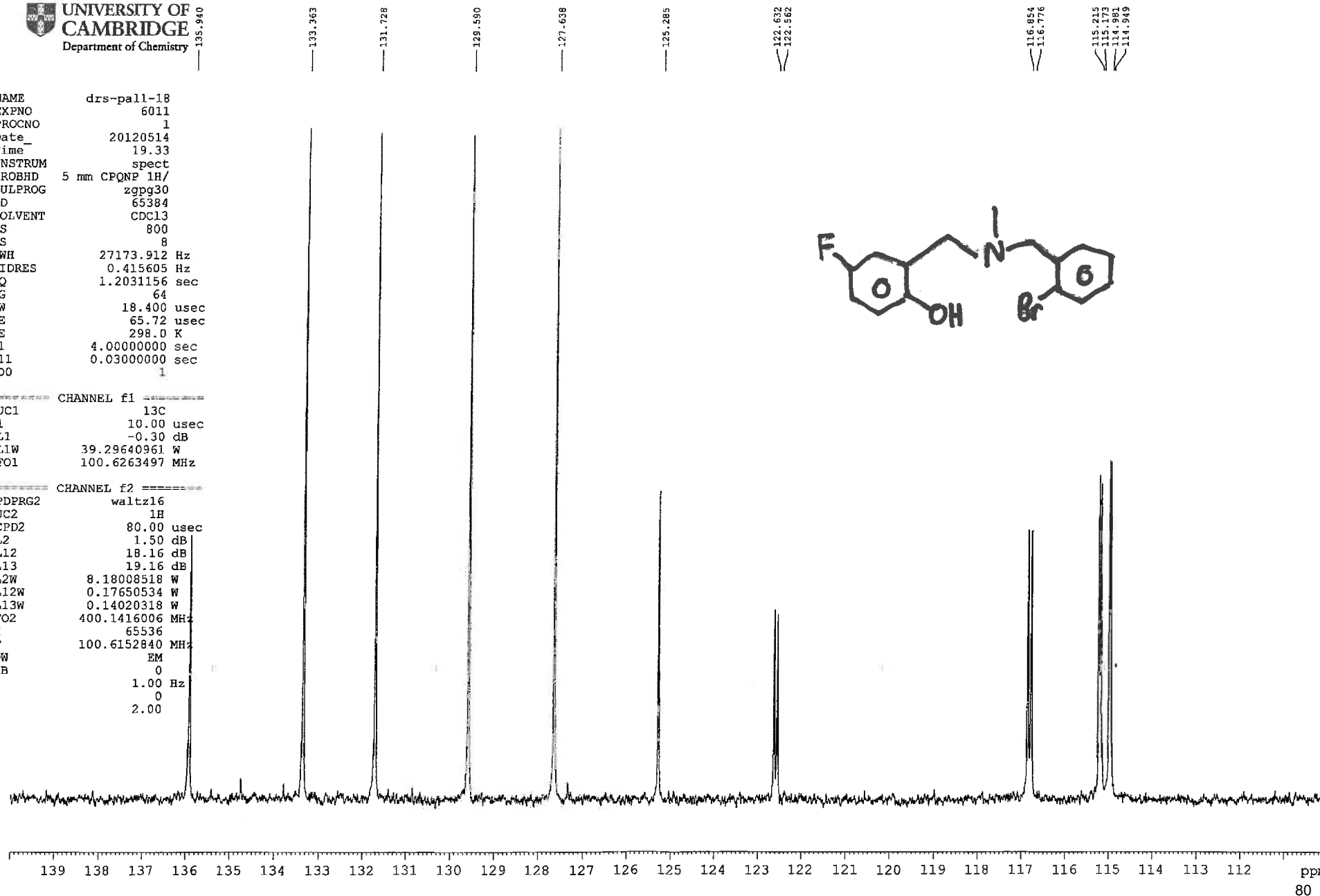
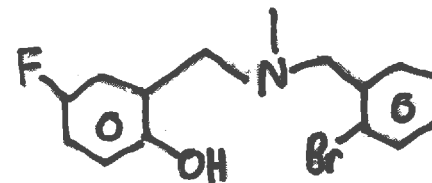
===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6152840 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00



NAME drs-pall-18  
EXPNO 6011  
PROCNO 1  
Date 20120514  
Time 19.33  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 800  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TDO 1

CHANNEL f1  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

CHANNEL f2  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6152840 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00

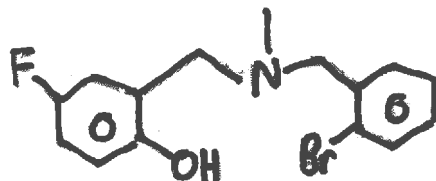




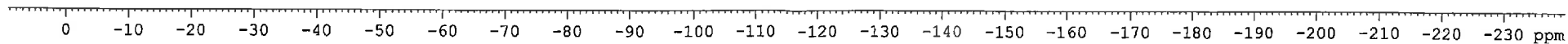
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EXPNO 13  
PROCNO 1  
Date\_ 20120514  
Time 20.07  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgig30  
TD 262144  
SOLVENT CDCl3  
NS 256  
DS 4  
SWH 93750.000 Hz  
FIDRES 0.357628 Hz  
AQ 1.3981513 sec  
RG 256  
DW 5.333 usec  
DE 6.50 usec  
TE 298.0 K  
D1 1.00000000 sec  
D11 0.03000000 sec  
TD0 1

CHANNEL f1  
NUC1 19F  
P1 17.25 usec  
PL1 -2.90 dB  
PL1W 30.48383522 W  
SFO1 376.4644766 MHz

CHANNEL f2  
CPDPRG2 waltz16  
NUC2 1H  
ECPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
SFO2 400.1416006 MHz  
SI 262144  
SF 376.5078623 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.00



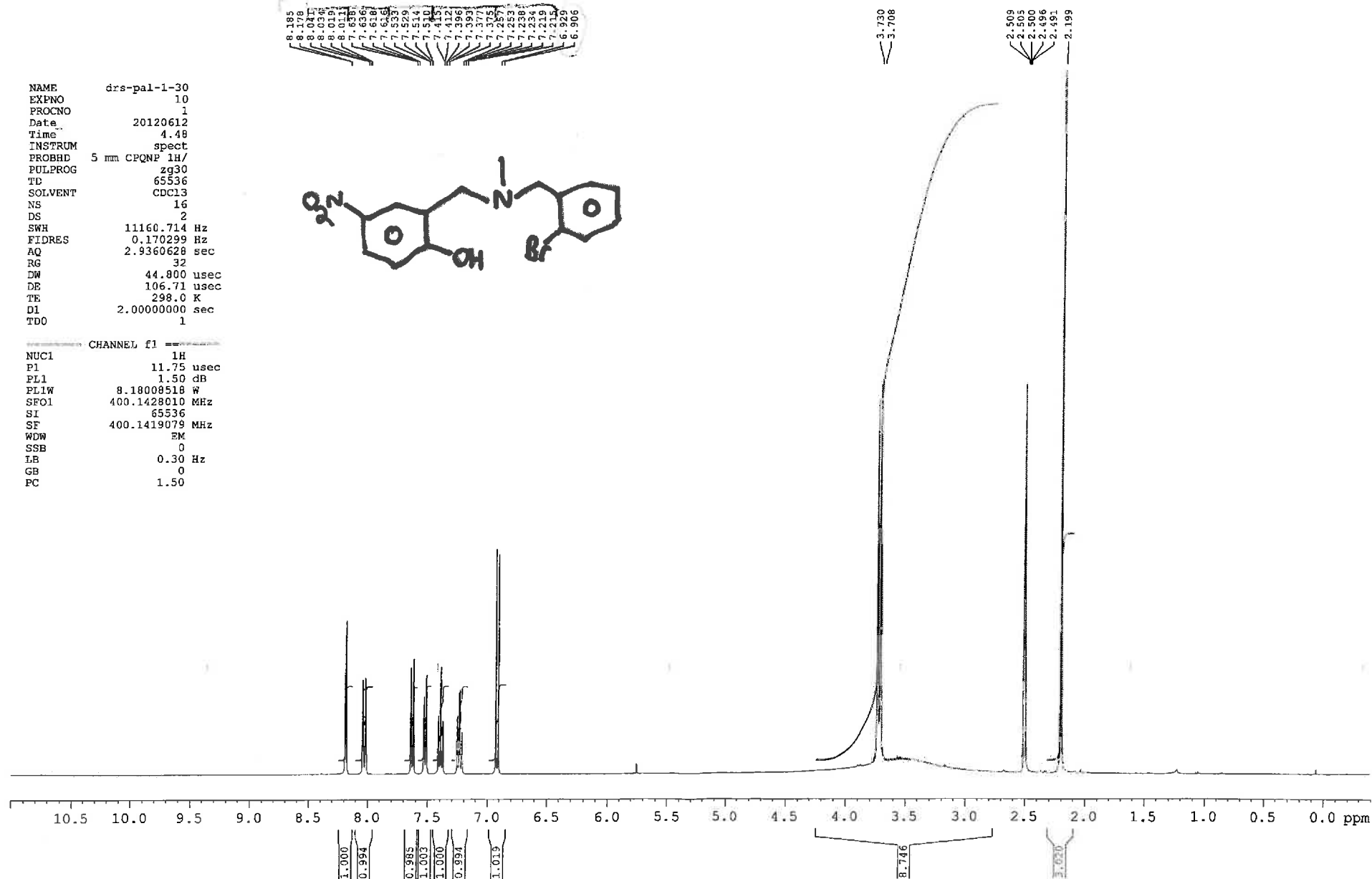
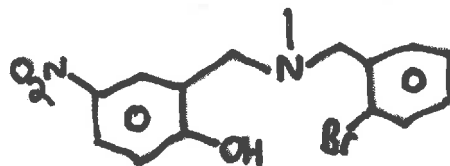
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NAME drs-pal-1-30  
EXPNO 10  
PROCNO 1  
Date\_ 20120612  
Time\_ 4.48  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 16  
DS 2  
SWH 11160.714 Hz  
FIDRES 0.170299 Hz  
AQ 2.9360628 sec  
RG 32  
DW 44.800 usec  
DE 106.71 usec  
TE 298.0 K  
D1 2.00000000 sec  
TD0 1

CHANNEL f1 ==  
NUC1 1H  
P1 11.75 usec  
PL1 1.50 dB  
PL1W 8.18008518 W  
SFO1 400.1428010 MHz  
SI 65536  
SF 400.1419079 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50

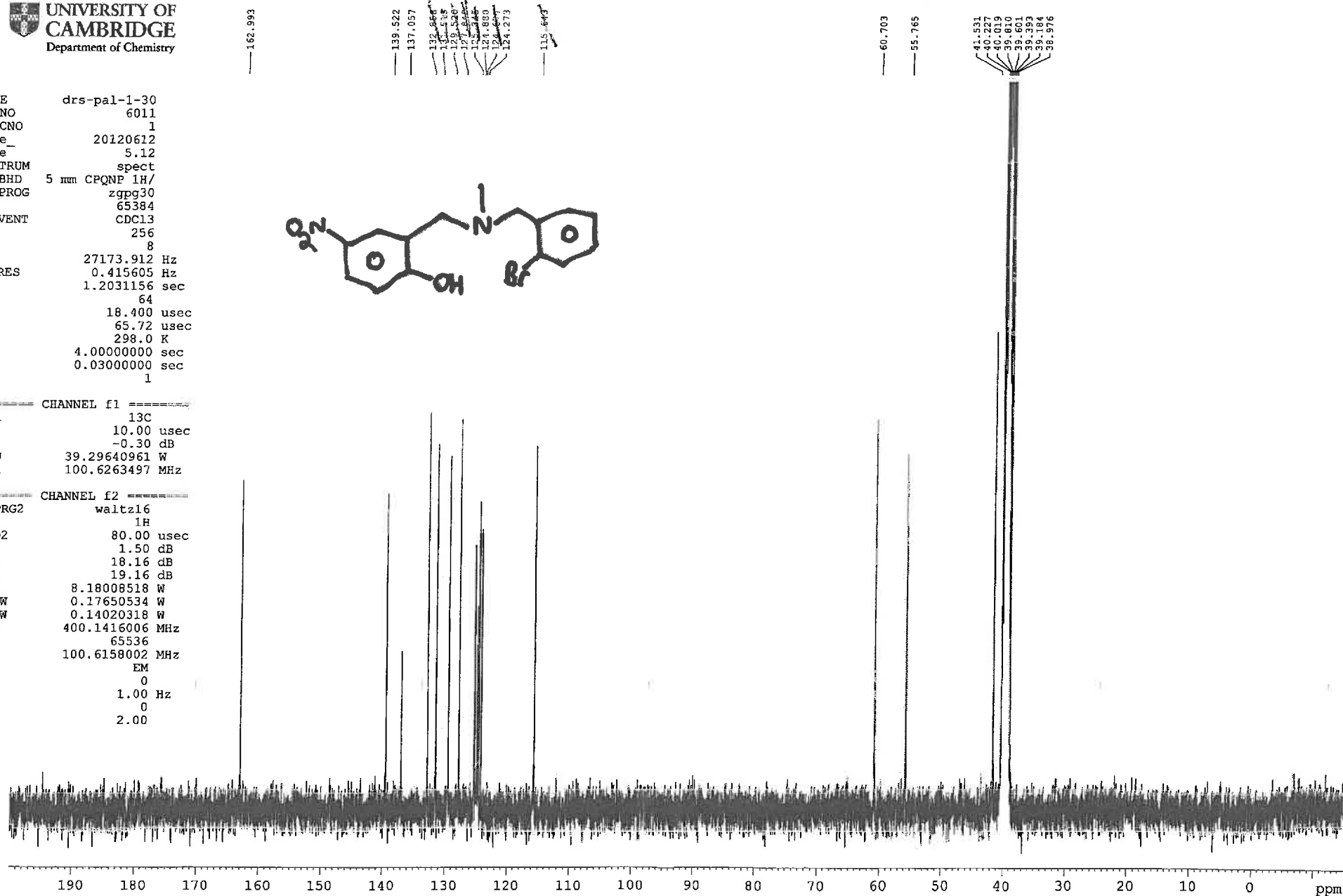
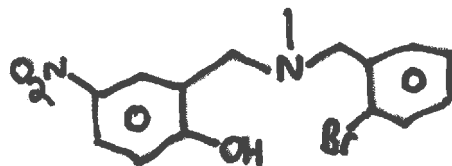
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7.682  
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7.634  
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7.615  
6.929  
6.906



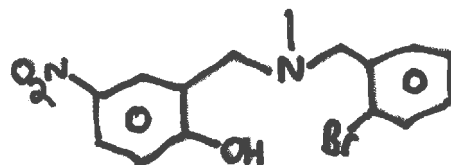
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EXPNO 6011  
PROCNO 1  
Date 20120612  
Time 5.12  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 256  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TD0 1

CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6158002 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00







132.855  
131.512  
129.517  
127.837  
125.342  
124.674

115.640

60.701

55.761

41.527  
40.068  
39.837  
39.630



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

139.522

137.057

132.858

131.515

129.520

127.840

125.345

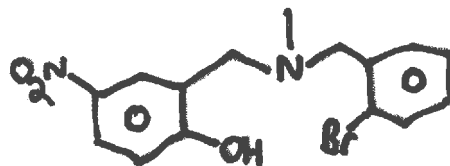
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124.677

124.273

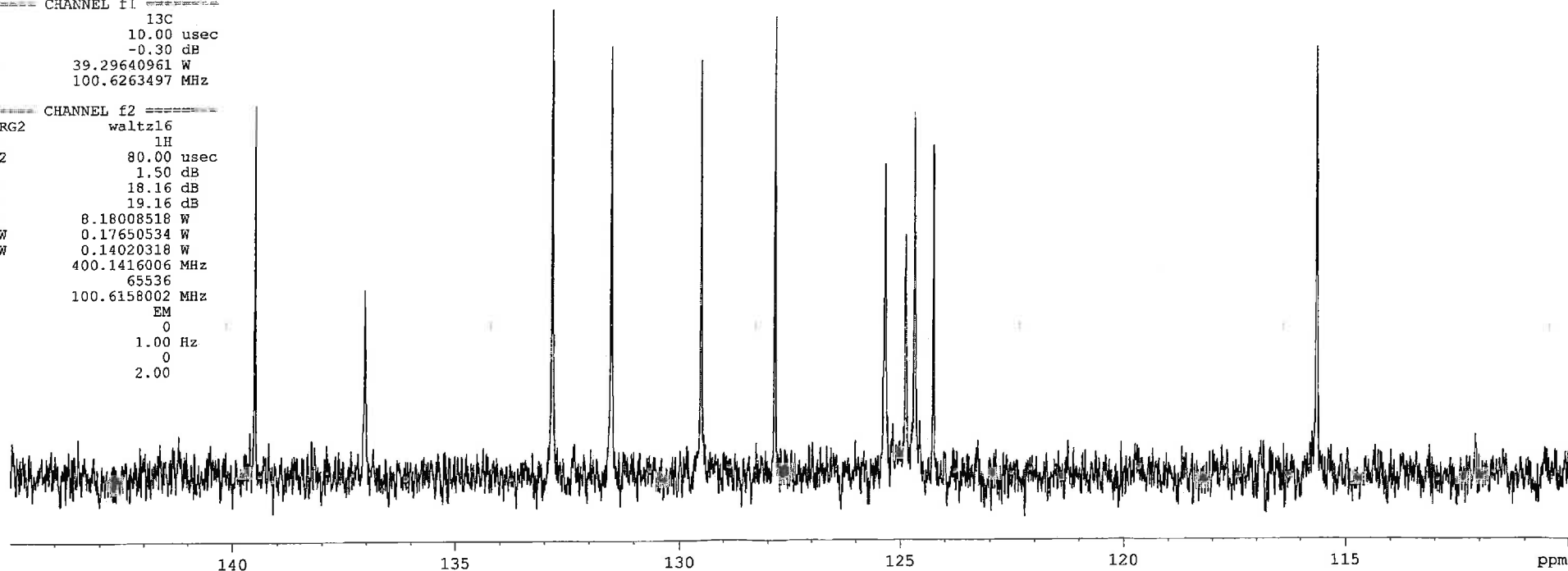
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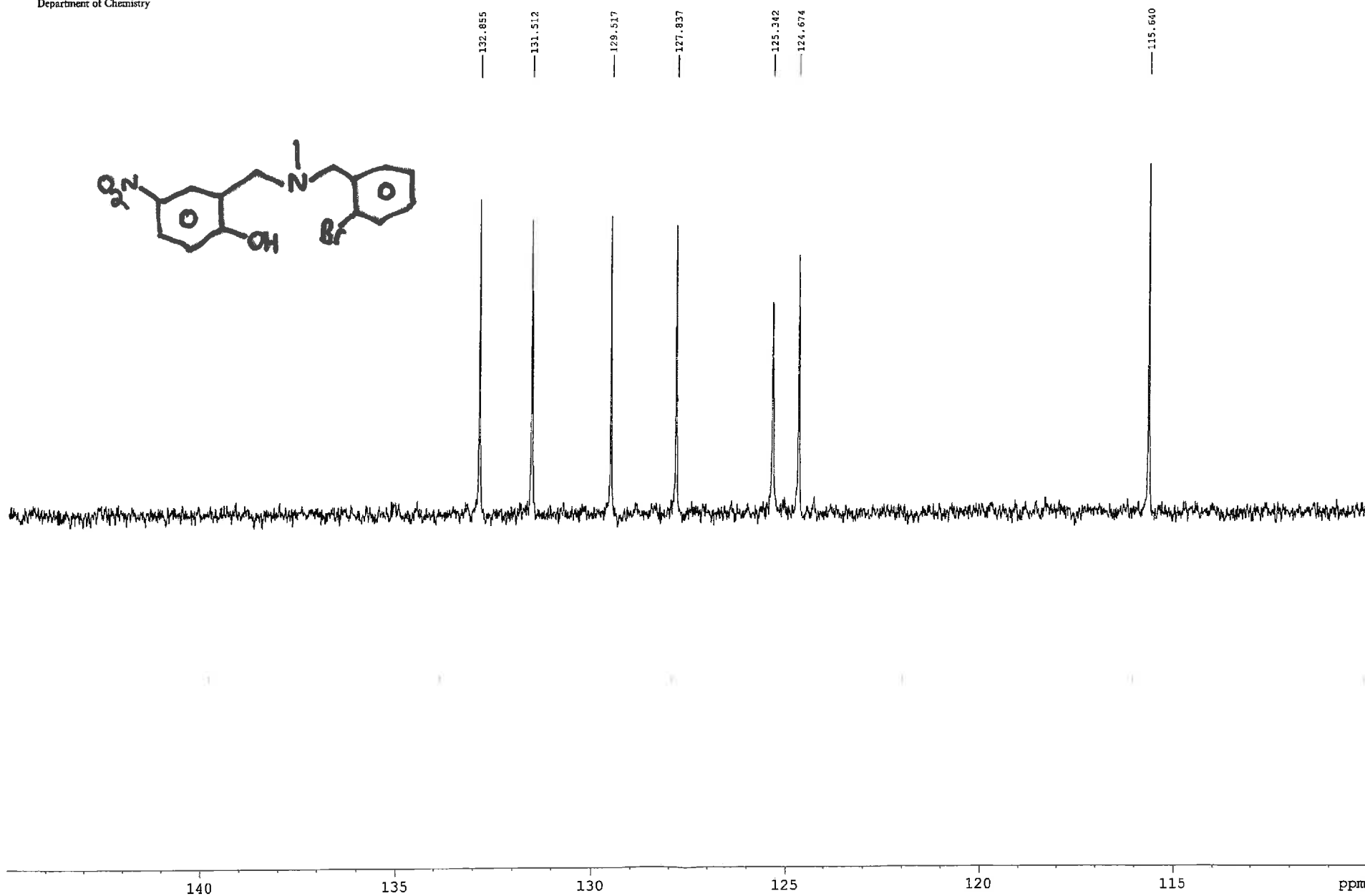
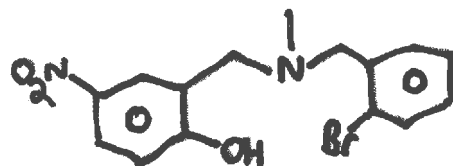
NAME drs-pal-1-30  
EXPNO 6011  
PROCNO 1  
Date\_ 20120612  
Time\_ 5.12  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 256  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TD0 1



CHANNEL f1  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

CHANNEL f2  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6158002 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00

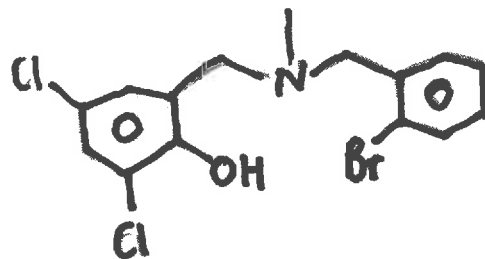




NAME drs-pal-1-36  
EXPNO 10  
PROCNO 1  
Date\_ 20120612  
Time 2.58  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zg30  
TD 65536  
SOLVENT CDC13  
NS 16  
DS 2  
SWH 11160.714 Hz  
FIDRES 0.170299 Hz  
AQ 2.9360628 sec  
RG 32  
DW 44.800 usec  
DE 106.71 usec  
TE 298.0 K  
D1 2.00000000 sec  
D1 1  
TDO 1

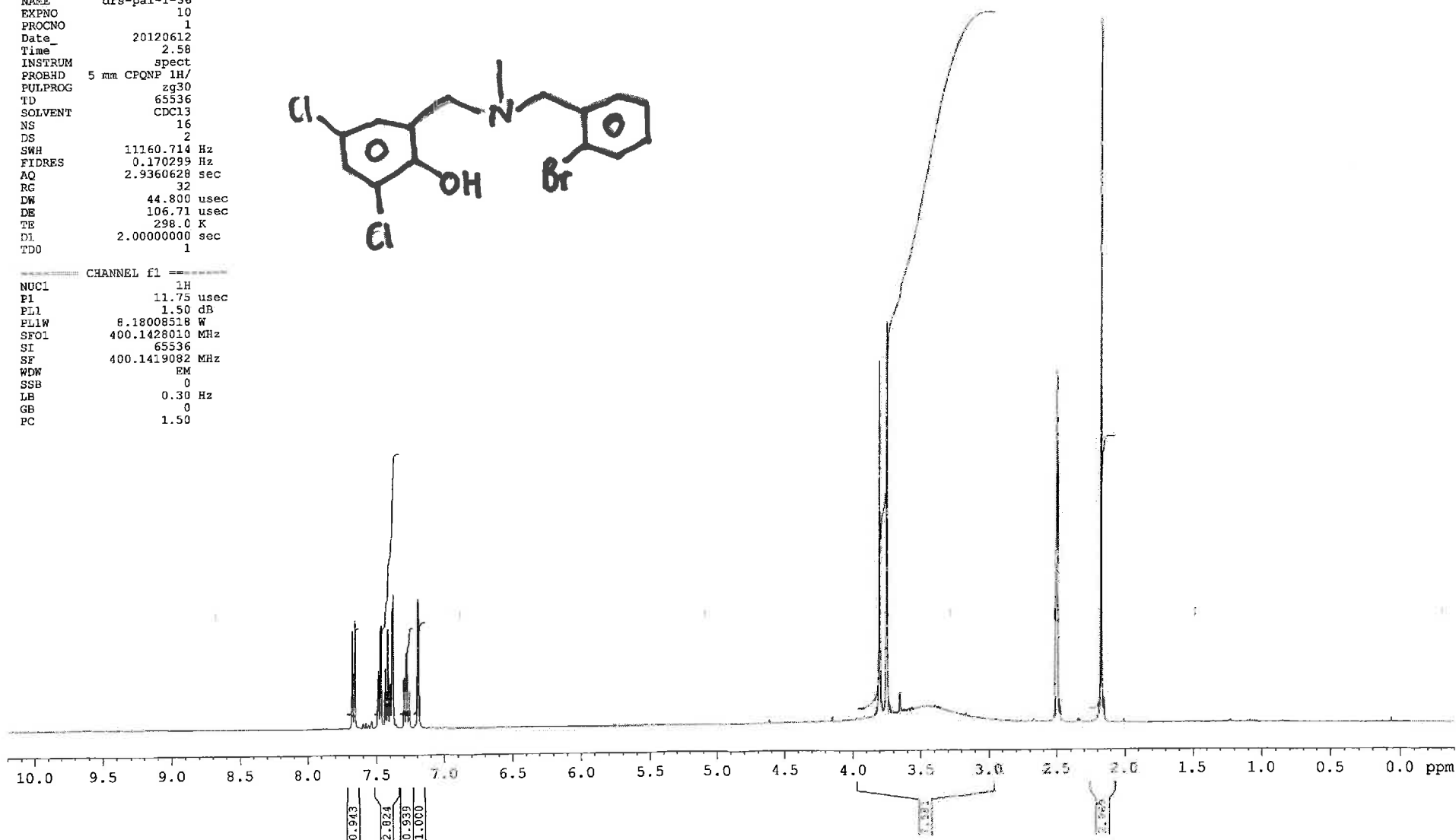
CHANNEL f1 ==  
NUC1 1H  
P1 11.75 usec  
PL1 1.50 dB  
PL1W 8.18008518 W  
SFO1 400.1428010 MHz  
SI 65536  
SF 400.1419082 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50

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3.797  
3.743

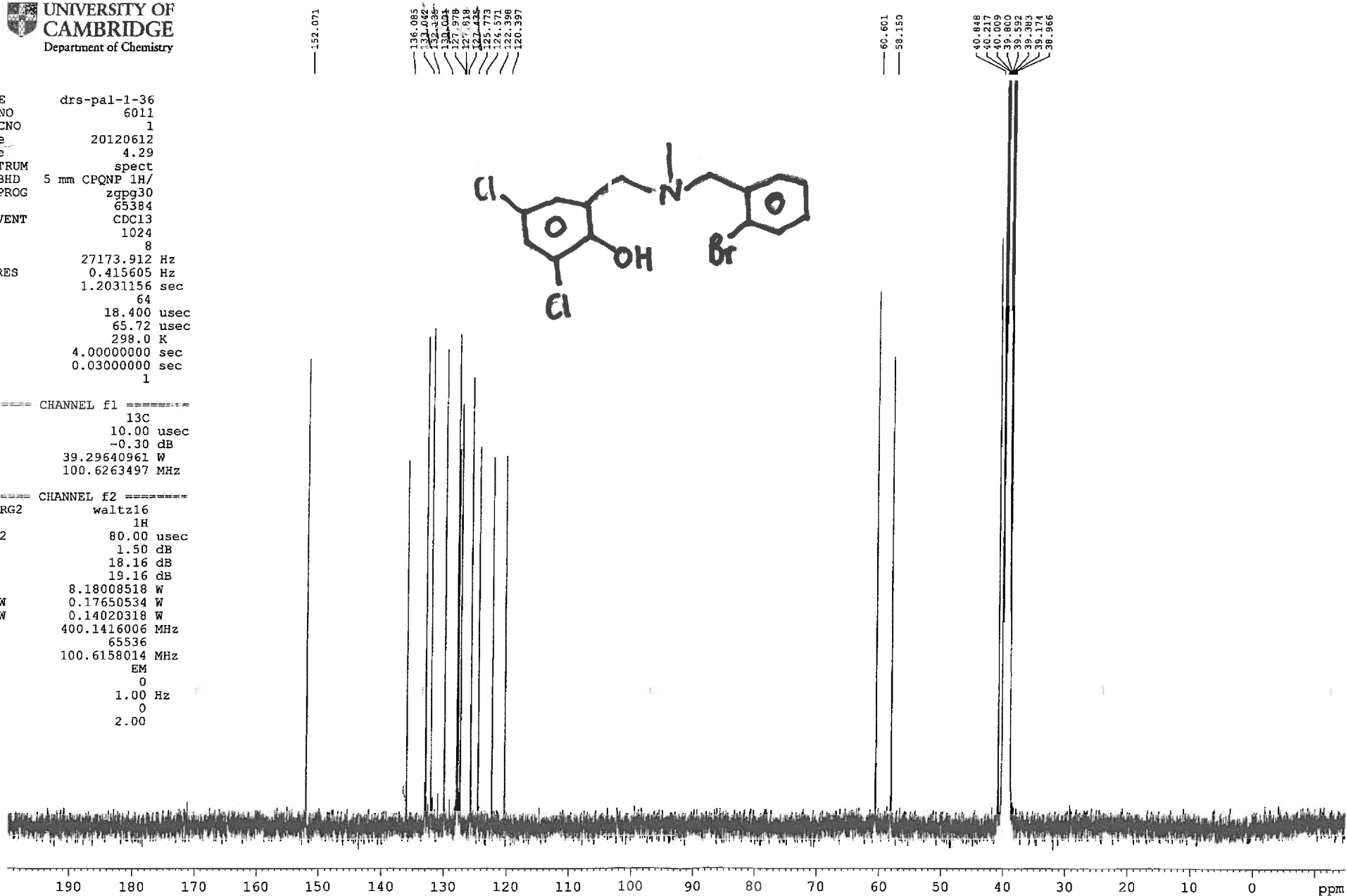
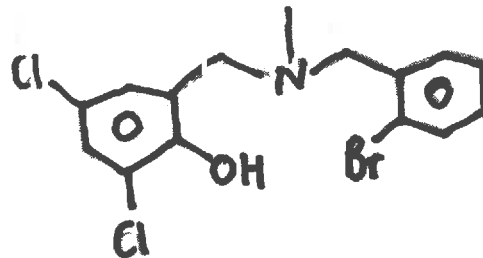
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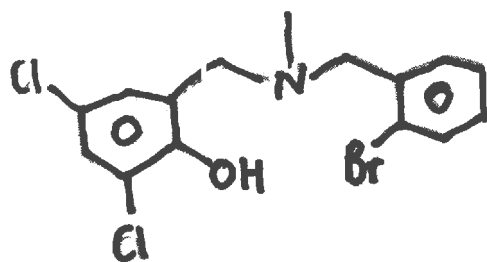


NAME drs-pal-1-36  
EXFNO 6011  
PROCNO 1  
Date 20120612  
Time 4.29  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 1024  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TDO 1

===== CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
ECPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6158014 MHz  
WDB EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00

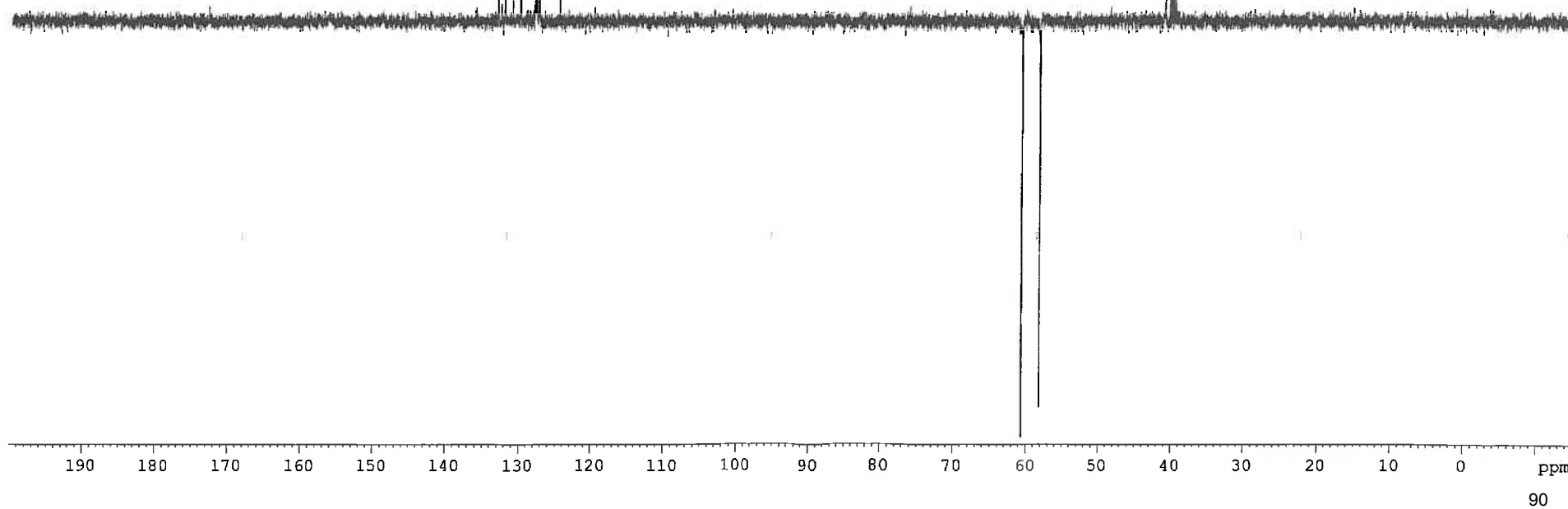




133.037  
132.131  
129.996  
127.974  
127.814  
127.431

60.597  
58.146

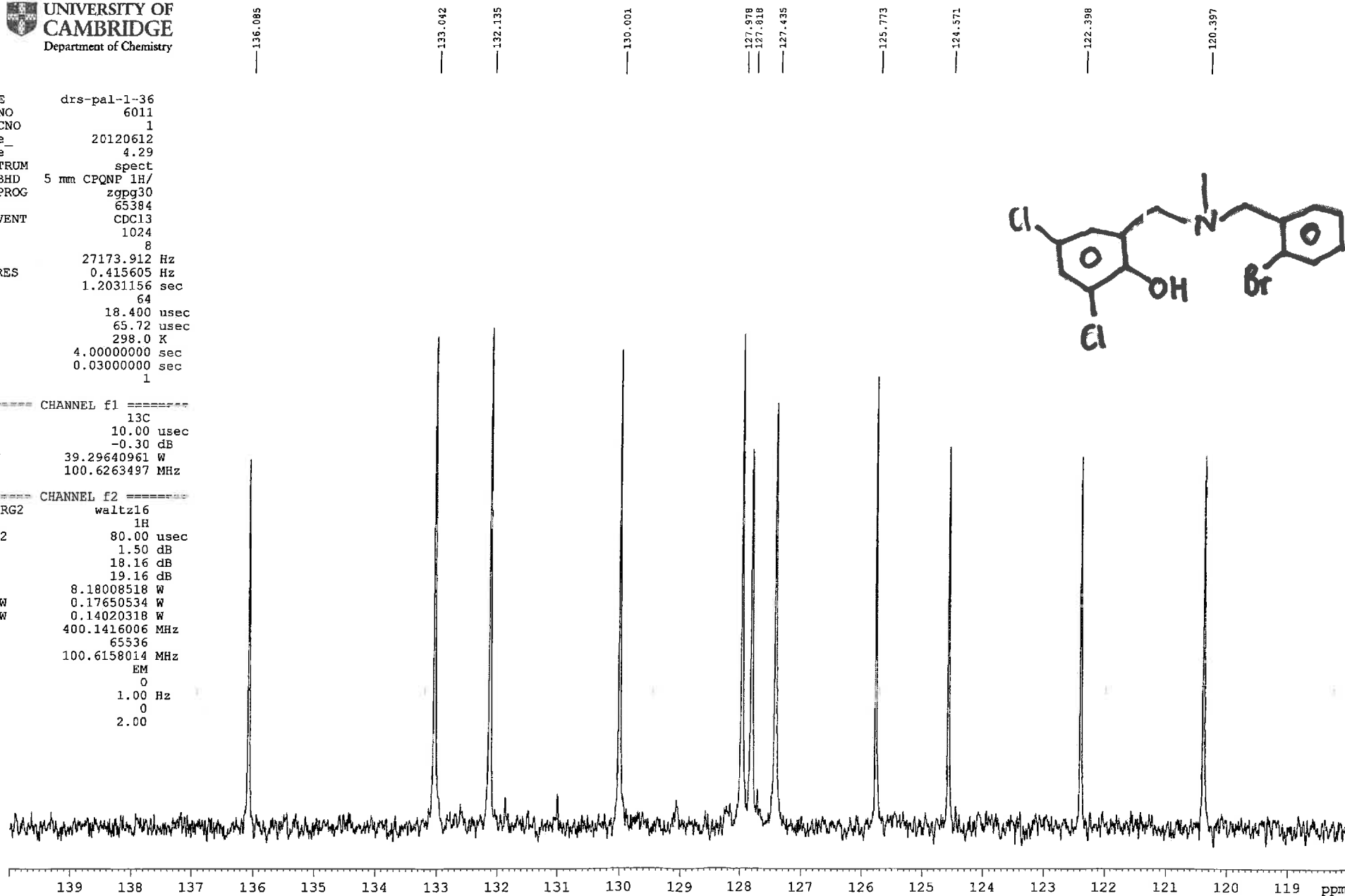
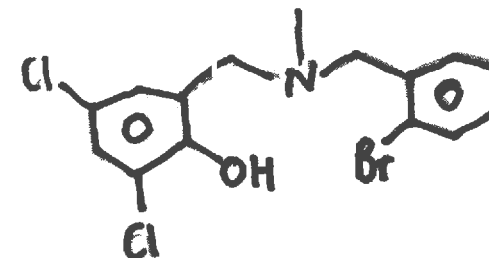
40.844  
40.563  
40.058  
39.847  
39.638

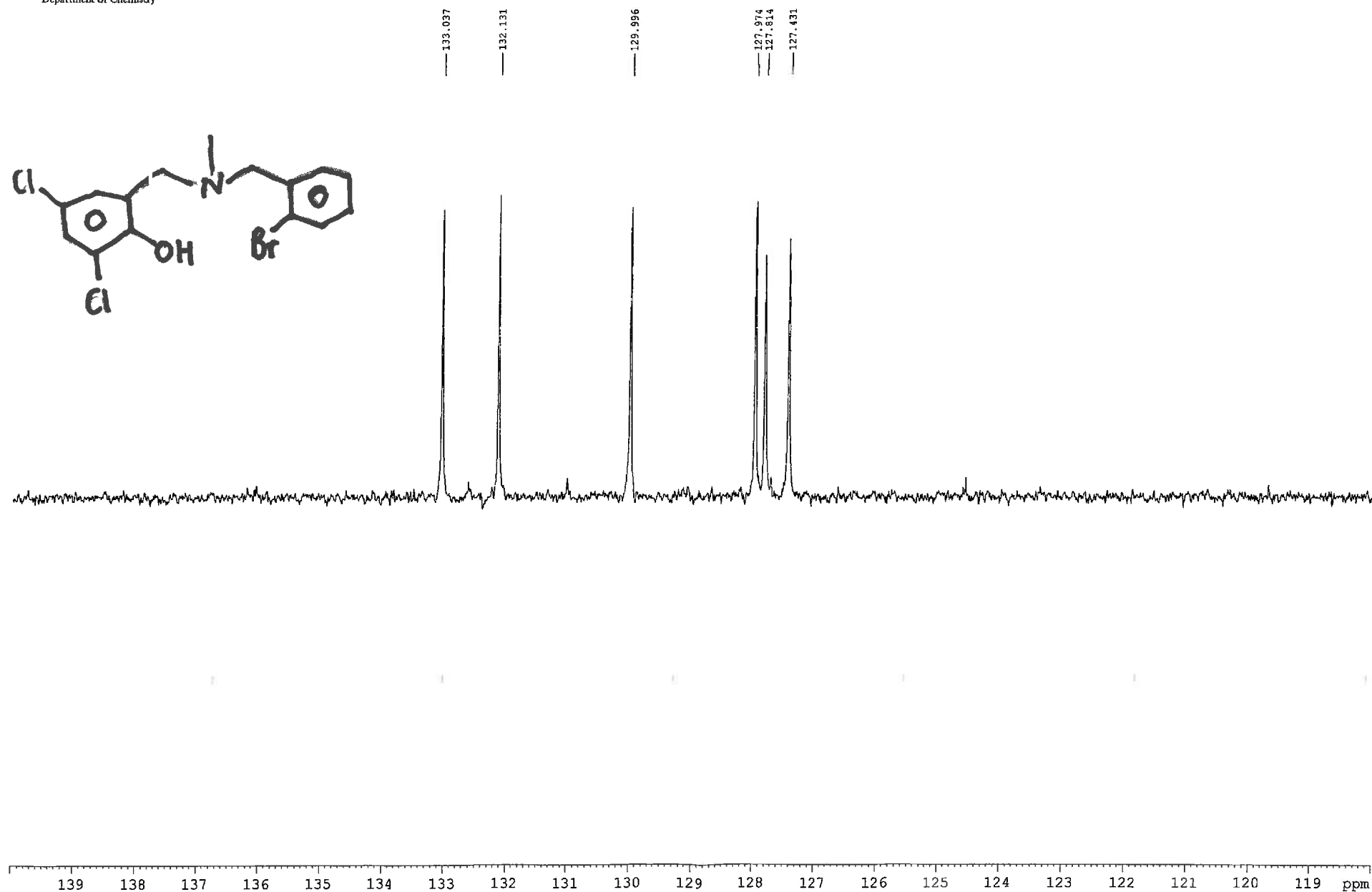
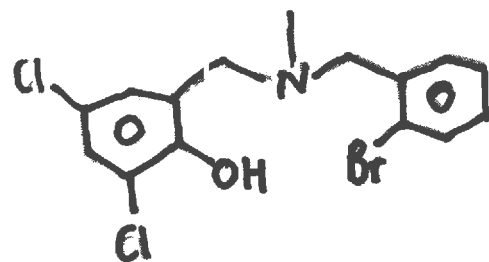


NAME drs-pal-1-36  
EXPNO 6011  
PROCNO 1  
Date 20120612  
Time 4.29  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 1024  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6158014 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00







7.565  
7.549  
7.538  
7.533  
7.507  
7.293  
7.278  
7.258  
7.214  
7.211  
7.145  
7.142  
7.129  
7.126  
7.114  
6.874  
6.872

3.784  
3.723

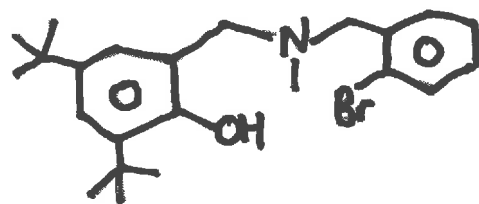
2.268

1.548  
1.432  
1.422  
1.313  
1.312  
1.311  
1.301  
1.295  
1.287  
1.285

dca-pal2-18

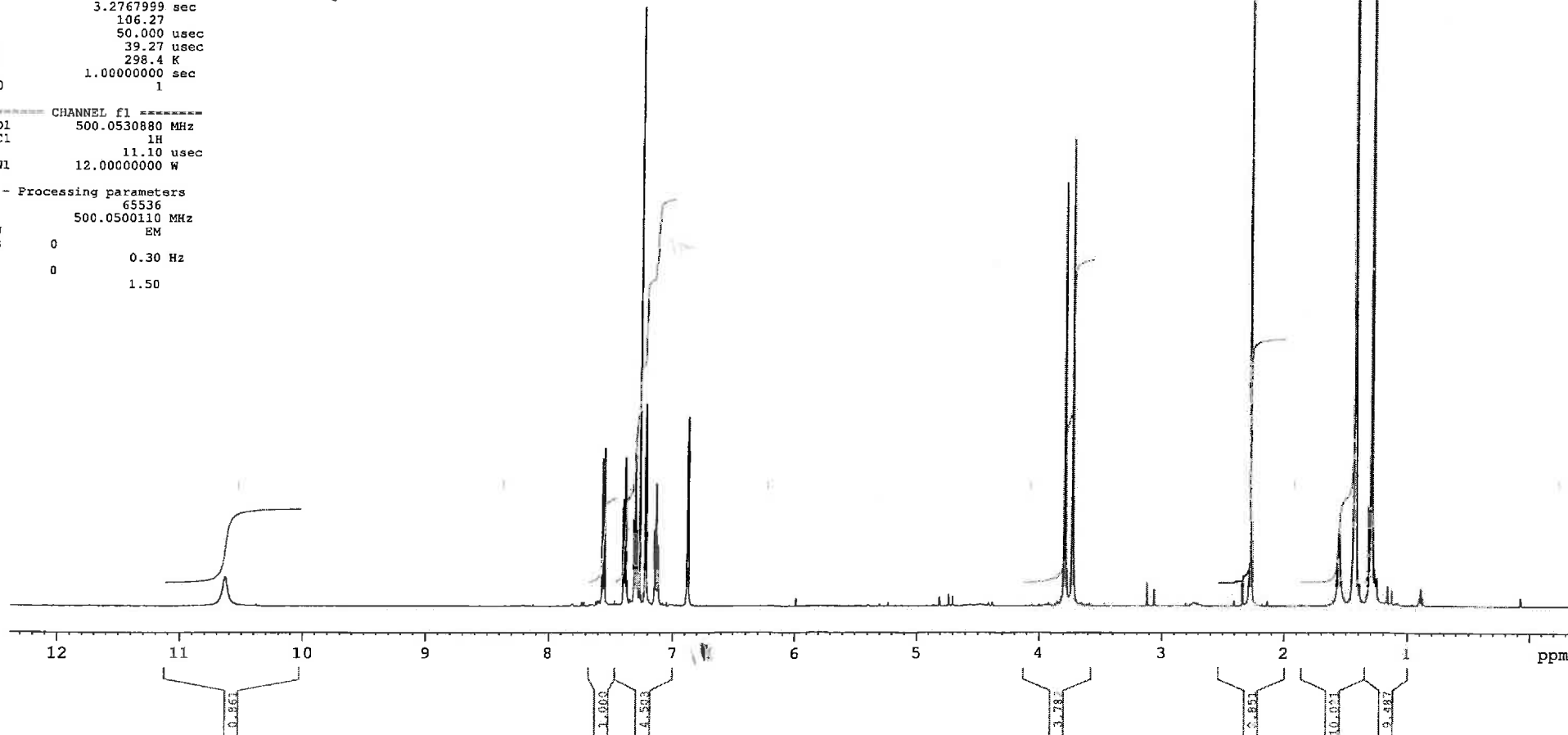
Current Data Parameters  
NAME drs-pal2-18  
EXPNO 10  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120913  
Time 21.14  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 16  
DS 2  
SWH 10000.000 Hz  
FIDRES 0.152588 Hz  
AQ 3.2767999 sec  
RG 106.27  
DW 50.000 usec  
DE 39.27 usec  
TE 298.4 K  
D1 1.00000000 sec  
TD0 1



----- CHANNEL f1 -----  
SFO1 500.0530880 MHz  
NUC1 1H  
P1 11.10 usec  
PLW1 12.00000000 W

F2 - Processing parameters  
SI 65536  
SF 500.0500110 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50



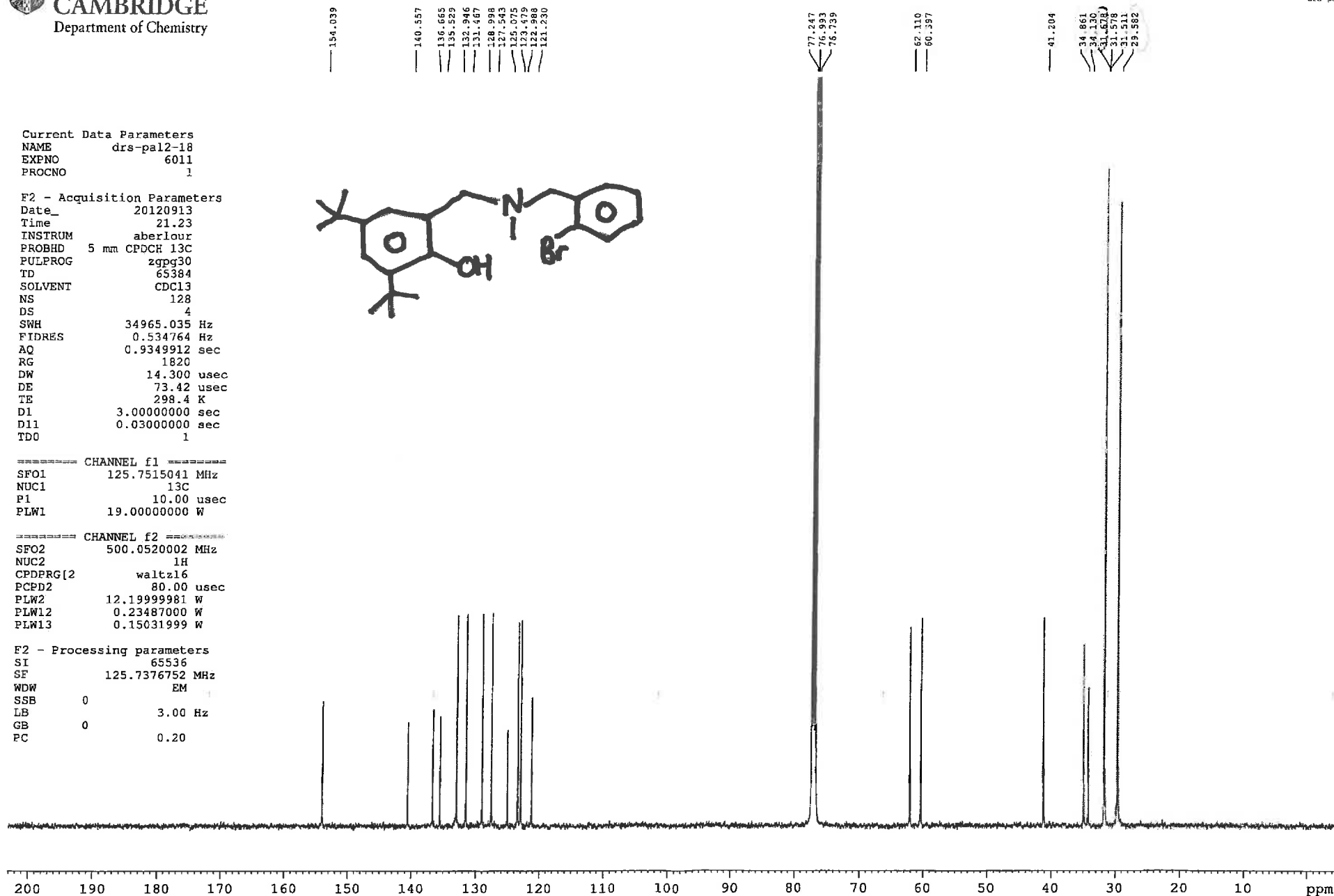
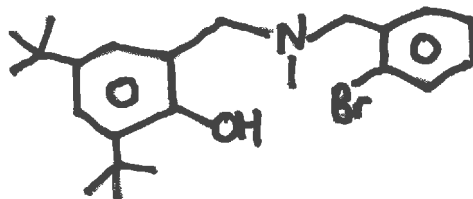
Current Data Parameters  
NAME drs-pal2-18  
EXPNO 6011  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120913  
Time 21.23  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 73.42 usec  
TE 298.4 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20



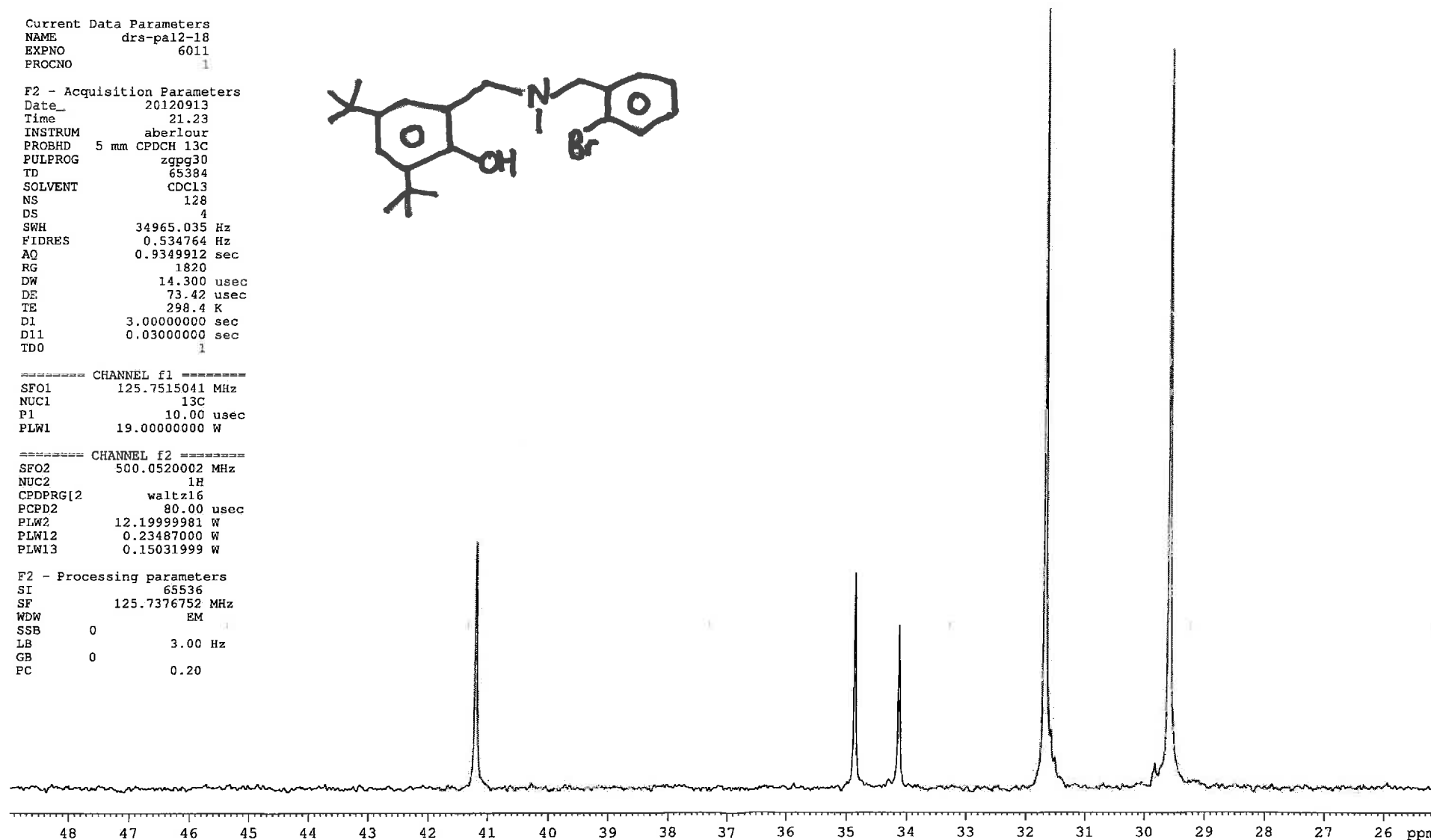
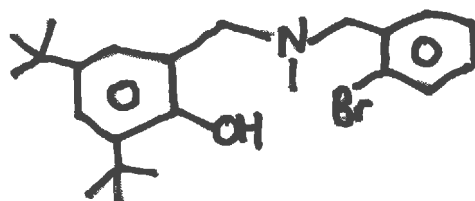
Current Data Parameters  
NAME drs-pa12-18  
EXPNO 6011  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120913  
Time 21.23  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 73.42 usec  
TE 298.4 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

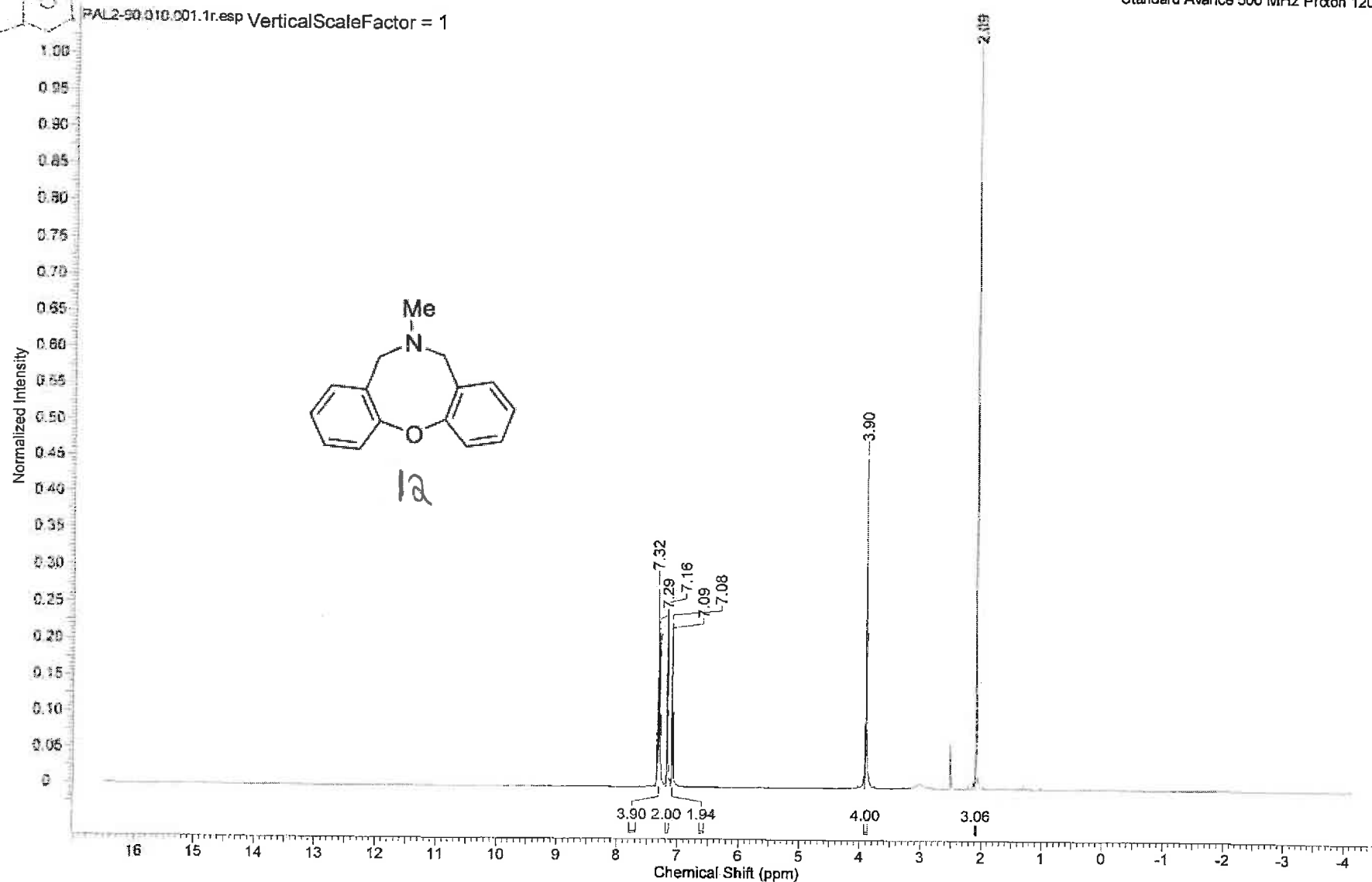
===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20



# TJS-024 Impure Product

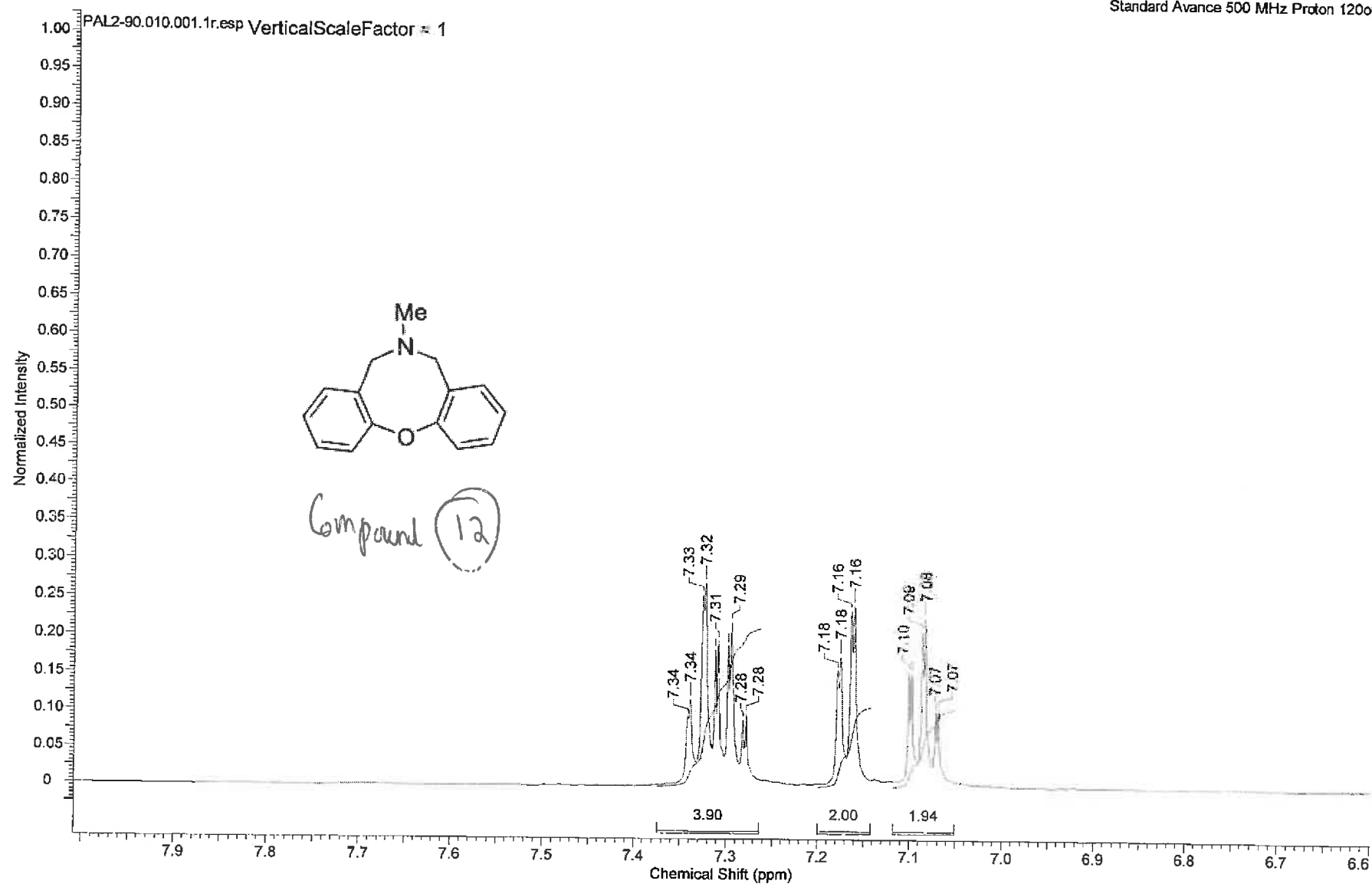
04/12/2012 11:06:56  
TJS-024 Impure Product  
Standard Avance 500 MHz Proton 120°C



Y:\glengrant\ids\nmr\PAL2-90\PAL2-90.010.001.1r.esp

## TJS-024 Impure Product

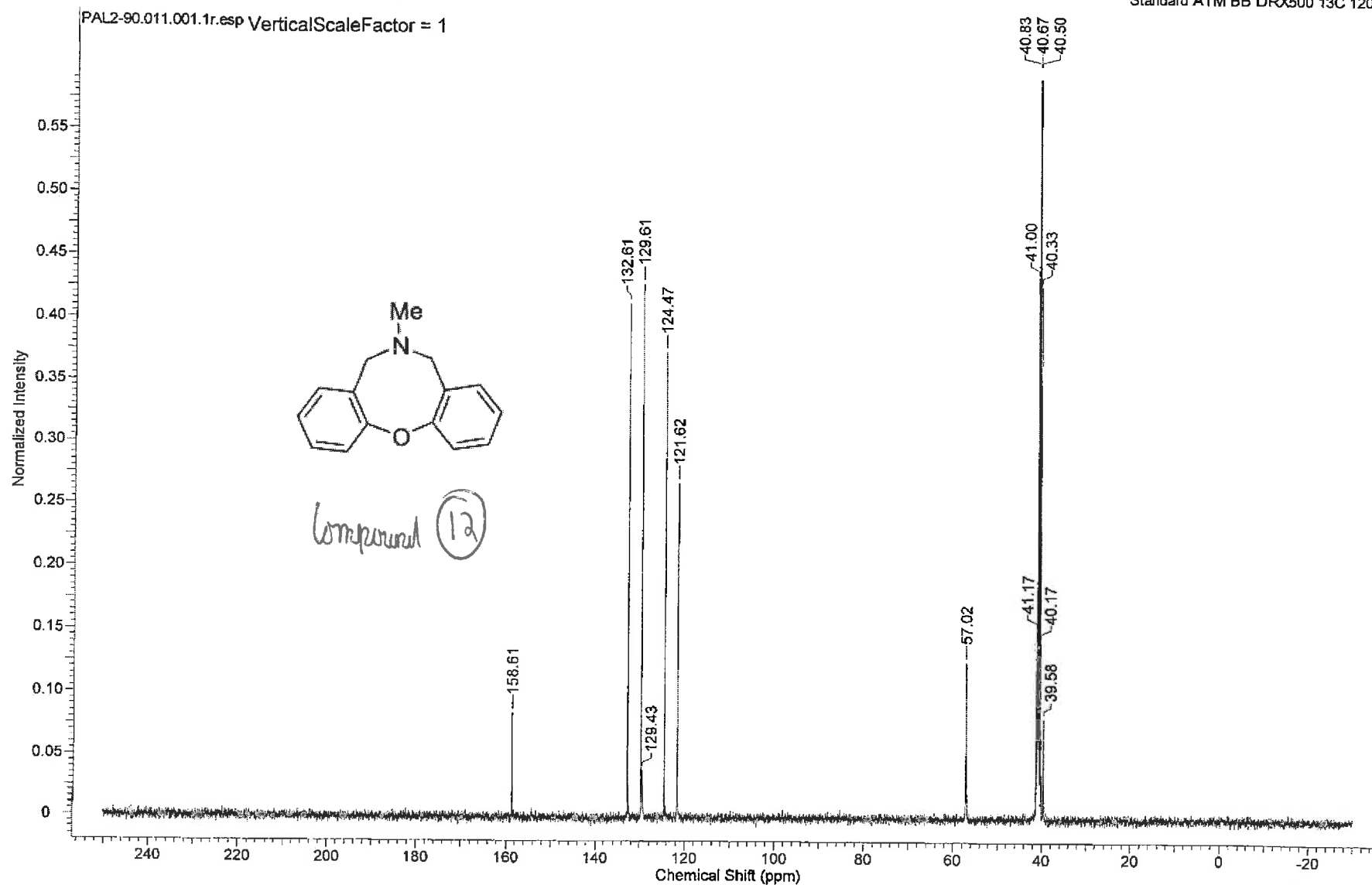
04/12/2012 11:06:17  
TJS-024 Impure Product  
Standard Avance 500 MHz Proton 120oC



Y:\glengrant\tdrs\nmr\PAL2-90\PAL2-90.010.001.1r.esp

## TJS-024 Impure Product

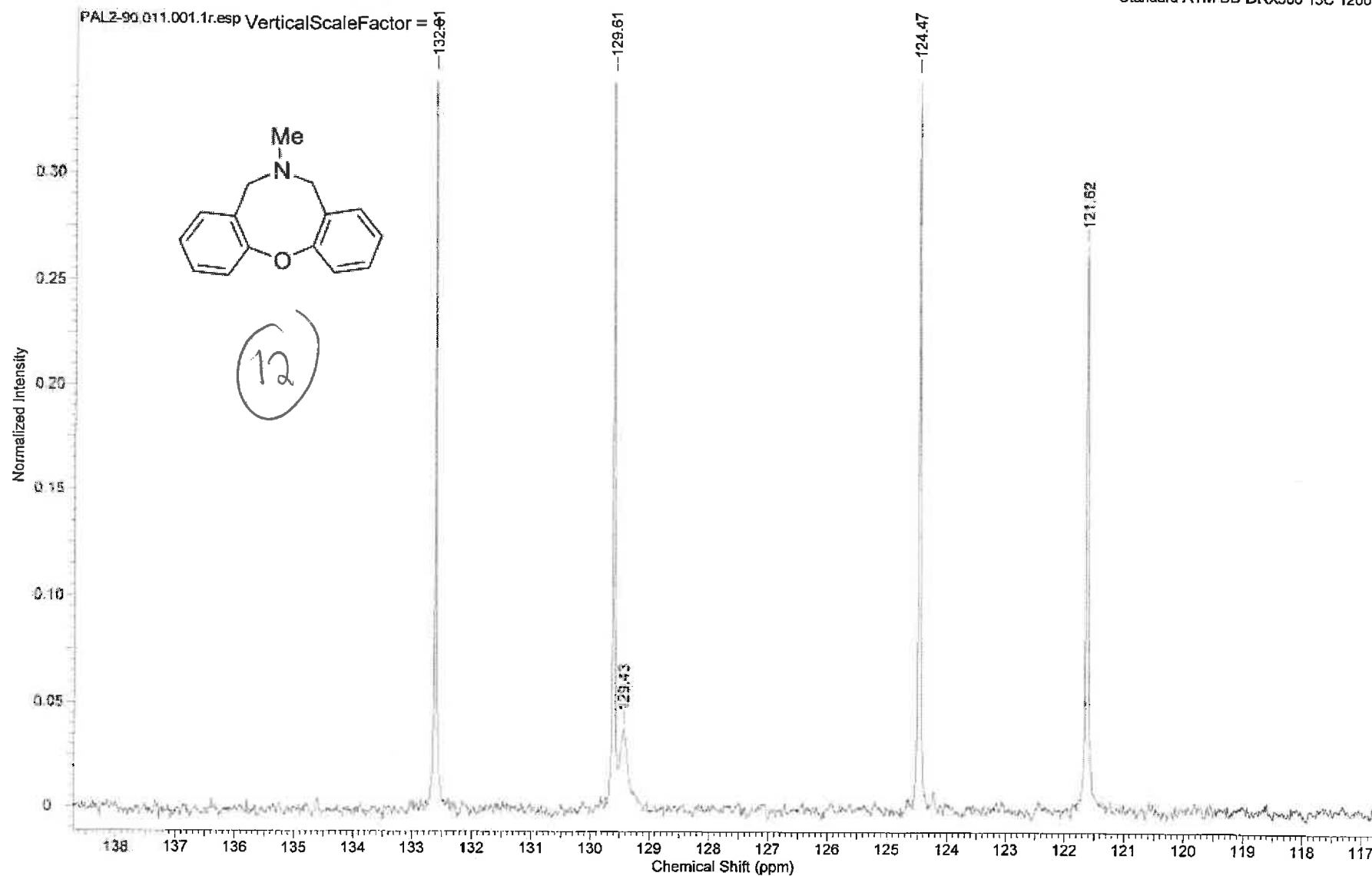
04/12/2012 11:07:58  
TJS-024 Impure Product  
Standard ATM BB DRX500 13C 120oC



Y:\glengrant\drs\nmr\PAL2-90\PAL2-90.011.001.1r.esp

## TJS-024 Impure Product

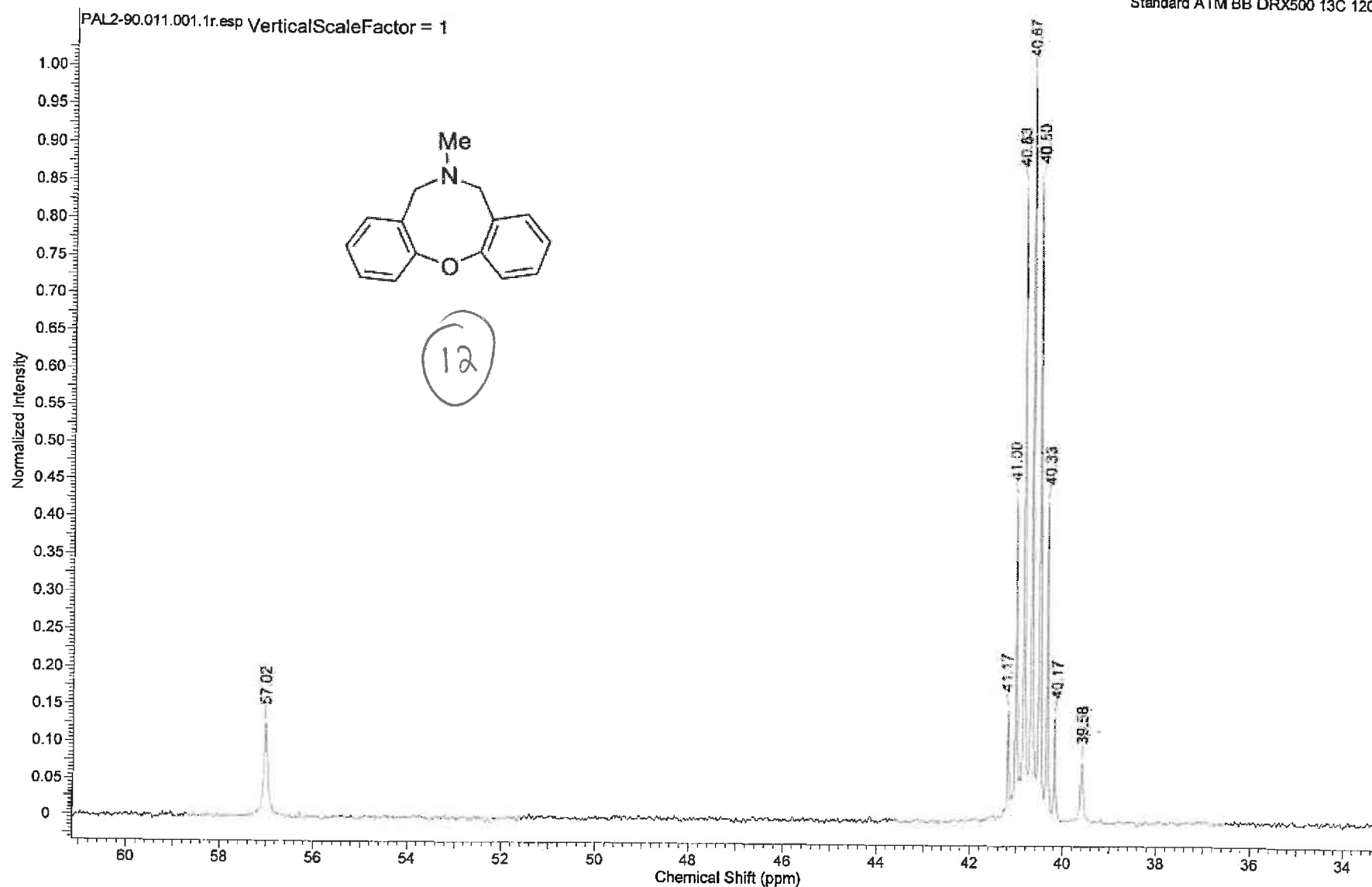
04/12/2012 11:08:15  
TJS-024 Impure Product  
Standard ATM BB DRX500 13C 120oC



Y:\glengrant\drsnmr\PAL2-90\PAL2-90.011.001.1r.esp

## TJS-024 Impure Product

04/12/2012 11:08:30  
TJS-024 Impure Product  
Standard ATM BB DRX500 13C 120oC

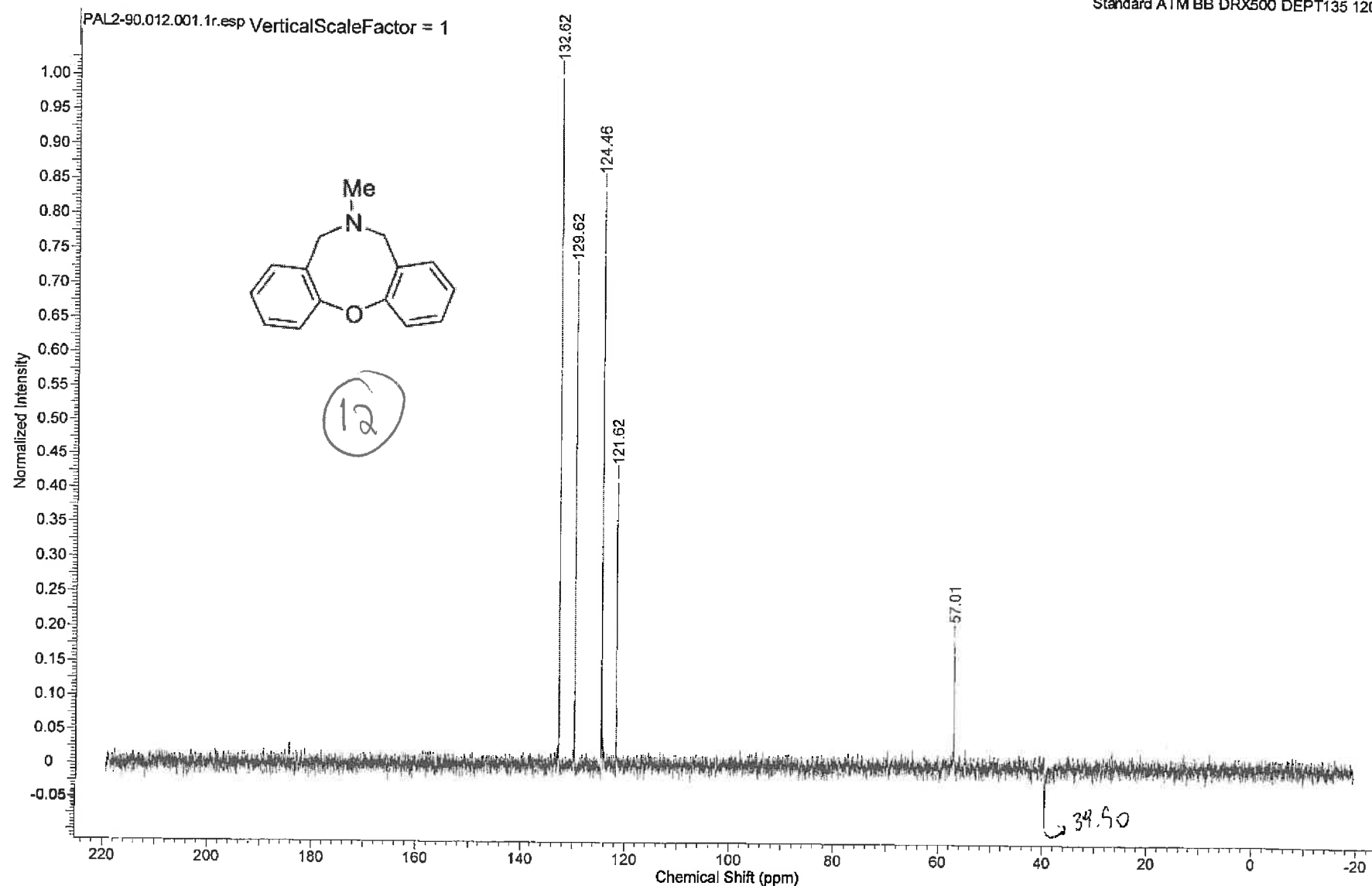


Y:\glengrant\drs\nmr\PAL2-90\PAL2-90.011.001.1r.esp



## TJS-024 Impure Product

04/12/2012 11:09:08  
TJS-024 Impure Product  
Standard ATM BB DRX500 DEPT135 120oC



Y:\glengrant\cds\nmr\PAL2-90\PAL2-90.012.001.1r.esp

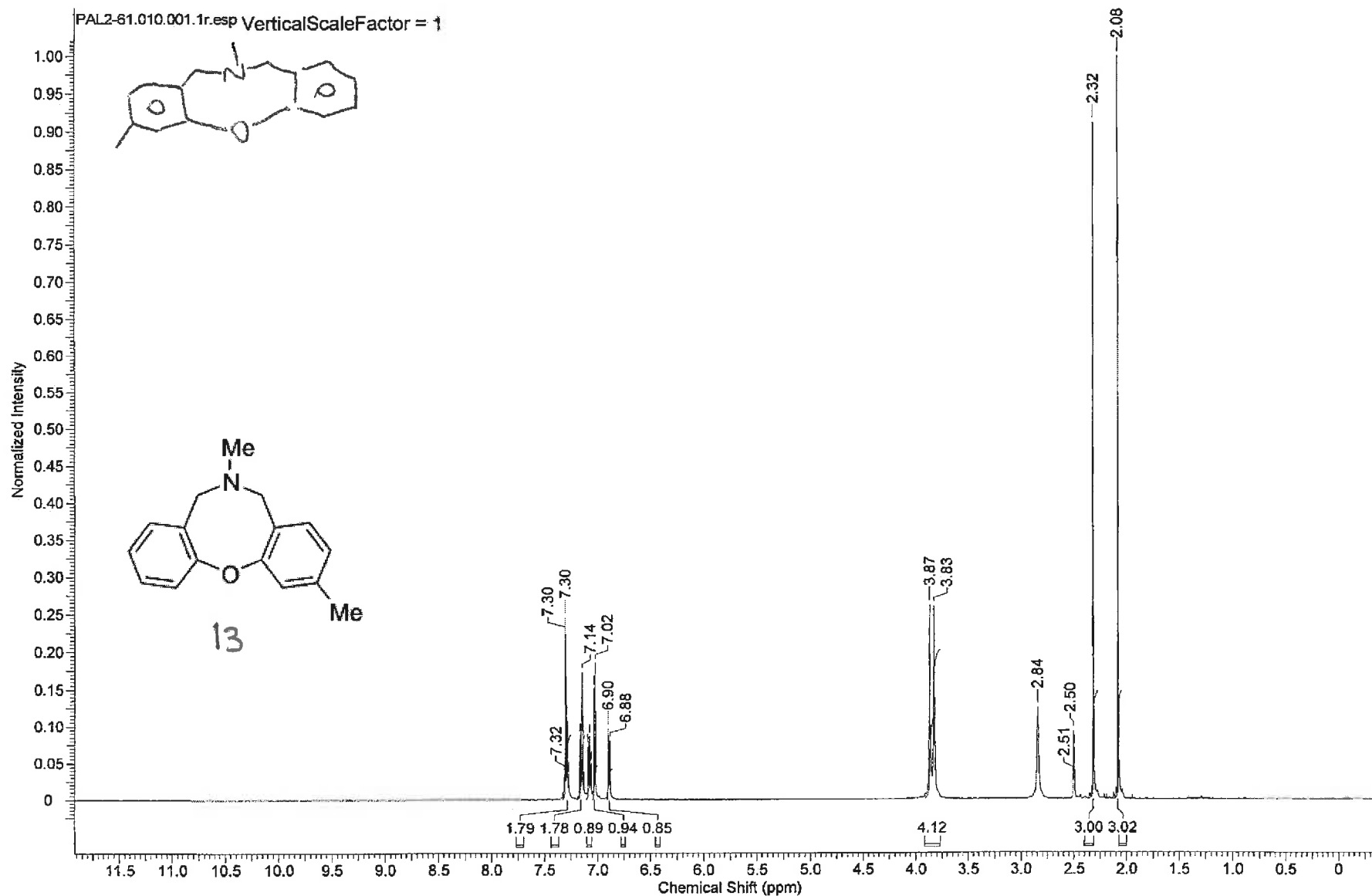
179, 182

This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

PAL 2-61 T=120°C

# TJS-013 2nd Fract

02/11/2012 11:50:02  
TJS-013 2nd Fract



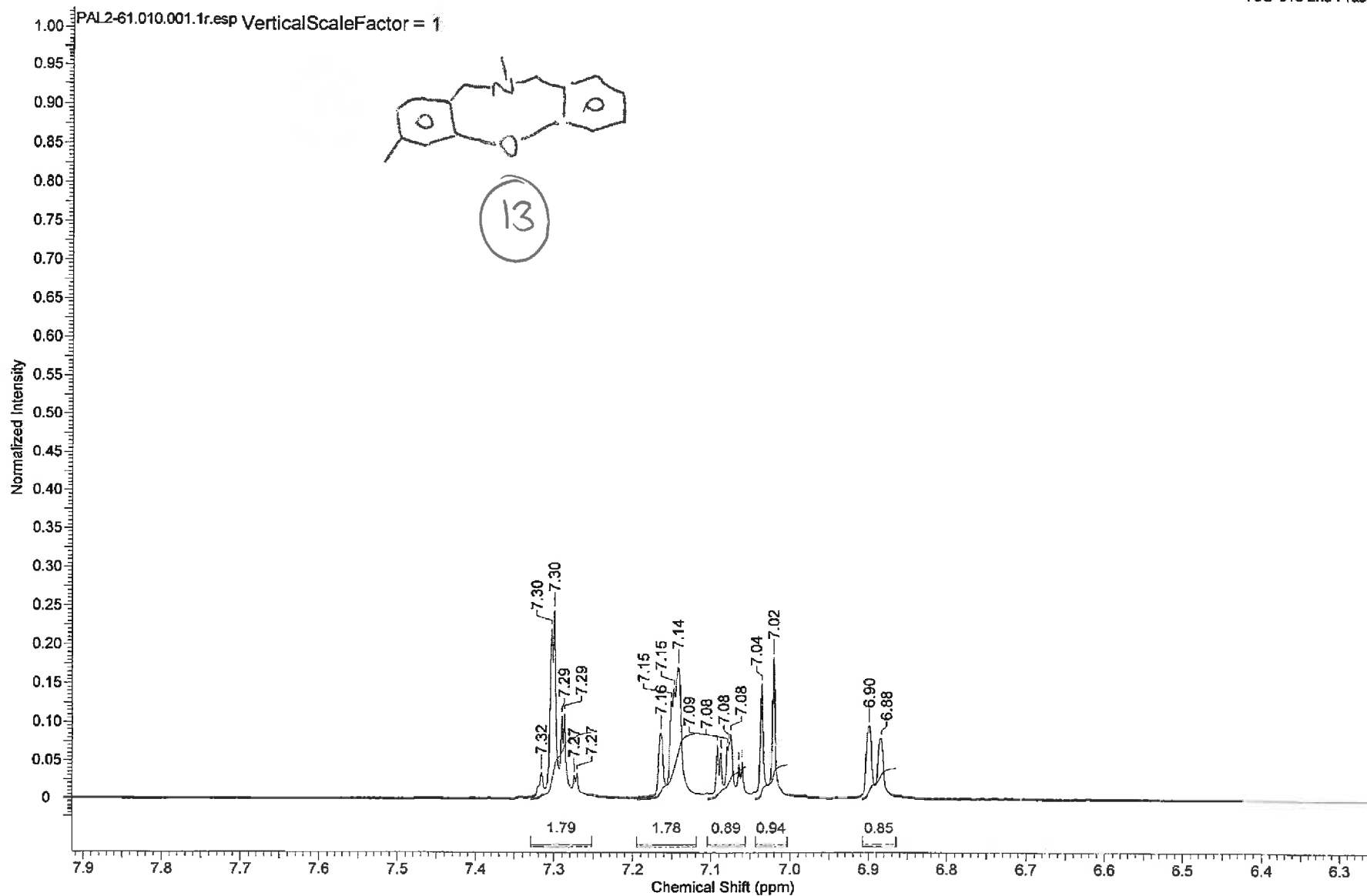
Y:\glengrant\drs\nmr\PAL2-61\PAL2-61.010.001.1r.esp

$-T^{\circ}C = 120^{\circ}C$

This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

## TJS-013 2nd Fract

02/11/2012 11:49:30  
TJS-013 2nd Fract



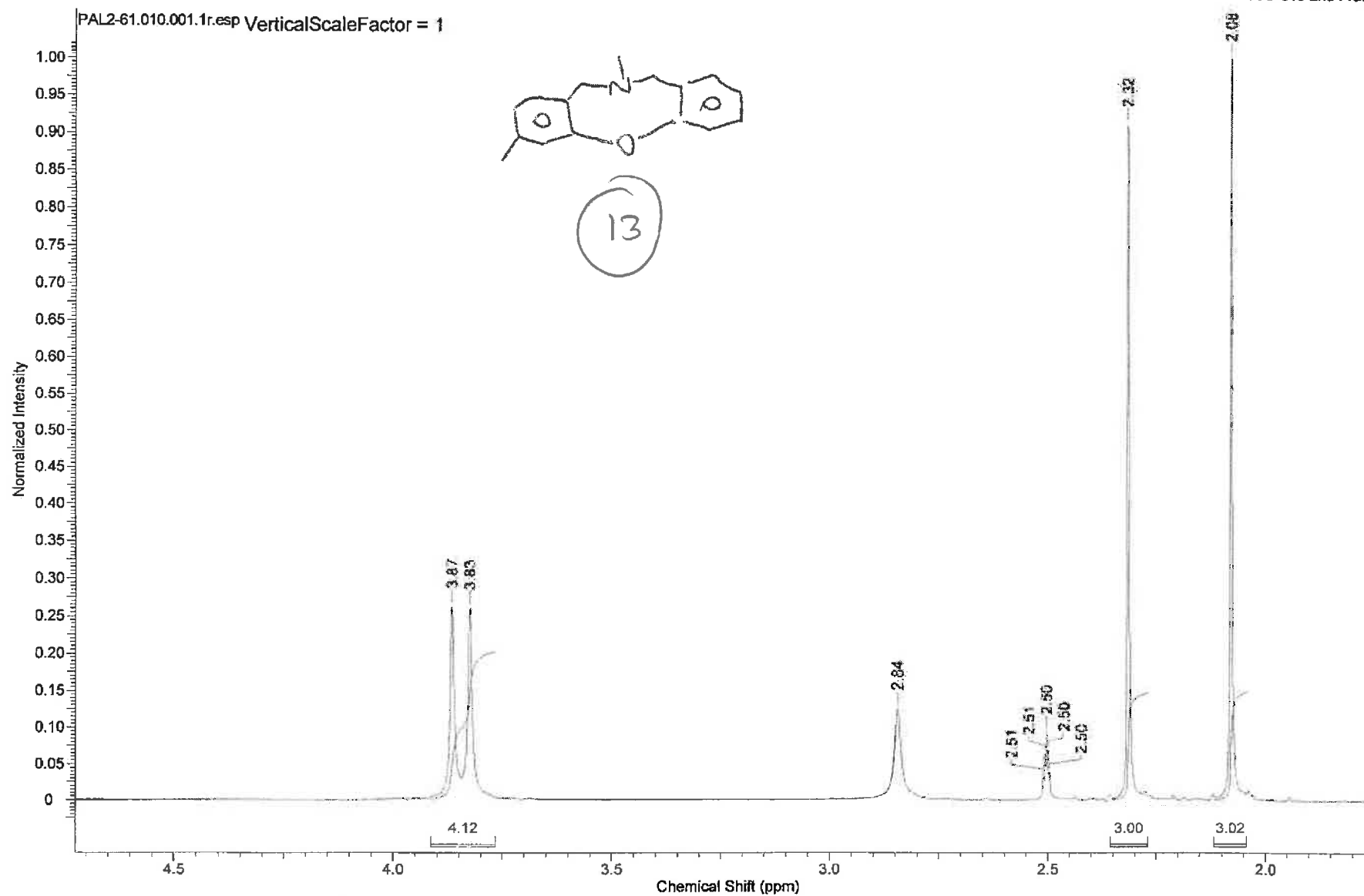
Y:\glengrant\drs\nmr\PAL2-61\PAL2-61.010.001.1r.esp

T°C = 120°C

This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

### TJS-013 2nd Fract

02/11/2012 11:50:35  
TJS-013 2nd Fract



Y:\gengrant\drs\nmr\PAL2-61\PAL2-61.010.001.1r.esp

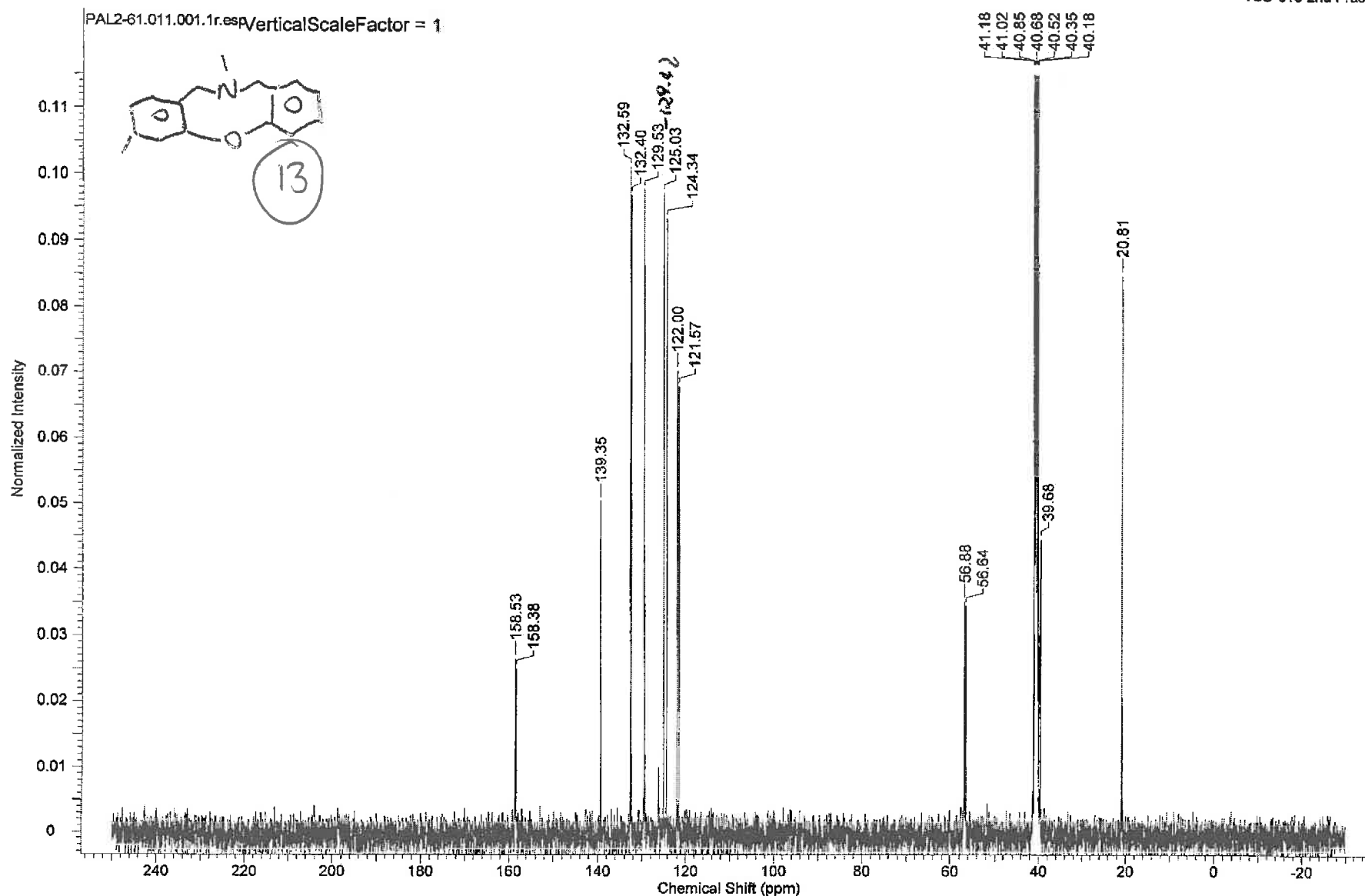
T = 120°C

AL 2-61

This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

# TJS-013 2nd Fract

02/11/2012 11:54:26  
TJS-013 2nd Fract



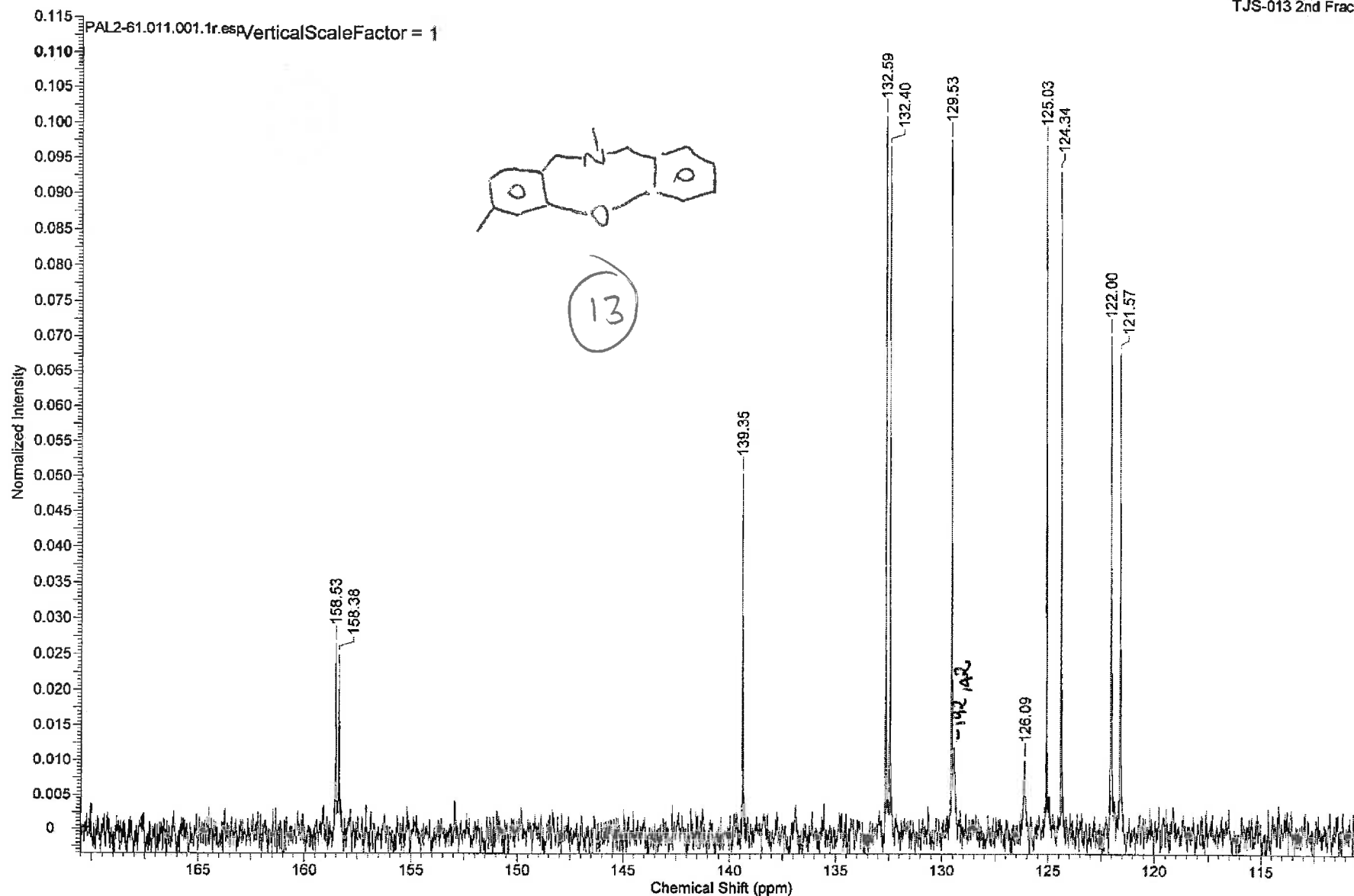
Y:\lgengrant\drs\nmr\PAL2-61\PAL2-61.011.001.1r.esp

T.C = 120°C

This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

# TJS-013 2nd Fract

02/11/2012 11:53:22  
TJS-013 2nd Fract



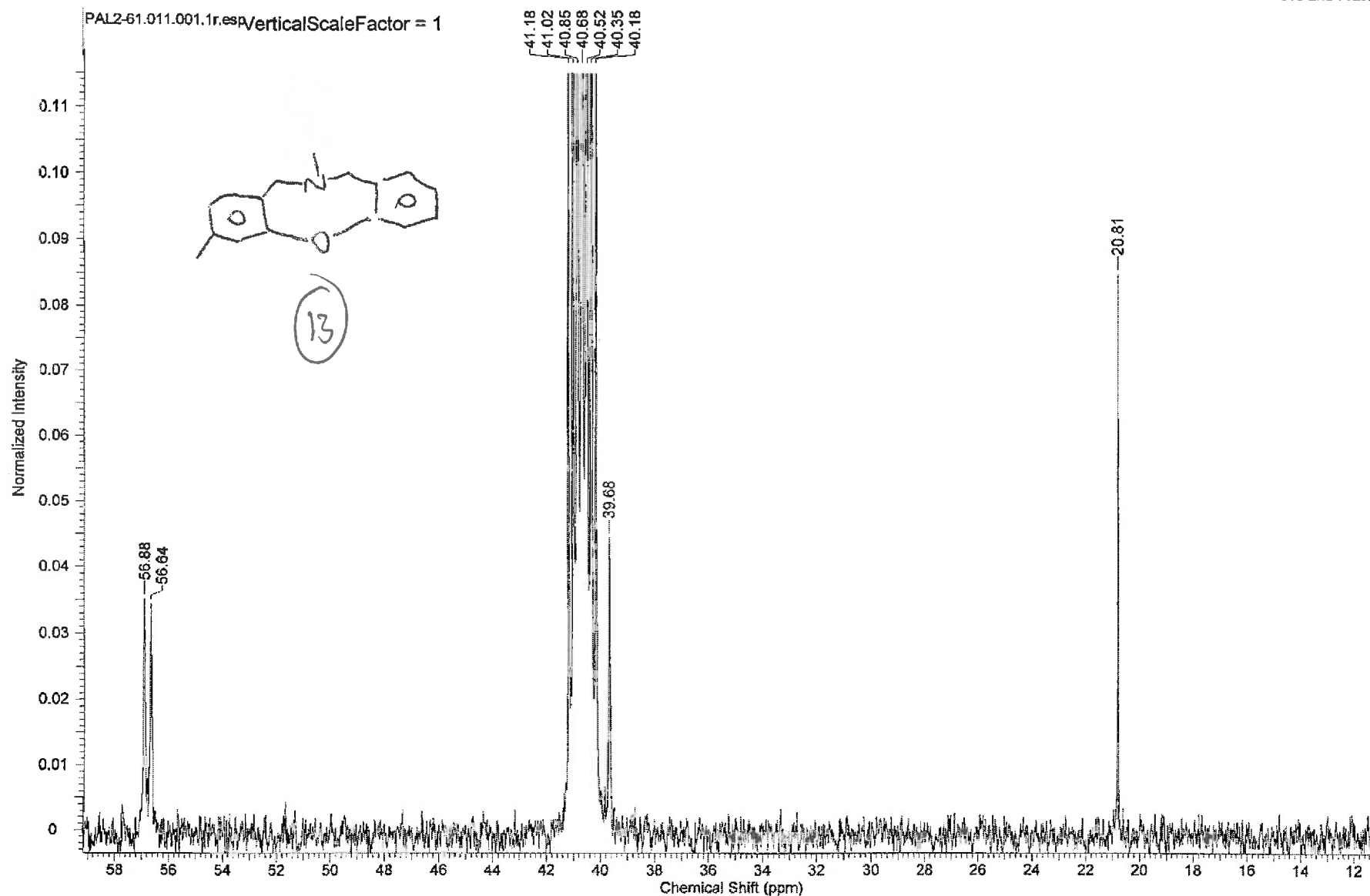
Y:\glengrant\cds\nmr\PAL2-61\PAL2-61.011.001.1r.esp

T<sup>o</sup>C = 120<sup>o</sup>C

This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

## TJS-013 2nd Fract

02/11/2012 11:55:00  
TJS-013 2nd Fract



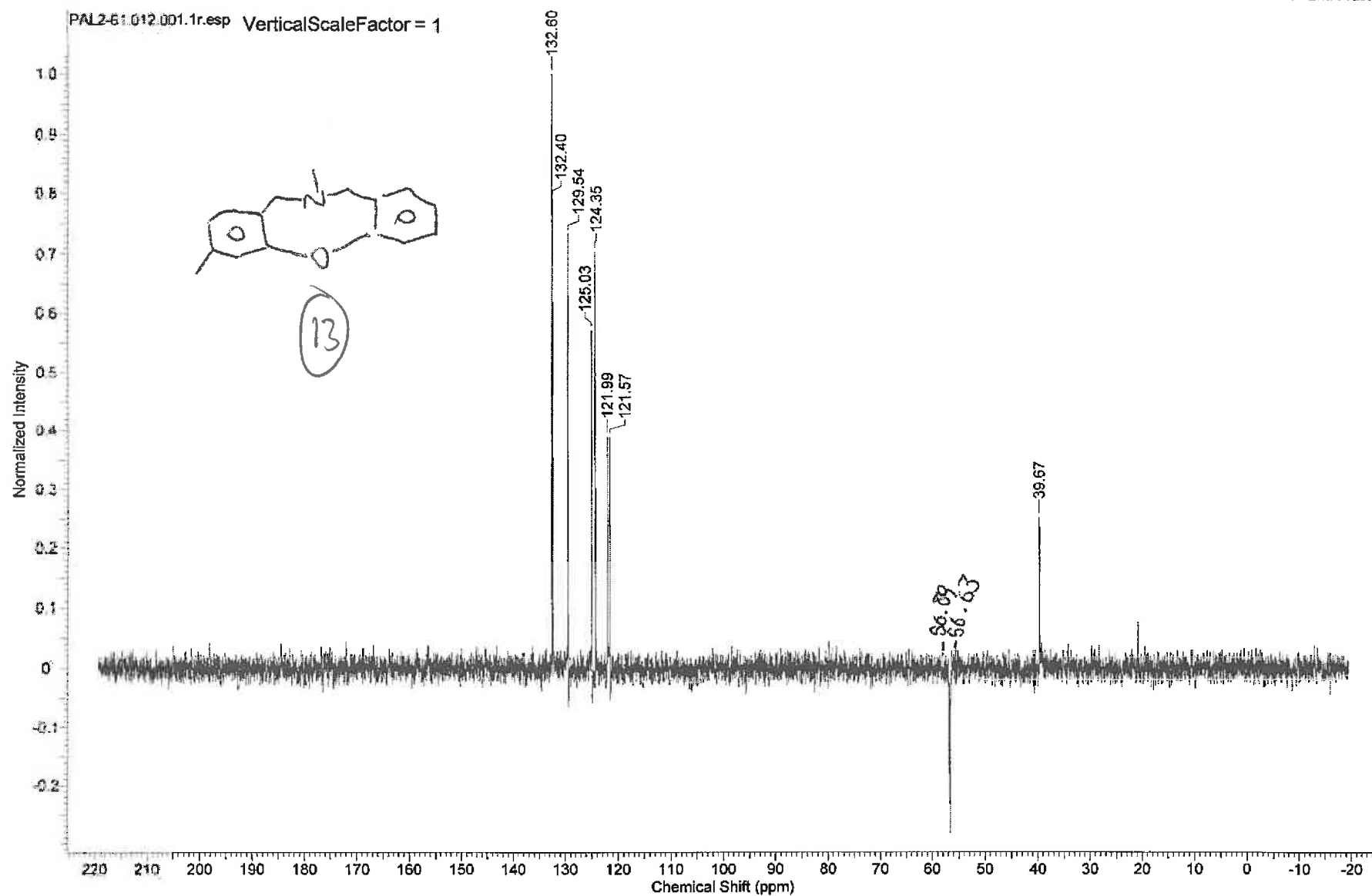
Y:\glengrant\drs\nmr\PAL2-61\PAL2-61.011.001.1r.esp

T<sup>o</sup>C = 120<sup>o</sup>C

This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

## TJS-013 2nd Fract

02/11/2012 12:02:47  
TJS-013 2nd Fract

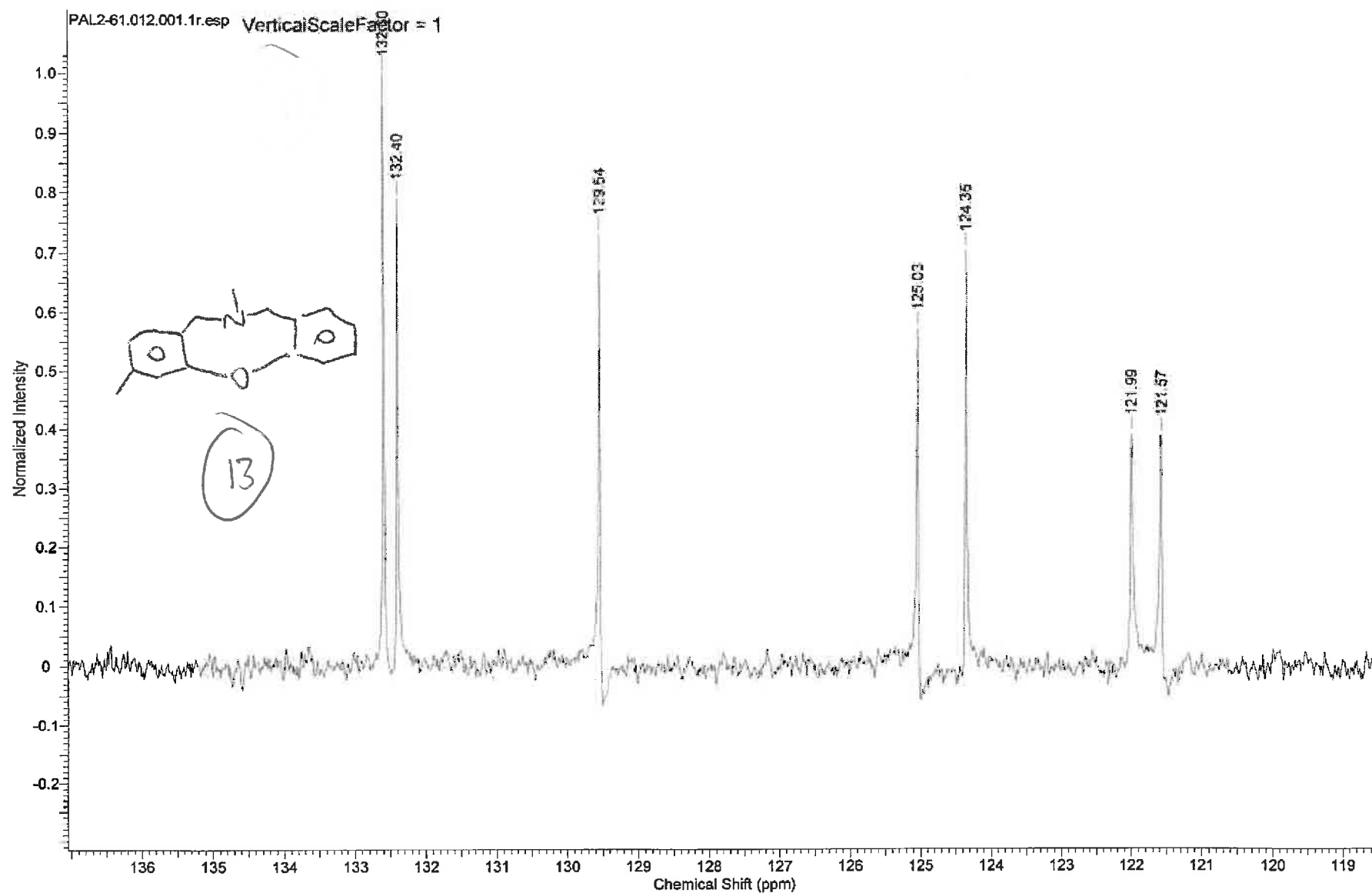


Y:\glengrant\drs\nmr\PAL2-61\PAL2-61.012.001.1r.esp



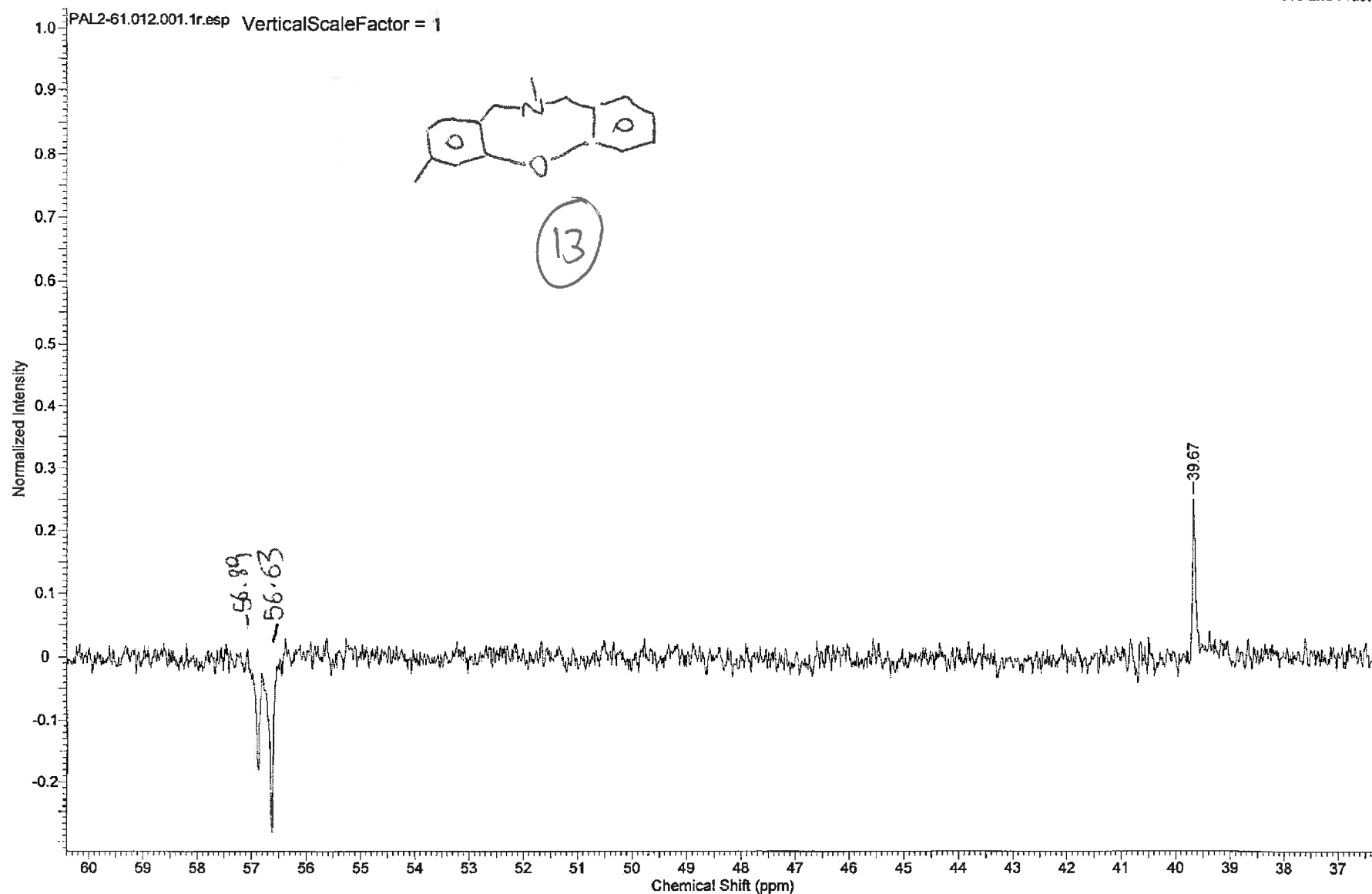
## TJS-013 2nd Fract

02/11/2012 12:09:59  
TJS-013 2nd Fract



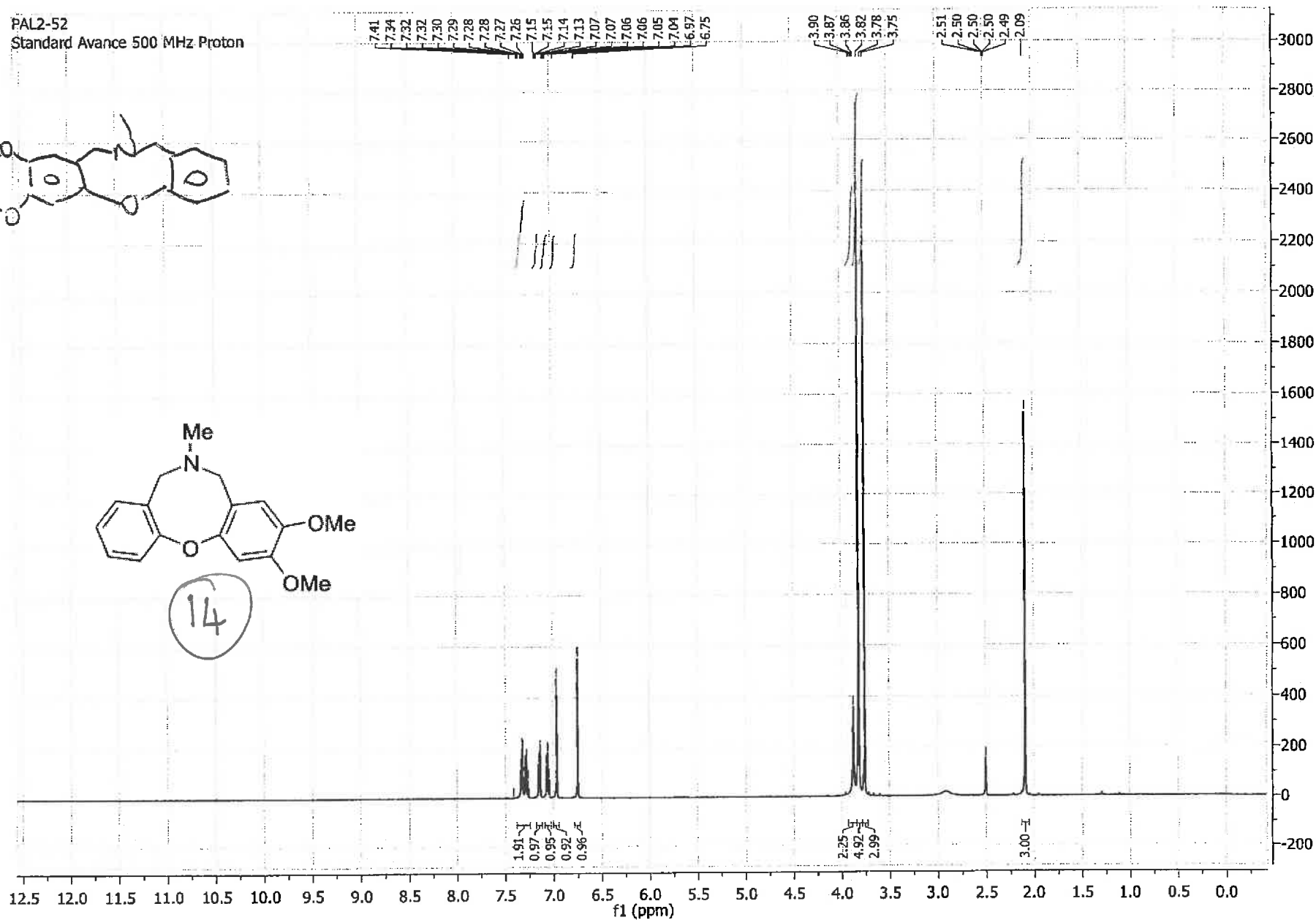
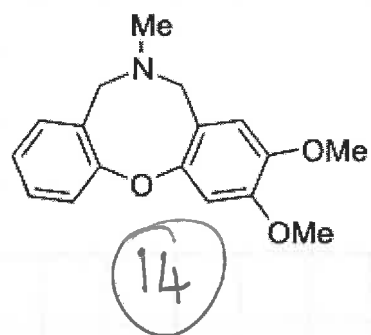
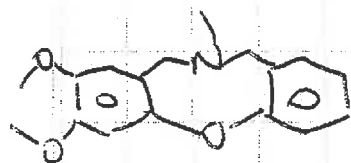
Y:\glengrant\drs\nmr\PAL2-61\PAL2-61.012.001.1r.esp

02/11/2012 12:10:28  
TJS-013 2nd Fract

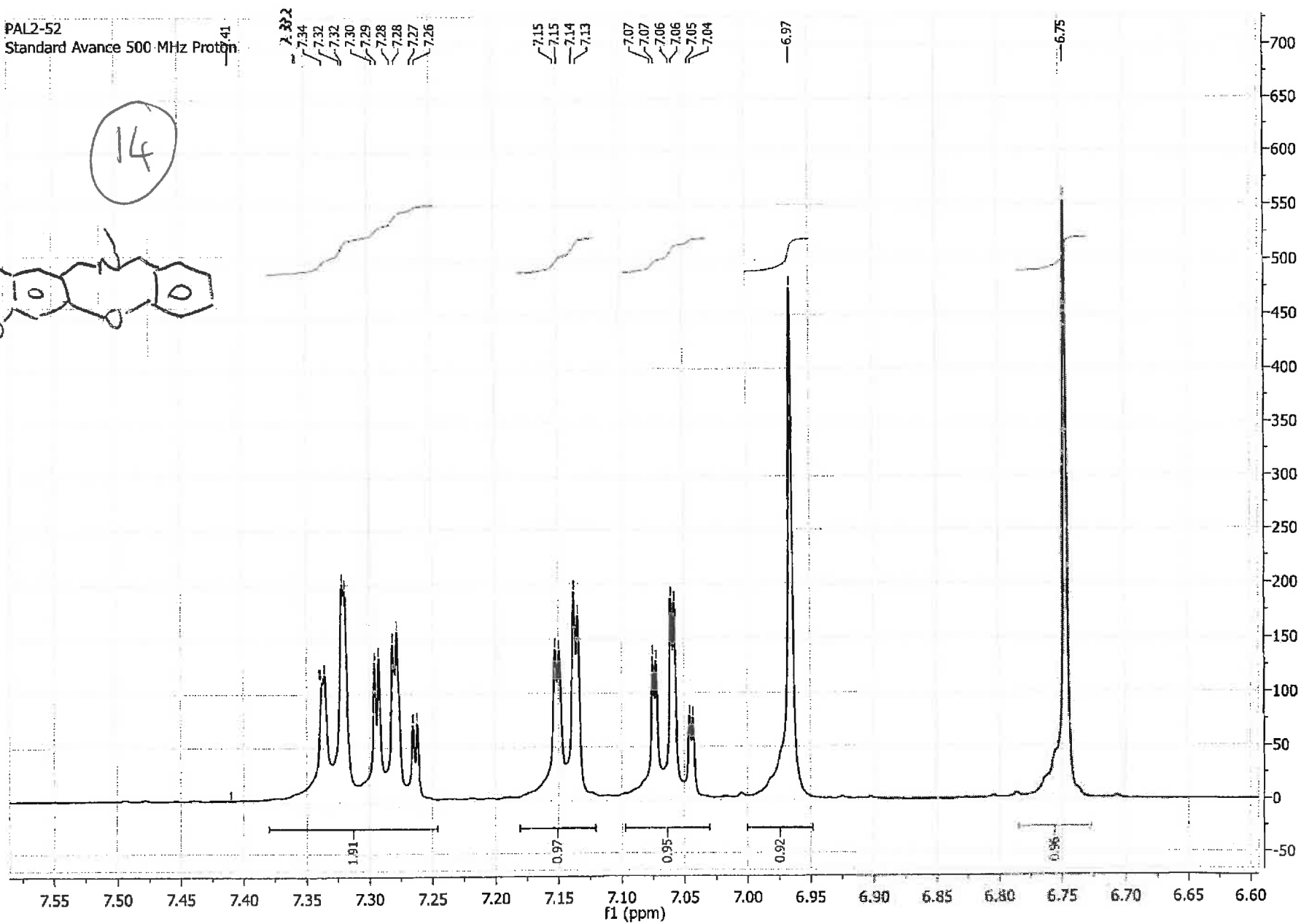
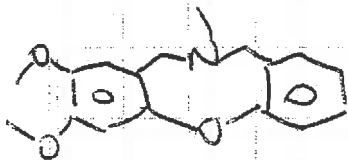


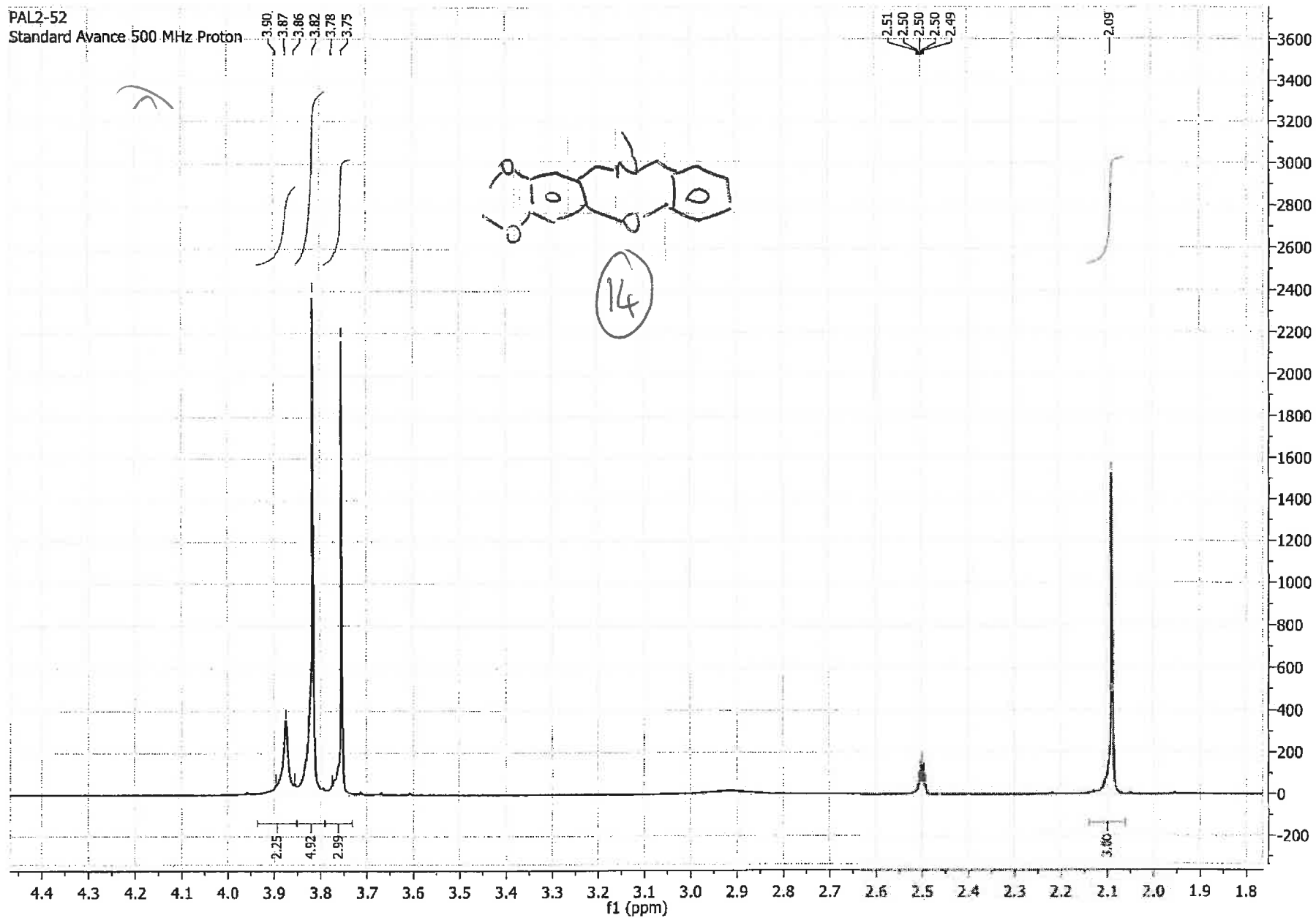
Y:\glengrant\drs\nmr\PAL2-61\PAL2-61.012.001.1r.esp

PAL2-52  
Standard Avance 500 MHz Proton

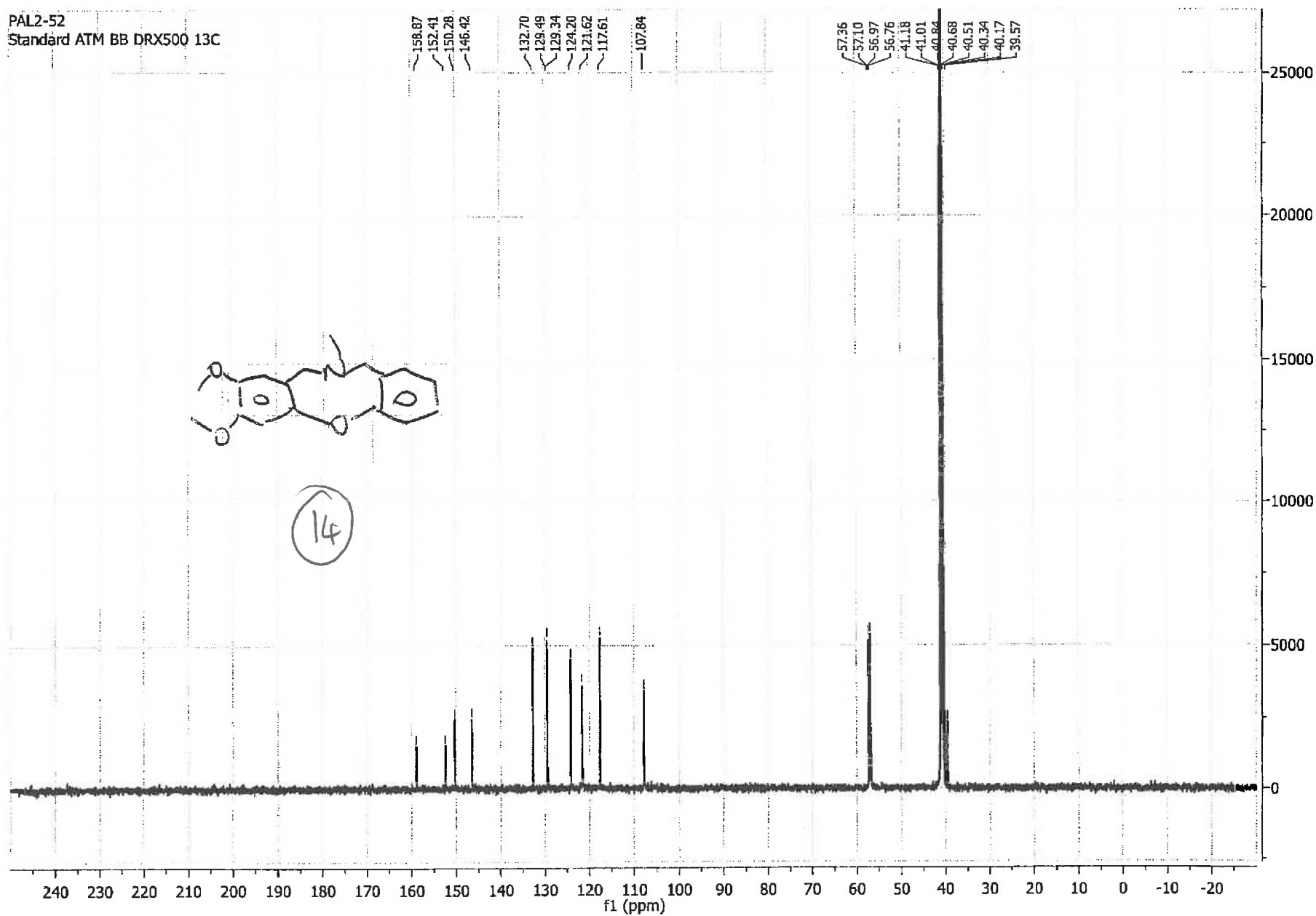


14

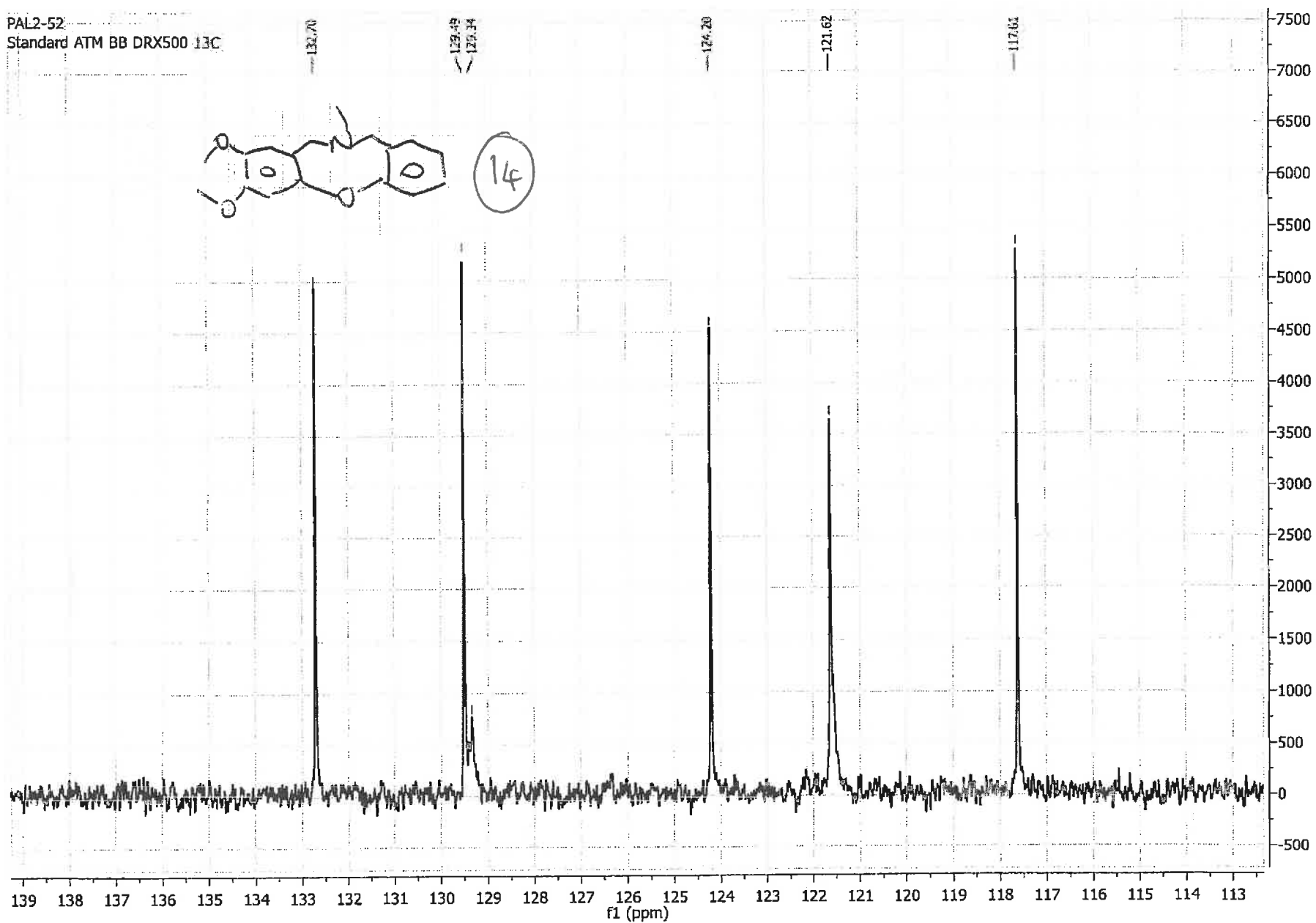




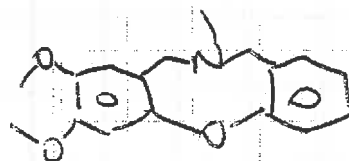
PAL2-52  
Standard ATM BB DRX500 13C



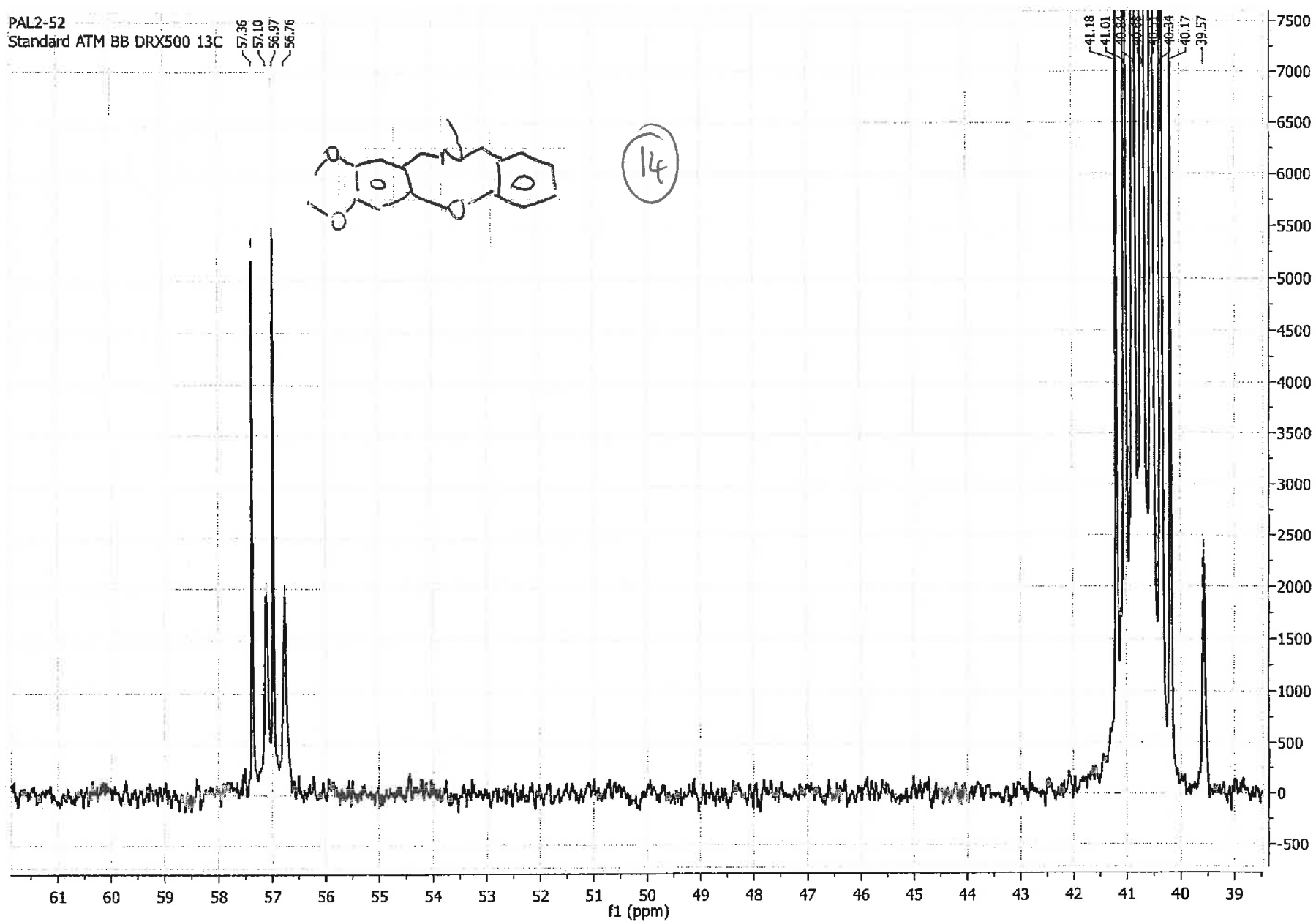
PAL2-52  
Standard ATM BB DRX500 13C



57.36  
57.10  
56.97  
56.76

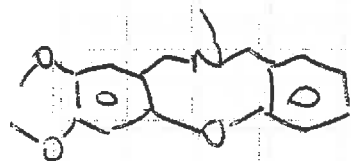


14

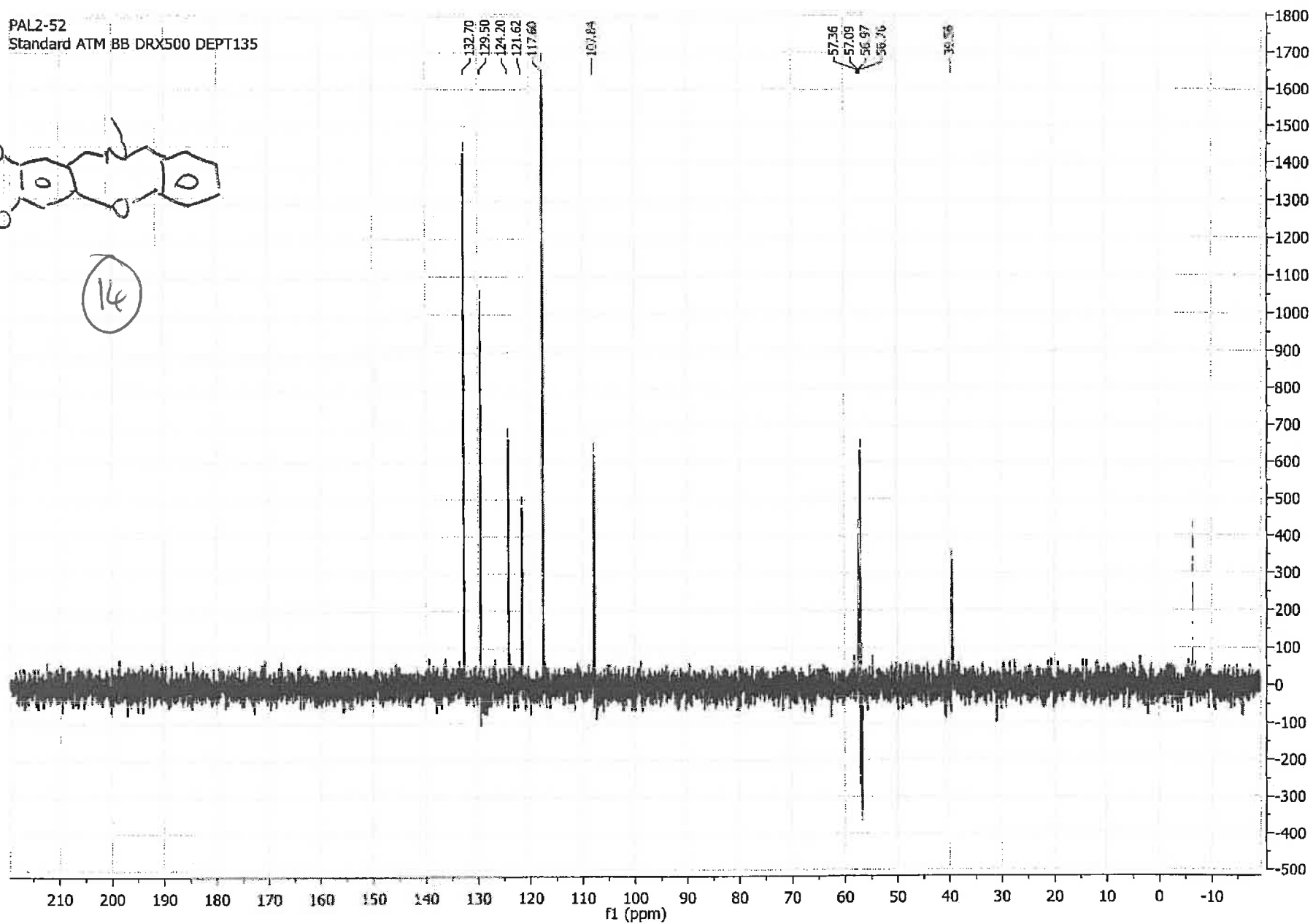




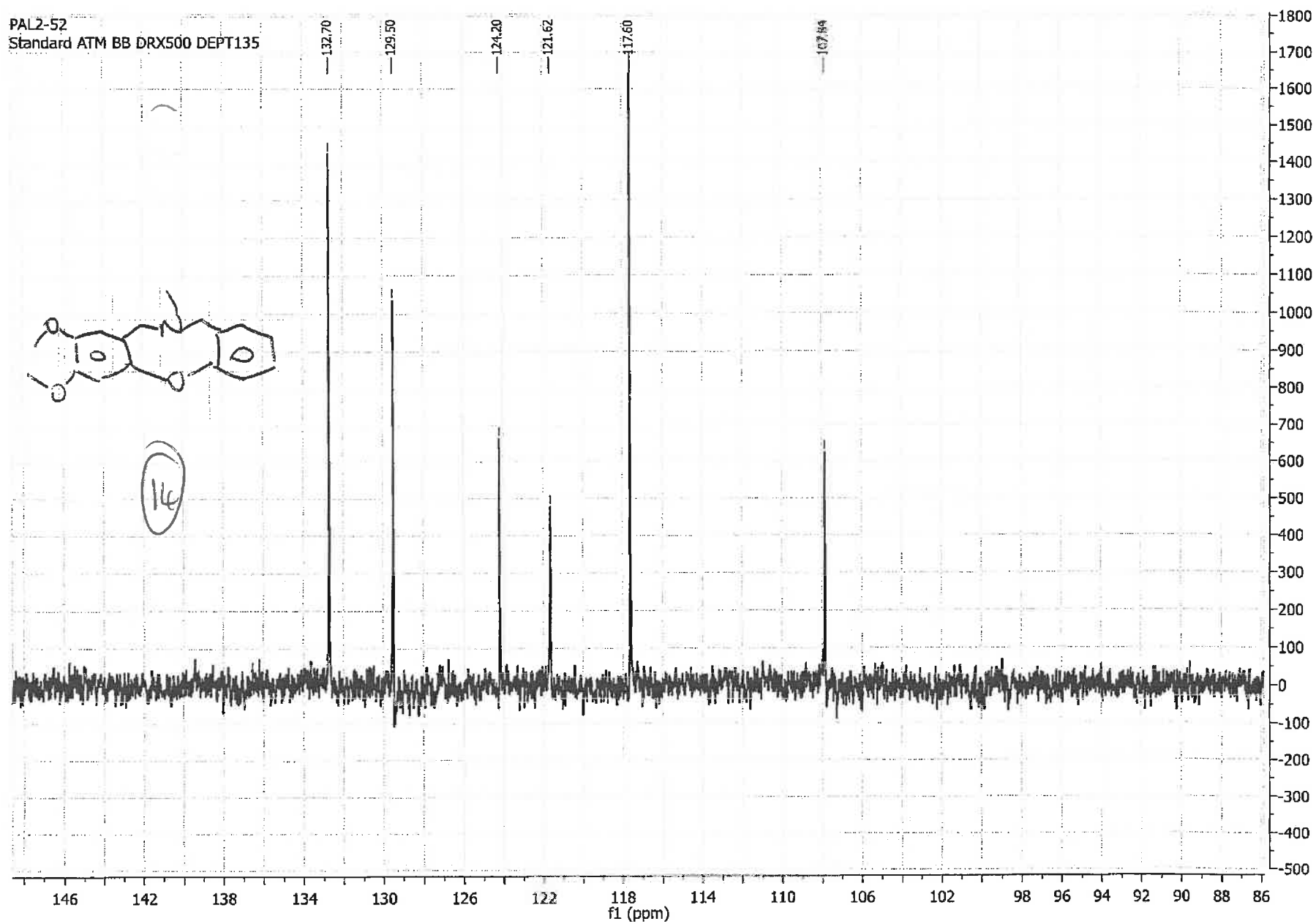
PAL2-52  
Standard ATM BB DRX500 DEPT135



14



PAL2-52  
Standard ATM BB DRX500 DEPT135

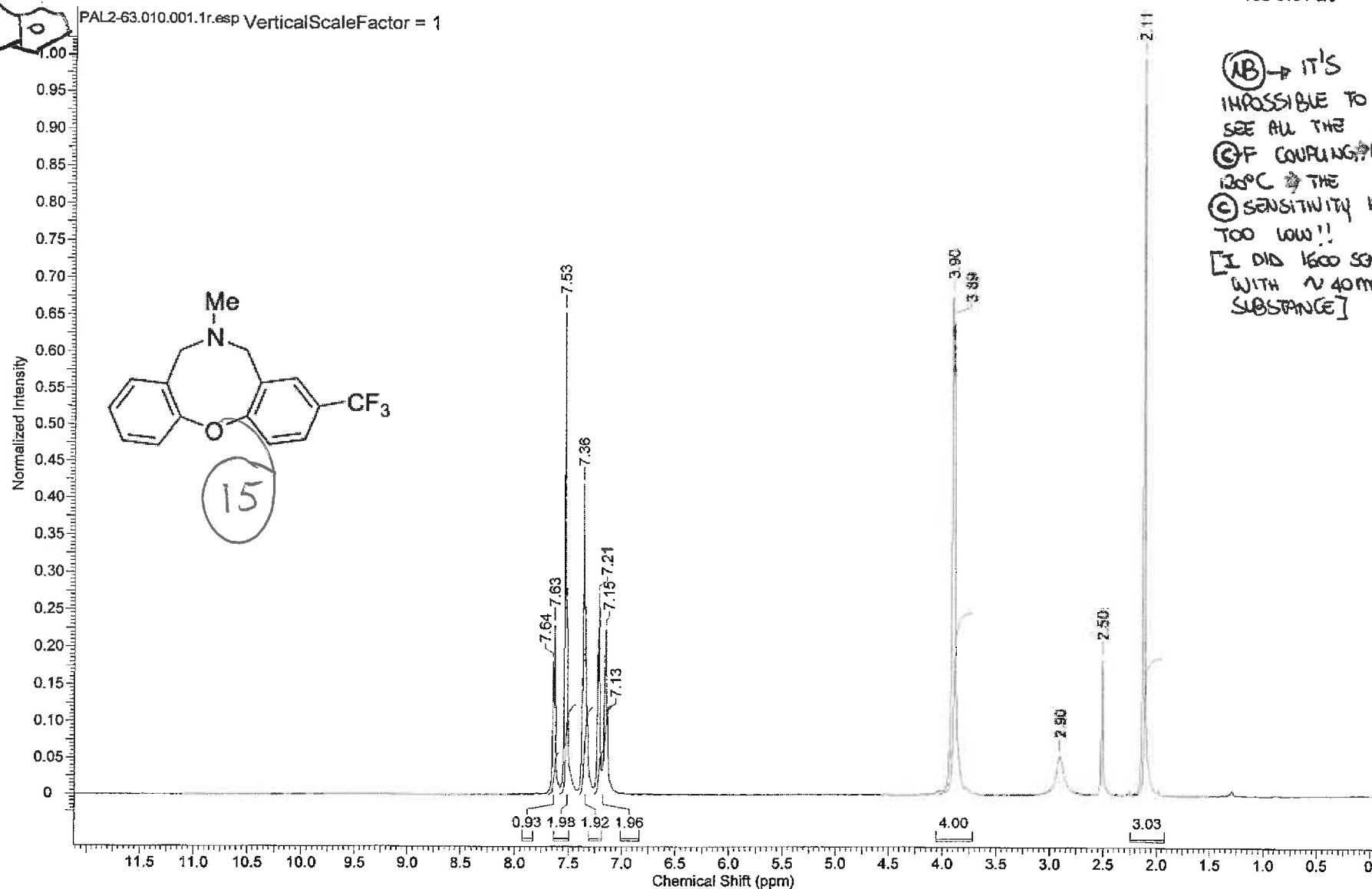




PAL 2-63

T<sub>0</sub>C = 120°CThis report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)

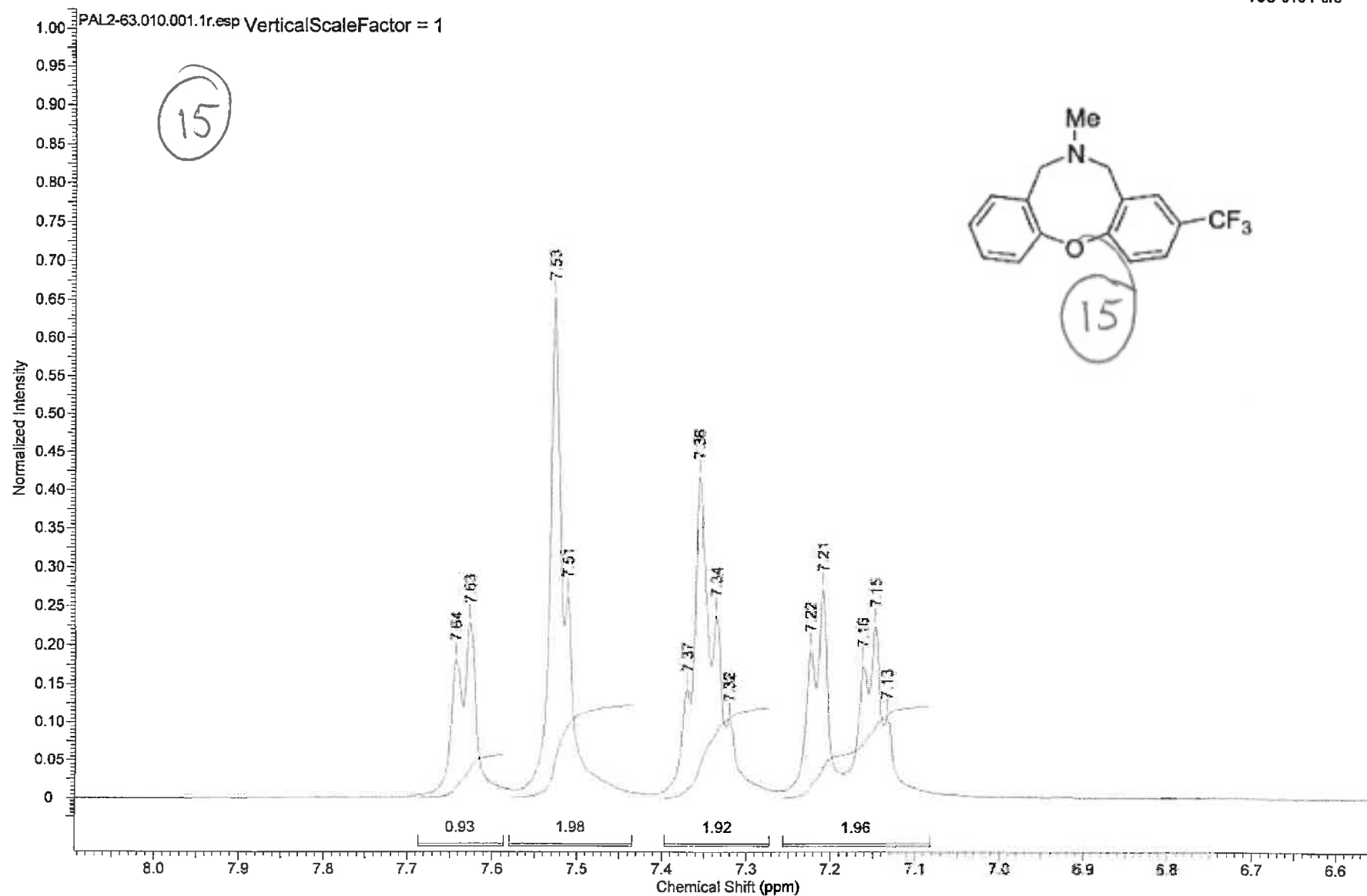
TJS-016 Pure

08/11/2012 19:18:08  
TJS-016 Pure

(AB) → IT'S  
IMPOSSIBLE TO  
SEE ALL THE  
C-F COUPLING AT  
120°C THE  
SENSITIVITY IS  
TOO LOW!!  
[I DID 1600 SCANS  
WITH ~40mg OF  
SUBSTANCE]

Y:\glengrant\drs\nmr\PAL2-63\PAL2-63.010.001.1r.esp

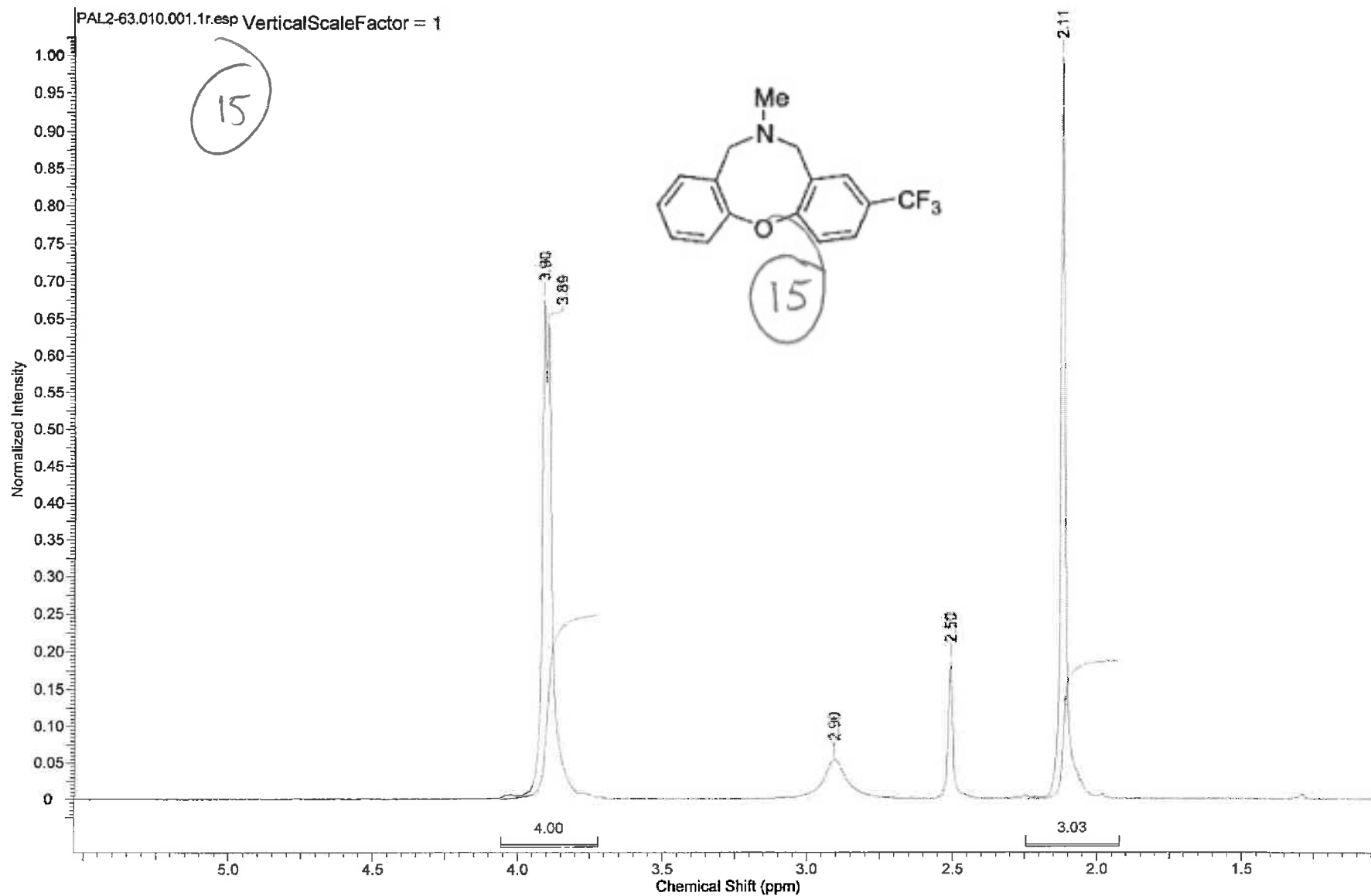
08/11/2012 19:17:21  
TJS-016 Pure



Y:\glengrant\ids\nmr\PAL2-63\PAL2-63.010.001.1r.esp

# TJS-016 Pure

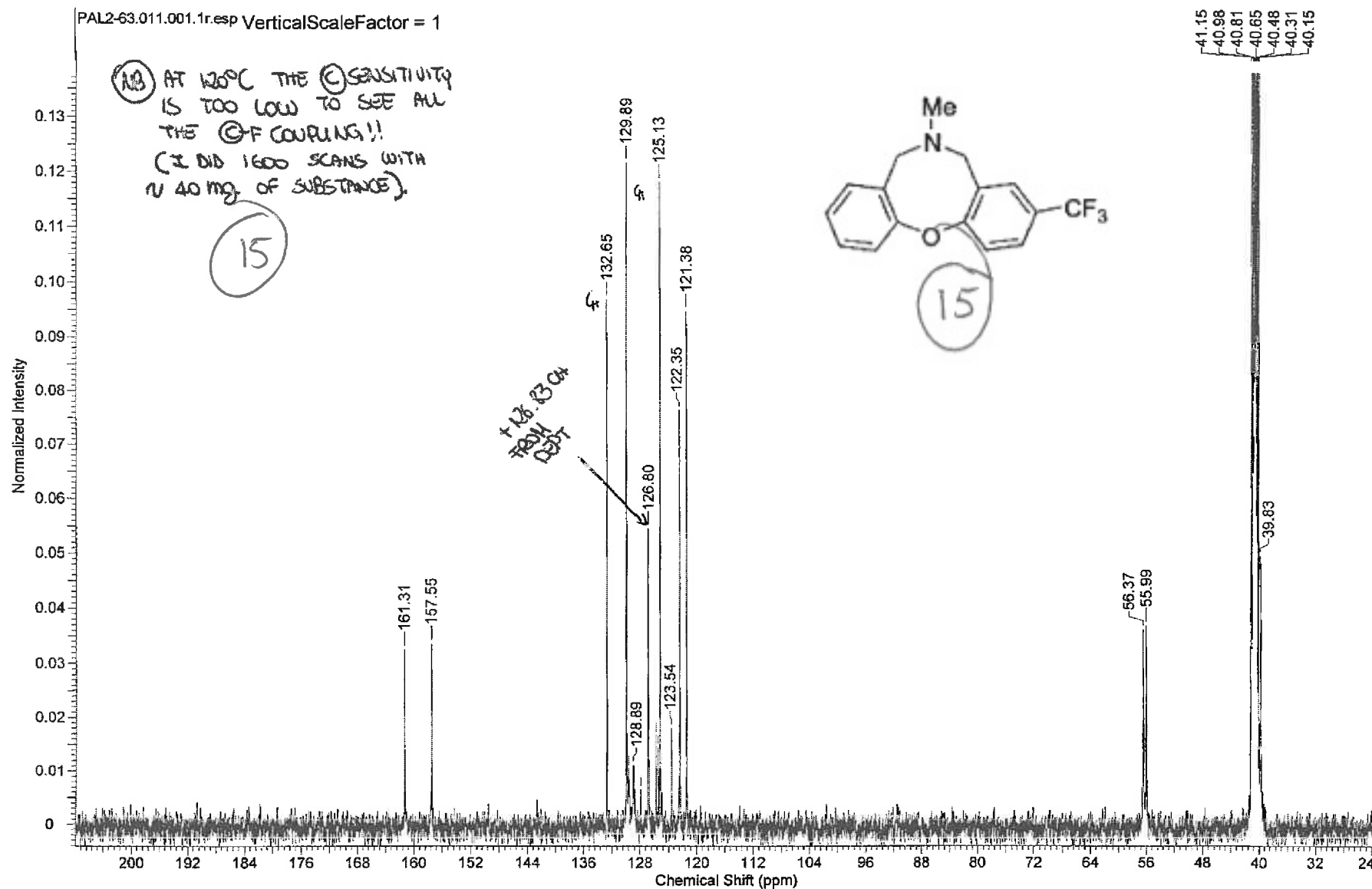
08/11/2012 19:17:45  
TJS-016 Pure



Y:\glengrant\drs\nmr\PAL2-63\PAL2-63.010.001.1r.esp

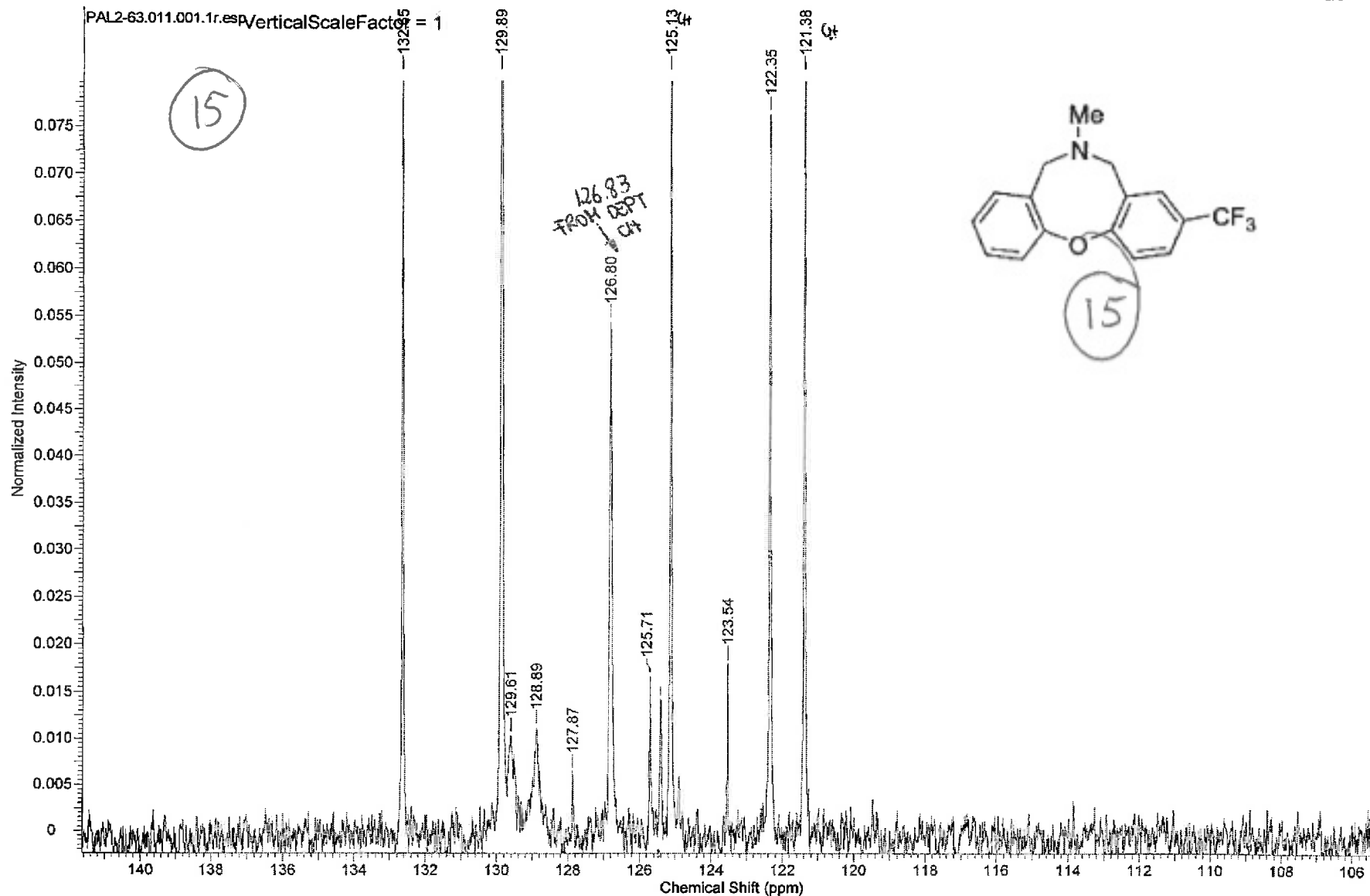
# TJS-016 Pure

08/11/2012 19:22:22  
TJS-016 Pure



# TJS-016 Pure

08/11/2012 19:21:56  
TJS-016 Pure

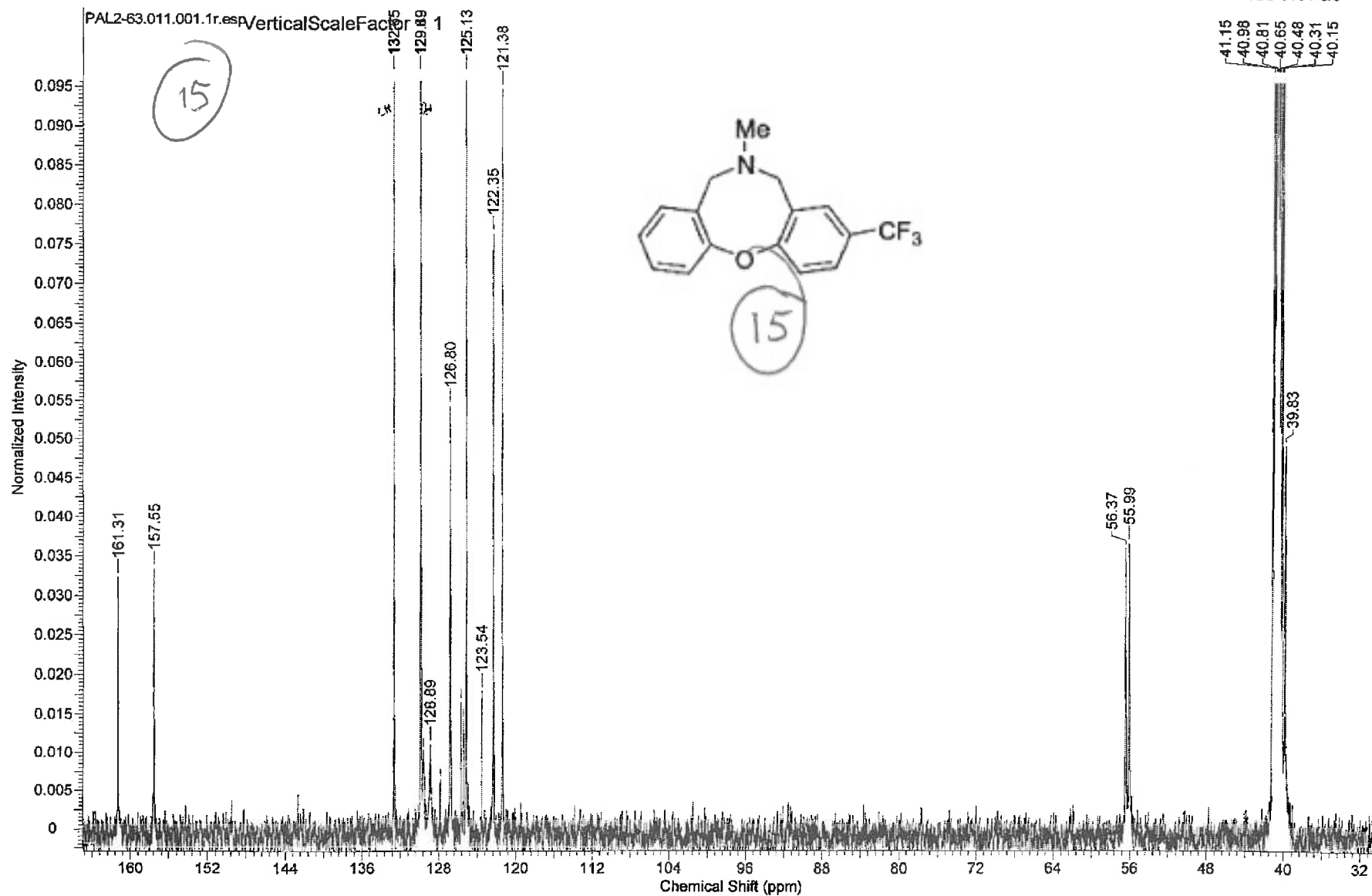


Y:\glengrant\ds\nmr\PAL2-63\PAL2-63.011.001.1r.esp

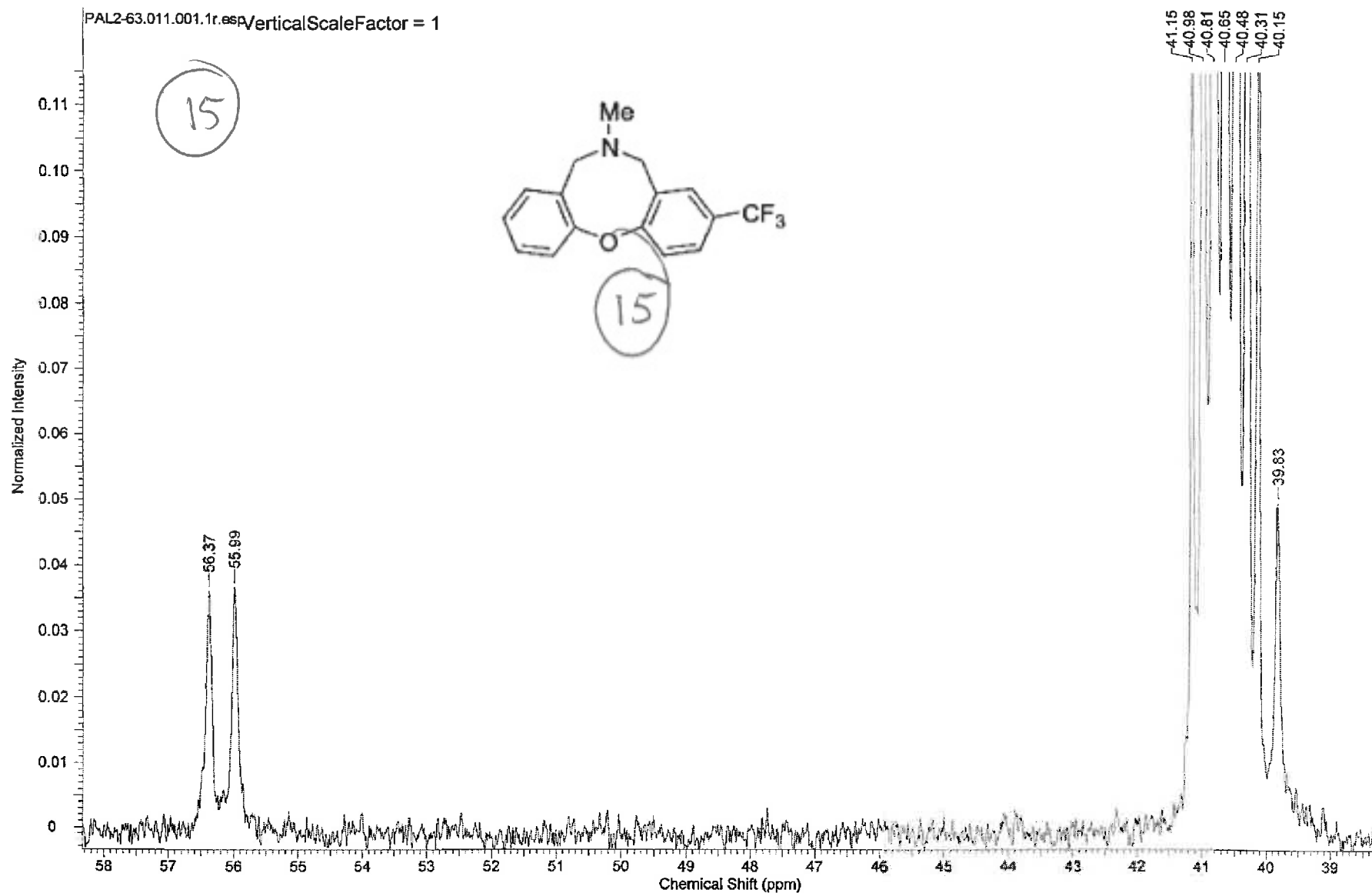


# TJS-016 Pure

08/11/2012 19:23:09  
TJS-016 Pure



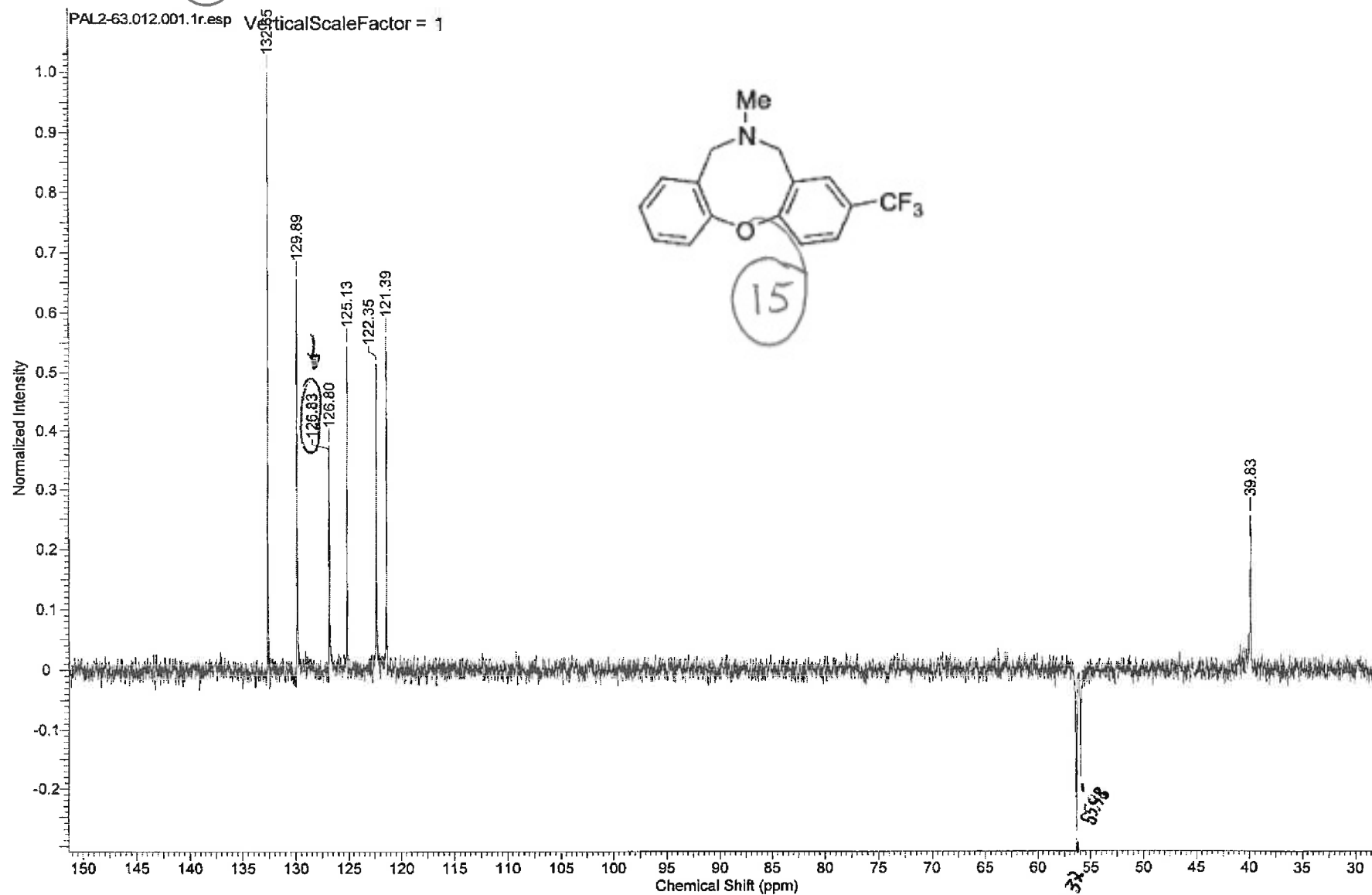
08/11/2012 19:19:23  
TJS-016 Pure



Y:\glengrant\drs\nmr\PAL2-63\PAL2-63.011.001.1r.esp

**TJS-016 Pure**

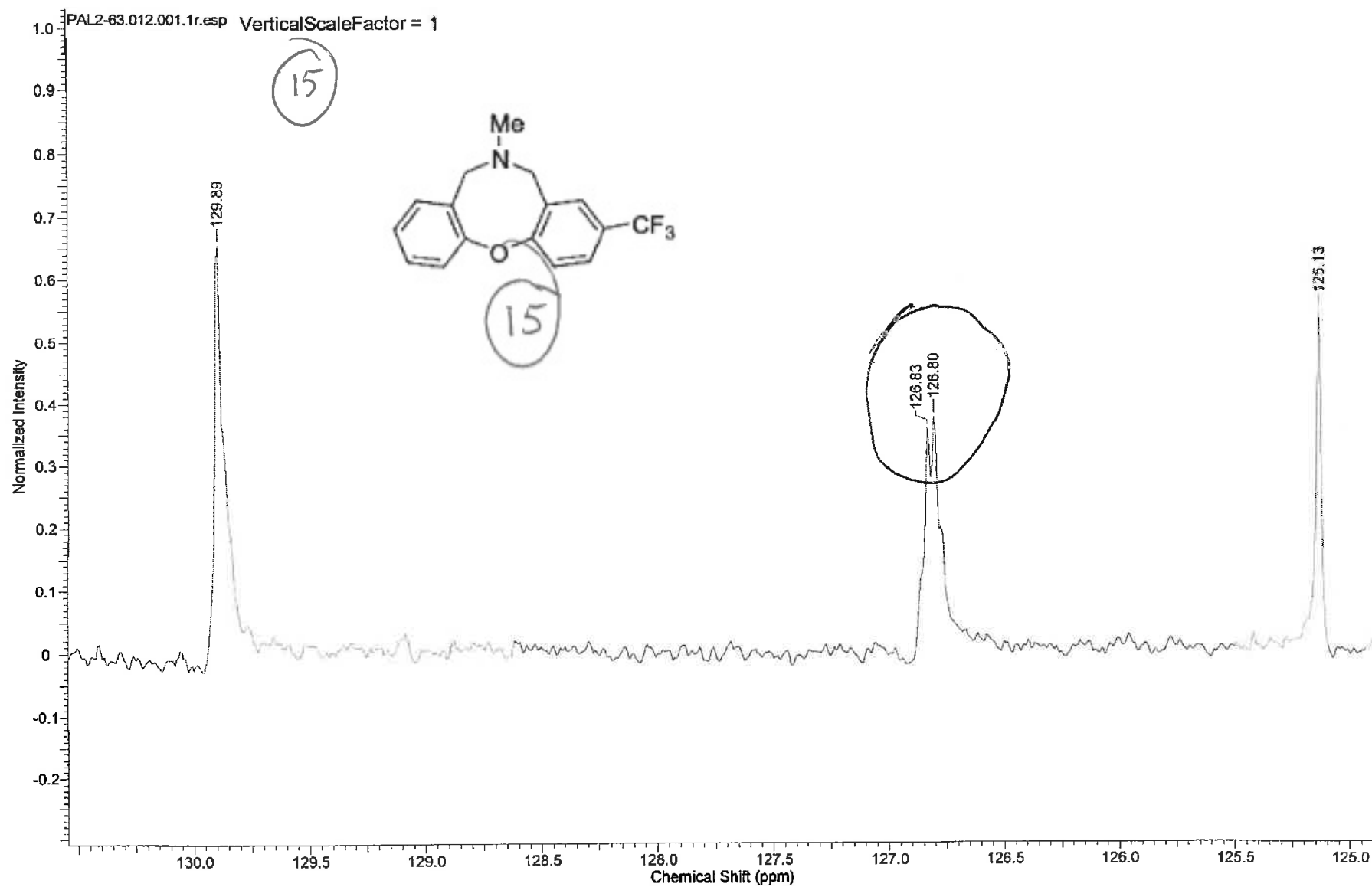
08/11/2012 19:27:31  
TJS-016 Pure



Y:\glengrant\drs\nmr\PAL2-63\PAL2-63.012.001.1r.esp

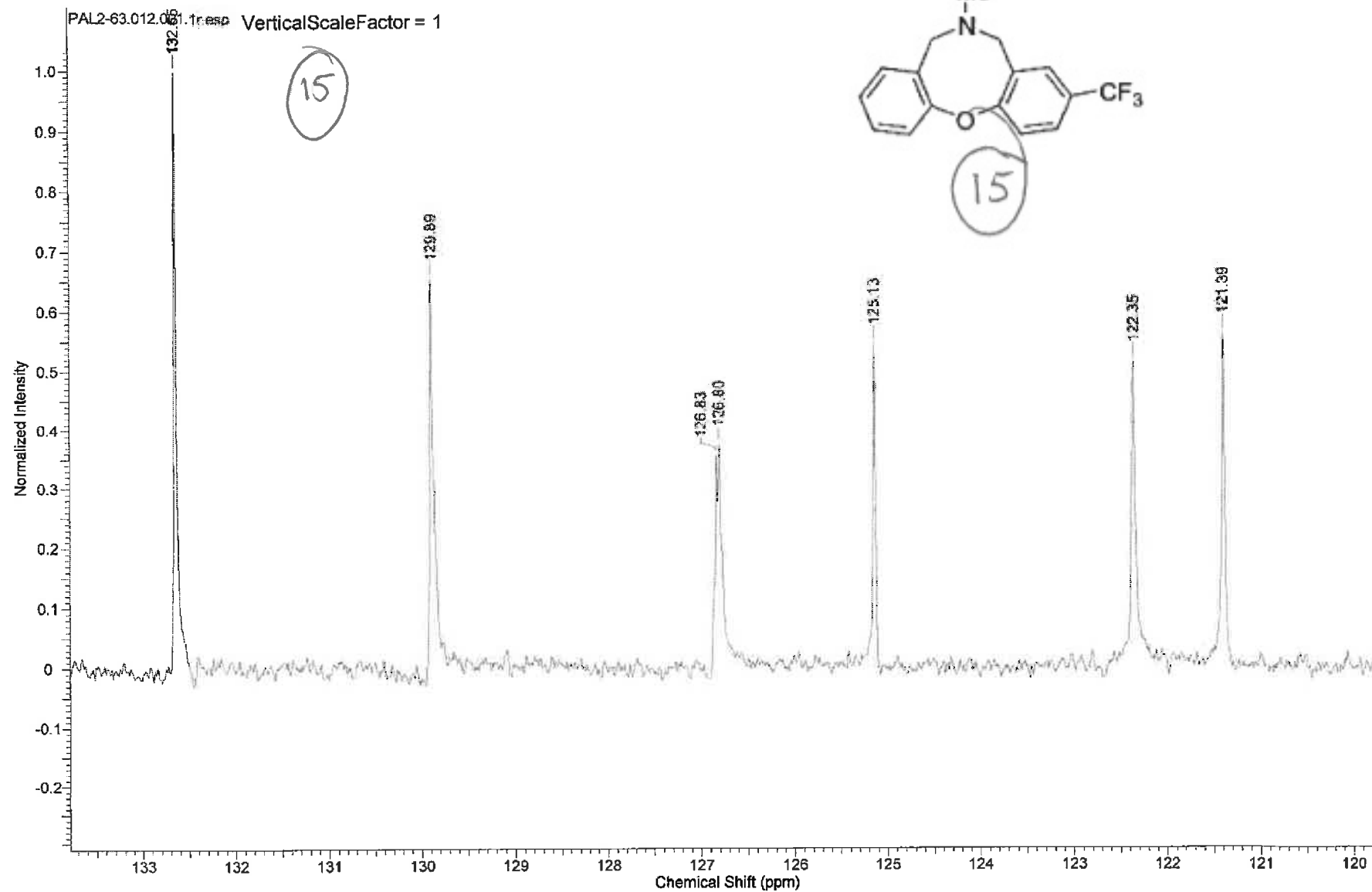
## TJS-016 Pure

08/11/2012 19:29:30  
TJS-016 Pure



Y:\glengrant\drs\nmr\PAL2-63\PAL2-63.012.001.1r.esp

08/11/2012 19:29:20  
TJS-016 Pure

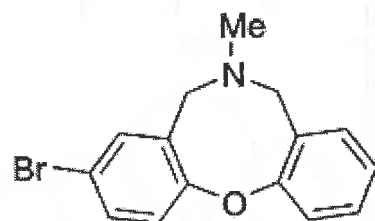
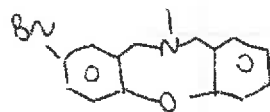


Y:\glengrant\drs\nmr\PAL2-63\PAL2-63.012.001.1r.esp

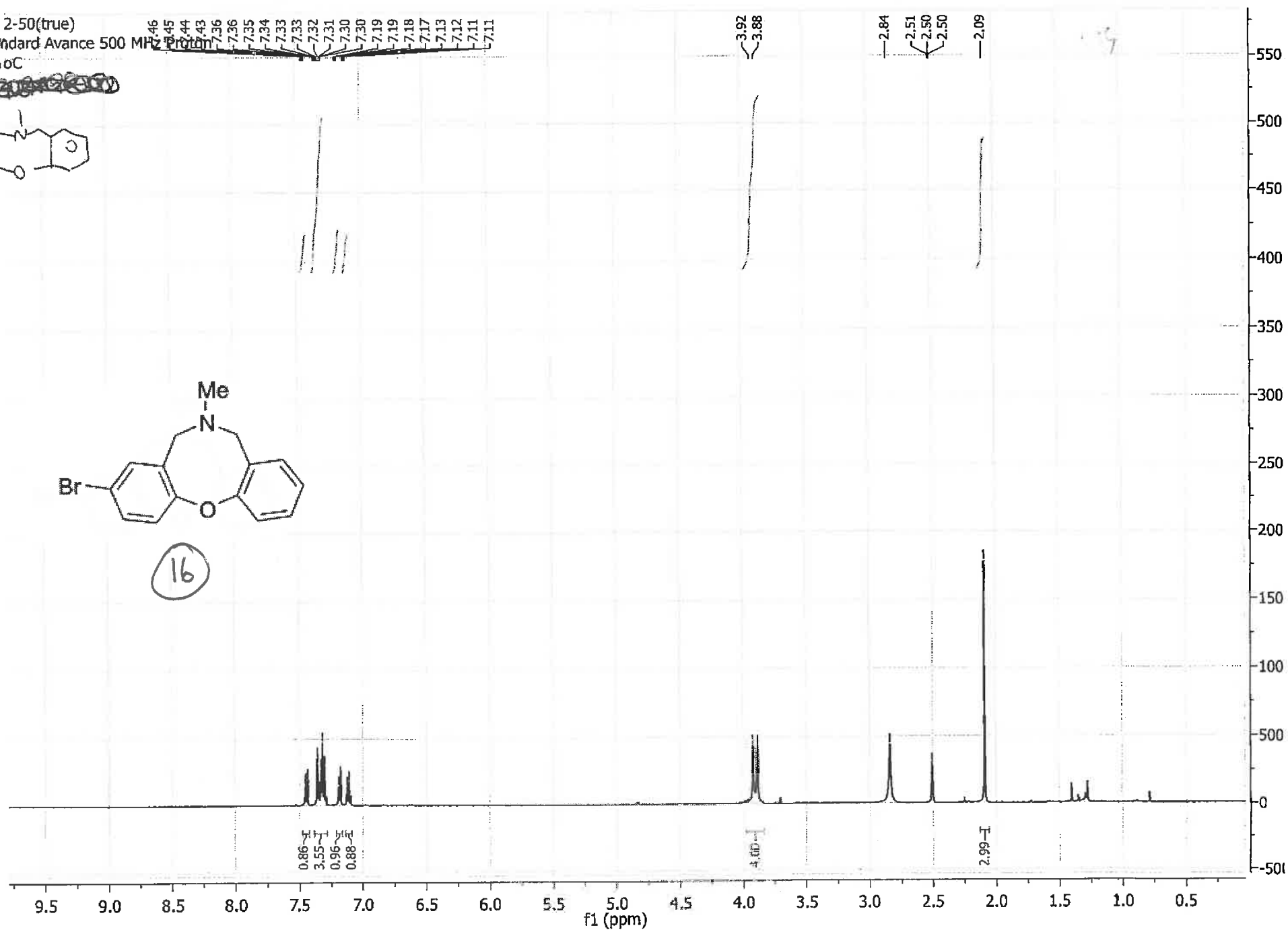
PAL 2-50(true)

Standard Avance 500 MHz Proton

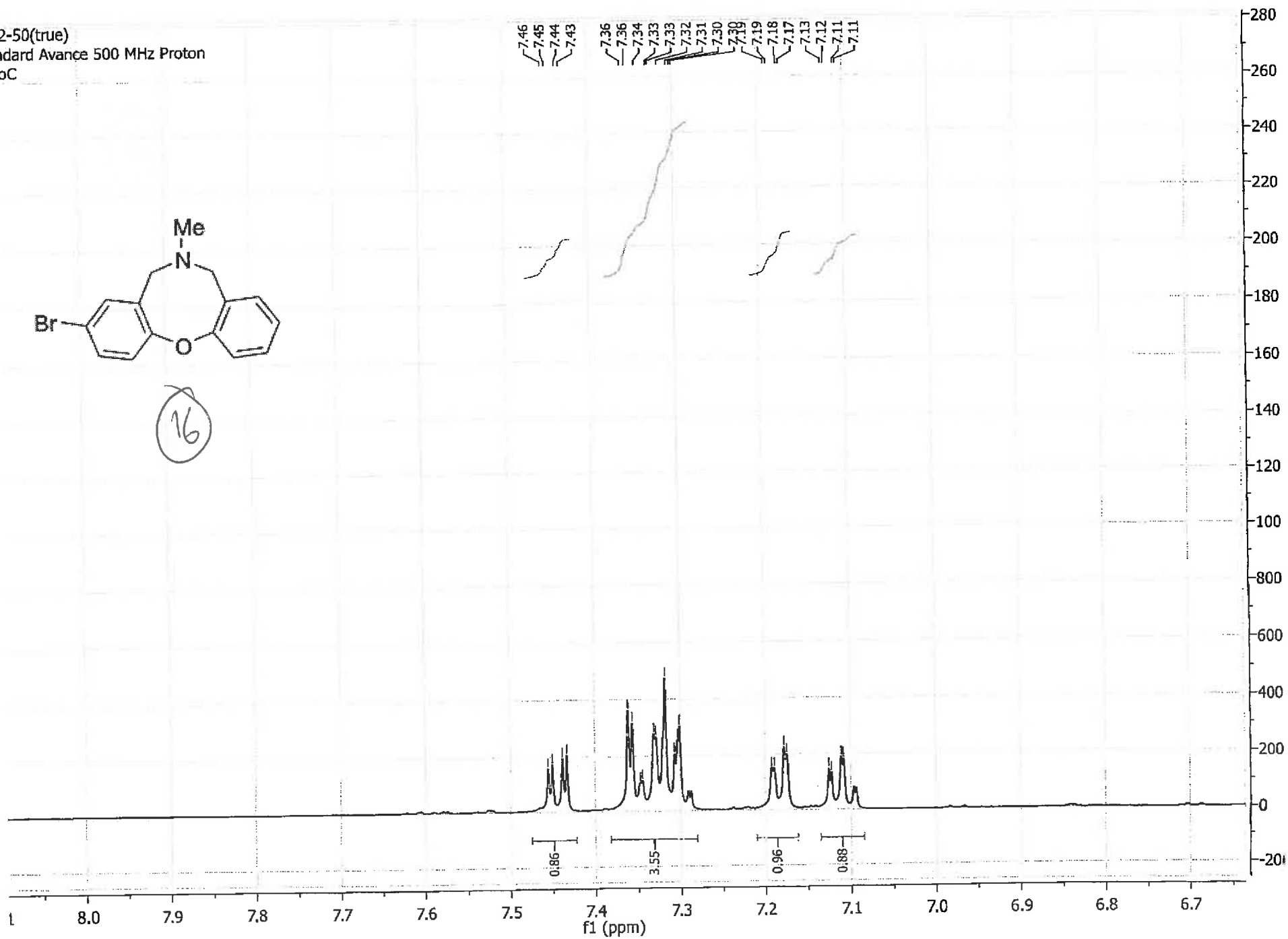
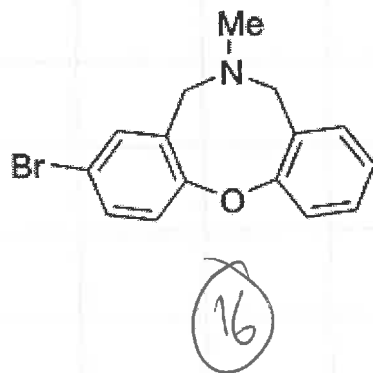
120.0C



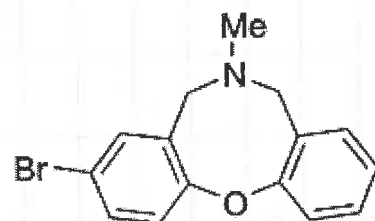
16



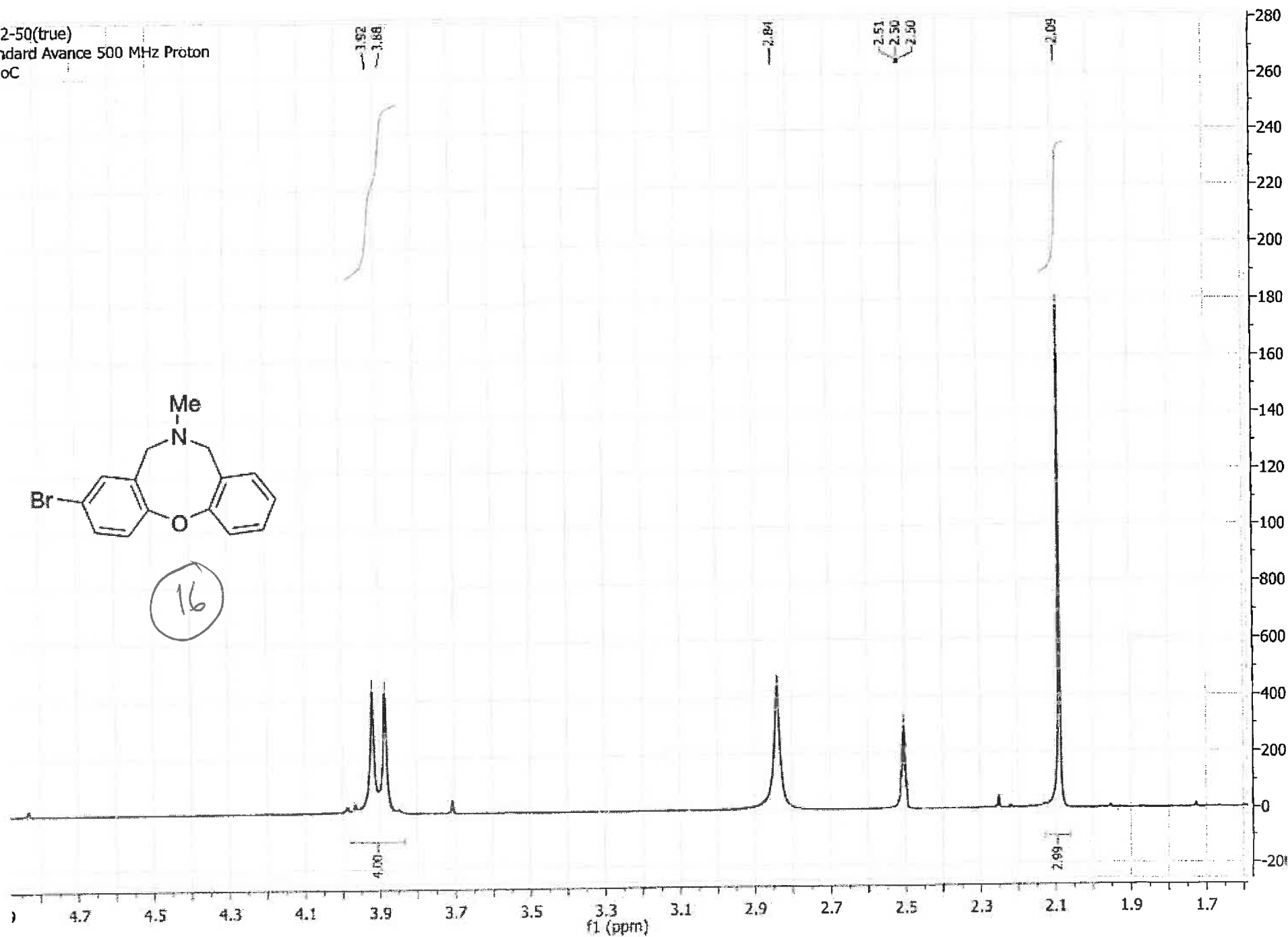
PAL 2-50(true)  
 Standard Avance 500 MHz Proton  
 R00 OC



PAL 2-50(true)  
 Standard Avance 500 MHz Proton  
 120 oC

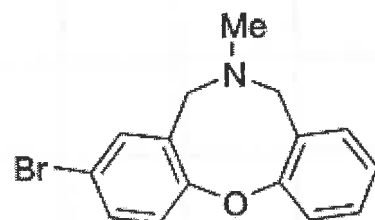


16

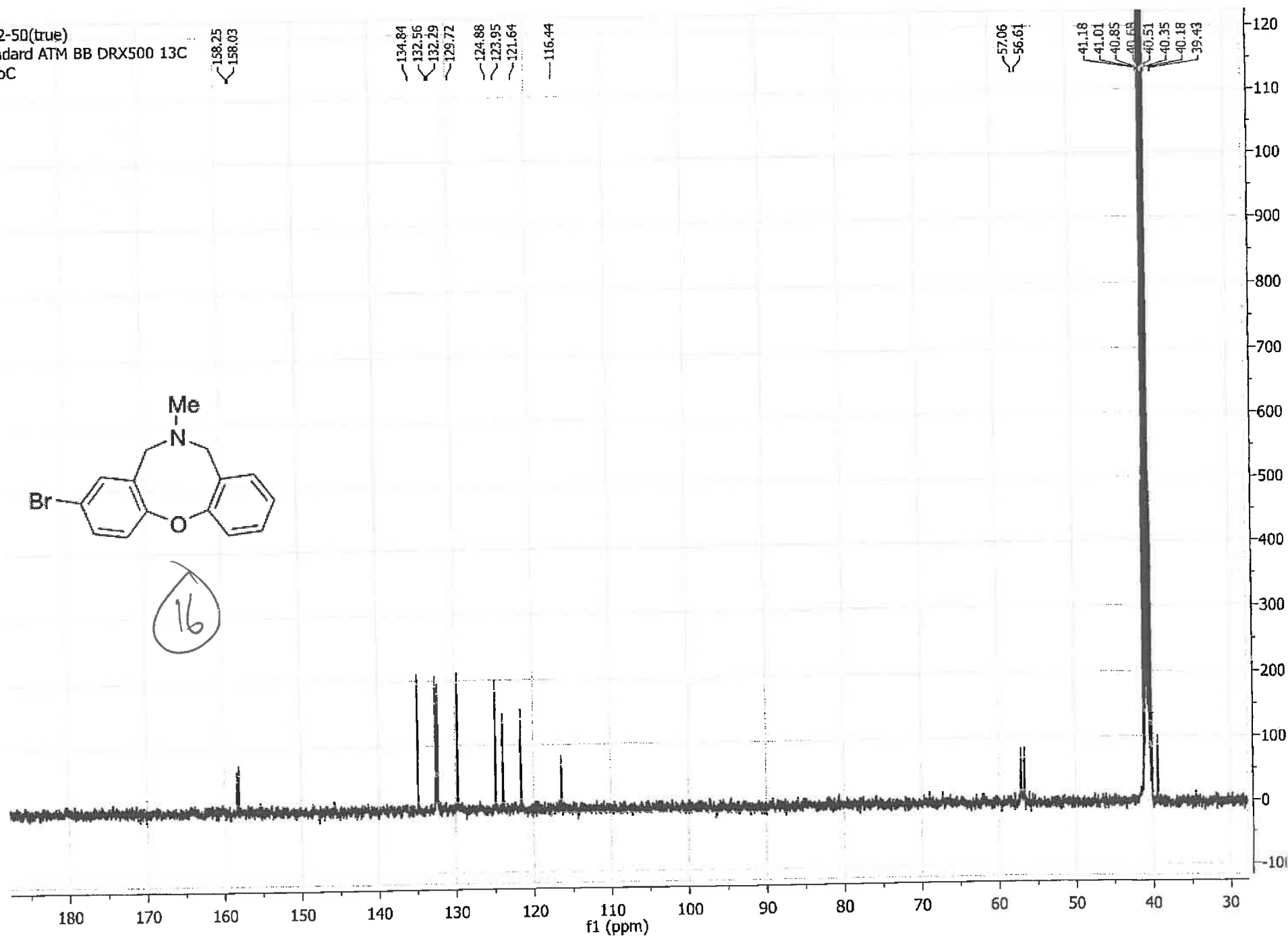




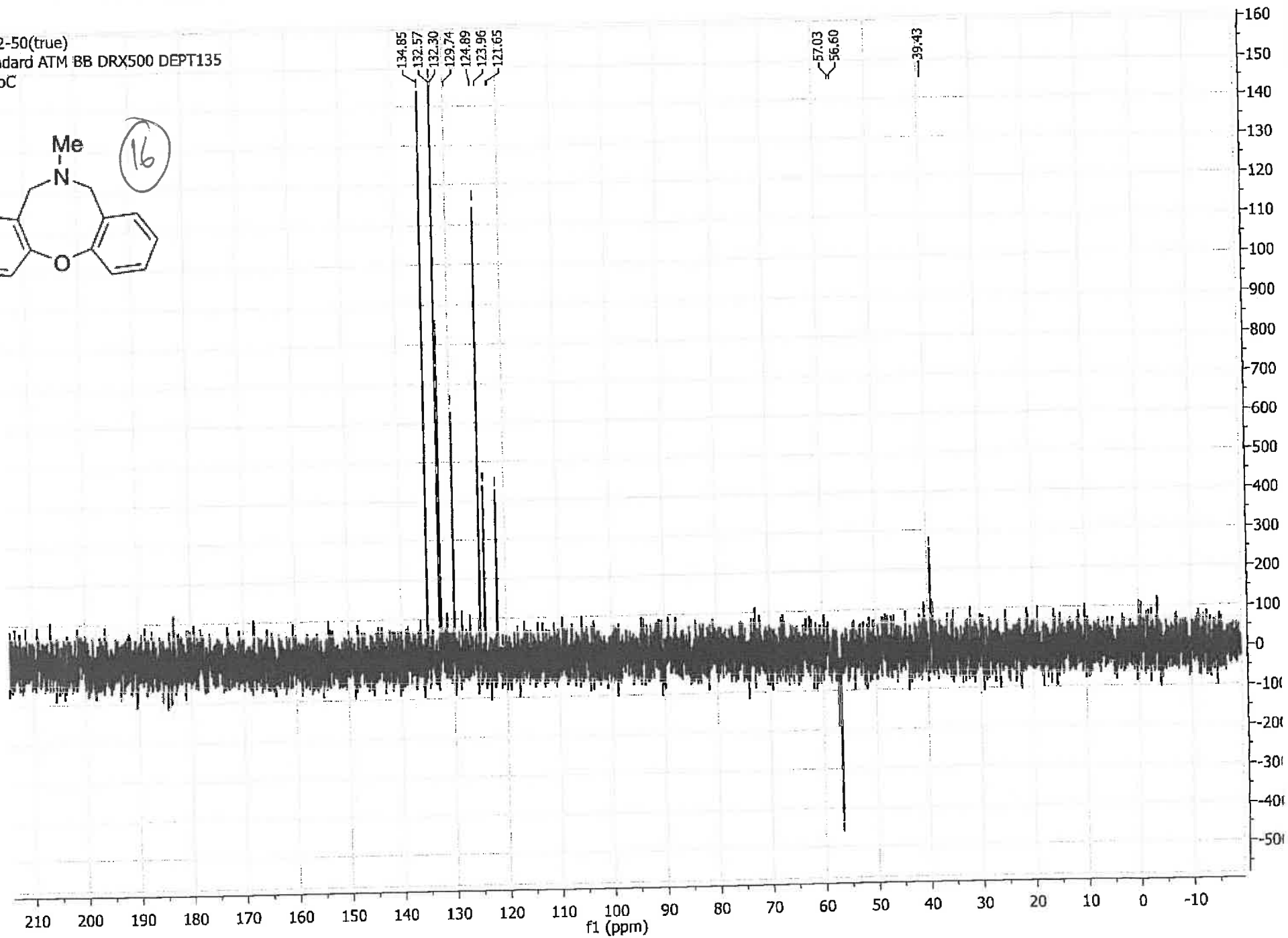
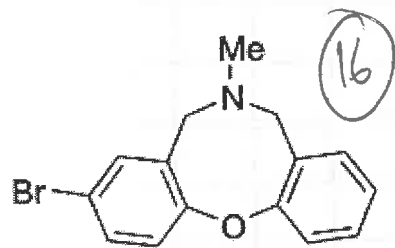
PAL 2-50(true)  
Standard ATM BB DRX500 13C  
120 oC



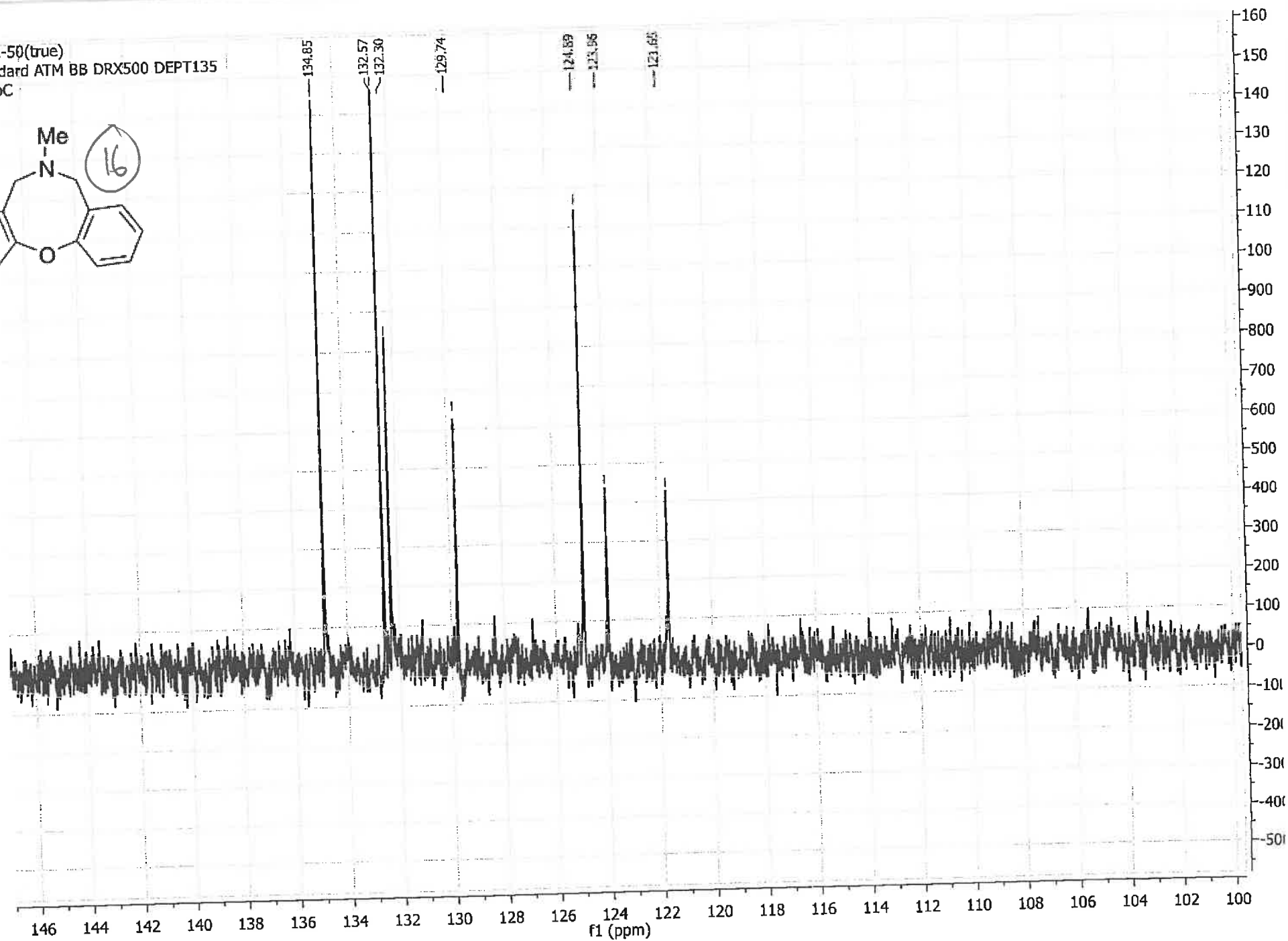
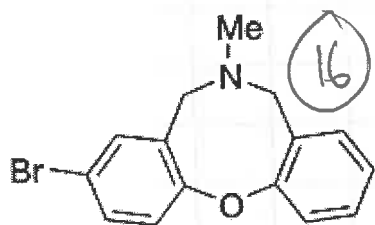
16

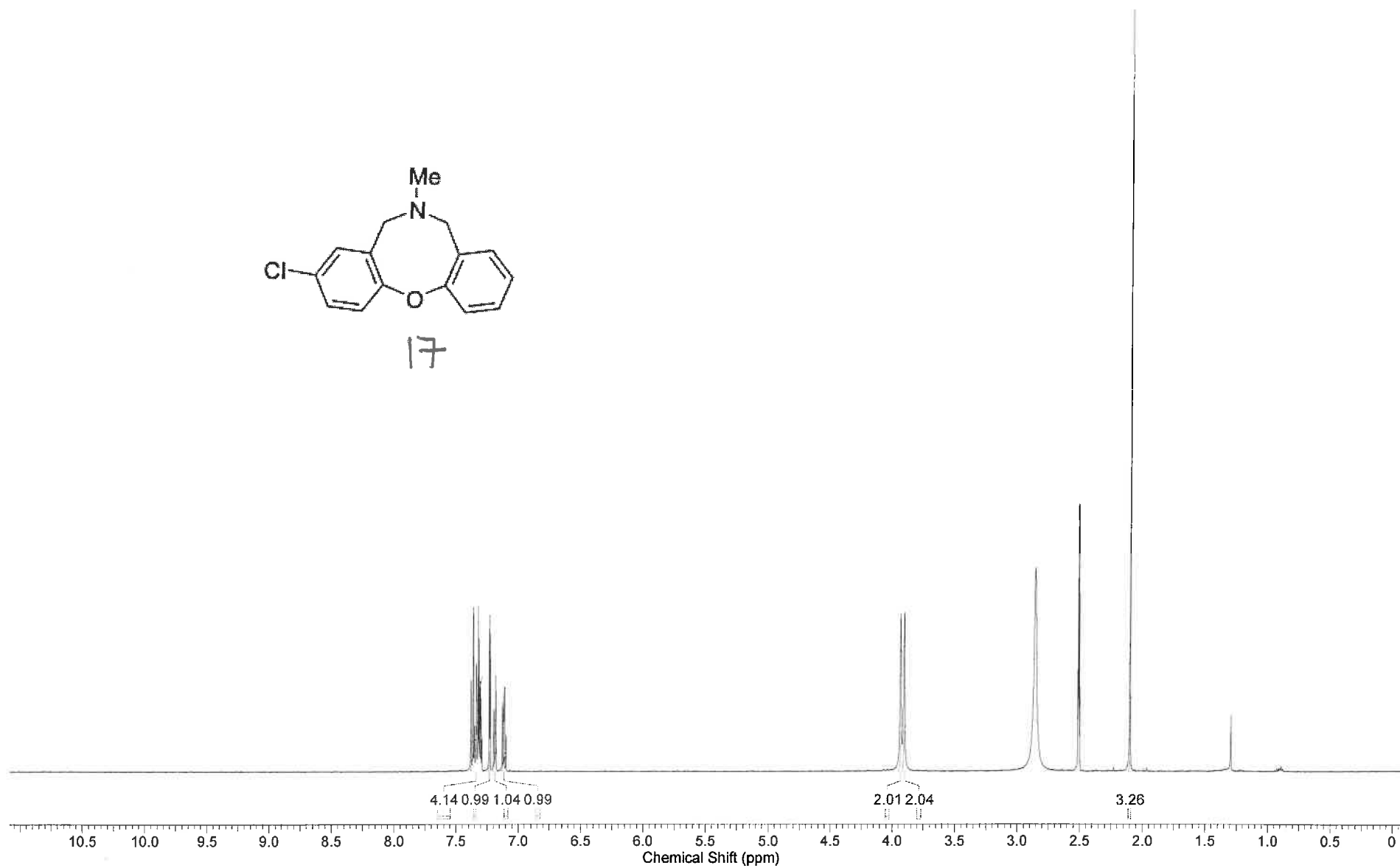
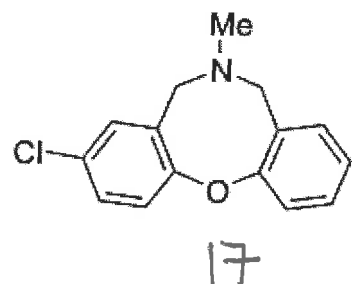


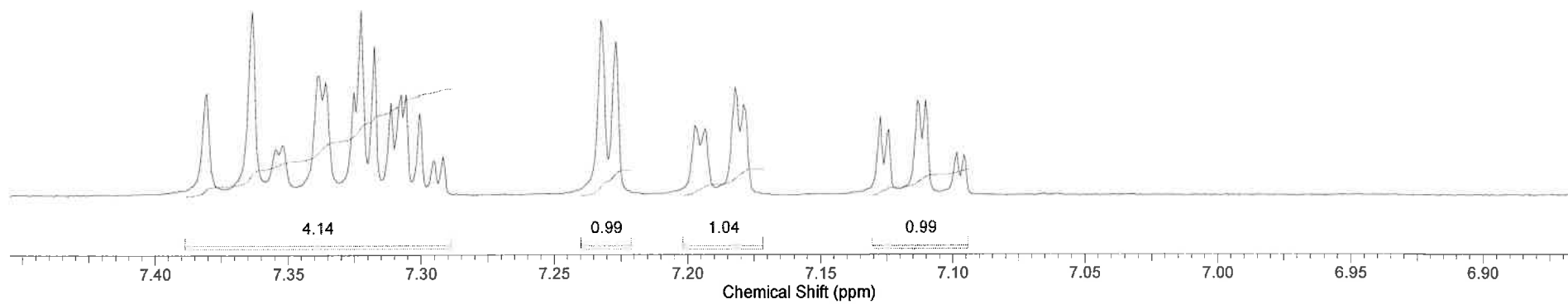
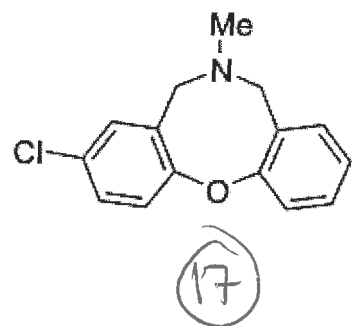
PA 2-50(true)  
Standard ATM BB DRX500 DEPT135  
120 oC

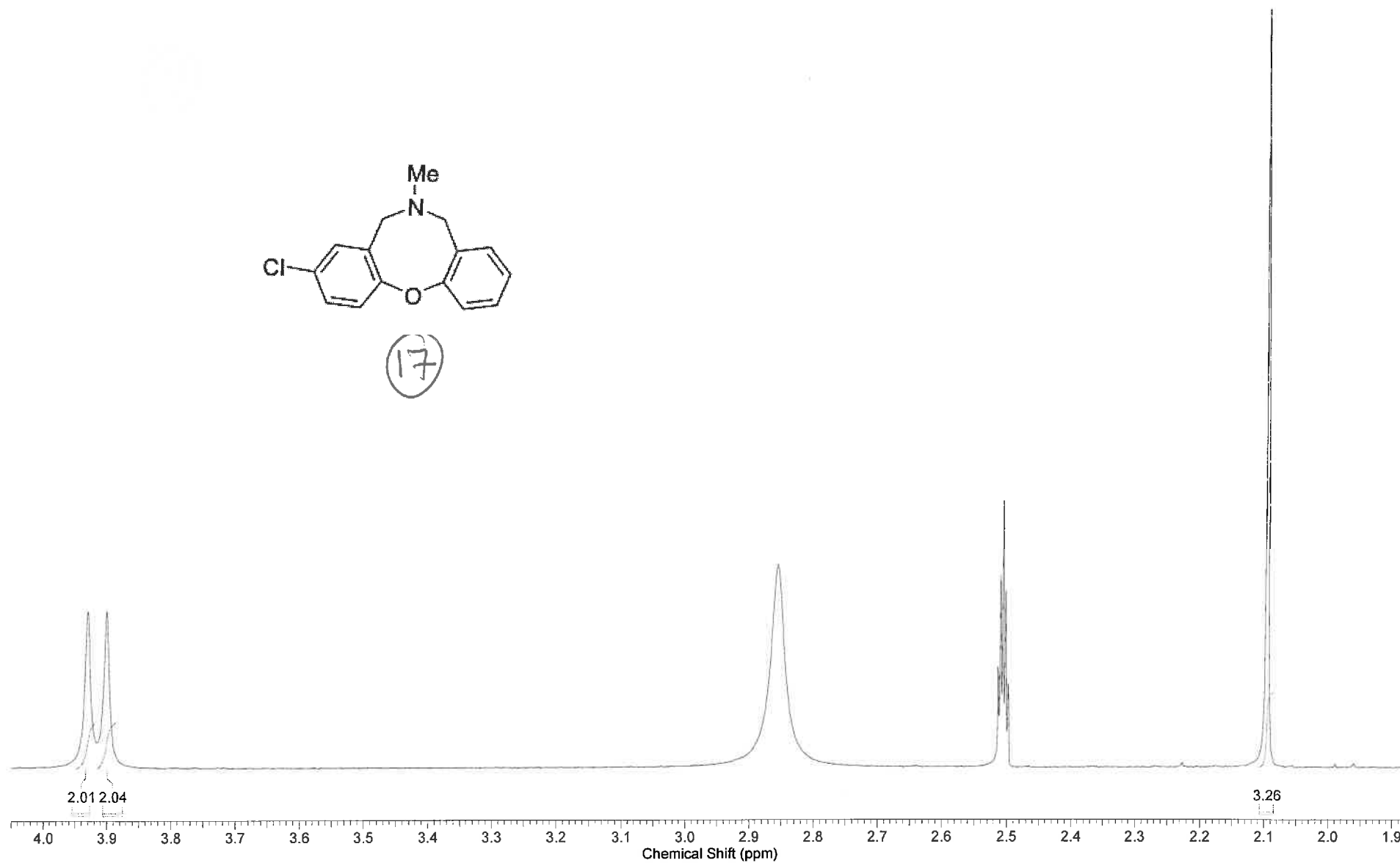
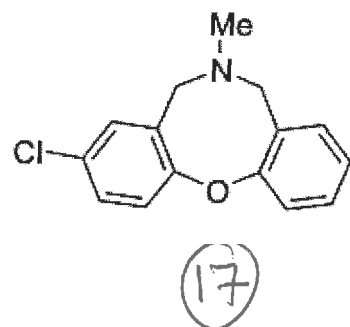


PAL 2-50(true)  
Standard ATM BB DRX500 DEPT135  
R00C





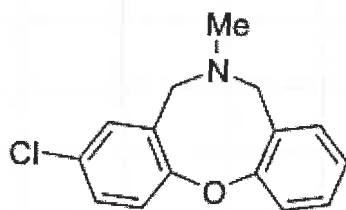




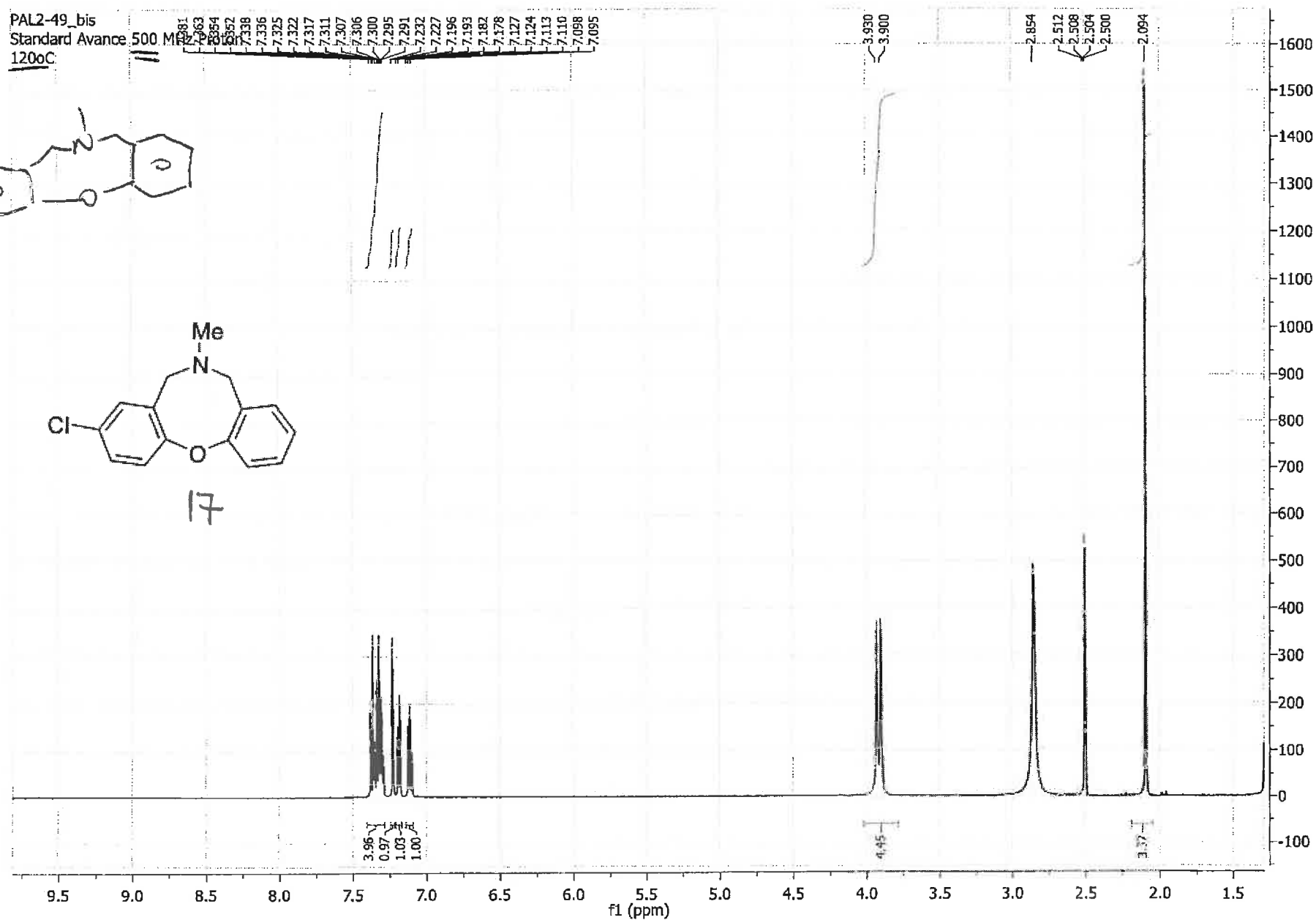
T = 120°C

PAL2-49\_bis

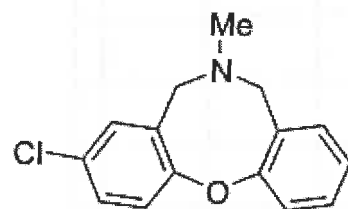
Standard Avance 500 MHz 120°C



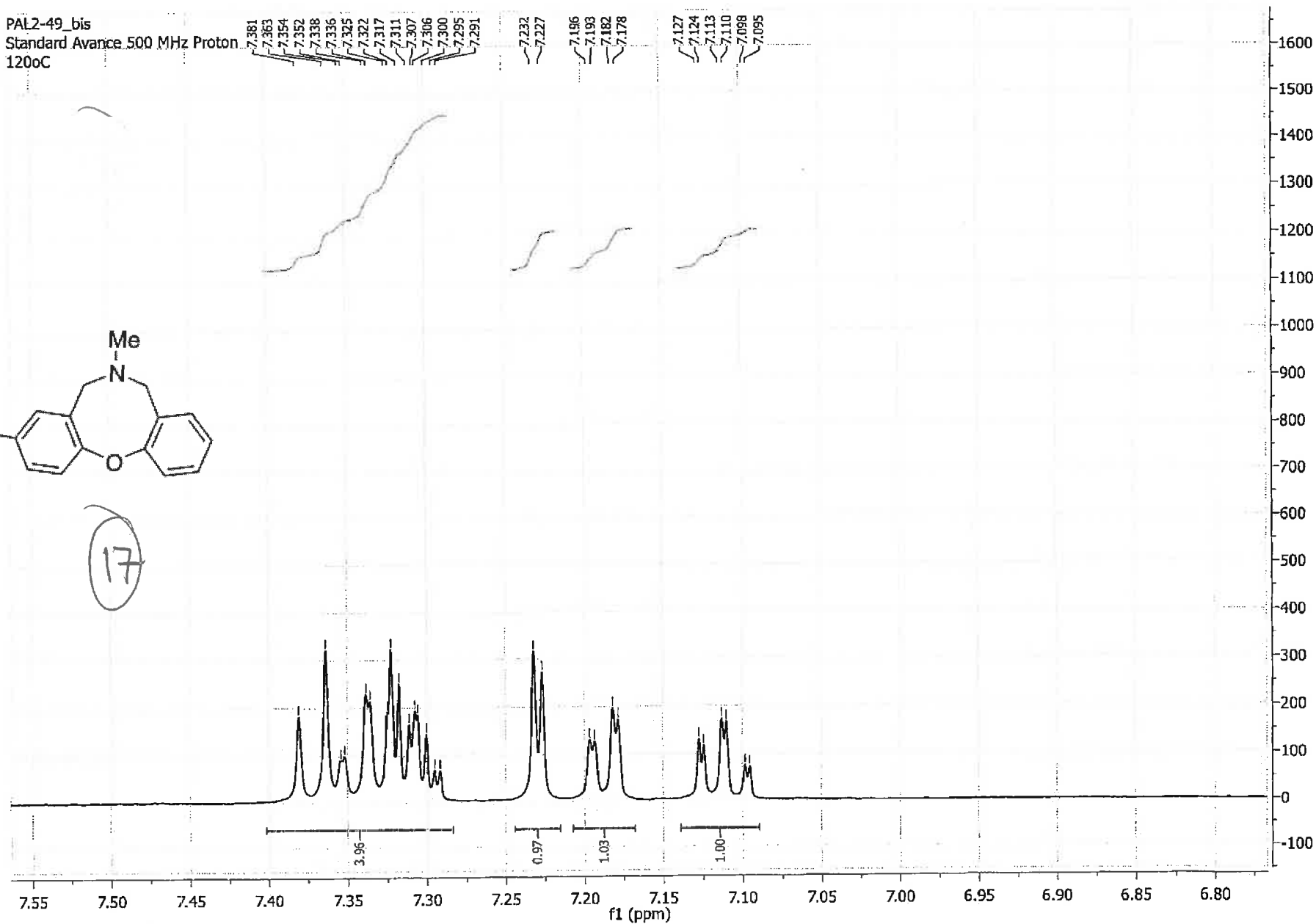
17



PAL2-49\_bis  
Standard Avance 500 MHz Proton  
120oC

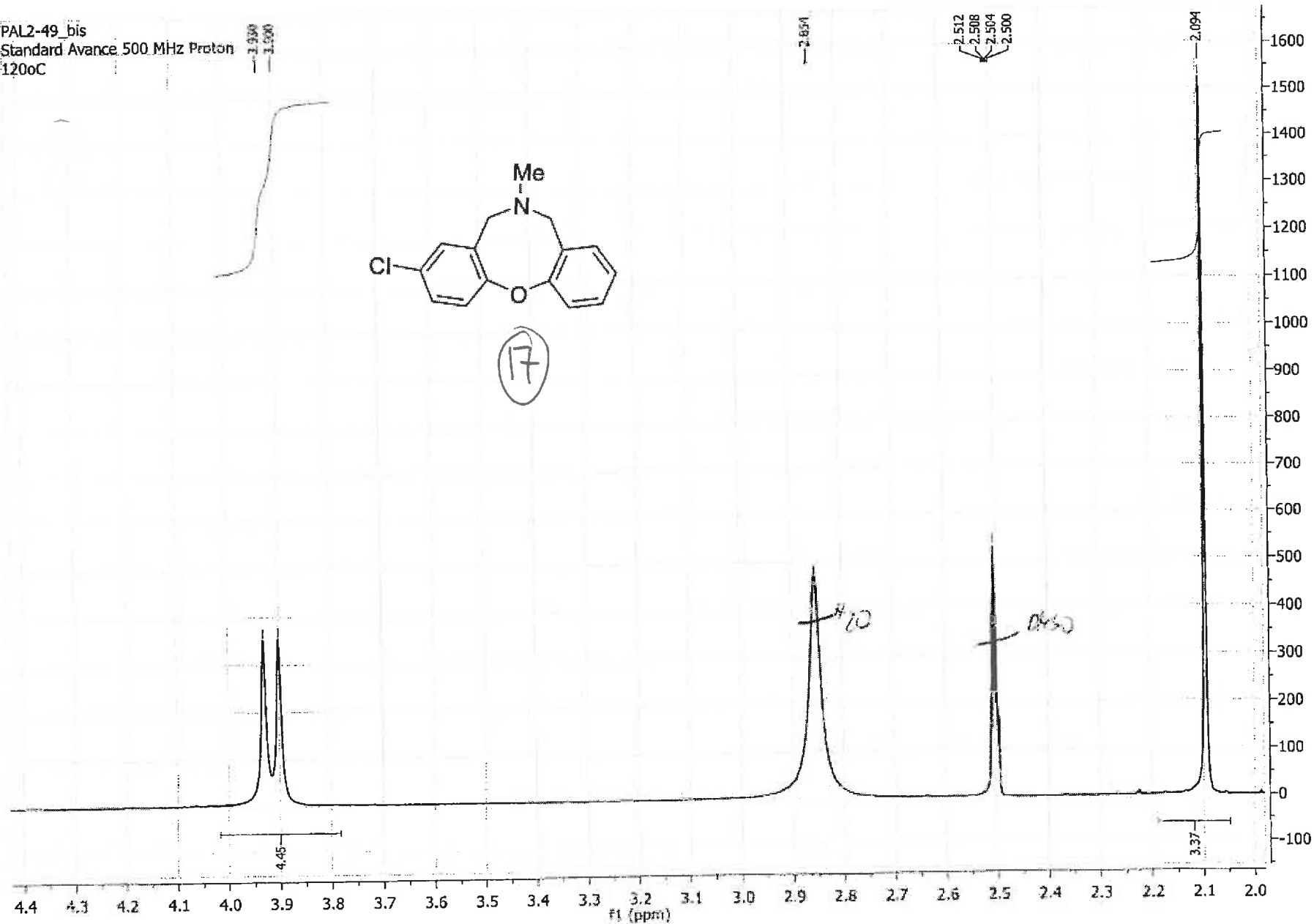


17

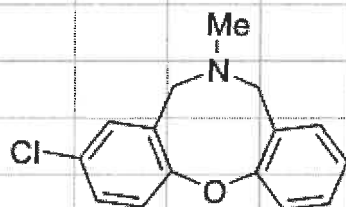




PAL2-49\_bis  
Standard Avance 500 MHz Proton  
120oC



2-49\_bis.11.fid  
dard ATM BB DRX500 13C  
5C



(17)

158.32  
157.50

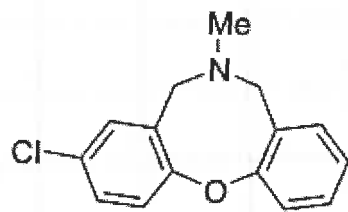
132.57  
131.92  
129.74  
129.30  
128.60  
124.86  
123.52  
121.65

57.09  
56.66

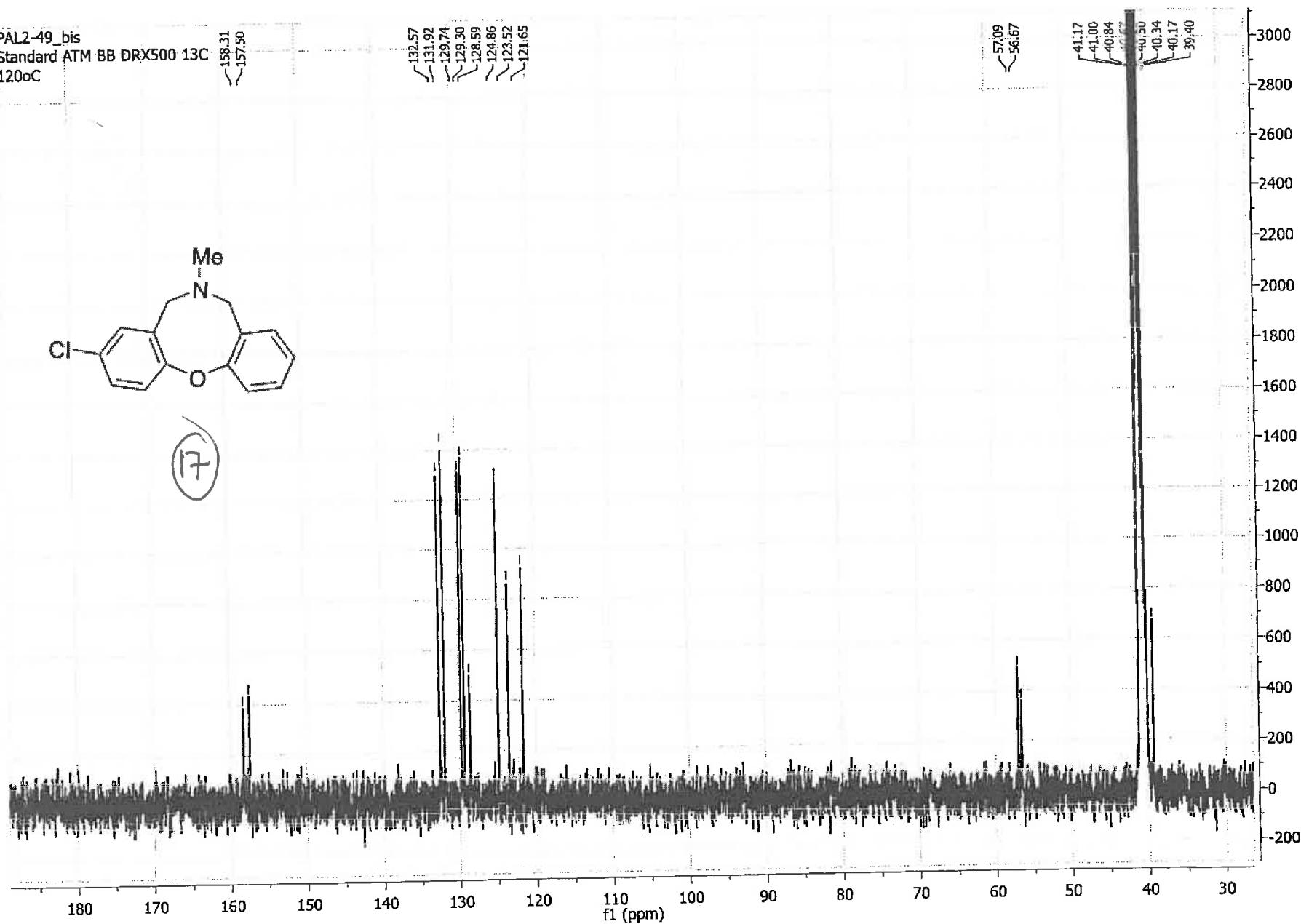
39.40

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0  
f1 (ppm)

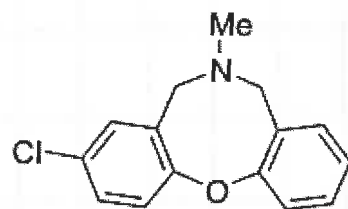
PAL2-49\_bis  
Standard ATM BB DRX500 13C  
120oC



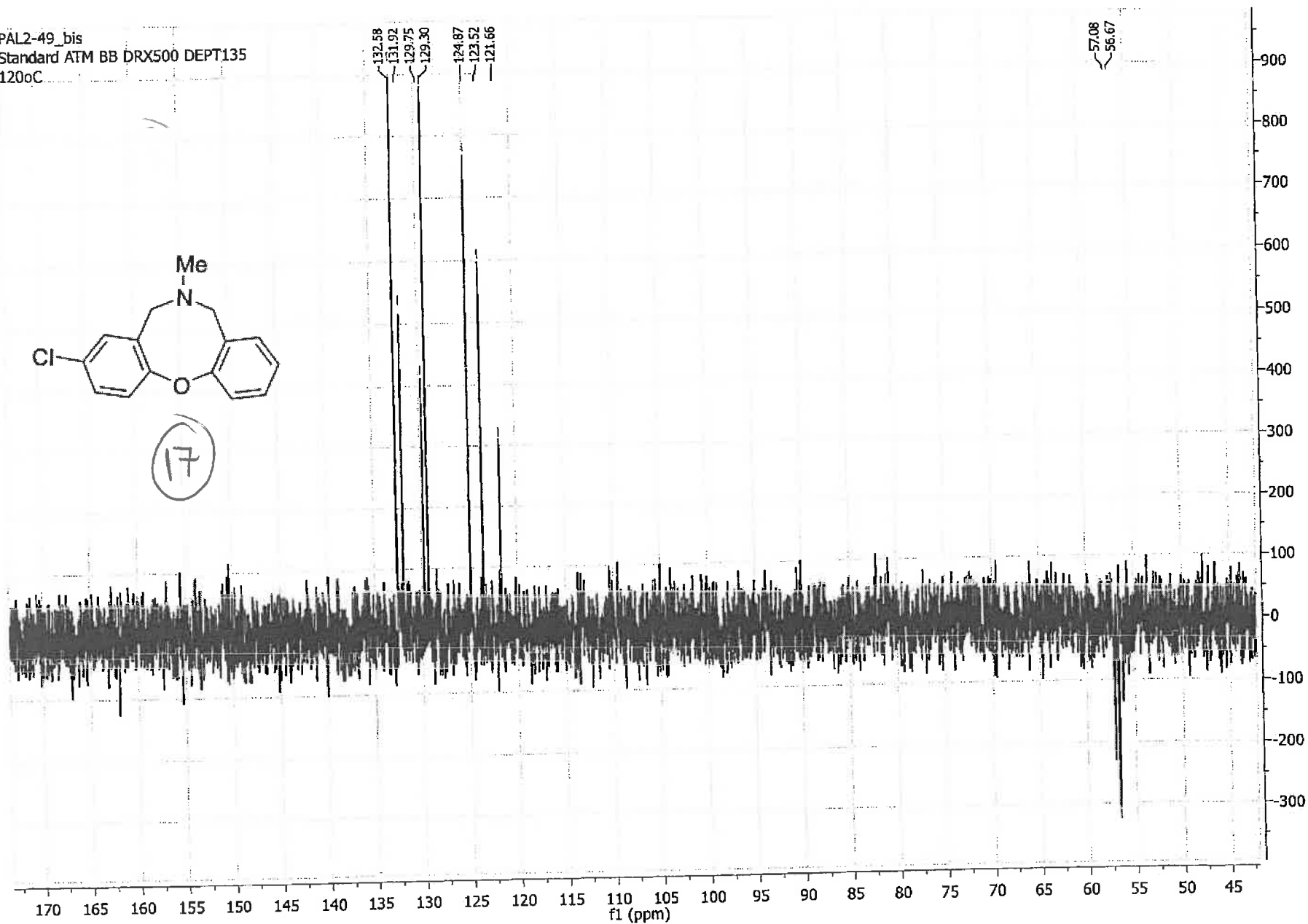
(17)



PAL2-49\_bis  
Standard ATM BB DRX500 DEPT135  
120oC

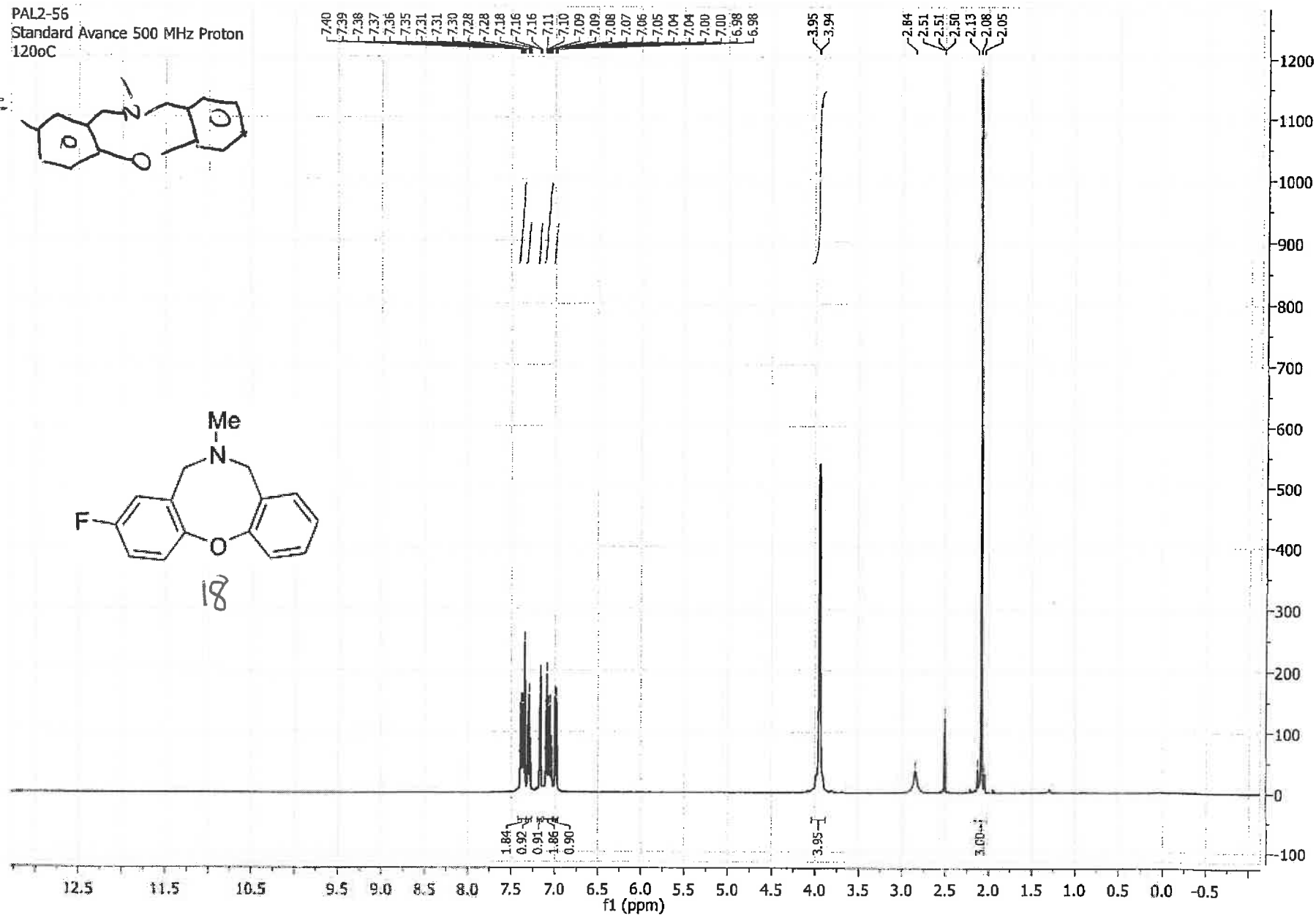
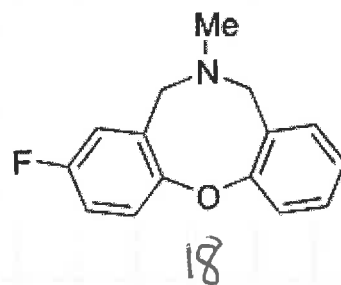
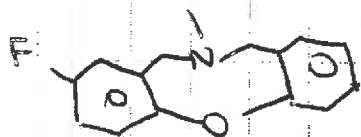


17

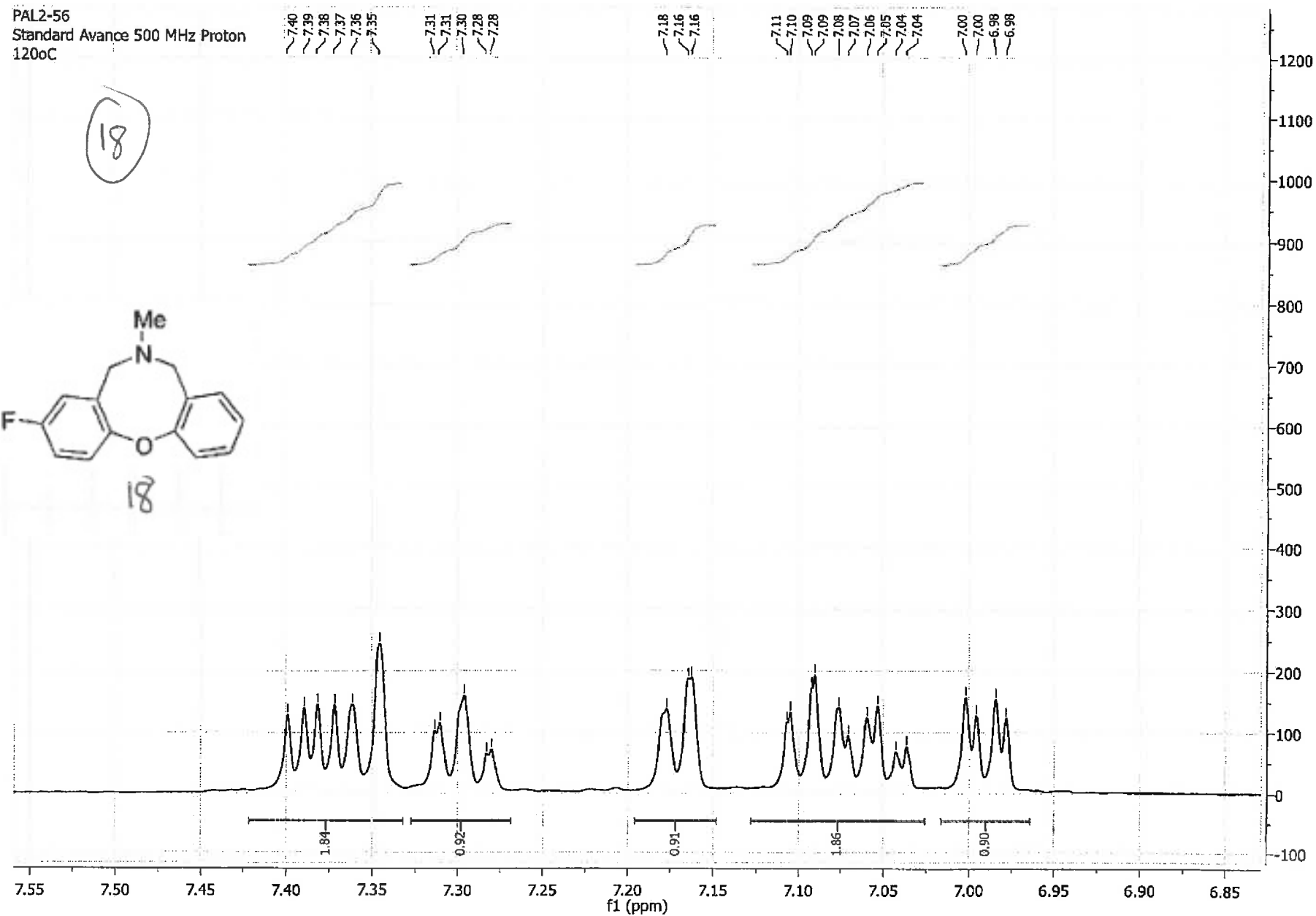
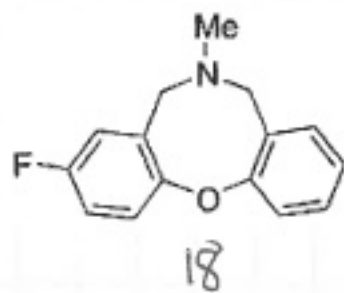


$T = 120^{\circ}\text{C}$

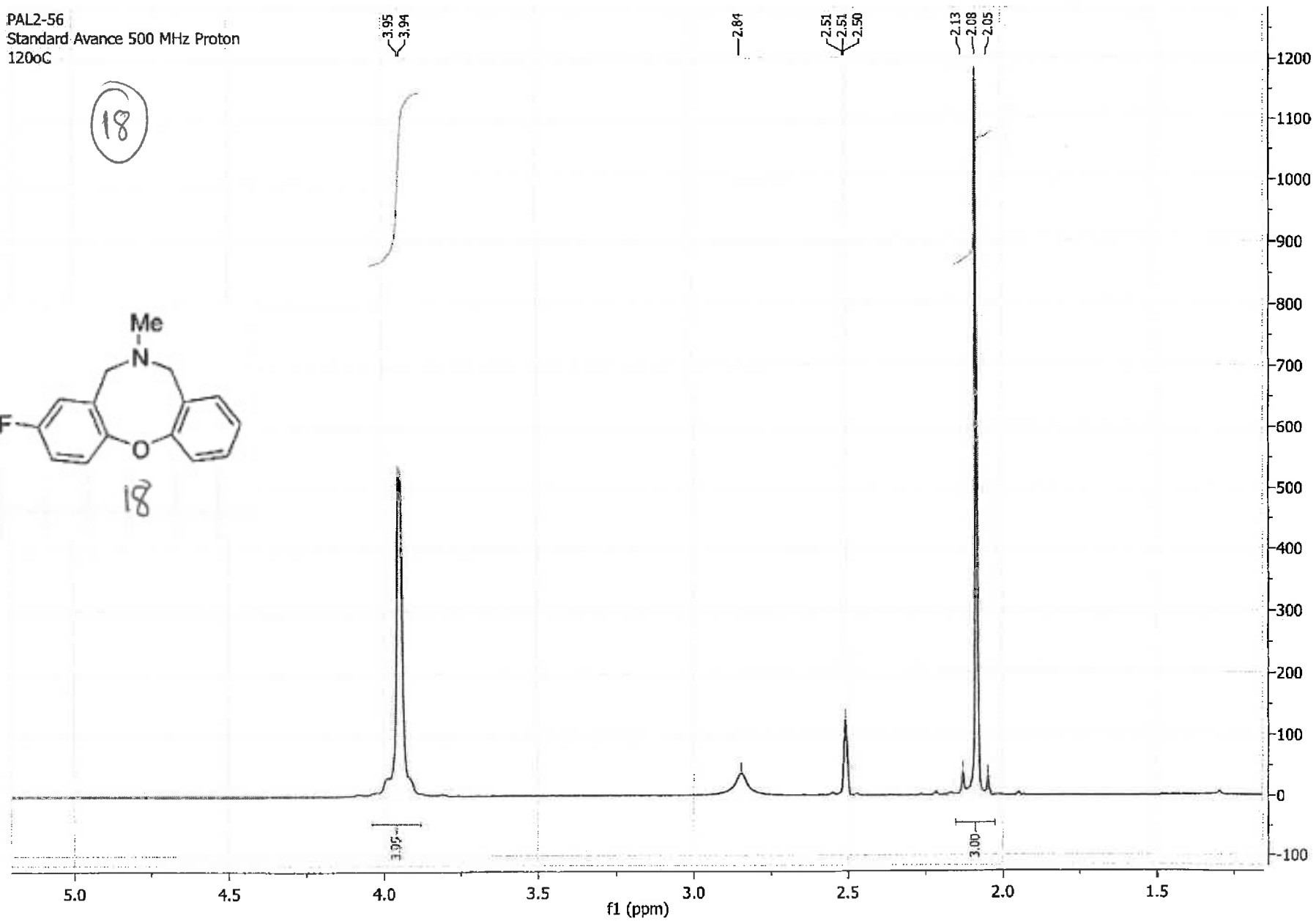
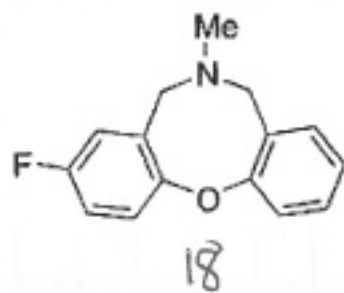
PAL2-56  
Standard Avance 500 MHz Proton  
120oC



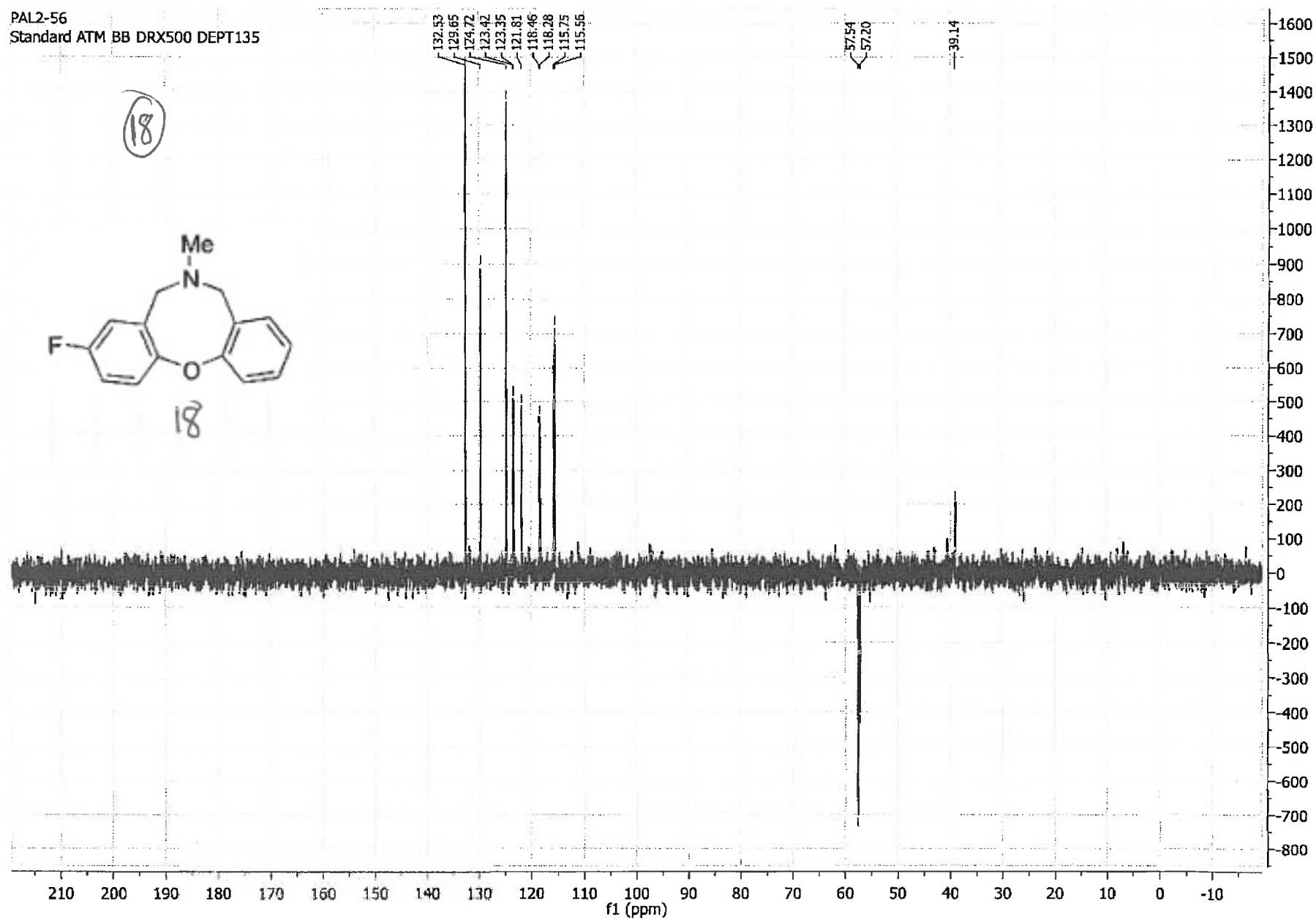
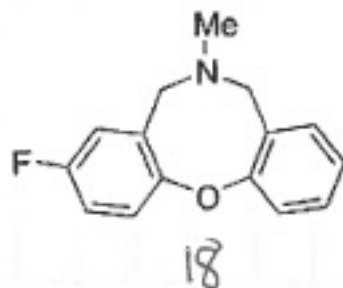
PAL2-56  
Standard Avance 500 MHz Proton  
120oC



PAL2-56  
Standard Avance 500 MHz Proton  
120oC



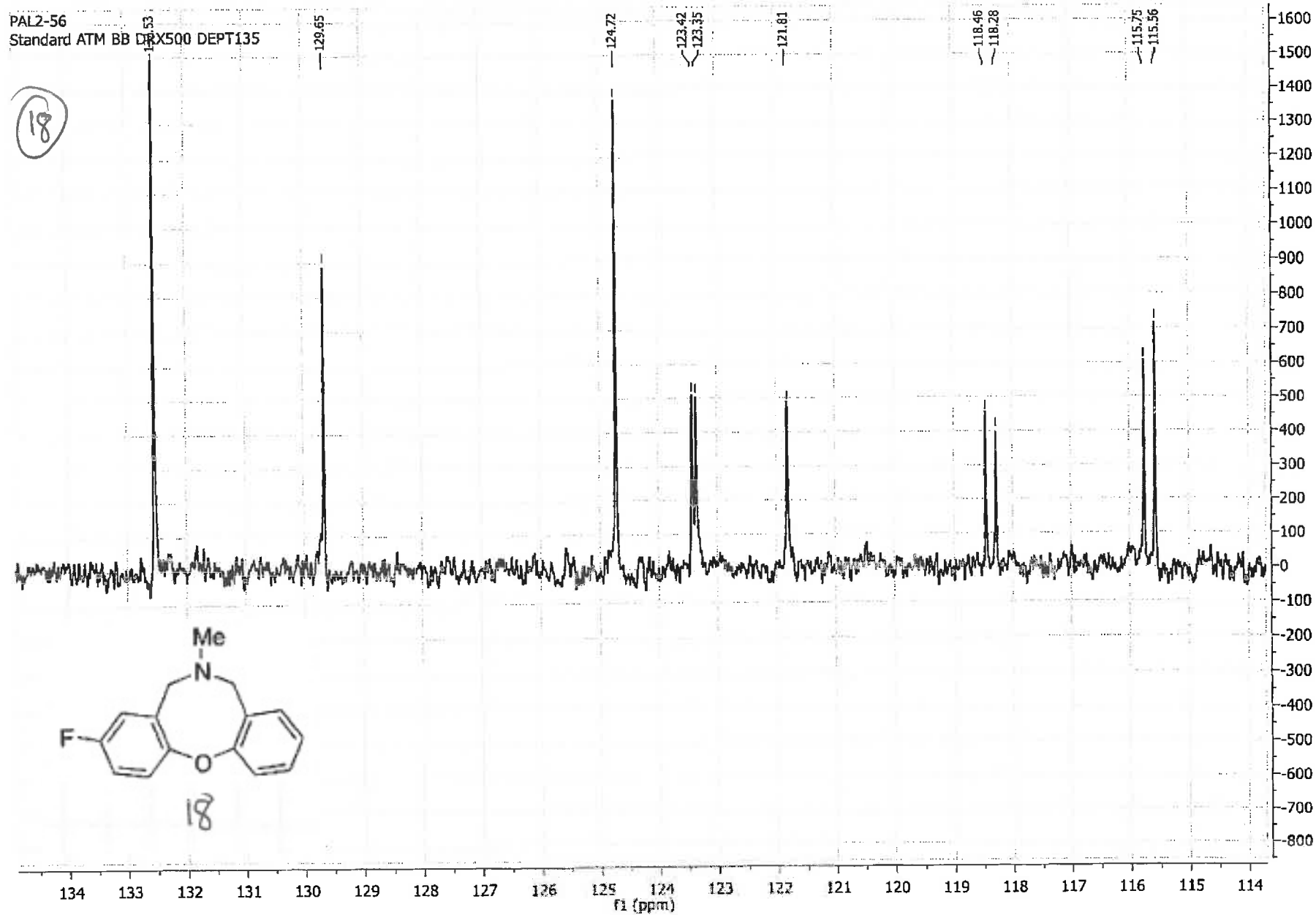
PAL2-56  
Standard ATM BB DRX500 DEPT135





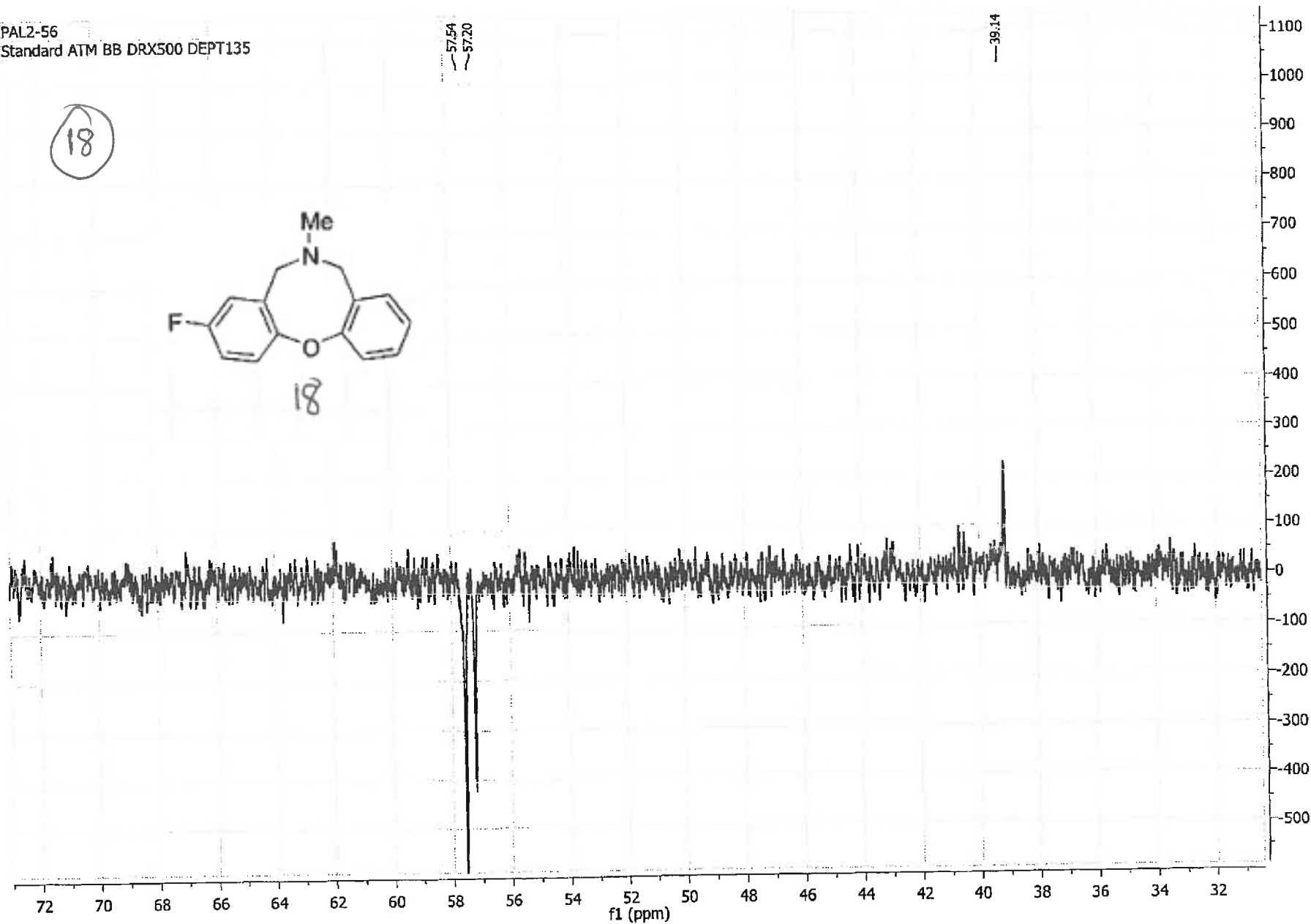
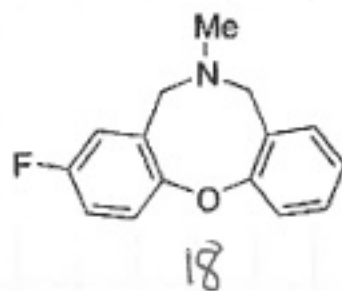
PAL2-56  
Standard ATM BB D8X500 DEPT135

18



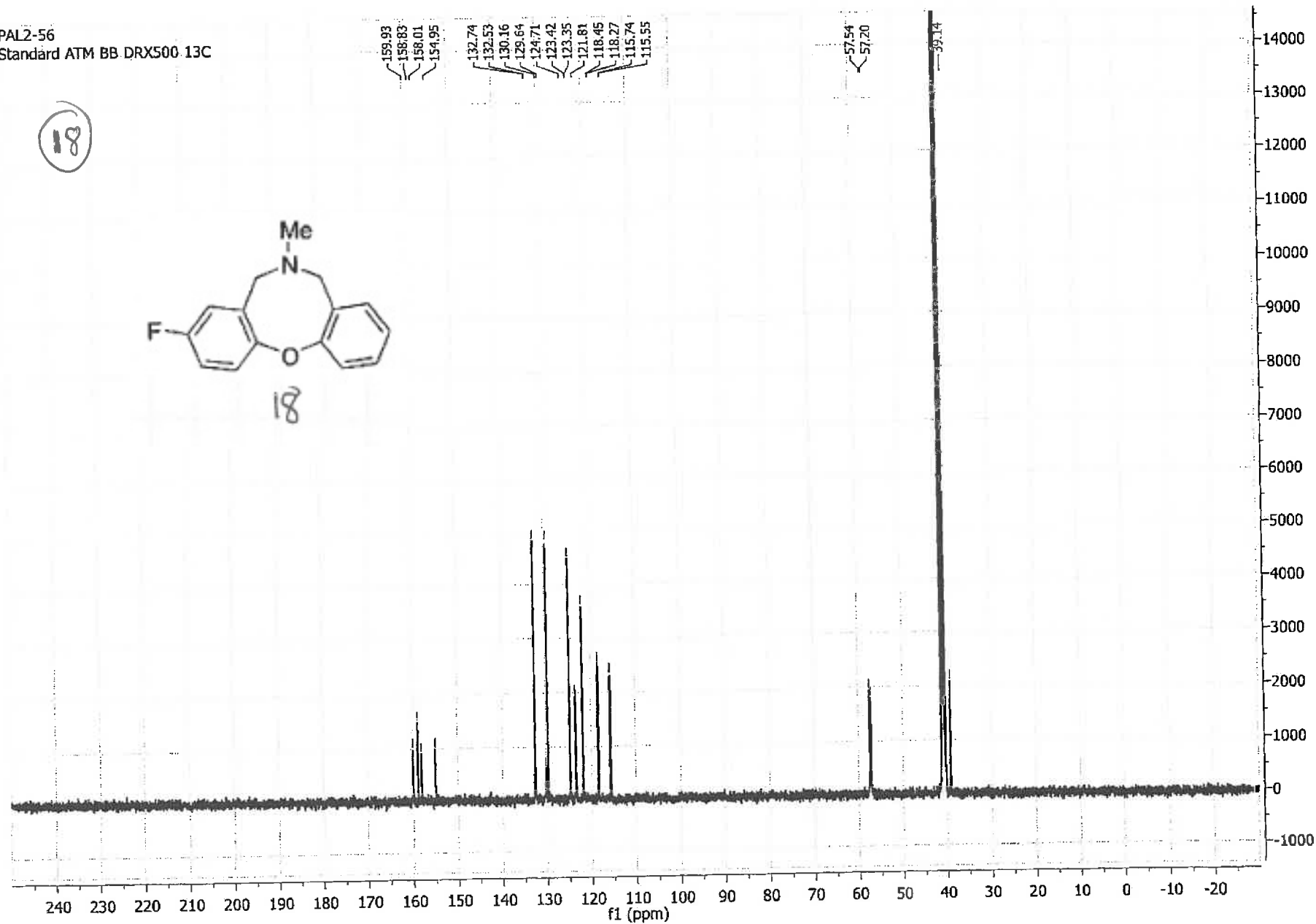
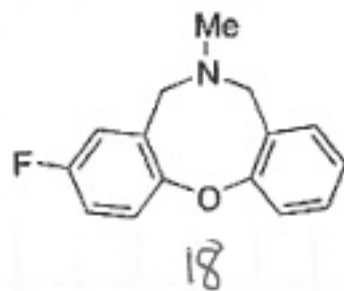
PAL2-56  
Standard ATM BB DRX500 DEPT135

18

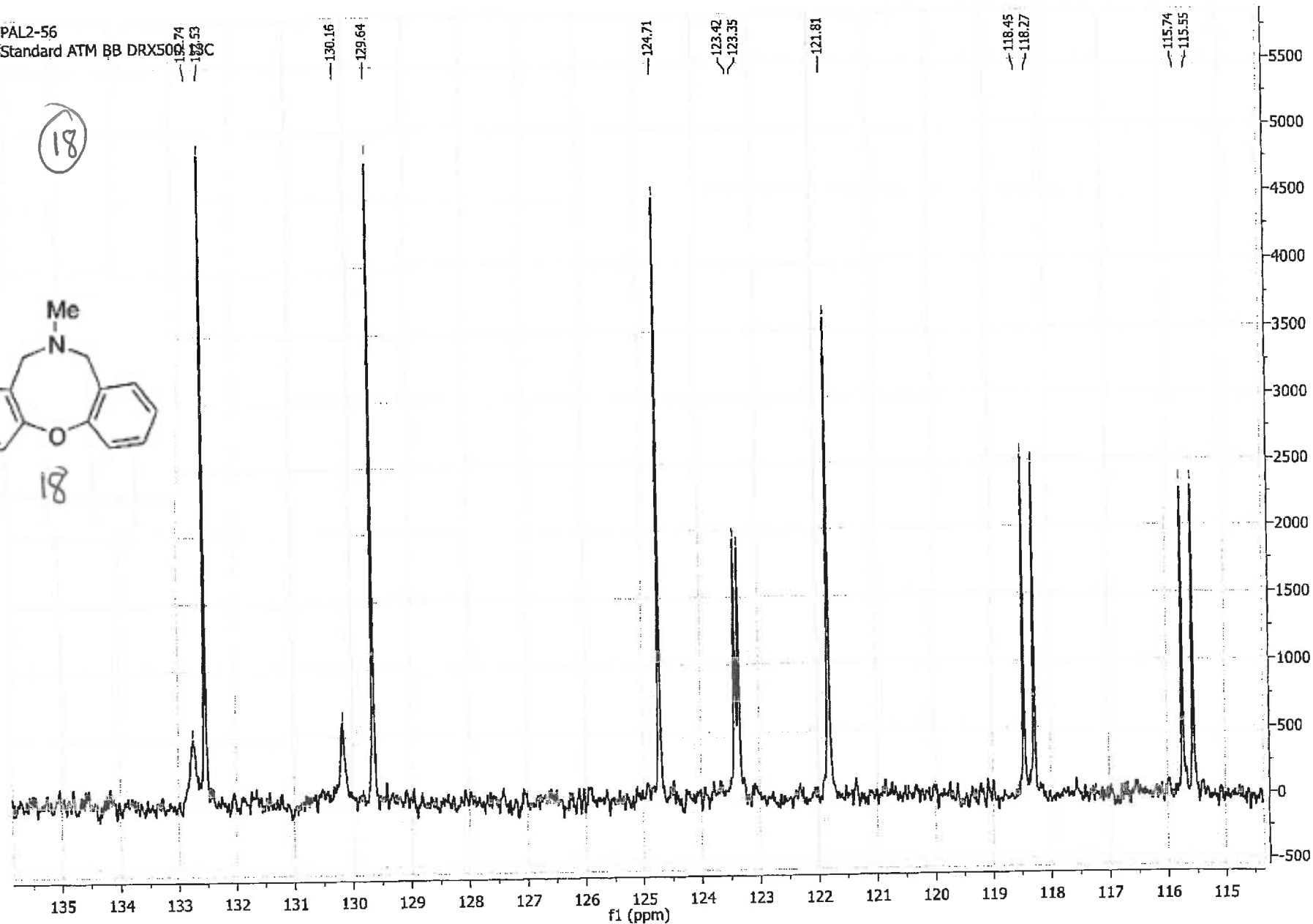
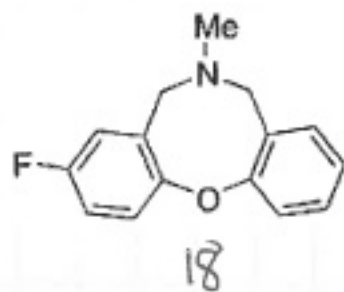


PAL2-56  
Standard ATM BB DRX500-13C

18

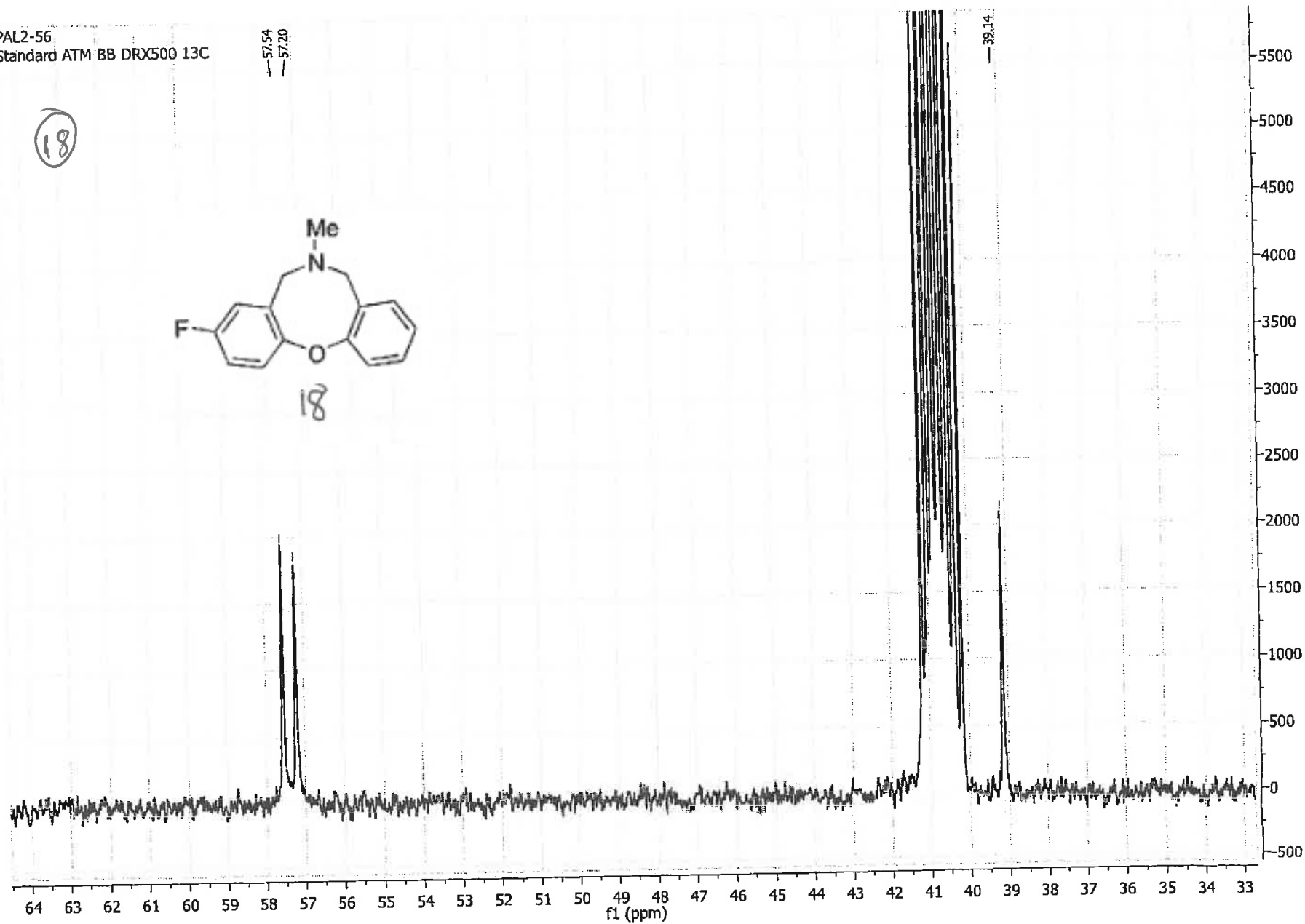
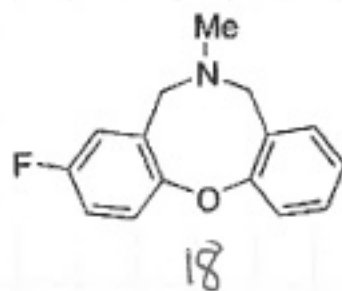


PAL2-56  
Standard ATM BB DRX500 13C



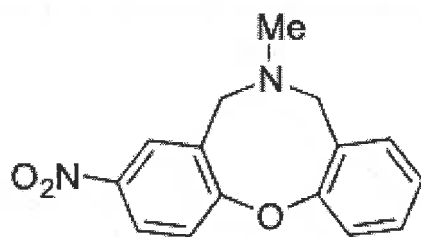
PAL2-56  
Standard ATM BB DRX500 13C

18

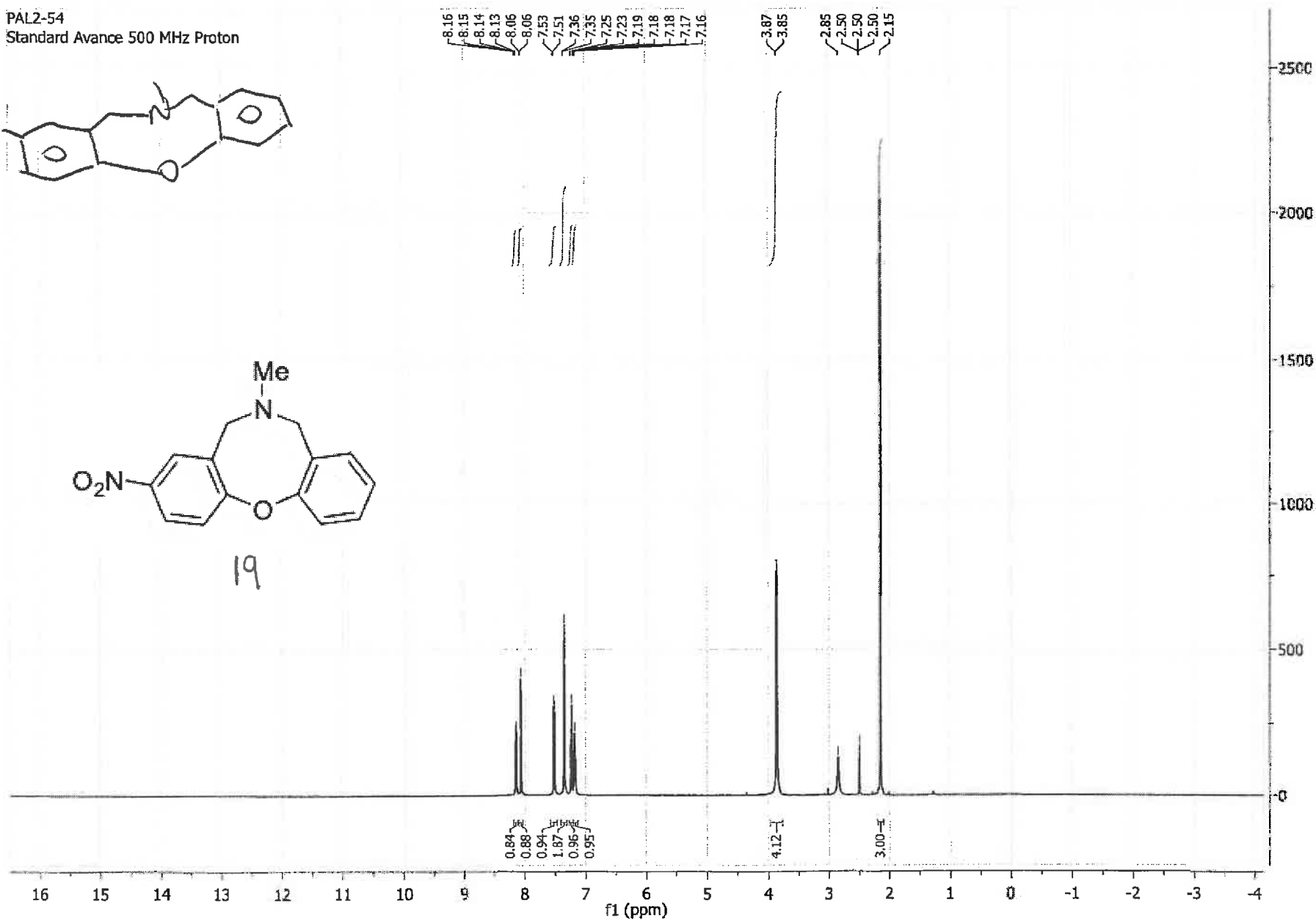


$T = 120^{\circ}\text{C}$

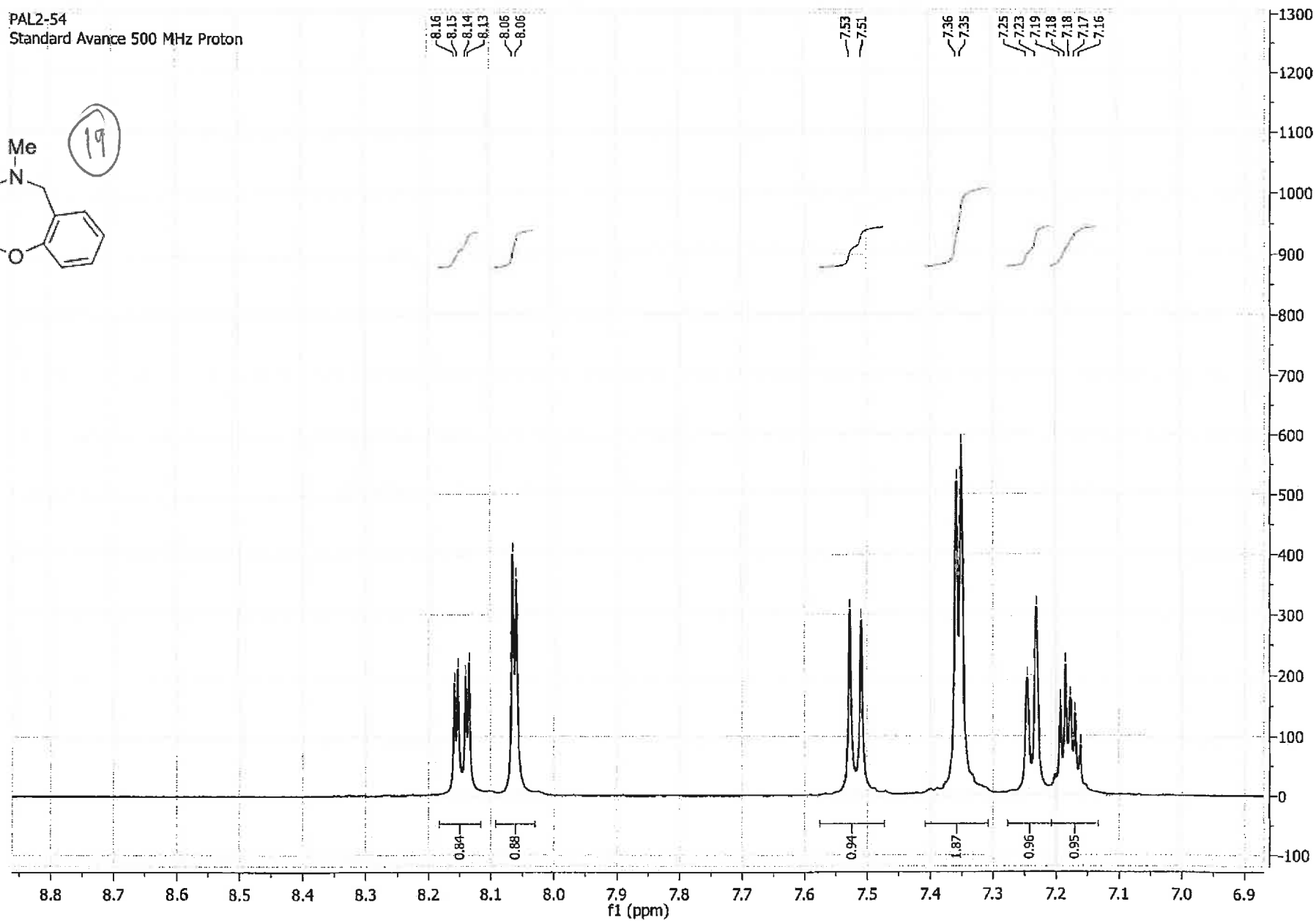
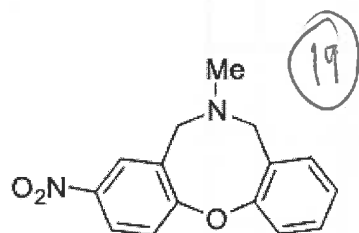
PAL2-54  
Standard Avance 500 MHz Proton



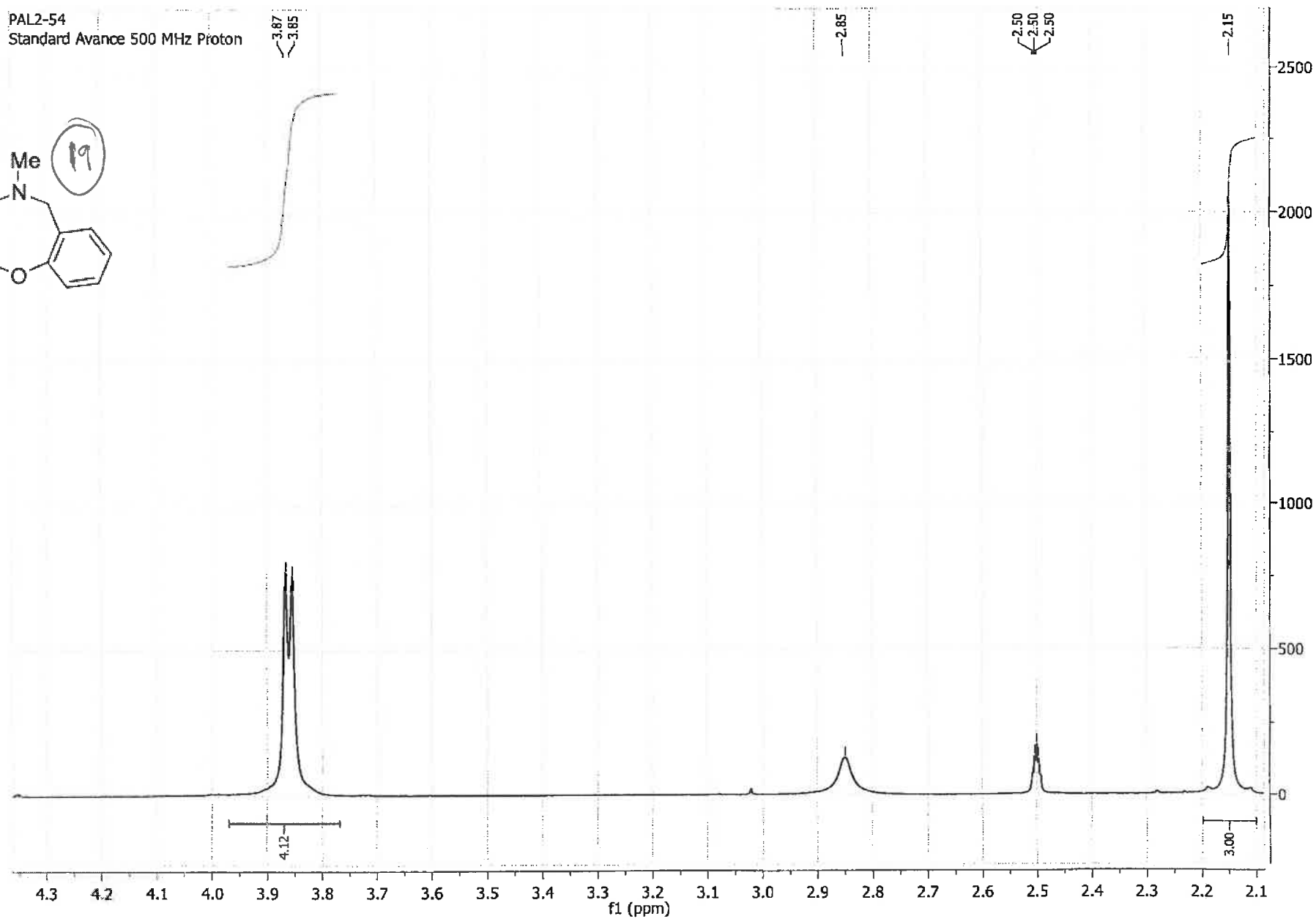
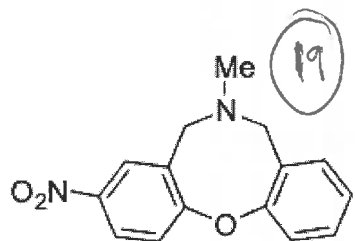
19



PAL2-54  
Standard Avance 500 MHz Proton

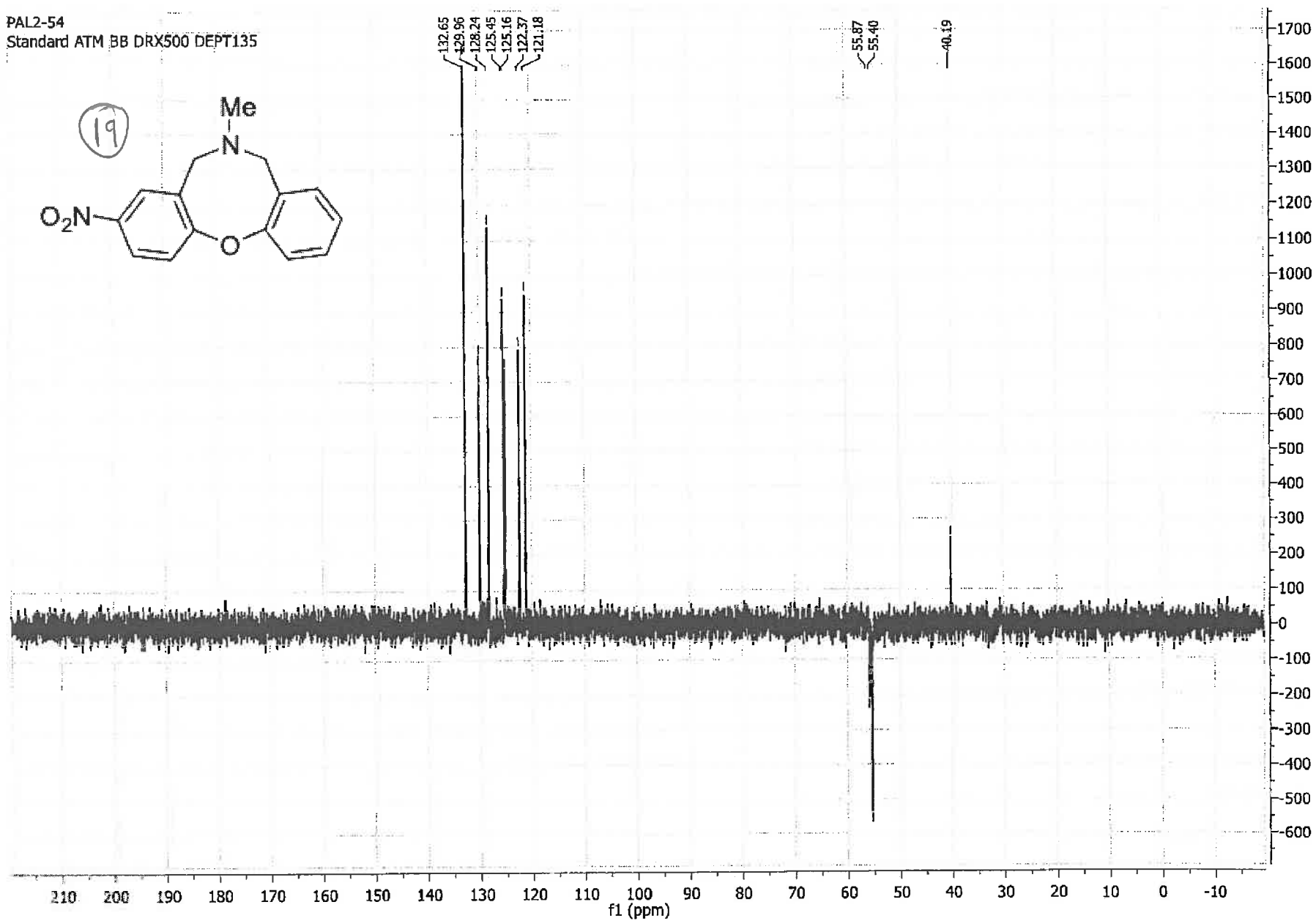
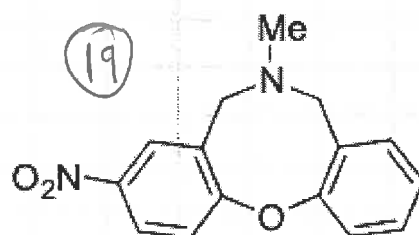


PAL2-54  
Standard Avance 500 MHz Proton

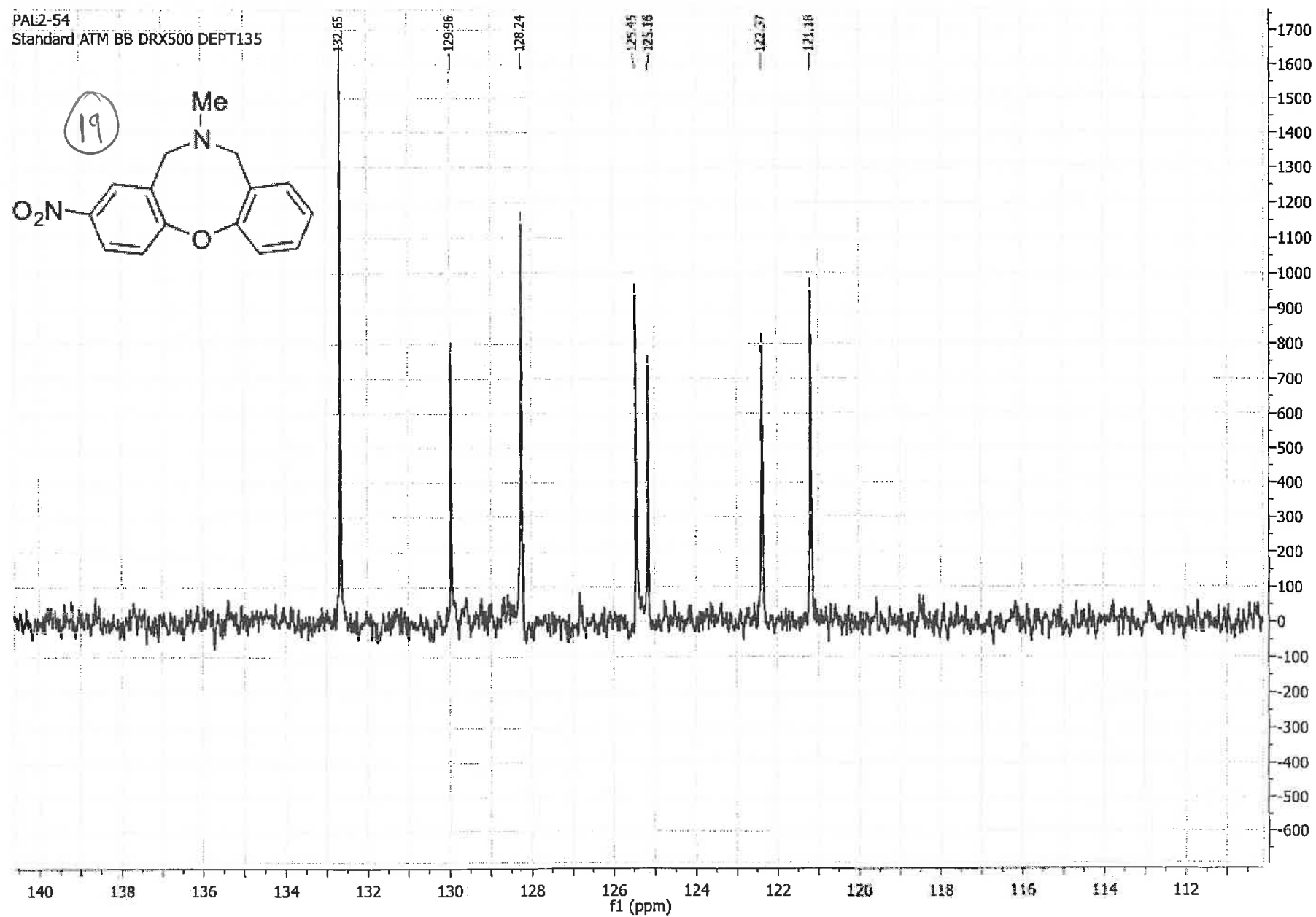
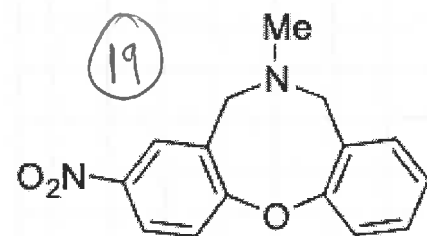




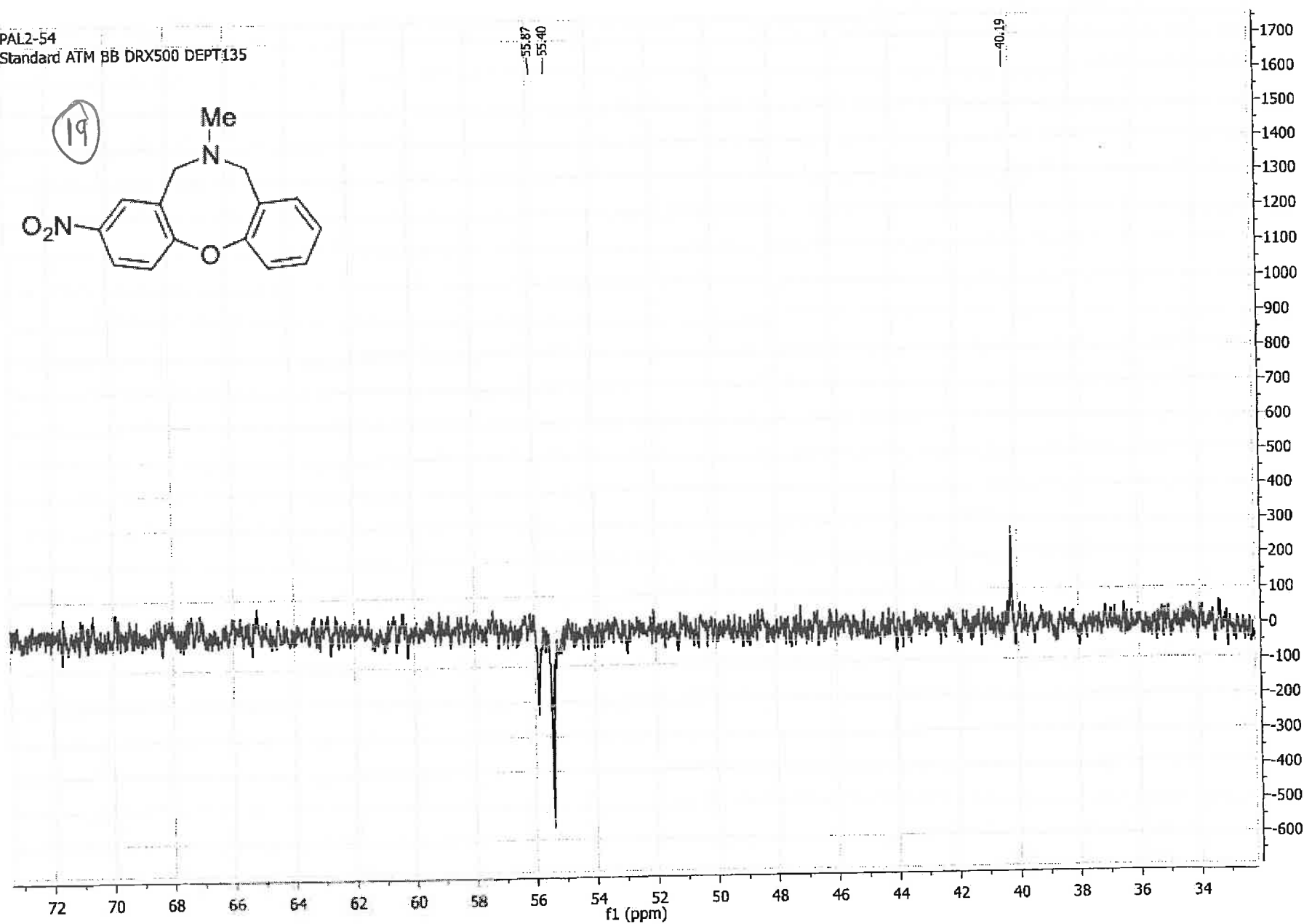
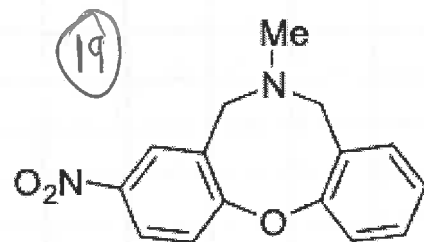
PAL2-54  
Standard ATM BB DRX500 DEPT135



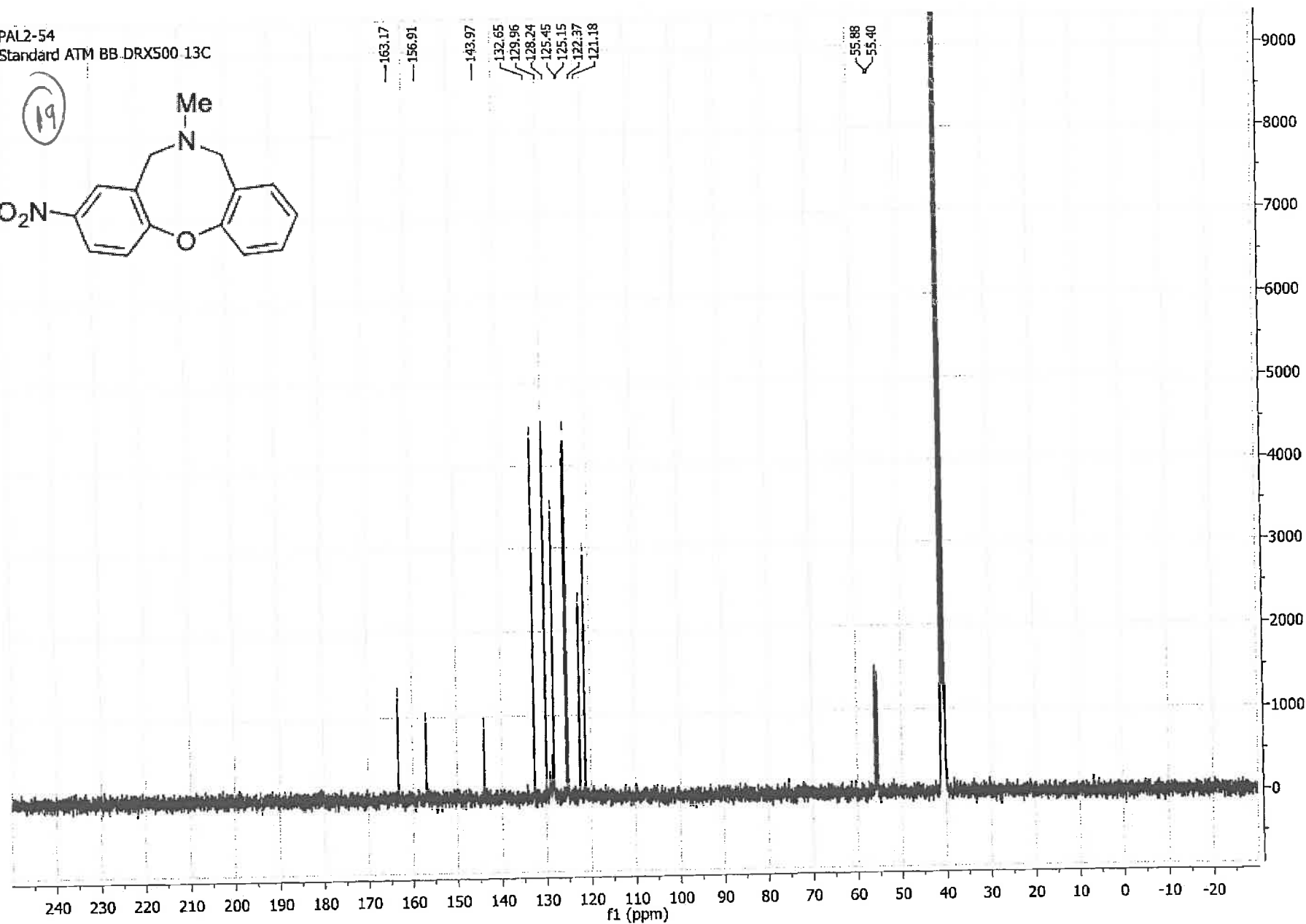
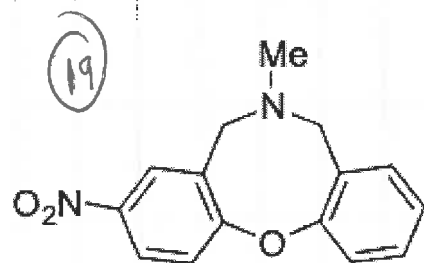
PAL2-54  
Standard ATM BB DRX500 DEPT135



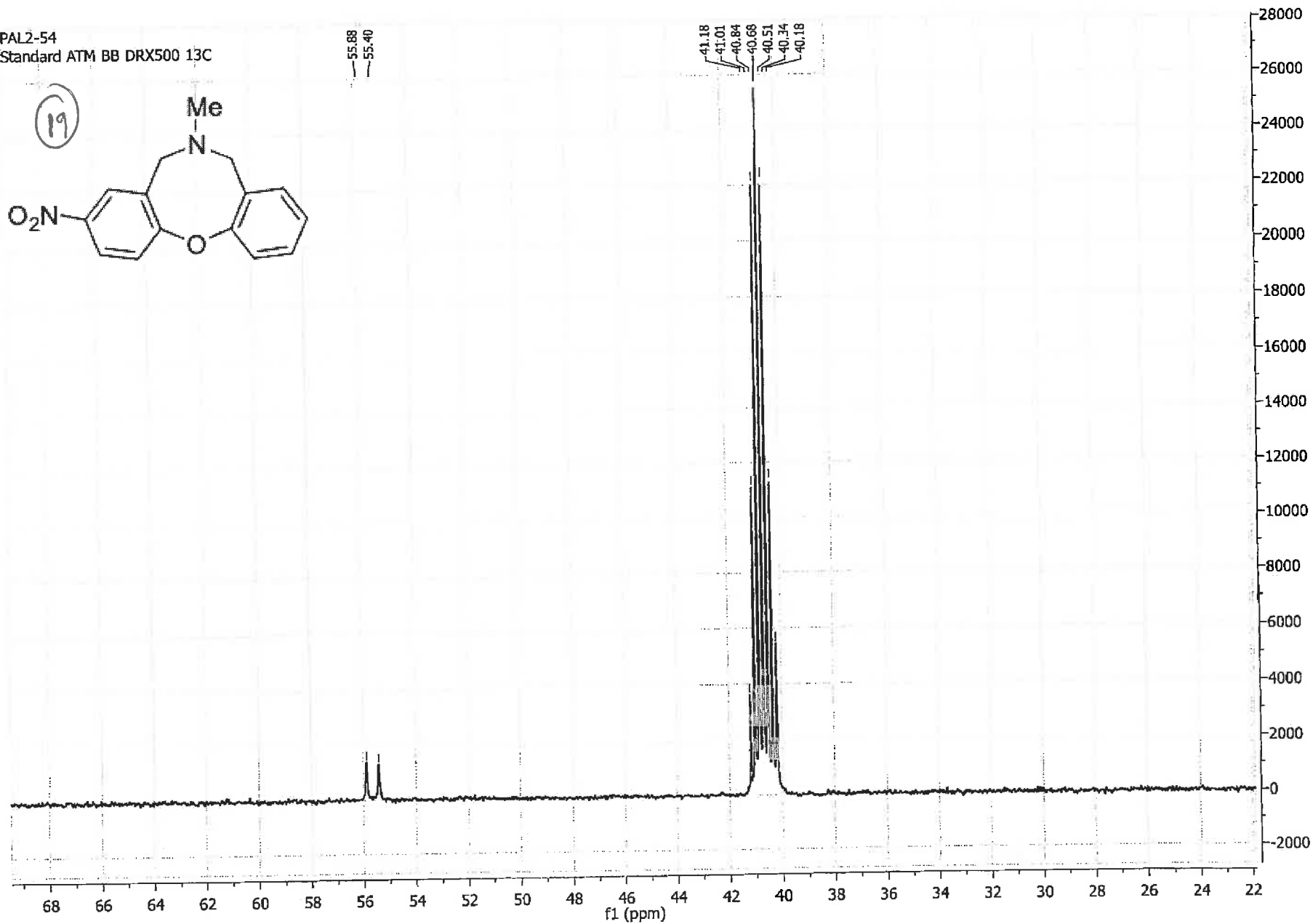
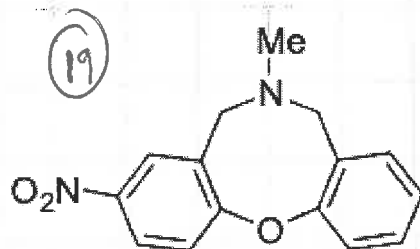
PAL2-54  
Standard ATM BB DRX500 DEPT135



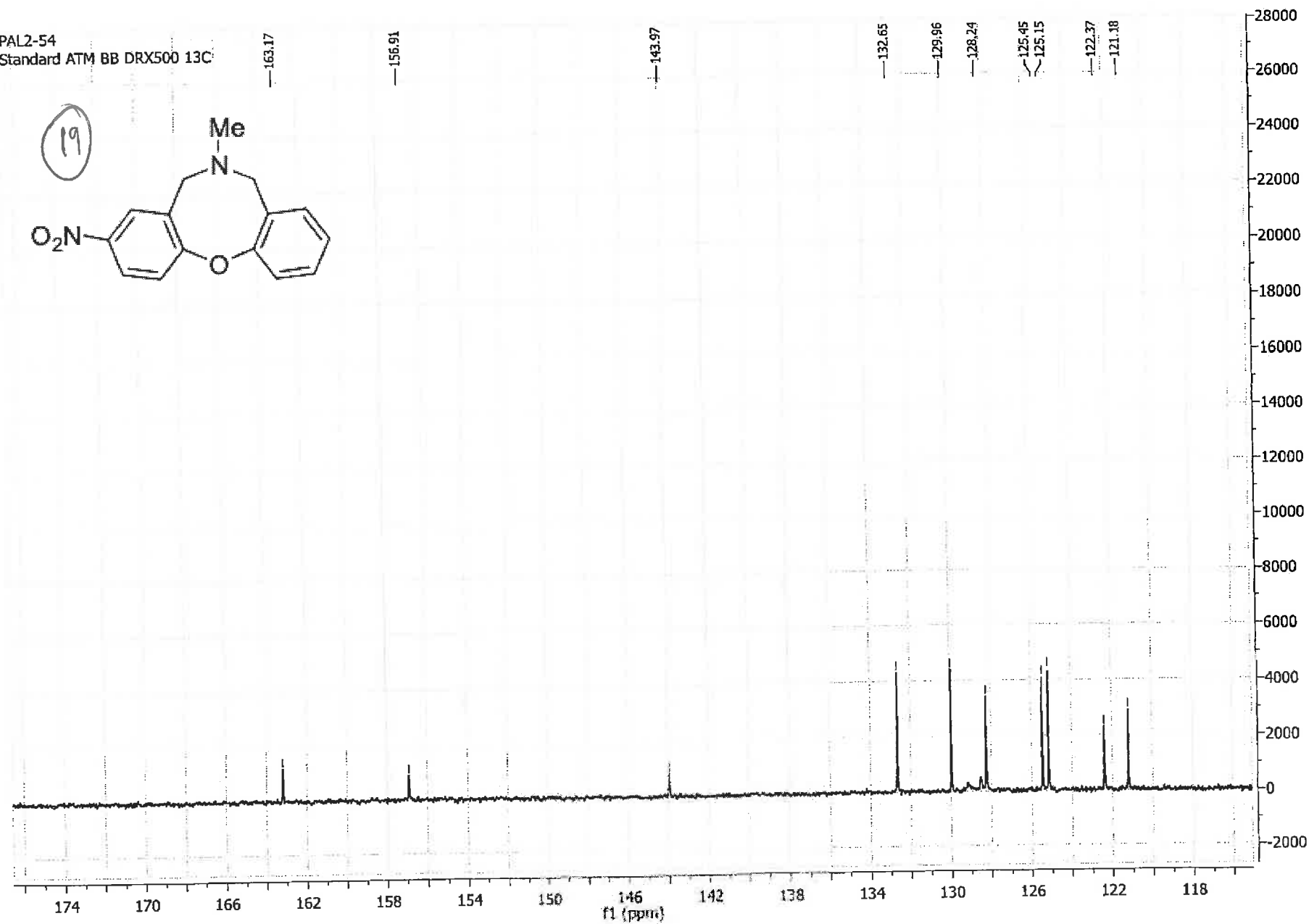
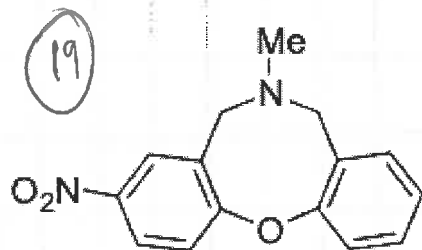
PAL2-54  
Standard ATM BB.DRX500 13C



PAL2-54  
Standard ATM BB DRX500 13C

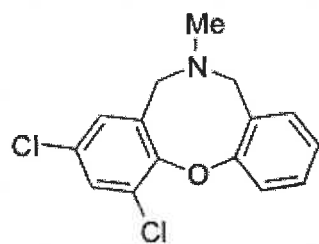
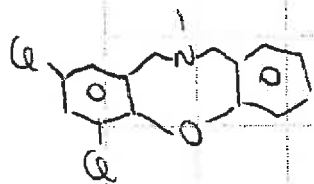


PAL2-54  
Standard ATM BB DRX500 13C

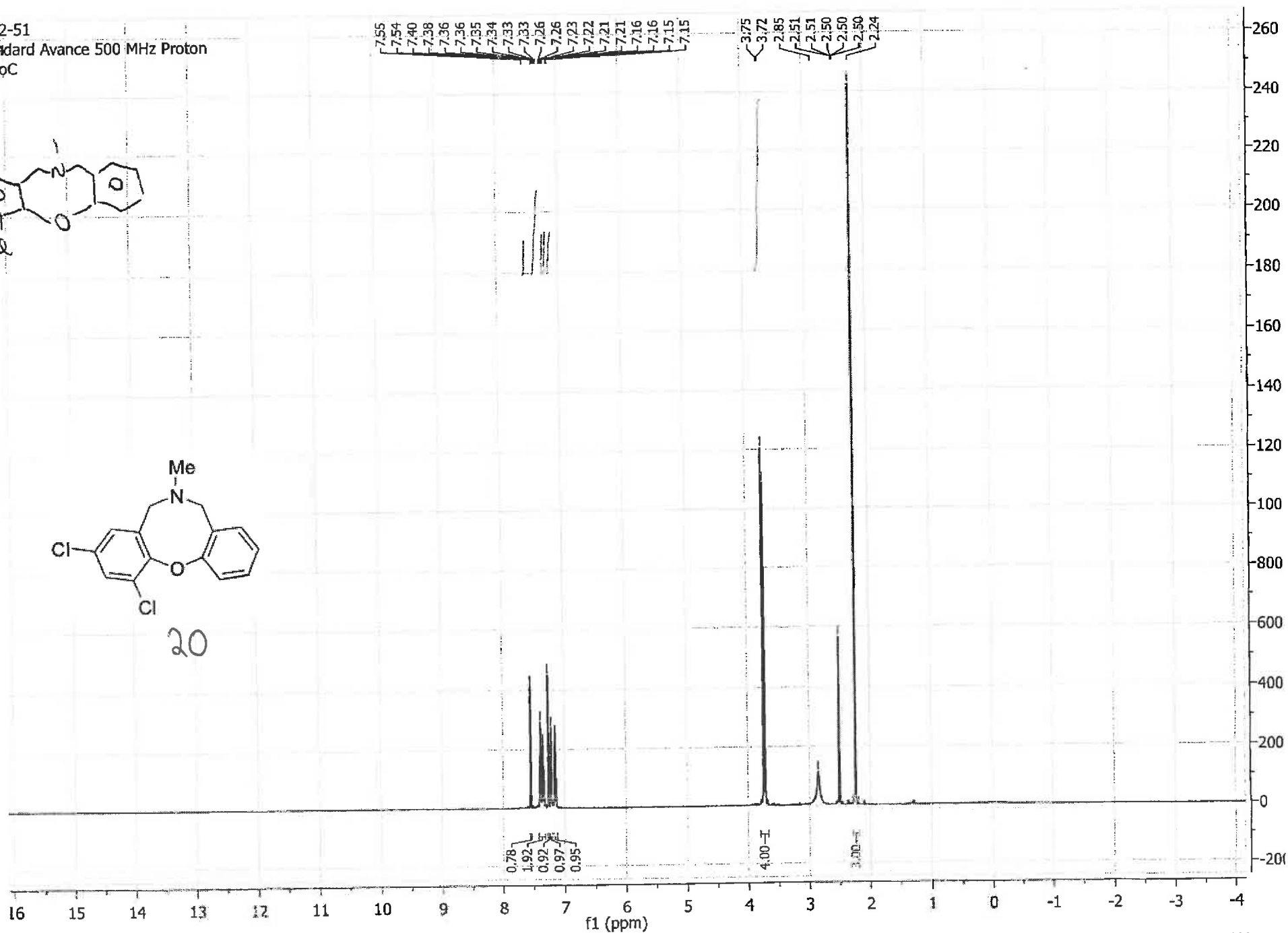


PAL 2-51

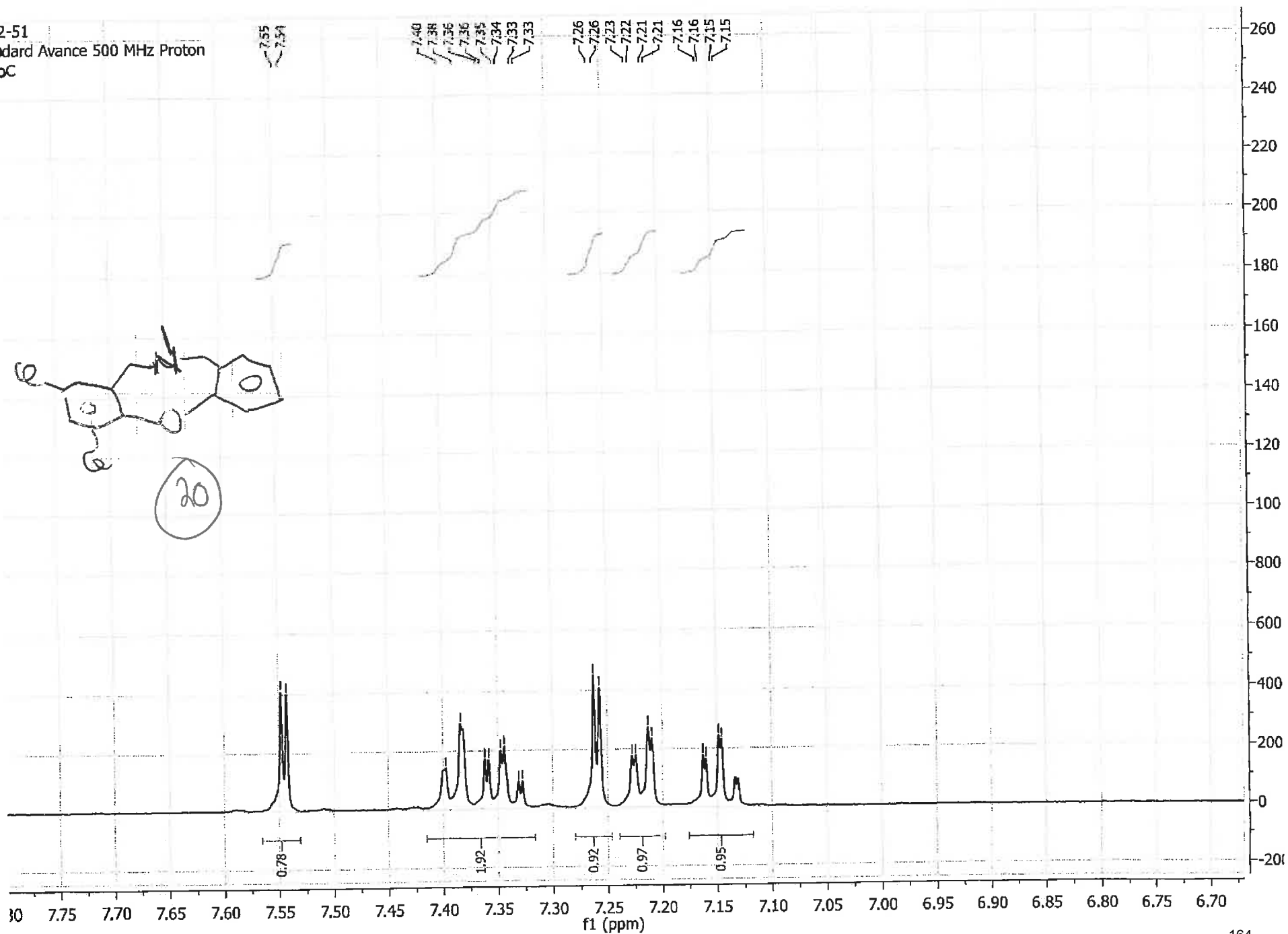
Standard Avance 500 MHz Proton  
125°C



20



ML 2-51  
Standard Avance 500 MHz Proton  
120 OC





PAL2-51

Standard Avance 500 MHz Proton

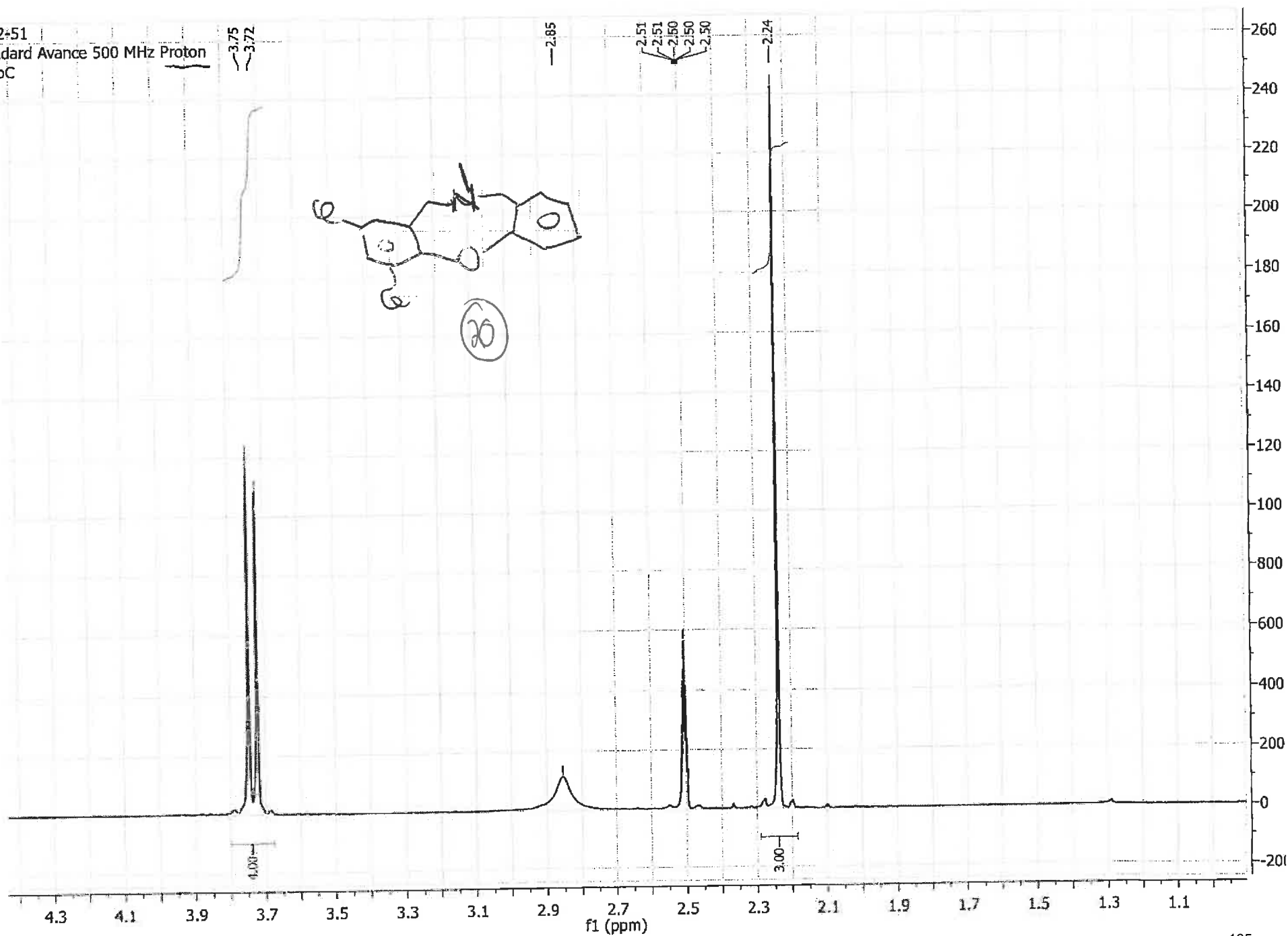
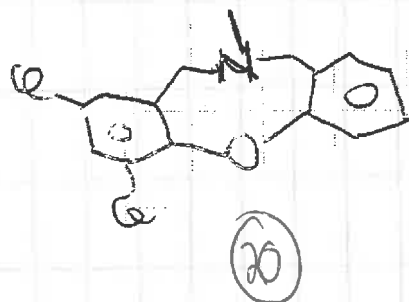
120 °C

3.75  
3.72

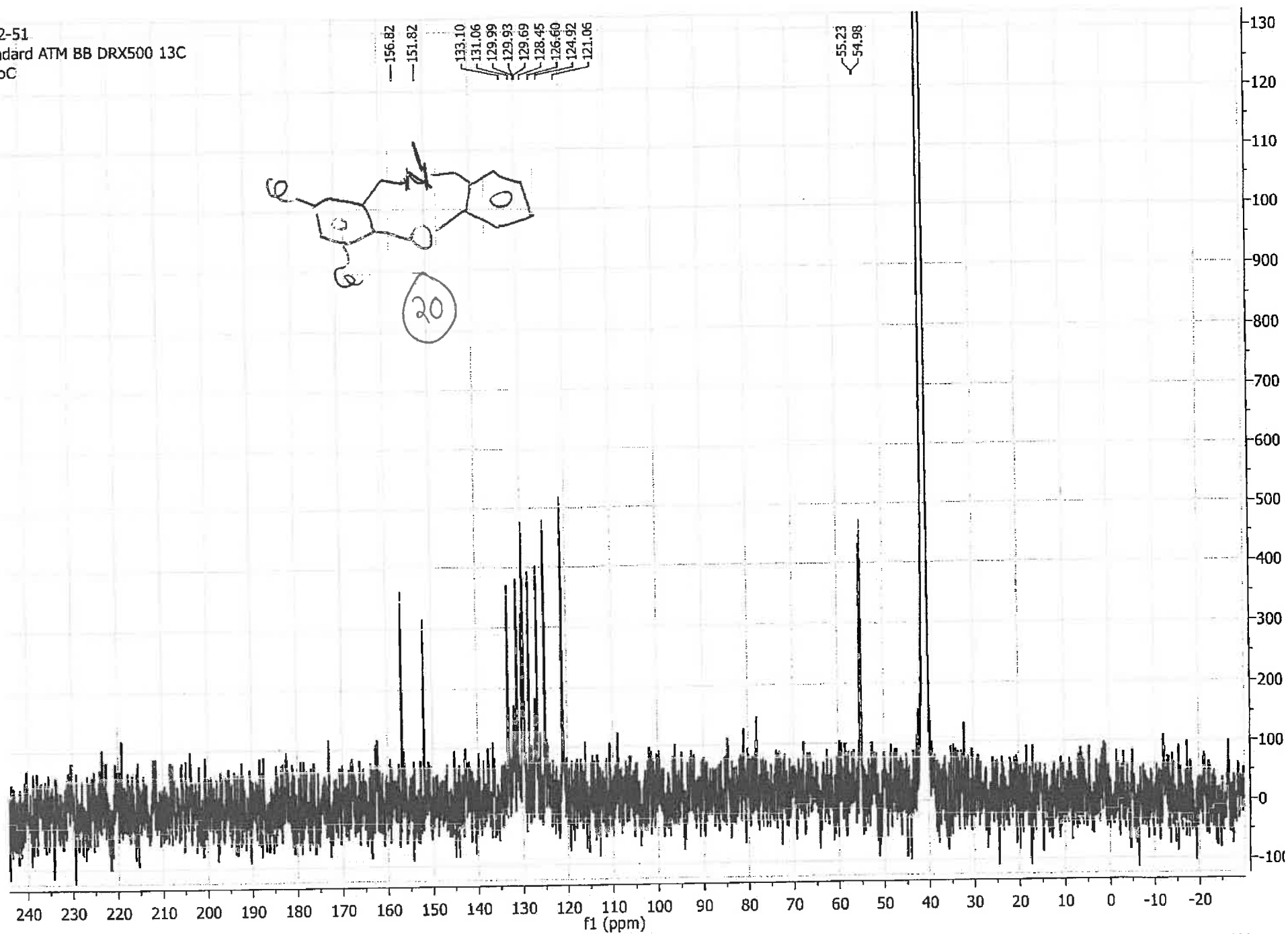
2.85

2.51  
2.51  
2.50  
2.50

2.24



PAL 2-51  
Standard ATM BB DRX500 13C  
120 oC



PAL 2-51  
Standard ATM BB DRX500 13C  
120°C

133.10

131.06

129.99

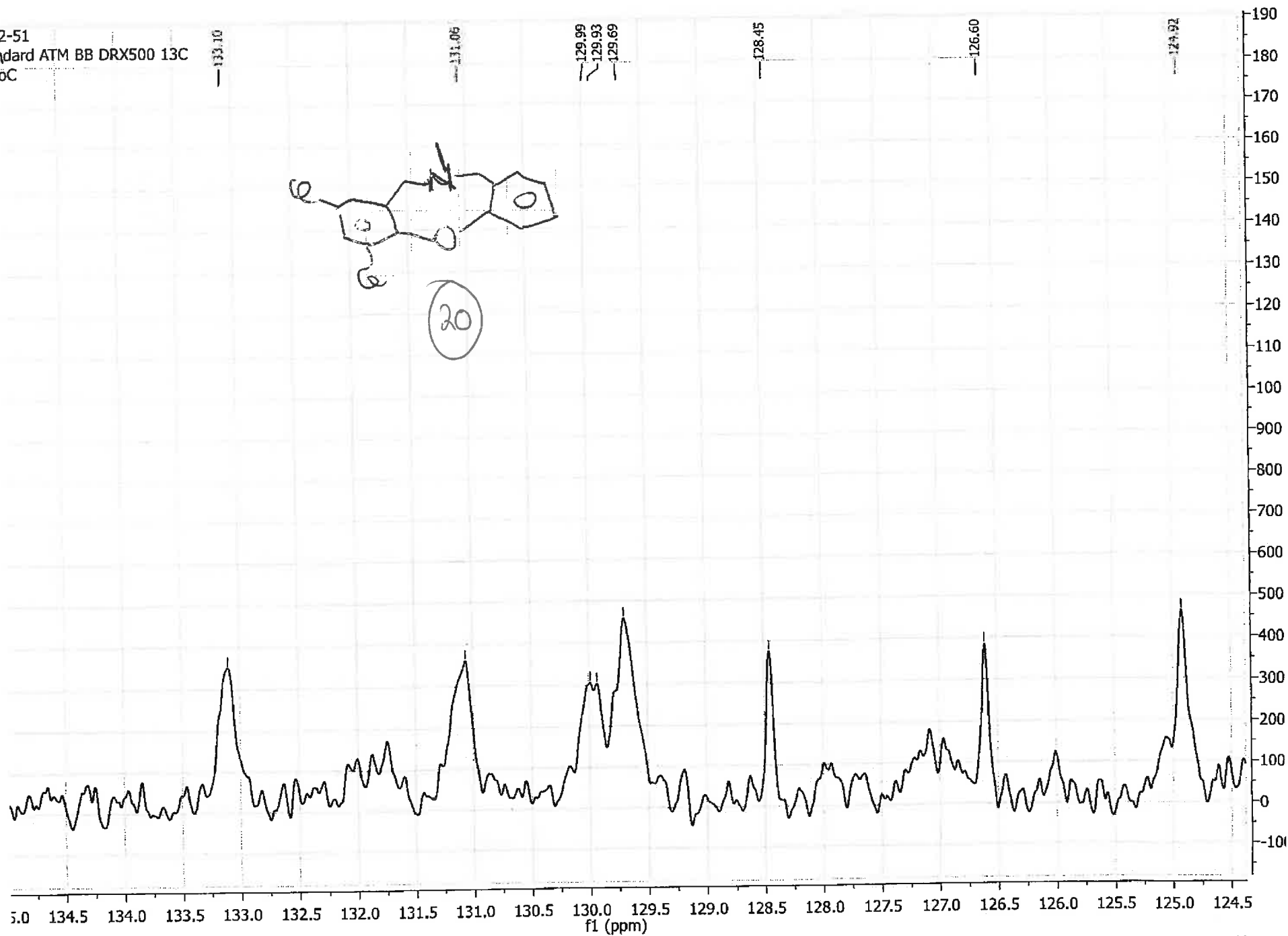
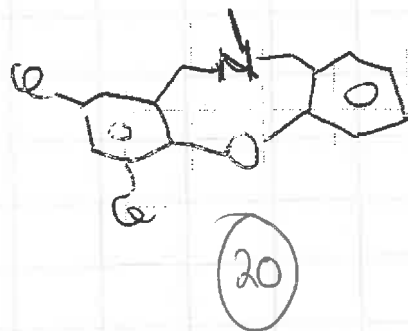
129.93

129.69

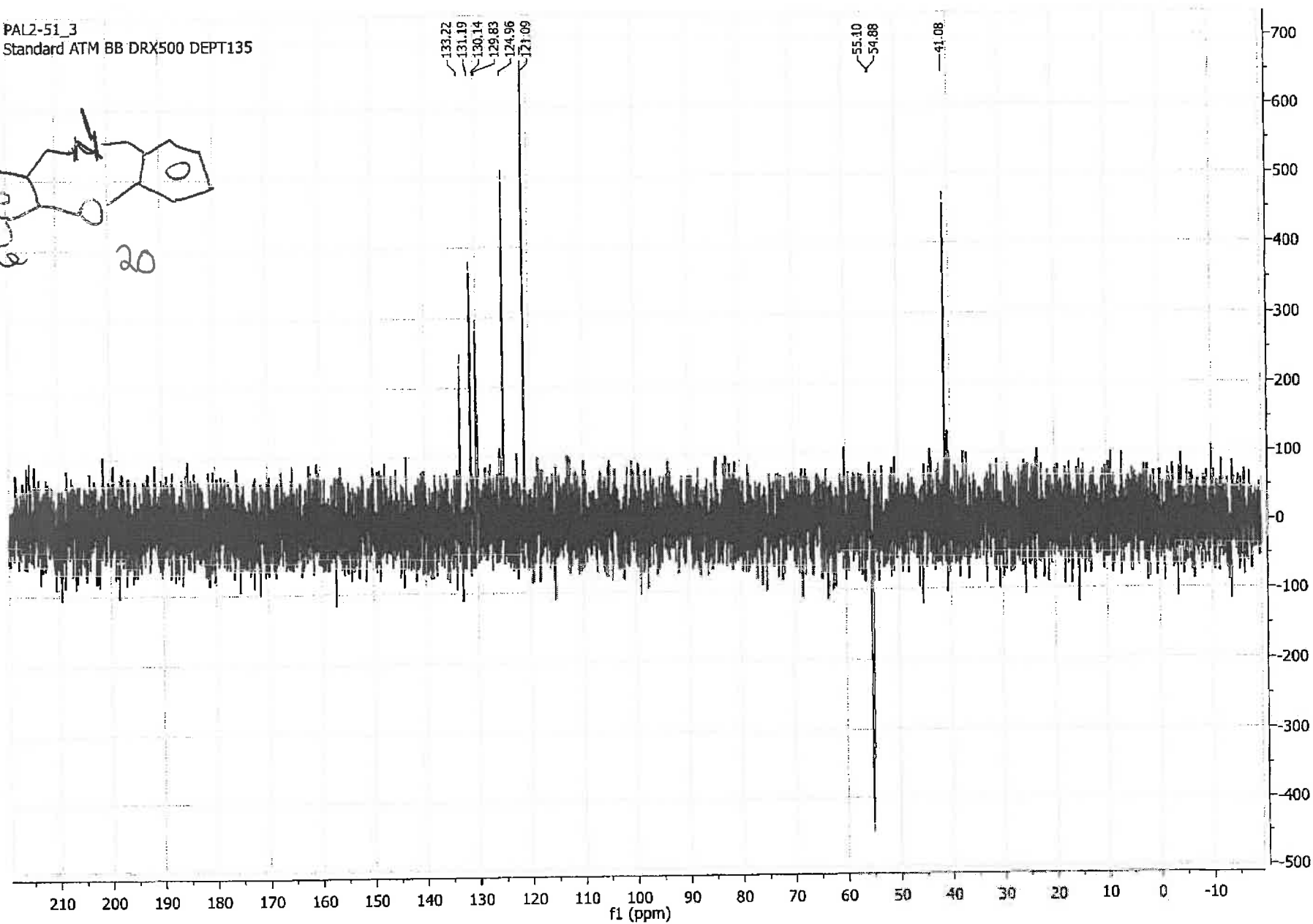
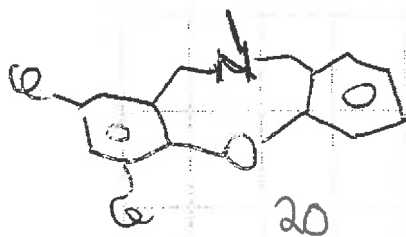
128.45

126.60

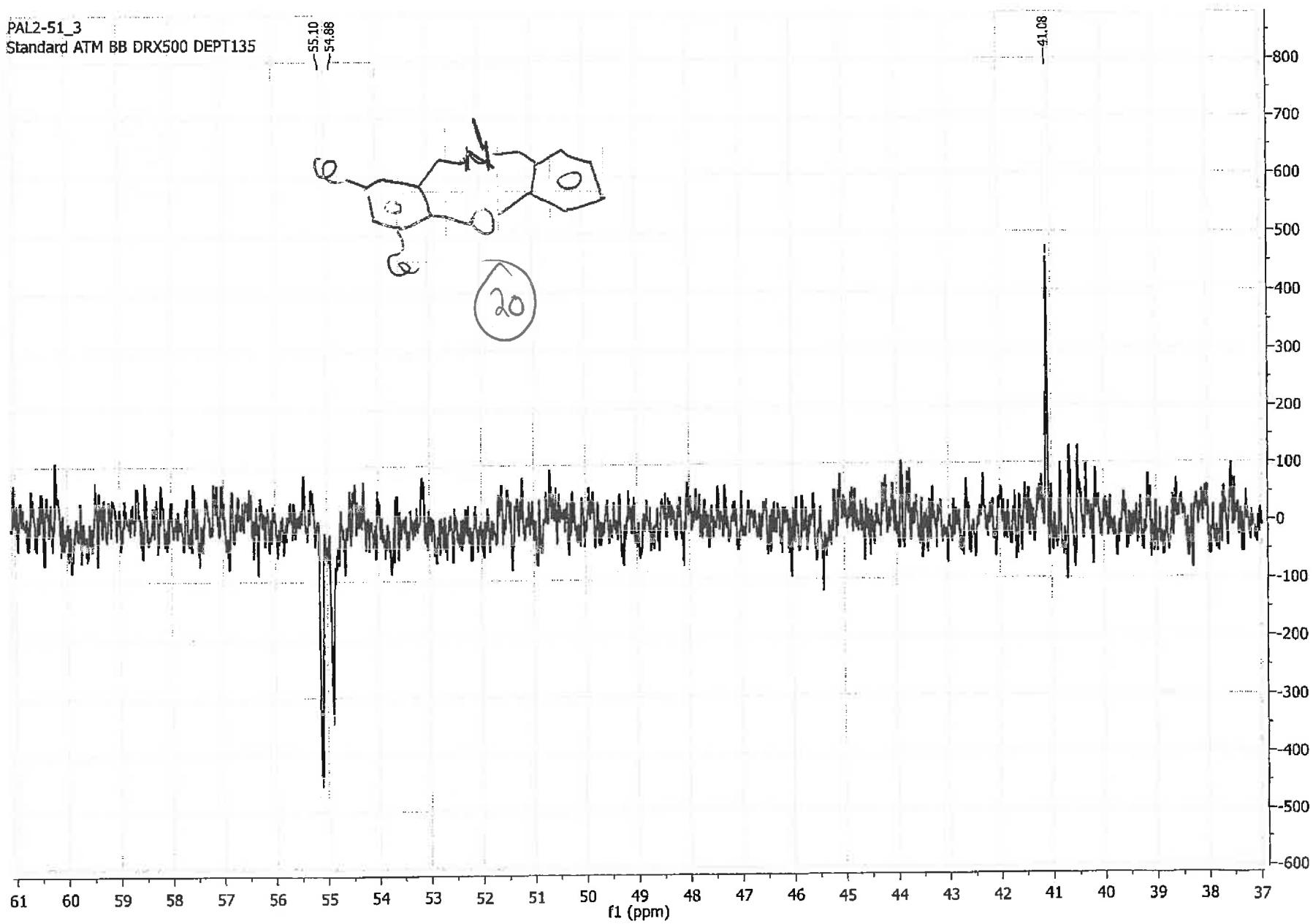
124.92



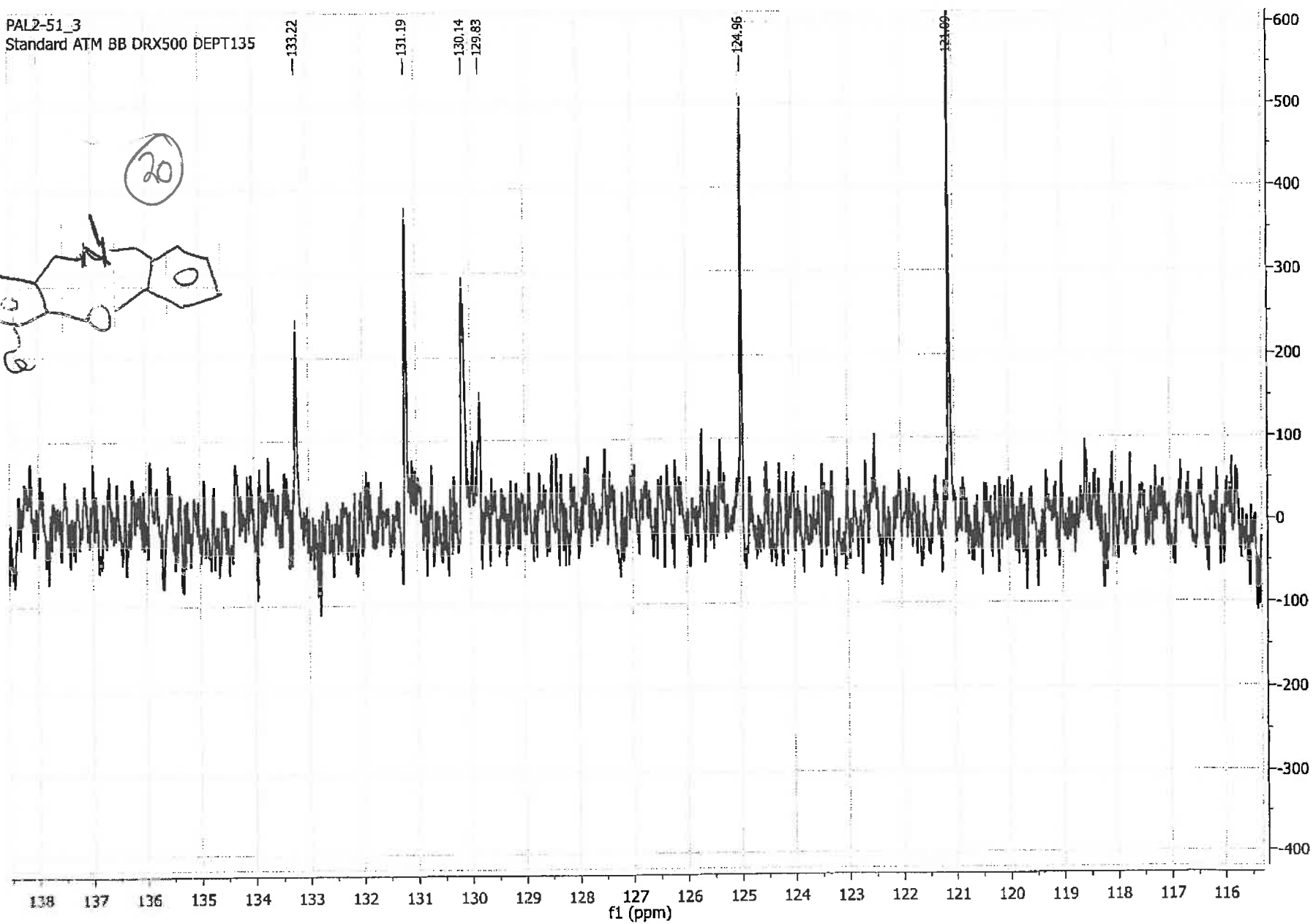
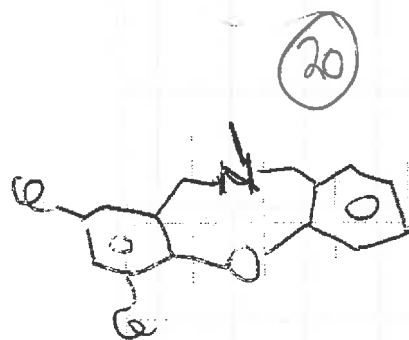
PAL2-51\_3  
Standard ATM BB DRX500 DEPT135



PAL2-51\_3  
Standard ATM BB DRX500 DEPT135



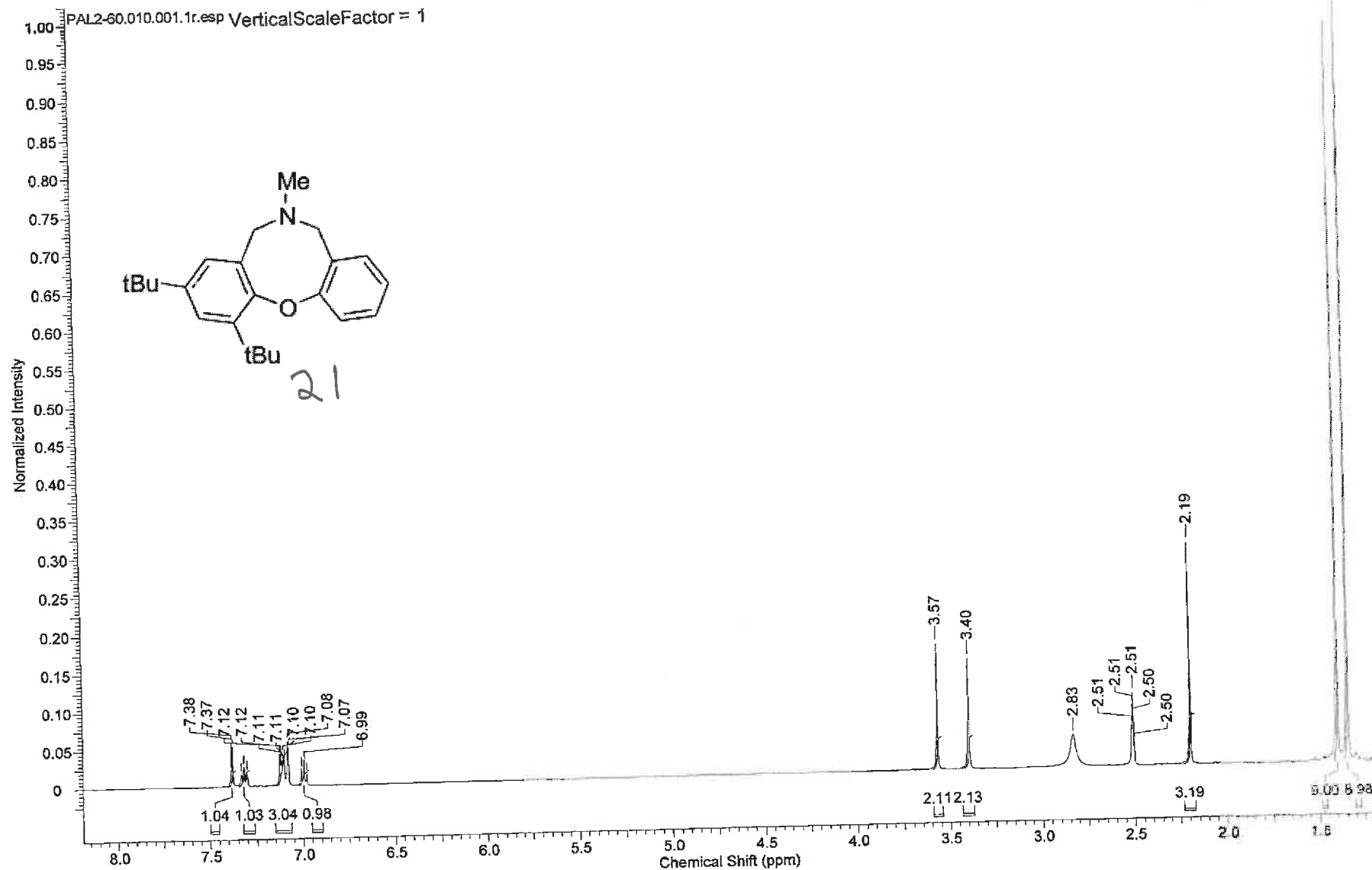
PAL2-51\_3  
Standard ATM BB DRX500 DEPT135



PAL 2-60

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**TJS-007 PURE**

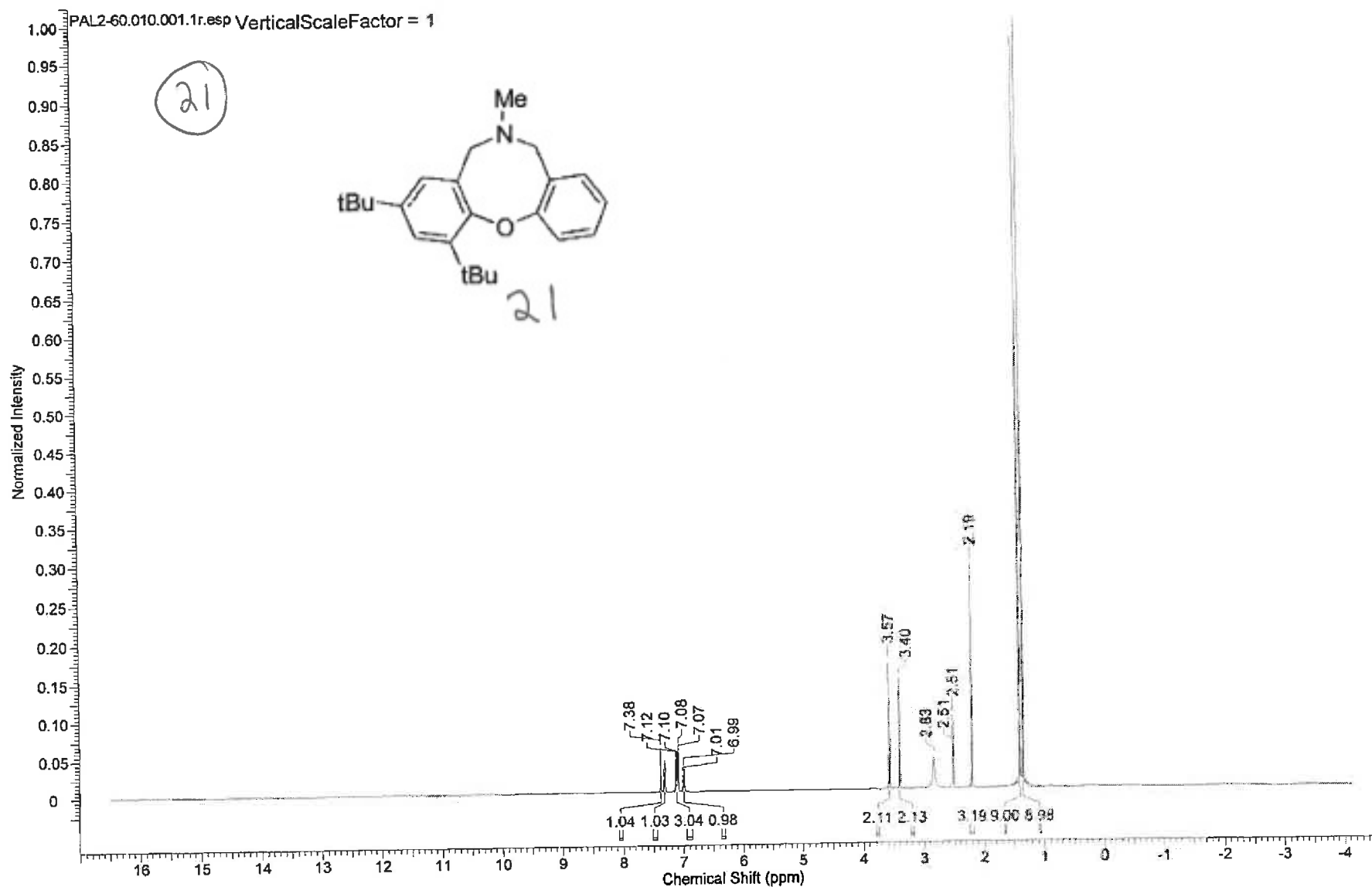
29/10/2012 19:00:42  
TJS-007 PURE



Y:\glengrant\dirs\nmr\PAL2-60\PAL2-60.010.001.1r.esp

**TJS-007 PURE**

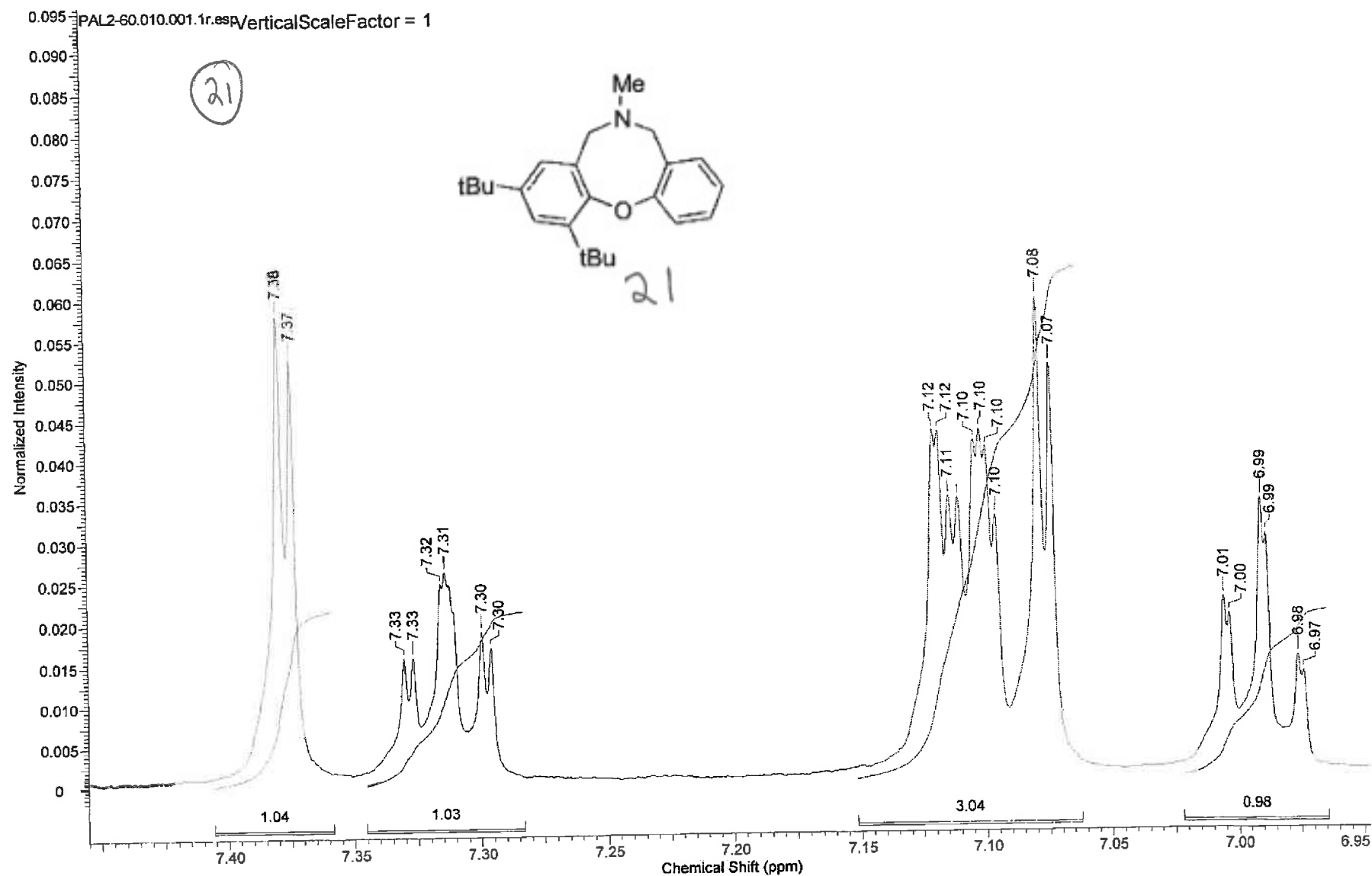
29/10/2012 18:59:32  
TJS-007 PURE





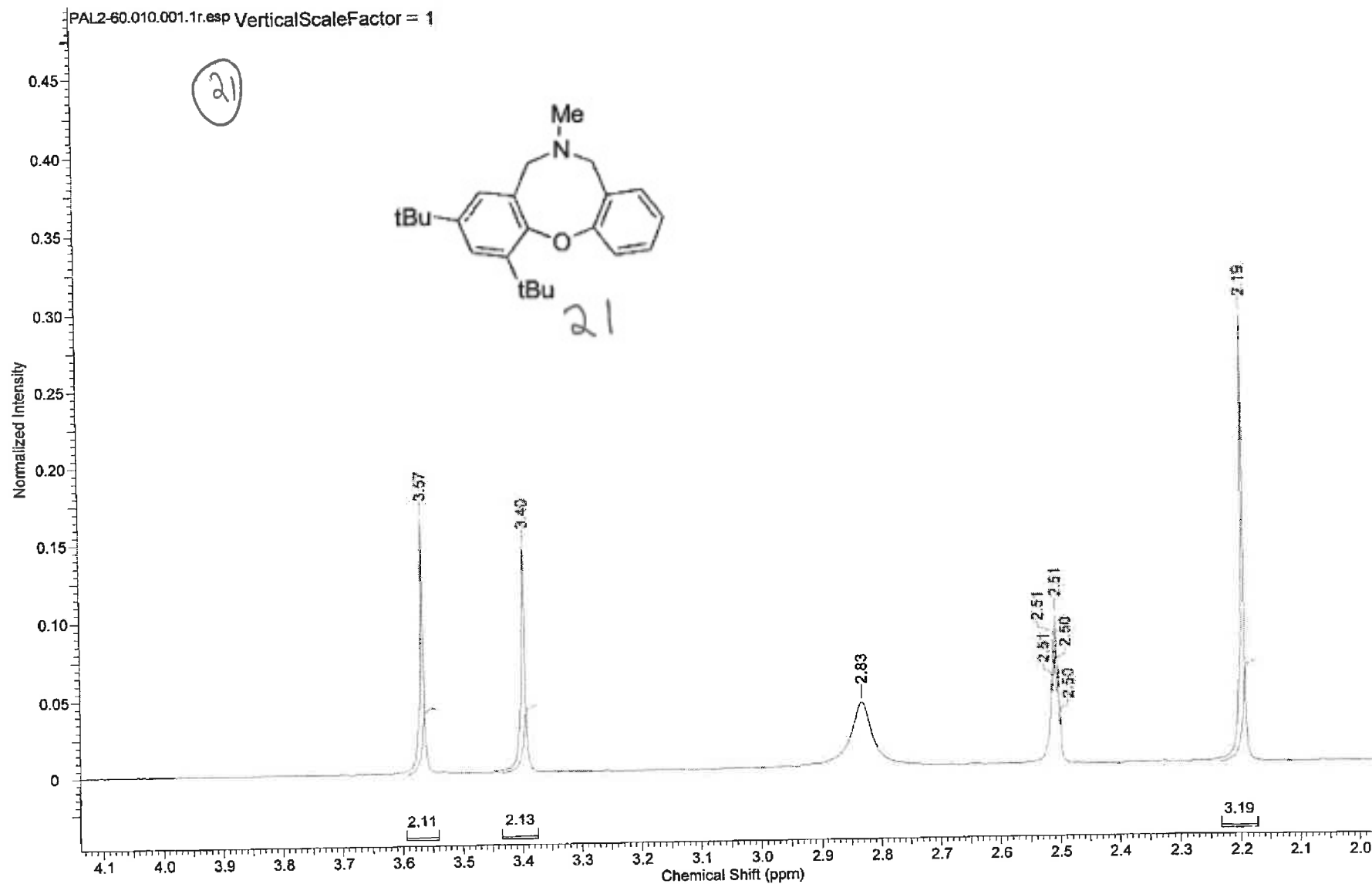
# TJS-007 PURE

29/10/2012 18:59:16  
TJS-007 PURE



# TJS-007 PURE

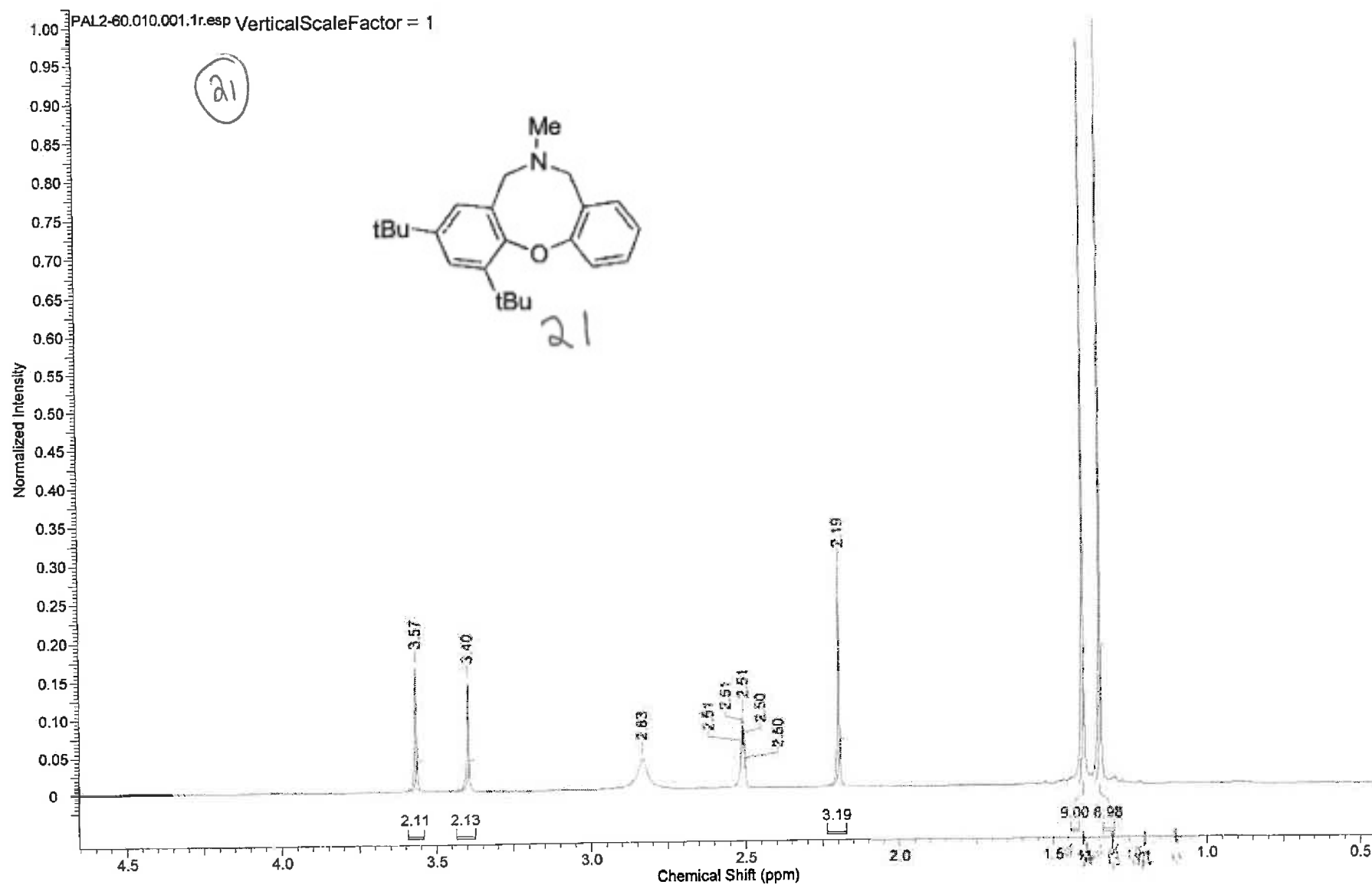
29/10/2012 18:57:10  
TJS-007 PURE



Y:\glengrant\drs\nmr\PAL2-60\PAL2-60.010.001.1r.esp

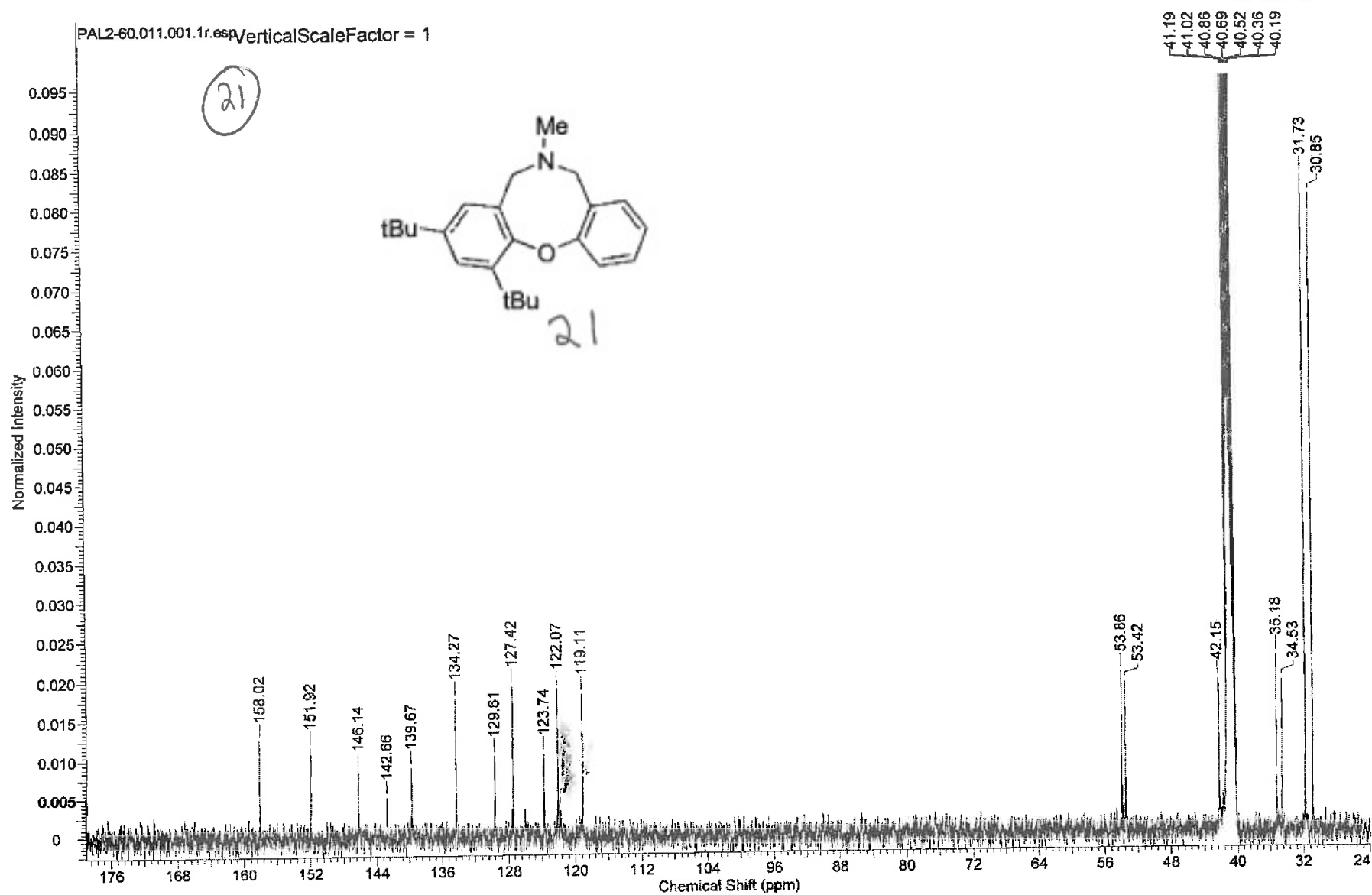
# TJS-007 PURE

29/10/2012 19:00:05  
TJS-007 PURE



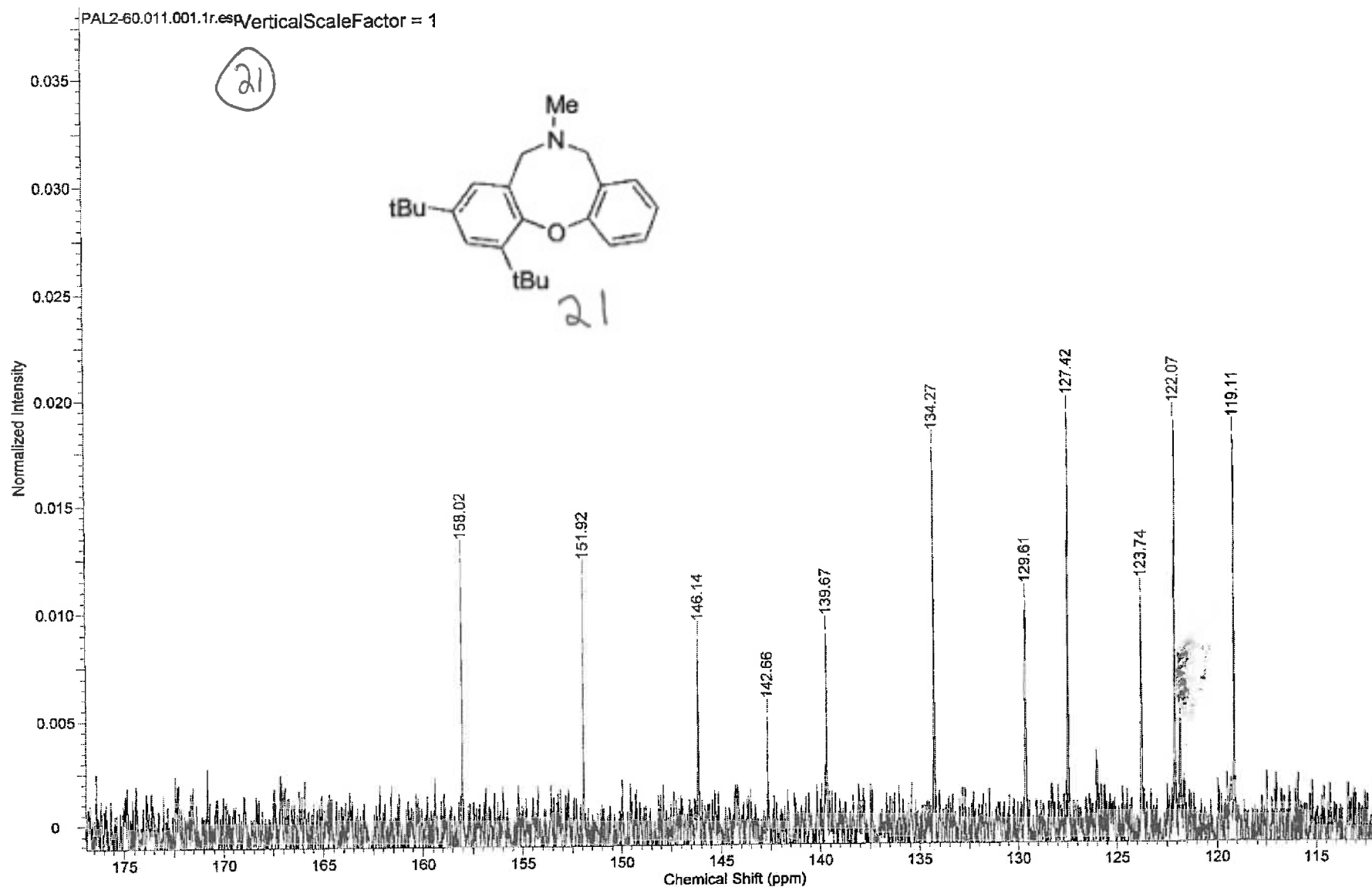
# TJS-007 PURE

29/10/2012 19:03:11  
TJS-007 PURE



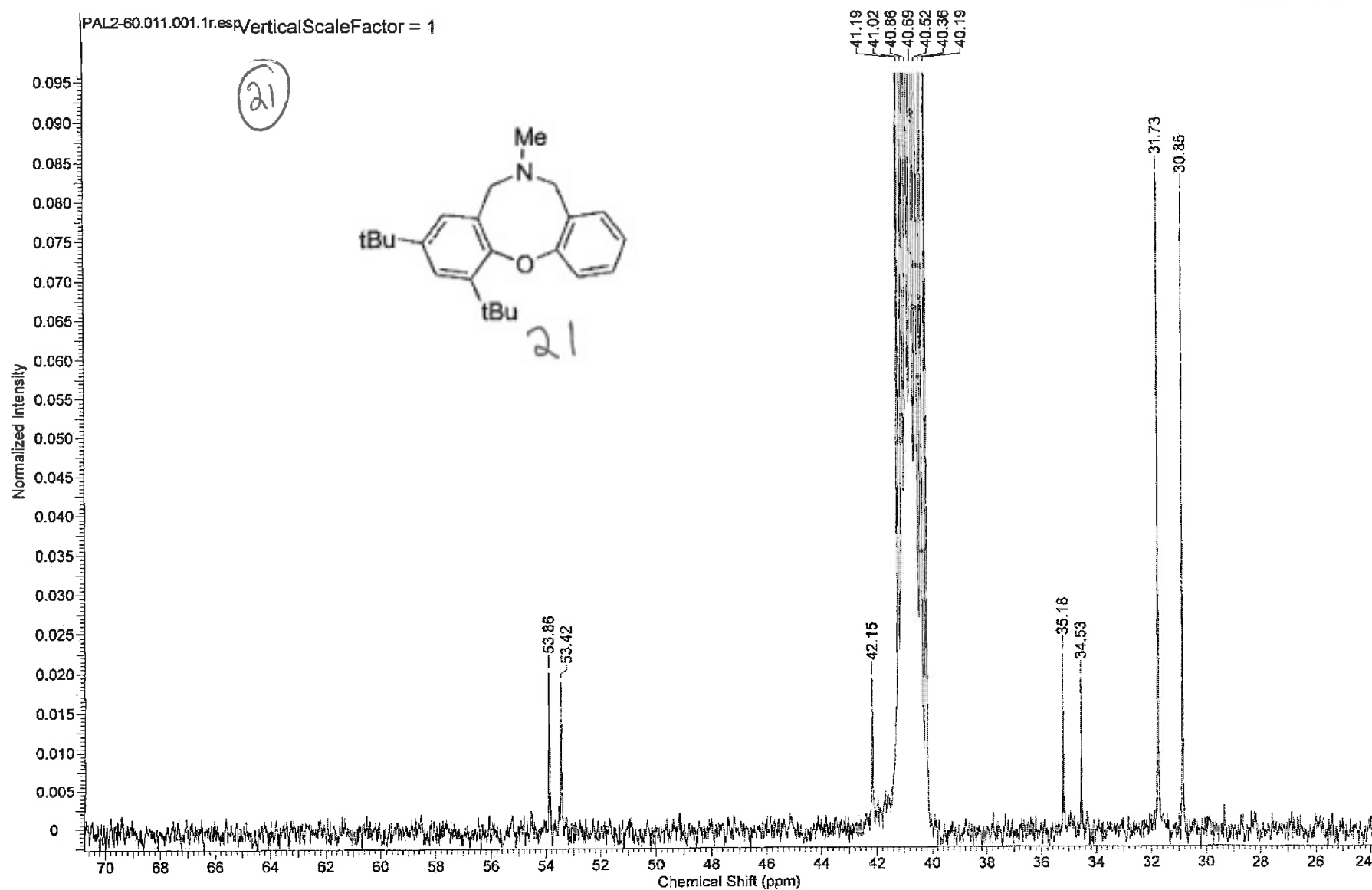
# TJS-007 PURE

29/10/2012 19:02:51  
TJS-007 PURE



# TJS-007 PURE

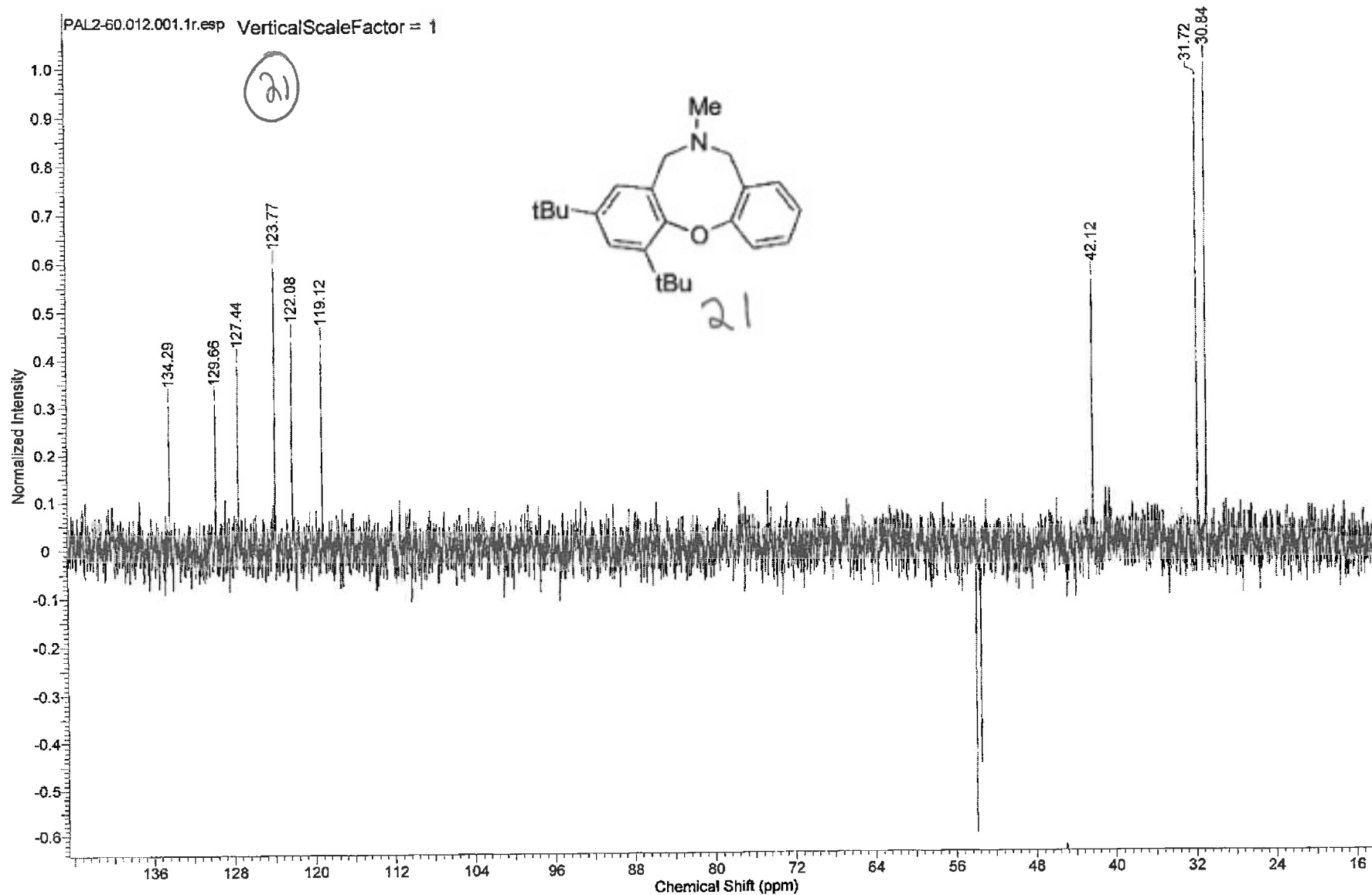
29/10/2012 19:03:44  
TJS-007 PURE



Y:\glengrant\drs\nmr\PAL2-60\PAL2-60.011.001.1r.esp

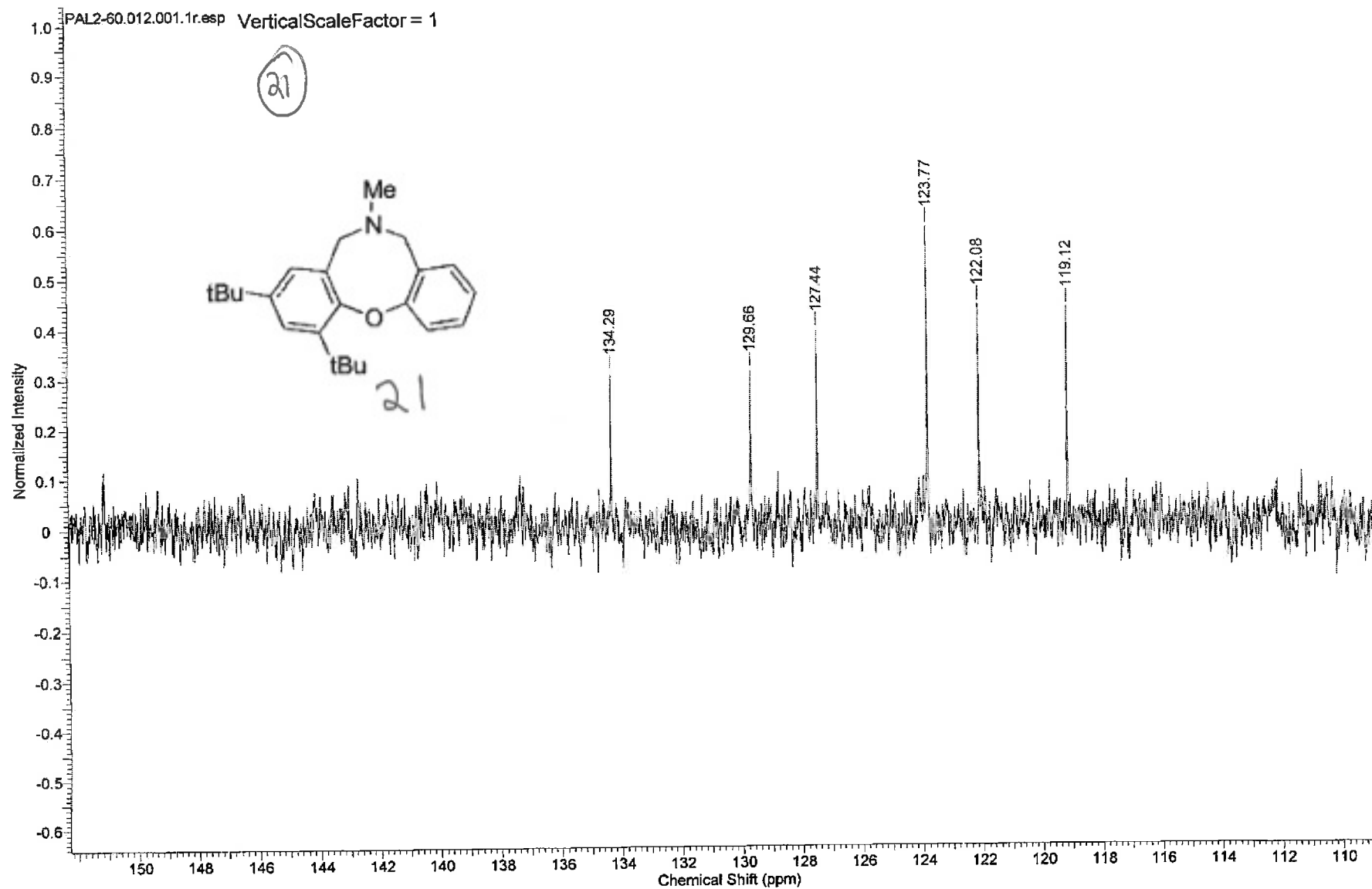
# TJS-007 PURE

29/10/2012 19:06:57  
TJS-007 PURE



Y:\glengrant\drs\nmr\PAL2-60\PAL2-60.012.001.1r.esp

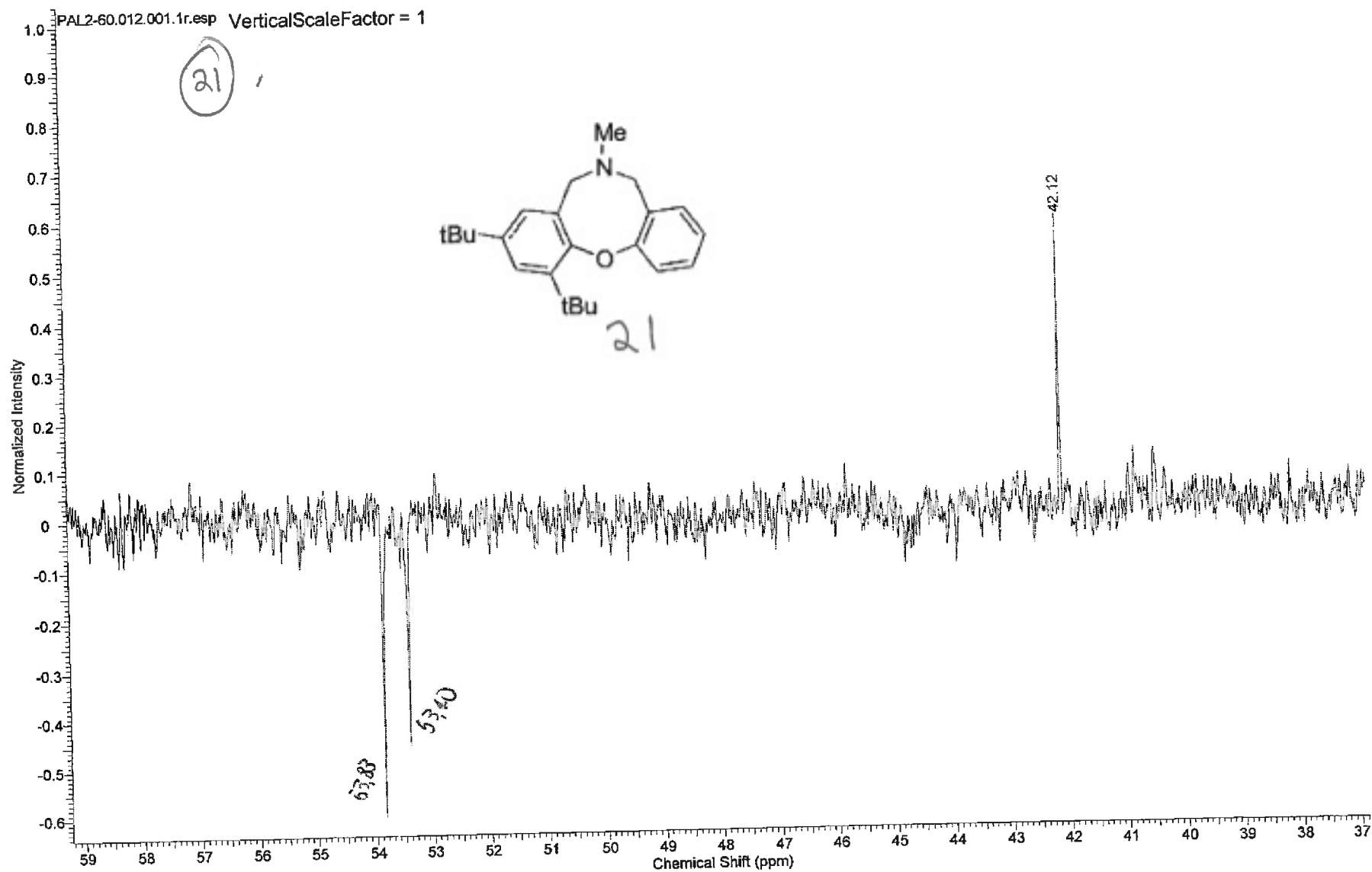
29/10/2012 19:06:37  
TJS-007 PURE



Y:\glengrant\drsnmr\PAL2-60\PAL2-60.012.001.1r.esp



29/10/2012 19:05:37  
TJS-007 PURE



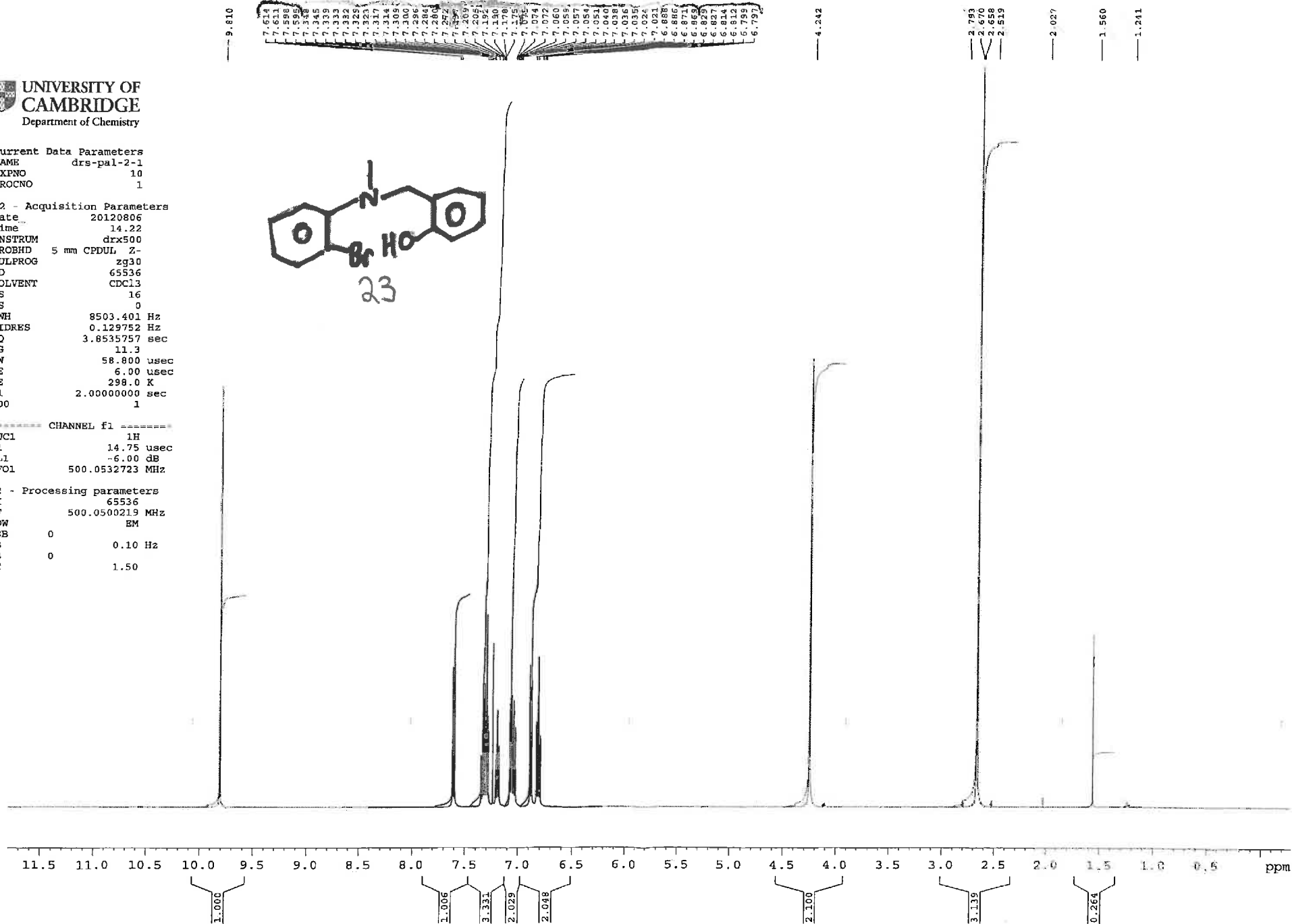
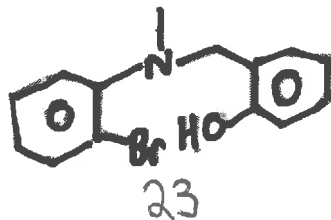
Y:\glengrant\drs\nmr\PAL2-60\PAL2-60.012.001.1r.esp

Current Data Parameters  
NAME drs-pal-2-1  
EXPNO 10  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120806  
Time 14.22  
INSTRUM drx500  
PROBHD 5 mm CPDUL Z-  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 16  
DS 0  
SWH 8503.401 Hz  
FIDRES 0.129752 Hz  
AQ 3.8535757 sec  
RG 11.3  
DW 58.800 usec  
DE 6.00 usec  
TE 298.0 K  
D1 2.00000000 sec  
TDO 1

===== CHANNEL f1 =====  
NUC1 1H  
P1 14.75 usec  
PL1 -6.00 dB  
SFO1 500.0532723 MHz

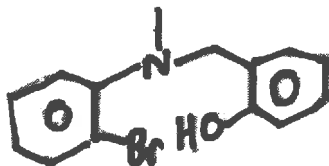
F2 - Processing parameters  
SI 65536  
SF 500.0500219 MHz  
WDW EM  
SSB 0  
LB 0.10 Hz  
GB 0  
PC 1.50



Current Data Parameters  
NAME drs-pal-2-1  
EXPNO 11  
PROCNO 1

F2 - Acquisition Parameters  
Date 20120806  
Time 14.40  
INSTRUM drx500  
PROBHD 5 mm CPDUL Z-  
PULPROG zgpg30  
TD 65536  
SOLVENT CDC13  
NS 256  
DS 8  
SWH 34013.605 Hz  
FIDRES 0.519006 Hz  
AQ 0.9633939 sec  
RG 4096  
DW 14.700 usec  
DE 6.00 usec  
TE 298.1 K  
D1 3.00000000 sec  
d11 0.03000000 sec  
DELTA 2.90000010 sec  
TD0 1  
SFO1 125.7520828 MHz  
NUC1 13C  
P1 9.80 usec  
PLW1 -1.00000000 W  
SFO2 500.0517480 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 100.00 usec  
PLW2 -1.00000000 W  
PLW12 -1.00000000 W  
PLW13 -1.00000000 W

F2 - Processing parameters  
SI 131072  
SF 125.7376766 MHz  
WDW RM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00



157.204

149.822

133.848  
129.177  
129.118  
128.549  
126.647  
122.331  
120.986  
120.970  
119.440  
116.440

77.273  
77.019  
76.764

59.549

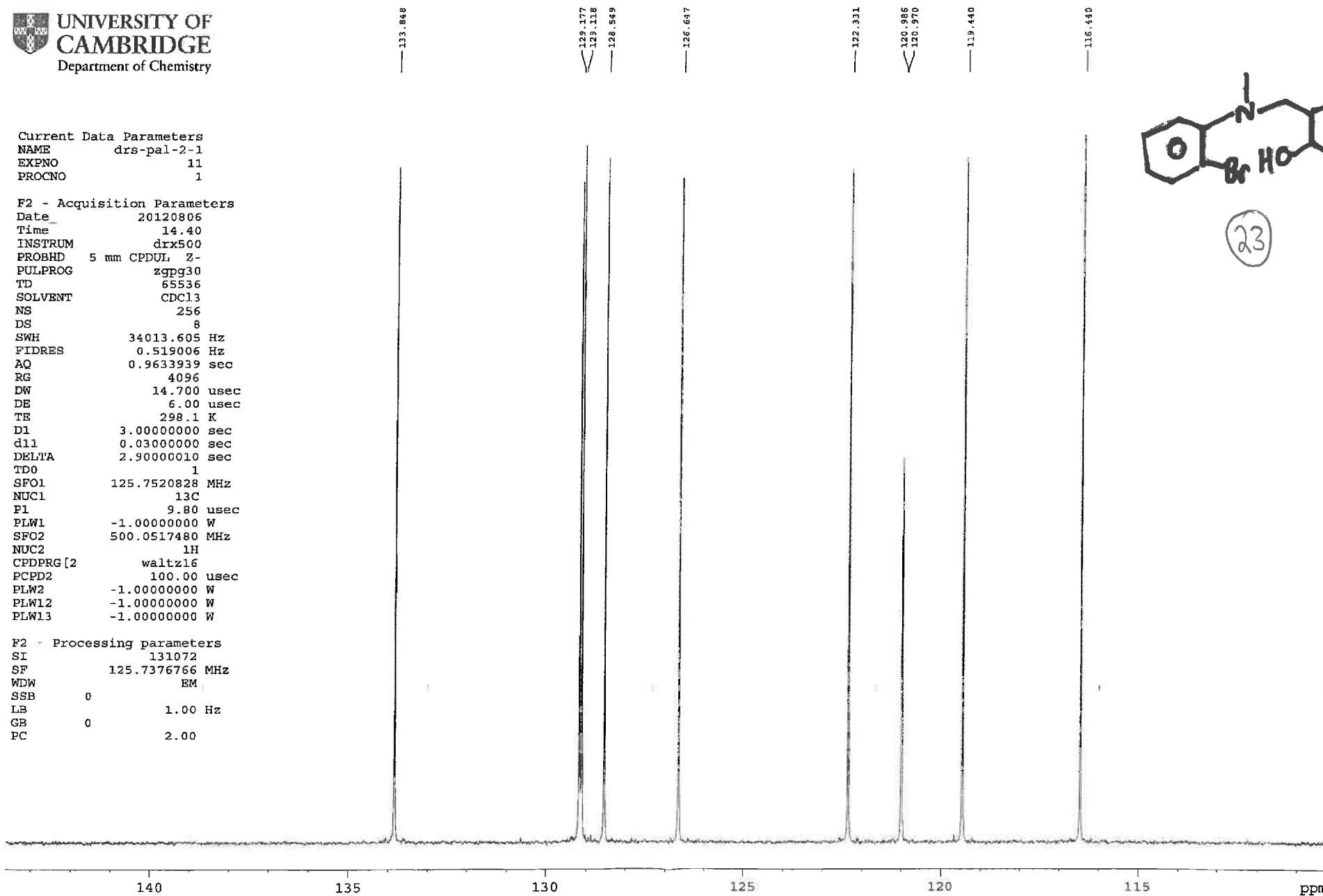
42.657

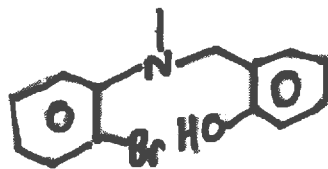
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

Current Data Parameters  
NAME drs-pal-2-1  
EXPNO 11  
PROCNO 1

F2 - Acquisition Parameters  
Date 20120806  
Time 14.40  
INSTRUM drx500  
PROBHD 5 mm CPDUL Z-  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 256  
DS 8  
SWH 34013.605 Hz  
FIDRES 0.519006 Hz  
AQ 0.9633939 sec  
RG 4096  
DW 14.700 usec  
DE 6.00 usec  
TE 298.1 K  
D1 3.00000000 sec  
d11 0.03000000 sec  
DELTA 2.90000010 sec  
TD0 1  
SFO1 125.7520828 MHz  
NUC1 13C  
P1 9.80 usec  
PLW1 -1.00000000 W  
SFO2 500.0517480 MHz  
NUC2 1H  
CPDPRG2 waltz16  
PCPD2 100.00 usec  
PLW2 -1.00000000 W  
PLW12 -1.00000000 W  
PLW13 -1.00000000 W

F2 - Processing parameters  
SI 131072  
SF 125.7376766 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00



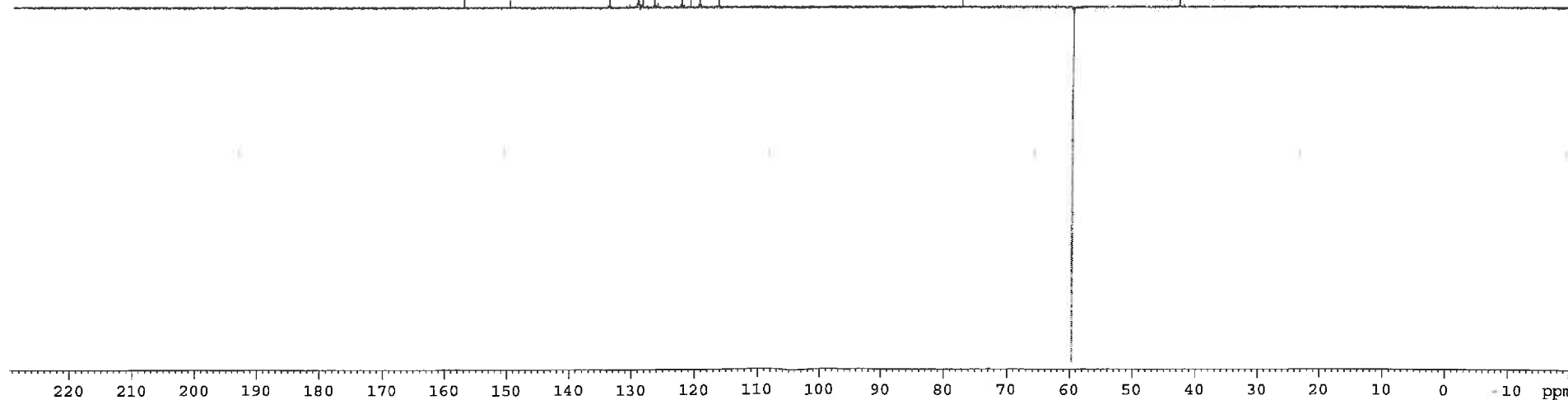


23

133.847  
129.176  
129.118  
128.549  
126.646  
122.330  
119.439  
115.439

59.548

42.657

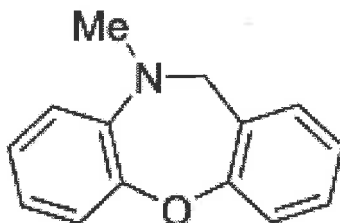


Current Data Parameters  
NAME dra-pa12-59  
EXPNO 10  
PROCNO 1

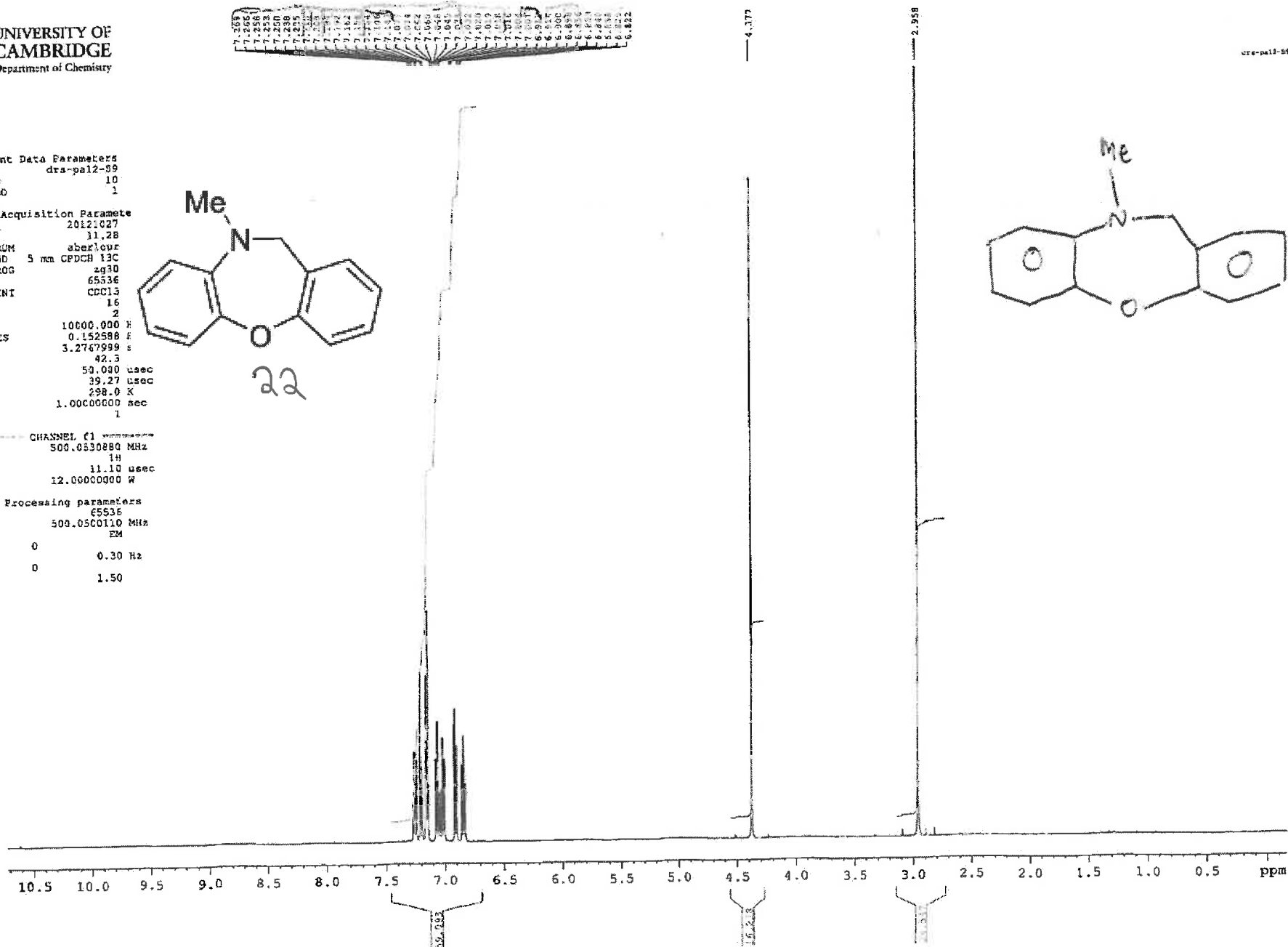
F2 - Acquisition Parameters  
Date\_ 2012-02-27  
Time 11.28  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 16  
DS 2  
SWH 10000.000 MHz  
FIDRES 0.152588 Hz  
AQ 3.2747999 s  
RG 42.3  
OW 50.000 usec  
DS 39.27 usec  
TE 298.0 K  
SI 1.0000000 sec  
TDC 1

CHANNEL f1  
SFOL 500.0530880 MHz  
NUC1 1H  
P1 11.10 usec  
PLW1 12.00000000 W

F2 - Processing parameters  
SI 65536  
SF 500.0500110 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50



22



dra-pa12-59

Current Data Parameters  
NAME drs-pal2-59  
EXPNO 6011  
PROCNO 1

F2 - Acquisition Parameters

Date\_ 20121027  
Time 11.36  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
PD 65384  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 34965.035 KHz  
FIDRES 0.534764 KHz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 73.42 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TDO

===== CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CDEPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20

157.250

148.896

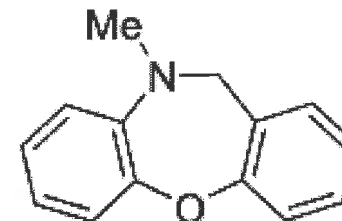
142.392

129.371  
126.690  
126.568  
124.522  
123.562  
121.683  
121.085  
120.326  
119.972

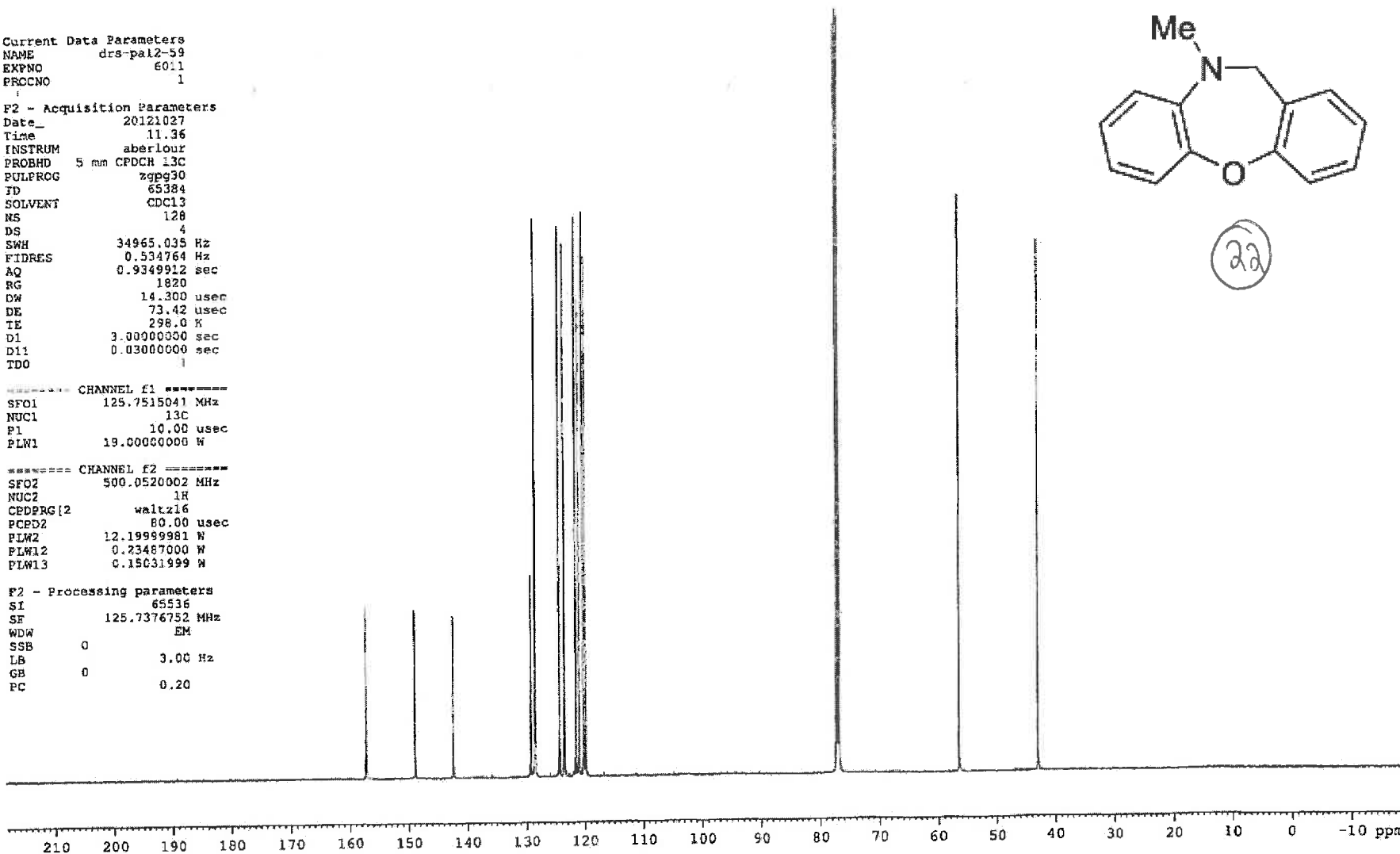
77.288  
77.044  
76.780

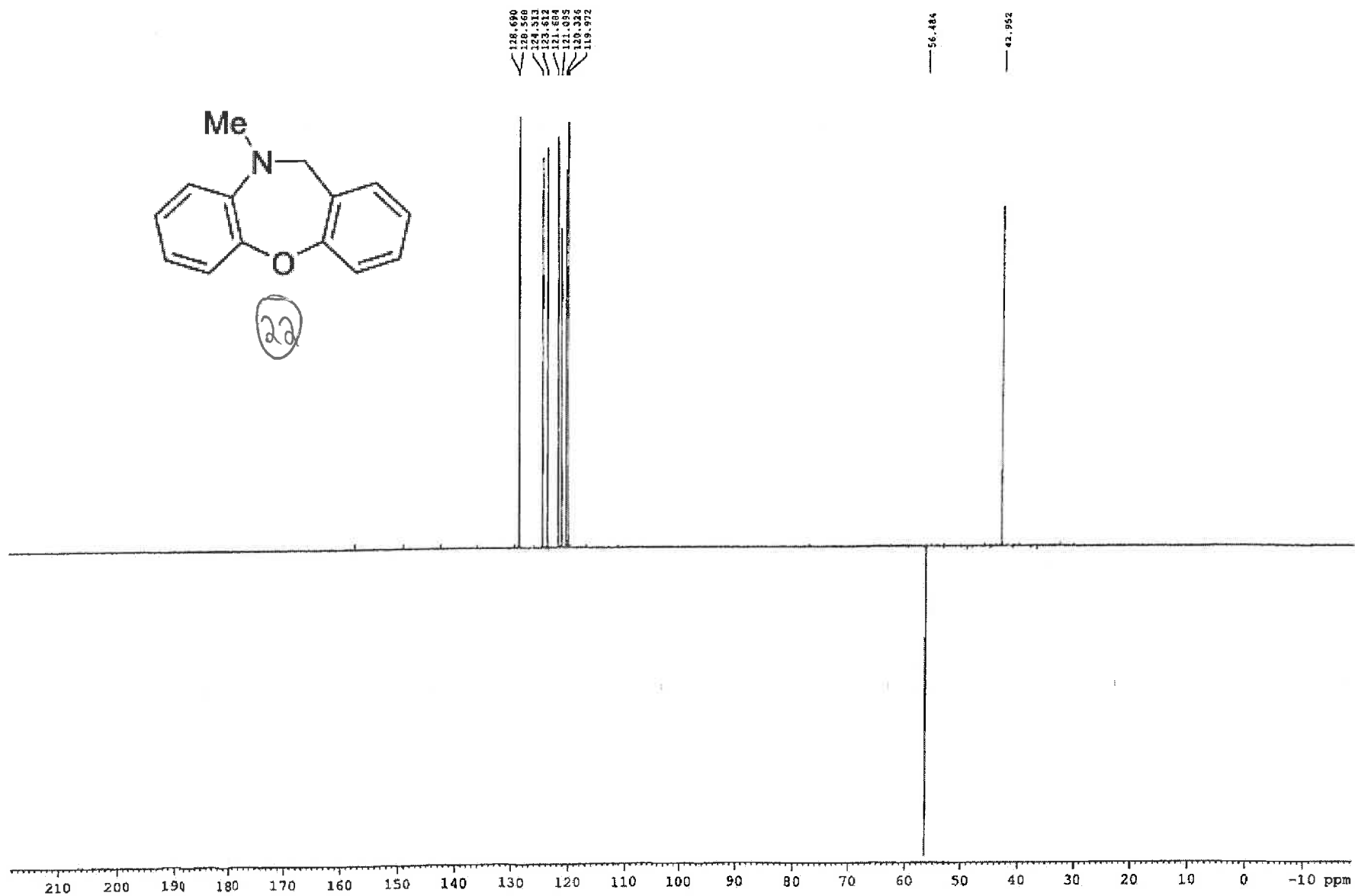
56.459

42.952



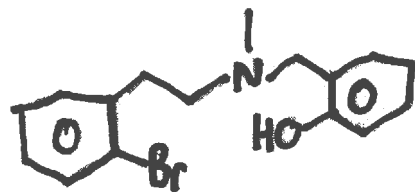
22



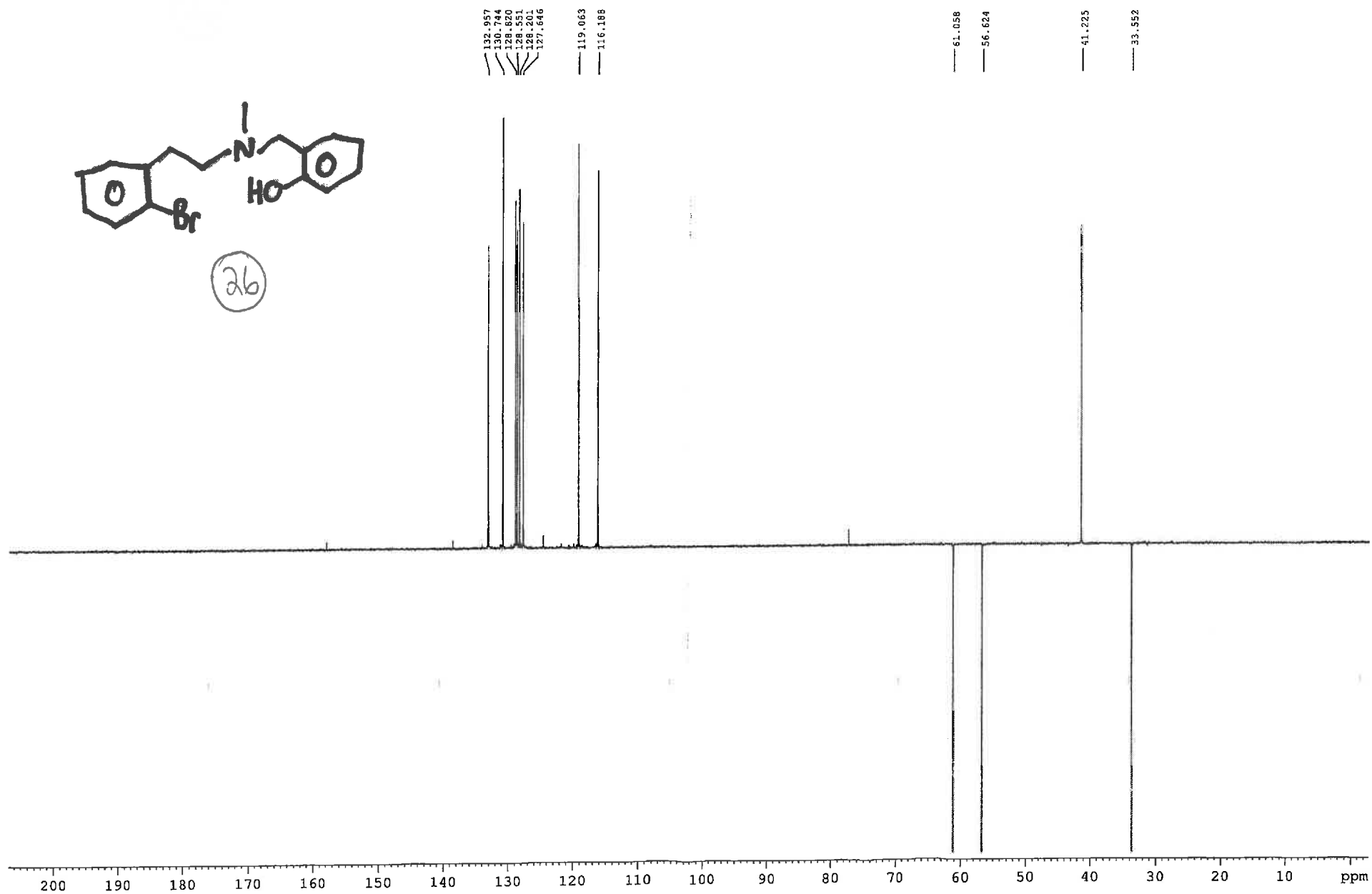








(26)



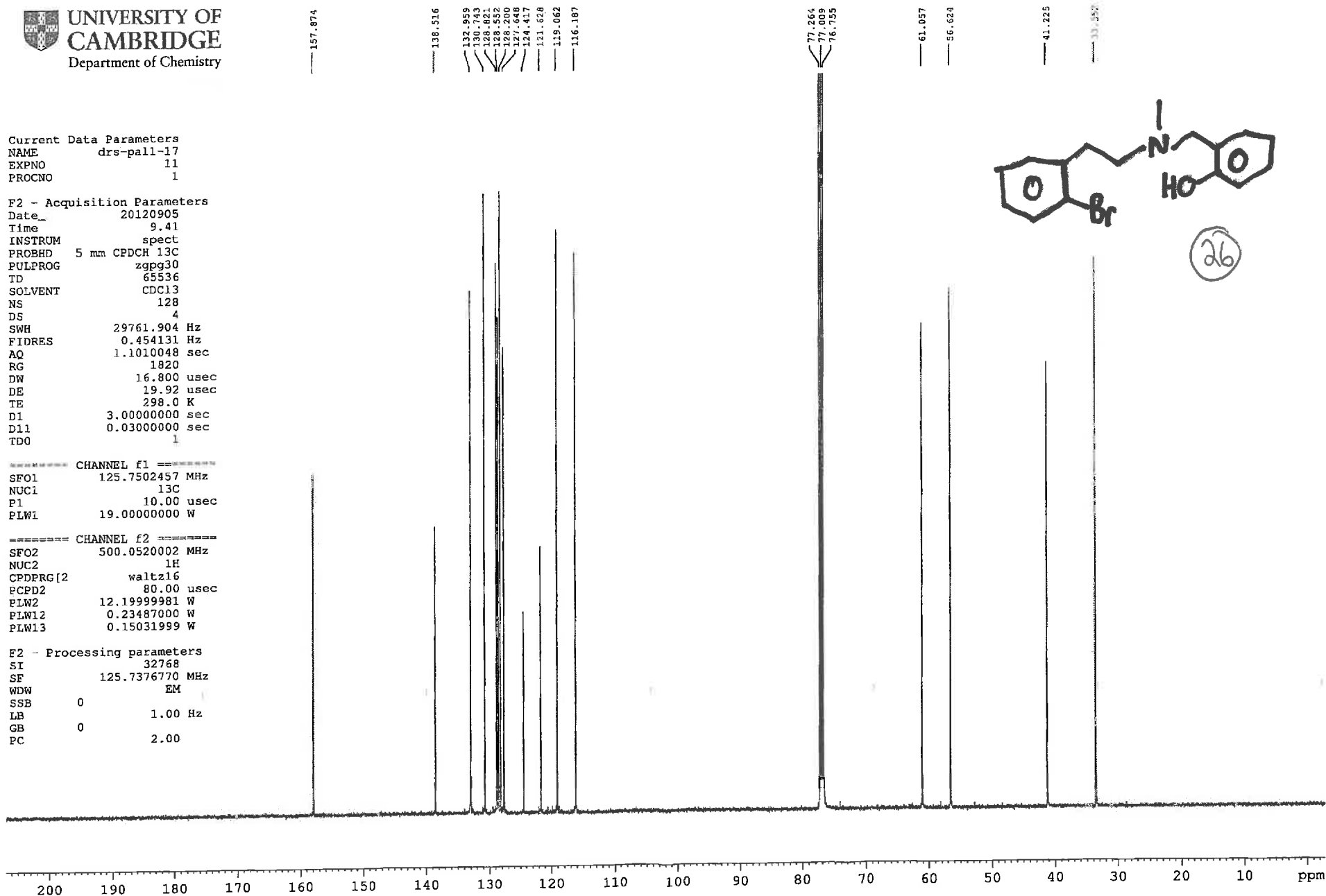
Current Data Parameters  
NAME drs-pall-17  
EXPNO 11  
PROCNO 1

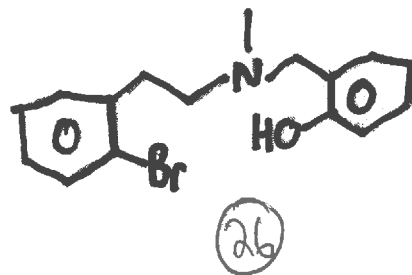
F2 - Acquisition Parameters  
Date\_ 20120905  
Time 9.41  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 29761.904 Hz  
FIDRES 0.454131 Hz  
AQ 1.1010048 sec  
RG 1820  
DW 16.800 usec  
DE 19.92 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 125.7502457 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 32768  
SF 125.7376770 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00





Current Data Parameters  
NAME drs-pall-17  
EXPNO 11  
PROCNO 1

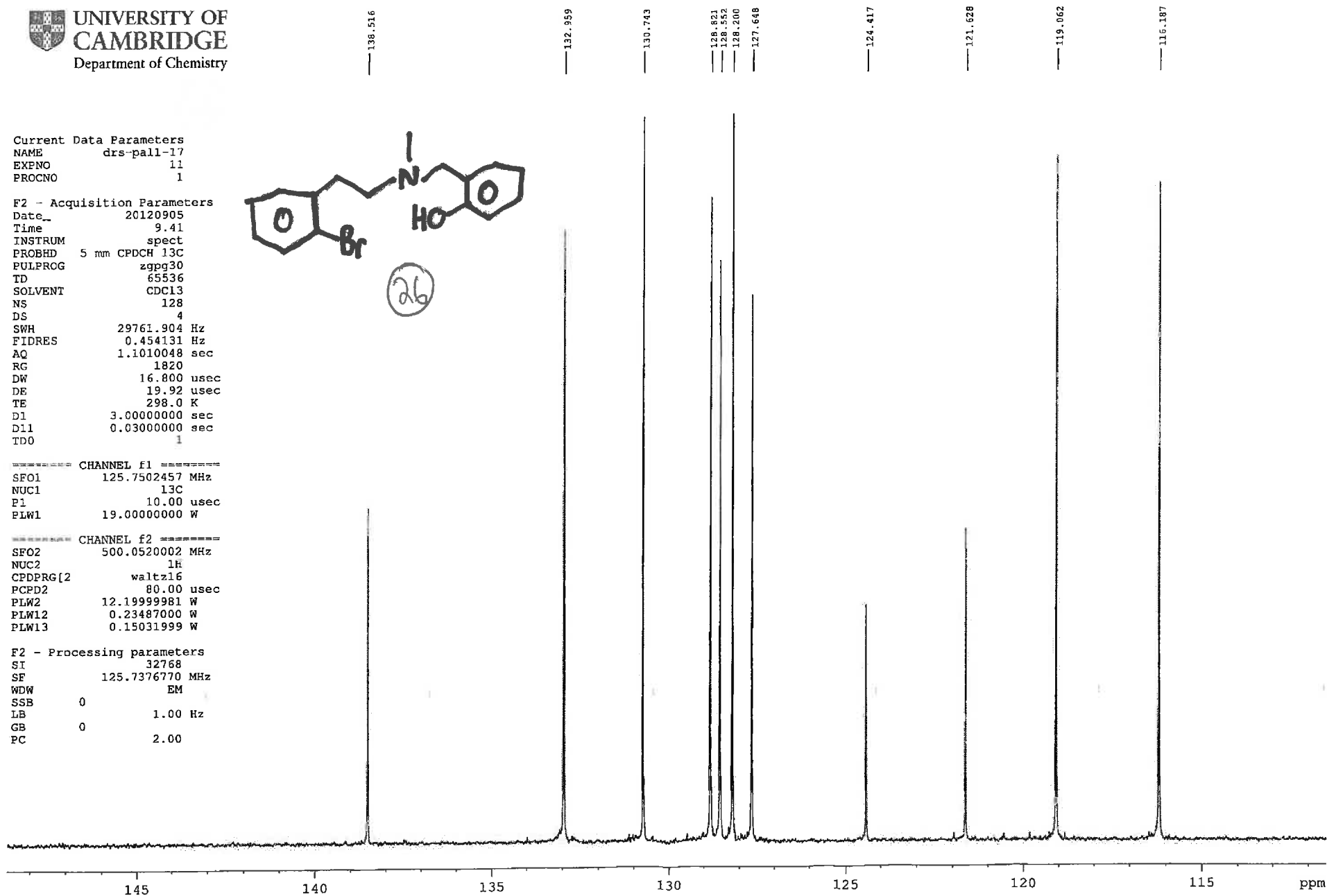
F2 - Acquisition Parameters

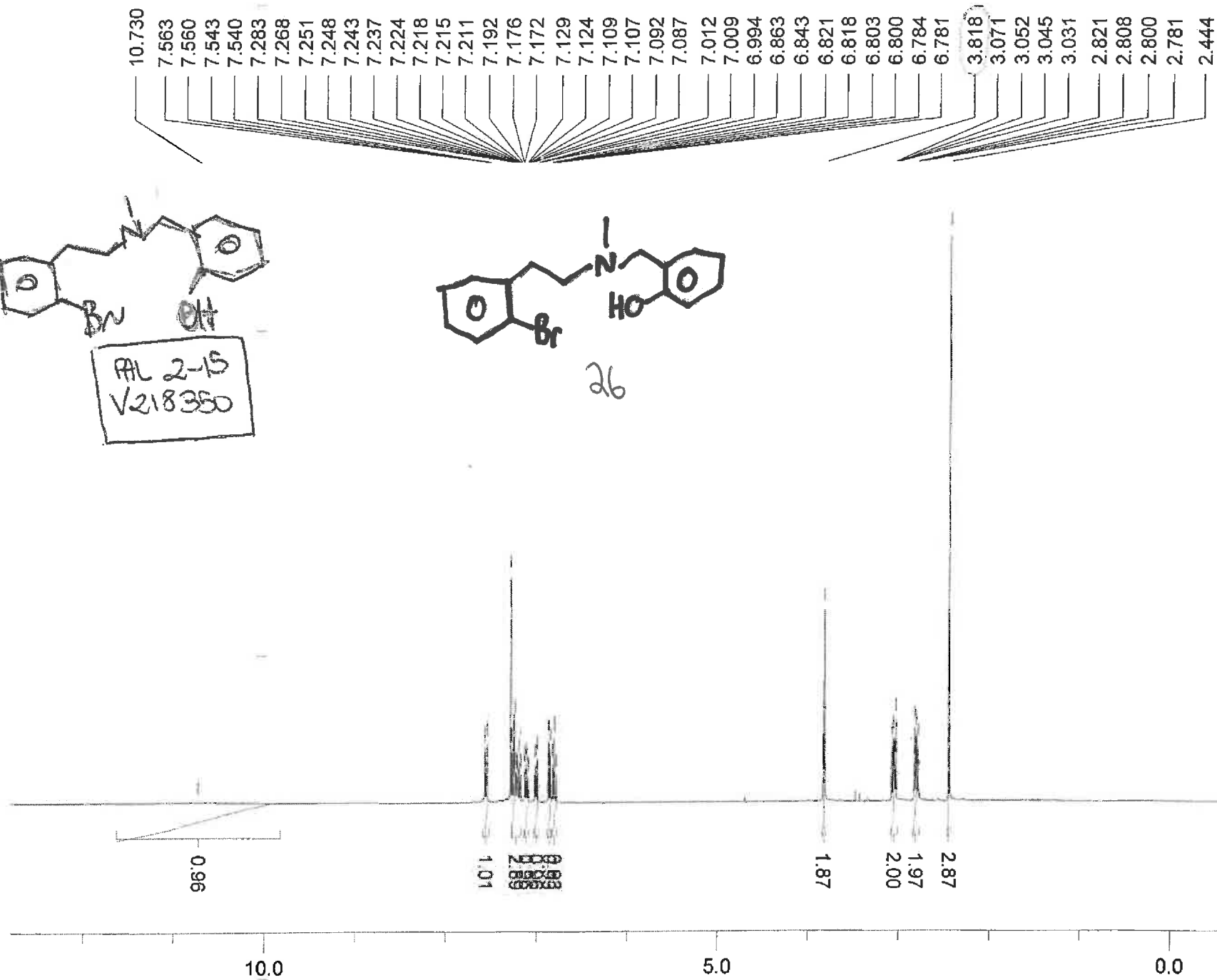
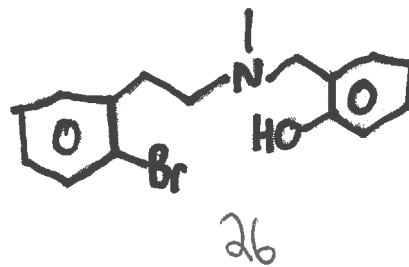
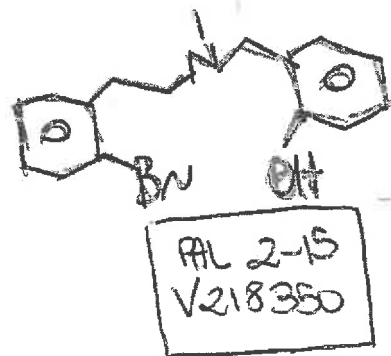
Date\_ 20120905  
Time 9.41  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 29761.904 Hz  
FIDRES 0.454131 Hz  
AQ 1.1010048 sec  
RG 1820  
DW 16.800 usec  
DE 19.92 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

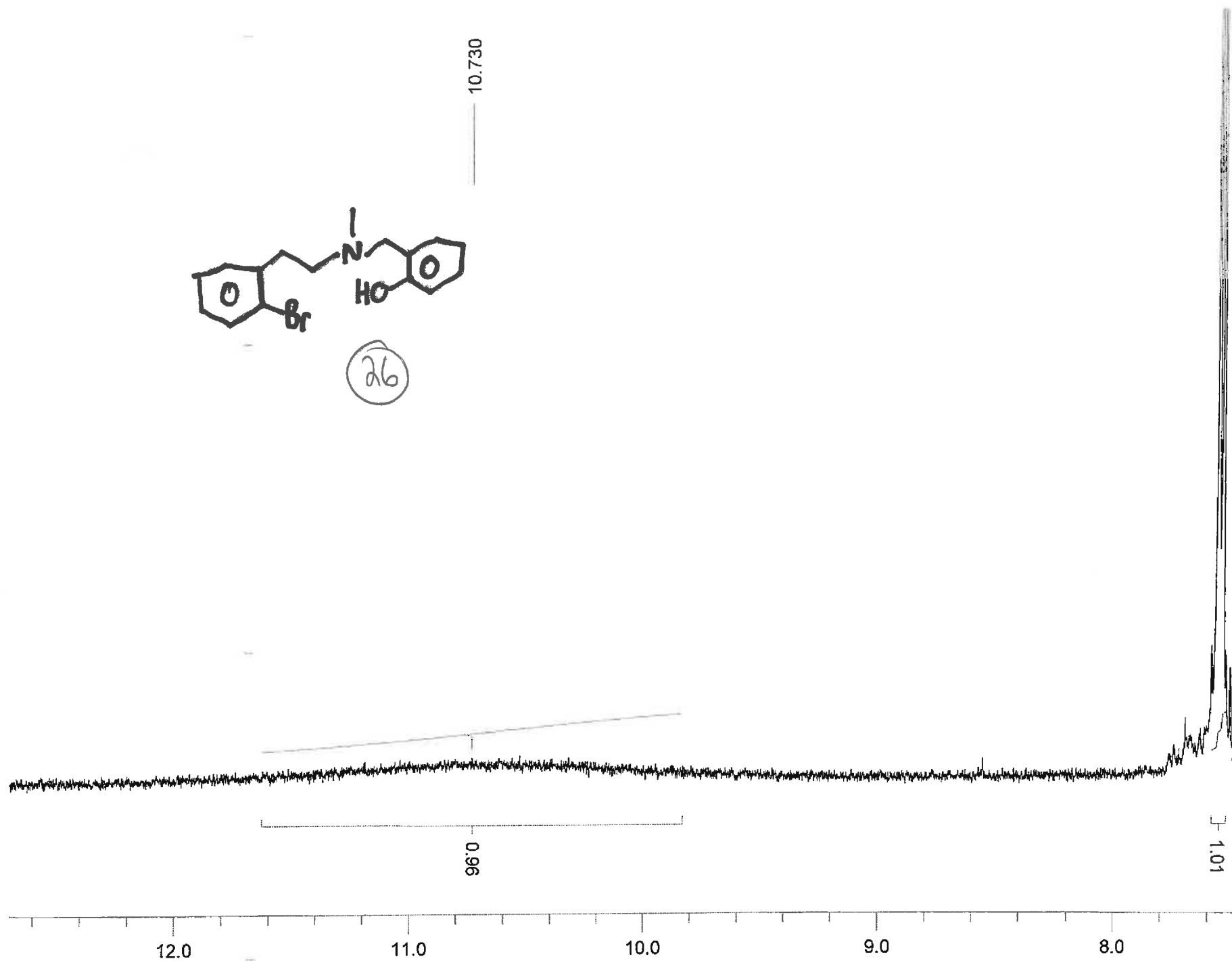
===== CHANNEL f1 =====  
SFO1 125.7502457 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

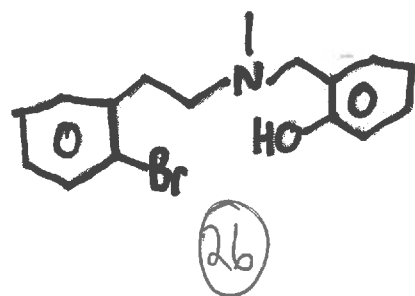
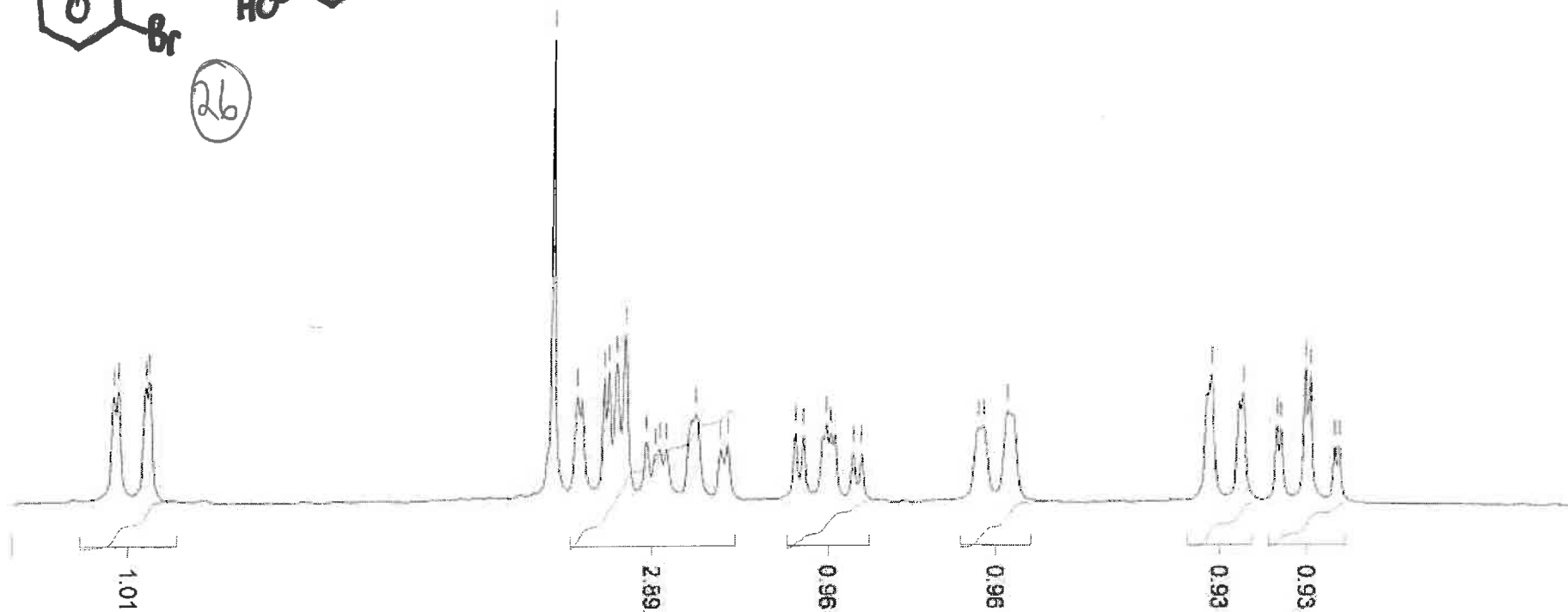
F2 - Processing parameters  
SI 32768  
SF 125.7376770 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00







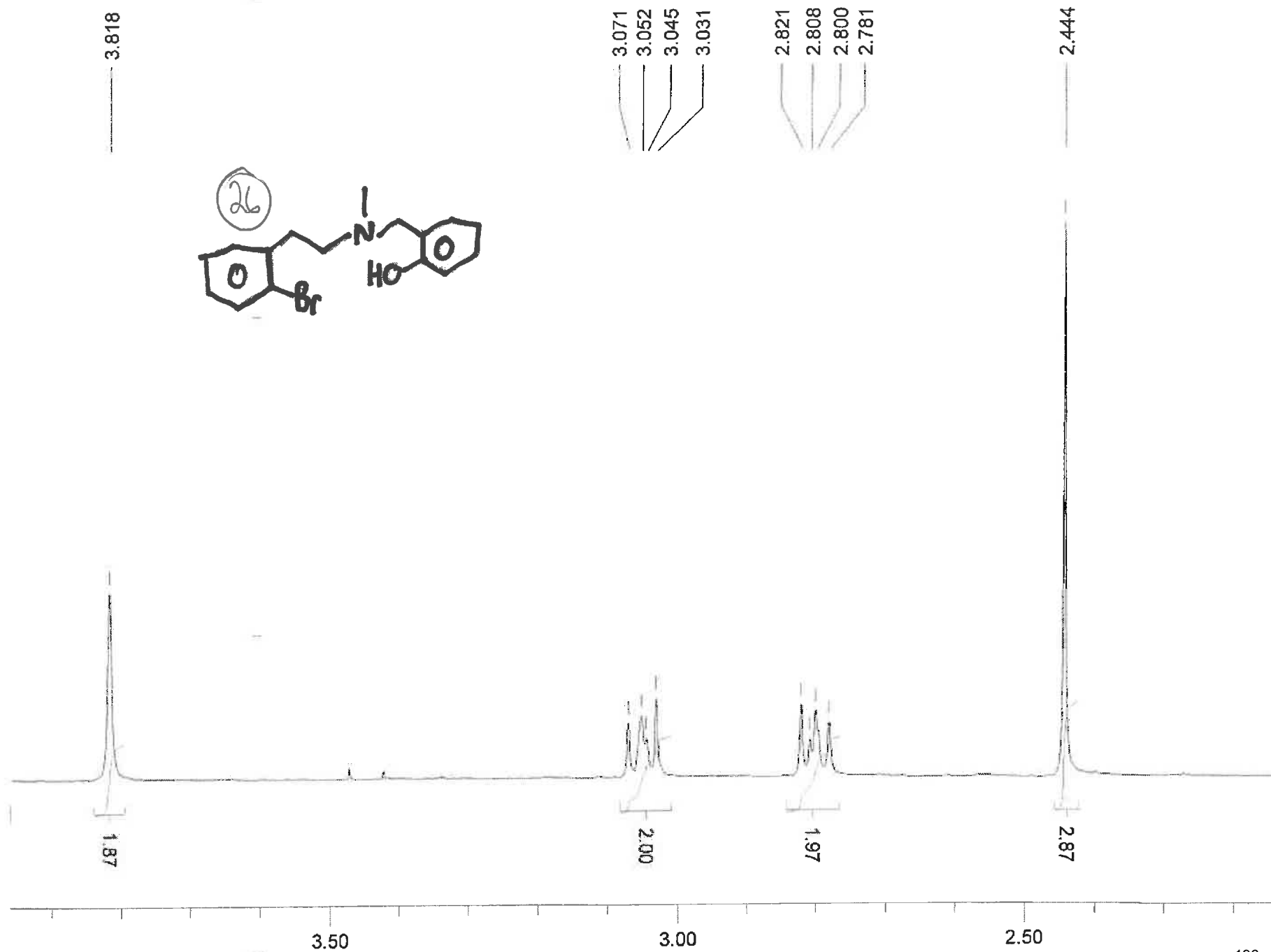
7.60 7.50 7.40 7.30 7.20 7.10 7.00 6.90 6.80 6.70



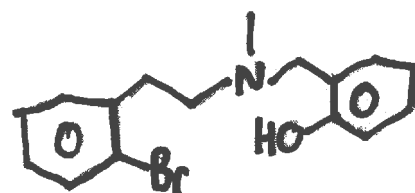
7.563  
7.560  
7.543  
7.540

10 15

7.283  
7.268  
7.251  
7.248  
7.243  
7.237  
7.224  
7.218  
7.215  
7.211  
7.192  
7.176  
7.172  
7.129  
7.124  
7.109  
7.107  
7.092  
7.087  
7.013  
7.009  
6.994  
6.863  
6.843  
6.821  
6.818  
6.803  
6.800  
6.784  
6.781



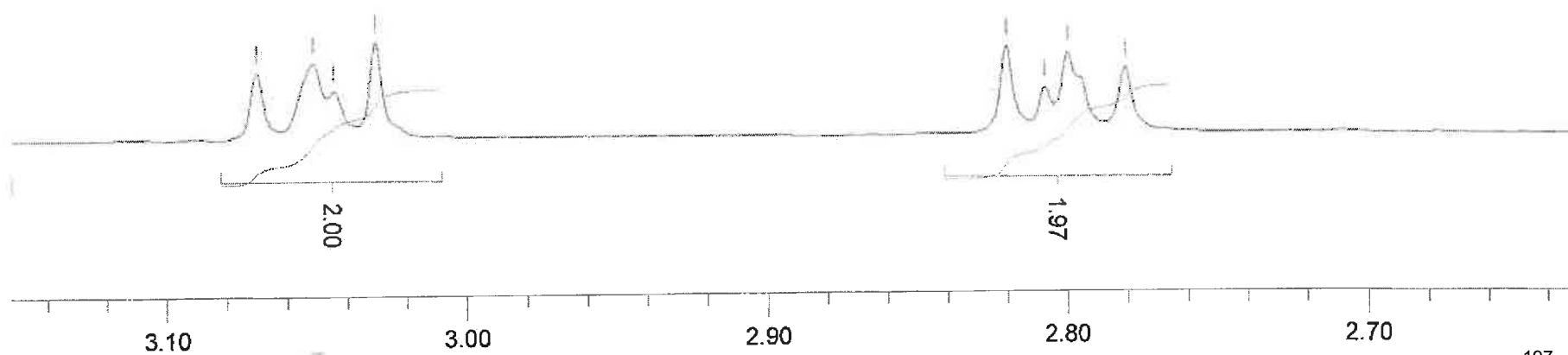




26

3.071  
3.052  
3.045  
3.031

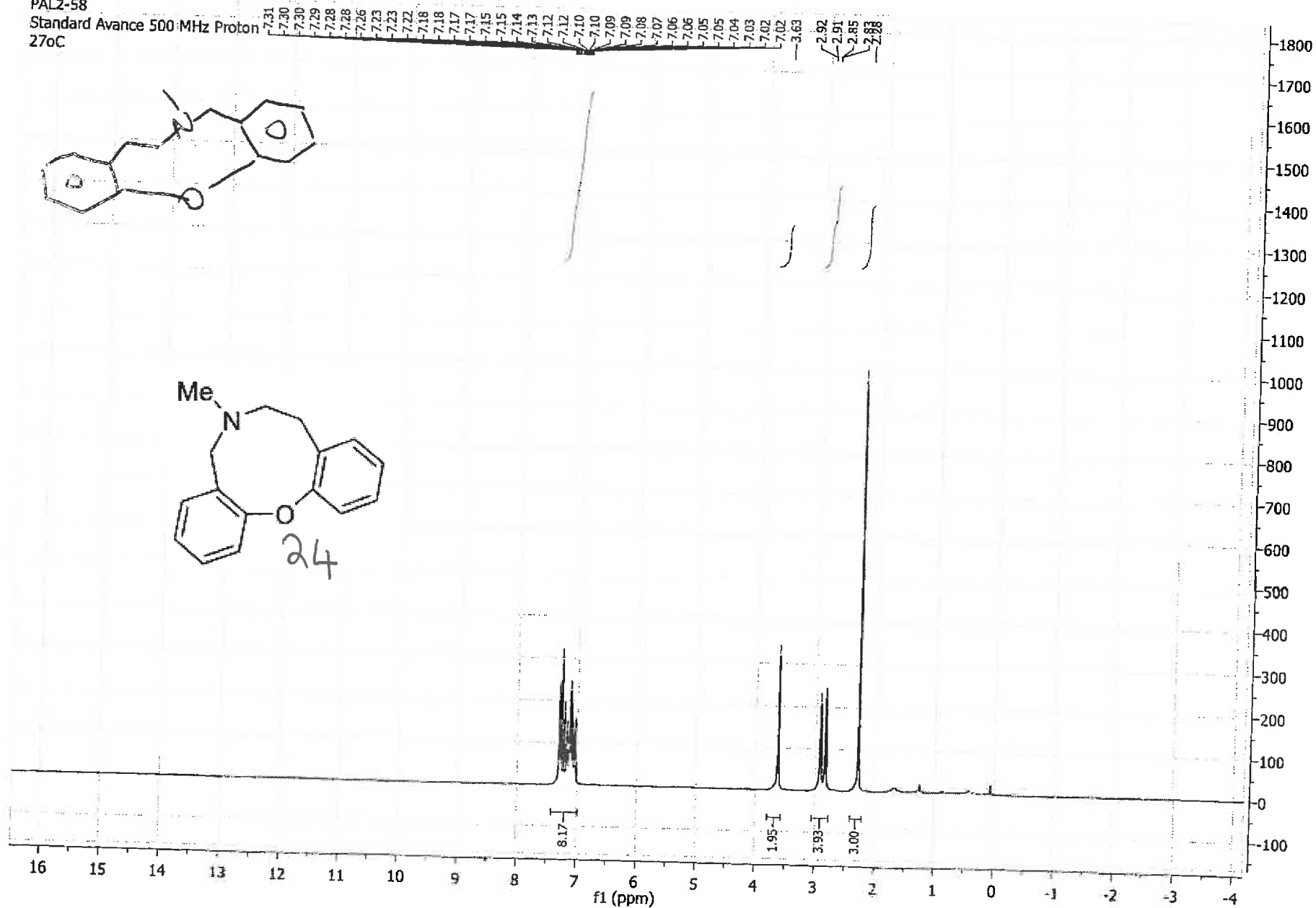
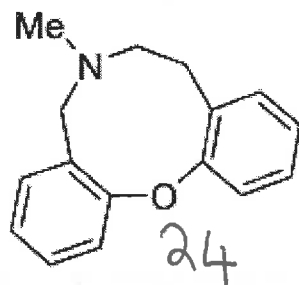
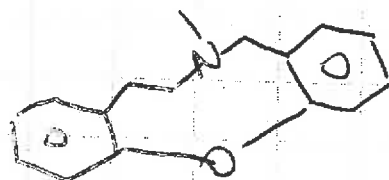
2.821  
2.808  
2.800  
2.781



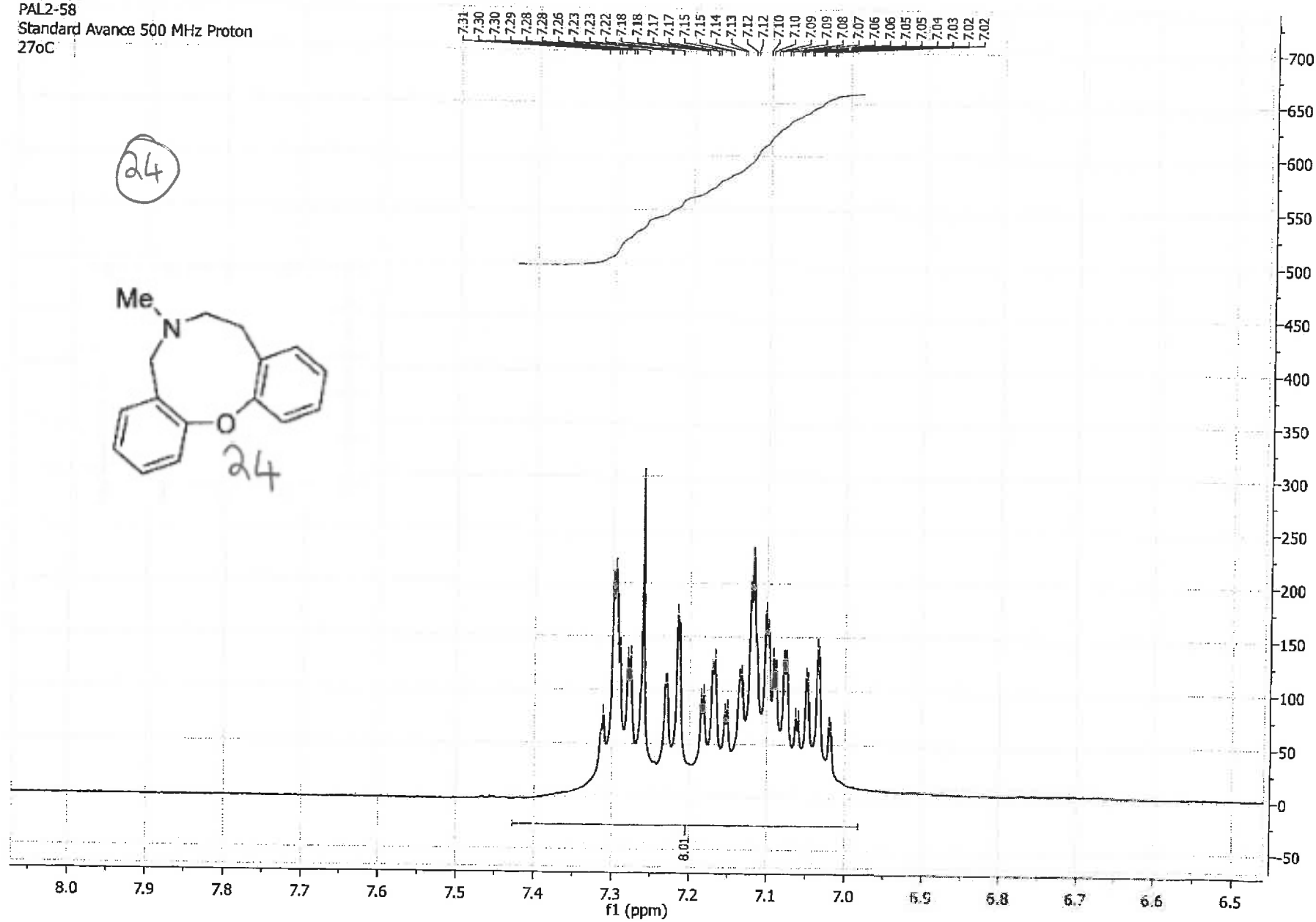
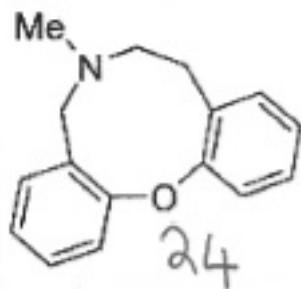
T = 27°C

PAL2-58

Standard Avance 500 MHz Proton  
27°C

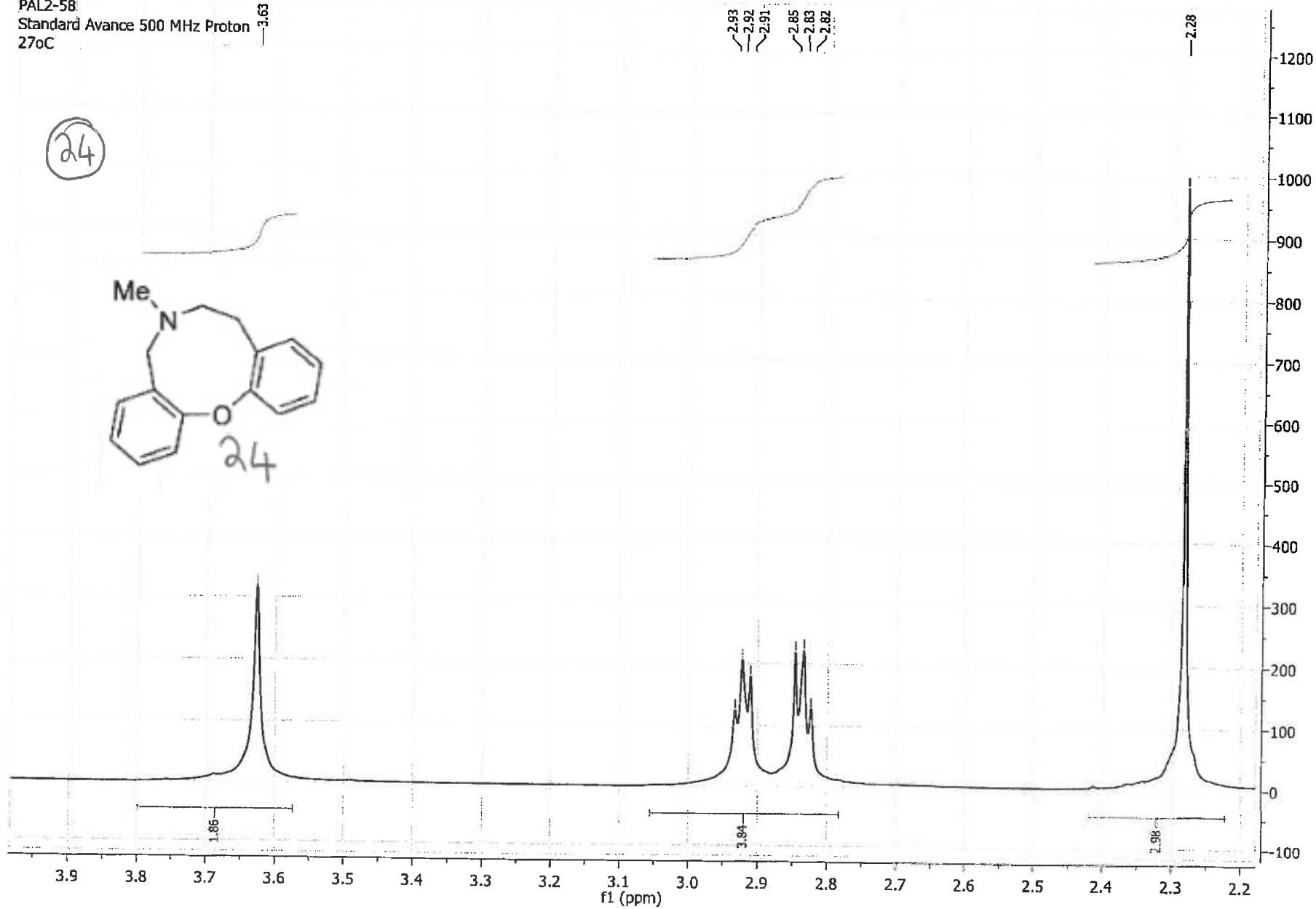
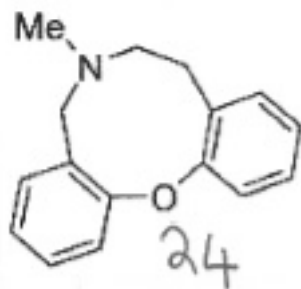


PAL2-58  
Standard Avance 500 MHz Proton  
270C



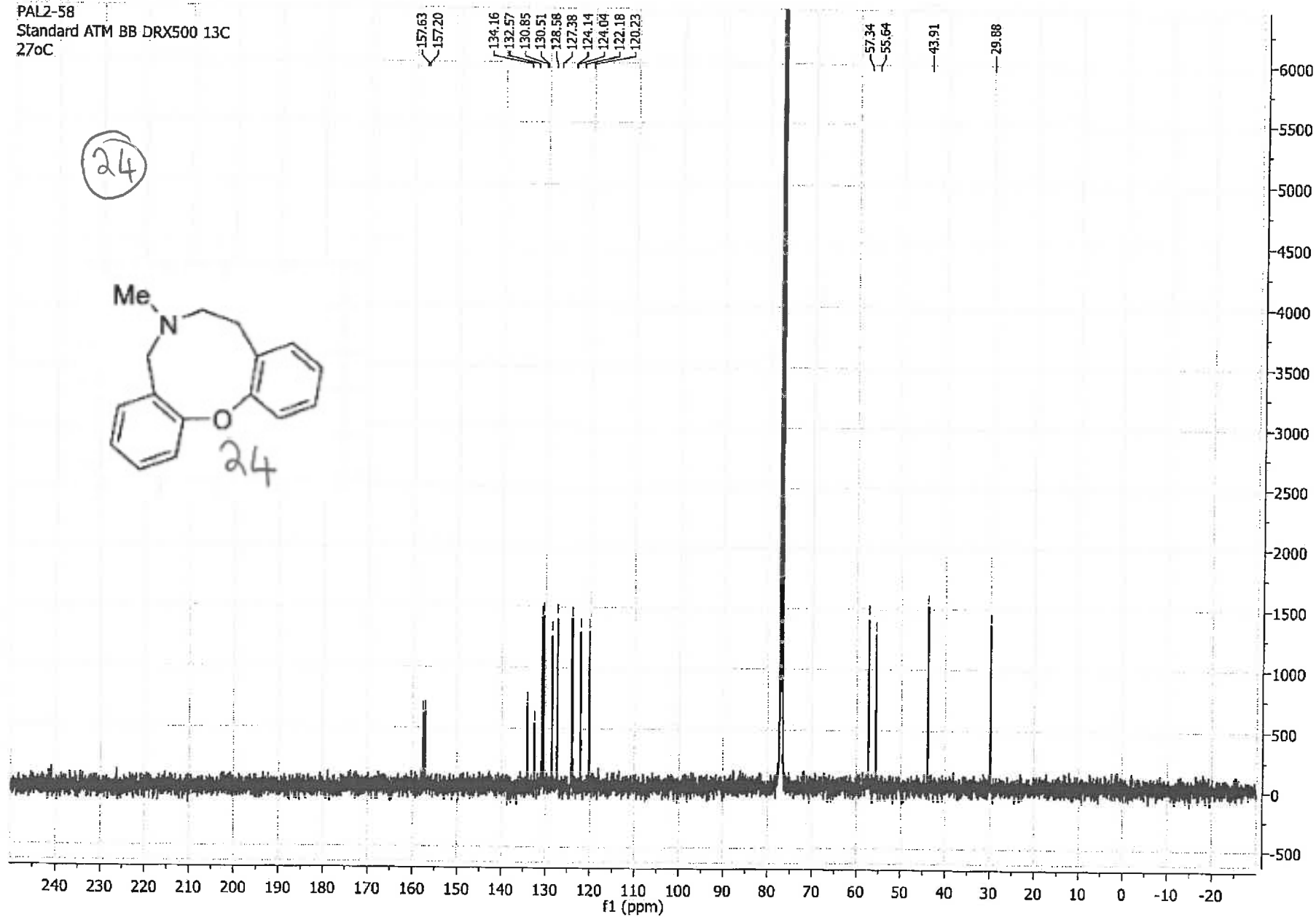
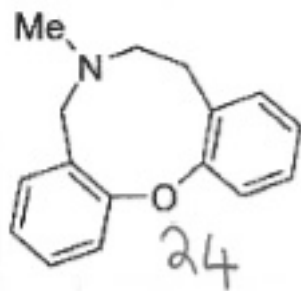
PAL2-58  
Standard Avance 500 MHz Proton  
270C

24



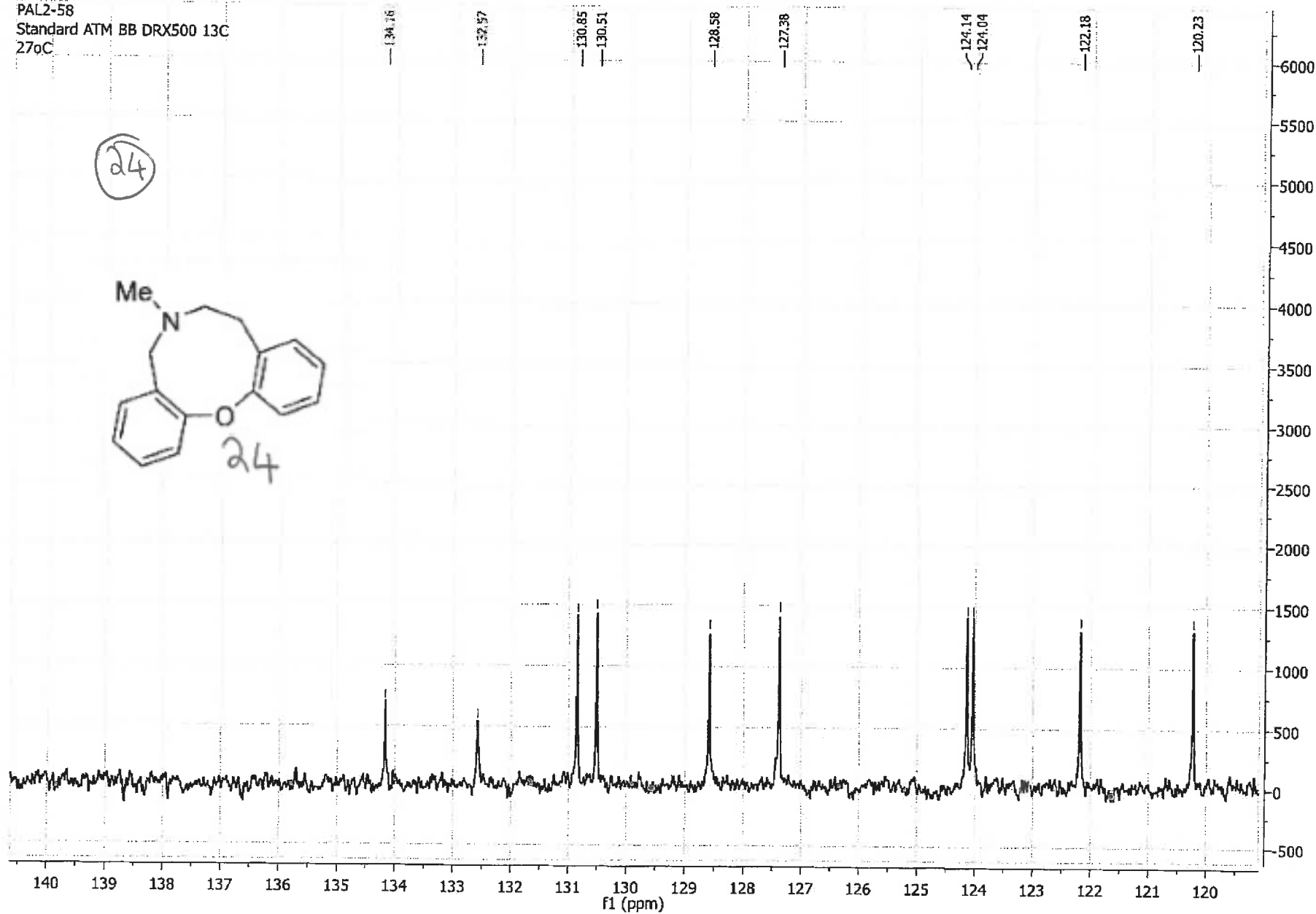
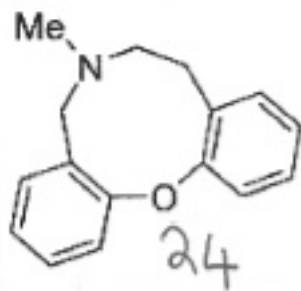
PAL2-58  
Standard ATM BB DRX500 13C  
27oC

24

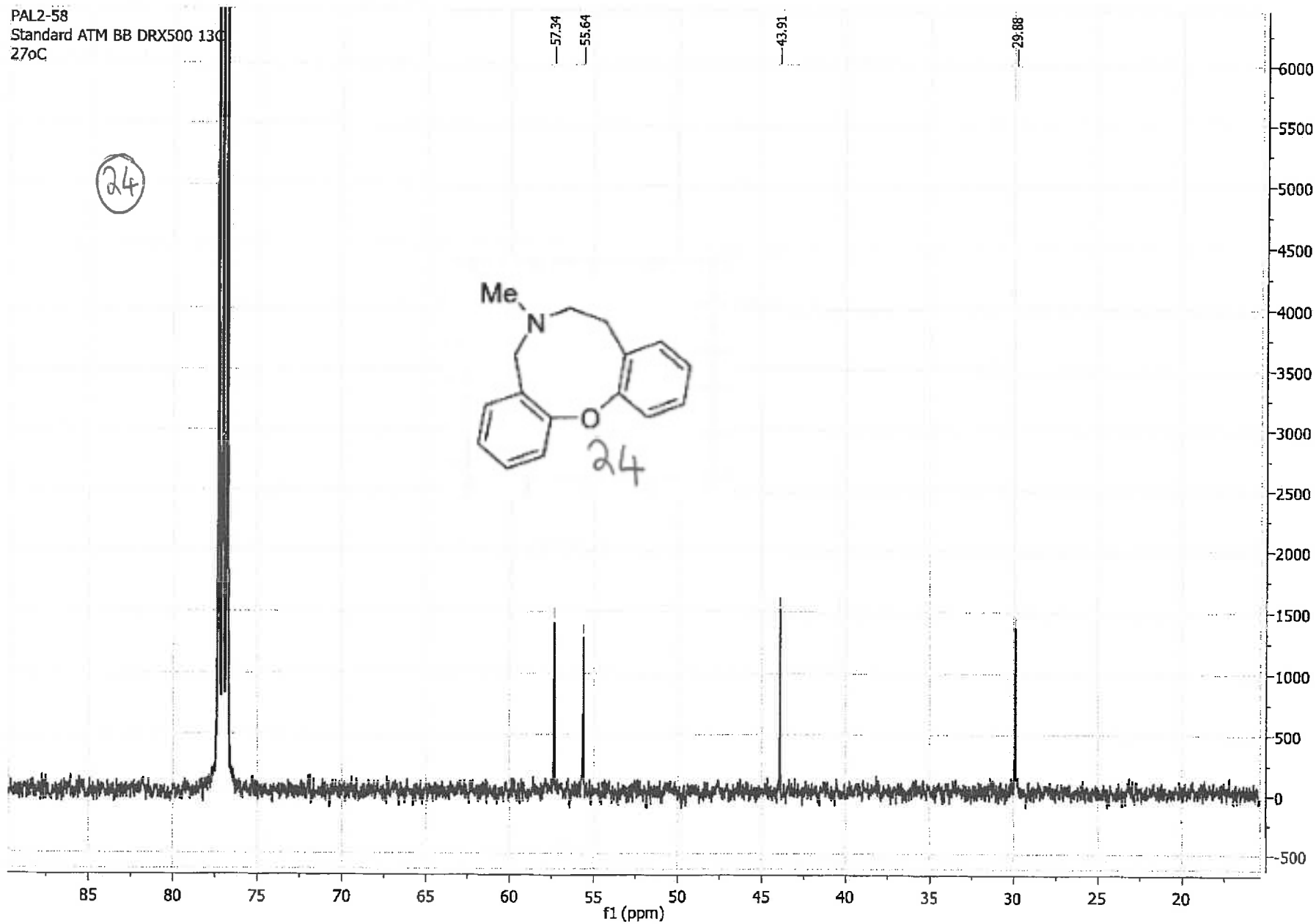


PAL2-58  
Standard ATM BB DRX500 13C  
27°C

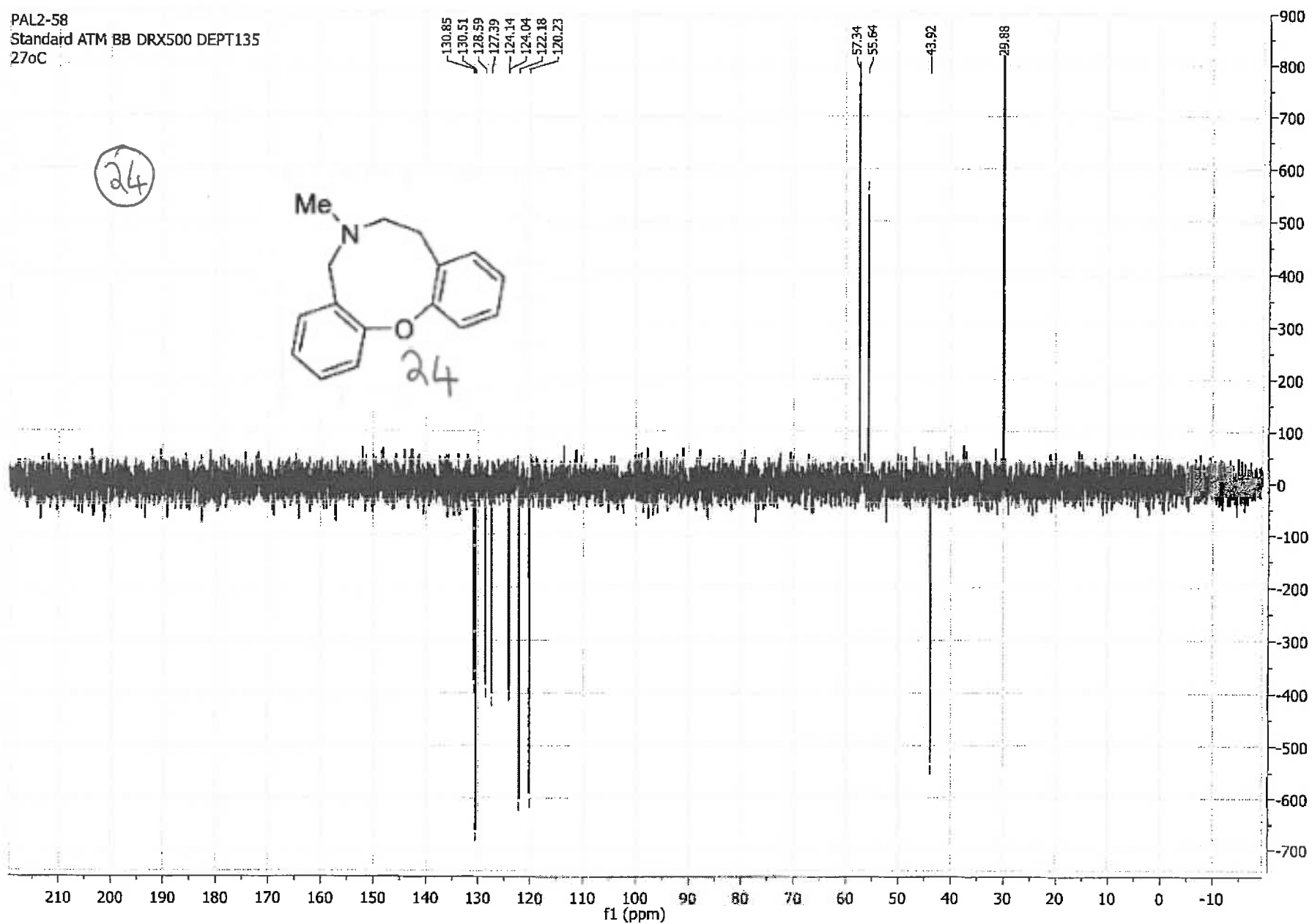
24



PAL2-58  
Standard ATM BB DRX500 13C  
27°C

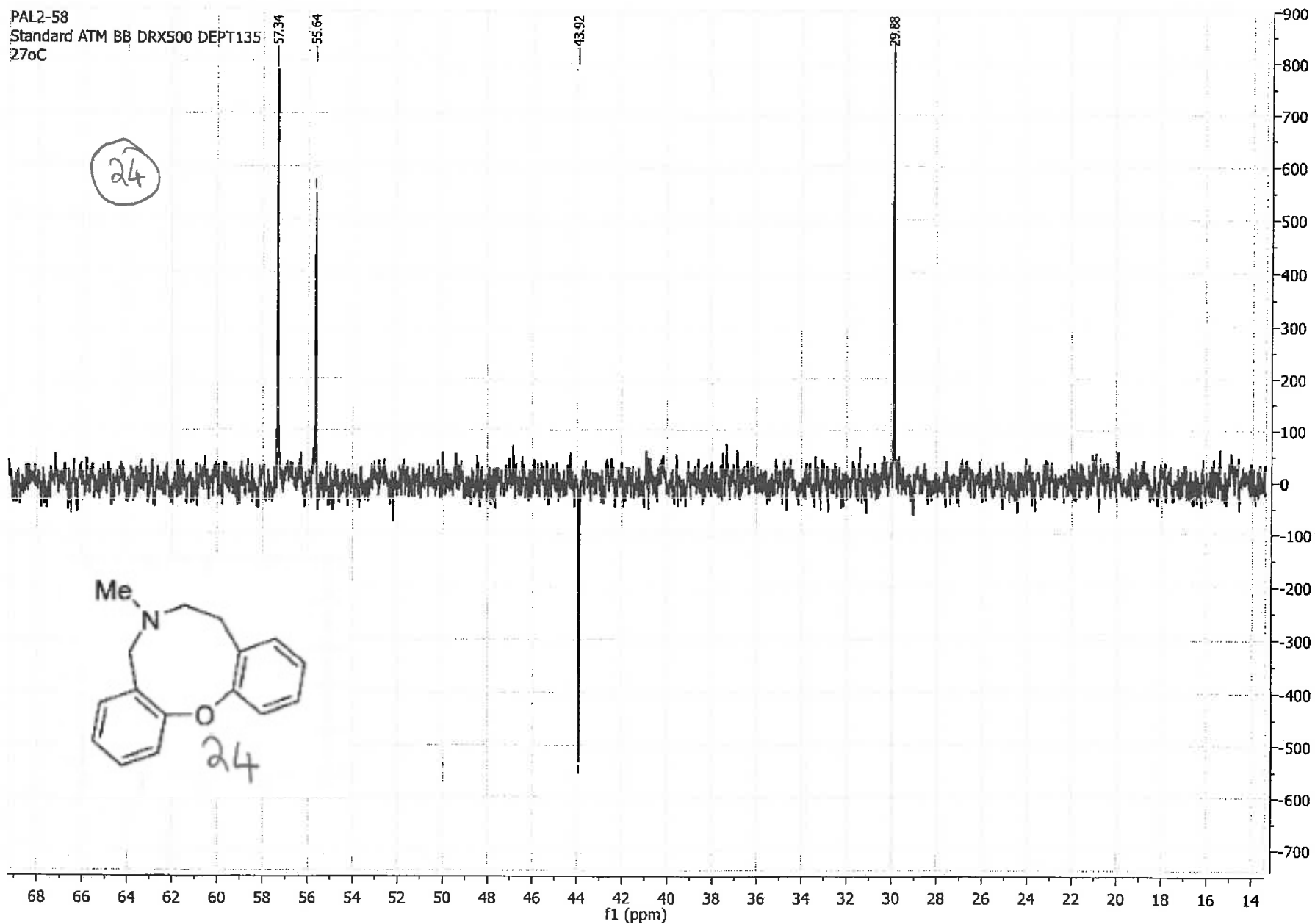


PAL2-58  
Standard ATM BB DRX500 DEPT135  
27oC



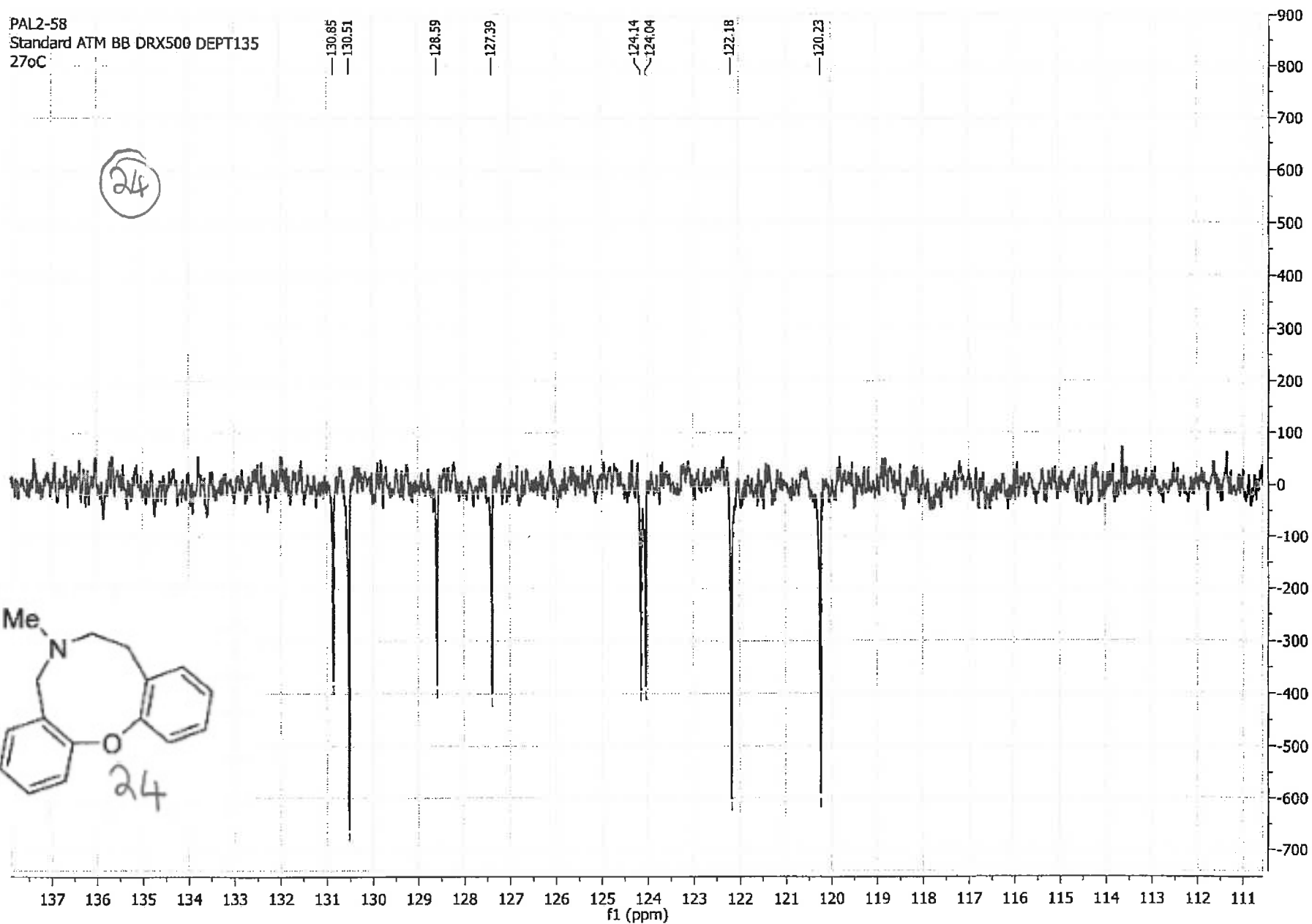
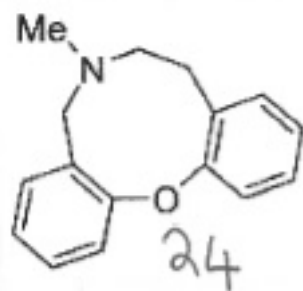


PAL2-58  
Standard ATM BB DRX500 DEPT135  
27oC



PAL2-58  
Standard ATM BB DRX500 DEPT135  
27°C

24

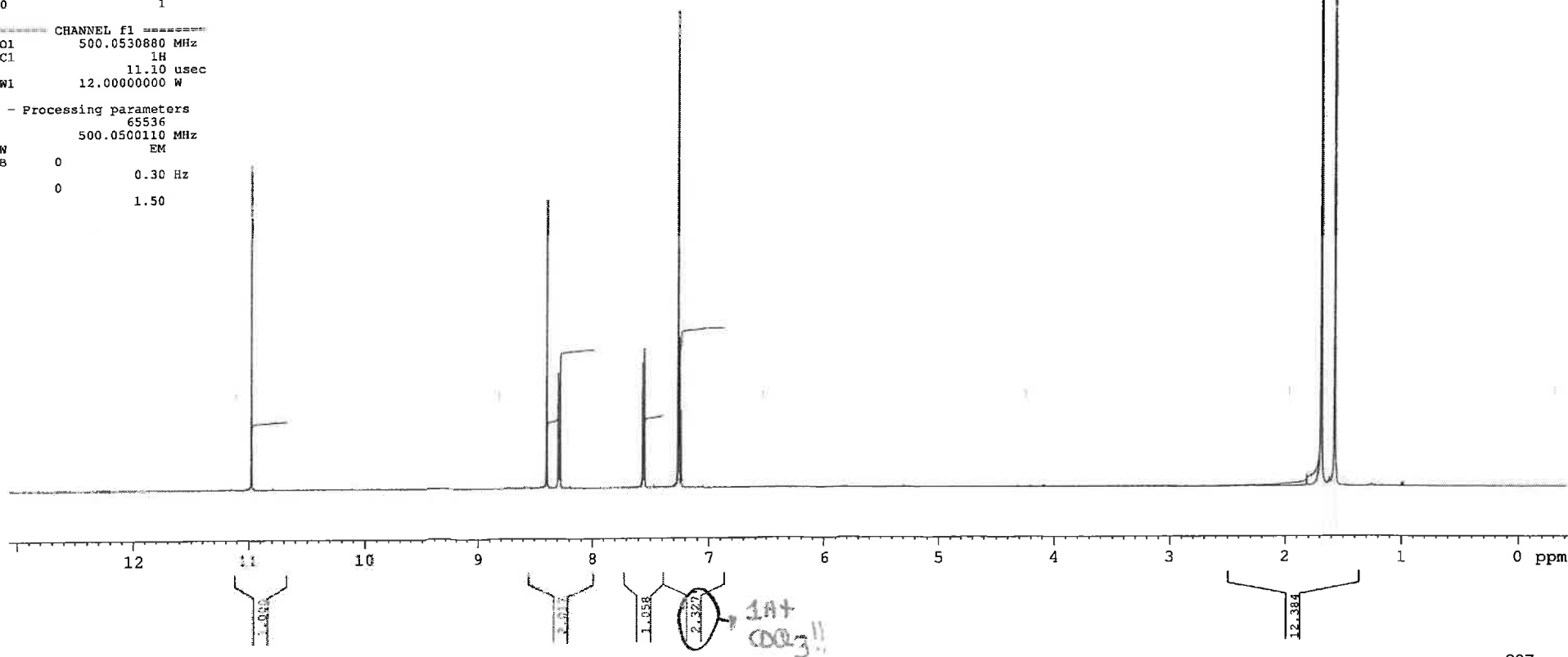
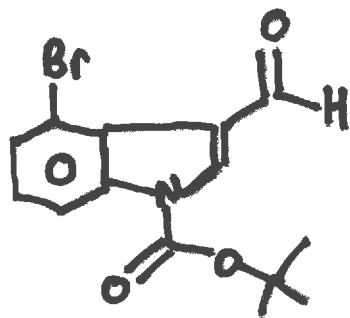


Current Data Parameters  
NAME drs-pall-52  
EXPNO 10  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120905  
Time 10.08  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 16  
DS 2  
SWH 10000.000 Hz  
FIDRES 0.152588 Hz  
AQ 3.2767999 sec  
RG 20.59  
DW 50.000 usec  
DE 10.00 usec  
TE 298.0 K  
D1 1.00000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 500.0530880 MHz  
NUC1 1H  
P1 11.10 usec  
PLW1 12.00000000 W

F2 - Processing parameters  
SI 65536  
SF 500.0500110 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50



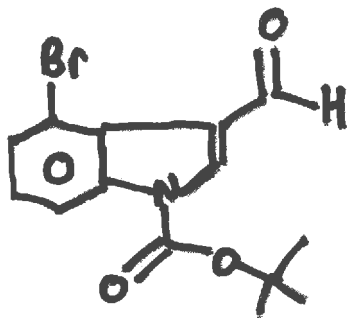
Current Data Parameters  
NAME dra-pall-52  
EXPNO 11  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120905  
Time 10.19  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 29761.904 Hz  
FIDRES 0.454131 Hz  
AQ 1.1010048 sec  
RG 1820  
DW 16.800 usec  
DE 19.92 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

CHANNEL f1 =====  
SFO1 125.7502457 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 32768  
SF 125.7376730 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00

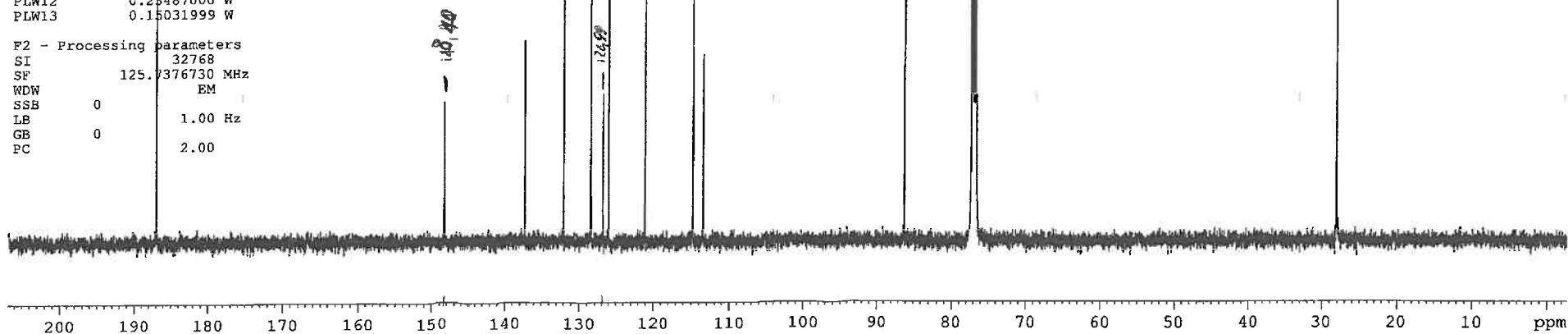


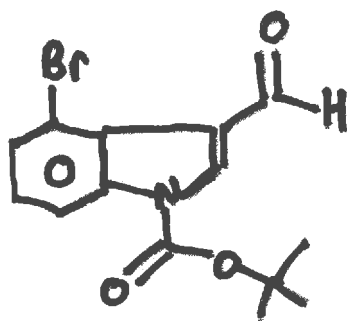
137.268  
132.009  
128.524  
126.022  
121.109  
114.833  
113.470

86.169

77.270  
77.027  
76.163

28.028





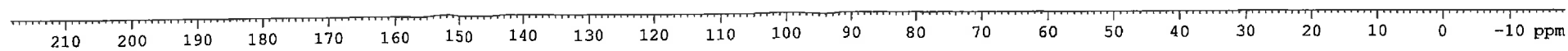
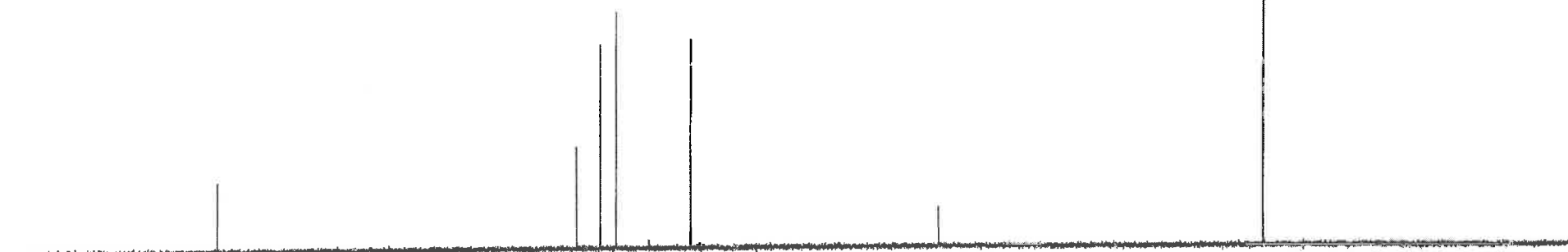
186.966  
186.946

132.008  
128.523  
126.022

114.834

77.220

28.029

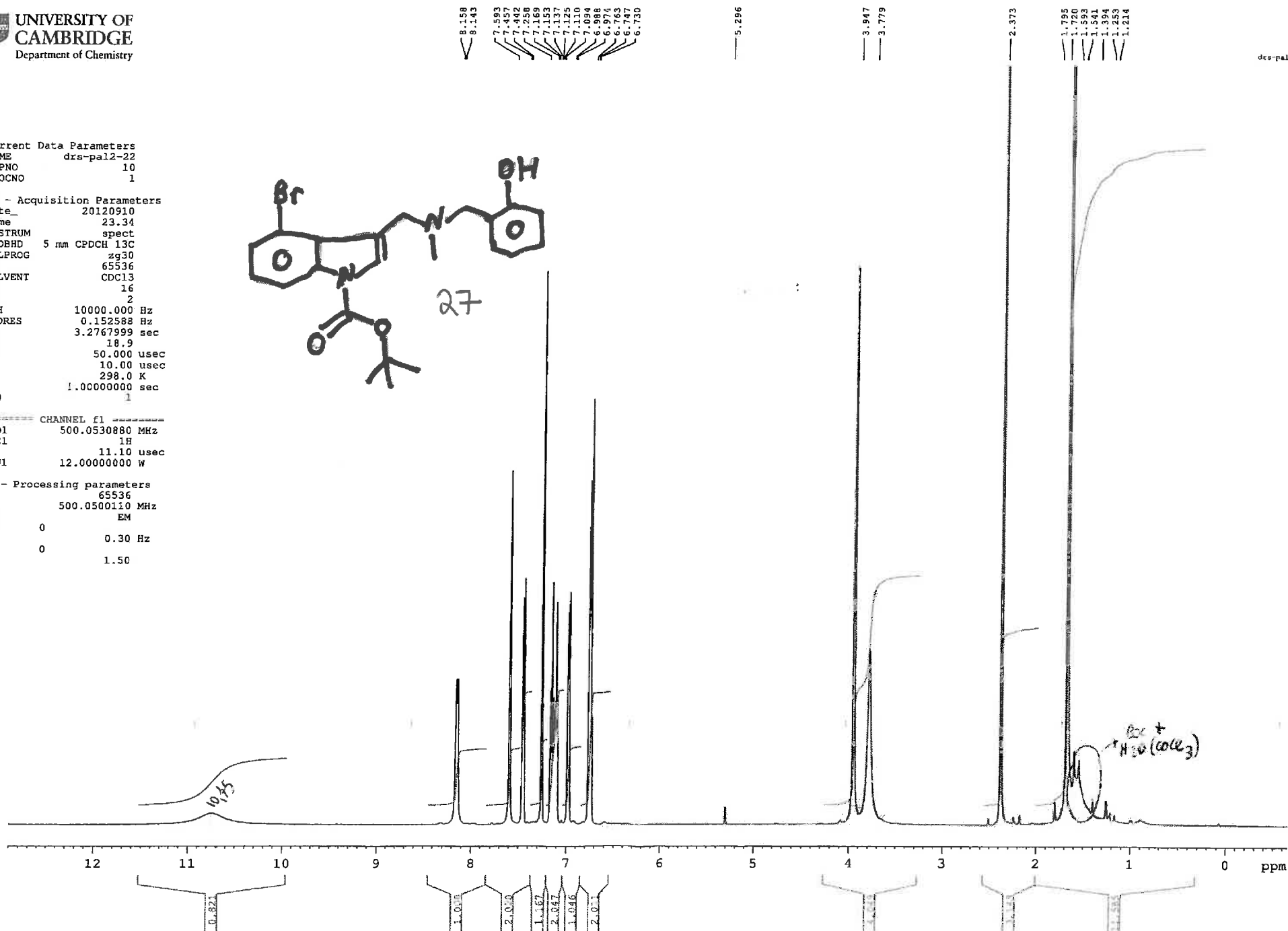
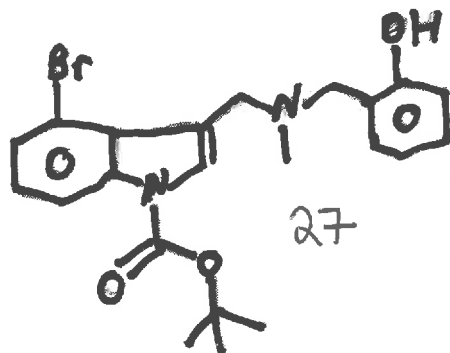


Current Data Parameters  
NAME drs-pal2-22  
EXPNO 10  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20120910  
Time 23.34  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 16  
DS 2  
SWH 10000.000 Hz  
FIDRES 0.152588 Hz  
AQ 3.2767999 sec  
RG 18.9  
DW 50.000 usec  
DE 10.00 usec  
TE 298.0 K  
D1 1.00000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 500.0530880 MHz  
NUC1 1H  
P1 11.10 usec  
PLW1 12.00000000 W

F2 - Processing parameters  
SI 65536  
SF 500.0500110 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50



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Current Data Parameters  
NAME drs-pal2-22  
EXPNO 6011  
PROCNO 1

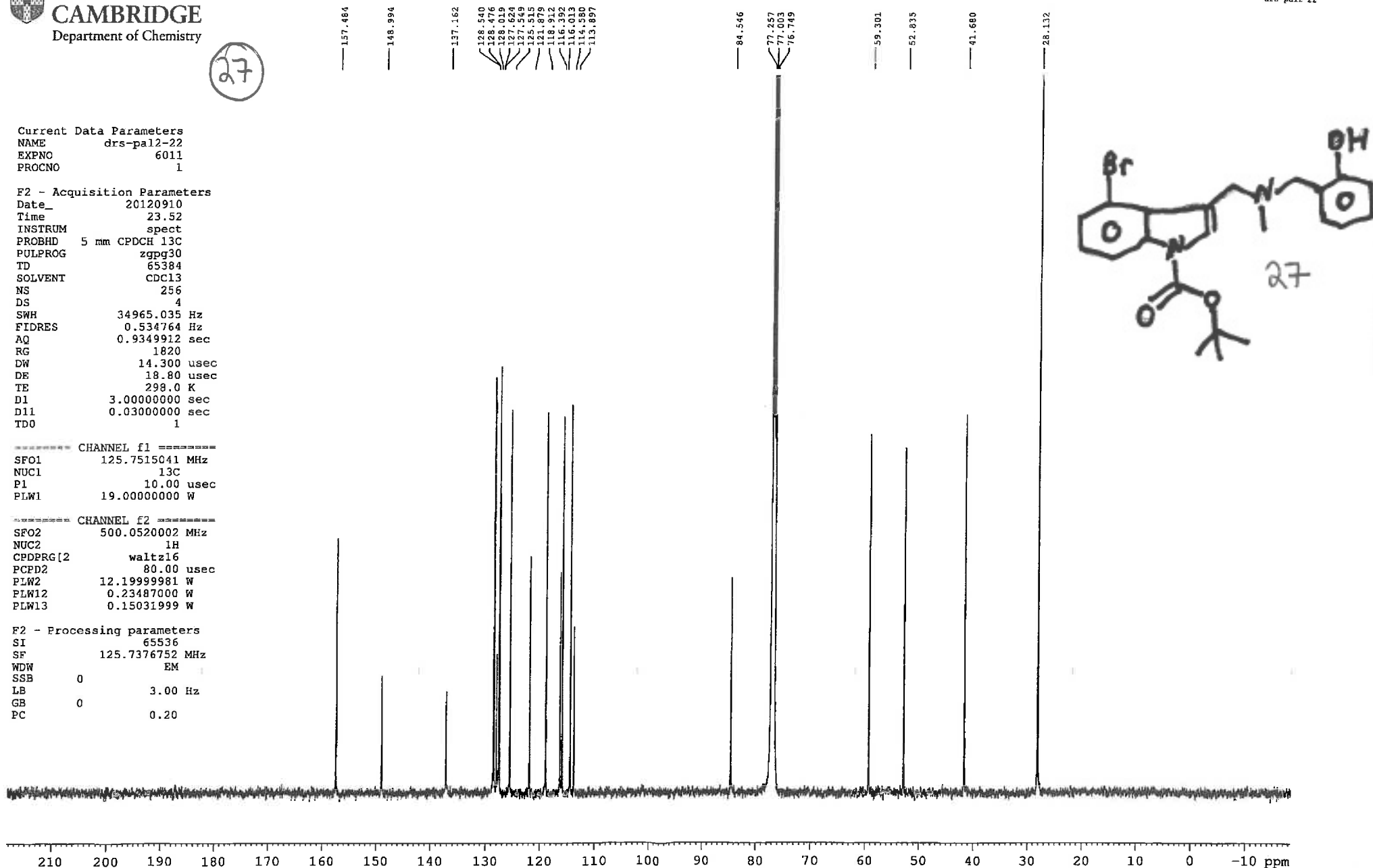
F2 - Acquisition Parameters  
Date\_ 20120910  
Time 23.52  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 256  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 18.80 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG2 waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20

Data has been converted to analogue. Backwards predicted 16 points to remove cryoprobe baseline roll.  
drs-pal2-22



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Current Data Parameters

NAME drs-pal2-22  
EXPNO 6011  
PROCNO 1

F2 - Acquisition Parameters

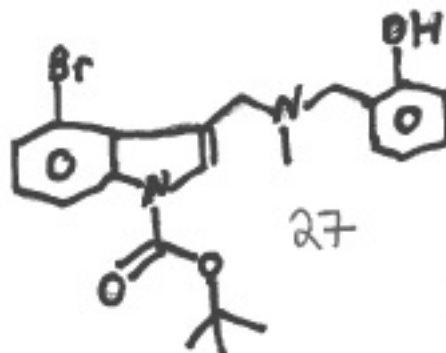
Date\_ 20120910  
Time 23.52  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 256  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 18.80 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

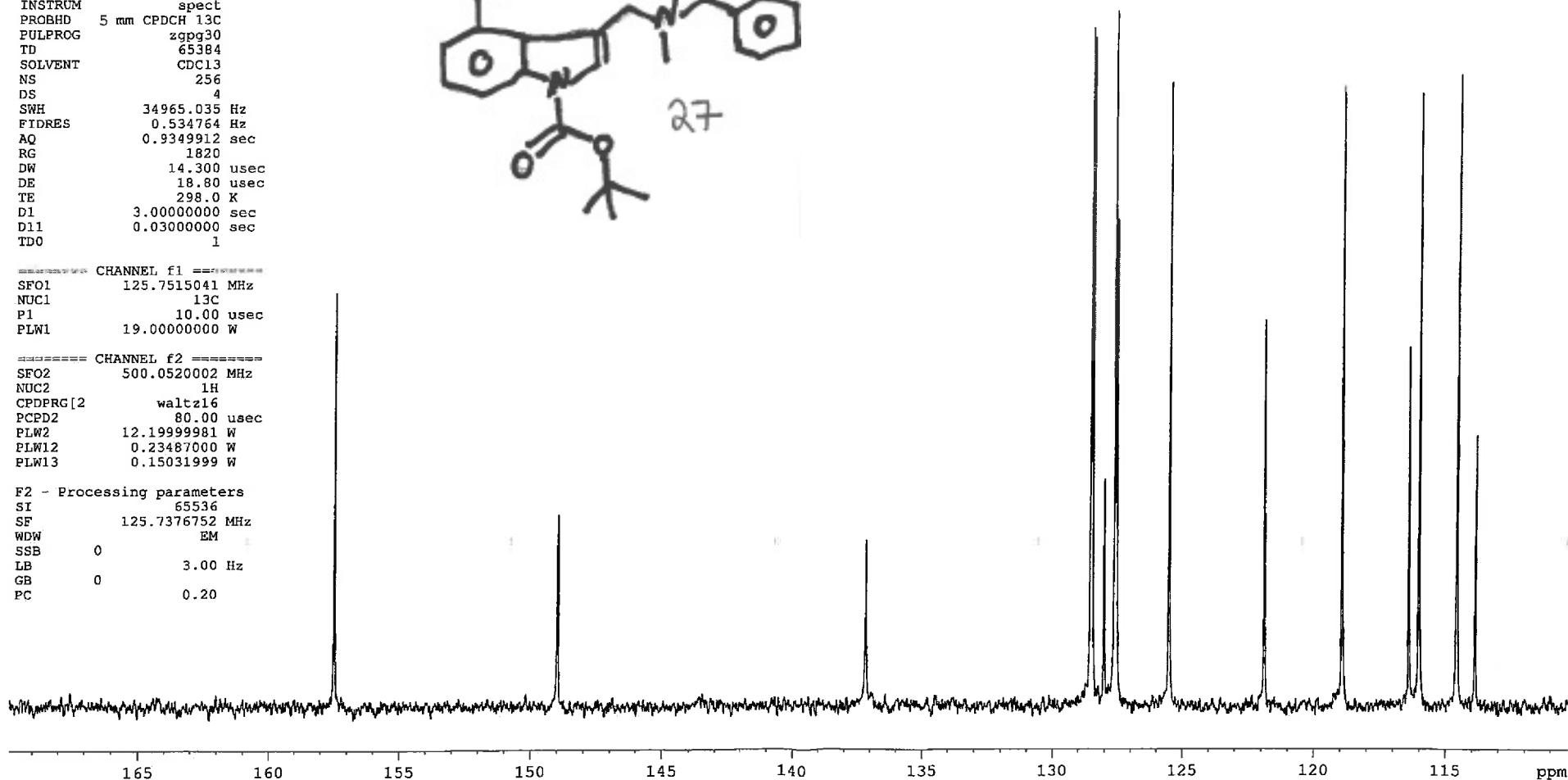
F2 - Processing parameters

SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20



Data has been converted to analogue. Backwards predicted 16 points to remove cryoprobe baseline roll.  
drs-pal2-22

128.540  
128.540  
128.019  
127.624  
127.549  
125.515  
121.879  
118.912  
116.392  
116.013  
114.580  
113.897





27

Current Data Parameters  
NAME drs-pal2-22  
EXPNO 6011  
PROCNO 1

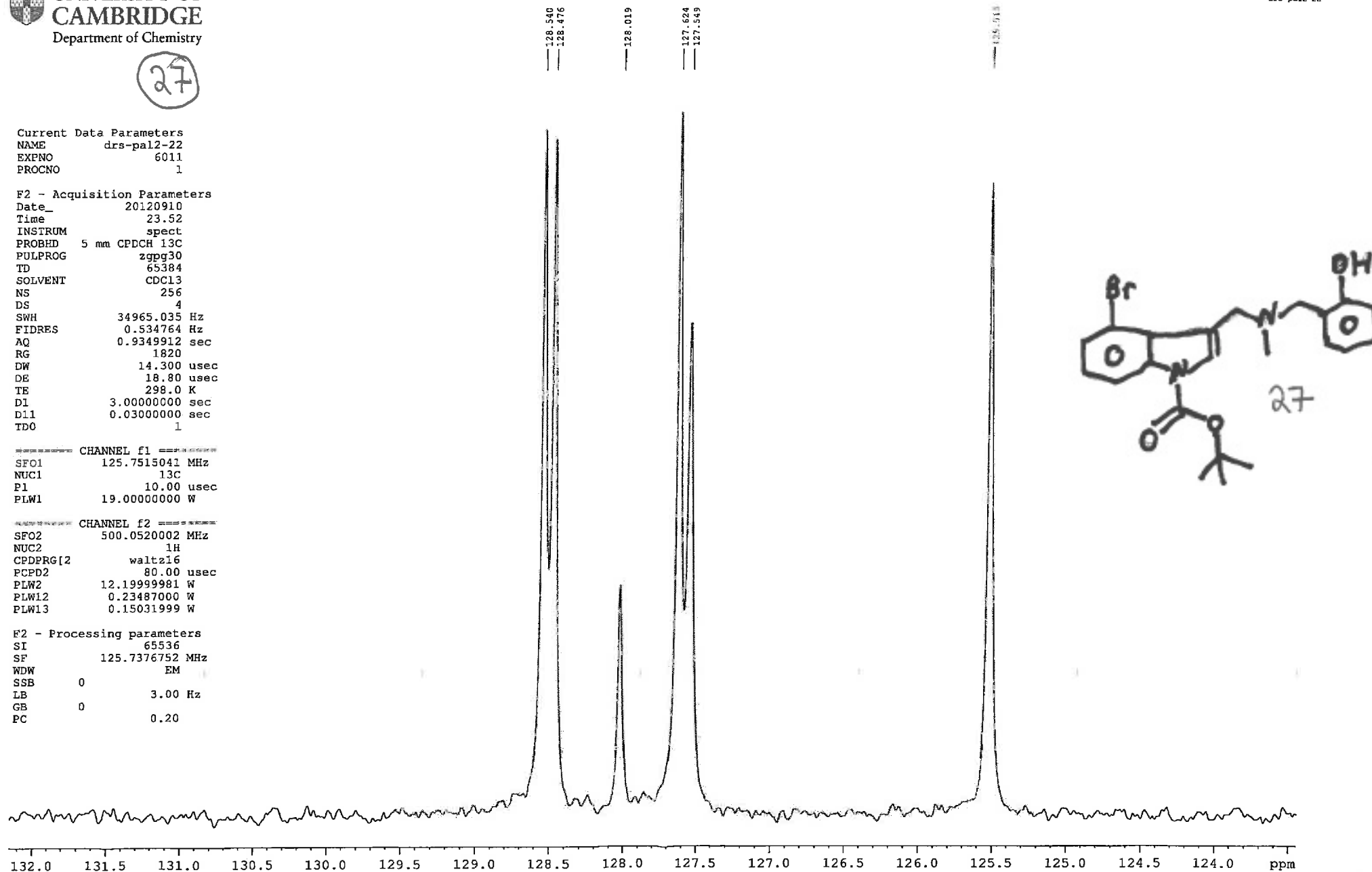
F2 - Acquisition Parameters  
Date\_ 20120910  
Time 23.52  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 256  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 18.80 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

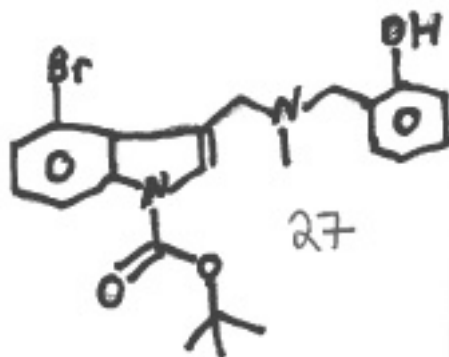
===== CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20

DRS has been converted to analogue. Backwards predicted 16 points to remove cryoprobe baseline roll.  
drs-pal2-22





27

128.540  
128.475  
127.624  
127.549  
125.515

118.912  
116.012  
114.580

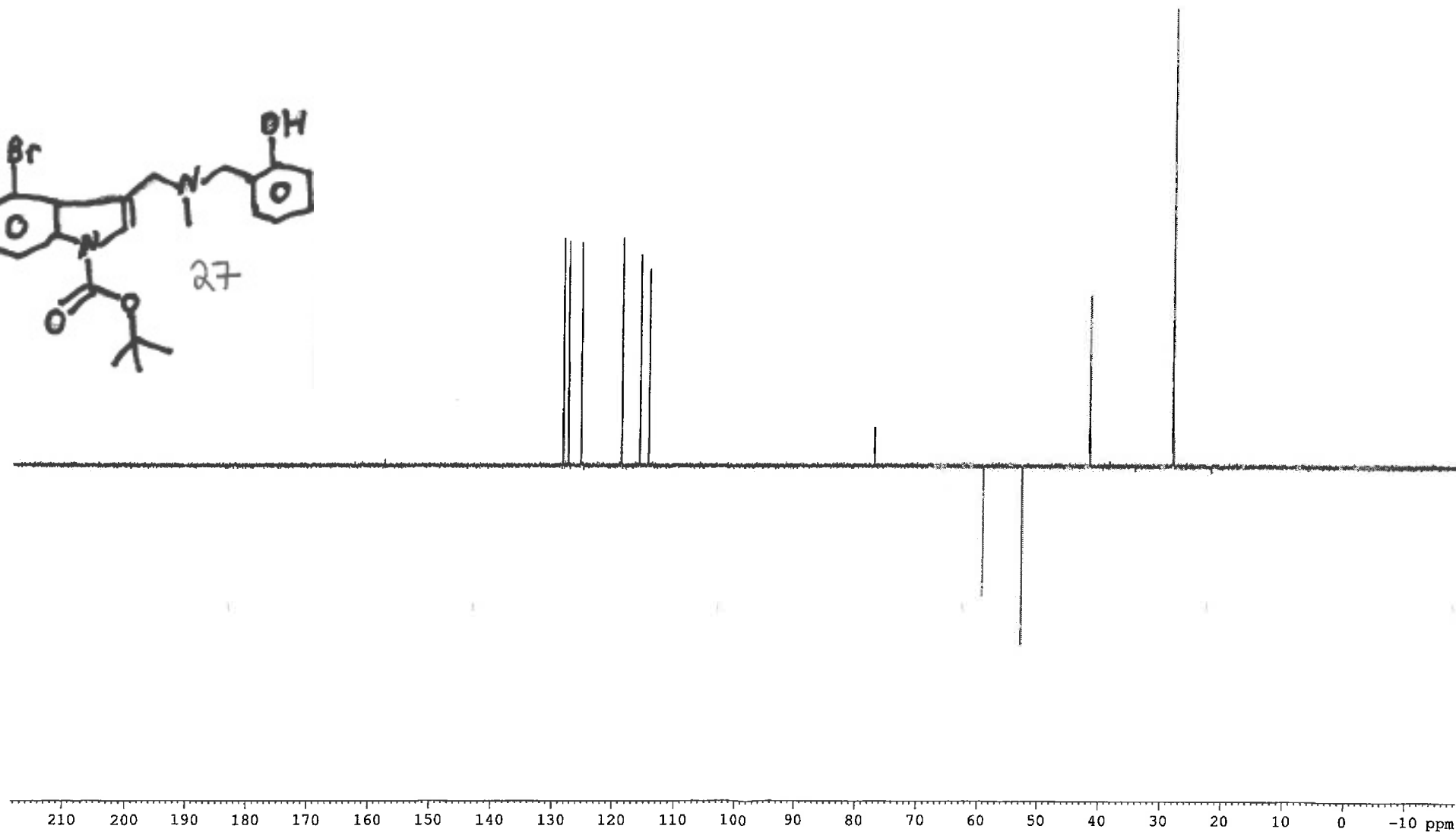
77.206

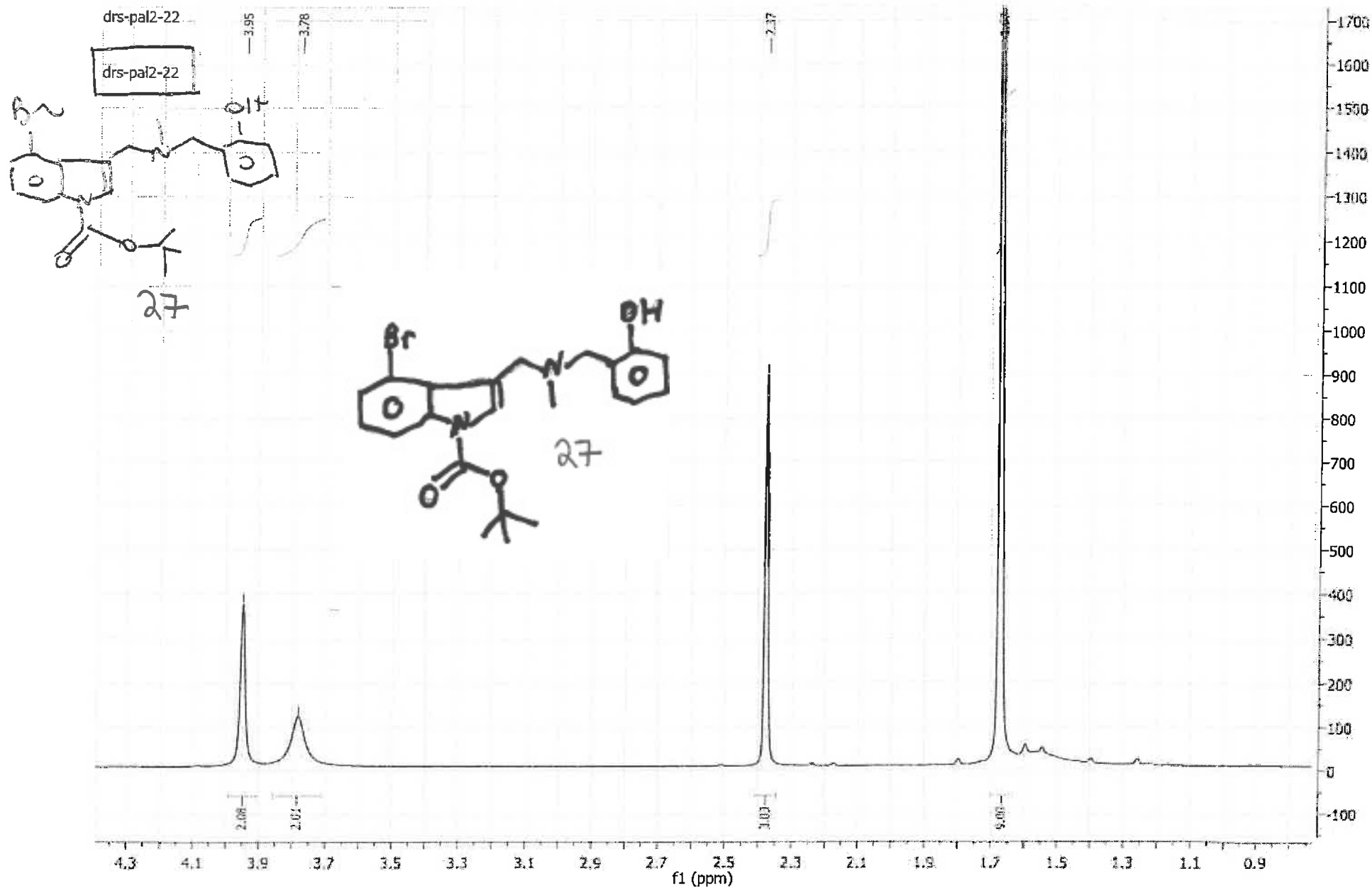
59.301

52.835

41.680

28.132

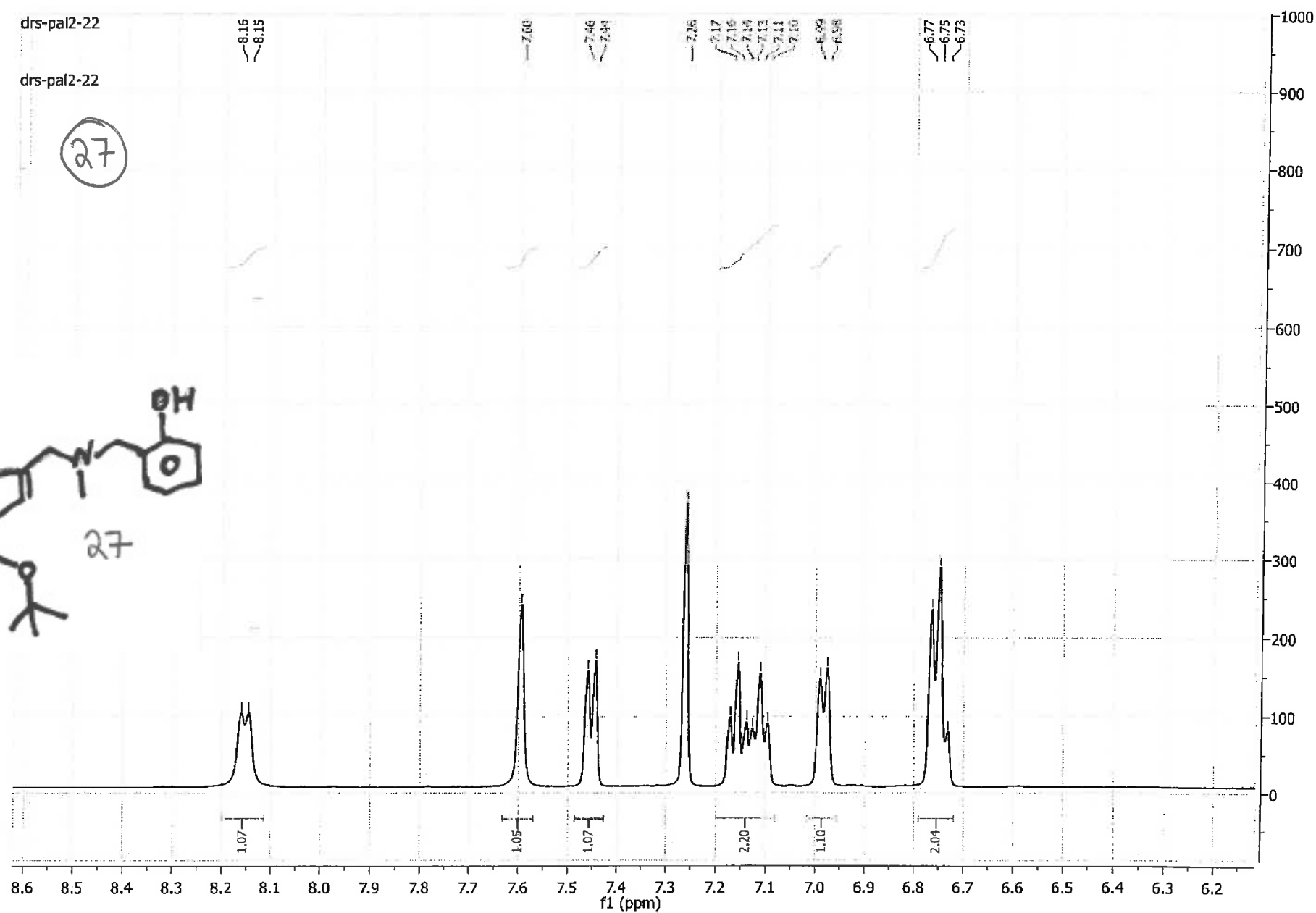
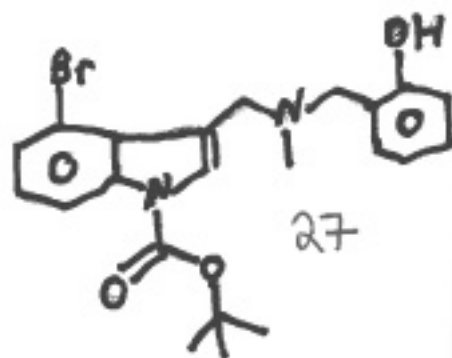




drs-pal2-22

drs-pal2-22

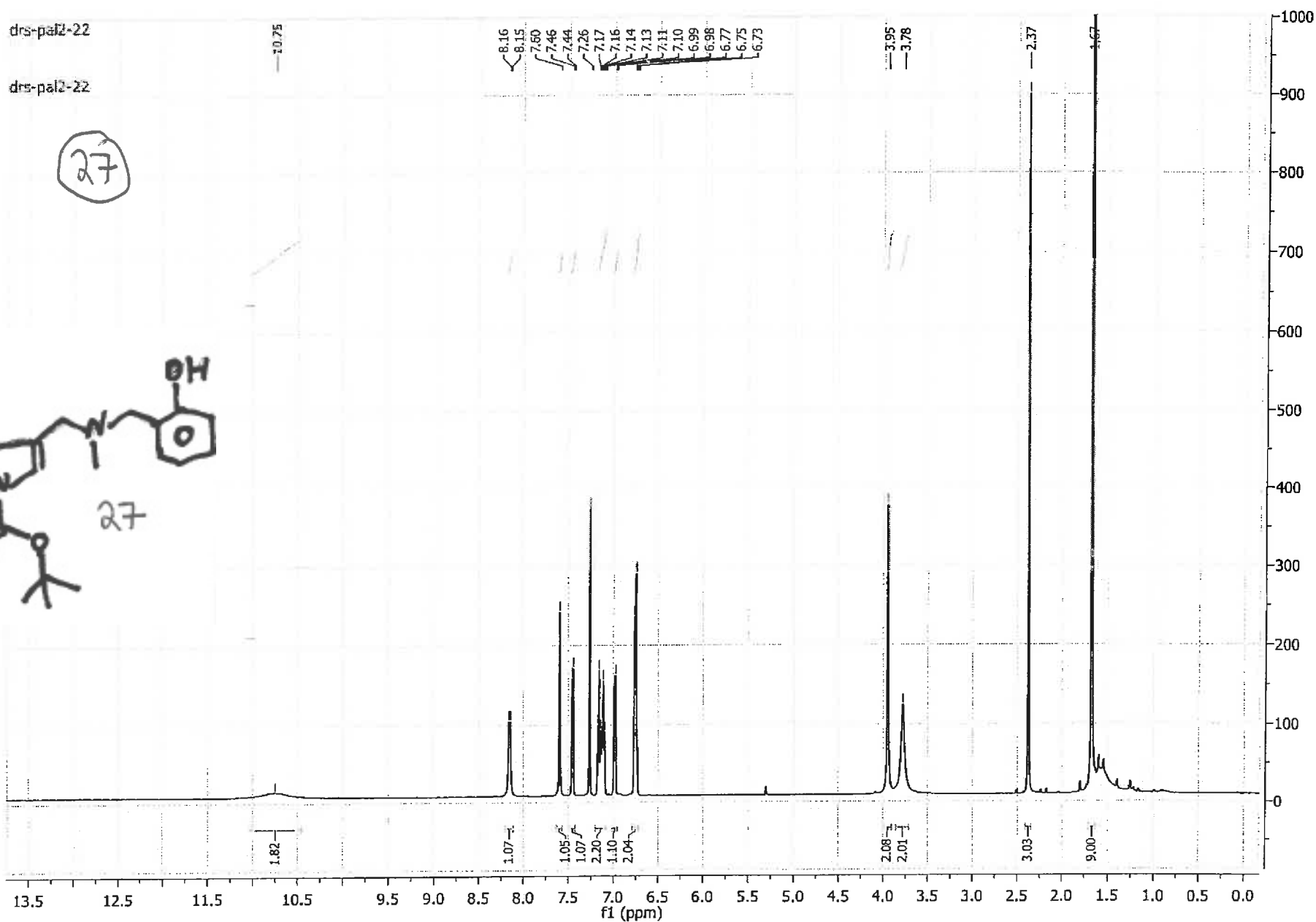
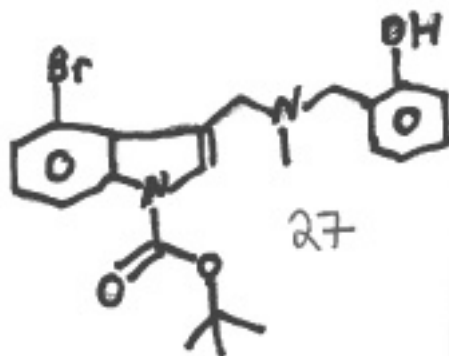
27



drs-pal2-22

drs-pal2-22

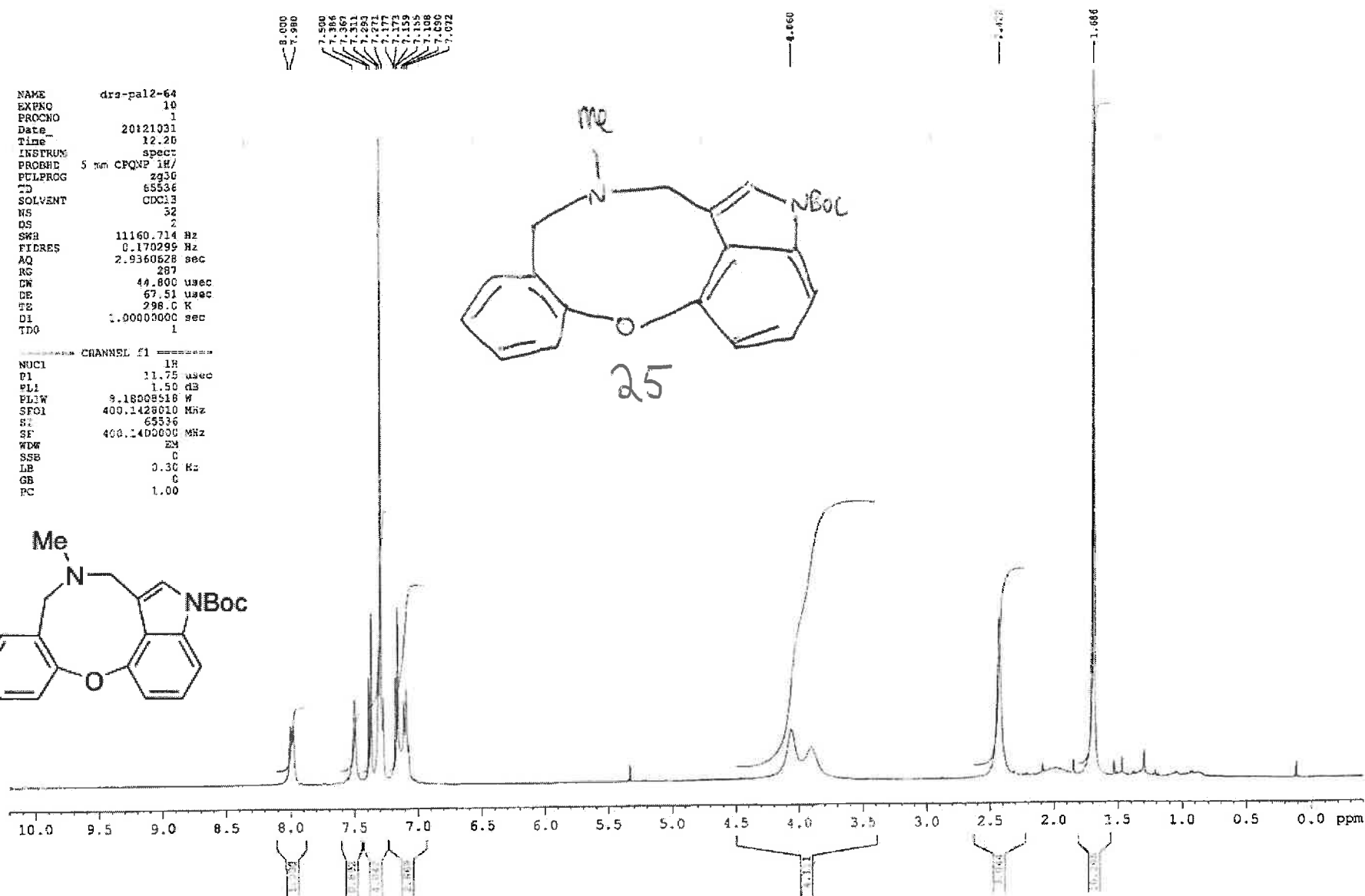
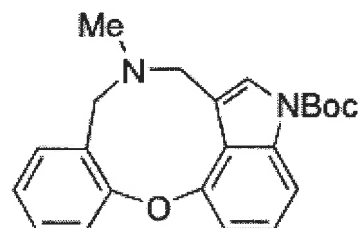
27



```

===== CHANNEL f1 =====
NUC1      1H
P1         11.75 usec
           1.50 dB
PL1W      9.18008518 W
SF01      400.1428010 MHz
S:         65536
SF         400.1400000 MHz
WDW        EM
SSB        C
LB         0.30 Kz
GB         C
PC         1.00

```



25

Current Data Parameters  
NAME mjc-pal2-64  
EXPNO 6011  
PROCNO 1

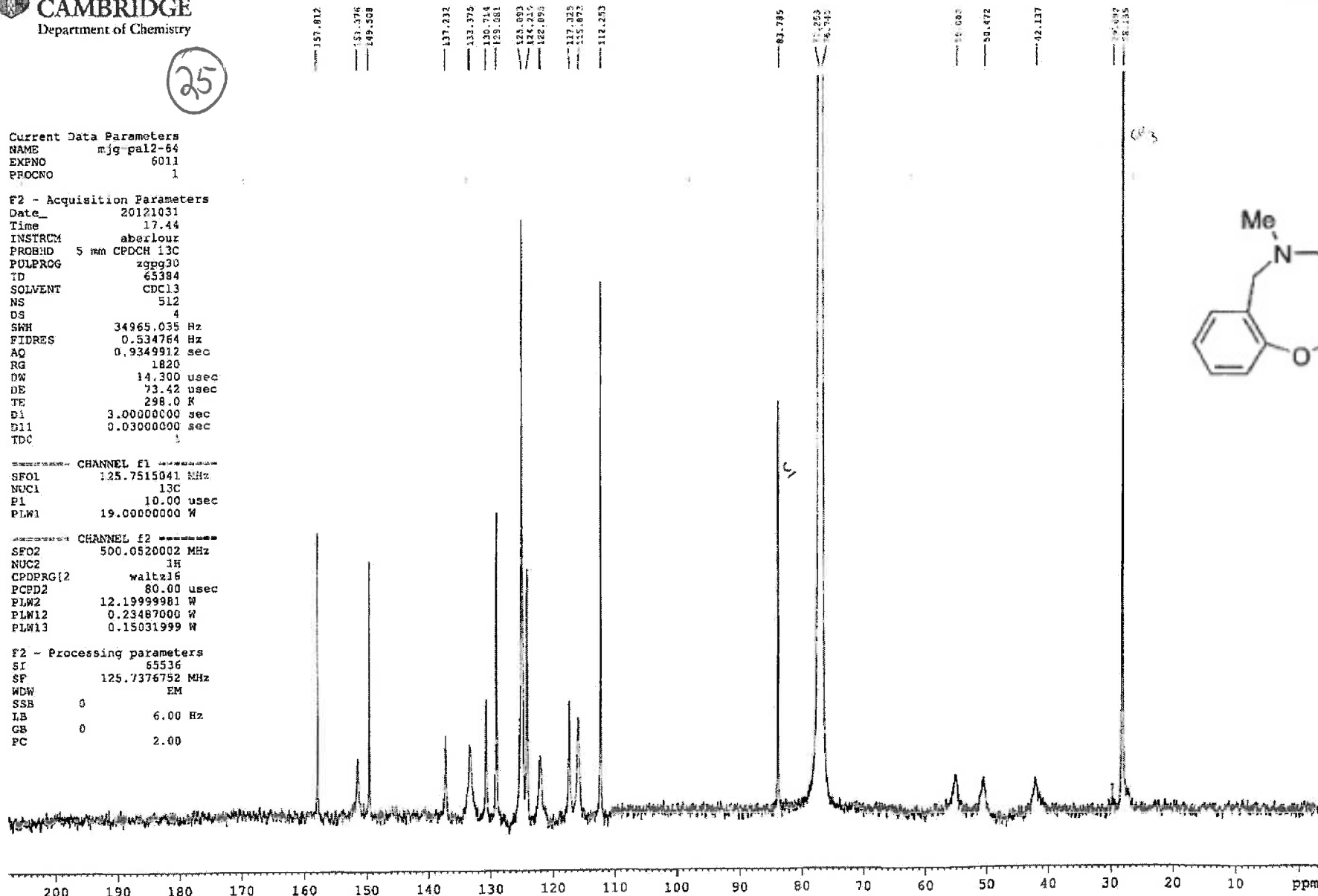
F2 - Acquisition Parameters  
Date\_ 20121031  
Time 17.44  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 512  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 73.42 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TDC 1

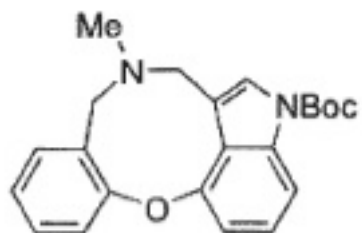
===== CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

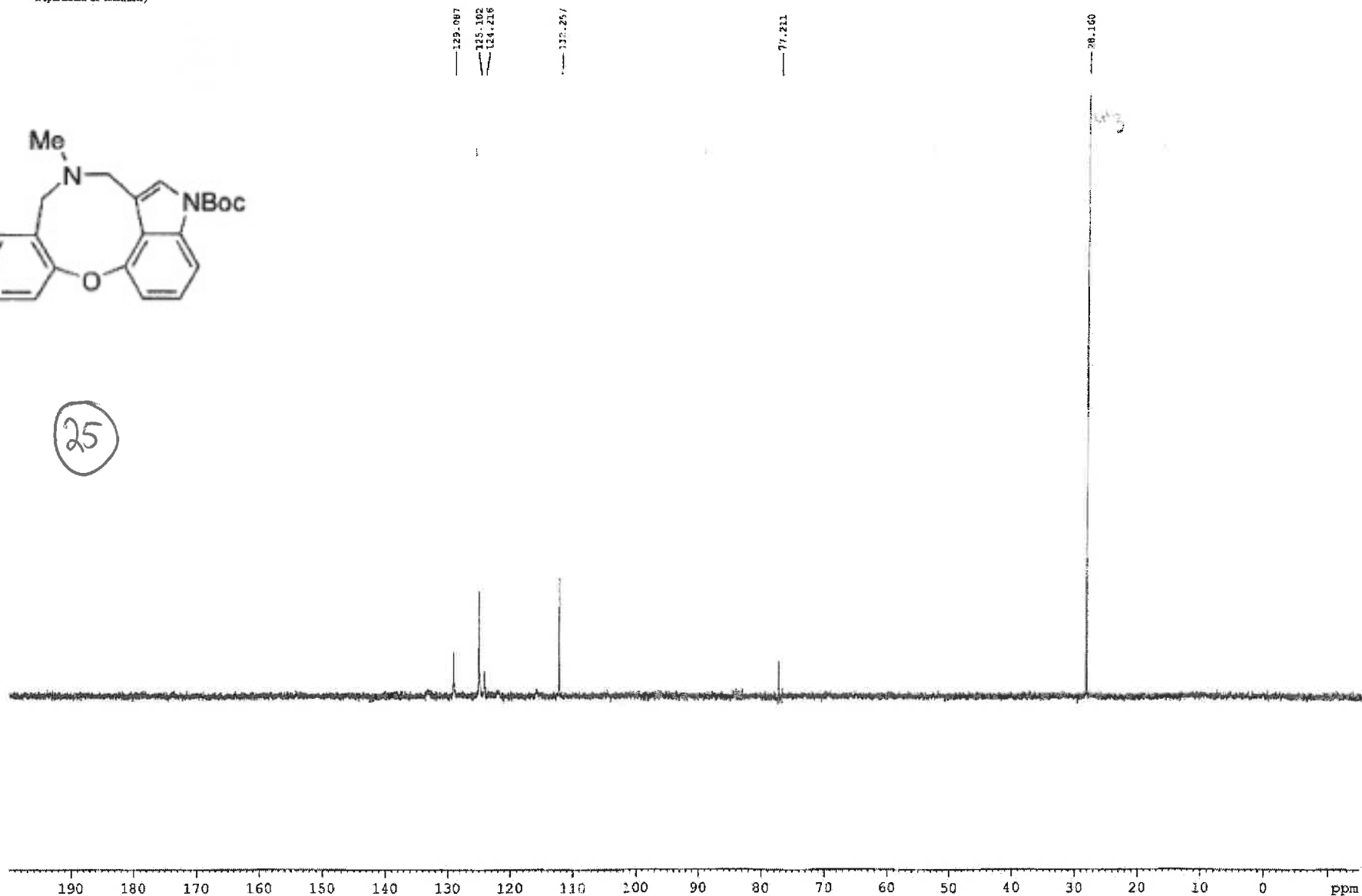
F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 6.00 Hz  
GB 0  
PC 2.00

Data has been converted to analogue. Backwards predicted 24 points to remove cryoprobe baseline roll.  
mjc-pal2-64



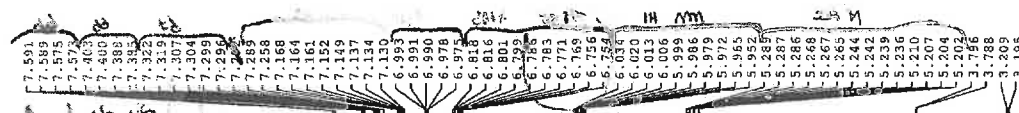


25





10.527



0.880  
0.874  
0.860  
0.847  
0.834

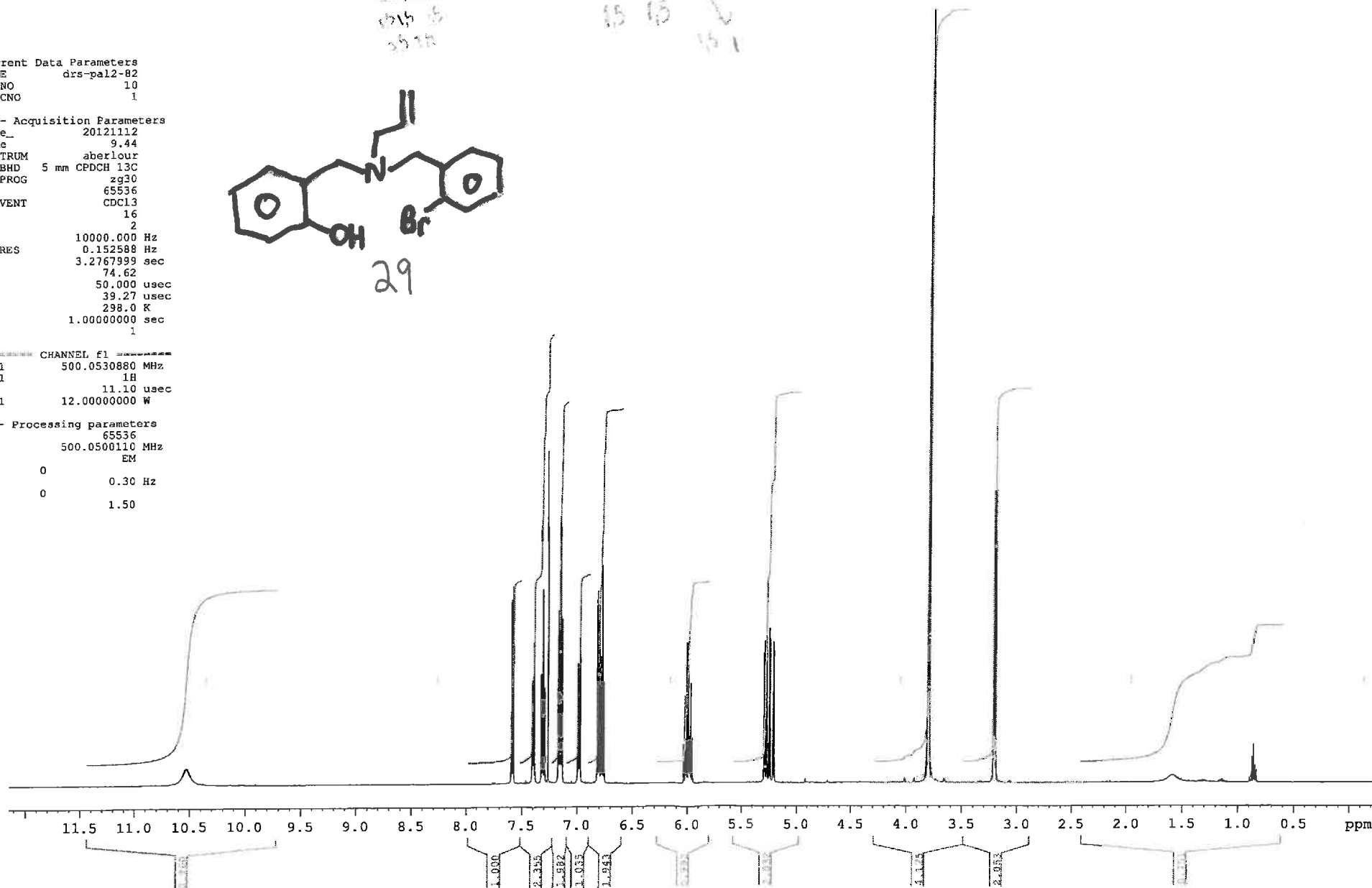
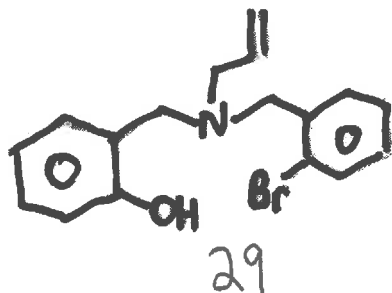
drs-pal2-82

Current Data Parameters  
NAME drs-pal2-82  
EXPNO 10  
PROCNO 1

F2 - Acquisition Parameters  
Date\_ 20121112  
Time 9.44  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 16  
DS 2  
SWH 10000.000 Hz  
FIDRES 0.152588 Hz  
AQ 3.2767999 sec  
RG 74.62  
DW 50.000 usec  
DE 39.27 usec  
TE 298.0 K  
D1 1.00000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 500.0530880 MHz  
NUC1 1H  
P1 11.10 usec  
PLW1 12.00000000 W

F2 - Processing parameters  
SI 65536  
SF 500.0500110 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50



29

Current Data Parameters  
NAME drs-pal2-82  
EXPNO 6011  
PROCNO 1

F2 - Acquisition Parameters

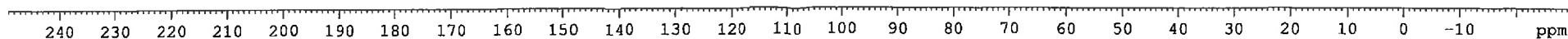
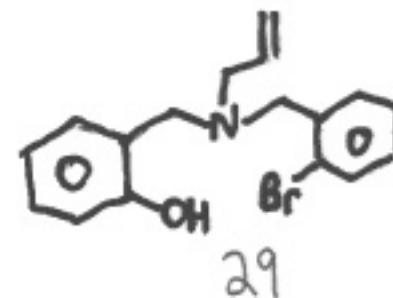
Date\_ 20121112  
Time 9.54  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1620  
DW 14.300 usec  
DE 73.42 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG12 waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20

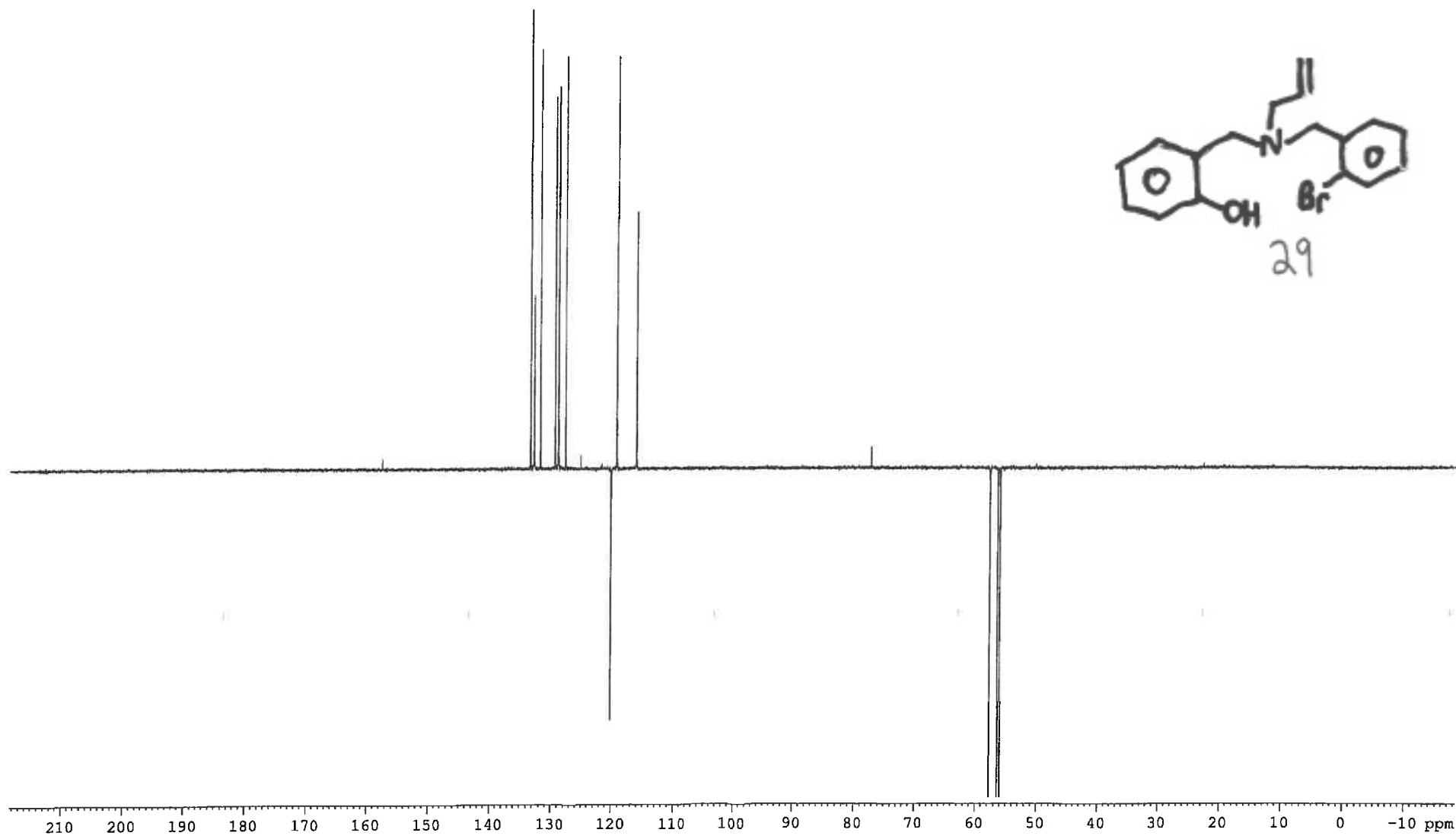
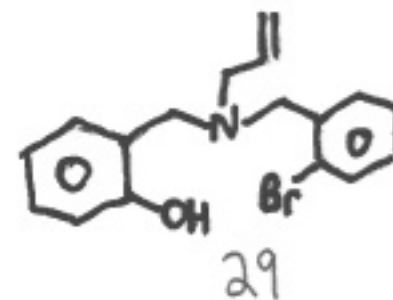
157.456  
136.368  
135.268  
132.757  
131.787  
129.381  
128.873  
128.831  
127.642  
125.150  
121.622  
120.143  
119.268  
116.131  
77.268  
77.268  
76.761  
57.702  
56.376  
56.011



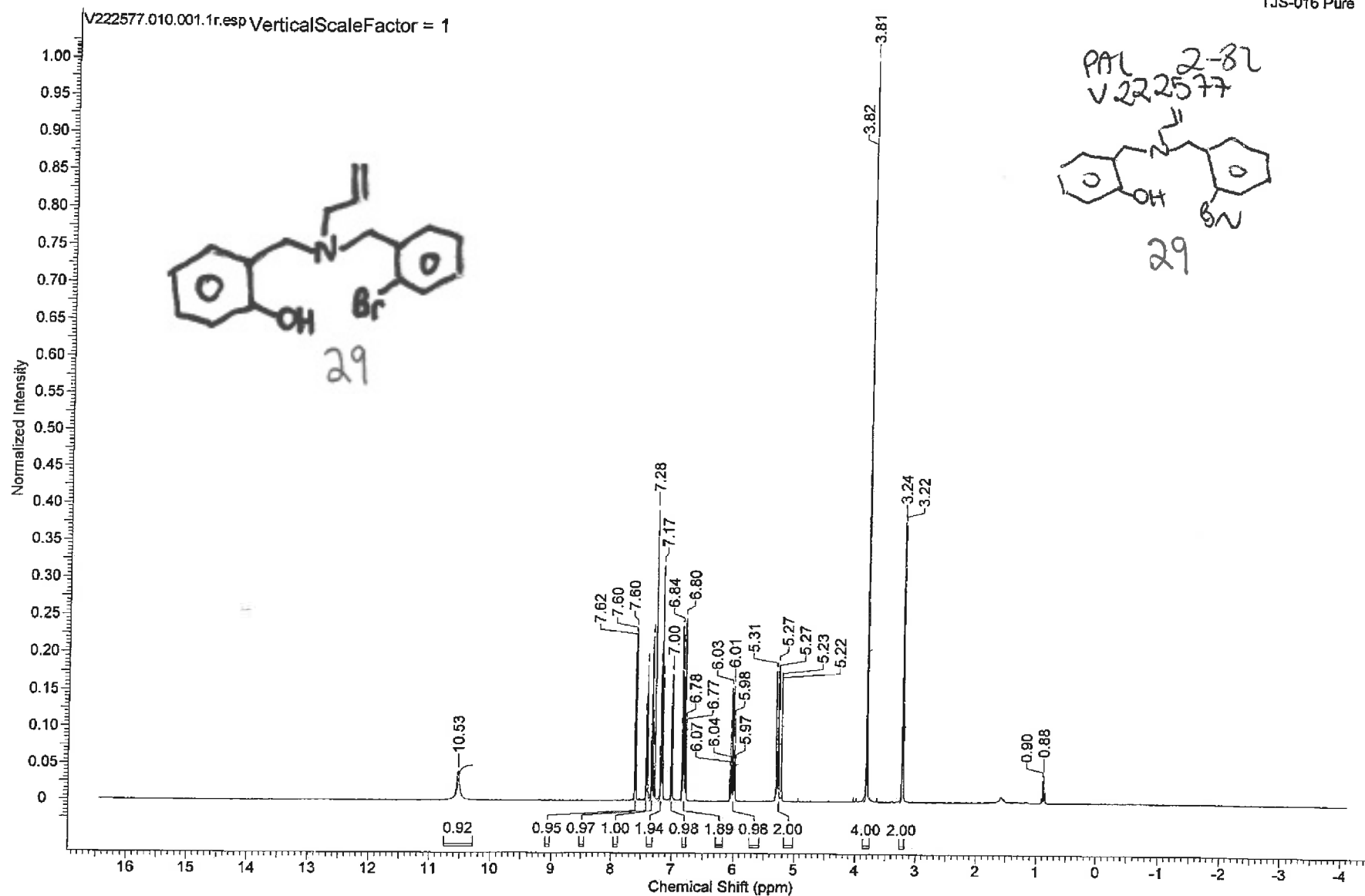
29

133.298  
132.731  
132.687  
129.881  
128.874  
128.831  
127.642  
120.143  
119.268  
116.131

57.702  
56.377  
56.011



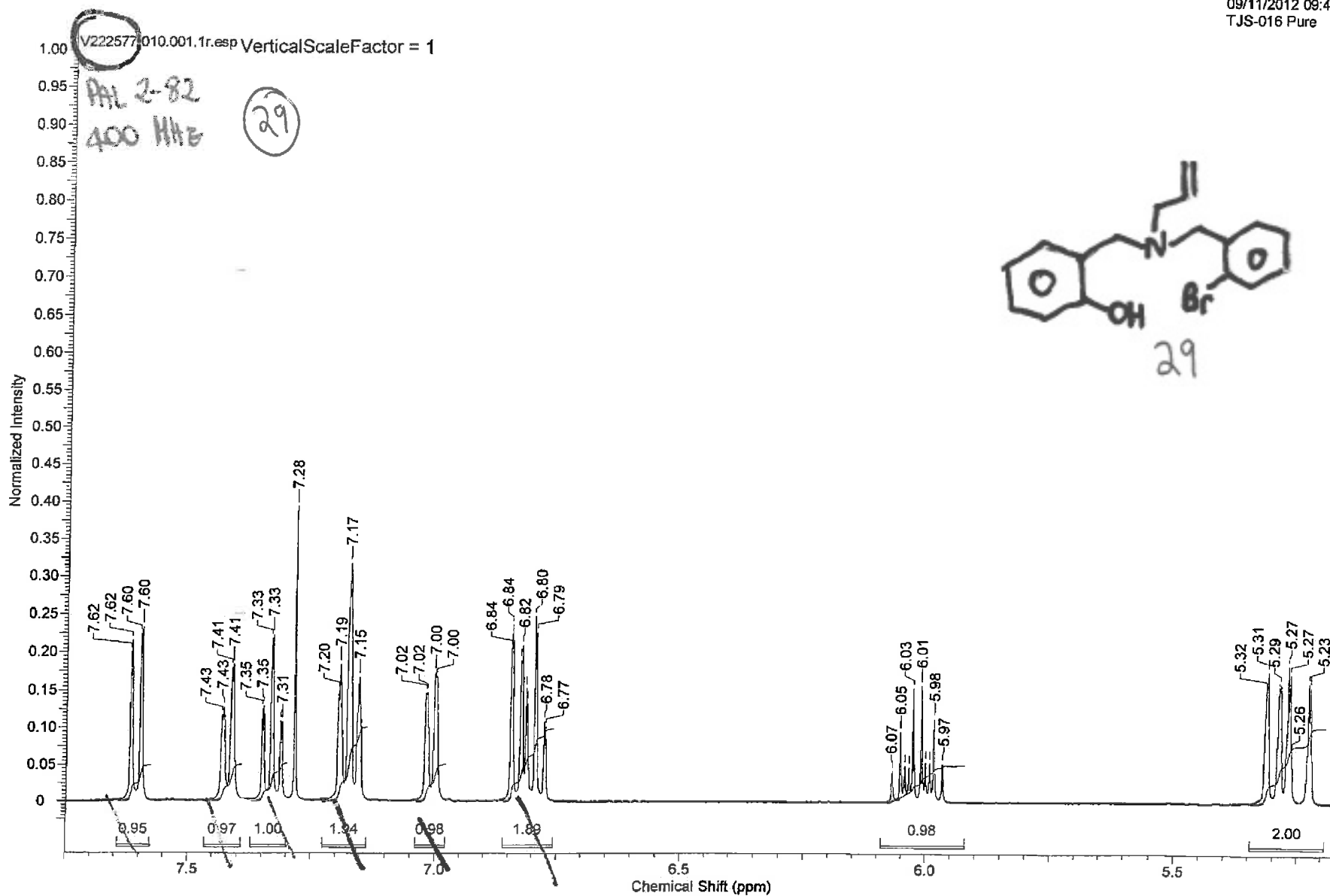
09/11/2012 09:44:01  
TJS-016 Pure



Y:\aphroaig\data\chemist\nmr\V222577\V222577.010.001.1r.esp

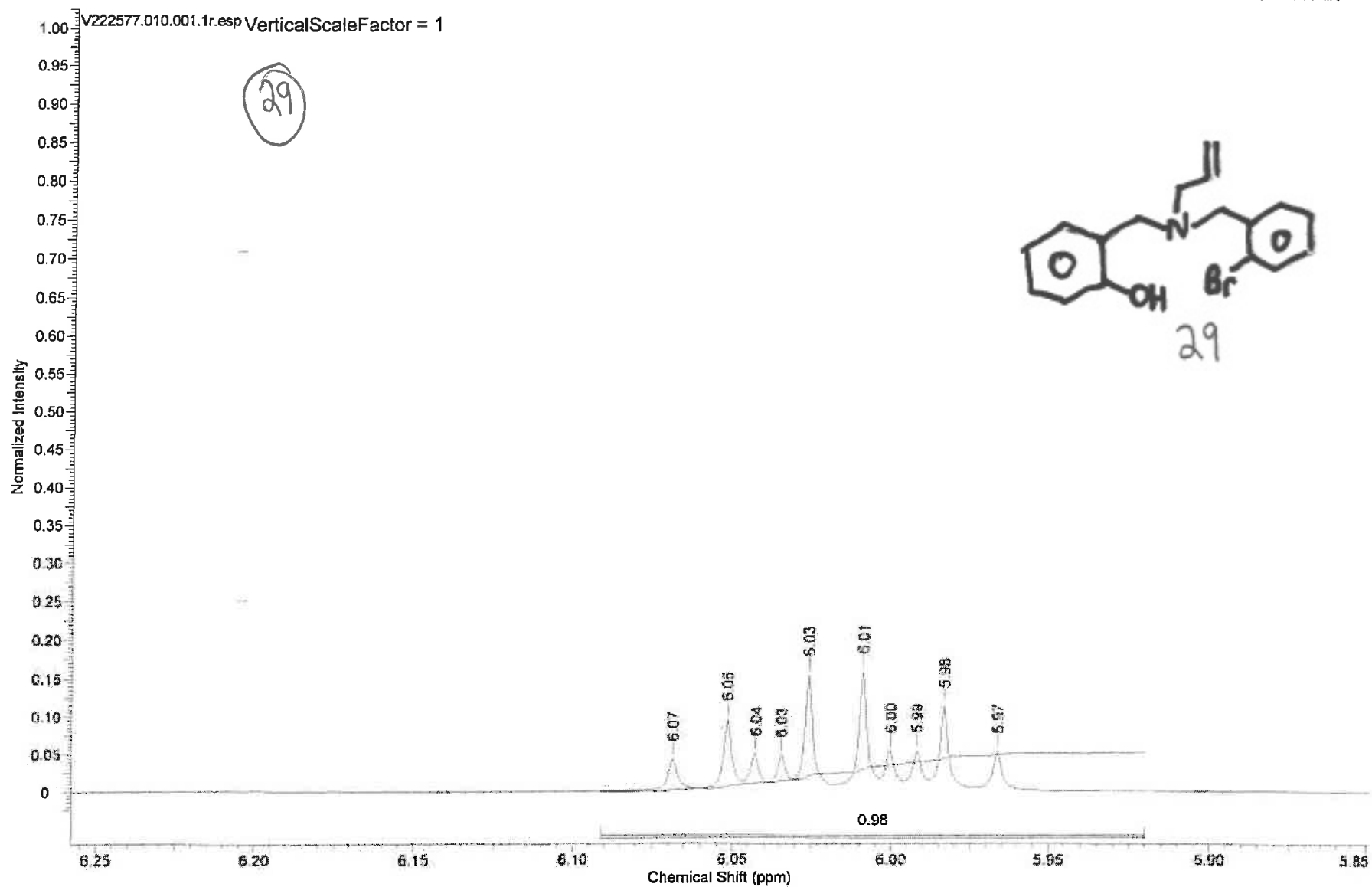
# TJS-016 Pure

09/11/2012 09:44:30  
TJS-016 Pure



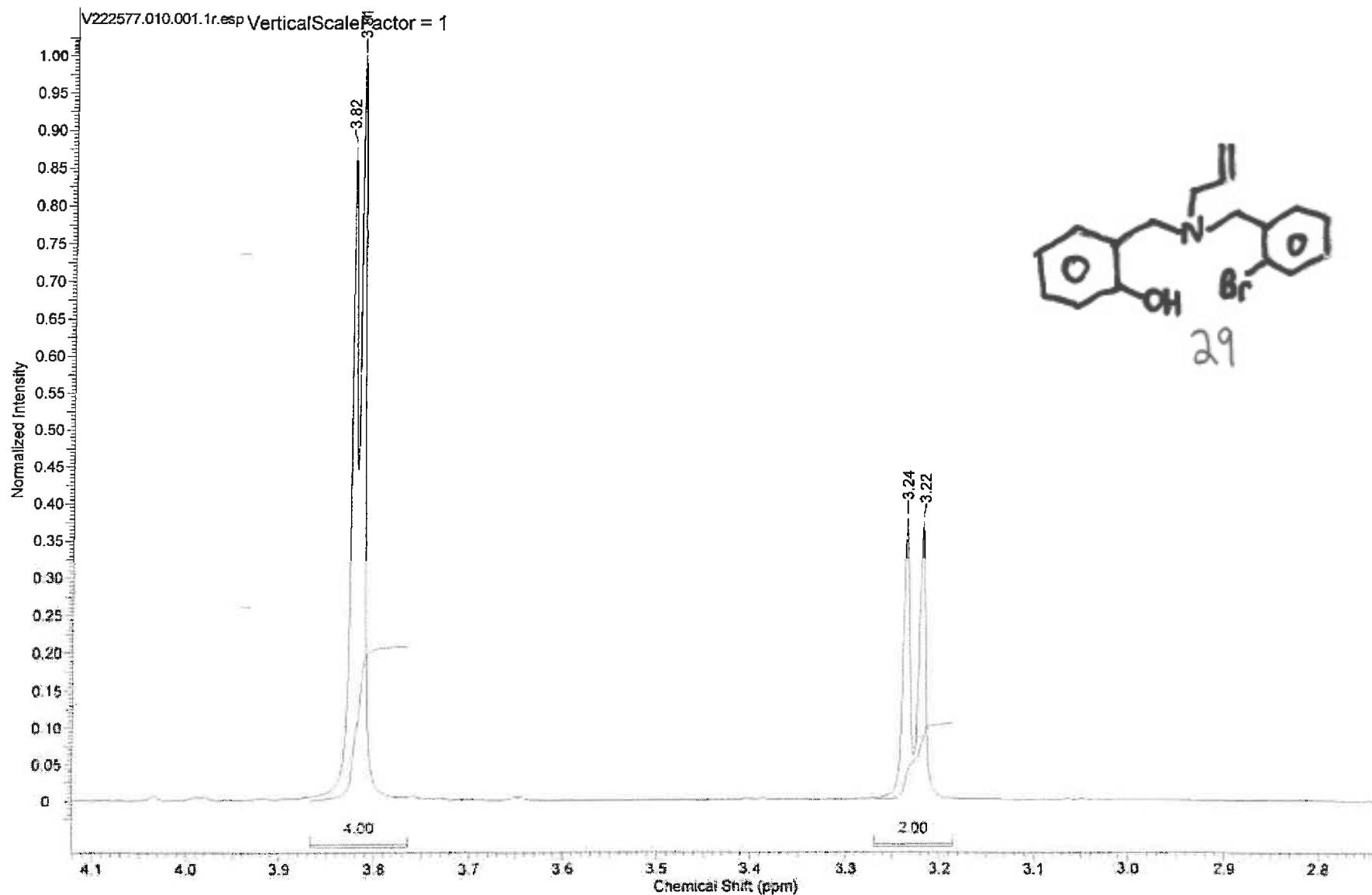
Y:\aphroaig\data\chemist\nmr\V222577\V222577.010.001.1r.esp

09/11/2012 09:44:40  
TJS-016 Pure



Y:\aphroaig\data\chemist\nmr\V222577\V222577.010.001.1r.esp

09/11/2012 09:45:45  
TJS-016 Pure



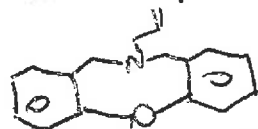
Y:\ephroaig\data\chemist\nmr\V222577\V222577.010.001.1r.esp

PAL 2-84

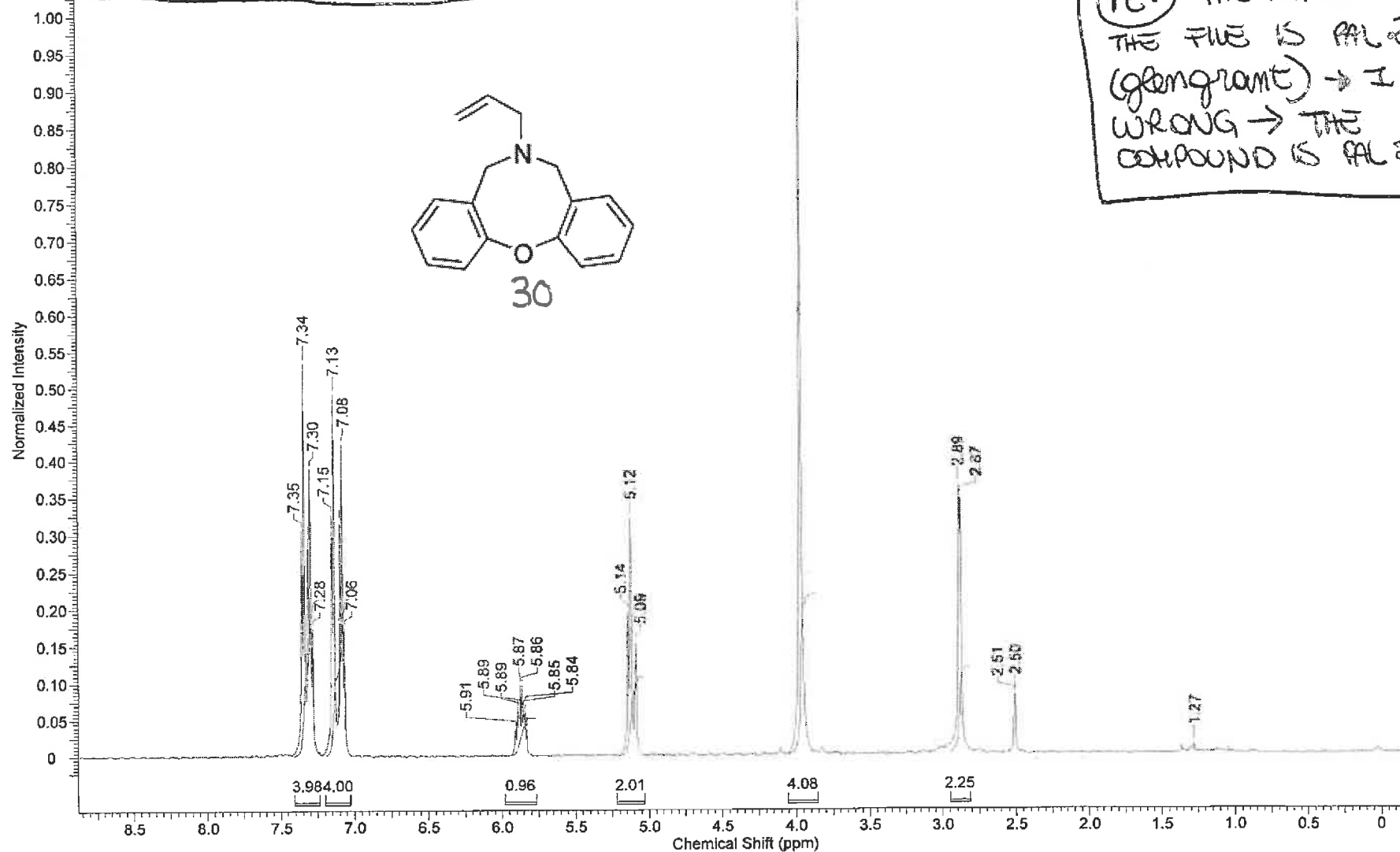
T<sup>o</sup>C = 120<sup>o</sup>C

# TJS-012 White Precipitate

20/11/2012 09:27:02  
TJS-012 White Precipitate  
Standard Avance 500 MHz Proton



PAL2-86.010.001.1r.esp VerticalScaleFactor = 1



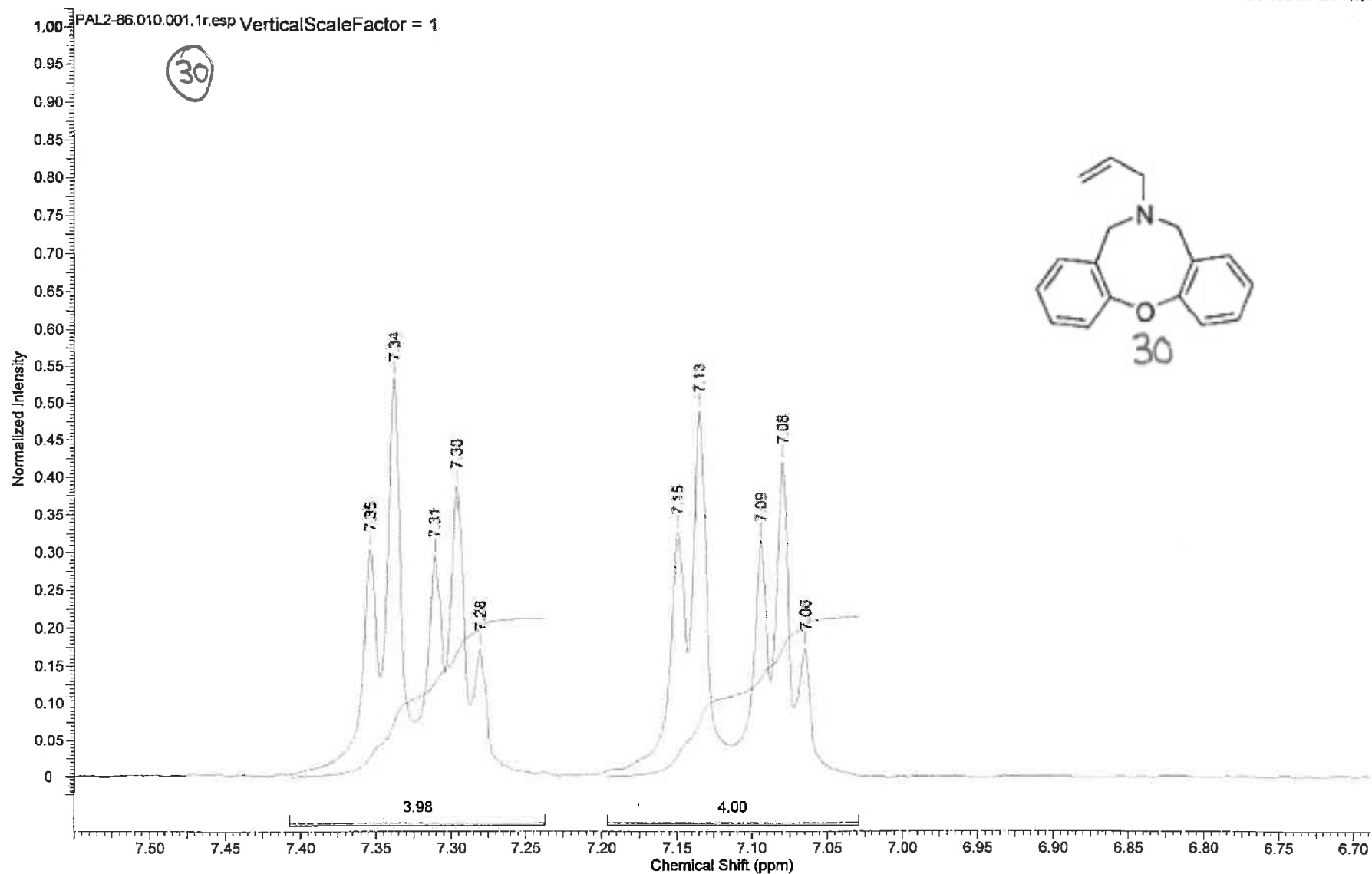
PE. THE NAME OF THE FILE IS PAL 2-86 (glengrant) → I WAS WRONG → THE COMPOUND IS PAL 2-84

Y:\glengrant\drsnmr\PAL2-86\PAL2-86.010.001.1r.esp



## TJS-012 White Precipitate

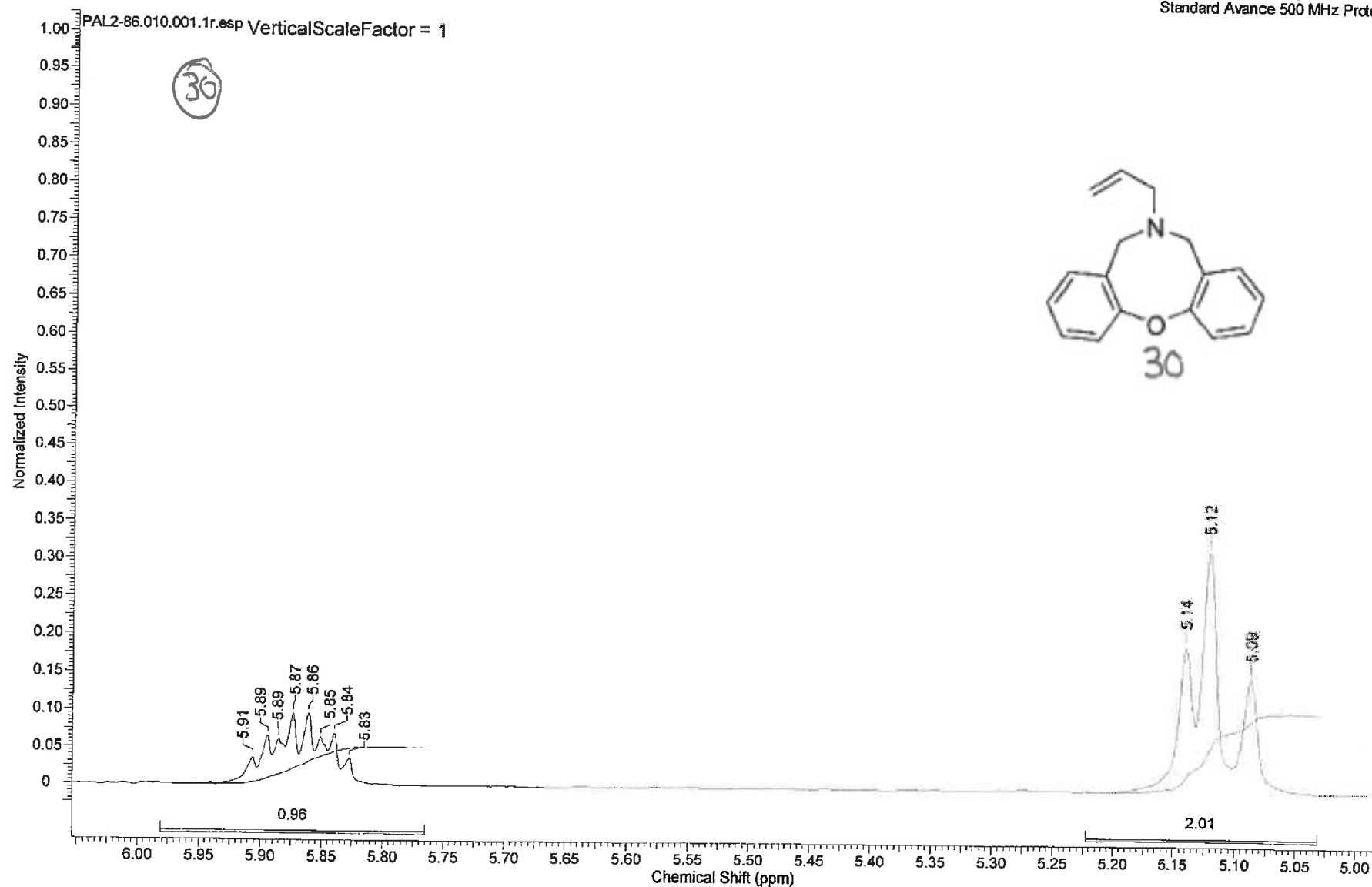
20/11/2012 09:26:23  
TJS-012 White Precipitate  
Standard Avance 500 MHz Proton



Y:\glengrant\drs\nmr\PAL2-86\PAL2-86.010.001.1r.esp

## TJS-012 White Precipitate

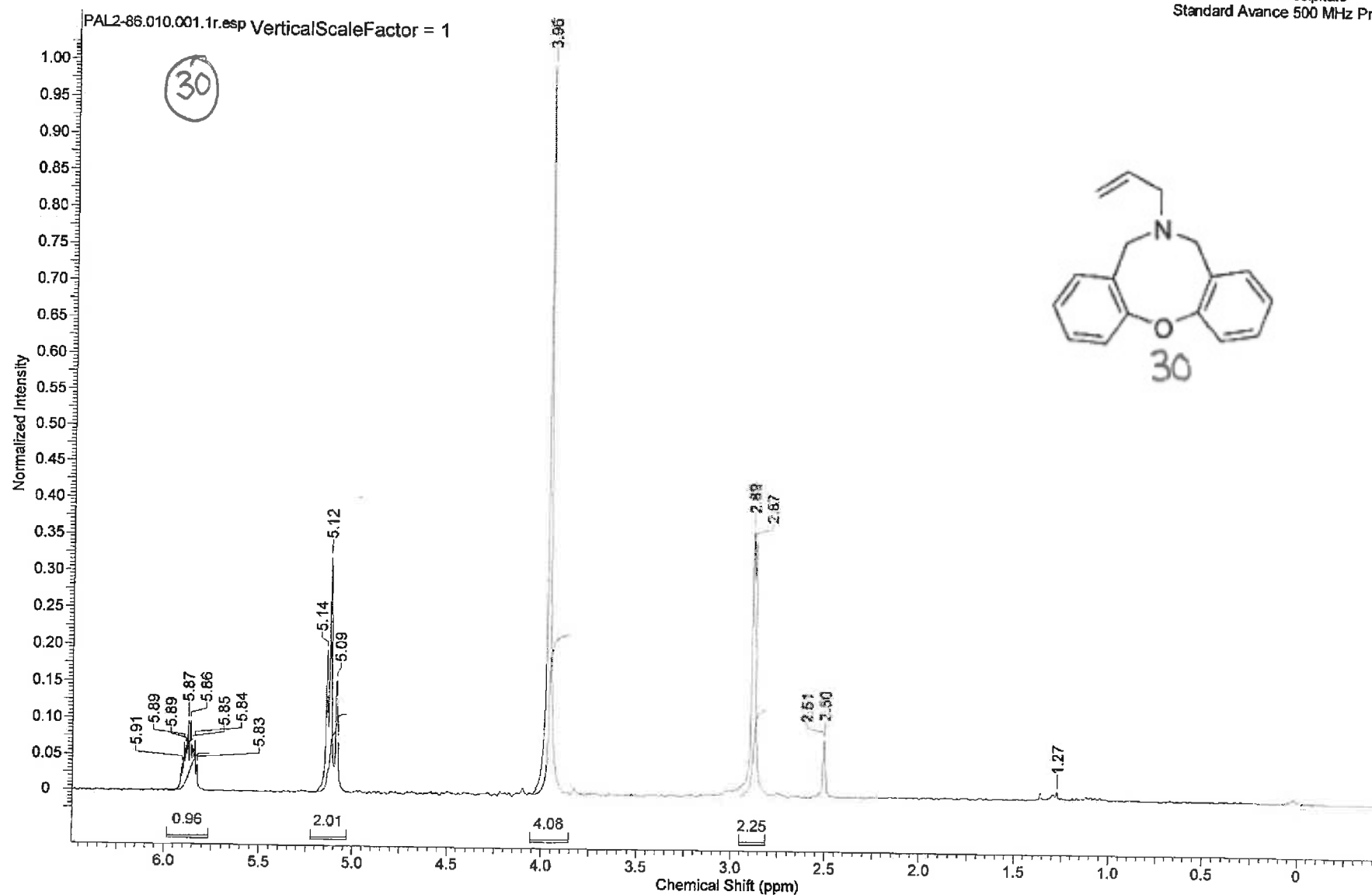
20/11/2012 09:26:46  
TJS-012 White Precipitate  
Standard Avance 500 MHz Proton



Y:\glengrant\drs\nmr\PAL2-86\PAL2-86.010.001.1r.esp

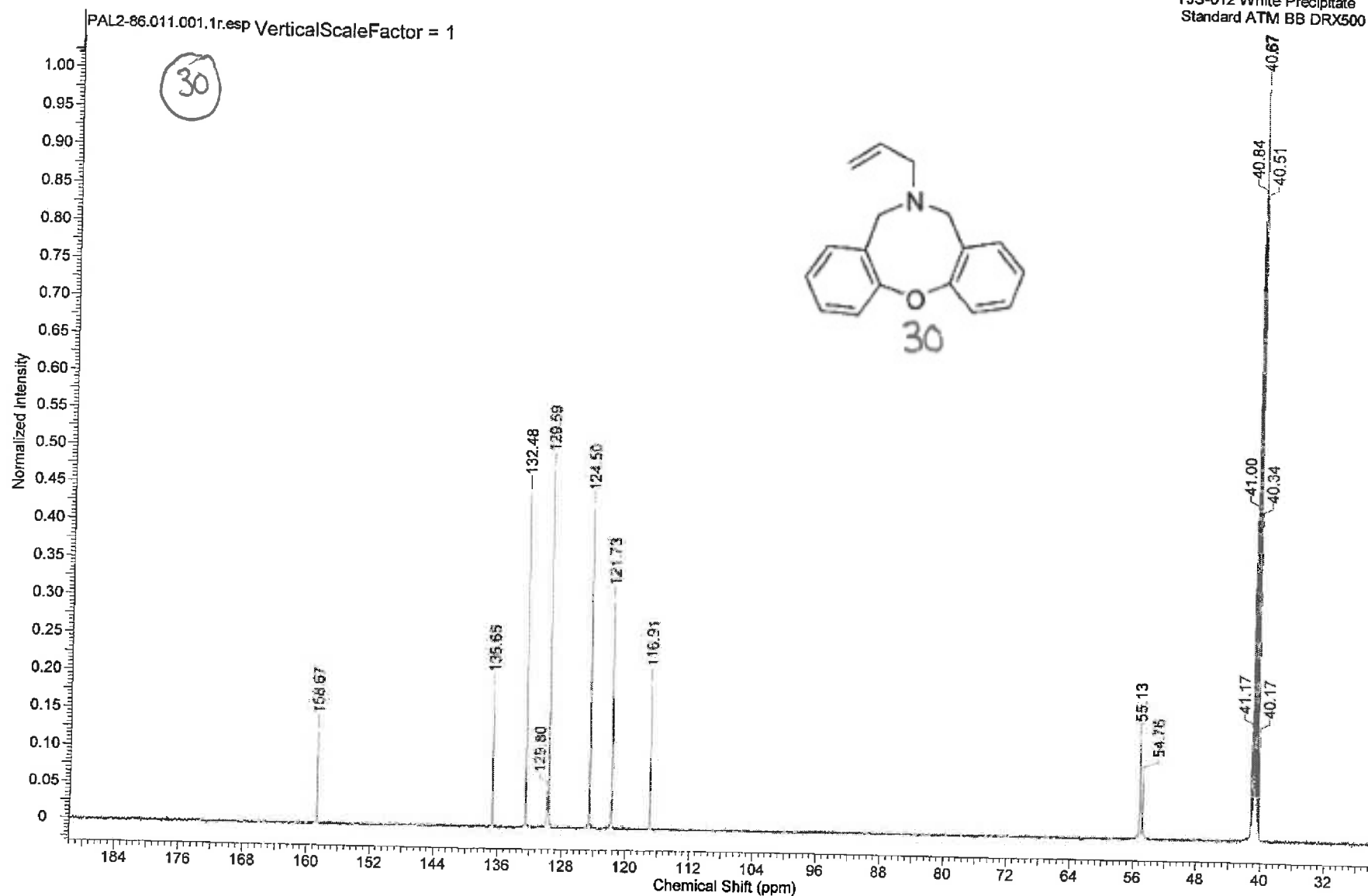
## TJS-012 White Precipitate

20/11/2012 09:25:43  
TJS-012 White Precipitate  
Standard Avance 500 MHz Proton



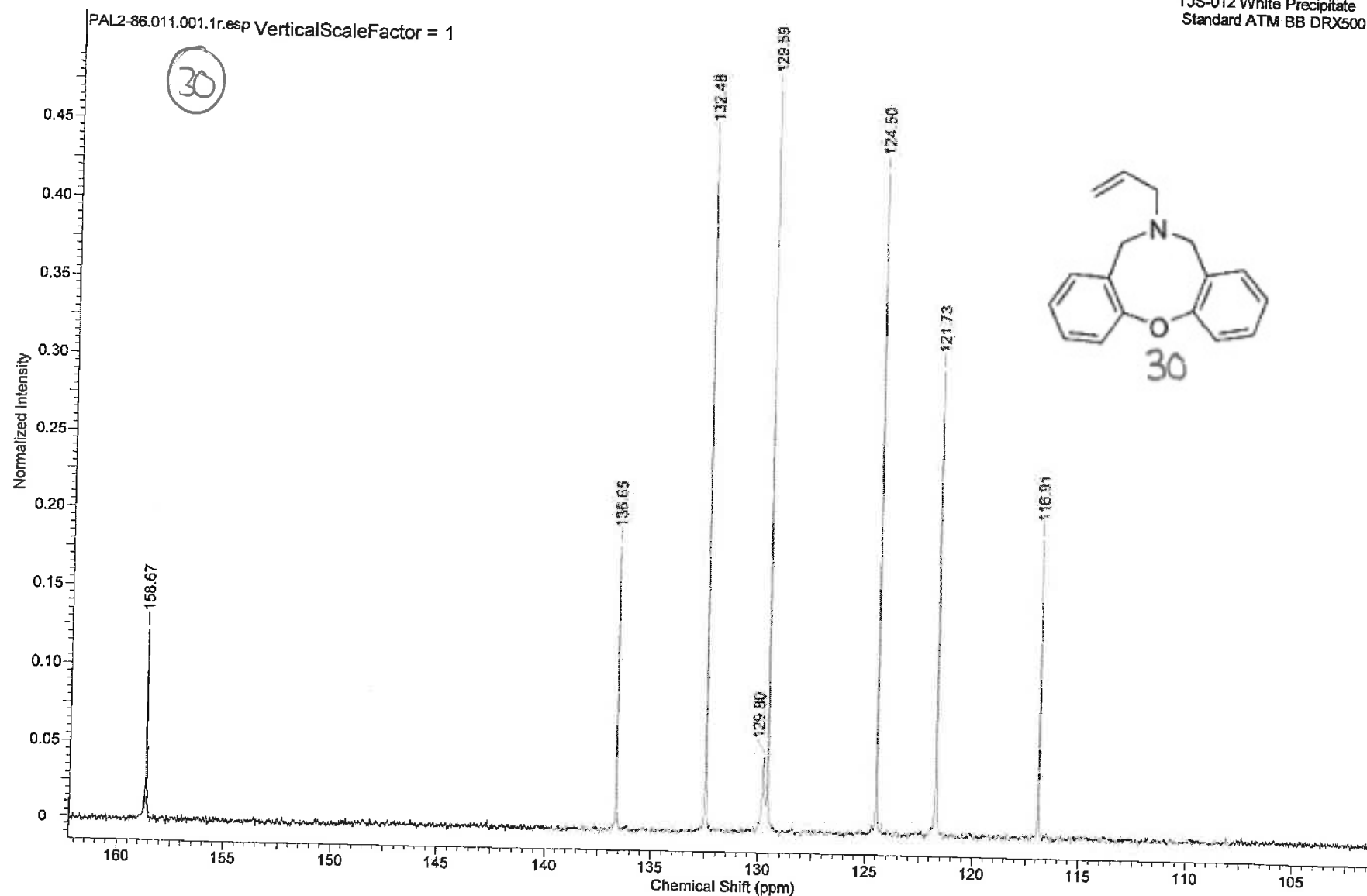
Y:\glengrant\ldrs\nmr\PAL2-86\PAL2-86.010.001.1r.esp

20/11/2012 17:20:26  
TJS-012 White Precipitate  
Standard ATM BB DRX500 13C



Y:\glengrant\drs\nmr\PAL2-86\PAL2-86.011.001.1r.esp

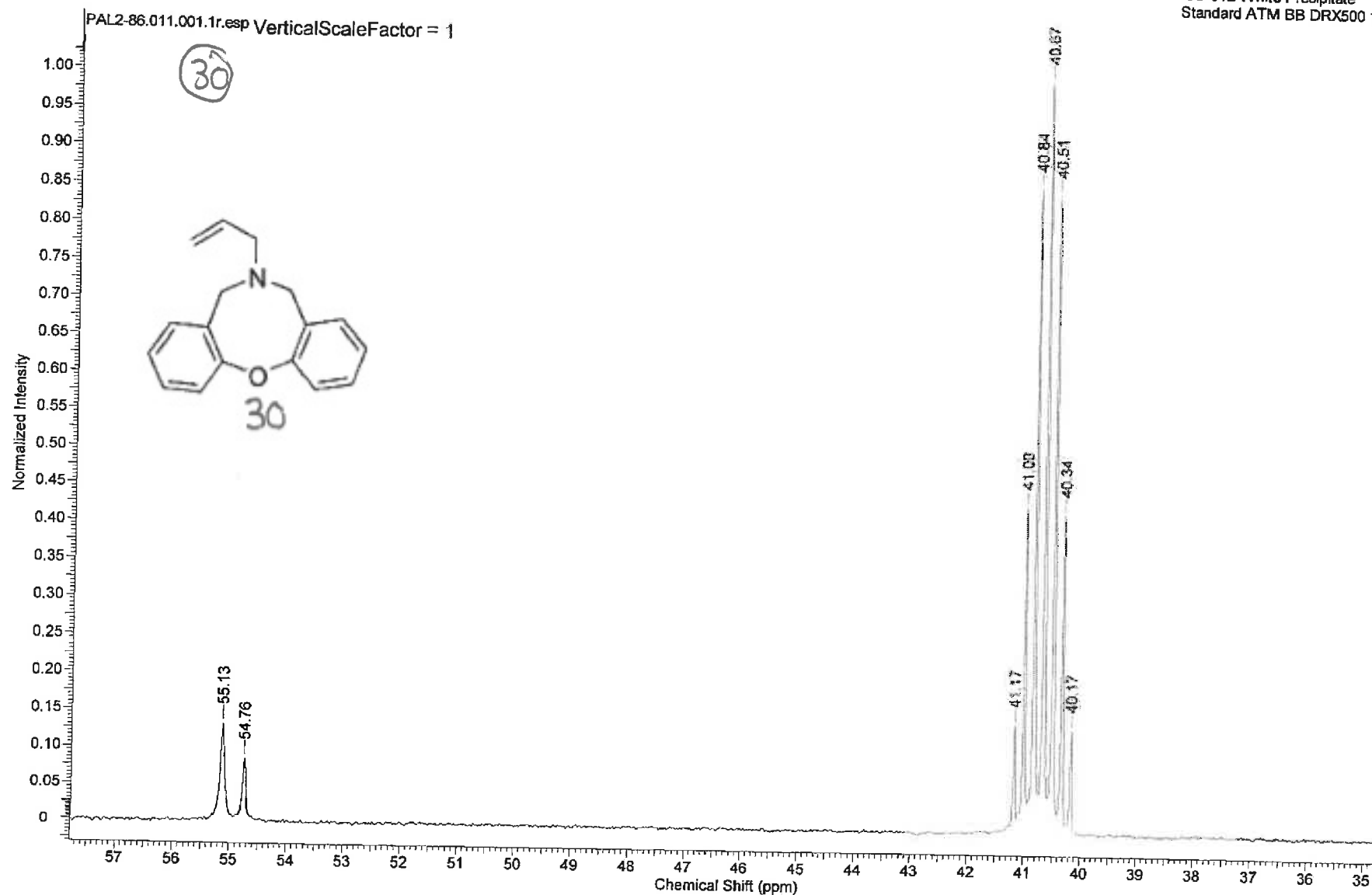
20/11/2012 17:17:59  
TJS-012 White Precipitate  
Standard ATM BB DRX500 13C



Y:\glengrant\drs\nmr\PAL2-86\PAL2-86.011.001.1r.esp

## TJS-012 White Precipitate

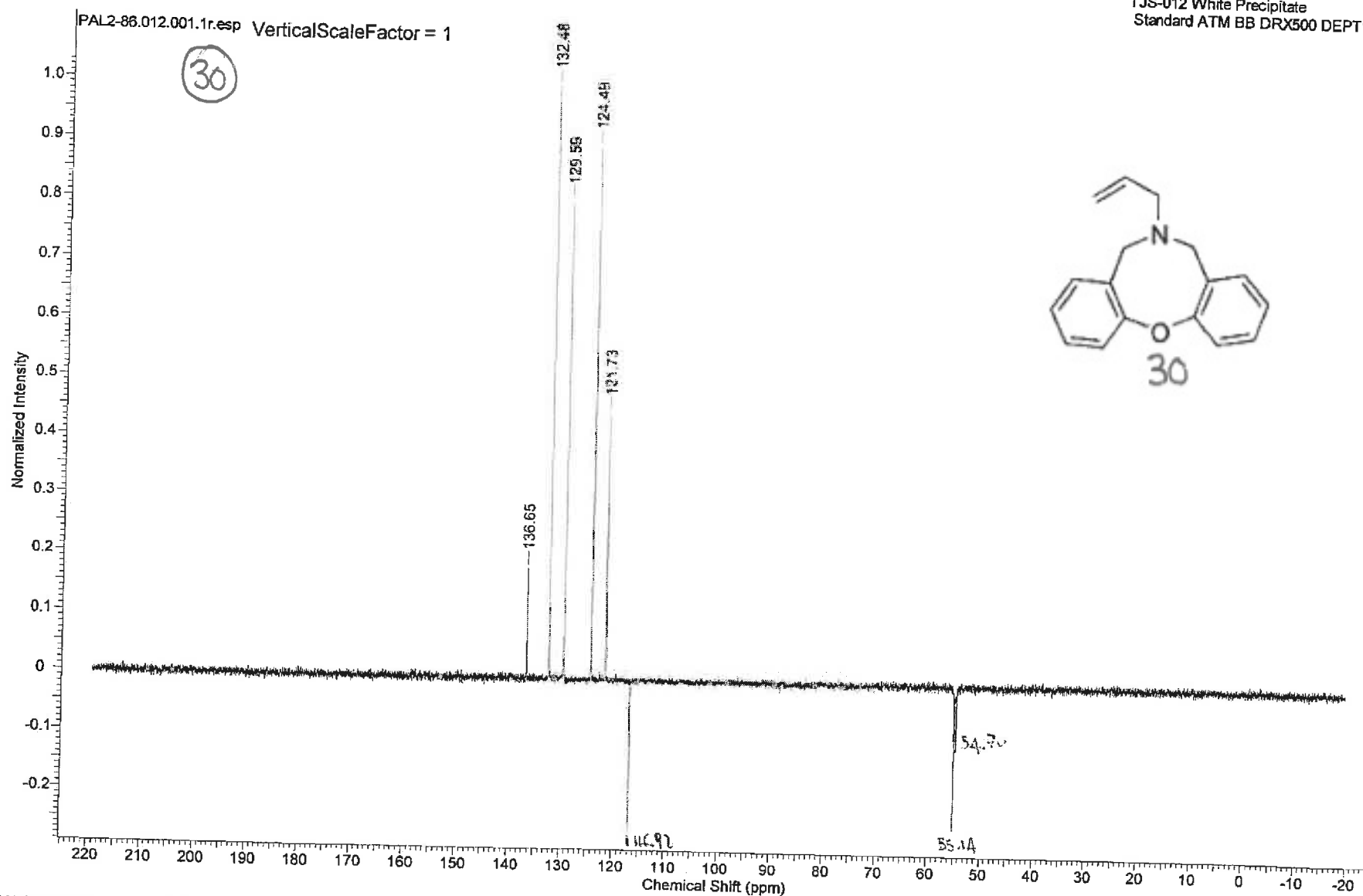
20/11/2012 17:18:21  
TJS-012 White Precipitate  
Standard ATM BB DRX500 13C



Y:\glengrant\cds\nmr\PAL2-86\PAL2-86.011.001.1r.esp

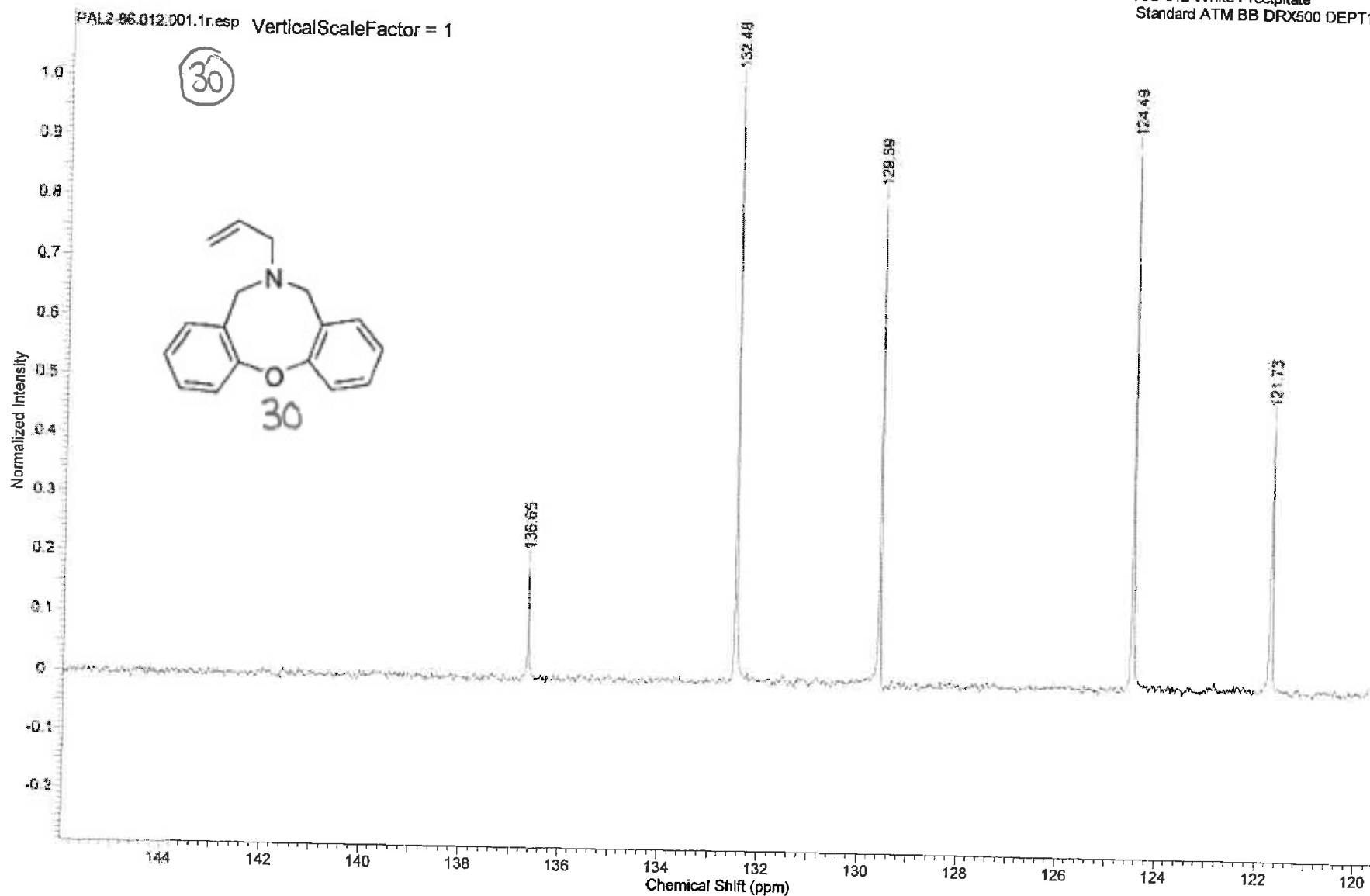
This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)  
**TJS-012 White Precipitate**

20/11/2012 17:21:37  
TJS-012 White Precipitate  
Standard ATM BB DRX500 DEPT135



Y:\glengrant\drs\vmr\PAL2-86\PAL2-86.012.001.1r.esp

20/11/2012 17:21:55  
TJS-012 White Precipitate  
Standard ATM BB DRX500 DEPT135

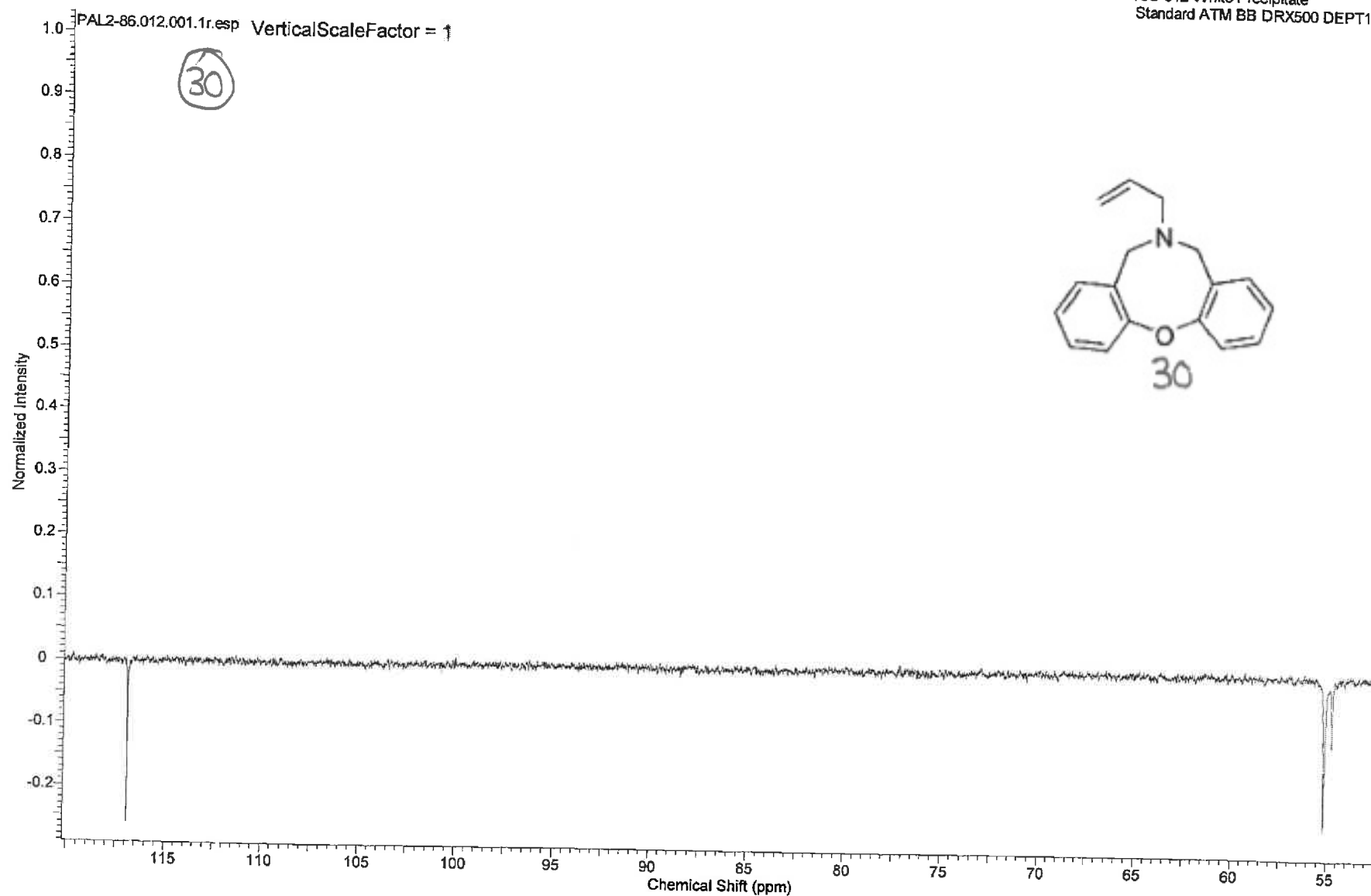


Y:\glengrant\drs\nmr\PAL2-86\PAL2-86.012.001.1r.esp



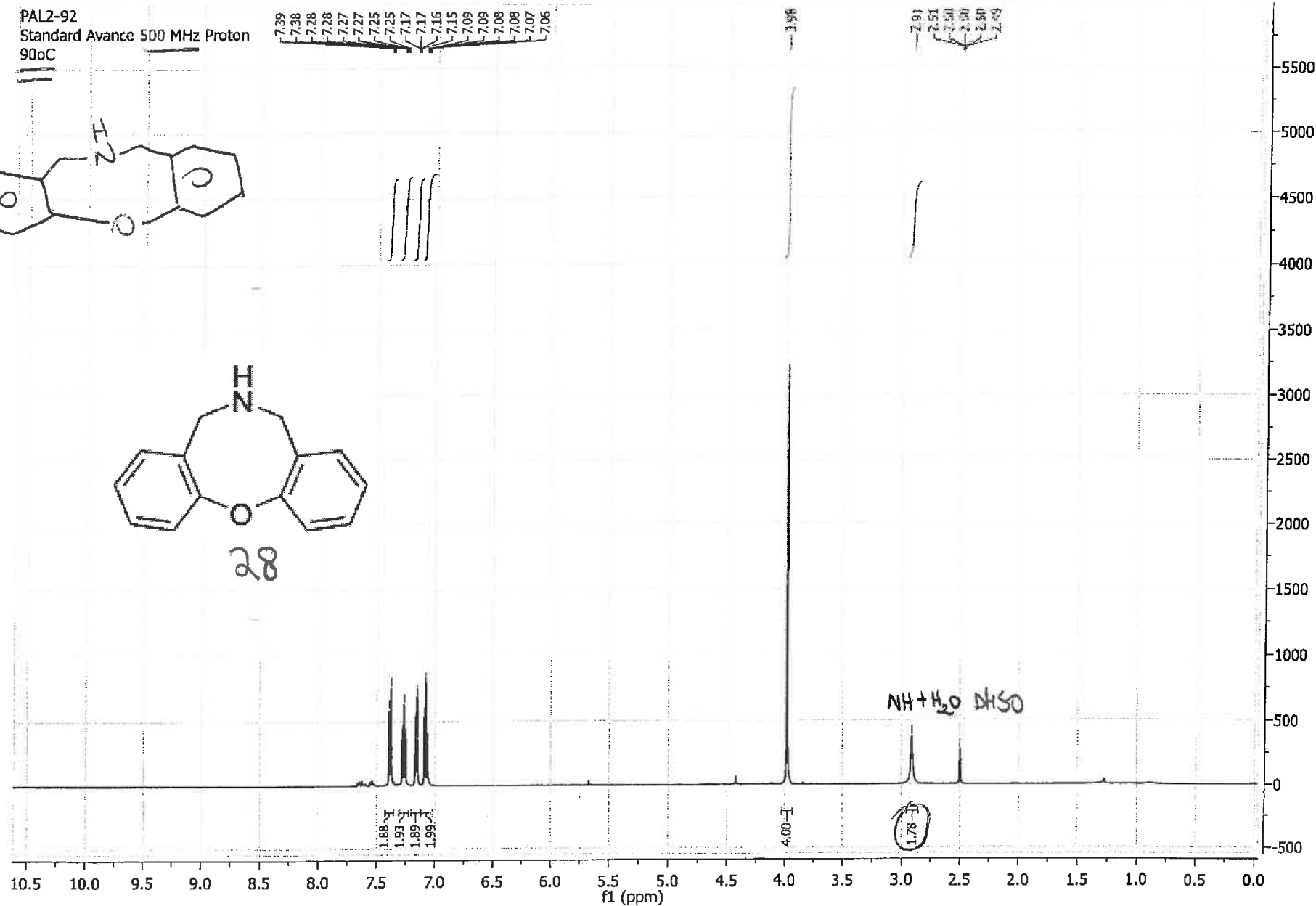
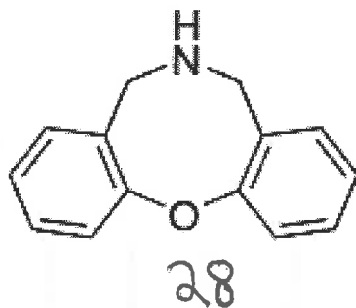
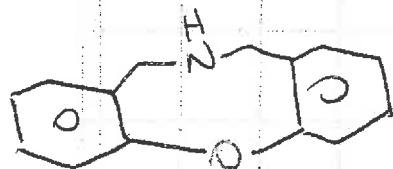
This report was created by ACD/NMR Processor Academic Edition. For more information go to [www.acdlabs.com/nmrproc/](http://www.acdlabs.com/nmrproc/)  
**TJS-012 White Precipitate**

20/11/2012 17:23:01  
TJS-012 White Precipitate  
Standard ATM BB DRX500 DEPT135



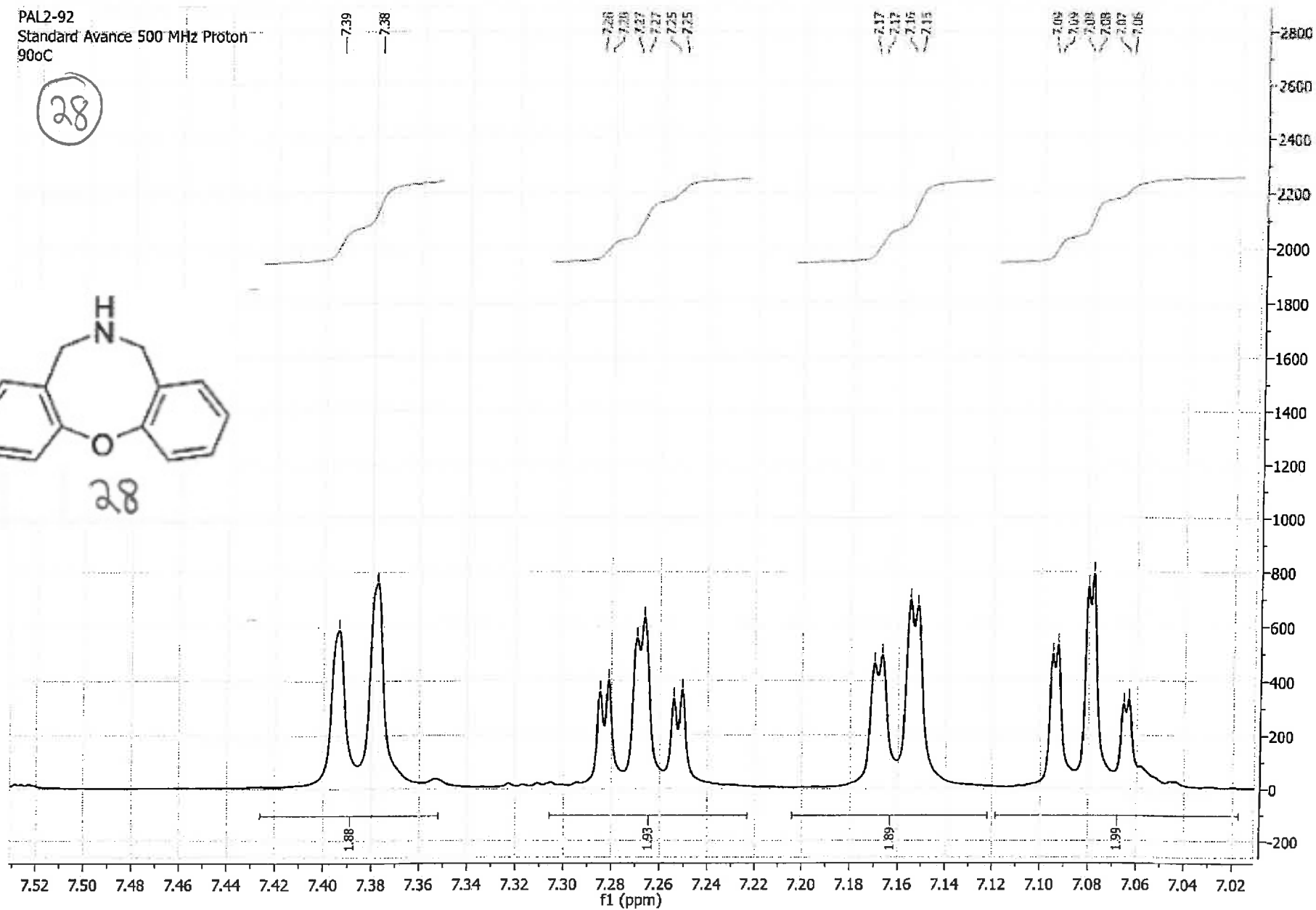
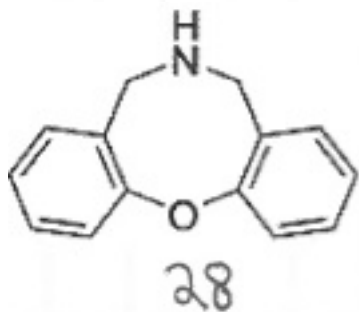
Y:\glengrant\drs\nmr\PAL2-86\PAL2-86.012.001.1r.esp

PALZ-92  
Standard Avance 500 MHz Proton  
90oC



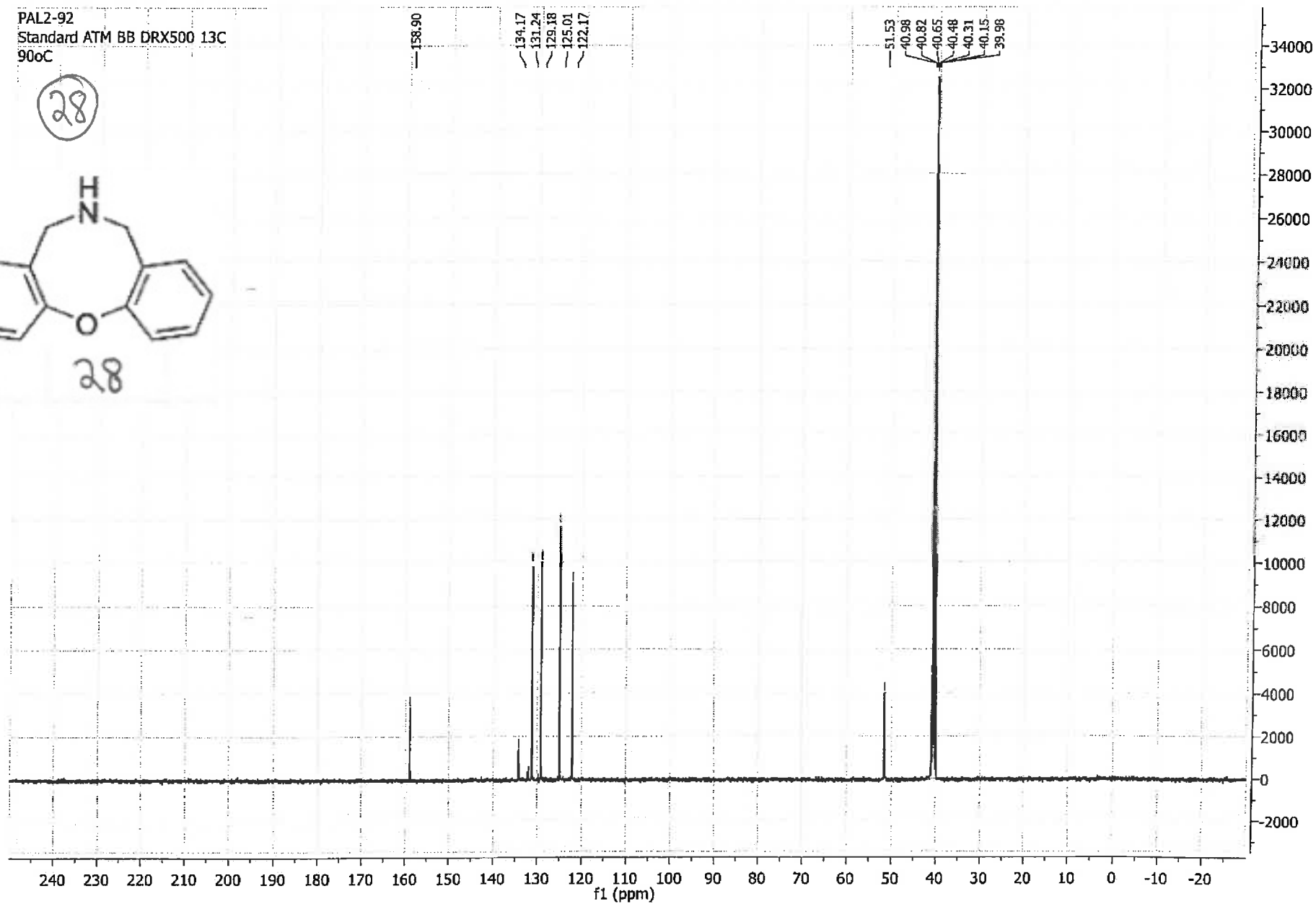
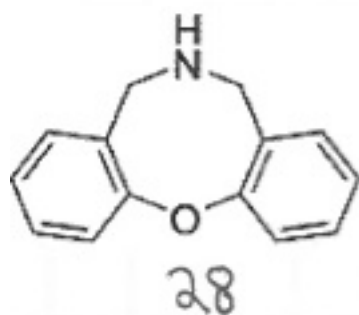
PAL2-92  
Standard Avance 500 MHz Proton  
90oC

28



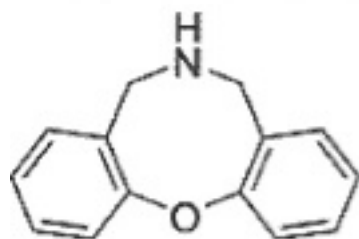
PAL2-92  
Standard ATM BB DRX500 13C  
90oC

28

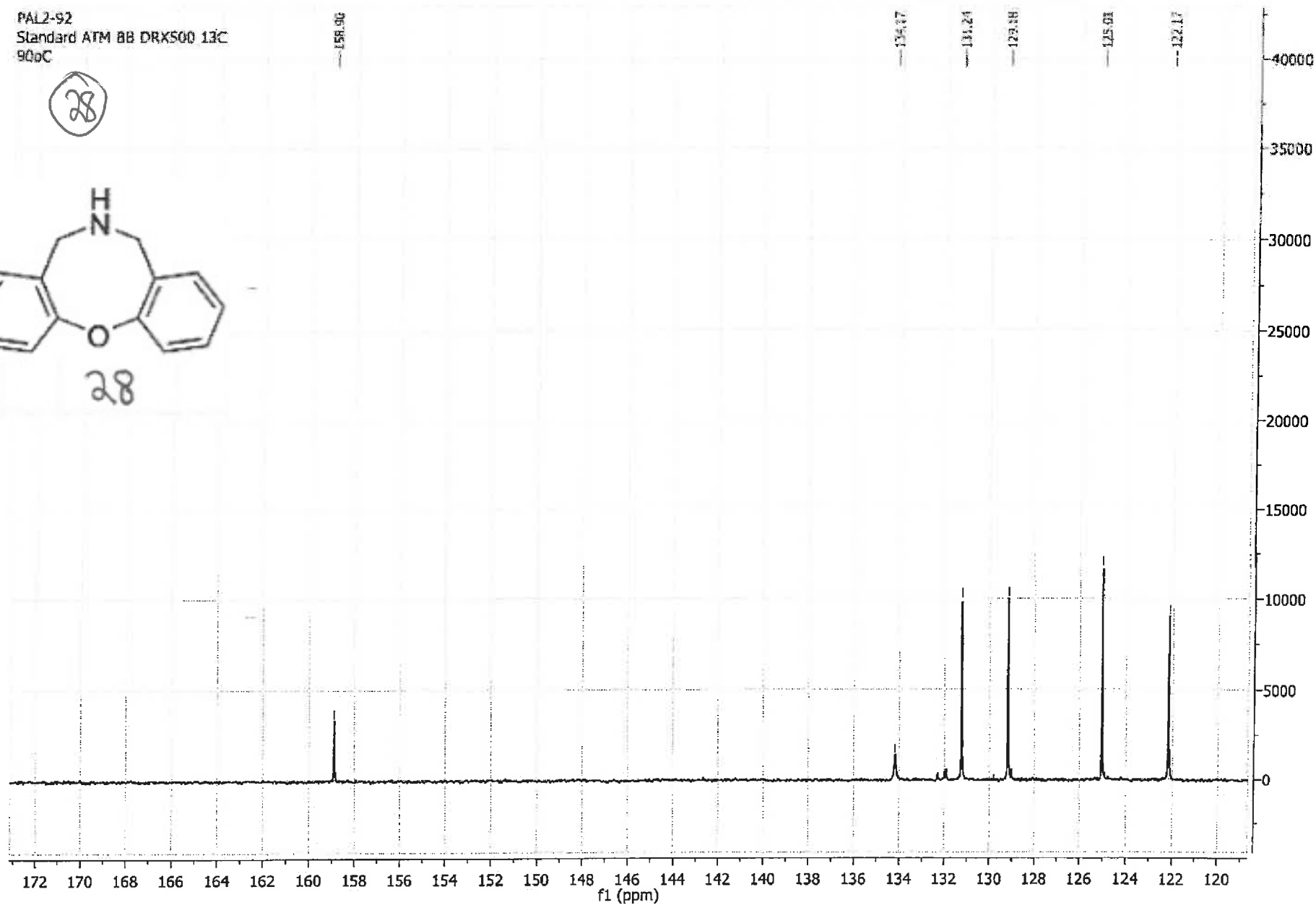


PAL2-92  
Standard ATM BB DRX500 13C  
90oC

28

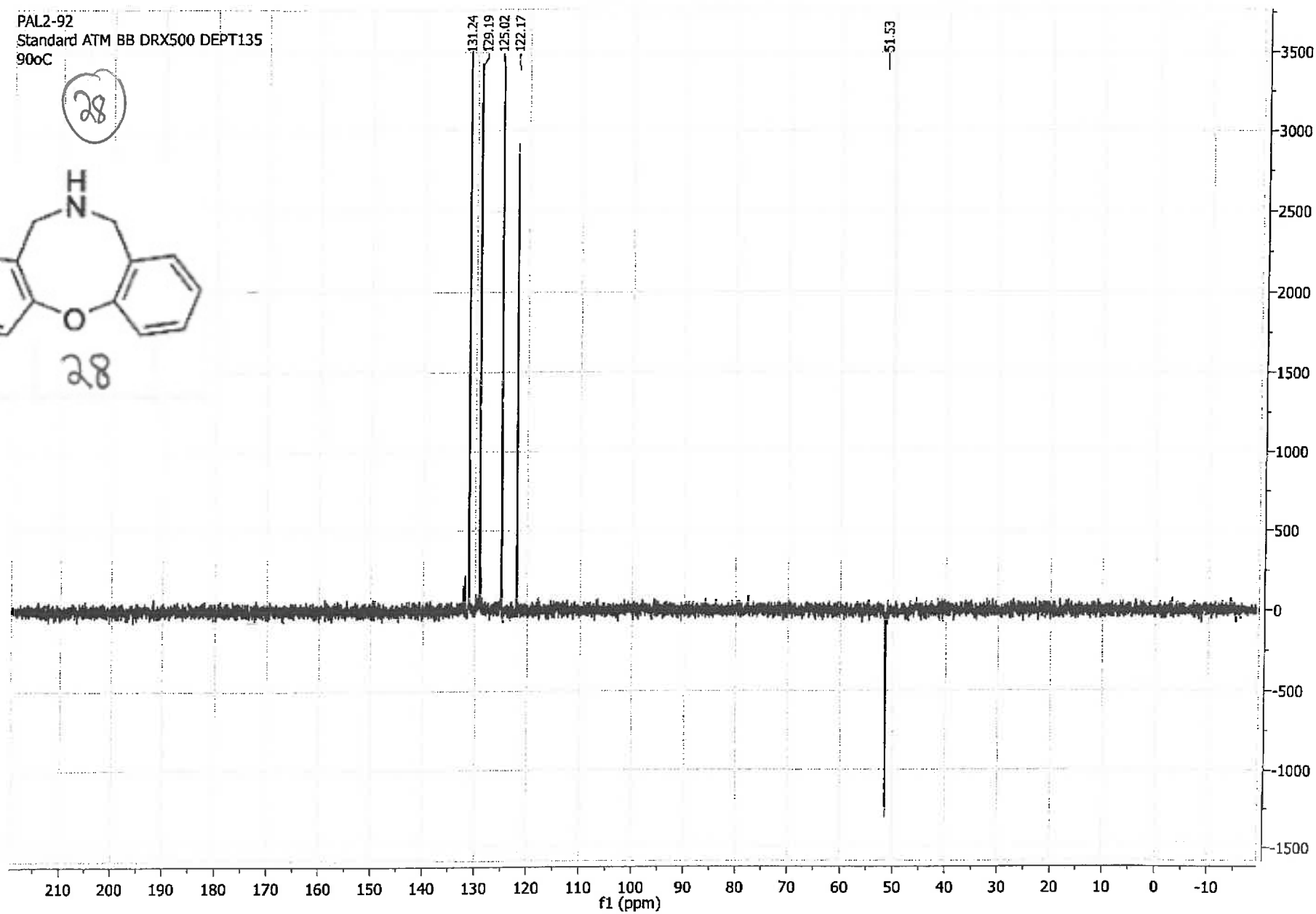
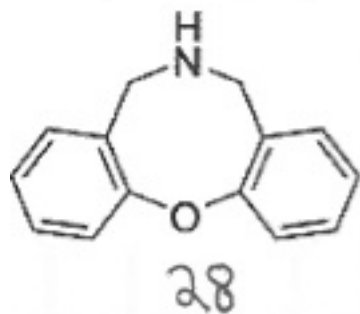


28



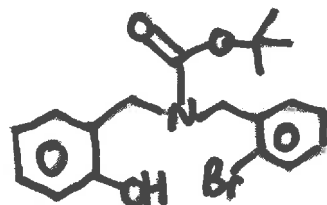
PAL2-92  
Standard ATM BB DRX500 DEPT135  
90oC

28

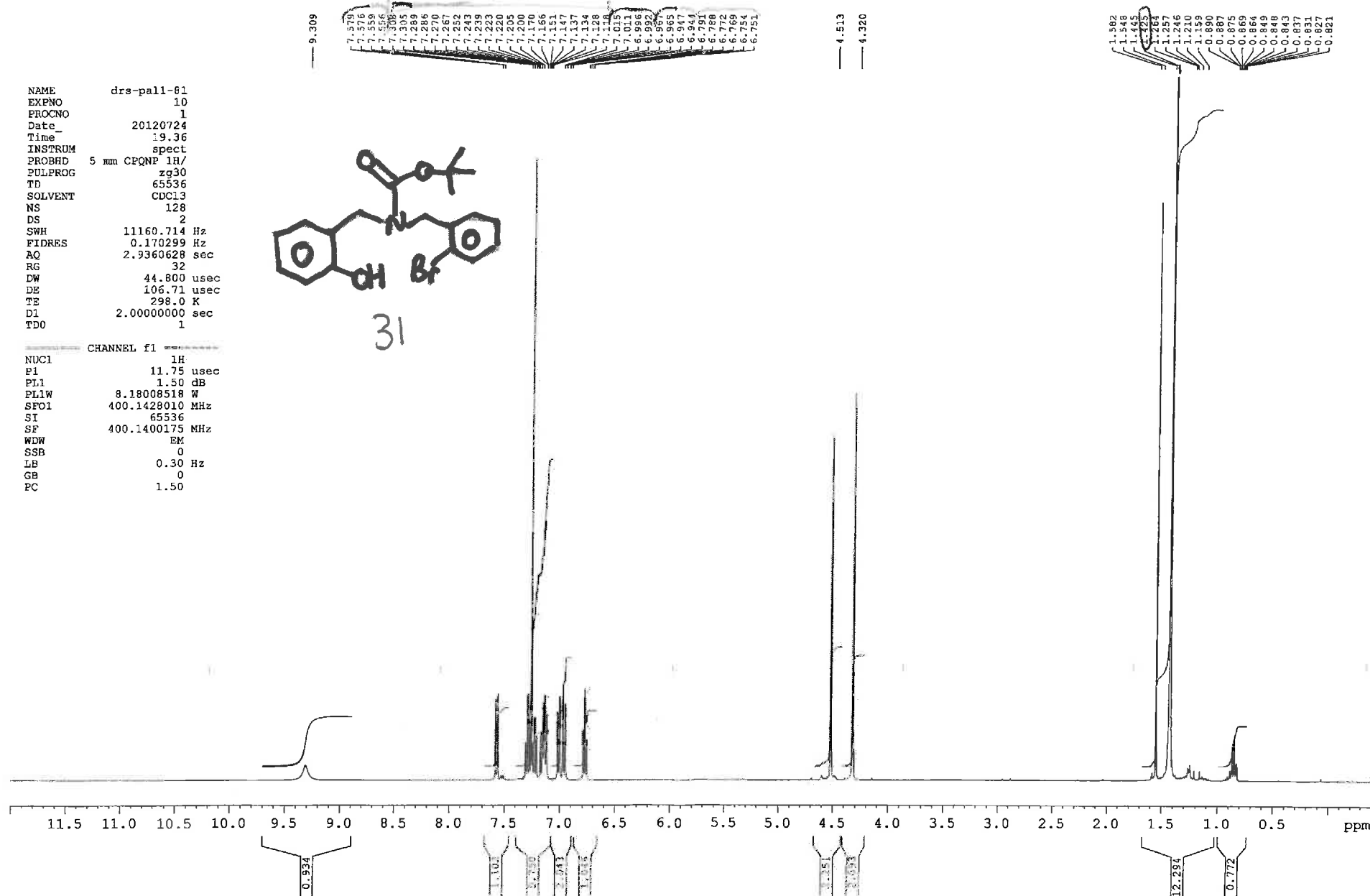


NAME drs-pal1-81  
EXPNO 10  
PROCNO 1  
Date\_ 20120724  
Time 19.36  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zg30  
TD 65536  
SOLVENT CDC13  
NS 128  
DS 2  
SWH 11160.714 Hz  
FIDRES 0.170299 Hz  
AQ 2.9360628 sec  
RG 32  
DW 44.800 usec  
DE 106.71 usec  
TE 298.0 K  
D1 2.00000000 sec  
TD0 1

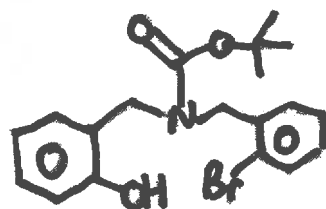
CHANNEL f1 ==  
NUC1 1H  
P1 11.75 usec  
PL1 1.50 dB  
PL1W 8.18008518 W  
SFO1 400.1428010 MHz  
SI 65536  
SF 400.1400175 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50



31

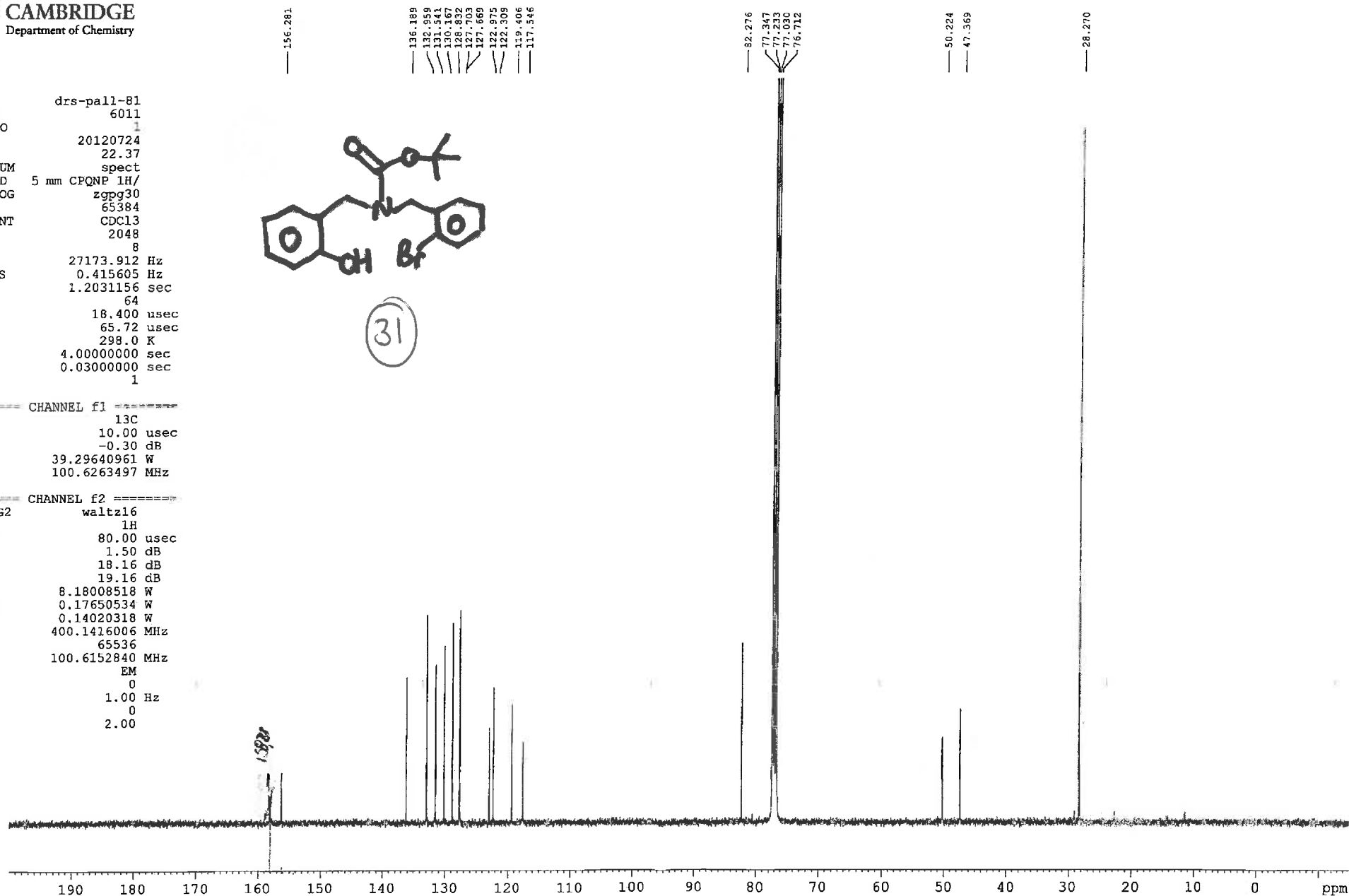


NAME drs-pall-81  
EXPNO 6011  
PROCNO 1  
Date\_ 20120724  
Time\_ 22.37  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 2048  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TDO 1

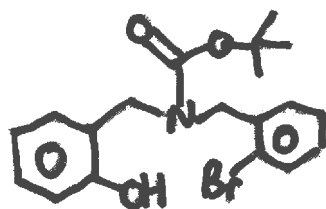


===== CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6152840 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00







31

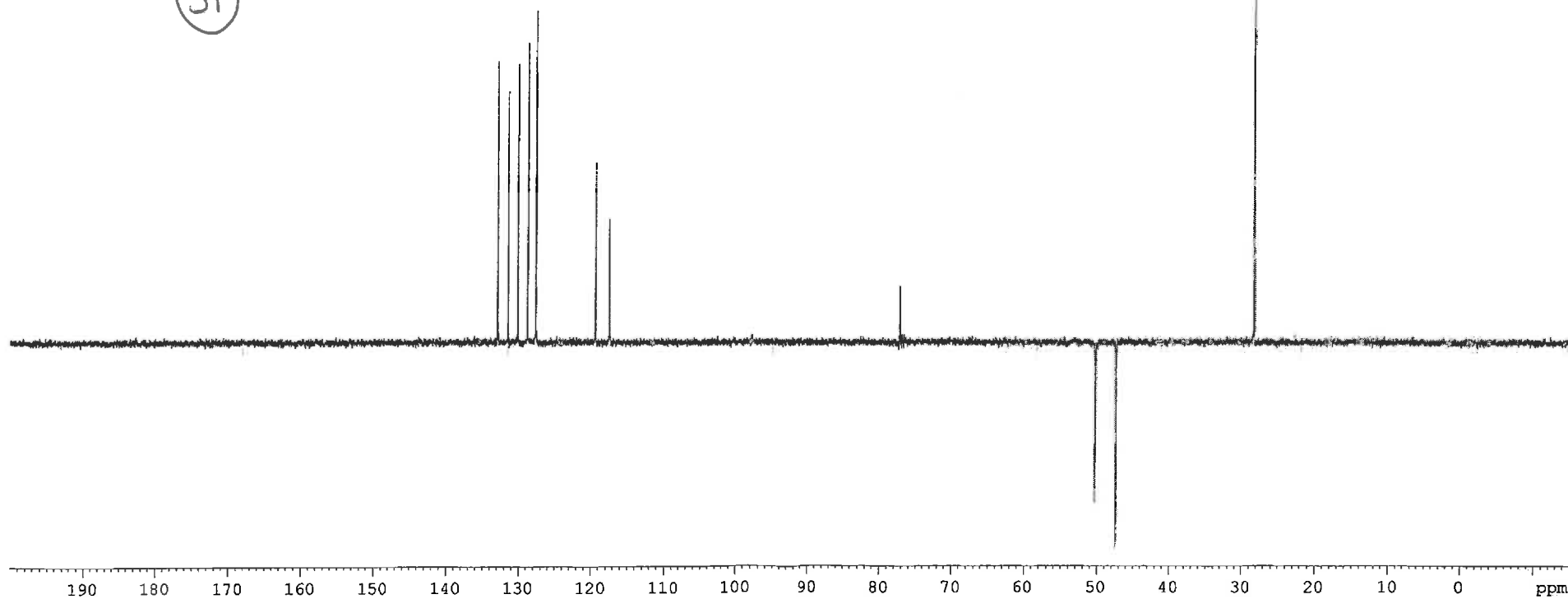
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131.241  
130.347  
128.812  
127.683  
127.646

119.385  
117.525

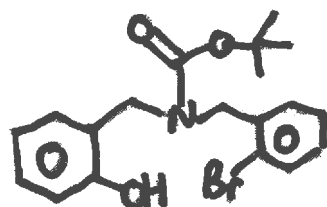
77.212

50.204  
47.348

28.248

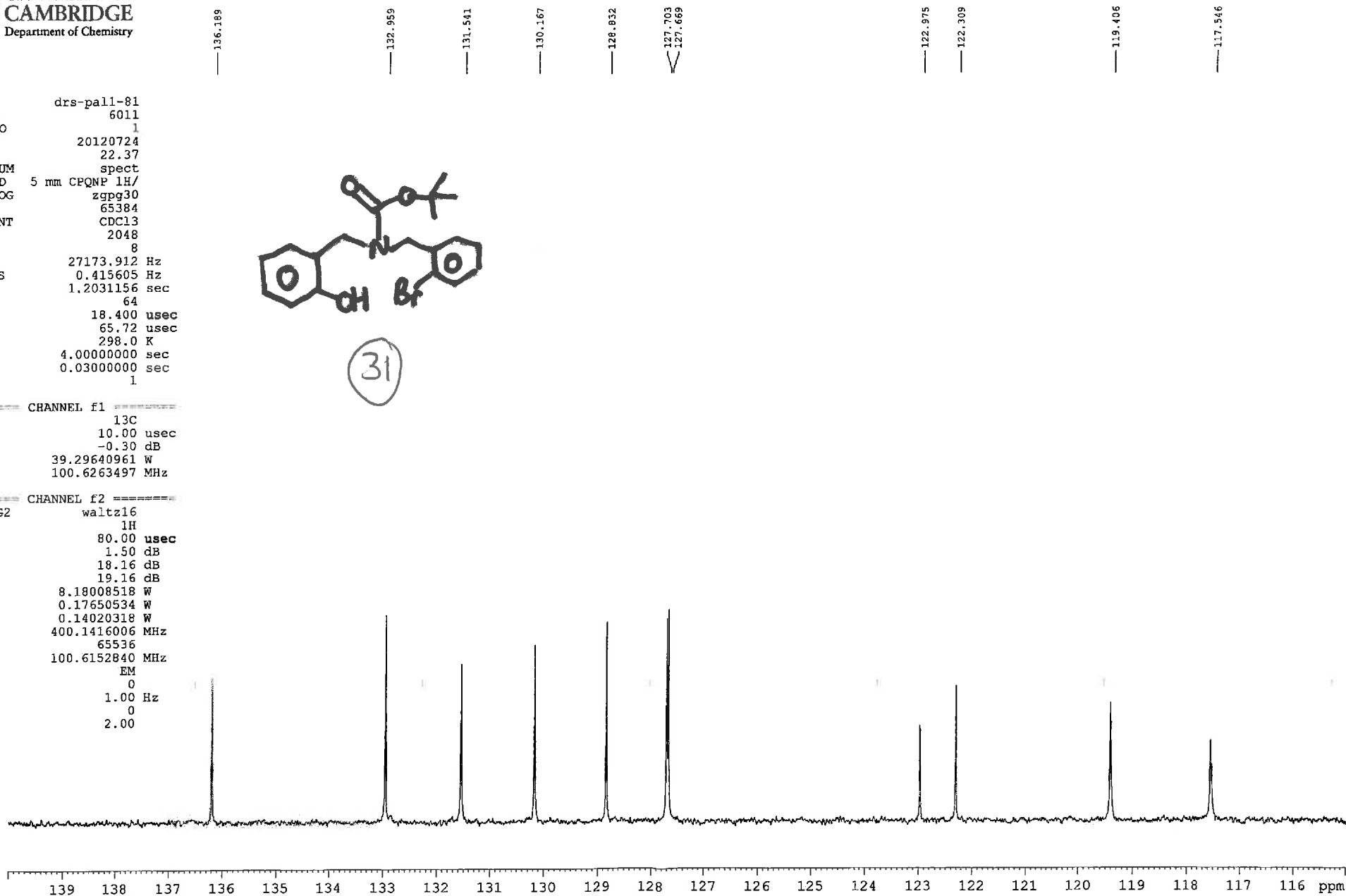


NAME drs-pal1-81  
EXPNO 6011  
PROCNO 1  
Date\_ 20120724  
Time\_ 22.37  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 2048  
DS 8  
SWH 27173.912 Hz  
FIDRES 0.415605 Hz  
AQ 1.2031156 sec  
RG 64  
DW 18.400 usec  
DE 65.72 usec  
TE 298.0 K  
D1 4.00000000 sec  
D11 0.03000000 sec  
TD0 1



===== CHANNEL f1 =====  
NUC1 13C  
P1 10.00 usec  
PL1 -0.30 dB  
PL1W 39.29640961 W  
SFO1 100.6263497 MHz

===== CHANNEL f2 =====  
CPDPRG2 waltz16  
NUC2 1H  
PCPD2 80.00 usec  
PL2 1.50 dB  
PL12 18.16 dB  
PL13 19.16 dB  
PL2W 8.18008518 W  
PL12W 0.17650534 W  
PL13W 0.14020318 W  
SFO2 400.1416006 MHz  
SI 65536  
SF 100.6152840 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00





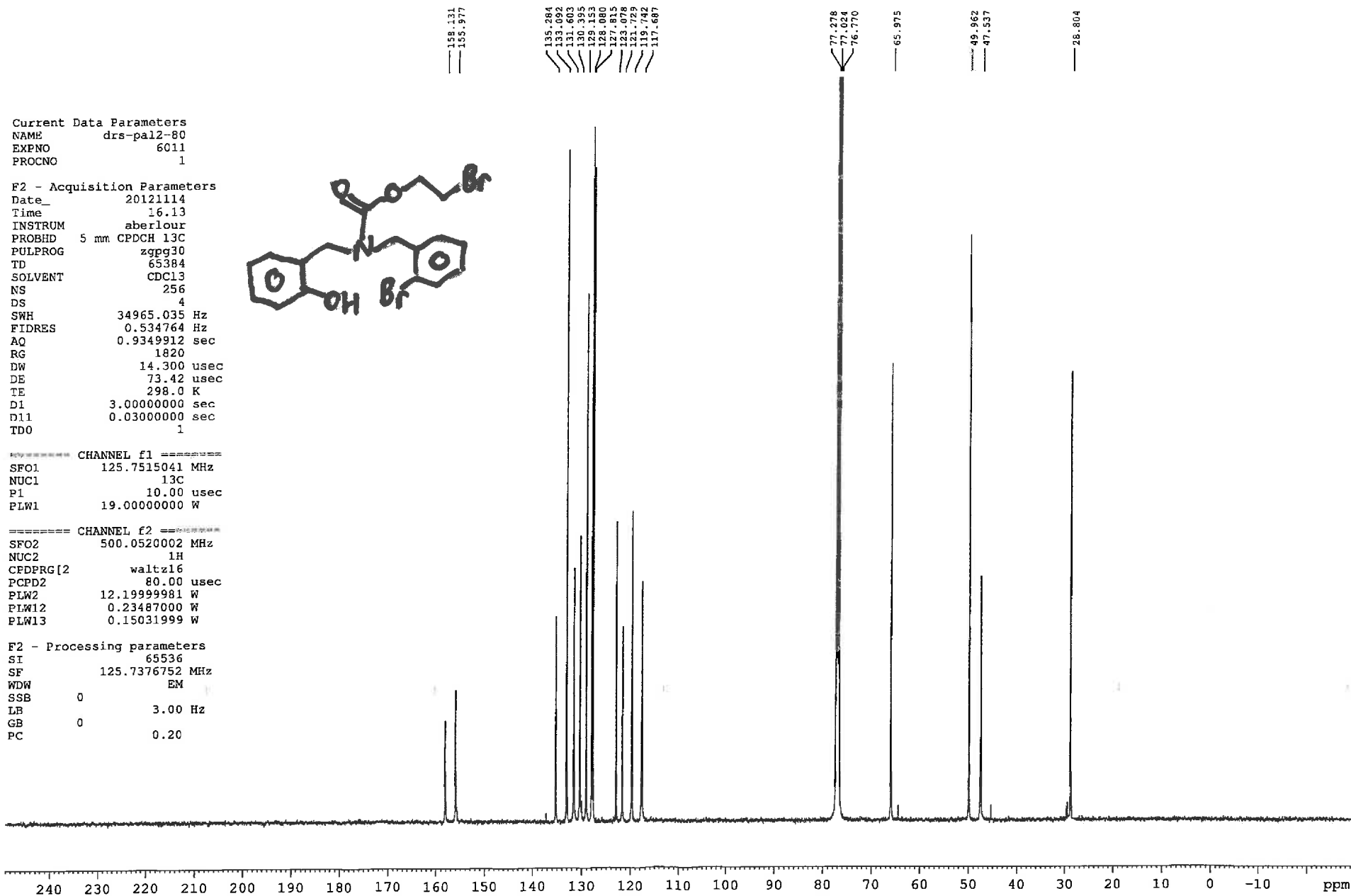
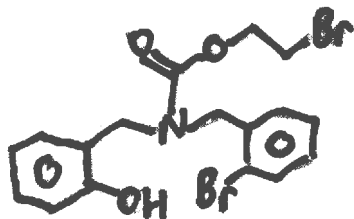
Current Data Parameters  
NAME drs-pal2-80  
EXPNO 6011  
PROCNO 1

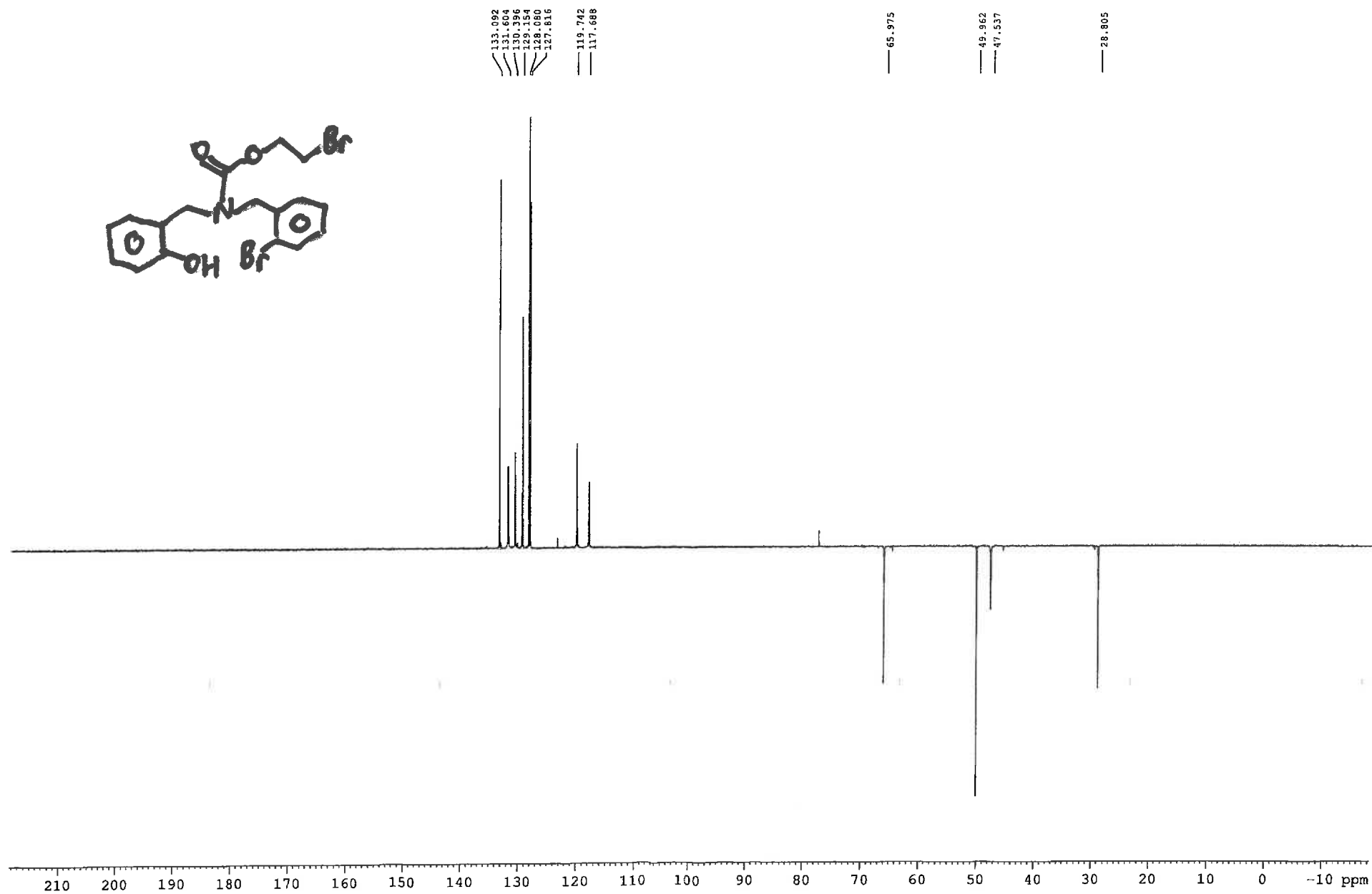
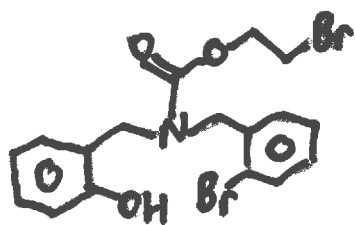
F2 - Acquisition Parameters  
Date\_ 20121114  
Time 16.13  
INSTRUM aberlour  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65384  
SOLVENT CDCl3  
NS 256  
DS 4  
SWH 34965.035 Hz  
FIDRES 0.534764 Hz  
AQ 0.9349912 sec  
RG 1820  
DW 14.300 usec  
DE 73.42 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 125.7515041 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SFO2 500.0520002 MHz  
NUC2 1H  
CPDPRG[2] waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 65536  
SF 125.7376752 MHz  
WDW EM  
SSB 0  
LB 3.00 Hz  
GB 0  
PC 0.20



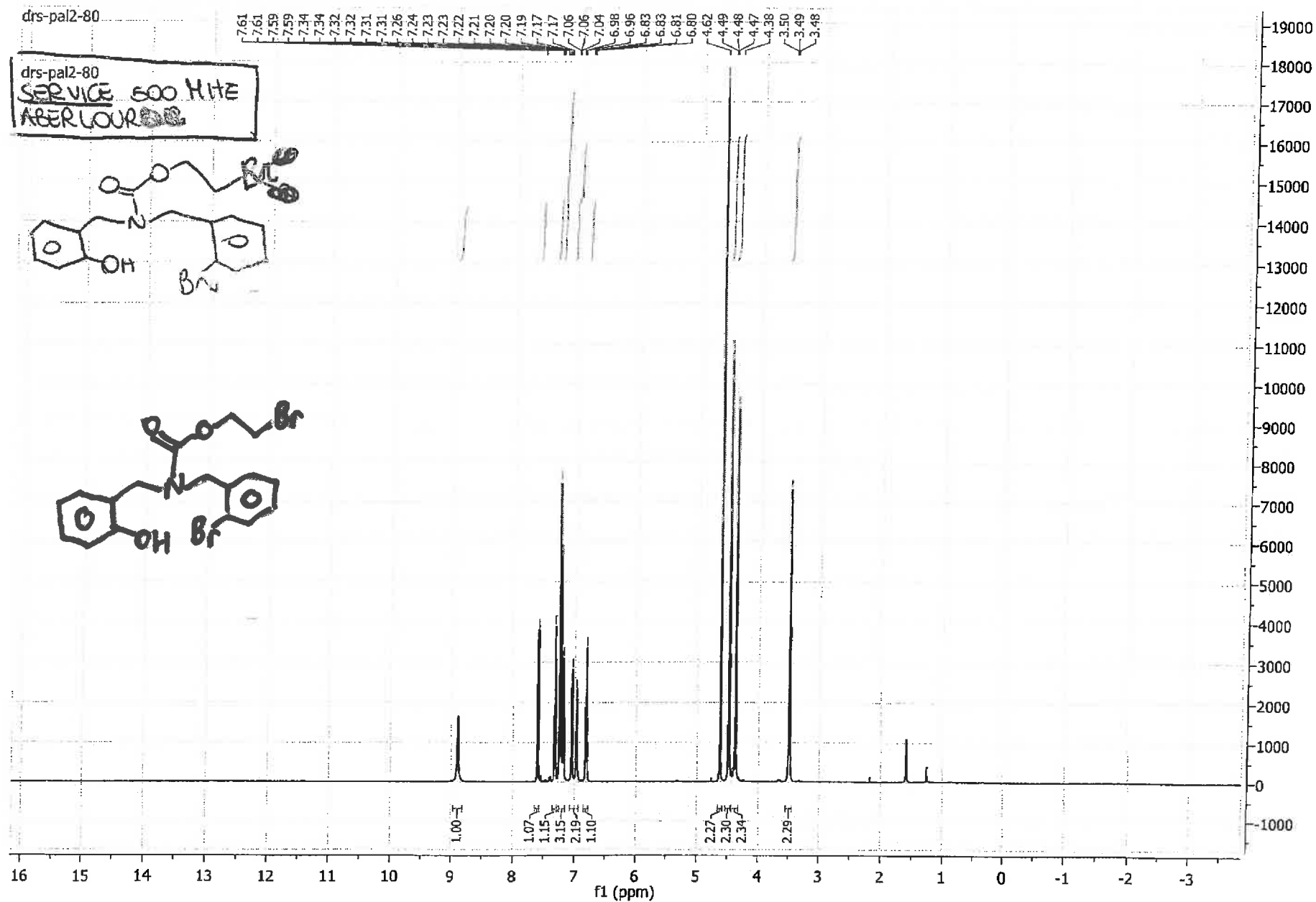
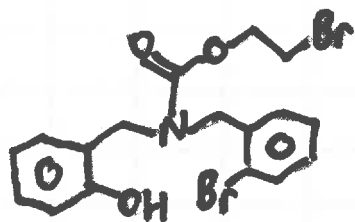
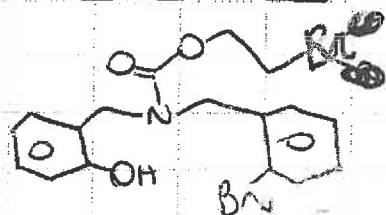


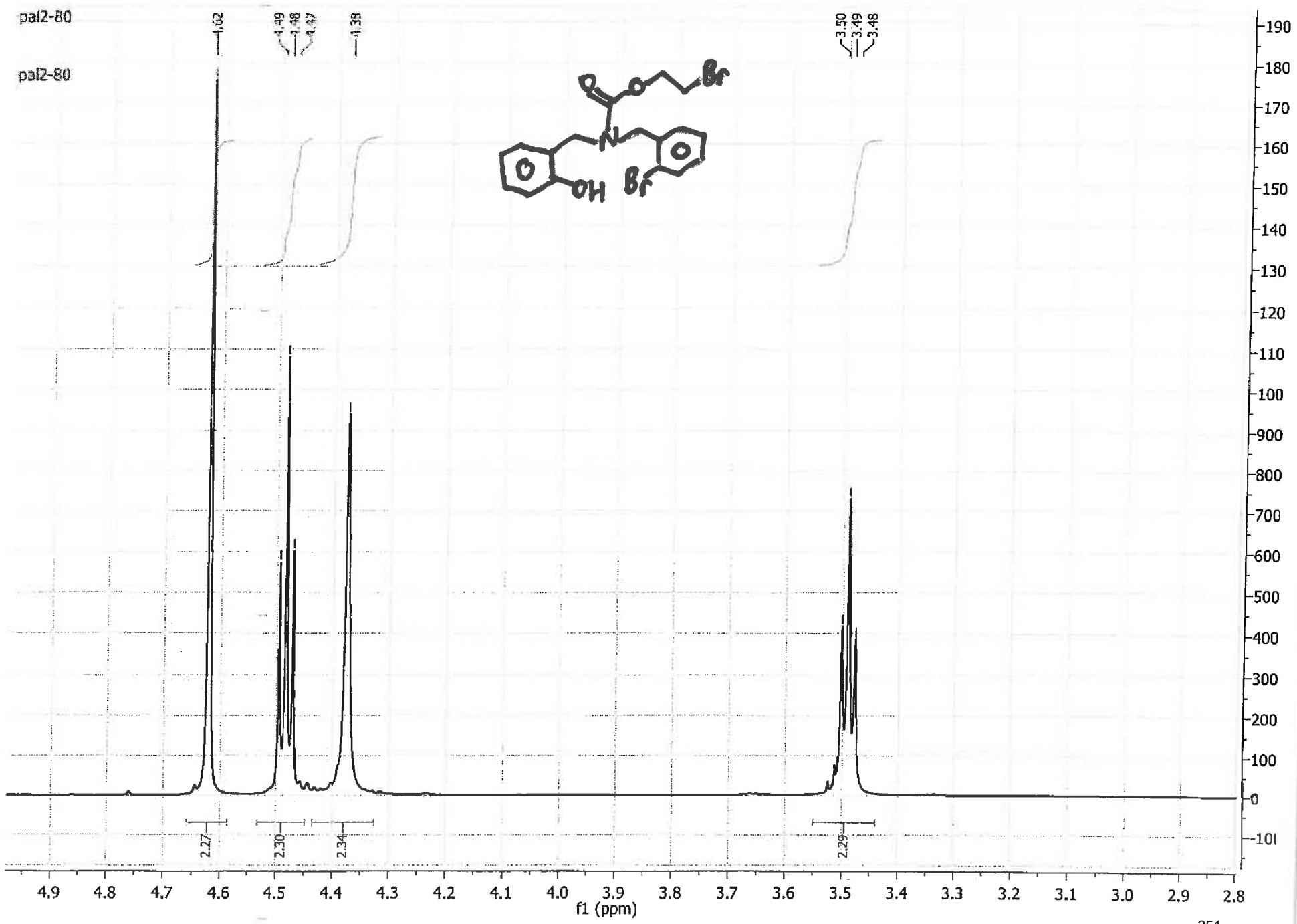
drs-pal2-80

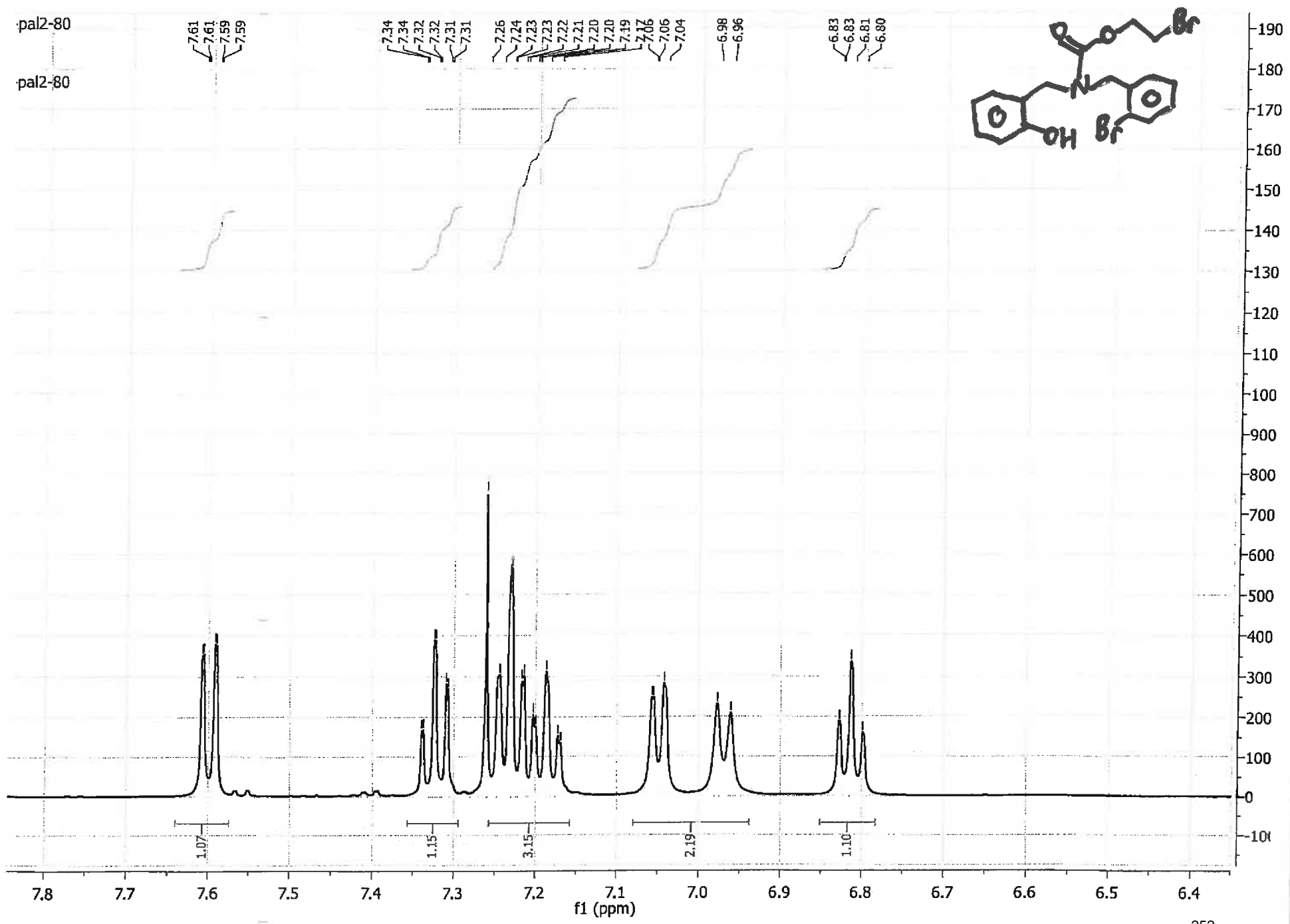
drs-pal2-80

SERVICE 600 MHz

ABERLOUR

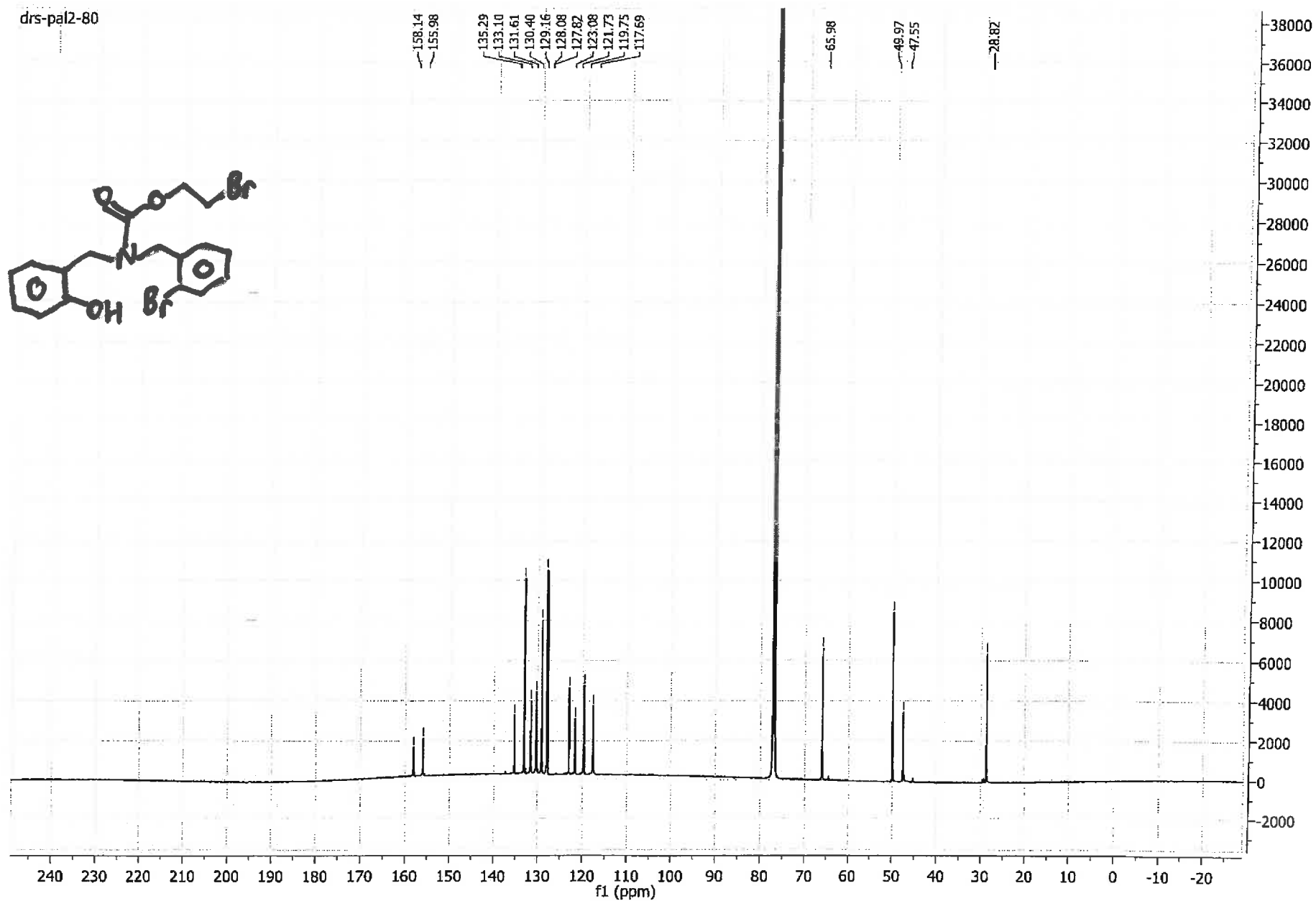




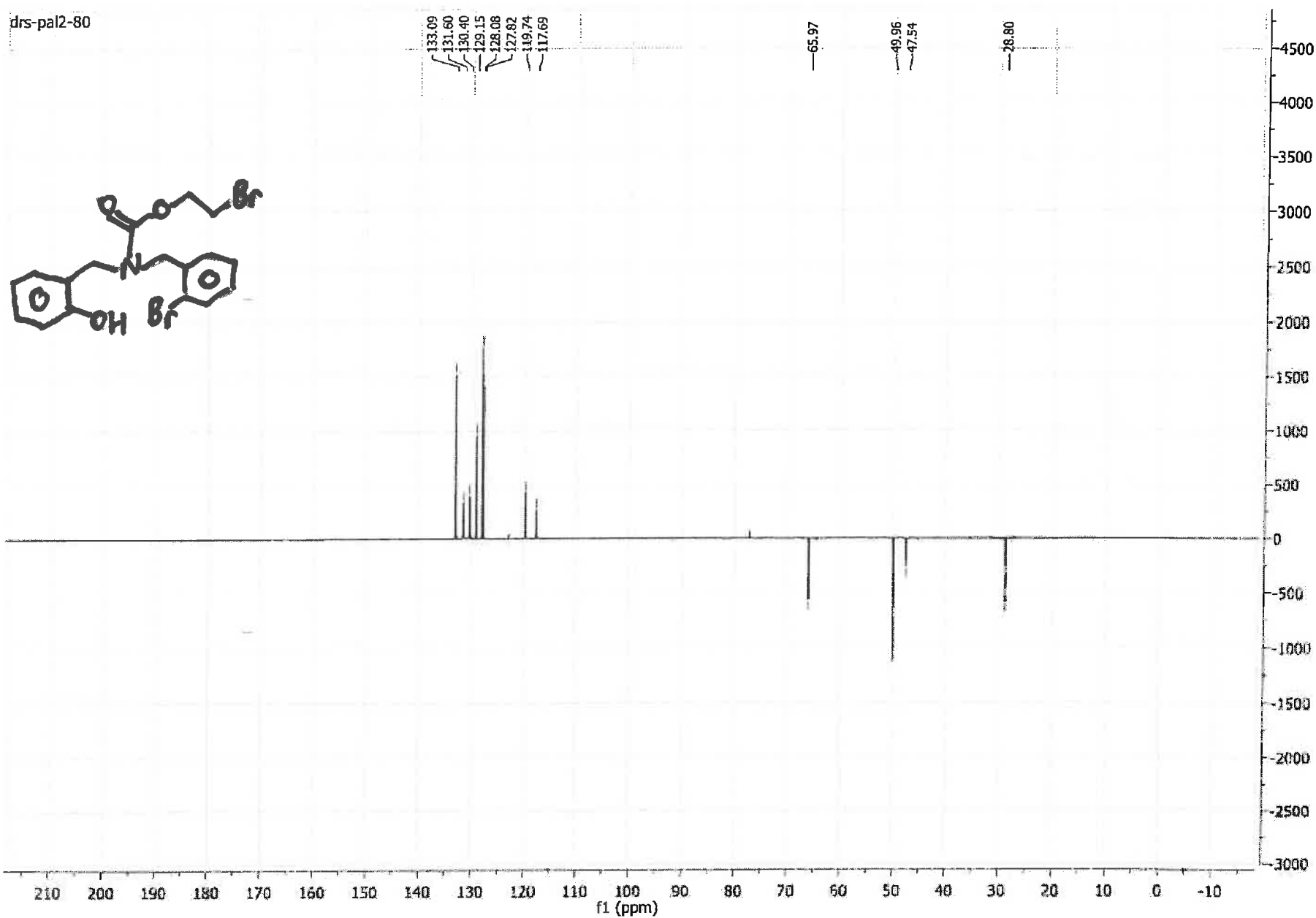




drs-pa12-80

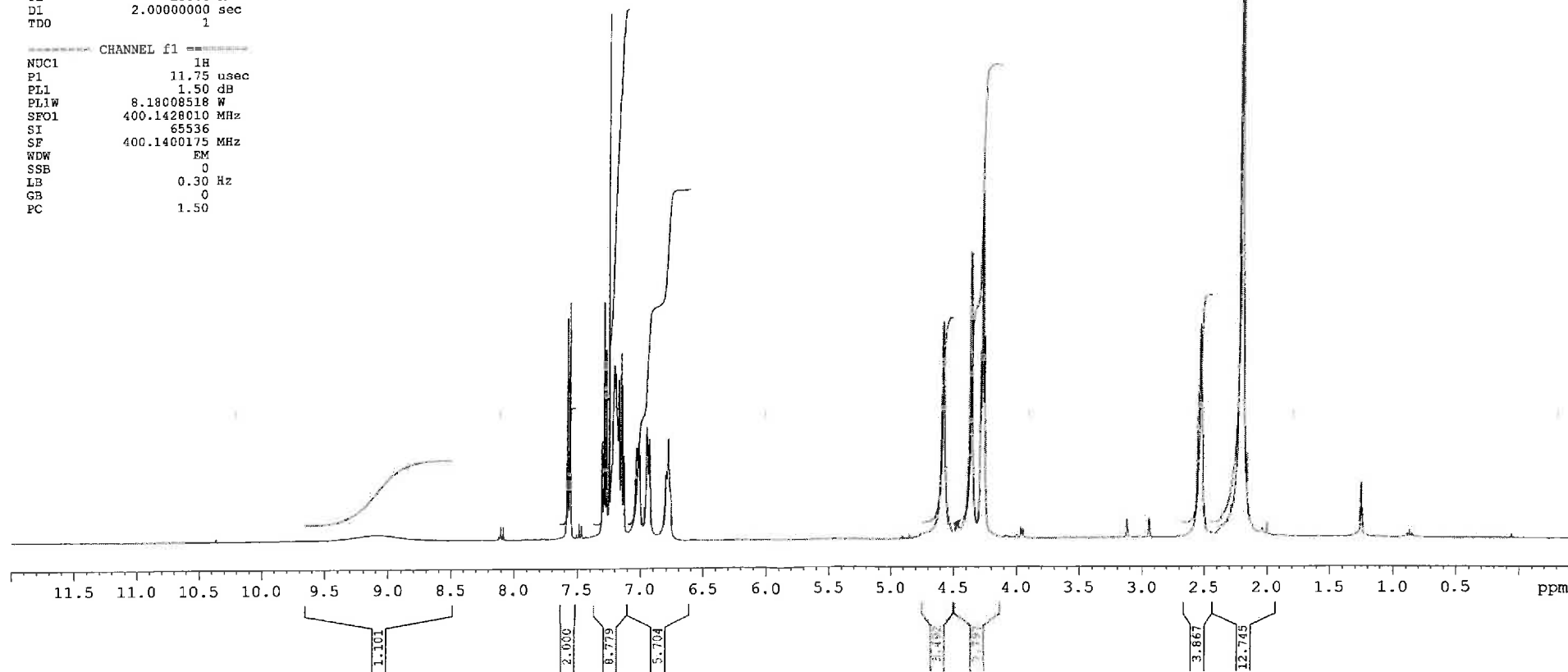
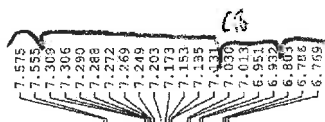
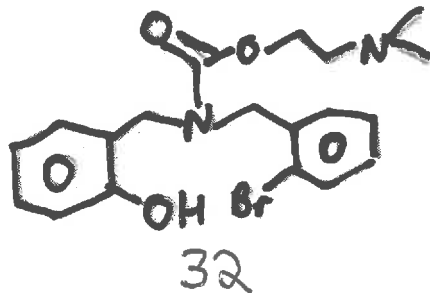


drs-pal2-80



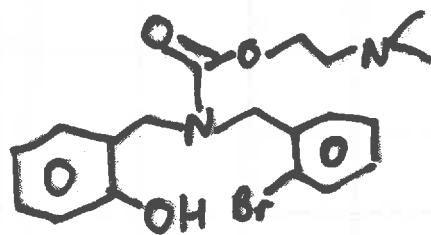
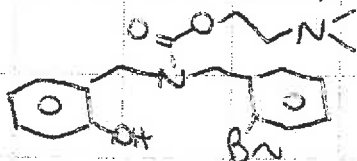
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EXPNO 10  
PROCNO 1  
Date\_ 20121119  
Time 15.10  
INSTRUM spect  
PROBHD 5 mm CPQNP 1H/  
PULPROG zg30  
TD 65536  
SOLVENT CDC13  
NS 32  
DS 2  
SWH 11160.714 Hz  
FIDRES 0.170299 Hz  
AQ 2.9360628 sec  
RG 32  
DW 44.800 usec  
DE 106.71 usec  
TE 298.0 K  
D1 2.00000000 sec  
TDO 1

CHANNEL f1  
NUC1 1H  
P1 11.75 usec  
PL1 1.50 dB  
PL1W 8.18008518 W  
SFO1 400.1428010 MHz  
SI 65536  
SF 400.1400175 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.50

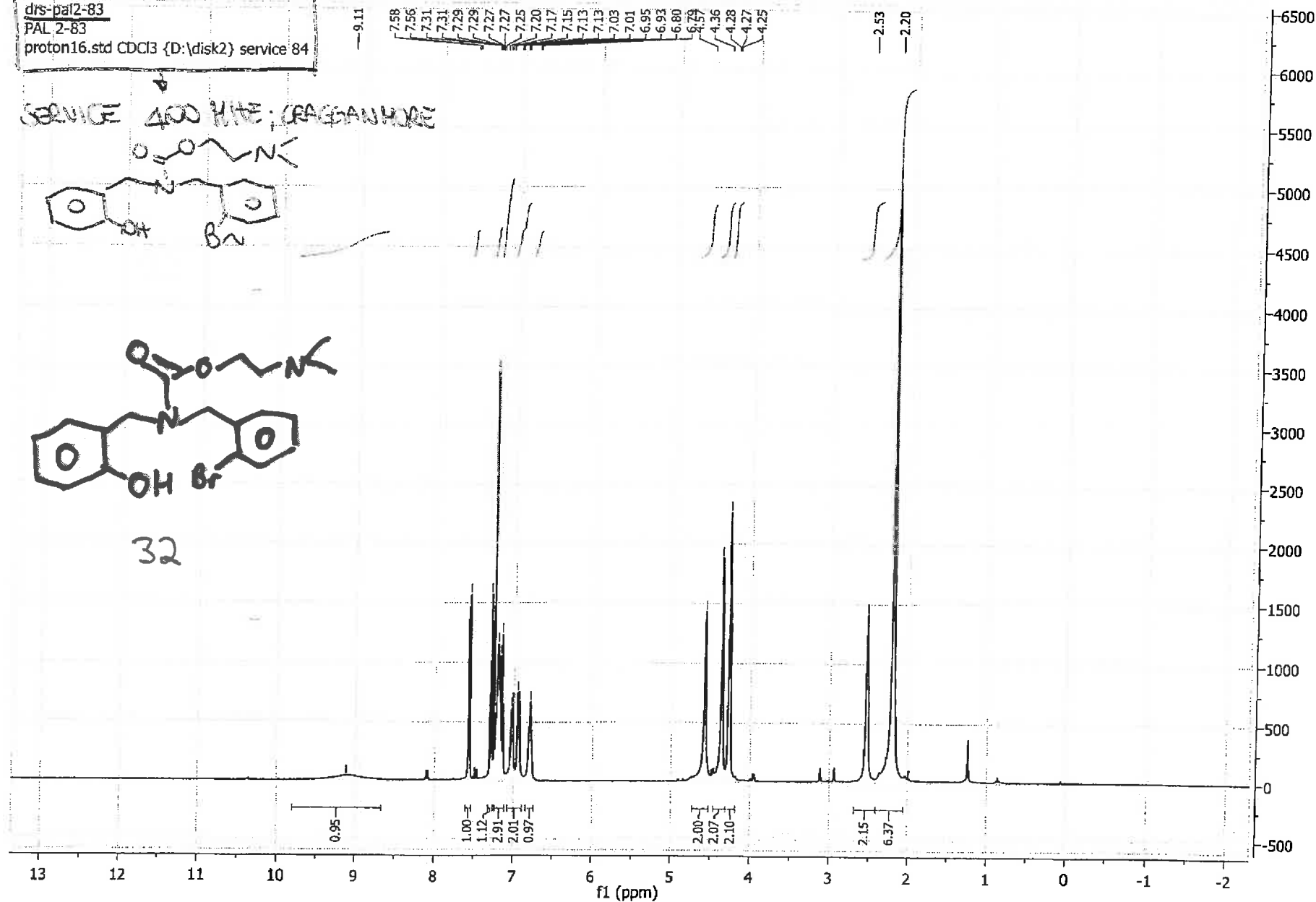


drs-pal2-83  
 PAL 2-83  
 proton16.std CDCl3 {D:\disk2} service 84

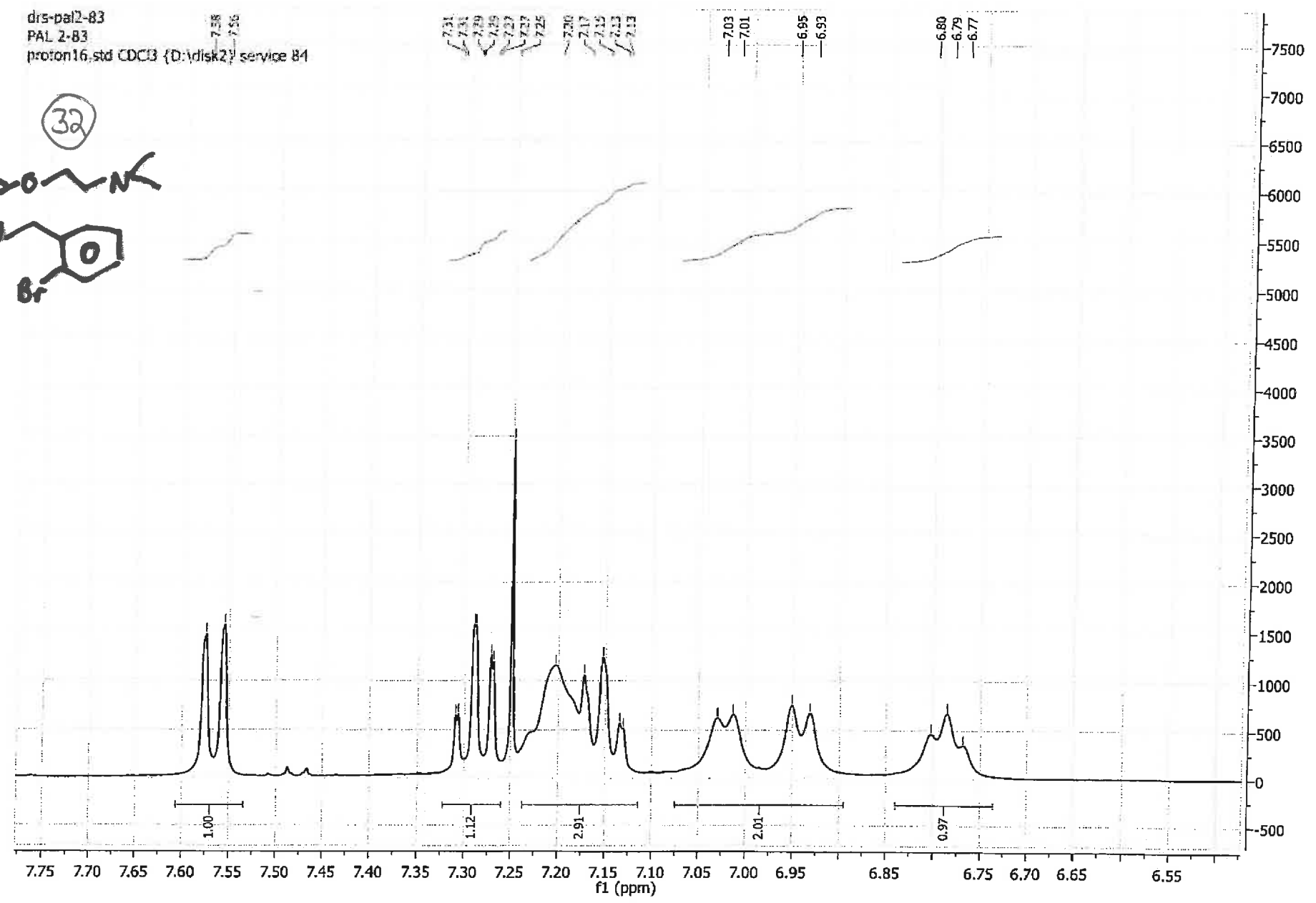
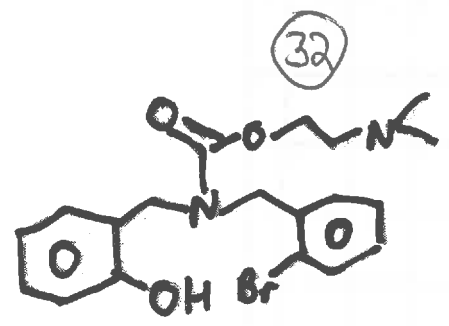
SERVICE 400 MHz; CRAGANHORE



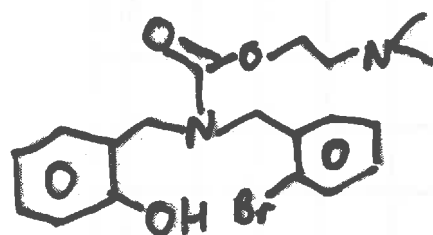
32



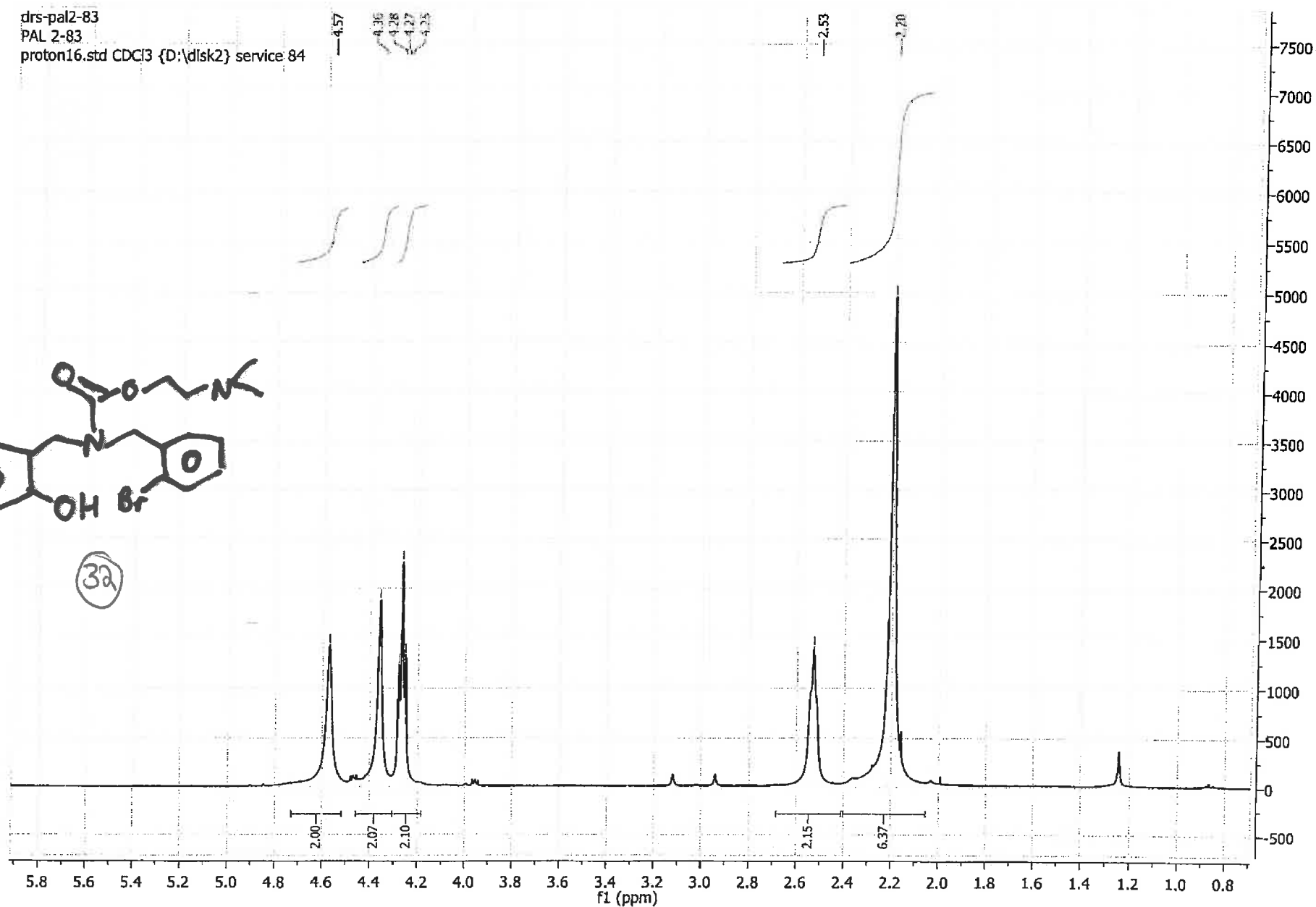
drs-pal2-83  
 PAL 2-83  
 proton16.std CDC13 {D:\disk2\ service 84



drs-pal2-83  
 PAL 2-83  
 proton16.std CDC13 {D:\disk2} service 84



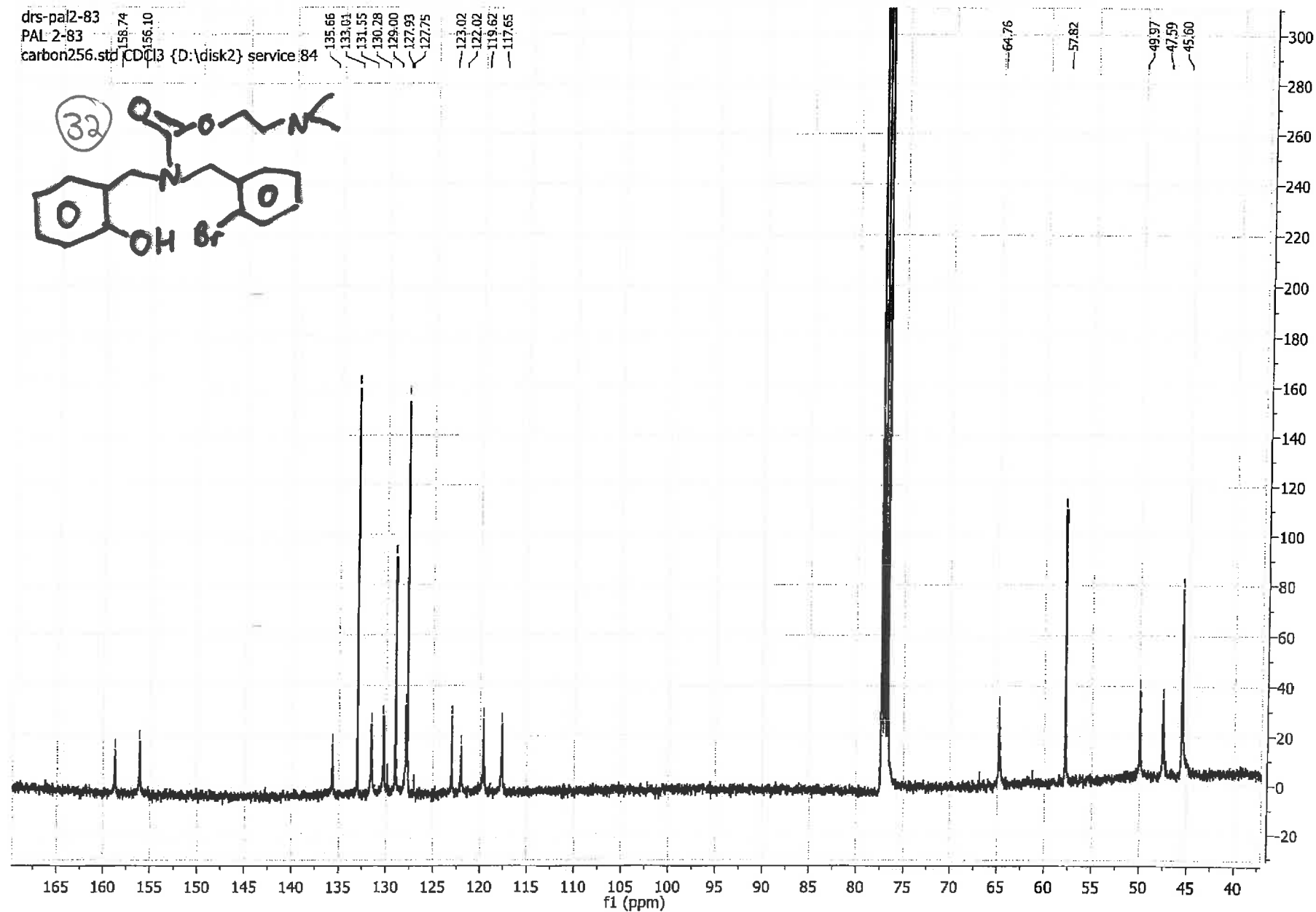
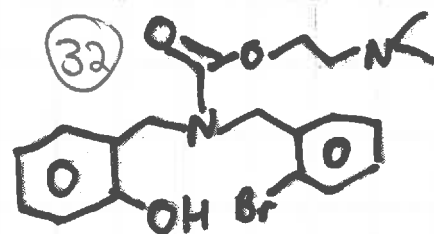
3a



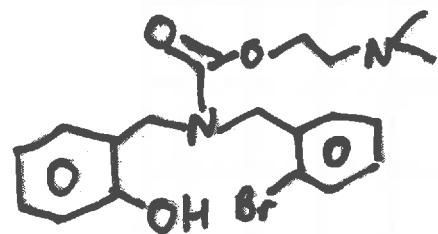
drs-pal2-83

PAL: 2-83

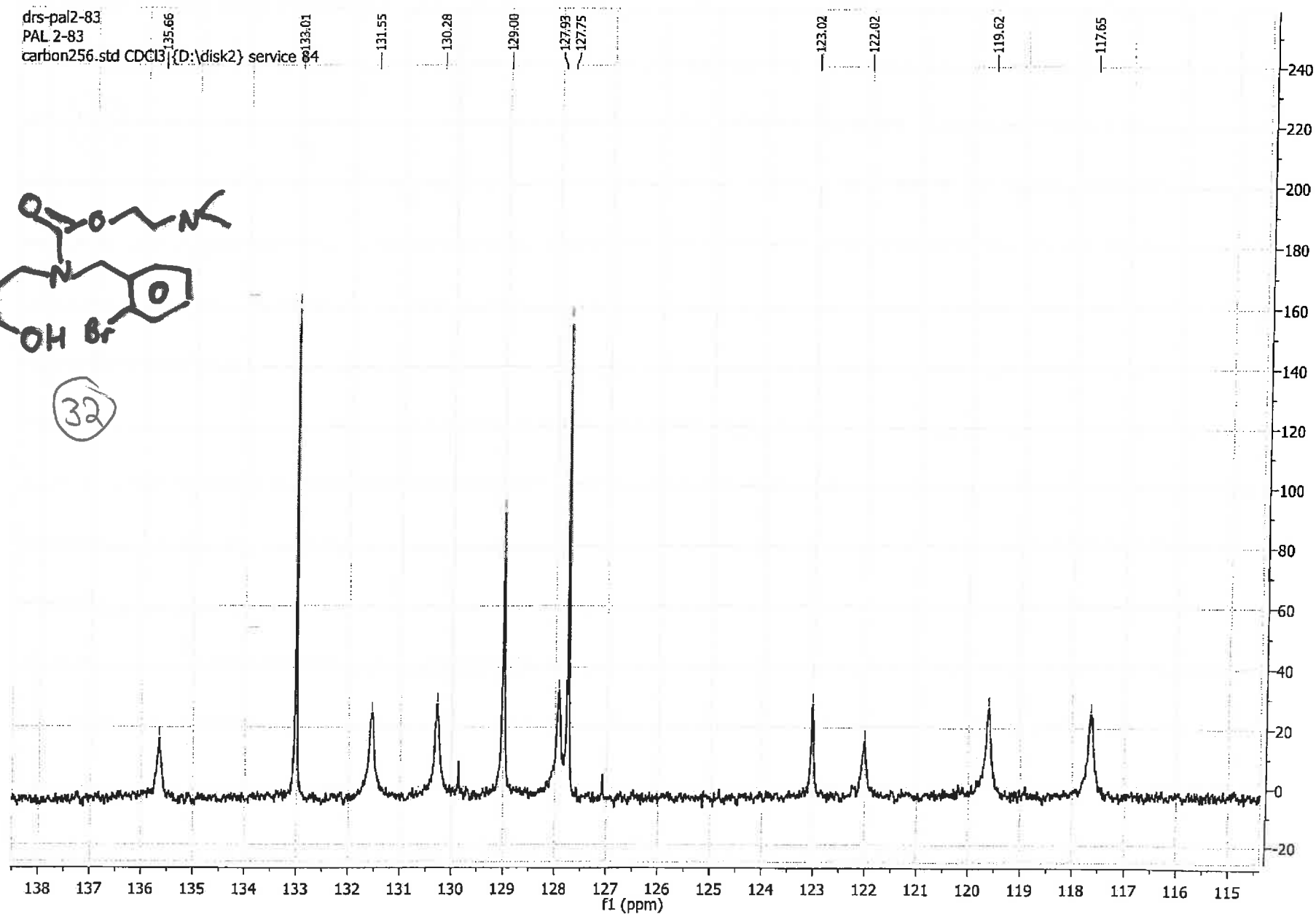
carbon256.stc CDCl<sub>3</sub> {D:\disk2} service 84



drs-pal2-83  
 PAL 2-83  
 carbon256.std CDCl<sub>3</sub> {D:\disk2} service 84



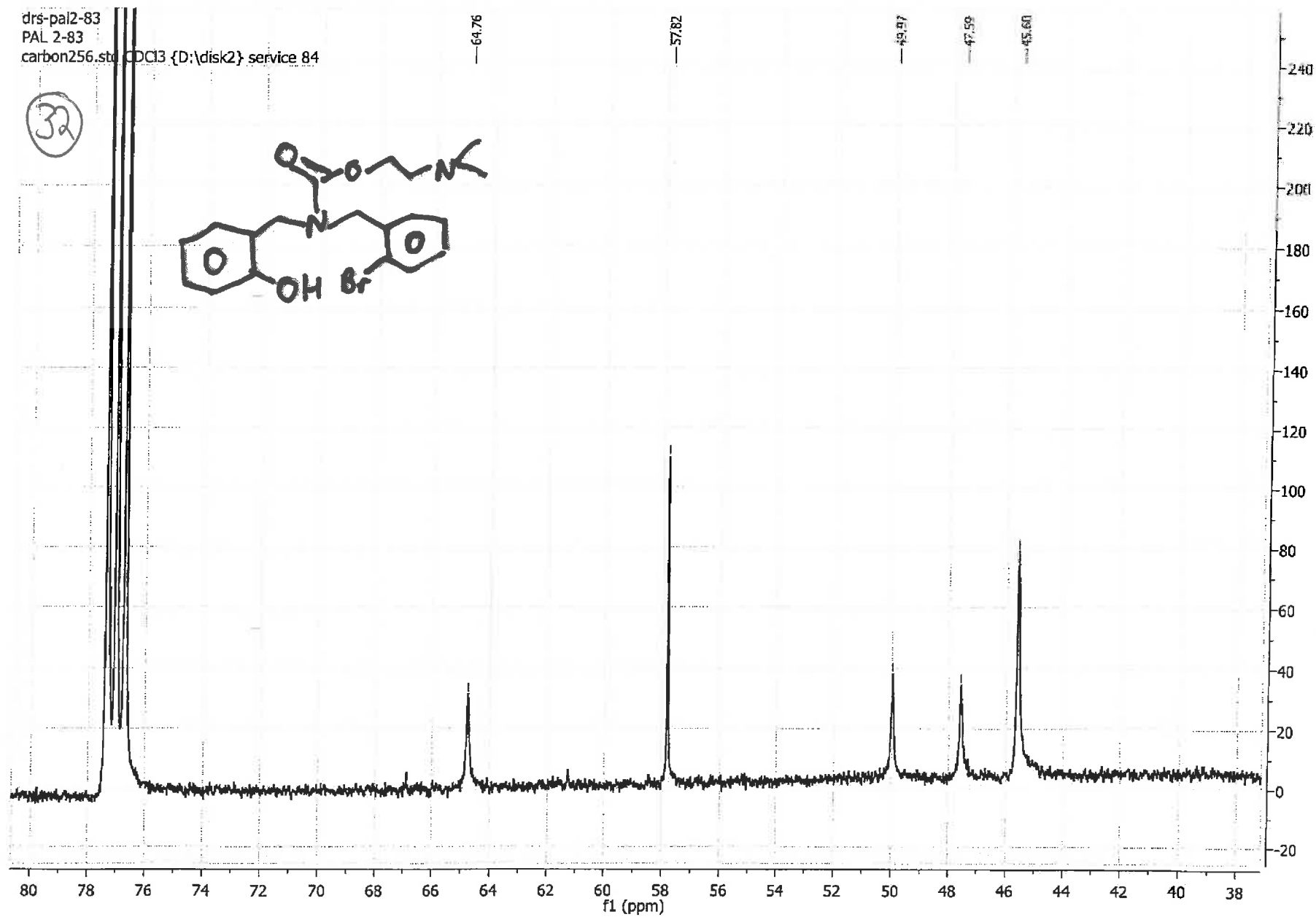
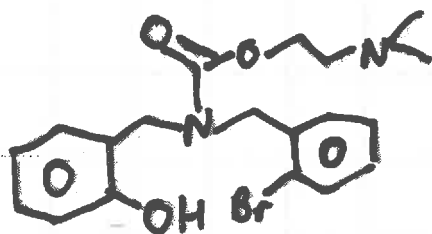
32



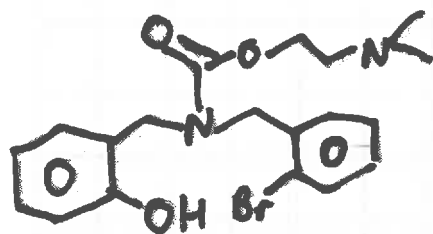


drs-pal2-83  
PAL 2-83  
carbon256.stc CDCl3 {D:\disk2} service 84

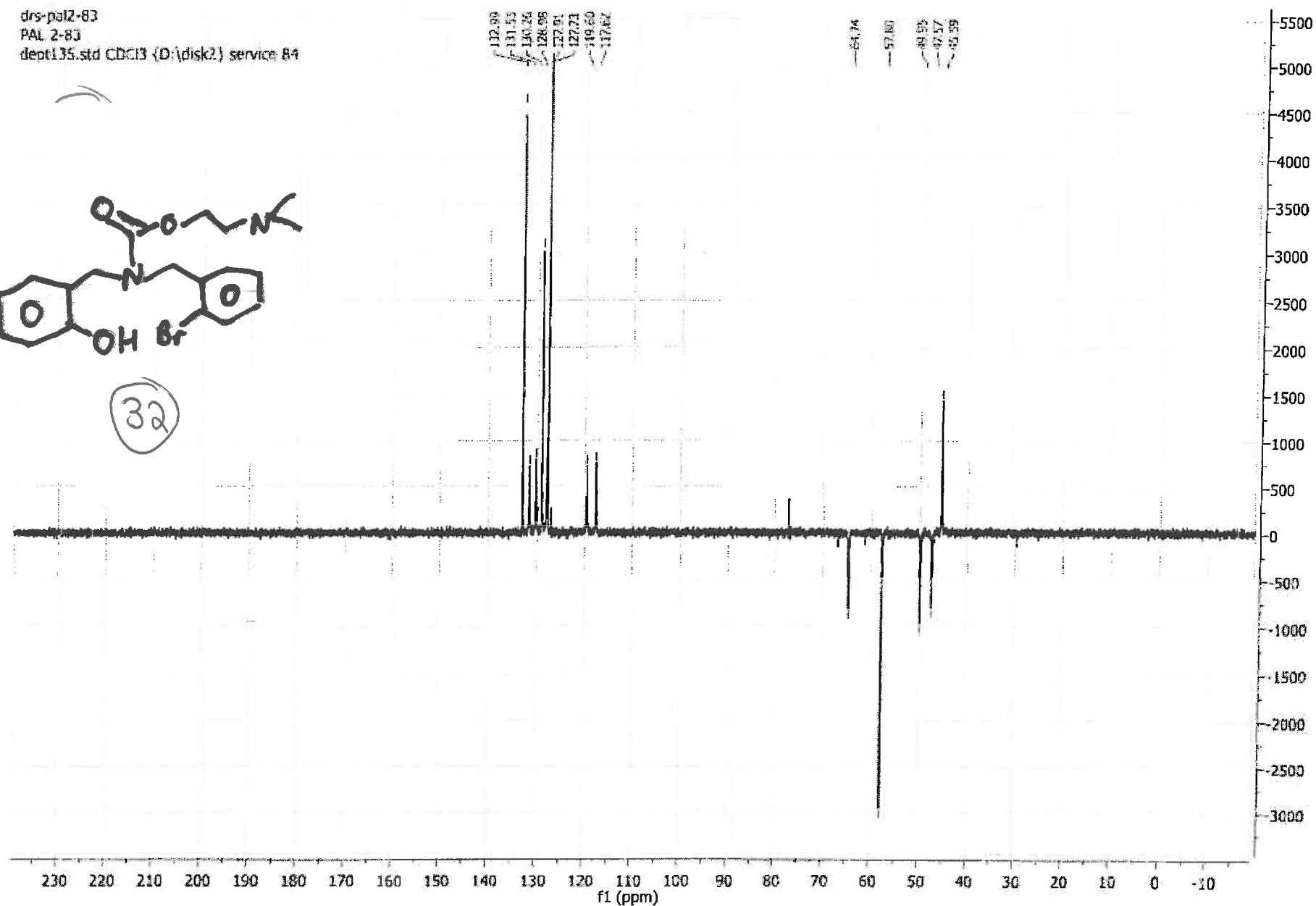
(32)



drs-pal2-83  
 PAL 2-83  
 dept135.std CDCl3 (D:\disk2) service 84

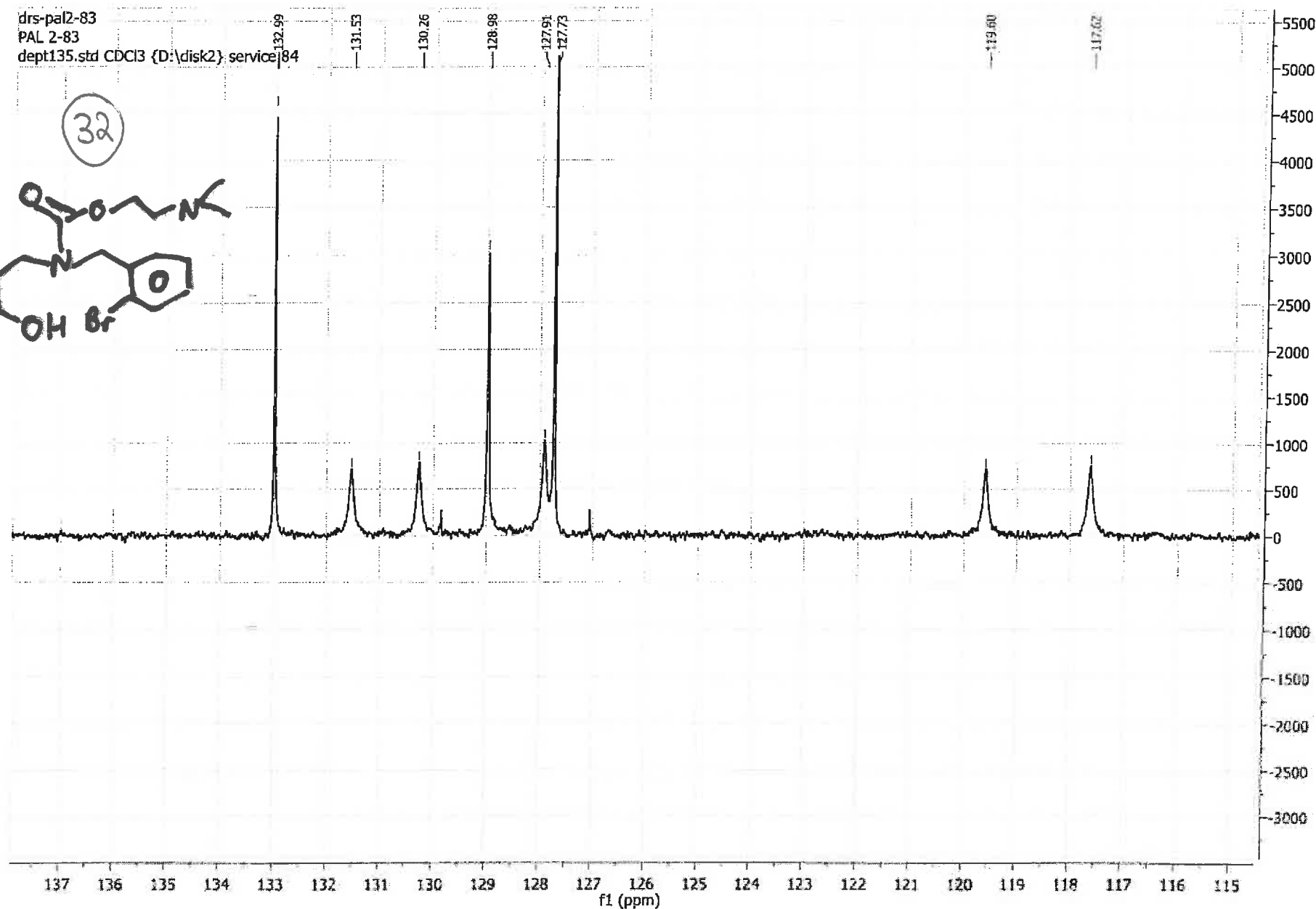
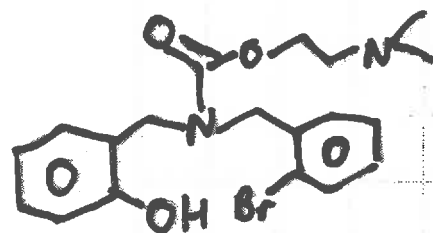


32

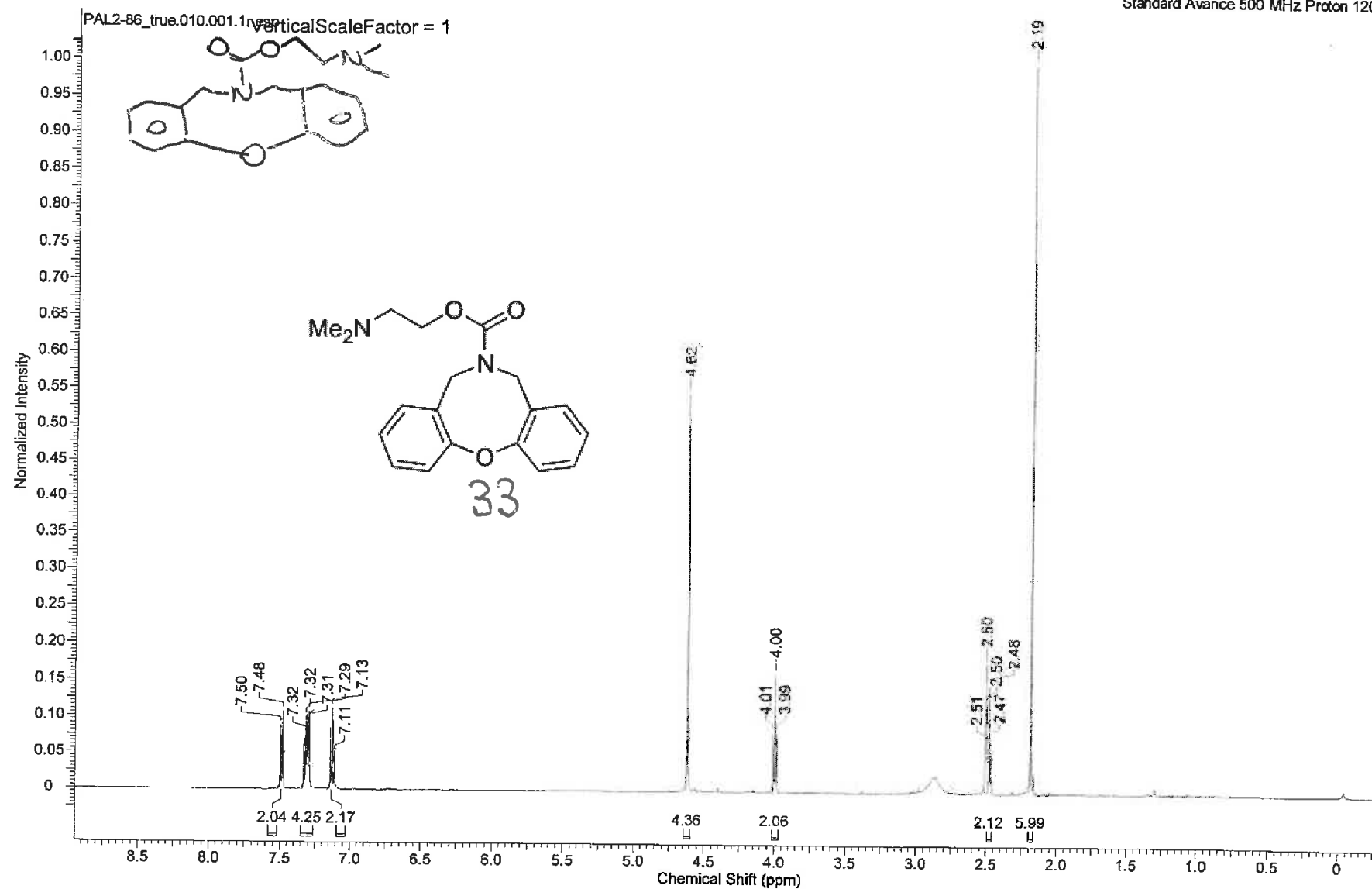


drs-pal2-83  
PAL 2-83  
dept135.std CDCl3 (D:\disk2\ service|84

32

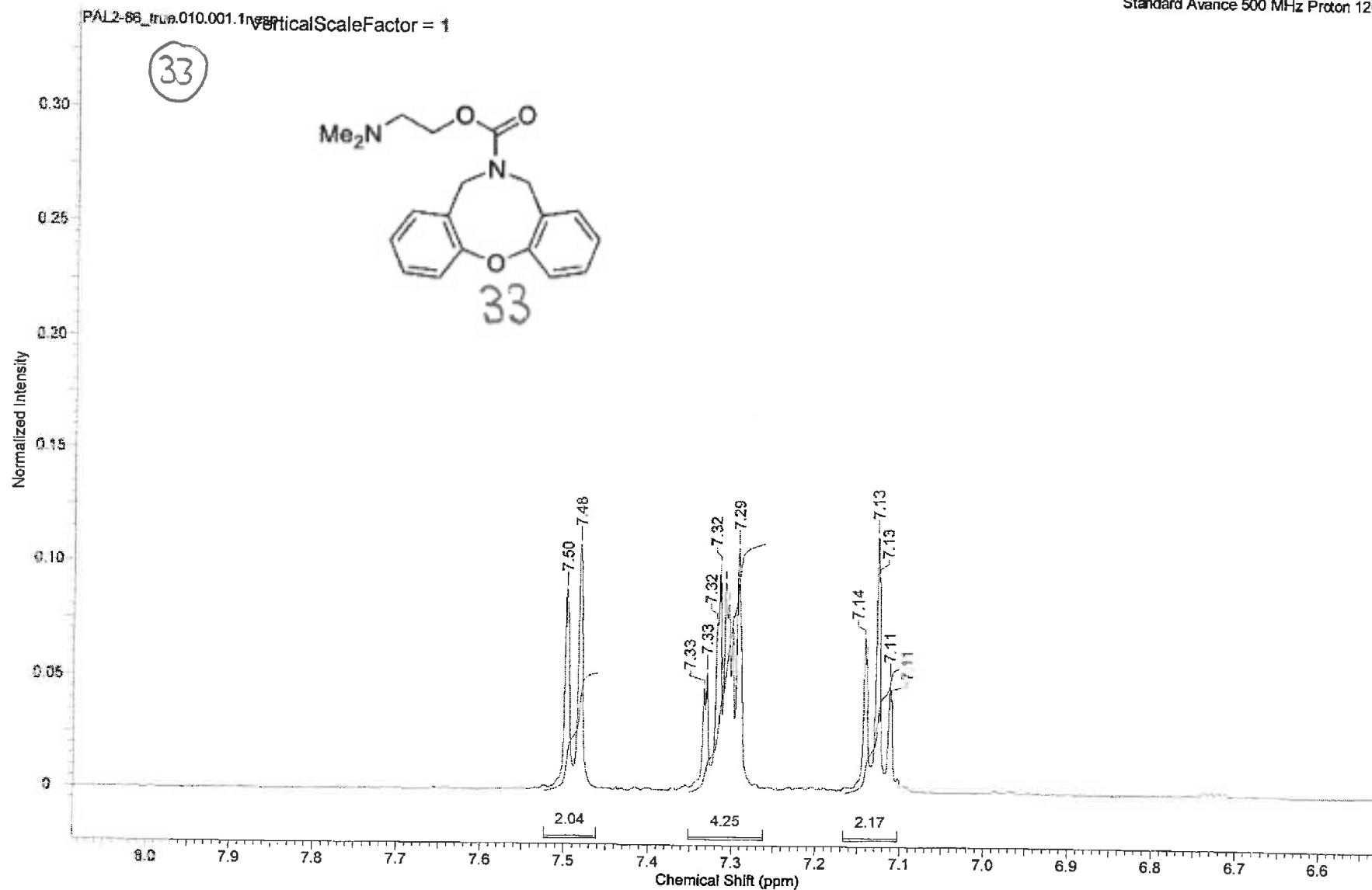


22/11/2012 10:59:48  
 TJS-021  
 Standard Avance 500 MHz Proton 120oC



Y:\glengrant\drs\nmr\PAL2-86\_true\PAL2-86\_true.010.001.1r.esp

22/11/2012 10:59:25  
TJS-021  
Standard Avance 500 MHz Proton 120oC



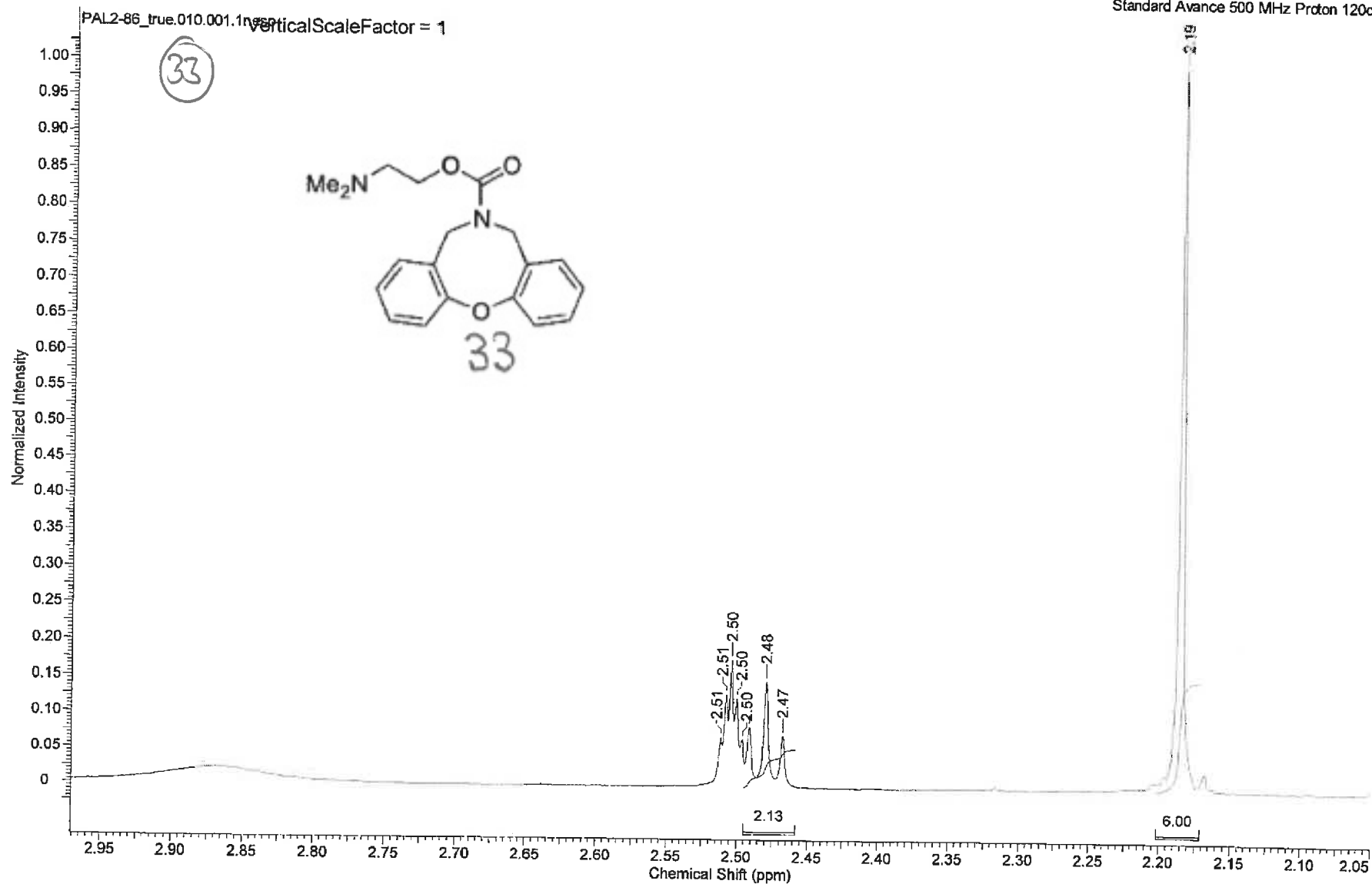
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TJS-021

22/11/2012 10:58:12

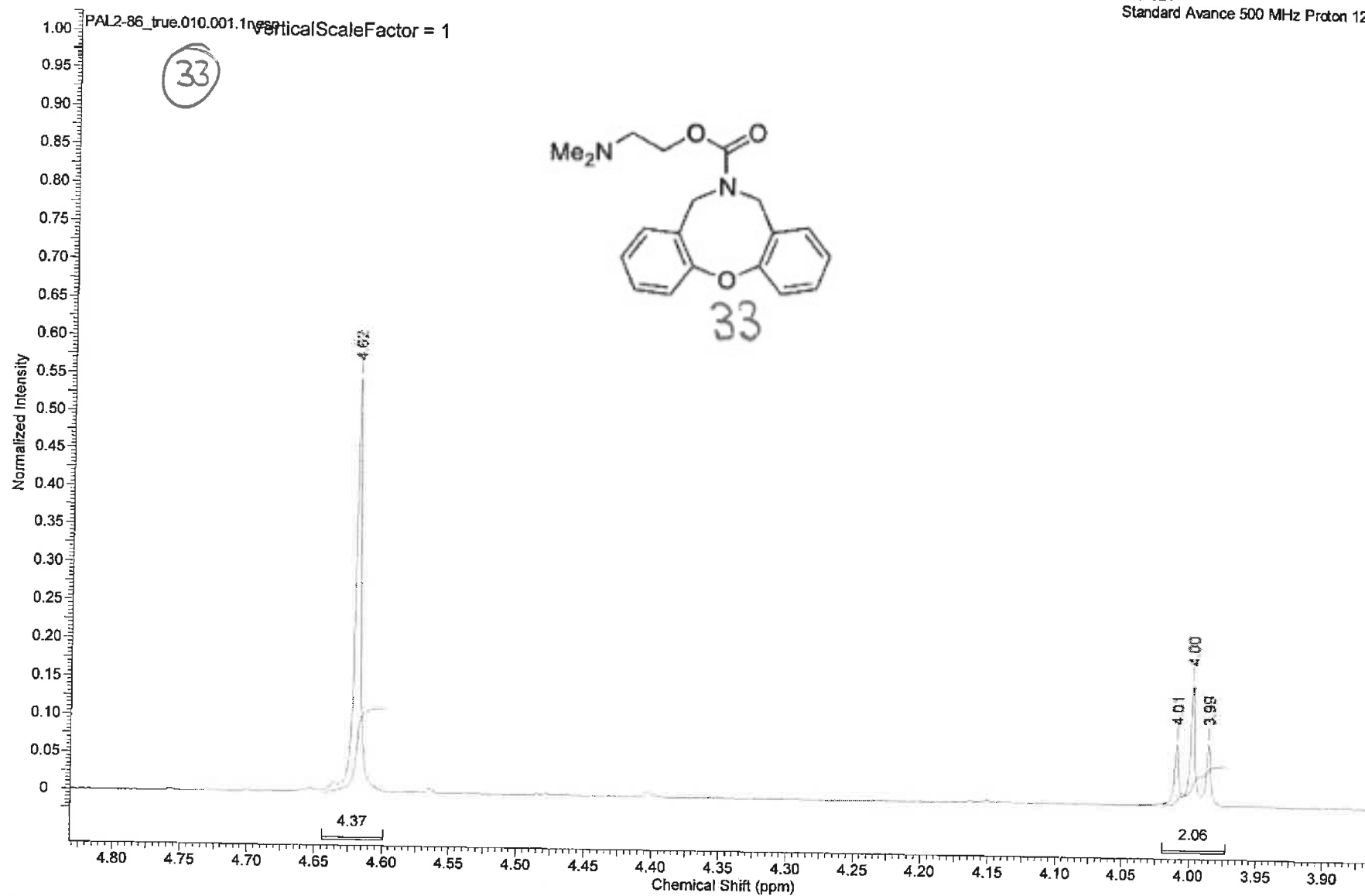
TJS-021

Standard Avance 500 MHz Proton 120oC



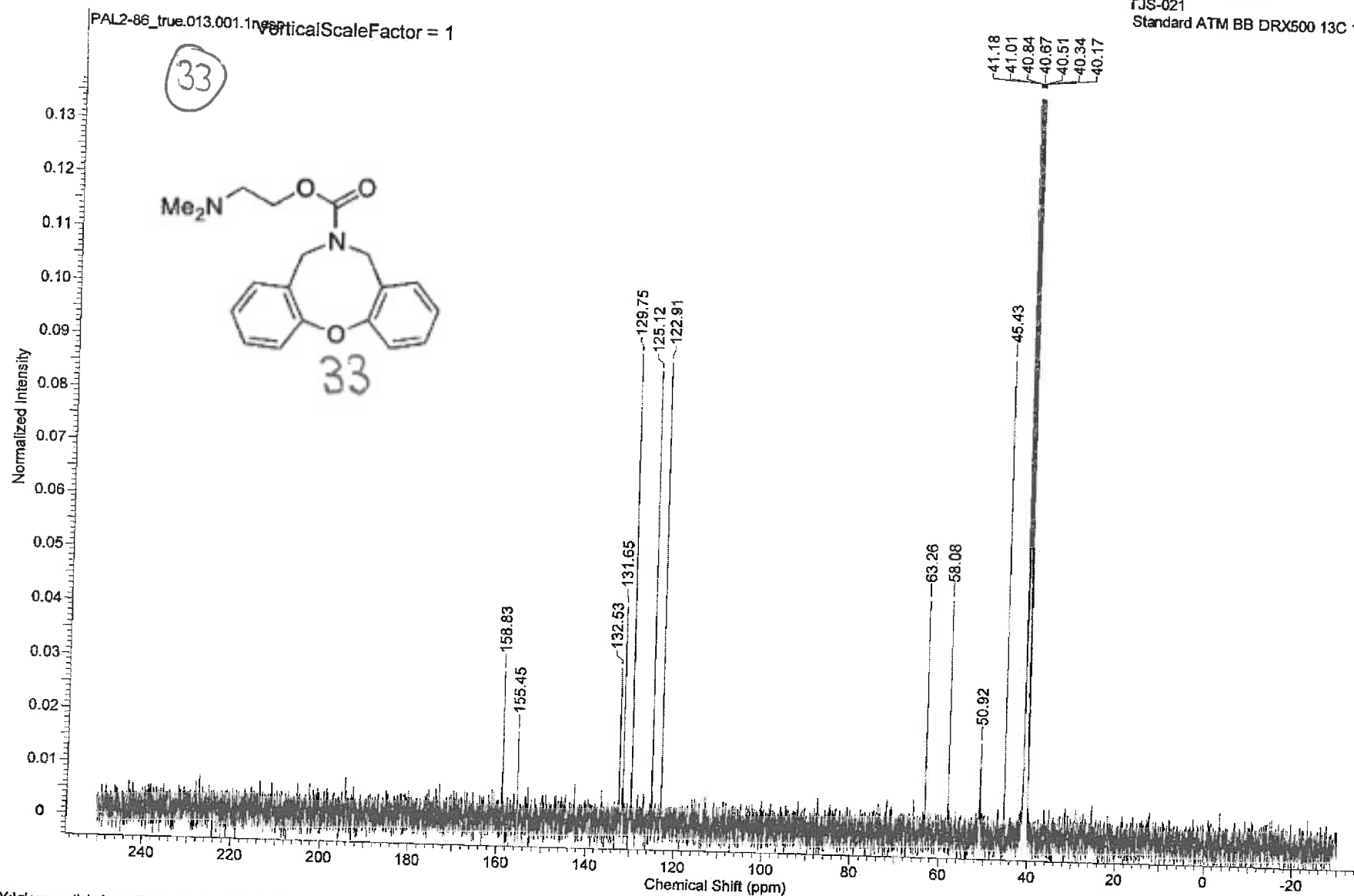
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22/11/2012 10:58:51  
TJS-021  
Standard Avance 500 MHz Proton 120oC



Y:\glengrant\drs\nmr\PAL2-86\_true.010.001.1r.esp

22/11/2012 11:30:49  
TJS-021  
Standard ATM BB DRX500 13C 120oC



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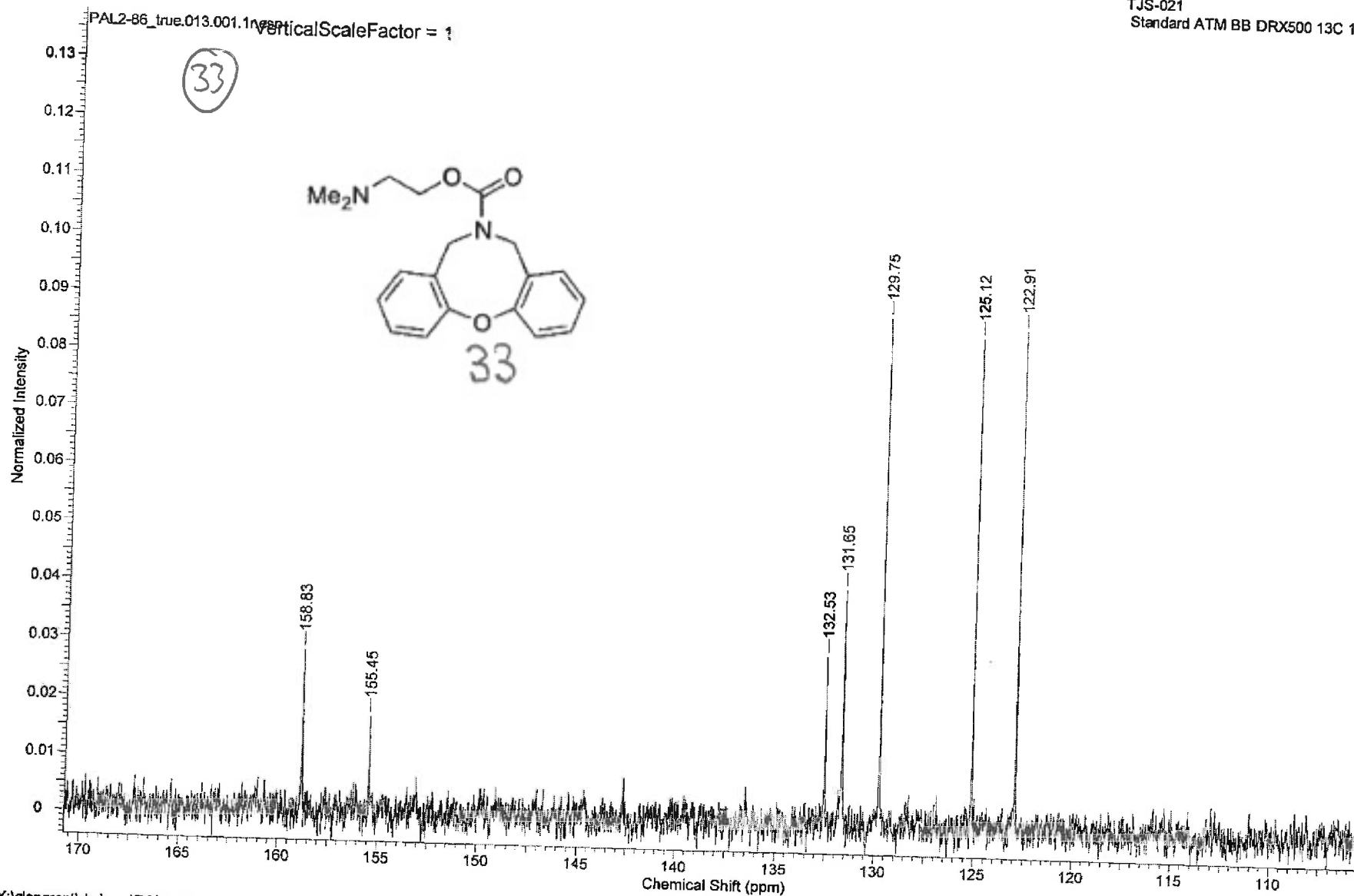


TJS-021

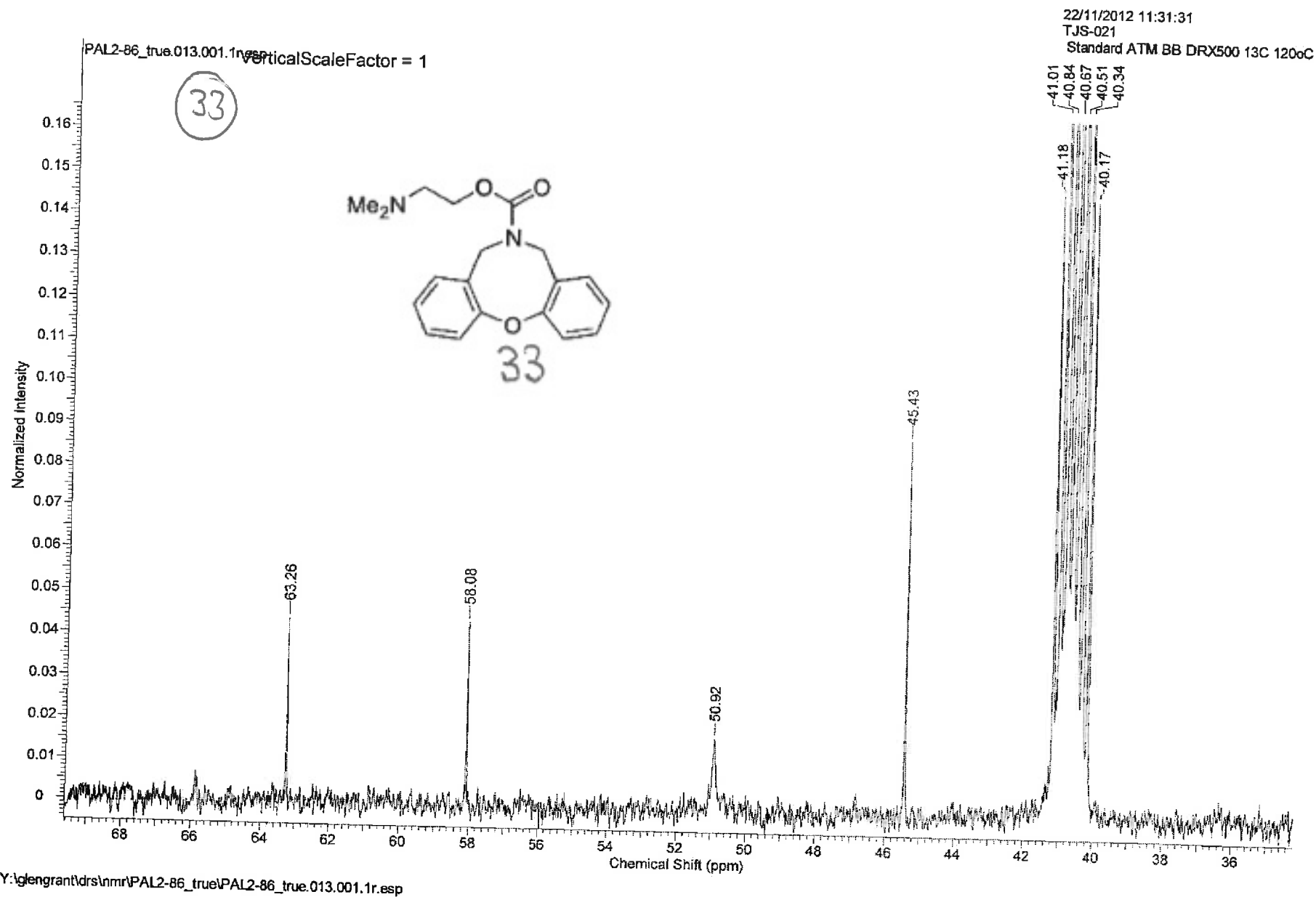
22/11/2012 11:31:05

TJS-021

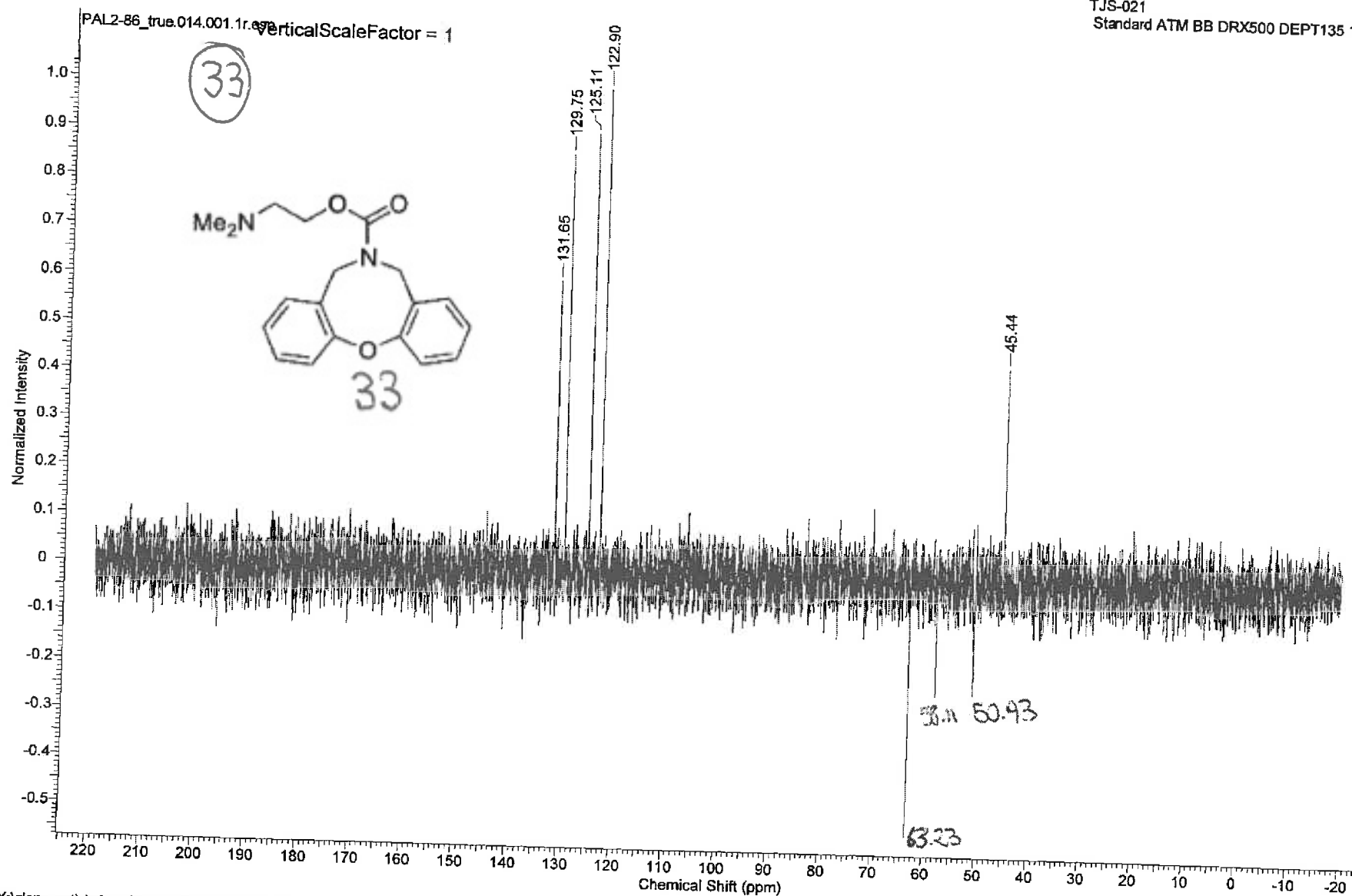
Standard ATM BB DRX500 13C 120oC



Y:\glengrant\drs\nmr\PAL2-86\_true\PAL2-86\_true.013.001.1r.esp



22/11/2012 11:32:21  
TJS-021  
Standard ATM BB DRX500 DEPT135 120oC



Y:\glengrant\drs\nmr\PAL2-86\_true\PAL2-86\_true.014.001.1r.esp



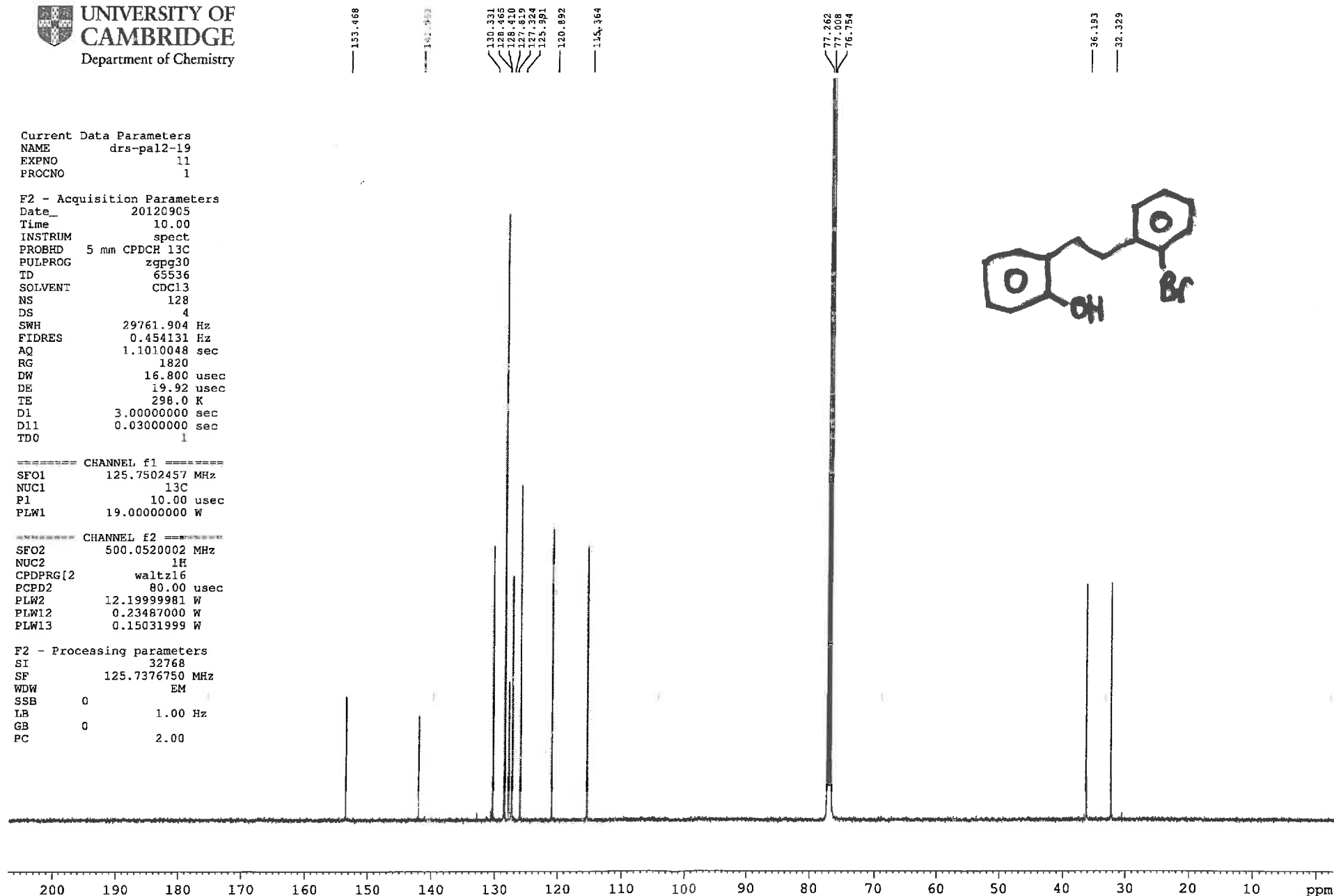
Current Data Parameters  
NAME drs-pa12-19  
EXPNO 11  
PROCNO 1

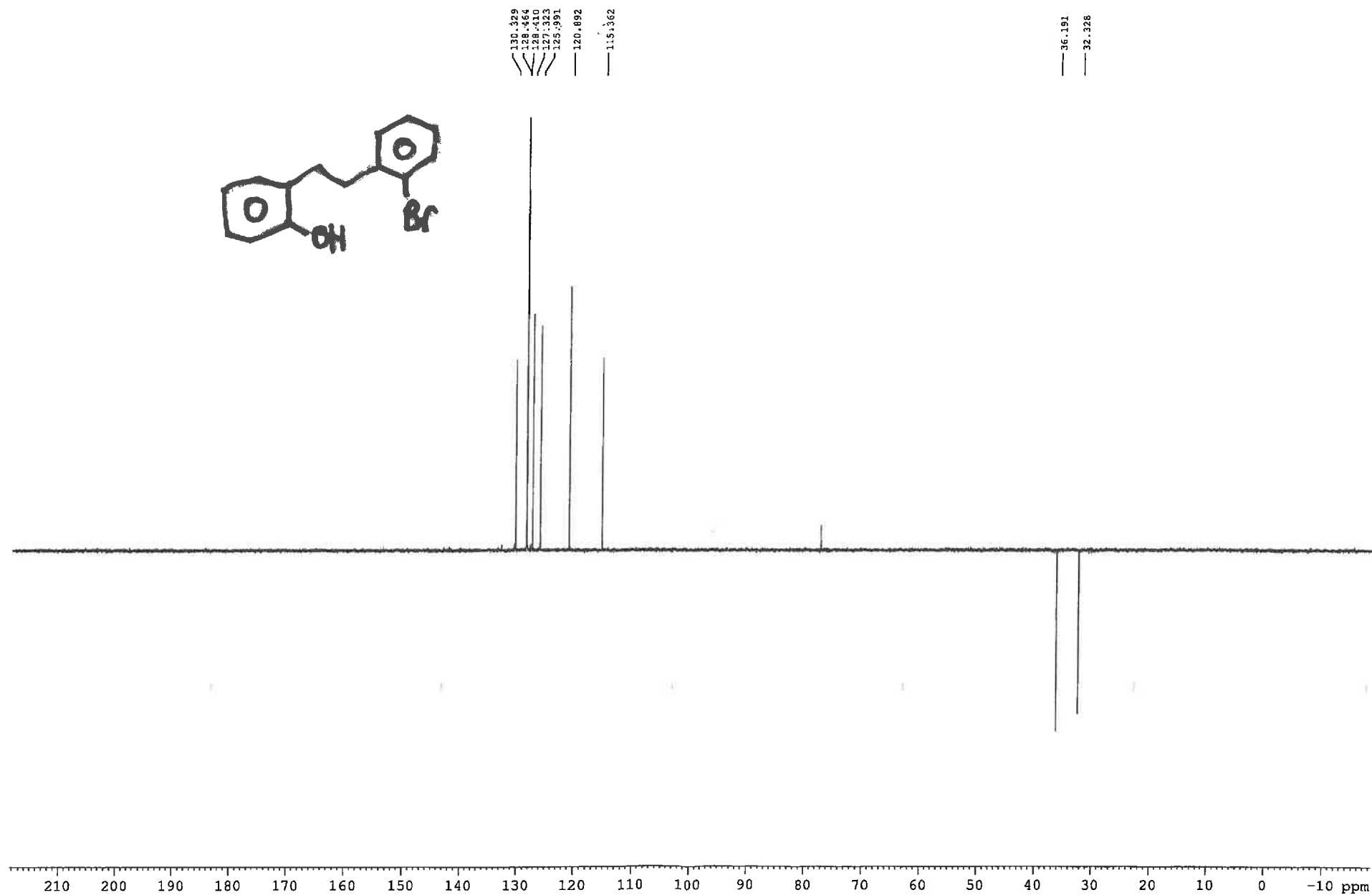
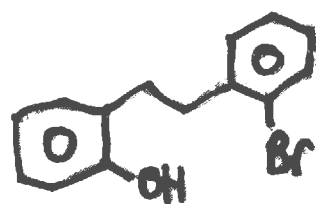
F2 - Acquisition Parameters  
Date\_ 20120905  
Time 10.00  
INSTRUM spect  
PROBHD 5 mm CPDCH 13C  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 128  
DS 4  
SWH 29761.904 Hz  
FIDRES 0.454131 Hz  
AQ 1.1010048 sec  
RG 1820  
DW 16.800 usec  
DE 19.92 usec  
TE 298.0 K  
D1 3.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
SF01 125.7502457 MHz  
NUC1 13C  
P1 10.00 usec  
PLW1 19.00000000 W

===== CHANNEL f2 =====  
SF02 500.0520002 MHz  
NUC2 1H  
CPDPRG12 waltz16  
PCPD2 80.00 usec  
PLW2 12.19999981 W  
PLW12 0.23487000 W  
PLW13 0.15031999 W

F2 - Processing parameters  
SI 32768  
SF 125.7376750 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 2.00

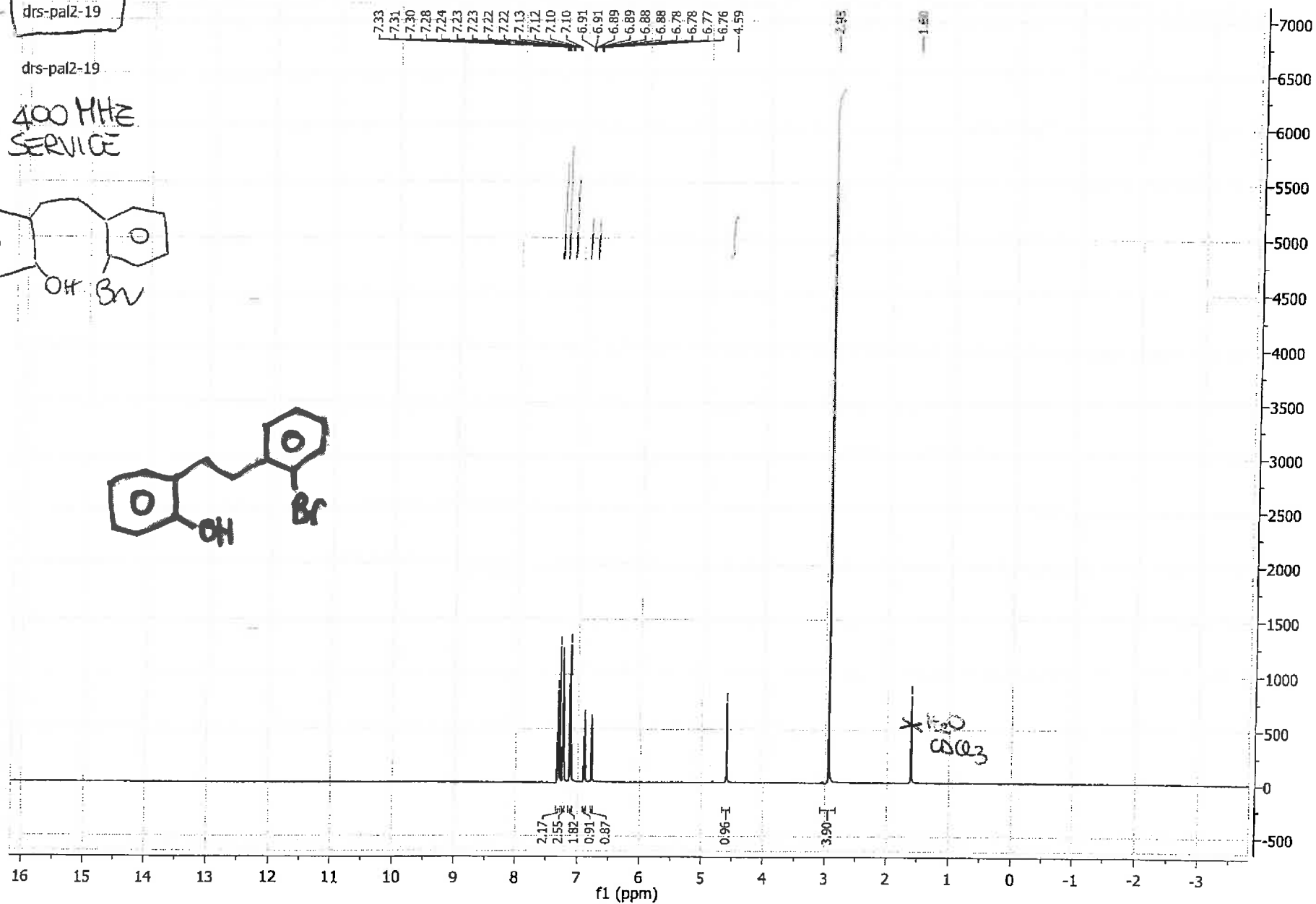
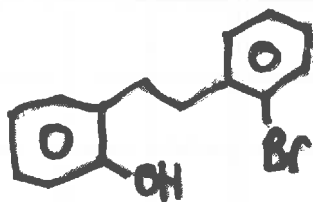
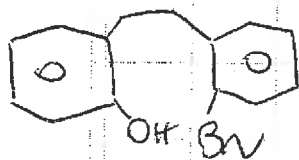




drs-pal2-19

drs-pal2-19

400 MHz  
SERVICE



drs-pal2-19

drs-pal2-19

