Concise Syntheses of Bridged Morpholines

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Supporting Information

Experimental Section

General Information

^{1}H, ^{2}H and ^{13}C nuclear magnetic resonance (NMR) spectra were obtained as solutions in a suitable deuterated solvent and recorded at 500 MHz, 76 MHz and 125 MHz, respectively, on a Bruker Avance III 500 spectrometer. Chemical shifts are reported in parts per million (δ) referenced to the deuterated solvent employed. Multiplicities are indicated by s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), b (broad), hep (heptet) or combinations thereof. LCMS was carried out on a Waters Acquity SQD operating in positive and negative ion electrospray mode, employing a 50 × 2.1 mm, Waters Acquity UPLC BEH C18, 1.7 μm column and a 1.5 min gradient elution of 0.1% aqueous formic acid and acetonitrile (5–95%) at a flow rate of 0.6 mL min^{-1}. High resolution mass spectrometry were measured using a Finnigan MAT 95 XP or a Finnigan MAT 900 XLT by the EPSRC National Mass Spectrometry Service Centre, University of Wales (Swansea), Singleton Park, Swansea, SA2 8PP. Infrared (IR) spectra were recorded on a Bio-Rad FTS 3000MX diamond ATR as a neat sample. UV spectra were obtained using a U-2001 Hitachi Spectrophotometer with the sample dissolved in ethanol. All commercial reagents and solvents were purchased from reputable suppliers. Where petrol is stated, this refers to the fraction of alkanes, which boils between 40 °C and 60 °C. The chemicals were of the highest available purity and used as supplied unless otherwise stated. Anhydrous solvents were stored under nitrogen. Reactions requiring microwave irradiation were carried out in a Biotage Initiator™ Sixty reactor.

General procedure A

10% Pd/C (~ 10 wt%) was added to the carboxylic acid (for typical scale see below) dissolved in AcOH (1.5 mL/mmol). Following evacuation, an atmosphere of hydrogen was introduced *via* a balloon. After stirring vigorously for 69 h at 60 °C, the suspension was filtered through a Celite plug, eluting with AcOH (1.5 mL/mmol). The solvent was removed *in vacuo* and the resultant solid was dissolved in water (0.6 mL/mmol) before the addition of 35% ammonium

hydroxide in water (0.6 mL/mmol). The mixture was stirred at RT for 30 min after which it was concentrated and dried *in vacuo* to afford the product.

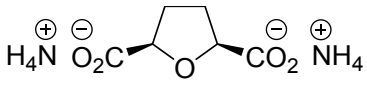
General procedure B

A reaction vessel was equipped with a stirrer bar, finely powdered diammonium salt (for typical scale see below and covereded with glass wool. The mixture was stirred and heated at 230 °C for 6 h. EtOAc (10 mL/mmol) was added along with sat. sodium bicarbonate solution (10 mL/mmol) and the mixture was sonicated to dissolve all the solids. The aqueous layer was extracted twice with EtOAc and the collated organic layers were dried ($MgSO_4$) and evaporated to dryness.

General procedure C

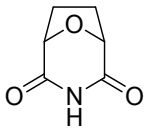
Under an inert atmosphere, to the imide (for typical scale see below) in anhydrous THF (2.3 mL/mmol) was added 1 M BH_3-THF solution (4 mmol per mmol substrate) was added cautiously and the reaction mixture was heated at reflux for 3 h. After cooling to RT, the reaction was quenched MeOH until effervescence ceased, evaporated to dryness and taken up in MeOH (1.7 mL/mmol). A 1.25 M solution of hydrogen chloride in MeOH (1.7 mL/mmol) was added and, under nitrogen, the solution was heated at reflux for 3 h. After cooling to RT, the solvent was removed *in vacuo* and the crude product was purified by recrystallisation from MeOH-diethyl ether.

Diammonium tetrahydrofuran-2,5-dicarboxylate 4:



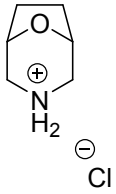
Prepared according to general procedure A with the following reagents: 2,5-furandicarboxylic acid (**3**, 5.00 g, 32.0 mmol), Pd/C (510 mg), AcOH (50 mL), water (20 mL) and 35% ammonium hydroxide in water (20 mL) affording **4** as a white solid (6.06 g, 32.0 mmol, 100%); R_f = 0.51 (DCM:MeOH, 90:10); m.p: 227–230 °C; IR ν_{max}/cm^{-1} 3178, 2993, 2869, 2778, 1699, 1545; ^1H NMR (500 MHz, D_2O) δ 1.73–1.79 (2H, m, 2 × CH), 2.13–2.20 (2H, m, 2 × CH), 4.10–4.16 (2H, m, 2 × CH); ^{13}C NMR (125 MHz, D_2O) δ 30.1, 79.7, 180.4); HRMS calcd. for $C_6H_6O_5$ *m/z* $[M+H]^+$ 159.0296, found 159.0299.

8-Oxa-3-azabicyclo[3.2.1]octane-2,4-dione 5:



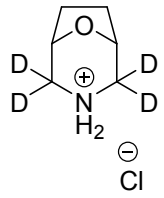
Prepared according to general procedure B starting from **4** (200 mg, 1.03 mmol), which gave **5** as a white solid (110 mg, 0.80 mmol, 78%). R_f = 0.60 (EtOAc); mp: 133–137 °C; IR ν_{max}/cm^{-1} 3082, 2839, 1907, 1713; ^{1}H NMR (500 MHz, DMSO-d_6) δ 1.92–1.97 (2H, m, 2 × CH), 2.13–2.21 (2H, m, 2 × CH), 4.70–4.74 (2H, m, 2 × CH), 11.10 (1H, br s, NH); ^{13}C NMR (125 MHz, DMSO-d_6) δ 30.1, 79.7, 180.4; HRMS calcd. for $C_6H_7NO_3$ *m/z* $[M+H]^+$ 142.0499, found 142.0496.

8-Oxa-3-azabicyclo[3.2.1]octane hydrochloride 1a:



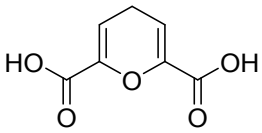
Prepared according to general procedure C with the following reagents: **5** (306 mg, 2.17 mmol), THF (5 mL), 1 M BH_3-THF solution (8.7 mL, 8.7 mmol), MeOH (5 mL), 1.25 M solution of hydrogen chloride in MeOH (6 mL) affording **1a** as an off white solid (0.227 g, 1.52 mmol, 70%); R_f = 0.93 (EtOAc); mp: 192–195 °C; IR ν_{max}/cm^{-1} 2958, 2899, 2845, 2768, 2660, 2548, 2492, 2360, 2293, 1598; ^{1}H NMR (500 MHz, DMSO-d_6) δ 1.91-1.98 (2H, m, 2 × CH), 2.03-2.09 (2H, m, 2 × CH), 2.95-3.06 (4H, m, 4 × CH), 4.37-4.41 (2H, m, 2 × CH), 8.93-9.37 (2H, m, NH_2); ^{13}C NMR (125 MHz, DMSO-d_6) δ 26.6, 47.1, 71.6; HRMS calcd. for $C_6H_{11}NO$ *m/z* $[M+H]^+$ 114.0912, found 114.0913.

8-Oxa-3-azabicyclo[3.2.1]octan-3-ium-2,2,4,4-d_4 chloride 1b:



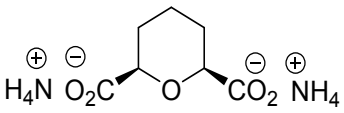
Prepared according to general procedure C with the following reagents: **5** (345 mg, 2.45 mmol), THF (5.6 mL), 1 M BD_3-THF solution (9.79 mL, 9.79 mmol), MeOH (5.6 mL), 1.25 M HCl in MeOH (5.6 mL) yielding **1b** as an off-white solid (113 mg, 0.96 mmol, 30%); R_f = 0.21 (DCM:MeOH, 80:20); mp: 192-198 °C; ^{1}H NMR (500 MHz, DMSO-d_6) δ 1.90-1.97 (2H, m, 2 × CH), 2.04-2.10 (2H, m, 2 × CH), 2.95-3.05 (0.76 H, m, non-deuterated material), 4.37-4.41 (2H, m, 2 × CH), 9.38 (2H, br s, NH_2); ^{13}C NMR (125 MHz, DMSO-d_6) δ 27.3 (CH_2), 46.3-47.5 (1:2:3:2:1 pent, 2 × CD_2), 72.0 (CH); ; HRMS calcd. for $C_6H_7D_4NO$ *m/z* $[M+H]^+$ 118.1164, found 118.1161.

4*H*-Pyran-2,6-dicarboxylic acid[1,2]



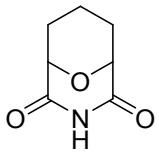
To a stirred solution of tetraethyl 1,5-dioxopentane-1,2,4,5-tetracarboxylate (1.59 g, 4.10 mmol) in water (1.6 mL) was added concentrated hydrochloric acid (1.6 mL). The mixture was heated at reflux for 6 h, after which the solvent was removed in *vacuo*. To the stirred residue was added conc. sulfuric acid (2 mL) dropwise. The mixture was cooled to 0 °C and stirred for 18 h. Ice-cold water was added to give a precipitate which was filtered, washed with ice cold water (3 × 10 mL) and dried to give a brown solid. According to ^{1}H NMR analysis this product was a mixture of the title compound and ethyl ester(s). The mixture was taken up in THF (25 mL) and 2M aqueous NaOH (22.5 mL) was added. After stirring at room temperature overnight, the resulting solution was acidified with 2M HCl. The precipitate was filtered, washed with ice-cold water and dried to afford the title compound as a brown solid (0.50 g, 2.9 mmol, 71%). R_f = 0.15 (DCM:MeOH, 95:5); mp = 250 °C dec; λ_{max} (EtOH/nm) 234; IR (neat) ν_{max}/cm^{-1} 3420, 3014, 2845, 1724, 1632; ^{1}H NMR (500 MHz, DMSO-d_6) δ 3.02 (2H, t, *J* = 3.7 Hz, CH_2), 6.01 (2H, t, *J* = 3.7 Hz), 13.1 (2H, br s, 2 × OH); ^{13}C NMR (125 MHz, DMSO-d_6) δ 21.6 (CH_2), 110.2 (CH), 142.2 (CH), 162.2 (C=O); HRMS calcd. for $C_7H_6O_5$ *m/z* $[M+H]^+$ 171.0288, found 171.0288.

Diammonium (2*R*,6*S*)-tetrahydro-2*H*-pyran-2,6-dicarboxylate 6a:



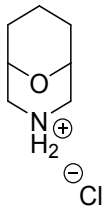
Prepared according to general procedure A with the following reagents: 4*H*-pyran-2,6-dicarboxylic acid (3.47 g, 20.5 mmol), AcOH (70 mL), Pd/C (326 mg), water (35 mL) and 35% ammonium hydroxide solution (6.3 mL). Compound **6a** was an off-white solid (4.16 g, 20 mmol, 98%). R_f = 0.41 (DCM:MeOH, 60:40); mp: 212-220 ^{o}C; IR ν_{max}/cm^{-1} 2921, 2851, 1561, 1403; ^{1}H NMR (500 MHz, DMSO-d_6) δ 1.24-1.37 (2H, m, 2 × CH), 1.49-1.62 (1H, m, CH), 1.76-1.93 (3H, m, 3 × CH), 3.66 (2H, dd, J = 2.2 and 10.9 Hz, 2 × CH), 7.90 (8H, br s, 2 × NH_4); ^{13}C NMR (125 MHz, DMSO-d_6) δ 23.9, 29.3, 77.9, 175.1; HRMS calcd. for $C_7H_{10}O_5$ *m/z* $[M+H]^+$ 173.0455, found 173.0459.

9-Oxa-3-azabicyclo[3.3.1]nonane-2,4-dione 7a:



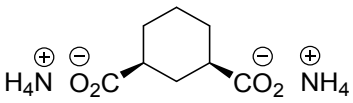
Prepared according to general procedure B starting from **6a** (150 mg, 0.72 mmol) furnishing **7a** as a white solid (85 mg, 0.55 mmol, 76%). R_f = 0.29 (petrol:EtOAc, 60:40); mp: 149-157 ^oC; IR ν_{max}/cm^{-1} 3077, 2958, 2925, 2852, 1702; ^1H NMR (500 MHz, DMSO-d_6) δ 1.35-1.50 (1H, m, CH), 1.66-1.77 (3H, m, 3 × CH), 1.84-1.94 (2H, m, 2 × CH), 4.45 (2H, dd, J = 1.0 and 5.4 Hz, 2 × CH), 11.58 (1H, br s, NH); ^{13}C NMR (125 MHz, DMSO-d_6) δ 16.6, 26.0, 71.3, 173.7; HRMS calcd. for $C_7H_9NO_3$ *m/z* $[M+H]^+$ 156.0655, found 156.0653.

9-Oxa-3-azabicyclo[3.3.1]nonane hydrochloride 2a:



Prepared according to general procedure C with the following reagents: **7a** (585 mg, 3.77 mmol), THF (5 mL), 1 M BH_3-THF (15.1 mL, 15.1 mmol), MeOH (15 mL) and 1 M HCl in Et_2O (30 mL), furnishing **2a** as a white solid (420 mg, 2.56 mmol, 68%). R_f = 0.16 (DCM:MeOH, 80:20); mp: 242-250 ^oC; IR ν_{max}/cm^{-1} 3092, 2753, 2637, 2494, 1591; ^1H NMR (500 MHz, DMSO-d_6) δ 1.56-1.69 (3H, m, 3 × CH), 1.89 (2H, heptet, 2 × CH), 2.00-2.16 (1H, m, CH), 3.19-3.22 (4H, m, 2 × CH_2), 4.03 (2H, br s, 2 × CH), 8.28 (1H, br s, NH), 9.72 (1H, br s, NH); ^{13}C NMR (125 MHz, DMSO-d_6) δ 16.7, 27.7, 44.4, 63.8; HRMS calcd. for $C_7H_{13}NO$ *m/z* $[M+H]^+$ 128.1070, found 128.1067.

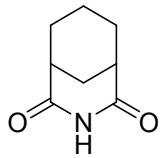
Diammonium (1*R*,3*S*)-cyclohexane-1,3-dicarboxylate 6b:



Prepared according to general procedure A with the following reagents: (1*R*,3*S*)-cyclohexane-1,3-dicarboxylic acid (2.5 g, 14.5 mmol) in water (10 mL) with 35% ammonium hydroxide in water (10 mL). Compound **6b** was a white solid (3.0 g, 14.5 mmol, 100%). R_f = 0.31 (DCM:MeOH, 90:10); mp: 127-134 ^oC; IR ν_{max}/cm^{-1} 2922, 1686; ^1H NMR (500 MHz, DMSO-d_6) δ 1.14-1.35 (4H, m, 4 × CH), 1.74-1.90 (3H, m, 3 × CH), 2.00-2.15 (3H, m, 3 × CH), 5.97

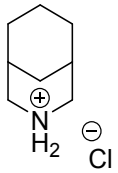
(8H, br s, 2 × NH_4); ^{13}C NMR (125 MHz, DMSO-d_6) δ 25.5 (CH_2), 29.7 (CH_2), 33.1, 44.2, 178.1; HRMS calcd. for $C_8H_{10}O_4$ *m/z* $[M+H]^+$ 171.0663, found 171.0667.

3-Azabicyclo[3.3.1]nonane-2,4-dione 7b:



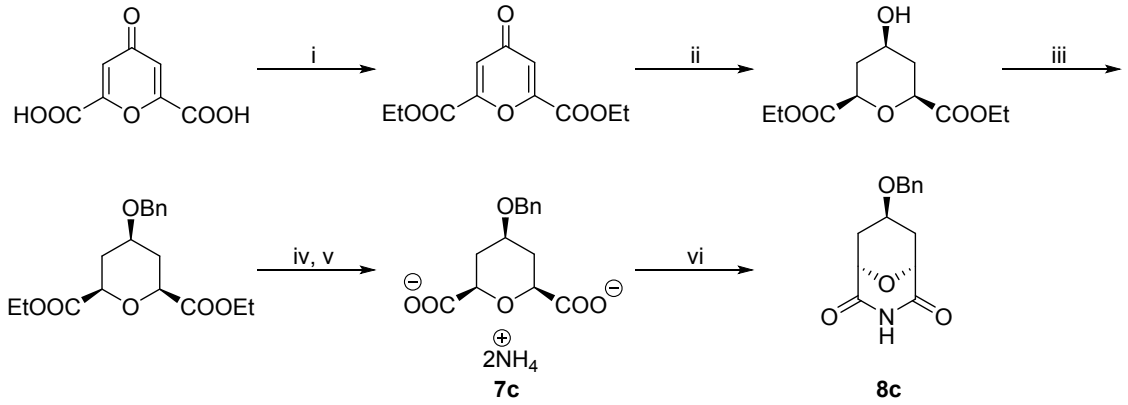
Prepared according to general procedure B from compound **6b** (950 mg, 4.61 mmol). **7b** was a white solid (489 mg, 3.20 mmol, 69%). R_f = 0.63 (DCM:MeOH, 90:10); mp: 123-130 °C; IR ν_{max}/cm^{-1} 2952, 2925, 1696; ^1H NMR (500 MHz, $CDCl_3$) δ 1.40-1.51 (2H, m, 2 × CH), 1.60-1.75 (3H, m, 3 × CH), 1.92-1.99 (2H, m, 2 × CH), 2.13-2.20 (1H, m, CH), 7.73-7.78 (2H, m, 2 × CH), 7.84 (1H, br s, NH); ^{13}C NMR (125 MHz, $CDCl_3$) δ 19.4, 27.9, 28.9, 37.7, 175.8; HRMS calcd. for $C_8H_{11}NO_2$ *m/z* $[M+H]^+$ 154.0863, found 154.0859.

3-Azabicyclo[3.3.1]nonane hydrochloride 2b



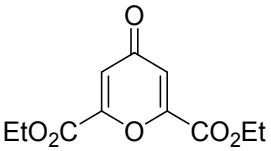
Prepared according to general procedure C with the following reagents: Compound **7b** (289 mg, 1.80 mmol), THF (3 mL), 1 M BH_3-THF (7.5 mL, 7.5 mmol), MeOH (10 mL) and 1 M HCl in MeOH (10 mL) furnishing **2b** as a white solid (200 mg, 1.23 mmol, 69%). R_f = 0.13 (MeOH); mp: 209-214 °C; IR ν_{max}/cm^{-1} 2924, 2674, 1587, 1445; ^1H NMR (500 MHz, $CDCl_3$) δ 1.50-1.79 (8H, m, 8 × CH), 1.86-2.00 (2H, m, 2 × CH), 3.03-3.12 (2H, m, 2 × CH), 3.17-3.23 (2H, m, 2 × CH), 7.67 (1H, br s, NH), 9.29 (1H, br s, NH); ^{13}C NMR (125 MHz, $CDCl_3$) δ 19.9, 25.7, 29.2, 30.2, 47.3; HRMS calcd. for $C_8H_{16}N$ *m/z* $[M+H]^+$ 126.1277, found 126.1277.

Synthesis of (1*R*,5*S*,7*s*)-7-(benzyloxy)-9-oxa-3-azabicyclo[3.3.1]nonane-2,4-dione 8c:



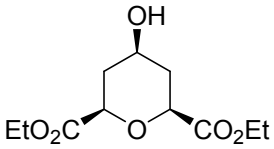
Reagents and Conditions: i) H_2SO_4, EtOH, RT, 48 h, 70%; ii) H_2, Pd/$BaSO_4$, EtOH, RT, 20 h, 67%; iii) $BnOC(NH)CCl_3$, TfOH, DCM:cyclohexane, RT, 24 h, 91%; iv) LiOH, THF, RT, 20 h, 100%; v) NH_4OH, H_2O, RT, 100%; vi) 230 °C, 6 h, 37%.

Diethyl 4-oxo-4*H*-pyran-2,6-dicarboxylate



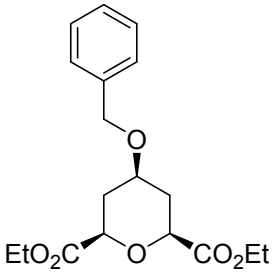
To a solution of 4-oxo-4*H*-pyran-2,6-dicarboxylic acid (1.54 g, 7.61 mmol) in ethanol (30 mL) at 0 °C was added conc. sulfuric acid (1.2 mL) dropwise over 5 min. The mixture was warmed to room temperature and then heated at reflux for 48 h. After cooling to RT, the solvent was removed *in vacuo* and the residue taken up into ethyl acetate (5 mL). Saturated sodium hydrogen carbonate was added until the aqueous layer pH was ~ 7. The aqueous layer was extracted with EtOAc (3 × 20 mL); the organic extracts were combined, dried over anhydrous $MgSO_4$ and the solvent was removed *in vacuo* to afford the title compound as an orange oil which was used directly (1.25 g, 5.2 mmol, 70%); R_f = 0.44 (Petrol:EtOAc, 1:1); λ_{max} (EtOH/nm) 271; IR ν_{max}/cm^{-1} 3071, 2984, 1650; ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.40 (6H, t, *J* = 7.1 Hz, 2 × CH_3), 4.44 (4H, q, *J* = 7.1 Hz, 2 × CH_2), 7.10 (2H, s, 2 × CH); ^{13}C-NMR (125 MHz, $CDCl_3$) δ 14.0, 63.2, 120.1, 153.0, 159.4, 177.1; HRMS calcd. for $C_{11}H_{12}O_6$ *m/z* $[M+H]^+$ 241.0707, found 241.0705.

Diethyl (2*R*,4*s*,6*S*)-4-hydroxytetrahydro-2*H*-pyran-2,6-dicarboxylate



To diethyl 4-oxo-4*H*-pyran-2,6-dicarboxylate (1.4 g, 5.82 mmol) in ethanol (20 mL) was added a catalytic quantity of Pd/$BaSO_4$ and the mixture was placed under an atmosphere of hydrogen. After stirring for 20 h, the slurry was filtered through a pad of Celite, which was washed with ethanol (20 mL); the solvent was removed *in vacuo.* The crude product was purified by column chromatography (silica, elution with petrol:EtOAc, 1:1) to give the title compound as a colourless oil (0.98 g, 3.79 mmol, 67%); R_f = 0.17 (PE:EA 1:1); IR ν_{max}/cm^{-1} 3497, 3339, 2983, 1719; ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.28 (6H, t, *J* = 7.1 Hz, 2 × CH_3), 1.54 (2H, q, *J* = 12.0 Hz, 2 × CH_2), 2.22 -2.32 (2H, m, 2 × CH_2), 2.39 (1H, br s, OH), 3.95 (1H, tt, *J* = 4.5 and 10.9 Hz, CH), 4.01 (2H, dd, *J* = 2.0 and 12.0 Hz, 2 × CH_2), 4.22 (4H, q, *J* = 7.1 Hz, 2 × CH_2); ^{13}C NMR (125 MHz, $CDCl_3$) δ 14.1, 37.2, 61.5, 67.2, 74.8, 169.7; HRMS calcd. for $C_{11}H_{18}O_6$ *m/z* $[M+H]^+$ 247.1176, found 247.1179.

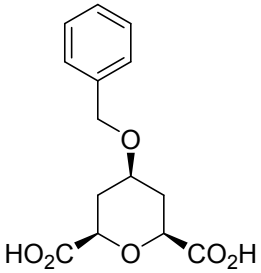
Diethyl (2*R*,4*s*,6*S*)-4-(benzyloxy)tetrahydro-2*H*-pyran-2,6-dicarboxylate[3]



Diethyl (2*R*,4*s*,6*S*)-4-hydroxytetrahydro-2*H*-pyran-2,6-dicarboxylate (1.3 g, 5.3 mmol) was dissolved in DCM (11 mL) and cyclohexane (11 mL). Benzyl trichloroacetamidate (1.09 mL, 5.83 mmol) was introduced dropwise followed by TFA (56 µL) in DCM (0.5 mL). After 15 h, more benzyl trichloroacetamidate (0.55 mL, 2.92 mmol) was added with TFA (38 µL) in DCM (0.5 mL). After a further 4 h at RT, the solvent was removed *in vacuo* and the crude product was purified by MPLC (elution with petrol:EtOAc, 70:30) affording the title compound as a colourless oil (1.6 g, 4.8 mmol, 91%); R_f = 0.53 (petrol:EtOAc, 1:1); IR (neat) ν_{max}/cm^{-1} 1734; ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.23 (6H, t, *J* = 7.2 Hz, 2 × CH_3), 1.55 (2H, q, *J* = 12.2 Hz, 2 × CH), 2.32-2.39 (2H, m, 2 × CH), 3.61 (1H, tt, *J* = 4.4 Hz and 10.9 Hz, CH), 4.18 (4H, q, *J* =

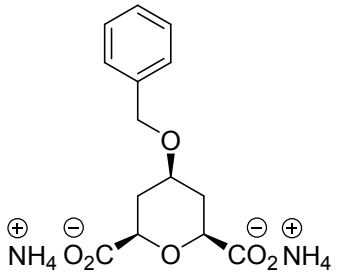
7.2 Hz, 2 × CH_2), 4.54 (2H, s, CH_2), 7.20-7.32 (5H, m, 5 × H-Ar); ^{13}C NMR (125 MHz, $CDCl_3$) δ 14.3, 34.6, 61.6, 69.9, 73.4, 75.0, 127.6, 127.9, 128.6, 138.0, 169.7; HRMS calcd. for $C_{18}H_{24}O_6$ *m/z* $[M+H]^+$ 354.1911, found 354.1915.

(2*R*,4*s*,6*S*)-4-(Benzyloxy)tetrahydro-2*H*-pyran-2,6-dicarboxylic acid 6c:



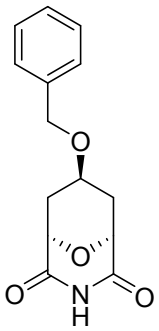
To diethyl (2*R*,4*s*,6*S*)-4-(benzyloxy)tetrahydro-2*H*-pyran-2,6-dicarboxylate (218 mg, 0.60 mmol) in THF (6.5 mL) was added 2 M LiOH in water (4.5 mL, 8.9 mmol) and the mixture was stirred at room temperature for 28 h. The solvent was removed *in vacuo* and the residue taken up in EtOAc (5 mL), H_2O (2 mL) was added and the pH of the aqueous layer was adjusted to 2 with 2M HCl. The product was extracted with EtOAc (3 × 15 mL), the organic extracts were combined and dried ($MgSO_4$), and the solvent was removed *in vacuo* to afford the title compound as a white solid (180 mg, 0.64 mmol, 100%.); R_f = 0.27 (DCM:MeOH, 50:50); mp 165-172 ^oC; IR (neat) ν_{max}/cm^{-1} 3247, 1765, 1711; ^{1}H NMR (500 MHz, DMSO-d_6) δ 1.30 (2H, q, *J* = 12.2 Hz, 2 × CH), 2.25-2.30 (2H, m, 2 × CH), 3.74 (1H, tt, *J* = 4.4 Hz and 10.9 Hz, CH), 4.02 (2H, dd, *J* = 1.9 and 12.3 Hz, 2 × CH), 4.57 (2H, s, CH_2), 7.25-7.40 (5H, m, 5 × H-Ar), 12.75 (2H, br s, OH); ^{13}C NMR (125 MHz, DMSO-d_6) δ 39.9, 69.3, 73.4, 74.0, 127.8, 127.9, 128.7, 139.2, 171.7; HRMS calcd. for $C_{14}H_{16}O_6$ *m/z* $[M-H]^-$ 279.0874, found 279.0876.

Diammonium (2*R*,4*s*,6*S*)-4-(benzyloxy)tetrahydro-2*H*-pyran-2,6-dicarboxylate 7c:



(2*R*,4*s*,6*S*)-4-(Benzyloxy)tetrahydro-2*H*-pyran-2,6-dicarboxylic acid (700 mg, 2.5 mmol) was solubilised in water (3.5 mL) and **35% ammonium hydroxide in water** (3.5 mL) was added dropwise. After stirring for 3 h at RT, the solvent was removed *in vacuo* and by freeze drying, to afford the title compound as a white solid (750 mg, 2.5 mmol, 100%.); R_f = 0.37 (DCM:MeOH, 50:50); mp 234-238 ^oC; IR (neat) ν_{max}/cm^{-1} 3199, 1574; ^1H NMR (500 MHz, DMSO-d_6) δ 1.14 (2H, q, *J* = 11.8 Hz, 2 × CH), 2.31-2.37 (2H, m, 2 × CH), 3.51-3.63 (3H, m, CH and 2 × CH), 4.59 (2H, s, CH_2), 7.20-7.44 (5H, m, 5 × H-Ar), 7.82 (8H, br s, NH); ^{13}C NMR (125 MHz, DMSO-d_6) δ 36.5, 69.0, 75.6, 76.4, 127.7, 127.8, 128.7, 139.6, 175.1; HRMS calcd. for $C_{14}H_{22}N_2O_6$ *m/z* 279.0874 $[M-H]^-$, found 279.0876.

(1*R*,5*S*,7*s*)-7-(benzyloxy)-9-oxa-3-azabicyclo[3.3.1]nonane-2,4-dione 8c:



(1*R*,5*S*,7*s*)-7-(benzyloxy)-9-oxa-3-azabicyclo[3.3.1]nonane-2,4-dione was synthesised according to general procedure B, using: diammonium (2*R*,4*s*,6*S*)-4-(benzyloxy)tetrahydro-2*H*-pyran-2,6-dicarboxylate (300 mg, 0.90 mmol) and purification by MPLC (petrol:EtOAc, 70:30) to afford the title compound as a white solid (83 mg, 0.32 mmol, 35%); R_f = 0.57 (EtOAc); mp 164-169 ^oC; IR (neat) ν_{max}/cm^{-1} 3178, 1698; ^1H NMR (500 MHz, $CDCl_3$) 2.07 (2H, dq, *J* = 3.3 and 14.5 Hz, 2 x CH), 2.21-2.34 (2H, m, 2 × CH), 3.78 (1H, pen, *J* = 2.7 Hz, CH), 4.33 (2H, s, CH_2), 4.41 (2H, d, *J* = 6.1 Hz, 2 × CH), 7.12-7.30 (5H, m, 5 × H-Ar), 7.87 (1H, bs, NH); ^{13}C NMR (125 MHz, $CDCl_3$) δ 29.9, 68.6, 69.4, 70.0, 126.3, 126.7, 127.4, 136.3, 171.6; HRMS calcd. for $C_{14}H_{15}NO_4$ *m/z* 279.1339 $[M+H]^+$, found 279.1344.

References

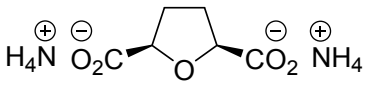
1. A.C. Cope and A. Fournier, *J. Am. Chem. Soc*., 1957, **79**, 3896.

2. E. E. Blaise and H. Gault, *Bull. Soc. Chim. Fr*., 1907, 4.

3. B. Schmidt, *Heterocycles*, 1999, **51**, 179.

Table 1: Crystal data and structure refinement for **6a**.

Empirical formula	$C_7H_{13}NO_5$
Formula weight	191.18
Temperature/K	150.0(2)
Crystal system	triclinic
Space group	P-1
a/Å	6.9141(2)
b/Å	9.3897(3)
c/Å	14.4781(5)
α/°	101.468(3)
β/°	96.993(3)
γ/°	98.349(3)
Volume/Å^3	900.34(5)
Z	4
ρ_{calc}g/cm^3	1.410
μ/mm^{-1}	1.036
F(000)	408.0
Crystal size/mm^3	0.15 × 0.11 × 0.08
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	6.306 to 133.746
Index ranges	$-8 \leq h \leq 8$, $-11 \leq k \leq 11$, $-16 \leq l \leq 14$
Reflections collected	12629
Independent reflections	3184 [R_{int} = 0.0253, R_{sigma} = 0.0180]
Data/restraints/parameters	3184/2/275
Goodness-of-fit on F^2	1.038
Final R indexes [I>=2σ (I)]	R_1 = 0.0312, wR_2 = 0.0817
Final R indexes [all data]	R_1 = 0.0345, wR_2 = 0.0843
Largest diff. peak/hole / e Å^{-3}	0.26/-0.24



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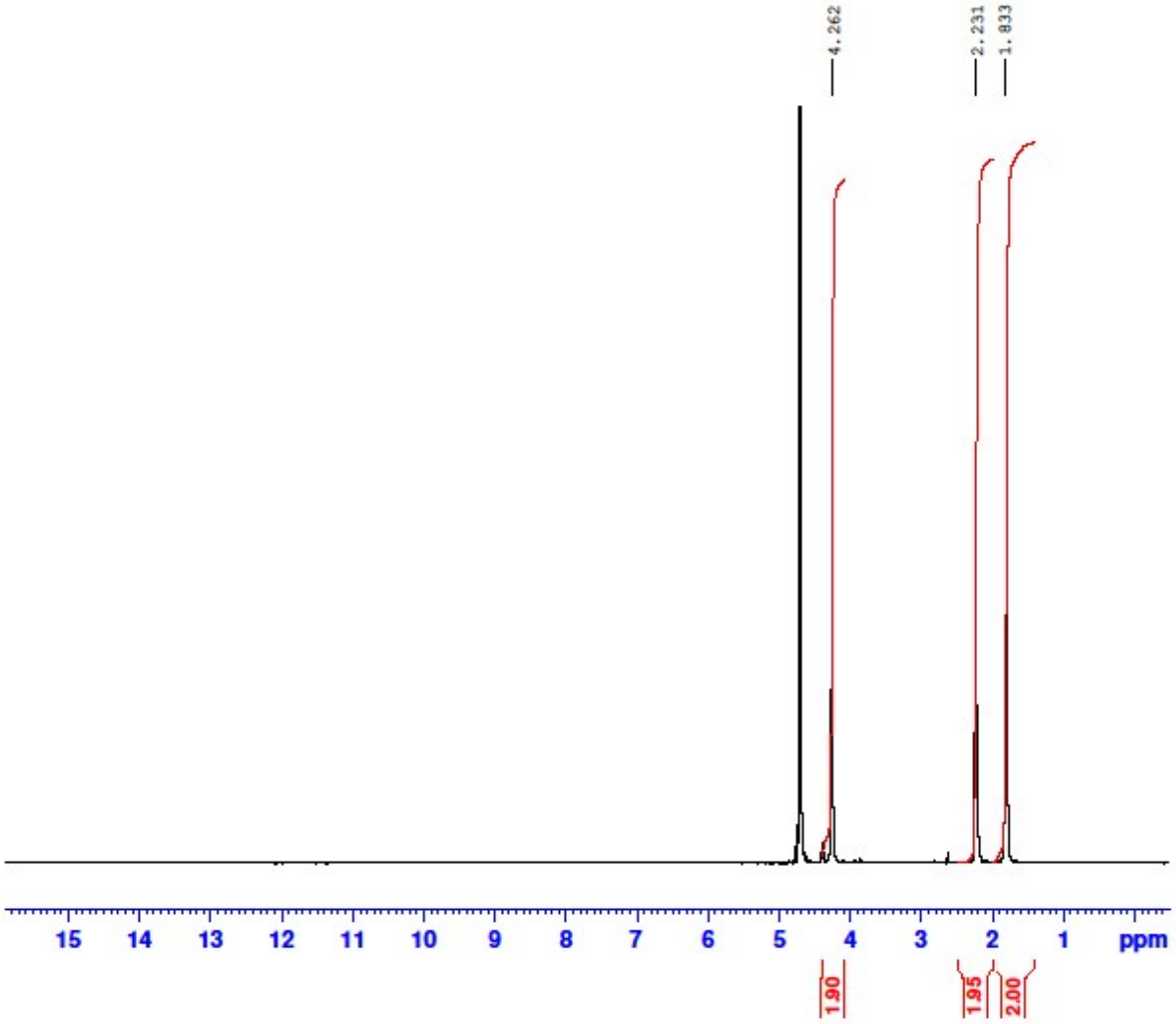


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FIDRES         0.157632 Hz
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TE               298.1 K
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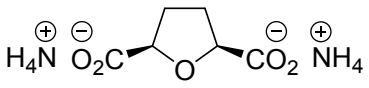

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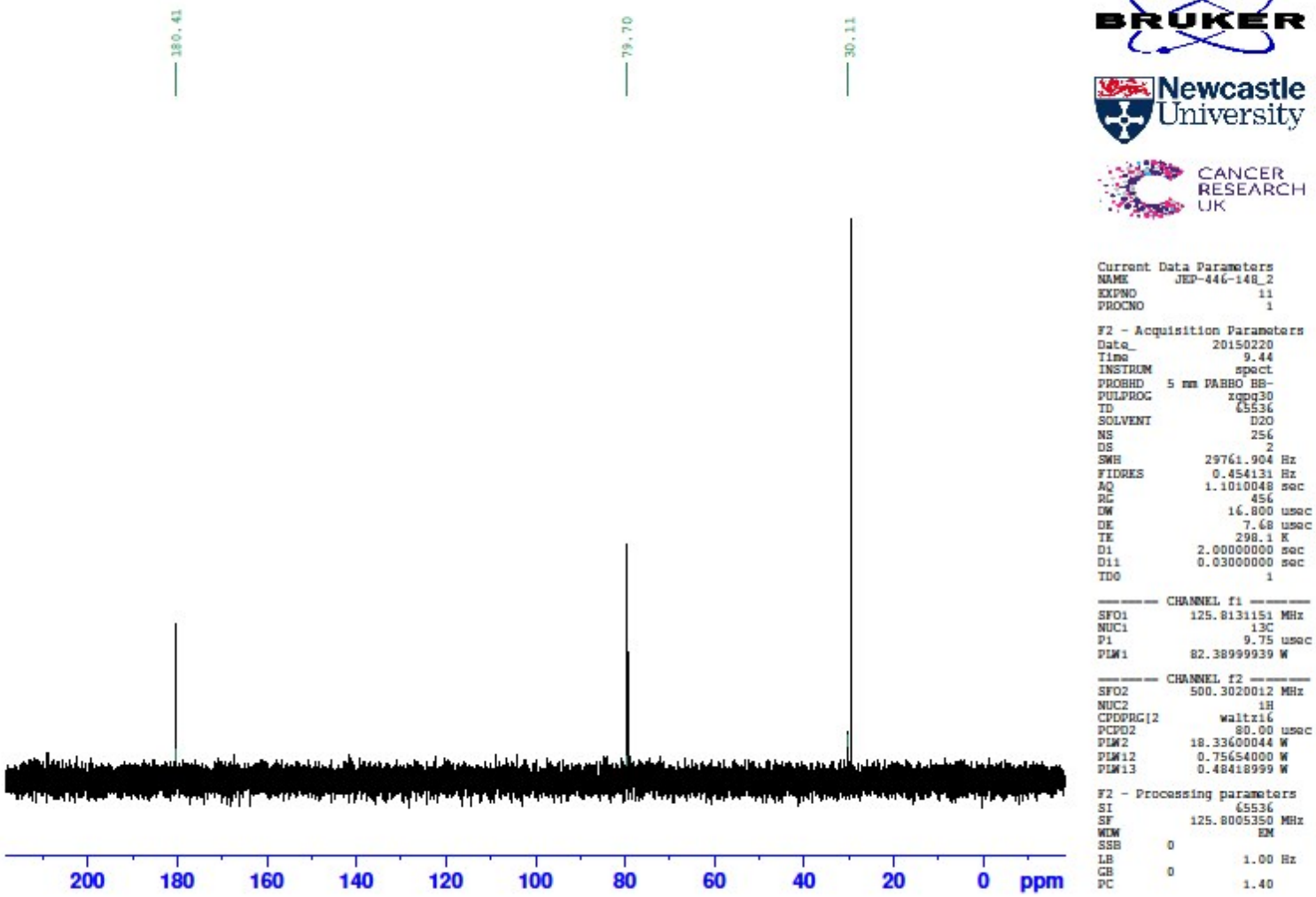

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PROCNO 1

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FIDRES 0.454131 Hz
AQ 1.1010048 sec
RG 456
DW 16.800 usec
DE 7.68 usec
TE 298.1 K
D1 2.00000000 sec
D11 0.03000000 sec
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NUC1 13C
P1 9.75 usec
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CHANNEL f2
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PCPD2 80.00 usec
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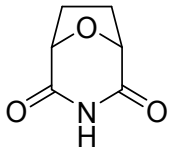

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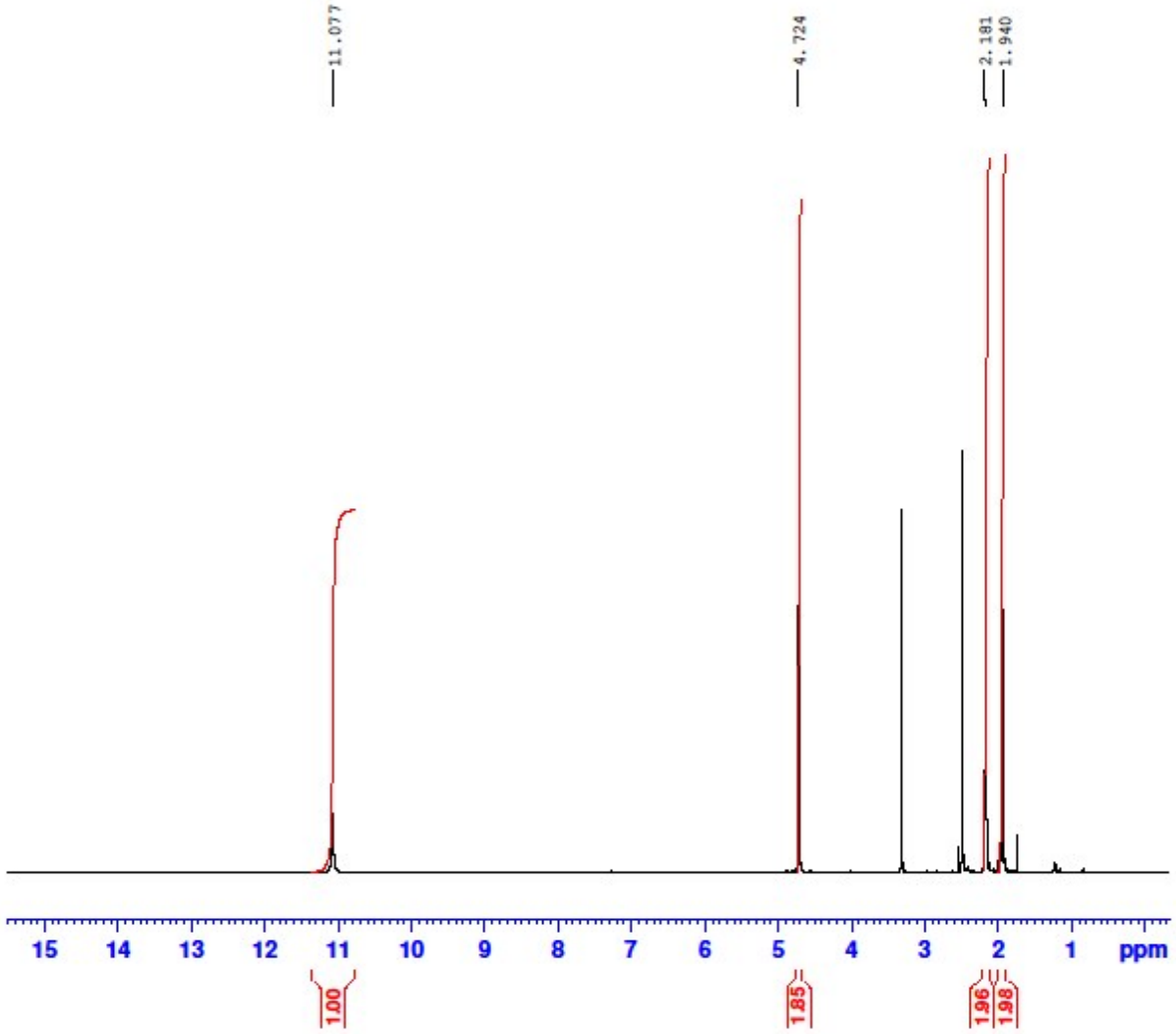

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AQ            3.1719425 sec
RG                   406
DW                48.400 usec
DE                12.35 usec
TE                295.0 K
D1           1.00000000 sec
TD0                    1

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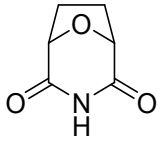

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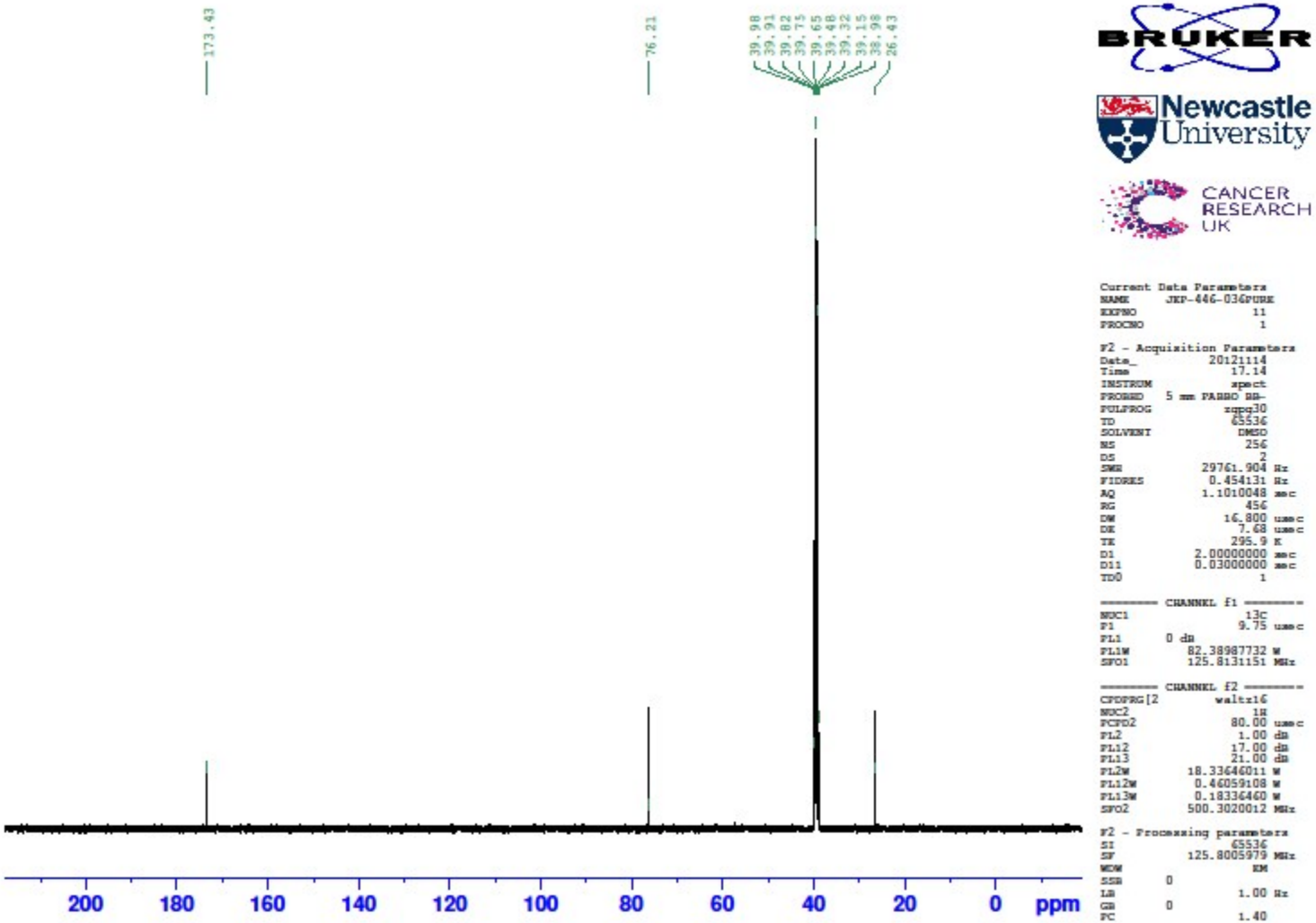
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76.21
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26.43
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180
160
140
120
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40
20
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ppm
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PL1 0 dB
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CHANNEL f2
CPDPRG[2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 1.00 dB
PL12 17.00 dB
PL13 21.00 dB
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PL12W 0.46059108 W
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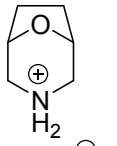

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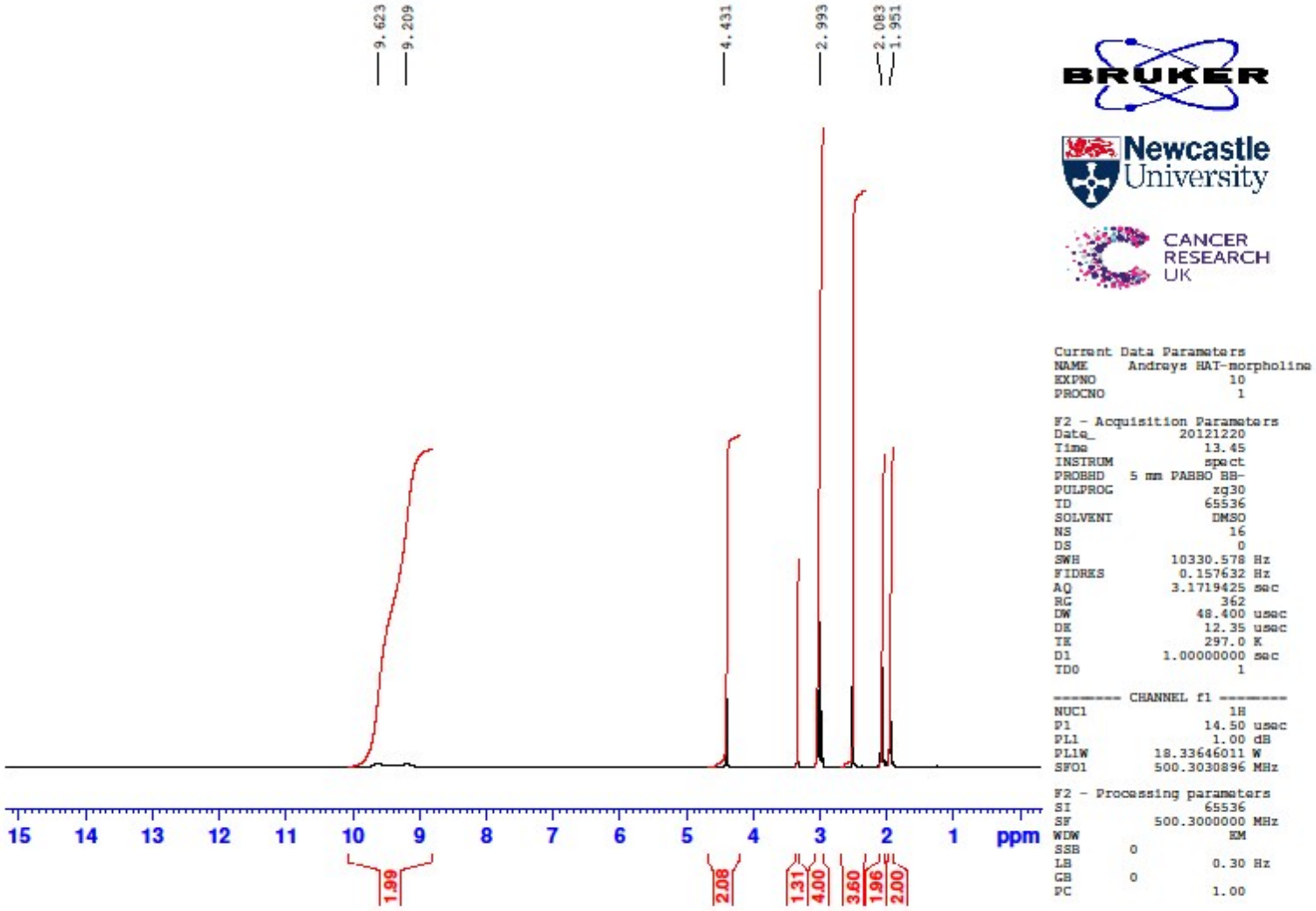

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PROCNO                         1

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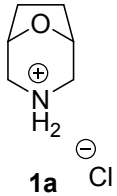

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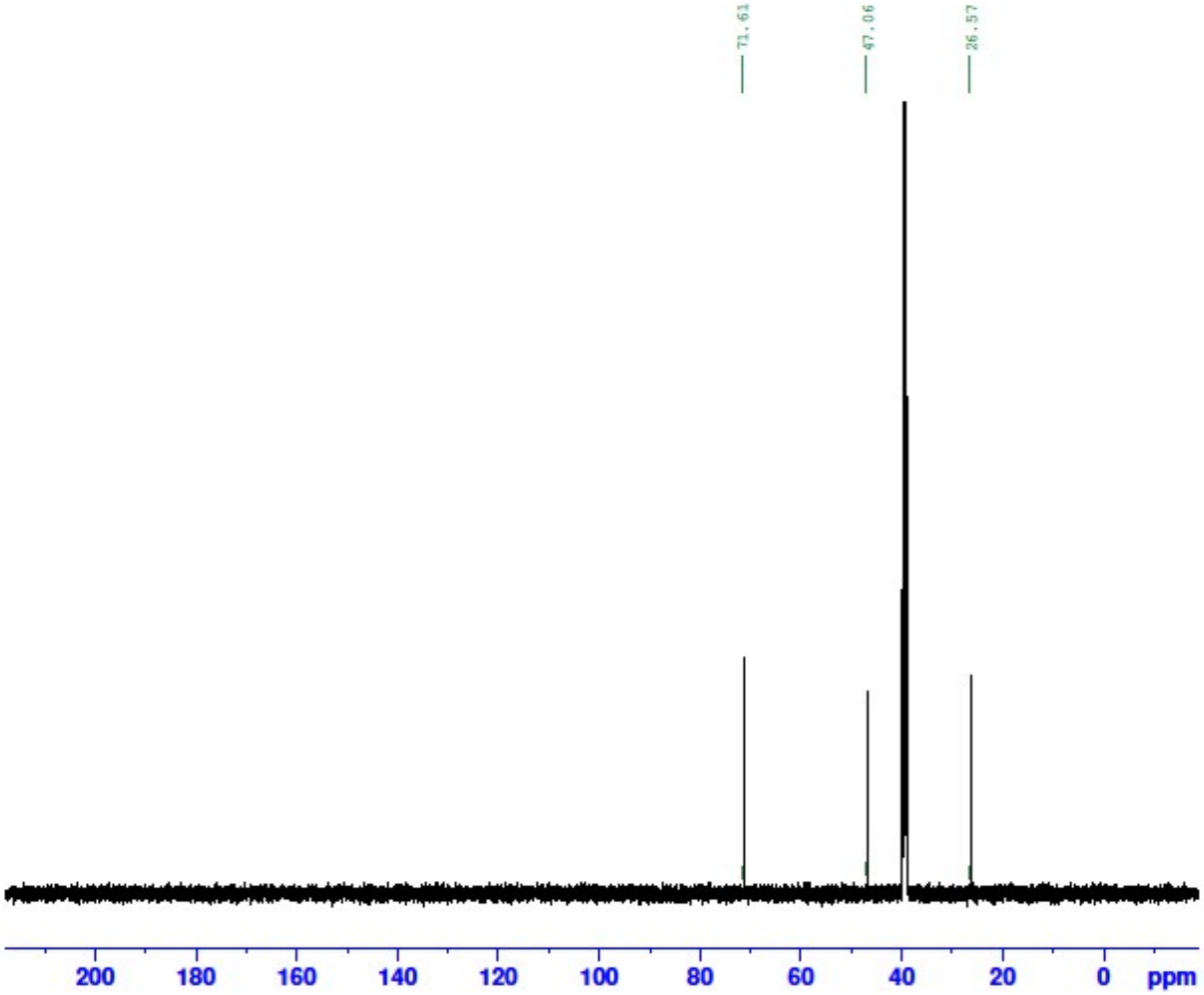


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TE               297.0 K
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D11           0.03000000 sec
TD0                    1

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P1                 9.75 usec
PL1       0 dB
PL1W       82.38987732 W
SFO1       125.8131151 MHz

========== CHANNEL f2 ========
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NUC2                 1H
PCPD2              80.00 usec
PL2                1.00 dB
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PL13W       0.18336460 W
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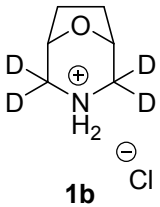

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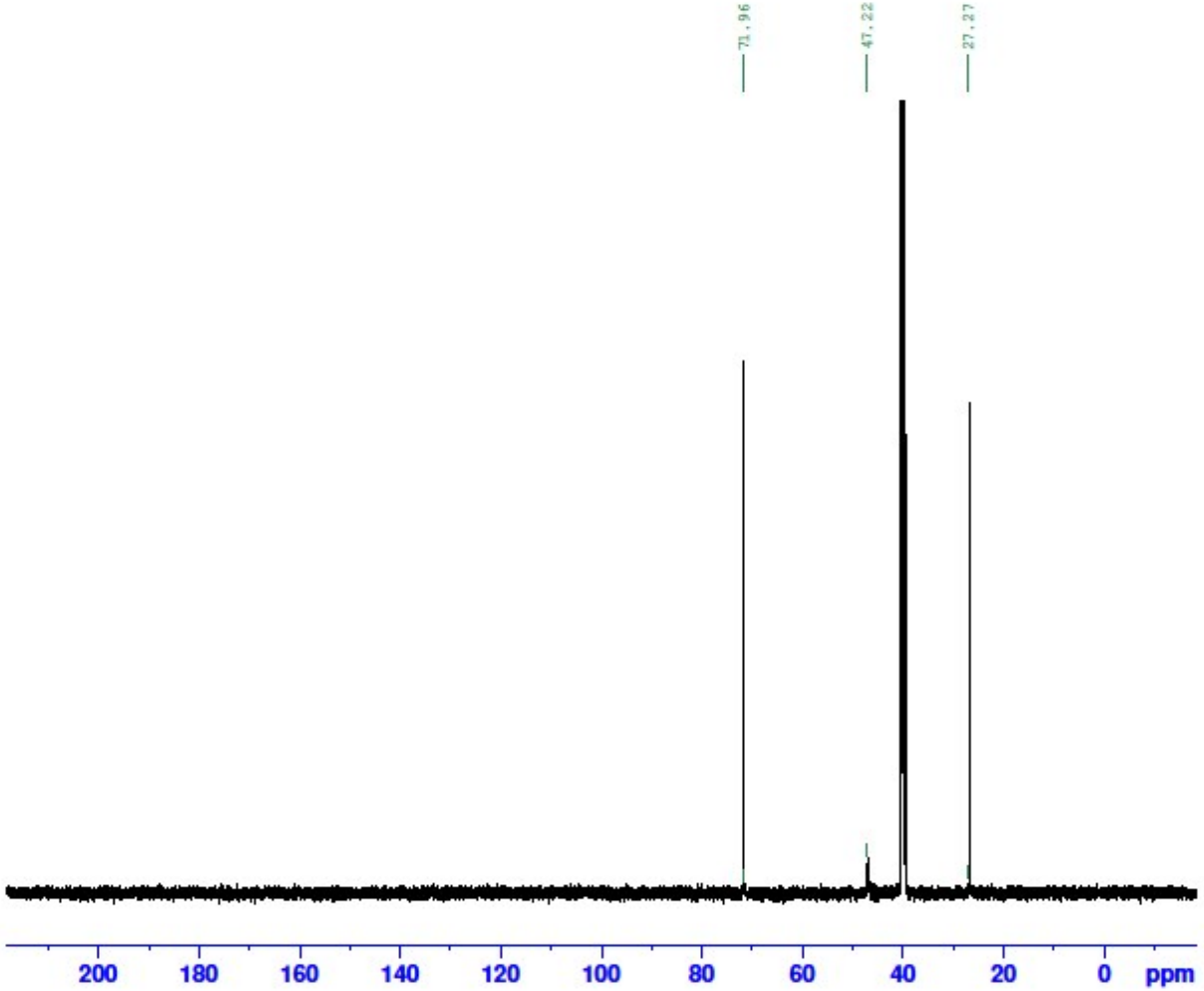

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DE                7.72 usec
TE               298.0 K
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D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
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NUC1               13C
P1                9.75 usec
PLW1         82.38999939 W

======== CHANNEL f2 ========
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NUC2               1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         18.33600044 W
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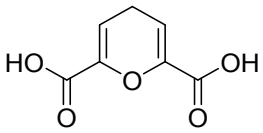
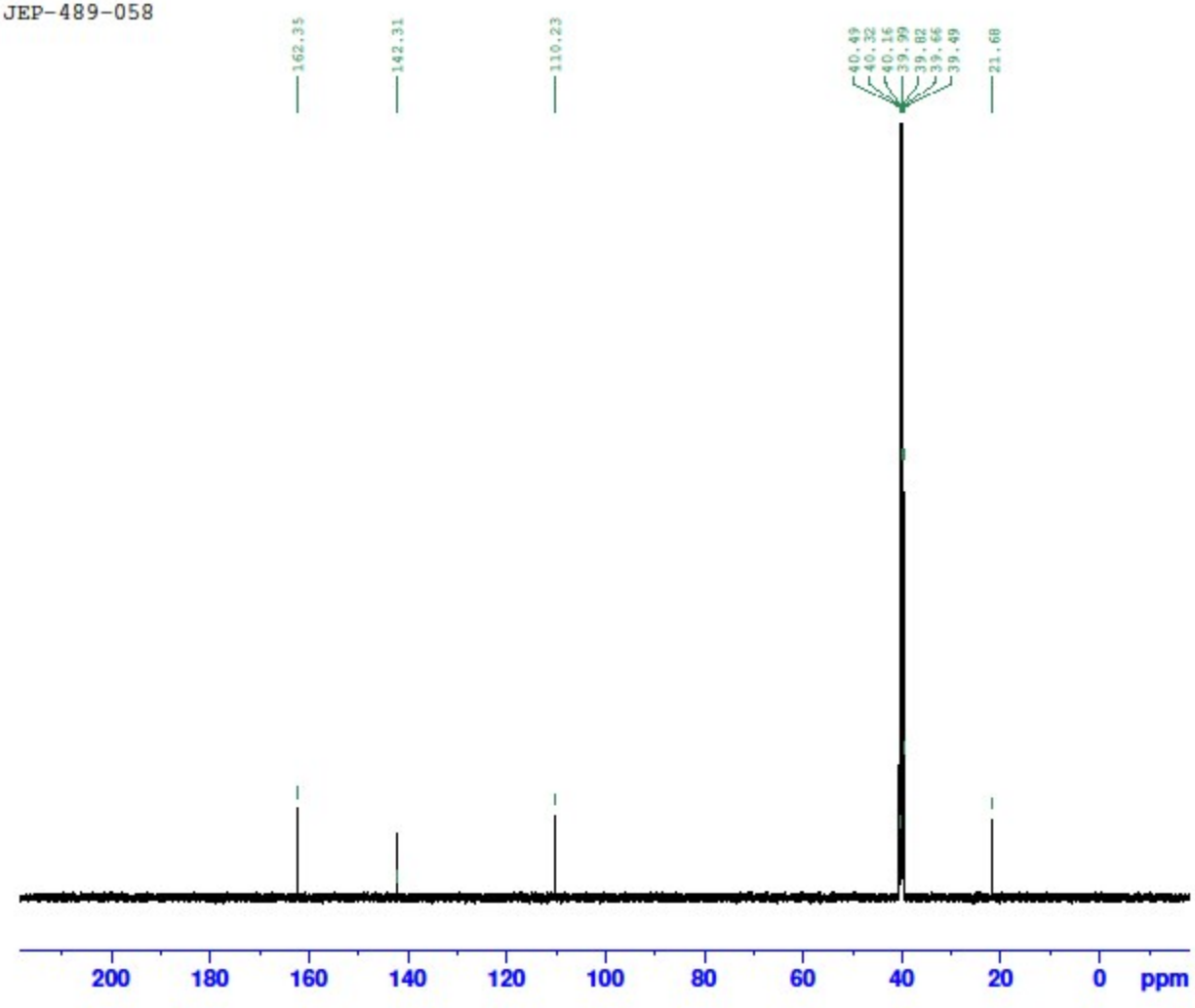


JEP-489-058



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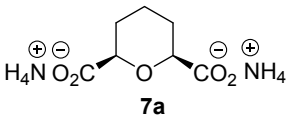
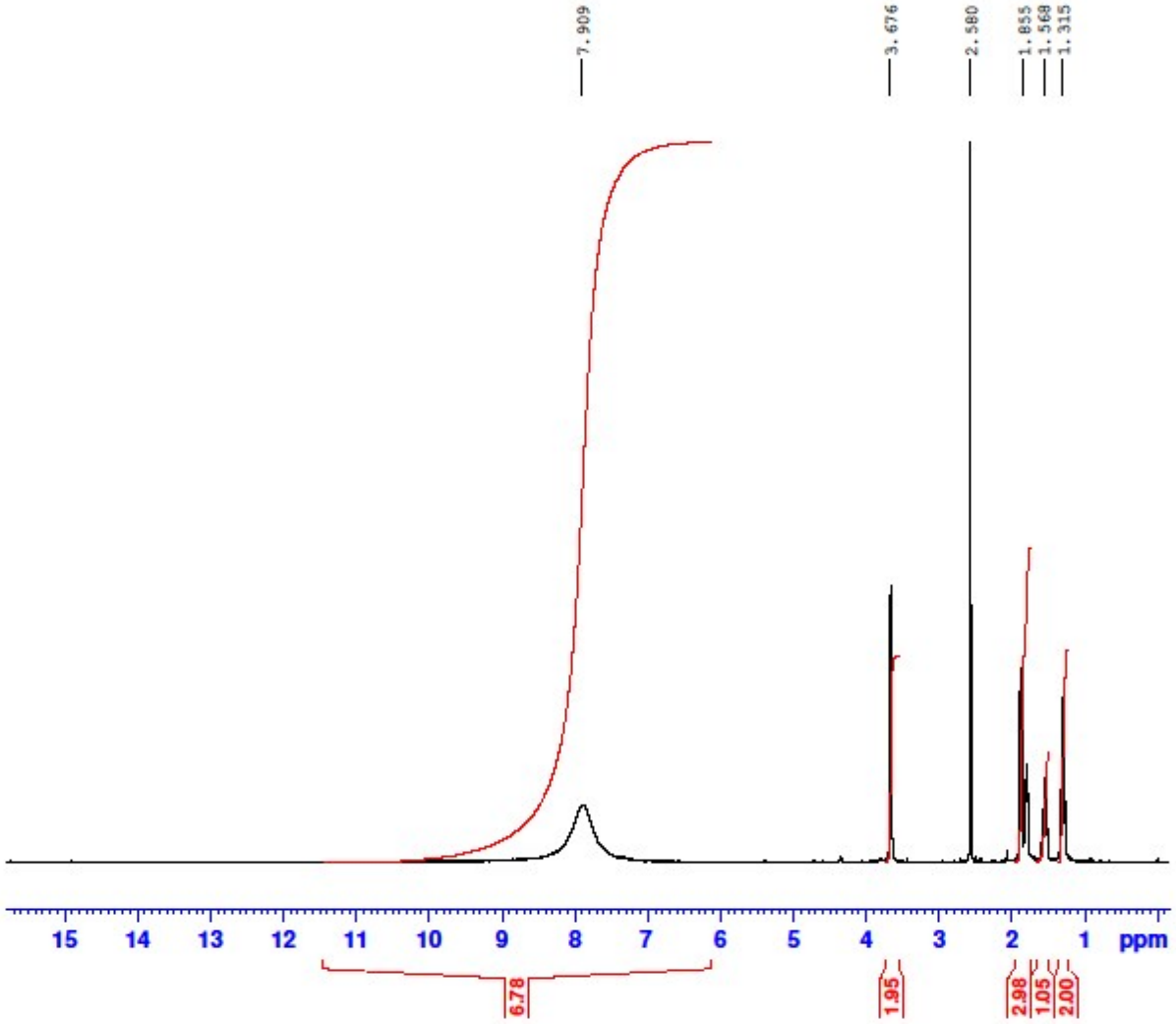
PC                1.40
```



7a



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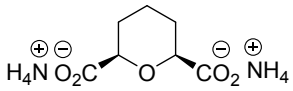
```
Current Data Parameters
NAME         JEP-489-152
EXPNO                 50
PROCNO                 1

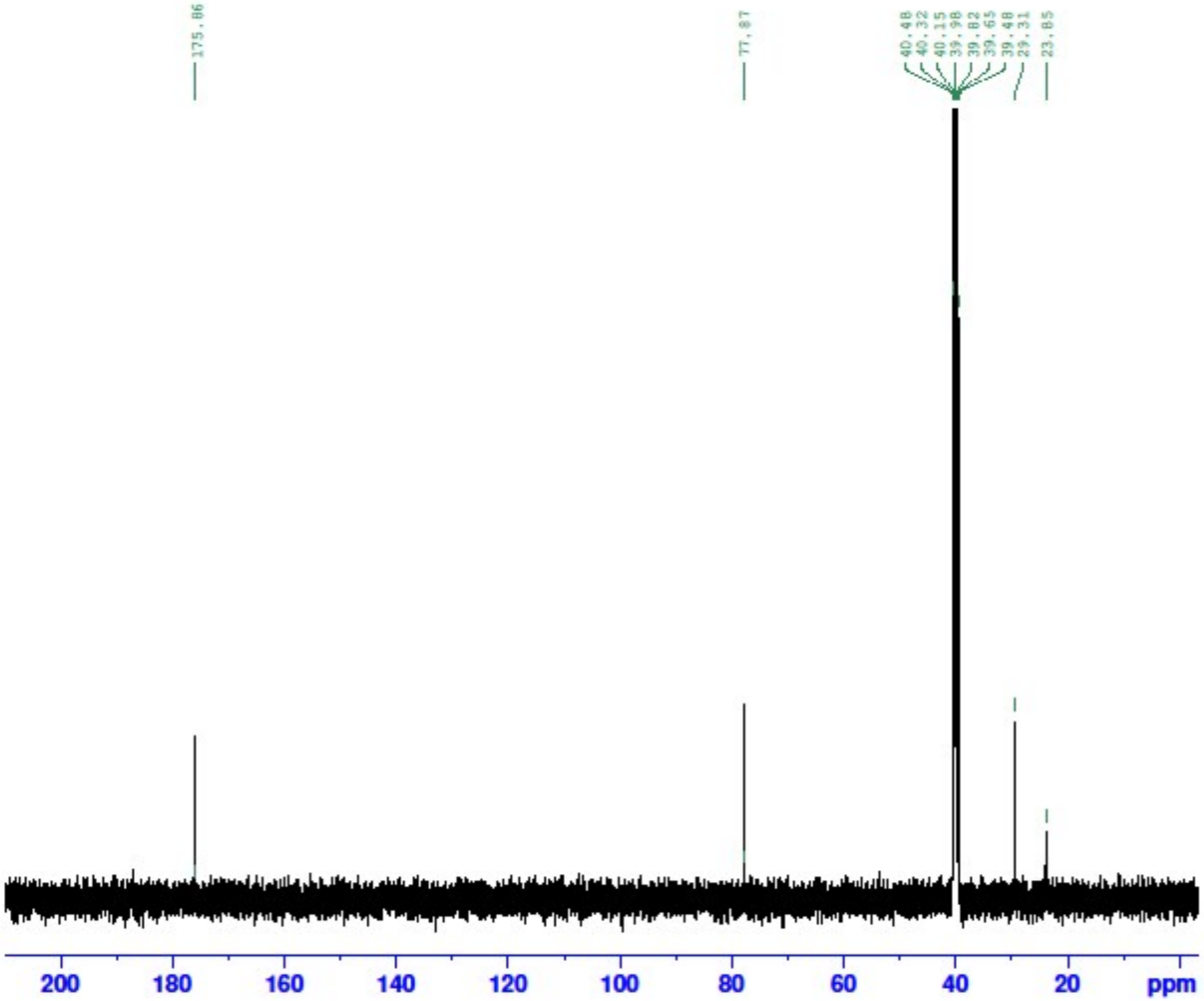
F2 - Acquisition Parameters
Date_           20150203
Time               15.37
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT             DMSO
NS                    16
DS                     0
SWH            10330.578 Hz
FIDRES         0.157632 Hz
AQ             3.1719425 sec
RG                   362
DW                48.400 usec
DE                11.99 usec
TE                292.7 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          500.3030896 MHz
NUC1                  1H
P1                 16.25 usec
PLW1          18.33600044 W

F2 - Processing parameters
SI                 65536
SF            500.2999679 MHz
WDW                   EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
```



7a



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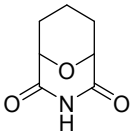
```
Current Data Parameters
NAME          JKP-489-152
EXPNO                  51
PROCNO                  1

F2 - Acquisition Parameters
Date_           20150203
Time              16.24
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG         zgpg30
TD               65536
SOLVENT           DMSO
NS                  256
DS                    2
SWH           29761.904 Hz
FIDRES        0.454131 Hz
AQ            1.1010048 sec
RG                  575
DW               16.800 usec
DE                7.68 usec
TE               295.7 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

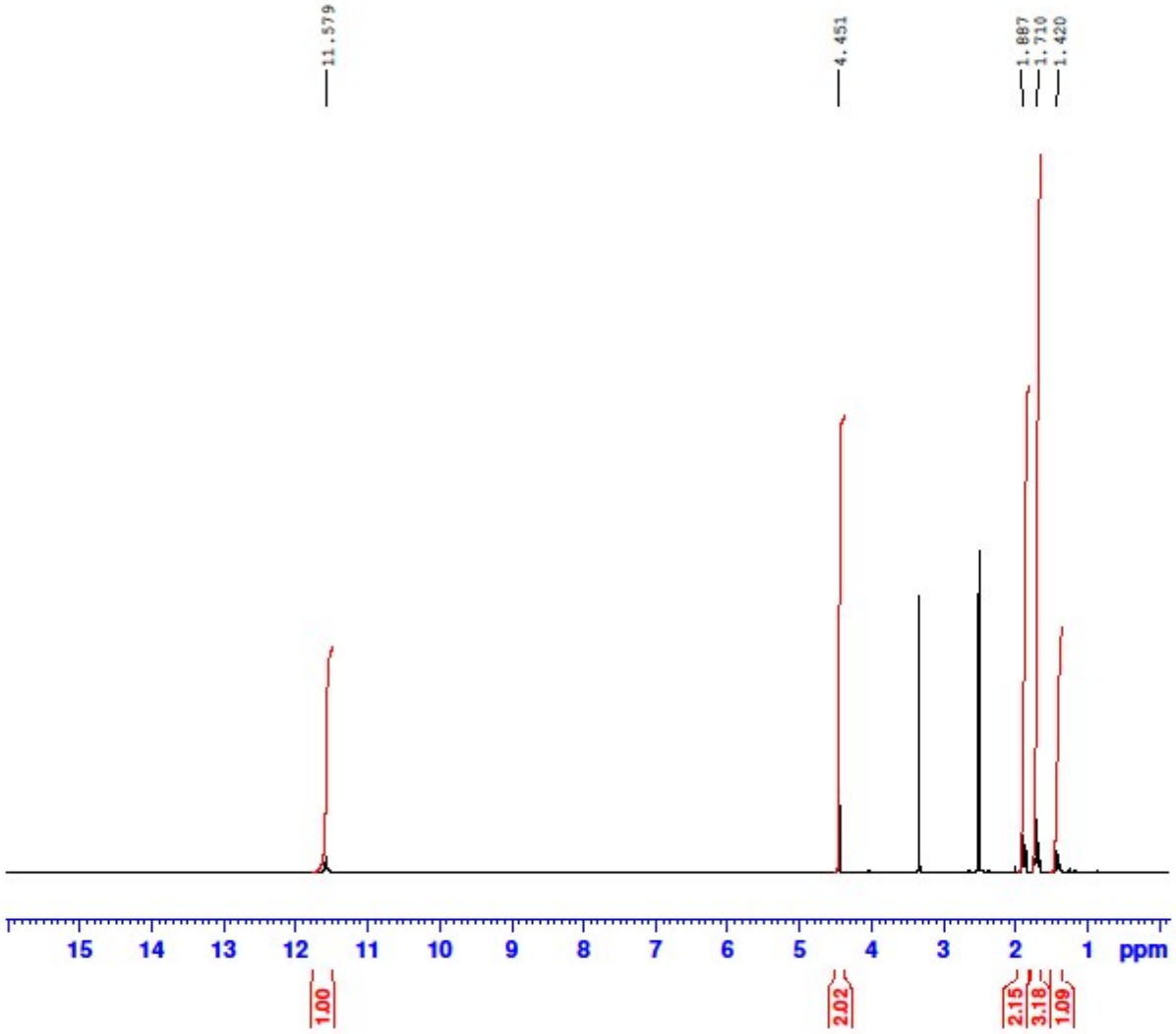
======== CHANNEL f1 ========
SFO1         125.8131151 MHz
NUC1               13C
P1                9.75 usec
PLW1         82.38999939 W

======== CHANNEL f2 ========
SFO2         500.3020012 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2             80.00 usec
PLW2         18.33600044 W
PLW12         0.75654000 W
PLW13         0.48418999 W

F2 - Processing parameters
SI                65536
SF           125.8005350 MHz
WDW                 EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



8a



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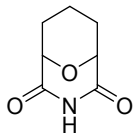
```
Current Data Parameters
NAME         JEP-489-090
EXPNO                 11
PROCNO                 1

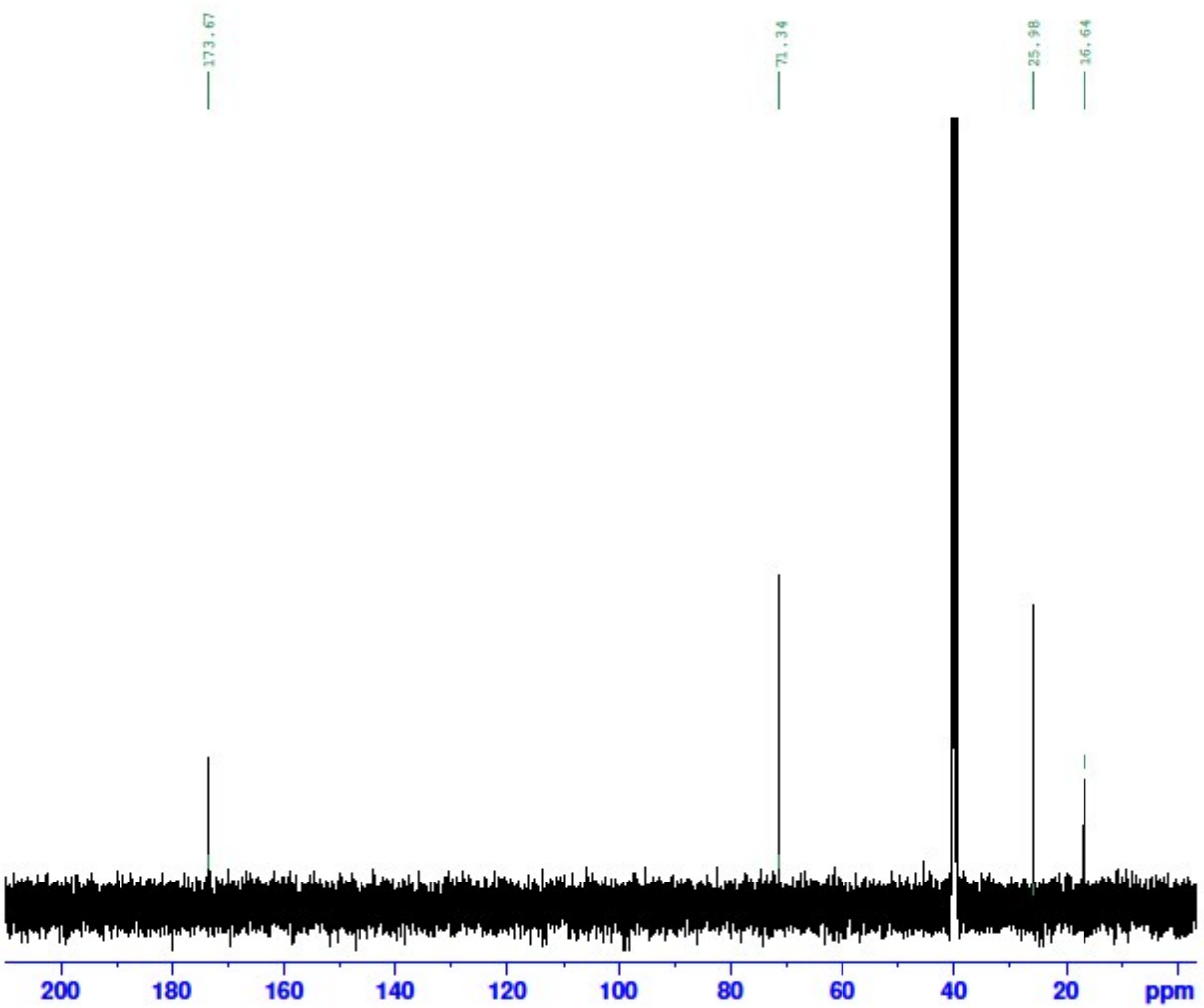
F2 - Acquisition Parameters
Date_           20141016
Time                8.51
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT             DMSO
NS                    16
DS                     0
SWH           10330.578 Hz
FIDRES         0.157632 Hz
AQ            3.1719425 sec
RG                   724
DW                48.400 usec
DE                11.99 usec
TE                295.3 K
D1           1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         500.3030896 MHz
NUC1                   1H
P1                  16.25 usec
PLW1        18.33600044 W

F2 - Processing parameters
SI                 65536
SF           500.3000000 MHz
WDW                   EM
SSB       0
LB                  0.30 Hz
GB        0
PC                  1.00
```



8a



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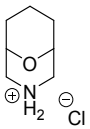
```
Current Data Parameters
NAME          JKP-489-090
EXPNO                  16
PROCNO                  1

F2 - Acquisition Parameters
Date_           20141016
Time              22.44
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG         zgpg30
TD               65536
SOLVENT           DMSO
NS                  256
DS                    2
SWH           29761.904 Hz
FIDRES        0.454131 Hz
AQ            1.1010048 sec
RG                  456
DW               16.800 usec
DE                7.68 usec
TE               298.5 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

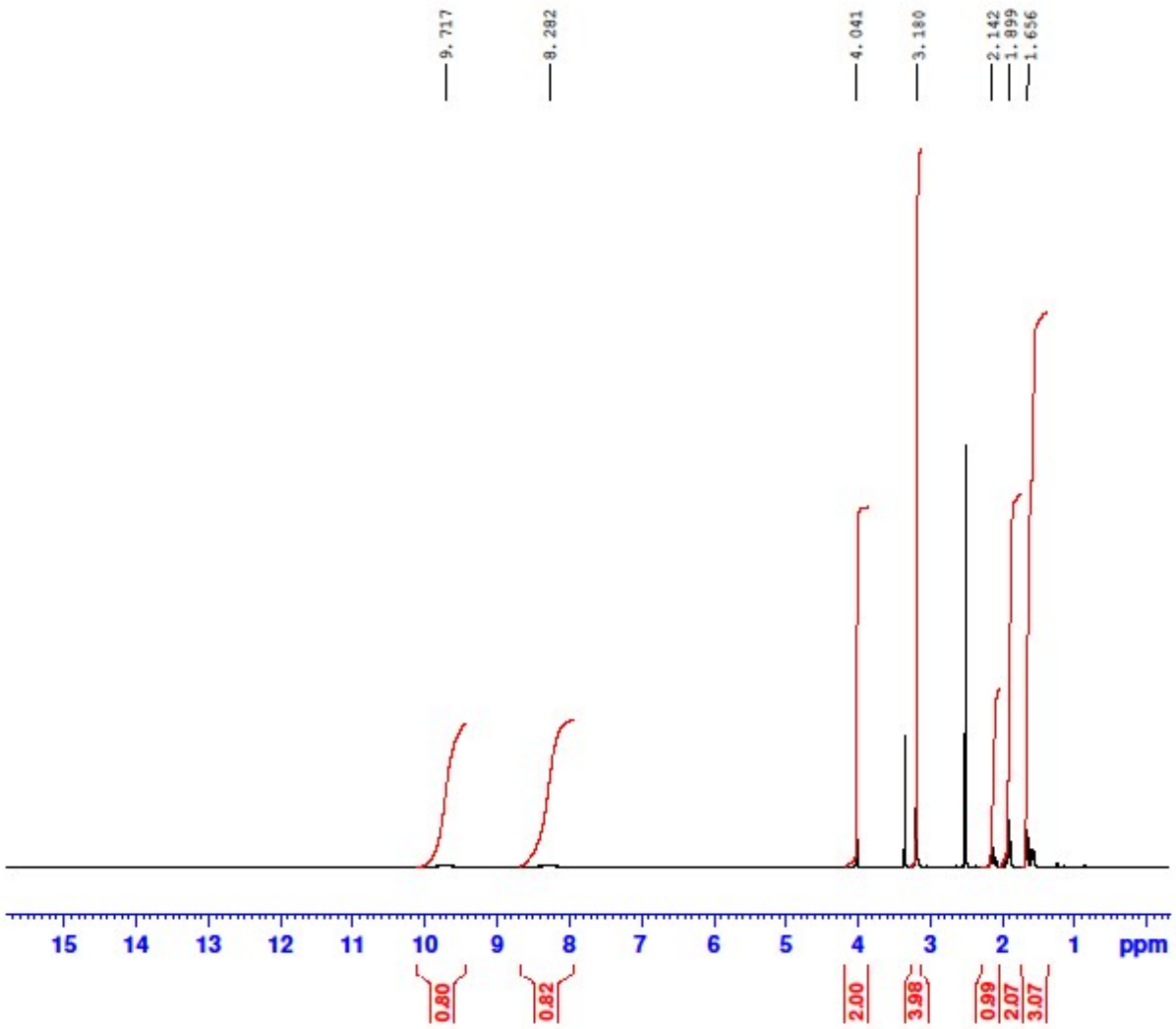
======== CHANNEL f1 ========
SFO1         125.8131151 MHz
NUC1               13C
P1                9.75 usec
PLW1         82.38999939 W

======== CHANNEL f2 ========
SFO2         500.3020012 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2             80.00 usec
PLW2         18.33600044 W
PLW12         0.75654000 W
PLW13         0.48418999 W

F2 - Processing parameters
SI                65536
SF           125.8005350 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



2a

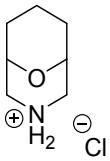



```
Current Data Parameters
NAME         JEP-489-162
EXPNO                 20
PROCNO                 1

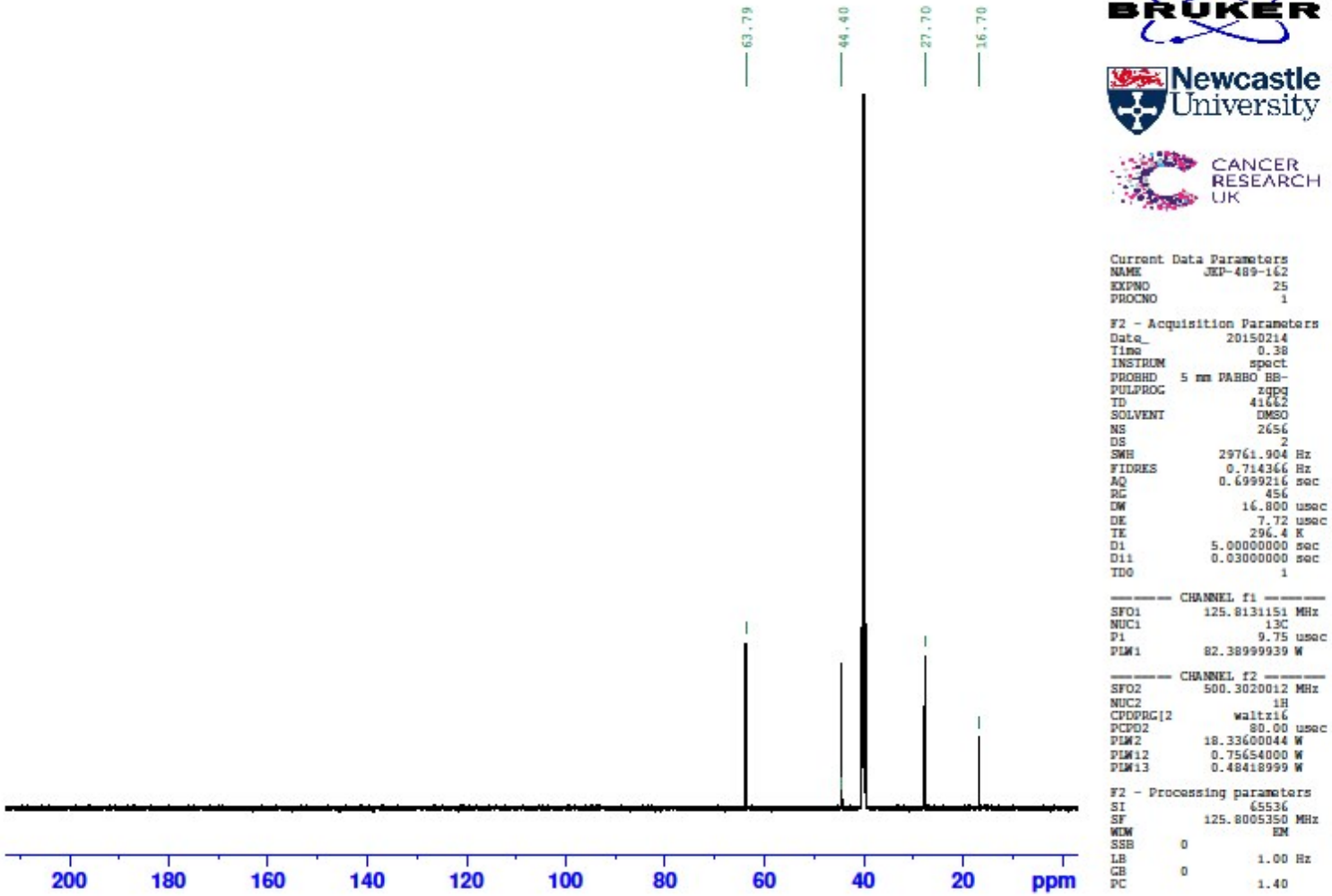
F2 - Acquisition Parameters
Date_           20150213
Time               9.15
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG            zg30
TD                65536
SOLVENT            DMSO
NS                   16
DS                    0
SWH           10330.578 Hz
FIDRES        0.157632 Hz
AQ            3.1719425 sec
RG                  575
DW               48.400 usec
DE               11.99 usec
TE               292.5 K
D1            1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         500.3030896 MHz
NUC1                1H
P1                16.25 usec
PLW1         18.33600044 W

F2 - Processing parameters
SI                65536
SF           500.3000000 MHz
WDW                  EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```



2a



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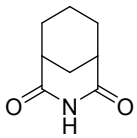
```
Current Data Parameters
NAME          JEP-489-162
EXPNO                  25
PROCNO                  1

F2 - Acquisition Parameters
Date_           20150214
Time                0.38
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG            zgpg
TD                41662
SOLVENT            DMSO
NS                  2656
DS                     2
SWH           29761.904 Hz
FIDRES        0.714366 Hz
AQ            0.6999216 sec
RG                   456
DW               16.800 usec
DE                7.72 usec
TE               296.4 K
D1            5.00000000 sec
D11           0.03000000 sec
TD0                    1

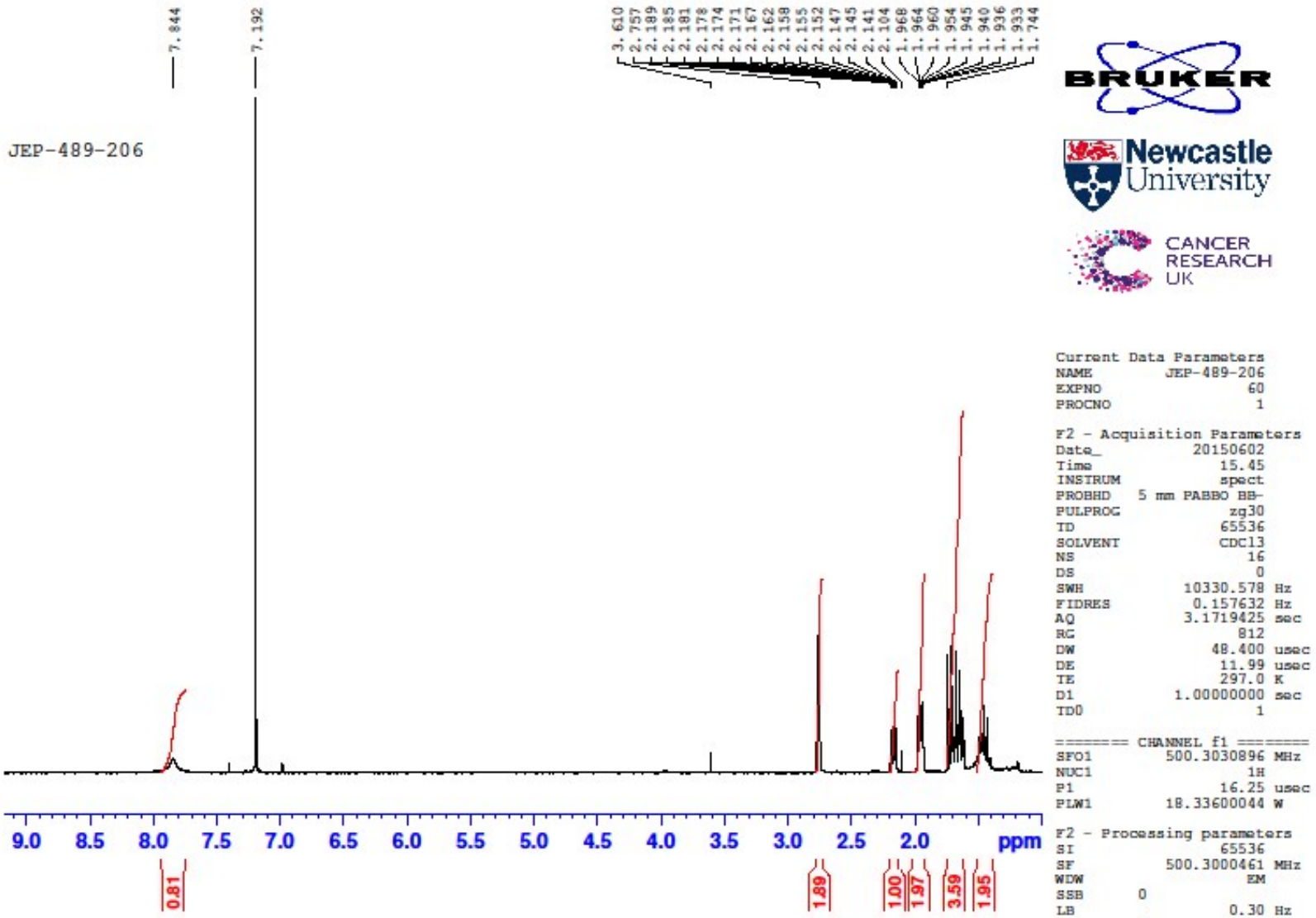
====== CHANNEL f1 ======
SFO1         125.8131151 MHz
NUC1                13C
P1                 9.75 usec
PLW1         82.38999939 W

====== CHANNEL f2 ======
SFO2         500.3020012 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2              80.00 usec
PLW2         18.33600044 W
PLW12         0.75654000 W
PLW13         0.48418999 W

F2 - Processing parameters
SI                 65536
SF           125.8005350 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```



8b



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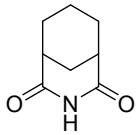
```
Current Data Parameters
NAME         JEP-489-206
EXPNO                 60
PROCNO                 1

F2 - Acquisition Parameters
Date_           20150602
Time               15.45
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     0
SWH          10330.578 Hz
FIDRES        0.157632 Hz
AQ           3.1719425 sec
RG                   812
DW              48.400 usec
DE              11.99 usec
TE              297.0 K
D1           1.00000000 sec
TD0                    1

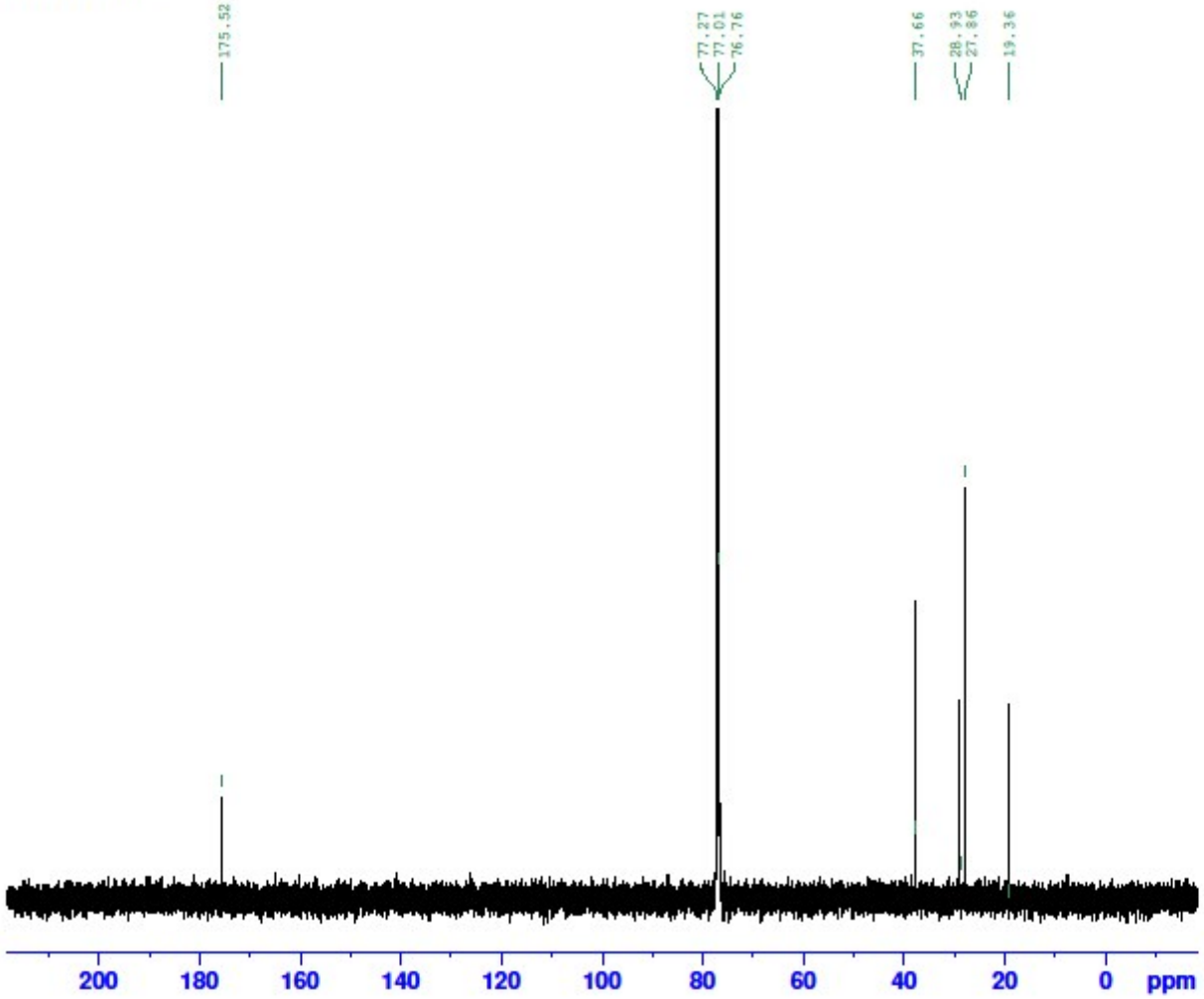
======== CHANNEL f1 ========
SFO1         500.3030896 MHz
NUC1                 1H
P1                16.25 usec
PLW1        18.33600044 W

F2 - Processing parameters
SI                 65536
SF           500.3000461 MHz
WDW                   EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
```



8b

JEP-489-206



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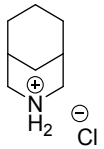
```
Current Data Parameters
NAME          JEP-489-206
EXPNO                  61
PROCNO                  1

F2 - Acquisition Parameters
Date_          20150603
Time               4.41
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG         zgpg30
TD               65536
SOLVENT          CDCl3
NS                2560
DS                   2
SWH          29761.904 Hz
FIDRES        0.454131 Hz
AQ            1.1010048 sec
RG                 456
DW              16.800 usec
DE               7.68 usec
TE              298.9 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

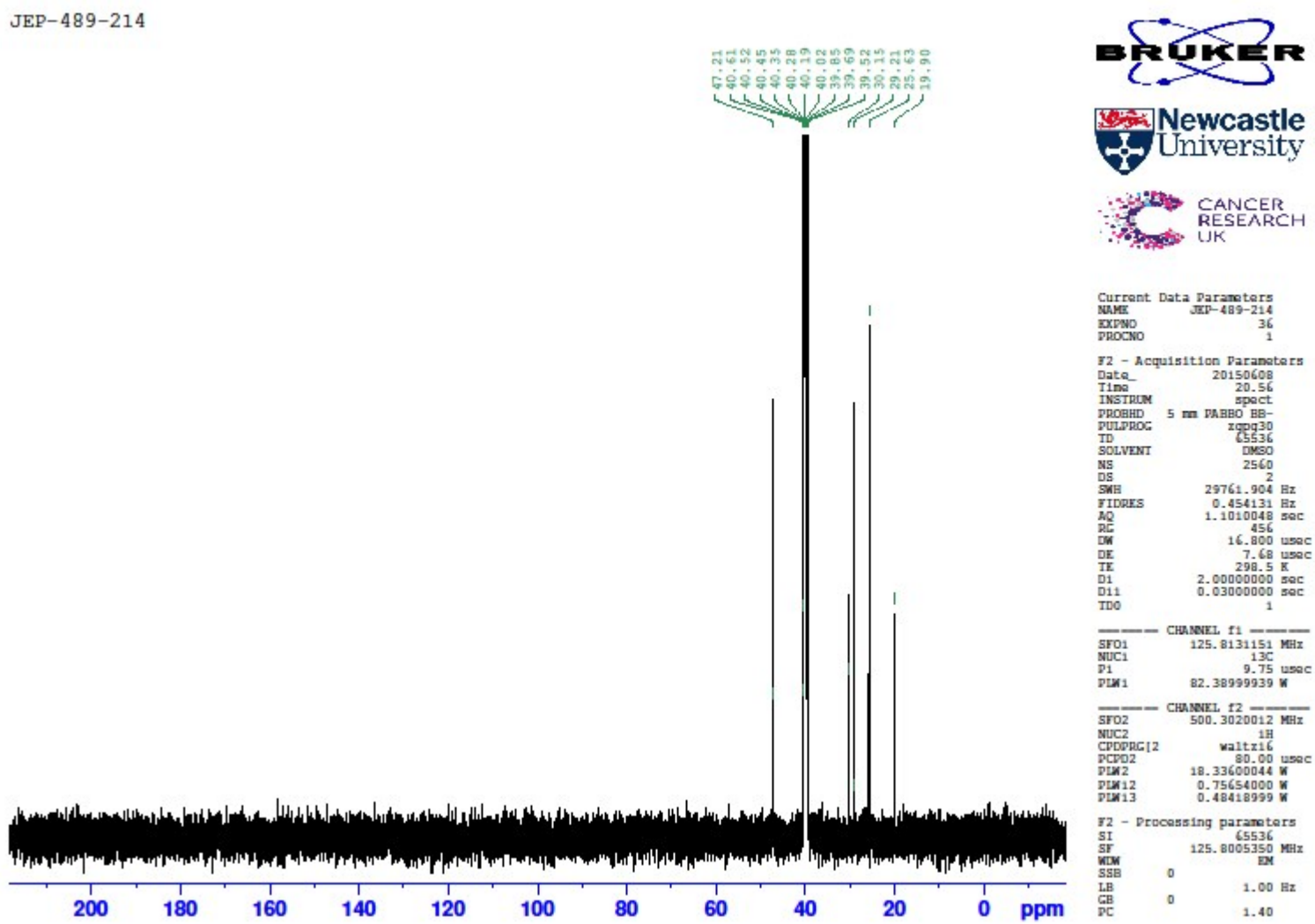
======== CHANNEL f1 ========
SFO1        125.8131151 MHz
NUC1              13C
P1               9.75 usec
PLW1        82.38999939 W

======== CHANNEL f2 ========
SFO2        500.3020012 MHz
NUC2              1H
CPDPRG[2        waltz16
PCPD2            80.00 usec
PLW2        18.33600044 W
PLW12        0.75654000 W
PLW13        0.48418999 W

F2 - Processing parameters
SI               65536
SF          125.8005350 MHz
WDW                 EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



2b



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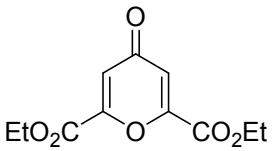
Current Data Parameters
NAME JEP-489-214
EXPNO 36
PROCNO 1

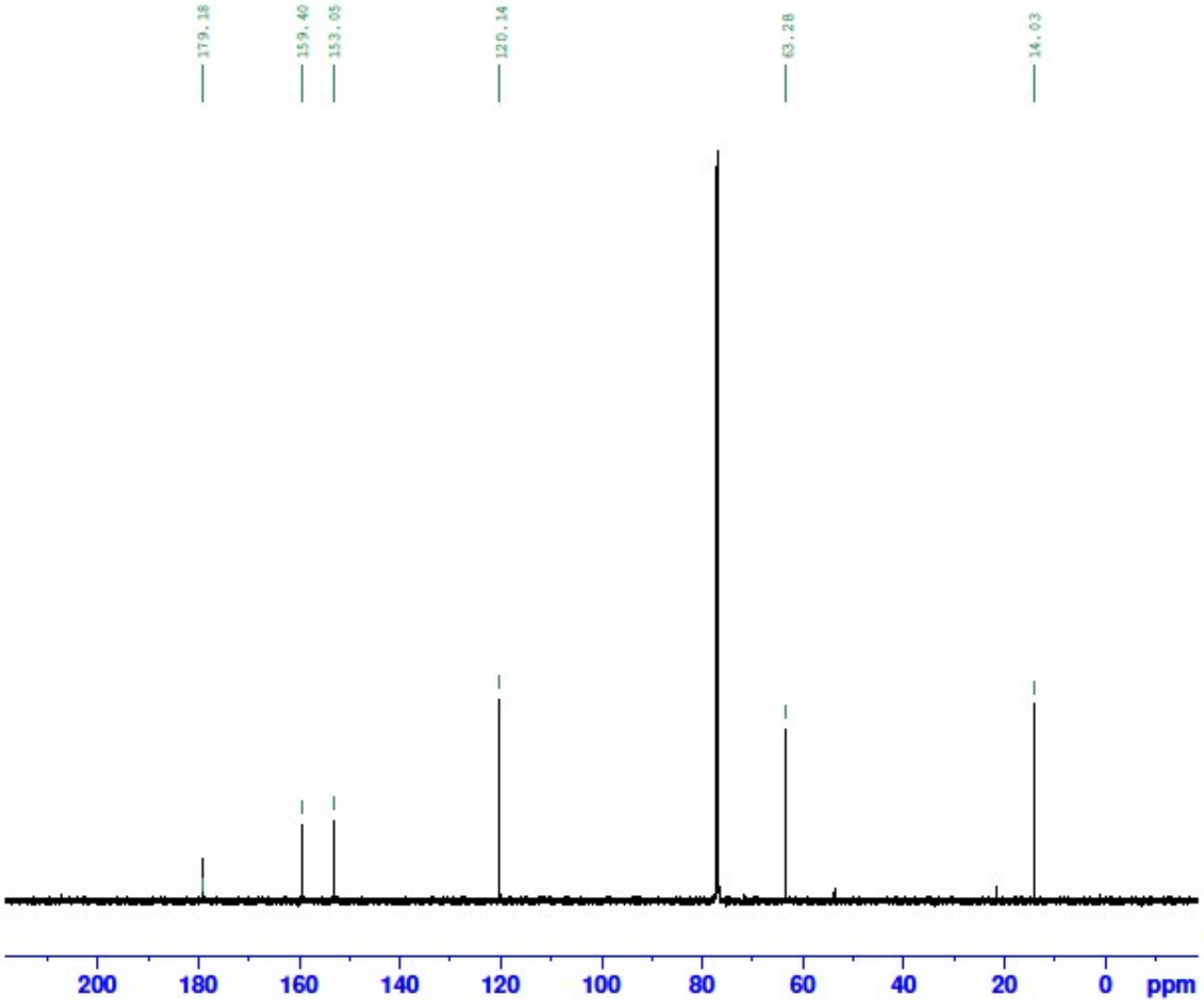
F2 - Acquisition Parameters
Date_ 20150608
Time 20.56
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 2560
DS 2
SWH 29761.904 Hz
FIDRES 0.454131 Hz
AQ 1.1010048 sec
RG 456
DW 16.800 usec
DE 7.68 usec
TE 298.5 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

======== CHANNEL f1 ========
SFO1 125.8131151 MHz
NUC1 13C
P1 9.75 usec
PLW1 82.38999939 W

======== CHANNEL f2 ========
SFO2 500.3020012 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 80.00 usec
PLW2 18.33600044 W
PLW12 0.75654000 W
PLW13 0.48418999 W

F2 - Processing parameters
SI 65536
SF 125.8005350 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40





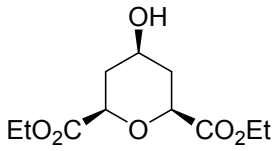
Current Data Parameters
NAME MA-502-76
EXPNO 32
PROCNO 1

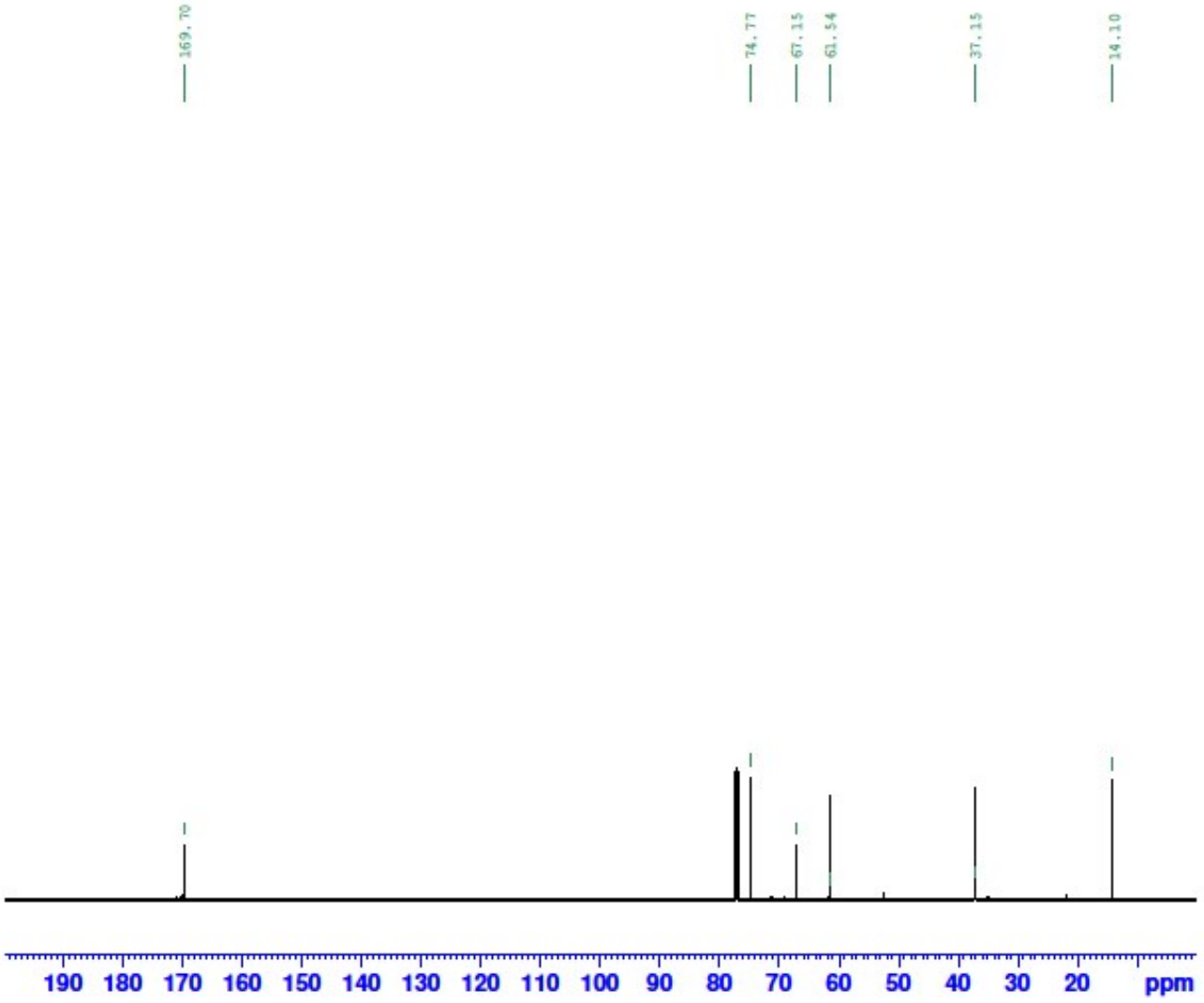
F2 - Acquisition Parameters
Date_ 20150701
Time 4.49
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 1024
DS 2
SWH 29761.904 Hz
FIDRES 0.454131 Hz
AQ 1.1010048 sec
RG 456
DW 16.800 usec
DE 7.68 usec
TE 299.7 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

====== CHANNEL f1 ======
SFO1 125.8131151 MHz
NUC1 13C
P1 9.75 usec
PLW1 82.38999939 W

====== CHANNEL f2 ======
SFO2 500.3020012 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 80.00 usec
PLW2 18.33600044 W
PLW12 0.75654000 W
PLW13 0.48418999 W

F2 - Processing parameters
SI 65536
SF 125.8005350 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40





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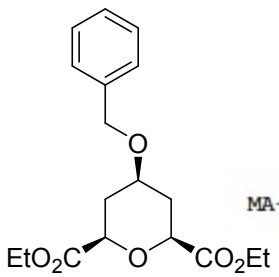
```
Current Data Parameters
NAME      ma-502-81(20-30)
EXPNO                   13
PROCNO                   1

F2 - Acquisition Parameters
Date_              20150709
Time                   1.37
INSTRUM               spect
PROBHD   5 mm PABBO BB-
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                    1024
DS                       2
SWH              29761.904 Hz
FIDRES           0.454131 Hz
AQ               1.1010048 sec
RG                     456
DW                16.800 usec
DE                 7.68 usec
TE                298.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                      1

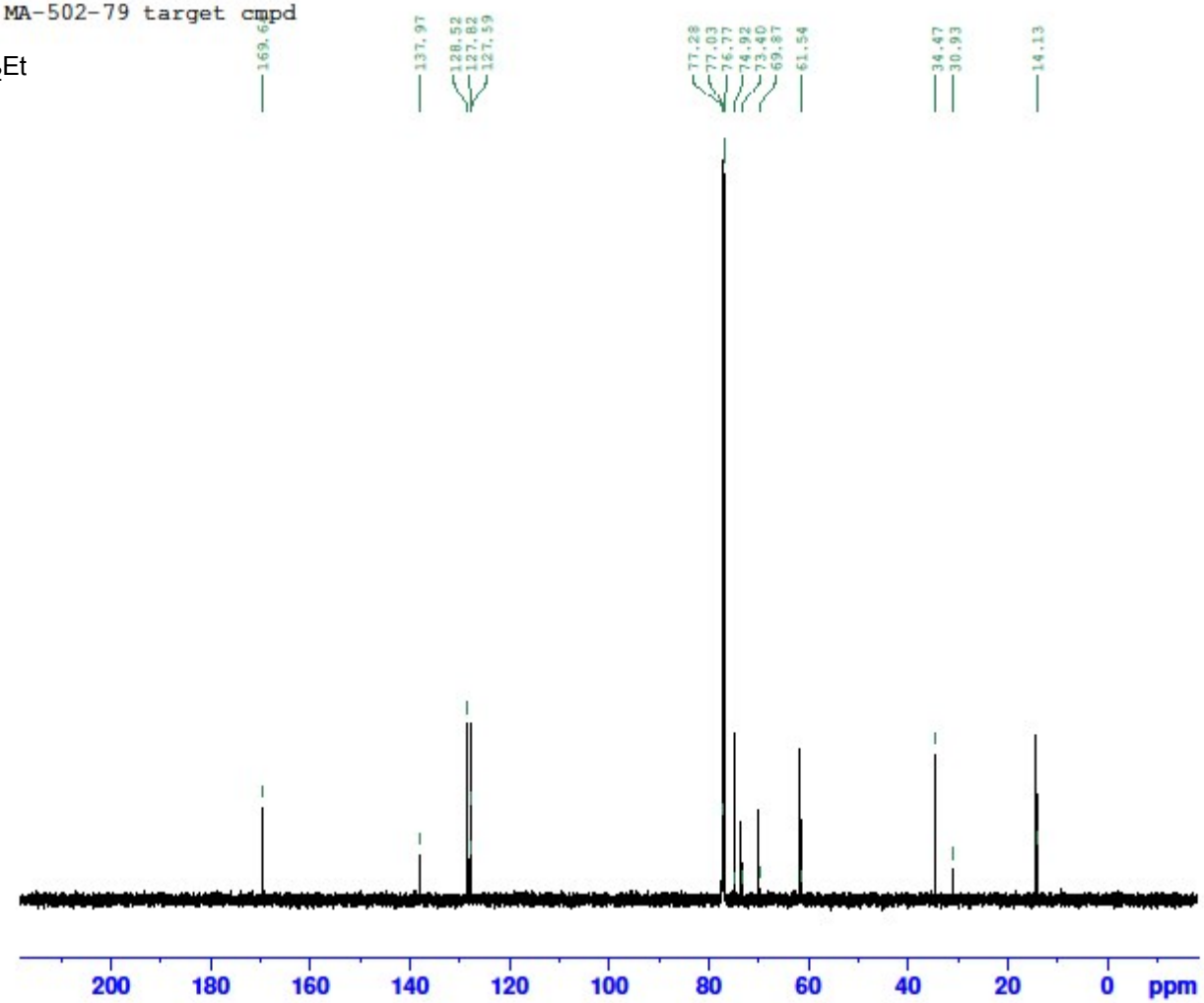
======== CHANNEL f1 ========
SFO1          125.8131151 MHz
NUC1                    13C
P1                    9.75 usec
PLW1         82.38999939 W

======== CHANNEL f2 ========
SFO2          500.3020012 MHz
NUC2                    1H
CPDPRG[2           waltz16
PCPD2                80.00 usec
PLW2         18.33600044 W
PLW12         0.75654000 W
PLW13         0.48418999 W

F2 - Processing parameters
SI                   65536
SF            125.8005350 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```



MA-502-79 target cmpd



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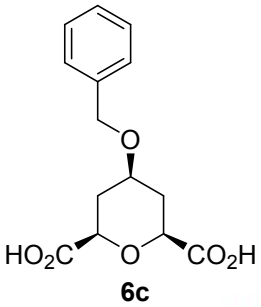
```
Current Data Parameters
NAME      MA-502-79 target cmpd
EXPNO                13
PROCNO                1

F2 - Acquisition Parameters
Date_          20150706
Time               20.57
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                  256
DS                    2
SWH           29761.904 Hz
FIDRES        0.454131 Hz
AQ            1.1010048 sec
RG                  575
DW               16.800 usec
DE                7.68 usec
TE               298.9 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         125.8131151 MHz
NUC1               13C
P1                 9.75 usec
PLW1        82.38999939 W

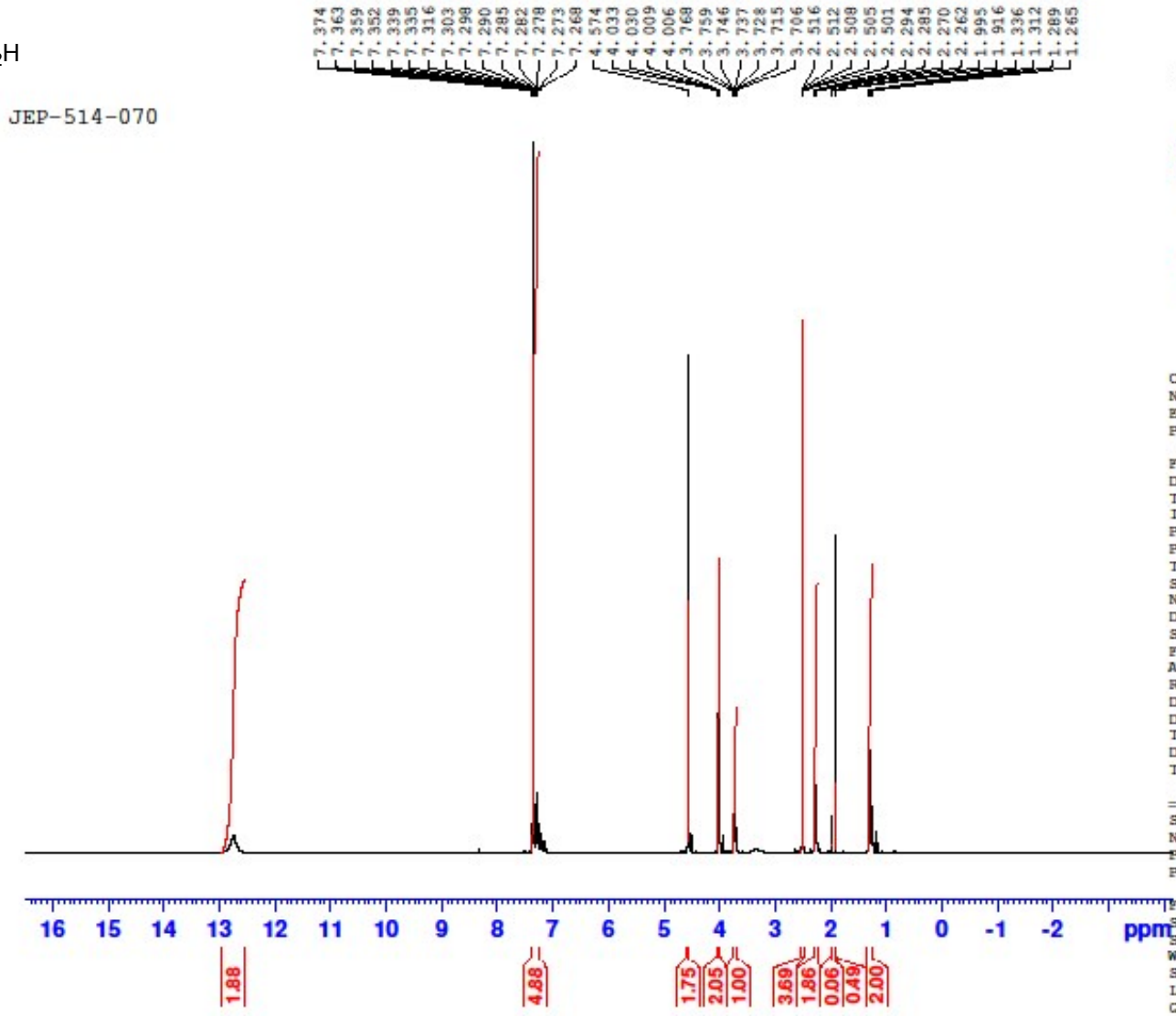
======== CHANNEL f2 ========
SFO2         500.3020012 MHz
NUC2               1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2        18.33600044 W
PLW12        0.75654000 W
PLW13        0.48418999 W

F2 - Processing parameters
SI                65536
SF           125.8005350 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



6c

JEP-514-070



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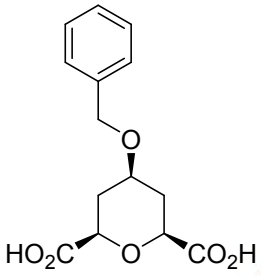
```
Current Data Parameters
NAME         JEP-514-070
EXPNO                 20
PROCNO                 1

F2 - Acquisition Parameters
Date_           20150814
Time               15.15
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT             DMSO
NS                    16
DS                     0
SWH            10330.578 Hz
FIDRES         0.157632 Hz
AQ             3.1719425 sec
RG                   322
DW                48.400 usec
DE                11.99 usec
TE                296.9 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          500.3030896 MHz
NUC1                  1H
P1                 16.25 usec
PLW1          18.33600044 W

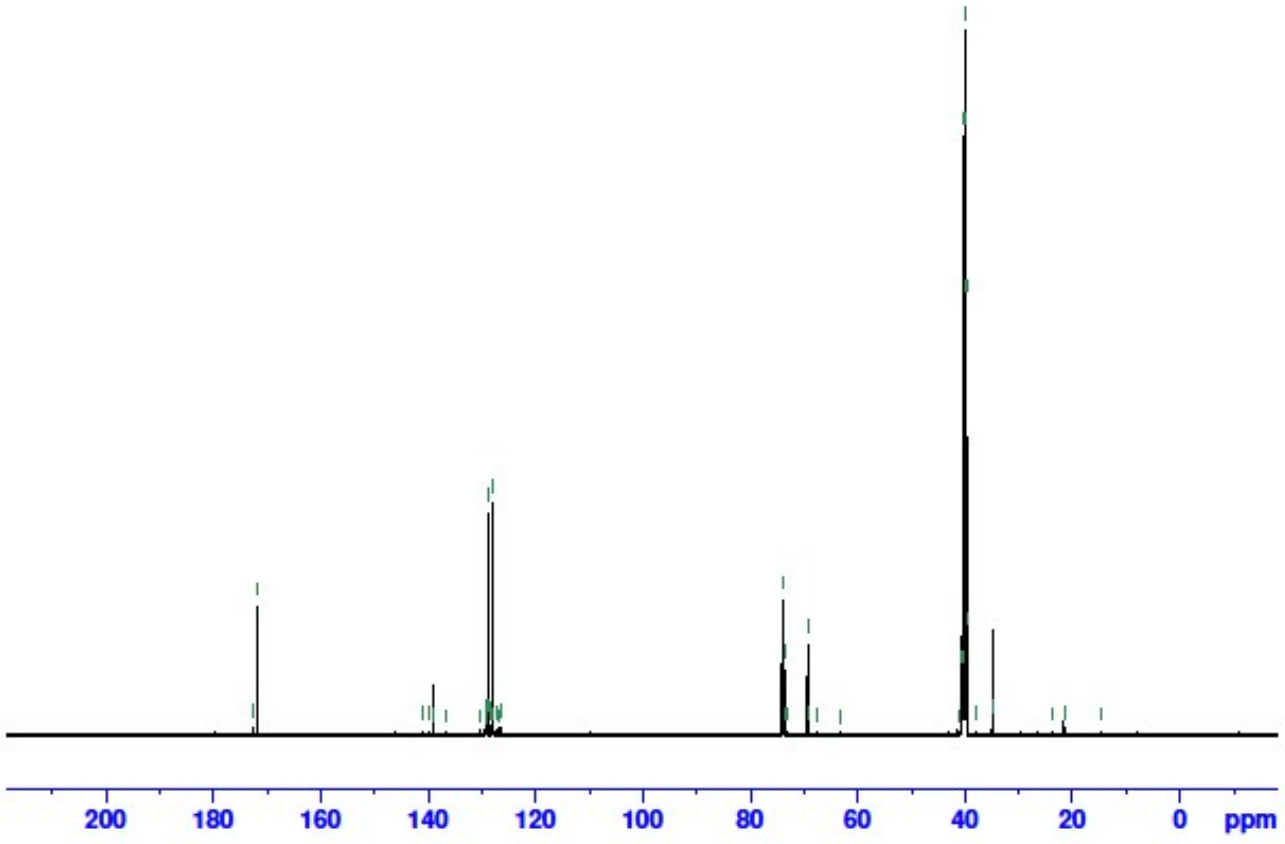
F2 - Processing parameters
SI                 65536
SF            500.3000000 MHz
WDW                   EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
```



6c

JEP-514-070

172.48 171.65 141.00 139.69 139.19 136.83 136.79 130.49 129.32 129.15 129.13 129.06 128.88 128.81 128.75 128.72 128.50 128.22 128.17 127.92 127.89 127.87 127.84 127.08 126.88 126.66 126.41 73.98 73.65 73.43 73.27 69.28 69.05 67.59 63.35 41.27 40.58 40.49 40.41 40.32 40.25 40.15 40.08 39.99 39.82 39.65 39.49 37.82 34.92 34.80 23.85 21.53 14.56



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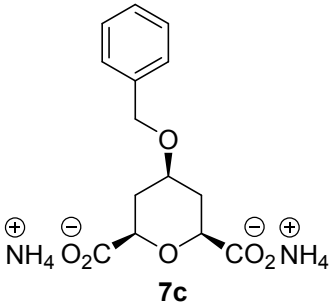
```
Current Data Parameters
NAME                  JEP-514-070
EXPNO                          21
PROCNO                          1

F2 - Acquisition Parameters
Date_                    20150815
Time                        11.53
INSTRUM                     spect
PROBHD    5 mm PABBO BB-
PULPROG                     zgpg
TD                         41662
SOLVENT                     DMSO
NS                          2656
DS                             2
SWH                   29761.904 Hz
FIDRES                0.714366 Hz
AQ                    0.6999216 sec
RG                           456
DW                        16.800 usec
DE                         7.72 usec
TE                        297.9 K
D1                   5.00000000 sec
D11                  0.03000000 sec
TD0                            1

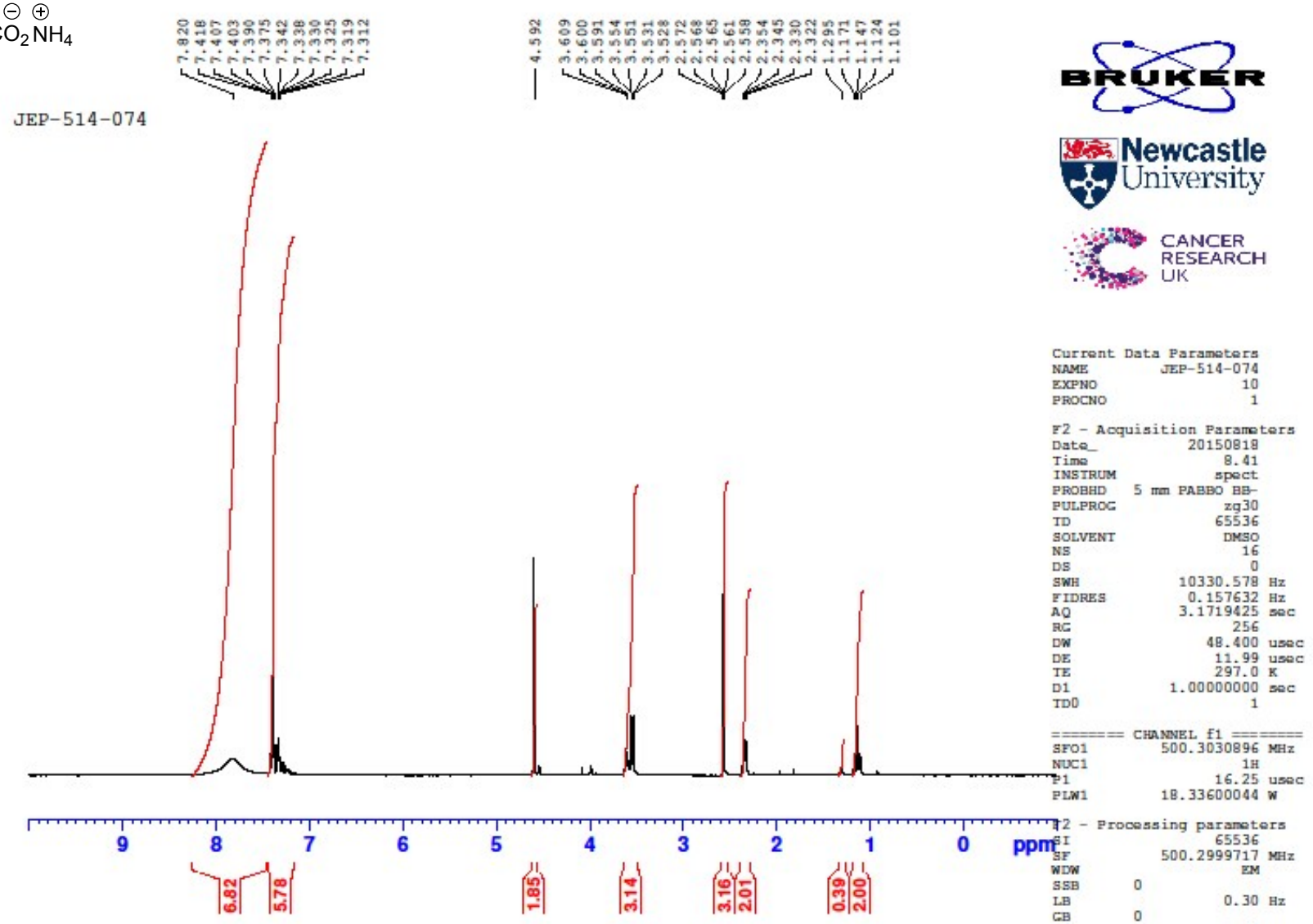
======== CHANNEL f1 ========
SFO1                125.8131151 MHz
NUC1                        13C
P1                         9.75 usec
PLW1                82.38999939 W

======== CHANNEL f2 ========
SFO2                500.3020012 MHz
NUC2                        1H
CPDPRG[2                waltz16
PCPD2                     80.00 usec
PLW2                18.33600044 W
PLW12                0.75654000 W
PLW13                0.48418999 W

F2 - Processing parameters
SI                         65536
SF                  125.8005350 MHz
WDW                            EM
SSB                   0
LB                         1.00 Hz
GB                    0
PC                         1.40
```



7c



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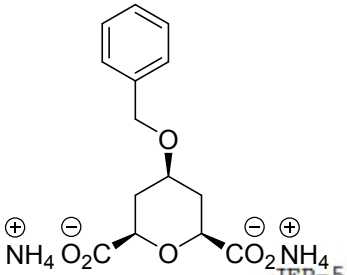
```
Current Data Parameters
NAME         JEP-514-074
EXPNO                 10
PROCNO                 1

F2 - Acquisition Parameters
Date_           20150818
Time                8.41
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT             DMSO
NS                    16
DS                     0
SWH            10330.578 Hz
FIDRES         0.157632 Hz
AQ             3.1719425 sec
RG                   256
DW                48.400 usec
DE                11.99 usec
TE                297.0 K
D1            1.00000000 sec
TD0                    1

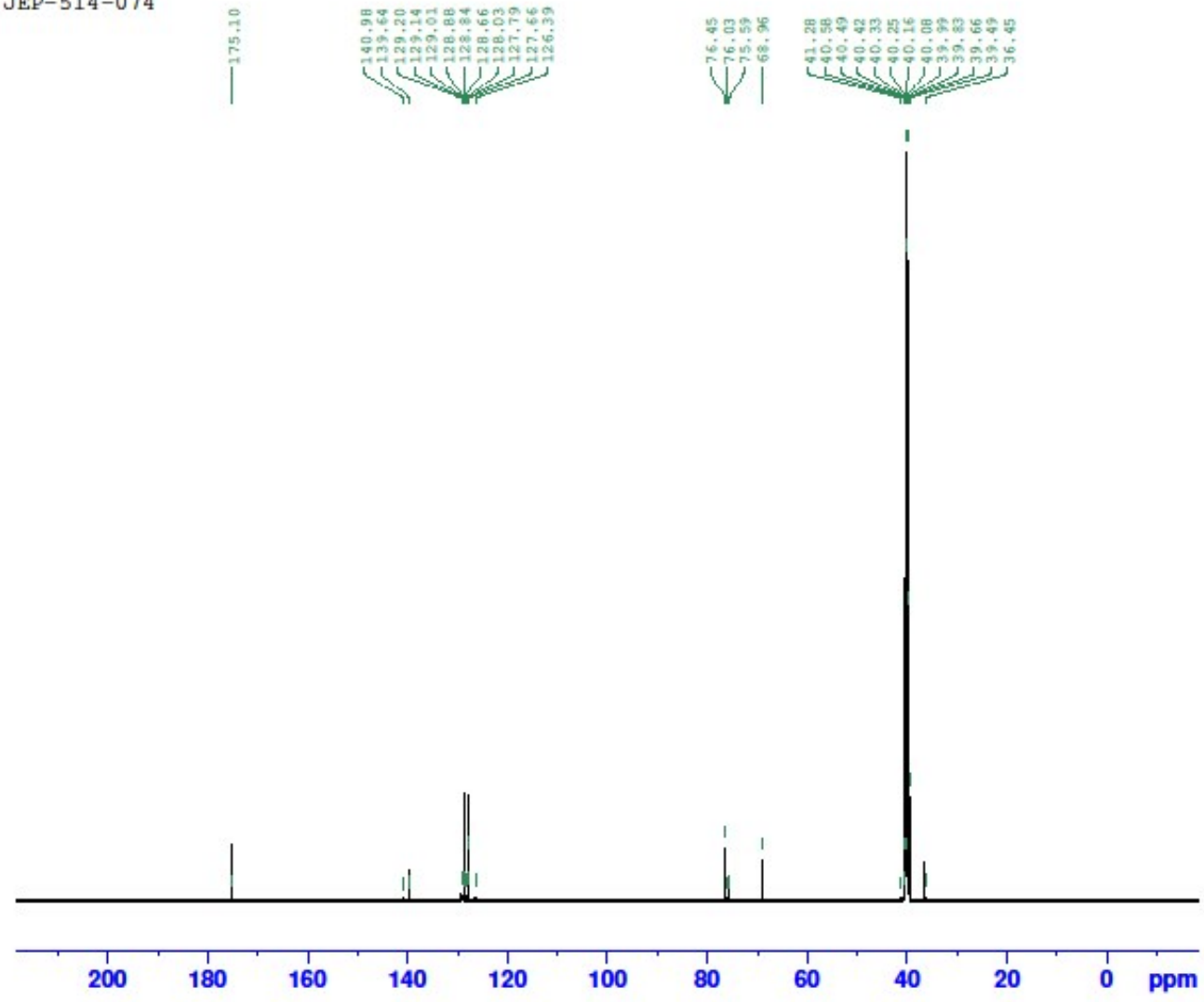
======== CHANNEL f1 ========
SFO1          500.3030896 MHz
NUC1                  1H
P1                 16.25 usec
PLW1          18.33600044 W

F2 - Processing parameters
SI                 65536
SF            500.2999717 MHz
WDW                   EM
SSB          0
LB                 0.30 Hz
GB           0
PC                 1.00
```



7c

JEP-514-074



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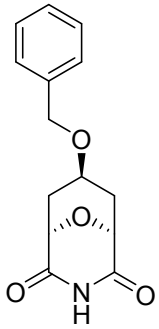
```
Current Data Parameters
NAME          JEP-514-074
EXPNO                  14
PROCNO                  1

F2 - Acquisition Parameters
Date_            20150818
Time                21.45
INSTRUM             spect
PROBHD   5 mm PABBO BB-
PULPROG          zgpg30
TD                65536
SOLVENT            DMSO
NS                  2560
DS                     2
SWH           29761.904 Hz
FIDRES        0.454131 Hz
AQ            1.1010048 sec
RG                   575
DW               16.800 usec
DE                7.68 usec
TE               297.5 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         125.8131151 MHz
NUC1                 13C
P1                  9.75 usec
PLW1        82.38999939 W

======== CHANNEL f2 ========
SFO2         500.3020012 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2              80.00 usec
PLW2        18.33600044 W
PLW12        0.75654000 W
PLW13        0.48418999 W

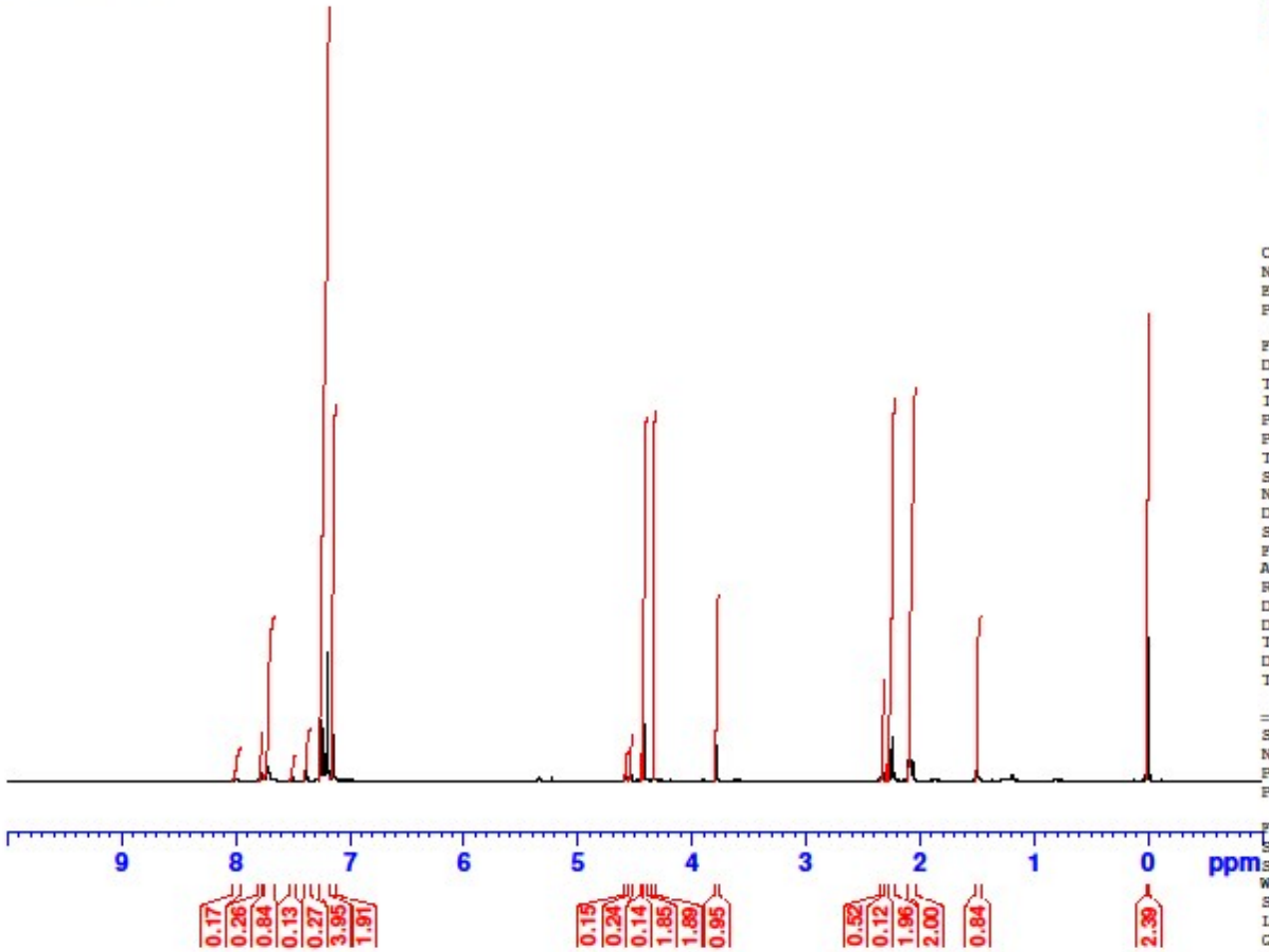
F2 - Processing parameters
SI                65536
SF           125.8005350 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



8c

JEP-514-078

7.713 7.267 7.264 7.250 7.235 7.234 7.211 7.196 7.191 7.152 7.138
4.444 4.426 4.413 4.334 3.789 3.783 3.778
2.323 2.265 2.262 2.237 2.236 2.233 2.094 2.088 2.083 2.076 2.065 2.059 2.053 2.047 1.493
0.007 0.000 -0.007



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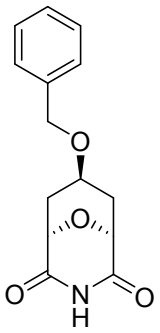
```
Current Data Parameters
NAME          JEP-514-078
EXPNO                  60
PROCNO                  1

F2 - Acquisition Parameters
Date_            20150821
Time                16.14
INSTRUM             spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     0
SWH           10330.578 Hz
FIDRES        0.157632 Hz
AQ            3.1719425 sec
RG                   512
DW               48.400 usec
DE               11.99 usec
TE                297.3 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         500.3030896 MHz
NUC1                   1H
P1               16.25 usec
PLW1         18.33600044 W

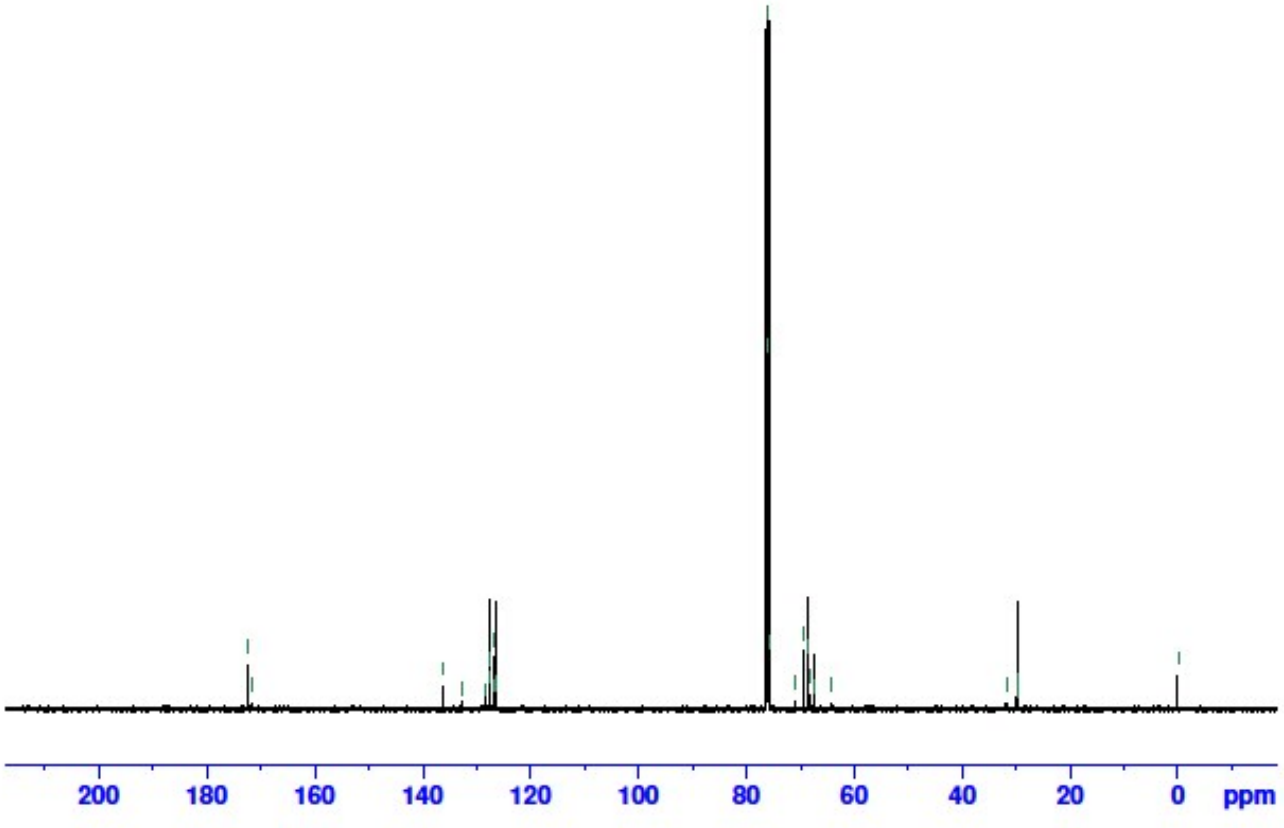
F2 - Processing parameters
SI                 65536
SF           500.3000467 MHz
WDW                   EM
SSB      0
LB                0.30 Hz
GB       0
PC                1.00
```



8c

JEP-514-078

172.32
171.57
136.28
132.52
128.47
127.69
127.55
127.42
126.95
126.71
126.56
126.31
76.25
75.99
75.74
70.89
69.47
68.54
68.24
67.52
64.27
31.80
29.87
29.76
0.00



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```
Current Data Parameters
NAME          JEP-514-078
EXPNO                  66
PROCNO                  1

F2 - Acquisition Parameters
Date_           20150822
Time                5.20
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 2560
DS                    2
SWH           29761.904 Hz
FIDRES        0.454131 Hz
AQ            1.1010048 sec
RG                  724
DW               16.800 usec
DE                7.68 usec
TE               298.3 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

====== CHANNEL f1 ======
SFO1         125.8131151 MHz
NUC1                13C
P1                 9.75 usec
PLW1         82.38999939 W

====== CHANNEL f2 ======
SFO2         500.3020012 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         18.33600044 W
PLW12         0.75654000 W
PLW13         0.48418999 W

F2 - Processing parameters
SI                 65536
SF           125.8006643 MHz
WDW                   EM
SSB          0
LB                 1.00 Hz
GB           0
PC                 1.40
```