Total Synthesis of (+)-Virgatusin via $AlCl_3$ –Catalyzed [3 + 2] Cycloaddition

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Supporting Information

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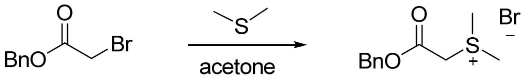
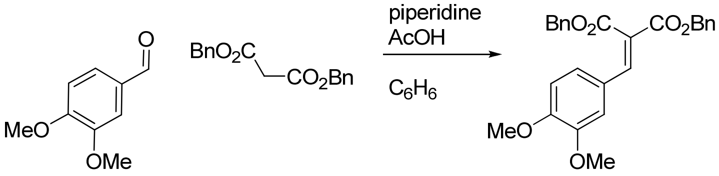
Experimental Section

Materials and Methods: General Information. Infrared (IR) spectra were obtained using a JACSO FT/IR 460-plus infrared spectrometer. Proton and carbon nuclear magnetic resonance spectra (^{1}H and ^{13}C NMR) were recorded on the following instruments: Bruker model Avance 400 (^{1}H NMR at 400 MHz and ^{13}C NMR at 100 MHz) and Varian Gemini 300 (^{1}H NMR at 300 MHz and ^{13}C at 75 MHz) spectrometers with solvent resonance as the internal standard (^{1}H NMR: $CDCl_3$ at 7.27 ppm or TMS at 0.00 ppm and ^{13}C NMR: $CDCl_3$ at 77.0 ppm). ^{1}H NMR data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, dd = doublet of doublets, ddd = doublet of doublet of doublets, dddd = doublet of doublet of doublet of doublets, t = triplet, q = quartet, quint = quintuplet, sep = septet, m = multiplet), coupling constants (Hz), and integration. Combustion analyses were performed by Atlantic Microlab Inc., Norcross, GA. Analytical thin layer chromatography (TLC) was performed on Whatman 0.25 mm silica gel 60 plates. Mass spectra were obtained on a Micromass Quattro II Triple Quadrupole Spectrometer using ESI ionization. Structural assignments were made using NOESY experiments. Enantiomeric ratios were obtained using a Berger Supercritical fluid Chromatograph mode FCM 1100/1200 equipped with an Agilent 1100 series UV-Vis detector using one of the following chiral HPLC columsn: Chiralcel Chiralpak AD, WO, or OD column. Samples were eluted with SFC grade CO_2 and the indicated percentage of MeOH. Visualization was accomplished with UV light and aqueous ceric ammonium nitrate molybdate solution followed by heating. Purification of the reaction products was carried out by flash chromatography using Sorbent Technologies silica gel 60 (32-63 µm). Yield refers to isolated yield of analytically pure material. Yields are reported for a specific experiment and as a result may differ slightly from those found in the tables and equations, which are averages of at least two experiments. Methylene chloride, THF, and toluene were dried by passage through a column of neutral alumina under nitrogen prior to use. Unless otherwise noted, reagents were obtained from commercial sources and used without further purification.



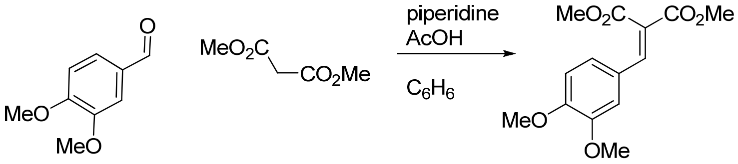
(2-benzyloxy)-2-oxoethyl)dimethylsulfonium bromide: Benzylbromoacetate (30.00 g, 131 mmol) was stirred with dimethyl sulfide (9.76 g, 157.2 mmol) in 10 mL of acetone. The reaction was allowed to stir overnight. During the course of the reaction small portions of acetone were added to aid in stirring the white precipitate that is formed. An ice bath can be used if the product does not fully precipitate. The mixture was filtered and the white solid was washed with cold hexanes to obtain 29.7 g (78%) of the dimethylsulfonium bromide. The filtrate can be concentrated to obtain more material if desired.

Analytical data: **mp** 94-95 °C; **IR** (thin film, cm^{-1}) 2970, 2723, 1719, 1459, 1377, 1156; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34 (s, 5H), 5.26 (s, 2H), 5.19 (s, 2H), 3.37 (s, 6H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.4, 134.0, 129.0, 128.8, 128.7, 128.6, 68.9, 44.3, 25.3; **Anal.** Calcd. for $C_{11}H_{15}BrO_2S$: C, 45.37; H, 5.19. Found: C, 45.23; H, 5.13; **HRMS** (ESI) calcd. for $C_{11}H_{15}O_2S$ $[M]^+$: 211.0787. Found $[M]^+$ = 211.0777.



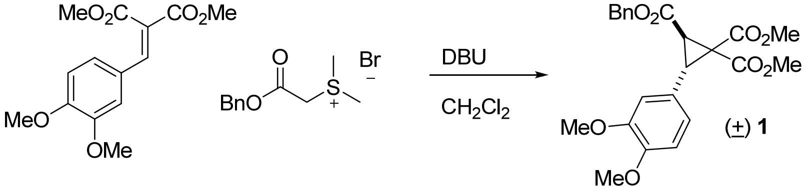
Dibenzyl 2-(3,4-dimethoxybenzylidene)malonate: A 250 mL round-bottomed flask equipped with a Dean-stark trap, condenser, and stirbar was charged with benzene (45 mL), dibenzyl malonate (14 g, 49.2 mmol), 3,4-dimethoxybenzaldehyde (9.82 g, 59.1 mmol), and 5 mol % piperidinium acetate. The mixture was brought to reflux and allowed to stir for 16 hours upon which TLC analysis showed disappearance of starting material. The reaction was allowed to cool to room temperature. The clear orange liquid was diluted with 20 mL of C_6H_6 and washed twice with 1 M HCl (25mL). The organic layer was washed once with saturated $NaHCO_3$ (20 mL) and once with brine (30 mL). The organic portion was dried over Na_2SO_4, filtered, and concentrated to an orange oil. The material formed a solid upon standing and was recrystallized with EtOAc/hexanes to yield 16.6 g (78%) of the benzylidene malonate.

Analytical data: **mp** 74-75 °C; **IR** (thin film, cm^{-1}) 2957, 2838, 1729, 1517, 1255, 1226, 1191, 1144; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.36-7.27 (m, 10H), 7.02-6.99 (m, 2H), 6.75 (d, *J* = 8.4 Hz, 1H), 5.29 (d, *J* = 10.8 Hz), 3.90 (s, 3H), 3.75 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 166.9, 164.2, 151.5, 149.0, 143.1, 135.7, 135.1, 128.6, 128.5, 128.4, 128.2, 128.0, 125.5, 124.3, 123.3, 112.0, 111.1, 67.4, 55.9, 55.8; TLC (30% EtOAc/hexanes) R_f 0.31; **Anal.** Calcd. for $C_{26}H_{24}O_6$; C, 72.21; H, 5.59. Found: C, 71.97; H, 5.61; **HRMS (ESI)** calculated for $C_{26}H_{24}O_6Cs$ $[M+Cs]^+$: 565.0627. Found: $[M+Cs]^+$ = 565.0651.



Dimethyl 2-(3,4-dimethoxybenzylidene)malonate: A 250 mL round bottomed flask equipped with a Dean-stark trap, condenser, and stirbar was charged with benzene (45 mL), dimethyl malonate (10 g, 75.7 mmol), 3,4-dimethoxybenzaldehyde (15.1 g, 90.8 mmol), and 10 mol % piperidinium acetate. The mixture was brought to reflux and allowed to stir for 24 hours upon which TLC analysis showed disappearance of starting material. The reaction was allowed to cool to room temperature. The clear orange liquid was diluted with C_6H_6 (20 mL) and washed with 1M HCl (25 mL). The organics were then washed once with saturated $NaHCO_3$ (20 mL) and once with brine (30 mL). The organic portion was dried over Na_2SO_4, filtered, and concentrated to an orange oil. The material formed a solid upon standing and was recrystallized with EtOAc/hexanes to yield 17.6 g (83%) of the benzylidene malonate.

Analytical Data: **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.71 (s, 1H), 7.09-7.07 (m, 1H), 7.00-6.99 (m, 1H), 6.87 (d, *J* = 8.4 Hz, 1H), 3.93 (s, 3H), 3.88 (s, 6H), 3.85 (s, 3H). Complete analytical data for this compound has been published previously.[1]

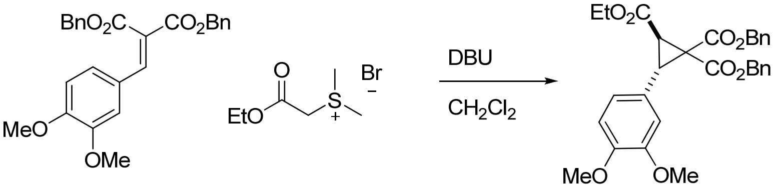


(±) **1**

(2*R*,3*S*)-2-benzyl 1,1-dimethyl 3-(3,4-dimethoxyphenyl)cyclopropane-1,1,2-tricarboxylate (±)-1: The sulfonium salt (8.3 g, 28.4 mmol) was placed in a round-bottomed flask under N_2 and partially dissolved in 20 mL of CH_2Cl_2 at 0 °C. DBU (4.2 mL, 28.4 mmol) was added and the mixture was allow to stir for 30 minutes, at which time all solids had gone into solution. The benzylidene malonate (5.3 g, 18.9 mmol) was added and the reaction was allowed to stir at 0 °C for 12 hours. The reaction was then washed with 1 M HCl (20 mL) and brine (20 mL). The organic layer was dried with Na_2SO_4 and concentrated. The material was subjected to flash chromatography with 30% EtOAc/hexanes to give 6.6 g (82%) of the product as a viscous liquid. Upon standing, this material formed a white solid. This material can also be purified by adding MeOH to precipitate the solid and recrystallizing with EtOAc/hexanes.

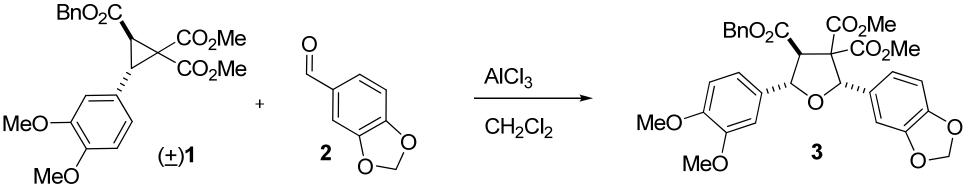
Analytical data: **mp** 70-72 °C; **IR** (thin film, cm^{-1}) 2954, 2838, 1739, 1590, 1520, 1252, 1162, 1027; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.39-7.36 (m, 5H), 6.78-6.76 (m, 3H), 5.21 (d, *J* = 12 Hz, 1H), 5.15 (d, *J* = 12 Hz, 1H), 3.86 (s, 3H) 3.85 (s, 3H), 3.68 (s, 3H), 3.62 (d, *J* = 7.6 Hz, 1H), 3.51 (s, 3H), 3.26 (d, *J* = 7.6 Hz, 1H). **^{13}C NMR** δ 168.9, 166.4, 165.6, 148.7, 148.6, 135.2, 128.6, 128.6, 128.5, 125.1, 120.8, 111.6, 110.8, 67.4, 55.9, 55.8, 53.0, 53.0, 44.3, 35.8, 31.3; TLC (30% EtOAc/hexanes) R_f 0.18; **Anal.** Calcd. for

$C_{23}H_{24}O_8$: C, 64.48; H, 5.65. Found: C, 64.59; H, 5.61; **HRMS (ESI)** calculated for $C_{23}H_{24}O_8Cs$ $[M+Cs]^+$: 565.0525. Found: $[M+Cs]^+$ = 565.0651.

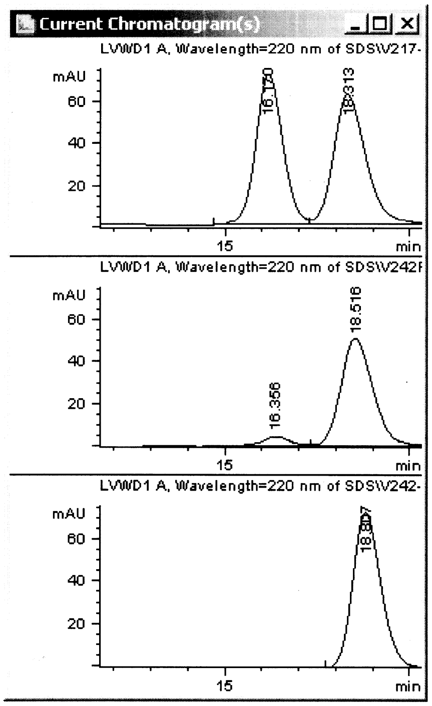


(2*R*,3*S*)-1,1-dibenzyl 2-ethyl 3-(3,4-dimethoxyphenyl)cyclopropane-1,1,2-tricarboxylate: The sulfonium salt (6 g, 13.9 mmol) was placed in a round-bottomed flask under N_2 and partially dissolved in 20 mL of toluene/CH_2Cl_2 (3:2) at 0 °C. DBU (3.1 mL, 20.8 mmol) was added and the mixture was allow to stir for 30 minutes. At this time, all solids had gone into solution. The benzylidene malonate (4.8 g, 20.8 mmol) was added and the reaction was allowed to stir at 45 °C for 6 hours. The reaction was then washed with 1 M HCl (20 mL) and brine (20 mL). The organic layer was dried with Na_2SO_4 and concentrated. Upon standing, a solid was formed which was recrystallized with EtOH to give 6.7 g (80%) of the product as a white solid.

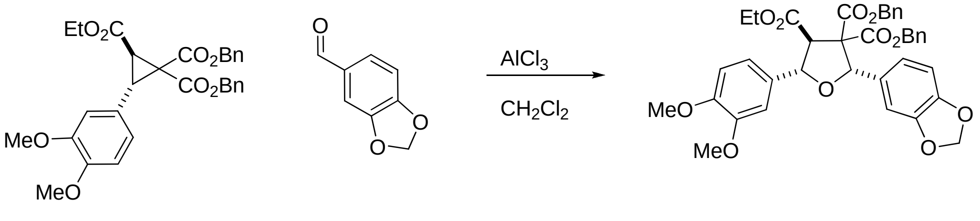
Analytical data: **mp** 98-100 °C; **IR** (thin film, cm^{-1}) 2959, 2837, 1734, 1520, 1456, 1252, 1028; **^{1}H NMR** (400MHz, $CDCl_3$) δ 7.35-7.22 (m, 7H), 6.99 (d, *J* = 6.8 Hz, 1H), 6.79-6.71 (m, 3H), 5.25 (d, *J* = 12.4 Hz, 1H) 5.21 (d, *J* = 12.4 Hz, 1H), 4.96 (d, *J* = 12 Hz, 1H), 4.87 (d, *J* = 12 Hz, 1H) 4.17-4.11 (m, 2H), 3.87 (s, 3H), 3.75 (s, 3H), 3.67 (d, *J* = 7.6 Hz, 1H), 3.26 (d, *J* = 7.6 Hz, 1H) 1.26 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR** δ 168.8, 165.8, 165.1, 148.8, 148.6, 135.4, 134.9, 128.5, 128.4, 128.3, 128.2, 128.1, 125.1, 121.1, 111.9, 110.8, 67.8, 67.5, 61.6, 55.8, 44.3, 35.8, 31.5, 14.1; TLC (30% EtOAc/hexane) R_f 0.32; **Anal.** Calcd. for $C_{30}H_{30}O_8$: C, 69.49; H, 5.83. Found: C, 69.30; H, 5.81; **HRMS (ESI)** calculated for $C_{30}H_{30}O_8Cs$ $[M+Cs]^+$: 651.0995. Found: $[M+Cs]^+$ = 651.1064.



(2*S*,4*S*,5*S*)-4-benzyl 3,3-dimethyl 2-(benzo[*d*][1,3]dioxol-5-yl)-5-(3,4-dimethoxyphenyl)dihydrofuran-3,3,4(2*H*)-tricarboxylate (3): A 125 mL round bottom flask with a stirbar was charged with 9.8 g of the cyclopropane (23 mmol), aldehyde (6.9 g, 46 mmol), and $AlCl_3$ (0.46 g, 3.5 mmol). Outside the glove box, CH_2Cl_2 was added under N_2 and the reaction was allowed to stir at room temperature. The reaction was allowed to become homogenous and then diluted with diethyl ether after 5 minutes. The solution was run through a silica plug with CH_2Cl_2 and concentrated. The reaction was flashed with 60% ether/petroleum ether to give the product in 80 % yield (10.7 g). Upon concentration the cycloadduct was obtained as an oil; MeOH can be used to precipitate the product, which can be recrystallized with EtOAc/hexanes to give a white solid. This material was also synthesized asymmetrically from (2*R*,3*S*)-**1** on a 0.55 mmol (0.24 g) scale. The crude material measured 90:10 er by chiral SFC analysis. After a single recrystallization the er was 99:1 (Chiralpak AD, 6.0% MeOH, 2.0 mL/min, 200 psi, 27 °C, 220 nm, $t_{r\text{-major}}$, 18.5 min, $t_{r\text{-minor}}$ 16.3 min).



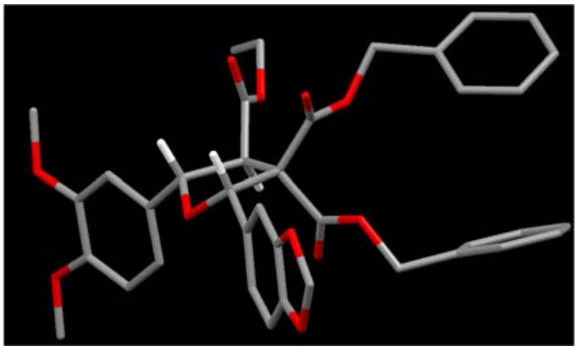
Analytical data: $[\alpha]_D^{24.7}$ -15.5 (c = 0.40, CH_2Cl_2) at 80 % ee; $[\alpha]_D^{24.5}$ -20.32 (c = 0.50, CH_2Cl_2) at 98 % ee; **mp** 117-118; **IR** (thin film, cm^{-1}) 2953, 1735, 1519, 1446, 1265, 1165, 1036; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32-7.025 (m, 8H), 6.99 (d, *J* = 8 Hz, 1H), 6.83 (d, *J* = 8.4 Hz, 1H), 6.78 (d, *J* = 8.4 Hz, 1H), 5.94 (s, 2H), 5.75 (s, 1H), 5.11 (m, 2H), 5.02 (d, *J* = 8.8 Hz, 1H), 4.13, (d, *J* = 8.8 Hz, 1H), 3.90 (s, 3H), 3.87 (s, 3H), 3.51 (s, 3H) 3.26 (s, 3H); **^{13}C NMR** δ 171.1, 168.5, 168.5, 149.4, 149.2, 147.6, 147.3, 135.4, 130.7, 130.3, 128.5, 128.3, 128.3, 120.8, 119.4, 111.1, 110.1, 107.8, 107.8, 101.0, 84.85, 83.8, 69.1, 67.0, 58.9, 55.9, 55.9, 52.7, 52.5; **Anal.** Calcd. for $C_{31}H_{30}O_{11}$: C, 64.35; H, 5.23. Found: C, 64.33; H, 5.12; **HRMS (ESI)** calculated for $C_{31}H_{30}O_{11}Cs$ $[M+Cs]^+$: 711.0842. Found: $[M+Cs]^+$ = 711.0831.

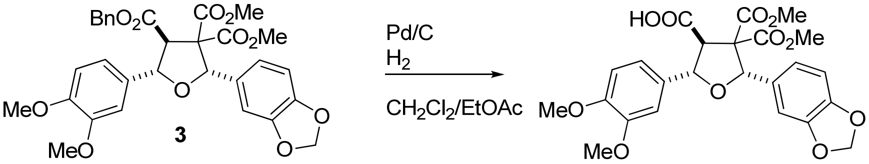


(2*S*,4*S*,5*S*)-3,3-dibenzyl 4-ethyl 2-(benxo[*d*][1,3]dioxol-5-yl)-5-(3,4-dimethoxyphenyl) dihydrofuran-3,3,4(2*H*)-tricarboxylate: A 125 mL round bottom flask with a stirbar was charged with 1.29 g of the cyclopropane (2.5 mmol), piperonal (0.75 g, 5 mmol), and $AlCl_3$ (0.07 g, 0.5 mmol). Outside the glove box, CH_2Cl_2 was added under N_2 and the reaction was allowed to stir. The reaction was allowed to become homogenous and then diluted with diethyl ether after 5 minutes. The solution was run through a silica plug and concentrated. The reaction was flashed with 60% ether/petroleum ether to give the product in 81 % yield (1.35 g). Upon concentration the cycloadduct was obtained as an oil; MeOH can be used to precipitate the product as a white solid, which can be recrystallized with EtOAc/hexanes.

Analytical data: **mp** 129-130 °C; **IR** (thin film, cm^{-1}) 2937, 2834, 1733, 1519, 1447, 1264, 1037; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.23-7.04 (m, 12 H), 6.92 (s, 1H), 6.90 (s, 1H), 6.86 (d, *J* = 8.4 Hz, 1H), 6.71 (d, *J* = 8.4 Hz, 1H), 5.88 (d, *J* = 13.6 Hz, 2H), 5.80 (s,1H), 5.14 (d, *J* = 12 Hz, 1H), 5.06 (d, *J* = 8.8 Hz, 1H), 5.00 (d, *J* = 12, 1H), 4.84 (d, *J* = 12.4 Hz, 1H), 4.41 (d, *J* = 12.4 Hz, 1H), 4.11 (d, *J* = 8.8 Hz, 1H), 3.97-3.95 (m, 1H), 3.93 (s, 3H), 3.90 (s, 3H), 3.85-3.83 (m, 1H), 1.07 (t, *J* = 6.8 Hz, 3H); **^{13}C NMR** δ 149.3, 149.1, 147.6, 147.3, 134.6, 134.5, 130.8, 130.1, 128.5, 128.4, 128.3, 128.2, 127.9, 120.8, 119.4, 110.9, 109.9, 107.9, 101.0, 84.9, 83.9, 69.2, 67.8, 61.3, 59.0, 55.9, 14.0; TLC (30% EtOAc/hexane) R_f 0.21; **Anal.** Calcd. for $C_{38}H_{36}O_{11}$: C, 68.25; H, 5.43. Found: C, 68.03; H, 5.53; **HRMS (ESI)** calculated for $C_{38}H_{36}O_{11}Cs$ $[M+Cs]^+$: 801.1312. Found: $[M+Cs]^+$ = 801.1338.

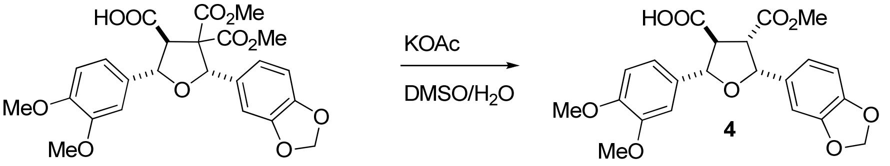
The relative stereochemistry was confirmed via an X-ray diffraction study. CCDC 734858 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.





(2*S*,3*S*,5*S*)-5-(benzo[*d*][1,4]dioxol-5-yl)-2-(3,4-dimethoxyphenyl)-4,4-bis(methoxycarbonyl)tetrahydrofuran-3-carboxylic acid: 10 % Pd/C (975 mg, 0.92 mmol) was added to a round bottom flask. The benzyl ester cycloadduct (5.3 g, 9.2 mmol) was then added in a 9:1 CH_2Cl_2/EtOAc mixture. A hydrogen ballon was added and the reaction was allowed to stir for 18 hours. After removal of the hydrogen balloon, the reaction contents were run through a celite plug and washed with EtOAc and CH_2Cl_2. To ensure product removal from the celite, a final wash was done with 5% MeOH/CH_2Cl_2. This material was also synthesized asymmetrically on a 0.4 mmol (0.22 g) scale.

Analytical data: $[\alpha]_D^{24.5}$ -24.1 (c = 1.00, CH_2Cl_2); **mp** 129 °C; **IR** (thin film, cm^{-1}) 2954, 2841, 1734, 1610, 1519, 1446, 1265, 1037; **^{1}H NMR** (400MHz, $CDCl_3$) δ 7.26-6.99 (m, 4H), 6.86 (d, *J* = 8 Hz, 1H), 6.77 (d, *J* = 8.8 Hz, 1H), 5.94 (s, 2H), 5.72 (s, 1H), 5.04 (d, *J* = 8.8 Hz, 1H), 4.12 (d, *J* = 9.2 Hz, 1H), 3.93 (s, 3H), 3.88 (s, 3H), 3.67 (s, 3H), 3.28 (s, 3H); **^{13}C NMR** δ 176.4, 168.4, 168.4, 149.6, 149.3, 147.7, 147.3, 130.3, 130.0, 120.8, 119.6, 111.1, 110.2, 107.9, 107.7, 101.1, 84.8, 83.5, 69.4, 58.6, 56.0, 55.9, 52.8, 52.7; TLC (5% MeOH/CH_2Cl_2) R_f 0.31; **HRMS (ESI)** calculated for $C_{24}H_{24}O_{11}Cs$ $[M+Cs]^+$: 621.0373. Found: $[M+Cs]^+$ = 621.0340.



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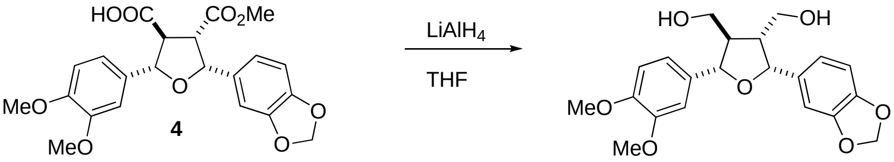
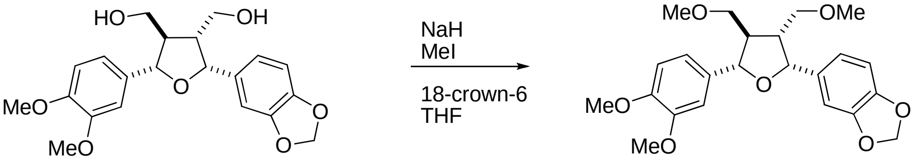
(2*S*,3*S*,4*S*,5*R*)-5-(benzo[*d*][1,3]dioxol-5-yl)-2-(3,4-dimethoxyphenyl)-4-(methoxycarbonyl)tetrahydrofuran-3-carboxylic acid (4): The tetrahydrofuran acid (3.0 g, 6.1 mmol) was added to a reaction tube with KOAc (1.2 g, 12.3 mmol). DMSO (10 mL) was added to dissolve the reagents followed by 0.5 mL of H_2O. The reaction tube was heated to 100 °C with stirring. After 16 hours the reaction was allowed to cool to room temperature and partitioned between Et_2O (20 mL) and H_2O (20 mL). After separation, the aqueous layer was extracted with three portions of Et_2O (20 mL). The combined organic extracts were washed with three portions of H_2O (20 mL), brine (20 mL), dried over $MgSO_4$, filtered and concentrated under rotary evaporation. This material was also synthesized asymmetrically on a 0.3 mmol (0.16 g) scale.

Analytical data: $[\alpha]_D^{24.9}$ 33.3 (c = 1.00, CH_2Cl_2); **IR** (thin film, cm^{-1}) 2951, 2834, 1735, 1519, 1445, 1242, 1035; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.24 (s, 1H), 7.16-7.13 (m, 1H), 6.91-6.78) (m, 4H), 5.97 (s, 2H), 5.26 (d, J = 7.6 Hz, 1H), 5.02 (d, J = 6.8 Hz, 1H), 3.96 (s, 3H), 3.91 (s, 3H), 3.80-3.77 (m, 2 H), 3.33 (s, 3H); **^{13}C NMR** δ 177.3, 171.5, 149.3, 149.2, 147.4, 147.4, 131.1, 130.8, 120.1, 119.7, 110.9, 110.2, 108.1, 107.1, 101.1, 83.3, 82.4, 56.0, 55.9, 54.4, 54.3, 52.0; TLC (5% MeOH/CH_2Cl_2) R_f 0.34; **Anal.** Calcd. for $C_{22}H_{22}O_9$: C, 61.39; H, 5.15. Found: C, 61.10; H, 5.26; **HRMS (ESI)** calculated for $C_{22}H_{22}O_9Cs$ $[M+Cs]^+$: 563.0318. Found: $[M+Cs]^+$ = 563.0321.



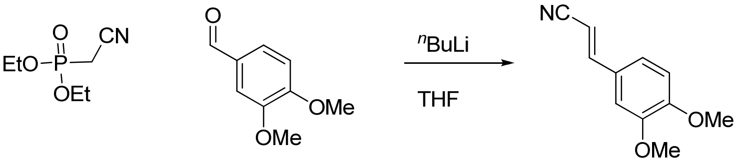
((2*R*,3*R*,4*R*,5*S*)-2-(benzo[*d*][1,3]dioxol-5-yl-5-(3,4-dimethoxyphenyl)tetrahydrofuran-3,4-diyl)dimethanol: A solution of 1 M $LiAlH_4$ (7.5 mL) in THF (10 mL) at 0 °C was treated with a solution of the cycloadduct (1.15 g, 2,5 mmol) in THF (5 mL) via syringe. After the addition the reaction was allowed to warm to room temperature with stirring. After two hours the reaction was quenched with 0.5 mL H_2O, 0.5 mL of a 15% NaOH solution, and 1.5 mL of H_2O. The solution was filtered through a Buchner funnel and the filter cake was washed with several portions of Et_2O (5 mL). The filtrate was dried over $MgSO_4$, filtered, and concentrated by rotary evaporation affording a white solid in 99% yield (0.97 g). This material was also synthesized asymmetrically on a 0.3 mmol (0.15 g) scale.

Analytical data: $[\alpha]_D^{27.5}$ 19.9 (c = 1.5, CH_2Cl_2); **IR** (thin film, cm^{-1}) 3365, 2931, 2904, 1608, 1594, 1518, 1490, 1444, 1261, 1035; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.01-6.76 (m, 6H), 5.95 (s, 2H), 5.08 (d, *J* = 8.8 Hz, 1H) 4.46 (d, *J* = 9.2 Hz, 1H), 3.90 (s, 3H), 3.88 (s, 3H), 3.73-3.70 (m, 1H), 3.58-3.53 (m, 1H), 3.33-3.30 (m, 1H), 3.14-3.09 (m, 1H), 2.59-2.57 (m, 1H), 2.27-2.24 (m, 1H); **^{13}C NMR** δ 149.2, 149.1, 147.7, 147.1, 132.9, 132.5, 119.8, 119.2, 111.3, 110.2, 108.1, 107.0, 101.1, 82.6, 81.3, 63.7, 63.0, 56.0, 55.1, 50.9; TLC (5% MeOH/CH_2Cl_2) R_f 0.28; **HRMS (ESI)** calculated for $C_{21}H_{24}O_7Cs$ $[M+Cs]^+$: 521.0576. Found: $[M+Cs]^+$ = 521.0616.

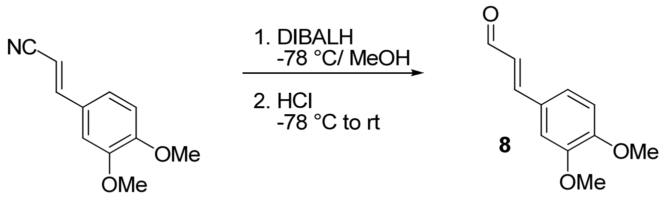


5-((2*R*,3*R*,4*R*,5*S*)-5-(3,4-dimethoxyphenyl)-3,4-bis(methoxymethyl)tetrahydrofuran-2-yl)benzo[*d*][1,1]dioxole: To a suspension of NaH (0.12 g, 3.1 mmol) in THF (4 mL) at room temperature was added a solution of the diol (0.50 g, 1.3 mmol) in THF (3 mL) followed by 18-crown-6 (0.02 g, 0.06 mmol), in a flame dried round bottom flask. This mixture was allowed to stir at room temperature for one hour. The mixture was then heated to 35 °C followed by addition of CH_3I (2.75 g, 19.4 mmol). This mixture was allowed to stir under N_2 for 16 hours. After cooling, the reaction was diluted with Et_2O, dried with $MgSO_4$, filtered, and evaporated under reduced pressure. The crude product was purified by flash chromatography using 30% EtOAc/hexanes to obtain 405 mg of the product (75 %). This material was also synthesized asymmetrically on a 0.15 mmol (0.06 g) scale.

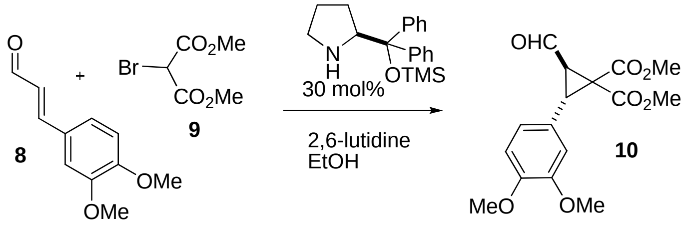
Analytical data: $[\alpha]_D^{28.7}$ 9.5 (c = 1.1, CH_2Cl_2); **IR** (thin film, cm^{-1}) 2927, 2830, 1593, 1516, 1444, 1238, 1033; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.04 (d, *J* = 1.2 Hz, 1H), 7.00 (d, *J* = 8 Hz, 1H), 6.90 (s, 1H), 6.85-6.82 (m, 2 H), 6.75 (d, *J* = 8 Hz, 1H), 5.93 (s, 2H), 5.04 (d, *J* = 7.2 Hz, 1H), 4.69 (d, *J* = 8 Hz, 1H), 3.89 (s, 3H), 3.86 (s, 3H), 3.53-3.45 (m, 2H), 3.33 (s, 3H), 3.06 (s, 3H), 3.04-3.02 (m, 1H), 2.97-2.94 (m, 1H), 2.61-2.54 (m, 1H), 2.35-2.29 (s, 1H); **^{13}C NMR** δ 148.9, 148.5, 147.4, 146.6, 134.1, 132.8, 119.6, 118.8, 111.0, 109.9, 107.8, 107.0, 100.9, 82.6, 81.4, 73.1, 73.0, 59.0, 58.6, 55.9, 55.8, 50.9, 46.5; **Anal.** Calcd. for $C_{23}H_{28}O_7$: C, 66.33; H, 6.78. Found: C, 66.28; H, 6.76; **HRMS (ESI)** calculated for $C_{23}H_{28}O_7Cs$ $[M+Cs]^+$: 549.0889. Found: $[M+Cs]^+$ = 549.0935.



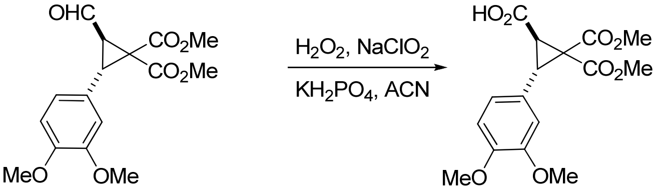
(E)-3-(3,4-dimethoxyphenyl)acrylonitrile: The phosphonate (4.9 g, 27.4 mmol) was deprotonated in 40 mL of dry THF with ^{n}BuLi (25.5 mmol) at 0 °C for 45 minutes. 4.9 g of the aldehyde (18.3 mmol) was dissolved in 15 mL of dry THF. The Wittig solution was added to the aldehyde dropwise via cannula transfer. After the addition was complete the reaction was allowed to stir for 20 more minutes. The reaction was then concentrated and purified by column chromatography with 30% EtOAc/hexanes to give 2.9 g (83 %) of the nitrile in a 7:1 ratio for the desired isomer. ^{1}H-NMR data is consistent with that reported previously.[2]



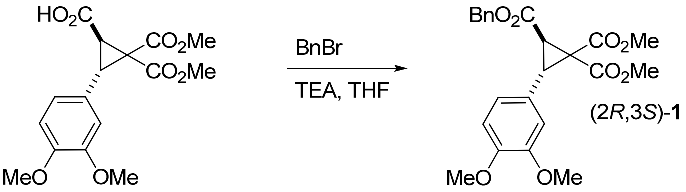
(E)-3-(3,4-dimethoxyphenyl)acrylaldehyde (8): 0.70 g of the nitrile was cooled in 25 mL of toluene to -78 °C with stirring. A 0.562 M solution of DIBALH in toluene (10.7 mL) was added dropwise to the nitrile via cannula transfer. The solution was allowed to stir for 2 hours. At -78 °C MeOH (2 mL) was added to quench the reaction. The reaction flask was allowed to warm to room temperature then stirred with 1M HCl (4 mL) for two minutes. The reaction was diluted with 20 mL of EtOAc and extracted. The aqueous layer was extracted twice with 10 mL of EtOAc. The combined organics were washed with brine and dried over Na_2SO_4. After concentration the material was purified by column chromatography to give the desired isomer in a 76% yield (0.55 g). ^{1}H NMR data is consistent with that reported previously.[2]



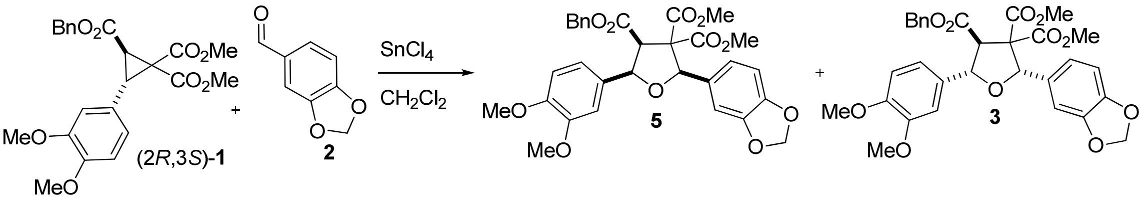
(2*S*,3*R*)-dimethyl 2-(3,4-dimethoxyphenyl)-3-formylcyclopropane-1,1-dicarboxylate (10): To a mixture of bromomalonate ester (1.66 g, 7.9 mmol), 2,6-lutidine (1 mL, 8.6 mmol), and the proline catalyst[3] (0.77 g, 2.4 mmol) was added the aldehyde (1.66 g, 8.6 mmol) at room temperature. The reaction was allowed to stir in a sealed scintillation vial for three days. At this time the reaction contents were washed with 1M HCl. The organic portion was dried and concentrated. This material was analyzed by ^{1}H NMR to confirm formation of the product. The crude material was taken on to the oxidation. Column chromatography resulted in complete racemization of the aldehyde by SFC analysis.



(1*R*,3*S*)-3-(3,4-dimethoxyphenyl)-2,2-bis(methoxycarbonyl)cyclopropanecarboxylic acid: A solution of the aldehyde (0.63 g, 2.0 mmol) in acetonitrile (6 mL)was cooled to 0 °C and a solution of KH_2PO_4 (0.53 g, 3.9 mmol) and H_2O_2 in H_2O (8 mL) was added under rigorous stirring. After addition of a solution of $NaClO_2$ (0.71 g, 7.8 mmol) H_2O (8 ml), the mixture was stirred at 0 °C. After 3 hours, Na_2SO_3 was added to destroy excess $NaClO_2$. The solution was made basic with 6M NaOH and extracted with EtOAc. The aqueous solution was acidified with 6M HCl (pH 3). It was extracted with EtOAc twice, once with brine, and dried with magnesium sulfate. This material was taken on to the benzylation without further purification.

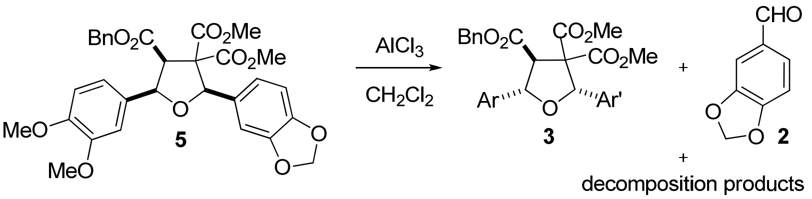


(2*R*,3*S*)-2-benzyl 1,1-dimethyl 3-(3,4-dimethoxyphenyl)cyclopropane-1,1,2-tricarboxylate (2*R*,3*S*)-1: The cyclopropane acid (1.1 g, 3.2 mmol), triethylamine (2.2 mL, 16 mmol), and benzyl bromide (1.88 mL, 16 mmol) were dissolved in 25 mL THF and allowed to stir at reflux overnight. TLC analysis indicated the disappearance of starting material. The reaction was cooled to room temperature and diluted with 15 mL of H_2O. The solution was extracted three times with Et_2O (15 mL) and the combined organics were washed with H_2O and brine, dried over $MgSO_4$, and concentrated to give (2*R*,3*S*)-1 in 43% over three steps. $[\alpha]_D^{25.7}$ -9.2 (c = 0.42, CH_2Cl_2).



(2*R*,4*S*,5*R*)-4-benzyl 3,3-dimethyl 2-(benzo[*d*][1,3]dioxol-5-yl)-5-(3,4-dimethoxyphenyl)dihydrofuran-3,3,4(2*H*)-tricarboxylate and (2*S*,4*S*,5*S*)-4-benzyl 3,3-dimethyl 2-(benzo[*d*][1,3]dioxol-5-yl)-5-(3,4-dimethoxyphenyl)dihydrofuran-3,3,4(2*H*)-tricarboxylate: A flame dried shell vial with a stirbar was charged with 0.15 g of the cyclopropane (0.35 mmol) and piperonal (0.11g, 0.7 mmol). Outside the glove box, a solution of $SnCl_4$ (0.07 g, 0.3 mmol) in CH_2Cl_2 was added under N_2 and the reaction was allowed to stir for 16 hours. The reaction was then diluted with diethyl ether and the solution was run through a silica plug and concentrated. The reaction was flashed with 60% ether/petroleum ether to isolate **5**.

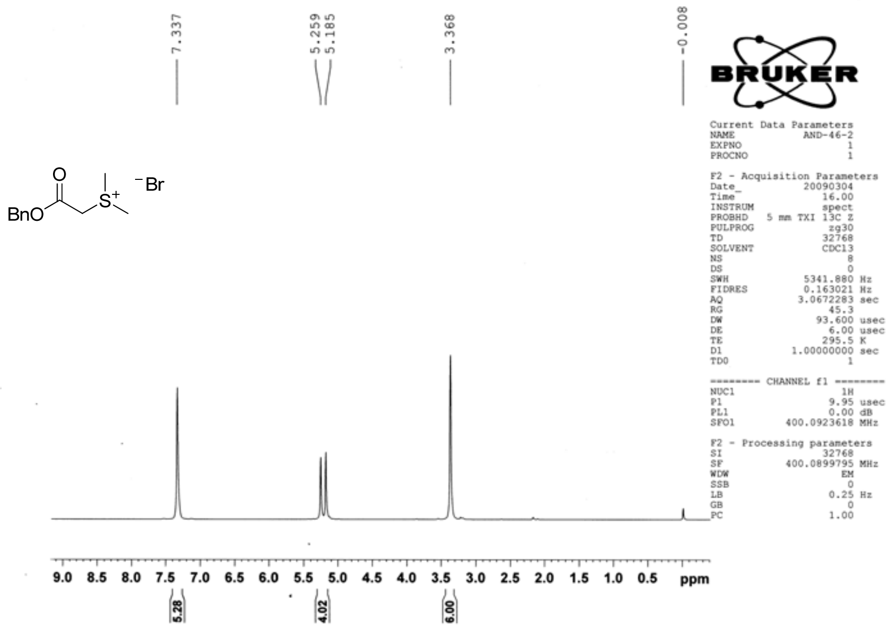
Analytical data: IR (thin film, cm^{-1}) 2940, 2845, 1730, 1530, 1430, 1227; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36-7.12 (m, 2H), 7.05 (d, *J* = 4 Hz, 1H), 7.02-6.99 (m, 4H), 6.80-6.77 (m, 2H), 5.98 (s, 2H), 5.47 (s, 1H), 5.19 (d, *J* = 6.8 Hz, 1H), 4.83 (d, *J* = 12 Hz, 1H), 4.67 (d, *J* = 12 Hz, 1H), 4.04 (d, *J* = 6.8 Hz, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 3.83 (s, 3H), 3.33 (s, 3H); ^{13}C NMR δ 170.5, 168.7, 166.5, 148.8, 148.8, 147.5, 147.2, 135.2, 130.6, 128.9, 128.5, 128.3, 128.1, 122.1, 119.2, 110.8, 110.2, 109.1, 107.5, 100.9, 84.7, 80.5, 68.0, 66.8, 57.5, 55.9, 55.9, 53.6, 52.1; **HRMS (ESI)** calculated for $C_{31}H_{30}O_{11}Cs$ $[M+Cs]^+$: 711.0843. Found: $[M+Cs]^+$ = 711.0842.



(2*S*,4*S*,5*S*)-4-benzyl 3,3-dimethyl 2-(benzo[*d*][1,3]dioxol-5-yl)-5-(3,4-dimethoxyphenyl)dihydrofuran-3,3,4(2*H*)-tricarboxylate and piperonal: A flame-dried shell vial with a stir bar was charged with **5** (45 mg, 0.12 mmol) and $AlCl_3$ (1.6 mg, 0.12 mmol) inside the glovebox. Outside the box CH_2Cl_2 was added to the vial under N_2. After the addition, the reaction was stirred for two minutes. It was then diluted with Et_2O and concentrated. ^{1}H NMR analysis confirmed formation of **3** and **2** with loss of **5.** Aldehyde **2** was obtained in 48% yield and cycloadduct **3** in 36% yield as determined using mesitylene as an internal standard.

References

1. T. F. Buckley and H. Rapoport, *J. Am. Chem. Soc.*, 1980, **102**, 3056-3062.
2. A. Y. Lukin, S. V. Shevyakov, A. V. Laptev, O. I. Davydova, V. I. Shvets, O. V. Demina, Y. P. Strokach, V. A. Barachevsky, M. V. Alfimov, S. P. Gromov, A. I. Vedernikov, J. Lugtenburg and A. A. Khodonov, *J. Incl. Phenom. Macro.*, 2004, **49**, 153-161.
3. J. V. Bhaskar Kanth and M. Periasamy, *Tetrahedron*, 1993, **49**, 5127-5132.



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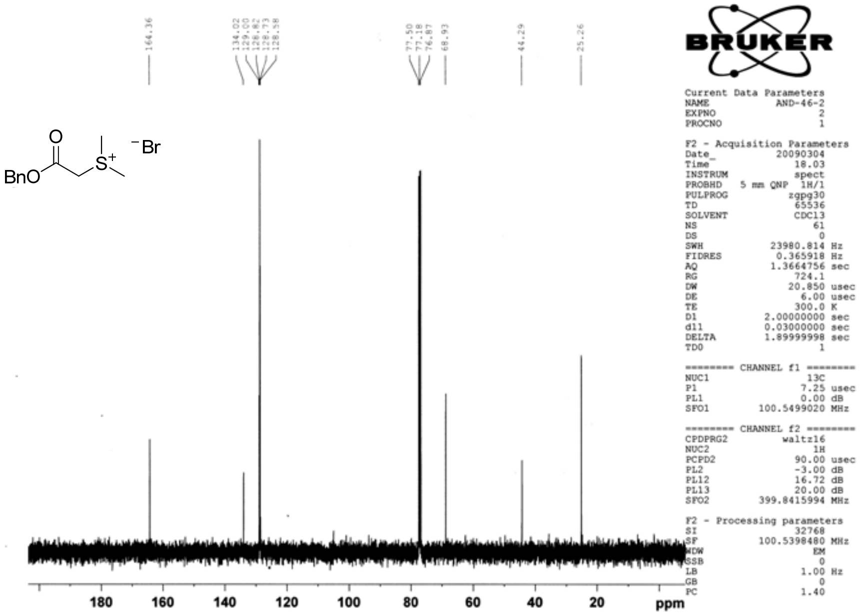

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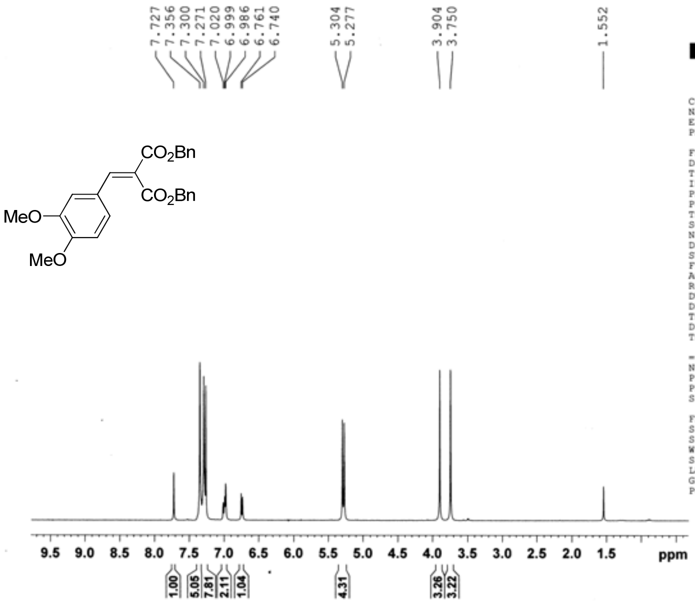

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F2 - Processing parameters
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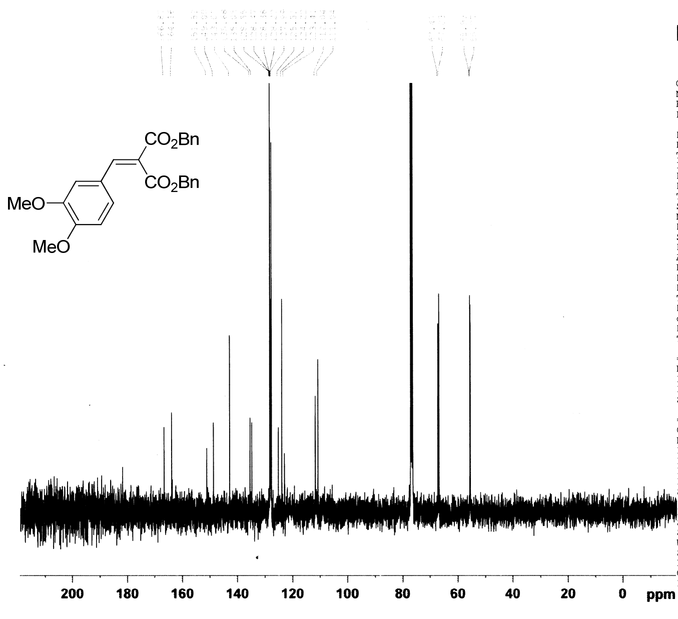

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DELTA         0.89999998 sec
TD0                    1

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PL12               16.72 dB
PL13               20.00 dB
SFO2         399.8415994 MHz

F2 - Processing parameters
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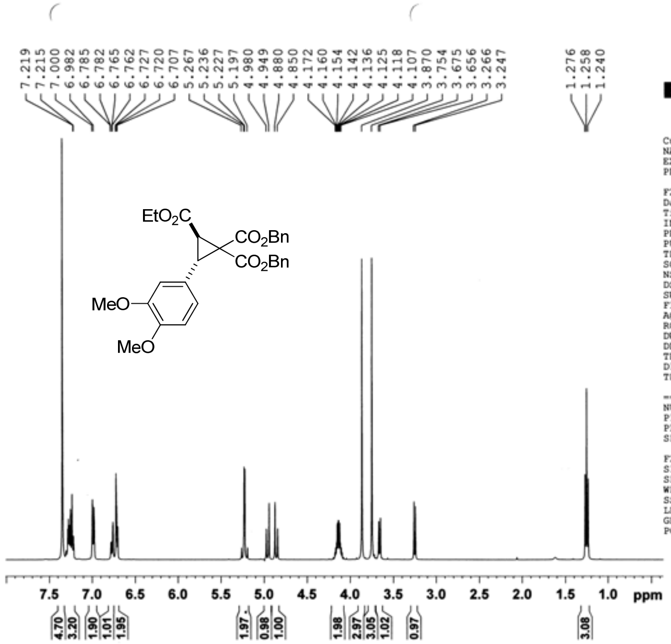

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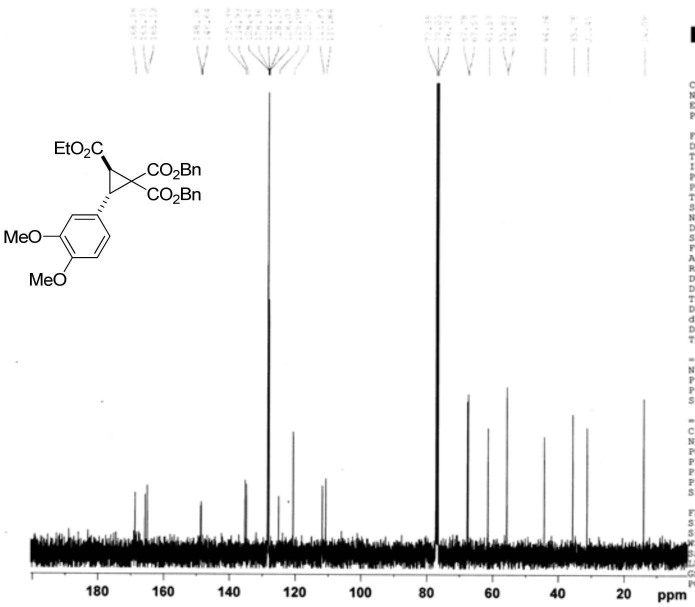

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DELTA           1.89999998 sec
TD0                      1

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SFO1           100.5499020 MHz

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PL12                 16.72 dB
PL13                 20.00 dB
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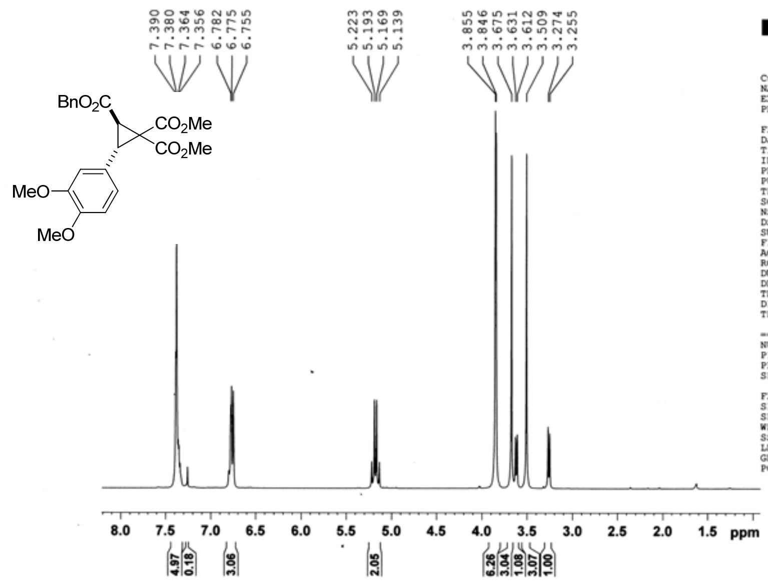

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======== CHANNEL f1 ========
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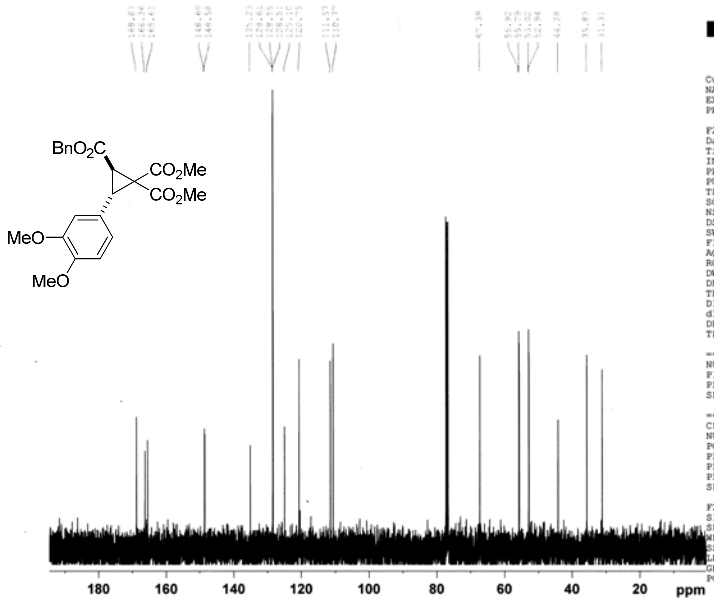

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PROCNO                   1

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F2 - Processing parameters
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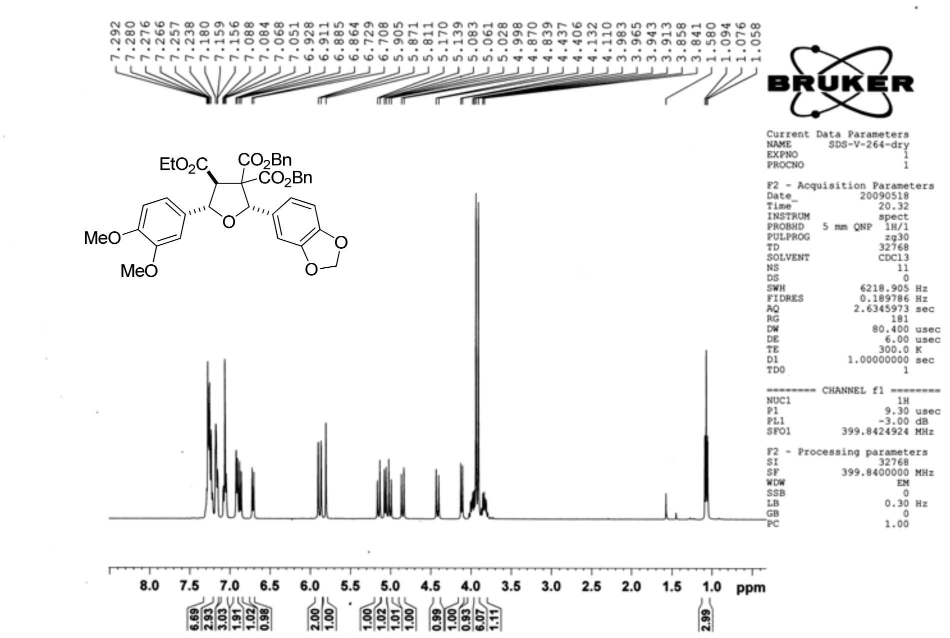
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```

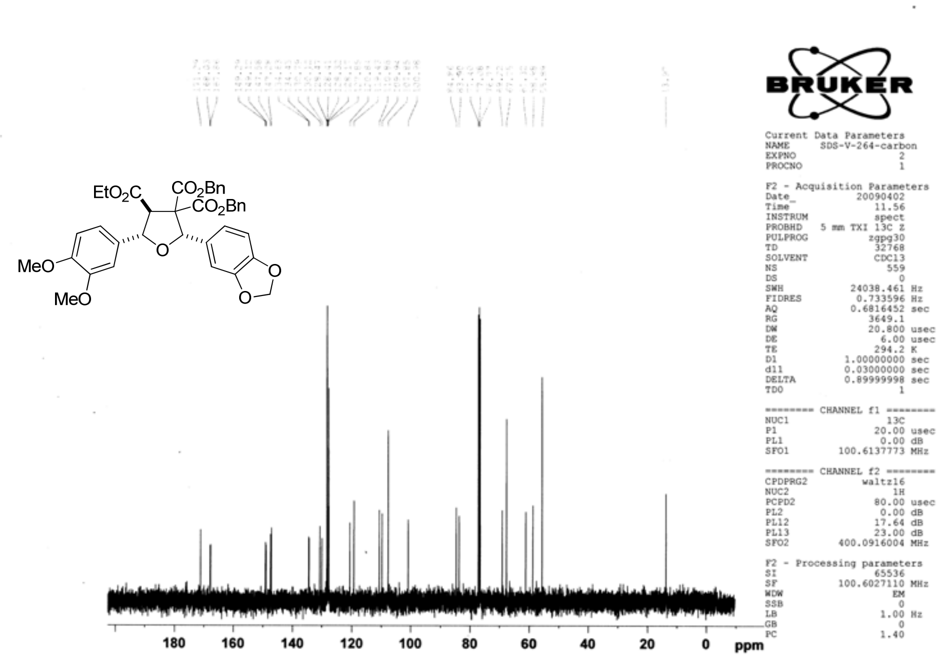


```
Current Data Parameters
NAME       SDS-V-264-dry
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20090518
Time               20.32
INSTRUM            spect
PROBHD   5 mm QNP  1H/1
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    11
DS                     0
SWH             6218.905 Hz
FIDRES          0.189786 Hz
AQ             2.6345973 sec
RG                   181
DW                80.400 usec
DE                  6.00 usec
TE                 300.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                  9.30 usec
PL1                -3.00 dB
SFO1         399.8424924 MHz

F2 - Processing parameters
SI                 32768
SF           399.8400000 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```



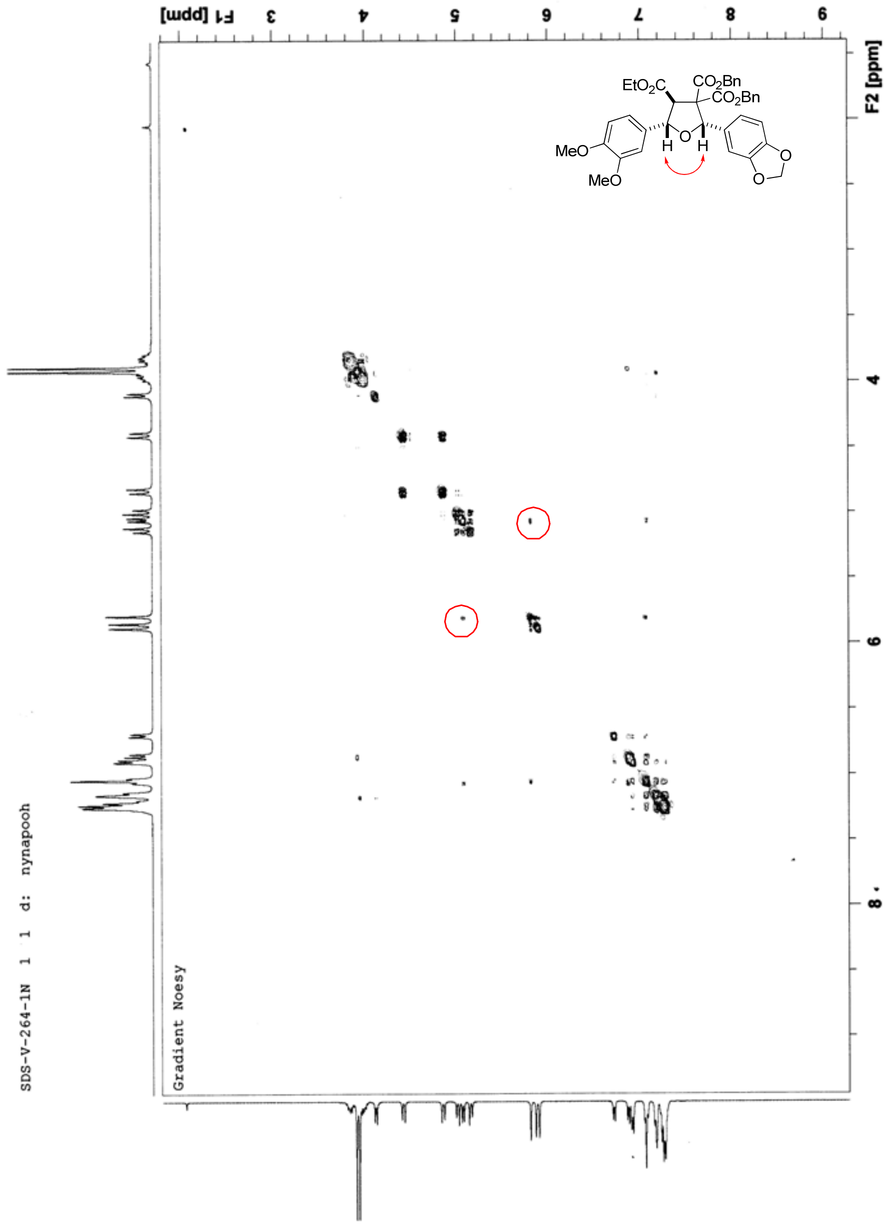
```
Current Data Parameters
NAME    SDS-V-264-carbon
EXPNO                  2
PROCNO                 1

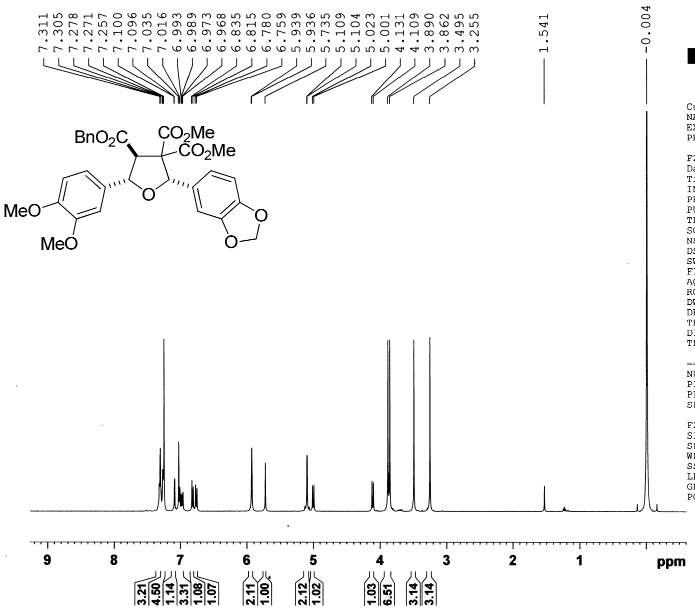
F2 - Acquisition Parameters
Date_           20090402
Time               11.56
INSTRUM            spect
PROBHD   5 mm TXI 13C Z
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                   559
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6816452 sec
RG                3649.1
DW                20.800 usec
DE                  6.00 usec
TE                 294.2 K
D1            1.00000000 sec
d11           0.03000000 sec
DELTA         0.89999998 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                 20.00 usec
PL1                 0.00 dB
SFO1         100.6137773 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                 0.00 dB
PL12               17.64 dB
PL13               23.00 dB
SFO2         400.0916004 MHz

F2 - Processing parameters
SI                 65536
SF           100.6027110 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```


SDS-V-264-1N 1 1 d: nynapooh
Gradient Noesy
F1 [ppm]
3
4
5
6
7
8
9
F2 [ppm]
4
6
8
EtO_2C
CO_2Bn
CO_2Bn
MeO
MeO
H
O
H
O
O



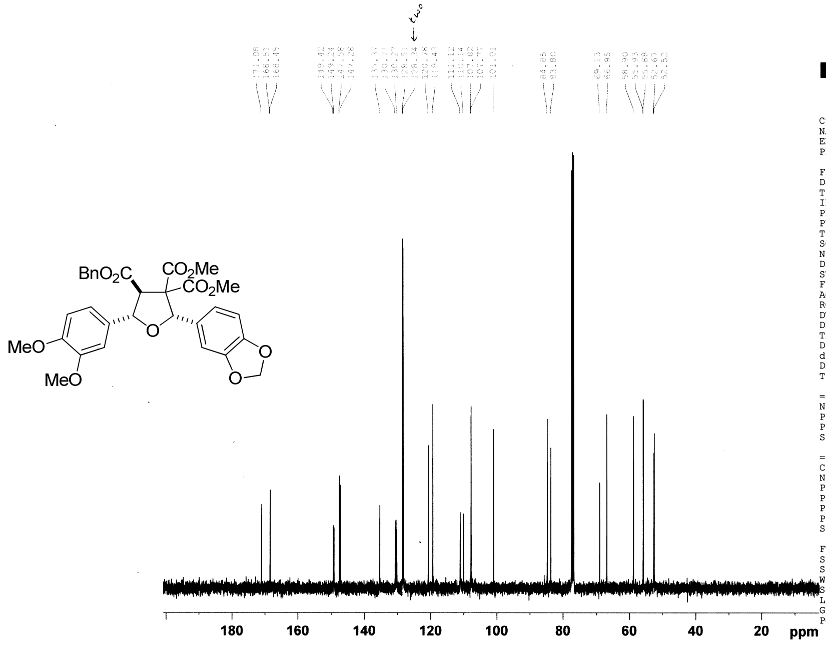
BRUKER

```
Current Data Parameters
NAME          SDS-V-243-2
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_            20090418
Time                17.14
INSTRUM             spect
PROBHD   5 mm TXI 13C Z
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                      8
DS                      0
SWH              5341.880 Hz
FIDRES           0.163021 Hz
AQ              3.0672283 sec
RG                  406.4
DW                 93.600 usec
DE                   6.00 usec
TE                  294.8 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                   9.95 usec
PL1                  0.00 dB
SFO1          400.0923618 MHz

F2 - Processing parameters
SI                  32768
SF            400.0900055 MHz
WDW                    EM
SSB                     0
LB                   0.25 Hz
GB                      0
PC                   1.00
```



BRUKER

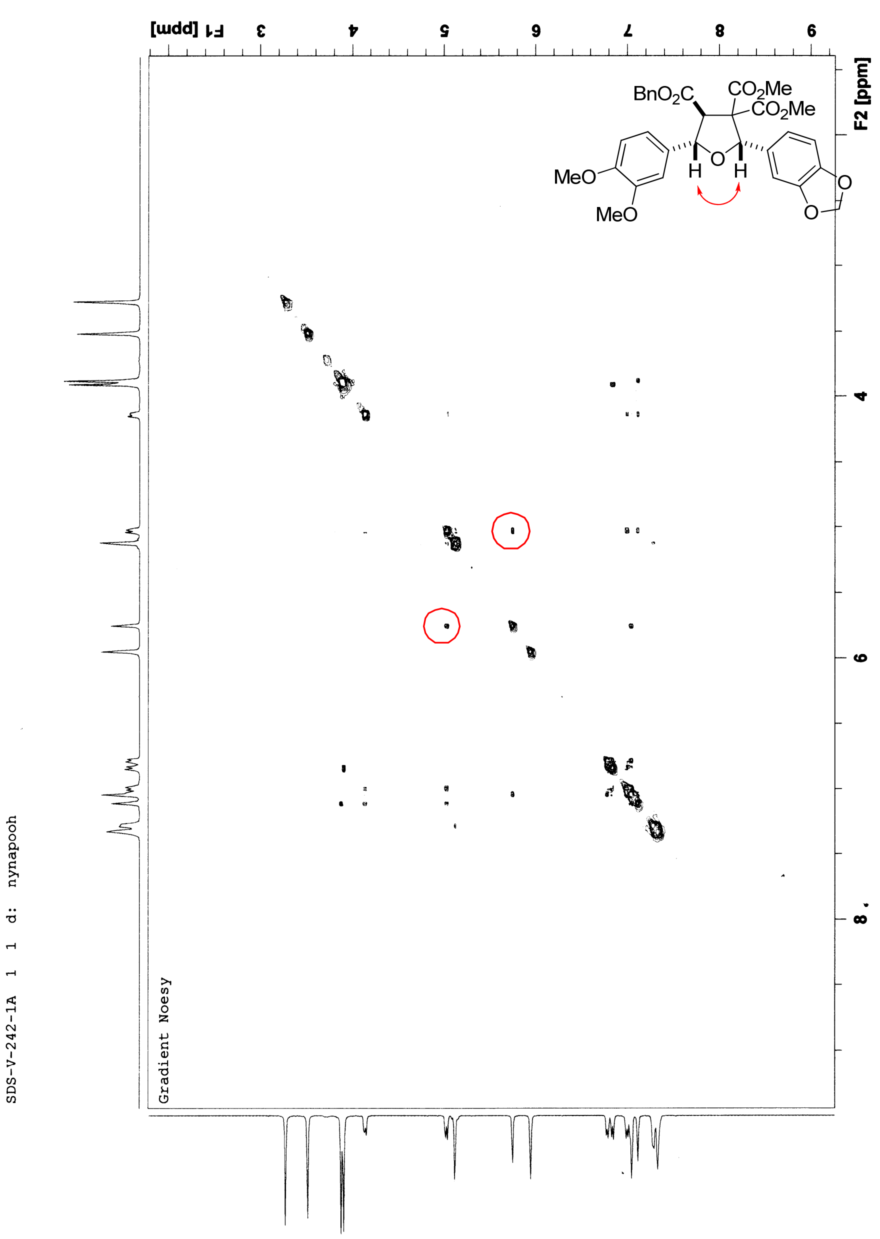
```
Current Data Parameters
NAME          SDS-V-217-2A
EXPNO                   2
PROCNO                  1

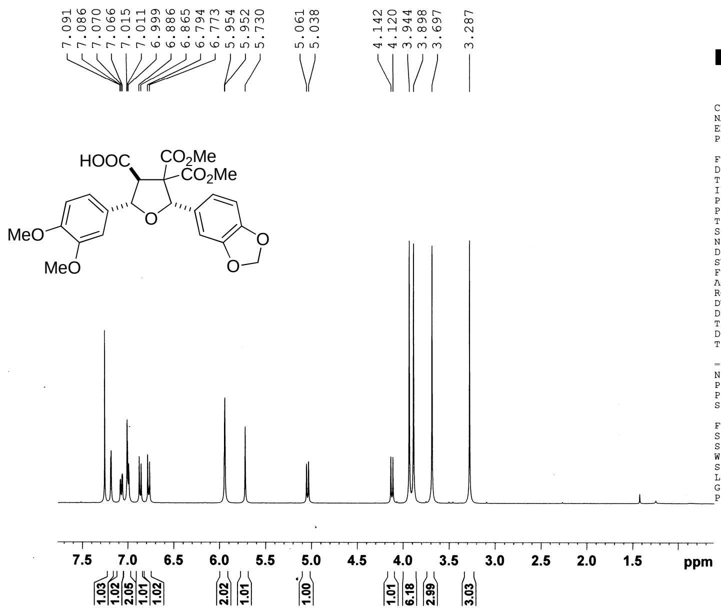
F2 - Acquisition Parameters
Date_            20090402
Time                11.34
INSTRUM             spect
PROBHD   5 mm QNP  1H/1
PULPROG            zgpg30
TD                  32768
SOLVENT             CDCl3
NS                    547
DS                      0
SWH             23980.814 Hz
FIDRES           0.731836 Hz
AQ              0.6832628 sec
RG                  16384
DW                 20.850 usec
DE                   6.00 usec
TE                  300.0 K
D1             1.00000000 sec
d11            0.03000000 sec
DELTA          0.89999998 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  13C
P1                   7.25 usec
PL1                  0.00 dB
SFO1          100.5499020 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2               90.00 usec
PL2                 -3.00 dB
PL12                16.72 dB
PL13                20.00 dB
SFO2          399.8415994 MHz

F2 - Processing parameters
SI                  32768
SF            100.5398480 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```


F1 [ppm]
3
4
5
6
7
8
9
F2 [ppm]
4
6
8
BnO_2C
CO_2Me
CO_2Me
MeO
MeO
H
O
H
O
O
Gradient Noesy
SDS-V-242-1A 1 1 d: nynapooh

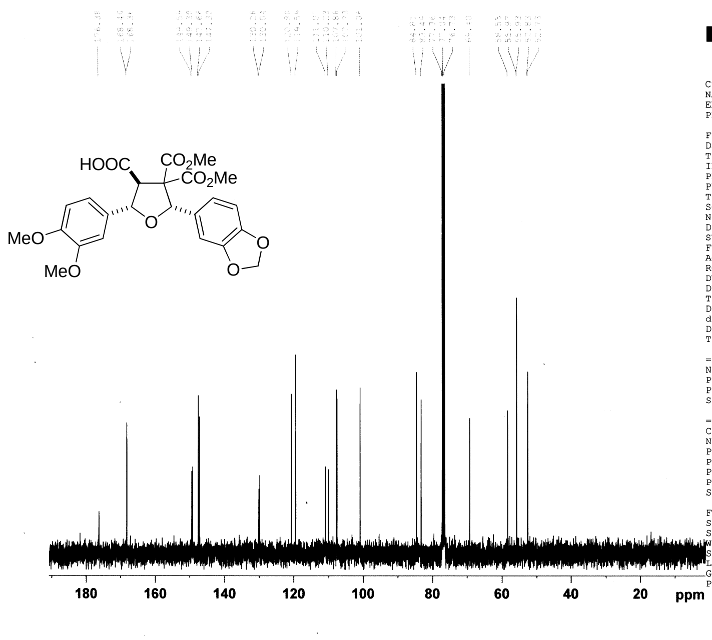


```
Current Data Parameters
NAME            SDS-V-105
EXPNO                   3
PROCNO                  1

F2 - Acquisition Parameters
Date_            20090526
Time                21.26
INSTRUM             spect
PROBHD   5 mm TXI 13C Z
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                      8
DS                      0
SWH              5341.880 Hz
FIDRES           0.163021 Hz
AQ              3.0672283 sec
RG                  228.1
DW                 93.600 usec
DE                   6.00 usec
TE                  293.6 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                   9.95 usec
PL1                  0.00 dB
SFO1          400.0923618 MHz

F2 - Processing parameters
SI                  32768
SF            400.0900032 MHz
WDW                    EM
SSB                     0
LB                   0.25 Hz
GB                      0
PC                   1.00
```



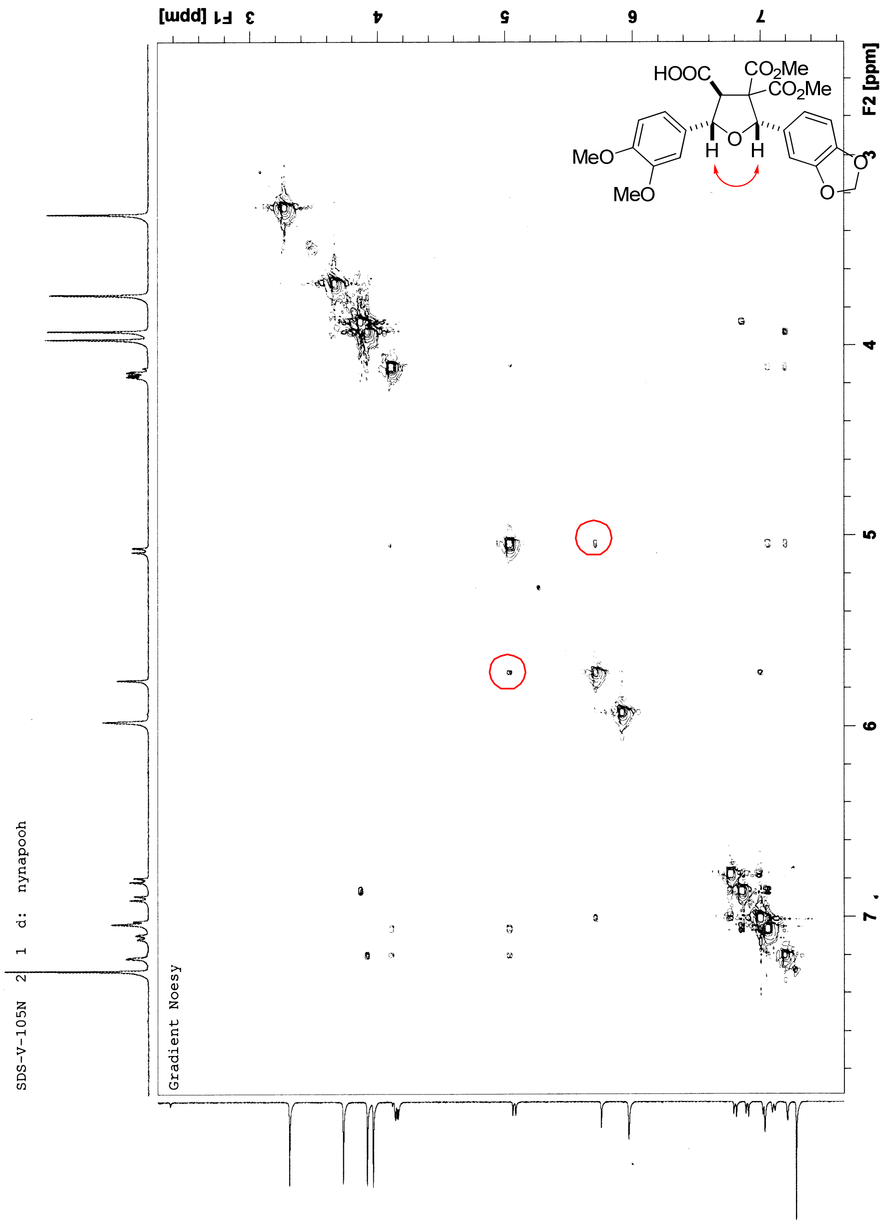
```
Current Data Parameters
NAME            SDS-~~110-1~~ 105
EXPNO                   1
PROCNO                  1

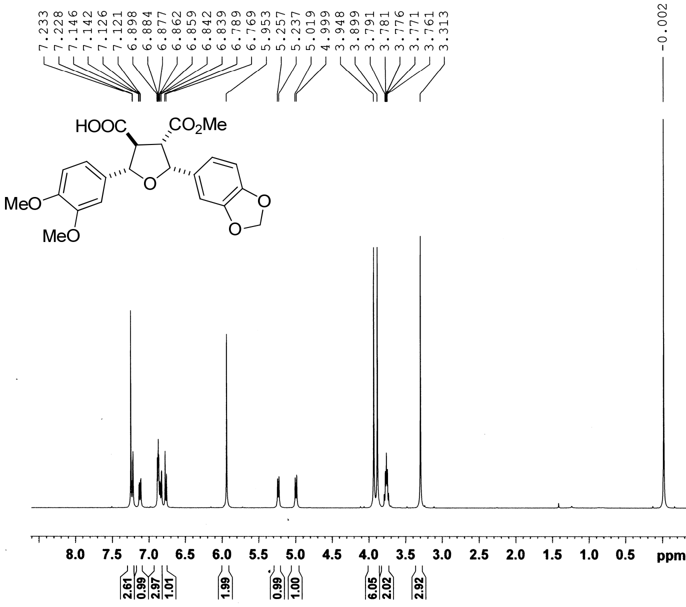
F2 - Acquisition Parameters
Date_            20090303
Time                16.07
INSTRUM             spect
PROBHD   5 mm QNP  1H/1
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                    216
DS                      2
SWH             23980.814 Hz
FIDRES           0.365918 Hz
AQ              1.3664756 sec
RG                   90.5
DW                 20.850 usec
DE                   6.00 usec
TE                  300.0 K
D1             2.00000000 sec
d11            0.03000000 sec
DELTA          1.89999998 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  13C
P1                   7.25 usec
PL1                  0.00 dB
SFO1          100.5499020 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2               90.00 usec
PL2                 -3.00 dB
PL12                16.72 dB
PL13                20.00 dB
SFO2          399.8415994 MHz

F2 - Processing parameters
SI                  32768
SF            100.5398480 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```


SDS-V-105N 2 1 d: nynapooh
Gradient Noesy
F1 [ppm]
F2 [ppm]
3
4
5
6
7
HOOC
CO2Me
CO2Me
MeO
MeO
H
O
H
O
O

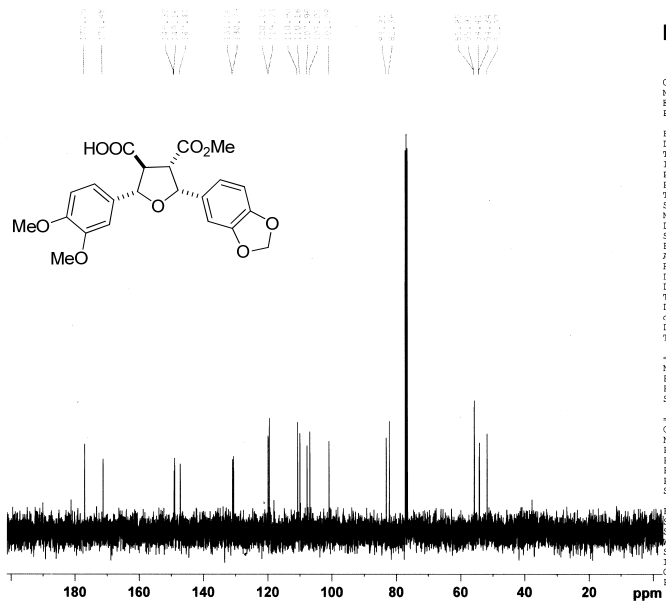


```
Current Data Parameters
NAME             SDS-V-229
EXPNO                    3
PROCNO                   1

F2 - Acquisition Parameters
Date_             20090526
Time                 17.06
INSTRUM              spect
PROBHD   5 mm TXI 13C Z
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               5341.880 Hz
FIDRES            0.163021 Hz
AQ               3.0672283 sec
RG                   287.4
DW                  93.600 usec
DE                    6.00 usec
TE                   294.7 K
D1              1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                    9.95 usec
PL1                   0.00 dB
SFO1           400.0923618 MHz

F2 - Processing parameters
SI                   32768
SF             400.0900048 MHz
WDW                     EM
SSB                      0
LB                    0.25 Hz
GB                       0
PC                    1.00
```



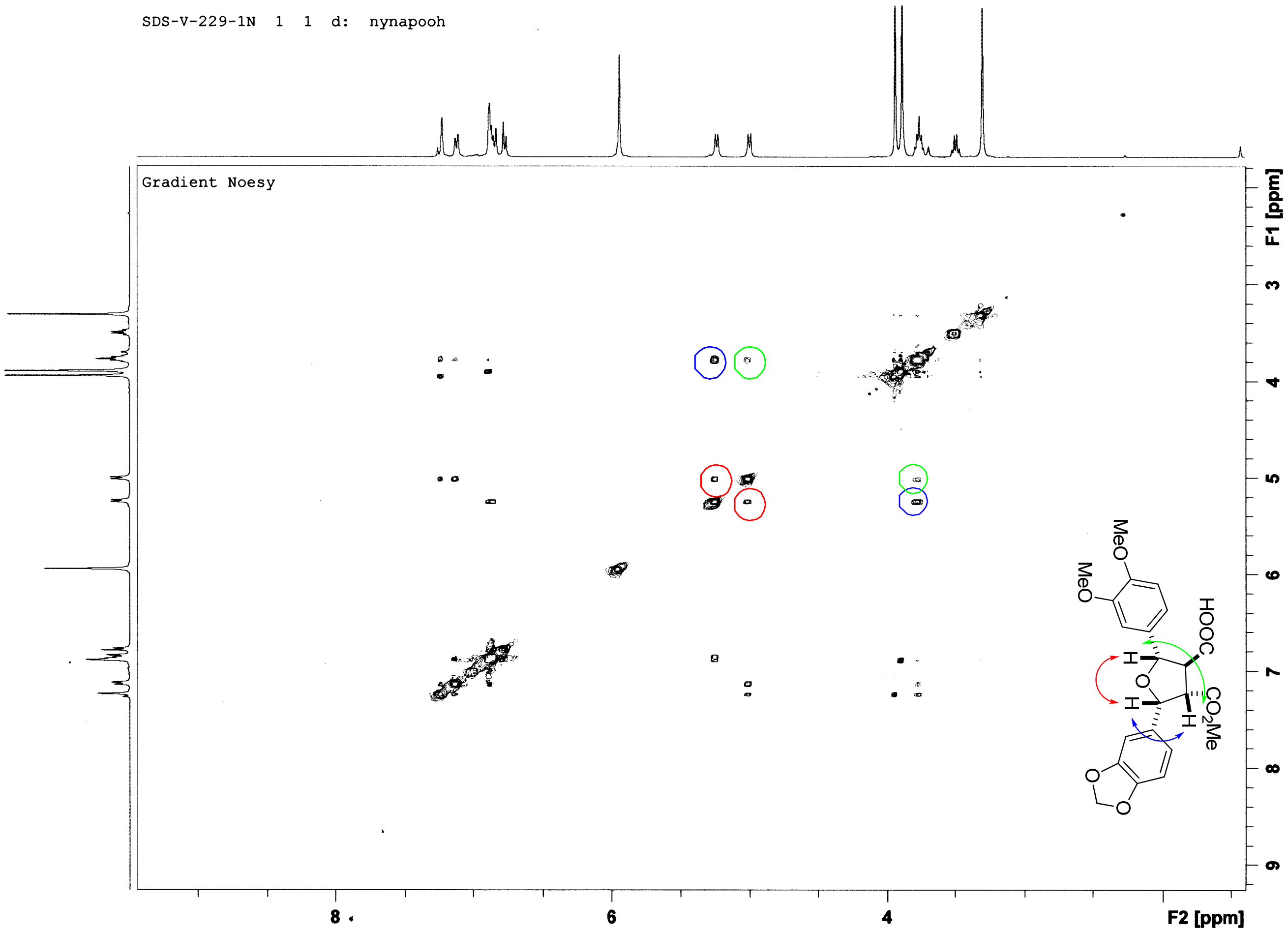
```
Current Data Parameters
NAME            SDS-V-229C
EXPNO                    2
PROCNO                   1

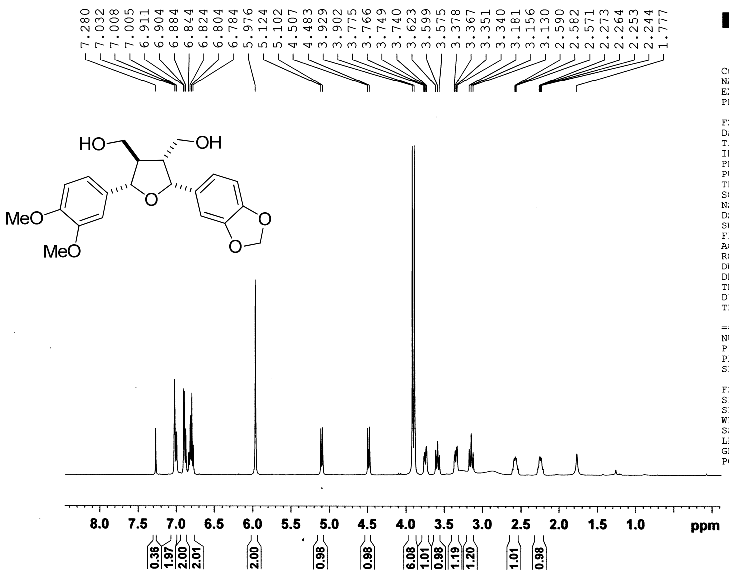
F2 - Acquisition Parameters
Date_             20090513
Time                 21.06
INSTRUM              spect
PROBHD   5 mm TXI 13C Z
PULPROG             zgpg30
TD                   32768
SOLVENT              CDCl3
NS                     628
DS                       0
SWH              24038.461 Hz
FIDRES            0.733596 Hz
AQ               0.6816452 sec
RG                  5160.6
DW                  20.800 usec
DE                    6.00 usec
TE                   295.4 K
D1              1.00000000 sec
d11             0.03000000 sec
DELTA           0.89999998 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                   13C
P1                   20.00 usec
PL1                   0.00 dB
SFO1           100.6137773 MHz

======== CHANNEL f2 ========
CPDPRG2            waltz16
NUC2                    1H
PCPD2                80.00 usec
PL2                   0.00 dB
PL12                 17.64 dB
PL13                 23.00 dB
SFO2           400.0916004 MHz

F2 - Processing parameters
SI                   65536
SF             100.6027110 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```


SDS-V-229-1N 1 1 d: nynapooh
Gradient Noesy
F1 [ppm]
F2 [ppm]
3
4
5
6
7
8
9
8
6
4
HOOC
CO2Me
H
H
O
H
MeO
MeO
O
O

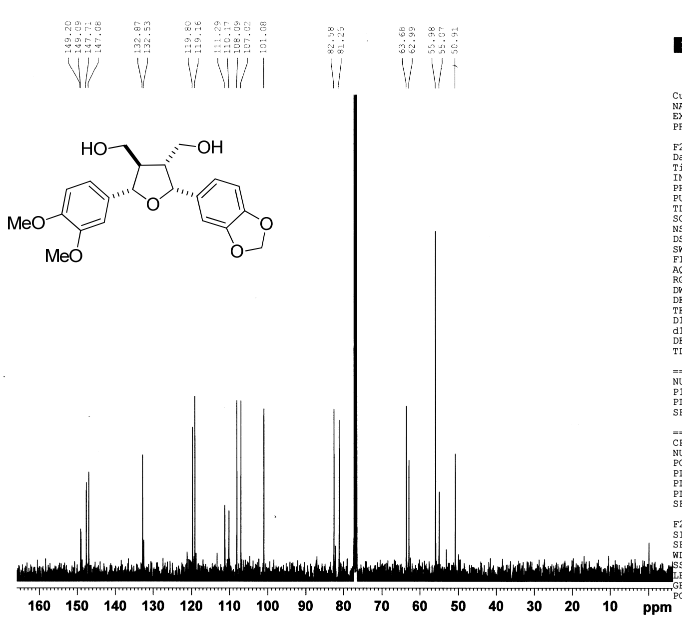


```
Current Data Parameters
NAME        SDS-V-~~262~~-1A  261
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_            20090515
Time                15.45
INSTRUM             spect
PROBHD   5 mm QNP  1H/1
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                      8
DS                      0
SWH              6218.905 Hz
FIDRES           0.189786 Hz
AQ              2.6345973 sec
RG                  161.3
DW                 80.400 usec
DE                   6.00 usec
TE                  300.0 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                   9.30 usec
PL1                 -3.00 dB
SFO1          399.8424924 MHz

F2 - Processing parameters
SI                  32768
SF            399.8400000 MHz
WDW                    EM
SSB                     0
LB                   0.30 Hz
GB                      0
PC                   1.00
```



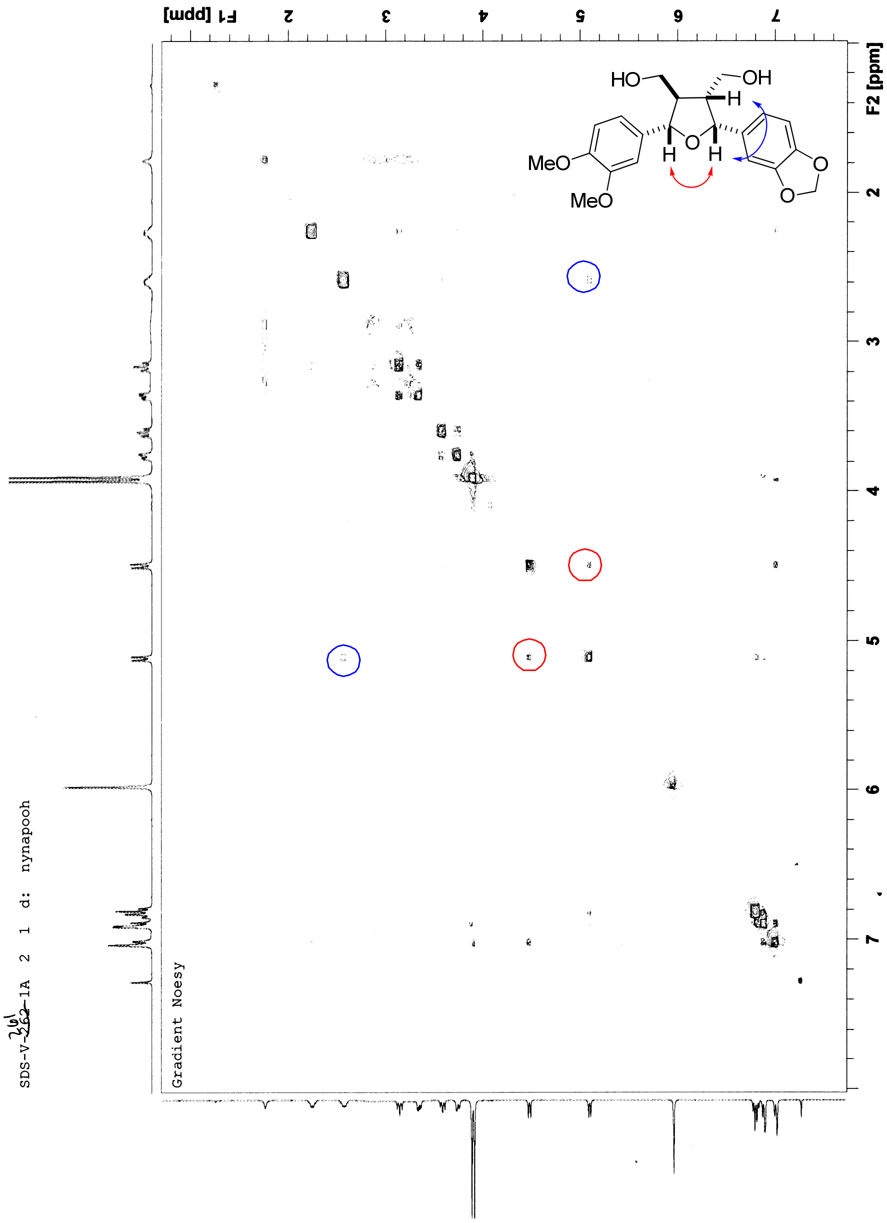
```
Current Data Parameters
NAME         SDS-V-111-2
EXPNO                  3
PROCNO                 1

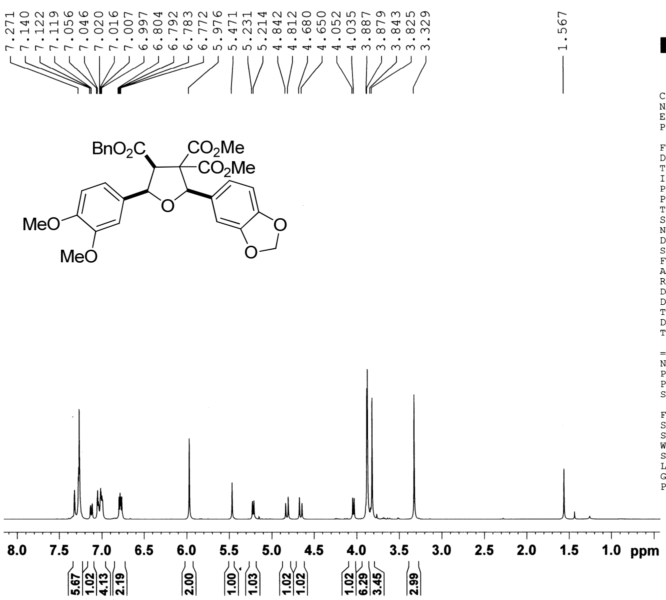
F2 - Acquisition Parameters
Date_           20090305
Time               16.08
INSTRUM            spect
PROBHD   5 mm QNP  1H/1
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                   210
DS                     2
SWH            23980.814 Hz
FIDRES          0.365918 Hz
AQ             1.3664756 sec
RG                 143.7
DW                20.850 usec
DE                  6.00 usec
TE                 300.0 K
D1            2.00000000 sec
d11           0.03000000 sec
DELTA         1.89999998 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                  7.25 usec
PL1                 0.00 dB
SFO1         100.5499020 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              90.00 usec
PL2                -3.00 dB
PL12               16.72 dB
PL13               20.00 dB
SFO2         399.8415994 MHz

F2 - Processing parameters
SI                 32768
SF           100.5398480 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```


SDS-V-261-1A 2 1 d: nynapooh
Gradient Noesy
F1 [ppm]
F2 [ppm]
2
3
4
5
6
7
HO
OH
H
MeO
MeO
O

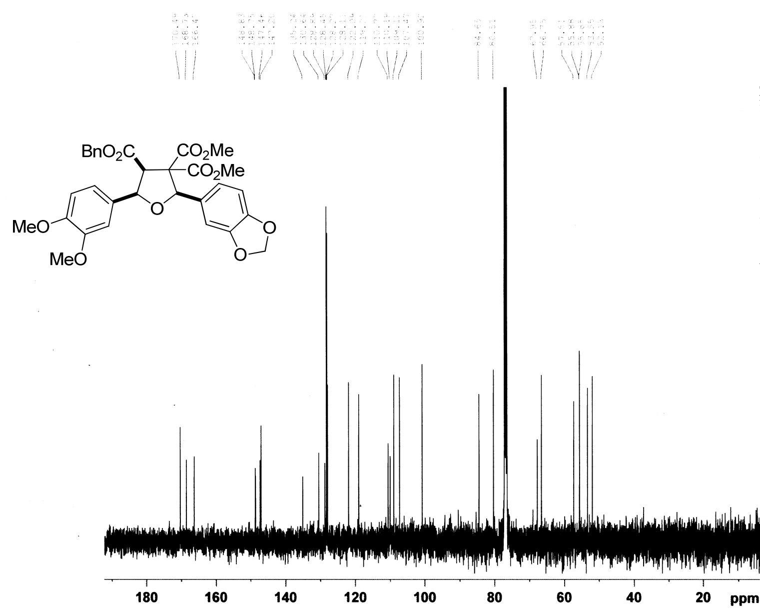


```
Current Data Parameters
NAME          SDS-V-262-2B
EXPNO                    2
PROCNO                   1

F2 - Acquisition Parameters
Date_             20090527
Time                 18.42
INSTRUM              spect
PROBHD   5 mm TXI 13C Z
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               5341.880 Hz
FIDRES            0.163021 Hz
AQ               3.0672283 sec
RG                   203.2
DW                  93.600 usec
DE                    6.00 usec
TE                   294.5 K
D1              1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                    9.95 usec
PL1                   0.00 dB
SFO1           400.0923618 MHz

F2 - Processing parameters
SI                   32768
SF             400.0900000 MHz
WDW                     EM
SSB                      0
LB                    0.25 Hz
GB                       0
PC                    1.00
```



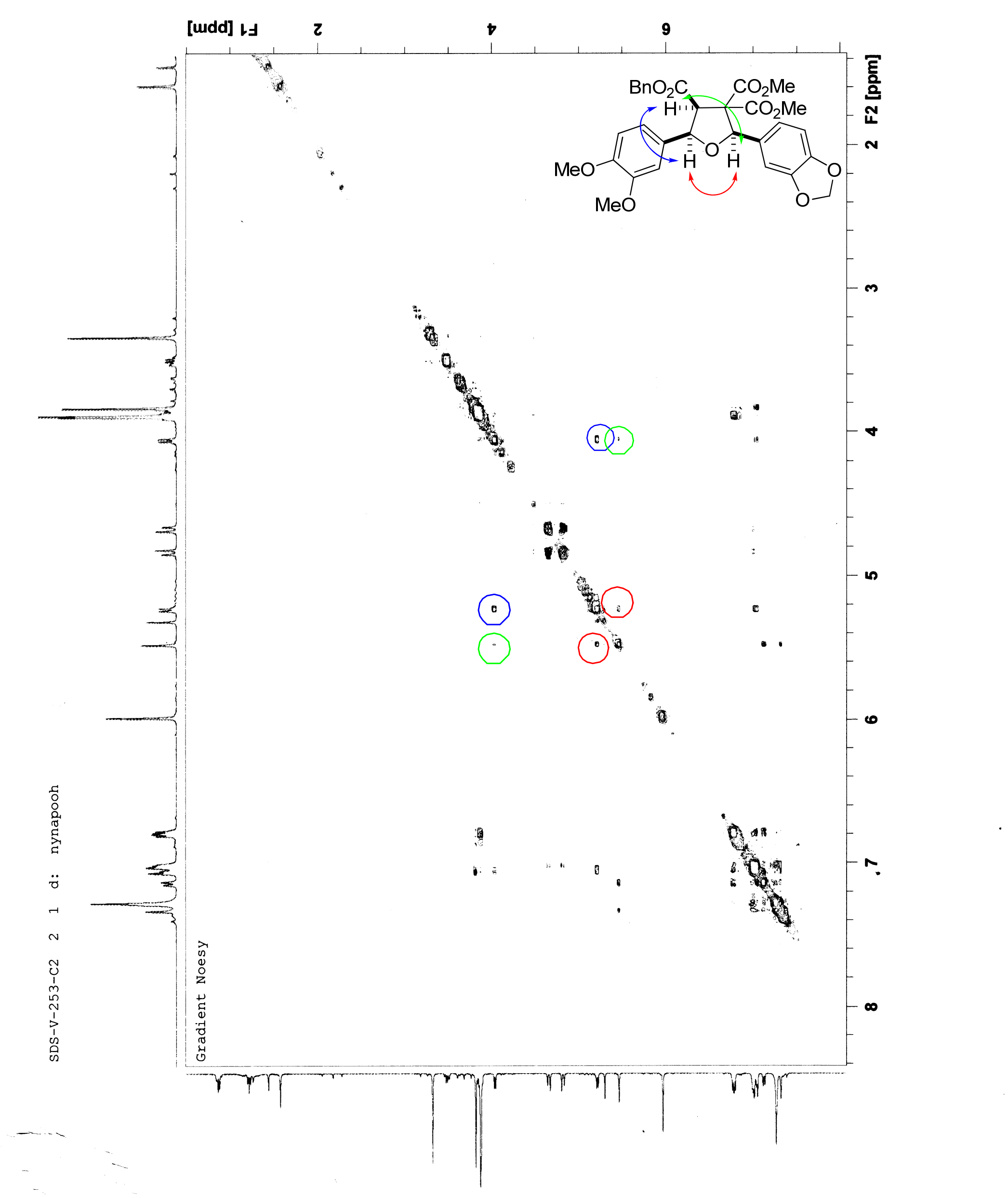
```
Current Data Parameters
NAME          SDS-V-262-2B
EXPNO                    3
PROCNO                   1

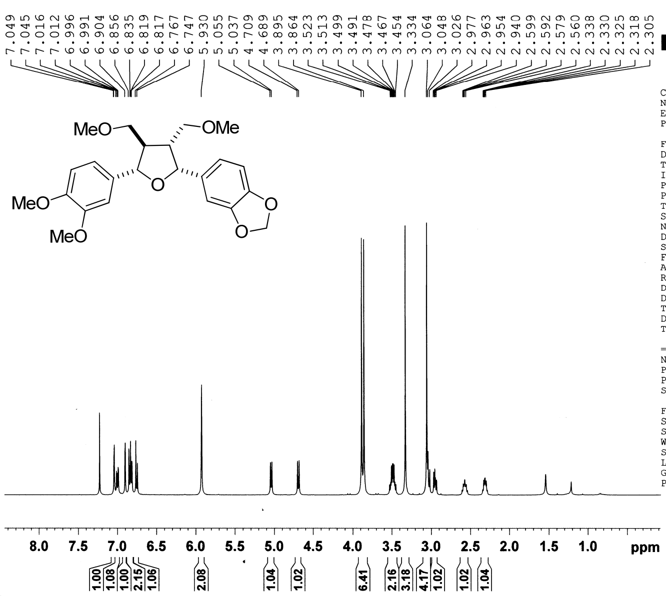
F2 - Acquisition Parameters
Date_             20090527
Time                 21.30
INSTRUM              spect
PROBHD   5 mm QNP  1H/1
PULPROG            zgpg30
TD                   32768
SOLVENT              CDCl3
NS                   18189
DS                       0
SWH              23980.814 Hz
FIDRES            0.731836 Hz
AQ               0.6832628 sec
RG                   16384
DW                  20.850 usec
DE                    6.00 usec
TE                   300.0 K
D1              1.00000000 sec
d11             0.03000000 sec
DELTA           0.89999998 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                   13C
P1                    7.25 usec
PL1                   0.00 dB
SFO1           100.5499020 MHz

======== CHANNEL f2 ========
CPDPRG2            waltz16
NUC2                    1H
PCPD2                90.00 usec
PL2                  -3.00 dB
PL12                 16.72 dB
PL13                 20.00 dB
SFO2           399.8415994 MHz

F2 - Processing parameters
SI                   32768
SF             100.5398480 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```


SDS-V-253-C2 2 1 d: nynapooh
Gradient Noesy
F1 [ppm]
F2 [ppm]
2
4
6
2
3
4
5
6
7
8
BnO$_2$C
CO$_2$Me
CO$_2$Me
H
H
O
H
MeO
MeO
O
O

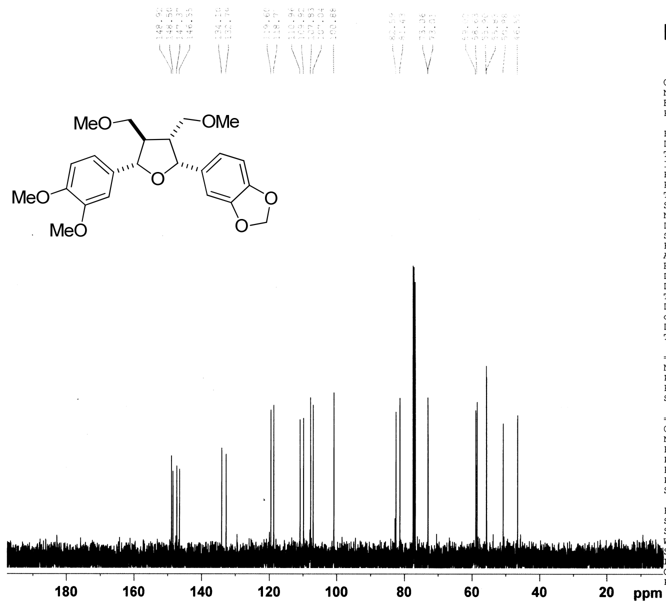


```
Current Data Parameters
NAME        SDS-V-263-1A
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20090531
Time               16.24
INSTRUM            spect
PROBHD   5 mm TXI 13C Z
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     8
DS                     0
SWH             5341.880 Hz
FIDRES          0.163021 Hz
AQ             3.0672283 sec
RG                   114
DW                93.600 usec
DE                  6.00 usec
TE                 294.6 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                  9.95 usec
PL1                 0.00 dB
SFO1         400.0923618 MHz

F2 - Processing parameters
SI                 32768
SF           400.0900160 MHz
WDW                   EM
SSB                    0
LB                  0.25 Hz
GB                     0
PC                  1.00
```



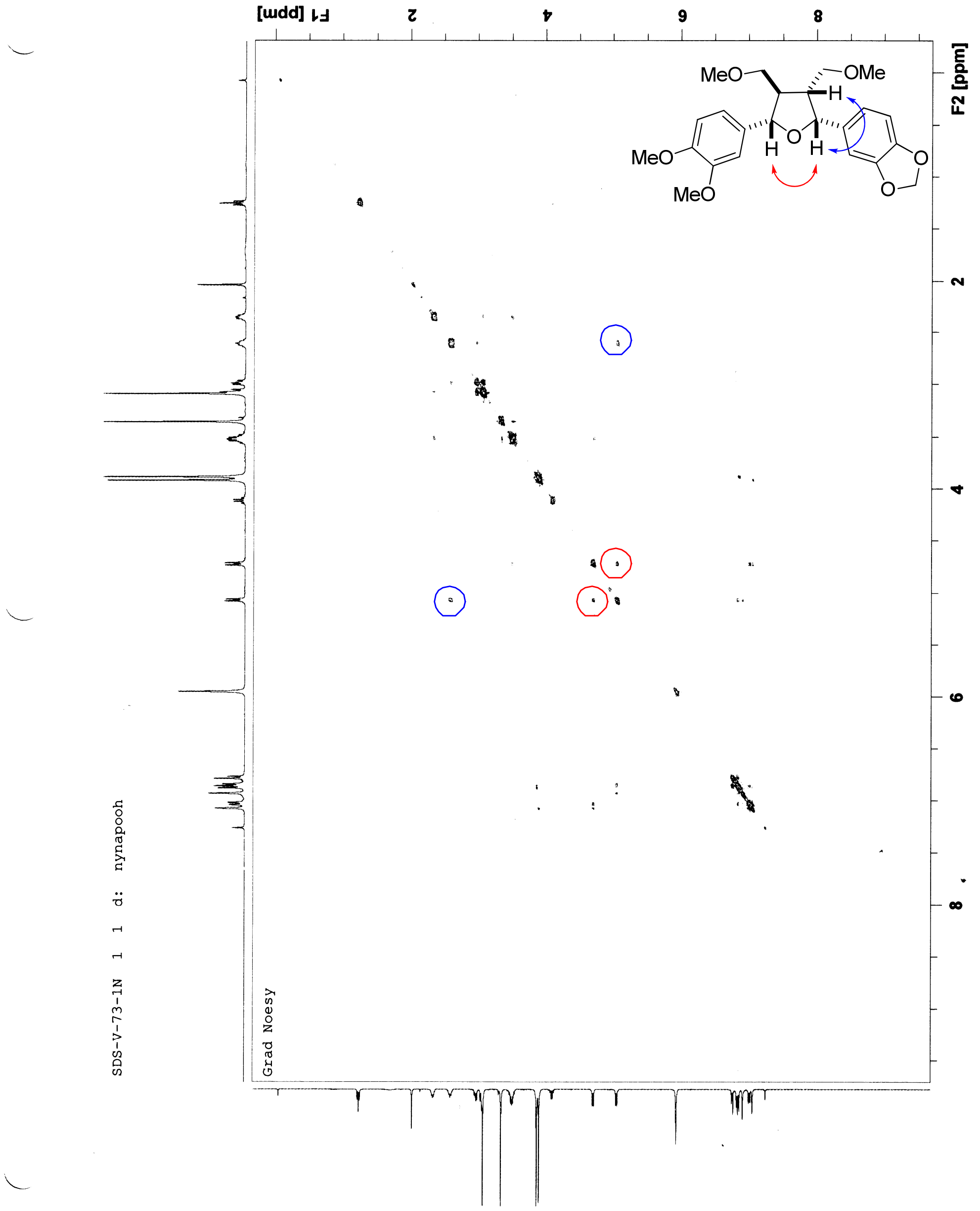
```
Current Data Parameters
NAME     SDS-V-73-carbon
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20090531
Time               16.50
INSTRUM            spect
PROBHD   5 mm TXI 13C Z
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                   177
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6816452 sec
RG               11585.2
DW                20.800 usec
DE                  6.00 usec
TE                 294.7 K
D1            1.00000000 sec
d11           0.03000000 sec
DELTA         0.89999998 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                 20.00 usec
PL1                 0.00 dB
SFO1         100.6137773 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                 0.00 dB
PL12               17.64 dB
PL13               23.00 dB
SFO2         400.0916004 MHz

F2 - Processing parameters
SI                 65536
SF           100.6027110 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```


F1 [ppm]
2
4
6
8
F2 [ppm]
2
4
6
8
Grad Noesy
SDS-V-73-1N 1 1 d: nynapooh
MeO
OMe
MeO
MeO
H
H
H
O
O
O

Red – Marsden Synthetic Sample
Blue- Johnson Synthetic Sample