Engineering Orthogonal Polypeptide GalNAc-Transferase and UDP-Sugar Pairs

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Supporting Information

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I. Supporting Figures and Tables

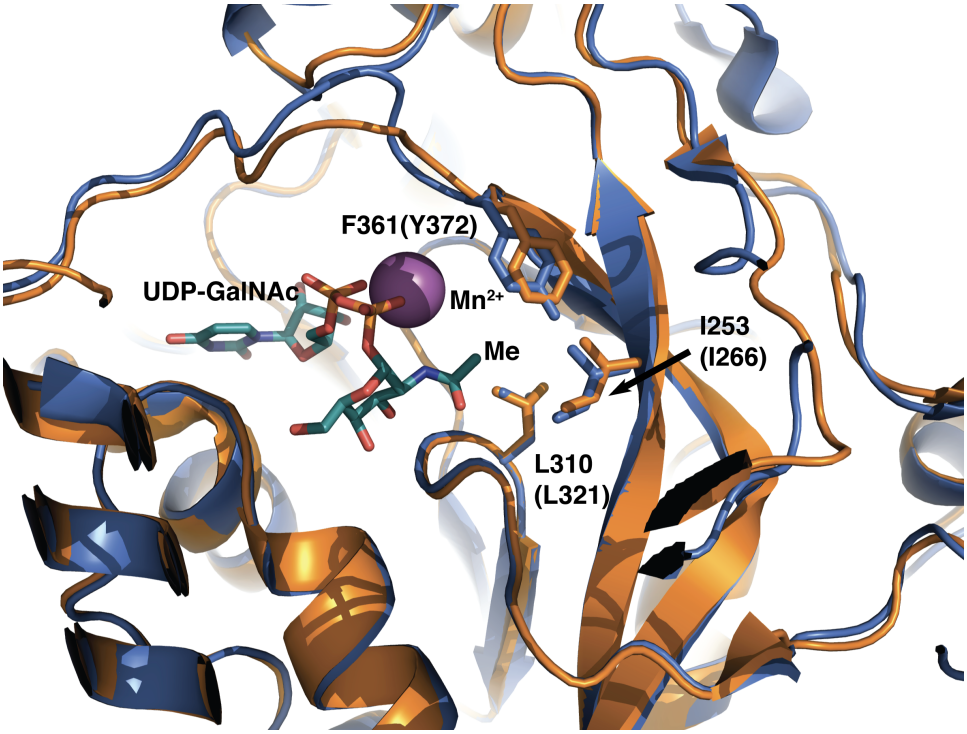
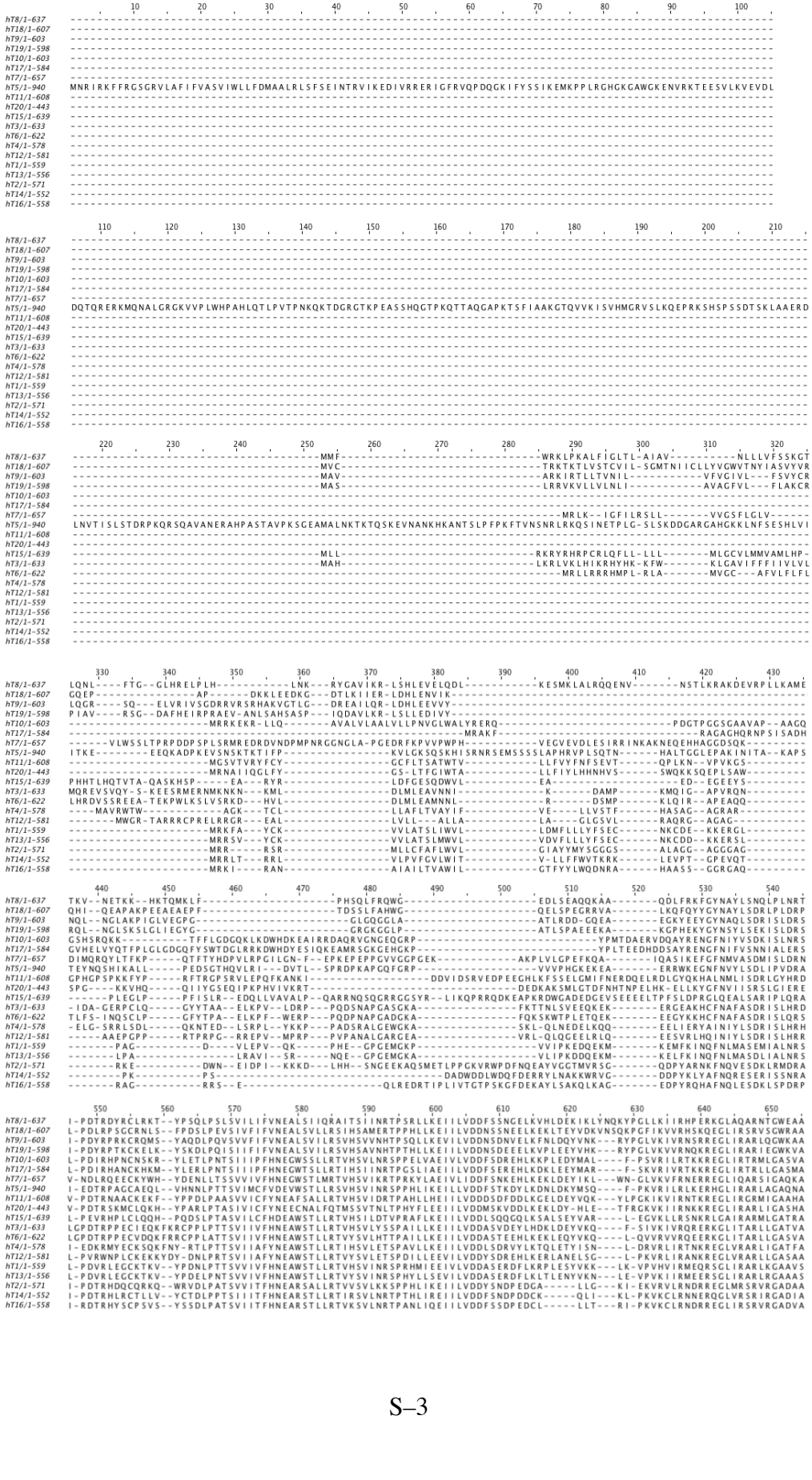


Figure S1. Alignment of GalNAc-T10 and GalNAc-T2 crystal structures. GalNAc-T10 (blue; co-crystallized with UDP and GalNAc, PDB ID: 2D7I)[1] aligned with GalNAc-T2 (orange; co-crystallized with UDP-GalNAc, PDB ID: 4D0T).[2] The three-dimensional structure of the active site of the two enzymes is closely conserved. Labeled structures include bound UDP-GalNAc (sticks), UDP-GalNAc methyl group (Me), and Mn^{2+} (purple sphere). Side chains of potential gatekeeper residues (sticks) are labeled with GalNAc-T2 residue names; GalNAc-T10 residue names are listed parenthetically. GalNAc-T2 served as the reference structure.



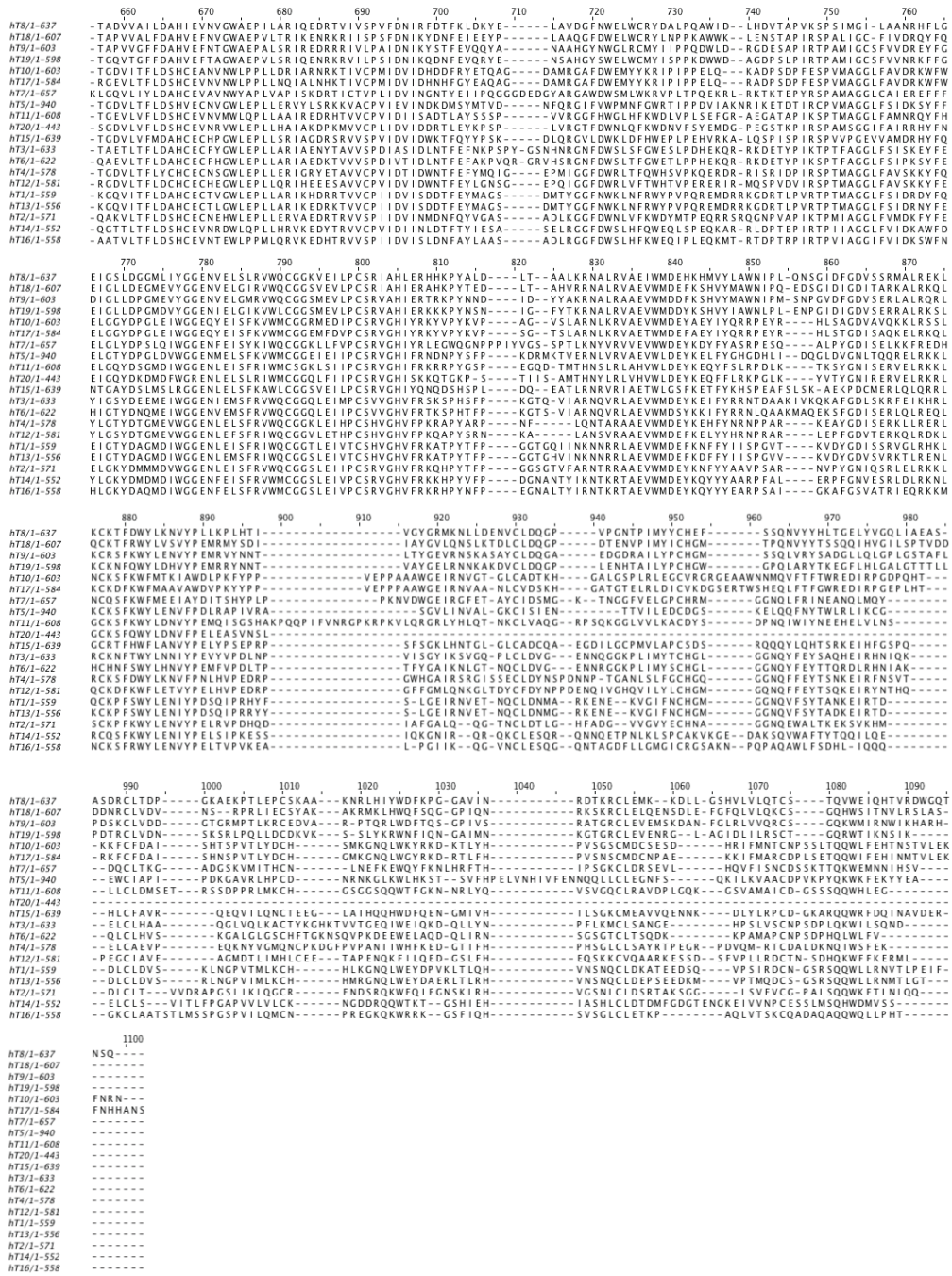


Figure S2. Alignment of human GalNAc-T genes. Amino acid sequences corresponding to full-length human GALNT1–GALNT20 (Table S1) were aligned using Clustal Omega.[3] GalNAc-Ts are labeled as follows: hT8(human GalNAc-T8)/1-637 (sequence contains 637 amino acids).

Table S1. GalNAc-T gene names and accession numbers.

Human gene name	Accession number[a]
GALNT1	X85018
GALNT2	X85019
GALNT3	X92689
GALNT4	Y08564
GALNT5	NM_014568[b]
GALNT6	Y08565
GALNT7	AJ002744
GALNT8	AJ271385
GALNT9	AB040672
GALNT10	AJ505950
GALNT11	Y12434
GALNT12	AJ132365
GALNT13	AJ505991
GALNT14	Y09324
GALNT15	NM_054110
GALNT16	AJ505951
GALNT17	AJ626725
GALNT18	AJ626724
GALNT19	AJ626726
GALNT20	145292

(a) GalNAc-T amino acid sequence and accession information is summarized in Bennett et al.[4]

(b) Reported in Guo et al.[5]

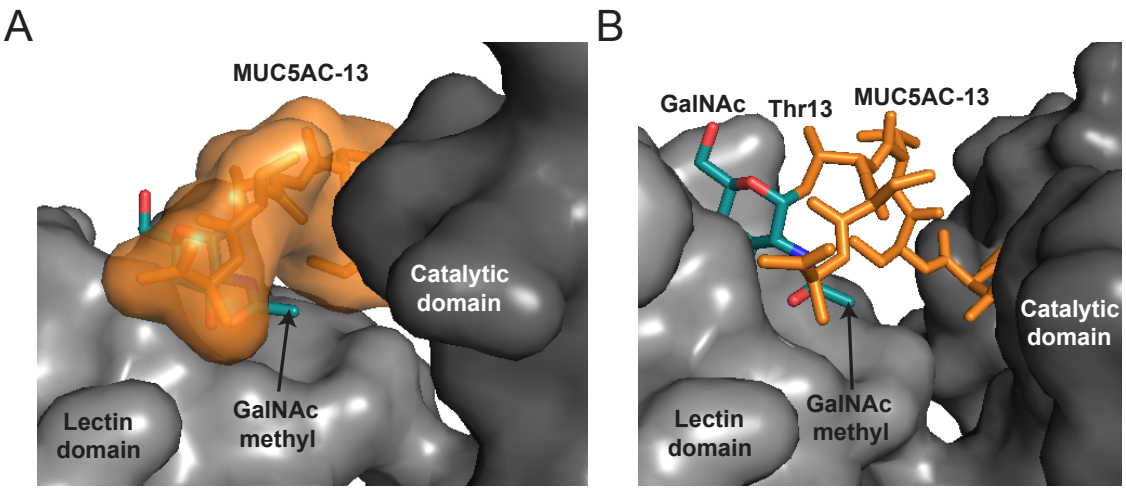


Figure S3. GalNAc-T2 with a GalNAc-peptide, MUC5AC-13, bound to the lectin domain. GalNAc-T2 (gray; active confirmation of the enzyme, co-crystallized with UDP and MUC5AC-13, PDB ID: 5AJP). (A) GalNAc (sticks) is attached to MUC5AC-13 (orange sticks and surface) at Thr13. The GalNAc methyl group (teal stick) extends out of the pocket formed by MUC5AC-13 and the lectin domain (light gray surface) into a solvent-exposed cleft between the acceptor peptide and the lectin and catalytic domains (dark gray surface). (B) View of the solvent exposed cleft into which GalNAc methyl extends. GalNAc (sticks) bound to Thr13 of MUC5AC-13 (orange sticks) is shown.

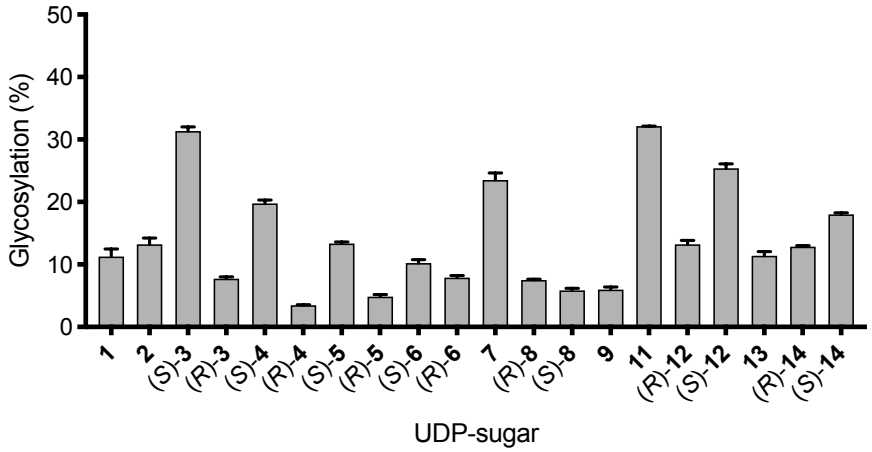


Figure S4. T2(I253A/L310A) activity assay with UDP-GalNAc analogs. Glycosylation reaction by 25 nM T2(I253A/L310A) with 250 μM UDP-GalNAc analog and 50.0 μM peptide (GAGAPGPTPGPGAG) at 37 °C for 1 h. Enzymatic activity was measured using the Glycosyltransferase Activity Kit (R&D Systems, Inc.). All data represent the mean of technical triplicates, and the error bars represent the standard deviation.

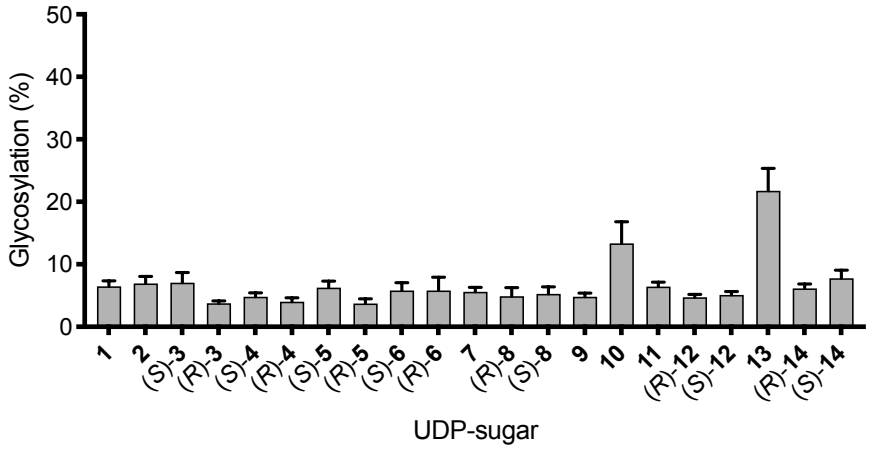


Figure S5. T1(I238A/L295A) activity assay with UDP-GalNAc analogs. Glycosylation reaction by 25 nM T1(I238A/L295A) with 500 μM UDP-GalNAc analog and 50.0 μM peptide (GAGAFFPTPGPAGAGK) at 37 °C for 1 h. Enzymatic activity was measured using the Glycosyltransferase Activity Kit (R&D Systems, Inc.). All data represent the mean of technical triplicates, and the error bars represent the standard deviation.

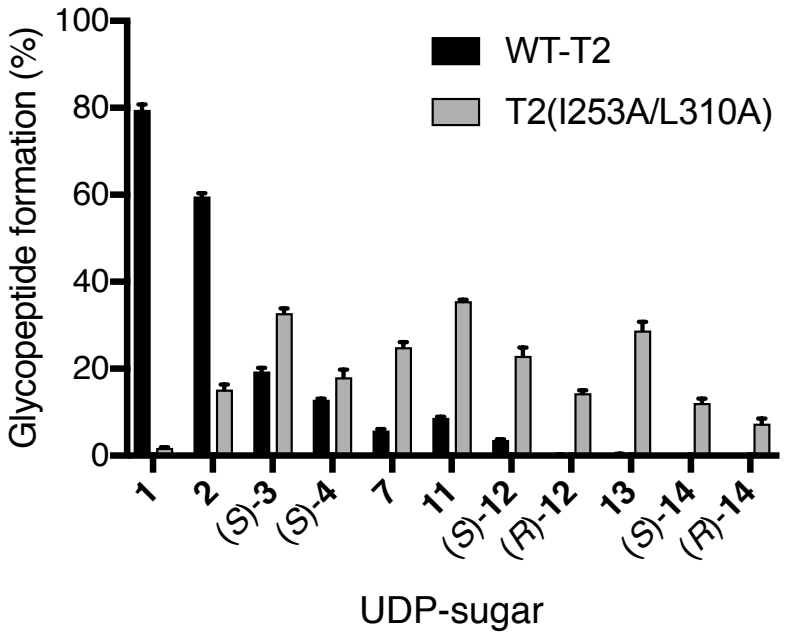


Figure S6. Screening GalNAc-T2 for an orthogonal enzyme-substrate pair. Glycopeptide formation by wild-type and double mutant GalNAc-T2. Peptide-1 and UDP-GalNAc or UDP-GalNAc analogs were incubated with GalNAc-T2 at 37 °C for 1 h, and the reaction was quenched with aqueous EDTA (150 mM, pH = 8.0). The percent conversion to glycopeptide product was quantified by HPLC separation and peak integration. These data are the same as those shown in Figure 3C. All data represent the mean of technical triplicates, and the error bars represent the standard deviation.

Table S2. Synthetic gBlocks used for GalNAc-T1 and GalNAc-T10 gene assembly.

T1_GB1[c]	GACAAGCTTGCGGCCGCGGATGAAAAAAAGGAGAGAGGACTTCC TGCTGGAGATGTTCTAGAGCCAGTACAAAAGCCTCATGAAGGTCC TGGAGAAATGGGGAAACCAGTCGTCATTCCTAAAGAGGATCAAGA AAAGATGAAAGAGATGTTTAAAATCAATCAGTTCAATTTAATGGC AAGTGAGATGATTGCACTCAACAGATCTTTACCAGATGTTAGGTTA GAAGGGTGTAAAACAAAGGTGTATCCAGATAATCTTCCTACAACA AGTGTGGTGATTGTTTTCCACAATGAGGCTTGGAGCACACTTCTGC GAACTGTCCATAGTGTCATTAATCGCTCACCAAGACACATGATAG AAGAAATTGTTGAGACCTGGTGTG
T1_GB2	GACAGGAGGTCTCATTGTTCTAGTAGATGATGCCAGTGAAAGAGA CTTTTTGAAAAGGCCTTTAGAGAGTTATGTGAAAAAACTAAAAGT ACCAGTTCATGTAATTCGAATGGAACAACGTTCTGGATTGATCAG AGCTAGATTAAAAGGAGCTGCTGTGTCTAAAGGCCAAGTGATCAC CTTCCTGGATGCCCATTGTGAGTGTACAGTGGGATGGCTGGAGCCT CTCTTGGCCAGGATCAAACATGACAGGAGAACAGTGGTGTGTCCC ATCATCGATGTGATCAGTGATGATACTTTTGAGTACATGGCAGGCT CTGATATGACCTATGGTGGGTTCAACTGGAAGCTCAATTTTCGCTG GTATCCTGTTCCCCAAAGAGAAATGGACAGAAGGAAAGGTGATCG GACTCTTCCTGTCAGGACACCTACCATGGCAGGAGGCCTTTTTTCA ATAGACAGAGATTACTTTTGAGACCTGGTGTG
T1_GB3	GACAGGAGGTCTCACTTTCAGGAAATTGGAACATATGATGCTGGA ATGGATATTTGGGGAGGAGAAAACCTAGAAATTTCCTTTAGGATT TGGCAGTGTGGAGGAACTTTGGAAATTGTTACATGCTCACATGTTG GACATGTGTTTCGGAAAGCTACACCTTACACGTTTCCAGGAGGCA CAGGGCAGATTATCAATAAAAATAACAGACGACTTGCAGAAGTGT GGATGGATGAATTCAAGAATTTCTTCTATATAATTTCTCCAGGTGT TACAAAGGTAGATTATGGAGATATATCGTCAAGAGTTGGTCTAAG ACACAAACTACAATGCAAACCTTTTTCCTGGTACCTAGAGAATATA TATCCTGATTCTCAAATTCCACGTCACTATTTCTCATTGGGAGAGA TACGAAATGTGGAAACGAATCAGTGTCTAGATAACATGGCTAGAA AAGAGAATGAAAAAGTTGGA TGAGACCTGGTGTG
T1_GB4[d]	GACAGGAGGTCTCATGGAATTTTTAATTGCCATGGTATGGG**T**GGT AATCAGGTTTTCTCTTATACTGCCAACAAAGAAATTAGAACAGAT GACCTTTGCTTGGATGTTTCCAAACTTAATGGCCCAGTTACAATGC TCAAATGCCACCACCTAAAAGGCAACCAACTCTGGGAGTATGACC CAGTGAAATTAACCCTGCAGCATGTGAACAGTAATCAGTGCCTGG ATAAAGCCACAGAAGAGGATAGCCAGGTGCCCAGCATTAGAGACT GCAATGGAAGTCGGTCCCAGCAGTGGCTTCTTCGAAACGTCACCC TTCCAGAAATATTCTGAGA ATTCATCGATAG

(c) BsaI restriction sites are underlined in each gBlock.
(d) Silent mutations in any gBlock are underlined and bold.

T10_GB1[e]	GACAGGAGGTCTCAGGCCGCGCCTGGGGGATCGGGGGCGGCGGT GGCGCCGGCGGCGGGACAGGGCTCACACAGTCGACAAAAGAAAA CGTTTTTCTTGGGAGATGGGCAGAAGCTGAAGGACTGGCATGACA AGGAGGCCATCCGGAGGGACGCTCAGCGCGTAGGAAATGGAGAA CAAGGAAGACCTTACCCCATGACCGATGCTGAGAGAGTGGATCAG GCATACCGAGAAAATGGATTTAACATCTACGTCAGTGATAAAATC TCCTTGAATCGCTCTCTCCCAGATATCCGGCACCCAAACTGCAACA GCAAGCGCTACCTGGAGACACTTCCCAACACAAGCATCATCATCC CCTTCCACAACGAGGGCTGGTCCTCCCTCCTCCGCACCGTCCACAG TGTGCTCAATCGCTCGCCTCCAGAGCTGGTCGCCGAGATTGTACTG GTCGACGACTTCAGTGATCGAGAGCACCTGAAGAAGCCTCTTGAA GACTACATGGCCCTTTTGAGACCTGGTGTG
T10_GB2_ WT	GACAGGAGGTCTCACTTTTCCCCAGTGTGAGGATTCTTCGAACCAA GAAACGGGAAGGGCTGATAAGGACCCGAATGCTGGGGGCCTCAG TGGCAACTGGGGATGTCATCACATTCTTGGATTCACACTGTGAAGC CAATGTCAACTGGCTTCCCCCCTTGCTTGACCGCATTGCTCGGAAC CGCAAGACCATTGTGTGCCCGATGAATGATGTAATTGACCATGAC GACTTTCGGTACGAGACACAGGCAGGGGATGCCATGCGGGGAGCC TTTGACTGGGAGATGTACTACAAGCGGATCCCGATCCCTCCAGAA CTGCAGAAAGCTGACCCCAGCGACCCATTTGAGTCTCCCGTGATG GCCGGTGGACTGTTCGCCGTGGATCGGAAGTGGTTCTGGGAACTC GGCGGGTATGACCCAGGCTTGGAGATCTGGGGAGGGGAGCAGTAT GAAATCTCCTTCAAGGTGTGGATGTGTGGGGGCCGCATGGAGGAC ATCCCCTGCTCCAGGGTGGGCCATATCTACAGGAAGTATGTGCCCT ACAAGGTCCCGGCCGGAGTCAGCCTGGCCCGGAACCTTAAGCGGG TGGCCGAAGTGTGGATGGATGAGTACGCAGAGTTGAGACCTGGTG TG
T10_GB2_ MUT	GACAGGAGGTCTCACTTTTCCCCAGTGTGAGGATTCTTCGAACCAA GAAACGGGAAGGGCTGATAAGGACCCGAATGCTGGGGGCCTCAG TGGCAACTGGGGATGTCATCACATTCTTGGATTCACACTGTGAAGC CAATGTCAACTGGCTTCCCCCCTTGCTTGACCGCATTGCTCGGAAC CGCAAGACCATTGTGTGCCCGATGGCCGATGTAATTGACCATGAC GACTTTCGGTACGAGACACAGGCAGGGGATGCCATGCGGGGAGCC TTTGACTGGGAGATGTACTACAAGCGGATCCCGATCCCTCCAGAA CTGCAGAAAGCTGACCCCAGCGACCCATTTGAGTCTCCCGTGATG GCCGGTGGAGCCTTCGCCGTGGATCGGAAGTGGTTCTGGGAACTC GGCGGGTATGACCCAGGCTTGGAGATCTGGGGAGGGGAGCAGTAT GAAATCTCCTTCAAGGTGTGGATGTGTGGGGGCCGCATGGAGGAC ATCCCCTGCTCCAGGGTGGGCCATATCTACAGGAAGTATGTGCCCT ACAAGGTCCCGGCCGGAGTCAGCCTGGCCCGGAACCTTAAGCGGG TGGCCGAAGTGTGGATGGATGAGTACGCAGAGTTGAGACCTGGTG TG

(e) GalNAc-T10 was assembled with T10_GB1, T10_GB2_WT, and T10_GB3 (wild-type) or T10_GB1, T10_GB2_MUT, and T10_GB3 (double mutant).

T10_GB3	GACAGGAGGTCTCAGAGTACATTTACCAGCGCCGGCCTGAATACC GCCACCTCTCCGCTGGGGATGTCGCAGTCCAGAAAAAGCTCCGCA GCTCCCTTAACTGCAAGAGTTTCAAGTGGTTTATGACGAAGATAGC CTGGGACCTGCCCAAATTCTACCCACCCGTGGAGCCCCCGGCTGC AGCTTGGGGGGAGATCCGAAATGTGGGCACAGGGCTGTGTGCAGA CACAAAGCACGGGGCCTTGGGCTCCCCACTAAGGCTAGAGGGCTG CGTCCGAGGCCGTGGGGAGGCTGCCTGGAACAACATGCAGGTATT CACCTTCACCTGGAGAGAGGACATCCGGCCTGG**G**GACCCCCAGCA CACCAAGAAGTTCTGCTTTGATGCCATTTCCCACACCAGCCCTGTC ACGCTGTACGACTGCCACAGCATGAAGGGCAACCAGCTGTGGAAA TACCGCAAAGACAAGACCCTGTACCACCCTGTCAGTGGCAGCTGC ATGGACTGCAGTGAAAGTGACCATAGGATCTTCATGAACACCTGC AACCCATCCTCTCTCACCCAGCAGTGGCTGTTTGAACACACCAACT CAACAGTCTTGGAAAAATTCAATAGGAACTGAG AATTTGAGACCTGGTGTG

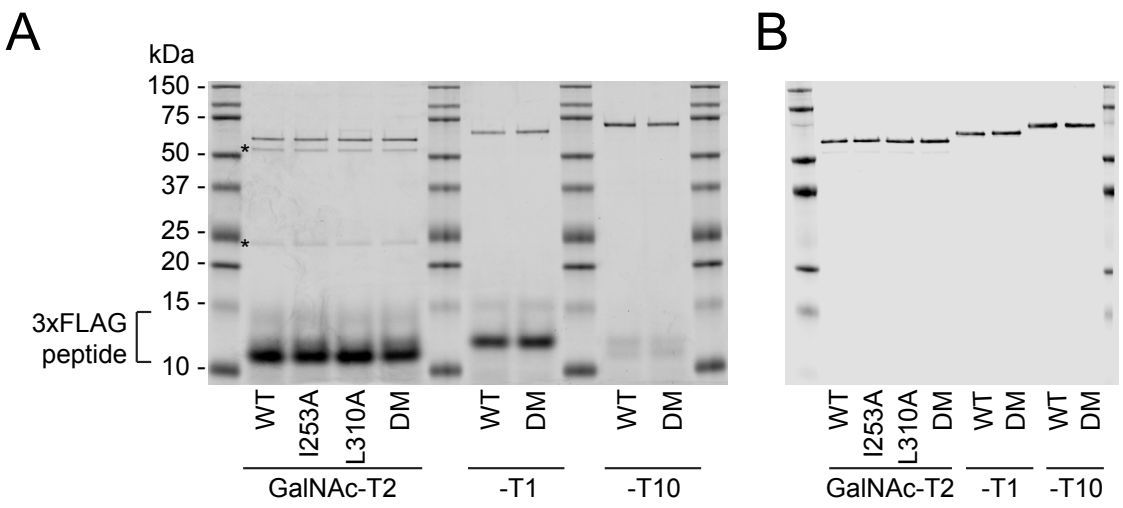


Figure S7. Purified soluble GalNAc-Ts. (A) SDS-PAGE of GalNAc-T2 (predicted MW of the wild-type enzyme 61.6 kDa), GalNAc-T1 (63.1 kDa) and GalNAc-T10 (65.9 kDa) preparations (Coomassie stain). GalNAc-Ts are labeled wild-type (WT), single mutant (I253A, L310A), or double mutant (DM). Asterisks depict potential degradation products. (B) Western blot with anti-FLAG® immunolabeling.

II. General Information

MUC5AC-3 (GTT*PSPVPTTSTTSAP), MUC5AC-13 (GTTPSPVPTTSTT*SAP), EA2 (PTTDSTTPAPTTK), and a peptide optimized for GalNAc-T2 (GAGAPGPTPGPGAG) were purchased from AnaSpec, Inc. and used without further purification. A peptide optimized for GalNAc-T1 (GAGAFFPTPGPAGAGK) was synthesized on 2-chlorotrityl chloride resin by solid phase peptide synthesis using *N*-Fmoc-protected amino acids. Peptide concentrations were determined by amino acid analysis at the UC Davis Molecular Structure Facility. UDP-sugar concentrations were quantified using the molar extinction coefficient of UDP at 262 nm (10,000 $M^{-1}cm^{-1}$).

MacPyMOL was used to model all crystal structures. Integrated DNA Technologies (IDT) synthesized all gBlocks. Primer synthesis and sequencing of all plasmids prior to use was by Elim Biopharmaceuticals, Inc. (Hayward, USA). Restriction enzymes, Antarctic phosphatase, and T4 DNA ligase were purchased from New England Biolabs and used according to the manufacturer's instructions. PfuUltra II Fusion HS DNA polymerase was from Agilent. cOmplete™ mini EDTA-free protease inhibitor, p3xFLAG-CMV-8, pFLAG-myc-CMV-19, recombinant human serum albumin, anti-FLAG® M2 agarose resin, and monoclonal anti-FLAG® M2 antibody were purchased from Sigma-Aldrich (now Millipore-Sigma). Colloidal Blue Staining Kit was obtained from Thermo Fisher Scientific.

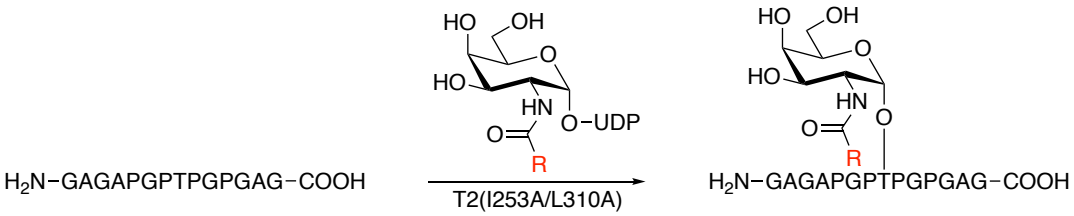
Dulbecco's Modified Eagle Medium with high glucose (DMEM), Dulbecco's Phosphate-Buffered Saline without calcium or magnesium (DPBS), and Penicillin/Streptomycin were purchased from Hyclone. Fetal bovine serum (FBS) was obtained from Omega Scientific, and 0.25% trypsin/EDTA and Opti-MEM® Reduced Serum Medium were purchased from Invitrogen. TransIT®-293 transfection reagent was purchased from Mirus Bio LLC.

Chemical reagents were obtained from commercial sources and used without further purification unless otherwise noted. Unless stated otherwise, reactions were conducted under an atmosphere of nitrogen using anhydrous solvents. THF and CH_2Cl_2 were deoxygenated and dried by sparging with nitrogen followed by passage through an activated alumina column prior to use. Deionized water (18.2 MΩ.cm) was prepared by a Millipore Milli-Q Biocel A10 purification unit and used to prepare all buffers and aqueous solutions.

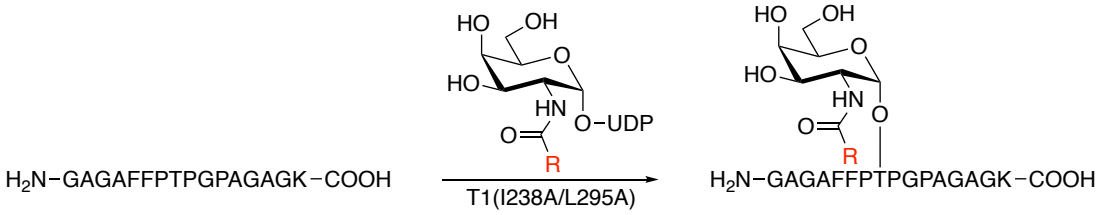
Glycosyltransferase Activity Kit was purchased from R&D Systems, Inc., and absorbance at 620 nm was acquired using a Molecular Devices SpectraMax M3 96-well plate reader. High-performance liquid chromatography (HPLC) analyses were carried out on an Agilent 1100 series system with an Agilent Poroshell 120 EC-C18 column (length 150 mm, I.D. 4.6 mm) at 40 °C with a solvent flow rate of 0.4 mL/min using a UV detector operating at 340 nm. Glycosylation sites were analyzed by an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC with an EASY-Spray™ LC 100 Å C18 column (length 150 mm, I.D. 75 μm).

Analytical thin layer chromatography (TLC) was performed with Silicycle 60 Å silica gel plates and analyzed by UV illumination or $KMnO_4$ stain. Flash column chromatography was performed using silica gel (60 Å pore size, 40–63 μm, 230–400 mesh). Preparative HPLC was performed on a Varian ProStar system with an Agilent Microsorb 100-5 C18 column (length 250 mm, I.D. 21.4 mm) or an Agilent prep 100 Å C18 column (length 250 mm, I.D. 21.2 mm) with a solvent flow rate of 20 mL/min. ^{1}H NMR, ^{13}C NMR, and ^{31}P NMR data were collected on a Varian Inova 500 MHz spectrometer at ambient temperature.

III. Glycosyltransferase Enzymatic Activity Assays (Figures S4, S5, S6, 3, 5A, and 5B)

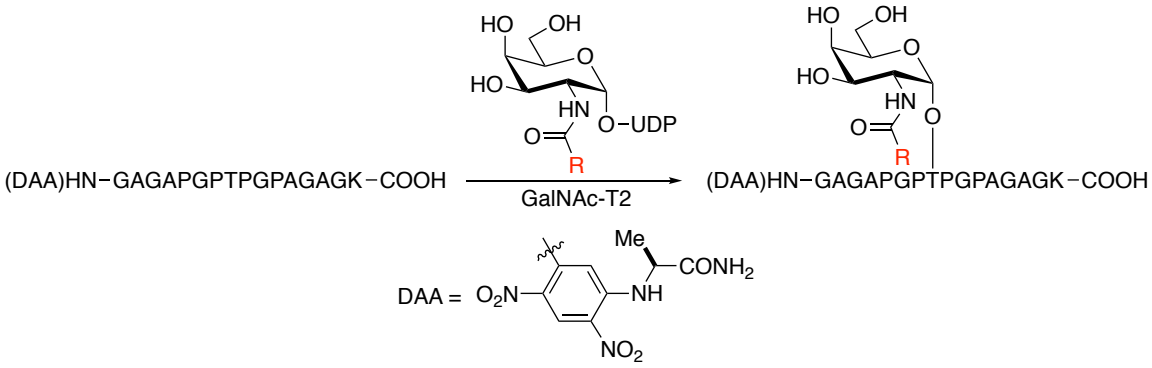


Glycosylation by T2(I253A/L310A) with UDP-GalNAc analogs (Figure S4). The glycosylation reaction was initiated by the addition of T2(I253A/L310A) (50.0 nM) in Tris-HCl buffer (16.7 mM Tris-HCl, 100 mM NaCl, 25% glycerol, pH = 7.4; 25.0 μL) to the mixture of UDP-GalNAc analog (500 μM), peptide (GAGAPGPTPGPGAG; 100 μM), and Coupling Phosphatase 1 (4 ng/μL) in Tris-HCl buffer (25 mM Tris-HCl, 20 mM $MnCl_2$; 25.0 μL) at 0 °C, resulting in a final reaction mixture containing T2(I253A/L310A) (25.0 nM), peptide (50.0 μM), UDP-GalNAc analog (250 μM), and Coupling Phosphatase 1 (2 ng/μL) in Tris-HCl buffer (20.8 mM Tris-HCl, 10 mM $MnCl_2$, 50 mM NaCl, 12.5% glycerol, pH = 7.4; 50.0 μL). The glycosylation was conducted at 37 °C for 1 h. The enzymatic activity was measured according to the manufacturer's protocol (Glycosyltransferase Activity Kit; R&D Systems, Inc.).

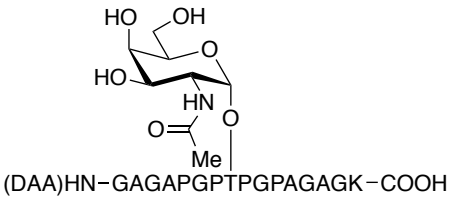


Glycosylation by T1(I238A/L295A) with UDP-GalNAc analogs (Figure S5). The glycosylation reaction was initiated by the addition of T1(I238A/L295A) (50.0 nM) in Tris-HCl buffer (16.7 mM Tris-HCl, 100 mM NaCl, 25% glycerol, pH = 7.4; 25.0 μL) to the mixture of UDP-GalNAc analog (1.00 mM), peptide (GAGAFFPTPGPAGAGK; 100 μM), and Coupling Phosphatase 1 (4 ng/μL) in Tris-HCl buffer (25 mM Tris-HCl, 20 mM $MnCl_2$; 25.0 μL) at 0 °C, resulting in a final reaction mixture containing

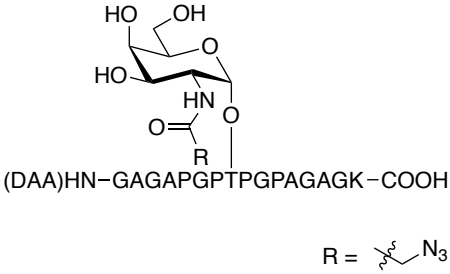
T1(I238A/L295A) (25.0 nM), peptide (50.0 μM), UDP-GalNAc analog (500 μM), and Coupling Phosphatase 1 (2 ng/μL) in Tris-HCl buffer (20.8 mM Tris-HCl, 10 mM $MnCl_2$, 50 mM NaCl, 12.5% glycerol, pH = 7.4; 50.0 μL). The glycosylation was conducted at 37 °C for 1 h. The enzymatic activity was measured according to the manufacturer's protocol (Glycosyltransferase Activity Kit; R&D Systems, Inc.).



Characterization of Peptide-1 glycosylation products of GalNAc-T2 with UDP-GalNAc and analogs (Figures S6 and 3).

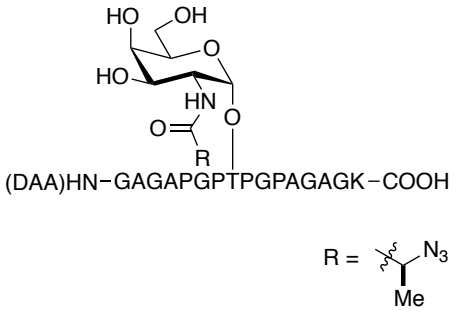


1-Peptide-1.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 12.2 min.
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{71}H_{110}N_{22}O_{28}$: 859.3930, found: 859.3926 (–0.46 ppm).

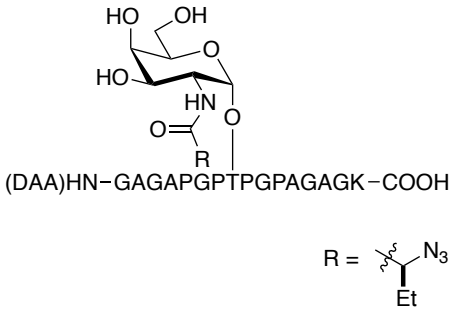


2-Peptide-1.
The product formation was determined by HPLC (20% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 33.6 min.

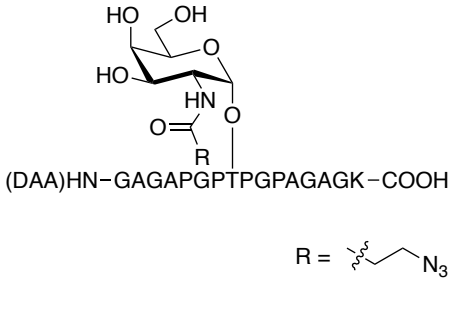
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{71}H_{109}N_{25}O_{28}$: 879.8937, found: 879.8928 (–1.02 ppm).



(*S*)-3-Peptide-1.
The product formation was determined by HPLC (21.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 27.2 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{72}H_{111}N_{25}O_{28}$: 886.9015, found: 886.9015 (–0.02 ppm).

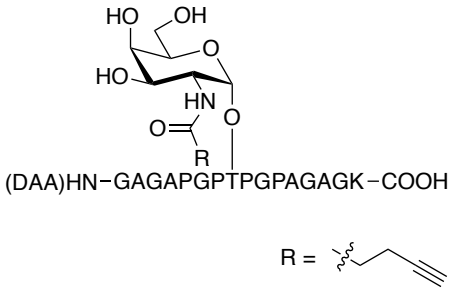


(*S*)-4-Peptide-1.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 30.2 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{73}H_{113}N_{25}O_{28}$: 893.9093, found: 893.9088 (–0.61 ppm).

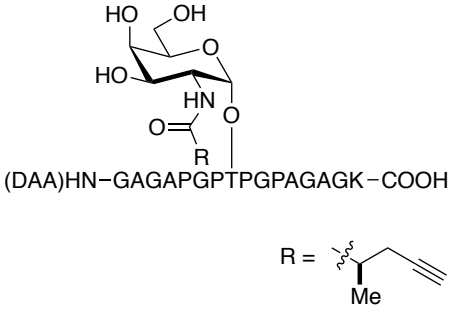


7-Peptide-1.
The product formation was determined by HPLC (21% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 29.0 min.

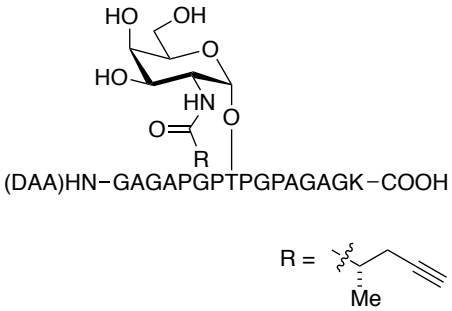
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{72}H_{111}N_{25}O_{28}$: 886.9015, found: 886.9011 (–0.47 ppm).



11-Peptide-1.
The product formation was determined by HPLC (21% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 26.1 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{74}H_{112}N_{22}O_{28}$: 878.4008, found: 878.4016 (+0.89 ppm).

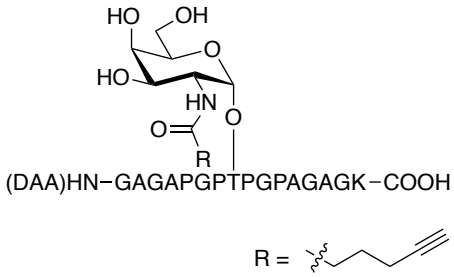


(*R*)-12-Peptide-1.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 22.6 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{75}H_{114}N_{22}O_{28}$: 885.4086, found: 885.4092 (+0.63 ppm).

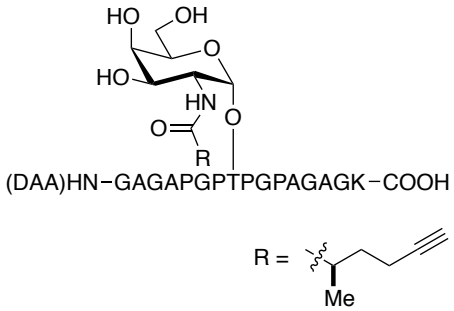


(*S*)-12-Peptide-1.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 21.9 min.

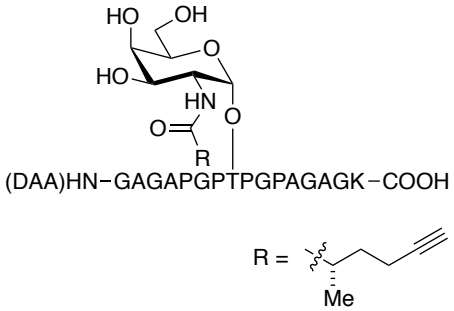
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{75}H_{114}N_{22}O_{28}$: 885.4086, found: 885.4090 (+0.40 ppm).



13-Peptide-1.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 21.8 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{75}H_{114}N_{22}O_{28}$: 885.4086, found: 885.4086 (–0.05 ppm).

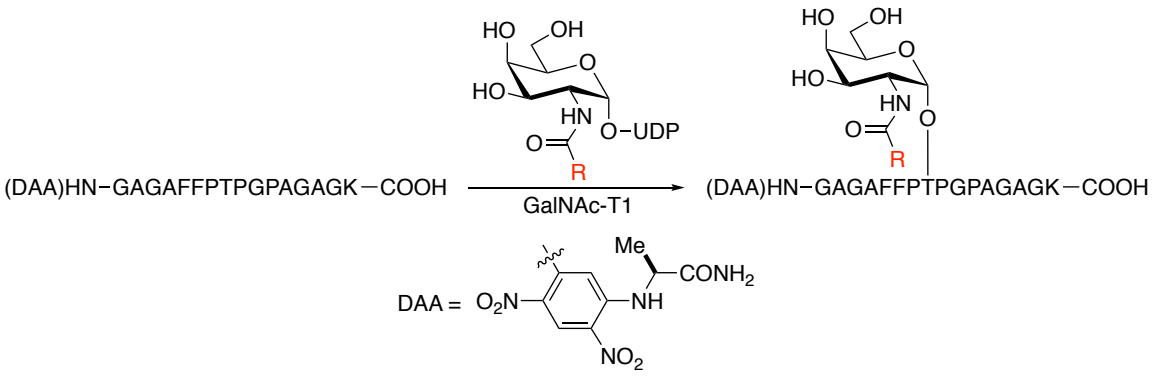


(*R*)-14-Peptide-1.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 30.4 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{76}H_{116}N_{22}O_{28}$: 892.4165, found: 892.4164 (–0.08 ppm).

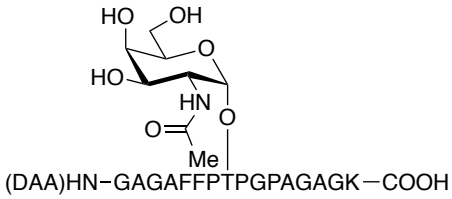


(*S*)-14-Peptide-1.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 30.5 min.

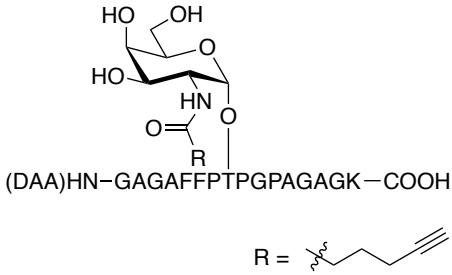
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{76}H_{116}N_{22}O_{28}$: 892.4165, found: 892.4172 (+0.82 ppm).



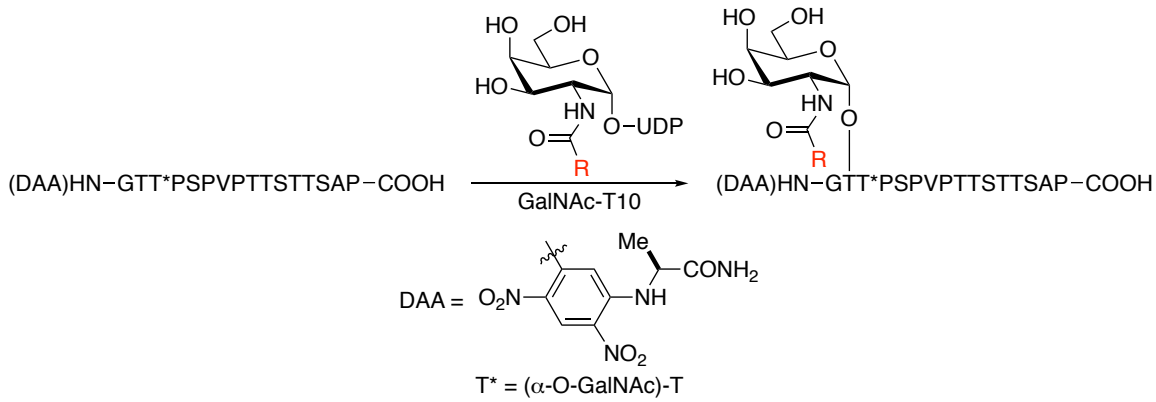
Characterization of Peptide-2 glycosylation products of GalNAc-T1 with UDP-GalNAc and analogs (Figures 5A and 5B).



1-Peptide-2.
The product formation was determined by HPLC (30% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 25.8 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{82}H_{118}N_{22}O_{28}$: 929.4243, found: 929.4242 (–0.10 ppm).

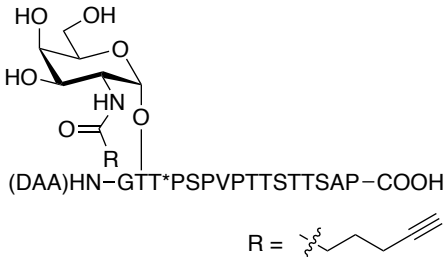


13-Peptide-2.
The product formation was determined by HPLC (30% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 42.1 min.
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{86}H_{122}N_{22}O_{28}$: 955.4399, found: 955.4413 (+1.42 ppm).



Characterization of Peptide-3 glycosylation products of GalNAc-T10 with UDP-GalNAc and analogs (Figures 5A and 5B).

1-Peptide-3.
The product formation was determined by HPLC (21% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 18.2 min.
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{88}H_{140}N_{22}O_{41}$: 1080.4773, found: 1080.4797 (+2.21 ppm).

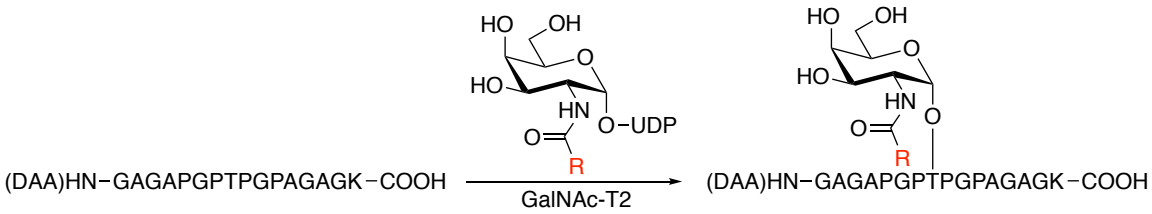


13-Peptide-3.
The product formation was determined by HPLC (22.5% acetonitrile/water; 0.1% trifluoroacetic acid; 0.4 mL/min) with t_r = 31.5 min.
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{92}H_{144}N_{22}O_{41}$: 1106.4930, found: 1106.4939 (+0.85 ppm).

IV. Glycosylation Reaction Kinetics (Table 1; Figure 5C)

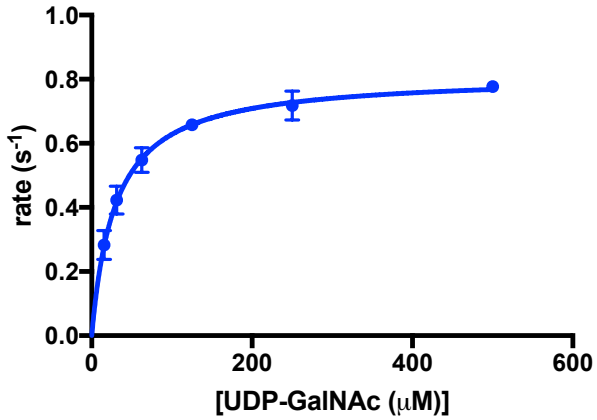
General reaction conditions for GalNAc-T kinetics

The glycosylation reaction was initiated by the addition of GalNAc-T in Tris-HCl buffer (16.7 mM Tris-HCl, 100 mM NaCl, 25% glycerol, pH = 7.4; 35.0 μL) to the mixture of UDP-sugar (31.2 μM, 62.5 μM, 125 μM, 250 μM, 500 μM and 1.00 mM), and peptide (Peptide-1 (**1**, (*S*)-**3**, and **11**) = 534 μM; Peptide-1 (**7**, (*S*)-**12**, **13**) = 500 μM); Peptide-2 = 500 μM; Peptide-3 = 532 μM) in Tris-HCl buffer (25 mM Tris-HCl, 20 mM $MnCl_2$; 35.0 μL) at 0 °C, resulting in a final reaction mixture containing GalNAc-T, UDP-sugar (15.6 μM, 31.2 μM, 62.5 μM, 125 μM, 250 μM, and 500 μM), and peptide (Peptide-1 (**1**, (*S*)-**3**, and **11**) = 267 μM; Peptide-1 (**7**, (*S*)-**12**, **13**) = 250 μM); Peptide-2 = 250 μM; Peptide-3 = 266 μM) in Tris-HCl buffer (20.8 mM Tris-HCl, 10 mM $MnCl_2$, 50 mM NaCl, 12.5% glycerol, pH = 7.4; 70.0 μL). The glycosylation was conducted at 37 °C. Aliquots were taken at 5, 10, and 15 min and quenched by the addition of aqueous EDTA (150 mM, pH = 8.0). The glycopeptide formation was analyzed by HPLC, and initial rates were calculated.

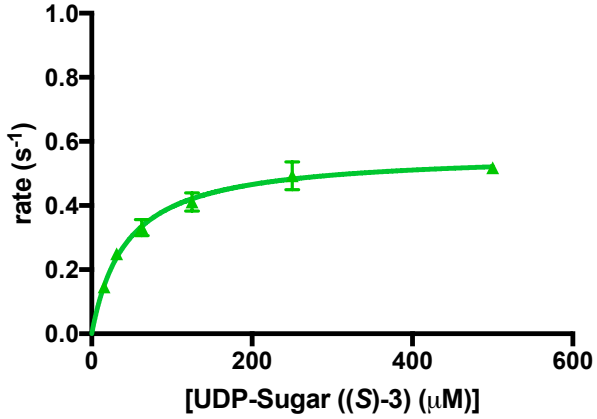


Determination of kinetic parameters for GalNAc-T2 with Peptide-1 (Table 1).

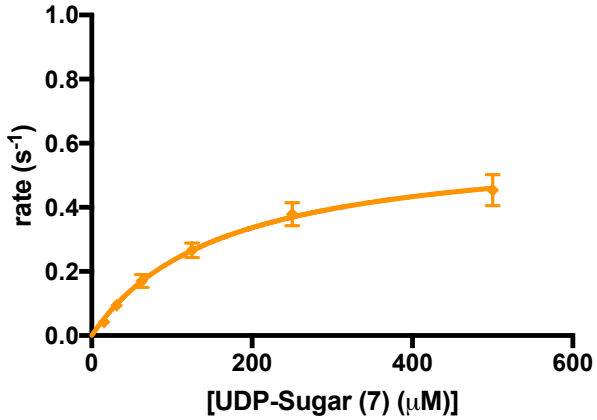
The reaction conditions differ from the general reaction conditions for GalNAc-T kinetics as described here. GalNAc-T concentrations were as follows: WT-T2 with **1** (initial = 8.33 nM, final = 4.17 nM); T2(I253A/L310A) with (*S*)-**3** (initial = 8.59 nM, final = 4.30 nM); T2(I253A/L310A) with **7** (initial = 20.0 nM, final = 10 nM); T2(I253A/L310A) with **11** (initial = 8.59 nM, final = 4.30 nM); T2(I253A/L310A) with (*S*)-**12** (initial = 20.0 nM, final = 10 nM); T2(I253A/L310A) with **13** (initial = 30.0 nM, final = 15.0 nM). These reactions had aliquots removed after 4, 8, and 12 min instead: T2(I253A/L310A)/**7** and T2(I253A/L310A)/(*S*)-**12**.



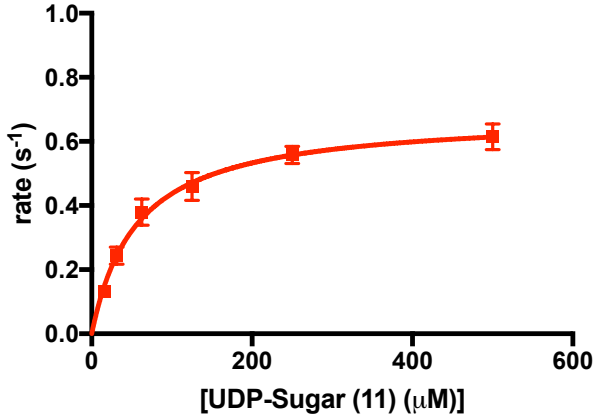
Kinetics of WT-T2 with UDP-GalNAc (1).
k_{cat} = 0.813 ± 0.017 s^{-1}; K_m = 30 ± 2 μM; k_{cat}/K_m = 28 mM^{-1} s^{-1}.



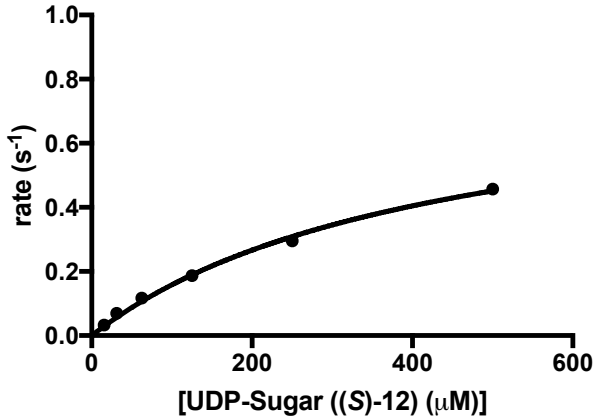
Kinetics of T2(I253A/L310A) with UDP-Sugar ((*S*)-3).
k_{cat} = 0.566 ± 0.014 s^{-1}; K_m = 43 ± 4 μM; k_{cat}/K_m = 13 mM^{-1} s^{-1}.



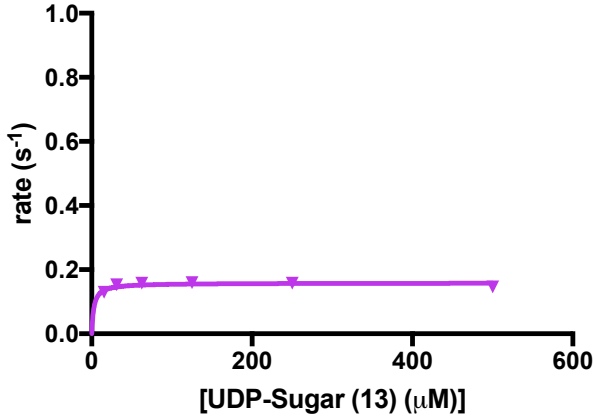
Kinetics of T2(I253A/L310A) with UDP-Sugar (7).
k_{cat} = 0.61 ± 0.03 s^{-1}; K_m = 1.6 x 10^2 ± 2 x 10^1 μM; k_{cat}/K_m = 3.8 mM^{-1} s^{-1}.



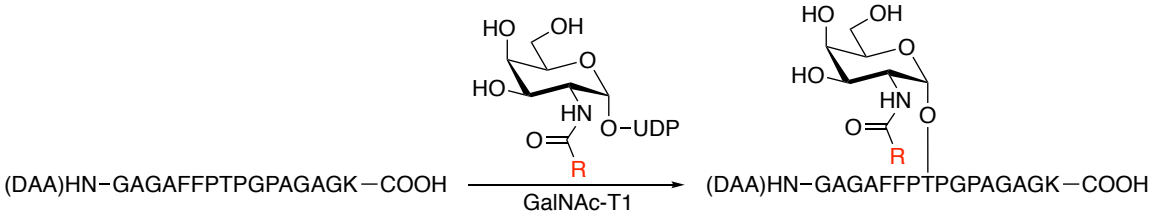
Kinetics of T2(I253A/L310A) with UDP-Sugar (11).
k_{cat} = 0.68 ± 0.02 s^{-1}; K_m = 56 ± 6 μM; k_{cat}/K_m = 12 mM^{-1} s^{-1}.



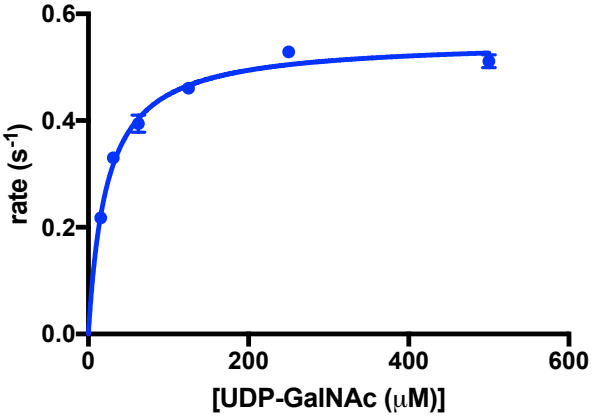
Kinetics of T2(I253A/L310A) with UDP-Sugar ((*S*)-12).
k_{cat} = 0.84 ± 0.05 s^{-1}; K_m = 4.3 x 10^2 ± 5 x 10^1 μM; k_{cat}/K_m = 2.0 mM^{-1} s^{-1}.



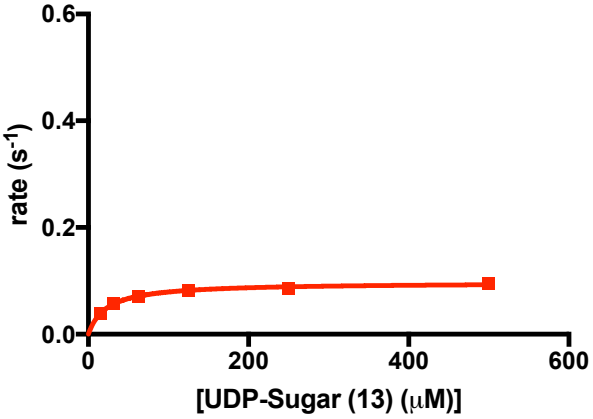
Kinetics of T2(I253A/L310A) with UDP-Sugar (13).
k_{cat} = 0.158 ± 0.003 s^{-1}; K_m = 2.6 ± 0.8 μM; k_{cat}/K_m = 61 mM^{-1} s^{-1}.



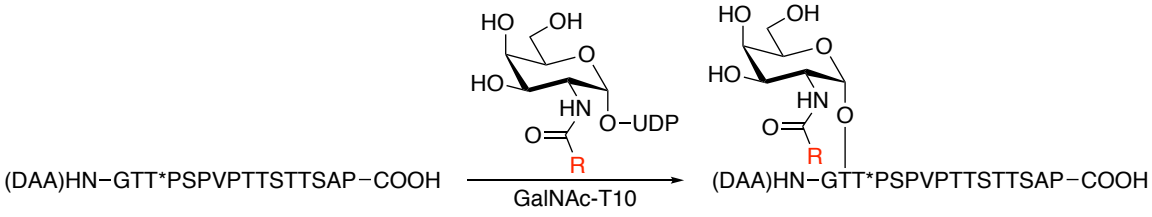
Determination of kinetic parameters for GalNAc-T1 with Peptide-2 (Figure 5C).
The reaction conditions differ from the general reaction conditions for GalNAc-T kinetics as described here. GalNAc-T concentrations were as follows: WT-T1 and **1** (initial = 100 nM, final = 50.0 nM); T1(I238A/L295A) and **13** (initial = 100 nM, final = 50.0 nM).



Kinetics of WT-1 with UDP-GalNAc (1).
k_{cat} = 0.551 ± 0.008 s^{-1}; K_m = 22.8 ± 1.5 μM; k_{cat}/K_m = 24.2 mM^{-1} s^{-1}.

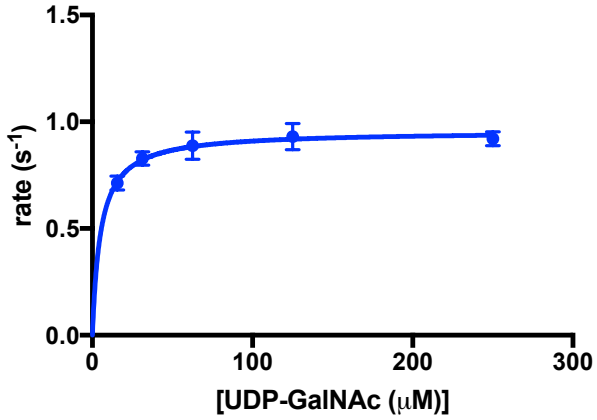


Kinetics of T1(I238A/L295A) with UDP-Sugar (13).
k_{cat} = 0.097 ± 0.002 s^{-1}; K_m = 22 ± 2 μM; k_{cat}/K_m = 4.3 mM^{-1} s^{-1}.

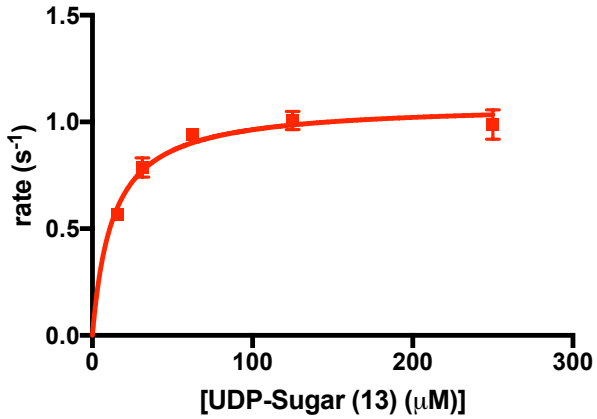


Determination of kinetic parameters for GalNAc-T10 with Peptide-3 (Figure 5C).
The reaction conditions differ from the general reaction conditions for GalNAc-T kinetics as described here. GalNAc-T concentrations were as follows: WT-T10 and **1** (initial = 6.18 nM, final = 3.09 nM); T10(I266A/L321A) and **13** (initial = 6.17 nM, final = 3.08

nM. For GalNAc-T10, UDP-sugar final concentrations were varied from 15.6 μM to 250 μM (31.2 μM to 500 μM initial concentrations).



Kinetics of WT-T10 with UDP-GalNAc (1).
k_{cat} = 0.956 ± 0.019 s^{-1}; K_m = 5.1 ± 0.9 μM; k_{cat}/K_m = 1.9 x 10^2 mM^{-1} s^{-1}.



Kinetics of T10(I266A/L321A) with UDP-Sugar (13).
k_{cat} = 1.09 ± 0.03 s^{-1}; K_m = 12.7 ± 1.6 μM; k_{cat}/K_m = 85.4 mM^{-1} s^{-1}.

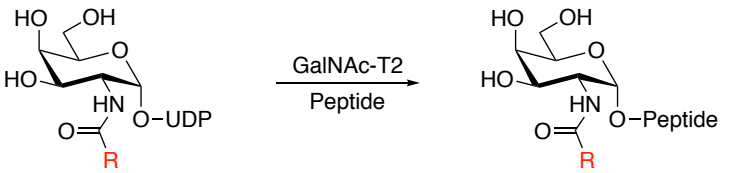
V. UDP-Sugar Competition Experiment (Figure 4)

Procedure.
The glycosylation reaction was initiated by the addition of WT-T2 (50.0 nM) in Tris-HCl buffer (16.7 mM Tris-HCl, 100 mM NaCl, 25% glycerol, pH = 7.4; 35.0 μL) to the mixture of UDP-GalNAc (500 μM), UDP-GalNAc analog (500 μM) and Peptide-1 ((DAA)GAGAPGPTPGPAGAGK; 100 μM) in Tris-HCl buffer (25 mM Tris-HCl, 20 mM $MnCl_2$; 35.0 μL) at 0 °C, resulting in a final reaction mixture containing WT-T2

(25.0 nM), UDP-GalNAc (250 μM), UDP-GalNAc analog (250 μM), and peptide (50.0 μM) in Tris-HCl buffer (20.8 mM Tris-HCl, 10 mM $MnCl_2$, 50 mM NaCl, 12.5% glycerol, pH = 7.4; 70.0 μL). The glycosylation was conducted at 37 °C. Reaction progress was monitored by taking aliquots and quenching them by the addition of aqueous EDTA (150 mM, pH = 8.0). The ratio between the two glycopeptides was determined by HPLC.

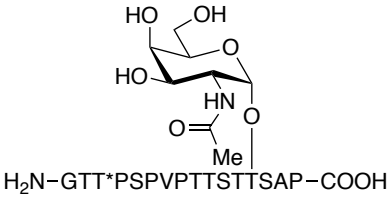
VI. Glycosylation of Natural Peptide Substrates by GalNAc-Ts (Figure 6)

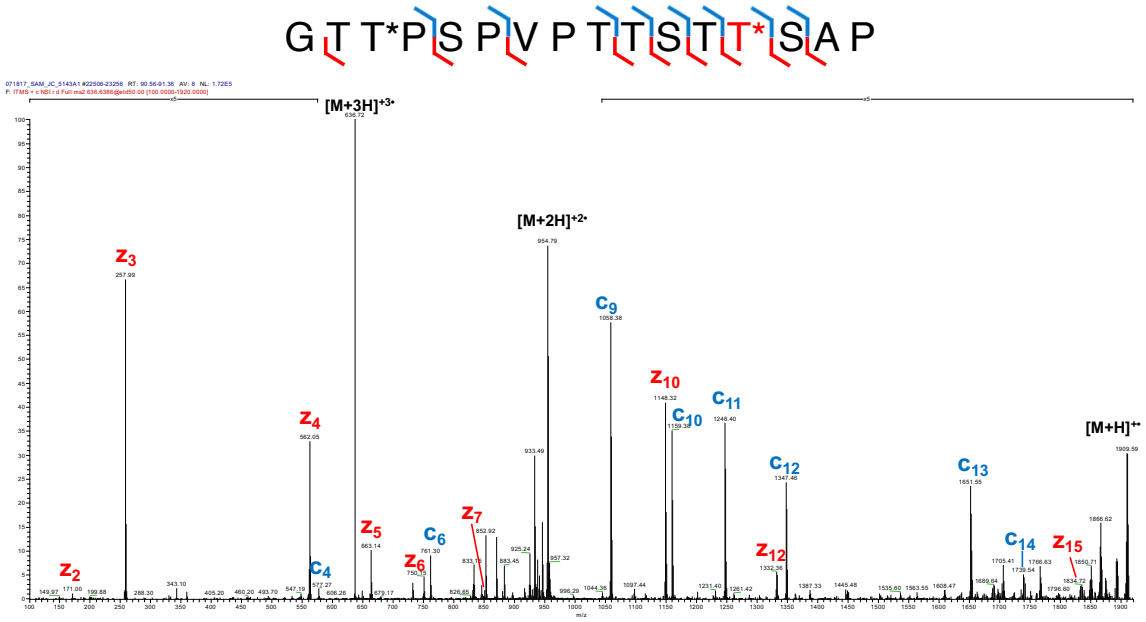
Procedure.
The glycosylation reaction was initiated by the addition of wild-type or double mutant GalNAc-T (-T2 = 60.0 nM; -T1 = 30.0 nM; -T10 = 200 nM) in Tris-HCl buffer (16.7 mM Tris-HCl, 100 mM NaCl, 25% glycerol, pH = 7.4; 25.0 μL) to the mixture of UDP-sugar (**1** was used for WT-T2, -T1, -T10, and **13** was used for double mutant -T2, -T1, -T10; 1.00 mM), and peptide (MUC5AC-3, MUC5AC-13, or EA2; 200 μM) in Tris-HCl buffer (25 mM Tris-HCl, 20 mM $MnCl_2$; 25.0 μL) at 0 °C, resulting in a final reaction mixture containing wild-type or double mutant GalNAc-T (-T2 = 30.0 nM; -T1 = 15.0 nM; -T10 = 100 nM), UDP-sugar (**1** was used for WT-T2, -T1, -T10, and **13** was used for double mutant -T2, -T1, -T10; 500 μM), and peptide (MUC5AC-3, MUC5AC-13, or EA2; 100 μM) in Tris-HCl buffer (20.8 mM Tris-HCl, 10 mM $MnCl_2$, 50 mM NaCl, 12.5% glycerol, pH = 7.4; 50.0 μL). The glycosylation was conducted at 37 °C. Reaction progress was monitored by taking aliquots and quenching them by the addition of aqueous EDTA (150 mM, pH = 8.0; 25.0 μL). Glycopeptide formation and glycosite occupancy were analyzed on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer (Thermo) coupled to a Dionex Ultimate 3000 HPLC with an EASY-Spray™ LC (100 Å C18 column length 150 mm, I.D. 75 μm). The samples were eluted at 0.3 μL/min using a 90-min gradient and a 185-min instrument method. Solvent A was 0.1% formic acid in water, and solvent B was 0.1% formic acid in acetonitrile. The gradient profile varied by peptide. The instrument method used an MS1 resolution of 60,000 at FWHM of 400 *m/z*, an automatic gain control (AGC) target of 3e5, and a mass range from 300 to 1,500 *m/z*. Electron transfer dissociation (ETD) MS2 spectra were generated at top speed for 3 s. ETD parameters were as follows: calibrated charge dependent ETD times, 2e5 reagent target, and precursor AGC target of 1e4. Glycopeptides were manually sequenced using Xcalibur software (Thermo). Relative abundances were obtained by integrating under the extracted ion chromatograms (±10 ppm).



10~20% peptide conversion

Characterization of peptides glycosylated by GalNAc-T2.

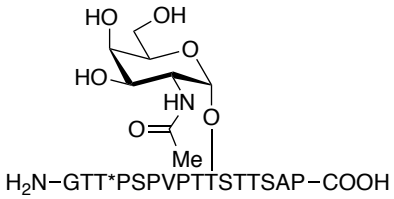


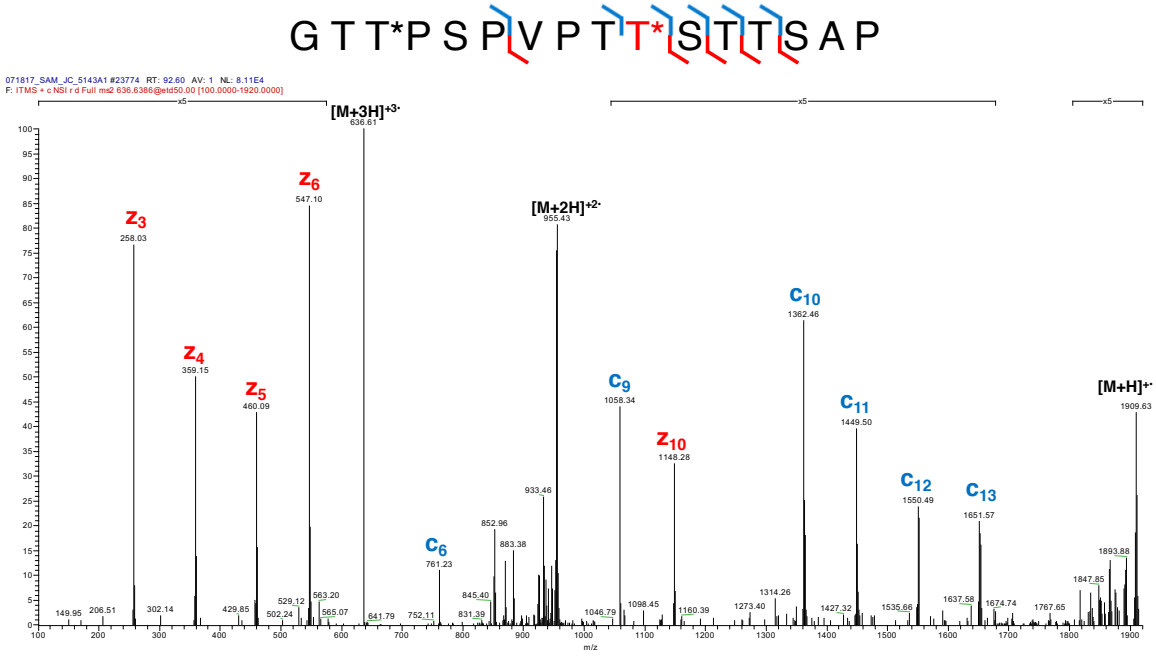


GTT*PSPVPTTSTT*SAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 91.0 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{79}H_{132}N_{18}O_{36}$: 954.4526, found: 954.4540 (+1.49 ppm).

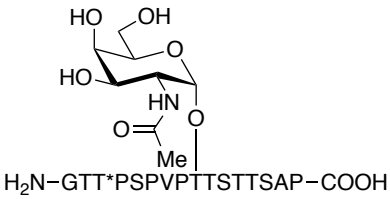


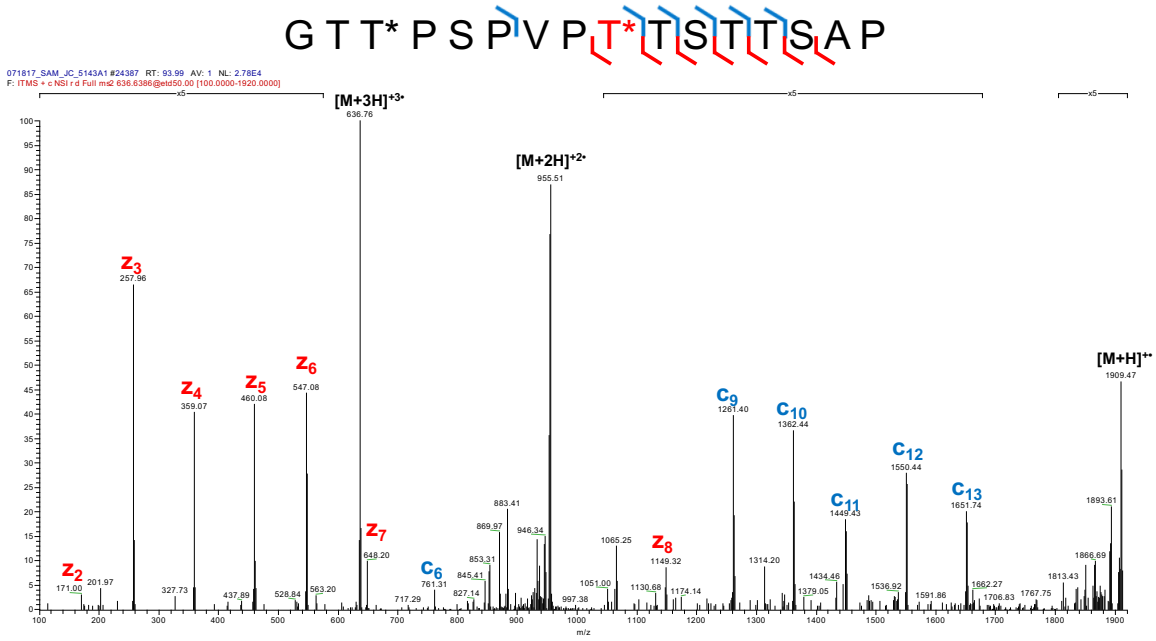


GTT*PSPVPTT*STTSAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 92.6 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{79}H_{132}N_{18}O_{36}$: 954.4526, found: 954.4545 (+2.01 ppm).

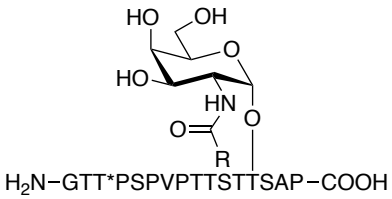


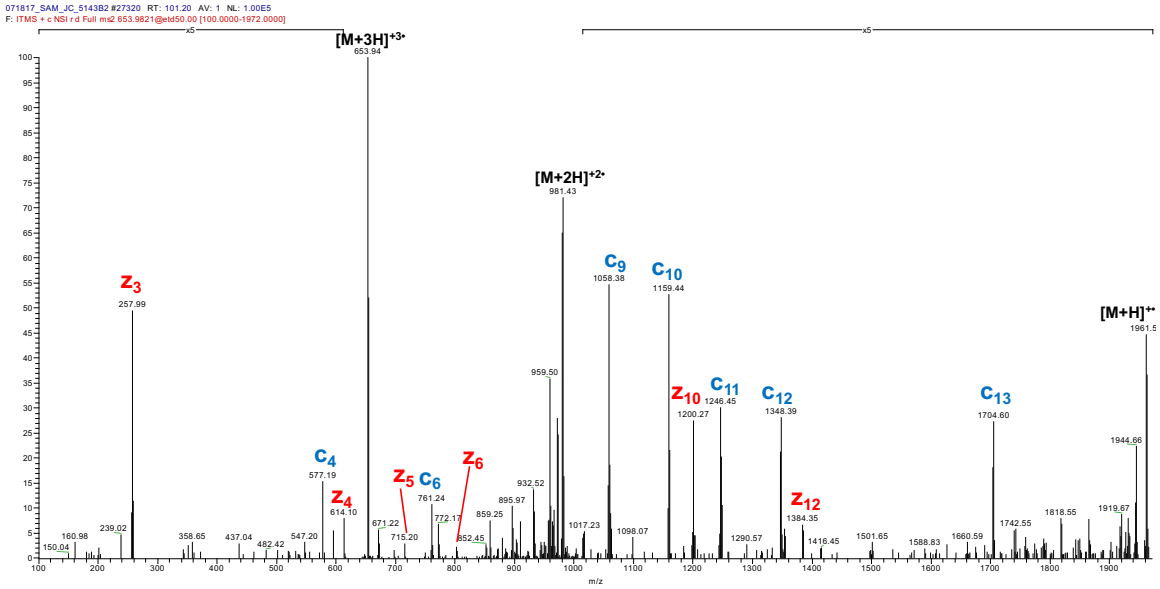


GTT*PSPVPT*TSTTSAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 94.0 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{79}H_{132}N_{18}O_{36}$: 954.4526, found: 954.4534 (+0.86 ppm).

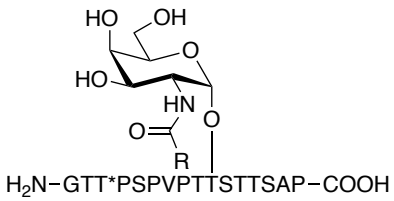


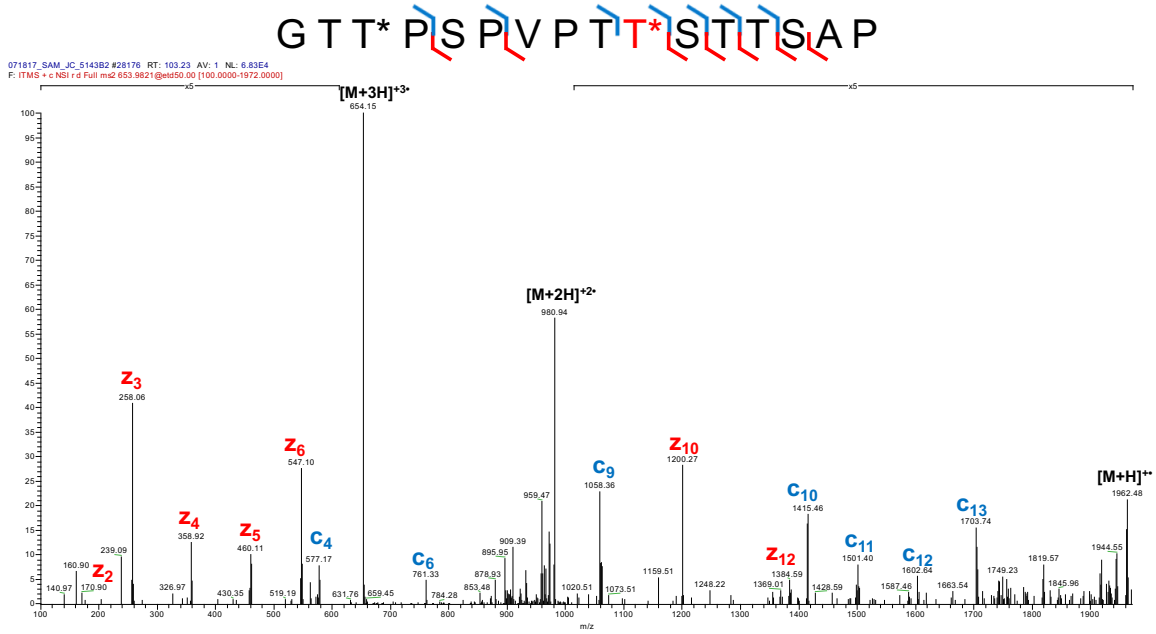


GTT*PSPVPTTST(13-T)SAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 100.6 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{83}H_{136}N_{18}O_{36}$: 980.4682, found: 980.4717 (+3.54 ppm).

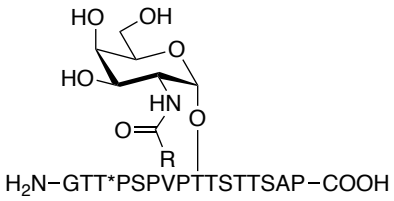


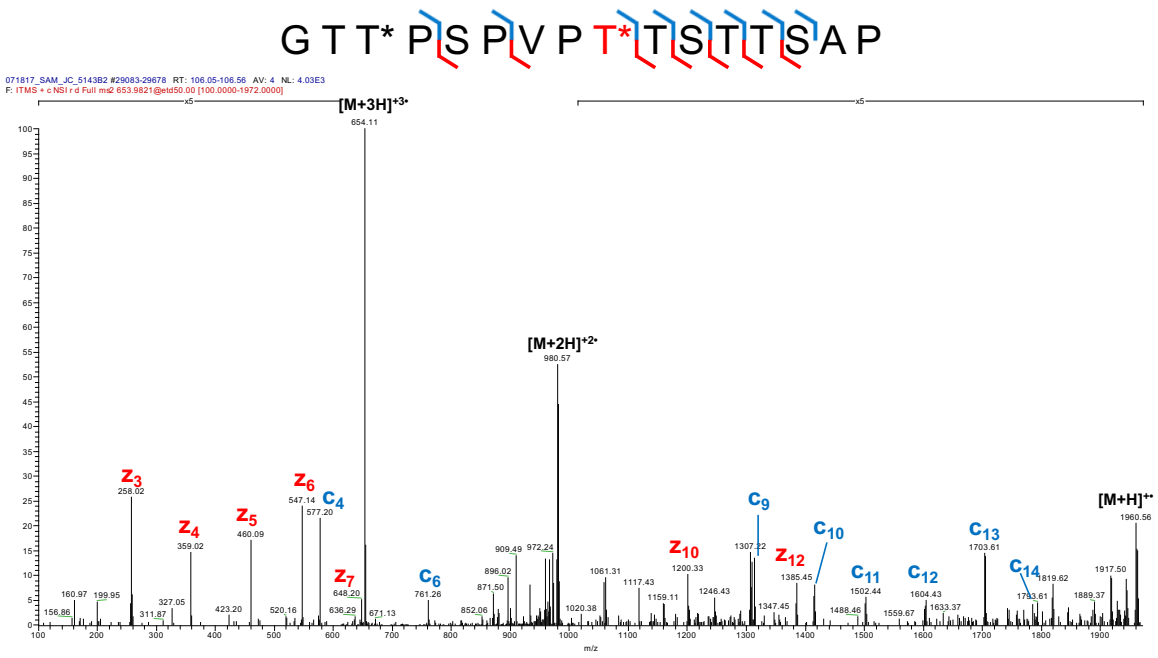


GTT*PSPVPT(13-T)STTSAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 102.7 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{83}H_{136}N_{18}O_{36}$: 980.4682, found: 980.4714 (+3.23 ppm).

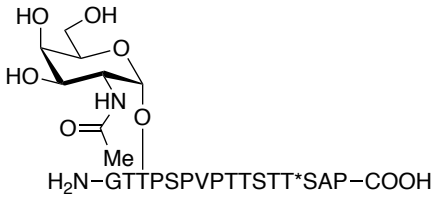


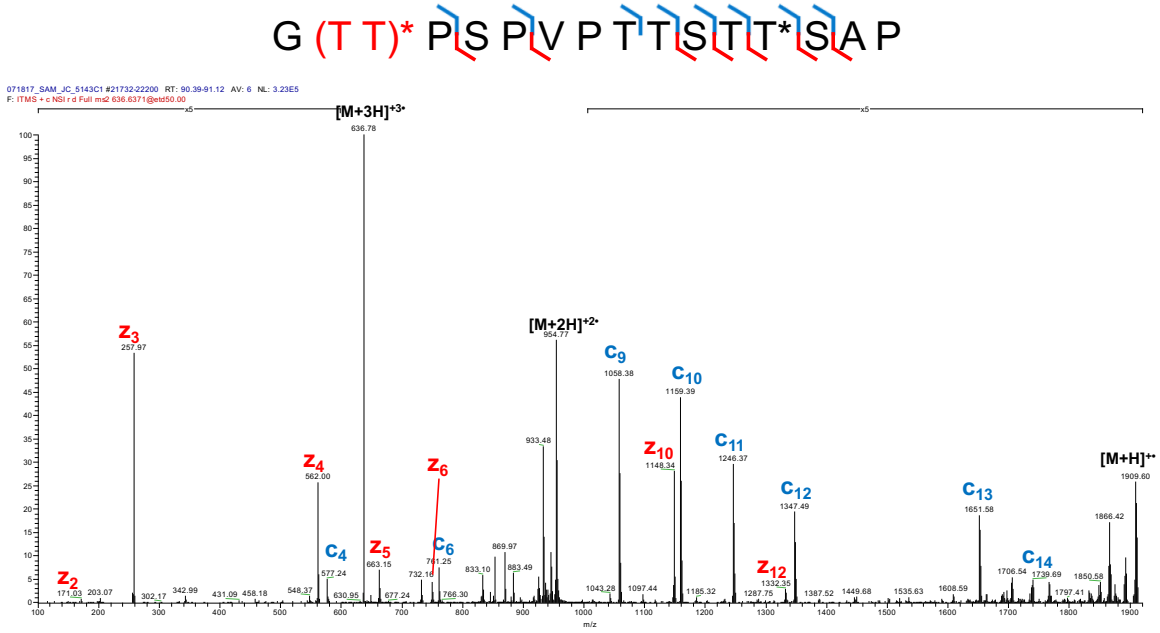


GTT*PSPVP(13-T)TSTTSAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 105.2 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{83}H_{136}N_{18}O_{36}$: 980.4682, found: 980.4710 (+2.83 ppm).

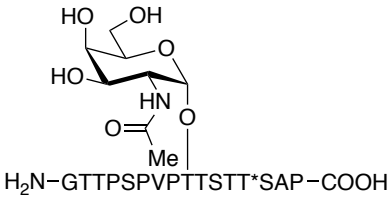


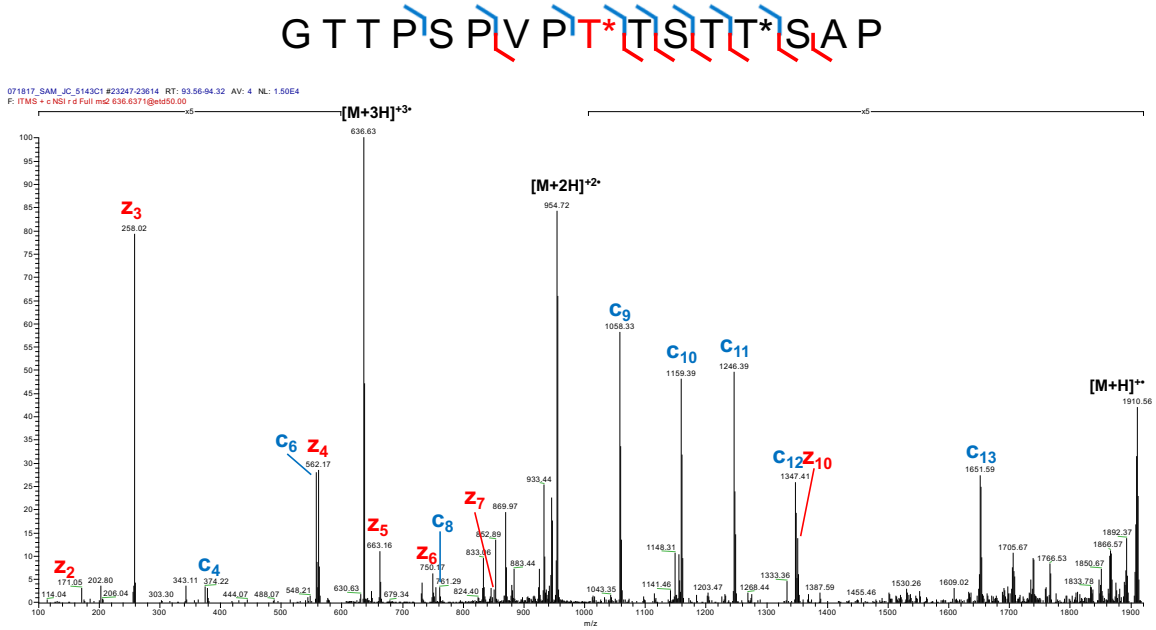


GTT*PSPVPTTSTT*SAP.

The mass spectrum for this peptide does not allow the unambiguous assignment of the glycosite to Thr2 or Thr3. However, this compound has the identical fragmentation pattern and retention time as the major product of WT-T2/**1** with MUC5AC-3, indicating that the glycopeptides are likely identical and that the occupied glycosite is Thr3. Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 91.0 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{79}H_{132}N_{18}O_{36}$: 954.4526, found: 954.4551 (+2.64 ppm).

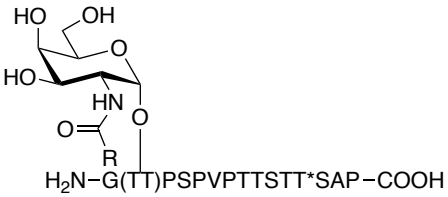


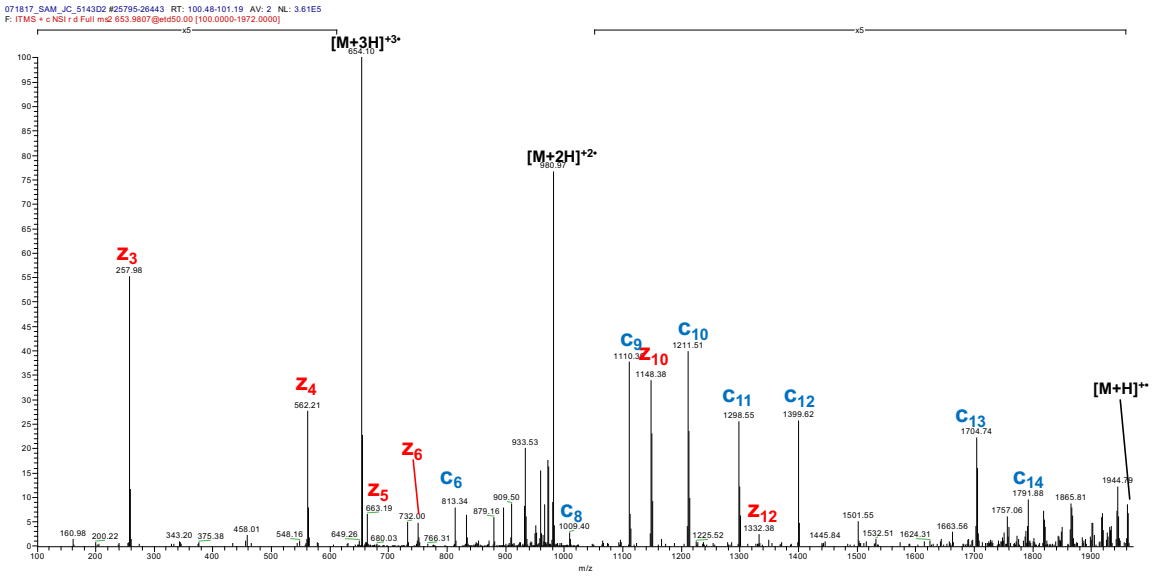


GTTPSPVPT*TSTT*SAP.

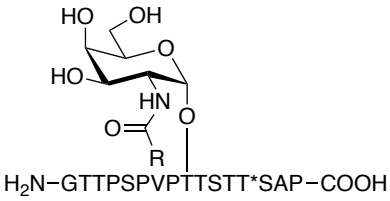
Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 93.6 min.

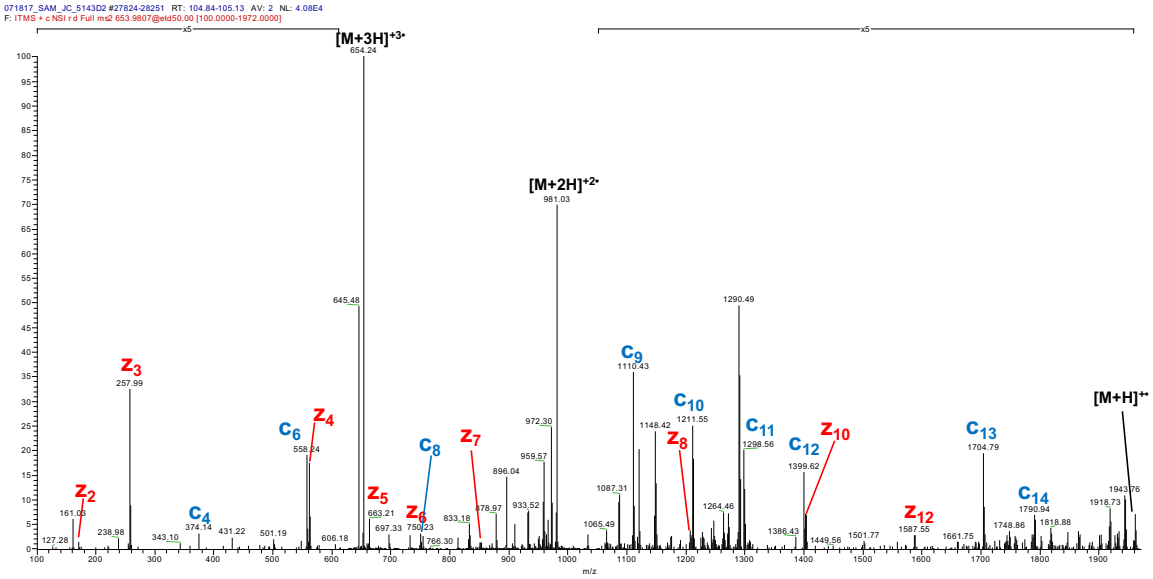
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{79}H_{132}N_{18}O_{36}$: 954.4526, found: 954.4528 (+0.23 ppm).





G(13-(TT))PSPVPTTSTT*SAP.
The glycosite cannot be unambiguously assigned, and either Thr2 or Thr3 (**13**-(TT)) is glycosylated by T2(I253A/L310A)/**13**. Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 100.4 min.
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{83}H_{136}N_{18}O_{36}$: 980.4682, found: 980.4715 (+3.34 ppm).

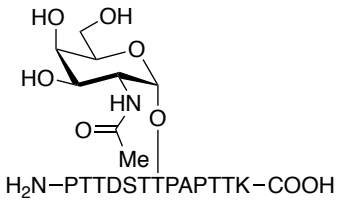


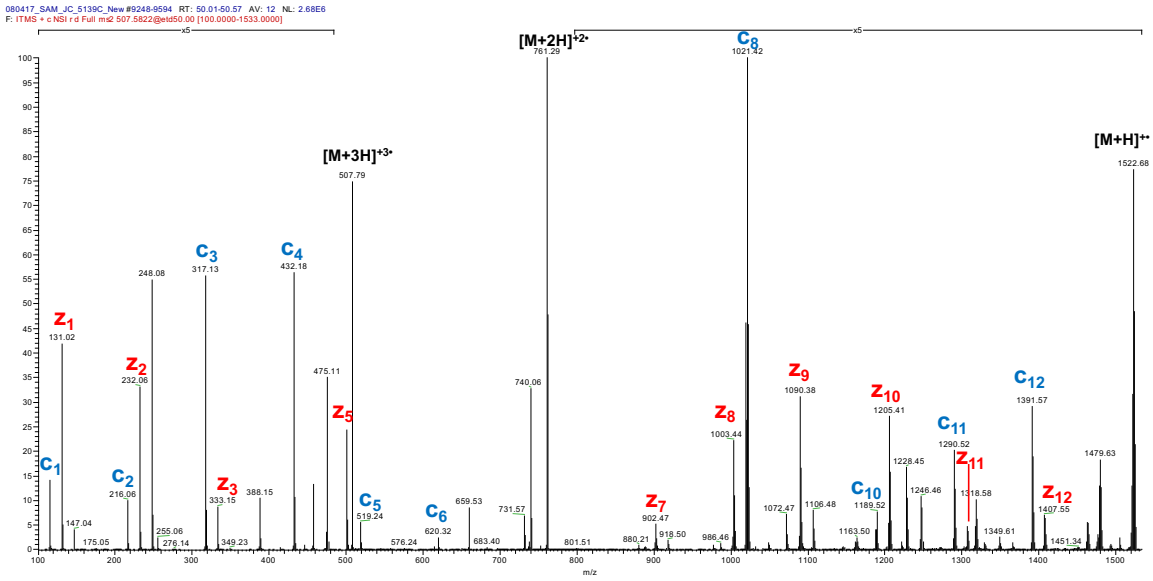


GTTPSPVP(13-T)TSTT*SAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 105.2 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{83}H_{136}N_{18}O_{36}$: 980.4682, found: 980.4687 (+0.48 ppm).

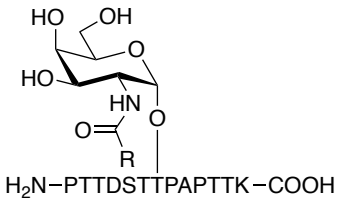


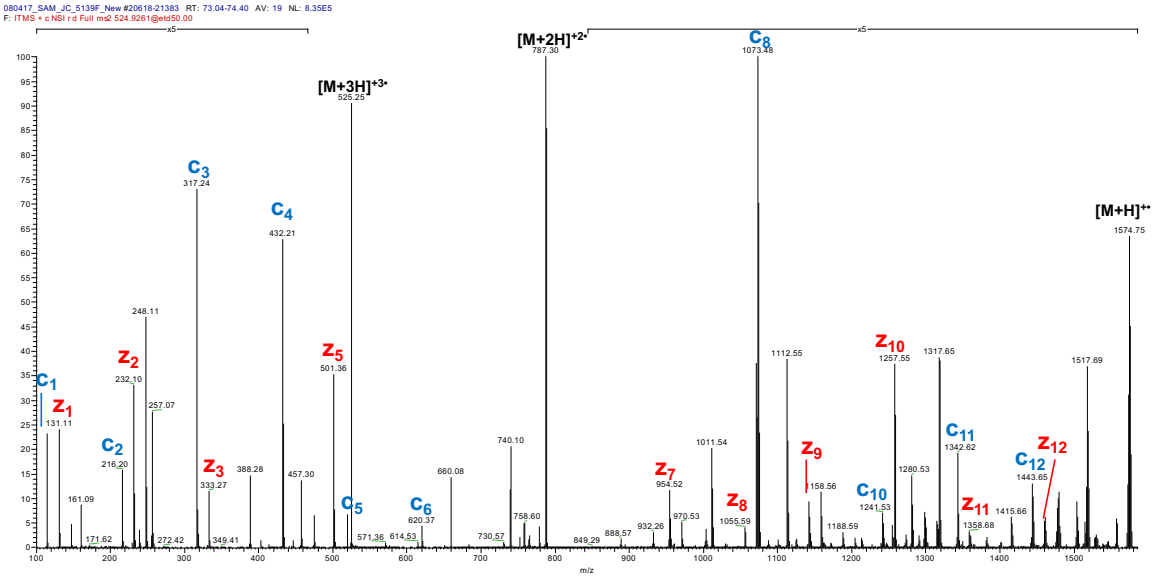


PTTDSTT*PAPTTK.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:20, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 50.0 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{63}H_{107}N_{15}O_{28}$: 760.8705, found: 760.8708 (+0.39 ppm).

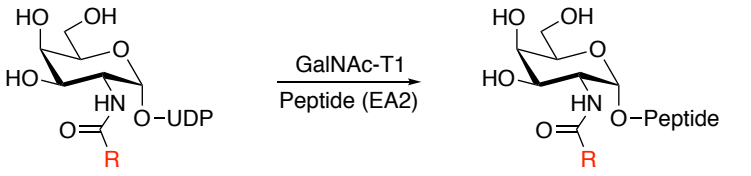




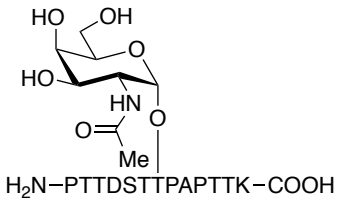
PTTDST(13-T)PAPTTK.

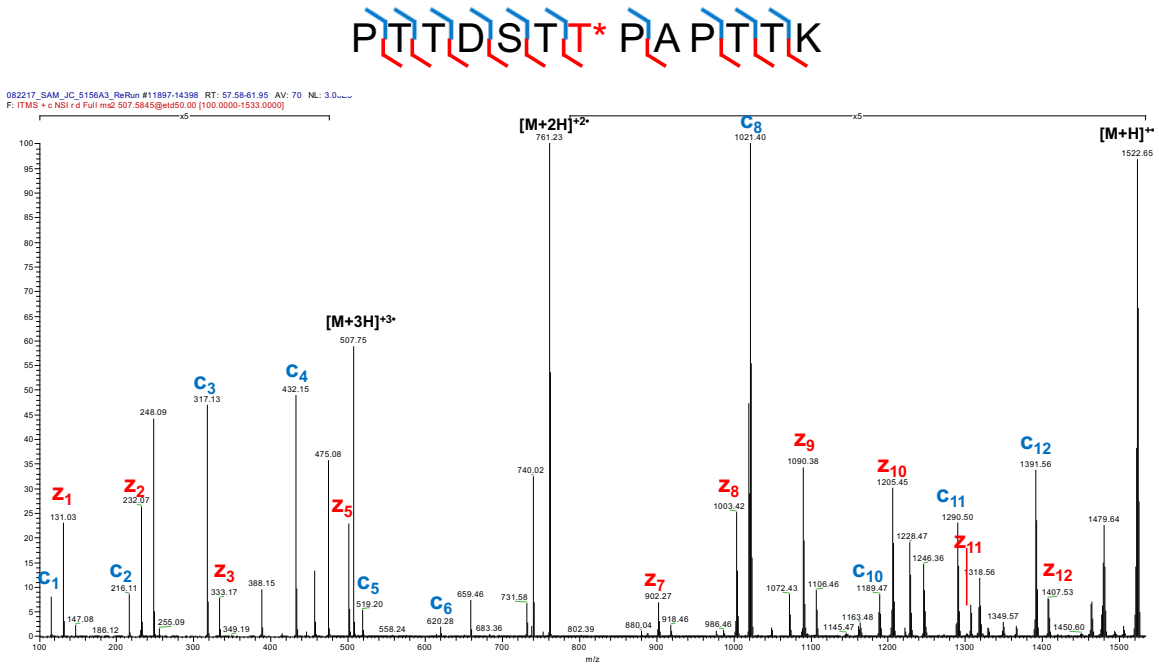
Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:20, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 73.0 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{67}H_{111}N_{15}O_{28}$: 786.8862, found: 786.8867 (+0.70 ppm).



Characterization of peptides glycosylated by GalNAc-T1.

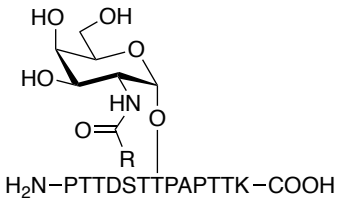


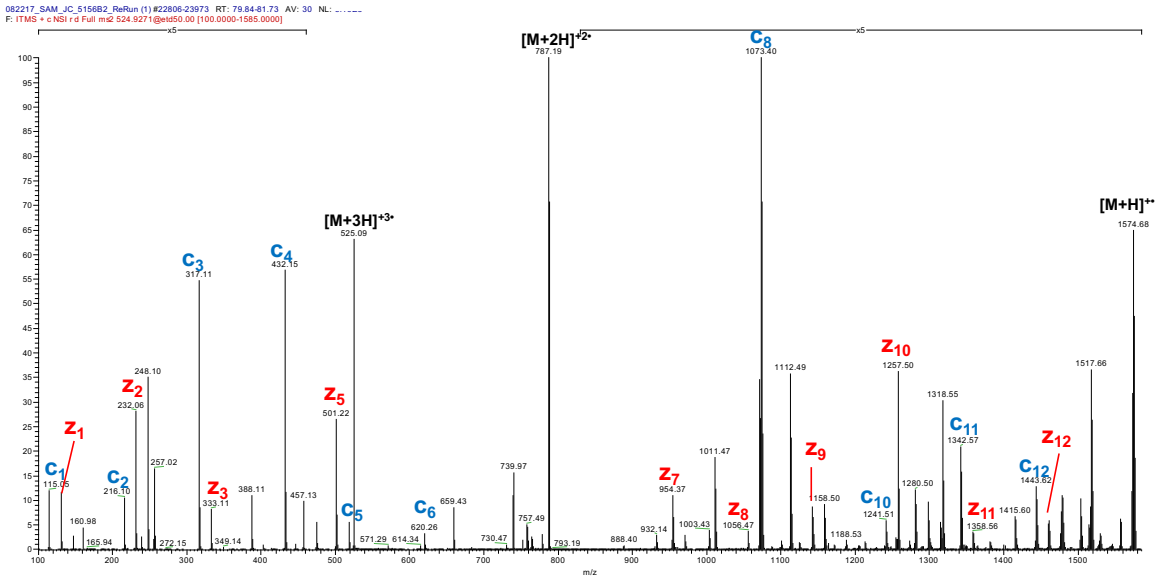


PTTDSTT*PAPTTK.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:20, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 59.0 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{63}H_{107}N_{15}O_{28}$: 760.8705, found: 760.8700 (–0.66 ppm).

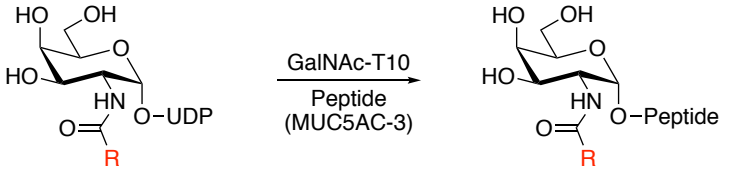




PTTDST(13-T)PAPTTK.

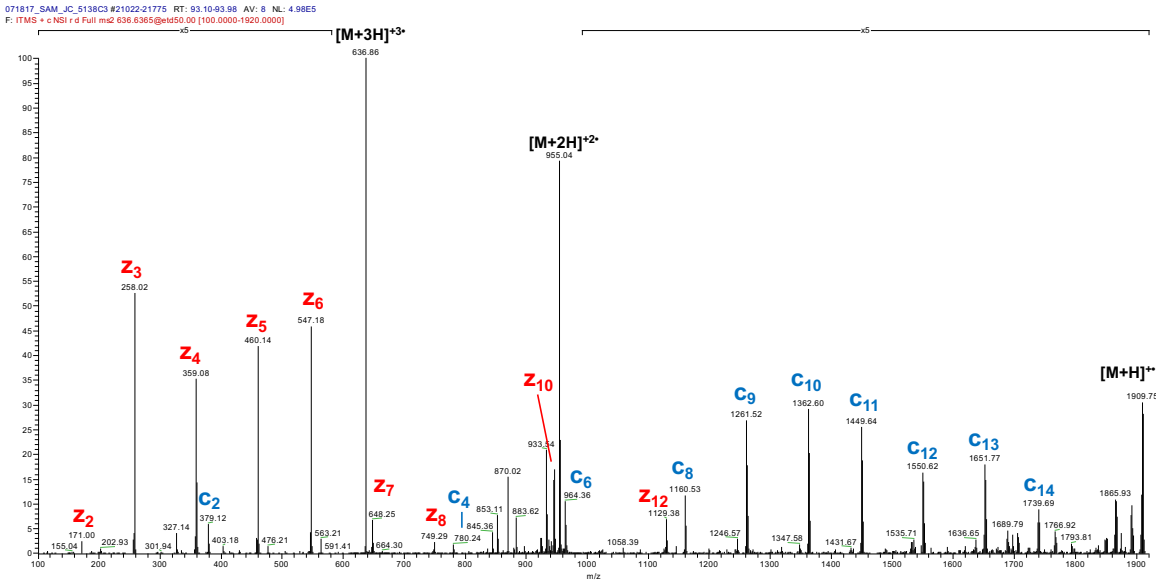
Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:20, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 80.0 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{67}H_{111}N_{15}O_{28}$: 786.8862, found: 786.8859 (–0.32 ppm).



10~20% peptide conversion

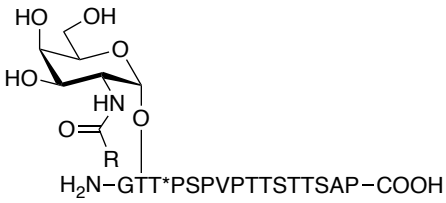
Characterization of peptides glycosylated by GalNAc-T10.

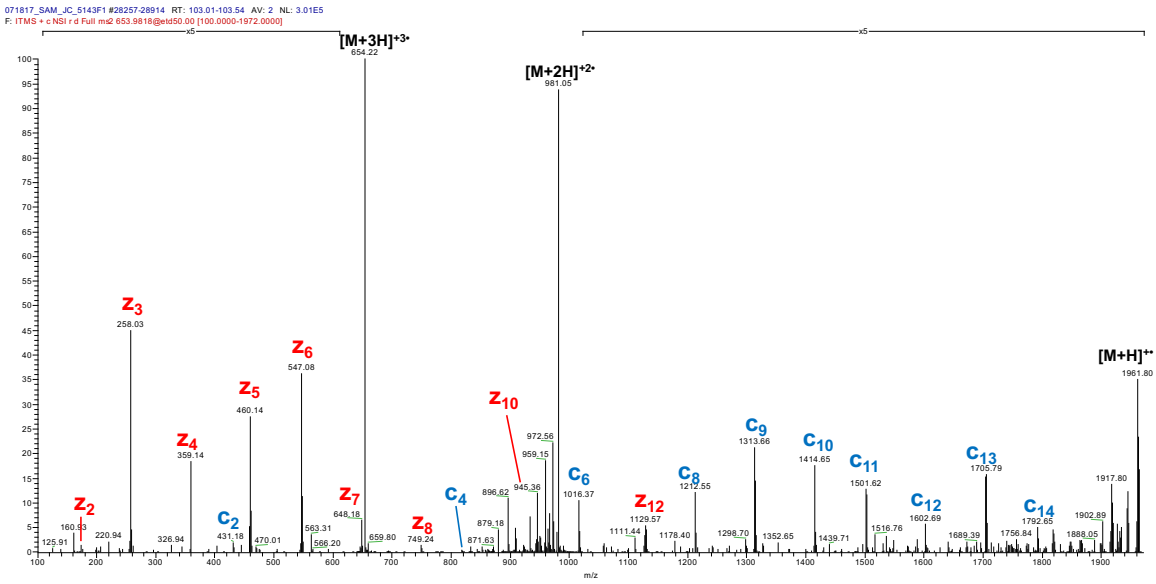


GT*T*PSPVPTTSTTSAP.

Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 93.4 min.

MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{79}H_{132}N_{18}O_{36}$: 954.4526, found: 954.4554 (+2.95 ppm).





G(13-T)T*PSPVPTTSTTSAP.
Product formation and glycosite occupancy were determined using ETD fragmentation on an Orbitrap Fusion™ Tribrid™ Mass Spectrometer coupled to a Dionex Ultimate 3000 HPLC. The gradient profile was as follows (min/%B): 0:3, 3:5, 93:25, 103:42, 104:98, 109:98, 110:3, 185:3 with t_r = 93.4 min.
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{83}H_{136}N_{18}O_{36}$: 980.4682, found: 980.4716 (+3.44 ppm).

VII. Preparation of GalNAc-Ts (Table S2; Figure S7)

Secretion design

Soluble human GalNAc-T2 was generated by removing the N-terminal transmembrane domain and referencing published truncations.[6,7] For GalNAc-T1 and -T10 secretion constructs, N-terminal truncations were made by cleaving at the middle or end of the stem region that follows the transmembrane domain, as identified by online protein secondary structure predictors GlobPlot (2.3) and HMMTOP (2.0), and published truncations were also referenced for GalNAc-T1 and -T10.[1,7–9]

Cloning of truncated GalNAc-Ts.
Full length human GalNAc-T2 (EBI accession number LC043140.1) in the plasmid pCMV-NTAP was a kind gift from Lawrence Tabak (National Institutes of Health, Bethesda, MD). A truncated version (aa E43-N571) was cloned into p3xFLAG-CMV-8 using primers (GalNAc-T2 coding sequence underlined) GACAAGCTTGCGGCCGCGGAGGACTGGAATGAAATTG (fwd) and CGATGAATTCCTACTGCTGCAGGTTGAGC (rev) and a NotI/EcoRI restriction strategy. As the presence of a 3xFLAG tag in the secretion construct prevented elution from FLAG® affinity resin, truncated GalNAc-T2 was sub-cloned into pFLAG-myc-CMV-19 using a NotI/EcoRI restriction strategy that excluded the myc tag from the coding sequence. This construct contains an N-terminal preprotrypsin leader sequence and an ampicillin resistance cassette.

Secretion constructs for GalNAc-T1 (NCBI Genbank® accession number X85018, aa D35-F559) and GalNAc-T10 (NCBI Genbank® accession number AJ505950, aa P40-N603) were assembled by Golden Gate cloning using the gBlocks depicted in Table S2. BsaI restriction sites at the joint regions of each gBlock enabled assembly. Silent mutations were included to mask endogenous BsaI sites.

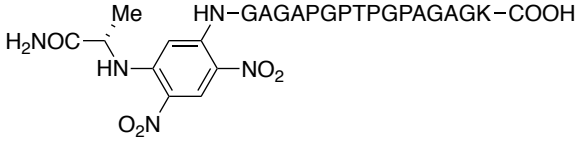
The Golden Gate reaction was carried out using 20 fmol of each gBlock and 2000 U T4 DNA ligase in 15 μL T4 DNA ligase buffer, using 25 cycles of 37 °C (2 min), 16 °C (5 min); 60 °C (10 min); 80 °C (20 min); and 4 °C (hold). Following assembly, BsaI sites were introduced into the flanking regions of the T1 gene by PCR using the primers CACACCAGGTCTCAGGCCGCGGATGAAAAAAAGGAGAGAGGACTT (fwd) and CACACCAGGTCTCTAATTCTCAGAATATTTCTGGAAGGGTGACGT (rev). Amplicons were digested with BsaI to give NotI and EcoRI overhangs, and cloned into pFLAG-myc-CMV-19 while excluding the myc tag from the coding sequence.

Generation of GalNAc-T mutants.
Point mutations were introduced into wild-type GalNAc-T2 (WT-T2) and WT-T1 by site-directed mutagenesis using a strategy according to a literature procedure.[10] The primer pairs used to generate GalNAc-T2 mutants (mismatch underlined) were CACCCATCGCCGATGTCATTAATATGGACAAC (fwd) and GACATCGGCGATGGGTGACACAACCCGAGTC (rev) for T2(I253A), GCTGGTGGGGCCTTTGTGATGGATAAGTTC (fwd) and CATCACAAAGGCCCCACCAGCAATCATGGGG (rev) for T2(L310A), GGACACGTGGCCCGGAAGCAGCACCCCTACACGTTC (fwd) and GCTTCCGGGCCACGTGTCCCACACGGCTGCAC (rev) for T2(F361A), and GACACGTGTCCCGGAAGCAGCAC (fwd) and CTTCCGGGACACGTGTCCCAC (rev) for T2(F361S). The F361 mutants were generated from full-length GalNAc-T2 in pCMV-NTAP, and truncated versions were cloned and sub-cloned as described for the wild-type enzyme in the previous section. Primer pairs for GalNAc-T1 mutants (mismatch underlined) were CCATCGCCGATGTGATCAGTGATGATAC (fwd) and ACATCGGCGATGGGACACACC (rev) for T1(I238A), and GAGGCGCCTTTTCAATAGACAGAGATTACTTTC (fwd) and GAAAAGGCGCCTCCTGCCATGG (rev) for T1(L295A). The GalNAc-T10 double

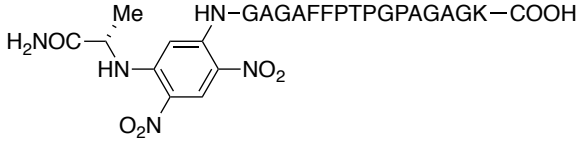
mutant was assembled using a modified gBlock during Golden Gate assembly (Table S2).

Protein expression.
Truncated GalNAc-Ts were expressed in HEK-293T cells and purified by FLAG affinity chromatography. Briefly, cells were grown in Dulbecco's Modified Eagle Medium with 10% (v/v) fetal bovine serum in 15-cm dishes and transfected with expression plasmids using TransIT®-293 according to the manufacturer's instructions and using 37.5 μg plasmid DNA per dish. The medium was changed after 24 h, and protein expression was allowed to continue for another 24 h. The supernatant was collected and centrifuged for 15 min at 3650 x *g* at 4 °C. The clarified supernatant was treated with cOmplete™ mini EDTA-free protease inhibitor and loaded on a column packed with anti-FLAG® M2 agarose resin (1.25 mL) pre-conditioned according to the manufacturer's instructions. The resin was washed with Tris buffered saline (TBS, 25 mM Tris-HCl, 150 mM NaCl, pH = 7.4; 2 x 10 mL). Protein was eluted by 3xFLAG® peptide (100 μg/mL) in TBS (25 mM Tris-HCl, 150 mM NaCl, pH = 7.4; 5 mL). Glycerol was added to the pooled elution fractions to a final concentration of 25% (v/v). Proteins were aliquoted and stored at –80 °C. Protein quantification was performed by densitometric analysis of bands on SDS-PAGE gels stained with Colloidal Blue Staining Kit and comparison to known standards of human serum albumin (Figure S7A). Immunodecoration after Western blot was performed using a murine anti-FLAG® antibody (Figure S7B).

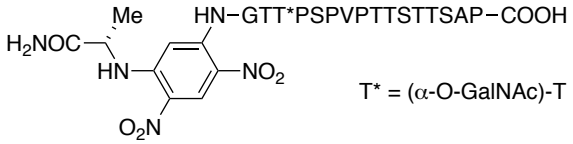
VIII. Characterization of Chromophore-Labeled Peptides (Figure 2A)



Peptide-1. The peptide was purified by preparative HPLC on C-18 silica gel (20→60% acetonitrile/water; 0.1% trifluoroacetic acid).
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{63}H_{97}N_{21}O_{23}$: 757.8533, found: 757.8524 (–1.20 ppm).

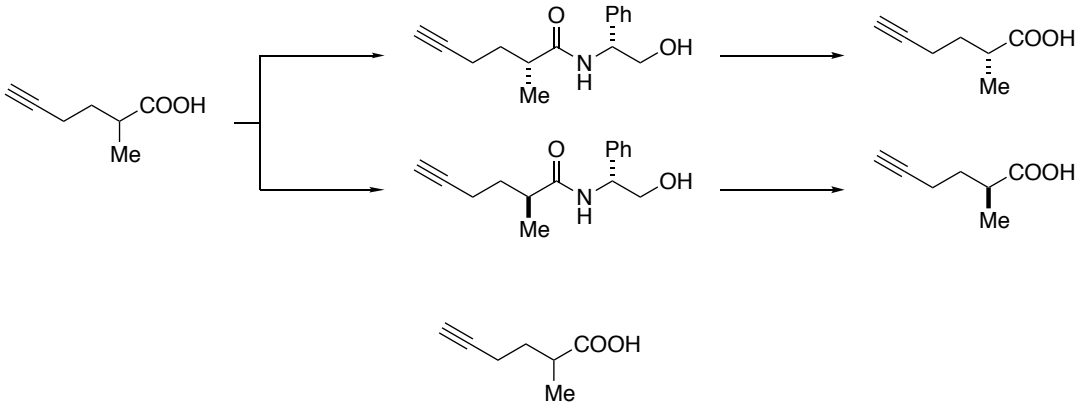


Peptide-2. The peptide was purified by preparative HPLC on C-18 silica gel (30→40% acetonitrile/water; 0.1% trifluoroacetic acid).
MS (ESI) *m/z* ($[M+2H]^{2+}$) calcd for $C_{74}H_{105}N_{21}O_{23}$: 827.8846, found: 827.8828 (–2.19 ppm).

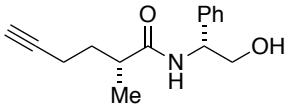


Peptide-3. The peptide containing a protected sugar was purified by preparative HPLC on C-18 silica gel (30→40% acetonitrile/water). The title compound was purified by preparative HPLC on C-18 silica gel (5→50% acetonitrile/water; 0.1% trifluoroacetic acid).
MS (ESI) *m/z* ([M+2H]$^{2+}$) calcd for $C_{80}H_{127}N_{21}O_{36}$: 978.9376, found: 978.9376 (–0.03 ppm).

IX. Preparation of UDP-Sugars (Figures 2B and 2C)

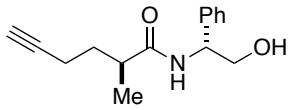


Methylhex-5-ynoic acid. LDA was prepared by the dropwise addition of *n*-BuLi (2.5 M in hexanes; 14.2 mL, 36 mmol) to a solution of *i*-Pr_2NH (6.43 mL, 45.9 mmol) in THF (24.0 mL) in a 250-mL round-bottom flask at −78 °C. The reaction mixture was stirred at 0 °C for 15 min, and then it was cooled to −20 °C. A solution of propanoic acid (1.33 mL, 17.8 mmol) in HMPA (3.00 mL) was added dropwise over 10 min to the LDA solution at −20 °C. The mixture was stirred at r.t. for 30 min, and then it was cooled to 0 °C. Next, a solution of (4-bromobut-1-yn-1-yl)trimethylsilane[11] (3.04 g, 14.8 mmol) in THF (5.90 mL) was added. The resulting mixture was allowed to warm to r.t., and it was stirred for 2 h. The reaction was quenched by the addition of water (100 mL). The aqueous layer was rinsed with ethyl acetate (50 mL), acidified using HCl (2 M), and extracted with ethyl acetate (3 x 50 mL). The extracted organic layers were combined, dried over Na_2SO_4, and concentrated. The acid was used without further purification.

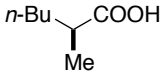


(*R*)-*N*-((*R*)-2-Hydroxy-1-phenylethyl)-2-methylhex-5-ynamide. The title compound was prepared from (*R*)-2-amino-2-phenylethan-1-ol (1.37 g, 10.0 mmol) and methylhex-5-ynoic acid (1.26 g, 10.0 mmol) according to a literature procedure.[12] The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes)

and then on C-18 silica gel (5%→100% acetonitrile/water; 0.1% trifluoroacetic acid): 495 mg (21% over two steps). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37–7.32 (m, 2H), 7.31–7.25 (m, 3H), 6.41 (d, J = 6.8 Hz, 1H), 5.05 (ddd, J = 7.0, 5.1, 5.1 Hz, 1H), 3.84 (d, J = 5.1 Hz, 2H), 3.08 (br s, 1H), 2.55–2.46 (m, 1H), 2.33–2.20 (m, 2H), 2.00 (t, J = 2.6 Hz, 1H), 1.91–1.82 (m, 1H), 1.65–1.56 (m, 1H), 1.14 (d, J = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 176.5, 139.2, 128.7, 127.6, 126.6, 83.8, 69.3, 66.1, 55.6, 39.8, 32.3, 17.6, 16.4.
FT-IR (neat) 3295, 3071, 3031, 2937, 2877, 1640, 1545, 1491, 1451, 1390, 1371, 1280, 1245, 1200, 1179, 1116, 1087, 1072, 1042, 1002, 939, 882, 841, 749, 697, 636, 614, 561, 524, 500 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{15}H_{19}NNaO_2$: 268.1313, found: 268.1309.
R_f = 0.38 (60% ethyl acetate/hexanes).

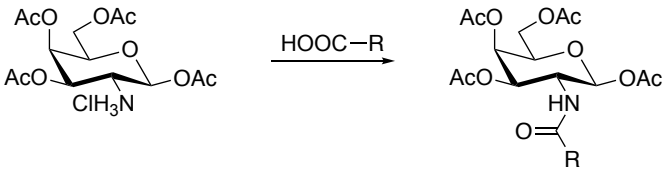


(*S*)-*N*-((*R*)-2-Hydroxy-1-phenylethyl)-2-methylhex-5-ynamide. The title compound was prepared from (*R*)-2-amino-2-phenylethan-1-ol (1.37 g, 10.0 mmol) and methylhex-5-ynoic acid (1.26 g, 10.0 mmol) according to a literature procedure.[12] The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water; 0.1% trifluoroacetic acid): 469 mg (19% over two steps). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38–7.33 (m, 2H), 7.32–7.27 (m, 3H), 6.43 (d, J = 7.4 Hz, 1H), 5.06 (ddd, J = 7.0, 5.0, 5.0 Hz, 1H), 3.89–3.80 (m, 2H), 2.82 (br s, 1H), 2.58–2.50 (m, 1H), 2.21 (dddd, J = 17.1, 6.1, 6.1, 2.6 Hz, 1H), 2.08 (dddd, J = 17.7, 8.9, 6.3, 2.7 Hz, 1H), 1.97 (t, J = 2.6 Hz, 1H), 1.86–1.78 (m, 1H), 1.62–1.53 (m, 1H), 1.19 (d, J = 6.8 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 176.5, 139.4, 128.8, 127.8, 126.7, 83.7, 69.4, 66.2, 55.6, 39.8, 32.5, 17.8, 16.5.
FT-IR (neat) 3271, 3069, 3033, 2966, 2947, 2928, 2876, 1642, 1538, 1492, 1472, 1453, 1385, 1367, 1347, 1292, 1270, 1252, 1218, 1195, 1184, 1115, 1095, 1067, 1046, 1002, 941, 910, 899, 882, 839, 753, 696, 679, 644, 556, 529, 502, 441 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{15}H_{19}NNaO_2$: 268.1313, found: 268.1308.
R_f = 0.26 (60% ethyl acetate/hexanes).



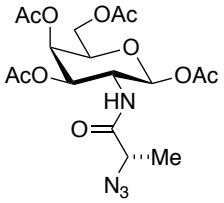
Assignment of absolute stereochemistry of (*S*)-2-methylhexanoic acid [49642-51-5]. A mixture of *N*-((*R*)-2-Hydroxy-1-phenylethyl)-2-methylhex-5-ynamide (80.0 mg, 0.326 mmol; R_f = 0.26 (60% ethyl acetate/hexanes)) and Pd/C (10 wt%; 14.8 mg) in MeOH (6.0 mL) in a 25-mL round-bottom flask was stirred under atmospheric pressure of H_2 at r.t. for 12 h, and then the reaction mixture was filtered through a pad of Celite® and concentrated. The compound was hydrolyzed to obtain 2-methylhexanoic acid according

to a literature procedure.[12] The product was purified by column chromatography (10%→78% diethyl ether/pentane): 39.8 mg (94% over two steps). Colorless oil.
^{1}H NMR (500 MHz, $CDCl_3$) δ 2.45 (h, *J* = 7.0 Hz, 1H), 1.73–1.64 (m, 1H), 1.48–1.38 (m, 1H), 1.36–1.27 (m, 4H), 1.17 (d, *J* = 6.9 Hz, 3H), 0.89 (t, *J* = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 183.9, 39.6, 33.4, 29.4, 22.7, 17.0, 14.1.
$[\alpha]_D^{23}$ = +18.1° (c = 1.02, $CHCl_3$).
The absolute stereochemistry was assigned as (*S*) by comparison with reported optical rotations (lit.[13] $[\alpha]_D^{20}$ = +20.6° (c = 0.5, $CHCl_3$; *S* enantiomer); lit.[14] $[\alpha]_D^{20}$ = +18.1° (c = 0.84, $CHCl_3$; *S* enantiomer)).



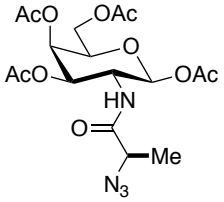
Representative experimental procedure for the preparation of peracetylated *N*-acetyl-β-D-galactosamine derivatives (Route 1).

1,3,4,6-Tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride[15] and azido acids[16] were prepared according to literature procedures. A mixture of the sugar (192 mg, 0.500 mmol), the acid (0.500 mmol), and Hünig's base (0.261 mL, 1.50 mmol) in DMF (4.00 mL) in a 25-mL round-bottom flask was cooled to 0 °C. COMU® was added, and the reaction mixture was stirred at 0 °C for 1 h. The solution was allowed to warm to r.t. and stirred for 3 h. The mixture was diluted by the addition of ethyl acetate (50 mL), rinsed with HCl (1 M; 2 x 10 mL), saturated aqueous $NaHCO_3$ (2 x 10 mL), and brine (20 mL), dried over Na_2SO_4, and concentrated. The product was purified by column chromatography.

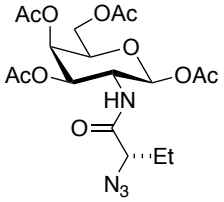


1,3,4,6-Tetra-*O*-acetyl-2-((*S*)-2-azidopropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (384 mg, 1.00 mmol) and (*S*)-2-azidopropanoic acid (115 mg, 1.00 mmol). The product was purified by column chromatography (15%→100% ethyl acetate/hexanes): 397 mg (89%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.77 (d, *J* = 9.5 Hz, 1H), 5.76 (d, *J* = 8.7 Hz, 1H), 5.30 (d, *J* = 3.3 Hz, 1H), 5.20 (dd, *J* = 11.3, 3.4 Hz, 1H), 4.27 (ddd, *J* = 11.3, 9.1, 9.1 Hz, 1H), 4.09–3.99 (m, 3H), 3.90 (q, *J* = 7.0 Hz, 1H), 2.06 (s, 3H), 2.01 (s, 3H), 1.94 (s, 3H), 1.90 (s, 3H), 1.32 (d, *J* = 7.0 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.7, 170.5, 170.4, 170.2, 169.3, 92.5, 71.7, 69.7, 66.4, 61.5, 59.1, 49.6, 20.6, 20.5, 20.5, 20.4, 17.1.

FT-IR (neat) 3337, 2975, 2956, 2934, 2109, 1745, 1665, 1530, 1435, 1369, 1321, 1268, 1215, 1162, 1151, 1068, 1036, 972, 946, 915, 903, 731, 703, 668, 645, 628, 601, 556, 539, 495, 480 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{17}H_{24}N_4NaO_{10}$: 467.1390, found: 467.1383.

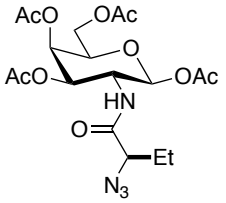


1,3,4,6-Tetra-*O*-acetyl-2-((*R*)-2-azidopropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (576 mg, 1.50 mmol) and (*R*)-2-azidopropanoic acid (173 mg, 1.50 mmol). The product was purified by column chromatography (12%→100% ethyl acetate/hexanes): 458 mg (69%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.59 (d, *J* = 9.5 Hz, 1H), 5.81 (d, *J* = 8.8 Hz, 1H), 5.36 (d, *J* = 3.1 Hz, 1H), 5.22 (dd, *J* = 11.2, 3.3 Hz, 1H), 4.35 (ddd, *J* = 11.2, 9.2, 9.2 Hz, 1H), 4.15–4.05 (m, 3H), 3.98 (q, *J* = 7.0 Hz, 1H), 2.14 (s, 3H), 2.09 (s, 3H), 2.01 (s, 3H), 1.97 (s, 3H), 1.41 (d, *J* = 7.0 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.7, 170.6, 170.5, 170.3, 169.5, 92.5, 71.9, 70.2, 66.5, 61.5, 59.2, 49.9, 20.9, 20.7, 20.6, 17.2.
FT-IR (neat) 3311, 2983, 2940, 2110, 1743, 1685, 1531, 1434, 1368, 1212, 1161, 1116, 1069, 1039, 955, 917, 904, 865, 733, 647, 601, 561, 537 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{17}H_{24}N_4NaO_{10}$: 467.1390, found: 467.1381.

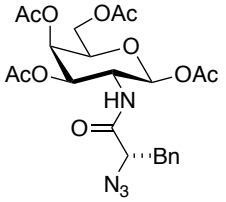


1,3,4,6-Tetra-*O*-acetyl-2-((*S*)-2-azidobutanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (544 mg, 1.42 mmol) and (*S*)-2-azidobutanoic acid (183 mg, 1.42 mmol). The product was purified by column chromatography (12%→100% ethyl acetate/hexanes): 435 mg (67%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.49 (d, *J* = 9.4 Hz, 1H), 5.78 (d, *J* = 8.8 Hz, 1H), 5.39 (dd, *J* = 3.3, 0.7 Hz, 1H), 5.21 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.38 (ddd, *J* = 11.3, 9.1, 9.1 Hz, 1H), 4.17–4.10 (m, 2H), 4.09–4.04 (m, 1H), 3.91 (dd, *J* = 6.6, 4.9 Hz, 1H), 2.15 (s, 3H), 2.09 (s, 3H), 2.03 (s, 3H), 1.99 (s, 3H), 1.90–1.74 (m, 2H), 0.92 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.6, 170.6, 170.3, 167.0, 169.4, 92.6, 71.9, 70.1, 66.4, 65.5, 61.4, 49.8, 25.3, 20.9, 20.8, 20.8, 20.7, 9.4.
FT-IR (neat) 3319, 2973, 2941, 2881, 2104, 1745, 1669, 1532, 1435, 1368, 1214, 1162, 1116, 1071, 1040, 941, 899, 736, 648, 601, 561, 538 cm^{-1}.

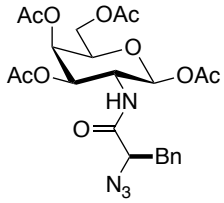
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{18}H_{26}N_4NaO_{10}$: 481.1547, found: 481.1535.



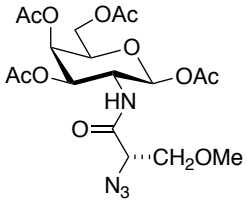
1,3,4,6-Tetra-*O*-acetyl-2-((*R*)-2-azidobutanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (518 mg, 1.35 mmol) and (*R*)-2-azidobutanoic acid (174 mg, 1.35 mmol). The product was purified by column chromatography (12%→100% ethyl acetate/hexanes): 417 mg (68%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.47 (d, *J* = 9.5 Hz, 1H), 5.80 (d, *J* = 8.8 Hz, 1H), 5.38 (dd, *J* = 3.3, 0.7 Hz, 1H), 5.19 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.40 (ddd, *J* = 11.3, 9.2, 9.2 Hz, 1H), 4.18–4.11 (m, 2H), 4.07–4.05 (m, 1H), 3.94 (dd, *J* = 6.2, 5.0 Hz, 1H), 2.16 (s, 3H), 2.11 (s, 3H), 2.04 (s, 3H), 1.98 (s, 3H), 1.91–1.78 (m, 2H), 0.92 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.6, 170.5, 170.3, 169.8, 169.5, 92.6, 71.9, 70.2, 66.4, 65.3, 61.4, 49.8, 25.2, 21.0, 20.8, 20.7, 9.3.
FT-IR (neat) 3317, 2973, 2937, 2881, 2104, 1746, 1671, 1532, 1435, 1368, 1215, 1161, 1117, 1071, 1041, 937, 901, 863, 736, 676, 630, 601, 561, 537 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{18}H_{26}N_4NaO_{10}$: 481.1547, found: 481.1550.



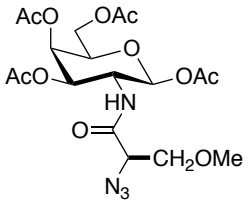
1,3,4,6-Tetra-*O*-acetyl-2-((*S*)-2-azido-3-phenylpropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (384 mg, 1.00 mmol) and (*S*)-2-azido-3-phenylpropanoic acid (191 mg, 1.00 mmol). The product was purified by column chromatography (1%→10% acetone/CH_2Cl_2): 456 mg (88%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32–7.29 (m, 2H), 7.28–7.25 (m, 1H), 7.25–7.22 (m, 2H), 6.48 (d, *J* = 9.3 Hz, 1H), 5.79 (d, *J* = 8.8 Hz, 1H), 5.39 (dd, *J* = 3.2, 0.7 Hz, 1H), 5.21 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.37 (ddd, *J* = 11.3, 9.0, 9.0 Hz, 1H), 4.18–4.05 (m, 4H), 3.27 (dd, *J* = 14.0, 4.3 Hz, 1H), 2.81 (dd, *J* = 14.1, 9.1 Hz, 1H), 2.17 (s, 3H), 2.10 (s, 3H), 2.03 (s, 3H), 1.97 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.6, 170.6, 170.3, 169.5, 169.5, 136.1, 129.4, 128.9, 127.4, 92.7, 71.9, 70.0, 66.4, 65.9, 61.4, 50.2, 38.6, 21.0, 20.8, 20.7.
FT-IR (neat) 3327, 3084, 3065, 3031, 2929, 2110, 1745, 1675, 1531, 1498, 1454, 1433, 1368, 1301, 1216, 1162, 1115, 1073, 1040, 947, 913, 733, 702, 595, 556, 538 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{23}H_{28}N_4NaO_{10}$: 543.1703, found: 543.1696.



1,3,4,6-Tetra-*O*-acetyl-2-((*R*)-2-azido-3-phenylpropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (192 mg, 0.50 mmol) and (*R*)-2-azido-3-phenylpropanoic acid (95.6 mg, 0.50 mmol). The product was purified by column chromatography (1%→10% acetone/CH_2Cl_2): 136 mg (52%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33–7.26 (m, 3H), 7.26–7.22 (m, 2H), 6.36 (d, *J* = 9.3 Hz, 1H), 5.80 (d, *J* = 8.8 Hz, 1H), 5.39 (dd, *J* = 3.2, 0.7 Hz, 1H), 5.20 (dd, *J* = 11.3, 3.4 Hz, 1H), 4.34 (ddd, *J* = 11.3, 9.1, 9.1 Hz, 1H), 4.19–4.09 (m, 3H), 4.05 (ddd, *J* = 6.5, 6.5, 1.0 Hz, 1H), 3.30 (dd, *J* = 14.1, 4.2 Hz, 1H), 2.82 (dd, *J* = 14.1, 9.0 Hz, 1H), 2.18 (s, 3H), 2.10 (s, 3H), 2.04 (s, 3H), 1.98 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.5, 170.3, 169.4, 169.4, 136.1, 129.5, 128.9, 127.5, 92.6, 72.0, 70.1, 66.4, 65.8, 61.4, 50.2, 38.6, 21.0, 20.8, 20.8, 20.7.
FT-IR (neat) 3327, 2952, 2924, 2854, 2113, 1746, 1685, 1532, 1455, 1435, 1368, 1300, 1217, 1160, 1117, 1074, 1041, 949, 919, 908, 735, 702, 601 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{23}H_{28}N_4NaO_{10}$: 543.1703, found: 543.1706.



1,3,4,6-Tetra-*O*-acetyl-2-((*S*)-2-azido-3-methoxypropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (510 mg, 1.33 mmol) and (*S*)-2-azido-3-methoxypropanoic acid (193 mg, 1.33 mmol). The product was purified by column chromatography (15%→100% ethyl acetate/hexanes): 453 mg (72%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.44 (d, *J* = 9.5 Hz, 1H), 5.78 (d, *J* = 8.7 Hz, 1H), 5.40 (dd, *J* = 3.2, 0.7 Hz, 1H), 5.18 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.36 (ddd, J = 11.3, 9.1, 9.1 Hz, 1H), 4.19–4.09 (m, 3H), 4.04 (ddd, *J* = 6.5, 6.5, 0.8 Hz, 1H), 3.80–3.69 (m, 2H), 3.38 (s, 3H), 2.17 (s, 3H), 2.11 (s, 3H), 2.05 (s, 3H), 2.02 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.5, 170.5, 170.2, 169.3, 167.9, 92.7, 72.4, 72.0, 69.9, 66.4, 63.3, 61.4, 59.4, 50.1, 20.9, 20.8, 20.8, 20.7.
FT-IR (neat) 3337, 2957, 2921, 2852, 2109, 1747, 1675, 1534, 1457, 1435, 1369, 1305, 1219, 1162, 1116, 1073, 1041, 950, 923, 900, 849, 800, 602, 562 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{18}H_{26}N_4NaO_{11}$: 497.1496, found: 497.1485.



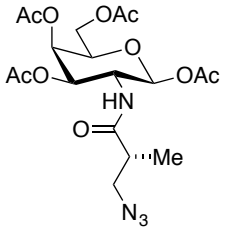
1,3,4,6-Tetra-*O*-acetyl-2-((*R*)-2-azido-3-methoxypropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (510 mg, 1.33 mmol) and (*R*)-2-azido-3-methoxypropanoic acid (193 mg, 1.33 mmol). The product was purified by column chromatography (15%→100% ethyl acetate/hexanes): 459 mg (73%). White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.43 (d, *J* = 9.4 Hz, 1H), 5.78 (d, *J* = 8.8 Hz, 1H), 5.39 (dd, *J* = 3.3, 0.6 Hz, 1H), 5.19 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.37 (ddd, *J* = 11.2, 9.1, 9.1 Hz, 1H), 4.19–4.09 (m, 3H), 4.04 (ddd, *J* = 6.6, 6.6, 0.9 Hz, 1H), 3.81–3.65 (m, 2H), 3.37 (s, 3H), 2.17 (s, 3H), 2.13 (s, 3H), 2.05 (s, 3H), 2.00 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 170.5, 170.4, 170.2, 169.4, 167.9, 92.6, 72.4, 72.1, 70.1, 66.4, 63.1, 61.3, 59.4, 50.1, 21.0, 20.8, 20.7.

FT-IR (neat) 3340, 2952, 2921, 2850, 2108, 1746, 1688, 1533, 1457, 1436, 1369, 1218, 1162, 1115, 1072, 1041, 955, 925, 901, 847, 803, 600, 557 cm^{-1}.

HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{18}H_{26}N_4NaO_{11}$: 497.1496, found: 497.1493.



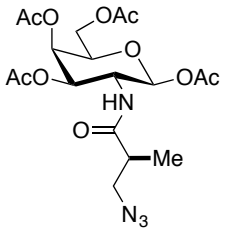
1,3,4,6-Tetra-*O*-acetyl-2-((*R*)-3-azido-2-methylpropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (384 mg, 1.00 mmol) and (*R*)-3-azido-2-methylpropanoic acid[17] (129 mg, 1.00 mmol). The product was purified by column chromatography (12%→100% ethyl acetate/hexanes): 318 mg (69%). White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.08 (d, *J* = 9.5 Hz, 1H), 5.76 (d, *J* = 8.8 Hz, 1H), 5.35 (d, *J* = 2.8 Hz, 1H), 5.15 (dd, *J* = 11.3, 3.4 Hz, 1H), 4.44 (ddd, *J* = 11.3, 9.2, 9.2 Hz, 1H), 4.16–4.03 (m, 3H), 3.48 (dd, *J* = 12.1, 9.1 Hz, 1H), 3.28 (dd, *J* = 12.1, 4.8 Hz, 1H), 2.39–2.32 (m, 1H), 2.14 (s, 3H), 2.11 (s, 3H), 2.02 (s, 3H), 1.97 (s, 3H), 1.06 (d, *J* = 7.0 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 174.2, 170.7, 170.6, 170.3, 169.8, 92.7, 71.9, 70.3, 66.6, 61.6, 53.9, 49.6, 41.4, 20.8, 20.8, 20.6, 15.4.

FT-IR (neat) 3317, 2974, 2937, 2102, 1747, 1665, 1545, 1439, 1369, 1218, 1161, 1118, 1071, 1041, 952, 923, 900, 596 cm^{-1}.

HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{18}H_{26}N_4NaO_{10}$: 481.1547, found: 481.1538.



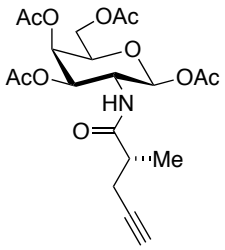
1,3,4,6-Tetra-*O*-acetyl-2-((*S*)-3-azido-2-methylpropanamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (384 mg, 1.00 mmol) and (*S*)-3-azido-2-methylpropanoic acid[14] (129 mg, 1.00 mmol). The product was purified by column chromatography (12%→100% ethyl acetate/hexanes): 328 mg (72%). Light-yellow solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 5.75 (d, *J* = 8.8 Hz, 1H), 5.74 (d, *J* = 9.4 Hz, 1H), 5.38 (dd, *J* = 3.4, 1.1 Hz, 1H), 5.14 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.47 (ddd, *J* = 11.3, 9.1, 9.1 Hz, 1H), 4.19–4.10 (m, 2H), 4.05 (ddd, *J* = 6.5, 6.5, 1.2 Hz, 1H), 3.51 (dd, *J* = 12.0, 9.2 Hz, 1H), 3.32 (dd, *J* = 12.0, 4.7 Hz, 1H), 2.39–2.30 (m, 1H), 2.18 (s, 3H), 2.11 (s, 3H), 2.05 (s, 3H), 2.02 (s, 3H), 1.09 (d, *J* = 7.0 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 174.1, 171.0, 170.6, 170.3, 169.6, 93.1, 72.1, 70.1, 66.5, 61.5, 54.0, 49.9, 41.6, 20.9, 20.8, 20.6, 15.5.

FT-IR (neat) 3312, 2977, 2937, 2102, 1745, 1664, 1545, 1437, 1369, 1216, 1162, 1118, 1071, 1041, 953, 923, 899, 850, 629, 597, 559, 538, 488 cm^{-1}.

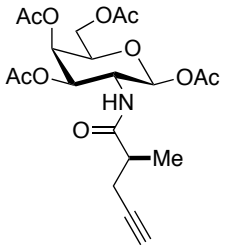
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{18}H_{26}N_4NaO_{10}$: 481.1547, found: 481.1523.



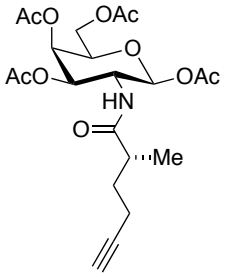
1,3,4,6-Tetra-*O*-acetyl-2-((*R*)-2-methylpent-4-ynamido)-2-deoxy-β-D-galactopyranose. (*R*)-2-Methylpent-4-ynoic acid was prepared according to a literature procedure.[12] The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (312 mg, 0.813 mmol) and (*R*)-2-methylpent-4-ynoic acid (91.0 mg, 0.812 mmol). The product was purified by column chromatography (1st purification: 8%→70% acetone/hexanes; 2nd purification: 12%→100% ethyl acetate/hexanes): 225 mg (63%). White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 5.69 (d, *J* = 8.8 Hz, 1H), 5.49 (d, *J* = 9.6 Hz, 1H), 5.38 (dd, *J* = 3.3, 0.8 Hz, 1H), 5.10 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.52 (ddd, *J* = 11.1, 9.3, 9.3 Hz, 1H), 4.18 (dd, *J* = 11.3, 6.7 Hz, 1H), 4.12 (dd, *J* = 11.3, 6.4 Hz, 1H), 4.02 (ddd, *J* = 6.5, 6.5, 1.0 Hz, 1H), 2.45–2.33 (m, 2H), 2.29 (ddd, *J* = 15.8, 4.9, 2.8 Hz, 1H), 2.17 (s, 3H), 2.12 (s, 3H), 2.05 (s, 3H), 2.01 (s, 3H), 1.98 (dd, *J* = 2.7, 2.7 Hz, 1H), 1.15 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 170.8, 170.5, 170.3, 169.7, 93.1, 81.8, 72.0, 70.5, 70.4, 66.5, 61.4, 49.6, 41.0, 23.2, 21.2, 20.8, 20.8, 17.4.
FT-IR (neat) 3291, 2968, 2919, 2852, 1747, 1663, 1543, 1457, 1432, 1369, 1220, 1162, 1114, 1070, 1042, 956, 923, 898, 710, 675, 659, 643, 630, 595, 536 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{20}H_{27}NNaO_{10}$: 464.1533, found: 464.1520.

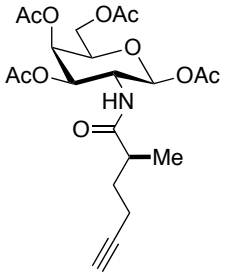


1,3,4,6-Tetra-*O*-acetyl-2-((*S*)-2-methylpent-4-ynamido)-2-deoxy-β-D-galactopyranose. (*S*)-2-Methylpent-4-ynoic acid was prepared according to a literature procedure.[12] The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (472 mg, 1.23 mmol) and (*S*)-2-methylpent-4-ynoic acid (138 mg, 1.23 mmol). The product was purified by column chromatography (1st purification: 12%→100% ethyl acetate/hexanes; 2nd purification: 8%→70% acetone/hexanes): 322 mg (59%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 5.72 (d, *J* = 8.8 Hz, 1H), 5.52 (d, *J* = 9.5 Hz, 1H), 5.38 (dd, *J* = 3.3, 0.7 Hz, 1H), 5.08 (dd, *J* = 11.3, 3.3 Hz, 1H), 4.51 (ddd, *J* = 11.4, 9.2, 9.2 Hz, 1H), 4.18 (dd, *J* = 11.4, 6.7 Hz, 1H), 4.12 (dd, *J* = 11.3, 6.5 Hz, 1H), 4.02 (ddd, *J* = 6.5, 6.5, 1.2 Hz, 1H), 2.45–2.29 (m, 3H), 2.17 (s, 3H), 2.12 (s, 3H), 2.05 (s, 3H), 2.01 (s, 3H), 1.98 (dd, *J* = 2.6, 2.6 Hz, 1H), 1.16 (d, *J* = 6.7 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 170.8, 170.5, 170.3, 169.6, 93.1, 81.8, 72.1, 70.4, 70.4, 66.4, 61.4, 49.6, 40.8, 23.1, 21.0, 20.9, 20.8, 17.4.
FT-IR (neat) 3294, 2967, 2918, 2851, 1748, 1665, 1542, 1458, 1431, 1370, 1221, 1162, 1115, 1073, 1042, 953, 921, 904, 674, 657, 642, 621, 596, 562, 553, 539 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{20}H_{27}NNaO_{10}$: 464.1533, found: 464.1524.

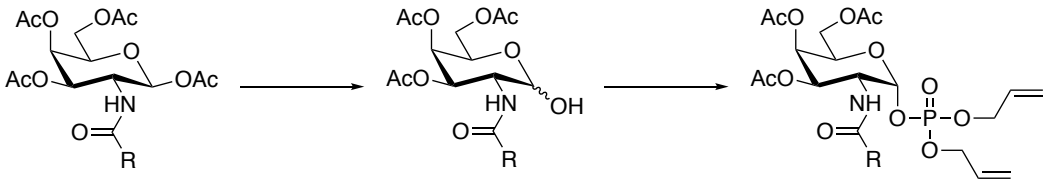


1,3,4,6-Tetra-*O*-acetyl-2-((*R*)-2-methylhex-5-ynamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (255 mg, 0.664 mmol) and (*R*)-2-methylhex-5-ynoic acid (83.7 mg, 0.663 mmol). The product was purified by column chromatography (15%→100% ethyl acetate/hexanes): 208 mg (69%). White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 5.73 (d, *J* = 8.8 Hz, 1H), 5.47 (d, *J* = 9.6 Hz, 1H), 5.38 (dd, *J* = 3.2, 0.6 Hz, 1H), 5.12 (dd, *J* = 11.2, 3.3 Hz, 1H), 4.49 (ddd, *J* = 11.4, 9.3, 9.3 Hz, 1H), 4.17 (dd, *J* = 11.3, 6.7 Hz, 1H), 4.11 (dd, *J* = 11.3, 6.5 Hz, 1H), 4.03 (ddd, *J* = 6.5, 6.5, 0.9 Hz, 1H), 2.43–2.36 (m, 1H), 2.26–2.05 (m, 2H), 2.17 (s, 3H), 2.13 (s, 3H), 2.05 (s, 3H), 2.01 (s, 3H), 1.95 (dd, *J* = 2.7, 2.7 Hz, 1H), 1.83–1.76 (m, 1H), 1.57–1.50 (m, 1H), 1.09 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 176.0, 170.8, 170.6, 170.3, 169.5, 92.8, 83.3, 72.1, 70.6, 69.6, 66.6, 61.4, 49.4, 40.1, 32.0, 21.0, 20.8, 20.7, 18.0, 16.3.
FT-IR (neat) 3285, 3081, 2967, 2936, 1746, 1660, 1541, 1434, 1369, 1217, 1161, 1118, 1070, 1041, 956, 928, 902, 736, 648, 597, 538 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{21}H_{29}NNaO_{10}$: 478.1689, found: 478.1682.

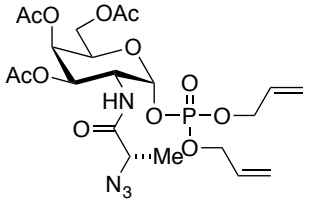


1,3,4,6-Tetra-*O*-acetyl-2-((*S*)-2-methylhex-5-ynamido)-2-deoxy-β-D-galactopyranose. The title compound was prepared from 1,3,4,6-tetra-*O*-acetyl-2-amino-2-deoxy-β-D-galactopyranose hydrochloride (265 mg, 0.690 mmol) and (*S*)-2-methylhex-5-ynoic acid (87.1 mg, 0.690 mmol). The product was purified by column chromatography (15%→100% ethyl acetate/hexanes): 229 mg (73%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 5.73 (d, *J* = 8.8 Hz, 1H), 5.49 (d, *J* = 9.5 Hz, 1H), 5.39 (dd, *J* = 3.2, 0.8 Hz, 1H), 5.08 (dd, *J* = 11.5, 3.3 Hz, 1H), 4.49 (ddd, *J* = 11.5, 9.2, 9.2 Hz, 1H), 4.18 (dd, *J* = 11.4, 6.6 Hz, 1H), 4.12 (dd, *J* = 11.4, 6.5 Hz, 1H), 4.03 (ddd, *J* = 6.5, 6.5, 1.2 Hz, 1H), 2.44–2.36 (m, 1H), 2.25–2.19 (m, 1H), 2.17 (s, 3H), 2.11 (s, 3H), 2.11–2.06 (m, 1H), 2.05 (s, 3H), 2.02 (s, 3H), 1.95 (dd, *J* = 2.7, 2.7 Hz, 1H), 1.82–1.75 (m, 1H), 1.57–1.50 (m, 1H), 1.09 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 176.1, 170.7, 170.5, 170.3, 169.6, 93.3, 83.3, 72.1, 70.3, 69.6, 66.4, 61.5, 49.3, 40.2, 32.0, 20.9, 20.8, 20.8, 18.0, 16.4.
FT-IR (neat) 3287, 2966, 2932, 1745, 1661, 1540, 1434, 1369, 1216, 1162, 1118, 1069, 1040, 957, 920, 902, 733, 647, 597, 537 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{21}H_{29}NNaO_{10}$: 478.1689, found: 478.1689.



Preparation of tri-*O*-acetylated *N*-acetyl-α-D-galactosamine 1-diallyl phosphates (Route 1).

The 1-*O*-acetyl group was deprotected according to a literature procedure,[18] and the crude product was used for the next step without further purification. These compounds were prepared according to a literature procedure.[19]



Diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azidopropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azidopropanamido)-2-deoxy-β-D-galactopyranose (748 mg, 1.86 mmol). The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 701 mg (67%). White solid.

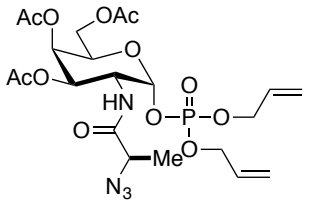
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.01 (d, *J* = 9.0 Hz, 1H), 5.90–5.81 (m, 2H), 5.65 (dd, *J* = 6.3, 3.3 Hz, 1H), 5.39 (dd, *J* = 3.2, 1.3 Hz, 1H), 5.32–5.26 (m, 2H), 5.22–5.18 (m, 2H), 5.15 (dd, *J* = 11.5, 3.2 Hz, 1H), 4.54–4.47 (m, 5H), 4.39 (ddd, *J* = 6.4, 6.4, 0.8 Hz, 1H), 4.07– 3.99 (m, 2H), 3.89 (q, *J* = 7.0 Hz, 1H), 2.07 (s, 3H), 1.94 (s, 3H), 1.89 (s, 3H), 1.39 (d, *J* = 7.0 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 170.9, 170.4, 170.2, 170.0, 132.0 (d, *J* = 6.9 Hz), 131.9 (d, *J* = 6.7 Hz), 118.8, 118.7, 96.4 (d, *J* = 6.7 Hz), 68.6 (d, *J* = 3.7 Hz), 68.5, 67.1, 66.7, 61.4, 58.5, 47.6 (d, *J* = 7.7 Hz), 20.5, 20.5, 17.1.

^{31}P NMR (202 MHz, $CDCl_3$) δ –2.1.

FT-IR (neat) 3270, 3079, 2983, 2114, 1745, 1690, 1529, 1454, 1427, 1371, 1217, 1164, 1137, 1103, 1052, 1018, 990, 945, 675, 647, 626, 601, 558, 531, 474 cm^{-1}.

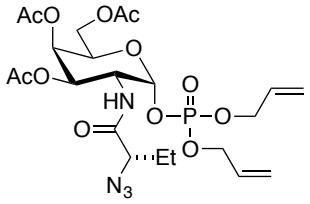
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{21}H_{31}N_4NaO_{12}P$: 585.1574, found: 585.1571.



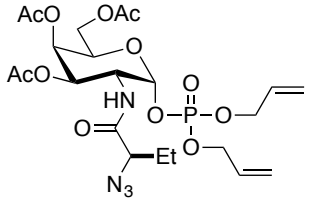
Diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azidopropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azidopropanamido)-2-deoxy-β-D-galactopyranose (277 mg, 0.688 mmol). The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 132 mg (34%). White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.51 (d, *J* = 9.5 Hz, 1H), 6.00–5.90 (m, 2H), 5.76 (dd, *J* = 6.0, 3.4 Hz, 1H), 5.45 (dd, *J* = 3.3, 1.3 Hz, 1H), 5.43–5.37 (m, 2H), 5.33–5.28 (m, 2H), 5.23 (dd, *J* = 11.4, 3.2 Hz, 1H), 4.65–4.57 (m, 5H), 4.42 (ddd, *J* = 6.5, 6.5, 1.4 Hz, 1H),

4.15–4.06 (m, 2H), 4.04 (q, J = 7.1 Hz, 1H), 2.16 (s, 3H), 2.03 (s, 3H), 1.99 (s, 3H), 1.49 (d, J = 7.0 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.7, 170.4, 170.2, 132.1 (d, J = 6.7 Hz), 119.2, 119.0, 96.5 (d, J = 6.1 Hz), 69.0 (d, J = 5.3 Hz), 68.9, 68.8 (d, J = 5.3 Hz), 67.5, 66.9, 61.5, 59.0, 47.8 (d, J = 7.8 Hz), 20.8, 20.8, 20.7, 17.1.
^{31}P NMR (202 MHz, $CDCl_3$) δ –1.4.
FT-IR (neat) 3268, 3083, 2959, 2928, 2854, 2112, 1749, 1691, 1534, 1457, 1427, 1372, 1235, 1164, 1138, 1102, 1052, 1024, 992, 949, 893, 875, 650, 625, 598, 536, 473 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{21}H_{31}N_4NaO_{12}P$: 585.1574, found: 585.1571.

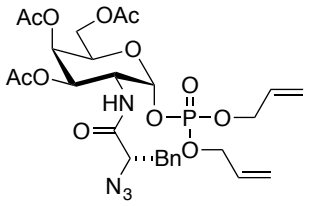


Diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azidobutanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azidobutanamido)-2-deoxy-β-D-galactopyranose (275 mg, 0.660 mmol). The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 124 mg (33%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.20 (d, J = 9.0 Hz, 1H), 5.90–5.82 (m, 2H), 5.64 (dd, J = 6.3, 3.3 Hz, 1H), 5.40 (dd, J = 3.2, 1.3 Hz, 1H), 5.32–5.27 (m, 2H), 5.23–5.19 (m, 2H), 5.16 (dd, J = 11.6, 3.1 Hz, 1H), 4.56 (dddd, J = 12.0, 9.1, 3.2, 3.2 Hz, 1H), 4.53–4.46 (m, 4H), 4.42 (ddd, J = 6.5, 6.5, 1.3 Hz, 1H), 4.78–4.01 (m, 2H), 3.68 (dd, J = 7.3, 5.7 Hz, 1H), 2.07 (s, 3H), 1.95 (s, 3H), 1.88 (s, 3H), 1.86–1.77 (m, 1H), 1.77–1.68 (m, 1H), 0.90 (t, J = 7.4 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.5, 170.4, 170.2, 170.0, 132.0 (d, J = 6.9 Hz), 131.9 (d, J = 6.5 Hz), 118.8, 118.7, 96.6 (d, J = 6.8 Hz), 69.0 (d, J = 5.3 Hz), 68.8, 68.8 (d, J = 5.9 Hz), 67.1, 66.7, 64.5, 61.4, 47.5 (d, J = 7.9 Hz), 25.3, 20.6, 20.5, 20.5, 9.9.
^{31}P NMR (202 MHz, $CDCl_3$) δ –1.5.
FT-IR (neat) 3271, 3077, 2966, 2924, 2852, 2105, 1746, 1688, 1554, 1461, 1427, 1371, 1219, 1164, 1138, 1102, 1052, 1019, 990, 956, 873, 806, 736, 648, 627, 533, 475 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{22}H_{33}N_4NaO_{12}P$: 599.1730, found: 599.1721.

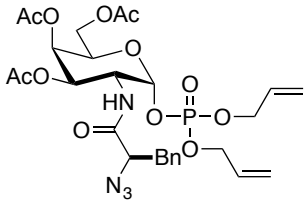


Diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azidobutanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azidobutanamido)-2-deoxy-β-D-galactopyranose (376 mg, 0.903 mmol). The product

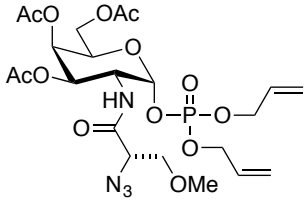
was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 293 mg (56%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.51 (d, *J* = 9.6 Hz, 1H), 6.01–5.91 (m, 2H), 5.76 (dd, *J* = 5.9, 3.4 Hz, 1H), 5.46 (dd, *J* = 3.2, 1.3 Hz, 1H), 5.44–5.38 (m, 2H), 5.33–5.29 (m, 2H), 5.21 (dd, *J* = 11.4, 3.1 Hz, 1H), 4.70–4.58 (m, 5H), 4.42 (ddd, *J* = 6.6, 6.6, 0.7 Hz, 1H), 4.15–4.07 (m, 2H), 4.00 (dd, *J* = 6.2, 4.7 Hz, 1H), 2.17 (s, 3H), 2.03 (s, 3H), 1.98 (s, 3H), 1.96–1.85 (m, 2H), 0.95 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.7, 170.4, 170.2, 169.5, 132.1 (d, *J* = 6.8 Hz), 119.2, 119.0, 96.6 (d, *J* = 6.1 Hz), 69.9 (d, *J* = 5.3 Hz), 68.8, 68.8 (d, *J* = 5.3 Hz), 67.5, 66.9, 65.1, 61.5, 47.6 (d, *J* = 7.8 Hz), 25.1, 20.8, 20.8, 20.8, 9.2.
^{31}P NMR (202 MHz, $CDCl_3$) δ –1.4.
FT-IR (neat) 3274, 3077, 2968, 2927, 2106, 1747, 1689, 1526, 1460, 1427, 1371, 1232, 1164, 1139, 1103, 1021, 991, 942, 875, 808, 677, 649, 626, 593, 535, 471 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{22}H_{33}N_4NaO_{12}P$: 599.1730, found: 599.1723.



Diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azido-3-phenylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azido-3-phenylpropanamido)-2-deoxy-β-D-galactopyranose (325 mg, 0.679 mmol). The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 188 mg (43%). Light-yellow solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39 (d, *J* = 8.9 Hz, 1H), 7.25–7.21 (m, 2H), 7.20–7.16 (m, 3H), 5.89–5.80 (m, 2H), 5.64 (dd, *J* = 6.3, 3.3 Hz, 1H), 5.41 (dd, *J* = 3.1, 1.3 Hz, 1H), 5.32–5.24 (m, 2H), 5.22–5.19 (m, 1H), 5.18–5.14 (m, 2H), 4.57 (dddd, *J* = 11.9, 8.9, 3.1, 3.1 Hz, 1H), 4.53–4.43 (m, 5H), 4.09–4.03 (m, 2H), 3.98 (dd, *J* = 9.5, 4.3 Hz, 1H), 3.14 (dd, *J* = 14.1, 4.3 Hz, 1H), 2.90 (dd, *J* = 14.1, 9.5 Hz, 1H), 2.09 (s, 3H), 1.95 (s, 3H), 1.86 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.3, 170.2, 170.0, 136.4, 132.0 (d, *J* = 7.1 Hz), 131.8 (d, *J* = 6.4 Hz), 129.1, 128.6, 127.1, 118.9, 118.7, 96.5 (d, *J* = 6.9 Hz), 68.6 (d, *J* = 5.5 Hz), 68.6, 68.6 (d, *J* = 5.1 Hz), 67.1, 66.6, 64.5, 61.3, 47.6 (d, *J* = 7.8 Hz), 38.3, 20.6, 20.5, 20.5.
^{31}P NMR (202 MHz, $CDCl_3$) δ –2.5.
FT-IR (neat) 3270, 3076, 3030, 2974, 2116, 1746, 1688, 1559, 1455, 1426, 1371, 1217, 1163, 1140, 1114, 1052, 1017, 987, 940, 876, 805, 731, 700, 647, 626, 601, 590, 556, 529, 482 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{27}H_{35}N_4NaO_{12}P$: 661.1887, found: 661.1890.

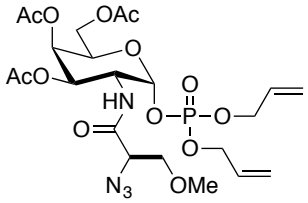


Diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azido-3-phenylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azido-3-phenylpropanamido)-2-deoxy-β-D-galactopyranose (351 mg, 0.734 mmol). The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 172 mg (37%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26–7.21 (m, 2H), 7.19–7.16 (m, 3H), 7.11 (d, *J* = 9.1 Hz, 1H), 5.89–5.78 (m, 2H), 5.67 (dd, *J* = 6.3, 3.3 Hz, 1H), 5.41 (d, *J* = 2.7 Hz, 1H), 5.31–5.24 (m, 2H), 5.20–5.14 (m, 3H), 4.59 (dddd, *J* = 12.1, 9.1, 3.2, 3.2 Hz, 1H), 4.51–4.40 (m, 5H), 4.09–4.02 (m, 3H), 3.22 (dd, *J* = 14.1, 4.0 Hz, 1H), 2.82 (dd, *J* = 14.2, 9.6 Hz, 1H), 2.09 (s, 3H), 1.94 (s, 3H), 1.87 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.4, 170.1, 169.9, 169.5, 136.3, 131.9 (d, *J* = 7.4 Hz), 131.9 (d, *J* = 7.2 Hz), 129.1, 128.5, 127.0, 118.7, 96.3 (d, *J* = 6.6 Hz), 68.6, 68.6 (d, *J* = 5.2 Hz), 68.4 (d, *J* = 5.3 Hz), 67.1, 66.6, 64.7, 61.4, 47.5 (d, *J* = 7.8 Hz), 37.9, 20.5, 20.5, 20.4.
^{31}P NMR (202 MHz, $CDCl_3$) δ –2.2.
FT-IR (neat) 3271, 3073, 3029, 2957, 2111, 1748, 1691, 1535, 1455, 1427, 1371, 1236, 1163, 1140, 1115, 1022, 991, 945, 877, 743, 701, 675, 649, 625, 594, 528, 473 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{27}H_{35}N_4NaO_{12}P$: 661.1887, found: 661.1882.

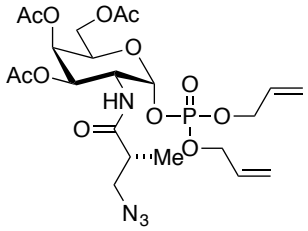


Diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azido-3-methoxypropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azido-3-methoxypropanamido)-2-deoxy-β-D-galactopyranose (268 mg, 0.620 mmol). The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 117 mg (32%). Light-yellow solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.89 (d, *J* = 9.2 Hz, 1H), 5.92–5.83 (m, 2H), 5.65 (dd, *J* = 6.0, 3.3 Hz, 1H), 5.38 (dd, *J* = 3.3, 1.3 Hz, 1H), 5.34–5.28 (m, 2H), 5.24–5.19 (m, 2H), 5.15 (dd, *J* = 11.5, 3.2 Hz, 1H), 4.56–4.47 (m, 5H), 4.36 (dd, *J* = 6.6, 6.6 Hz, 1H), 4.07–3.98 (m, 3H), 3.72 (dd, *J* = 10.2, 3.9 Hz, 1H), 3.60 (dd, *J* = 10.1, 7.0 Hz, 1H), 3.30 (s, 3H), 2.07 (s, 3H), 1.94 (s, 3H), 1.91 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.4, 170.2, 167.0, 167.9, 132.0 (d, *J* = 7.4 Hz), 132.0 (d, *J* = 7.5 Hz) 118.7, 96.3 (d, *J* = 6.4 Hz), 72.6, 68.6 (d, *J* = 5.2 Hz), 68.6 (d, *J* = 5.8 Hz), 68.5, 67.1, 66.7, 62.5, 61.3, 59.1, 47.7 (d, *J* = 8.1 Hz), 20.6, 20.5.

^{31}P NMR (202 MHz, $CDCl_3$) δ –1.4.
FT-IR (neat) 3279, 3078, 2959, 2926, 2855, 2108, 1745, 1688, 1527, 1458, 1427, 1371, 1219, 1163, 1113, 1020, 991, 945, 875, 803, 627, 602, 555, 533, 481 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{22}H_{33}N_4NaO_{13}P$: 615.1679, found: 615.1672.



Diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azido-3-methoxypropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azido-3-methoxypropanamido)-2-deoxy-β-D-galactopyranose (284 mg, 0.657 mmol). The product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 134 mg (34%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.63 (d, *J* = 9.5 Hz, 1H), 6.01–5.91 (m, 2H), 5.77 (dd, *J* = 6.0, 3.4 Hz, 1H), 5.45 (dd, *J* = 3.3, 1.3 Hz, 1H), 5.44–5.38 (m, 2H), 5.33–5.29 (m, 2H), 5.22 (dd, *J* = 11.4, 3.2 Hz, 1H), 4.67–4.58 (m, 5H), 4.42 (ddd, *J* = 6.6, 6.6, 0.8 Hz, 1H), 4.16–4.06 (m, 3H), 3.82 (dd, *J* = 10.2, 3.5 Hz, 1H), 3.73 (dd, *J* = 10.2, 6.2 Hz, 1H), 3.39 (s, 3H), 2.16 (s, 3H), 2.03 (s, 3H), 1.99 (s, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 170.7, 170.4, 170.2, 167.7, 132.1 (d, *J* = 6.7 Hz), 132.1 (d, *J* = 6.9 Hz), 119.2, 119.0, 96.5 (d, *J* = 6.0 Hz), 72.5, 69.0 (d, *J* = 5.4 Hz), 68.9, 68.8 (d, *J* = 5.3 Hz), 67.4, 66.9, 63.1, 61.5, 59.4, 47.8 (d, *J* = 7.9 Hz), 20.8, 20.8, 20.7.
^{31}P NMR (202 MHz, $CDCl_3$) δ –1.4.
FT-IR (neat) 3268, 3081, 2929, 2110, 1748, 1688, 1527, 1459, 1427, 1372, 1234, 1164, 1137, 1115, 1023, 992, 948, 874, 804, 648, 628, 603, 593, 553, 534, 500, 472 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{22}H_{33}N_4NaO_{13}P$: 615.1679, found: 615.1675.



Diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-3-azido-2-methylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. 3,4,6-Tri-*O*-acetyl-2-((*R*)-3-azido-2-methylpropanamido)-2-deoxy-β-D-galactopyranose (148 mg, 0.355 mmol) and 1*H*-tetrazole (74.6 mg, 1.06 mmol) were suspended in toluene (5.0 mL) in a 20-mL vial. The mixture was sonicated for 1 h, and the toluene was removed under reduced pressure. The vial was charged with nitrogen, and dichloromethane (3.5 mL) was added. The resulting mixture was cooled to 0 °C, and then diallyl *N*,*N*-diisopropylphosphoramidite (0.132 mL, 0.499 mmol) was added dropwise over 5 min. The reaction mixture was stirred at 0 °C

for 1 h, and then cooled to –78 °C. 3-Chloroperbenzoic acid (123 mg, 0.711 mmol) was added, and the mixture was stirred at 0 °C for 1 h. The mixture was diluted with dichloromethane (100 mL), washed with aqueous Na_2SO_3 (10%; 50 mL), saturated aqueous $NaHCO_3$ (50 mL), and brine (50 mL), dried over Na_2SO_4, and concentrated. The crude product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 121 mg (59%). White solid.

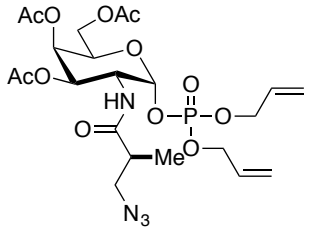
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.89 (d, *J* = 9.2 Hz, 1H), 5.92–5.83 (m, 2H), 5.63 (dd, *J* = 6.2, 3.3 Hz, 1H), 5.39 (dd, *J* = 3.1, 1.3 Hz, 1H), 5.33–5.29 (m, 2H), 5.23–5.20 (m, 2H), 5.16 (dd, *J* = 11.5, 3.1 Hz, 1H), 4.62 (dddd, *J* = 12.1, 9.2, 3.2, 3.2 Hz, 1H), 4.57–4.48 (m, 4H), 4.44 (dd, *J* = 6.6, 6.6 Hz, 1H), 4.08– 4.02 (m, 2H), 3.52 (dd, *J* = 12.1, 7.9 Hz, 1H), 3.20 (dd, *J* = 12.1, 5.9 Hz, 1H), 2.50–2.43 (m, 1H), 2.08 (s, 3H), 1.95 (s, 3H), 1.89 (s, 3H), 1.06 (d, *J* = 7.0 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 174.4, 170.5, 170.3, 170.1, 132.2 (d, *J* = 6.9 Hz), 132.0 (d, *J* = 6.7 Hz), 118.8, 118.7, 97.0 (d, *J* = 7.1 Hz), 68.7, 68.6 (d, *J* = 6.1 Hz), 68.6 (d, *J* = 5.0 Hz), 67.4, 66.8, 61.5, 53.7, 47.3 (d, *J* = 7.6 Hz), 40.7, 20.6, 20.6, 20.5, 15.5.

^{31}P NMR (202 MHz, $CDCl_3$) δ –2.5.

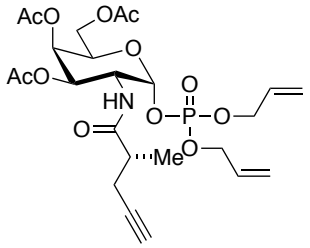
FT-IR (neat) 3280, 3082, 2975, 2938, 2880, 2101, 1745, 1679, 1544, 1458, 1426, 1371, 1216, 1163, 1141, 1109, 1053, 1017, 989, 942, 805, 733, 702, 645, 626, 591, 542, 529, 474 cm^{-1}.

HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{22}H_{33}N_4NaO_{12}P$: 599.1730, found: 599.1715.

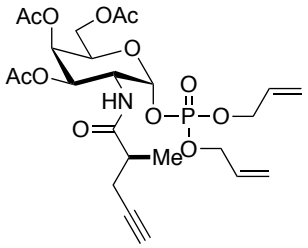


Diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-3-azido-2-methylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. 3,4,6-Tri-*O*-acetyl-2-((*S*)-3-azido-2-methylpropanamido)-2-deoxy-β-D-galactopyranose (247 mg, 0.593 mmol) and 1*H*-tetrazole (125 mg, 1.78 mmol) were suspended in toluene (5.0 mL) in a 20-mL vial. The mixture was sonicated for 1 h, and the toluene was removed under reduced pressure. The vial was charged with nitrogen, and dichloromethane (5.9 mL) was added. The resulting mixture was cooled to 0 °C, and then diallyl *N*,*N*-diisopropylphosphoramidite (0.220 mL, 0.832 mmol) was added dropwise over 5 min. The reaction mixture was stirred at 0 °C for 1 h, and then cooled to –78 °C. 3-Chloroperbenzoic acid (205 mg, 1.19 mmol) was added, and the mixture was stirred at 0 °C for 1 h. The mixture was diluted with dichloromethane (100 mL), washed with aqueous Na_2SO_3 (10%; 50 mL), saturated aqueous $NaHCO_3$ (50 mL), and brine (50 mL), dried over Na_2SO_4, and concentrated. The crude product was purified by column chromatography on silica gel (15%→100% ethyl acetate/hexanes) and then on C-18 silica gel (5%→100% acetonitrile/water): 249 mg (73%). Viscous light-yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.83 (d, *J* = 9.0 Hz, 1H), 5.92–5.80 (m, 2H), 5.63 (dd, *J* = 6.4, 3.3 Hz, 1H), 5.40 (dd, *J* = 3.2, 1.3 Hz, 1H), 5.33–5.27 (m, 2H), 5.24–5.18 (m, 2H), 5.15 (dd, *J* = 11.5, 3.2 Hz, 1H), 4.61 (dddd, *J* = 12.0, 9.0, 3.2, 3.2 Hz, 1H), 4.55–4.46 (m, 4H), 4.43 (dd, *J* = 6.6, 6.6 Hz, 1H), 4.08–4.01 (m, 2H), 3.44 (dd, *J* = 12.0, 8.7 Hz, 1H), 3.21 (dd, *J* = 12.0, 5.4 Hz, 1H), 2.49–2.42 (m, 1H), 2.09 (s, 3H), 1.95 (s, 3H), 1.91 (s, 3H), 1.06 (d, *J* = 7.0 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 174.2, 170.9, 170.4, 170.2, 132.2 (d, *J* = 6.8 Hz), 132.0 (d, *J* = 6.6 Hz), 119.1, 119.1, 97.0 (d, *J* = 6.7 Hz), 68.8 (d, *J* = 5.4 Hz), 68.8, 68.7 (d, *J* = 5.3 Hz), 67.3, 66.9, 61.6, 54.1, 47.6 (d, *J* = 7.6 Hz), 41.0, 20.8, 20.7, 20.6, 15.3.
^{31}P NMR (202 MHz, $CDCl_3$) δ –2.4.
FT-IR (neat) 3283, 3085, 2975, 2938, 2876, 2100, 1746, 1680, 1542, 1458, 1427, 1372, 1232, 1163, 1141, 1110, 1052, 1021, 991, 948, 888, 711, 676, 650, 626, 603, 526, 477 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{22}H_{33}N_4NaO_{12}P$: 599.1730, found: 599.1720.



Diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-methylpent-4-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*R*)-2-methylpent-4-ynamido)-2-deoxy-β-D-galactopyranose (148 mg, 0.371 mmol). The product was purified by column chromatography (12%→100% ethyl acetate/hexanes): 179 mg (86%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.53 (d, *J* = 9.2 Hz, 1H), 5.93–5.83 (m, 2H), 5.65 (dd, *J* = 6.0, 3.3 Hz, 1H), 5.40 (dd, *J* = 3.2, 1.3 Hz, 1H), 5.35–5.30 (m, 2H), 5.25–5.21 (m, 2H), 5.16 (dd, *J* = 11.5, 3.1 Hz, 1H), 4.63 (dddd, *J* = 12.2, 9.3, 3.2, 3.2 Hz, 1H), 4.55–4.50 (m, 4H), 4.41 (dd, *J* = 6.7, 6.7 Hz, 1H), 4.01–4.01 (m, 2H), 2.45–2.38 (m, 2H), 2.27–2.21 (m, 1H), 2.09 (s, 3H), 1.98 (dd, *J* = 2.5, 2.5 Hz, 1H), 1.96 (s, 3H), 1.90 (s, 3H), 1.13 (d, *J* = 6.6 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 175.2, 170.6, 170.3, 170.1, 132.2 (d, *J* = 6.8 Hz), 132.0 (d, *J* = 6.7 Hz), 119.0, 118.9, 97.1 (d, *J* = 6.9 Hz), 81.8, 70.2, 68.7 (d, *J* = 5.3 Hz), 68.7, 68.6 (d, *J* = 5.3 Hz), 67.4, 66.9, 61.5, 47.2 (d, *J* = 7.8 Hz), 40.0, 22.6, 20.7, 20.6, 20.6, 17.1.
^{31}P NMR (202 MHz, $CDCl_3$) δ –2.1.
FT-IR (neat) 3296, 2973, 2251, 1746, 1674, 1542, 1459, 1426, 1371, 1232, 1163, 1140, 1103, 1053, 1018, 988, 947, 907, 726, 646, 593, 552, 527, 473 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{24}H_{34}NNaO_{12}P$: 582.1716, found: 582.1708.



Diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-methylpent-4-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*S*)-2-methylpent-4-ynamido)-2-deoxy-β-D-galactopyranose (219 mg, 0.548 mmol). The product was purified by column chromatography on silica gel (12%→100% ethyl acetate/hexanes) and then on C-18 silica gel (10%→100% acetonitrile/water): 234 mg (76%). Viscous colorless oil.

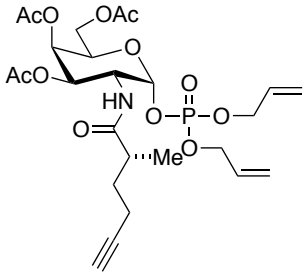
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.44 (d, *J* = 9.2 Hz, 1H), 5.94–5.83 (m, 2H), 5.65 (dd, *J* = 6.1, 3.3 Hz, 1H), 5.40 (d, *J* = 2.3 Hz, 1H), 5.36–5.29 (m, 2H), 5.26–5.20 (m, 2H), 5.13 (dd, *J* = 11.5, 3.2 Hz, 1H), 4.64 (dddd, *J* = 12.2, 9.3, 3.2, 3.2 Hz, 1H), 4.56–4.49 (m, 4H), 4.40 (dd, *J* = 6.5, 6.5 Hz, 1H), 4.09–4.02 (m, 2H), 2.44–2.34 (m, 2H), 2.27–2.19 (m, 1H), 2.10 (s, 3H), 1.96 (s, 3H), 1.94 (dd, *J* = 2.7, 2.7 Hz, 1H), 1.91 (s, 3H), 1.14 (d, *J* = 6.4 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 175.0, 170.6, 170.3, 170.2, 132.1 (d, *J* = 6.7 Hz), 132.0 (d, *J* = 6.7 Hz), 119.0, 119.0, 97.0 (d, *J* = 6.8 Hz), 81.9, 70.1, 68.7 (d, *J* = 5.3 Hz), 68.7, 68.6 (d, *J* = 5.4 Hz), 67.5, 66.8, 61.5, 47.2 (d, *J* = 7.8 Hz), 40.1, 23.0, 20.8, 20.7, 20.6, 17.0.

^{31}P NMR (202 MHz, $CDCl_3$) δ –2.0.

FT-IR (neat) 3281, 2976, 2938, 2248, 1745, 1676, 1540, 1459, 1426, 1371, 1219, 1164, 1139, 1104, 1052, 1018, 989, 945, 910, 728, 645, 600, 591, 526, 481 cm^{-1}.

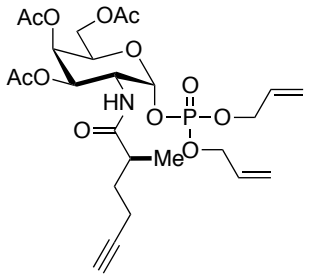
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{24}H_{34}NNaO_{12}P$: 582.1716, found: 582.1702.



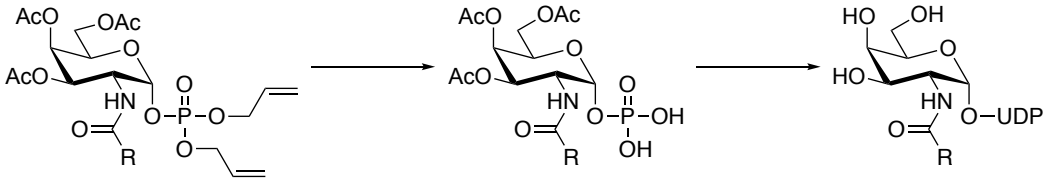
Diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-methylhex-5-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*R*)-2-methylhex-5-ynamido)-2-deoxy-β-D-galactopyranose (150 mg, 0.363 mmol). The product was purified by column chromatography (15%→100% ethyl acetate/hexanes): 173 mg (83%). White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.29 (d, *J* = 9.2 Hz, 1H), 5.93–5.84 (m, 2H), 5.64 (dd, *J* = 5.8, 3.3 Hz, 1H), 5.39 (dd, *J* = 3.3, 1.4 Hz, 1H), 5.35–5.29 (m, 2H), 5.24–5.20 (m, 2H), 5.15 (dd, *J* = 11.5, 3.1 Hz, 1H), 4.63 (dddd, *J* = 12.6, 9.4, 3.3, 3.3 Hz, 1H), 4.57–4.48 (m, 4H), 4.39 (ddd, *J* = 6.4, 6.4, 1.2 Hz, 1H), 4.09–4.00 (m, 2H), 2.40–2.33 (m, 1H), 2.17–

2.06 (m, 2H), 2.09 (s, 3H), 1.96 (s, 3H), 1.91 (s, 3H), 1.90 (dd, J = 2.7, 2.7 Hz, 1H), 1.85–1.78 (m, 1H), 1.53–1.46 (m, 1H), 1.04 (d, J = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 176.3, 170.6, 170.3, 170.1, 132.2 (d, J = 6.6 Hz), 132.0 (d, J = 6.6 Hz), 118.9, 118.8, 97.1 (d, J = 6.9 Hz), 83.5, 69.1, 68.6 (d, J = 5.1 Hz), 68.6, 68.6 (d, J = 6.3 Hz), 67.5, 66.9, 61.5, 47.2 (d, J = 8.0 Hz), 39.8, 31.9, 20.7, 20.6, 20.6, 17.6, 16.3.
^{31}P NMR (202 MHz, $CDCl_3$) δ –1.9.
FT-IR (neat) 3287, 2966, 2935, 1745, 1676, 1535, 1459, 1428, 1371, 1218, 1162, 1138, 1109, 1054, 1017, 990, 943, 808, 734, 627, 600, 527, 472 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{25}H_{36}NNaO_{12}P$: 596.1873, found: 596.1866.

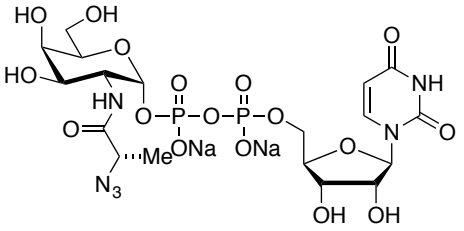


Diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-methylhex-5-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate. The title compound was prepared from 3,4,6-tri-*O*-acetyl-2-((*S*)-2-methylhex-5-ynamido)-2-deoxy-β-D-galactopyranose (169 mg, 0.409 mmol). The product was purified by column chromatography (15%→100% ethyl acetate/hexanes): 185 mg (79%). White solid.
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.36 (d, J = 9.1 Hz, 1H), 5.92–5.82 (m, 2H), 5.64 (dd, J = 6.2, 3.3 Hz, 1H), 5.39 (dd, J = 3.2, 1.3 Hz, 1H), 5.34–5.28 (m, 2H), 5.24–5.19 (m, 2H), 5.12 (dd, J = 11.6, 3.1 Hz, 1H), 4.62 (dddd, J = 12.1, 9.1, 3.2, 3.2 Hz, 1H), 4.54–4.47 (m, 4H), 4.38 (ddd, J = 6.5, 6.5, 1.4 Hz, 1H), 4.08–4.01 (m, 2H), 2.41–2.34 (m, 1H), 2.17–2.07 (m, 1H), 2.09 (s, 3H), 2.06–1.99 (m, 1H), 1.95 (s, 3H), 1.92 (s, 3H), 1.89 (dd, J = 2.6, 2.6 Hz, 1H), 1.79–1.70 (m, 1H), 1.52–1.46 (m, 1H), 1.05 (d, J = 6.8 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 176.1, 170.5, 170.3, 170.1, 132.2 (d, J = 6.8 Hz), 132.0 (d, J = 6.6 Hz), 118.9, 118.8, 97.0 (d, J = 6.9 Hz), 83.3, 69.3, 68.6 (d, J = 6.5 Hz), 68.6, 68.6 (d, J = 7.0 Hz), 67.3, 66.7, 61.5, 47.0 (d, J = 7.7 Hz), 39.6, 32.4, 20.7, 20.6, 17.4, 16.2.
^{31}P NMR (202 MHz, $CDCl_3$) δ –2.1.
FT-IR (neat) 3283, 3079, 2967, 2937, 1745, 1676, 1540, 1458, 1428, 1371, 1217, 1163, 1139, 1110, 1052, 1017, 990, 944, 807, 734, 711, 642, 627, 601, 528, 472, 433 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{25}H_{36}NNaO_{12}P$: 596.1873, found: 596.1861.



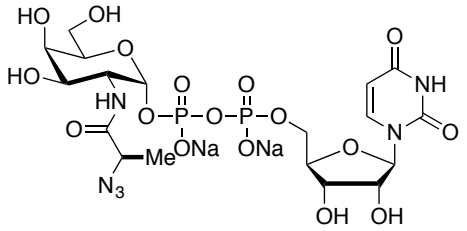
Representative procedure for the preparation of UDP-*N*-acetyl-α-D-galactosamine derivatives (Route 1)

Tri-*O*-acetylated *N*-acetyl-α-D-galactosamine 1-phosphate derivatives were prepared from tri-*O*-acetylated *N*-acetyl-α-D-galactosamine 1-diallyl phosphates according to a literature procedure.[19] Then, UDP-sugars were prepared using a modified literature procedure.[19,20] A mixture of the sugar 1-phosphate (0.200 mmol), uridine 5′-monophosphomorpholidate 4-morpholine-*N*,*N*′-dicyclohexylcarboxamidine salt (224 mg, 0.326 mmol), 1-methylimidazole hydrochloride (128 mg, 1.08 mmol), and NEt_3 (55.8 μL, 0.400 mmol) in DMF (3.92 mL) in a 25-mL round-bottom flask was stirred at r.t. for 12 h. The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$) and then preparative HPLC on C-18 silica gel (MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). Aqueous *n*-$Bu_3NH{\bullet}HCO_3$ solution (10 mM) was prepared by bubbling CO_2 through a solution of *n*-Bu_3NH (10 mM) in water until all *n*-Bu_3NH dissolved into the water. Pure fractions were collected, concentrated, redissolved in water (100 mL), rinsed with CH_2Cl_2 (3 x 50 mL), and concentrated. The compound was dissolved in MeOH/water/NEt_3 (5 mL, 5:2:1) in a 25-mL round-bottom flask, and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on C-18 silica gel (MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). Pure fractions were collected, concentrated, redissolved in water (100 mL), rinsed with CH_2Cl_2 (3 x 50 mL), and concentrated. Finally, the purified compound was passed through a Bio-Rad AG® 50W-X8 resin (sodium form) and lyophilized.

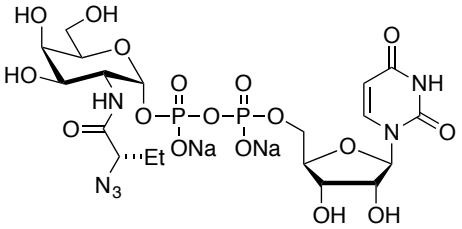


UDP-Sugar (*S*)-3. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azidopropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (415 mg, 0.738 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$) and then preparative HPLC on C-18 silica gel (10%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 36.8 min): 148 mg (28%). White solid.

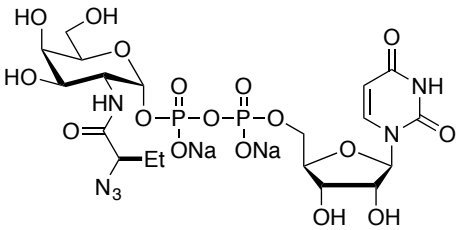
^{1}H NMR (500 MHz, D_2O) δ 7.94 (d, *J* = 8.1 Hz, 1H), 5.97–5.94 (m, 2H), 5.56 (dd, *J* = 7.0, 3.4 Hz, 1H), 4.37–4.33 (m, 2H), 4.29–4.21 (m, 4H), 4.21–4.15 (m, 2H), 4.04 (d, *J* = 3.0 Hz, 1H), 3.98 (dd, *J* = 11.0, 3.2 Hz, 1H), 3.79–3.72 (m, 2H), 1.47 (d, *J* = 7.1 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 175.0, 166.8, 152.4, 142.3, 103.2, 95.3 (d, *J* = 6.2 Hz), 89.2, 83.8 (d, *J* = 9.0 Hz), 74.4, 72.7, 70.2, 69.1, 68.1, 65.6 (d, *J* = 4.9 Hz), 61.6, 58.8, 50.5 (d, *J* = 8.6 Hz), 17.5.
^{31}P NMR (202 MHz, D_2O) δ –10.5 (d, *J* = 20.8 Hz), –12.3 (d, *J* = 20.8 Hz).
FT-IR (neat) 3234, 2115, 1665, 1544, 1468, 1425, 1392, 1342, 1227, 1114, 1076, 1037, 985, 916, 861, 814, 780, 766, 717, 685, 620, 533, 503, 492, 444 cm^{-1}.
HRMS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{18}H_{27}N_6Na_2O_{17}P_2$: 707.0703, found: 707.0706.



UDP-Sugar (*R*)-3. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azidopropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (132 mg, 0.235 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on C-18 silica gel (10%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent Microsorb 100-5 C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 51.4 min): 53.6 mg (32%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.93 (d, *J* = 8.1 Hz, 1H), 5.97–5.93 (m, 2H), 5.54 (dd, *J* = 7.1, 3.5 Hz, 1H), 4.37–4.32 (m, 2H), 4.28–4.23 (m, 2H), 4.23–4.15 (m, 4H), 4.03 (d, *J* = 3.1 Hz, 1H), 3.98 (dd, *J* = 10.9, 3.2 Hz, 1H), 3.78–3.71 (m, 2H), 1.47 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 174.8, 167.3, 152.7, 142.2, 103.3, 95.1 (d, *J* = 6.2 Hz), 89.2, 83.7 (d, *J* = 9.0 Hz), 74.4, 72.7, 70.2, 69.0, 67.9, 65.6 (d, *J* = 4.9 Hz), 61.6, 58.8, 50.6 (d, *J* = 8.2 Hz), 17.1.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 20.6 Hz), –12.3 (d, *J* = 20.7 Hz).
FT-IR (neat) 3254, 2115, 1669, 1536, 1464, 1426, 1391, 1346, 1232, 1116, 1078, 1037, 984, 921, 858, 814, 779, 718, 689, 630, 506 cm^{-1}.
HRMS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{18}H_{27}N_6Na_2O_{17}P_2$: 707.0703, found: 707.0699.

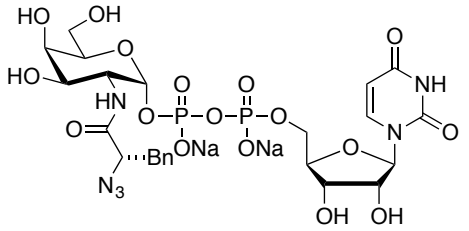


UDP-Sugar (*S*)-4. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azidobutanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (124 mg, 0.215 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$) and then preparative HPLC on C-18 silica gel (10%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent Microsorb 100-5 C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 53.5 min): 70.1 mg (45%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.92 (d, *J* = 8.1 Hz, 1H), 5.97–5.92 (m, 2H), 5.55 (dd, *J* = 6.9, 3.5 Hz, 1H), 4.36–4.32 (m, 2H), 4.30–4.14 (m, 5H), 4.09 (dd, *J* = 6.6, 6.6 Hz, 1H), 4.02 (d, *J* = 3.2 Hz, 1H), 3.95 (dd, *J* = 11.0, 3.2 Hz, 1H), 3.78–3.71 (m, 2H), 1.89–1.75 (m, 2H), 0.96 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 174.2, 167.4, 152.8, 142.2, 103.3, 95.4 (d, *J* = 6.6 Hz), 89.2, 83.7 (d, *J* = 9.1 Hz), 74.4, 72.7, 70.3, 69.2, 68.0, 65.6 (d, *J* = 5.4 Hz), 64.6, 61.6, 50.5 (d, *J* = 8.6 Hz), 25.7, 9.8.
^{31}P NMR (202 MHz, D_2O) δ –10.5 (d, *J* = 20.8 Hz), –12.3 (d, *J* = 20.2 Hz).
FT-IR (neat) 3294, 2107, 1671, 1537, 1465, 1427, 1392, 1238, 1118, 1080, 1053, 987, 919, 855, 814, 779, 714, 685, 611, 504, 438 cm^{-1}.
HRMS (ESI) *m/z* ($[M+H]^+$) calcd for $C_{19}H_{29}N_6Na_2O_{17}P_2$: 721.0860, found: 721.0852.

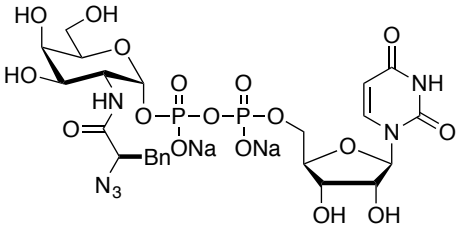


UDP-Sugar (*R*)-4. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azidobutanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (293 mg, 0.508 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$) and then preparative HPLC on C-18 silica gel (10%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent Microsorb 100-5 C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 53.8 min): 113 mg (31%). White solid.

^{1}H NMR (500 MHz, D_2O) δ 7.95 (d, *J* = 8.2 Hz, 1H), 5.97–5.95 (m, 2H), 5.56 (dd, *J* = 6.8, 3.5 Hz, 1H), 4.38–4.34 (m, 2H), 4.31–4.16 (m, 5H), 4.07–4.03 (m, 2H), 4.00 (dd, *J* = 10.9, 3.1 Hz, 1H), 3.80–3.72 (m, 2H), 1.94–1.76 (m, 2H), 0.98 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 174.0, 166.8, 152.3, 142.3, 103.2, 95.2 (d, *J* = 5.7 Hz), 89.2, 83.7 (d, *J* = 8.9 Hz), 74.4, 72.6, 70.2, 69.0, 67.9, 65.5 (d, *J* = 3.8 Hz), 64.7, 61.6, 50.5 (d, *J* = 8.5 Hz), 25.3, 9.9.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 20.8 Hz), –12.4 (d, *J* = 20.6 Hz).
FT-IR (neat) 3232, 2109, 1669, 1464, 1429, 1391, 1232, 1115, 1079, 1038, 987, 918, 811, 717, 687, 511, 444, 425 cm^{-1}.
HRMS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{19}H_{29}N_6Na_2O_{17}P_2$: 721.0860, found: 721.0860.



UDP-Sugar (*S*)-5. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azido-3-phenylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (188 mg, 0.294 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent Microsorb 100-5 C18 column (MeOH/water (min:%): 0:0, 10:0, 60:50; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 52.4 min): 107 mg (46%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.86 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.37–7.32 (m, 4H), 7.32–7.27 (m, 1H), 5.90 (d, *J* = 3.5 Hz, 1H), 5.85 (d, *J* = 8.0 Hz, 1H), 5.56 (dd, *J* = 7.1, 3.4 Hz, 1H), 4.43 (dd, *J* = 9.2, 5.3 Hz, 1H), 4.32–4.13 (m, 7H), 4.01 (d, *J* = 2.5 Hz, 1H), 3.94 (dd, *J* = 11.1, 3.0 Hz, 1H), 3.79–3.70 (m, 2H), 3.20 (dd, *J* = 14.1, 5.1 Hz, 1H), 3.01 (dd, *J* = 14.0, 9.4 Hz, 1H).
^{13}C NMR (126 MHz, D_2O) δ 173.6, 166.9, 152.4, 142.2, 137.2, 130.1, 129.4, 127.9, 103.2, 95.4 (d, *J* = 5.3 Hz), 89.2, 83.8 (d, *J* = 9.3 Hz), 74.5, 72.8, 70.3, 69.2, 68.2, 65.7 (d, *J* = 4.9 Hz), 64.6, 61.7, 50.6 (d, *J* = 8.6 Hz), 38.5.
^{31}P NMR (202 MHz, D_2O) δ –10.5 (d, *J* = 21.4 Hz), –12.2 (d, *J* = 20.6 Hz).
FT-IR (neat) 3250, 2115, 1670, 1539, 1458, 1426, 1394, 1338, 1235, 1113, 1079, 1052, 987, 921, 859, 812, 742, 700, 621, 501 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{24}H_{30}N_6Na_3O_{17}P_2$: 805.0836, found: 805.0833.



UDP-Sugar (*R*)-5. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azido-3-phenylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (172 mg, 0.269 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent Microsorb 100-5 C18 column (MeOH/water (min:%): 0:0, 10:0, 60:50; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 51.5 min): 52.2 mg (25%). White solid.

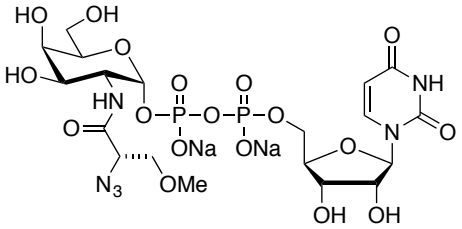
^{1}H NMR (500 MHz, D_2O) δ 7.80 (d, *J* = 8.0 Hz, 1H), 7.40–7.25 (m, 5H), 5.85 (d, *J* = 3.3 Hz, 1H), 5.80 (d, *J* = 8.2 Hz, 1H), 5.54 (dd, *J* = 6.8, 3.4 Hz, 1H), 4.38 (dd, *J* = 10.0, 4.2 Hz, 1H), 4.30–4.17 (m, 6H), 4.17–4.11 (m, 1H), 4.04 (d, *J* = 3.1 Hz, 1H), 3.98 (dd, *J* = 11.0, 3.0 Hz, 1H), 3.80–3.71 (m, 2H), 3.27 (dd, *J* = 14.2, 4.2 Hz, 1H), 2.98 (dd, *J* = 14.2, 10.0 Hz, 1H).

^{13}C NMR (126 MHz, D_2O) δ 173.4, 166.9, 152.3, 142.2, 137.2, 130.0, 129.4, 127.8, 103.2, 95.3 (d, *J* = 5.9 Hz), 89.4, 83.7 (d, *J* = 9.0 Hz), 74.4, 72.8, 70.2, 69.1, 68.2, 65.8 (d, *J* = 4.8 Hz), 64.6, 61.7, 50.7 (d, *J* = 8.4 Hz), 38.0.

^{31}P NMR (202 MHz, D_2O) δ –10.5 (d, *J* = 20.8 Hz), –12.4 (d, *J* = 21.4 Hz).

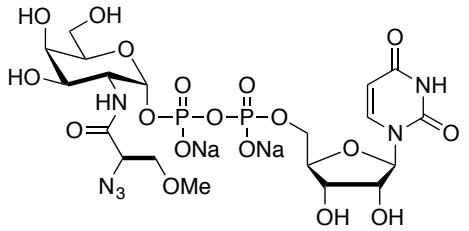
FT-IR (neat) 3294, 2114, 1665, 1543, 1459, 1425, 1390, 1342, 1232, 1112, 1079, 1053, 986, 921, 861, 812, 741, 699, 626, 510 cm^{-1}.

HRMS (ESI) *m/z* ($[M+H]^+$) calcd for $C_{24}H_{31}N_6Na_2O_{17}P_2$: 783.1016, found: 783.1027.

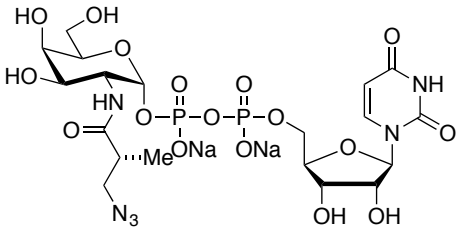


UDP-Sugar (*S*)-6. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-azido-3-methoxypropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (117 mg, 0.197 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$) and then preparative HPLC on C-18 silica gel (10%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent Microsorb 100-5 C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 52.4 min): 72.5 mg (50%). White solid.

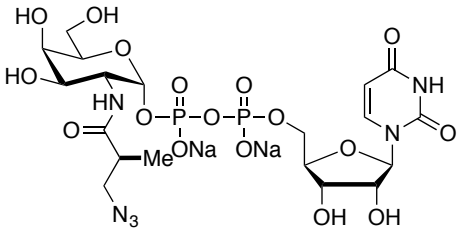
^{1}H NMR (500 MHz, D_2O) δ 7.94 (d, J = 8.1 Hz, 1H), 5.98–5.93 (m, 2H), 5.56 (dd, J = 6.9, 3.0 Hz, 1H), 4.50–4.46 (m, 1H), 4.38–4.32 (m, 2H), 4.31–4.15 (m, 5H), 4.03 (d, J = 3.2 Hz, 1H), 3.98 (dd, J = 10.9, 2.8 Hz, 1H), 3.84–3.70 (m, 4H), 3.41 (s, 3H).
^{13}C NMR (126 MHz, D_2O) δ 171.3, 166.8, 152.4, 142.3, 103.2, 95.2 (d, J = 6.4 Hz), 89.2, 83.8 (d, J = 9.1 Hz), 74.4, 72.8, 72.7, 70.2, 69.1, 68.0, 65.7 (d, J = 5.0 Hz), 62.7, 61.6, 59.2, 50.6 (d, J = 8.6 Hz).
^{31}P NMR (202 MHz, D_2O) δ –10.4 (d, J = 19.4 Hz), –12.2 (d, J = 17.8 Hz).
FT-IR (neat) 3250, 2111, 1670, 1539, 1466, 1427, 1392, 1234, 1111, 1079, 1056, 986, 920, 854, 812, 766, 715, 690, 625, 512 cm^{-1}.
HRMS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{19}H_{29}N_6Na_2O_{18}P_2$: 737.0809, found: 737.0800.



UDP-Sugar (*R*)-6. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-azido-3-methoxypropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (133 mg, 0.224 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on C-18 silica gel (10%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent Microsorb 100-5 C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 52.4 min): 48.7 mg (29%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.95 (d, J = 8.1 Hz, 1H), 5.99–5.94 (m, 2H), 5.56 (dd, J = 6.4, 2.9 Hz, 1H), 4.44 (dd, J = 6.4, 3.9 Hz, 1H), 4.39–4.33 (m, 2H), 4.31–4.16 (m, 5H), 4.04 (d, J = 3.1 Hz, 1H), 4.01 (dd, J = 11.0, 2.6 Hz, 1H), 3.90–3.70 (m, 4H), 3.42 (s, 3H).
^{13}C NMR (126 MHz, D_2O) δ 171.2, 168.7, 153.8, 142.1, 103.3, 95.1 (d, J = 6.4 Hz), 89.3, 83.7 (d, J = 9.0 Hz), 74.4, 72.7, 72.3, 70.3, 69.0, 67.9, 65.7 (d, J = 5.3 Hz), 62.8, 61.6, 59.3, 50.74 (d, J = 8.3 Hz).
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, J = 20.8 Hz), –12.3 (d, J = 20.8 Hz).
FT-IR (neat) 3246, 2109, 1668, 1466, 1427, 1391, 1232, 1110, 1079, 1056, 986, 917, 857, 813, 768, 714, 688, 624, 506 cm^{-1}.
HRMS (ESI) *m/z* ([M+Na]$^+$) calcd for $C_{19}H_{28}N_6Na_3O_{18}P_2$: 759.0628, found: 759.0619.

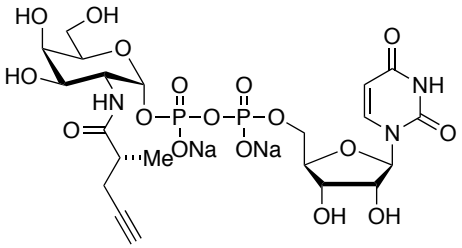


UDP-Sugar (*R*)-8. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-3-azido-2-methylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (67.0 mg, 0.116 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on C-18 silica gel (40%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 39.9 min): 18.8 mg (22%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.92 (d, *J* = 8.1 Hz, 1H), 5.97–5.92 (m, 2H), 5.53 (dd, *J* = 6.8, 3.4 Hz, 1H), 4.36–4.32 (m, 2H), 4.30–4.14 (m, 5H), 4.01 (d, *J* = 3.1 Hz, 1H), 3.95 (dd, *J* = 10.9, 3.2 Hz, 1H), 3.77–3.69 (m, 2H), 3.52 (dd, *J* = 12.4, 8.2 Hz, 1H), 3.36 (dd, *J* = 12.4, 5.8 Hz, 1H), 2.85–2.77 (m, 1H), 1.14 (d, *J* = 7.0 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 178.7, 168.3, 153.5, 142.2, 103.3, 95.6 (d, *J* = 6.5 Hz), 89.2, 83.8 (d, *J* = 8.9 Hz), 74.4, 72.7, 70.3, 69.2, 68.3, 65.7 (d, *J* = 5.4 Hz), 61.6, 54.1, 50.3 (d, *J* = 8.7 Hz), 41.0, 15.4.
^{31}P NMR (202 MHz, D_2O) δ –10.5 (d, *J* = 20.8 Hz), –12.4 (d, *J* = 20.8 Hz).
FT-IR (neat) 3263, 2105, 1671, 1549, 1464, 1430, 1391, 1350, 1235, 1115, 1080, 1058, 1035, 986, 921, 814, 717, 697, 617, 513 cm^{-1}.
HRMS (ESI) *m/z* ($[M+H]^+$) calcd for $C_{19}H_{29}N_6Na_2O_{17}P_2$: 721.0860, found: 721.0845.

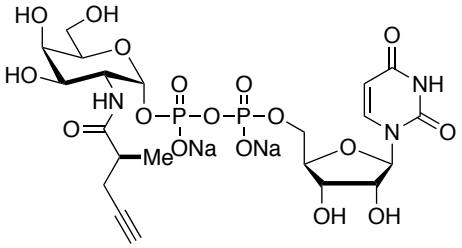


UDP-Sugar (*S*)-8. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-3-azido-2-methylpropanamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (48.3 mg, 0.0838 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on C-18 silica gel (40%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 41.2 min): 14.4 mg (24%). White solid.

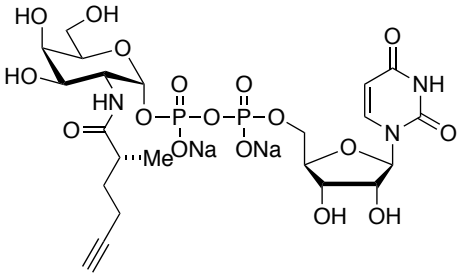
^{1}H NMR (500 MHz, D_2O) δ 7.96 (d, *J* = 8.1 Hz, 1H), 5.99–5.95 (m, 2H), 5.54 (dd, *J* = 7.1, 3.4 Hz, 1H), 4.39–4.34 (m, 2H), 4.31–4.16 (m, 5H), 4.04 (d, *J* = 3.2 Hz, 1H), 3.98 (dd, *J* = 10.9, 2.9 Hz, 1H), 3.80–3.69 (m, 2H), 3.49 (dd, *J* = 12.3, 9.1 Hz, 1H), 3.41 (dd, *J* = 12.4, 5.4 Hz, 1H), 2.86–2.77 (m, 1H), 1.16 (d, *J* = 7.0 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 178.8, 167.1, 152.6, 142.3, 103.3, 95.4 (d, *J* = 6.1 Hz), 89.2, 83.9 (d, *J* = 9.3 Hz), 74.4, 72.7, 70.3, 69.1, 68.2, 65.6 (d, *J* = 4.1 Hz), 61.7, 54.2, 50.4 (d, *J* = 8.2 Hz), 41.0, 15.4.
^{31}P NMR (202 MHz, D_2O) δ –10.5 (d, *J* = 20.8 Hz), –12.3 (d, *J* = 21.2 Hz).
FT-IR (neat) 3276, 2106, 1673, 1548, 1465, 1427, 1392, 1347, 1235, 1115, 1079, 1058, 1035, 986, 919, 814, 782, 768, 714, 696, 643, 625, 509 cm^{-1}.
HRMS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{19}H_{29}N_6Na_2O_{17}P_2$: 721.0860, found: 721.0853.



UDP-Sugar (*R*)-12. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-methylpent-4-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (64.6 mg, 0.115 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on C-18 silica gel (30%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 38.8 min): 44.8 mg (55%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.94 (d, *J* = 8.0 Hz, 1H), 5.97–5.93 (m, 2H), 5.51 (dd, *J* = 6.5, 3.4 Hz, 1H), 4.37–4.33 (m, 2H), 4.30–4.15 (m, 5H), 4.03 (d, *J* = 3.0 Hz, 1H), 3.96 (dd, *J* = 11.0, 3.2 Hz, 1H), 3.78–3.69 (m, 2H), 2.75 (apparent sextet, *J* = 7.0 Hz, 1H), 2.47–2.31 (m, 3H), 1.18 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 179.7, 167.7, 153.0, 142.2, 103.3, 95.7 (d, *J* = 6.5 Hz), 89.1, 83.8 (d, *J* = 9.5 Hz), 83.2, 74.4, 72.7, 71.6, 70.3, 69.1, 68.2, 65.6 (d, *J* = 4.6 Hz), 61.6, 50.2 (d, *J* = 9.0 Hz), 40.2, 23.0, 17.1.
^{31}P NMR (202 MHz, D_2O) δ –10.5 (d, *J* = 20.8 Hz), –12.5 (d, *J* = 20.8 Hz).
FT-IR (neat) 3274, 1672, 1539, 1463, 1428, 1394, 1339, 1241, 1117, 1078, 1054, 986, 919, 814, 780, 714, 690, 655, 628, 513 cm^{-1}.
HRMS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{21}H_{30}N_3Na_2O_{17}P_2$: 704.0846, found: 704.0848.

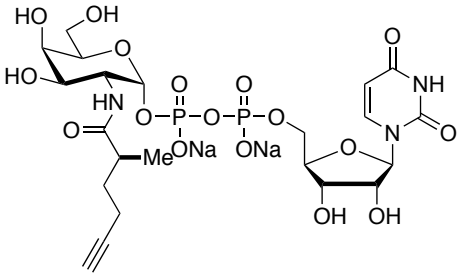


UDP-Sugar (*S*)-12. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-methylpent-4-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (59.0 mg, 0.105 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on C-18 silica gel (30%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 39.1 min): 38.0 mg (51%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.93 (d, *J* = 8.1 Hz, 1H), 5.97–5.93 (m, 2H), 5.52 (dd, *J* = 7.0, 3.4 Hz, 1H), 4.36–4.32 (m, 2H), 4.29–4.15 (m, 5H), 4.02 (d, *J* = 3.2 Hz, 1H), 3.95 (dd, *J* = 11.0, 3.2 Hz, 1H), 3.78–3.69 (m, 2H), 2.79–2.71 (m, 1H), 2.46–2.39 (m, 1H), 2.36–2.30 (m, 2H), 1.18 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 179.7, 167.8, 153.1, 142.2, 103.3, 95.4 (d, *J* = 6.4 Hz), 89.1, 83.8 (d, *J* = 9.1 Hz), 83.4, 74.4, 72.7, 71.2, 70.3, 69.1, 68.1, 65.6 (d, *J* = 5.3 Hz), 61.6, 50.3 (d, *J* = 8.6 Hz), 40.4, 22.9, 17.3.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 20.8 Hz), –12.3 (d, *J* = 20.8 Hz).
FT-IR (neat) 3260, 1675, 1541, 1463, 1427, 1392, 1237, 1117, 1079, 1055, 988, 920, 860, 816, 717, 688, 664, 647, 623, 510 cm^{-1}.
HRMS (ESI) *m/z* ($[M+Na]^+$) calcd for $C_{21}H_{29}N_3Na_3O_{17}P_2$: 726.0665, found: 726.0660.

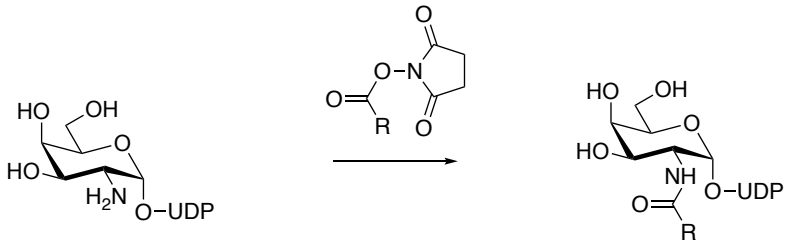


UDP-Sugar (*R*)-14. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*R*)-2-methylhex-5-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (62.5 mg, 0.109 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on C-18 silica gel (30%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column

(MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 42.8 min): 38.7 mg (50%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.93 (d, *J* = 8.1 Hz, 1H), 5.98–5.93 (m, 2H), 5.52 (dd, *J* = 6.6, 3.4 Hz, 1H), 4.36–4.32 (m, 2H), 4.28–4.15 (m, 5H), 4.02 (d, *J* = 2.8 Hz, 1H), 3.95 (dd, *J* = 11.0, 3.2 Hz, 1H), 3.78–3.69 (m, 2H), 2.66–2.58 (m, 1H), 2.32 (t, *J* = 2.6 Hz, 1H), 2.28–2.13 (m, 2H), 1.84–1.75 (m, 1H), 1.64–1.56 (m, 1H), 1.12 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 181.1, 167.6, 153.0, 142.3, 103.3, 95.6 (d, *J* = 6.7 Hz), 89.2, 85.7, 83.8 (d, *J* = 8.8 Hz), 74.4, 72.6, 70.2, 69.1, 68.3, 65.6 (d, *J* = 5.1 Hz), 61.6, 50.2 (d, *J* = 8.9 Hz), 40.5, 32.5, 17.7, 16.5.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 20.6 Hz), –12.5 (d, *J* = 20.6 Hz).
FT-IR (neat) 3266, 1674, 1538, 1465, 1430, 1392, 1349, 1234, 1117, 1079, 1057, 1038, 987, 918, 850, 813, 775, 687, 631, 511 cm^{-1}.
MS (ESI) *m/z* ($[M+H]^+$) calcd for $C_{22}H_{32}N_3Na_2O_{17}P_2$: 718.1002, found: 718.0994.

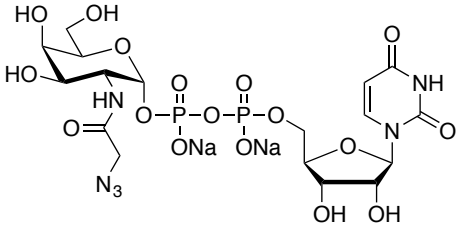


UDP-Sugar (*S*)-14. The title compound was prepared from diallyl 3,4,6-tri-*O*-acetyl-2-((*S*)-2-methylhex-5-ynamido)-2-deoxy-α-D-galactopyranosyl-1-phosphate (60.5 mg, 0.105 mmol). The tri-*O*-acetylated UDP-sugar was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$) and then preparative HPLC on C-18 silica gel (30%→60% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$). The compound was dissolved in MeOH/water/NEt_3 (5:2:1), and the reaction mixture was stirred at r.t. overnight. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 39.7 min): 35.8 mg (47%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.93 (d, *J* = 8.1 Hz, 1H), 5.98–5.92 (m, 2H), 5.52 (dd, *J* = 6.9, 3.4 Hz, 1H), 4.37–4.32 (m, 2H), 4.28–4.14 (m, 5H), 4.01 (d, *J* = 3.2 Hz, 1H), 3.94 (dd, *J* = 11.0, 3.2 Hz, 1H), 3.78–3.69 (m, 2H), 2.70–2.62 (m, 1H), 2.33 (t, *J* = 2.7 Hz, 1H), 2.26–2.13 (m, 2H), 1.81–1.72 (m, 1H), 1.65–1.57 (m, 1H), 1.12 (d, *J* = 6.8 Hz, 3H).
^{13}C NMR (126 MHz, D_2O) δ 181.0, 167.0, 152.5, 142.3, 103.3, 95.4 (d, *J* = 6.5 Hz), 89.1, 85.7, 83.9 (d, *J* = 9.1 Hz), 74.4, 72.6, 70.3, 70.2, 69.2, 68.1, 65.6 (d, *J* = 5.1 Hz), 61.6, 50.2 (d, *J* = 8.6 Hz), 40.3, 32.7, 17.6, 16.3.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 20.6 Hz), –12.3 (d, *J* = 20.8 Hz).
FT-IR (neat) 3252, 1674, 1540, 1463, 1430, 1393, 1350, 1235, 1115, 1078, 1058, 1036, 986, 920, 851, 814, 779, 691, 624, 511 cm^{-1}.
HRMS (ESI) *m/z* ($[M+H]^+$) calcd for $C_{22}H_{32}N_3Na_2O_{17}P_2$: 718.1002, found: 718.0995.



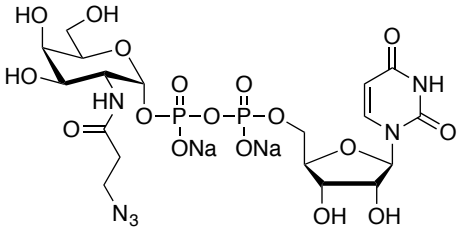
Preparation of UDP-*N*-acetyl-α-D-galactosamine derivatives (Route 2).

NHS esters were prepared according to a literature procedure.[21] A solution of the NHS ester (0.150 mmol) in DMF (1.08 mL) was added to a mixture of UDP-α-D-galactosamine disodium salt (30.5 mg, 0.0500 mmol) in HEPES buffer (0.1 M, pH = 8.0; 1.08 mL) at 0 °C.[22] The reaction mixture was allowed to warm to r.t. and stirred overnight. Next, the mixture was purified by column chromatography on C-18 silica gel (MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). Aqueous *n*-$Bu_3NH•HCO_3$ solution (10 mM) was prepared by bubbling CO_2 through a solution of *n*-Bu_3NH (10 mM) in water until all *n*-Bu_3NH dissolved into the water. Fractions containing the sugar were collected, concentrated, redissolved in water (100 mL), rinsed with CH_2Cl_2 (3 x 50 mL), and concentrated. The product was purified by preparative HPLC on C-18 silica gel (MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$). Pure fractions were collected, concentrated, redissolved in water (100 mL), rinsed with CH_2Cl_2 (3 x 50 mL), and concentrated. Finally, the purified compound was passed through a Bio-Rad AG® 50W-X8 resin (sodium form) and lyophilized.



UDP-GalNAz 2. The title compound was prepared from UDP-α-D-galactosamine ditributylammonium salt (41.7 mg, 0.0445 mmol) and 2,5-dioxopyrrolidin-1-yl 2-azidoacetate (71.0 mg, 0.358 mmol). The product was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 37.5 min): 10.8 mg (35%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.91 (d, *J* = 8.1 Hz, 1H), 5.96 (d, *J* = 4.2 Hz, 1H), 5.93 (d, *J* = 8.0 Hz, 1H), 5.55 (dd, *J* = 7.2, 3.4 Hz, 1H), 4.37–4.31 (m, 2H), 4.31–4.05 (m, 7H), 4.02 (d, *J* = 2.6 Hz, 1H), 3.96 (dd, *J* = 10.9, 2.9 Hz, 1H), 3.79–3.69 (m, 2H).
^{13}C NMR (126 MHz, D_2O) δ 171.8, 167.7, 153.0, 142.2, 103.4, 95.2 (d, *J* = 6.3 Hz), 89.3, 83.8 (d, *J* = 9.0 Hz), 74.4, 72.8, 70.3, 69.1, 68.2, 65.7 (d, *J* = 5.5 Hz), 61.7, 52.3, 50.6 (d, *J* = 8.4 Hz).
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 20.8 Hz), –12.2 (d, *J* = 20.6 Hz).
FT-IR (neat) 3251, 2113, 1672, 1549, 1465, 1426, 1233, 1111, 1080, 1042, 987, 923, 853, 815, 719, 690, 623, 512 cm^{-1}.

MS (ESI) *m/z* ([M–2Na+H]$^-$) calcd for $C_{17}H_{25}N_6O_{17}P_2$: 647.0751, found: 647.0738.



UDP-Sugar 7. The title compound was prepared from UDP-α-D-galactosamine disodium salt and 2,5-dioxopyrrolidin-1-yl 3-azidopropanoate. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 42.1 min). White solid.

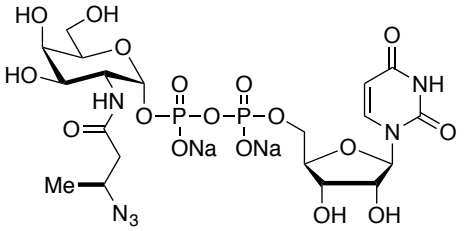
^{1}H NMR (500 MHz, D_2O) δ 7.92 (d, *J* = 8.1 Hz, 1H), 5.97–5.92 (m, 2H), 5.53 (dd, *J* = 7.1, 3.5 Hz, 1H), 4.36–4.31 (m, 2H), 4.30–4.13 (m, 5H), 4.02 (d, *J* = 3.1 Hz, 1H), 3.94 (dd, *J* = 10.9, 3.1 Hz, 1H), 3.78–3.69 (m, 2H), 3.58 (t, *J* = 6.4 Hz, 2H), 2.69–2.58 (m, 2H).

^{13}C NMR (126 MHz, D_2O) δ 175.0, 167.5, 152.9, 142.2, 103.3, 95.4 (d, *J* = 6.3 Hz), 89.2, 83.8 (d, *J* = 9.1 Hz), 74.4, 72.8, 70.3, 69.1, 68.3, 65.7 (d, *J* = 5.5 Hz), 61.7, 50.4 (d, *J* = 8.5 Hz), 47.7, 35.5.

^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 21.4 Hz), –12.2 (d, *J* = 20.6 Hz).

FT-IR (neat) 3259, 2100, 1672, 1547, 1463, 1424, 1389, 1345, 1234, 1114, 1080, 1049, 985, 919, 851, 812, 767, 717, 692, 636, 620, 509 cm^{-1}.

MS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{18}H_{27}N_6Na_2O_{17}P_2$: 707.0703, found: 707.0706.



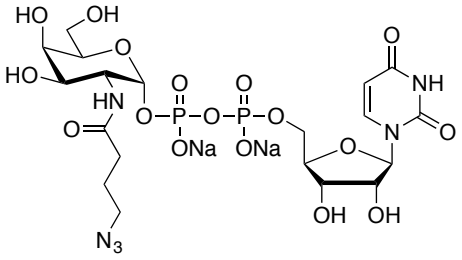
UDP-Sugar 9. The title compound was prepared from UDP-α-D-galactosamine disodium salt and 2,5-dioxopyrrolidin-1-yl (*S*)-3-azidobutanoate. The product was purified by preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH{\bullet}HCO_3$; 20 mL/min; t_r = 45.1 min). White solid.

^{1}H NMR (500 MHz, D_2O) δ 7.93 (d, *J* = 8.1 Hz, 1H), 5.97–5.92 (m, 2H), 5.53 (dd, *J* = 7.1, 3.5 Hz, 1H), 4.36–4.31 (m, 2H), 4.28–4.13 (m, 5H), 4.02 (d, *J* = 3.0 Hz, 1H), 4.00–3.91 (m, 2H), 3.78–3.69 (m, 2H), 2.58–2.49 (m, 2H), 1.28 (d, *J* = 6.6 Hz, 3H).

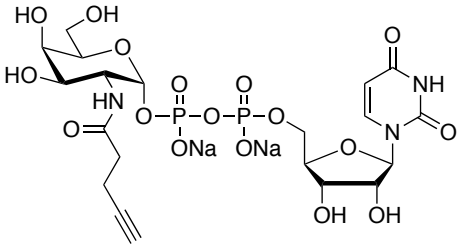
^{13}C NMR (126 MHz, D_2O) δ 174.6, 167.5, 152.9, 142.3, 103.3, 95.3 (d, *J* = 6.3 Hz), 89.2, 83.8 (d, *J* = 9.1 Hz), 74.4, 72.7, 70.3, 69.1, 68.2, 65.7 (d, *J* = 5.3 Hz), 61.7, 55.7, 50.4 (d, *J* = 8.3 Hz), 42.7, 19.3.

^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 21.4 Hz), –12.2 (d, *J* = 21.2 Hz).

FT-IR (neat) 3219, 2112, 1673, 1546, 1462, 1424, 1387, 1342, 1233, 1112, 1080, 1040, 986, 917, 852, 813, 707, 688, 620, 509 cm^{-1}.
MS (ESI) *m/z* ($[M+H]^+$) calcd for $C_{19}H_{29}N_6Na_2O_{17}P_2$: 721.0860, found: 721.0858.

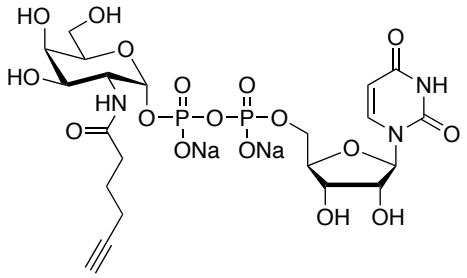


UDP-Sugar 10. The title compound was prepared from UDP-α-D-galactosamine disodium salt (12.6 mg, 0.0207 mmol) and 2,5-dioxopyrrolidin-1-yl 4-azidobutanoate (14.0 mg, 0.0619 mmol). The product was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 41.3 min): 7.4 mg (50%). White solid.
^1H NMR (500 MHz, D_2O) δ 7.93 (d, *J* = 8.1 Hz, 1H), 5.99–5.92 (m, 2H), 5.52 (dd, *J* = 7.2, 3.3 Hz, 1H), 4.37–4.31 (m, 2H), 4.29 –4.13 (m, 5H), 4.01 (d, *J* = 3.2 Hz, 1H), 3.94 (dd, *J* = 11.0, 2.8 Hz, 1H), 3.78–3.68 (m, 2H), 3.35 (t, *J* = 6.9 Hz, 2H), 2.42 (t, *J* = 7.5 Hz, 2H), 1.87 (p, *J* = 7.2 Hz, 2H).
^{13}C NMR (126 MHz, D_2O) δ 177.3, 168.1, 153.3, 142.2, 103.4, 95.4 (d, *J* = 6.4 Hz), 89.2, 83.81 (d, *J* = 9.2 Hz), 74.5, 72.7, 70.3, 69.1, 68.3, 65.7 (d, *J* = 5.3 Hz), 61.7, 51.1, 50.4 (d, *J* = 8.3 Hz), 33.6, 25.2.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 21.4 Hz), –12.2 (d, *J* = 20.6 Hz).
FT-IR (neat) 3263, 2106, 1671, 1546, 1464, 1425, 1388, 1351, 1231, 1112, 1079, 1053, 1037, 985, 918, 851, 812, 719, 688, 623, 510 cm^{-1}.
MS (ESI) *m/z* ($[M+H]^+$) calcd for $C_{19}H_{29}N_6Na_2O_{17}P_2$: 721.0860, found: 721.0862.



UDP-Sugar 11. The title compound was prepared from UDP-α-D-galactosamine disodium salt (50.0 mg, 0.0821 mmol) and 2,5-dioxopyrrolidin-1-yl pent-4-ynoate (48.0 mg, 0.246 mmol). The product was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 43.5 min): 29.5 mg (52%). White solid.

^{1}H NMR (500 MHz, D_2O) δ 7.95 (d, *J* = 8.1 Hz, 1H), 5.99–5.93 (m, 2H), 5.53 (dd, *J* = 7.1, 3.4 Hz, 1H), 4.37–4.32 (m, 2H), 4.30–4.14 (m, 5H), 4.02 (d, *J* = 3.1 Hz, 1H), 3.95 (dd, *J* = 11.0, 3.0 Hz, 1H), 3.79–3.69 (m, 2H), 2.63–2.51 (m, 2H), 2.51–2.45 (m, 2H), 2.34 (t, *J* = 2.3 Hz, 1H).
^{13}C NMR (126 MHz, D_2O) δ 176.0, 167.0, 152.5, 142.3, 103.3, 95.5 (d, *J* = 6.5 Hz), 89.2, 84.3, 83.8 (d, *J* = 9.1 Hz), 74.4, 72.7, 70.6, 70.3, 69.1, 68.2, 65.6 (d, *J* = 5.3 Hz), 61.7, 50.4 (d, *J* = 8.7 Hz), 35.0, 15.0.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 20.8 Hz), –12.3 (d, *J* = 20.6 Hz).
FT-IR (neat) 3268, 1671, 1547, 1469, 1423, 1391, 1234, 1113, 1080, 1045, 986, 919, 852, 814, 765, 712, 687, 626, 552, 514 cm^{-1}.
MS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{20}H_{28}N_3Na_2O_{17}P_2$: 690.0689, found: 690.0677.



UDP-Sugar 13. The title compound was prepared from UDP-α-D-galactosamine disodium salt (50.0 mg, 0.0821 mmol) and 2,5-dioxopyrrolidin-1-yl hex-5-ynoate (51.4 mg, 0.246 mmol). The product was purified by column chromatography on C-18 silica gel (0%→100% MeOH/water; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$) and then preparative HPLC on an Agilent prep 100 Å C18 column (MeOH/water (min:%): 0:10, 10:10, 60:60; water was doped with 10 mM *n*-$Bu_3NH•HCO_3$; 20 mL/min; t_r = 38.2 min): 25.2 mg (44%). White solid.
^{1}H NMR (500 MHz, D_2O) δ 7.94 (dd, *J* = 8.2, 1.4 Hz, 1H), 5.98–5.92 (m, 2H), 5.52 (dd, *J* = 7.2, 3.4 Hz, 1H), 4.37–4.31 (m, 2H), 4.29–4.13 (m, 5H), 4.02 (d, *J* = 3.1 Hz, 1H), 3.94 (dd, *J* = 10.8, 2.2 Hz, 1H), 3.79–3.68 (m, 2H), 2.44 (t, *J* = 7.4 Hz, 2H), 2.34 (t, *J* = 2.6 Hz, 1H), 2.26–2.21 (m, 2H), 1.80 (p, *J* = 7.4 Hz, 2H).
^{13}C NMR (126 MHz, D_2O) δ 177.6, 167.0, 152.5, 142.3, 103.3, 95.4 (d, *J* = 6.5 Hz), 89.1, 85.6, 83.8 (d, *J* = 9.3 Hz), 74.4, 72.7, 70.4, 70.3, 69.1, 68.3, 65.6 (d, *J* = 5.3 Hz), 61.7, 50.3 (d, *J* = 8.6 Hz), 35.3, 24.9, 17.8.
^{31}P NMR (202 MHz, D_2O) δ –10.6 (d, *J* = 21.4 Hz), –12.2 (d, *J* = 20.6 Hz).
FT-IR (neat) 3274, 1676, 1547, 1467, 1425, 1392, 1345, 1234, 1113, 1080, 1054, 1042, 986, 919, 852, 813, 768, 715, 687, 652, 627, 512 cm^{-1}.
MS (ESI) *m/z* ([M+H]$^+$) calcd for $C_{21}H_{30}N_3Na_2O_{17}P_2$: 704.0846, found: 704.0836.

X. References

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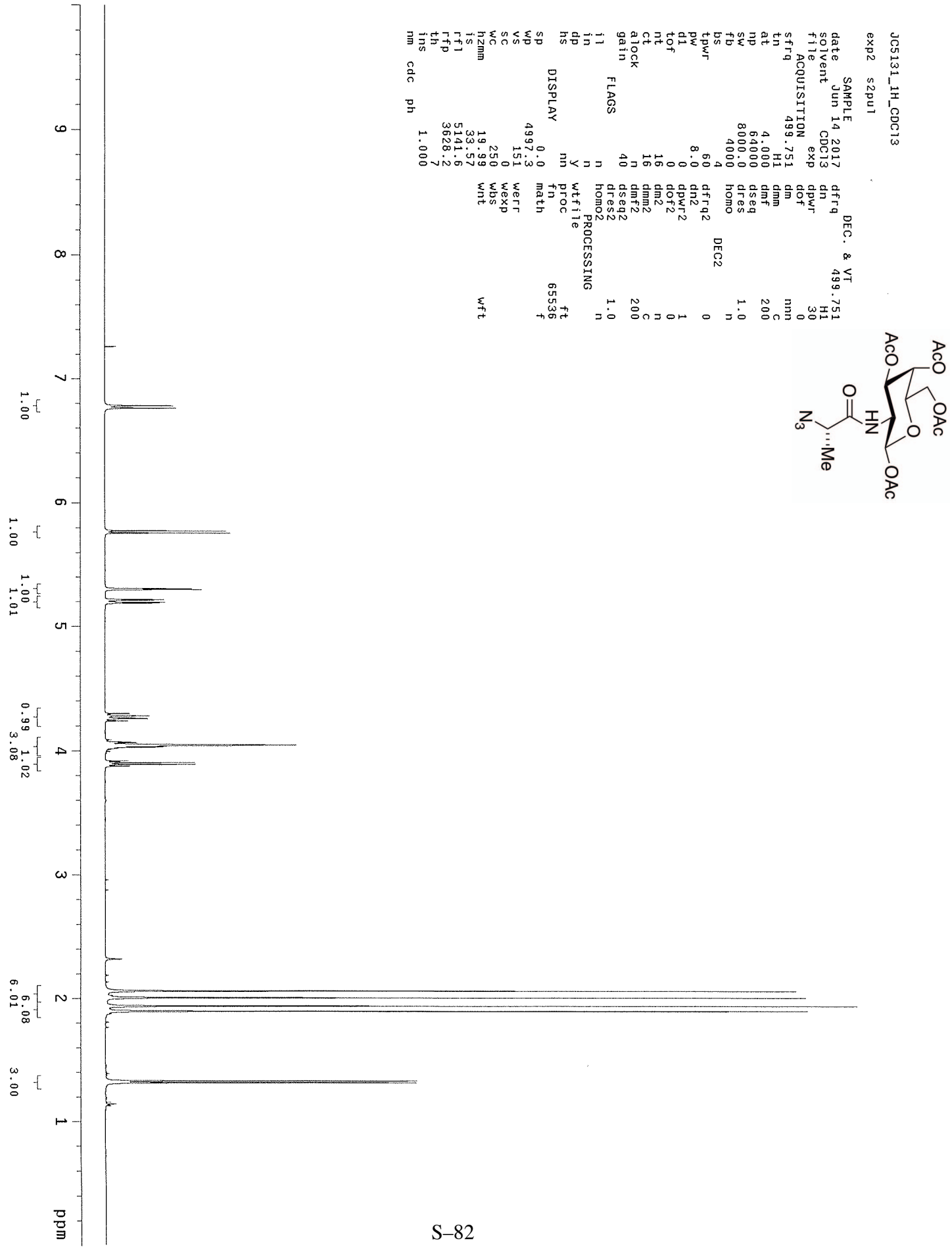
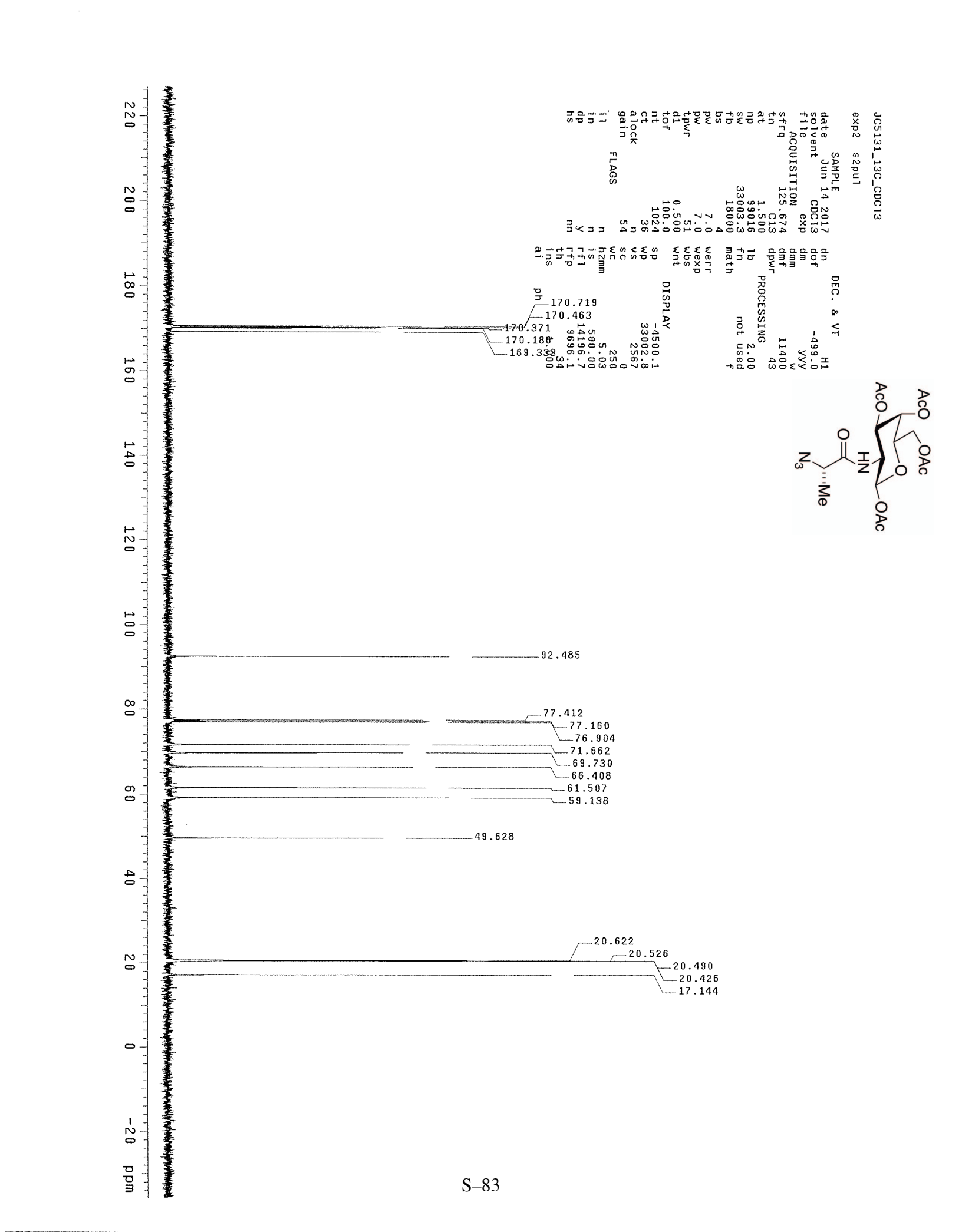
XI. NMR Spectra

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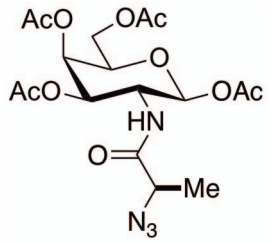

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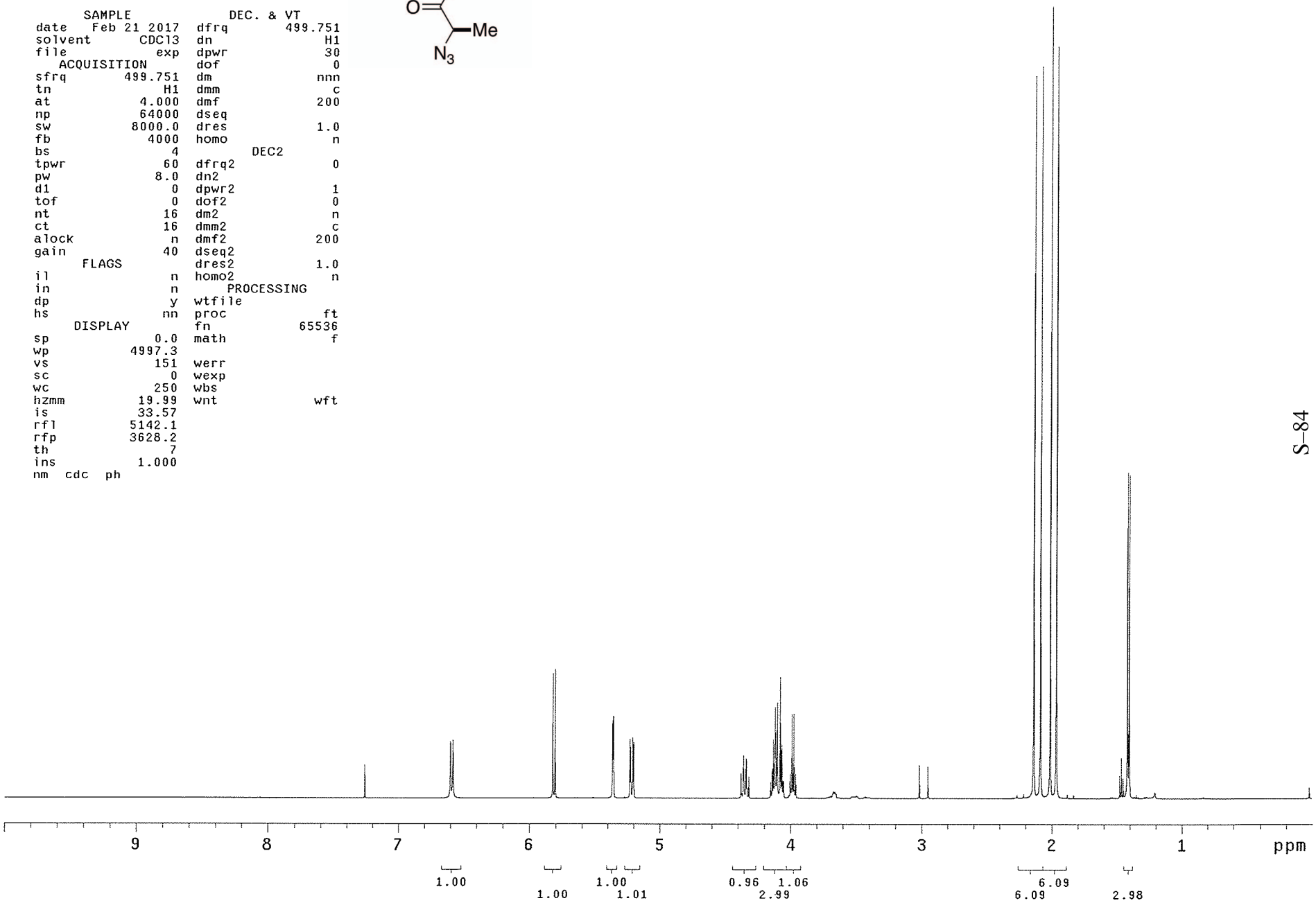

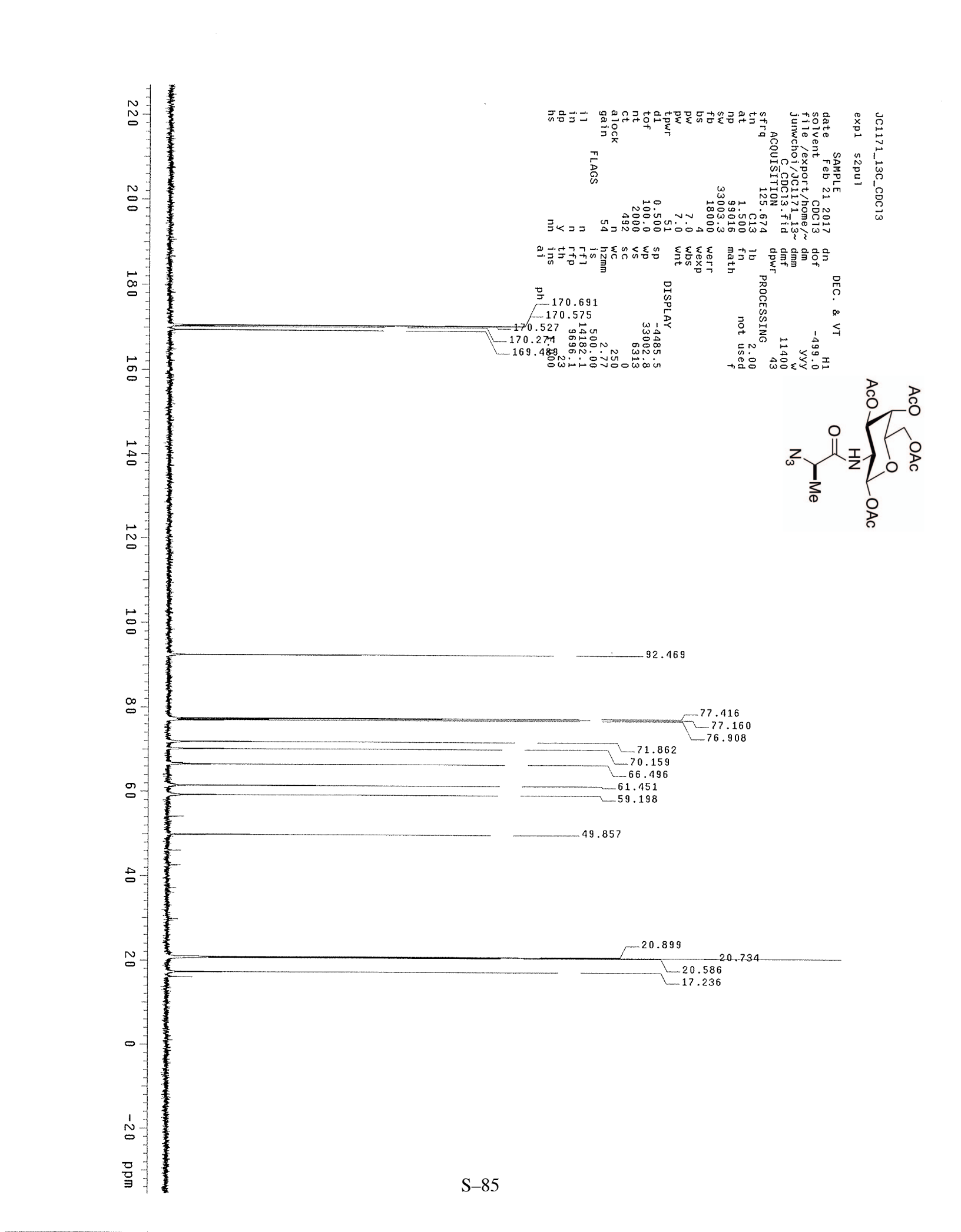
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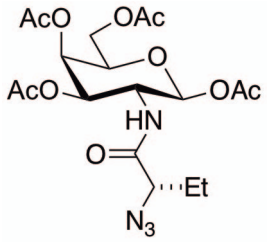

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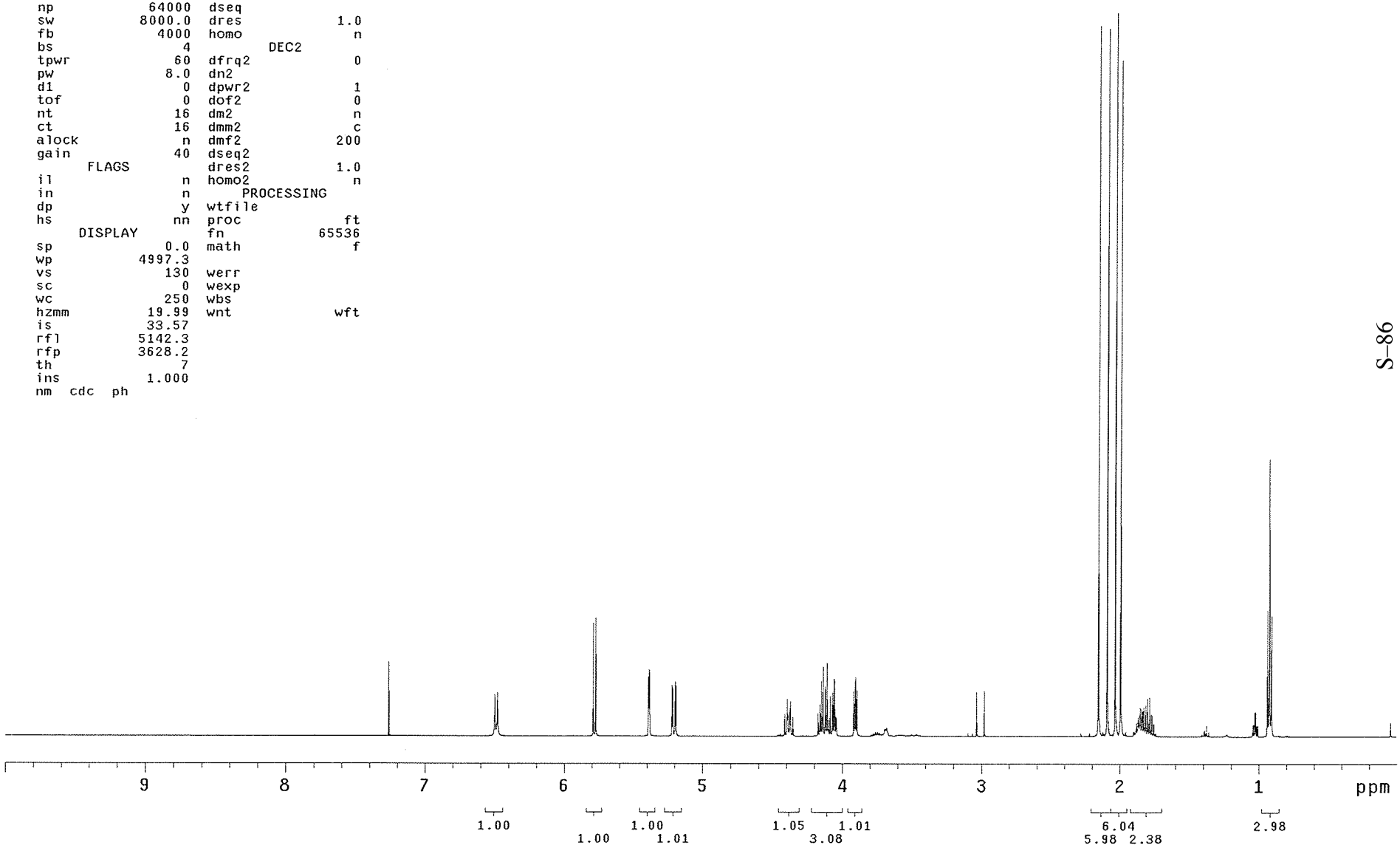

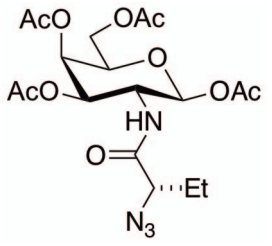

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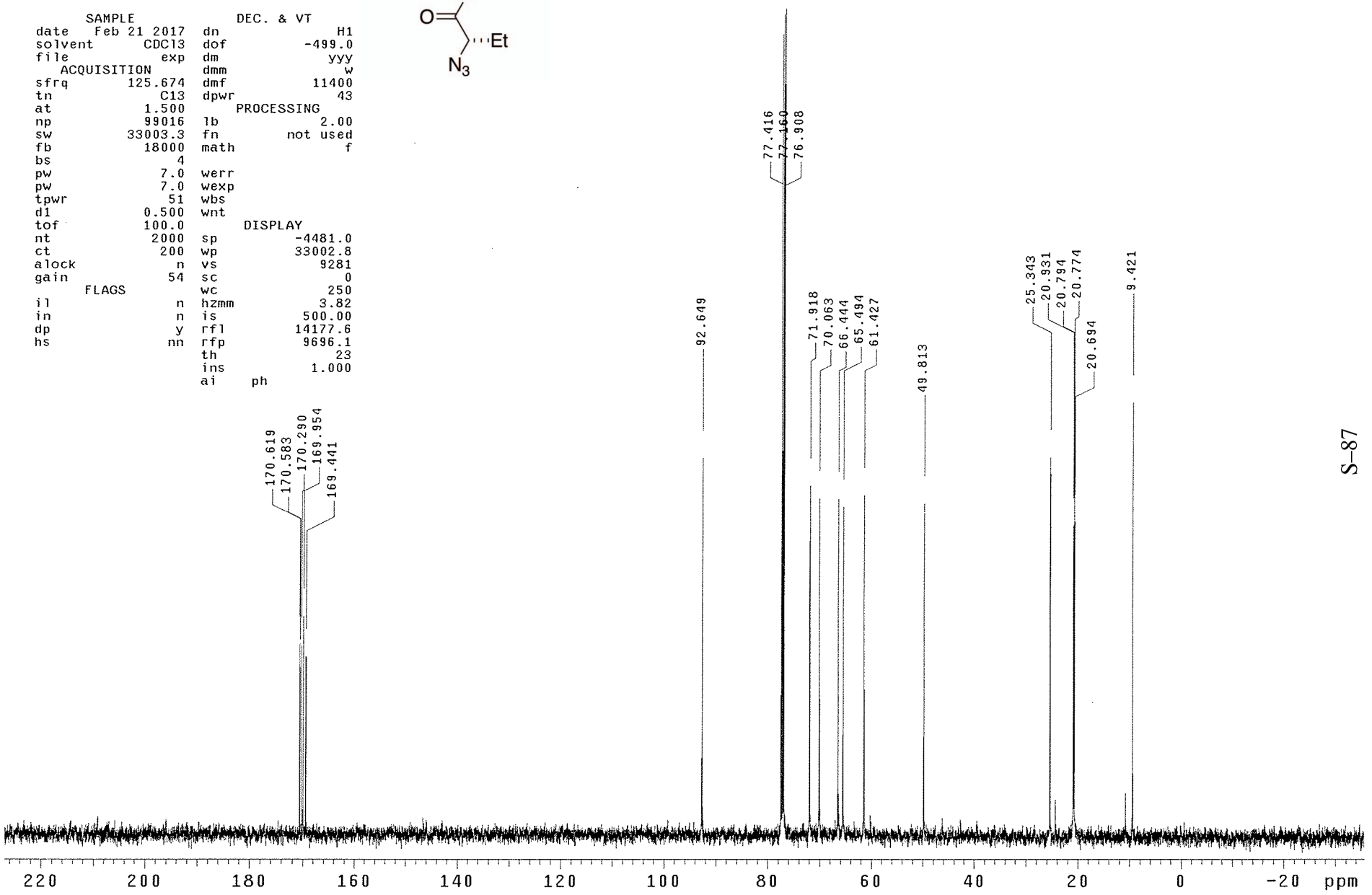

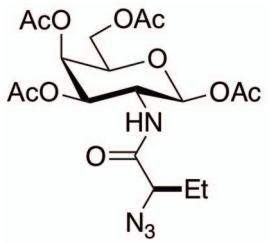

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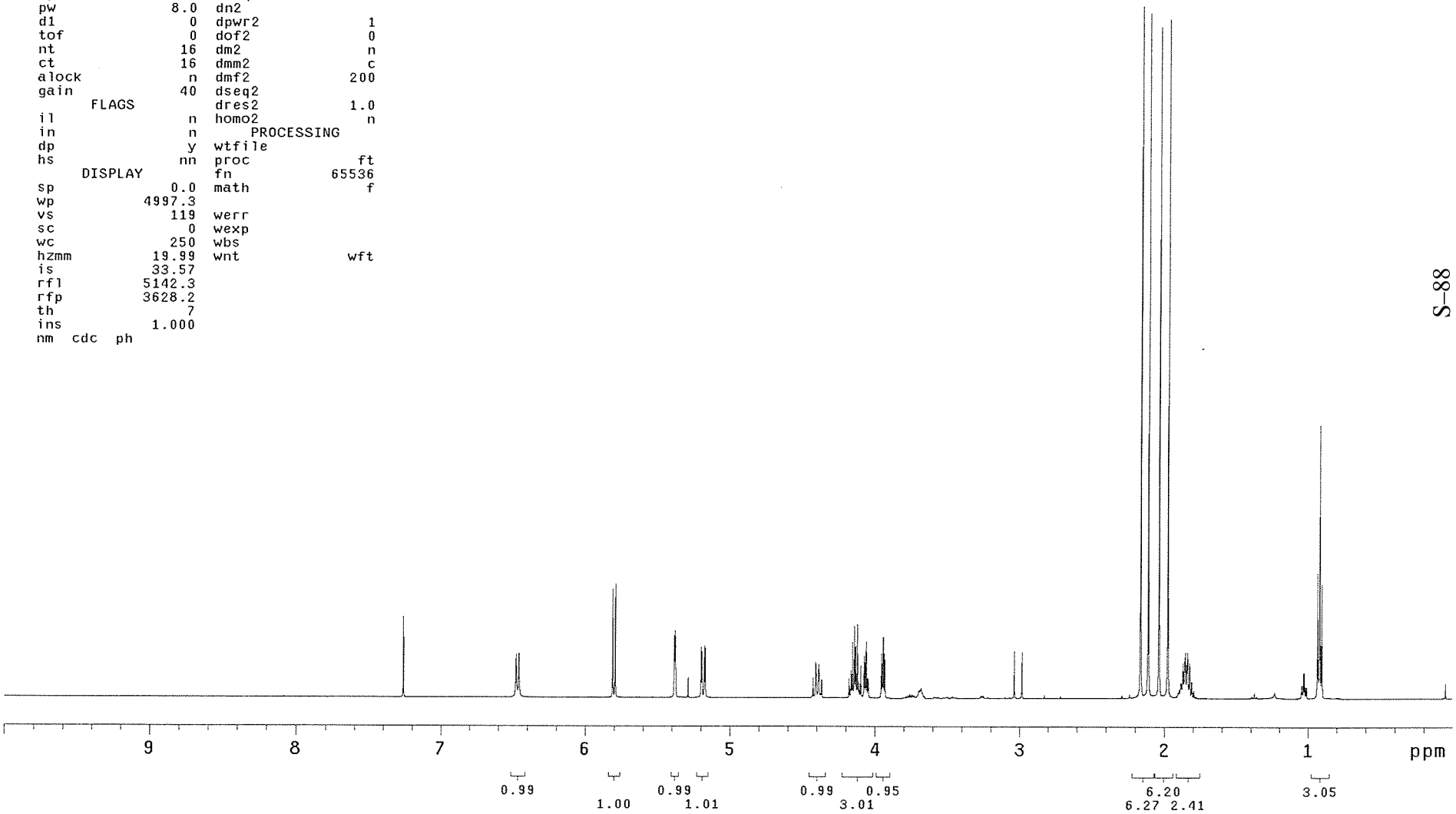

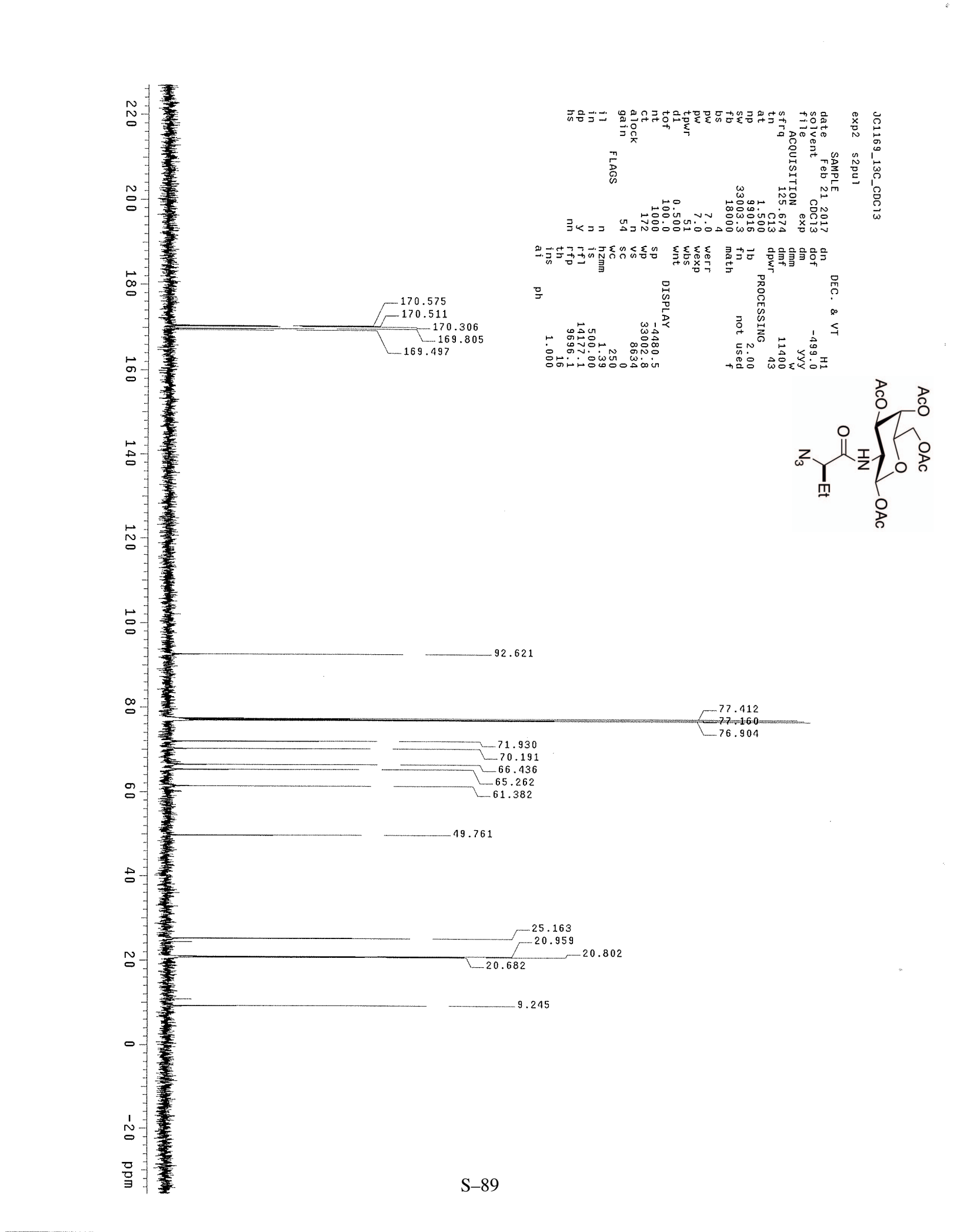
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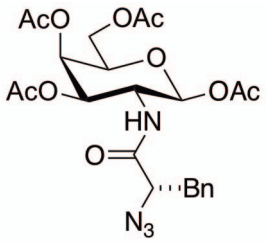

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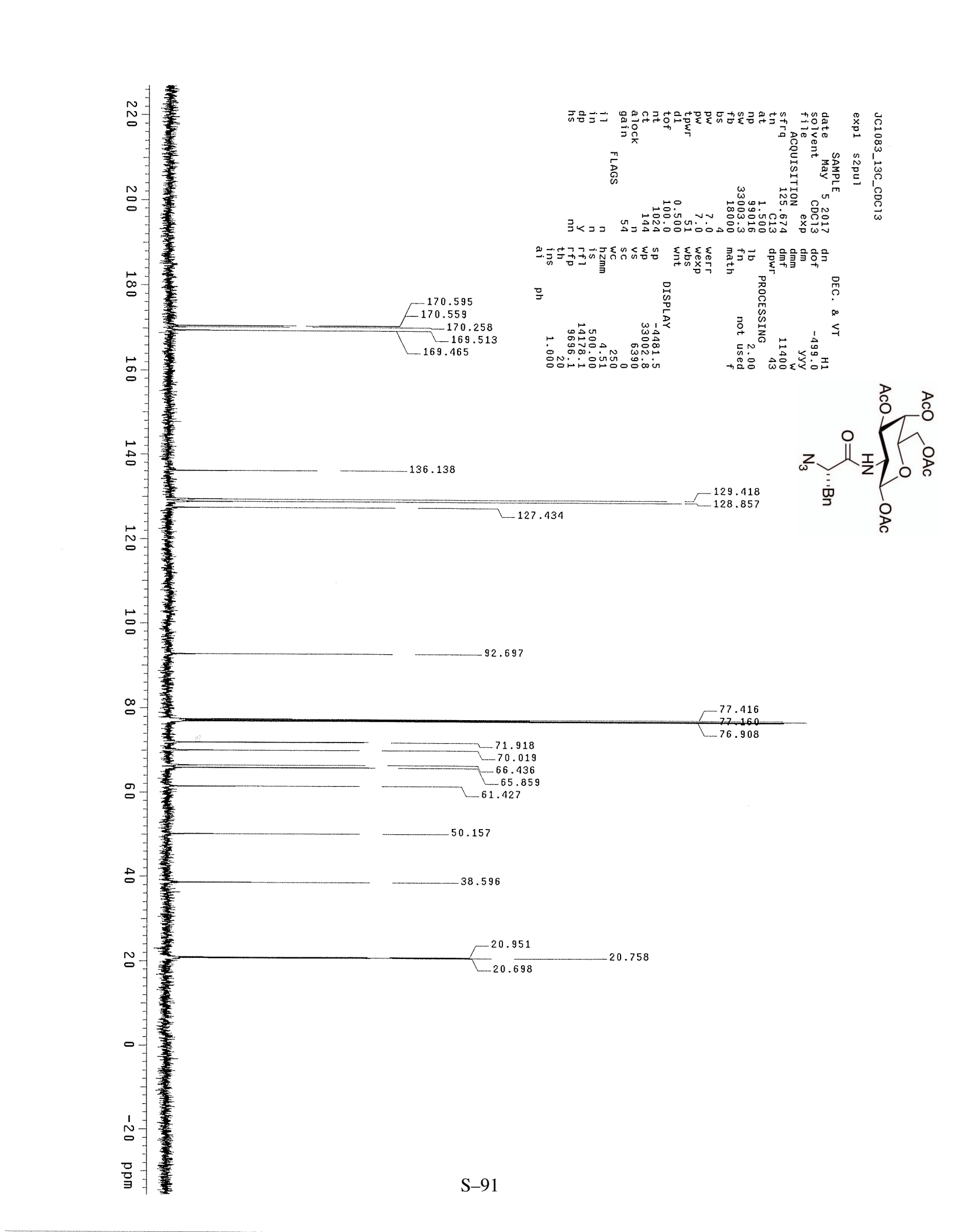
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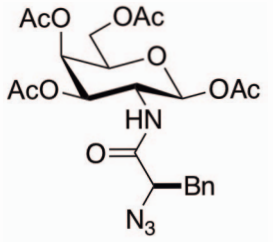
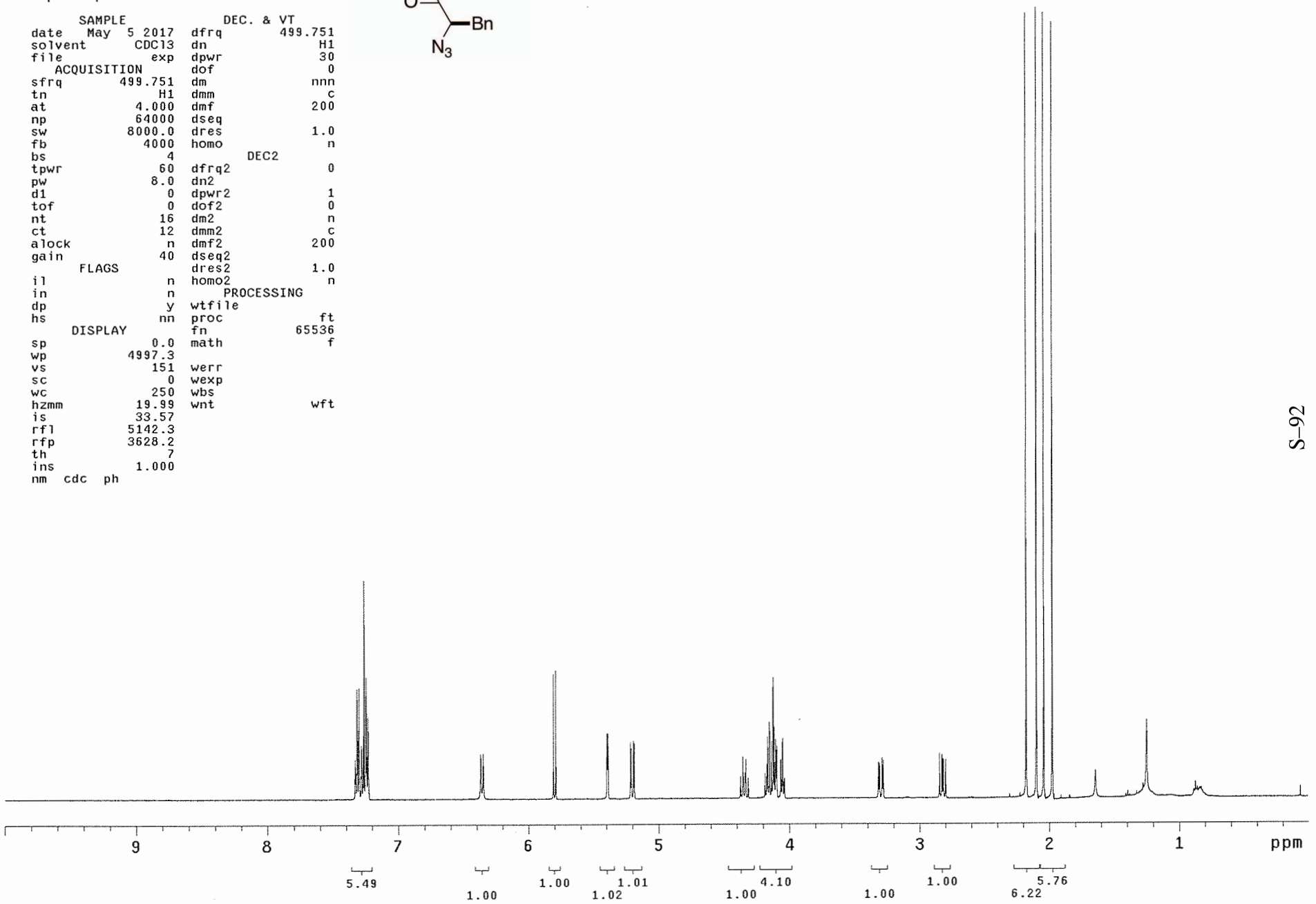
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4481.5
wp 33002.8
vs 6390
sc 0
wc 250
hzmm 4.51
is 500.00
rfl 14178.1
rfp 9696.1
th 20
ins 1.000
AcO
AcO
OAc
O
HN
O
N3
Bn
OAc
170.595
170.559
170.258
169.513
169.465
136.138
129.418
128.857
127.434
92.697
77.416
77.160
76.908
71.918
70.019
66.436
65.859
61.427
50.157
38.596
20.951
20.758
20.698
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

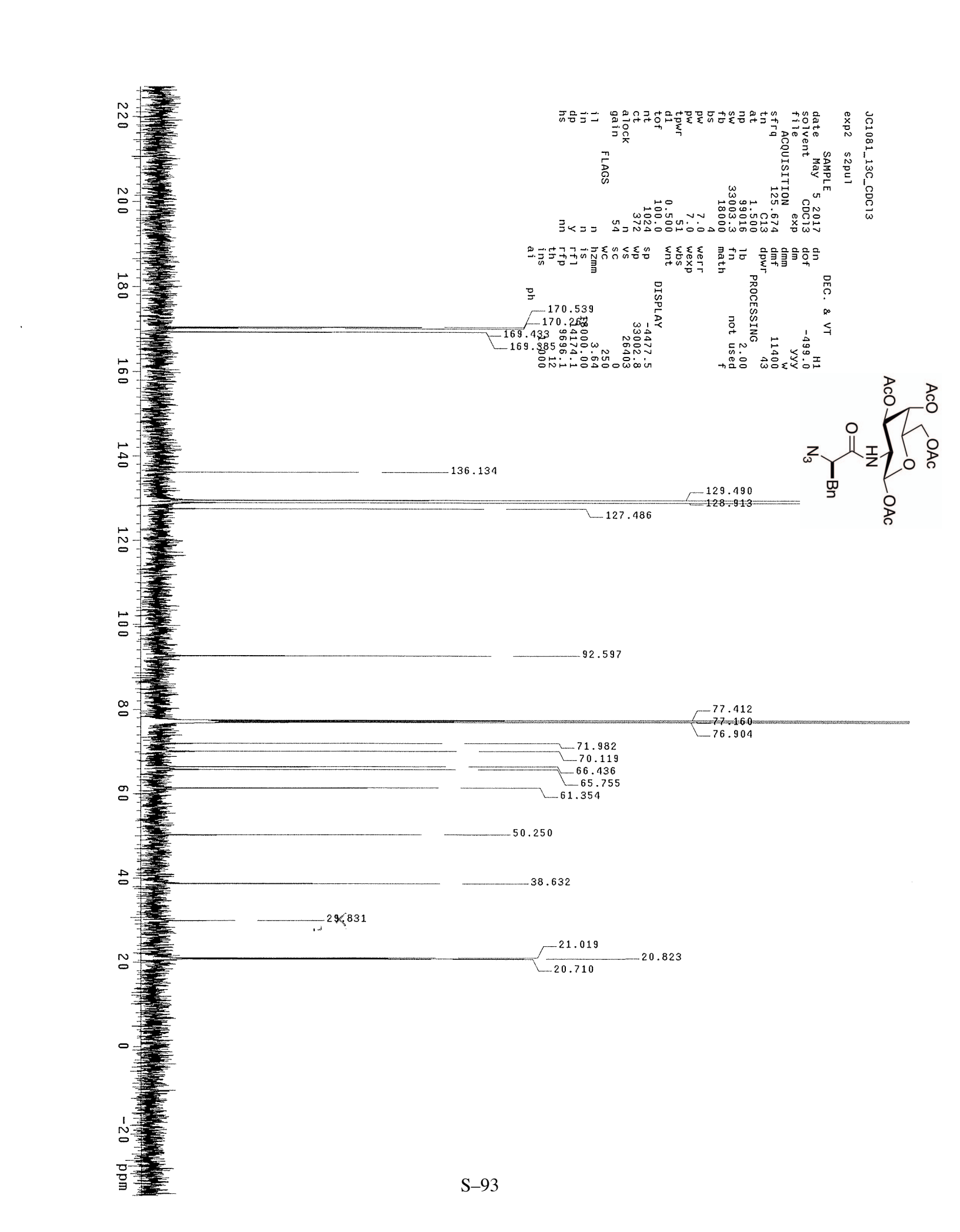


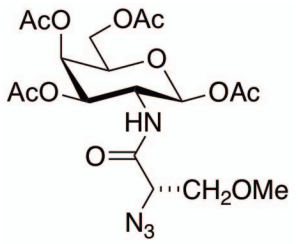
JC1081_1H_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	May 5 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	12	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			




JC1081_13C_CDCl3
exp2 s2pul
SAMPLE
date May 5 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 372
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ph
ai
ins
th
rfp 14174.1
rfl 9696.1
lp 12
sc 250
wc 3.64
hzmm 18000.00
is 18000.00
DISPLAY
sp -4477.5
wp 33002.8
vs 26403
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
AcO
OAc
HN
O
N3
Bn
170.539
170.218
169.433
169.185
136.134
129.490
128.913
127.486
92.597
77.412
77.160
76.904
71.982
70.119
66.436
65.755
61.354
50.250
38.632
29.831
21.019
20.823
20.710
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

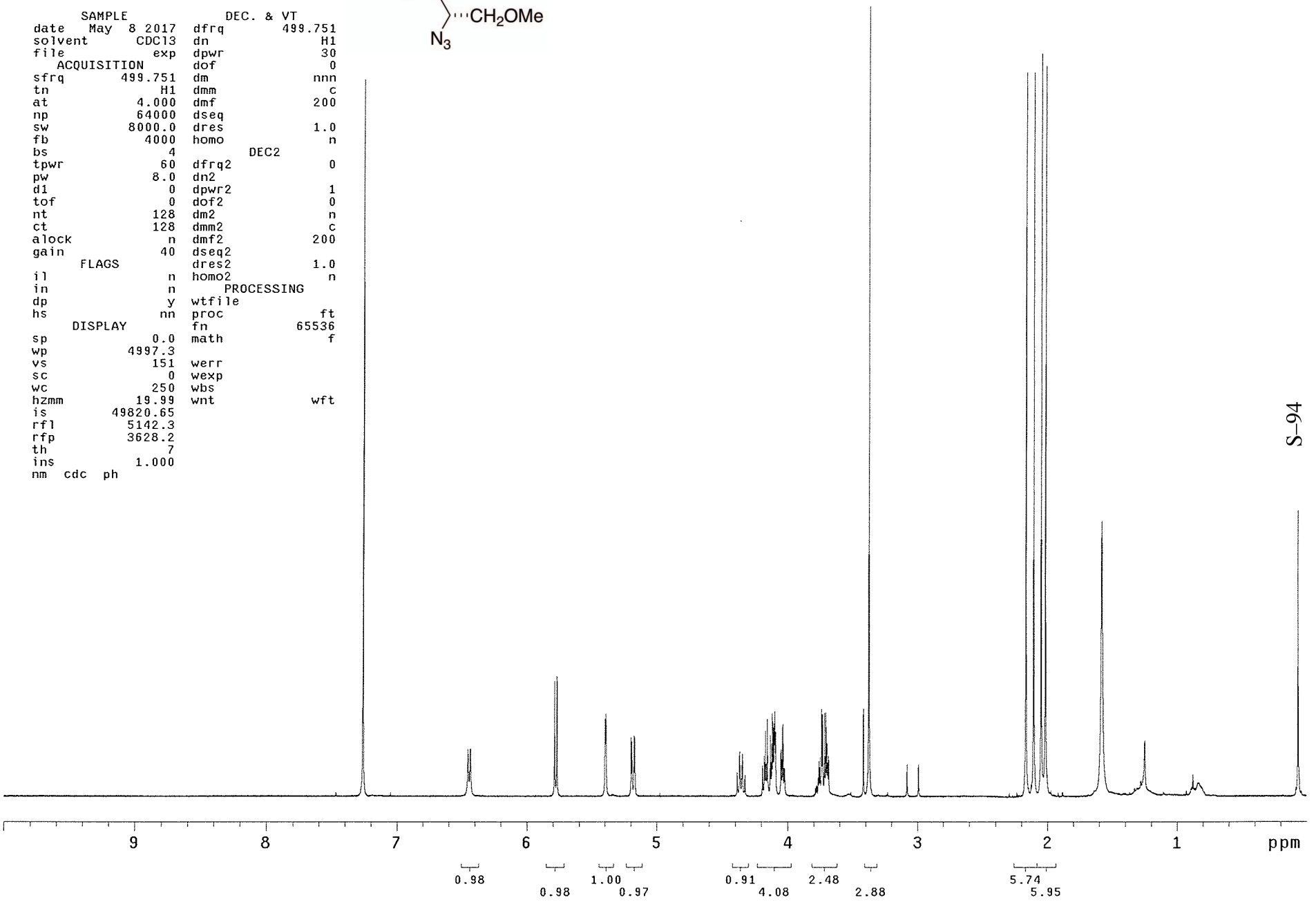


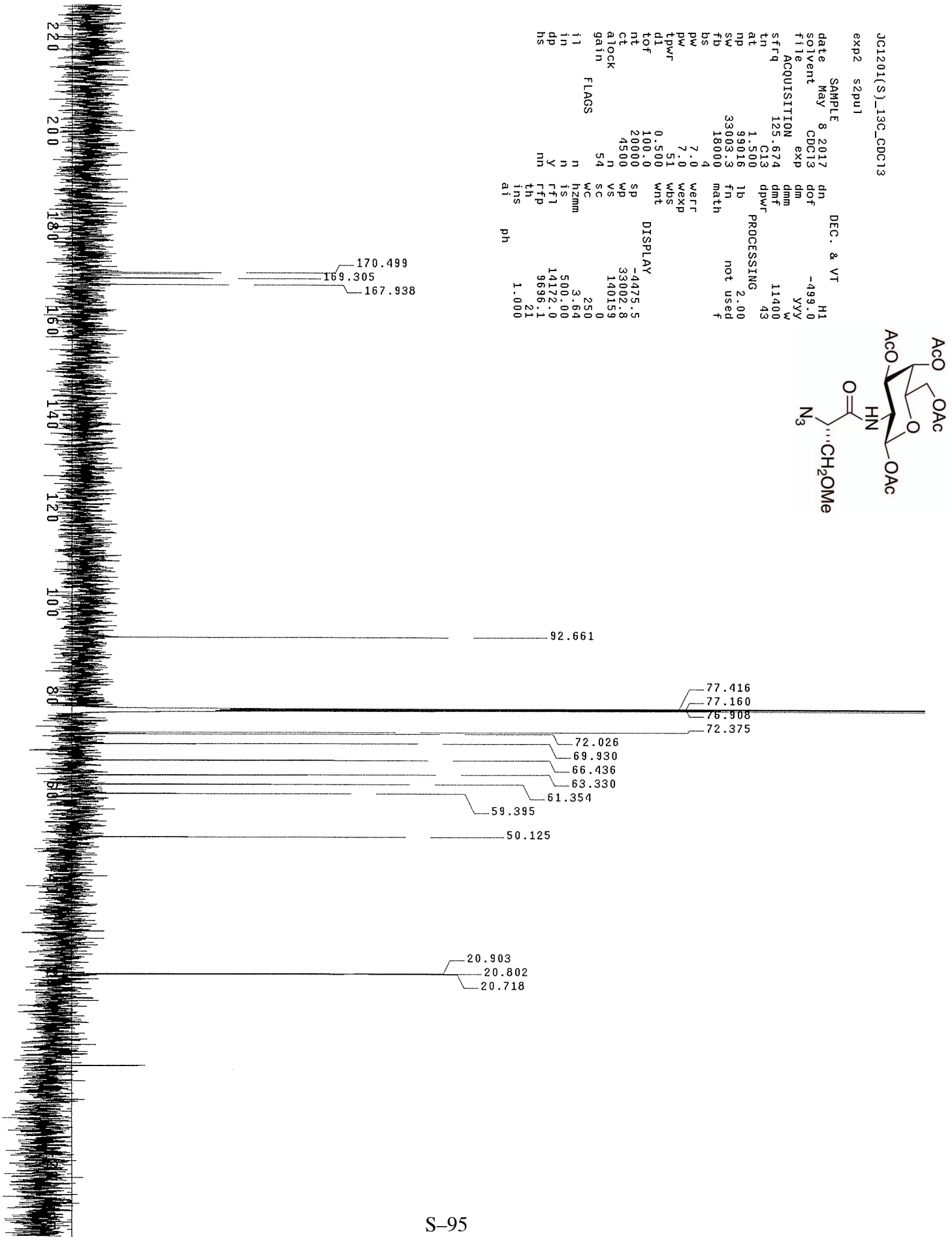
JC1201(S)_1H_CDCl3

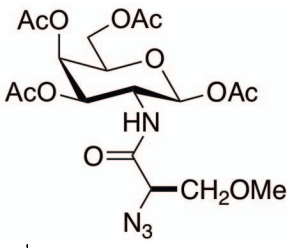
exp1 s2pul

SAMPLE		DEC. & VT	
date	May 8 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	128	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	49820.65		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph




JC1201(S)_13C_CDC13
exp2 s2pul
SAMPLE
date May 8 2017
solvent CDC13
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 20000
ct 4500
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ph
ai
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4475.5
wp 33002.8
vs 140159
sc 0
wc 250
hzmm 3.64
is 500.00
rfl 14172.0
rfp 9696.1
th 21
ins 1.000
AcO
AcO
OAc
OAc
HN
O
O
N3
CH2OMe
170.499
169.305
167.938
92.661
77.416
77.160
76.908
72.375
72.026
69.930
66.436
63.330
61.354
59.395
50.125
20.903
20.802
20.718

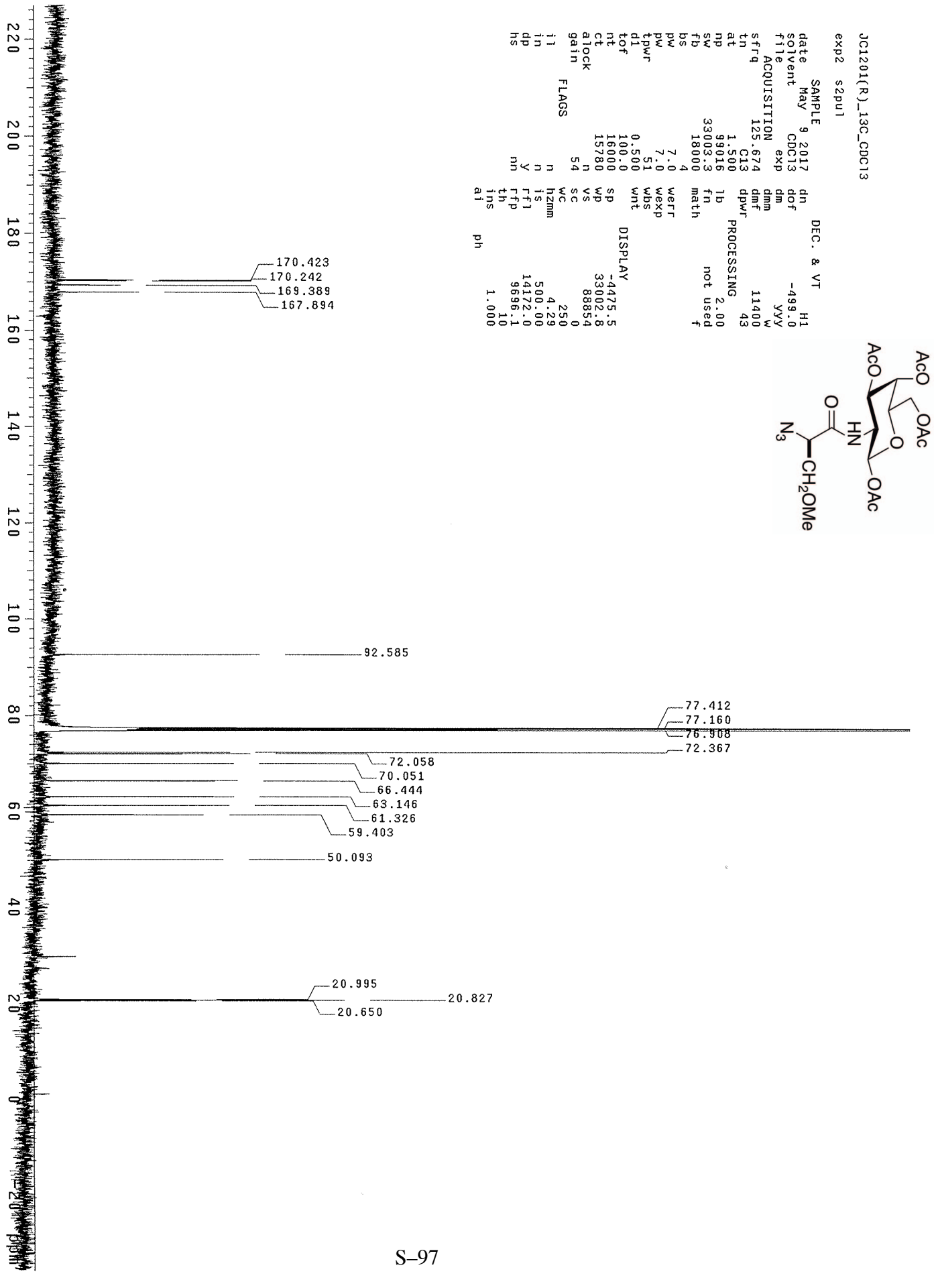


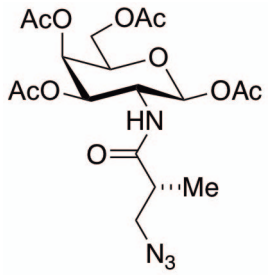
JC1201(R)_1H_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	May 9 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	128	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	184	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph

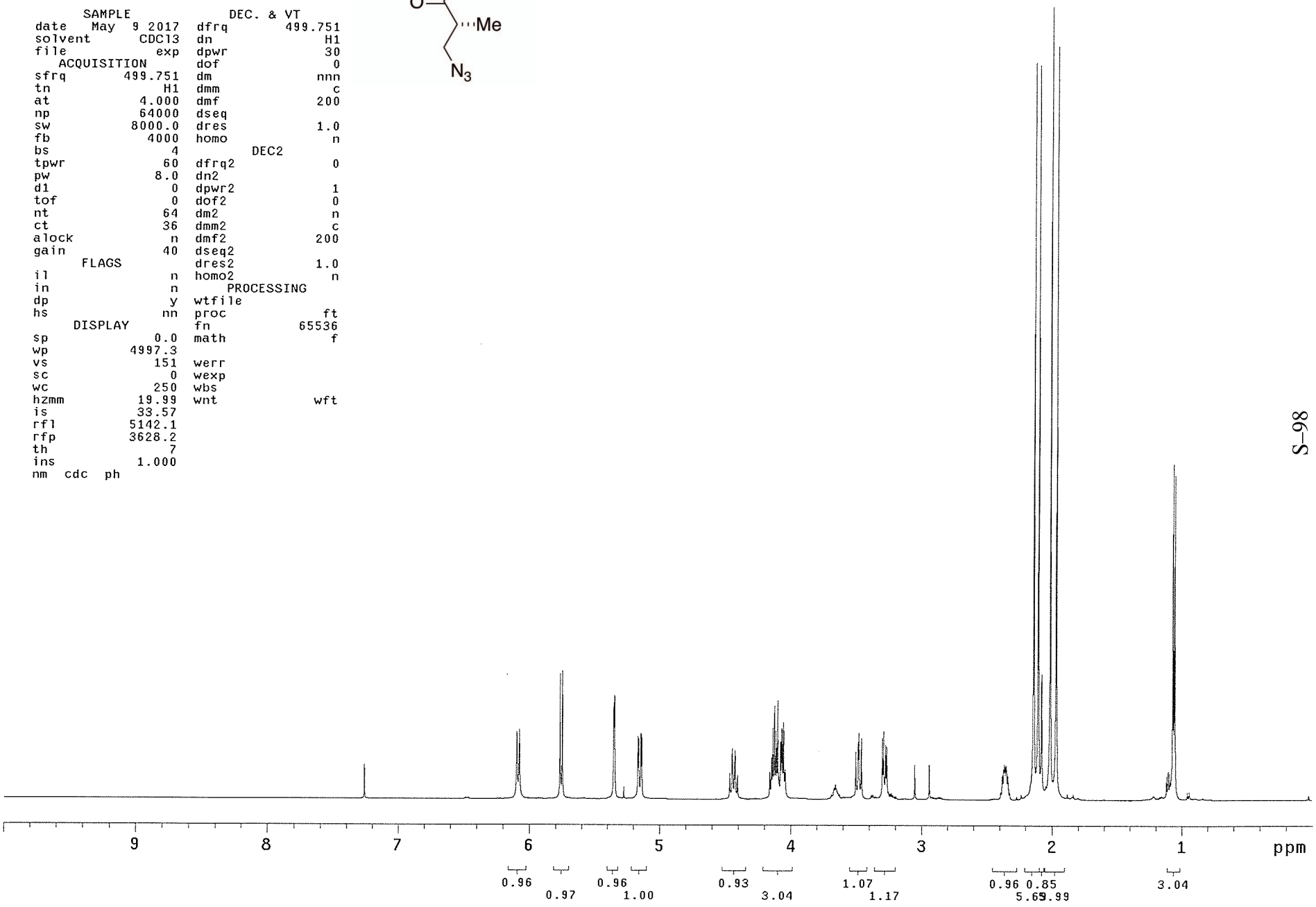

JC1201(R)_13C_CDC13
exp2 s2pul
SAMPLE
date May 9 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 16000
ct 15780
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ph
ai
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4475.5
wp 33002.8
vs 88854
sc 0
wc 250
hzmm 4.29
is 500.00
rfl 14172.0
rfp 9696.1
th 10
ins 1.000
AcO
AcO
OAc
OAc
O
HN
O
N3
CH2OMe
170.423
170.242
169.389
167.894
92.585
77.412
77.160
76.908
72.367
72.058
70.051
66.444
63.146
61.326
59.403
50.093
20.995
20.827
20.650
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

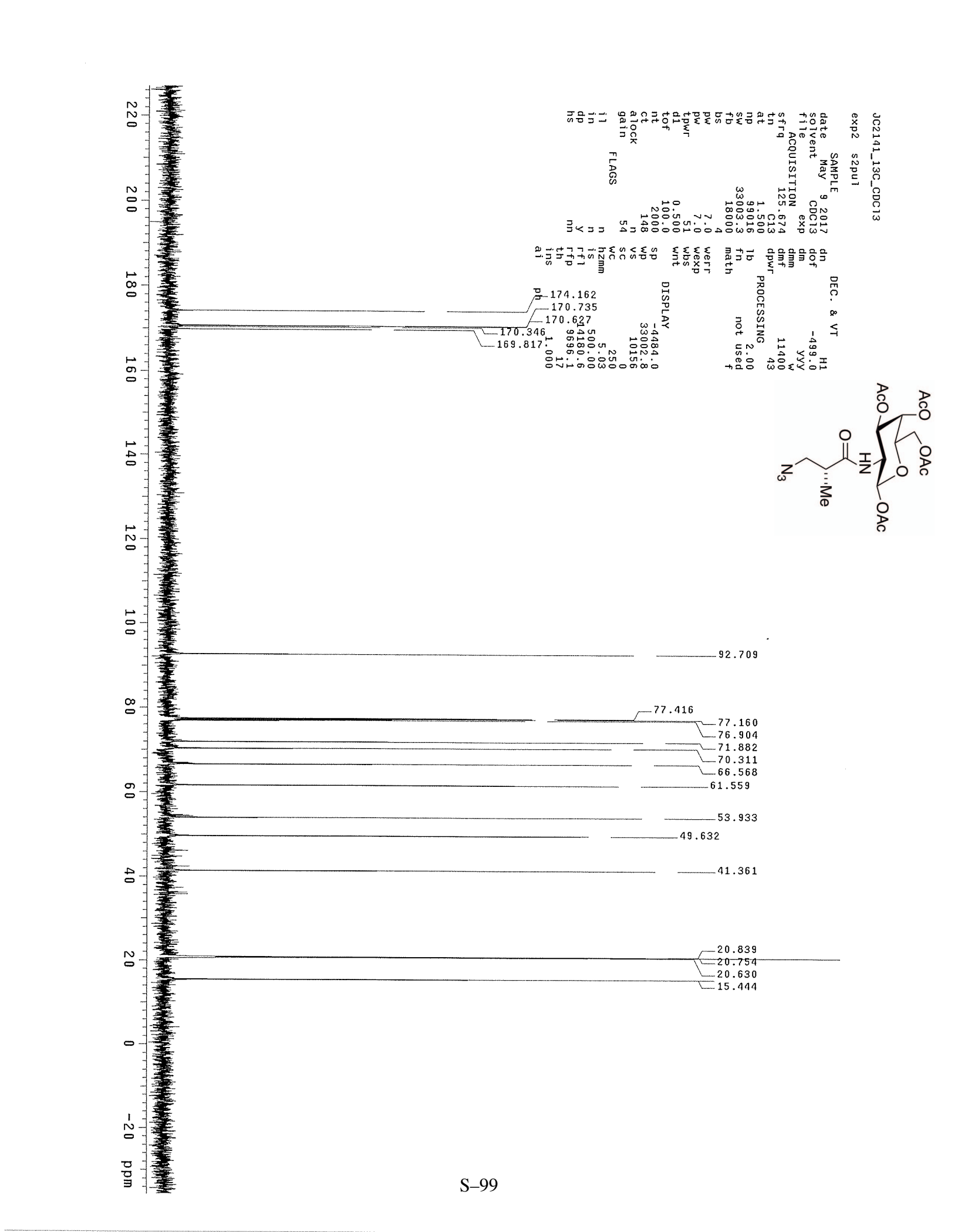


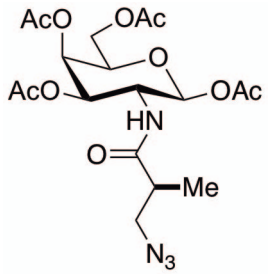
JC2141_1H_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	May 9 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	36	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.1		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			



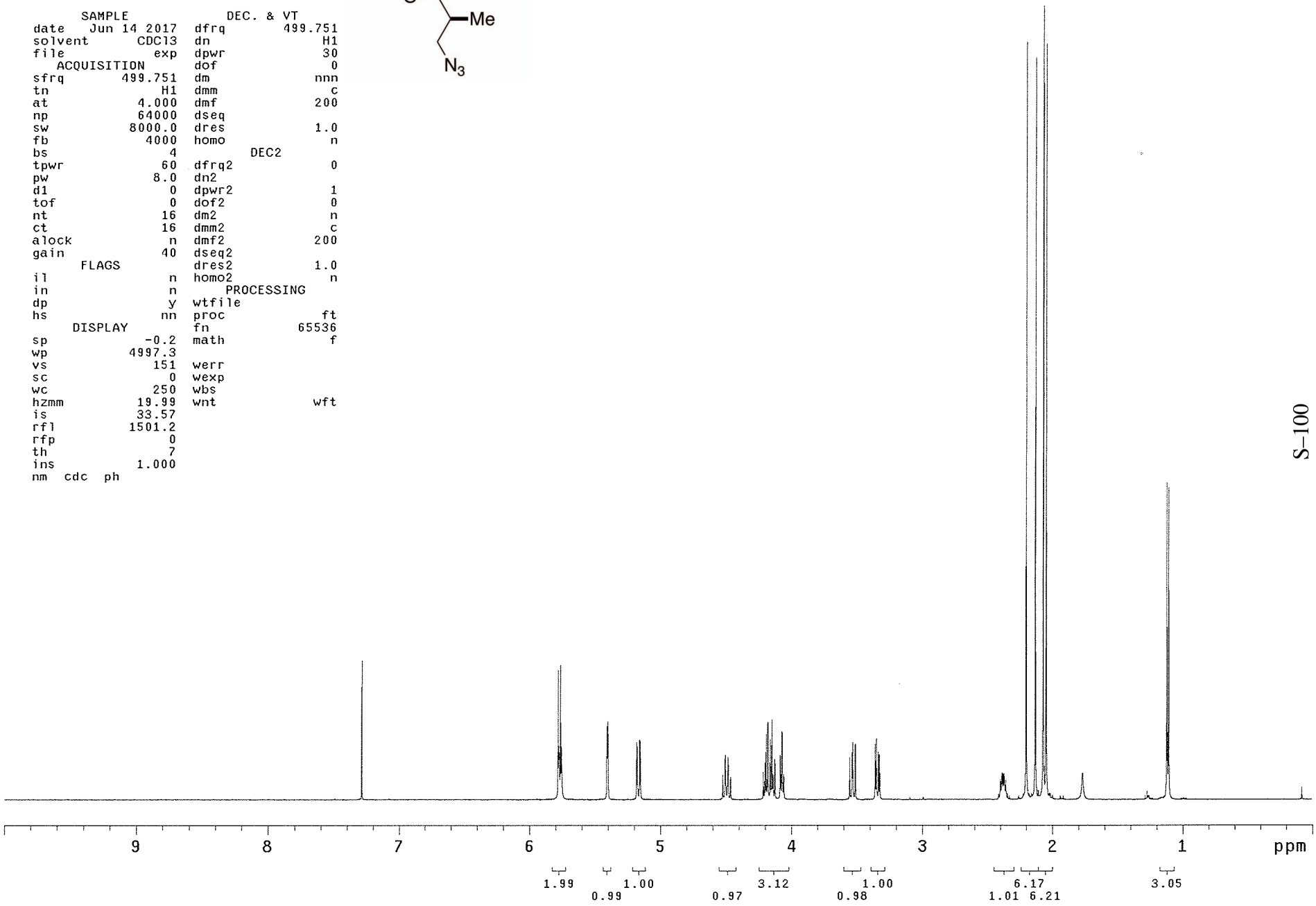

JC2141_13C_CDCl3
exp2 s2pul
SAMPLE
date May 9 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 2000
ct 148
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4484.0
wp 33002.8
vs 10156
sc 0
wc 250
hzmm 5.03
is 500.00
rfl 14180.6
rfp 9696.1
th 17
ins 1.000
174.162
170.735
170.627
170.346
169.817
92.709
77.416
77.160
76.904
71.882
70.311
66.568
61.559
53.933
49.632
41.361
20.839
20.754
20.630
15.444
AcO
AcO
OAc
O
HN
O
N3
Me
OAc
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

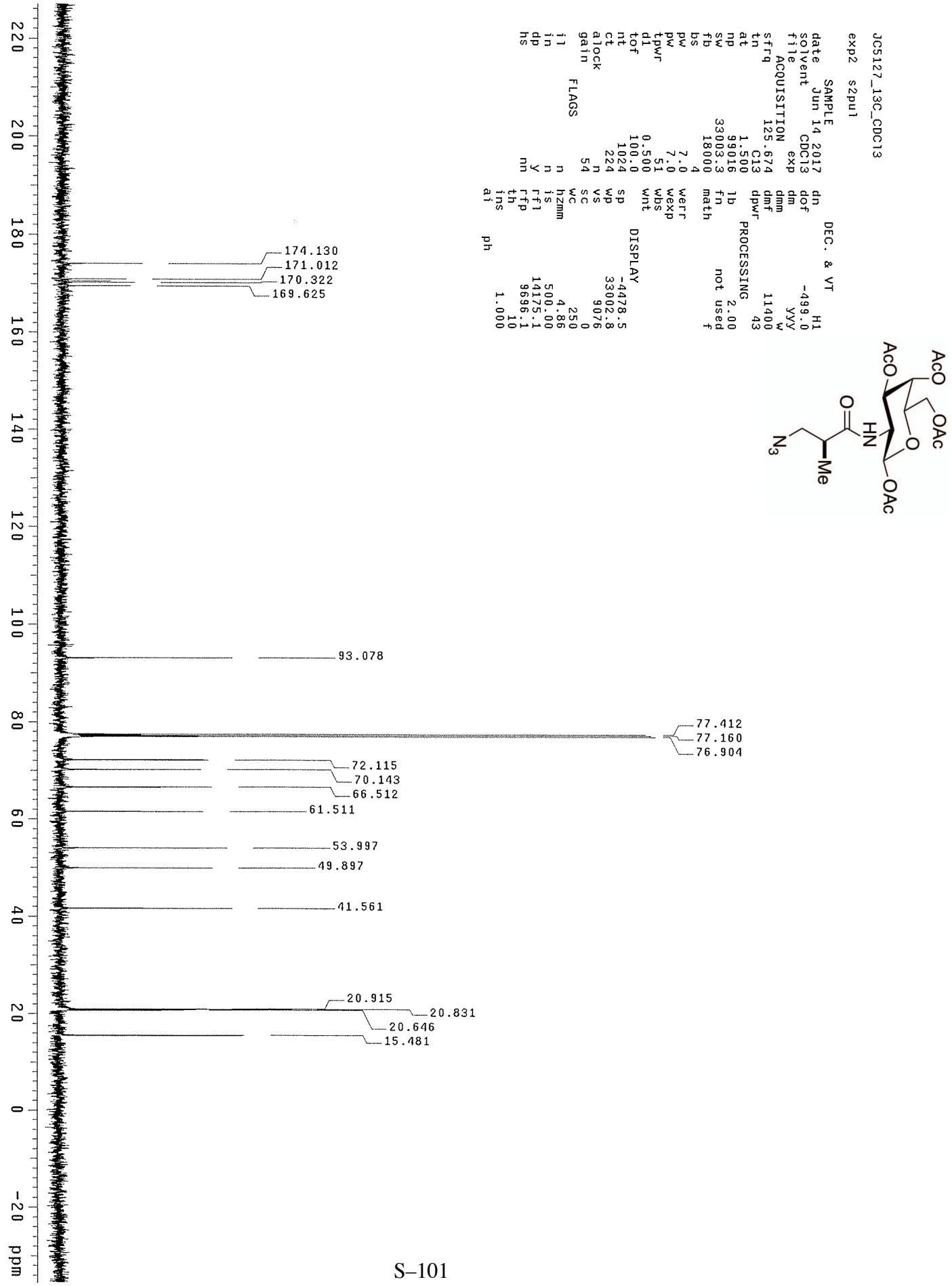


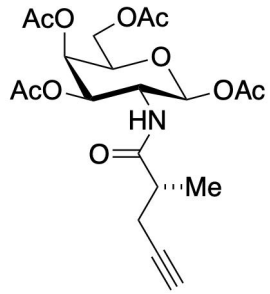
JC5127_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 14 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	1501.2		
rfp	0		
th	7		
ins	1.000		
nm cdc ph			



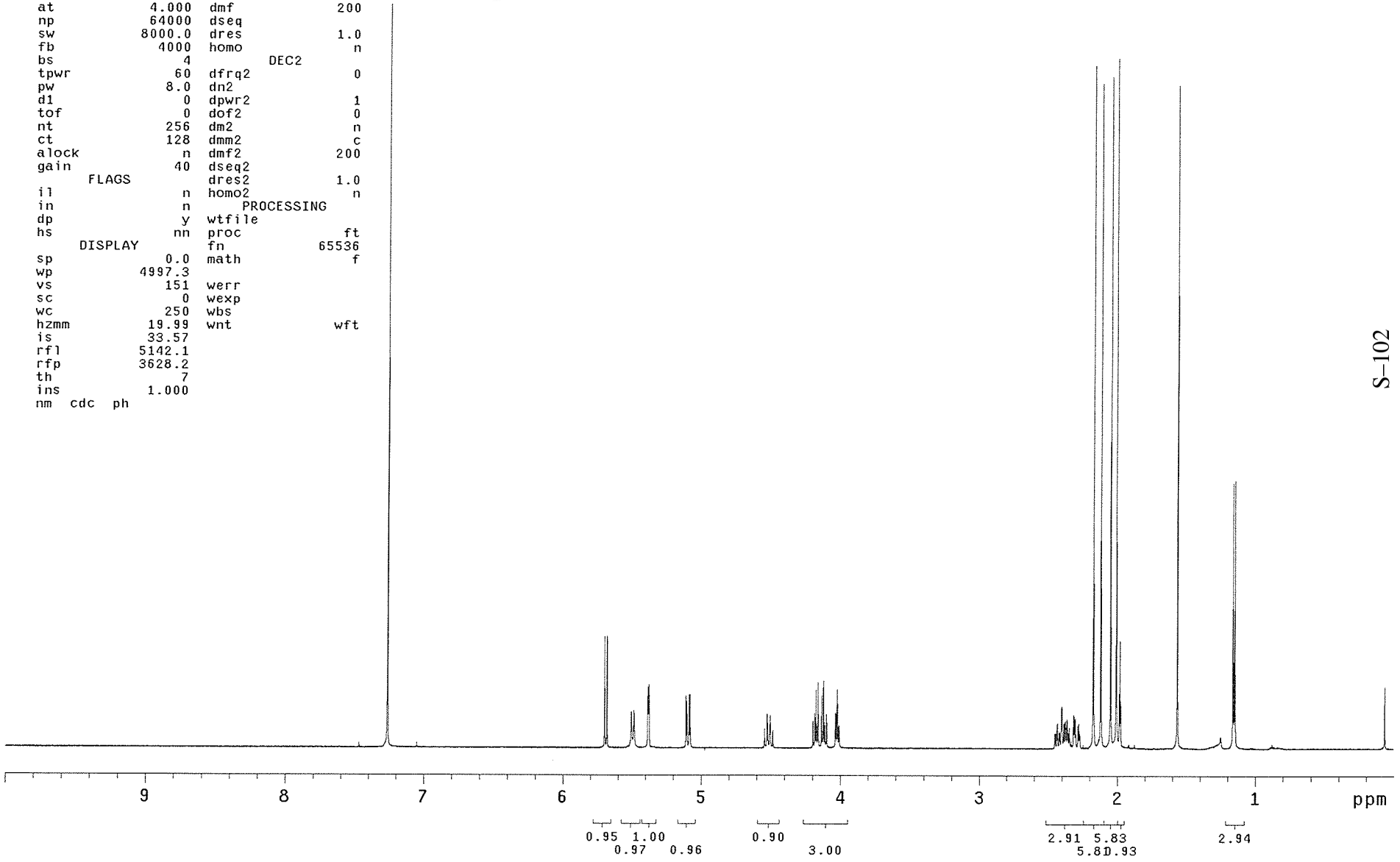

JC5127_13C_CDC13
exp2 s2pul
SAMPLE
date Jun 14 2017
solvent CDC13
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 4
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 224
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
DISPLAY
wc 250
hzmm 4.86
is 500.00
rfl 14175.1
rfp 9696.1
th 10
ins 1.000
AcO
AcO
OAc
OAc
O
HN
N3
Me
174.130
171.012
170.322
169.625
93.078
77.412
77.160
76.904
72.115
70.143
66.512
61.511
53.997
49.897
41.561
20.915
20.831
20.646
15.481
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

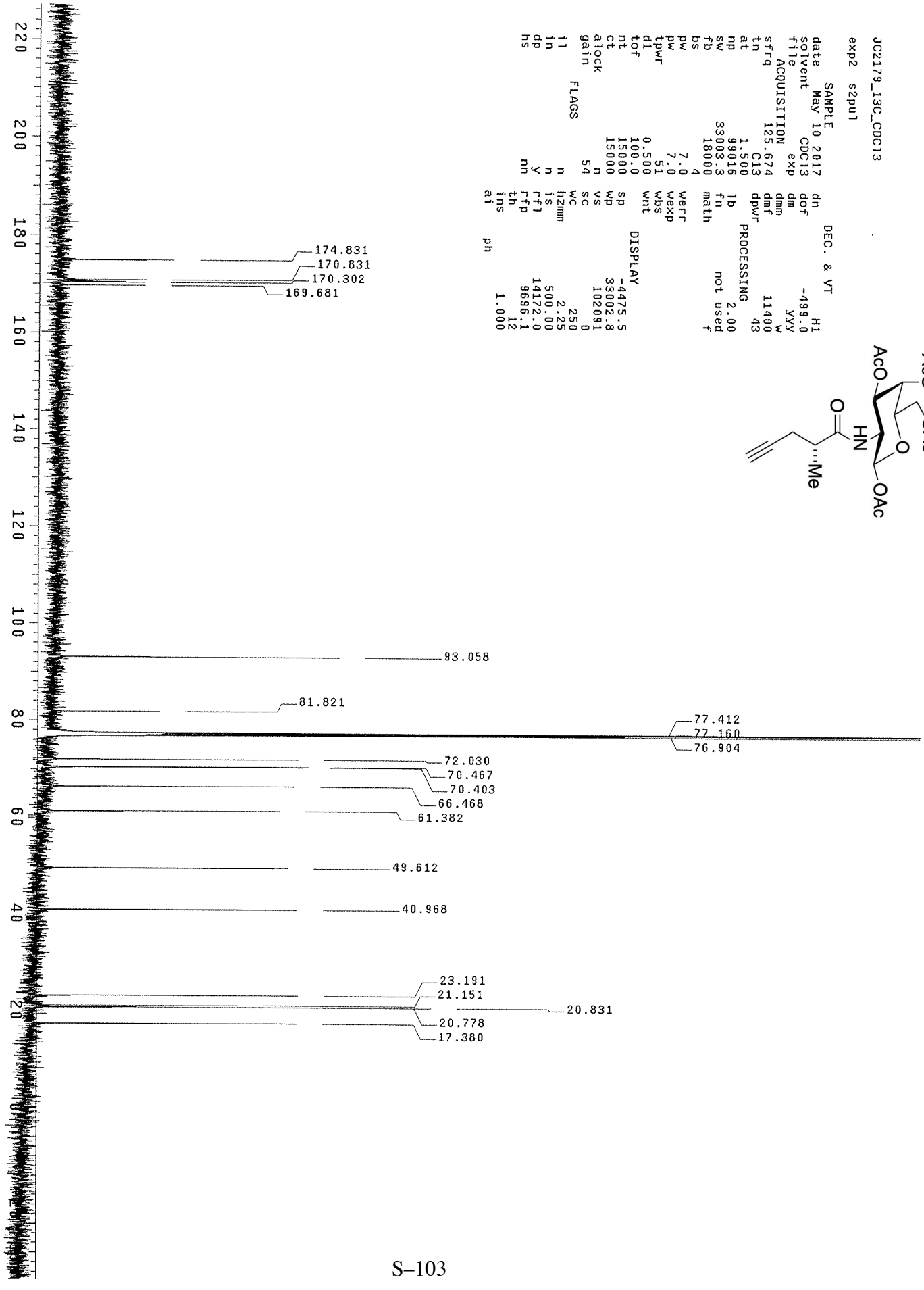


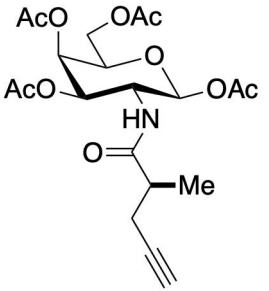
JC2179_1H_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	May 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	256	dm2	n
ct	128	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.1		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			



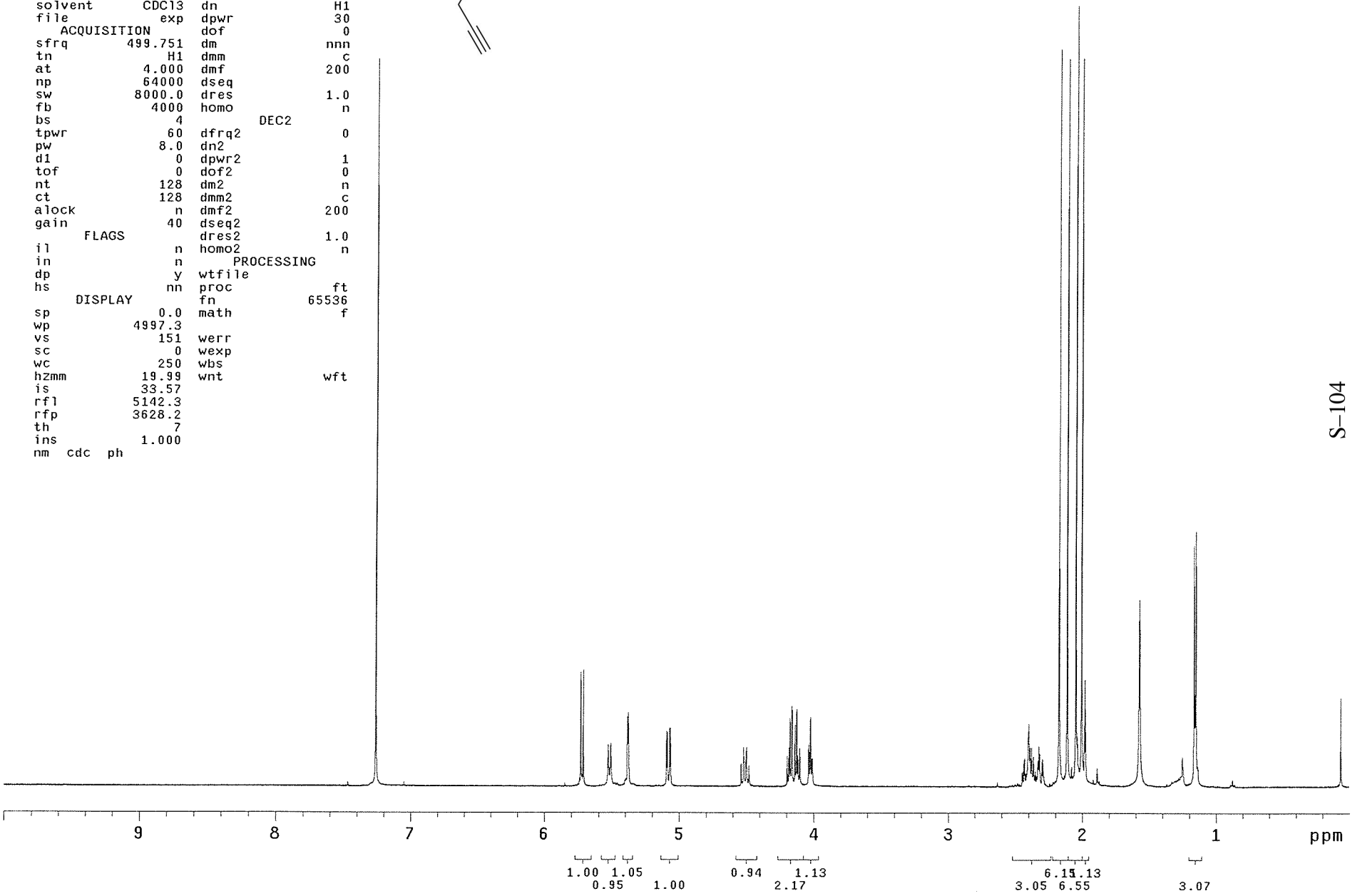

JC2179_13C_CDCl3
exp2 s2pul
SAMPLE
date May 10 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 15000
ct 15000
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
WC 250
hzmm 2.25
is 500.00
rfl 14172.0
rfp 9696.1
th 12
ins 1.000
DISPLAY
sp -4475.5
wp 33002.8
vs 102091
sc 0
wc 250
hzmm 2.25
is 500.00
rfl 14172.0
rfp 9696.1
th 12
ins 1.000
werr
wexp
wbs
wnt
AcO
AcO
OAc
OAc
O
HN
O
Me
174.831
170.831
170.302
169.681
93.058
81.821
77.412
77.160
76.904
72.030
70.467
70.403
66.468
61.382
49.612
40.968
23.191
21.151
20.831
20.778
17.380

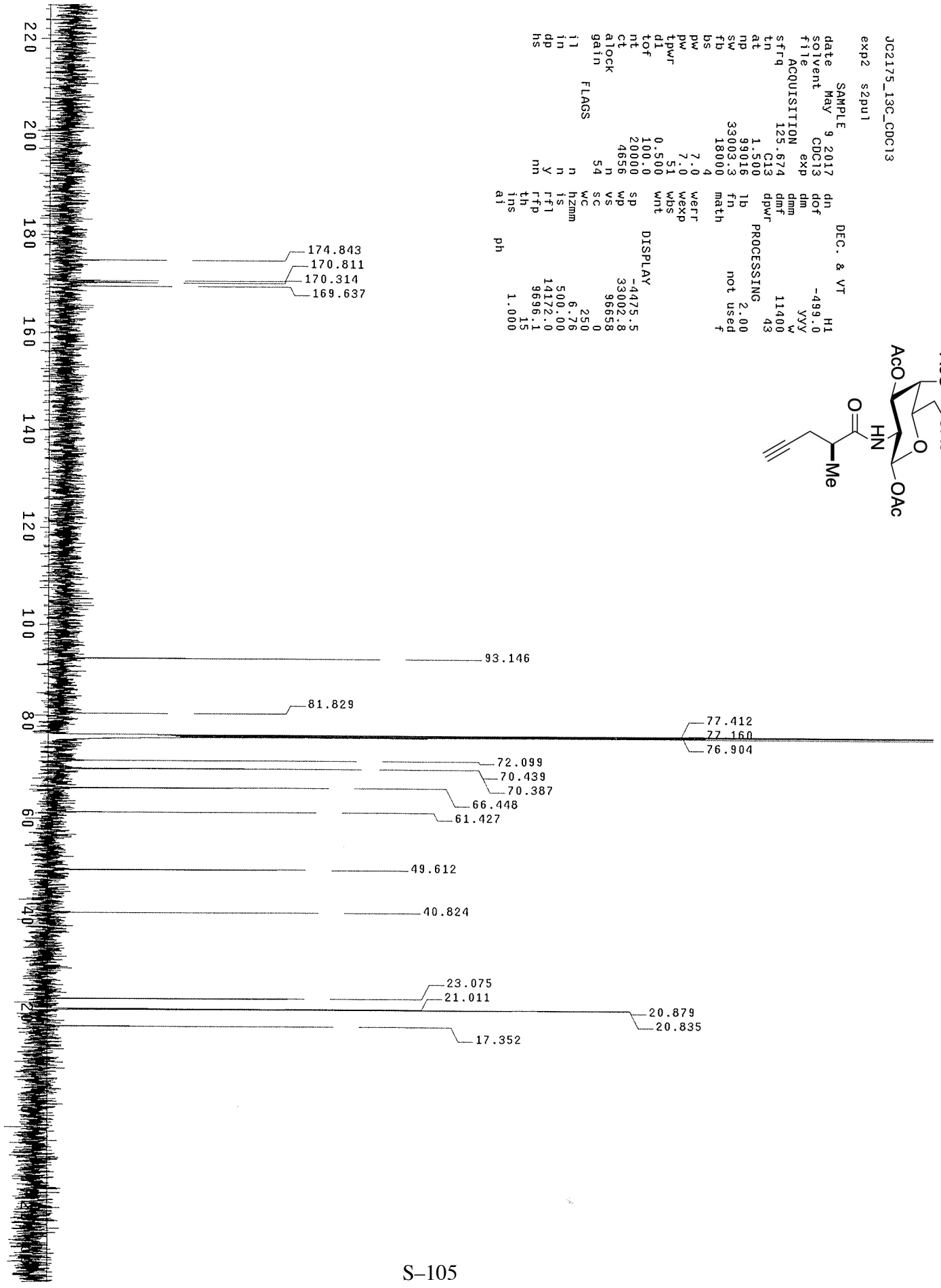


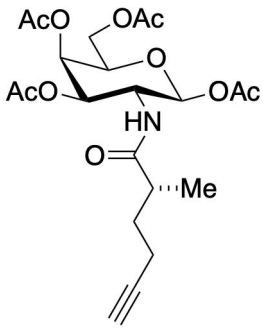
JC2175_1H_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	May 9 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	128	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			



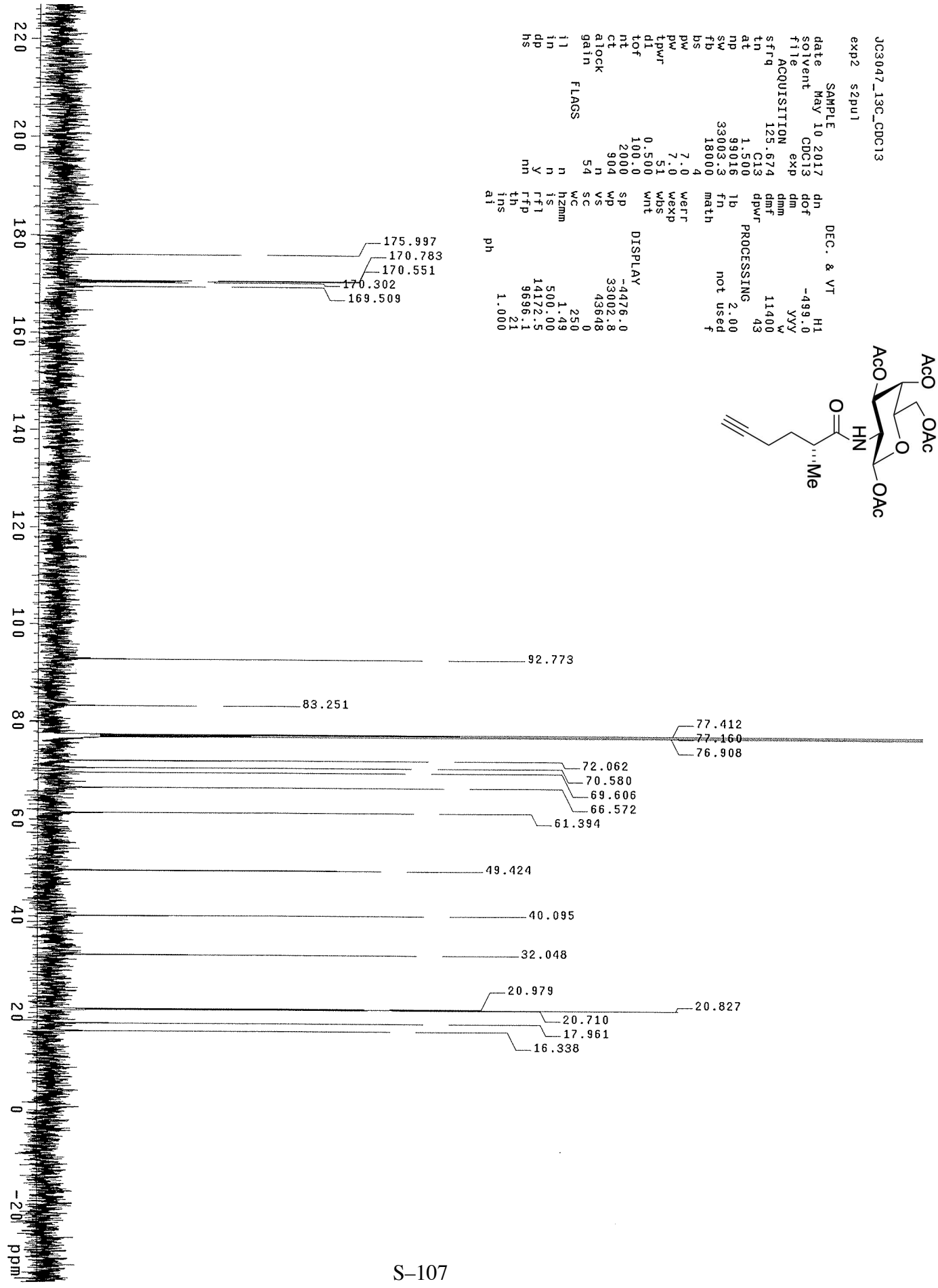

JC2175_13C_CDCl3
exp2 s2pul
SAMPLE
date May 9 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 20000
ct 4656
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4475.5
wp 33002.8
vs 96658
sc 0
wc 250
hzmm 6.76
is 500.00
rfl 14172.0
rfp 9696.1
th 15
ins 1.000
174.843
170.811
170.314
169.637
93.146
81.829
77.412
77.160
76.904
72.099
70.439
70.387
66.448
61.427
49.612
40.824
23.075
21.011
20.879
20.835
17.352
AcO
AcO
OAc
OAc
O
HN
O
Me

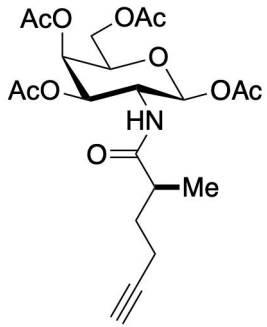


JC3047_1H_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	May 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	100	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	157	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			


JC3047_13C_CDCl3
exp2 s2pul
SAMPLE
date May 10 2017
solvent CDCl3
file
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 2000
ct 904
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
DISPLAY
werr
wexp
wbs
wnt
sp -4476.0
wp 33002.8
vs 43648
sc 0
wc 250
hzmm 1.49
is 500.00
rfl 14172.5
rfp 9696.1
th 21
ins 1.000
ai
ph
AcO
AcO
OAc
OAc
O
HN
O
Me
175.997
170.783
170.551
170.302
169.509
92.773
83.251
77.412
77.160
76.908
72.062
70.580
69.606
66.572
61.394
49.424
40.095
32.048
20.979
20.827
20.710
17.961
16.338
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

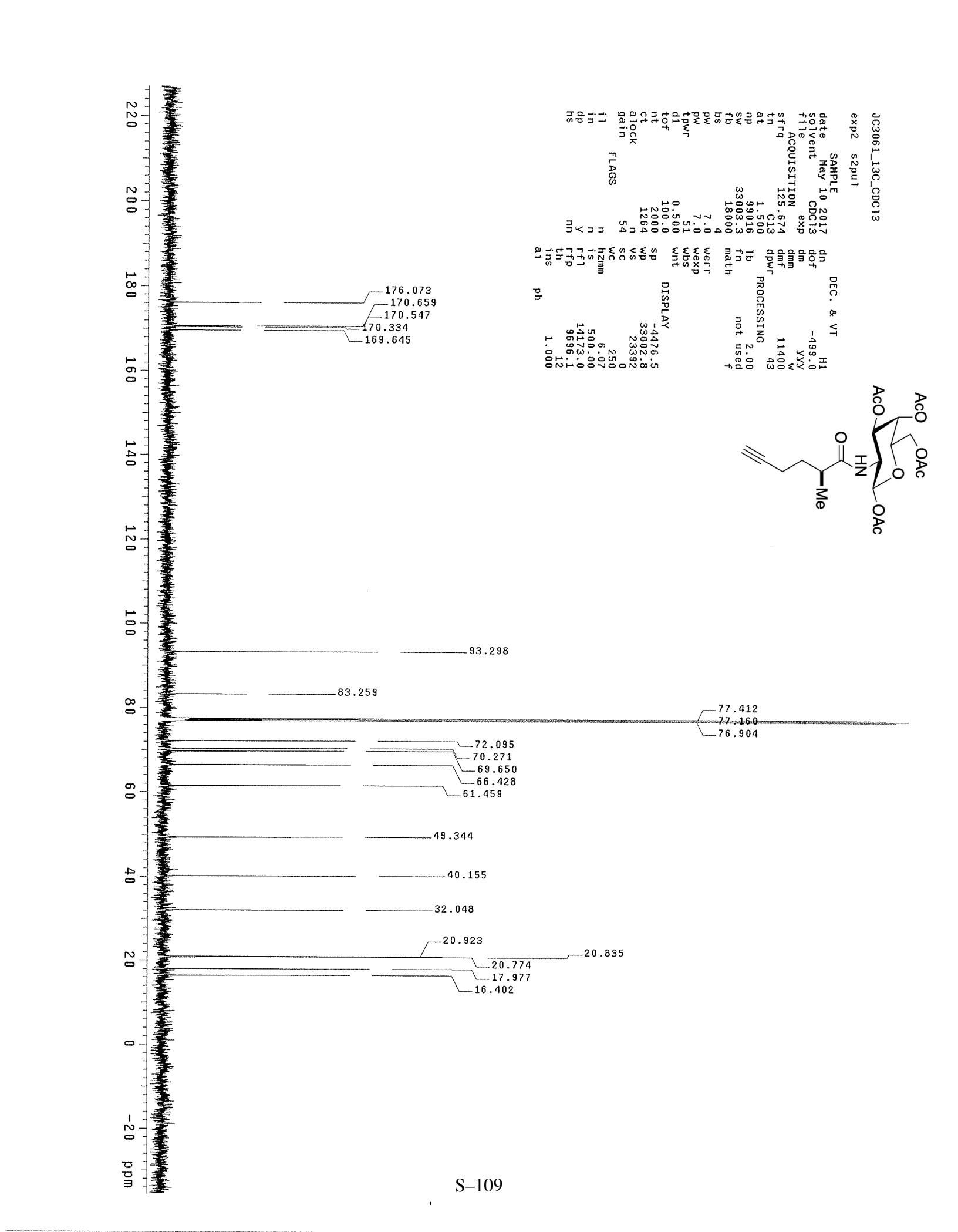


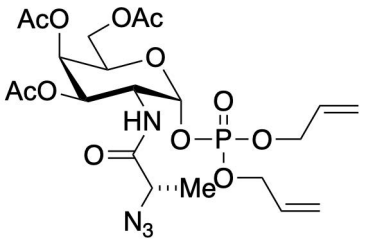
JC3061_1H_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT		DEC2	
date	May 10 2017	dfrq	499.751	dfrq2	0
solvent	CDCl3	dn	H1	dn2	
file	exp	dpwr	30	dpwr2	1
ACQUISITION		dof	0	dof2	0
sfrq	499.751	dm	nnn	dm2	n
tn	H1	dmm	c	dmm2	c
at	4.000	dmf	200	dmf2	200
np	64000	dseq		dseq2	
sw	8000.0	dres	1.0	dres2	1.0
fb	4000	homo	n	homo2	n
bs	4				
tpwr	60				
pw	8.0				
d1	0				
tof	0				
nt	128				
ct	100				
alock	n				
gain	40				
FLAGS				PROCESSING	
il	n			wtfile	
in	n			proc	ft
dp	y			fn	65536
hs	nn			math	f
DISPLAY					
sp	0.0			werr	
wp	4997.3			wexp	
vs	381			wbs	
sc	0			wnt	wft
wc	250				
hzmm	19.99				
is	33.57				
rfl	5142.3				
rfp	3628.2				
th	7				
ins	1.000				

nm cdc ph

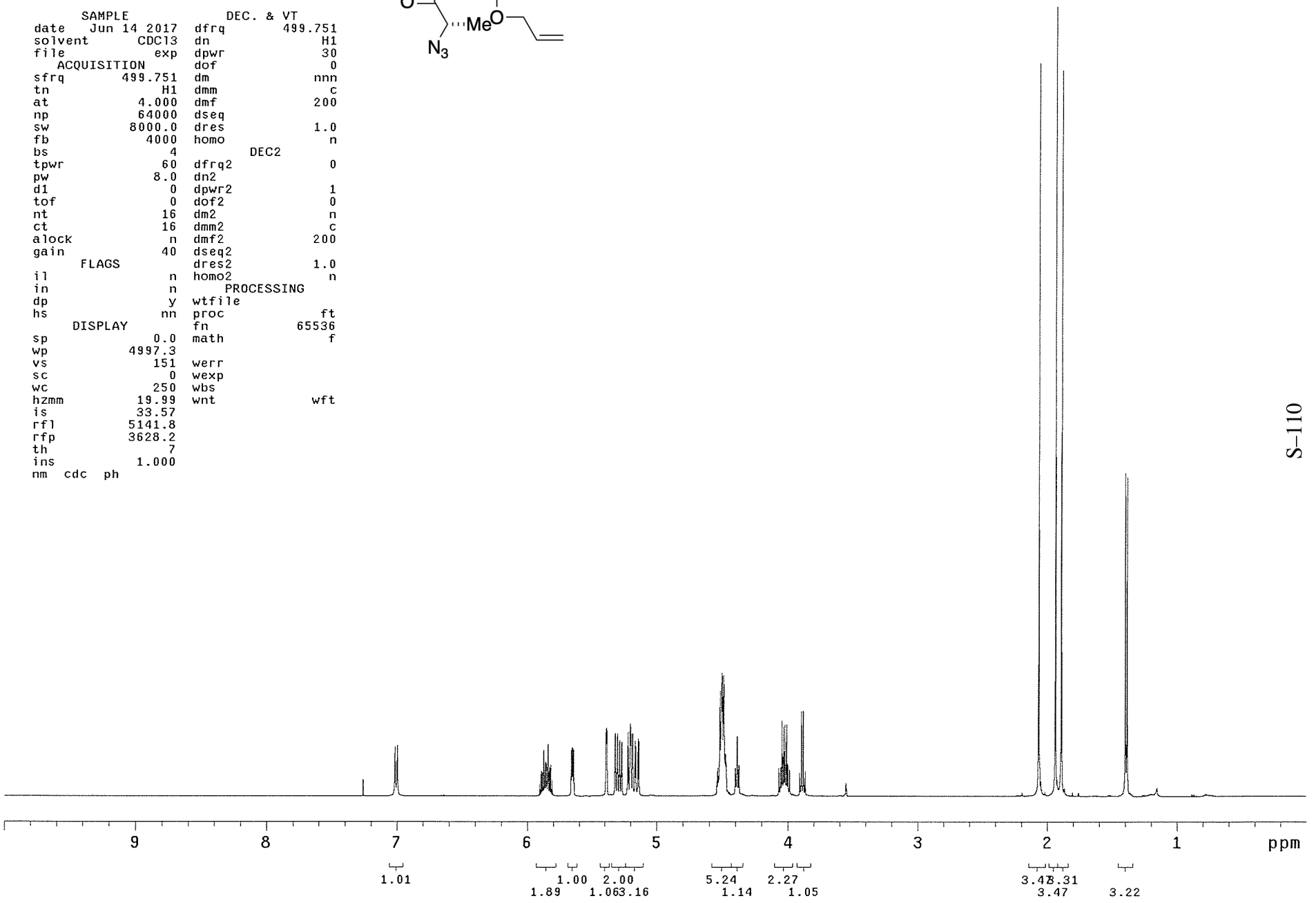

JC3061_13C_CDCl3
exp2 s2pul
SAMPLE
date May 10 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 2000
ct 1264
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4476.5
wp 33002.8
vs 23392
sc 0
wc 250
hzmm 6.07
is 500.00
rfl 14173.0
rfp 9696.1
th 12
ins 1.000
ai
ph
AcO
AcO
OAc
OAc
O
HN
O
Me
176.073
170.659
170.547
170.334
169.645
93.298
83.259
77.412
77.160
76.904
72.095
70.271
69.650
66.428
61.459
49.344
40.155
32.048
20.923
20.835
20.774
17.977
16.402
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

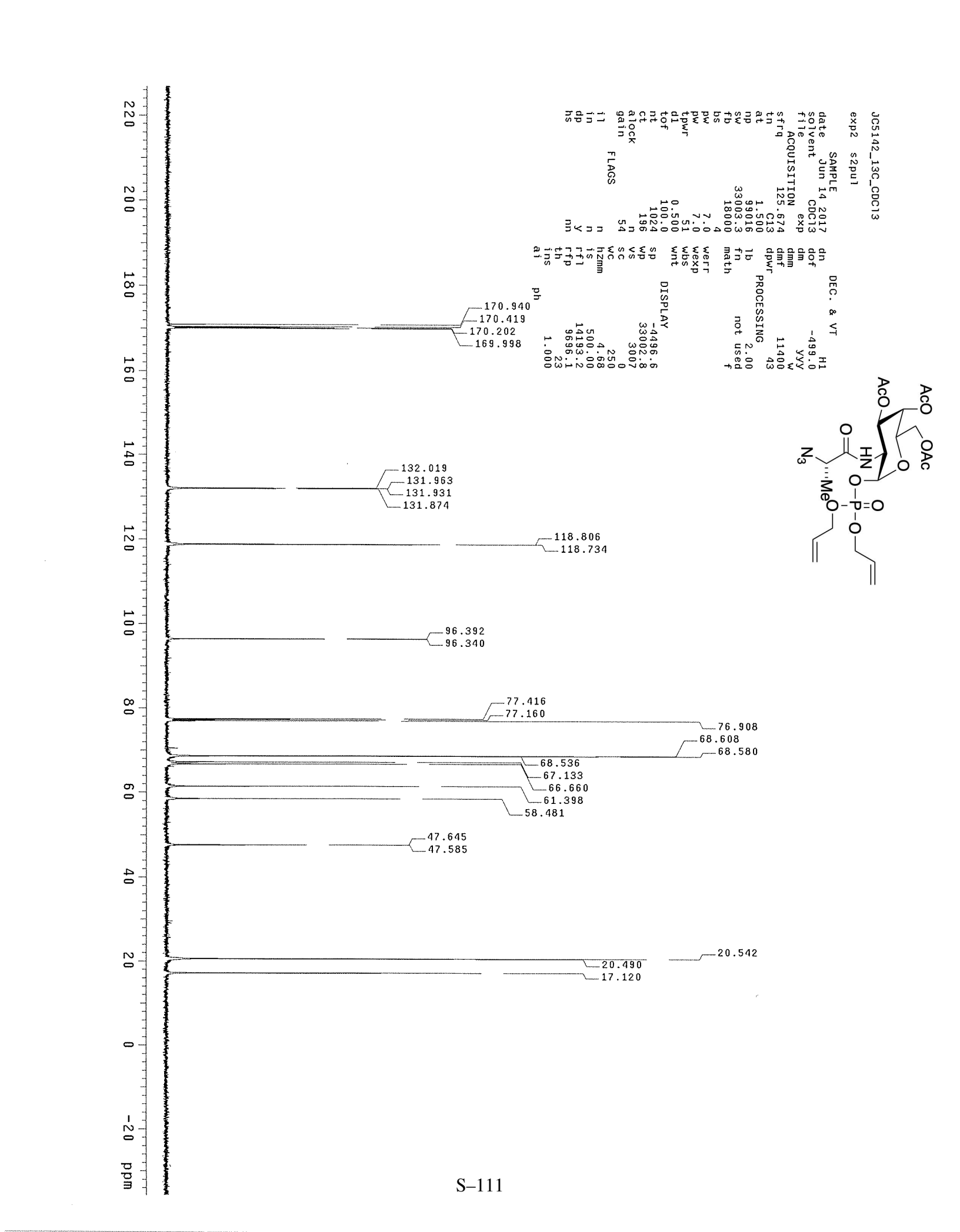


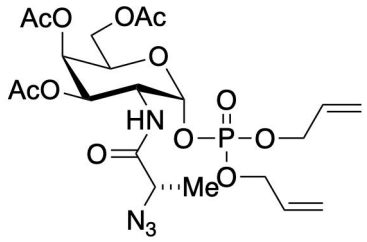
JC5142_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 14 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.8		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			




JC5142_13C_CDC13
exp2 s2pul
SAMPLE
date Jun 14 2017
solvent CDC13
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 196
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4496.6
wp 33002.8
vs 3007
sc 0
wc 250
hzmm 4.68
is 500.00
rfl 14193.2
rfp 9696.1
th 23
ins 1.000
ai
ph
170.940
170.419
170.202
169.998
132.019
131.963
131.931
131.874
118.806
118.734
96.392
96.340
77.416
77.160
76.908
68.608
68.580
68.536
67.133
66.660
61.398
58.481
47.645
47.585
20.542
20.490
17.120
AcO
AcO
OAc
O
HN
O
N3
MeO
O-P=O
O
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

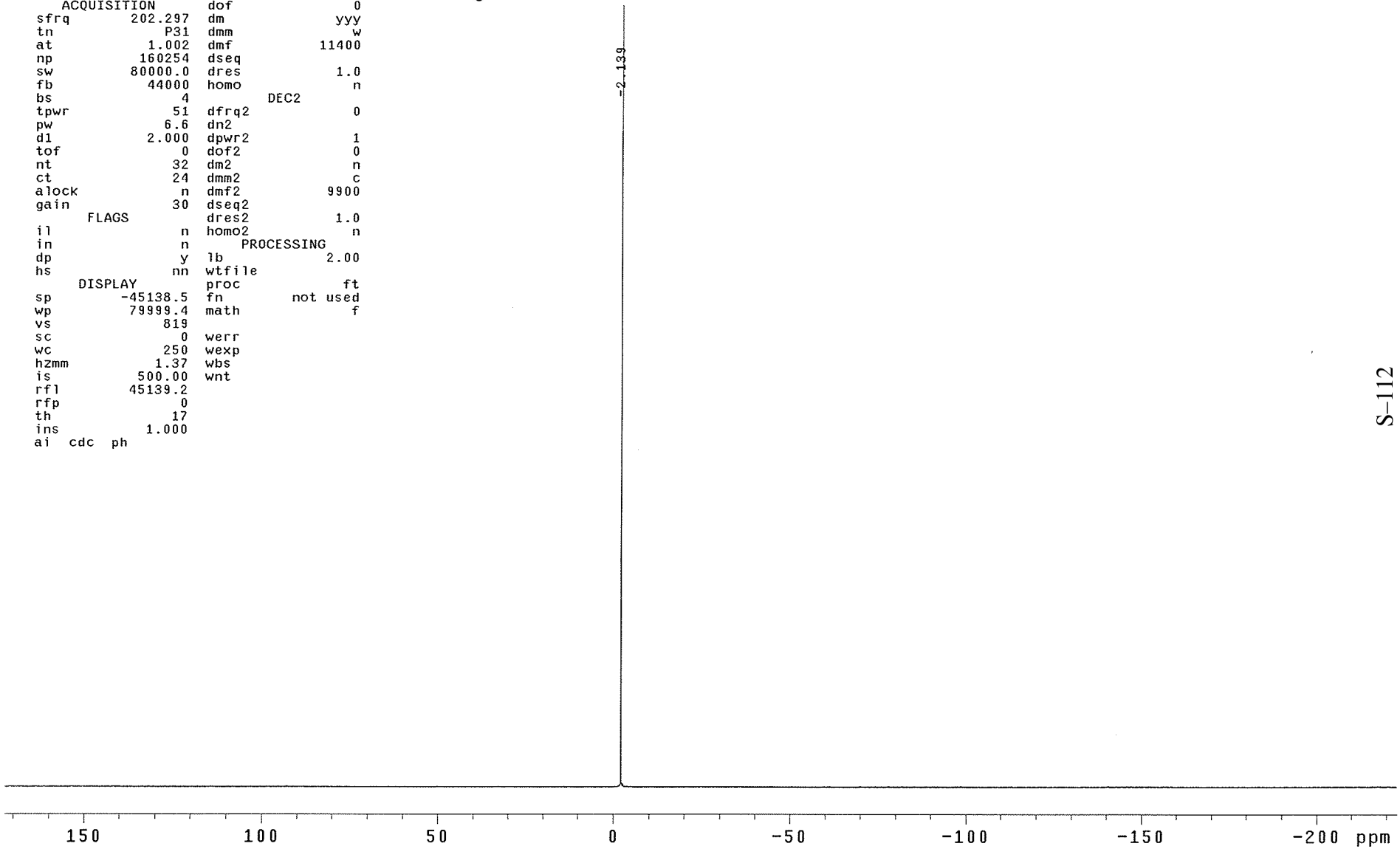


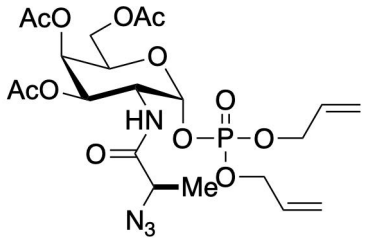
JC5142_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 14 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	24	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45138.5	fn	not used
wp	79999.4	math	f
vs	819		
sc	0	werr	
wc	250	wexp	
hzmm	1.37	wbs	
is	500.00	wnt	
rfl	45139.2		
rfp	0		
th	17		
ins	1.000		

ai cdc ph

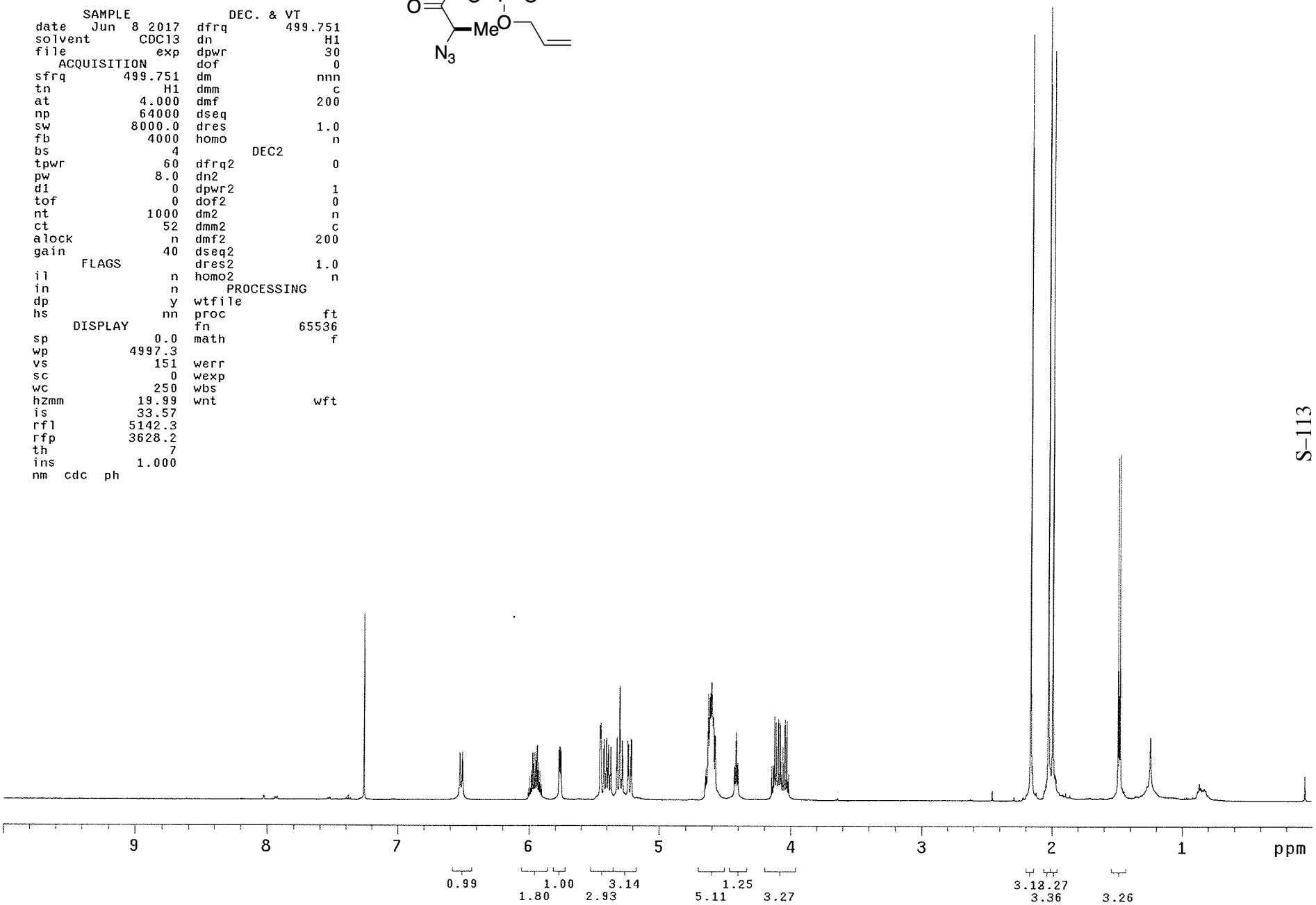


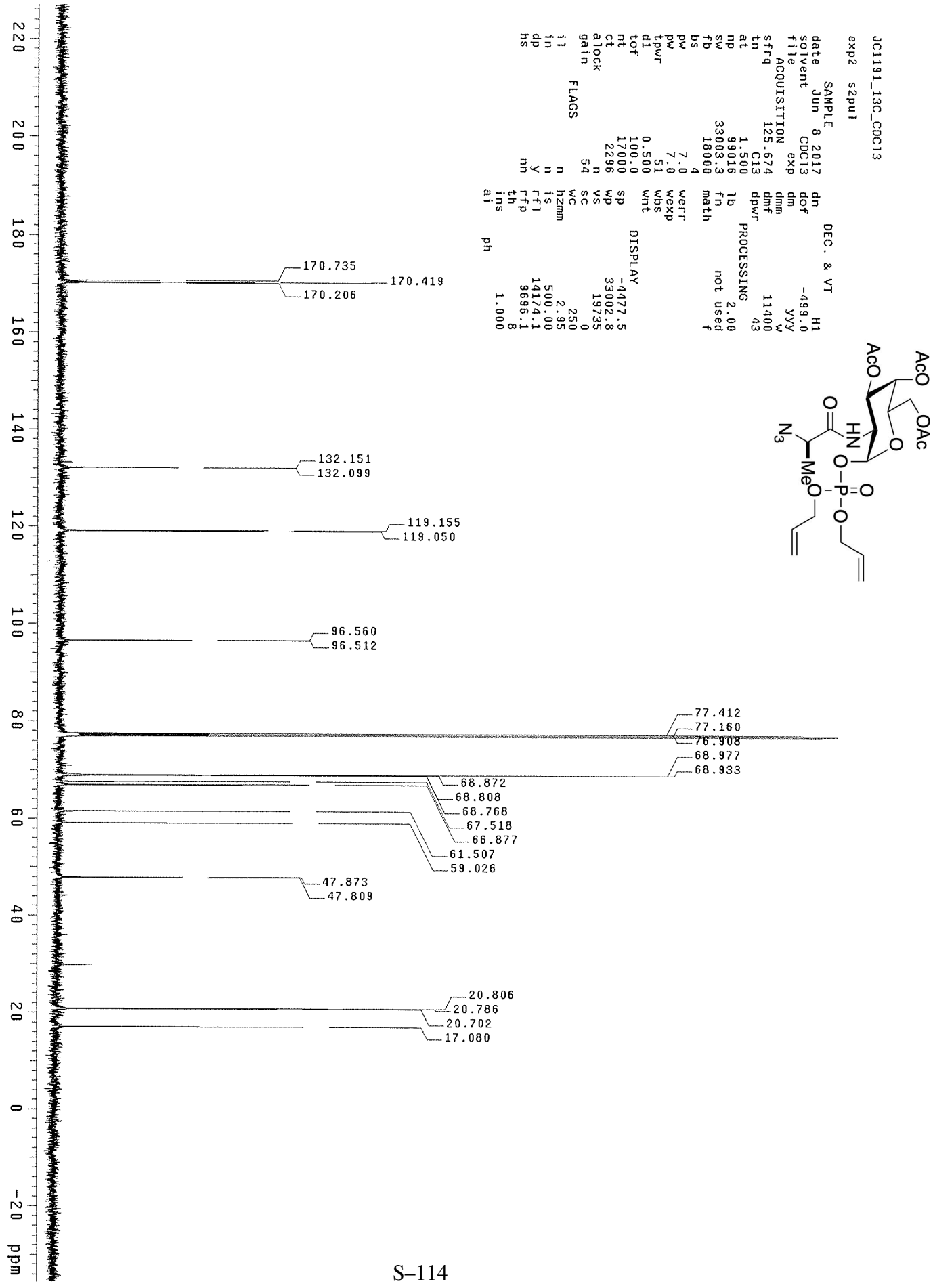


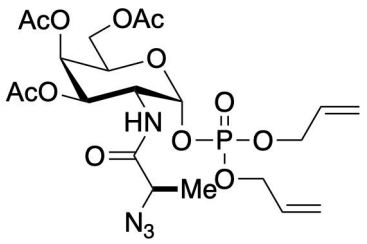
JC1191_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 8 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	1000	dm2	n
ct	52	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			




JC1191_13C_CDCl3
exp2 s2pul
SAMPLE
date Jun 8 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 17000
ct 2296
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4477.5
wp 33002.8
vs 19735
sc 0
wc 250
hzmm 2.95
is 500.00
rfl 14174.1
rfp 9696.1
th 8
ins 1.000
ai
ph
AcO
AcO
OAc
HN
O
N3
MeO
O
P
O
O
O
170.735
170.419
170.206
132.151
132.099
119.155
119.050
96.560
96.512
77.412
77.160
76.908
68.977
68.933
68.872
68.808
68.768
67.518
66.877
61.507
59.026
47.873
47.809
20.806
20.786
20.702
17.080
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

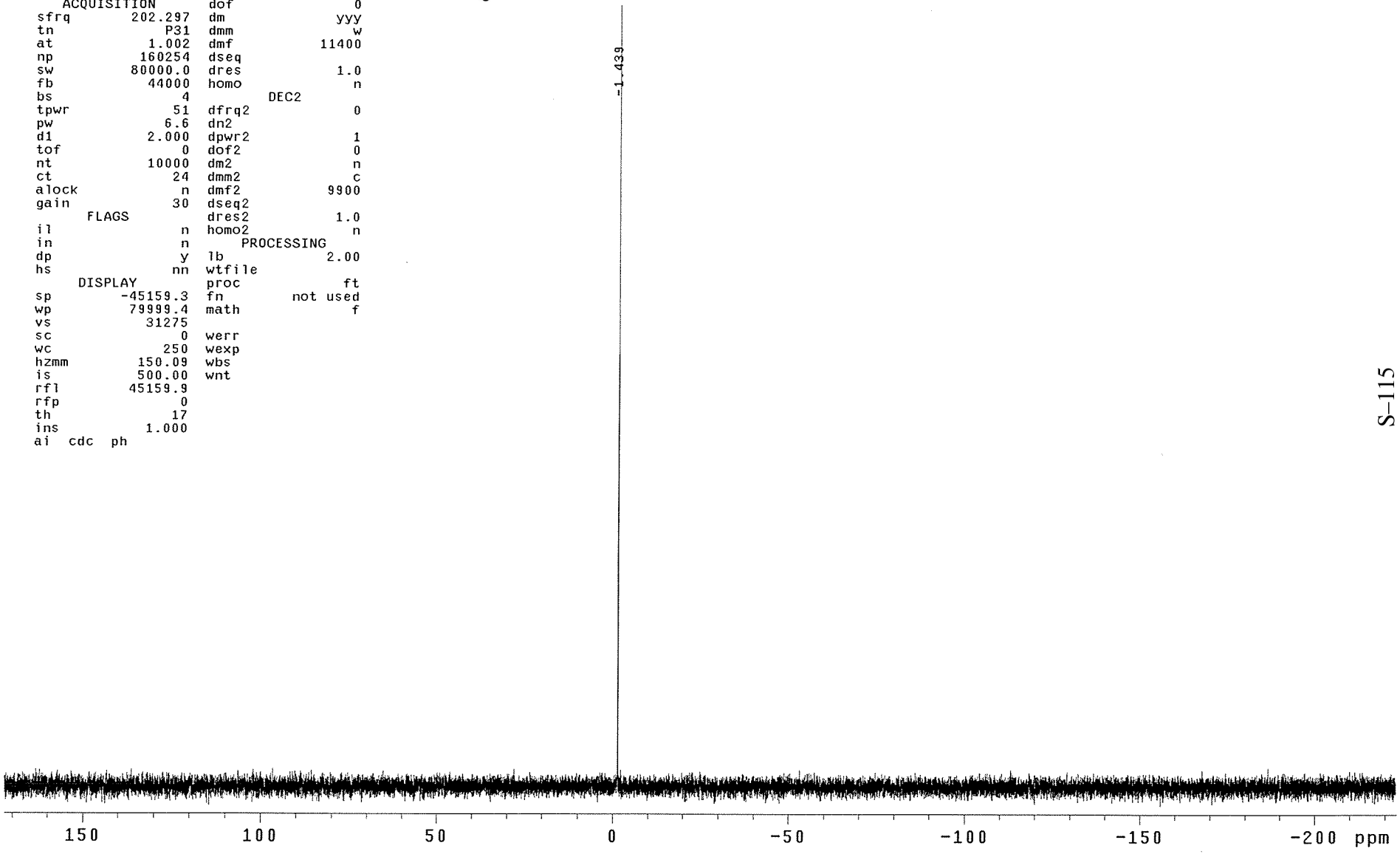


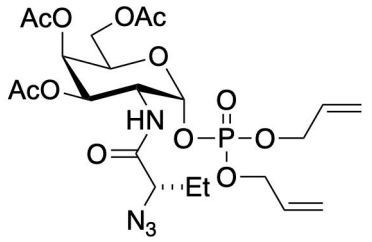
JC1191_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 9 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	10000	dm2	n
ct	24	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45159.3	fn	not used
wp	79999.4	math	f
vs	31275		
sc	0	werr	
wc	250	wexp	
hzmm	150.09	wbs	
is	500.00	wnt	
rfl	45159.9		
rfp	0		
th	17		
ins	1.000		

ai cdc ph



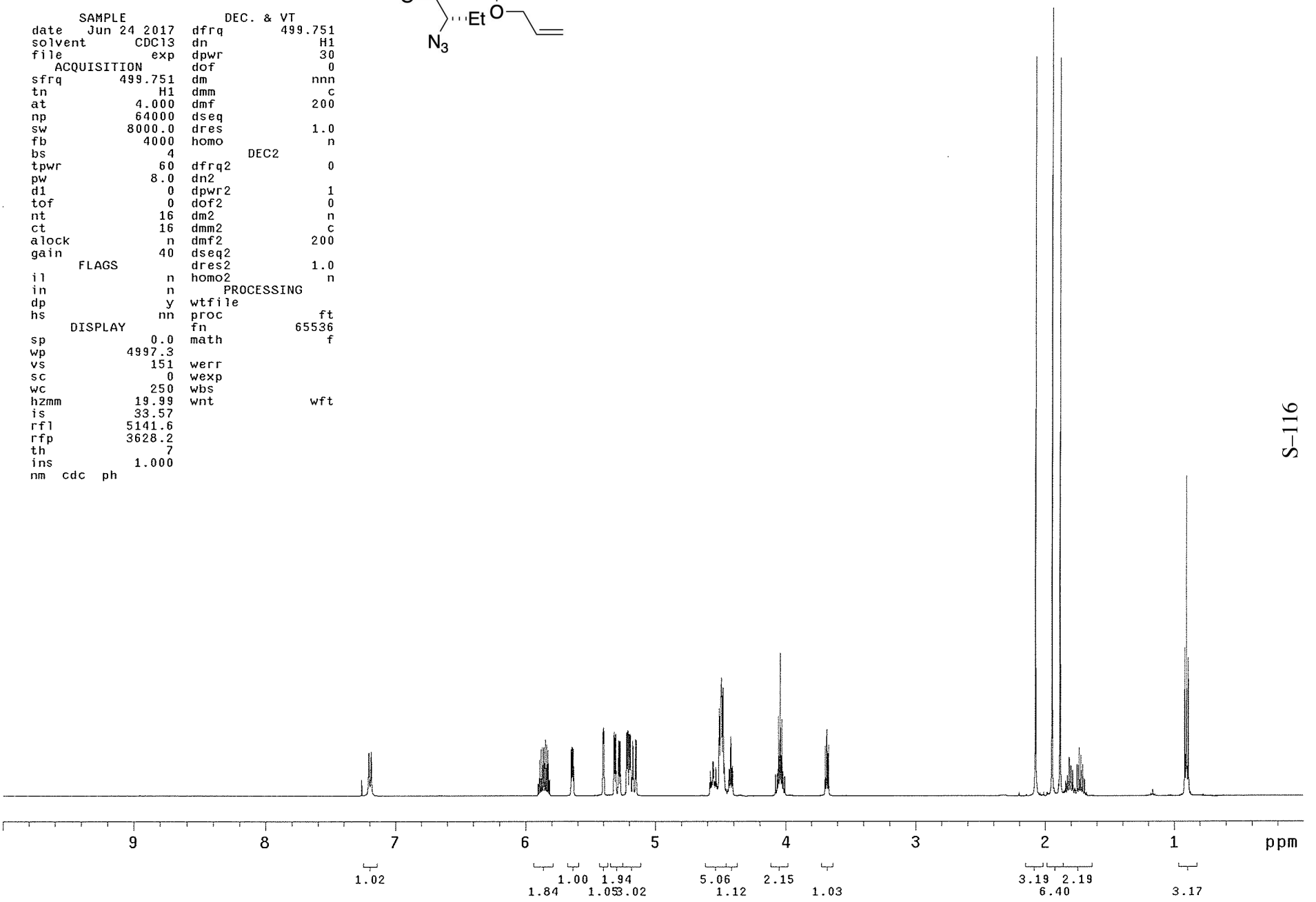


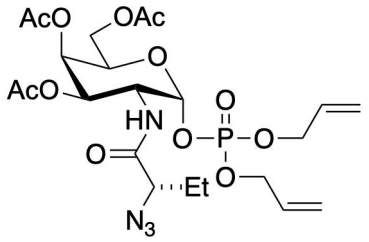
JC5155_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 24 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.6		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph

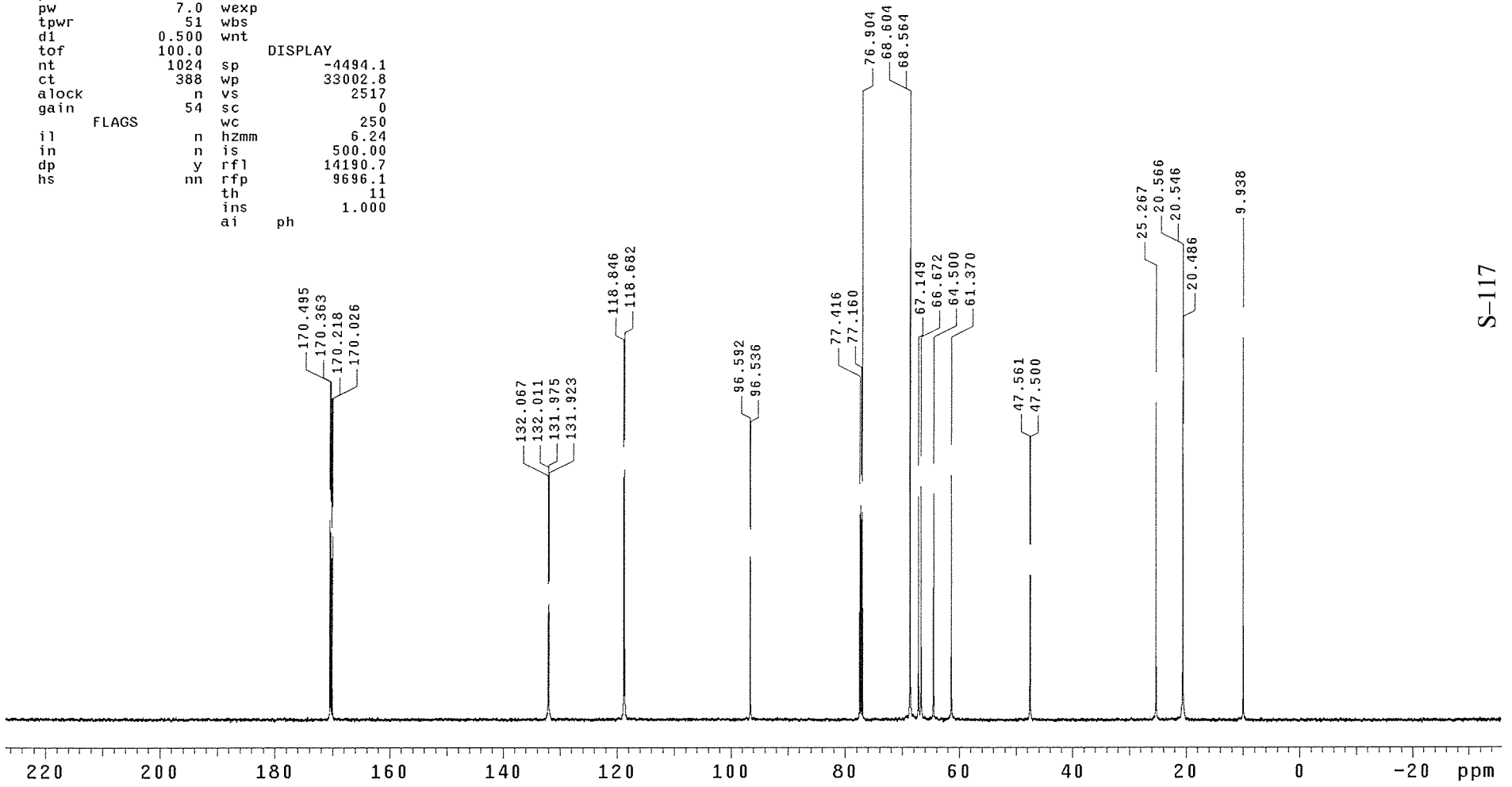


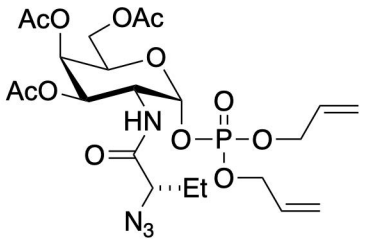


JC5155_13C_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 24 2017	dn	H1
solvent	CDCl3	dof	-499.0
file	exp	dm	yyy
ACQUISITION		dmm	w
sfrq	125.674	dmf	11400
tn	C13	dpwr	43
at	1.500	PROCESSING	
np	99016	lb	2.00
sw	33003.3	fn	not used
fb	18000	math	f
bs	4		
pw	7.0	werr	
pw	7.0	wexp	
tpwr	51	wbs	
d1	0.500	wnt	
tof	100.0	DISPLAY	
nt	1024	sp	-4494.1
ct	388	wp	33002.8
alock	n	vs	2517
gain	54	sc	0
FLAGS		wc	250
il	n	hzmm	6.24
in	n	is	500.00
dp	y	rfl	14190.7
hs	nn	rfp	9696.1
		th	11
		ins	1.000
		ai ph	

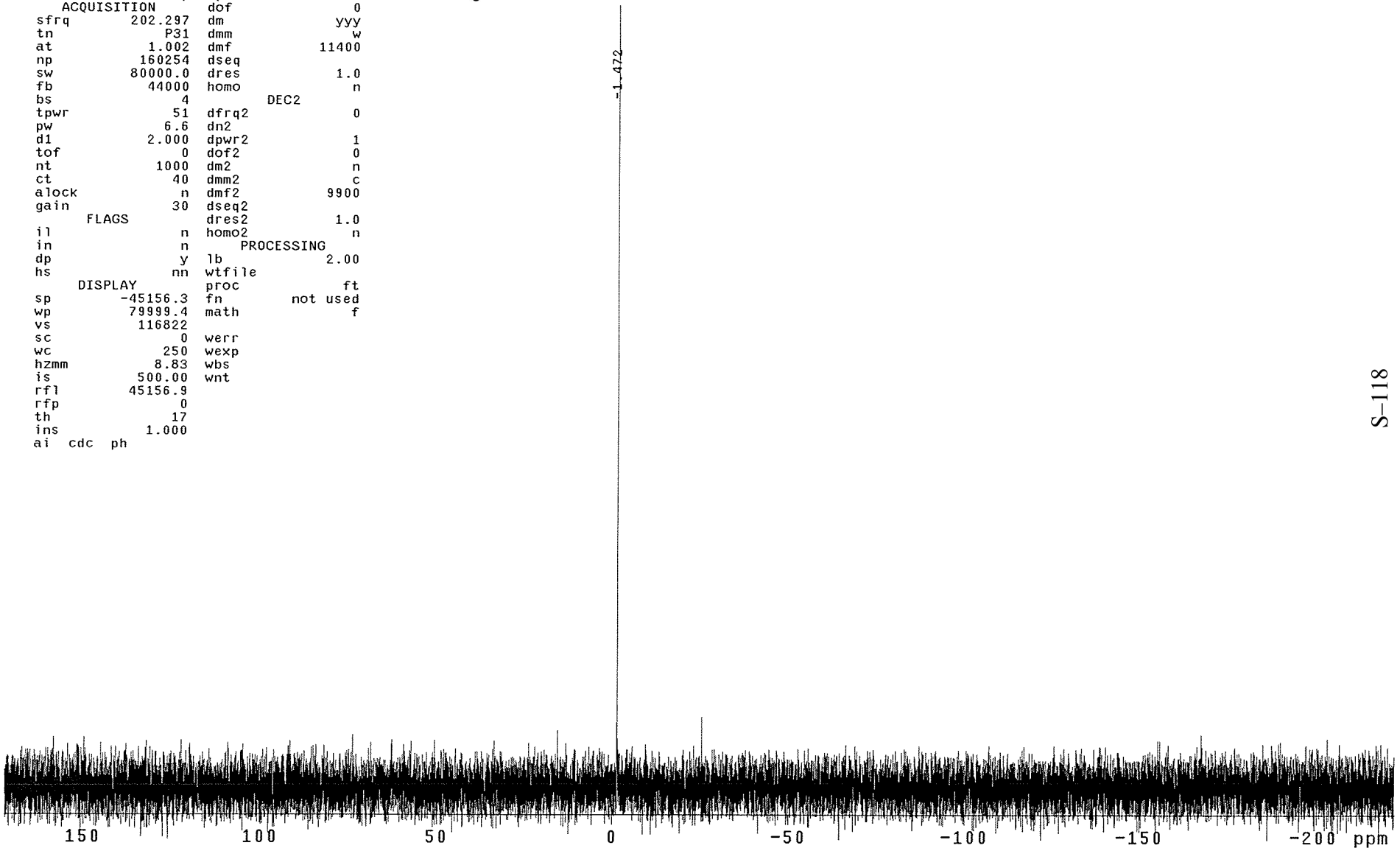


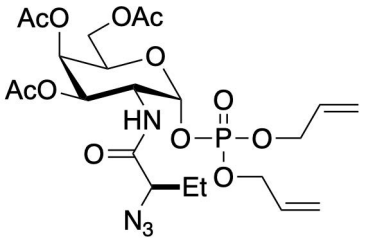


JC1187_31P_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	Jun 9 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	1000	dm2	n
ct	40	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45156.3	fn	not used
wp	79999.4	math	f
vs	116822		
sc	0	werr	
wc	250	wexp	
hzmm	8.83	wbs	
is	500.00	wnt	
rfl	45156.9		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



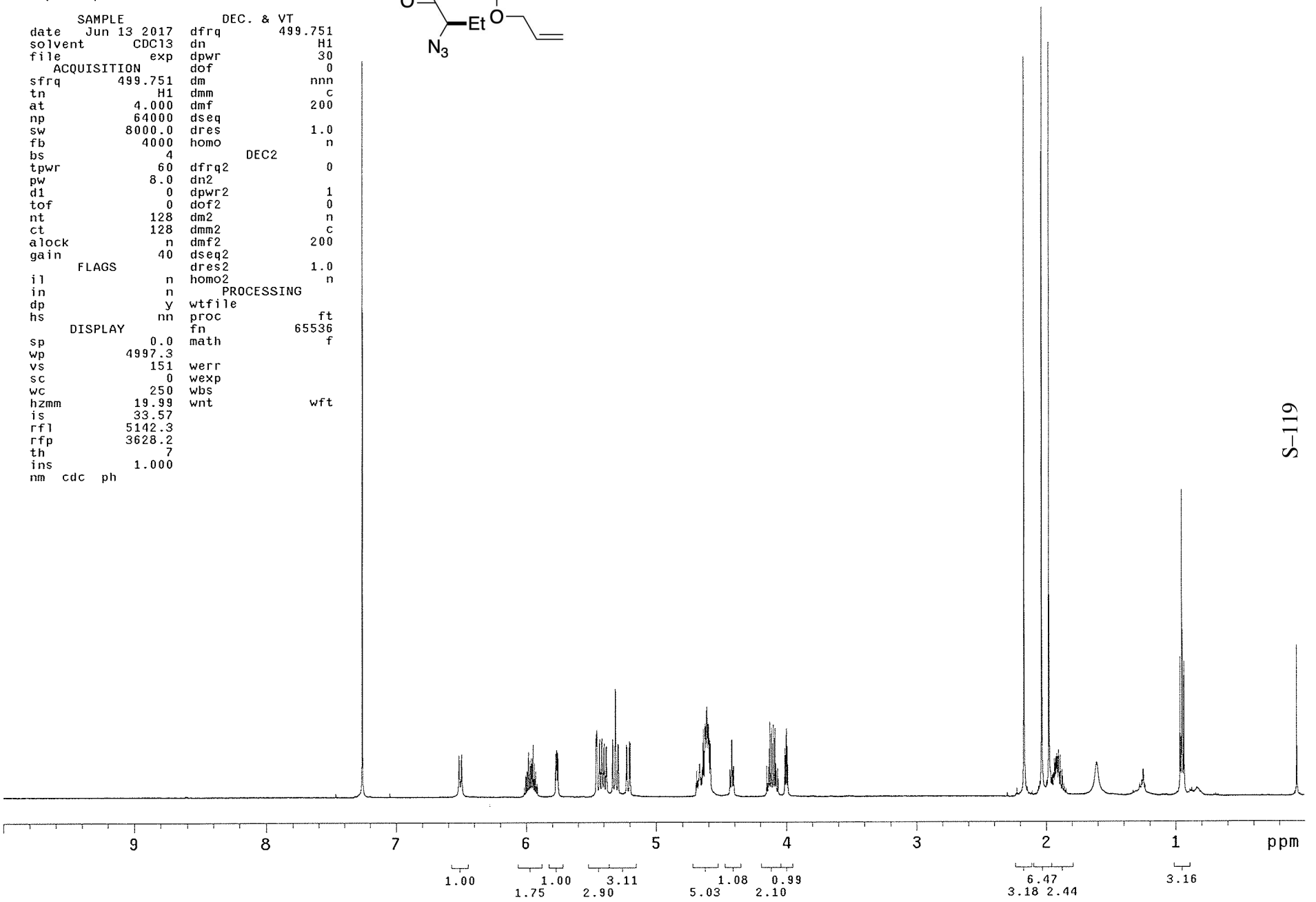


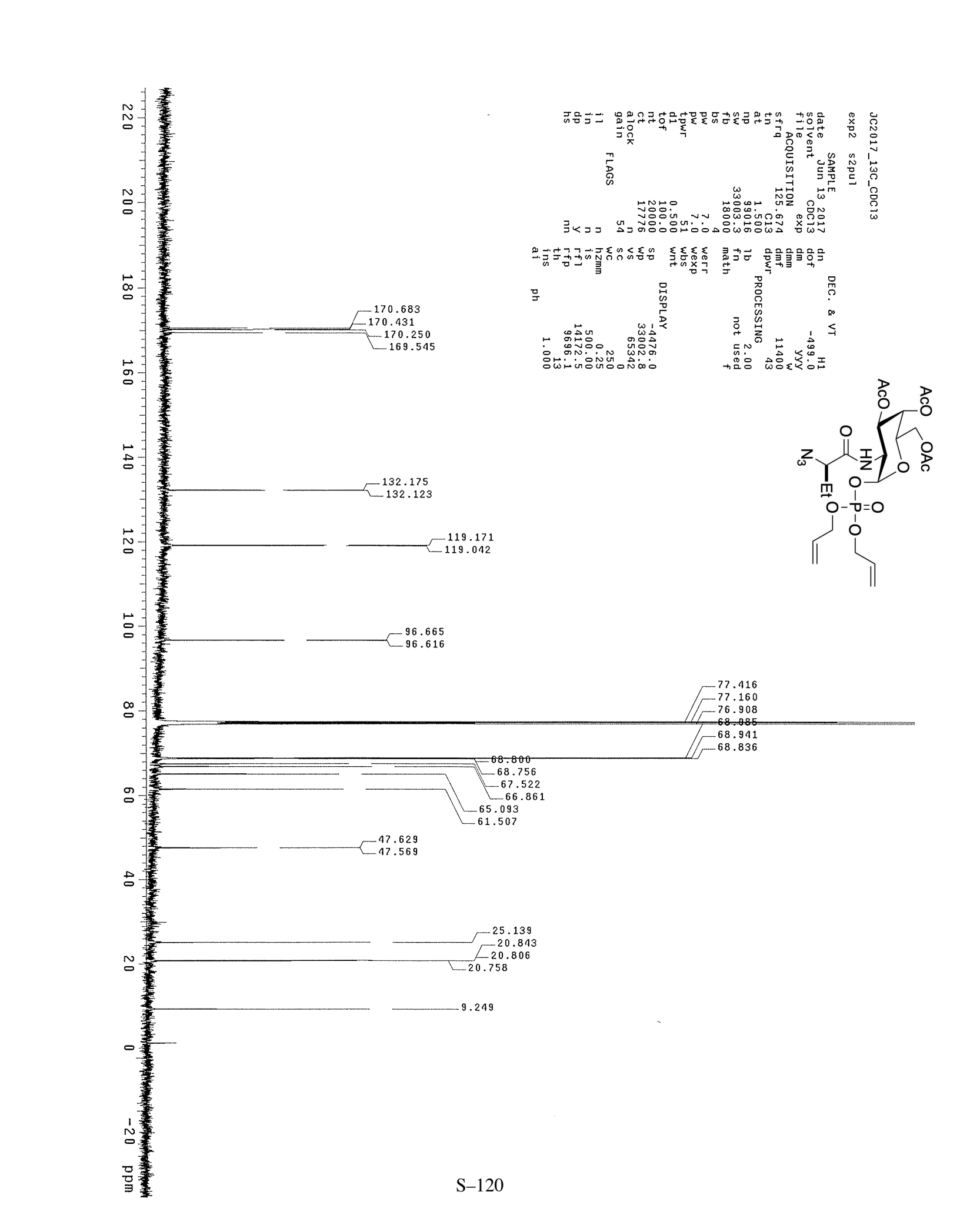
JC2017_1H_CDCl3

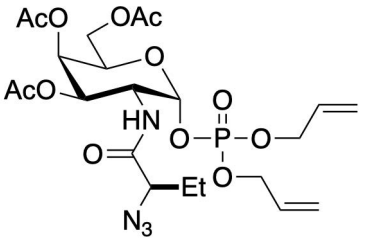
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	128	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph




JC2017_13C_CDC13
exp2 s2pul
SAMPLE
date Jun 13 2017
solvent CDC13
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 20000
ct 17776
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai ph
dn
dof
dm
dmm
dmf
dpwr
PROCESSING
lb
fn
math
werr
wexp
wbs
wnt
DISPLAY
sp
wp
vs
sc
wc
hzmm
is
rfl
rfp
th
ins
DEC. & VT
H1
-499.0
yyy
w
11400
43
2.00
not used
f
-4476.0
33002.8
65342
0
250
0.25
500.00
14172.5
9696.1
13
1.000
170.683
170.431
170.250
169.545
132.175
132.123
119.171
119.042
96.665
96.616
77.416
77.160
76.908
68.085
68.941
68.836
68.600
68.756
67.522
66.861
65.093
61.507
47.629
47.569
25.139
20.843
20.806
20.758
9.249
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

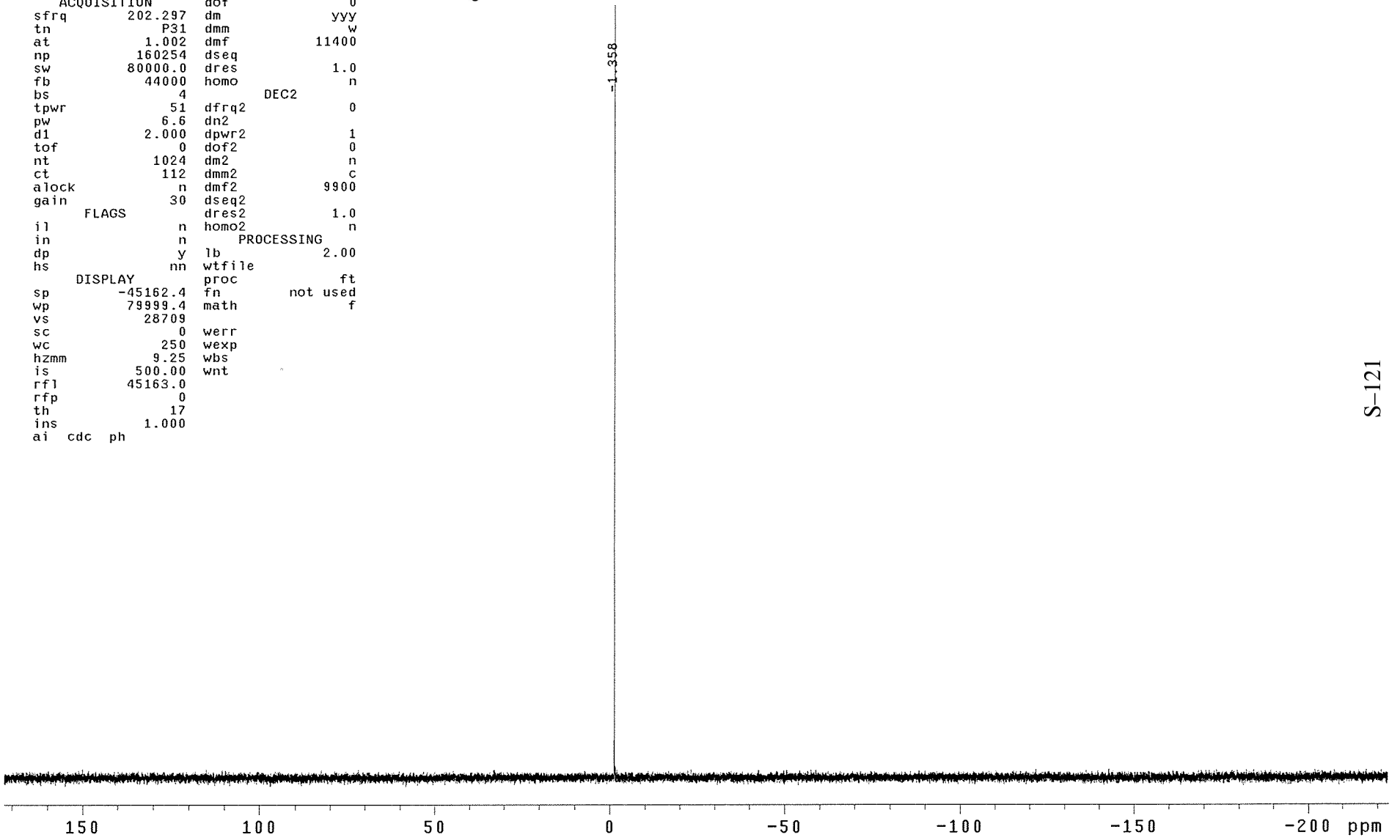


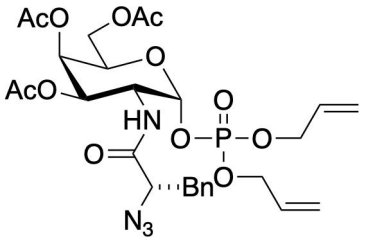
JC2017_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	1024	dm2	n
ct	112	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45162.4	fn	not used
wp	79999.4	math	f
vs	28709		
sc	0	werr	
wc	250	wexp	
hzmm	9.25	wbs	
is	500.00	wnt	
rfl	45163.0		
rfp	0		
th	17		
ins	1.000		

ai cdc ph



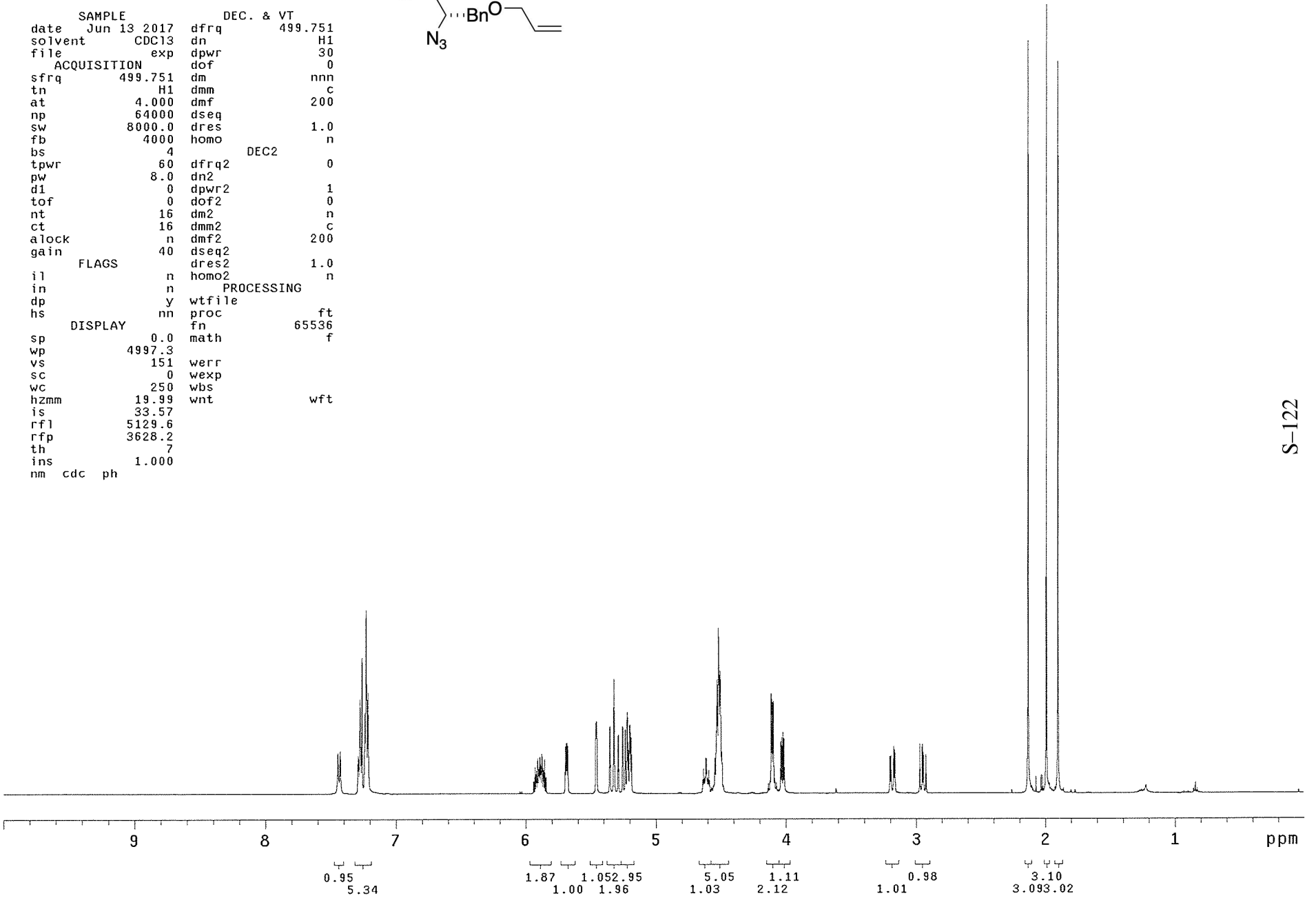


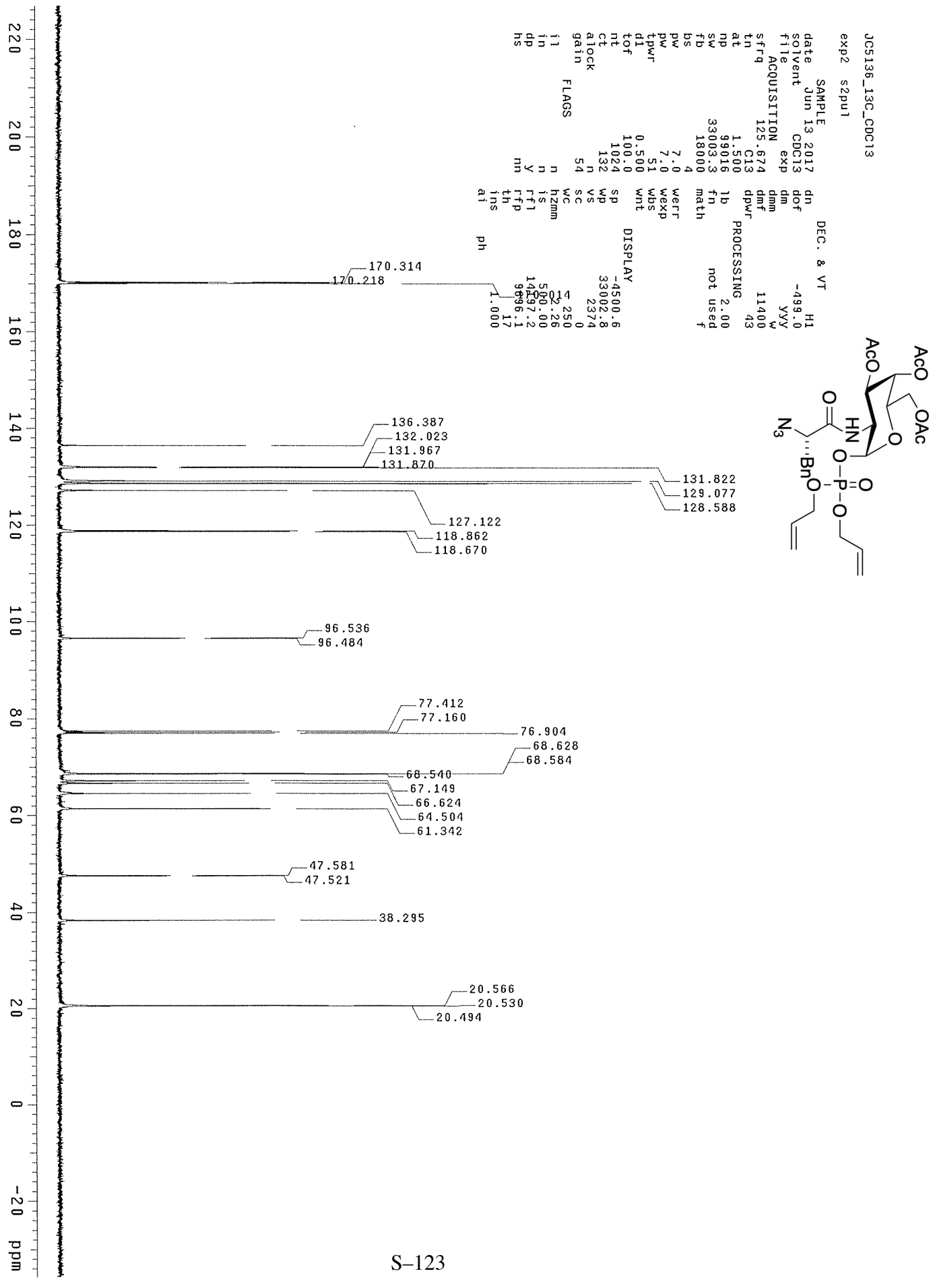
JC5136_1H_CDCl3

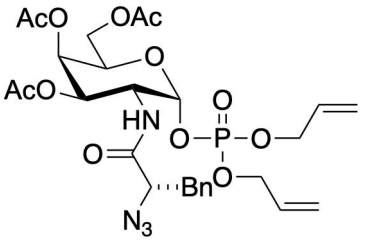
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5129.6		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph




JC5136_13C_CDC13
exp2 s2pul
SAMPLE
date Jun 13 2017
solvent CDC13
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 132
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ph
ai
ins
th 17
ff 1.000
sc 0
wc 250
hzmm 50.26
is 500.00
rfl 14997.2
rfp 9996.1
wp 33002.8
vs 2374
DISPLAY
sp -4500.6
wnt
wbs
wexp
werr
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
AcO
AcO
OAc
O
HN
N3
BnO
O-P=O
O
170.314
170.218
136.387
132.023
131.967
131.870
131.822
129.077
128.588
127.122
118.862
118.670
96.536
96.484
77.412
77.160
76.904
68.628
68.584
68.540
67.149
66.624
64.504
61.342
47.581
47.521
38.295
20.566
20.530
20.494
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

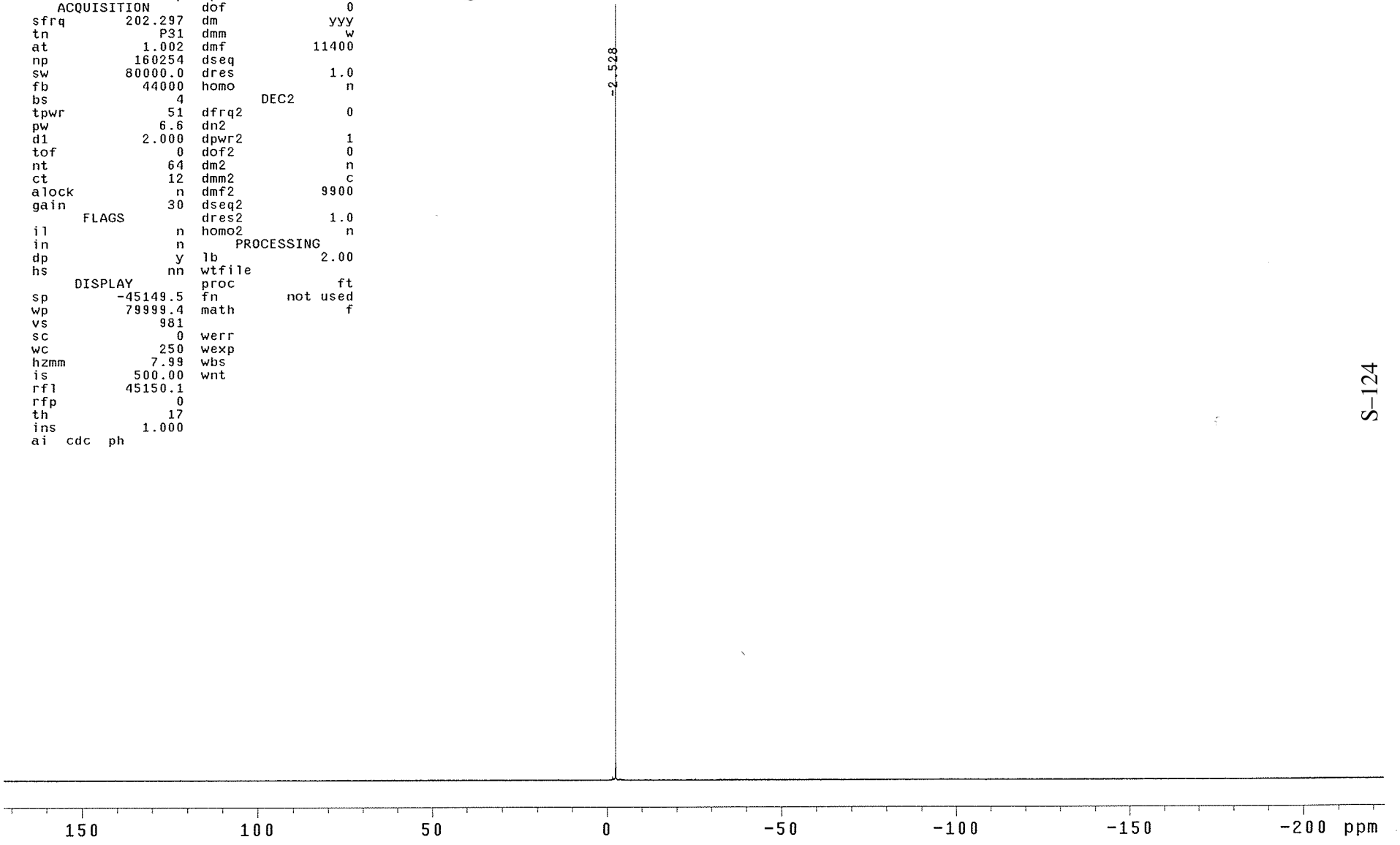


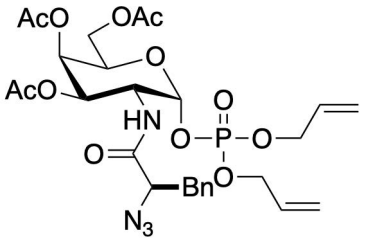
JC5136_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	12	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45149.5	fn	not used
wp	79999.4	math	f
vs	981		
sc	0	werr	
wc	250	wexp	
hzmm	7.99	wbs	
is	500.00	wnt	
rfl	45150.1		
rfp	0		
th	17		
ins	1.000		

ai cdc ph



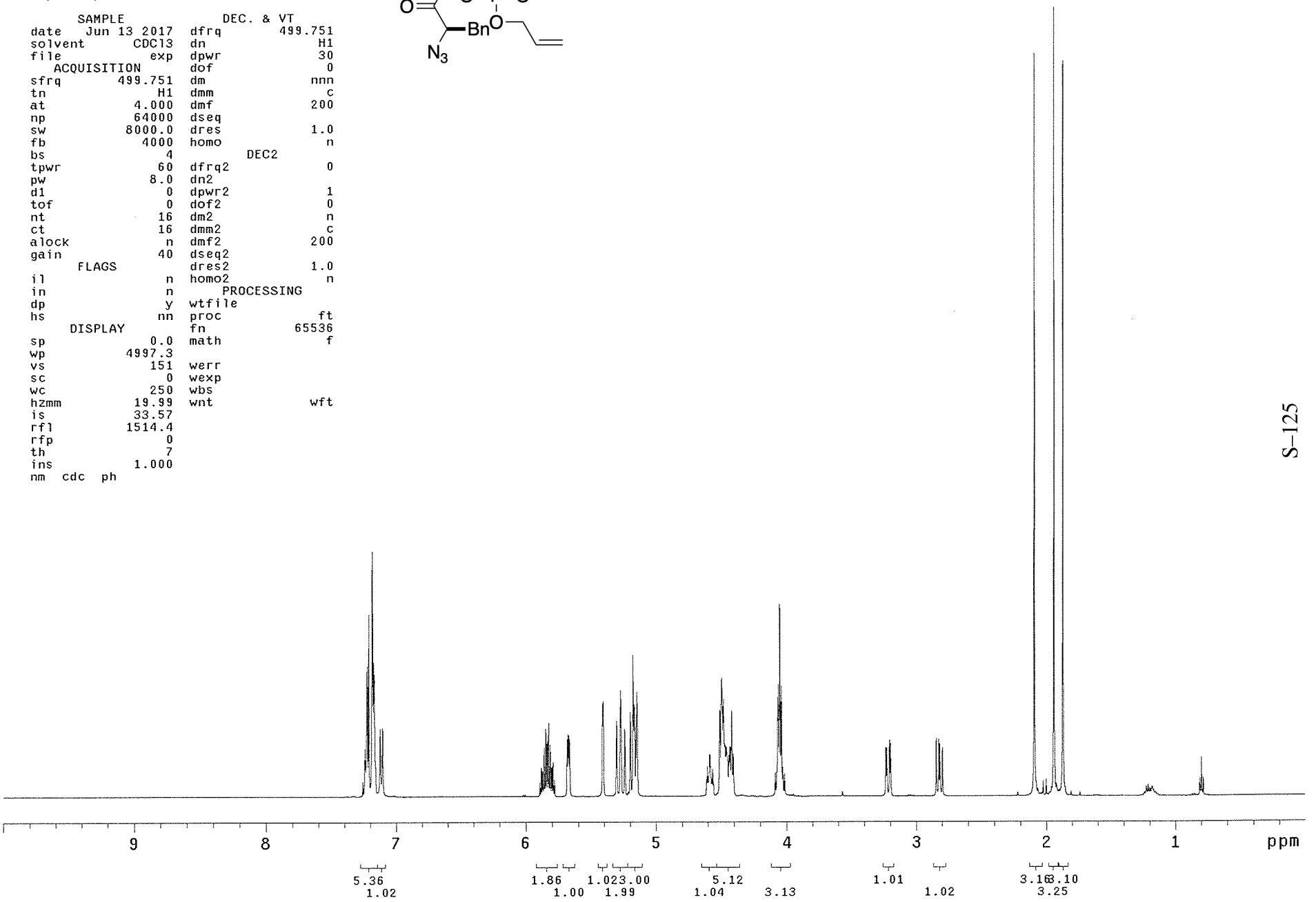


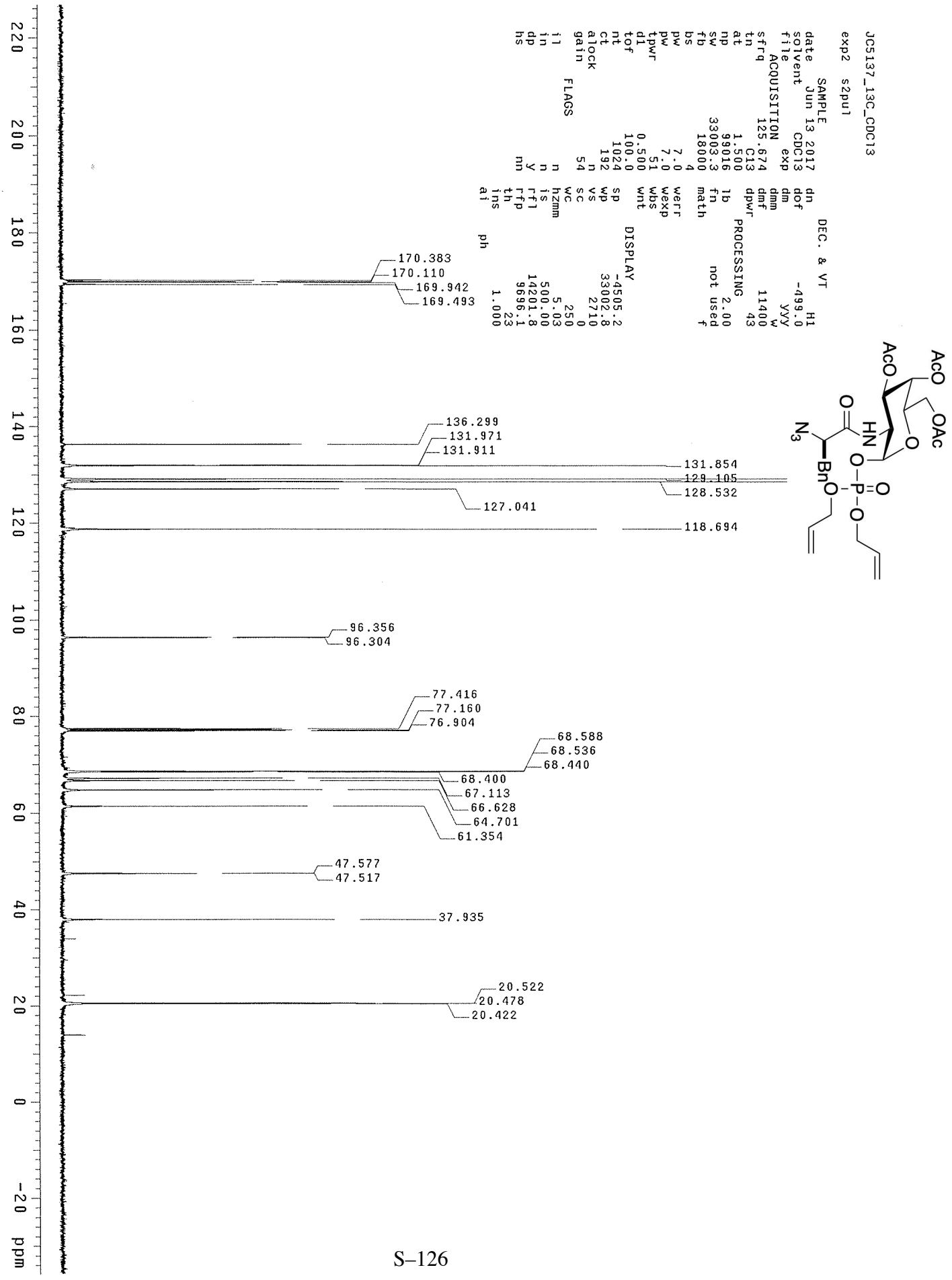
JC5137_1H_CDCl3

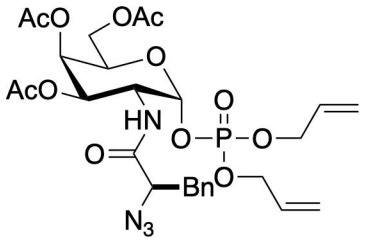
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	1514.4		
rfp	0		
th	7		
ins	1.000		

nm cdc ph



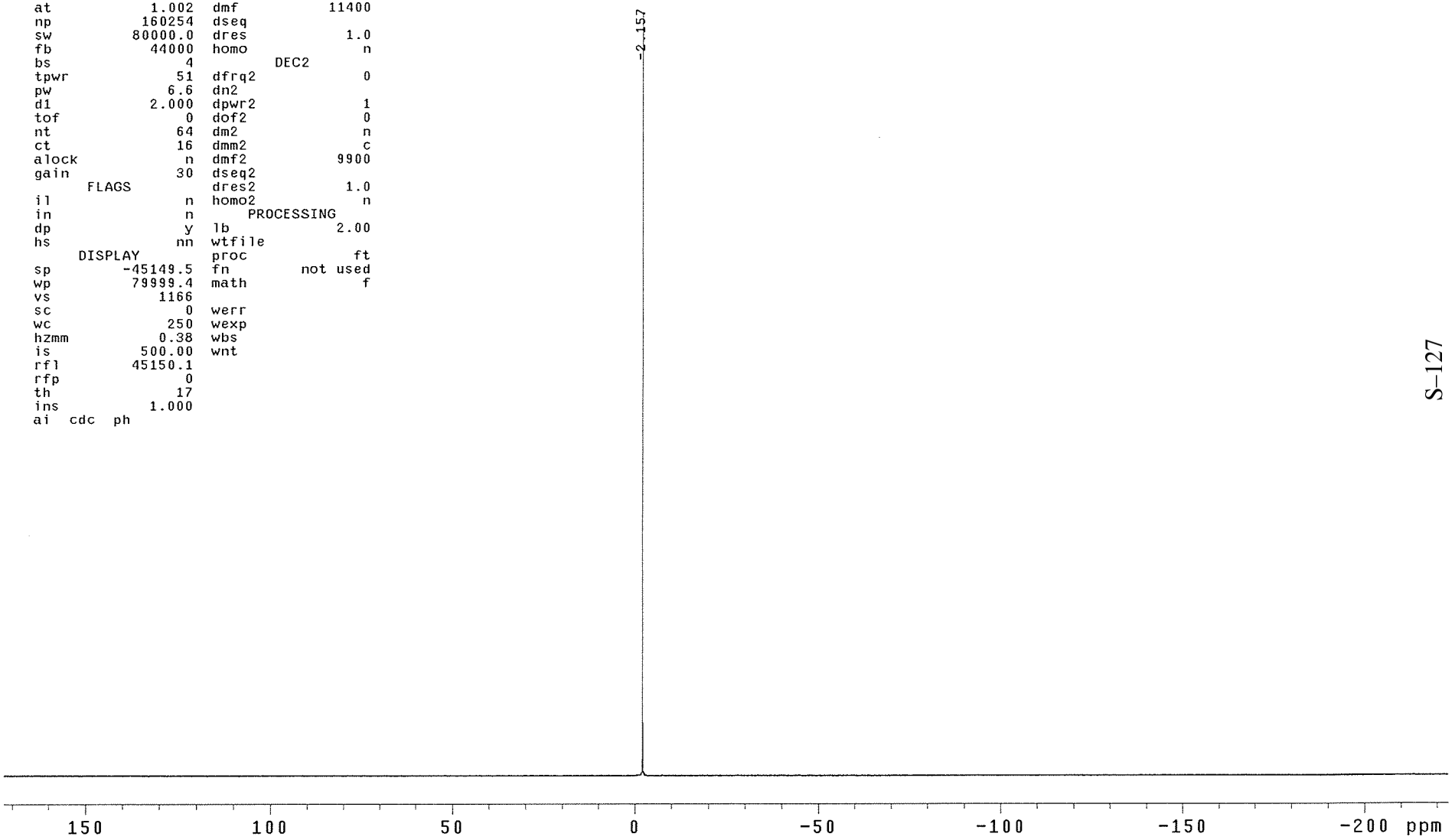

JC5137_13C_CDC13
exp2 s2pul
SAMPLE
date Jun 13 2017
solvent CDC13
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
bw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 192
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ph
ai
ins
th 23
rfp 1.000
rfl 9696.1
sp 14201.8
wp 33002.8
vs 2710
sc 0
wc 250
hzmm 5.03
is 500.00
DISPLAY
-4505.2
dn DEC. & VT
dof H1
dm -499.0
dmm yyy
dmf w
dpwr 11400
lb 43
PROCESSING
fn 2.00
math not used
werr f
wexp
wbs
wnt
170.383
170.110
169.942
169.493
136.299
131.971
131.911
131.854
129.105
128.532
127.041
118.694
96.356
96.304
77.416
77.160
76.904
68.588
68.536
68.440
68.400
67.113
66.628
64.701
61.354
47.577
47.517
37.935
20.522
20.478
20.422
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

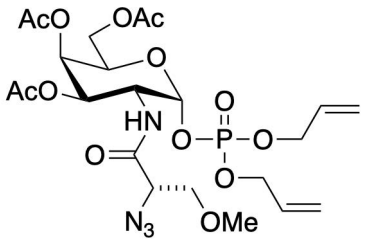


JC5137_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45149.5	fn	not used
wp	79999.4	math	f
vs	1166		
sc	0	werr	
wc	250	wexp	
hzmm	0.38	wbs	
is	500.00	wnt	
rfl	45150.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

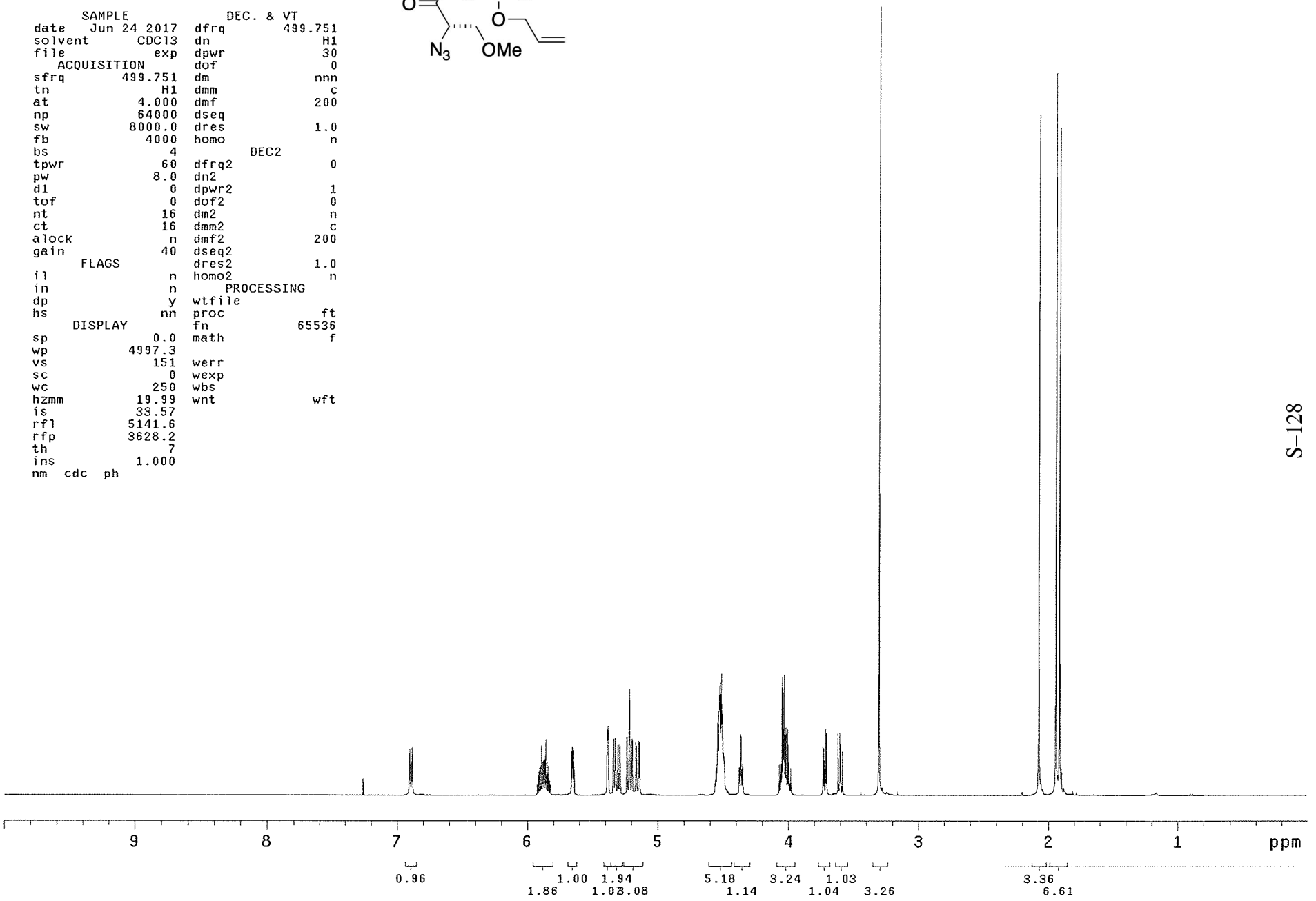


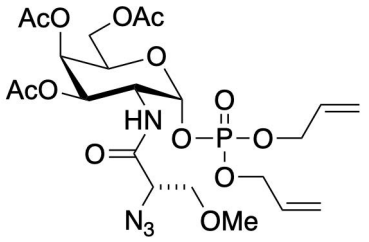


JC5146_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 24 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.6		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			

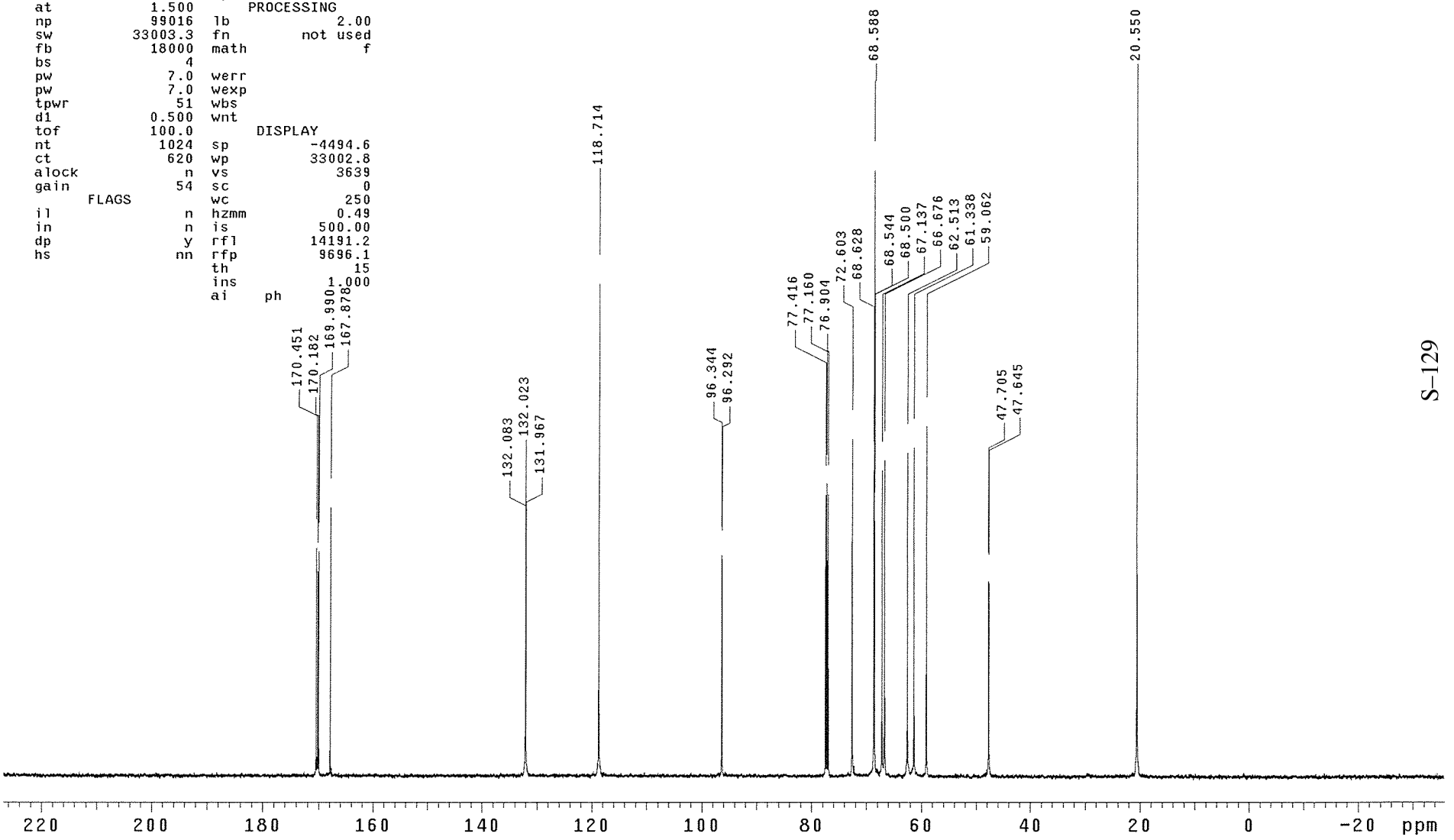


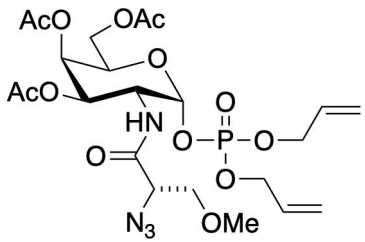


JC5146_13C_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 24 2017	dn	H1
solvent	CDCl3	dof	-499.0
file	exp	dm	yyy
ACQUISITION		dmm	w
sfrq	125.674	dmf	11400
tn	C13	dpwr	43
at	1.500	PROCESSING	
np	99016	lb	2.00
sw	33003.3	fn	not used
fb	18000	math	f
bs	4		
pw	7.0	werr	
pw	7.0	wexp	
tpwr	51	wbs	
d1	0.500	wnt	
tof	100.0	DISPLAY	
nt	1024	sp	-4494.6
ct	620	wp	33002.8
alock	n	vs	3639
gain	54	sc	0
FLAGS		wc	250
il	n	hzmm	0.49
in	n	is	500.00
dp	y	rfl	14191.2
hs	nn	rfp	9696.1
		th	15
		ins	1.000
		ai ph	

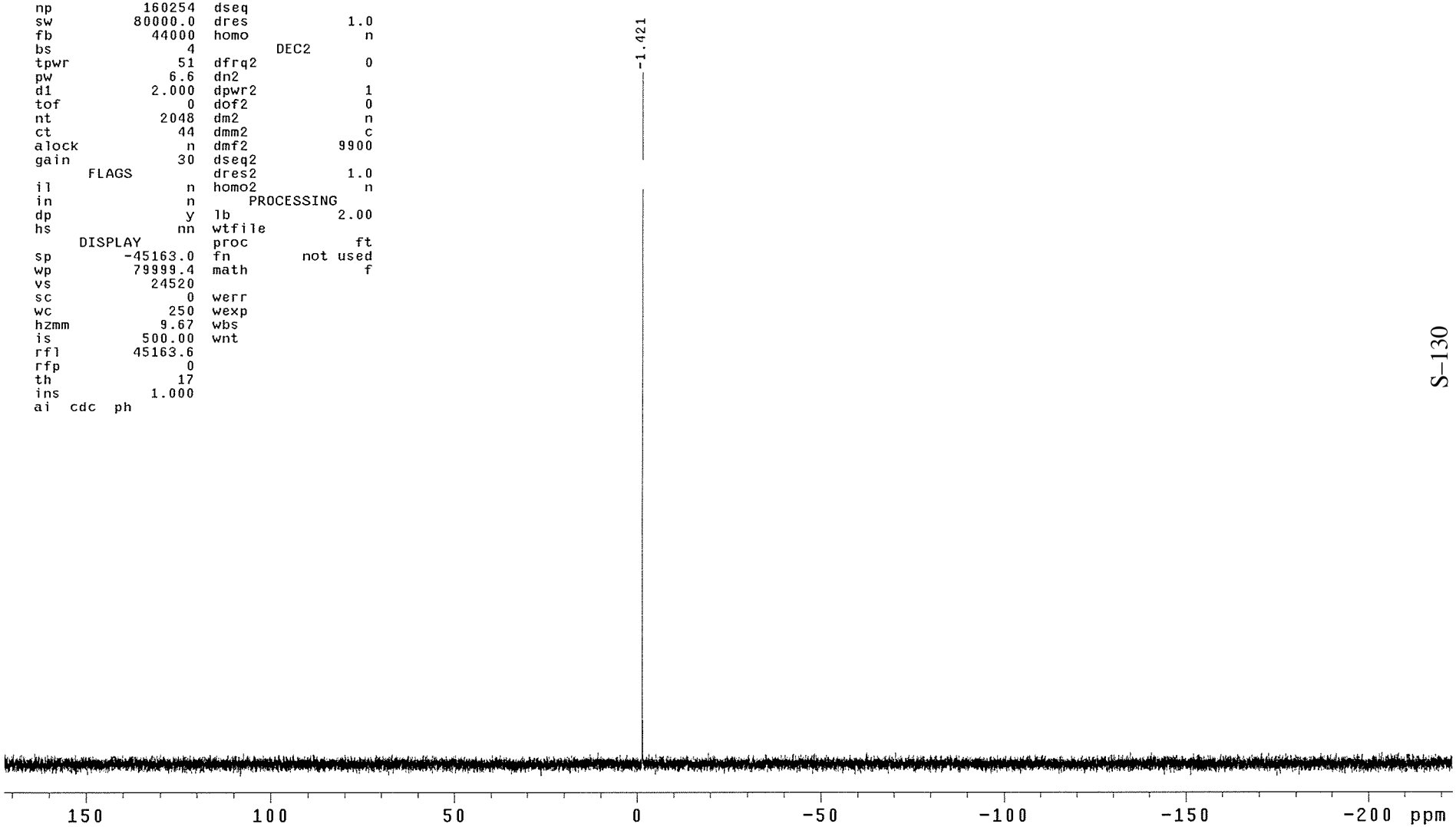


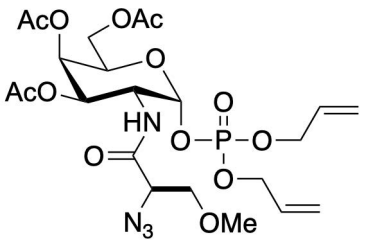


JC2011_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 15 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	2048	dm2	n
ct	44	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45163.0	fn	not used
wp	79999.4	math	f
vs	24520		
sc	0	werr	
wc	250	wexp	
hzmm	9.67	wbs	
is	500.00	wnt	
rfl	45163.6		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



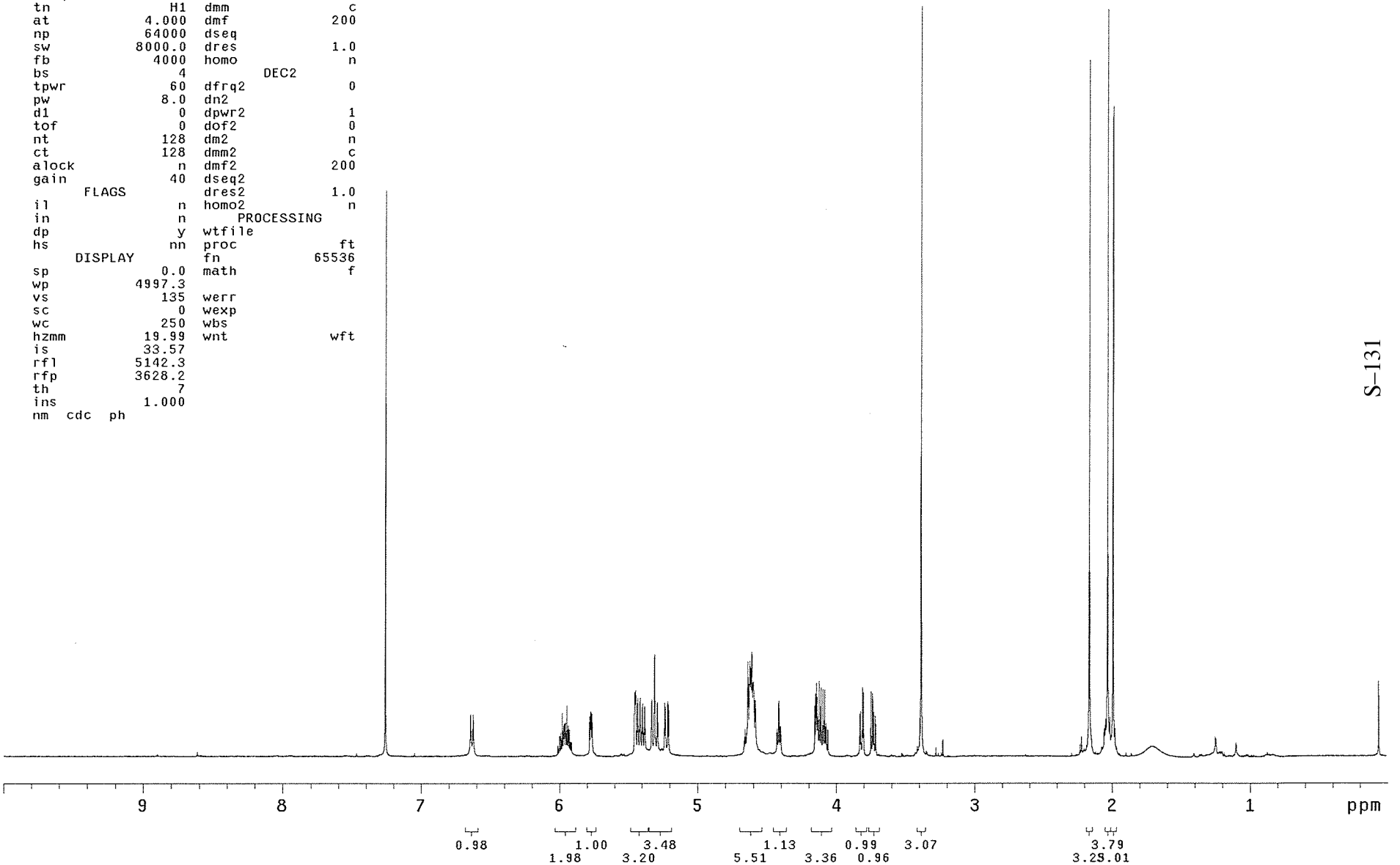


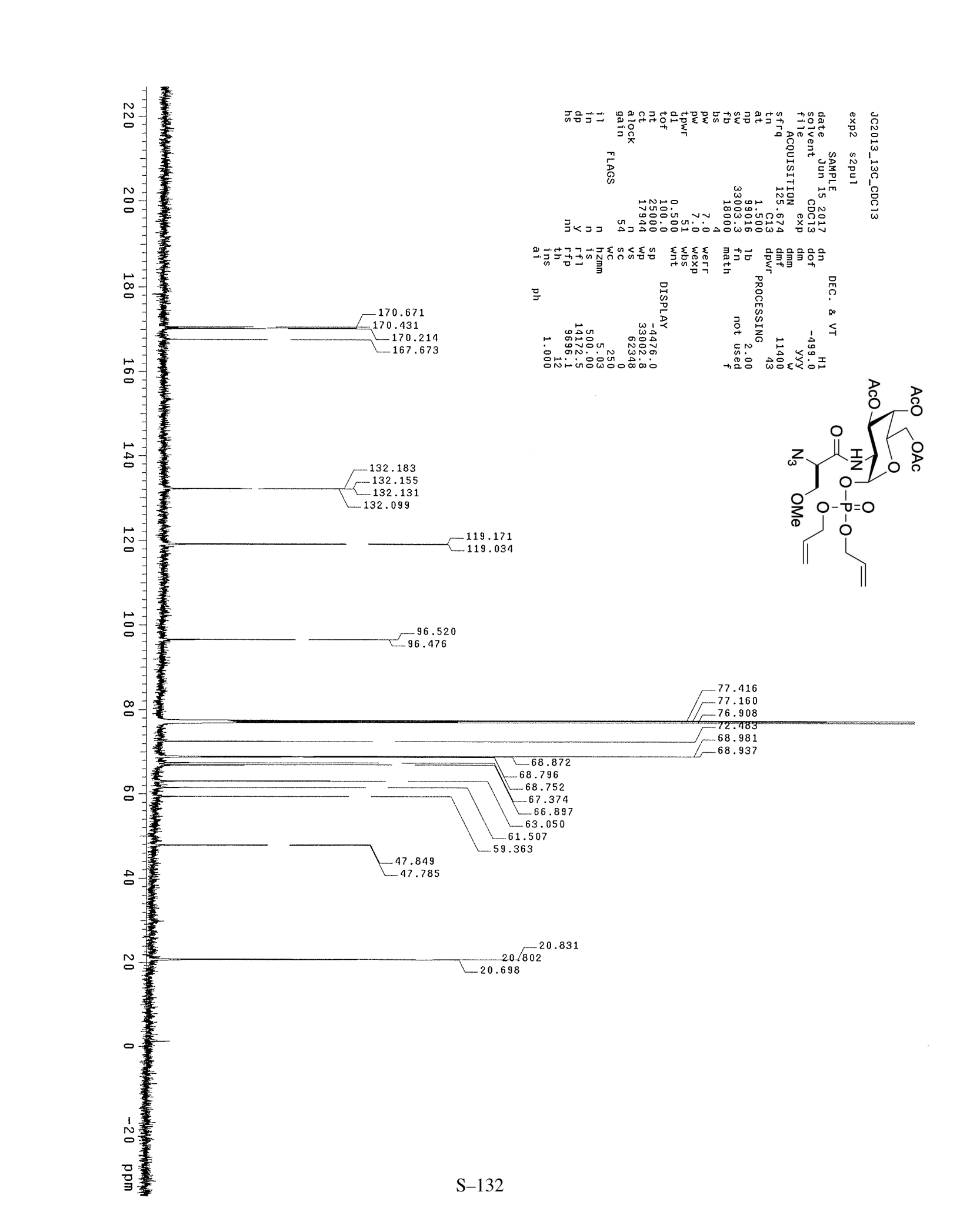
JC2013_1H_CDCl3

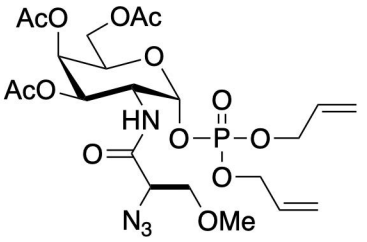
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 15 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	128	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	135	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5142.3		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph



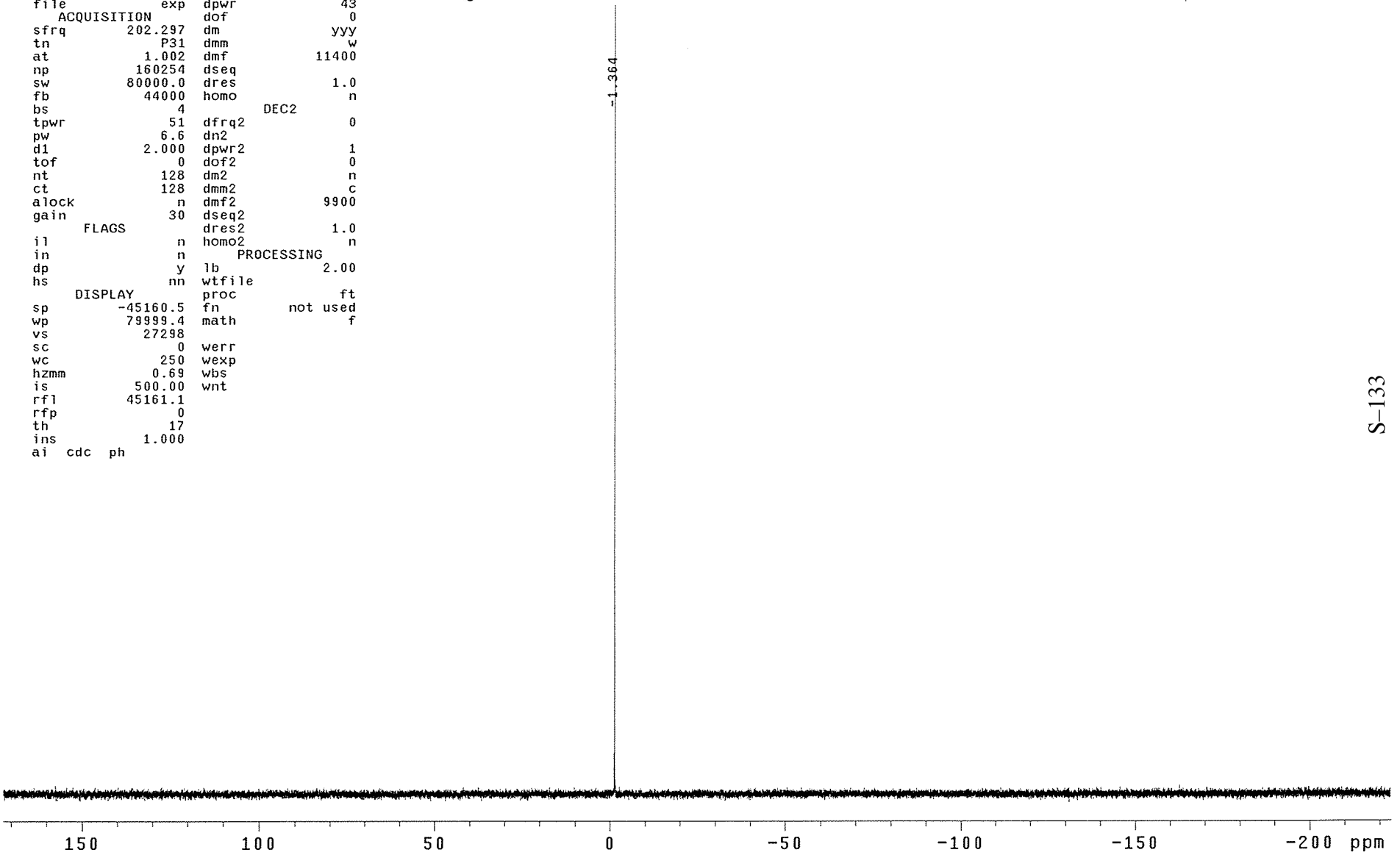

JC2013_13C_CDCl3
exp2 s2pul
SAMPLE
date Jun 15 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 25000
ct 17944
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4476.0
wp 33002.8
vs 62348
sc 0
wc 250
hzmm 5.03
is 500.00
rfl 14172.5
rfp 9696.1
th 12
ins 1.000
ai
ph
AcO
AcO
OAc
HN
O
N3
OMe
O
P
170.671
170.431
170.214
167.673
132.183
132.155
132.131
132.099
119.171
119.034
96.520
96.476
77.416
77.160
76.908
72.483
68.981
68.937
68.872
68.796
68.752
67.374
66.897
63.050
61.507
59.363
47.849
47.785
20.831
20.802
20.698
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

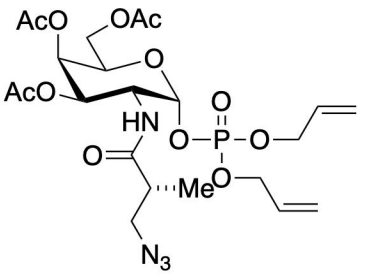


JC2013_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 16 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	128	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45160.5	fn	not used
wp	79999.4	math	f
vs	27298		
sc	0	werr	
wc	250	wexp	
hzmm	0.69	wbs	
is	500.00	wnt	
rfl	45161.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



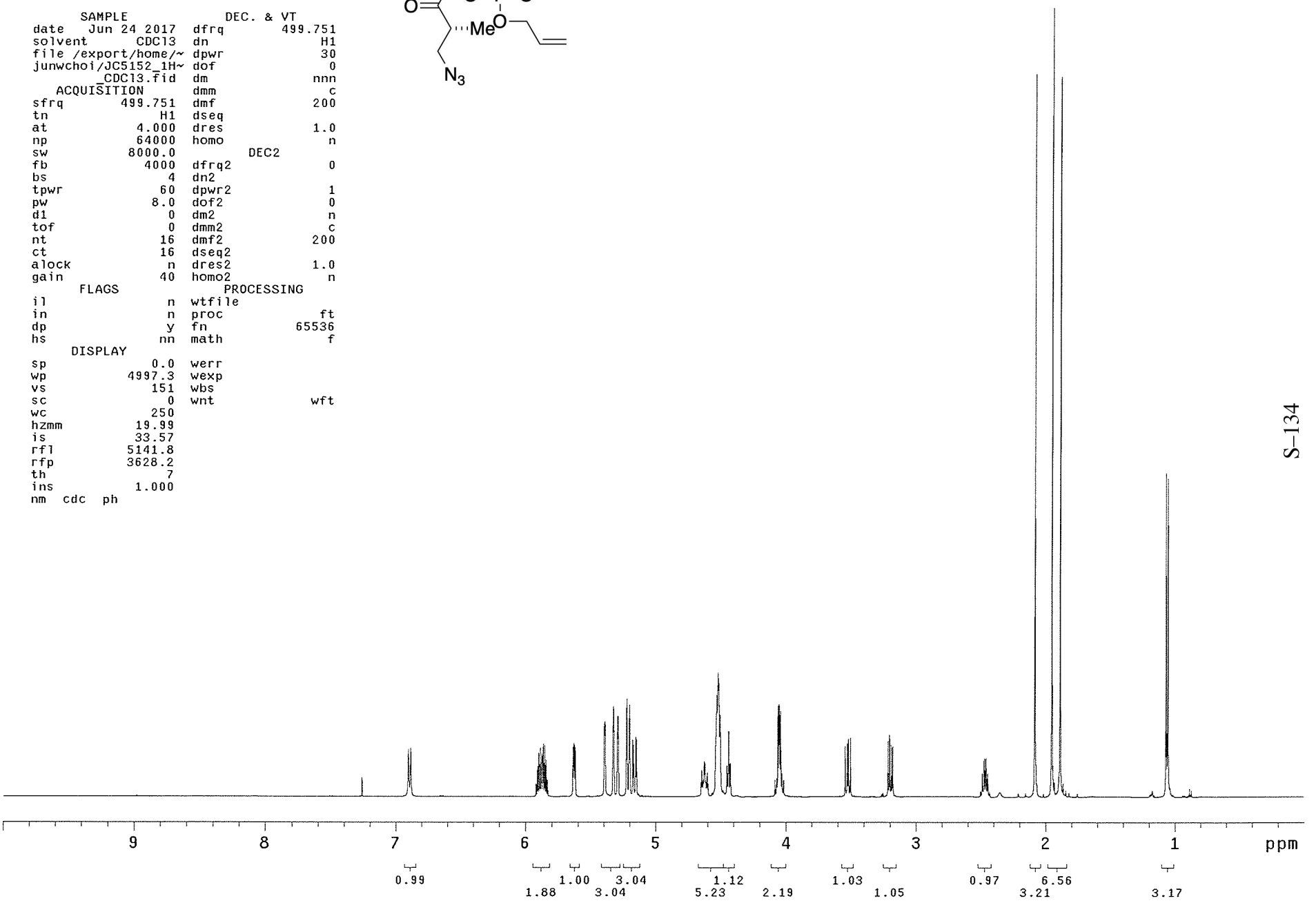


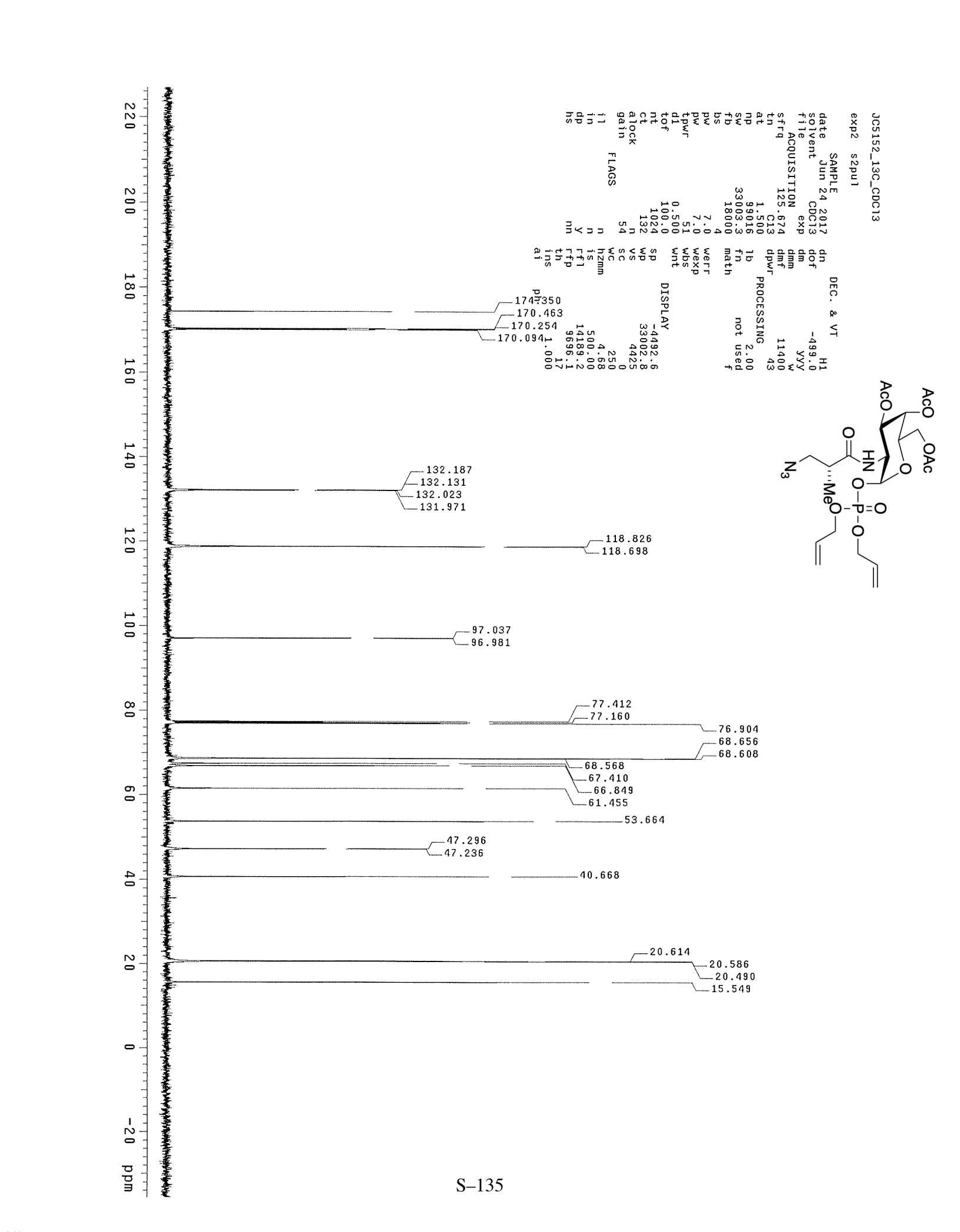
JC5152_1H_CDCl3

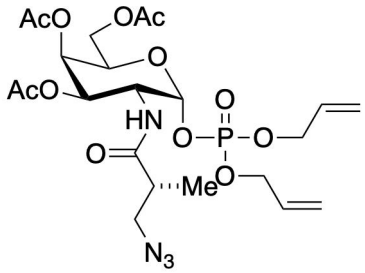
exp3 s2pul

SAMPLE		DEC. & VT	
date	Jun 24 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	/export/home/~	dpwr	30
junwchoi/JC5152_1H~		dof	0
	CDCl3.fid	dm	nnn
ACQUISITION		dmm	c
sfrq	499.751	dmf	200
tn	H1	dseq	
at	4.000	dres	1.0
np	64000	homo	n
sw	8000.0	DEC2	
fb	4000	dfrq2	0
bs	4	dn2	
tpwr	60	dpwr2	1
pw	8.0	dof2	0
d1	0	dm2	n
tof	0	dmm2	c
nt	16	dmf2	200
ct	16	dseq2	
alock	n	dres2	1.0
gain	40	homo2	n
FLAGS		PROCESSING	
il	n	wtfile	
in	n	proc	ft
dp	y	fn	65536
hs	nn	math	f
DISPLAY			
sp	0.0	werr	
wp	4997.3	wexp	
vs	151	wbs	
sc	0	wnt	wft
wc	250		
hzmm	19.99		
is	33.57		
rfl	5141.8		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph



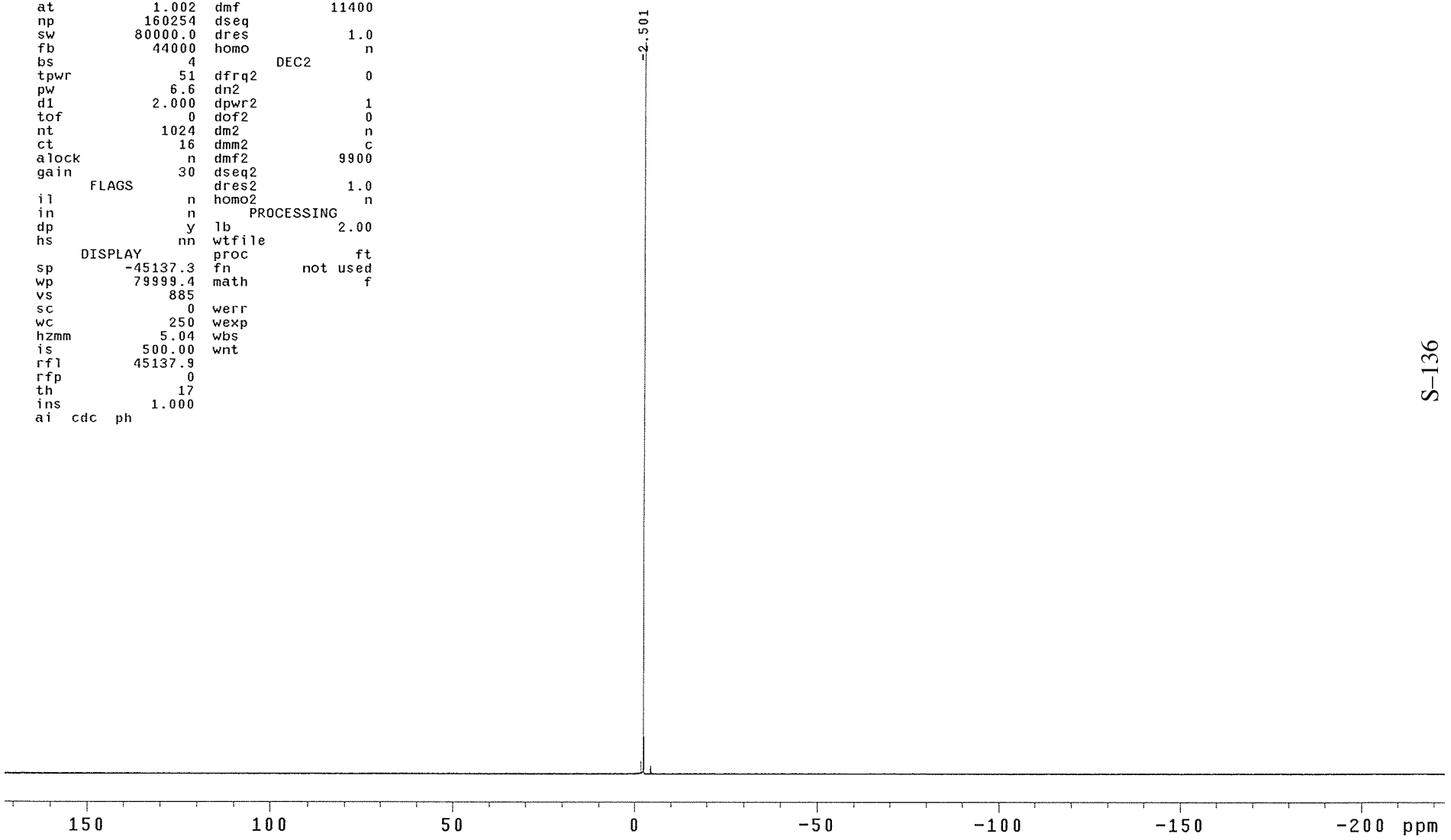

JC5152_13C_CDCl3
exp2 s2pul
SAMPLE
date Jun 24 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 132
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4492.6
wp 33002.8
vs 4425
sc 0
wc 250
hzmm 4.68
is 500.00
rfl 14189.2
rfp 9696.1
th 17
ins 1.000
ai
ppm
174.350
170.463
170.254
170.094
132.187
132.131
132.023
131.971
118.826
118.698
97.037
96.981
77.412
77.160
76.904
68.656
68.608
68.568
67.410
66.849
61.455
53.664
47.296
47.236
40.668
20.614
20.586
20.490
15.549
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

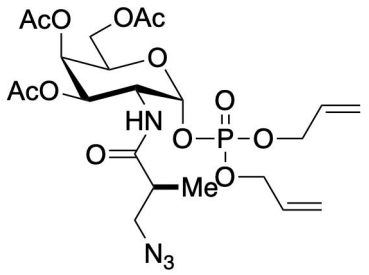


JC5152_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 24 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	1024	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45137.3	fn	not used
wp	79999.4	math	f
vs	885		
sc	0	werr	
wc	250	wexp	
hzmm	5.04	wbs	
is	500.00	wnt	
rfl	45137.9		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

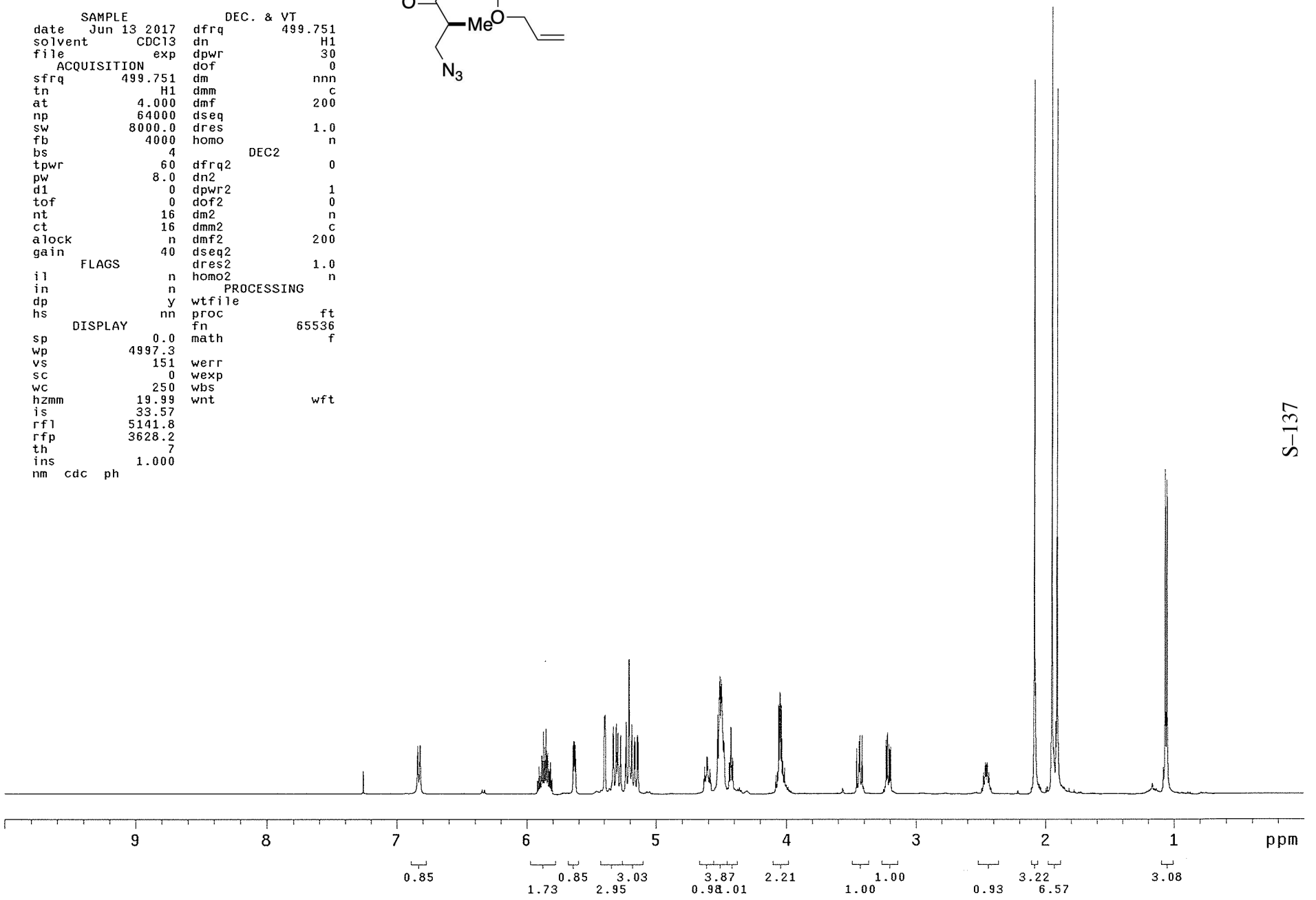


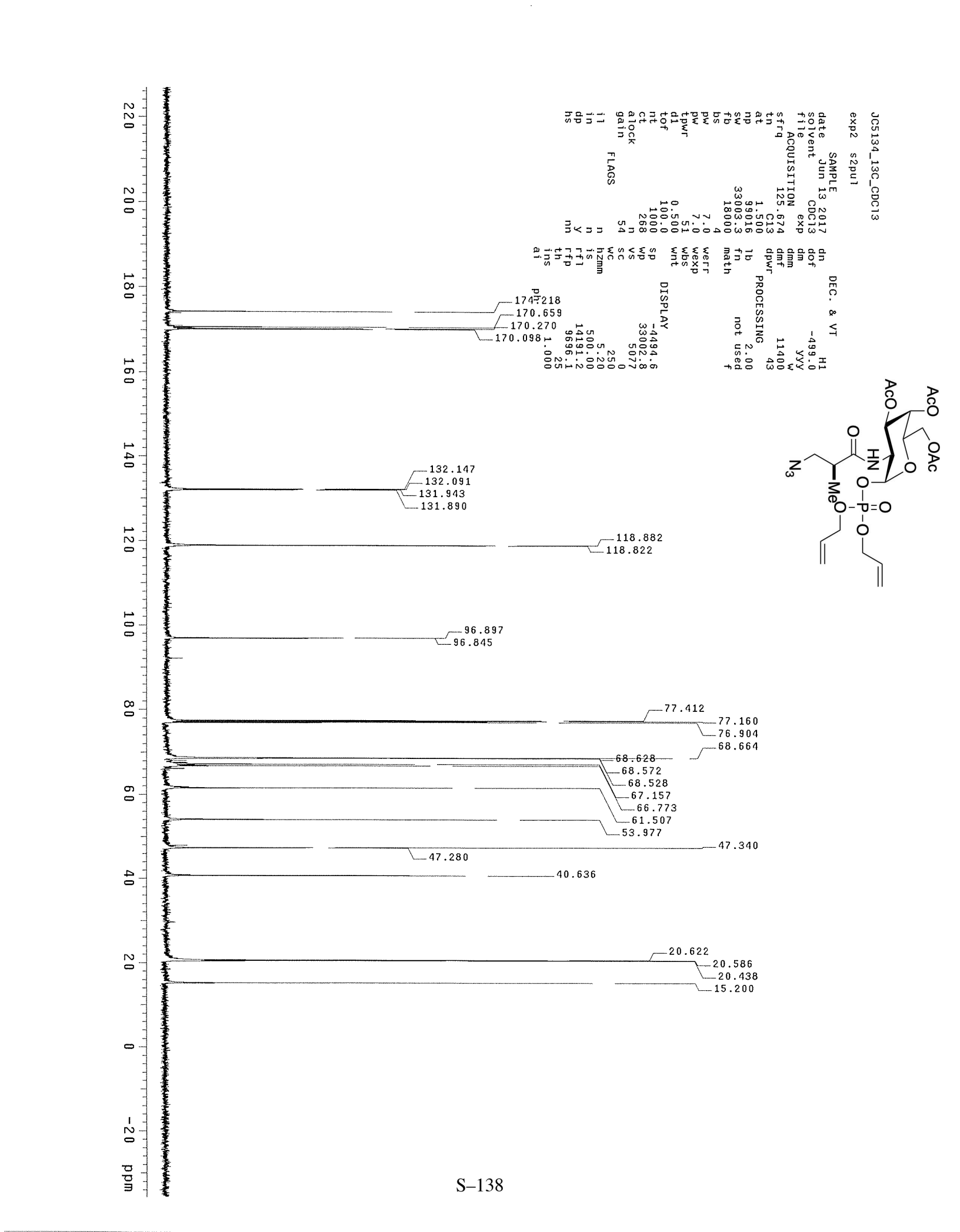


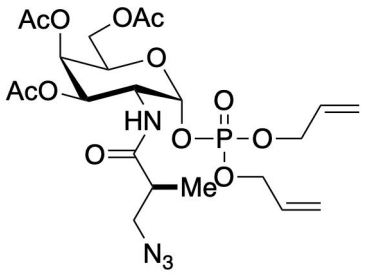
JC5134_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.8		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			



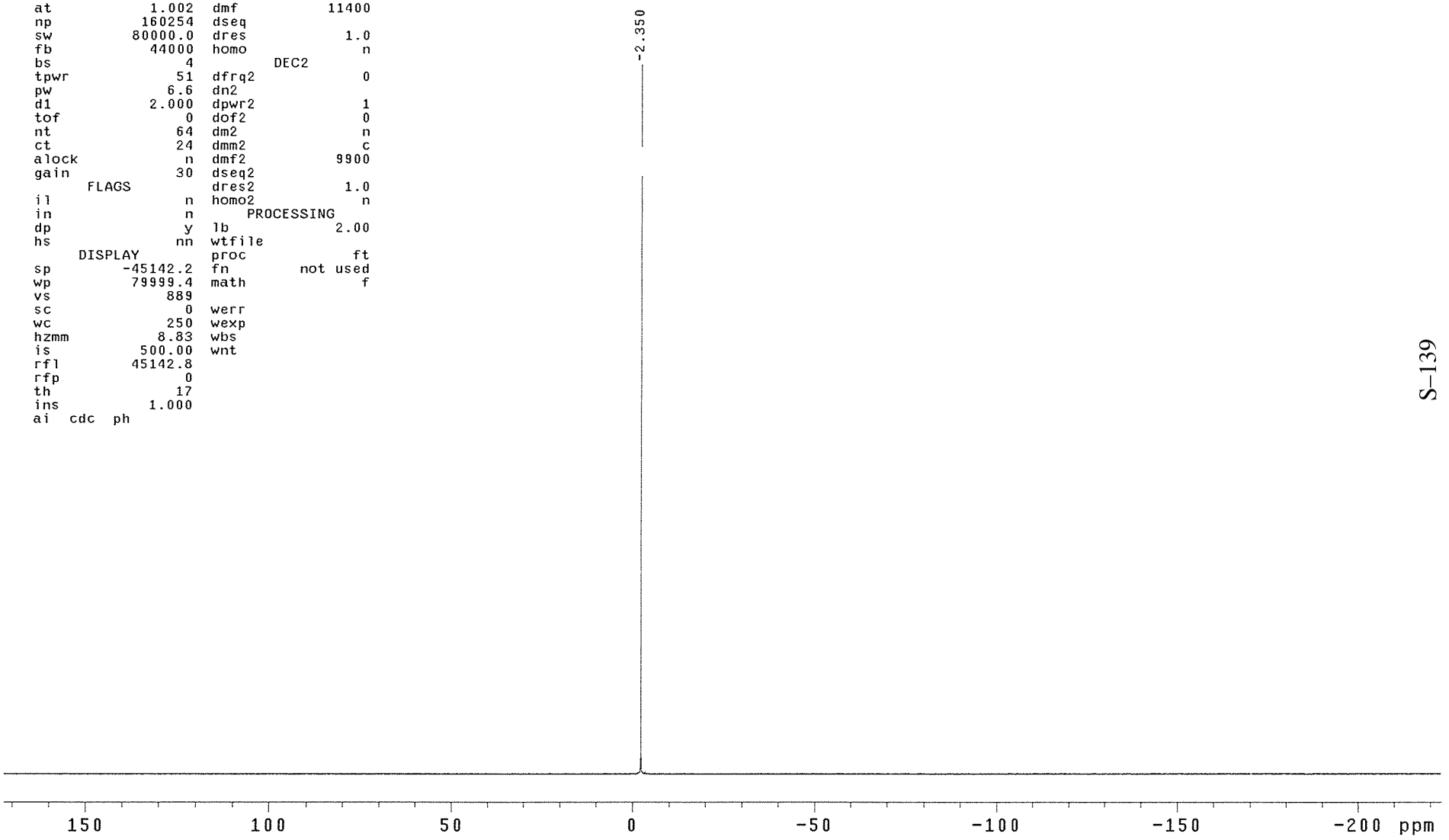

JC5134_13C_CDCl3
exp2 s2pul
SAMPLE
date Jun 13 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 4
bs 7.0
pw 7.0
pw 51
tpwr 0.500
d1 100.0
tof 1000
nt 268
ct n
alock 54
gain
FLAGS
il n
in n
dp y
hs nn
ai
th
ins
ph
DISPLAY
sp -4494.6
wp 33002.8
vs 5077
sc 0
wc 250
hzmm 5.20
is 500.00
rfl 14191.2
rfp 9696.1
25
1.000
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
174.218
170.659
170.270
170.098
132.147
132.091
131.943
131.890
118.882
118.822
96.897
96.845
77.412
77.160
76.904
68.664
68.628
68.572
68.528
67.157
66.773
61.507
53.977
47.340
47.280
40.636
20.622
20.586
20.438
15.200
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

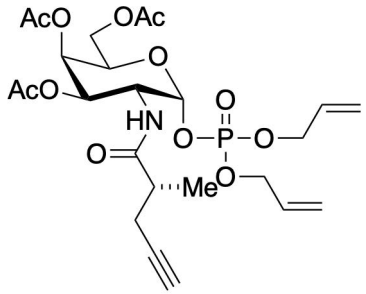


JC5134_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	24	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45142.2	fn	not used
wp	79999.4	math	f
vs	889		
sc	0	werr	
wc	250	wexp	
hzmm	8.83	wbs	
is	500.00	wnt	
rfl	45142.8		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

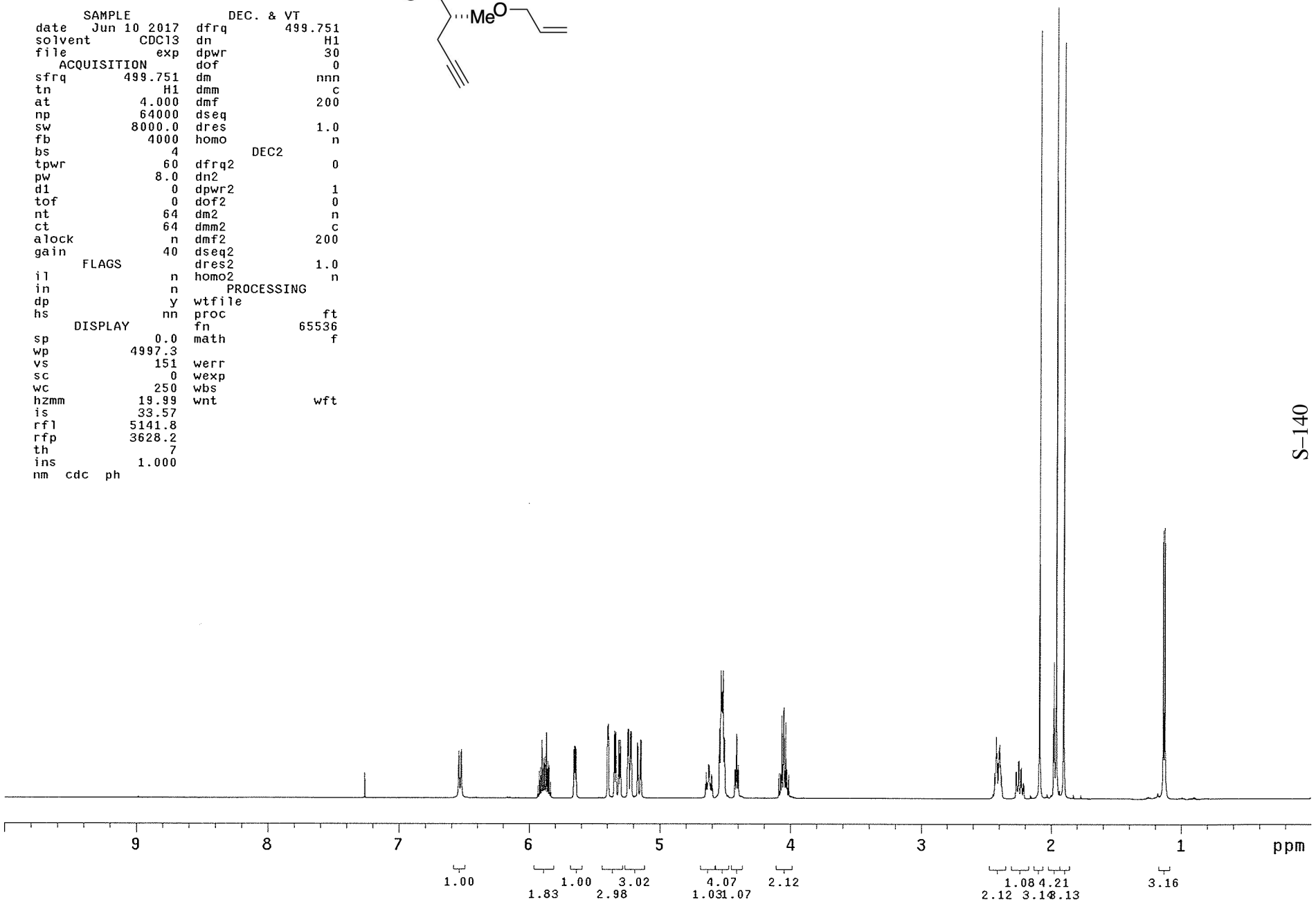


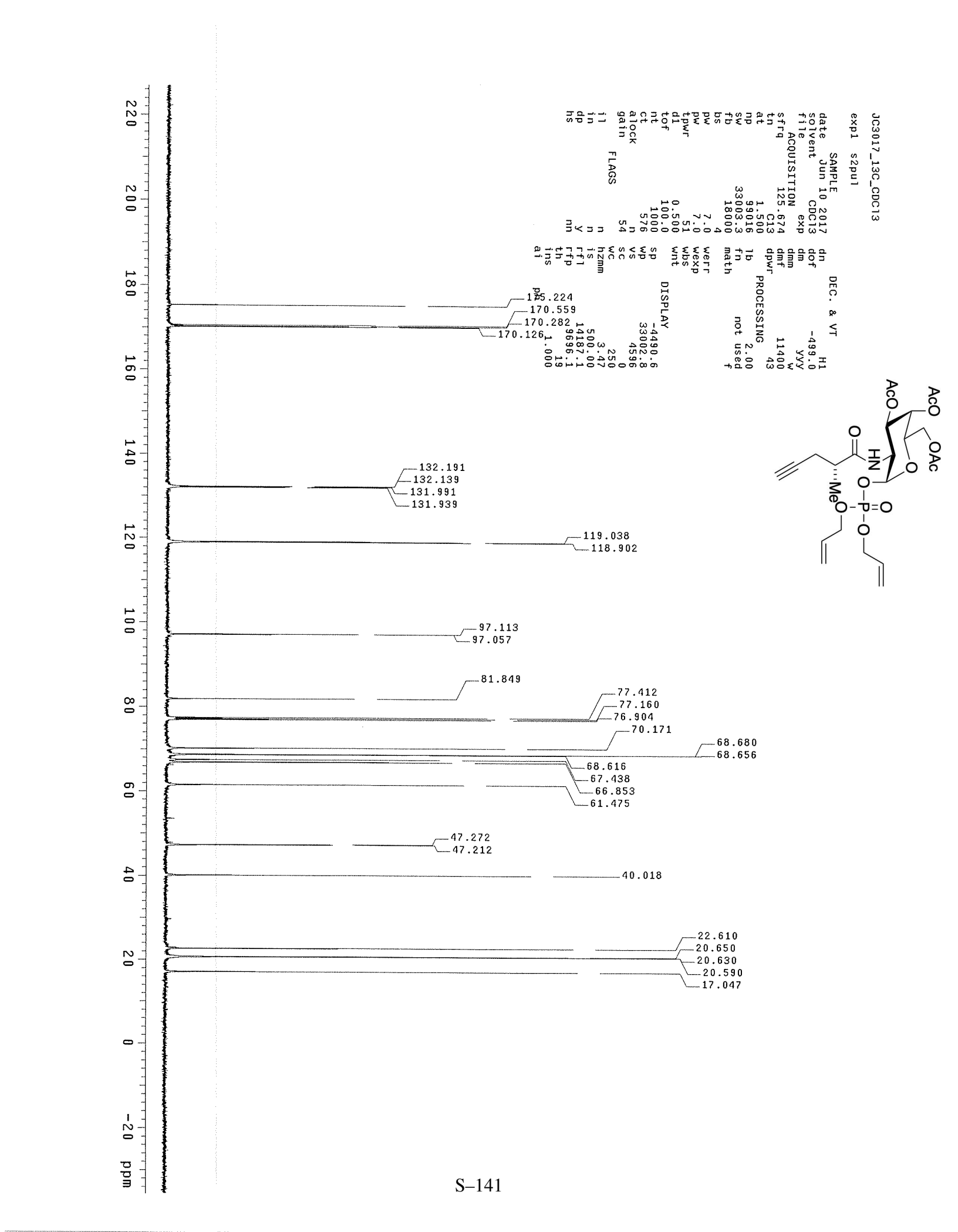


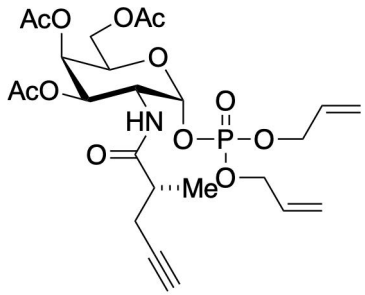
JC3017_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	64	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.8		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			



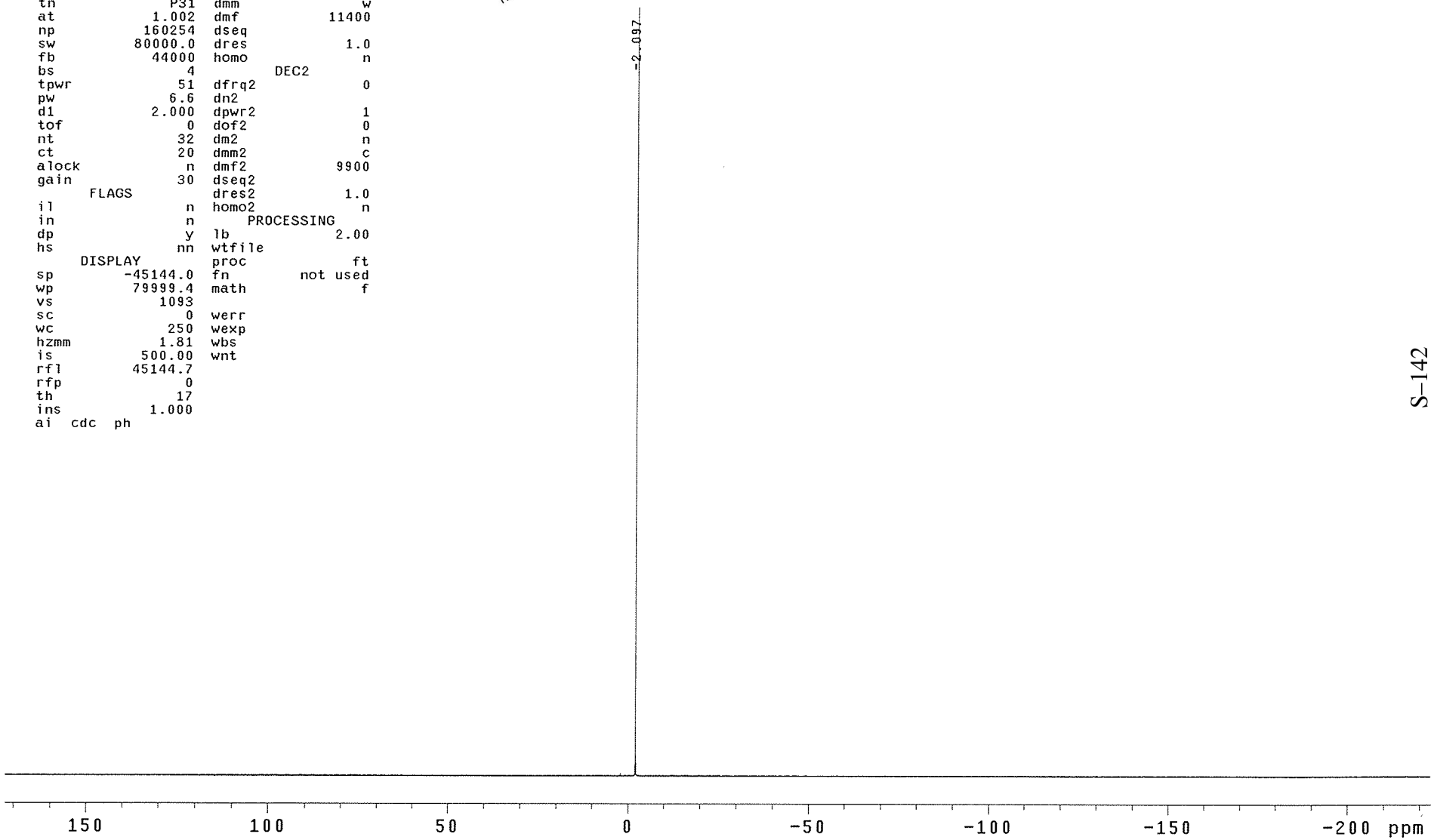

JC3017_13C_CDCl3
exp1 s2pul
SAMPLE
date Jun 10 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1000
ct 576
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4490.6
wp 33002.8
vs 4596
sc 0
wc 250
hzmm 3.47
is 500.00
rfl 14187.1
rfp 9696.1
th 19
ins 1.000
ai
ppm
175.224
170.559
170.282
170.126
132.191
132.139
131.991
131.939
119.038
118.902
97.113
97.057
81.849
77.412
77.160
76.904
70.171
68.680
68.656
68.616
67.438
66.853
61.475
47.272
47.212
40.018
22.610
20.650
20.630
20.590
17.047
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm
AcO
AcO
OAc
O
HN
O
O
Me
O
P
O
O
O

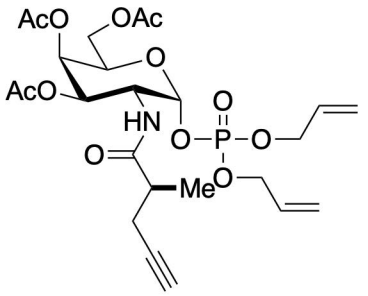


JC3017_31P_CDCl3

exp1 s2pul

SAMPLE		DEC. & VT	
date	Jun 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	20	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45144.0	fn	not used
wp	79999.4	math	f
vs	1093		
sc	0	werr	
wc	250	wexp	
hzmm	1.81	wbs	
is	500.00	wnt	
rfl	45144.7		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

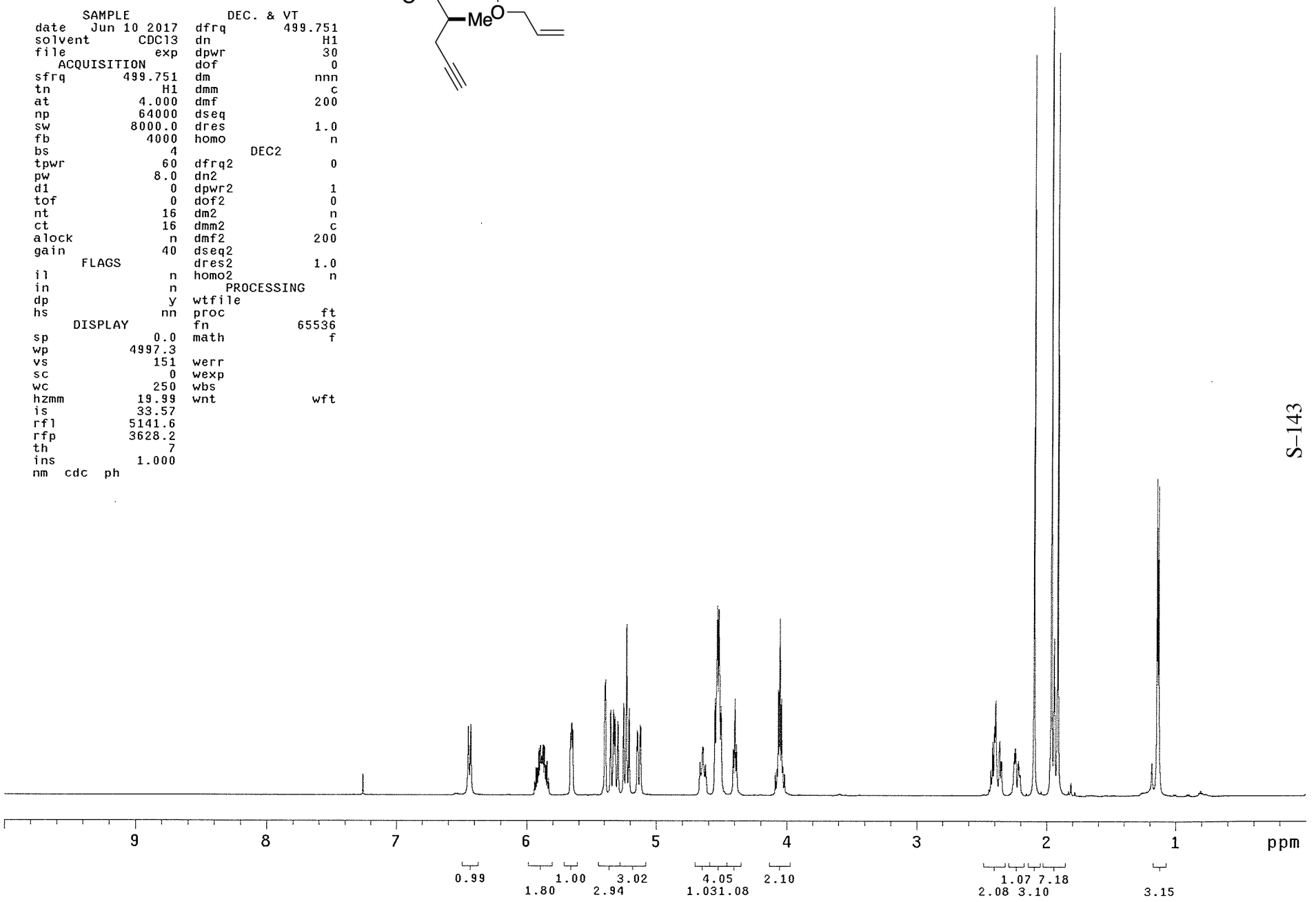


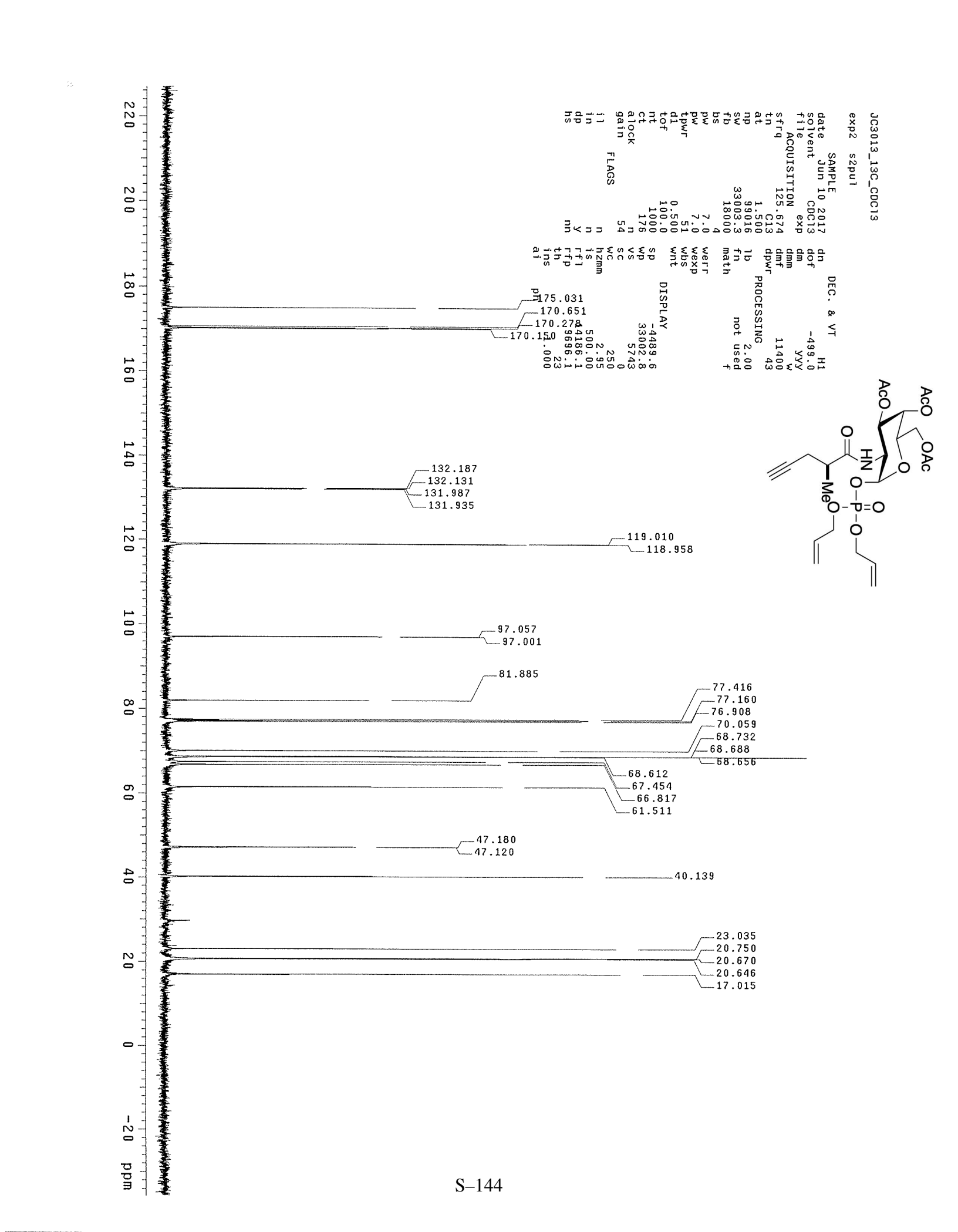


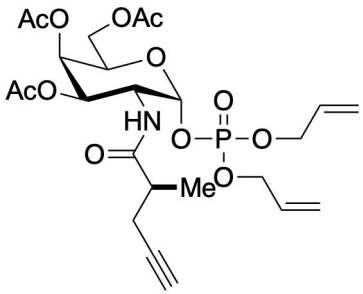
JC3013_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.6		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			




JC3013_13C_CDCl3
exp2 s2pul
SAMPLE
date Jun 10 2017
solvent CDCl3
file
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1000
ct 176
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4489.6
wp 33002.8
vs 5743
sc 0
wc 250
hzmm 2.95
is 500.00
rfl 4186.1
rfp 9696.1
th 23
ins 1.000
ai
ppm
175.031
170.651
170.274
170.150
132.187
132.131
131.987
131.935
119.010
118.958
97.057
97.001
81.885
77.416
77.160
76.908
70.059
68.732
68.688
68.656
68.612
67.454
66.817
61.511
47.180
47.120
40.139
23.035
20.750
20.670
20.646
17.015
AcO
AcO
OAc
O
HN
O
O
Me
O
P
O
O
O
220
200
180
160
140
120
100
80
60
40
20
0
-20

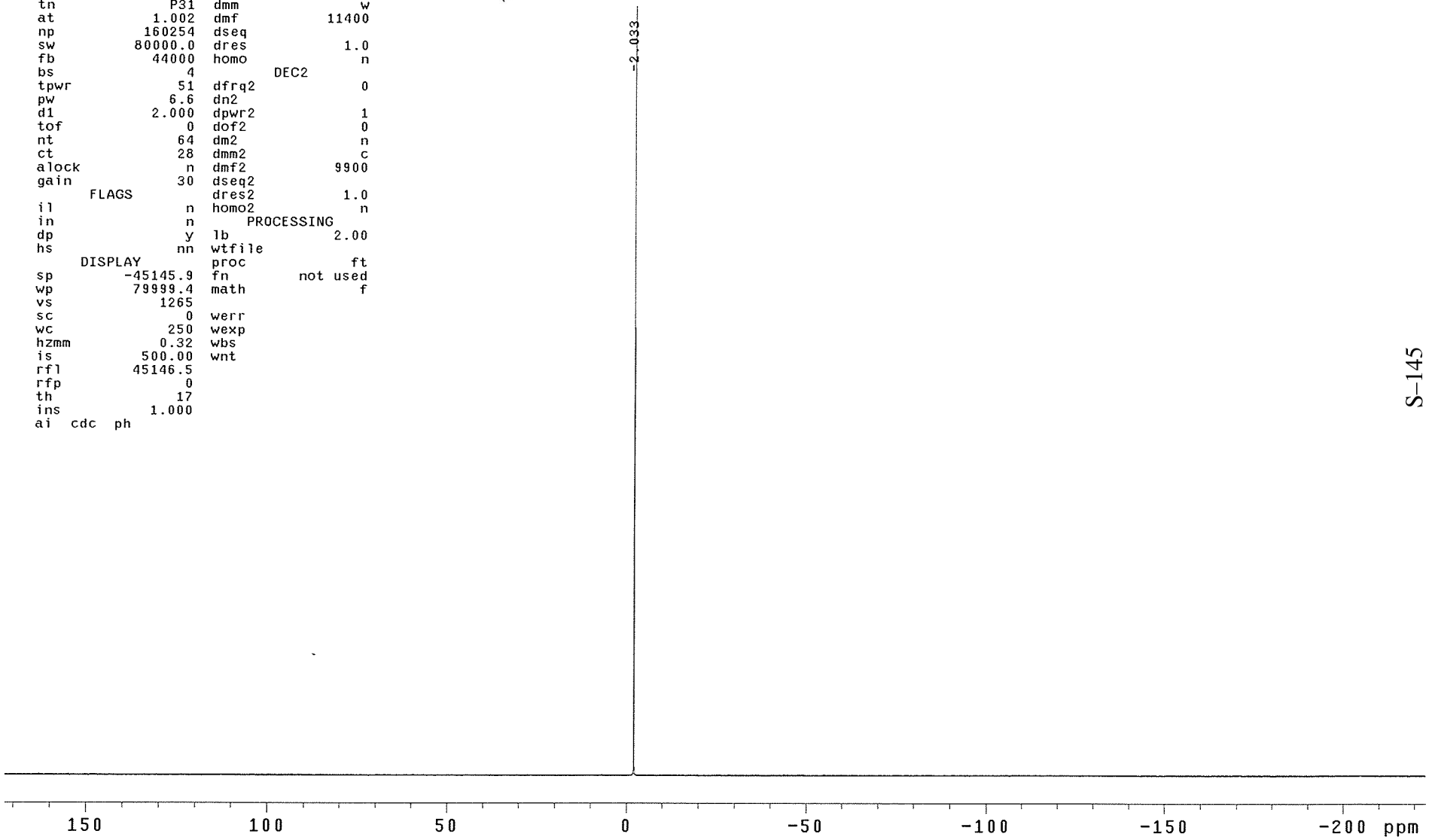


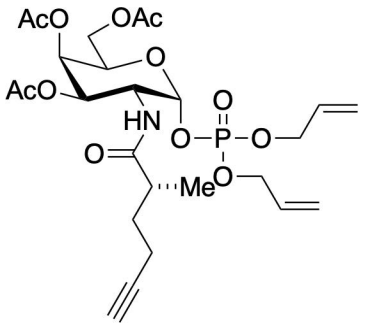
JC3013_31P_CDCl3

exp3 s2pul

SAMPLE		DEC. & VT	
date	Jun 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	28	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45145.9	fn	not used
wp	79999.4	math	f
vs	1265		
sc	0	werr	
wc	250	wexp	
hzmm	0.32	wbs	
is	500.00	wnt	
rfl	45146.5		
rfp	0		
th	17		
ins	1.000		

ai cdc ph



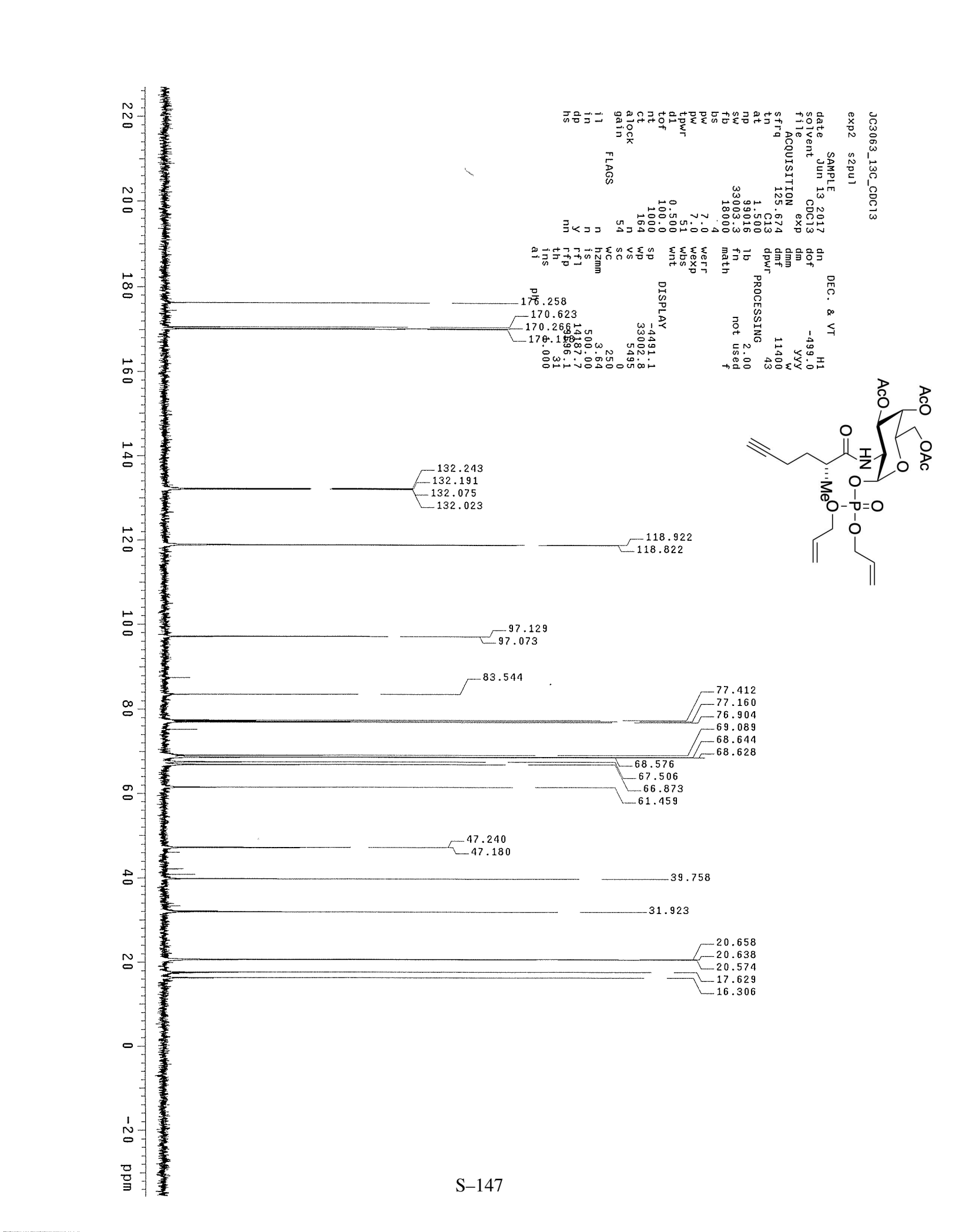


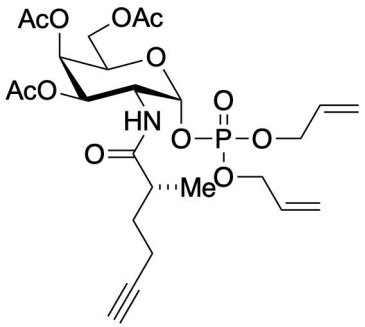
JC3063_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.8		
rfp	3628.2		
th	7		
ins	1.000		

nm cdc ph

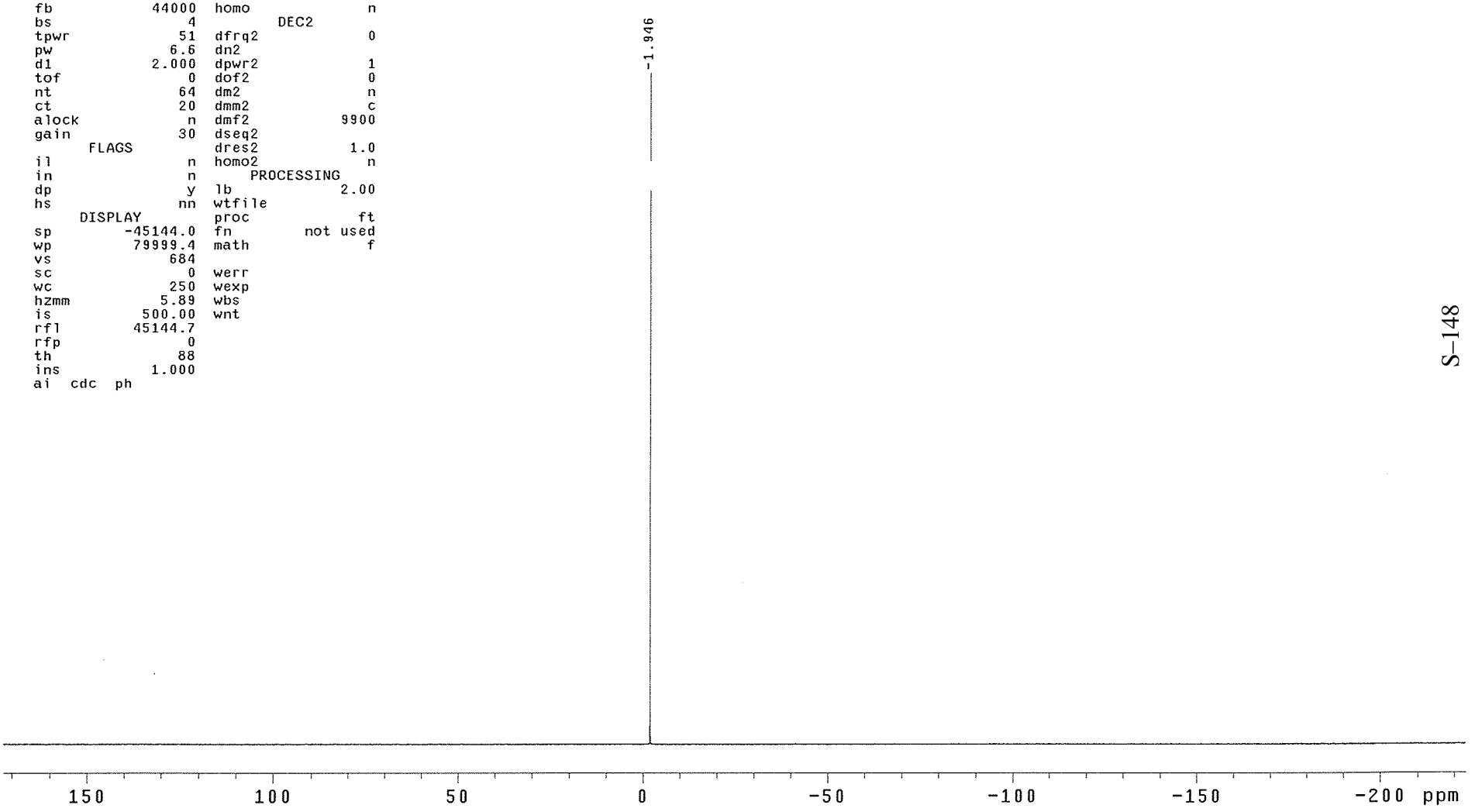

JC3063_13C_CDCl3
exp2 s2pul
SAMPLE
date Jun 13 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1000
ct 164
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
wexp
wbs
wnt
DISPLAY
sp -4491.1
wp 33002.8
vs 5495
sc 0
wc 250
hzmm 3.64
is 500.00
rfl 14187.7
rfp 336.1
th 31
ins 1.000
ppm
175.258
170.623
170.266
169.139
132.243
132.191
132.075
132.023
118.922
118.822
97.129
97.073
83.544
77.412
77.160
76.904
69.089
68.644
68.628
68.576
67.506
66.873
61.459
47.240
47.180
39.758
31.923
20.658
20.638
20.574
17.629
16.306
AcO
AcO
OAc
O
HN
O
O-P=O
O
Me
O
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

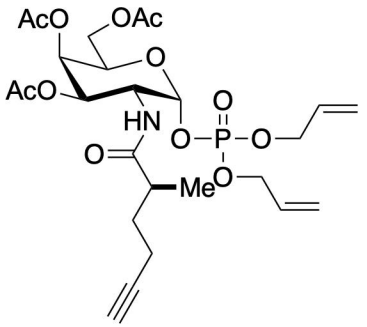


JC3063_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 13 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	20	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45144.0	fn	not used
wp	79999.4	math	f
vs	684		
sc	0	werr	
wc	250	wexp	
hzmm	5.89	wbs	
is	500.00	wnt	
rfl	45144.7		
rfp	0		
th	88		
ins	1.000		
ai cdc ph			

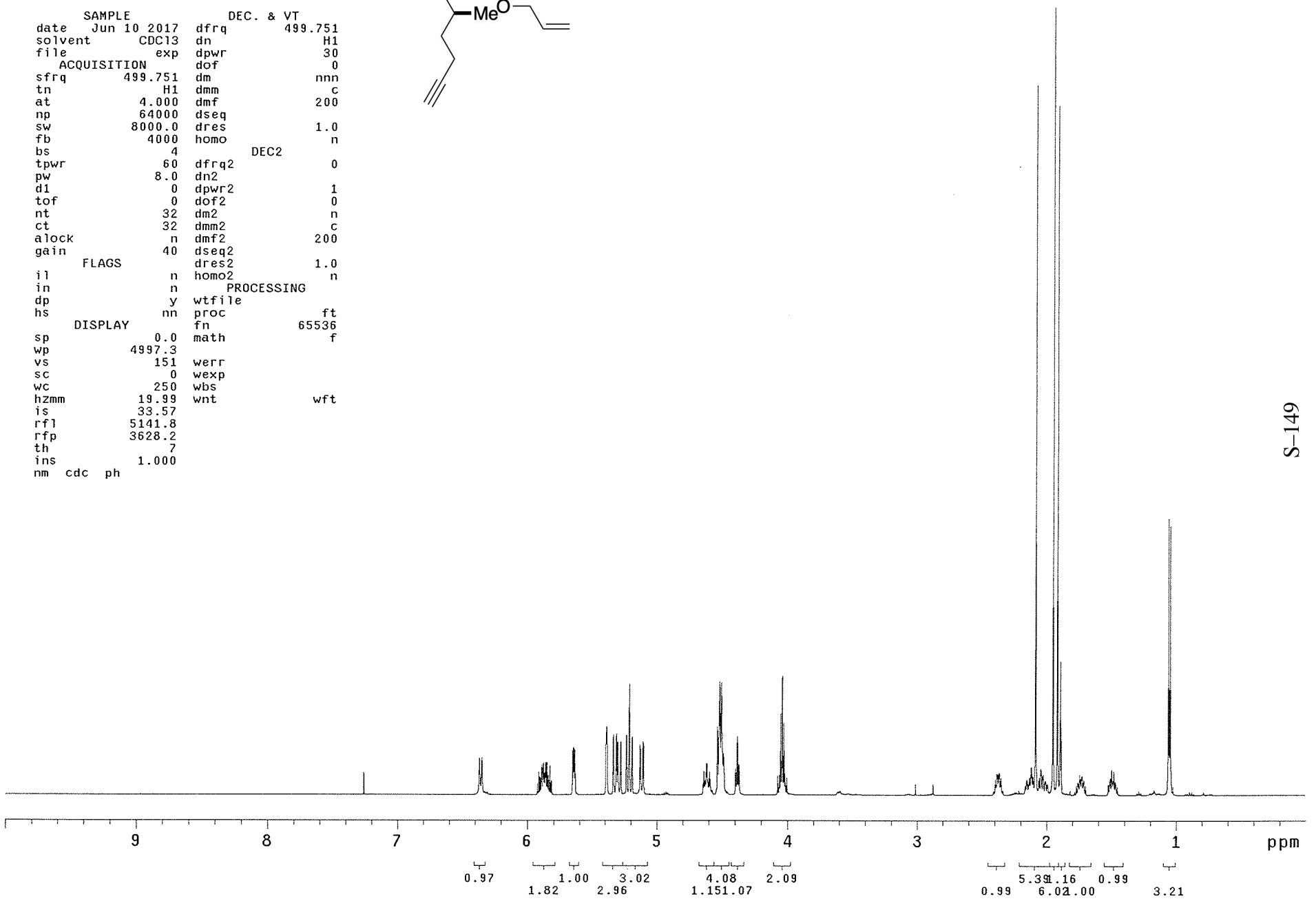


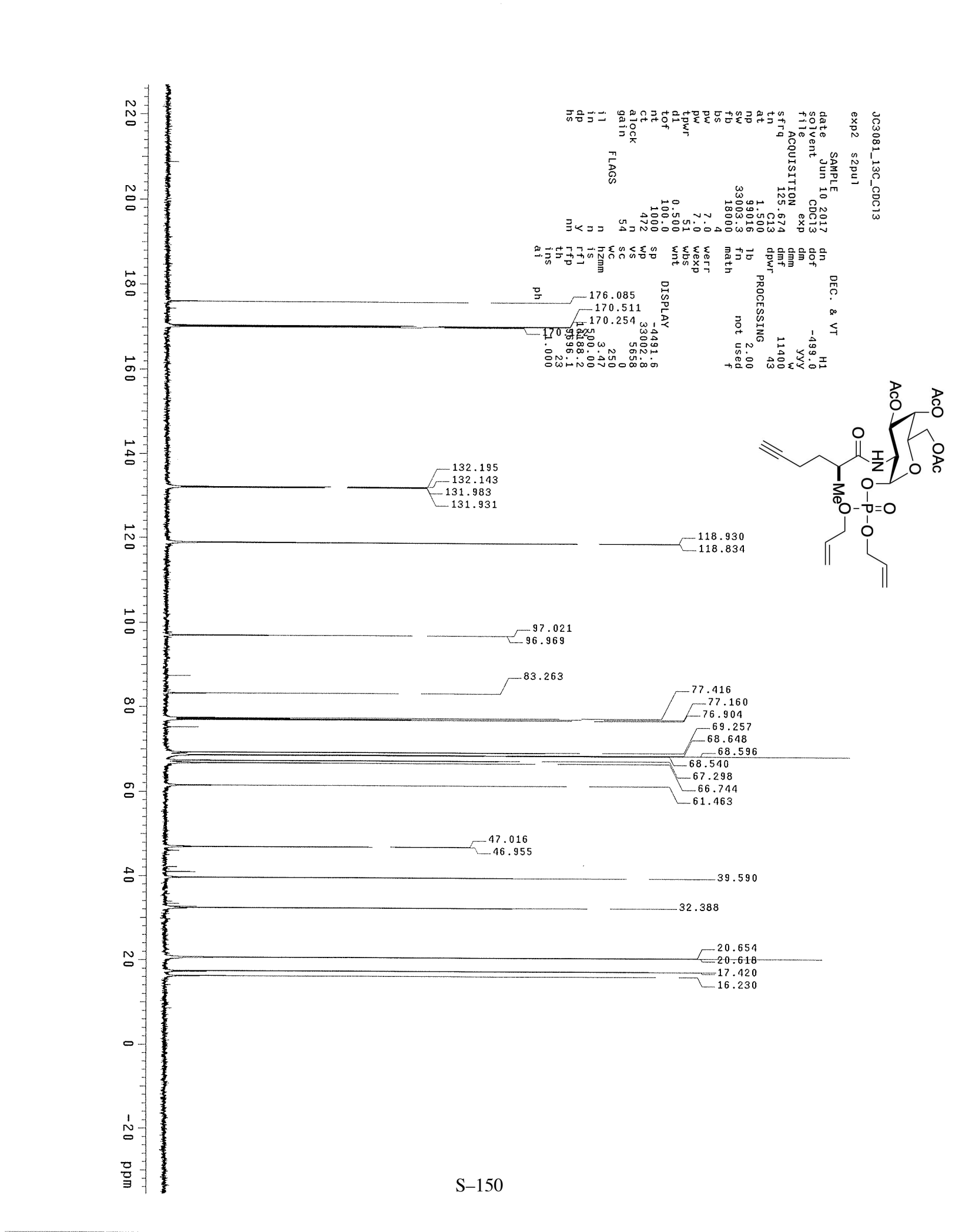


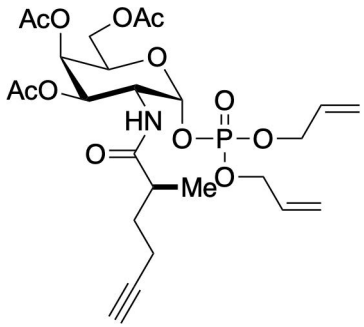
JC3081_1H_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.751	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	32	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	0.0	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	5141.8		
rfp	3628.2		
th	7		
ins	1.000		
nm cdc ph			




JC3081_13C_CDCl3
exp2 s2pul
SAMPLE
date Jun 10 2017
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1000
ct 472
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
DISPLAY
wc 250
sc 0
vs 5658
wp 33002.8
sp -4491.6
wc 3.47
hzmm 500.00
is 1188.2
rfl 5596.1
rfp 23
th 17.000
AcO
AcO
OAc
O
HN
O
O
P
O
O
Me
O
O
176.085
170.511
170.254
132.195
132.143
131.983
131.931
118.930
118.834
97.021
96.969
83.263
77.416
77.160
76.904
69.257
68.648
68.596
68.540
67.298
66.744
61.463
47.016
46.955
39.590
32.388
20.654
20.618
17.420
16.230
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm

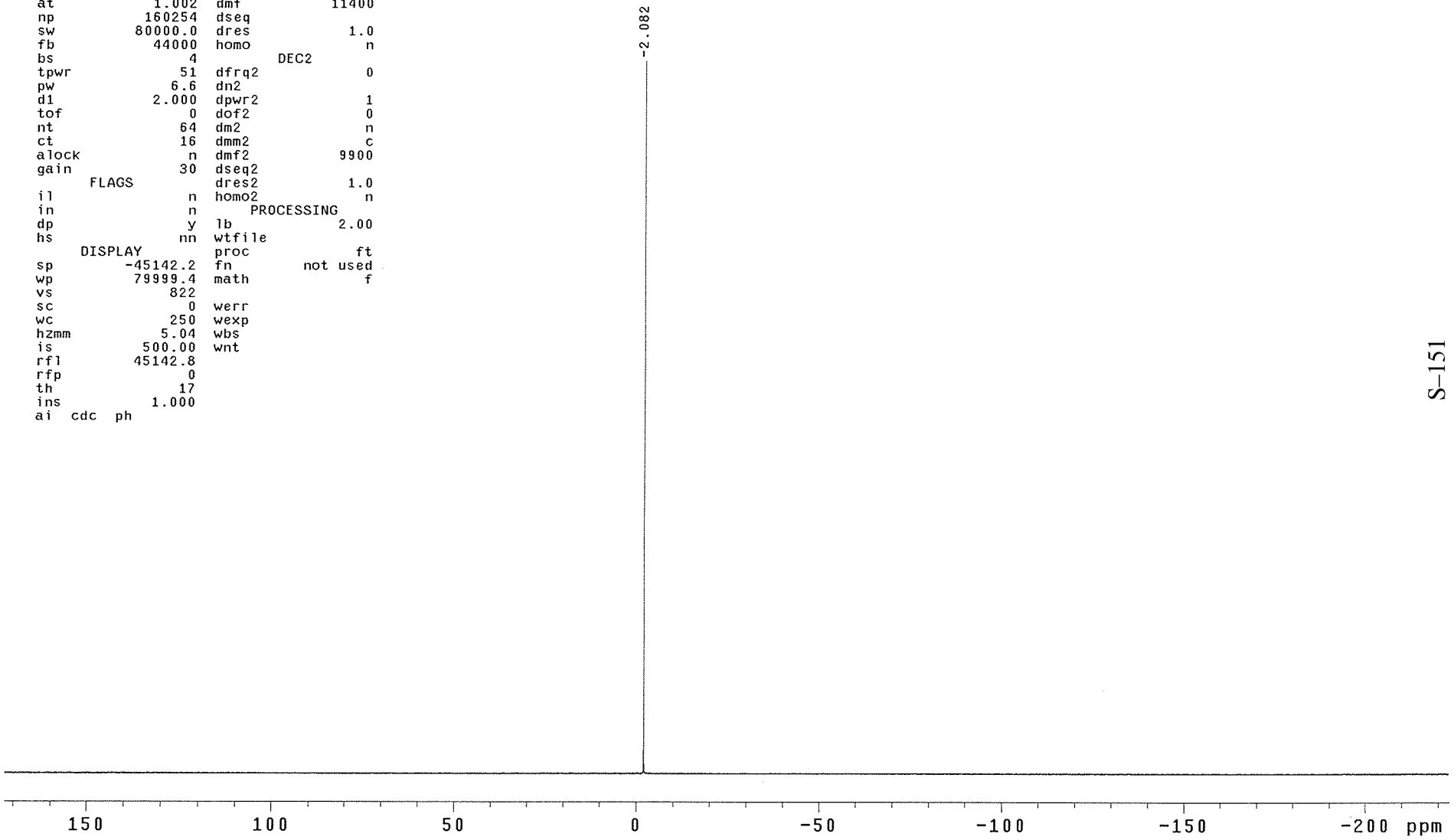


JC3081_31P_CDCl3

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jun 10 2017	dfrq	499.751
solvent	CDCl3	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45142.2	fn	not used
wp	79999.4	math	f
vs	822		
sc	0	werr	
wc	250	wexp	
hzmm	5.04	wbs	
is	500.00	wnt	
rfl	45142.8		
rfp	0		
th	17		
ins	1.000		

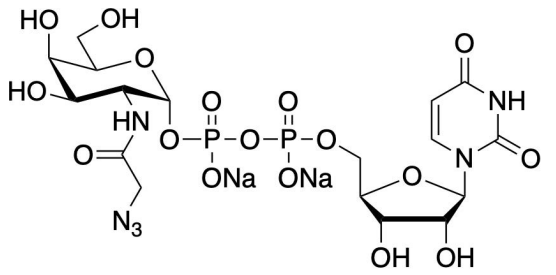
ai cdc ph



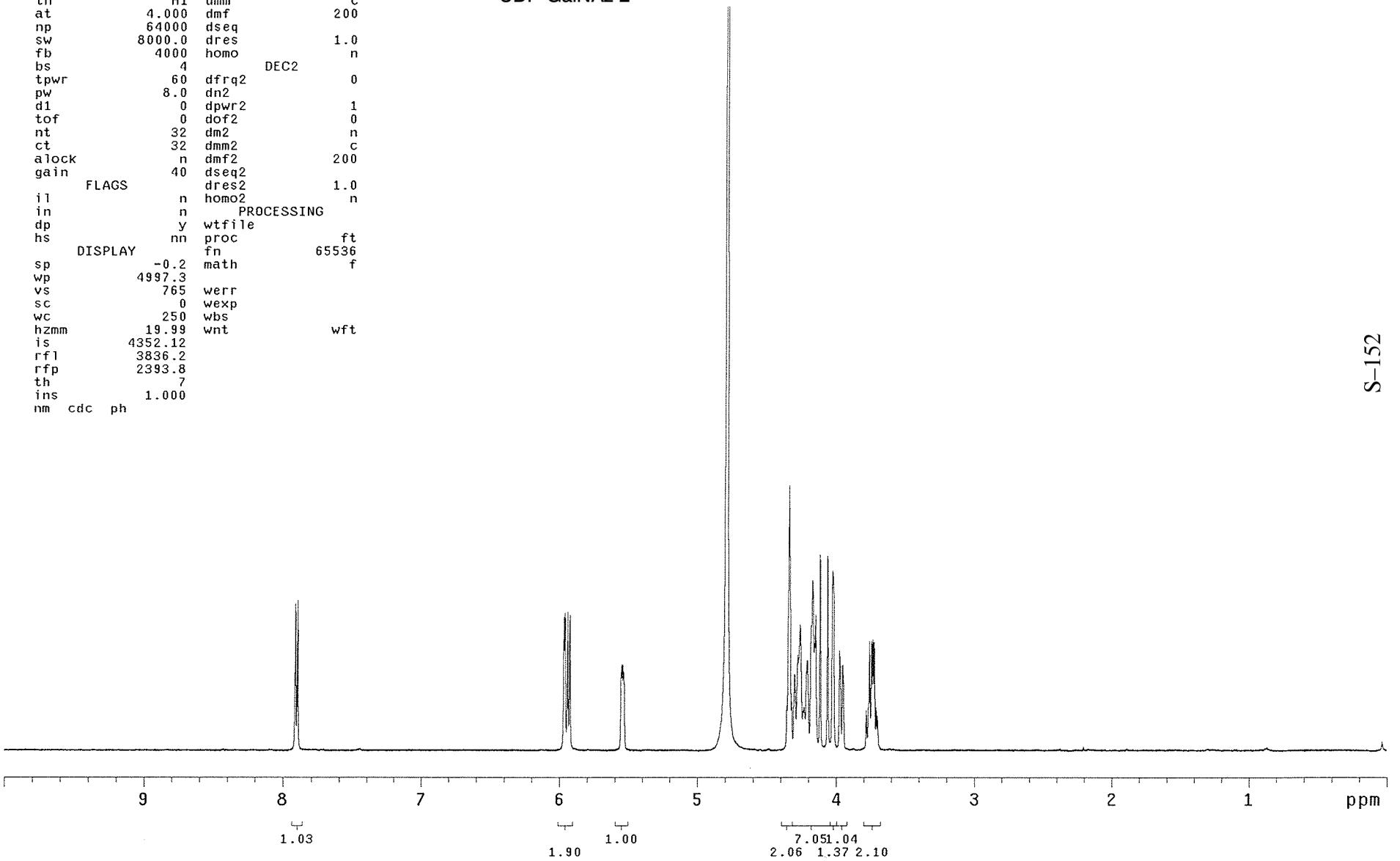
UDP-GalNAz_1H_D2O

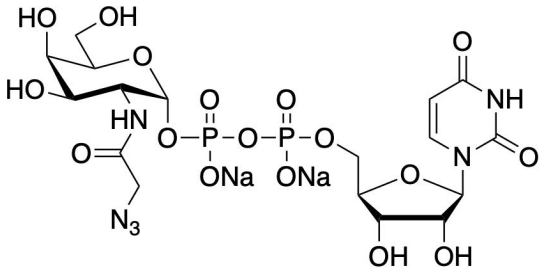
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 22 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	32	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	765	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	4352.12		
rfl	3836.2		
rfp	2393.8		
th	7		
ins	1.000		
nm cdc ph			



UDP-GalNAz **2**



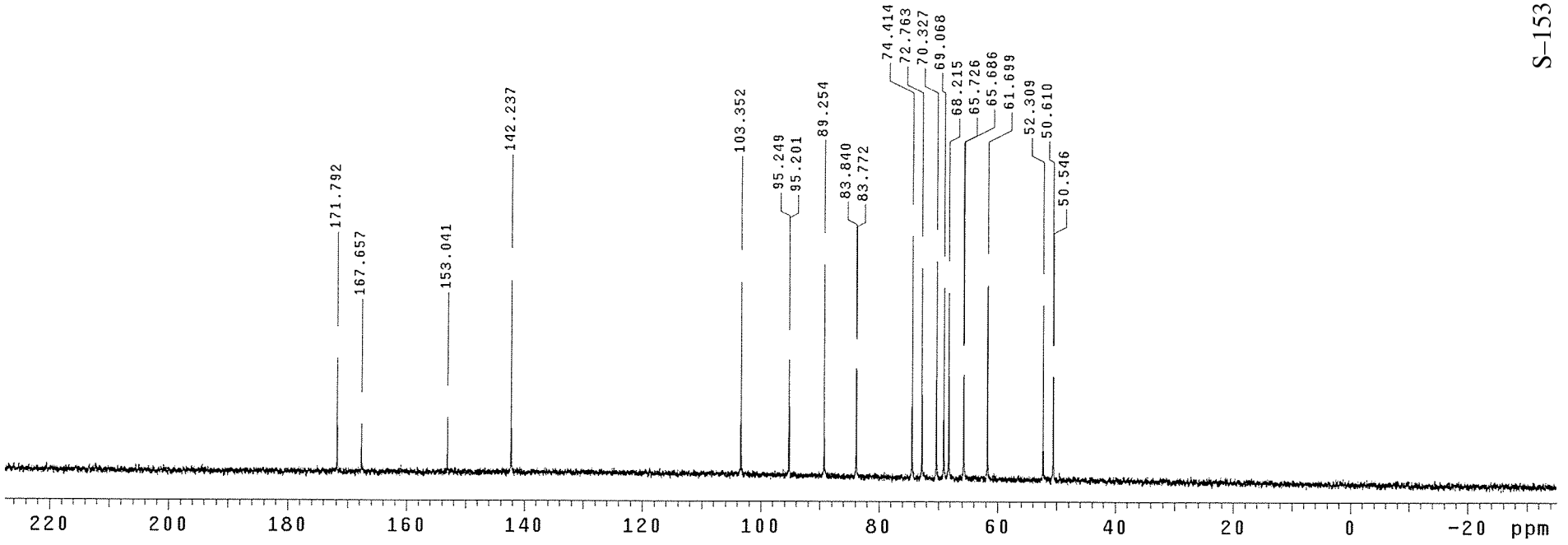


UDP-GalNAz **2**

JC2119_13C_D2O

exp3 s2pul

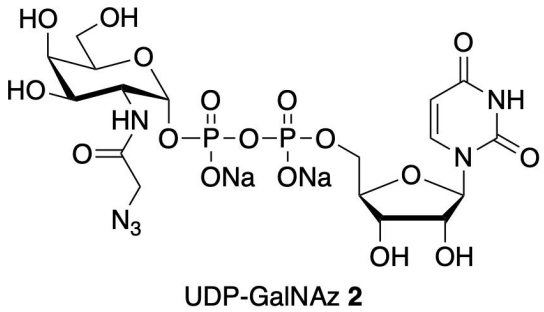
SAMPLE		DEC. & VT	
date	Jul 24 2017	dn	H1
solvent	D2O	dof	-499.0
file	exp	dm	yyy
ACQUISITION		dmm	w
sfrq	125.674	dmf	11400
tn	C13	dpwr	43
at	1.500	PROCESSING	
np	99016	lb	2.00
sw	33003.3	fn	not used
fb	18000	math	f
bs	4		
pw	7.0	werr	
pw	7.0	wexp	
tpwr	51	wbs	
d1	1.000	wnt	
tof	100.0	DISPLAY	
nt	20000	sp	-4411.1
ct	15668	wp	33002.8
alock	n	vs	30529
gain	54	sc	0
FLAGS		wc	250
il	n	hzmm	6.24
in	n	is	500.00
dp	y	rfl	10984.8
hs	nn	rfp	6573.3
		th	6
		ins	1.000
		ai ph	



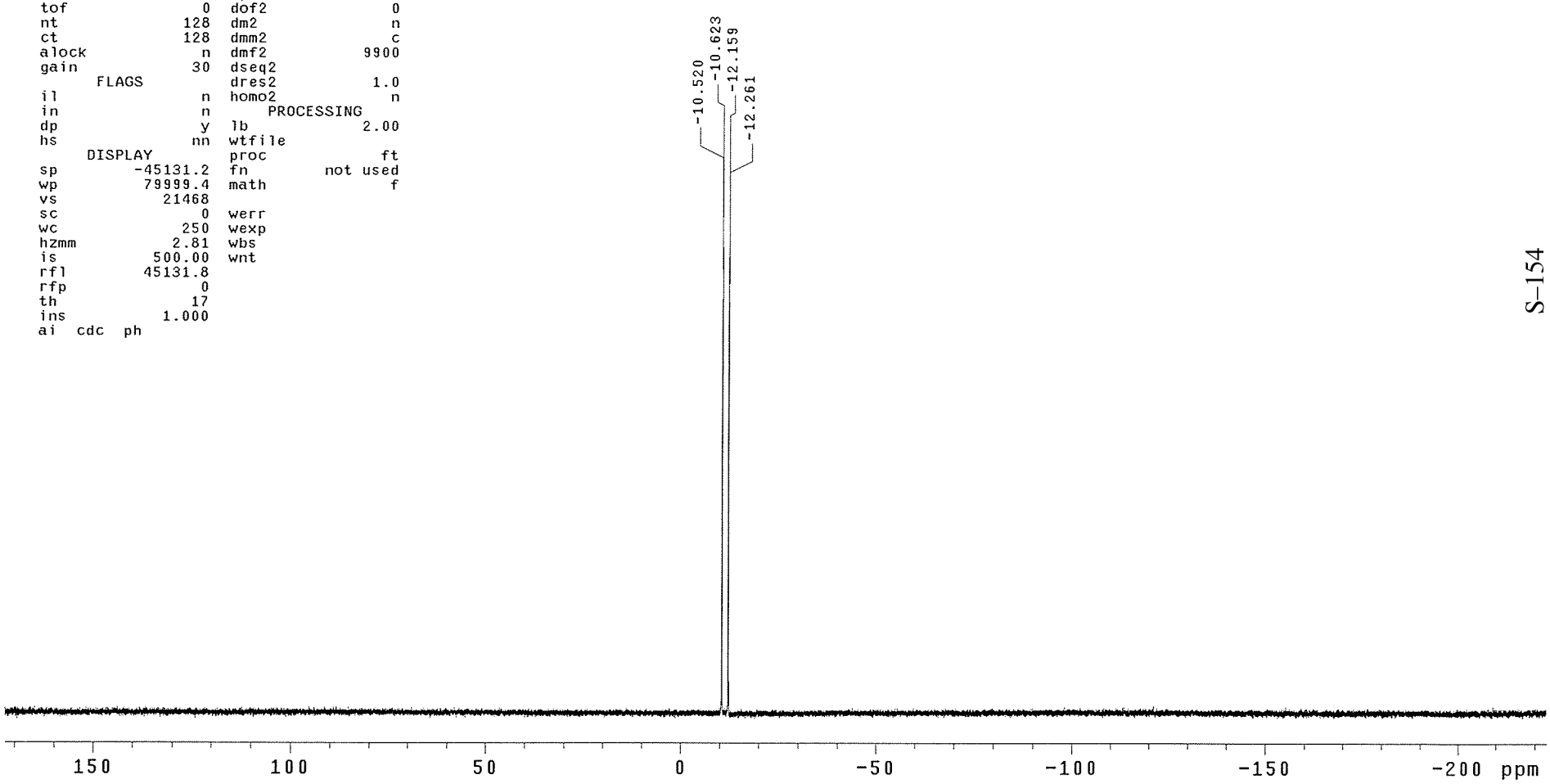
UDP-GalNAz_Na-form_1H_D2O

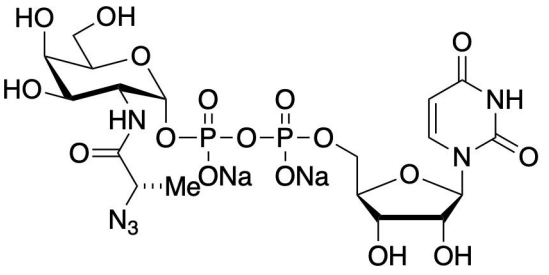
exp1 s2pul

SAMPLE		DEC. & VT	
date	Jul 26 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	128	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45131.2	fn	not used
wp	79999.4	math	f
vs	21468		
sc	0	werr	
wc	250	wexp	
hzmm	2.81	wbs	
is	500.00	wnt	
rfl	45131.8		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



UDP-GalNAz **2**





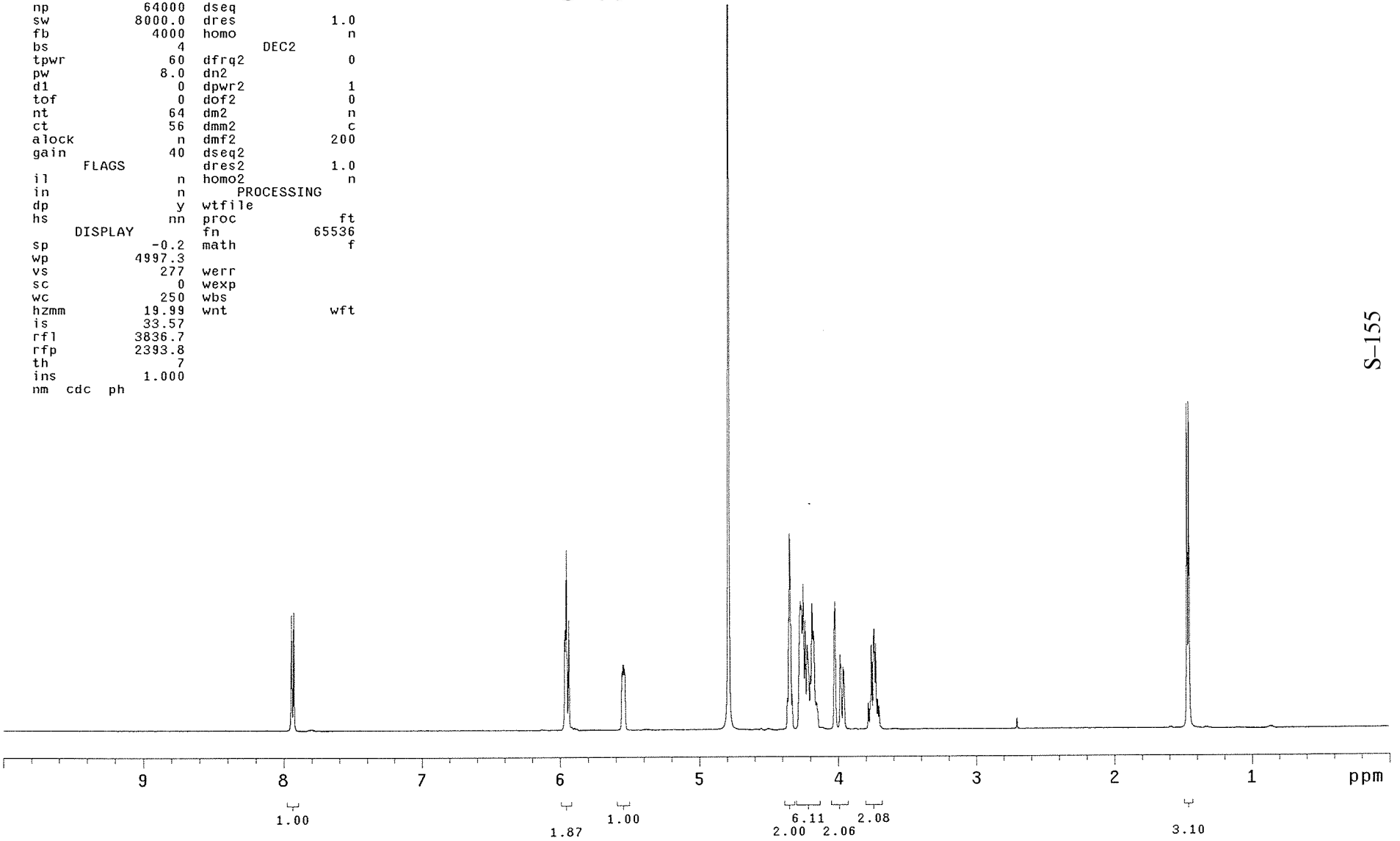
UDP-Sugar (*S*)-**3**

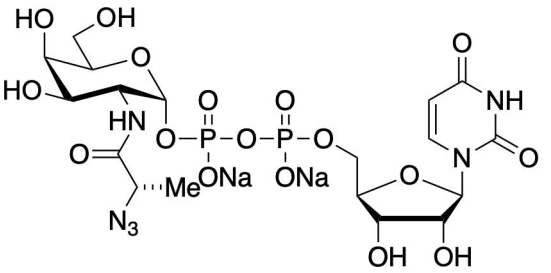
JC1125_1H_d2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 22 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	56	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	277	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	3836.7		
rfp	2393.8		
th	7		
ins	1.000		

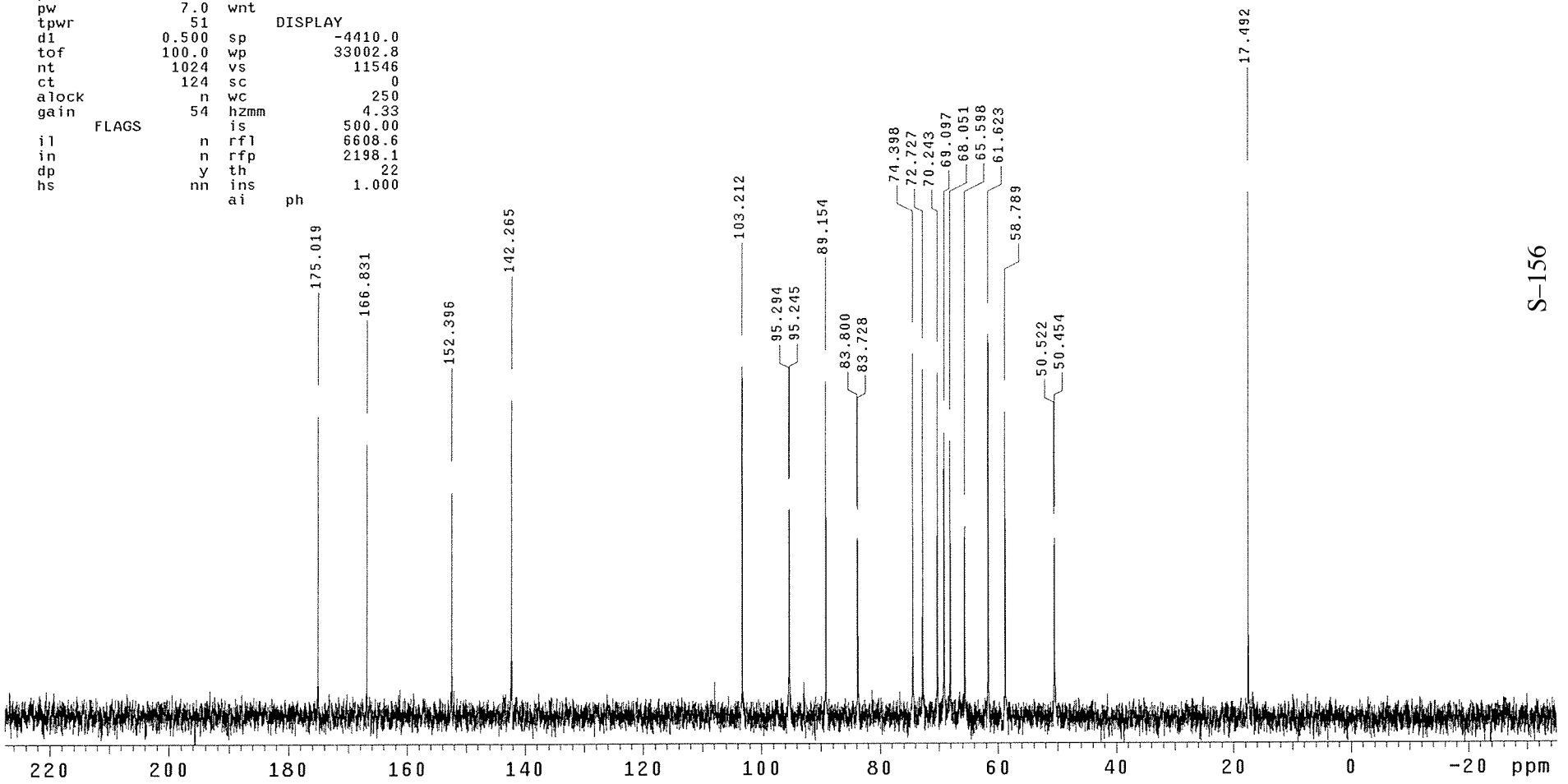
nm cdc ph

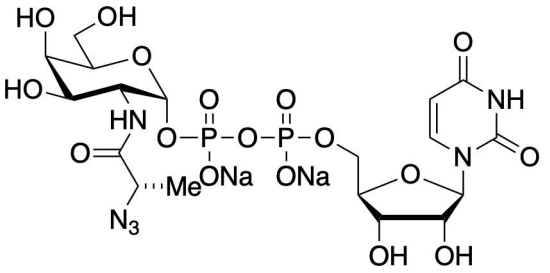




UDP-Sugar (*S*)-**3**

```
JC1125_13C_D2O

exp2  s2pul

      SAMPLE            DEC. & VT
date   Jul  7 2017  dn              H1
solvent       D2O  dof          -499.0
file /export/home/~ dm             yyy
junwchoi/JC1125_13~ dmm              w
          C_D2O.fid  dmf          11400
   ACQUISITION       dpwr            43
sfrq        125.674       PROCESSING
tn              C13  lb            2.00
at            1.500  fn        not used
np            99016  math             f
sw         33003.3
fb            18000  werr
bs                4  wexp
pw              7.0  wbs
pw              7.0  wnt
tpwr             51       DISPLAY
d1            0.500  sp         -4410.0
tof           100.0  wp         33002.8
nt             1024  vs           11546
ct              124  sc               0
alock             n  wc             250
gain             54  hzmm          4.33
      FLAGS          is          500.00
il                n  rfl         6608.6
in                n  rfp         2198.1
dp                y  th              22
hs               nn  ins          1.000
                     ai     ph
```



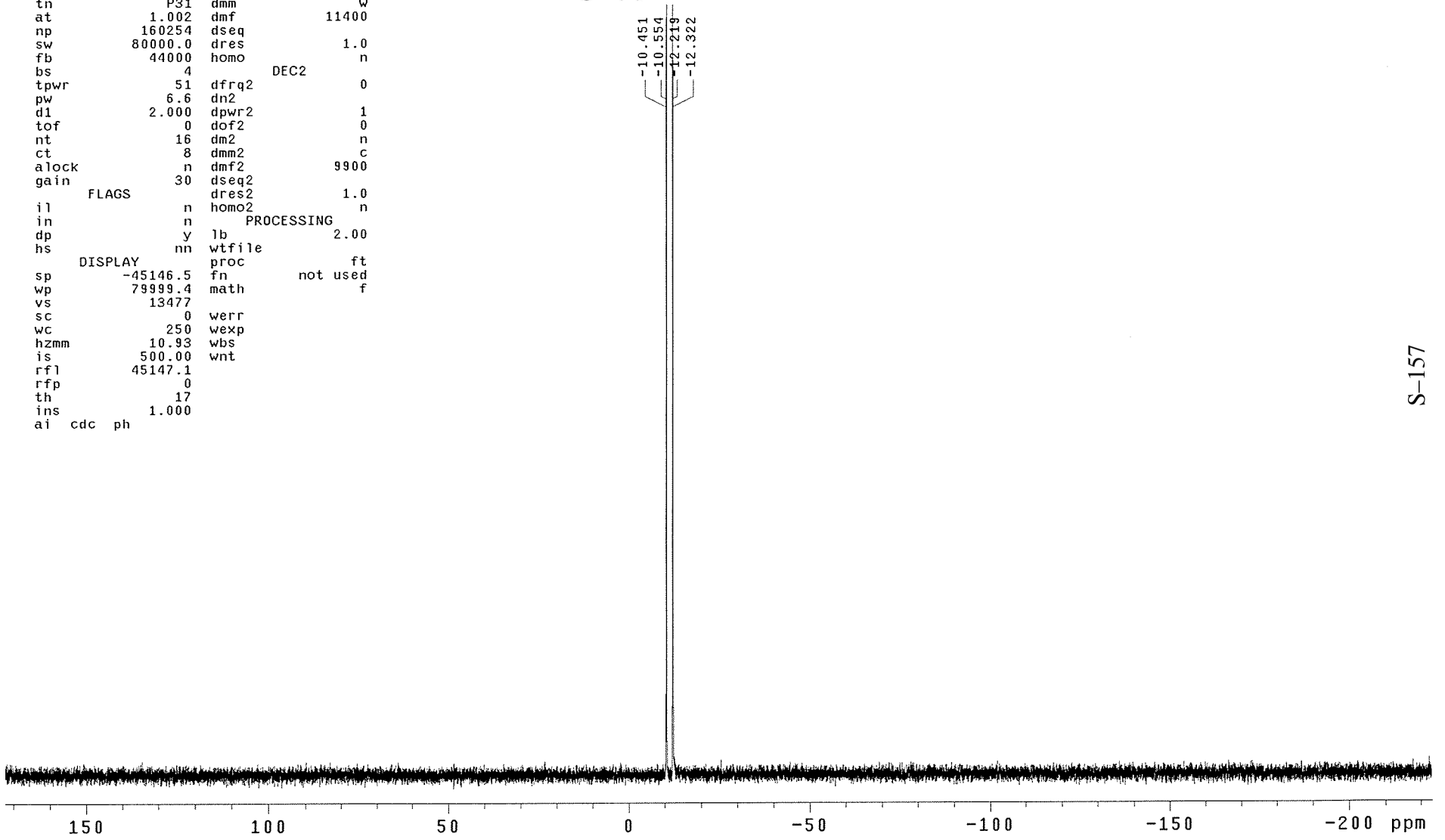


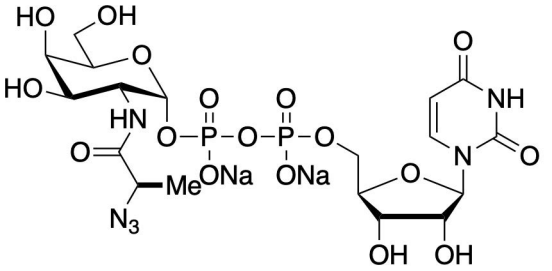
UDP-Sugar (*S*)-**3**

JC1125_31P_D2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 7 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	8	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45146.5	fn	not used
wp	79999.4	math	f
vs	13477		
sc	0	werr	
wc	250	wexp	
hzmm	10.93	wbs	
is	500.00	wnt	
rfl	45147.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



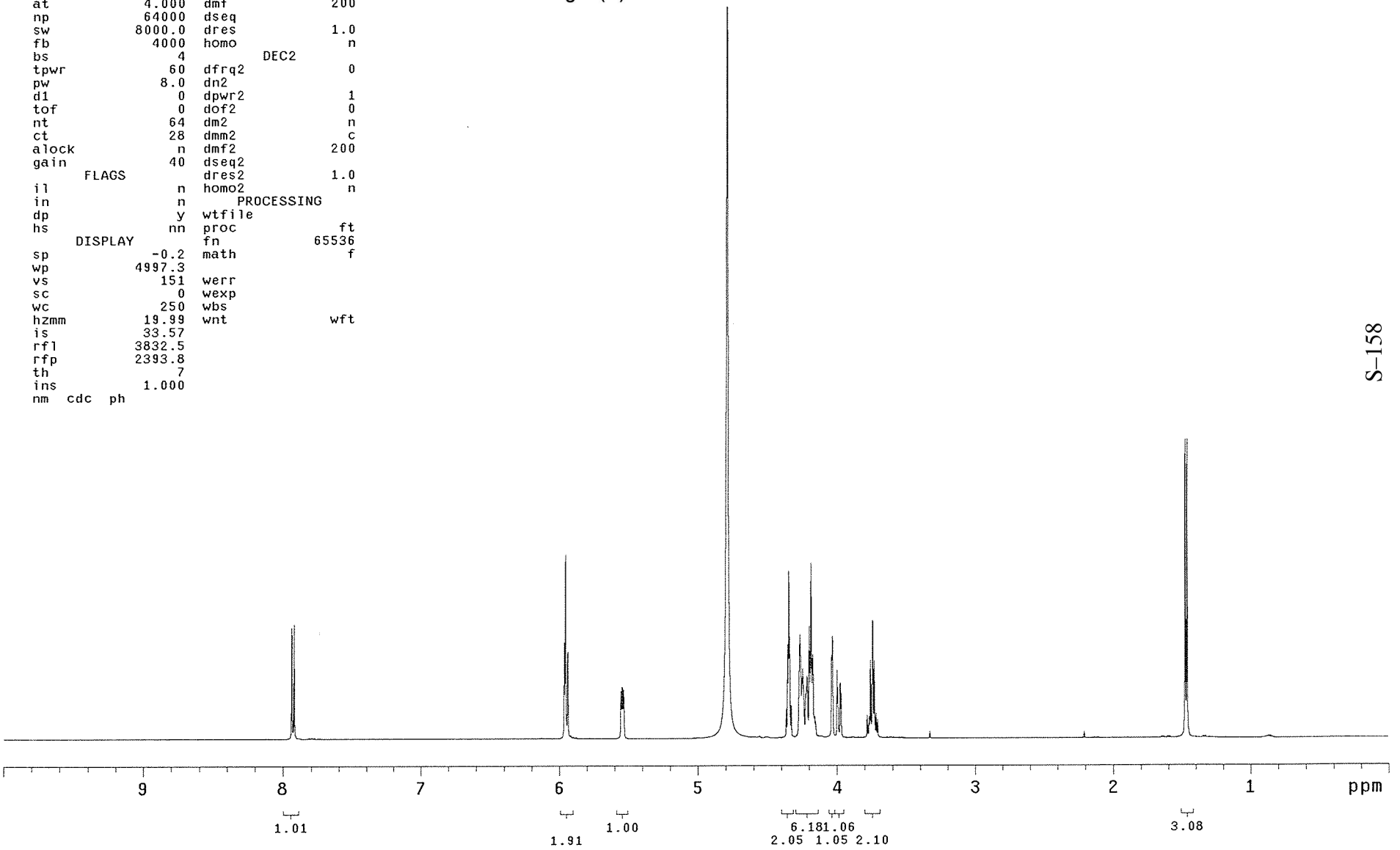


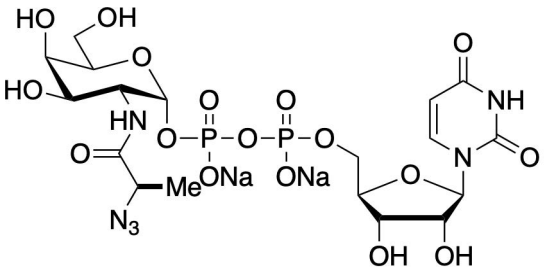
UDP-Sugar (*R*)-**3**

JC2009_1H_D2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 7 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	28	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	151	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	3832.5		
rfp	2393.8		
th	7		
ins	1.000		
nm cdc ph			



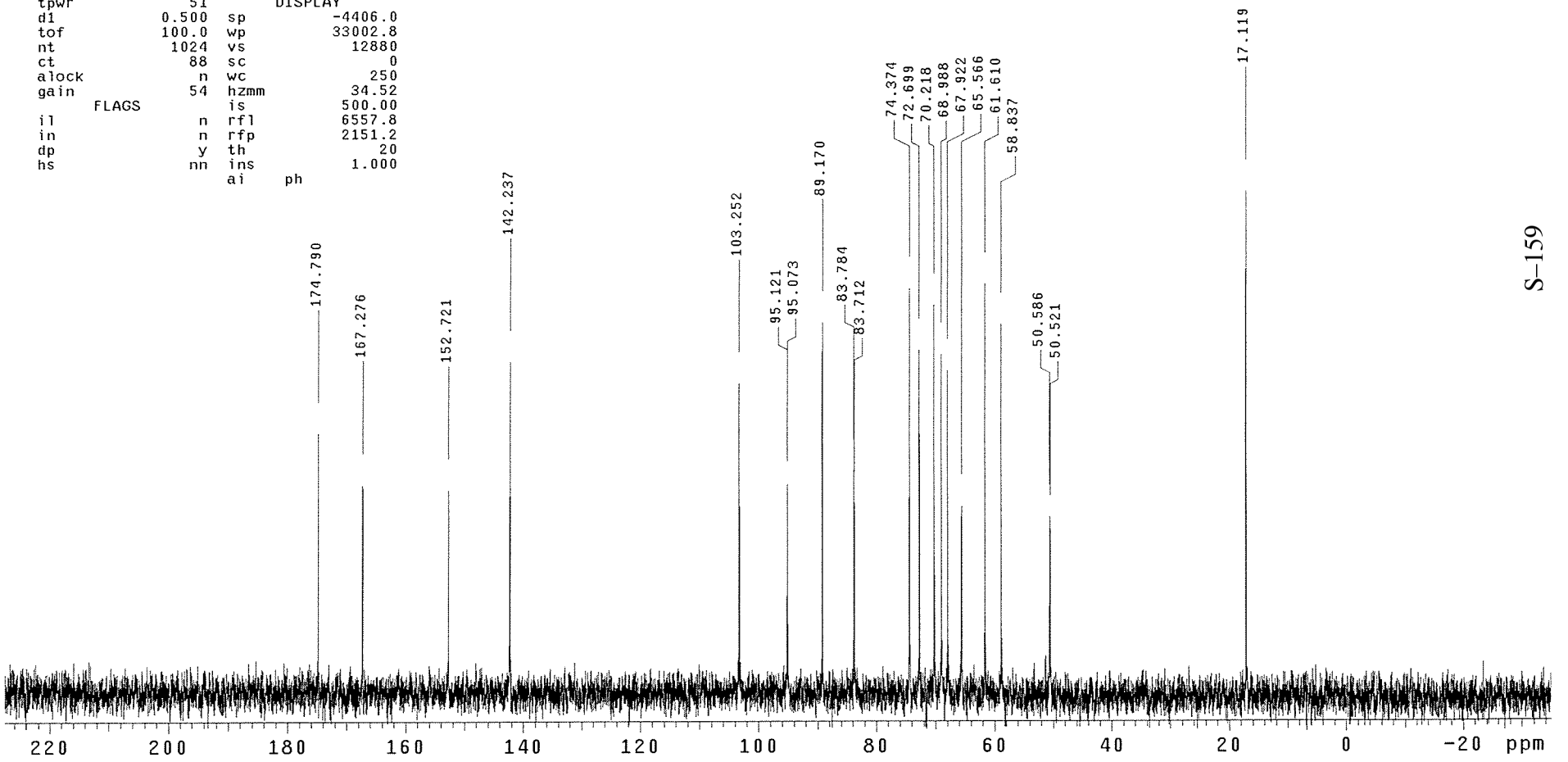


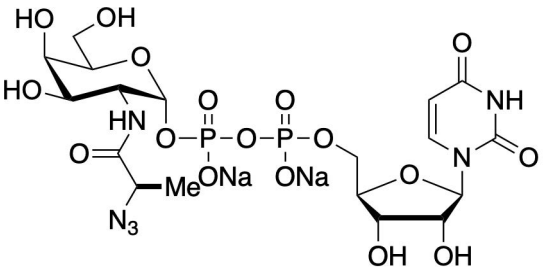
UDP-Sugar (*R*)-**3**

JC2009_13C_D2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 7 2017	dn	H1
solvent	D2O	dof	-499.0
file	/export/home/~	dm	yyy
junwchoi/JC2009_13~		dmm	w
	C_D2O.fid	dmf	11400
ACQUISITION		dpwr	43
sfrq	125.674	PROCESSING	
tn	C13	lb	2.00
at	1.500	fn	not used
np	99016	math	f
sw	33003.3		
fb	18000	werr	
bs	4	wexp	
pw	7.0	wbs	
pw	7.0	wnt	
tpwr	51	DISPLAY	
d1	0.500	sp	-4406.0
tof	100.0	wp	33002.8
nt	1024	vs	12880
ct	88	sc	0
alock	n	wc	250
gain	54	hzmm	34.52
FLAGS		is	500.00
il	n	rfl	6557.8
in	n	rfp	2151.2
dp	y	th	20
hs	nn	ins	1.000
		ai ph	



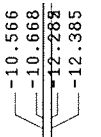


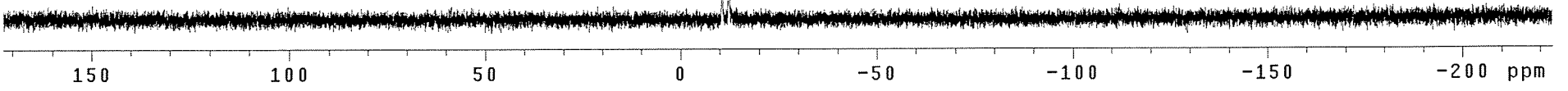
UDP-Sugar (*R*)-**3**

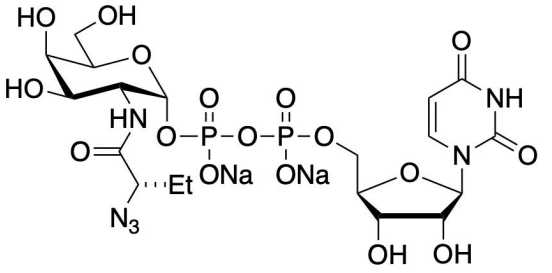
JC2009_31P_D2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 7 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	8	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45146.5	fn	not used
wp	79999.4	math	f
vs	12462		
sc	0	werr	
wc	250	wexp	
hzmm	10.93	wbs	
is	500.00	wnt	
rfl	45147.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

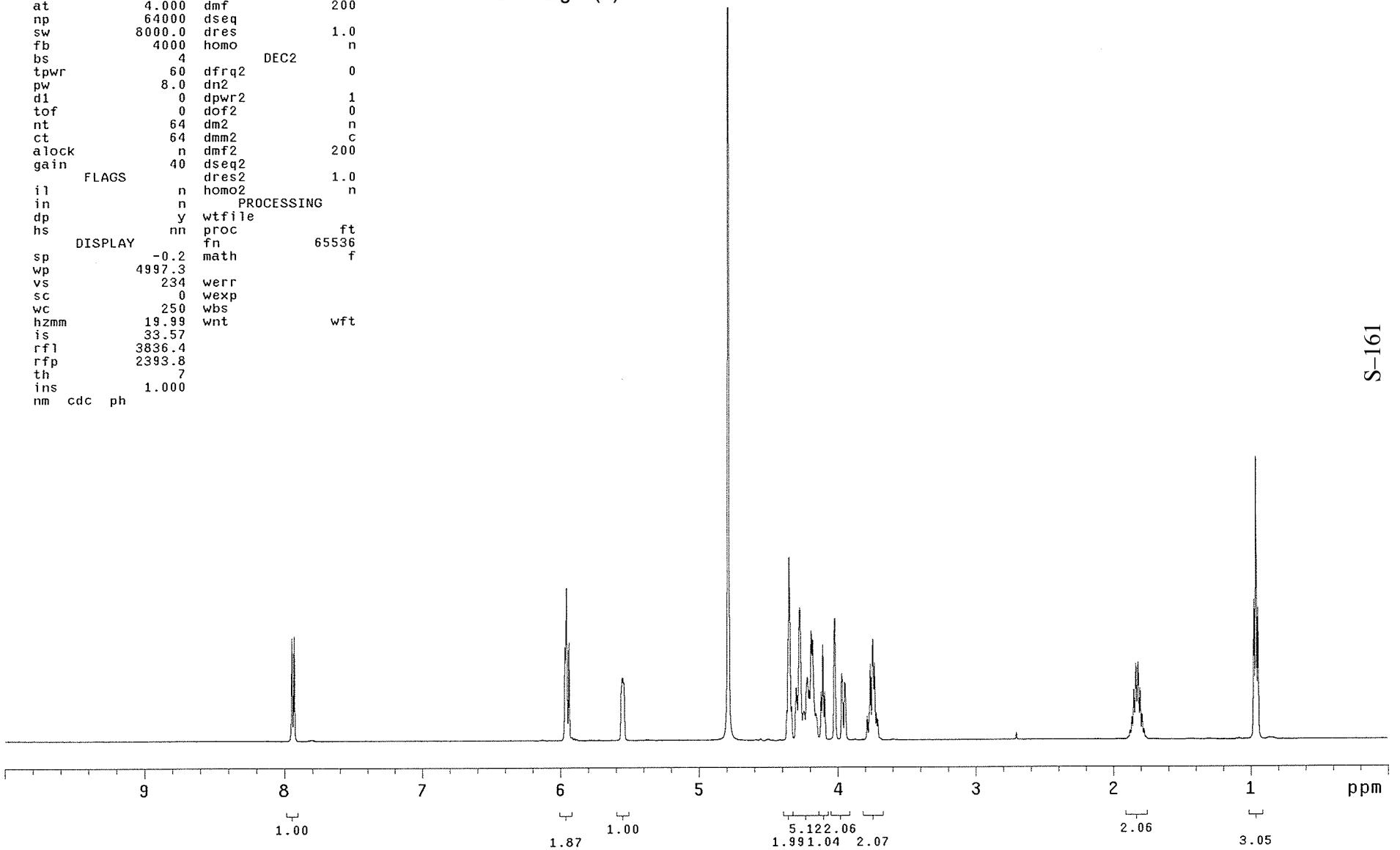


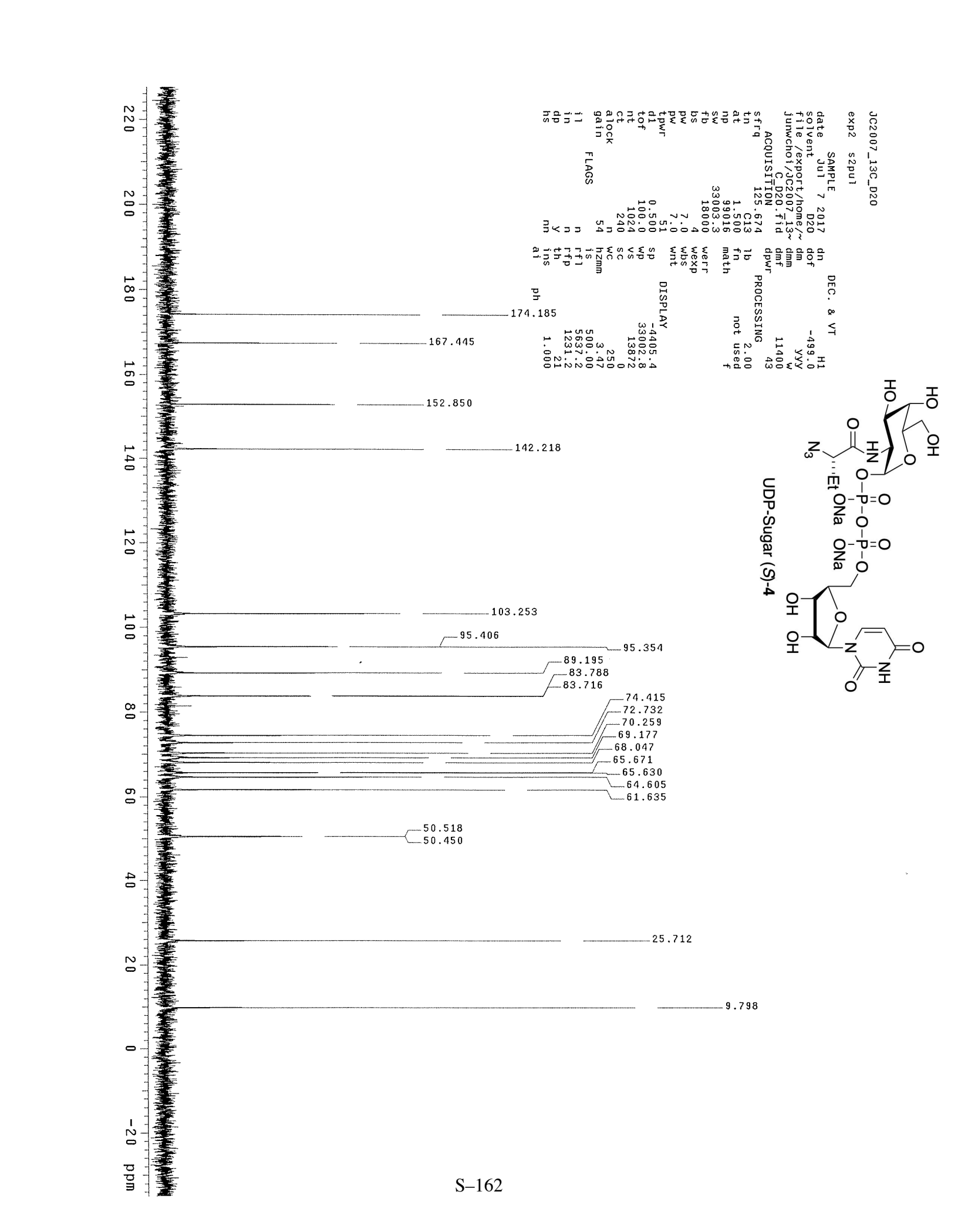


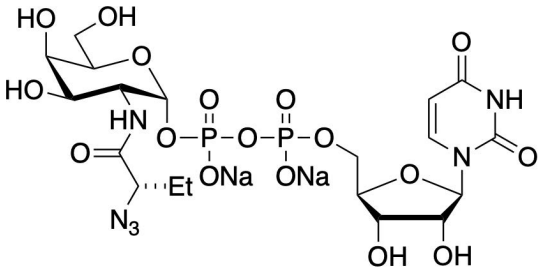


UDP-Sugar (*S*)-**4**

```
JC2007_1H_D2O

exp2  s2pul

      SAMPLE
date   Jul 22 2017
solvent        D2O
file           exp
   ACQUISITION
sfrq       499.752
tn              H1
at             4.000
np             64000
sw            8000.0
fb              4000
bs                 4
tpwr              60
pw               8.0
d1                 0
tof                0
nt                64
ct                64
alock              n
gain              40
      FLAGS
il                 n
in                 n
dp                 y
hs                nn
     DISPLAY
sp              -0.2
wp            4997.3
vs               234
sc                 0
wc               250
hzmm           19.99
is             33.57
rfl           3836.4
rfp           2393.8
th                 7
ins            1.000
nm  cdc  ph

      DEC. & VT
dfrq       499.752
dn              H1
dpwr            30
dof              0
dm             nnn
dmm              c
dmf            200
dseq
dres           1.0
homo             n
      DEC2
dfrq2            0
dn2
dpwr2            1
dof2             0
dm2              n
dmm2             c
dmf2           200
dseq2
dres2          1.0
homo2            n
     PROCESSING
wtfile
proc            ft
fn           65536
math             f

werr
wexp
wbs
wnt            wft
```




JC2007_13C_D20
exp2 s2pul
SAMPLE
date Jul 7 2017
solvent D20
file /export/home/~ dm
junwchoi/JC2007_13~ dmm
C_D20.fid dmf
ACQUISITION dpwr
sfrq 125.674 C13
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 240
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
yyy
w 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
-4405.4
33002.8
13872
0
sp 3.47
wp 500.00
vs 5637.2
sc 1231.2
wc 21
hzmm 1.000
is
rfl
rfp
th
ins
ai
174.185
167.445
152.850
142.218
103.253
95.406
95.354
89.195
83.788
83.716
74.415
72.732
70.259
69.177
68.047
65.671
65.630
64.605
61.635
50.518
50.450
25.712
9.798
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm
UDP-Sugar (S)-4
HO
OH
HN
O
N3
Et ONa ONa
OH OH
NH

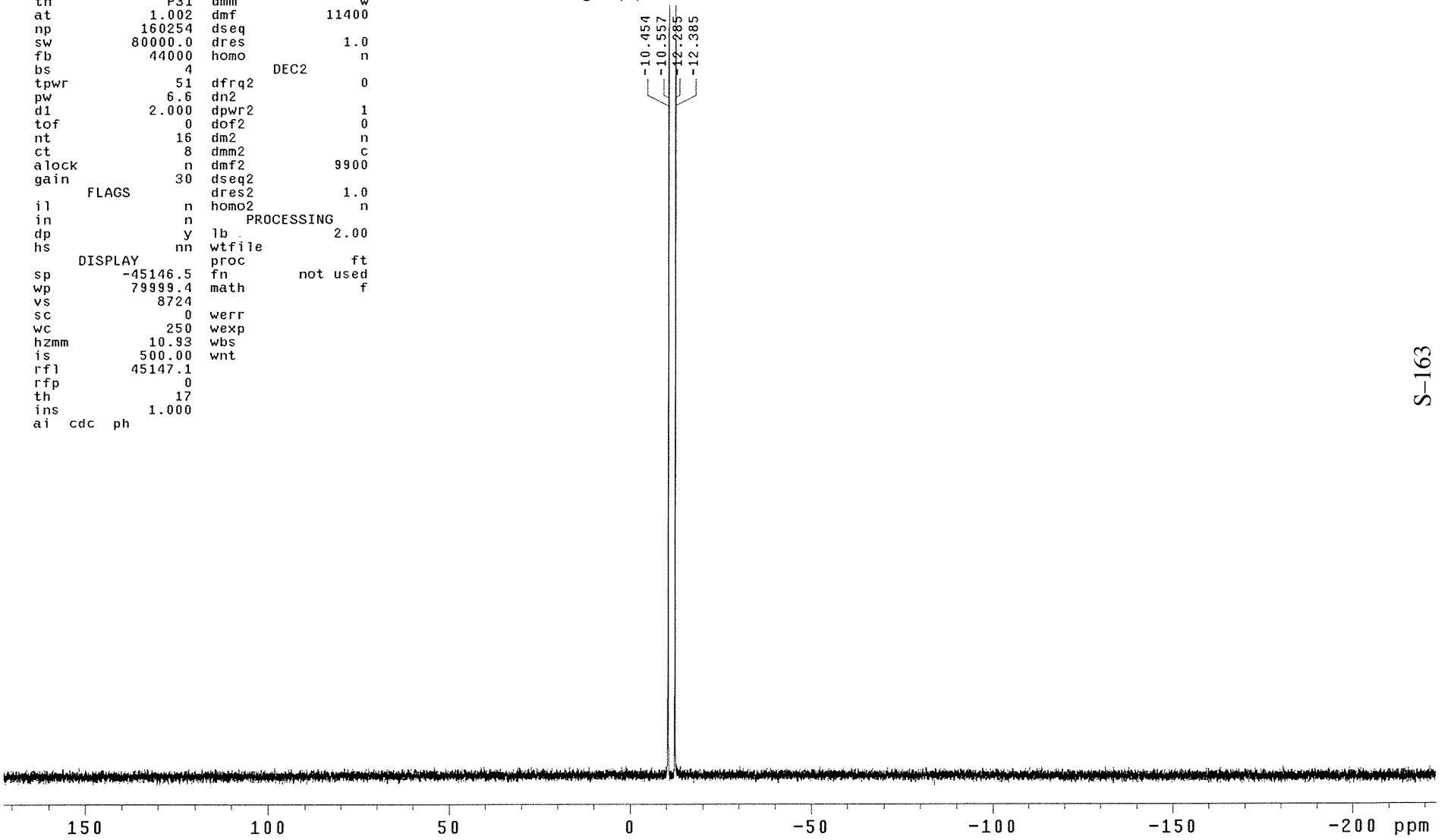


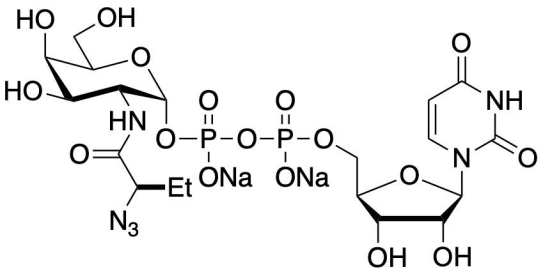
UDP-Sugar (*S*)-**4**

JC2007_31P_D2O

exp2 s2pul

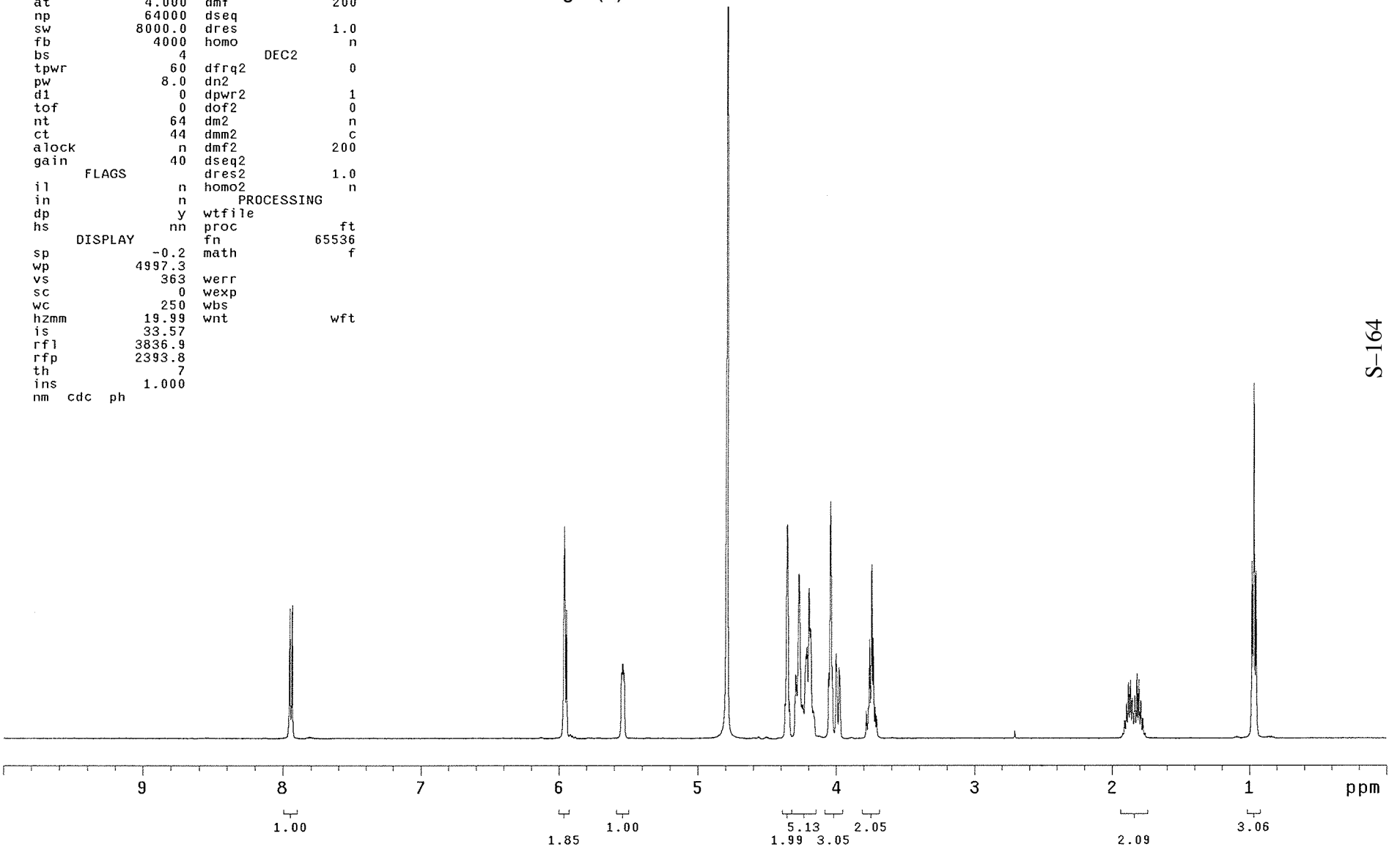
SAMPLE		DEC. & VT	
date	Jul 7 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	8	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45146.5	fn	not used
wp	79999.4	math	f
vs	8724		
sc	0	werr	
wc	250	wexp	
hzmm	10.93	wbs	
is	500.00	wnt	
rfl	45147.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

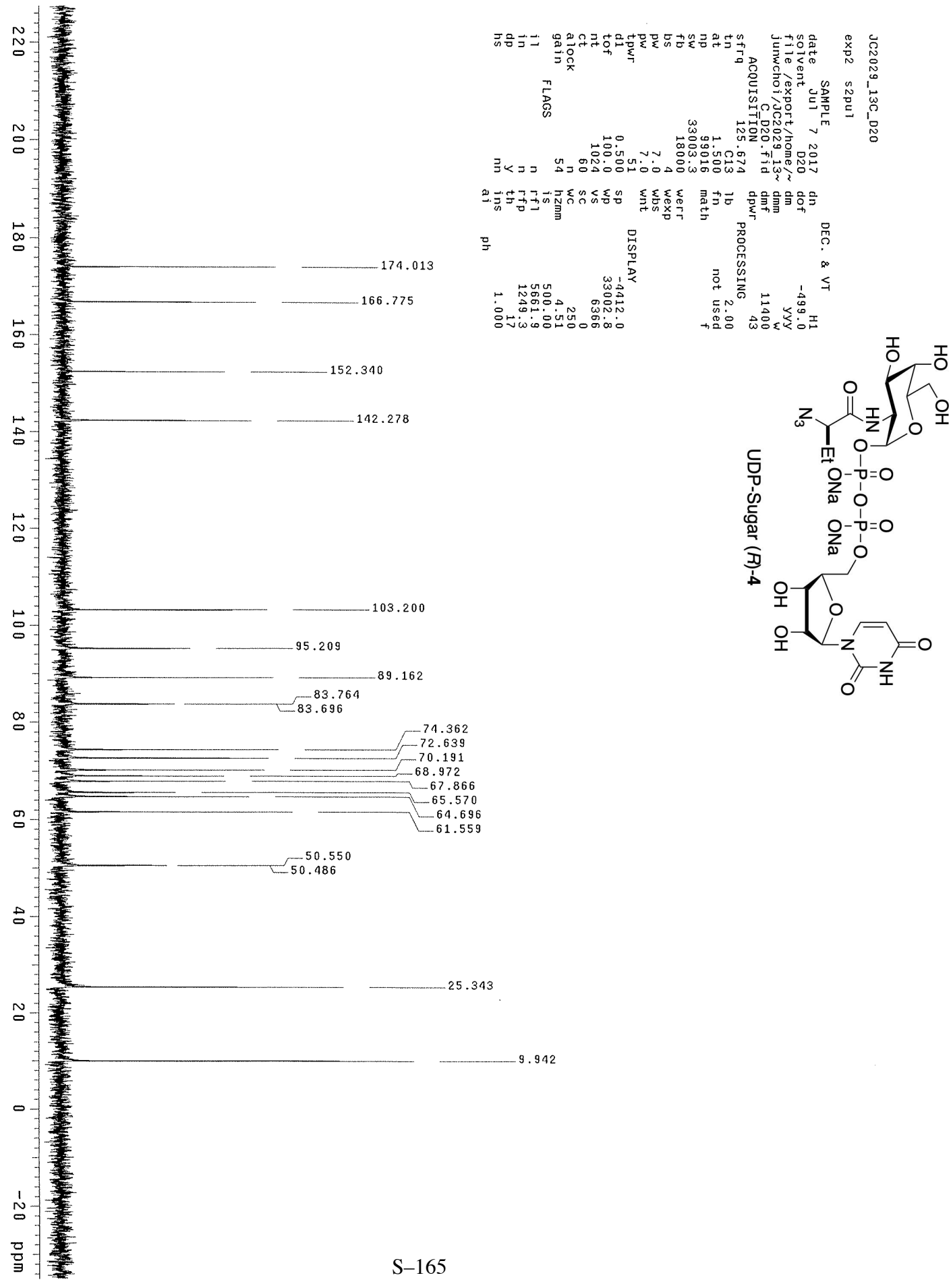


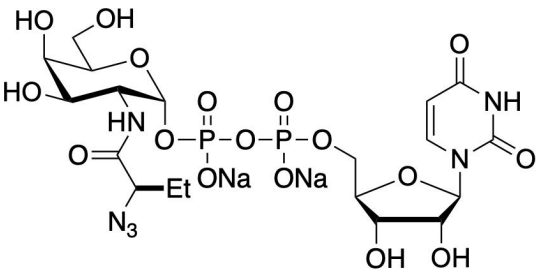


UDP-Sugar (*R*)-**4**

```
JC2029_1H_D2O

exp2  s2pul

      SAMPLE
date   Jul 22 2017
solvent        D2O
file           exp
   ACQUISITION
sfrq       499.752
tn              H1
at           4.000
np           64000
sw          8000.0
fb            4000
bs               4
tpwr            60
pw             8.0
d1               0
tof              0
nt              64
ct              44
alock            n
gain            40
      FLAGS
il               n
in               n
dp               y
hs              nn
     DISPLAY
sp            -0.2
wp          4997.3
vs             363
sc               0
wc             250
hzmm         19.99
is           33.57
rfl          3836.9
rfp          2393.8
th               7
ins          1.000
nm  cdc  ph

      DEC. & VT
dfrq       499.752
dn              H1
dpwr            30
dof              0
dm             nnn
dmm              c
dmf            200
dseq
dres           1.0
homo             n
      DEC2
dfrq2            0
dn2
dpwr2            1
dof2             0
dm2              n
dmm2             c
dmf2           200
dseq2
dres2          1.0
homo2            n
     PROCESSING
wtfile
proc            ft
fn           65536
math             f

werr
wexp
wbs
wnt            wft
```

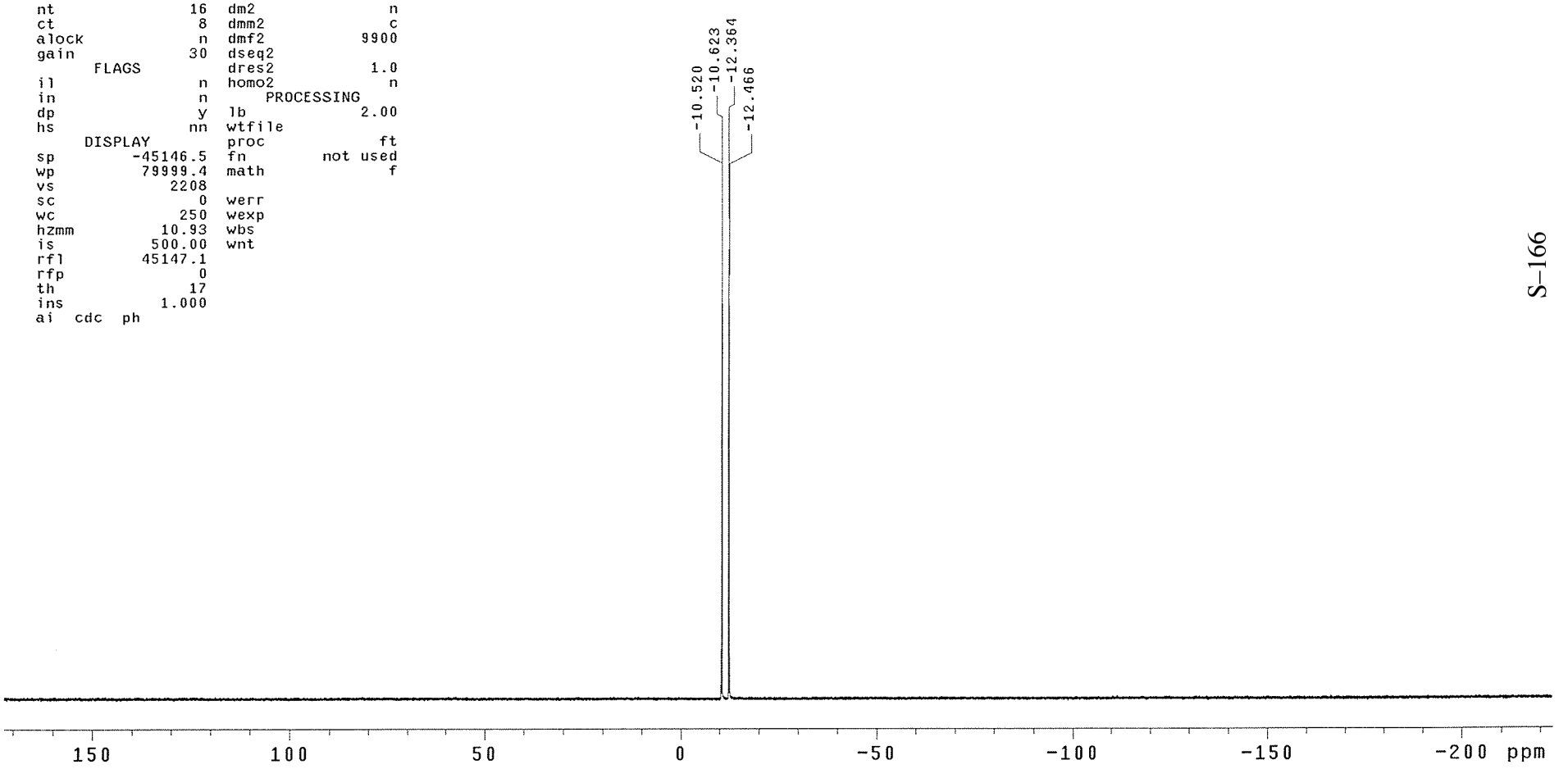


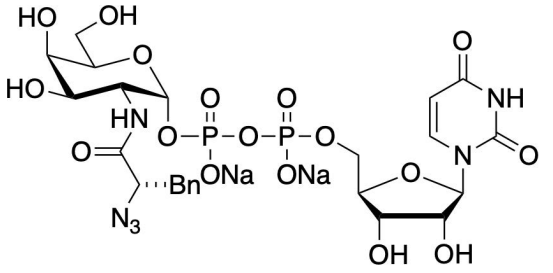

JC2029_13C_D20
exp2 s2pul
SAMPLE
date Jul 7 2017
solvent D20
file /export/home/~
junwchoi/JC2029_13~
C_D20.fid
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 60
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4412.0
wp 33002.8
vs 6366
sc 0
wc 250
hzmm 4.51
is 500.00
rfl 5661.9
rfp 1249.3
th 17
ins 1.000
ai
ph
174.013
166.775
152.340
142.278
103.200
95.209
89.162
83.764
83.696
74.362
72.639
70.191
68.972
67.866
65.570
64.696
61.559
50.550
50.486
25.343
9.942
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm
UDP-Sugar (R)-4



UDP-Sugar (*R*)-**4**

```
JC2029_31P_D2O

exp2  s2pul

      SAMPLE            DEC. & VT
date   Jul  7 2017  dfrq        499.752
solvent        D2O  dn               H1
file           exp  dpwr             43
   ACQUISITION      dof               0
sfrq       202.297  dm              yyy
tn             P31  dmm               w
at           1.002  dmf           11400
np          160254  dseq
sw         80000.0  dres            1.0
fb           44000  homo              n
bs               4        DEC2
tpwr            51  dfrq2             0
pw             6.6  dn2
d1           2.000  dpwr2             1
tof              0  dof2              0
nt              16  dm2               n
ct               8  dmm2              c
alock            n  dmf2           9900
gain            30  dseq2
      FLAGS         dres2           1.0
il               n  homo2            n
in               n      PROCESSING
dp               y  lb            2.00
hs              nn  wtfile
     DISPLAY        proc              ft
sp        -45146.5  fn         not used
wp         79999.4  math              f
vs            2208
sc               0  werr
wc             250  wexp
hzmm         10.93  wbs
is          500.00  wnt
rfl        45147.1
rfp              0
th              17
ins           1.000
ai  cdc  ph
```





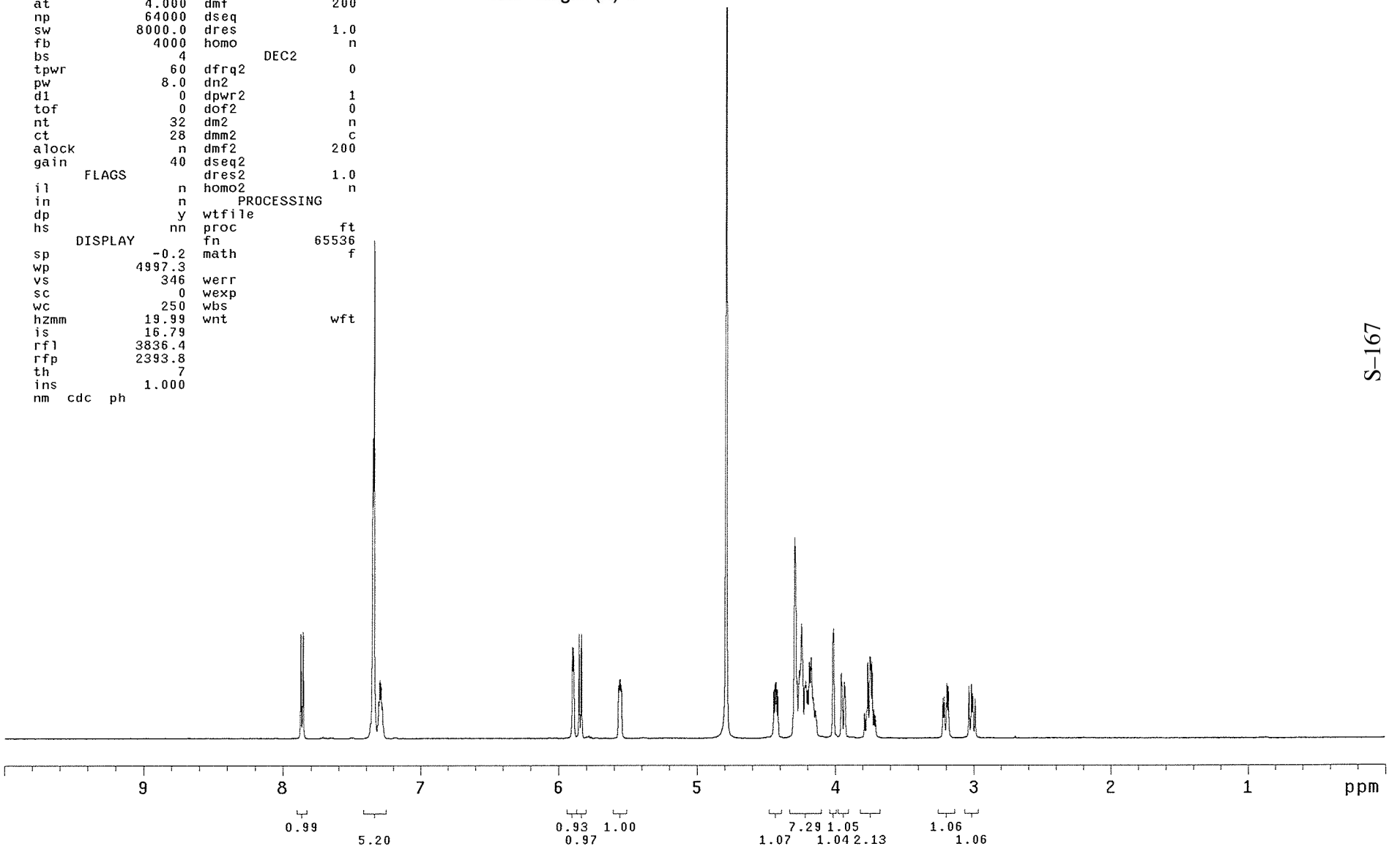
UDP-Sugar (*S*)-**5**

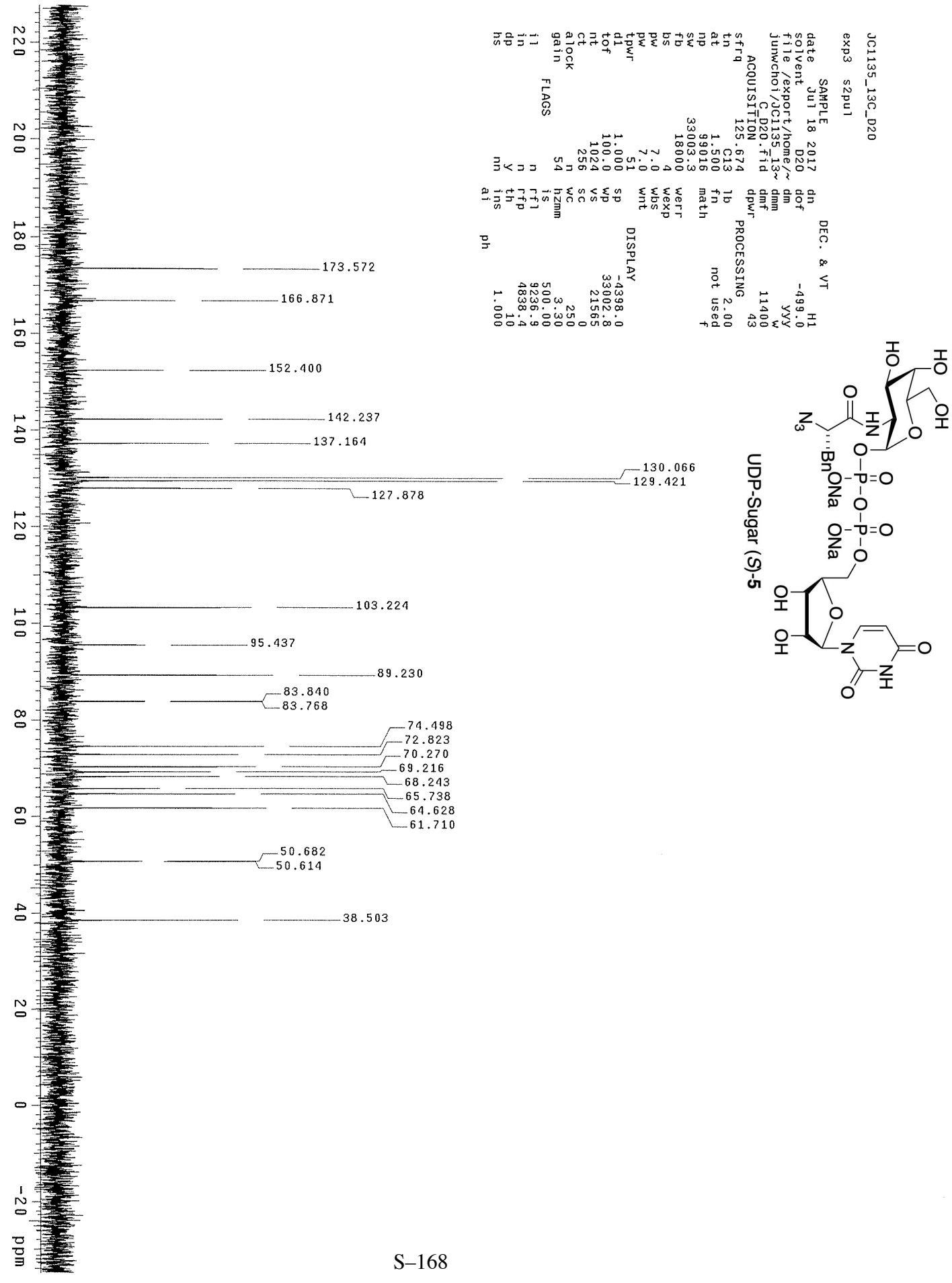
JC1135_1H_D2O

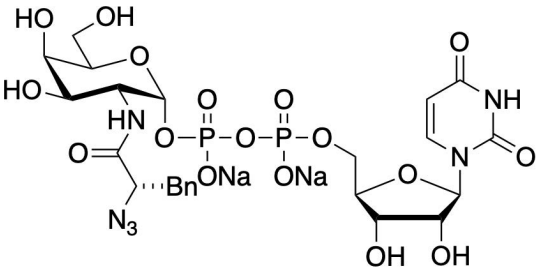
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 18 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	28	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	346	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	16.79		
rfl	3836.4		
rfp	2393.8		
th	7		
ins	1.000		

nm cdc ph




JC1135_13C_D20
exp3 s2pul
SAMPLE
date Jul 18 2017
solvent D20
file /export/home/~
junwchoi/JC1135_13~
C_D20.fid
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw
pw 7.0
tpwr 51
d1 1.000
tof 100.0
nt 1024
ct 256
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
-4398.0
33002.8
21565
0
250
3.30
hzmm
is 500.00
9236.9
4838.4
10
1.000
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm
173.572
166.871
152.400
142.237
137.164
130.066
129.421
127.878
103.224
95.437
89.230
83.840
83.768
74.498
72.823
70.270
69.216
68.243
65.738
64.628
61.710
50.682
50.614
38.503
UDP-Sugar (S)-5

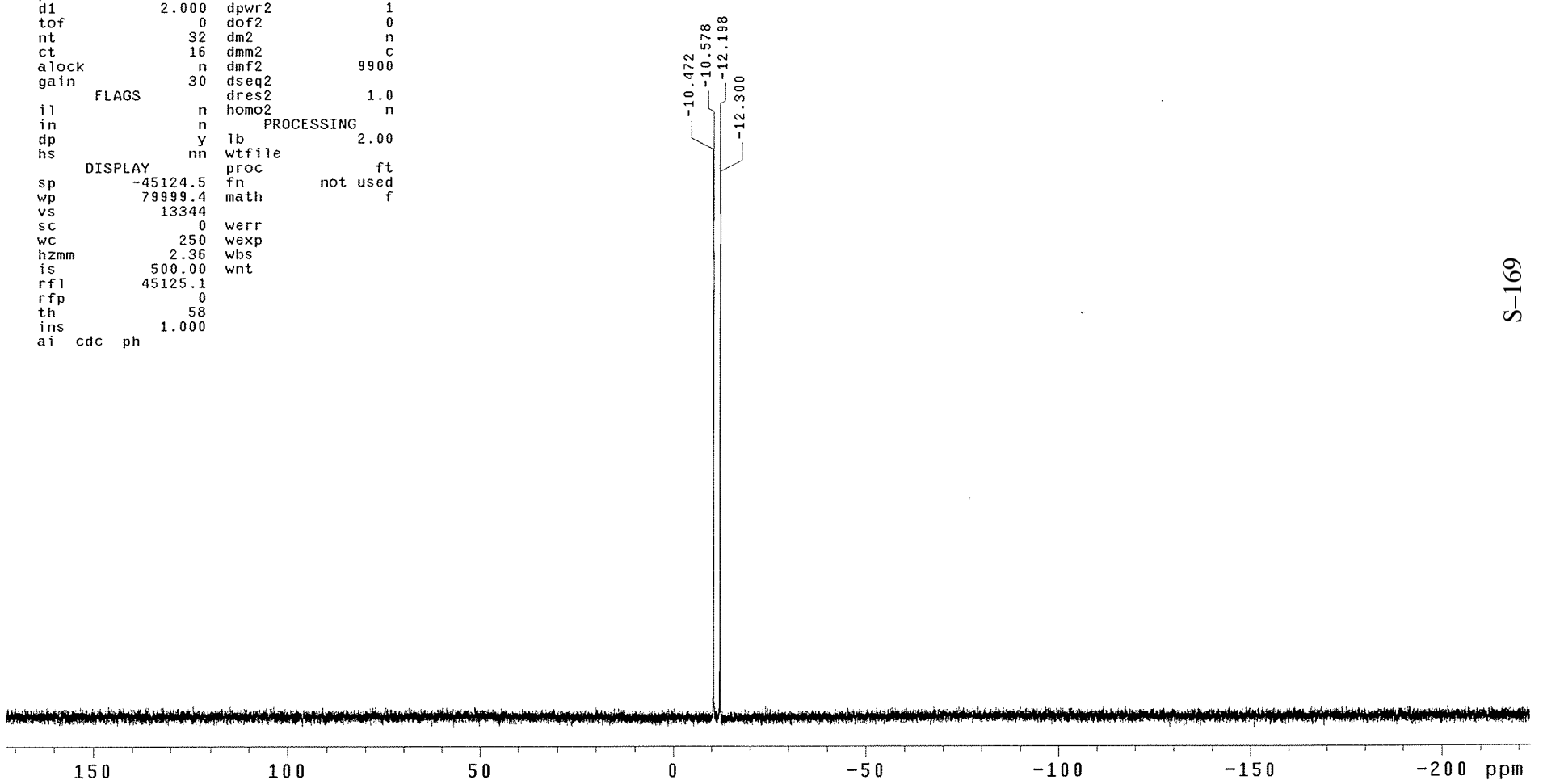


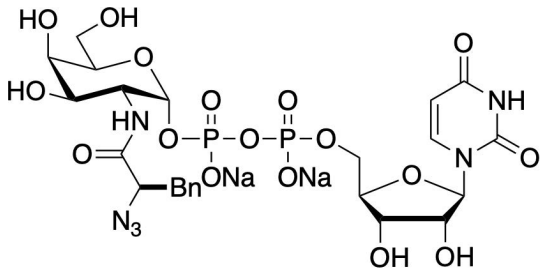
UDP-Sugar (*S*)-**5**

JC1135_31P_D2O

exp2 s2pul

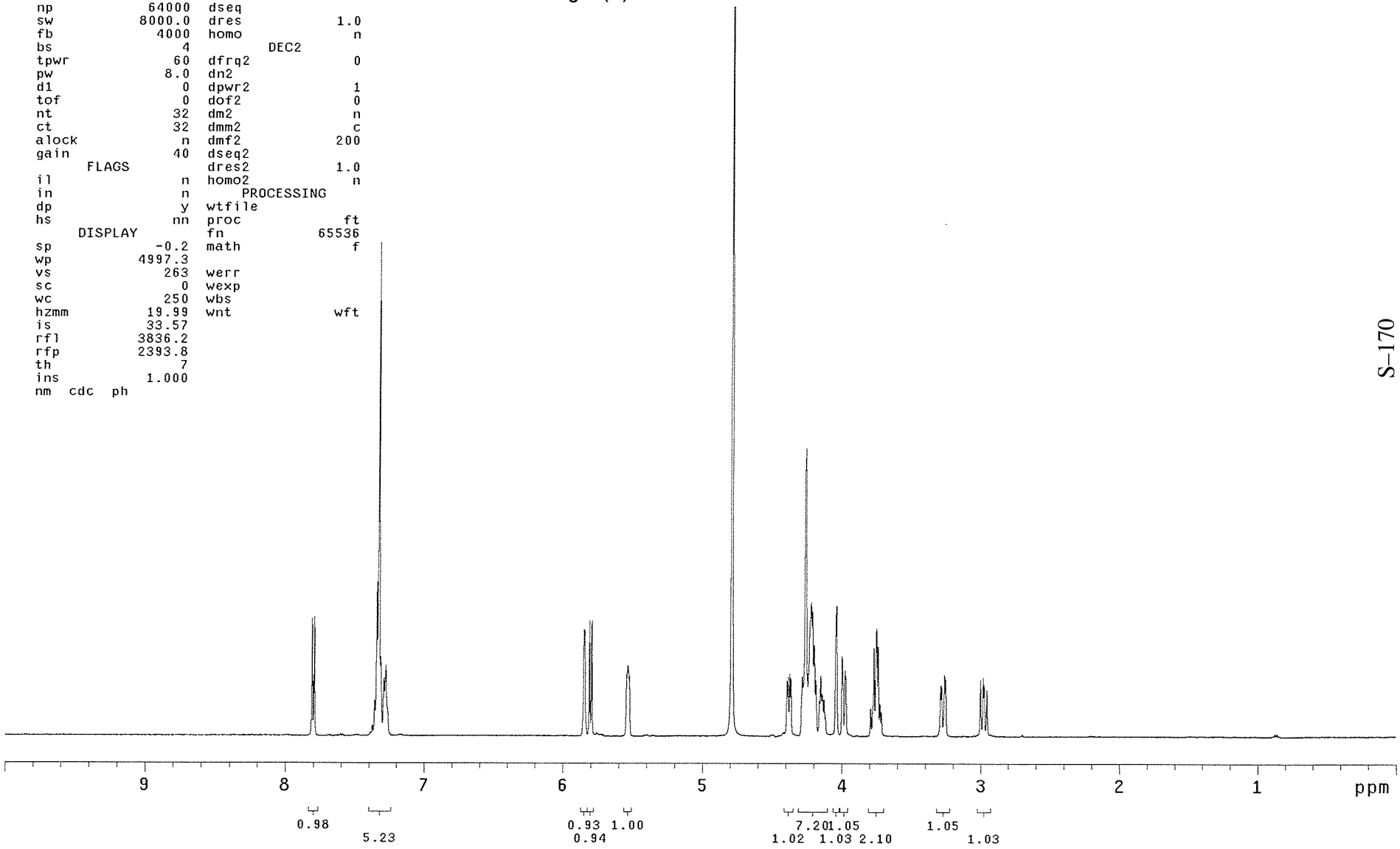
SAMPLE		DEC. & VT	
date	Jul 18 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45124.5	fn	not used
wp	79999.4	math	f
vs	13344		
sc	0	werr	
wc	250	wexp	
hzmm	2.36	wbs	
is	500.00	wnt	
rfl	45125.1		
rfp	0		
th	58		
ins	1.000		
ai cdc ph			

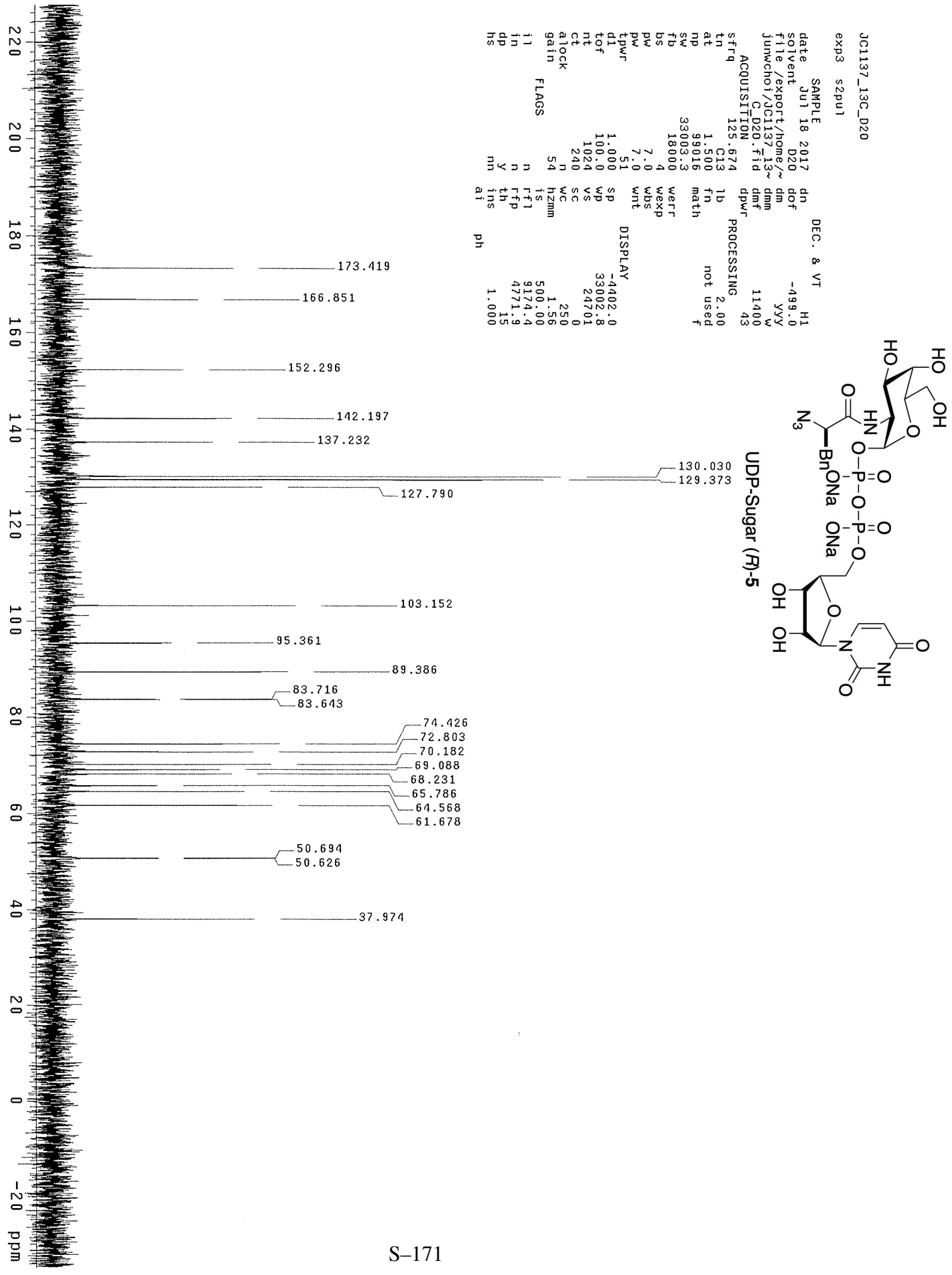




UDP-Sugar (*R*)-**5**

```
JC1137_1H_D2O

exp2  s2pul

      SAMPLE              DEC. & VT
date   Jul 18 2017  dfrq        499.752
solvent        D2O  dn               H1
file           exp  dpwr             30
   ACQUISITION      dof               0
sfrq        499.752 dm              nnn
tn               H1 dmm               c
at            4.000 dmf             200
np            64000 dseq
sw           8000.0 dres            1.0
fb            4000  homo              n
bs               4              DEC2
tpwr            60  dfrq2             0
pw             8.0  dn2
d1               0  dpwr2             1
tof              0  dof2              0
nt              32  dm2               n
ct              32  dmm2              c
alock            n  dmf2            200
gain            40  dseq2
      FLAGS         dres2           1.0
il               n  homo2            n
in               n      PROCESSING
dp               y  wtfile
hs              nn  proc             ft
     DISPLAY        fn            65536
sp            -0.2  math              f
wp          4997.3
vs             263  werr
sc               0  wexp
wc             250  wbs
hzmm         19.99  wnt             wft
is           33.57
rfl        3836.2
rfp        2393.8
th               7
ins          1.000
nm  cdc  ph
```

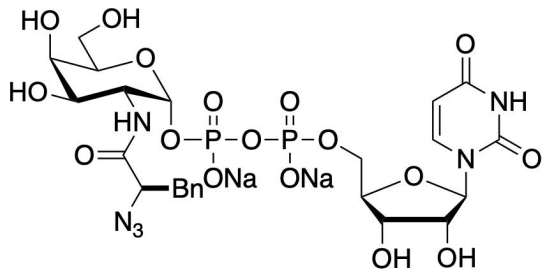



JC1137_13C_D20
exp3 s2pul
SAMPLE
date Jul 18 2017
solvent D20
file /export/home/~
JunwchoI/JC1137_13~
C_D20.fid
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 1.000
tof 100.0
nt 1024
ct 240
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4402.0
wp 33002.8
vs 24701
sc 0
wc 250
hzmm 1.56
is 500.00
rfl 9174.4
rfp 4771.9
th 15
ins 1.000
173.419
166.851
152.296
142.197
137.232
130.030
129.373
127.790
103.152
95.361
89.386
83.716
83.643
74.426
72.803
70.182
69.088
68.231
65.786
64.568
61.678
50.694
50.626
37.974
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm
UDP-Sugar (R)-5

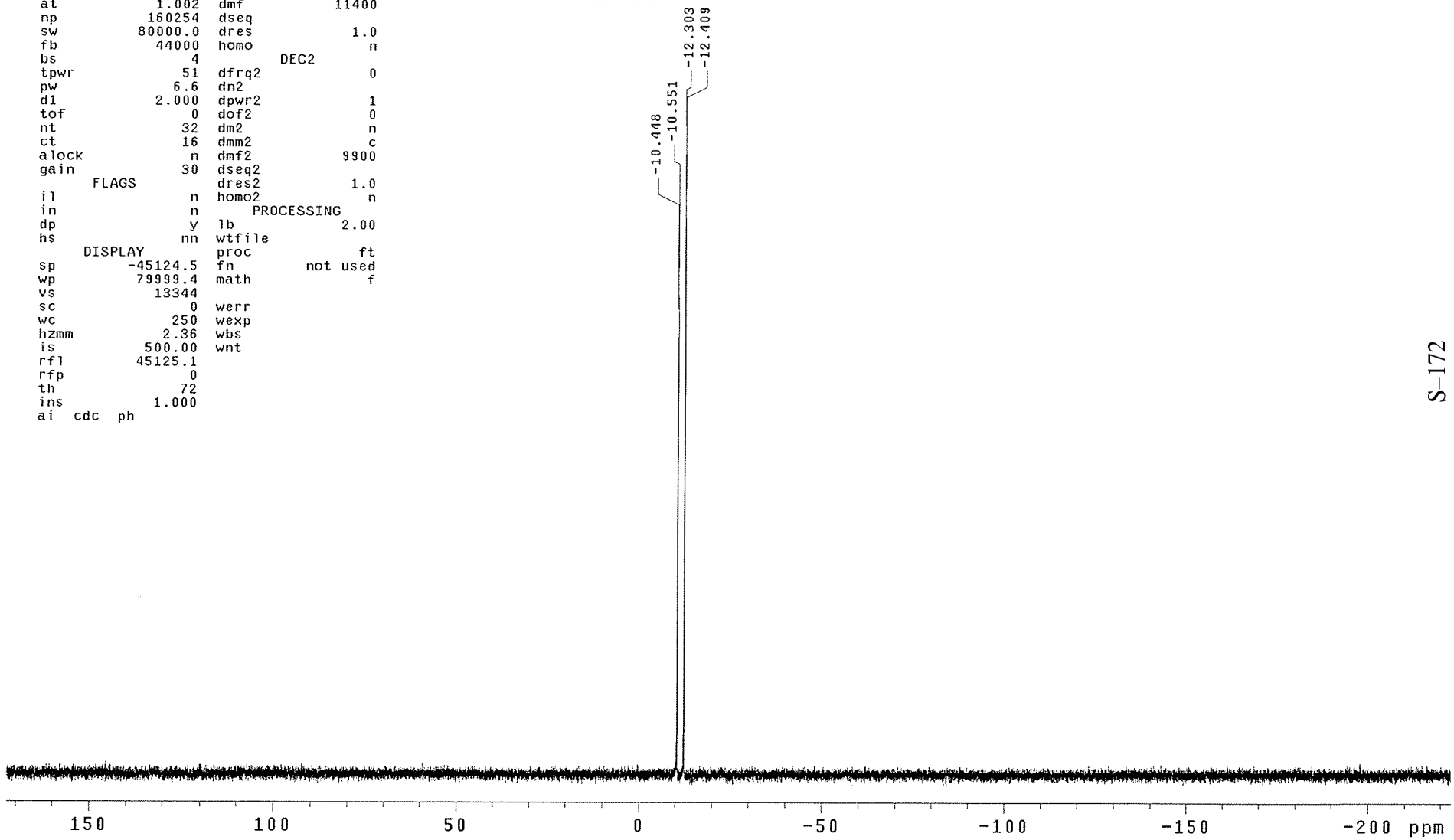
JC1137_31P_D2O

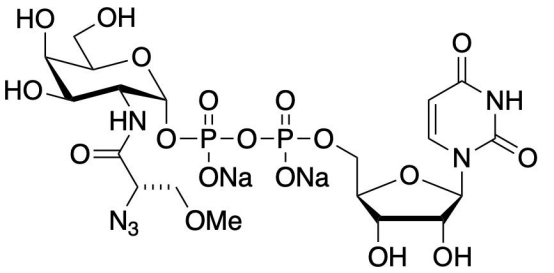
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 18 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45124.5	fn	not used
wp	79999.4	math	f
vs	13344		
sc	0	werr	
wc	250	wexp	
hzmm	2.36	wbs	
is	500.00	wnt	
rfl	45125.1		
rfp	0		
th	72		
ins	1.000		
ai cdc ph			



UDP-Sugar (*R*)-**5**



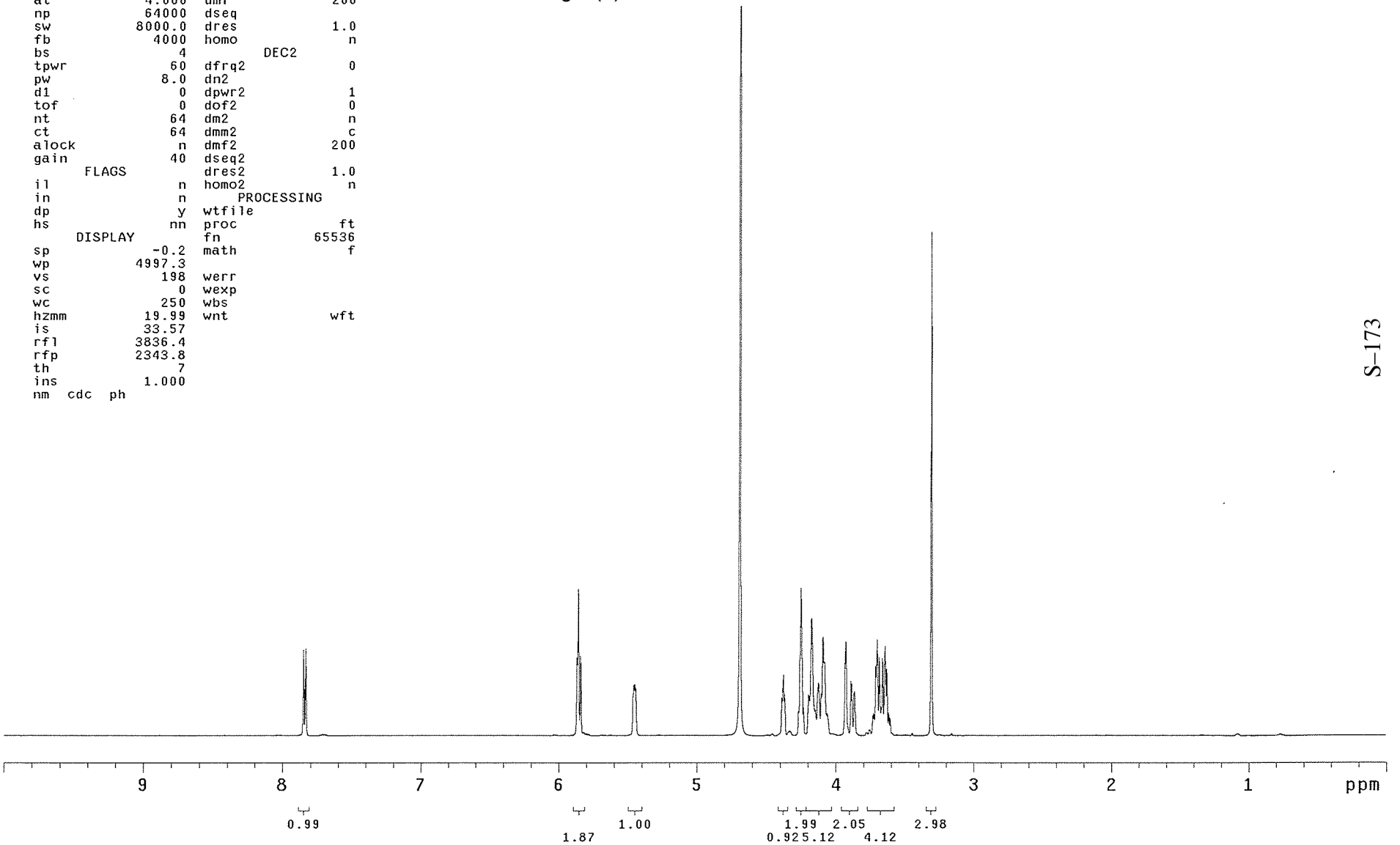


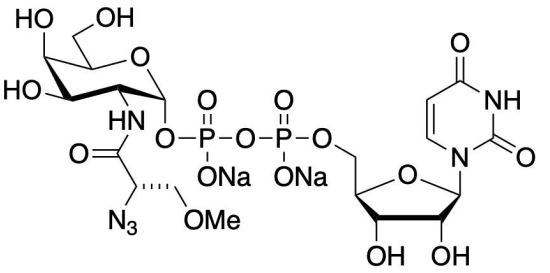
UDP-Sugar (*S*)-**6**

JC2025_1H_D2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 24 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	64	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3	werr	
vs	198	wexp	
sc	0	wbs	
wc	250	wnt	wft
hzmm	19.99		
is	33.57		
rfl	3836.4		
rfp	2343.8		
th	7		
ins	1.000		
nm cdc ph			



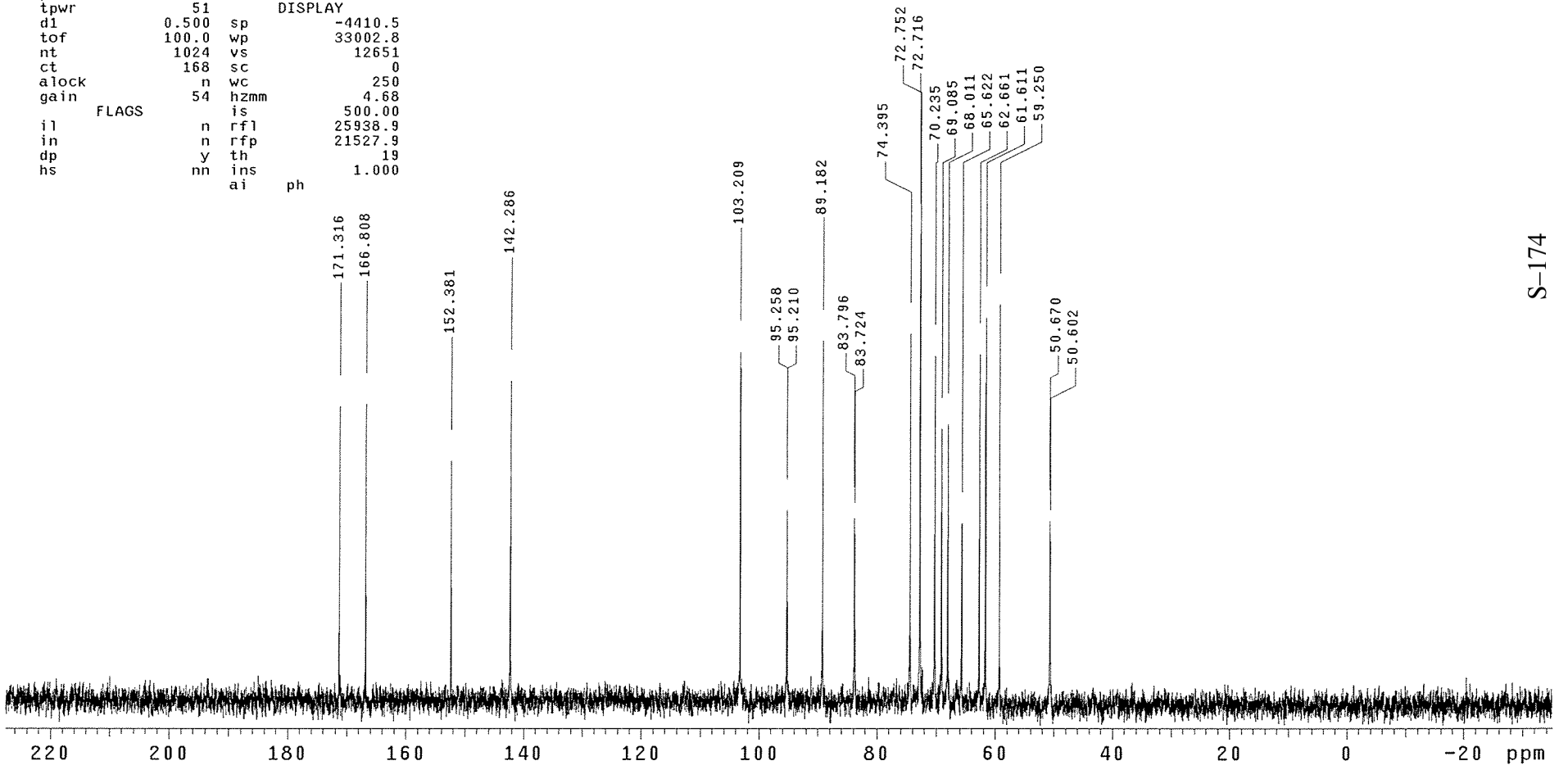


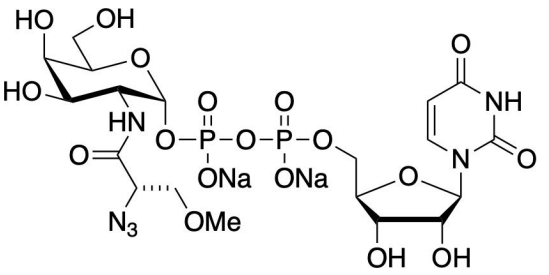
UDP-Sugar (*S*)-**6**

JC2025_13C_D2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 7 2017	dn	H1
solvent	D2O	dof	-499.0
file	/export/home/~	dm	yyy
junwchoi/JC2025_13~		dmm	w
	C_D2O.fid	dmf	11400
ACQUISITION		dpwr	43
sfrq	125.674	PROCESSING	
tn	C13	lb	2.00
at	1.500	fn	not used
np	99016	math	f
sw	33003.3		
fb	18000	werr	
bs	4	wexp	
pw	7.0	wbs	
pw	7.0	wnt	
tpwr	51	DISPLAY	
d1	0.500	sp	-4410.5
tof	100.0	wp	33002.8
nt	1024	vs	12651
ct	168	sc	0
alock	n	wc	250
gain	54	hzmm	4.68
FLAGS		is	500.00
il	n	rfl	25938.9
in	n	rfp	21527.9
dp	y	th	19
hs	nn	ins	1.000
		ai ph	



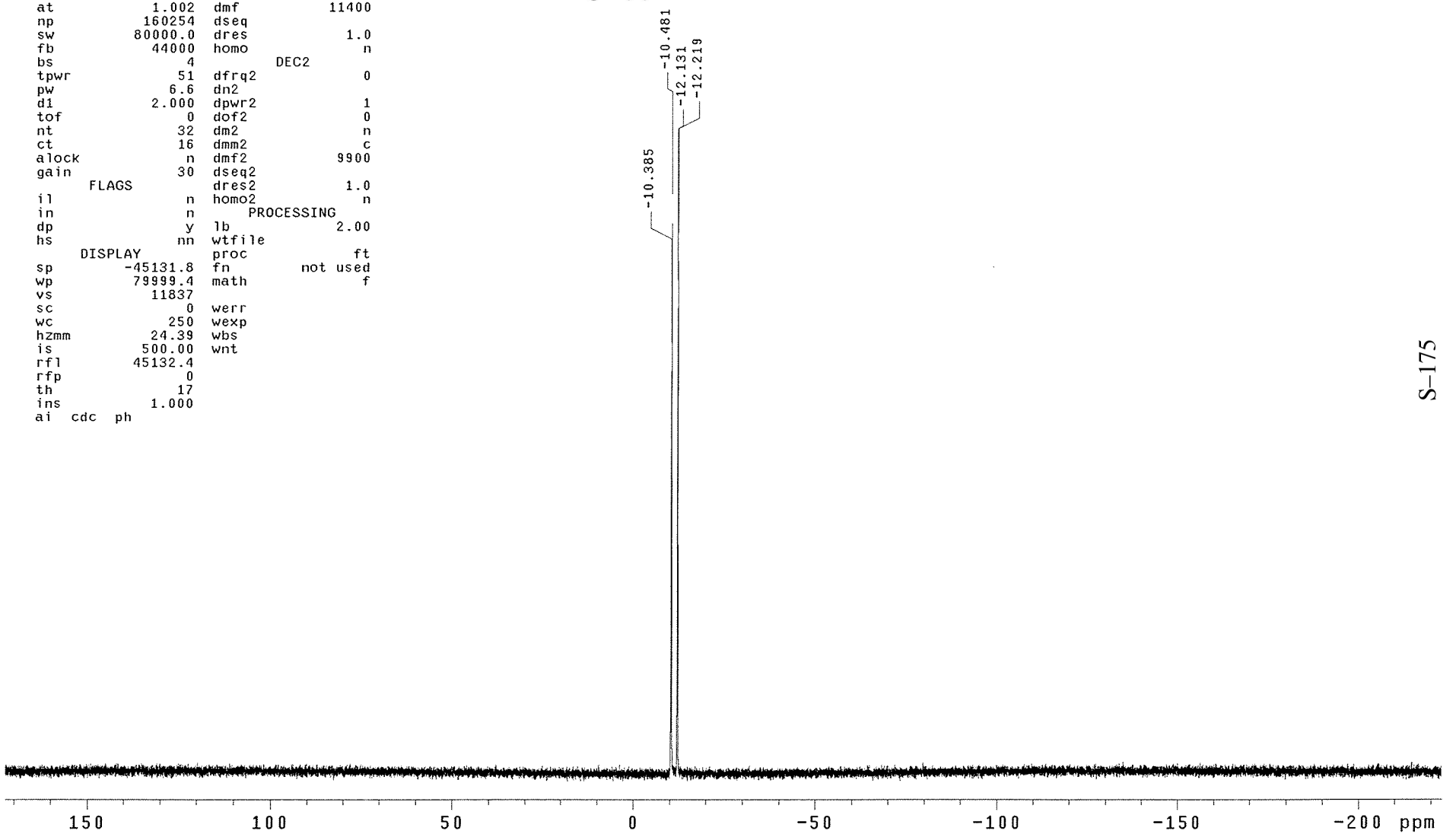


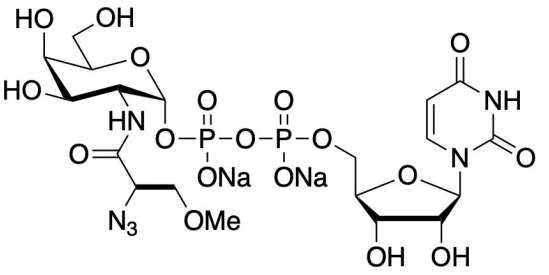
UDP-Sugar (*S*)-**6**

JC2025_31P_D2O

exp3 s2pul

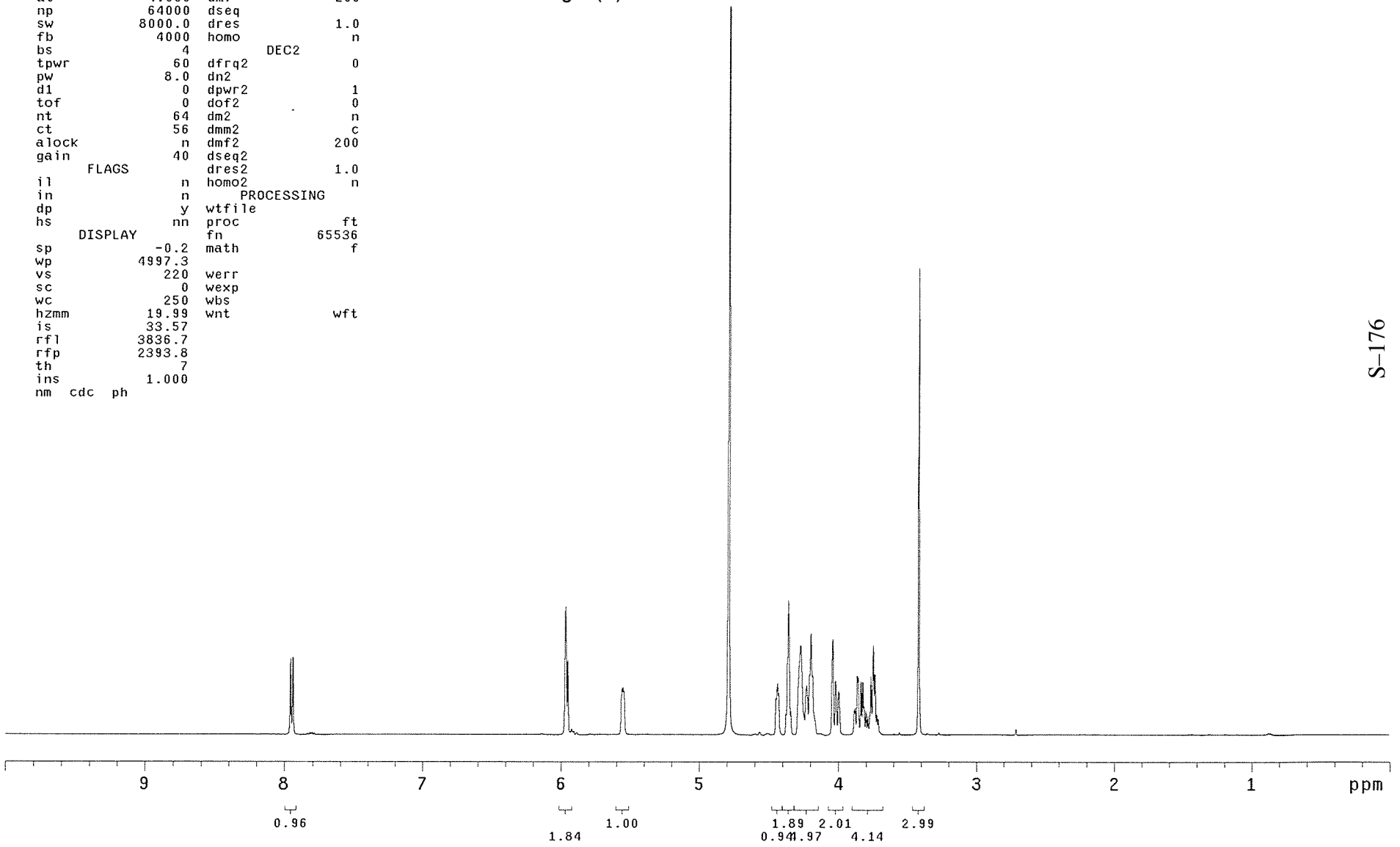
SAMPLE		DEC. & VT	
date	Jul 7 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45131.8	fn	not used
wp	79999.4	math	f
vs	11837		
sc	0	werr	
wc	250	wexp	
hzmm	24.39	wbs	
is	500.00	wnt	
rfl	45132.4		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

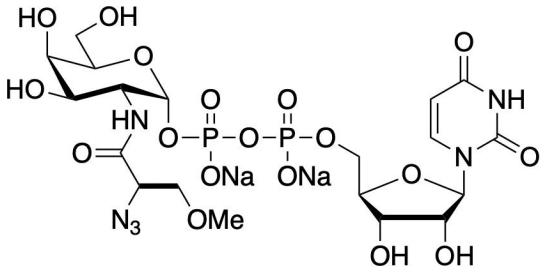




UDP-Sugar (*R*)-**6**

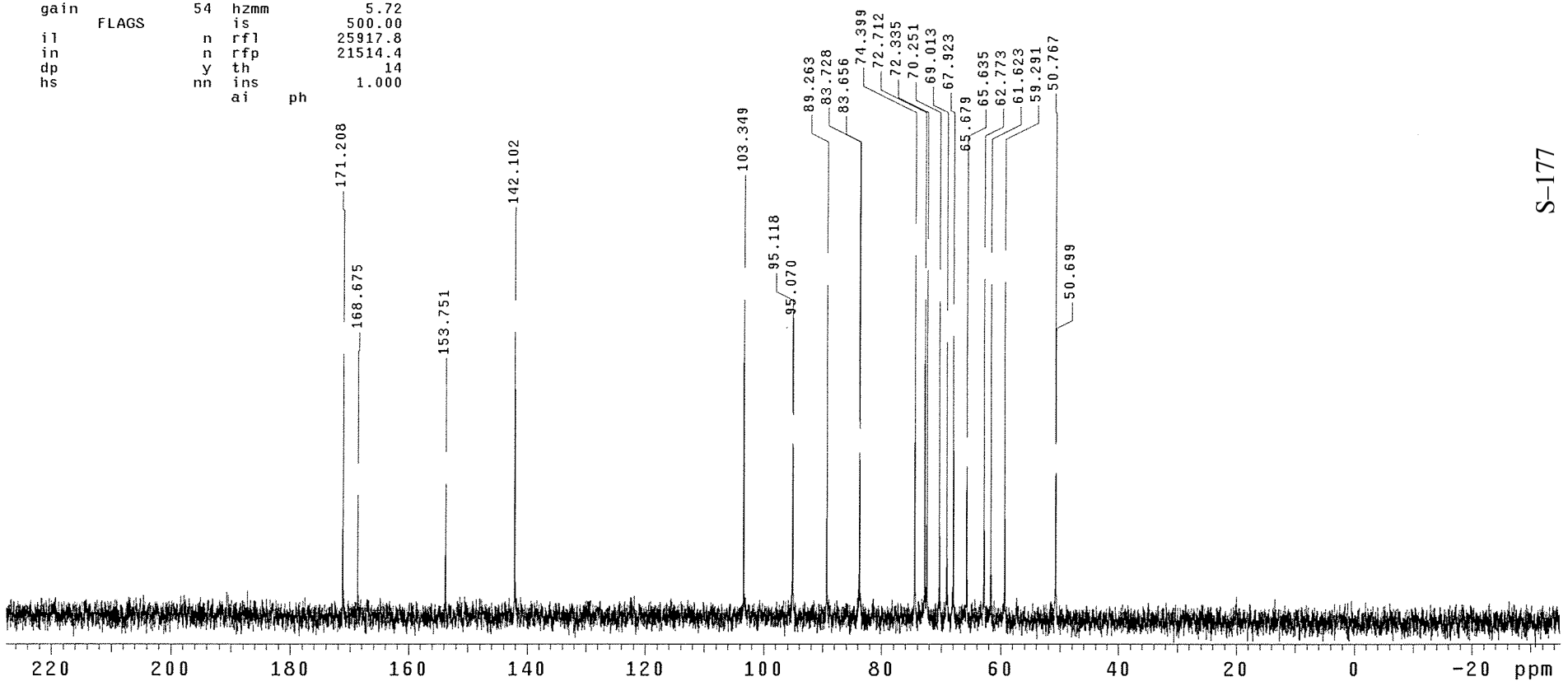
```
JC2027_1H_D2O

exp2  s2pul

      SAMPLE           DEC. & VT
date   Jul 24 2017  dfrq       499.752
solvent        D2O  dn              H1
file           exp  dpwr            30
   ACQUISITION      dof              0
sfrq       499.752  dm             nnn
tn              H1  dmm              c
at           4.000  dmf            200
np           64000  dseq
sw          8000.0  dres           1.0
fb            4000  homo             n
bs               4          DEC2
tpwr            60  dfrq2            0
pw             8.0  dn2
d1               0  dpwr2            1
tof              0  dof2             0
nt              64  dm2              n
ct              56  dmm2             c
alock            n  dmf2           200
gain            40  dseq2
      FLAGS         dres2          1.0
il               n  homo2            n
in               n      PROCESSING
dp               y  wtfile
hs              nn  proc            ft
     DISPLAY        fn           65536
sp            -0.2  math             f
wp          4997.3
vs             220  werr
sc               0  wexp
wc             250  wbs
hzmm         19.99  wnt            wft
is           33.57
rfl         3836.7
rfp         2393.8
th               7
ins          1.000
nm  cdc  ph
```





UDP-Sugar (*R*)-**6**

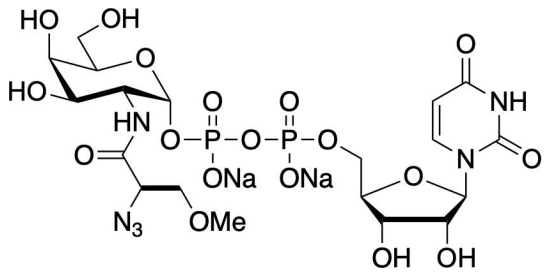
```
JC2027_13C_D2O

exp3  s2pul

      SAMPLE            DEC. & VT
date   Jul  7 2017  dn              H1
solvent       D2O   dof         -499.0
file /export/home/~ dm              yyy
junwchoi/JC2027_13~ dmm               w
         C_D2O.fid  dmf           11400
   ACQUISITION      dpwr            43
sfrq       125.674      PROCESSING
tn             C13   lb            2.00
at           1.500   fn        not used
np           99016   math             f
sw        33003.3
fb           18000   werr
bs               4   wexp
pw             7.0   wbs
pw             7.0   wnt
tpwr            51       DISPLAY
d1           0.500   sp         -4402.9
tof          100.0   wp         33002.8
nt            1024   vs           16073
ct             284   sc               0
alock            n   wc             250
gain            54   hzmm          5.72
      FLAGS         is          500.00
il               n   rfl         25917.8
in               n   rfp         21514.4
dp               y   th               14
hs              nn   ins           1.000
                     ai    ph
```



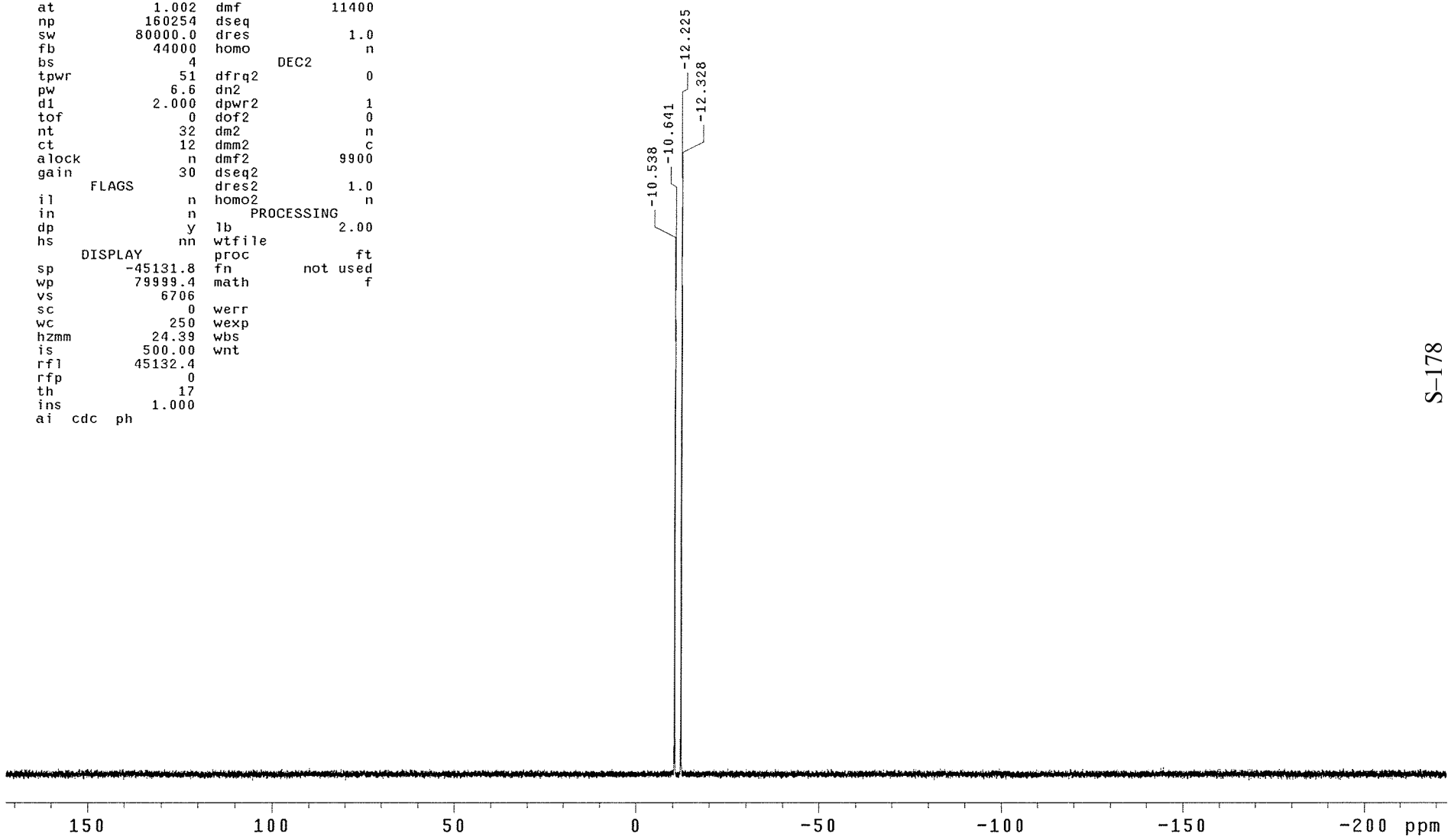
JC2027_31P_D2O

exp3 s2pul

SAMPLE		DEC. & VT	
date	Jul 7 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	12	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45131.8	fn	not used
wp	79999.4	math	f
vs	6706		
sc	0	werr	
wc	250	wexp	
hzmm	24.39	wbs	
is	500.00	wnt	
rfl	45132.4		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



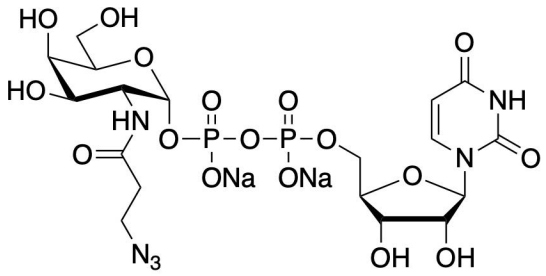
UDP-Sugar (*R*)-**6**



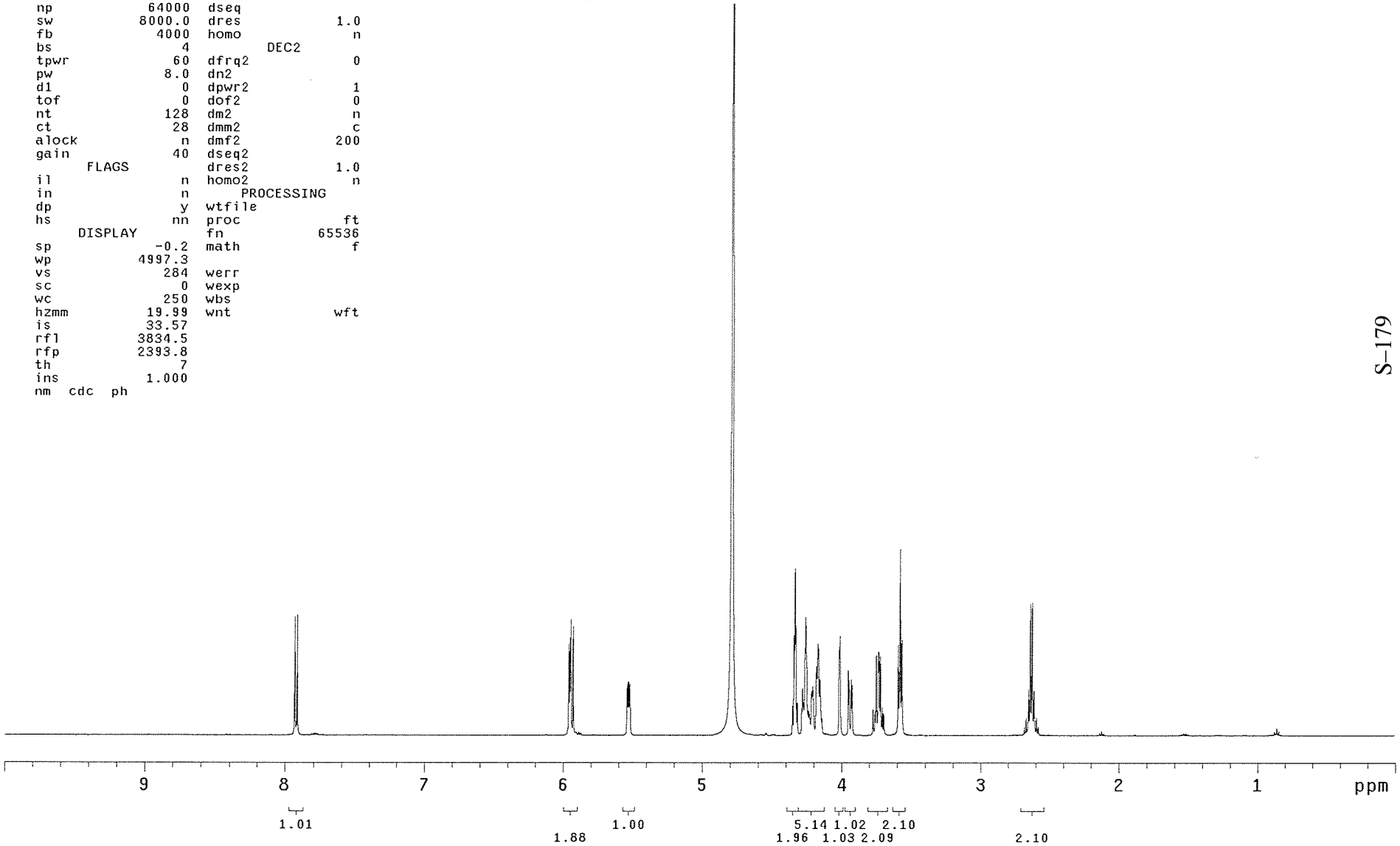
UDP-GalNAcCH2N3_1H_D2O

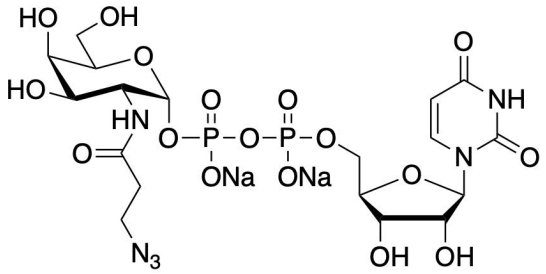
exp3 s2pul

SAMPLE		DEC. & VT	
date	Jul 13 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	28	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	284	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	3834.5		
rfp	2393.8		
th	7		
ins	1.000		
nm cdc ph			



UDP-Sugar **7**



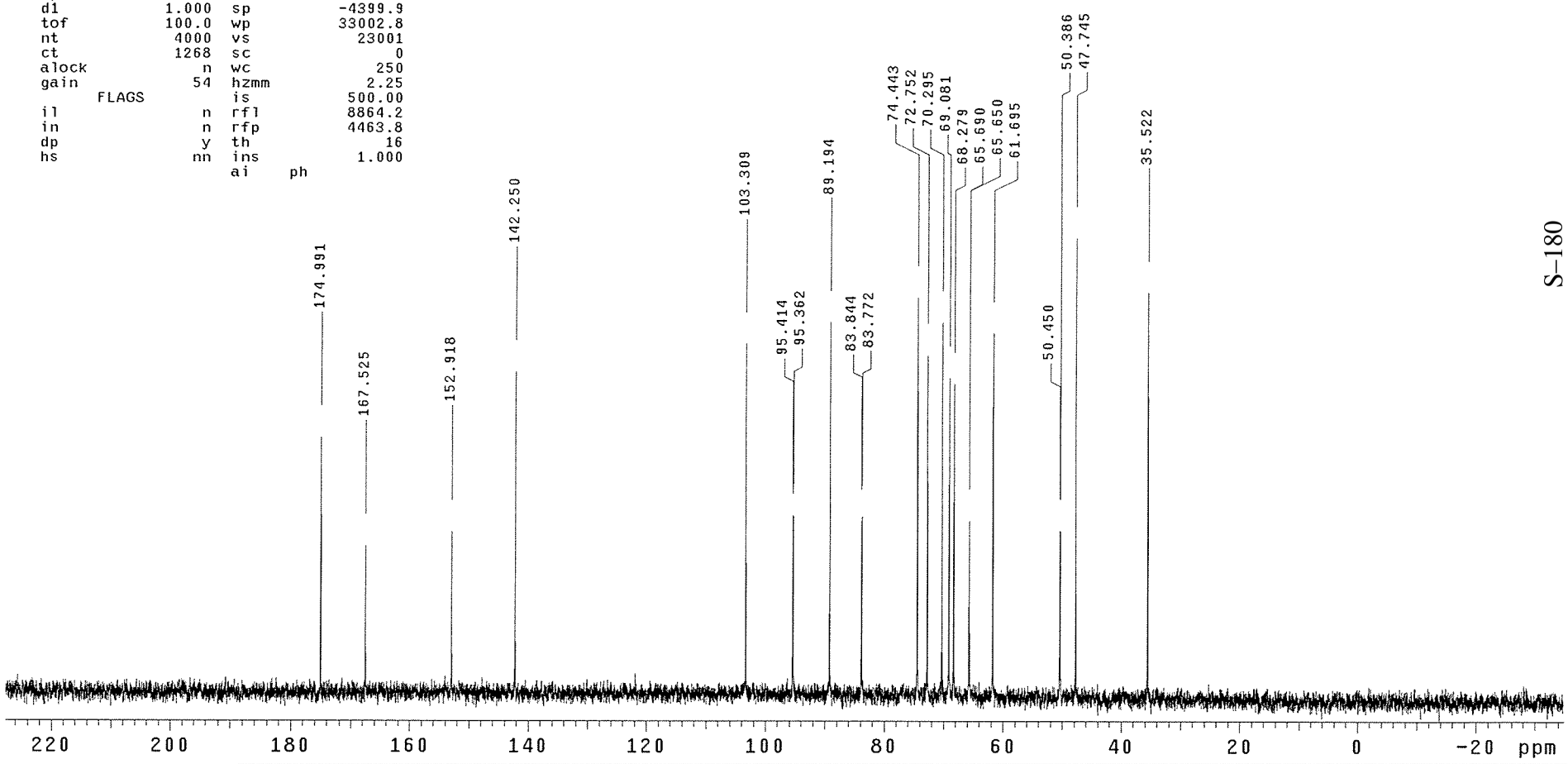


UDP-Sugar **7**

UDP-GalNAcCH2N3_13C_D2O

exp3 s2pul

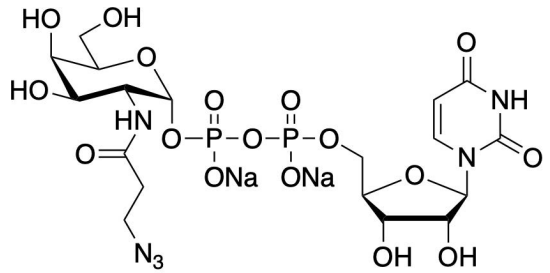
SAMPLE		DEC. & VT	
date	Jul 13 2017	dn	H1
solvent	D2O	dof	-499.0
file	/export/home/~	dm	yyy
junwchoi/UDP-GalNA~		dmm	w
cCH2N3_13C_D2O.fid		dmf	11400
ACQUISITION		dpwr	43
sfrq	125.674	PROCESSING	
tn	C13	lb	2.00
at	1.500	fn	not used
np	99016	math	f
sw	33003.3		
fb	18000	werr	
bs	4	wexp	
pw	7.0	wbs	
pw	7.0	wnt	
tpwr	51	DISPLAY	
d1	1.000	sp	-4399.9
tof	100.0	wp	33002.8
nt	4000	vs	23001
ct	1268	sc	0
alock	n	wc	250
gain	54	hzmm	2.25
FLAGS		is	500.00
il	n	rfl	8864.2
in	n	rfp	4463.8
dp	y	th	16
hs	nn	ins	1.000
		ai ph	



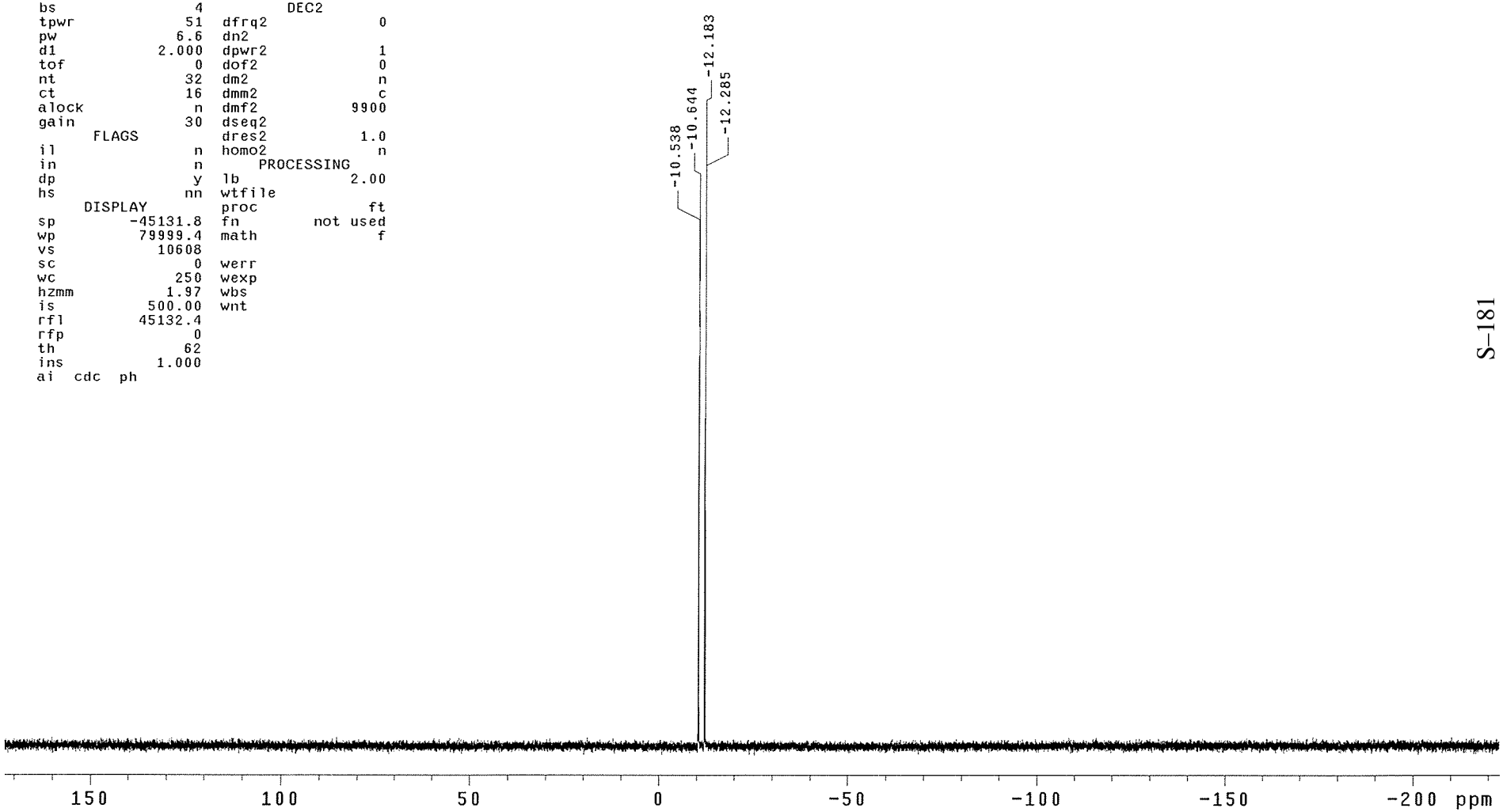
UDP-GalNAcCH2N3_31P_D2O

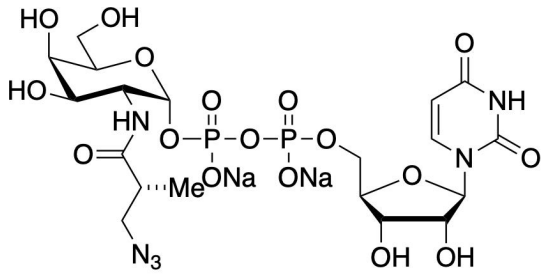
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 13 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45131.8	fn	not used
wp	79999.4	math	f
vs	10608		
sc	0	werr	
wc	250	wexp	
hzmm	1.97	wbs	
is	500.00	wnt	
rfl	45132.4		
rfp	0		
th	62		
ins	1.000		
ai cdc ph			



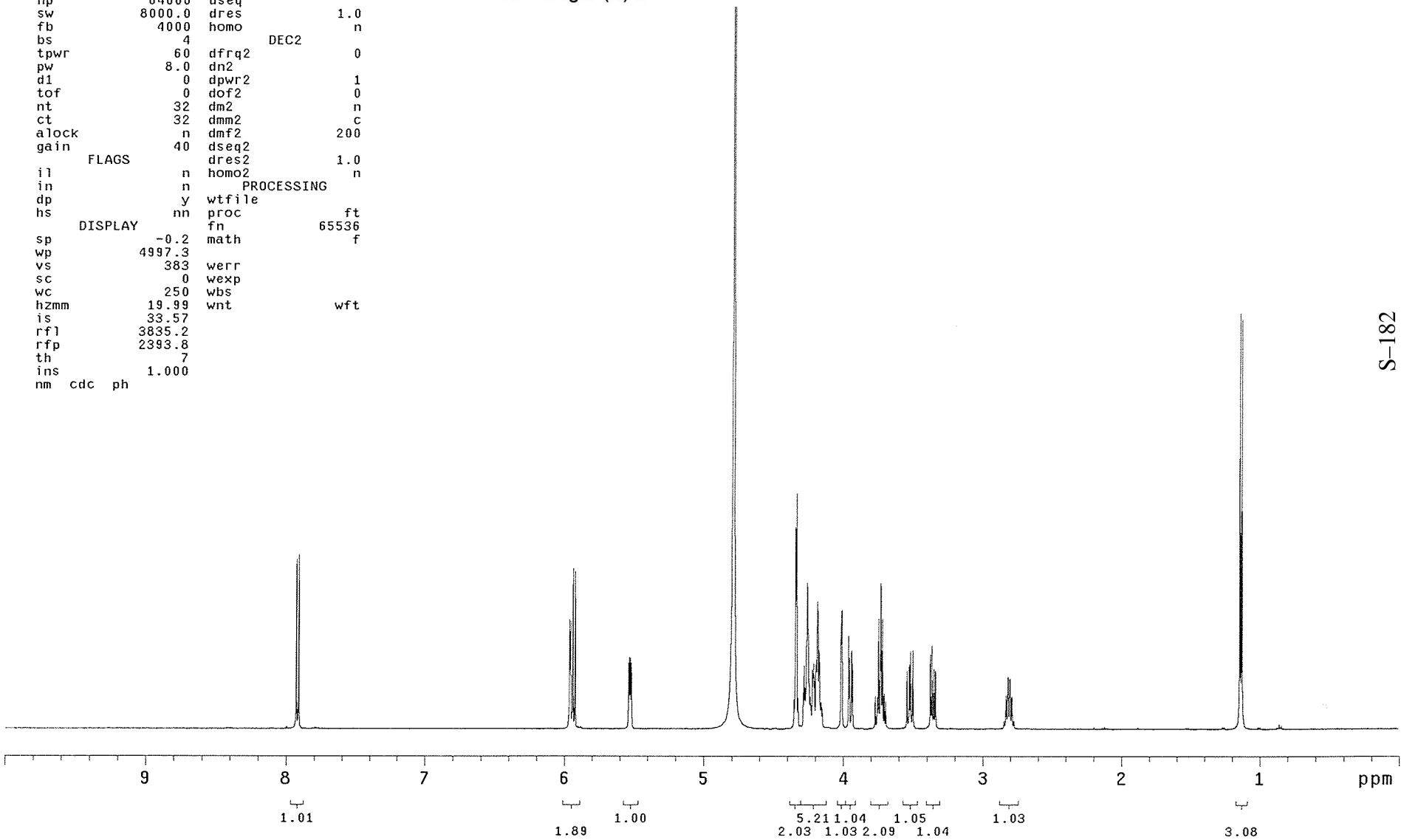
UDP-Sugar **7**

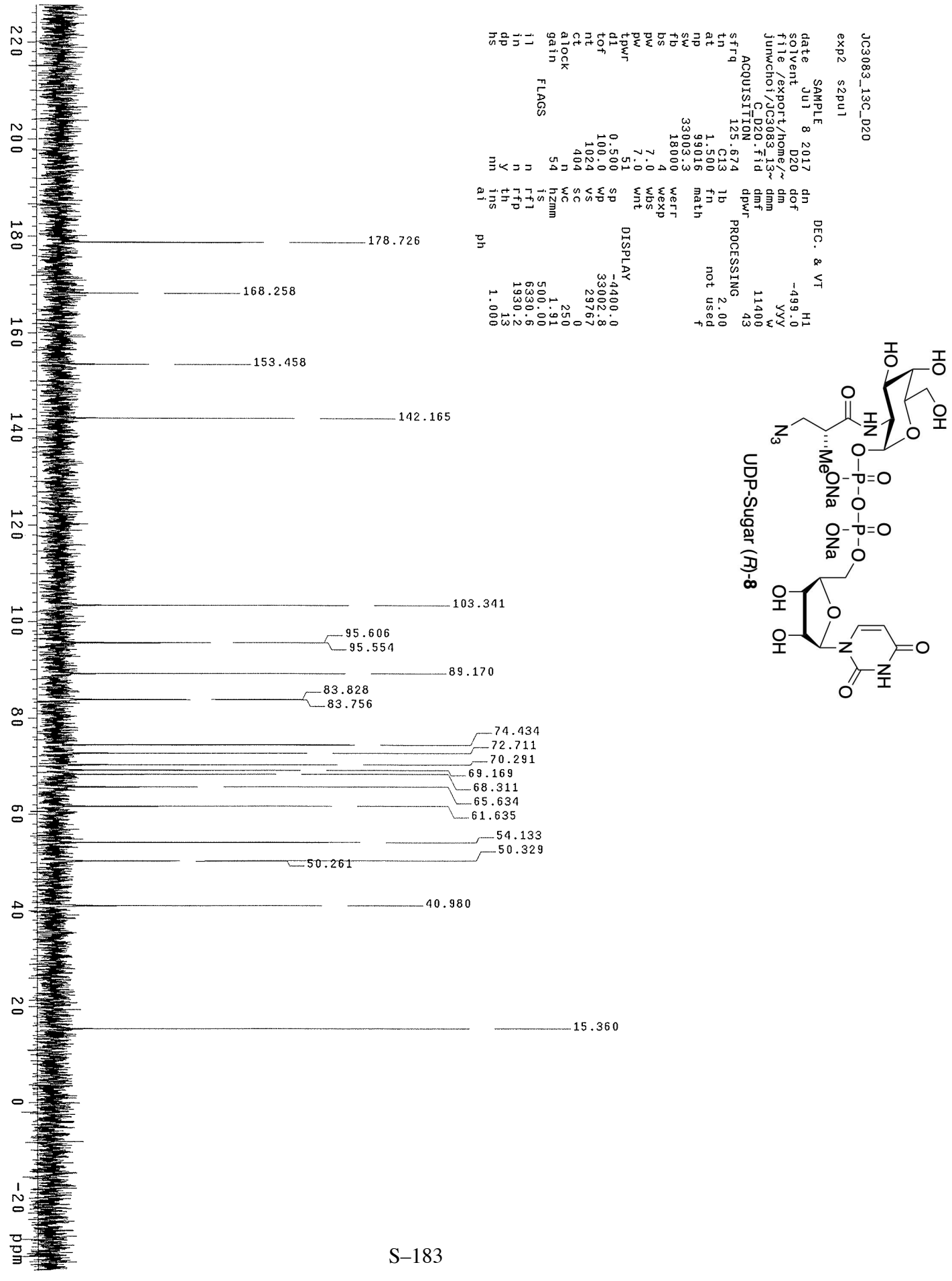


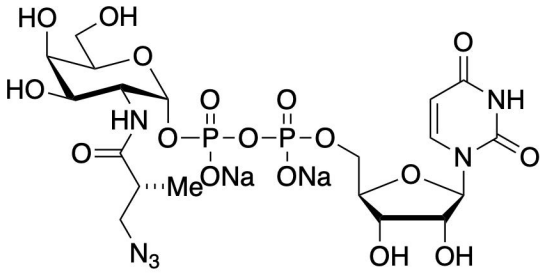


UDP-Sugar (*R*)-**8**

```
JC3083_1H_D2O

exp3  s2pul

      SAMPLE                DEC. & VT
date   Jul  8 2017  dfrq        499.752
solvent        D2O  dn               H1
file           exp  dpwr             30
   ACQUISITION      dof               0
sfrq        499.752  dm              nnn
tn               H1  dmm               c
at            4.000  dmf             200
np            64000  dseq
sw           8000.0  dres            1.0
fb             4000  homo              n
bs                4        DEC2
tpwr             60  dfrq2             0
pw              8.0  dn2
d1                0  dpwr2             1
tof               0  dof2              0
nt               32  dm2               n
ct               32  dmm2              c
alock             n  dmf2            200
gain             40  dseq2
      FLAGS          dres2           1.0
il                n  homo2            n
in                n      PROCESSING
dp                y  wtfile
hs               nn  proc             ft
     DISPLAY         fn            65536
sp             -0.2  math              f
wp           4997.3
vs              383  werr
sc                0  wexp
wc              250  wbs
hzmm          19.99  wnt             wft
is            33.57
rfl         3835.2
rfp         2393.8
th                7
ins           1.000
nm  cdc  ph
```



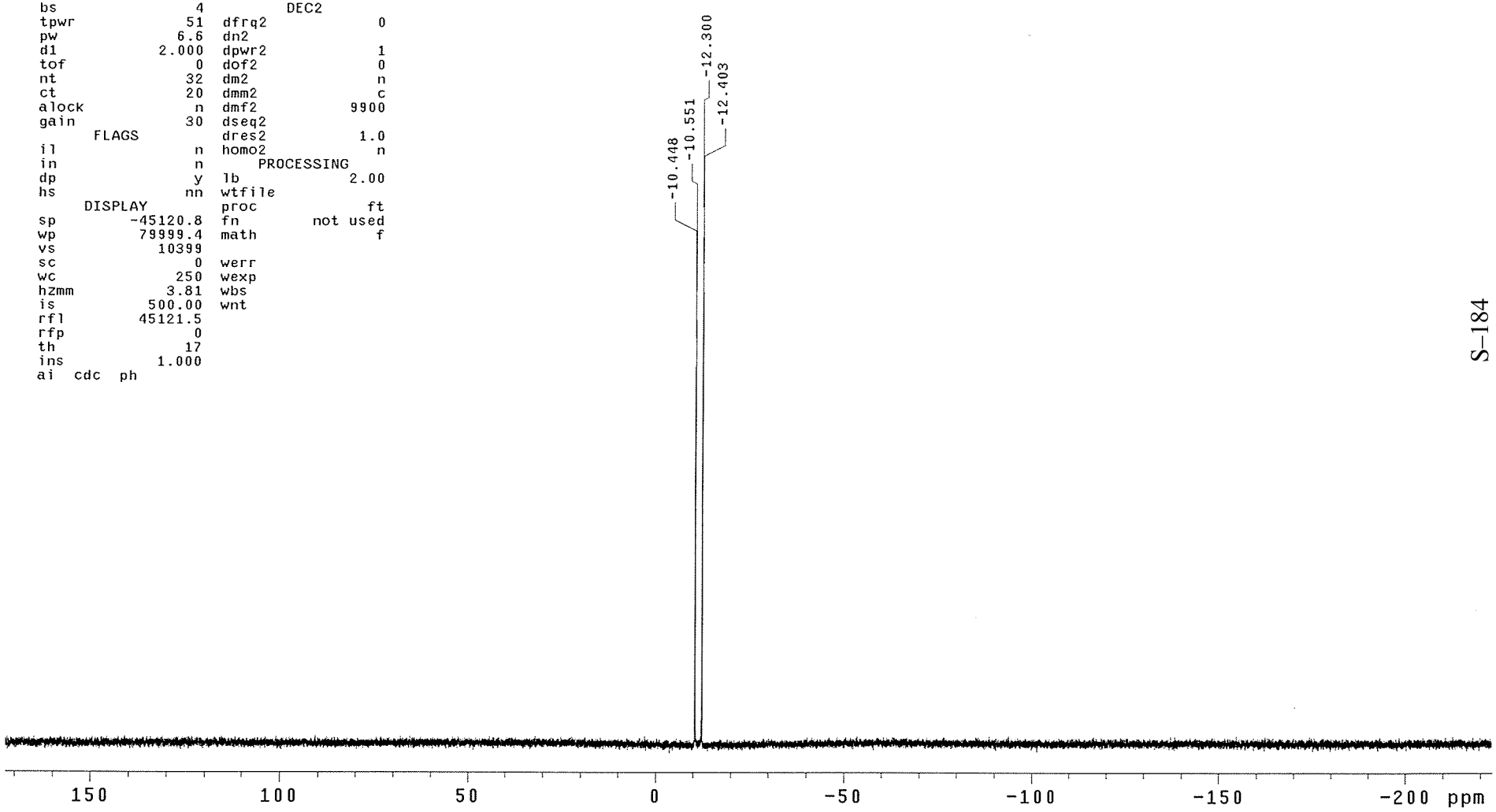

JC3083_13C_D20
exp2 s2pul
SAMPLE
date Jul 8 2017
solvent D20
file /export/home/~
junwchoi/JC3083_13~
C_D20.fid
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 0.500
tof 100.0
nt 1024
ct 404
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
-4400.0
33002.8
2976.7
0
250
1.91
500.00
6330.6
1930.2
13
1.000
178.726
168.258
153.458
142.165
103.341
95.606
95.554
89.170
83.828
83.756
74.434
72.711
70.291
69.169
68.311
65.634
61.635
54.133
50.329
50.261
40.980
15.360
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm
UDP-Sugar (R)-8

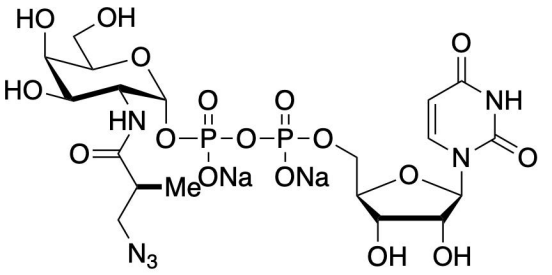


UDP-Sugar (*R*)-**8**

```
JC3083_31P_D2O

exp2  s2pul

      SAMPLE
date   Jul  8 2017
solvent        D2O
file           exp
   ACQUISITION
sfrq       202.297
tn             P31
at             1.002
np           160254
sw          80000.0
fb            44000
bs                4
tpwr             51
pw              6.6
d1            2.000
tof               0
nt               32
ct               20
alock             n
gain             30
      FLAGS
il                n
in                n
dp                y
hs               nn
     DISPLAY
sp         -45120.8
wp          79999.4
vs            10399
sc                0
wc              250
hzmm           3.81
is           500.00
rfl         45121.5
rfp               0
th               17
ins           1.000
ai  cdc  ph
```

```
      DEC. & VT
dfrq         499.752
dn                H1
dpwr              43
dof                0
dm               yyy
dmm                w
dmf            11400
dseq
dres             1.0
homo               n
      DEC2
dfrq2              0
dn2
dpwr2              1
dof2               0
dm2                n
dmm2               c
dmf2            9900
dseq2
dres2            1.0
homo2              n
     PROCESSING
lb              2.00
wtfile
proc               ft
fn          not used
math               f

werr
wexp
wbs
wnt
```





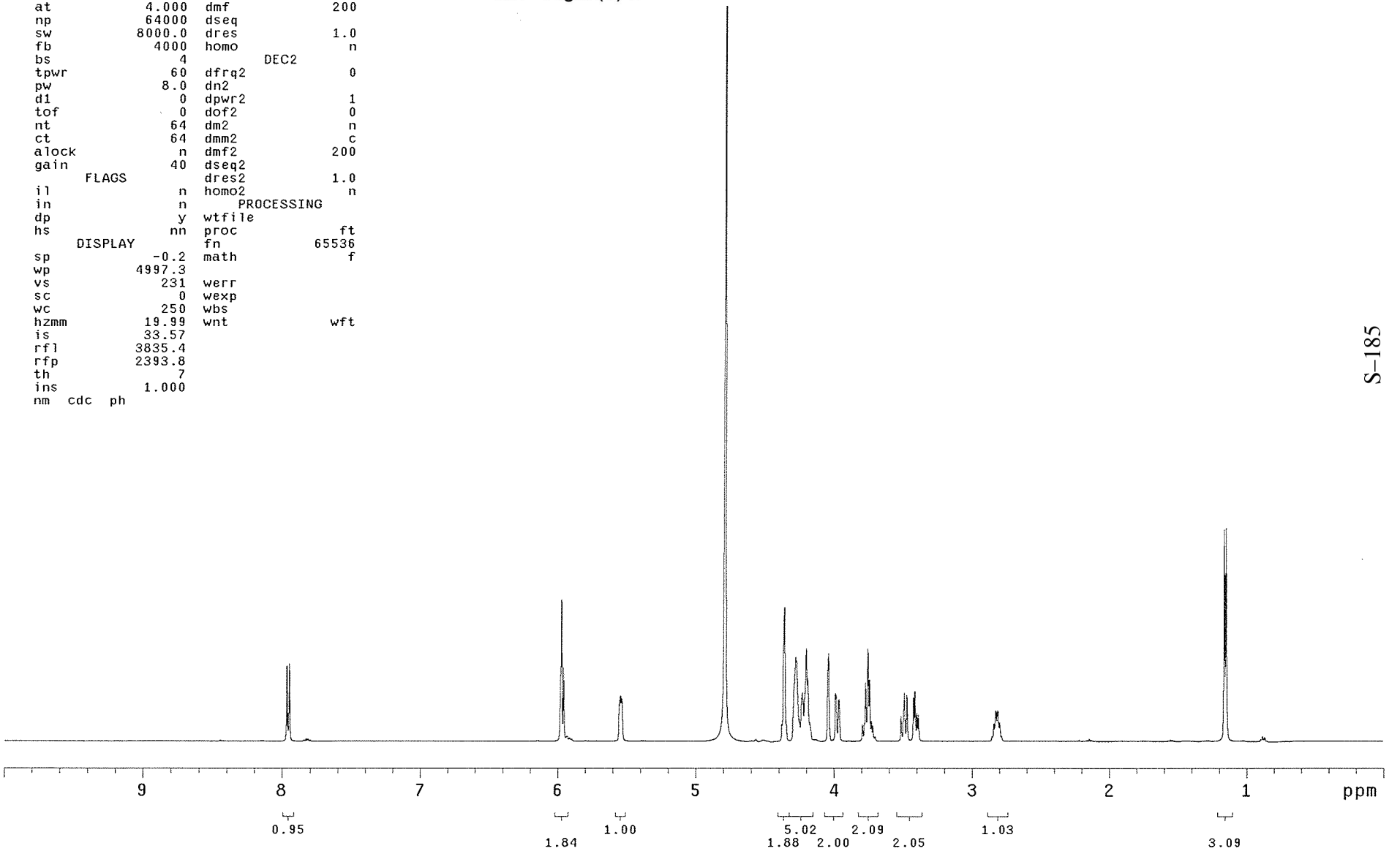
UDP-Sugar (*S*)-**8**

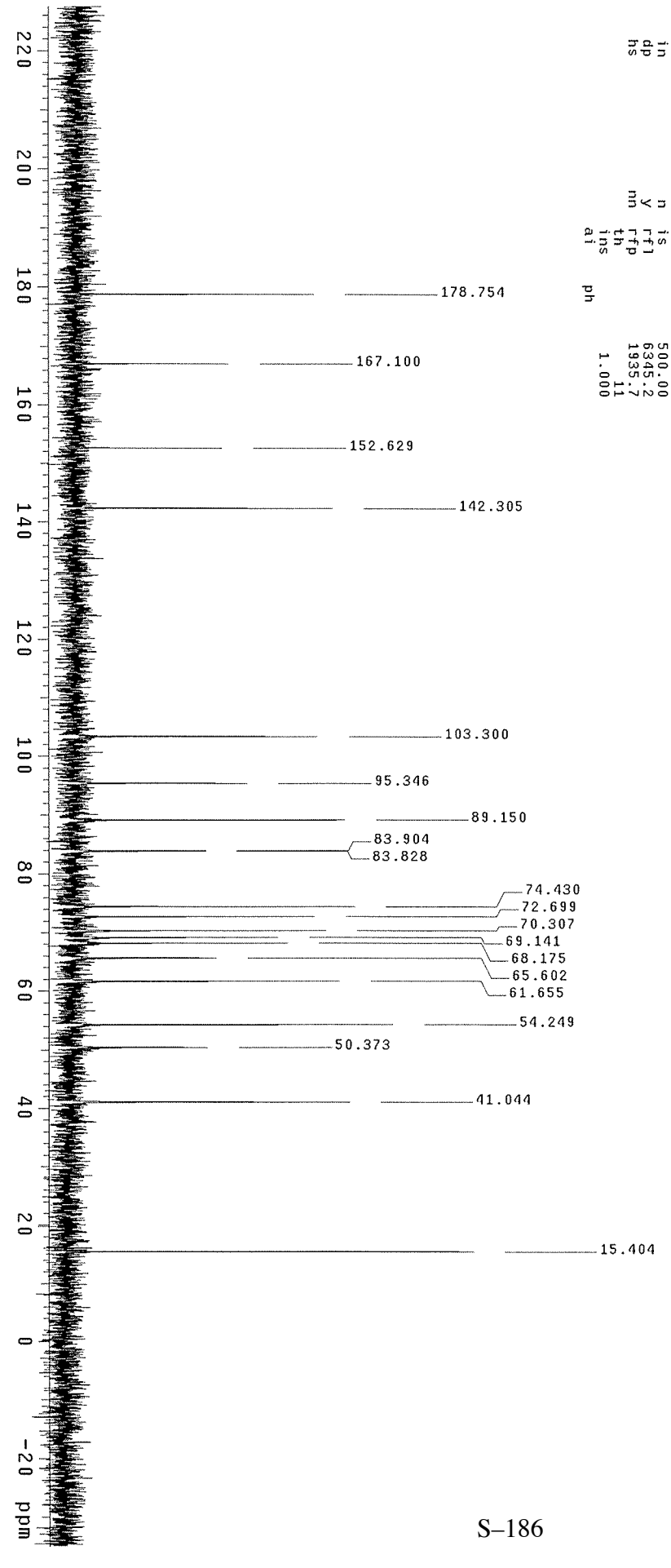
JC4007_1H_D2O

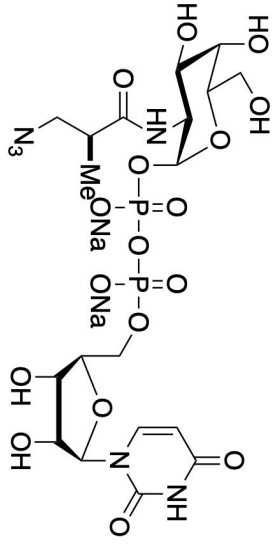
exp2 s2pul

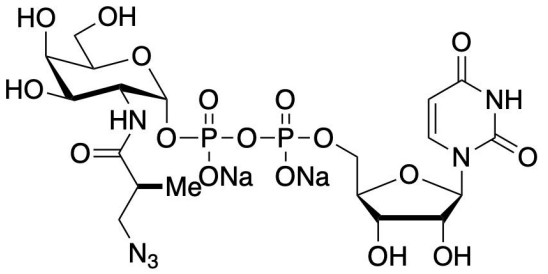
SAMPLE		DEC. & VT	
date	Jul 24 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	64	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	231	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	3835.4		
rfp	2393.8		
th	7		
ins	1.000		

nm cdc ph



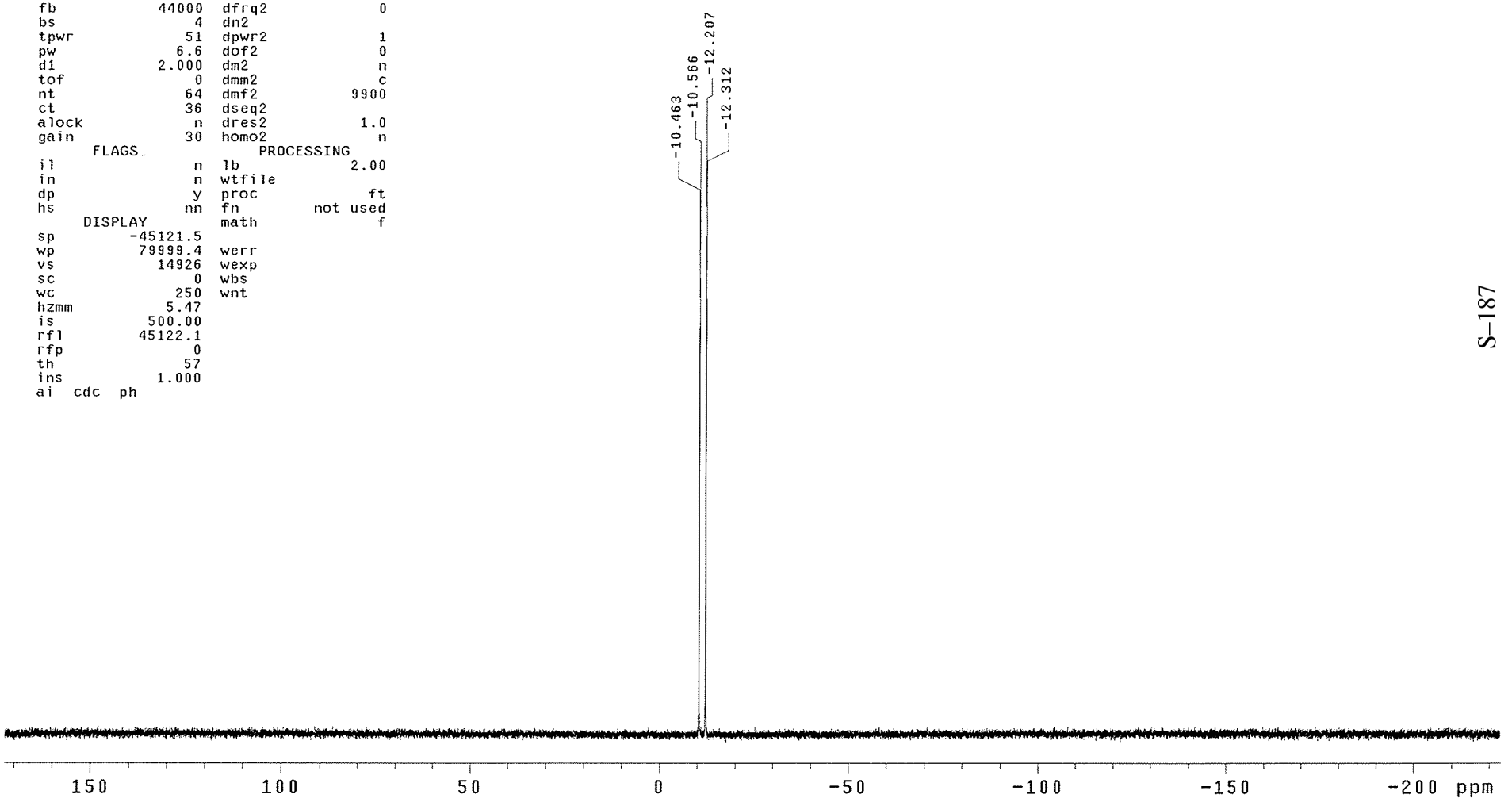

JC4007_13C_D20
exp3 s2pul
SAMPLE
date Jul 24 2017
solvent D20
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 4
bs 4
pw 7.0
pw 7.0
tpwr 51
dl 1.000
tof 100.0
nt 2048
ct 720
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
-4409.0
33002.8
33222
0
250
4.29
hzmm
is 500.00
rfl 6345.2
rfp 1935.7
th 11
ins 1.000
178.754
167.100
152.629
142.305
103.300
95.346
89.150
83.904
83.828
74.430
72.699
70.307
69.141
68.175
65.602
61.655
54.249
50.373
41.044
15.404
220
200
180
160
140
120
100
80
60
40
20
0
-20
ppm


HO
OH
HN
O
N3
MeO
ONa
ONa
OH
OH
N
NH
UDP-Sugar (S)-8



UDP-Sugar (*S*)-**8**

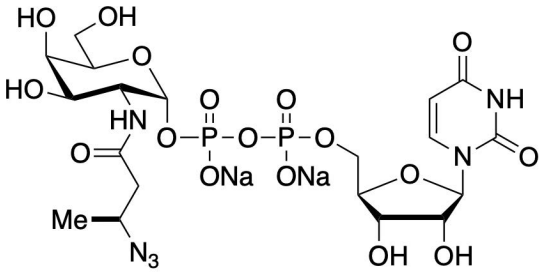
```
JC4007_31P_D2O

exp3  s2pul

      SAMPLE            DEC. & VT
date   Jul 24 2017  dfrq        499.752
solvent        D2O  dn               H1
file /export/home/~ dpwr             43
junwchoi/JC4007_31~ dof               0
         P_D2O.fid  dm              yyy
   ACQUISITION      dmm               w
sfrq       202.297  dmf           11400
tn             P31  dseq
at           1.002  dres            1.0
np          160254  homo              n
sw         80000.0        DEC2
fb           44000  dfrq2             0
bs               4  dn2
tpwr            51  dpwr2             1
pw             6.6  dof2              0
d1           2.000  dm2               n
tof              0  dmm2              c
nt              64  dmf2           9900
ct              36  dseq2
alock            n  dres2           1.0
gain            30  homo2             n
      FLAGS              PROCESSING
il               n  lb             2.00
in               n  wtfile
dp               y  proc             ft
hs              nn  fn         not used
     DISPLAY        math              f
sp        -45121.5
wp         79999.4  werr
vs           14926  wexp
sc               0  wbs
wc             250  wnt
hzmm          5.47
is          500.00
rfl        45122.1
rfp              0
th              57
ins           1.000
ai  cdc  ph
```



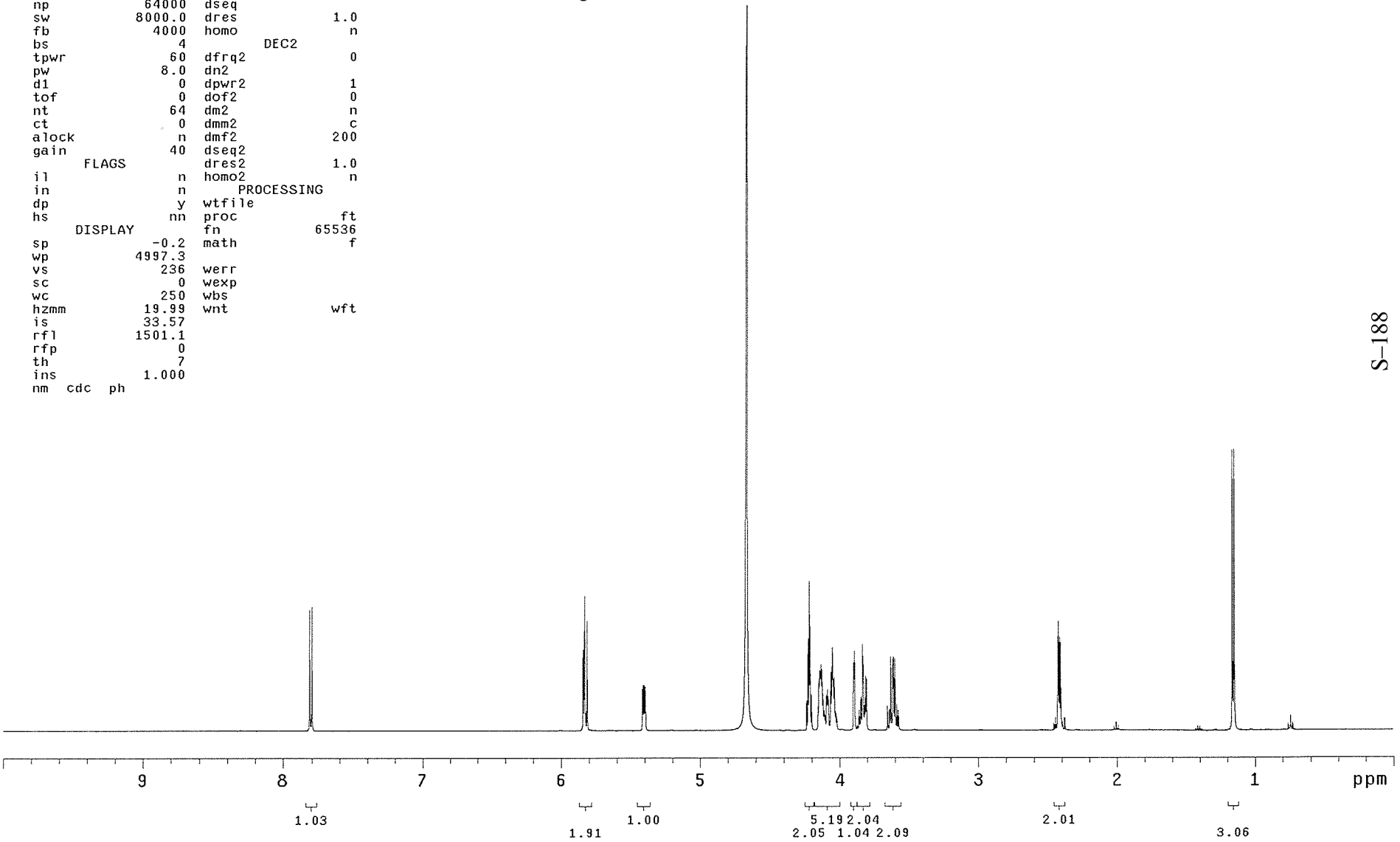
UDP-GalNAcCHMEN3(S)_1H_D2O

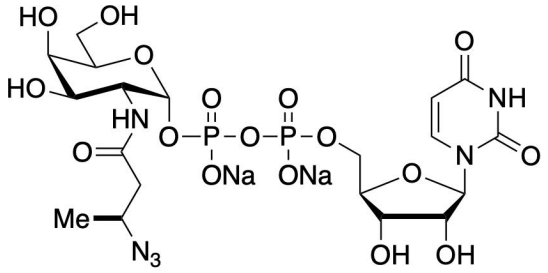
exp3 s2pul

SAMPLE		DEC. & VT	
date	Jul 13 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	0	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	236	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	1501.1		
rfp	0		
th	7		
ins	1.000		
nm cdc ph			



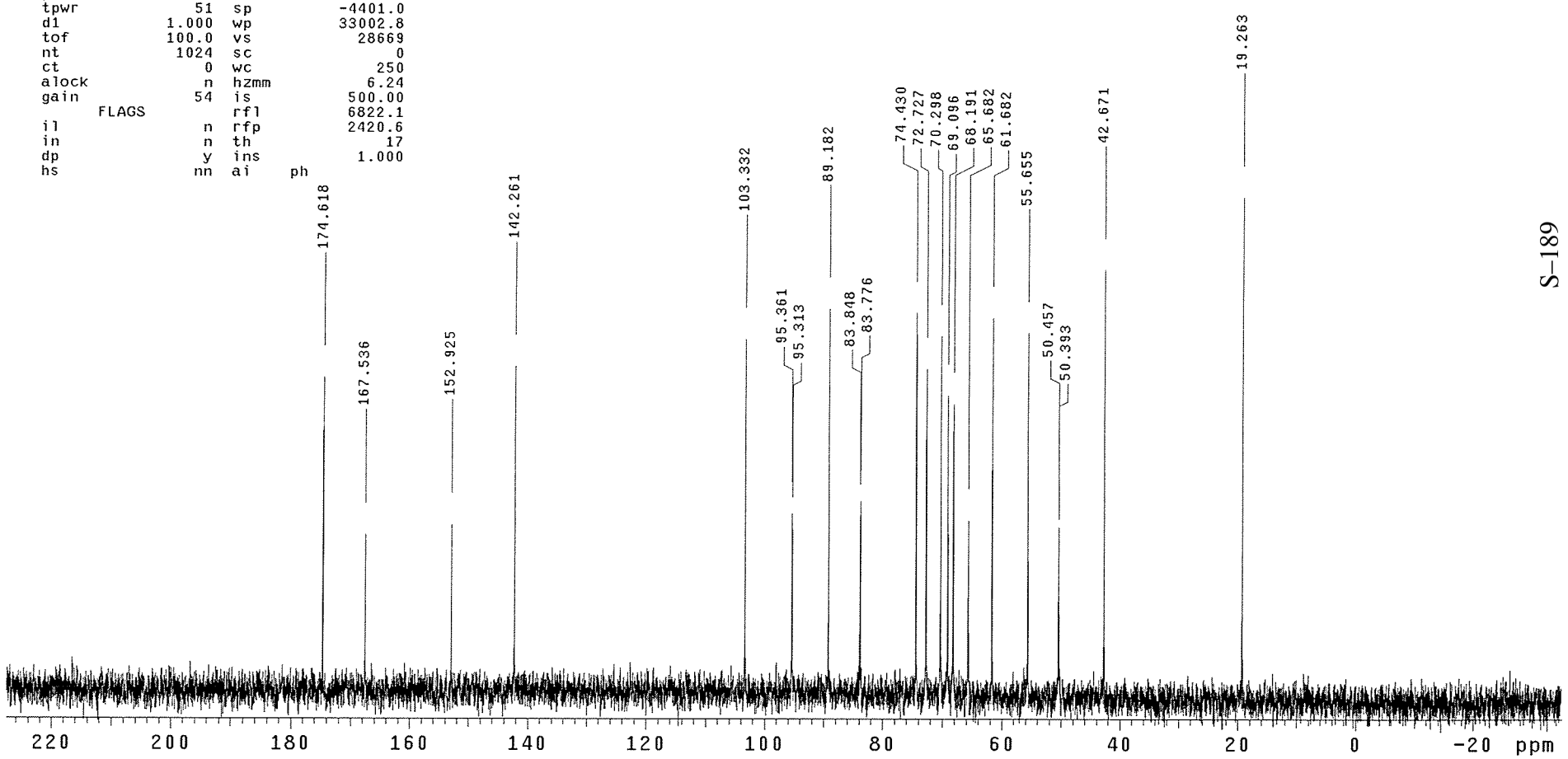
UDP-Sugar **9**





UDP-Sugar **9**

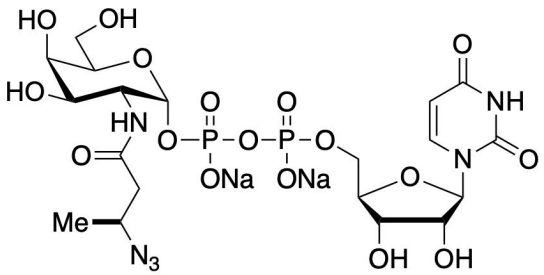
```
UDP-GalNAcCHMeN3(S)_13C_D2O

exp3  s2pul

      SAMPLE              DEC. & VT
date   Jul 13 2017  dn              H1
solvent        D2O  dof          -499.0
file /export/home/~ dm             yyy
junwchoi/UDP-GalNA~ dmm              w
cCHMeN3_S_13C_D2O.~ dmf          11400
                fid  dpwr           43
   ACQUISITION          PROCESSING
sfrq        125.674  lb            2.00
tn              C13  fn        not used
at            1.500  math             f
np            99016
sw          33003.3  werr
fb            18000  wexp
bs                4  wbs
pw              7.0  wnt
pw              7.0        DISPLAY
tpwr             51  sp         -4401.0
d1            1.000  wp         33002.8
tof           100.0  vs           28669
nt             1024  sc               0
ct                0  wc             250
alock             n  hzmm          6.24
gain             54  is           500.00
      FLAGS          rfl          6822.1
il                n  rfp          2420.6
in                n  th               17
dp                y  ins           1.000
hs               nn  ai    ph
```



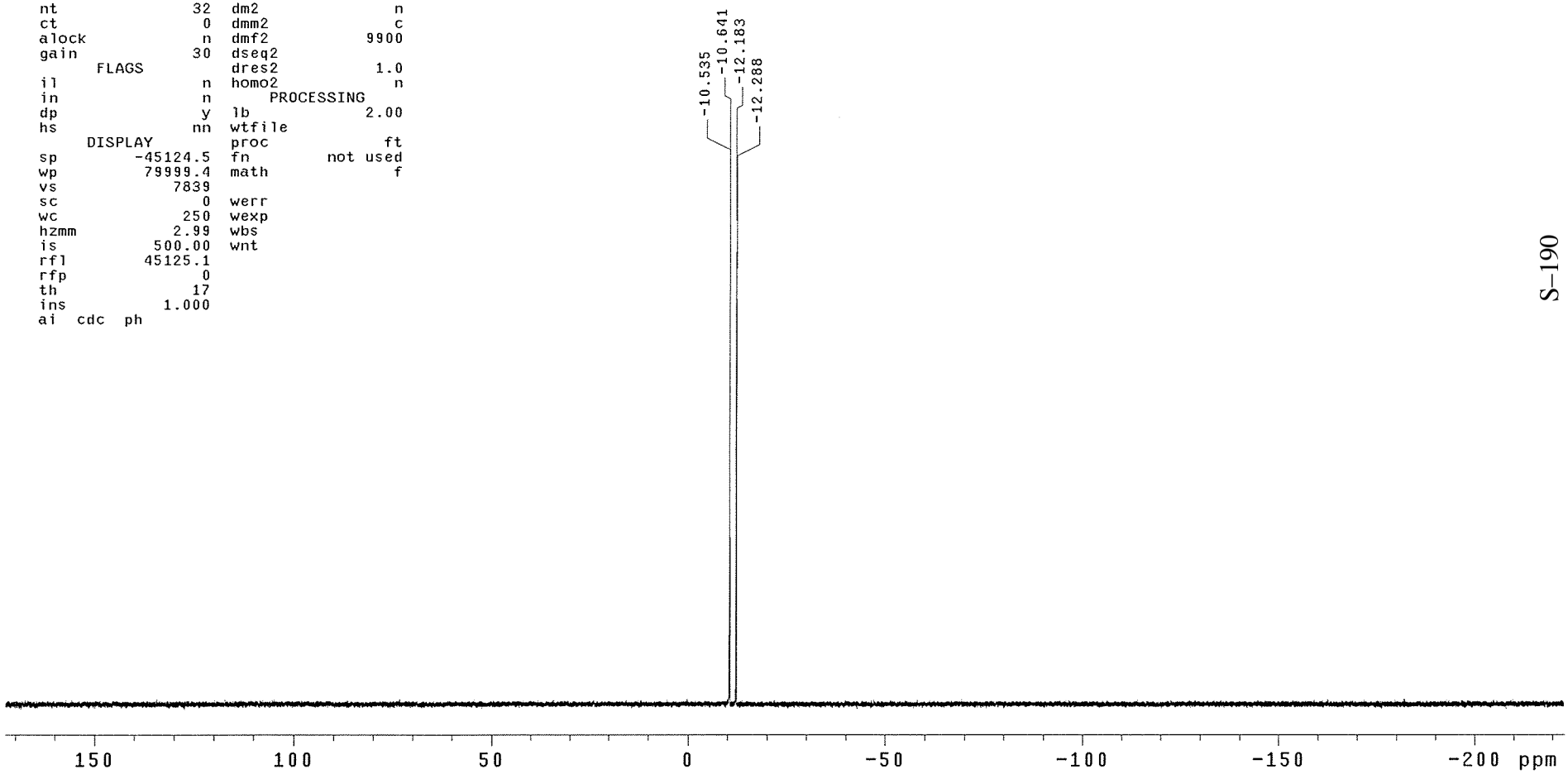
UDP-GalNAcCHMeN3_S_31P_D2O

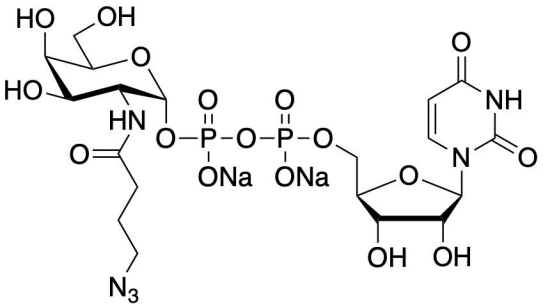
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 13 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	0	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45124.5	fn	not used
wp	79999.4	math	f
vs	7839		
sc	0	werr	
wc	250	wexp	
hzmm	2.99	wbs	
is	500.00	wnt	
rfl	45125.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



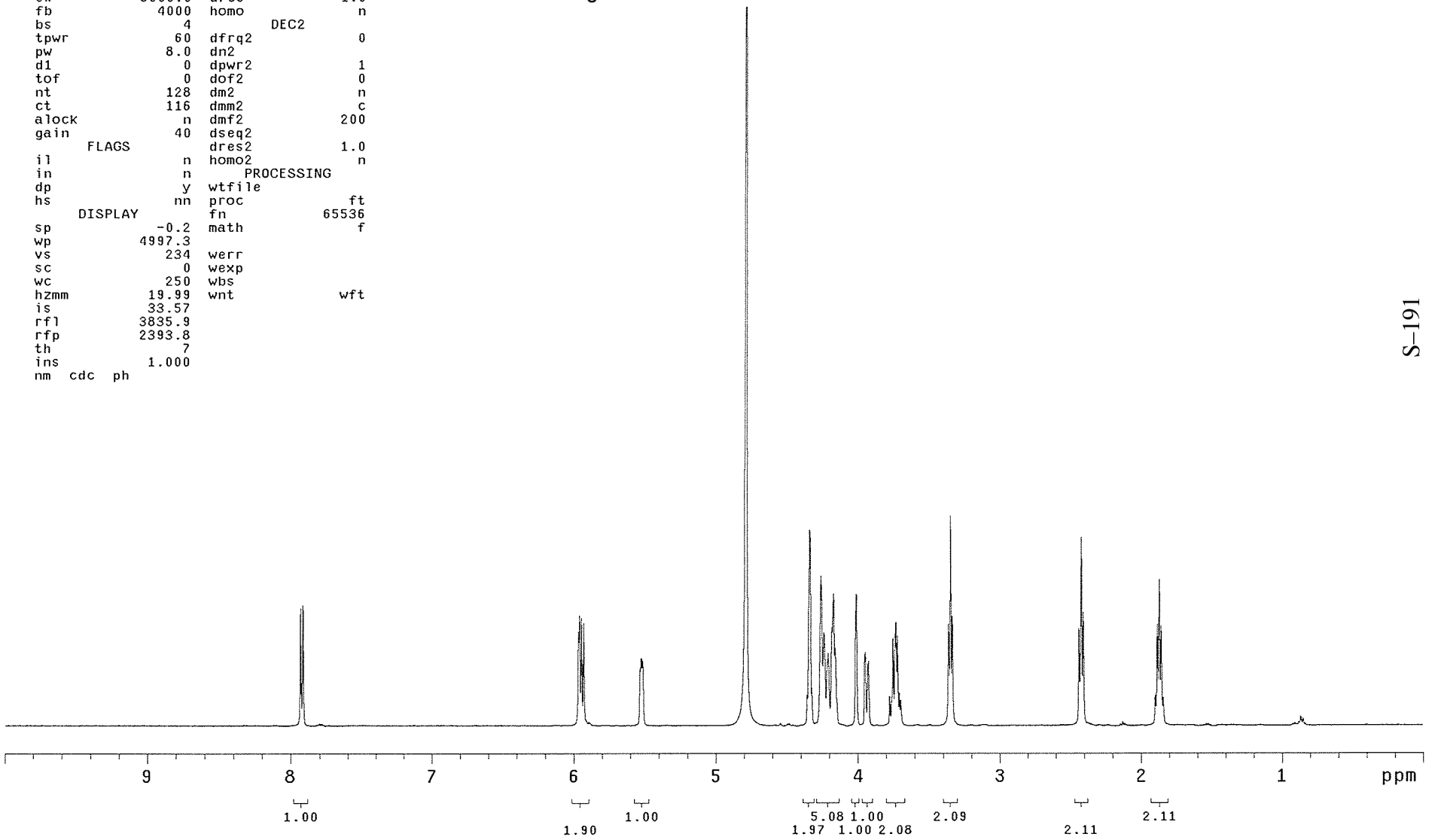
UDP-Sugar **9**

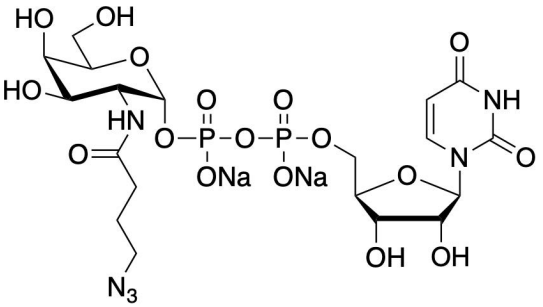




UDP-Sugar **10**

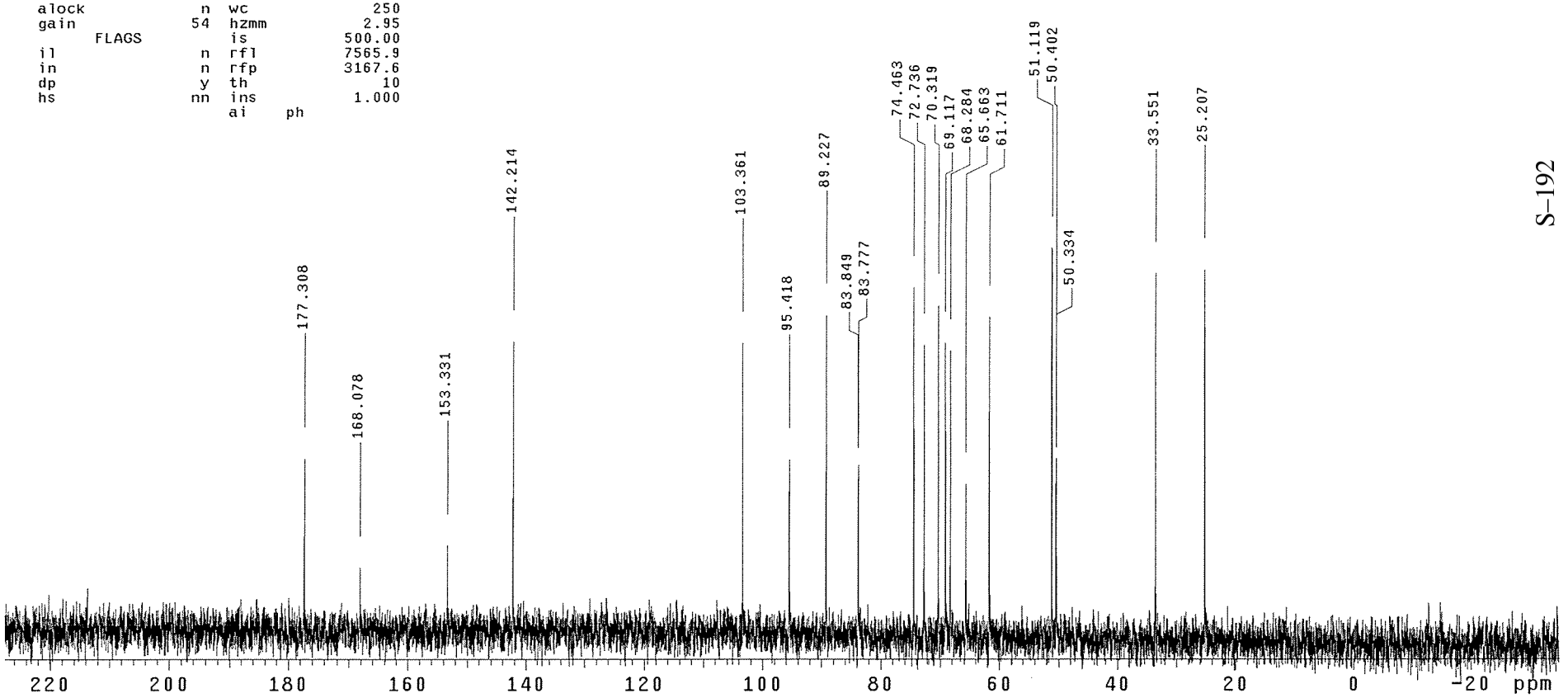
```
JC3151_1H_D2O

exp2  s2pul

      SAMPLE          DEC. & VT
date   Jul 19 2017  dfrq        499.752
solvent        D2O  dn               H1
file           exp  dpwr             30
   ACQUISITION      dof               0
sfrq       499.752  dm              nnn
tn              H1  dmm               c
at           4.000  dmf             200
np           64000  dseq
sw          8000.0  dres            1.0
fb            4000  homo              n
bs               4        DEC2
tpwr            60  dfrq2             0
pw             8.0  dn2
d1               0  dpwr2             1
tof              0  dof2              0
nt             128  dm2               n
ct             116  dmm2              c
alock            n  dmf2            200
gain            40  dseq2
      FLAGS         dres2           1.0
il               n  homo2            n
in               n     PROCESSING
dp               y  wtfile
hs              nn  proc             ft
     DISPLAY        fn           65536
sp            -0.2  math             f
wp          4997.3
vs             234  werr
sc               0  wexp
wc             250  wbs
hzmm         19.99  wnt            wft
is           33.57
rfl         3835.9
rfp         2393.8
th               7
ins          1.000
nm  cdc  ph
```





UDP-Sugar **10**

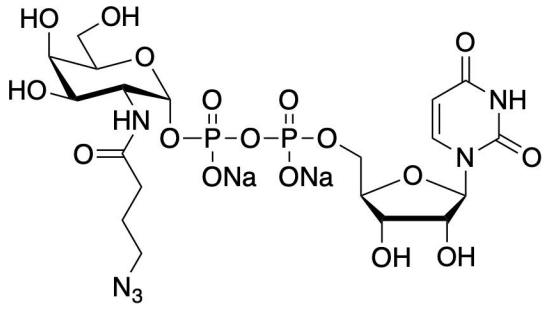
```
JC3151_13C_D2O

exp3  s2pul

      SAMPLE            DEC. & VT
date   Jul 19 2017  dn              H1
solvent       D2O  dof          -499.0
file /export/home/~ dm             yyy
junwchoi/JC3151_13~ dmm              w
         C_D2O.fid  dmf          11400
   ACQUISITION      dpwr            43
sfrq       125.674      PROCESSING
tn             C13  lb           2.00
at           1.500  fn       not used
np           99016  math            f
sw        33003.3
fb           18000  werr
bs               4  wexp
pw             7.0  wbs
pw             7.0  wnt
tpwr            51      DISPLAY
d1           1.000  sp        -4397.9
tof          100.0  wp        33002.8
nt            2048  vs          35154
ct             572  sc              0
alock            n  wc            250
gain            54  hzmm         2.95
      FLAGS         is         500.00
il               n  rfl         7565.9
in               n  rfp         3167.6
dp               y  th             10
hs              nn  ins          1.000
                    ai    ph
```



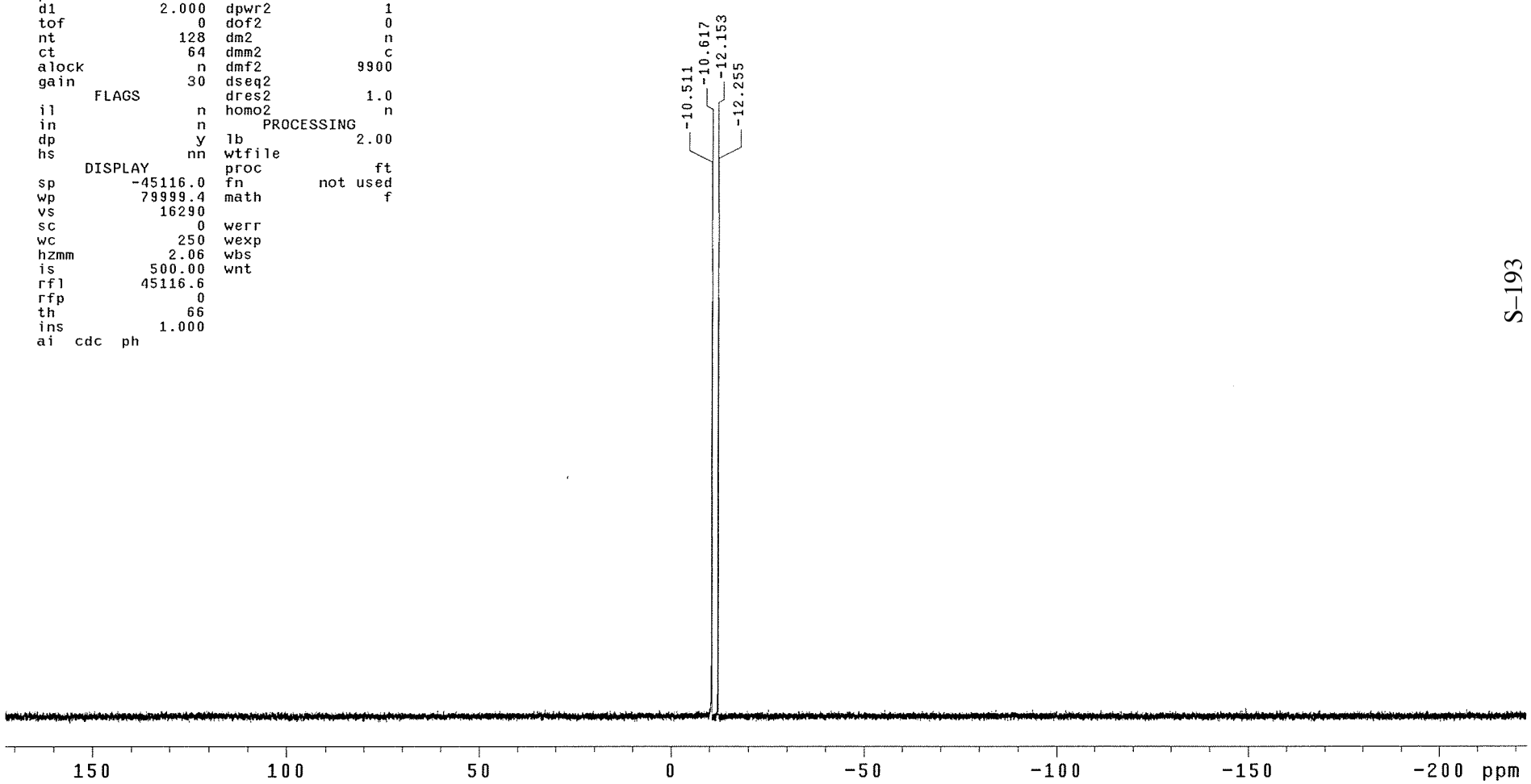
JC3151_31P_D2O

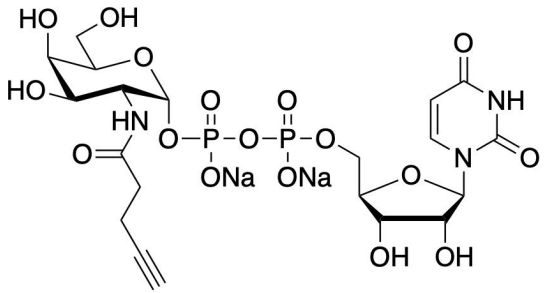
exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 19 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	128	dm2	n
ct	64	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45116.0	fn	not used
wp	79999.4	math	f
vs	16290		
sc	0	werr	
wc	250	wexp	
hzmm	2.06	wbs	
is	500.00	wnt	
rfl	45116.6		
rfp	0		
th	66		
ins	1.000		
ai cdc ph			



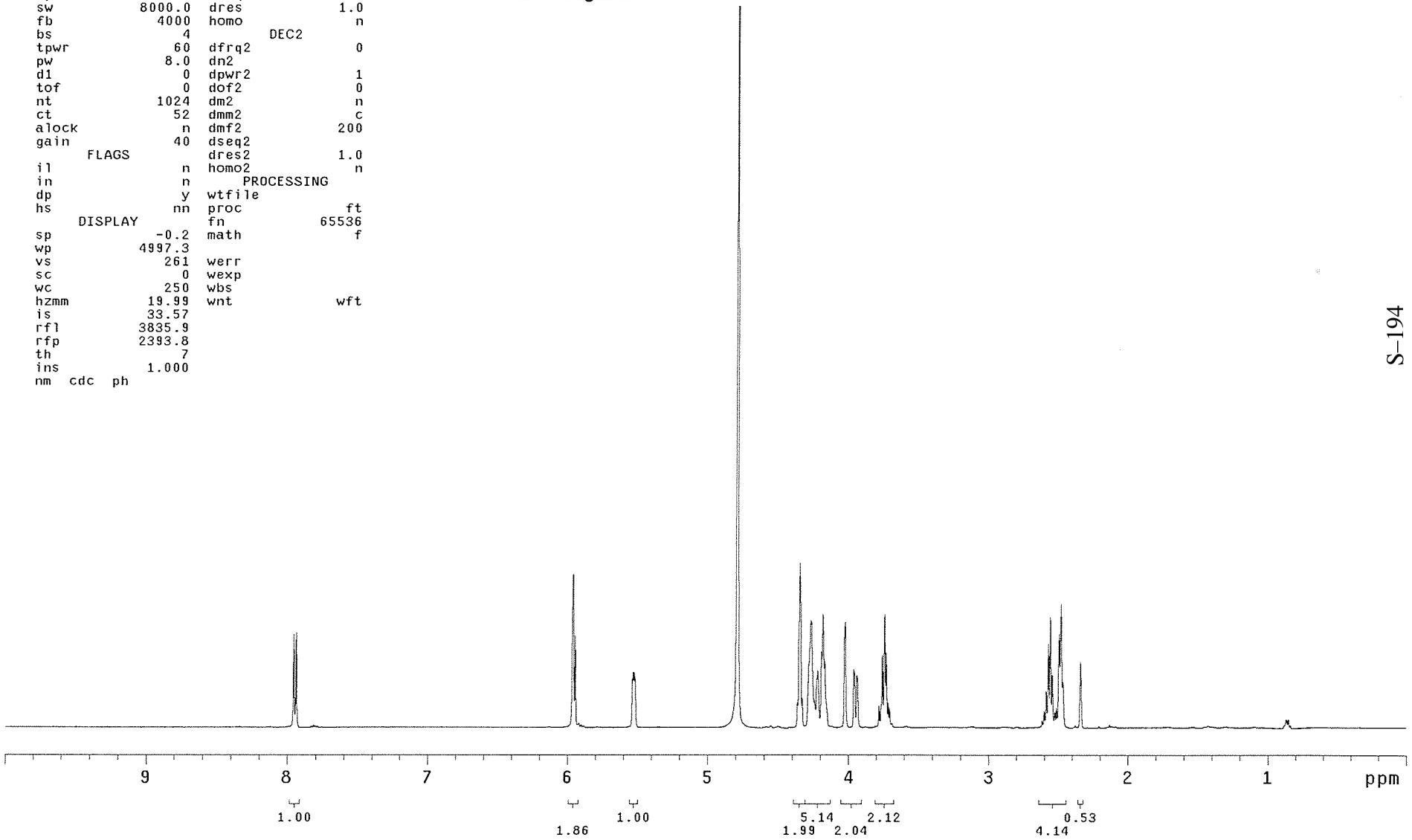
UDP-Sugar **10**

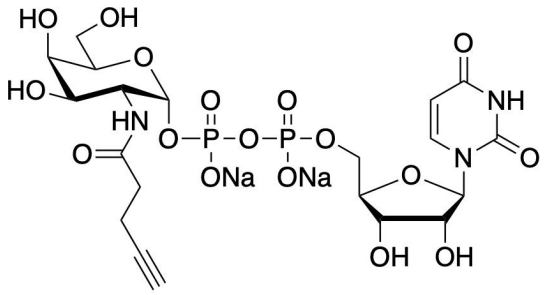




UDP-Sugar **11**

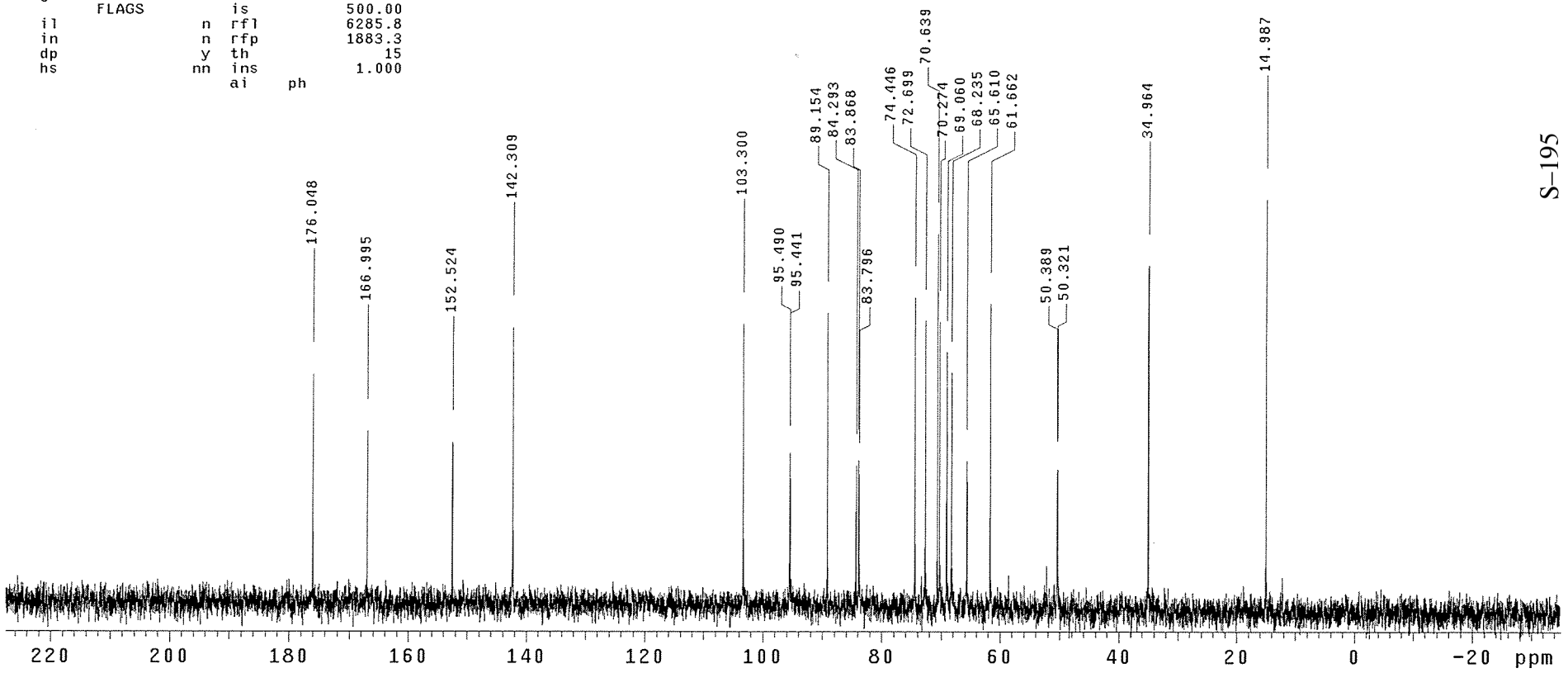
```
JC5061_1H_D2O

exp1  s2pul

      SAMPLE              DEC. & VT
date   Jul 28 2017  dfrq        499.752
solvent        D2O  dn               H1
file           exp  dpwr             30
   ACQUISITION      dof               0
sfrq       499.752  dm              nnn
tn              H1  dmm               c
at           4.000  dmf             200
np           64000  dseq
sw          8000.0  dres            1.0
fb            4000  homo              n
bs               4          DEC2
tpwr            60  dfrq2             0
pw             8.0  dn2
d1               0  dpwr2             1
tof              0  dof2              0
nt            1024  dm2               n
ct              52  dmm2              c
alock            n  dmf2            200
gain            40  dseq2
      FLAGS         dres2           1.0
il               n  homo2            n
in               n       PROCESSING
dp               y  wtfile
hs              nn  proc             ft
     DISPLAY        fn           65536
sp            -0.2  math              f
wp          4997.3
vs             261  werr
sc               0  wexp
wc             250  wbs
hzmm         19.99  wnt             wft
is           33.57
rfl          3835.9
rfp          2393.8
th               7
ins          1.000
nm  cdc  ph
```

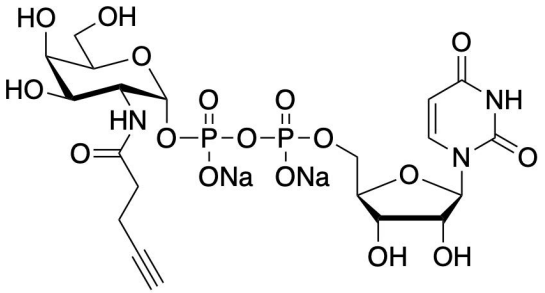




UDP-Sugar **11**

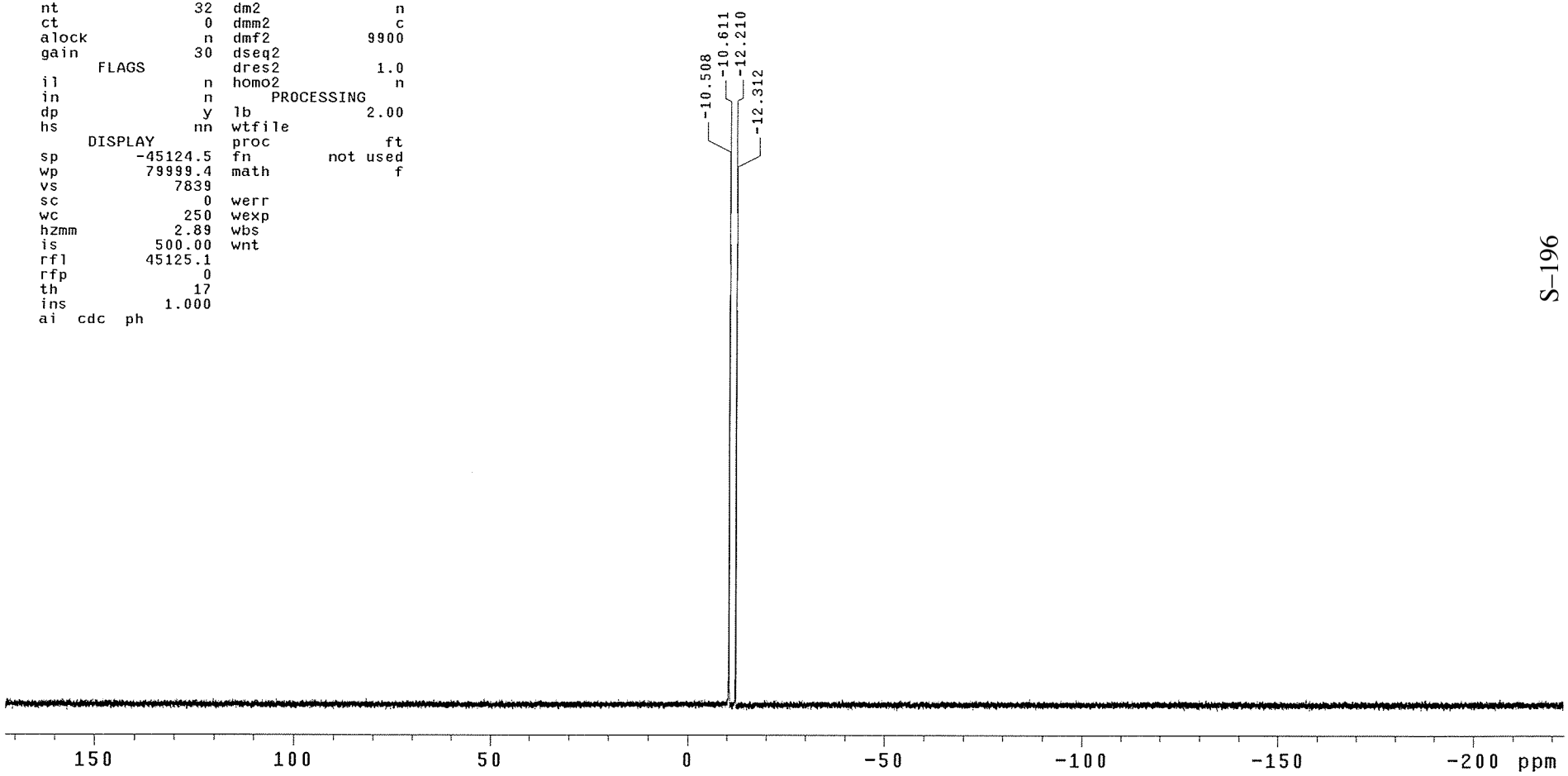
```
JC5061_13C_D2O

exp3  s2pul

      SAMPLE              DEC. & VT
date   Jul 12 2017  dn              H1
solvent        D2O  dof          -499.0
file /export/home/~ dm             yyy
junwchoi/JC5061_13~ dmm              w
         C_D2O.fid  dmf          11400
   ACQUISITION      dpwr            43
sfrq       125.674      PROCESSING
tn             C13  lb            2.00
at           1.500  fn        not used
np           99016  math             f
sw        33003.3
fb           18000  werr
bs               4  wexp
pw             7.0  wbs
pw             7.0  wnt
tpwr            51       DISPLAY
d1           0.500  sp         -4402.0
tof          100.0  wp         33002.8
nt            1024  vs           26076
ct             592  sc               0
alock            n  wc             250
gain            54  hzmm          5.38
      FLAGS         is           500.00
il               n  rfl          6285.8
in               n  rfp          1883.3
dp               y  th               15
hs              nn  ins           1.000
                    ai    ph
```

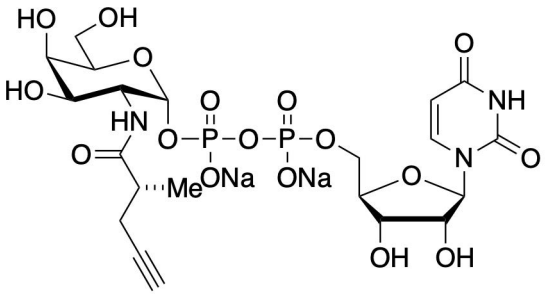




UDP-Sugar **11**

```
JC5061_31P_D2O

exp3  s2pul

      SAMPLE              DEC. & VT
date   Jul 13 2017  dfrq        499.752
solvent        D2O  dn               H1
file           exp  dpwr             43
   ACQUISITION      dof               0
sfrq       202.297  dm              yyy
tn             P31  dmm               w
at           1.002  dmf           11400
np          160254  dseq
sw         80000.0  dres            1.0
fb           44000  homo              n
bs               4        DEC2
tpwr            51  dfrq2             0
pw             6.6  dn2
d1           2.000  dpwr2             1
tof              0  dof2              0
nt              32  dm2               n
ct               0  dmm2              c
alock            n  dmf2           9900
gain            30  dseq2
      FLAGS         dres2           1.0
il               n  homo2             n
in               n      PROCESSING
dp               y  lb             2.00
hs              nn  wtfile
     DISPLAY        proc              ft
sp       -45124.5  fn         not used
wp        79999.4  math              f
vs           7839
sc              0  werr
wc            250  wexp
hzmm         2.89  wbs
is         500.00  wnt
rfl       45125.1
rfp             0
th             17
ins         1.000
ai  cdc  ph
```



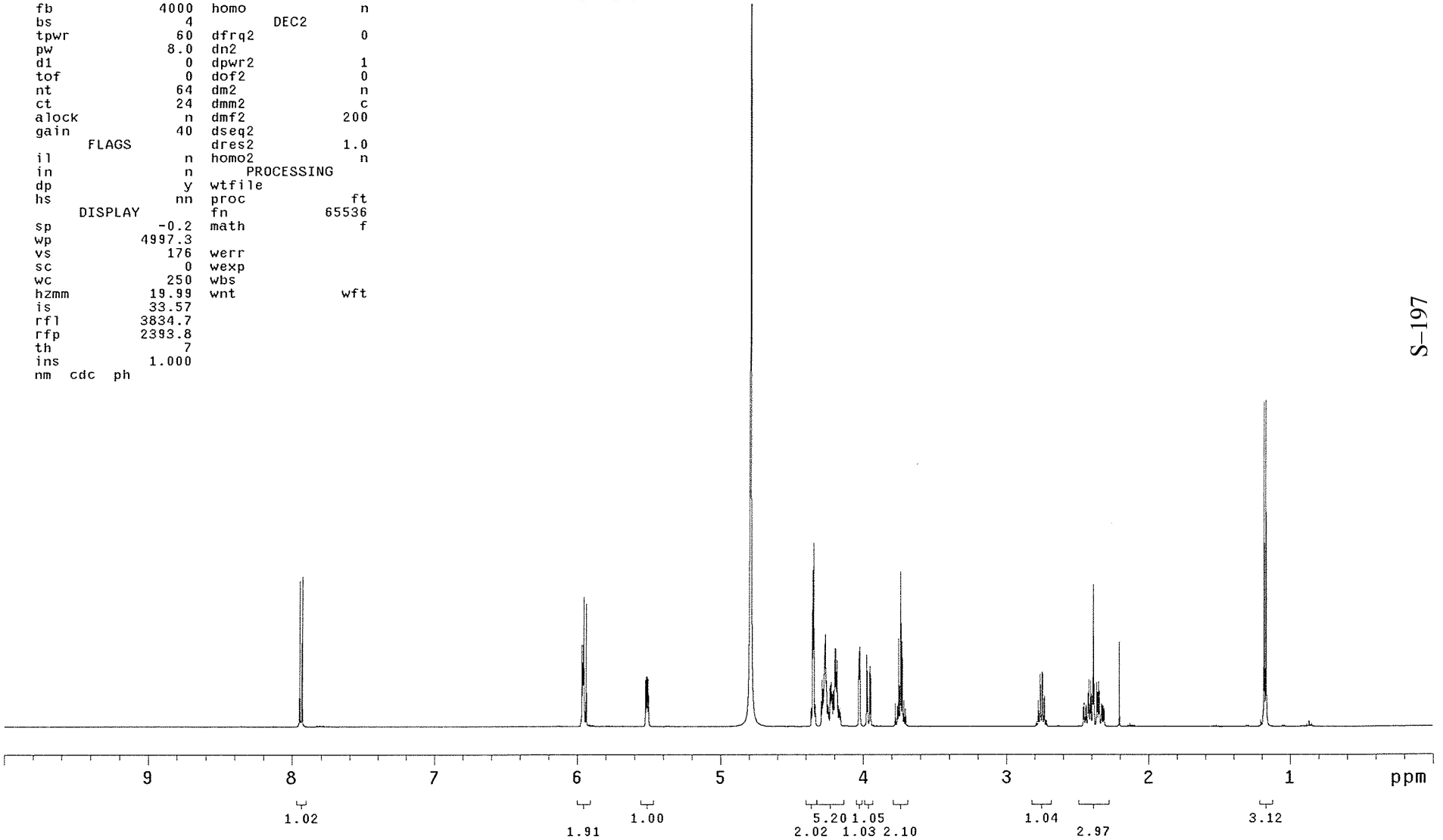


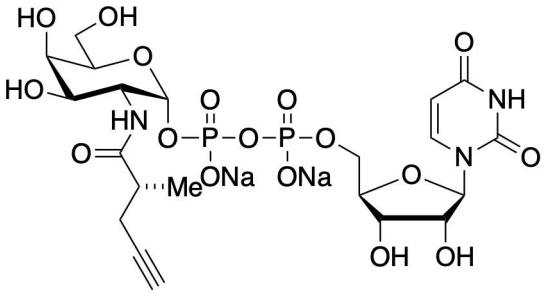
UDP-Sugar (*R*)-**12**

JC3099_1H_D2O

exp2 s2pul

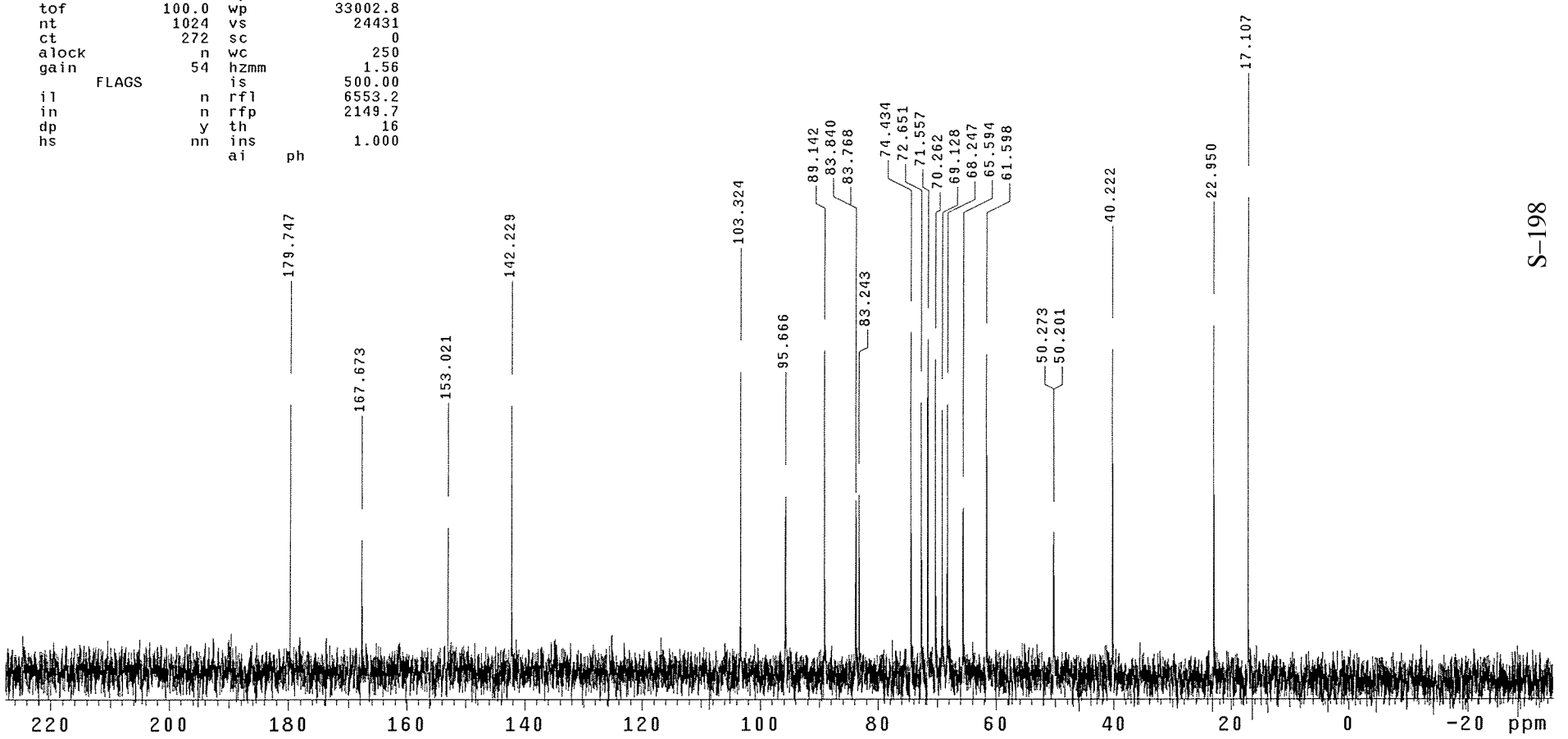
SAMPLE		DEC. & VT	
date	Jul 10 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	24	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	176	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	3834.7		
rfp	2393.8		
th	7		
ins	1.000		
nm cdc ph			

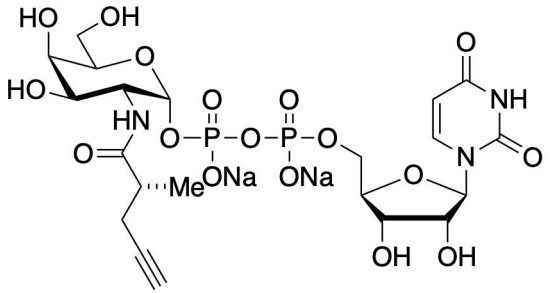




UDP-Sugar (*R*)-**12**

```
JC3099_13C_D2O

exp2  s2pul

      SAMPLE              DEC. & VT
date   Jul 10 2017  dn              H1
solvent        D2O  dof          -499.0
file /export/home/~ dm             yyy
junwchoi/JC3099_13~ dmm              w
          C_D2O.fid dmf          11400
   ACQUISITION      dpwr            43
sfrq       125.674       PROCESSING
tn             C13  lb           2.00
at           1.500  fn       not used
np           99016  math            f
sw        33003.3
fb           18000  werr
bs               4  wexp
pw             7.0  wbs
pw             7.0  wnt
tpwr            51       DISPLAY
d1            0.500  sp         -4403.0
tof           100.0  wp         33002.8
nt             1024  vs           24431
ct              272  sc               0
alock             n  wc             250
gain             54  hzmm          1.56
      FLAGS          is          500.00
il                n  rfl         6553.2
in                n  rfp         2149.7
dp                y  th              16
hs               nn  ins          1.000
                     ai    ph
```



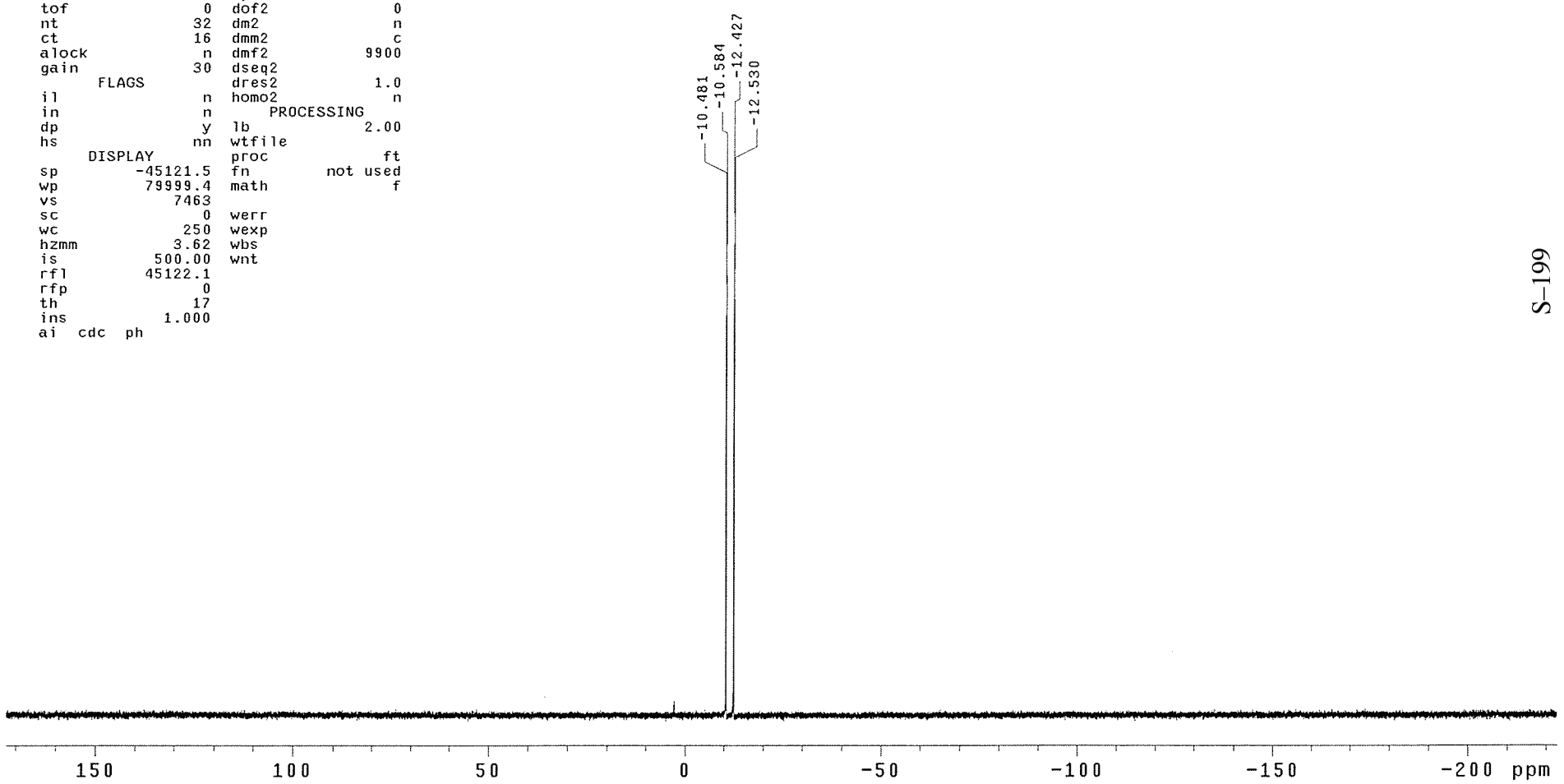


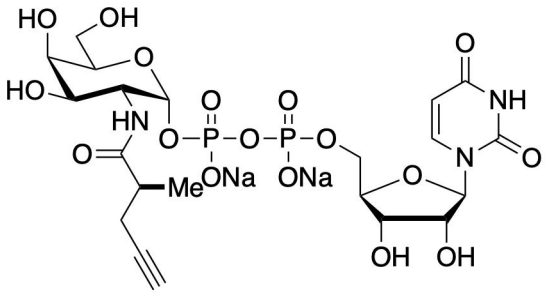
UDP-Sugar (*R*)-**12**

JC3099_31P_D2O

exp2 s2pul

SAMPLE		DEC. & VT	
date	Jul 10 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45121.5	fn	not used
wp	79999.4	math	f
vs	7463		
sc	0	werr	
wc	250	wexp	
hzmm	3.62	wbs	
is	500.00	wnt	
rfl	45122.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			





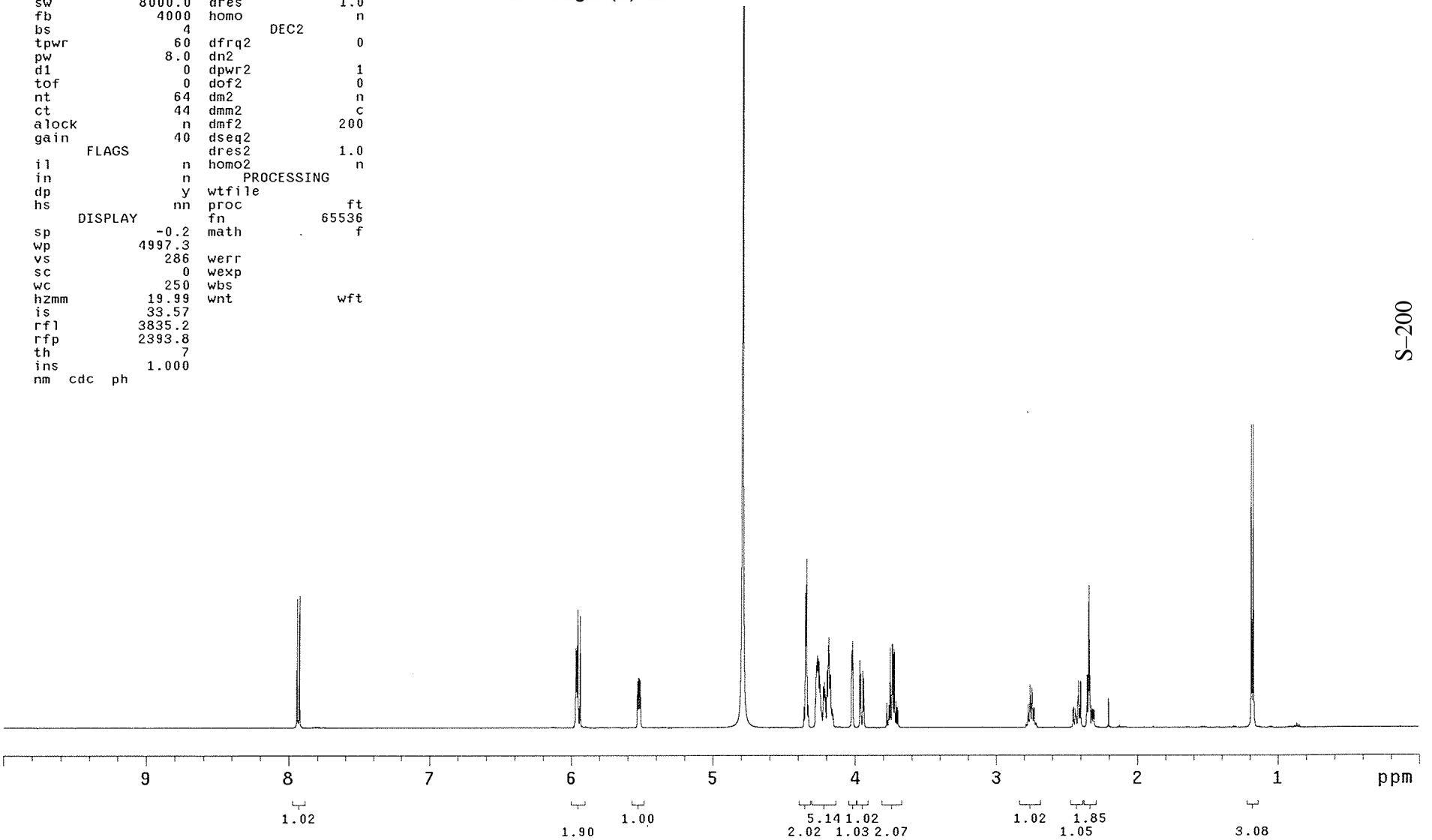
UDP-Sugar (*S*)-**12**

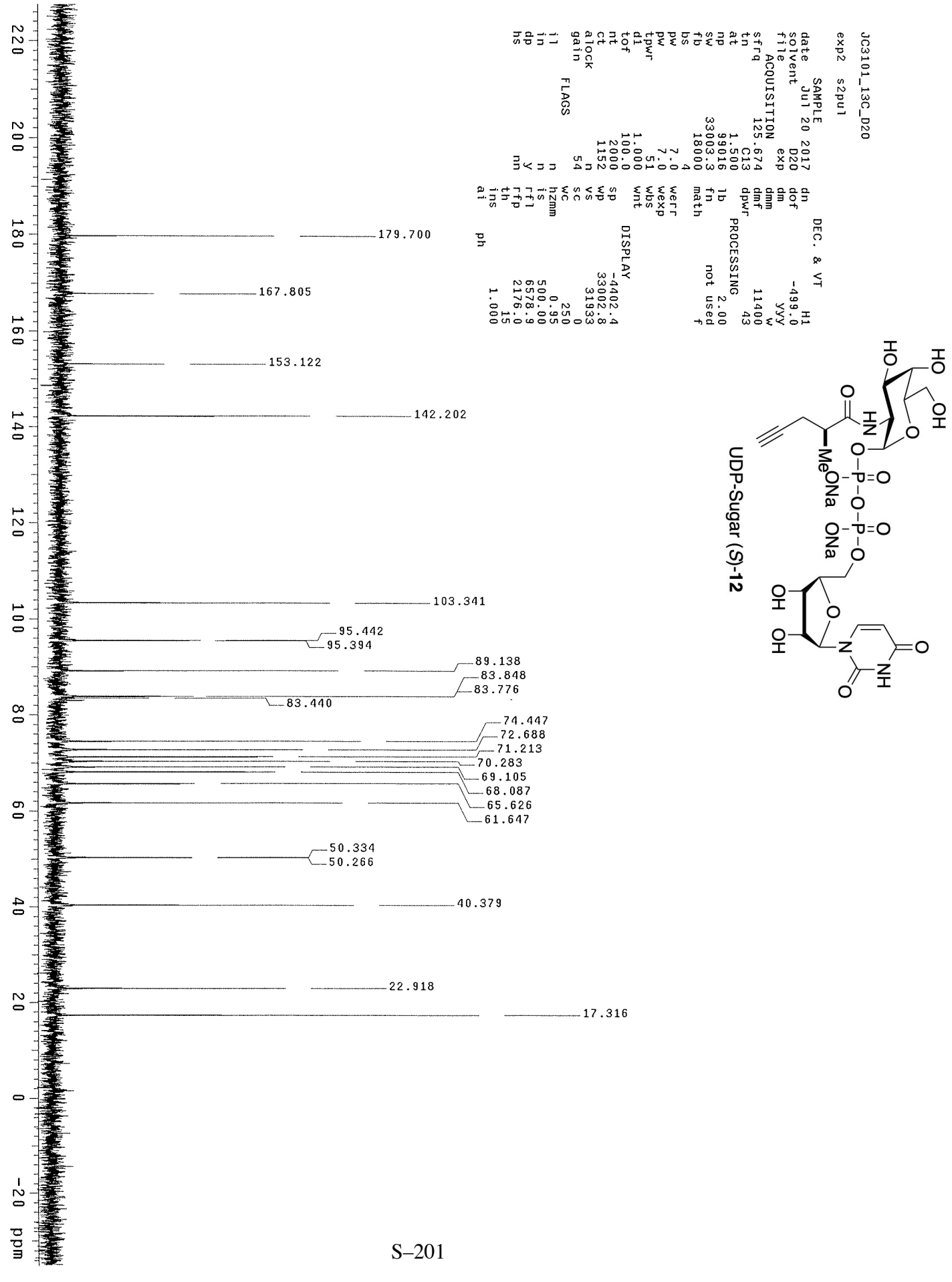
JC3101_1H_D2O

exp2 s2pul

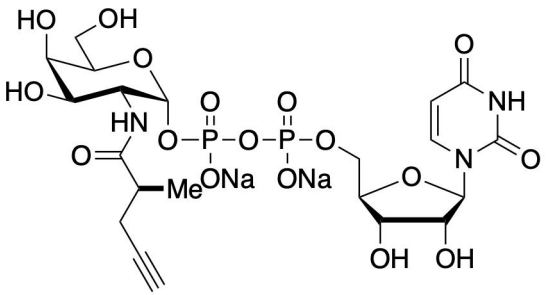
SAMPLE		DEC. & VT	
date	Jul 10 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	64	dm2	n
ct	44	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	286	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	33.57		
rfl	3835.2		
rfp	2393.8		
th	7		
ins	1.000		

nm cdc ph





UDP-Sugar (*S*)-**12**

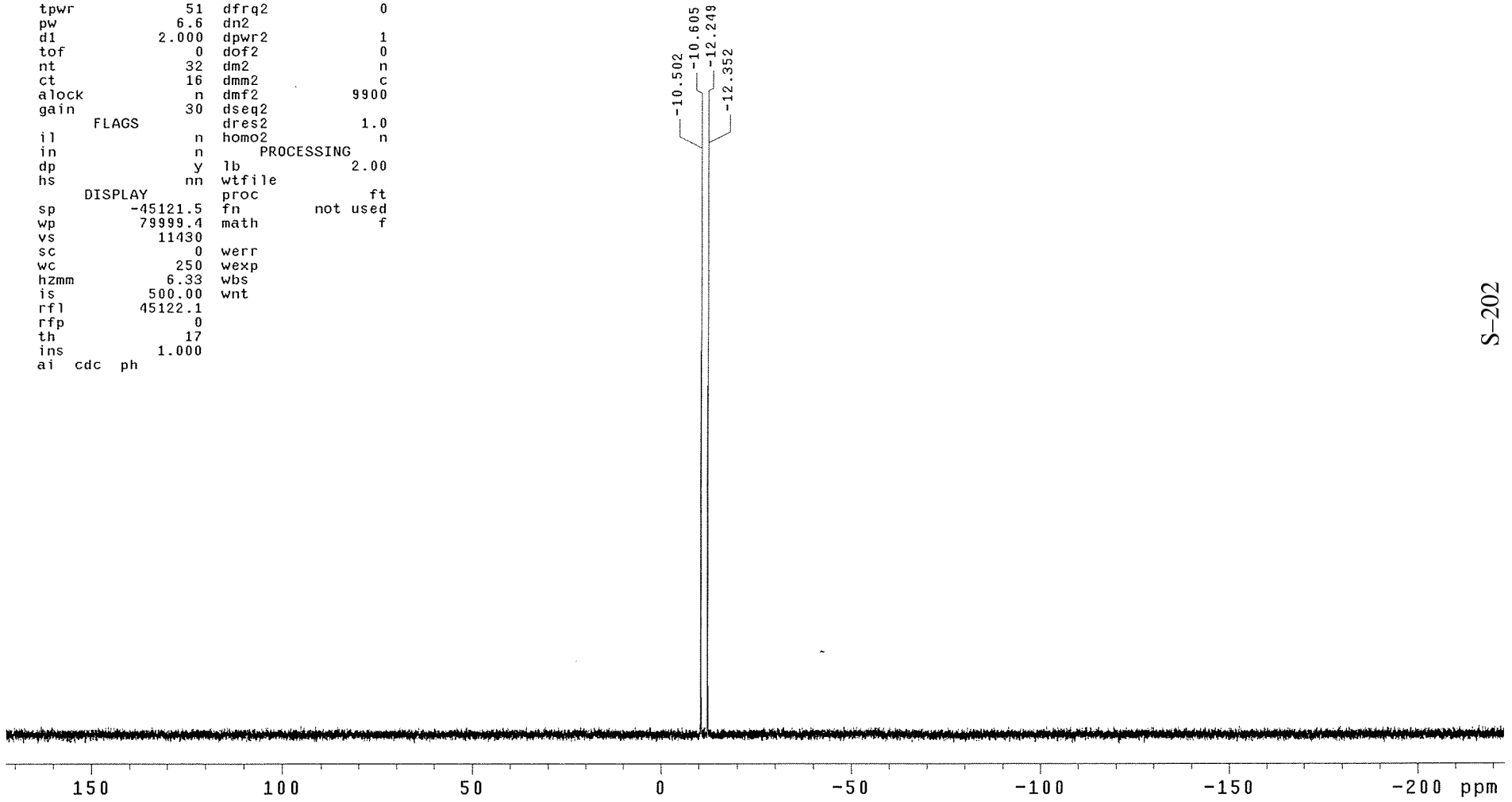


UDP-Sugar (*S*)-**12**

JC3101_31P_D2O

exp2 s2pul

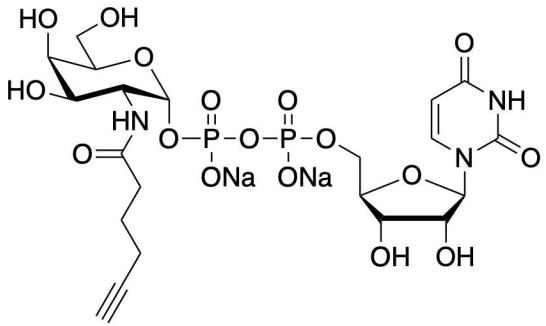
SAMPLE		DEC. & VT	
date	Jul 10 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45121.5	fn	not used
wp	79999.4	math	f
vs	11430		
sc	0	werr	
wc	250	wexp	
hzmm	6.33	wbs	
is	500.00	wnt	
rfl	45122.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



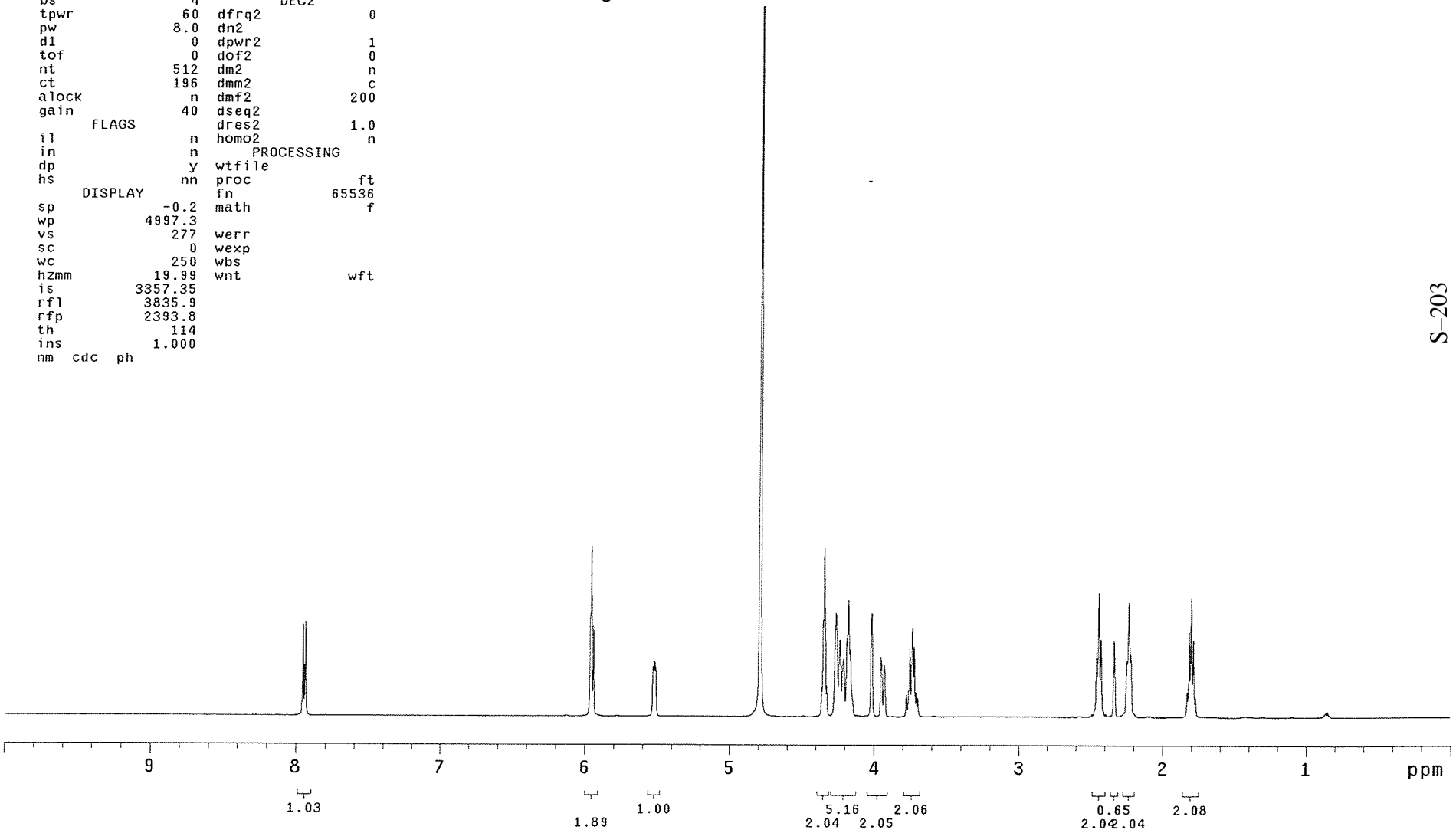
JC5158_1H_D2O

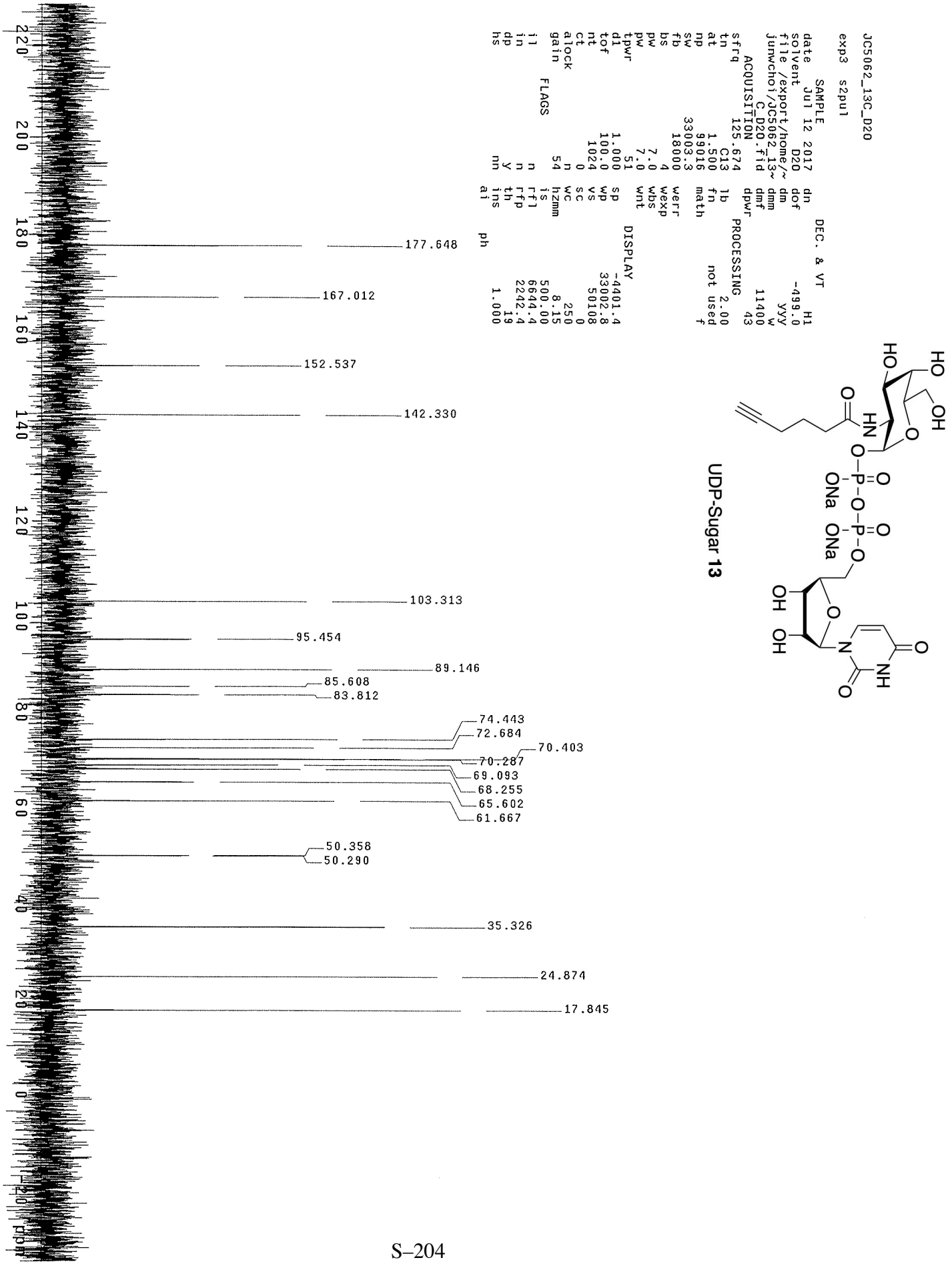
exp3 s2pul

SAMPLE		DEC. & VT	
date	Aug 4 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	30
ACQUISITION		dof	0
sfrq	499.752	dm	nnn
tn	H1	dmm	c
at	4.000	dmf	200
np	64000	dseq	
sw	8000.0	dres	1.0
fb	4000	homo	n
bs	4	DEC2	
tpwr	60	dfrq2	0
pw	8.0	dn2	
d1	0	dpwr2	1
tof	0	dof2	0
nt	512	dm2	n
ct	196	dmm2	c
alock	n	dmf2	200
gain	40	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	wtfile	
hs	nn	proc	ft
DISPLAY		fn	65536
sp	-0.2	math	f
wp	4997.3		
vs	277	werr	
sc	0	wexp	
wc	250	wbs	
hzmm	19.99	wnt	wft
is	3357.35		
rfl	3835.9		
rfp	2393.8		
th	114		
ins	1.000		
nm cdc ph			



UDP-Sugar **13**



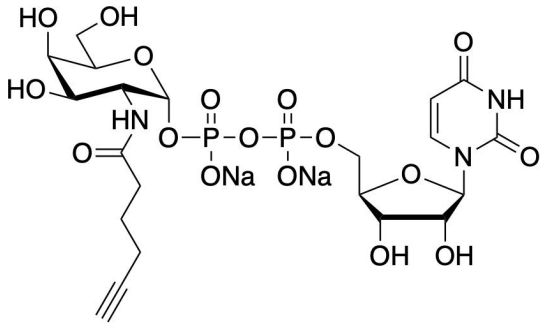

JC5062_13C_D20
exp3 s2pul
SAMPLE
date Jul 12 2017
solvent D20
file /export/home/~
junwchoi/JC5062_13~
C_D20.fid
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb 18000
bs 4
pw 7.0
pw 7.0
tpwr 51
d1 1.000
tof 100.0
nt 1024
ct 0
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
ai
ph
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 11400
dpwr 43
PROCESSING
lb 2.00
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4401.4
wp 33002.8
vs 50108
sc 0
wc 250
hzmm 8.15
is 500.00
rfl 6644.4
rfp 2242.4
th 19
ins 1.000
177.648
167.012
152.537
142.330
103.313
95.454
89.146
85.608
83.812
74.443
72.684
70.403
70.287
69.093
68.255
65.602
61.667
50.358
50.290
35.326
24.874
17.845
ppm

UDP-Sugar **13**

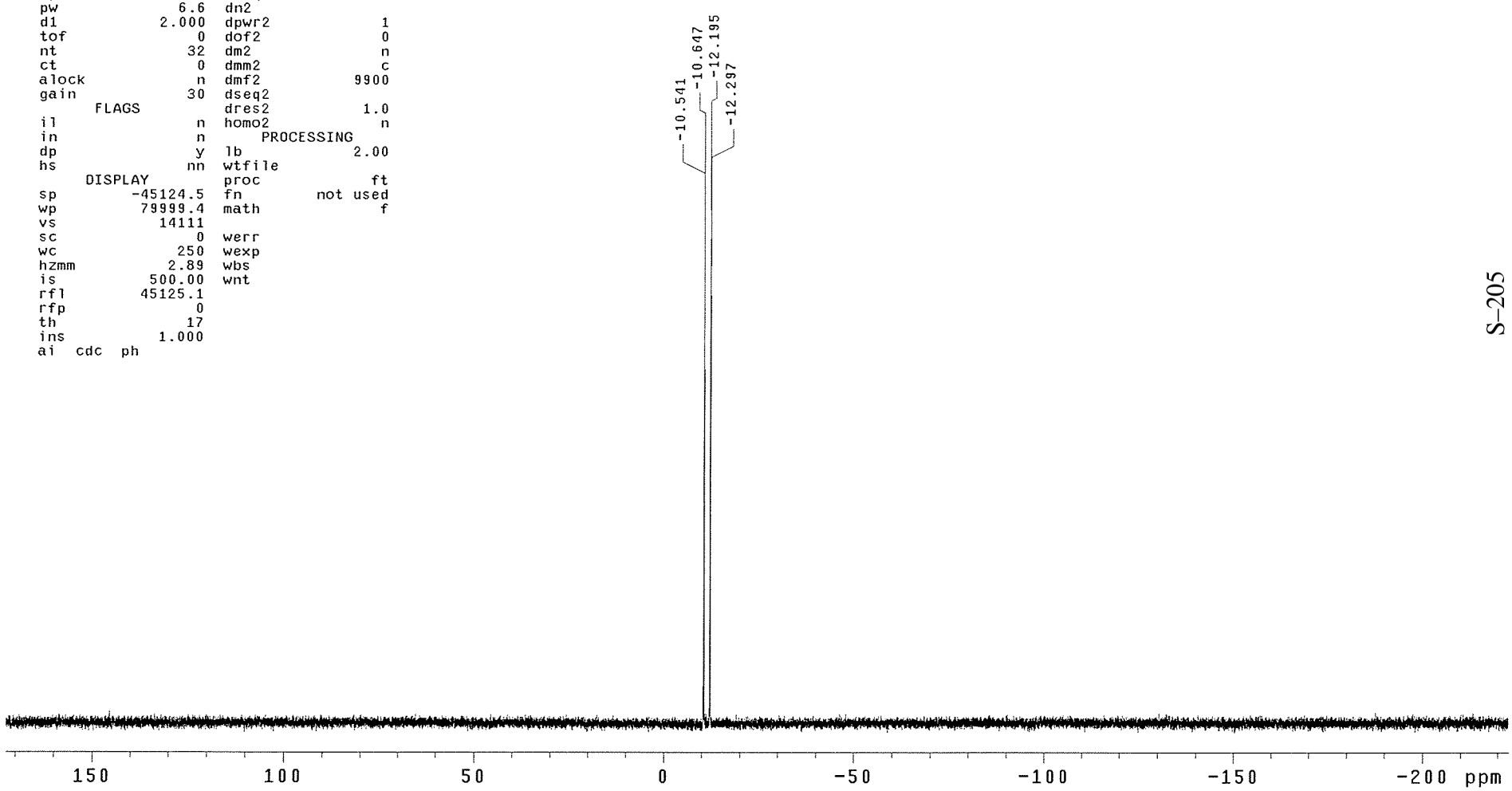
JC5062_31P_D2O

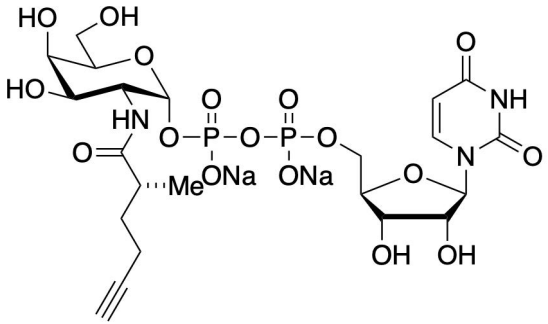
exp3 s2pul

SAMPLE		DEC. & VT	
date	Jul 13 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	32	dm2	n
ct	0	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45124.5	fn	not used
wp	79999.4	math	f
vs	14111		
sc	0	werr	
wc	250	wexp	
hzmm	2.89	wbs	
is	500.00	wnt	
rfl	45125.1		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			



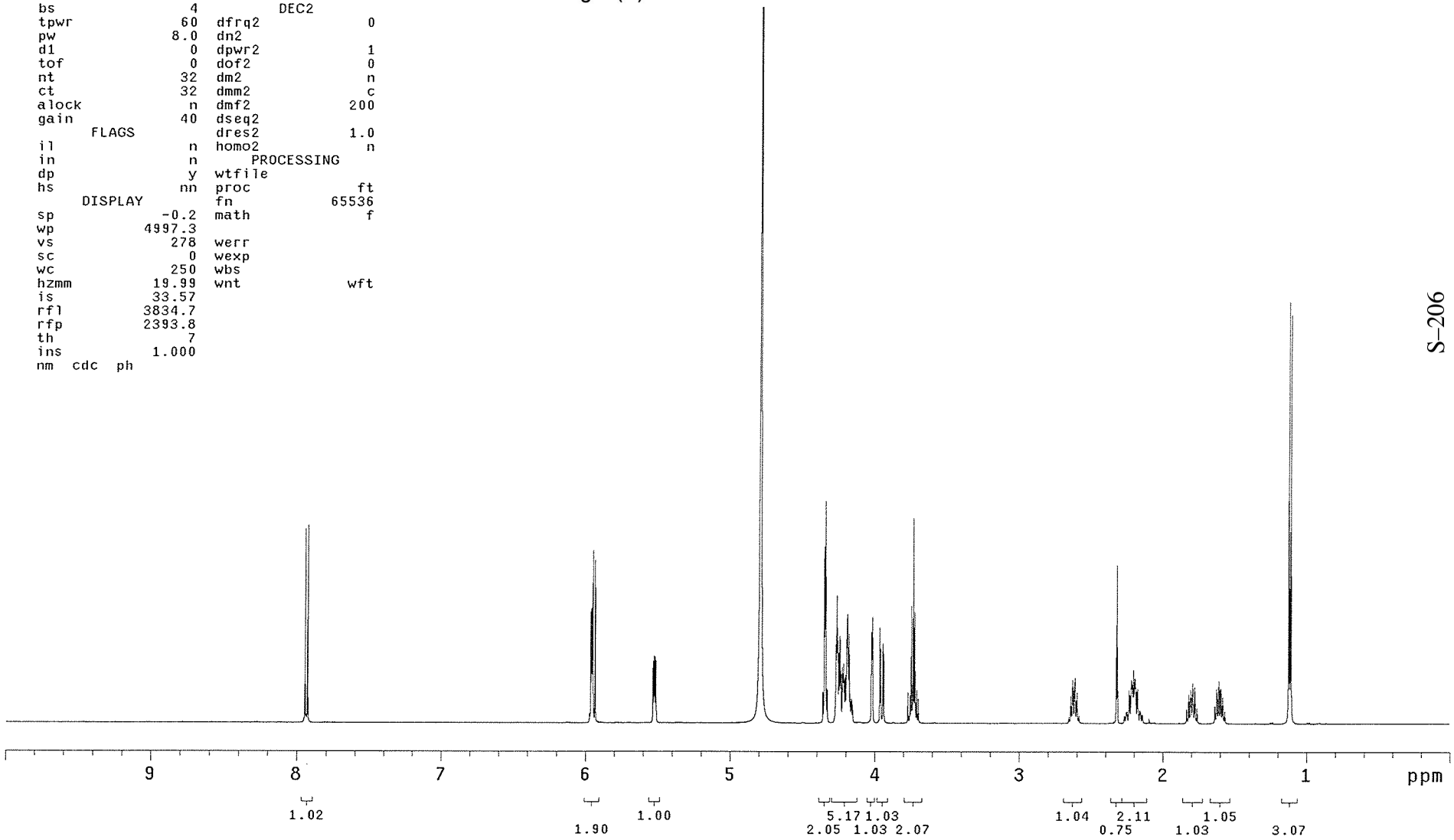
UDP-Sugar **13**

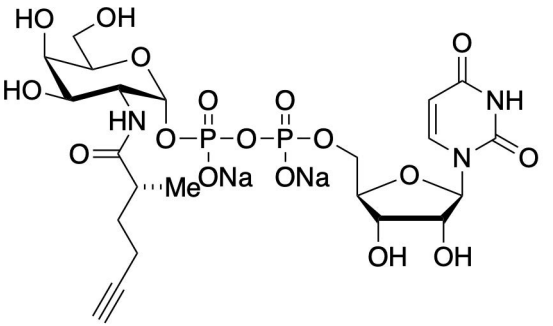




UDP-Sugar (*R*)-**14**

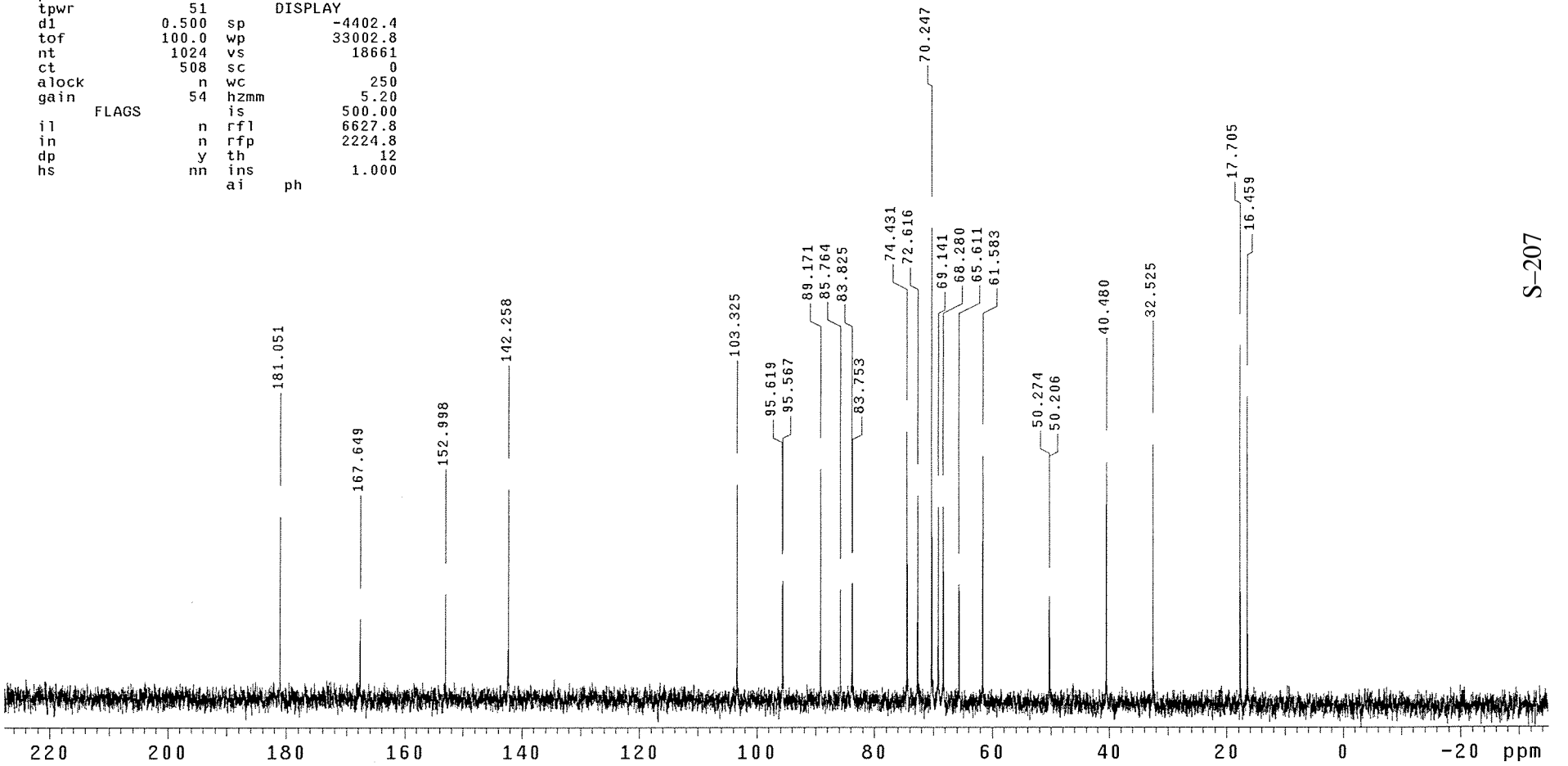
```
JC3103_1H_D2O

exp2  s2pul

      SAMPLE
date    Jul 11 2017
solvent        D2O
file           exp
   ACQUISITION
sfrq       499.752
tn              H1
at           4.000
np           64000
sw          8000.0
fb            4000
bs               4
tpwr            60
pw             8.0
d1               0
tof              0
nt              32
ct              32
alock            n
gain            40
      FLAGS
il               n
in               n
dp               y
hs              nn
     DISPLAY
sp            -0.2
wp          4997.3
vs             278
sc               0
wc             250
hzmm         19.99
is           33.57
rfl          3834.7
rfp          2393.8
th               7
ins          1.000
nm  cdc  ph

      DEC. & VT
dfrq       499.752
dn              H1
dpwr            30
dof              0
dm             nnn
dmm              c
dmf            200
dseq
dres           1.0
homo             n
      DEC2
dfrq2            0
dn2
dpwr2            1
dof2             0
dm2              n
dmm2             c
dmf2           200
dseq2
dres2          1.0
homo2            n
     PROCESSING
wtfile
proc            ft
fn           65536
math             f

werr
wexp
wbs
wnt            wft
```

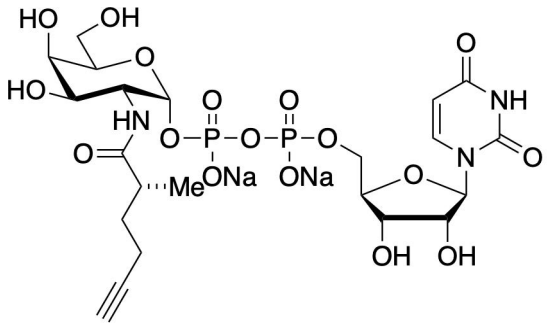




UDP-Sugar (*R*)-**14**

```
JC3103_1H_D2O

exp3  s2pul

      SAMPLE            DEC. & VT
date   Jul 11 2017  dn              H1
solvent       D2O   dof          -499.0
file /export/home/~ dm               yyy
junwchoi/JC3103_13~ dmm               w
          C_D2O.fid dmf           11400
   ACQUISITION      dpwr             43
sfrq       125.674      PROCESSING
tn             C13   lb             2.00
at           1.500   fn         not used
np           99016   math              f
sw        33003.3
fb           18000   werr
bs               4   wexp
pw             7.0   wbs
pw             7.0   wnt
tpwr            51        DISPLAY
d1           0.500   sp          -4402.4
tof          100.0   wp          33002.8
nt            1024   vs            18661
ct             508   sc                0
alock            n   wc              250
gain            54   hzmm           5.20
      FLAGS         is           500.00
il               n   rfl          6627.8
in               n   rfp          2224.8
dp               y   th               12
hs              nn   ins           1.000
                     ai    ph
```



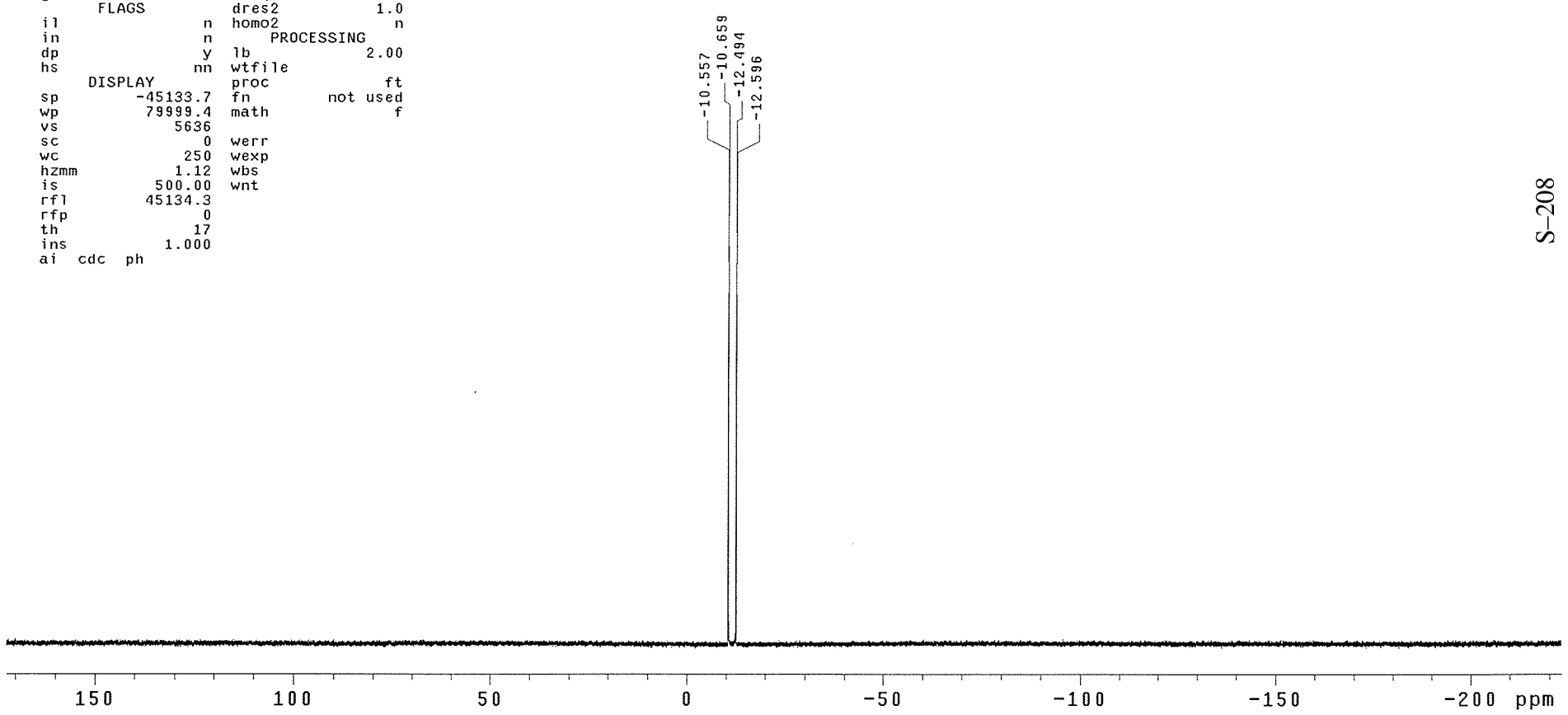


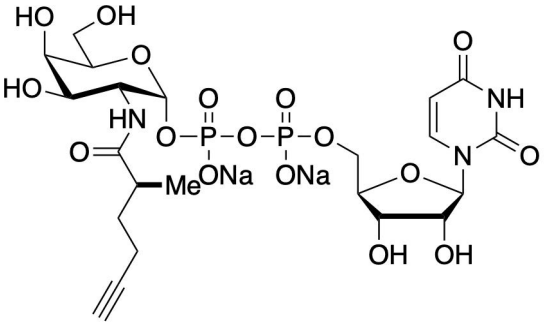
UDP-Sugar (*R*)-**14**

JC3103_31P_D2O

exp3 s2pul

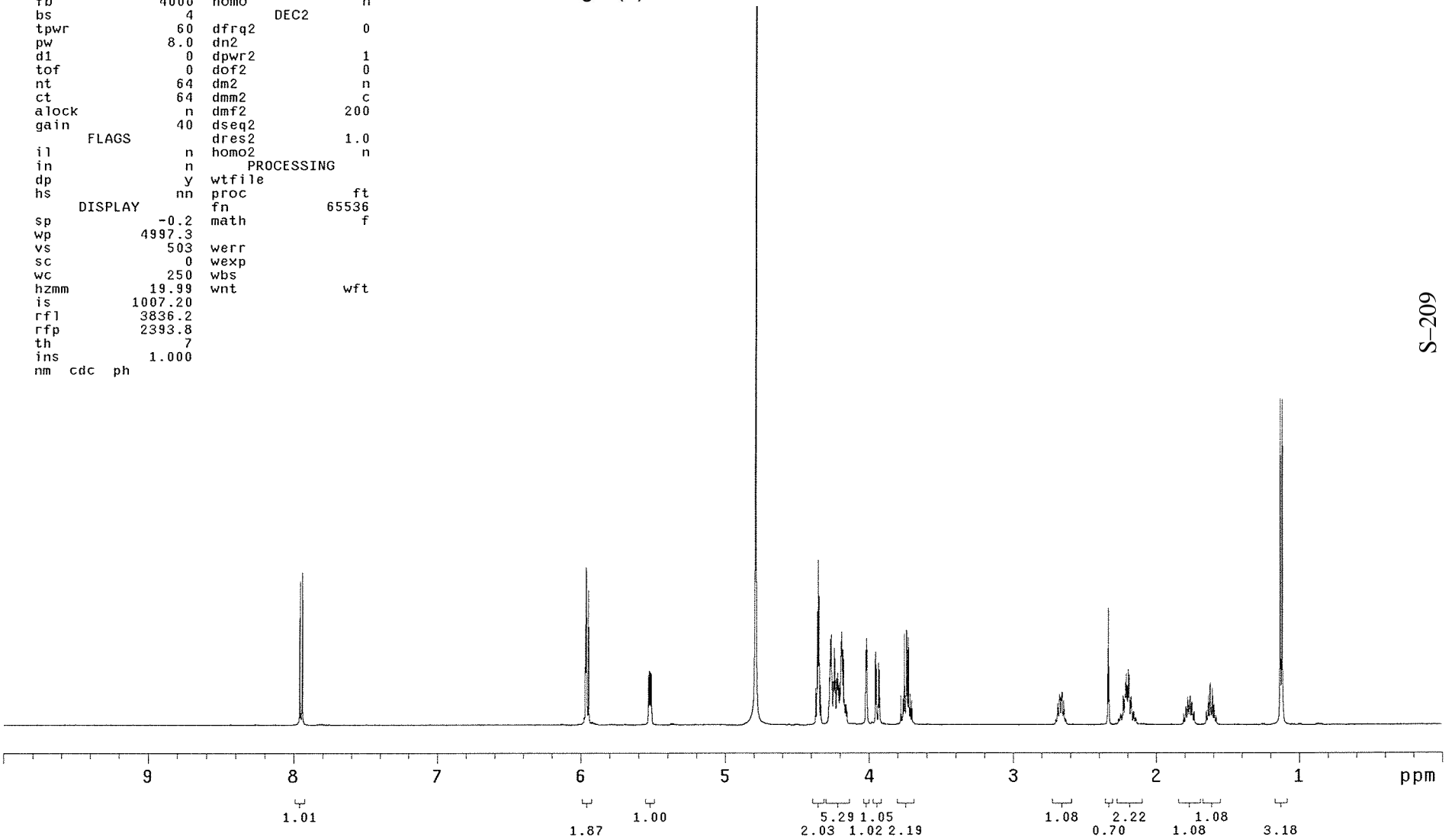
SAMPLE		DEC. & VT	
date	Jul 11 2017	dfrq	499.752
solvent	D2O	dn	H1
file	exp	dpwr	43
ACQUISITION		dof	0
sfrq	202.297	dm	yyy
tn	P31	dmm	w
at	1.002	dmf	11400
np	160254	dseq	
sw	80000.0	dres	1.0
fb	44000	homo	n
bs	4	DEC2	
tpwr	51	dfrq2	0
pw	6.6	dn2	
d1	2.000	dpwr2	1
tof	0	dof2	0
nt	16	dm2	n
ct	16	dmm2	c
alock	n	dmf2	9900
gain	30	dseq2	
FLAGS		dres2	1.0
il	n	homo2	n
in	n	PROCESSING	
dp	y	lb	2.00
hs	nn	wtfile	
DISPLAY		proc	ft
sp	-45133.7	fn	not used
wp	79999.4	math	f
vs	5636		
sc	0	werr	
wc	250	wexp	
hzmm	1.12	wbs	
is	500.00	wnt	
rfl	45134.3		
rfp	0		
th	17		
ins	1.000		
ai cdc ph			

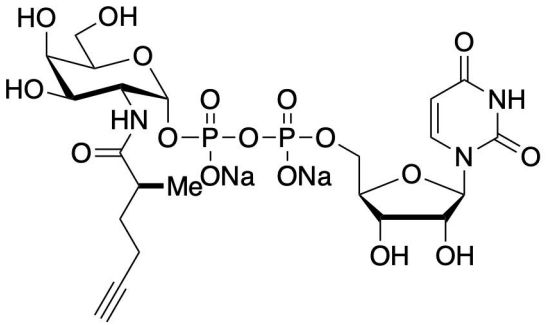




UDP-Sugar (*S*)-**14**

```
JC5163_1H_D2O

exp1  s2pul

      SAMPLE            DEC. & VT
date   Aug 12 2017  dfrq        499.752
solvent         D2O  dn              H1
file            exp  dpwr            30
   ACQUISITION       dof              0
sfrq        499.752  dm             nnn
tn               H1  dmm              c
at            4.000  dmf            200
np            64000  dseq
sw           8000.0  dres           1.0
fb             4000  homo             n
bs                4         DEC2
tpwr             60  dfrq2            0
pw              8.0  dn2
d1                0  dpwr2            1
tof               0  dof2             0
nt               64  dm2              n
ct               64  dmm2             c
alock             n  dmf2           200
gain             40  dseq2
      FLAGS          dres2          1.0
il                n  homo2           n
in                n      PROCESSING
dp                y  wtfile
hs               nn  proc            ft
     DISPLAY         fn           65536
sp             -0.2  math             f
wp           4997.3
vs              503  werr
sc                0  wexp
wc              250  wbs
hzmm          19.99  wnt            wft
is          1007.20
rfl          3836.2
rfp          2393.8
th                7
ins           1.000
nm  cdc  ph
```



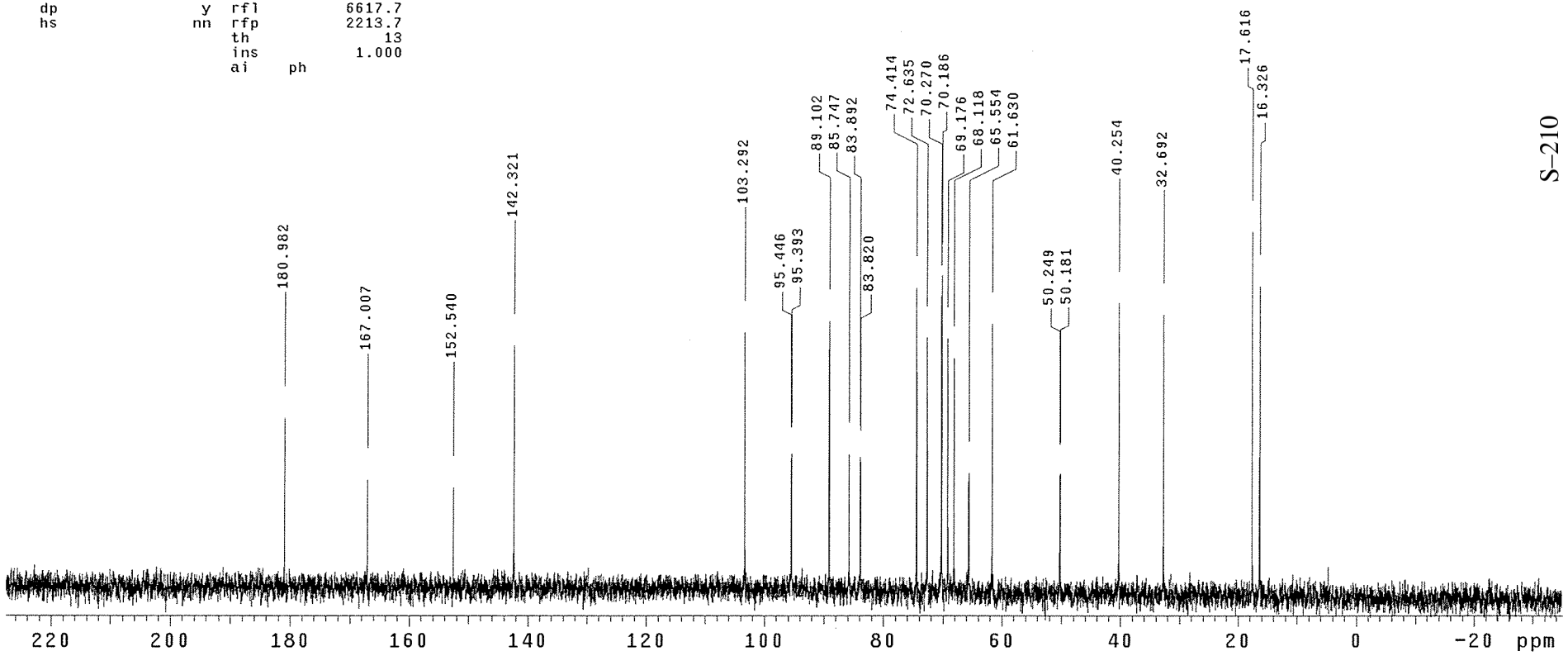


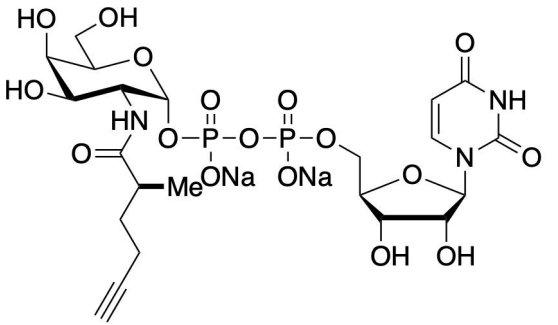
UDP-Sugar (*S*)-**14**

JC5163_13C_D20

exp1 s2pul

SAMPLE		DEC. & VT	
date	Aug 12 2017	dn	H1
solvent	D2O	dof	-499.0
file	exp	dm	yyy
ACQUISITION		dmm	w
sfrq	125.674	dmf	11400
tn	C13	dpwr	43
at	1.500	PROCESSING	
np	99016	lb	2.00
sw	33003.3	fn	not used
fb	18000	math	f
bs	4		
pw	7.0	werr	
pw	7.0	wexp	
tpwr	51	wbs	
d1	1.000	wnt	
tof	100.0	DISPLAY	
nt	2048	sp	-4403.5
ct	992	wp	33002.8
alock	n	vs	29382
gain	54	sc	0
FLAGS		wc	250
il	n	hzmm	17.87
in	n	is	500.00
dp	y	rfl	6617.7
hs	nn	rfp	2213.7
		th	13
		ins	1.000
		ai ph	





UDP-Sugar (*S*)-**14**

```
JC3105_31P_D2O

exp3  s2pul

      SAMPLE            DEC. & VT
date   Jul 11 2017  dfrq        499.752
solvent        D2O  dn              H1
file           exp  dpwr            43
   ACQUISITION      dof              0
sfrq       202.297  dm             yyy
tn             P31  dmm              w
at           1.002  dmf          11400
np          160254  dseq
sw         80000.0  dres           1.0
fb           44000  homo             n
bs               4          DEC2
tpwr            51  dfrq2            0
pw             6.6  dn2
d1           2.000  dpwr2            1
tof              0  dof2             0
nt              16  dm2              n
ct              16  dmm2             c
alock            n  dmf2          9900
gain            30  dseq2
      FLAGS         dres2          1.0
il               n  homo2            n
in               n      PROCESSING
dp               y  lb           2.00
hs              nn  wtfile
     DISPLAY        proc             ft
sp       -45133.7  fn         not used
wp        79999.4  math             f
vs           5636
sc              0  werr
wc            250  wexp
hzmm         1.12  wbs
is         500.00  wnt
rfl       45134.3
rfp             0
th             17
ins         1.000
ai  cdc  ph
```