Electronic Supplementary Information (ESI)

Convergent Synthesis of Glycoalkaloids Solasonine and its Saponin Derivative

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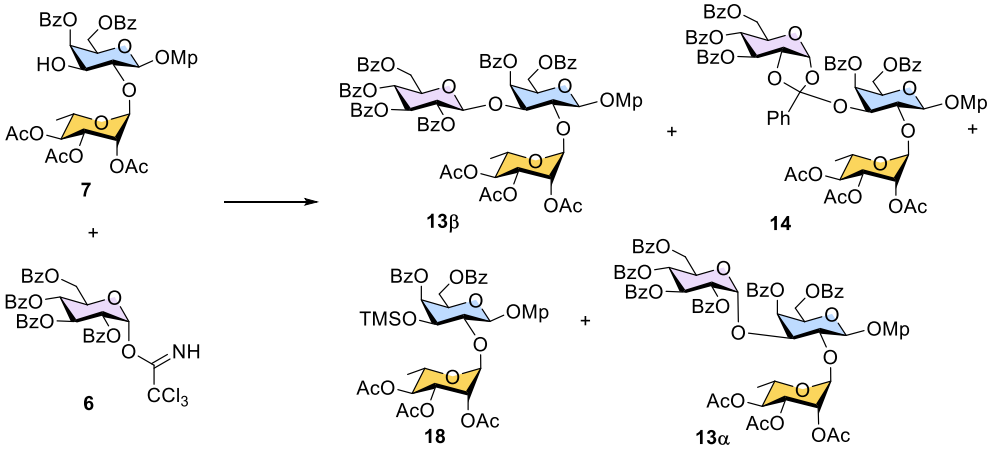
Table of Contents

1. General Procedures

Material and Methods: All reagents and solvents were dried prior to use according to standard methods. Commercial reagents were used without further purification, unless otherwise stated. NMR spectra were recorded on an AVANCE DRX Bruker-400 MHz, or AVANCE NEO Bruker-600 MHz spectrometer at 25°C and referenced using residual $CHCl_3$ for ^{1}H-NMR (δ 7.26 ppm), $CDCl_3$ for ^{13}C-NMR (δ 77.0 ppm), and residual Pyridine for ^{1}H-NMR (δ 7.57 ppm), Pyridine-d_5 for ^{13}C-NMR (δ 135.4 ppm). High-resolution mass spectrometry was performed on a Bruker Maxis-II QTOF. All reactions were performed in flame-dried modified Schlenk (Kjeldahl shape) flasks fitted with a glass stopper or rubber septa under a positive pressure of argon. Analytical TLC was performed on silica gel 60-F254 precoated on aluminum plates (E. Merck), with detection by fluorescence and/or by staining with acidic ceric ammonium molybdate. Column chromatography was performed employing Silica Gel (Qingdao Ocean) 100-200 mesh (for *O*-glycosyl trichloroacetimidates donor) or 200-300 mesh.

2. Optimization of Trisaccharide 13 Synthesis with Donor 6 and Acceptor 7.

Table 1 Optimization Reaction Conditions for Trisaccharide **13** Synthesis[a].



entry	catalyst (equiv)	molecular sieves	concentration	yield(%)[b]	
				13	**14**
1	TMSOTf (0.1)	4Å	0.03	69	28
2[c]	TMSOTf (0.1)	4Å	0.03	no desired product	
3	BF_3•OEt_2 (0.1)	4Å	0.03	no reaction	
4[c]	TfOH (0.1)	4Å	0.03	0	85
5[d]	TMSOTf (0.1)	4Å	0.2	90	0
6[e]	TMSOTf (0.1)	5Å	0.2	93	0

[a] Reaction condition: **6** (1.0 equiv.), **7** (0.8 equiv.), 0 °C, anhydrous DCM. [b] Isolation yield. [c] Inverse procedure. [d] 7% of **13α** was also isolated. [e] 5% of **13α** was also isolated.

Normal procedure:

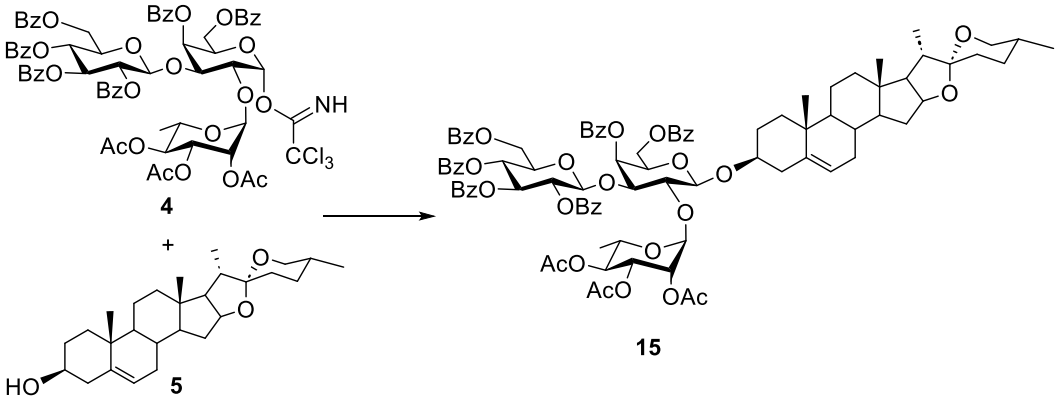
To a solution of glycosyl donor **6** (1.0 equiv.), glycosyl acceptor **7** (0.8 equiv.) and 4 Å (or 5 Å) molecular sieves in anhydrous DCM at 0 °C under argon atmosphere was added catalyst (0.1 equivalents of TMSOTf or $BF_3{\cdot}OEt_2$). The reaction was further stirred at this temperature for 40 min. After the TLC analysis showed the reaction was complete, the reaction was quenched by addition of triethylamine and diluted with 100 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The organic layer was washed with $NaHCO_3$ (aq.) and brine, dried over Na_2SO_4, filtered, and concentrated. The residue was purified by column chromatography (petroleum ether/DCM/ethyl acetate = 6:6:1) on silica gel to afford trisaccharide **13** or orthoester **14**.

Inverse procedure:

To a solution of glycosyl acceptor **7** (0.8 equiv.) and 4 Å molecular sieves in anhydrous DCM (2.2 mL) at 0 °C under argon atmosphere was added catalyst (0.1 equivalents of TfOH or TMSOTf) as added to the solution. After being stirred for 15min at 0 °C, glycosyl donor **6** (1.0 equiv.) was added to the solution. The reaction was further stirred at this temperature for 40 min. After the TLC analysis showed the reaction was complete, the reaction was quenched by addition of triethylamine and diluted with 100 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The organic layer was washed with $NaHCO_3$ (aq.) and brine, dried over Na_2SO_4, filtered, and concentrated. The residue was purified by column chromatography (petroleum ether/DCM/ethyl acetate = 6:6:1) on silica gel to afford trisaccharide **13** or orthoester **14**.

3. Glycosidation of Trichloroacetimidate 4 and Aglycon 5 with Different Catalysts

Table 2. Glycosidation of Aglycon **5** as Acceptor and Trichloroacetimidate **4**



entry	promoter (equiv)	solvent	temp (°C)	Time	yield (%)	ratio of **15** (α:β)
1	TfOH (0.3)	DCM/MeCN=1/1	-50	45 min	81%	1/4.0
2	$AuCl_3$ (0.1)	DCM	-60	10 min	80%	1/6.3
3	$PtCl_4$ (0.1)	DCM	-60	12 h	91%	1/13.1
4	$AuCl_3$ (0.1)	DCM/*t*BuCN=5/1	-50	10 min	84%	β

For TfOH as catalyst:

To a solution of donor **4** (30 mg, 22.2 μmol) and 4 Å molecular sieves in solvent of DCM/MeCN = 1:1 (2.2 mL, 0.01M) was added acceptor **5** (11 mg, 26.1 μmol) at room temperature. After the reaction mixture cooling down to –50 ℃, TfOH (1.1 μL, 6.66 μmol) was added into the reaction. After the TLC analysis showed the reaction was complete (45 min), the reaction was quenched by addition of triethylamine and diluted with 50 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 3:1) on silica gel to afford compound **15αβ** (29 mg, α/β=1/4.0, 81%) as semisolid.

For $AuCl_3$ as catalyst:

To a solution of donor **4** (30 mg, 22.2 μmol) and 4 Å molecular sieves in solvent of DCM (2.2 mL, 0.01M) was added acceptor **5** (11 mg, 26.1 μmol) at room temperature. After the reaction mixture cooling down to –60 ℃, $AuCl_3$ (0.7 mg, 2.22 μmol) was added into the reaction. After the TLC analysis showed the reaction was complete (10

min), the reaction was quenched by addition of triethylamine and diluted with 50 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 3:1) on silica gel to afford compound **15αβ** (28.7 mg, α/β=1/6.3, 80%) as semisolid.

For $PtCl_4$ as catalyst:

To a solution of donor **4** (50 mg, 36.2 μmol) and 4 Å molecular sieves in solvent of DCM (1.0 mL, 0.036 M) was added acceptor **5** (19 mg, 43.4 μmol) at room temperature. After the reaction mixture cooling down to –60 ℃, $PtCl_4$ (1.2 mg, 3.62 μmol) was added into the reaction. After the TLC analysis showed the reaction was complete (12 h), the reaction was quenched by addition of triethylamine and diluted with 50 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 3:1) on silica gel to afford compound **15αβ** (53.7 mg, α/β=1/13.1, 91%) as semisolid.

Catalysis of $AuCl_3$–*t*BuCN system:

To a solution of donor **4** (50 mg, 36.2 μmol) and 4 Å molecular sieves in solvent of DCM/*t*BuCN (3.6 mL, v/v =5:1, 0.01M) was added acceptor **5** (19 mg, 43.4 μmol) at room temperature. After the reaction mixture cooling down to –50 ℃, gold(III) chloride (1.1 mg, 3.62μmol) was added into the reaction. After the TLC analysis showed the reaction was complete (10 min), the reaction was quenched by addition of triethylamine and diluted with 50 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 3:1) on silica gel to afford compound **15β** (49.6 mg, 84%) as semisolid.

4. NMR Data for Synthetic Solasonine 1 or Saponin 2 and Natural Product

Table S3: Comparison of the ^{1}H NMR spectroscopic data (400 MHz, Pyridine-d_5) of the synthetic and authentic Solasonine **1**[1].

Position	Synthetic **1**	Authentic **1**	Position	Synthetic **1**	Authentic **1**
Gal			1	1.74, 1.01	1.72, 0.98
1′	4.89 (d, 7.8)	4.93	2	1.82, 2.08	1.85, 2.10
2′	3.94	3.97	3	3.93	3.97
3′	4.31	4.34	4	2.73, 2.79	2.74, 2.83
4′	4.87	4.90	6	5.28 (d, 5)	5.37
5′	3.99	4.12	7	1.51, 1.86	1.54, 1.90
6′	4.20, 4.31	4.24, 4.34	8	1.50	1.54
Rha			9	0.86	0.90
1″	6.25 (d, 1.4)	6.23	11	1.41, 1.40	1.45, 1.45
2″	4.90	4.90	12	1.07, 1.66	1.10, 1.70
3″	4.56(dd, 9.3, 3.4)	4.60	14	1.06	1.10
4″	4.31	4.34	15	1.50, 2.05	1.54, 2.10
5″	4.90	4.90	16	4.52	4.51
6″	1.66 (d, 6.1)	1.69	17	1.79	1.83
Glu			18	0.85	0.88
1‴	5.15 (d, 7.7)	5.15	19	1.01	1.06
2‴	4.66 (9.6, 7.8)	4.67	20	1.97	2.01
3‴	4.22	4.24	21	1.15	1.17
4‴	4.11	4.09	23	1.66	1.70
5‴	3.96	3.97	24	1.62	1.65
6‴	4.33, 4.44	4.34, 4.49	25	1.44	1.48
			26	2.79	2.83
			27	0.77 (d, 4.5)	0.81

Table S4: Comparison of the ^{13}C NMR spectroscopic data (150 MHz, Pyridine-d_5) of the synthetic and authentic Solasonine **1** [2].

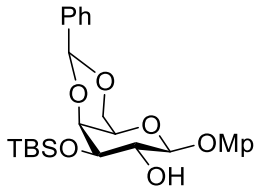
Position	Synthetic **1**	Authentic **1**	Position	Synthetic **1**	Authentic **1**
Gal			1	37.4	37.6
1′	100.3	100.4	2	30.0	30.2
2′	76.4	76.6	3	78.4	78.6
3′	84.7	84.8	4	38.7	38.8
4′	70.4	70.5	5	140.8	140.9
5′	75.0	75.2	6	121.7	121.8
6′	62.5	62.6	7	32.5	32.7
Rha			8	31.6	32.4
1″	102.2	102.3	9	50.2	50.3
2″	72.5	72.7	10	37.1	37.2
3″	72.8	72.9	11	21.0	21.2
4″	74.1	74.2	12	39.9	40.1
5″	69.4	69.5	13	40.6	40.7
6″	18.5	18.7	14	56.5	56.7
Glu			15	31.6	31.6
1‴	105.8	105.9	16	79.2	79.9
2‴	74.9	75.0	17	63.3	63.5
3‴	78.3	78.4	18	16.4	16.6
4‴	71.5	71.6	19	19.3	19.4
5‴	77.4	77.5	20	41.6	41.6
6‴	62.5	62.6	21	15.6	15.7
			22	98.3	98.4
			23	34.4	34.7
			24	31.2	31.1
			25	31.6	31.7
			26	47.7	48.1
			27	19.5	19.8

Table S5: Comparison of the ^{13}C NMR spectroscopic data (100 MHz, Pyridine-d_5) of the synthetic and authentic Saponin **2** [3].

Position	Synthetic **2**	Authentic **2**	Position	Synthetic **2**	Authentic **2**
Gal			1	37.3	37.4
1′	100.2	100.4	2	29.8	29.9
2′	76.3	76.5	3	78.2	78.3
3′	84.7	84.8	4	38.6	38.7
4′	70.2	70.8	5	140.7	140.8
5′	75.1	74.9	6	121.6	121.7
6′	62.3	62.5	7	32.1	32.2
Rha			8	31.5	31.6
1″	101.9	102.2	9	50.1	50.2
2″	72.4	72.5	10	37.0	37.1
3″	72.7	72.8	11	20.9	21.0
4″	73.8	74.1	12	39.7	39.8
5″	69.2	69.4	13	40.3	40.8
6″	18.4	18.6	14	56.5	56.6
Glu			15	32.1	32.3
1‴	105.7	105.9	16	81.0	81.8
2‴	74.8	75.0	17	62.7	62.9
3‴	78.2	78.3	18	16.2	16.3
4‴	71.6	71.6	19	19.2	19.4
5‴	78.2	78.5	20	41.8	41.9
6‴	62.7	62.6	21	14.9	15.0
			22	109.1	109.2
			23	30.0	30.1
			24	29.8	29.9
			25	30.4	30.6
			26	66.7	66.8
			27	17.2	17.3

5. Total Synthesis of Solasonine 1 and Saponin 2.

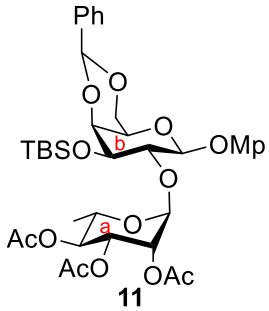
4-Methoxylphenyl 4,6-*O*-benzylidene-3-*O*-*tert*-butyldimethylsilyl-β-D-galactopyranoside (10)



10

To a solution of **9** (2 g, 5.3 mmol) in DMF (18 mL) was added 2,6-lutidine (1.9 mL, 15.9 mmol) at room temperature under Ar atmosphere. After being stirred for 20min at –50 ℃, TBSOTf (2.4 mL, 10.6 mmol) was added to the solution. After the TLC analysis showed the reaction was complete (25 min), the reaction was quenched with sat. $NaHCO_3$ (aq.). and diluted with 200 mL of DCM. The organic layer was washed with $NaHCO_3$ (aq.) and brine, dried over Na_2SO_4, filtered, and concentrated. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 6:1) on silica gel to afford compound **10** (2.3 g, 88%) as white solid. Proton NMR was consistent with literature data[4].

4-Methoxylphenyl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-4,6-*O*-benzylidene-3-*O*-*tert*-butyldimethylsilyl-β-D-galactopyranoside (11)

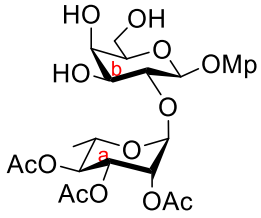


11

To a solution of glycosyl donor **8** (3.8 g, 8.8 mmol), glycosyl acceptor **10** (3.9 g, 8.0 mmol) and 4 Å molecular sieves in anhydrous DCM (80 mL) at 0 ℃ under argon atmosphere was added TMSOTf (163 μL, 0.9 mmol). The reaction was further stirred at this temperature for 10 min. After the TLC analysis showed the reaction was complete, the reaction was quenched by addition of triethylamine and diluted with 150 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The organic

layer was washed with $NaHCO_3$ (aq.) and brine, dried over Na_2SO_4, filtered, and concentrated. The residue was purified by column chromatography (DCM/MeOH = 20:1) on silica gel to afford compound **11** (5.7 g, 95%) as white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (dd, *J* = 7.5, 2.2 Hz, 2H, Ar*H*), 7.39 – 7.33 (m, 3H, Ar*H*), 7.02 – 6.98 (m, 2H, Ar*H*), 6.84 – 6.80 (m, 2H, Ar*H*), 5.50 (s, 1H, PhC*H*), 5.39 (dd, *J* = 3.4, 1.7 Hz, 1H, 2a-H), 5.27 (d, *J* = 1.6 Hz, 1H, 1b-H), 5.21 (dd, *J* = 10.1, 3.5 Hz, 1H, 3a-H), 5.05 (t, *J* = 10.1 Hz, 1H, 4a-H), 4.90 (d, *J* = 7.9 Hz, 1H, 1a-H), 4.46 – 4.38 (m, 1H, 5a-H), 4.34 (dd, *J* = 12.3, 1.4 Hz, 1H, 6b-H), 4.24 (dd, *J* = 9.4, 7.9 Hz, 1H, 2b-H), 4.07 (td, *J* = 5.3, 4.7, 1.8 Hz, 2H, 6b-H, 4b-H), 3.96 (dd, *J* = 9.4, 3.6 Hz, 1H, 3b-H), 3.78 (s, 3H, OC*H*$_3$), 3.50 (s, 1H, 5b-H), 2.11 (s, 3H, COC*H*$_3$), 2.00 (s, 3H, COC*H*$_3$), 1.96 (s, 3H, COC*H*$_3$), 1.20 (d, *J* = 6.3 Hz, 3H, 6a-C*H*$_3$), 0.86 (s, 9H, *tert-Butyl*), 0.11 (d, *J* = 7.2 Hz, 6H, Si*Me*). ^{13}C NMR (100 MHz, $CDCl_3$) δ 175.0, 174.8, 174.6, 160.1, 156.0, 142.5, 133.6, 132.8, 130.9, 123.3, 119.3, 105.5, 105.2, 103.1, 103.0, 81.1, 79.9, 79.0, 75.7, 74.4, 74.1, 73.9, 71.3, 71.2, 60.4, 30.4, 25.8, 25.84, 25.62, 22.8, 22.0, 0.7. HRMS (ESI) Calcd for $C_{38}H_{52}NaO_{14}Si^+$ $[M+Na]^+$: 783.3019, found: 783.3049.

4-Methoxylphenyl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-β-D-galactopyranoside (12)

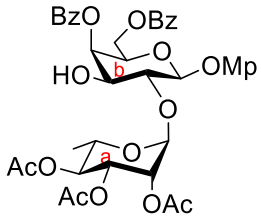


12

To a solution of **11** (11 g, 14.5mmol) in TBAF (72.5 mL of 1 M solution in THF, 72.5mmol) was stirred at rt for 1 h, After the TLC analysis showed the reaction was complete. The solution was diluted with ethyl acetate and washed with NH_4Cl (aq.) and brine, dried over Na_2SO_4, filtered, and concentrated. The resulting residue was dissolved in 200 mL 80% AcOH, the mixture was stirred for 1 h at 90 °C. After the TLC analysis showed the reaction was complete, and then cooled, and concentrated. The residue was purified by column chromatography (EtOAc/CH_3OH = 10:1) on silica gel to afford compound **12** (7.2 g, 89%) as white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ

7.01 – 6.95 (m, 2H, Ar*H*), 6.87 – 6.80 (m, 2H, Ar*H*), 5.37 (dd, *J* = 3.4, 1.8 Hz, 1H, 2a-H), 5.32 (d, *J* = 1.8 Hz, 1H, 1a-H), 5.22 (dd, *J* = 10.2, 3.4 Hz, 1H, 3a-H), 5.08 (t, *J* = 10.0 Hz, 1H, 4a-H), 4.87 (d, *J* = 7.7 Hz, 1H, 1b-H), 4.27 (dt, *J* = 9.8, 6.2 Hz, 1H, 5a-H), 4.04 – 3.80 (m, 4H, 2b-H, 3b-H, 6b-H), 3.78 (s, 3H, OC*H*$_3$), 3.60 (t, *J* = 5.3 Hz, 1H, 5b-H), 3.52 – 3.42 (m, 2H, 4b-H), 2.66 (s, 1H), 2.14 (s, 3H, COC*H*$_3$), 2.02 (s, 3H, COC*H*$_3$), 1.98 (s, 3H, COC*H*$_3$), 1.21 (d, *J* = 6.2 Hz, 3H, 6a-C*H*$_3$). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 170.5, 170.0, 155.2, 151.0, 117.7, 114.6, 100.3, 98.0, 76.1, 74.3, 70.9, 69.7, 69.5, 69.3, 66.5, 61.3, 55.6, 20.8, 20.73, 20.70, 17.3. HRMS (ESI) Calcd for $C_{25}H_{34}NaO_{14}^+$ $[M+Na]^+$: 581.1841, found: 581.1893.

4-Methoxylphenyl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-4,6-di-*O*-benzoyl-β-D-galactopyranoside (7)

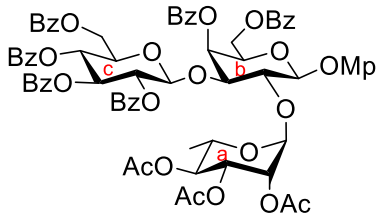


7

To a solution of **12** (7.1 g, 12.7 mmol) and 4 Å molecular sieves in 255 mL mixture of DCM/DMF = 3:1 was added benzoyl cyanide (3.7 g, 27.9 mmol) at room temperature under argon atmosphere. After cooling down the reaction mixture to -78 ^{o}C, DMAP (379 mg, 3.1 mmol) was added. The reaction was further stirred for 5 h at this temperature. After the TLC analysis showed the reaction was complete, the reaction was quenched by addition of NH_4Cl (s) and MeOH. Then the mixture was filtered through a pad of Celite and the Celite was further washed with DCM for 3 times. Then the organic layer was concentrated. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 1:3) on silica gel to afford compound **7** (7.8 g, 80 %) as white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 – 8.08 (m, 2H, Ar*H*), 8.05 – 8.00 (m, 2H, Ar*H*), 7.59 – 7.53 (m, 2H, Ar*H*), 7.43 (td, *J* = 7.7, 1.4 Hz, 4H, Ar*H*), 7.06 – 7.01 (m, 2H, Ar*H*), 6.75 – 6.69 (m, 2H, Ar*H*), 5.66 – 5.63 (m, 1H, 4b-H), 5.39 (dd, *J* = 3.5, 1.8 Hz, 1H, 2a-H), 5.32 (d, *J* = 1.8 Hz, 1H, 1a-H), 5.24 (dd, *J* = 10.1, 3.4 Hz, 1H, 3a-H), 5.10 (t, *J* = 10.0 Hz, 1H, 4a-H), 4.99 (d, *J* = 6.8 Hz, 1H, 1b-H), 4.54 –

4.44 (m, 2H, 6b-H), 4.40 (dt, *J* = 9.9, 6.2 Hz, 1H, 5a-H), 4.22 – 4.11 (m, 3H, 2b-H, 3b-H, 5b-H), 3.74 (s, 3H, OC*H*$_3$), 2.06 (s, 3H, COC*H*$_3$), 2.03 (s, 3H, COC*H*$_3$), 1.96 (s, 3H, COC*H*$_3$), 1.29 (d, *J* = 6.2 Hz, 3H, 6a-C*H*$_3$). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 170.2, 170.0, 166.8, 166.0, 155.4, 151.1, 130.1, 129.8, 128.5, 128.4, 118.1, 114.6, 100.5, 98.3, 75.9, 73.6, 71.5, 71.0, 70.9, 69.6, 69.4, 66.6, 62.7, 55.6, 20.84, 20.82, 20.75, 17.4. HRMS (ESI) Calcd for $C_{39}H_{42}NaO_{16}^+$ $[M+Na]^+$: 789.2366, found: 789.2395.

4-Methoxylphenyl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-3-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-glucopyranosyl)-4,6-di-*O*-benzoyl-β-D-galactopyranoside (13β)

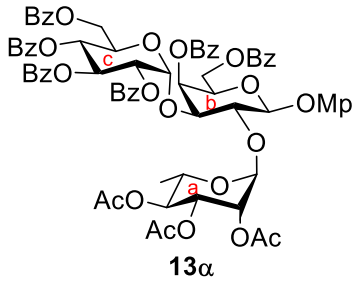


13β

To a solution of glycosyl donor **6** (384 mg, 519 μmol), glycosyl acceptor **7** (766 mg, 415 μmol) and 5 Å molecular sieves in anhydrous DCM (2.6 mL) at 0 °C under argon atmosphere was added TMSOTf (9.4 μL, 51.9 μmol). The reaction was further stirred at this temperature for 40 min. After the TLC analysis showed the reaction was complete, the reaction was quenched by addition of triethylamine and diluted with 100 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The organic layer was washed with $NaHCO_3$ (aq.) and brine, dried over Na_2SO_4, filtered, and concentrated. The residue was purified by column chromatography (petroleum ether/DCM/ethyl acetate = 6:6:1) on silica gel to afford compound **13β** (500 mg, 93%) as white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (dd, *J* = 14.9, 8.0 Hz, 6H, Ar*H*), 7.92 (d, *J* = 7.8 Hz, 2H, Ar*H*), 7.75 (d, *J* = 7.8 Hz, 2H Ar*H*), 7.67 – 7.18 (m, 18H Ar*H*), 6.99 – 6.91 (m, 2H Ar*H*), 6.70 – 6.61 (m, 2H Ar*H*), 6.01 (t, *J* = 9.6 Hz, 1H, 3c-H), 5.75 – 5.63 (m, 2H, ,4b-H, 4c-H), 5.41 (dd, *J* = 9.9, 7.8 Hz, 1H, 2c-H), 5.38 – 5.35 (m, 1H, 2a-H), 5.31 (dd, *J* = 10.2, 3.5 Hz, 1H, 3a-H), 5.27 (d, *J* = 7.9 Hz, 1H, 1c-H), 5.24 (d, *J* = 1.8 Hz, 1H, 1a-H), 5.11 (t, *J* = 10.0 Hz, 1H, 4a-H), 4.75 (d, *J* = 7.3 Hz, 1H, 1b-H), 4.65 (dd, *J* = 12.2, 4.9 Hz, 1H, 6c-H), 4.56 (dd, *J* = 12.2, 3.2 Hz, 1H, 6c-H), 4.45 (qd,

J = 11.6, 6.2 Hz, 2H, 6b-H), 4.34 – 4.16 (m, 5H, 3b-H, 2b-H, 5c-H, 5b-H, 5a-H), 3.98 (dd, *J* = 8.0, 4.7 Hz, 1H), 3.71 (s, 3H, OCH_3), 2.14 (s, 3H, COCH_3), 2.09 (s, 3H, COCH_3), 2.05 (s, 2H, COCH_3), 1.13 (d, *J* = 6.2 Hz, 3H, 6a-CH_3). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 170.1, 170.0, 166.0, 165.9, 165.7, 165.5, 165.1, 164.7, 155.4, 151.0, 118.1, 114.4, 100.6, 99.4, 97.8, 75.5, 72.54, 72.51, 71.8, 70.9, 70.0, 69.9, 69.8, 69.0, 67.0, 62.9, 62.7, 55.6, 20.9, 17.3. HRMS (ESI) Calcd for $C_{73}H_{68}NaO_{25}^+$ $[M+Na]^+$: 1367.3942, found: 1367.3985.

4-Methoxylphenyl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-3-*O*-(2,3,4,6-tetra-*O*-benzoyl-α-D-glucopyranosyl)-4,6-di-*O*-benzoyl-β-D-galactopyranoside (13α)

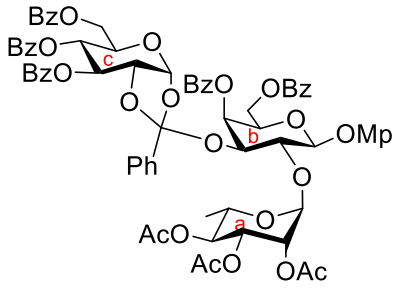


13α

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 – 8.11 (m, 2H, Ar*H*), 8.09 – 8.04 (m, 2H, Ar*H*), 8.05 – 7.98 (m, 2H, Ar*H*), 7.78 – 7.72 (m, 2H, Ar*H*), 7.70 – 7.63 (m, 2H, Ar*H*), 7.63 – 7.52 (m, 3H, Ar*H*), 7.47 (t, *J* = 7.6 Hz, 4H, Ar*H*), 7.41 – 7.24 (m, 8H, Ar*H*), 7.21 (t, *J* = 7.6 Hz, 2H, Ar*H*), 7.05 (td, *J* = 7.7, 4.3 Hz, 4H, Ar*H*), 7.01 – 6.93 (m, 2H, Ar*H*), 6.75 – 6.67 (m, 2H, Ar*H*), 5.90 (t, *J* = 10.0 Hz, 1H, 3c-H), 5.83 (d, *J* = 2.8 Hz, 1H, 4b-H), 5.76 (d, *J* = 4.3 Hz, 1H, 1c-H), 5.66 – 5.57 (m, 2H, 2c-H, 4c-H), 5.52 (d, *J* = 1.7 Hz, 1H, 1a-H), 5.38 - 5.41 (m, 2H, 2a-H, 3a-H), 5.21 (t, *J* = 10.0 Hz, 1H, 4a-H), 4.70 – 4.57 (m, 3H, 6a-H, 5a-H), 4.55 (d, *J* = 7.7 Hz, 1H, 1b-H), 4.50 – 4.25 (m, 4H, 2b-H, 5b-H, 6b-H), 4.16 (dd, *J* = 9.8, 2.9 Hz, 1H, 3b-H), 3.76 (m, 4H, OCH_3), 2.22 (s, 3H, COCH_3), 2.05 (s, 3H, COCH_3), 1.88 (s, 3H, COCH_3), 1.29 (d, *J* = 6.3 Hz, 3H, 6a-CH_3). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.00, 169.96, 169.8, 165.8, 165.25, 165.23, 165.0, 155.5, 150.9, 133.3, 133.1, 132.9, 132.8, 130.4, 129.94, 129.88, 129.83, 129.79, 129.7, 129.5, 129.1, 128.8, 128.51, 128.48, 128.4, 128.2, 128.1, 128.0, 118.4, 114.5, 100.7, 98.7, 91.5, 75.1, 73.0, 71.6, 71.2, 71.0, 70.2, 69.43, 69.38, 69.3, 69.0, 66.9, 64.7, 62.8, 62.4, 55.6, 20.9,

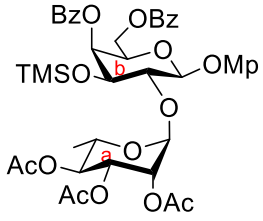
20.7, 17.4. HRMS (ESI) Calcd for $C_{73}H_{68}NaO_{25}^+$ [M+Na]$^+$: 1367.3942, found: 1367.3934.

Orthoester 14



14

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (ddd, *J* = 8.6, 4.8, 1.3 Hz, 4H, Ar*H*), 7.95 (td, *J* = 7.5, 7.0, 1.4 Hz, 4H, Ar*H*), 7.84 – 7.80 (m, 2H, Ar*H*), 7.69 – 7.36 (m, 10H, Ar*H*), 7.34 – 7.23 (m, 5H, Ar*H*), 6.94 – 6.88 (m, 2H, Ar*H*), 6.59 – 6.53 (m, 2H, Ar*H*), 5.86 (d, *J* = 4.9 Hz, 1H, 1c-H), 5.79 (d, *J* = 3.2 Hz, 1H, 4b-H), 5.54 (dd, *J* = 3.3, 1.4 Hz, 1H, 3c-H), 5.38 (t, *J* = 2.2 Hz, 1H, 3a-H), 5.33 – 5.28 (m, 2H, 1a-H, 2a-H), 5.15 – 5.07 (m, 2H, 4c-H, 4a-H), 4.82 (d, *J* = 7.8 Hz, 1H, 1b-H), 4.60 (dd, *J* = 11.8, 3.6 Hz, 1H, 6c-H), 4.53 – 4.45 (m, 2H, 2c-H, 5a-H), 4.42 – 4.21 (m, 4H, 2b-H, 6b-H, 5c-H), 4.08 (dd, *J* = 9.0, 3.6 Hz, 1H, 6c-H), 3.90 (dd, *J* = 9.6, 3.2 Hz, 1H, 3b-H), 3.81 (t, *J* = 3.0 Hz, 1H, 5b-H), 3.67 (s, 3H, OC*H*$_3$), 2.15 (s, 3H, COC*H*$_3$), 2.02 (s, 3H, COC*H*$_3$), 1.94 (s, 3H, COC*H*$_3$), 1.28 (d, *J* = 6.5 Hz, 3H, 6a-C*H*$_3$). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.0, 169.9, 166.1, 166.0, 165.9, 165.0, 164.3, 155.3, 150.9, 134.6, 133.6, 133.5, 133.4, 133.2, 133.0, 130.3, 130.0, 129.9, 129.85, 129.78, 129.74, 129.71, 129.02, 128.99, 128.9, 128.7, 128.5, 128.4, 128.4, 128.2, 126.1, 122.4, 118.1, 114.4, 100.4, 98.1, 97.6, 75.4, 72.8, 72.3, 72.0, 71.1, 70.5, 69.4, 69.3, 68.7, 68.1, 66.6, 64.0, 63.3, 55.5, 20.9, 20.8, 20.7, 17.4. HRMS (ESI) Calcd for $C_{73}H_{68}NaO_{25}^+$ [M+Na]$^+$: 1367.3942, found: 1367.3937.

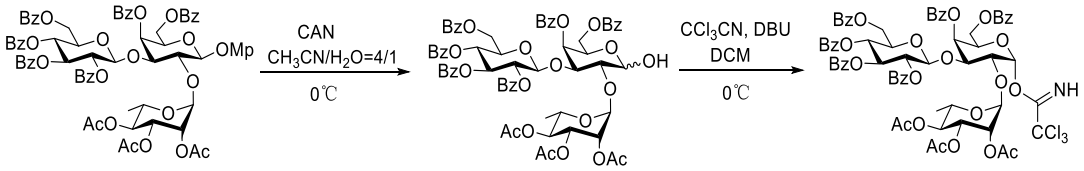


18

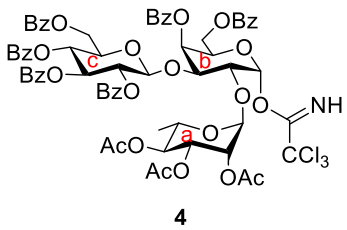
4-Methoxylphenyl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-3-*O*-

trimethylsilyl-4,6-di-*O*-benzoyl-β-D-galactopyranoside (18)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.13 – 8.09 (m, 2H, Ar*H*), 8.05 – 8.01 (m, 2H, Ar*H*), 7.62 – 7.56 (m, 2H, Ar*H*), 7.49 – 7.43 (m, 4H, Ar*H*), 7.01 – 6.97 (m, 2H, Ar*H*), 6.69 – 6.65 (m, 2H, Ar*H*), 5.56 (dd, *J* = 3.6, 1.1 Hz, 1H, 4b-H), 5.35 (dd, *J* = 3.4, 1.8 Hz, 1H, 2a-H), 5.25 (dd, *J* = 10.2, 3.4 Hz, 1H, 3a-H), 5.22 (d, *J* = 1.7 Hz, 1H, 1a-H), 5.10 (t, *J* = 10.0 Hz, 1H, 4a-H), 4.96 (d, *J* = 7.8 Hz, 1H, 1b-H), 4.53 – 4.43 (m, 3H, 5a-H, 6b-H), 4.22 – 4.16 (m, 2H, 2b-H, 5b-H), 4.07 (dd, *J* = 9.3, 3.5 Hz, 1H, 3b-H), 3.72 (s, 3H, OC*H*$_3$), 2.11 (s, 3H, COC*H*$_3$), 2.03 (s, 3H, COC*H*$_3$), 1.97 (s, 3H, COC*H*$_3$), 1.29 (d, *J* = 6.2 Hz, 3H, 6a-C*H*$_3$), 0.12 (s, 9H, Si*Me* (x3)). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.10, 170.07, 170.0, 169.7, 166.0, 165.9, 155.3, 151.0, 133.4, 133.2, 130.0, 129.8, 129.6, 129.3, 128.5, 128.4, 118.0, 114.5, 100.3, 98.2, 75.1, 74.1, 71.6, 71.0, 70.7, 69.4, 69.3, 66.5, 62.9, 55.6, 20.81, 20.76, 20.7, 17.4, -0.2. HRMS (ESI) Calcd for $C_{42}H_{54}NO_{16}Si^+$ $[M+NH_4]^+$: 856.3207, found: 856.3225; $C_{42}H_{50}NaO_{16}Si^+$ $[M+Na]^+$: 861.2761, found: 861.2767.



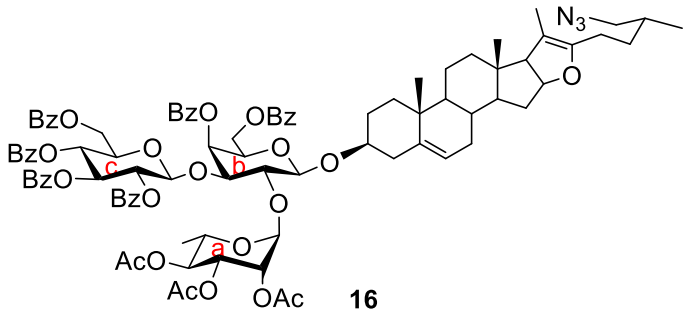
2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-3-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-glucopyranosyl)-4,6-di-*O*-benzoyl-α-D-galactopyranosyl trichloroaetimidate (4)



To a solution of **13** (1.1 g, 0.8 mmol) in solvent of CH_3CN/H_2O (80 mL, v/v = 4:1), CAN (2.2 g, 4.1 mmol) was added. The mixture was stirred for 15 min at 0 °C. After the TLC analysis showed the reaction was complete, the solution was diluted with ethyl acetate and washed with $NaHCO_3$ (aq.) and brine, dried over Na_2SO_4, filtered, and

concentrated. Then the organic layer was concentrated. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 1:1) on silica gel to afford compound **S1** (890 mg, 89 %) as white solid. Compound **S1** (1.6 g, 1.3 mmol) was dissolved in anhydrous DCM, and trichloroacetonitrile (391 μL, 3.9 mmol) and DBU (39 μL, 260 μmol) were added in sequence at 0 °C. The reaction was further stirred for 5 h at this temperature. After the TLC analysis showed the reaction was complete, the reaction was concentrated and purified by column chromatography (petroleum ether/ethyl acetate = 1:1) on silica gel to afford compound **4** (1.4 g, 78 %) as white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (s, 1H, N*H*CCl_3), 8.05 – 7.93 (m, 6H, Ar*H*), 7.94 – 7.88 (m, 2H, Ar*H*), 7.76 – 7.71 (m, 2H Ar*H*), 7.56 – 7.29 (m, 11H Ar*H*), 7.21 (td, *J* = 7.8, 2.0 Hz, 4H Ar*H*), 6.51 (d, *J* = 3.7 Hz, 1H, 1b-H), 6.03 – 5.95 (m, 2H, 4b-H, 3c-H), 5.70 (t, *J* = 9.7 Hz, 1H, 4c-H), 5.47 – 5.43 (t, 1H, 2c-H), 5.39 – 5.34 (m, 2H, 1c-H, 2a-H), 5.23 (dd, *J* = 10.2, 3.1 Hz, 1H, 3a-H), 5.07 (t, *J* = 10.0 Hz, 1H, 4a-H), 4.88 (d, *J* = 1.8 Hz, 1H, 1a-H), 4.63 – 4.52 (m, 4H, 5c-H, 3b-H, 6c-H), 4.47 – 4.33 (m, 3H, 5b-H, 6b-H), 4.26 (dd, *J* = 9.9, 3.7 Hz, 1H, 2b-H), 3.96 – 3.87 (m, 1H, 5a-H), 2.12 (s, 3H, COC*H*$_3$), 2.06 (s, 3H, COC*H*$_3$), 2.02 (s, 3H, COC*H*$_3$), 1.15 (d, *J* = 6.3 Hz, 3H, 6a-C*H*$_3$). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 169.8, 169.5, 166.2, 166.0, 165.9, 165.4, 165.3, 165.1, 164.6, 160.8, 133.3, 133.2, 133.13, 133.07, 133.03, 132.96, 132.9, 129.93, 129.86, 129.8, 129.73, 129.66, 129.64, 129.58, 129.5, 129.1, 129.04, 129.03, 128.3, 128.15, 128.10, 99.8, 95.0, 90.8, 72.7, 72.4, 72.3, 71.7, 70.5, 70.1, 69.9, 69.6, 69.4, 69.1, 67.7, 63.0, 62.7, 60.3, 21.0, 20.93, 20.85, 20.82, 20.77, 17.4. HRMS (ESI) Calcd for $C_{68}H_{62}Cl_3NNaO_{24}^+$ $[M+Na]^+$: 1404.2620, found: 1404.2660.

26-azido-pseudodiosgen-3-yl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-3-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-glucopyranosyl)-4,6-di-*O*-benzoyl-β-D-galactopyranoside (16)

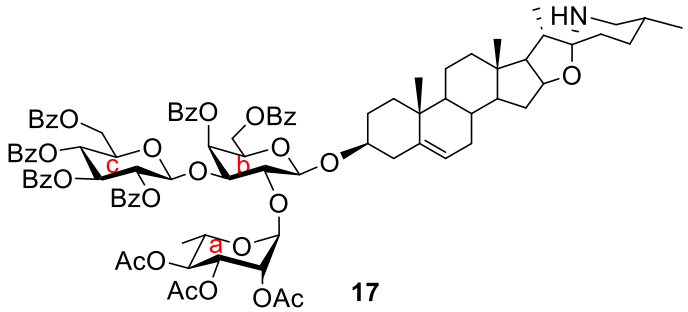


16

To a solution of donor **4** (50 mg, 36.2 μmol) and 4 Å molecular sieves in a mixed solvent of DCM/tBuCN (724 μL, v/v = 5:1, 0.05 M) was added acceptor **3** (19 mg, 43.4 μmol) at room temperature. After the reaction mixture cooling down to –50 °C, gold(III) chloride (1.1 mg, 3.62μmol) was added into the reaction. After the TLC analysis showed the reaction was complete (10 min), the reaction was quenched by addition of triethylamine and diluted with 50 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 1:1) on silica gel to afford compound **16** (48 mg, 81%) as semisolid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 – 7.95 (m, 7H, Ar*H*), 7.93 – 7.86 (m, 2H, Ar*H*), 7.77 – 7.70 (m, 2H, Ar*H*), 7.64 – 7.58 (m, 2H, Ar*H*), 7.58 – 7.18 (m, 19H, Ar*H*), 5.96 (t, *J* = 9.6 Hz, 1H, 3c-H), 5.70 – 5.60 (m, 2H, 4c-H, 4b-H), 5.40 – 5.25 (m, 4H, 3a-H, 2a-H, 2c-H, 5b-H), 5.21 – 5.14 (m, 2H, 1a-H, 1c-H), 5.08 (t, *J* = 9.9 Hz, 1H, 4a-H), 4.75 (ddd, *J* = 10.1, 7.8, 5.7 Hz, 1H, 6c-H), 4.60 (dd, *J* = 12.2, 4.7 Hz, 1H, 6c-H), 4.54 – 4.47 (m, 1H, 6b-H), 4.47 – 4.31 (m, 3H, 5a-H, 6b-H, 1b-H), 4.19 (ddd, *J* = 21.5, 8.8, 3.7 Hz, 2H, 5c-H, 3b-H), 3.98 (dd, *J* = 9.4, 7.8 Hz, 1H, 2b-H), 3.87 (dd, *J* = 7.9, 5.3 Hz, 1H, 5b-H), 3.52 (tt, *J* = 11.1, 4.6 Hz, 1H), 3.23 (dd, *J* = 12.0, 5.6 Hz, 1H), 3.10 (dd, *J* = 12.0, 7.0 Hz, 1H), 2.48 (d, *J* = 10.1 Hz, 1H), 2.45 – 2.37 (m, 1H), 2.25 (dd, *J* = 28.1, 13.9 Hz, 1H), 2.13 (s, 3H, COCH_3), 2.04 (s, *3*H, COCH_3), 2.05 (s, *3*H, COCH_3),1.92 – 1.68 (m, 2H), 1.60 (d, *J* = 7.0 Hz, 5H), 1.51 – 1.38 (m, 2H), 1.36 – 1.21 (m, 5H), 1.15 (d, *J* = 6.2 Hz, 3H, 6a-CH_3), 0.97 (d, *J* = 6.7 Hz, 6H), 0.89 (q, *J* = 7.1, 5.5 Hz, 3H), 0.68 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 170.2, 170.0, 166.0, 165.98, 165.96, 165.5, 165.1, 164.7, 151.2, 140.3, 133.3, 133.1, 133.03, 133.00, 132.91, 132.88, 130.1, 130.0, 129.9, 129.88, 129.80, 129.77, 129.71, 129.68, 129.6, 129.1, 129.0, 128.9, 128.4, 128.34, 128.29, 128.2, 128.1, 121.8, 104.0, 100.0, 99.3, 97.2, 84.3, 79.7, 74.0,

72.5, 71.4, 71.1, 70.1, 69.9, 69.7, 69.0, 66.5, 64.2, 62.7, 57.6, 55.0, 50.0, 43.3, 39.5, 38.4, 37.0, 36.8, 34.1, 33.0, 32.2, 31.5, 31.2, 29.71, 29.65, 23.2, 20.95, 20.90, 20.86, 19.3, 17.6, 17.3, 14.0, 11.7. HRMS (ESI) Calcd for $C_{93}H_{102}N_3O_{25}^+$ $[M+H]^+$: 1661.6831, found: 1661.6881.

Solasodin-3-yl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-3-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-glucopyranosyl)-4,6-di-*O*-benzoyl-β-D-galactopyranoside (17)

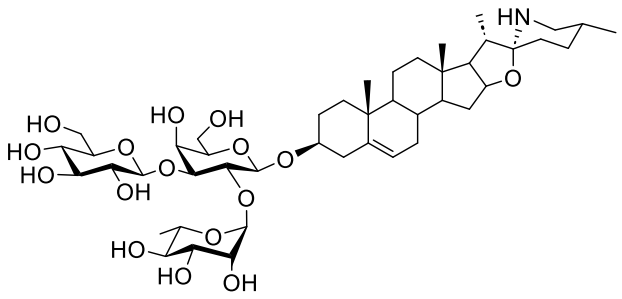


17

To a solution of **16** (110 mg, 66.3 μmol) in anhydrous CH_3CN (3 mL) was added NaI (20 mg, 133 μmol) was added. After the mixture was stirred for 30 min at rt, a solution of TMSCl (18 μL, 142.5 μmol) in anhydrous CH_3CN (150 μL) was added dropwise. After the TLC analysis showed the reaction was complete (30min), the reaction was quenched with 10% $Na_2S_2O_3$ solution, and 5% NaOH was added to adjust the pH value of the solution to 10. The mixture was stirred at rt for 1h. The solution was diluted with DCM and washed with brine, dried over Na_2SO_4, filtered, and concentrated. The residue was purified by column chromatography (petroleum ether/ethyl acetate/Et_3N = 1:2:0.03) on silica gel to afford compound **17** (90.4 mg, 84 %) as white foam. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 – 7.94 (m, 6H, Ar*H*), 7.90 (d, *J* = 7.8 Hz, 2H, Ar*H*), 7.73 (d, *J* = 7.8 Hz, 2H, Ar*H*), 7.61 (d, *J* = 7.7 Hz, 2H, Ar*H*), 7.58 – 7.25 (m, 17H, Ar*H*), 7.21 (t, *J* = 7.7 Hz, 2H, Ar*H*), 5.96 (t, *J* = 9.6 Hz, 1H, 3c-H), 5.68 – 5.61 (m, 2H, 4c-H, 4b-H), 5.38 – 5.27 (m, 4H, 3a-H, 2a-H, 2c-H, 5b-H), 5.21 – 5.15 (m, 2H, 1a-H, 1c-H), 5.08 (t, *J* = 9.8 Hz, 1H, 4a-H), 4.61 (dd, *J* = 12.2, 4.8 Hz, 1H, 6c-H), 4.55 – 4.25 (m, 5H, 6c-H, 6b-H, 5a-H, 6b-H, 1b-H), 4.25 – 4.14 (m, 2H, 5c-H, 3b-H), 3.98 (t, *J* = 8.6 Hz, 1H, 2b-H), 3.86 (dd, *J* = 7.7, 5.3 Hz, 1H, 5b-H), 3.51 (tt, *J* = 10.8, 4.6 Hz, 1H), 2.71 – 2.56 (m, 2H), 2.44 – 2.37 (m, 1H), 2.27 (t, *J* = 12.2 Hz, 1H), 2.13 (s, 3H, COC*H*$_3$), 2.06 (s,

3H, COCH_3), 2.04 (s, 3H, COCH_3), 2.02 – 1.94 (m, 2H), 1.89 (q, J = 7.2 Hz, 2H), 1.82 – 1.39 (m, 11H), 1.32 – 1.22 (m, 3H), 1.15 (d, J = 6.2 Hz, 3H, 6a-CH_3), 0.96 (d, J = 6.7 Hz, 5H), 0.85 (d, J = 6.2 Hz, 3H), 0.81 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.2, 170.1, 169.9, 166.0, 165.9, 165.5, 165.1, 164.6, 140.3, 133.3, 133.0, 132.8, 130.1, 129.9, 129.8, 129.7, 129.6, 129.2, 129.0, 128.9, 128.38, 128.36, 128.3, 128.13, 128.07, 121.8, 100.1, 99.4, 98.3, 97.2, 79.7, 74.1, 72.6, 71.4, 71.2, 70.2, 69.9, 69.8, 69.0, 66.5, 62.8, 62.7, 60.4, 56.5, 50.1, 47.7, 41.3, 40.5, 39.9, 38.4, 37.0, 36.8, 34.1, 32.2, 31.4, 30.3, 29.7, 20.9, 20.8, 19.3, 19.2, 17.3, 16.4, 15.3, 14.2. HRMS (ESI) Calcd for $C_{93}H_{104}NO_{25}^+$ $[M+H]^+$: 1635.6926, found: 1635.6963.

Solasonine 1

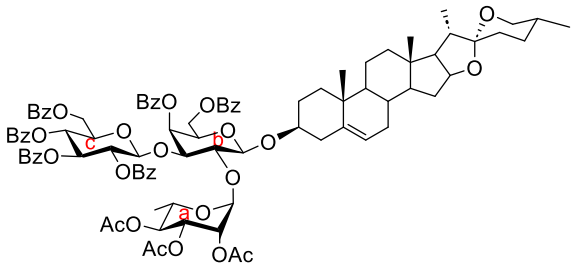


1

To a solution of **17** (130mg, 79.5 μ mol) in a mixed solvent of DCM/MeOH (4.5 mL, v/v =1:4) was added 1M NaOH to adjust the pH value of the solution to 12. The mixture was stirred for 4 h at 70 ℃. After the TLC analysis showed the reaction was complete. The mixture was concentrated and the residue was purified by column chromatography (DCM/MeOH containing 8% H_2O/Et_3N = 3:1:0.01) on silica gel to afford compound **1** (64 mg, 91 %) as white solid[1, 2]. ^{1}H NMR (400 MHz, Pyridine-d_5) δ 6.25 (d, J = 1.4 Hz, 1H), 5.28 (d, J = 5.0 Hz, 1H), 5.15 (d, J = 7.7 Hz, 1H), 4.89 (d, J = 7.8 Hz, 2H), 4.86 (dd, J = 3.2, 1.7 Hz, 1H), 4.77 (d, J = 3.1 Hz, 1H), 4.66 (dd, J = 9.6, 7.8 Hz, 1H), 4.56 (dd, J = 9.3, 3.4 Hz, 1H), 4.45 – 4.37 (m, 2H), 4.34 (dd, J = 11.2, 6.5 Hz, 1H), 4.30 – 4.23 (m, 3H), 4.20 (dd, J = 11.3, 5.1 Hz, 1H), 4.17 – 4.10 (m, 2H), 3.97 (t, J = 6.1 Hz, 1H), 3.90 (q, J = 7.3, 5.8 Hz, 3H), 2.80 – 2.66 (m, 4H), 2.12 – 1.97 (m, 2H), 1.92 (q, J = 9.2, 8.1 Hz, 1H), 1.88 – 1.78 (m, 1H), 1.78 – 1.13 (m, 17H), 1.11 – 0.97 (m, 8H), 0.96 – 0.80 (m, 6H), 0.77 (d, J = 4.5 Hz, 3H). ^{13}C NMR (150 MHz, Pyridine-d_5) δ 140.8,

121.6, 105.8, 102.2, 100.3, 98.3, 84.7, 79.2, 78.4, 78.3, 77.4, 76.4, 75.0, 74.9, 74.1, 72.8, 72.5, 71.5, 70.4, 69.4, 63.3, 62.52, 62.47, 56.5, 50.2, 47.7, 41.6, 40.6, 39.9, 38.7, 37.4, 37.1, 34.4, 32.5, 32.2, 31.6, 31.2, 30.7, 30.0, 21.0, 19.5, 19.3, 18.5, 16.4, 15.6.

Diosgenyl 2-*O*-(2,3,4-tri-*O*-acetyl-α-L-rhamnopyranosyl)-3-*O*-(2,3,4,6-tetra-*O*-benzoyl-β-D-glucopyranosyl)-4,6-di-*O*-benzoyl-β-D-galactopyranoside (15)

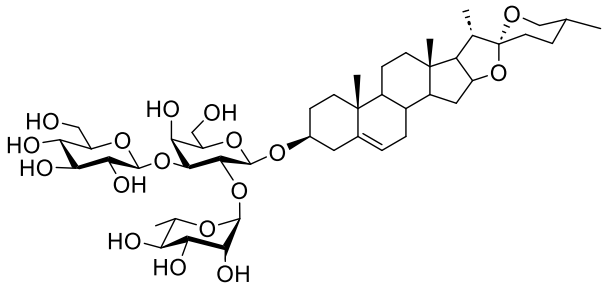


15

To a solution of donor **4** (50 mg, 36.2 μmol) and 4 Å molecular sieves in solvent of DCM/*t*BuCN (3.6 mL, v/v =5:1, 0.01 M) was added acceptor **5** (19 mg, 43.4 μmol) at room temperature. After the reaction mixture cooling down to –50 ℃, gold(III) chloride (1.1 mg, 3.62μmol) was added into the reaction. After the TLC analysis showed the reaction was complete (10 min), the reaction was quenched by addition of triethylamine and diluted with 50 mL of DCM. Then the precipitate was filtered off through a pad of Celite. The residue was purified by column chromatography (petroleum ether/ethyl acetate = 3:1) on silica gel to afford compound **15** (49.6 mg, 84%) as semisolid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 – 7.95 (m, 6H, Ar*H*), 7.90 (d, *J* = 7.9 Hz, 2H, Ar*H*), 7.73 (d, *J* = 7.7 Hz, 2H, Ar*H*), 7.61 (d, *J* = 7.7 Hz, 2H, Ar*H*), 7.56 – 7.18 (m, 15H, Ar*H*), 5.96 (t, *J* = 9.6 Hz, 1H, 3c-H), 5.70 – 5.62 (m, 2H, 4c-H, 4b-H), 5.40 – 5.27 (m, 5H, 2c-H, 2a-H, 3a-H), 5.22 – 5.15 (m, 2H, 1c-H, 1a-H), 5.08 (t, *J* = 9.7 Hz, 1H, 4a-H), 4.61 (dd, *J* = 12.2, 4.8 Hz, 1H, 6c-H), 4.54 – 4.30 (m, 6H, 6c'-H, 5a-H, 1b-H, 5b-H, 6b-H, 6b'-H), 4.25 – 4.09 (m, 2H, 5c-H), 3.98 (t, *J* = 8.6 Hz, 1H, 3b-H), 3.86 (dd, *J* = 7.8, 5.2 Hz, 1H, 2b-H), 3.50 (ddd, *J* = 15.6, 10.8, 5.5 Hz, 2H), 3.38 (t, *J* = 10.9 Hz, 1H), 2.46 – 2.38 (m, 1H), 2.32 – 2.23 (m, 1H), 2.13 (s, 3H, COCH_3), 2.05 (d, *J* = 5.8 Hz, 6H, COCH_3), 2.03 – 1.93 (m, 1H), 1.92 – 1.70 (m, 4H), 1.69 – 1.60 (m, 6H), 1.55 – 1.36 (m, 3H), 1.35 – 1.22 (m, 4H), 1.15 (d, *J* = 6.2 Hz, 3H, 6a-CH_3), 1.00 – 0.95 (m, 6H), 0.94 – 0.83 (m, 2H), 0.79 (d, *J* = 6.4 Hz, 6H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 169.2,

169.1, 169.0, 165.00, 164.98, 164.9, 164.5, 164.1, 163.6, 139.3, 132.3, 132.02, 132.00, 131.97, 131.9, 131.8, 129.1, 128.9, 128.8, 128.74, 128.69, 128.65, 128.63, 128.56, 128.1, 127.93, 127.87, 127.4, 127.3, 127.13, 127.08, 120.8, 108.3, 99.0, 98.3, 96.2, 79.8, 78.8, 76.5, 73.0, 71.5, 70.4, 70.1, 69.1, 68.9, 68.7, 68.0, 65.8, 65.5, 61.6, 61.1, 55.5, 49.0, 40.6, 39.2, 38.7, 37.4, 35.9, 35.8, 35.6, 31.1, 30.9, 30.8, 30.4, 29.3, 28.7, 28.6, 27.8, 19.9, 19.81, 19.78, 18.2, 16.3, 16.1, 15.3, 13.5. HRMS (ESI) Calcd for $C_{93}H_{103}O_{26}^+$ $[M+H]^+$: 1636.6766, found: 1636.6751; $C_{93}H_{102}NaO_{26}^+$ $[M+Na]^+$: 1658.6586, found: 1636.6586; $C_{93}H_{106}NO_{26}^+$ $[M+NH_4]^+$: 1653.7032, found: 1653.7023.

Saponin 2



2

To a solution of **15** (55.4mg, 33.9 μ mol) in a mixed solvent of DCM/MeOH (1.8 mL, v/v = 1:2) was added 1M NaOH to adjust the pH value of the solution to 9-10. The mixture was stirred for 6h at rt. After the TLC analysis showed the reaction was complete. The mixture was concentrated and the residue was purified by column chromatography (DCM/MeOH = 2:1) on silica gel to afford compound **2** (24.9 mg, 83%) as white solid[3, 5]. ^{1}H NMR (400 MHz, Pyridine-d_5) δ 6.27 (s, 1H), 5.32 (d, *J* = 5.1 Hz, 1H), 5.20 (d, *J* = 7.7 Hz, 1H), 5.05 – 4.77 (m, 4H), 4.72 – 4.52 (m, 3H), 4.47 (dd, *J* = 11.7, 2.4 Hz, 1H), 4.32 (tdd, *J* = 16.6, 11.1, 5.1 Hz, 6H), 4.20 (t, *J* = 9.1 Hz, 1H), 4.08 – 3.85 (m, 5H), 3.63 – 3.55 (m, 1H), 3.51 (t, *J* = 10.0 Hz, 1H), 2.84 – 2.57 (m, 3H), 2.08 (ddd, *J* = 25.4, 11.7, 6.4 Hz, 2H), 2.00 – 1.77 (m, 3H), 1.76 – 1.36 (m, 12H), 1.26 (q, *J* = 7.7, 7.3 Hz, 2H), 1.19 – 1.00 (m, 6H), 0.99 – 0.78 (m, 5H), 0.71 (d, *J* = 5.1 Hz, 4H). ^{13}C NMR (100 MHz, Pyridine-d_5) δ 140.7, 121.6, 109.1, 105.7, 101.9, 100.2, 84.7, 81.0, 78.24, 78.20, 77.4, 76.3, 75.1, 74.8, 73.8, 72.7, 72.4, 71.4, 70.2, 69.2, 66.7,

62.7, 62.4, 62.3, 56.5, 50.1, 41.8, 40.3, 39.7, 38.6, 37.3, 37.0, 32.1, 31.5, 30.4, 30.0, 29.8, 29.1, 20.9, 19.2, 18.4, 17.2, 16.2, 14.9.

6. References

1. A. Usubillaga, I. Aziz, M. C. Tettamanzi, R. Waibel and H. Achenbach, *Phytochemistry*, 1997, **44**, 537-543.
2. K. Fukuhara and I. Kubo, *Phytochemistry*, 1991, **30**, 685-687.
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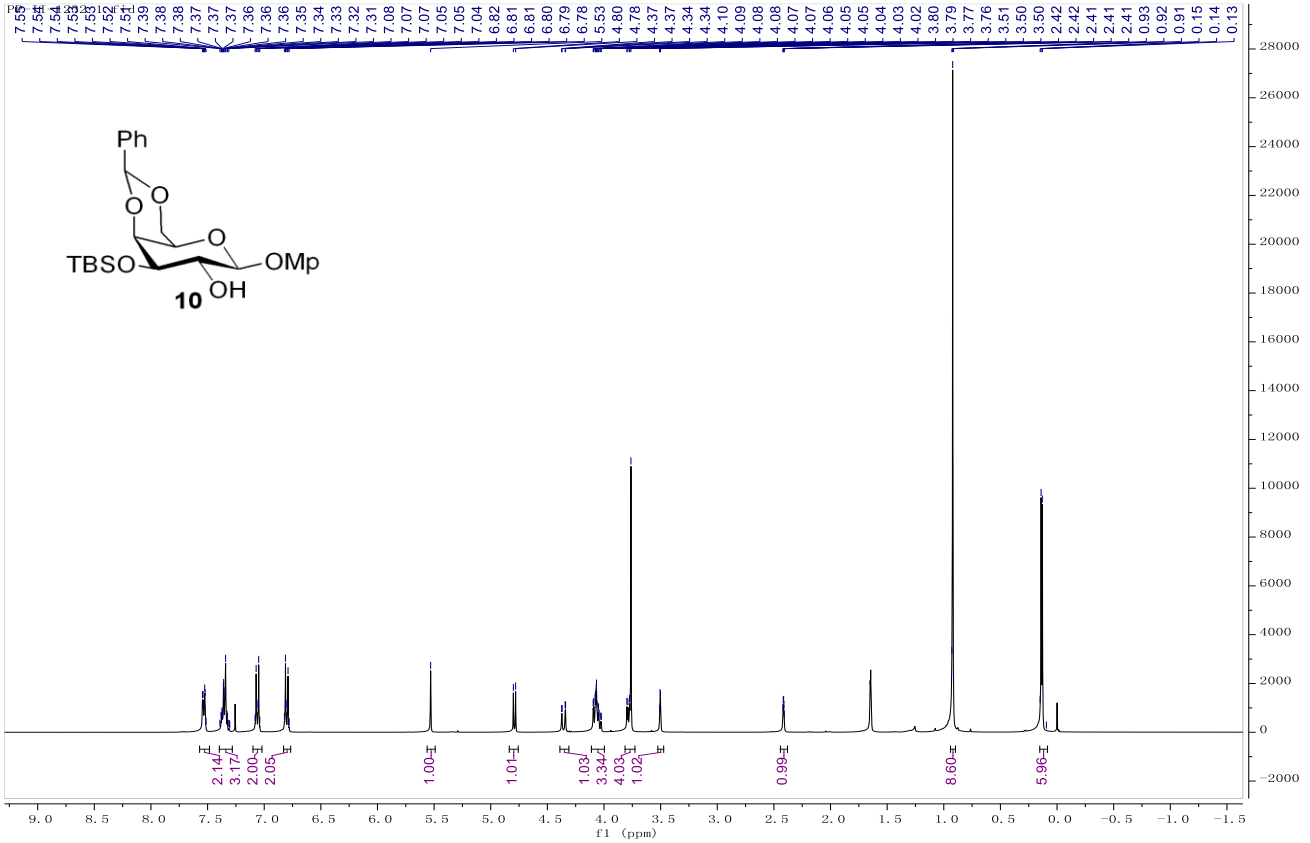
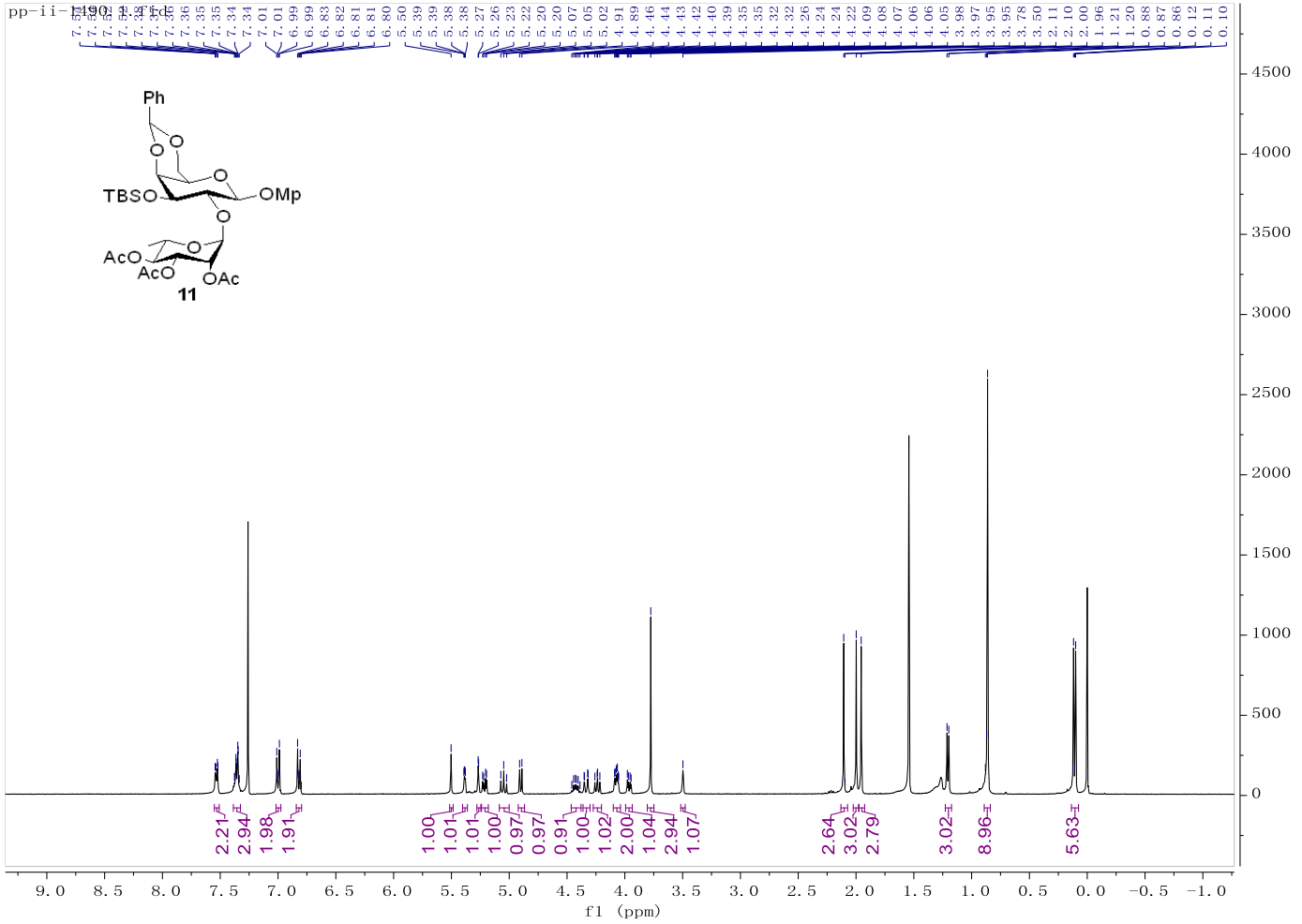
4. S. Bhaduri and N. L. Pohl, *Org. Lett.*, 2016, **18**, 1414-1417.
5. G. Gu, Y. Du and R. J. Linhardt, *J. Org. Chem.*, 2004, **69**, 5497-5500.

7. Copies of NMR Spectra

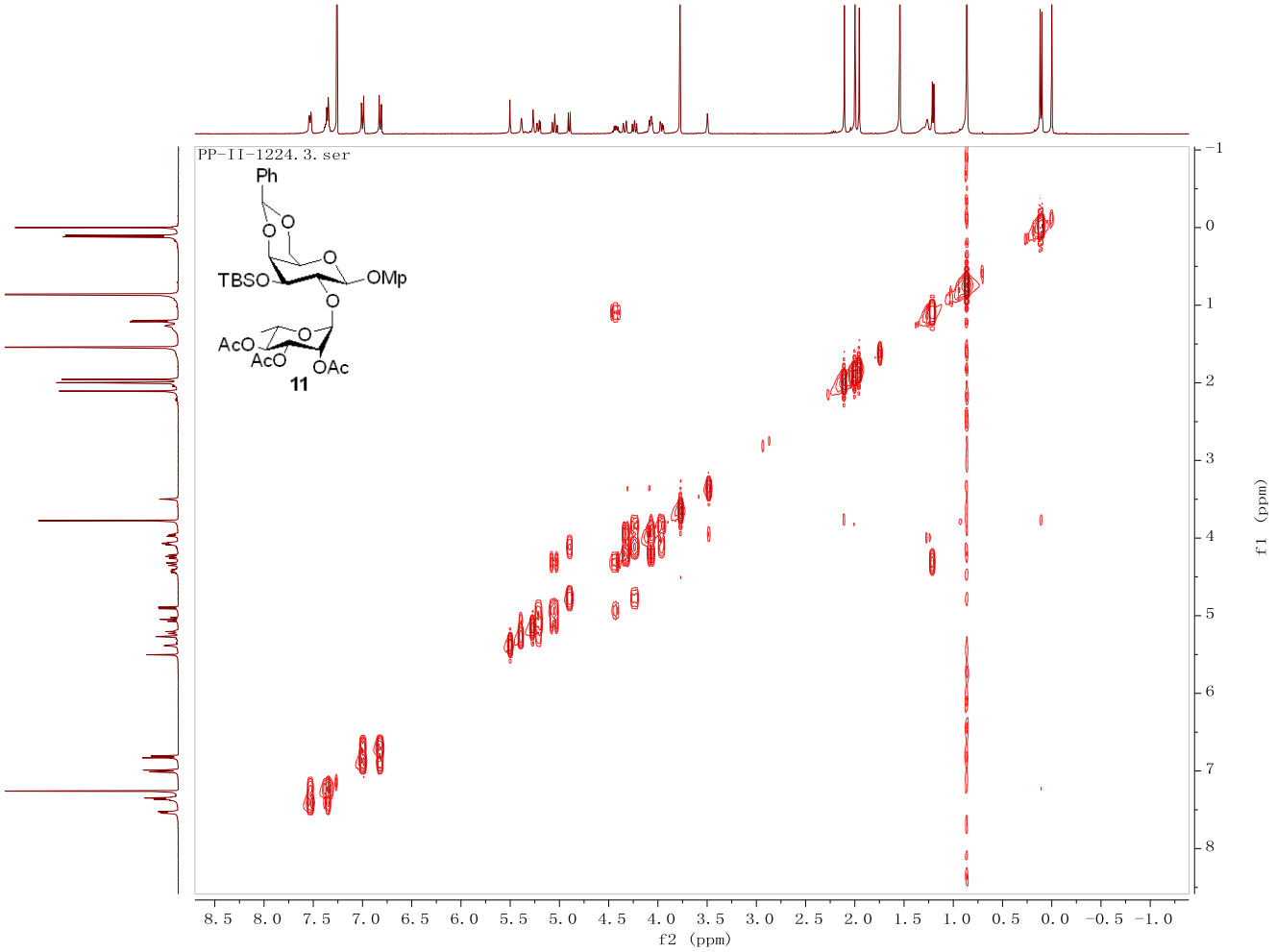
^{1}H spectrum of compound **10** (400 MHz, $CDCl_3$)



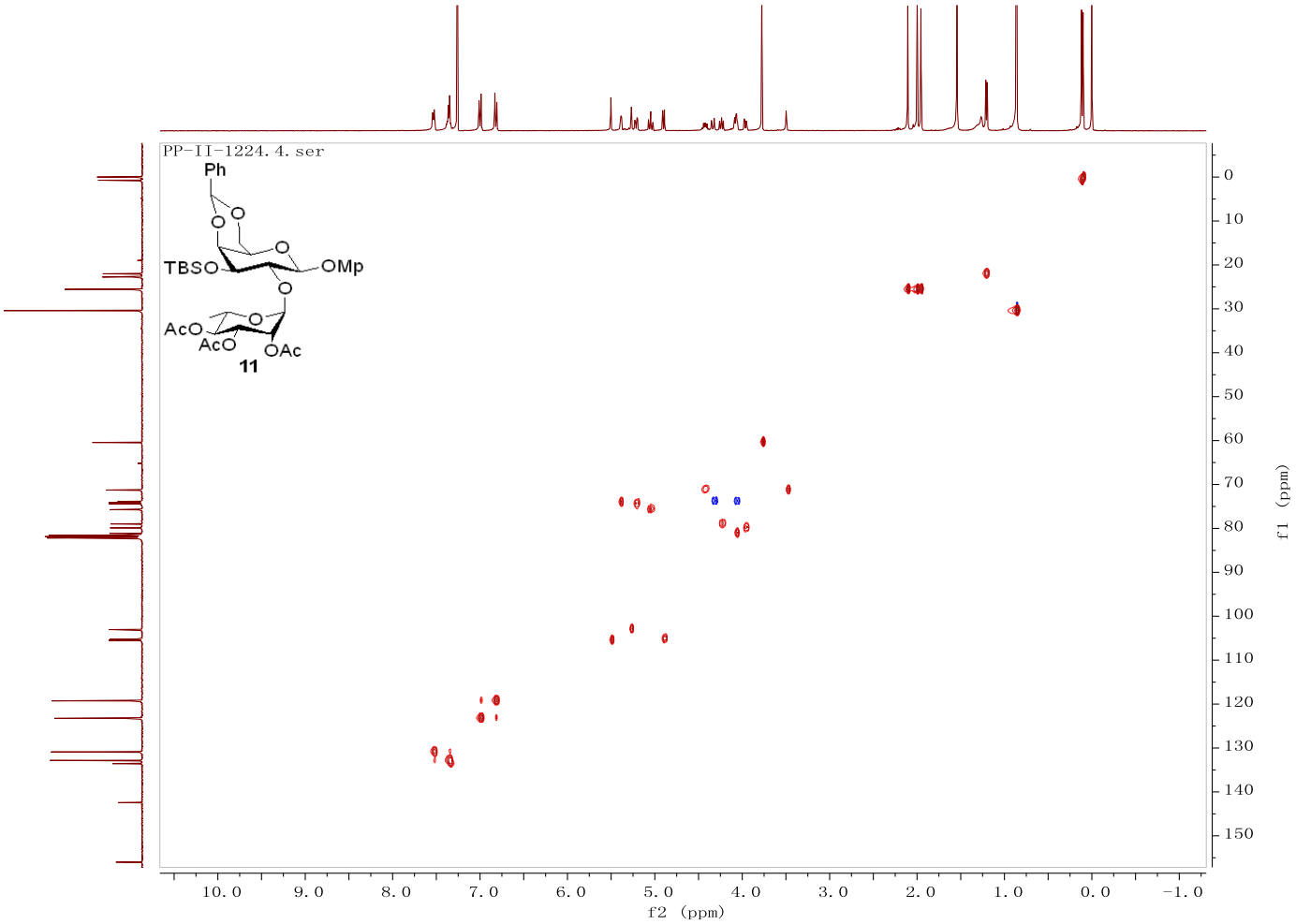
^{1}H spectrum of compound **11** (400 MHz, $CDCl_3$)



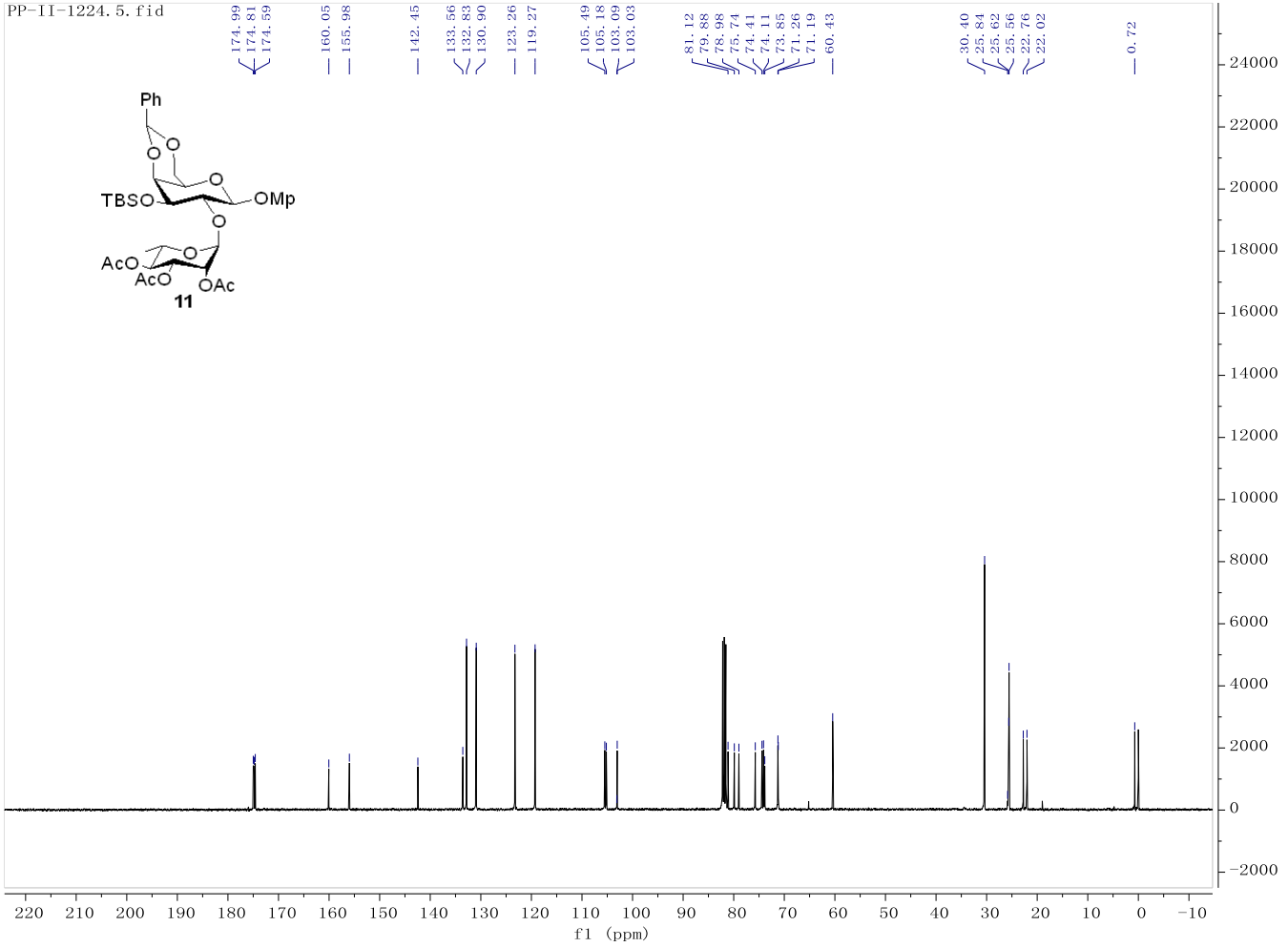
^{1}H- ^{1}H COSY of compound **11**



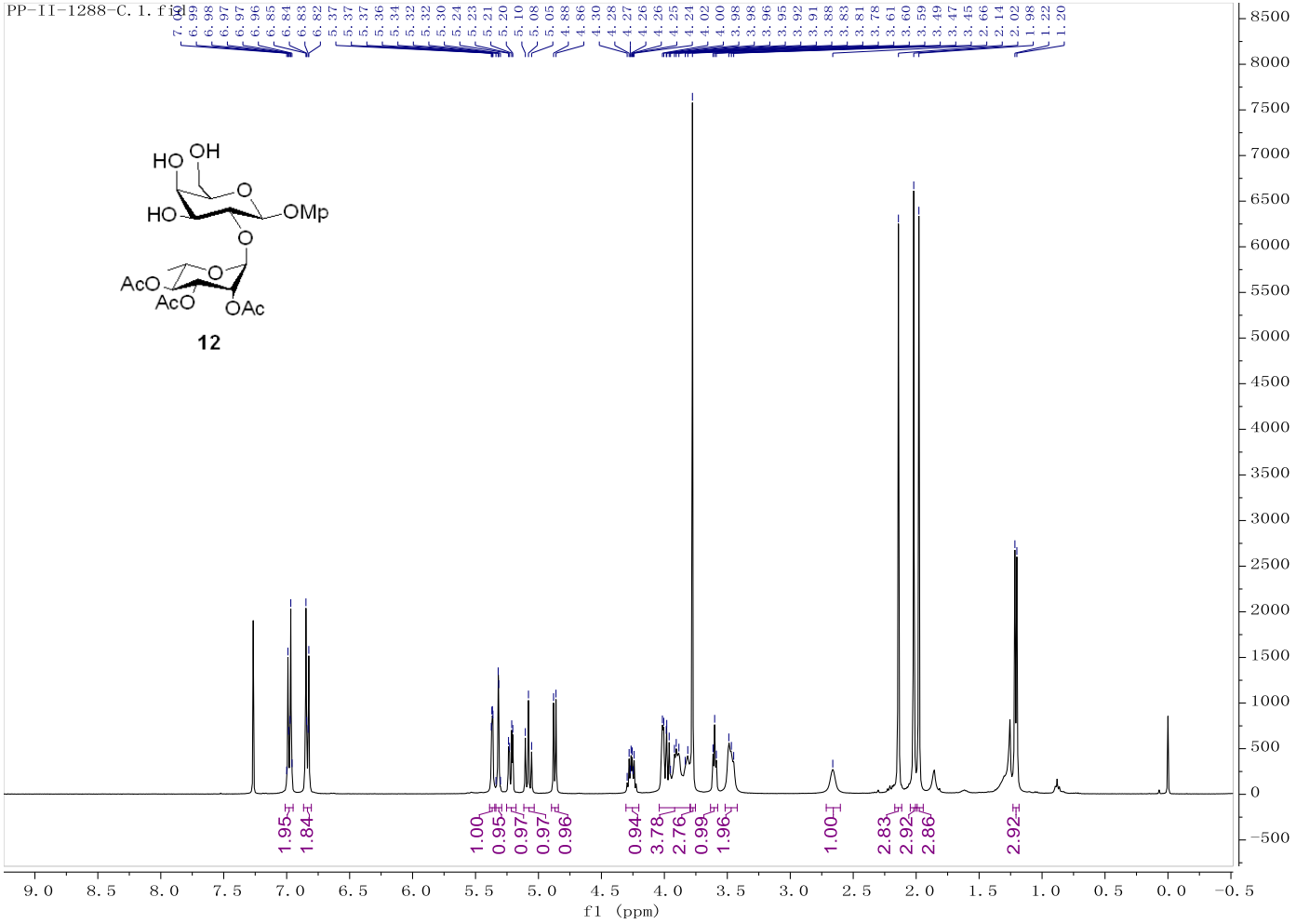
HSQC of compound **11**



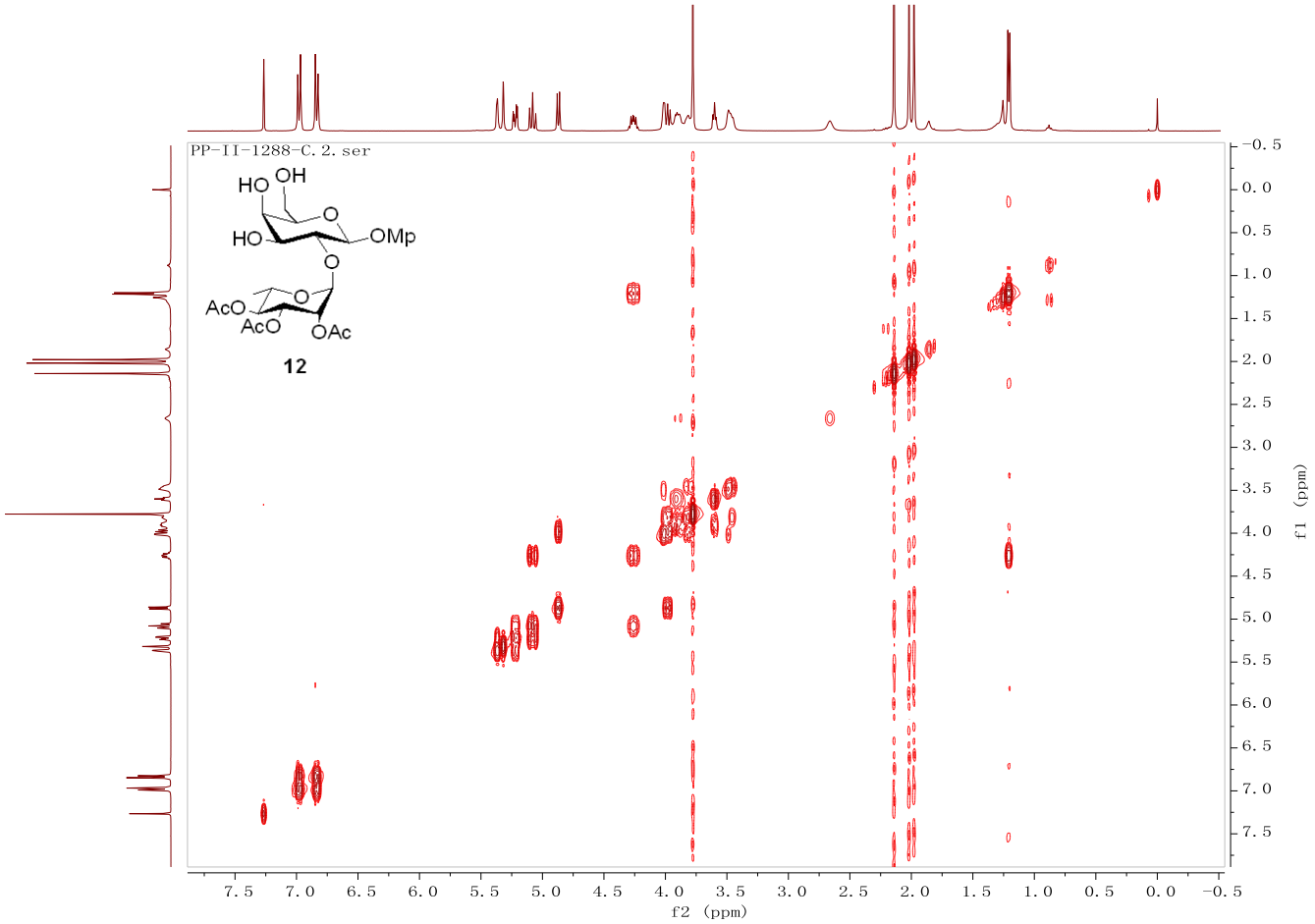
^{13}C spectrum of compound **11** (100 MHz, $CDCl_3$)



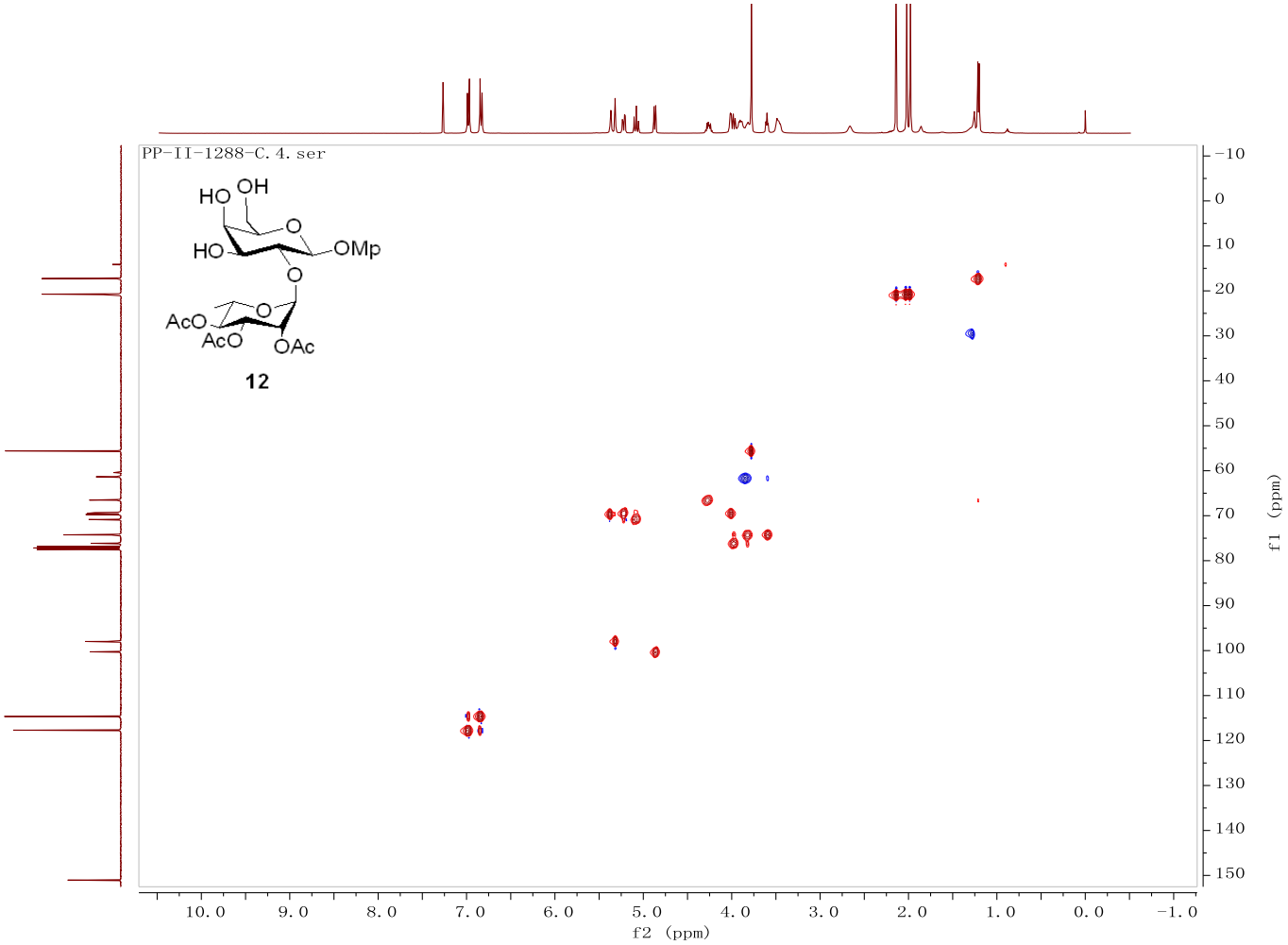
^{1}H spectrum of compound **12** (400 MHz, $CDCl_3$)



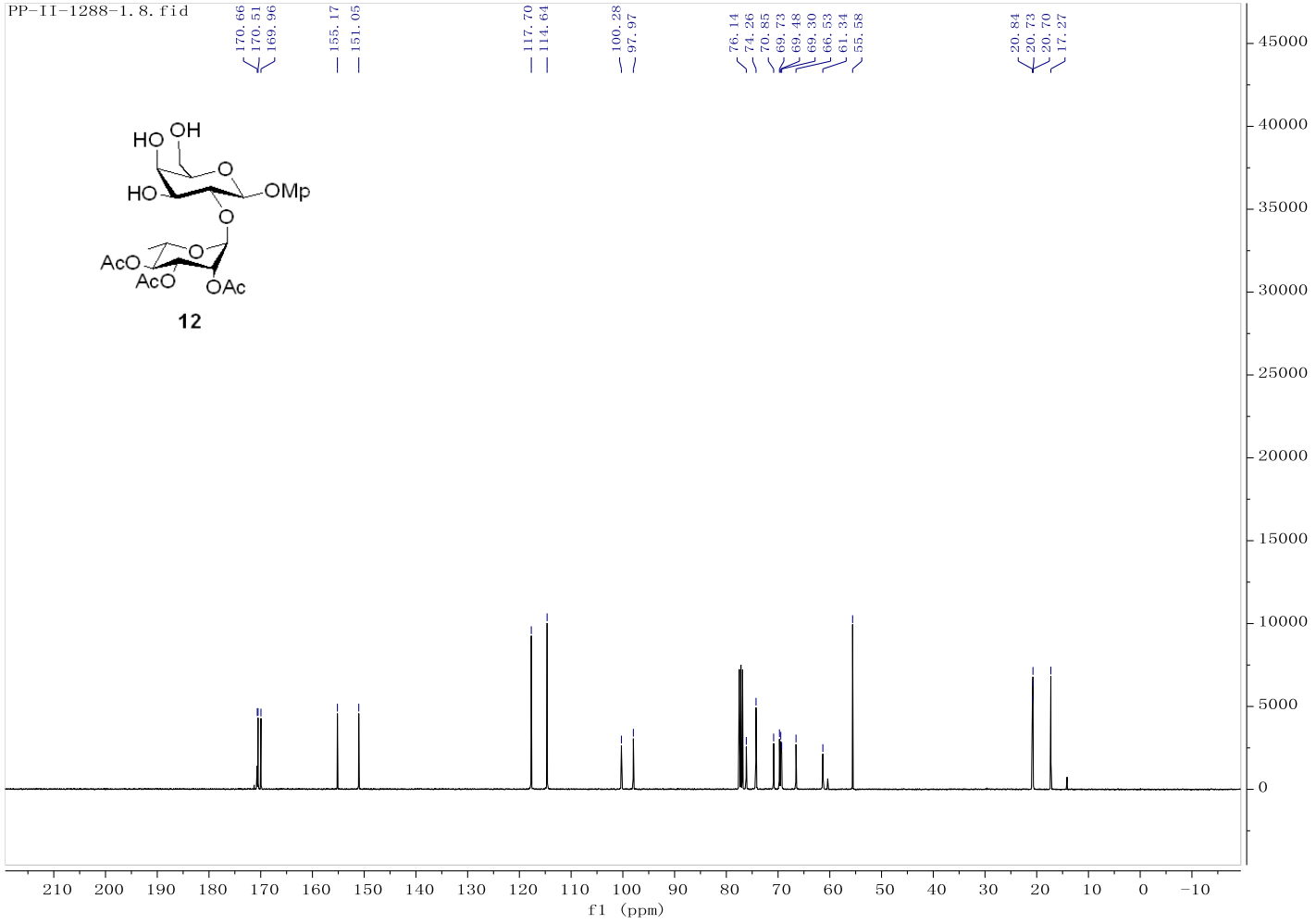
^{1}H- ^{1}H COSY of compound **12**



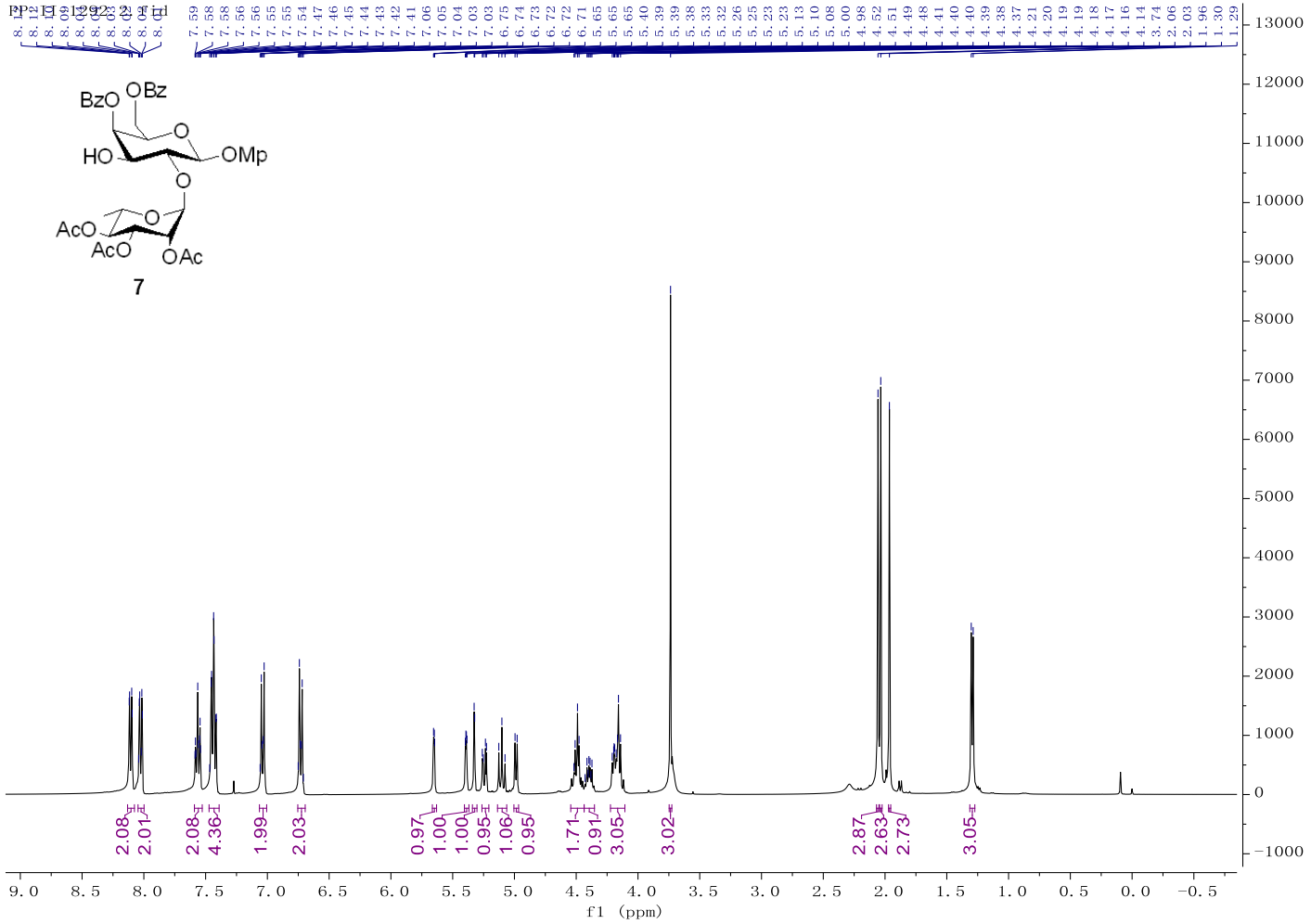
HSQC of compound **12**



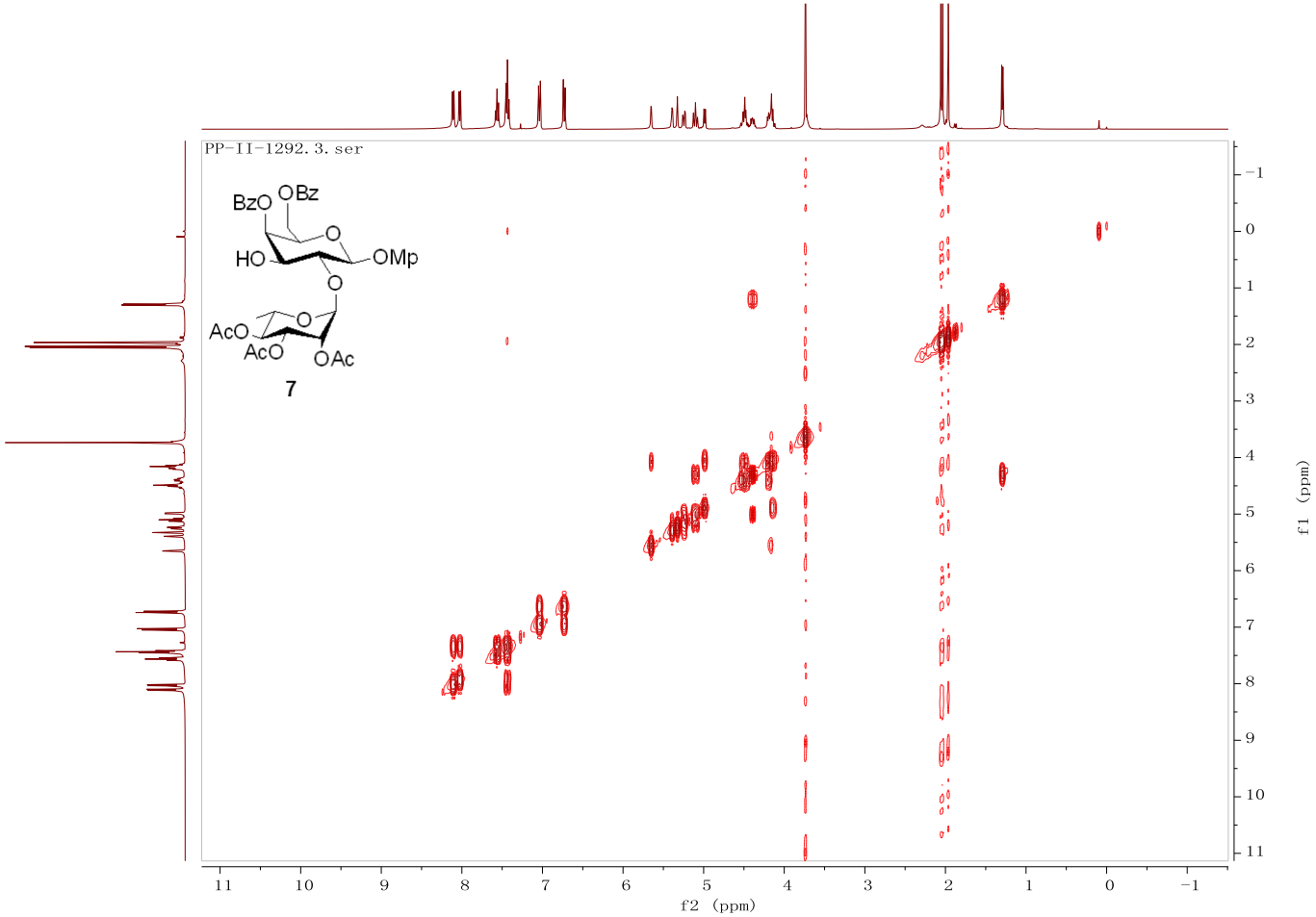
^{13}C spectrum of compound **12** (100 MHz, $CDCl_3$)



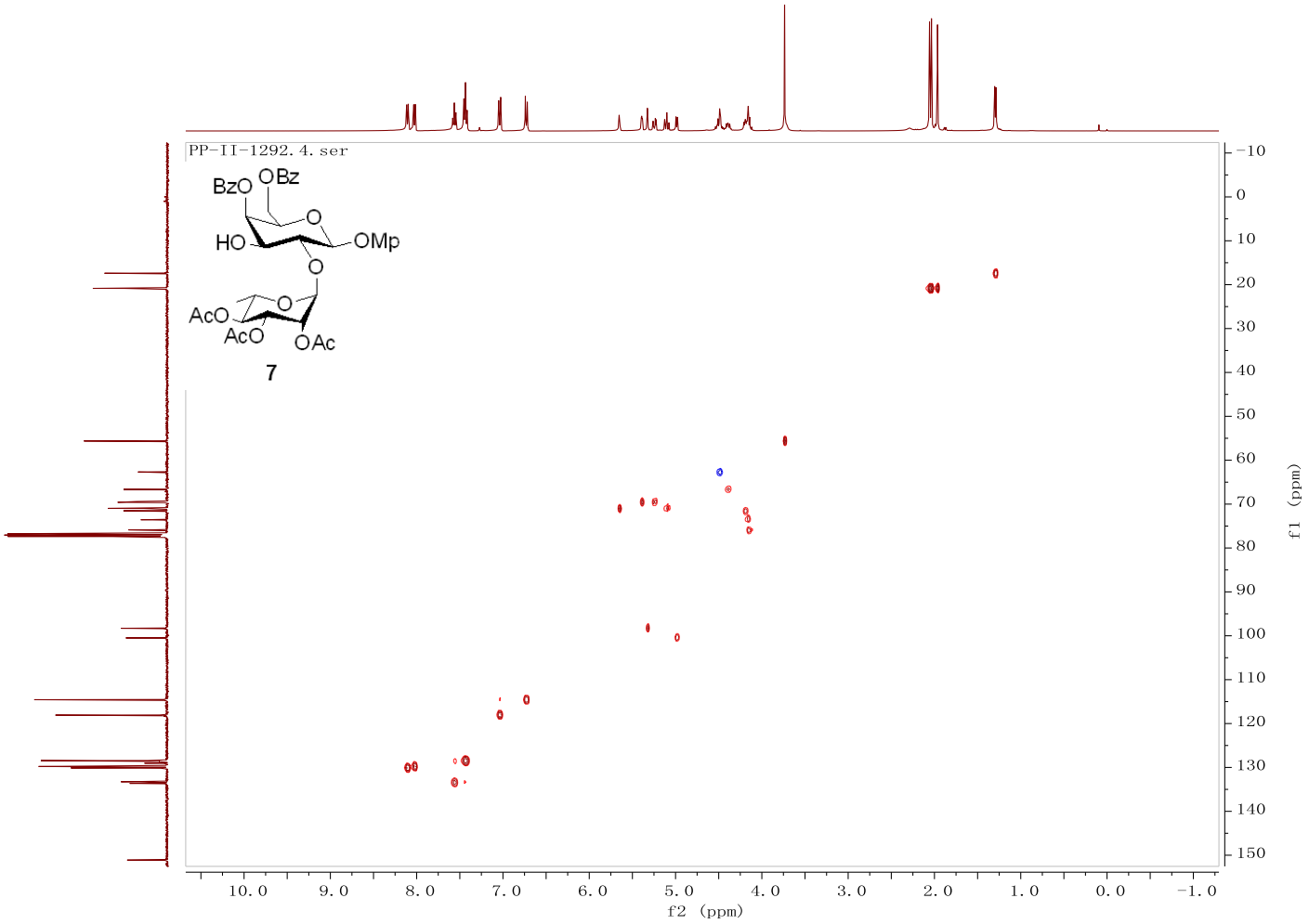
^{1}H spectrum of compound **7** (400 MHz, $CDCl_3$)



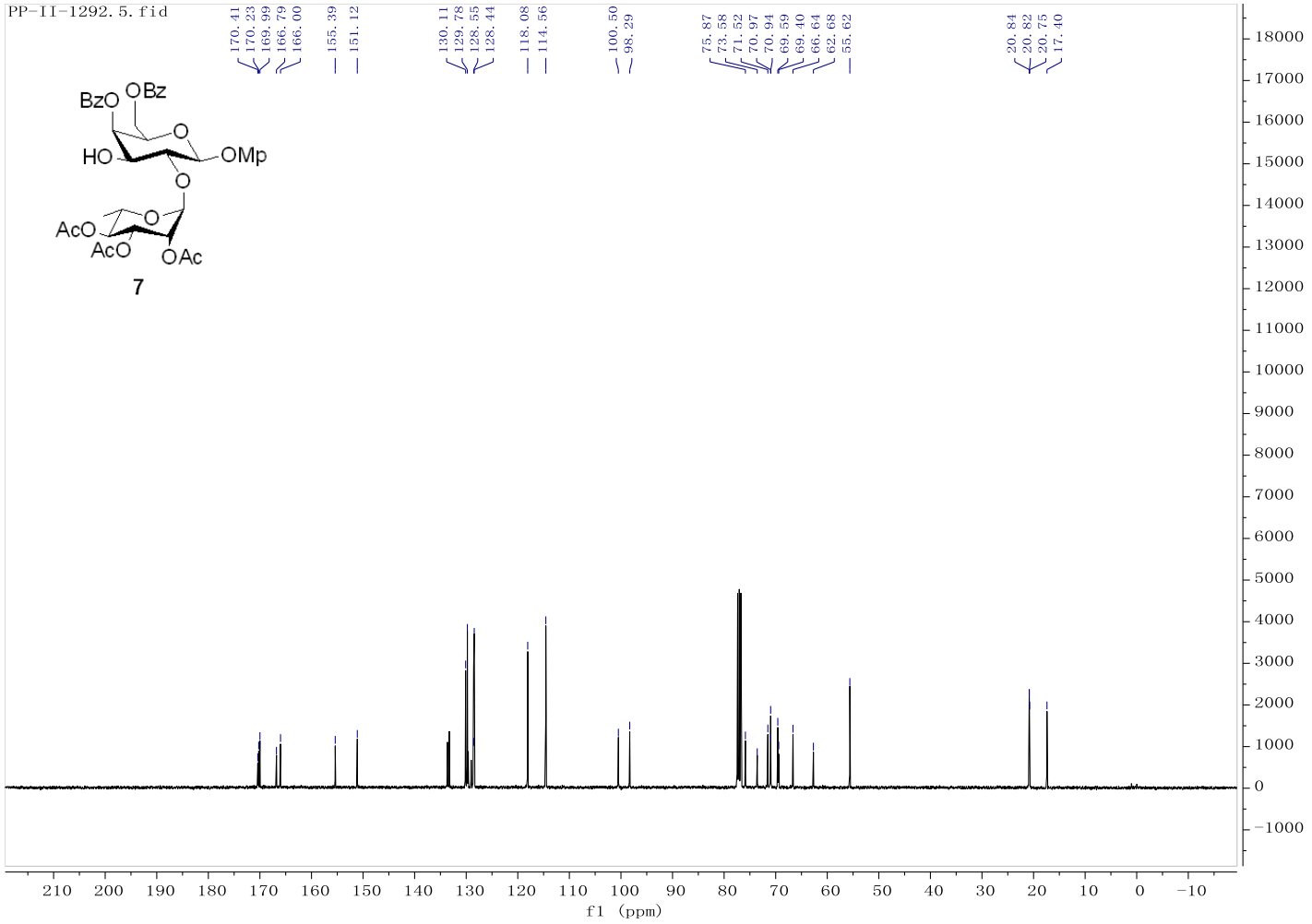
^{1}H-^{1}H COSY of compound **7**



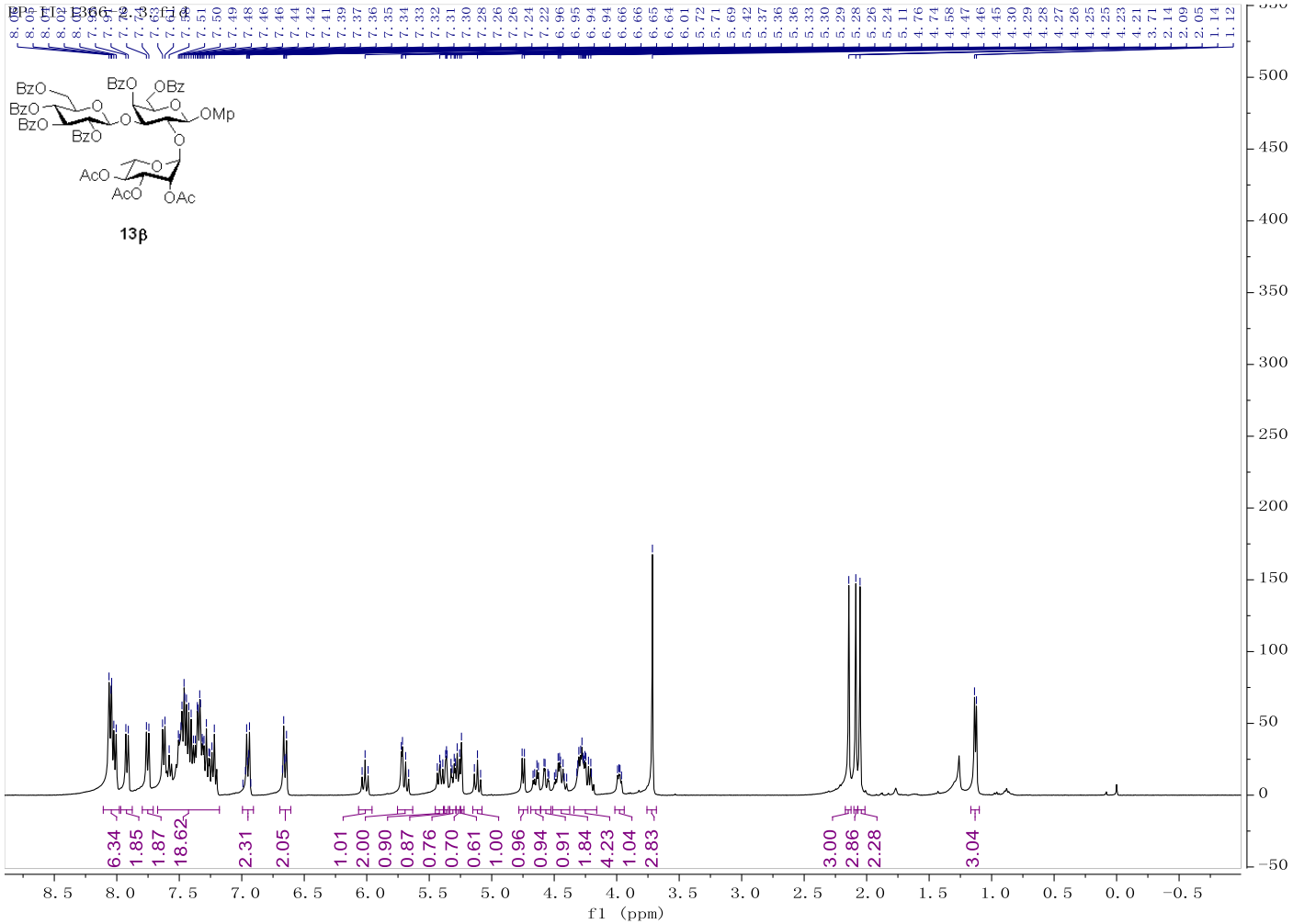
HSQC of compound **7**



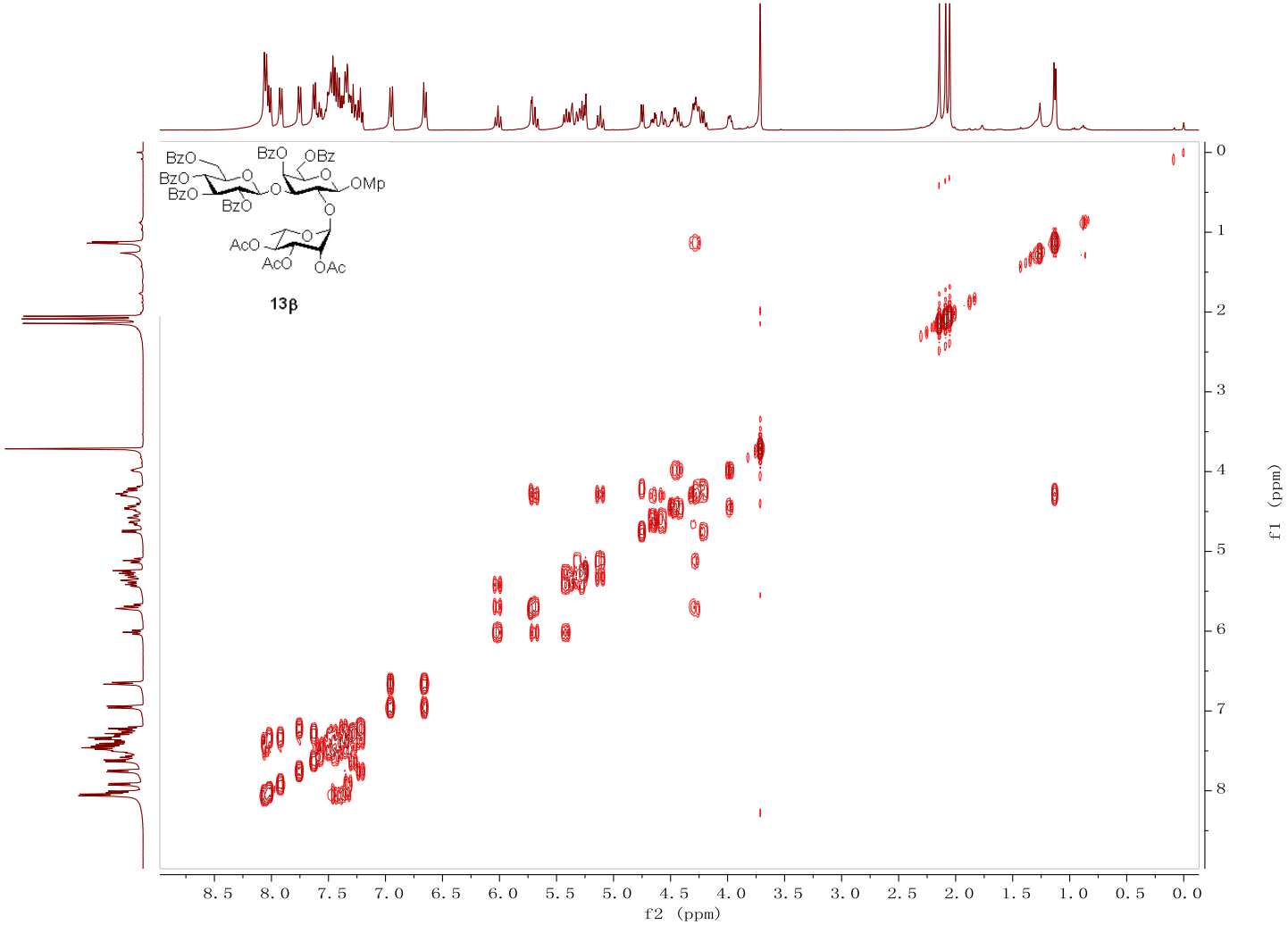
^{13}C spectrum of compound **7** (100 MHz, CDCl3)



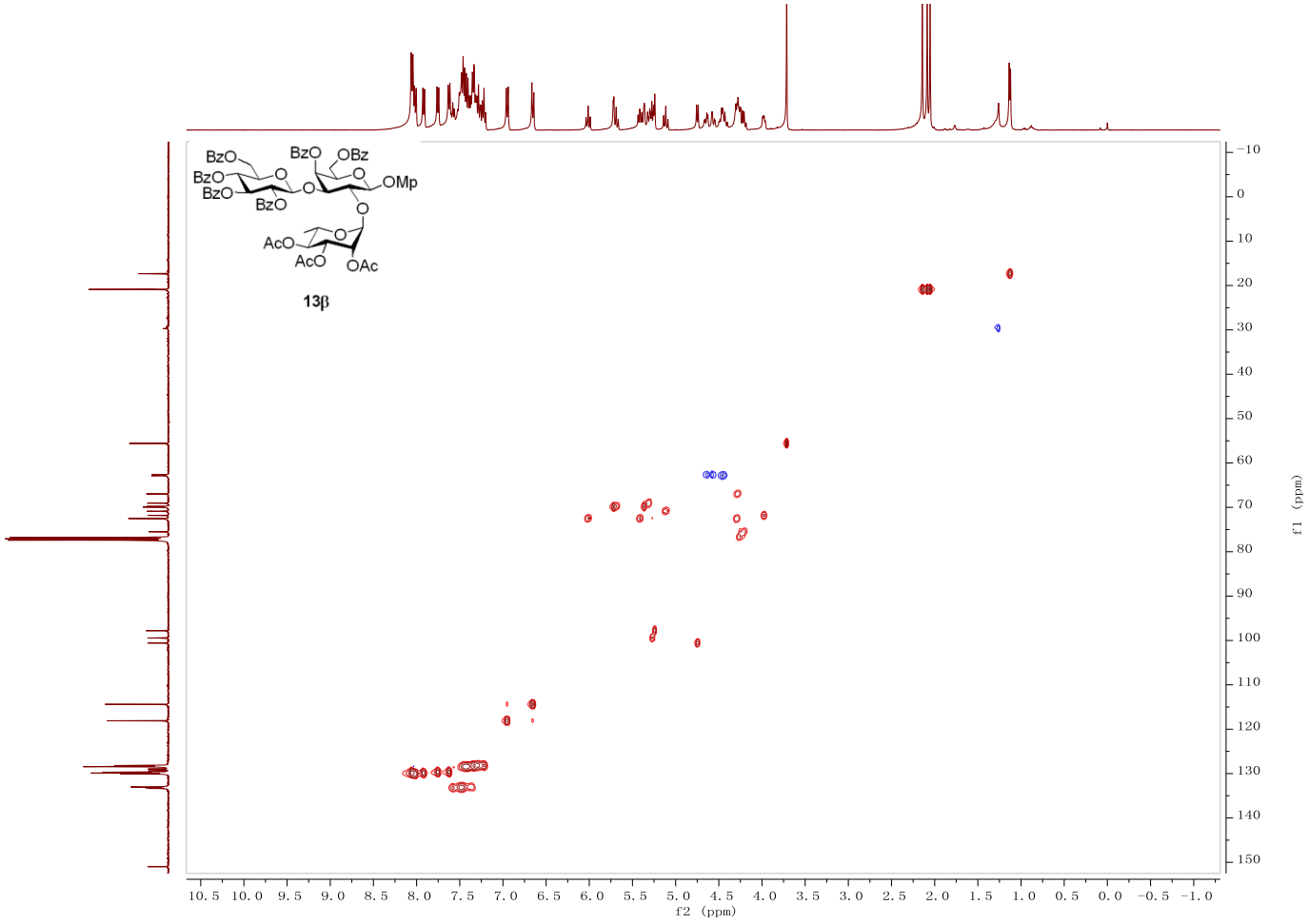
^{1}H spectrum of compound **13β** (400 MHz, $CDCl_3$)



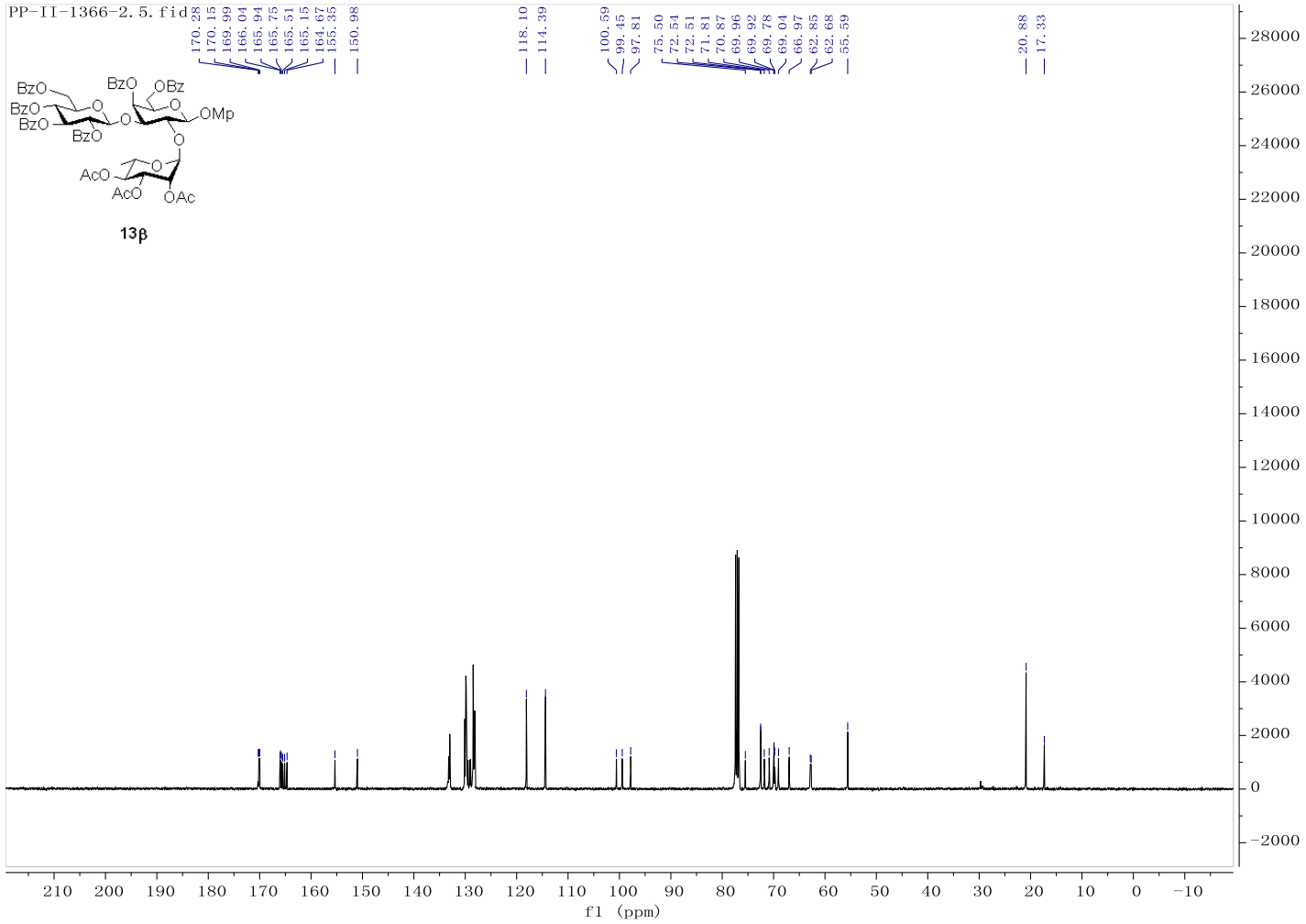
^{1}H- ^{1}H COSY of compound **13β**



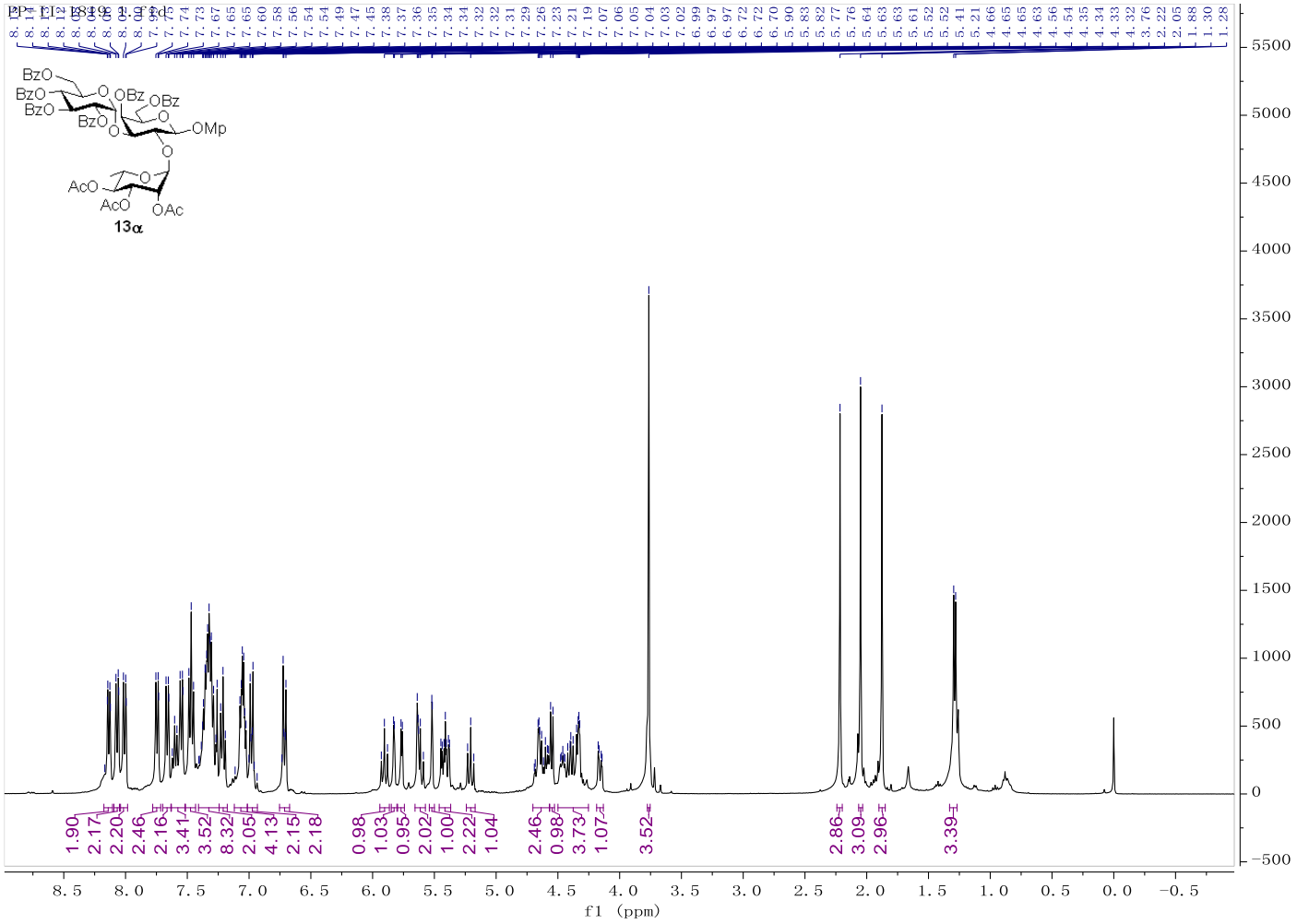
HSQC of compound **13β**



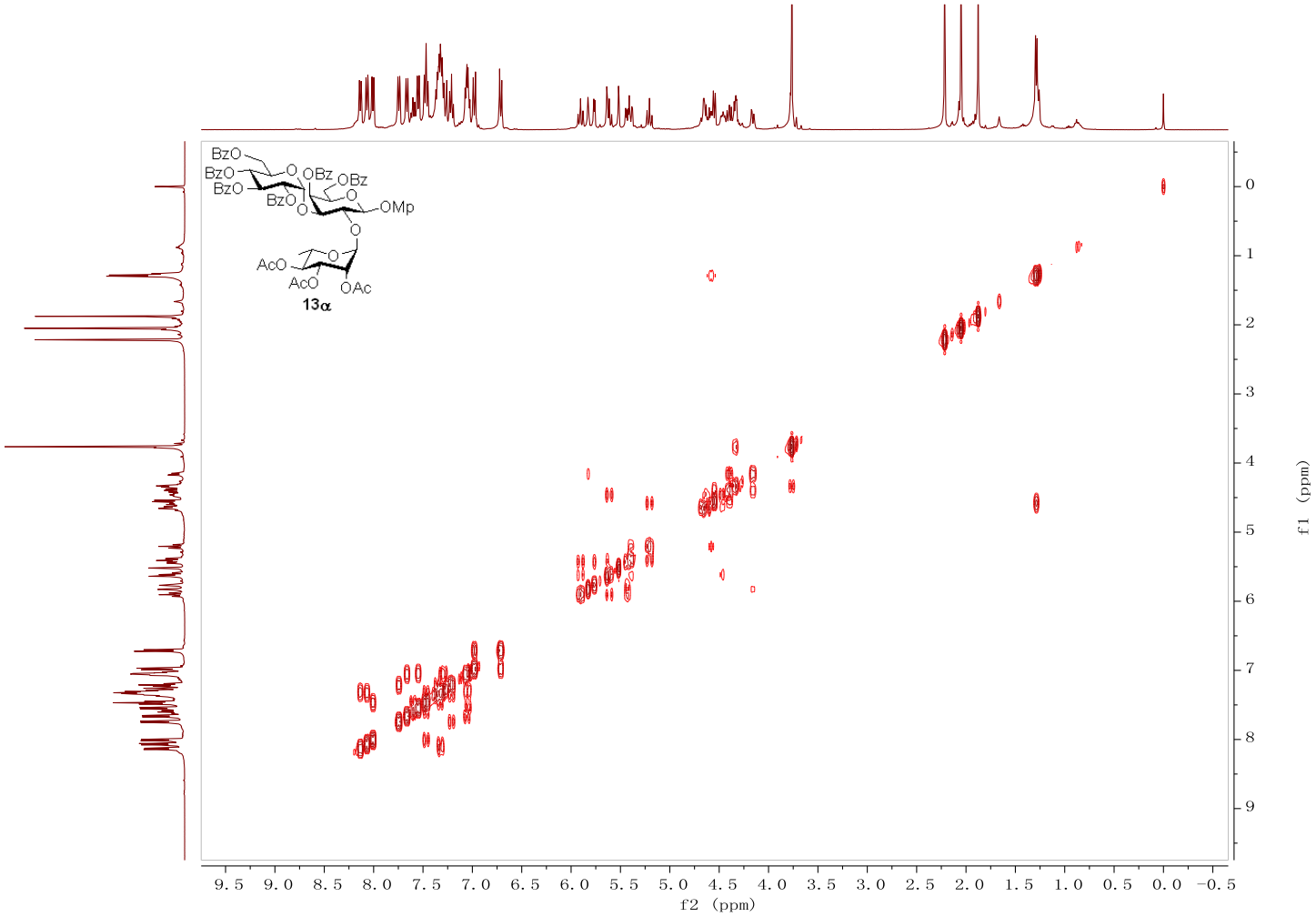
^{13}C spectrum of compound **13β** (100 MHz, $CDCl_3$)



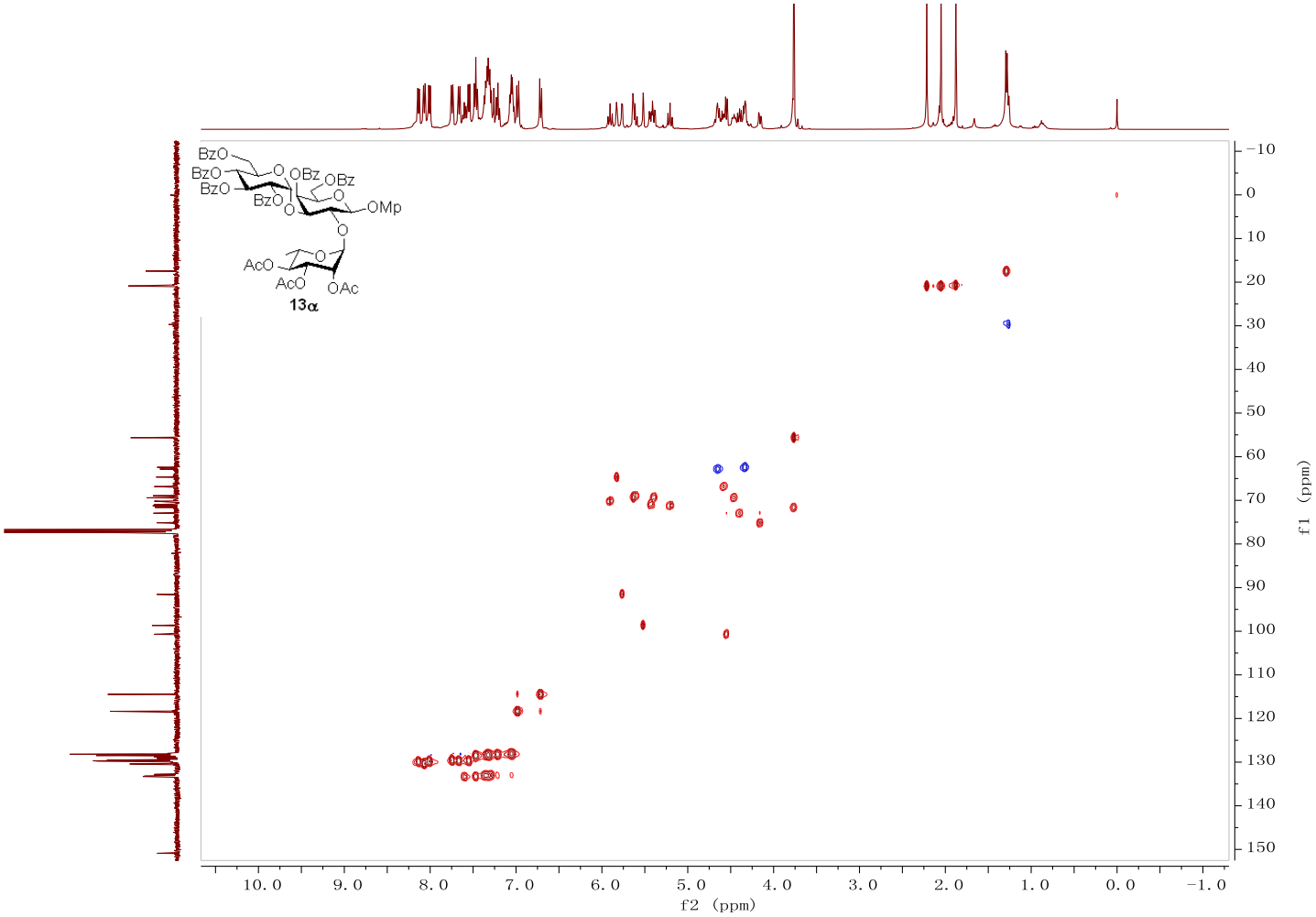
^{1}H spectrum of compound **13α** (400 MHz, $CDCl_3$)



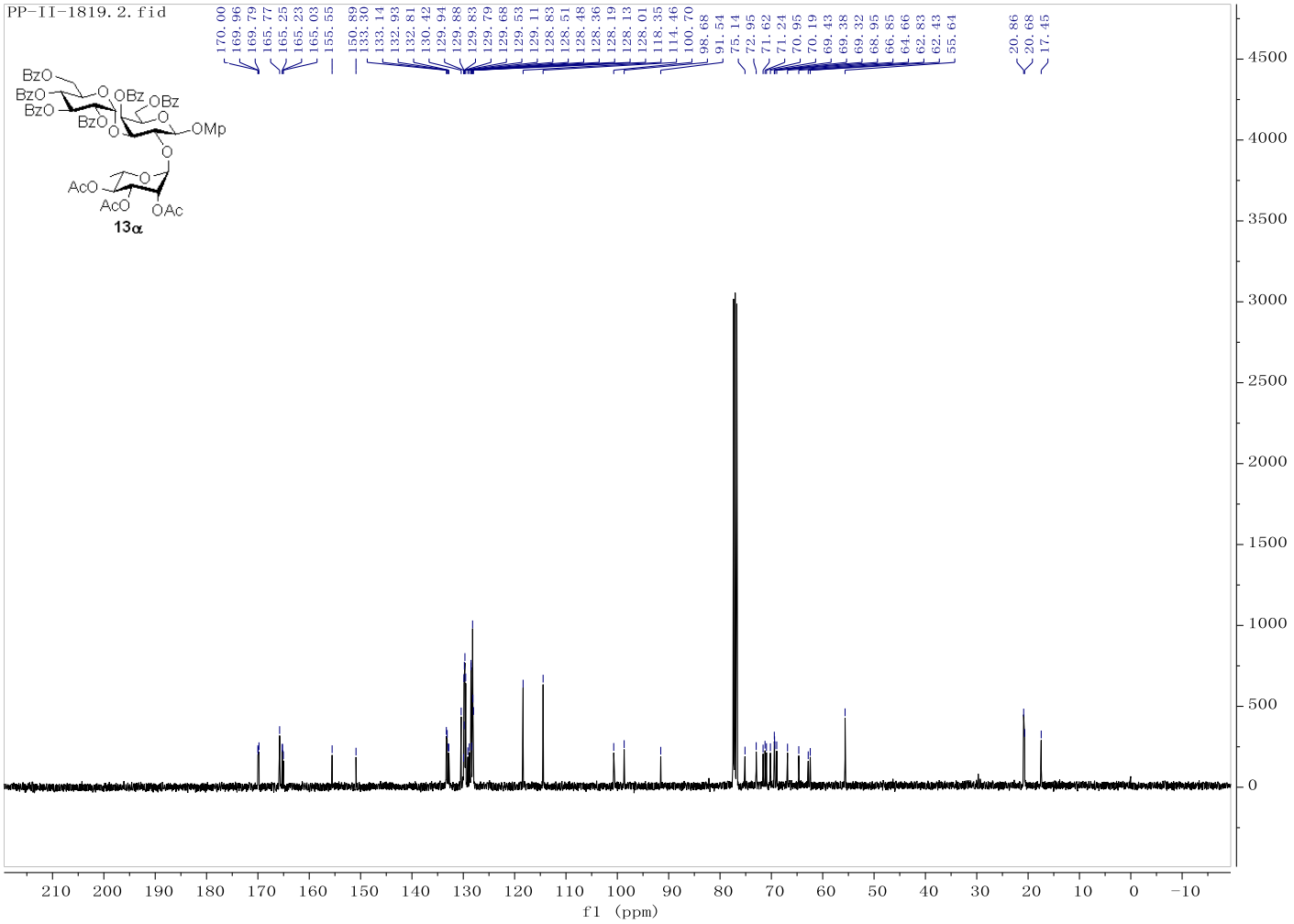
^{1}H- ^{1}H COSY of compound **13α**



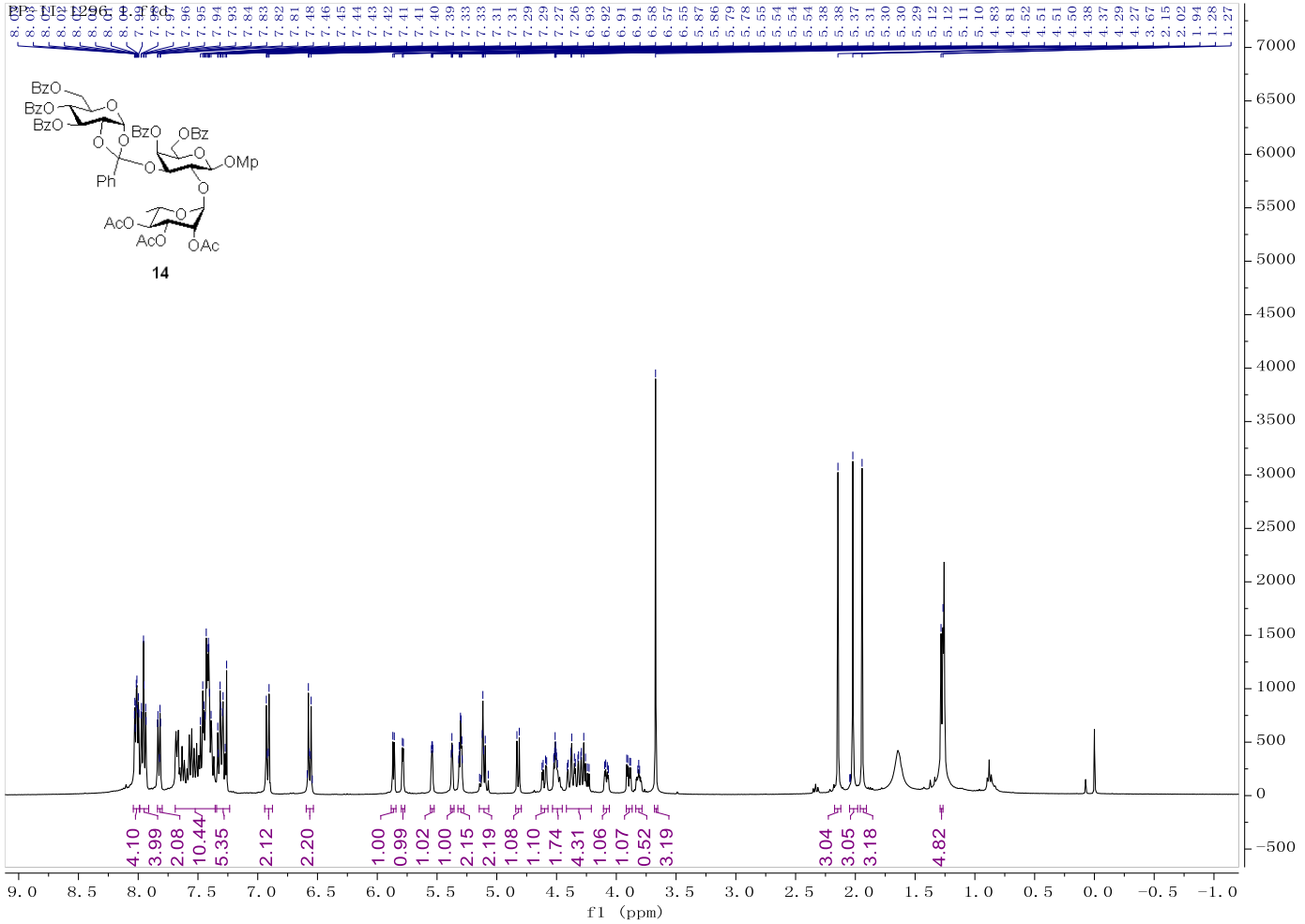
HSQC of compound **13α**



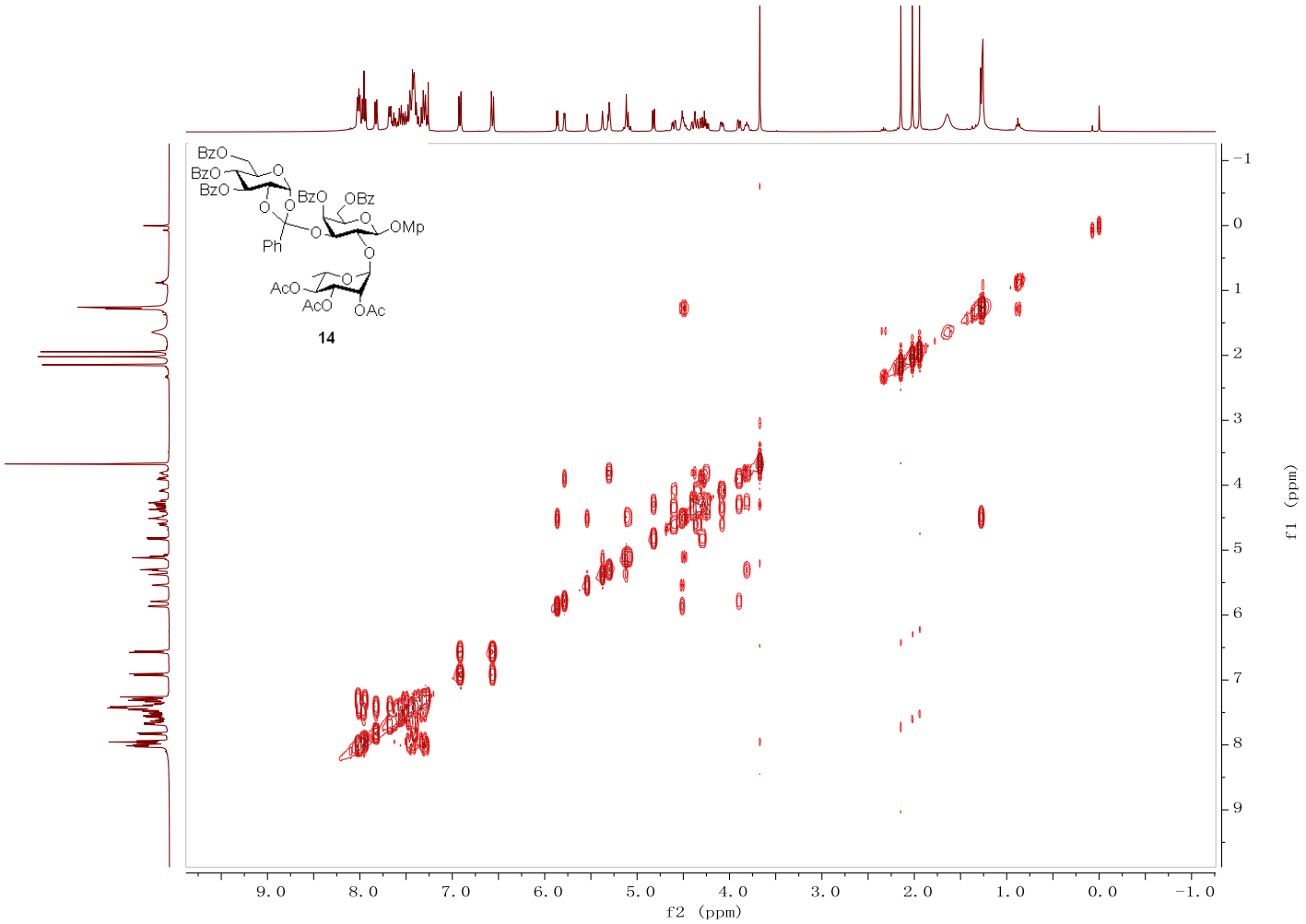
^{13}C spectrum of compound **13α** (100 MHz, $CDCl_3$)



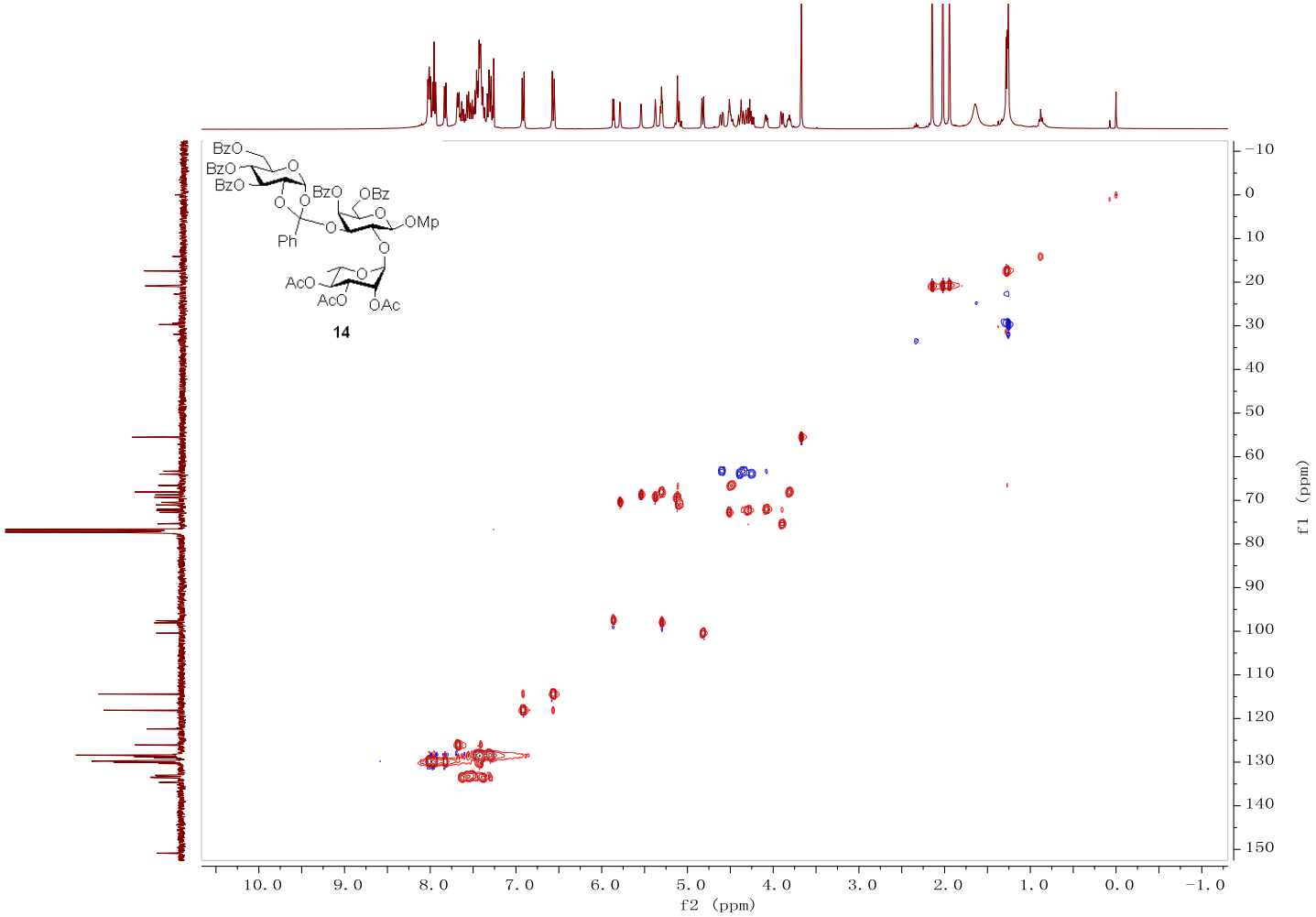
^{1}H spectrum of compound **14** (400 MHz, $CDCl_3$)



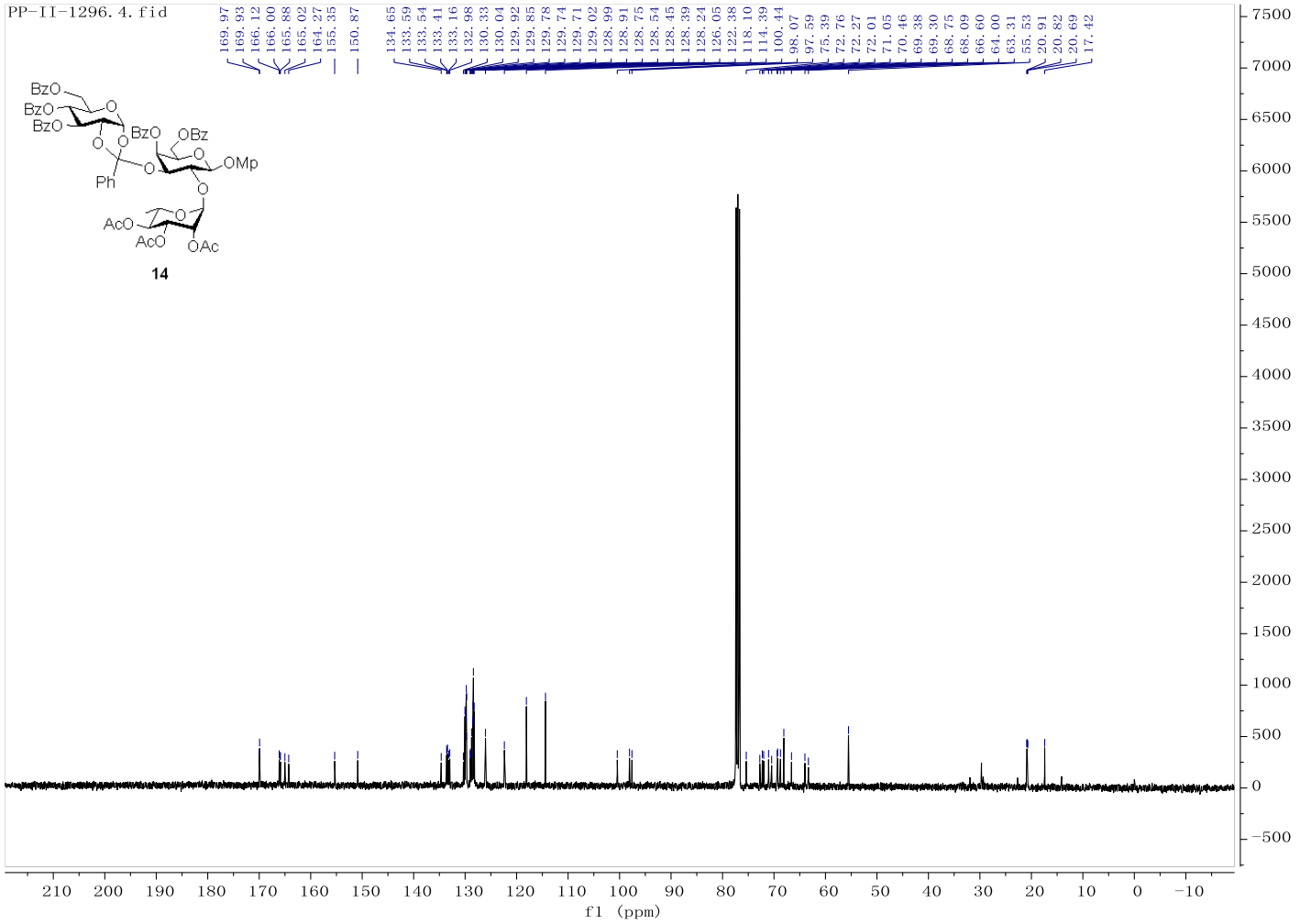
^{1}H- ^{1}H COSY of compound **14**



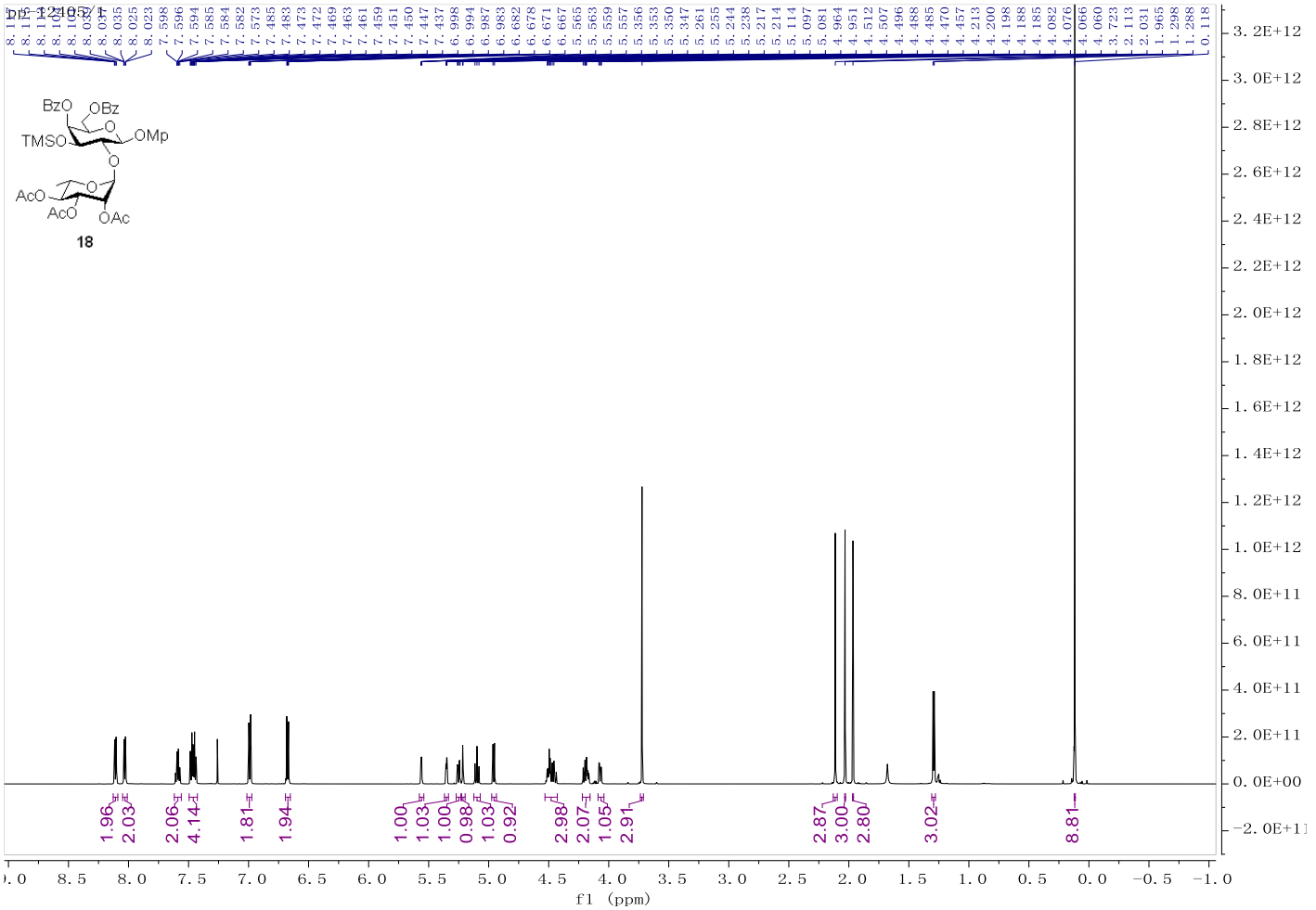
HSQC of compound **14**



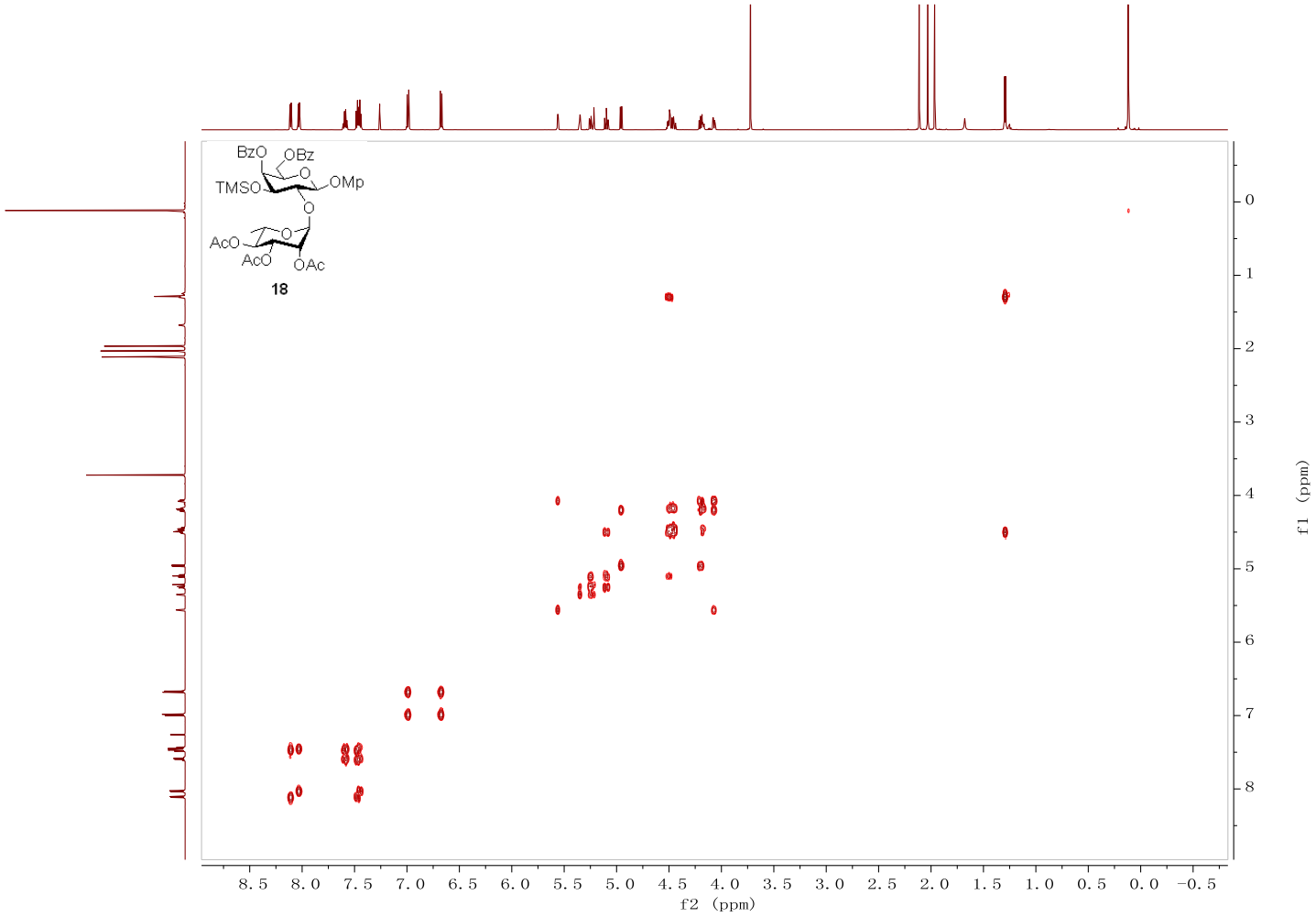
^{13}C spectrum of compound **14** (100 MHz, $CDCl_3$)



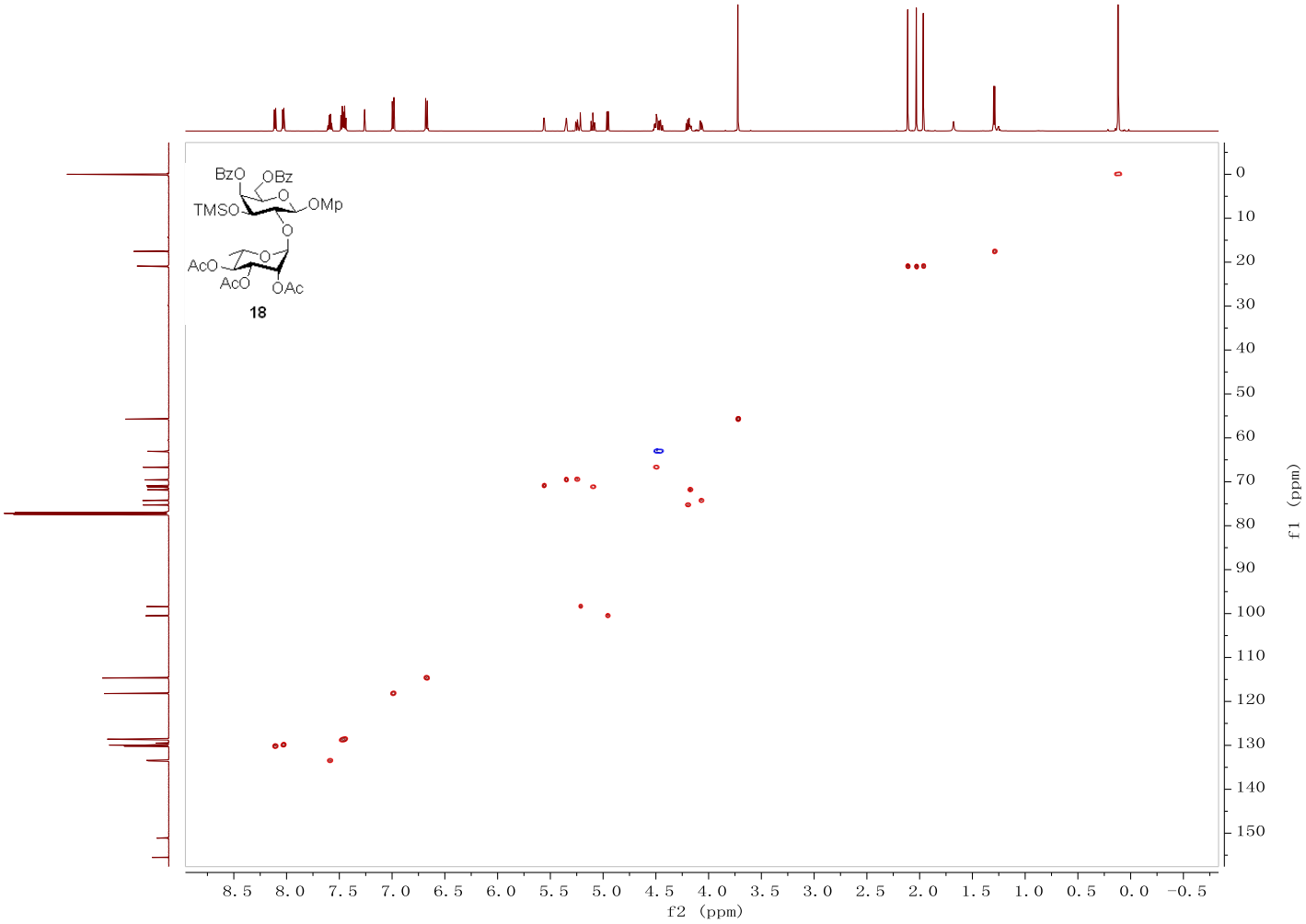
^{1}H spectrum of compound **18** (600 MHz, $CDCl_3$)



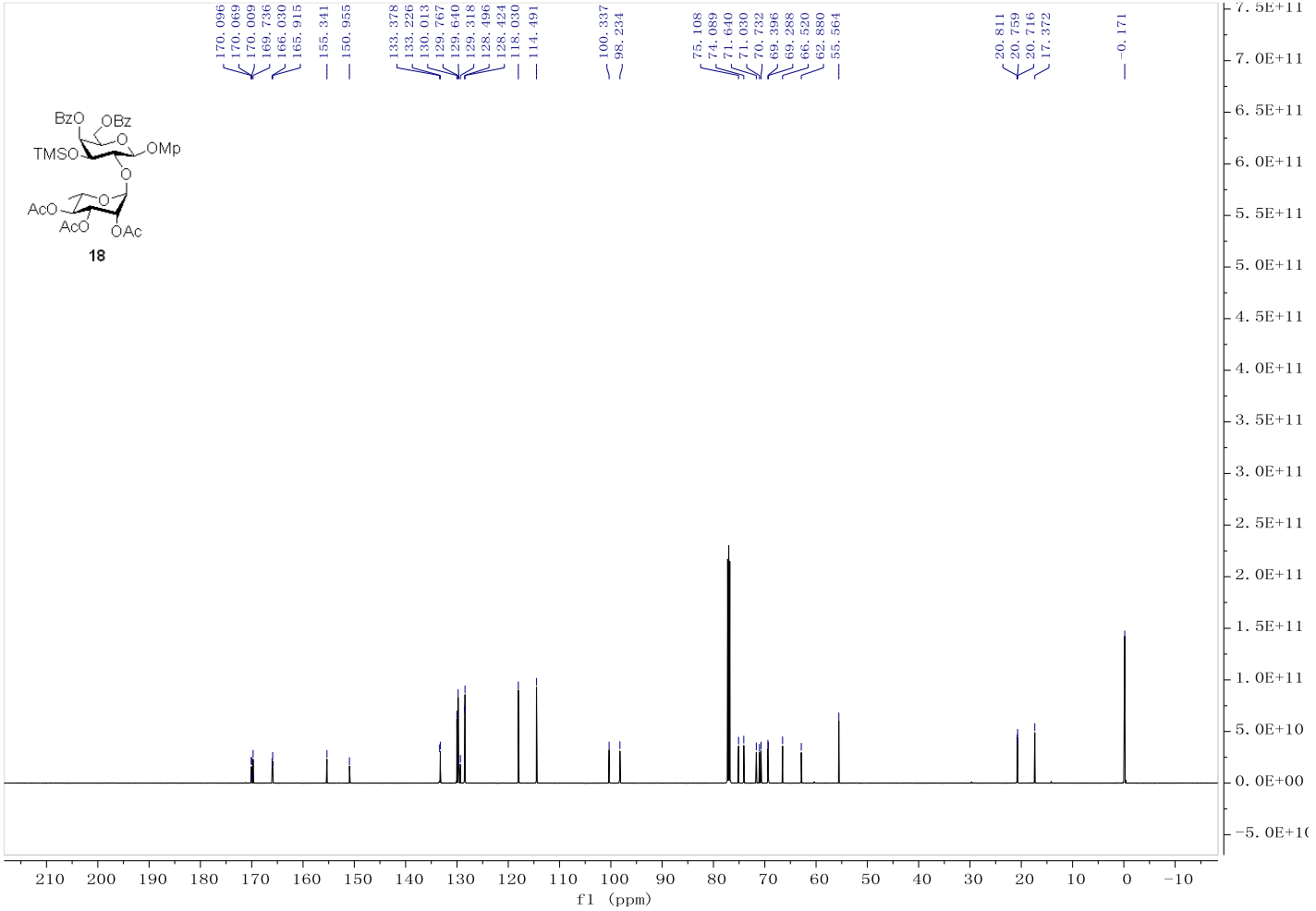
^{1}H- ^{1}H COSY of compound **18**



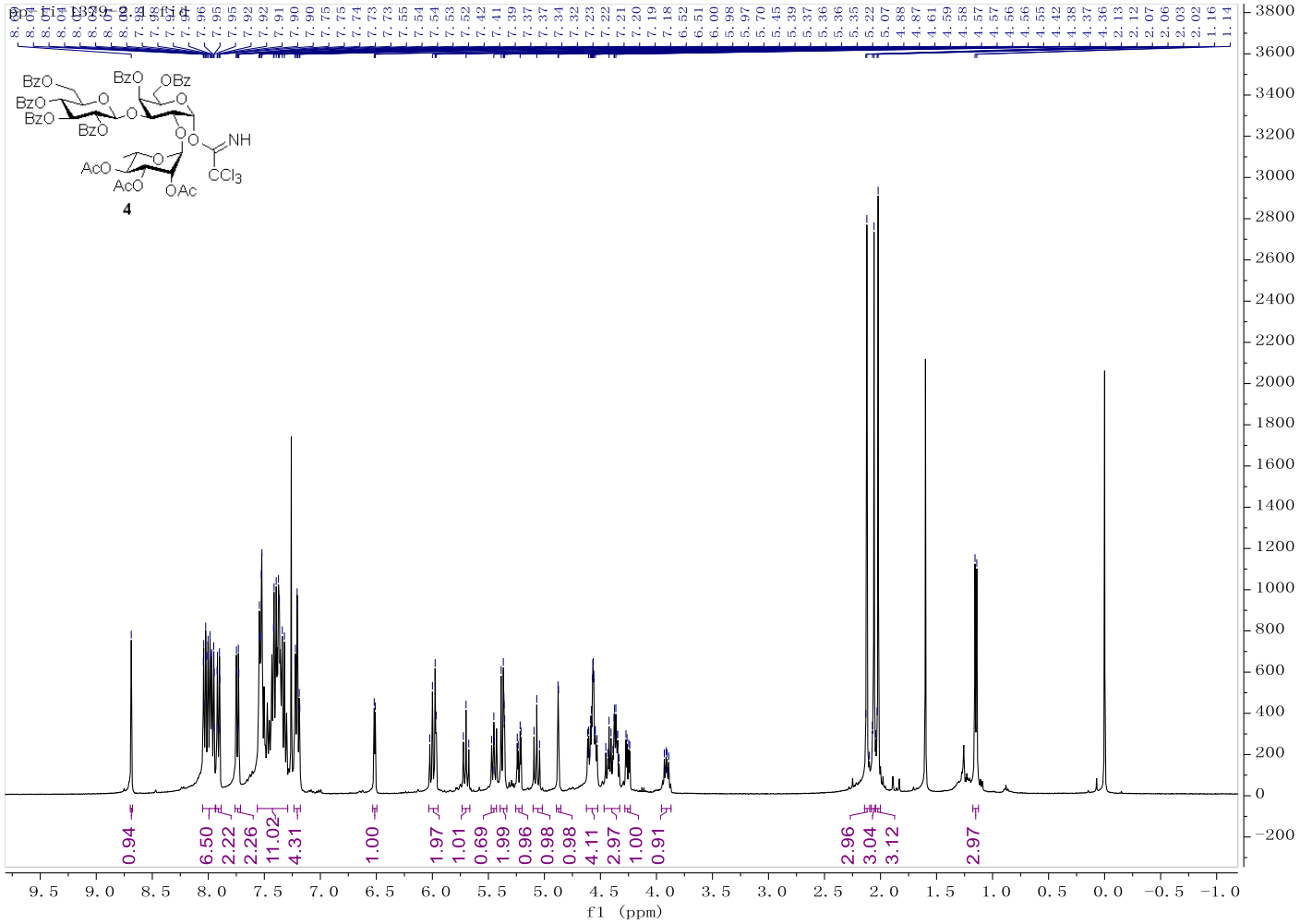
HSQC of compound **18**



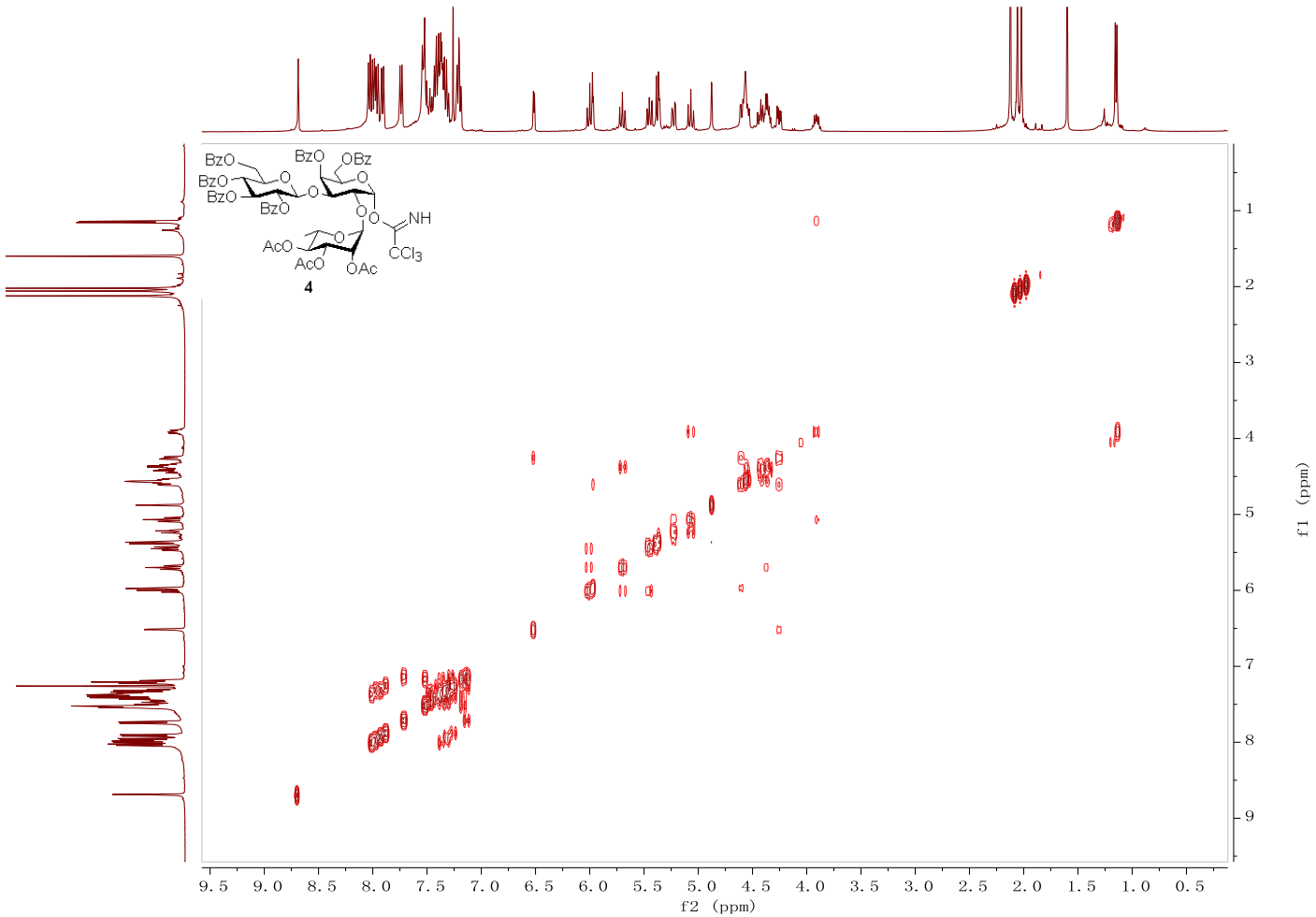
^{13}C spectrum of compound **15** (150 MHz, $CDCl_3$)



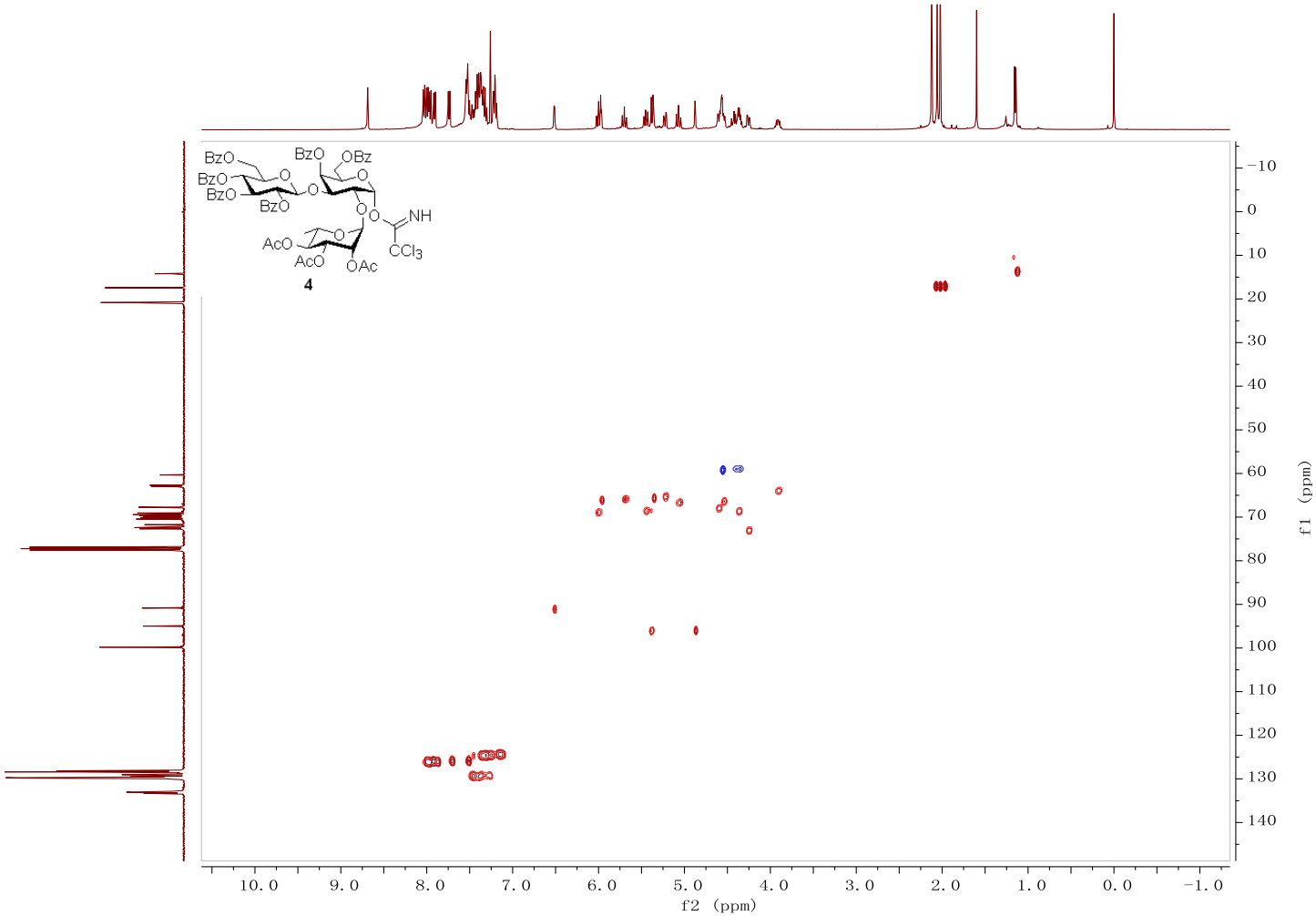
^{1}H spectrum of compound **4** (400 MHz, $CDCl_3$)



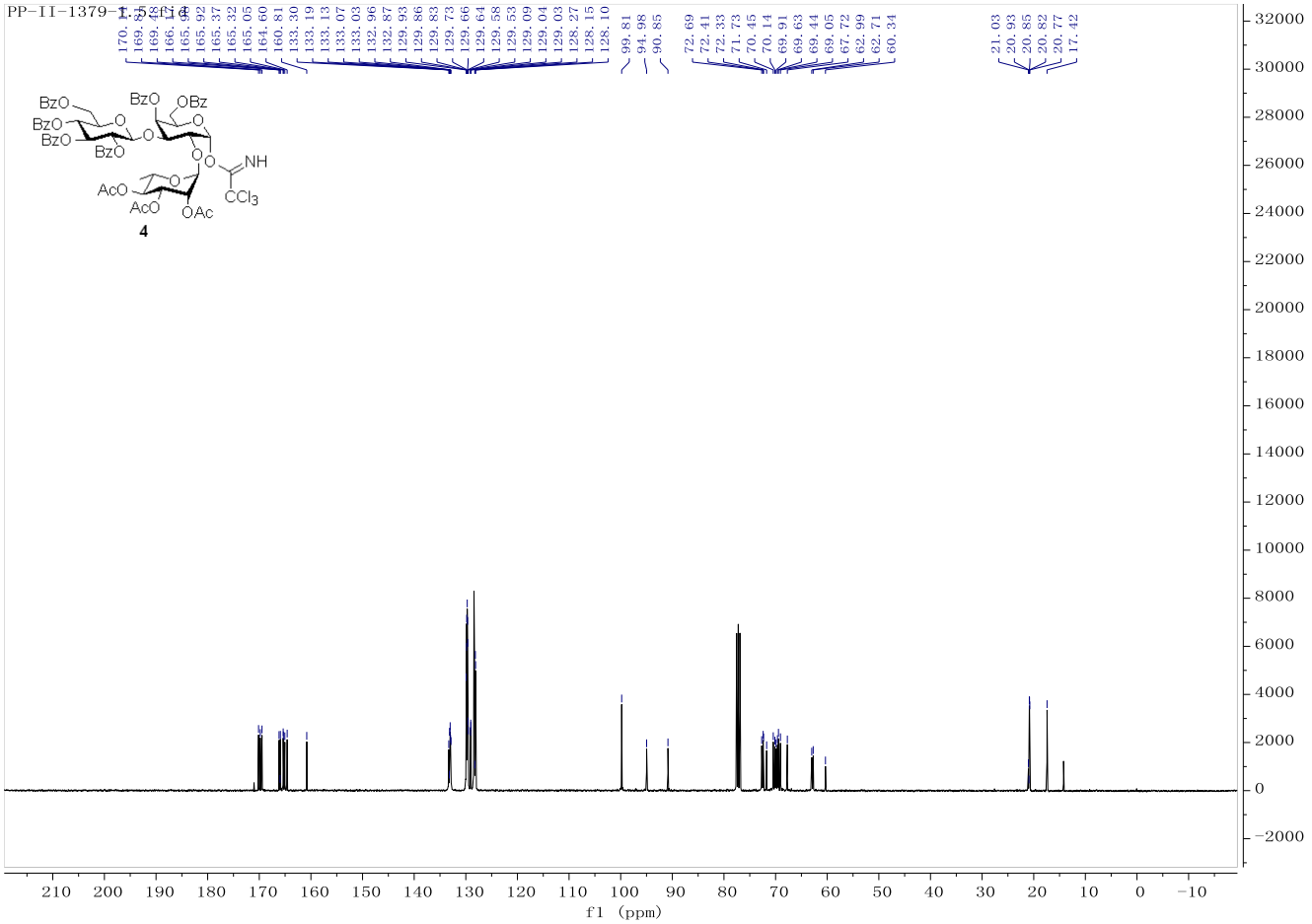
^{1}H- ^{1}H COSY of compound **4**



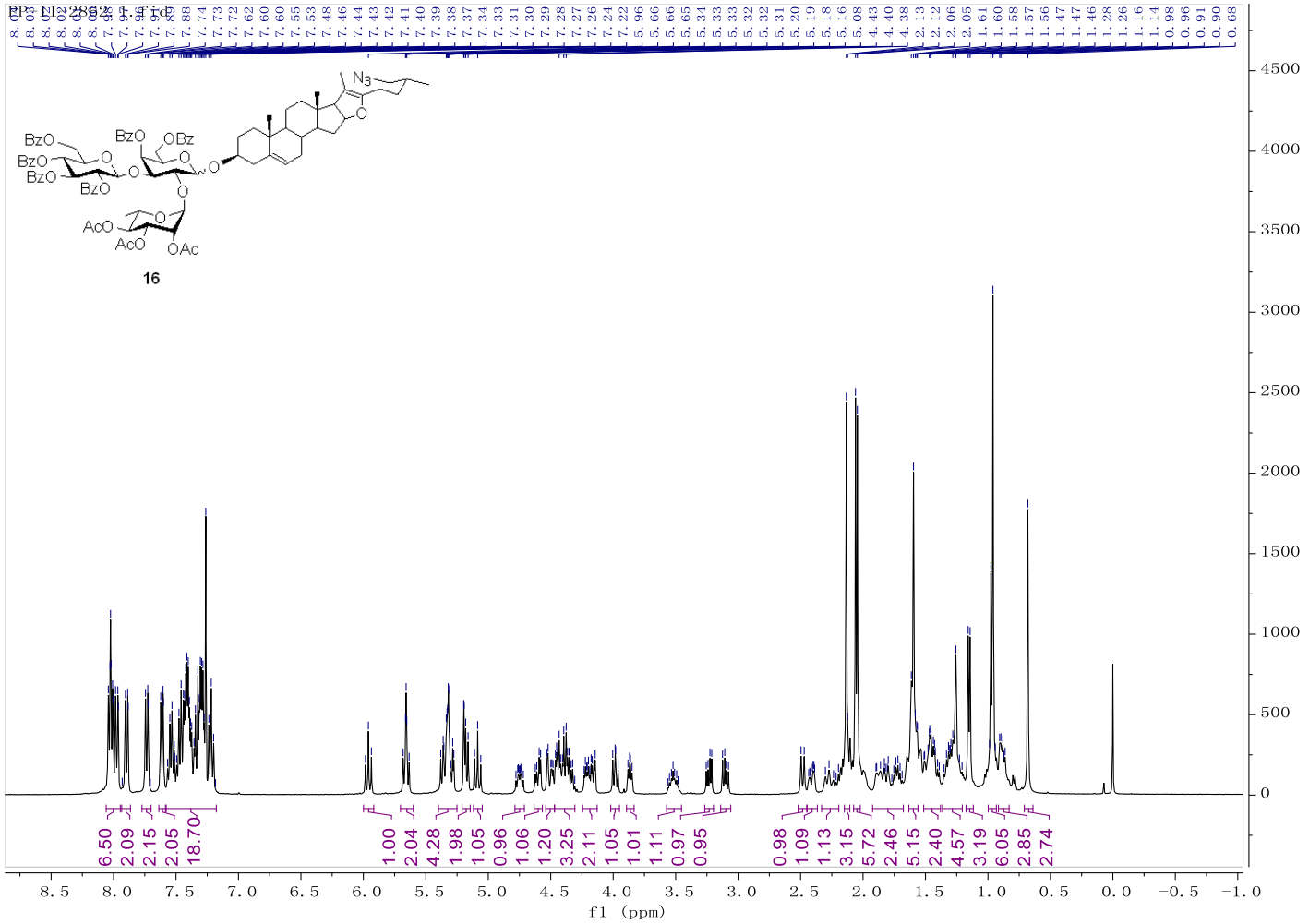
HSQC of compound **4**



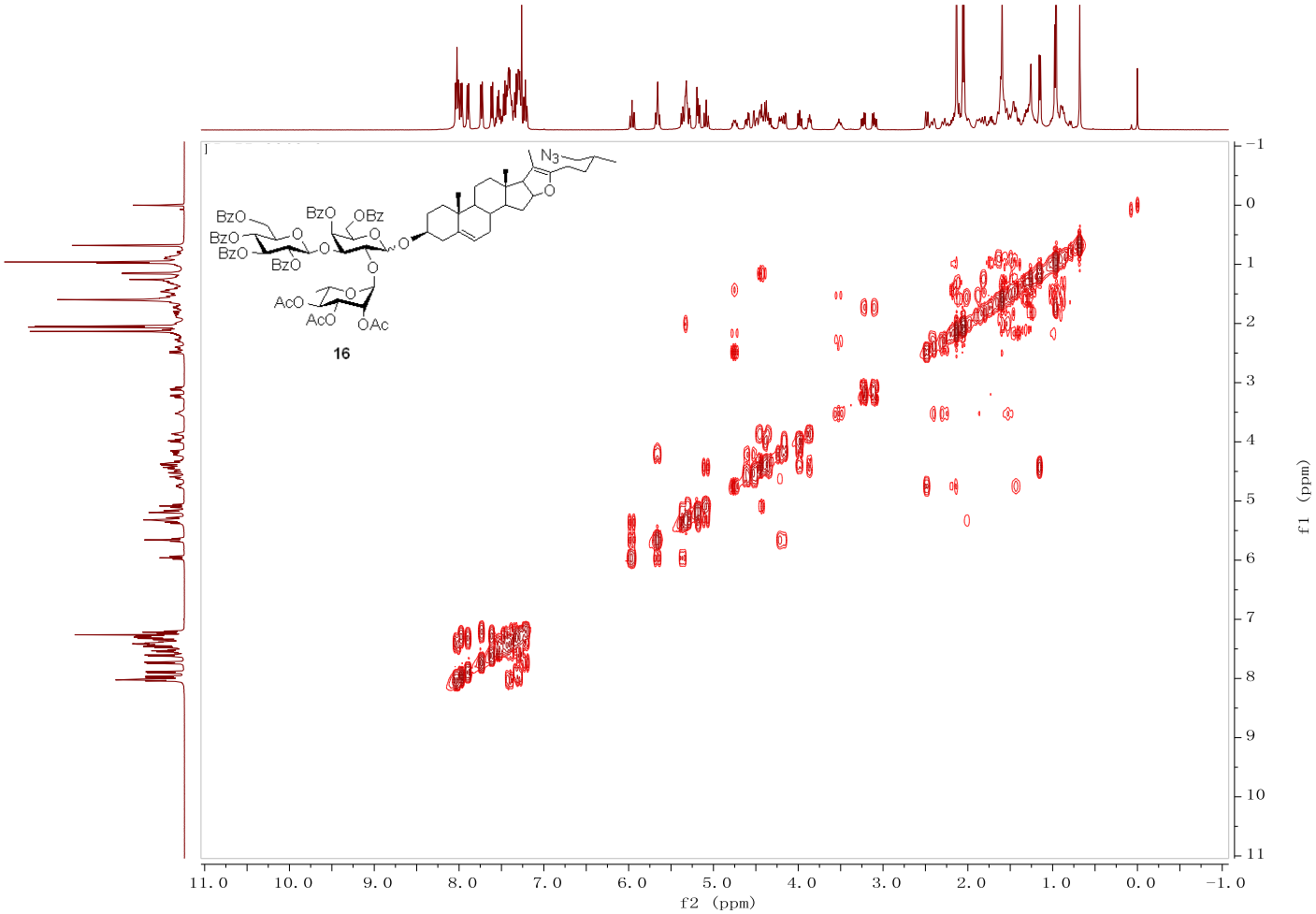
^{13}C spectrum of compound **4** (100 MHz, $CDCl_3$)



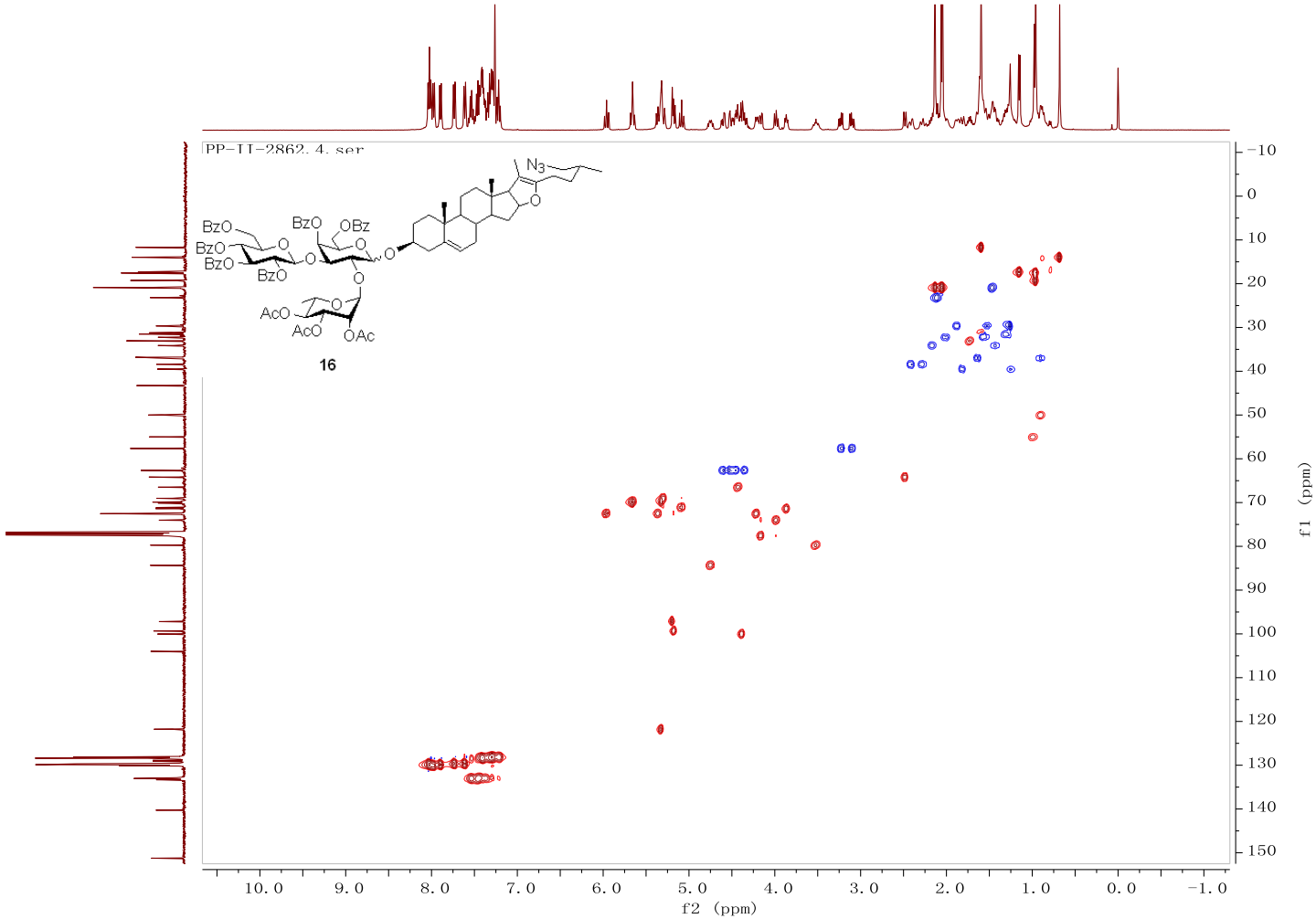
^{1}H spectrum of compound **16** (400 MHz, $CDCl_3$)



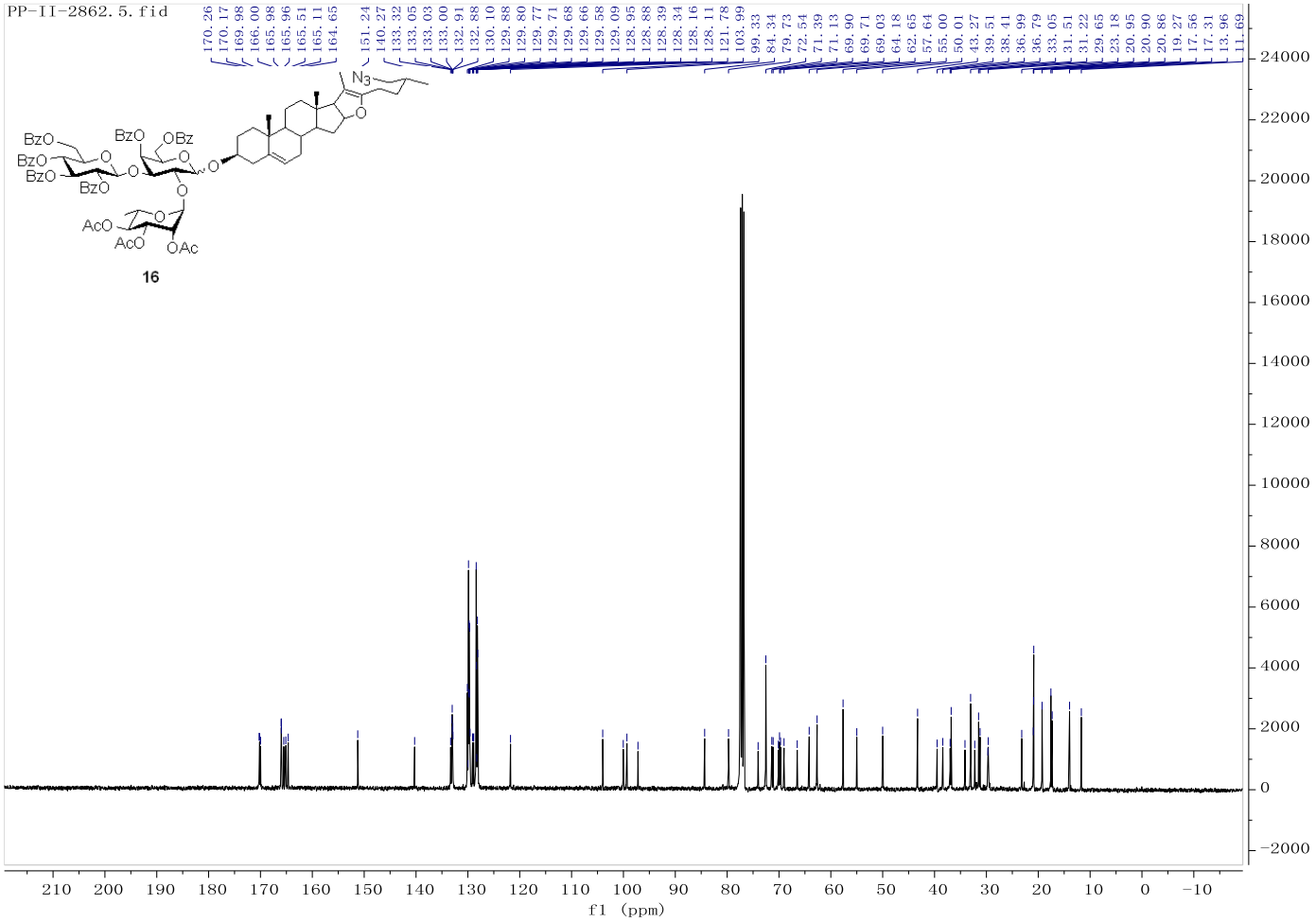
^{1}H- ^{1}H COSY of compound **16**



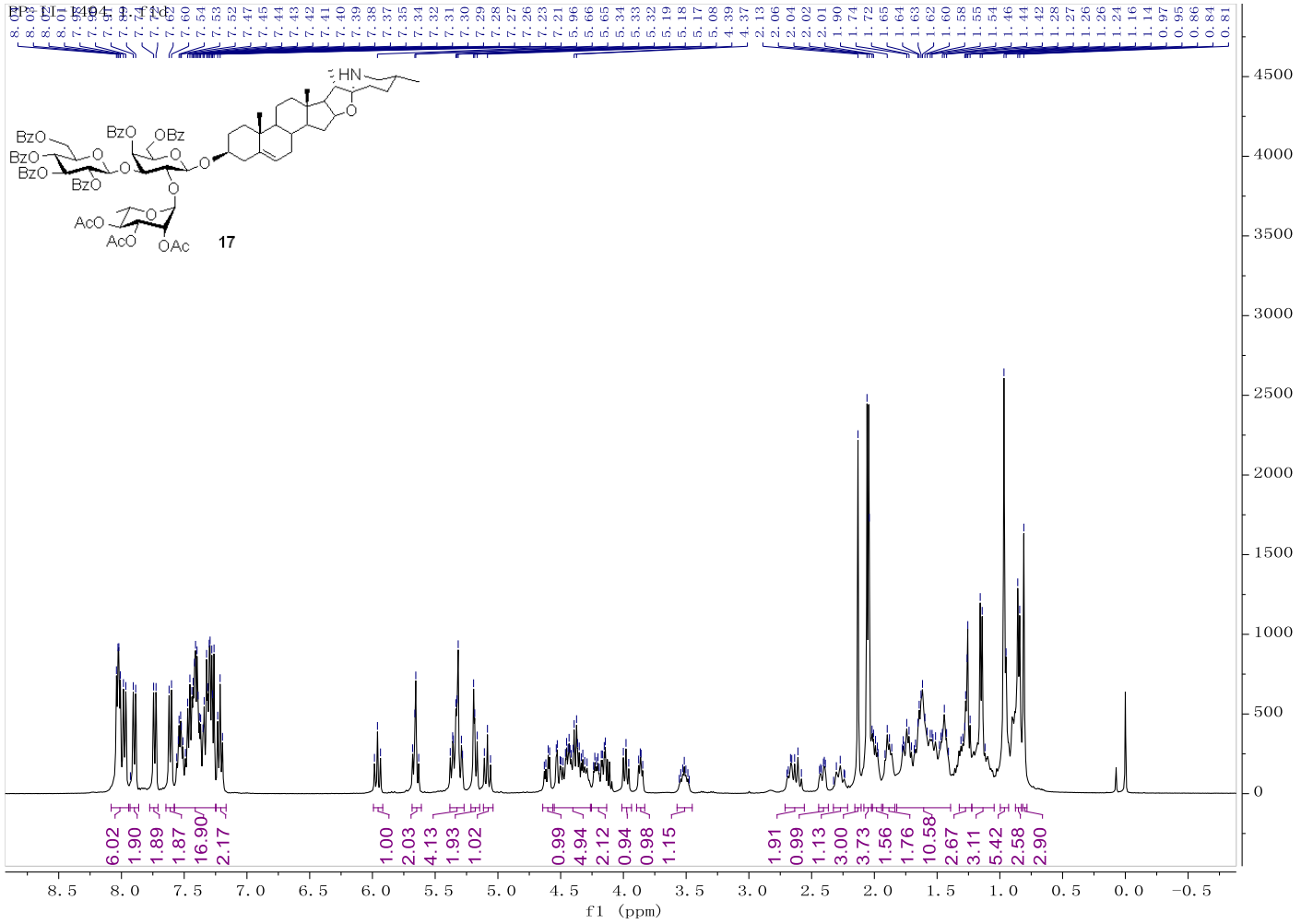
HSQC of compound **16**



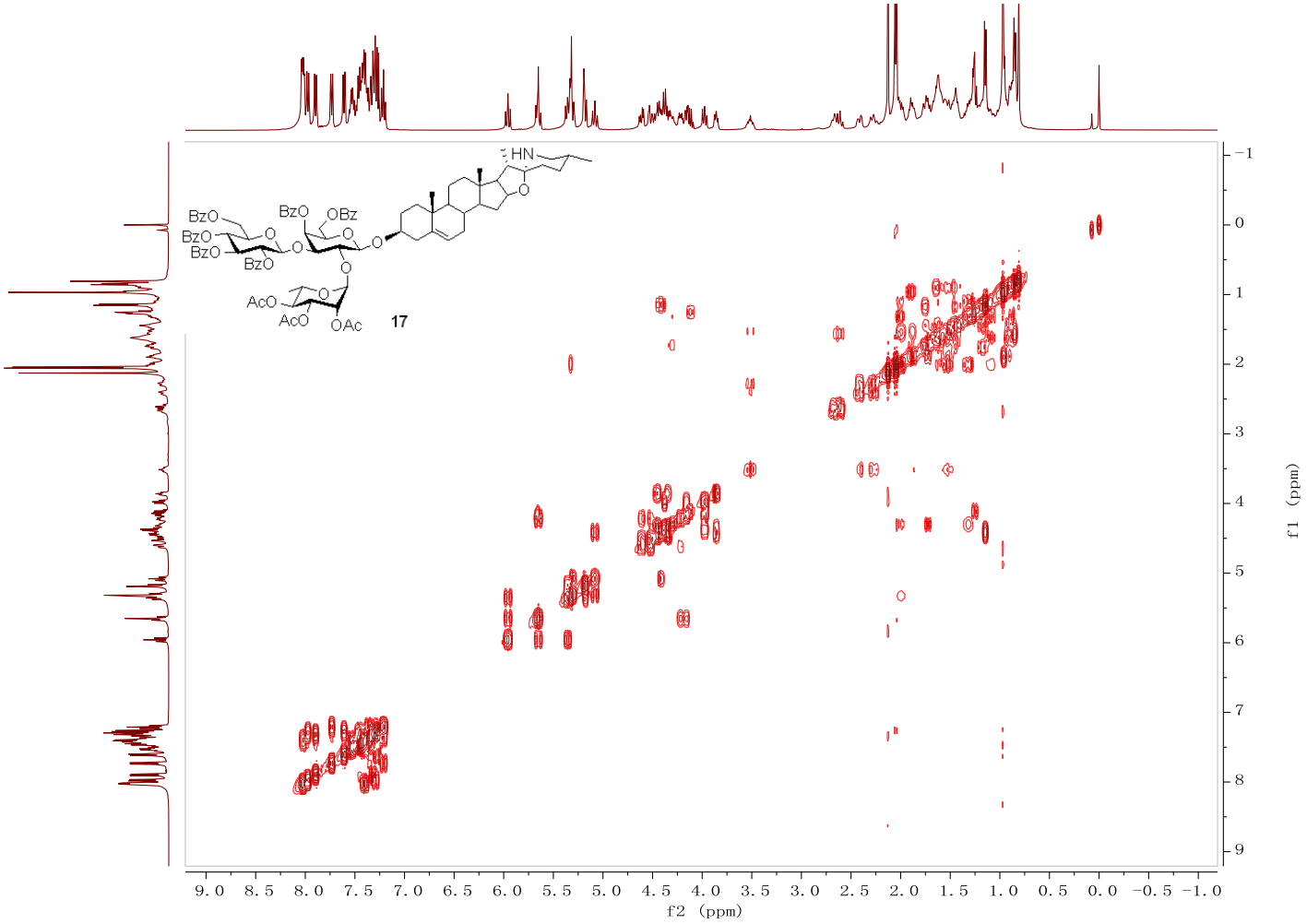
^{13}C spectrum of compound **16** (100 MHz, $CDCl_3$)



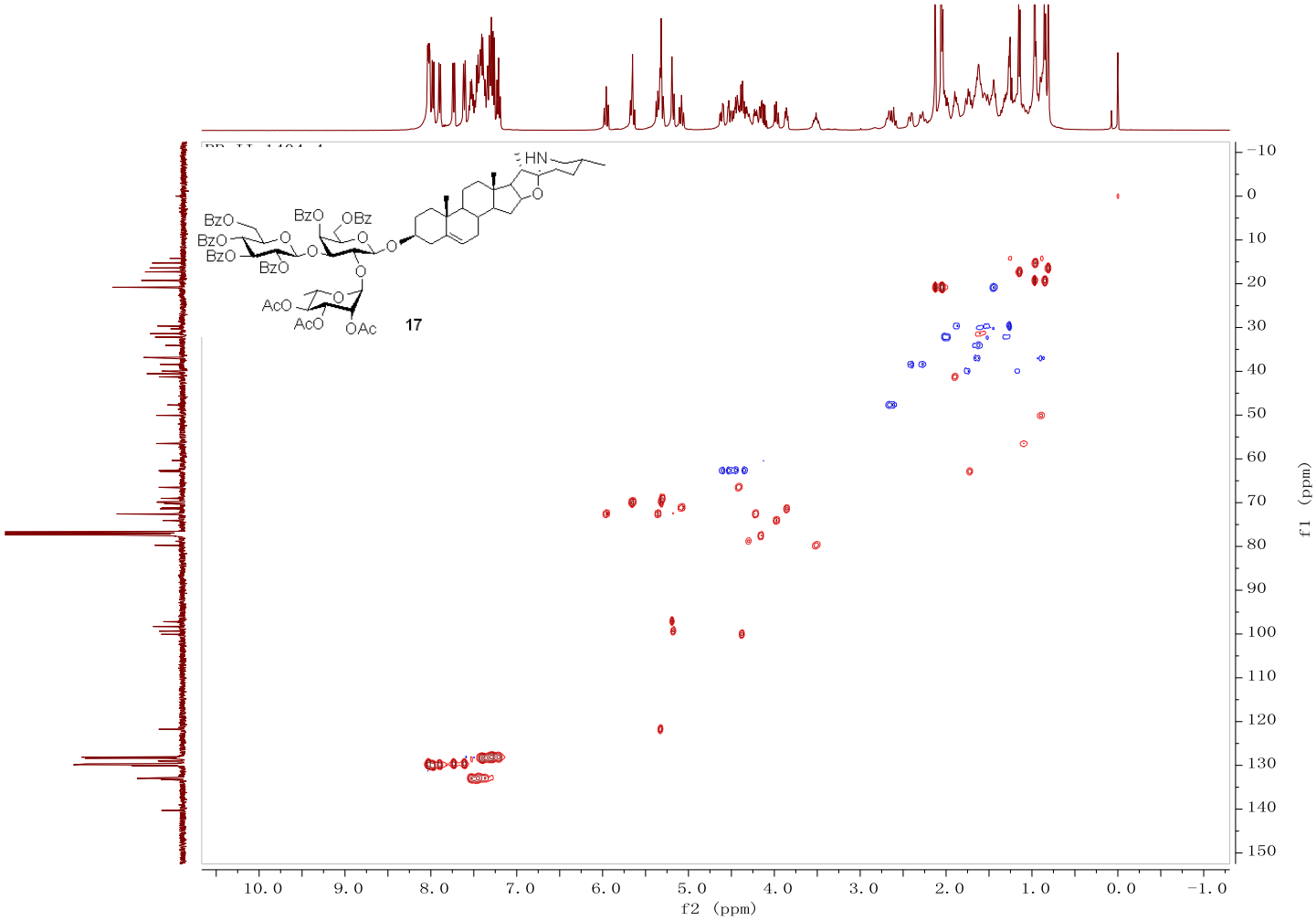
^{1}H spectrum of compound **17** (400 MHz, $CDCl_3$)



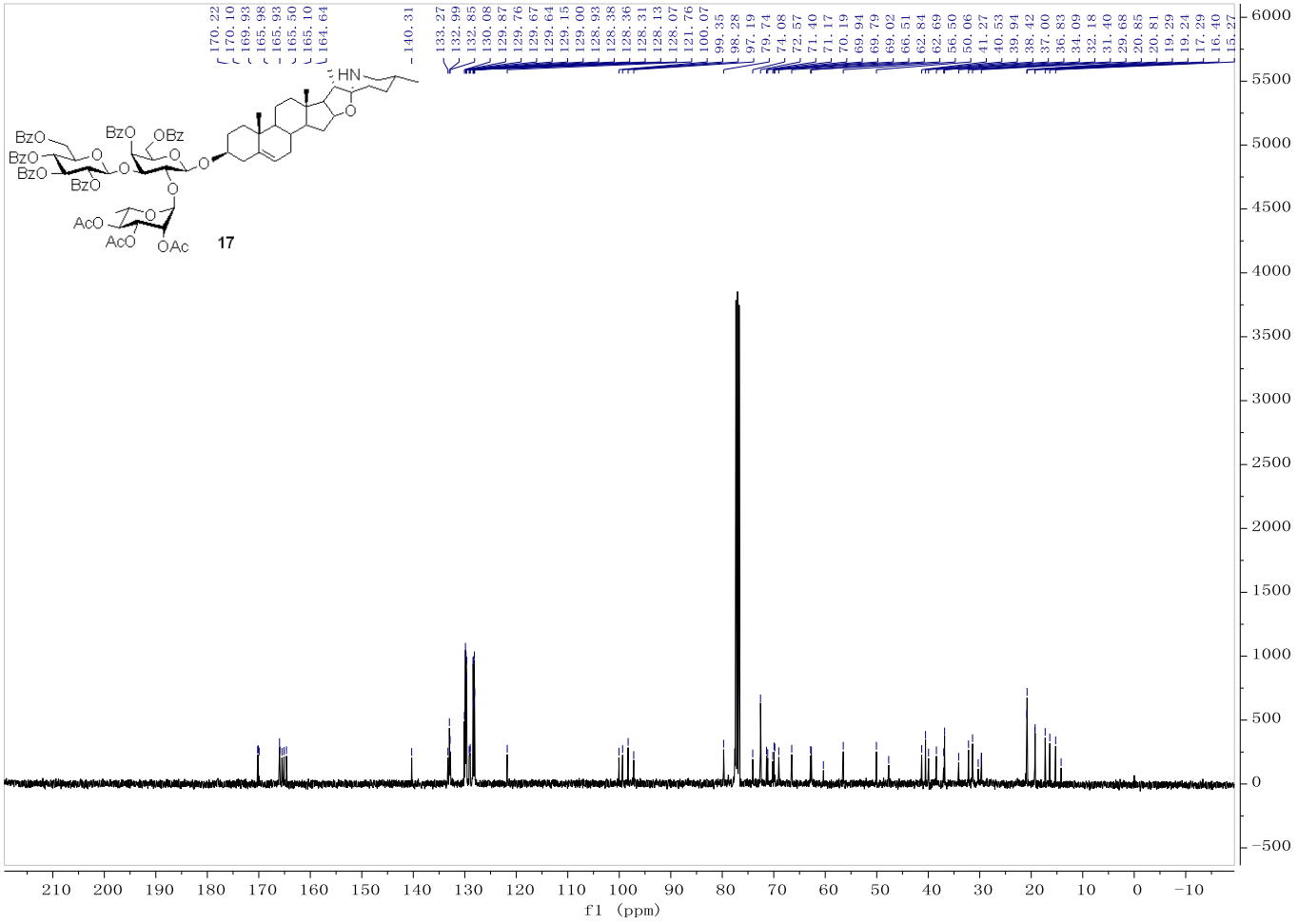
^{1}H- ^{1}H COSY of compound **17**



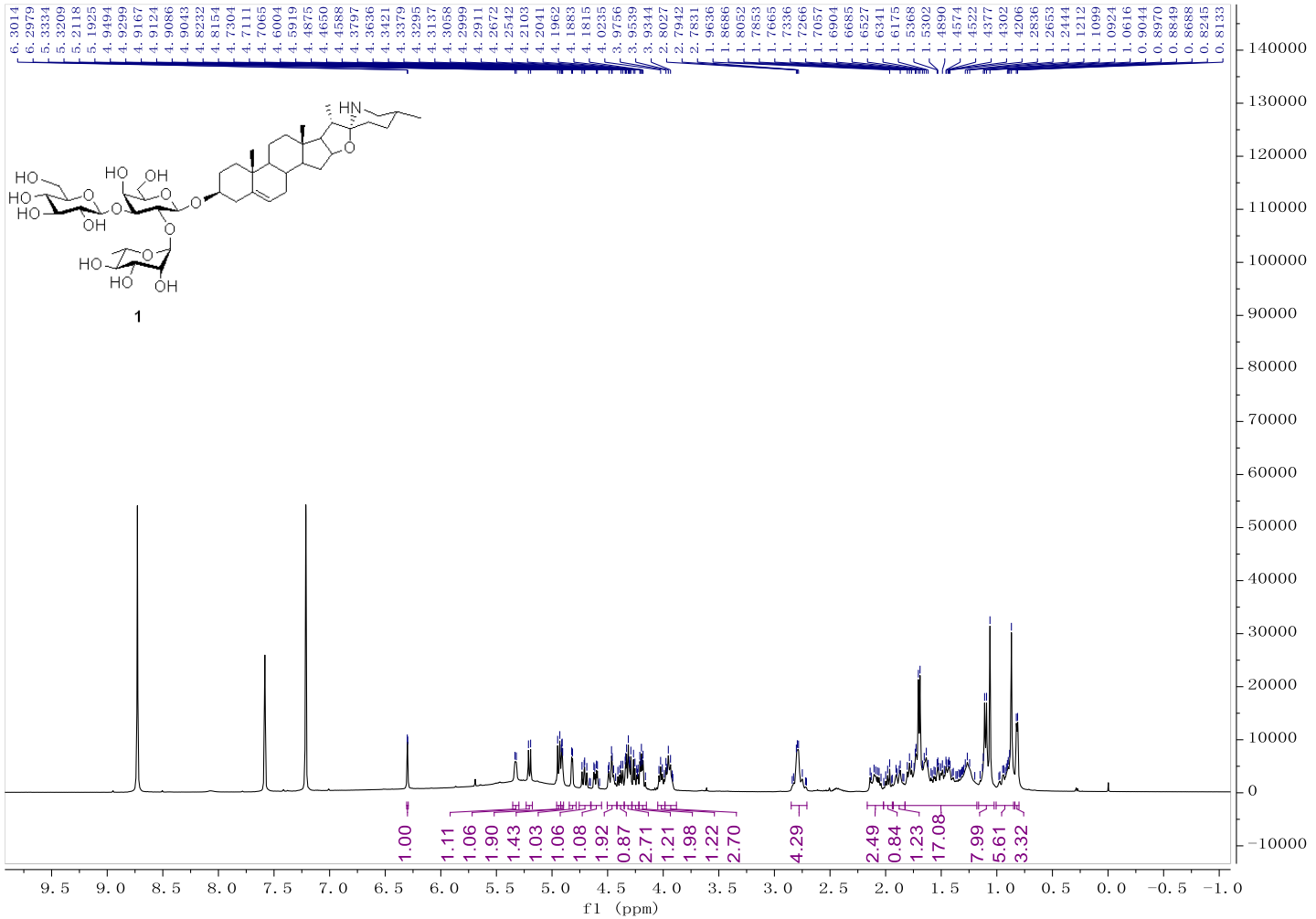
HSQC of compound **17**



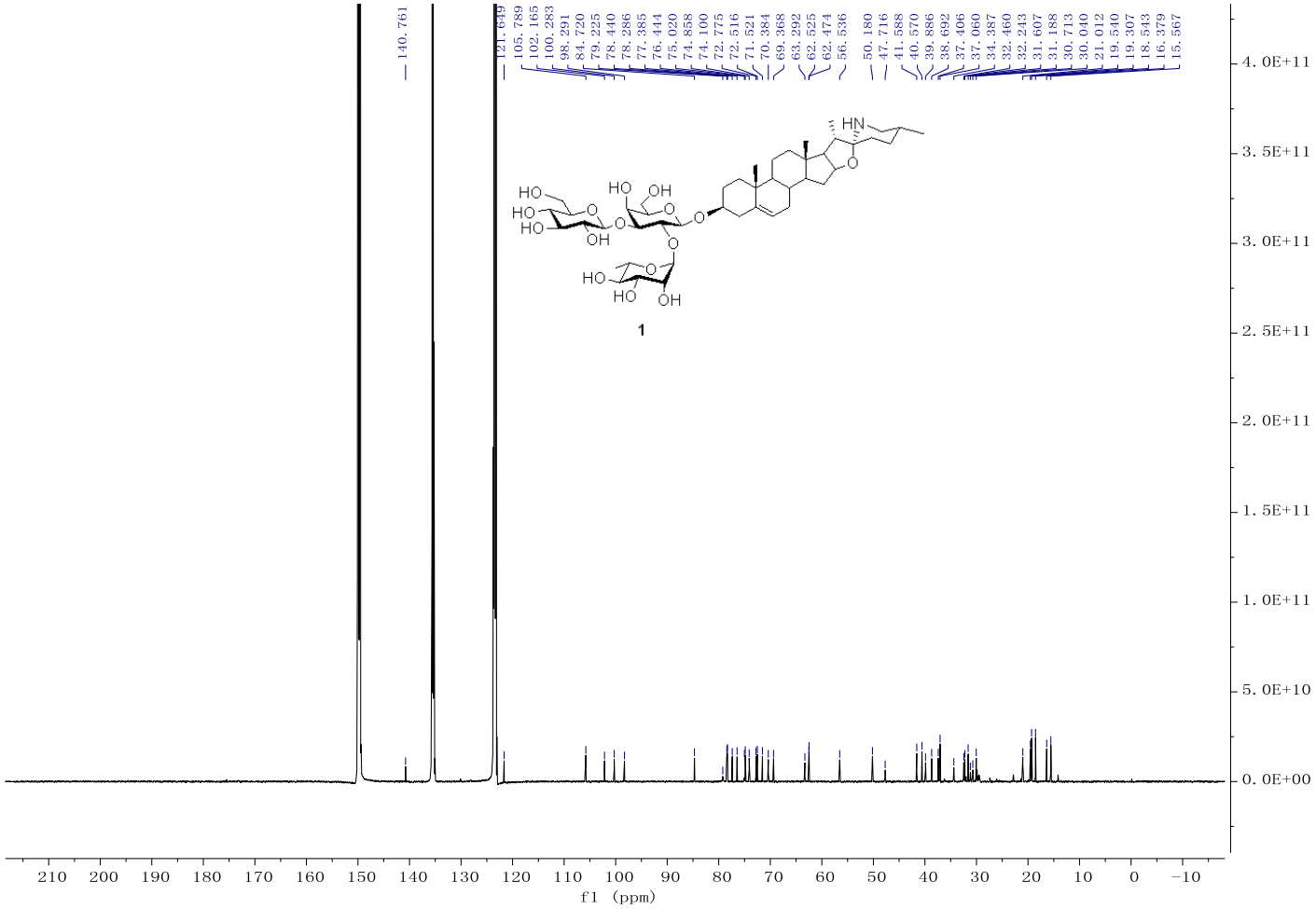
^{13}C spectrum of compound **17** (100 MHz, CDCl3)



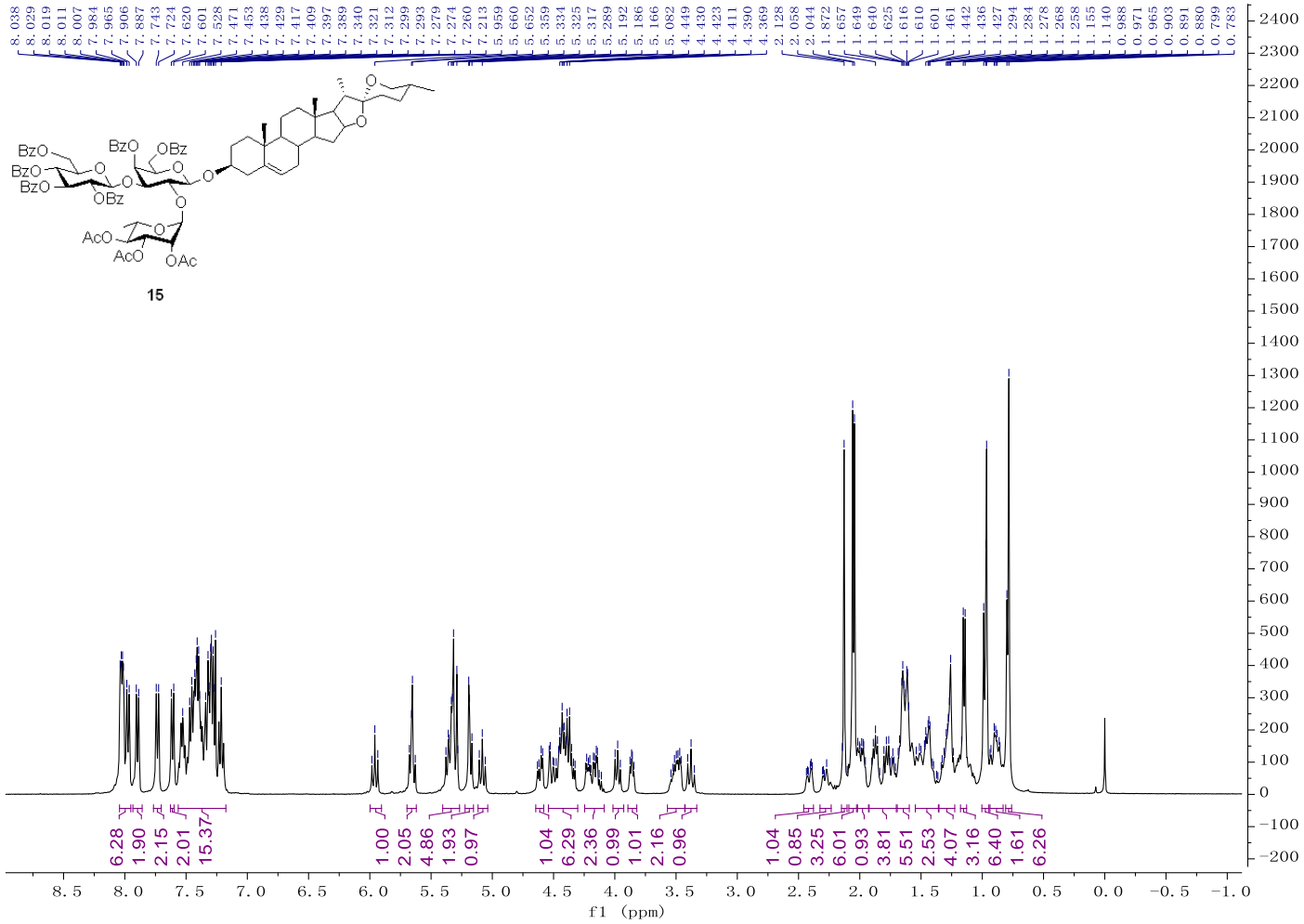
^{1}H spectrum of compound **1** (400 MHz, pyridine-d_5)



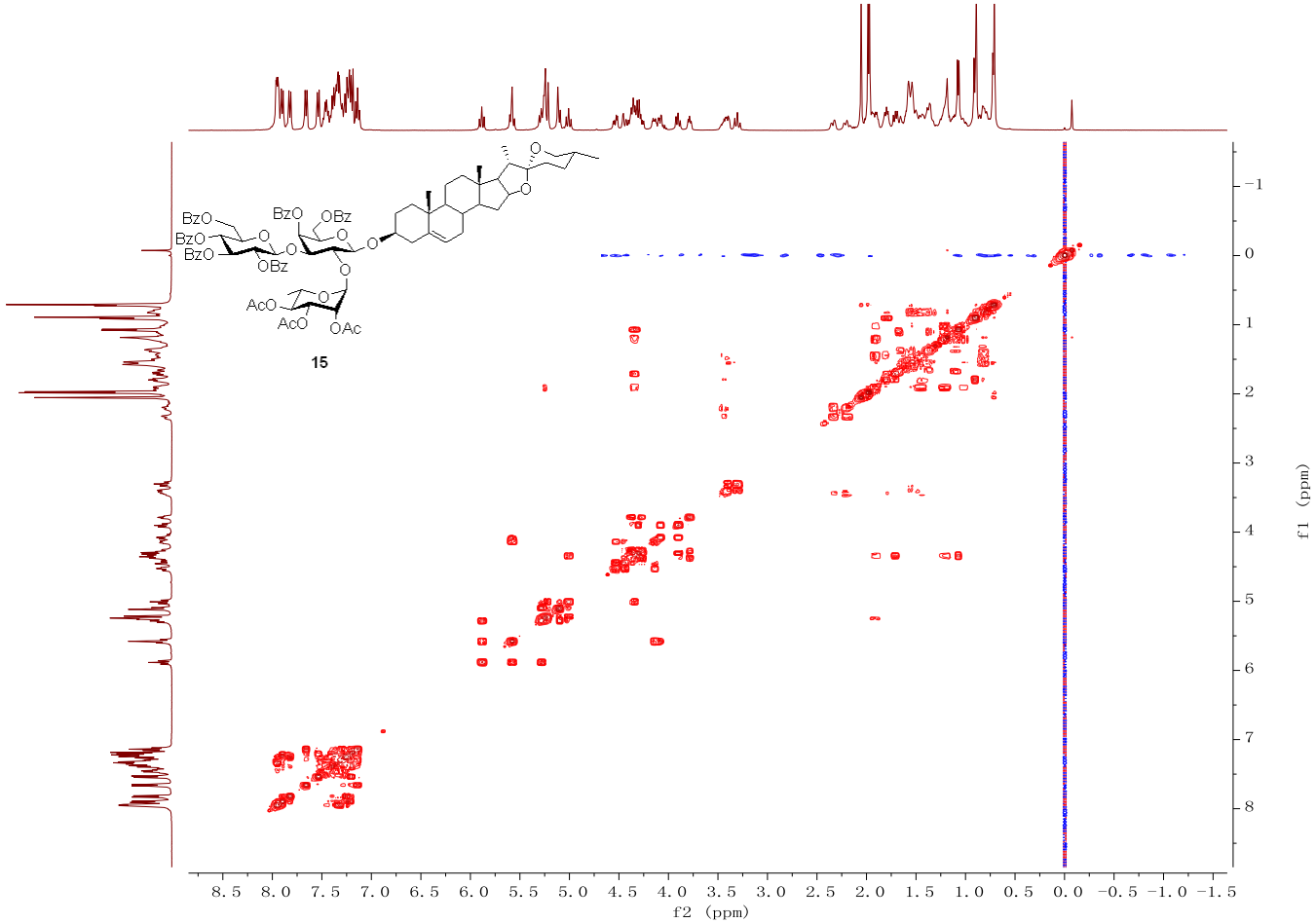
^{13}C spectrum of compound **1** (150 MHz, pyridine-d_5)



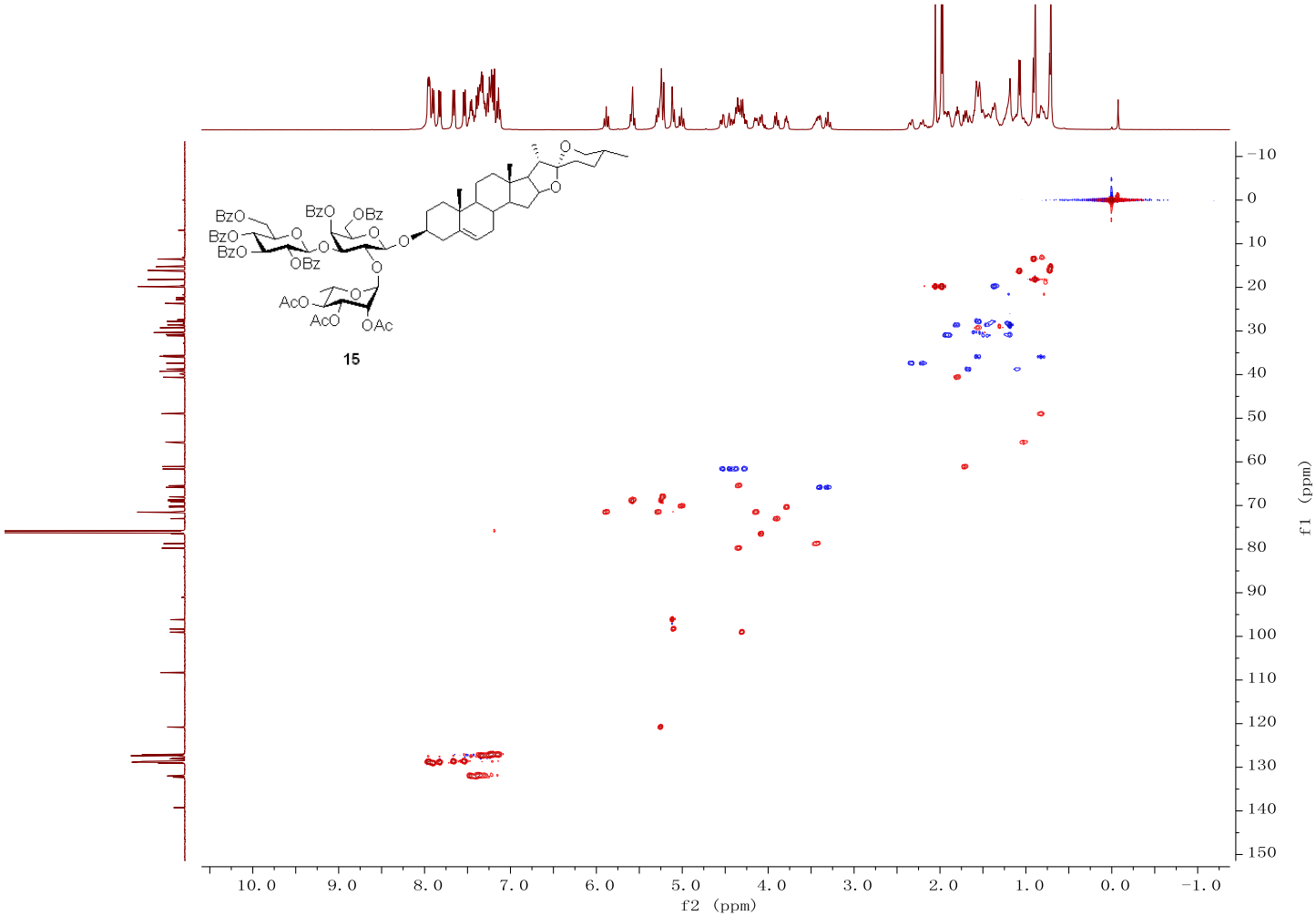
^{1}H spectrum of compound **15** (400 MHz, $CDCl_3$)



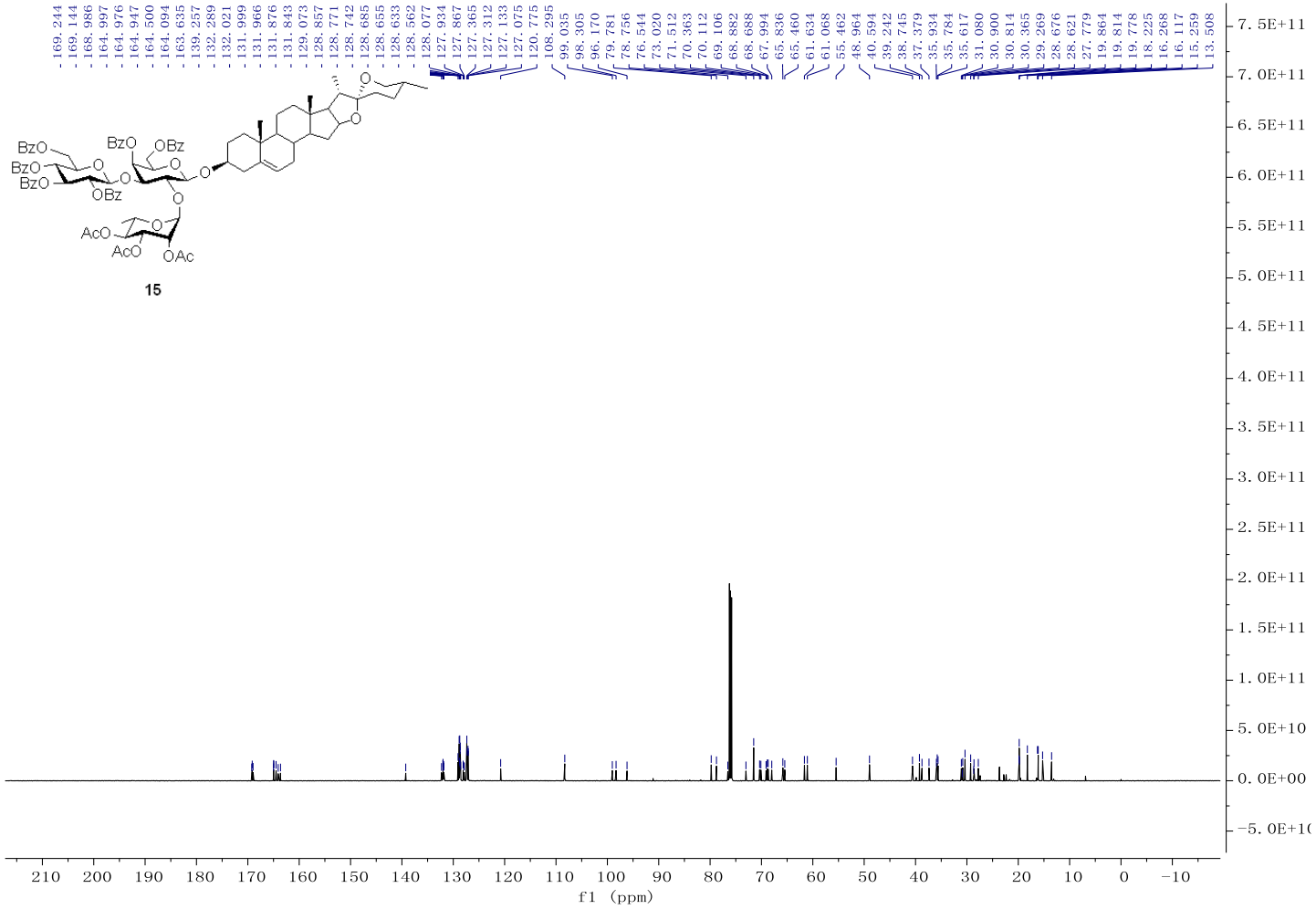
^{1}H- ^{1}H COSY of compound **15**



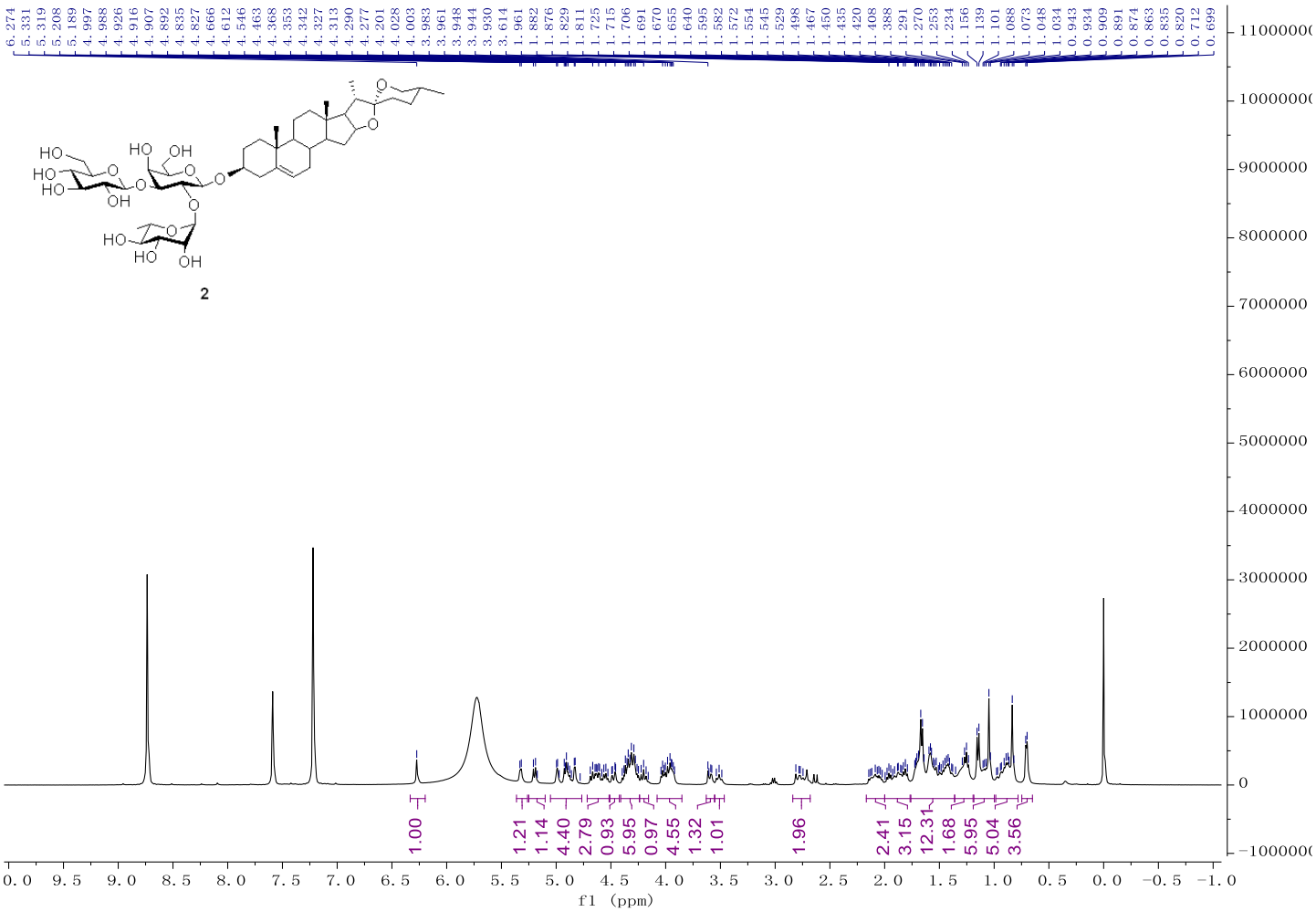
HSQC of compound **15**



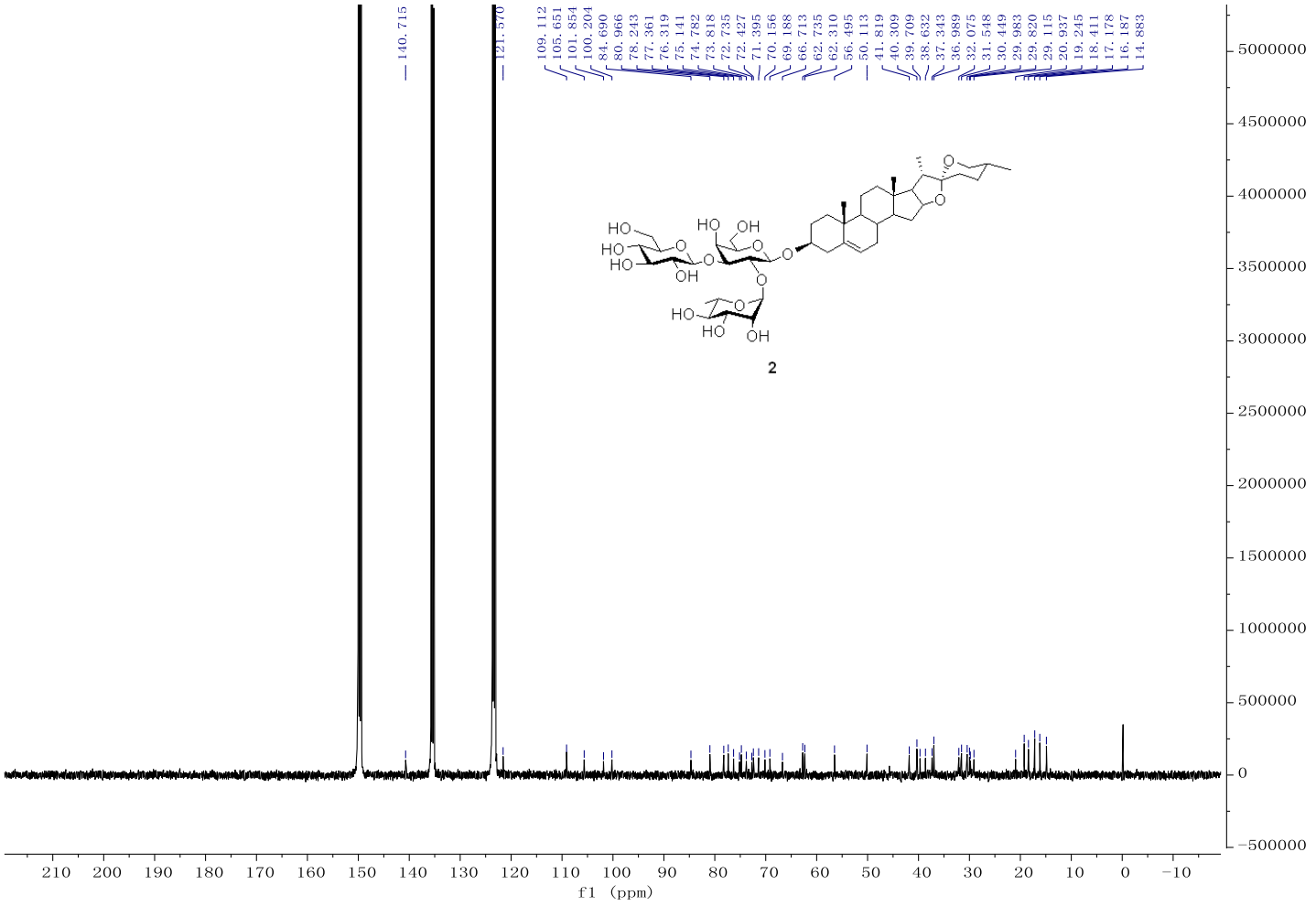
^{13}C spectrum of compound **15** (150 MHz, $CDCl_3$)



^{1}H spectrum of compound **2** (400 MHz, pyridine-d_5)



^{13}C spectrum of compound **2** (100 MHz, pyridine-d_5)



2