

Supporting information

Comparison of glycosyl donors: a supramer approach

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Single crystal X-ray analysis of methyl (phenyl 3,5-dideoxy-2-thio-4,9-bis-*O*-chloroacetyl-5-trifluoroacetamido-D-glycero- β -D-galacto-nonulopyranosid)onate (7)

Single crystals of methyl (phenyl 3,5-dideoxy-2-thio-4,9-bis-*O*-chloroacetyl-5-trifluoroacetamido-D-glycero- β -D-galacto-nonulopyranosid)onate water solvate ($7 \cdot H_2O$) were grown from acetone- d_6 in an NMR tube. A suitable crystal was selected and the XRD analysis was performed on a Bruker SMART APEX2 DUO CCD diffractometer (CuK α radiation, $\lambda = 1.54178 \text{ \AA}$). The crystal was kept at 120 K during data collection. The data set was corrected for absorption with SADABS [1], the structure was solved with the ShelXT [2,3] structure solution program using Direct Methods and refined with the ShelXL [2,3] refinement package using Least Squares minimization (Olex2 [4] was used as an interface to ShelXT and ShelXL packages). Non-hydrogen atoms were refined anisotropically. The hydrogen atoms of water molecules, amino and hydroxyl groups were localized in the difference-Fourier maps and refined isotropically with X-H distances fixed at values 0.84 \AA for O-H and 0.95 \AA for N-H bonds. The other hydrogen atoms were placed in calculated positions and refined within riding model with fixed isotropic displacement parameters [$U_{iso}(H) = 1.2U_{eq}(C)$].

Crystal Data for $6C_{22}H_{24}Cl_2F_3NO_{10}S \cdot 3H_2O$ [$C_{132}H_{150}Cl_{12}F_{18}N_6O_{63}S_6$] ($M = 3788.23 \text{ g} \cdot \text{mol}^{-1}$): hexagonal, space group $P6_1$ (no. 169), $a = 22.9311(10) \text{ \AA}$, $c = 27.2831(12) \text{ \AA}$, $V = 12424.4(12) \text{ \AA}^3$, $Z = 3$, $T = 120 \text{ K}$, $\mu(\text{CuK}\alpha) = 3.520 \text{ mm}^{-1}$, $D_{calc} = 1.519 \text{ g} \cdot \text{cm}^{-3}$, 78997 reflections measured ($4.45^\circ \leq 2\theta \leq 146.052^\circ$), 15162 unique ($R_{int} = 0.0838$, $R_{\sigma} = 0.0608$) which were used in all calculations. The final R_1 was 0.0531 ($I > 2\sigma(I)$) and wR_2 was 0.1498 (all data). Crystal structure has been deposited with Cambridge Crystallographic Data Center (CCDC reference number 1843708).

Crystal unit of methyl (phenyl 3,5-dideoxy-2-thio-4,9-bis-*O*-chloroacetyl-5-trifluoroacetamido-D-glycero- β -D-galacto-nonulopyranosid)onate (further, carbohydrate) water solvate constitutes of three independent carbohydrate molecules and 1.5 water molecules. The main conformation of one of the carbohydrate molecules is shown in Figure 5S. A superposition of the main conformations of all three independent carbohydrate molecules is shown in Figure 6S.

Two of the carbohydrate molecules are well ordered (with slightly disordered CH_2Cl , CF_3 and Ph groups) and have very similar conformations (Figure 5S). They are connected by hydrogen bonds (both direct and through a complete water molecule) to form an infinite helix (Helix 1 on Figure 8S). The period of this helix is $27.2831(12) \text{ \AA}$ and consists of 6 carbohydrate molecules.

The third carbohydrate molecule is strongly disordered (Figure 7S, shift between parts is about 0.55–0.75 \AA) with identical occupancies of both parts. This molecule has a conformation different from the first two (Figures 6S, 7S). It is bonded by hydrogen bonds to its symmetrical images in neighboring cells to form another infinite helix (Helix 2 on Figure 8S). The period of this helix is identical to that of the first helix ($27.2831(12) \text{ \AA}$) and also consists of 6 carbohydrate molecules. Given the identical occupancies of the disordered parts, it is likely that they alternate in the helix.

Overall, the crystal structure consists of two independent infinite helices, and a disordered halfly occupied water molecules residing between them.

Table 1S. Conditions and results of sialylation of glycosyl acceptor **3** with sialyl donors **1** and **2** at 0.05 and 0.15 mol·L⁻¹ concentrations (C).

entry	sialyl donor	R	C (mol·L ⁻¹)	α/β	yield (%)	time (h)
1 ^[a]	1	TFA	0.05	16:1	55	2.5
2	1	TFA	0.15	12:1	66	3
3	2	ClAc	0.05	13:1	57	2
4	2	ClAc	0.15	18:1	62	1

[a] Data taken from [5].

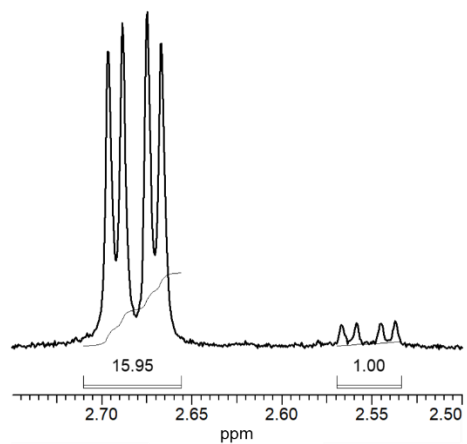


Figure 1S. A part of ¹H NMR spectrum of disaccharide fraction (Entry 1 in Table 1S) showing the signals of α-H-3eq and β-H-3eq of Neu5Ac residue of **4**.

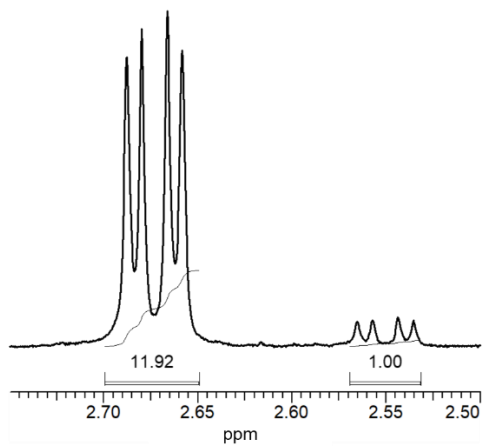


Figure 2S. A part of ¹H NMR spectrum of disaccharide fraction (Entry 2 in Table 1S) showing the signals of α -H-3eq and β -H-3eq of Neu5Ac residue of **4**.

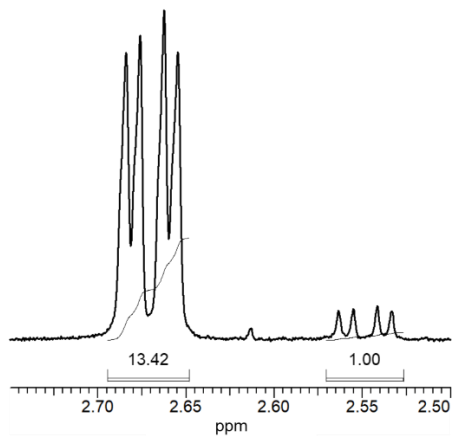


Figure 3S. A part of ¹H NMR spectrum of disaccharide fraction (Entry 3 in Table 1S) showing the signals of α -H-3eq and β -H-3eq of Neu5Ac residue of **4**.

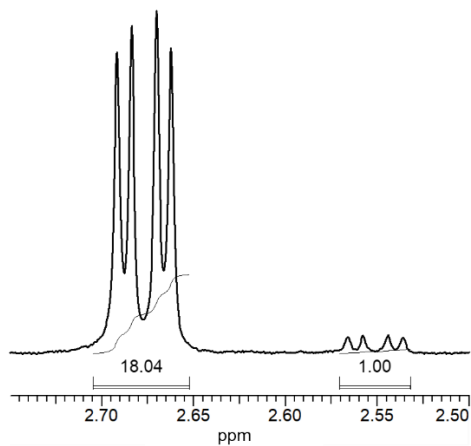


Figure 4S. A part of ¹H NMR spectrum of disaccharide fraction (Entry 4 in Table 1S) showing the signals of α -H-3eq and β -H-3eq of Neu5Ac residue of **4**.

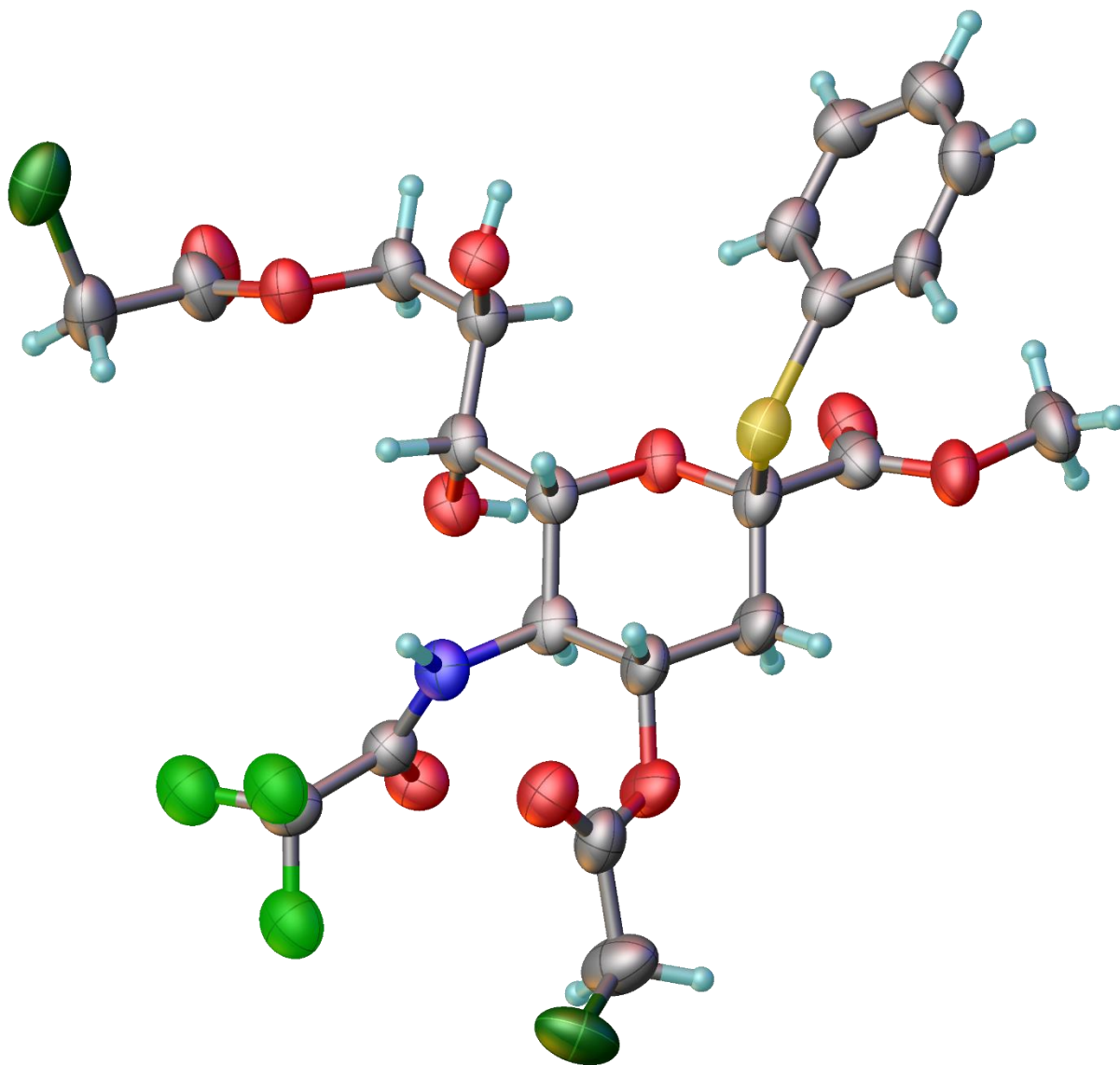


Figure 5S. The general view of a molecule of **7** in the crystal in representation of atoms by thermal ellipsoids ($p = 40\%$). Coloring: carbon – grey, oxygen – red, nitrogen – blue, fluorine – light green, sulphur – yellow, chlorine – dark green, hydrogen – sky blue.

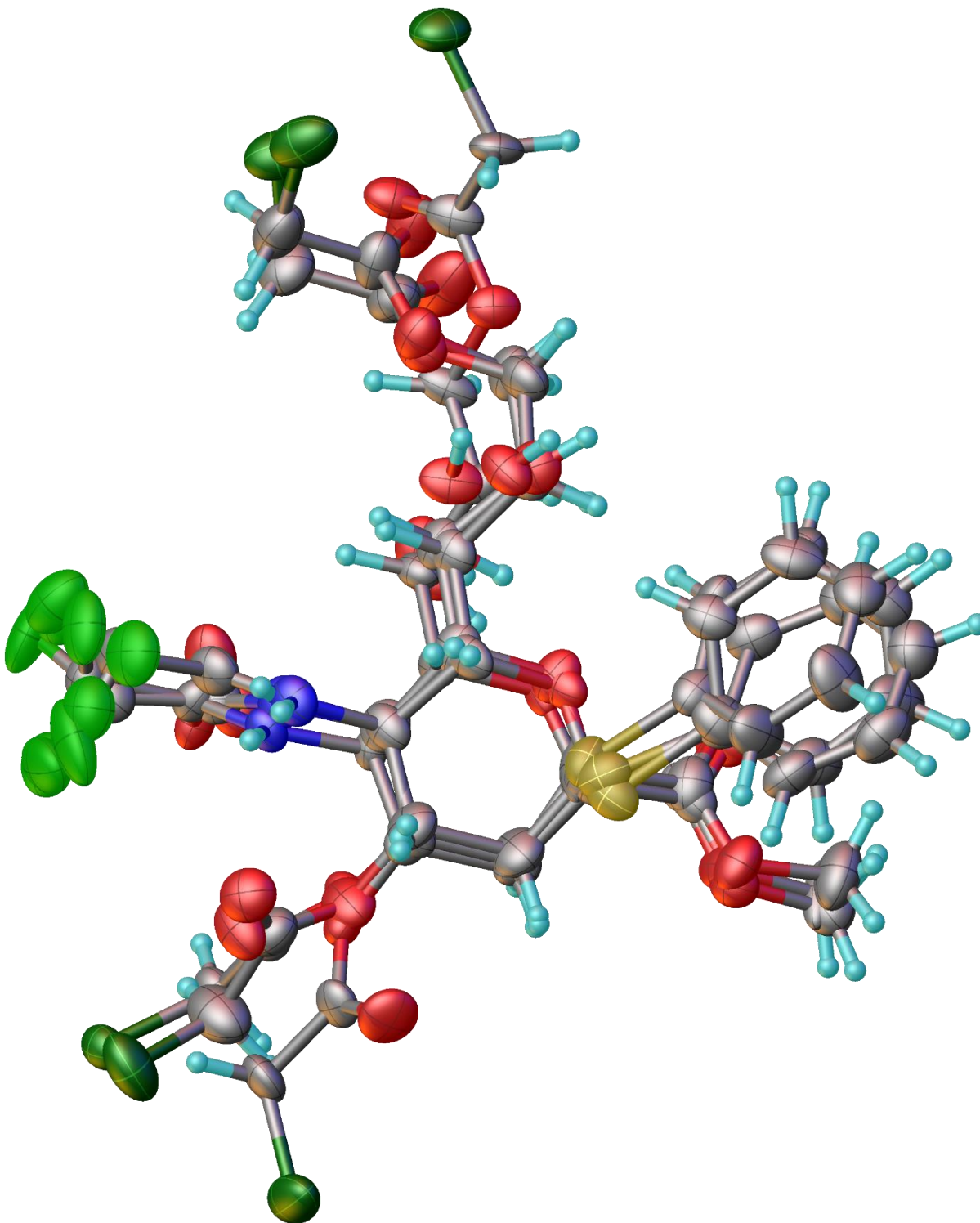


Figure 6S. Superposition of the main conformations of the three independent molecules of **7** in the crystal in representation of atoms by thermal ellipsoids ($p = 40\%$). Coloring: carbon – grey, oxygen – red, nitrogen – blue, fluorine – light green, sulphur – yellow, chlorine – dark green, hydrogen – sky blue.

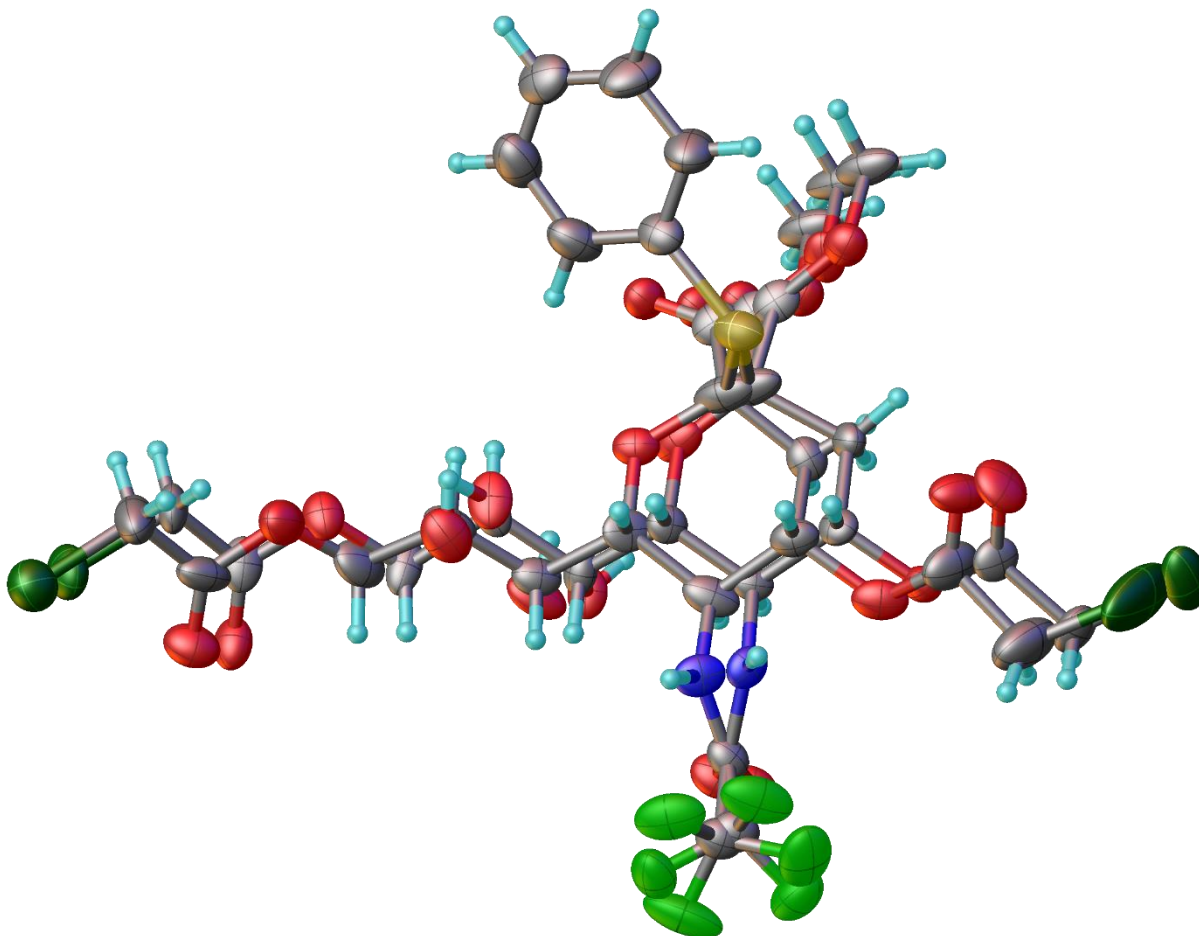
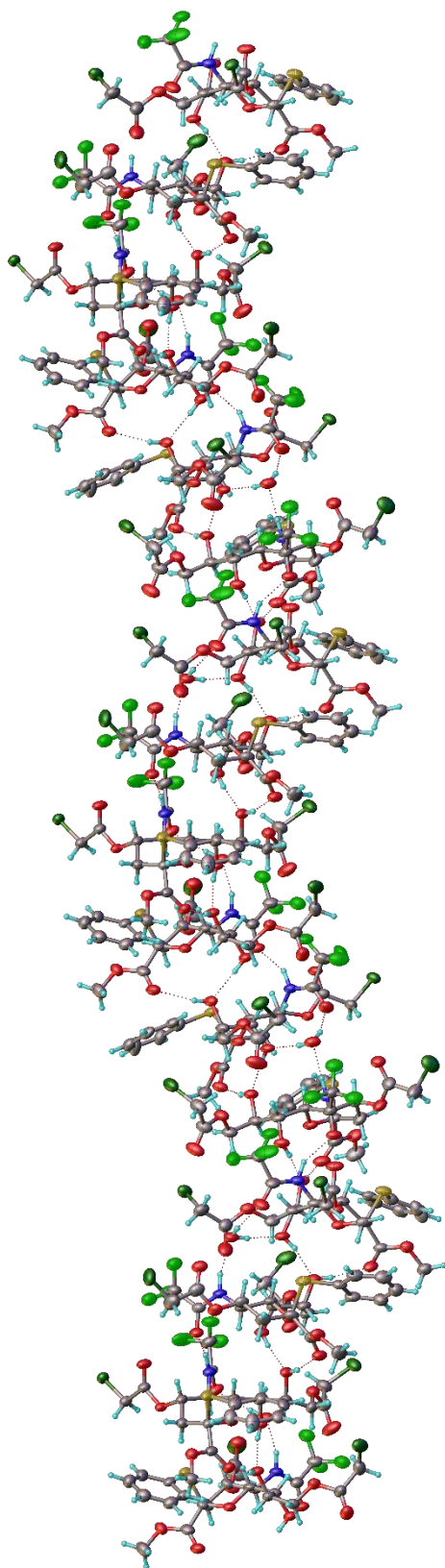


Figure 7S. The general view of the disordered molecule of **7** in the crystal in representation of atoms by thermal ellipsoids ($p = 40\%$). Coloring: carbon – grey, oxygen – red, nitrogen – blue, fluorine – light green, sulphur – yellow, chlorine – dark green, hydrogen – sky blue.

Helix 1 (with incorporated water molecule)



Helix 2 (disordered)

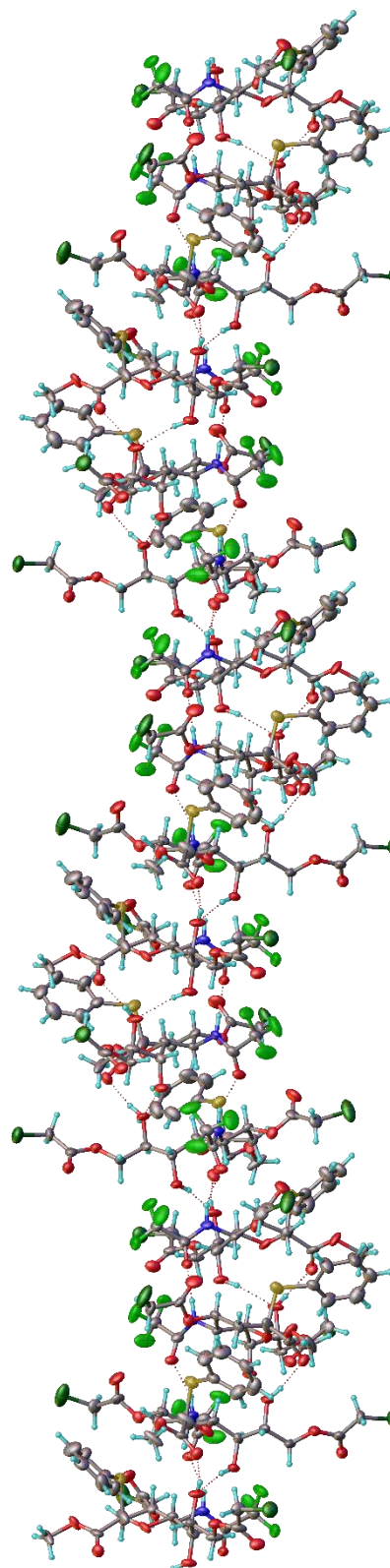
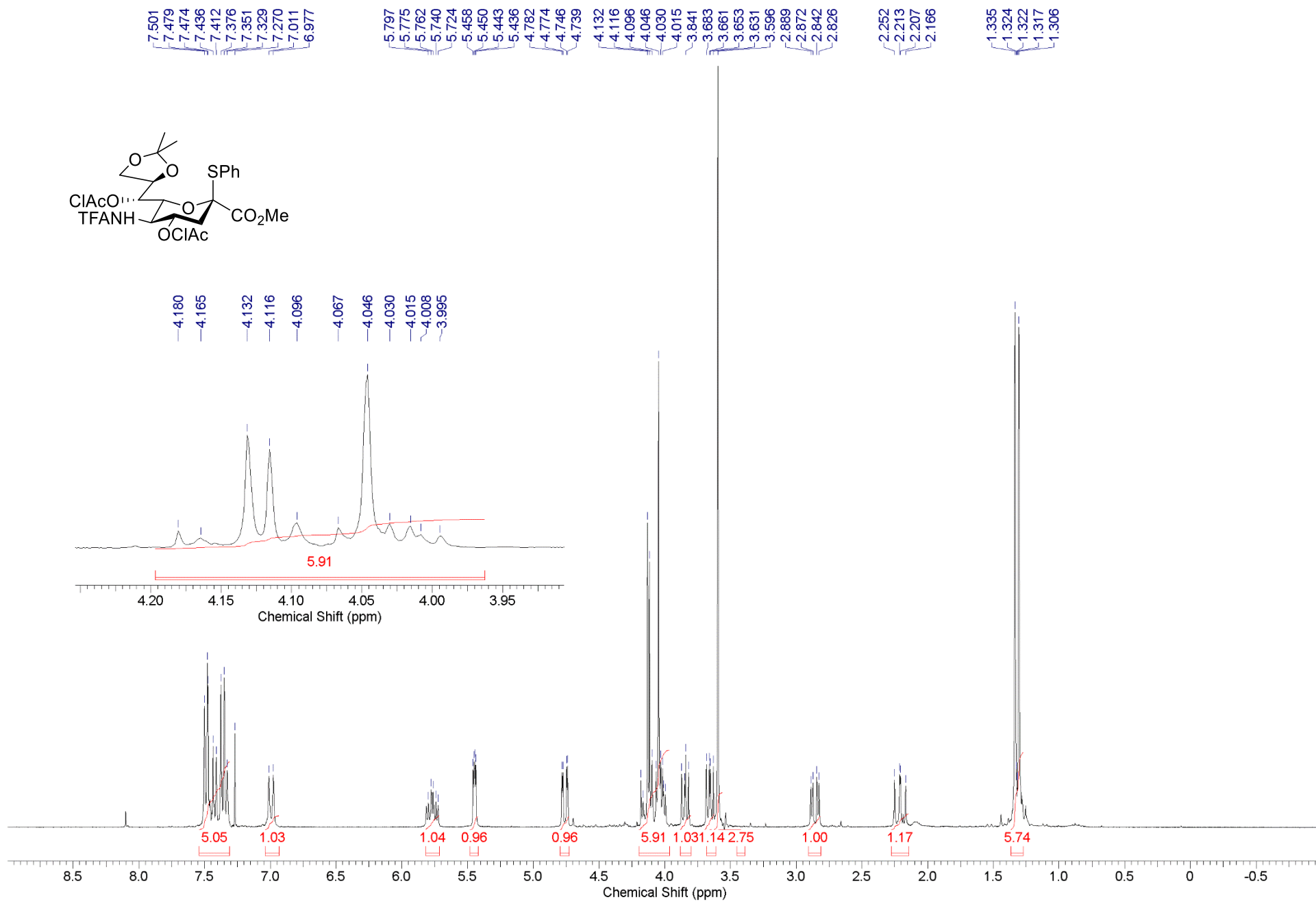
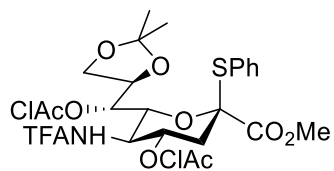
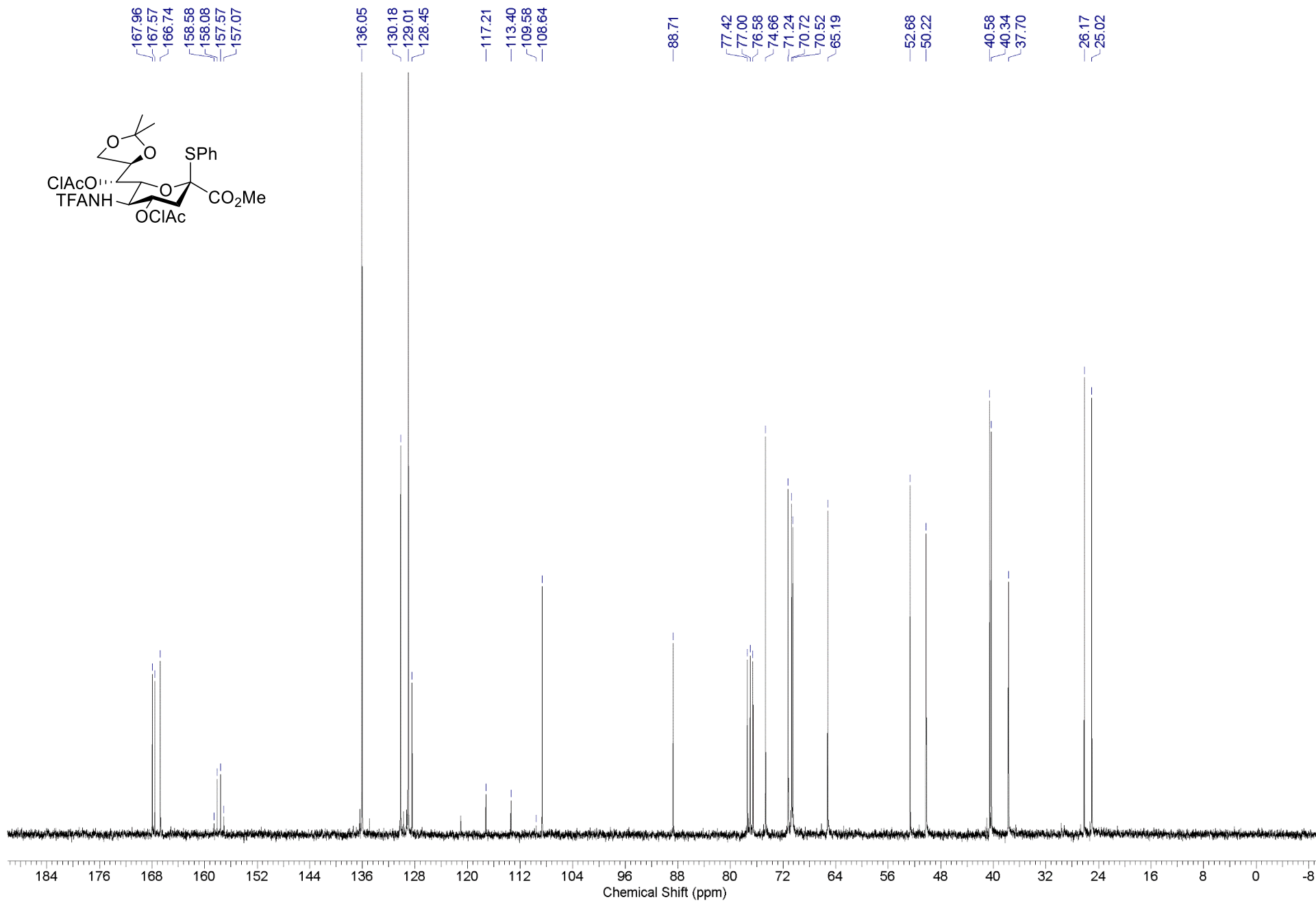


Figure 8S. Infinite helices formed in the crystal structure of **7**. Atoms are represented by thermal ellipsoids ($p = 40\%$). Coloring: carbon – grey, oxygen – red, nitrogen – blue, fluorine – light green, sulphur – yellow, chlorine – dark green, hydrogen – sky blue.

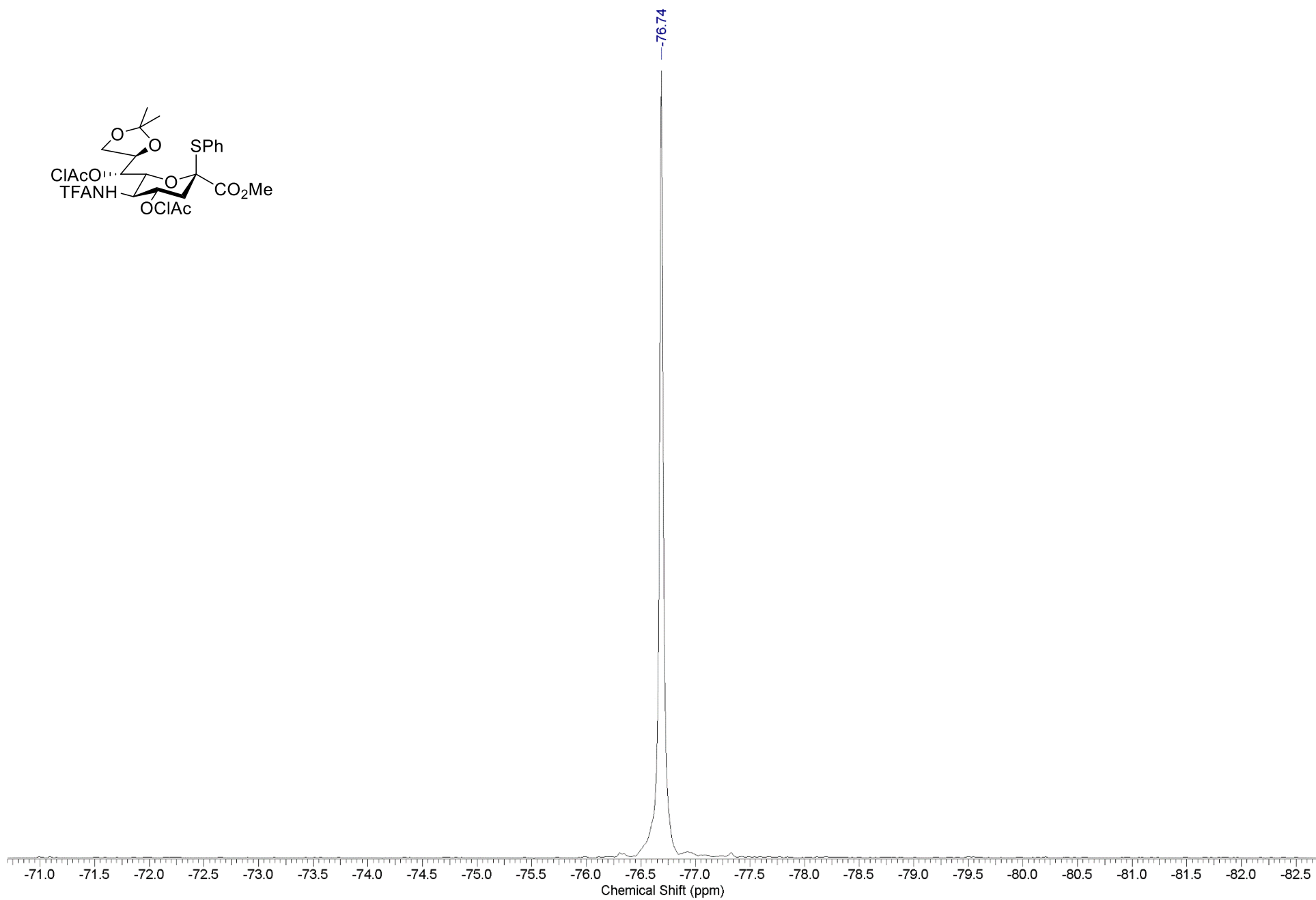
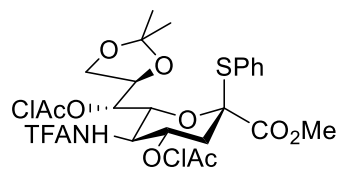
¹H NMR (300 MHz) spectrum of compound 6 in CDCl₃



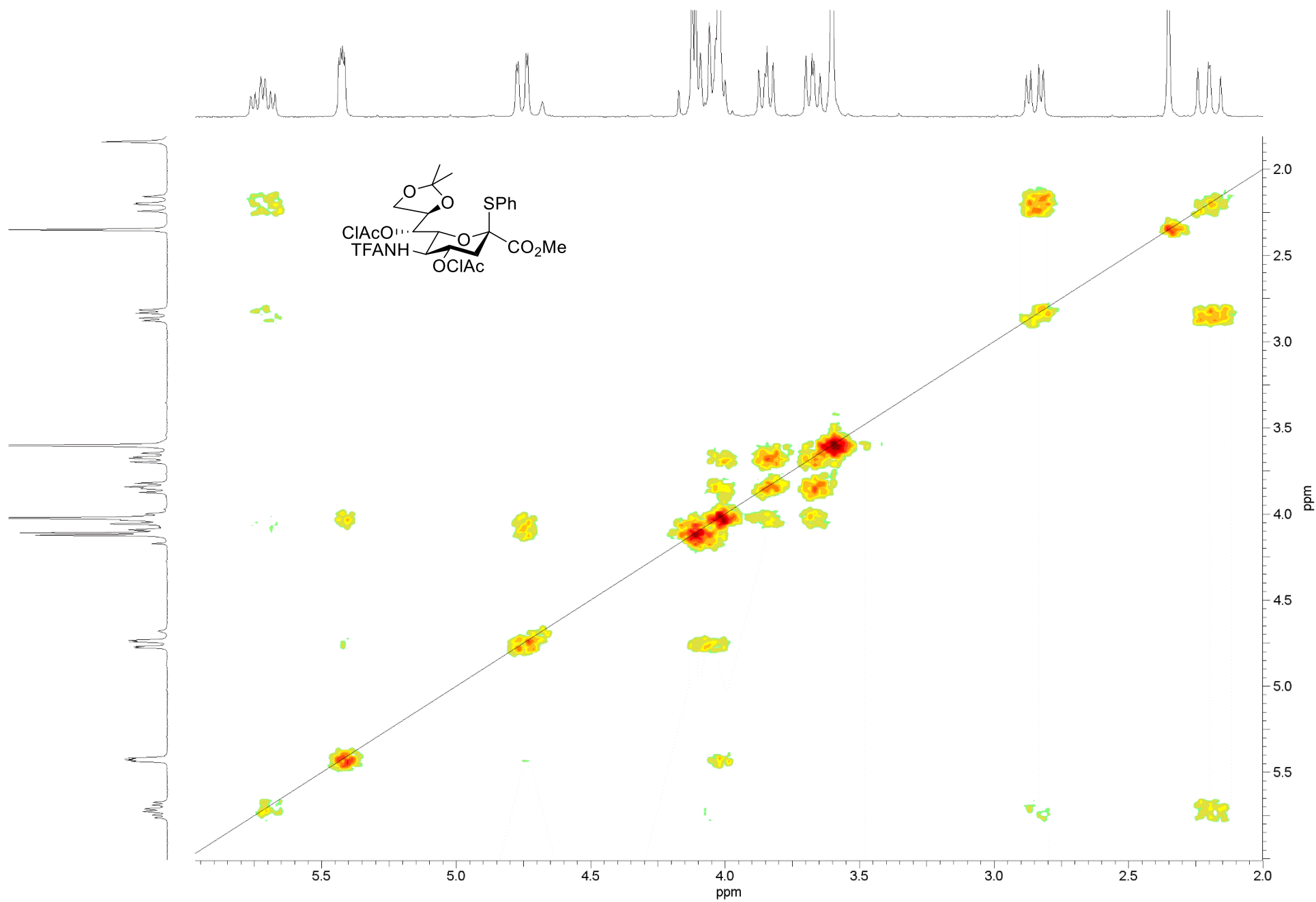
¹³C NMR (75 MHz) spectrum of compound 6 in CDCl₃



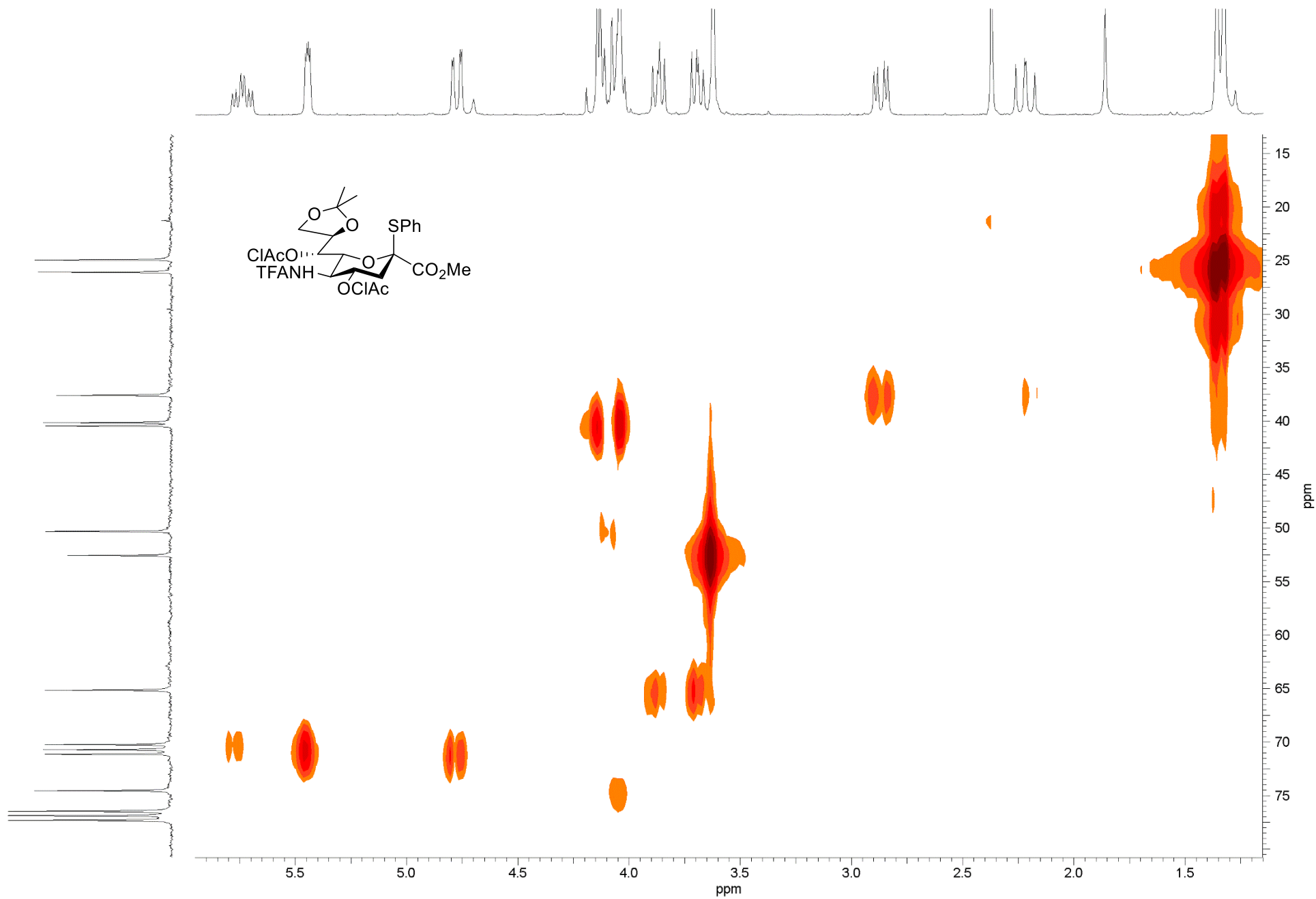
^{19}F NMR (282 MHz) spectrum of compound 6 in CDCl_3



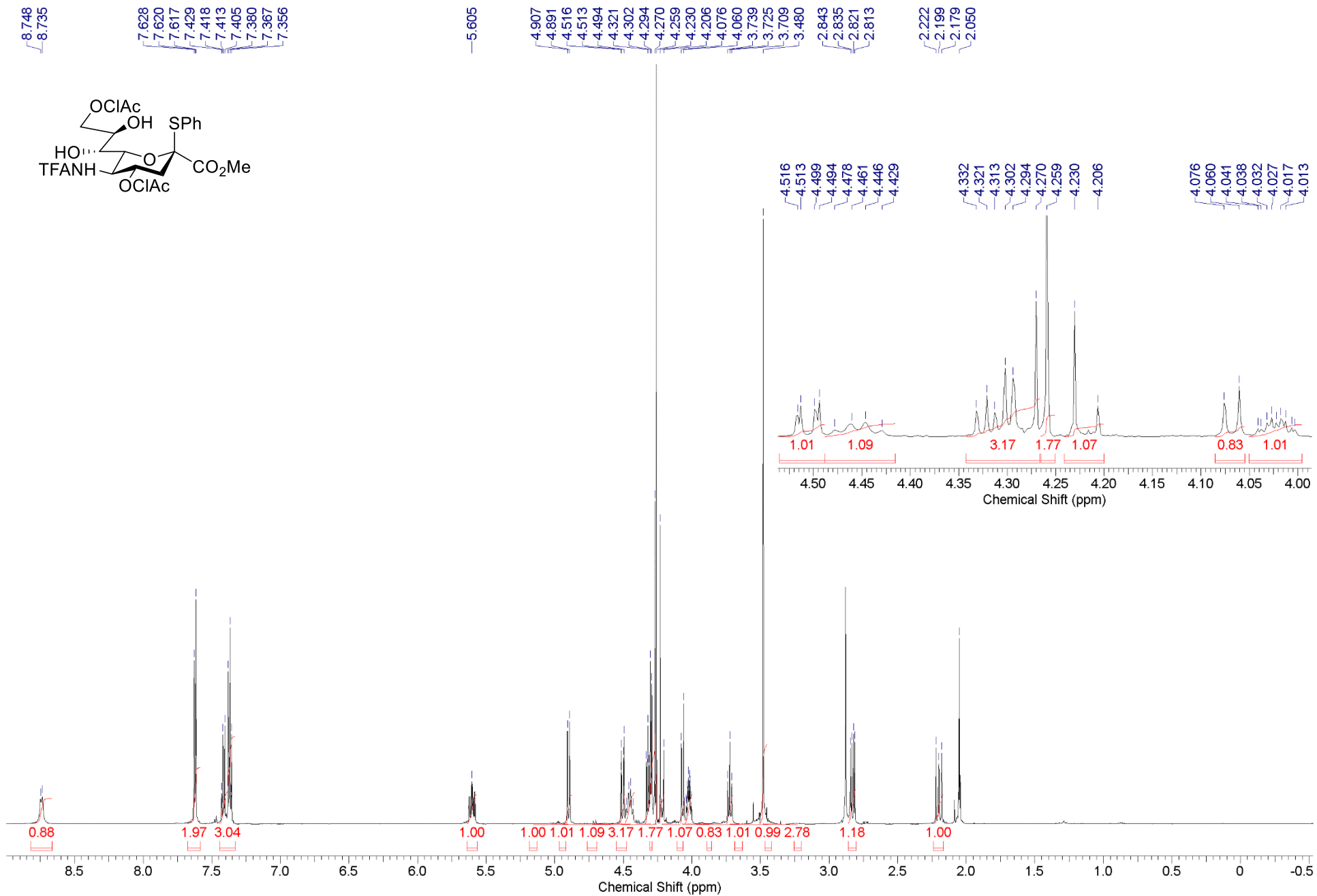
COSY (300 MHz) spectrum of compound 6 in CDCl₃



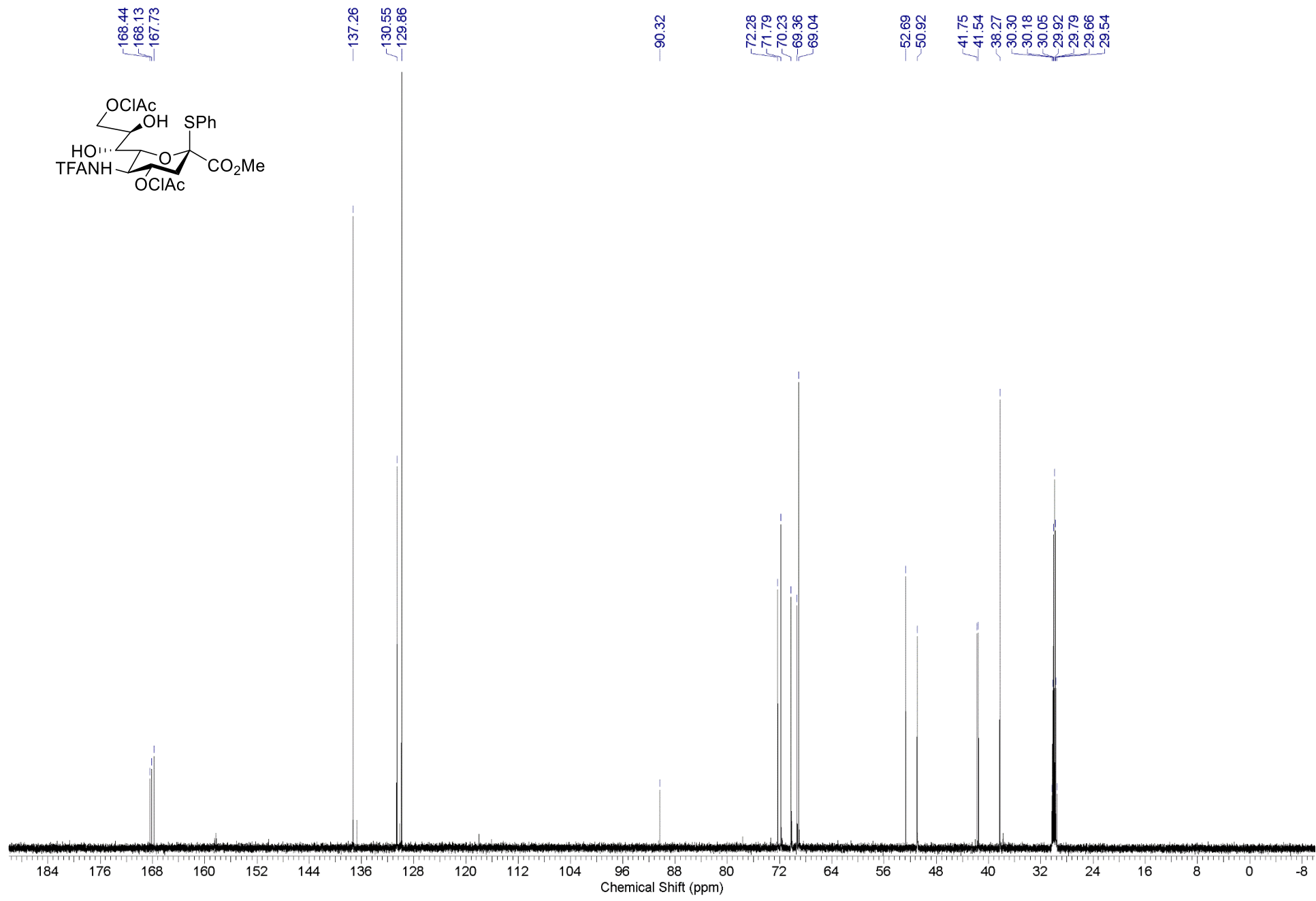
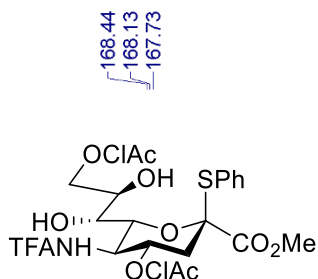
HSQC (300 MHz) spectrum of compound 6 in CDCl₃



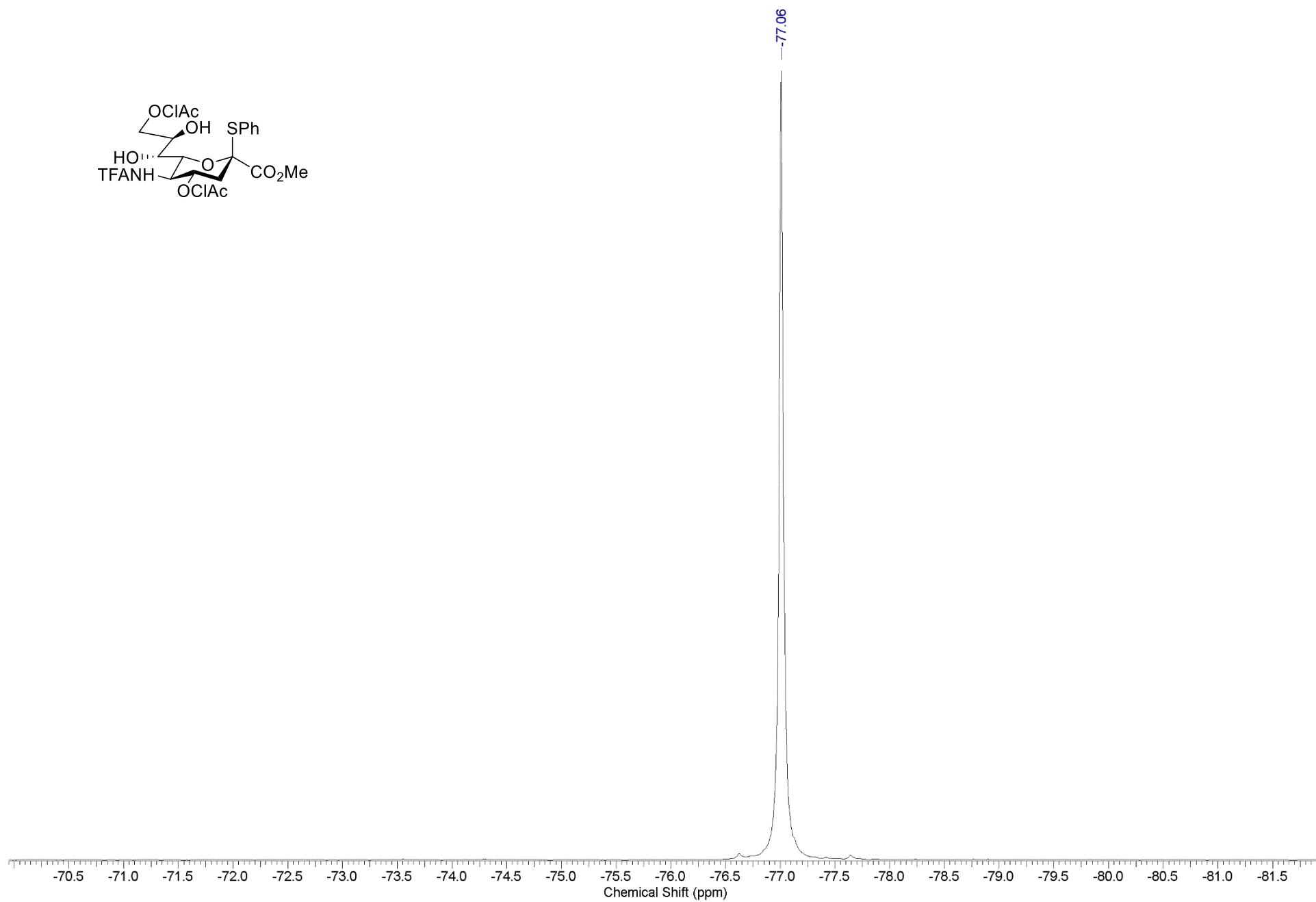
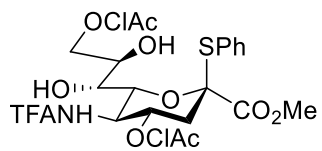
¹H NMR (600 MHz) spectrum of compound 7 in acetone-d₆



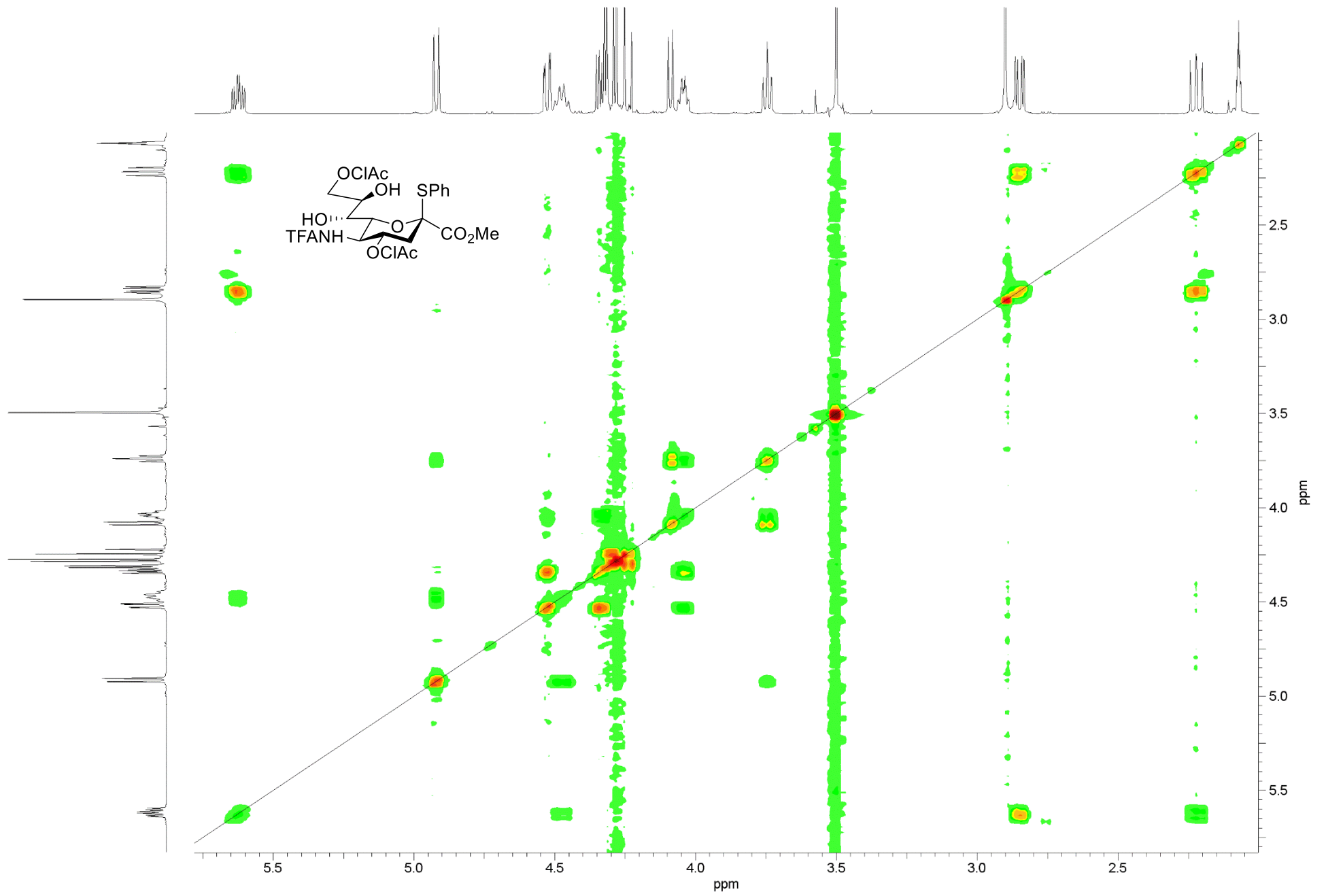
¹³C NMR (151 MHz) spectrum of compound 7 in acetone-d₆



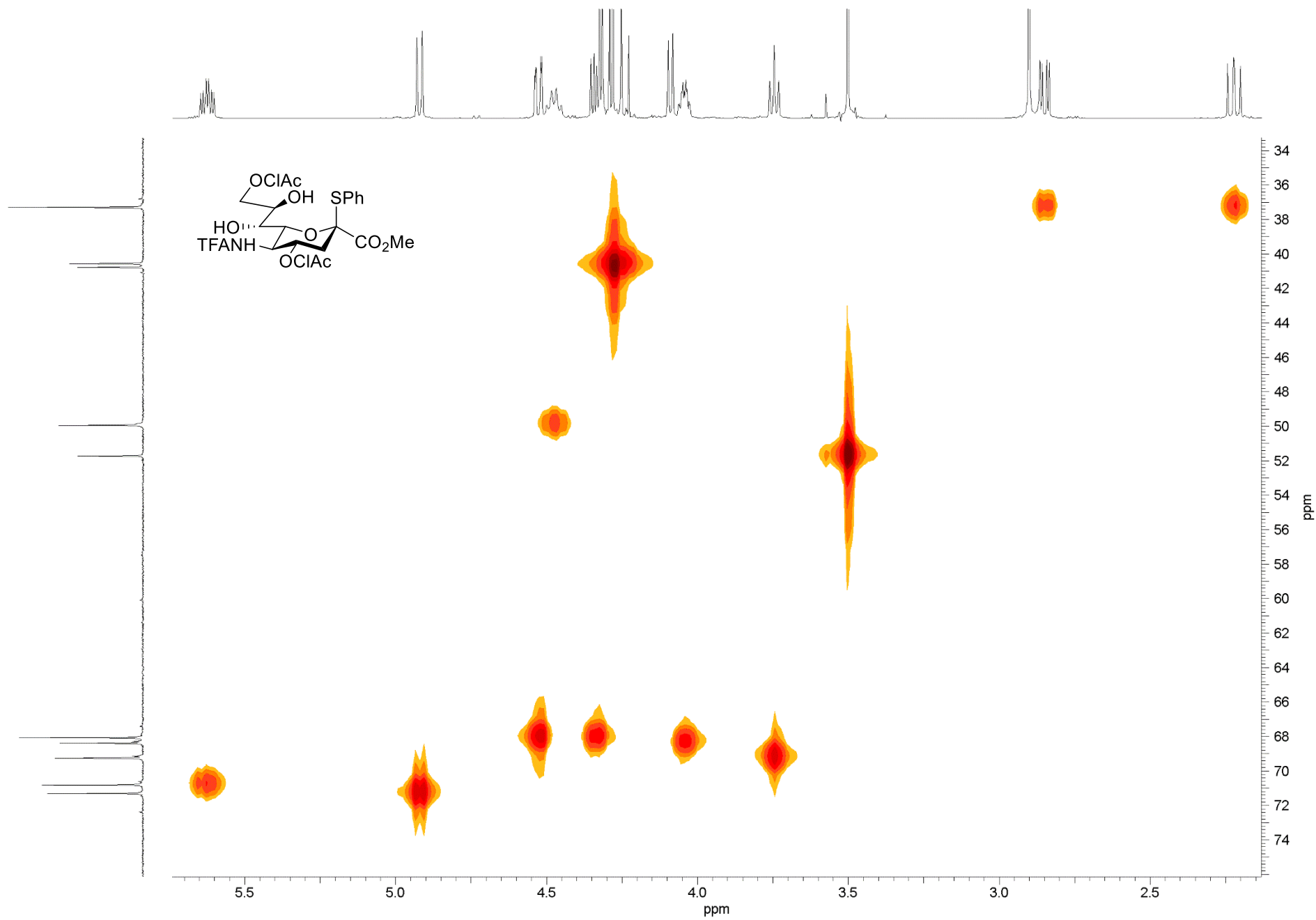
^{19}F NMR (282 MHz) spectrum of compound 7 in acetone- d_6



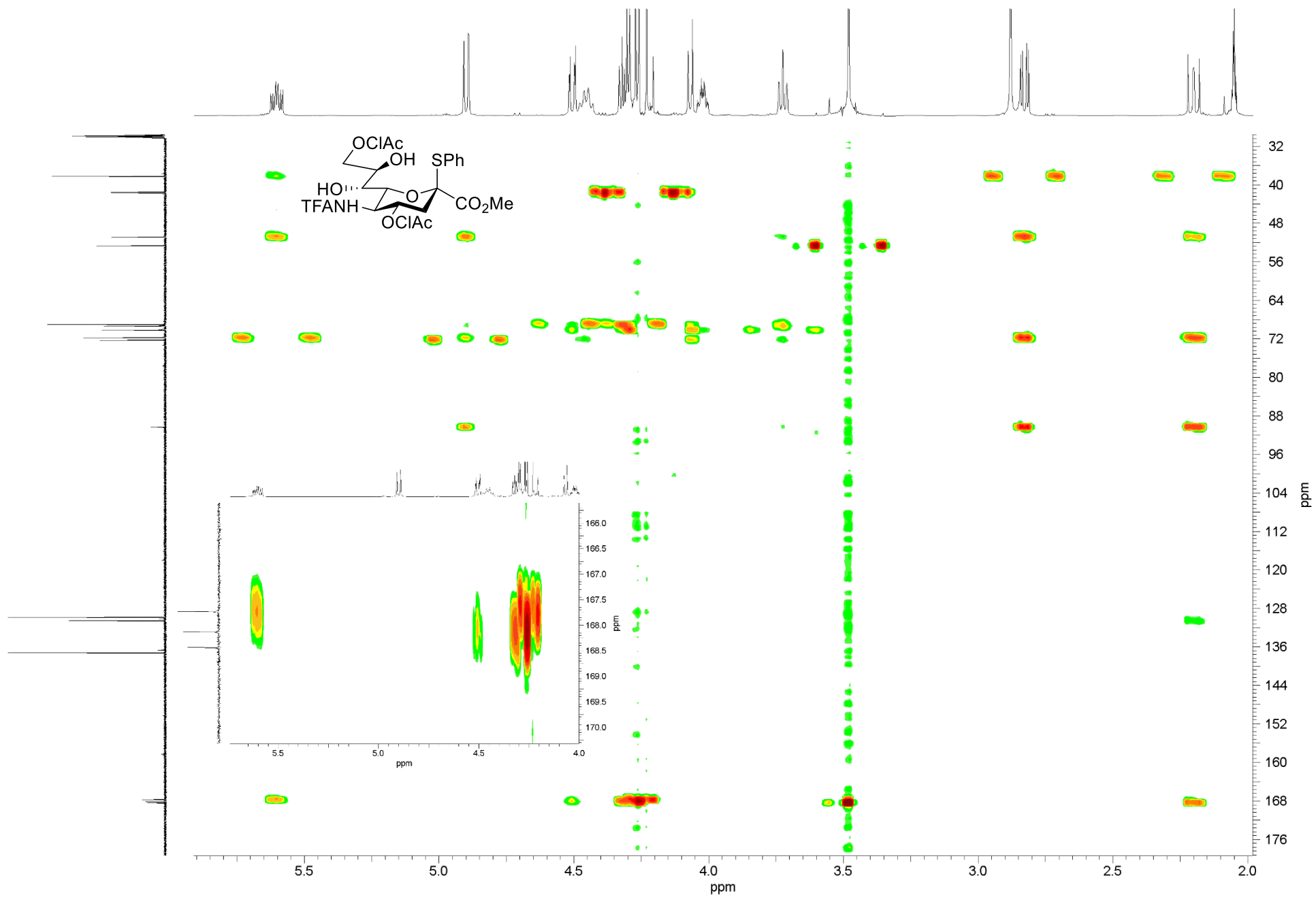
COSY (600 MHz) spectrum of compound 7 in acetone- d_6



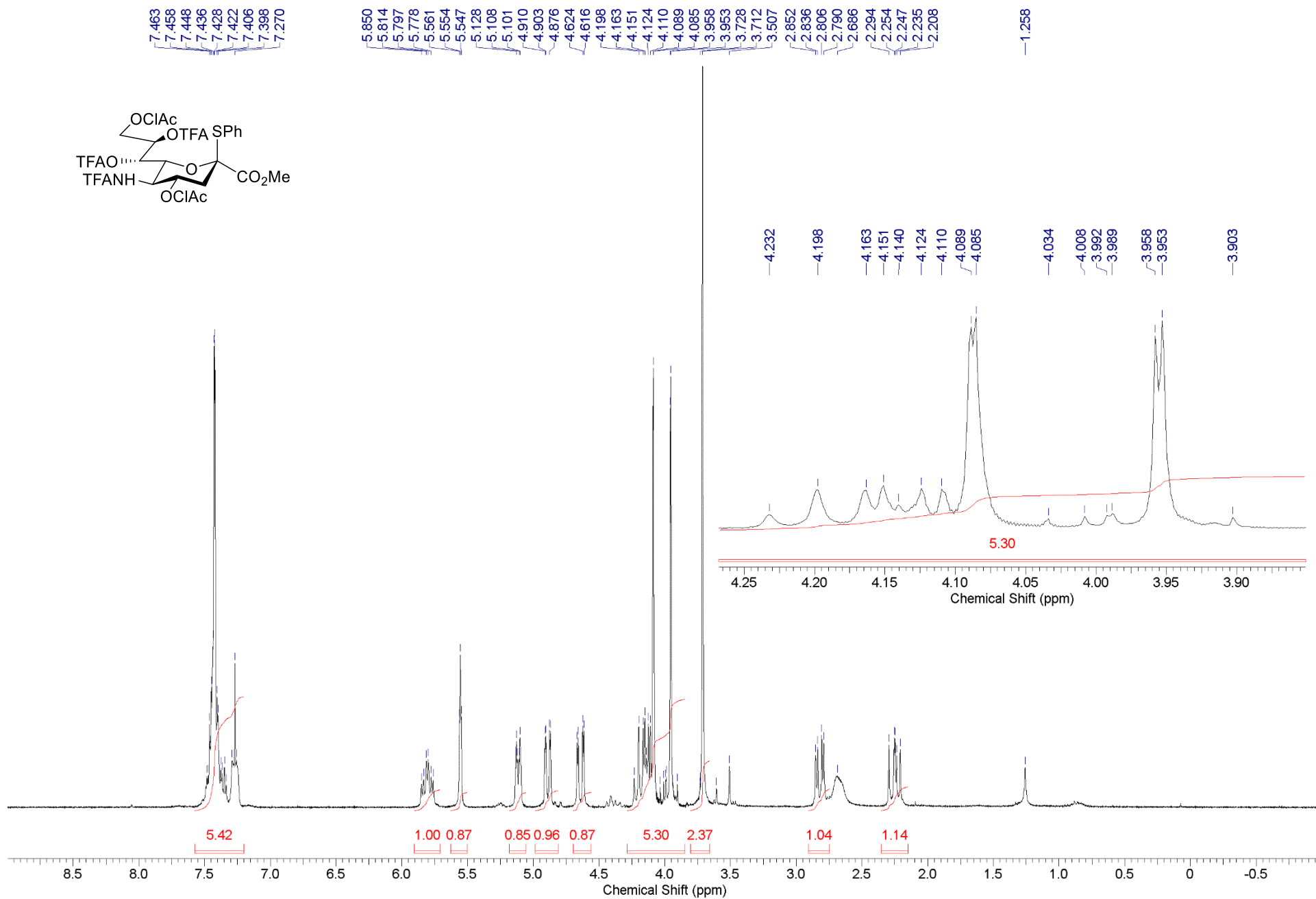
HSQC (600 MHz) spectrum of compound 7 in acetone- d_6



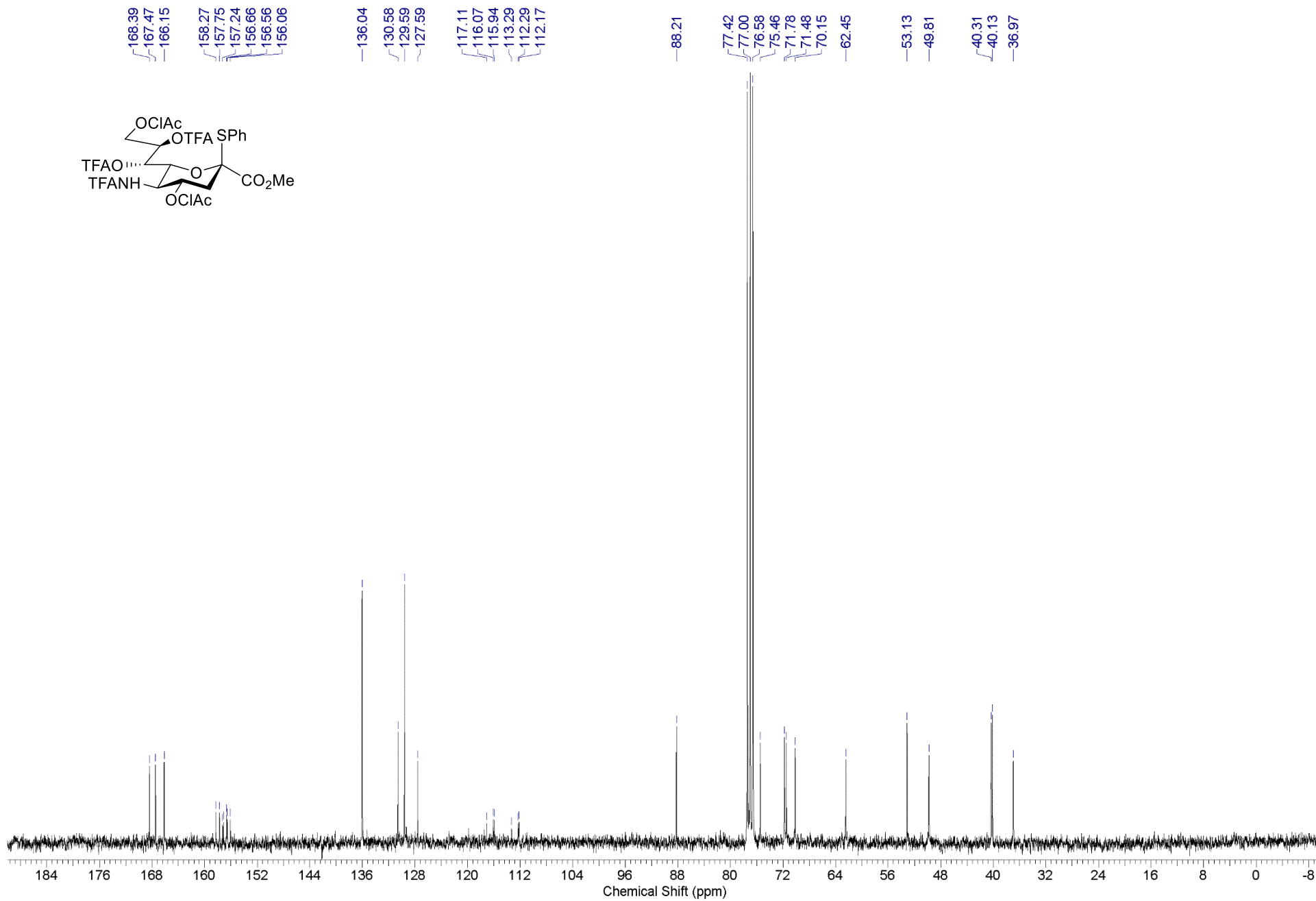
HMBC (600 MHz) spectrum of compound 7 in acetone- d_6



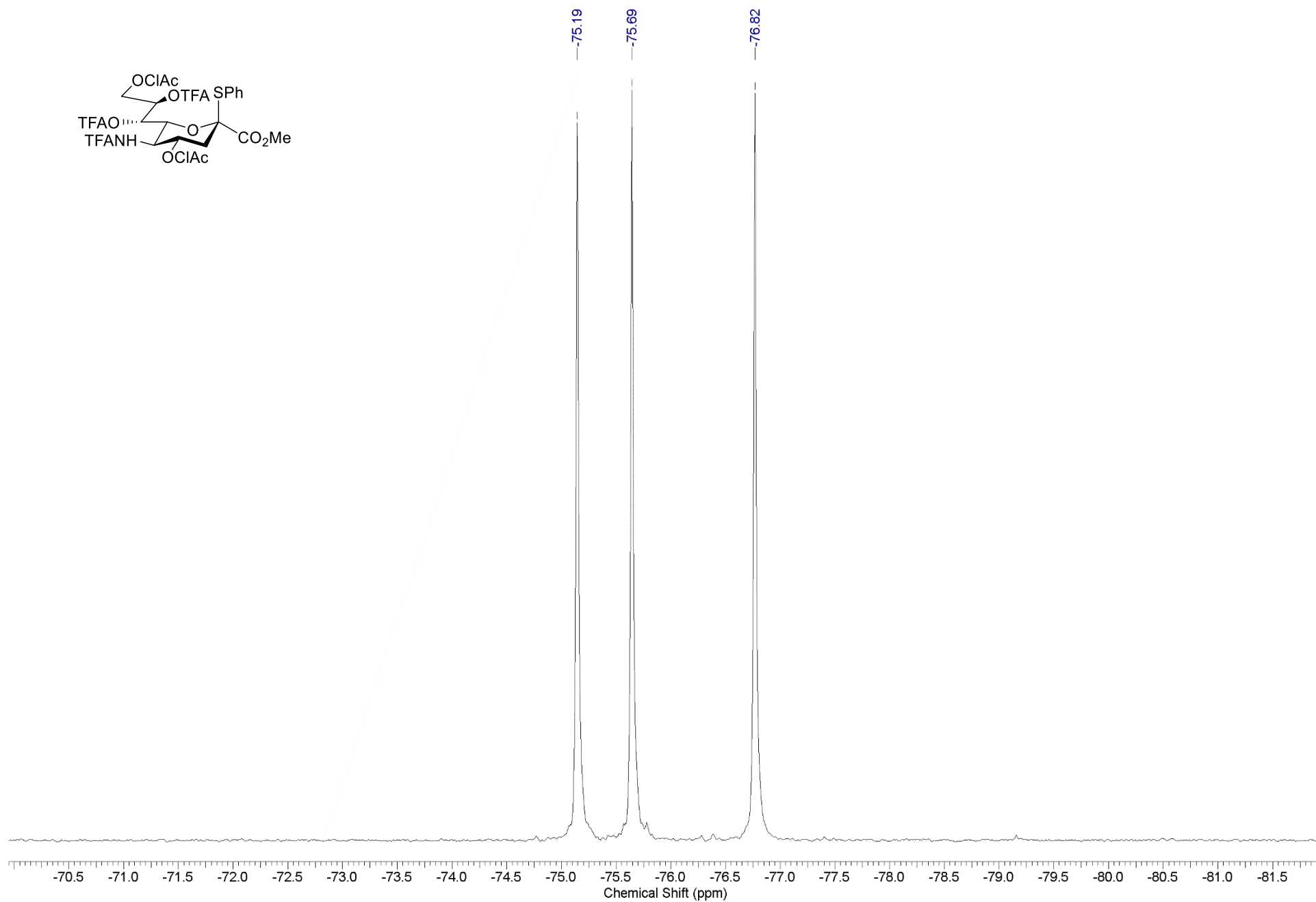
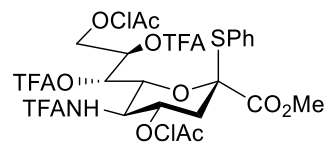
¹H NMR (300 MHz) spectrum of compound 2 in CDCl₃



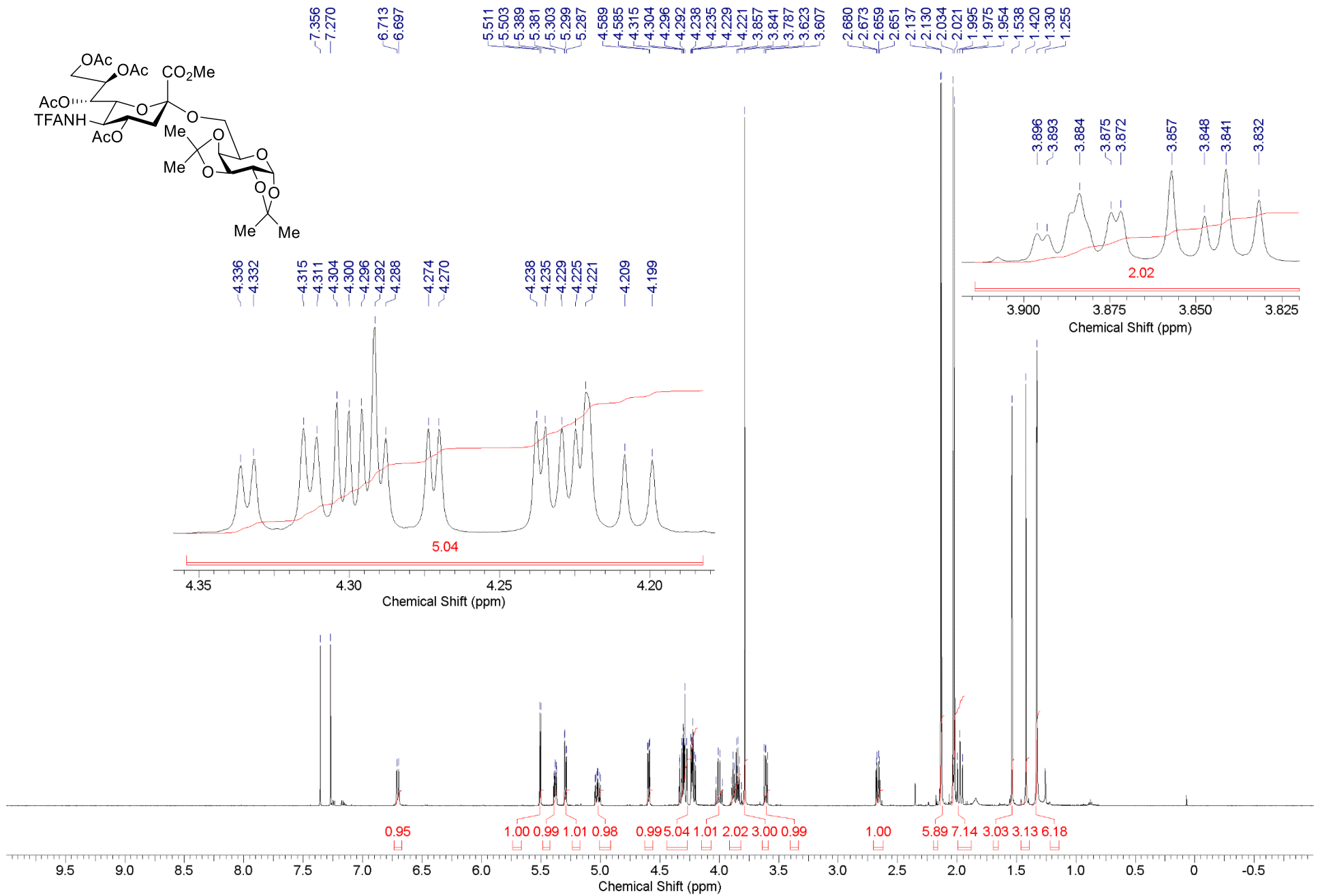
¹³C NMR (75 MHz) spectrum of compound 2 in CDCl₃



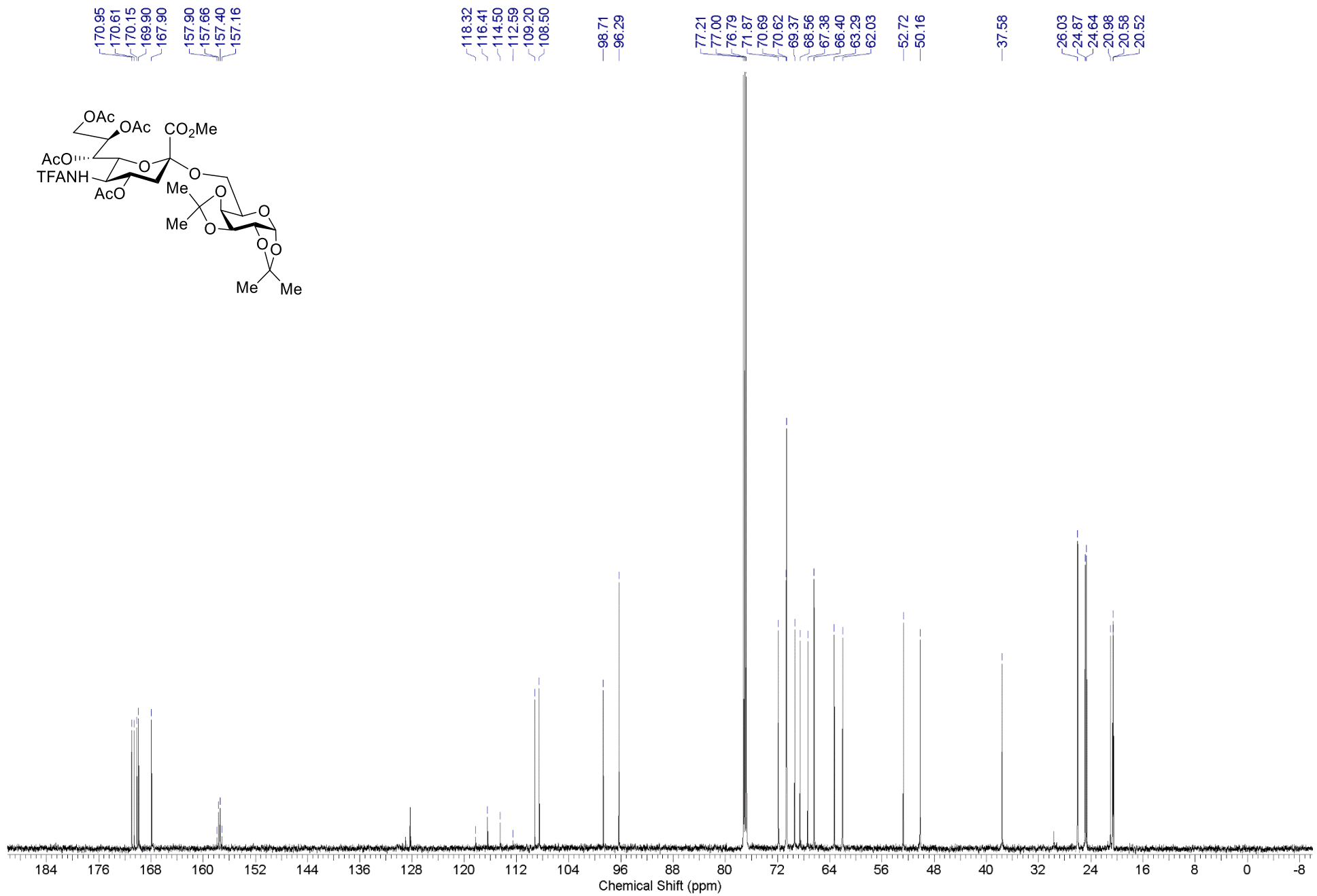
¹⁹F NMR (282 MHz) spectrum of compound 2 in CDCl₃



¹H NMR (600 MHz) spectrum of compound α -4 in CDCl₃



¹³C NMR (151 MHz) spectrum of compound α -4 in CDCl₃



References

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