

Supporting Information

Balancing Hydrophilic vs Hydrophobic Volumes: A New Approach to Enhance Ionic Conductivity of Amphiphilic Cyclodextrins

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[†]Equal contributions

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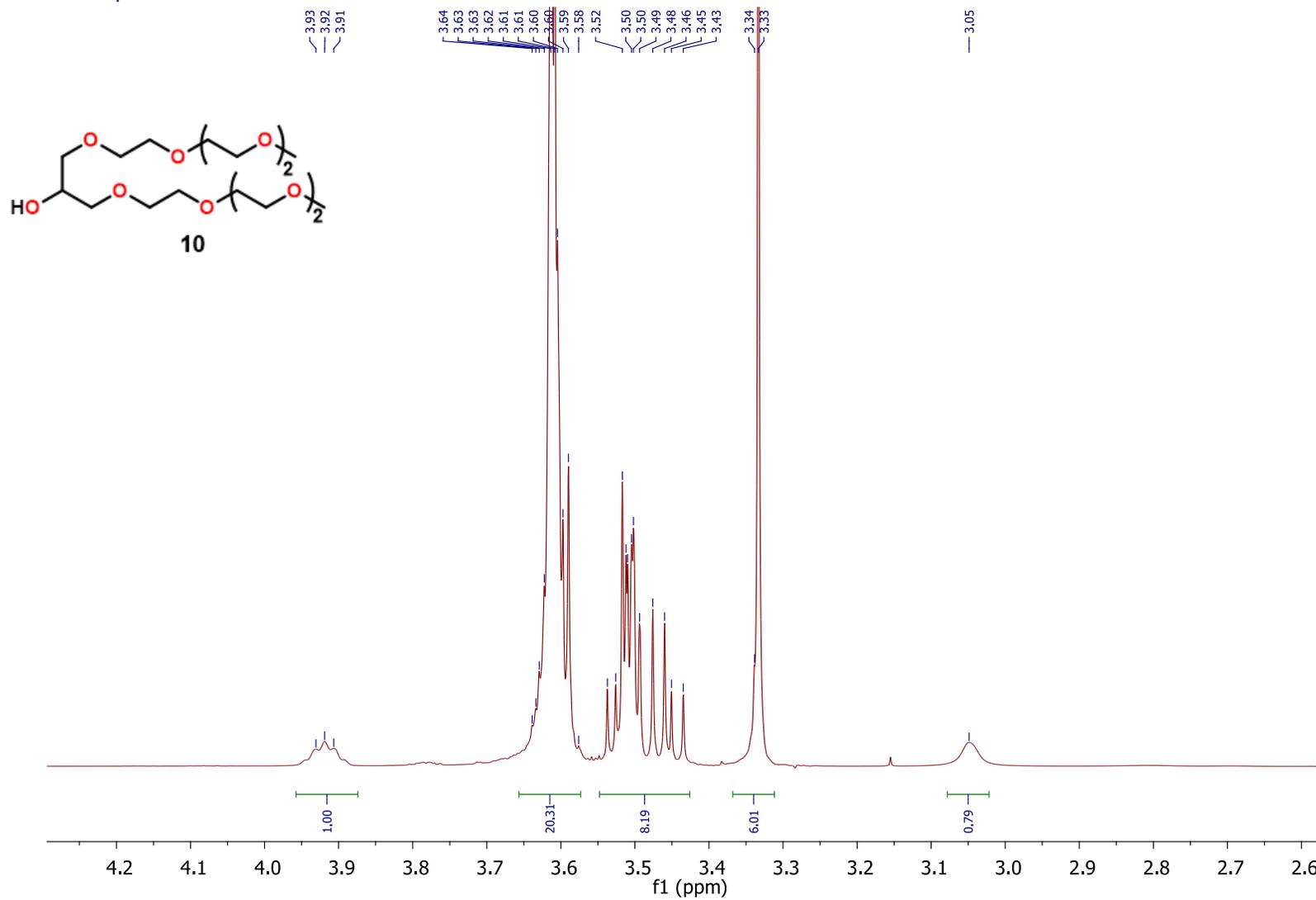
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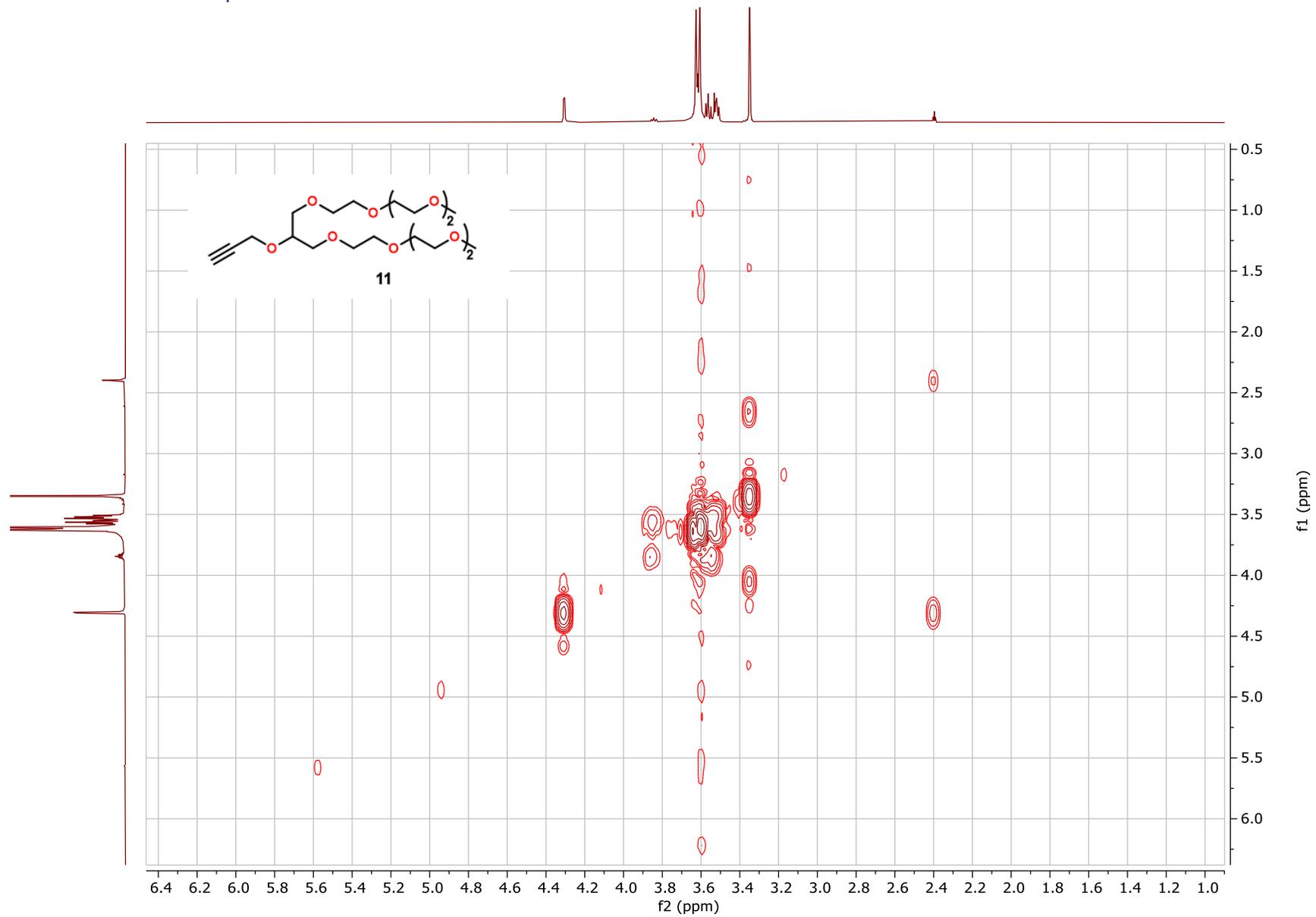
I. NMR Spectra

NMR Spectra of **10**

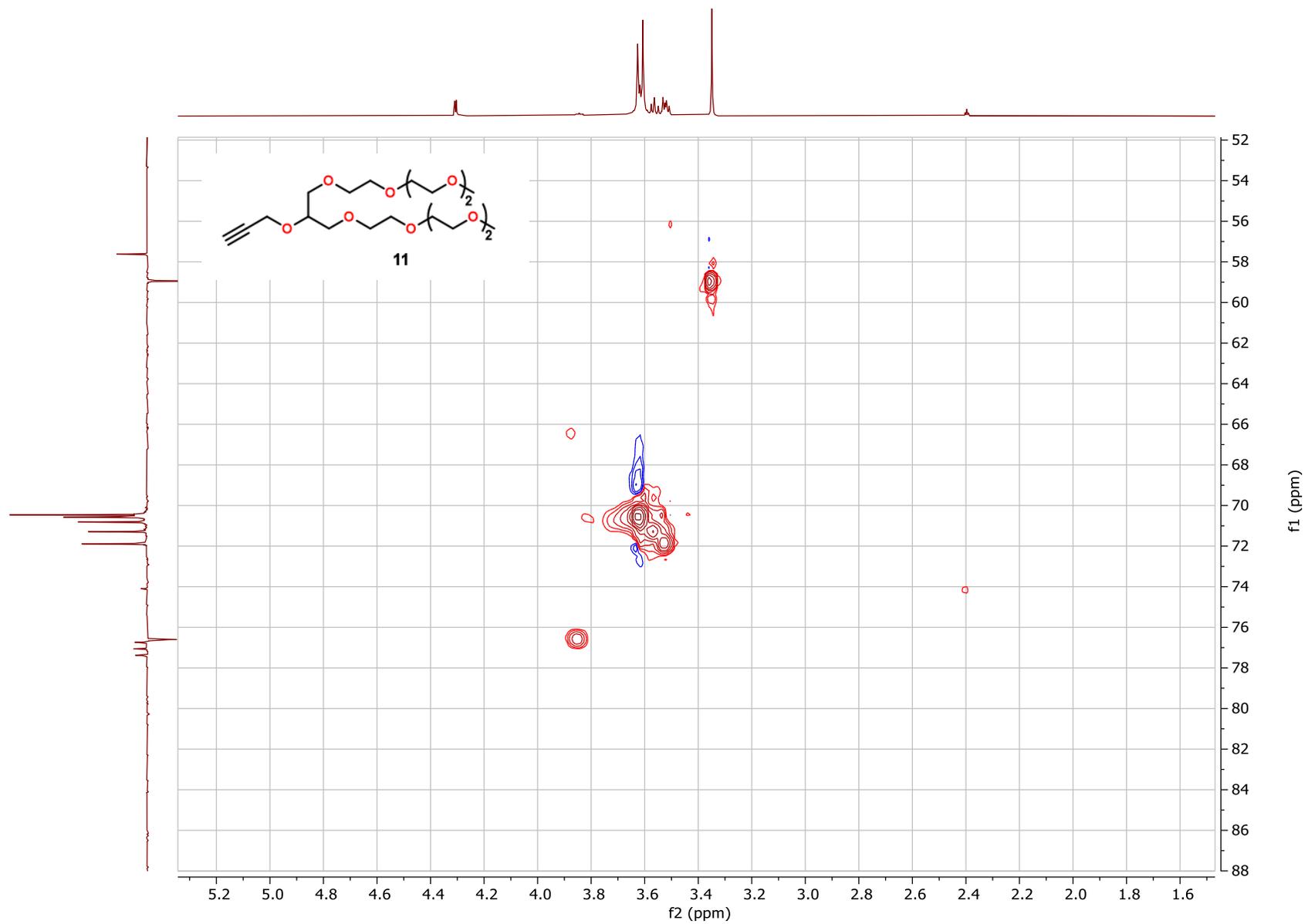
S1. ^1H NMR Spectrum of **10**



S5. ^1H - ^1H COSY NMR Spectrum of **11**

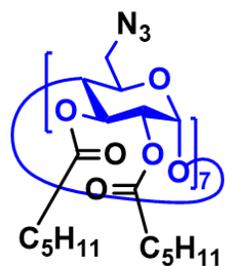


S6. ^1H - ^{13}C HSQC NMR Spectrum of **11**



NMR Spectra of 18

S7. ¹H NMR Spectrum of 18



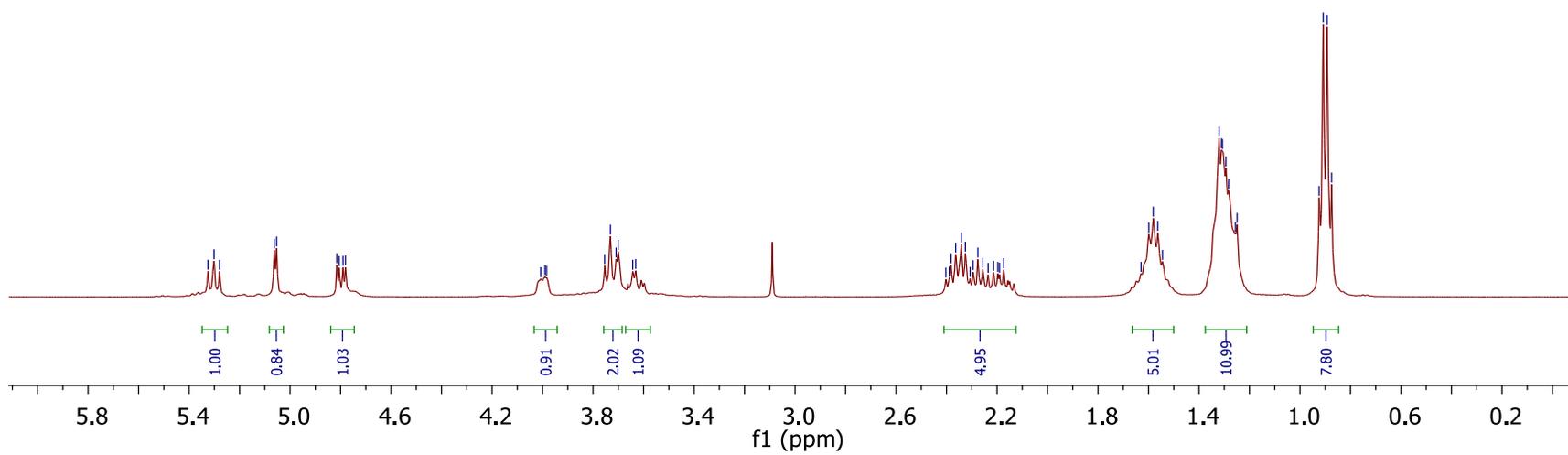
18

5.33
5.30
5.28
5.06
5.05
4.82
4.81
4.79
4.78

4.01
3.99
3.98
3.75
3.73
3.71
3.70
3.64
3.63

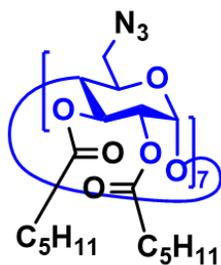
2.39
2.38
2.36
2.34
2.33
2.31
2.29
2.28
2.26
2.24
2.21
2.20
2.19
2.17

1.63
1.60
1.58
1.56
1.54
1.52
1.29
1.28
1.26
1.25
0.92
0.91
0.89
0.87



S8. ^{13}C NMR Spectrum of **18**

173.22
171.72



96.36

76.66

70.77
70.07

51.55

39.38

33.98

33.76

31.38

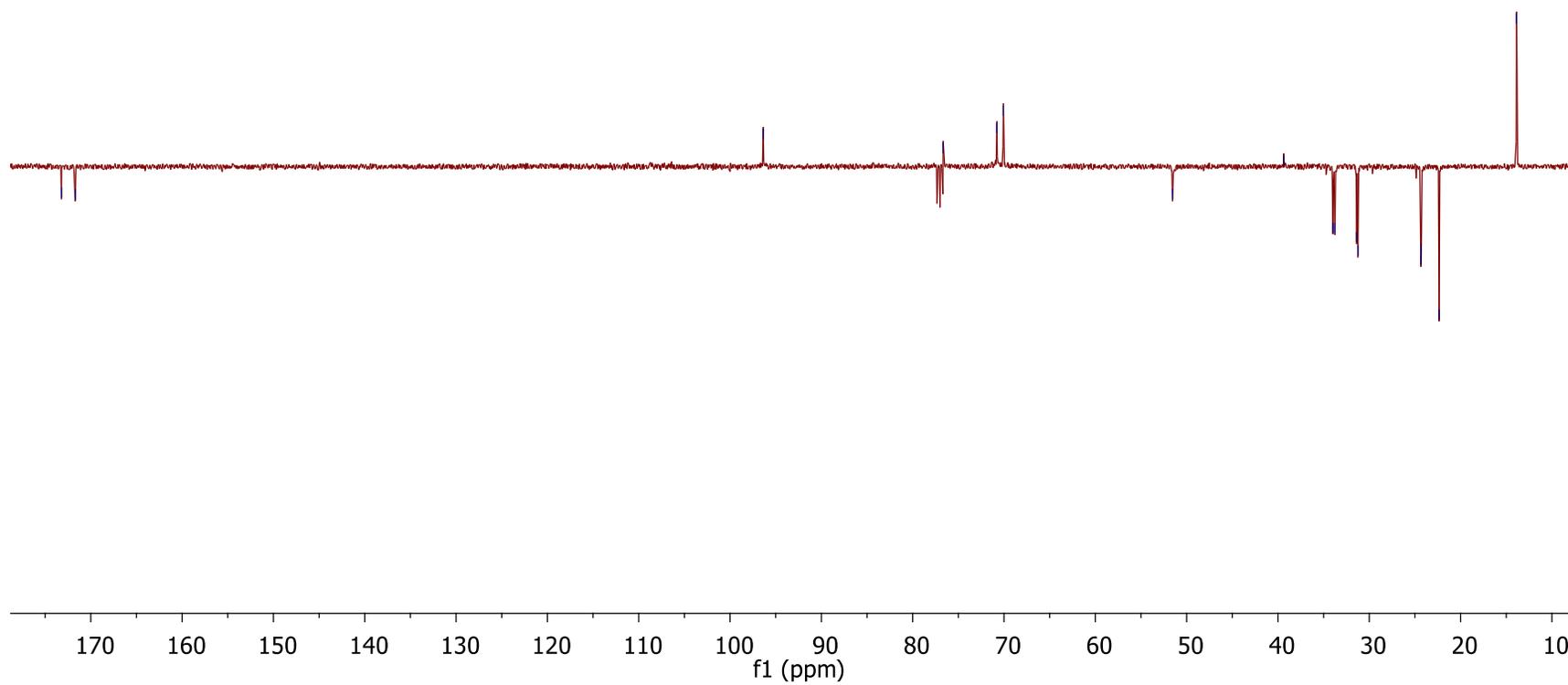
31.25

24.35

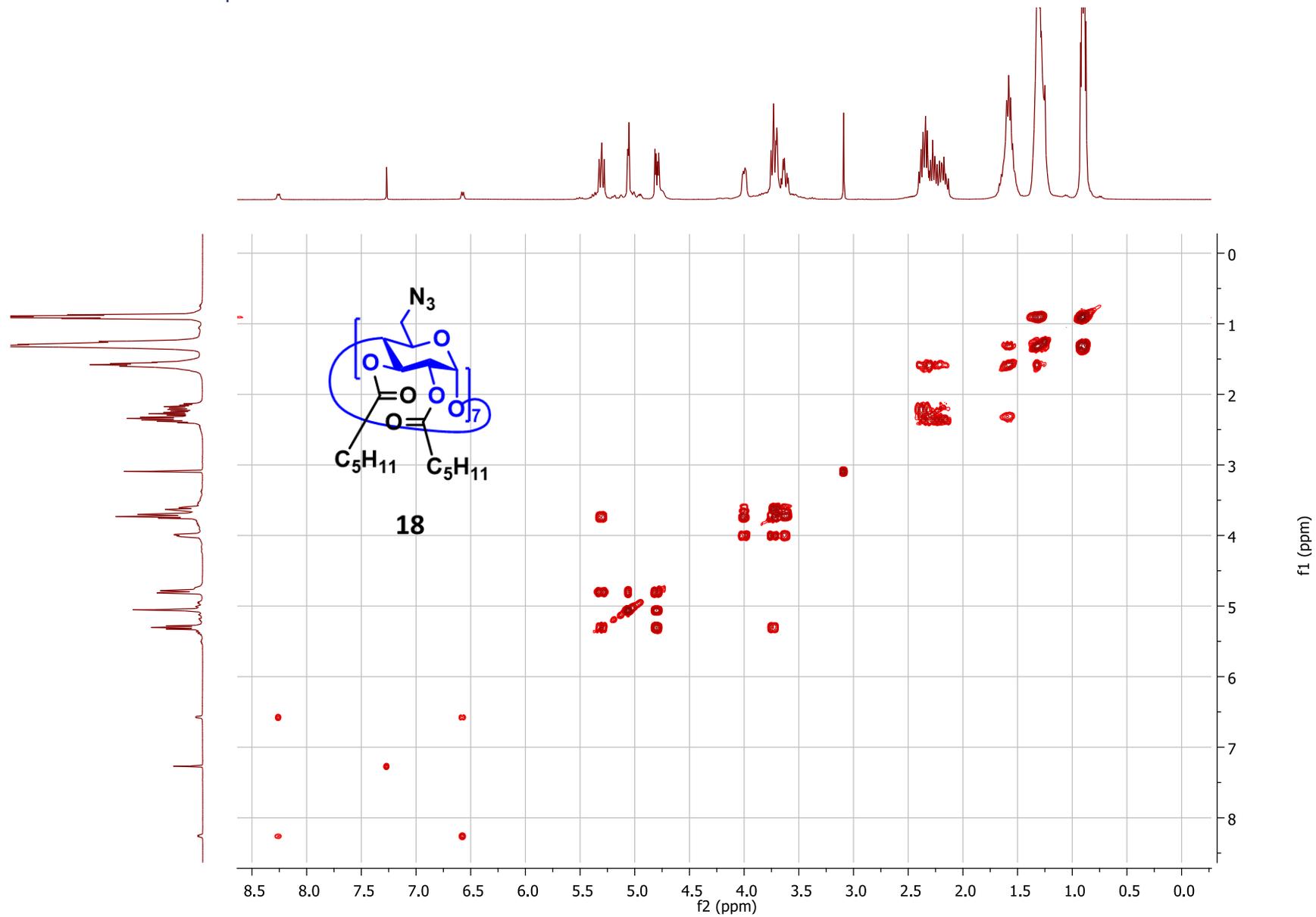
24.31

22.35

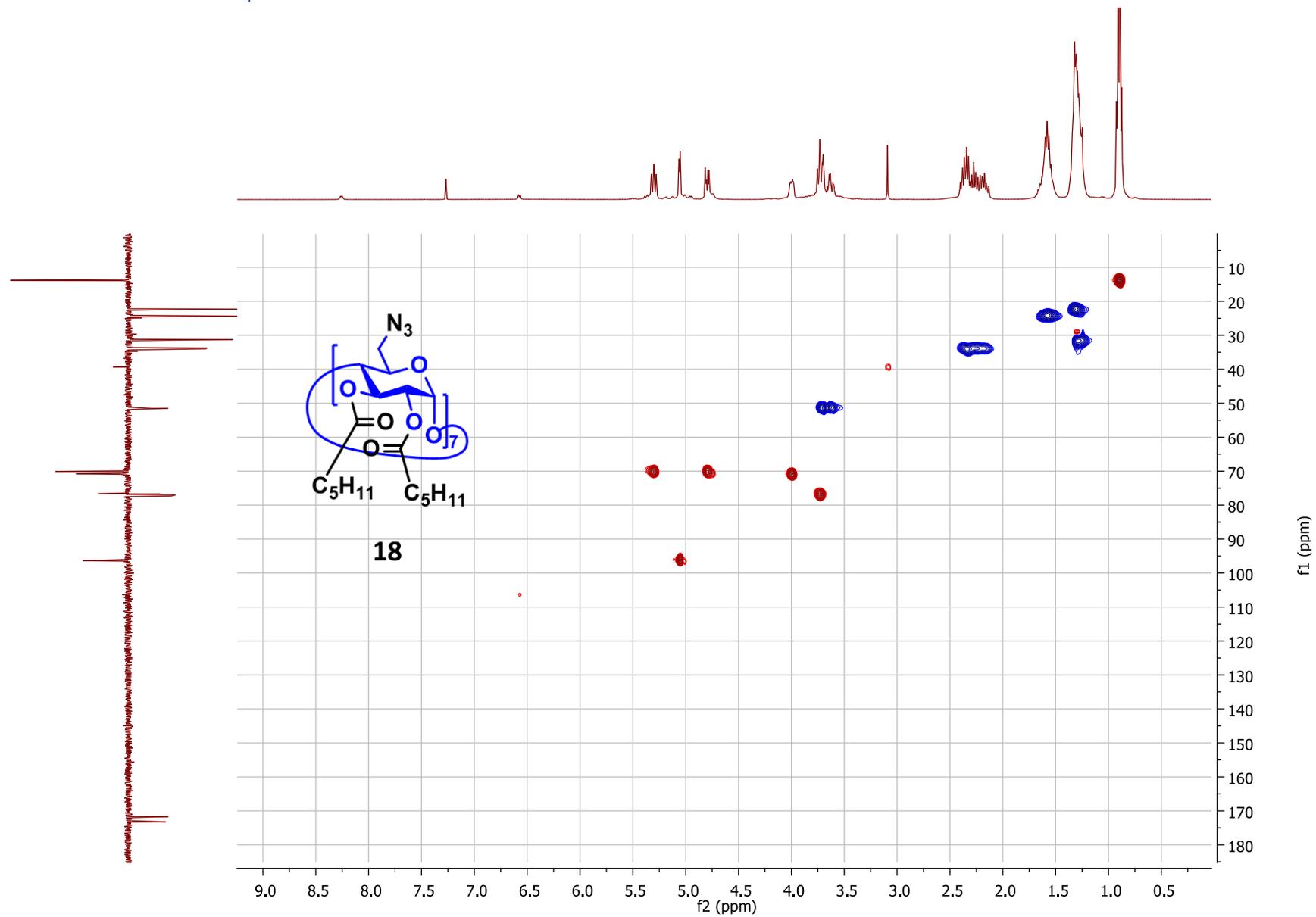
13.87



S9. ^1H - ^1H COSY NMR Spectrum of **18**

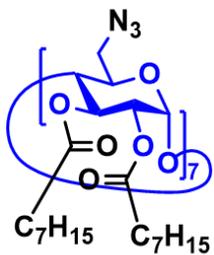


S10. ^1H - ^{13}C HSQC NMR Spectrum of **18**

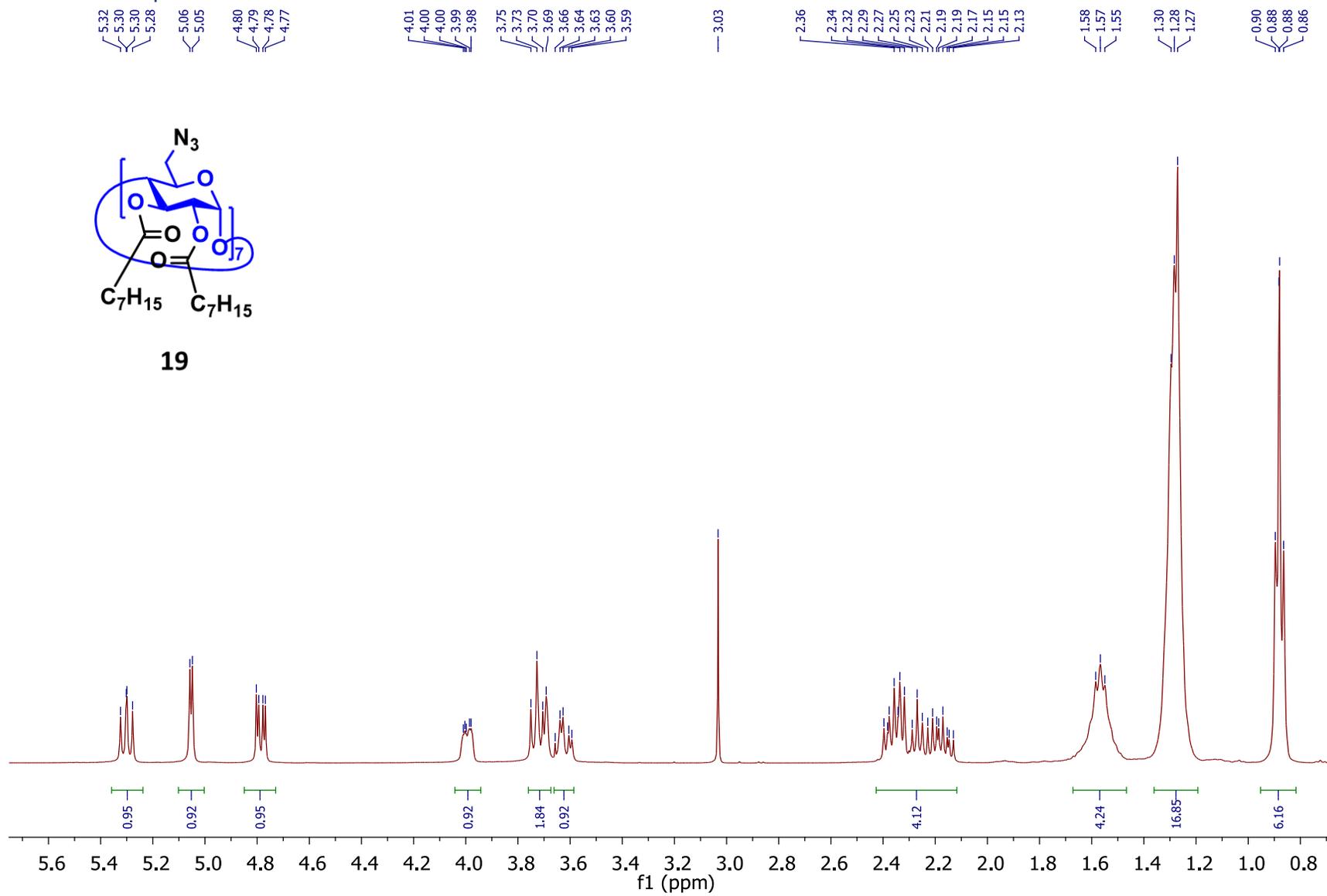


NMR Spectra of 19

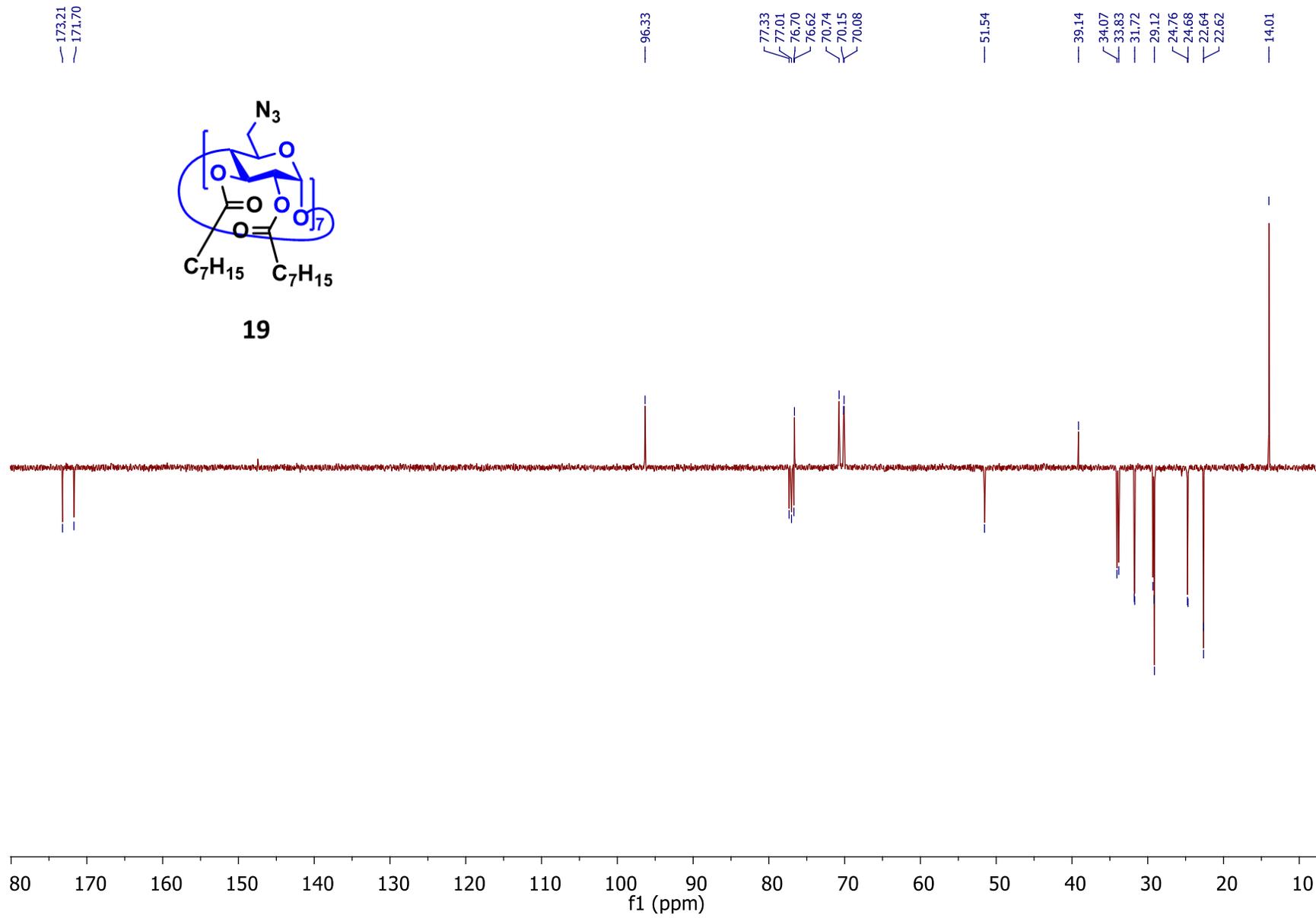
S11. ¹H NMR Spectrum of 19



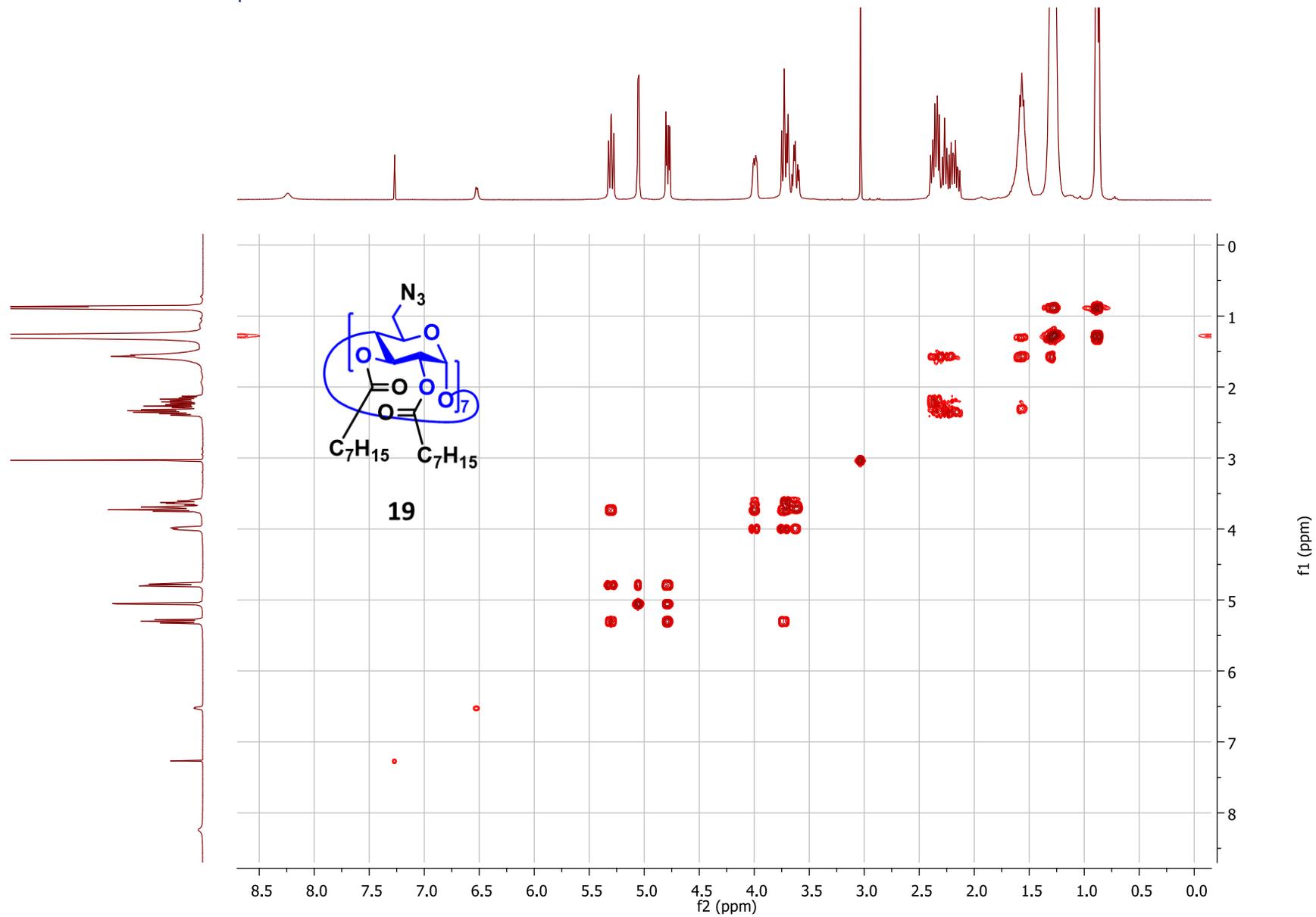
19



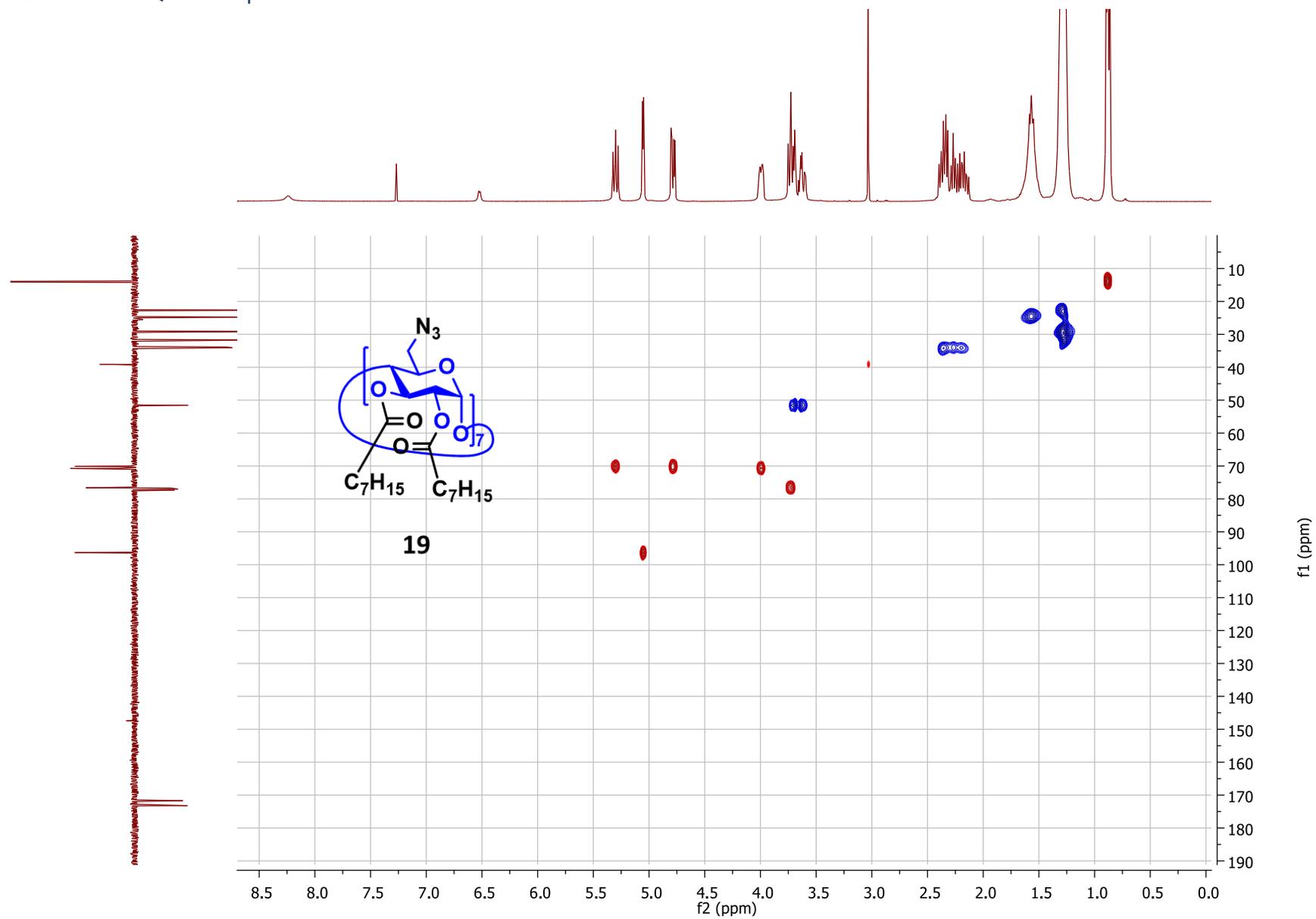
S12. ¹³C NMR Spectrum of **19**



S13. ^1H - ^1H COSY NMR Spectrum of **19**

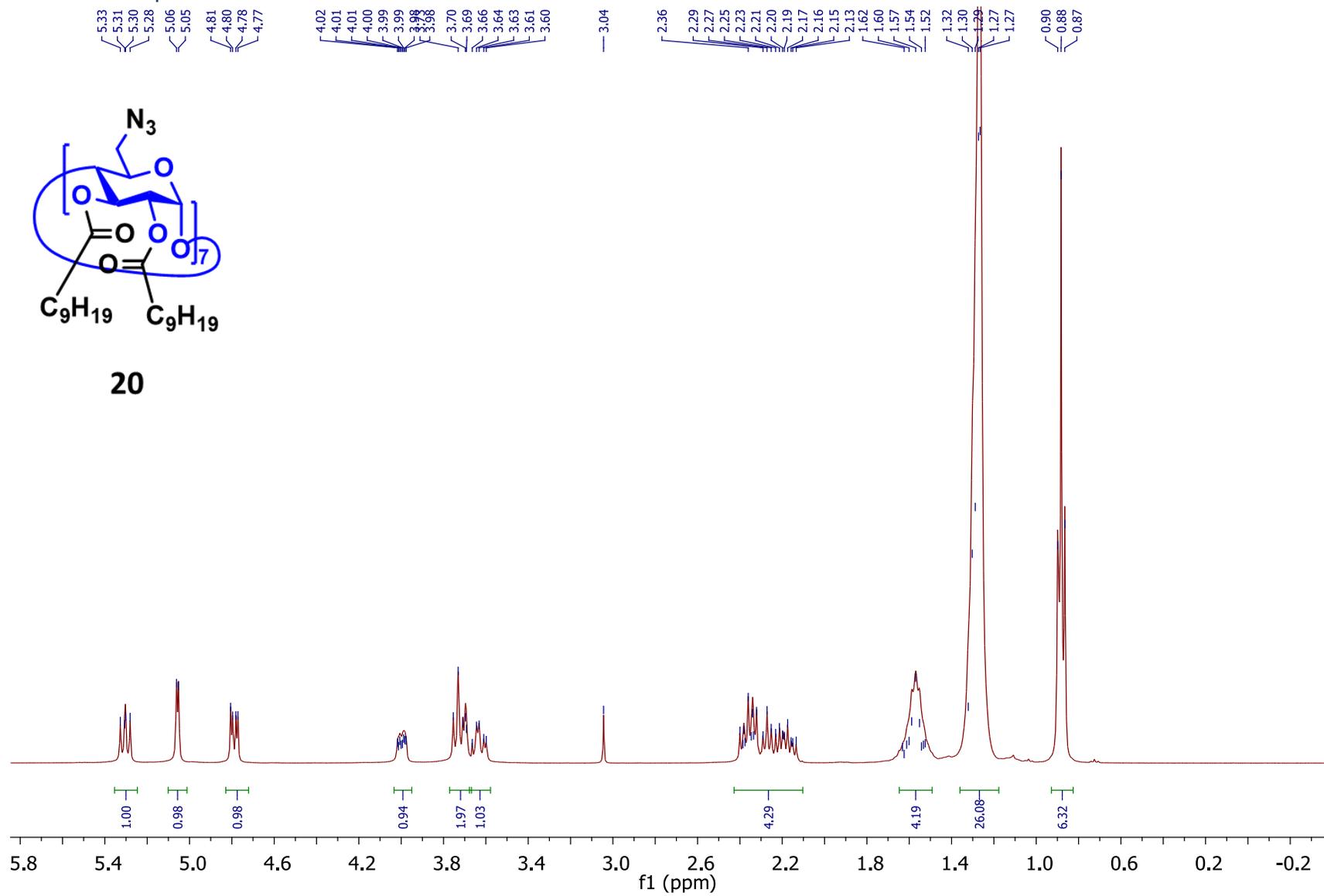


S14. ^1H - ^{13}C HSQC NMR Spectrum of **19**

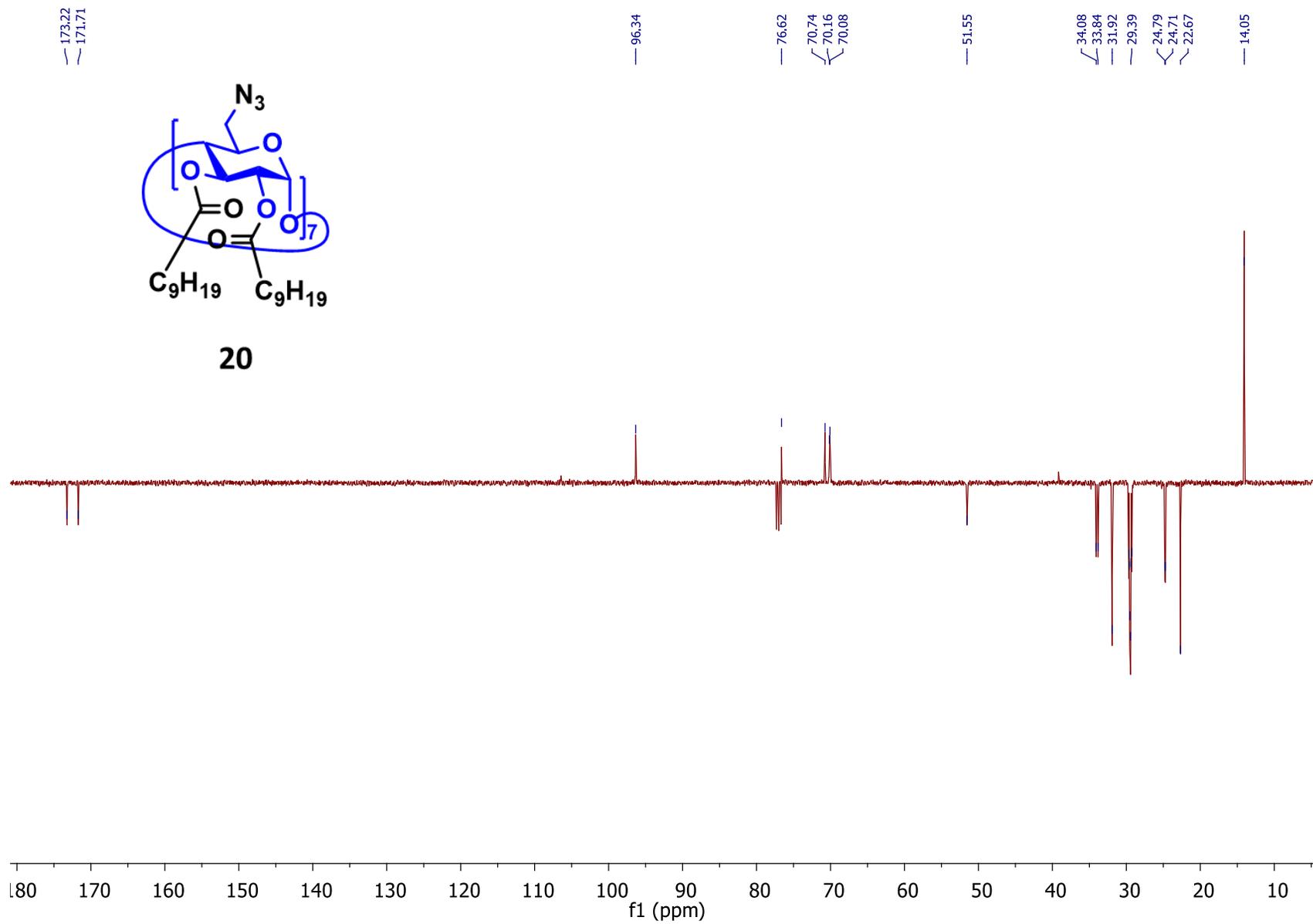


NMR Spectra of 20

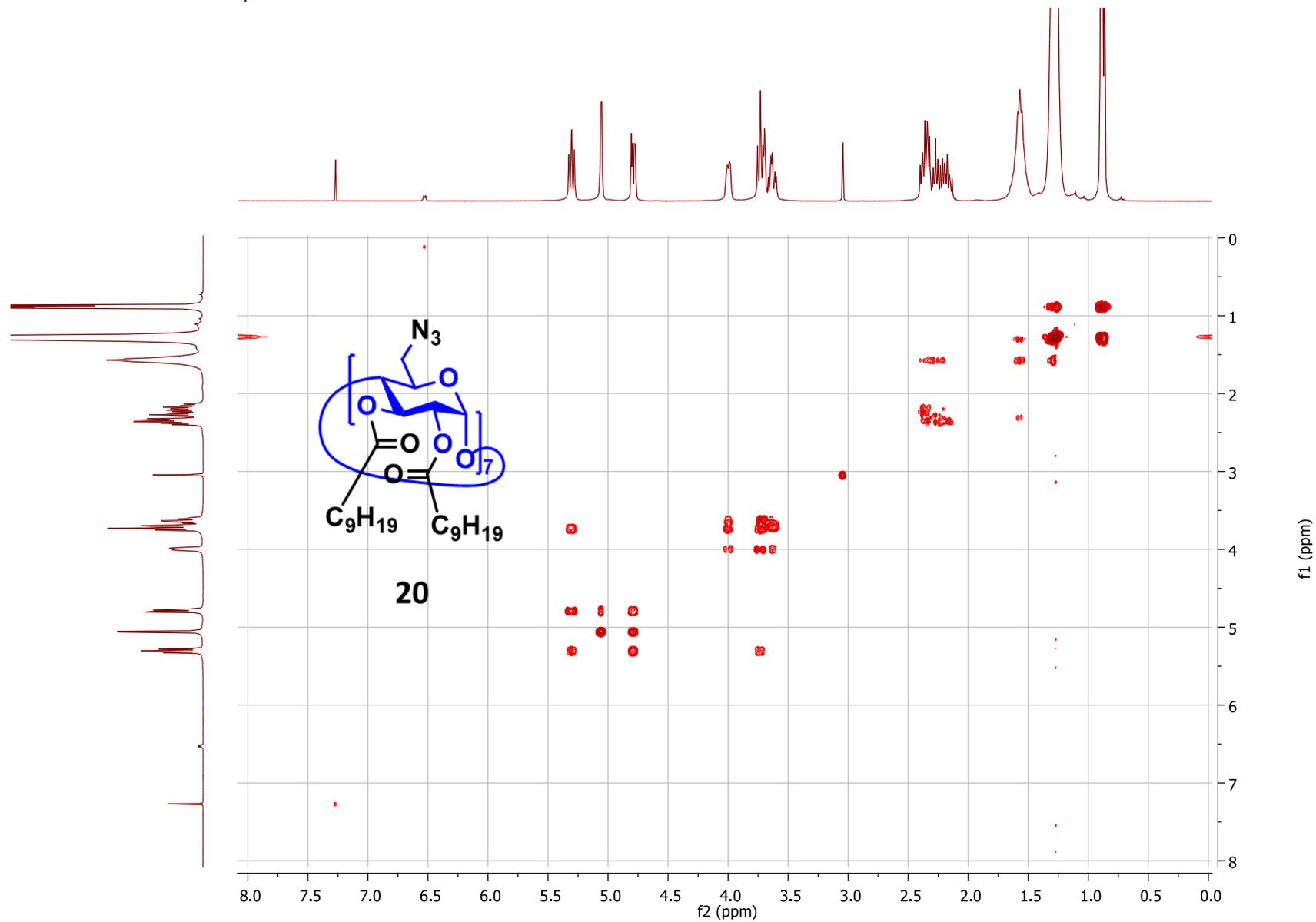
S15. ¹H NMR Spectrum of 20



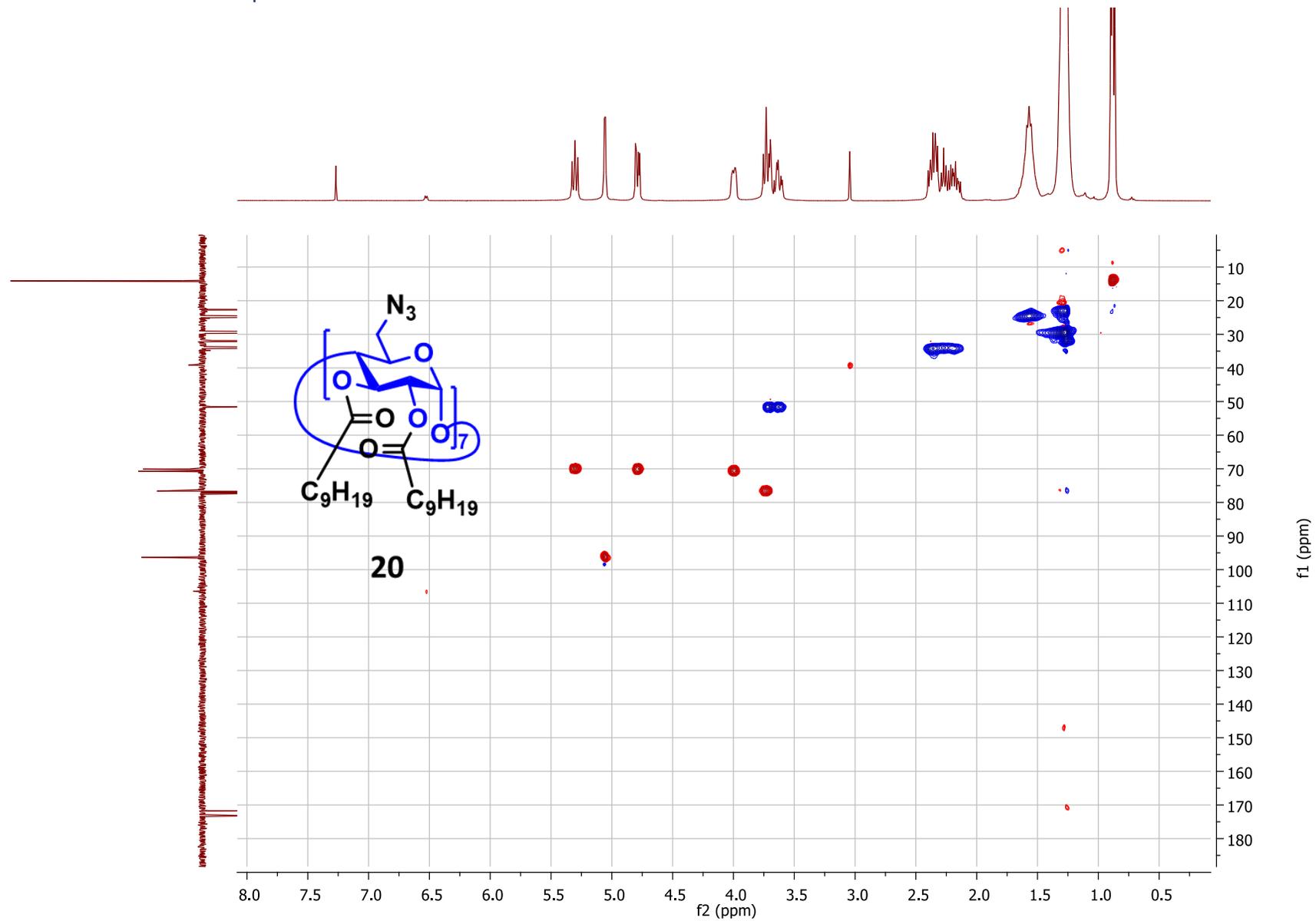
S16. ^{13}C NMR Spectrum of **20**



S17. ^1H - ^1H COSY NMR Spectrum of **20**

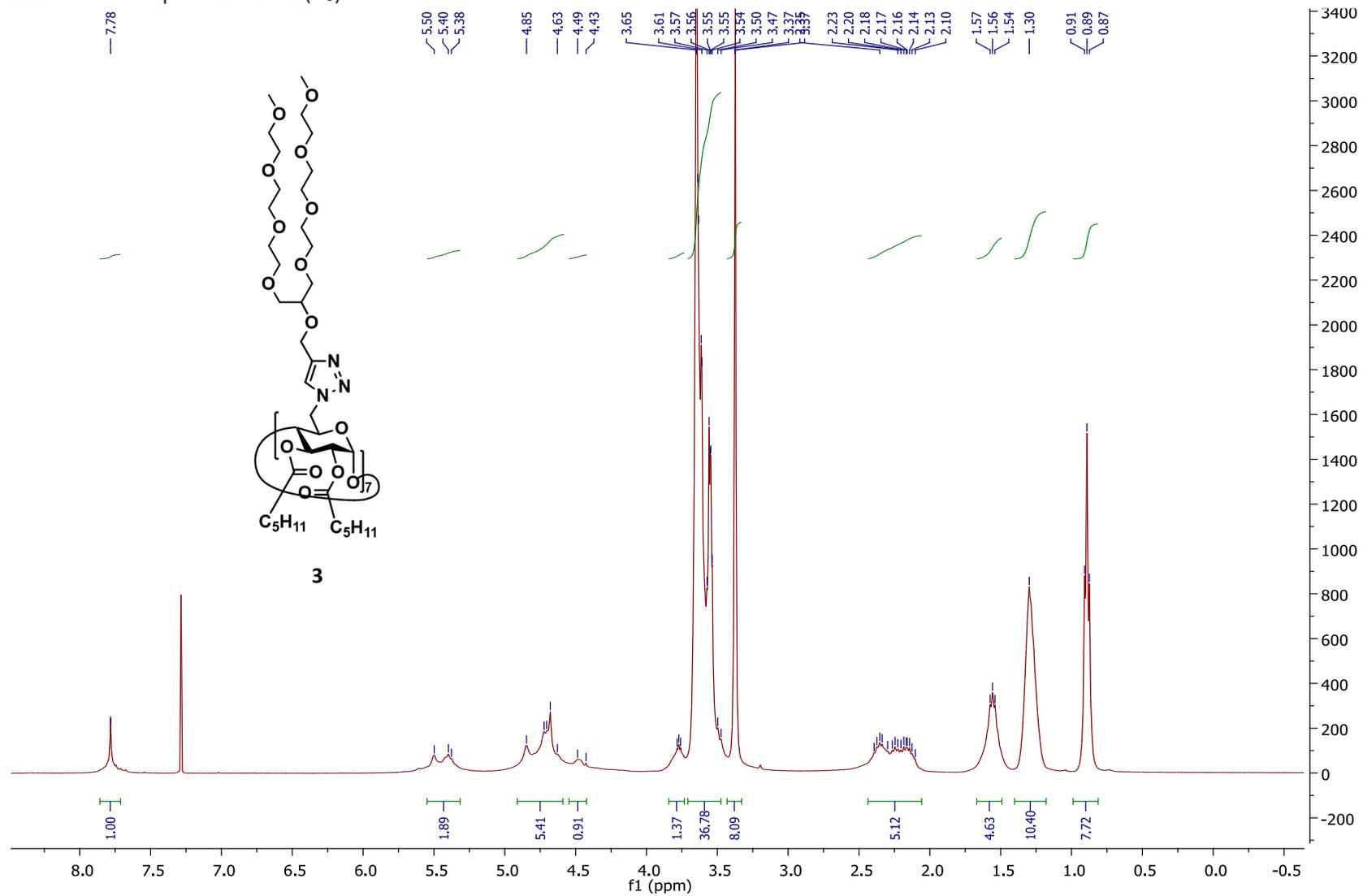


S18. ^1H - ^{13}C HSQC NMR Spectrum of **20**

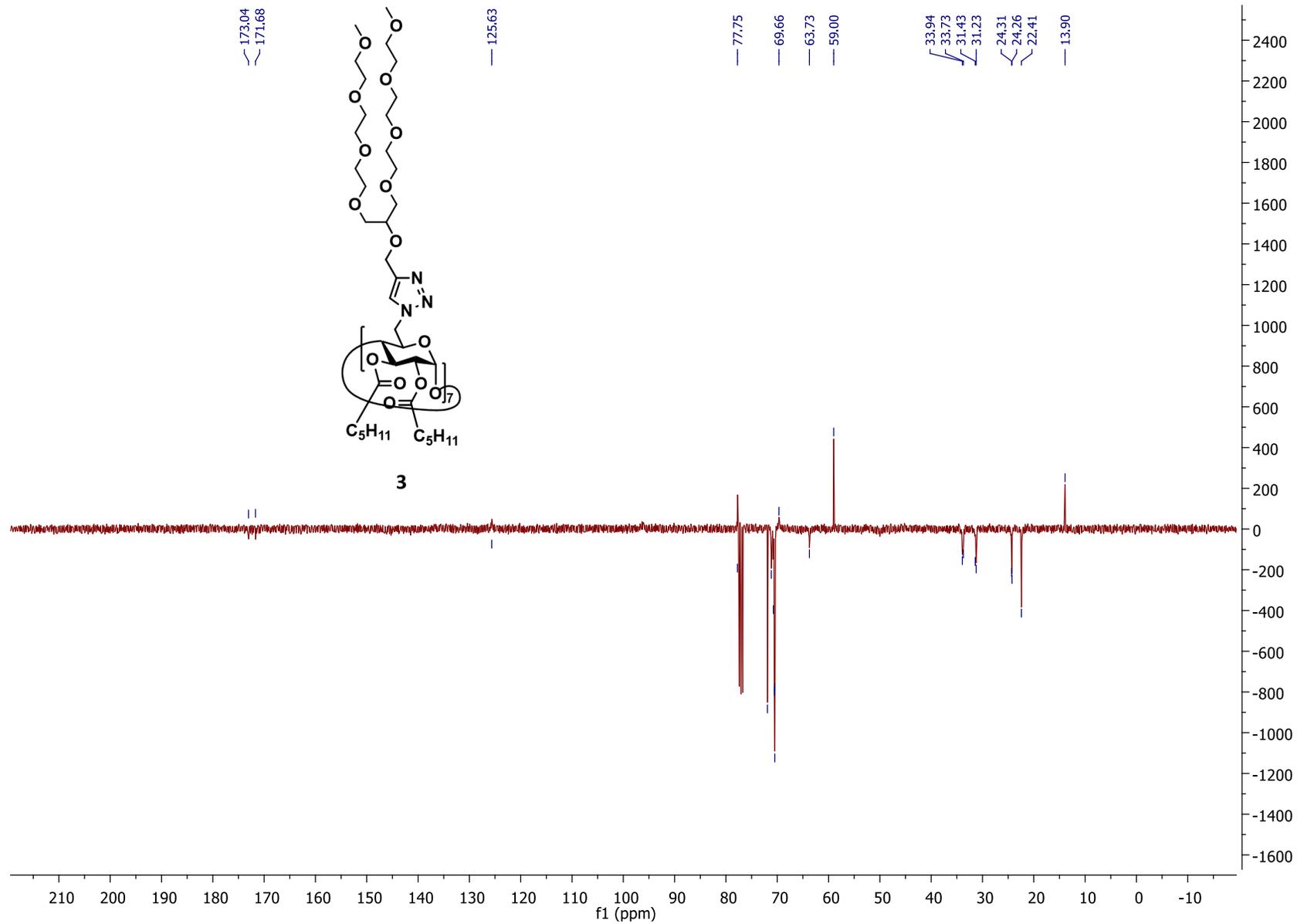


NMR Spectra of **3** (C₆)

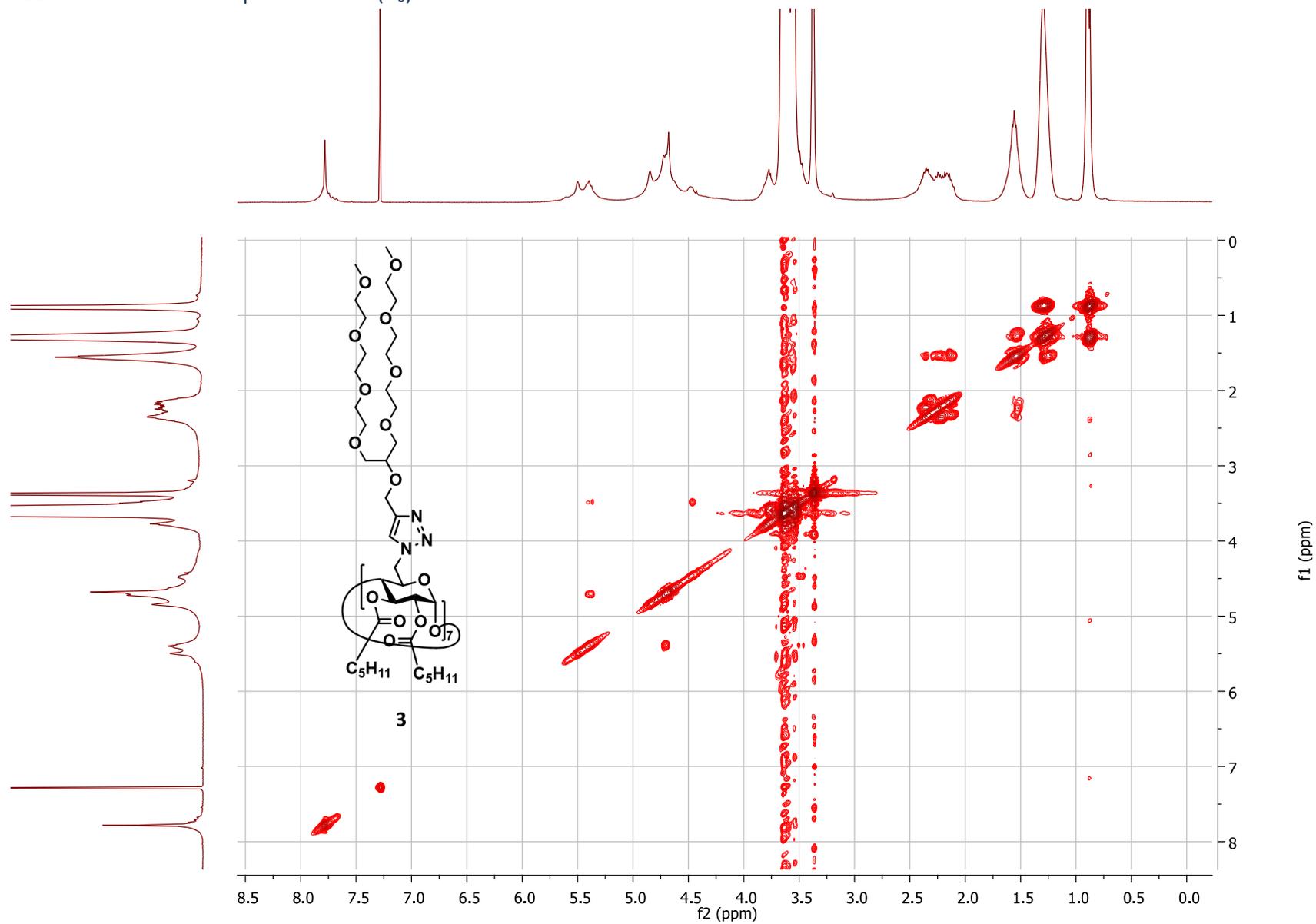
S19. ¹H NMR Spectrum of **3** (C₆)



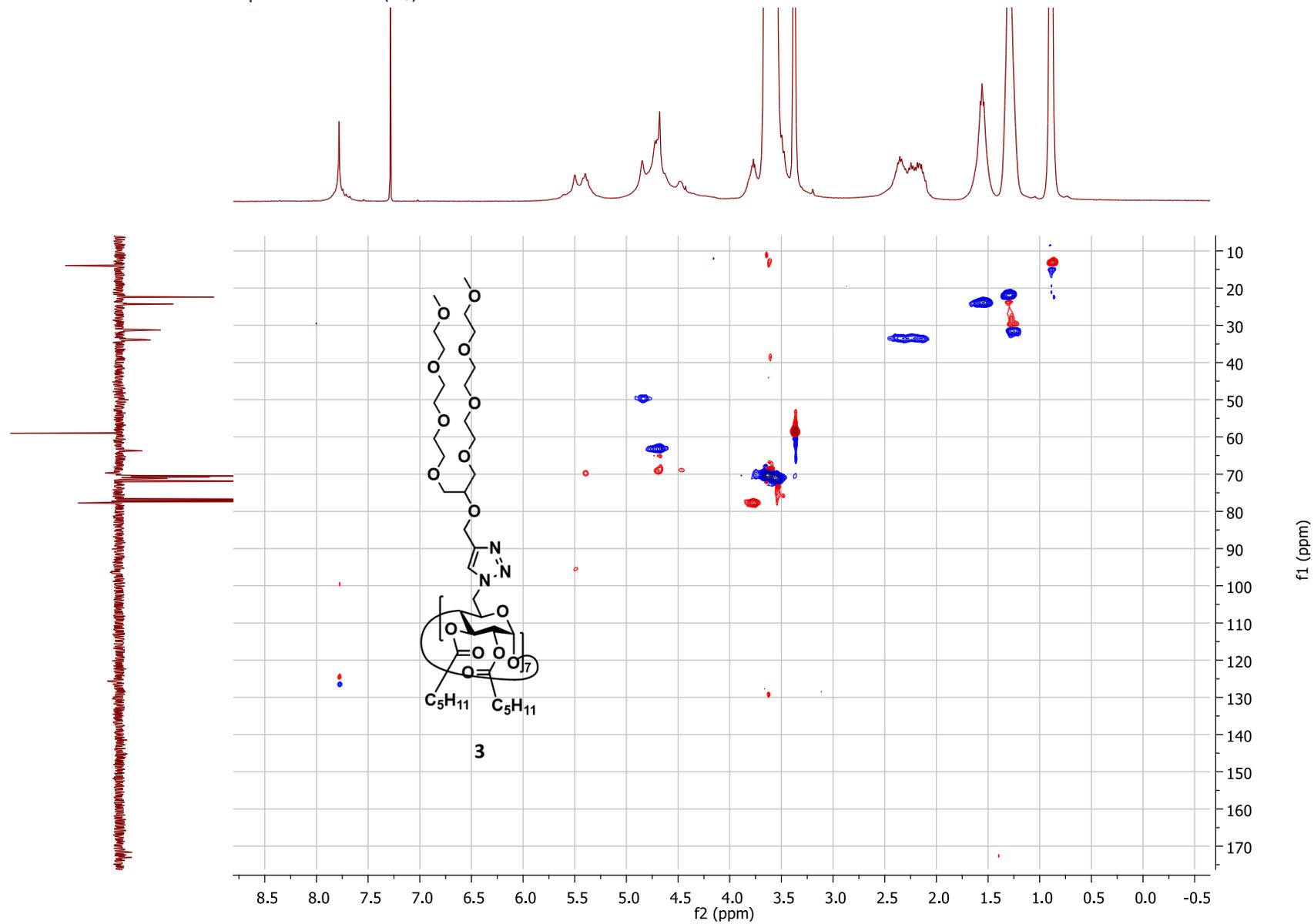
S20. ¹³C NMR Spectrum of **3** (C₆)



S21. ^1H - ^1H COSY NMR Spectrum of **3** (C_6)

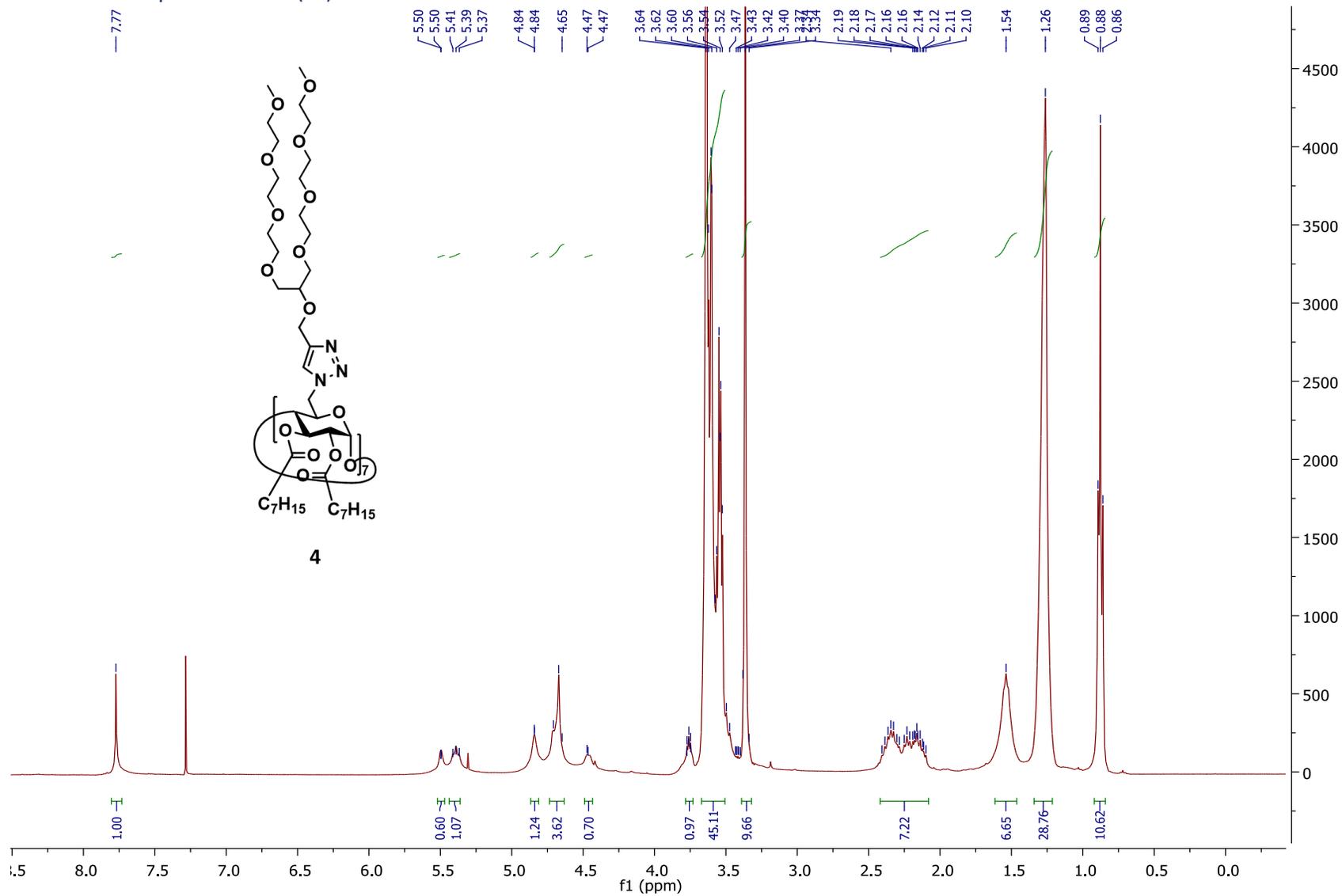


S22. ^1H - ^{13}C HSQC NMR Spectrum of **3** (C_6)

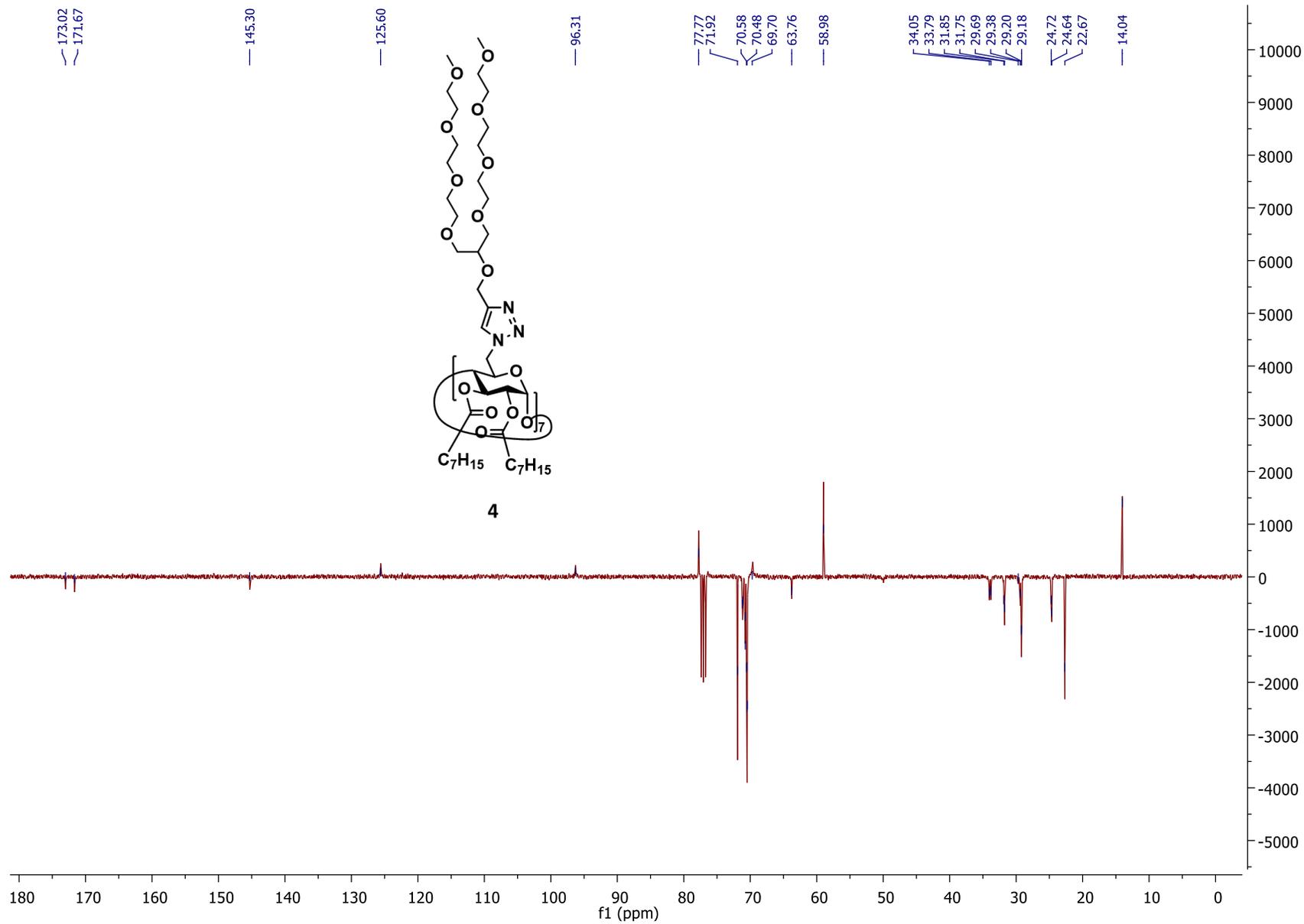


NMR Spectra of 4 (C₈)

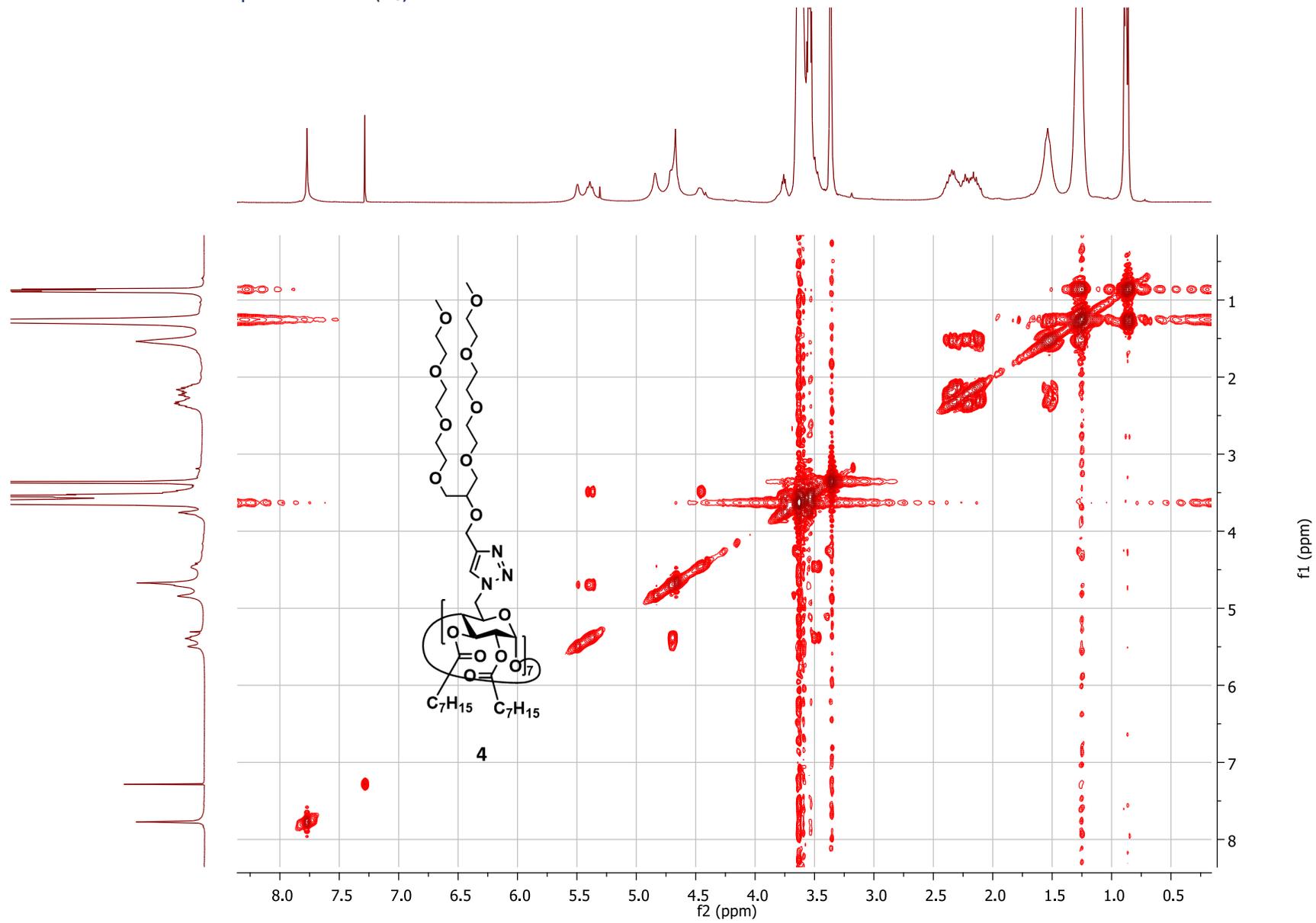
S23. ¹H NMR Spectrum of 4 (C₈)



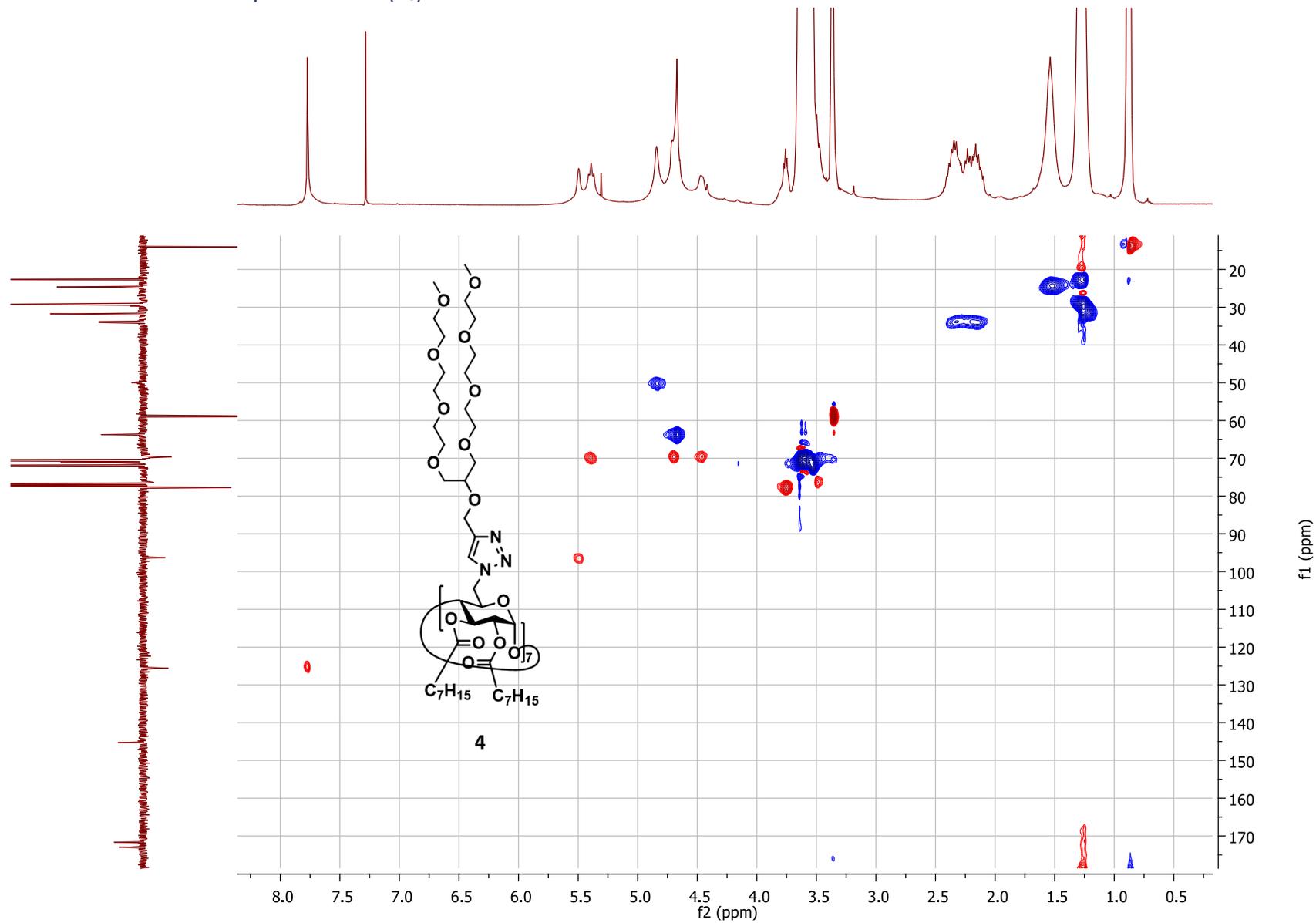
S24. ¹³C NMR Spectrum of **4** (C₈)



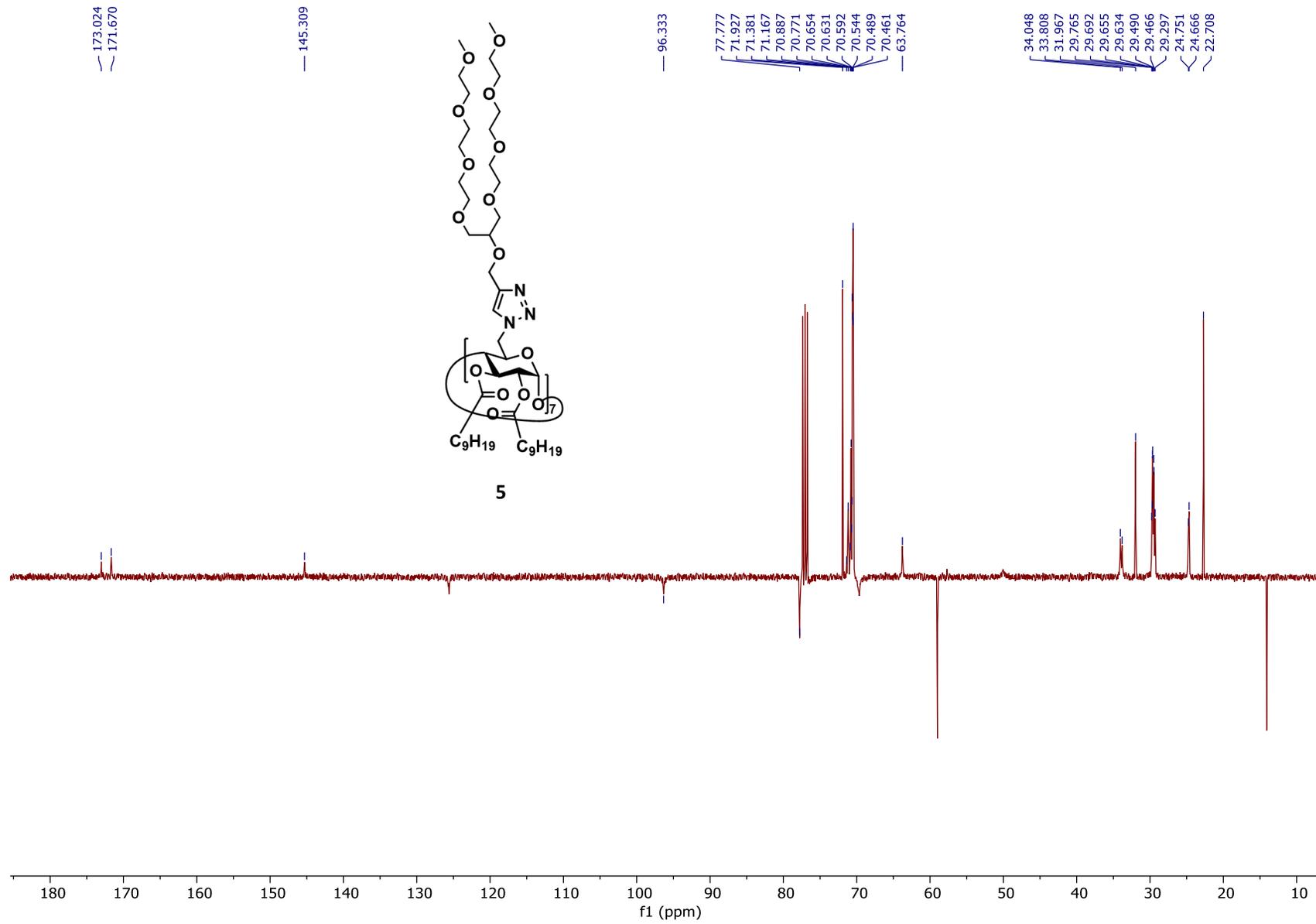
S25. ^1H - ^1H COSY NMR Spectrum of **4** (C_8)



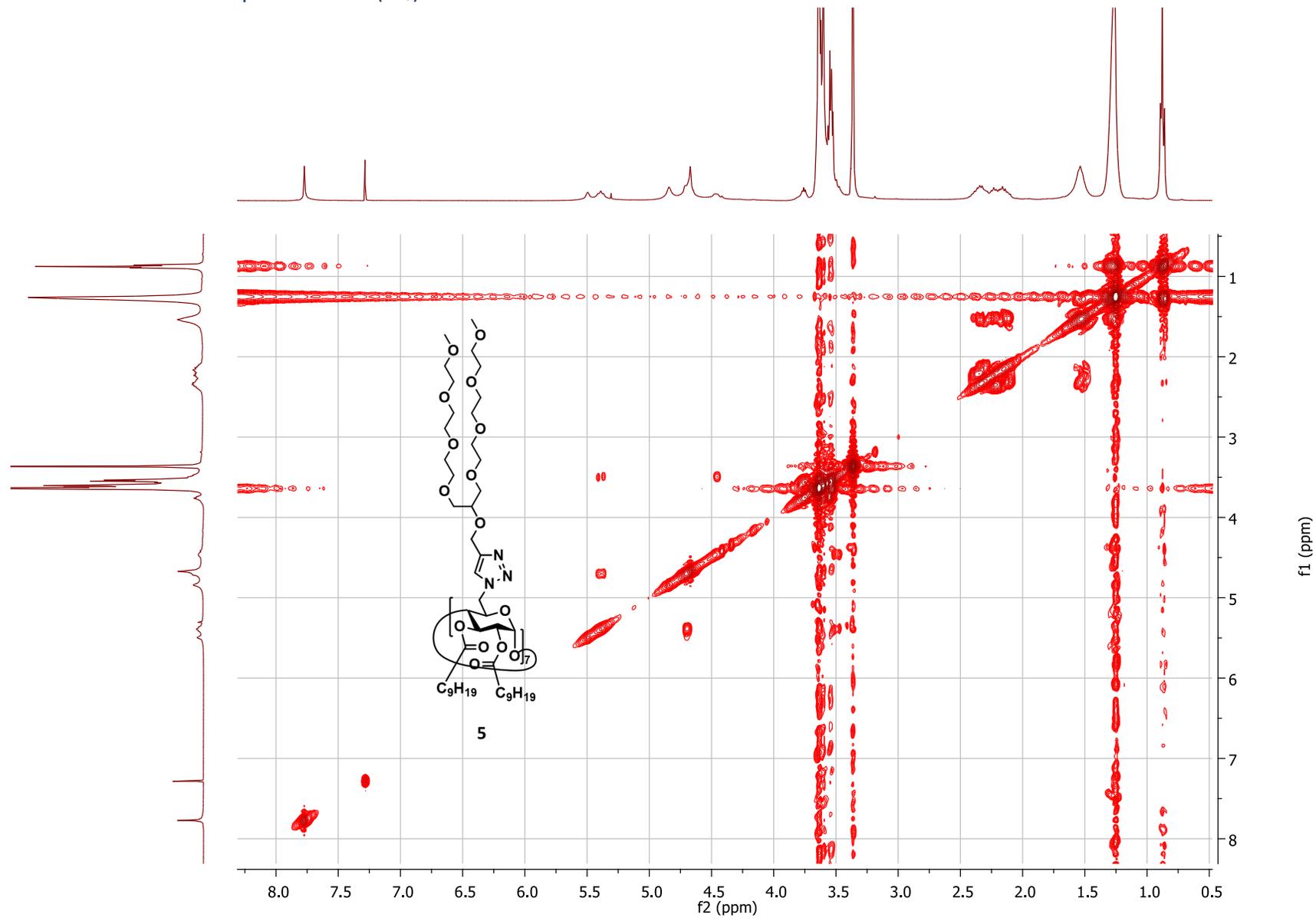
S26. ^1H - ^{13}C HSQC NMR Spectrum of **4** (C_8)



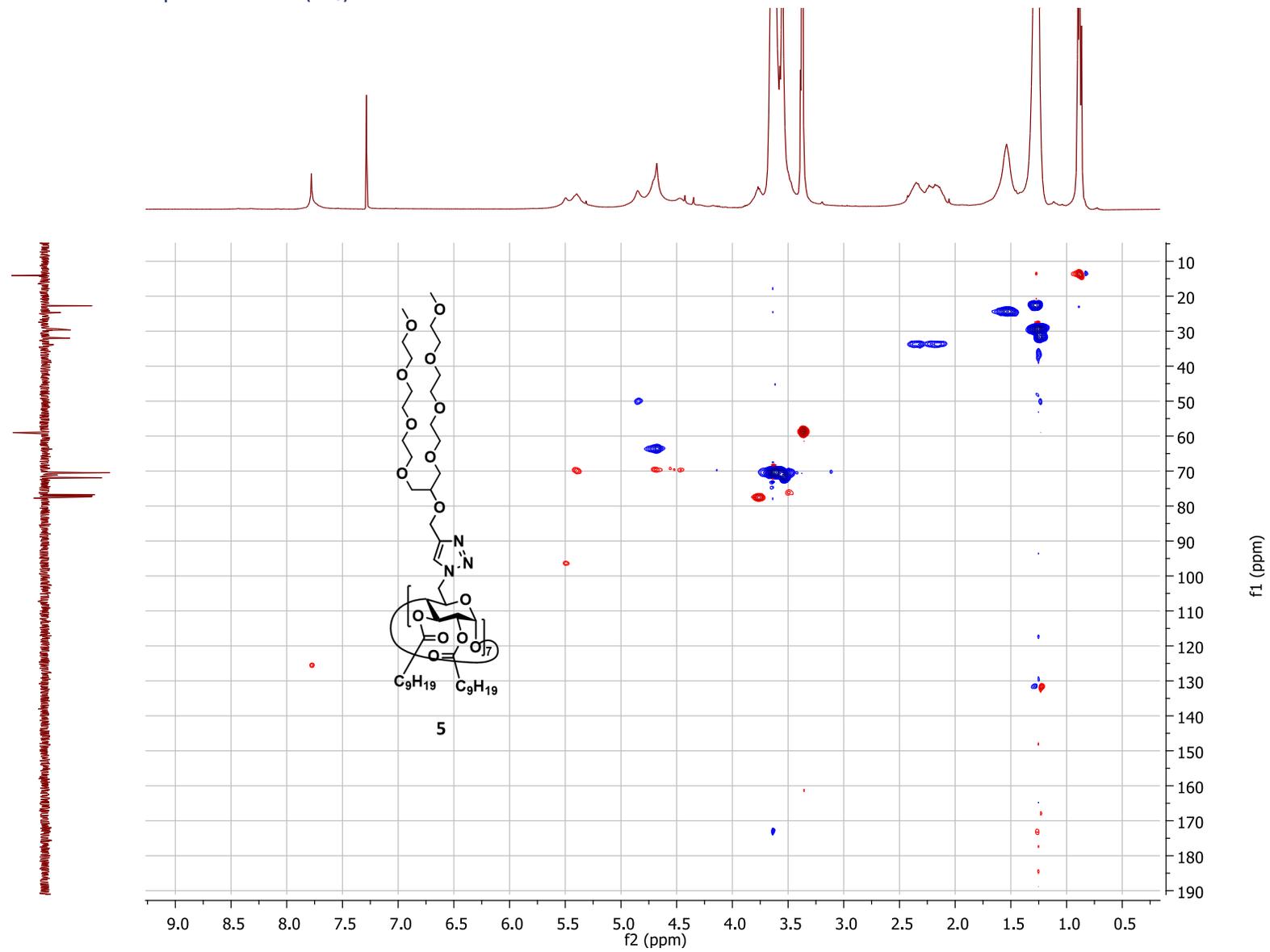
S28. ¹³C NMR Spectrum of **5** (C₁₀)



S29. ^1H - ^1H COSY NMR Spectrum of **5** (C_{10})

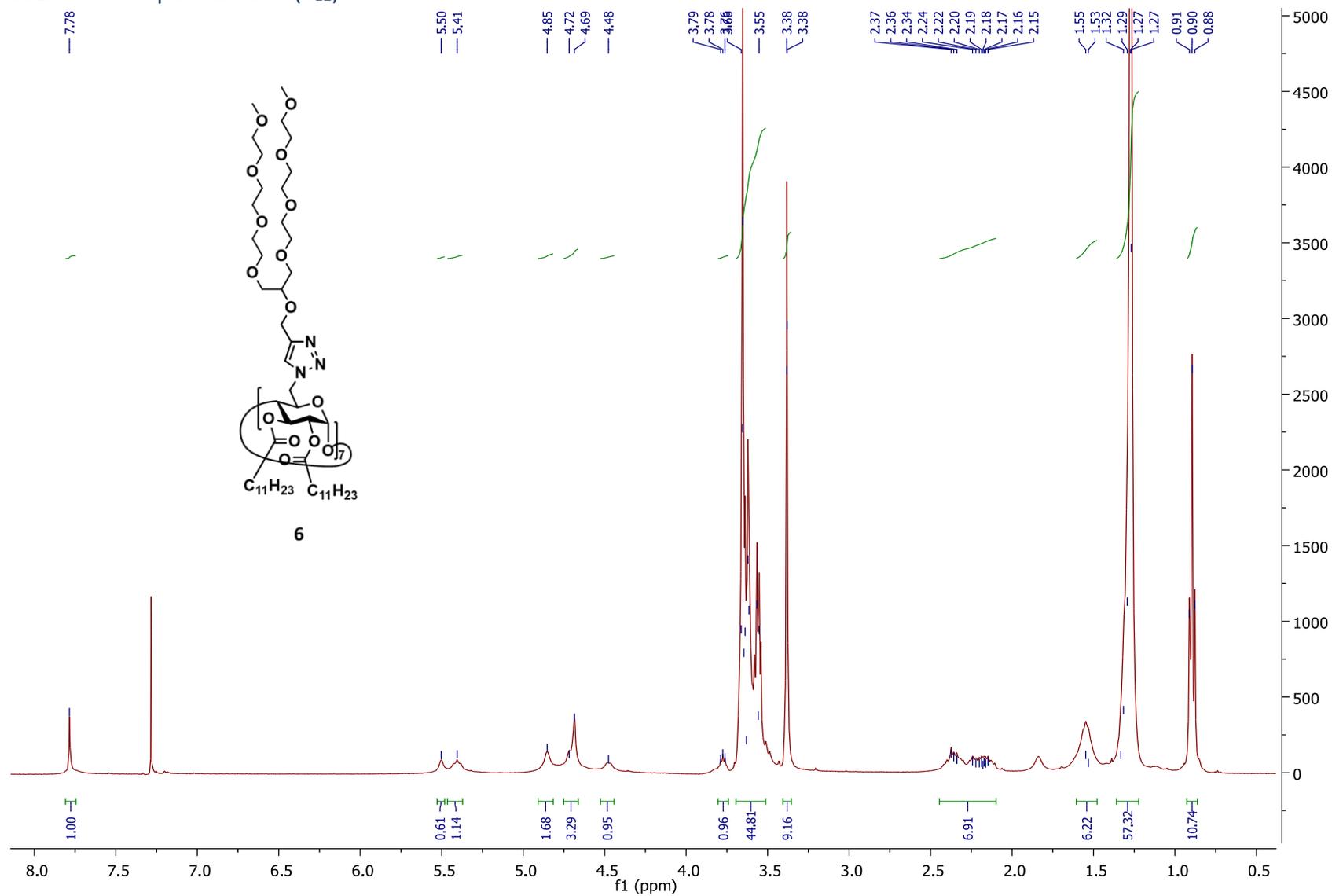


S30. ^1H - ^{13}C HSQC NMR Spectrum of **5** (C_{10})

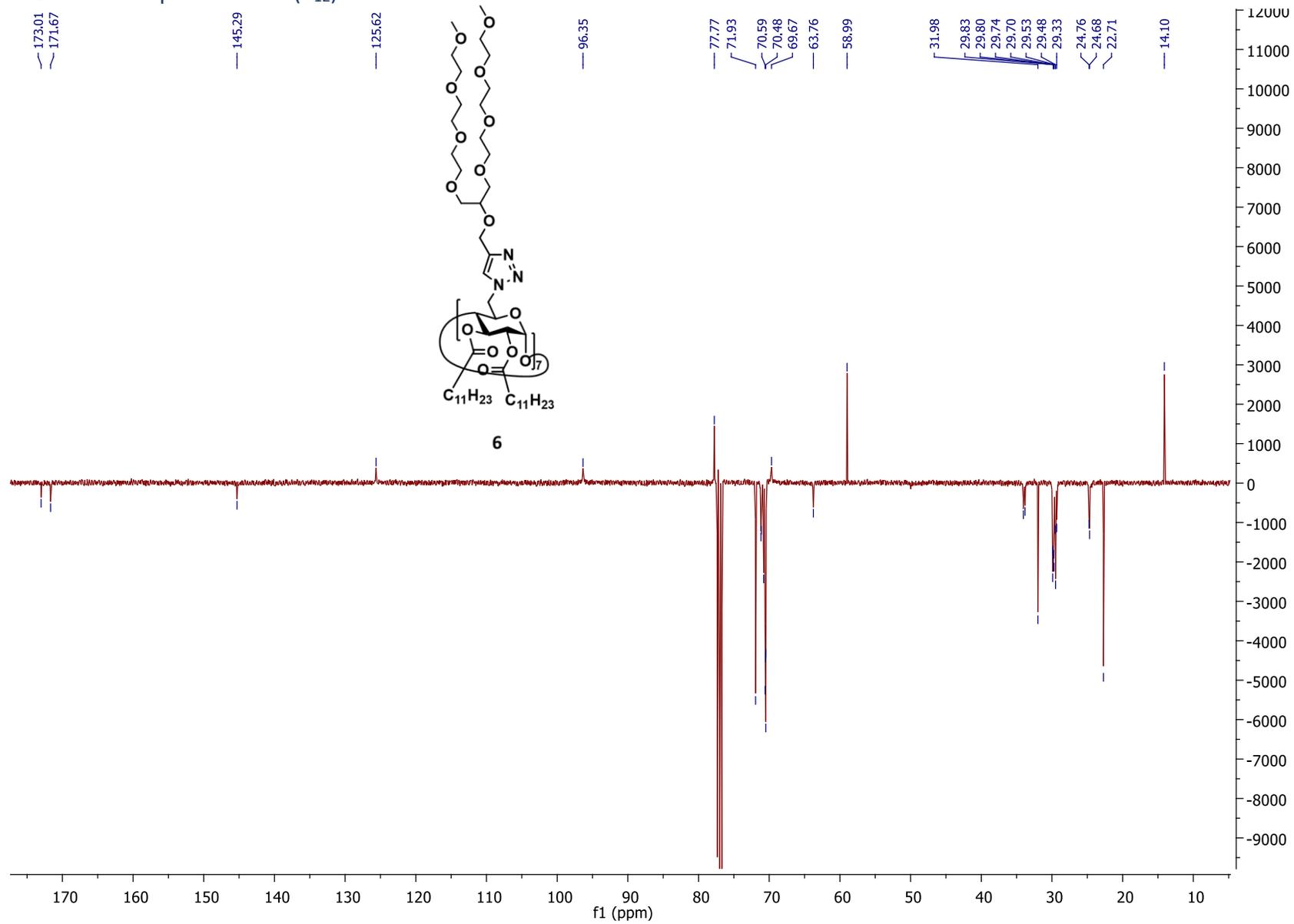


NMR Spectra of 6 (C₁₂)

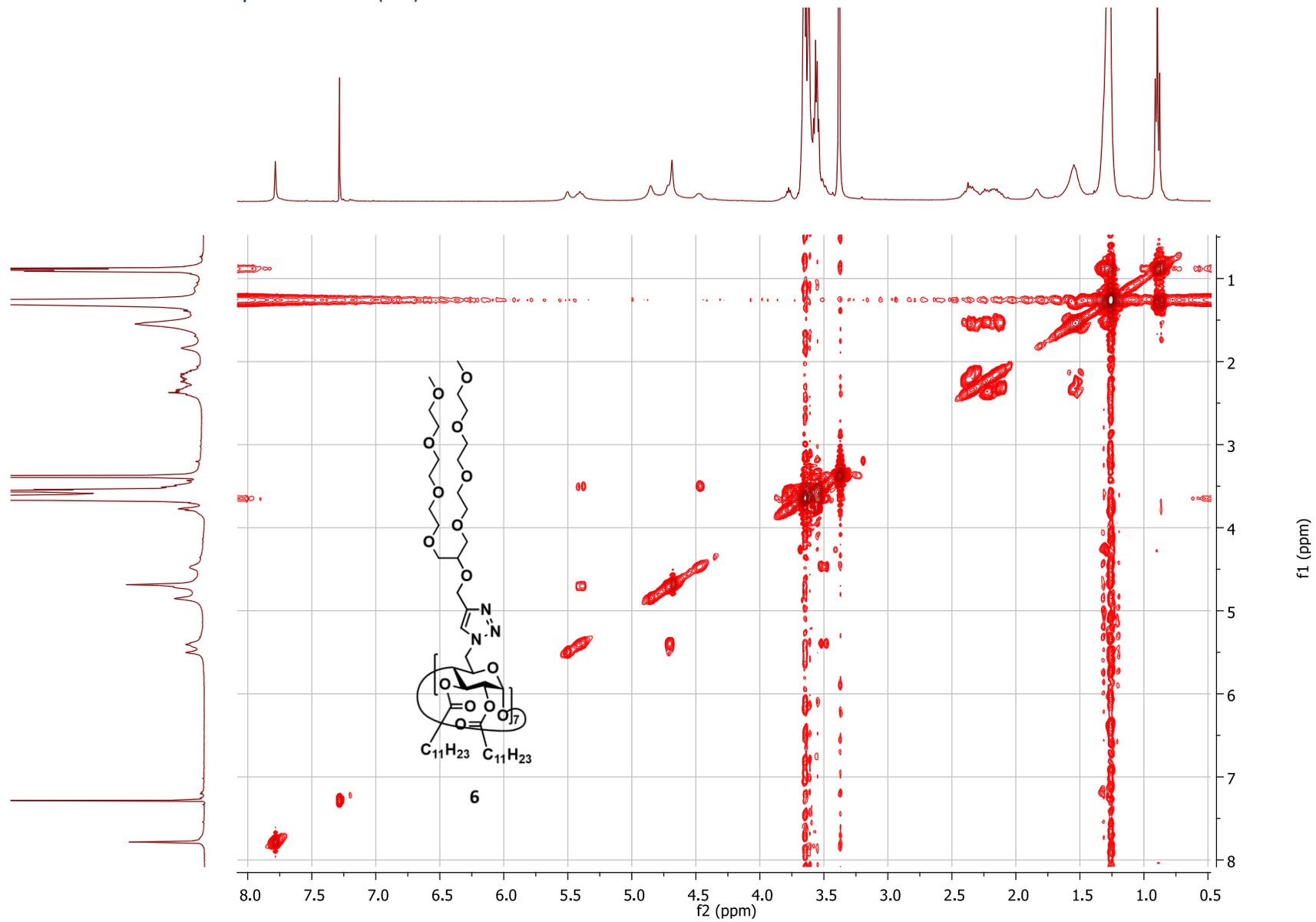
S31. ¹H NMR Spectrum of 6 (C₁₂)



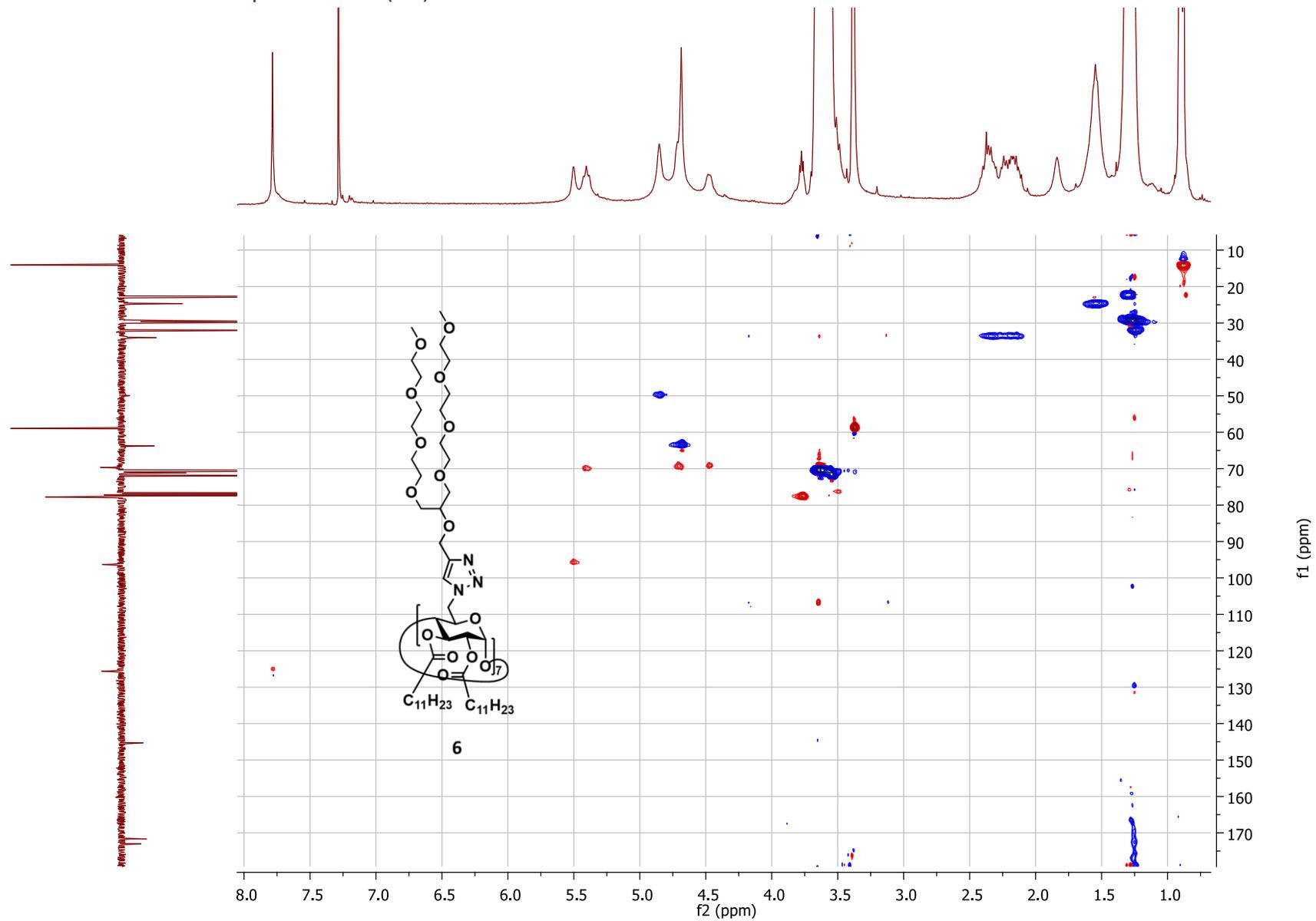
S32. ¹³C NMR Spectrum of **6** (C₁₂)



S33. ^1H - ^1H COSY NMR Spectrum of **6** (C_{12})

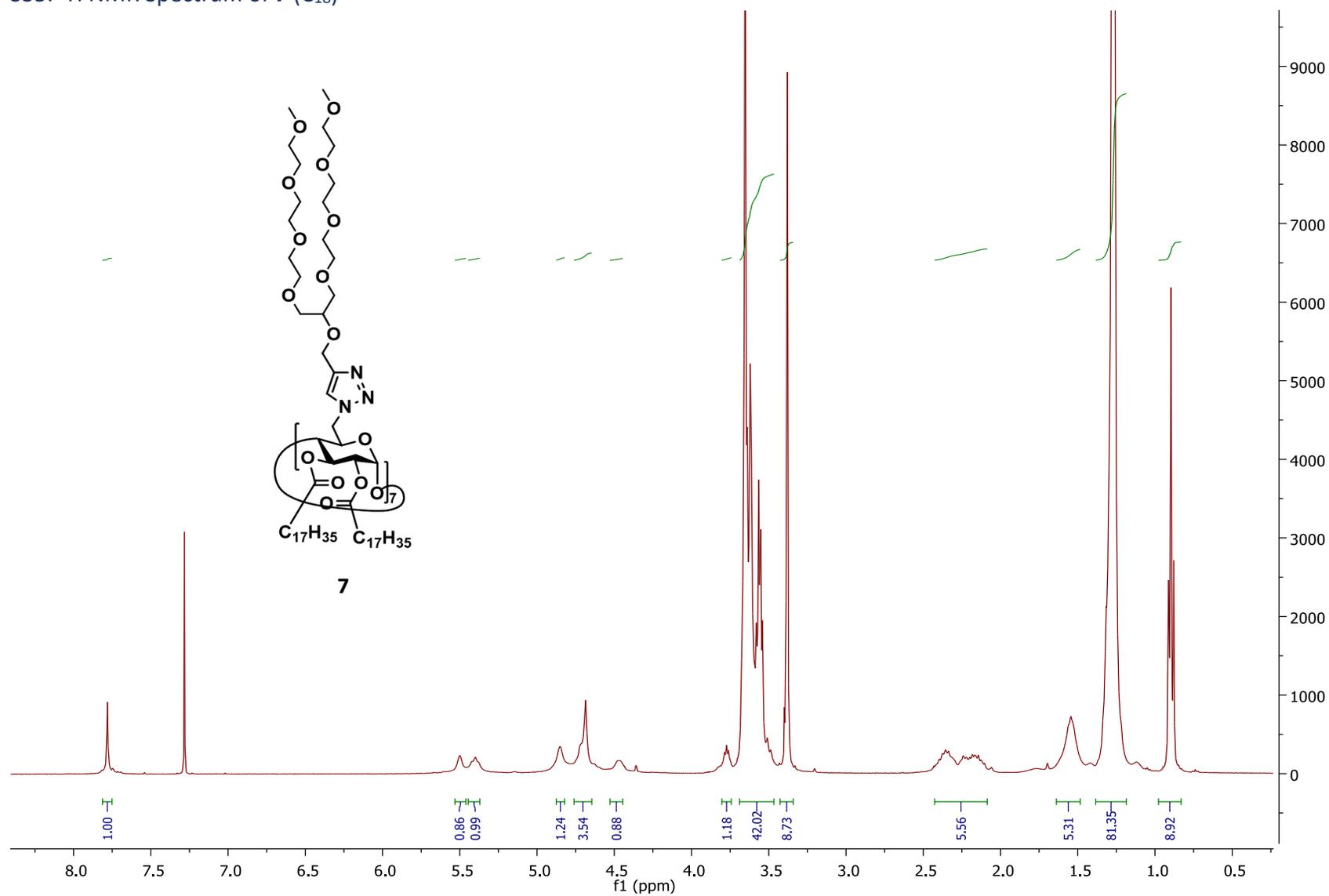


S34. ^1H - ^{13}C HSQC NMR Spectrum of **6** (C_{12})

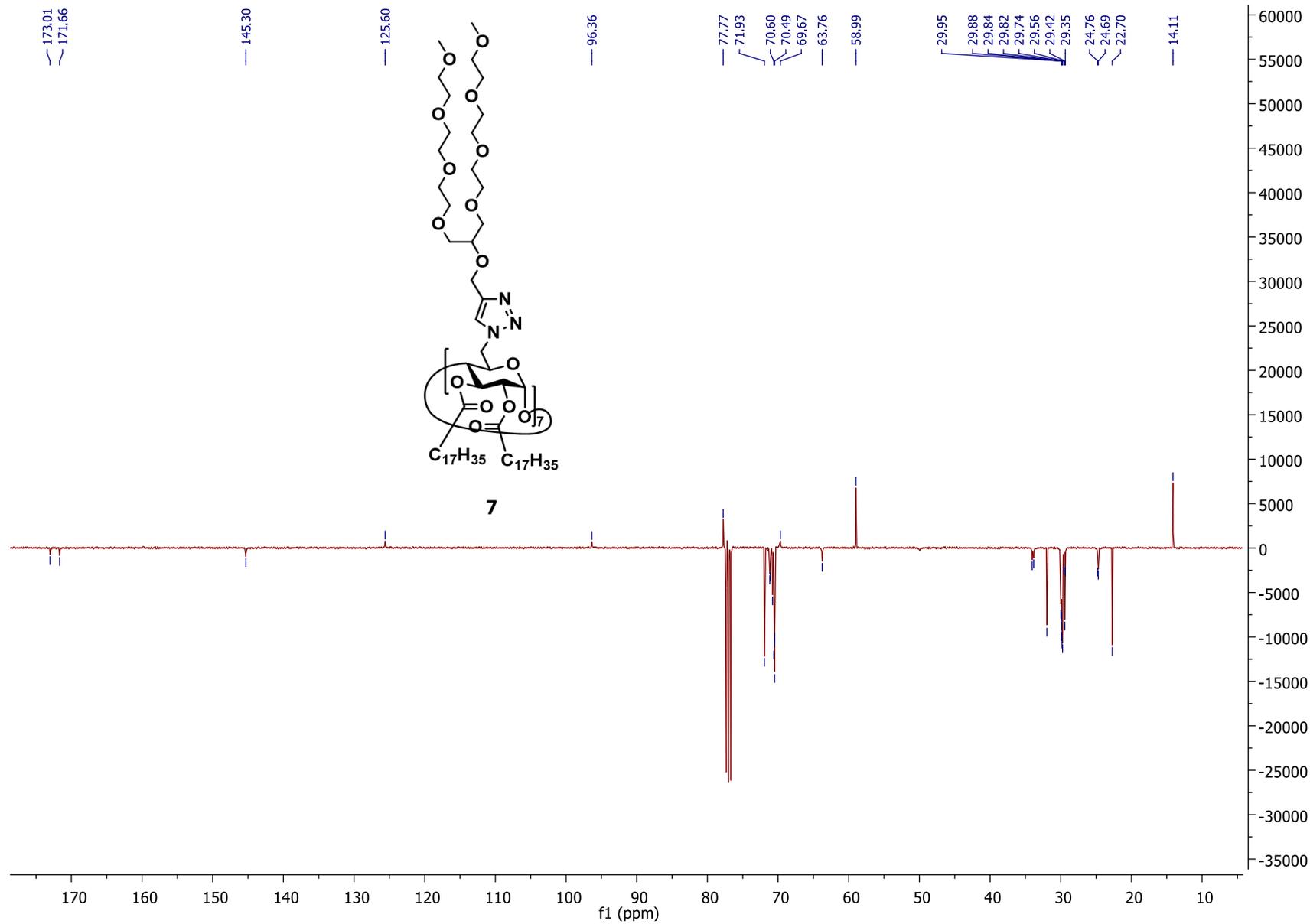


NMR Spectra of 7 (C₁₈)

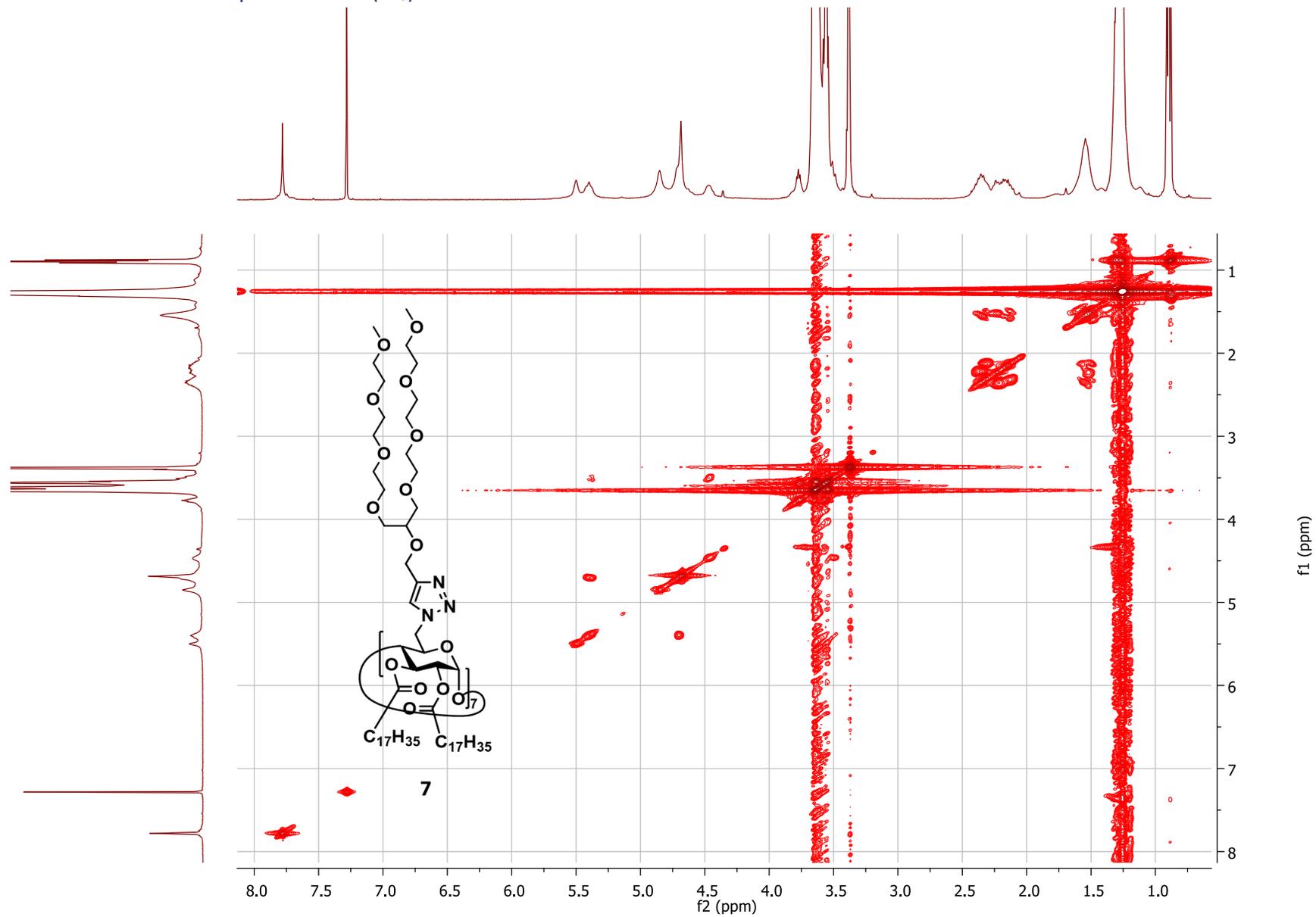
S35. ¹H NMR Spectrum of 7 (C₁₈)



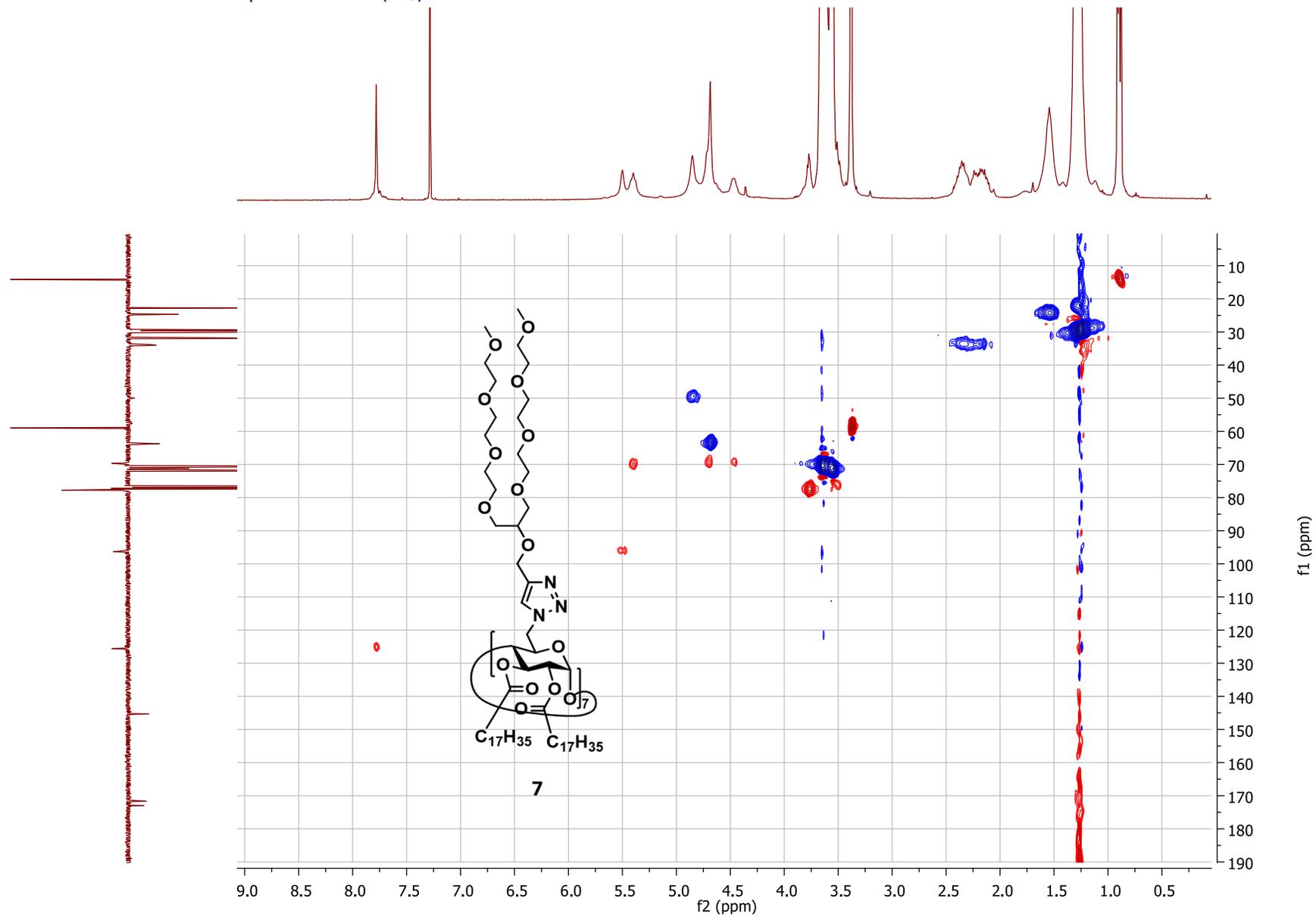
S36. ¹³C NMR Spectrum of **7** (C₁₈)



S37. ^1H - ^1H COSY NMR Spectrum of **7** (C_{18})



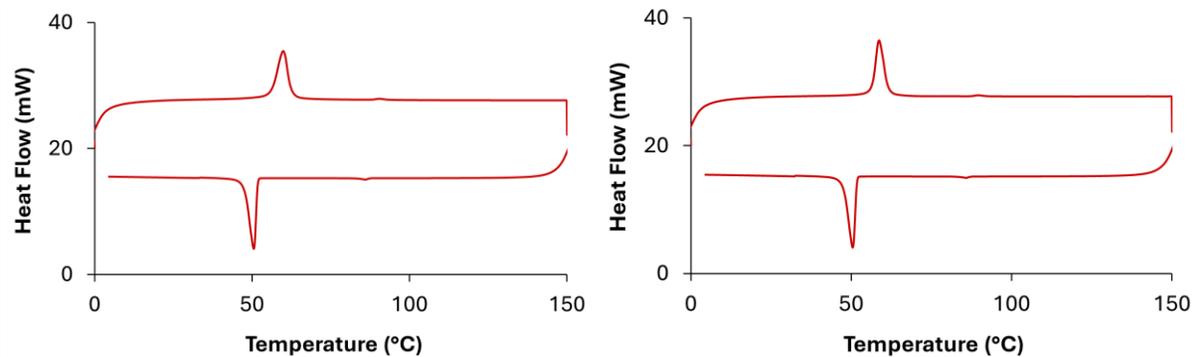
S38. ^1H - ^{13}C HSQC NMR Spectrum of **7** (C_{18})



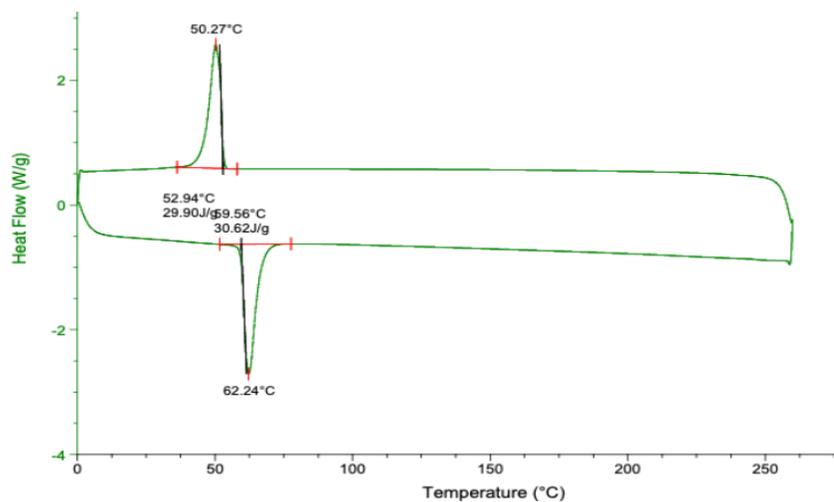
II. Differential Scanning Calorimetry (DSC)

Note: For Red, heating curves are displayed on top while cooling curves are displayed on the bottom. Green curves are reversed.

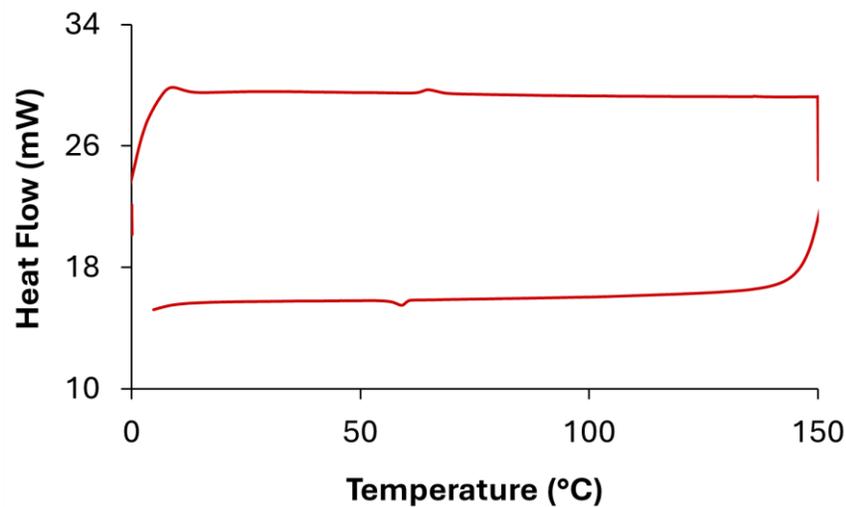
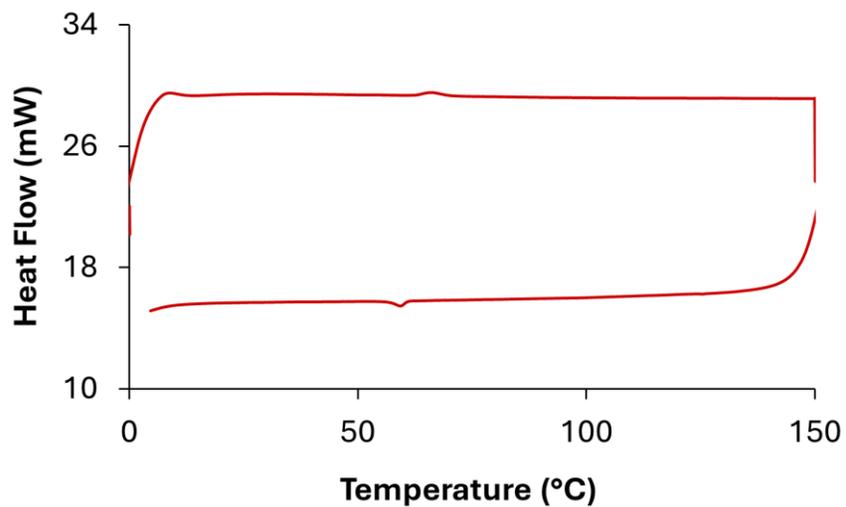
S39. DSC thermograms of compound **7** (C₁₈) showing the first (left) and second (right) heating/cooling scans.



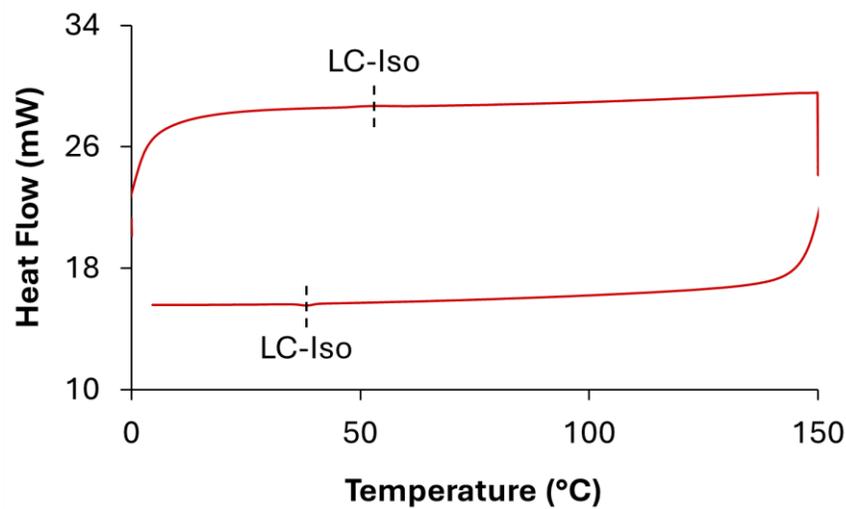
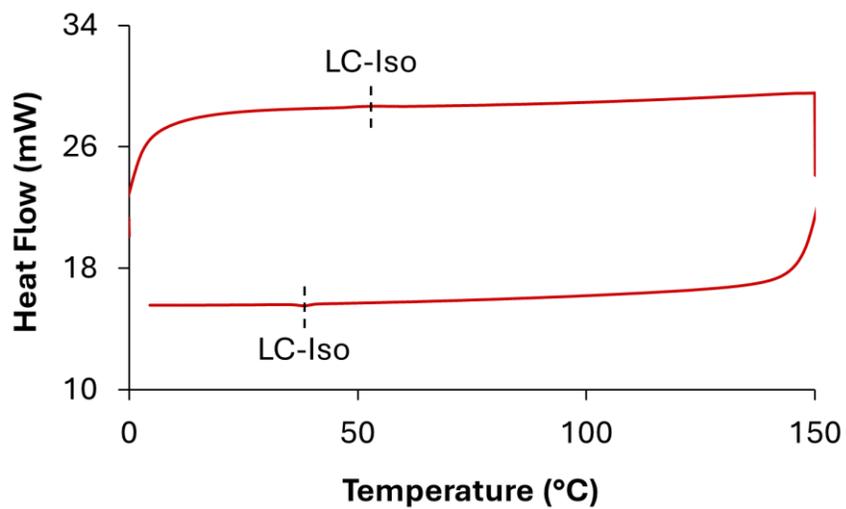
S40. DSC thermograms of composite **7** (C₁₈)-Li



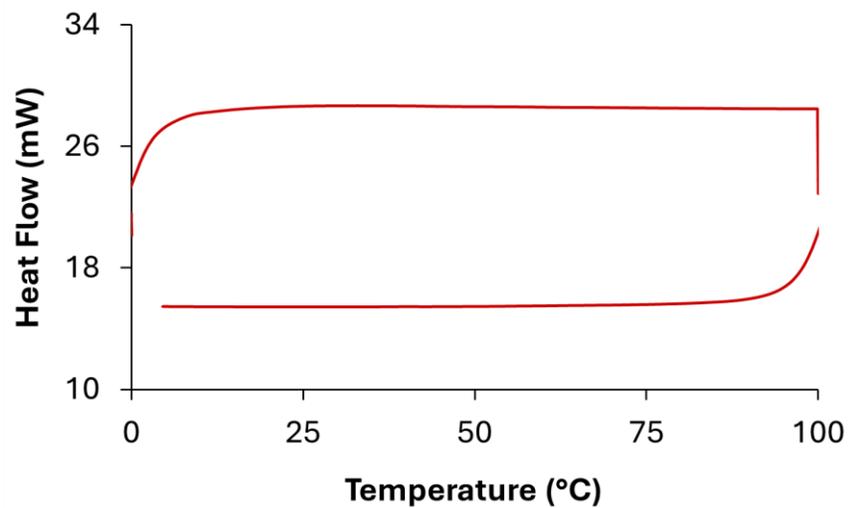
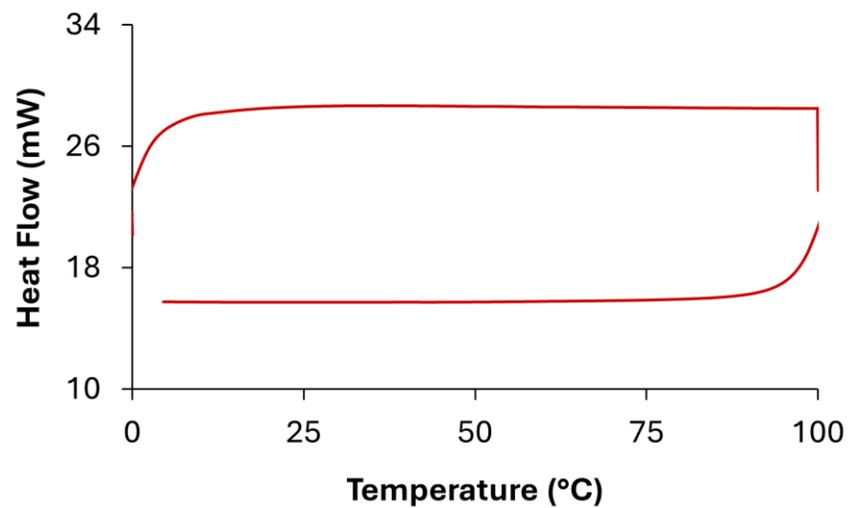
S41. DSC thermograms of **6** (C₁₂) showing the first (left) and second (right) heating/cooling scans.



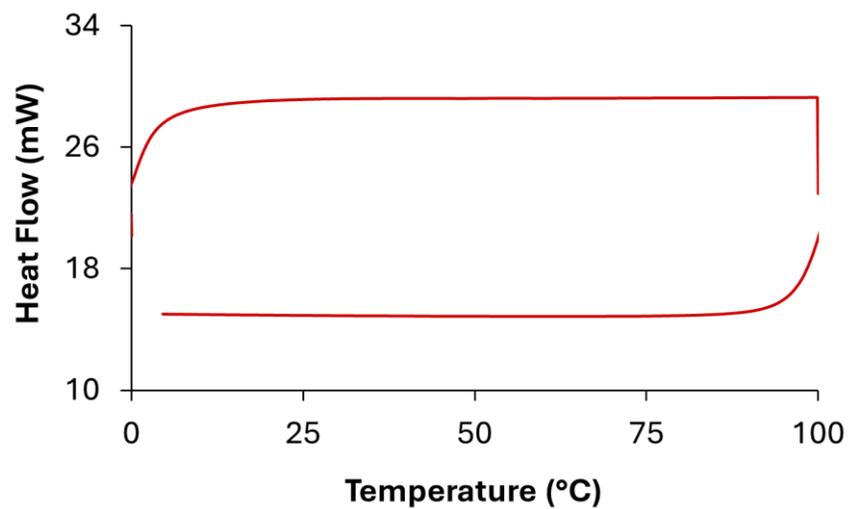
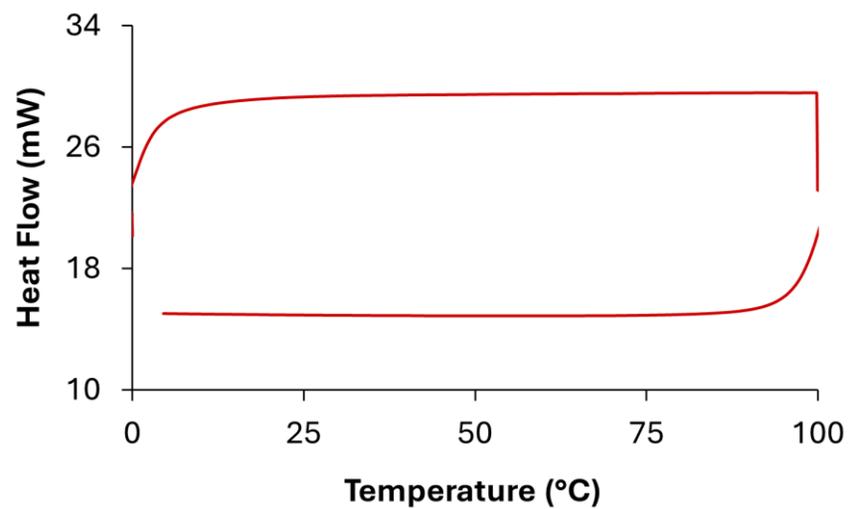
S42. DSC thermograms of **5** (C₁₀) showing the first (left) and second (right) heating/cooling scans.



S43. DSC thermograms of **4** (C₈) showing the first (left) and second (right) heating/cooling scans.



S44. DSC thermograms of **3** (C₆) showing the first (left) and second (right) heating/cooling scans.

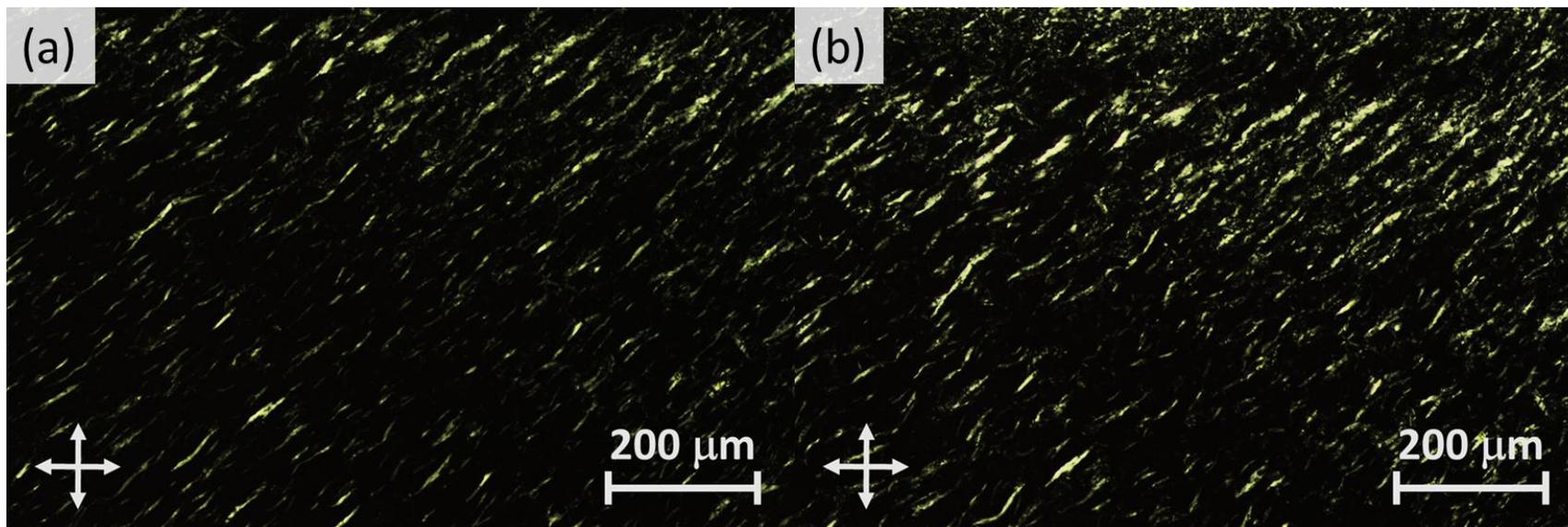


III. Polarized Optical Microscope (POM)

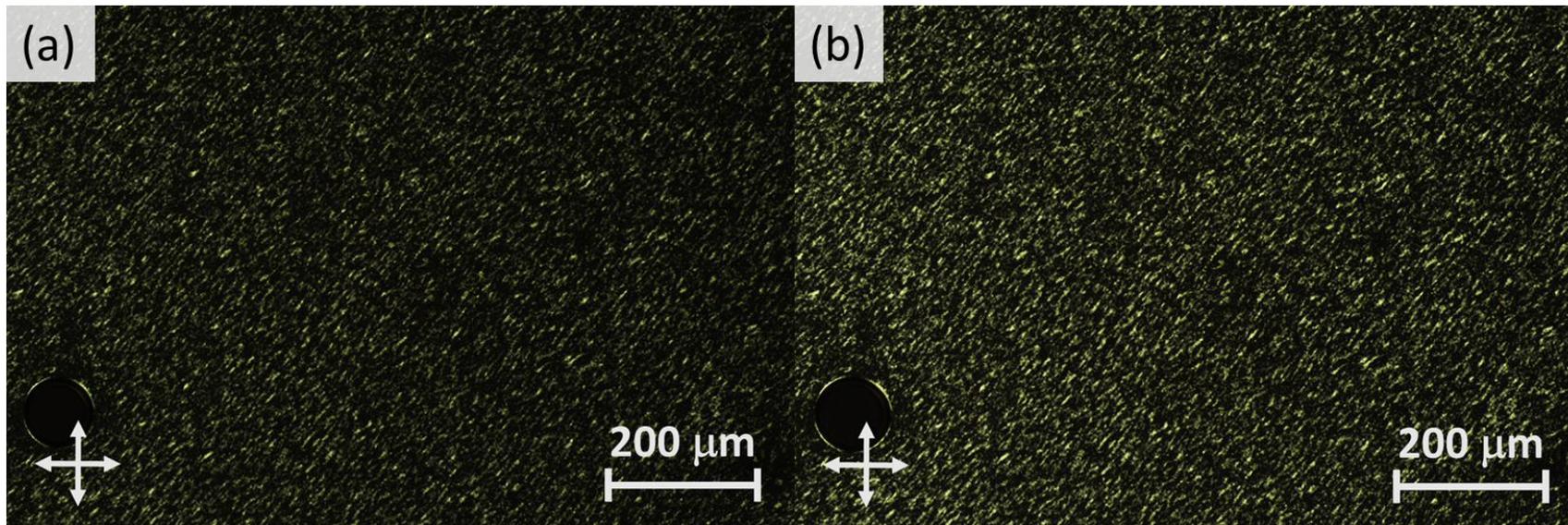
S45. POM images of composite **7** (C₁₈)-Li at (a) 225 °C and (b) 100 °C, and (c) 50 ° C.



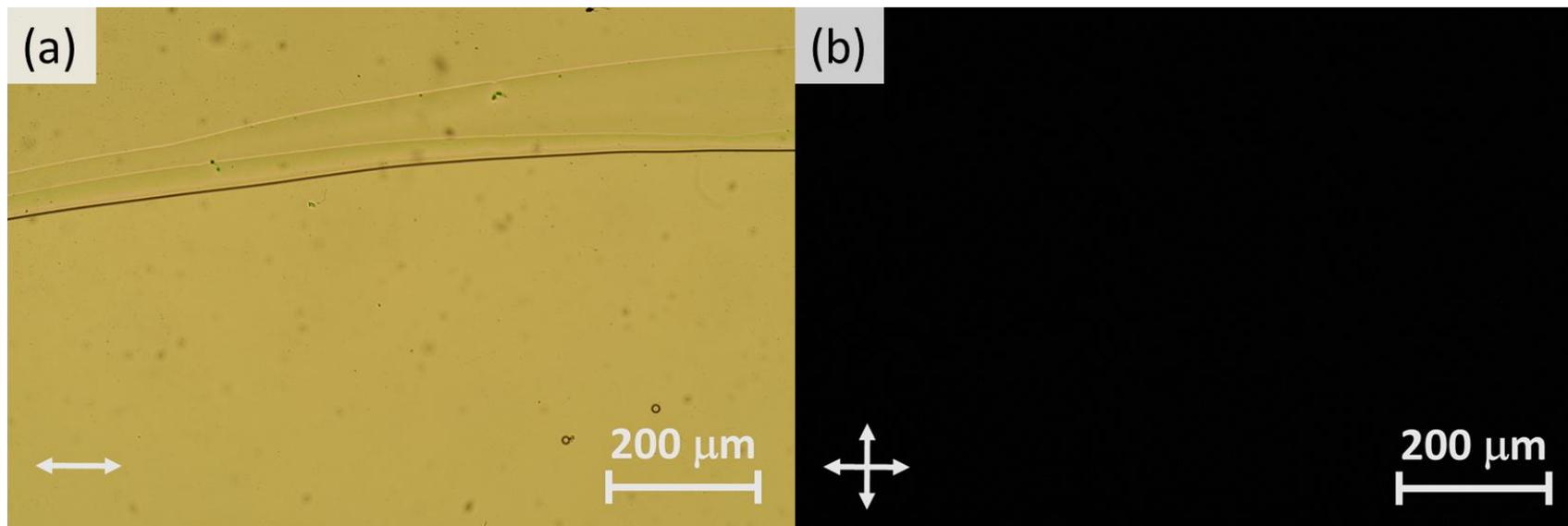
S46. POM images of **6** (C_{12}) at (a) 48 °C and (b) 25 °C.



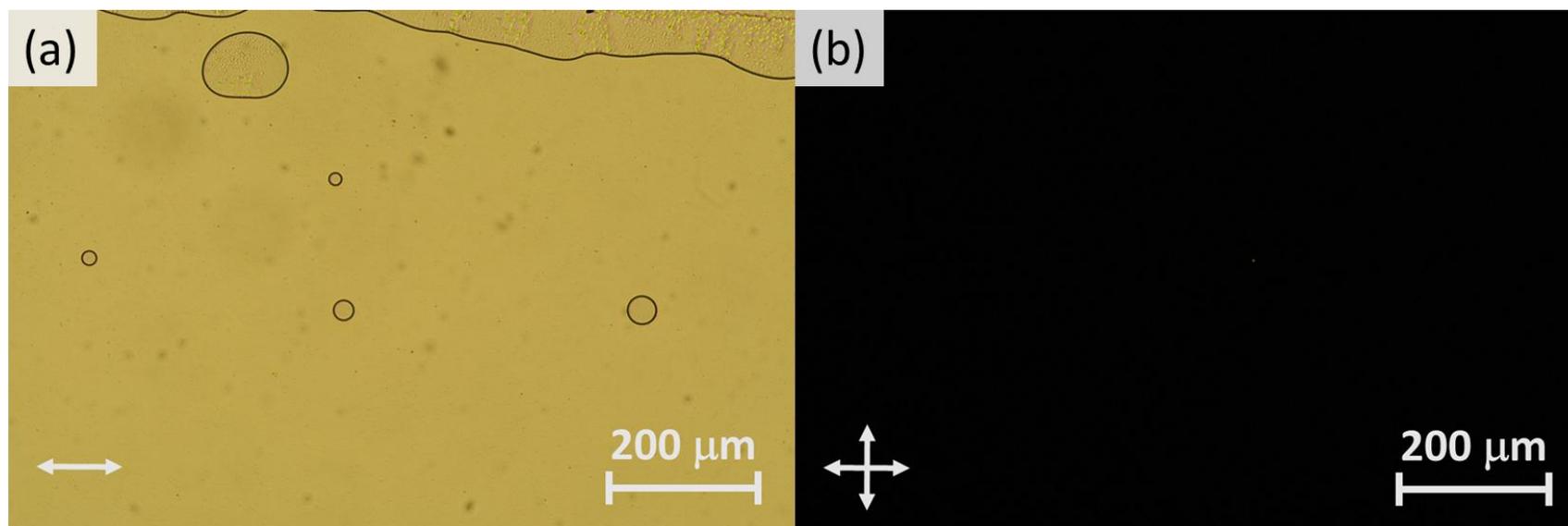
S47. POM images of **5** (C_{10}) at (a) 36 °C and (b) 25 °C.



S48. POM images of **4** (C_8) at room temperature with the cross-polarizers (a) parallelly and (b) orthogonally aligned.

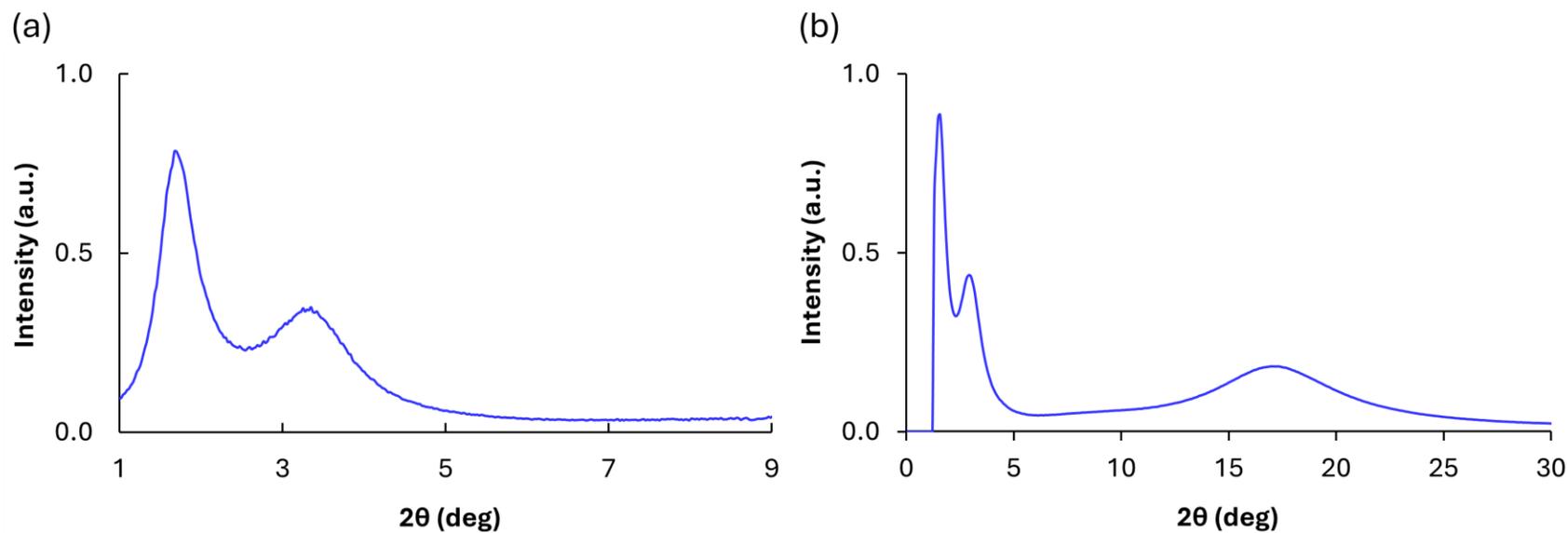


S49. POM images of **3** (C_6) at room temperature with the cross-polarizers (a) parallelly and (b) orthogonally aligned.

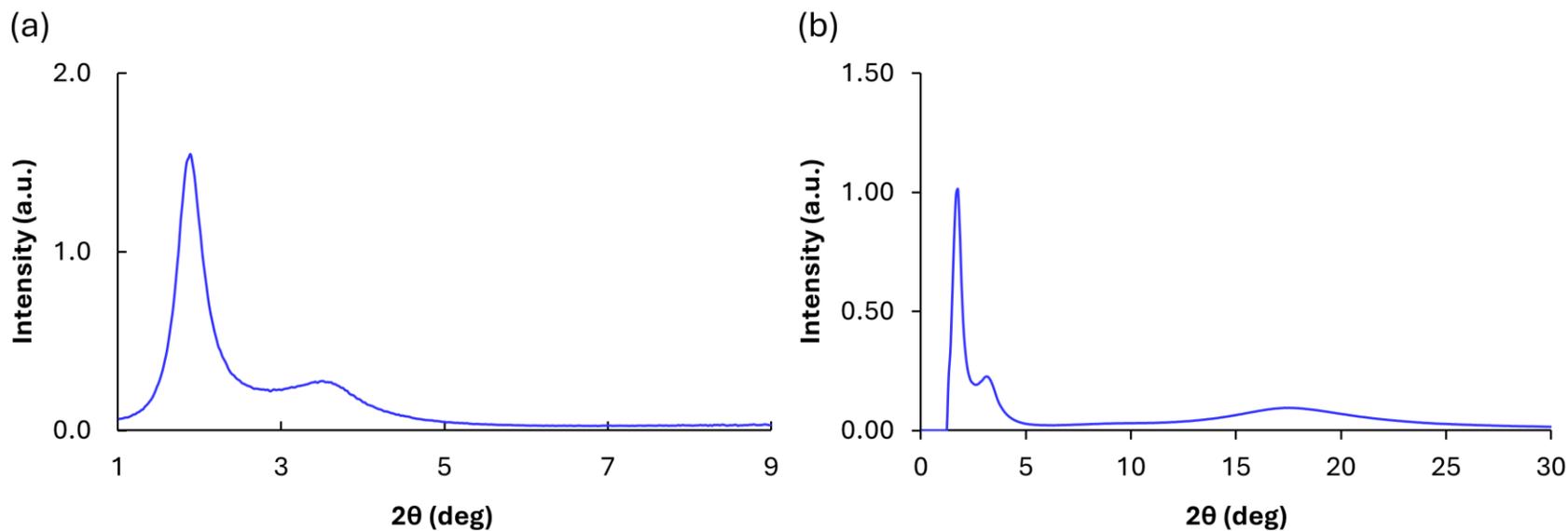


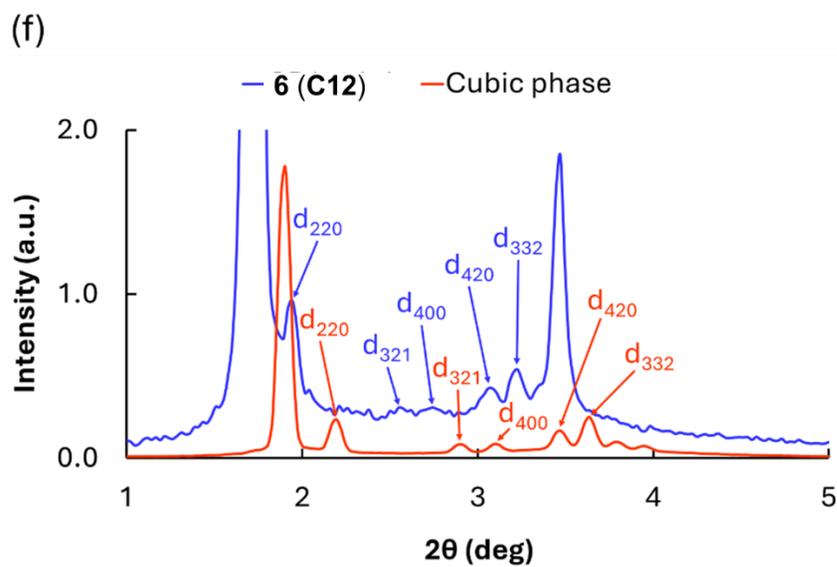
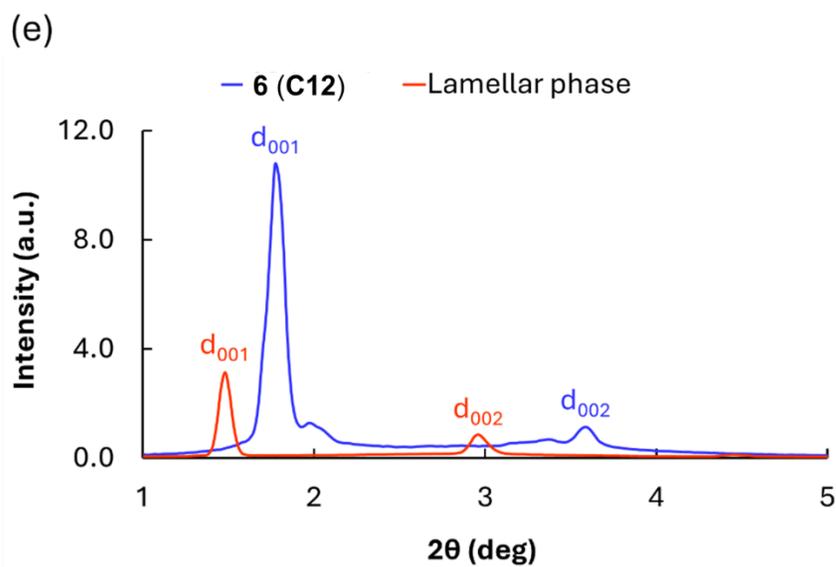
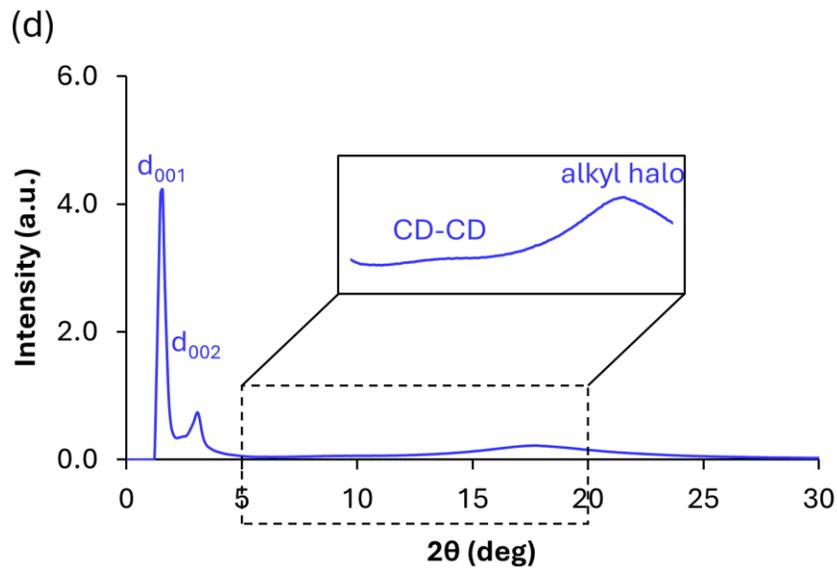
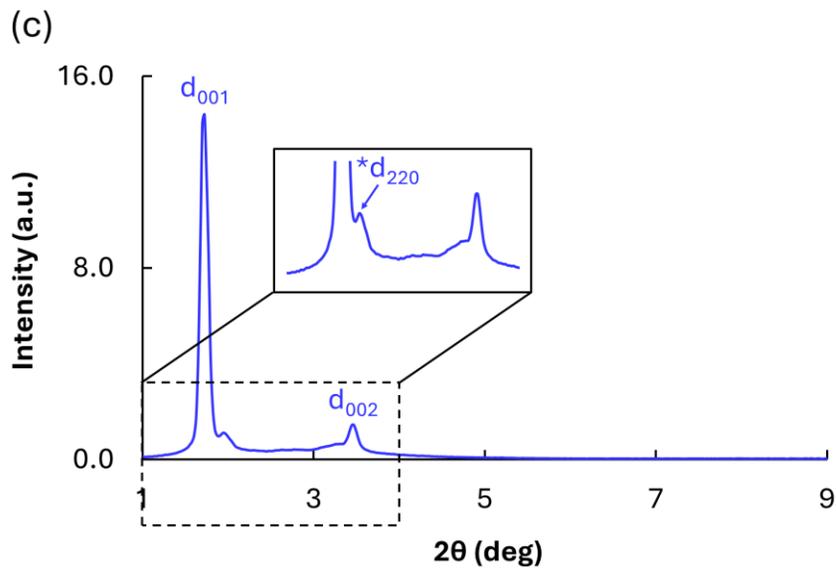
IV. X-ray Diffraction (XRD)

S50. X-ray diffractograms of **7** (C₁₈) of the isotropic phase at 125 °C, showing both the (a) mid-angle X-ray scattering and (b) wide-angle X-ray scattering measurements.

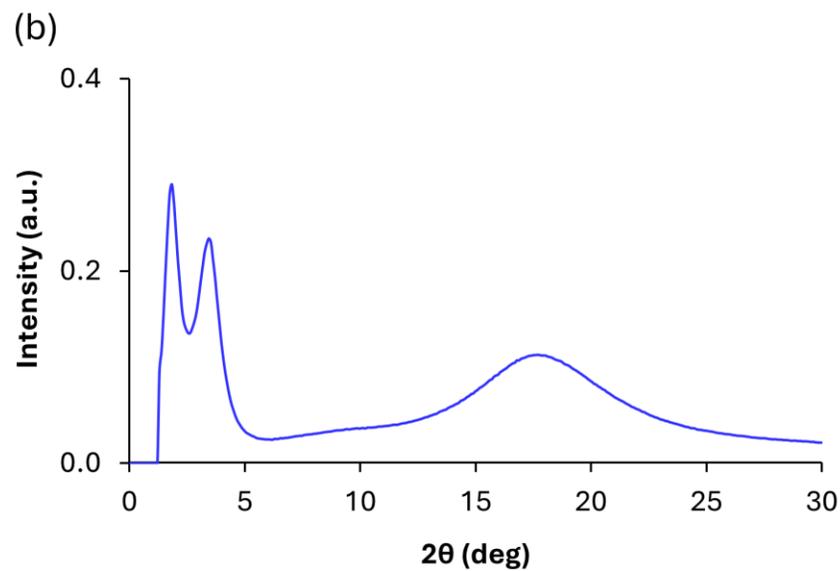
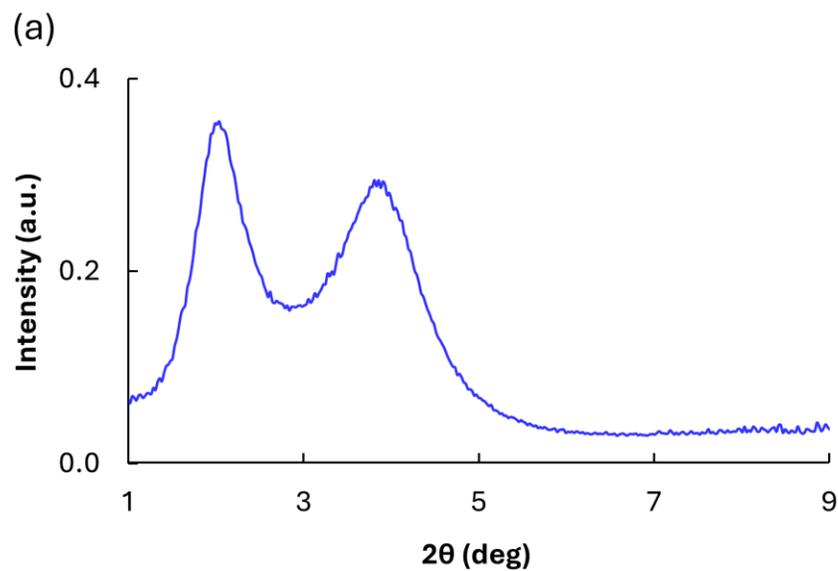


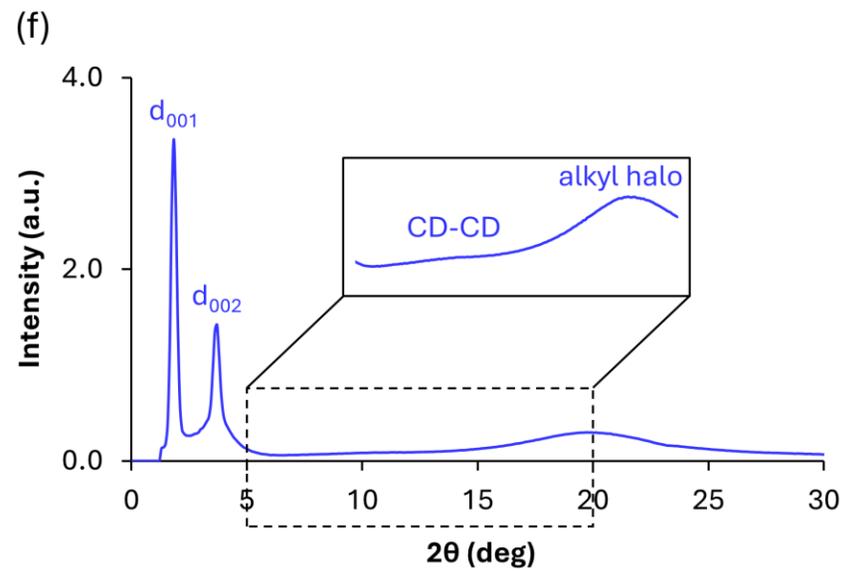
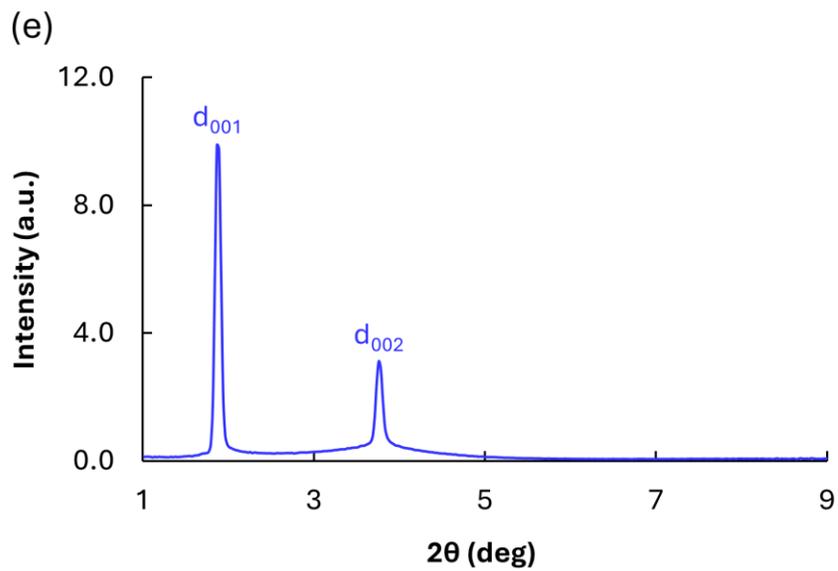
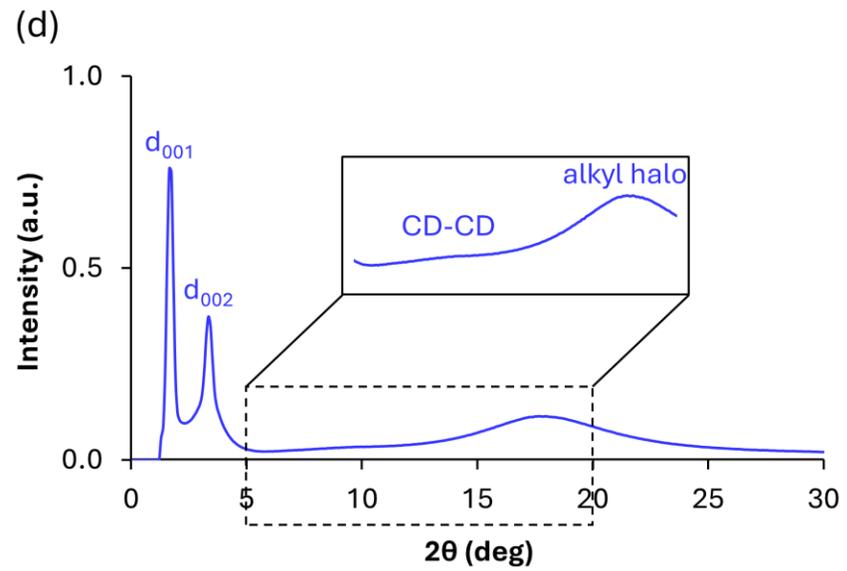
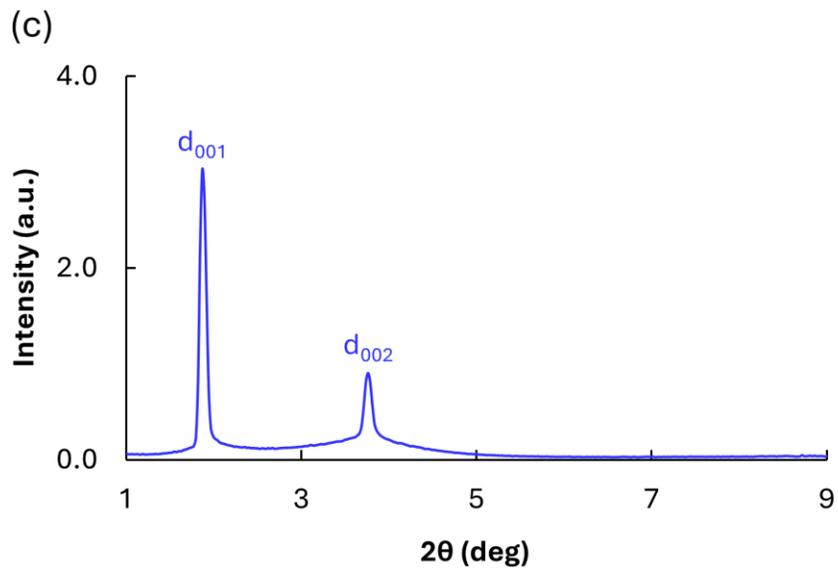
S51. X-ray diffractograms of **6** (C_{12}) of the (a-b) isotropic phase at 100 °C, (c-d) the liquid crystal phase at 25 °C, and (e-f) the liquid crystal phase at 25 °C overlaid with the lamellar phase from **7** (18) (e) and the cubic phase from a previously reported CD derivative.¹ (f). Both the mid-angle X-ray scattering (a,c,e,f) and wide-angle X-ray scattering (b,d) measurements are shown.



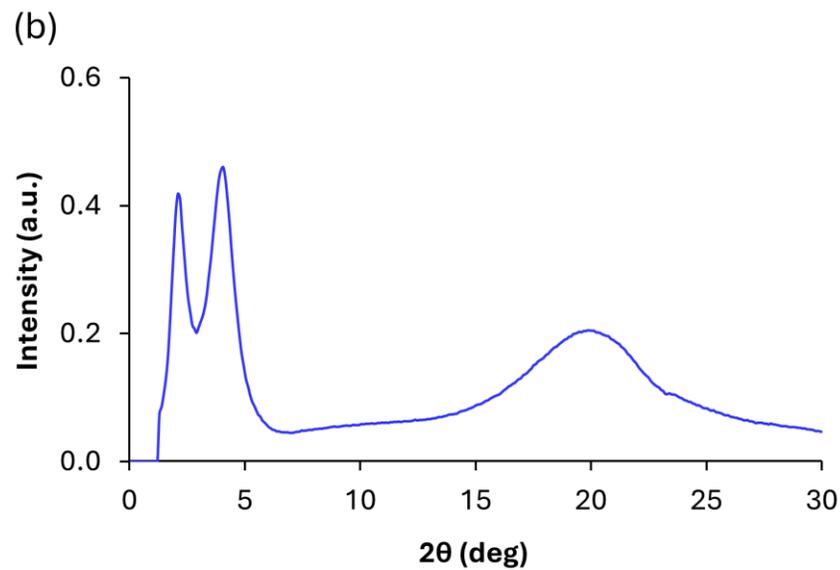
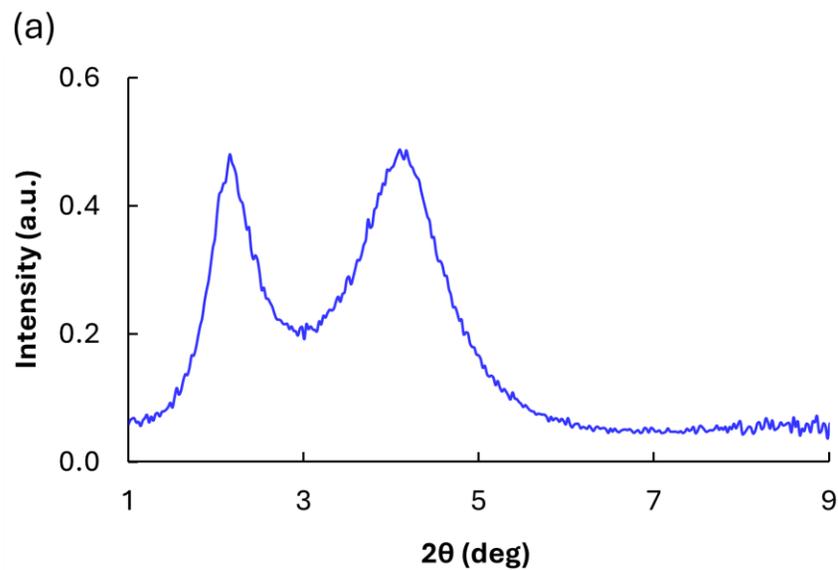


S52. X-ray diffractograms of **5** (C_{10}) of (a-b) the isotropic phase at 80 °C and the liquid crystal phase at (c-d) 40 °C and at (e-f) 25 °C. Both the mid-angle X-ray scattering (a,c,e) and wide-angle X-ray scattering (b,d,f) measurements are shown.

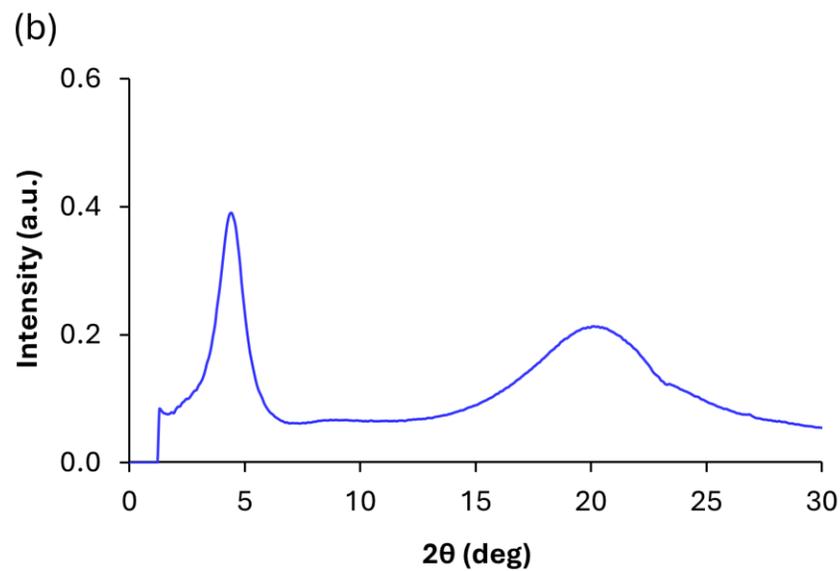
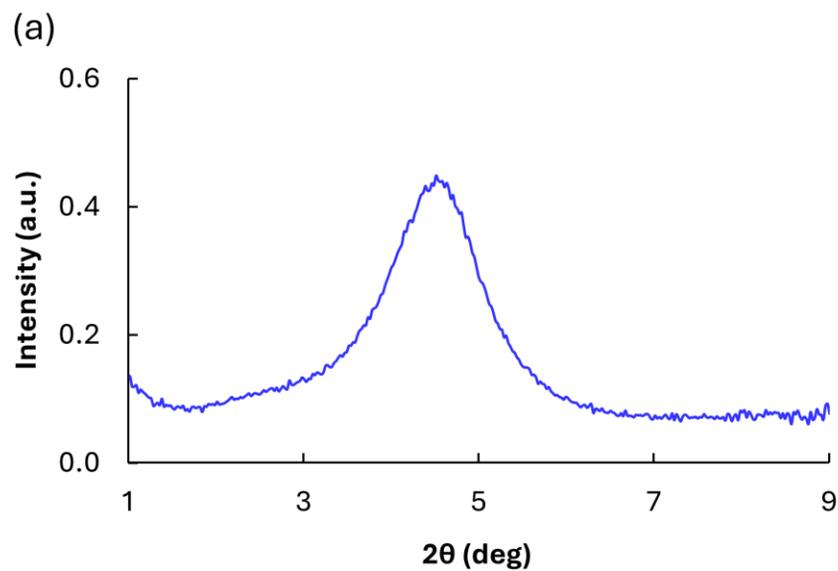




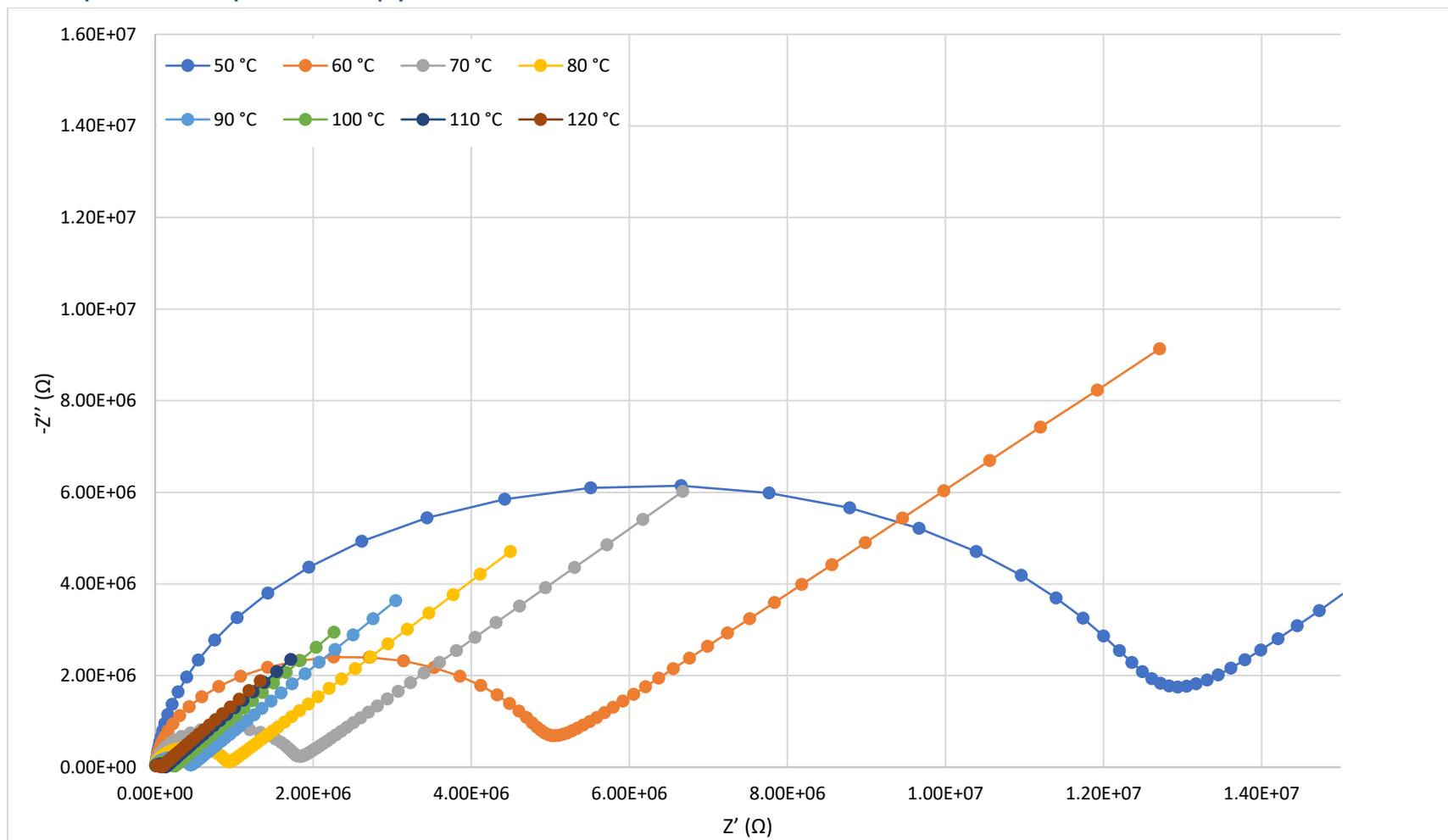
S53. X-ray diffractograms of **4** (C_8) of the isotropic phase at 25 °C. showing both the (a) mid-angle X-ray scattering and (b) wide-angle X-ray scattering measurements.



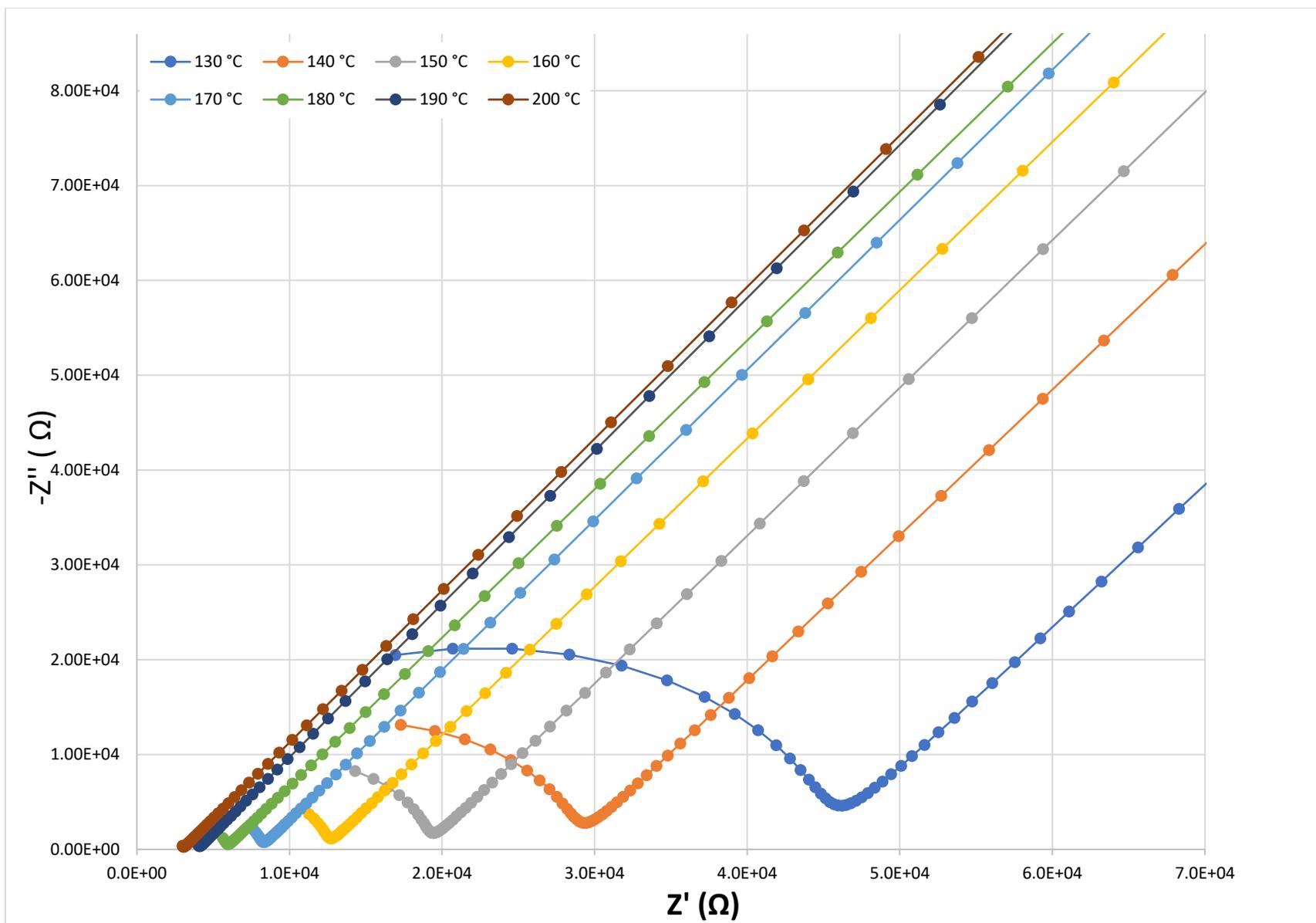
S54. X-ray diffractograms of **3** (C_6) of the isotropic phase at 25 °C, showing both the (a) mid-angle X-ray scattering and (b) wide-angle X-ray scattering measurements.



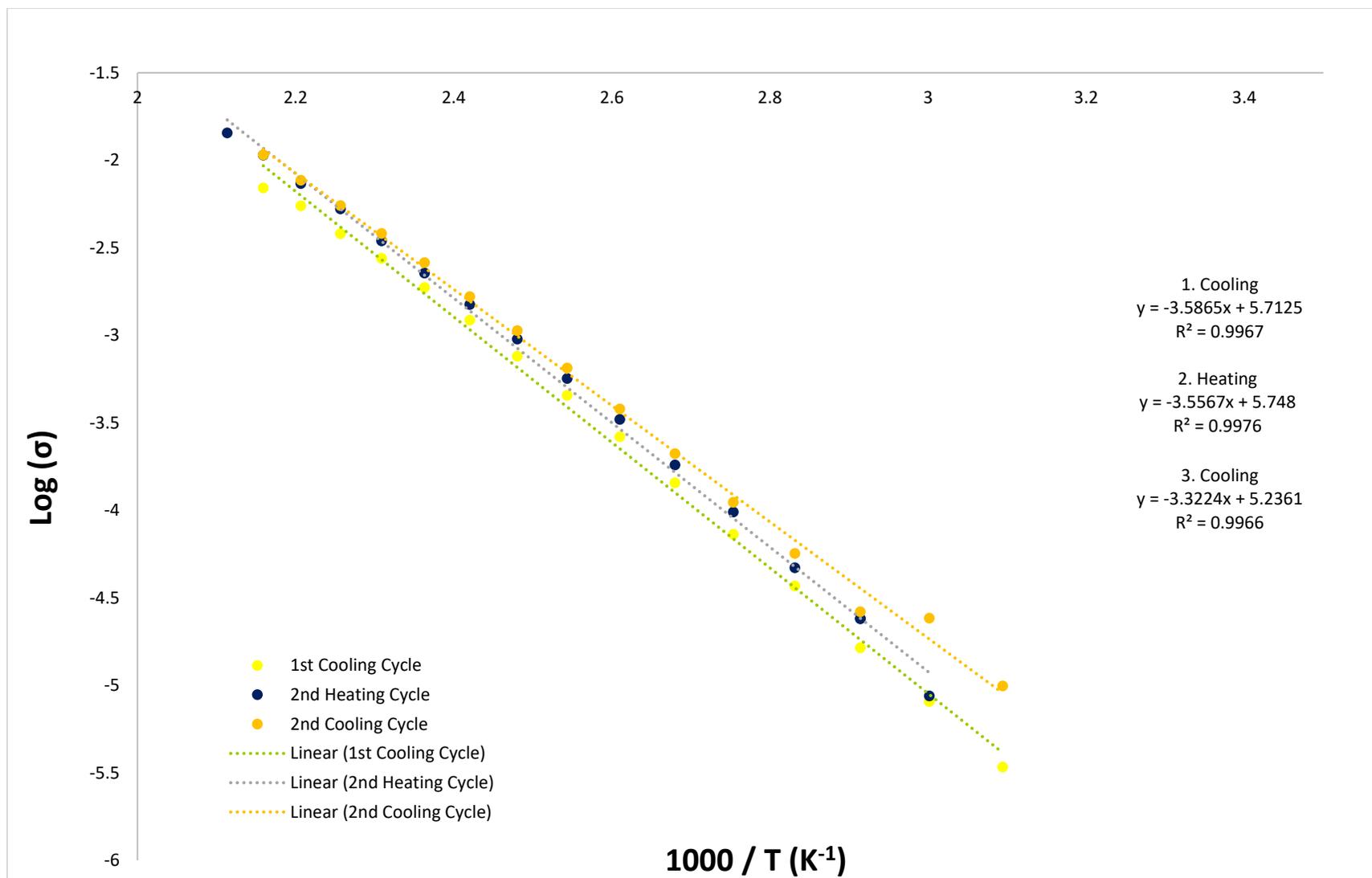
V. Impedance Spectroscopy



S55. Nyquist plots of composite 7 (C₁₈)-Li from 50 °C to 120 °C



S56. Nyquist plots of composite 7 (C₁₈)-Li from 130 °C to 200 °C.



S57. Arrhenius plots of both heating and cooling cycles from 50 °C to 200 °C of compound composite **7** (C_{18})-Li.

Table S1. Table of Calculated Li⁺ Conductivity of Composite 7 (C₁₈)-Li during Second Heating Cycle.

Temperature (°C)	Conductivity (S cm ⁻¹)
60	8.15 x 10 ⁻⁷
80	1.59 x 10 ⁻⁶
100	6.17 x 10 ⁻⁶
120	1.93 x 10 ⁻⁵
140	5.09 x 10 ⁻⁵
160	1.17 x 10 ⁻⁴
180	2.50 x 10 ⁻⁴
200	4.86 x 10 ⁻⁴

VI. References

- (1) Che, A.; Zellmann-Parrotta, C. O.; Sarkar, D.; Espejo, J.; Michaelis, V. K.; Sutherland, T. C.; Williams, V. E.; Ling, C.-C. Cyclodextrin-Based Liquid Crystals: A Novel Approach to Promote the Formation of Thermotropic Cubic Mesophases and Their Potential Applications as Electrolytes. *Carbohydr. Polym.* **2025**, *359*, 123587. <https://doi.org/10.1016/j.carbpol.2025.123587>.