

## Artemisinin

Artemisinin is a widely used drug in the standard treatment of malaria. It is extracted from the plant *Artemisia annua*, sweet wormwood, but can also be produced in a semi-synthetic fashion. Figure 1 shows the  $^1\text{H}$  NMR spectrum of a 250 mM Artemisinin sample in  $\text{CDCl}_3$  measured in a single scan taking 10 seconds to acquire.

### 1D Proton spectrum

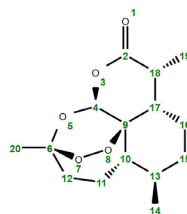


#### Artemisinin

Solvent =  $\text{CDCl}_3$   
Concentration = 250 mM  
Frequency = 80 MHz

#### 1D Proton

Number of scans = 1  
Repetition time = 10 s  
Pulse angle =  $90^\circ$   
Total experimental time = 10 s



10 seconds

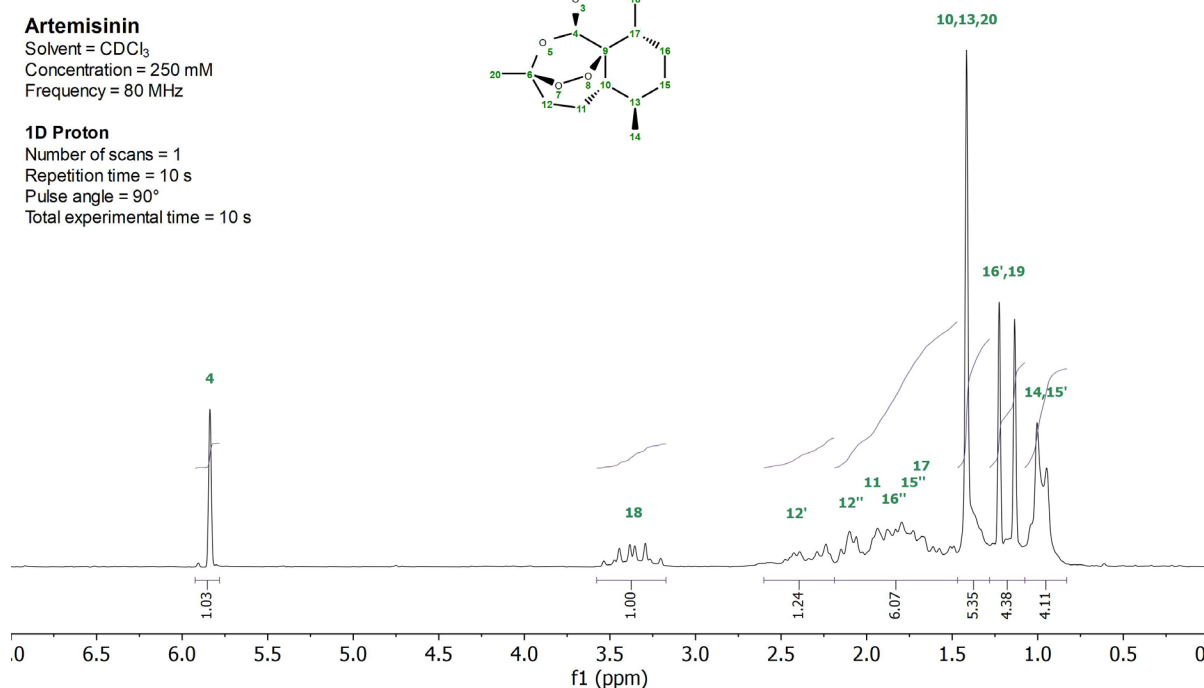


Figure 1:  $^1\text{H}$  NMR spectrum of a 250 mM Artemisinin sample in  $\text{CDCl}_3$  measured on a Spinsolve 80 MHz system in a single scan.

### 1D Carbon spectrum

Figure 2 shows the  $^{13}\text{C}$  NMR spectrum of 250 mM Artemisinin in  $\text{CDCl}_3$  acquired using NOE polarization transfer from  $^1\text{H}$  to  $^{13}\text{C}$  and  $^1\text{H}$  decoupling. The 1D Carbon experiment using NOE is sensitive to all  $^{13}\text{C}$  nuclei in the sample. It clearly resolves all the expected resonances.

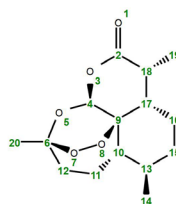


#### Artemisinin

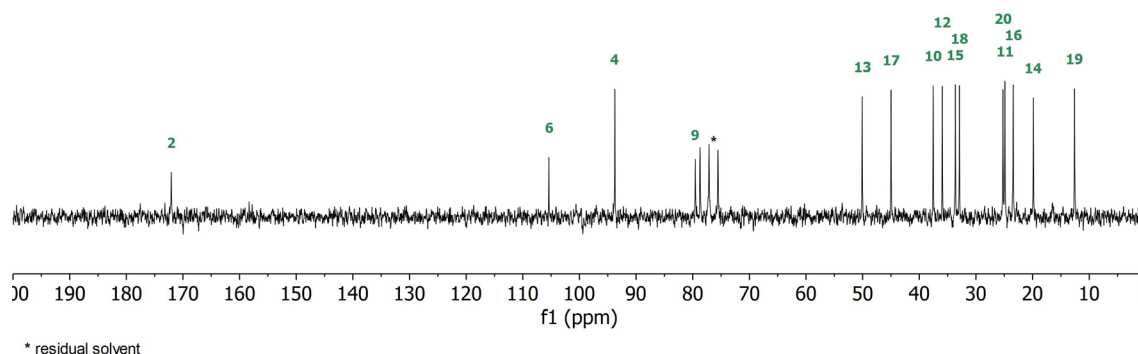
Solvent =  $\text{CDCl}_3$   
Concentration = 250 mM  
Frequency = 20 MHz

#### 1D Carbon

Number of scans = 1500  
Repetition time = 3 s  
Pulse angle =  $45^\circ$   
Total experimental time = 75 min



75 min



\* residual solvent

Figure 2:  $^{13}\text{C}$  NMR spectrum of a 250 mM Artemisinin sample in  $\text{CDCl}_3$  measured on a Spinsolve 80 MHz system in 75 minutes.

## 2D COSY spectrum

The 2D COSY experiment allows one to identify coupled  $^1\text{H}$  nuclei as they generate cross peaks out of the diagonal of the 2D data set. In Figure 3 a large number of cross peaks can be nicely observed. For example, the protons at position 4 and 17 (dark blue) couple with each other. Furthermore, proton 18 couples with proton 17 (cyan) and 19 (pink).



### Artemisinin

Solvent =  $\text{CDCl}_3$   
Concentration = 250 mM  
Frequency = 80 MHz

### COSY

Number of scans = 1  
Total experimental time = 17 min

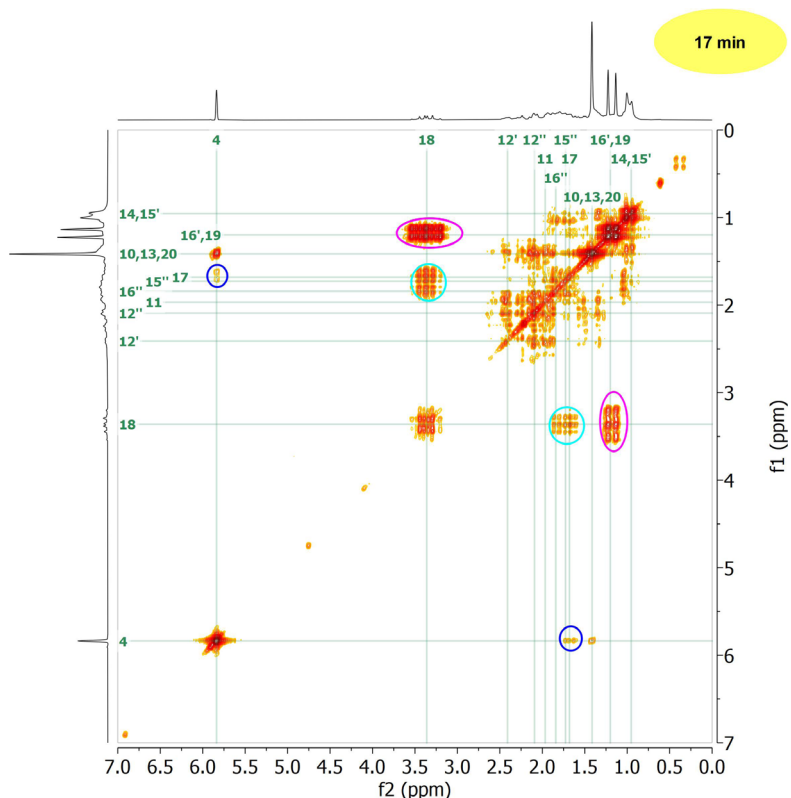
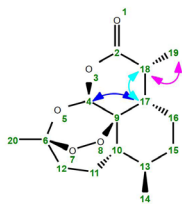


Figure 3:  $^1\text{H}$  2D COSY experiment of a 250 mM Artemisinin sample in  $\text{CDCl}_3$  acquired in 17 minutes on a Spinsolve 80 MHz system.

## 2D HSQC-ME

The HSQC is a powerful sequence widely used to correlate  $^1\text{H}$  with the one-bond coupled  $^{13}\text{C}$  nuclei. The Spinsolve is equipped with a multiplicity edited version (HSQC-ME) of this method. It provides the editing power of the DEPT-135 sequence, which is useful to differentiate the signals of  $\text{CH}_2$  groups (blue) from  $\text{CH}$  and  $\text{CH}_3$  groups (red). Figure 4 shows the HSQC-ME spectrum of a 250 mM Artemisinin sample in  $\text{CDCl}_3$  acquired in 17 minutes.

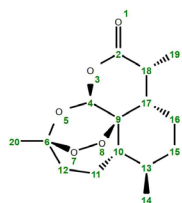


### Artemisinin

Solvent =  $\text{CDCl}_3$   
Concentration = 250 mM  
Frequency  $^1\text{H}$  = 80 MHz

### HSQC-ME

Number of scans = 2  
Repetition time = 1 s  
Number of steps = 256  
Total experimental time = 17 min



Red =  $\text{CH}$  and  $\text{CH}_3$

Blue =  $\text{CH}_2$

\* residual solvent

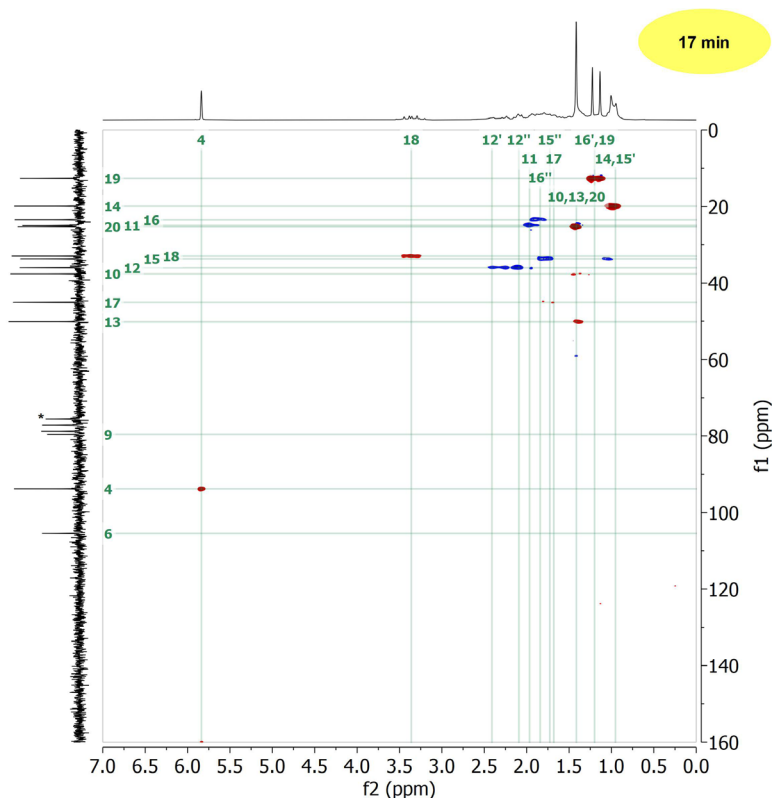


Figure 4: HSQC-ME spectrum of a 250 mM Artemisinin sample in  $\text{CDCl}_3$  showing the correlation between the  $^1\text{H}$  (horizontal) and  $^{13}\text{C}$  (vertical) signals.

## 2D HMBC

To obtain long-range  $^1\text{H}$ - $^{13}\text{C}$  correlations through two or three bond couplings, the Heteronuclear Multiple Bond Correlation (HMBC) experiment can be used. Figure 5 shows the HMBC spectrum of a 250 mM Artemisinin sample measured in 34 minutes on our Spinsolve 80 MHz. As an example, the long-range correlation of protons 19 with carbons 2, 17 and 18 are marked. The experiment shows the correlation with quaternary carbons, too.

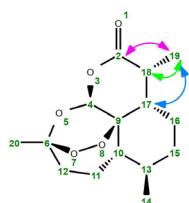


## Artemisinin

Solvent = CDCl<sub>3</sub>  
Concentration = 250 mM  
Frequency 1H = 80 MHz

## HMBC

Number of scans = 8  
Repetition time = 1 s  
Number of steps = 256  
Total experimental time = 34 min



\* residual solvent

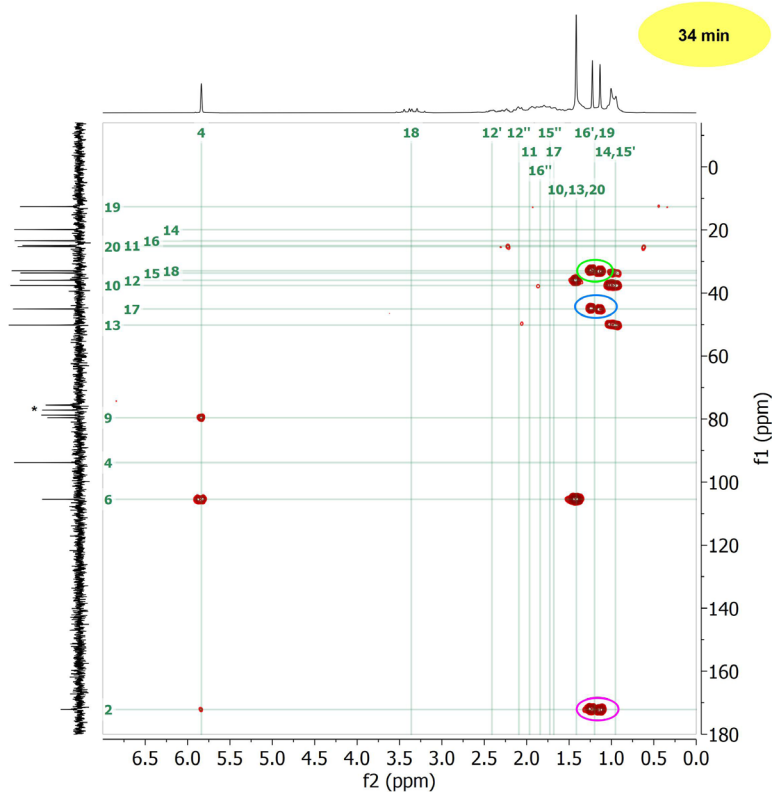


Figure 5: HMBC spectrum of a 250 mM Artemisinin sample in  $\text{CDCl}_3$  showing the long-range couplings between  $^1\text{H}$  and  $^{13}\text{C}$  nuclei.