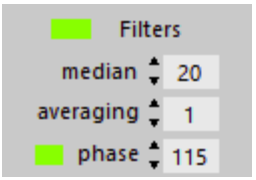
Overview of the filters in the absorption measurements



- **Median filter**

N=3 (filter array size)
x = [2 80 6 3]

median filtered
output signal y :

y[1] = Median[2 2 80] = 2
y[2] = Median[2 80 6] = Median[2 6 80] = 6
y[3] = Median[80 6 3] = Median[3 6 80] = 6
y[4] = Median[6 3 3] = Median[3 3 6] = 3

y = [2 6 6 3].

In this example the value 80 has been removed
This is the spiky noise cancellation concept.

- **Average filter**

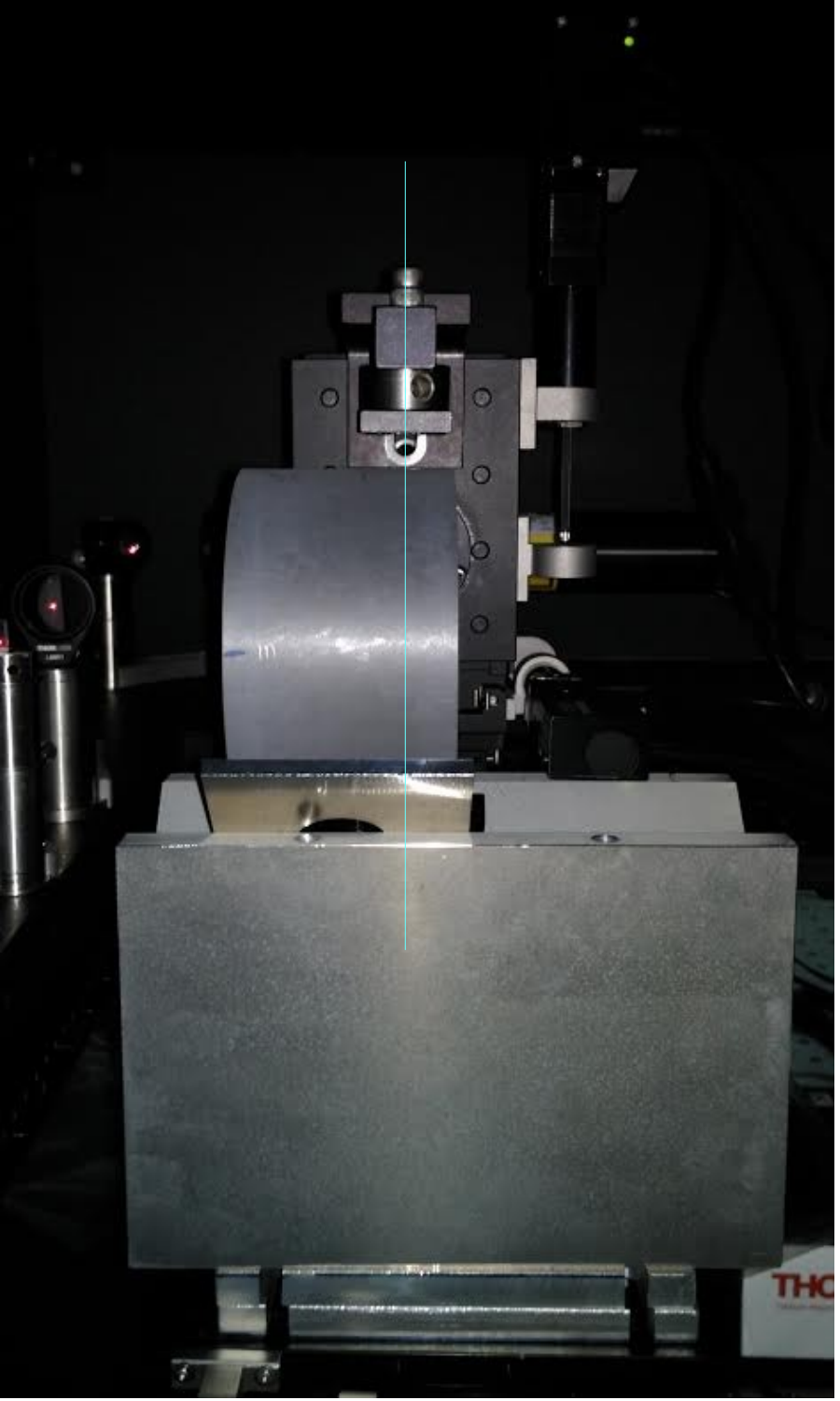
$$y[82] = \frac{x[80] + x[81] + x[82] + x[83] + x[84]}{5}$$

Same effect as increasing the Lock-in time constant

- **Phase filter**

$$AC' = AC\cos(\phi - \phi_{\text{expected}})$$

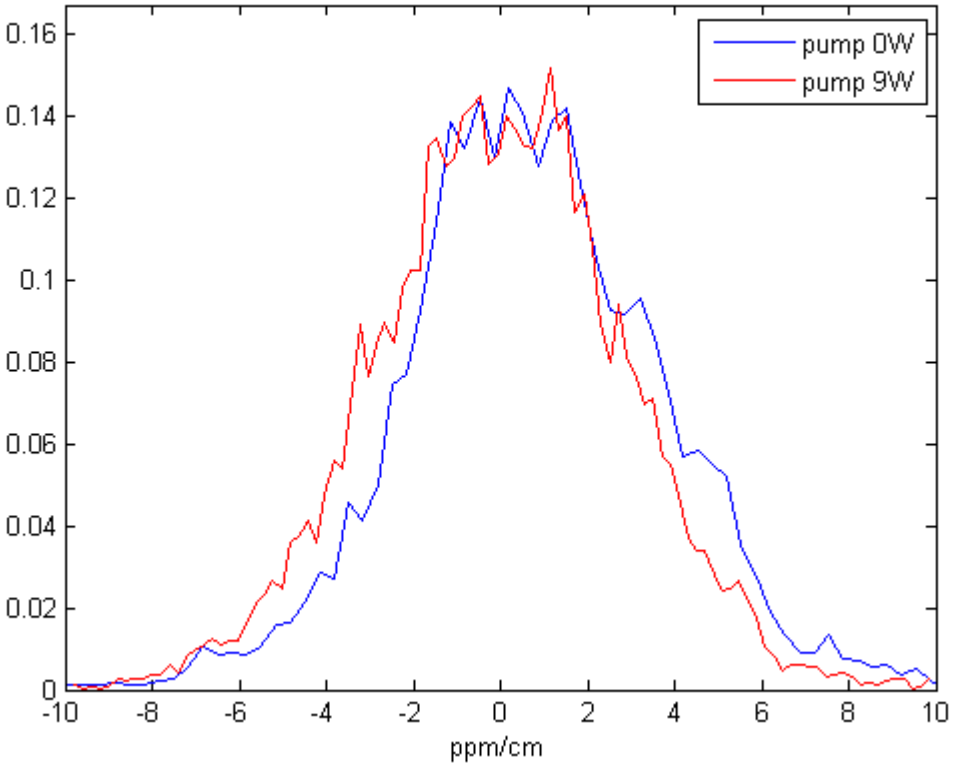
Makes the pure noise oscillating around zero



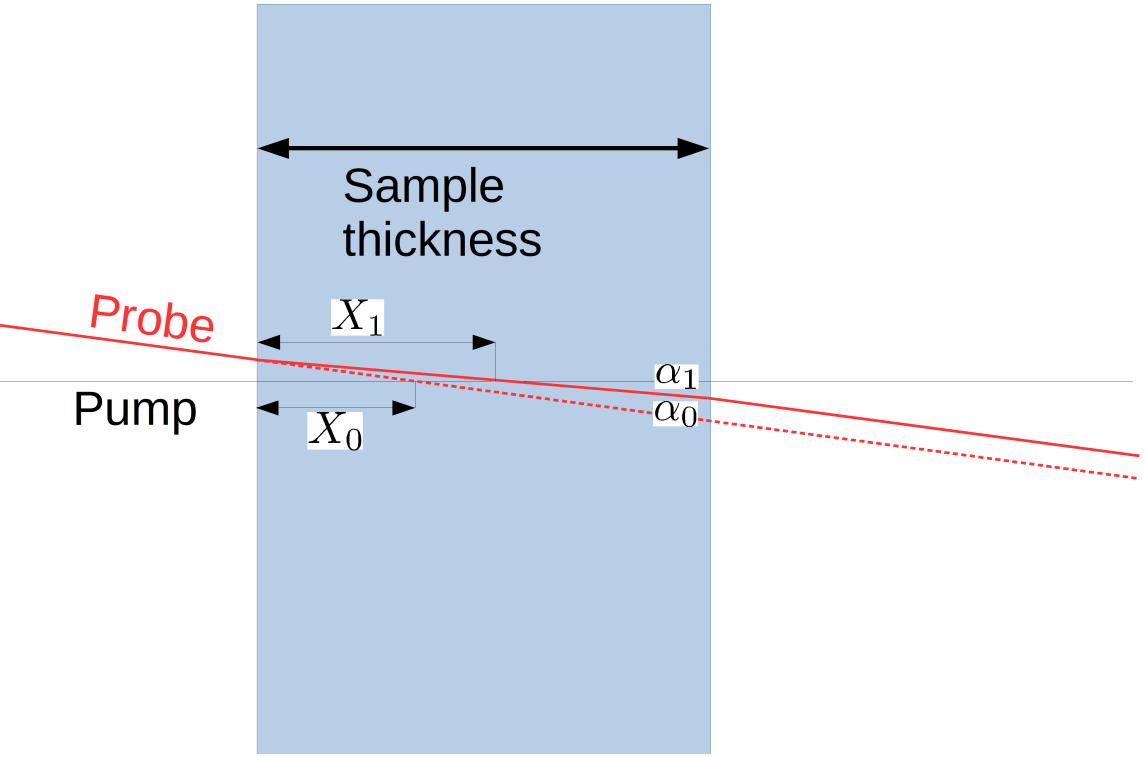
Measurement of the Tama-size sapphire sample

Sampling rate: 100ms
Median array: 100 (10s)
Average array: 600 (1min)
Acquisition time: 1 hour

Histograms of the AC signal filtered



The cross point between pump and probe moves if the refractive index changes
Depending on the probe incidence angle (the pump incidence is perpendicular)



Applying Snell's Law:

$$\sin(\alpha_0)n_0 = \sin(\alpha_1)n_1$$
$$n_0 = 1$$
$$n_1 = 1.76$$

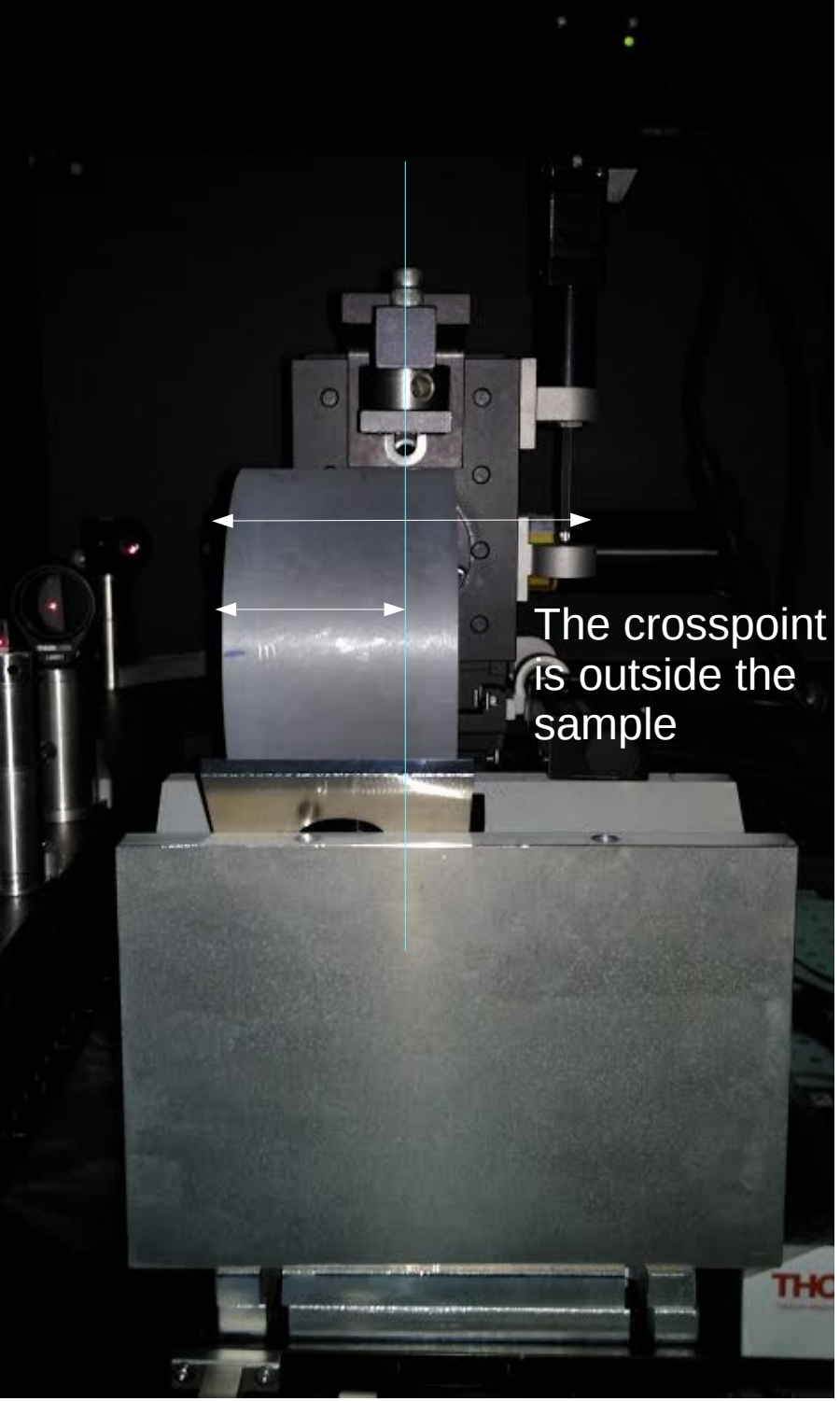
$$X_1 = X_0 \frac{\tan(\alpha_0)}{\tan(\alpha_1)}$$
$$= X_0 \frac{n_1}{n_0} \frac{\cos(\alpha_1)}{\cos(\alpha_0)}$$
$$= X_0 1.76 \frac{\cos\left(\frac{\sin^{-1}(\alpha_0)}{1.76}\right)}{\cos(\alpha_0)}$$

$$\alpha_0 = 6^\circ \rightarrow X_1 = X_0 \cdot 1.81$$
$$\alpha_0 = 7^\circ \rightarrow X_1 = X_0 \cdot 2.17$$

Using Sapphire sample (n=1.76), the cross point between probe and pump, moves of a factor of 2.0±0.2 from the incidence surface

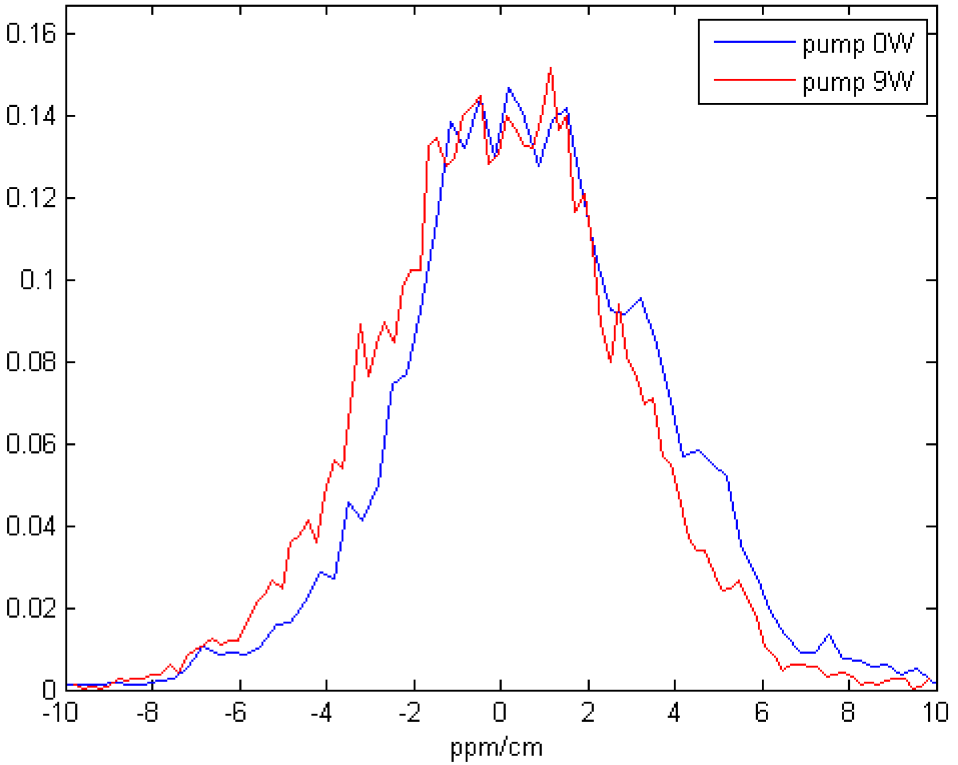
This also means that to scan the thickness we have to move the sample by half of the thickness

Measurement of the Tama-size sapphire sample

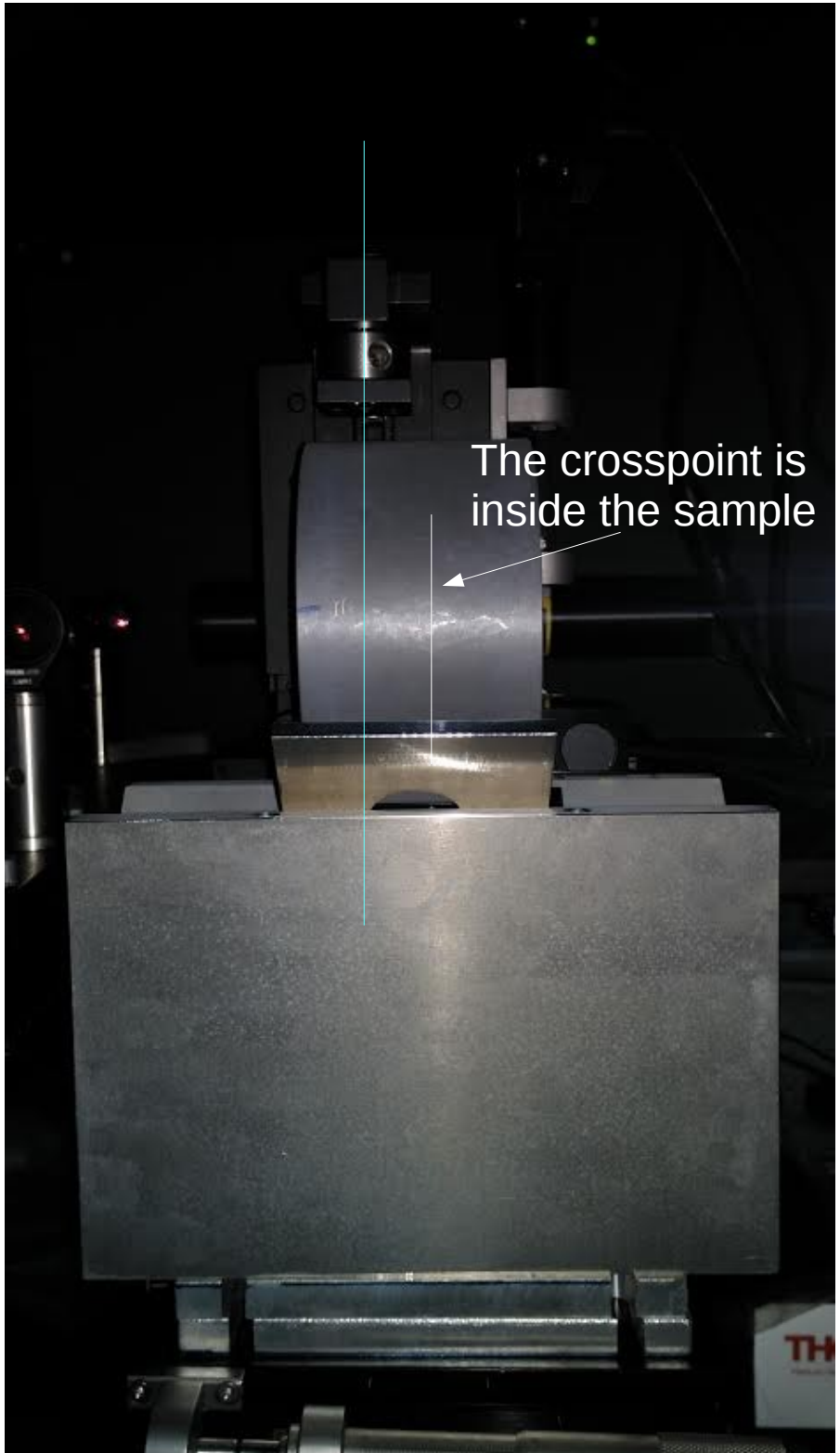


Sampling rate: 100ms
Median array: 100 (10s)
Average array: 600 (1min)
Acquisition time: 1 hour

Histograms of the AC signal filtered



The crosspoint is outside the sample
No absorption signal visible

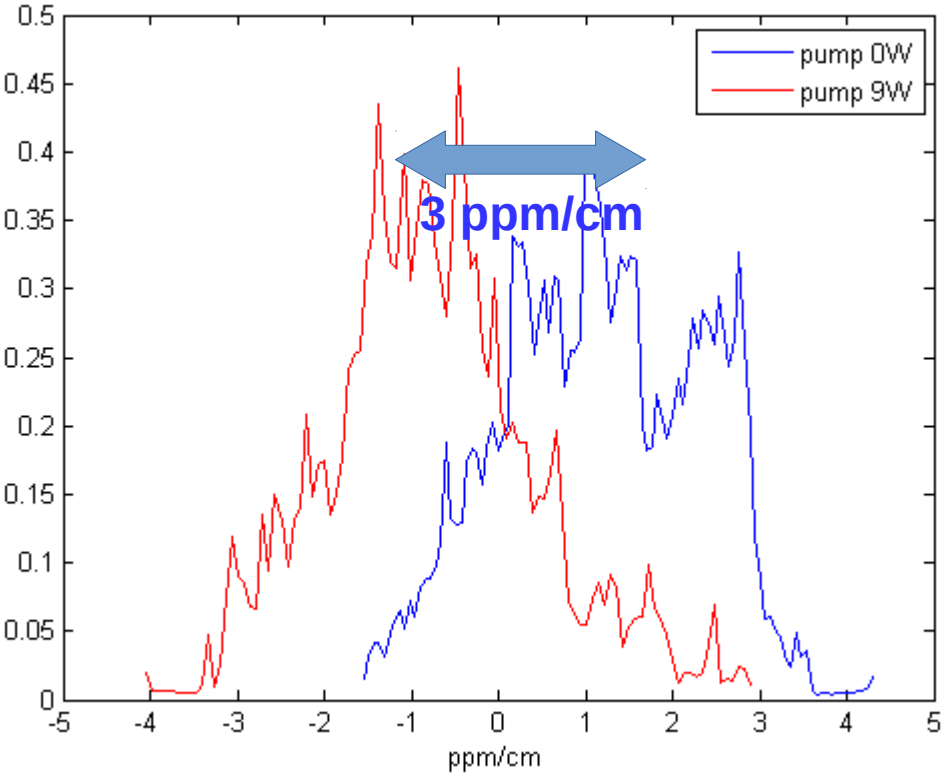


Measurement of the Tama-size sapphire sample

I moved the sample

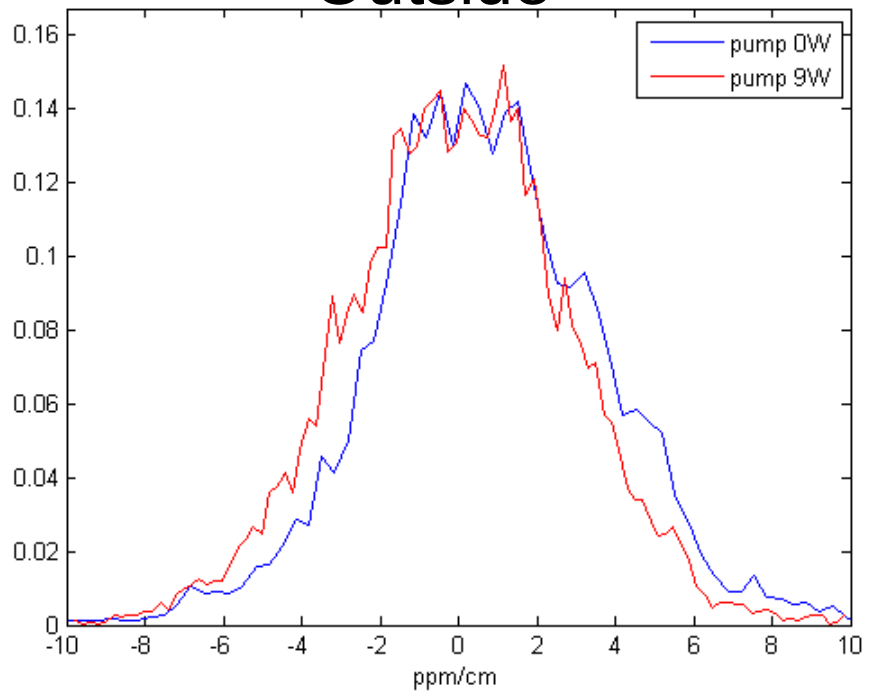
Sampling rate: 100ms
Median array: 100 (10s)
Average array: 600 (1min)
Acquisition time: 1 hour

Histograms of the AC signal filtered



Measurement of the Tama-size sapphire sample

Outside



Inside