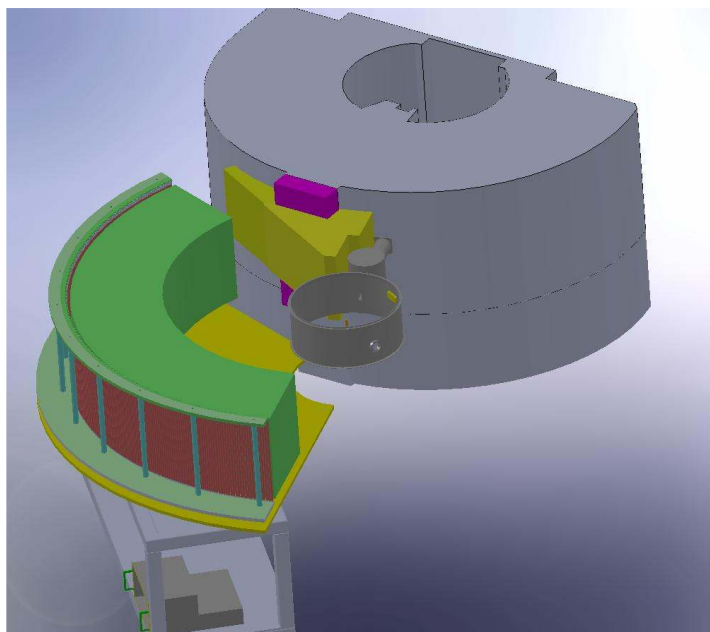## A new detector for 7C2
diffractometer for liquid and amorphous materials
on the hot neutron source of ORPHEE

The current detector of 7C2 is a BF₃ banana, which has a good stability but a low efficiency and detection solid angle. This new project is built from vertical position sensitive ^{3}He counters. The primary diffractometer remains unchanged.

What we want to do :

- **224 vertical counters** at about 1.5m of the sample :
  - internal diameter around **1.2cm**,
  - fill pressure **25b** (^{3}He), efficiency : **70%**
  - distant by 0.2cm, around 1.5cm between two detector axis (**0.57°**).
  - **position sensitive counters**, with an **active length around 50cm**.

- most probably the detectors will be paired. The vertical resolution will be better than 1cm, to be compared to the present vertical size of our samples, generally between 3 and 5cm.

- **collimation** : we want to put a collimation between the sample and detector. It is still not chosen. The main idea is to reduce the parasitic reflections from the sample environment. We would like to cut most of the signal of the resistor in a furnace configuration, in order to be able to use resistors else than vanadium and reach higher temperatures with a classical furnace (around 1700°C).

How does it compare to the current 7C2?

	new	today	Gain	global counting rate
Efficiency (for 0.7Å)	**0.70**	**0.17**	**× 4.1**	
Active height (cm)	47	7		
Angular range	1 à 125°	1 à 125° (*)		**× 23**
Detection solid angle (Sr)	**0.56**	**0.102**	**× 5.5**	
Angle step	0.56°	0.2°		

Comments :

1. The efficiency is averaged over the detector diameter. This variation of the efficiency with the position (see figure) should have no real effect since the instrumental width (measured on Bragg peaks) is larger than a detector (that covers 0.47°). Nevertheless, if we want a more homogeneous efficiency, we can place some absorbing rods (B₄C or BN) between two detectors, in order to hide the low efficiency/high noise sides of each detector (if not hidden by the collimator).

Efficiency along the 12.2mm diameter (p=25b)

distance from the detector axis (mm)
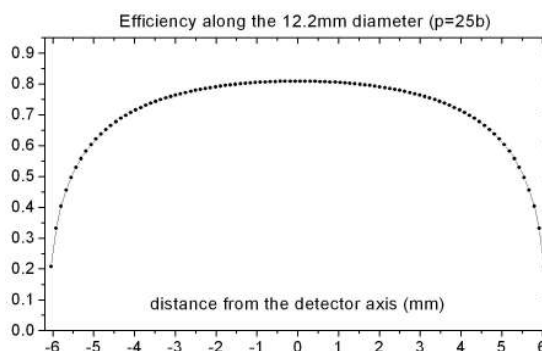
2. we loose about 14% of detection surface because of the 2mm space between two detectors. We have considered a distance 1mm between two (which implies less tolerance in the detector straightness and welds). We have renounced for two reasons: first we need some place between two detectors in order to fix them precisely, second this distance 2mm will allow us to place some absorbing plates between two detectors if it appears to be necessary because of noise. For the same reason we have discarded the z configuration (one detector row behind the first one), that would allow 30% more detection solid angle.

3. the step between two detectors will be increased by a factor nearly 3. But the resolution should not be really damaged since the diameter of the samples is generally 8 to 10 mm, up to 15mm, and the horizontal spreading about 0.3°. For some more precise measurements (Bragg peaks) it would be possible to put some absorbing rods between detectors, hiding part of the detectors. The signal would be measured in two steps, with a small rotation of the whole detector bank. We want to keep this present option to move precisely the detector bank. It must also be emphasized that the vertical resolution is better than 1cm and might be used for small samples.

Effect on the resolution:

Summing the signal of the cells by groups of 3 in a 7C2 measurement (step 0.2°) results in an angular step 0.6° which is close to the one of the project. So it gives an idea of what the signal will look like.

Case of a nickel powder spectrum.

This spectrum is used for the calibration of the wavelength and position of the first cell of 7C2. There are 2560 points instead of 640 because we measure intermediate points : the spectrum is measured in 4 steps, the banana being rotated by 0.05° between two spectra (0.2° between two cells).

For the simulated new spectrum that we will also measure the spectrum by steps, with the same angular rotation.

One can see that even a Bragg peak measurement would not be much penalized by the fact that the detectors cover 0.56° instead of the 0.2° distance of the present cells.

However our incident beam is not very collimated because the priority in on the flux, and it has a strong spreading : the peak width observed on the Ni spectra is the instrument width.
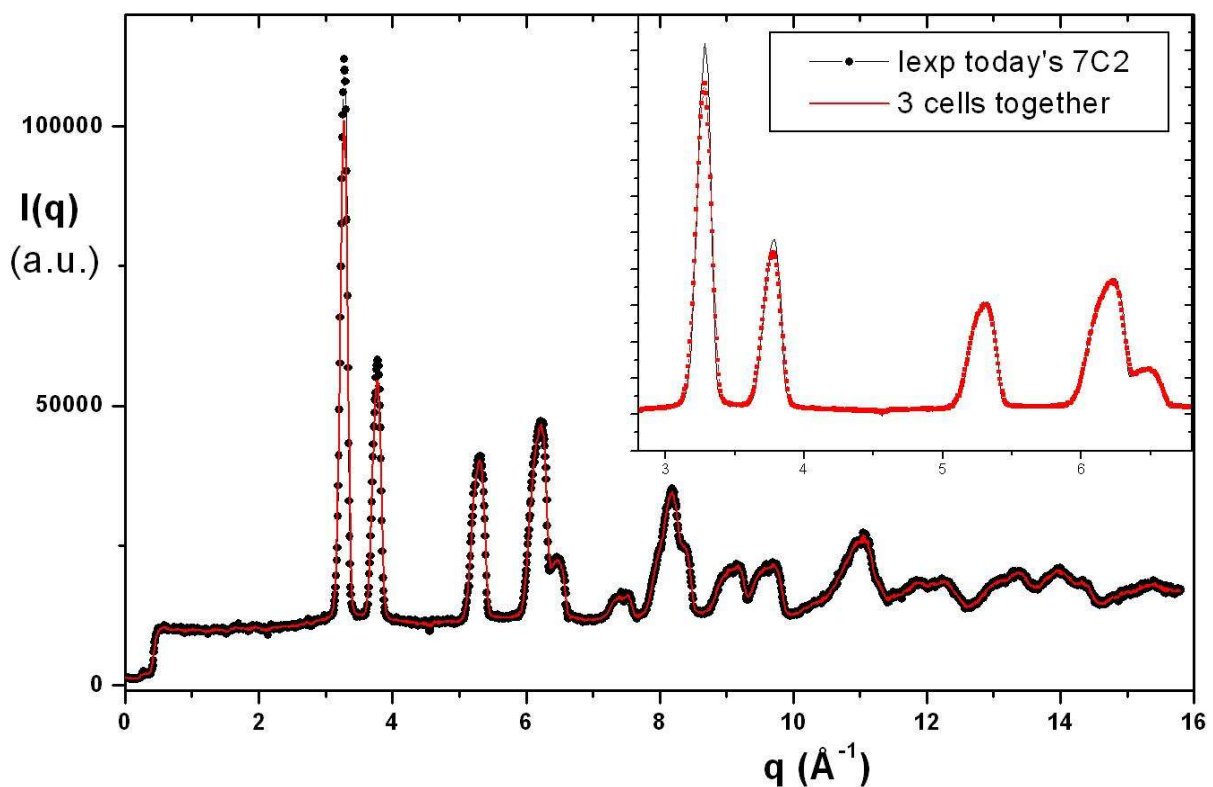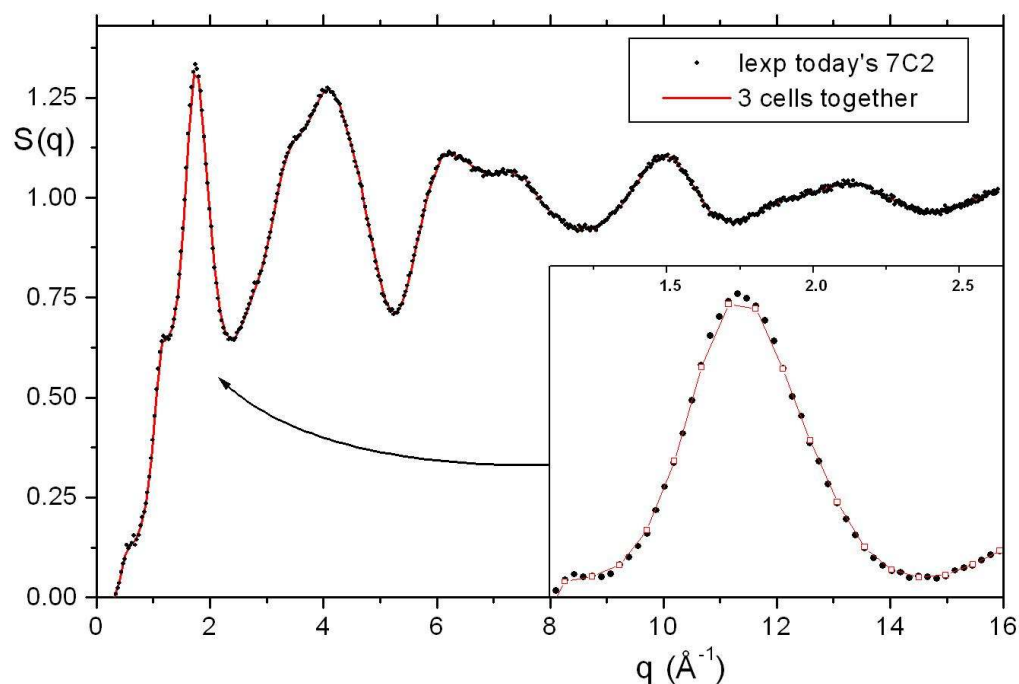
Case of liquid sulphur

The liquid sulphur signal is typical of the 7C2 samples. At low temperatures (here 125°C, just above the melting point) the S atoms form S_8 rings.

The quality of the S(q) signal is normally improved when the cells are grouped (statistics).

But the first peak seems to be slightly reduced, as can be seen on the insert of the figure.

The effect on the g(r) function has been estimated for this liquid sulphur measured at 125°C, and also for the signal measured at 300°C, where most of the rings are broken in open chains with less middle range order.
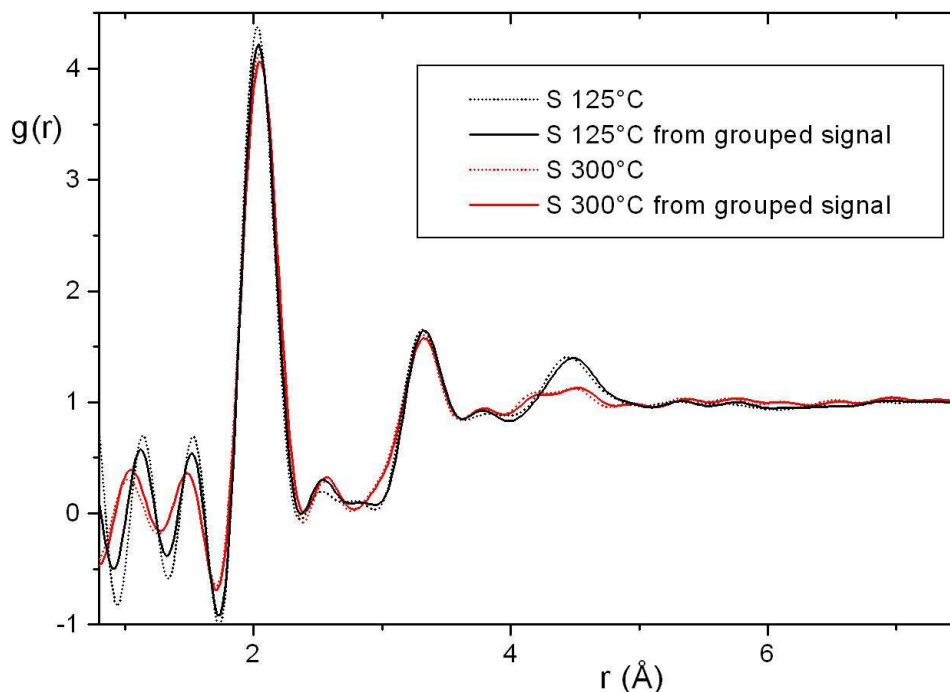
Except in the domain of the cut-off oscillations ($q<1.7Å^{-1}$), the g(r) function obtained from the grouped signal is very close to the grouping of cells, and the very small effect is far beyond the temperature effect that evidences the polymerization of sulphur (the 3rd peak disappears)

The **coordination number** for first neighbours calculated from the first peak vary by less than 1% when grouping the cells.