IN4C: MEASUREMENT OF THE FLUX AT THE SAMPLE POSITION

Index	Date	Rédacteurs	Vérificateur	Approbateur	Modifications
B	18 04 2013	S. Rols	IN4C team		Accounts for correct value of x
A	06 03 2013	S. Rols	P. van Esch		Original document

Goal

We aim at measuring the flux at the sample position on IN4C. This set of measurements completes the initial studies done using a calibrated monitor in 2012 [1].

Team

P. van Esch (SDN/DPT) prepared the complete apparatus to realize the measurements. It consisted of a honeycomb detector in current mode. P. van Esch performed the necessary calibration of this apparatus to allow for absolute values. The calibration procedure is reported in [2].

O. Meulien prepared the support device for aligning the detector with the incident beam. He also covered the whole surface of the detector with Cadmium, letting just an aperture of 2x2 cm^2 in front of the incident beam.

S. Rols performed the measurements on February 23rd and February 24th.

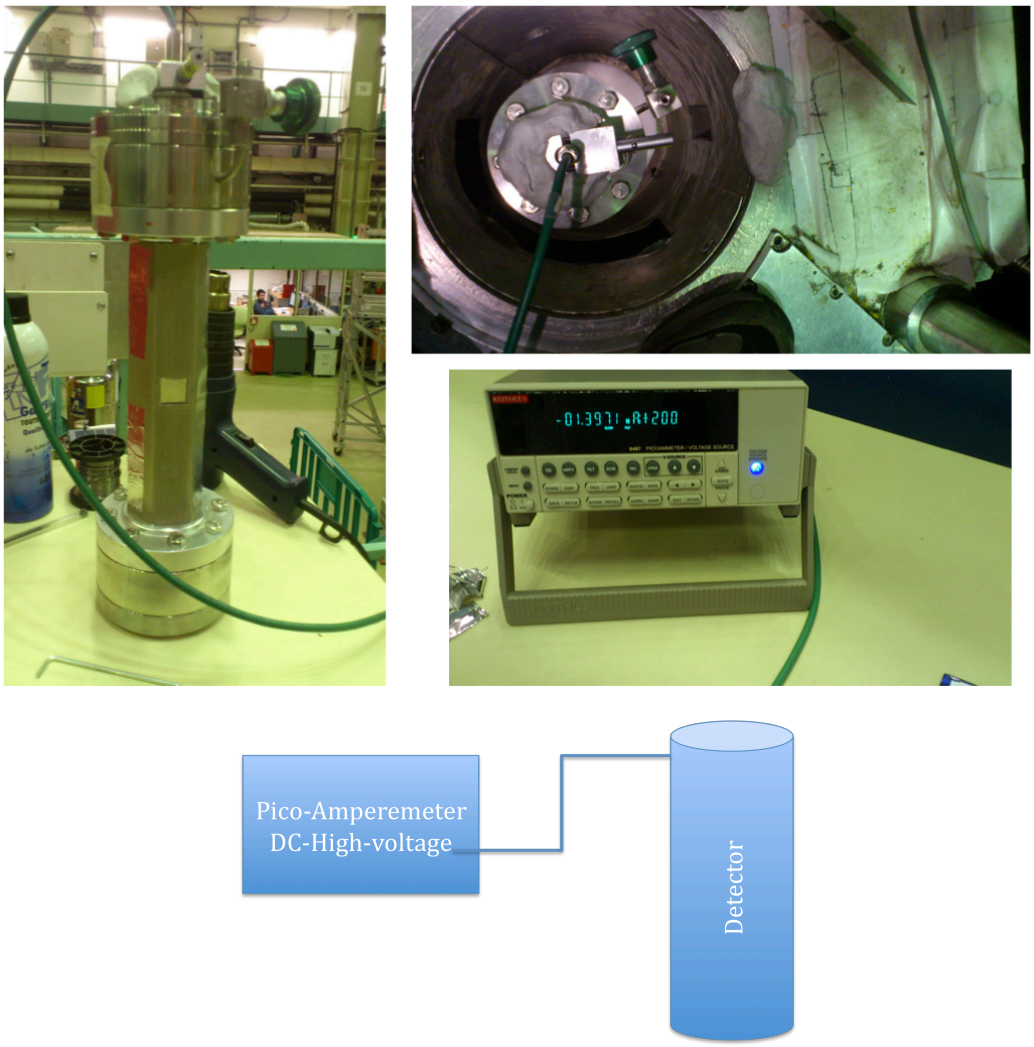

Figure 1: sketch of the cabling and picture of the apparatus.

Measurements

Measurements were performed at variable wavelengths following the procedure described below:

Each instrument configuration (i.e. a wavelength set up) is optimized for obtaining the maximum flux at the detectors. This is achieved by optimizing the values of the MBA (monochromator Bragg angle) and the MHGR (horizontal mono curvature) motors to have a maximum flux at the detectors (without small angle bank). The sample used to do this is a 1mm thick rectangular Vanadium sample attached at the bottom of an Al blade, which is further placed in front of the detector (using vacuum paste). Note that the value of the entrance slit was set to 100/100/100/100 (top/bot/right/left). The calibrated detector was operated at 200 V. The entrance face is positioned at the sample position (@center of the sample pit), with its face perpendicular to the incident beam (see figure 1). Note that the measurements were performed in air.

After the instrument configuration is set, the Vanadium is removed. The current is read directly on the multimeter on the nA scale. Two readings were performed: one with the sapphire filter set in the beam, and one without. This allowed deriving the Sapphire transmission at each wavelength.

The current is transformed in neutron counts following the calibration from PvE (see appendix): 1 neutron gives a charge of 3.3 fC. The current has therefore to be divided by 3.3 10^{-15} to have the number of neutron per second. Further treatment implies correction from the wavelength dependent detector efficiency and surface of the beam to obtain the flux.

Note: The reactor power was 53 MW.

Data - Results

Lambda (Å)	I (nA) w filter	I (nA) w/o filter	Efficiency	Counts (with filter)	Counts (w/out filter)	Filter Tr (%)
1.1	1.405	2.19	0.66	1.61E+05	2.51E+05	64
1.2	1.69	2.455	0.69	1.85E+05	2.68E+05	69
1.3	1.655	2.315	0.72	1.74E+05	2.43E+05	71
1.5	1.215	1.605	0.77	1.19E+05	1.58E+05	76
1.6	1.012		0.79	9.67E+04		
1.7	0.853		0.81	7.95E+04		
2.2	1.55	2	0.89	1.33E+05	1.71E+05	78
2.4	1.31	1.71	0.91	1.10E+05	1.43E+05	77
2.6	1.025	1.335	0.92	8.42E+04	1.10E+05	77
2.8	0.72	0.95	0.94	5.82E+04	7.69E+04	76
3	0.48	0.64	0.95	3.84E+04	5.12E+04	75
3.2	0.285	0.385	0.96	2.26E+04	3.05E+04	74
3.4	0.196	0.27	0.96	1.54E+04	2.12E+04	73

Table 1: Data and Results

The flux ϕ is calculated according to the following equations:

$$\phi(\lambda) = \frac{I}{3.3 eff(\lambda) S} 10^6$$

with

$$eff(\lambda) = 1 - \exp(-\sigma \frac{\lambda}{1.8} \rho x)$$

S	Surface of the beam	4 cm^2
λ	incident wavelength	Å
ρ	^{3}He density (at 3 bar)	$3*2.7\ 10^{19}\ cm^{-3}$
σ	^{3}He absorption cross section	$5335\ 10^{24}\ cm^2$
x	width of the calibrated detector	4.1 cm

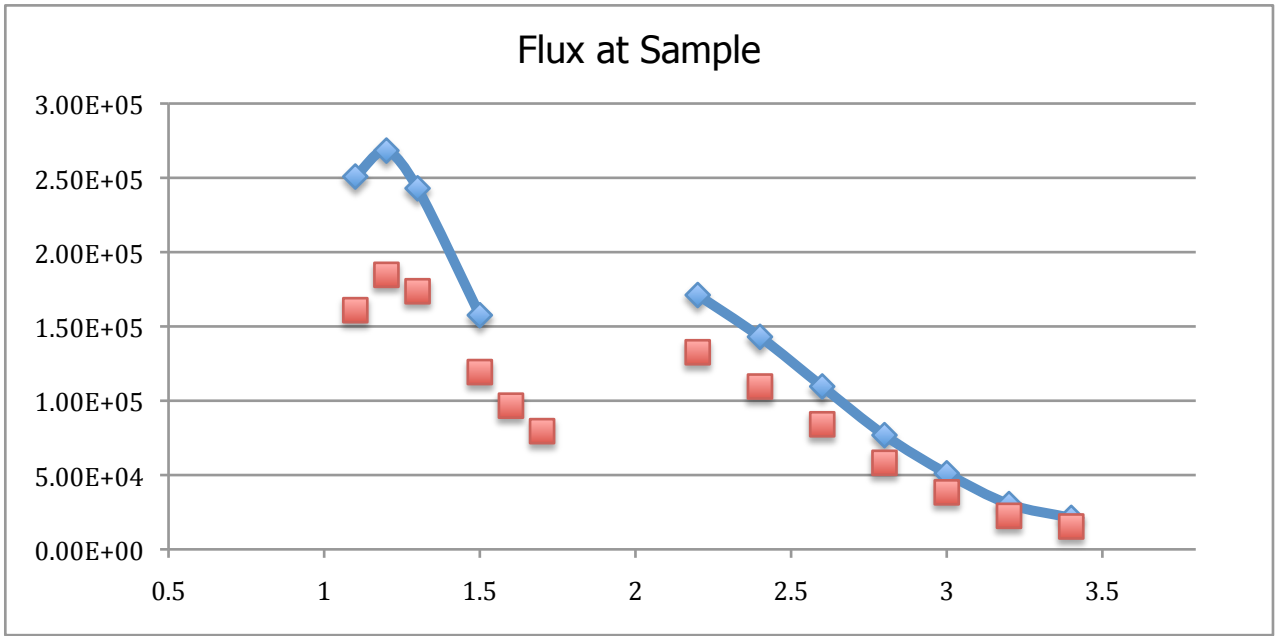

Figure 2: Flux at the sample position as a function of the incident neutron wavelength

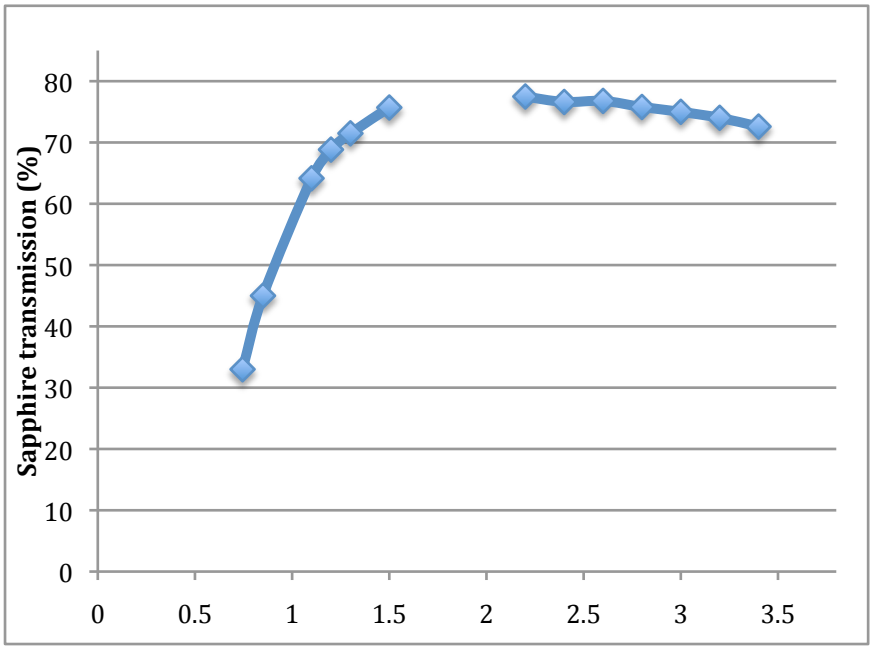

Figure 3: Sapphire transmission as a function of the incident neutron wavelength (note that the points at 0.745 Å and 0.85 Å were measured in a subsequent test -April 2013- using the IN4C monitor values and the HOPG (006) and Cu (220) monochromator respectively)

Conclusions:

The previous conclusions [1] are valid and better defined in this round as the surface of the incident beam was precisely defined. The maximum flux is obtained at an incident wavelength of 1.2 Å and corresponds to 2.5 10^5 n/cm^2/s (1.85 10^5 n/cm^2/s with filter). At 1.1 Å and 2.2 Å the flux are respectively 1.6 10^5 n/cm^2/s and 1.35 10^5 n/cm^2/s in normal condition (e.g. with the filter).

[1] IN4C team, "IN4 – Measurement of the absolute flux at the sample position", DS/TOFHR report, June 2012
[2] P. van Esch, "Self-calibration of the honeycomb detector in current mode", SDN/DPT report, February 2013