H3. NEW SUPERMIRROR COLLIMATORS FOR THE IN PILE COLD TRIPLE AXIS

B. HENNION, P. BOUTROUILLE

Léon Brillouin Laboratory, CEA-CNRS, CE Saclay, 91191 Gif sur Yvette, France.

Neutron optics elements are now commonly used to improve the flux on the instruments. Taking advantage of a maintenance on the 4F thimble, during the summer 2006, m=3 supermirror have been installed in the collimators of the 4F1 and 4F2 beam ports which feed two cold neutron triple axis. An expected gain of intensity on the sample up to 80% for some experimental conditions is foreseen.

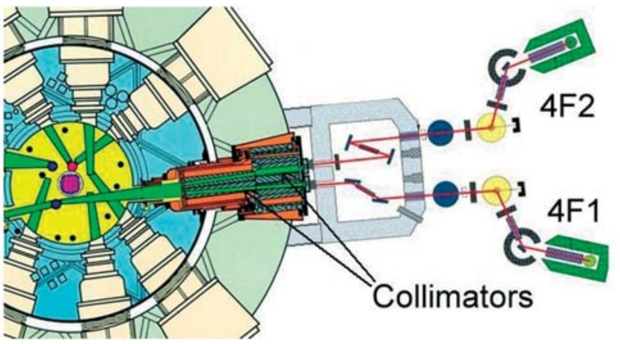

Figure 1. Setup of 4F1 4F2 cold triple axis spectrometers around the Orphée reactor.

Thimbles of beam ports are submitted to high radiation damages. They modify the metallurgical properties of the alloy which becomes more fragile. An important part of this effect is due to transmutation of aluminum atoms in silicon. As a consequence, thimbles have to be changed before the amount of Si in the Al alloy becomes larger than a known limit. This limit is close to be reached by the 4F thimble which has to be replaced. This is a long and delicate operation which requires the removal of 4F beam plug and the whole 4F1 and 4F2 spectrometers.
This is a unique opportunity to change the collimators inserted within this beam plug (see fig. 1) since the flux available on the 4F1 and 4F2 instruments is very dependant upon the geometry of these collimators. Such a modification has already been done in 1999 on the channel 2T [1] where an increase of the size of the beam plug collimators did provide a gain in intensity of 80%. However, an increase of the mean gamma radiation level on the 2T area has been notice afterwards.
During these last years, tremendous progress have been done in supermirrors neutron optics elements [2]. They provide a way to transport more neutrons through the beam plug collimators without having to change their size, and hence without changing the radiation protection provided by the beam plug. Supermirrors are especially efficient with the cold neutrons used on the 4F spectrometers. This is why we have chosen to insert m=3 supermirrors in the beam plug collimators without changing their size (see fig. 2).

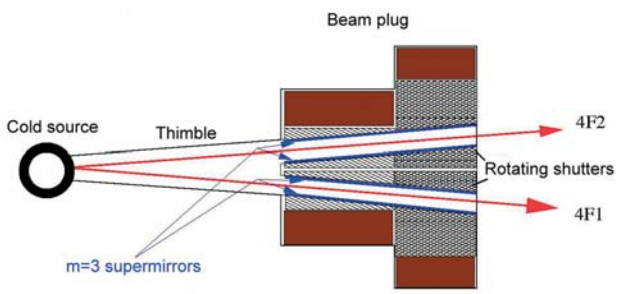

Figure 2. Schematic view of the cold source, thimble and beam plug assembly.

M=3 supermirrors enable the transmission of neutrons which hit the mirrors up to angles of 0.3*λ degrees, (λ being the wavelength of the incident neutron in angstroms). Compared to collimators without guides, they allow a transmission of a larger divergence, and provide a higher flux on the monochromator.

Simple ray tracing simulations have been performed in order to obtain an estimation of the gain provided by the supermirrors. A source of equal and homogeneous intensity has been assumed. These simulations enable to obtain an estimation of the loss of angular resolution and energy resolution due to the increase of divergence of the incoming beam on the sample.

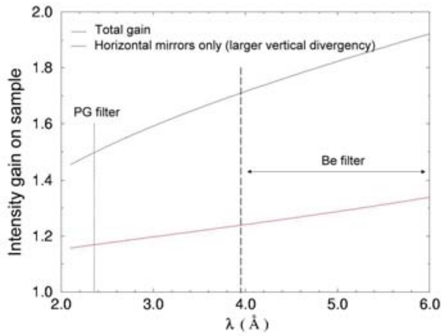

Figure 3. Calculated gain with supermirrors as a function of wavelength in two different configurations (see text).

Two different configurations have been taken into account :

a. Install only horizontal mirrors at the top and bottom part of the collimators (increase only transmitted vertical divergence).
b. Mirrors installed on the 4 sides of the collimators (increase transmitted vertical and horizontal divergence)
Results of the expected flux gain compare to the current collimators without mirrors are presented on Fig. 3.
It shows that horizontal mirrors (configuration **a**) bring only a gain of 20% in intensity (red curve). This comes from the fact that the current height of the beam (8 cm) provides already the transmission of a divergence of 5°. M=3 supermirrors just add an additional 0.9° at 3 Å. However, this gain is obtained with a negligible loss in resolution.
Configuration **b** with horizontal and vertical supermirrors in the beam plug is more interesting since it provides a potential gain varying from 40% at 2 Å to 90% at 6 Å. The corresponding energy resolution degradation has been calculated to be 15% at maximum. For most of the inelastic experiments performed on these spectrometers this is an acceptable degradation.

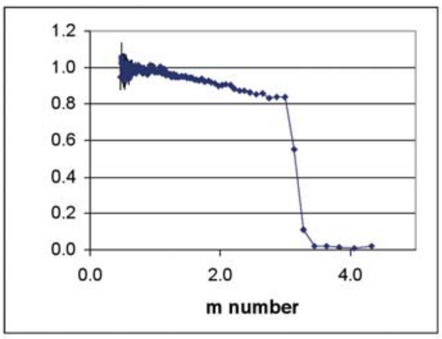

Figure 4. Neutron reflectivity measurement of one of the supermirrors inserted in the beam plug.

Our rotating shutters offered 3 different positions. In order to be able to perform high flux or high resolution experiments, we have chosen to install the 3 following configurations :

- High flux : Horizontal and vertical supermirrors m=3
- Intermediate : 40' collimators without mirrors
- High resolution : 15' collimators without mirrors

Supermirrors have been purchased from the Mirrotron company, and collimators from the GMI-STEEM company. Supermirrors have been deposited on float glass substrate which is known to sustain high irradiation damages without degradation. The reflection quality of each mirror has been checked before being inserted in the beam plug. A typical measurement is represented on fig. 4. They show up a reflectivity coefficient above 80% at m=3.
Mirrors have then been carefully aligned, and inserted in the beam plug in july 2006 (fig. 5). At the restart of the reactor, test measurements will be performed. They will have to show that, no significant increase of the gamma radioactive background is present, and validate the calculated gain of flux on the sample. If deviation to the predictions will be detected, we will take the opportunity of the second part of the maintenance of 4F thimbles that will occur in summer 2007 to apply corrective actions.

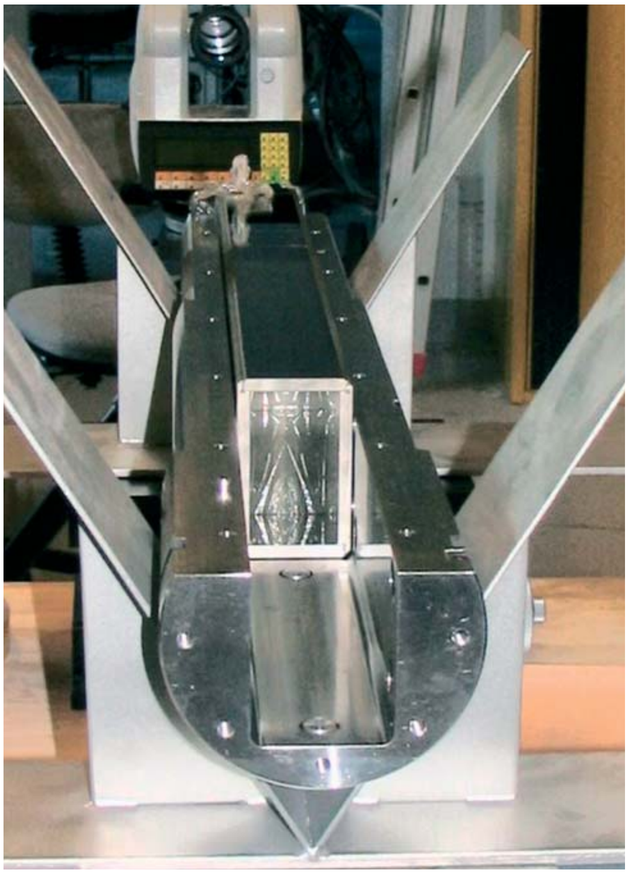

Figure 5. Alignment of the mirrors in the collimator

[1] LLB Scientific report, 1999-2000 p.108-113
[2] O. Elsenhans, P. Boni, H.P. Friedli, et al., Thin Solid Films, 246 (1994) 110-119.