	Experiment title: **Influence of the quality of Bragg-diffracting diamond surfaces on the coherence the diffracted beam**	**Experiment number**: SI-1139
Beamlines: ID1/ID19	**Date of experiment**: from: 13 May 2005 to: 7 May 2005 from: 5 23 July 2004 to: 27 July 2005	**Date of report**: 30.08.2005
Shifts: 2x12	**Local contact(s)**: **Dr. Gerardina CARBONE (ID1)** **Dr. Paul TAFFOREAU (ID19)**	*Received at ESRF:*

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Report:

The focus point of this proposal was the characterisation of the crystalline quality of thin diamond crystal surface layers by surface sensitive X-ray diffraction and -reflection methods, combined with coherence measurements. The crystalline quality of the diamond samples used in the experiment was pre-characterised by optical, X-ray diffraction imaging, and high-resolution diffraction methods. The measurement of the coherence properties of the wave front at the exit of the Bragg-reflecting crystal plates was carried out at ID19 using the Talbot effect (self-imaging by propagation imaging of a periodic object). This beamline is equipped for such kind of measurements and has the best beam properties at the ESRF for them. The analysis of this part of the experiment is finished. The characterisation of the crystalline quality of thin crystal surface layers by surface sensitive diffraction methods was carried out at beamline ID1. The analysis of those data started only recently, so only some preliminary results may be given.

The measurements of the degree of transversal coherence, or more exactly the increase of the effective angular source size, here indicated as vertical and horizontal divergence, were carried out with the following experimental parameters:

Undulator U32, gap = 17mm, E = 20.5keV, 6μm mesh, mesh-to-camera distances 300mm and 900mm.

For comparison we give the theoretical values:

vertical divergence 0.4μrad and
horizontal divergence 1.2μrad.

As experimental reference the values measured without any sample may be used:

vertical divergence from 0.2μrad to 0.4μrad and
horizontal divergence 1.2μrad.

It appears that they are very close to the mentioned theoretical limit. Thus, windows, absorbers and the monochromator crystals decrease the coherence only on a very limited level.

The best polishing was measured on a type Ib sample with a rather low crystalline quality of the bulk. A value of 0.3nm rms was obtained, which is surely not yet the limit. But unfortunately, for a coherence preserving crystal the bulk and the surface quality must both be sufficiently high. The high quality type IIa crystal plates were not yet polished to that top quality. The sample with the lowest roughness (0.96nm rms) is shown in figure 1 (image size 3*3mm^2). Its experimental values of the effective angular source size are:

vertical divergence from 0.8µrad to 1.0µrad and

horizontal divergence from 1.3µrad to 1.6µrad.

This is an increase of only 1.1 to 2.5 times with respect to the value measured without sample.

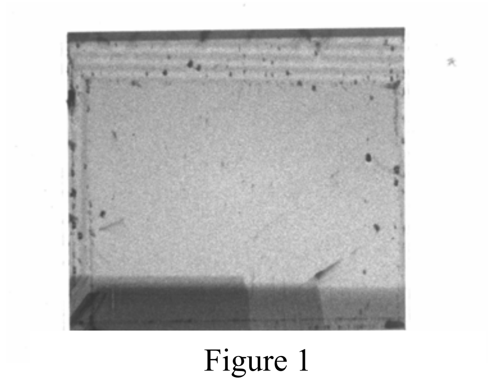
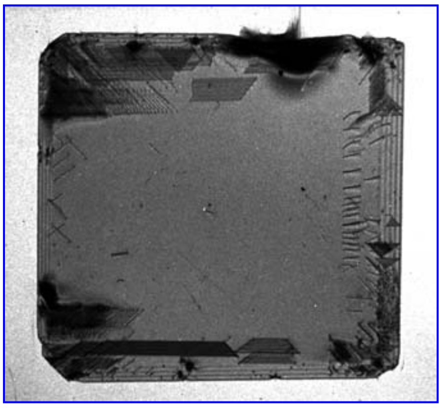


Figure 1

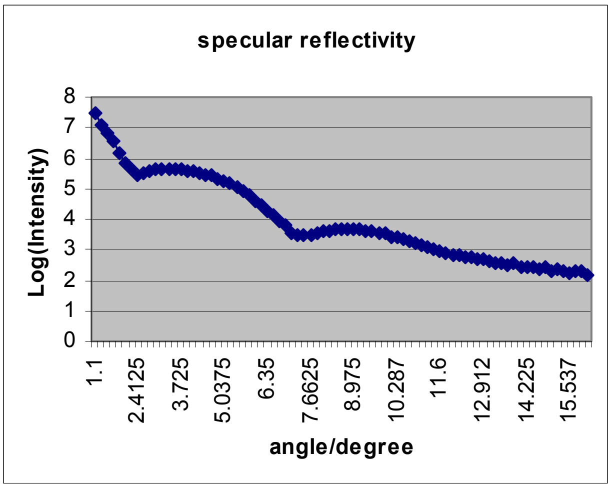
The measurements under gracing incidence conditions were complicated by the fact that the crystals had a too large miscut. Because we do not want to present incomplete results, we limit ourself to two experimental examples.

Figure 1 shows a white beam topograph of a sample with a very low impurity content. It has a central region of very high quality. However, this is the sample with the worst polishing quality (26nm rms). As visible in the left figure 2, this results in an effective thin surface layer (thickness 1 nm) with lower effective density, as prooved by the modulation of the specular reflectivity curves. In the same time the reflectivity curves measured under gracing incidence showed increased intensity in the wings fare from the Bragg peak due to a certain mosaicity of of this thin surface layer due to the insufficient polishing process (figure 2, right curve). In the remaining samples these effects became less and less visible with increasing (but not sufficient) polishing quality.



2 mm

figure 1



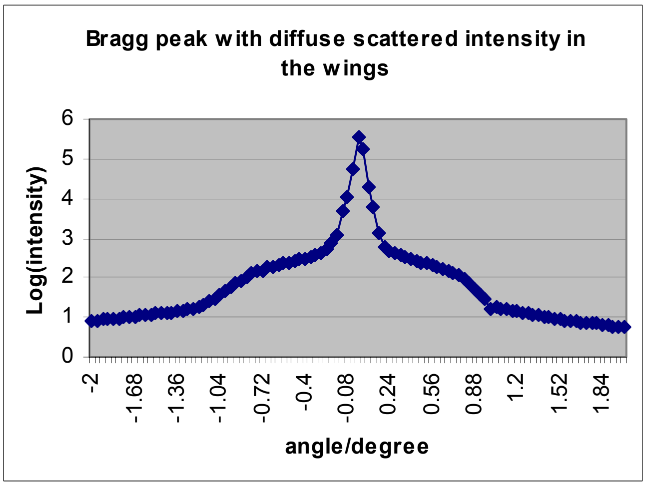


figure 2

The measurements allowed to establish optimised measuring procedures for the experiments at both beamlines, together with the best conditions for the sample preparation. This give a excellent basis for a future successful continuation of those measurements, once the polishing process will be be improved. This improvement is plannd for the second half of 2005.