Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Diffractive-refractive optics: X-ray collimator	**Experiment number**: MI - 960
Beamline: BM05	**Date of experiment**: from: 2.4.2009 to: 5.4.2009	**Date of report**: 25.5.2009
Shifts: 9	**Local contact(s)**: Luca Peverini	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

The goal of the experiment was to verify a low aberration focusing Bragg device. The focusing was based on a diffractive-refractive effect. Crystals in previous experiments had a circular hole which is an approximation of the ideal parabolic groove. This lead to high abberations which enlarged the focal spot size. Device in the current experiment consisted of two Si(111) bulk crystals with two opposing precise parabolic grooves, fig. 1. Both crystals had an asymmetry of 15°. The used energy was 7.31 keV, which equals to a Bragg angle of 15.7°. With an asymmetry of 15°, the incident angle was just 0.7°.

These crystals were used in a dispersive arrangement, i.e. with 4 diffraction events. Because of the low incident angle, the geometry was very surface sensitive. Thanks to precisely prepared parabolic groove shape, all the aberrations introduced by the shape of the optics were reduced to minimum. The only aberrations were due to the geometrical arrangement of the crystals (can not be principally removed) and partially to the surface quality.

Analytically calculated focusing distance was 1.1 m. The crystals were placed 34 m from the source, which represents a de-magnefication of 22. The dimension of the source was 270 μm, so the theoretical focal spot size should be 10.8 μm.

Ray-tracing simulations were used, based on the Monte-Carlo approach, to simulate the focal spot shape and verify the focusing distance. The simulated focusing distance was 1.08 m, which was in agreement with the analytical calculations. The detected and measured focal distance was at 1.4 m, with a focal spot size of 38 μm, fig.2.

The focusing distance for 1.4 m corresponds to a Bragg angle of 15.875°, what is a mismatch of 0.165° to the calculated angle of 15.7°. The dependence of the focusing distance on the Bragg angle becomes very steep in the range of 15°- 20°, fig.3, and even small changes in angle are responsible for a substancial change in the focusing distance. A change of angle by 0.165° can lead to a prolongation of the focusing distance by the measured 0.3 m.

The discrepancy in ray-tracing simulated and measured focal size was due to the surface quality of the parabolic groove. Even after mechano – chemicall polishing there are still some artefacts on the surface after the drilling tools. We were not able to polish the parabolic surface as good as a flat Si surface.

This experiment demonstrated to the first time a low aberration focusing by precise parabolic groove and reached the smallest focal spot with this kind of crystal optics.

Fig.1

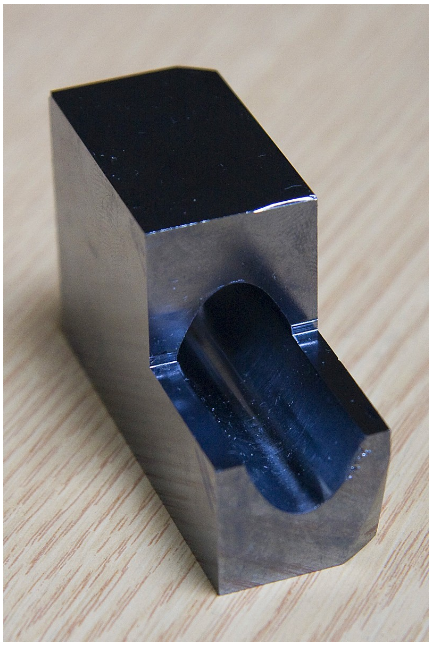
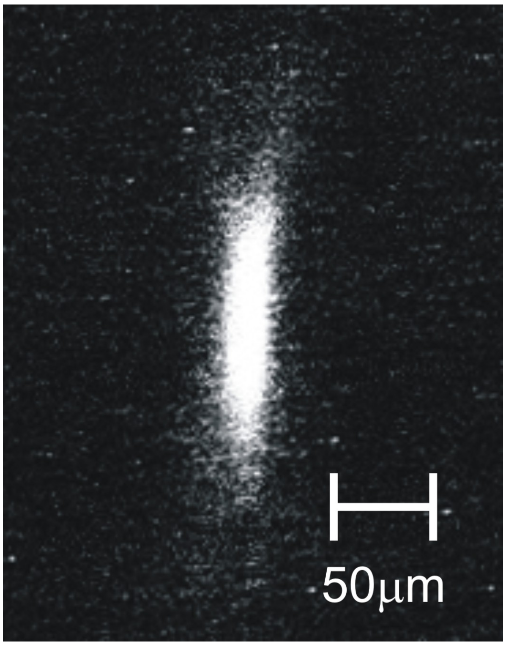


Fig.2



.Fig.3