ESRF	**Experiment title:** Self-standing quasi-mosaic crystals as optical components of a Laue lens for focusing of hard x-rays	**Experiment number**: MA-1744
Beamline: ID15A	**Date of experiment**: from: 28/06/2013 to: 02/07/2013	**Date of report**: 30 August 2013
Shifts: 12	**Local contact(s)**: Veijo Honkimäki	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

*Riccardo Camattari (1), *Battelli Alessandro (1), *Bandiera Laura (1), *Mazzolari Andrea (1), *Bellucci Valerio (1), Guidi Vincenzo (1), Von Ballmoos Peter (2), Barrière Nicolas (3)

(1) Department of Physics and Earth Sciences, University of Ferrara (Italia)

(2) Institut de Recherche en Astrophysique et Plantologie, Toulouse (Francia)

(3) Space Sciences Laboratory 7 Gauss way, Berkeley CA94703 (USA)

Report:

Crystals having curved diffracting planes (CDP crystals) represent a good candidate to focalize X-ray with high-efficiency, as optical elements of a Laue lens. Their energy bandpass can be very well controlled, as is proportional to the curvature, and their diffraction efficiency is not limited to 50% because the continuous change of the incidence angle on bent crystalline planes prevents re-diffraction of a diffracted beam. The energy passband of the photons diffracted by these crystals is orders of magnitude broader than for a flat crystal, featuring a uniform transfer function provided that crystal curvature is homogeneous. In the two previous experiments at ESRF (MA-717 and MI-1021) CDP crystals proved to work for hard X-rays with a diffraction efficiency ideally close to the unity [1,2].

In this experiment we measured new self-standing silicon and germanium curved samples. We were interested to check the quality of the curvature and the diffraction efficiency of the samples. In fact, these two factors are the key parameters for the concrete realization of a Laue lens based on CDP crystals.

The measurements were performed using a pencil beam of 50x50 μm^2 of monochromatic energy varying from 150 keV to 300 keV. The monchromator was composed of 2 crystals in Laue geometry, insuring a monochromatic beam position independent of the energy (fixed exit setup). The sample holder was set on the first tower, close to the optical hutch. The measurements consisted in rocking curves (RC) in Laue geometry, both diffracted and transmitted beams were alternatively recorded by moving back and forth a germanium detector.

In the first part of the experiment, we measured the samples we realized for the Laue project, i.e., a project financed by ASI for the fabrication of a prototipe of a sector of Laue lens. The sample was a Ge crystal, bent by grooving one of the largest surfaces of the sample itself with a diamond blade [3]. The diffracting plane were (111), bent through the quasi-mosaic effect (see Fig.1a). The beam energy was set at 150 and 300 keV. Results are shown in Fig.1b and 1c.

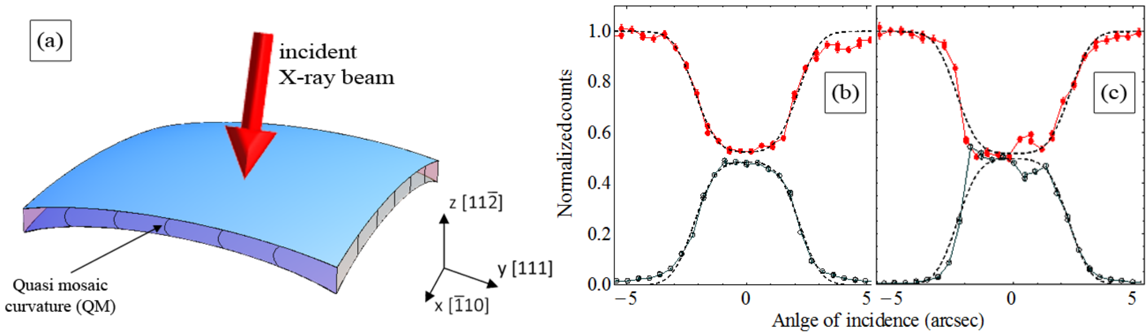
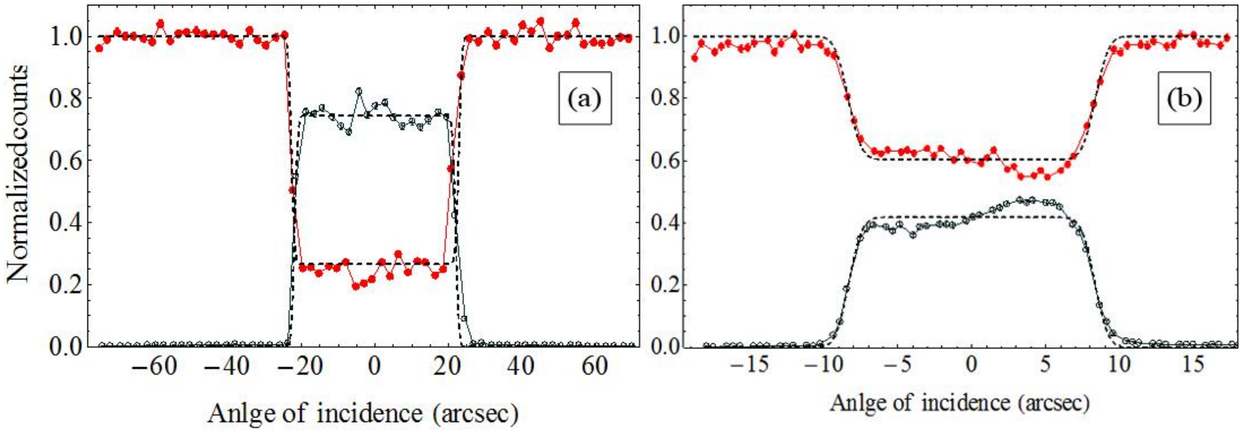


Figure 1. (a) Schematic representation of a quasi-mosaic crystal plate. Crystallographic orientation and QM curvature are highlighted. (b) and (c) RCs of Ge crystal. The filled red circles plot the intensity of the transmitted beam, whereas the empty blue circles plot the intensity of the diffracted beam. (b) Beam energy at 150 keV. (c) Beam energy at 300 keV.

In the second part of the experiment we measured some samples bent with a new technique, worked out to realize a self-standing bent sample without the tipical damages of the grooving method. The technique consists in the deposition of a very rigid material upon one of the largest surface of the sample. From a very first analysis of data, the method appears very promising for the mass production of thick bent crystals. Preliminar results are shown in Fig.2a and 2b.



RCs of samples bents with the deposition of very rigid material. The filled red circles plot the intensity of the transmitted beam, whereas the empty blue circles plot the intensity of the diffracted beam. (a) the beam entered from the side of the sample. (b) the beam entered from the largest side of the sample, diffracting in bent quasi-mosaic planes (Fig.1a). The results fit with the theoretical expectation, plotted with dashed lines. (b) Beam energy at 150 keV. (c) Beam energy at 300 keV

Finally, we tried to verify our theoretical model [4] describing the diffraction efficiency in crystals whose curvature is lower than the critical value, i.e., crysatls with high radius of curvature. The crystal was a silicon sample mounted on a holder able to finely change the curvature. However, this kind of experiment would need more time to develop a better holder and more shifts to collect more data.

Concluding, the experiment was a full success, thanks especially to the competencies and great availability of our local contacts Veijo Honkimäki and Thomas Buslaps. Based on the data acquired during this experiment, several papers are being written or have been submitted for publication.

Reference:

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