EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

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:** Hard X rays wavefront sensor development	**Experiment number:** MI-811
Beamline: BM05	**Date of experiment:** from: 2006-07-21 to: 2006-07-24	**Date of report:** 2006-08-29
Shifts:	**Local contact(s):** Dr. Anatoly SNIGIREV	*Received at ESRF:*

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Report:

Introduction

The goal of the experiment was to validate a design of Hartmann sensor for X rays (>8keV) and to evaluate its performances. Three configurations (1/ direct detection, 2/ wavelength conversion with YAG crystal and microscope objective, 3/ wavelength conversion with fiber optic coupling) were tested with a particular emphasis on the first one. Main difficulty resides in the at-wavelength calibration of the Hartmann Wavefront Sensor (HWS), which needs a perfect wavefront as reference.

A HWS is composed of a multi-hole array (a number of holes distributed in matrix) place in the pupil of optical beam being measured and a CCD camera. The position of the hole centroïd projected on the CCD are measured and compared to a reference position. A Software algorithm is then used to reconstruct the wavefront. To extract the absolute wavefront, the first step is to calibrate the HWS with a "perfect" incident beam. To produce this "perfect" incident beam, we used a high resolution zone plate available on the Micro optics test bench at BM5. The focus spot size was measured with high resolution X-ray CCD camera (Sensicam QE - 12 bit) (figure 1). A spot size of 2x4 microns was achieved.

Figure 1: Focused beam at 10 keV on BM5 using a Fresnel Zone Plate

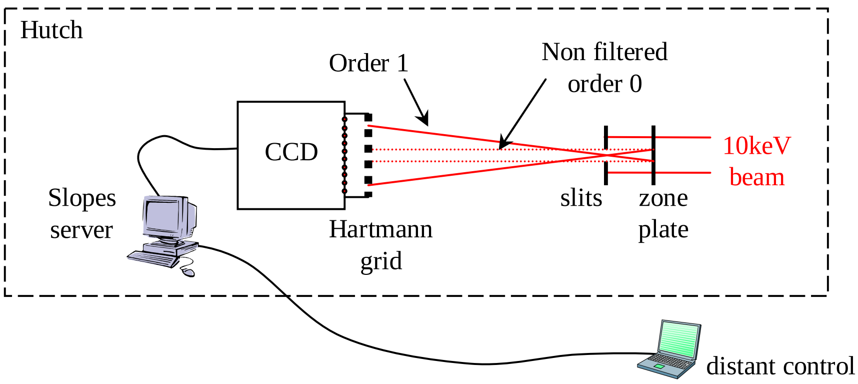

Figure 2: Wavefront sensors characterization principle

Hartmann validation

During the first step of our experiment, we fully characterised the direct sensor and the Hartmann sensor using a YAG crystal and a microscope objective in terms of accuracy and sensitivity. Figure 3 give more details on the sensitivity of the direct Hartmann wavefront sensor.

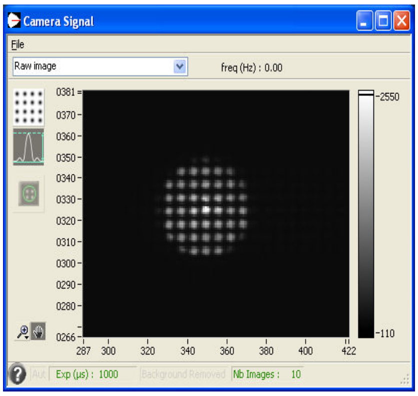

Figure 3 : Hartmanngramm obtained with the direct detection system (Hamamatsu)

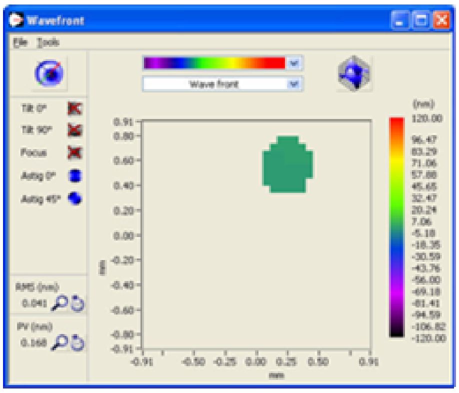

Figure 4: HWS with direct detection (Hamamatsu) ; calibrated wavefront, **sensitivity = 0.041nm rms**

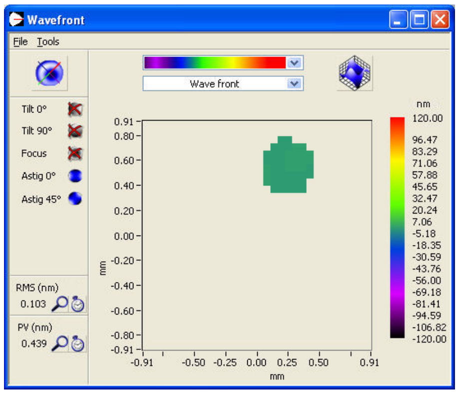

Figure 5: HWS with direct detection(Hamamatsu) ; relative wavefront, **accuracy = 0.103nm rms**

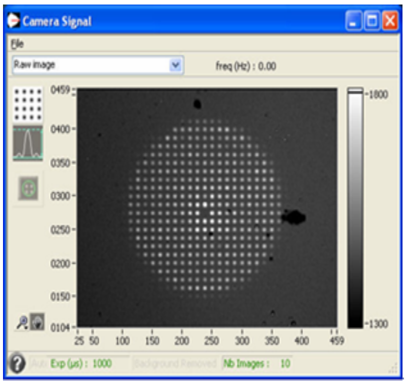

Figure 6 : Hartmanngramm obtained with the YAG crystal and microscope objective system

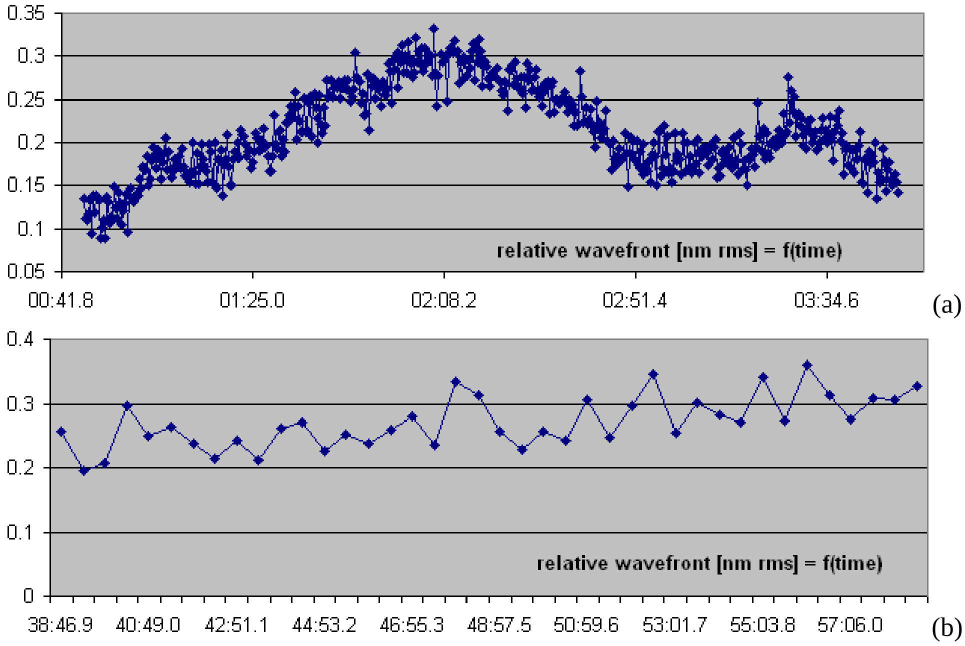

Figure 7:
(a) The HWS with direct detection presents a repetebility with tilt and curvature less than 3Arms over 3 minutes, including the pointing and focusing stability of the beamline!
(b) Same order of repetability is measured with the HWS with YAG and microscope objective over 20 minutes

Unfortunately because of lack of time, no measurements were done on the Hartmann sensor with the optic fibres.

Conclusion

Our experiment shows that a hard x-ray wavefront sensor with very good performances has been developed (**sensitivity = 0.041nm rms**) based on two kinds of detectors:

- the use of fast direct X-ray cameras able to read several images per second (Hamamatsu). Reading of several images per second will make possible to increase the signal to noise ratio (there is no more shot noise limitations on such system). A significant work however remains to be made on the integration and the tests of these various cameras.
- The use of a conversion wavelength system. Instead of an X-ray direct CCD camera.. In this case also, a significant work remains to be made on the optical systems design and the tests of the scintillator.

Next step is:

-- To test the HWS based on fiber optic coupling and compare the results with the other system,

-- To perform beamline aberration measurement and automatic x-ray optics alignment.