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:** X-Ray Near Field Scattering	**Experiment number**: MI-696
Beamline: BM 05	**Date of experiment**: from: june 22 2004 to: june 29 2004	**Date of report**: 15 feb 2005
Shifts:	**Local contact(s)**: Luca Peverini	*Received at ESRF:*

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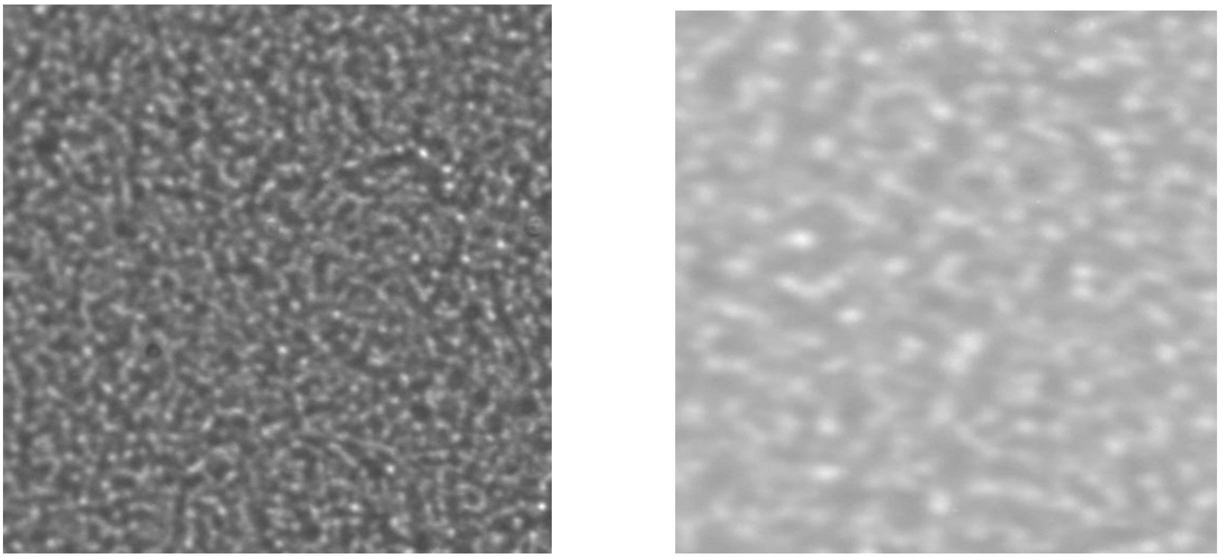
Report:

The experiment has been dedicated to study the interference patterns originated by the light scattered from a sample illuminated by a partially coherent X ray beam. Near Field Scattering (NFS) speckle fields have been recorded by using many samples (see for example Fig. 1), and the fundamental, statistical features of the intensity distribution has been checked to be as expected[1, 2]. A new method for measuring the pointing stability of the beam has also been tested.

The experimental apparatus has been set as follows: the white X ray beam generated in the full beam mode has been sent onto a Si (111) monochromator, to generate monochromatic 12 keV or 24 keV X rays, with a relative bandwidth of the order of 10^{-4}. All but one of the Berillium windows have been removed to reduce the stray contribution, and the monochromatic beam was delivered to the second hutch through Kapton windows only. A number of known and unknown samples (see below), that could be automatically inserted and removed from the beam, has been used. The transmitted and the scattered radiation has been collected along the optical axis of the system by a Frelon camera with 0.7 microns equivalent pixel size. The camera has been mounted onto a test bench having three degrees of freedom in such a way to move the sample along the axis of beam propagation (optical axis) and in the perpendicular plane. The former movement was used to investigate the formation of the interference patterns along the optical axis for sample-detector distances ranging from some millimeters up to about few meters.

Very close to the sample the sensor records an intensity distribution determined by the shadow of the structures inside the sample, that are the amplitude modulations. For increasing distances the visibility of the contributions arising from the phase modulations becomes more important, and where many stochastic scattered contributions superimpose a speckled field is generated by the phase modulation inside the sample.



(a) (b)

Fig. 1: Example of the speckle fields obtained at two different distances from the sample (800 and 1335 mm respectively). The sample was a cellulose acetate filter with 8.0 microns pores in both cases. In the figure a subframe 512x512 from a 2024x2024 full frame has been represented.

Test measurements have been performed with a number of samples having low-density contrast at the wavelengths in use. Some of them were calibrated porous micron sized filters. Only static samples have been used and relatively long integration times have been used (typically 100 seconds). The stray contribution has been subtracted from each frame by recording the flat field for each image. The preliminary statistical analysis is being performed trough the power spectra, readily recovered from the measured speckle fields. A complete comparison of the optical and the X ray results is not straightforward because of the partial spatial coherence of the X rays mentioned above, and will need a deep study on the basis of the existing data. Ultimately, the analysis will allow to check if the information gathered by the interference patterns can be used in the X rays regime to implement a scattering technique to enhance the X-rays inspection capability.
Finally, the experiment showed that a good quality of the beam and the mechanical stability of the whole beamline are crucial requirements for our measurements, any movement of the beam during the exposure time causing changes in the speckle structure. This sensitivity of the speckle pattern with respect to the beam properties can be used as diagnostic tool for the investigation of beam stability in time. Measurements have been performed by fine tuning the secondary mirror of the monochromator with sub-arcsecond steps. Preliminary data analysis has proved the reliability of the method and its applicability in alternative to the current ones[3].

References

1 M. Giglio, M. Carpineti, and A. Vailati, Physical Review Letters **85**, 1416 (2000).
2 D. Brogioli, A. Vailati, and M. Giglio, Applied Physics Letters **81**, 4109 (2002).
3 S. Qian, P. Takacs, Q. Dong, et al., in *SYNCHROTRON RADIATION INSTRUMENTATION: Eighth International Conference on Synchrotron Radiation Instrumentation* (AIP, San Francisco, California (USA), 2004), Vol. 705, p. 616.