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:** **New imaging methods at ID19 – computed laminography and tomosynthesis, rapid CT and ultrafast radioscopy**	**Experiment number**: MI-576
Beamline: ID19	**Date of experiment**: from: 29/04/02 to: 01/05/02	**Date of report**: 21th May 03
Shifts: 6	**Local contact(s)**: Lukas Helfen	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

In the first allocation of beamtime for MI-576, the test experiments on a prototype for synchrotron laminography (SL) were conducted. The schematic drawing of the set-up is presented in fig. 1. The goniometric head with a plexiglass (transparent for X-rays) sample holder was mounted on the Huber rotation stage and fixed at the inclined mounting plane by 30° with respect to the incident beam. A sphere of confusion of 3.5 µm of the χ (laminographic) rotation was measured prior to the experiment for an anti-clockwise turning direction at the required sample height. For the alignment of the rotation axis χ, the Y-translation below the assembly was implemented. The entire device was mounted on the big “Horizontal Diffractometer” installed in the ID19 experimetal hutch, which allows supplementary movements as two perpendicular tilts and a big Z-translation.

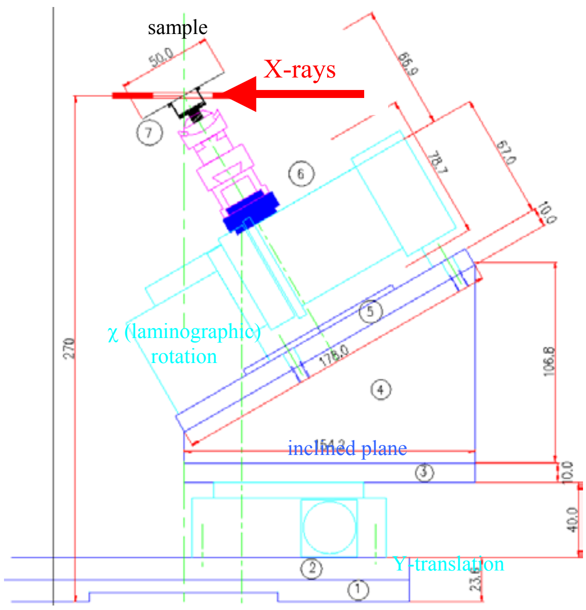

Fig. 1: Set-up for the synchrotron laminography.

Working energies were 14.7 keV and 35 keV obtained using wiggler radiation and multilayer as a monochromator. The detector used was FReLoN camera with 2048×2048 pixels, having pixel size of 1.4 µm with a resulting field of view of 2.87 mm.

The alignment was carried out with a 50 µm thick W wire, using the "alignment" matlab macro. A problem was found in the changing geometry with respect to 180° rotational angles for the autocorrelation-based macro: objects out of the rotation axis change their height because of the inclination angle. A good method to find the approximate position of the rotation axis was to put a mesh (Cu mesh 351", i.e. periodicity 73 µm) about at the same angle as the base of the rotation

table and turning it. The spot, which does not move during the rotational movement, is the intersection of the rotation axis with the mesh plane.
A quantity of samples was investigated performing the laminography scans, i.e. the tomography-like projection data sets were recorded when rotating the sample by 360º. The typical parameters of the scans

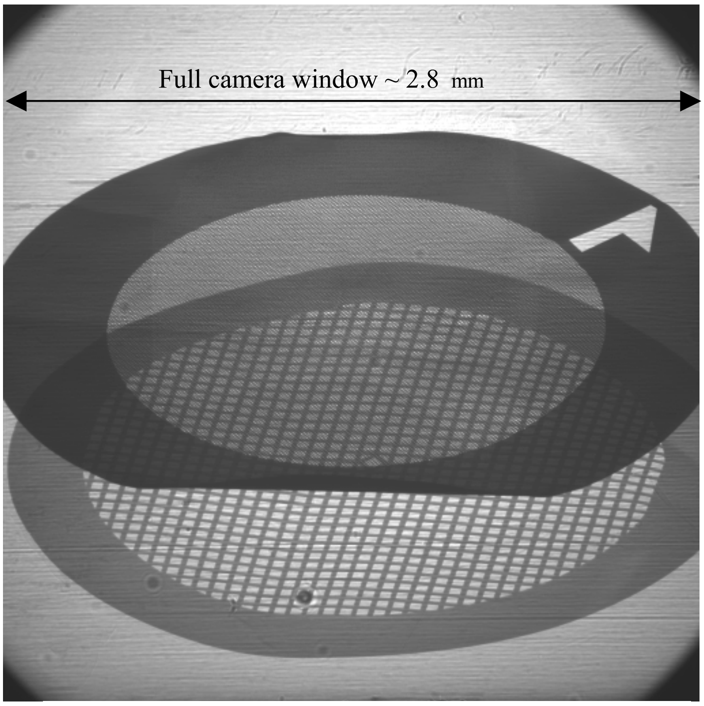

Fig. 2 Raw laminograph of two overimposed meshes.

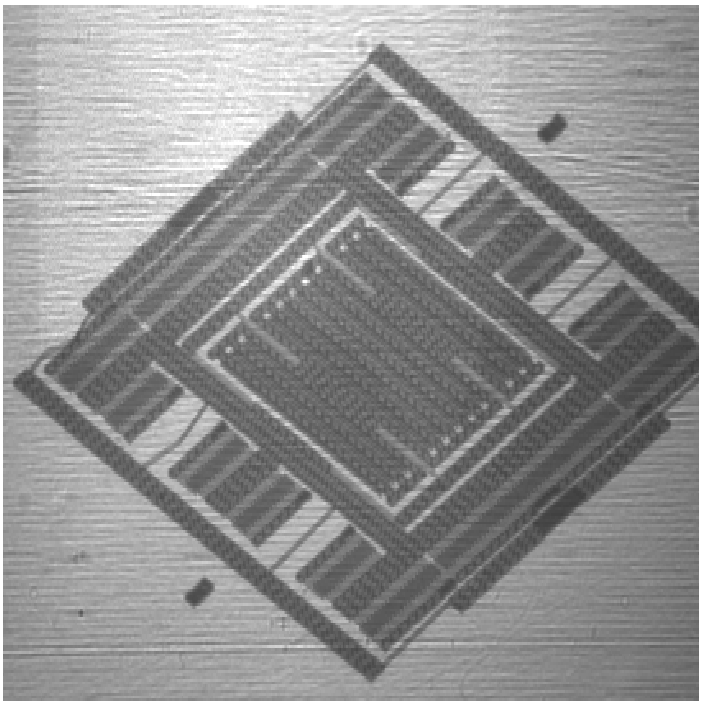

Fig. 3 Part of the raw laminograph of a chip.

were: 900 images, measuring time 3 s/image, step 0.4°, distance sample-to-scintillator 26 mm. Figs. 2 and 3 show examples of obtained data. Fig. 2 corresponds to a raw image (i.e. without flat and dark corrections) of two grids pasted one on top of the other: Cu (periodicity 73 μm) and Au (periodicity 12.5 μm, with Au wire width of 4 μm and window size 8.5 μm not being perfectly rectangular; thickness is about 5 μm). Fig. 3 is a single projection image of a chip.
The evaluation of the experiment is still under way. To achieve this, we have developed a simulation program for phantom samples. Together with the recently implemented laminographic reconstruction program, it is intended for determination of the optimum experimental conditions (for given sample types), like:

- influence of lamino angle (its uncertainty and size) on reconstruction results,
- influence of alignment errors (tilts, parallelism, etc.),
- which movements are the most crucial ones (sphere of confusion, reproducibility-flat, etc.),
- sample-to-detector distance (phase-contrast effects),
- limited-volume scans (sample not entirely in the beam, resulting artefacts).

In addition to these properties, the "real" lamino-scan reconstruction makes possible to distinguish between different artefacts stemming from various errors (e.g. a movement of the axis of rotation, tilt, flat-field correction, choice of energy, distance, angle, etc.). All these calculations allow us to draw very important conclusions for the requirements of the future laminographic set-up.
In the first year of the long-term project we have used only 6 shifts from the 30 allocated. This delay was caused by a) the long-time unsuccessful negotiations with two suppliers asked to fulfil our technical requirements for the synchrotron laminography set-up, b) a considerable effort devoted to the development of the adequate simulation and reconstruction programs. At the time being, all these difficulties are overcome (negotiation with HUBER company of the final contract is in a final stage and programs are available). The new set-up will presumably be implemented on the ID19 beamline at the beginning of the year 2004. Consequently, we ask to postpone the obtained beamtime for 1 year further, i.e. until the end of the year 2004.

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