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 via the User Portal: *https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do*

Deadlines for submission of Experimental Reports

Experimental reports must be submitted within the period of 3 months after the end of the experiment.

Experiment Report supporting a new proposal ("relevant report")

If you are submitting a proposal for a new project, or to continue a project for which you have previously been allocated beam time, you must submit a report on each of your previous measurement(s):

- even on those carried out close to the proposal submission deadline (it can be a *"preliminary report"),*
- even for experiments whose scientific area is different form the scientific area of the new proposal,
- carried out on CRG beamlines.

You must then register the report(s) as "relevant report(s)" in the new application form for beam time.

Deadlines for submitting a report supporting a new proposal

- 1st March Proposal Round - **5th March**
- 10th September Proposal Round - **13th September**

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.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report in English.
- include the experiment number 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: Study of both the strain relaxation dynamics and dislocation generation using 100 nm-Laue 2D mapping on state-of-the-art avalanche photodiode IR detectors**	**Experiment number**: **A32-2-827**
Beamline: BM32	**Date of experiment**: 06/05/2021	**Date of report**: 1 March 2022
Shifts: 3	**Local contact(s)**: JS. Micha	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Xavier BIQUARD*, CEA-Grenoble, IRIG/DEPHY/MEM/NRS

Philippe BALLET, CEA-Grenoble, LETI/DPFT/SMTP/LMP

Report:

The first try was made in November 2020 but the beamsize was not sufficiently small. Then COVID made it difficult to reprogram a close-by date. Finally, later in May 2021 — once the KB mirrors have been repolished — the beamsize could be made sufficiently small horizontally but not vertically as was originally intended. And we obtained a 125 nm width as shown on Figure 1.

A 15 µm long cross-section profile was successfully recorded on APD sample number 28016 with 25 nm steps. At each step, we record the 60s long µLaue spectra on a 4096x4096 CCD camera placed at #300 mm. At each step, the same 8 diffraction peaks without harmonics may be seen (see Figure 2), out of which only the 4 most intense peaks are kept to ensure a good signal-to-noise ratio. We logically made the assumption that the strain is biaxial along the growth axis cc=[211].

Applying the techniques described in [1], and since this time the growth axis is along axis X see Figure 3, the slope of the variation of the x position of peaks as a function of x is $Slope=\left(\frac{1+\epsilon_{bb}}{1+\epsilon_{cc}}-1\right)\approx-\left(1+\frac{1}{A}\right)\epsilon_{cc}=\left(1+A\right)\epsilon_{bb}$ where $\varepsilon_{cc}/\varepsilon_{bb}=\frac{-2\nu}{1-\nu}=-A$ with ν=0.323 [2] is the Poisson ratio along the cc=[211] direction, and bb=[-1,1,1] direction. Thus, we were able to determine the local strain inside our sample as a function of depth (see Figure 4).

We see that the in-plane strain ε_{bb} increases in a linear way inside the substrate before switching to an exponential growth in the last 2 microns. This very clearly shows that the substrate possesses an in-plane lattice adaptation to the compressive layer with a 4 10^{-4} in-plane adaptation, while no such adaptation is present in the tensile case (see [1]). This clearly constitutes our first remarkable result.

On the layer side, we have at first deposited a 2.0 µm thick layer that possesses a Cd gradient. We see that the part that is in contact with the substrate presents a -2.4 10^{-4} (compressive) in-plane strain while at the other side, we have a 3.1 10^{-4} (tensile) strain, with a strain evolution that appears quite linear. This clearly constitutes our second remarkable result.

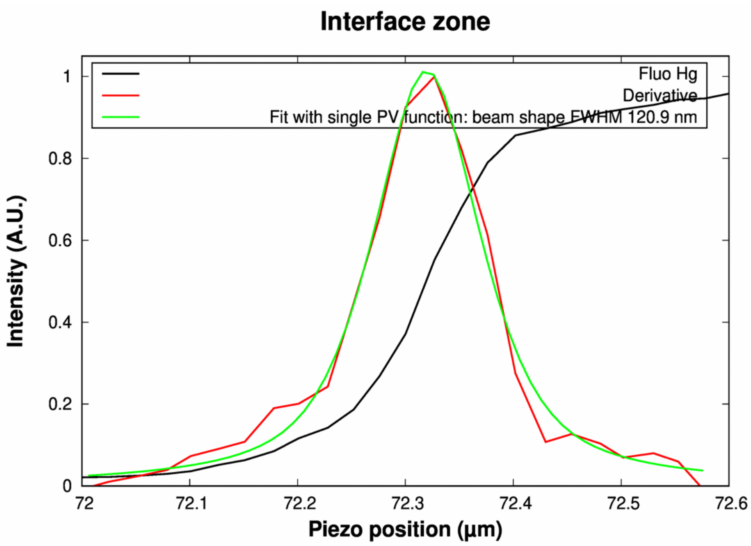

Figure 1: Beam size deduced from the derivative of the Hg fluorescence

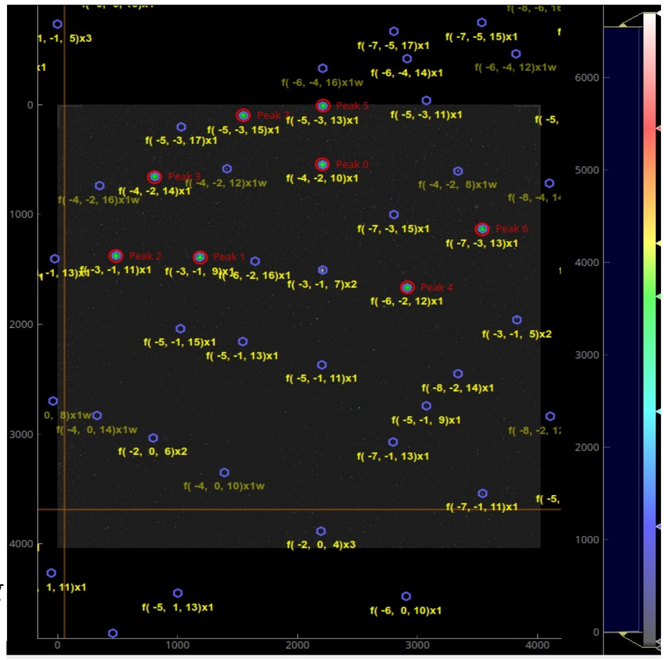

Figure 2: Recorded CCD image showing the 8 diffraction peak (red circle) among 15 peaks (top half only) that have no harmonics with their Miller indexes

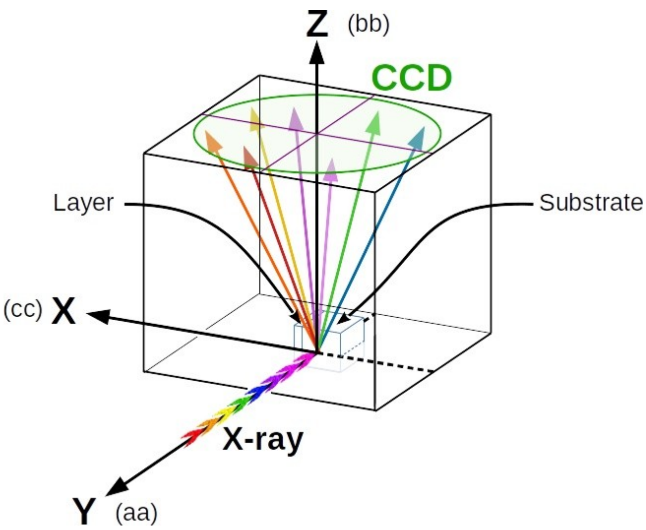

Figure 3: experimental setup

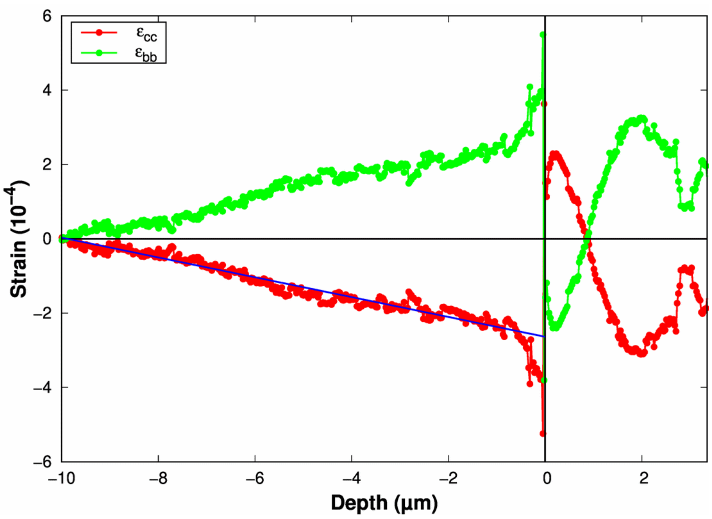

Figure 4: Strains as measured by fitting the peak positions as a function of depth

[1] X. Biquard et al., J. Synchrotron Radiation 28, 181 (2021)
[2] A. Tuaz, Ph.D. thesis, University Grenoble Alpes, available online at: https://tel.archives-ouvertes.fr/tel-01822798, (Dec. 2017).