	Experiment title: **New imaging methods at ID19 – computed laminography and tomosynthesis, rapid CT and ultrafast radioscopy**	**Experiment number**: MI-576
Beamline: ID19	**Date of experiments**: from: 05/11/03 to: 09/11/03	**Date of report**: 2 Aug 04
Shifts: 12	**Local contact(s)**: Lukas Helfen	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

L. Helfen*, T. Baumbach*, P. Mikulík* *Fraunhofer Institut IZFP EADQ, Dresden, Germany*

P. Pernot* *Fraunhofer Institut IZFP EADQ, Dresden, Germany; ESRF, Grenoble, France*

Report:

In the third allocation of beamtime for MI-576, further test experiments on the prototype sample manipulator (as already described in the first report) for synchrotron laminography (SL) were carried out. Exact alignment of the rotation axis was possible (but still rather time consuming) by means of a 50 μm thick W wire and a Cu mesh (i.e. a Cu mesh 351", corresponding to a periodicity of 73 μm) which results in reconstructed images of significantly increased contrast and resolution of detail. The final sample manipulator is conceived to facilitate the alignment procedure by stringent requirements on the perpendicularity of the axes and extended travel they provide.

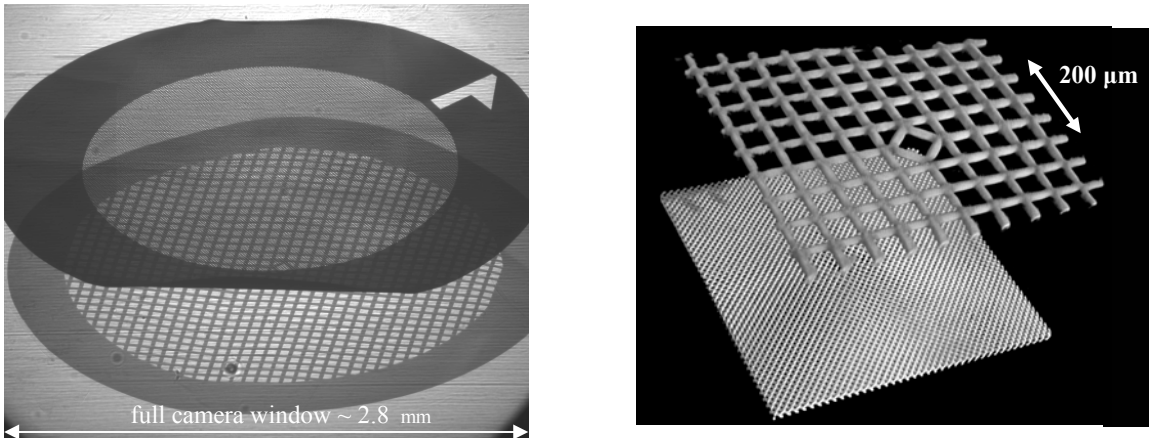

Fig. 1 Left: raw radiograph of a phantom sample consisting of two overimposed meshes (see text). Right: 3d rendering of the 3d reconstructed data of the corresponding laminographic scan.

We worked under similar experimental conditions as in previous beam allocations, *i.e.* at energies of 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 width 2.87 mm. A variety 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 were: 900 images, measuring time 3 s/image, step 0.4°, distance sample-to-scintillator 26 mm.

Some examples of obtained data are presented in figs.1-3. Fig. 1 corresponds to a raw radiograph (i.e. without flat-field and dark corrections) of a phantom consisting of two grids mounted one on top of each 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) and a three-dimensional view of the 3d scan reconstruction. Fig. 2 shows the reconstructed two-dimensional slices of this phantom sample.

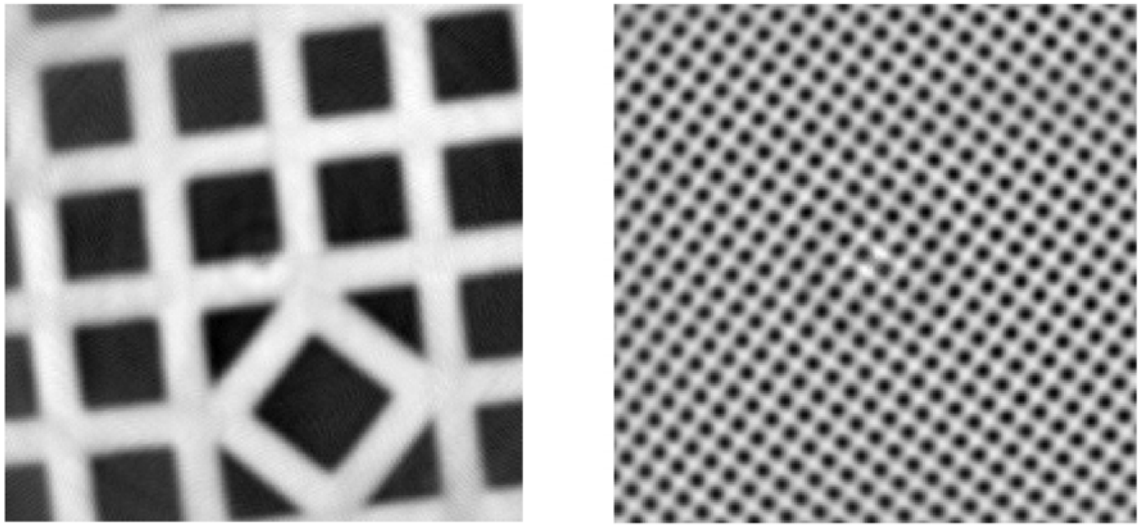

Fig. 2: Reconstructed slices of the phantom consisting of two meshes. Left: slice through the Cu mesh (73 μm periodicity). Right: slice through the Au mesh (12.5 μm periodicity).

The implemented laminographic reconstruction program was employed to reconstruct 3d data sets which give evidence of the sample structures. For a flip-chip bonded device (cf. previous experimental report) significantly better reconstructed images could be obtained for projection data sets for which the laminographic angle was adjusted precisely. Voids with sizes down to 5 μm in the 80 to 100 μm thick solder bumps are clearly visible. With these new images, the voids are found rather localised towards the interface to the chip metallisation layers which could in the future allow conclusions on the optimisation of bonding process parameters. Furthermore, as already noticed before, we see the faint outline of the Si chip and pores in the printed circuit board.
Fig. 3 shows a raw radiograph of a complex electronic device and three-dimensional reconstruction of laminographic data set.

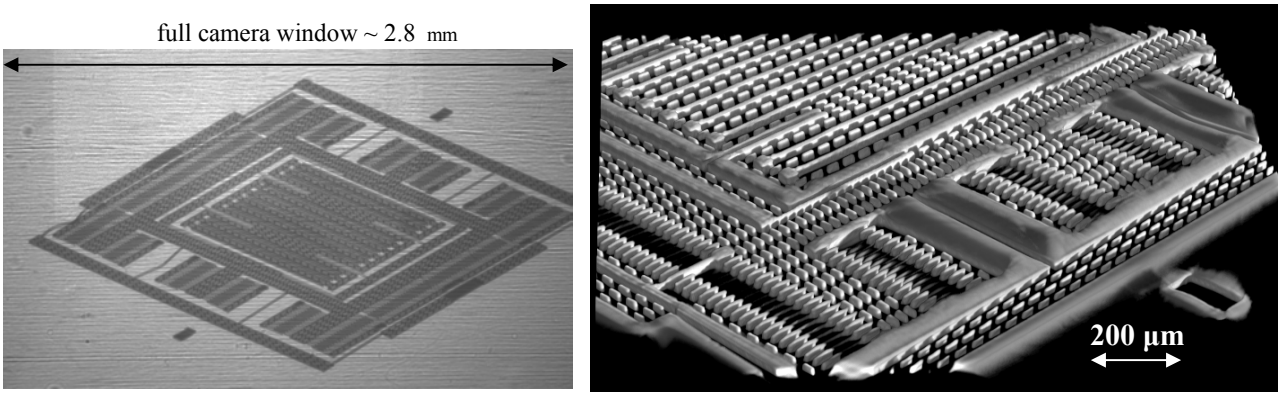

Fig. 3: Left: raw radiograph of a complex electronic device. Right: 3d renditions of the 3d reconstructed data of the corresponding laminographic scan.

The experiments have confirmed our decision to invest in a dedicated sample manipulator. If the precision requirements can be met, an image quality significantly better than currently available by laboratory set-ups is expected. Further methodical advantages are expected to arise from the use of phase-contrast imaging exploiting partially coherent radiation.