ESRF	**Experiment title:** Development and testing of Fourier-Transform-Holography with hard X-rays	**Experiment number:** MI-317
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Report:

A new type of multi-keV X-ray microscopic technique using the Fourier-transform-holography (FTH) was experimentally investigated at the ESRF. The FTH makes use of the good coherence properties of the synchrotron radiation of an undulator. The experiments were done with monochromatic X-rays of 14keV.

The 'beam splitting' Fresnel zone plate (FZP) formed a submicron focal spot in 0.7m distance (it is the demagnified image of the undulator source). The diffraction efficiency of the FZP was about 8 %. The experimental geometry is schematically shown in Fig.1. The object was directly illuminated by the transmitted beam (zero order diffracted beam). At the same time the reference wave was formed by the first order diffracted beam. The object under investigation was placed close to the reference source (some µm distance). The zero and higher than first order diffracted portions of the FZP were removed by a pinhole placed 5 mm before the sample. The hologram itself was detected at a distance of 2.7 m behind the sample. The X-ray hologram was converted into light by a thin scintillator screen and the image was magnified by a microscope and recorded on a CCD-camera. The effective pixelsize in the arrangement was 1 μm and the exposure time for each hologram was two minutes. We experimentally investigated the holograms from one and two dimensional objects.

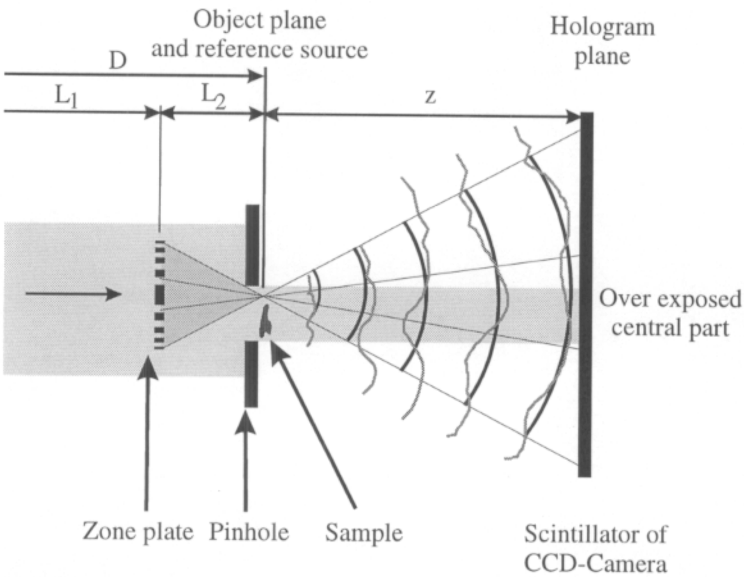

Fig. 1 Experimental set-up for Fourier transform holography

In order to observe a simple and easy understandable interference pattern we recorded at first holograms of a 50μm pinhole and a 5μm wire which had different distances from the reference pointsource. We could observe the change of the fringe spacing in the hologram which depends on the distance between the object (wire) and the reference point the focal spot of the FZP).

A two dimensional test object (a fine gold mesh with 15 μm pitch) was investigated in another experiment. We successfully reconstructed the object from a hologram which is shown in Fig. 2a by calculating its two dimensional Fourier transform. Here the image and the twin image are separated and the grid and the 100μm pinhole as well are clearely visible in the reconstruction (see Fig. 2b).

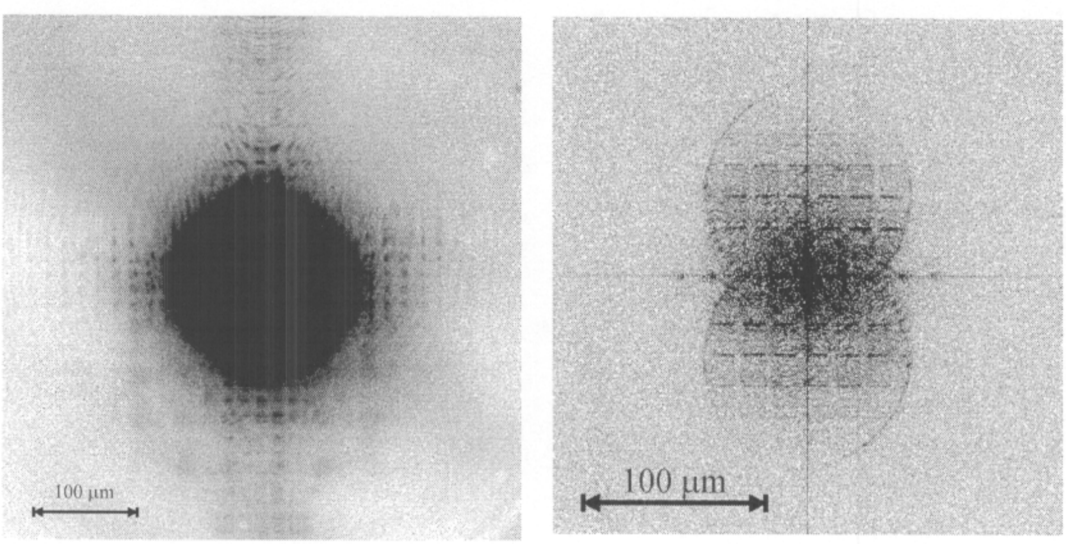

FIG.2
a) Fourier transform hologram of a grid structure.The central part is overexposed while the outer part contains the hologram.
b) Numerical reconstruction of the hologram shown in 2a) after applying inverse Fourier transform.

For more details see:

W. Leitenberger and A. Snigirev in X-ray Microscopy 1999 , *eds. A. Warwick and D. T. Attwood; American Institute of Physics Press, Washington, 2000.*
W. Leitenberger and A. Snigirev in preparation for Optics Communication