# Fresnel Bi-mirror for hard X-rays for coherence measurements

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In February 2005 we were invited to perform experiments at the ESRF Beamline BM05. One objective was to perform interferometric X-ray measurements with a Fresnel bi-mirror (FBM) in the spectral range of 5 to 50 keV. The aim was to test this method for quantitative determination of the coherence properties of hard X-rays which is still a topic under investigation.
The experimental set-up is shown in Fig. 1. A double crystal monochromator selects a single energy out of the white spectrum emitted at a bending magnet. The bi-mirror under test was mounted at a goniometer. The X-ray interference pattern was converted by a fluorescence screen into visible light and magnified by a optical microscope to a CCD camera (FRELON). The effective pixel size was 7.5 µm and the distance between FBM and detector was L = 5.5 m
The Fig. 1b shows the principle of the FBM. Two small mirrors on a single substrate are reflecting X-rays at incidence angles below the critical angle and acting as narrow slits of micrometer size with a separation of a few micrometer. We could observe high contrast interference fringes equivalent to Young‘s fringes generated by sub-micrometer pinholes. The mean exposure time was a minute for each image.
The width of the mirror substrate was 5 mm and the gap between the two remaining mirror was about 3.5 mm. The typical incidence angles were between $\alpha$ = 0.01° ... 0.1 deg. By this slit separations of $\sin \alpha \mathrm{D} = 3 ... 20$ µm were realized. The lower limit of the incidence angles was given by the minimum spearation of the direct beam and the reflected beam. The largest incidence angle of 0.1 deg. was limited by some fixed beamline slits in between the FBM and the camera.
The quantitative evaluation of the diffraction pattern requires a modification of the standard formalism for evaluating double slit interference pattern which is described elswhere. Anothe problem is in a small inclination of the two small mirrors which reduces the fringe visibility compared to an exact paralell alignment.
The Fig. 2 shows three typical interference pattern recorded for 8, 15 and 40 keV all recorded with the same FBM at a incident angle of 0.02 deg. (see caption). One sees clearly the horizontal Young’s fringes having different period. Another important point are the inhomogenities presumely due to inhomogenities due to beamline components as mirrors or vacuum windows
The quantitative evaluation of the data is in progress. It is done by fitting the data to a suited analytical expression to determine the mutual coherence function.

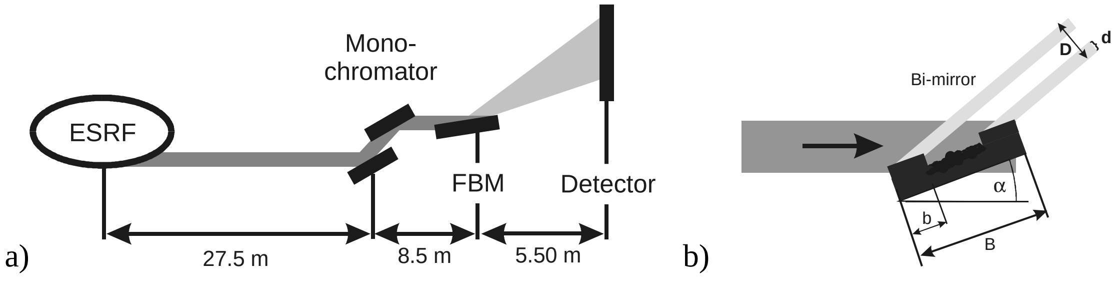

**Fig. 1** Experimental set-up diffraction experiments **a)** Diffraction **b)**

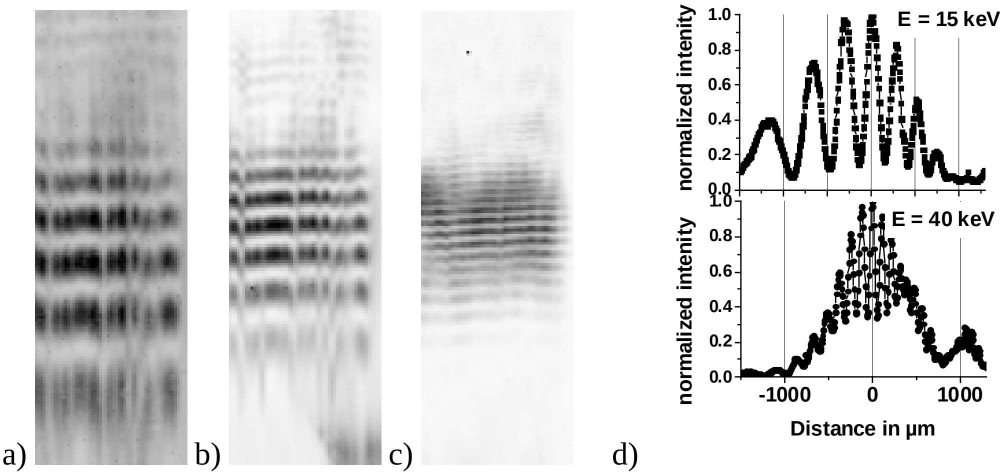
a) b) c) d)

**Fig 2.** Typical interference pattern at incidence angle 0.02 deg. a) E=8 keV , b) 15 keV c) 40 keV (1.55 Å, 0.83 Å and 0.31 Å wavelength)

d) extracted line-profiles at 15 and 40 keV (parameter see text)