ESRF	**Experiment title:** Development of High Energy Focusing Optics for Materials Diffraction (longterm proposal)	**Experiment number**: MI-225
Beamline: ID15a/BM5	**Date of experiment**: from: 10-11-97/10-12-97 to: 12-11-97/13-12-97	**Date of report**: 28 Feb 98
Shifts: 9 / 9	**Local contact(s)**: U. Lienert	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

U. Lienert, A. Freund, H. Graafsma, O. Hignette, V. Honkimäki*, Å. Kvick, M. Lingham, Ch. Morawe, E. Ziegler; ESRF

S. Garbe, H.F. Poulsen*; Risø, Materials Research Department, DK-4000

C. Schulze*; Swiss Light Source, PSI-OVGA/202A, CH-5232 Villigen PSI Switzerland

Report: The two beamtimes available for the development of high energy, focusing optics were used as follows:

(1) ID15a: Scattering from apertures of micrometer size opening

Motivation: Slits are the most basic optical elements and will be used behind focusing optics to further slit down a focal spot size and select a local scattering volume within a bulk sample. The required slit openings are typically about 5 µm. The opening to thickness ratio of such slits is of the same order as the critical angle of total reflection (1 mrad). Substantial scattering could therefore arise, biasing the beam defining properties of an ideal slit. Available theoretical approaches do not apply for the present case as the roughness of the blades might be much larger than the perpendicular momentum transfer of the scattered radiation. The (internal) surfaces of high energy micro-apertures are often difficult to characterize. The aim of the experiment was the characterization of various existing apertures and comparison to theoretical predictions.

Expected result: Experimental results were expected indicating possible limitations of apertures to define high energy micro-beams. The potential of reducing the scattering by appropriate surface profiles should be estimated by comparison to theory.

Experimental results: Due to major machine problems 2 days of beamtime were lost and no experiments could be performed.

Conclusion: The experiment should be repeated, possibly in the ID15 port-hutch.

(2) BM5: Test of analyzing, focusing multilayer optics

Motivation: The definition of a local scattering volume in a bulk sample by focusing optics instead of slits behind the sample should provide the following advantages: intensity gain by larger aperture, better spatial resolution, remedy of systematic errors occurring in strain measurements and simultaneous data acquisition.

Expected results: The expected advantages of this novel technique should be experimentally verified. In particular, the influence of aberrations on the imaging properties of the multilayer should be characterized.

Experimental results: The experimental details will be published within the next months. The technique was validated using a bent, laterally graded, periodic multilayer as the focusing analyser element. The incoming beam was monochromatized - at 30 keV - and focused to a 15 μm spot size by means of a bent Laue crystal. The resulting depth profile from the (222) reflection of a 21 μm thick rolled Au foil had a width of 41 μm. The depth resolution, magnification and reflectivity as function of energy band width was found to be well matched by theory. The successful experiment became possible by a close cooperation with the optics group and an extension of the beamtime by two days from the BM5 in-house beamtime.

Conclusion: The concept of diffraction studies in millimeter thick powder samples with a depth resolution of 10 μm seems within reach. The focusing, analyzing multilayer optics will be implemented at the instrument of the new ID11 extension hutch.