Optics for high resolution imaging

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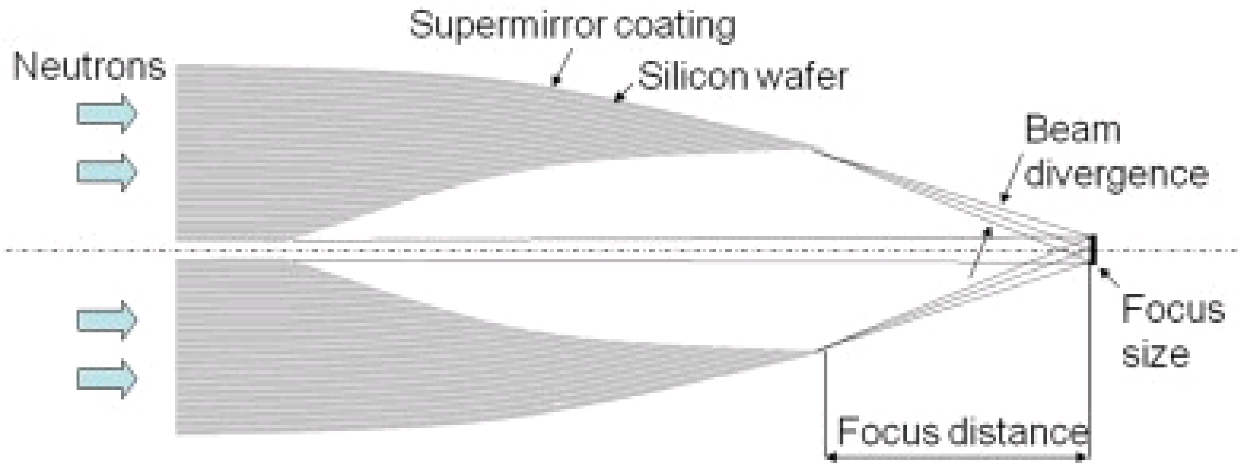
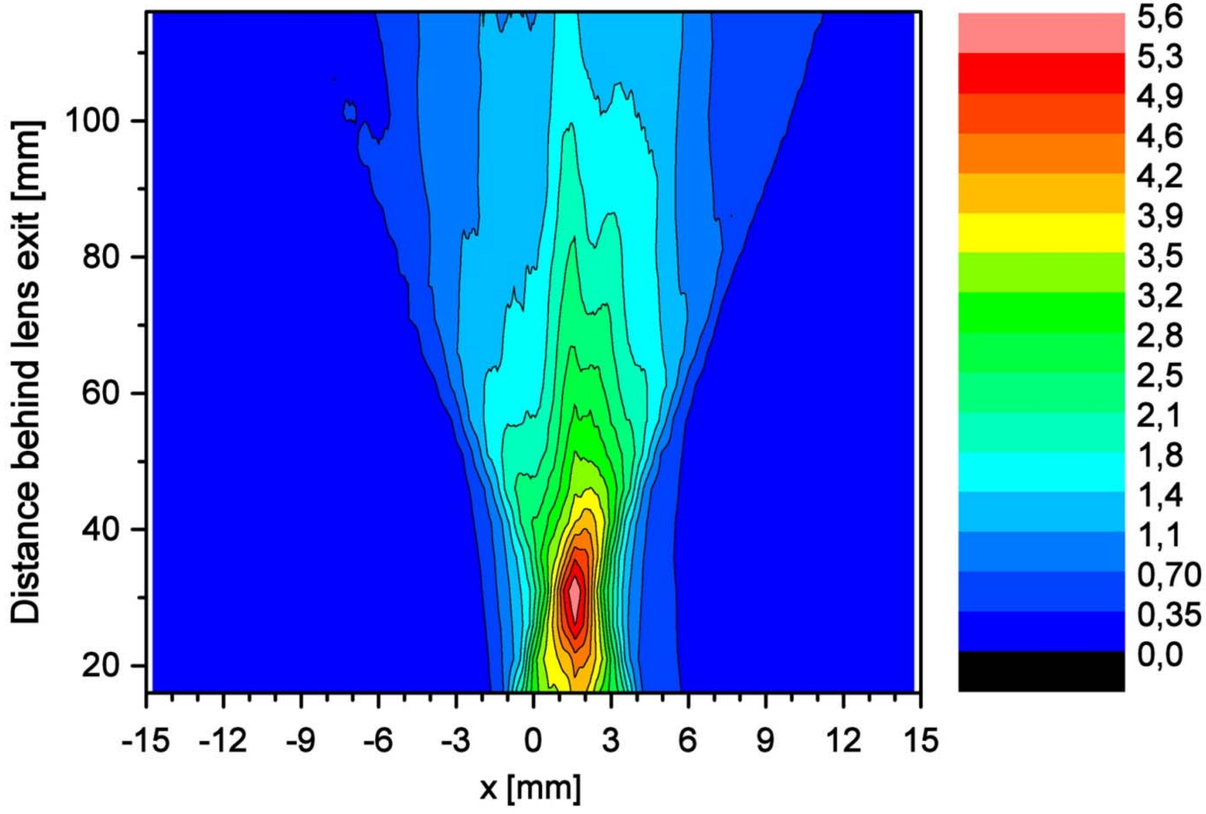
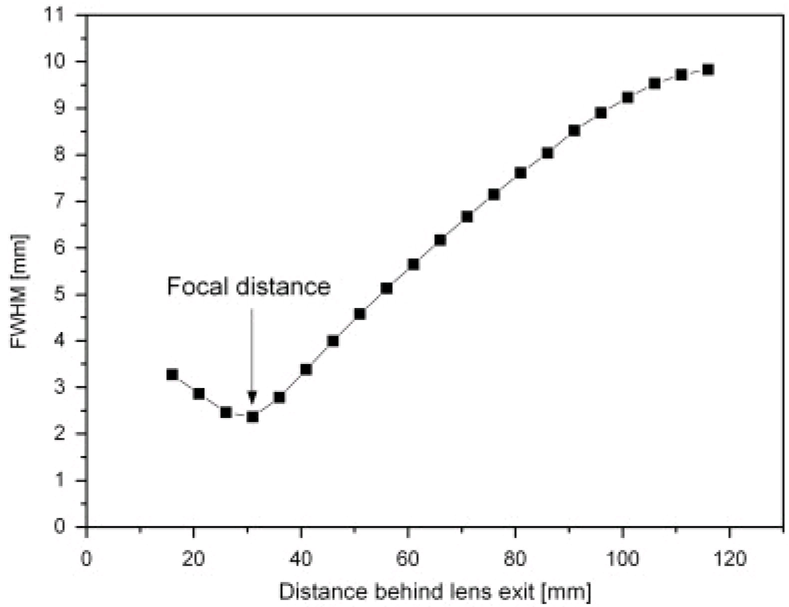
The tests of focusing elliptic guide have shown intensity inhomogeneities (dark stripes) in the cone beam imaging geometry. Therefore other neutron optic components were realised for beam focusing in case of neutron imaging.



Such focusing lenses can be used for imaging purposes where i) cone beam geometry is used or ii) high-flux density in the focal point is used for high-spatial resolution experiments.

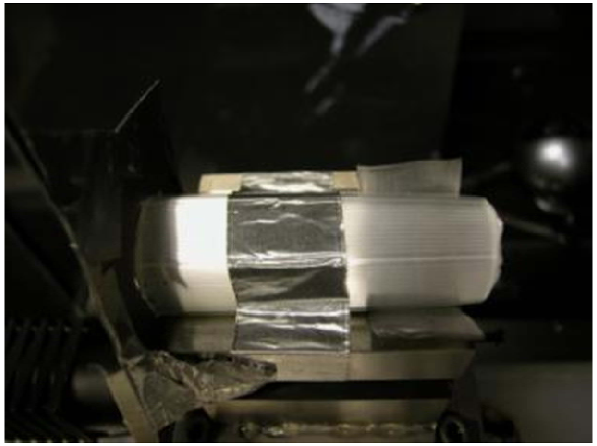
•**Test of solid state lenses was performed at the neutron imaging instrument CONRAD at HZB. The figure shows the neutron intensity behind the end of the lens, with the focus at 36mm.**

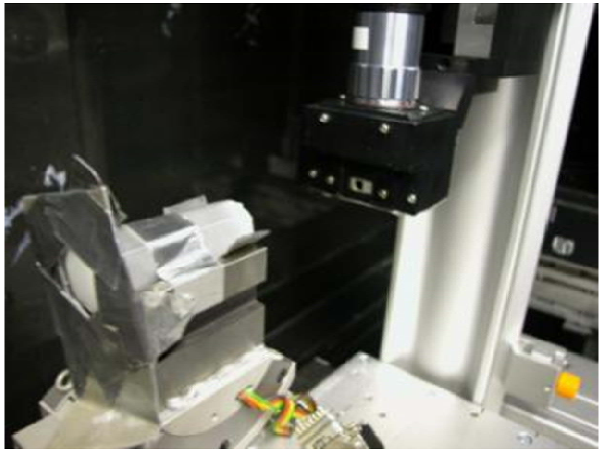


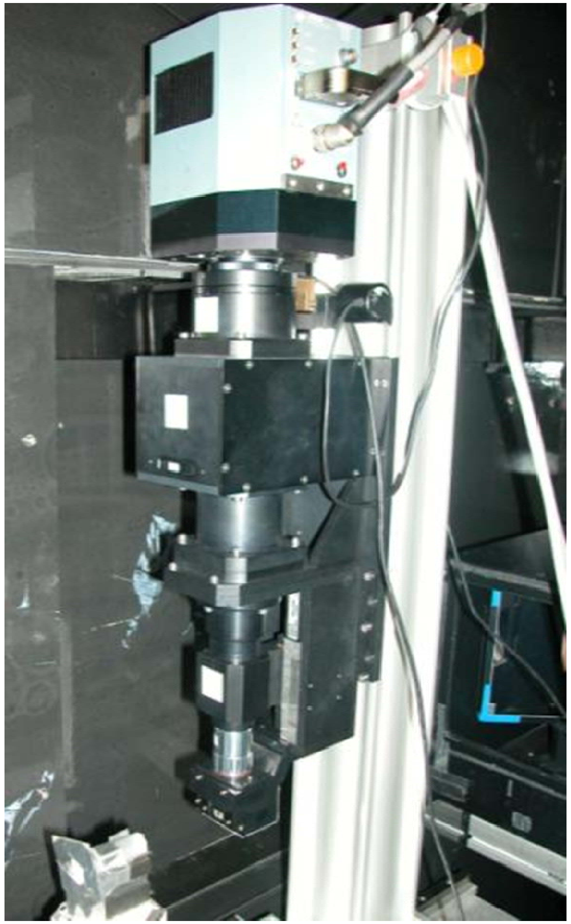


FWHM of the neutron intensity perpendicular to the beam direction in dependence of the distance from the end of the lens.

A full scale setup for high resolution imaging was realized with the help of high resolution detector (provided by ESRF) and a neutron Kumakhov lens. If the pixel size of the detector has an area of 1 x 1 µm^2 then at a standard imaging beam line with a flux of 10^7 n/cm^{2}s at the sample position the time which needed in order to detect one neutron will be 10s. Additionally the field-of-view of such high-resolution detectors is very limited.
Standard detectors have approximately 2000 x 2000 pixels which provides 2 mm x 2 mm field-of-view with a pixels size of 1 µm. The state of the art at the existing imaging facilities is a beam size of 20 cm x 20 cm which is a very ineffective geometry in case of micro imaging experiments. The utilization of neutron optical devices (e.g. Kumakhov lens) for focusing can solve this problem.
Experiments were performed at the neutron imaging beam line CONRAD at HZB, see Fig. 1.
This way the high resolution setup can be used for investigation of flat samples in a close distance to the scintillator.







High-resolution neutron imaging setup. A Kumakhov lens is used to focus the beam at the scintillator screen. High resolution detector based on light microscope magnifies the image from the scintillator on the CCD chip providing effective pixel size of 2 µm. The setup was equipped with a GGG scintillator screen.

A new high resolution neutron imaging detectors was designed which requires a high flux density.

A focusing device based on Kumakhov-type lenses was used which focuses a cross-section of 2 cm into a diameter of less than 1mm provided a flux gain of 20x which was essential for the application of a high resolution detector with a pixel size of 2 µm. In this way realistic exposure times of several minutes were achieved.