Miniaturized X-ray zoom lens

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X-ray optics with variable focal length are now limited to two main systems: mirror optics with adjustable radii of curvature [1] and refractive systems, in which individual lens elements or groups of lens elements are driven out of the beam path by pneumatic actuators (transfocator) [2] or two stepper motors driving a switching claw along a leadscrew (F-Switch) [3]. Mirror optics with a tuneable working distance are complex and difficult to adjust. Both types of systems normally have focal lengths in the range of meters. All these devices with changeable focal length are typically used for beam conditioning only.
KIT/IMT presents a new X-ray zoom lens for imaging based on Compound Refractive X-ray Lenses (CRLs) made out of SU-8 negative photoresist by deep X-ray lithography [4]. The zoom lens has a construction space of about one litre and uses piezo actuators to move individual lens elements in and out of the beam. As a first benefit, installing this zoom lens in different experiment setups is very easy due to its compactness. Secondly, remote-controlled adjusting of the focal length needs only tens of milliseconds to adapt the CRL to changed photon energy or sample distance or to choose another magnification ratio.
Additionally, if the same sample shall be examined with different energies in the same setup, the software of the zoom lens controller will calculate the necessary focal length and the best lens configuration will be set automatically. The zoom lens can be configured for line or point focus, or even astigmatic to compensate for asymmetrical source dimensions, forming a more round focal spot on a sample. At ESRF ID01 focal spot sizes of $\sigma = 0.45$ µm were measured at two energies with a first prototype of this X-ray zoom lens. We will present concept and set-up of the zoom lens, its fabrication, first results from experiments done at PETRA III and at ESRF.

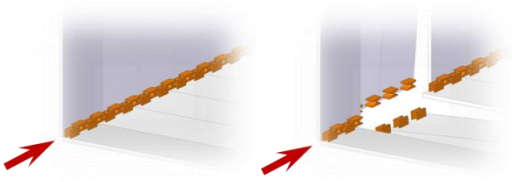

Fig. 1: Principle of an X-ray zoom lens made out of SU-8 CRLs from KIT/IMT.

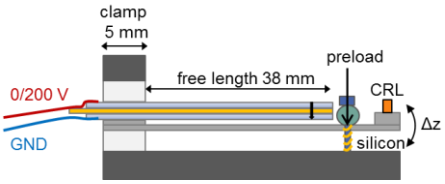

Fig. 2: Actuation principle of an X-ray zoom lens with piezo bender actuator on silicon bending stripes holding the CRL elements.

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