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Versatile X-ray Microscopy Endstation for the XUV Beamline P04 at PETRA III

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The synchrotron radiation facility PETRA III at DESY accomodates one beamline (P04) for soft x-rays, covering the photon energy range 200 –3000 eV and offering exceptionally high flux, high spectral resolving power (104) and variable polarization. It is thus perfectly suited for soft x-ray microscopy, but has to serve other applications as well.

We developed and implemented a versatile x-ray microscopy endstation for P04, based on a modular vacuum system with especially designed high precision piezo stages for fast movements, long travel ranges and nm accuracy. The modular design allows for setting up different image acquisition modes, such as full field, stxm, fluorescence; some in addition with temporal resolution or 3d-imaging.

The microscopy endstation is designed in a way that it can be set up from the blank platform placed at the beamline to full x-ray microscope operation within a few hours and disassembled in even shorter time scales, which is necessary because P04 operates in a mode that needs endstations to be exchanged on a weekly basis, depending on the users application. Thus, the versatile endstation is an "x-ray microscope on demand", showing nevertheless the full performance needed for high resolution x-ray imaging.

Imaging tests were carried out in full-field mode with photon energies between 500 and 1000 eV, demonstrating that P04 equipped with the versatile endstation can be a state-of-the-art x-ray microscopy beamline. Exposure times are short (down to 0.1 s) and the object field is –due to the installed DOE condenser –homogeneously illuminated. The high flux at P04 allows for achieving very good SNR in reasonable acquisition times.

As first application XMCD microscopy experiments with high temporal resolution were performed, employing a magnetic pulser close to the sample plane and an especially designed gateable image detector, both developed by the CUI at Hamburg University. Changes of the magnetization in microscopic samples could be traced with temporal resolution < 250 ps and spatial resolution < 65 nm at photon energies around 700 –800 eV. The high photon flux delivered at P04 enabled good SNR and very high XMCD image contrast in relatively short acquisition times.

In addition, first images of interesting samples for biomedical research –for investigations of transendothelial transport mechanisms –and of specific clay minerals, in this case with spectroscopic contrast (element mapping) –for ceramic material research –have been taken with the full-field setup of the versatile x-ray microscopy endstation at P04.

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