Beamline Jockey Days - Challenges in Imaging



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Phase-contrast X-ray microscopy and tomography on EMBL beamline P14 at PETRA III

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EMBL Hamburg operates the P14 beamline at the high-brilliance PETRA III storage ring at DESY. Delivering hard X-rays (6 –30 keV), P14 is very versatile: shape, size and intensity of the X-ray beam are easily tunable by using both reflective and refractive optical elements. Sample stage and detecting systems are state-of-the-art including a high-precision vertical goniometer (developed in collaboration with EMBL Grenoble and ARINAX, a robotized sample changer (developed in-house) and a DECTRIS (Baden, Switzerland) EIGER 16M detector. These features enable crystallography of large macromolecular complexes, serial crystallography, time-resolved and in-situ diffraction data collection.

Exploiting the flexibility of the beamline optics, we are investigating new methods and techniques to look into samples of interest via full-field phase-contrast X-ray imaging and microscopy. Unlike conventional absorption X-ray imaging, phase contrast makes interfaces and density gradients clearly visible in a biological sample. To achieve higher resolution and to see fine structure, we also implement X-ray refractive lenses as an objective in the microscopy mode. This approach allows us to magnify details of the sample up to 15 times prior to the optical detection of X-rays that carry the phase-contrast information from the interaction with sample. With the current setup, a sub-100nm resolution can be achieved and it is possible to visualize crystal boundaries and their local deformations in situ. High-precision rotation of the sample stage at P14 also allows to perform X-ray tomography. Due to the use of high-energy X-rays for the imaging process, materials and tissues with thicknesses in the mm-range can be penetrated. The latter also allows P14 to look forward for time-resolved experimental applications with other biological objects.

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