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Live 3D-Reconstruction of X-Ray Tomographic Data

3D-Tomographic imaging using Synchrotron / X-Ray radiation in the 10 keV photon energy regime is a powerful technique to investigate bio-medical samples of 1 to 5 mm sizes at sub-μm voxel sizes. We present our recent implementations of both an offline Python-pipeline for phase retrieval and 3D reconstruction as well as online (live) FPGA-based reconstruction and immediate feedback to steer the experiment.

The Göttingen Instrument for Nano-Imaging with X-rays (GINIX) as a 3D X-Ray microscope can be operated in two modes: Making use of the intense and large parallel beam of the PETRA III synchrotron, overview 3D-data with a field of view of ~1.5 mm can be acquired within two minutes. Switching to the waveguide filtered cone-beam geometry, GINIX can routinely measure at voxel sizes below 200 nm.

In the parallel beam geometry, about 30 GiB worth of holographic projections need to be pre-processed (phase-retrieval and 3D reconstruction) at (currently) up to 50 frames per second. We show that modern FPGA (field-programmable gate-arrys) can be exploited to facilitate massively parallel processing of such data. Here, we emphasize on reconstruction latency and pipeline-throughput with approximative algorithms.
The cone-beam modality, however, employs a deeply holographic imaging regime demanding for iterative phase reconstruction algorithms. Also geometrical parameters such as rotation axis alignment and physical models beyond single-material approximation are implemented in our Python based HoToPy toolbox.

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