Contribution ID: **63** Type: **not specified**

# What is a HoToPy? A holo- and tomographic toolbox for X-ray imaging in Python

The ability of X-rays to penetrate through matter and non-destructively reveal its inner structure makes it an integral tool for a wide range of applications. From the medical study of brain tumors, analysis of crack formation in catalytic particles, to capturing of cavitation dynamics using X-ray free electron lasers, X-ray phase contrast imaging is a key element. The request for high spatial resolution, at large field of views and high throughput scanning on the one side; fast evolving instrumental capabilities (fourth-generations synchrotrons, availability of XFELs, larger detectors) and new paradigms in image analysis fueled by machine learning on the other, demand reconstruction software and pipelines to keep up.

To this end, we develop *HoToPy*, a holographic and tomographic X-ray imaging toolbox in Python. Here, we implement well-established reconstruction algorithms with strong GPU acceleration as well as novel algorithms. By combining state-of-the-art numerical optimization methods, automatic differentiation and GPU support, we offer a modern reconstruction framework that is flexible, robust and yet fast. HoToPy currently is focused on holo-tomography on synchrotron or laboratory sources. The implemented reconstruction routines are accompanied by a collection of tools for data pre-processing, alignment as well as simulation methods.

At present, HoToPy is rapidly evolving. Here, we like to showcase its current state and outline future directions. We demonstrate HoToPy on experimental data taken on the Göttinger instrument for nano-imaging with X-rays (GINIX) operated by the Salditt group located at the P10 beamline of the PETRA III storage ring at DESY in Hamburg.

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**Session Classification:** Poster Session & Fingerfood