NXtomomill: more than just a data conversion tool

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The ESRF tomography software is undergoing a complete re-write, targeted at unifying the tomography user experience, acquisition, data format, and processing tools.

NXtomomill plays a key role in managing the large complexity of the data coming from multiple beamlines, techniques and facilities, by offering advanced data conversion, manipulation and reduction functions. This has a remarkable impact on resource management, software robustness, and data storage. It also unlocks unimagined opportunities with respect to the automation of AI techniques on large and heterogeneous collections of datasets.

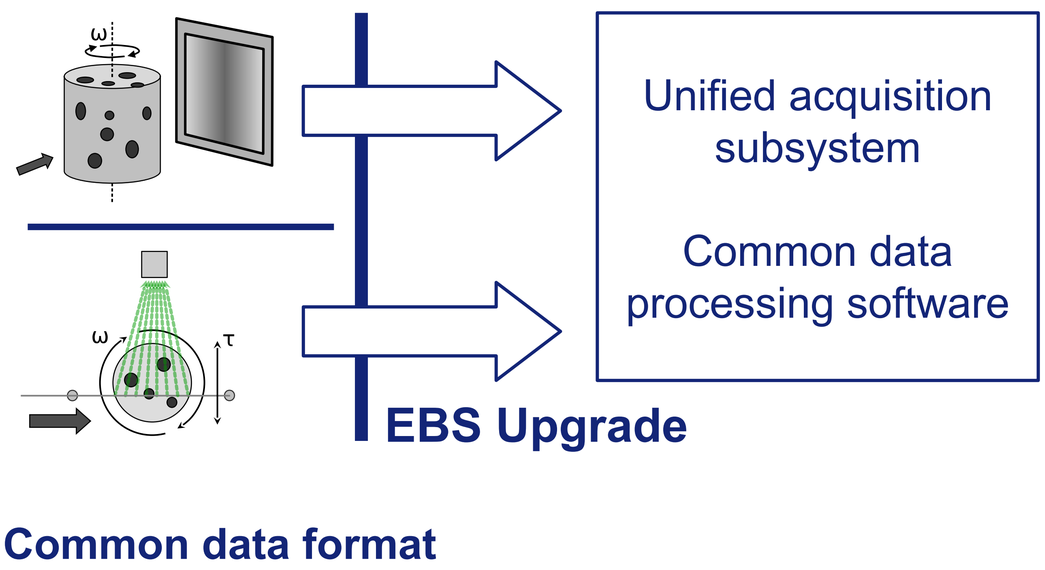
Introduction

The ESRF (European Synchrotron) hosts several tomography beamlines, which use different types of contrast and offer vastly different resolutions and performance. Their acquisition and processing software are exceedingly fragmented. There exist many different codes and solutions for similar problems. This hinders the exchange and processing of data collected on different beamlines, while its associated maintenance / development costs hindered its progress.

Unified acquisition & processing

We are rebuilding acquisition and processing workflows from scratch, with unified solutions whenever possible, to deliver both a homogeneous experience across all ESRF beamlines, and robust high-performance processing software [1]. This means a unified acquisition solution for all tomography scans, ranging from full-field X-ray phase-contrast, to pencil-beam X-ray Fluorescence and X-ray Diffraction CT.

Due to the specificity of the different beamlines and techniques: (a) the acquisition data format might still differ; (b) the data itself might require specific pre-processing, before reconstruction.

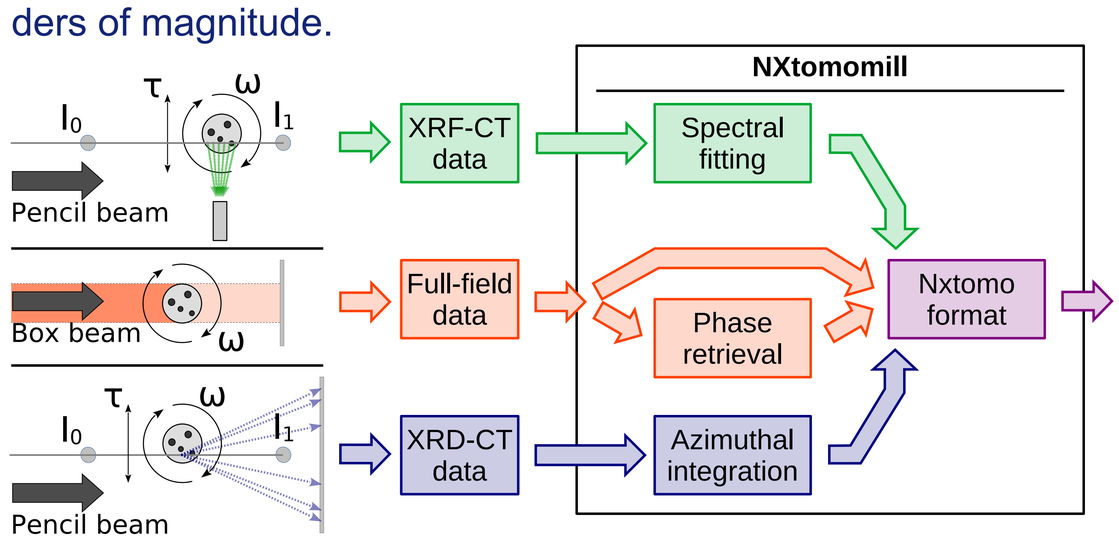


Common data format

We are solving points (a) and (b) with a common data format and versatile conversion software for all X-ray tomography techniques and beamlines. NXtomo (from the NeXus international standard [2]) is our choice for a common tomographic data format. NXtomomill is an open source software package, developed at the ESRF, for the transformation of all the required raw tomographic data into NXtomo compliant form [3].

Inter-technique and inter-facility

Full-field data can be rearranged from several input data formats. This includes traditional ESRF's EDF full-field datasets, and APS' DataExchange [4]. In the future, it will support advanced phase retrieval methods (e.g. for holotomography), through a plug-in that uses specialized external software. Similarly, NXtomomill is currently receiving support for azimuthal integration of XRD-CT scans and elemental fitting of XRF-CT scans. This process typically reduces data sizes by three orders of magnitude.



Highlights

NXtomomill guarantees an identical output data format for each ingested raw data format and data type. It decouples data handling from data reconstruction, resulting in uniform user experience, easier development, reduced maintenance costs, and greater robustness of the tomography processing pipeline. This also supports easier data and software exchanges with other synchrotron radiation facilities.

The ESRF data portal will allow browsing multitudes of related datasets [5]. When coupled with a common and informative data format, it will render the automatic training of AI / deep-learning methods a trivial process. Those methods will benefit from large and heterogeneous collections of datasets, producing similar outcome and impact of ImageNet [6].

References

[1] N. Viganò, *et al.*, doi: 10.1364/DH.2021.DF2G.4
[2] M. Könnecke, *et al.*, doi: 10.1107/S1600576714027575
[3] https://gitlab.esrf.fr/tomotools/nxtomomill
[4] https://github.com/data-exchange/dxchange
[5] R. Dimper, *et al.*, doi: 10.5281/zenodo.5155787
[6] J. Deng, *et al.*, doi: 10.1109/CVPR.2009.5206848

Nxtomomill is part of a software ecosystem, developed in the context of the **tomo-bridge** [1]. The tomo-bridge is in charge of defining the development and strategic directions of the ESRF tomographic software (for both acquisition and processing). It relies on the work and competence of the supporting groups in the EXPD and ISDD: BCU, DAU, and ADA.

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