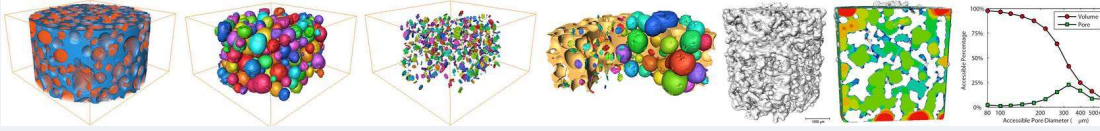# XCT: Image Reconstruction Frameworks Software Working Together

CCPi Core Imaging Library (CIL)

M. Turner[1,2], E. Pasca[1], J. Jorgensen[2], D. Kazantsev[2], M. Hanwell[3], P. Withers[2], B. Lionheart[2], E. Ovtchinnikov[1], R. Fowler[1], S. Nagella[1]

[1] Science and Technology Facilities Council (UKRI); [2] University of Manchester; [3] Kitware, Inc.

On behalf of CCPi and Tomviz

Core Imaging Library CCPi: UK Software Aims

CIL *Framework* for 3D and 4D reconstruction of CT data is a set of modules for each process involved in the data analysis workflow. This is part of the Collaborative Computational Project in Tomographic Imaging for the UK tomography community (over 370 registered).

Starting from the preparing the dataset for reconstruction which involves applying filters to remove the noise and beam hardening to correct the datasets etc to quantifying the segmented volume. The motivation for creating this library is to provide the CT imaging community with set of tools that is easily accessible and can be integrated into existing workflows such as SAVU and potentially Tomviz. The algorithms are contributed by the community and the core CCPi staff have reengineered the code to make them run faster, easily accessible and maintainable.

http://www.ccpi.ac.uk

Kitware Inc. Tomviz: USA Software Aims

Tomviz *Framework* in the USA by Kitware Inc. carries out three-dimensional characterization of materials at the nano- and meso-scale using transmission and scanning transmission electron microscopes (S/TEM) data.
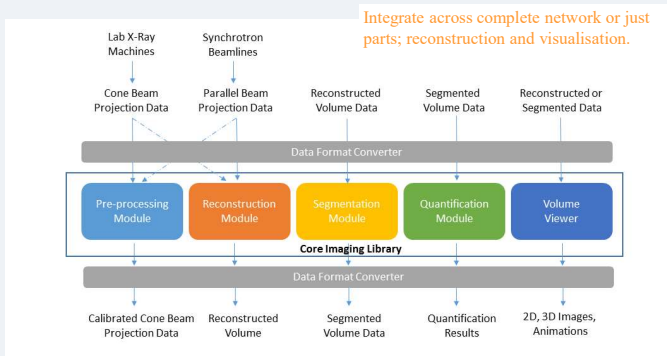
https://tomviz.org/

Proposal for Tomviz is to incorporate Xray CT data set within the framework so a potential to merge the UK / USA Research Software Engineering experience, best-practice, code and examples.
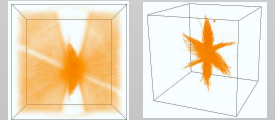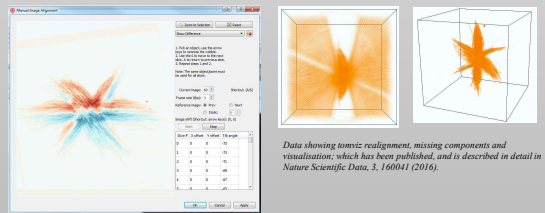
Data showing tomviz realignment, missing components and visualisation; which has been published, and is described in detail in Nature Scientific Data, 3, 160041 (2016).

- *Open Source* 3-clause BSD and Apache 2.0 License – to be accepted / combined
- *Easy installation* via scripts, handholding,… – to be automated
- *Python framework* – to be rewritten for CIL and cross-linked across libraries
  http://cil.readthedocs.io/en/latest/ https://www.ccpi.ac.uk/CIL
- *Link to Flagship RSE code:* Multichannel Iterative Reconstruction – to be included
  Daniil Kazantsev et al. "Joint image reconstruction method with correlative multi-channel prior for X-ray spectral computed tomography" Inverse Problems http://iopscience.iop.org/10.1088/1361-6420/aaba86 2018

Example possible case studies and integration points for future work:

Integrate across complete network or just parts; reconstruction and visualisation.

Integrate across pre- and post- processing stages

Example of beam hardening artefacts in (a) a homogenous object; aluminium and (b) heterogeneous object; natural lava exhibiting a number of crystal phases with different densities. Cupping is illustrated by an X direction profile across the aluminium block (aii), whereas the influence is cryptic in the lava (bi), yet can be observed to imparts errors when relating chemical zonation to image brightness (bii).
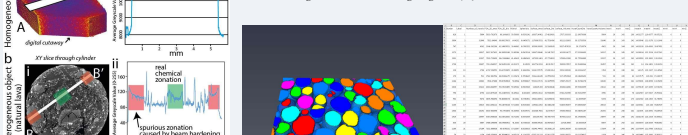
Example evaluation of 3D bioactive glass scaffolds dissolution in a perfusion flow system with X-ray microtomography. Yue S, Lee PD, Poologasundarampillai G, Jones JR. DOI: 10.1016/j.actbio.2011.02.009

Example test datasets for demonstration: Sophia beads dataset 64 projections. Reconstructed using CGLS algorithm in CIL. Code and data at multiple resolutions in zenodo.
- SophiaBeads Dataset Project Codes (DOI): https://zenodo.org/record/16539
- SparseBeads paper is published in Measurement Science and Technology's Special Feature on Advanced X-ray Tomography: https://doi.org/10.1088/1361-6501/aa8c29 https://doi.org/10.1088/1361-650 https://zenodo.org/record/290117 https://zenodo.org/record/290117 and code on Github:
https://github.com/jakobsj/SparseBeads_code

USA-UK week-long visit in September 2018 – between RSEs

Installation of software and coder discussion at the University of Manchester; Daresbury Labs, STFC and Harwell Campus, STFC.

Tour of new tomography labs; i13 beamline at Diamond Light Source and IMAT beamline at ISIS (Neutron spallation and muon source).
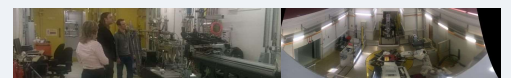
Want to know more? Contact martin.turner@manchester.ac.uk or edoardo.pasca@stfc.ac.uk