Lecture Title	**Make the best of your Synchrotron Tomography Experiment - 3D Image Analysis Crash Course**
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Abstract	The large volume of data produced by Synchrotron X-ray Computed Tomography (SXCT) experiments and the lack of open and reproducible data analysis procedures are common obstacles that hinder the widespread and efficient use of SXCT. This lecture aims at providing basic knowledge and guidelines for the visualization and processing of SXCT. Protocols guiding prospective users in the manipulation and analysis of 3D images will be presented. The lecture will introduce in a practical way the visualization and manipulation of synchrotron Computed Tomography (CT) images. Open source and commercial software for the analysis of 3D datasets will be presented. Techniques for the characterization of the internal microstructure of cultural heritage specimens will be showcased and discussed. Participants are highly encouraged to install 3D image processing software before the lecture and take active part in the course.
Learning Objectives	Basic 3D image processing know-how is developed. Participants are expected to learn how to: • Load and display micro-CT datasets • 3D volume rendering and window levelling • 3D image manipulation and filtering • Basic segmentation techniques • Quantitative analysis of the specimen porosity and internal constituents
Keywords	X-ray imaging; computed tomography; image processing; signal processing; volume rendering;
Target audience	Micro-CT users (prospective, beginner and expert)
Language	English
Contents	1. Overview of 3D image analysis software 2. Load and inspect large 3D datasets 3. Image manipulation: crop; rescale; transform 4. Principles of computer vision: digital image representation; window levelling and 3D rendering 5. Useful filters: image smoothing; edge detection 6. Image segmentation techniques 7. Working with binary masks: morphological operators 8. Porosity, thickness and particle analysis
Prerequisites	A computer or laptop with ImageJ installed. The installation of Dragonfly is highly recommended.
References	1) Maire, E., & Withers, P. J. (2014). Quantitative X-ray tomography. International Materials Re-views, 59(1), 1–43. https://doi.org/10.1179/1743280413Y.0000000023 2) Rawson, S. D., Maksimcuka, J., Withers, P. J., & Cartmell, S. H. (2020). X-ray computed tomog-raphy in life sciences. BMC Biology, 18(1), 21. https://doi.org/10.1186/s12915-020-0753-2 3) Withers, P. J., Bouman, C., Carmignato, S., Cnudde, V., Grimaldi, D., Hagen, C. K., Maire, E., Manley, M., Du Plessis, A., & Stock, S. R. (2021). X-ray computed tomography. Nature Reviews Methods Primers, 1(1), Article 1. https://doi.org/10.1038/s43586-021-00015-4

3D image processing software

name	URL	features	open source	license type
ImageJ	https://fiji.sc/	Image analysis for everyone	yes	
Dragonfly	https://www.theobjects.com/dragonfly/index.html		no	Academic; single user
BONEJ	https://bonej.org/	ImageJ plugin	yes	
Paraview	https://www.paraview.org/		yes	
3D Slicer	https://www.slicer.org/		yes	
napari	https://napari.org	Interactive Python viewer for multi-dimensional images	yes	
simpleITK	https://github.com/InsightSoftwareConsortium/SimpleITK-Notebooks	Python package for advanced 3D image processing	yes	
Silx	https://www.silx.org/	Explore RAW synchrotron experiment data	yes	