

<b>Lecture Title</b>	<b>Make the best of your Synchrotron Tomography Experiment - 3D Image Analysis Crash Course</b>
<b>Speaker</b>	<p>Dr.-Ing. Gianluca Iori</p> <p>Research Assistant in Advanced X-ray Imaging Institute for Biomedical Engineering ETH Zurich</p> <p>BEATS beamline scientist Synchrotron-light for Experimental Science and Applications in the Middle East</p>
<b>Abstract</b>	<p>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.</p>
<b>Learning Objectives</b>	<p>Basic 3D image processing know-how is developed. Participants are expected to learn how to:</p> <ul style="list-style-type: none"> <li>• Load and display micro-CT datasets</li> <li>• 3D volume rendering and window levelling</li> <li>• 3D image manipulation and filtering</li> <li>• Basic segmentation techniques</li> <li>• Quantitative analysis of the specimen porosity and internal constituents</li> </ul>
<b>Keywords</b>	X-ray imaging; computed tomography; image processing; signal processing; volume rendering;
<b>Target audience</b>	Micro-CT users (prospective, beginner and expert)
<b>Language</b>	English
<b>Duration</b>	2 hours
<b>Contents</b>	<ol style="list-style-type: none"> <li>1. Overview of 3D image analysis software</li> <li>2. Load and inspect large 3D datasets</li> <li>3. Image manipulation: crop; rescale; transform</li> <li>4. Principles of computer vision: digital image representation; window levelling and 3D rendering</li> <li>5. Useful filters: image smoothing; edge detection</li> <li>6. Image segmentation techniques</li> <li>7. Working with binary masks: morphological operators</li> <li>8. Porosity, thickness and particle analysis</li> </ol>
<b>Prerequisites</b>	A computer or laptop with ImageJ installed. The installation of Dragonfly is highly recommended.
<b>References</b>	<ol style="list-style-type: none"> <li>1) Maire, E., &amp; Withers, P. J. (2014). Quantitative X-ray tomography. International Materials Re-views, 59(1), 1–43. <a href="https://doi.org/10.1179/1743280413Y.0000000023">https://doi.org/10.1179/1743280413Y.0000000023</a></li> <li>2) Rawson, S. D., Maksimcuka, J., Withers, P. J., &amp; Cartmell, S. H. (2020). X-ray computed tomography in life sciences. BMC Biology, 18(1), 21. <a href="https://doi.org/10.1186/s12915-020-0753-2">https://doi.org/10.1186/s12915-020-0753-2</a></li> <li>3) Withers, P. J., Bouman, C., Carmignato, S., Cnudde, V., Grimaldi, D., Hagen, C. K., Maire, E., Manley, M., Du Plessis, A., &amp; Stock, S. R. (2021). X-ray computed tomography. Nature Reviews Methods Primers, 1(1), Article 1. <a href="https://doi.org/10.1038/s43586-021-00015-4">https://doi.org/10.1038/s43586-021-00015-4</a></li> </ol>

### 3D image processing software

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