X-RAY NANO-CT FOR PAINTED MICRO-SAMPLES

FROM PREPARATION TO PUBLICATION:

An interdisciplinary participative project

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INTRODUCTION Cultural heritage artefacts are historical treasures. During transportation and restoration, parts are removed or breaks. The resulting micro-samples are archived by the museums. The micro-samples are mostly less than 3 mm and ask for special care concerning their analyse. Laboratory high-resolution X-ray computed tomography (hCT) is non-destructive and allows detailed 3D inspections in a short time. The information extracted from the 3D dataset is of high interest for the conservation, restoration and comparison of techniques in the cultural heritage field. A huge amount of data are created every second. Their availability to the community and the need to interconnect them is an important part of scientific work. Our work focus on the development of a conservative methodology for the micro-samples from their preparation to their way back in the museums, their analysis and the availability of the results to the community.

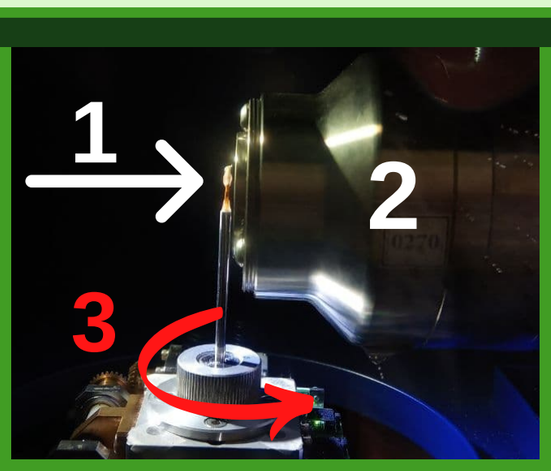
PREPARATION of the sample

Micro-sample of an easel painting. Fibres, preparatory and coloured layers are visible.

Holder designed to:

- Protect
- Stabilize
- Standardize
- Ease the preparation

MEASUREMENT

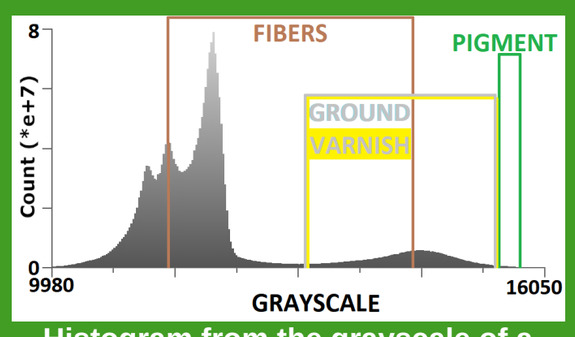


1. **X-ray goes through the sample**
2. **The detector records values according to material density and X-ray strength.**
3. **Slices recording from 360° around the sample**

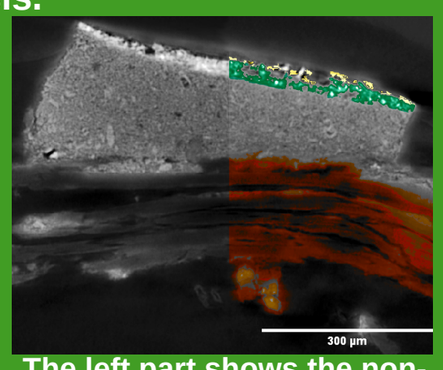
- **Laboratory-based hCT**
- **Non-destructive**
- **Non-invasive**
- **Micron to nanometer resolution**
- **Multi-material analysis**
- **Multi-dimensional**
- **Measurement in hours**
- **Easy access to the device**

SEGMENTATION

- **Separation of the dataset in different regions: Pores/Material.**
- **Affects strongly the later analysis.**



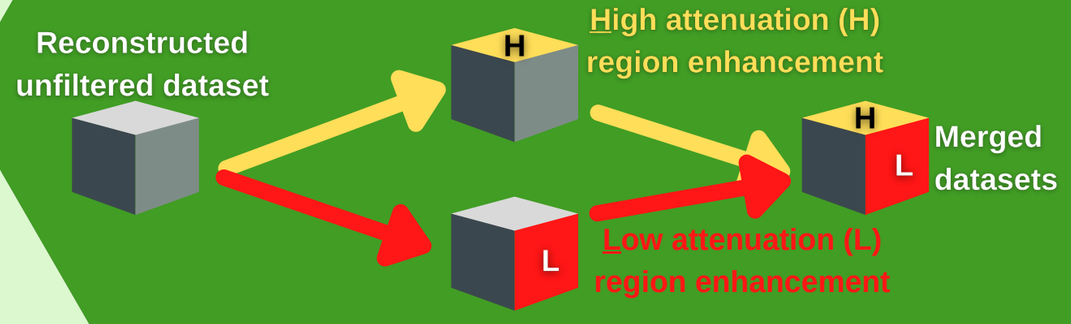
Histogram from the grayscale of a dataset with the various layers related to.



The left part shows the non-segmented data and the right side the segmentation based on the histogram.

POST-PROCESSING

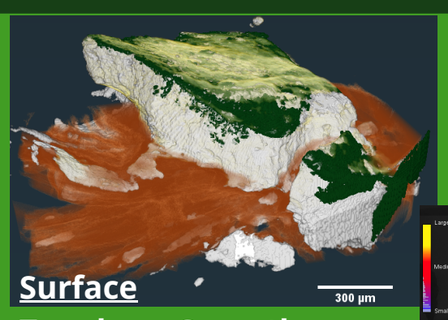
- **Reconstruction of the 3D volume based on the 2D slices**
- **Blurring, Edge enhancement, Filtering, Artefacts suppression**



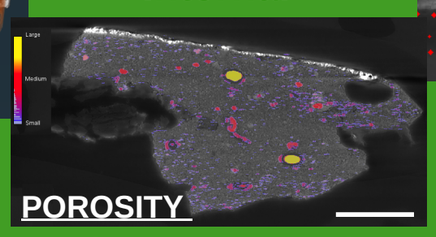
We extracted the H (painted layers) and L (fibres) regions, enhanced their visualization and recombined the datasets.

ANALYSIS

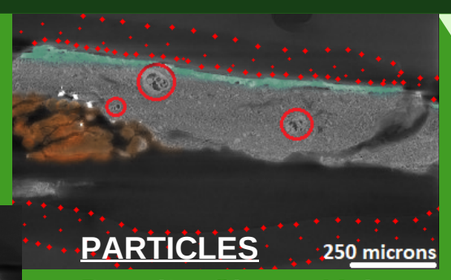
- **External**
- **Internal**



Topology, Smoothness, Strokes, Cavities, Layers relation, Thickness. | ***Brush/device type, Techniques, Layering, Loss of material.***



Cracks, Pores, Interstices. | ***Shrinkage, Soft/Hard material interface, Growth, Infiltration, Filling, Weaknesses.***



Density, Shape, Volume, Repartition, determination. | ***Organic and inorganic, Microfossils, Pigments, Fibers, Wood, Stone, Metal.***

DATA CORRELATION

Painting
Painter, Colours, Techniques, Materials, Period, Creation place, Material provenance

X-ray Nano CT
Material, Techniques, Provenance, Conservation and restoration problematic

Other Analysis
Non-destructive: Optical microscopy, Confocal microscopy
Semi-destructive or invasive: SEM, RAMAN, FTIR
Destructive: TEM, GC-MS

Painter or Painting school
Birth, Death, Travels, Technique, Materials, Specificities, Mecene

Jaques V., Zemek M., Šalplachta J., Zikmund T., Ožvoldík D., and Kaiser J. "X-ray high resolution computed tomography for cultural heritage material micro-inspection", Proc. SPIE (2021); doi:**10.1117/12.2592310**

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TAKE PART!

Fill in some forms about painters, artworks or methods:

www.db-art.zd.lu

We thanks CzechNanoLab Research Infrastructure supported by MEYS CR (LM2018110) for the infrastructure and Quentin Arguillère for the precious artworks samples.

CONCLUSION The increasing use of hCT asks for more standardization and clear preservation rules. We address this issue in our work and continually try to improve it. With the development of a stable and preservative preparation method, the search for dedicated measurement and post-processing parameters offers a precise reconstructed sample and more visibility for each particle and material.
The 3D volume can be used by the scientists for the scientists or for the public understanding, which asks for publicly available data.