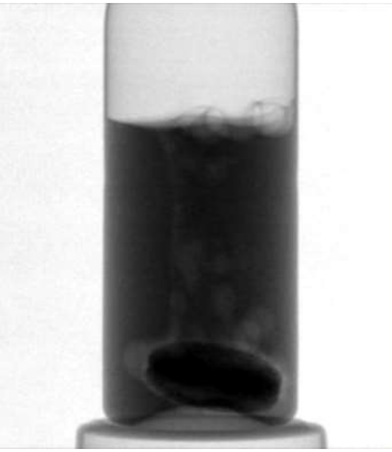
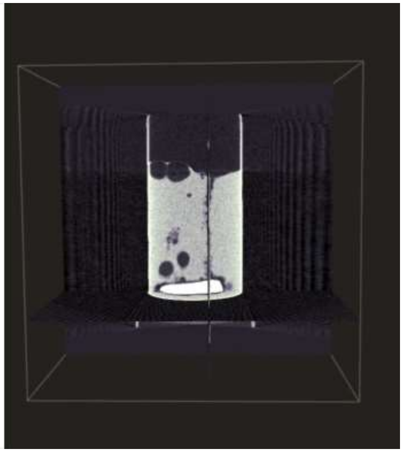
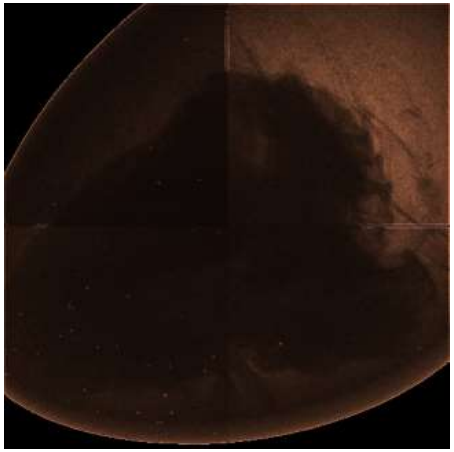
The FleX-ray Lab: Past, Present and Future

Tristan van Leeuwen, Felix Lucka & Martin Fransen


X-ray Computed Tomography (CT)

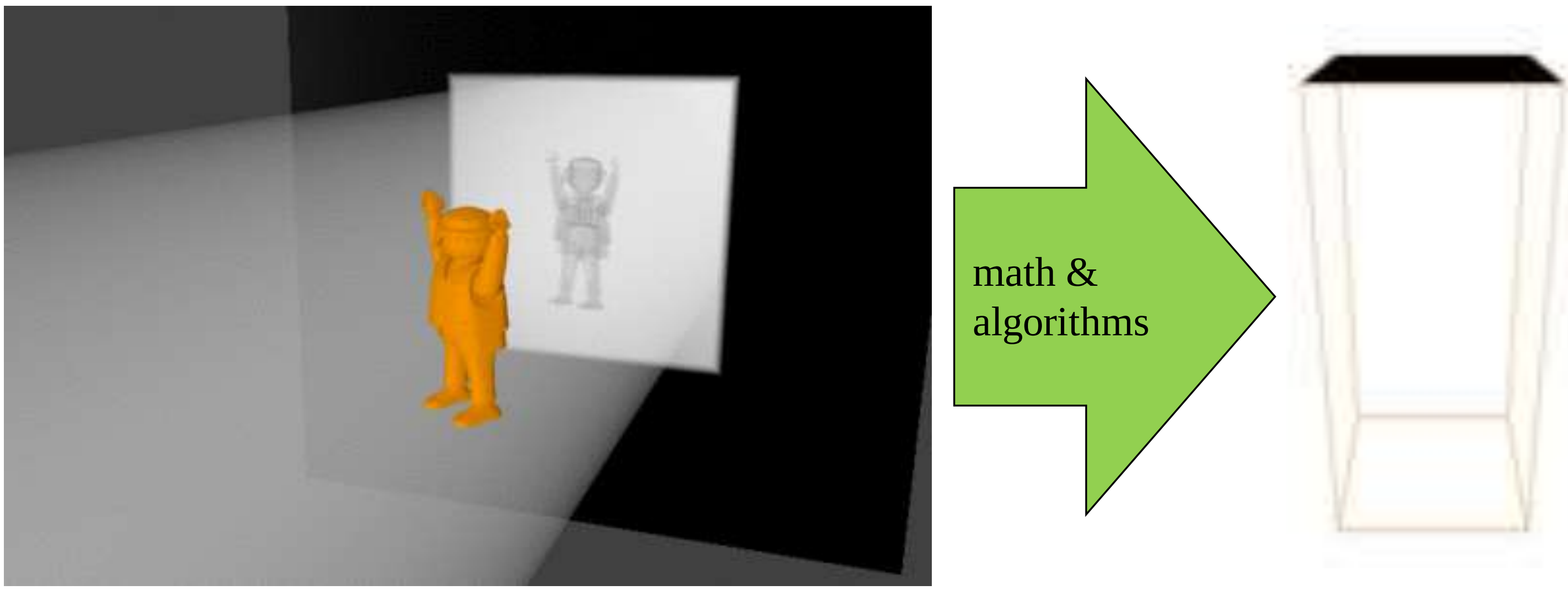
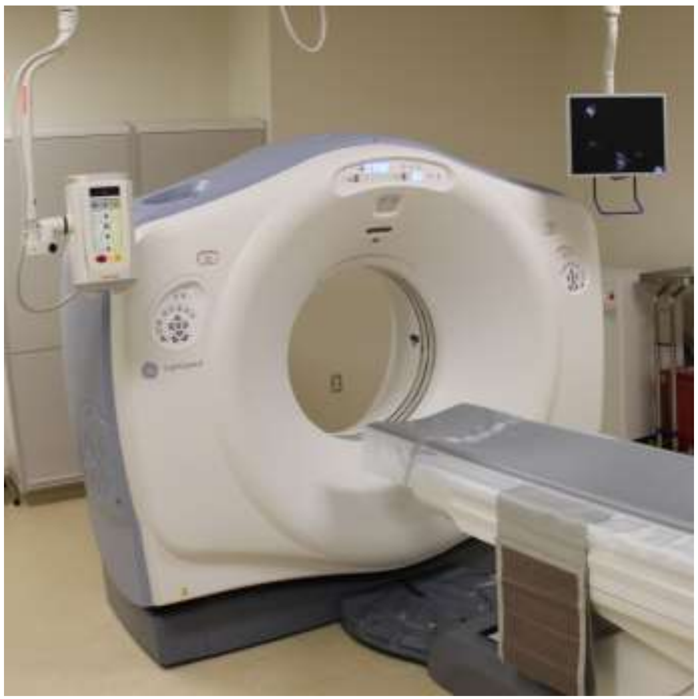
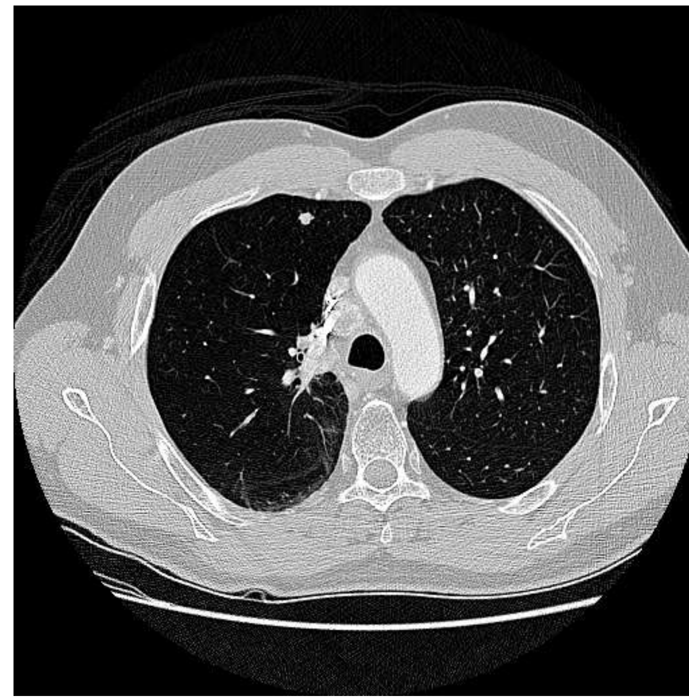


Image credit: Daniël Pelt and University of Antwerp

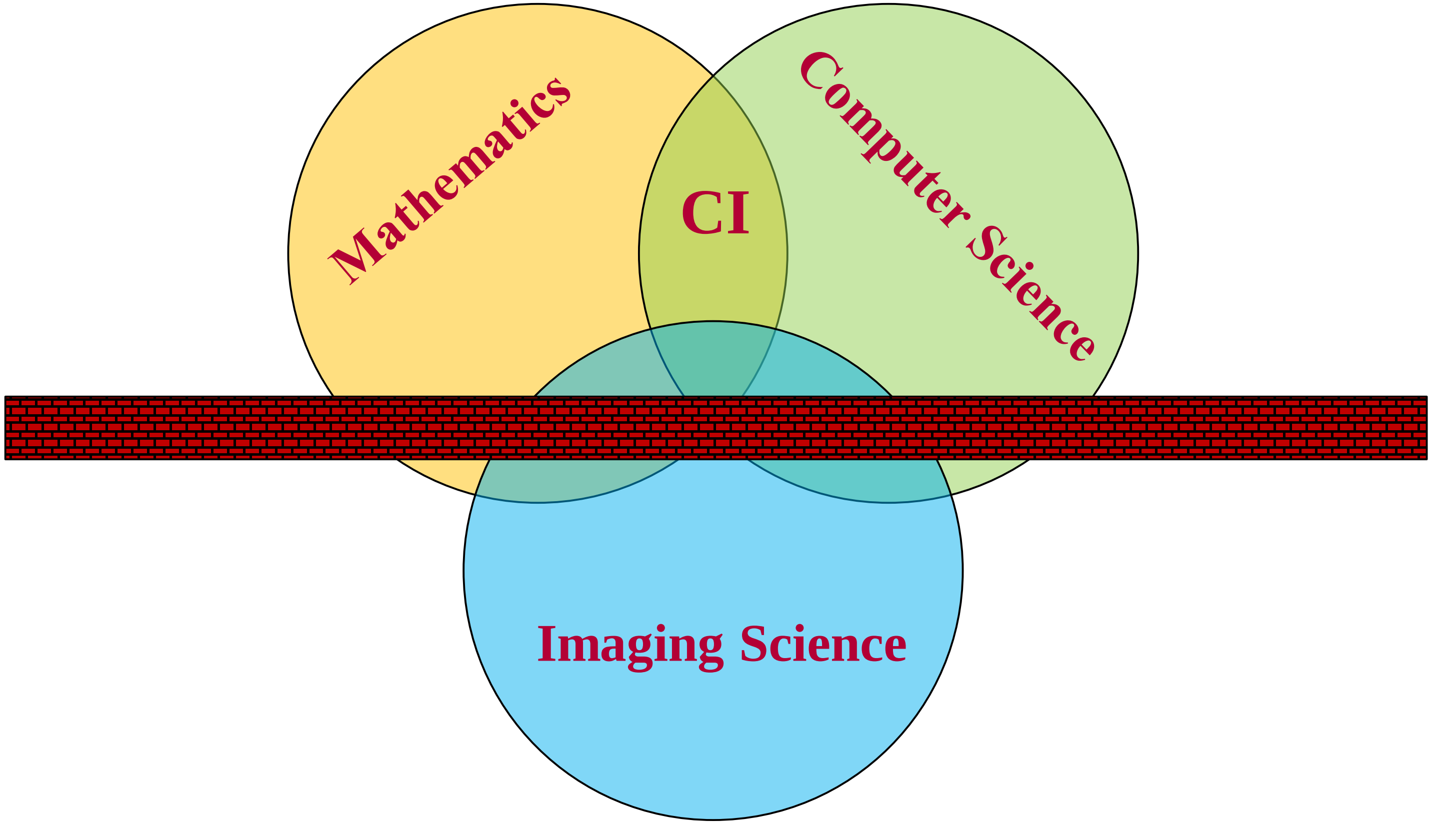
Medical X-ray CT



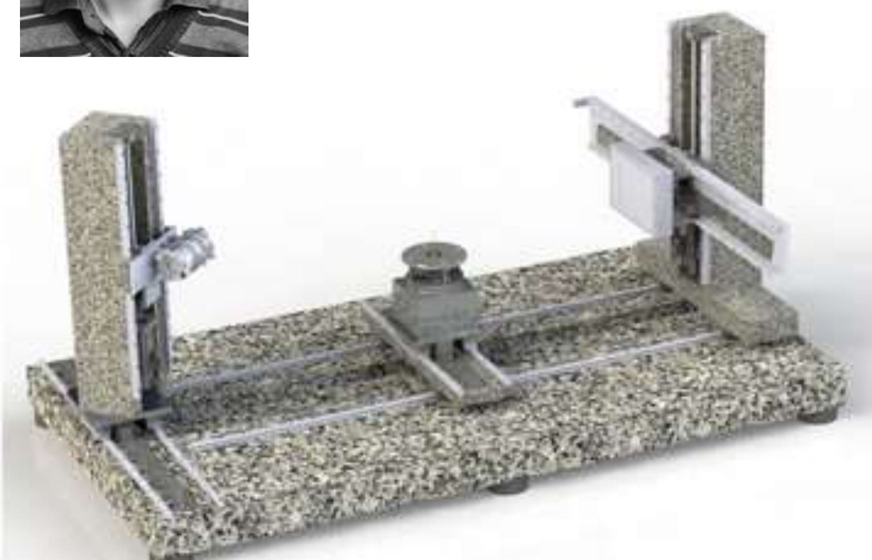
math &
algorithms

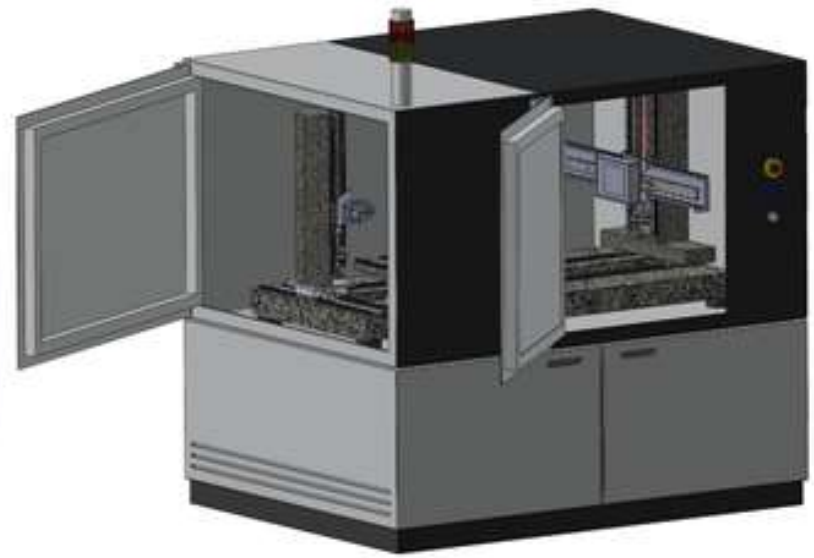


Computational Imaging



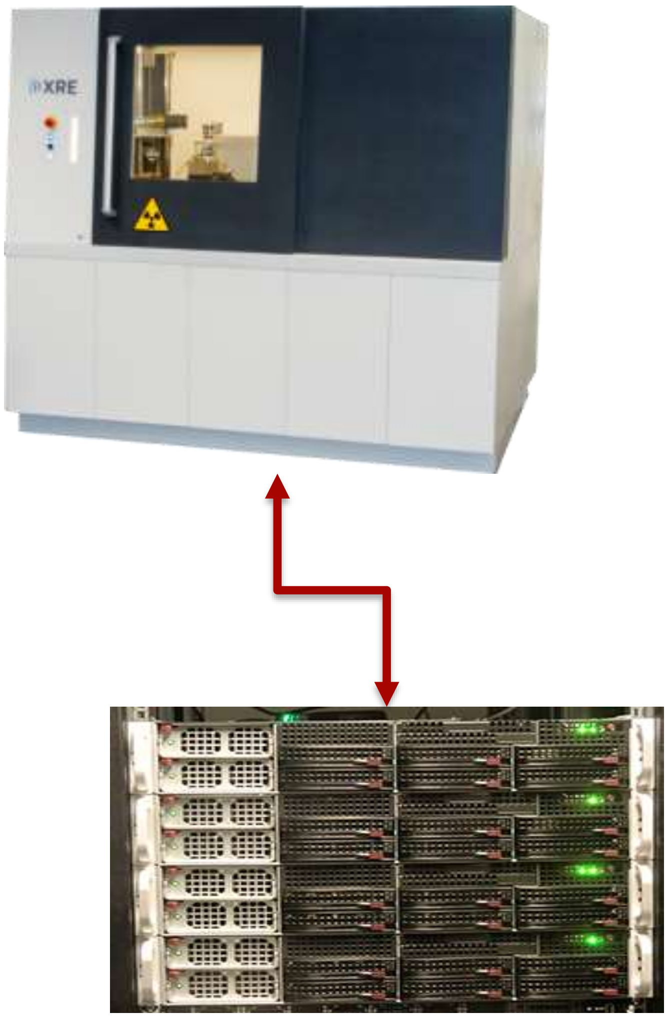
The beginning of FleX-ray

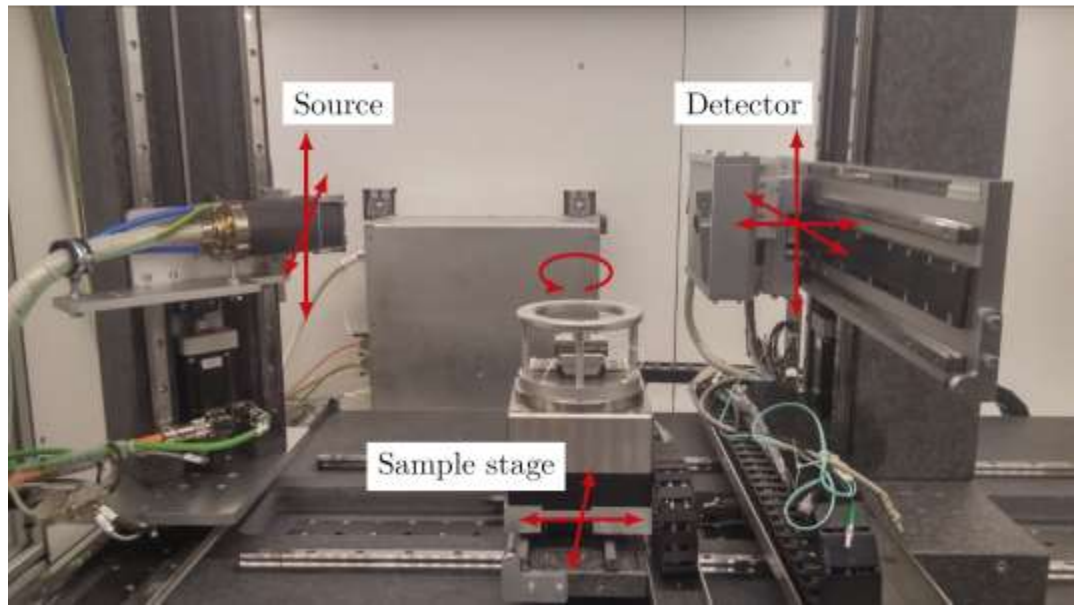




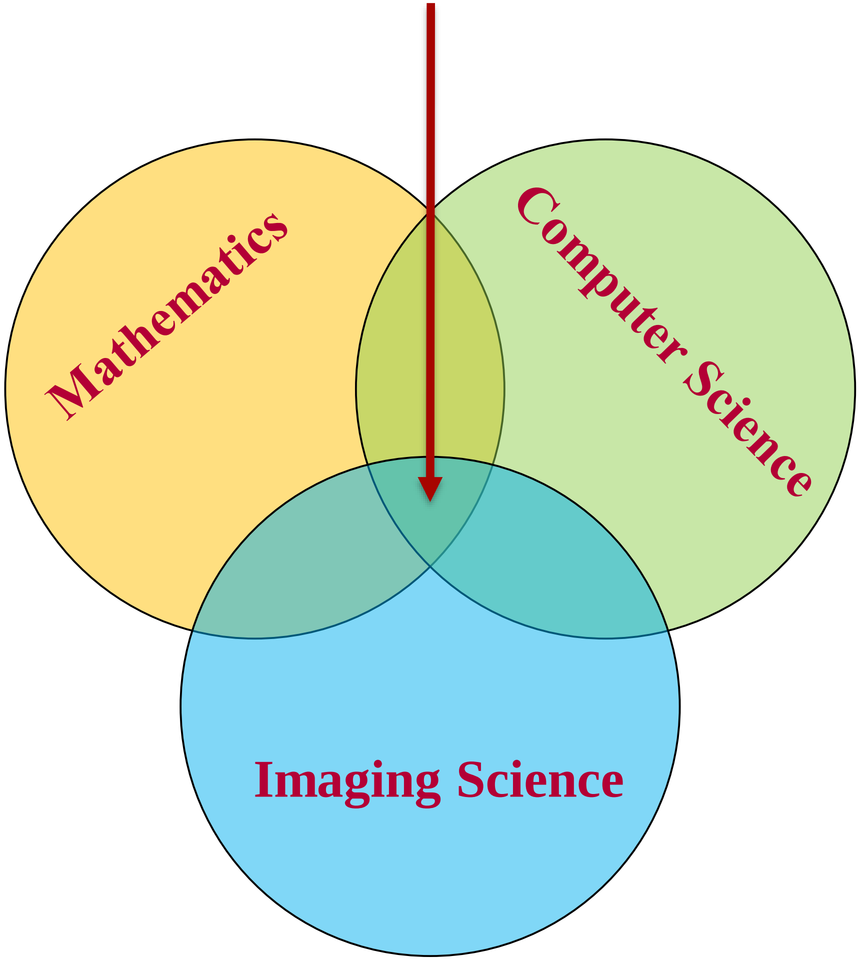
The opening

The FleX-ray Lab





The FleX-ray Lab



Selected Highlights

CWI

Cultural heritage & natural history

CWI

Artifact

↓

FlexRay scan

↓

3D reconstruction

↓

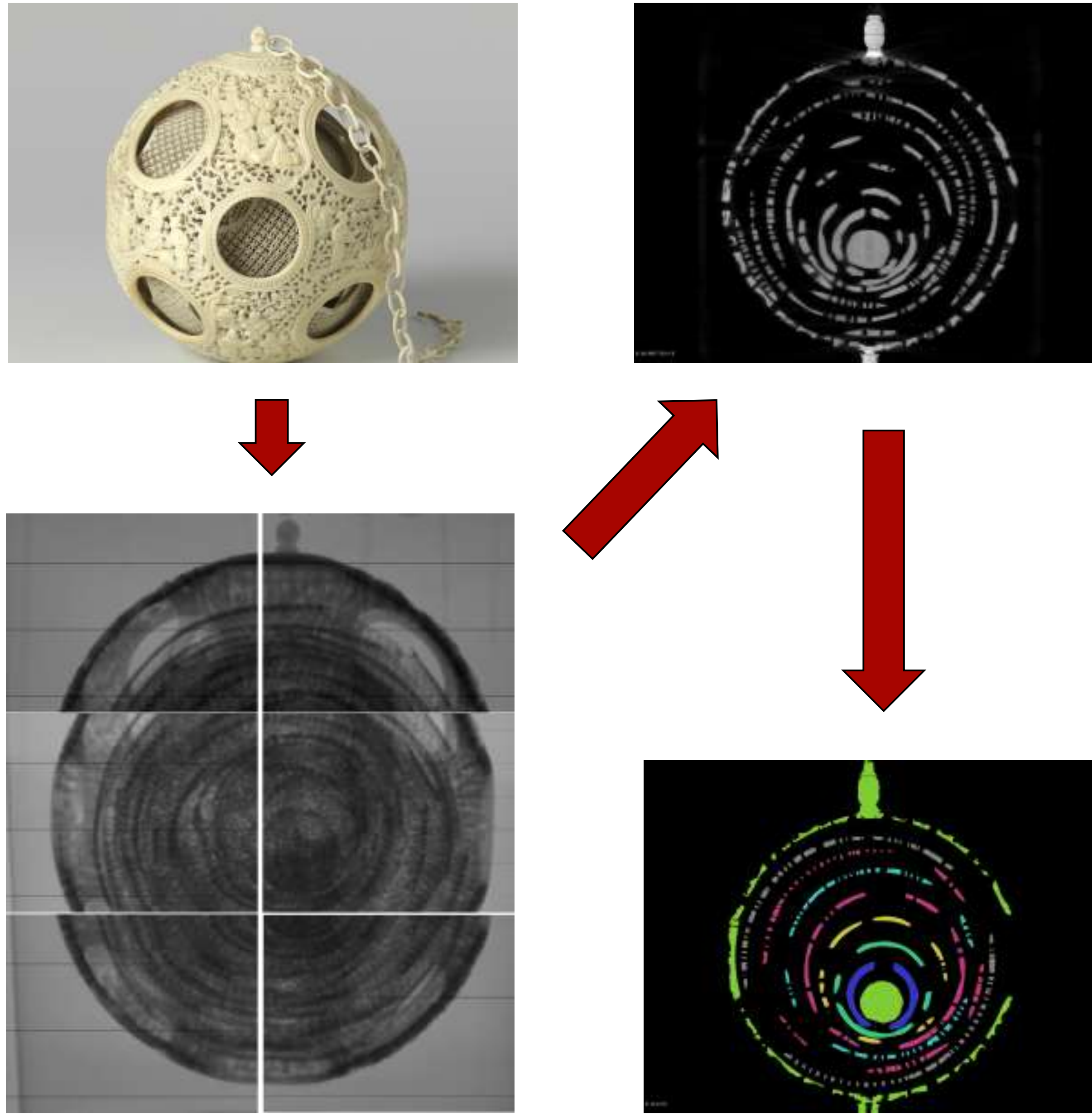
Image processing

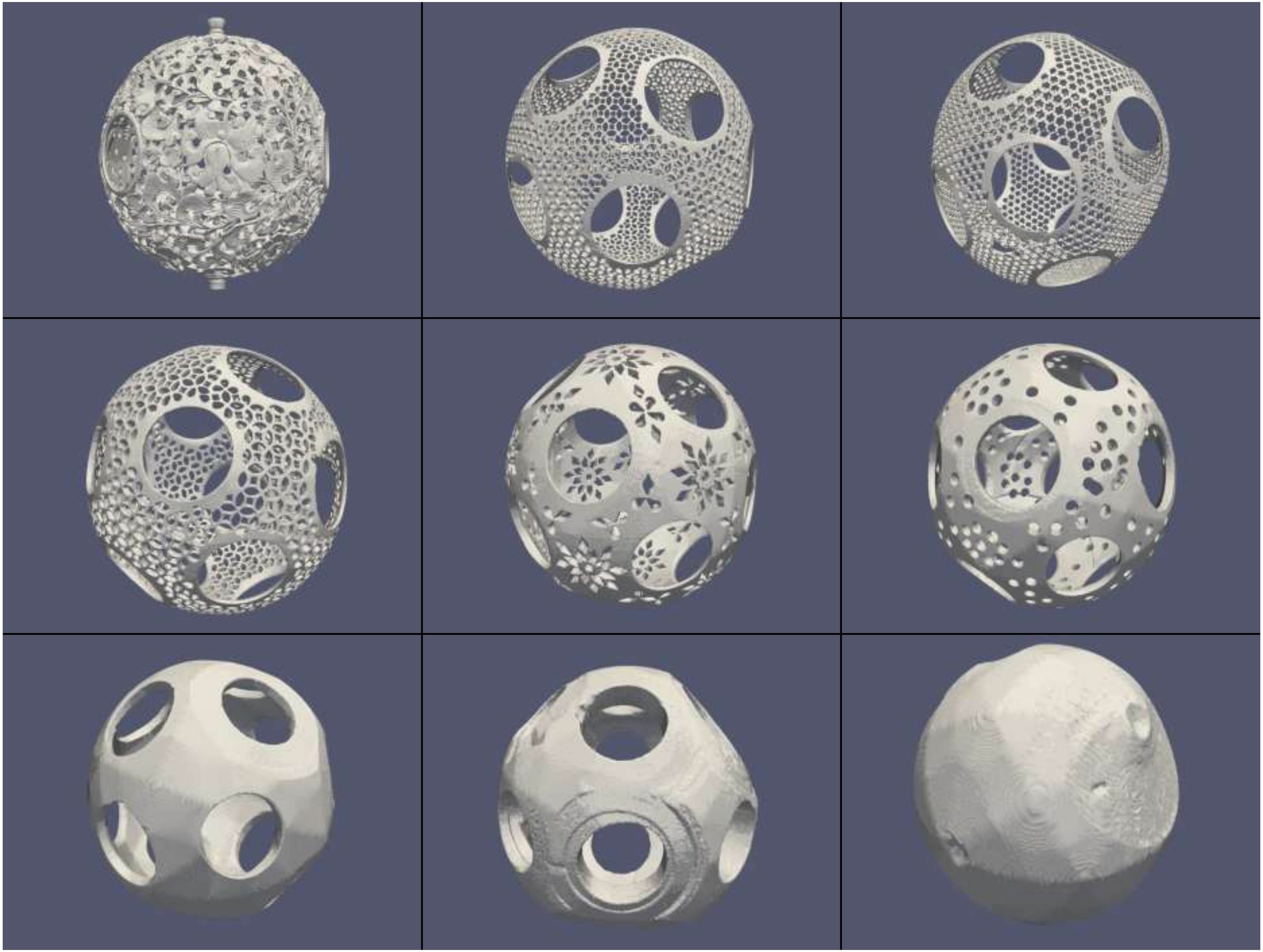
↓

Patterns

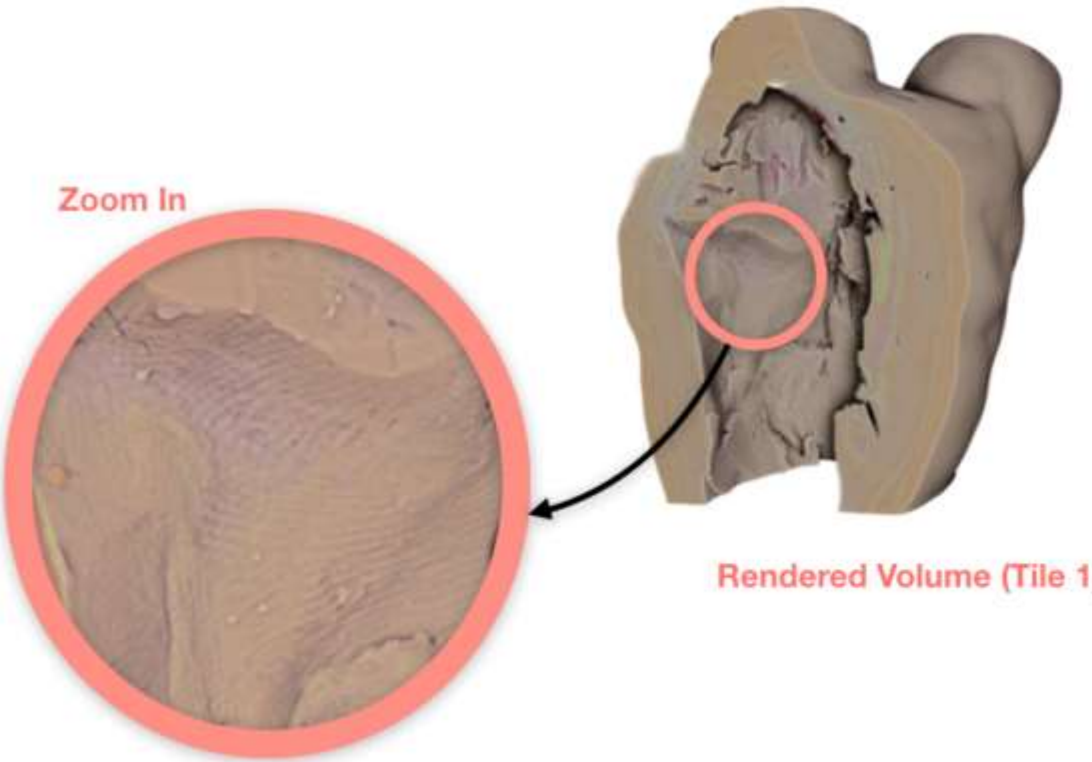
↓

Visualization

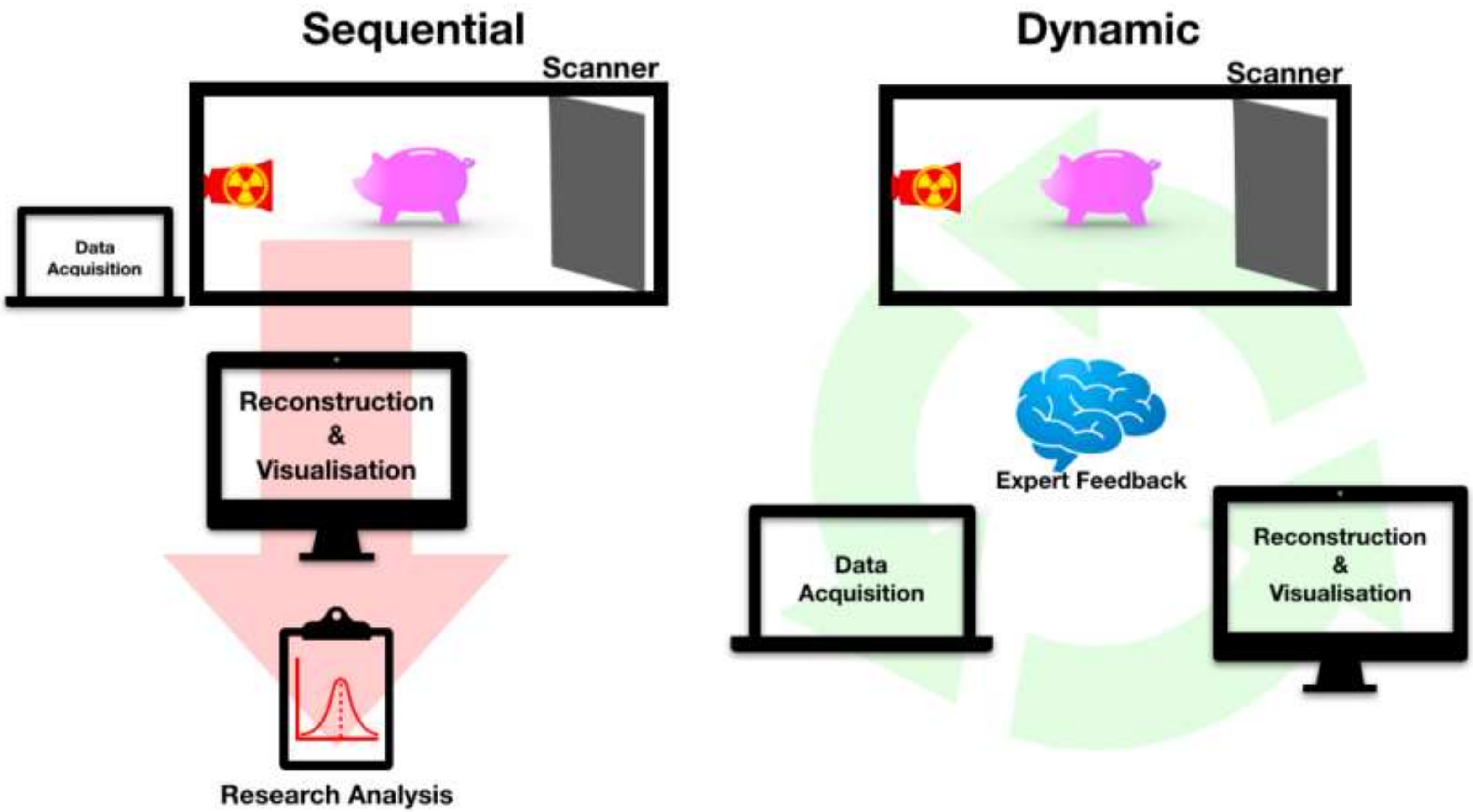




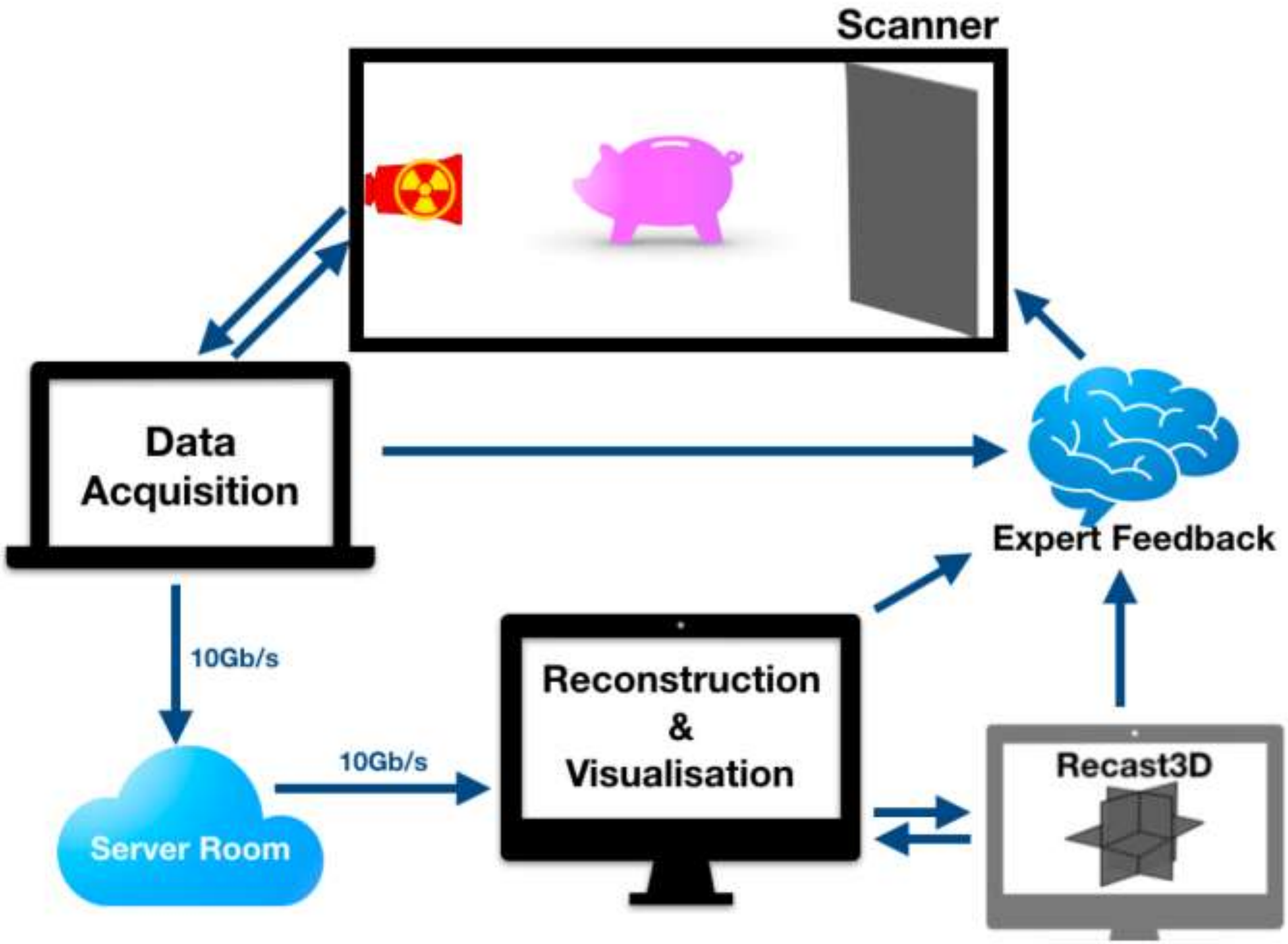
Michelangelo...or not?



Explorative imaging

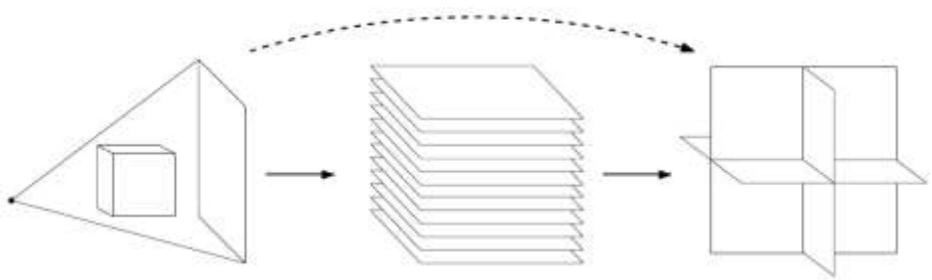


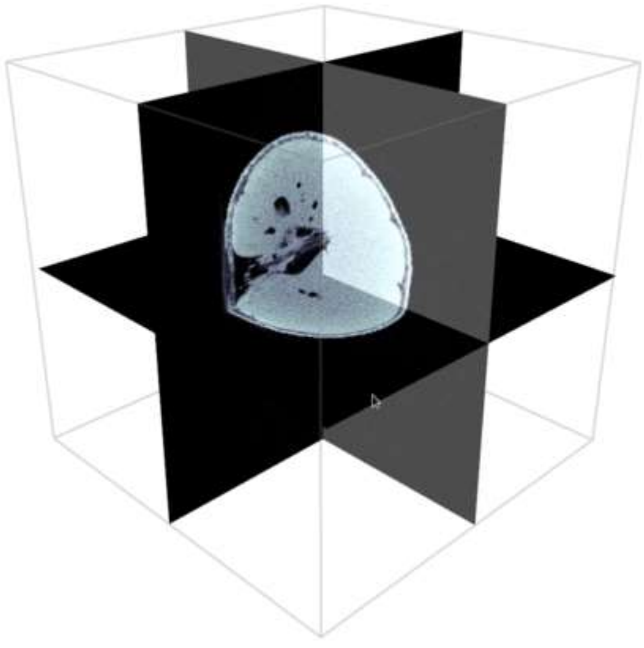
Explorative imaging



RECAST3D

- Real-time quasi-3D reconstruction and visualization of arbitrary slices
- Plugin infrastructure for on-the-fly analysis
- Active experimental adaptation & control

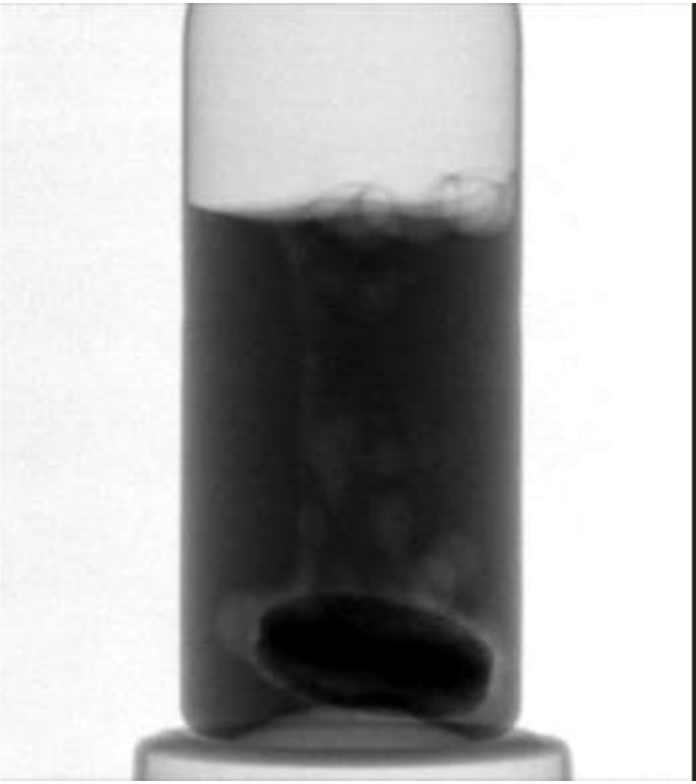
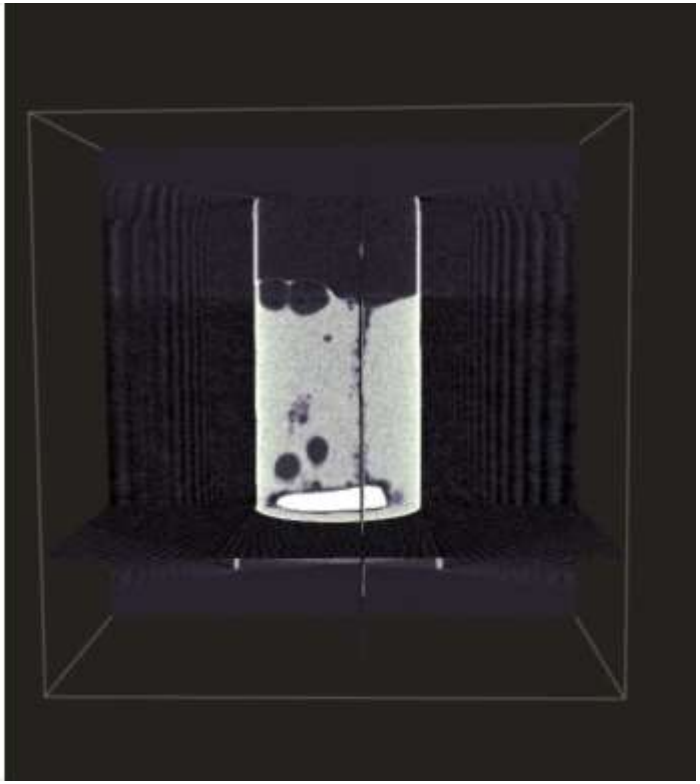




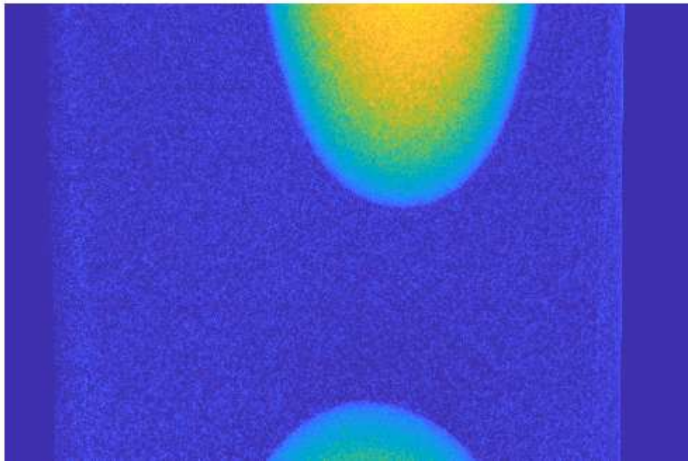
Did someone say live demo?

Well…Murphy’s law

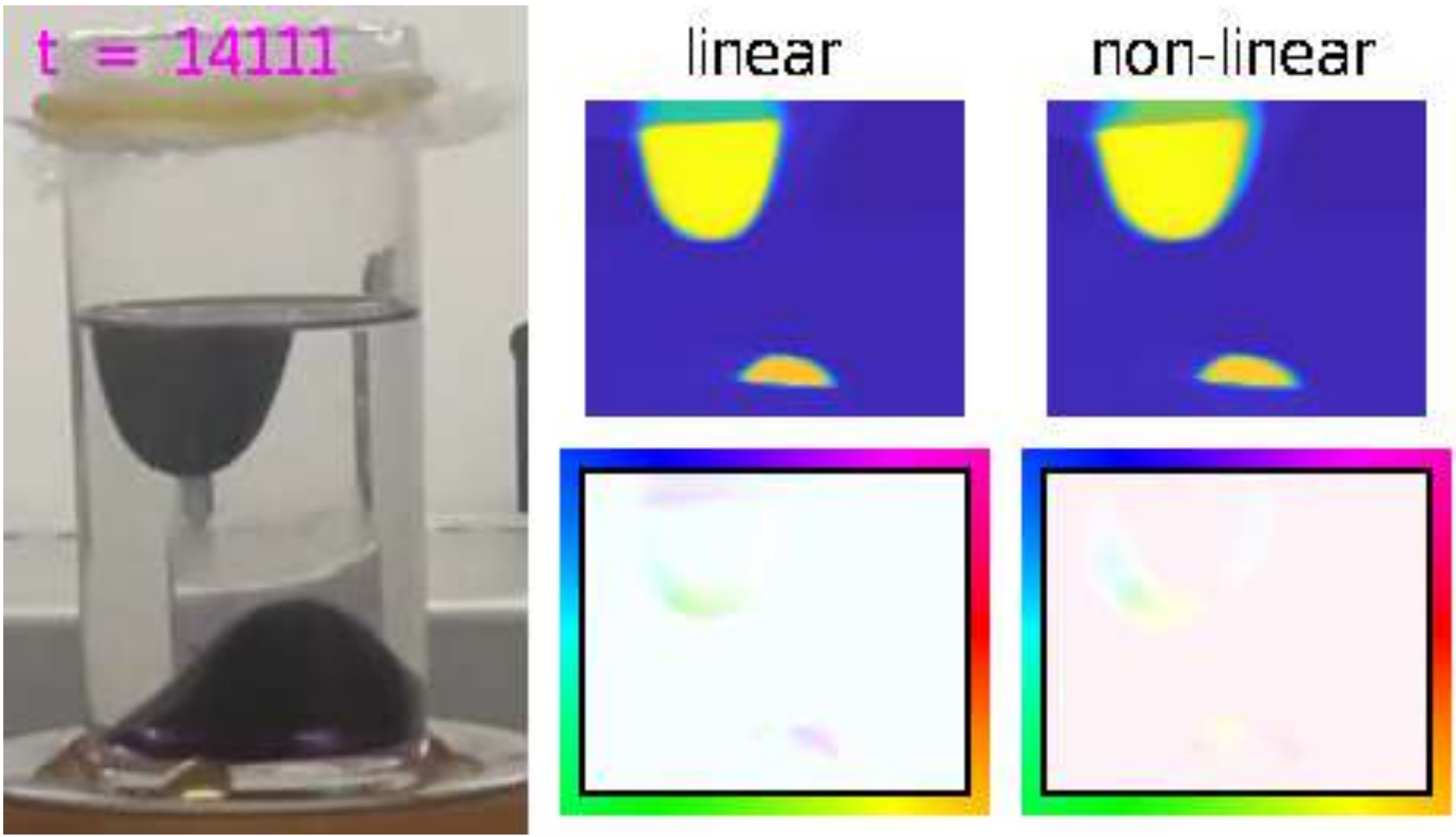
Dynamic real-time imaging and scan adaptation

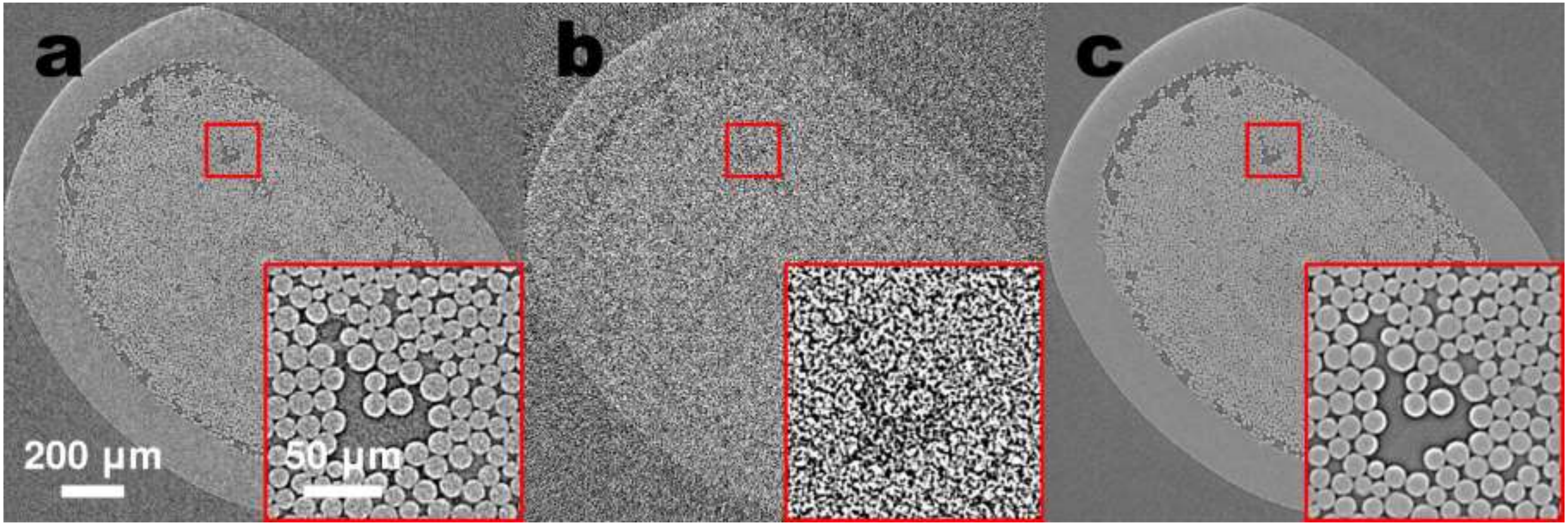
Imaging dynamic processes



Imaging dynamic processes

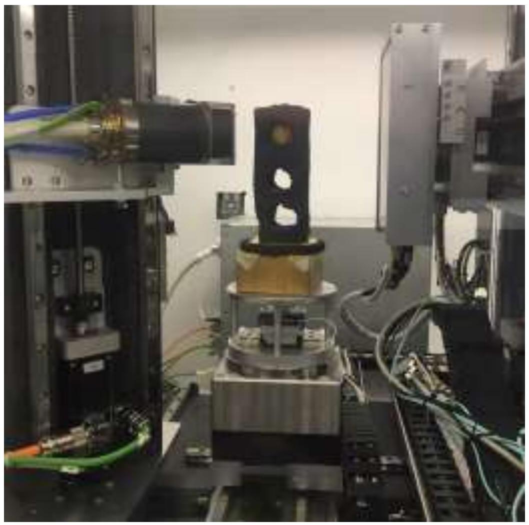


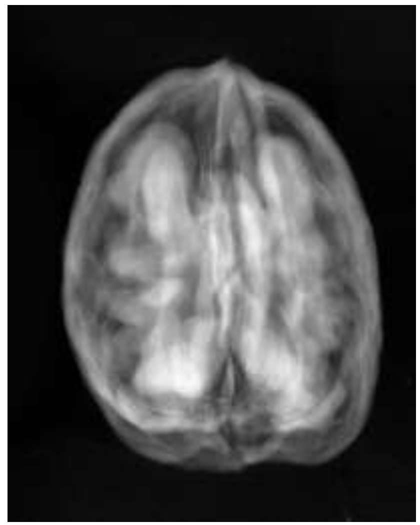
AI in tomography

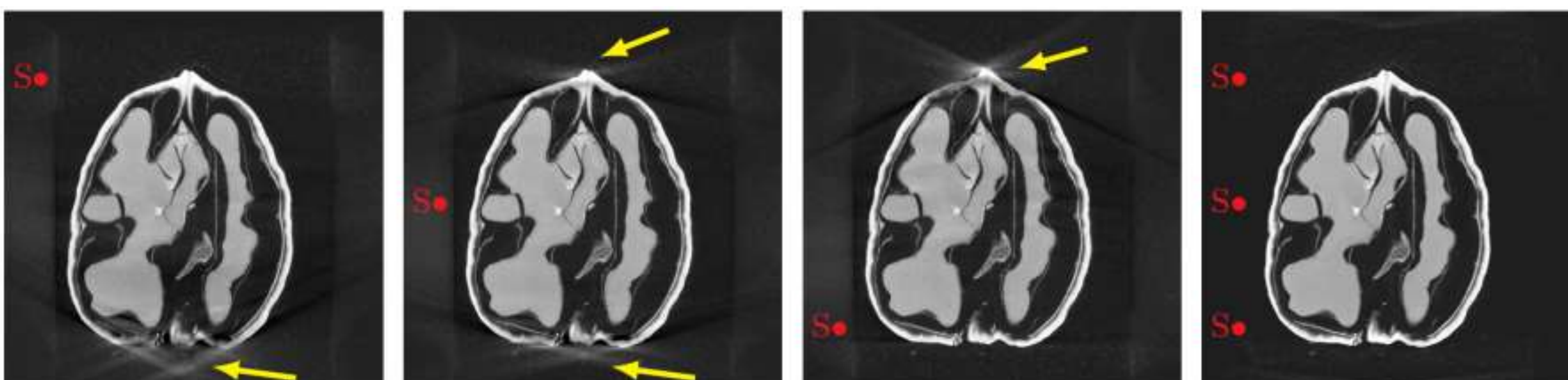


- data collections
- scaling
- robustness
- task-adaptation
- software coupling
- real-time

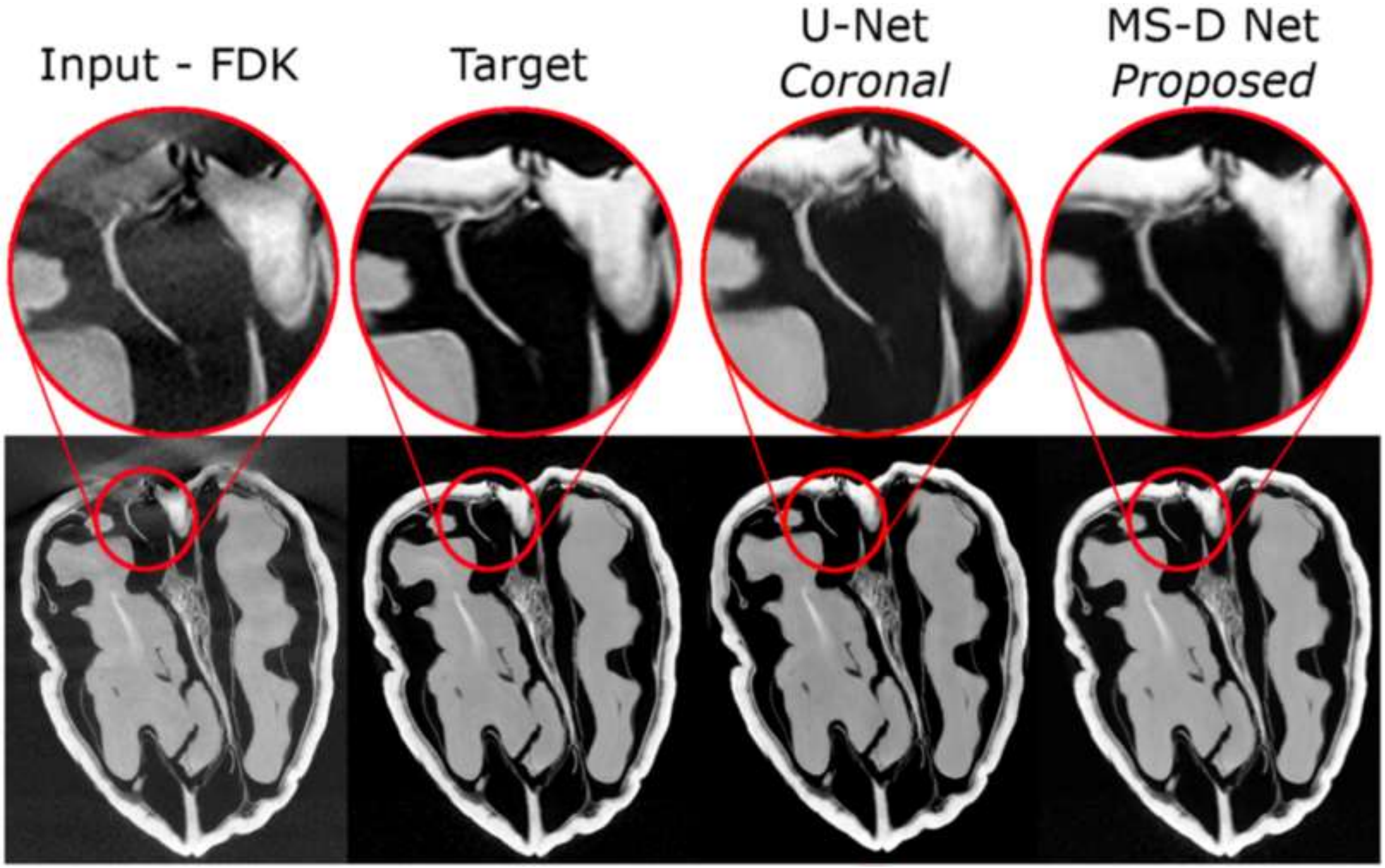
Open data collections for machine learning







Open data collections for machine learning



Open data


zenodo
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March 14, 2022 (v1)
Dataset
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Trajectory with Overlapping Projections x-ray Computed Tomography (TOP-CT) dataset of 23 mandarins moving over a circular trajectory
Dirk Elias Schut;
Summary This dataset is a collection of X-ray projection images of 23 mandarins moving over a circular trajectory in such a way that the projections of multiple adjacent mandarins overlap. The dataset was acquired to test out Trajectory with Overlapping Projections x-ray Computed Tomography (TOP-CT
Uploaded on March 24, 2022
January 17, 2022 (v1)
Dataset
Open Access
View
A collection of 131 CT datasets of pieces of modeling clay containing stones - Part 5 of 5
Mathé T. Zeegers;
Summary This submission contains a collection of 131 CT scans of pieces of modeling clay (Play-Doh) with various numbers of stones inserted. The submission is intended as raw supplementary material to reproduce the CT reconstructions and subsequent results in the paper titled 'A tomographic wo
Uploaded on January 19, 2022
January 17, 2022 (v1)
Dataset
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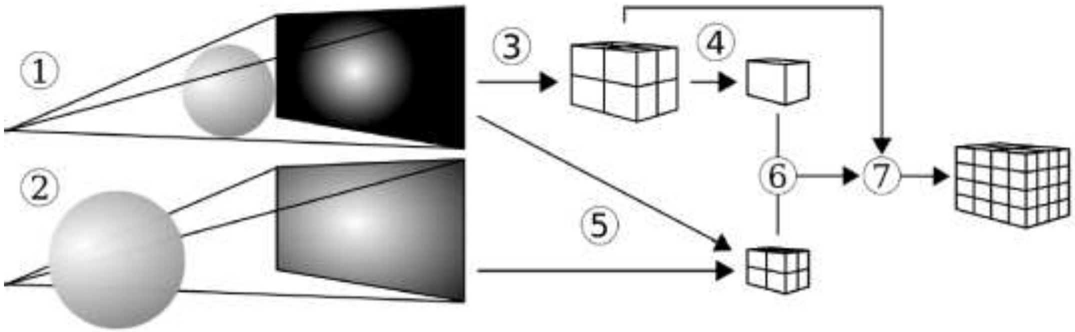
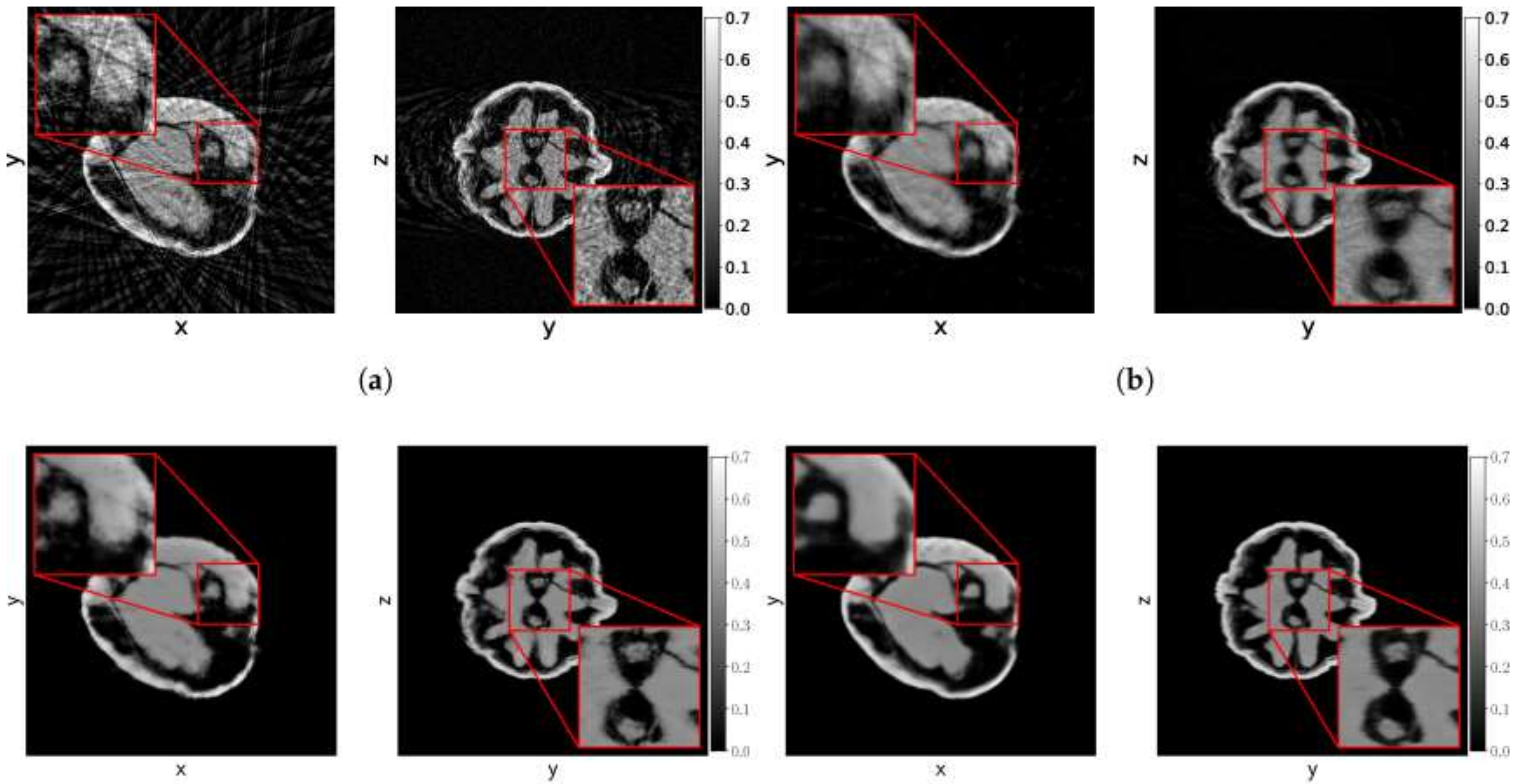
View
A collection of 131 CT datasets of pieces of modeling clay containing stones - Part 4 of 5
Mathé T. Zeegers;
Community
CWI
COMPUTATIONAL IMAGING
Computational Imaging – Centrum Wiskunde & Informatica
Welcome to the Zenodo community for the Computational Imaging at Centrum Wiskunde & Informatica (CI-CWI).
This community, created and maintained by the CI-CWI, is a collection of the research materials produced by its members.
Here, you can find various dataset collected by our flexible, state-of-the-art scanner, various publications, PhD or MSc Thesis supplements and conference presentations by the CI-CWI members.

On-the-fly Machine Learning for superresolution



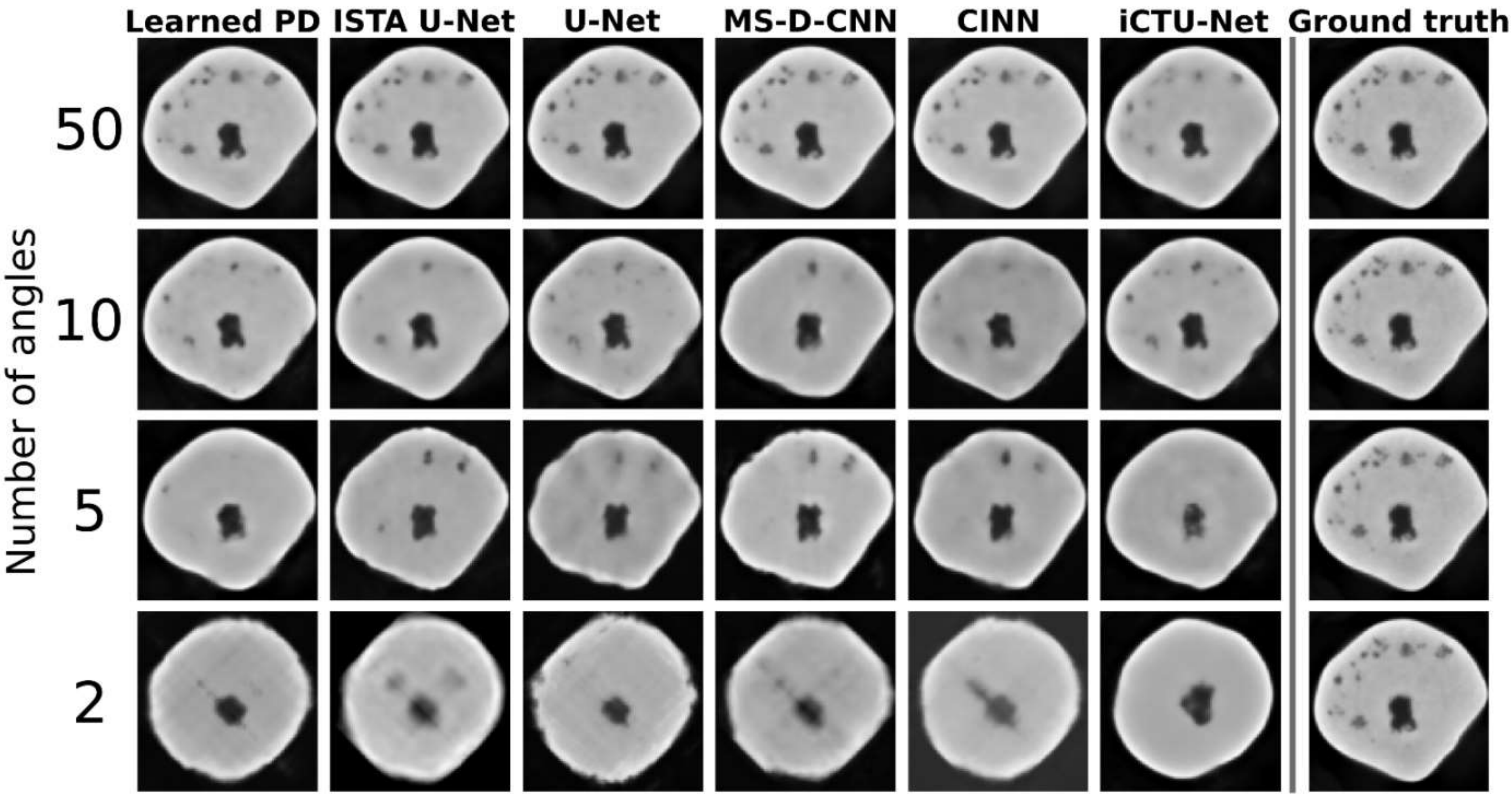
Efficient ML-based large-scale 3D tomography



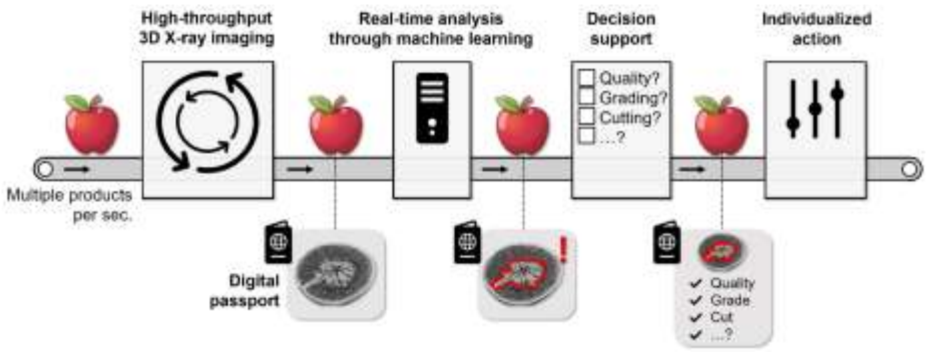
(a) (b)

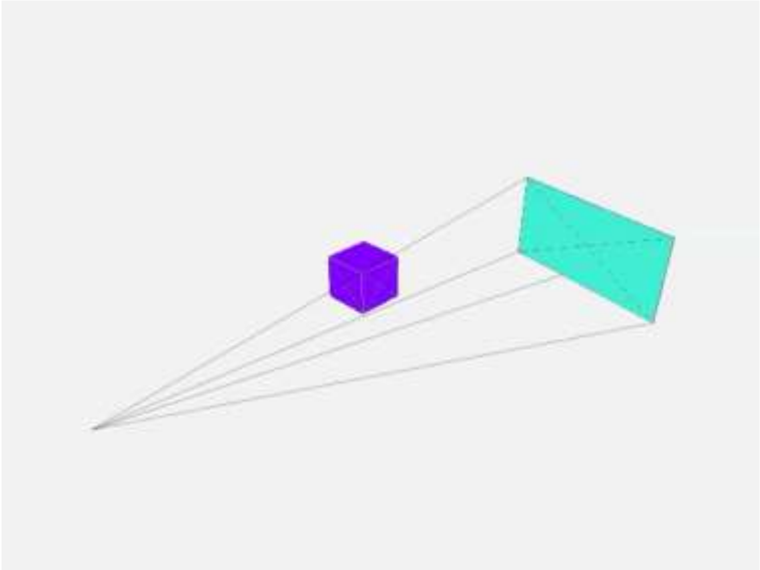
(c) (d)

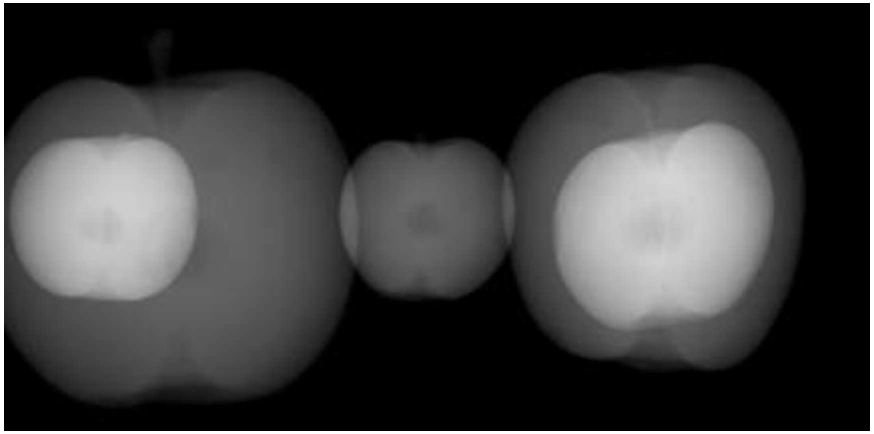
Benchmarking AI



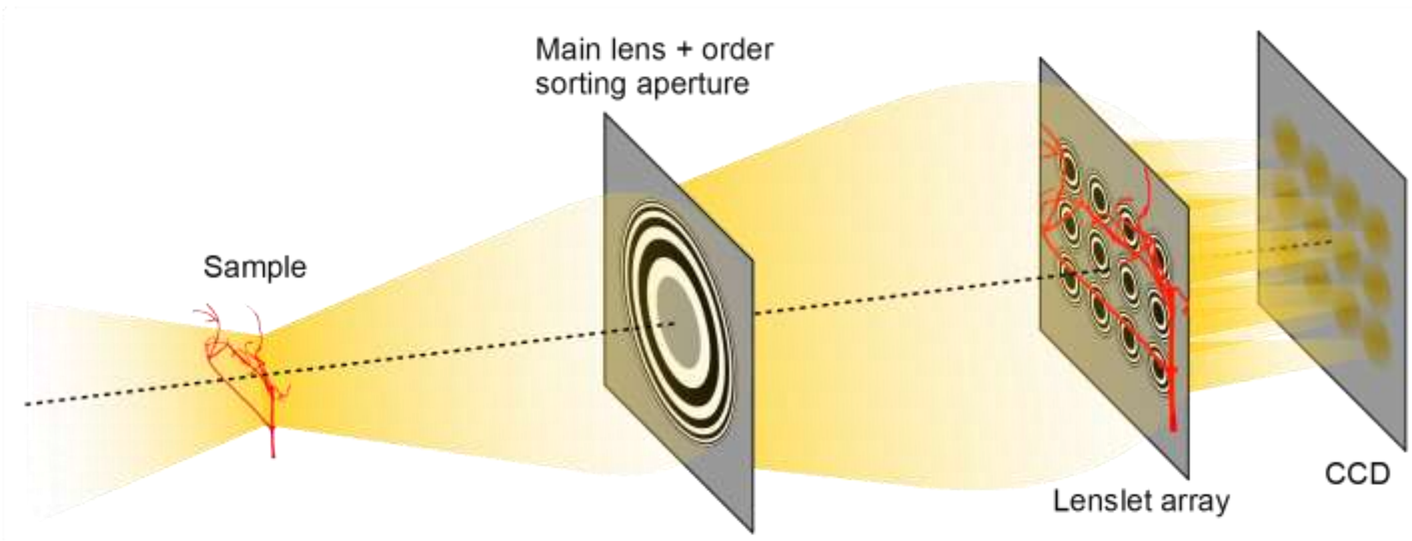
Imaging for the Industry 4.0

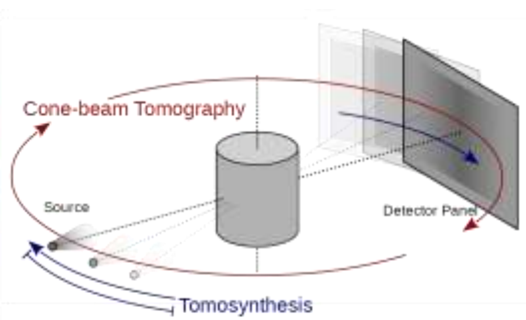


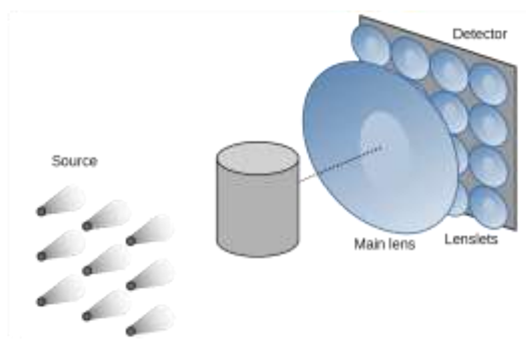


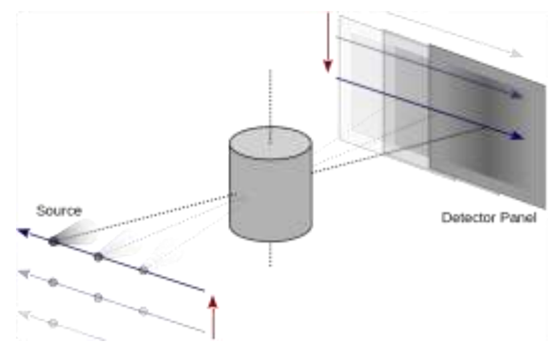


Emulation of X-ray light-field cameras

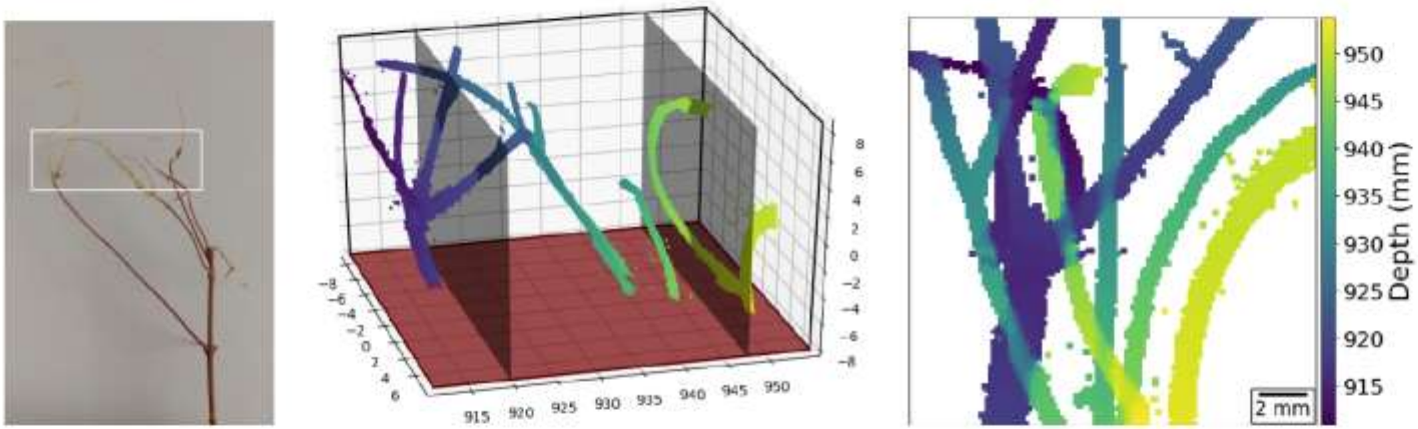




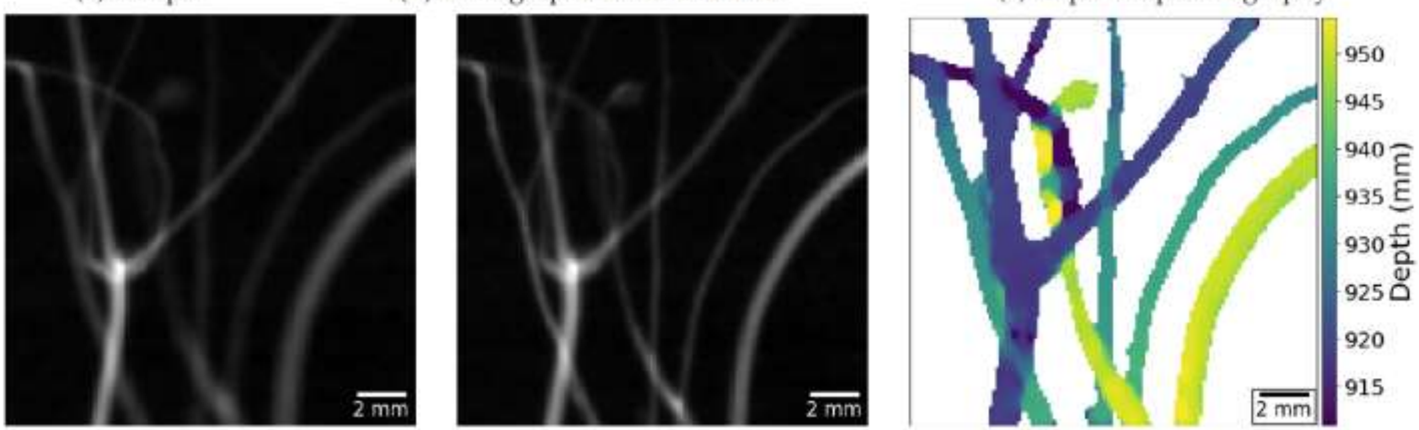




Emulation of X-ray light-field cameras



(a) Sample (b) Tomographic reconstruction (c) Depth map tomography



(d) z = 917.527 mm (e) z = 947.496 mm (f) Depth map light-field

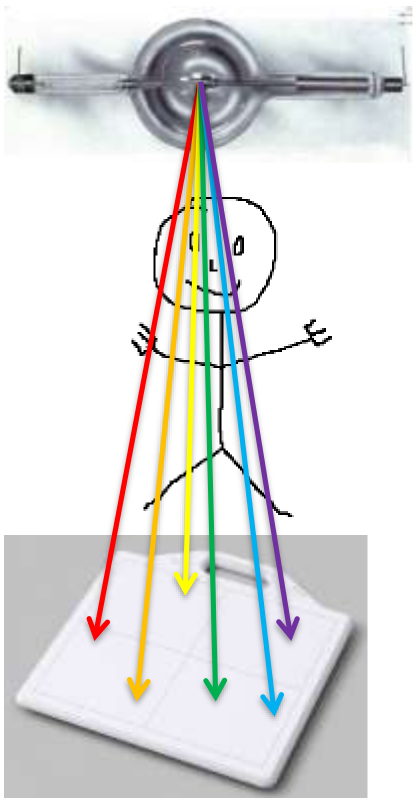
Looking at colours the eye can't see

Spectral X-ray imaging with Medipix3 in FleX-ray

Martin Fransen

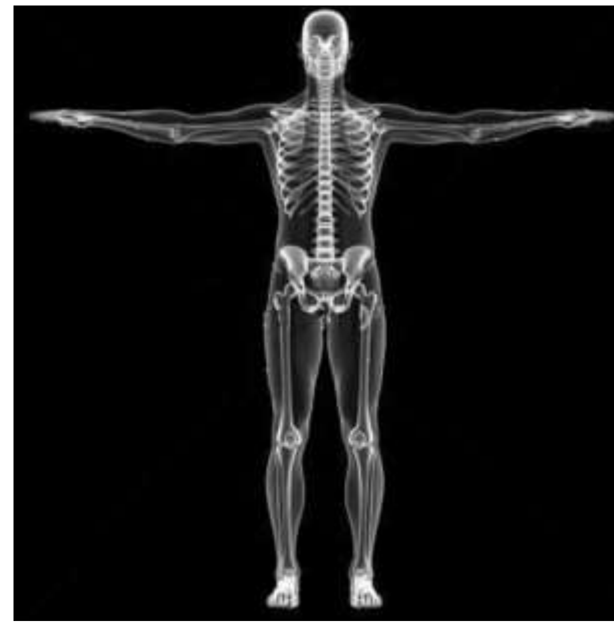
Nikhef

Conventional X-ray image



X-ray source
(broad spectrum)

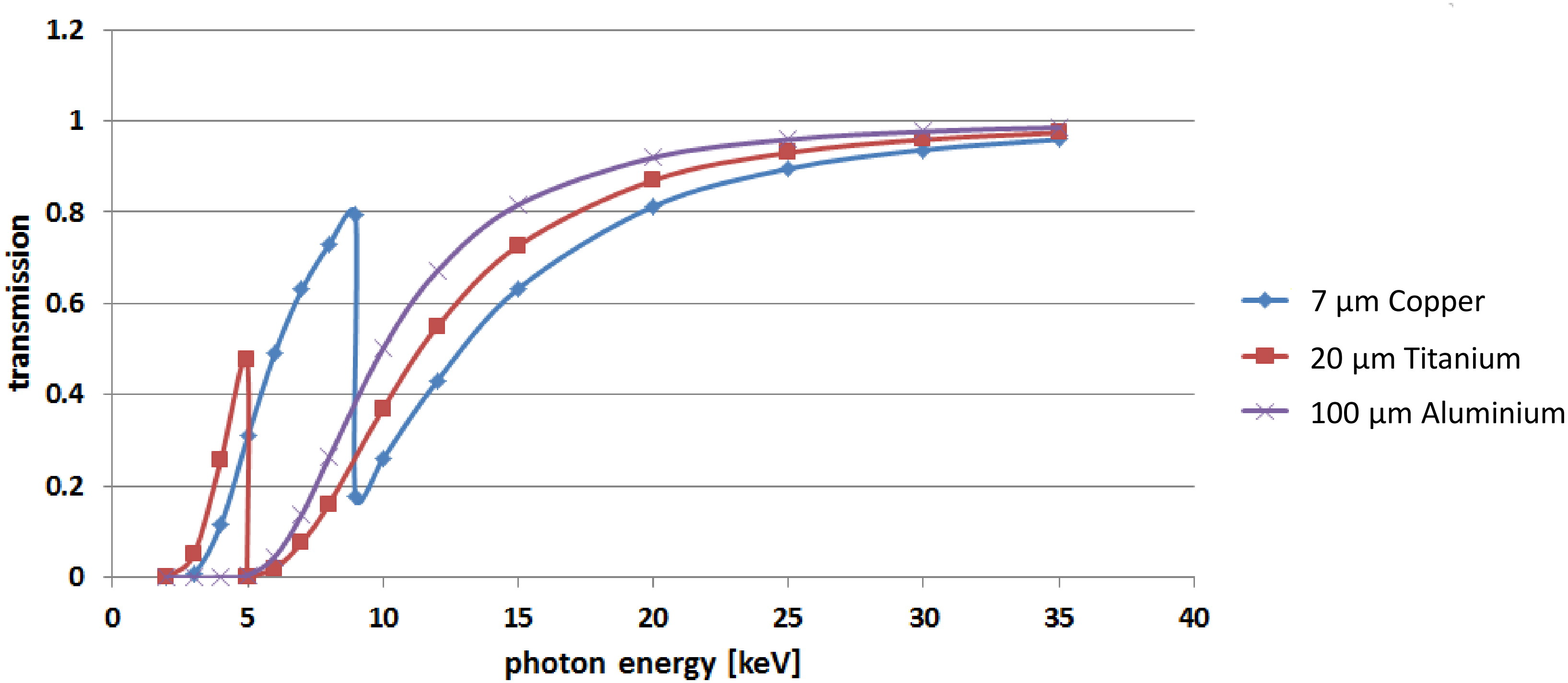
X-ray detector



grey scale image

X-ray transmission

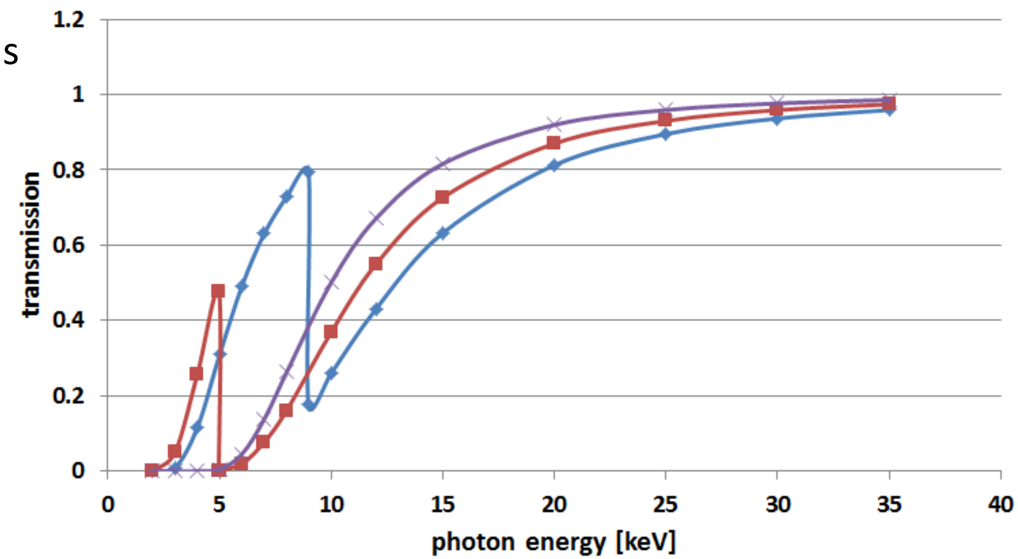
Unique for each element!



X-ray transmission

- Easy to identify materials, right?
- Not with conventional X-ray imaging, pixels record total amount of X-ray energy!

→ about the same shade of grey.



Also:

- Spectrum changes as X-rays traverse sample → beam hardening.
- Response to thickness and density variation is sensitive to thickness and density itself!

X-ray detection

- Easy to identify materials, right?
- Not with conventional X-ray imaging, pixels record total amount of X-ray energy!

→ about the same shade of grey.

Also:

- Spectrum changes as X-rays traverse sample → beam hardening.
- Response to thickness and density variation is sensitive to thickness and density itself!

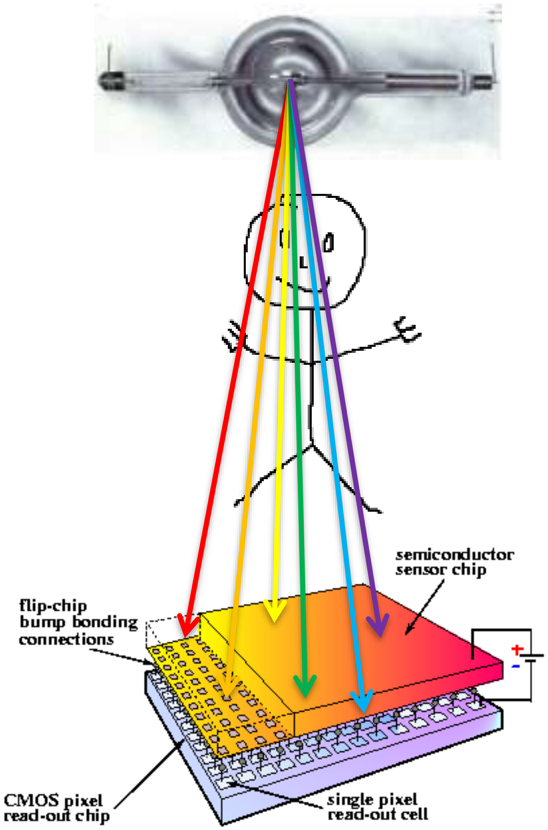
Possible detector improvements:

- Photon counting (increasing ‘weight’ of low energy photons for better contrast)
- Even better: Measure each photon’s energy

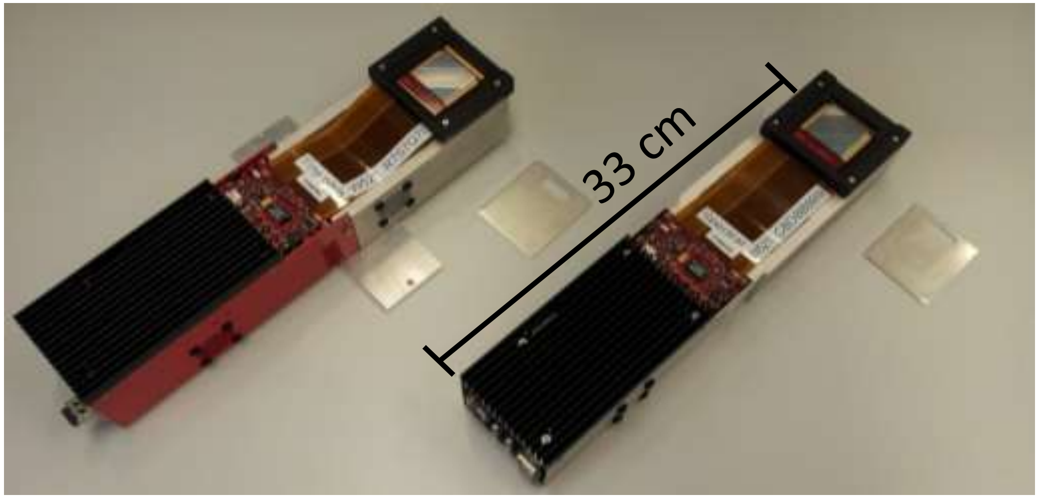
Common alternative: modifying X-ray spectrum by means of ‘colour filters’. Some drawbacks:

- Limited choice in energy bands
- Lower X-ray intensity
- Multiple scans for multiple energy ranges
- …

(Spectral) X-ray imaging with 'Medipix3'



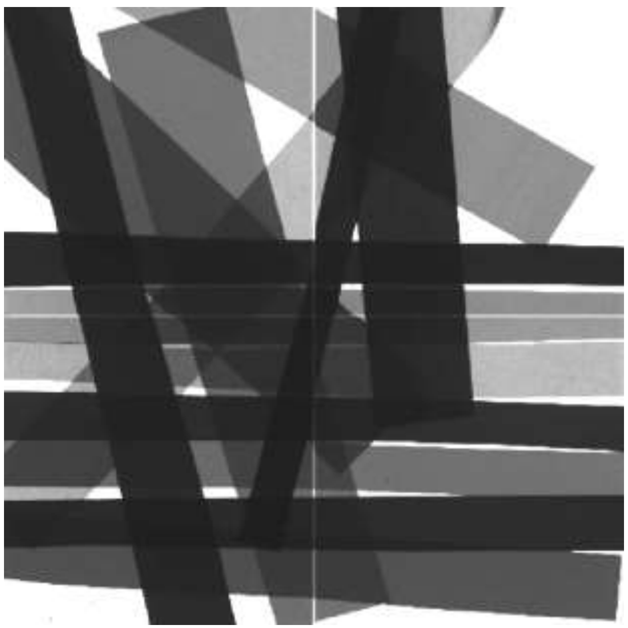
- Each absorbed X-ray photon releases charge proportional to it's energy.
- Charge detected by pixels → detecting individual X-ray photons.
- Set 8 different detection thresholds → 8 energy bins.

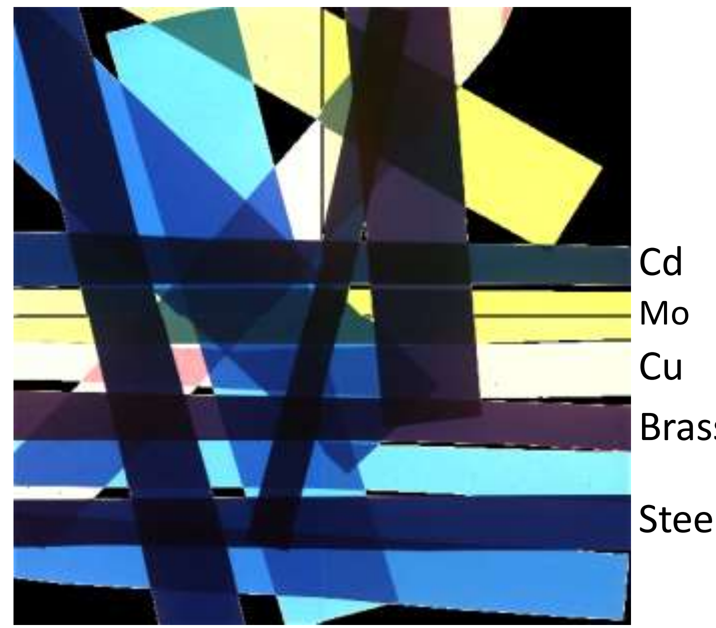


Medipix3 detectors (electronics developed at Nikhef).

From grey scale to spectral

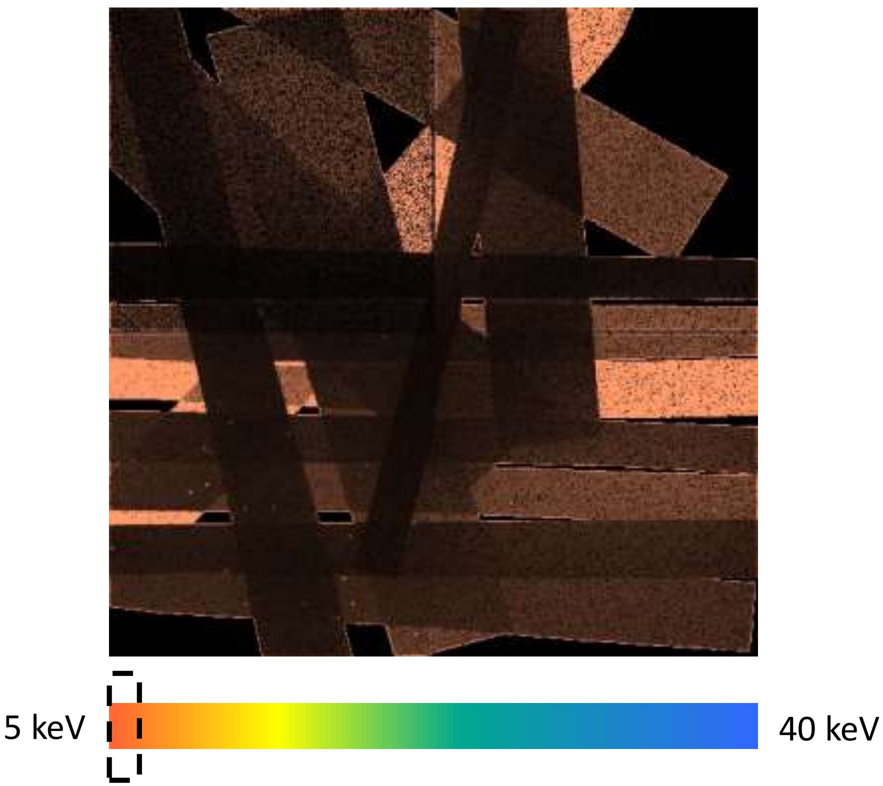
Metal foils (sample 3 x 3 cm).



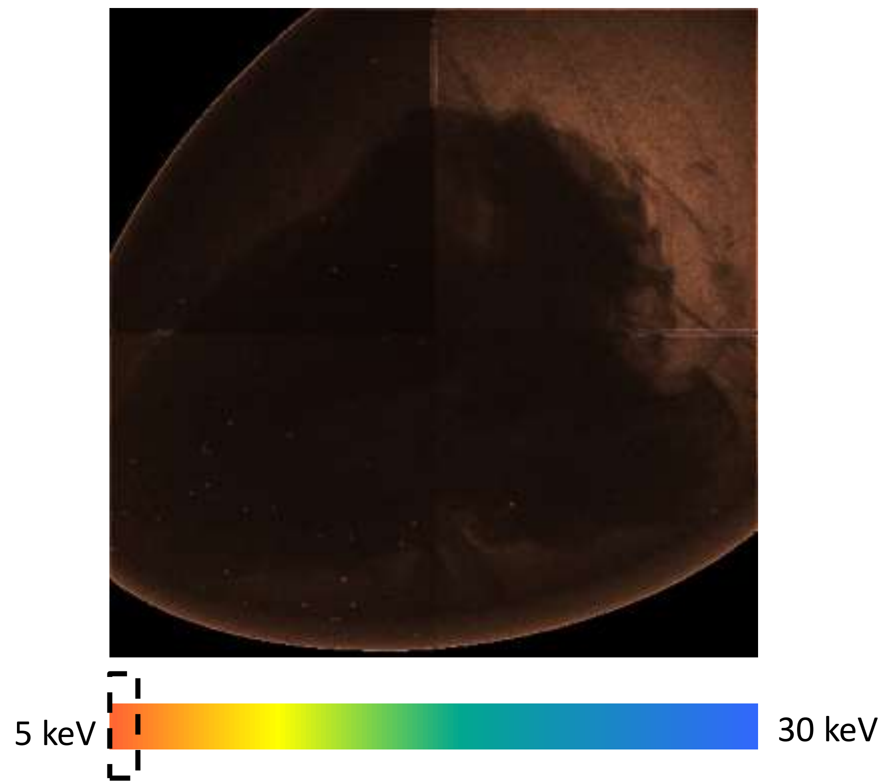


X-ray energy scan

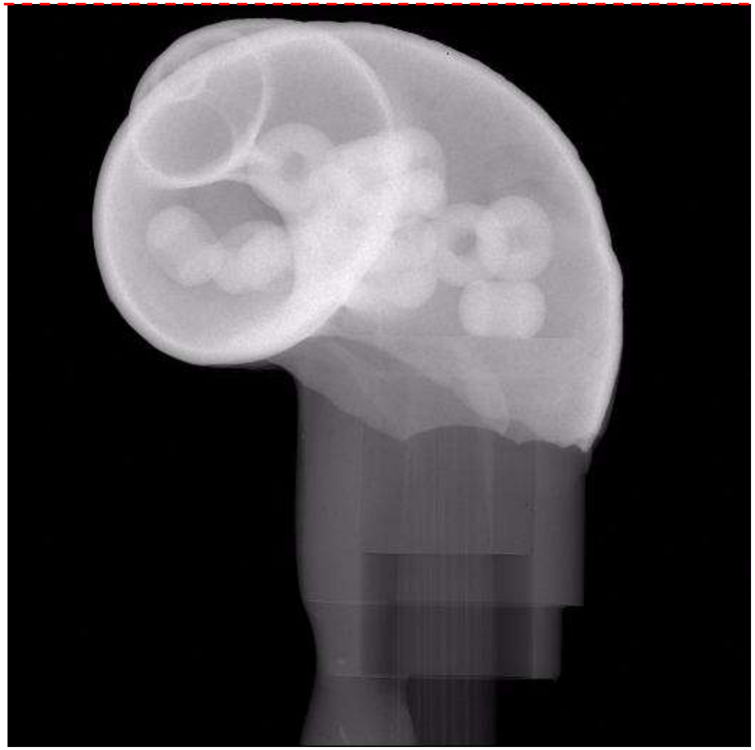
Metal foils.

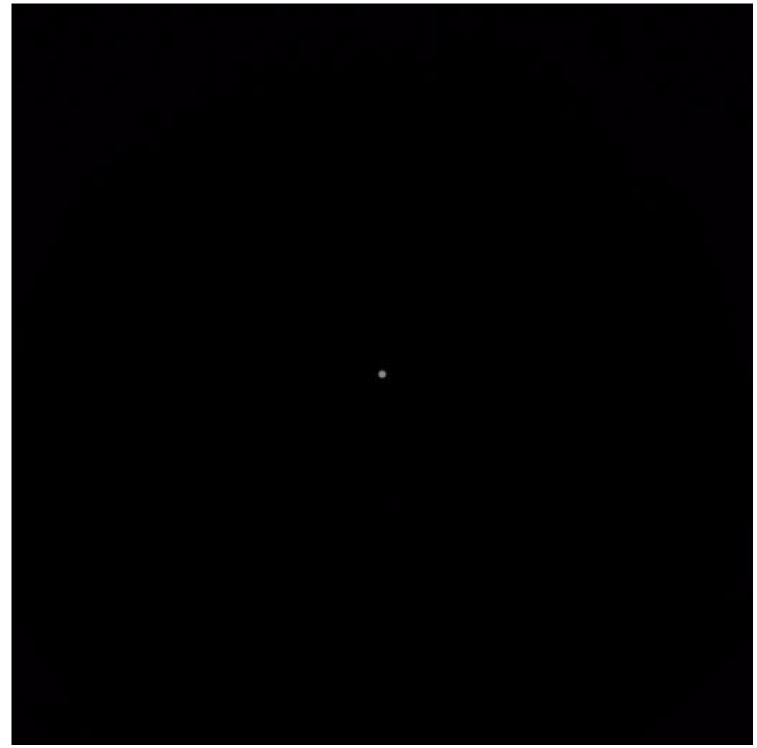


Small egg.

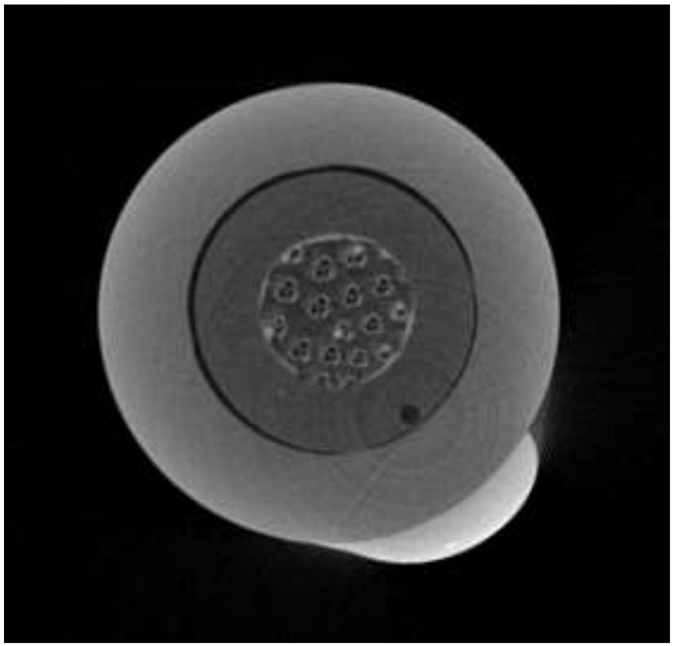


Example 3d CT reconstruction



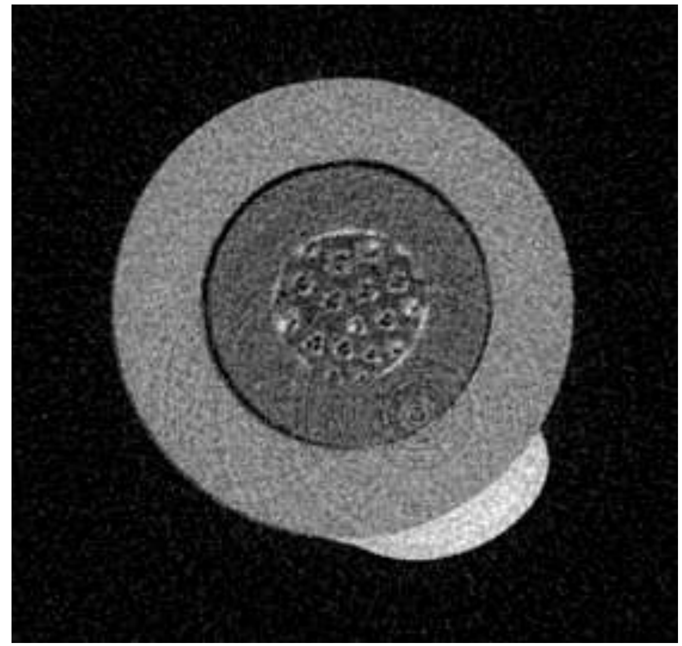


Beam hardening and CT scans



35 keV full spectrum.

Density gradient?

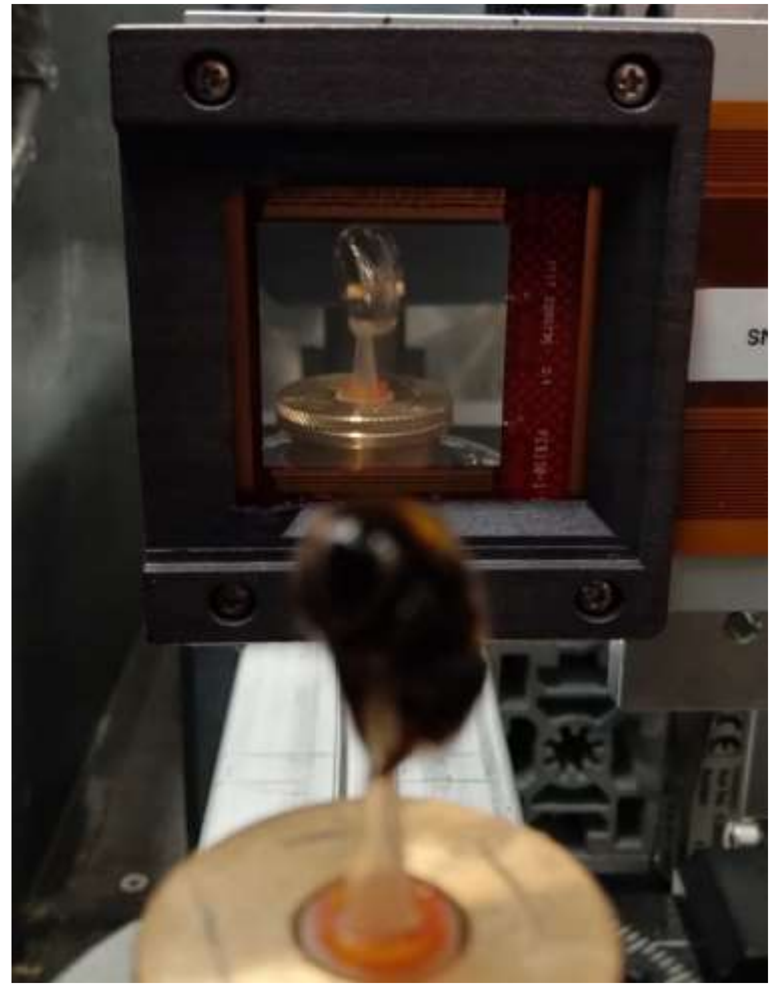


16-20 keV band.

Nope!

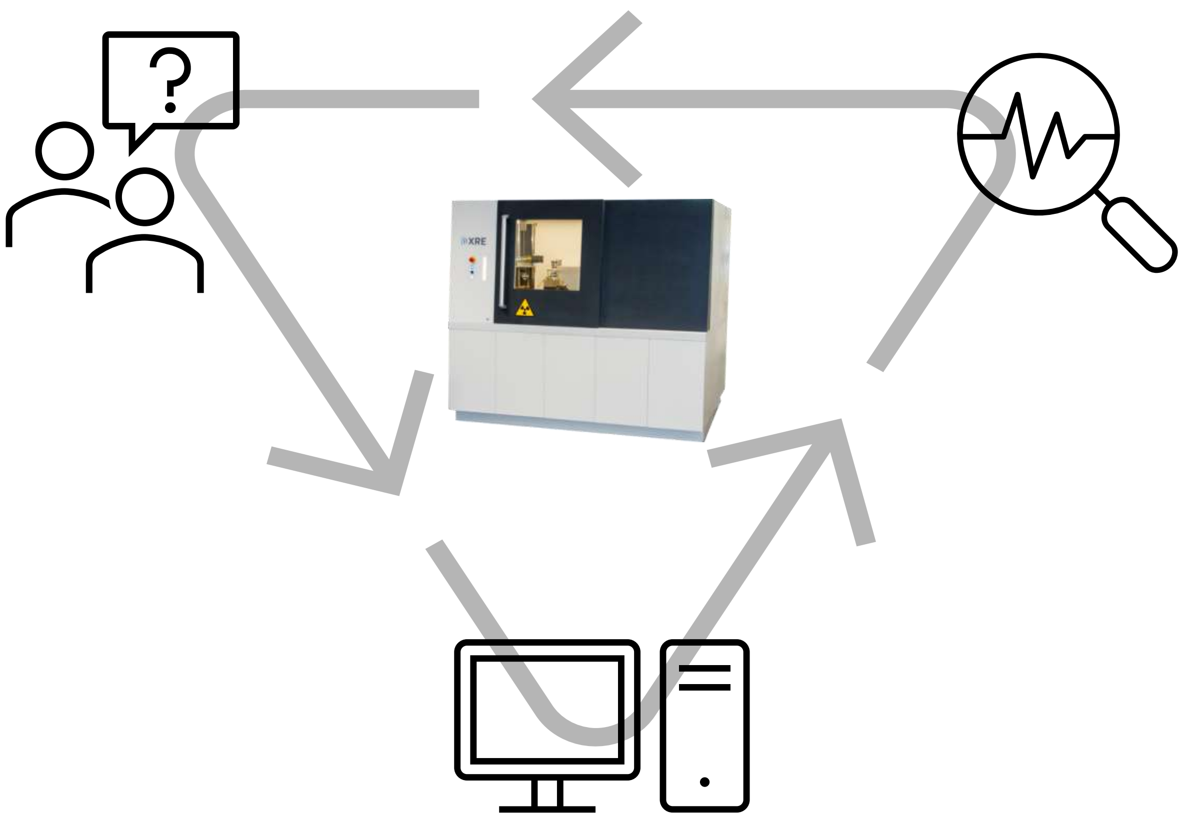
Medipix3 in FleX-ray

- Photon counting and energy binning.
- In addition to conventional X-ray imaging.
- Medipix3 detector in FleX-ray cabinet.
- Medipix3 based micro CT scanning set-up @ Nikhef.

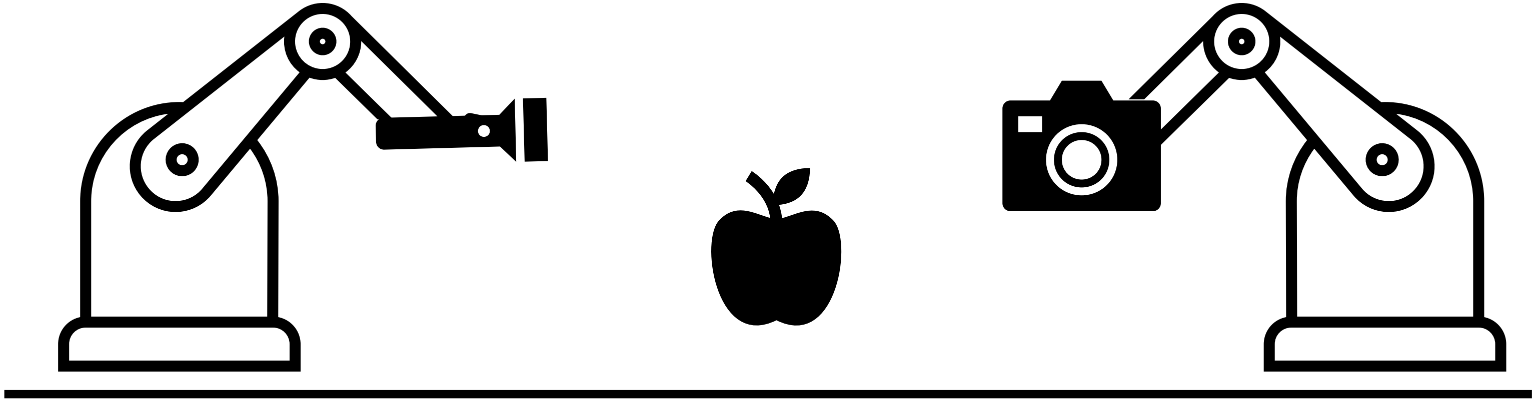


The Future

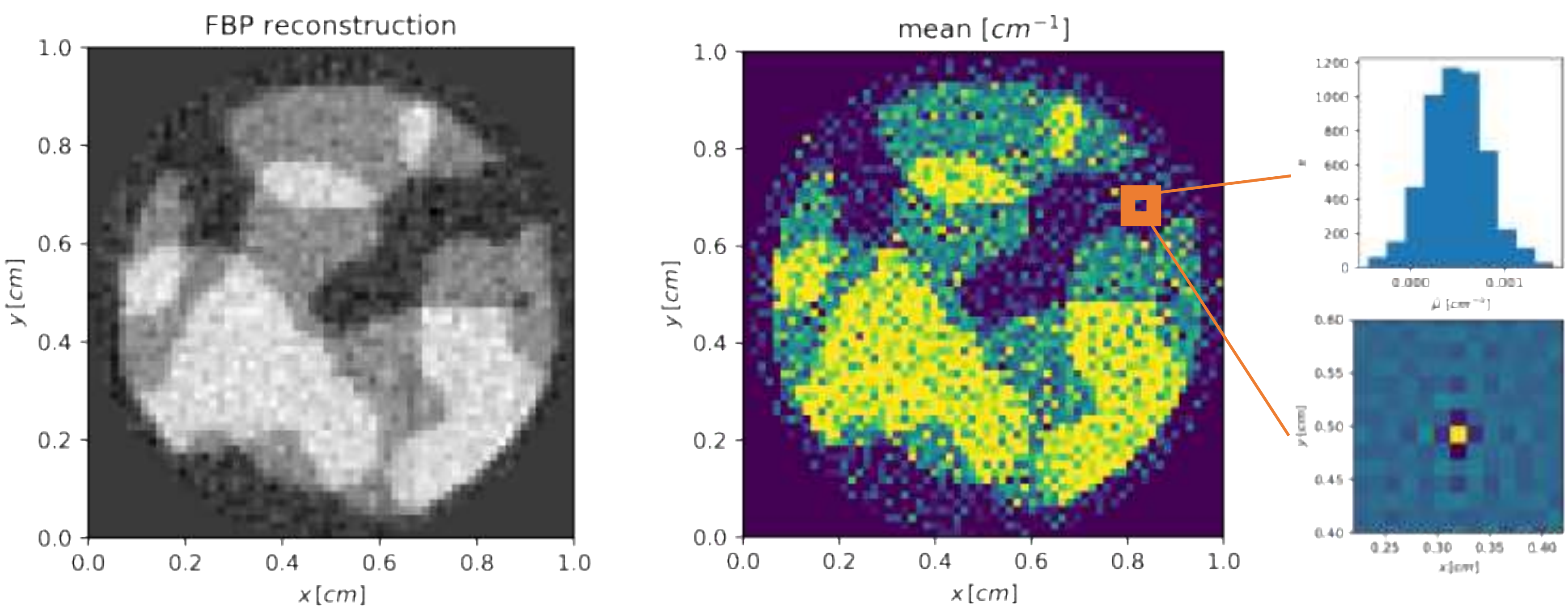
A collaborative platform



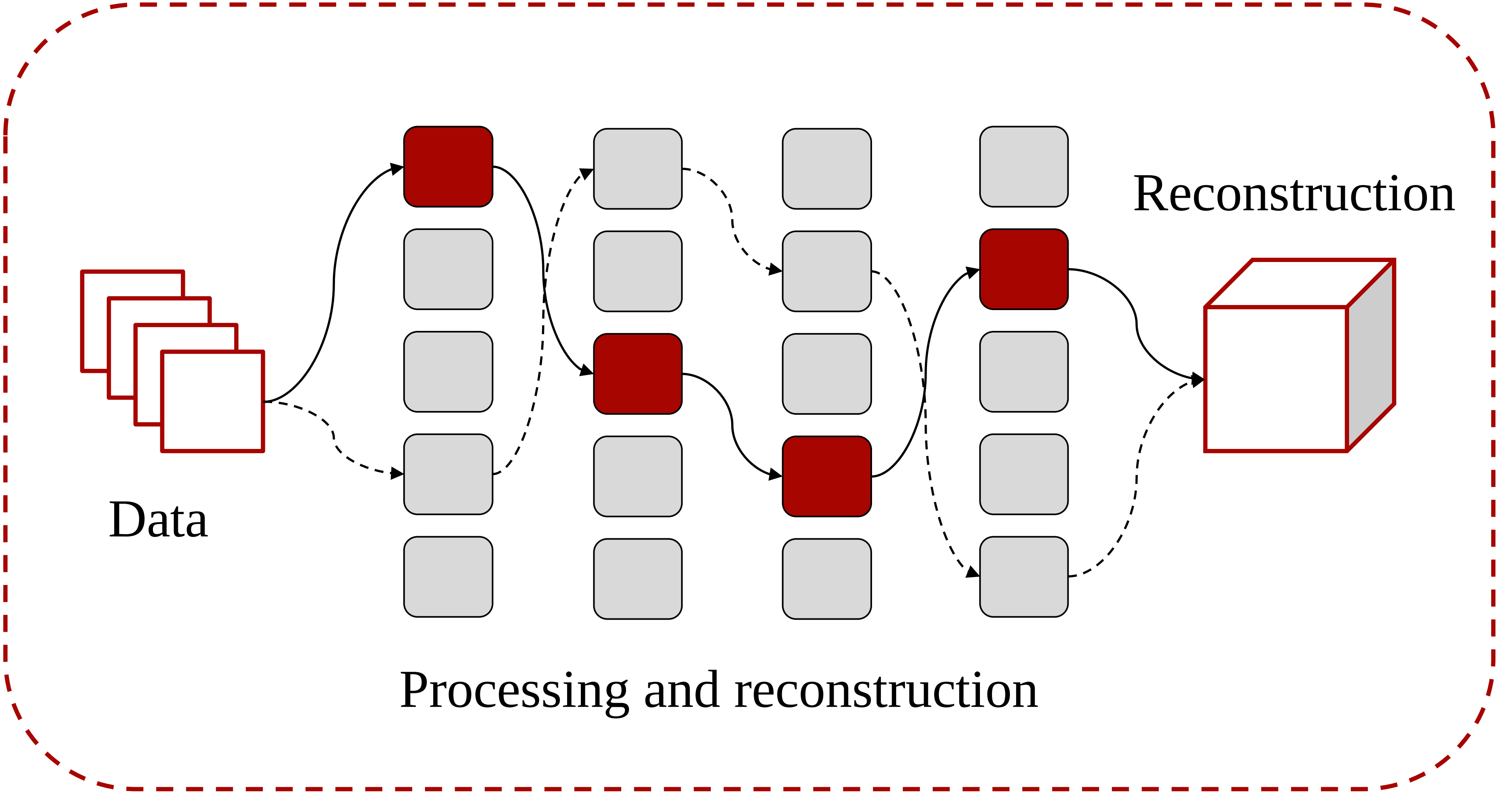
Adaptive scanning

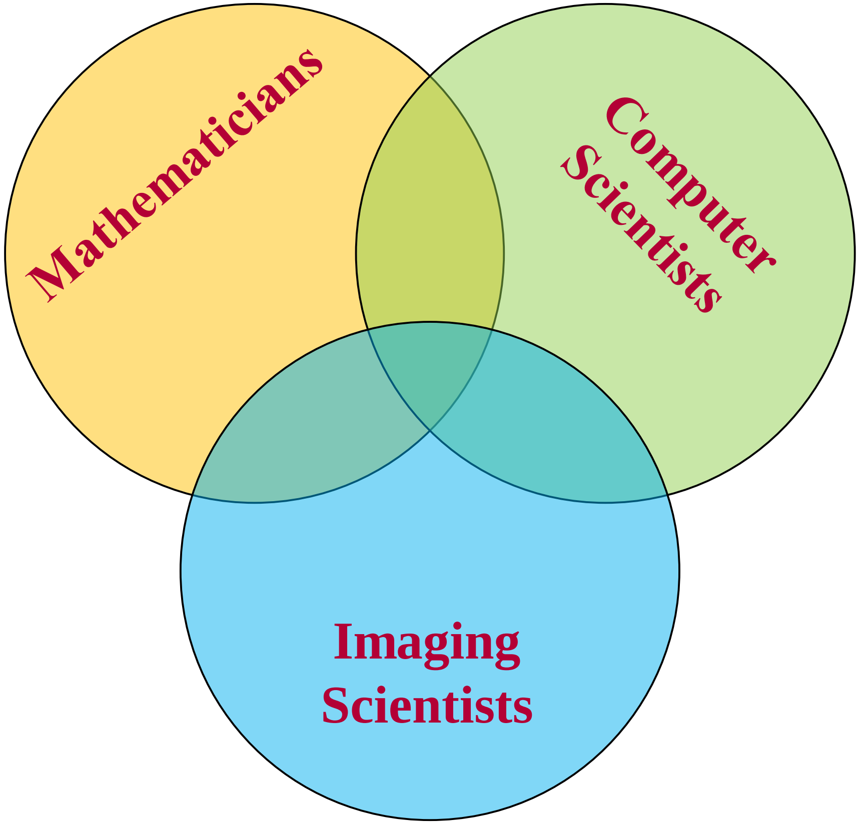


Quantitative imaging



Beyond images




Mathematicians
Computer Scientists
Imaging Scientists

Acknowledgements

Thanks!

- Joost Batenburg
- CWI, Tescan XRE, Nikhef, ASI
- Sophia B. Coban & Alexander Kostenko
- Willem Jan Palenstijn, Navrit Bal
- The Computational Imaging group

CWI

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MARIE CURIE ACTIONS

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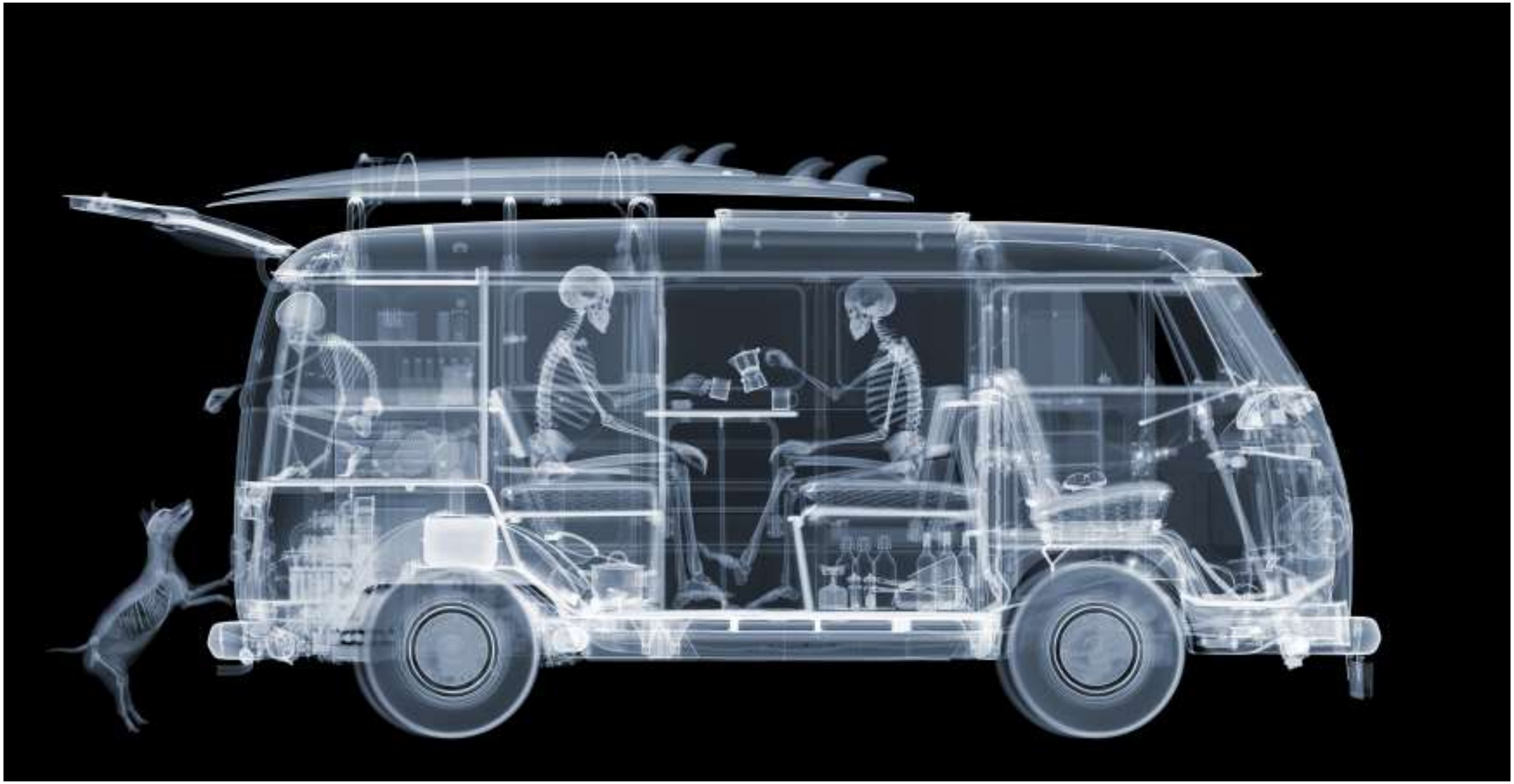
Tea & coffee time



Nick Veasey, VW Camper Van , 2019