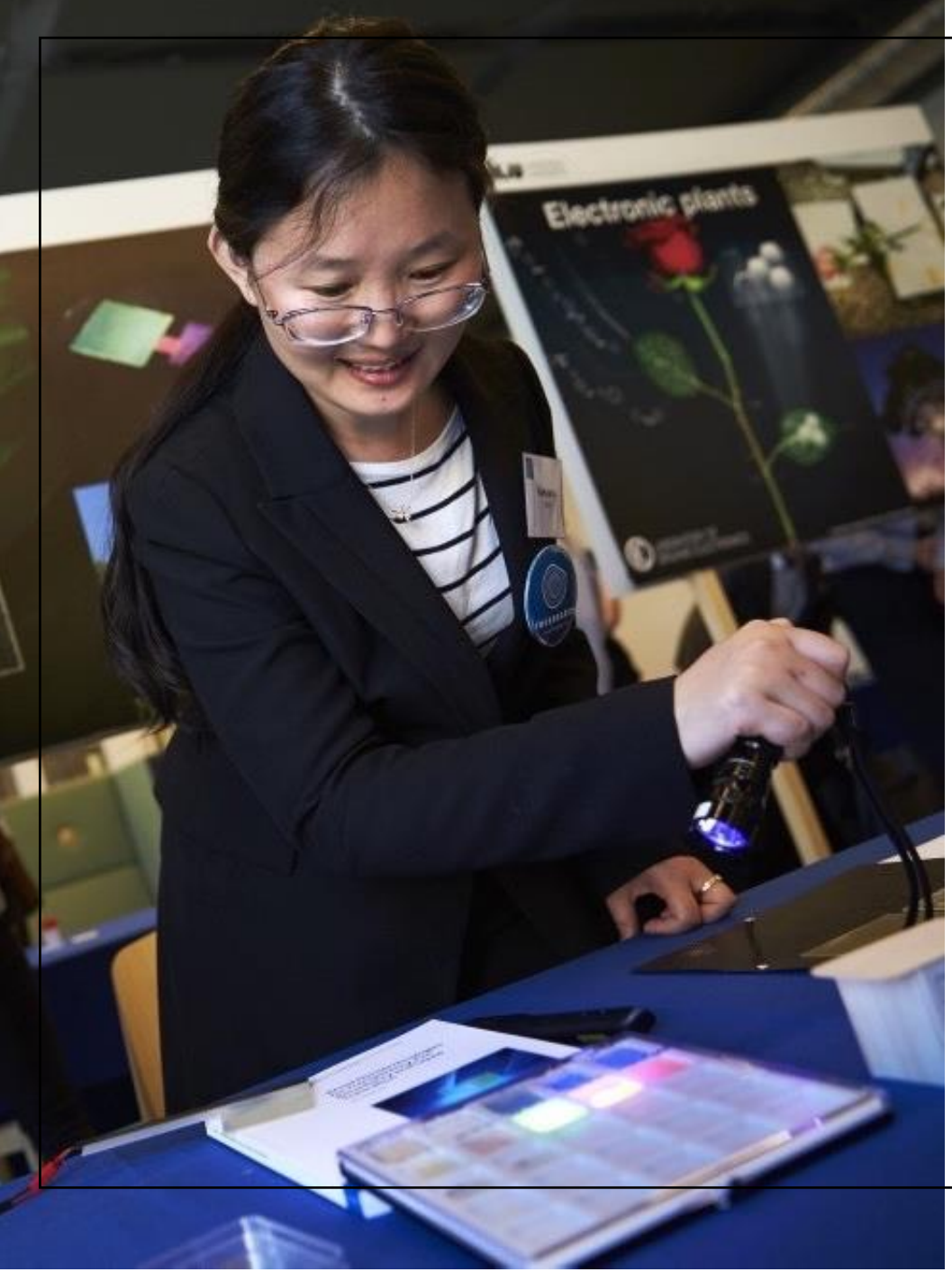
Treesearch and Formax

Mikael Thyrel, P3 FeedPro

- **Treesearch is a collaborative platform for research and competence building for new materials from the forest**

Treesearch is a national initiative where academia, industry, private foundations and the state create a world-leading open research environment for the bioeconomy of the future



Treesearch coordinates and supports research on new materials from the forest

- All researchers and research projects at associated Swedish universities can join and take part in Treesearch. The Wallenberg Wood Science Center is at the heart of the research activities using the platform.

- Over 450 researchers and over 200 projects connected to Treesearch (2023).

Treesearch's impact goals

Treesearch is expected to lead, among other things

- Increase in **knowledge and skills** in industry and academia
- Career opportunities for at least **250 young researchers**
- **Groundbreaking research** that can transformed by industry

TREESEARCH

Treesearch has activities in four areas: research, education, research infrastructure and cooperation.

- **Coordinate research**

Gathers researchers in academia and industry to collaborate strategically with the research area

Build skills and competence

Organizes courses and training courses, open to academia and industry. In education, there is a strong link to research infrastructure.

Provide advanced research infrastructure

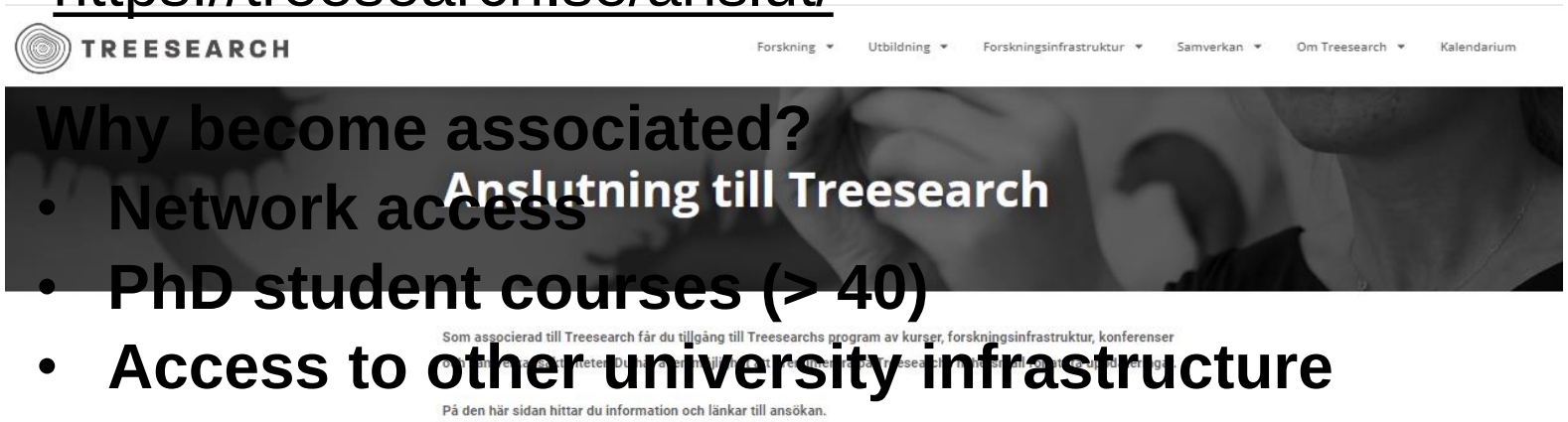
Identifies and packages equipment and methods and offers support for academia and industry in use.

Increased cooperation

Creates meeting places, such as conferences and seminars for increased interaction and for increased opportunity to access research and knowledge.

Association to Treesearch

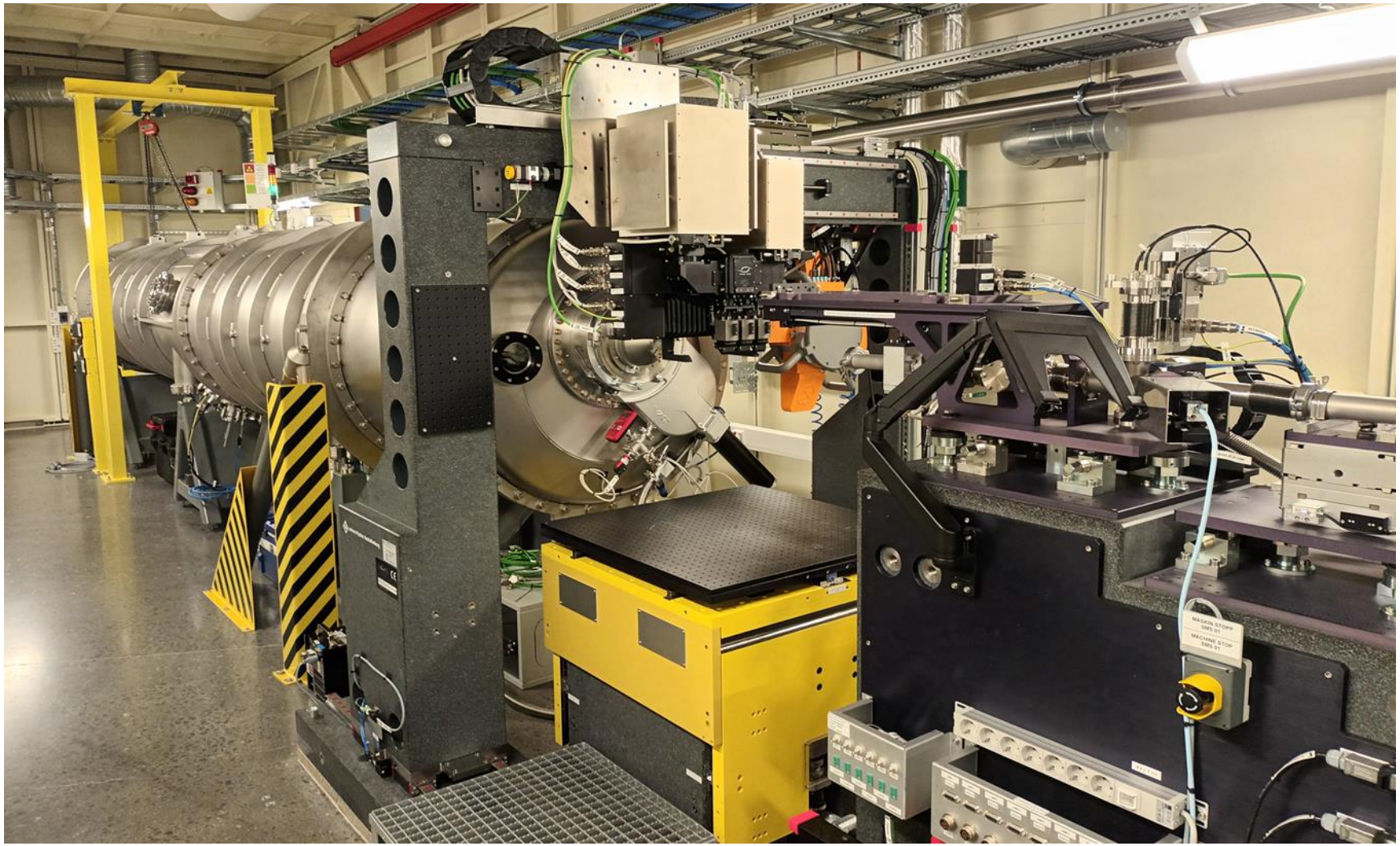
- https://treesearch.se/anslut/

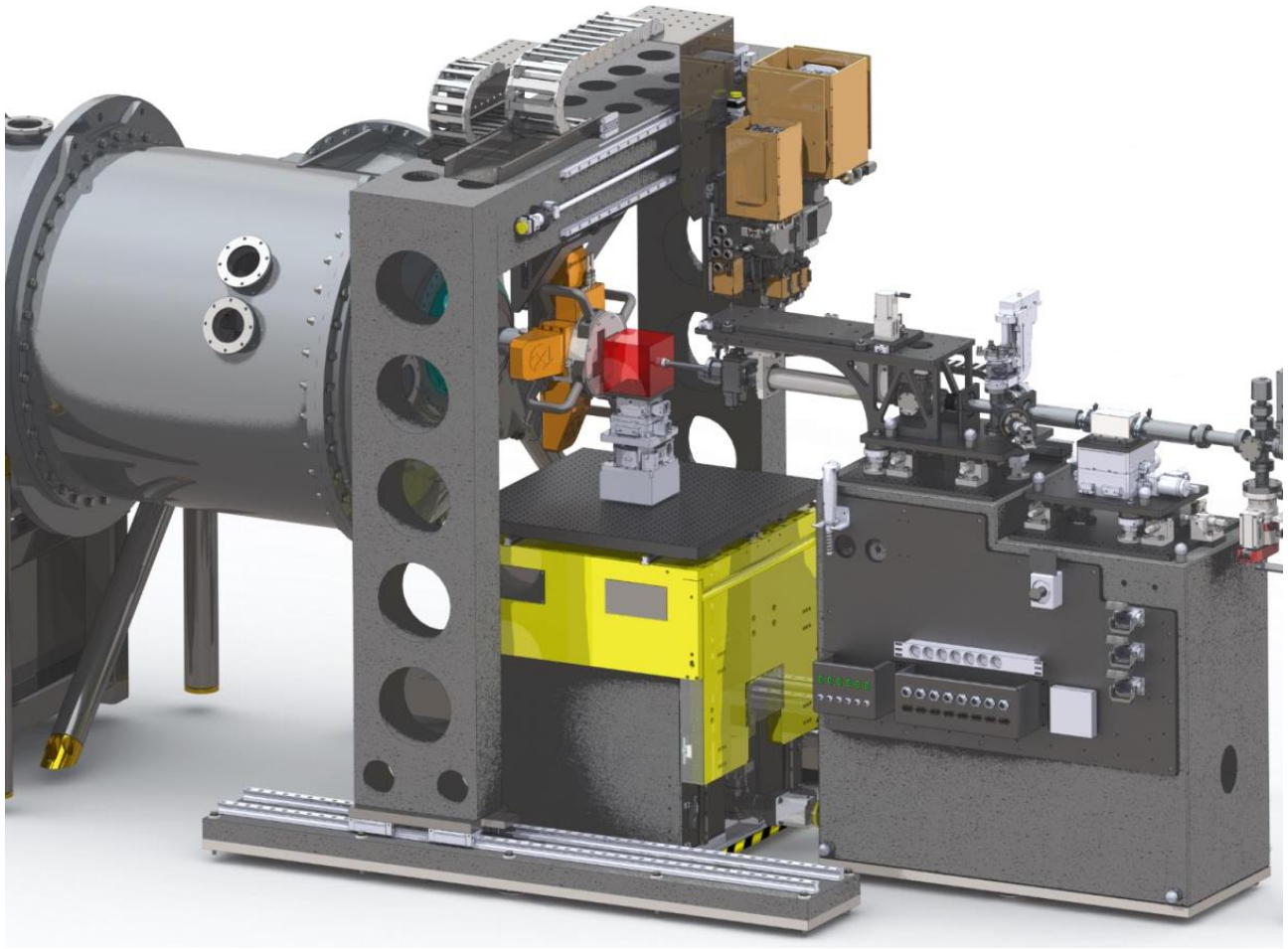


Why become associated?

- Network access
- PhD student courses (> 40)
- Access to other university infrastructure
- Easier access to ForMAX

ForMAX – the forest industry beamline





ForMAX beamline

Funding:

- 100 MSEK investment for construction cost by KAW
- 80 MSEK operation cost by industry via Treesearch

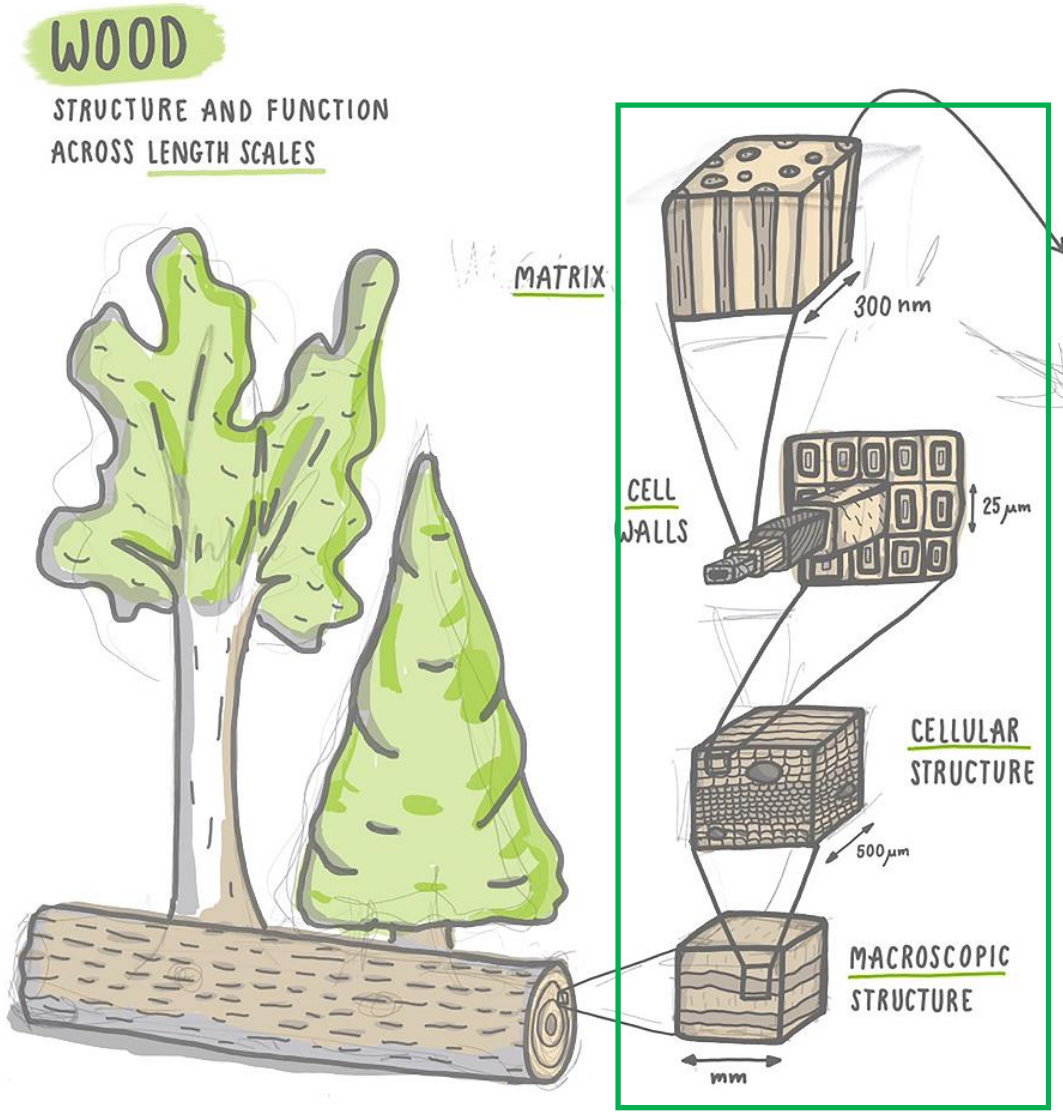
Beam time allocation:

- 50% Treesearch access
- 50% general access

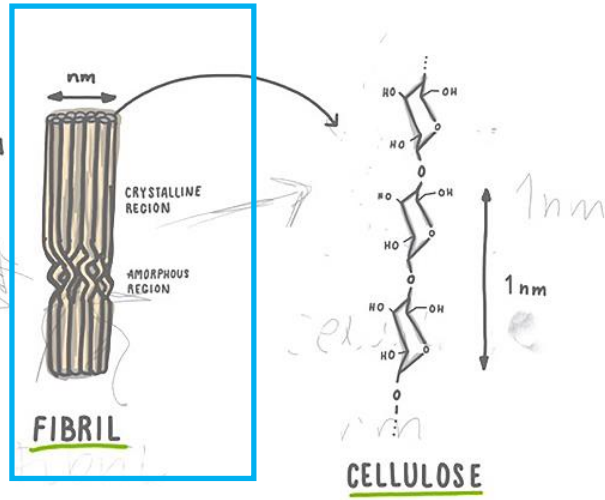
General, non-proprietary access

Hierarchical materials (or heterogeneous materials)

Important structure at many different length scales



Nanoscale building blocks



Assembly at nano- & microscopic length scales

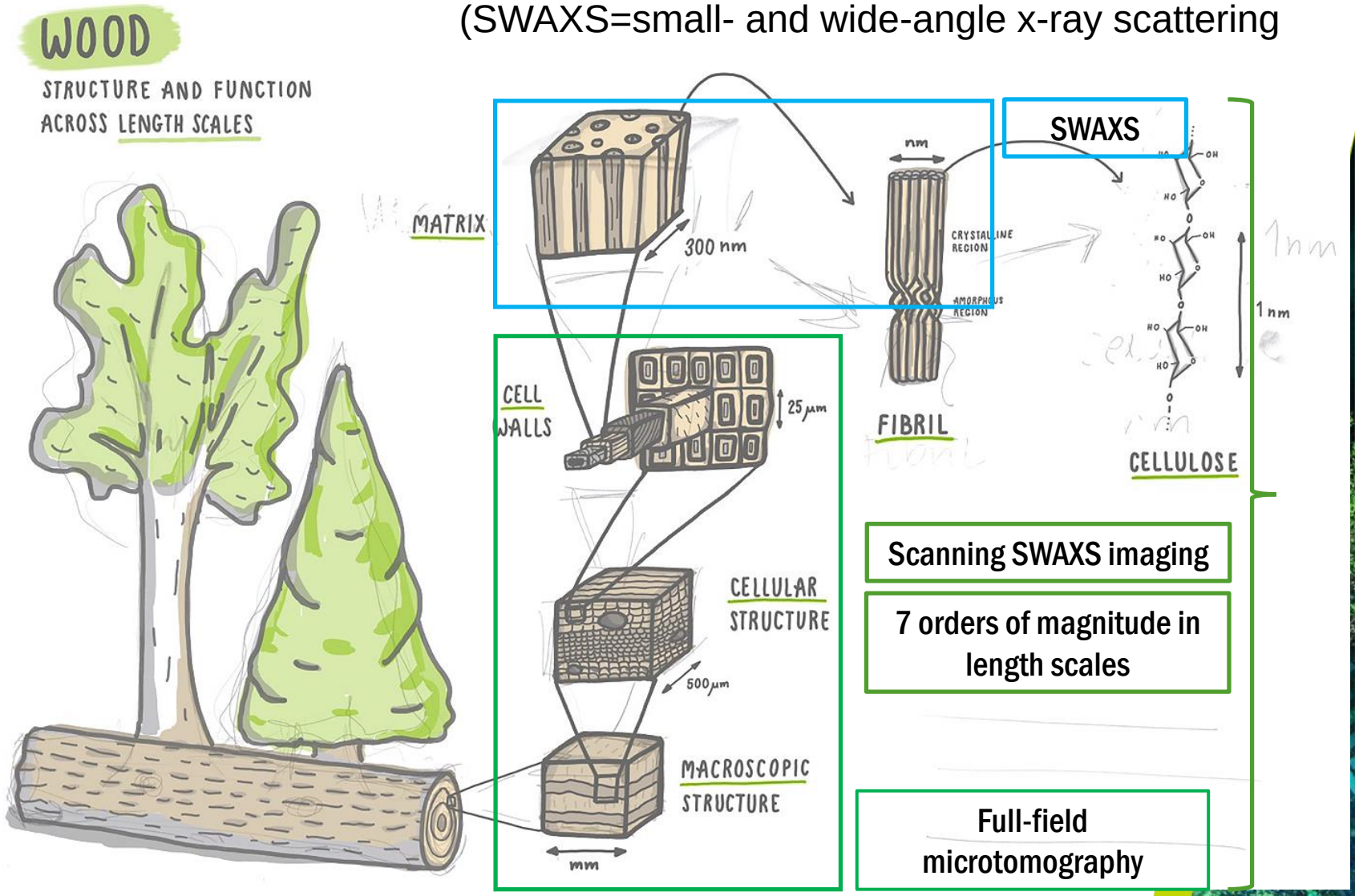
Structure-function relationship

- Multiscale structural characterization
- Temporal resolution to study processes *in situ*

Multiscale & multimodal imaging

Probing structure at many different length scales

(SWAXS=small- and wide-angle x-ray scattering



Flexible techniques

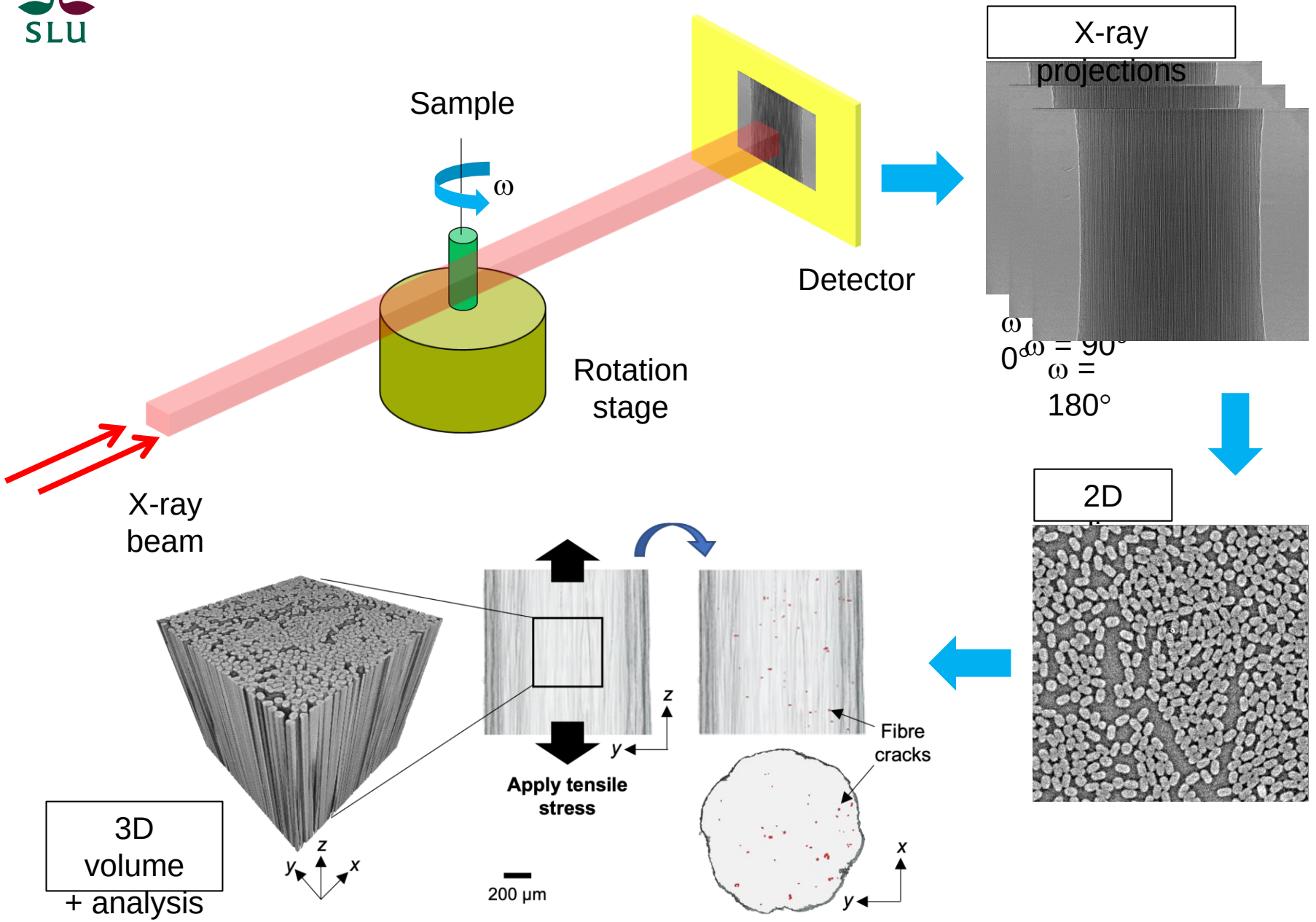
- Widely applicable to different materials
- Fairly insensitive to sample environments

Key features

- 8-25 keV
- High photon density

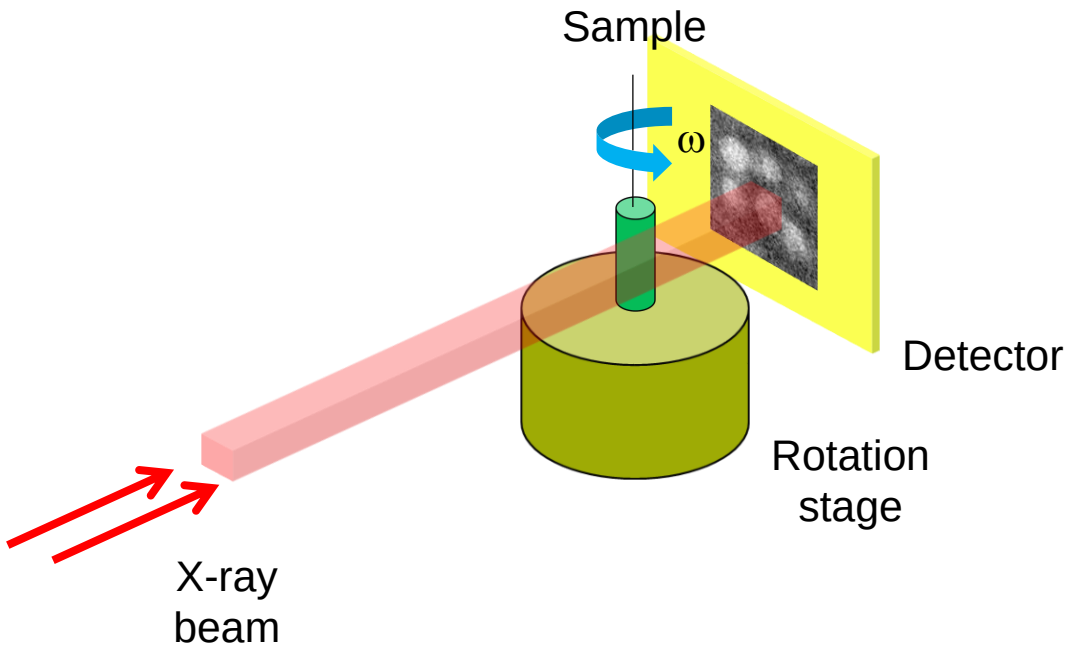
X-ray microtomography

How does it work?

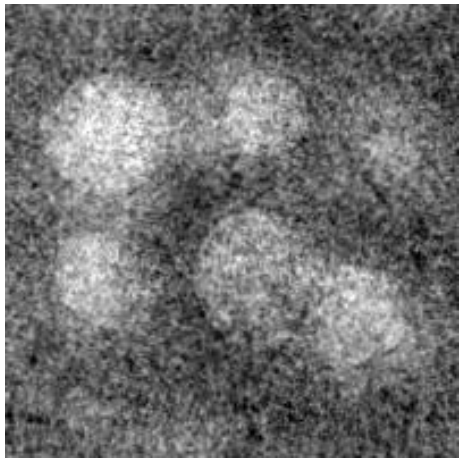


X-ray microtomograph

Propagation-based phase contrast



X-ray projection

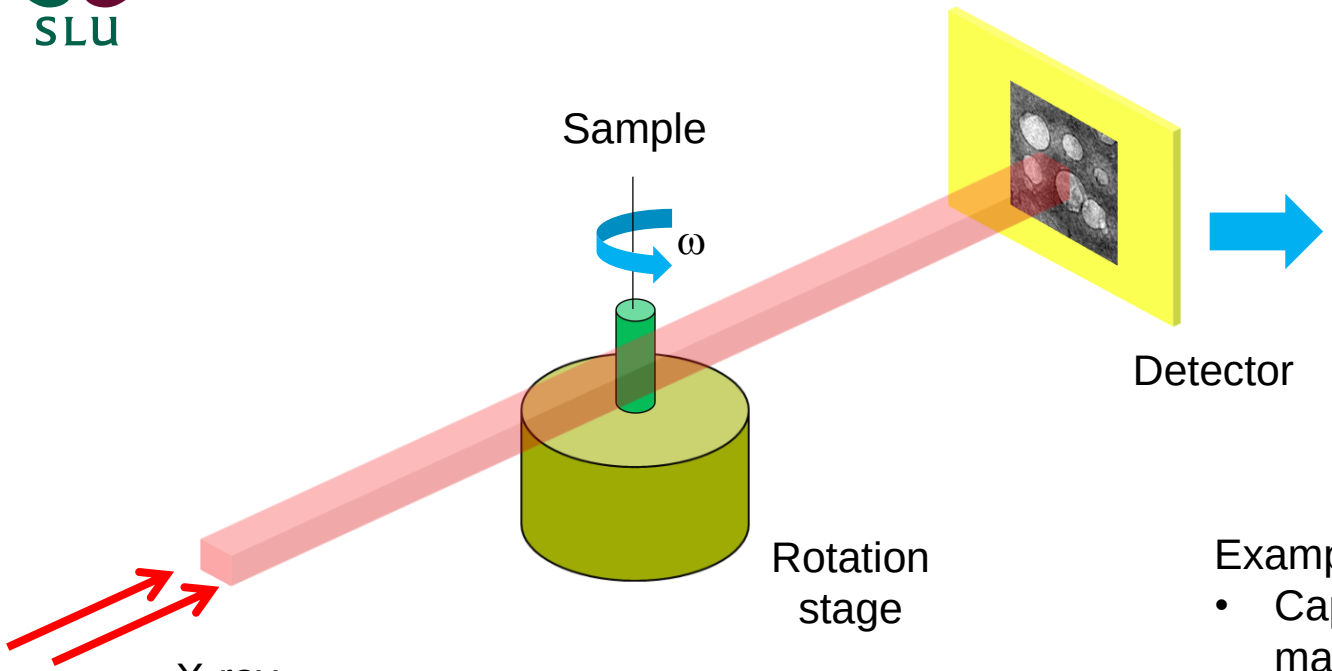


Example: Polymer composite

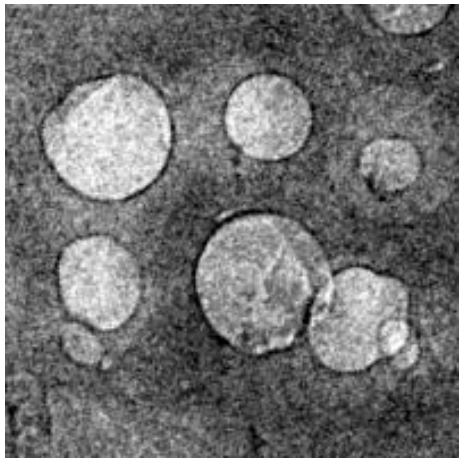
- Capsules within epoxy matrix
- Effect of propagation distance

X-ray microtomography

Propagation-based phase contrast

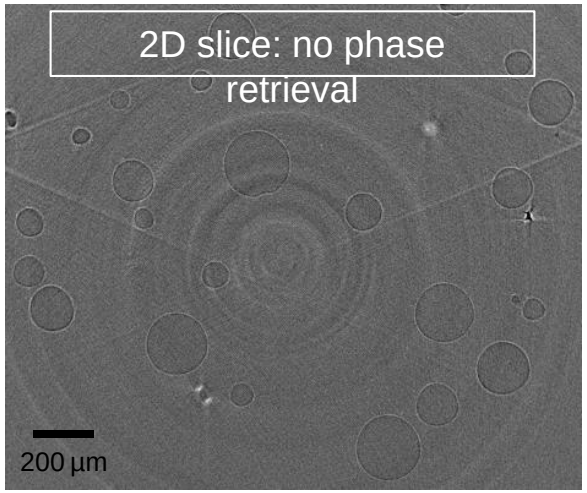


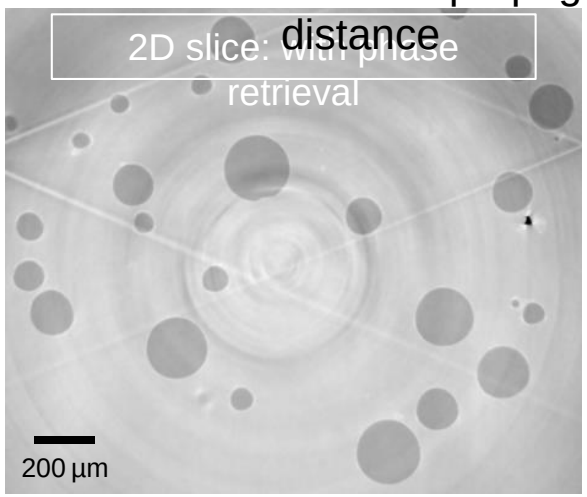
X-ray projection

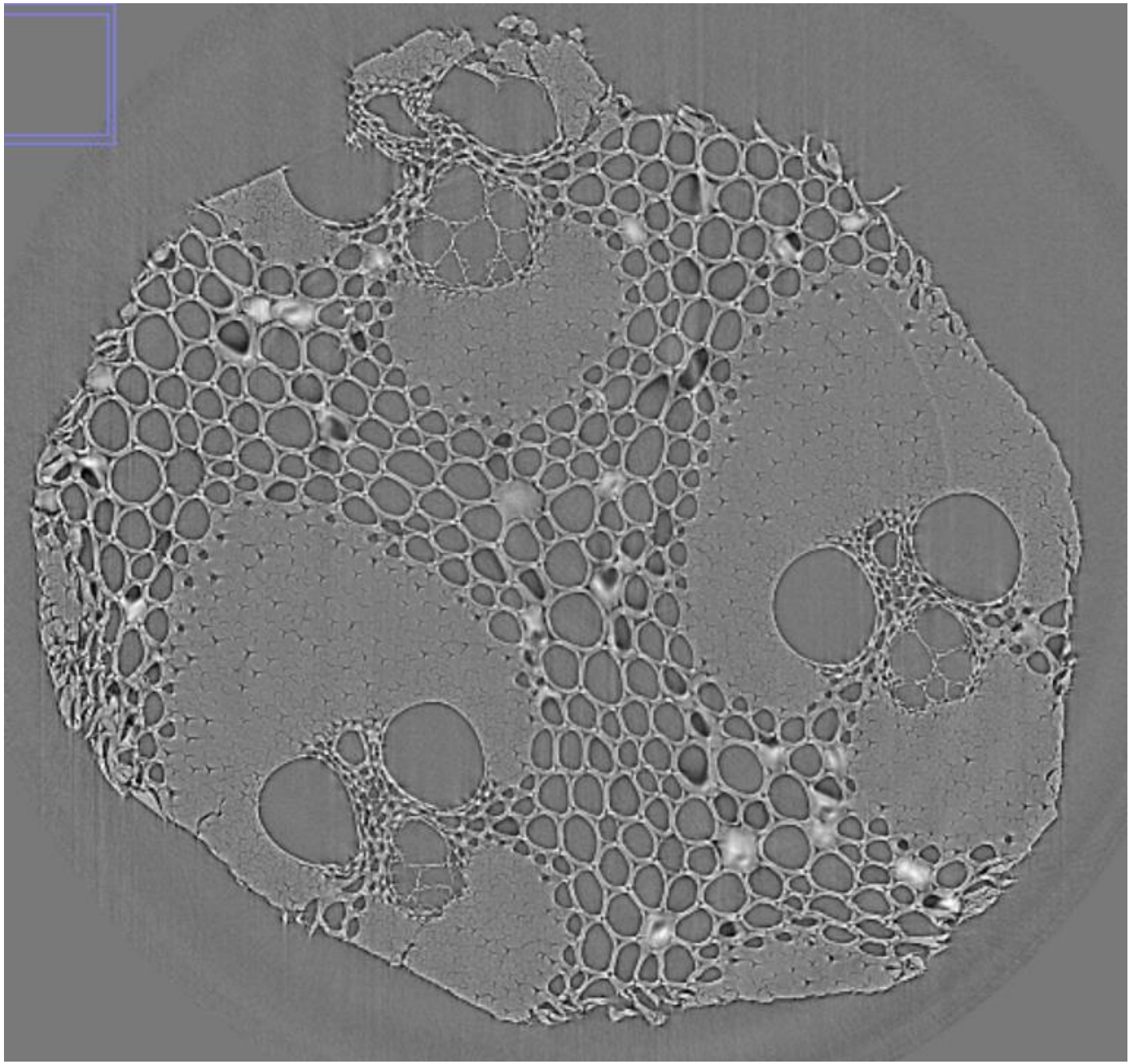


Example: Polymer composite

- Capsules within epoxy matrix
- Effect of propagation distance



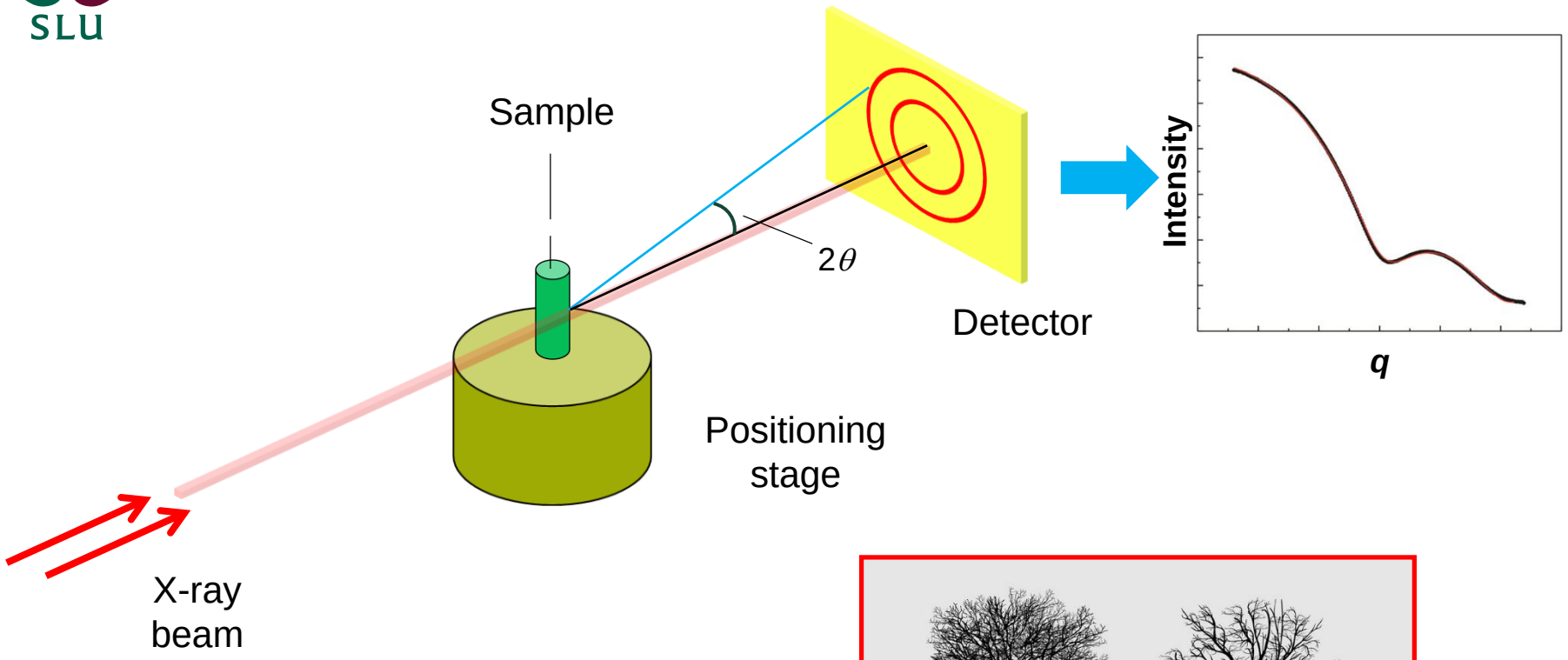




X-ray microtomography

Microscopic characterization:

- Length scales ≈ 1 µm – 5 mm
- Time scales down to sub-s

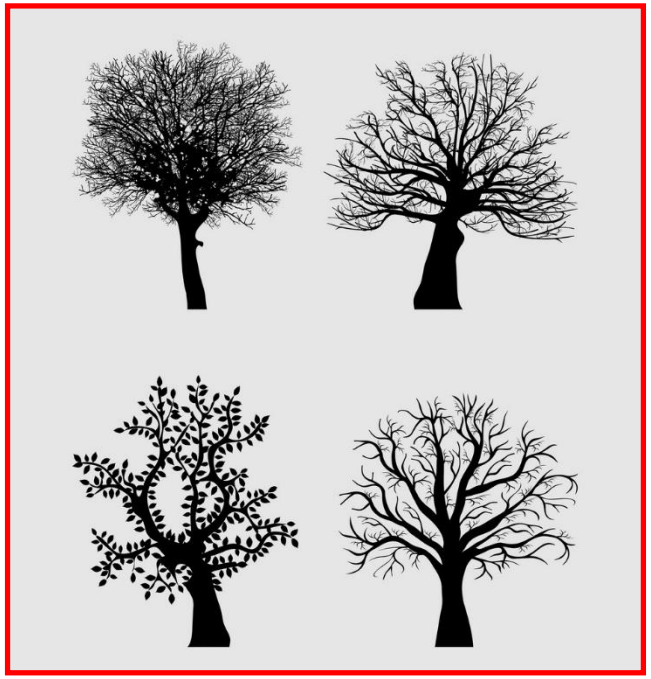


SWAXS

Nanoscopic characterization:

- Length scales ≈ 1-500 nm
- Time scales ≥ few ms

Ensemble-averaged statistics of nanoscale features of the sample



Zooming into hierarchical structures

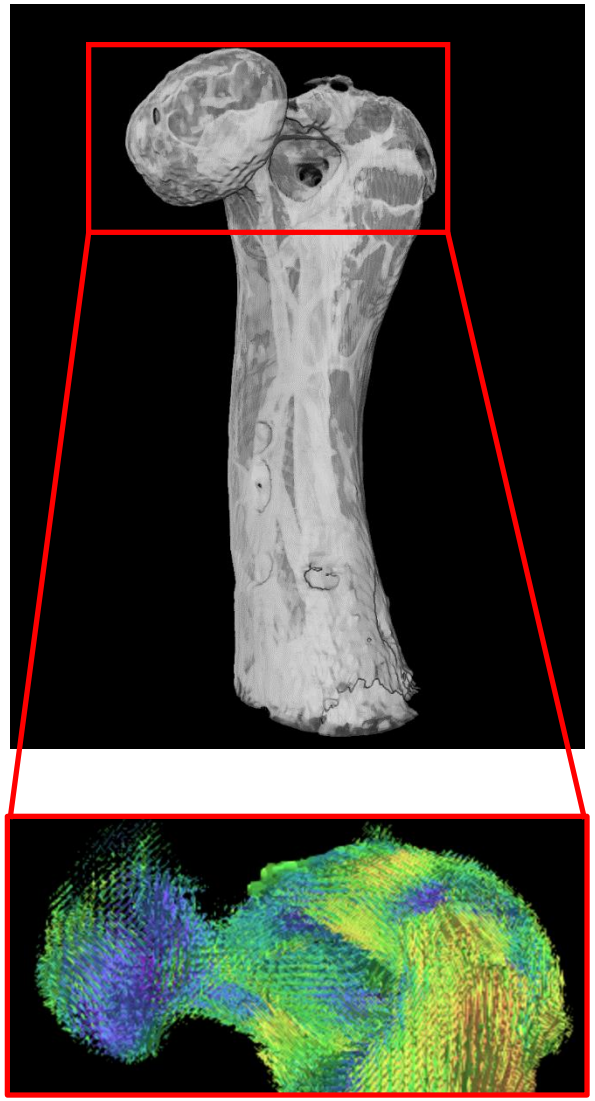
Key feature of ForMAX

Image courtesy C Appel (PSI)

Multimodal imaging

Full-field microtomography
- Overview of 3D structure
- Identify ROIs

Local SWAXS imaging
- Nanoscopic structure
- Orientation



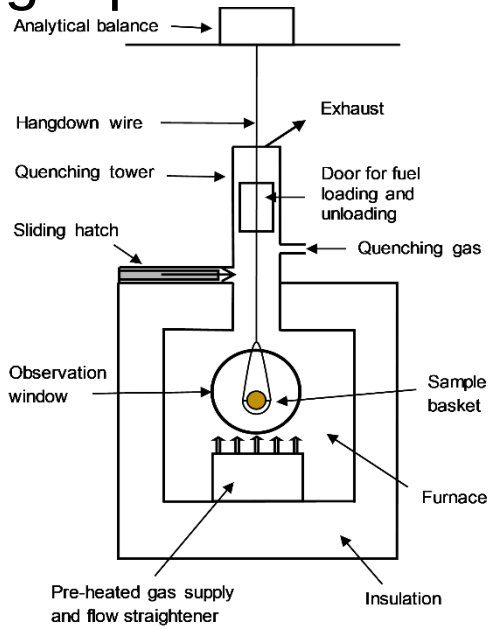
Biomass pellet combustion: characterized by synchrotron X-ray micro-tomography

Aim: achieve time resolved information on char morphology and the development of cavities and ash layers during the combustion

Pellet combustion

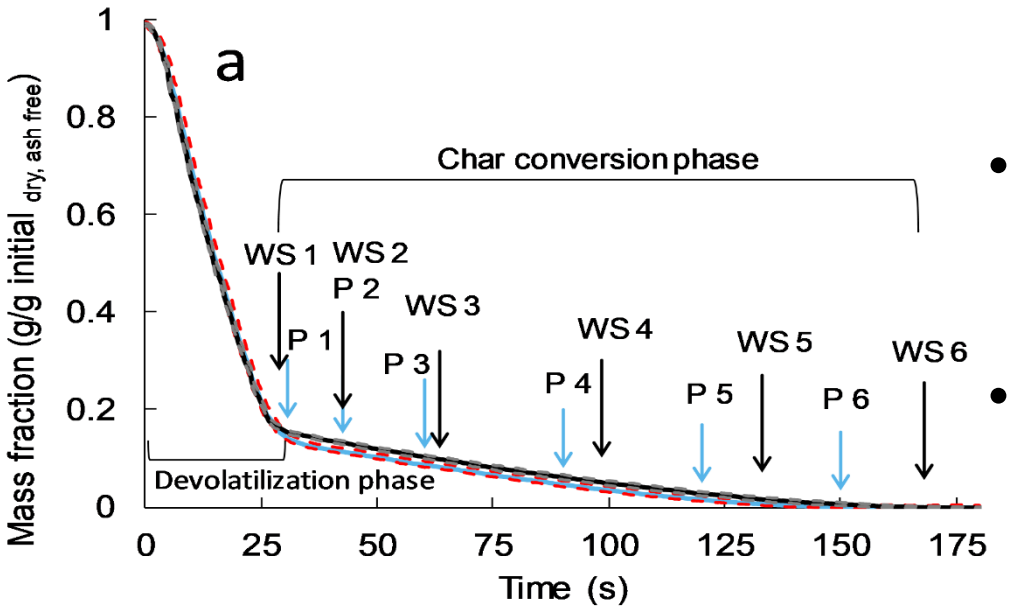
@pelletpro.org

Single pellet combustion



(Strandberg et al. 2018 Fuel Proc. Tech. **176**, 211-220)

Single pellet experiments

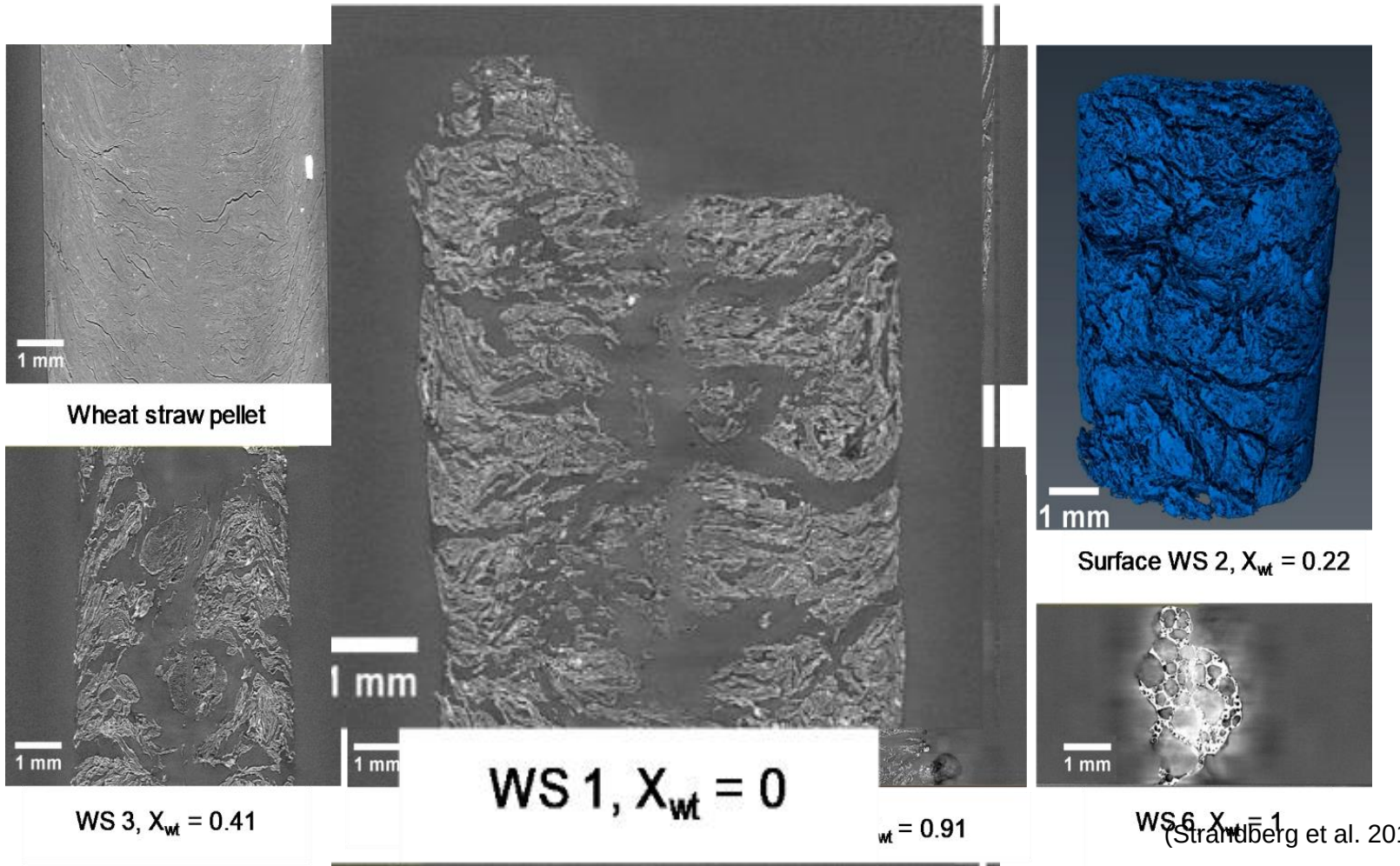


- Wheat straw was chosen as a biomass model
- Quenched at 6 conversion points

WS 1, X_{wt} = 0 | WS 2, X_{wt} = 0.22 | WS 3, X_{wt} = 0.41 | WS 4, X_{wt} = 0.68 | WS 5, X_{wt} = 0.91

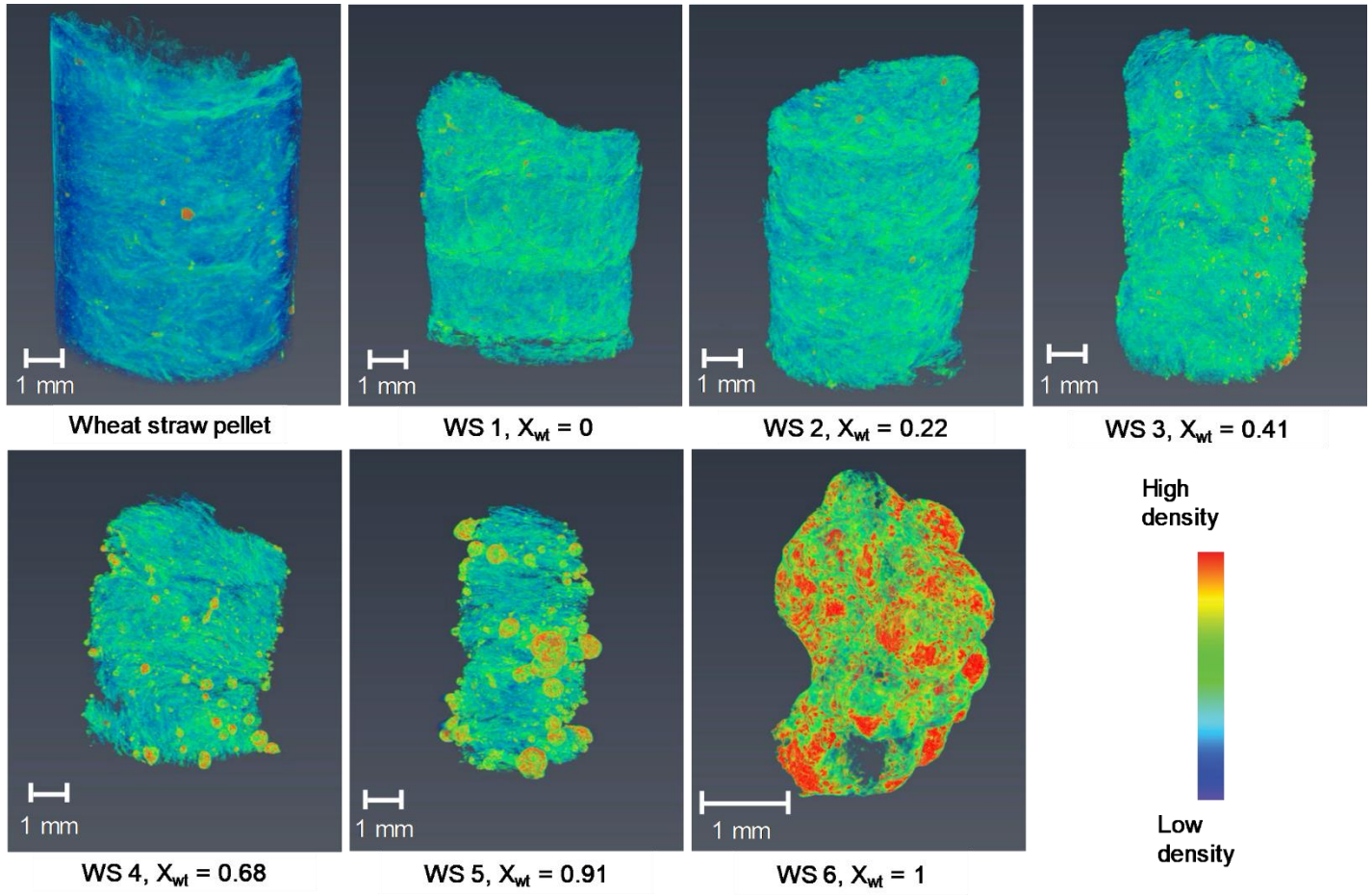
X-ray tomography, ALS Berkeley

Resolution 3.25 µm



(Strandberg et al. 2018 Fuel)

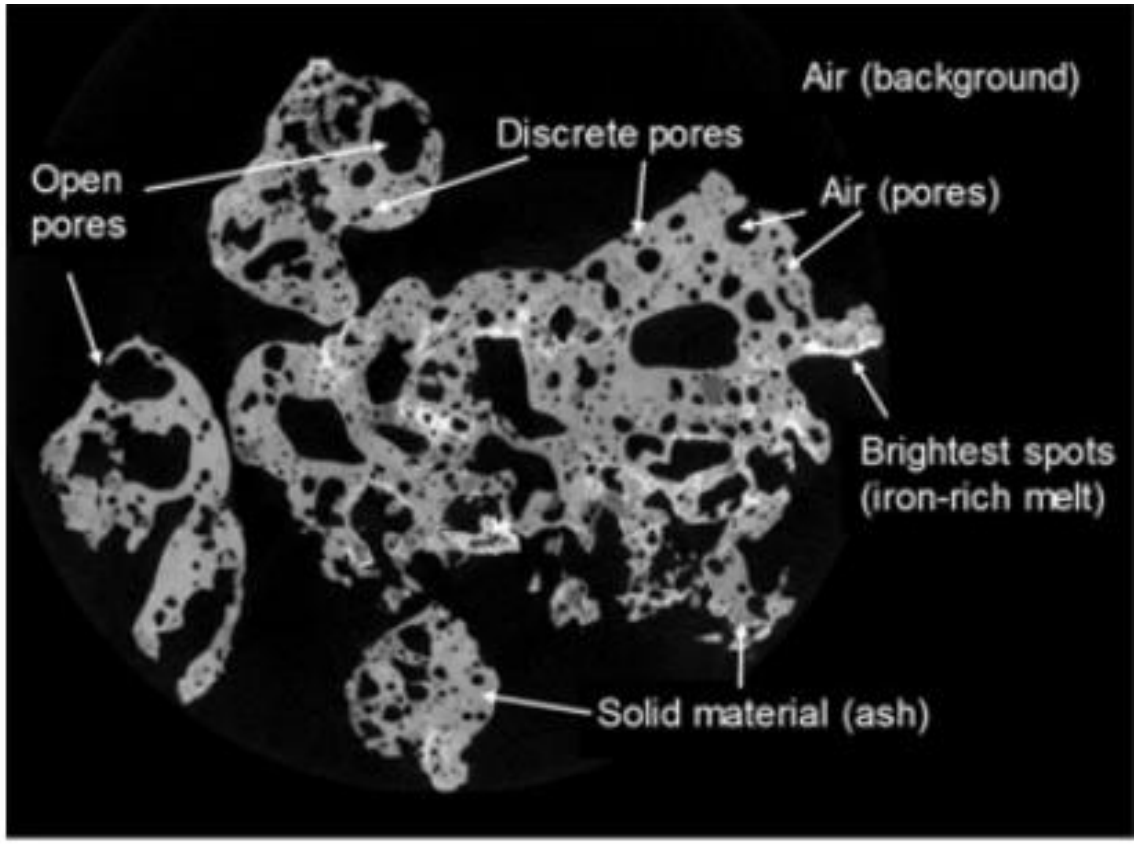
Ash layer formation

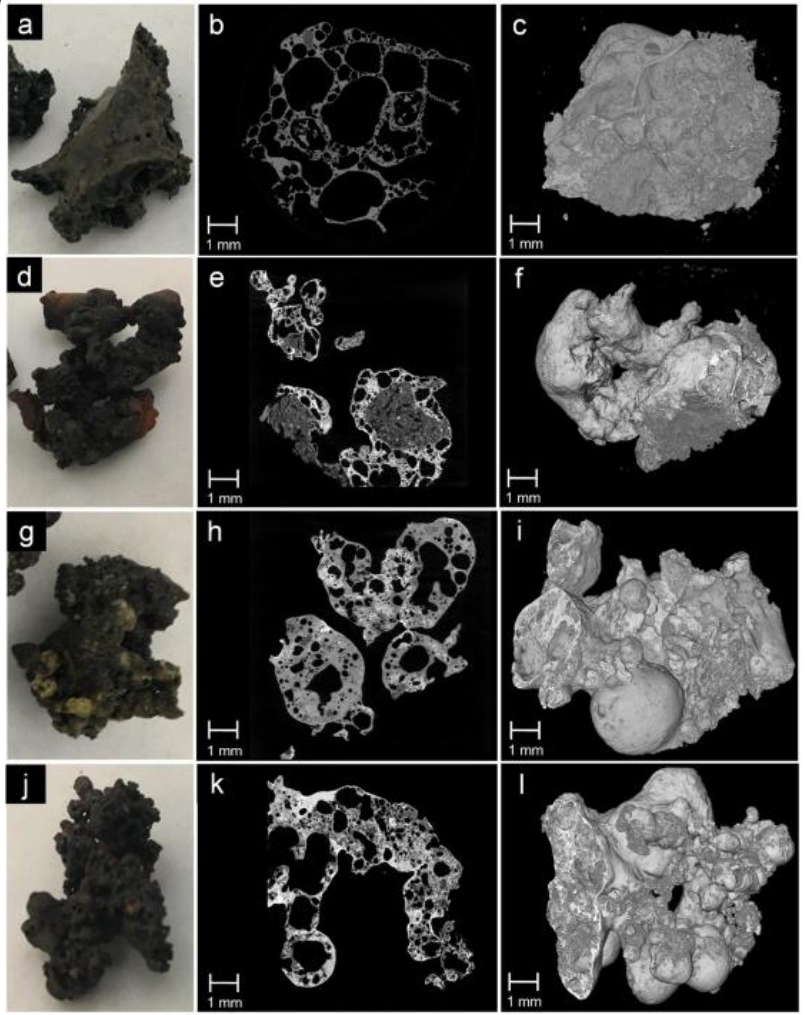


Ash “bubbles” forming on the outside of the pellets. SEM-EDS confirmed K-Si melts

Study of ash from co-combustion of sewage sludge and wheat straw with X-ray microtomography

Aim: study the ash particles' porosity and internal microstructure to assess interaction with plant roots and pore water

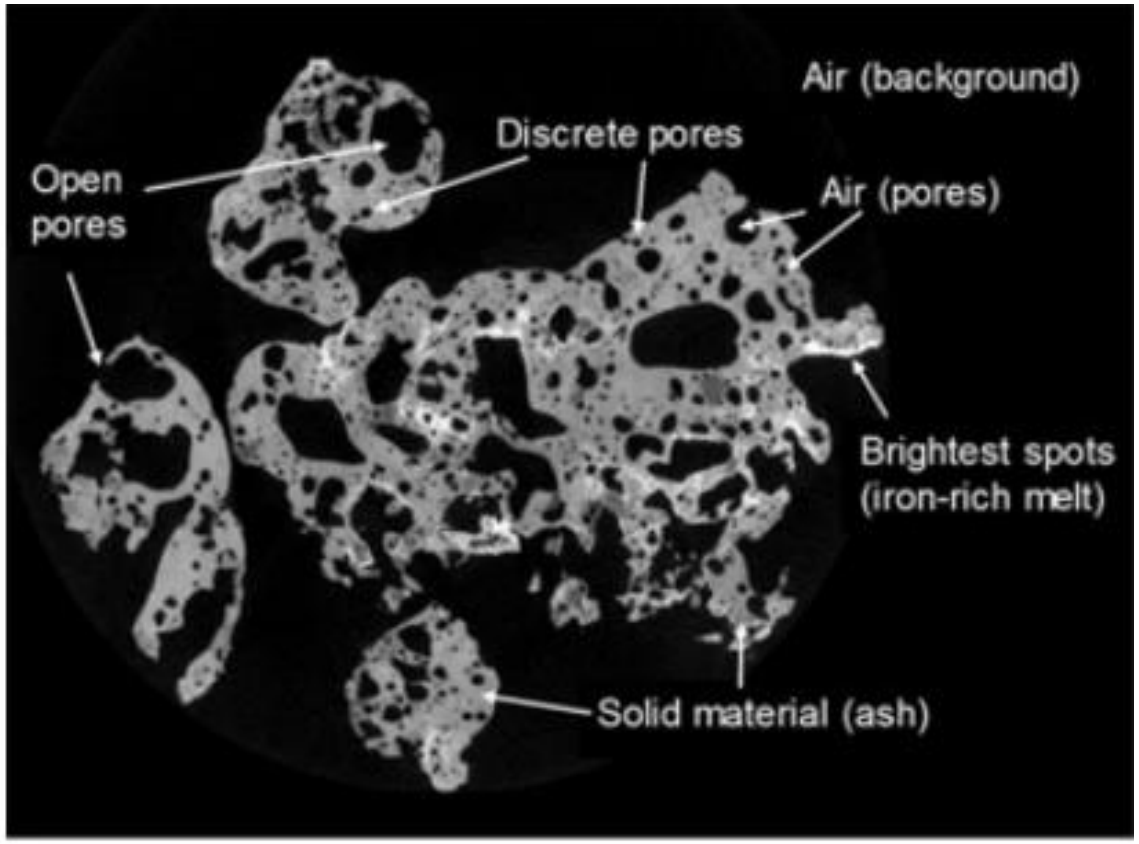




Strandberg et al. Waste management (2021)

Study of ash from co-combustion of sewage sludge and wheat straw with X-ray microtomography

Aim: study the ash particles' porosity and internal microstructure to assess interaction with plant roots and pore water.



- 72–99 vol% was open pores
- Thin particle walls and open pores may promote weathering upon soil application.
- Pore openings over 200 µm provides an opportunity for root and microbe interaction.

Strandberg et al. Waste management (2021)

Thank you!

ForMax beamline scientist
Kim.nygard@maxiv.lu.se

David Castor, https://commons.wikimedia.org/w/index.php?curid=37567445