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A large, ornate classical building facade with columns and a pediment, set against a sky filled with dramatic, golden-hued clouds. A black street lamp is visible in the foreground.

# Opportunities with synchrotron imaging

- Internationally and locally

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MARTIN BECH  
MEDICAL RADIATION PHYSICS, LUND UNIVERSITY

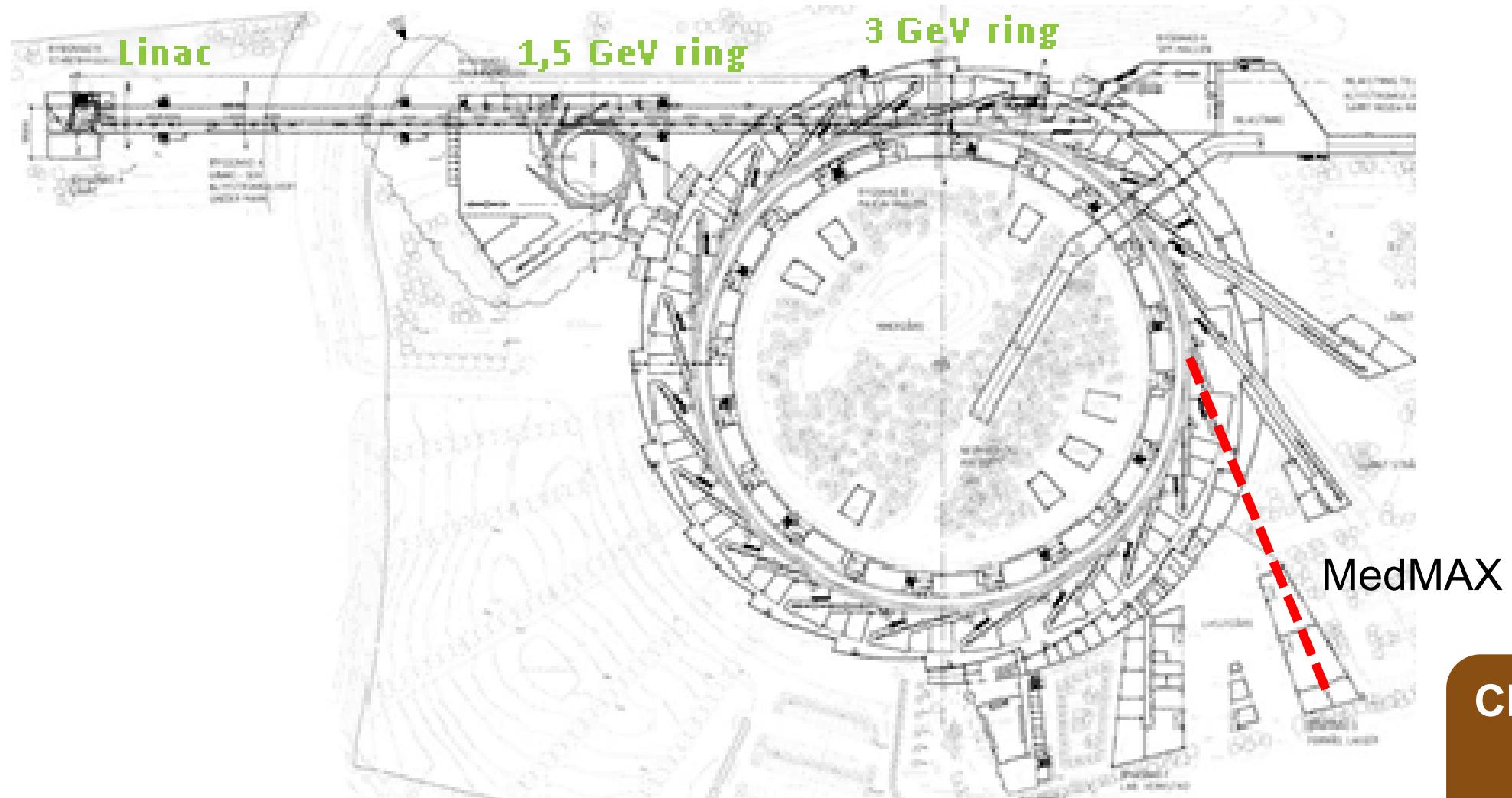


# Large scale synchrotron facilities



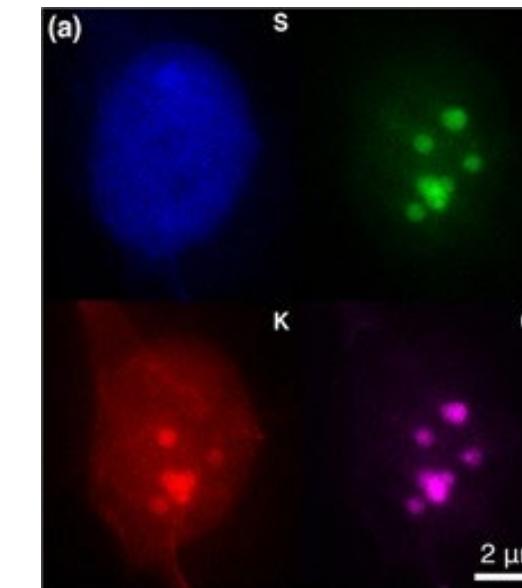
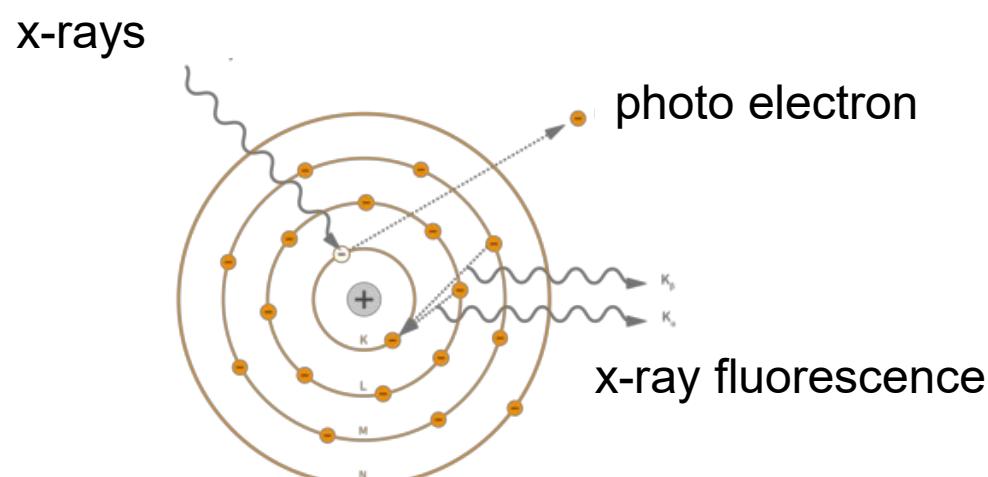
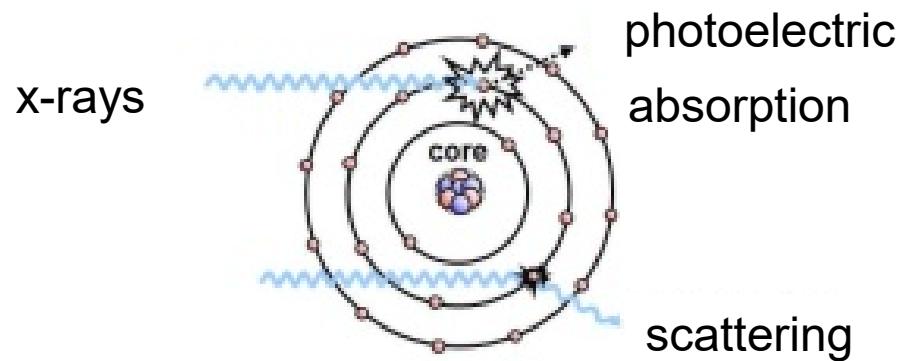
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# MedMAX – for biomedical imaging

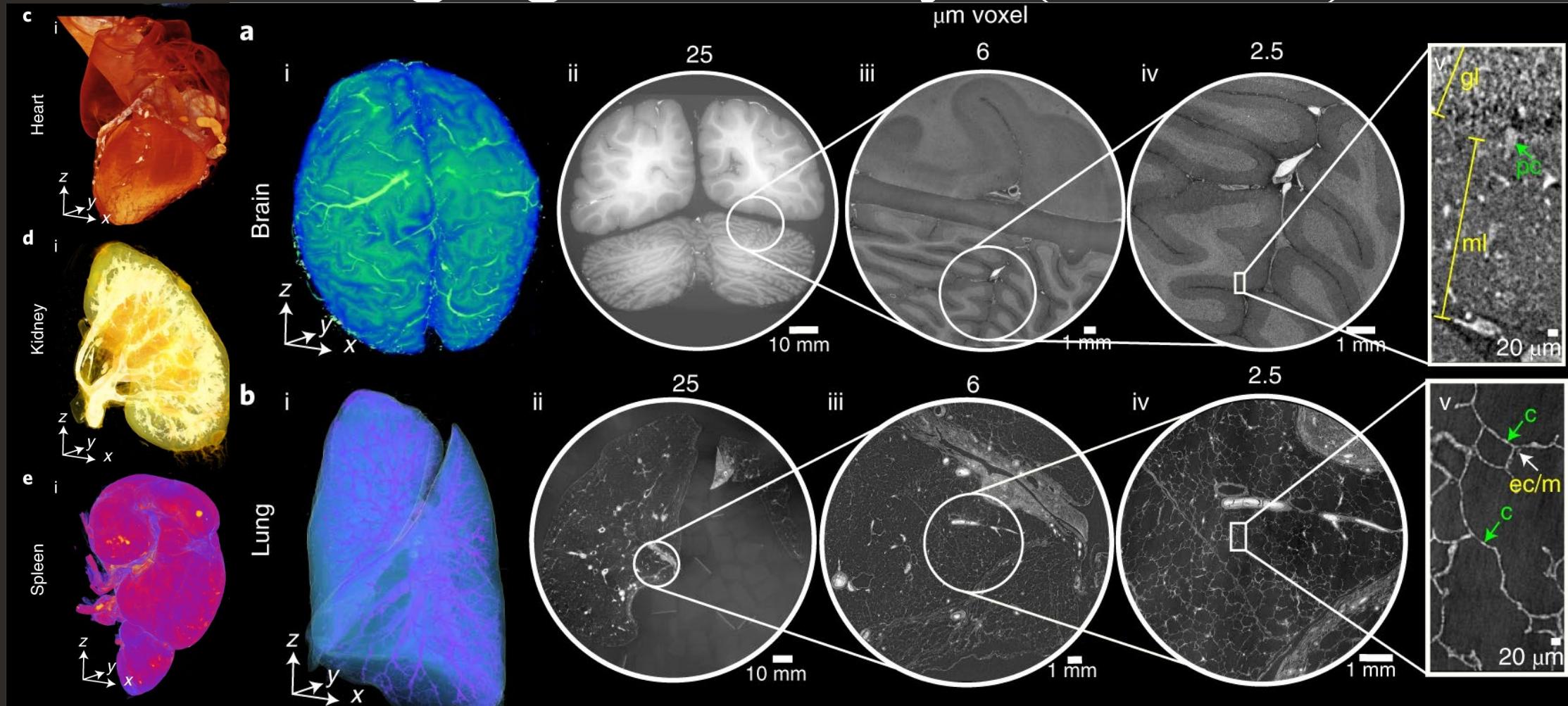


CMU

# X-ray interaction with tissue



# Imaging with x-rays (ex-vivo)



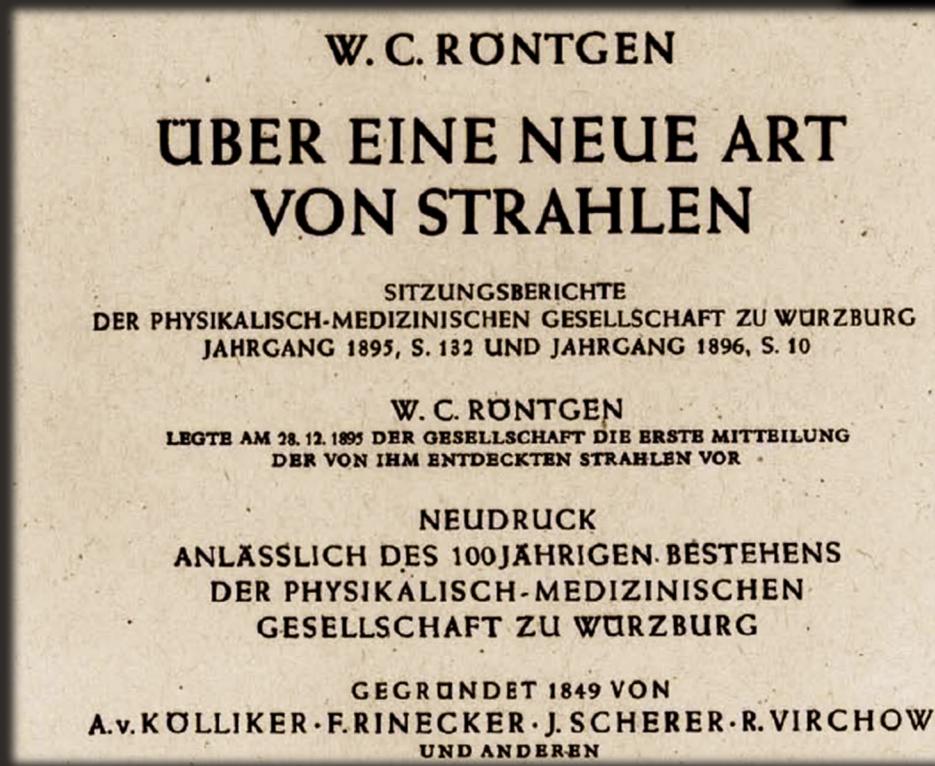
Walsh et al. *Nature Methods* **18** (2021) pages 1532–1541

Imaging intact human organs with local resolution of cellular structures using hierarchical phase-contrast tomography



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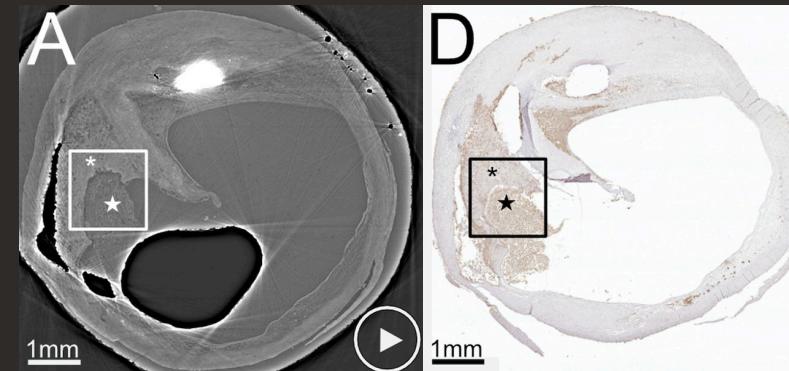
# X-rays: just another type of radiation



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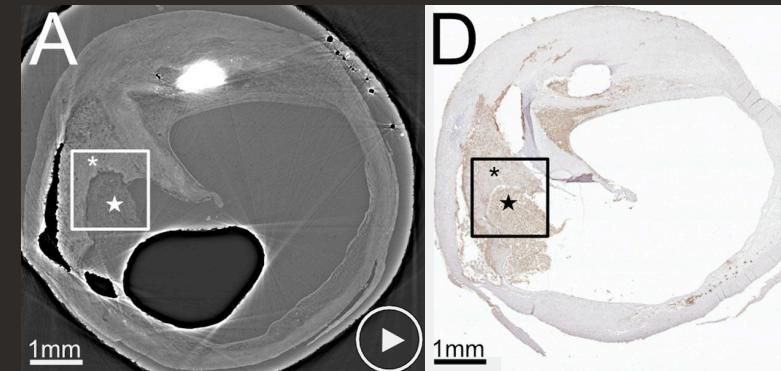
# Advantages of X-ray microscopy

- Virtual sectioning (no actual slicing)

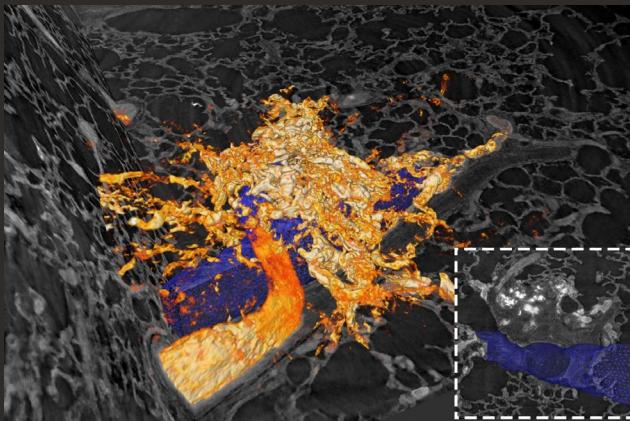


# Advantages of X-ray microscopy

- Virtual sectioning (no actual slicing)



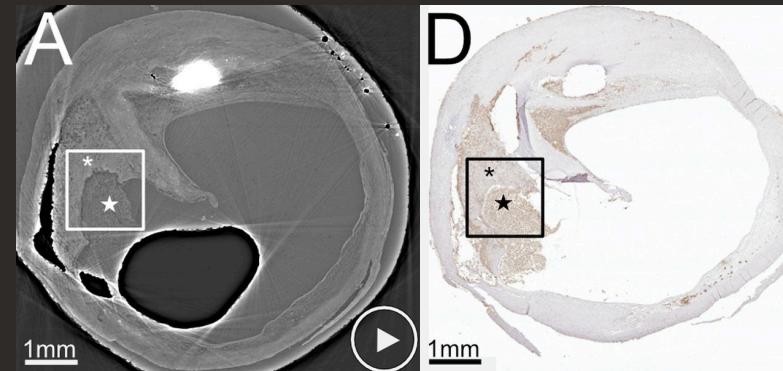
- Obtaining morphological insight of volumetric structures



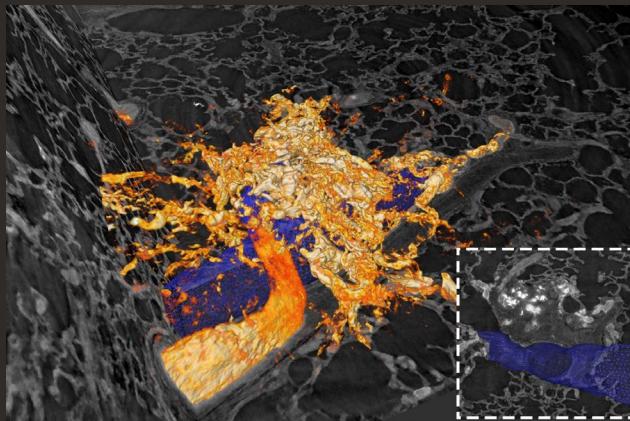
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# Advantages of X-ray microscopy

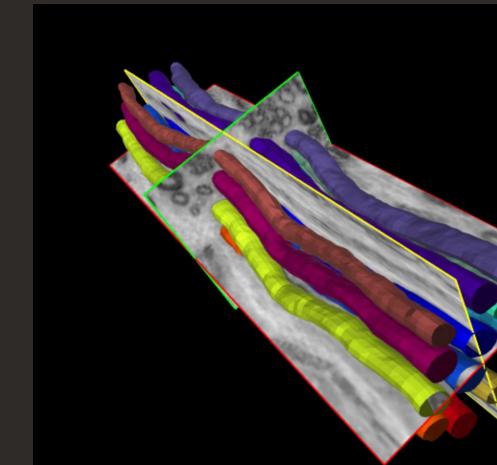
- Virtual sectioning (no actual slicing)



- Obtaining morphological insight of volumetric structures



- Extracting quantitative information about morphology



# Workflow

- Tissue biopsy extracted



- Tissue dehydrated



- Tissue embedded in e.g. paraffin



- X-ray microtomography



- Tomographic slicing



- Visible light microscopy / X-ray fluorescence microscopy

In-vivo imaging

# Carotid plaque

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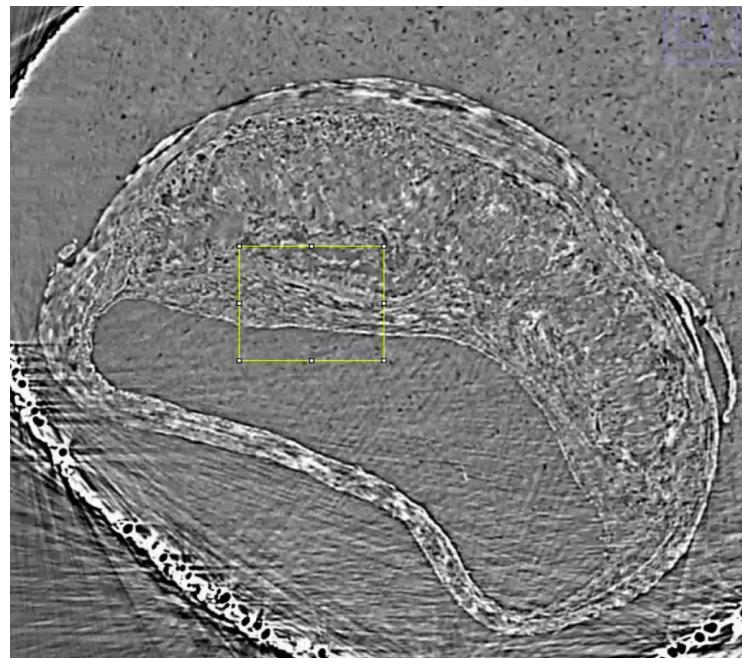


# Phase contrast imaging

- High resolution

## Carotid plaque

Without phase retrieval

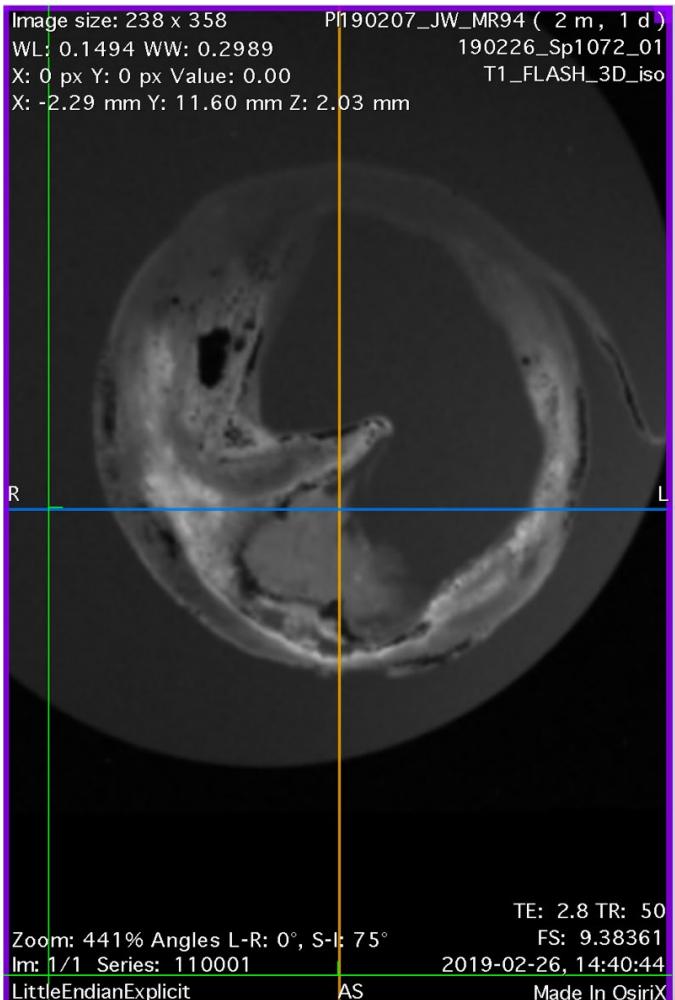


With phase retrieval

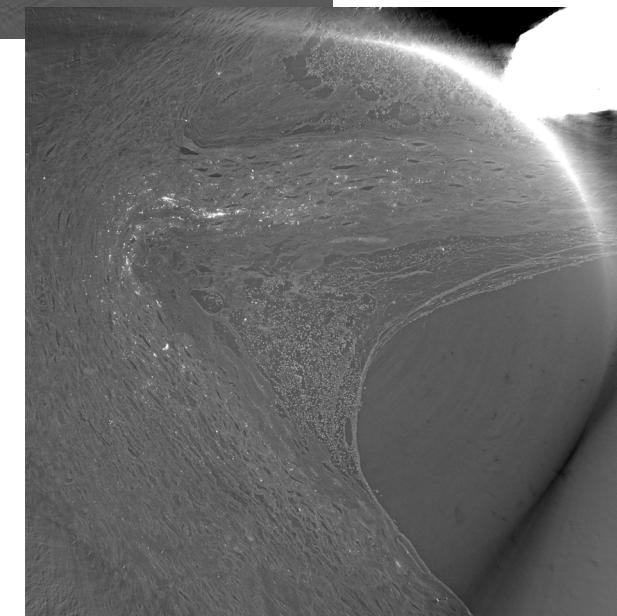
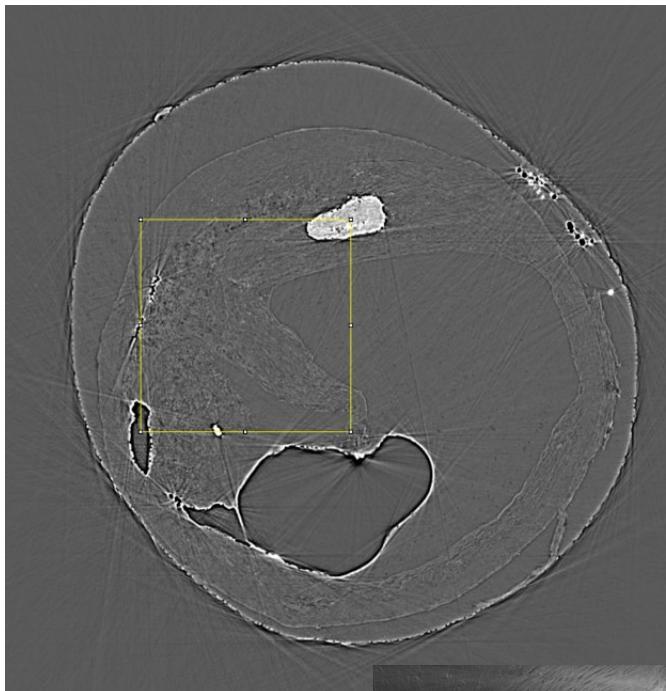


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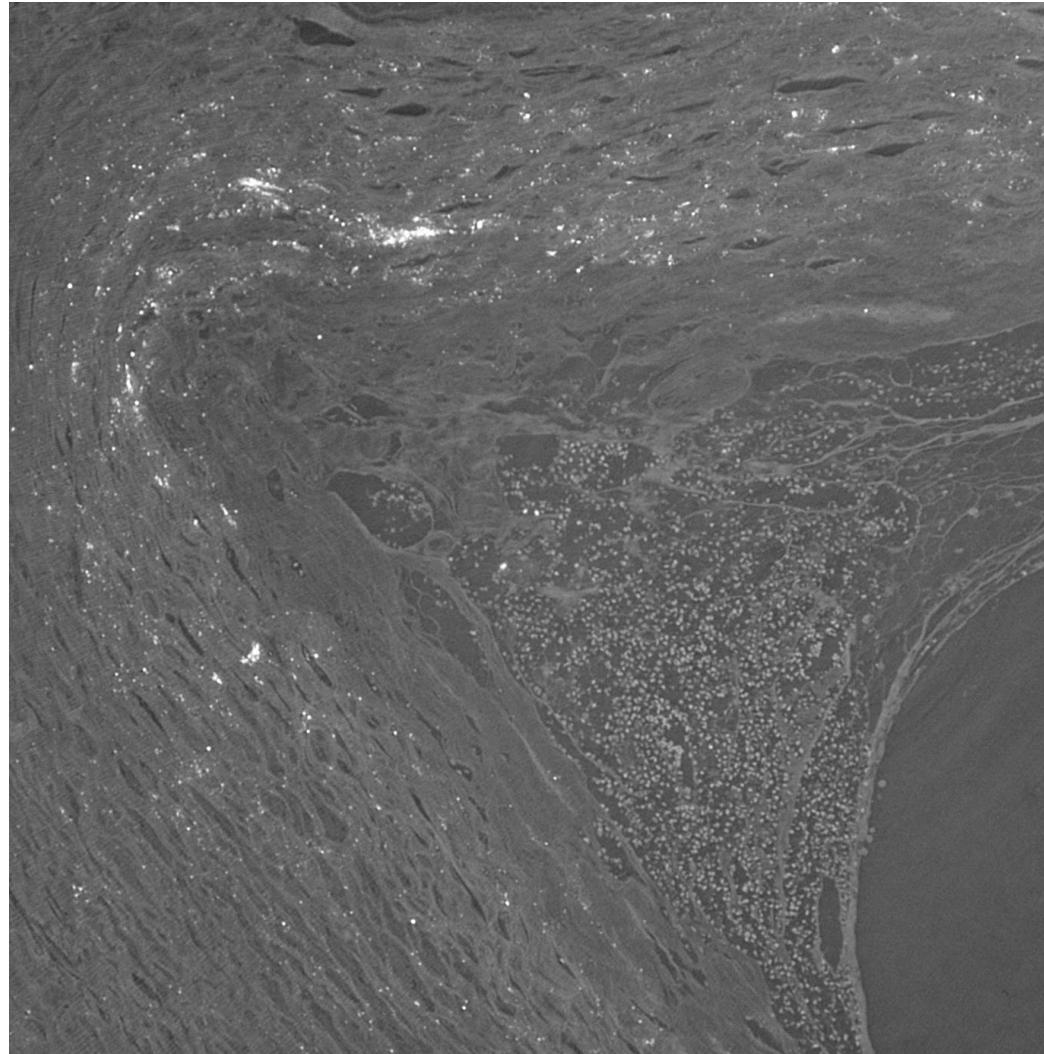
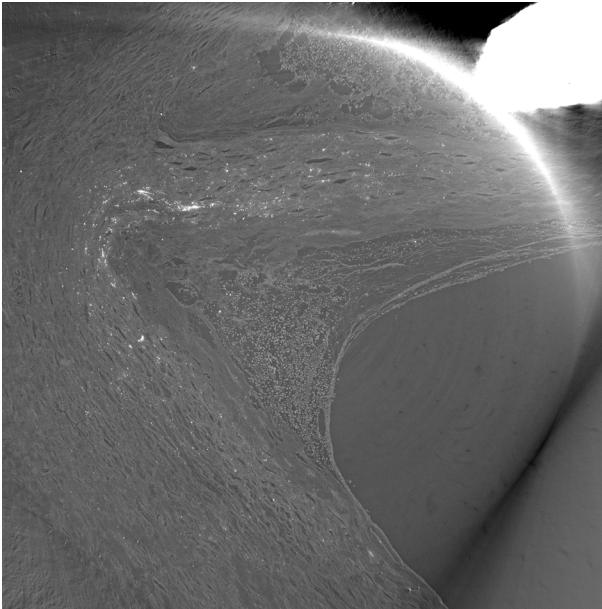
# Carotid Plaque



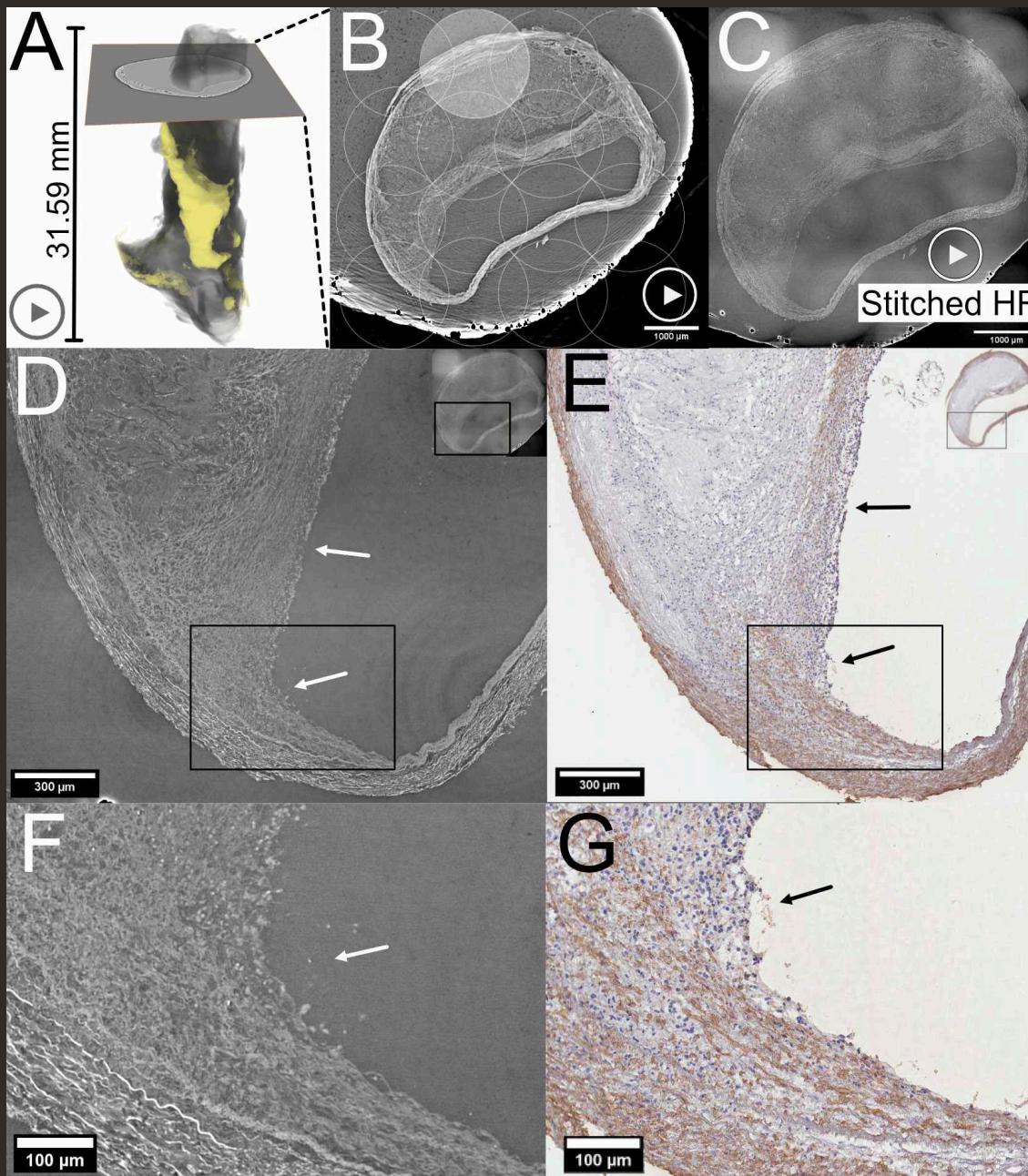
Micro-MRI



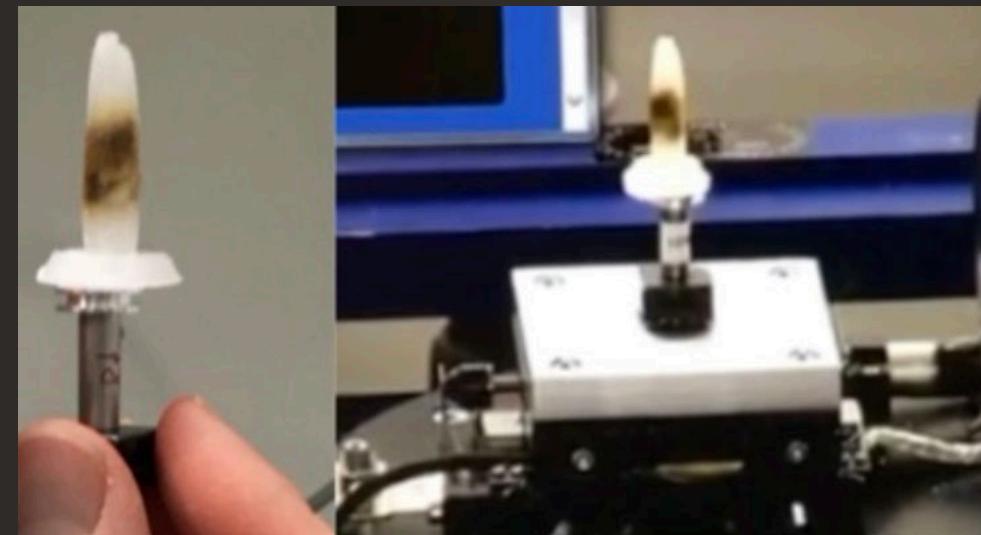
# Carotid Plaque – Zoom of risk zone



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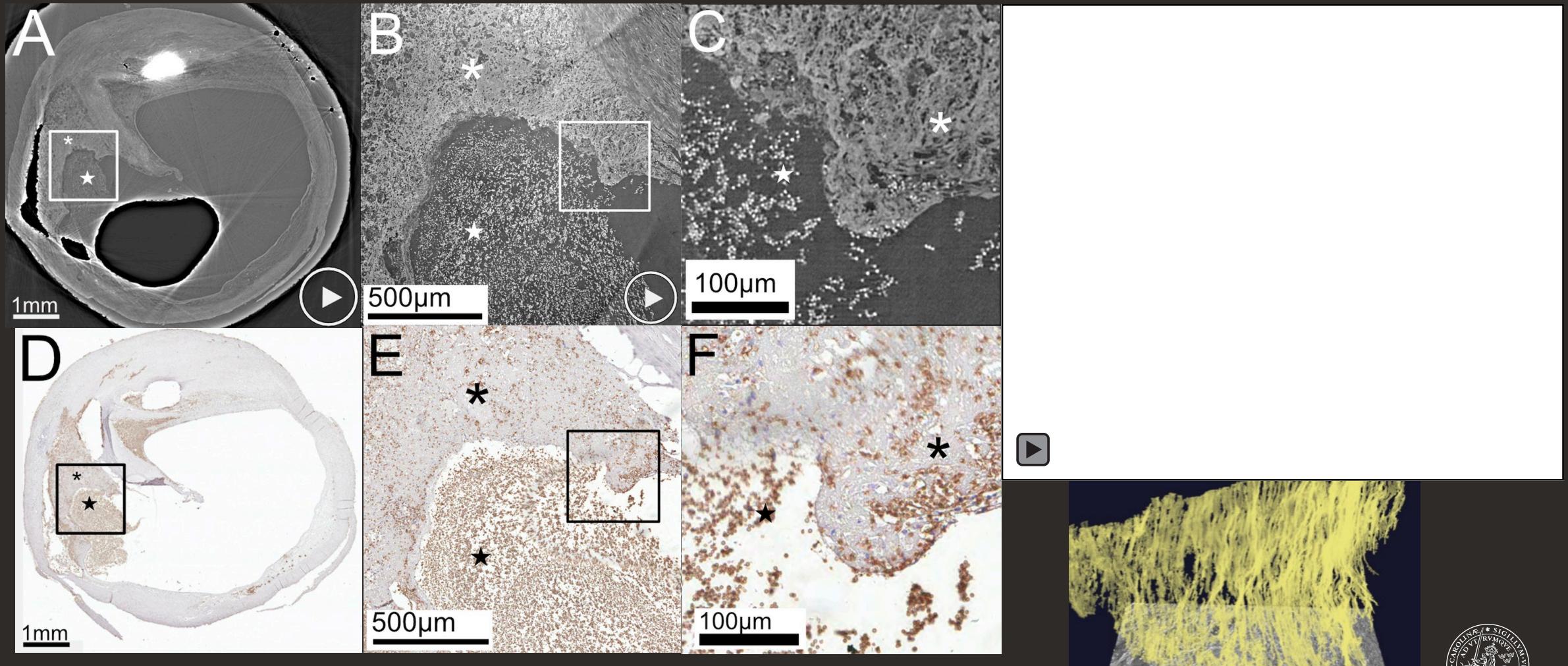


# X-ray microscopy 1 $\mu$ m resolution Carotid plaque



Truong et al. (2022) PLOS ONE 17(4): e0265598.

# Imaging with x-rays (ex-vivo)



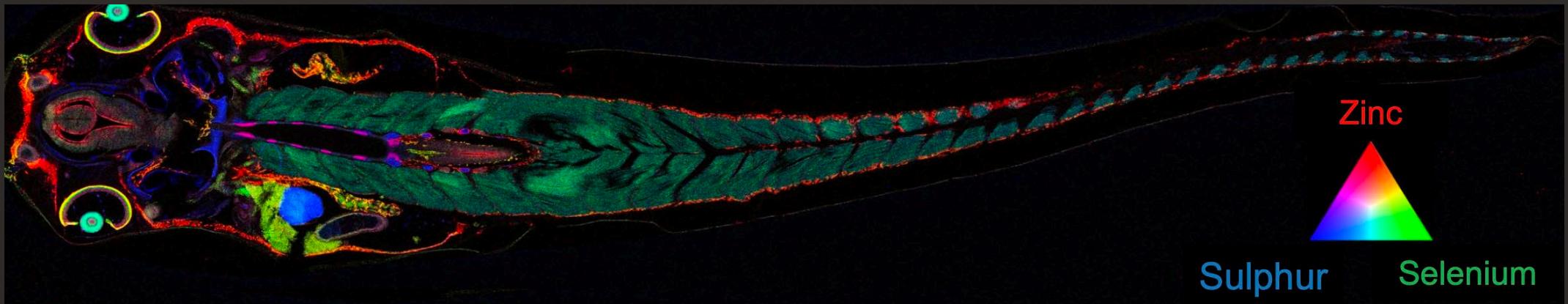
Truong et al. (2022) Sub-micrometer morphology of human atherosclerotic plaque revealed by synchrotron radiation based  $\mu$ CT—A comparison with histology. PLOS ONE 17(4): e0265598.

# Visualization of neo-vessels in thrombus



# X-ray Fluorescence – XRF

- Element specific microscopy

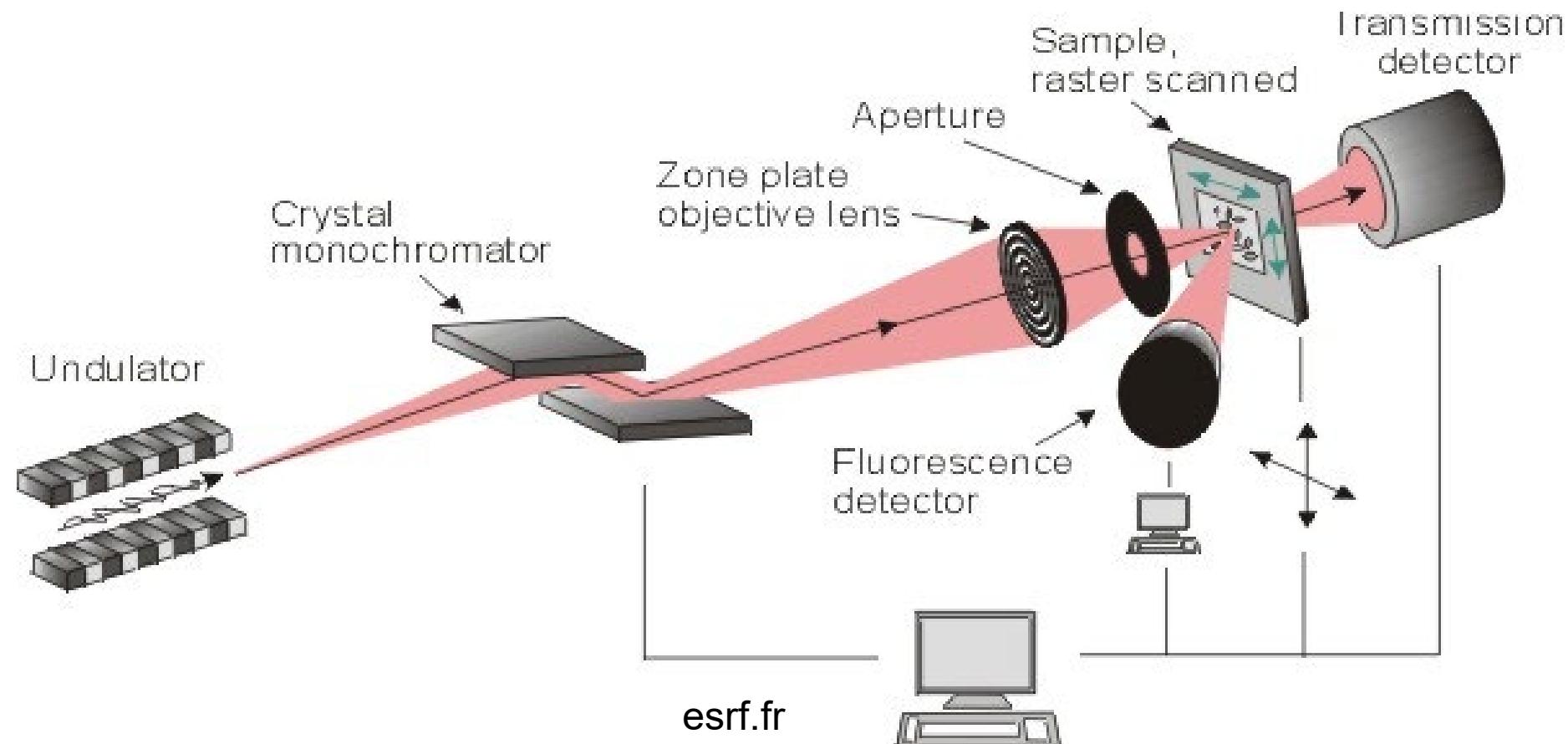


Chantal Lanctôt (Griffith University), Tom Cresswell (Environmental Research ANSTO) et al.



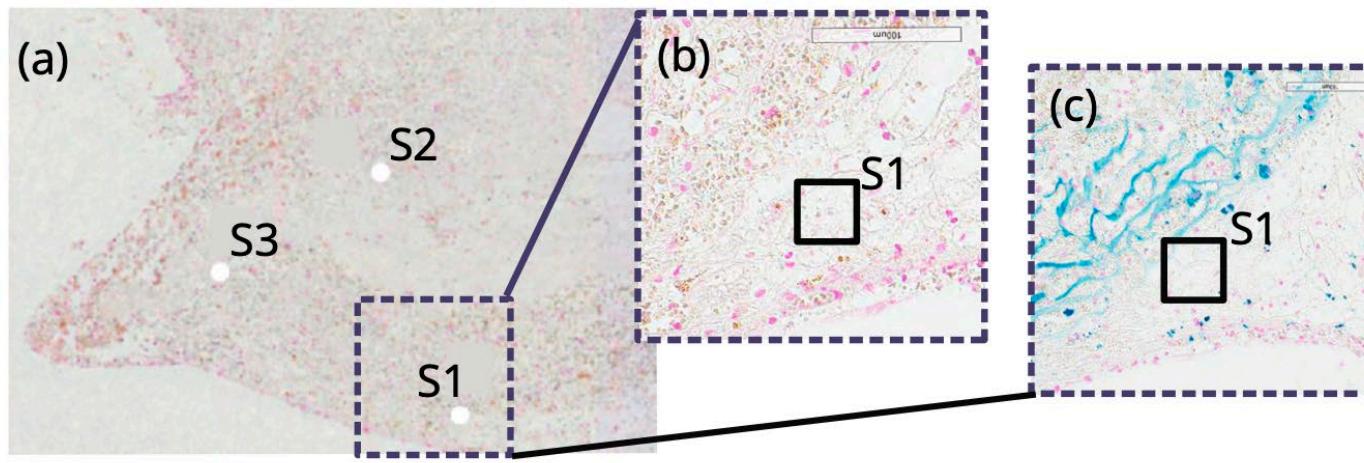
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# XRF : X-Ray Fluorescence Microscopy

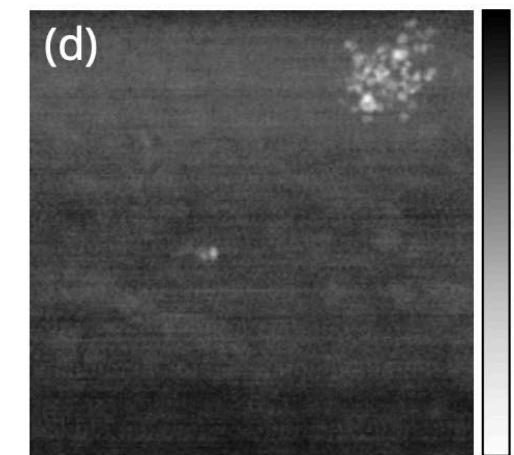


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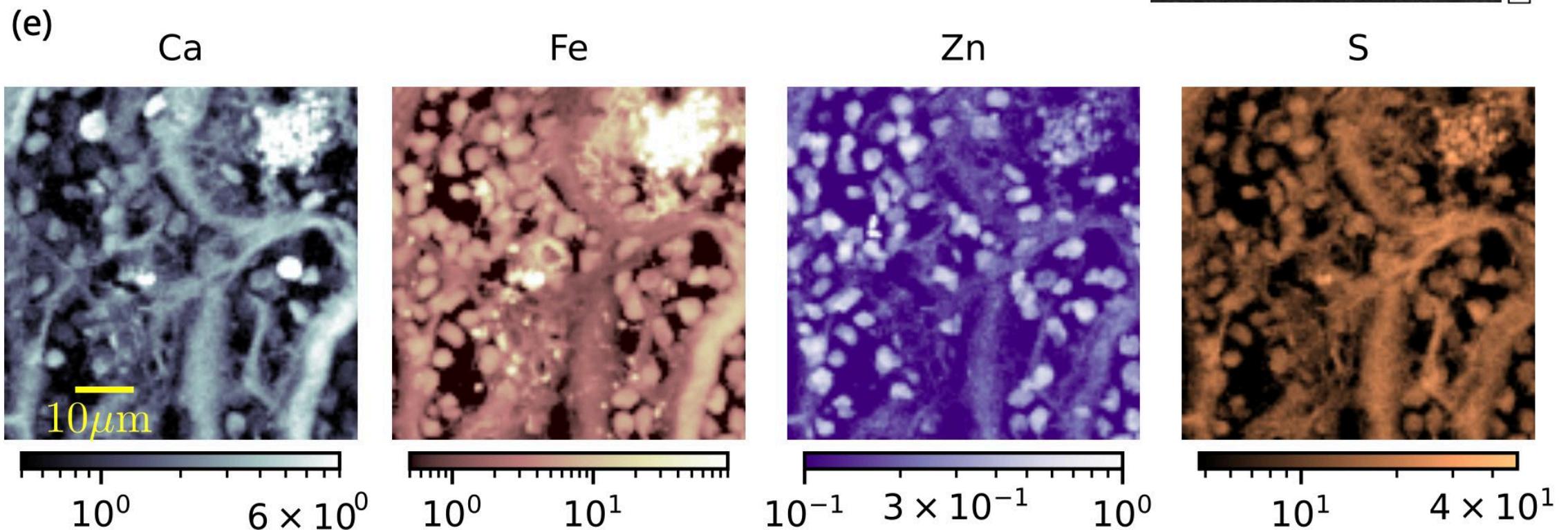
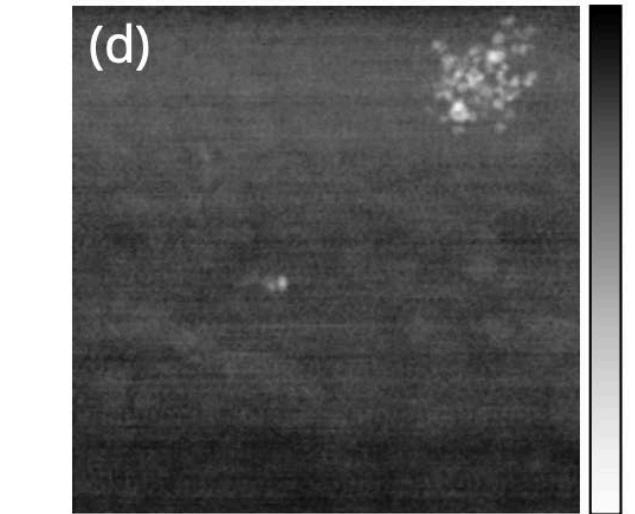
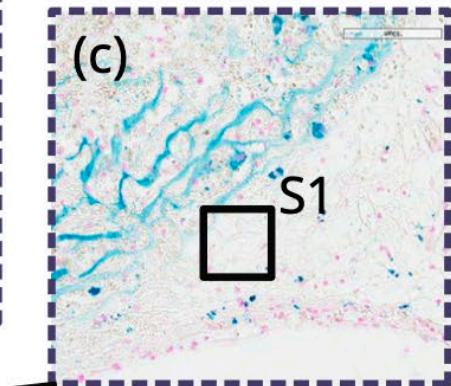
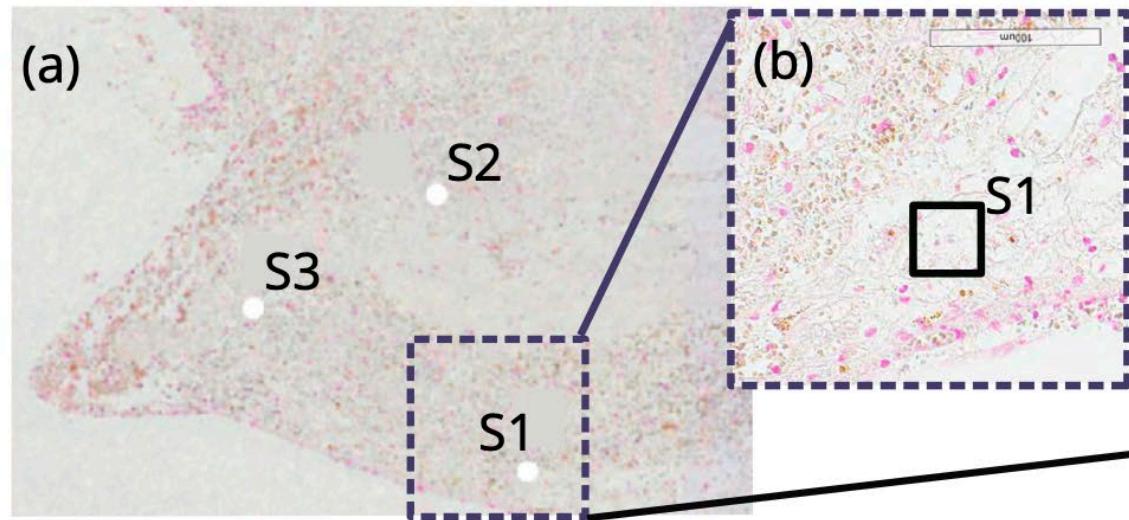
# Human carotid atherosclerotic symptomatic plaques with XRF mapping



Histology with staining

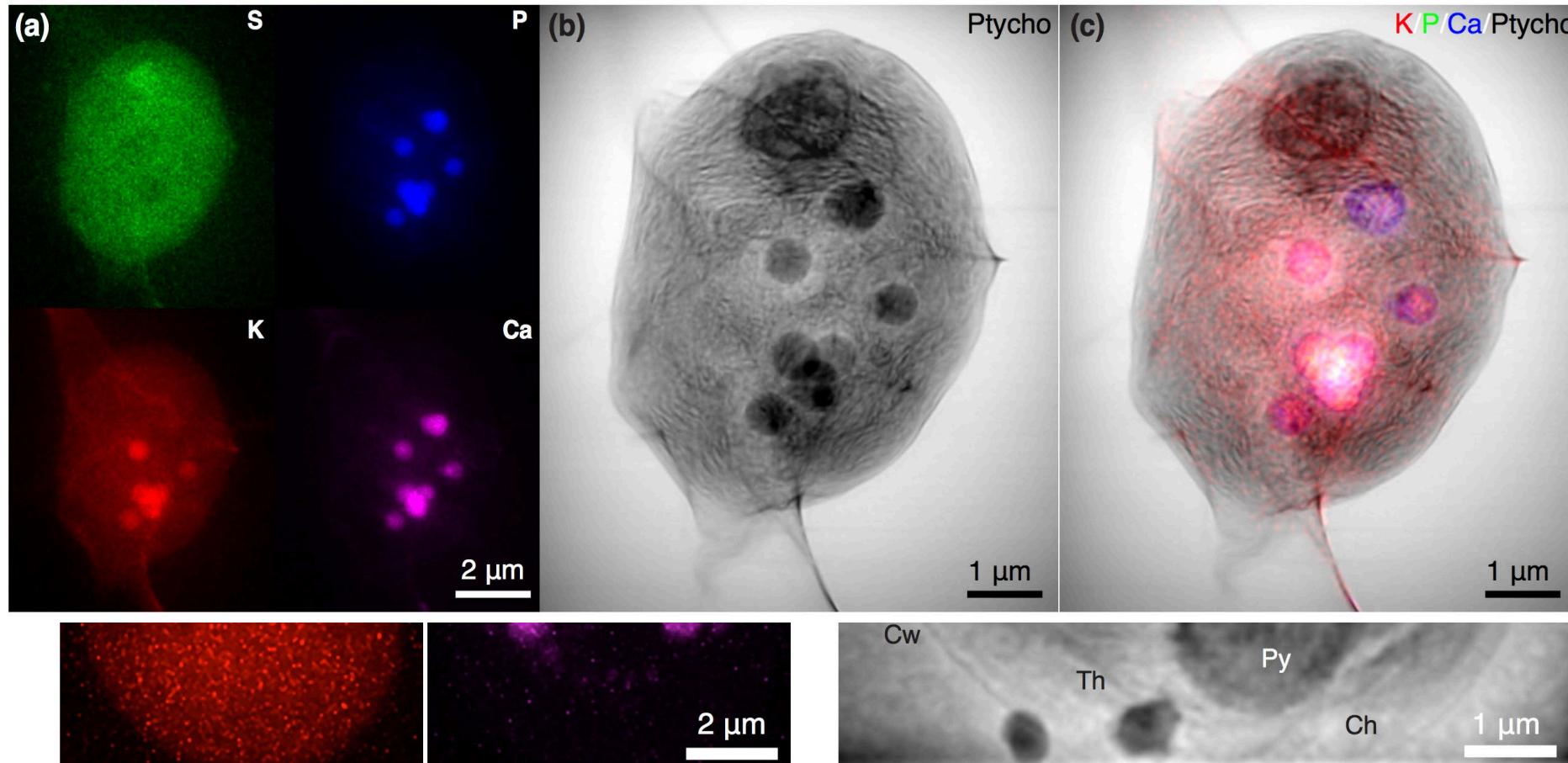


X-ray transmission



# Combined fluorescence and ptychography of *Chlamydomonas*

Deng *et al.*, PNAS 112, 2314 (2015)



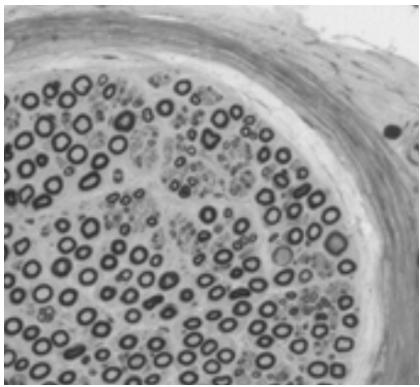
Slide courtesy: Chris Jacobsen



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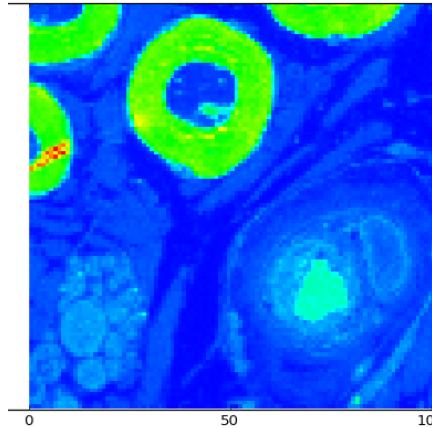
# XRF Imaging of human peripheral sural nerve (Healty control)

Histology

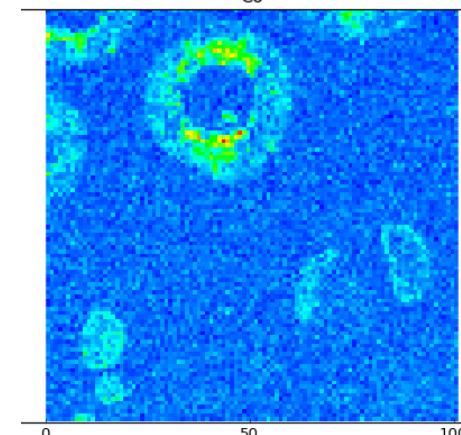
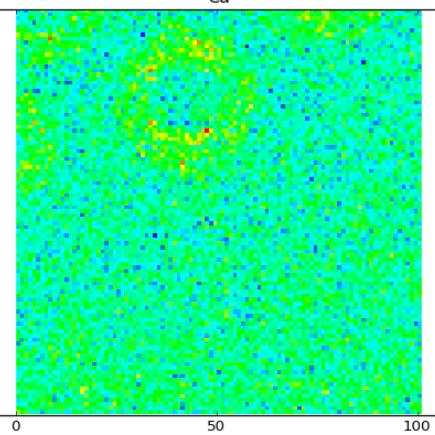
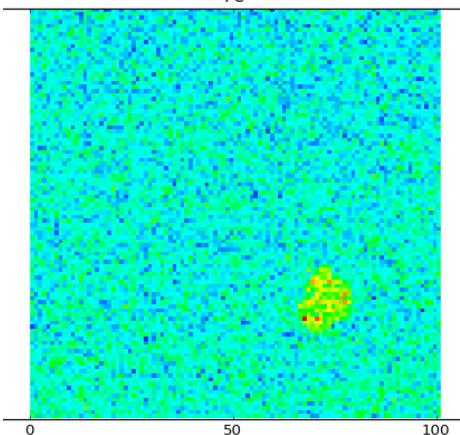


Lars Dahlin<sup>1</sup>, Niccolò Peruzzi<sup>2</sup>  
and Martin Bech<sup>2</sup>  
Lund University  
<sup>1</sup>Clinical sciences, Malmö  
<sup>2</sup>Medical Radiation Physics, Lund

Os map @ 13.235 keV



Maps of Fe, Ca and Co @ 9.480 keV (where Os does not fluoresce)

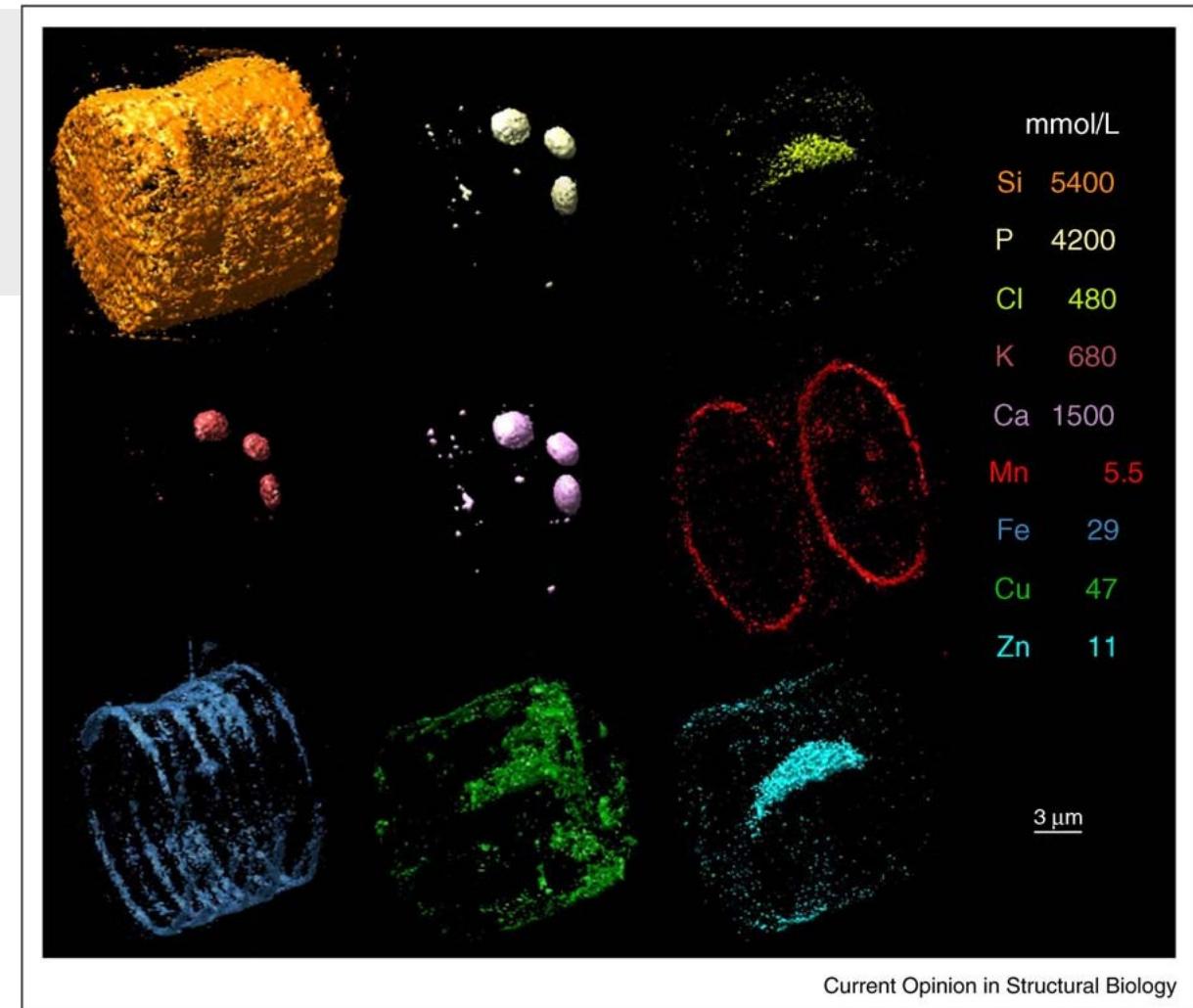
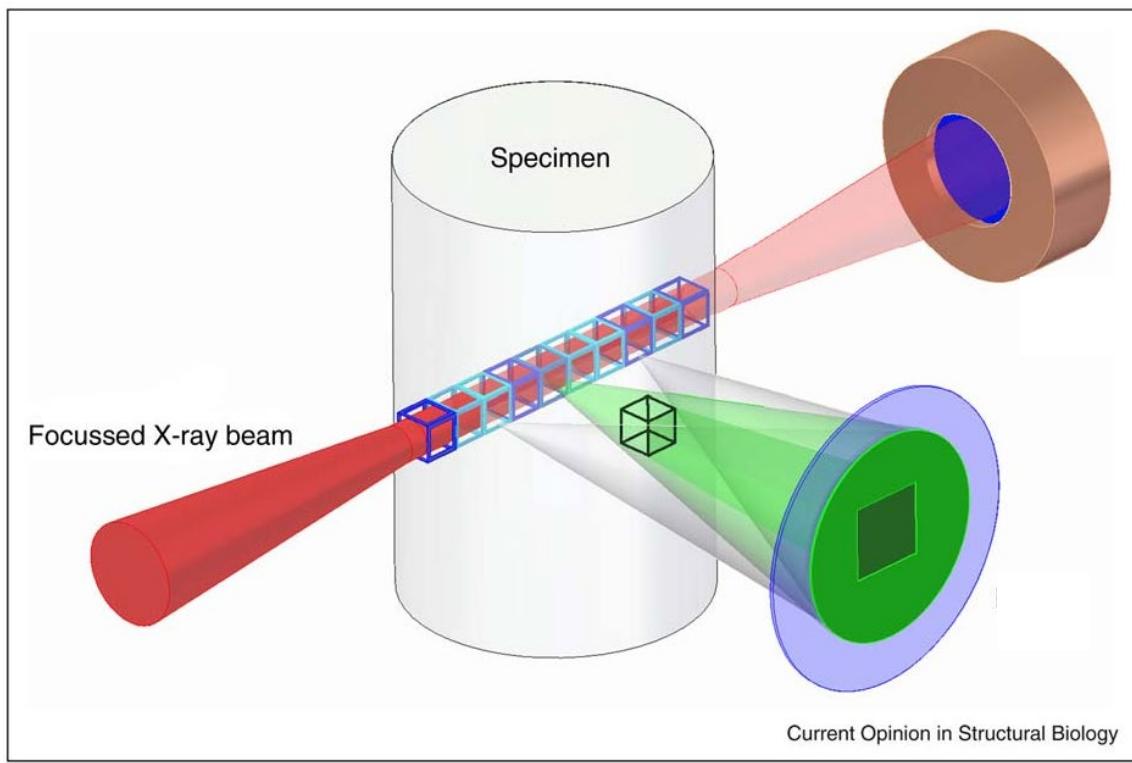


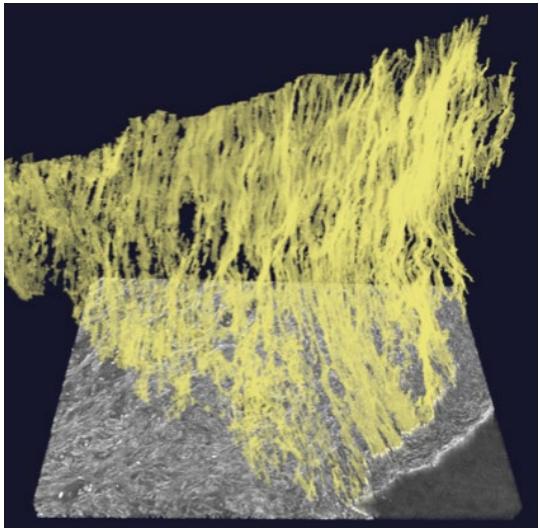
# XRF tomography

DOI: 10.1016/j.sbi.2010.09.002 • Corpus ID: 21547459

## Hard X-ray fluorescence tomography--an emerging tool for structural visualization.

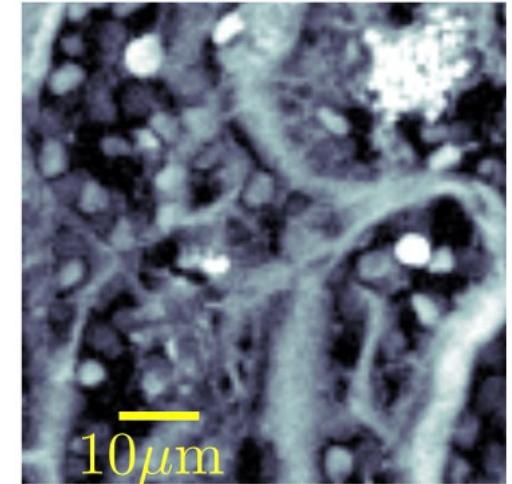
M. D. de Jonge, S. Vogt • Published 1 October 2010 • Physics • Current opinion in structural biology





# Virtual histology with 3D visualization

Element specific imaging  
with x-ray fluorescence



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Thank you

Isabel Goncalves  
My Truong

Nathaly de la Rosa  
Till Dreier  
Niccolò Peruzzi