Australian Government

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X-ray Fluorescence Microscopy at the Australian Synchrotron

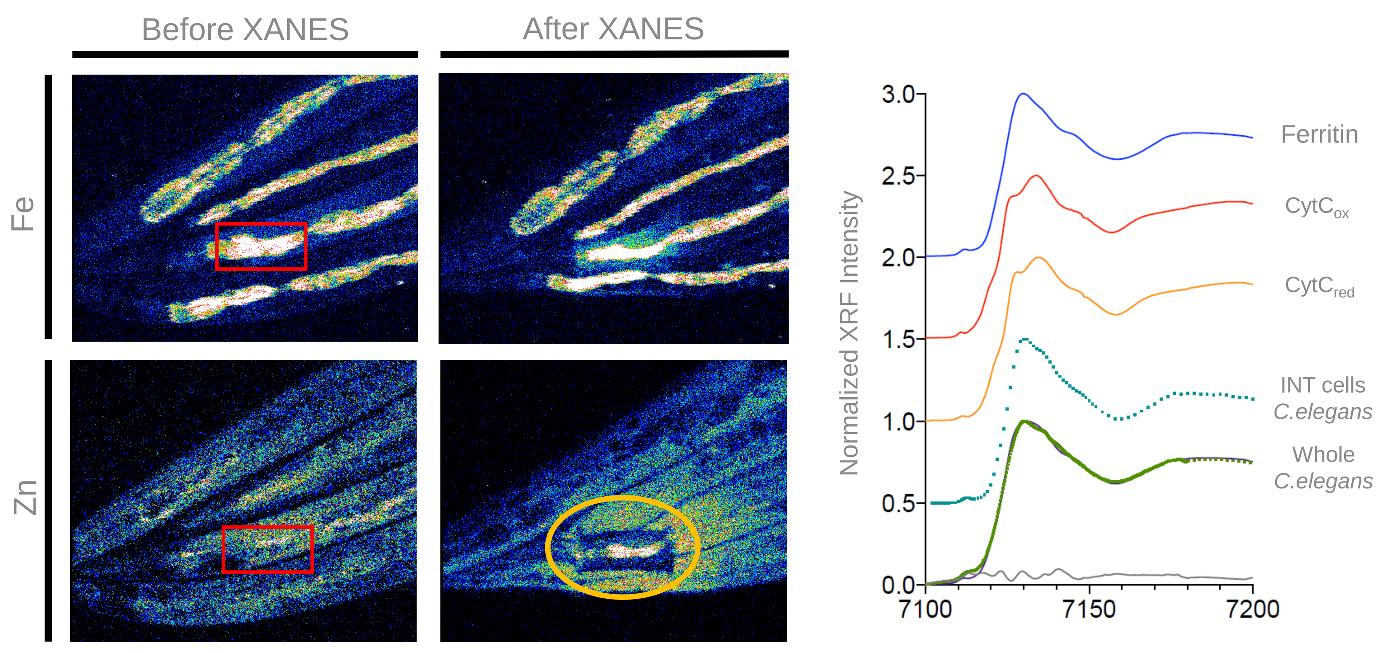
Overview - Key Specifications

	Milliprobe	Microprobe
Spatial resolution	50 – 200 µm	1 – 5 µm
Scan range (h x v)	600 x 1200 mm	150 x 100 mm
Maximum flux	10^{12} Ph/s	4×10^{10} Ph/s
Energy range	4.1-27 keV	
Energy resolution	ΔE/E ~10^{-4}	
Source	In-vacuum undulator	

- ✓ Simultaneous access to 10+ elements
- ✓ No contrast agents required
- ✓ Quantitative analysis
- ✓ High signal-to-noise ratio → ppb sensitivity, improving with Z
- ✓ Little sample damage
- ✓ Extended penetration depth → study "intact" specimens
- ✓ Sensitive to chemical bonding → XANES mapping
- ✓ Cryogenic cooling (N_2 stream) available to avoid beam damage

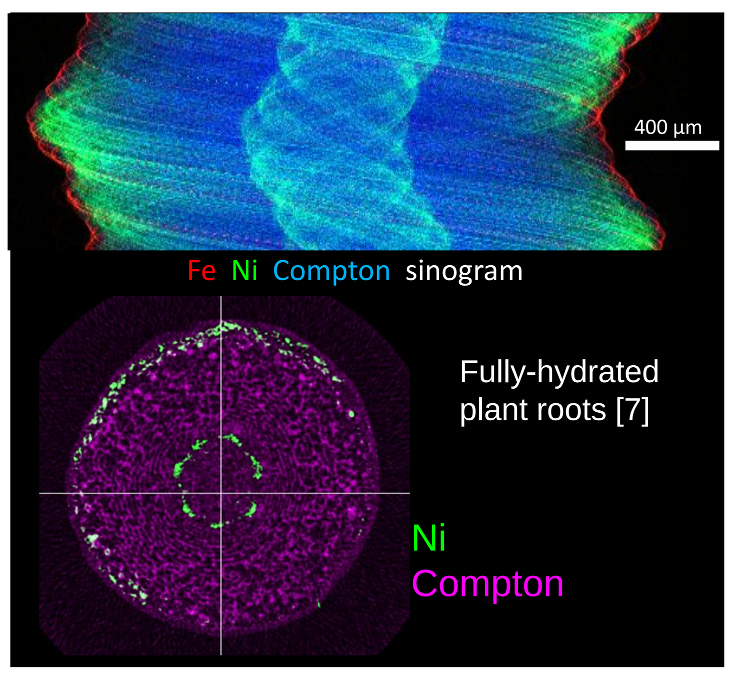
Special acquisition modes

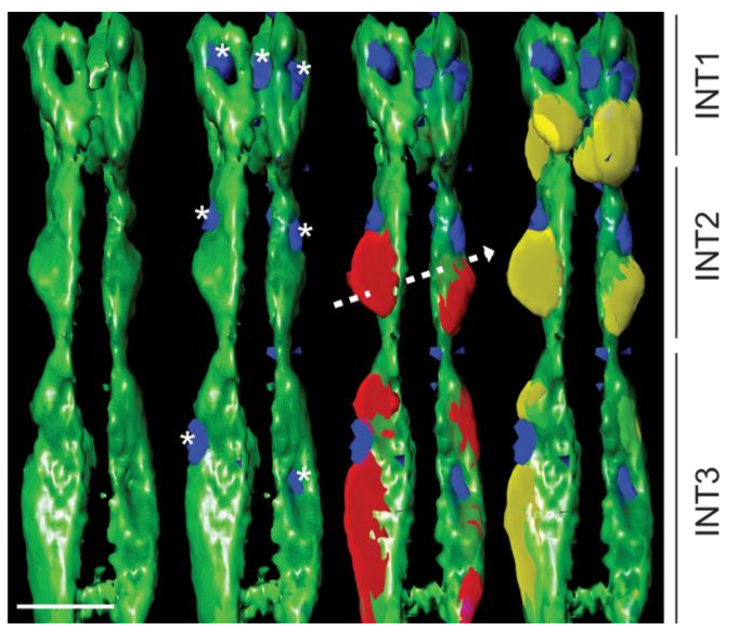
XANES Imaging



XANES mapping of *C. elegans* [8]

XRF Tomography (after upgrade in mid/late 2020)

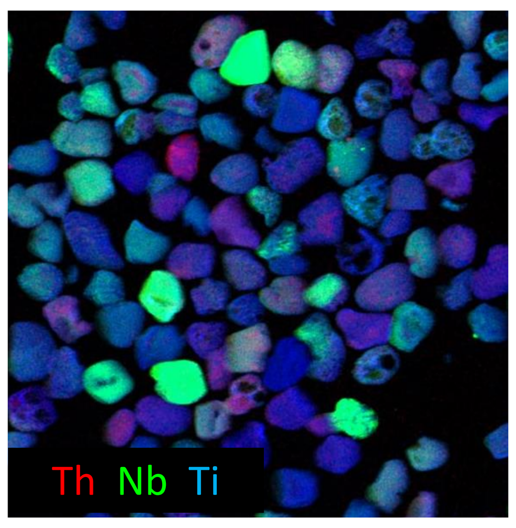




Sub-cellular distributions in *C. elegans* [6]

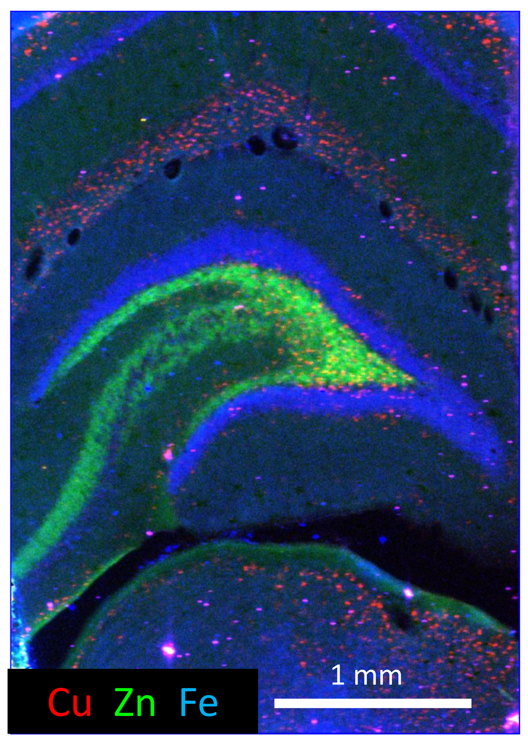
What can you analyse?

Minerals



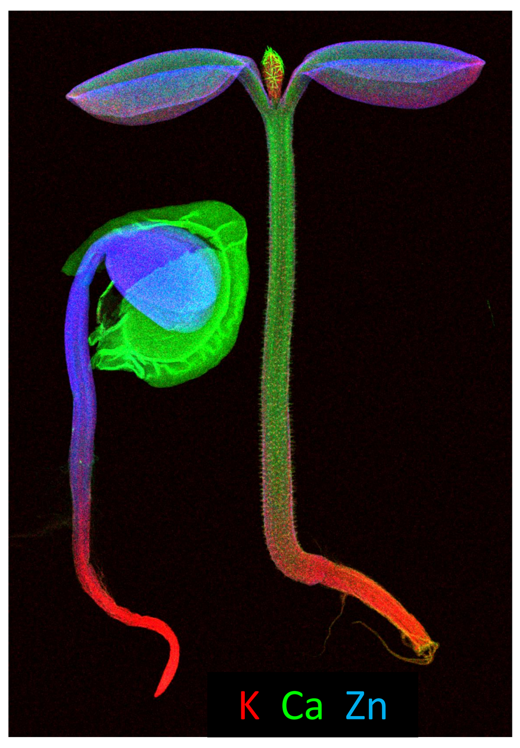
Mineral sands [1]

Animals



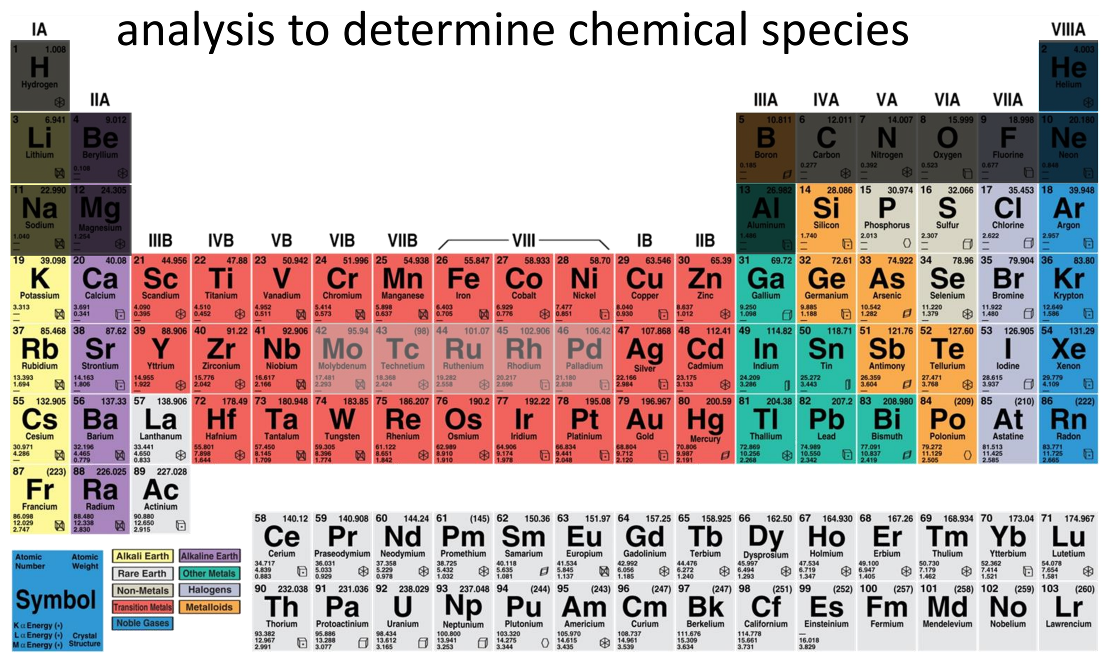
Rat hippocampus [2]

Plants

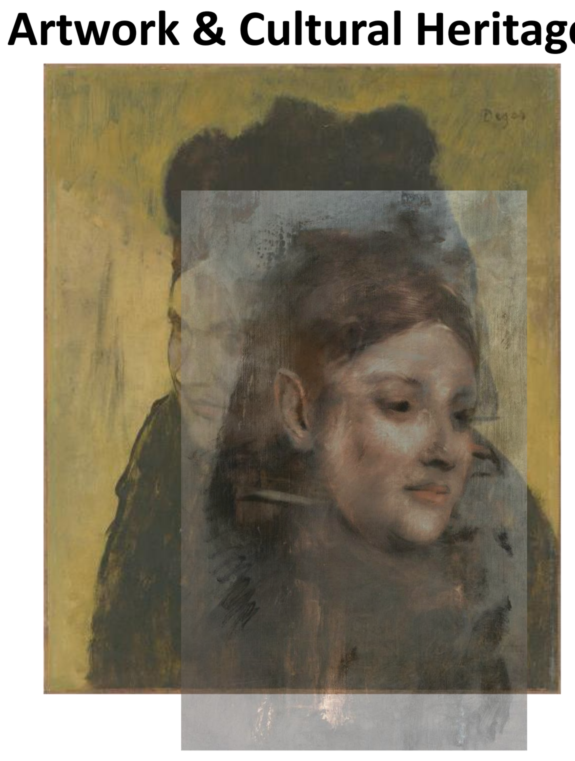


Alyssum murale [3]

Broad range of elements is accessible for X-ray fluorescence mapping and XANES analysis to determine chemical species



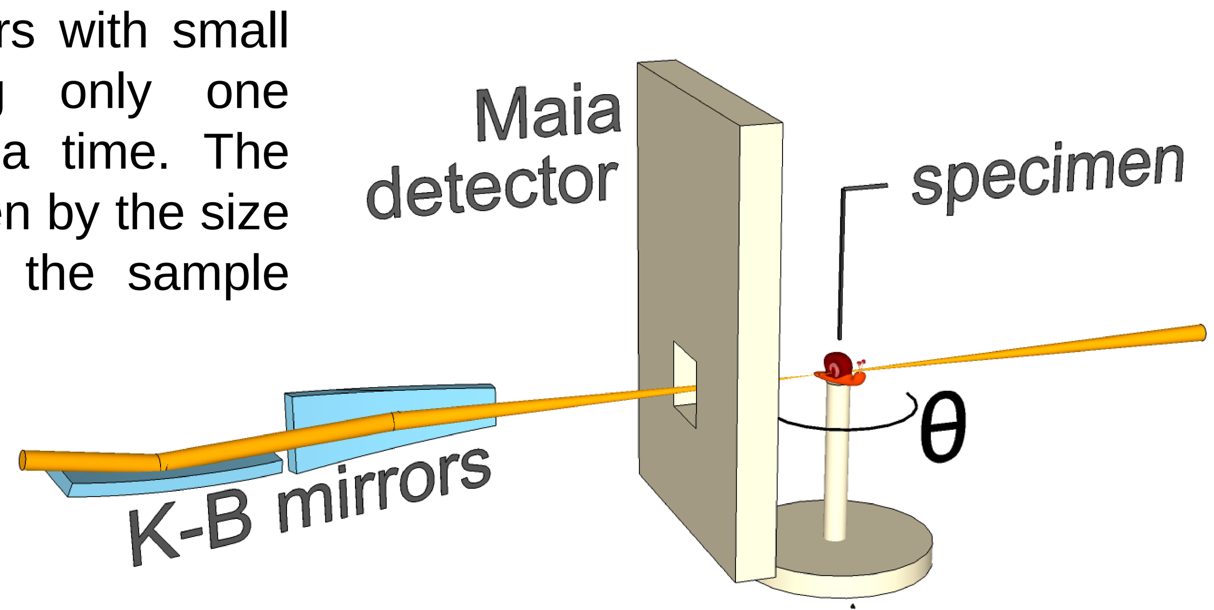
Artwork & Cultural Heritage


A hidden Degas [4]

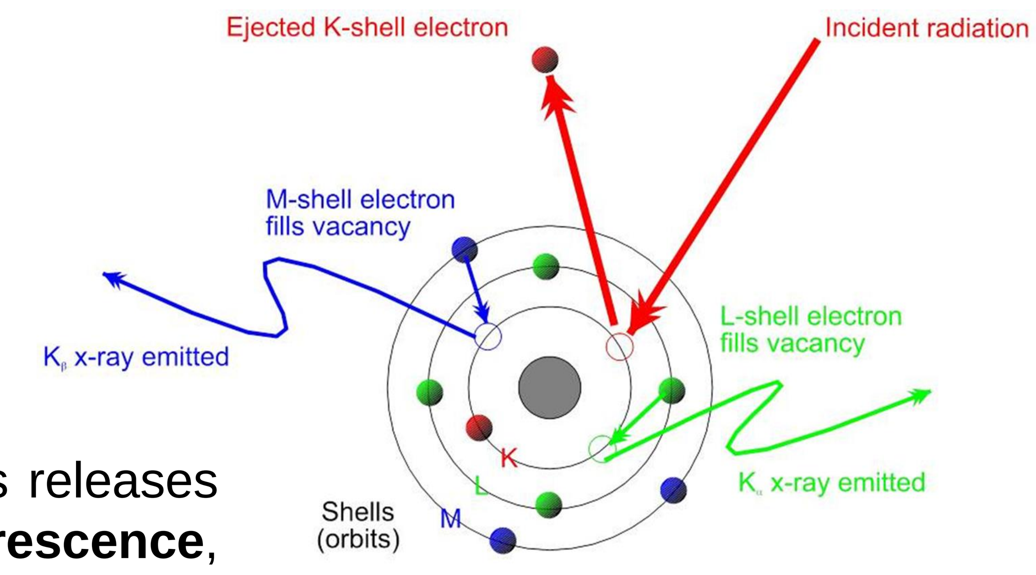
How does it work?

In **scanning microscopy**, the specimen is placed at the focus of a KB-mirror, illuminating only a small part of the sample.

Scanning microscopy avoids the need for high-resolution imaging optics or small detectors with small pixels by illuminating only one resolution element at a time. The spatial resolution is given by the size of the X-ray beam at the sample position.



Incident x rays excite the atoms via photo-ionisation, knocking out inner-shell electrons. Excited atoms relax through a series of bound-bound transitions.



Each of these transitions releases *characteristic* **x-ray fluorescence**, causing the specimen to 'glow' in the x-ray domain.

[1] Image courtesy: Peter Kappen
[2] Lins et al., PLoS ONE 11(6), (2016)
[3] van der Ent et al. (2016)
[4] Thurrowgood et al., Scientific Reports 6, 29594 (2016)
[5] James et. al, Chem. Comm. 52, 11834-11837, (2016)
[6] McColl et al., PLoS ONE **7**(2), (2012)
[7] van der Ent et al., New Phytologist **218**, (2018)
[8] James et al., Scientific Reports 6, 20350, (2016)

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https://www.ansto.gov.au/user-access/instruments/australian-synchrotron-beamlines/x-ray-fluorescence-microscopy

Scan me