SOLEIL SYNCHROTRON

FOR **BIOLOGISTS**

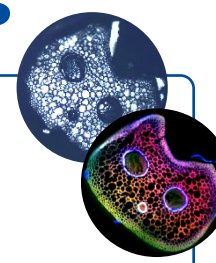
LUCIA
beamline

XRF, XANES and EXAFS

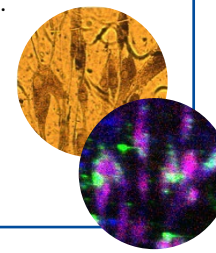
- ORGANISMS
- **TISSUES**
- **CELLS**
- ORGANELLES
- COMPLEXES
- PROTEINS
- ATOMS

SAMPLES

TYPES



- Cryogenic or freeze-dried thin sections from vegetal, animal, fungi's tissues. Thickness between 5 and 50 µm.
- Cryo-fixed or freeze-dried cells.
- Freeze-dried grounded material from living organism or from soils, sediments, suspended matters,... pressed as pellets.



SAMPLE HOLDERS

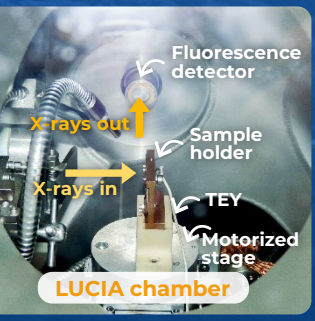
- Thin section placed between two Ultralene foils in Cu-sample holder.
- Cells cultivated onto Ultralene or Si_3N4 windows.
- Pellets placed on Cu-sample holder.

ENVIRONMENT

- **Vacuum** chamber.
- **Cryogenic conditions** using N_2 or He cryostat.
- No glass or quartz slide. Resin impregnation is not recommended.
- Constraints on the sample holder and sample preparation may vary as a function of the selected energy, the nature and concentration of the elements of interest and of the matrix, and of the type of analysis.

TECHNIQUE

LUCIA is a **microfocused beamline** in the 0.8-8 keV energy range. The spatial stability of the beam spot over a wide spectral range enables elemental distribution studies by **micro-fluorescence X-ray spectroscopy** (μ-XRF) as well as elemental speciation by **X-ray absorption spectroscopy** (XANES and EXAFS) to determine the speciation (local chemistry, quantitative determination of the local geometric structure around the absorbing atom) in heterogeneous samples.



Micro-fluorescence X-ray spectroscopy (μXRF)

High spatial resolution mapping (2.5 μm) on large fields of view (up to 20 x 20 mm^2) with excitation energies between 0.8 and 8 keV.

Fast scans (FlyScan) to analyze a large number of samples.

X-ray absorption spectroscopy

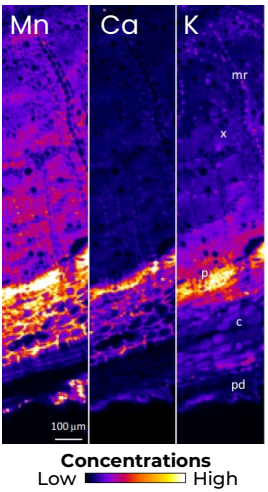
XANES (X-ray Absorption Near-Edge structure) and EXAFS (Extended X-ray absorption fine structure) at the K-edge of elements from Na to Fe, L edges from Ni to Gd, and M edges of rare earths and actinides.

Combination of micro-XRF and micro-XANES

After a μXRF cartography of the sample, interesting spots can be analyzed by μXAS to determine locally the speciation of the elements and how this depends on the different elemental composition.

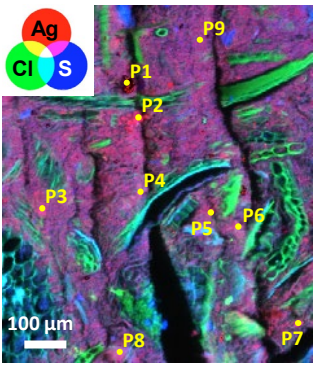
HIGHLIGHTS

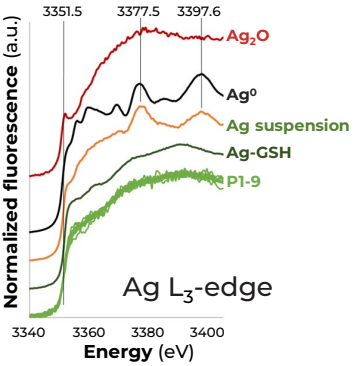
µXRF mapping was used to determine the tissue-level distribution of Mn, Ca, and other elements in different tissues of *G. Meisner*, a Mn-accumulator plant. Mn concentrations were highest in leaf epidermal tissues, in cortex and vascular tissues of primary roots. The co-localization of Ca and Mn might in some way facilitate the formation of mixed Ca–Mn oxides



C. Bihanic et al., **Sci. Rep**. (2021)

Combination of **µXRF and µXANES at Ag L_3-edge** evidenced the physico-chemical changes of Ag colloidal suspension following ingestion and digestion by mice.





The XRF map of a cryo-thin section of mouse colonic content displays a co-localization of Ag and S. µXANES evidence the formation of Ag complexes with thiol groups of proteins and/or peptides.

K. Gillois et al., **Environ. Sci. Nano**. (2023)

REFERENCES

- D. Vantelon et al., **The LUCIA beamline at SOLEIL**. J. Synchrotron Rad., (2016)
- A.M. Flank et al., **LUCIA, a microfocus soft XAS beamline**. Nucl Instrum Methods Phys Res B, (2006)

More information on LUCIA publications web page

COMPLEMENTARY BEAMLINES

NANOSCOPIUM for quantitative imaging (morphology, elemental composition and chemical speciation) from nano to microscopic size. **ANATOMIX** to obtain two- and three dimensional radiographic images of bulk volume samples of macroscopic and nano size.

SMIS, to obtain images using infrared spectromicroscopy. **DISCO** to probe the fluorescence of living and fixed samples using VUV to visible light.

LUCIA end-station

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Health & Well-Being at SOLEIL

Link to the web page

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SOLEIL's Health and Well-being Scientific Section is composed of 30 scientific experts from different fields. Through collaborative and science-driven approaches, the Section offers the community a coherent portfolio of state-of-the-art techniques to serve scientific and societal health-related challenges.

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