SOLEIL SYNCHROTRON

FOR **BIOLOGISTS**

NANOSCOPIUM

beamline

Hard X-ray nanoprobe

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

SAMPLES

TYPES

- Cells (fixed chemically or freeze-dried)
- Histological slices of animal or vegetal tissue. Thickness between 1 and 100 µm.
- Polished solid samples e.g. for (Paleo)-Geobiology, Geology, & Material science studies.
- “Free standing” samples. Max. diameter: 1 mm

ENVIRONMENT

- The sample support must be “clean” from elements heavier than Aluminium, e.g. Si_3N_4 membrane, quartz glass, PEEK frame, etc
- Ambient measurement conditions in air
- The installation of simple, compact, sample environment like microfluidic chip, miniature gas chamber, is possible on demand.
- Clean conditions in the experimental hutch: SAS, T control, contamination control

LABORATORY INSTRUMENTS

- Optical microscope
- Binocular microscope
- Basic sample preparation possibilities

TECHNIQUE

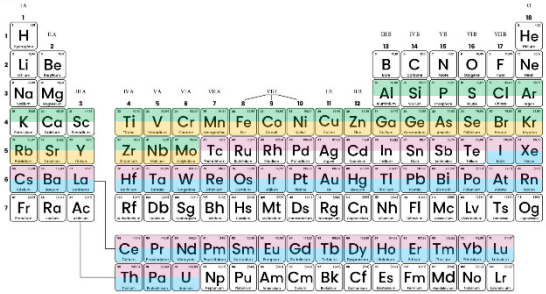
The NANOSCOPIUM **X-ray (5-20 keV) nanoprobe beamline** is dedicated to **multi-technique hard X-ray imaging** using fast scanning and high spatial resolution. It offers simultaneous information in a quantitative manner about the **elemental composition, chemical speciation and sample morphology.** The tunability of the X-ray beam in the 5-20 keV energy range permits to obtain information about the distribution and speciation of a large range of elements of the periodic table.

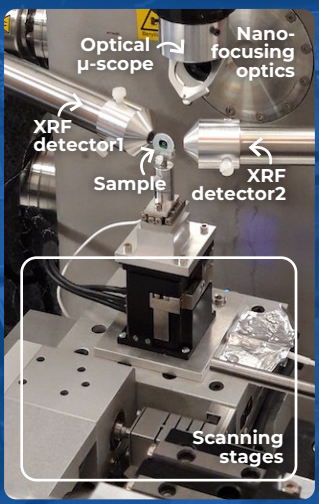
Scanning X-ray spectromicroscopy: elemental and speciation repartition

Analytical sensitivity: trace level ppm/ppb
Energy: 5-20 keV range, monochromatic: $\Delta E/E$:~10^{-4}

Detectable elements by XRF
- K-lines: Al - Mo
- L-line: Mo - U

Chemical speciation by XANES
- K-edge: Ti – Mo
- L-edge: I - U

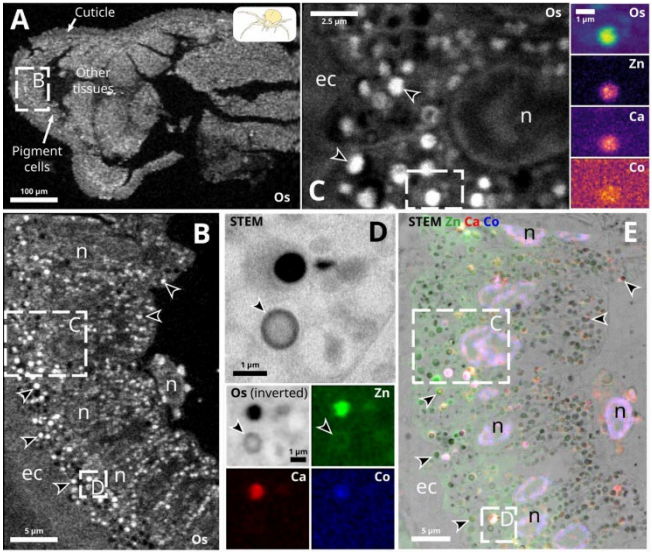




Scanning multi-length scale imaging with spatial resolution readily adaptable in the 100 nanometer - 1 micron range is provided routinely. This multilength scale "zoom-in" capability is well adapted to the study of complex heterogeneous samples and of tiny features embedded in intact mesoscale samples.

HIGHLIGHTS

Integrative biology: nanoscale hard X-ray fluorescence (XRF) Imaging provides unique complementary information to scanning transmission electron microscopy and electron tomography on the intracellular catabolism of pigment organelles.



Correlative Synchrotron XRF and scanning transmission electron microscopy (STEM) reveals metal accumulation in pigment organelles. (A-C) Hierarchical length-scale XRF imaging of osmium (white) enables the structural mapping from tissues down to subcellular organelles. (A) Pixel size: 2 µm. (B) Zoom on the region depicted in A. pixel size: 500 nm. (C) Zoom of the upper region depicted in B. Pixel size: 50 nm. Inset, Os, zinc (Zn), calcium (Ca) and cobalt (Co) colocalize to discrete structures.. (D) Scanning transmission electron microscopy (STEM) and SXRF (Os in black) of the lower region depicted in B show similar structures (e.g. black arrowhead). (E) Correlative SXRF & STEM of the region depicted in B. SXRF pixel size, 200 nm, ec: endocuticle, n: nucleus.

F. Figon et al., **PNAS**, e2103020118 (2021)

REFERENCES

- K. Medjoubi, et al., **Development of fast, simultaneous and multi-technique scanning hard X-ray microscopy at Synchrotron Soleil.** Journal of Synchrotron Radiation, (2013).
- A. Somogyi, et al., **Optical design and multilength-scale scanning spectro-microscopy possibilities at the Nanoscopium beamline of Synchrotron Soleil**. Journal of Synchrotron Radiation, (2015).

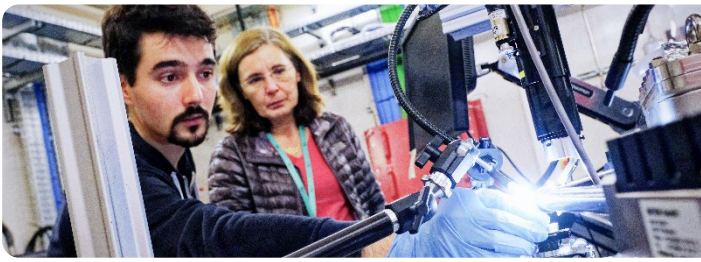
More information on NANOSCOPIUM publications web page

COMPLEMENTARY BEAMLINES

ANATOMIX to obtain three dimensional morphological information on intact samples.

HERMES to obtain nanometer spatial resolution information about the distribution and speciation of light elements in few hundred nanometers thin samples by soft Xray Scanning Transmission X-Ray Microscopy.

DIFFABS can provide complementary information by scanning hard X-ray microscopy on large samples with ~10 µm spatial resolution.



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Health & Well-Being at SOLEIL

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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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