X-RAY FLUORESCENCE MICROPROBE
(XFM)

SCIENTIFIC SCOPE

XFM is a versatile hard X-ray microprobe beamline optimized for spatially-resolved characterization of elemental abundances and chemical speciation in “as-is” samples that are heterogeneous at the micrometer scale. It will be situated on a three-pole wiggler source and employ compound focusing to achieve a user-tunable spot size from 1 to 10 microns. If desired, a macro-focus beam (1 x 1 mm) can be produced at the sample position for “bulk” XAS measurements.

BEAMLINE CHARACTERISTICS

TECHNIQUES:
• X-ray Fluorescence Imaging
• Micro-XAS
• Fluorescence Micro-Tomography
• Micro-Diffraction

XFM at NSLS-II:
• Will enable on-the-fly XRF imaging of trace elements in physically large samples and intact biological specimen (e.g., plants)
• High quality micro-XAS spectroscopy (step or on-the-fly) and XAS imaging
• High throughput and non-invasive 3D imaging of trace element composition with attogram detection sensitivity

ENDSTATION DETAILS:
• Long working distance KB station
• MAIA-384 KB station
• Custom in-situ environmental cells
• Ambient or He atmosphere
• Cold stage and cryo-cooling capabilities

Overview

PORT: 4-BM
SOURCE: three-pole wiggler (3PW)
ENERGY RANGE: 4 – 20 keV
ENERGY RESOLUTION: ΔE/E = 10⁻⁴
SPATIAL RESOLUTION: tunable 1-10 µm
CONSTRUCTION PROJECT: NxtGen
BEAMLINE STATUS: Construction
AVAILABLE TO USERS: 2017

LONG WORKING DISTANCE KB STATION

STAFF
Ryan Tappero: lead beamline scientist
Lukas Lienhard: mechanical engineer
Michael Johanson: designer

Beamline Team

BEAMLINE DEV. PROPOSAL LEAD
Antonio Lanzirotti (U. Chicago, GSE-CARS)

XFM will provide the NSLS-II user community an optimized beamline for studying the genetic control of metal ion uptake, transport and storage in plants relevant to agriculture and bioenergy.

• The only beamline in the world designed to directly support plant biochemistry, XFM will provide high-throughput and high-resolution whole-plant fCMT.
• fCMT provides 3D, non-invasive, spatially-resolved analysis of trace elements in specific cell layers and organelles in plants in their natural state.

SCIENTIFIC APPLICATIONS

• XFM will provide the NSLS-II user community an optimized beamline for studying the genetic control of metal ion uptake, transport and storage in plants relevant to agriculture and bioenergy.

• XFM’s unique optical design, which allows it to maintain a small spot size at long working distances with high flux and at high energies, will provide an ideal platform for microfocused analysis of samples within environmental cells.
• For example, environmental cells designed for XFM allow users to analyze materials under scCO₂ confinement (T > 31°C, P > 7.4 MPa), while controlling ΔP.
• XFM will utilize in-situ μXRF, μXAS and μXRD to quantify hydraulic/transport properties of brine films confined by CO₂ under geologically relevant conditions.

• Imaging physically large samples at X-ray microprobes is impractical, but XFM with its variable focus and collimation and advanced ultrafast, large solid-angle MAIA-384 detector is ideal for these studies.
• Large format translation stages will allow for analysis of whole objects including panel paintings, sculpture, paleontological and archaeological materials.
• XFM will be the focus of such work for cultural heritage and museum scientists in the northeastern U.S.