X-RAY FLUORESCENCE MICROPROBE (XFM)

BROOKHAVEN NATIONAL LABORATORY

NATIONAL SYNCHROTRON LIGHT SOURCE II

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.

Overview

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

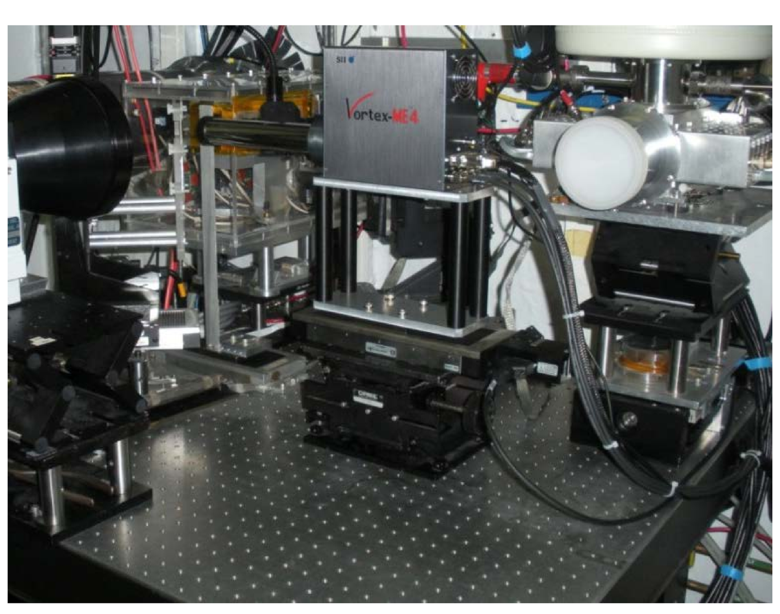
BEAMLINE CHARACTERISTICS

TECHNIQUES:

- X-ray Fluorescence Imaging
- Micro-XAS
- Fluorescence Micro-Tomography
- Micro-Diffraction

ENDSTATION DETAILS:

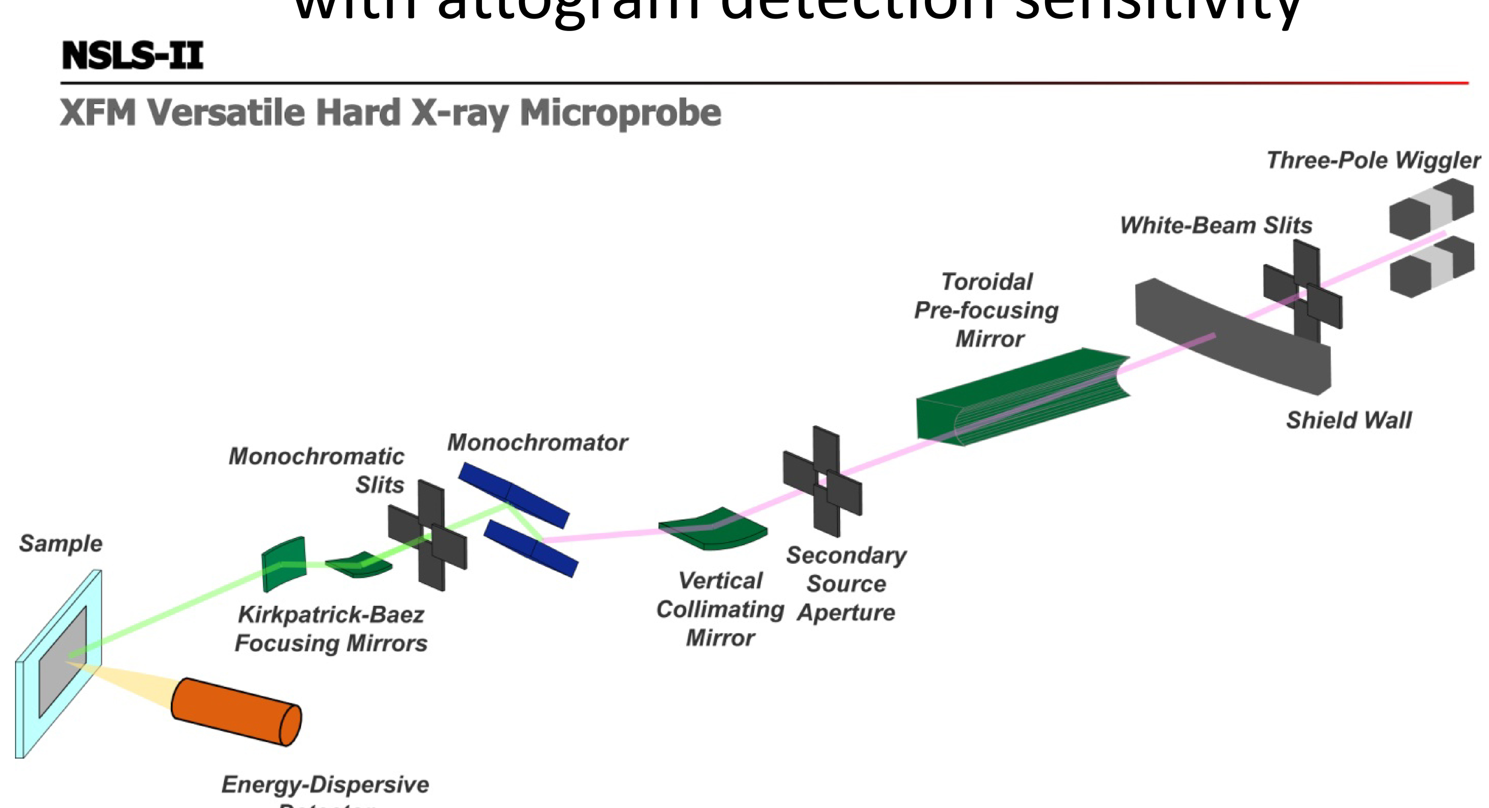
- Long working distance KB station
- MAIA-384 KB station
- Custom *in-situ* environmental cells
- Ambient or He atmosphere
- Cold stage and cryo-cooling capabilities



Long-working distance KB station now installed at NSLS beamline X27A

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



Schematic of XFM compound-focusing optical scheme using toroid and KB mirrors

Beamline Team

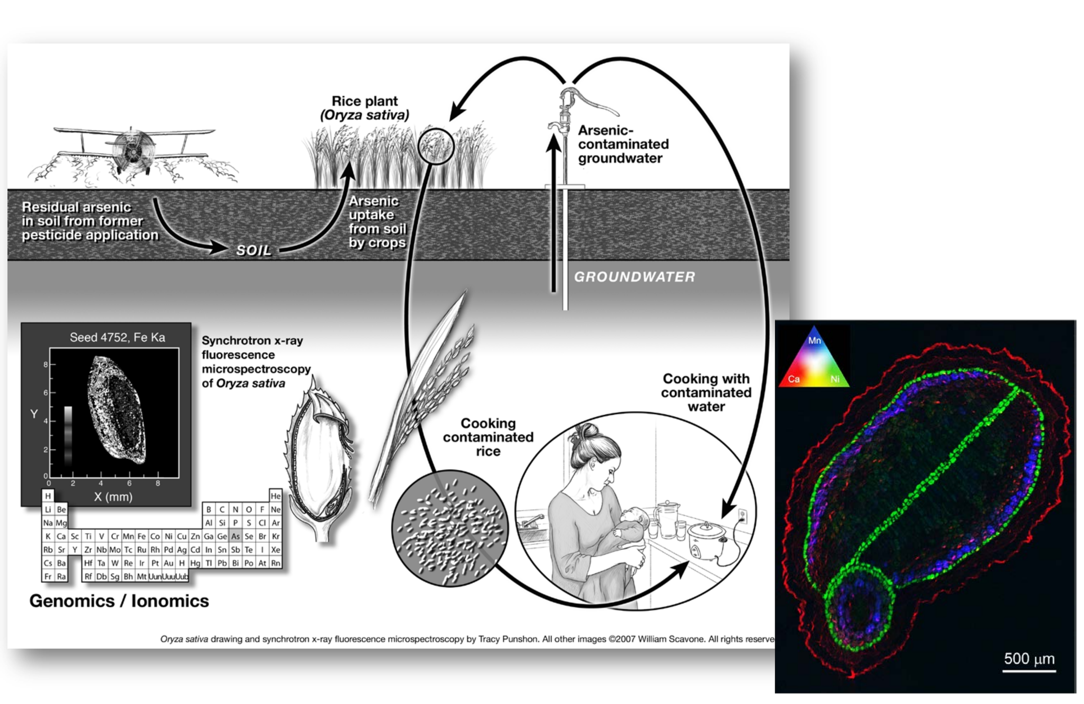
STAFF

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

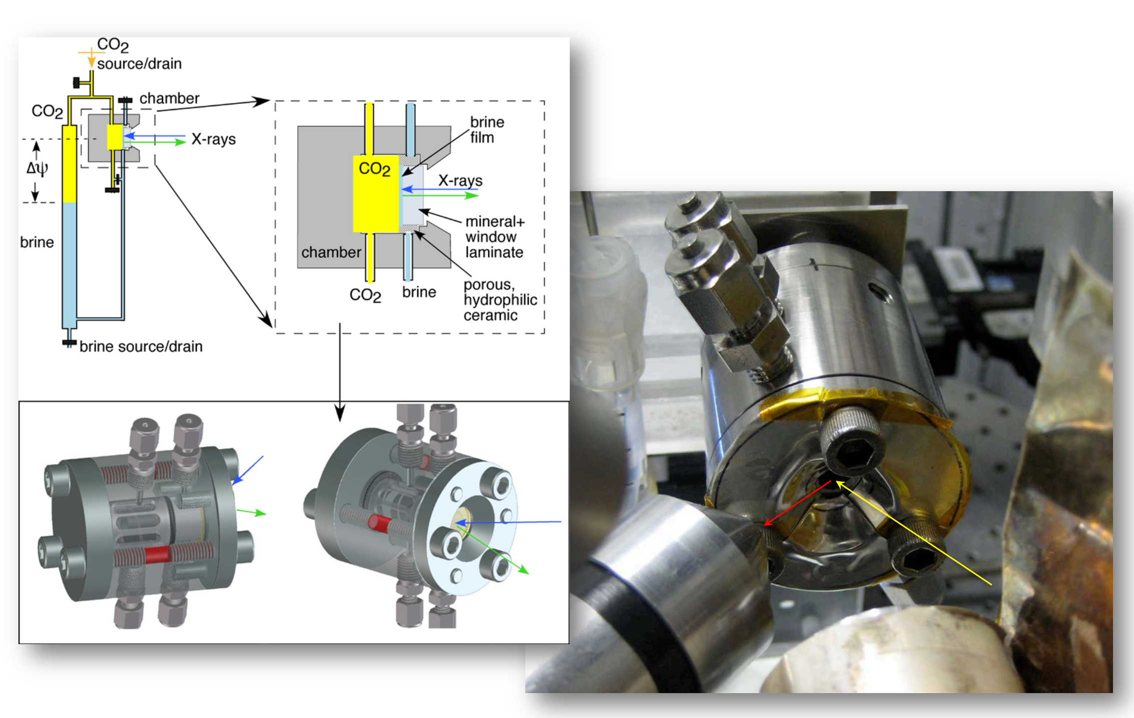
BEAMLINE DEV. PROPOSAL LEAD

Antonio Lanzirotti (U. Chicago, GSE-CARS)

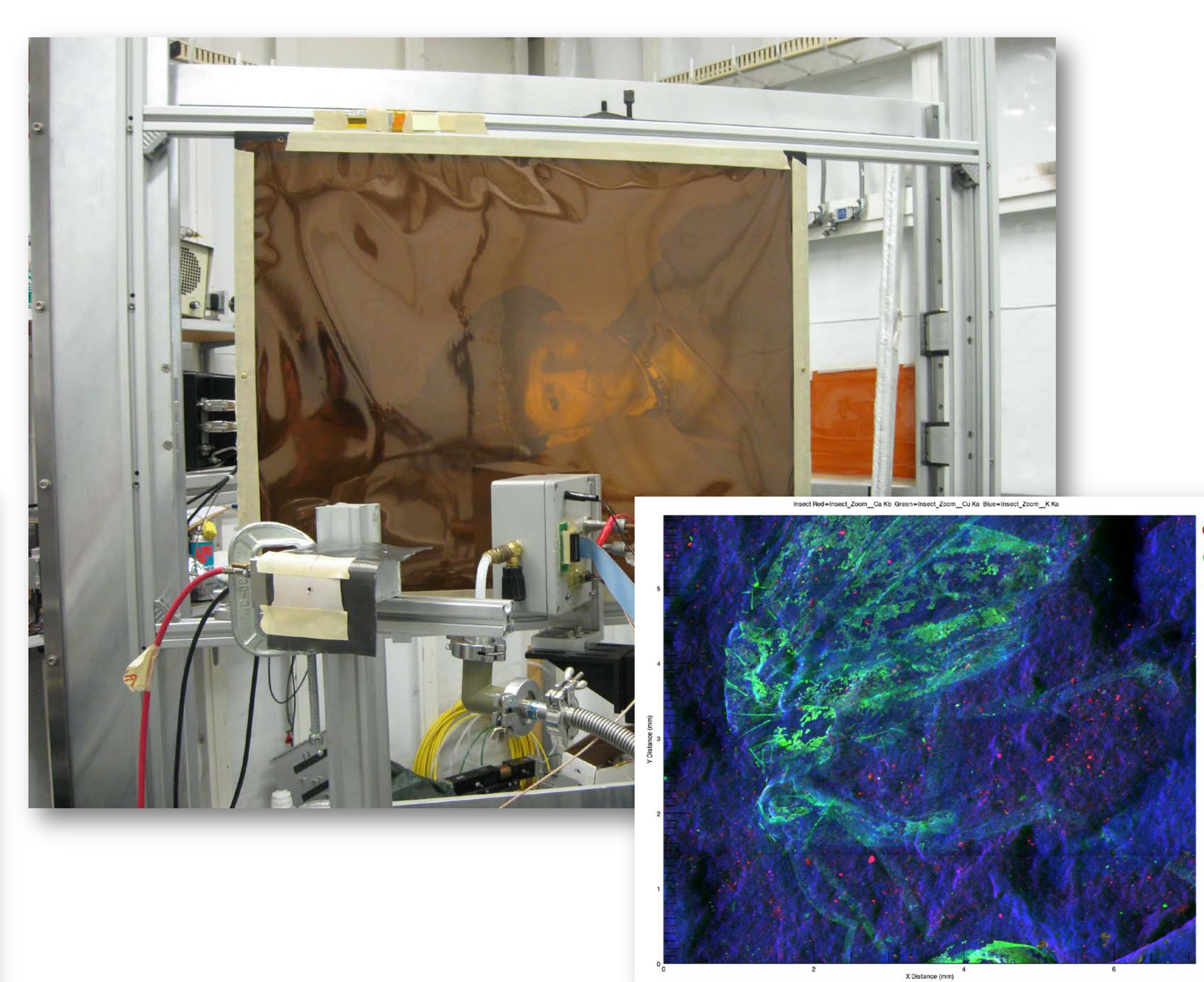
SCIENTIFIC APPLICATIONS



- 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.
- 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.



- 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 $scCO_2$ 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 CO_2 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.