FRONTIER, MAGNETIC, ELLIPSOMETRIC AND TIME-RESOLVED INFRARED SPECTROSCOPY (FIS + MET)

BROOKHAVEN NATIONAL LABORATORY

NATIONAL SYNCHROTRON LIGHT SOURCE II

SCIENTIFIC CAPABILITIES

Frontier Infrared Spectroscopy (FIS) and Magnetic, Ellipsometric and Time-Resolved Infrared Spectroscopy (MET) are bending magnet beamlines sharing the large gap dipole source at cell 23. The design is intended to span the largest possible spectral range needed for condensed matter and geophysical infrared spectroscopy, including the very far-infrared and sub-THz. Sample environments include extreme pressures and temperatures, high magnetic fields, and laser excitation. Both microsampling (for small samples in diamond anvil cells) and Mueller-matrix ellipsometry (for direct extraction of the dielectric and diamagnetic response) are included.

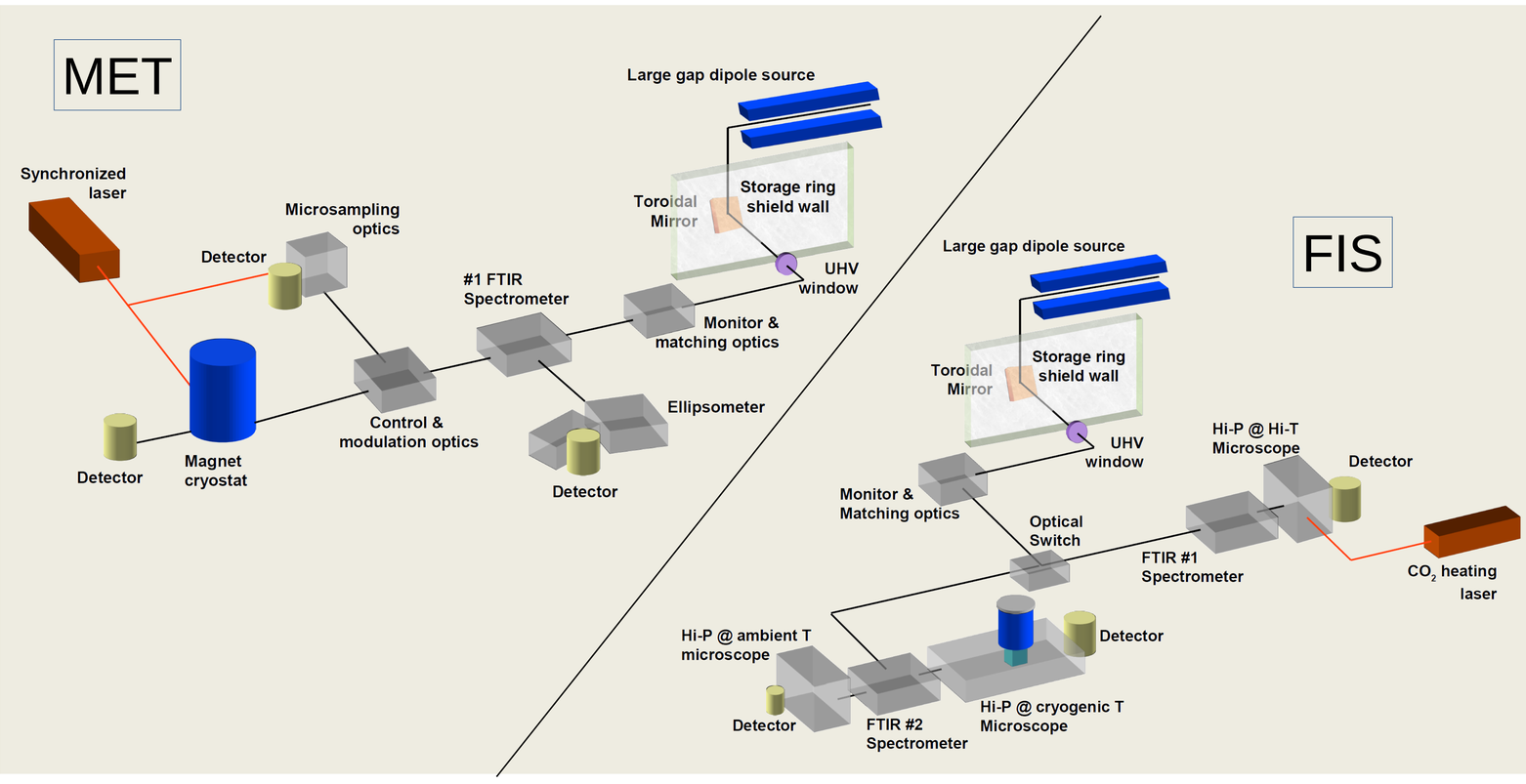
BEAMLINE CHARACTERISTICS

TECHNIQUES:

- High pressure spectroscopy
- High and low temperature spectroscopy
- High field spectroscopy
- Ellipsometry
- Photo-induced and time-resolved

FIS/MET at NSLS-II:

- Ultra-wide spectral range using large gap dipole bend source.
- Diffraction-limited brightness at 500 ma
- Very low noise.



Schematic beamline layout for MET (left) and FIS (right). Infrared from large gap dipole source at cell 23 will be switched between the two programs. Layout compatible with future expansion to dedicated sources for each beamline.

Overview

LOCATION: 22-ID and 22-BM floor space
SOURCE: Large gap dipole bend at cell 23
ENERGY RANGE: 0.5 meV to 5 eV
SPATIAL RESOLUTION: Diffraction limited up to 1 eV, for throughput-limited techniques
CONSTRUCTION PROJECT: NxtGen
BEAMLINE STATUS: Design
AVAILABLE TO USERS: Spring 2018

Beamline Team

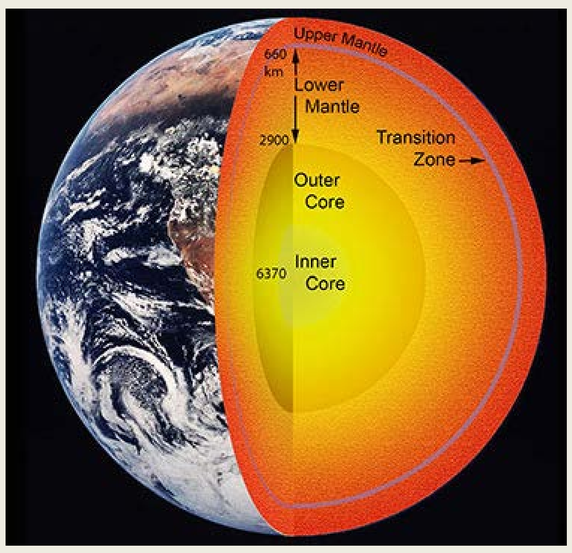
STAFF

Larry Carr: MET lead beamline scientist
Zhenxian Liu (CIW): FIS lead beamline scientist
Randy Smith: science associate
Lukas Lienhard: mechanical engineer
Michael Johanson: designer
Z. Yin: controls engineer

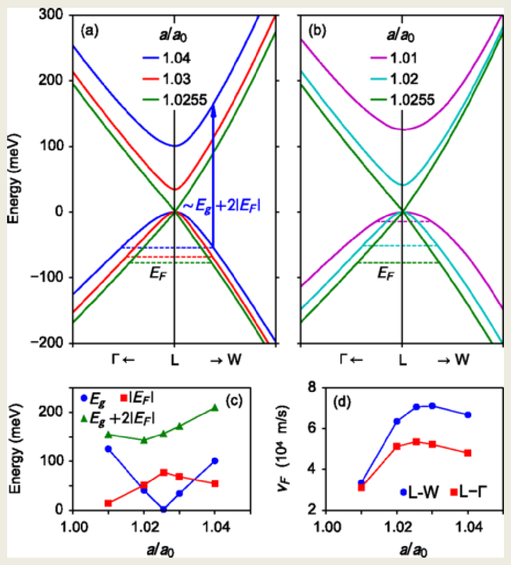
BEAMLINE DEV. PROPOSAL LEADS

MET: Larry Carr (Brookhaven Nat'l Lab)
FIS: Zhenxian Liu (Carnegie Institution of Washington)

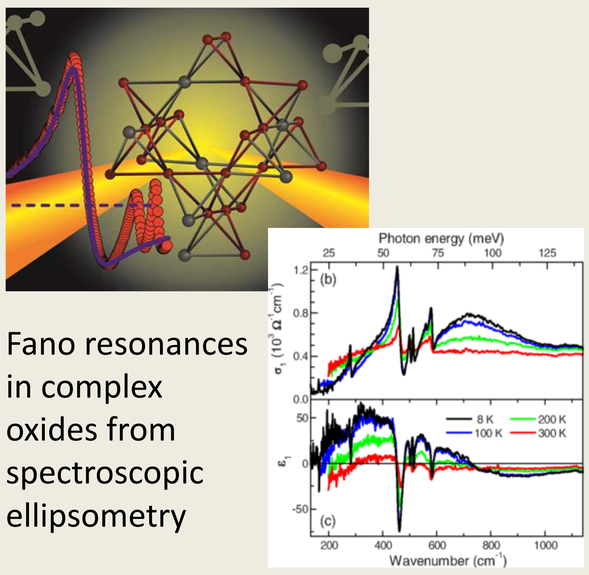
SCIENTIFIC APPLICATIONS



Behavior of materials under conditions deep within Earth's interior, e.g. water in minerals. See "Dehydration melting at the top of the lower mantle"; Brandon Schmandt et al, *SCIENCE*, **344**, 2014, p.1265 (2014).

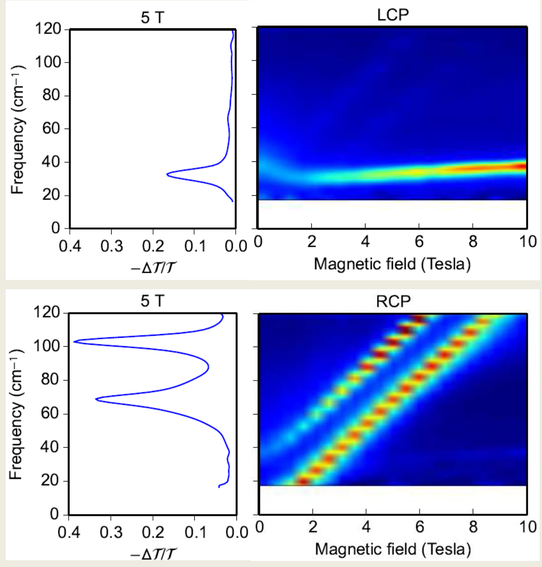


Topological phase transitions and protect surface states through tuning of band structure with pressure. See "Bulk Signatures of Pressure-Induced Band Inversion & Topological Phase Transitions in $Pb_{1-x}Sn_xSe$"; X. Xi et al *Phys. Rev. Lett.* **113**, 096401 (2014) and *Phys. Rev. Lett.* **111**, 155701 (2013)



Fano resonances in complex oxides from spectroscopic ellipsometry

Electronic and spin properties of emergent complex oxides (superconductors, multiferroics) See "Fano Resonances in the Infrared Spectra of Phonons in Hyperkagome $Na_3Ir_3O_8$"; D. Pröpper et al, *Phys. Rev. Lett.* **112**, 087401 (2014)



Time-resolved & magneto-spectroscopy. Electron & exciton dynamics in semiconductors, non-equilibrium superconductivity to probe gap structure. See X. Xi et al, *Infr. Phys. Tech.* (2014), X. Xi et al, *Phys. Rev.* B**87**, 180509R (2013)