SOFT INELASTIC X-RAY SCATTERING (SIX)

BROOKHAVEN NATIONAL LABORATORY

NATIONAL SYNCHROTRON LIGHT SOURCE II

SCIENTIFIC SCOPE

Soft Inelastic X-ray Scattering (SIX) is an undulator beamline providing resonant inelastic x-ray scattering (RIXS) at an unprecedented energy resolution of 15 meV at 1000 eV. Meeting this ambitious goal requires several technical tour de forces, including the fabrication of VLS plane gratings with 50-nrad figure error and μm stability for the critical optical components. Continuous variation of the scattering angle of the 15-m long spectrometer arm from 38° to 150° will allow tunable momentum transfer in 3D materials. These capabilities will offer unrivaled sensitivity to low-energy collective excitations, enabling studies of collective ordered states as a function of dimensionality, from 1D electronic models to 3D complex systems.

BEAMLINE CHARACTERISTICS

TECHNIQUES:

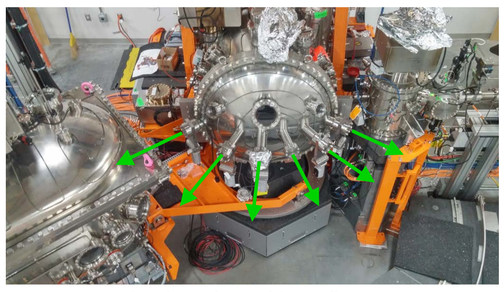
- Resonant inelastic X-ray scattering (RIXS)
- X-ray emission spectroscopy (XES)
- X-ray absorption near-edge structure (XANES)

ENDSTATION DETAILS:

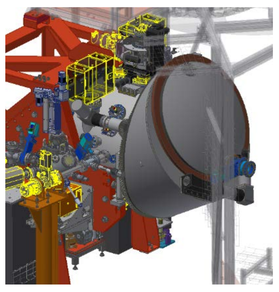
- Ultrahigh resolution 'Centurion' spectrometer with 100,000 resolving power
- 15-m spectrometer arm in a dedicated building
- Continuous tunable momentum transfer
- Open-flow cryostat with motorized manipulator
- In-vacuum diffractometer connected to closed-cycle cryostat

SIX at NSLS-II:

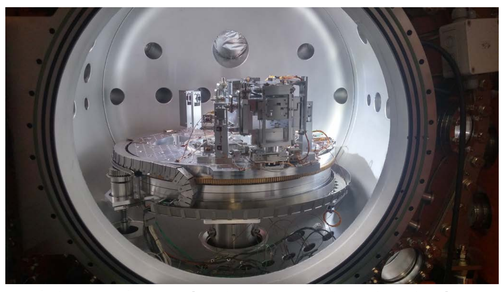
- Soft X-ray (160 eV-2300 eV) energy range to access transition metal L edges, rare-earth M edges, and K edges from C to Si
- RIXS with world-leading energy resolution (15 meV @ 1000 eV)
- Focused beam (0.6 μm x 6 μm) to study small crystals / μ-scale structures
- Photodiodes on rotatable optics table around sample for diffraction
- CCD with 3-μm effective pixel size



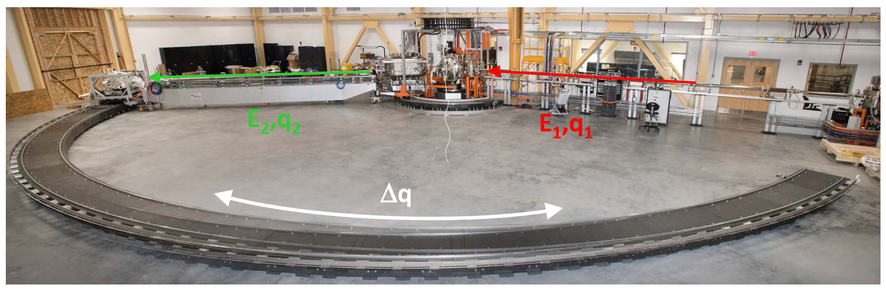
Fixed-angle multiport flange



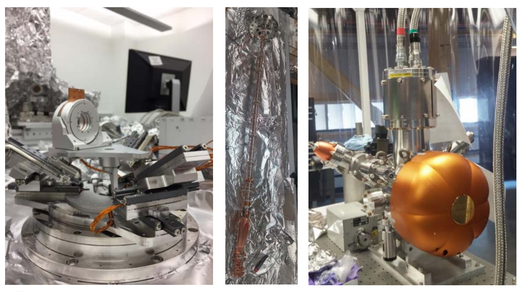
Triple rotating flange (summer 2017)



Interior of sample chamber with optics table



Overview of the 15-m long spectrometer arm.



From left to right: In-vacuum sample diffractometer, closed-cycle cryostat with two sample holders, CCD

Overview

PORT: 2-ID

SOURCE: Undulator (EPU57)

ENERGY RANGE: 160 – 2300 eV

RESOLVING POWER: $E/\Delta E = 10^4 – 10^5$

SPATIAL RESOLUTION: 0.6 μm V x 6 μm H

BEAMLINE STATUS: Technical commissioning

AVAILABLE TO USERS: Fall 2018

BEAMLINE PHONE: 631.344.1602

BEAMLINE WEBSITE: www.bnl.gov/nsls2/beamline/2-ID

Beamline Staff

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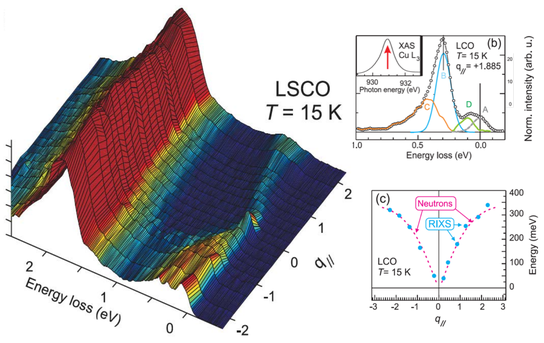
Beamline Scientist

Apply for Beam Time

Beamlines at NSLS-II are available to all scientific researchers through a peer-review proposal process. For more information, see the NSLS-II Users' Guide at:

www.bnl.gov/ps/userguide/

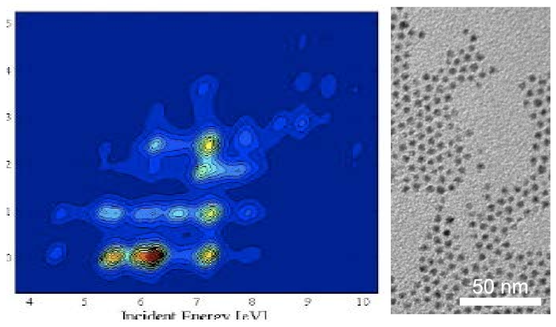
SCIENTIFIC APPLICATIONS



Phys. Rev. Lett. 104, 077002 (2010): Dispersing magnetic excitations in $La_{2-x}Sr_xCuO_4$ measured by RIXS

COMPLEX MATERIALS FOR ADVANCED TECHNOLOGIES

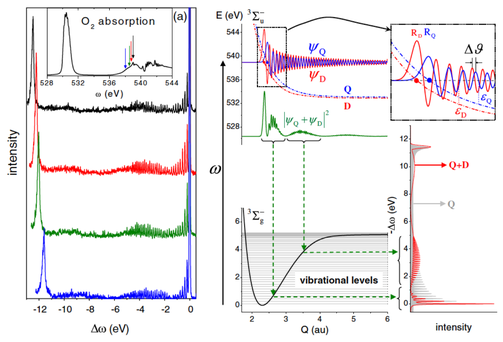
Studies of collective excitations of charge, spin, orbital, and lattice degrees of freedom in quantum materials with correlated electrons such as high-T_c superconductors, Kondo topological insulators, CMR materials, heterostructures, multiferroics.



J. Phys. Chemistry C 116, 15218 (2012): Electronic structure of CoO nanocrystals determined by RIXS

CHEMICAL AND ENERGY SCIENCES

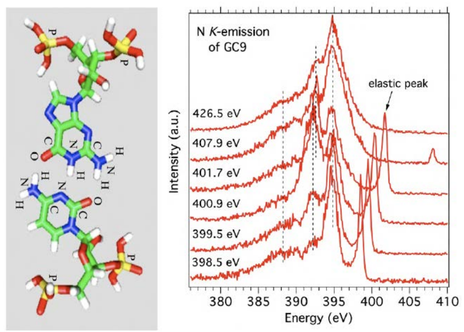
In-situ measurements of the occupied and unoccupied density of states of energy materials. Size-dependent studies of the electronic structure of nano particles to create novel, tailored materials with optimized reactivity.



Phys. Rev. Lett. 106, 153004 (2011): Vibrational resonant soft x-ray scattering in gas-phase O_2

ATOMIC AND MOLECULAR SCIENCES

The nature of the RIXS process will serve as an experimental test-bench for advanced quantum chemical theory, including the behavior of highly excited states, ultrafast wave packet dynamics, and the role of localization and symmetry.



RIXS of Guanine-Cytosine base pairs in aqueous solution taken at BL 7.0.1 at ALS

LIFE AND ENVIRONMENTAL SCIENCES

The ability to study liquid systems *in-situ* will allow studies of active centers of large biomolecules in an aqueous environment, homogenous catalysis, and complex processes at mineral surfaces, for example.