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 at an unprecedented energy resolution of 14 meV at 1000 eV. Meeting this ambitious goal requires several technical tour de forces, including the fabrication of state-of-the-art VLS plane gratings with 50 nrad figure error and the achievement of μm level stability for critical optical components. Continuous variation of the scattering angle of the 15-m long spectrometer arm from 30° to 150° will allow tunable momentum transfer. 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

TECHNIQUE:

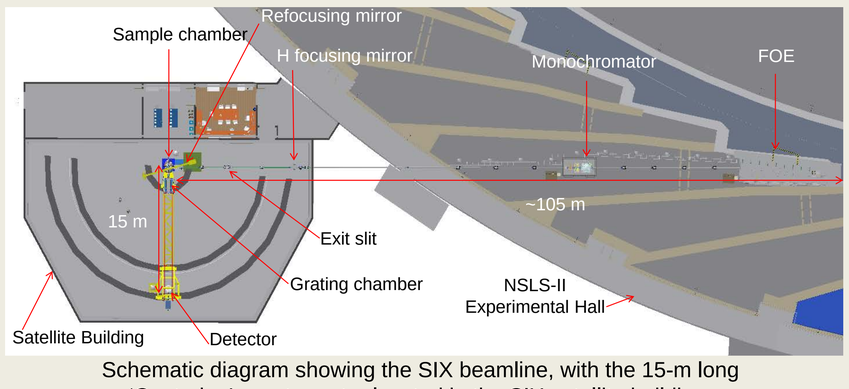
- Resonant Inelastic X-ray Scattering (RIXS)

ENDSTATION DETAILS:

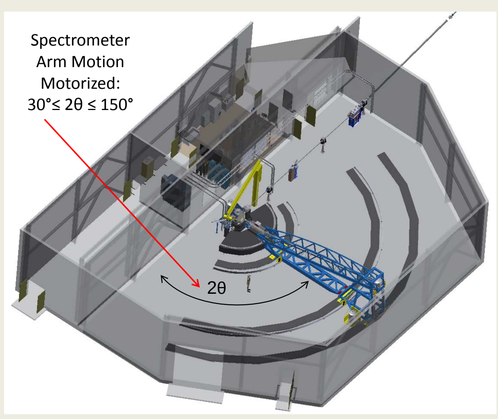
- Ultrahigh resolution 'Centurion' spectrometer with 100'000 resolving power
- 15m-spectrometer arm in a dedicated building
- Continuous tunable momentum transfer

SIX at NSLS-II:

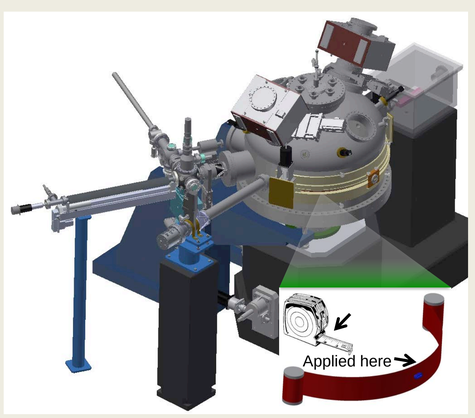
- Soft X-ray (165 eV-2300 eV) energy range to access transition metal L edges, rare-earth M edges, and K edges from C to Si.
- RIXS with world-leading energy resolution (14 meV @ 1000 eV) .
- Focused beam (0.3 μm x 2.5 μm) to study small crystals / μ-scale structures.
- High-sensitivity soft x-ray detector operating at near grazing incidence



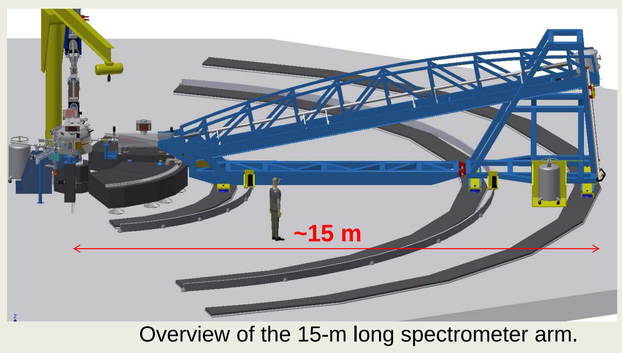
Schematic diagram showing the SIX beamline, with the 15-m long 'Centurion' spectrometer located in the SIX satellite building.



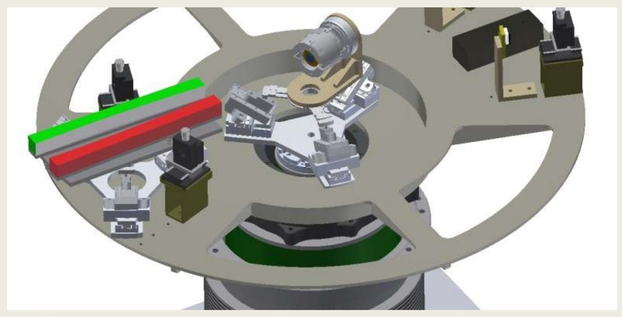
Close-up view of the 2θ rotating arm of the spectrometer.



Close up view of the sample chamber vacuum belt allowing a continuous rotation of the arm.



Overview of the 15-m long spectrometer arm.



Expanded view of the diffractometer and other sample chamber components.

Overview

PORT: 2-ID

SOURCE: Undulator (EPU57)

ENERGY RANGE: 165 – 2300 eV

BL ENERGY RESOLUTION: $\Delta E/E = 10^{-5}$

SPECTRO ENERGY RESOLUTION: $\Delta E/E = 10^{-5}$

CONSTRUCTION PROJECT: NEXT

BEAMLINE STATUS: Construction

AVAILABLE TO USERS: Autumn 2016

Beamline Team

STAFF

Ignace Jarrige: lead beamline scientist
Valentina Bisogni: beamline scientist
Joseph Dvorak: optics scientist
William Leonhardt: mechanical engineer
Yi Zhu: mechanical engineer
Amanda King: designer

ADVISORS

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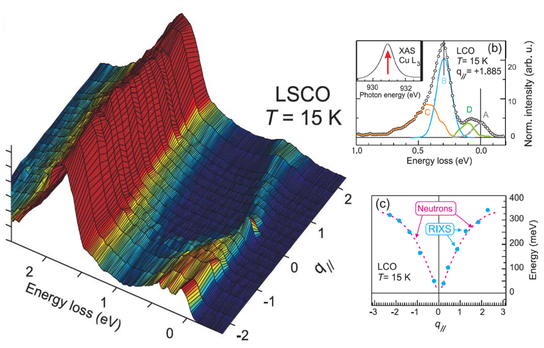
Justina Schlappa (BESSY)
Thorsten Schmitt (Paul Sherrer Institute)
Kevin Smith (Boston University)

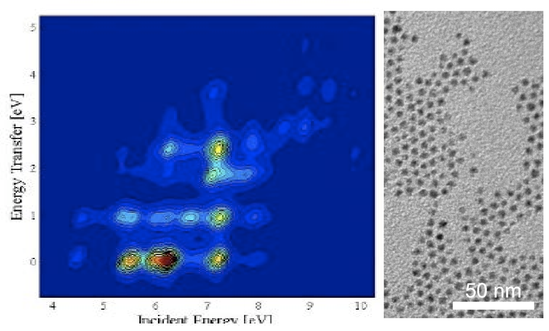
SCIENTIFIC APPLICATIONS



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

COMPLEX MATERIALS FOR ADVANCED TECHNOLOGIES

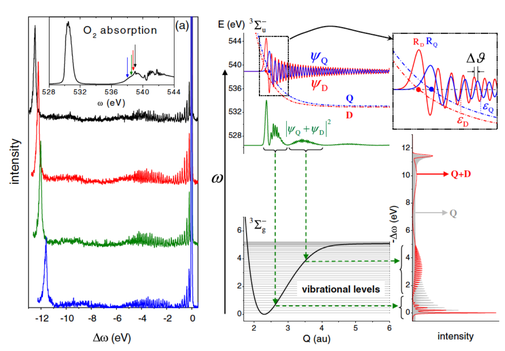
Enables the study of magnetic, orbital, phonon, and Kondo excitations in strongly correlated electron materials and heterostructures ➔ potential applications in high T_c superconductivity, CMR materials and multiferroics.



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

CHEMICAL AND ENERGY SCIENCES

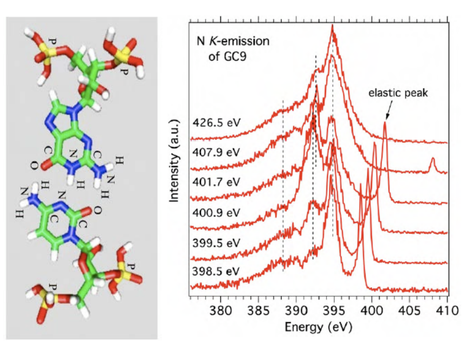
The size dependency of the electronic structure (which is a key factor determining reactivity) of nanoparticles holds the potential to create novel, tailored materials. RIXS allows both the occupied and unoccupied density of states to be measured *in-situ*.



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 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.