# LIFE SCIENCES X-RAY SCATTERING (LiX)

BROOKHAVEN NATIONAL LABORATORY

NATIONAL SYNCHROTRON LIGHT SOURCE II

## SCIENTIFIC SCOPE

The LiX beamline is an undulator-based, micro beam-capable x-ray scattering instrument dedicated to life science research. This instrument is designed to provide capabilities for structural studies of (1) biological macromolecules in solution, in several different modes of solution scattering, including time-resolved measurements using flow mixers; (2) biological tissues, using the scattering intensity as a contrast mechanism for scanning imaging; and (3) lipid membranes, in model systems such as vesicles and substrate supported single bilayer and multi-bilayers. The LiX beamline is part of the Life Science and Biomedical Technology Research (LSBR) resource jointly funded by NIH and DOE-BER.

## BEAMLINE CHARACTERISTICS

### TECHNIQUES (currently available):

*Biomolecular solution scattering*

- High throughput measurements: either with an auto sampler using PCR tubes in 16-position racks and flow-through cells with flat windows; or with windowless cells for samples that do not flow easily
- In-line size exclusion chromatography with an auto sampler; possible to alternate between two columns to increase throughput
- Anomalous scattering

*Scattering-based scanning imaging*

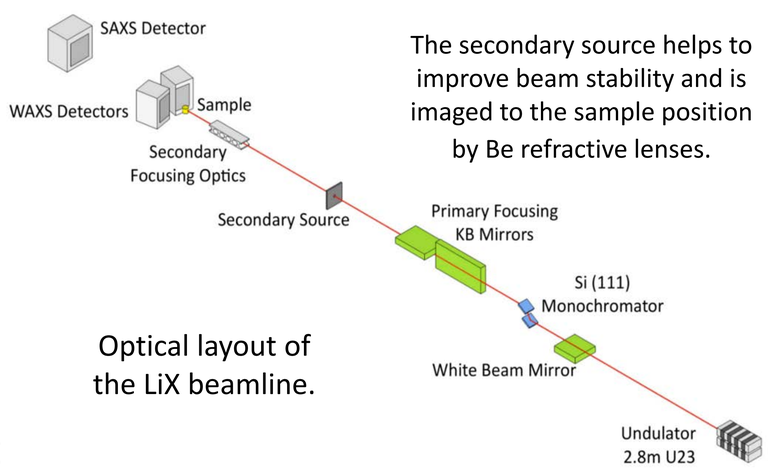
- Routine measurements with 5 micron beam
- 1 micron beam size possible with some loss of beam intensity

### ENDSTATION DETAILS:

- Pilatus3 detectors for SAXS/WAXS, with continuously variable camera lengths
- On-axis microscope and scanning stages
- 6-axis robot to be installed for sample handling

### LiX at NSLS-II:

- Will enable time-resolved solution scattering with resolution down to 10µs; the range of time scales can be varied by selecting from a set of mixing cells
- Will support scattering-based imaging of biological tissues, at down to 1µm resolution; coherent diffraction imaging will also be possible
- Will provide new tools for studying membrane structures




The secondary source helps to improve beam stability and is imaged to the sample position by Be refractive lenses.

Optical layout of the LiX beamline.

## Overview

**PORT**: 16-ID

**SOURCE**: undulator (2.8m IVU23)

**ENERGY RANGE**: 2.1 – 18 keV

**ENERGY RESOLUTION**: $\Delta E/E = 10^{-4}$, Si (111)

**SPATIAL RESOLUTION**: down to 1 µm

**BEAMLINE STATUS:** Available to users

**BEAMLINE PHONE:** 631.344.1416

**BEAMLINE WEBSITE:** https://www.bnl.gov/nsls2/beamline/16-ID

## Beamline Staff

**Lin Yang**
Lead Beamline Scientist

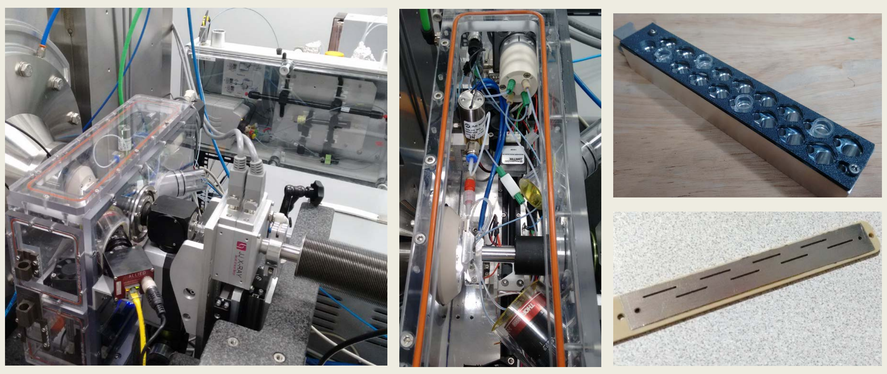
**Shirish Chodankar**
Beamline Scientist

## Apply for Beam Time

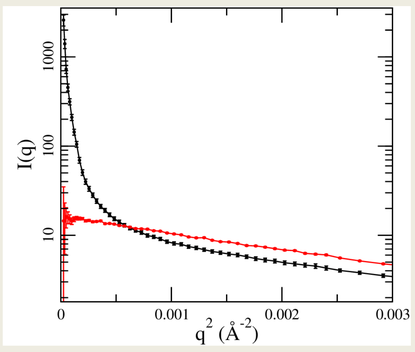
Beamlines at NSLS-II are available to all scientific researchers through a peer-review proposal process. For more information, see the NSLS-II Users' Guide at:

**https://www.bnl.gov/ps/userguide/**

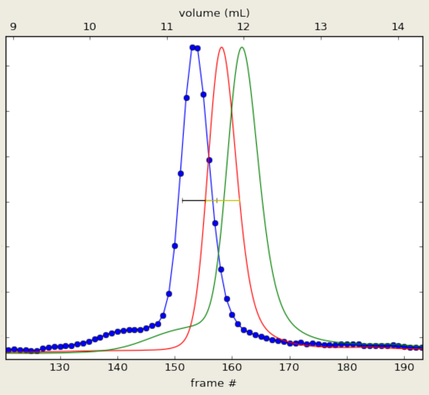
## SCIENTIFIC APPLICATIONS



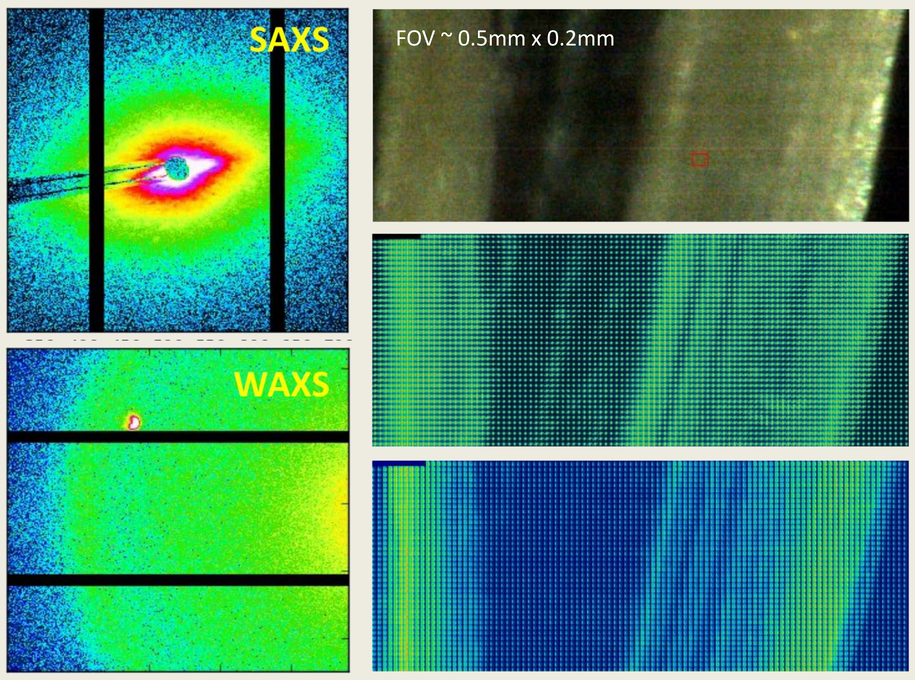
The integrated solution scattering module allows for instantaneous switch between high throughput mode and in-line size exclusion chromatography (SEC) mode. This is essential for users working on molecules that tend to aggregate, who can decide on-the-fly which mode to use based on initial results.




Guinier plots of the data collected on the same sample after simple spin-down (black) and using in-line SEC (red).




The in-line chromatograms of a reference sample. The traces are based on x-ray scattering intensity (blue), UV absorbance (red) and reflective index( green).




Individual and composite scattering patterns and the optical image from a plant section (L Makowski, Northeastern U).

At LiX several modes of solution scattering technique are being offered to the users. These methods are ideal for monitoring the structure of biological macromolecules under physiological conditions. They are often combined with high resolution techniques like protein crystallography to help understand how these molecules function.

The scattering intensity from biological tissues can be used as a contrast mechanism to construct maps of the underlying structure. These false color images can be correlated with those obtained in other types of microscopy to reveal new information. Each pixel in the map can also be examined following classical scattering data analysis methods.