

LARIAT-2 Endstation (7-ID) Equipment Readiness Review

Conan Weiland

On behalf of the NIST NSLSII Partner Beamline Readiness Team



Acknowledgement

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Kristen Rubino
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Steve Devery
Andreas Castiblanco
Ewart Orr
Jerry Malley
Ken Harsch...+ many more

Outline

- Background
- Pillar I: Documentation
 - Endstation Design
 - RSC Review
 - Radiation Survey Procedure
 - Hazard Identification and Mitigation
- Pillar II: Hardware
 - Chamber Design
 - Radiation Safety Components
 - Configuration Control
 - Vacuum
 - Utilities
- Pillar III: Personnel

NIST Project @ BNL: Successful Partnership

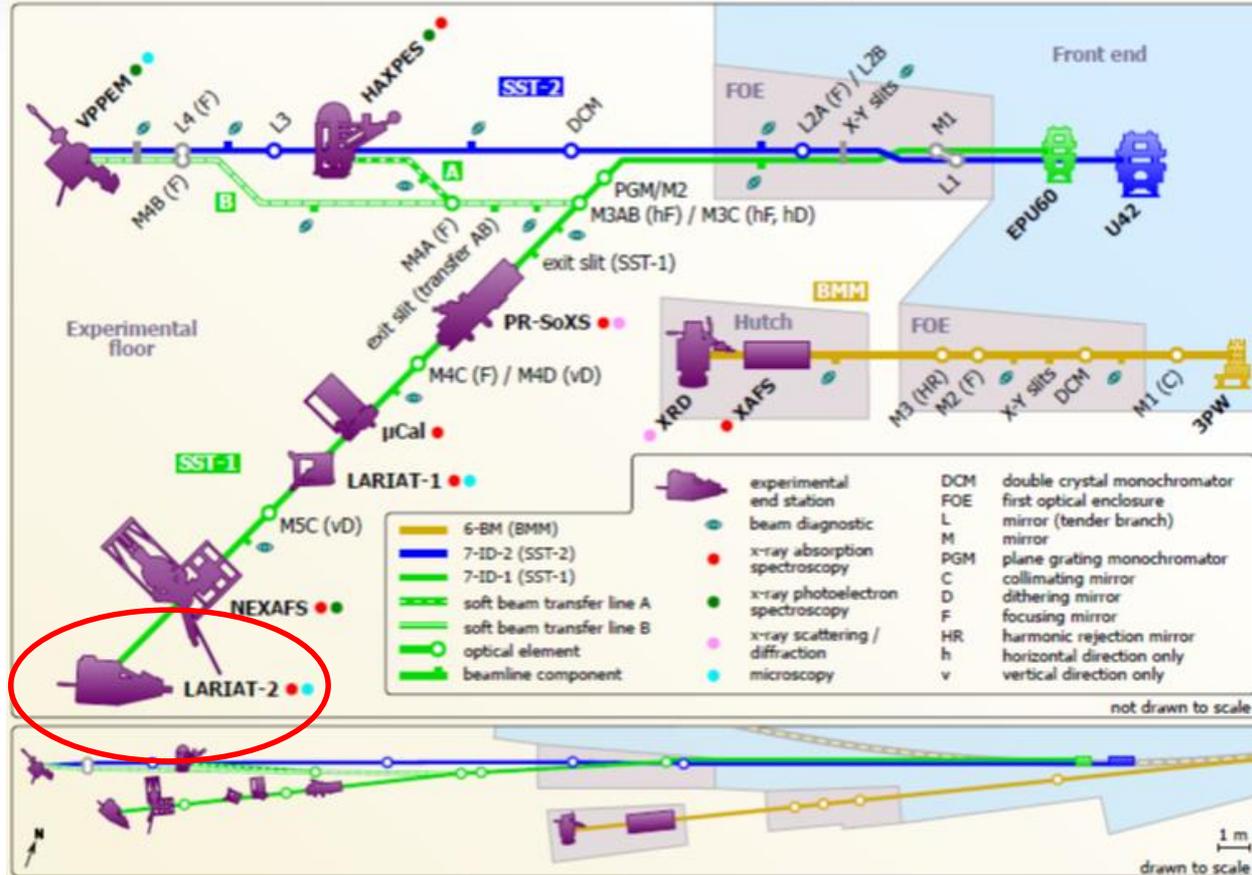
- NIST has over 35 years of partnership/history with BNL
- Operated 5 beamlines at the NSLS
- Provided X-ray spectroscopies that span the entire periodic table
- SST 1, SST2 and BMM to improve upon and provide new capabilities (imaging and diffraction) to NSLS

NIST Project @ NSLSII: Design, Construction, Commissioning, Operation of SST1, SST2 and BMM

- BMM: IRR held in 2017, now in user operations
- SST-1 and 2: IRR held in Feb., now in commissioning with two endstations
 - Eventually will contain seven endstations
- LARIAT-2 is NEXAFS microscope for large-area full-field imaging

Location on SST-1

Soft x-rays (150 eV – 2200 eV)



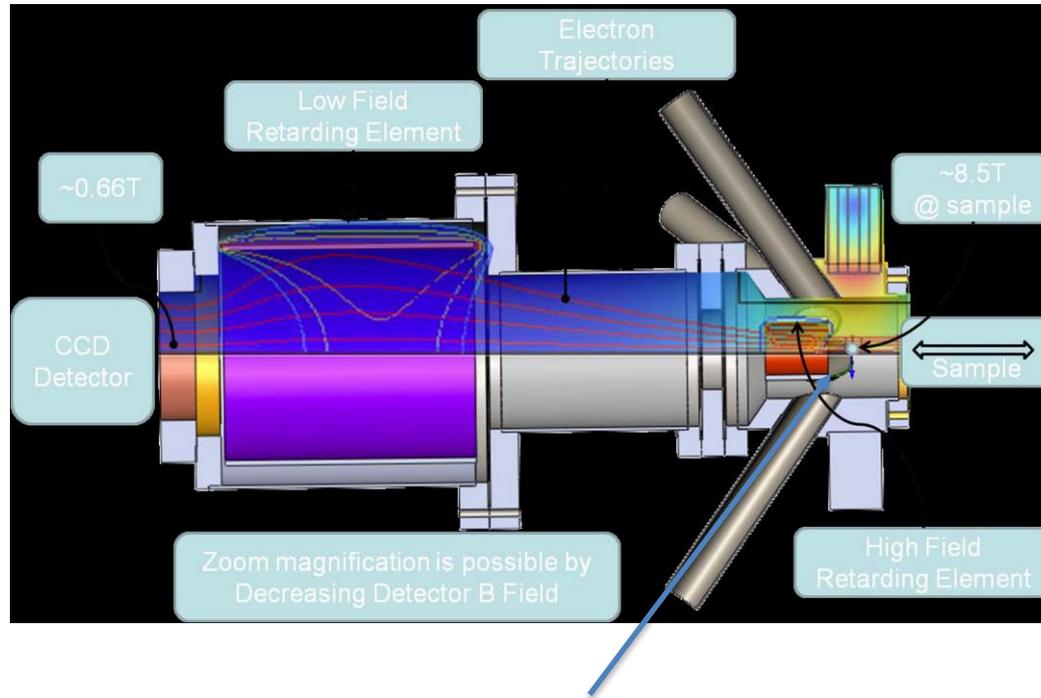
Large Area Rapid Image Analysis Tool, MK-II

- Re-purposed endstation from NSLS, U8B
- High-efficiency NEXAFS microscope
- Chemical and orientation maps of samples, devices, and combinatorial arrays of up to 1000 samples at a time
- Micron-scale resolution with 400 mm² field of view



LARIAT-2 Operating Principle

SST has only operating magnetic lens microscopes



$$\vec{F} = q(\vec{v} \times \vec{B})$$

$$M = \sqrt{\frac{B_0}{B_D}}$$

$$r = \frac{\sqrt{2m_e E_0}}{q_e B} \cos \theta$$

Resolution of $6 \mu\text{m}$ at C K-edge

Pillar I: Documentation

Endstation Design

- Re-purposed endstation from NSLS.
 - In Lieu of design reviews, use endstation traveler
 - SME walkthrough on 10/03/2017
 - SME recommendations carried out
 - SME sign off on completion
- Drawings:
 - Interface Control (PD-SST-ES-3000)

Radiation Shielding Analysis:

- Tech Note #275 (S. Chitra):
 - For soft, monochromatic beam, 1 mm stainless steel or equivalent is sufficient for normal incidence

RSC Review

- Endstation was presented to RSC on 6 Nov., 2018
 - Aspects of radiation safety (shielding, configuration control) were discussed.
 - RSC had NO recommendations

Radiation Survey Plan

- ❑ NSLSII procedure *NSLSII-7ID-PRC-001* is available from SharePoint at
 - ❑ <https://ps.bnl.gov/docs/default.aspx>.
- ❑ Procedure (including LARIAT-2) was developed and reviewed prior to the beamline IRR
- ❑ Since soft, monochromatic beam is used, initial commissioning may be performed at normal ring current.

Hazard Identification and Mitigation

- ❑ USI evaluation is Negative; hazards covered by existing SAD/ASE
- ❑ BNL/NSLS-II safety procedures and practices are adhered to during design/construction and commissioning

Hazard	Mitigation
Radiation	Shielding, Vacuum Switch
Superconducting Magnet	Work instructions for magnet operation – only beamline staff to operate magnet Magnet contains dump circuit for safe release of energy in case of quench; Magnetic survey has been performed to determine 5 Gauss line extent. Magnetic hazard signs are posted at 5 Gauss line when magnet is energized.
Cryogen (He compressors)	Closed circuit system;
Pressure safety – vacuum vessels	Burst discs and PRVs are installed where necessary to prevent over-pressure during venting using GN2 backfill
Electrical	EEL; grounding

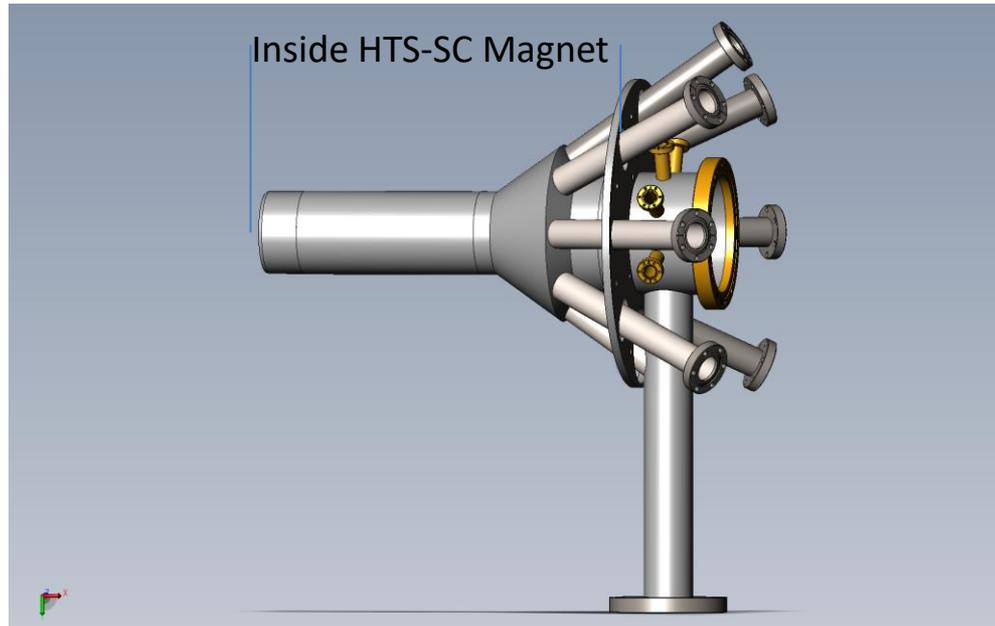
Pillar II: Hardware

Sample Loading Platform

- LARIAT-2 has platform for easy access to load-lock.
- Platform installation has been reviewed by ES&H for safety and is compliant with BNL requirements.

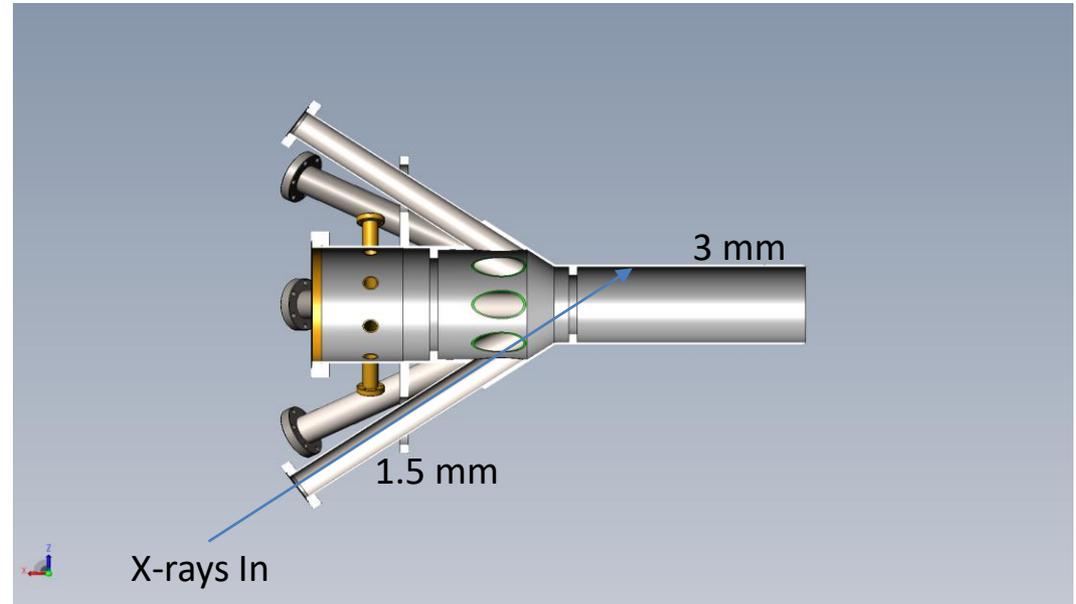
Vacuum Chamber Design

- Stainless steel chamber
 - Sits inside of magnet bore



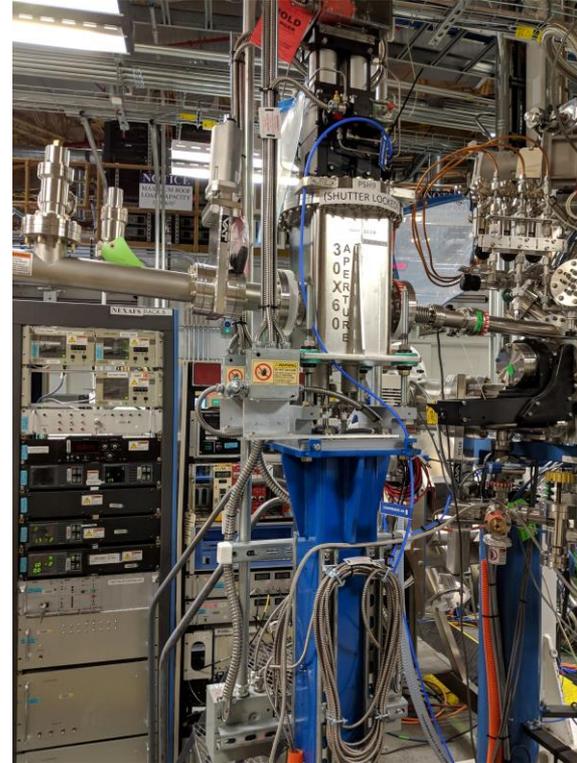
End of Beamline

- With no sample, beam impacts sidewall
 - Min. wall thickness 1.5 mm
 - Most at least 3 mm
 - Chamber acts as end of beamline



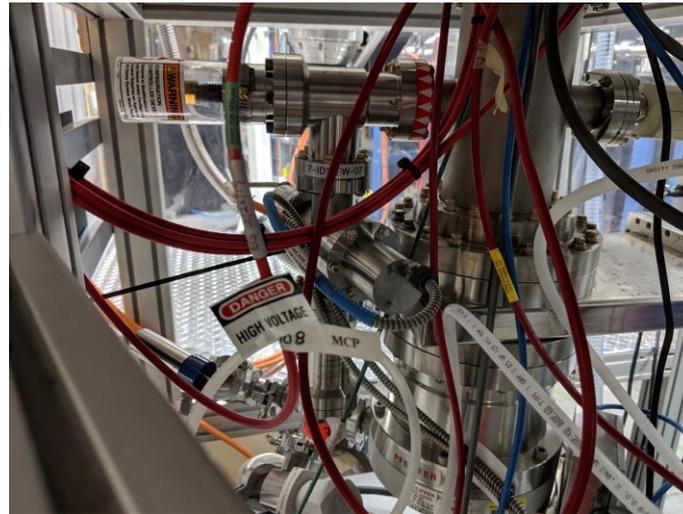
Radiation Safety Components

- Photon Shutter 9
 - *Reviewed with beamline IRR*
 - Upstream of LARIAT-2



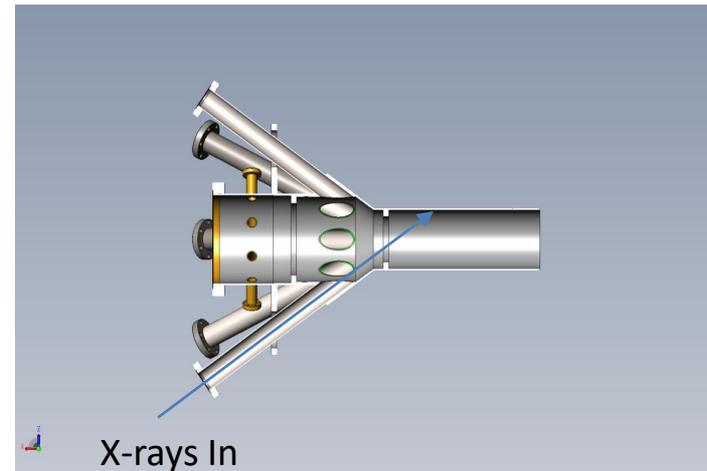
Radiation Safety Components

- Photon Shutter 9
 - *Reviewed with beamline IRR*
 - Upstream of LARIAT-2
- Vacuum Switch (PPS)
 - *Reviewed with beamline IRR*
 - Integrated with PPS
 - Interlocked with PSH9



Radiation Safety Components

- Photon Shutter 9
 - Reviewed with beamline IRR
 - Upstream of LARIAT-2
- Vacuum Switch (PPS)
 - Reviewed with beamline IRR
 - Integrated with PPS
 - Interlocked with PSH9
- End of Beamline
 - Chamber wall



Configuration Control

- PSH9 and Vacuum Switch already on Rad. Safety Comp. checklist
 - Additionally, vacuum chamber 7-ID-VVS-02 (beam stop) added
- Reviewed by RSC sub-committee on 6 Nov.

7-ID1-PSH-09 Check that photon shutter 9 is in place and labeled.

SECTION E:

The following section does NOT need to be verified subject to SSWP# _____ and LOTO has been applied to the Beamline Photon Shutter 9.

Lead Beamline Scientist (signature): _____ Date: _____

- 7-ID1-VA-30 Check that contiguous vacuum section between photon shutter 9 and the upstream flange of the LARIAT-2 endstation is in place and labeled.
- 7-ID1-SW-07 Check that pair of vacuum switches are in place and labeled, and that valve connecting to chamber is open.

7-ID1-PSH-09 Check that photon shutter 9 is in place and labeled.

SECTION E:

The following section does NOT need to be verified subject to SSWP# _____ and LOTO has been applied to the Beamline Photon Shutter 9.

Lead Beamline Scientist (signature): _____ Date: _____

- 7-ID1-VA-30 Check that contiguous vacuum section between photon shutter 9 and the upstream flange of the LARIAT-2 endstation is in place and labeled.
- [7-ID1-VVS-01](#) [Check that vacuum vessel LARIAT-2 vacuum vessel which acts as beam stop is in place and labeled.](#)
- 7-ID1-SW-07 Check that pair of vacuum switches are in place and labeled, and that valve connecting to chamber is open.

Utilities

- Electrical power:
 - Single phase, 208V, 3-Phase
 - No modification from beamline IRR
- Process Chilled Water
 - No modification from beamline IRR to main system, but some additional local tubing from drops

Vacuum

- Vacuum provided by air-cooled turbo pumps
- Endstation vacuum 10^{-7} Torr or better
- Gauge and pump controllers located in water-cooled rack

Controls

- ❑ Motion control for sample introduction and selection
 - ❑ All motions and motion control have been established and tested
 - ❑ Motion controllers for photon delivery system on water-cooled rack
 - ❑ Motion control via EPICS PVs, to be integrated with commercial analyzer software package.

Pillar III: Personnel

Commissioning Team

NIST Group Leader	Daniel Fischer
Lead Beamline Scientist, SST-1	Cherno Jaye
LARIAT-2 Lead Scientist	Conan Weiland

All beamline staff have completed their assigned training 😊

Summary

- LARIAT-2 NEXAFS microscope for large area imaging
 - Unique instrument
- Endstation design is compliant with radiation shielding for monochromatic soft x-ray beam as per Tech. Note #275
- Potential hazards have been reviewed and mitigated per BNL policies and procedures.

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