NSLS-II Final Design Review
Spectroscopy Soft and Tender - SST1 and SST2

February 9, 2017

Dan Fischer
Leader Synchrotron Science Group

Materials Measurement Science Division
Material Measurement Laboratory
National Institute of Standards and Technology

"Promote Innovation and Enhance US Industrial Competitiveness"

NIST NSLS-II Partner Beamlines

NIST Synchrotron Science Group

Stationed at NSLS-II

Ray Browning
Dan Fischer
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Barry Karlin
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Conan Weiland
Joe Woicik
Eliot Gann (NRC)
Nick Quackenbush (NRC)

w/Jean Jordan-Sweet (IBM)
w/Ron Jones MML/NIST Liaison
w/Ruben Reininger (SAS)

NSLS-II

Andy Broadbent
Zhong Zhong, Howard Robinson

John Fabijanic
Greg Fries
Chris Stebbins

ID, FE, EPS, Controls, Safety Groups

FMB Oxford (UK)

Andrew Fairley
Scott Mowat
FMB Team

People create opportunities !

35 year NIST NSLS I/II Partnership

Need

Development and optimization of advanced materials and innovative devices by U.S. industry requires measurement of electronic, chemical, and spatial structure at the nanoscale

NIST NSLS-II Partner Beamline Suite

$40M+ investment, started in 2009

Spectroscopy Soft and Tender(SST) Beamlines

- 100 eV to 7.5 keV in a single experiment (common focus in 2 stations, rare capability)
- 2 full-field microscopes micro to nanoscale (unique magnetic projection design, SBIRs)

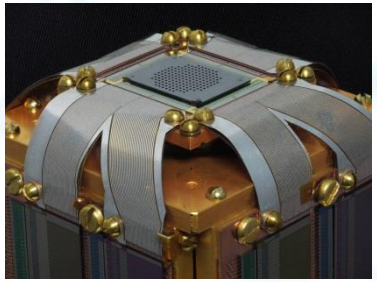
Beamline for Materials Characterization(BMM)

Hard X-ray Absorption Spectroscopy and Diffraction 4.9 keV to 22 keV

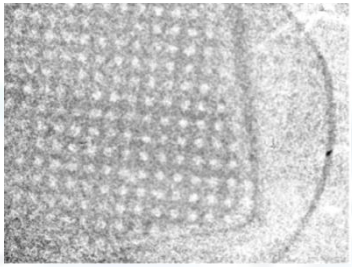
Synchrotron Science Group (9) at BNL

NSLS-I Achievements and Impact

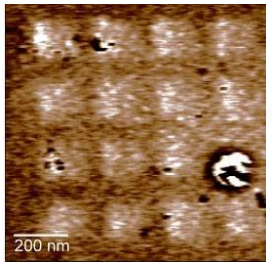
- Spectroscopy beamlines that span the entire periodic table (90 experiments/year; 110 users)
- State-of-the-art X-ray and electron detectors
- In-situ capabilities for "real" samples/conditions



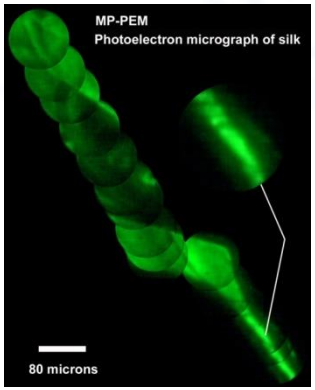
NIST μ-calorimeter X-ray detectors



Chemical imaging of designer photo voltaics



Ferroelectric $SrTiO_3$ thin film on Silicon



Photoelectron image of silk

Customers and Partners:

25 private, 14 public, 25 academic

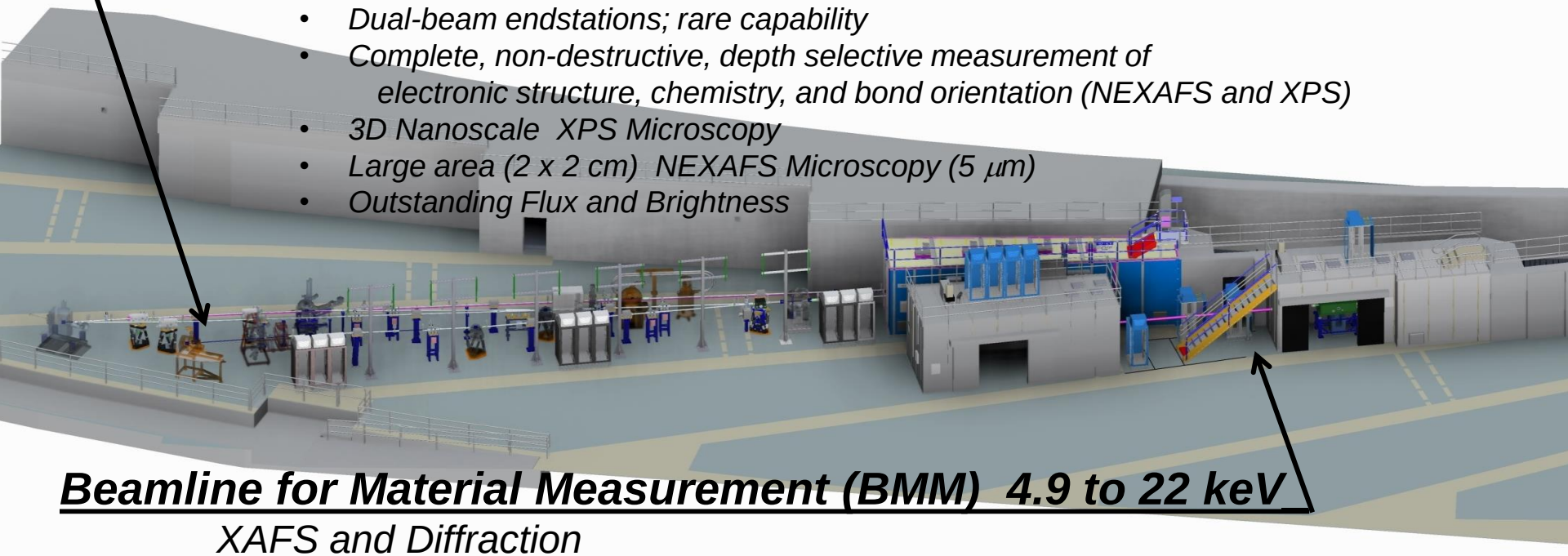
NIST NSLS-II Spectroscopy Beamline Suite spanning the entire periodic table (FY17)

"We develop and apply new synchrotron X-ray measurement methods to establish structure-function relationships for advanced materials design"

Spectroscopy Soft and Tender (SST 1 and 2)

Soft and Tender Beamlines

- *100 eV to 7.5 keV x-ray energy range*
- *Dual-beam endstations; rare capability*
- *Complete, non-destructive, depth selective measurement of electronic structure, chemistry, and bond orientation (NEXAFS and XPS)*
- *3D Nanoscale XPS Microscopy*
- *Large area (2 x 2 cm) NEXAFS Microscopy (5 μm)*
- *Outstanding Flux and Brightness*



Beamline for Material Measurement (BMM) 4.9 to 22 keV

XAFS and Diffraction

- *High flux: dilute samples, quick scanning for chemical reactions*
- *Focused beam: XAFS thin films, XAFS scan imaging*
- *High-energy resolution for enhanced chemical speciation*
- *6-circle goniometer for high-resolution specular and non-specular diffraction*

SST and BMM User Communities

SST: NEXAFS, HAXPES, XPS, Microscopy **BMM**: XAFS, Diffraction

Communities or industries served: inorganic and organic microelectronics, plastics, chemical / catalysis, biomaterials, batteries, environmental materials.

Established User Community: **informed and prepared for operations**

25 Academic, 25 Industrial,

14 National Laboratory Groups

SST Scope

- FOE Hutch
- Mechanical and Electrical Utilities
- EPS
- PPS
- Sources: EPU60 and U42
- Straight
- Front End

- Photon Delivery System with controls (FMB-O)
- End stations: HAXPES/NEXAFS, μXPS, HP NEXAFS/FY, μNEXAFS1, NEXAFS/XPS, μNEXAFS2 (NIST)
- Data acquisition and end station controls (NIST)

SST construction project

NSLS-II direct involvement in all aspects of construction, true partnership

Andy Broadbent: NSLS-II Partner Beamline Portfolio Manager

Zhong Zhong and Howard Robinson : NSLS-II NIST Partner Beamline Manager

John Fabijanic: NSLS-II Designer

NIST/BNL Interagency Agreements fund BNL purchase and construction

IDs testing and integration; Straights and Front Ends (NSLS-II Groups; ID, FE, EPS, Controls)

Hutches/Common systems (NSLS-II Utilities)

Photon Delivery Systems – NIST Direct Purchases

Ruben Reininger optical designs, mirror specs

FMB Oxford/Berlin SST beamline mechanics, Diagnostics, PGM, DCM, mirrors, and installation

Experimental Stations – State of the art from NSLS-1 (at 7-ID)

SST1 – NEXAFS Microscope I & II, NEXAFS/XPS, Soft X-ray Emission Micro-calorimeter

Funded Scope addition: Polarization-dependent Resonant Soft X-ray Scattering Station

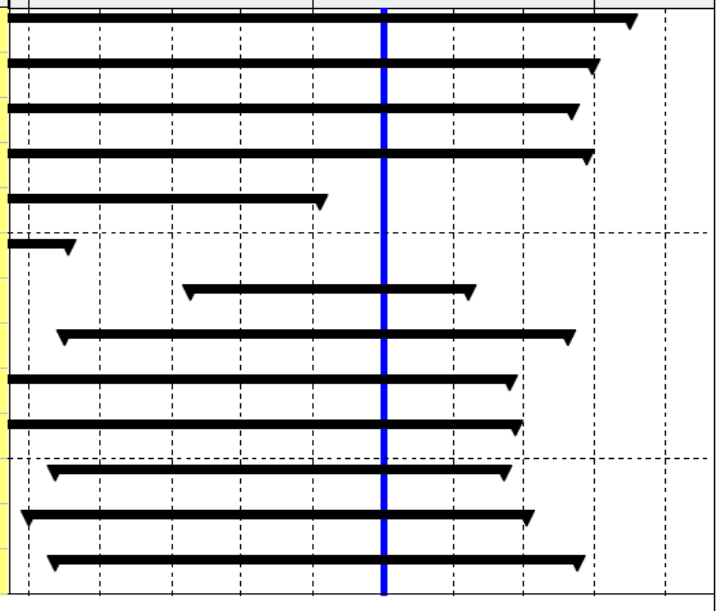
SST2 – HAXPES/NEXAFS, XPS Microscope, *future high pressure XAS*

SST Schedule

All activities finish Sept. 30, 2017, IRR in Oct.

SST12 and BMM Partner Beamlines - 2016 December Draft | IPD - Summary Schedule | 02-Feb-17 09:51

Activity ID	Start	Finish
SST 1&2 Management	02-Mar-15 A	15-Nov-17
SST 1&2 Design	02-Mar-15 A	28-Sep-17
SST 1&2 Construction	01-Oct-12 A	01-Sep-17
SST 1&2 Hutches	02-Mar-15 A	19-Sep-17
SST 1&2 Utilities - Mechanical	10-Mar-15 A	10-Oct-16 A
SST 1&2 Utilities - Electrical	10-Mar-15 A	20-Nov-15 A
SST 1&2 EPS	25-Apr-16 A	19-Apr-17
SST 1&2 PPS	16-Nov-15 A	28-Aug-17
SST 1&2 Front End	03-Aug-15 A	12-Jun-17
SST 1&2 EPU60 Refurbishment	03-Aug-15 A	19-Jun-17
SST 1&2 U42 Refurbishment	02-Nov-15 A	05-Jun-17
SST 1&2 Straight	29-Sep-15 A	05-Jul-17
SST 1&2 Controls	02-Nov-15 A	08-Sep-17



Photon Delivery System
History FMB-O SST FDRs at NSLS-II
(minutes, action items and responses posted)

- Sept. 1, 2015 SST FDR: 8 action items
  - June 29, 2016 – NIST approves

- Sept. 13, 2016 FMB-O contract amendment

  Secondary Bremsstrahlung shielding and other shielding, diagnostics

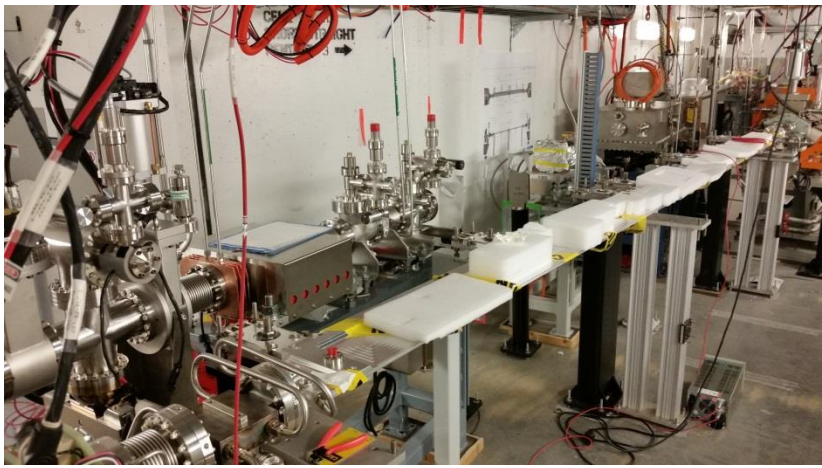
- Nov. 29, 2016 FMB-O FDR: 13 action items
  - Dec. 21, 2016 NIST approves

SST1&2 Layout: DCM, PGM, mirrors (14)

Current state of SST beamline component installation (30th December), all main optical elements are in position.

SST1&2 Progress

- Beamline Photon Delivery System
  - **FMB-Oxford contract progressing well, although significant delay due to (NIST) contract modification.**
  - Installation Phase #1,2 completed, 3 mirrors, 2 monos installed. 2 precision slits and 7 hexapod mirror systems (9 mirrors) installed in Oct ’16, some additional work completed Dec ‘16.
  - Some shielding analysis work completed (Zhong, Lee, Xia) and written up in the beamline PDR documents. **Requires further analysis by NSLS-II RSO (~Feb 2017)**.
- Insertion Device and Straight
  - New control systems for the refurbished EPU60 and U42 devices are in progress.
  - Need to have devices plotted and checked for compatibility with NSLS-II as soon as possible. Magnetic measurement scheduled for Jan/Feb 2017.
  - Vacuum chamber is now installed (Dec ‘16 shutdown), see photo. Plan to install IDs in May 2017 shutdown.
- Front End
  - Manufacturing of mask and slit bodies in progress, everything else was installed in Dec 2017 shutdown.
- Infrastructure
  - Mechanical and electrical utilities completed (includes LN2 and exhaust systems).
  - PPS work in progress (mainly wiring for shutters and vacuum sensors and assembly of HMI panels).
  - EPS work in progress. Most wiring is now complete.



ID straight chamber installed.

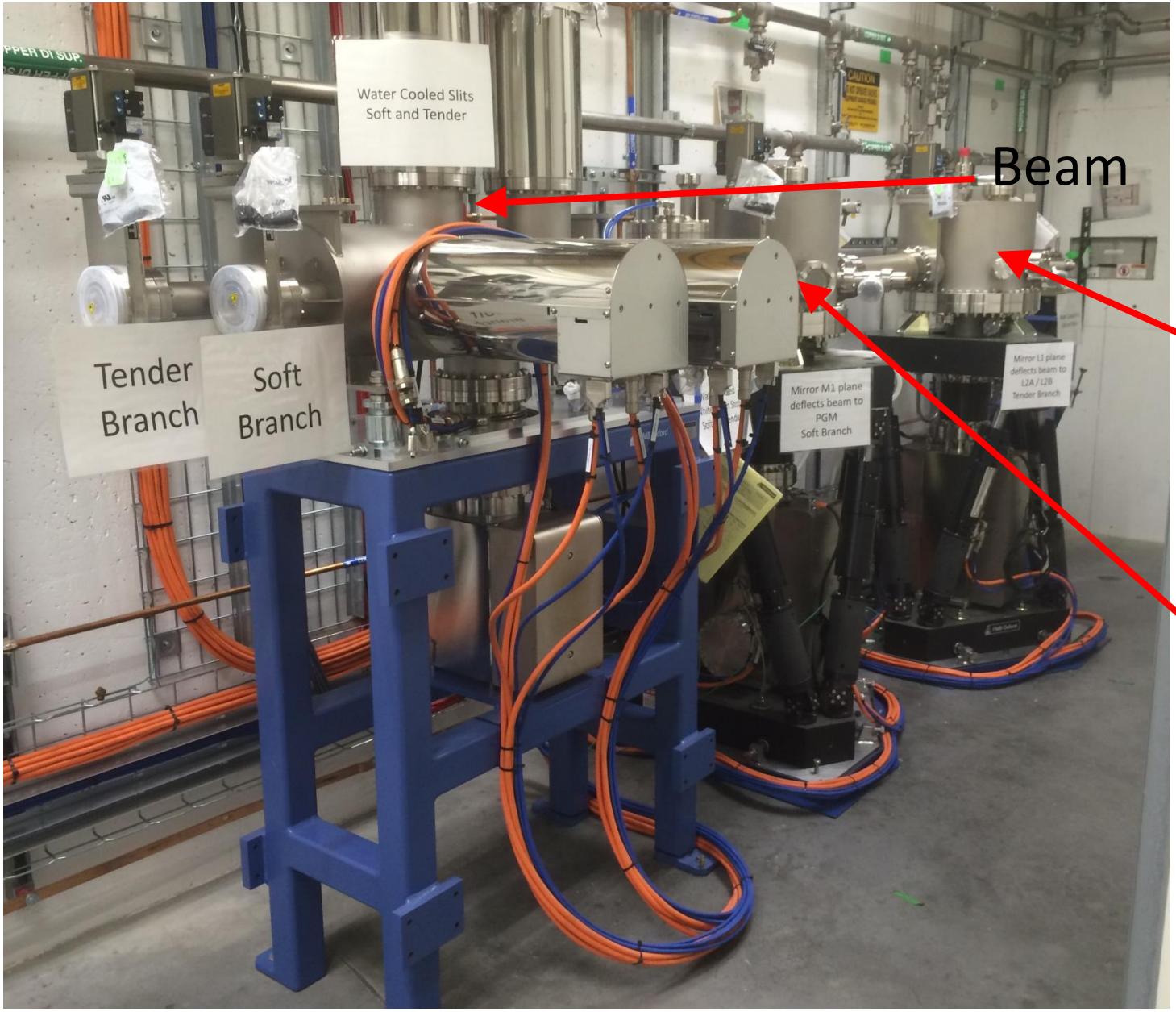
SST 1&2 Layout: Insertion Devices

- New control systems for refurbished EPU60 and U42 devices in progress Bldg. 842.
- Need to have devices plotted and checked for compatibility with NSLS-II ASAP. Magnetic measurement scheduled for Jan/Feb 2017.

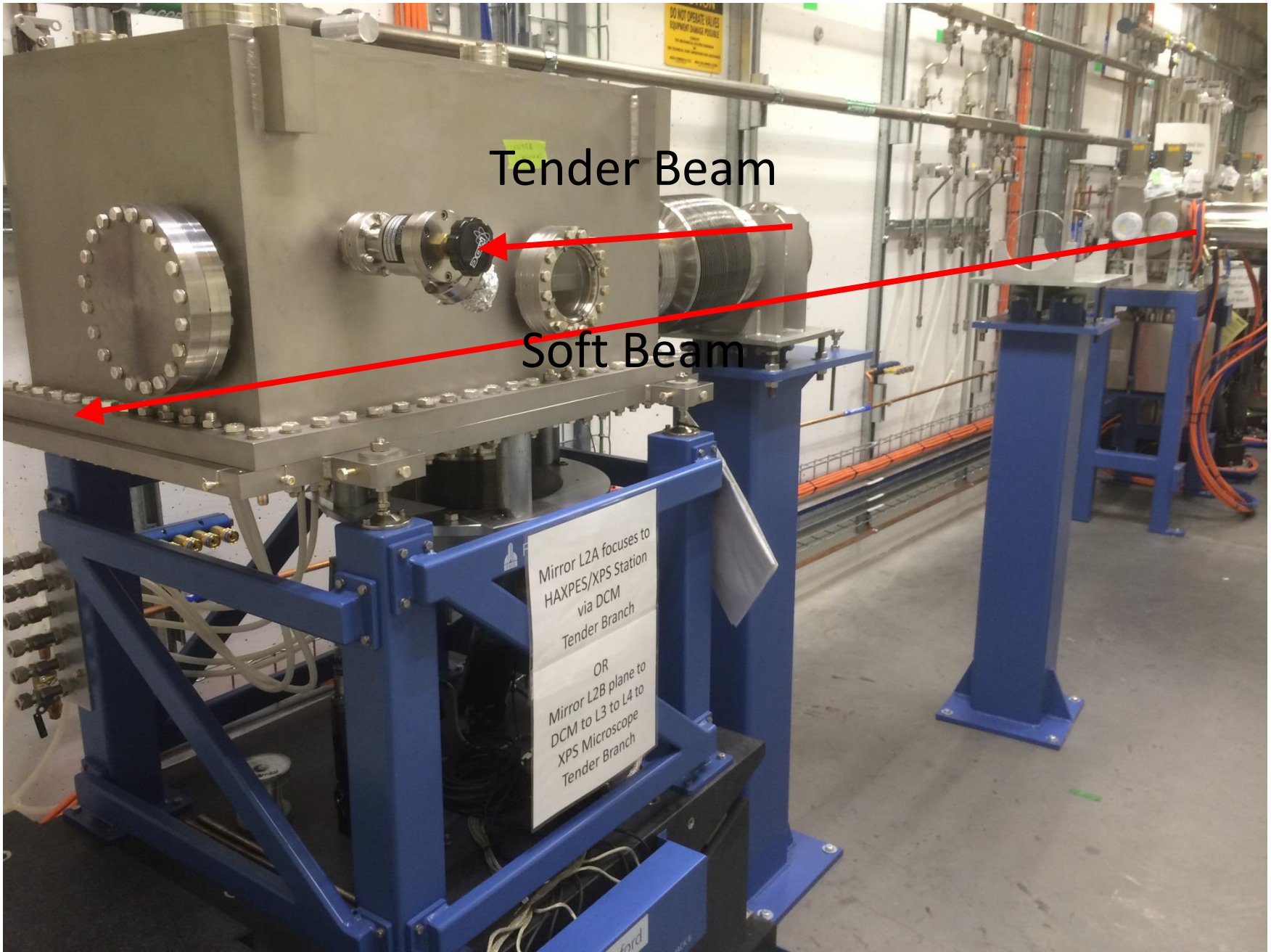
ESRF U42 (Tender)

Aladdin EPU 60 (Soft)

SST1&2 Layout: FOE, mirrors, and diagnostics



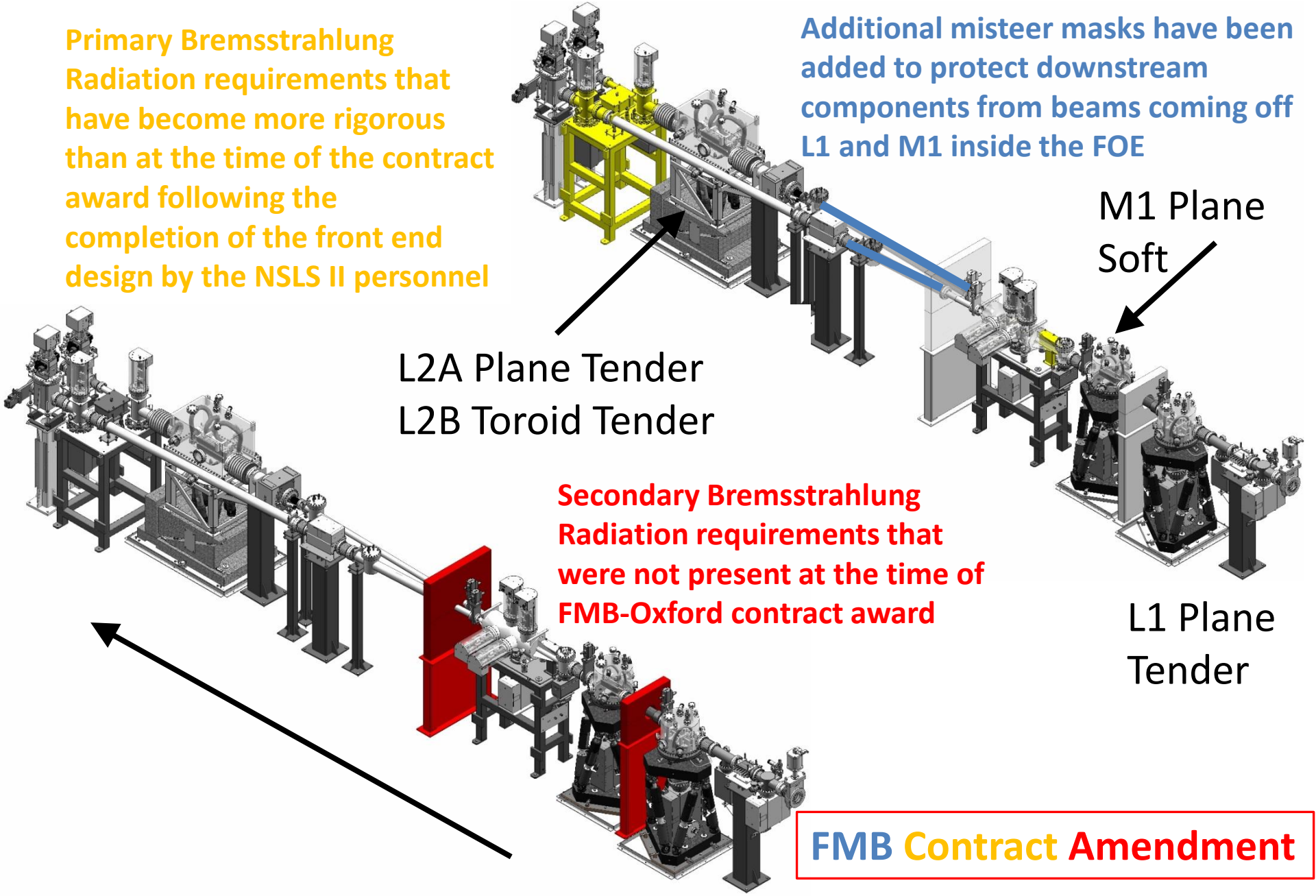
SST1&2 Layout: FOE, mirrors, and diagnostics



SST1&2 Layout: FOE, mirrors, diagnostics, and shielding

Primary Bremsstrahlung Radiation requirements that have become more rigorous than at the time of the contract award following the completion of the front end design by the NSLS II personnel

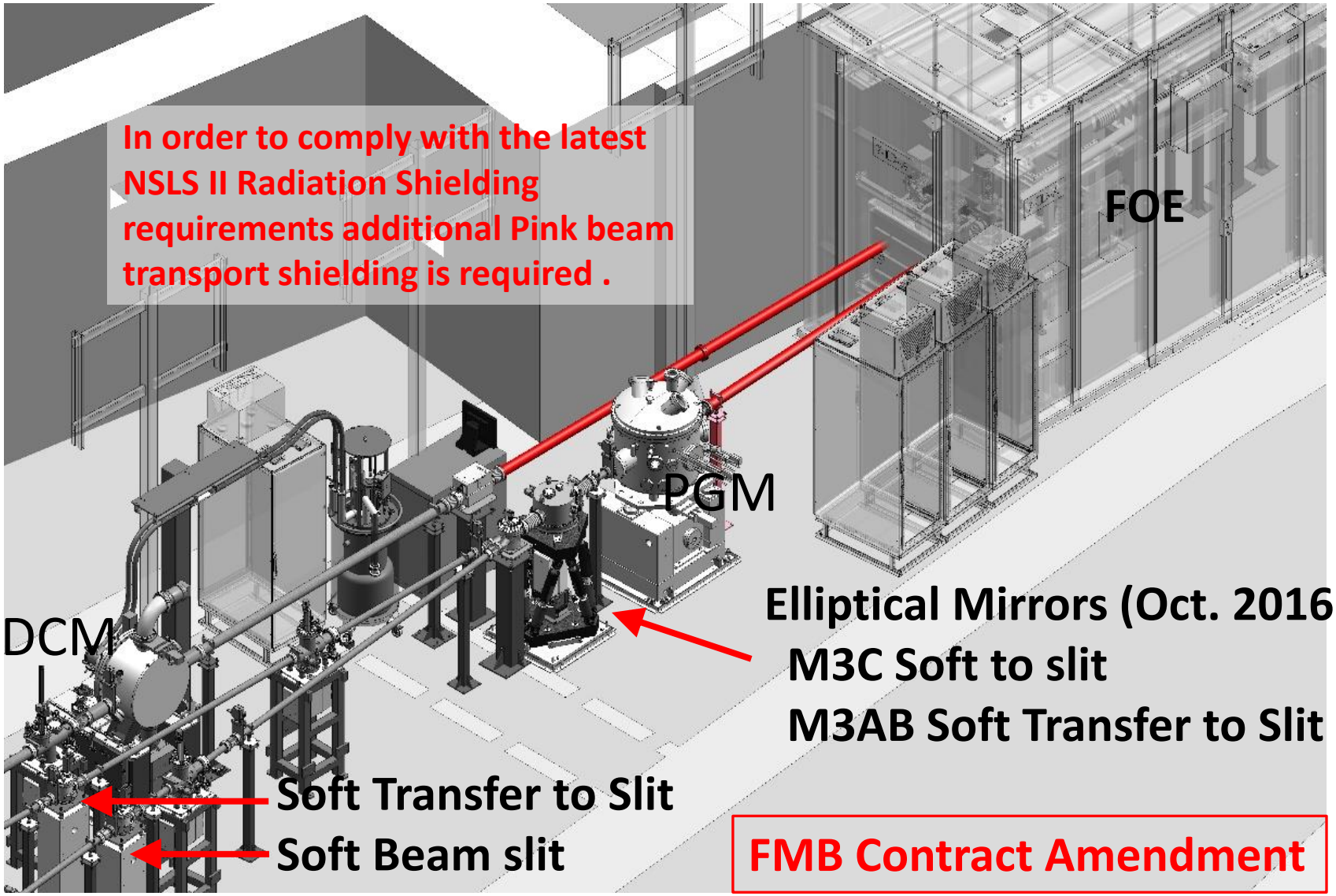
Additional misteer masks have been added to protect downstream components from beams coming off L1 and M1 inside the FOE



Secondary Bremsstrahlung Radiation requirements that were not present at the time of FMB-Oxford contract award

FMB Contract Amendment

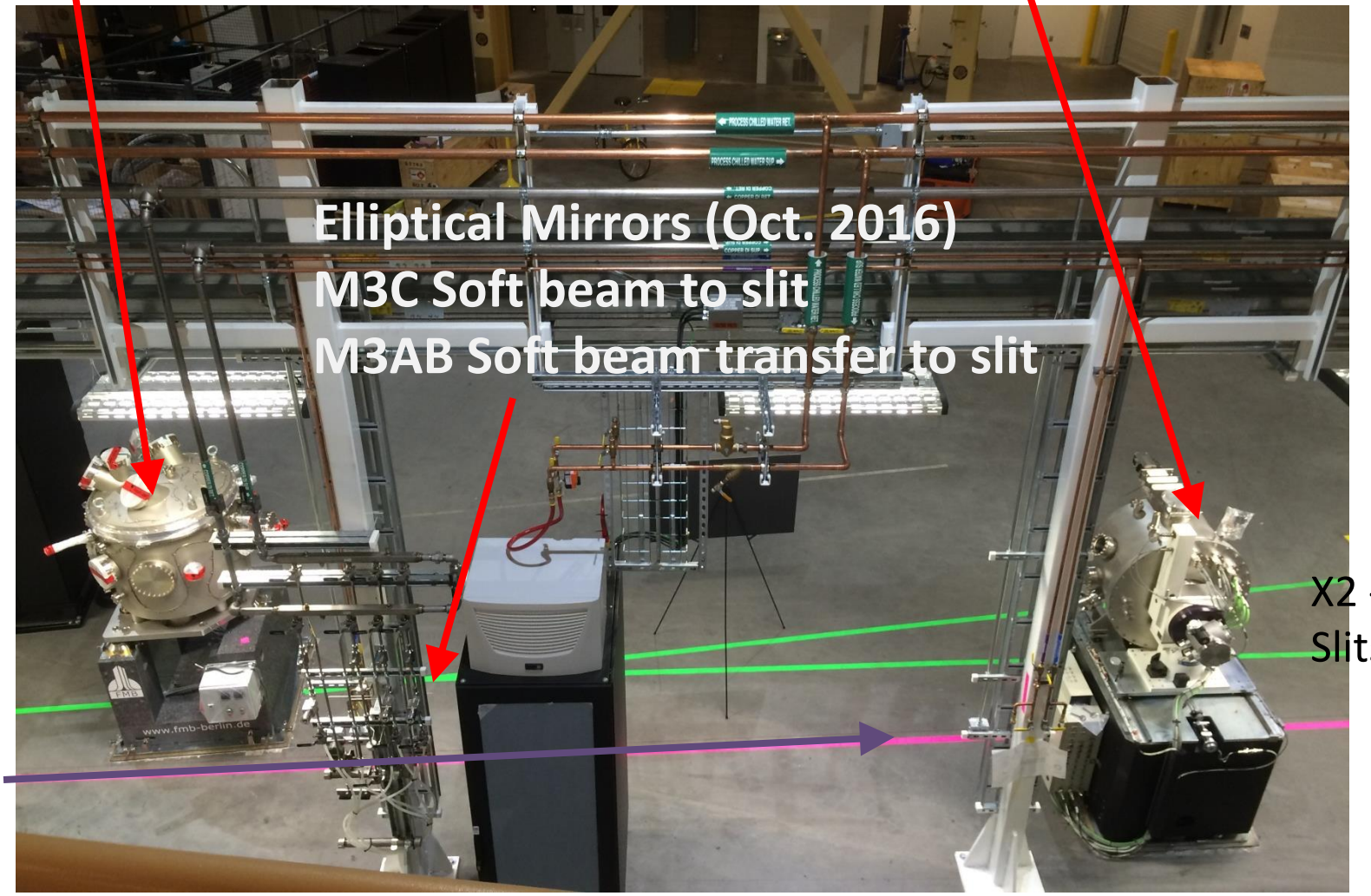
SST1&2 Layout: PGM, DVM, mirrors, and diagnostics and pink beam shielding



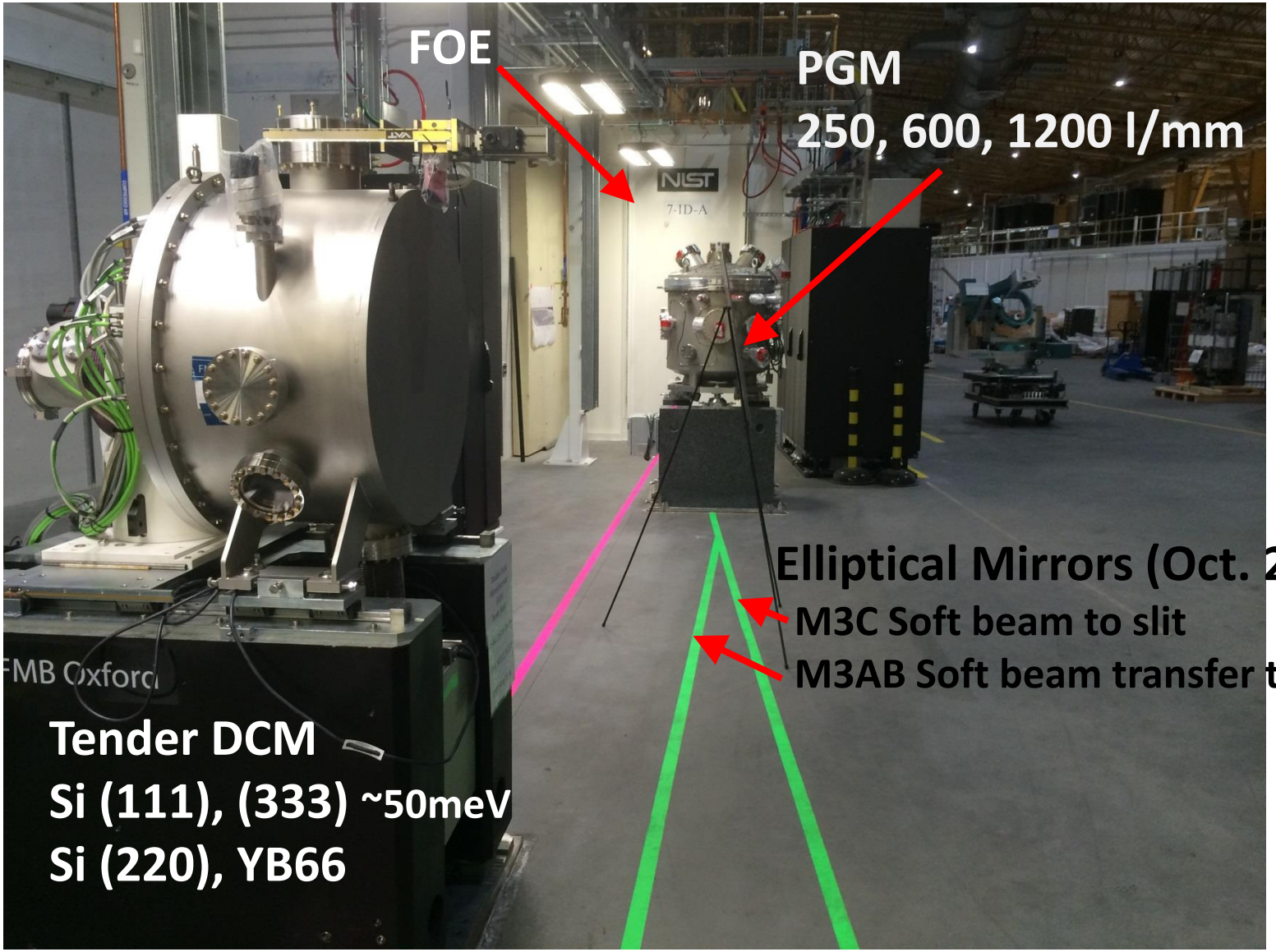
SST1&2 Layout: PGM, DCM, operation modes

PGM (100 – 2200eV)
250, 600, 1200 l/mm

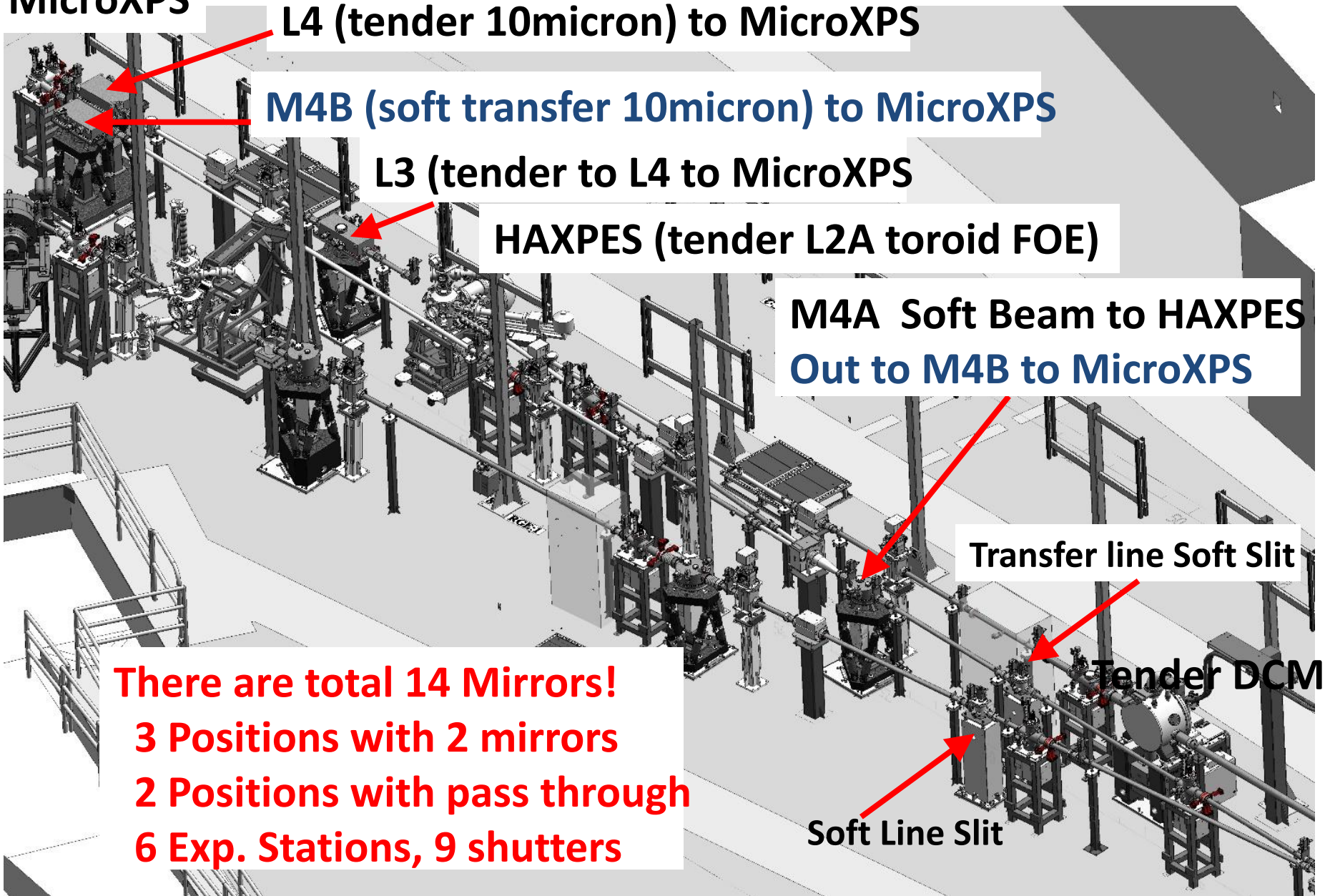
Special DCM 85° (1-7.5 keV)
Si (111), (333), ~50meV
Si (220), YB66



SST1&2 Layout: PGM, DCM, operation modes



SST1&2 Layout: mirrors, op. modes, exp. stations and diagnostics



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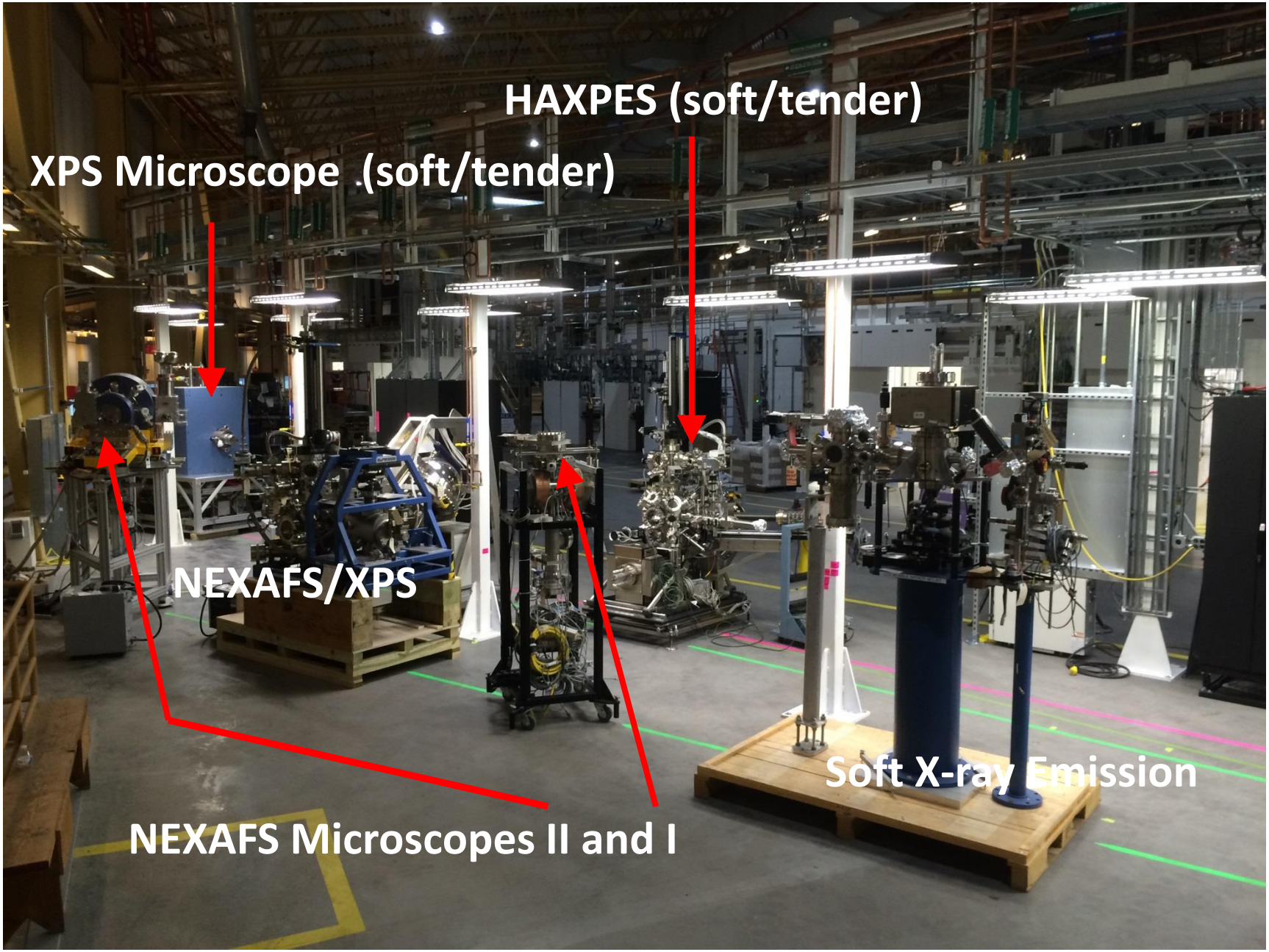
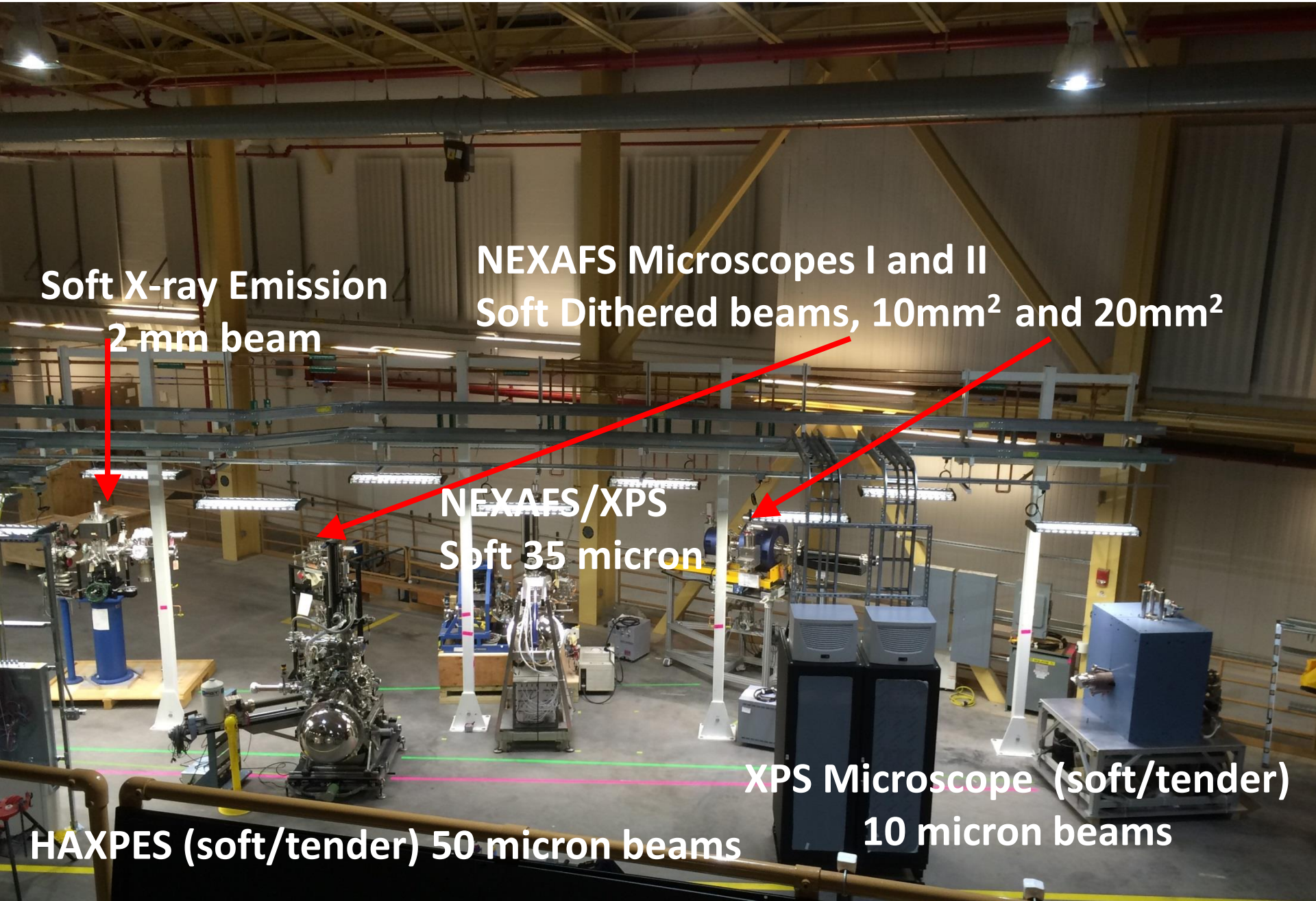


SST1&2 Layout: op. modes, beam sizes and exp. stations



SST Safety

BMM is a NIST NSLS-II Partner Beamline

Safety for Partner and Facility Beamlines is identical from conception, construction, commissioning and operations; this includes policies, training, equipment and procedures.

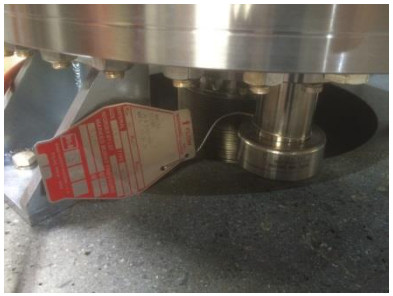
- Andy Broadbent and Zhong Zhong (Howard Robinson) ensure that the NIST Partner Beamlines design and construction are fully compliant with all NSLS-II safety policies and practices.

- Dan Fischer (Lead Beamline Scientist) develop, monitor, and maintain safe operating conditions within the beamline during commissioning and operations.

- NSLS-II fully funds, designs, constructs, maintains and tests the beamline personnel protection systems.

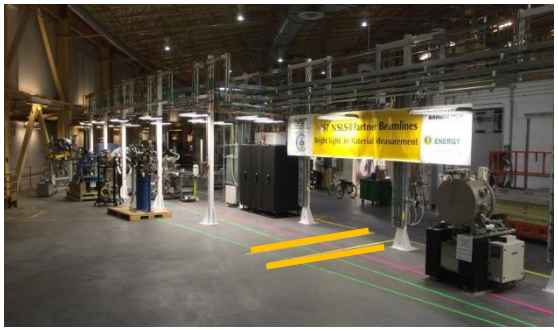
- The NIST group has excellent safety track record of compliance, cooperation, and collaboration spanning 33 years of construction and operation of beamlines at NSLS.

SST Safety Walk Thru:



- Burst Disks needed DCM, PGM, FOE components

✓ **Egress path; duck under**



✓ Static experimental gases on NEXAFS/XPS station w/approved barriers

✓ **LN2 safety shut off** on S8

✓ Gaseous N2 for bleed up w/BNL approved **relief valves**

✓ Static Magnetic Fields

NEXAFS Microscope 8T – Plexiglas exclusion zone

XPS Microscope 2T – High Field contained in small region inside 6” CFF cross