Refer to Photon Sources Directorate procedure “Design Reviews” in the Photon Sciences Document Center for complete details and requirements for completing design reviews. Contact the PSD Quality Representative for further guidance.

**PHOTON SCIENCES DIRECTORATE**  
**BROOKHAVEN NATIONAL LABORATORY**

<table>
<thead>
<tr>
<th>Report No.</th>
<th>PS-DRR-1020</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Obtain from Quality Group)</td>
<td></td>
</tr>
</tbody>
</table>

**DESIGN REVIEW REPORT**

<table>
<thead>
<tr>
<th>EDP Report No. (if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT-EDP-015-042</td>
</tr>
</tbody>
</table>

The Design Review Report shall include at a minimum:

- The title of the item or system;
- A description of the item;
- Design Review Report Number;
- The ESH&Q risk level;
- The design parameters;
- The type of design review;
- The date of the review;
- The names and association of the reviewers;
- The major comments and concerns of the reviewers;
- Any reference not appearing in the EDP used to support the design during the Design Review meeting;

### TYPE OF REVIEW:

- ☑ PRELIMINARY
- ☐ INTERMEDIATE
- ☐ FINAL

Prepared By: M. Buckley

Review Date: 5/26/2015

**TITLE of ITEM/SYSTEM:** 7-BM Quick x-ray Absorption and Scattering (QAS) Beamline Preliminary Design Review

**PRESENTED BY:** Steven Ehrlich (Photon Div. QAS Beamline Scientist) and Lukas Lienhard (QAS Beamline Mechanical Engineer)

**ESH&Q Risk Level:** A-2

(Application of the Graded Approach Table)

**PURPOSE/DESCRIPTION:**

This is a preliminary design review for the 7-BM Beamline – Photon Delivery System; which will be a mixture of reused major beamline optical and endstation components previously used at NSLS, This beamline includes a mirror in the Front End section and will include a review by the Top Off Coordinator.

**REVIEWERS - ASSOCIATION:** M. Buckley (Chair), L. Stiegler (ESH), M. Carlucci-Dayton (Engineer), S. Moss (USI), J. Zipper (QA), R. Todd (Vacuum), Z. Xia (Rad Safety)

Attendees: Refer to attached attendance sheet

**DISTRIBUTION:**

All reviewers and presenters.

**ATTACHMENTS:**

- Data Sheets
- Calculations (Checked and countersigned)
- Support documentation
- Design Checklist
- See Continuation Page

**MAJOR COMMENTS & CONCERNS OF REVIEWERS**

A presentation of the 7-BM (QAS) Beamline was provided by Steve Ehrlich and Lukas Lienhard. Refer to attached documentation for details of the topics discussed.

Steve Ehrlich provided an overview of the QAS Beamline and Endstation.

**Beamline Overview:**

- Scientific Mission & Technical Scope
- Preliminary Design
  - Optics and performance
  - Beamline design layout
  - Major optical components

**Equipment being reused from NSLS:**

- Collimating Mirror
  - Single-crystal Si flat (700mm x 100mm x 50mm) w/ SESO bender
  - 11.7m from source, 2.7 mrad incident angle
  - Stripped, re-polished, Rh and Pt stripes
  - Rh: ~25 keV cutoff; Pt: ~31 keV cutoff
  - Add external cooling & disaster mask >> FEA
• New stand
• Will be located in the Front End

- Monochromator
  • X18A: quick and conventional scanning
  • Si(111) channel-cut
  • E = 4.7 – 31 keV
  • 28.3m from source
  • DC motor with cam for quick scanning
  • Heidenhein rotary encoder
  • Fluor. powder on first crystal for diagnostic
  • Repurpose mono stand from X6A
  • Pink beam stop downstream of monochromator
  • Use old beam stop for diagnostic

- Focusing Mirror
  • X21 toroidal mirror with NSLS bender
  • glass, 1000mm x 100mm x 60mm
  • 42.7mm sagittal radius
  • 30.0m from source
  • 2.135 mrad incident angle
  • Stripped, re-polished, Recoated with Rh
  • ~31.5 keV cutoff energy

- End of Beamline Be Window
  • Be window from NSLS X4A
  • NSLS drawing number: SLS-92.19-086-4; 8” diameter Conflat flanges
  • Window size: 10mm horizontal x 123mm vertical

- Safety:
  • Front End
    • Masks, Bremsstrahlung and ratchet wall collimators as shown by ray tracing
    • Photon and safety shutters
  • FOE – First Optics Enclosure
    • Lead shielded lateral wall (18mm), downstream wall (50mm), roof (4mm)
    • Bremsstrahlung, local shielding and masks as shown by ray tracing
    • Beam stop downstream of monochromator chamber
    • Photon shutter
    • Guillotine around beam pipe exiting FOE
  • Transport Pipe
    • FOE to experimental hutch - lead shielded
  • Experimental Hutches
    • Steel walls and roof
    • Beam stop on downstream side of each hutch
  • Personnel Protection System (PPS)

- Schedule:
  • Prep/Mod June 2015 – January 2016
  • Procurement June 2015 – February 2016
  • Hutches and Utilities Installation September 2015 – February 2016
  • Component Installation December 2015 – September 2016
  • Beamline Complete - September 2016

QAS Beamline Design: (presented by Lukas Lienhard)
Numerous components are planned to be reused from NSLS as identified in the overview including optical assemblies, vacuum components, stands, however all radiation safety components will be new.

Monochromator:
• Re-using Monochromator system from X-18A
• Modifying stand from X-6 to support Mono assembly
• Existing beam stop may be used as diagnostic
• Burst Disc and vacuum gauges to be added
• Cooling water in Monochromator:
Cooling water lines need to be pressure tested unless there is documented proof that they were pressure tested.

Cooling will be provided by self-contained cooling system that will not exceed 30 psig.

- The chiller will have a pressure relief device or a device will be added.

**Toroidal Focusing Mirror:**
- Mirror is fixed to vacuum chamber; position and angles controlled with stages on support assembly, 7 possible axes of motion
- No cooling required
- Electronics upgraded to new standards
- Blocks will be used to increase the height.
- Longitudinal motion shall be removed

**Fixed Masks:**
- Copy design of FE 3PW mask
- Only changing aperture size
- Fins allow natural convection alone to keep mask from failing under full 3PW/BM power load
- Machined as a single block. This design was used in the Front End.
- 2 Masks required
  - 1 Pink beam aperture
  - 1 PBS/Mono aperture

  - Fixed Mask Analysis revealed that without cooling can reach only 305 °C under pink beam. At this temperature, this is below the design limits.

**Lead Collimator:**
- Copy design of FE lead collimators
- Re-sized as required by raytracing
- Between Mono and Focusing Mirror
- Used to stop Primary GB.

**Common photon shutter:**
- Standard photon shutter will be used with a aperture size of 60mm X 30 mm
- Monochromatic beam does not require cooling (< 1 W load)

**Pink Beam X-Y Slits:**
- Will be purchased new
- 4 Tungsten blades >2mm thick
- >51 x 8 mm max aperture
- 1μm resolution
- Beam intensity monitoring through drain current measurements
- Water cooling needed for pink beam

**Fluorescence Screen:**
- Viewport came from Accel (now Bruker) which is mounted in a standard Conflat flange. Note that this is being used under monochromatic beam.
- Re-used from X-6
- Located downstream of focusing mirror

**Common supports**
- A new thicker plate will replace the existing plate for the monochromator.
- A new stand will be used for mounting radiation safety components

**Beamline Layout – Shielded transport:**
- Will be designed and built by an outside contractor.
- A separate design review will be performed for the shielded transport by the Contractor.

**Vacuum:**
- Gate Valves, ion pumps, right angle valves, and vacuum gauges sourced from NSLS
- Misc. vacuum bellows, spools & crosses sourced from NSLS to be designed into beamline to minimize new component cost ($20k budget)
- Nomenclature for beamline valves starts with GV3 due to mirror & extra GV in front end.
- Valves and ion pumps will be reused from NSLS-I. All valves will be tested and all ion pumps will get Safe Conn connections.
• Verify any Kapton used in wiring in vacuum is of good quality. [Action]
  – 7-BM team - Pressure issues not expected based on the configuration of the beamline.
• Assure all vacuum valves are properly supported.
• Valves will consist of All-Metal and Viton seal.

Gas System:
• 7-BM will include gas supplied from 8-ID Gas handling system.
  – Further review will be needed to determine requirements for the gas lines needed for the 7-
    BM beamline (e.g. fire suppression, gas detectors, double wall piping, exhaust, etc). [Action]

Beryllium Window:
• Previously used at X4A since 1996.
• An incident beam path is planned to be mounted to the downstream side of the window.
• Pressure relief device will be installed upstream of window.
• Look into previous documentation from X4 beamline at 725 to see if there are any supporting
  documents. [Action]

Collimating mirror:
• Located in FE.
• Mirror will have two coatings added which will be completed by a Contractor.
• Several internal components have been redesigned with minor changes.
• Parts plan to be machined in-house.
• New frame has been designed in house and will be fabricated by a Contractor.
• Cooling water line design for Collimating mirror is made of OFHC. Since this material is not listed in
  B31.3, pressure testing will be needed.
• Collimating mirror should have hard stops added. [Action]
• FEA provided for collimating mirror and stand.

Kapton window: [Comment from Mario Cubillo]
Refer to SBMS and the “GUIDE FOR GLASS AND PLASTIC WINDOW DESIGN FOR PRESSURE VESSELS”.

Kapton windows fall under section 2.2.1:

“2.2.1 Plastic Windows with Large Deflection. The following tests and conditions shall apply for all windows
whose calculated deflection is greater than ten times the actual window thickness: a. A window shall be cycled a
minimum of 3 times at 50% over operating pressure to demonstrate its integrity in going from load to no load
conditions, with its maximum deflection being monitored at each cycle and the magnitude of the maximum
deflection at the end of the third cycle taken as a base line. These tests should be witnessed by both a representative
of the Safety and Health Services Division and the facility. Any subsequent deformation during operation that
exceeds the maximum deflection established at the third cycle by 10% shall be deemed grounds for changing the
window.”

The same guide has calculation guidelines for thin large deflection windows. A basic calculation should be
provided.

In addition to it, a design drawing documenting the window construction and assembly procedure should be
produced.

QA: Concern about drawings for equipment that is coming over. No drawing for diagnostics chamber and only
sketches for monochromator. Consider creating an ICD and add all specs in the drawing or reference other
applicable drawing numbers.

Ray Tracing:
Front End Ray Tracing drawing was displayed to show it was released/approved, including Zhong Zhong. Beamline Ray Tracing was presented by Lukas. Further review of the beamline ray tracing will need to be performed by Zhong and Amy. QAS will need to concentrate on Beam Stop on the end and Bremsstrahlung.

**End Station Overview:** (presented by Steve Ehrlich)
Steve provided an overview of the endstation which included:

1. **Detection System**
   - Absorption Spectroscopy
   - Scattering
2. **Sample Handling**
3. Rapid change of samples between experiments in hutch 1.
4. Discussed two endsations for use in hutch 2
   - Combined XAFS/DRIFTS endstation
     - IR setup from SCC (Partner User)
     - XAFS and infrared spectroscopy
   - Combined XAFS/Raman endstation
     - Raman instrument from SCC
5. Detectors (All from NSLS)
   - PerkinElmer 1621 area detector
   - Vortex-ME4 4-element Si-drift fluorescence – upgrade electronics
   - Canberra multi-element Ge fluorescence – upgrade electronics
   - Ion chambers and point detectors
   - Canberra PIPS fluorescence
6. Sample environments (All from NSLS or Partner Users)
   - Closed-cycle He refrigerators: T > 10K
   - Clausen cells: T < 700°C
   - Nashner-Adler reaction cells: -200 – 500°C
   - Large Clam Shell furnace reactor: room T - 1000°C
   - In-situ high pressure, high temperature XAS flow cell: temperatures to 600°C and pressures to 1200 psi (83 bar)
7. QAS Safety Aspects
   - Gases
     - Both experimental hutches will have gas lines from the outside fed in through mass flow controllers and will have HEPA filtered exhaust.
       1. This system will undergo a separate review.
       - Includes flammable and toxic gases
       - Interlocks for gas flow and exhaust operation
       - Gas sensors
     - Liquid Nitrogen
       - Oxygen monitoring system required in endstations where LN2 is piped in
     - Proper PPE
   - Nanoparticles
     - HEPA filtered exhaust for experimental sample chamber
   - Lasers
     - Alignment and Raman

**ESH:**
Beryllium Use Review Form (BURF) needs to be completed or modified, as applicable.
Need to check working clearance around components in the FOE

**Top Off Safety System (TOSS):**
The front end has not been reviewed for top off safety (yet). This will be completed as per procedure PS-C-ASD-PRC-183, “Approval of New and Modified NSLS-II Beamline Front Ends for Top Off Safety”

**USI:**
USI Screening has been determined to be Negative.

Actions resulting from this review have been identified within the body of this report and will be included in the
NSLS-II Family ATS.

**Action Item 1:** Verify any Kapton used in wiring in vacuum is of good quality and meeting NSLS-II requirements for white beam components.

**Action Item 2:** Further review will be needed to determine requirements for the gas lines needed for the 7-BM beamline (e.g. fire suppression, gas detectors, double wall piping, exhaust, etc).

**Action Item 3:** Look for existing documentation to support Be window that was previously used at X4A at NSLS. If such supporting documentation is not made available, SBMS requirements must be met.

**Action Item 4:** Collimating mirror should have hard stops added to motion axes.

**Action Item 5:** Further review of the beamline ray tracing will need to be performed.

---

**REVIEWED DRAWINGS / SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Presentation material:</th>
<th>Design Drawings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>QAS – Beamline Layout PDR</td>
<td>PD-QAS-PCM-1000_Rev2_Informal.pdf</td>
</tr>
<tr>
<td>QAS – Collimating Mirror PDR</td>
<td>PD-QAS-PCM-1313_Rev1.pdf</td>
</tr>
<tr>
<td>QAS Beamline Overview</td>
<td>PD-QAS-PCM-1320_Rev1.pdf</td>
</tr>
<tr>
<td>QAS Endstation Overview</td>
<td>PD-QAS-PCM-1321_Rev1.pdf</td>
</tr>
<tr>
<td>X-4A Beryllium Window</td>
<td>PD-QAS-PCM-1322_Rev1.pdf</td>
</tr>
</tbody>
</table>

**Preliminary Ray Tracing:**

- PD-QAS-RAYT-0001_Rev2_Informal.pdf
- SR-FE-3PW-4001_Rev_A.pdf

**FEA:**

- Finite Element Analyses of the QAS Beamline Collimating Mirror and Protective Mask

**Calculations:**

- QAS End station Beryllium (Be) Window Design Calculations
- QAS Beamline Components Preliminary Vacuum Calculations

**Beamline Drawings:**

- PD-QAS-1000, QAS BEAMLINE LAYOUT, 7-BM, (Preliminary)
- PD-QAS-BL-1000, QAS BEAMLINE ASSEMBLY, QAS BEAMLINE COMPONENTS, Rev 4 (Informal)
- PD-QAS-LAT-1001, QAS BEAMLINE LATTICE, QAS BEAMLINE, Rev 4 (Informal)

**Approval:**

Review Committee Chairperson: M. Buckley

Date: 6/30/2015

Please forward completed original to the PSD Quality Assurance Group.

8/10/2015

Michael Buckley
Research Operations Support Group Leader
Signed by: Buckley, Michael
Agenda for 7-BM Quick x-Ray Absorption and Scattering (QAS) Beamline PDR Meeting
28 May 2015.

This review will serve two purposes:

1. Primarily it is a design review for the 7-BM Beamline – Photon Delivery System; which will be a mixture of major beamline components used in operations at NSLS, and new components such as a mask and a collimator.
2. The PDR also serves as a first safety review, which will used to assist the Instrument Readiness Review (IRR) process. A successful review will help to mitigate many of the potential risks associated with installation and commissioning activities.

The following staff is formally invited. All are welcome to attend the review for any or all of the sessions. Please attend the sessions that are applicable to your area of review. If they cannot attend the session please send someone on your behalf to review that area and provide comments as needed.

<table>
<thead>
<tr>
<th>Time</th>
<th>Detailed Technical Review</th>
<th>Attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00-1:10</td>
<td>Introduction (J. Adams)</td>
<td>ALL</td>
</tr>
<tr>
<td>1:10-1:50</td>
<td>QAS Overview (Ehrlich)</td>
<td>ALL</td>
</tr>
<tr>
<td>1:50-3:00</td>
<td>QAS Engineering Design</td>
<td>Carlucci - Dayton Todd Stiegler O’Hara Cubillo/Gaffney BL Team Zipper</td>
</tr>
<tr>
<td></td>
<td>• BL Layout</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• BL Vacuum System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Collimating Mirror Upgrade (FEA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Be window</td>
<td></td>
</tr>
<tr>
<td>3:00-3:10</td>
<td>Break</td>
<td>Stiegler/ Zipper</td>
</tr>
<tr>
<td>3:10:30</td>
<td>ESH/QA</td>
<td></td>
</tr>
<tr>
<td>3:30-4:10</td>
<td>• Approved FE Ray Trace</td>
<td>Carlucci - Dayton Xia Zhong Stiegler BL Team Zipper Fliller</td>
</tr>
<tr>
<td></td>
<td>• BL Ray Trace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Top Off (Front End)</td>
<td></td>
</tr>
<tr>
<td>4:10-4:30</td>
<td>Endstation (Ehrlich)</td>
<td>Carlucci-Dayton Todd Stiegler Cubillo/Gaffney BL Team Zipper</td>
</tr>
<tr>
<td></td>
<td>• Endstation layout</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Kapton window</td>
<td></td>
</tr>
</tbody>
</table>

Updated 5/26/2015
The Date/Time has changed for this meeting from 5/28 to 5/26. Thank you.

You are invited to this preliminary design review for the QAS (7-BM) beamline. Included in this design review will be a mixture of major beamline components, that were used in operations at NSLS, and new components such as a mask and a collimator.

An agenda will be sent out shortly as well as support documentation will be available on the NSLS-II SharePoint Site. I will send an email shortly providing you with the agenda and a link to the support files.

Thank You,
Mike
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Department/Division or Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mike Buckley</td>
<td>Mos Group Leader</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Michael Johnson</td>
<td>Mach Design</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Lukas Lienhard</td>
<td>Mach Engineer</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Steven Ehrlich</td>
<td>Scientist</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Ray Fuller</td>
<td>Physicist</td>
<td>NSLS II</td>
</tr>
<tr>
<td>Julian Johnson</td>
<td>BDV PM</td>
<td>NSLS II</td>
</tr>
<tr>
<td>Steve Colay</td>
<td>MECh. Eng.</td>
<td>NSLS II</td>
</tr>
<tr>
<td>Michael Sullivan</td>
<td>Beamline Eng.</td>
<td>CUURU</td>
</tr>
<tr>
<td>Lori Shigley</td>
<td>NSLS II ES4</td>
<td>ES4 H</td>
</tr>
<tr>
<td>Ed Haas</td>
<td>Beamline Engineer</td>
<td>NSLS II</td>
</tr>
<tr>
<td>Ryan Tapero</td>
<td>Scientist</td>
<td>NSLS II</td>
</tr>
<tr>
<td>Mario Cubillo</td>
<td>Safety Engineer</td>
<td>HP</td>
</tr>
<tr>
<td>Steve Moss</td>
<td>ARB</td>
<td>NSLS II</td>
</tr>
<tr>
<td>William Rose</td>
<td>Tech</td>
<td>XFM</td>
</tr>
<tr>
<td>Paul Northrup</td>
<td>Beamline Scientist</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Stephen Sherwood</td>
<td>LASER Eng.</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Joe Zippor</td>
<td>ENG.</td>
<td>NSLS 2</td>
</tr>
<tr>
<td>Mary Carlucci-Dayton</td>
<td>P-LENG.</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Masa Fukuto</td>
<td>Physicist</td>
<td>NSLS - II</td>
</tr>
<tr>
<td>Robert Todd</td>
<td>VAC. ENG.</td>
<td>NSLS II</td>
</tr>
<tr>
<td>Zhenghua &quot;Amy&quot; Xia</td>
<td>Asst Physicist</td>
<td>ES4 H</td>
</tr>
</tbody>
</table>
QAS Beamline Overview

Steven N. Ehrlich
QAS Preliminary Design Review
May 26, 2015
Outline

• Scientific Mission & Technical Scope

• Preliminary Design
  – Optics and performance
  – Beamline design layout
  – Major optical components

• Safety

• Schedule

• Conclusion
Scientific Program

Proposed to serve chemical and energy sciences community (Synchrotron Catalysis Consortium and Battery Group)

Scientific program moving from X18A, X18B, high energy part of X19A

- Development of new chemical processes and catalysts
- Development of energy conversion and energy storage products
- Measure reactions on sub-second and longer time scales
- Separate and combined measurements of XAFS and XRD as well as DRIFTS and Raman spectroscopy with analysis of gas phase by mass spectrometry (MS)
Technical Scope - Photon Delivery System

Energy Range and Scanning Conditions

- 3-pole wiggler at port 7-BM
- Energy range: 4.7 keV – 31 keV (to include Ti K-edge at 4.966 keV and Sn K-edge at 29.2 keV)
- Resolution (ΔE/E): 10^{-4}
- Beam spot size (in focused mode): less than 1.0H x 0.5V (mm)
- Photon Flux: up to 10^{12} photons/s (at 10 keV)
- Quick XAFS speed: ≥10ms per scan
Optics Layout

CM: vertical collimating mirror (M1) – 700mm long; 11.7m from source; Rh & Pt stripes

DCM: quick-scan monochromator – 28.3m from source

FM: toroidal focusing mirror (M2) – 1000mm long; 30.0m from source; Rh-coated; 2:1 horiz. demagnification

Sample position – 45.0m from source
Modes of Operation

Beamline Modes using NSLS Optical Components

1. $E = 4.7 – 23$ keV – Rh collimating mirror(X7B), Rh focusing mirror(X21)
2. $E = 24 - 31$ keV – Pt collimating mirror(X7B), Rh focusing mirror(X21)
3. $E = 23 – 24$ keV – Pt collimating mirror(X7B), no focusing mirror(X21)
Performance Estimates

<table>
<thead>
<tr>
<th>E (keV)</th>
<th>FWHM H (mm)</th>
<th>FWHM V (mm)</th>
<th>FWHM div H' (mrad)</th>
<th>FWHM div V' (mrad)</th>
<th>Estimated flux (ph/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.255</td>
<td>0.070</td>
<td>1.28</td>
<td>0.123</td>
<td>6.4E11</td>
</tr>
<tr>
<td>10</td>
<td>0.260</td>
<td>0.064</td>
<td>1.24</td>
<td>0.129</td>
<td>7.9E11</td>
</tr>
<tr>
<td>15</td>
<td>0.262</td>
<td>0.067</td>
<td>1.21</td>
<td>0.130</td>
<td>5.4E11</td>
</tr>
<tr>
<td>20</td>
<td>0.270</td>
<td>0.063</td>
<td>1.20</td>
<td>0.114</td>
<td>2.9E11</td>
</tr>
<tr>
<td>25</td>
<td>0.263</td>
<td>0.059</td>
<td>1.18</td>
<td>0.110</td>
<td>1.1E11</td>
</tr>
<tr>
<td>30</td>
<td>0.257</td>
<td>0.057</td>
<td>1.21</td>
<td>0.092</td>
<td>3.8E10</td>
</tr>
</tbody>
</table>

M1: Rh
M2: Rh
M1: Pt
M2: Rh
Maximum Power of Monochromatic Beam

Assume maximum combination of photon energy and flux from SHADOW calculations

\[ E = 15 \text{ keV} \]

Estimated flux = \( 5.4 \times 10^{11} \) photons/sec

1 electron volt = \( 1.6 \times 10^{-19} \) Joules

Power = \( 15000 \text{eV} \times 1.6 \times 10^{-19} \text{ Joules/eV} \times 5.4 \times 10^{11} /\text{sec} \)

\[ = 0.0013 \text{ watts} \]
QAS Front End

Horiz. fan = 2 mrad
Vertical fan = 0.3 mrad

Drawing from Aftab Hussain
Beamline Overview
Beamline Design Layout: FOE

- Mask
- X-Y slits
- Monochromator
- Beam stop
- Bremsstrahlung collimator
- Focusing mirror
- Diagnostics
- Photon shutter
Major Optical Components: Collimating Mirror

**X7B collimating mirror in X6B mirror system**

- Single-crystal Si flat (700mm x 100mm x 50mm) w/ SESO bender
- 11.7m from source, 2.7 mrad incident angle
- Stripped, re-polished, Rh and Pt stripes
- Rh: ~25 keV cutoff; Pt: ~31 keV cutoff
- Add external cooling & disaster mask >> FEA
- New stand
Major Optical Components: Monochromator

- X18A: quick and conventional scanning
- Si(111) channel-cut
- E = 4.7 – 31 keV
- 28.3m from source
- DC motor with cam for quick scanning
- Heidenhein rotary encoder
- Fluor. powder on first crystal for diagnostic
- Repurpose mono stand from X6A
- Pink beam stop downstream of monochromator
- Use old beam stop (shown below) for diagnostic

Crystal Sizes
1st: 15.84mm long
2nd: 71.0 mm long
Both 50.8mm wide
Major Optical Components: Focusing Mirror

- X21 toroidal mirror with NSLS bender
- glass, 1000mm x 100mm x 60mm
- 42.7mm sagittal radius
- 30.0m from source
- 2.135 mrad incident angle
- Stripped, re-polished, Recoated with Rh
- ~31.5 keV cutoff energy
End of Beamline Be Window

- Be window from NSLS X4A
- NSLS drawing number: SLS-92.19-086-4; 8” diameter Conflat flanges
- Window size: 10mm horizontal x 123mm vertical
QAS Radiation Safety

Front End
• Masks, Bremsstrahlung and ratchet wall collimators as shown by ray tracing
• Photon and safety shutters

FOE – First Optics Enclosure
• Lead shielded lateral wall (18mm), downstream wall (50mm), roof (4mm)
• Bremsstrahlung, local shielding and masks as shown by ray tracing
• Beam stop downstream of monochromator chamber
• Photon shutter
• Guillotine around beam pipe exiting FOE

Transport Pipe
• FOE to experimental hutch - lead shielded

Experimental Hutches
• Steel walls and roof
• Beam stop on downstream side of each hutch

Personnel Protection System (PPS)
# Future QAS Schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prep/Mod</td>
<td>June 2015 – January 2016</td>
</tr>
<tr>
<td>Component Installation</td>
<td>January 2016 – September 2016</td>
</tr>
<tr>
<td>Beamline Complete</td>
<td>September 2016</td>
</tr>
</tbody>
</table>
Conclusions

• Scope of work
  • Provide optimized beam transport to the endstations

• Preliminary Design
  • Use NSLS components
    • Make best use of existing NSLS components
    • Upgrade to NSLS-II standards
  • Preliminary design exists providing
    • Description of concept, performance and feasibility analysis
    • Specifications of individual equipment
QAS – Beamline Layout PDR

May 26th 2015
Prepared by: Lukas Lienhard
Mechanical Engineer
OUTLINE

• Design Overview
  • Conceptual Design Plan
• Preliminary Beamline Design
  • Beamline Layout (Photon Delivery System)
  • Optical Components (Monochromator & Focusing Mirror)
  • Radiation components (Masks, collimators, & shutter)
  • Slits/Diagnostics
• Common Parts
• Transport Section
• Vacuum Layout
QAS Beamline Design Plan

- Re-use Optical Assemblies from NSLS
  - Modify or replace as necessary to meet performance
- Re-use ancillary vacuum components from NSLS
- Re-purpose stands and supports from NSLS
- New radiation safety components
Monochromator

- Re-using Monochromator system from X-18A
- Modifying stand from X-6 to support Mono assembly
- Existing beam stop may be used as diagnostic
- Burst Disc and vacuum gauges to be added
Toroidal Focusing Mirror

- Mirror is fixed to vacuum chamber; position and angles controlled with stages on support assembly, 7 possible axes of motion
- No cooling required
- Electronics upgraded to new standards
Fixed Masks

- Copy design of FE 3PW mask
- Only changing aperture size
- Fins allow natural convection to keep mask from failing under full 3PW/BM power load
- 2 Masks required
  - 1 Pink beam aperture
  - 1 PBS/Mono aperture
Fixed Mask Analysis – for Reference

Courtesy of Aftab Hussain

**Analysis Parameters**

- Distance from Source ~ 7.9m
- Total Power (3PW & BM) = 319 W
- Assumed heat transfer coefficient of 10 W/m².K for natural convection.
- Assumed film coefficient of 0.4 W/cm².°C for a flow rate of 1GPM in Ø0.375" cooling channel.

**Cu-Cr-Zr Fixed Mask**

- Temperature Contour Plot, Tmax ~ 93°C
- Temperature Contour Plot, Tmax ~ 305°C

- Beamline power density @ 25 m ~ 0.55 W/mm² max
- Beamline nominal heat load @ 25 m ~ 80 W
- Beamline max heat load @ 25 m ~ 190 W
Lead Collimator

- Copy design of FE lead collimators
- Re-sized as required by raytracing
- Between Mono and Focusing Mirror
- Used to stop Primary GB.

12 Inch Thick Lead

Base Plate

Stainless Steel Lead Cover
Common Photon Shutter

- Use largest aperture current design is capable of (60 x 30 mm)
- Monochromatic beam does not require cooling (< 1 W load)
Pink Beam X-Y Slits

- Will be purchased new
- 4 Tungsten blades >2mm thick
- >51 x 8 mm max aperture
- 1µm resolution
- Beam intensity monitoring through drain current measurements
- Water cooling needed for pink beam
Fluorescence Screen

• Re-used from X-6
• Diagnostic feedthrough made by Accel (now Bruker)
• Located downstream of focusing mirror
• Viewports for camera
Common - Supports

- Sourced from NSLS or custom designed/built steel tubing stands

<table>
<thead>
<tr>
<th>NSLS</th>
<th>NEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$500-$1k (new baseplate)</td>
<td>$2k-$4k (Custom Fab or Proc)</td>
</tr>
<tr>
<td>Kinematic adj.</td>
<td>Aligned when installed</td>
</tr>
<tr>
<td>Limited # and sizes</td>
<td>Can be more rigid</td>
</tr>
</tbody>
</table>

NEW

NSLS
Beamline Layout – Shielded Transport

- 9 m length
- Will go out for procurement (SPEC/SOW & ICD required)
- 2 mm lead shielding recommended for 3PW Monochromatic beam (LT-C-ESH-STD-001 V4)
- Shielded enclosures with labyrinths required for inline pumps
- Welded Steel covers for all lead
Vacuum Requirements/Plan

• 1x10^{-8} mbar target UHV base pressure for beamline
• 1x10^{-2} mbar for low vacuum sections in end station
• Gate Valves, ion pumps, right angle valves, and vacuum gauges sourced from NSLS
• Misc. vacuum bellows, spools & crosses sourced from NSLS to be designed into beamline to minimize new component cost ($20k budget)
Vacuum Layout

- UHVS-3,4 (Mask + Slits)
- UHVS-4,5 (Mono + collimator)
- UHVS-5,6 (Mirror)
- UHVS-6,7 (Diagnostic + Photon Shutter)
- UHVS-7 (Transport Pipe + Be Window)

- LVS (Incident beam path – ES1)
- LVS (Incident beam path – ES2)
SUPPORTING SLIDES
Backup Slides

- Beamline vacuum calculations
- Floor sector layout
- Hutch layout
- FOE
- Endstations
Vacuum Layout

<table>
<thead>
<tr>
<th>Vacuum</th>
<th>Section</th>
<th>Components</th>
<th>Min. Pump Size*</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHV 10⁻⁸ mbar</td>
<td>GV3 – GV4</td>
<td>Mask + Slits</td>
<td>30 L/s</td>
</tr>
<tr>
<td>UHV 10⁻⁸ mbar</td>
<td>GV4 – GV5</td>
<td>Mono + Collimator</td>
<td>45 L/s</td>
</tr>
<tr>
<td>UHV 10⁻⁸ mbar</td>
<td>GV5 – GV6</td>
<td>Mirror</td>
<td>100 L/s</td>
</tr>
<tr>
<td>UHV 10⁻⁸ mbar</td>
<td>GV6 – GV7</td>
<td>Diagnostic + Shutter</td>
<td>135 L/s</td>
</tr>
<tr>
<td>UHV 10⁻⁸ mbar</td>
<td>GV7 – BeW</td>
<td>Transport Pipe + Window</td>
<td>90 L/s</td>
</tr>
</tbody>
</table>

*See vacuum spreadsheet

GV7

GV6

GV5

GV4

GV3 (FE)
Preliminary UHV Profile

QAS Full Line Pressure Distribution (17.1 m)

- Calculation by Eugene Hu

- 6 pumps: 2x60+1x220+1x60=2x 60 L/s
- 6 pumps: 2x60+1x220+1x60+2x150 L/s
- 6 pumps: 2x60+1x220+1x60+3x220 L/s

Distance to the Gate Valve #1 (m)

Pressure (mBar, x10^-9)
Beamline Location – 7-BM

• Between ISS (8-ID) and SST (7-ID)
• Shared sample prep lab with ISS
Hutch Layout

- 1 Lead FOE (7-BM-A)
- 2 Steel Endstations (7-BM-B & 7-BM-C)
FOE Hutch

- Shielding IAW LT-C-ESH-STD-001, Version 4, Guidelines for Shielded Enclosures
  - 18 mm Pb lateral walls
  - 4 mm Pb roof
  - 50 mm Pb downstream walls
7-BM-B: QAS END STATION 1

- 5 x 3.5 m area
- Space for 1 x 2m optical table
- 1.2 m sliding door w/ window
- 1 rack on roof

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VARIABLE</th>
<th>VALUE/DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure type</td>
<td></td>
<td>3-Pole Wiggler, Odd Cell</td>
</tr>
<tr>
<td>Enclosure description</td>
<td></td>
<td>QAS Monochromatic Beam Enclosure</td>
</tr>
<tr>
<td>Shielding material</td>
<td></td>
<td>Steel</td>
</tr>
<tr>
<td>Dimensions (m) (Reference)</td>
<td></td>
<td>Height: 3.5 m, Width: 3.5 m, Length: 5.0 m</td>
</tr>
<tr>
<td>Shielding</td>
<td></td>
<td>Side (lateral) panels: 3 mm steel, Roof panels: 2 mm steel, Upstream wall panels: 3 mm steel, Downstream wall panels: 6 mm steel, 7-BM-B shares downstream wall with 7-BM-C upstream wall</td>
</tr>
<tr>
<td>Guillotine</td>
<td></td>
<td>Qty 1, Required, single beam pipe penetration upstream</td>
</tr>
<tr>
<td>Beam stop</td>
<td></td>
<td>Qty 1, downstream, incorporated into Beam pipe penetration door</td>
</tr>
<tr>
<td>Beam pipe penetration door</td>
<td></td>
<td>(alignment window): Qty 1 with interlock switch provisions</td>
</tr>
<tr>
<td>Entry 1</td>
<td></td>
<td>Position: Outboard Side – of beam direction</td>
</tr>
<tr>
<td>Size (m)</td>
<td></td>
<td>2.4 H x 1.2 W</td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td>Sliding</td>
</tr>
<tr>
<td>Actuated/Manual Opening</td>
<td></td>
<td>Actuated</td>
</tr>
<tr>
<td>Floor groove/Threshold</td>
<td></td>
<td>Floor groove</td>
</tr>
<tr>
<td>PPS Interfaces</td>
<td></td>
<td>Mounting plates for magnetic lock and dual position switches.</td>
</tr>
<tr>
<td>Switch position for actuated door</td>
<td></td>
<td>Downstream</td>
</tr>
<tr>
<td>Window Door</td>
<td></td>
<td>Door</td>
</tr>
<tr>
<td>Strip Curtain (internal)</td>
<td></td>
<td>Not Required</td>
</tr>
<tr>
<td>Hoist</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Labyrinths</td>
<td></td>
<td>Positioned as on drawing, sealed with anti-tamper screws except where locks/interlocks specified.</td>
</tr>
<tr>
<td>Roof labyrinth, compact</td>
<td></td>
<td>(on roof): Qty 4</td>
</tr>
<tr>
<td>LN2 roof labyrinth</td>
<td></td>
<td>(on roof): Qty 0</td>
</tr>
<tr>
<td>Labyrinth wall, single sided</td>
<td></td>
<td>(on sidewall): Qty 1, with interlock switch provisions</td>
</tr>
<tr>
<td>Labyrinth wall, double sided</td>
<td></td>
<td>(on sidewall): Qty 0</td>
</tr>
<tr>
<td>Air outlet labyrinth</td>
<td></td>
<td>(base of sidewall): Qty 1</td>
</tr>
<tr>
<td>Roof exhaust labyrinth</td>
<td></td>
<td>(on roof): Qty 1</td>
</tr>
<tr>
<td>Roof fan with labyrinth</td>
<td></td>
<td>(on roof): Qty 1</td>
</tr>
<tr>
<td>Lighting</td>
<td></td>
<td>LED</td>
</tr>
<tr>
<td>Bridges</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Attachment points for adjacent enclosures: 7-BM-C</td>
</tr>
</tbody>
</table>
## 7-BM-C: QAS END STATION 2

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VARIABLE</th>
<th>VALUE/DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure type</td>
<td>3-Pole Wiggler, Odd Cell</td>
<td></td>
</tr>
<tr>
<td>Enclosure description</td>
<td>QAS Monochromatic Beam Enclosure</td>
<td></td>
</tr>
<tr>
<td>Shielding material</td>
<td>Steel</td>
<td></td>
</tr>
<tr>
<td>Dimensions (m) (Reference)</td>
<td>Height 3.5 m, Width 3.5 m, Length 4.0 m</td>
<td></td>
</tr>
<tr>
<td>Shielding</td>
<td>Side (lateral) panels 3 mm steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roof panels 2 mm steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upstream wall panels 6 mm steel, 7-BM-C shares upstream wall with 7-BM-B downstream wall</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Downstream wall panels 6 mm steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guillotine Not Required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Beam stop Qty 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Beam pipe penetration door (alignment window): Not Required</td>
<td></td>
</tr>
<tr>
<td>Entry 1</td>
<td>Position Outboard Side – of beam direction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Size (m) 2.4 H x 1.2 W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type Sliding Single</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Actuated/Manual Opening Actuated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Floor groove/Threshold Floor groove</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PPS Interfaces Mounting plates for magnetic lock and dual position switches.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Switch position for actuated door Upstream</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Window Door</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strip Curtain (internal) Not Required</td>
<td></td>
</tr>
<tr>
<td>Hoist</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Labyrinths</td>
<td>Positioned as on drawing, sealed with anti-tamper screws except where locks/interlocks specified.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roof labyrinth, compact (on roof): Qty 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LN2 roof labyrinth (on roof): Qty 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Labyrinth wall, single sided (on sidewall): Qty 1, with interlock switch provisions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Labyrinth wall, double sided (on sidewall): Qty 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air outlet labyrinth (base of sidewall): Qty 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roof exhaust labyrinth (on roof): Qty 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roof fan with labyrinth (on roof): Qty 1</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>LED</td>
<td></td>
</tr>
<tr>
<td>Bridges</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Attachment points for adjacent enclosures: 7-BM-B</td>
<td></td>
</tr>
</tbody>
</table>
May 26th 2015
Prepared by: Lukas Lienhard
Beamline Mechanical Engineer
OUTLINE

• Design Goals
  • Withstand 3PW white beam
  • Modifications to X-6B mirror system
• Design Overview
  • X-7B Mirror
  • X-6B Mirror System
  • Modification Assembly
• Design Calculations
  • FEA Results
Design Goals & Assumptions

• Withstand 3PW White beam @ 11.7 meters
  • ~365 W/mrad² max power density
• Modifications to X-6B mirror system
  • Integrate X-7B mirror into X-6B mirror system
  • Water cooling for X-7B mirror
  • Add absolute encoders for all motions
  • New stand for 1.2 m beam height in Front End
X-7B Mirror

- SESO U-bender (same type as in X-6B mirror chamber)
- 100 mm wide x 700 mm length
- Vertical deflection
X-6B Mirror System

- Oxford-Danfysik Mirror System (~2001)
- Mirror is fixed to chamber and all motions control chamber position.
- Baseplate will be modified to support the shorter X-7B mirror.
Motion Control

- Horizontal motion and yaw actuated with two linear drives
- Horizontal motion will be used for switching stripes on mirror
- Vertical, pitch and roll motions actuated by three vertical jacks
- Horizontal and vertical motions have datum and limit switches for each axis
- Kinematic spheres between horizontal and vertical stages
- 6 axes total (including bender)

+/- 5 mm limited range
10mrad max pitch

+/- 15 mm limited horizontal motion
Modification Summary

- Rework of existing baseplate to support mirror assembly
- Modified kinematic supports for mirror assembly
- New Water cooling circuit
- New support stand to accommodate SR tunnel elevation

White beam
Baseplate Modification

- Additional blind tapped holes required to mount 700 mm length mirror
Mirror Supports

- Modification of existing supports to match interfaces on X-7B mirror
Mirror System Support

- Beam height at NSLS: 1400
- Beam height NSLS-II SR: 1200
- Will fabricate new stand
- Re-using kinematic support feet
  - Future leveling adjustment
  - Will need stand as flat as possible to minimize mirror position error when switching stripes
Cooling Design

- Side cooling, intermittent copper blocks to minimize influence on bending
- Seamless copper 101 tube (no water-vacuum joints)
- 200 micron Indium foil between silicon and copper
- 192 cm² total contact area copper-indium-silicon
- ~75 cm² for copper-water heat transfer
- 1 L/min DI water – 6mm OD metric tubing
Side Clamping Design

- Metric U-180 Stainless Steel Channel
- Aluminum discs fit into feature on copper blocks
- Set screw used for compression
- Weight: .43 lb (.195 kg)
Side Clamping Design

- Spring max force 14.16 lb (63 N)
- Nominal spring force 10.1 lb (45 N)
- Total supported weight (clamp + copper block + tube) = .911 lbmass (.413 kg)
- Normal Force required against gravity assuming $\mu=.3$ (copper-silicon): 3.03 lb (13.5 N)
- Max pressure for copper to silicon interface: 6 psi (41 kPa)
Strong back Analysis (Stress)

- Strong back required to be rigid for effective and reliable clamping
- Assumed 20 lb force load (89 N)
- 48.6 MPa Max Von Mises Stress

Exaggerated deformation
Strong back Analysis (Displacement)

- Strong back required to be rigid for effective and reliable clamping
- Assumed 20 lb force load (89 N)
- 0.6 mm max displacement

Actual deformation
Maximum Synchrotron Fan Clearances

- 2mm beam clearance to tube (w/o crotch & exit absorber)
- 7mm clearance to tube (w/ crotch & exit absorber)
Remaining Work

- Remaining work before FDR
  - Add absolute encoders for vertical and horizontal axes
  - Finalize disaster mask design
  - Confirm all interface dimensions in lab before starting modifications
  - Add burst disc and vacuum gauges
  - Add type K thermocouples provisions
  - Coordinate installation & infrastructure with Accelerator group
FEA Assumptions

• FEA completed by Steve O’Hara
• 3PW+BM total power distribution @ 11.7 m from source
• ~101 W max for 2.0 x 0.3 (h x v) mrad nominal
  - 2.58 W/mm² peak power density
• Simulated 3 heat load cases
  - Normal operating condition with slits
  - Max operating condition without slits
  - Max incidence angle to simulate max temperature
• Cooling: 1 L/min DI water @ 29.5°C
  - Film coefficient: 0.00753 W/mm² °C
Normal Operating Conditions (Slits)
Normal Operating Conditions (No slits)
Slope Error

- < 2 $\mu$rad total slope error
• Max Operating heat bump radius ~136 km
Backup Slides

• Support Stand Structural Calculations
• Effect of cooling assembly weight on mirror bending
Support Structural Analysis

- Load to support 615 kg (1355 lb) (complete Mirror System)
- Simulation conditions: $F_y = 5000lb$, $F_z = 1000lb$, $F_x = 1000lb$
- Removable section excluded from simulation for worst case scenario
Support Structural Analysis – Stress

- Simulation conditions: \( F_y = 5000\text{lb}, F_z = 1000\text{lb}, F_x = 1000\text{lb} \)
- Max Stress: 10.5 ksi (72.4 MPa), SF = 2.86 minimum
Support Structural Analysis - Deformation

• Simulation conditions: \( F_y = 5000\text{lb}, F_z = 1000\text{lb}, F_x = 1000\text{lb} \)
• Max Deflection: \( 0.0068 \text{ in (173 microns)} \)
Cooling assembly weight on mirror

- Total weight of cooling assembly: ~6 lbs. (26.7 N)
- Theoretical impact on bending: .35 micron max deflection
- ~175 km radius bend due to added weight
X-4A Beryllium Window

- Re-used from X-4A (in use since 1996)
- 10 mil (254um) thickness
- 10 mm x 123 mm rectangular aperture
- Furnace brazed assembly
- UHV incident side, 1 ATM downstream
- Drawing SLS-92.19-092-4 calls out pressure testing
  - “APPLY A DIFFERENTIAL PRESSURE OF 30 PSI (HIGHER PRESSURE AT ATMOSPHERIC SIDE OF BERYLLIUM WINDOW) WITH SUB-ASSEMBLY HEATED TO 250°C, HOLD FOR 5 (FIVE) MINUTES, REPEAT 5 (FIVE) TIMES.”

P/N: SLS-92.19-086-4
Beryllium Window Calculation

- 254 um thickness
- 10 mm aperture height
- Foil edges assumed held and fixed for thin plate (assembly is brazed)
- Stress @ center = 51.6 MPa
- Safety Factor @ center = 5.3
- Stress @ edge = 102 MPa
- Safety Factor @ edge = 2.6
Steven N. Ehrlich
QAS Preliminary Design Review
May 26, 2015
Outline

• Technical Scope
• Preliminary Design
• Experimental Hutch Safety
• Conclusion
1. Detection System
   • Absorption Spectroscopy
     • Transmission – ion chambers
     • Fluorescence – Ge multi-element, Vortex ME-4 Si-drift, PIPS
   • Scattering
     • PerkinElmer 1621 - 16 inch square
       - 2048 x 2048 pixels; 200µm pixel
       - Up to 15 frames/s
   • Point detectors

2. Sample Handling
   • Geometry: capillary, flat surface or user defined
   • Sample temperature: ~10K-1000°C
   • Sample atmosphere: 10⁻⁵ mbar - 80 bar
   • X-Y-Z, rotary and tilt stages for sample manipulation
   • User endstations
Hutch 1 – samples which can be changed rapidly between experiments

- Optical table on motorized platform
- Area detector on slides to adjust distance from sample and vertical position
- Ion chambers on slide to remove from beam path when doing XRD
- X-Y-Z stage for mounting samples – multiple sample manipulation
- Motorized rotary and tilt stages for samples requiring orientation
- Mass flow controller for gases
- RGA for gas analysis
Hutch 1 Endstation

- area detector (from NSLS)
- ion chambers from NSLS
- optical breadboard (new)
- motorized support table (from NSLS)
- filter inserter (from NSLS)
- x-y slits (new)
- vertical manipulator (new)
- Be window (from NSLS)
- incident beam path (evacuated)

mounts for detectors and samples will be updated

45.0m

43.5m

U.S. DEPARTMENT OF ENERGY
Office of Science

BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES
Hutch 2 - experimental endstations requiring extensive alignment

- Mass flow controller for gases
- RGA for gas analysis

- **Combined XAFS/DRIFTS endstation**
  - IR setup from SCC (Partner User)
  - XAFS and infrared spectroscopy

- **Combined XAFS/Raman endstation**
  - Raman instrument from SCC

- Both endstations can be used in standalone mode
- Both endstations can be used in Hutch 1
Detectors

All from NSLS

- PerkinElmer 1621 area detector
- Vortex-ME4 4-element Si-drift fluorescence – upgrade electronics
- Canberra multi-element Ge fluorescence – upgrade electronics
- Ion chambers and point detectors
- Canberra PIPS fluorescence
Sample Environments

All from NSLS or Partner Users

- Closed-cycle He refrigerators: T > 10K
- Clausen cells: T < 700°C
- Nashner-Adler reaction cells: -200 – 500°C
- Large Clam Shell furnace reactor: room T - 1000°C
- In-situ high pressure, high temperature XAS flow cell:
  temperatures to 600°C and pressures to 1200 psi (83 bar)
QAS Specific Safety Aspects

• **Gases**
  - Both experimental hutches will have gas lines from the outside fed in through mass flow controllers and will have HEPA filtered exhaust on roof
  - Includes flammable and toxic gases
  - Interlocks for gas flow and exhaust operation
  - Gas sensors

• **Liquid Nitrogen**
  - Oxygen deficiency hazard monitor
  - Proper PPE

• **Nanoparticles**
  - HEPA filtered exhaust for experimental hutches

• **Lasers**
  - Alignment and Raman
Conclusions

• Scope of work
  • Provide appropriate detectors
  • Provide sample environments, endstations and controls to benefit science program

• Preliminary Design
  • Use NSLS detectors and endstation components
    • Make best use of existing detectors and endstation components
    • Upgrade to NSLS-II standards