Attachment B

USI Screening Checklist

A) USI Screening Purpose: ☒ **Proposed Activity** ☐ **Existing Condition**	**B) Description of Proposed Activity/Discovered Condition and Sponsor/Condition Owner:** Review of QAS (7-BM) 3PW Beamline and Front End Commissioning and Operation
C) USI Screening Outcome: ☒ **No potential USI** ☐ ***Potential USI***	**USI Screening Performed by/Date:** Steve Moss / August 24, 2017 08/24/17 QAS (7-BM) is a Three Pole Wiggler beamline. NSLS-II SAD Section 3.3.3.8 – Photon Sources specifically includes Three Pole Wiggler type Insertion Devices, as well as Bending Magnets. These devices tend to produce very stable beams with relatively low emitted power (as compared to Damping Wigglers and Undulators); which simplifies the cooling requirements on the optics. From the point of view of safety, a key parameter is total power of the synchrotron radiation beam produced by the source. NSLS-II SAD Table 3.9 – Basic Parameters of NSLS-II Radiation Sources for Storage Ring Operation at 3.0 GeV and 500 mA, shows that the total power radiated by bending magnets and 3PWs are orders of magnitude below that from Undulators and Damping Wigglers (that have been deemed acceptable for use at NSLS-II). So long as the design and construction of the beamline and its key radiation generating and safety components comply with the NSLS-II Shielding Policy and ASE commitments its introduction and operation create no Unreviewed Safety Issue. The following answers are based on compliance with: 1) RSC Memorandum dated August 20, 2017 with subject: Review of the Ray-Tracing Designs of the XFM (4-BM) and QAS (7-BM) Front-Ends (copy attached). 2) RSC Memorandum of Endorsement of the PPS Design for 7-BM (QAS) Beamline dated August 22, 2017 (copy attached). 3) RSC Memorandum dated August 23, 2017 with Subject: Review of the Radiation Safety Design of the 7-BM (QAS) Beamline (copy attached).

Qualified Screener answers the following questions; if:

- Any question is answered yes (i.e., "Y"), check "Potential USI" box in Part C, above.
- If all questions are answered no (i.e., "N"), check "No potential USI" box in Part C, above.

Does the proposed change or discovered condition impact or potentially impact:

1) The personnel protection system (PPS)?
   Examples: Access doors, fencing, hutches, accelerator enclosures, software change, hardware modifications that are not, "replacement-in-kind."

   ☐Y or ☒N

2) ODH Monitoring System?

Examples: Hutch ODH monitors, filling station ODH monitors.

☐Y or ☒N

3) Radiation Safety Component?
Examples: Shielding, earthen berms, hutches, concrete walls, beam shutters, scatter shields, burn-through devices, exclusion zones, labyrinths, beam stops, beam masks, collimators, hutch guillotine and beam transport pipes.

☐Y or ☒N

4) Area radiation monitoring system or components?
Examples: Changing instrument position or use of a new type of instrument used for area radiation monitoring, alarms and controls.

☐Y or ☒N

5) Radiological source terms identified in the SAD?
Examples: New insertion devices, change to the maximum synchrotron energy or accelerated charge values, accelerator modifications that are not "replacement-in-kind."

☐Y or ☒N

6) Critical devices
Examples: Safety shutters, dipole magnets, top-off apertures.

☐Y or ☒N

7) PS operating organization?
Examples: Control room operators, support staff responsible for PPS, radiation monitoring or shielding configuration management.

☐Y or ☒N

8) Operational safety limits described in the Authorization Basis Documents?
Examples: Maximum current, beam energy, pulse rate.

☐Y or ☒N

Forward the completed form to the Authorization Basis Manager

National Synchrotron Light Source

BROOKHAVEN
NATIONAL LABORATORY

Building 743, National Synchrotron Light Source
Brookhaven National Laboratory
Upton, NY 11973-5000
Phone 631 344-2117
Fax 631 344-3238
zhong@bnl.gov

managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

Date: August 20, 2017
To: Mark Breitfeller, Frank DePaola, Mohamed Benmerrouche, and Sushil Sharma
From: Zhong Zhong (chair), Photon Science Radiation Safety Committee
Subject: Review of the ray-tracing designs of the XFM (4-BM) and QAS(7-BM) front-ends

Dear Mark, Frank, Mo and Sushil,

The Photon Science Radiation Safety Committee (RSC)'s ray-tracing subcommittee concluded review of the front-end ray-tracing drawings of the XFM (4-BM) and QAS(7-BM) front-ends on August 18.

Subjects reviewed include the synchrotron max-fan and Bremsstrahlung drawings. Since the max. fan drawings are sufficient for assuring the safety of the front-end against synchrotron radiation, the nominal synchrotron ray-tracings, included in the drawing packages on sheets 2 and 3, were not reviewed by the RSC.

Written documents

The following documents were submitted to the RSC on July 17, 2017 for review:

1. QAS front-end assembly drawing, SR-FE-3PW-4001, Rev. B by J. Tuozzolo.
2. QAS front-end Bremsstrahlung ray-tracing, SR-FE-3PW-4001, Rev. B, sheets 6 and 7 for horizontal and vertical projections, respectively.
3. QAS front-end max. synchrotron ray-tracing, SR-FE-3PW-4001, Rev. B sheets 4 and 5 for horizontal and vertical projections, respectively.
4. XFM front-end assembly drawing, SR-FE-3PW-6001, Rev. B by J. Tuozzolo.
5. XFM front-end Bremsstrahlung ray-tracing, SR-FE-3PW-6001, Rev. B, sheets 6 and 7 for horizontal and vertical projections, respectively.
6. XFM front-end max. synchrotron ray-tracing, SR-FE-3PW-6001, Rev. B sheets 4 and 5 for horizontal and vertical projections, respectively.

Notes

XFM and QAS both use three-pole wiggler as x-ray source. The masks of XFM and QAS in the front-end use standard 3-PW mask design that incorporates cooling fins which enable the masks to be passively safe even without cooling water. XFM is similar to CMS (no mirror, 3-PW as source), and QAS is similar to BMM (single mirror, rising reflection angle, 3-PW source). Both the CMS and BMM front-ends have recently been reviewed by the RSC ray-tracing sub-committee and have since been successfully commissioned.

Conclusions

Based on our assessment of the ray-tracing drawings, the RSC finds the Bremsstrahlung and synchrotron shielding designs for the front-ends of both the XFM and QAS beamlines meeting the NSLS-II shielding policy.

Radiation Safety Committee

Name	*Expertise*	*Directorate*
Andrew Ackerman	Deputy ESH Manager	PS
Dana Beavis	Experimental Nuclear Particle Physics	NPP
Andi Barbour	Beam Line Physicist	PS
Mohamed Benmerrouche	Nuclear and Radiation Physics	PS
Scott Buda	Personnel Protective Systems	PS
Ray Fliller	Accelerator Physicist	PS
Wah-Keat Lee	Beam Line Physicist	PS
Boris Podobedov	Accelerator Physics	PS
Chuck Schaefer	Accelerator SME	ESH
Lutz Wiegart	Beam Line Physicist	PS
Zhong Zhong	Beam Line Physicist	PS
Emil Zitvogel	Accelerator Operations	PS
Ashley Shoemaker-Skokov	Administrative Support	PS

Ray-tracing sub-committee

Andrew Ackerman	Deputy ESH Manager	PS
Mary Carlucci-Dayton	Mechanical Engineer	PS
Wah-Keat Lee	Beam Line Physicist	PS
Chuck Schaefer	Accelerator SME	ESH
Christopher Stelmach	Designer	PS
Lutz Wiegart	Beam Line Physicist	PS
Zhong Zhong	Beam Line Physicist	PS

PPS sub-committee

Dana Beavis	Experimental Nuclear Particle Physics	NPP
Mohamed Benmerrouche	Nuclear and Radiation Physics	PS
Scott Buda	Personnel Protective Systems	PS
Robert Lee	ESH manager	PS
Zhong Zhong	Beam Line Physicist	PS

RSC checklist sub-committee

Andi Barbour	Beam Line Physicist	PS
Mohamed Benmerrouche	Nuclear and Radiation Physics	PS
Ray Fliller	Accelerator Physicist	PS

National Synchrotron Light Source

BROOKHAVEN
NATIONAL LABORATORY

Building 743, National Synchrotron Light Source
Brookhaven National Laboratory
Upton, NY 11973-5000
Phone 631 344-2117
Fax 631 344-3238
zhong@bnl.gov

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Memo

Date: August 22, 2017
To: George Ganetis, and Scott Buda
From: Zhong Zhong (chair), NSLS II Radiation Safety Committee
Subject: Radiation Safety Committee endorsement of the PPS design of 4-BM(XFM), 7-BM(QAS) and 18-ID (FXI) beamlines

Dear George and Scott

I would like to thank you for inviting the RSC sub-committee for PPS (personal protection system) interlock, Mohamed Benmerrouche, Dana Beavis, Robert Lee, and myself, to the review of the PPS logic diagrams for the 4-BM(XFM), 7-BM(QAS) and 18-ID (FXI) beamlines.

We reviewed the logic diagrams, sent beforehand on July 28, for the three beamlines. We then met with Scott Buda and George Ganetis on August 14, 2017 to discuss the drawings.

The following logic diagrams were reviewed:

1. Wiring diagram, 4-BM search logic, LT-EL-BL-EI-PPS-2040-96, rev. A by S. Buda.
2. Wiring diagram, 7-BM EESE B search logic, LT-EL-BL-EI-PPS-1070-96 rev. A by S. Buda
3. Wiring diagram, 18-ID search logic, LT-EL-BL-EI-PPS-1180-91 rev. A by S. Jarzabkowski.

We note that the PPS logic diagrams for these three beamlines, two three-pole wigglers and one damping wiggler, are similar to the operational NSLS-II beamlines.

While the IWG should be the primary reviewer for interlock logic diagrams, the RSC brings in broader expertise in areas such as radiation physics and PS shielding policy. This review by the RSC sub-committee compliments the recent shielding and ray-tracing reviews of XFM and QAS. The shielding and ray-tracing of FXI will be reviewed by the RSC in the future.

As a result of the sub-committee review, the RSC concurs that the PPS designs of 4-BM, 7-BM and 18-ID beamlines meet Photon Sciences shielding policy.

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National Synchrotron Light Source

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NATIONAL LABORATORY

Building 743, National Synchrotron Light Source
Brookhaven National Laboratory
Upton, NY 11973-5000
Phone 631 344-2117
Fax 631 344-3238
zhong@bnl.gov

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Memo

Date: August 23, 2017
To: Steven Ehrlich, Julian Adams, and Paul Zschack
From: Zhong Zhong (chair), Photon Science Radiation Safety Committee
Subject: Review of the radiation safety design of the 7-BM (QAS) beamline

Dear Steve, Julian and Paul,

The Photon Science Radiation Safety Committee (RSC) conducted review of the design of the QAS beamline, 7-BM, on Tuesday August 15, 2017. Subjects reviewed include synchrotron max-fan and Bremsstrahlung drawings, Secondary Bremsstrahlung and synchrotron radiation shielding analysis, top-off safety analysis, and aspects of thermal management that relate to radiation safety.

Written documents

The following documents and drawings were reviewed:

1. QAS assembly drawing, PD-QAS-RAYT-0001 rev. A, by M. Johanson, sheet 1, "QAS (7-BM) Beamline Ray Trace".
2. QAS Bremsstrahlung ray-tracing drawings, PD-QAS-RAYT-0001 rev. A, sheets 5 and 6 for horizontal and vertical projections, respectively. Detail for Bremsstrahlung stop is included on sheet 7.
3. QAS max. synchrotron ray-tracing drawings, PD-QAS-RAYT-0001 rev. A, sheets 2 and 3 for horizontal and vertical projections, respectively. Additional details around the monochromator are shown on sheet 4. Details for mis-steering by mirrors are shown on sheet 8.
4. Powerpoint presentation "QAS (7-BM) Radiation Safety Committee Review" presented by Steve Ehrlich on August 15, 2017.
5. Powerpoint presentation "07BM-QAS FE/BL GB FLUKA Analysis" by Mo Benmerrouche, June 2, 1017.
6. NSLS-II technical note, #NSLSII-TOS-RPT-014, entitled "07BM (QAS) Top-off Radiation Safety Analysis", by M. Benmerrouche, dated 08/08/2017.

Presentation

Attendance: Andrew Ackerman, Andi Barbour, Mo Benmerrouche, Sunil Chitra, Mary Carlucci-Dayton, Steven Ehrlich, Edwin Haas, Wah-Keat Lee, Lukas Lienhard, Paul Northrup, Christopher Stebbins, Chris Stelmach, Ryan Tappero, Emil Zitvogel, and Joseph Zipper. Wah-Keat Lee was delegated by Zhong Zhong to chair the meeting.

Steve Ehrlich gave the presentation entitled "QAS (7-BM) Radiation Safety Committee Review". Following the guideline from the memo by Paul Zschack to the RSC on May 29, 2014, the following were discussed:

1. QAS is a quick x-ray spectroscopy and diffraction beamline using a standard three-pole wiggler as x-ray source. The beamline optics consists of collimating mirror (bounce up) located at 11.7 m in the front-end; double crystal monochromator followed by a focusing mirror in the First Optical Enclosure (FOE). A shielded beam pipe transports the monochromatic beam from the FOE to the experimental station B.
2. The compact monochromator design allows for fast scanning of x-ray energy. The energy range is 4.7 to 31 keV using Si 111 reflection.
3. The preliminary QAS ray-tracing drawings were reviewed by the ray-tracing sub-committee before, most recently in June. The comments from that review are attached for completeness.
4. The white beam is always on the collimating mirror. The pink beam on the monochromator is controlled by the front-end shutter. The monochromatic beam is controlled by shutter at the downstream end of the FOE.
5. Shielding for the primary Bremsstrahlung x-rays is designed using ray-tracing method. A collimator (frontend collimator 1) and beamstop combination, with a vertically deflecting collimating mirror in between, stops the primary Bremsstrahlung in the FOE. The Bremsstrahlung beam-stop, at 25.435 m, intercepts all possible primary Bremsstrahlung radiation. The beam stop has an aperture to allow the synchrotron pink beam through.
6. Shielding and control of secondary Bremsstrahlung radiation is designed by ray-tracing from possible secondary scattering sources in FOE, and verified by FLUKA analysis performed by Benmerrouche. The FLUKA analysis results were summarized in the ppt presentation prepared by Benmerrouche for the review.
7. The transport pipe between the FOE and experimental station B is shielded with 5 mm lead, exceeding the 2 mm recommended by NSLS-II shielding guideline. The monochromatic beam, when mis-steered by the mirrors, could strike the shielded transport pipe. Analysis by Benmerrouche, using STAC8, shows that this condition is safe.
8. The tracking analysis shows no electron beam can reach the fixed mask 1 in the front end. The top-off safety analysis shows that in the case of top-off fault at QAS, the dose rates on the FOE walls and roof are less than 100 mrem/hr required by NSLS-II shielding policy for fault conditions. Thus Area Radiation Monitor (ARM) is not needed at the QAS beamline.
9. Thermal protection of the beamline shielding components is designed using ray-tracing method. The design is supported by synchrotron ray-tracing drawings assuming maximum possible synchrotron fan and collimating mirror alignment errors.

10. Access to the QAS endstations B and C, and FOE (station A) is controlled by standard door interlock and search-and-secure mechanism. The PPS logic diagram for the QAS beamline was reviewed separately by the RSC PPS subcommittee on August 15.
11. Configuration control of the radiation safety component was discussed.
12. Ray traces are awaiting Paul's approval at the time of meeting. They are expected to be approved.
13. FEA (provided to committee) for fixed mask shows that air cooling is sufficient, however, water will be used simply to reduce surface temperature. Since water cooling is not required for PPS safety, the water interlock will be tied to the beam line EPS (equipment protection system). This arrangement is similar to that at CMS.

Recommendations

The RSC has no recommendations for action.

Conclusions

1. Based on our assessment of the ray-tracing drawings and radiation simulation results, the RSC find that the QAS beamline shielding design meets the NSLS-II shielding policy. Subject to experimental verification by radiation survey, we believe the installed shielding will provide adequate personnel protection for normal operation and against failures of synchrotron orbit.
2. Based on our review of the max. synchrotron ray-tracing drawings, the RSC believes that the QAS masks, collimating mirror, white- and pink- beam-stops are adequately designed to protect against thermal failure of shielding components.
3. Based on our review of the beamline layout, the RSC finds that all Radiation Safety Components meet NSLS-II design requirements.

Report from the preliminary review of ray-tracing in June 2017

The Photon Science Radiation Safety Committee (RSC)'s ray-tracing subcommittee concluded preliminary review of ray-tracing of the QAS beamline. Subjects reviewed include the synchrotron max-fan and Bremsstrahlung drawings and aspects of thermal management that relate to radiation safety.

We met with QAS team in May 2017 to review the preliminary QAS ray-tracing. At that time we recommended the following:

1. Please check with Mary re. what simulation, if any, is needed to allow QAS pink-beam strike the first mask at normal incidence, and reference that in note 6.
2. Please either perform simulation similar to that of BMM, or ask Mo to perform the simulation in a timely fashion, or draw in realistic yet conservative beam width in the beam-pipe/beam cross-section drawing.

To address items 1 and 2, the QAS team submitted the following to RSC on June 19:

1. The FEA calculation from Lukas for pink beam hitting the first mask.
2. Copy of an e-mail from Mo stating the results of a STAC8 calculation of a miss-steered monochromatic beam hitting at normal incidence the inside of the shielded transport pipe.

The RSC ray-tracing sub-committee reviewed both documents and believes that items 1 and 2 above are adequately addressed.

We note that there is an action item from the QAS design review to have the RSC review the QAS beamstop. The original reason for the pink beam stop action item is that with the small gap between first and second crystal faces in the channel-cut monochromator crystal resulted in not meeting a requirement to have at least 3.00 mm between the pink beam and the bottom of the pink beam stop aperture. The team decided to solve this problem by purchasing a new crystal with a larger gap between crystal faces, thus meeting the requirement as shown on page 4 of the ray trace document, where it says " 0.127in [3.22mm] MIN EDGE DISTANCE" (middle left of page). Therefore, by meeting this requirement, we recommend that the action item should be closed.

To conclude, we recommend that the QAS ray-tracing be approved.

Radiation Safety Committee

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