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Memo

Date: August 24, 2017
To: Ryan Tappero, Julian Adams, and Paul Zschack
From: Zhong Zhong (chair), Photon Science Radiation Safety Committee
Subject: Review of the radiation safety design of the 4-BM (XFM) beamline

Dear Ryan, Julian and Paul,

The Photon Science Radiation Safety Committee (RSC) conducted review of the design of the XFM beamline, 4-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. XFM assembly drawing, PD-XFM-RAYT-0001 rev. A, by M. Johanson, sheet 1, "XFM (4-BM) Beamline Ray Trace".
2. XFM Bremsstrahlung ray-tracing drawings, PD-XFM-RAYT-0001 rev. A, sheets 6 and 7 for horizontal and vertical projections, respectively. Details for Bremsstrahlung collimator and Bremsstrahlung stop are included on sheet 8.
3. XFM max. synchrotron ray-tracing drawings, PD-XFM-RAYT-0001 rev. A, sheets 2 and 4 for horizontal and vertical projections, respectively. Additional details are shown on sheets 3 and 5 for horizontal and vertical projections, respectively. Considerations for mirror-mis-steering are presented on sheets 9 and 10 for horizontal and vertical projections, respectively.
4. Powerpoint presentation "XFM Radiation Safety" presented by Ryan Tappero and XFM BDT on August 15, 2017.
5. "XFM Beamline Lead Bricks Thermal Analysis Report", PD-XFM-CO-CALC-0107 Rev. A by Mary Carlucci-Dayton and Yi Zhu dated February 23, 2017.
6. NSLS-II technical note, "Radiation shielding analysis of the 04-BM-XFM beamline" by S. Chitra and M. Benmerrouche.
7. NSLS-II technical note, #NSLSII-TOS-RPT-013, entitled "07BM (XFM) Top-off Radiation Safety Analysis", by S. Chitra, M. Benmerrouche and Y. Li, 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.

Ryan Tappero gave the presentation entitled "XFM Radiation Safety ". Following the guideline from the memo by Paul Zschack to the RSC on May 29, 2014, the following were discussed:

1. XFM is x-ray spectroscopy and imaging beamline using a standard three-pole wiggler as x-ray source. The beamline optics consists of a focusing mirror (bounce horizontally) located in the First Optical Enclosure (FOE); secondary source aperture, vertically collimating mirror followed by a vertical-bounce double crystal monochromator, all in the Second Optical Enclosure (SOE, enclosure B).
2. The energy range of the monochromator is from 2 to 23 keV using Si 111 reflection.
3. The preliminary XFM ray-tracing drawings were reviewed by the ray-tracing sub-committee in February and in March. The approved ray-tracing drawings were reviewed in early August. The report from the March review documenting adequate addressing of the concerns raised at the February meeting are attached for completeness. There were no concerns at the early August review.
4. The white beam is stopped in the FOE. The white beam and the pink beam on the monochromator are controlled by the front-end shutter. The monochromatic beam is controlled by shutter at the downstream end of the SOE.
5. Shielding for the primary Bremsstrahlung x-rays is designed using ray-tracing method. A collimator (Lead collimator 1 in the FOE) and beam-stop combination, with a horizontally deflecting collimating mirror in-between, stops the primary Bremsstrahlung in the FOE. The Bremsstrahlung collimator 2, at 31.541 m, is the Bremsstrahlung stop. The collimator 2 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 documented in the technical note "Radiation shielding analysis of the 04-BM-XFM beamline" by S. Chitra and M. Benmerrouche.
7. A shielded beam pipe transports the pink synchrotron beam from the FOE to the SOE. The pink-beam transport pipe between the FOE and experimental station B is shielded with 5 mm lead.
8. The top-off safety analysis shows that in the case of top-off fault at XFM, the dose rates on the FOE side walls is 120-150 mrem/hr, exceeding the 100 mrem/hr required by NSLS-II shielding policy for fault conditions. Thus Area Radiation Monitor (ARM) is needed at the XFM beamline. ARM is located about 2 m downstream of ratchet wall.
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 focusing and collimating mirrors alignment errors.

10. Access to the XFM endstation C, SOE (Station B) and FOE (station A) is controlled by standard door interlock and search-and-secure mechanism. The PPS logic diagram for the XFM beamline was reviewed separately by the RSC PPS subcommittee on August 15.
11. Configuration control of the radiation safety component was discussed.

Notes

The following are noted for completeness:

1. Calculation of pink beam from M1, scattering off M2 (neglecting its reflective property), shows a dose rate of 0.13 mrem/hr on contact and 0.1 mrem/hr at 30 cm distance behind the B station 6 mm Fe downstream wall. Calculations show that an added 2 mm steel shielding would reduce the dose rates to below 0.05 mrem/hr on contact. Based on prior discussion with Bob Lee, it was decided that the DCM tank just downstream of the M2 mirror was well-placed to provide the additional shielding. Thus, the DCM tank (stationary part) would be placed under configuration control as part of required shielding. Work on the DCM would not require a radiation work permit because the DCM tank is stationary.
2. There was a discussion regarding documentation/information about the radiation component checklist and the basis of how these components end up on the list. This came up because the DCM tank described above is not on the ray traces. Thus it is not clear how to capture this information. One suggested solution is to add a note on the survey layout drawing denoting the DCM tank as a radiation safety component.
3. The XFM was awaiting installation of a secondary bremsstrahlung shield (SBRS) in the A station at the time of the meeting. The SBRS installation and final survey was completed on August 23.

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 XFM 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 XFM masks, collimators, white- and pink- beam-stops are adequately designed to protect against thermal failure of shielding components, and the low total power (<10 W) allows reduced clearances for synchrotron max fan as demonstrated by thermal simulations.
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 March 2017

I would like to thank you for inviting members of the ray-tracing subcommittee of the Photon Science Radiation Safety Committee (RSC) to discuss the preliminary ray-tracing of the XMF beamline. Wah-Keat Lee, Lutz Wiegart, Mary Carlucci-Dayton, Chris Stelmach, Andrew Ackerman and Zhong Zhong met with Ryan Tappero and Paul Northrup on February 28, 2017. Items #1 and 2 on the following document list were distributed to us before the meetings. At the meeting, we requested further FEA simulation to demonstrate that the lead surrounding the collimator tube is indeed safe from thermal impact. The FEA simulations were subsequently conducted by Ed Haas, Mary Carlucci-Dayton and Yi Zhu, and were submitted to the RSC.

The following documents and drawings were reviewed:

1. Memo from Ryan Tappero to the RSC, dated February 6, 2017.
2. XFM preliminary ray-tracing drawings, PD-XFM-RAYT-0001 rev. A, by M. Johanson.
3. Thermal simulation report "XFM misdirected beam thermal analysis report", by Edwin Haas, PD-XFM-CO-CALC-0100 Rev A.
4. Thermal simulation report "XFM misdirected beam thermal analysis report", by Mary Carlucci-Dayton and Yi Zhu, PD-XFM-CO-CALC-0107 Rev A.

At the XFM, it is possible to have extremal rays of the mirror-reflected beam strike the inner wall of the collimator tube with a total power <10 Watts. We find this potential fault condition acceptable for the following reasons:

1. The beam pipe in question is located in the FOE, thus there is no radiation issues with the pink beam striking the pipe.
2. With total power of < 10 W at grazing incidence, there is no danger of melting the lead outside of the pipe, as was demonstrated in the thermal simulation reports, items 3 and 4 listed above.

Conclusions

RSC ray-tracing sub-committee endorses the current XFM shielding design, as shown in the preliminary XFM ray-tracing. We also endorse the notes included in the XFM ray-tracing. We recommend that the XFM team proceed with having the ray-tracing drawings approved in the vault.

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

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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.

Radiation Safety Committee

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Lutz Wiegart	Beam Line Physicist	PS
Zhong Zhong	Beam Line Physicist	PS
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Ray-tracing sub-committee

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PPS sub-committee

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Zhong Zhong	Beam Line Physicist	PS