National Synchrotron Light Source-II

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Memo

Date: Feb. 9, 2016
To: Dieter Schneider, Dileep Bhogadi, Lonny Berman, and Paul Zschack
From: Zhong Zhong (chair), Photon Science Radiation Safety Committee
Subject: Review of the radiation safety configuration design of the AMX and FMX beamlines

Dear Dieter, Dileep, Lonny and Paul,

The Photon Science Radiation Safety Committee (RSC) conducted review of the design of the AMX/FMX beamlines, 17-ID, on Tuesday January 5, 2016. Subjects reviewed include synchrotron max-fan and Bremsstrahlung drawings, Secondary Bremsstrahlung and synchrotron radiation shielding analysis, and aspects of thermal management that relate to radiation safety.

Written documents

The following documents were submitted to the RSC prior to the review:

1. AMX/FMX (17-ID) beamline assembly drawing, sheet 1 of PD-AMX-FMX-RAYT-0001 Rev.A, by J. Fabijanic.
2. AMX/FMX max. synchrotron ray-tracing drawings, PD-AMX-FMX-RAYT-0001 Rev.A, by J. Fabijanic. Sheet 2 depicts horizontal projection of both AMX and FMX beamlines; Sheets 3 and 4 are for vertical projections of AMX and FMX, respectively.
3. AMX/FMX Bremsstrahlung ray-tracing drawings, PD-AMX-FMX-RAYT-0001 Rev.A, by J. Fabijanic. Sheet 5 depicts horizontal Bremsstrahlung of both AMX and FMX beamlines; Sheets 6 and 7 are vertical Bremsstrahlung drawings of FMX and AMX, respectively. Sheet 8 shows Bremsstrahlung collimator and stop details.
4. NSLS-II technical note by V.J. Ghosh and M. Benmerrouche entitled “17-ID AMX-FMX beamline radiation shielding analysis”, dated 12/18/2015. The document presents analysis results of Gas Bremsstrahlung (GB) as well as Synchrotron Radiation (SR) at 500 mA.

Oral Presentation

Attendance: Andrew Ackerman, Mo Benmerrouche, Dileep Bhogadi, Mary Carlucci-Dayton, Wah-Keat Lee, Ray Fliller, Boris Podobedov, Vinita Ghosh, Dieter Schneider, Chris Stelmach, Emil Zitvogel, and Zhong Zhong

Dieter Schneider gave the presentation entitled “RSC review of AMX and FMX”. Following the guideline from the memo by Paul Zschack to the RSC on May 29, 2014, and fueled by nothing less the Peets’ coffee, the following were discussed:

1. AMX and FMX are canted macromolecular crystallography (MX) beamlines that operate independently. FMX, the downstream endstation, uses in-hutch K-B mirrors to deliver micro-focused beam of a few microns focal spot, whereas AMX is optimized for highly automated operation at larger, but still amazingly tiny at 5 microns, focal size. The beamlines share the same front-end, front-end shutters, and First Optical Enclosure (FOE).
2. FMX uses a horizontally deflecting double-crystal monochromator, in FOE, as its first optical component, followed by a horizontally focusing mirror (in FOE), secondary source aperture, and a pair of KB mirrors. The aperture and K-B mirrors are located in the FMX experimental enclosure.
3. AMX uses a vertically deflecting monochromator, followed by a monochromatic tandem mirrors deflecting horizontally, all in FOE. The purpose of the mirror is to create enough divergence between the AMX and FMX monochromatic beams to facilitate independent operations. AMX is designed with a pair of in-hutch focusing KB mirrors.
4. Shielding for the primary Bremsstrahlung x-rays is designed using ray-tracing method. Lead Bremsstrahlung collimator 1 is downstream of and in close proximity to the fixed mask. It has two apertures to allow synchrotron white beam through. AMX Bremsstrahlung beamstop at 28.881, and FMX Bremsstrahlung beamstop at 40.167 m, intercept all possible primary Bremsstrahlung radiation.
5. 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 Ghosh and Benmerrouche. Shielding of synchrotron x-ray is supported by simulation results specifying the shielding thicknesses for FOE (white beam) and AMX and FMX experimental hutches (monochromatic beam). Detailed considerations of harmonics were documented in the synchrotron shielding analysis.
6. 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. FEA of the white-beam components was performed by the equipment vendor. This analysis was independently verified by Steve O'Hara.
7. Configuration control of the radiation safety component was discussed.
8. A prior preliminary review of the ray-tracing of AMX/FMX beamlines by the RSC occurred on May 26, 2015. The current ray-tracing incorporates suggestions by the RSC at that review.
9. The PPS logic diagram for was reviewed separately by the RSC PPS subcommittee.

Notes

The following comments or minor omission are noted for completeness.

1. The mirrors for both AMX and FMX are all monochromatic beams. Considerations were given to assure that the mis-steered monochromatic beams stay within the beams-stops at the end of experimental enclosures. For this reason, we concur with the practice of using nominal mirror positions for the max. synchrotron ray-tracing.
2. We recommend finalizing and releasing the drawings PD-AMX-FMX-RAYT-0001.
3. Collimator and beam-stop are fixed to the monochromator chamber. The issue of configuration control was discussed. We suggest that only the chamber, not the chamber's sliding door and the crystal cage inside, be configuration-controlled.
4. We recommend finalizing the Radiation Analysis report.

Recommendations
There are no recommendations from the RSC at this time.

Conclusions

1. Based on our assessment of the ray-tracing drawings, thermal analysis, and simulation results, the RSC find the AMX/FMX 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 and max. synchrotron ray-tracing drawings, the RSC believes that the AMX/FMX mask and monochromator designs are sufficient to protect against thermal failure of shielding components.

Radiation Safety Committee

Name	Expertise	Directorate
Andrew Ackerman	Deputy ESH Manager	PS
Dana Beavis	Experimental Nuclear Particle Physics	NPP
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
Om Singh	Accelerator Controls	PS
Lutz Wiegart	Beam Line Physicist	PS
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Ray-tracing sub-committee		
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