National Synchrotron Light Source

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Memo

Date: October 12, 2016
To: Elaine DiMasi, Steven Hulbert, and Paul Zschack
From: Zhong Zhong (chair), NSLS II Radiation Safety Committee
Subject: Review of the radiation safety configuration design of the 12-ID, SMI beamline

Dear Elaine, Steve, and Paul

The NSLS II Radiation Safety Committee (RSC) conducted review of the design of the SMI beamline, 12-ID, on Tuesday October 11, 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 and drawings were reviewed:

1. SMI assembly drawing, PD-SMI-RAYT-0001 rev. A, by C. Stelmach, sheet 1, "SMI Beamline Ray Tracing", dated 03/2016.
2. SMI Bremsstrahlung ray-tracing drawings, PD-SMI-RAYT-0001 rev. A, sheets 7 and 8 for horizontal and vertical projections, respectively.
3. SMI max. synchrotron ray-tracing drawings, PD-SMI-RAYT-0001 rev. A, sheets 2 and 3 for horizontal and vertical projections, respectively; sheet 4 for vertical PLS, sheets 5 and 6 for SMI B-hutch details, and sheet 9 and 10 for mirror- mis-steered synchrotron ray tracing.
4. Power point presentation "12-ID SMI Radiation Safety Committee Presentation" by Elaine DiMasi et al dated Oct.11, 2016.
5. NSLS-II technical note, #228, by A. L. Hanson and M. Benmerrouche entitled "12-ID SMI Beamline Radiation Shielding Analysis" dated 10/8/2016. The document presents analysis results of Gas Bremsstrahlung (GB) as well as Synchrotron Radiation (SR) at 500 mA.

Oral Presentation

Elaine DiMasi gave the presentation entitled "12-ID SMI Radiation Safety Committee Presentation". Wah-Keat Lee chaired the meeting. Following the guideline from the memo by Paul Zschack to the RSC on May 29, 2014, the following were discussed:

1. SMI is hard x-ray scattering beamline that operates from 2.1 to 24 keV with flux on the sample in the 10^{13} to 10^{14} ph/s range. The beamline serves two experimental enclosures, B and C. The canted source, IVU23, 2.8 m long, is installed downstream of the ID center. The design of the SMI beamline allows for future installation of another undulator serving the PLS beamline. PLS is not in the scope of current review.
2. The white beam in the FOE (First Optical Enclosure) is conditioned by fixed aperture mask, white beam slits and optional pinhole aperture before reaching the double-crystal monochromator. The white beam stop is immediately downstream of the DCM. Only monochromatic beam can propagate downstream of the white beam stop. FOE optics in the monochromatic beam consist of horizontal- and vertical-focusing mirrors. Monochromatic beam leaving the FOE is controlled by shutter at the downstream end of the FOE.
3. Shielding for the primary Bremsstrahlung x-rays is designed using ray-tracing method. A Tungsten collimator and Bremsstrahlung stop combination, with a vertically offset monochromator in between, stops all primary Bremsstrahlung in the FOE at 33.27 m.
4. 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 Hanson and Benmerrouche.
5. X-rays in the experimental enclosures are shielded by 6-mm thick steel with beamstops. The transport pipe leading to the B hutch, and the pipe inside B hutch when C is taking beam, are shielded with 5 mm lead.
6. Thermal protection of the beamline shielding components is designed using ray-tracing method. Masks and white-beam stop are validated by finite element analysis performed by Steve O'Hara and by contractor IDT.
7. Access to the FOE and C hutch is by standard door interlock and search-and-secure mechanism. Configuration of the shielded pipe and beam stop in B hutch is interlocked via PPS. The PPS logic diagram for the SMI beamline was reviewed separately by the RSC PPS subcommittee.
8. The SMI front-end ray-tracing was previously reviewed by the RSC ray-tracing subcommittee.
9. Configuration control of the radiation safety component was discussed.

Coffee, sorely missed by many, was not served.

Notes

The following comments are noted for completeness:

1. A preliminary review of the SMI ray-tracing by the RSC occurred on June 21, 2016. It was noted then that thermal calculations are not needed for monochromatic beam.
2. The issue of set point for water flow through the fixed aperture mask was discussed. Elaine DiMasi followed up via e-mail with prior FEA results and estimates indicating that SMI mask is safe at 0.6 gpm flow. Thus no further FEA simulation is needed. Of course setting a trip point higher than 0.6 gpm would be more conservative. A trip point of 1.06 gpm, used by CHX, was suggested as a guidance and this has been implemented for SMI by the PPS Group immediately following the RSC meeting on Tues 11 Oct.

Recommendations

There are no recommendations from the RSC at this time.

Conclusions

1. Based on our assessment of the ray-tracing drawings, FLUKA analysis, and synchrotron x-ray simulation results, the RSC find that the SMI 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 SMI masks and whitebeam stop are adequately designed 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
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
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Wah-Keat Lee	Beam Line Physicist	PS
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Christopher Stelmach	Designer	PS
Lutz Wiegart	Beam Line Physicist	PS
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