National Synchrotron Light Source-II

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Memo

Date: March 11, 2016
To: Klaus Attenkofer, Eli Stavitski, Steven Hulbert, and Paul Zschack
From: Zhong Zhong (chair), Photon Science Radiation Safety Committee
Subject: Review of the radiation safety configuration design of the ISS beamline

Dear Klaus, Eli, Steve and Paul,

The Photon Science Radiation Safety Committee (RSC) conducted review of the design of the ISS beamlines, 8-ID, on Tuesday, March 1, 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. ISS beamline assembly drawing, sheet 1 of PD-ISS-RAYT-0001 Rev.A, by C. Longo.
2. ISS max. fan synchrotron ray-tracing drawings, PD-ISS-RAYT-0001 Rev.A, by C. Longo. Sheet 2 depicts horizontal projection; Sheets 3 and 4 are for vertical projection assuming nominal collimating mirror angle, and worst-case incorrect mirror angle, respectively. Synchrotron beamstop detail is shown on sheet 7.
3. ISS Bremsstrahlung ray-tracing drawings, PD-ISS-RAYT-0001 Rev.A, by C. Longo. Sheet 5 depicts horizontal Bremsstrahlung; Sheet 6 is the vertical Bremsstrahlung drawing. Bremsstrahlung collimator and stop detail is shown on sheet 8.
4. NSLS-II technical note by V.J. Ghosh and M. Benmerrouche entitled “8-ID ISS beamline radiation shielding analysis”, dated 2/29/2016. The document presents analysis results of Gas Bremsstrahlung (GB) as well as Synchrotron Radiation (SR) at 500 mA.
5. “Technical Note: Properties of monochromatic beam at ISS” by Klaus Attenkofer, dated 2/3/2016.
6. Power-point presentation “Radiation safety committee meeting: 8-ID overview”, dated March 1, 2016.

Oral Presentation

Attendance: Klaus Attenkofer, Edward Cheswick, Mary Carlucci-Dayton, Steve Hulbert, Wah-Keat Lee, Ray Fliller, Jeff Keister, Cynthia Longo, Boris Podobedov, Vinita Ghosh, Alex Price, Chris Stelmach, Patrick Sullivan, and Zhong Zhong

Klaus Attenkofer gave the presentation entitled “Radiation safety committee meeting: 8-ID overview”. Aided by the guideline from the memo by Paul Zschack to the RSC on May 29, 2014, and abetted by the Peets’ coffee, we discussed the following:

1. ISS is an x-ray spectroscopy beamlines that operates from 4.9 keV to 36 keV. The source is the NSLS-II damping wiggler, consisting of 2 un-canted wigglers of 3.8 m length each.
2. The high heat-load optics consist of a flat-mirror to manage the heat-load, followed by a collimating mirror and high heat-load monochromator. In the monochromatic beam, a toroid mirror focuses the x-rays on the sample. A high-resolution monochromator can be optionally used in the monochromatic beam. The horizontal opening, at 1 mrad, is relatively large compared to most NSLS-II ID beamlines.
3. Shielding for the primary Bremsstrahlung x-rays is designed using ray-tracing method. CM-BS1 is downstream of and in close proximity to a fixed mask. It has an aperture to allow synchrotron white beam through. Bremsstrahlung beam-stop, at 34.603 m, intercepts all possible primary Bremsstrahlung radiation. The Bremsstrahlung stop is over-sized laterally to also act as secondary Bremsstrahlung shielding.
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 Ghosh and Benmerrouche. Shielding of synchrotron x-ray is supported by simulation results specifying the shielding thicknesses for FOE (white beam) and ISS experimental hutches (monochromatic beam). Detailed considerations of harmonics were documented document 5.
5. 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.
6. Configuration control of the radiation safety component was discussed.
7. The PPS logic diagram for ISS was reviewed separately by the RSC PPS subcommittee.

Notes

The following comments are noted for completeness.

1. We support the proposal to install hard-stop to limit the mirror angular-adjustment motors to +- 1 mm after initial alignment.
2. On sheet 5, the line is shown to go through CM-BS-01. This is not a mistake, but rather the team is not taking credit for this collimator to stop the out-board Bremsstrahlung ray, due to inadequate distance from the ray to the outboard edge of collimator. This outboard ray is instead stopped by the Bremsstrahlung beamstop further downstream.
3. While the Bremsstrahlung and secondary Bremsstrahlung shielding of ISS is similar to the other NSLS-II ID beamlines, the thermal management is more challenging due to the large (~60 kW) power output of the damping wiggler at 8-ID. We thus urge precaution, by starting with small aperture, and low ring-current if possible, during the initial alignment.
4. By analyzing the spectral flux of ISS x-rays and attenuation of lead shielding, it was concluded that due to the presence of two pink/white beam mirrors, the fundamental and harmonics are adequately shielded by the lead wrapping of beam transport pipe and by the lead experimental hutches (4 mm lead thickness). Thus, the synchrotron ray-tracing of the monochromatic beam is not as critical as that of the white or pink beams.

Recommendations

1. Mis-steered pink beam can have up to 4 kW of power. The 16-mrad mirror- mis-steered beam will strike the un-tapered portion of water-cooled masked. We expect the reflected beam to have much lower power at 16-mrad due to the low mirror cut-off energy. Nevertheless, please verify that the 16-mrad mirror mis-steered beam is safe for the un-tapered water-cooled mask.
2. MA2 is internal to the long dual-mirror tank. A survey strategy should be developed to assure its position.

Conclusions

1. Based on our assessment of the ray-tracing drawings, thermal analysis, and simulation results, the RSC find the ISS 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 ISS 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
Zhong Zhong	Beam Line Physicist	PS
Emil Zitvogel	Accelerator Operations	PS
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Ray-tracing sub-committee

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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

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Scott Buda	Personnel Protective Systems	PS
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