Commissioning of absorbers for high heat load x-ray undulator beamlines at SPring-8

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1. Introduction

A compact and high heat load absorber for the SPring-8 x-ray undulator beamline has been developed and installed. Photon absorbers are one of the high-heat-load components used in undulator beamlines. The absorber completely intercepts the synchrotron radiation beam via a fast-acting mechanism in order to isolate the downstream components from direct beam impingement. The absorber for the SPring-8 standard undulator beamline is heated with a total power of 12.3 kW and a peak power density of 497 kW/mrad^2 from the undulator source. The absorber intercepts the beam at a distance of 23 m from the source point and receives almost the full power and the maximum heat flux of 940 W/mm^2 at normal incidence.

The design of the high heat load absorbers is based on the use of a tilted surface and high heat transfer coolant channels. The tilted surface is effective in reducing the maximum heat flux, but this does lead to a large absorber and an increase of scattered x-rays to the downstream components [1]. The surface of the SPring-8 undulator absorber is set at an angle of 0.88^O to the beam; therefore, the maximum heat flux is reduced to 14.4 W/mm^2 and the beam footprint length on the surface is about 550 mm. A notch shape absorber was devised to reduce the absorber length. This absorber receives the beam with both surfaces of the notch. Consequently, the compact absorber, equivalent to the SR foot print length, allows each of the surfaces to block the scattered x-rays from the other surface.

2. Design

The design of the absorber was subject to the same criteria for the SPring-8 front-end components. All water joints and connections had to be isolated from UHV with venting to the atmosphere. The absorber was baked at 200^{O}C. Therefore, its surface exposed to the beam had to be cooled under 200^{O}C to avoid vacuum degradation due to outgassing from the exposed surface.

The absorber, as well as the other front-end components, is set on a common support which consists of two parallel I-shape channels with a space of 240 mm. It consists of an absorber block and an actuator unit which supports the block. Figure 1 shows the block . This block consists of a horizontal notch shaped SR receiver, a beam transporting channel, and water channels. It vertically moves up with the pneumatic actuator to open the beamline and down to close the beamline. The absorber closes within 2.0 seconds.

Two types of absorbers were designed. One, with smooth bore channels, is 610 mm long, 75 mm high and 70 mm wide. The other, with wire mesh coolant channels [2], is 486 mm long, 70 mm high and 64 mm wide. Thermal and stress analyses with the ANSYS code were carried out at the maximum heat load. The maximum temperature of the smooth coolant channel absorber (type-A absorber) was found to be 153^{O}C which satisfies the design criterion of the UHV surface temperature (200^{O}C) and the maximum Mises stress was found to be 206 MPa which is 100 MPa lower than the yield stress of GlidCop [3]. The analysis results of the another model, with wire mesh brazed water channels (type-B absorber), showed that the maximum temperature is 169^{O}C and that the maximum Mises stress of the GlidCop body is 240MPa.

3. commissioning

Four type-A and four type-B absorbers are installed in the SPring-8 undulator beamlines. At the commissioning of the beamlines, temperature measurements were carried out on the absorbers in the BL47XU beamline (in which a type-A absorber is installed) at a ring stored current of 17 mA and in the BL10XU beamline (in which a type-B absorber is installed) at 17.9 mA. Table 1 shows a comparison between the measurement and numerical simulations.

The maximum temperature difference is 1.6^{O}C at the No. 1 thermocouple of the type-A absorber. Considering the uncertainty of the coefficient for heat transfer, the position error of the thermocouple, and the measurement error for the temperature, it can be concluded that the measurement agrees with the simulation. The verification of the absorber thermal design will be carried out through the commissioning at 100mA in 1998.

Table 1 Comparison between temperature measurements and ANSYS thermal analysis

absorber type	type-A		type-B	
thermocouple	1	2	1	2
measurement (°C)	36.0	34.1	40.3	37.2
analysis (°C)	37.6	35.2	40.5	36.7

References

[1] Munekawa, S., Sakurai. Y., Tong, X. M., & Nagasawa, H., (1992). Rev. Sci. Instrum. **63**, 376.
[2] Kuzay, T. M., (1992). Rev. Sci. Instrum. **63**, 468.
[3] GlidCop is a trademark of SCM Metal Products, Inc.

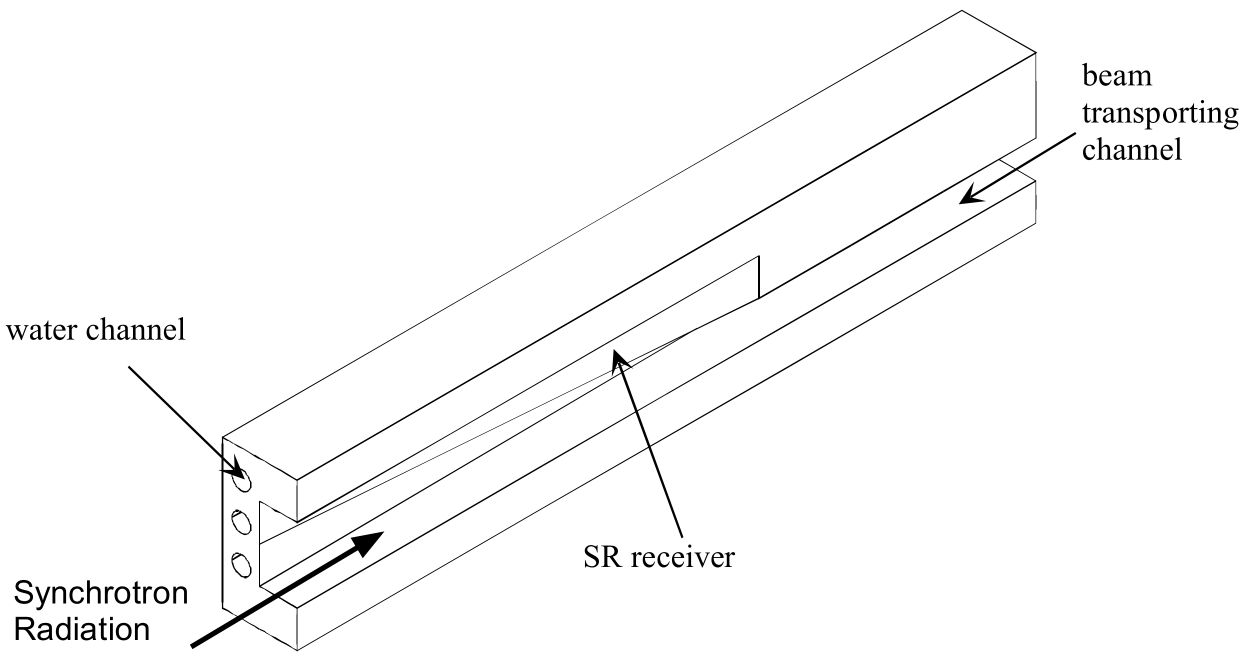

Figure 1 Absorber block (half-cut) model