Front End XY-Slits for the SPring-8 Undulator Beamlines

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1. Introduction

The front end XY-slits assembly is one of the high-heat-load components in undulator beamlines [1]. The main objective of the XY-slits assembly is to reduce the heat load on Be windows [2] and a first optical element by cutting off the off-axis part of the photon beam [3]. It consists of a set of L-shaped slit equipped on the precision horizontal and vertical linear actuators (as shown in Fig.1) and associated bellows for lateral movement. The L-shaped slit will be impinged by very intensive undulator beam with 451 kW/mrad2 peak heat flux in the worst case. To handle such high-heat-flux, the L-shaped slit has been designed to be a grazing-incidence knife-edge configuration so as to reduce the heat load on the slit-blade and minimize the scattering of x rays downstream. The XY-slits can be manipulated into a variety of aperture shapes sized from 10 mm (H) x 8 mm (V) down to 0 mm x 0 mm by controlling the XZ actuators.

2. Design

The shape of the grazing-incidence slit-blade was designed based on the APS-L5 slit [4] with suitable modifications for direct cooling. The grazing-incidence angle was fixed at 1.57˚ on the vertical blade surface. This angle will decrease the peak power from 540 to 14.8 W/mm^2 on the slit-blade. The slit was made of a single Glidcop block and was formed as part of the inner-wall of vacuum vessel. Figure 2 shows conceptional view of the front end XY-slits assembly. Both ends of the Glidcop block have been explosive bonded to stainless-steel UHV joint. Each slit block has two parallel cooling channels and is water-cooled with the convective heat transfer coefficient enhanced by the use of copper mesh brazed into the cooling channels. The slit block is mounted on an X translation (transverse to the beam and in a horizontal axis) stage and a Z translation (transverse to the beam and in a vertical axis) stage to allow the vessel to be positioned with respect to each other such that a rectangular aperture size can be adjustable.

3. Installation

The center of the front end XY-slits assembly is located at 28.9 m from the undulator and the total length of the assembly is 1.935 m. This is installed downstream of the pre slit [5] and the graphite filters assembly [6] so as to reduce waste photons on the slit-blade. A separate kit of water cooling system is mounted on the common base just beneath the assembly. This kit consists of two cooling manifolds and flexible stainless steel hosing for connection to the slit bodies via Swagelock connectors. Each manifold has two pressure gauges and two different type flow monitors. Figure 3 shows schematic drawing of the water cooling system. The pressure gauges and one of the flow monitor give outputs of 4 ~ 20 mA DC. So that we can monitor both of water pressure (P_{IN} and P_{OUT}) and flow rate outside the shield wall. We can also have information about pressure drop (P_{IN} - P_{OUT})

due to the mesh brazed inside cooling channel. After the installation of the first XY-slits assembly into the front end of the pilot undulator beamline (BL47XU), we have measured the pressure drop of the cooling water as a function of the flow rate. Figure 4 shows the relationship between the pressure drop and the flow rate. The flow rate in abscissa is for the gross water flowing in two parallel cooling channels. Pressure drop is to be in proportion to the square of the flow rate and the friction factor which depends on the Reynolds number. Because there are so many influencing factor, it is not easy to discuss quantitatively about curves in Fig.4. We can suppose, however, a heat transfer coefficient by comparing with the experimental data obtained by APS group [7]. We expect the cooling channel as much as 4-5-fold increase in the heat transfer coefficient relative to a plain channel is possible.

References

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[4] D.Shu et al., Rev. Sci. Instrum. 66, 1789 (1995).

[5] S.Takahashi et al., SPring-8 Annual Report 1995, p.183.

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[7] T.M.Kuzay, private communication.

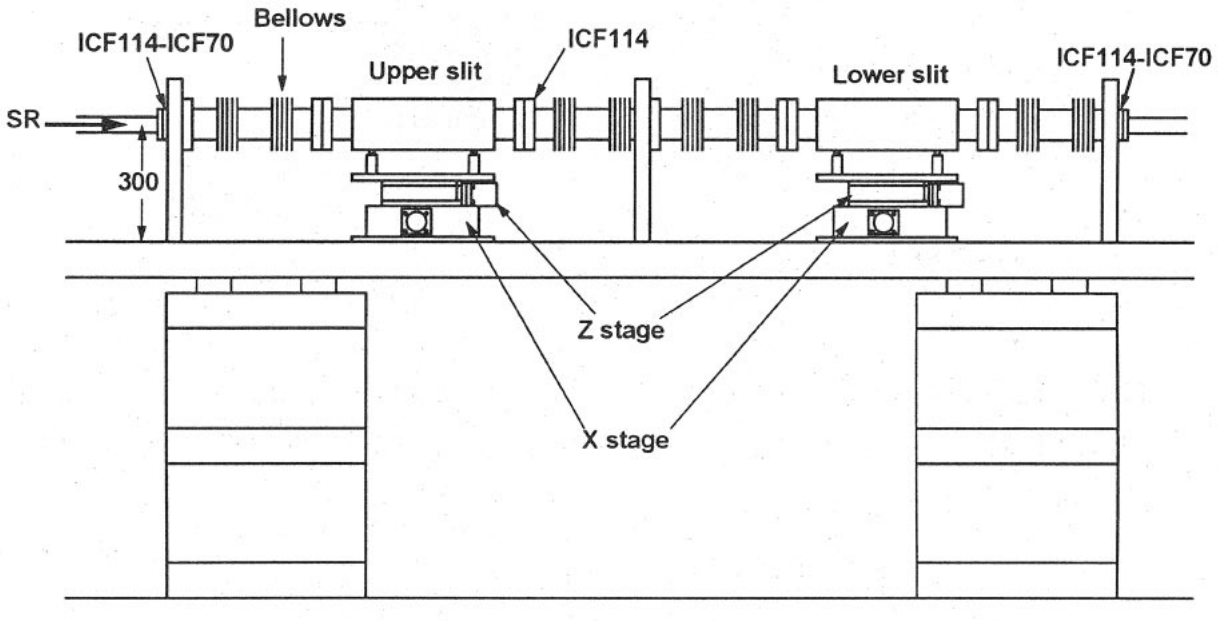

Fig.1 Schematic view of the front end XY-slits assembly

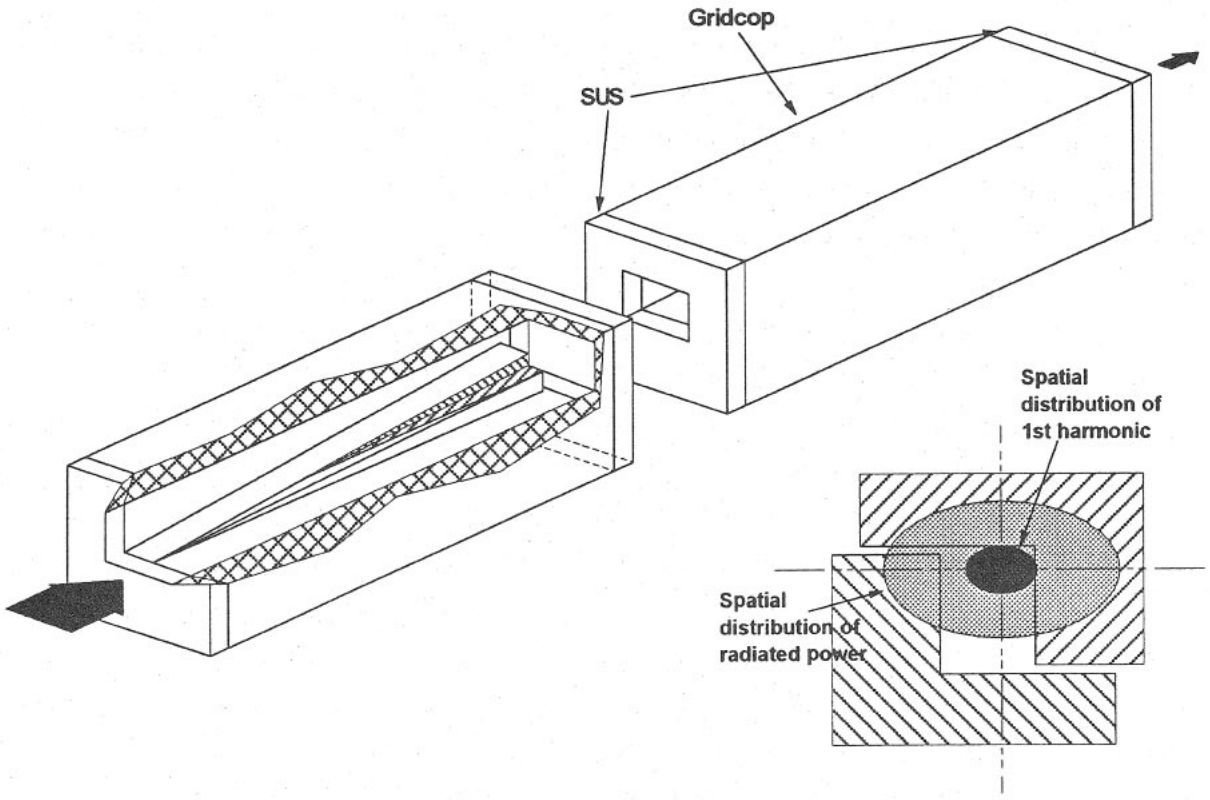

Fig.2 Conceptual drawing of the front end XY-slits assembly

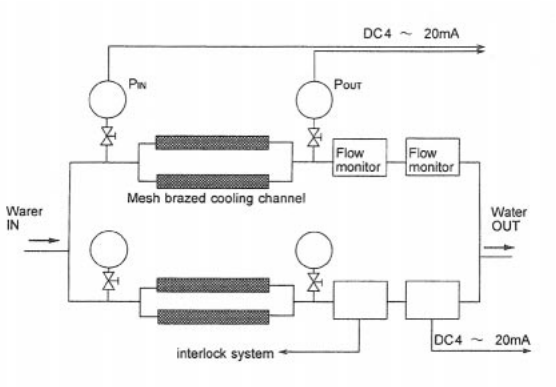

Fig.3 Schematic drawing of the water cooling system

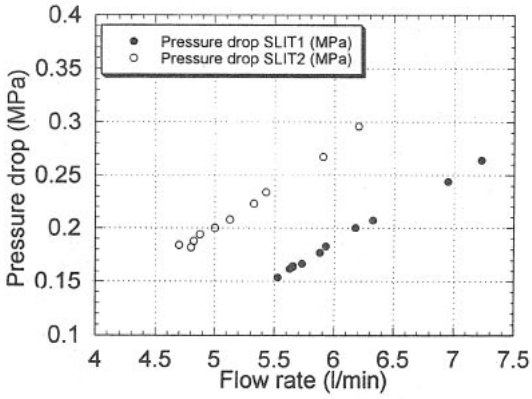

Fig.4 Relationship between the pressure drop and the flow rate of the cooling water