Present Status of X-ray Beam Position Monitors for ID Beamlines

Hideki AOYAGI, Hisaharu SAKAE*), Togo KUDO, Yoshifumi OIKAWA,
Yoshiharu SAKURAI, Hideaki SHIWAKU and Hideo KITAMURA

SPring-8, Kamigori, Ako-gun, Hyogo 678-12, Japan

1. Introduction

The development of the X-ray beam position monitors(XBPMs) with high resolution and stability under the severe heat load conditions is important not only for the diagnostic for X-ray but also for the electron beam orbit feedback in future. The maximum total power and density of radiation from a standard undulator will be about 11kW and 470 kW/mrad^2, respectively. The requirement of resolution is ~ 1μm, which allows to measure the beam position less than 10% of beam size at an experimental station. The CVD diamond can be a good candidate for material of a detector head, because it has good properties as follows: highest heat conductivity, low X-ray absorption coefficient and excellent electric parameters. To realize ideal XBPMs we have been developing a blade type monitor, which is operated in photoemission mode, and also an area type, which is operated in photoconduction mode.

Here we describe the present status of XBPMs for insertion devise(ID) beamlines. The signal operation systems are described in ref.[1].

2. Blade Type XBPMs

Blade type XBPMs are operated in photoelectron mode. We use four blades as a detector head. These blades are mounted on the blade holder which is made of copper, and parallel to the beam axis, as shown in Figure 1. The electrodes for bias voltage are placed near blades. Blades are isolated from the monitor chamber. Each signal current is measured with a I-V converter.

The monitor chamber has a linear actuator for vertical motion of the detector head and a X-stage for horizontal motion of the chamber itself. The blades can be moved to off-axis of the beam.

Finite element analyses of CVD diamond and tungsten as blades were performed to see their thermal and structural properties assuming that a XBPM is placed 20m from a source point on a standard undulator beamline[2]. This study shows that in the case of CVD diamond a temperature and an equivalent stress do not excess acceptable limits, however in the case of tungsten both of them excess the limits by the direct irradiation from undulator with the minimum gap and the ring current of 100mA.

Tungsten blades have been installed and will be used during a beamline commissioning. Then we will install CVD diamond blades.

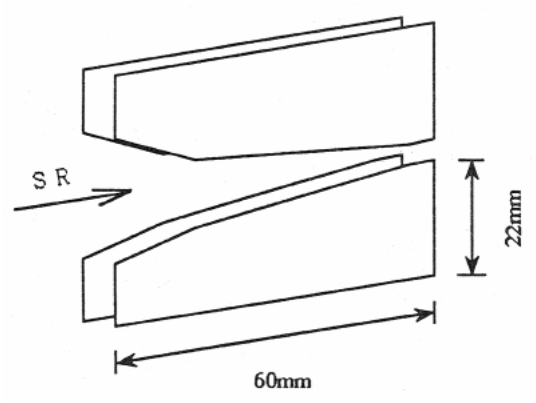

Figure 1 Schematic view of a blade type monitor head

3. Area Type XBPMs

The area type XBPM is operated in photo-conduction mode. The electrodes are formed on the both sides of a CVD diamond, and bias voltage is applied to produce an electric field inside the diamond. When photons are absorbed inside, electron-hole pairs are created. These carriers drift along the electric field and generate a current in the external circuit. The number of carriers are proportional to the energy of photon which is absorbed in the diamond, therefore the amount of signal current is proportional to the absorbed beam power. The efficiency of detection is emphasized

at the order of keV as shown in Figure 2. This property is promising to detect photon beams from undulators, because this detector is less sensitive to the background from the bending magnet.

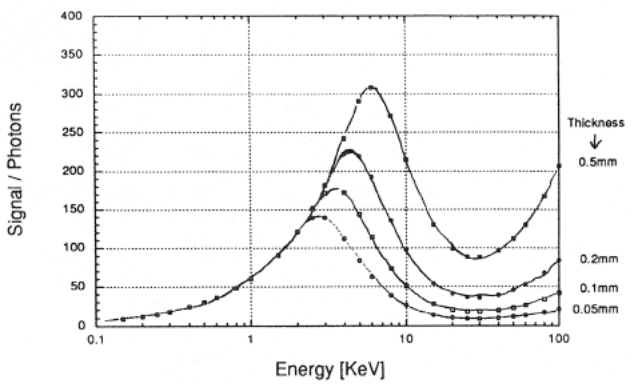

Figure 2 Signal efficiency of diamond detector
Vertical axis indicates and estimated number of created electron-hole pairs per one irradiated photon.

The prototype monitor was tested on TSLF (Tristan Super Light Facility) beamline at KEK[3]. We demonstrated the fundamental operation of photo-conduction mode under the typical ring current of 1mA. After this test we modified the shape of detector head and its holder to match the high ring current operation. The evaporated films of gold are deposited on the fringe of diamond to have good heat contact against the copper mount holder. The electrical contact of diamond is also modified. The schematic view of this diamond detector head is shown in Figure 3.

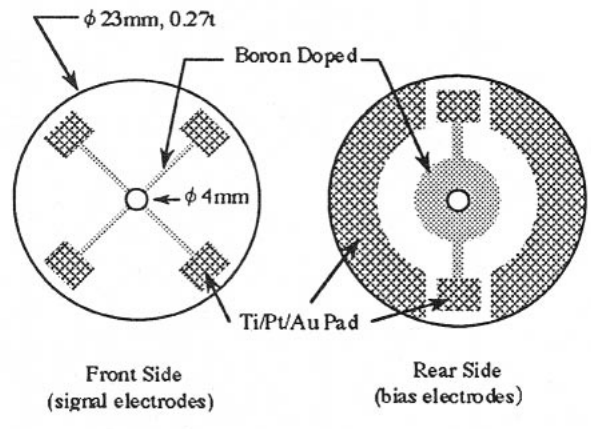

Figure 3 Schematic view of an area type mnitor head

4. Installation

We are planing to install two XBPMs in each front end of the ID beamline. The upper and the down stream sites for XBPMs are placed at 20m and 26m from the source point, respectively. At present, the blade type monitors are installed at upper stream sites of BL47, BL09, BL41 and BL45. The area type monitor will be installed soon at the down stream site of BL47.

References

[1] T. Kudo et al. in this Annual Report.
[2] H. Sakae et al., SPring-8 Engineering Note, FE-012-95
[3] H. Sakae et al., SPring-8 Annual Report 1995
H. Sakae et al., to be published in Journal of Synchrotron Radiation

*) Present Address: Ishikawajima-Harima Heavy Industries Co., Ltd.