Development of X-ray Beam Position Monitor for Bending Magnet Beamline at SPring-8

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1. Introduction

Development of a X-ray beam monitor has been studied to measure the photon beam position from bending magnet source at SPring-8. We adopted the X-ray beam monitor by use of a photoemission device because of its stability and easy to insert it into a vacuum chamber in a beamline.

The X-ray beam monitor has a type of a two-split triangular electrode made of tungsten blades as a detector[1]. This beam monitor also consists of a water cooling system, an electrical shielding box which is made of copper, a linear actuator, a pulse motor with a harmonic gear reducer, a rotary encoder, a vacuum chamber, and a x-axis stage. It is estimated that temperature of tungsten blades will increase to about 110 degree by X-ray irradiation of normal power density from the bending magnet at SPring-8. The beam monitors were settled in front-end of beamlines at about 19 m far from X-ray source point.

Fundamental characters and capability of the X-ray beam monitor was evaluated at the beginning of the beamline commissioning.

2. Principle of detector

Figure 1 shows a principle of the detector. The two-split triangular blade was irradiated by synchrotron radiation (SR), then photo-electron which occurred on blades was detected as a current . The blades are made of tungsten, its size are 50 mm wide, 16 mm high and 0.3 mm thickness. Not to be affected by the beam direction change, the blade have slightly slope of 2/50 against ideal beam axis.

Beam position is calculated by an equation as follows,

$$Y = A\frac{I_U - I_D}{I_U + I_D}$$

Y is beam position, A is a conversion coefficient, I_U is a signal intensity from the upper blade, and I_D is a signal intensity from the lower blade.

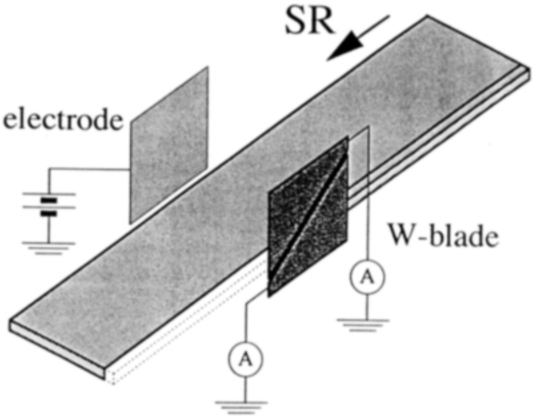

Fig. 1 Principle of the detector

3. Experimental and Results

Fundamental characters, for example a relation of applied bias voltage versus signal intensity, setting of optimum position of the blade, estimation of a conversion coefficient, spatial resolution, and a long time stability, were measured at several beamlines.

In the relationship between the applied high voltage to the detector and the signal intensity, the signal intensity was increased with applying bias voltage, then it was saturated in the region more than 200 V. The signal intensity was about 18 µA at 18 mA R.C. The Linearity of signal intensity within the position from -3 mm to +3 mm in Y-axis direction was very good.

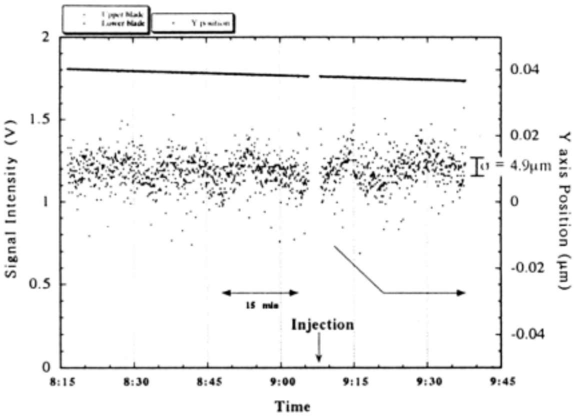

Fig. 2 Stability of the beam position monitor

Figure 2 shows the stability of the beam position monitor. The signal intensity (left ordinate) of each blades were shown by upper bars, while the beam position (right ordinate) shown by dot in Fig. 2. standard deviation of the beam position was σ=4.9 μm.

We have designed and optimized the beam position monitor with the two-split triangular electrode. Spatial resolution was about σ=~5 μm, but its spatial resolution was including an influence of the periodical motion noise in ~15 minutes interval. Original mechanical spatial resolution was less than 1 μm. The upper and lower blade as the detector cut off SR beam about less than 0.1 mrad in this beam position monitor. We have a plane to minimize cut off area in the new beam position monitor.

References

[1] T. Mitsuhashi et al., Rev. Sci. Instrum. 63, 534 (1992)