Effects of Bending Magnet Radiation on X-ray Beam Position Monitors

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For third generation synchrotron radiation facilities using insertion devices as the radiation source, the accurate measurement of the photon beam with sensitivity of less than few microns and the stable transmission of the collimated photon beam through long beamlines are required. To realize X-ray beam position monitors that fulfill these requirements, it is necessary to improve the performance of the monitor and to reduce the background radiation caused by the photon beam or the noise coming from the environment around beamlines. Especially the background radiation from bending magnets adjacent to insertion devices has become a serious problem. Various countermoves have been devised in ESRF, APS and other synchrotron radiation facilities[1],[2]. Because same problems are also expected to happen in SPring-8, the simulation of the synchrotron radiation including the bending radiation was performed and its effect on the monitor is presented. Parameters of the undulator used in this simulation are shown below.

periodic length of the undulator	:	32 mm
total length of the undulator	:	4.5 m
K value	:	1.5
Energy of the first harmonic	:	9 keV
electron beam energy	:	8 GeV
electron beam current	:	100 mA

The spatial distributions of the power density for an undulator and bending magnets are shown in Fig.1. Fig.2 shows the S/N ratio of the power density of the undulator radiation to that of the background radiation. As shown in these figures, the background radiation has the effect on the limited region of ±0.1 mrad (±2 mm at 20 m). Hence a monitor that can sense the power loss will be able to have the high capability of the accurate position measurement, if its probe was placed where the effect of the background radiation does not reach.

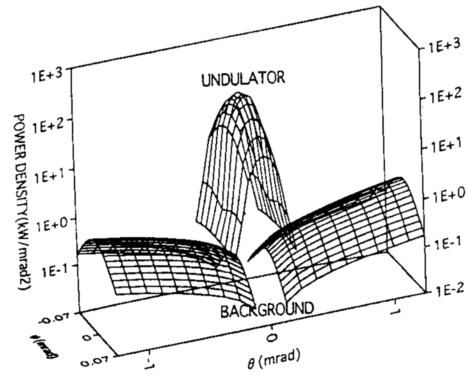

Fig.1 Spatial distribution of the power density of the undulator radiation and the background radiation.

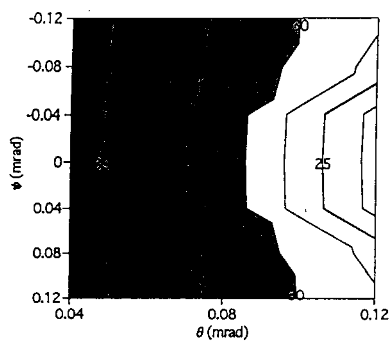

Fig.2 S/N ratio of the power density. The ratio shows in a unit of db.

The photoelectron yield of a photoemissive beam monitor was also simulated on the basis of this result. It shows that the background effect on the monitor with the probe made by low atomic number material like graphite will reach near the central axis, therefore an error in position measurement will be unavoidable. If the graphite filter with the thickness of 100 μm was placed upstream of the monitor, the available region for the position measurement will be $|\theta| < 0.04$ mrad (0.8 mm at 20 m), however it is not still large enough considering the displacement of the background radiation owing to the COD of the electron beam. Therefor the available region must be widen by the selection of the probe material with low quantum efficiency to soft photons or the suppression of the photoemission to soft photons by the impression of the bias voltage to the probe.

Though the background radiation is expected to be displaced owing to the COD of the electron beam at quadrupole magnets, it is not considered in this study. We will proceed to study in detail about the effect of the displacement of the radiation owing to the COD and to evaluate the performance of the monitor in consideration with its structure and material of the probe in the following study.

References

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[2] H.Winick et al., Nucl.Instr.Meth. A 208 (1983)