A New Concept for Photon Beam Monitoring

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1. Introduction

In photon beam monitoring, many kinds of beam monitors have been studied, and constructed, in which some metal blade or wire are irradiated by the photon beam and, photo-electron is emitted from them. Then, the photo-electron current is measured to obtain beam position or beam intensity etc. In such monitors, heat-stable substance and cooling system are required to construct the detector part.

Presently, we propose the new concept of photon beam monitoring, in which free electron beam is used as detector part to replace the metal or other substances. This system might be suitable for monitoring the ID beam, because any heat proof structures might not be required.

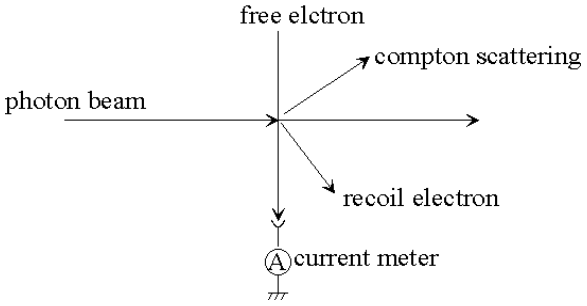

Fig.1 Photon beam monitoring with electron beam

2. Photon Beam Monitoring

Fig.1 shows the concept of the monitoring. The photon beam hits vertically the electron beam, and then the current amount of the electron beam is decreased because of recoil electron. The photon beam could be scanned by the electron beam, and then the photon beam intensity or position etc. might be recognized as the beam current decreasing. In this system, the electron beam acceptor size should be small enough to effectively exclude the recoil electron. The electron recoiling angle can be calculated following the Compton scattering theory[1], and the angle profiles are not so much varied even if the photon energy is varied 0～200keV(Fig. 2). Moreover, the amount of recoil electron in the direction of the beam acceptor is small, so that the recoil can be effectively recognized as beam current decreasing.

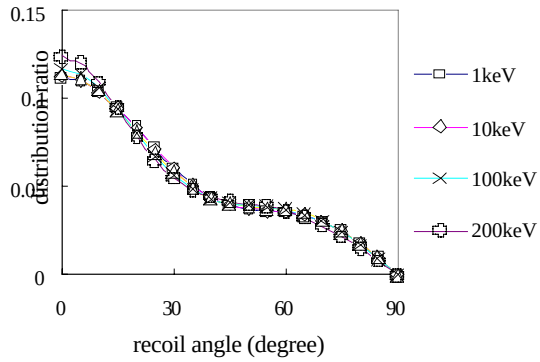

Fig.2 Distribution rate of recoil electron in each angle. The distribution rate is normalized by the value integrated from 0 to 90° . Photon beam is varied from 1 to 200keV.

The amount of the recoil electron is depend on the electron density of the electron beam, because σ_c(cross sectional area of Compton scattering) is proportional to the number of electron. Therefore, the electron beam energy should be large enough to store the sufficient number of electron. In this condition, the electron might be accelerated to the velocity which should be considered based on relativity. On the other hand, even if the electron density of the electron beam is large enough to give the measurable signal, the photon beam is hardly destroyed in this system, because the interaction between the photon and electron is very small, so that most photon particles can pass through the electron beam without interaction.

Now, we continue to estimate this system from various points of view.

Reference

[1] W. Heitler, "The Quantum Theory of Radiation(I)(3rd Edit.)", Yoshioka shoten, p.225