Estimation of effective dose caused by stray radiation of photons, electrons and positrons around a small storage ring for a synchrotron radiation facility

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In order to design radiation shieldings for accelerator facilities, we have to estimate the amount of radiations behind the shielding materials. There are several works to calculate the radiation doses around accelerators in consideration of shielding materials and thicknesses. However, these works were done for large accelerator facilities which need to have thick bulk shieldings around the accelerators. Whereas in small synchrotron radiation facilities, we have to construct simple and effective shieldings for radiation protection because of the small area of the facilities.

The precise information of radiation spectra at each point in the facilities is necessary to design the effective shieldings. Most stray radiations around an accelerator are caused by beam loss. Some of electrons interact with the residual gases or other electrons in the same bunch and then leave their stable orbit and hit on the beam duct with small incident angles. As a result, cascade shower of particles are generated in the beam duct and spread over in the facility.

The Monte Carlo simulation code EGS4 was used to calculate radiation doses caused by the beam loss. We used a simple geometry for the calculation with the shielding materials lead, concrete and iron for primary electron energy 0.2 GeV to 5 GeV. The materials of the beam duct were supposed to be iron in the EGS4 calculation which is a substitute for SUS. The results were parameterized in simple formulas to calculate the radiation dose in the accelerator facilities.

As an example of the dose calculation using the simple formula, we present an estimation of radiation dose for the small synchrotron radiation facility which is planned to be constructed in Nagoya University.