Proposal of Gamma Rays Detector with Position Resolution of 0.1 mm

In particle physics experiment, position resolution of typical detectors for gamma rays is approximately 10 mm at most because the center of the electromagnetic shower in inorganic scintillators is measured. If the position where the incident gamma ray produce the electron-positron pair can be measured, the position resolution of the incident gamma ray becomes much better. We are developing 511-keV gamma rays detectors for PET (Positron Emission Tomography). When 511-keV gamma rays enter scintillators, scintillation light is emitted due to photoelectric effect and Compton scattering. Our detectors have high position resolution because wave-length shifting fibers with a diameter of 0.2 mm are spread over the upstream face and the downstream face of the scintillator plate without a gap in the scintillator part. Therefore, detectors can measure all the emission position by using plate-like scintillators and wavelength-shifting fibers. When a gamma ray whose energy is approximately 1 GeV enters these detectors, the positions and the energy of scintillation light by charged particles in the electromagnetic shower will be measured. Considering the density of the two types of scintillators we use, it is estimated that the scintillation light will be emitted at interval of 1 mm or 3 mm which are the thickness of the two types of the scintillators. The scintillation light will continue to be emitted over four times the length of the initial radiation length of the incident gamma ray. By this detectors installed on the upstream of conventional calorimeter, the position where an incident gamma ray create the electron-positron pair could be measured with an efficiency of 99% or more with a standard deviation of approximately 0.1 mm.