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Development of a Gaseous Photomultiplication Based Cherenkov Detector Targeting Picosecond Time Resolution

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To meet the growing demand for photosensors with high time resolution, large photocoverage, and low cost in Cherenkov imaging detectors, we have developed a gaseous photomultiplier (GasPM). It has a photocathode and a simple electron multiplication mechanism similar to that of resistive plate chambers. Using a picosecond pulse laser, we have already demonstrated that the GasPM with a LaB_6 photocathode and a mixture of R134a and SF_6 gas has a single-photon time resolution of $\sigma = 25 \pm 1.1$ ps at a gain of 3.3×10^6. The next milestone of the R&D is to detect Cherenkov photons with that excellent time resolution.
The photocathode was replaced with CsI deposited on a MgF_2 window, which can detect Cherenkov photons at wavelengths below 200 nm generated in the window. We performed beam tests of this detector with a 5 GeV electron beam at the PF-AR test beamline at KEK. We achieved a time resolution of $\sigma = 73.0 \pm 2.4$ ps with a gap electric field of 140 kV/cm. To improve the time resolution, the thickness of the MgF_2 window and the gap electric field were increased to 187 kV/cm. In addition, a digitizer with a higher sampling rate of 10 Gsamples/sec was used to distinguish between overlapping initial signal pulse and subsequent ones due to photon feedback.
The results of these beam tests will be discussed in this presentation.

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