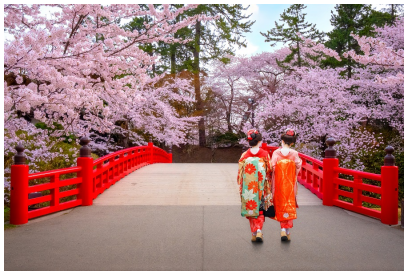

ID de Contribution: **66** Type: **Non spécifié**

Development of a Gaseus photomultiplier with a 20-ps single photon time resolution

Scaling up the size and performance of particle detectors is necessary to explore the cutting edge of particle physics and nuclear physics. Common requirements for photodetectors used for such particle detectors are high time resolution, large detection area, and low cost.

To satisfy those requirements, we have developed a gaseous photodetector, GasPM. It consists of a photocathode, a resistive plate, a high voltage electrode and an anode electrode. The photocathode and resistive plate delimit a gas gap of 210 um, where photoelectrons from the photocathode are amplified by an avalanche process. GasPM is expected to have a great time resolution because of the fast avalanche amplification. GasPM has a uniform structure and it is easy to scale up without losing the time resolution. Because the structure is very simple compared to other photodetectors, GasPM can be constructed at a low cost.

In this study, we developed a prototype to demonstrate the great time resolution of GasPM. The photocathode used in the prototype is LaB6. The QE of LaB6 drops in the air, but it is enough high to detect single photon signals in the test, and high resistance to the air is a great advantage to develop the prototype. The gas for the prototype is a mixture of 90% R134a and 10% SF6 which is commonly used in resistive plate chambers. To test time resolution, a test bench was developed. In the test, a pico-second pulse laser with wavelength of 375 nm was spotted at the GasPM, and the signal was recorded as a waveform using a DRS4 evaluation board. The single-photon signal was successfully obtained, and the timing was extracted by waveform fitting. The time resolution is $\sigma = 36.0 \pm 0.9$ ps. The width of the laser pulse and the time resolution of the readout system are 27 ps and 14 ps, respectively, and the intrinsic time resolution of the GasPM prototype is σ=19.2 ps.

This was the first study of the GasPM using a prototype and demonstrated that GasPM has a great time resolution. GasPM has potential to explore the cutting edge of physics through its great time resolution, large photo coverage, and low cost.

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Classification de Session: Poster session