Test on the neutron-insensitive photon detector for the KOPIO experiment

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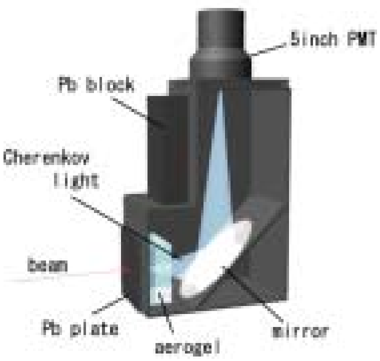
Purpose

The purpose of this test experiment is to evaluate various properties of a prototype of the neutron-insensitive photon detector which was developed for the future KOPIO experiment. The KOPIO is the experiment which aims to measure the branching ratio of the $K_L \rightarrow \pi^0\nu\nu$, using 24GeV AGS proton synchrotron at Brookhaven National Laboratory. In this type of experiments, photon veto counters surrounding the decay region play quite important role to reduce background events, and should cover even the intense neutral beam region where the detector is exposed to a vast number of neutrons. To operate in such environment, we designed a new type of photon detector which consists of a series of the module composed with a lead converter and an aerogel Cherenkov radiator. In principle, a Cherenkov detector with relatively low refractive index can be blind to slow particles generated by neutron interactions. In addition, we can further suppress the neutron signal with π^0 production by requiring the coincident hits along the beam direction. In this experiment, we evaluate the response of the prototype to protons which is expected to be analogous to neutron reactions.

Description of the Experiment

We constructed a prototype of the neutron-insensitive photon detector, called the beam catcher in the KOPIO experiment, whose 3D image is shown in the figure. It equips an asymmetric parabola mirror and is very similar to our final design except for its size. We conducted the beam test at the T1 line. At first, we performed tests with electrons and charged pions to evaluate the light yield for fast particles. We obtained the light yield as expected by our simulation in which measured optical parameters of the aerogel in use are implemented. After the calibration, we proceeded to the measurement of the efficiencies for protons of both single module and coincident hits along the beam direction, in the momentum region from 0.8 to 2.0 GeV/c.



Results

We found the measured efficiencies were well consistent with expected values by our simulation. As for the single module efficiency, we saw a pretty good agreement with them. In addition, we realized that there was some portion of gas scintillation lights, which resulted in higher efficiencies in whole region if the threshold is set to be single photoelectron level. This information is fed back to our simulation later. In case of requiring the coincident hits, as shown in the right figure, we concluded that our simulation can reproduce the measured efficiency within 50% uncertainty. In conclusion, we can verify that the prototype based on our proposed design performed as expected and this test becomes a proof of the principle in our method.