Development of Threshold Type Fiber Cherenkov Counter

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We propose a new Cherenkov counter for high intensity beam experiments. This counter is a detector to perform the particle identification at the trigger stage. We made the counter of plastic clear fiber

I. Introduction

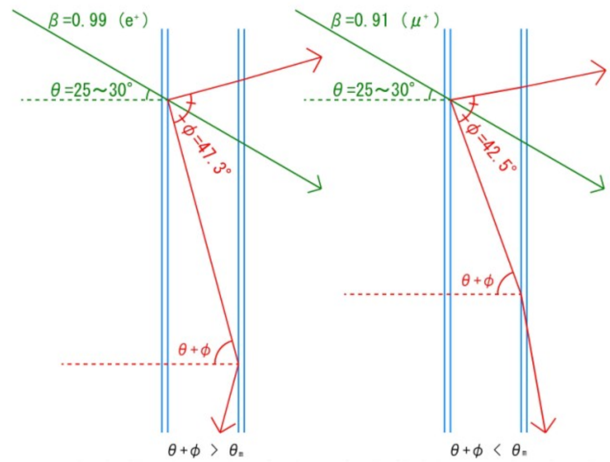
It is important to identify particles at the trigger stage for high intensity beam experiments. Although there exist several types of particle identification (PID) detectors, a threshold type Cherenkov counter is the only one that can identify particles at the trigger stage. We propose a new Cherenkov counter. The radiator is made of Clear Fiber. Total reflection occurs on a border between the core and cladding. Since the difference of reflective index between core and cladding is rather small, we distinguish two particles with same momentum by total reflection of Cherenkov light attend or not.

II. Clear Fiber Cherenkov Counter

Cherenkov radiation occurs when the speed of the charged particle is faster than speed of light in the material. The condition is particle velocity β (= v/c) >= 1/n. the radiation angle at that time is φ = arccos (1/nβ).

When light incident on the high refractive index to the low of the refractive index, the total reflection is the phenomenon that incident radiation reflects all back on a boundary surface. When the incidence angle is larger than the threshold angle, total reflection happens. The critical angle is 72.3 degree, because the cladding refractive index is 1.42 and the core reflective index is 1.49.

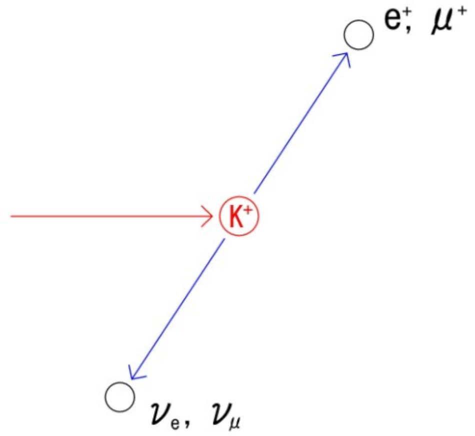
For example, a positron and a muon with 240 MeV over c through into clear fiber.

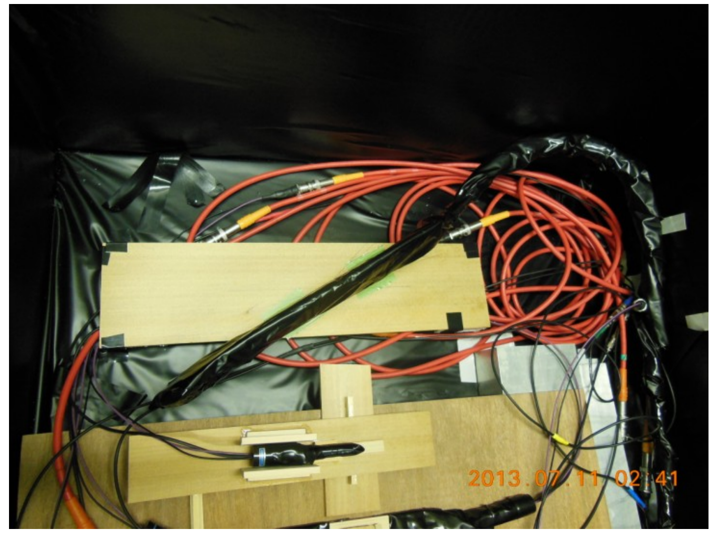


A charged particle incident in a material, the In an upper figure, when θ+φ is bigger than the critical angle, the total reflection happens. And, when θ+φ is smaller than the critical angle, the total reflection doesn't happen. When fiber is connected to PMT, if total reflection happens, a signal from PMT arrives, and the signal from PMT does not arrive if total reflection does not happen. In this way, we perform particle identification

III. J-PARC E-36 Experiment

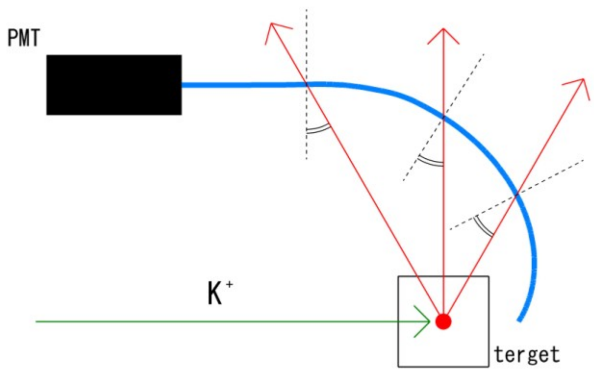
E-36 experiment will be carried out in J-PARC (Ibaraki, Japan) 2014-2015. E-36 is an experiment to the branching ratios of the kaon decay. The kaon with 800 MeV pass Degrader ant stop in target scintillation fiber. The momentums of positron and muon which occur by the decay of the kaon which stood still are constants.





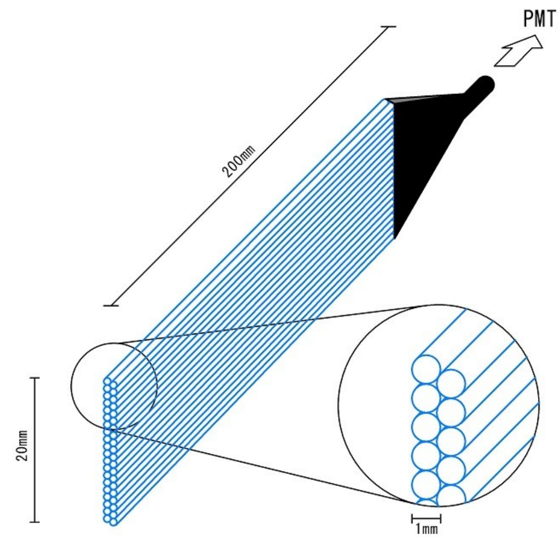
We want to distinguish these two particles.

The outbreak probability of the positron is a one-100,00th or less of the muon. Trigger frequency becomes 100 kHz with out the identification. Silica Aerogel Cherenkov Counter (SAC) can dicurrs trigger frequency to 1 kHz. If possibility, we want to install other threshold type Cherenkov counter. We are examining a plan to put the Clear Fiber Cherenkov counter in a detector of E-36.



IV. EXPERIMENT

In July, in Spring-8 (Hyogo, Japan), we changed the incidence angle of the beam by changing the installation angle of the detector, and checked the relations of an incidence angle of the beam and the light requirement. We display fiber of 1 mm in diameter by 20*2 2 layers structure, and let a beam of 0.7-1.0 GeV be incident on it. We carried out the experiment the plural times, but didn't get effective data. Total reflection has happened at angles less than 30 degrees.



V. CONSIDERATION

By this experiment, we didn't get effective data. Total reflection having happen on a border between the cladding of the air is considered as the cause. In future, after having painted the fiber surface black to prevent total reflection on a border between the cladding of the fiber and the air, we will perform an experiment to measure a light requirement by changing the incidence angle and the incident speed of the beam. We really develop an available detector in E-36.

REFERENCES

[1] Review of Particle Physics Particle Data Group "Journal of Physics G Nuclear and Particle Physics" volume 37, number 7A, July 2010, Article 075021, pp. 740-758..