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Production and Performance Measurement of Multipurpose Silica Aerogel Cherenkov Counter

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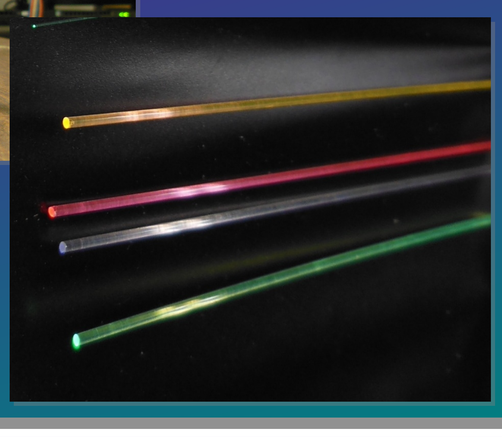
Introduction

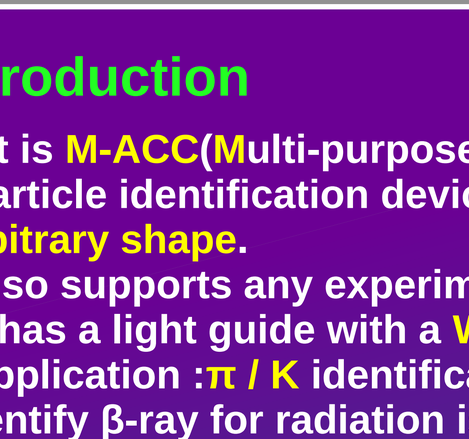
what is M-ACC(Multi-purpose Aerogel Cherenkov Counter)?

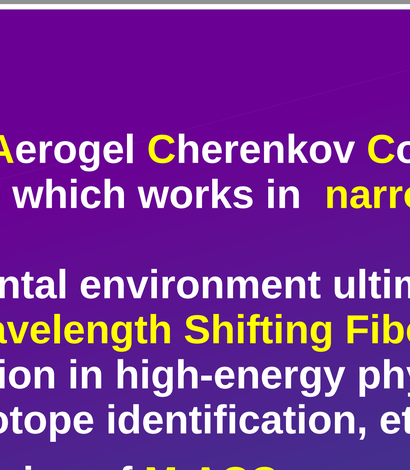
- Particle identification device which works in narrow space, large area with arbitrary shape.
- Also supports any experimental environment ultimately.
- It has a light guide with a Wavelength Shifting Fiber.
- Application :π / K identification in high-energy physics experiments, identify β-ray for radiation isotope identification, etc.

We propose and introduce a design of M-ACC concretely with an example of the planed installation for LEPS2 experiment. Penta-quark Θ^+ had been discovered by LEPS in 2003, however the existence is controversial even now. We have developed detectors to install them into LEPS2 by the planed start in 2014.



M-ACC Design for LEPS2

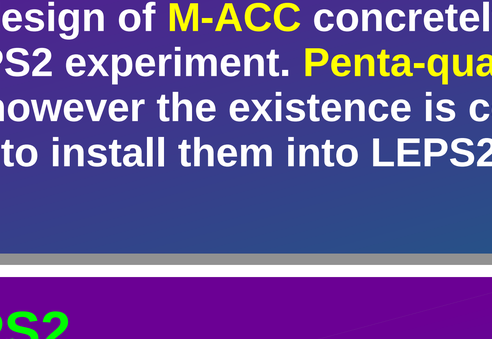




LEPS2 ACC

Required from LEPS2 ACC

- Limited space
- Donut shape
- Working in Magnetic field
- π / K: PID 97%

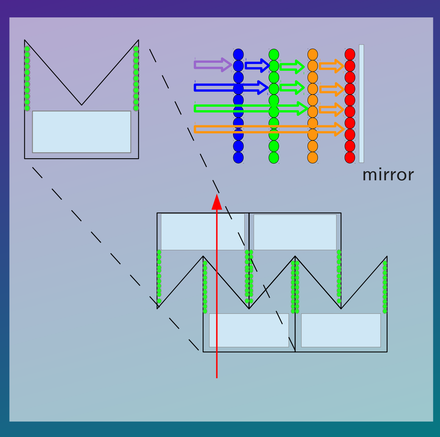


Fiber Light guide System

A feature of M-ACC is using 4 colors of WLSF(Wave Length Shifting Fiber). It is expected to cover a large area and make arbitrary shape. Generally, an optical fiber transmits photons with less attenuation. A photon is transmitted satisfying the total reflection condition determined by the ratio of the refractive index of the core and cladding.

Wave Length Shifter is excited by light of a specific wavelength range and re-emits light of a longer wavelength. The WLSF can absorb photons from the side and transmit the photons to both ends

A photon unsatisfying the total refractive condition leaks out of the fiber. If the photon has the appropriate wavelength, it pass to the next layer.



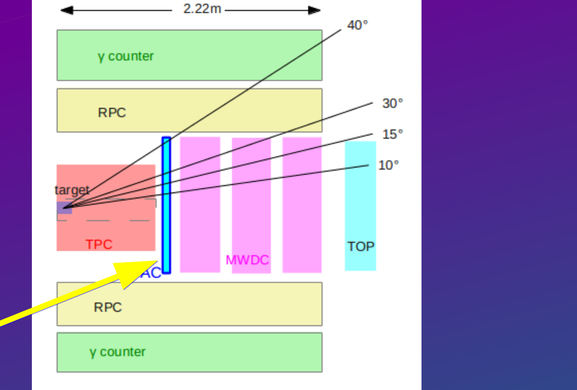
M-ACC Prototype I

WLSF(Wave Length Shifting Fiber)
Kurary:
B-3 0.2mm Dia
Y-11 0.2mm Dia
O-2 0.2mm Dia
R-3 0.2mm Dia

Aerogel index :1.05
trans. Length: 40mm

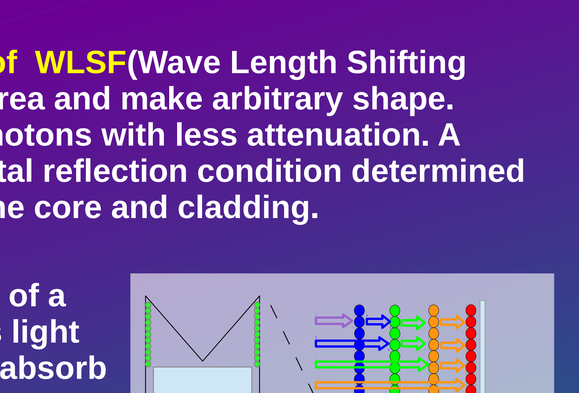
PMT :
photocathode:8mm Dia
R9880U-210:for Fiber B&Y
R9880U-20 :for Fiber O&R

area:2cm x 4cm

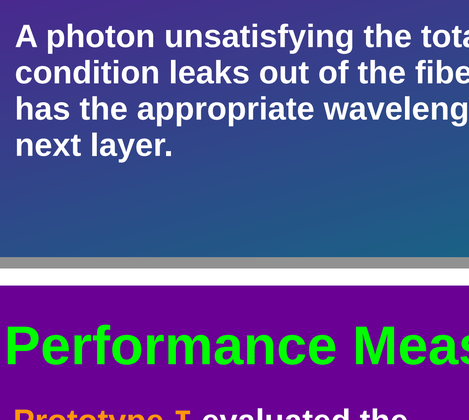


Performance Measurement

Prototype I evaluated the performance test using e^+ of 1-2GeV at Spring-8 BR33LEP beam line.
The Cherenkov light from an aerogel enter to WLSF by a reflector by 45° to the beam. Four PMTs were measured light from the fiber.
We analyzed the detection efficiency from the ADC distribution of them. The detection efficiency of M-ACC is a combination of the or logic of the signal of 4 PMTs.



	Efficiency	error	p.e.	error
1ch	36.5%	±1.0	0.45	±0.02
2ch	31.3%	±0.9	0.38	±0.01
3ch	10.7%	±0.6	0.11	±0.01
4ch	36.4%	±1.0	0.45	±0.02
M-ACC	67.3%	±0.9	1.12	±0.03



However, the original purpose is to identify pion. The PID efficiency is calculate to
PID 59% per M-ACC layer,
PID 96.7% using 4-layers M-ACC.

Current Development Progress

2010 Seint-Gobain's WLS
As results of the beam test, sheet did not make transmission by total internal reflection.

2011 Seint-Gobain's WLSF(1mmΦ)
The fiber employed instead of sheet.
Light intensity of measurement agreed with the prediction 0.2p.e., but still insufficient.

2012 Kuraray's 4 colors-double cladding WLSF(1mmΦ)
There was a difference in the amount of light by combination of four colors. Wavelength sensitivity of the PMT did not much with the emission wavelength of each fiber.

2013 March Kuraray's 4 colors-double cladding WLSF（0.2mmΦ）
Two kinds of PMT were used since each fiber emits different wavelength. In case of the order of fiber layer was BYOR, PMT detected the most light intensity.

Beam Test in July
Performance Evaluation of M-ACC
small prototype which I produced in fiber 0.2mm Φ

Summary

- We have evaluated the performance of M-ACC small prototype.
- Prototype is able to read out Cherenkov light by WLSF . Confirmed 1.12p.e. per M-ACC layer
- Performance of a four-layer M-ACC can be estimated 97% (π / K) Identification for 0.7-1.5GeV / c momentum.

Reference

- M. Tabata,et al.IEEE 2011,NP3-M32
- M. Tabata,et al.IEEE 2012,N1-217
- M. Kubo, et al.,IEEE 2011,NP3-M34
- M. Wada,et al.,IEEE 2012,N14-162