Studies of Proximity Focusing RICH with an Aerogel Radiator

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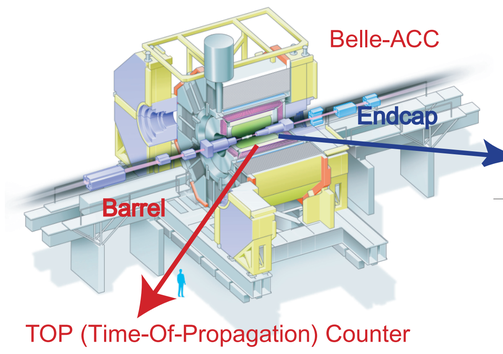
A Proximity focusing ring imaging Cherenkov detector using aerogel as the radiator has been studied for an upgrade of the endcap part of the Belle threshold aerogel Cherenkov counter (Belle-ACC) at the KEK-B factory. This poster presents the results of a recent beam test , where we used improved aerogel radiator and an array of "Flat panel PMT" for photodetection.

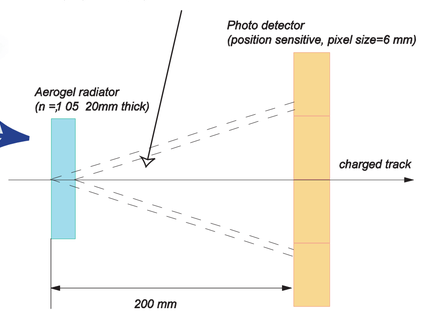
Detector Concept

- For the upgrade of the endcap part of the present Belle-ACC counter, we are studying feasibility of a proximity focusing aerogel RICH, to extend the momentum coverage for K/π separation > 4GeV/c.
- The detector consists of a layer of aerogel radiator (n=1.03~1.05) with a thickness of about 2 cm and a photodetection plane, parallel to the radiator face at a distance of about 20 cm.



TOP (Time-Of-Propagation) Counter

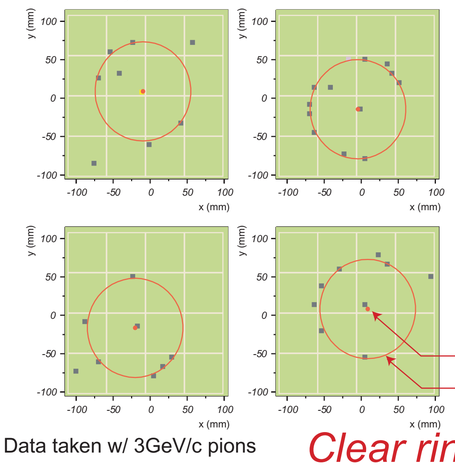
θc(K)-θc(π)=23mrad at 4GeV/c



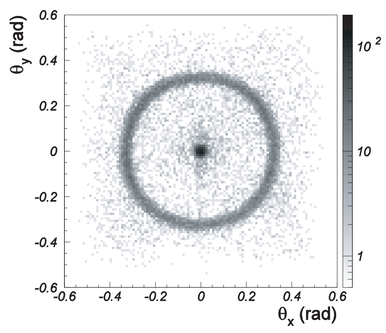
Observed Cherenkov Ring Image

- These figures show the observed event-by-event and accumulated hits.

Event-by-event hit record



Accumulated hit record



Impact point of the incident track
Ring expected from tracking

Data taken w/ 3GeV/c pions

Clear ring images are observed !

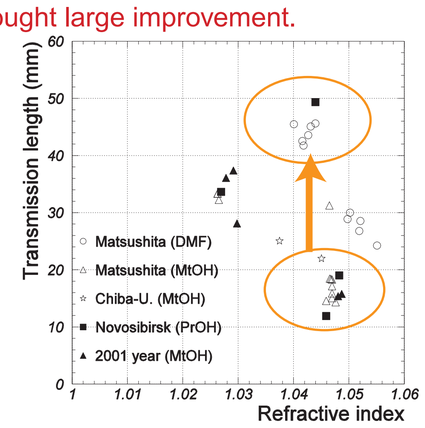
Aerogel Radiator

- In our earlier work, we developed a method to produce hydrophobic aerogel. Aerogel for the present Belle-ACC was optimized for n=1.01~1.03.
- Recent optimization for n~1.05 has brought large improvement.

Solvent
methyl alchohol
→di-methyl-formamide(DMF)

Precurser (methyl-silicate 51)
change the supplier

Transmission length (λT) at 400nm
15mm → 40mm
Large Improvement

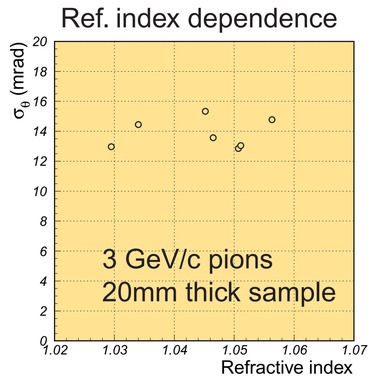


- These works for aerogel radiator have been made under collaboration with Matsushita Electric Work Ltd.

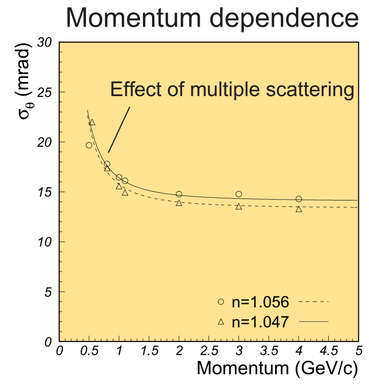
Single Photon Resolution

- For 3GeV/c pions and 20mm thick aerogel samples, the obtained single pe resolution σc~14mrad, independent of the refractive index.
- The main contribution comes from uncertainty in the photon emission point and the pixel size of PMT, which add to ~10mrad. The residual effects are subject to further investigation.

Ref. index dependence



Momentum dependence

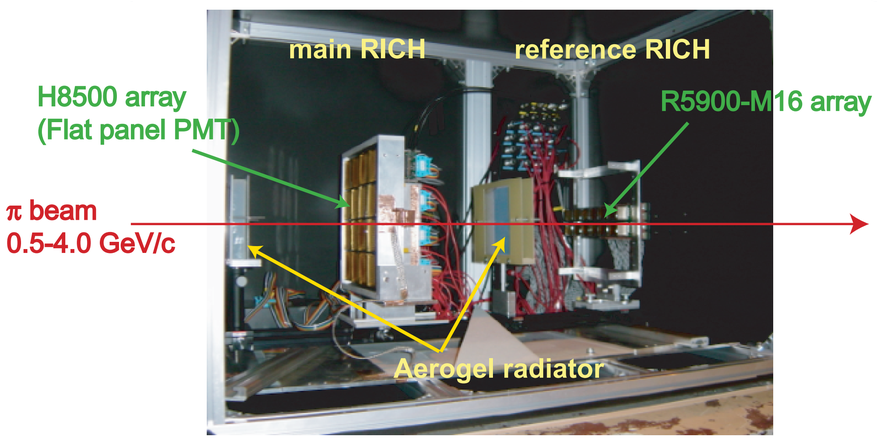


Beam Test of Aerogel-RICH

Two beam tests have been carried out at the KEK-PS π2 beam line.

1st beam test (Nov-Dec, 2001)
6 × 6 array of R5900-M16
Basic performance check

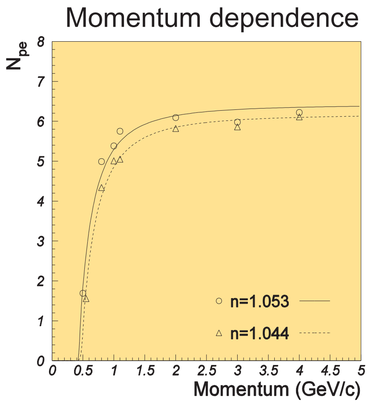
2nd beam test (Nov., 2002)
4 × 4 array of H8500
Improved detection area & aerogel



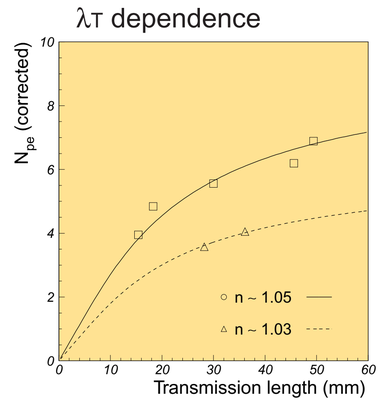
Number of Detected Photons

- The number of detected photons N_{pe} for n~1.05, 20mm thick aerogel is about 6 in the momentum region above 1 GeV/c.
- The improvement in the transmission of n~1.05 aerogel has brought × 1.5 increase of N_{pe}.

Momentum dependence



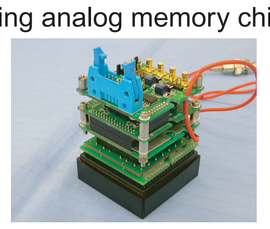
λT dependence

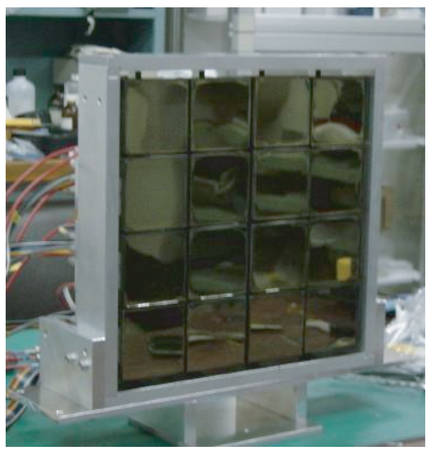


Flat Panel PMT (Hamamatsu H8500)

For the 2nd beam test, we constructed 4 × 4 array of H8500 "Flat panel PMT" to increase the photodetection area.

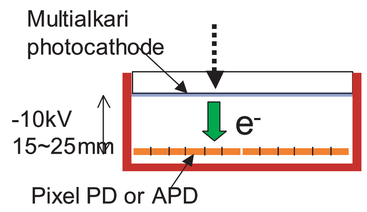
- Effective area : 84%
  Pixel size: 6mm × 6mm
  8 × 8 channels/PMT
  Quantum efficiency: 16~25%(400nm)
  Gain: 1~ 6×10^6
- Readout of 1024 channels was made by using analog memory chips





Summary & Plan

- The beam test of the proximity focusing aerogel-RICH has demonstrated
  σ_c =14mrad and N_{pe}=6 for n=1.05 and 20mm thick radiator,
  →The track-by-track Cherenkov angle resolution is then estimated to be
  $\sigma_c/(Npe)^{1/2}$=5.3mrad, giving a 4σ K/π separation at 4GeV/c.
- The remaining important items to be developed are
  Photodetector with B field immunity (1.5T) and large effective area.
  Large size aerogel tiles to minimize the loss at boundary.
- Development of multi-anode H(A)PD is in progress (w/ Hamamatsu).



Package	72mm × 72mm
Number of pixels	12 × 12 (6 × 6/chip)
Pixel size	5mm × 5mm
Effective area	64%
Gain	2000(HPD) 20000(HAPD)