Aerogel RICH: Overview & Issues

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Proto-Collaboration Meeting
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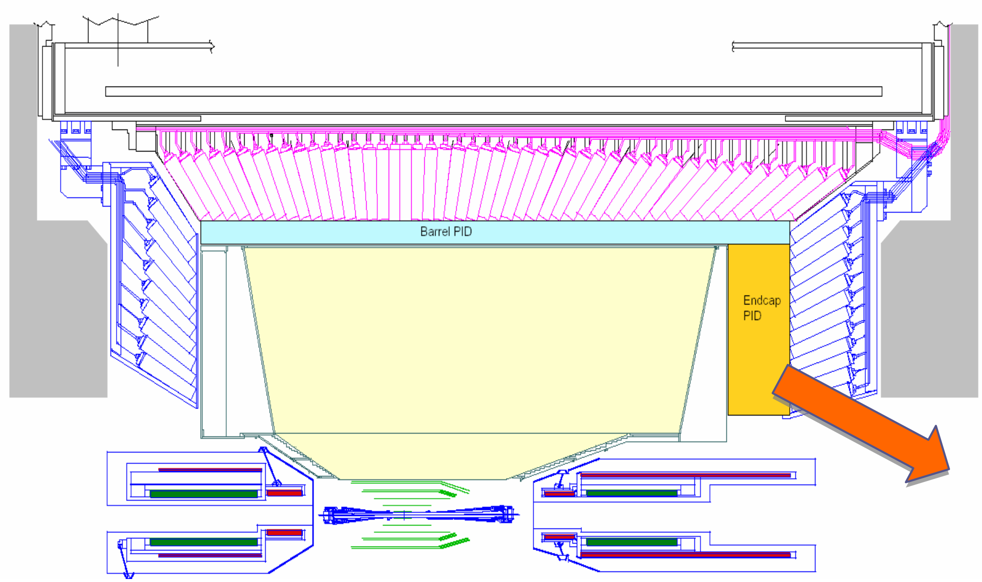
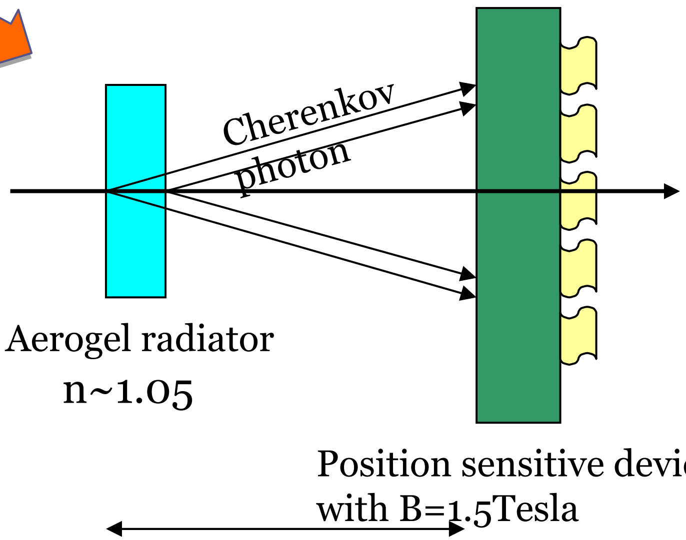
Introduction

- Proximity focusing RICH



Present endcap ACC replaced into new PID device to expand π/K separation from 1.5 GeV/c to 4.0 GeV/c

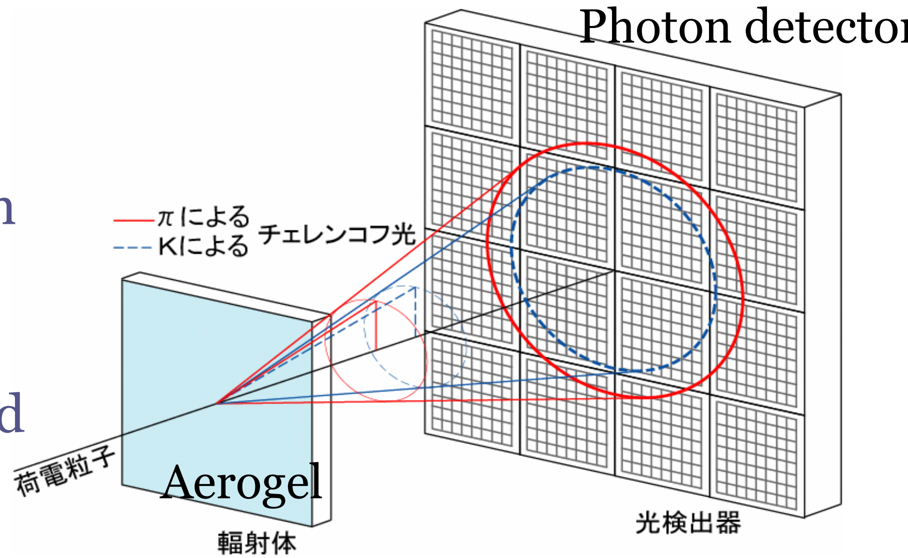


Proximity focusing type due to a limited available space (~280 mm total thickness)

Inside an axial magnetic field

Detector Elements

- Aerogel radiator
  - Transparent
  - Stable for long-term operation
- Photon detector
  - Sensitive to a single photon
  - Operational under 1.5 T B field
- Readout electronics
  - O(0.1) M readout channels
  - Low noise
- Mechanical structure
  - Should be fit into the present Belle layout



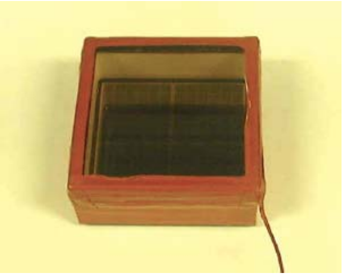
- n = 1.05
- $\theta_c(\pi)$ ~ 308 mrad @ 4 GeV/c
- $\theta_c(\pi) - \theta_c(K)$ ~ 23 mrad
- pion threshold 0.44 GeV/c
- kaon threshold 1.54 GeV/c

σ(single photon) = 14 mrad with 6 photoelectrons

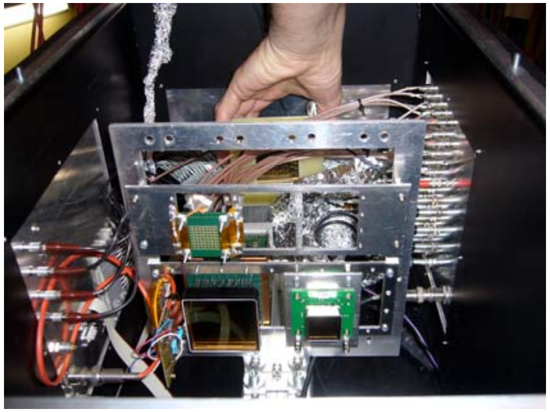
→ 4 σ π/K separation

Photon detector options

- Three candidates
  - Hybrid avalanche photon detector (HAPD)
    - Developed with HPK
    - ASIC readout tested concurrently



  - Micro Channel Plate (MCP)-PMT
    - Burle sample with 25 pore size tested
    - Advantage with excellent timing resolution



  - Geiger-mode APD: MPPC (SiPM)
    - High PDE
    - No HV required

All three technologies tested in beam and clear Cherenkov images observed

Detailed reports will be presented

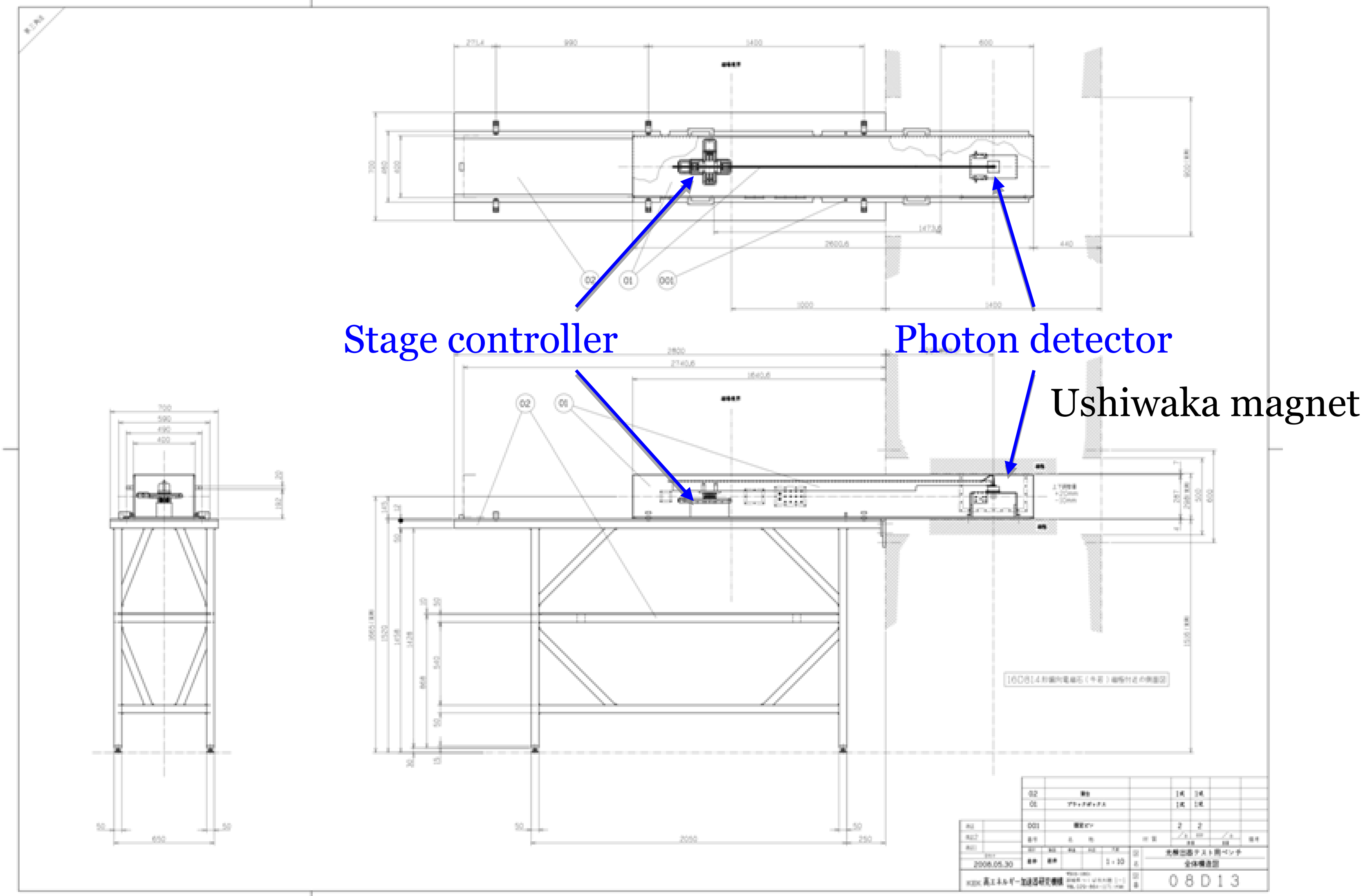
Photon detector summary

	Hybrid Avalanche Photon Detector	MCP-PMT	Geiger mode APD
Advantage	Good S/N	Excellent timing resolution	Stable No HV required
Issues & Remarks	Further understanding Long-term stability	Small pore size Lifetime	Noise rate Radiation damage

- Performance test under a magnetic field is necessary.
- Scheduled from this summer

Test set-up in a magnetic field

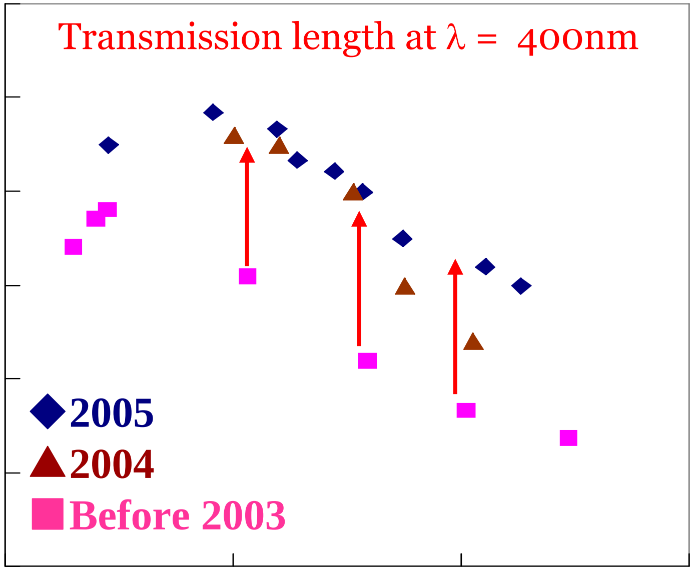
- XY dimensional scan will be performed

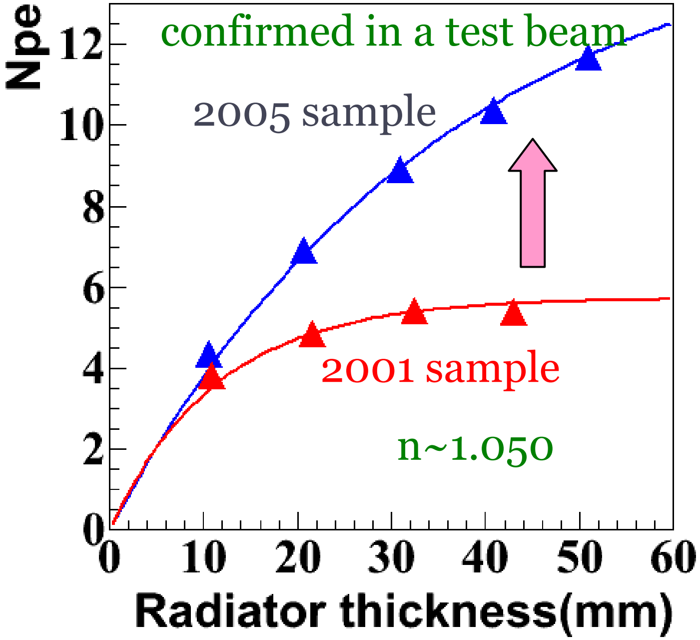


Aerogel Radiator Improvements

- Transparency for index ~ 1.04-1.06 samples almost doubled
- Crack-free sample for $150x150x20mm^3$
  - Collaboration with Matsushita

Transmission: $T = T0\ exp(-d/\Lambda(\lambda))$
$\Lambda(\lambda)$: transmission length
d: sample thickness



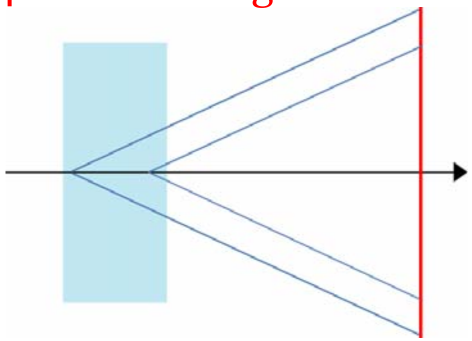


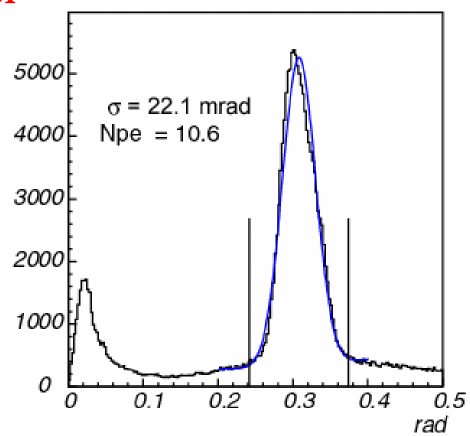
Aerogel radiator configuration

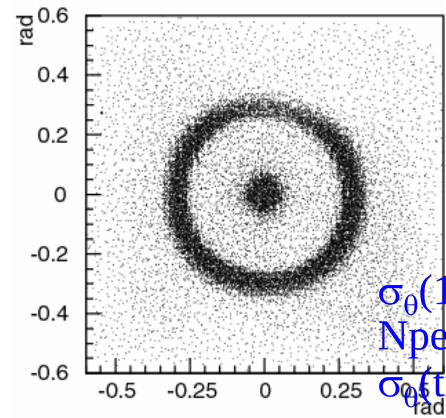
Cherenkov photons are "focused" onto the photon detector plan.

New idea has been validated in test beam (3.0GeV/c π beam)

4cm-thick single index aerogel

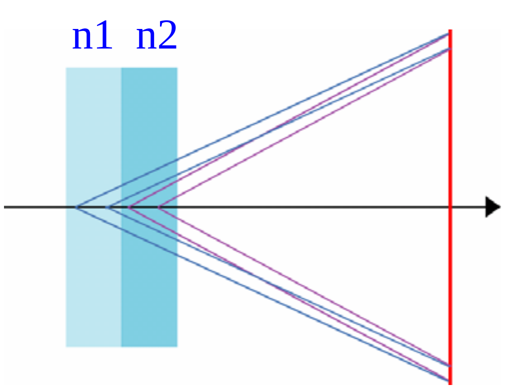


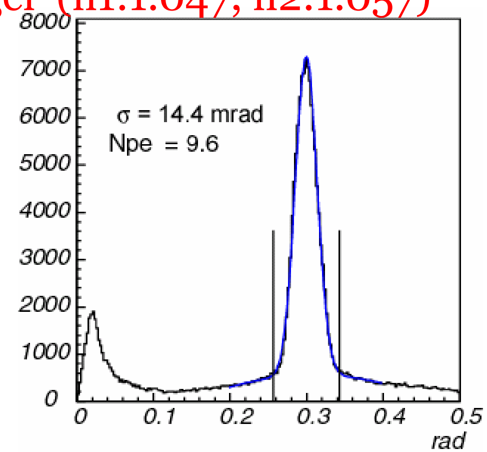


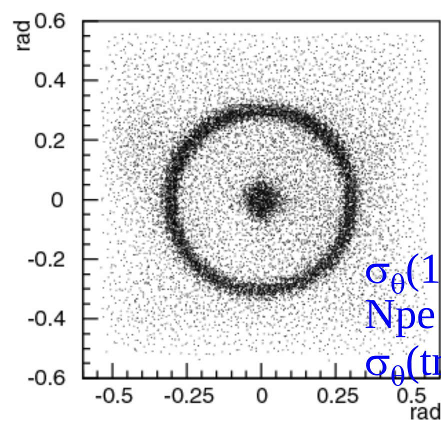


σ_θ(1p.e.) = 22 mrad
Npe ~ 10.6
σ_θ(track) = 6.9 mrad

Focusing by 2cm+2cm aerogel (n1:1.047, n2:1.057)







σ_θ(1p.e.) = 14.4 mrad
Npe ~ 9.6
σ_θ(track) = 4.8 mrad

NIM A548(2005)383

Aerogel radiator layout options

	Radiator layout	σ_{single}	Npe	σ_{track} π/K sep.	production	arrangement
1	n=1.045 10mmx4layer	22 mrad	10.6	6.9 mrad 3.3 σ	simple	How to stack?
2	1.047+1.057 10mmx2 + 10mmx2	14.4 mrad	9.6	4.9 mrad 4.8 σ	possible	Monolithic 2 layer?
3	1.045+1.050+ 1.055 10mmx3	13 mrad	9.0	4.2 mrad 5.5 σ	possible further control needed	Further trial to monolithic 3 layer? Difficult?

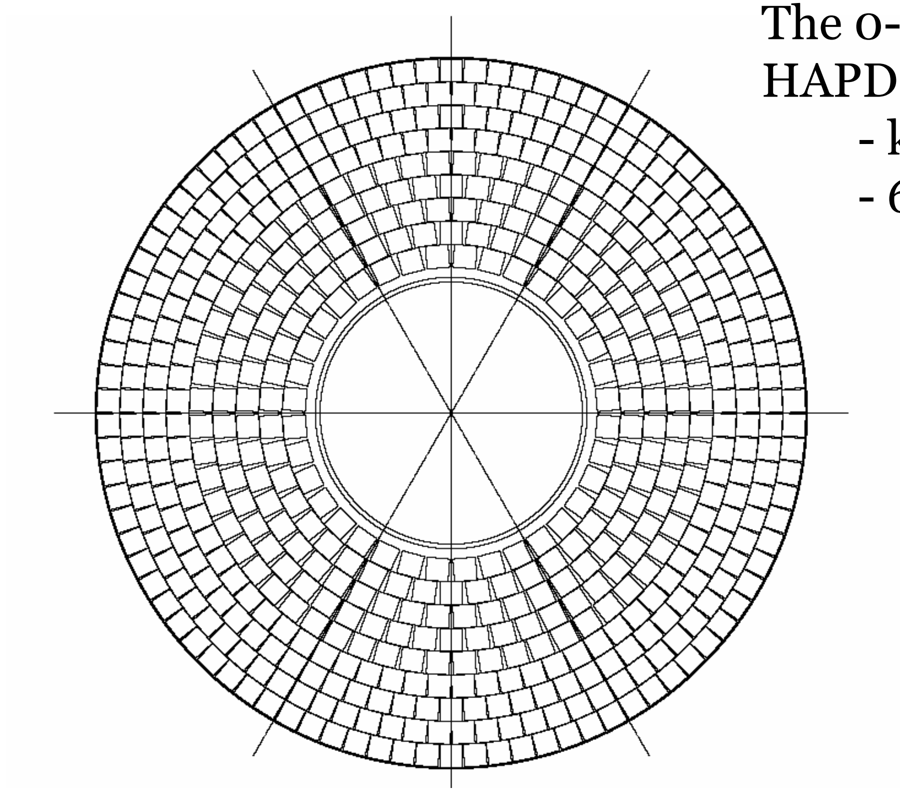
2005 beam test ←→ (columns σ_{single} to σ_{track})

Aerogel production ←→ (columns production to arrangement)

Case3 is the best but case2 would be practical ??
Need further studies of radiator and design of arrangements

Photon detector arrangement

- Photon detector has square cross-section although we have to cover donuts-shape volume.



The 0-th version of tiling scheme assuming HAPD dimension
- keeping symmetries in the phi direction
- 6 identical sectors for “honeycomb” shape

Optimal ?

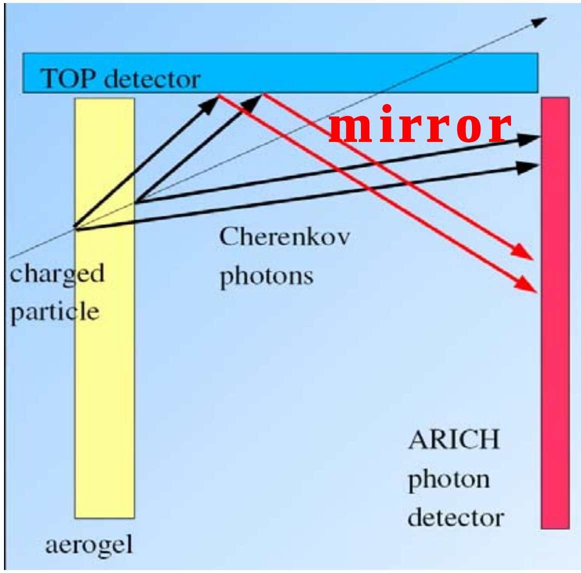
Simple arrangement could give smaller dead space?

Related with how to make a “module”

(photon device + electronics)

Mirror accommodation

- Junction region between the barrel and the endcap
  - Mirror system recovers efficiency
- To optimize mirror system, one may need detailed simulations
- Serious consideration haven't made if really need

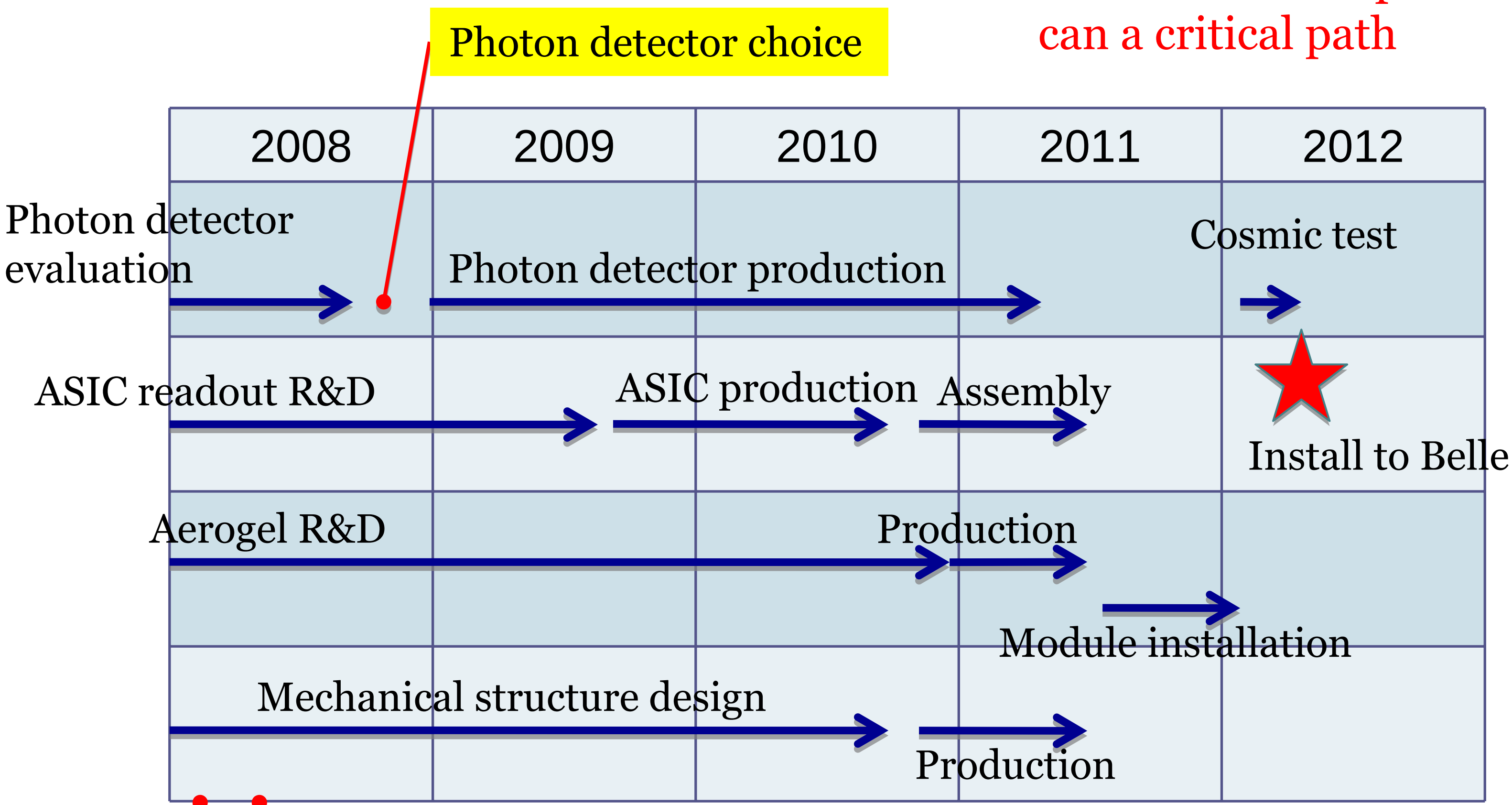


Issues

- Photon detector
  - Performance under a magnetic field
  - Long-term stability
- Aerogel radiator
  - Performance and practical accommodation have to be considered
  - Further studies required
- Mechanical stuff
  - Photon detector tilling scheme
  - Mirror installation
  - Careful consideration
- Software development
  - Did not mention, but we should have reconstruction programs
  - Try to apply beam test data

Aerogel RICH Schedule

Photon detector production can a critical path



Beam test

March: verification of HAPD operation

June: realistic configuration of HAPD array
tests of MPPC array and MCP-PMTs