Simulation Study for Particle Identification with the dRICH of the ePIC Experiment at the EIC

Tiziano Boasso
Università degli Studi di Trieste – INFN, Sezione di Trieste
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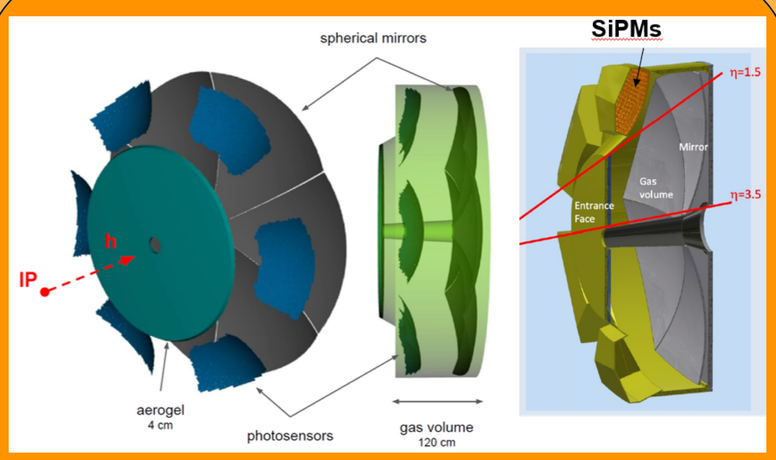
dRICH

- Uses two radiators: aerogel (4 cm thick, n ~ 1.019) C2F6 gas (~1 m thick, n ~ 1.0008).
- Provides particle identification (PID) for both low and high momentum regions (up to ~50GeV/c).
- Covers pseudorapidity range (1.5, 3.5).
- Features six identical mirror arrangements with spherical photosensor sectors.
- Photosensor: SiPM (Si sensor operated in Geiger mode) for single photon detection.

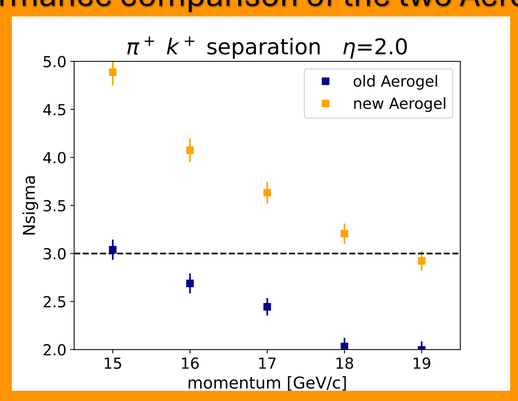


Artistic view of the dRICH detector

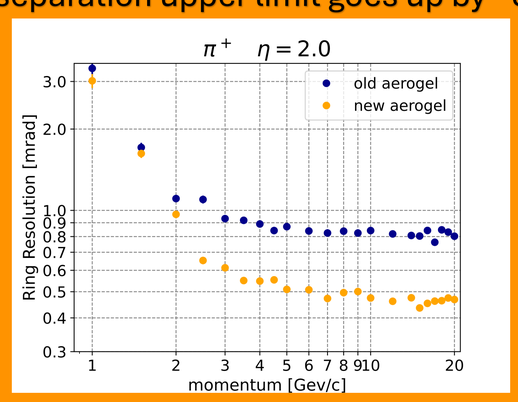
New Aerogel Parameters

We compared the performance of two different Aerogels, the default one and a new option with n = 1.0256 and others better optical parameters.

Performance comparison of the two Aerogel



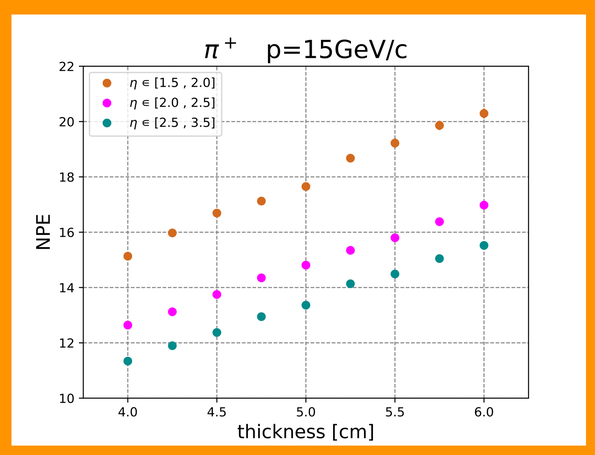
3σ πk separation upper limit goes up by ~3GeV/c



Ring resolution goes down by ~37%

Increase Aerogel Thickness

Increasing Aerogel thickness can help with performance due to the higher average NPE produced by particles. Constructing thicker Aerogel tails it's not trivial, piling up layers can be considered, but in this case surface effects must be take in account.



Number of detected photoelectrons (NPE) produced increase linearly with the radiator thickness.
Moving to a 6cm radiator increase by ~25% NPE produced.

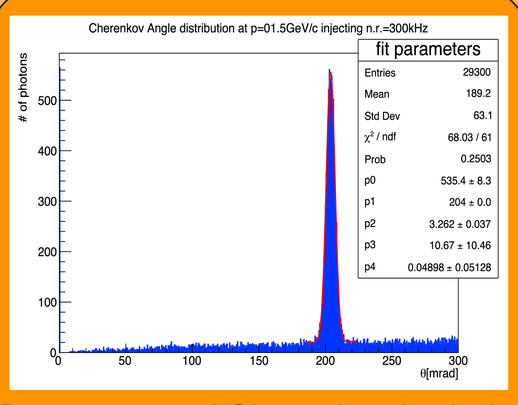
PID performance tacking into account the SiPM dark noise

SiPMs performance are affected by the presence of dark noise

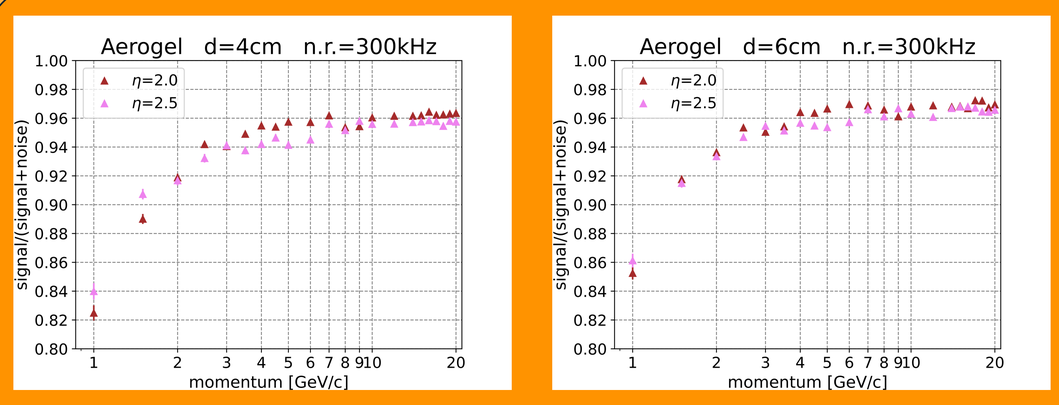
- Dark counts mitigated by operating at low temperatures (~ -40°C).
- Radiation damage increases dark count rate.
- Noise hits inside the ring region

These results are obtained adding noise to the simulated events

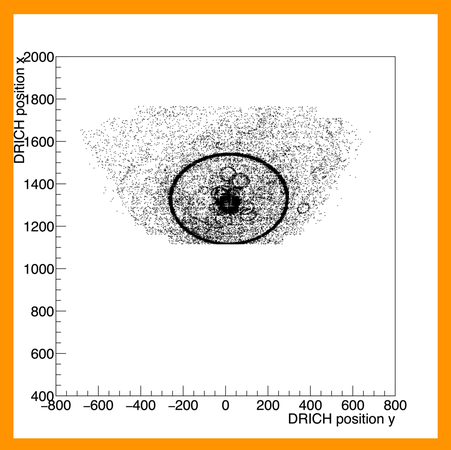
- white noise counts are added uniformly on the detector surface
- The maximum noise rate estimated is 300kHz/(SiPm*Event),
- The noise is integrated over a time window of 1ns



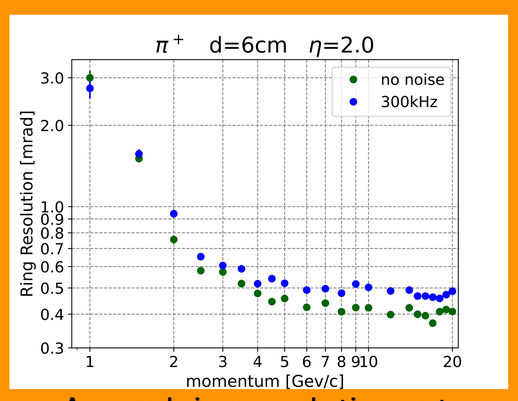
Reconstructed Cherenkov Angle for the Aerogel Ring with noise



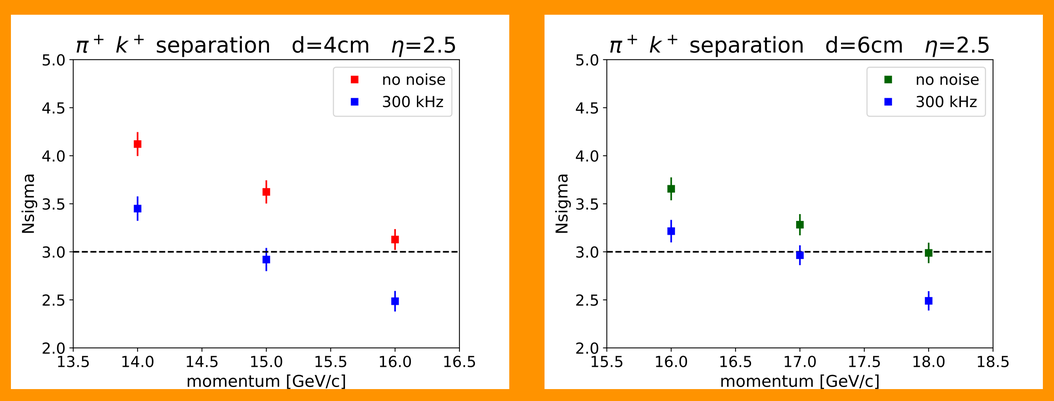
Signal purity at different momentum and Aerogel thickness



Hit map for the detected photons from 1000 pions at p=15GeV/c, fixed Φ and η = 2.0



Areogel ring resolution gets worsen by ~20% at saturation



We can improve PID performance by increasing the aerogel thickness

Bibliography

[1] R. Abdul Khalek et al., "Science Requirements and Detector Concepts for the Electron-Ion Collider: EIC Yellow Report," Nucl. Phys. A, vol. 1026, p. 122447

[2] C. Chatterjee, "Particle Identification with the ePIC detector at the EIC", DIS 2024