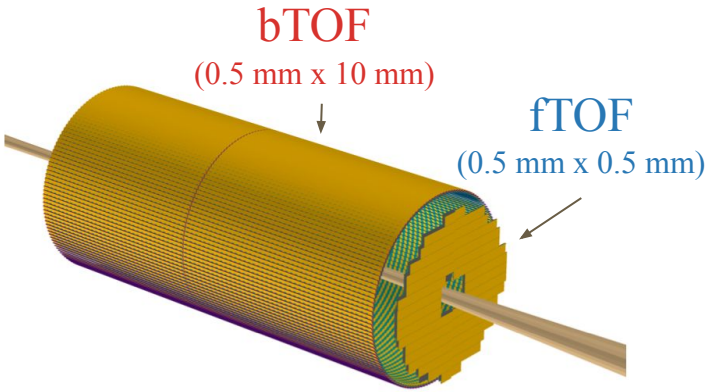
Effect of Time of Flight layer on PID efficiency of dRICH

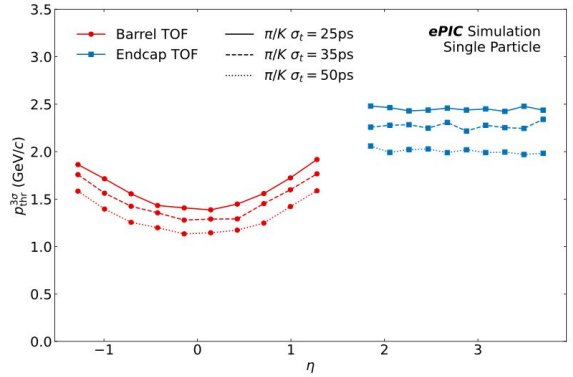
dRICH Simulation Meeting

$2^2/3^2/45^2$

Introduction

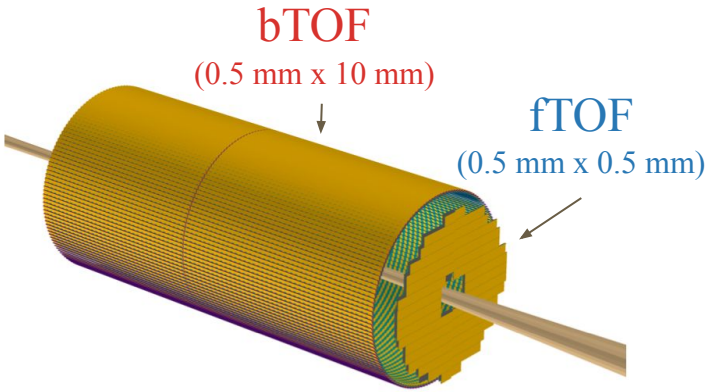
- ePIC@EIC: PID over a wide kinematical range.
  - dRICH (forward), hpDIRC (barrel), pfRICH (endcap)
- Improvement of low-momentum PID: using TOF in barrel and end-cap regions (AC-LGAD based)
  - Single-hit timing resolution of 35 ps from the bTOF (strip sensors) and 25 ps from the fTOF (pixel sensors)
  - π-K separation at the 3σ level:
    - for p < 1.2 GeV/c (forward region: −1.2 < η < 1.6),
    - p < 2.5 GeV/c for (endcap region: 1.9 < η < 3.6)



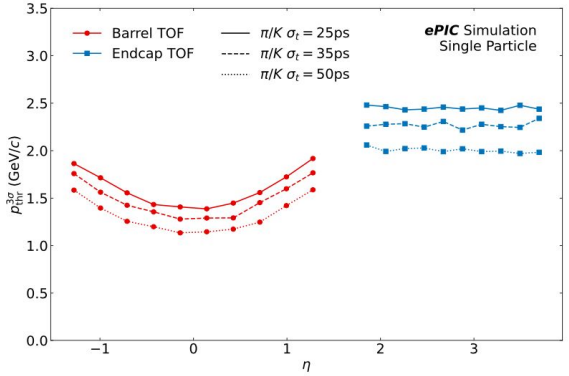


Aim & Motivation

- Aim: To understand the role of fTOF in terms of PID efficiency of dRICH
  - π-K separation
  - e-π separation



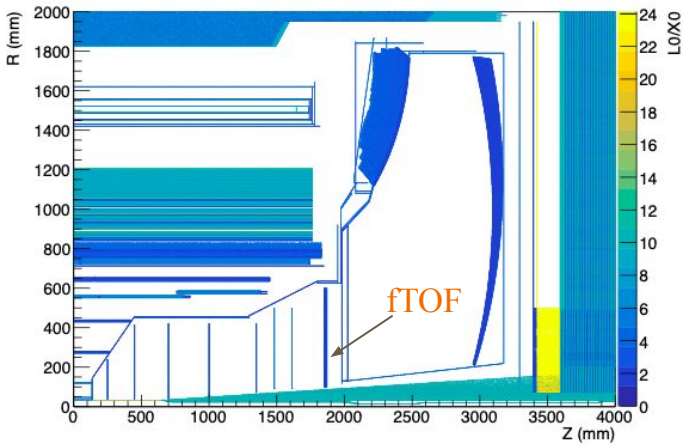
- Addition of TOF is expected to provide an additional hit point for improved track reconstruction
  - Causes multiple scattering (for low momentum particles)
  - Expensive (AC-LGAD sensor) technology



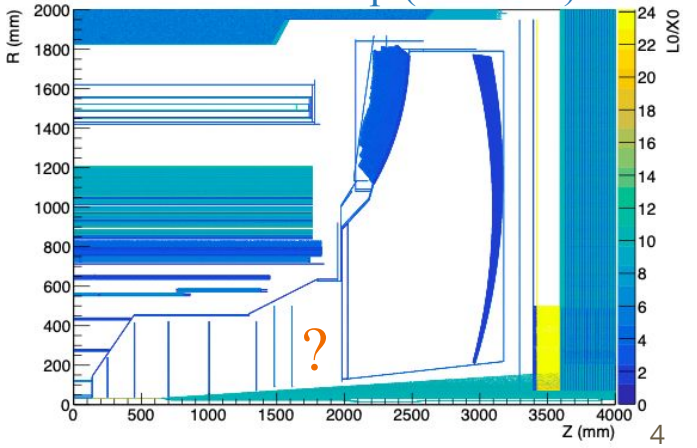
Methodology

- Change in geometry (.xml file)
  - Removal of the fTOF layer
- Update the material map (.cbor file)
  - Using the recipe provided at: https://github.com/eic/epic/blob/main/scripts/material_map/readme.md
- Make sure:
  - Reconstruction modules of fTOF are not available during fTOF (by making the required changes in EICrecon/src/detectors/CMakeLists.txt & rebuild)
  - Appropriate material map (cbor) file is accessed during reconstruction step.

Material Map (with fTOF)



Material Map (no fTOF)



Methodology

Four Cases	**No fTOF** material (cbor file)	**with fTOF** material (cbor file)
No fTOF layer (xml file)	00	01
with fTOF layer (xml file)	10	11

eic-shell (v 25.07.0-stable) | epic (v 25.06.1) | ElCrecon (v1.26.1) | Ref. Geometry epic_craterlake.xml

- Three Particles: Electron, Pion, and Kaon
- 25 Momentum bins [GeV/c]: 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0
- Four different pseudorapidity regions: (1.7-1.9), (1.9-2.5), (2.5-3.0), (3.0-3.5)
- 1000 particles for each step
- 3 x 25 x 4 = 300 for two cases

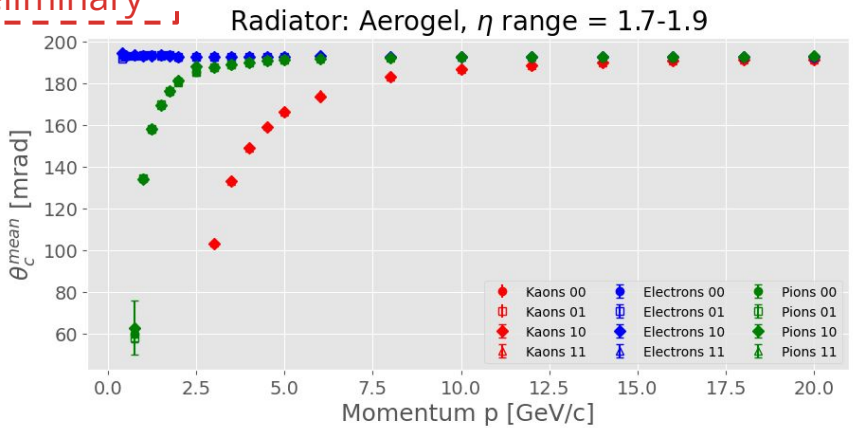
- Two Particles: Electrons, and Pions
- 14 Momentum bins [GeV/c]: 0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0
- Four different pseudorapidity regions: (1.7-1.9), (1.9-2.5), (2.5-3.0), (3.0-3.5)

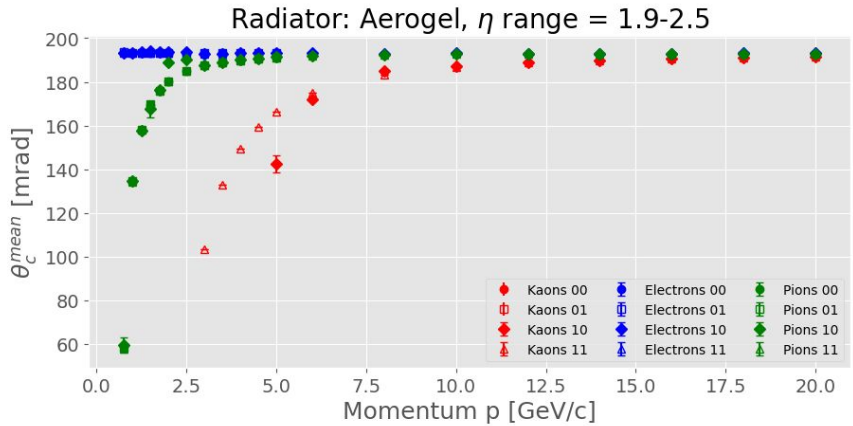
Thanks to Deepak & Chandra!
(for generation & analysis scripts)

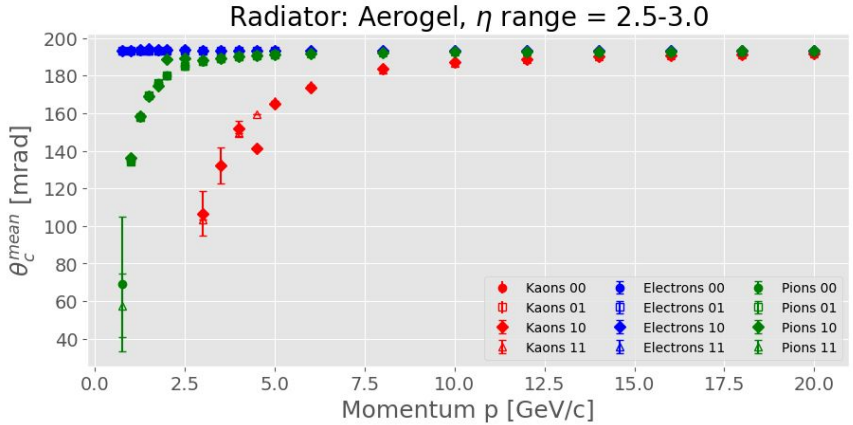
Cherenkov Angle [Radiator: Aerogel] (Mean)

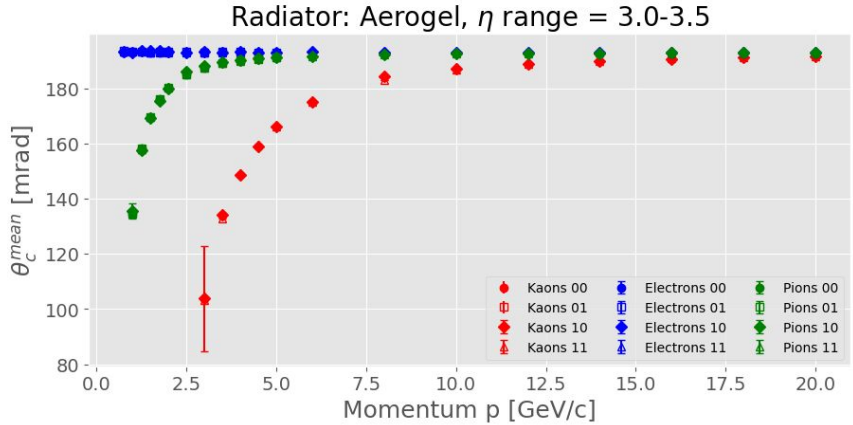
00: No layer, No mapping
01: No layer, With mapping
10: With layer, No mapping
11: With layer & mapping

Preliminary









Cherenkov Angle [Radiator: Aerogel] (Sigma)

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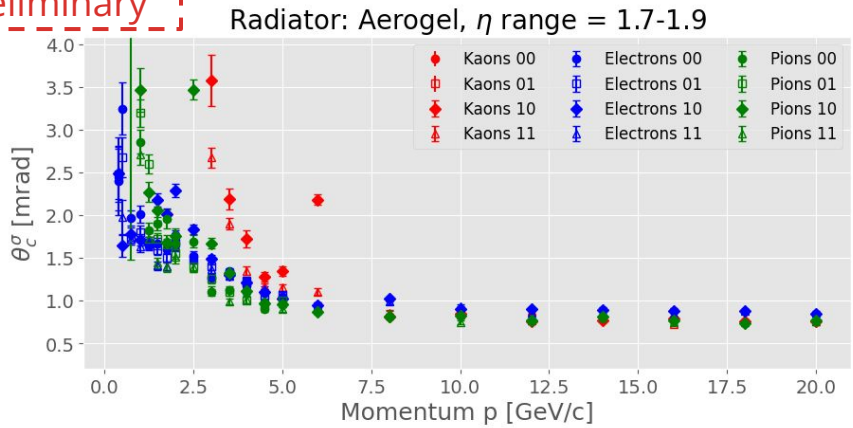
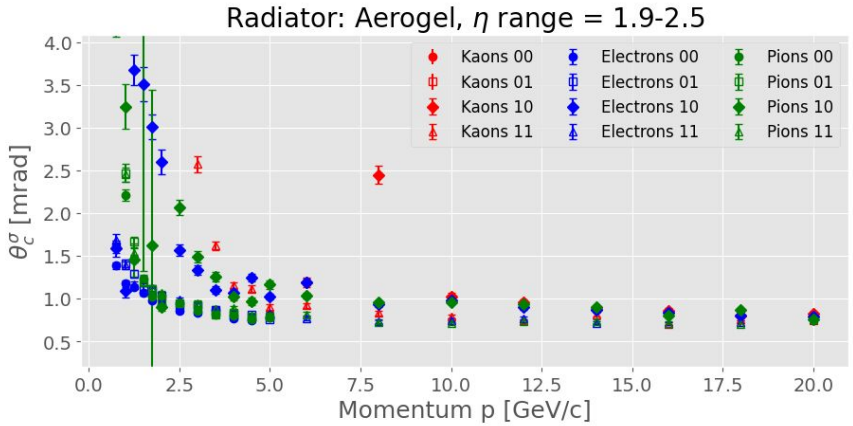
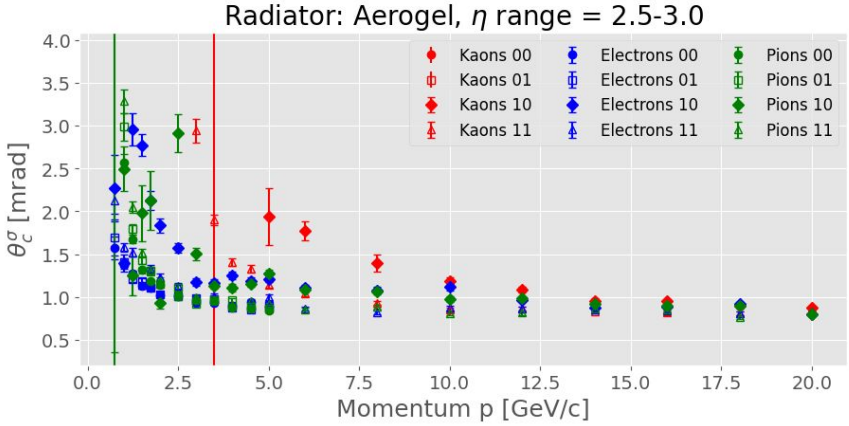
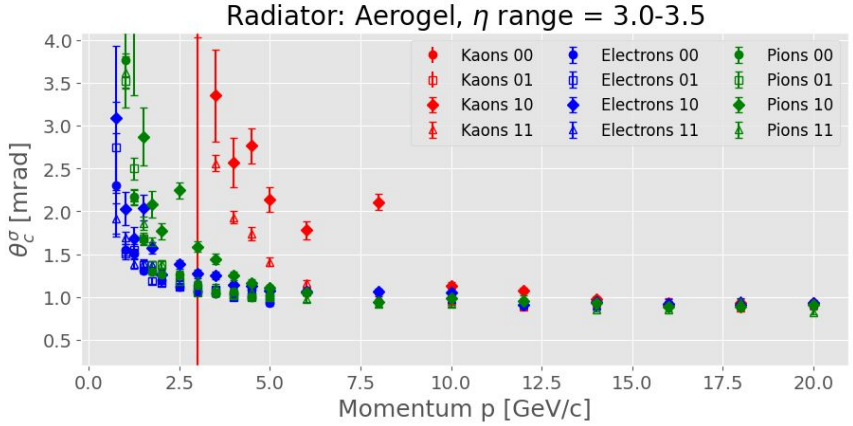
Preliminary









Cherenkov Angle [Radiator: Aerogel] (Sigma)

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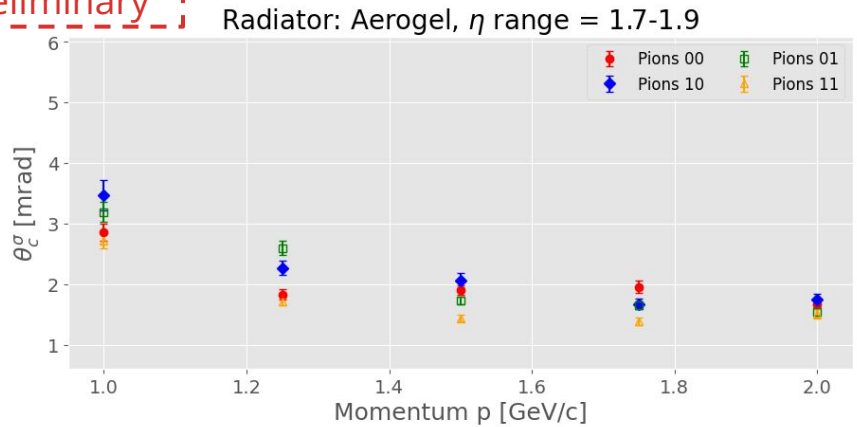
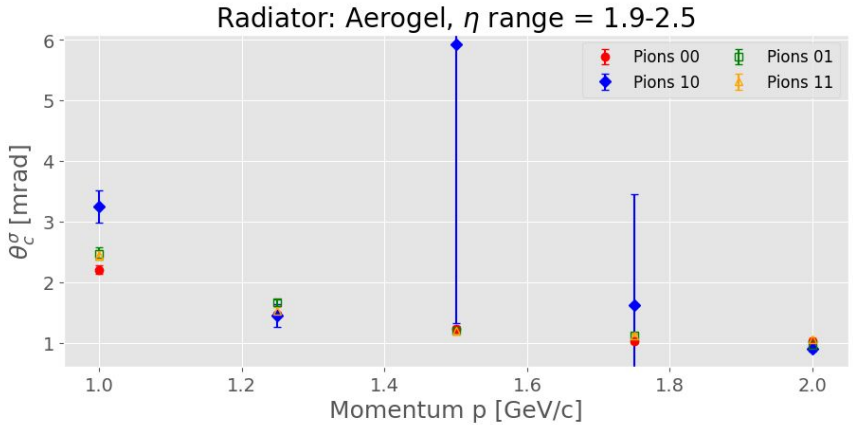
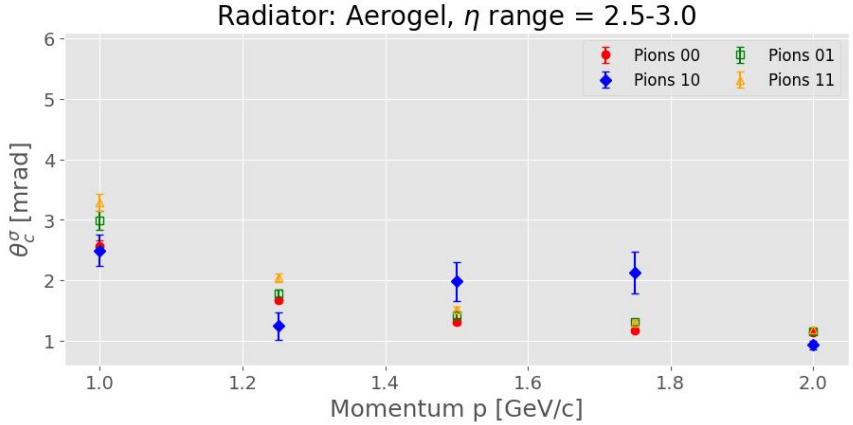
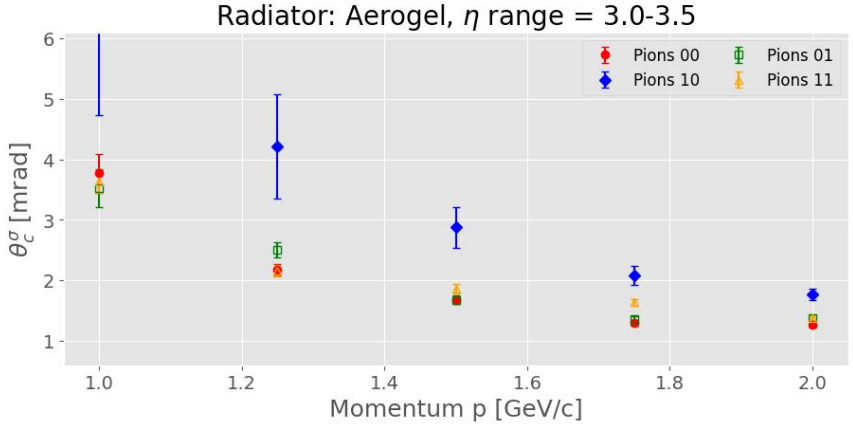
Preliminary



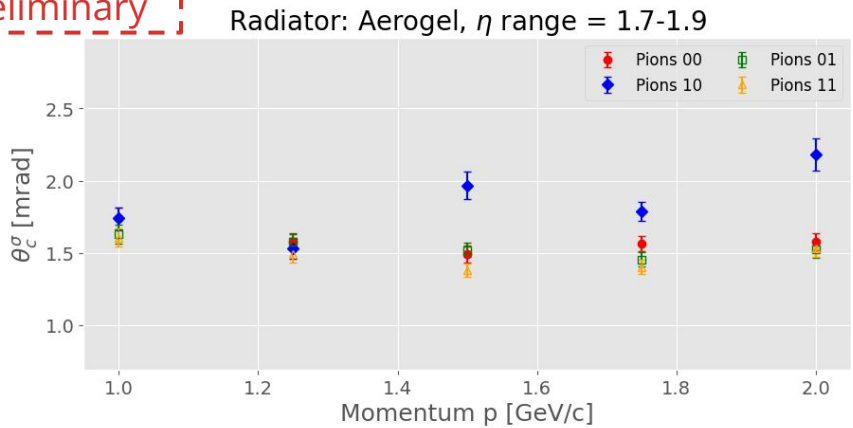


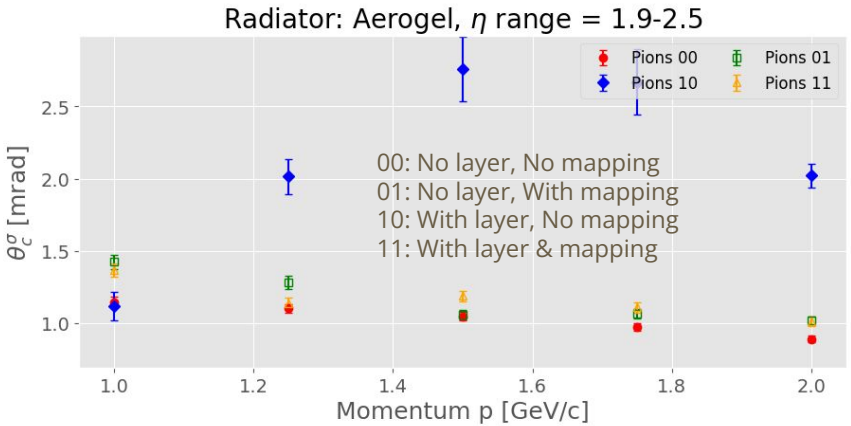


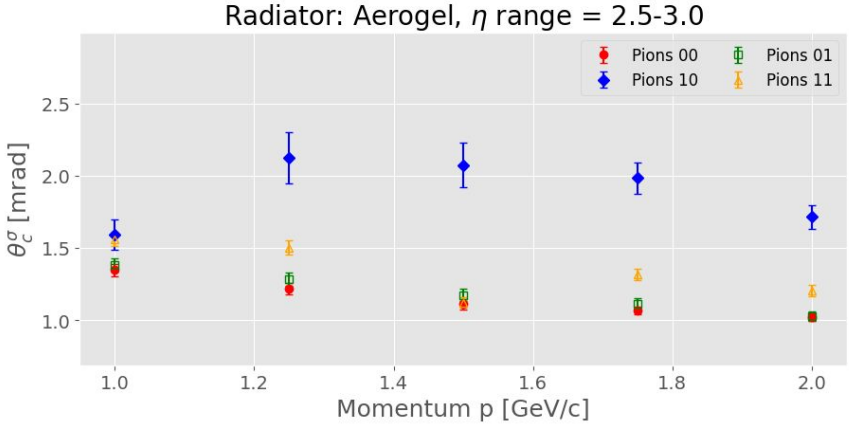


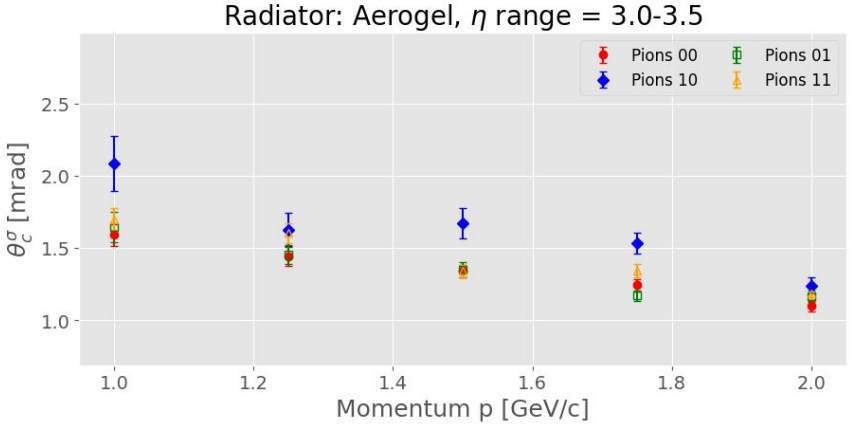
Res. Cherenkov Angle [Radiator: Aerogel] (Sigma)

Preliminary



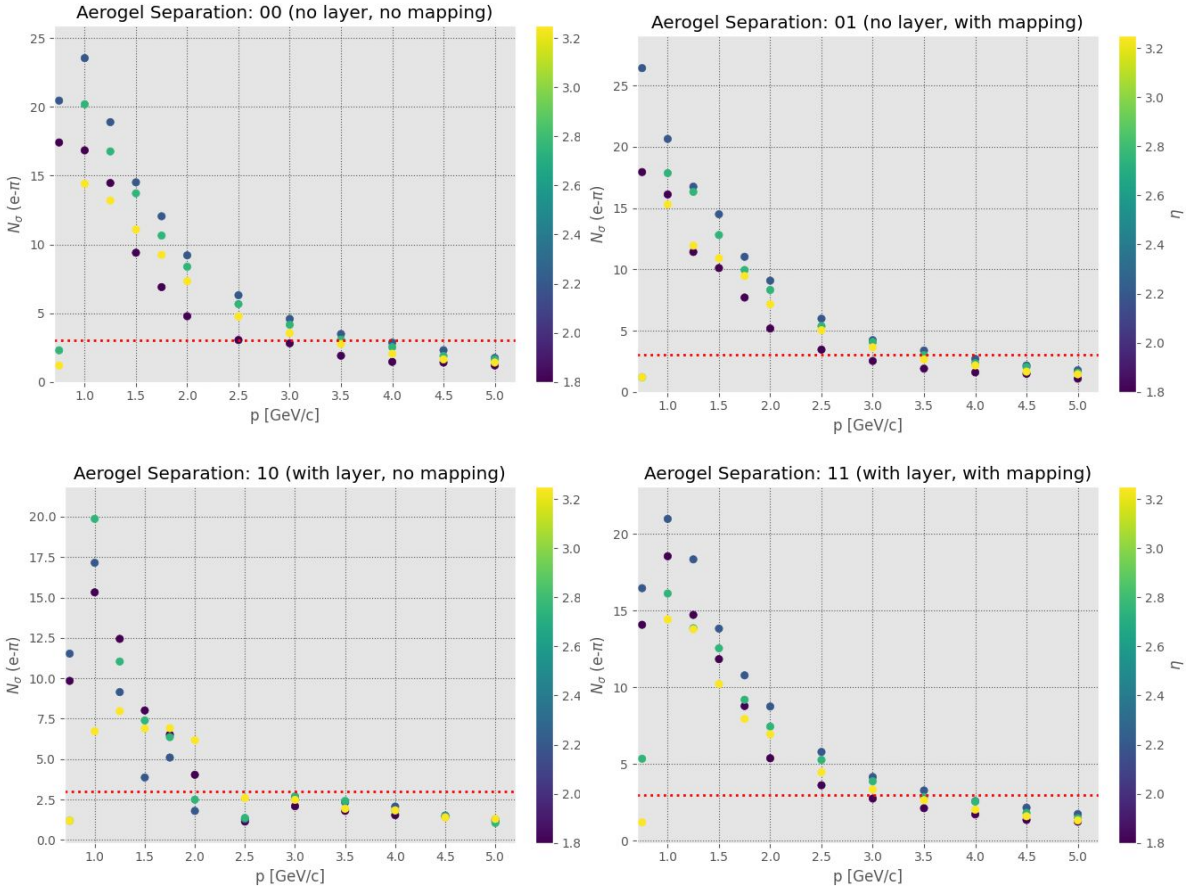


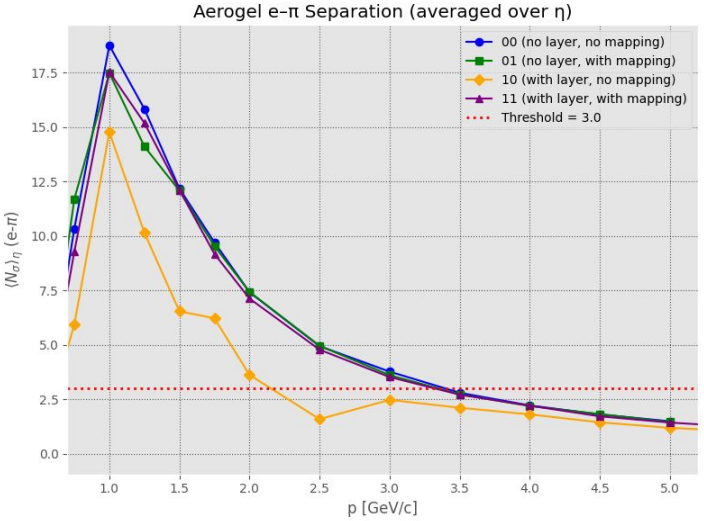




Electron-pion separation (Radiator: Aerogel)

Preliminary





? Need to understand the behavior

Summary

- **Very preliminary** study to understand the effect of fTOF in terms of dRICH performance
- **Disclaimer:** Geometry of the fTOF is not the actual one
  - “Air” between two fTOF layers (not the REAL case)
  - Communicated to concerned person
- Working machinery for analysis with real (or quasi-real) geometry