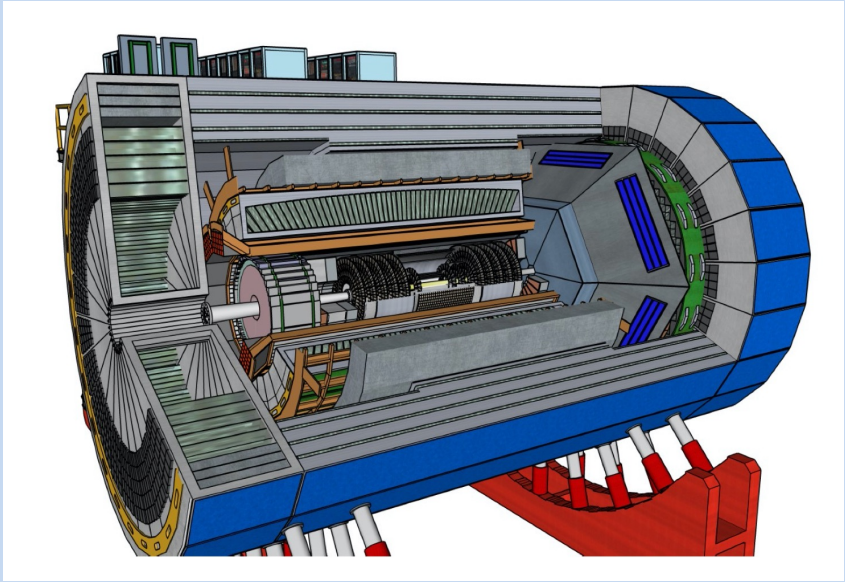
Forward RICH @ EIC

dRICH has been a common reference in the forward region since EIC Yellow Report



p/A beam → ← e beam

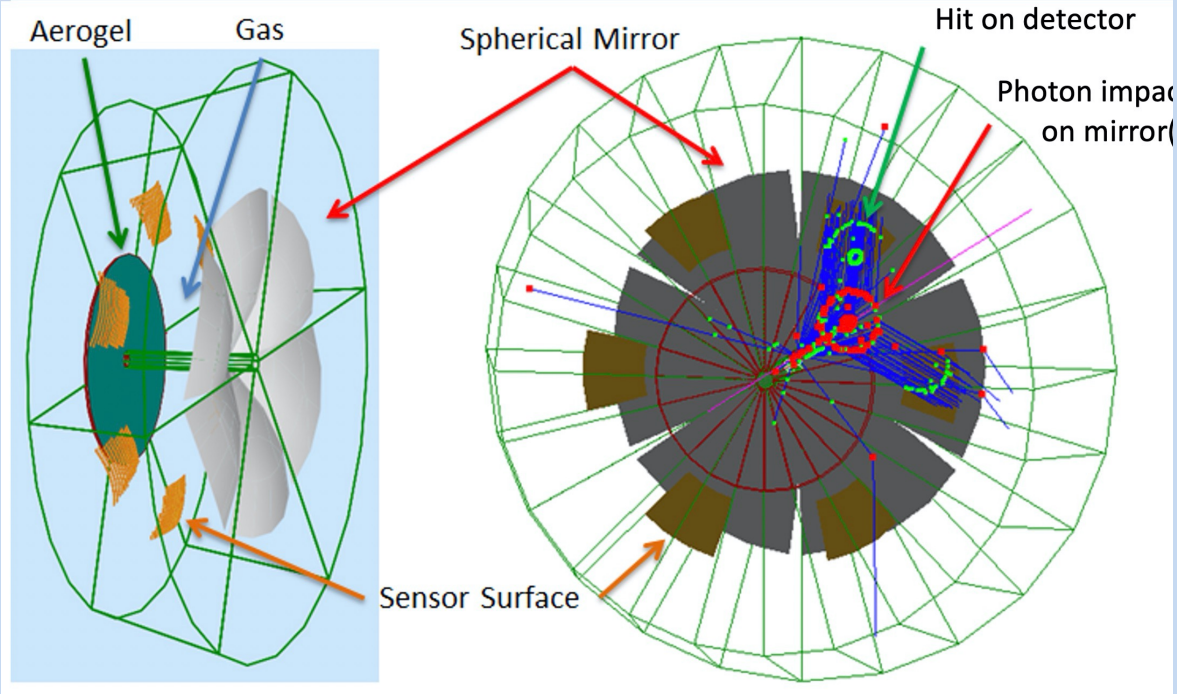
p: 41 GeV, 100 to 275 GeV

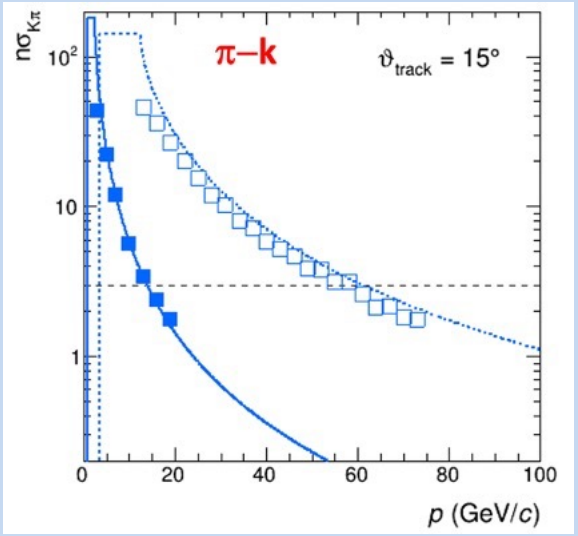
e: 5 GeV to 18 GeV

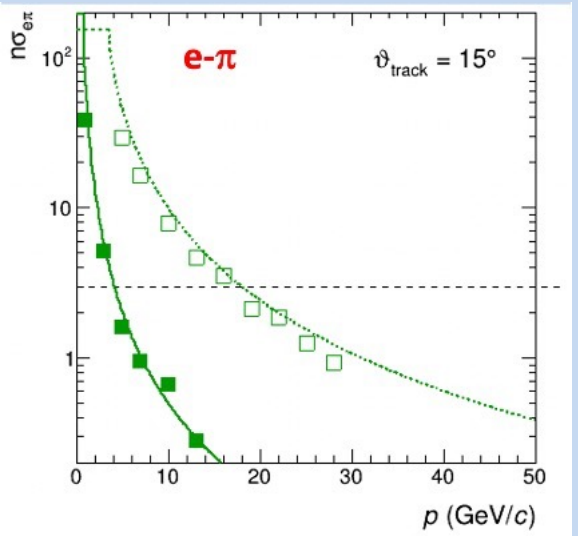
Contalbrigo Marco - INFN Ferrara

Dual Radiator RICH @ EIC

Two challenges: cover wide momentum range 3 - 60 GeV/c
work in high (~ 1T) magnetic field







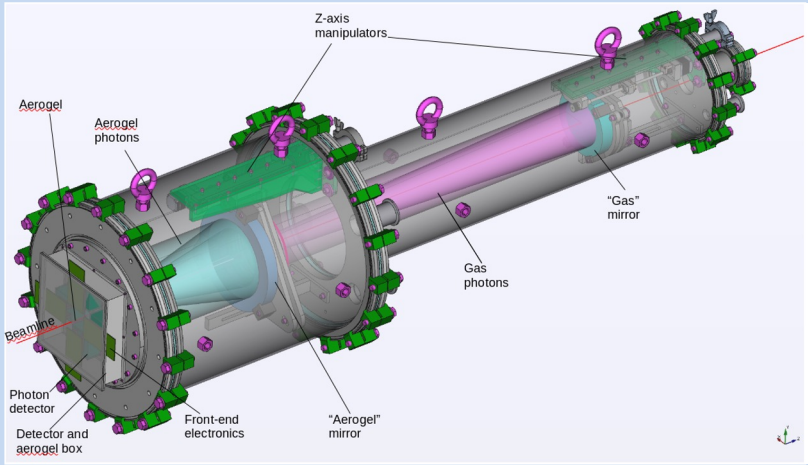
dRICH: effective solution, part of EIC reference detector

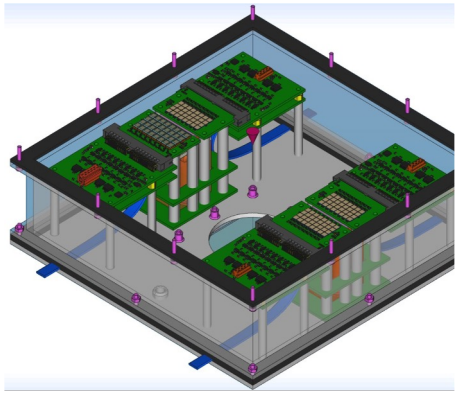
Radiators: Aerogel (n_{AERO}~1.02) + Gas (n_{C2F6} ~ 1.0008)

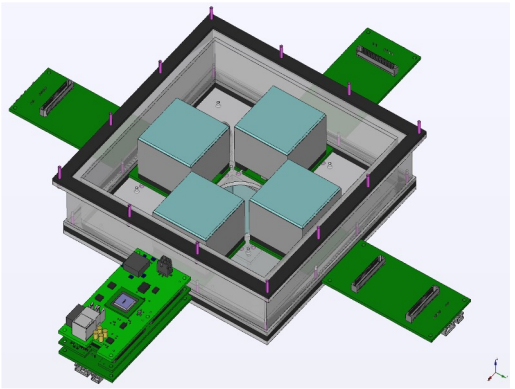
Detector: 0.5 m^2/sector , 3x3 mm^2 pixel. → SiPM option

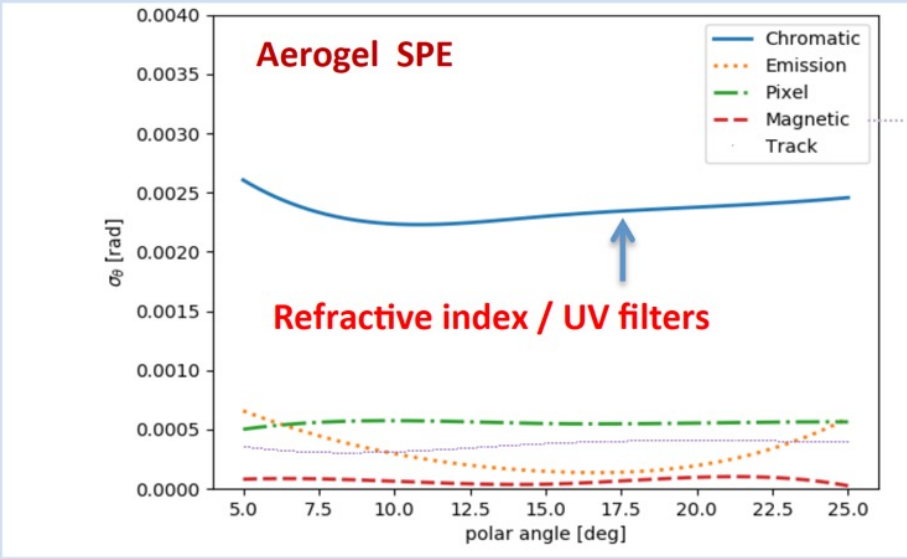
Phase Space:
- Polar angle: 5-25 deg
- Momentum: 3-60 GeV/c

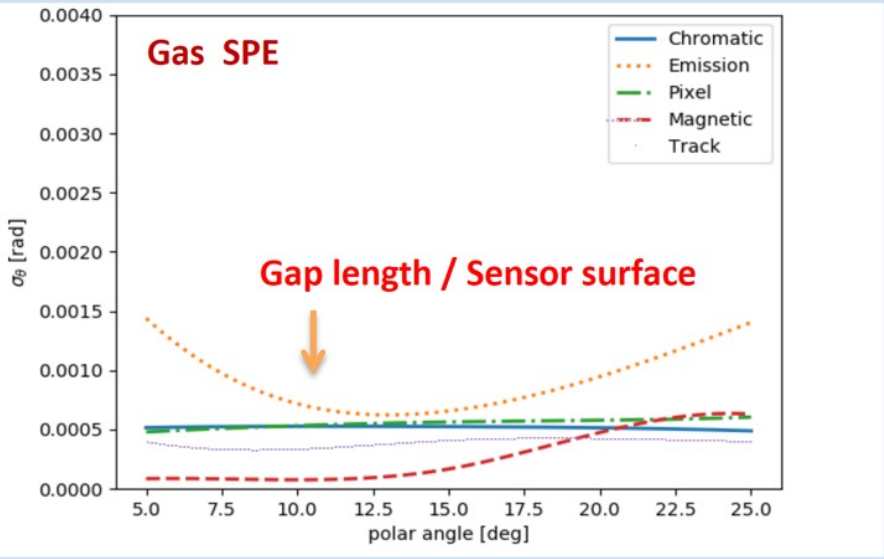
Prototipe to validate dual-radiator working principle,
optimize performance and define specifications for components



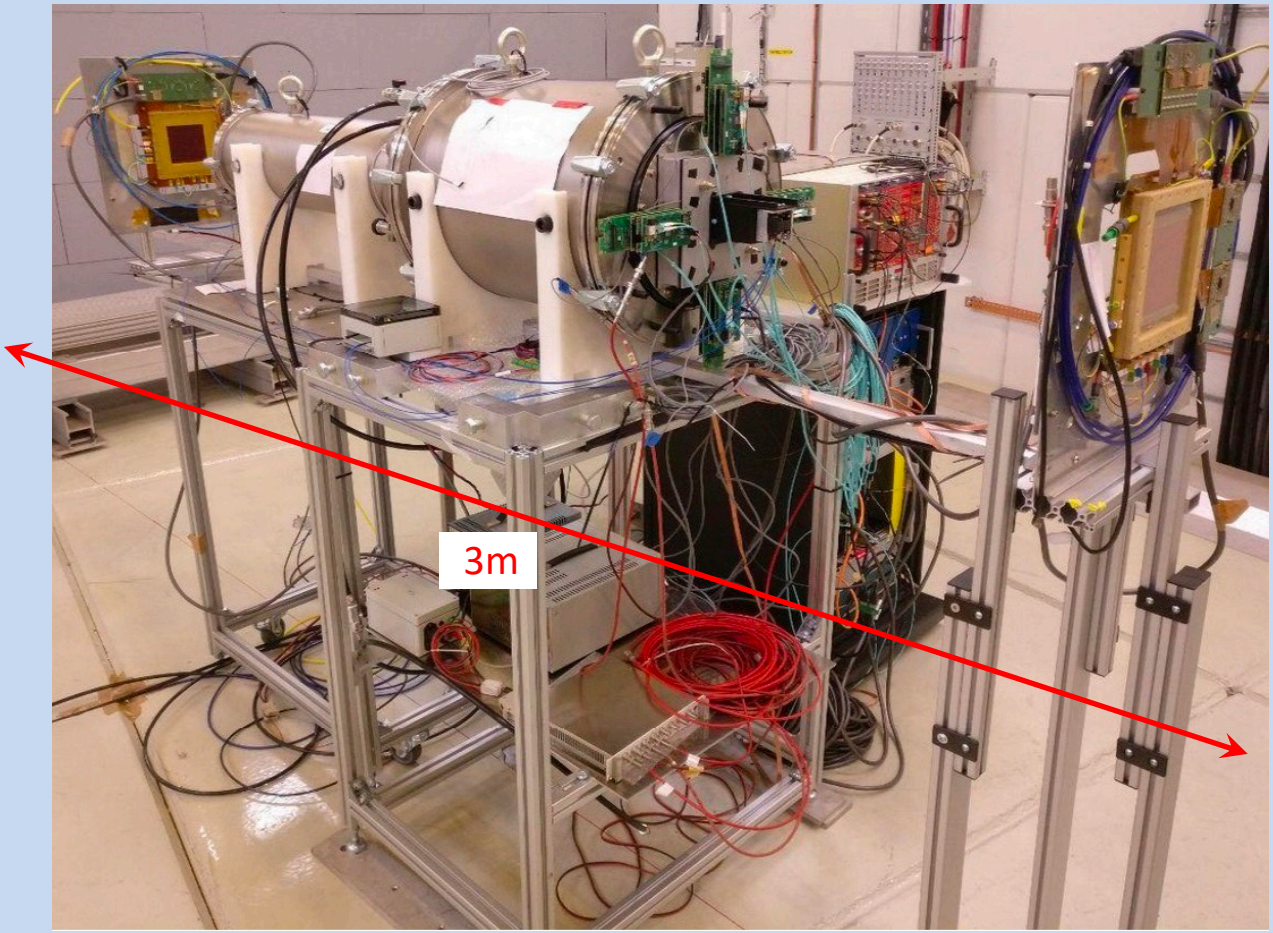








dRICH Prototype



Goals:

- Study dual radiator performance and interplay
- Study specifications and alternatives for optical components
- Test alternate single-photon detection systems
- Design parameters and optimization

Basic system commissioned in 2021 runs

Prototype Signals

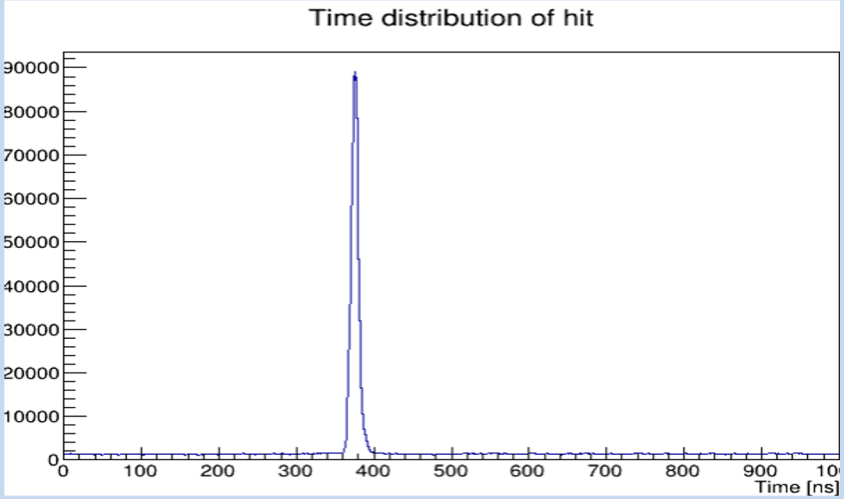
2021 beam time:

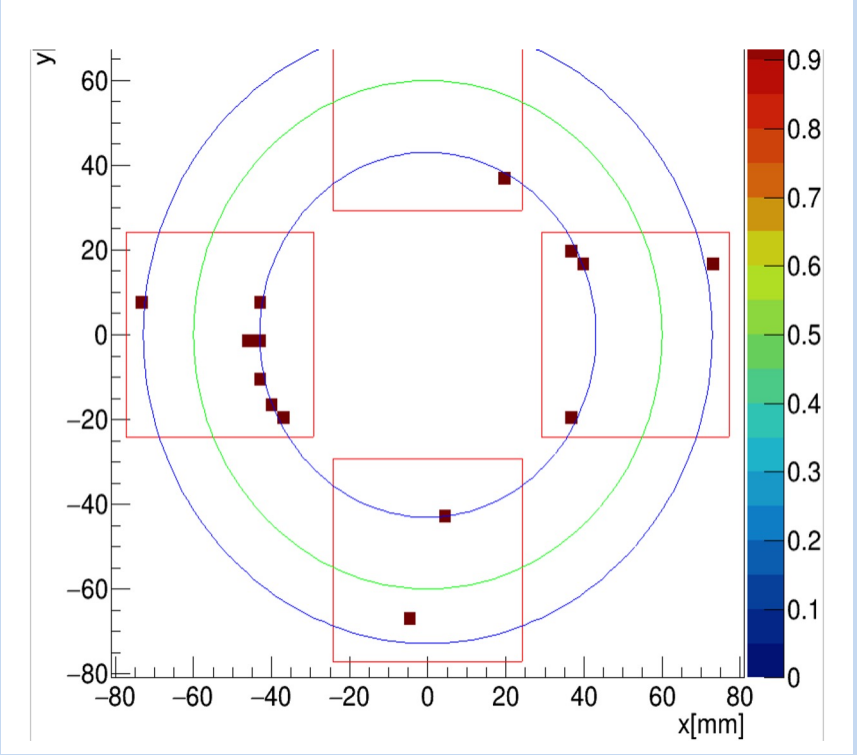
- Most of the time was parassitic
- Sensors + readout shared with eRD101
- Beam line still under commissioning

Prevented a detailed systematic study
Nevertheless preliminary performance study was possible

Example of event display

- Recorded hit
- Sensor
- Geometrical selection
- Gas and aerogel reconstructed rings

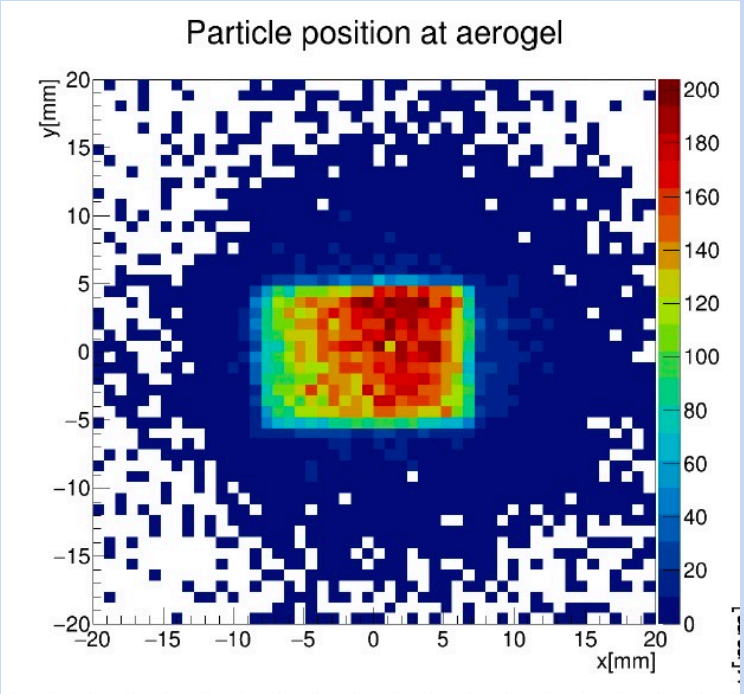


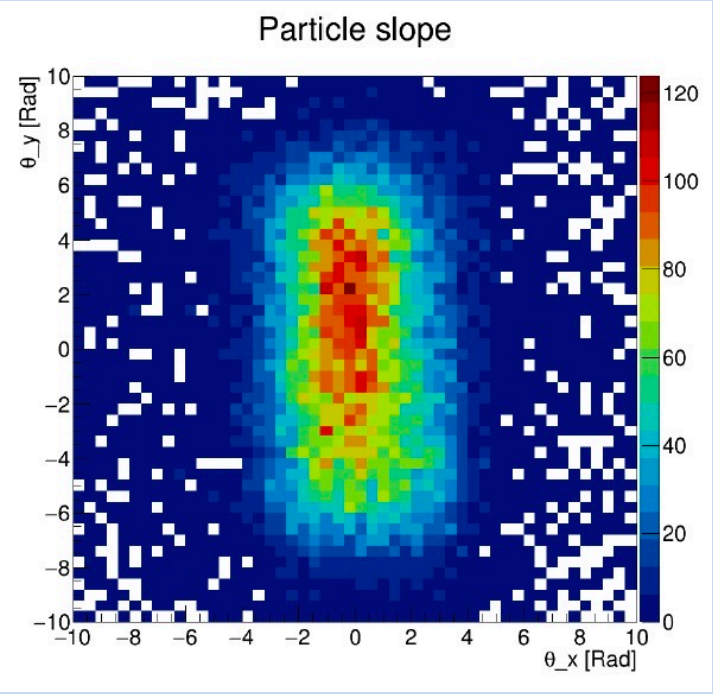


GEM tracking and alignment

A tracking system based on two GEM detectors was used during the test beam to track the beam particles for measuring alignment and beam divergence.

The combination of the dRICH optical information and GEM track information allows to correct data on an event by event analysis.

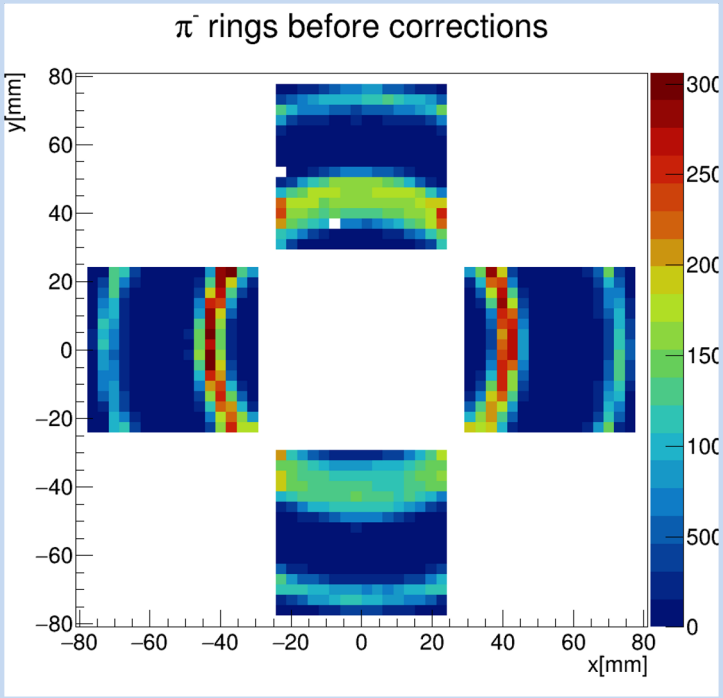


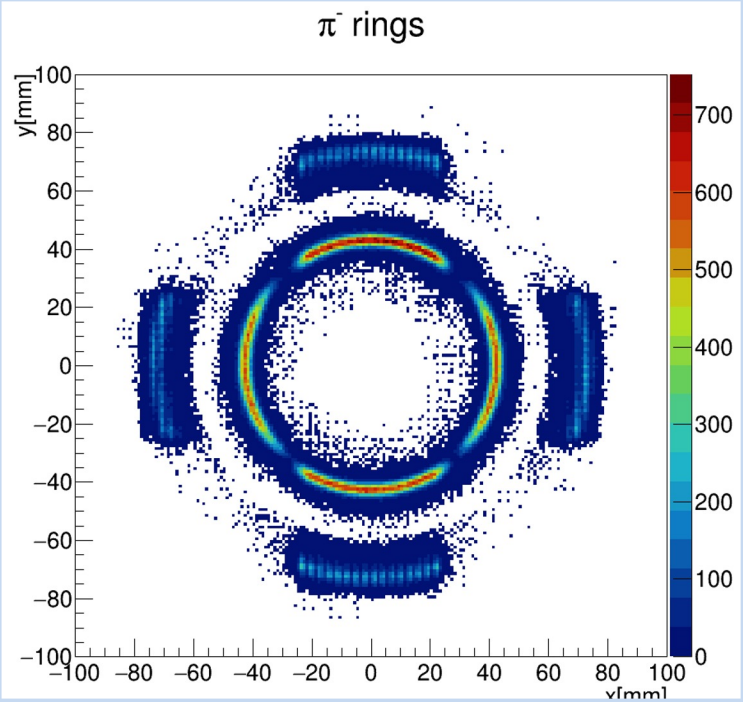


Cherenkov Rings

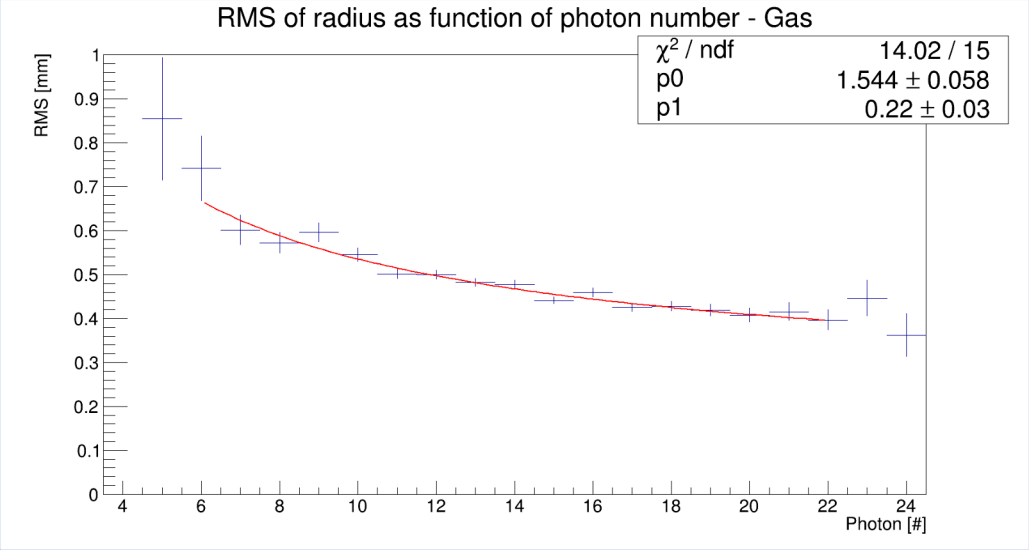
A tracking system based on two GEM detectors was used during the test beam to track the beam particles for measuring alignment and beam divergence.

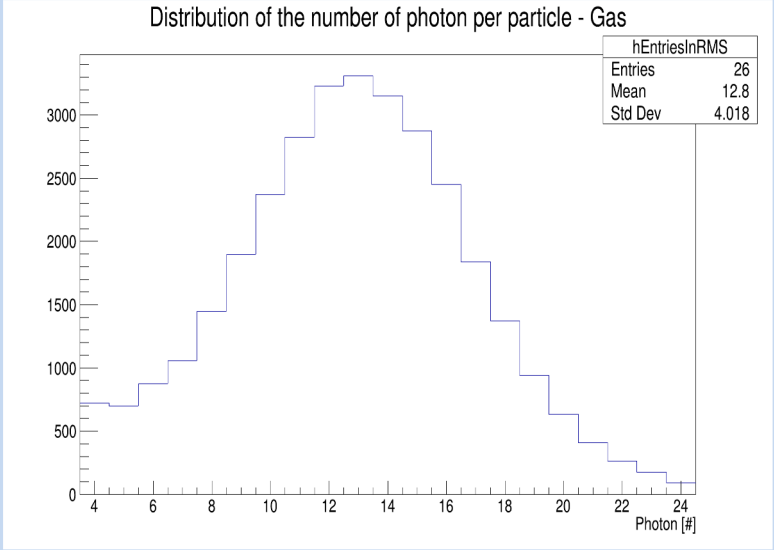
The combination of the dRICH optical information and GEM track information allows to correct data on an event by event analysis.





Preliminary Performance: Gas





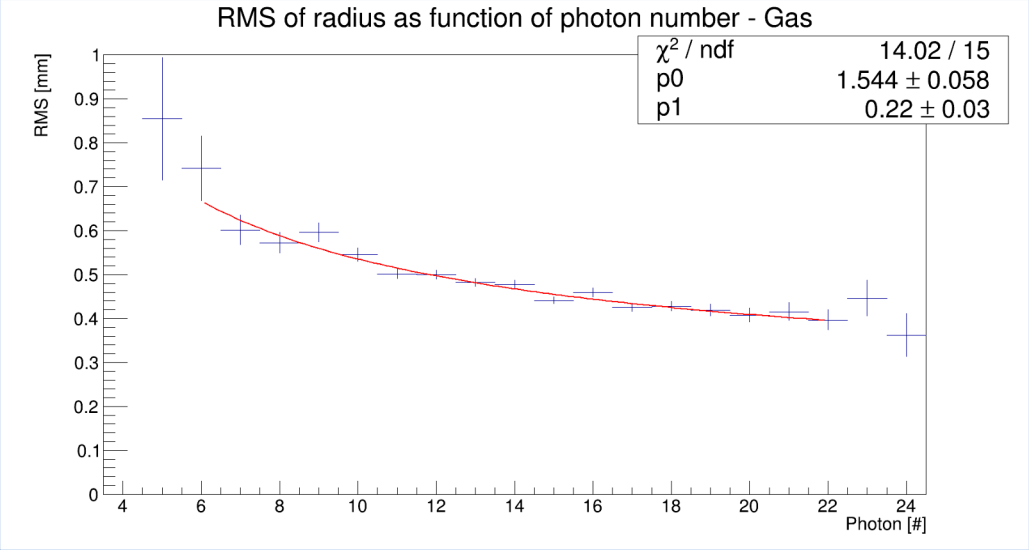
Fitting function: $y = \sqrt{\frac{{p_0}^2}{x} + {p_1}^2}$

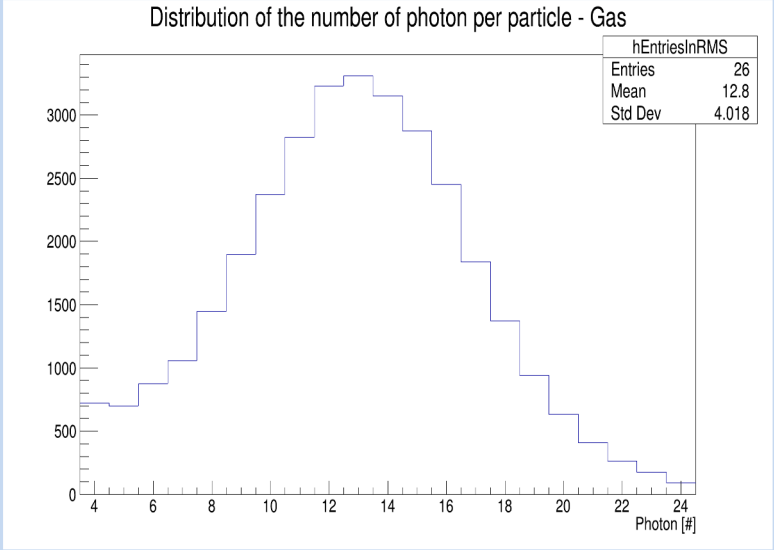
p_0 = single photon resolution

p_1 = single particle resolution constant term

Gas	Data	Simulation
p_0 [mm]	1.5	1.1
p_1 [mm]	0.22	0.07
Avg photon	12.8	11.3

Preliminary Performance: Aerogel





Fitting function: $y = \sqrt{\frac{{p_0}^2}{x} + {p_1}^2}$

p_0 = single photon resolution

p_1 = single particle resolution constant term

Aerogel	Data	Simulation
p_0 [mm]	1.9	0.8
p_1 [mm]	0.53	0.26
Avg photon	3.5	3.5

Next Steps

Progress with the analysis and simulation

Prepare for the next test-beam campaign (fall 2022)

Characterize and optimize the radiators

Move from reference detectors (MAPMTs) towards EIC driven detector

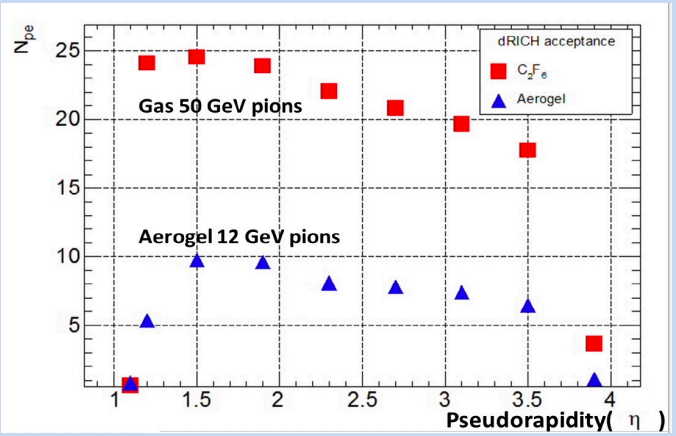
- SiPM with dedicated streaming readout

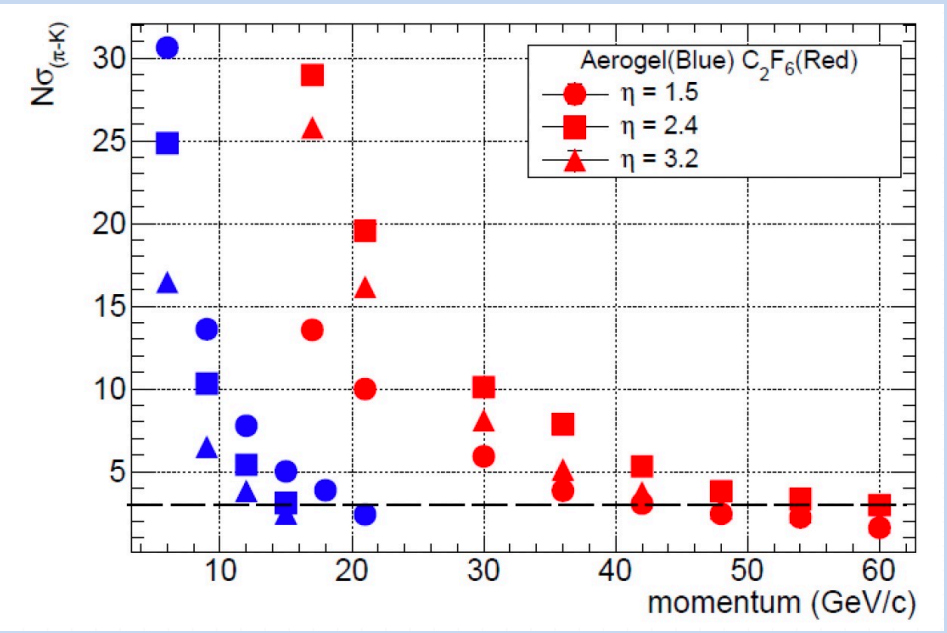
EIC Detector Simulations

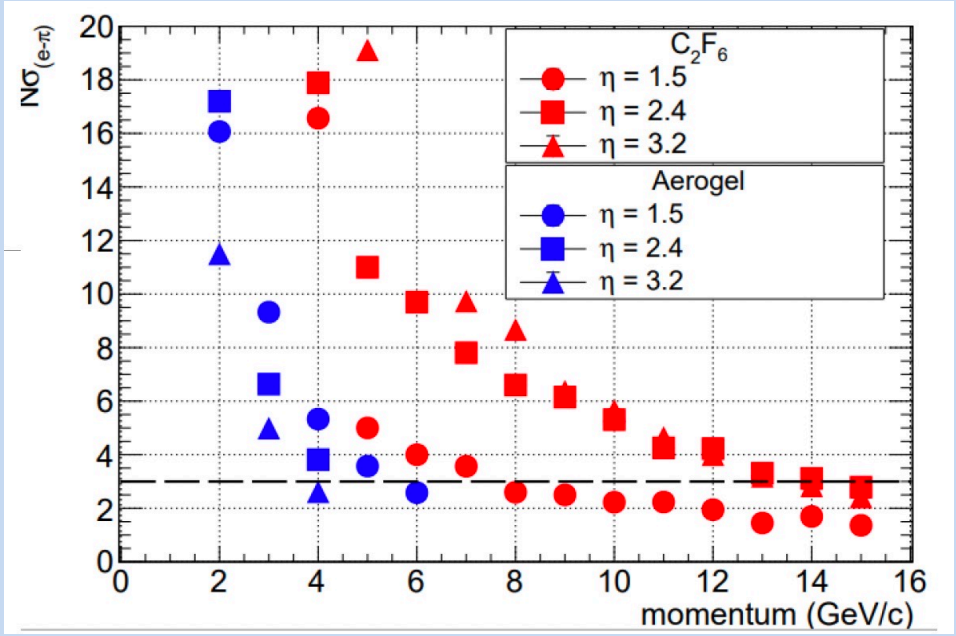
Goal: study realistic implementation

compare with YR specifications

benchmark with prototype performance







EIC Detector Simulations

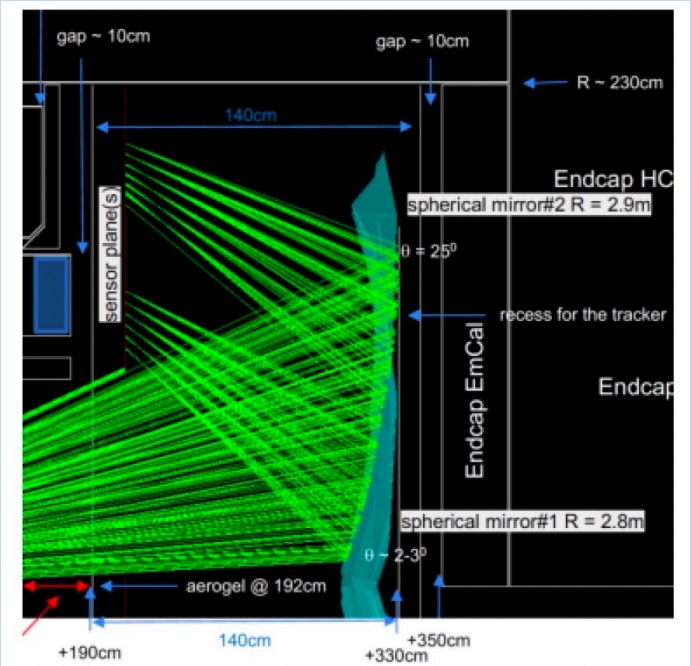
Study optics vs geometry constraints

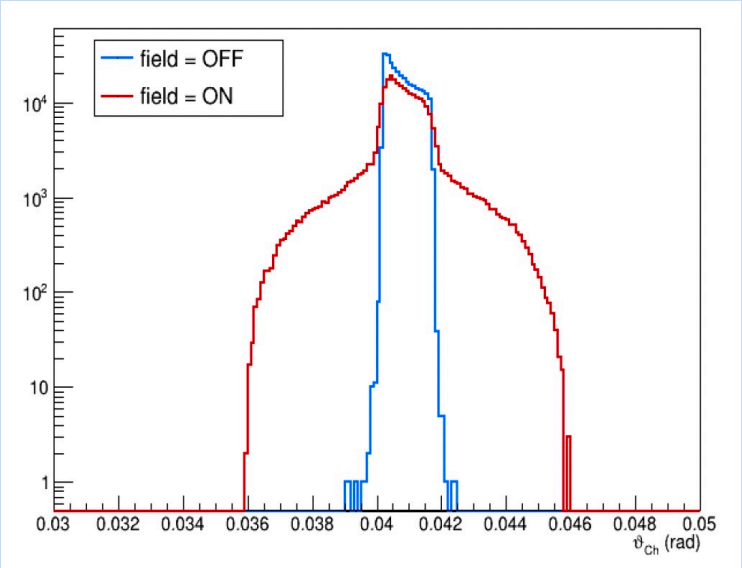
radiator n vs thickness

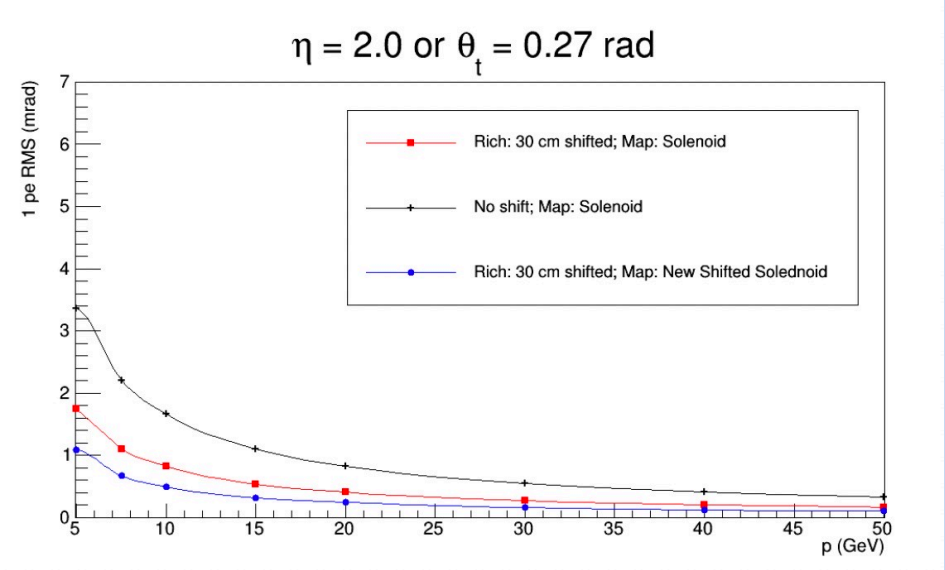
focal plane vs detector surface

Study magnetic bending effect

…..



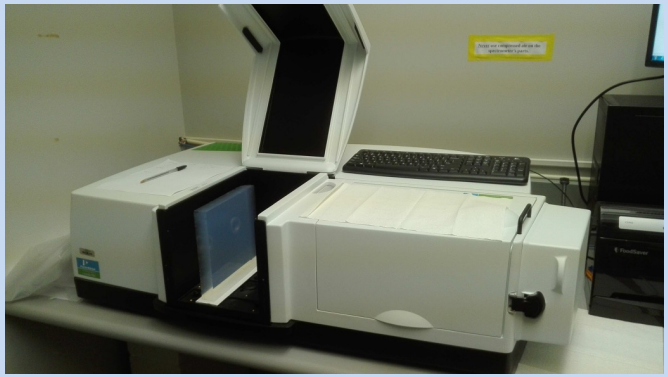




Optical Components

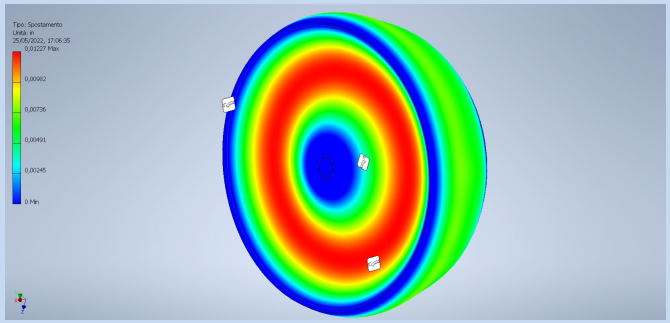
Aerogel (japanes, Russian)

Acrylic windows

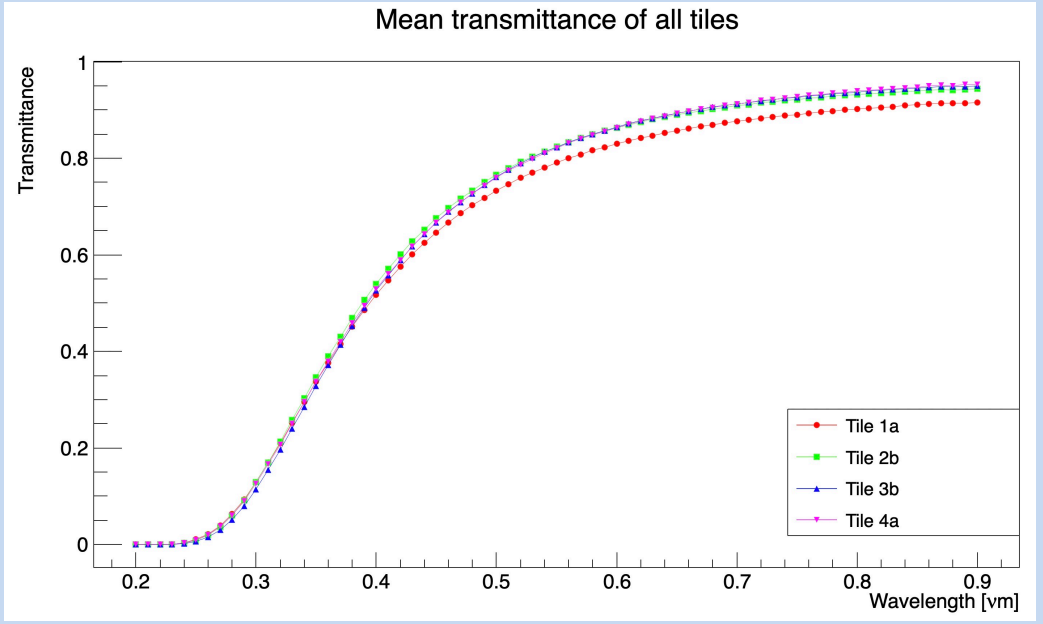


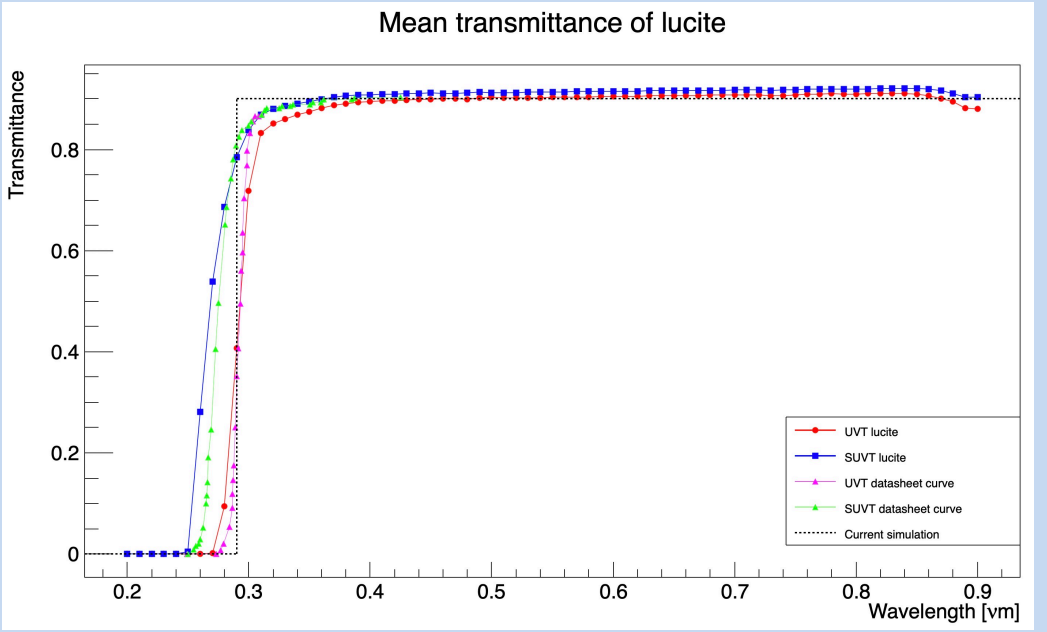
Light mirrors

High-P Ar alternate of greenhouse gas



Optical quality characterization
Input for simulations and
Performance optimization

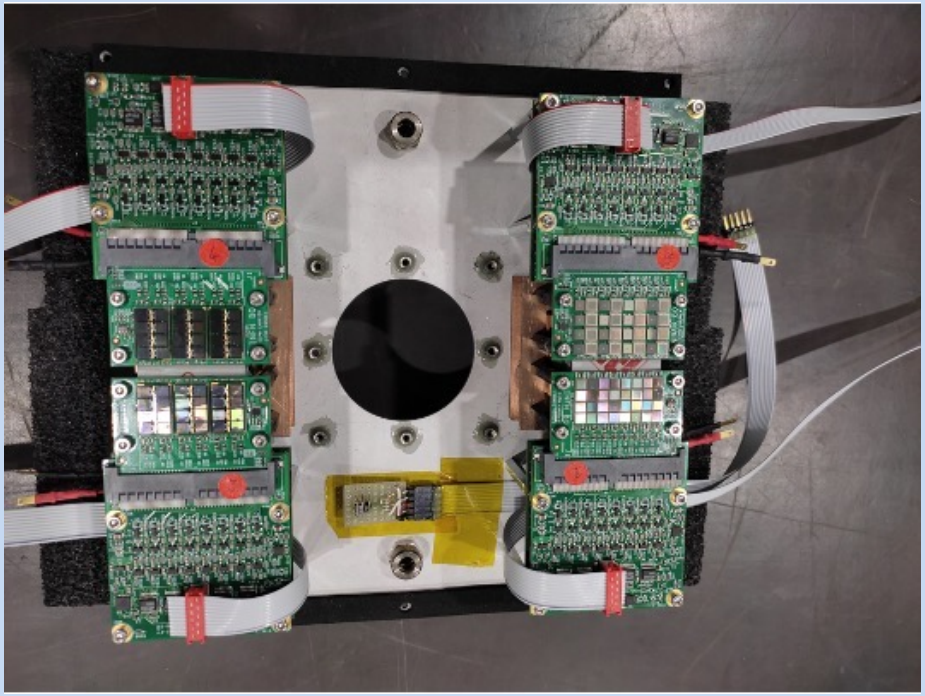


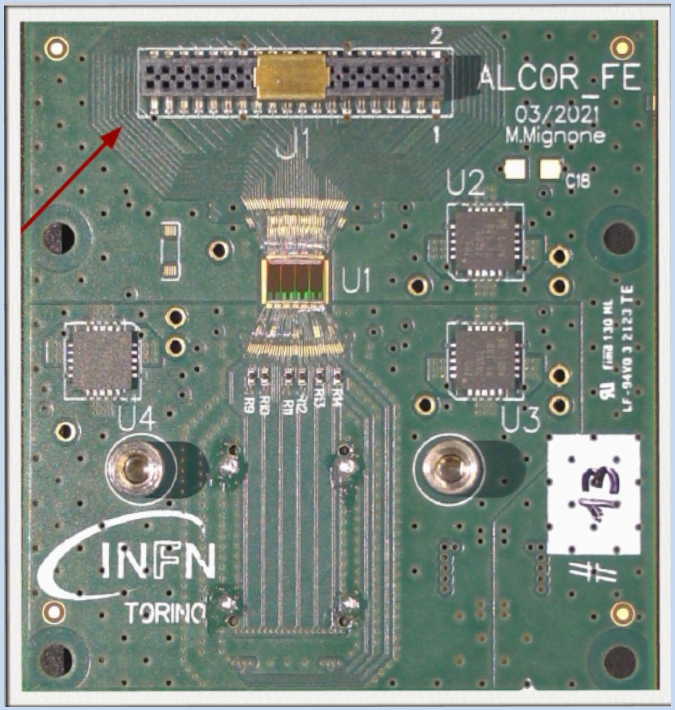


First Steps towards SiPM

Test Cherenkov application for magnetic field insensitive sensor (SiPM)
Control SiPM high dark count to isolate single photon signal (same amplitude!)
Use a new ALCOR chip (high-rate ToT architecture) in streaming mode

50 ps time bin, > 500 kHz rate per channel, cryogenic compatible

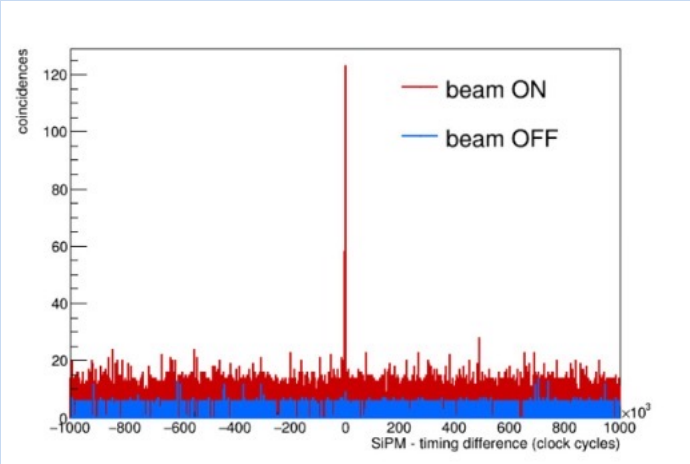


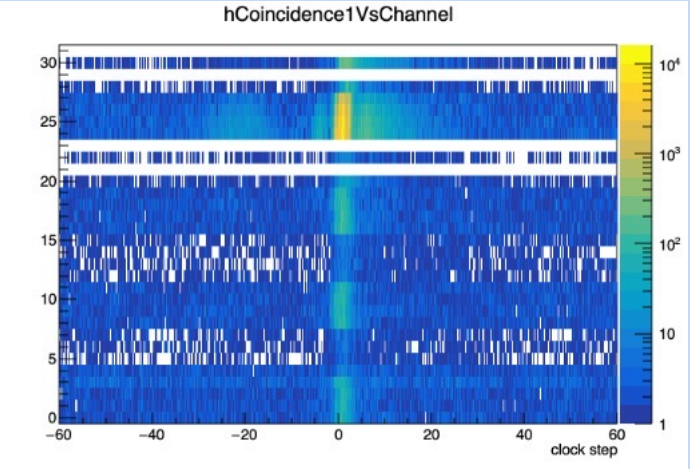


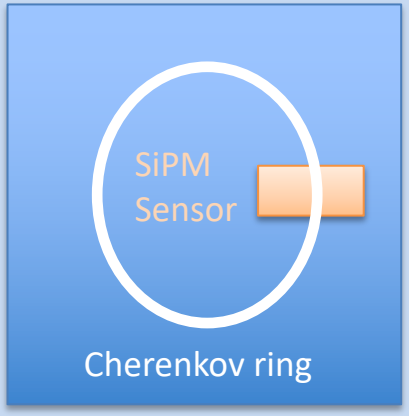
First Steps towards SiPM

Test Cherenkov application for magnetic field insensitive sensor (SiPM)
Control SiPM high dark count to isolate single photon signal (same amplitude!)
Use a new ALCOR chip (high-rate ToT architecture) in streaming mode

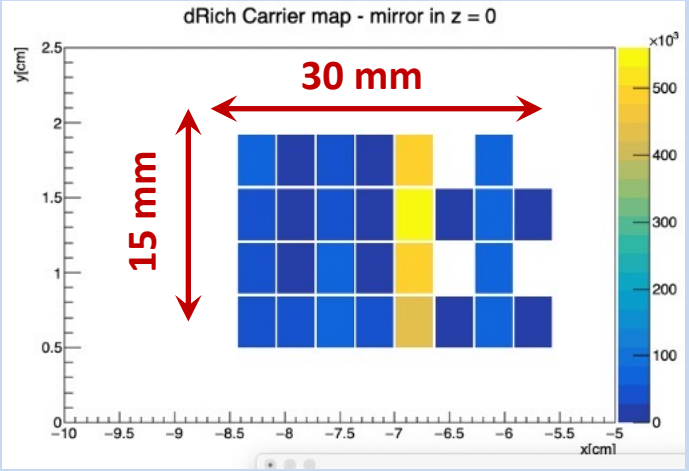
Time coincidence with beam particle

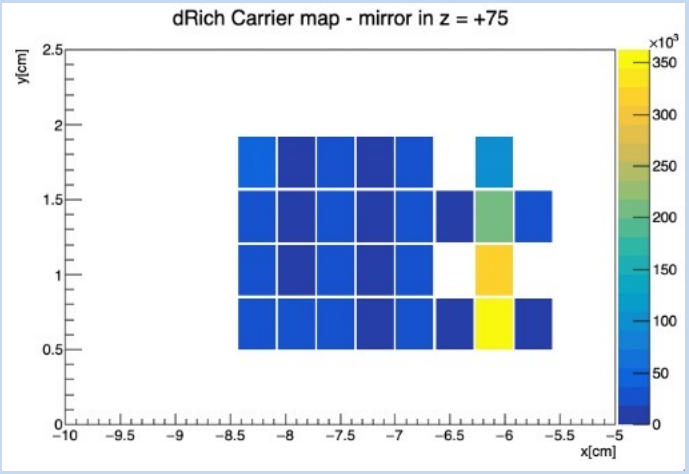






Reflected signal moves with mirror





Conclusions

eRD102 seeks for cost-effective solution for particle identification in EIC hadron endcap

Preliminary studies show that the wanted (YR) specifications could be meet

A detailed R&D is ongoing with a realistic prototype and on single components

Milestones:

Realistic implementation of dRICH into the EIC detector – **10/22**

Initial assessment based on the first test beam – **12/22**

Realization of a suitable detector plane for the dRICH prototype – **3/23**