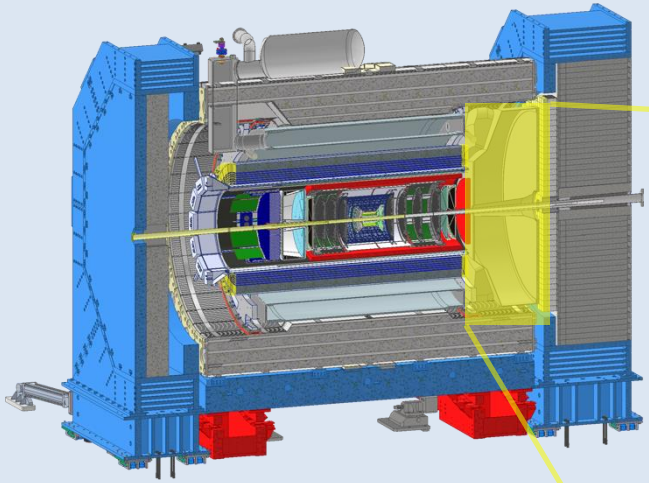
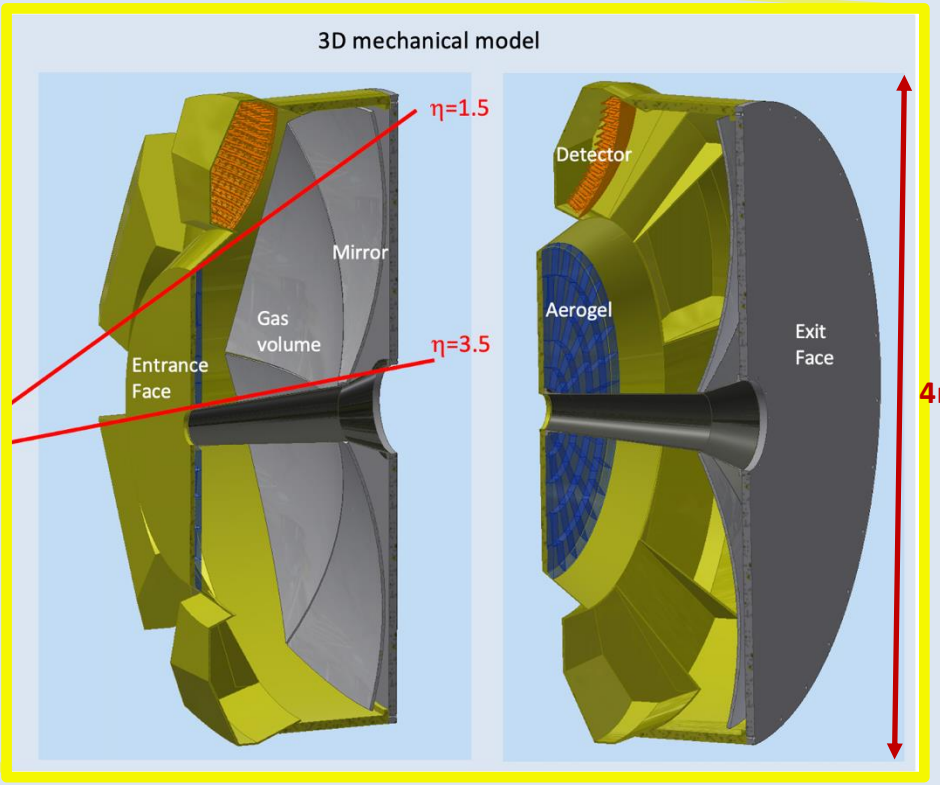


Dual-radiator Ring-imaging Cherenkov Detector (dRICH)

Essential to access flavor information



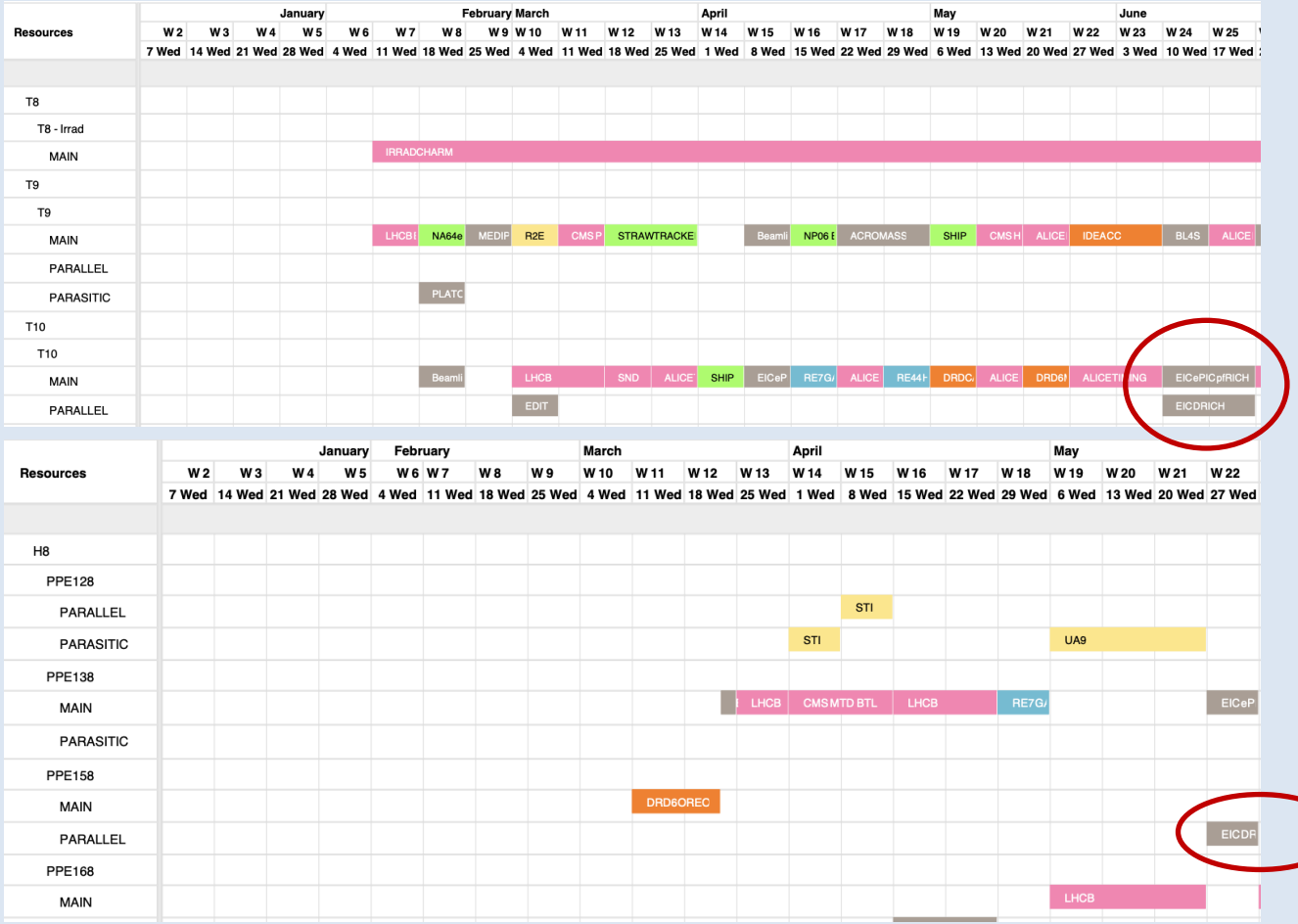
Goals:

- Hadron 3σ–separation between 3 - 50 GeV/c
- Complement electron ID below 15 GeV/c
- Cover forward pseudorapidity 1.5 (barrel) - 3.5 (b. pipe)

dRICH Features:

- Extended 3-50 GeV/c momentum range --> Dual radiator
- Single-photon detection in high Bfield --> SiPM
- Limited space --> Compact optics with curved detector

Test-Beams



1 + 2 weeks approved
in conjunction with pfRICH

27 May – 3 June

SPS H8 line

180 GeV/c protons

20-60 GeV/c hadrons

10 June – 24 June

PS T10 line

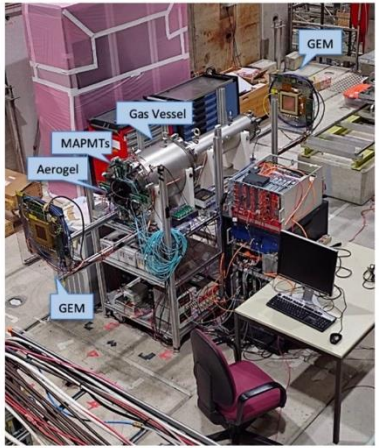
0.5 - 11 GeV/c hadrons

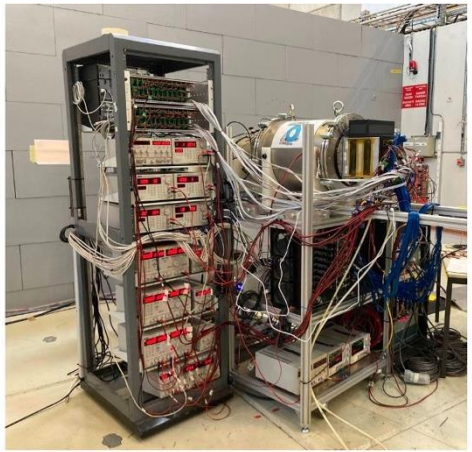
0.5 - 3 GeV/c electrons

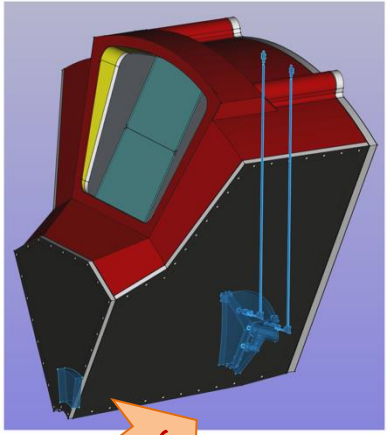
Test Beams

Previous validations:

- Dual-radiator concept
- C_2F_6 radiator gas performance
- Aerogel rafractive index
- SiPM-ALCOR readout chain
- EIC-drive readout plane
- Temperature gradients
- RDO readout



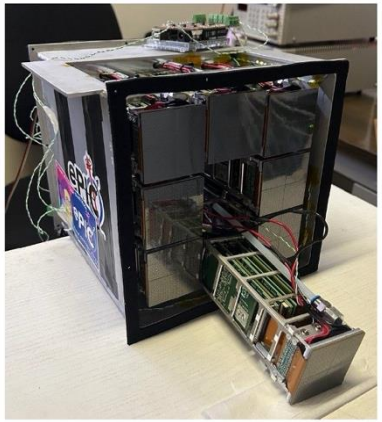


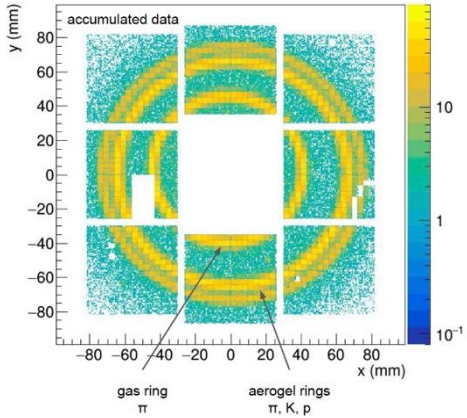


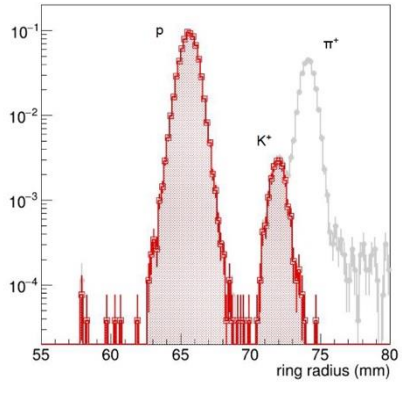
2026

2026 main goals:

Real scale 1-sector prototype with demo components







Slot at SPS/PS in June

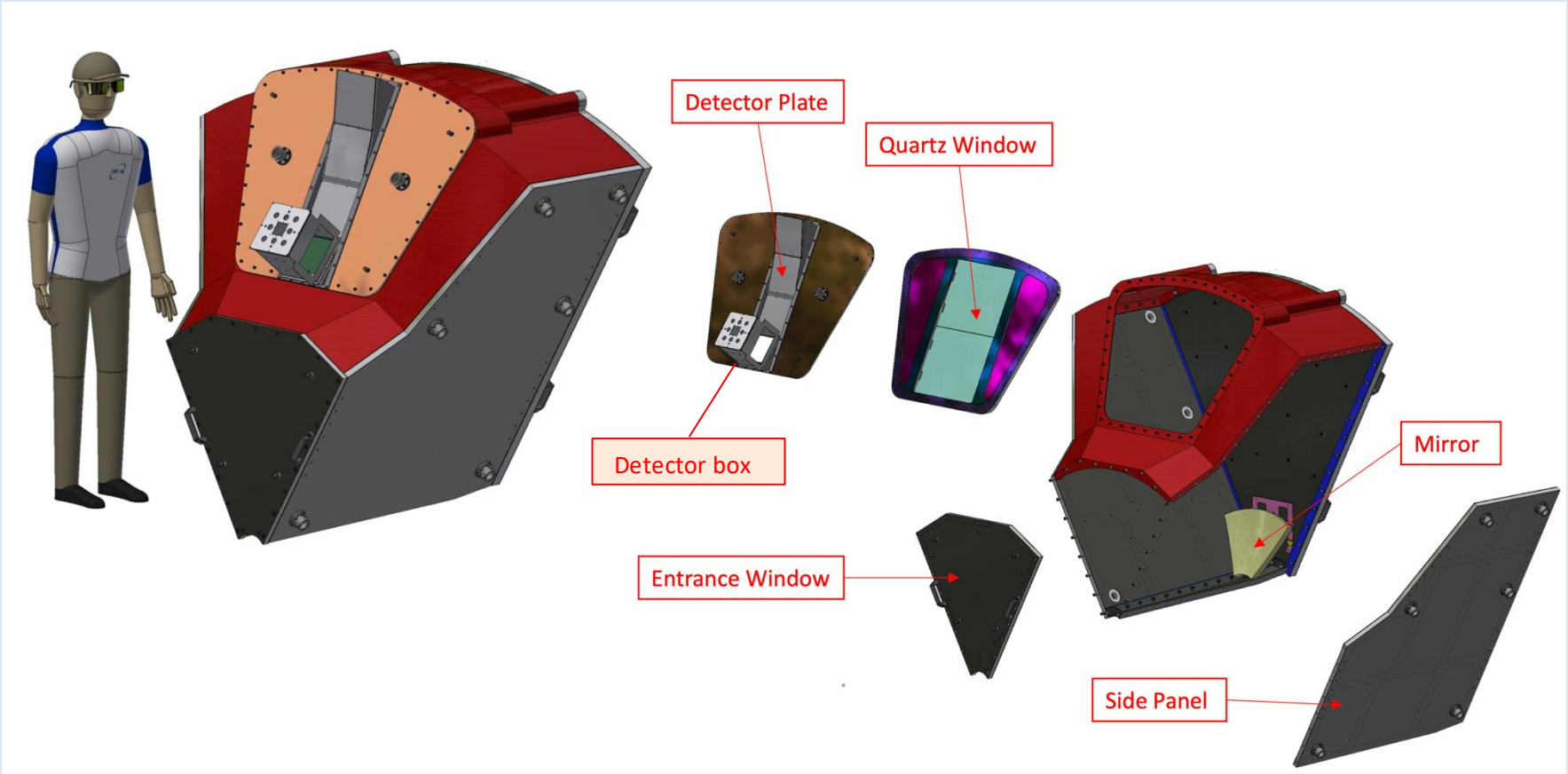
Question 1

Do you have all necessary hardware (components) available, and if not what is the timeline to receive them?

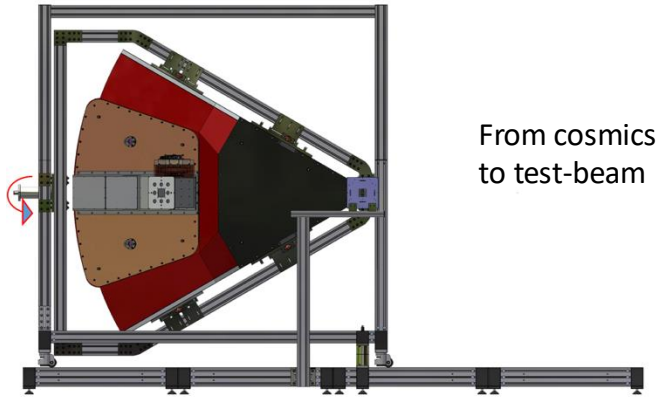
Yes

Assembling and functionality test ongoing

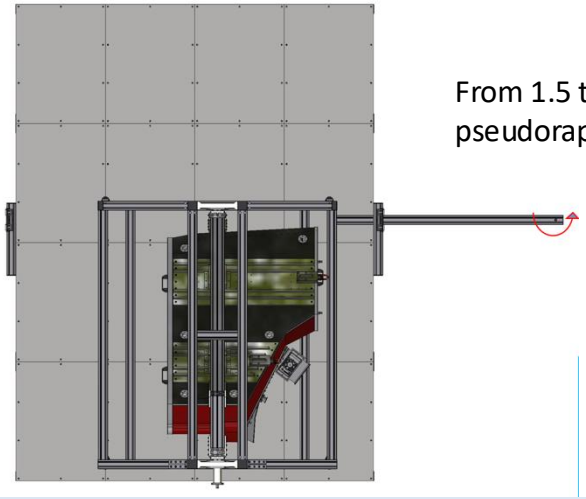
1/6 of the detector (1 ePIC sector), mid-size optical and radout components, optics as in ePIC



Prototype



From cosmics
to test-beam

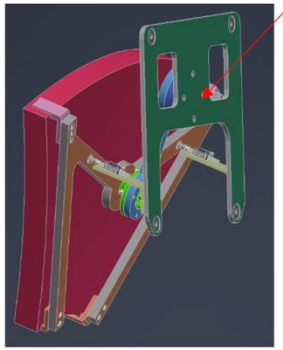


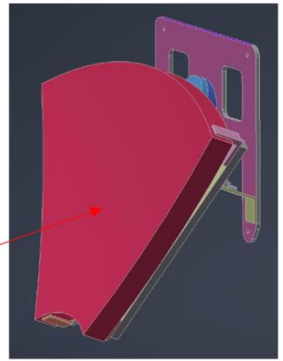
From 1.5 to 3.5
pseudorapitidy

Safety requires special attention (transport & assembling)

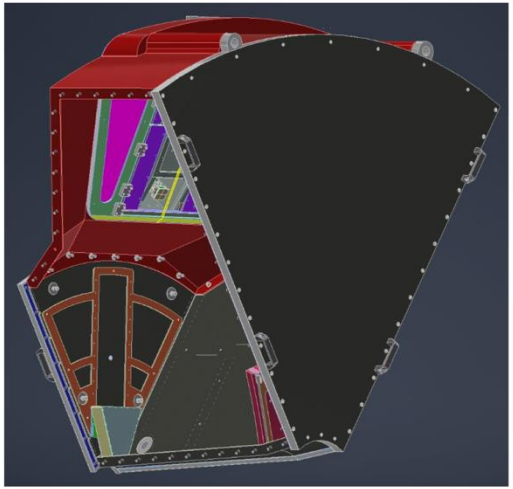
Inner Components

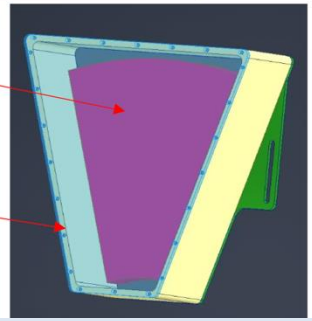
Mirror





Aerogel

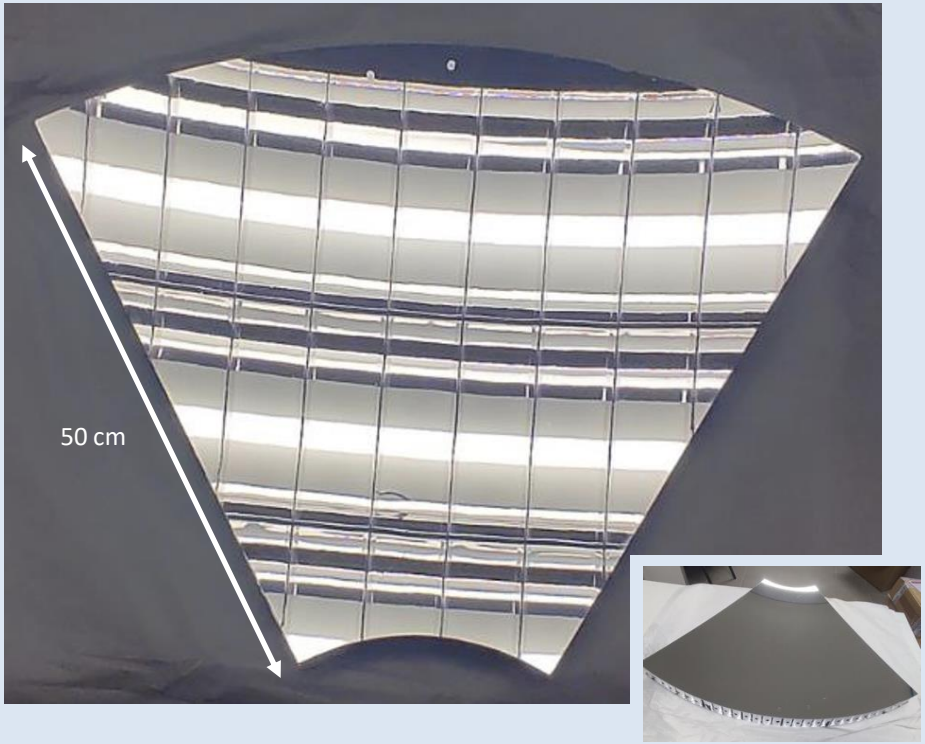




Mid-Size Components

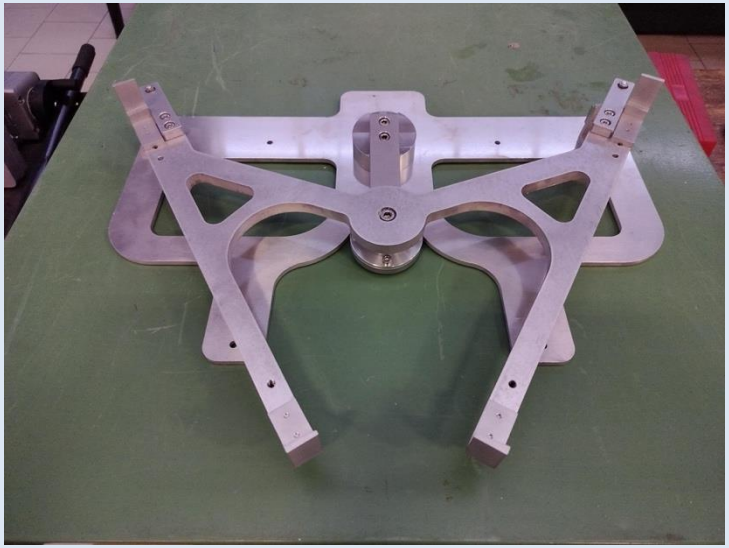
Mid-size demonstrators successfully produced

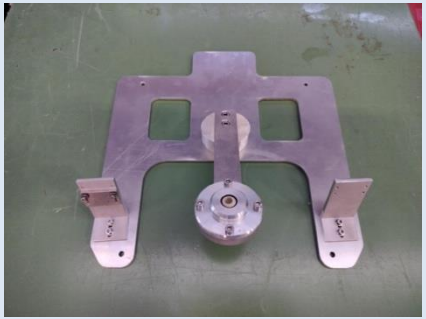
Mid-size mirror coating successfully done at ECI
Mirror has arrived in EU (FE)



2025 production of mid-size aerogel (15 -18 cm) successfully completed

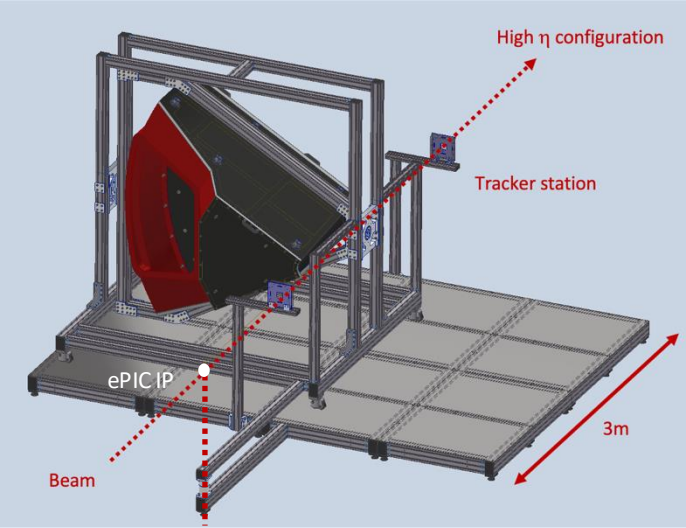
Mounting support for the mirror and piezo's (2 positions)

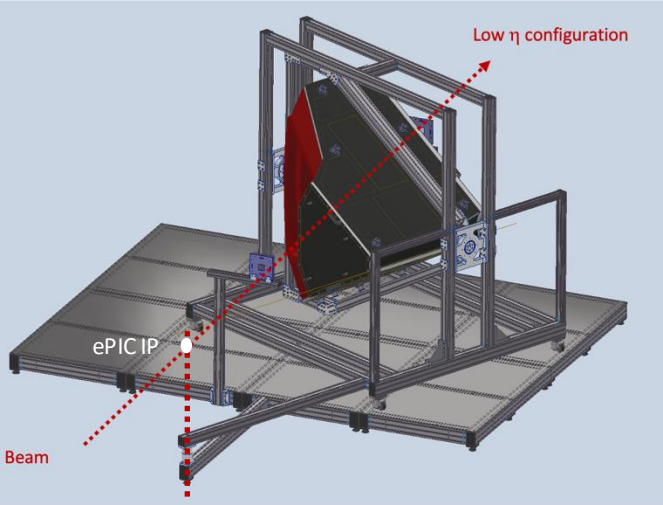




Mounting support for the aerogel

Saddle + Platform for safe operations (pseudorapidity scan with beam and cosmic tests)

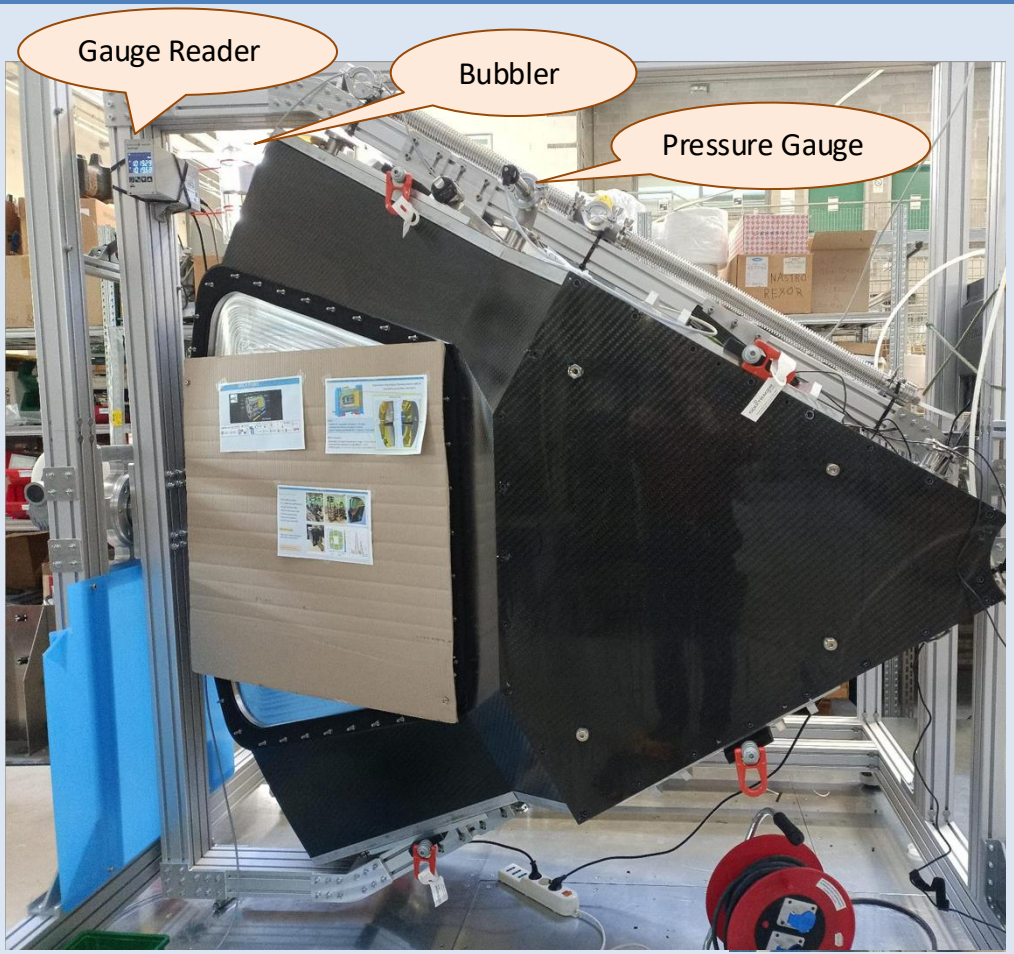


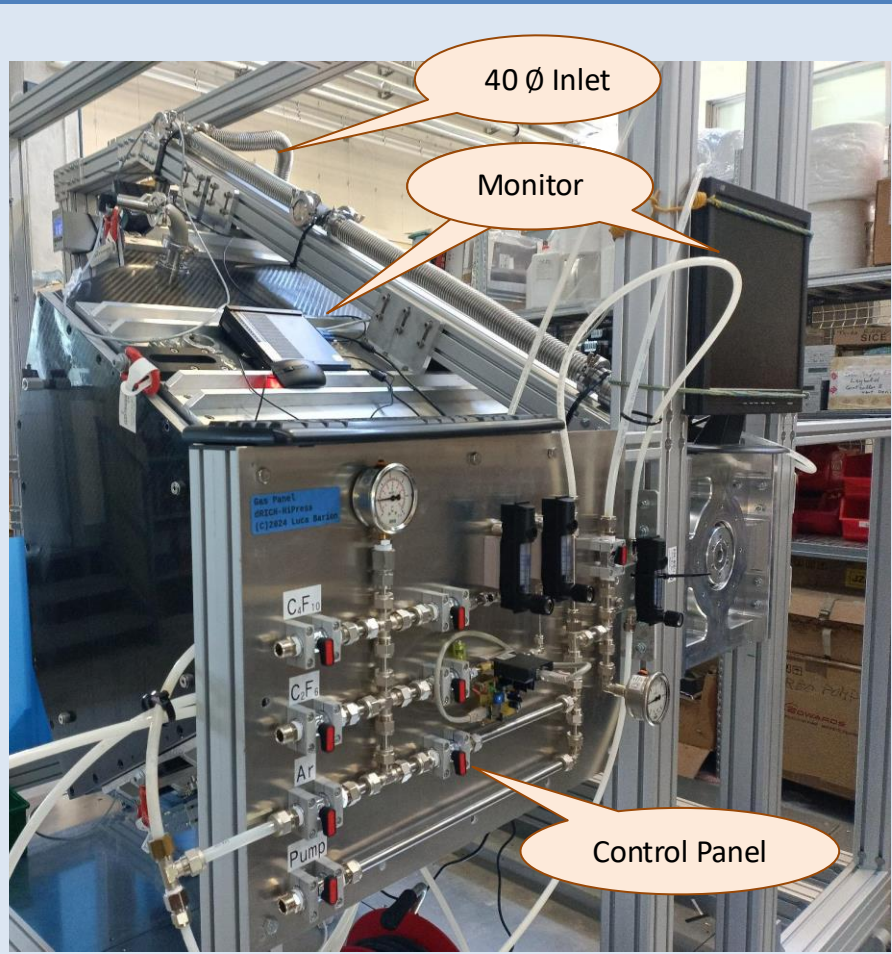


Being prepared for *safety handling* and gas operation validation prior of 2026 test-beam

Real Scale Prototype

Gas Control


Gauge Reader
Bubbler
Pressure Gauge


40 Ø Inlet
Monitor
Control Panel
Ar
Pump

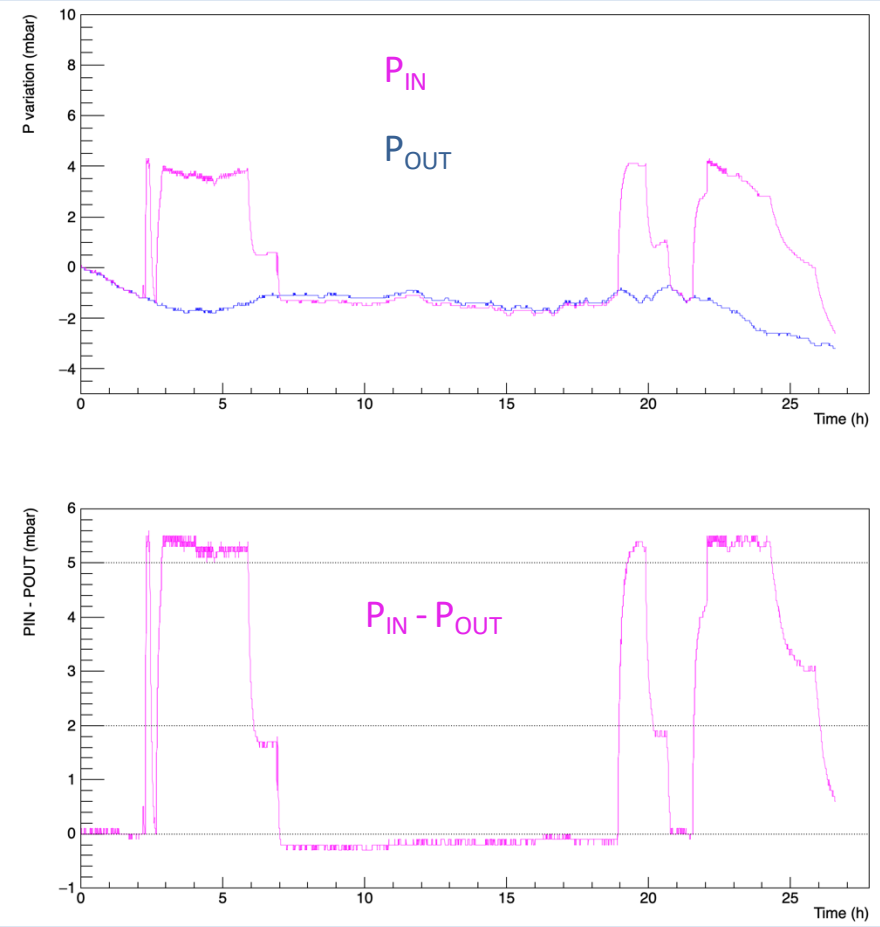
About 2 m^2 with large surfaces

Fragile quartz window

Reliable control system

- Inner vs outer pressure gauges
- Bubbler (+5 mbar)
- Flowmeters

Curing leaks:
inlet flow reduced from 2 lt/min down to 0.1 lt/min at more than 2 mbar overpressure



Gas System

C0-C10 membranes

Close circuit to preserve and recover C_2F_6
Use of C0-C10 filtering membranes

Tests ongoing at CERN and in Trieste
Initial 50-50% CO_2-C_2F_6 mix is purged in matters of minutes at 200 l/h

Gas analyzer

Test stand

Purging section

Question 2

Is the readout electronics and corresponding readout software running in the lab and thoroughly tested?

Yes

MaPMT plane available as reference (since years)

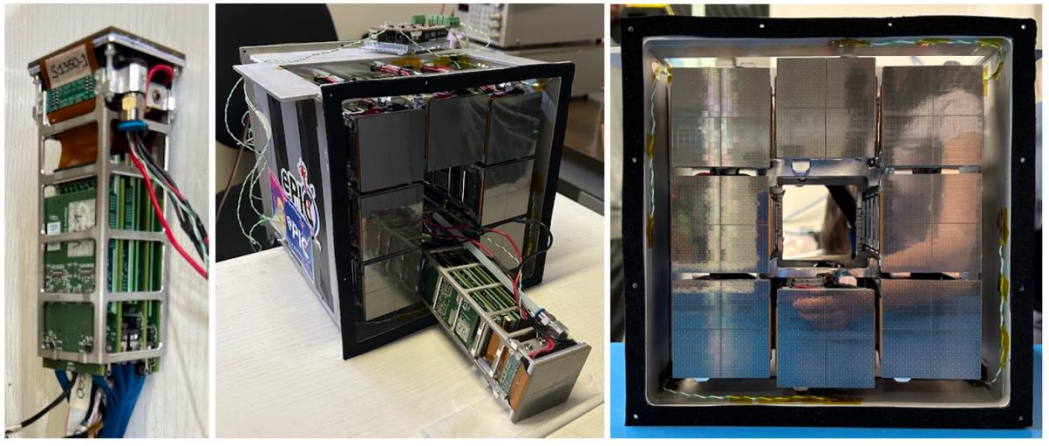
SiPM plane tested with ALCORv32 + RDO readout chain last year (Nov ’25 test-beam)

ALCORv64 will not be ready in time

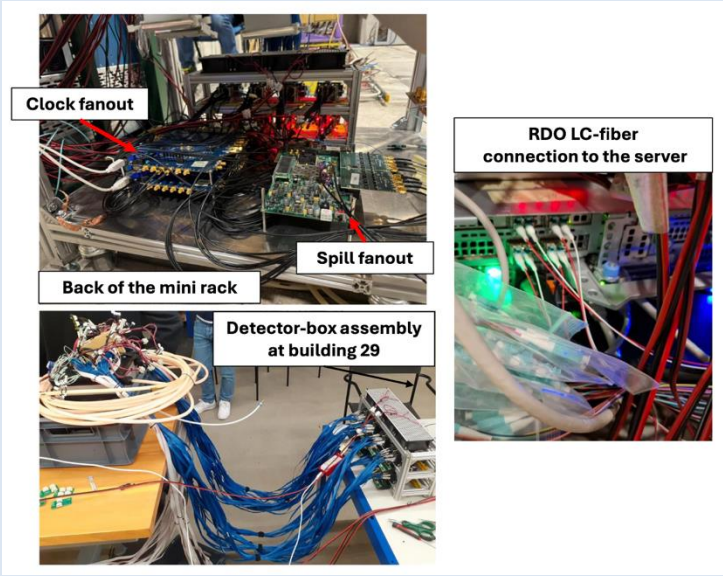
The test-beam will rely on the current (consolidated) version of PDU with ALCOR-32 and the fake-FEB adapters to RDO.

Integration of ALCOR64 into the PDU is deferred and will not be ready for the test-beam.

Fast UVE-SiPM can possibly be used for a comparative test.



RDO integration in Nov ‘25



The off-axis optics of the real-scale prototype allows to use up to 9 PDUs (no central hole for beam & aerogel)

Question 3

What type of "live QA" software do you have that helps you build confidence during the beam time that you are taking good data?

Slow control of detector plane and gas volume

Online data analysis: few minutes to reconstruct

MaPMT run (triggered DAQ) with GEM tracking

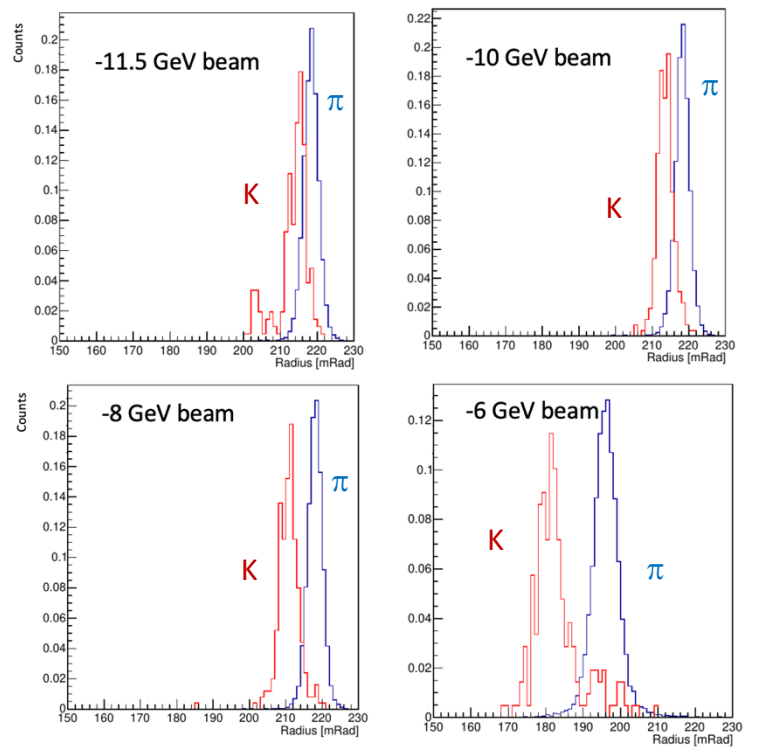
SiPM O(10) selected number of spills (streaming DAQ) with a basic multi-thread process

Kaon-Pion separation

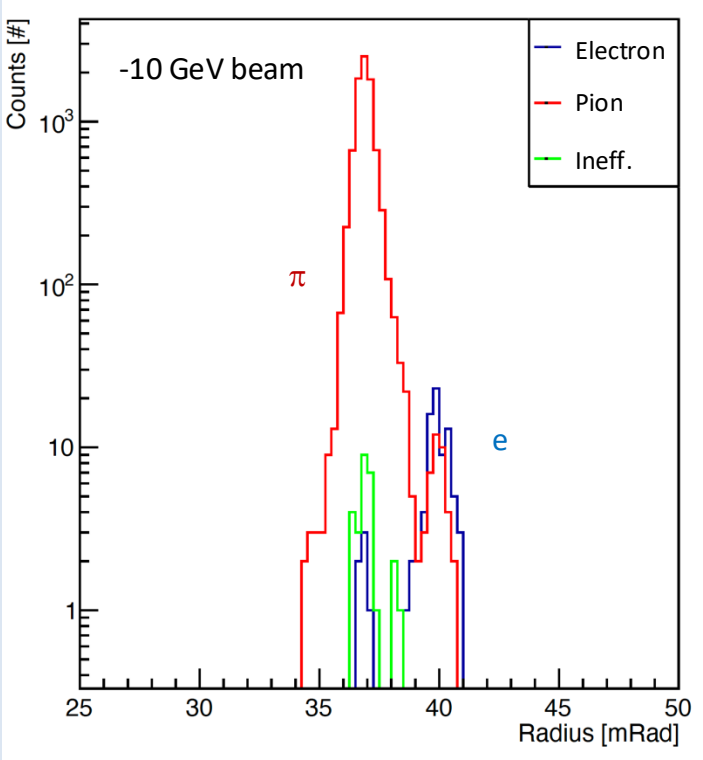
XCET Tagging Online Analysis

Electron-Pion separation

Aerogel ring n=1.026 with beam Cherenkov tagging

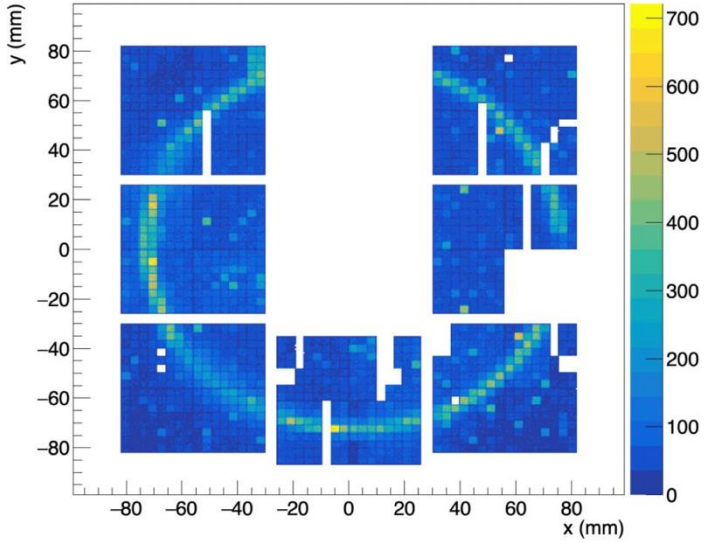


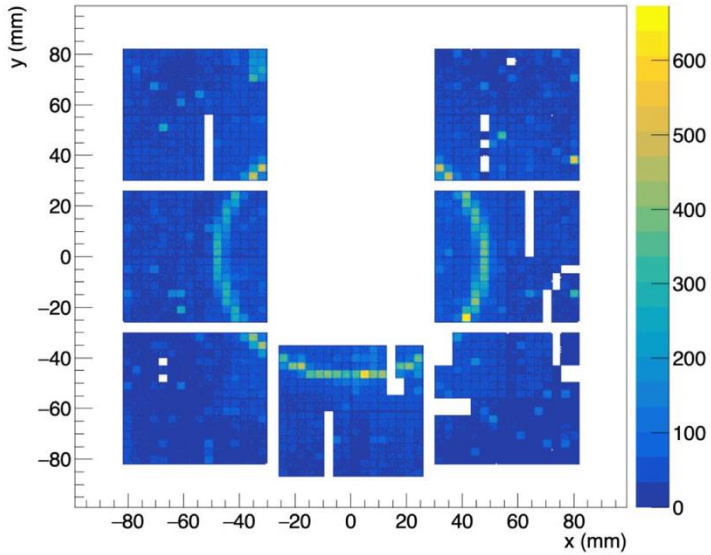
Gas ring with beam Cherenkov tagging



8 RDO successfully synchronized and operated in different conditions

Aerogel:
V_{bias} = 52 V
T = -28 °C
N_{spill} = 50





Argon:
V_{bias} = 52 V
T = -25 °C
N_{spill} = 20

Both **Aerogel and Argon (P = 3 bar)** were used as Cherenkov radiators. **V_{bias} and temperature scans** were performed for all the SiPM channels.

The data analysis is not yet finished, but the new **RDO readout system provided full data-taking identifying the Cherenkov ring** at different DCR levels.

RDO: 9 validated, 1 damaged during preparation, 1 VTRX+ connection was foulty during test-beam

Question 4

Describe your scientific goals and the specific measurements and parameter scans required to fulfil it.

Operate real-scale prototype and mid-size components in the ePIC-like configuration

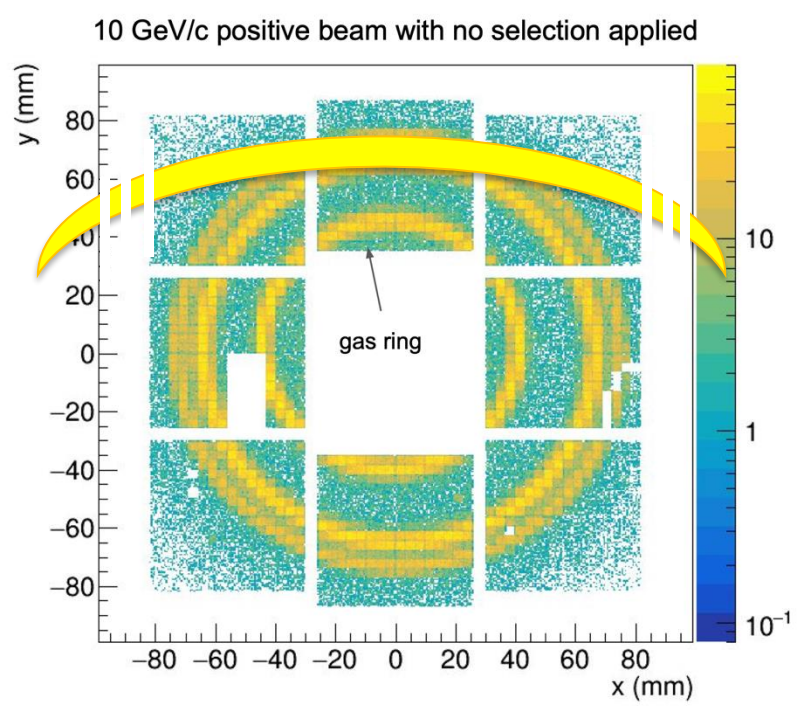
- off axis optics
- mimic focal distance and curved detector surface
- practice in the operation of a detector module with a scale comparable to the experiment
- at SPS commissioning with 180 GeV/c protons

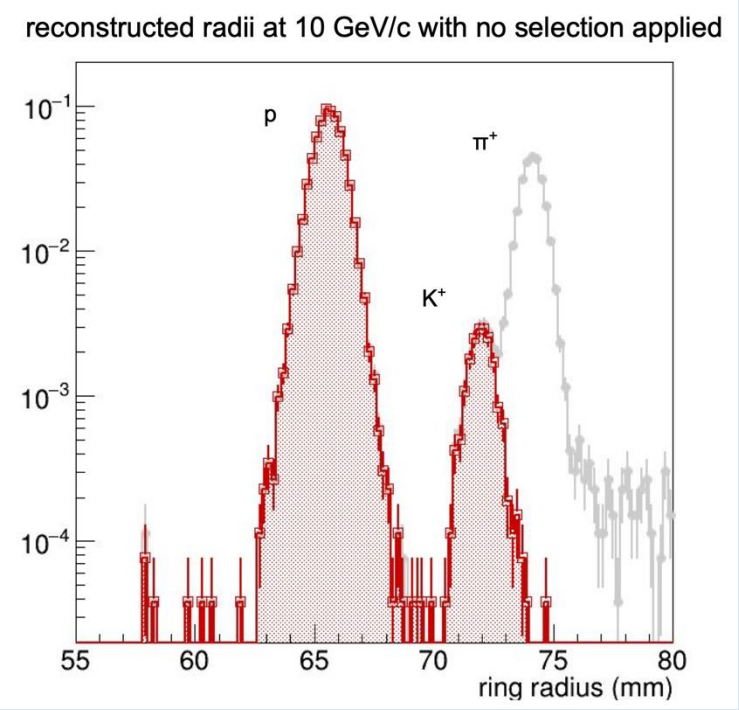
  scan of gas range (20 - 60 GeV/c) with XCET tagging
- at PS scan of aerogel range and transient (2 - 11 GeV/c) with XCET tagging

  scan in the electron sensitive range (0.5 – 11 GeV/c)

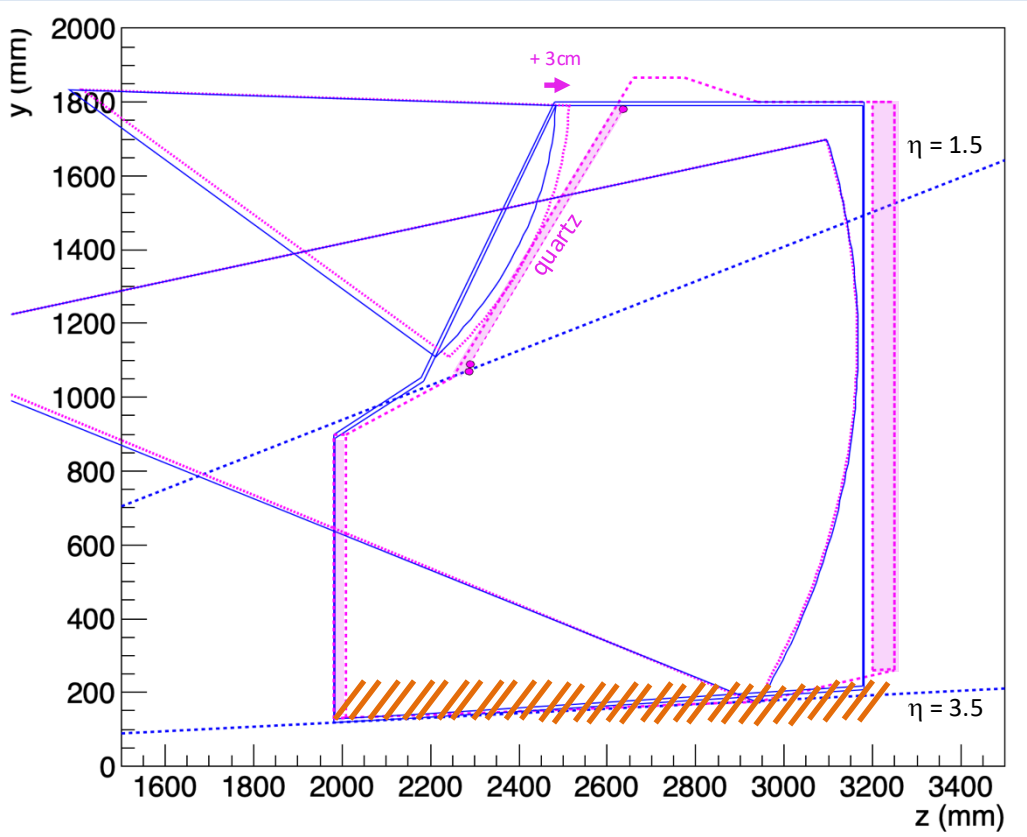
Goal: study Cherenkov imaging in the ePIC conditions

Full ring for gas radiator, just a portion for aerogel

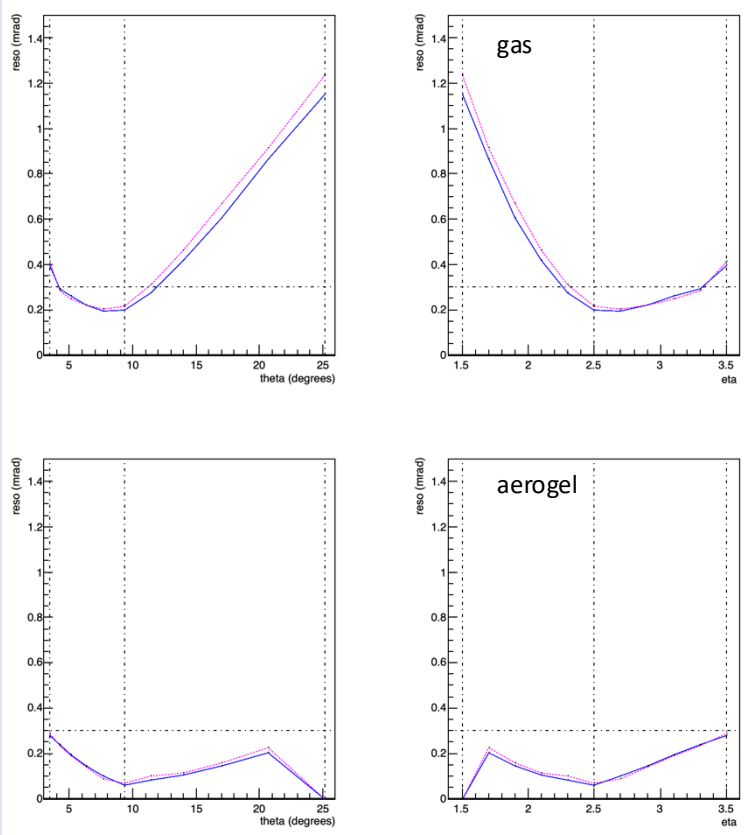




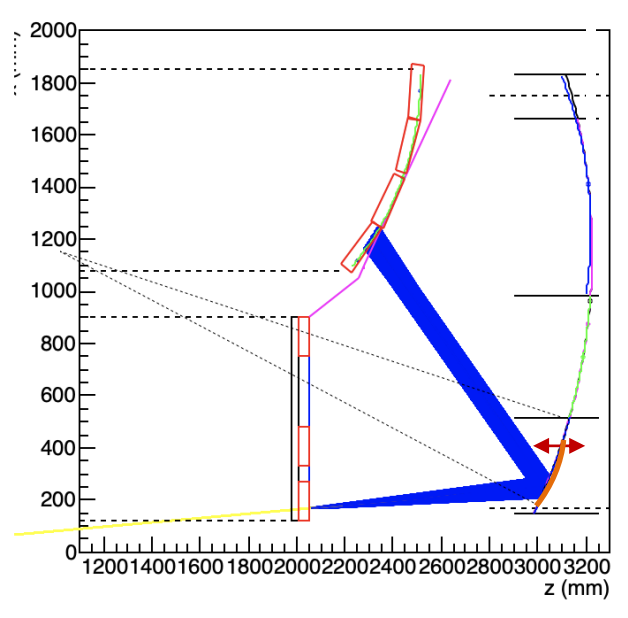
– dd4hep standard – mechanics standard

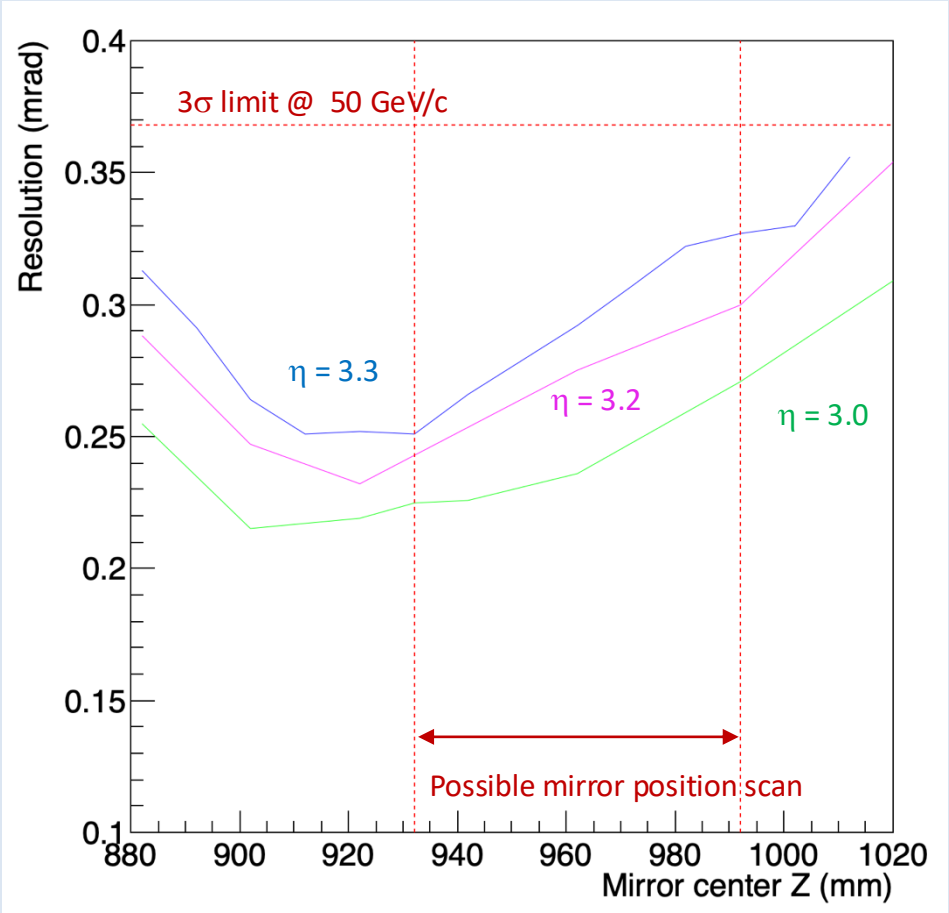


Resolution due to emission uncertainty

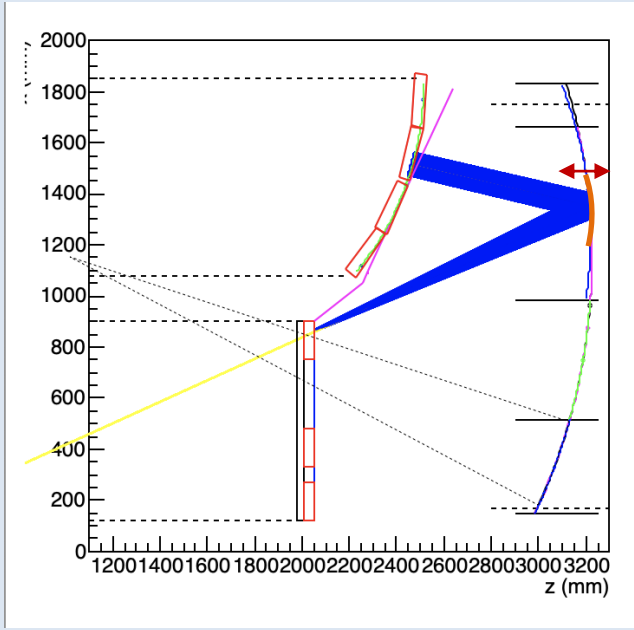


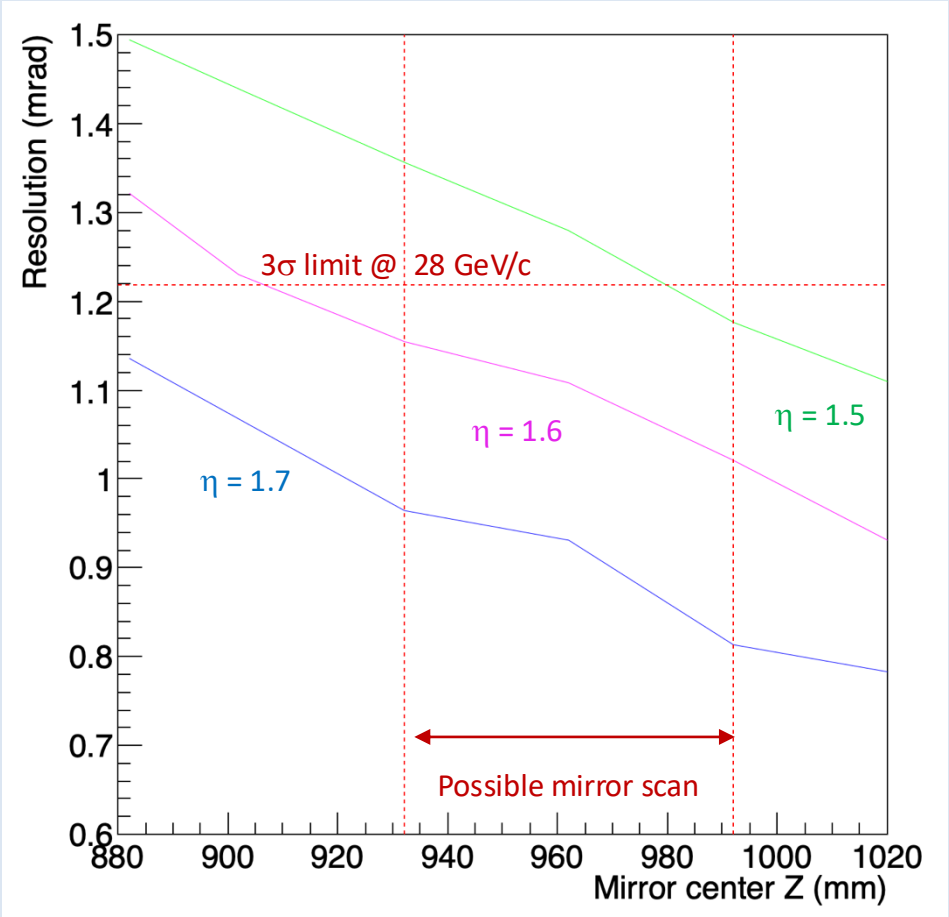
Optics optimized at η ~ 2.7





Optics optimized at η ~ 2.7





Question 5

What is the status of data analysis of previous beam tests? Which insights of previous beam tests are required to guarantee success of the upcoming beam test?

Consolidated analysis for MaPMTs (0.5 ns time resolution, no significant DCR)

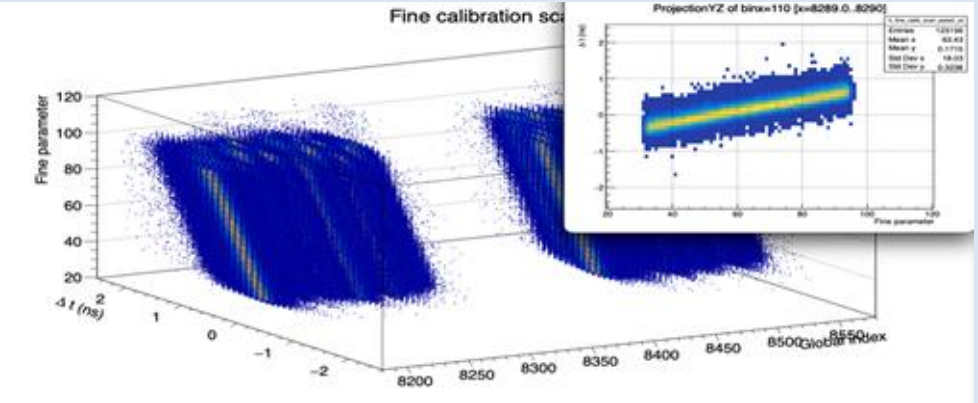
Advanced analysis for SiPM: boost time resolution towards 200 ps

working to refine calibrations and optimize timing

deal with significant DCR

characterize background

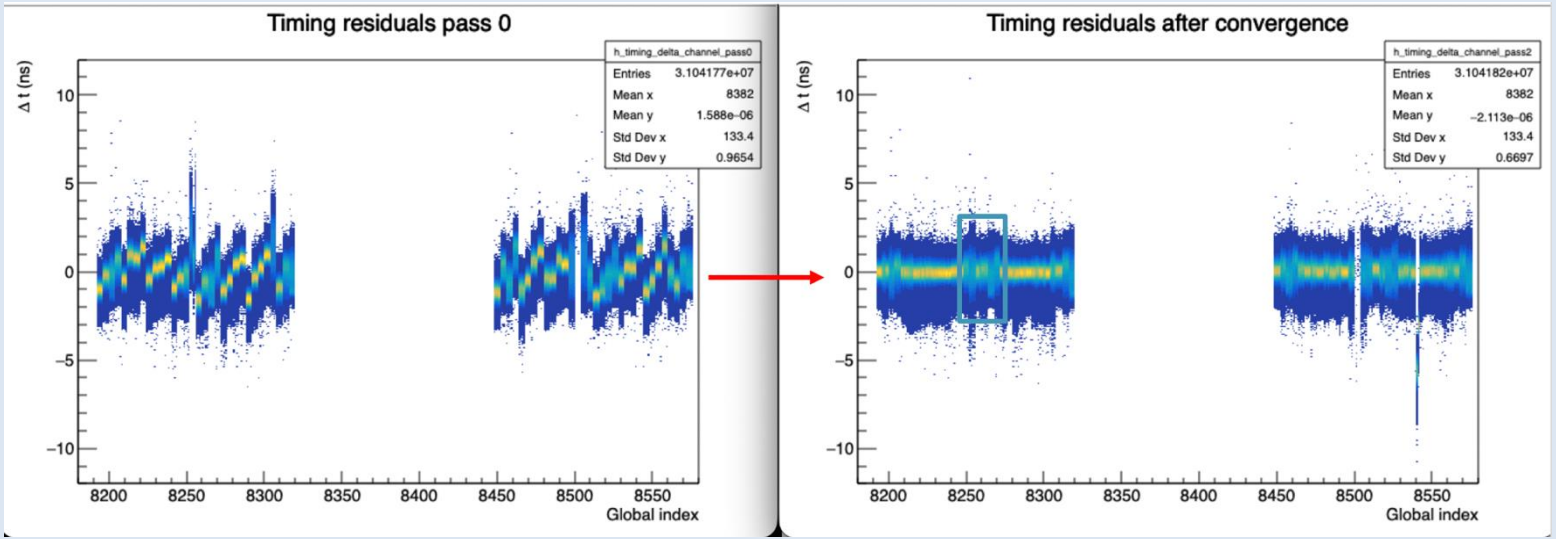
Fine ALCOR Time Calibration



The TDC calibration is linear:

[0]*fine + [1]

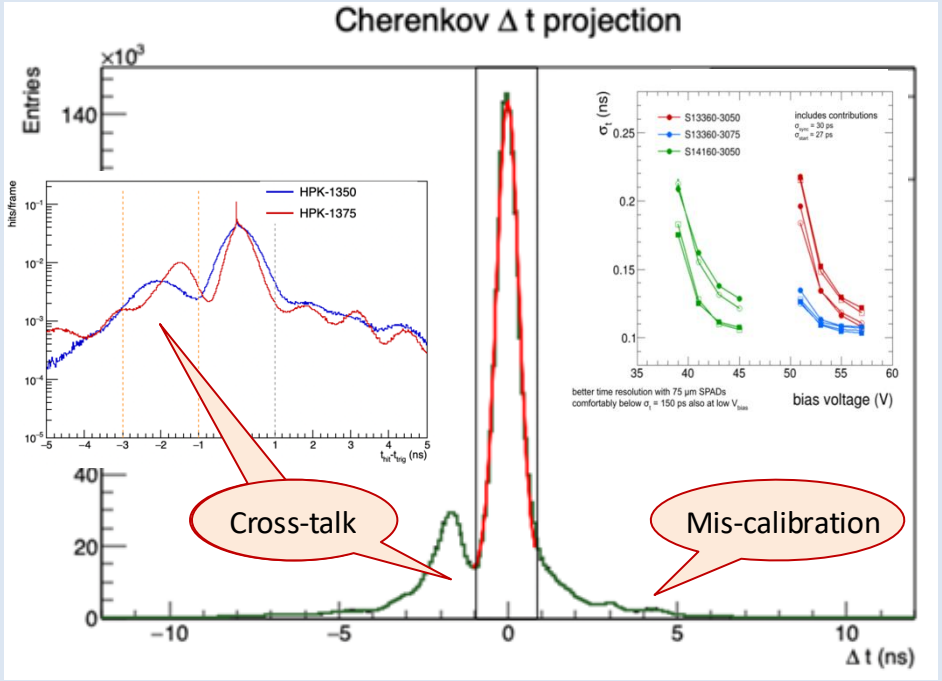
One can plot the time difference of the single TDC against the average of all other channels, fine calibrated with the MIN-MAX method (1st level calibration)



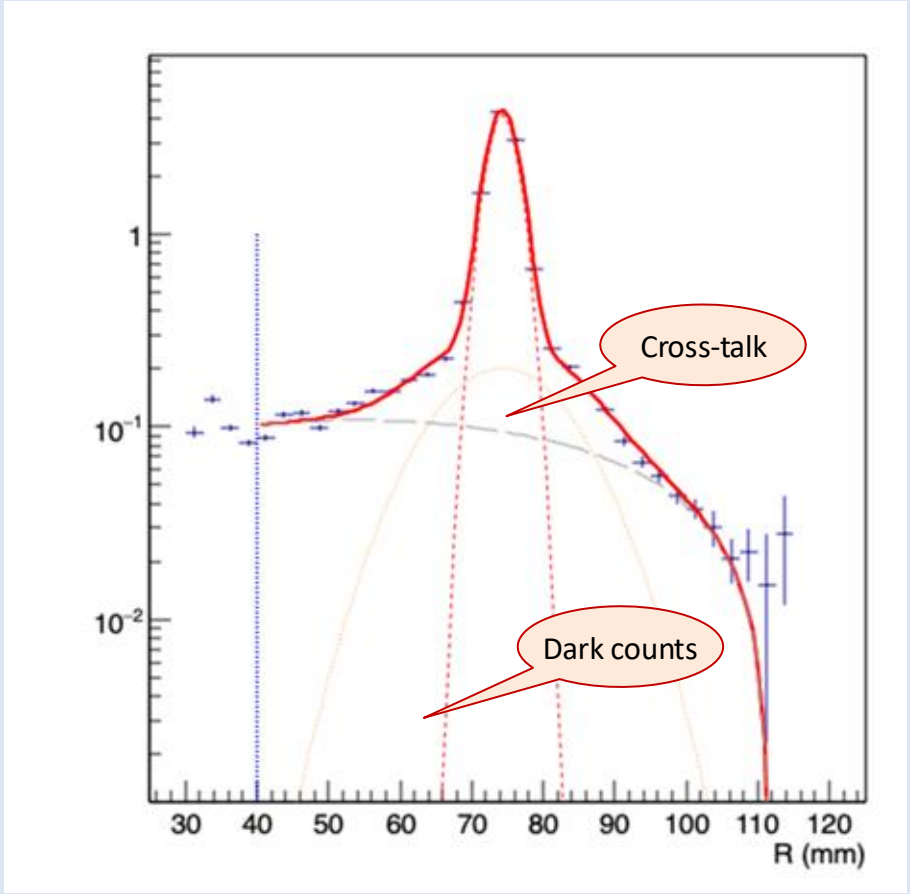
Time offsets

Main peak show a ~330 ps resolution

Secondary peak: likely cross-talk



Cherenkov ring radius



Question 6

Which components are matched to the ePIC detector design, and which ones are being used as intermediate/ad hoc solutions?

The prototype reproduce 1 sector of ePIC

quartz window is basic quality (3 arc parallelism)

The readout uses most updated versions of baseline SiPM sensor (S13360), ALCOR (v32), FEB and RDO in streaming mode

the integration of PDU is not completed

The radiator gas is C_2F_6

The radiator aerogel is the baseline n=1.026 with current maximum available dimensions (18 cm side)

the aerogel targeted dimensions are equal or greater than 20 cm

The mirror is CFRP made with ePIC specifications and mid-size dimension (0.5 m diagonal)

the mirror targeted dimensions are 1 m diagonal

The services are a simplified version and will provide operational experience

need to be properly designed and scaled for ePIC