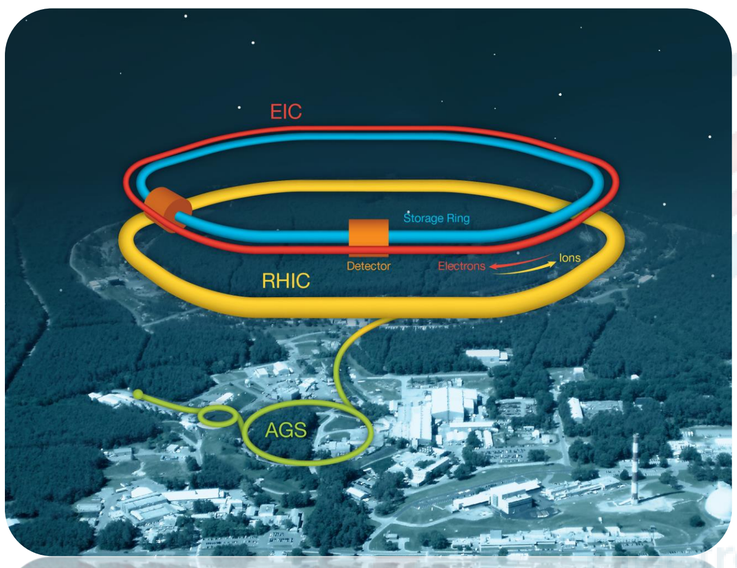
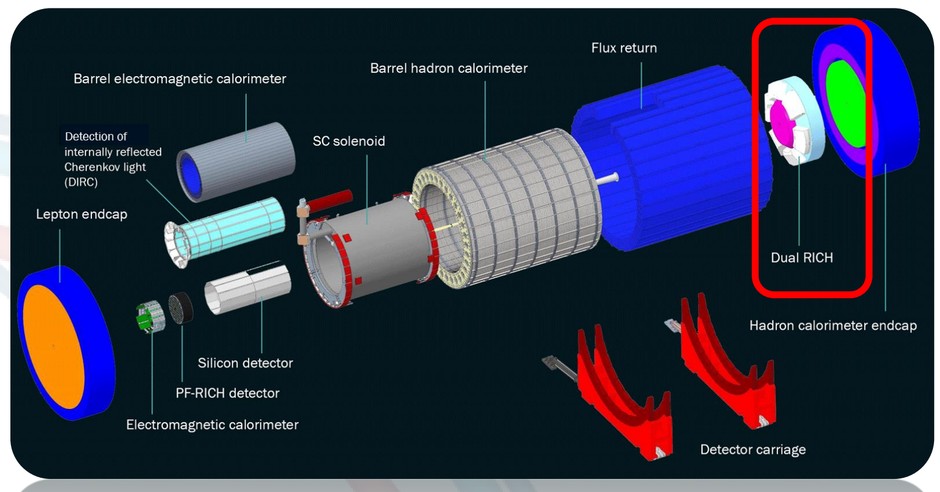
# A large-area SiPM readout plane for the ePIC-dRICH detector at the EIC: realisation and beam test results

Chiara Alice – on behalf of ePIC collaboration

## The Electron-Proton/Ion Collider (ePIC) at EIC




The Electron-Ion Collider (**EIC**) is a large scale innovative particle accelerator that is planned to be built at Brookhaven National Laboratories (BNL) at Long Island, New York (USA).
The collider will consist of two intersecting accelerators, one producing an intense beam of electrons, the other a high-energy beam of protons or heavier atomic nuclei, which are steered into head-on collisions. The center of mass energy will range from 20 to 100 GeV, with a possible upgrade to reach up to 140 GeV. The first beam operations are expected to start in the early 2030s.



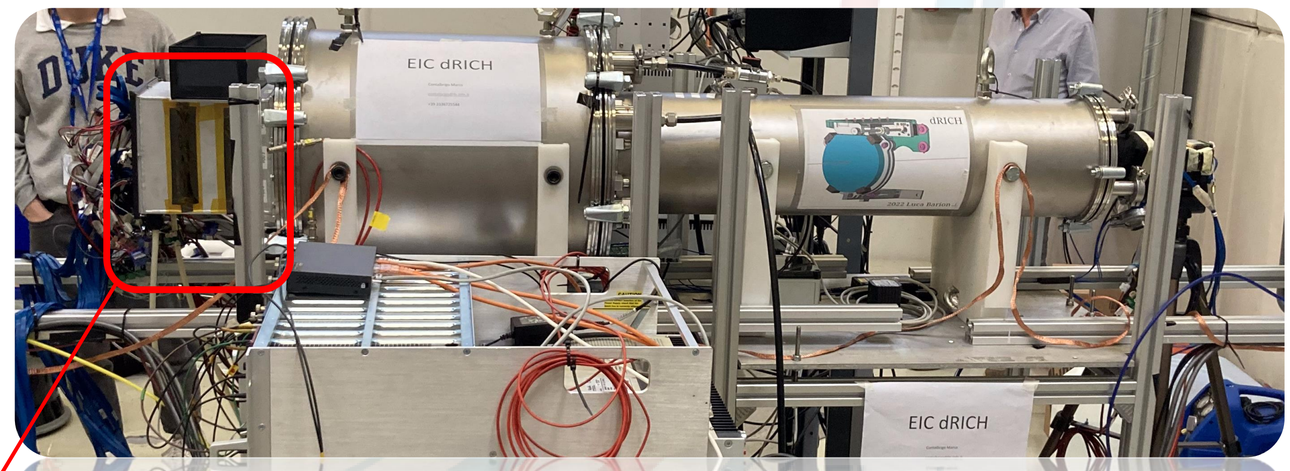

*The **ePIC** experiment will be an approximately 10m long cylindrical barrel detector with additional instrumentation that extends to up to 45m in each direction down the **EIC** beamline.*

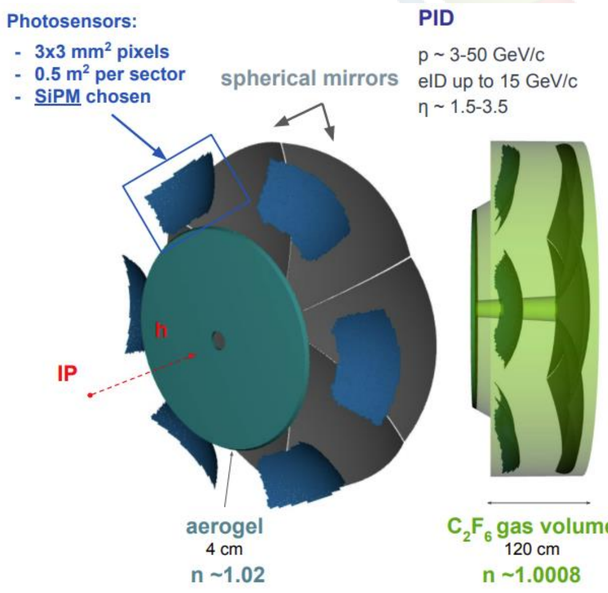
**ePIC** includes a dual-radiator RICH (**dRICH**) detector for PID in the forward region. dRICH will be equipped with 3x3 mm$^2$ silicon photomultipliers (SiPM) to detect Cherenkov light over a surface of ~3 m$^2$ (~300k readout channels), representing the first HEP SiPMs application for single-photon detection.

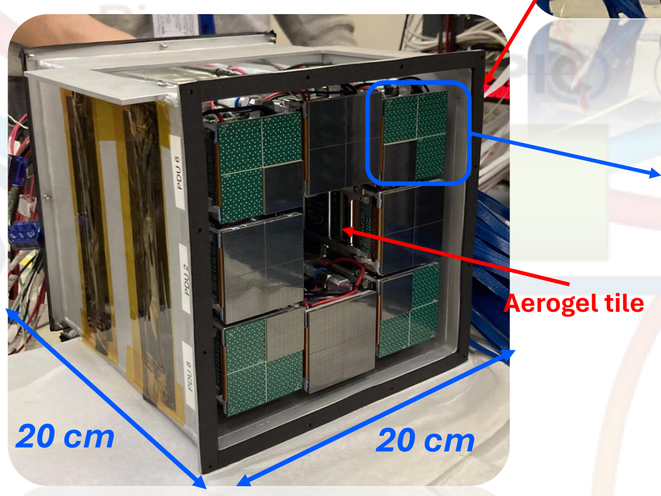
## dRICH prototype and SiPM readout integration

*A dual-radiator Ring Imaging Cherenkov (**dRICH**) detector allows a cost-effective solution for the extensive momentum coverage needed at forward rapidity.*

It achieves 3$\sigma$ separation between kaons and pions from a few GeV/$c$ up to 50 GeV/$c$. The detector comprises aerogel and gaseous ($C_2F_6$) Cherenkov radiators with refractive indices of ~1.02 and 1.0008, respectively.



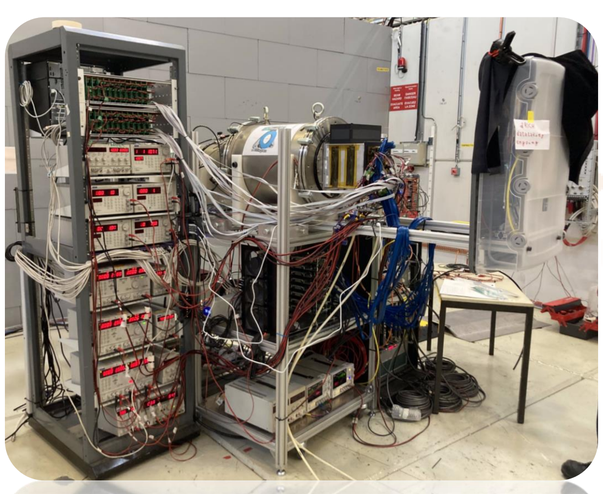



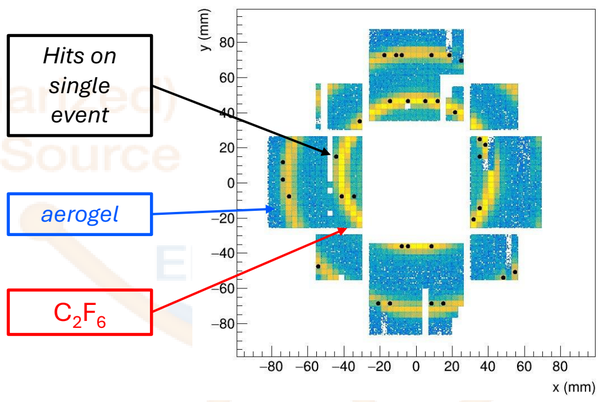

## Photo-detection Unit (PDU)

- **4x matrices of 8x8 SiPMs total 256 channels**
- ***2 Peltier cells for T down to -30/-40°C***
- ***Liquid heat exchange aluminum vessel***
- ***Light-weight aluminum structure***
- ***4x Dual ALCOR front-end boards***
- ***Cables to the PDU***
  - ***HV bias for SiPM***
  - ***LV for FEE***
  - ***LV for T sensor***
  - ***FireFly for Config/control and DATA signals***

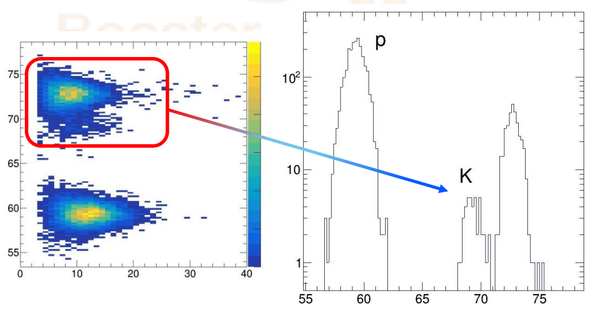
## Test Beam at CERN-PS results Oct. 2023

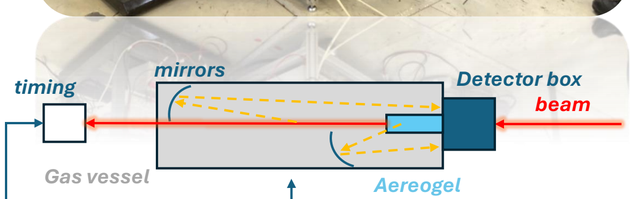


***Dual radiator configuration for 10 GeV negative beam***




***Separation of kaons from pions for 8 GeV/c positive beam***



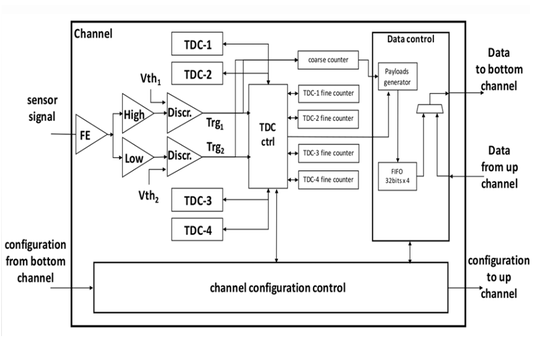




timing scintillators downstream of the detector to trigger on incoming particles

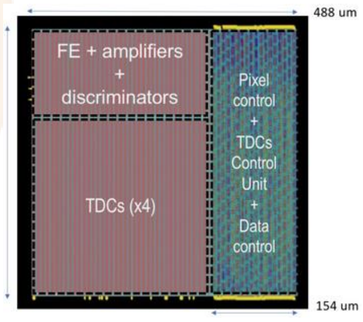
two mirrors to focus aerogel and gas light that can be calibrated

## ALCOR-based Front-End Electronics

- 32 channels 4x8 pixels array
- pixel size 440 x 440 μm$^2$
- 4 LVDS serializers for data transmission
- Single-photon time tagging & Time-over-Threshold measurement




***Fabricated in 110 nm CMOS technology***




- common gate amplifier (10-20Ω impedance)
- Post amp TIA with 4 gain settings
- 2 leading-edge discriminators with independent threshold settings
- 4 TDCs based on analogue interpolation with 25-50 ps LSB (@ 320 MHz)