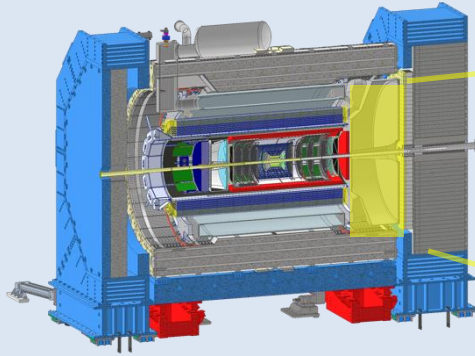


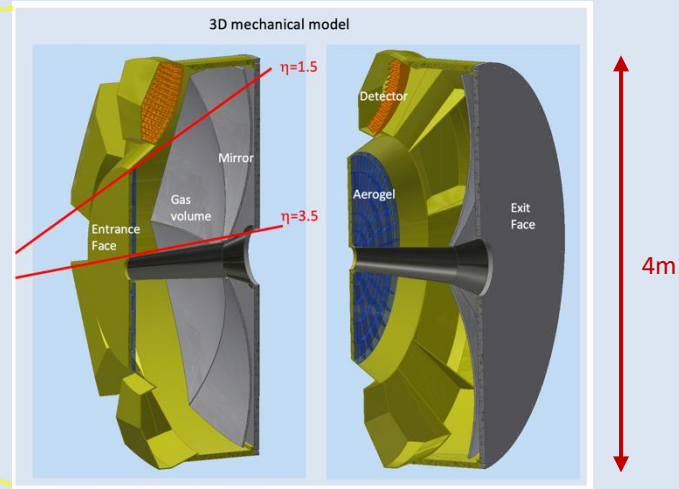
dRICH Test Beam, an Introduction

Contalbrigo Marco - INFN Ferrara

TIC Meeting, 12th October 2026



Hadron 3σ -separation between 2 - 50 GeV/c
 Complement electron ID below 15 GeV/c
 Cover forward pseudorapidity 1.5 (barrel) - 3.5 (b. pipe)



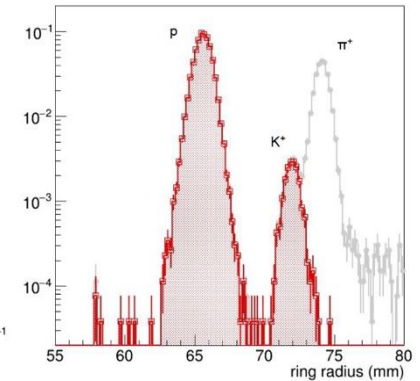
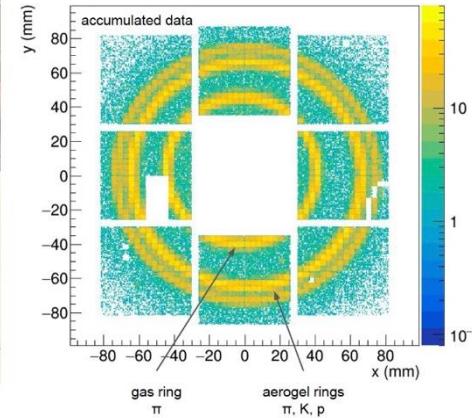
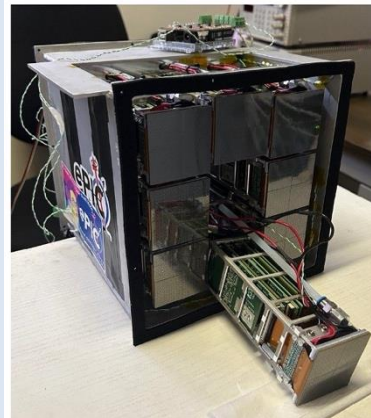
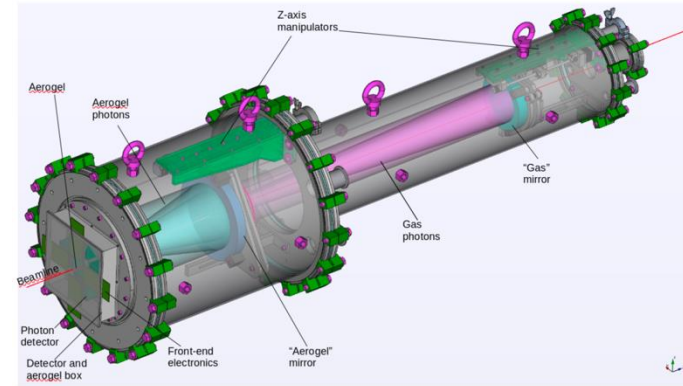
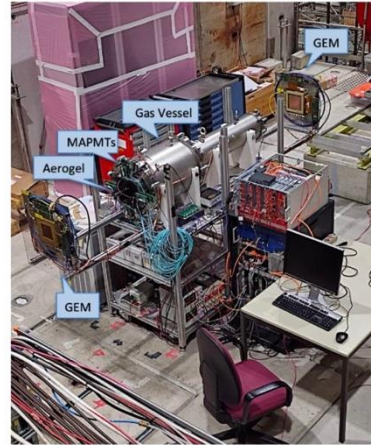
Special NIMA issue from RICH 2025 Conference (September 2025)

- M. Contalbrigo et al., *"The ePIC dual-radiator RICH detector"*, NIMA 1088 (2026) 171537
- N. Rubini et al., *"The SiPM readout plane for the ePIC-dRICH detector at the EIC: overview and beam test results"*, NIMA 1091 (2026) 171751
- C. Rossi et al., *"Online AI-based distributed data reduction for the dual-radiator RICH detector in the ePIC experiment"*, NIMA 1087 (2026) 171416
- F. Tassarotto et al., *"The ePIC dRICH radiator gas"*, NIMA 1088 (2026) 171508
- F. Cossio and R. Preghenella et al., *"ALCOR: a SiPM readout chip for the ePIC-dRICH detector at the EIC"*, NIMA 1087 (2026) 17146
- T. Boasso et al., *"Simulation Study for Particle Identification with the dRICH of the ePIC Experiment at the EIC"*, NIMA 1088 (2026) 171509

- world-record size of aerogel tiles at $n=1.026$
- $C_2 F_6$ radiator gas
- SiPM sensor with in-situ annealing
- light carbon-fiber mirrors with optimized core
- curved photon detection surface matching the mirror focal area
- dedicated ALCOR precision-time digitization
- streaming readout with ML assisted on-line data filtering

Previous validations w Basic Prototype:

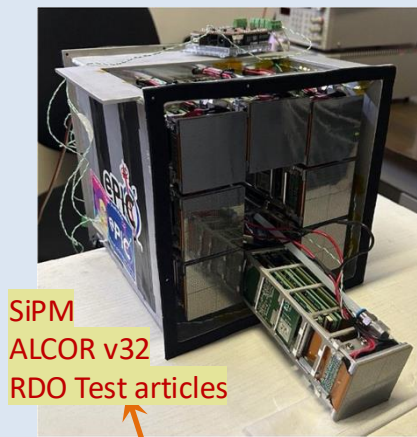
- Dual-radiator concept
- C_2F_6 radiator gas performance
- Aerogel refractive index
- SiPM-ALCOR readout chain
- EIC-driven readout plane
- Temperature gradients
- RDO data acquisition
- Alternate gases



Real-Scale Prototype to study:

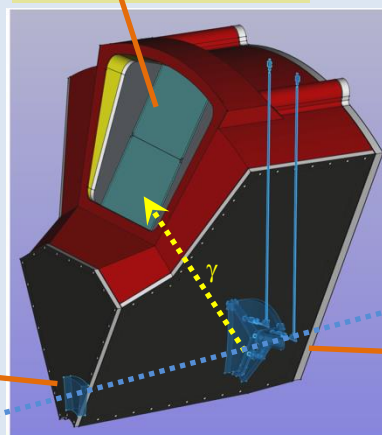
- Mechanical stability
- Gas & light thightness
- Temperature gradients
- Assembling scheme
- Inner components supports
- Realistic components
- Off-axis optics
- ePIC pseudo-rapidity scan
- Cosmics

.....

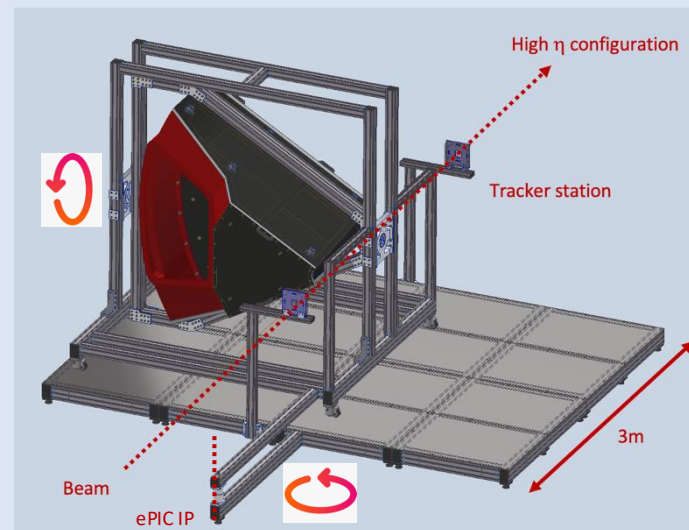


SiPM
ALCOR v32
RDO Test articles

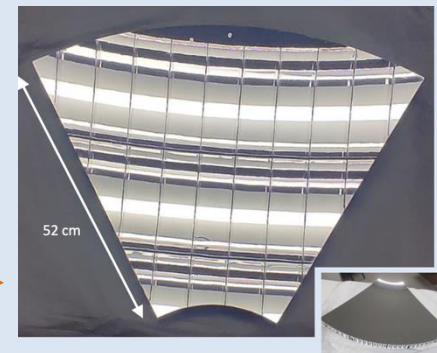
Photon Detector Units

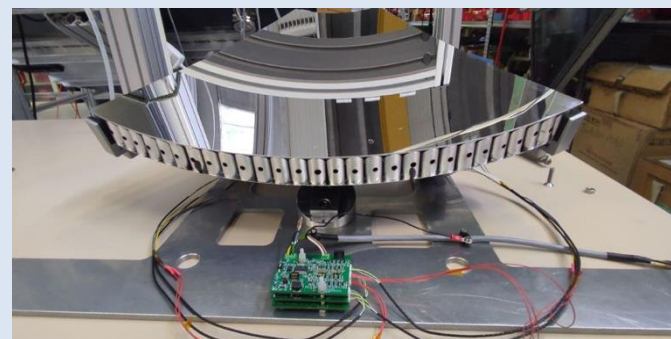
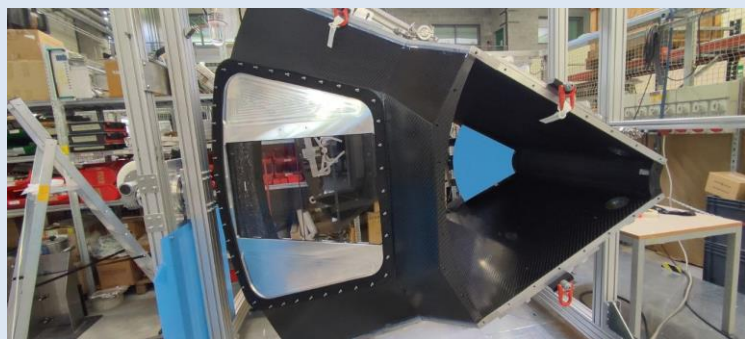
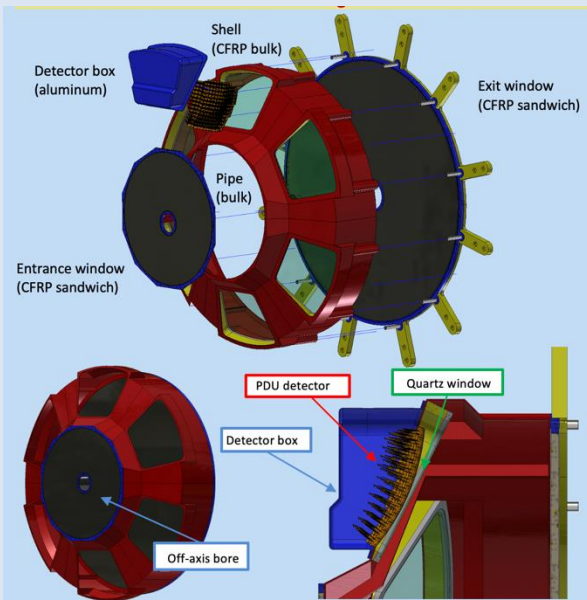


Aerogel
Test Article

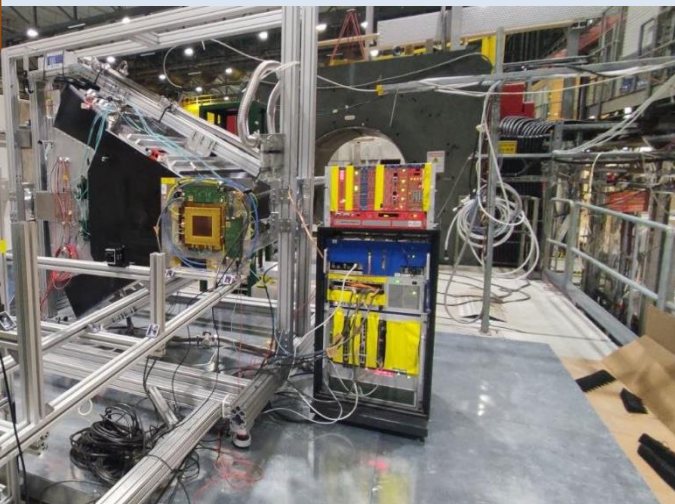
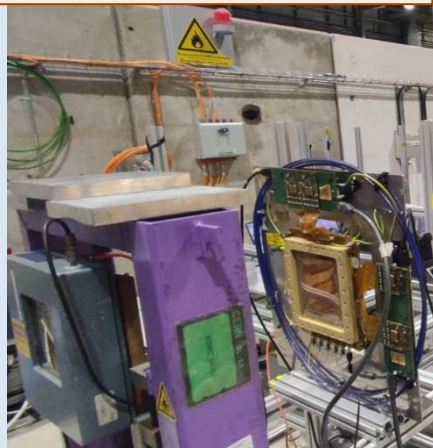
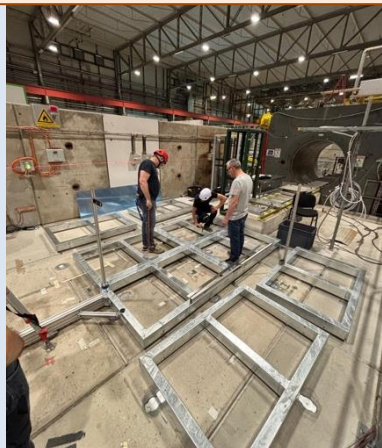


Mirror
Test Article

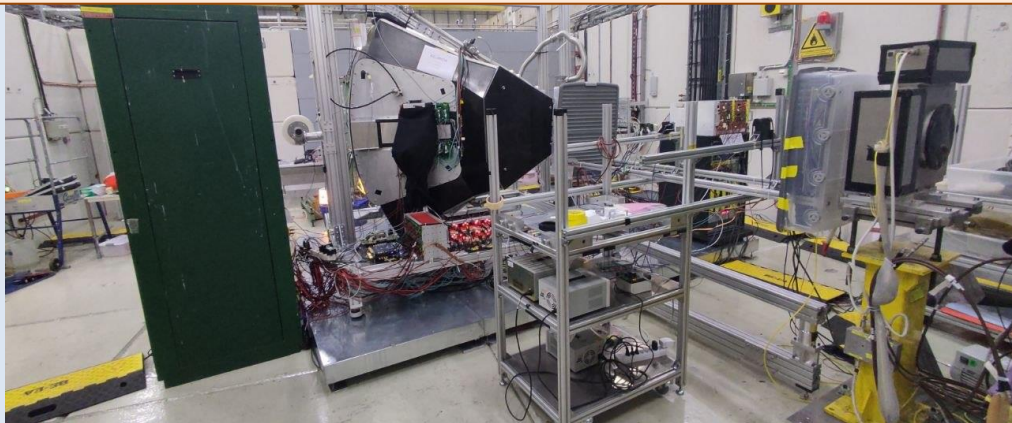




SPS – 1.5 week: 20-180 GeV/c mixed hadron beam (gas momentum range)

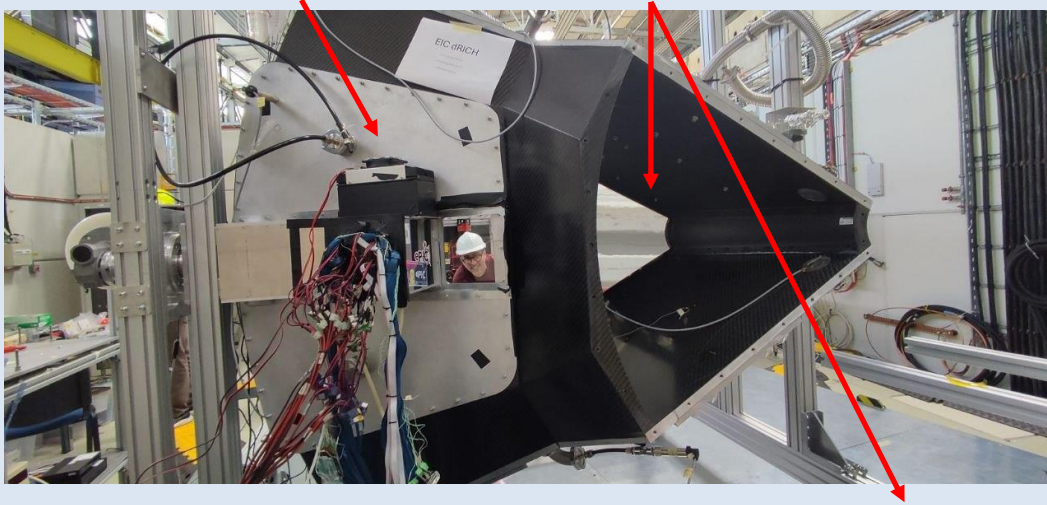


PS – 2 weeks: 2-11 GeV/c mixed hadron beam (aerogel and gas interplay)



SiPM detector box

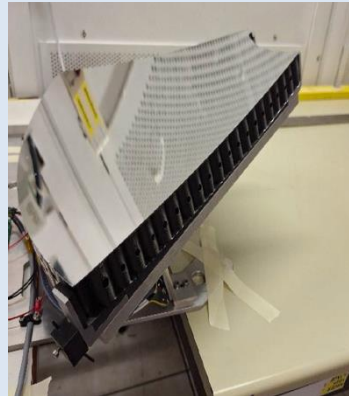
Carbon fiber mirror



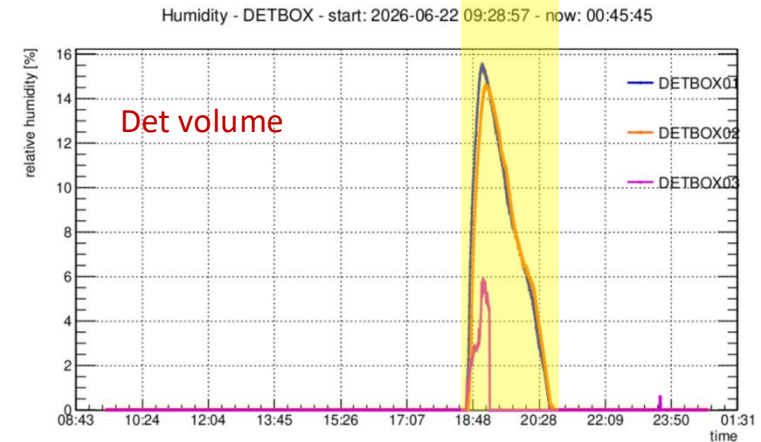
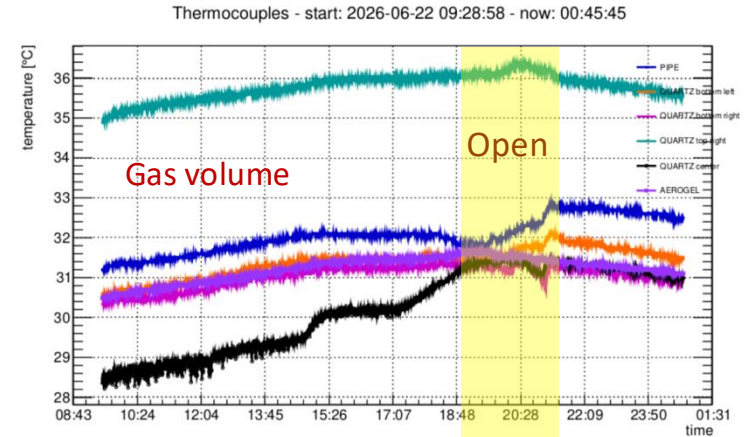
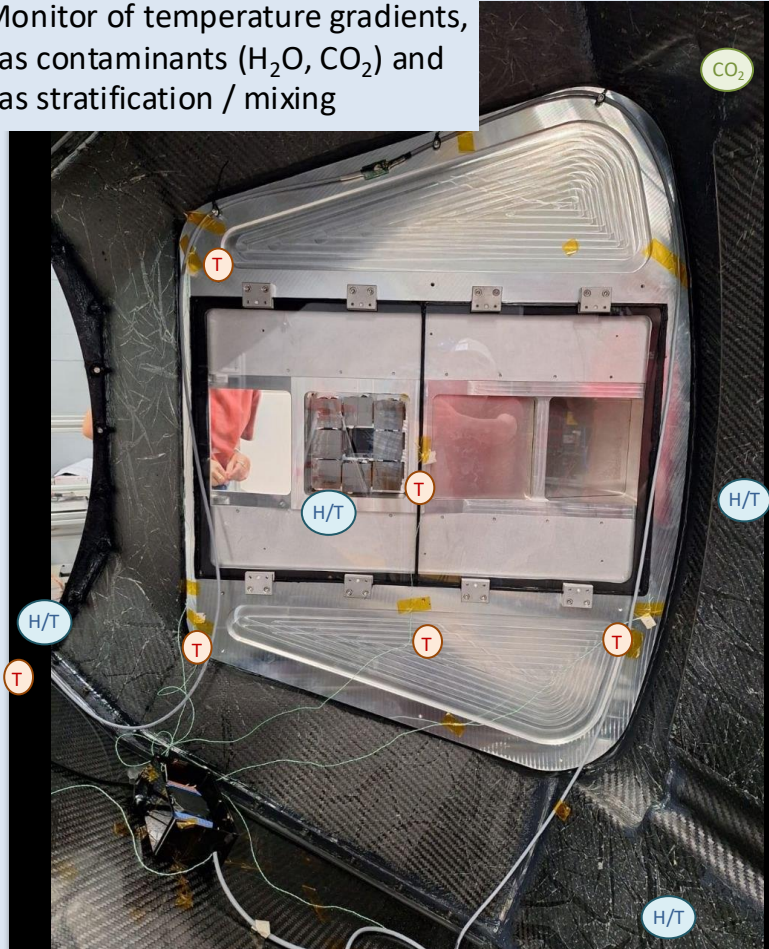
Aerogel demonstrator



Quartz window and curved active surface mockup



Monitor of temperature gradients,
gas contaminants (H_2O , CO_2) and
gas stratification / mixing



C0-C10 membranes



Real-scale volume is 2 m³ (1/6 of dRICH):
a full gas-system is required

Successful gas operations:

Air --> N₂ flushing --> CO₂ filling --> C₂F₆ filling

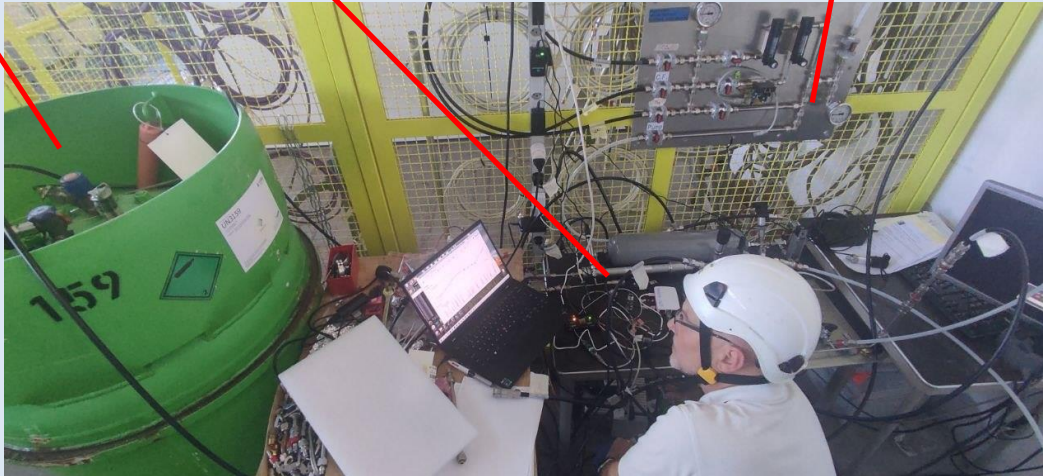
Successful purging and recovery of C₂F₆

Re-use of the same gas in the two test-beams

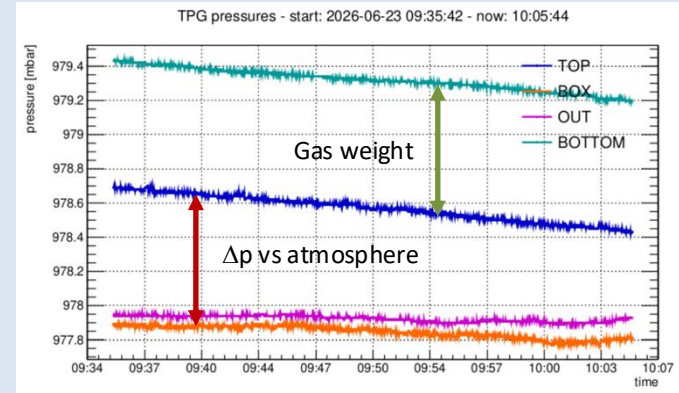
Validation of the C₂F₆ gas system concept

Recovery

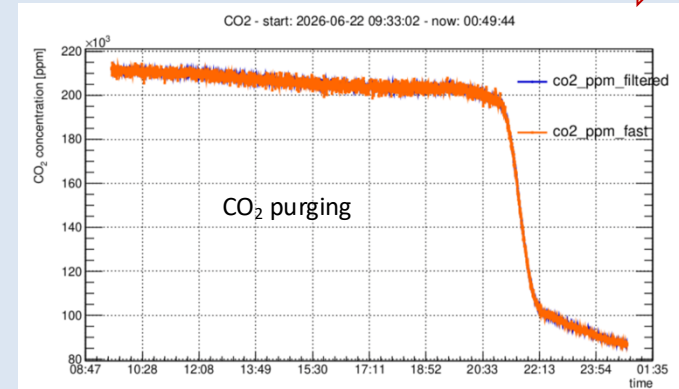
Gas panel



Suitable slow control system



F. Tassarotto



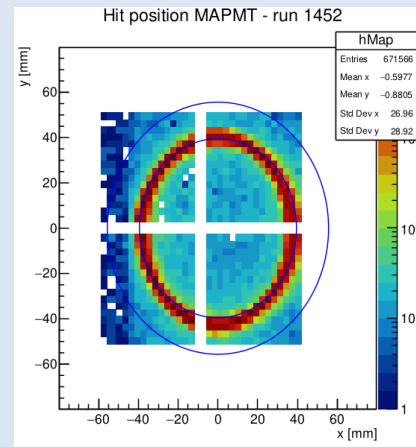
Highlight SPS: performance (MaPMTs) in the ball-park of ePIC simulations

PRELIMINARY

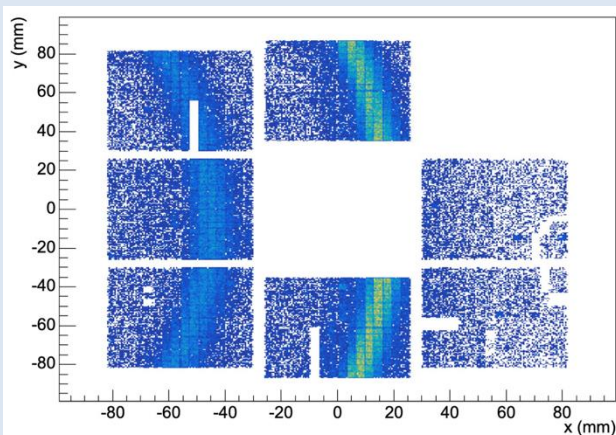
Beam	N. photoelectrons	Singl-photon resolution	Track resolution
180 GeV/c proton (MaPMT)	20	1.3	0.45
50 GeV/c ePIC (SiPM)	18	1.2	0.3

Highlight PS: 2% kaons ID on aerogel after tagging pions/electrons with gas

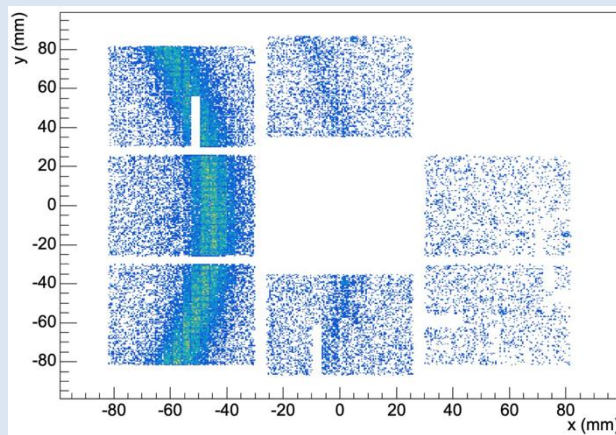
PRELIMINARY



Before tagging

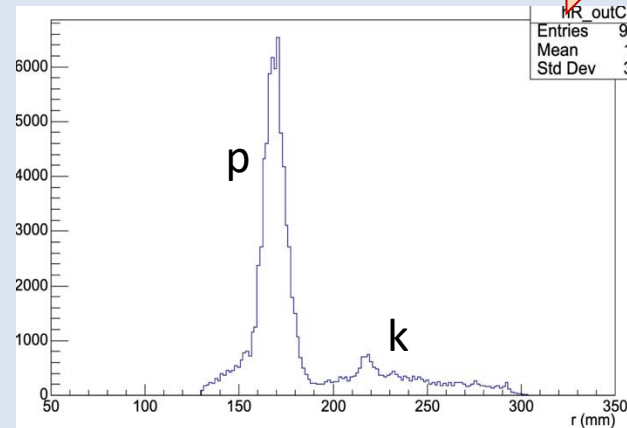


After tagging



Projection

R. Preghenella



Lesson Learned

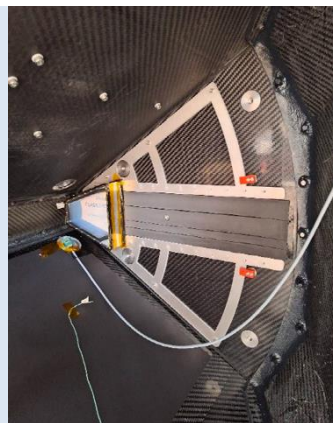
- Sealing problems with C2F6: the flat gaskets used with shims work well with nitrogen and CO₂, but with C2F6 they start to leak after a short while. C2F6 is a dense gas and behaves almost like a liquid.
- Sealing problems at the joints of the gas enclosure: the same problems as those encountered with the flat gaskets on the windows.
- Difficulties in adjusting the mirror (PS): the mirror drive mechanism is over-constrained, so the motors are overloaded.
- Another problem is that C2F6 appears to act as a lubricant and, as the piezo elements remain under load due to friction when not powered, they tend to move under load.
- Reflection from the carbon fibre: the inner surfaces are glossy and reflect light off the mirror.
- Aerogel container: transparent base and poor gas-tightness.



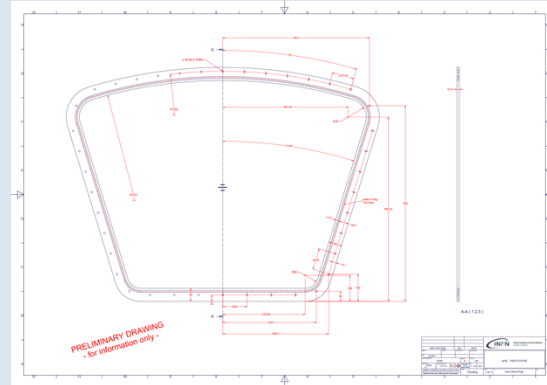
Upgrade piezo-motors



Improve alignment System



Redesign frames and sealing



A real-scale dRICH prototype has been realized to

- ✓ validate mechanical stability and sealing of composite materials
- ✓ study assembling of realistic components
- ✓ validate C_2F_6 gas operations
- ✓ mimic ePIC off-axis optics
- ✓ study the temperature gradients induced by the sensor cooling

The 2026 test-beam allowed a global assessment of the performance in a replica of ePIC configuration

The prototype will continue to serve as a test-station of the evolving photo-detector and optical elements, at test-beams and with cosmics

