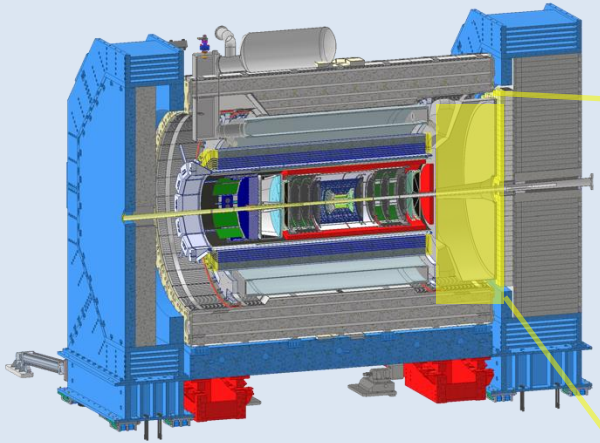
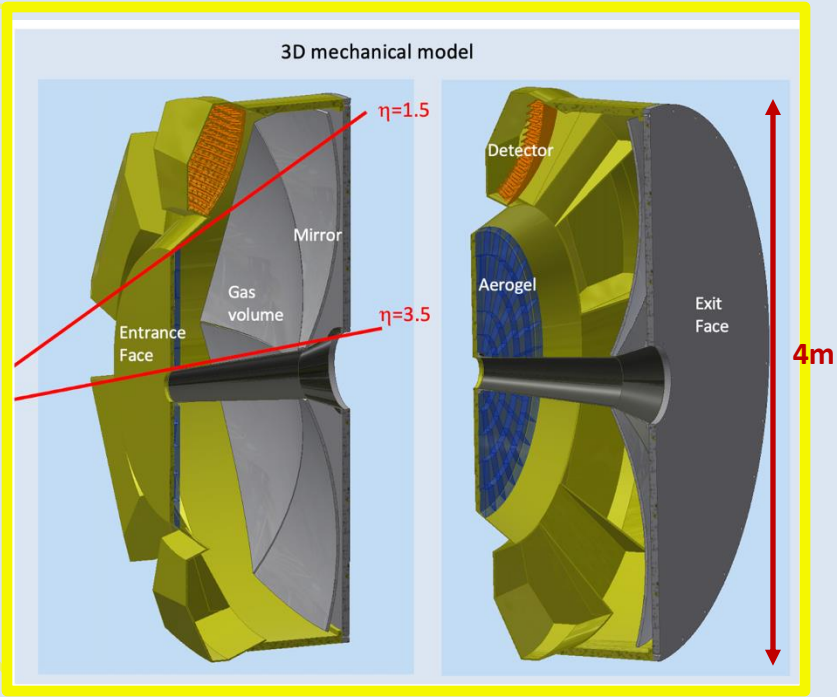
ePIC dRICH



Dual-radiator Ring-imaging Cherenkov Detector (dRICH)

Essential to access flavor information



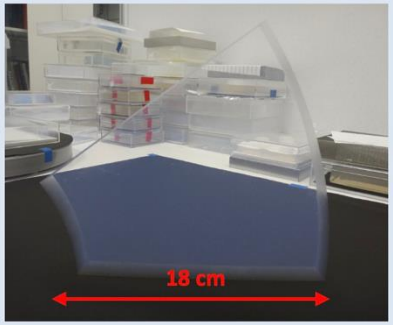
Goals: Hadron 3σ–separation between 3 - 50 GeV/c
Complement electron ID below 15 GeV/c
Cover forward pseudorapidity 1.5 (barrel) - 3.5 (b. pipe)

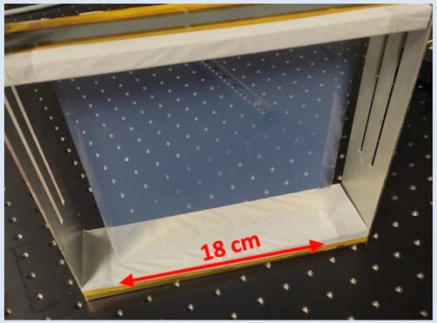
dRICH Features:

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

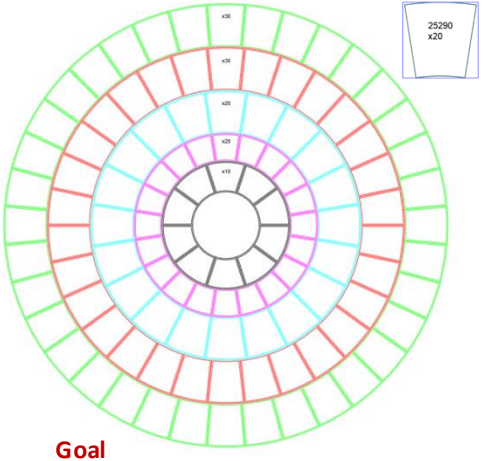
dRICH Radiators

Aerogel with n=1.026 validated with lab and prototype tests



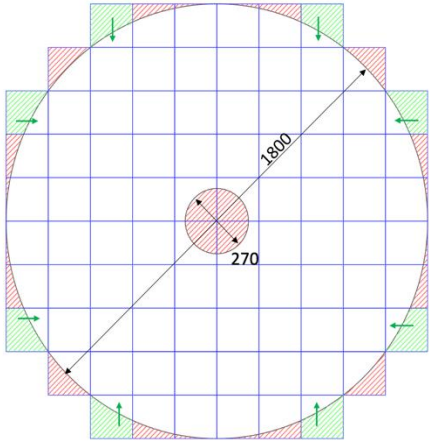


Large demonstrators delivered – Wall engineering ongoing



Goal

Active Area = 21605 cm^2
Dead Area = 3269 cm^2 (13%)
Wasted Area = 9112 cm^2 (27%)

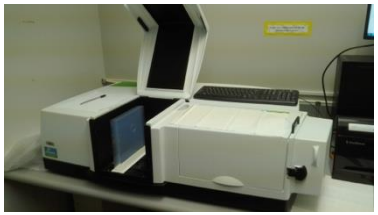


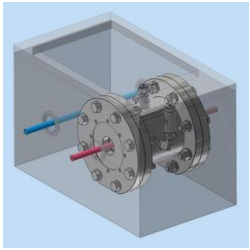
Active Area = 21368 cm^2
Dead Area = 3506 cm^2 (14%)
Wasted Area = 1868 cm^2 (7 %)

C_2F_6 validated with lab & prototype tests
Design of online purity monitors ongoing

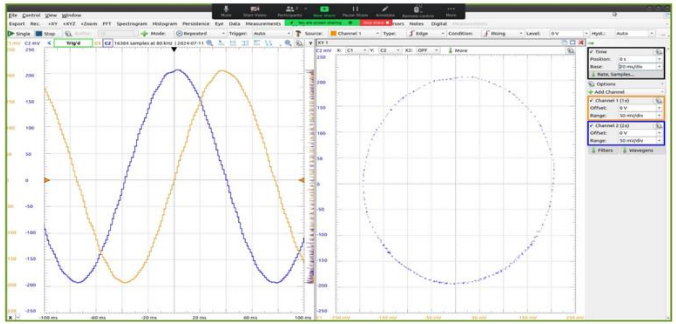
Sonar to measure speed of sound

10 bar chamber + specrophotometer to measure light transmission in the visible range





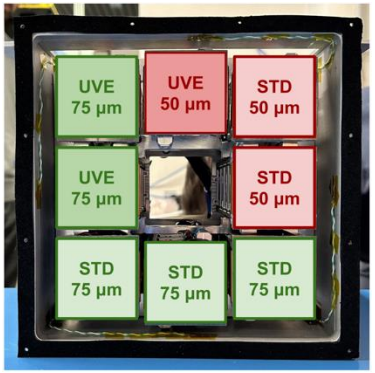
Jamin interferometer for precise n determination



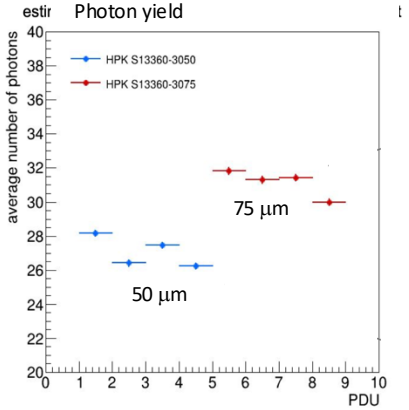
Un periodo (360°) corrisponde a 1 ppm di variazione dell'indice di rifrazione
La risoluzione consente la misura di variazioni di n inferiori a 10 ppb

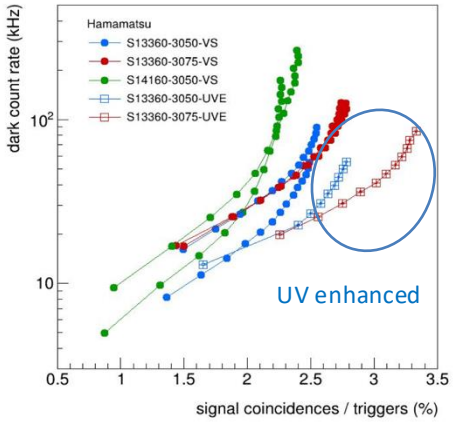
dRICH Photo Sensor Engineering

FInalization of the engineering of the SiPM optimized layout and temperature treatments ongoing

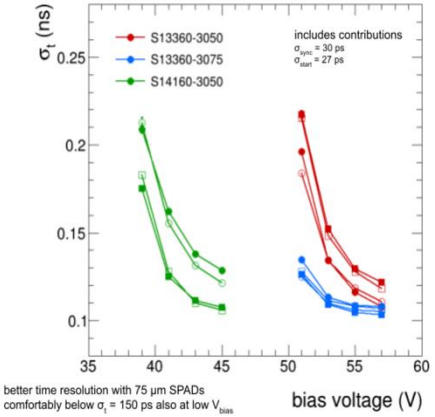


Testing new Hamamatsu sensors after
- 10^9 neq
- oven annealing

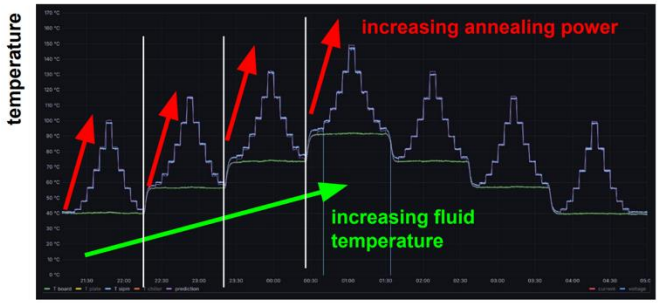




Time resolution with ALCOR redout

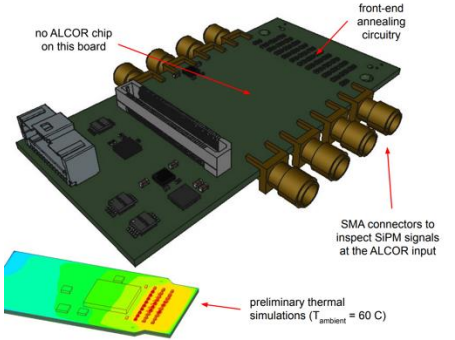


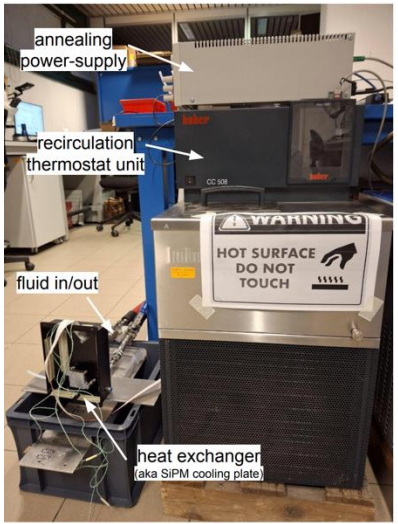
Details of in-situ annealing protocol based on Joule-effect



features
- like a final FEB with all annealing circuitry
- SMA connectors to inspect SiPM signals on scope

goals
- test realistic dRICH annealing electronics
- study/engineering of annealing process details





dRICH Readout Electronic

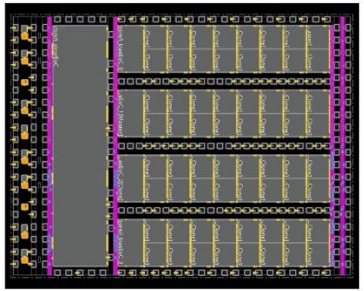
Design of the readout electronics in the “final” ePIC layout version is ready for test production.

Proton irradiation campaigns for ALCOR-32 and key RDO components showed SEU rate is within the expected manageable levels

A working DAQ scheme has been identified to support ML online data filtering at sub-detector level against pure dark-count event

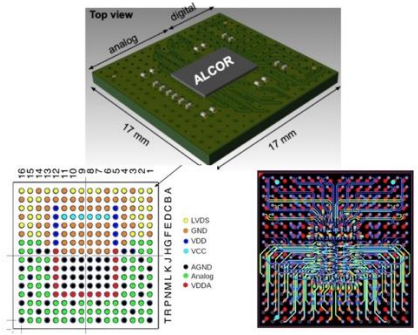
ALCOR v3 – 64 channels

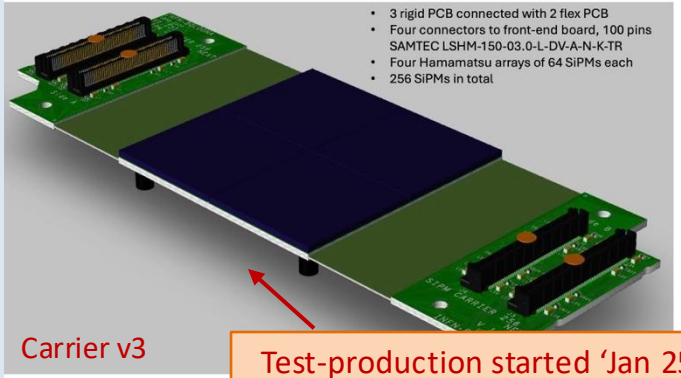
MPW run in March ‘25



Silicon die layout

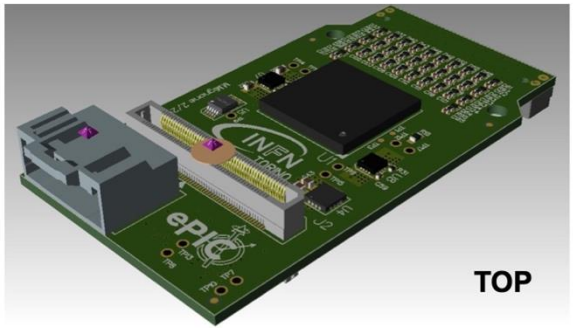
Compact ball-grid array (BGA) package with interposer





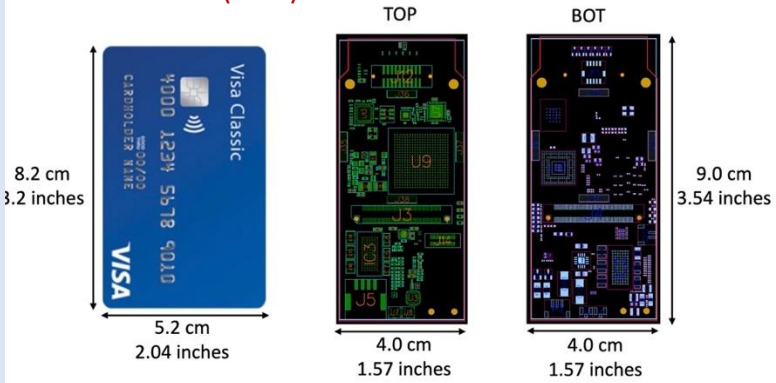
Carrier v3

Test-production started ‘Jan 25

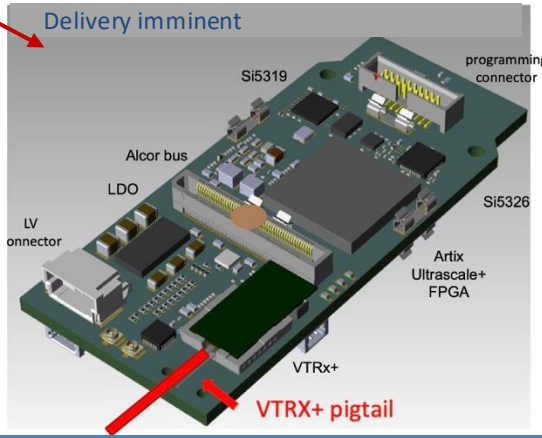


Front-End Board (FEB)

Readout Board (RDO)



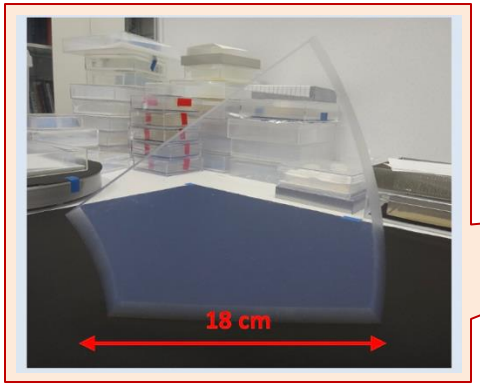
Delivery imminent

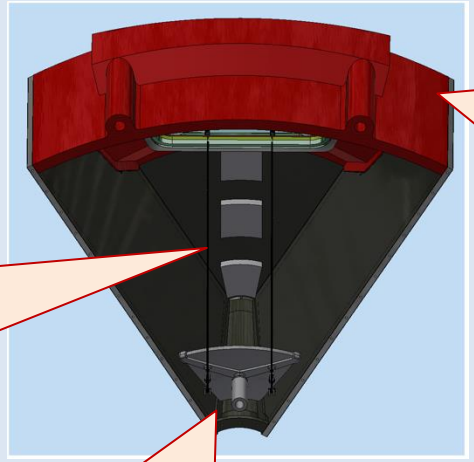


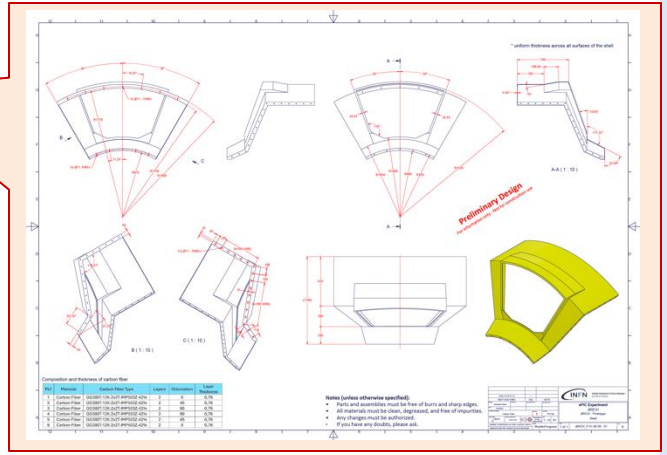
Real Scale Prototype

Engineering of all the mechanical details pursued with the real-scale prototype and component demonstrators

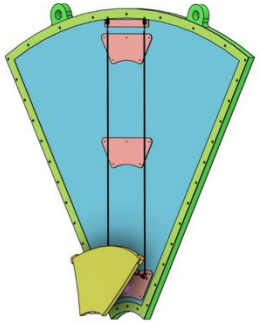
Aerogel support

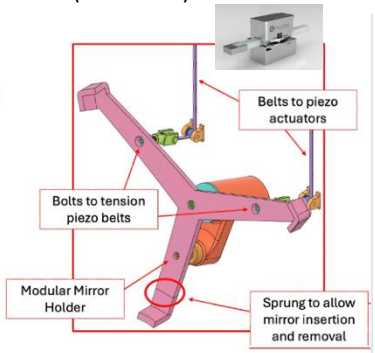


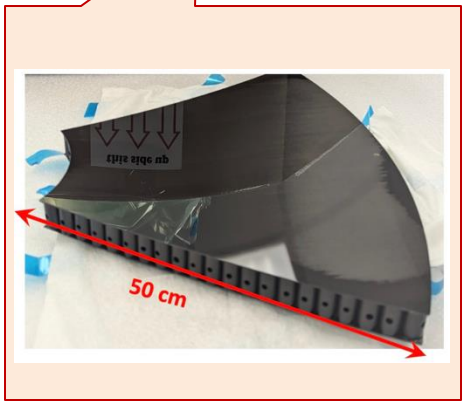




Mirror mounting and alignment (aka NA62)







Vessel

PO issued

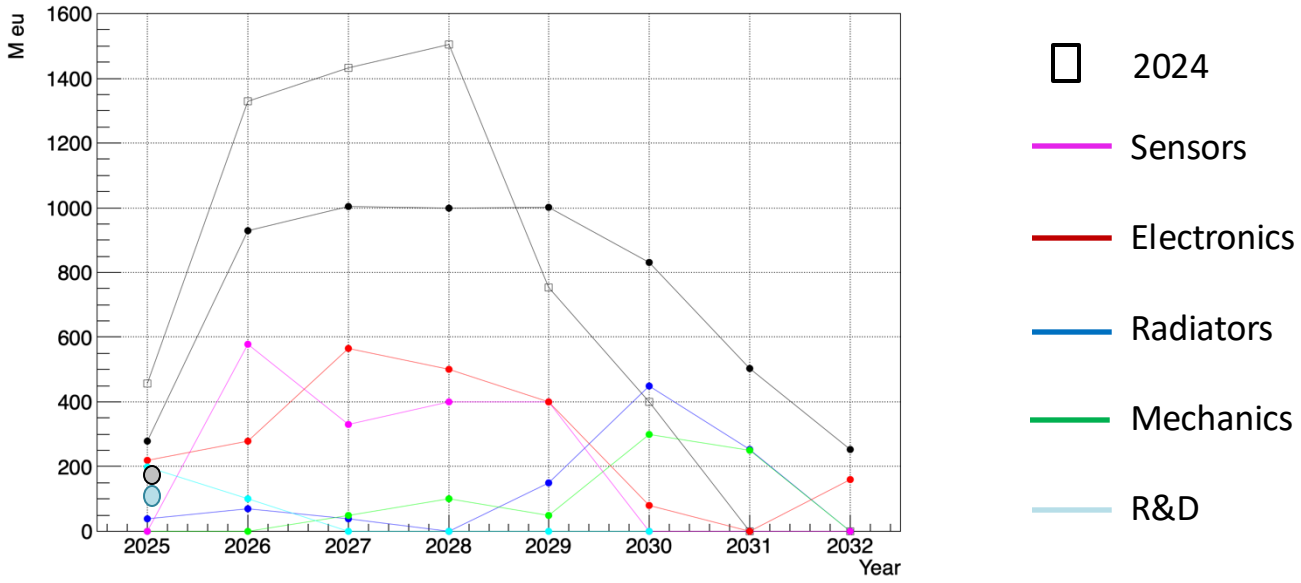
CFRP Layer composition

60% Preliminary Design Review passed. A construction and QA plan is outlined accounting for lead, assembling and commissioning time

Assumptions: - Installation in 2032
- possibility to split the major procurements in batches/years

Potential risk: - sub-optimal spreading of vendor effort for SiPM
- late investment on aerogel

Peak investment being mitigated with respect 2024 anticipation



dRICH Online Filtering

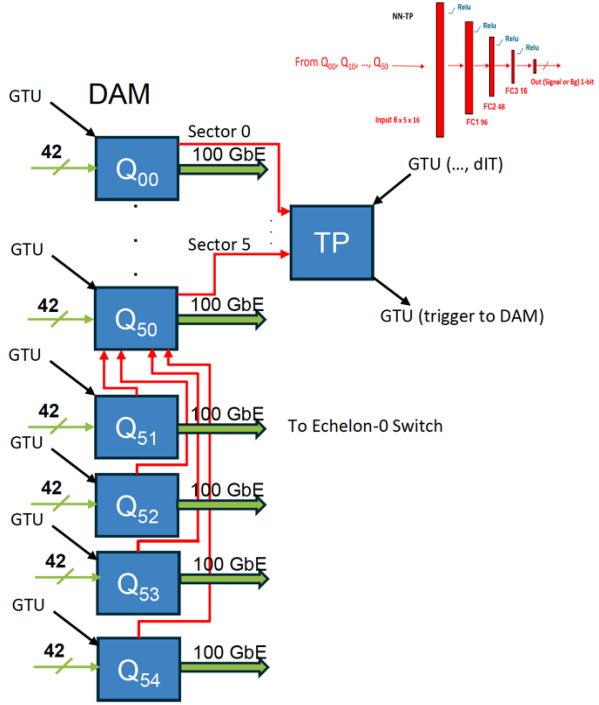
A working DAQ scheme has been identified to support ML online data filtering at sub-detector level against pure dark-count event

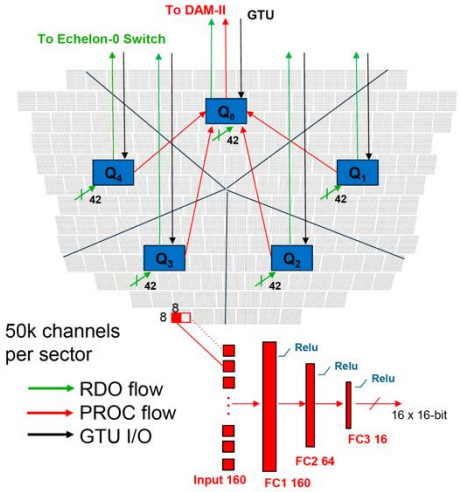
The feasibility of a scintillating fiber layer operated as a charged particle tagger is being studied

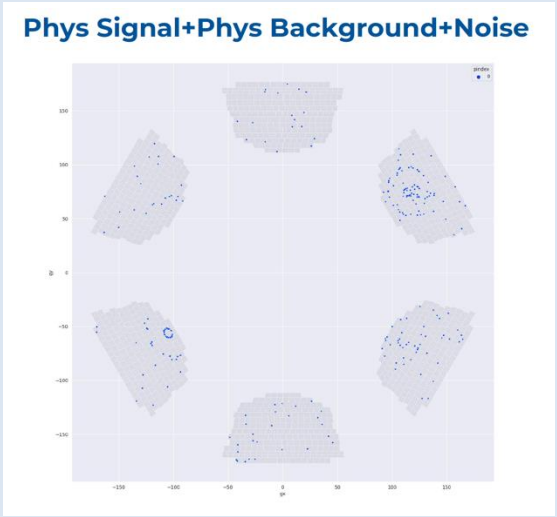
Scheme based on ePIC DAM (Felix) &
APEIRON communication network (INFN)

sub-sector integrated analysis

detector integrated analysis





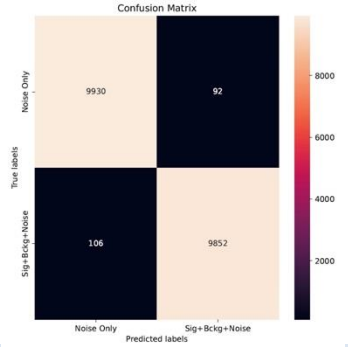


Preliminary tests

Classifier

- Accuracy = (TP+TN) / (TP+TN+FP+FN) = 0.990
- Precision = TP/(TP+FP) = 0.989
- Recall = TP/(TP+FN) = 0.991

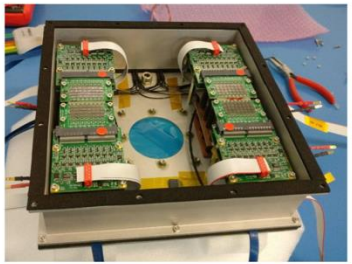
➔ Through **quantization**, we defined:
quantized fixed point<16,6> inputs
quantized fixed point<8,1> weights
quantized fixed point<8,1> biases



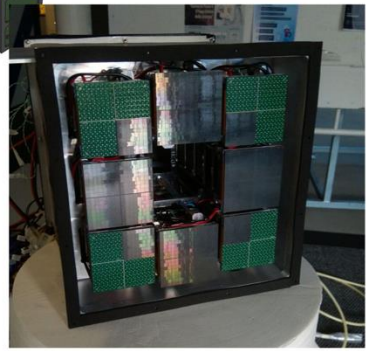
Steadly progress of photodetector towards integrated design completion in 2026

towards construction

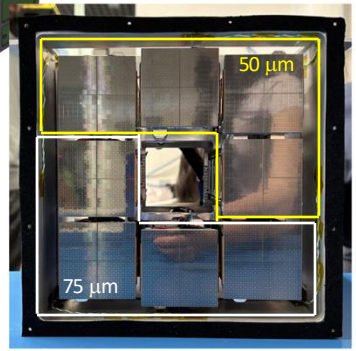
2022
electronics v1



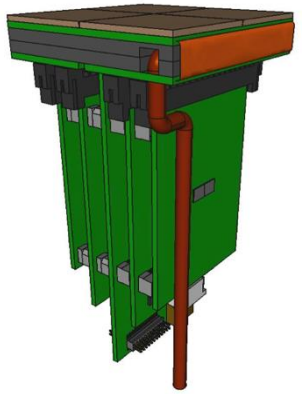
2023
electronics v2



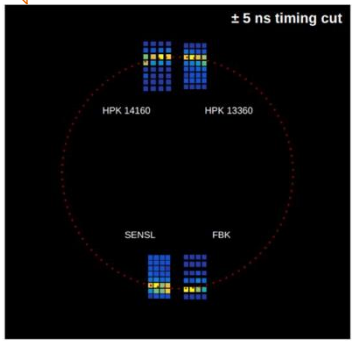
2024
electronics v2.1

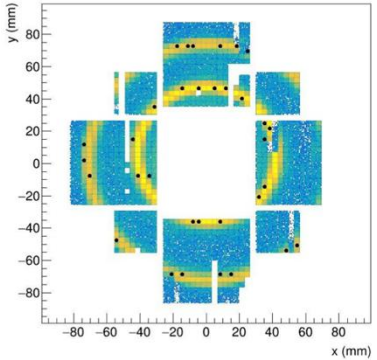


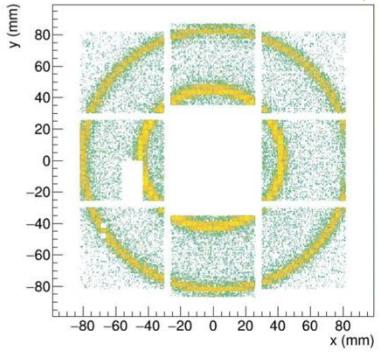
2025/26
electronics v3



ALCOR 32 ch







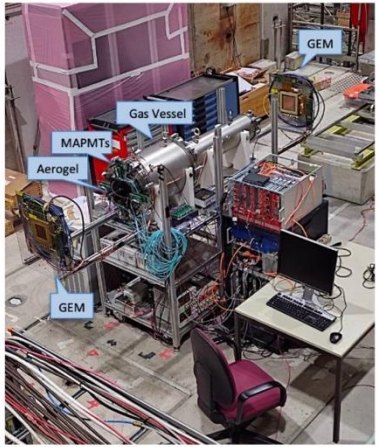
Full size engineering test article

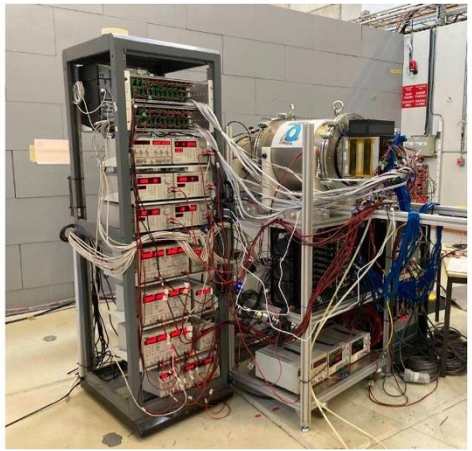
2025 + SiPM carrierv3 + RDO

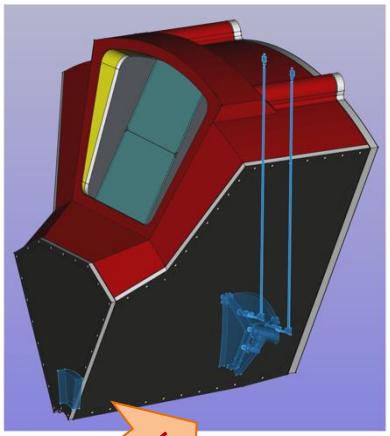
2026 + ALCOR 64ch + FEB 64

Previous validations:

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







2025

2025 main goals:

Real scale 1-sector prototype with demo components

ALCOR readout with RDO

Slot at SPS H8 in November