# dRICH Status

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INFN - Ferrara

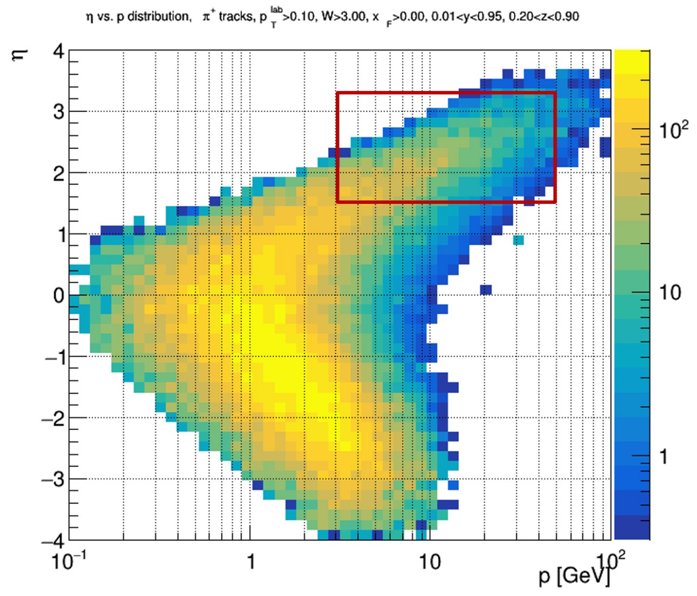
ePIC Meeting, Lehigh University, July 25th 2024

**Main challenges:**

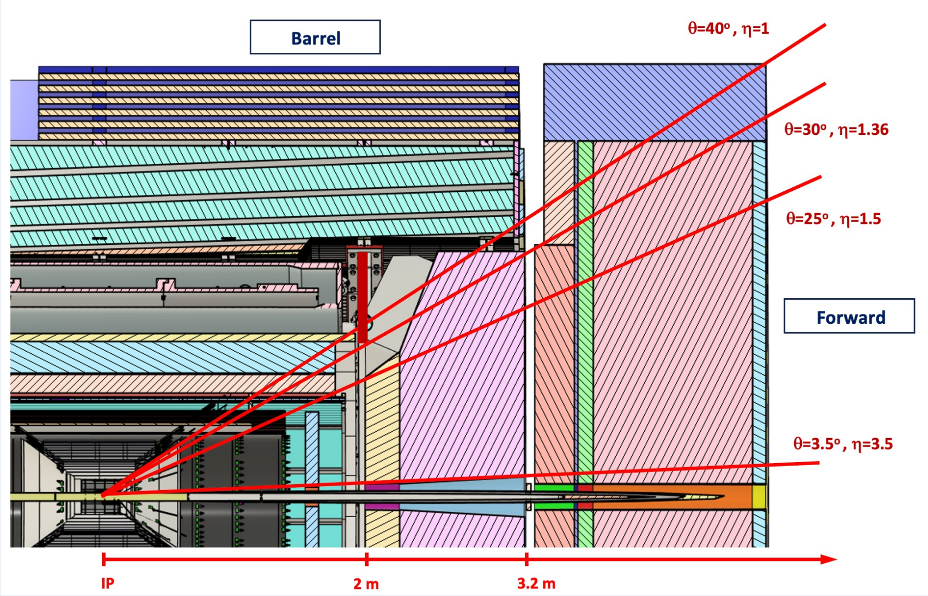
Cover wide momentum range 3 - 50 GeV/c -> dual radiator
Work in high (~ 1T) magnetic field -> SiPM
Fit in a quite limited (for a gas RICH) space -> curved detector

| η | Nomenclature | Electrons and Photons | | | π/K/p | |
|---|---|---|---|---|---|---|
| | | Resolution $\sigma_E/E$ | PID | Min E Photon | p-Range | Separation |
| 1.0 to 1.5 | Forward Detectors | 2%/E ⊕ (4*-12)%/√E ⊕ 2% | 3σ e/π up to 15 GeV/c | 50 MeV | ≤ 50 GeV/c | ≥ 3σ |
| 1.5 to 2.0 | | | | | | |
| 2.0 to 2.5 | | | | | | |
| 2.5 to 3.0 | | | | | | |
| 3.0 to 3.5 | | | | | | |

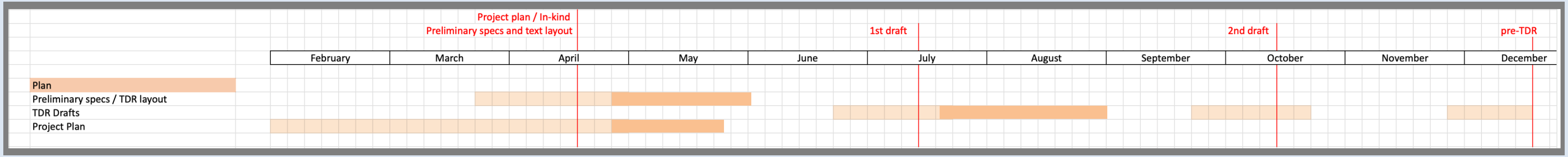
Essential for semi-inclusive physics due to absence of kinematics constraints at event-level




Acceptance in oseudo-rapidity defined by barrel and beam pipe



# TDR Effort in 2024




✓ April: Preliminary specs & text layout
Project plan / in-kind preview

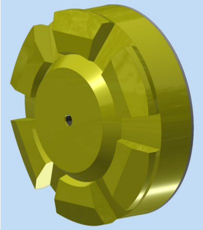
✓ July: 1$^{st}$ draft

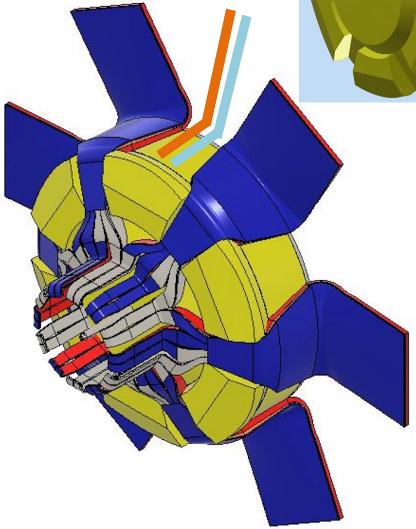
October: 2$^{nd}$ draft

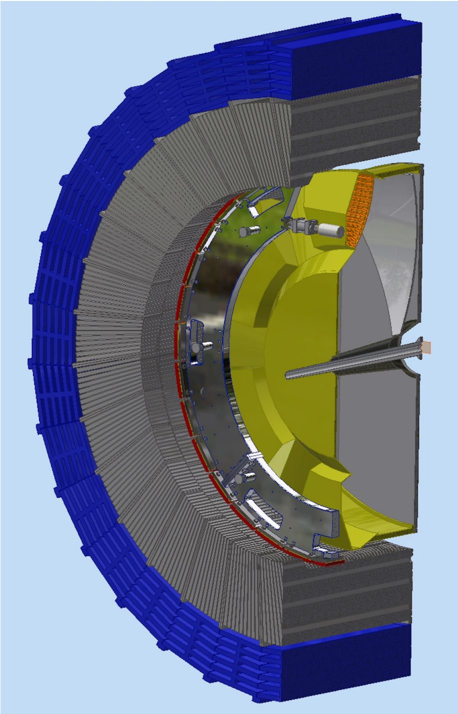
December: Pre-TDR

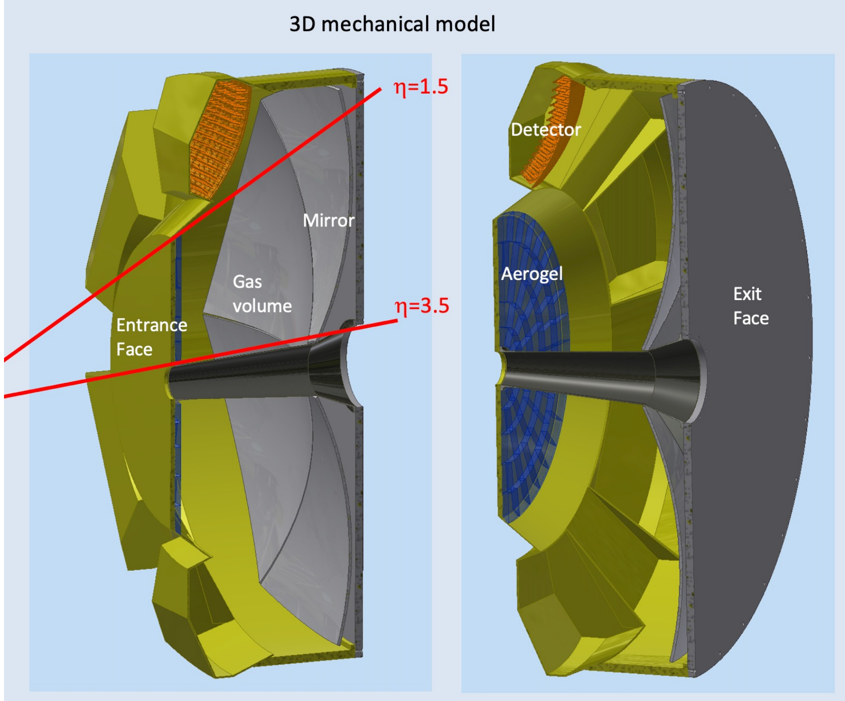
Assumptions: Pre-TDR (CD2) required at the end of the year
Scheme driven by manpower/lead time: remains the same for a TDR (CD3)
Extra-time needed fo real-scale mechanics & RDO demonstrators

- Φ3600 mm x L1200 mm
- Operating pressure up to 200 Pa
- Operating temperature of 22 °C










**Acceptance**: minimize material budget with the use of composite materials
CFRP skins + honeycomb sandwich (~1 %) for windows, 1 cm bulk CFRP (~ 4 %) for round vessel

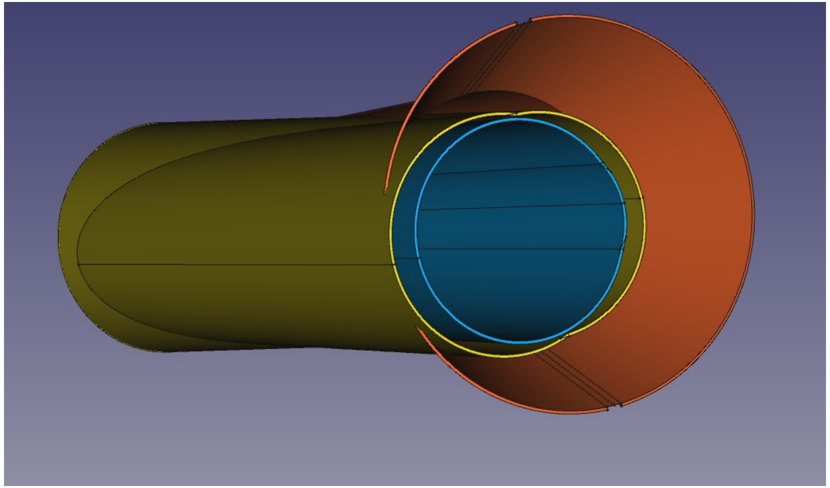
**Interferences**: material budget concentrated beheind the barrel ecal and its support ring
readout electronics designed in order to minimize the detector box volume

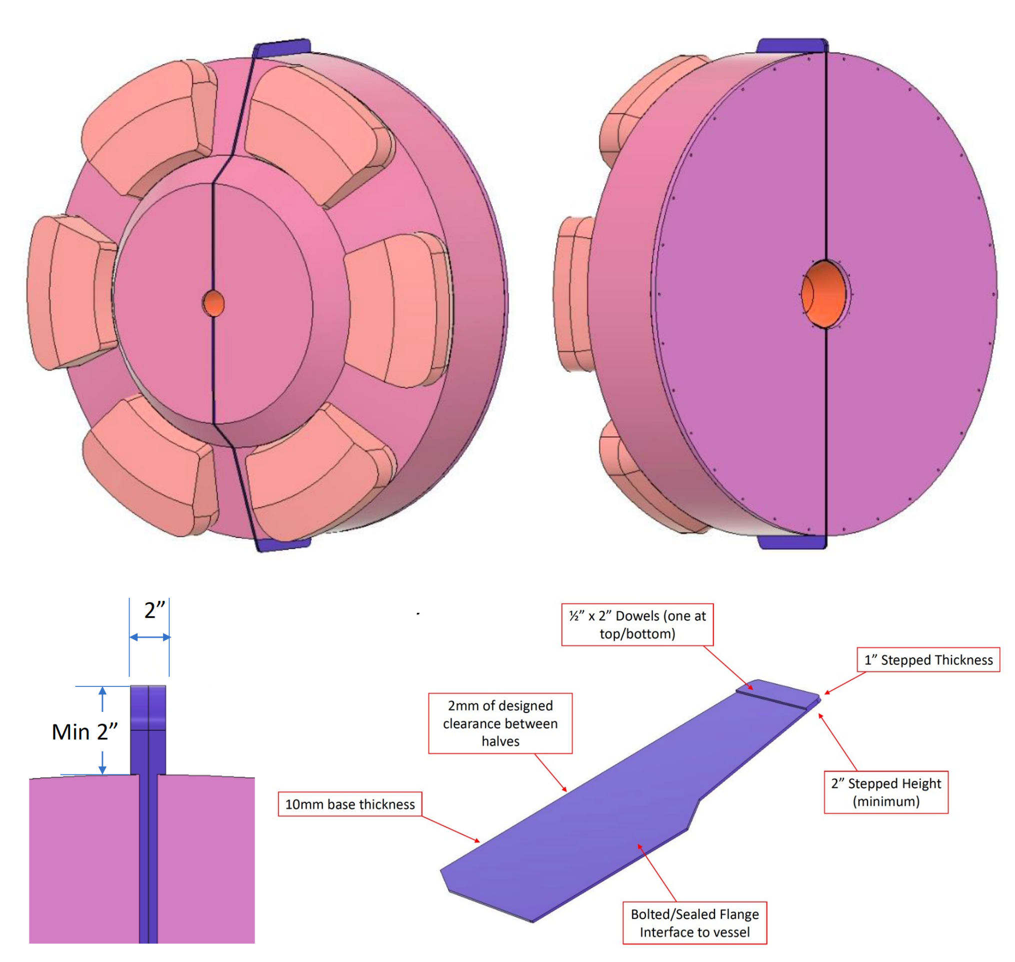
Real scale prototype

Detector box integration

dRICH split model

Alex E.

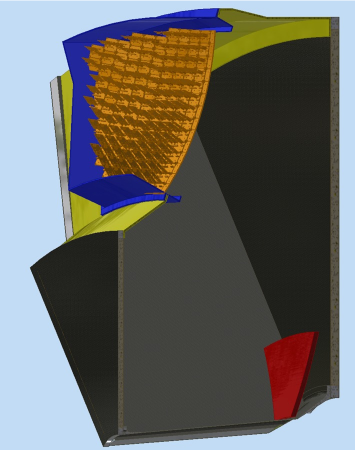


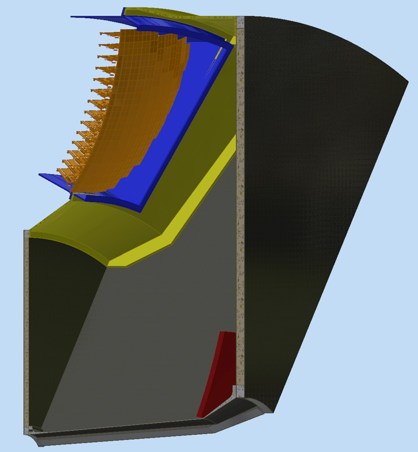


# Vessel

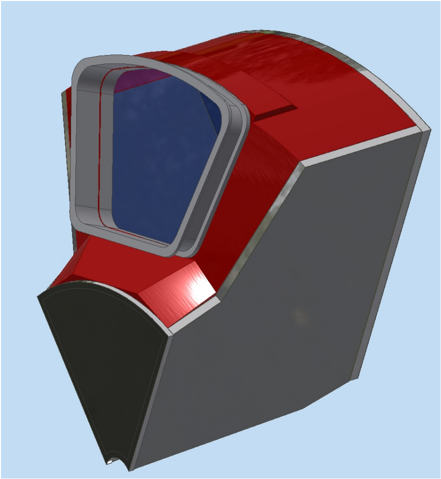
Program towards TDR:

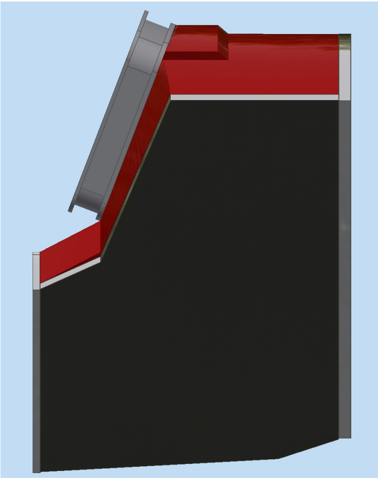
- ✓ 2024: Real scale prototype
- ✓ 2025: Inner structure & support
- ✓ 2025: Detector box & services



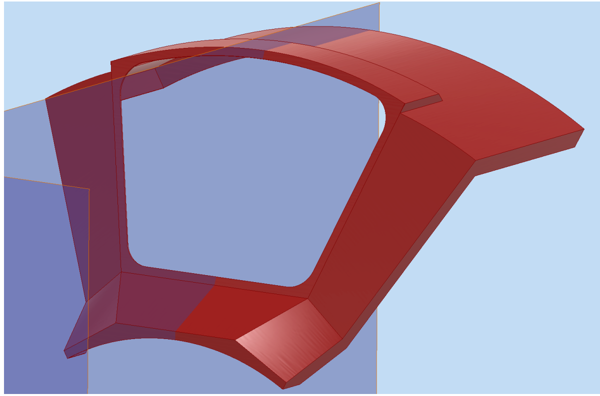


Concepual



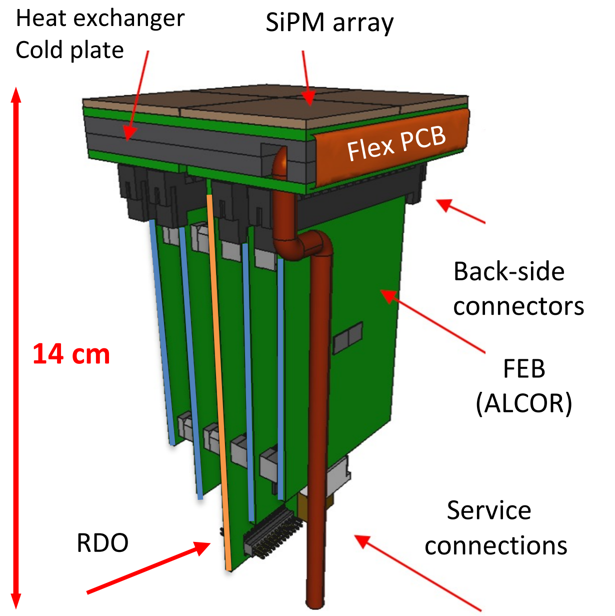


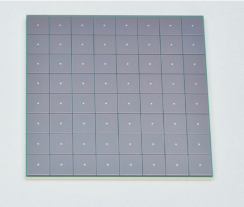
Custom shell
&
Standard CFRP
laminate foils

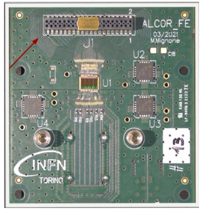


Executive

# dRICH Photo-Detector





SiPM array



ALCOR chip

**Photon Detector Unit (PDU):**

Compact to minimize space

4x Hamamatsu S13361-3050HS SiPM arrays

4x Front-End Boards (FEB)

4x ALCOR chip (ToT discrimination)

4 x Annealing Circuitry

1x Read-Out Board (RDO)

1x Cooling plate (< -30 C)

Active area is shaped to resemble the focal surface and best exploits the focalization

**Detector box:**

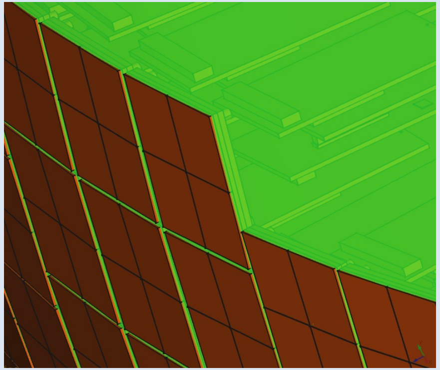
Shaped to fit the space

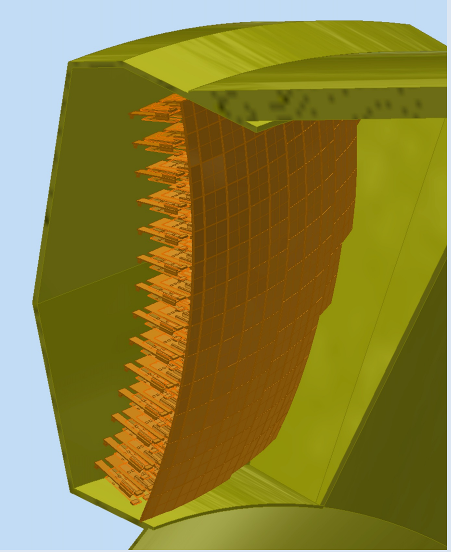
Quartz window

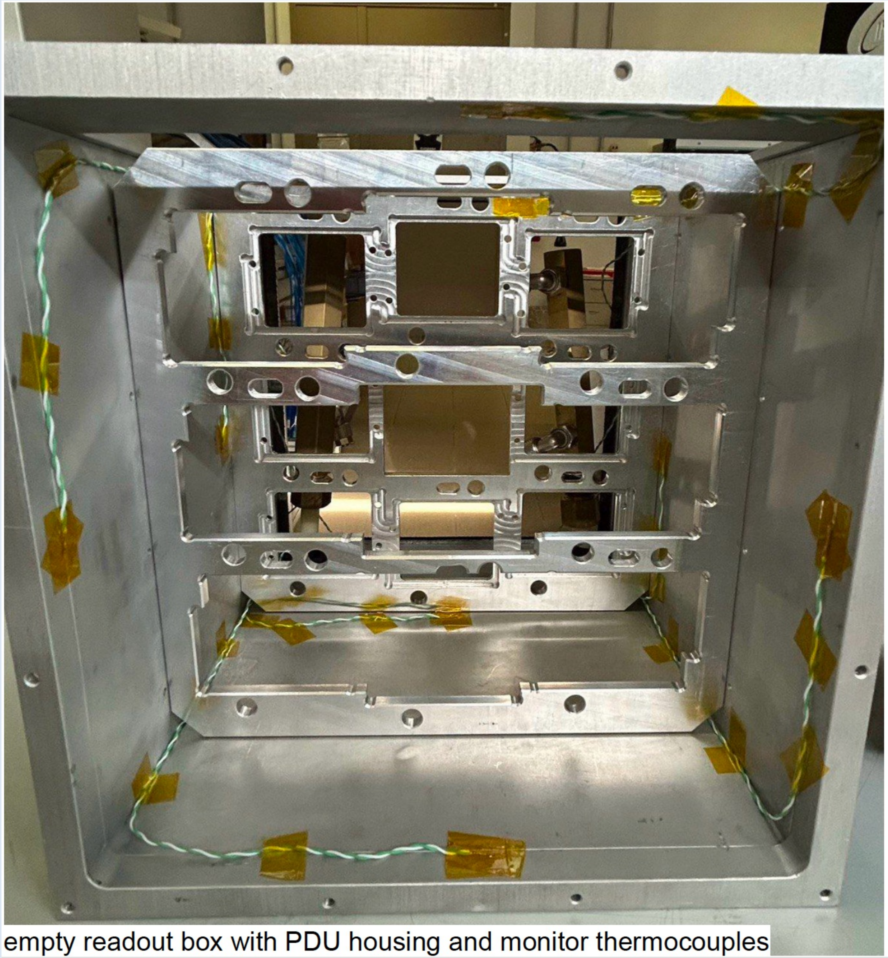
Cooling for sensors and electronics

Power distributing patch panel

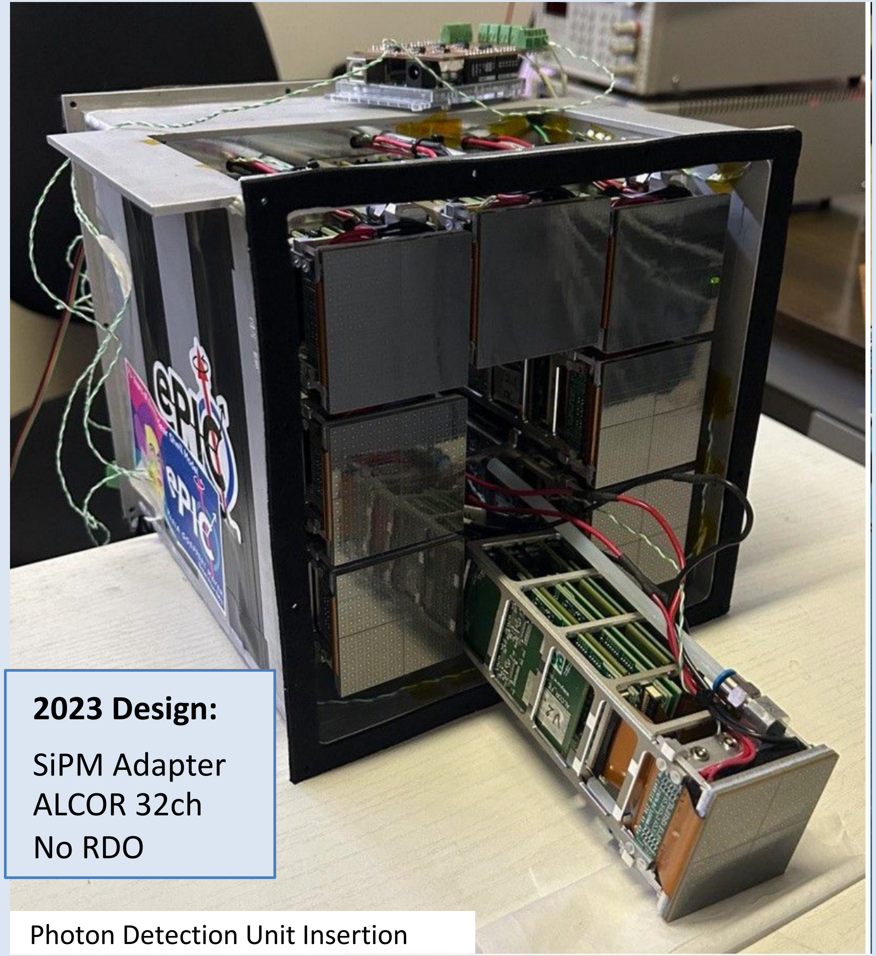
Heat insulation







empty readout box with PDU housing and monitor thermocouples



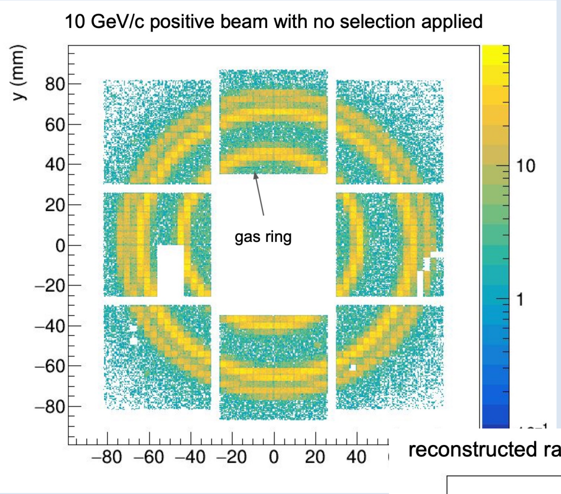

**2023 Design:**

SiPM Adapter
ALCOR 32ch
No RDO

Photon Detection Unit Insertion

## Successful campaign:

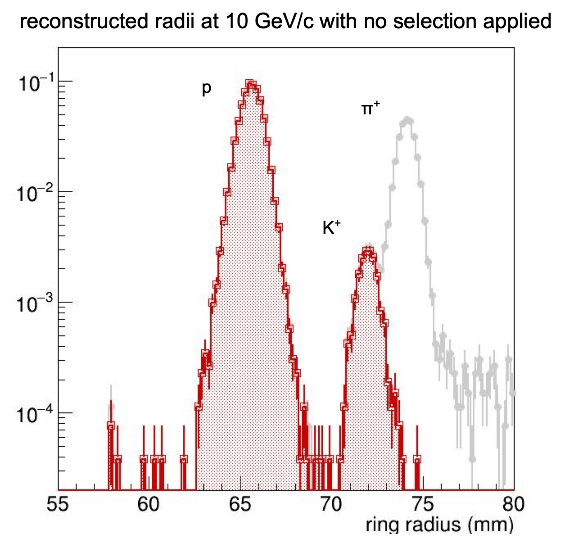
- Mixed hadron beam 2-11 GeV/c
- Various aerogel samples (1.020-1.026)
- Two gas radiators ($C_2F_6$, $C_4F_{10}$)
- Two SiPM working points (-40 C and -20 C)
- Many optical fiters
- Two tracking systems (GEM & SciFi)
- Beam line Cherenkov tagging
- Temperature monitor




Almost complete ring coverage

Nicola R. (early career w)

Aerogel ring w and w/o gas signal



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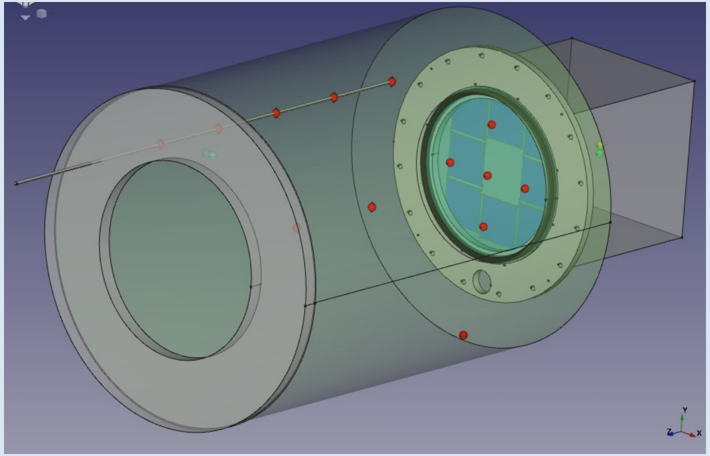
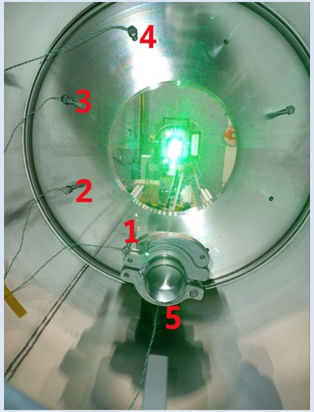
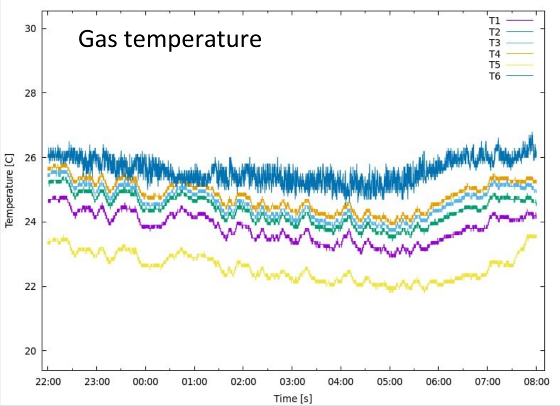
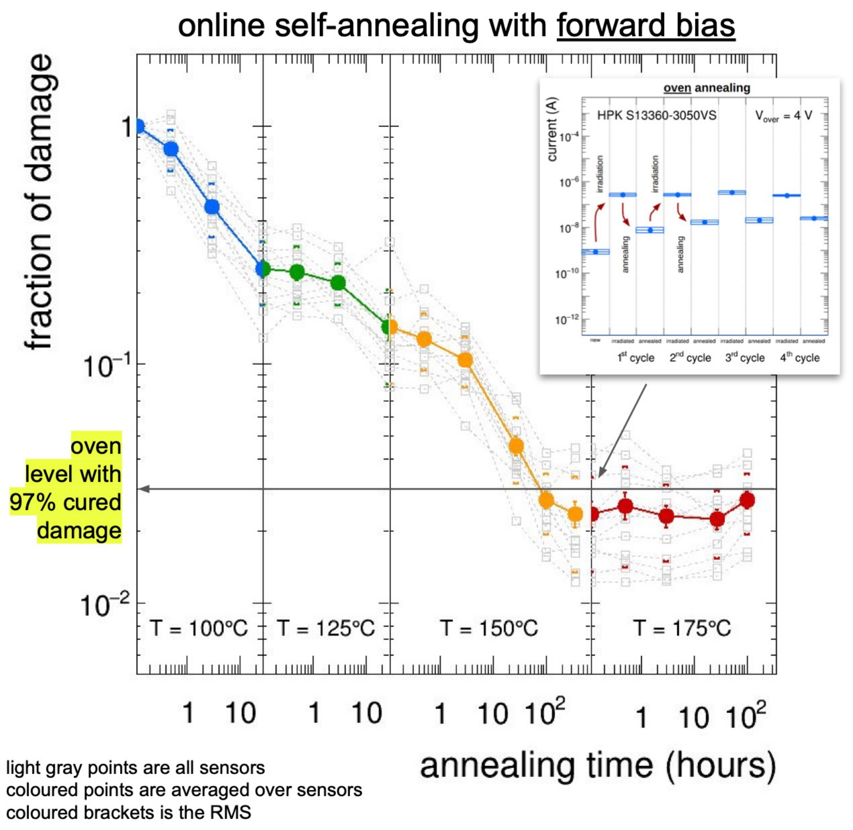
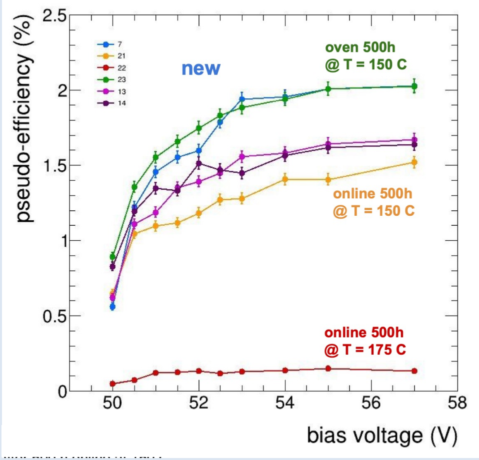
- Beam line Cherenkov tagging
- **Temperature monitor**



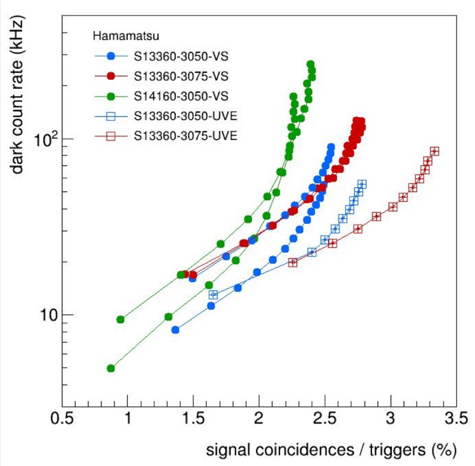





Hamamatsu sensors
oven vs ob-board
annealing




Hamamatsu sensors
- $10^9$ neq
- oven annealing

Program towards TDR:

✓ 2024: annealing & sensors

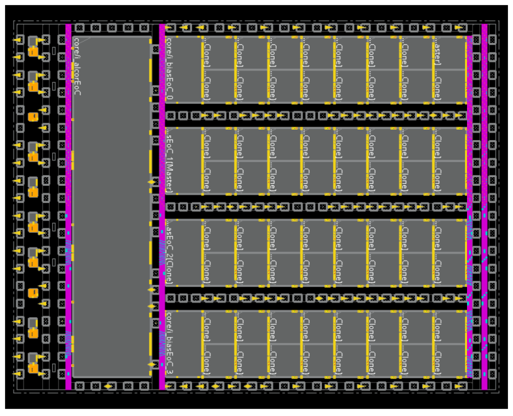
✓ 2025: on-board annealing

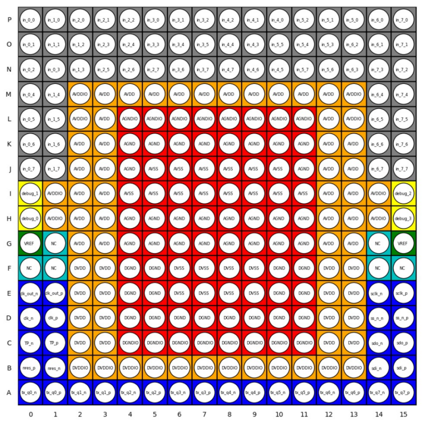
✓ 2025: SiPM sensor optimized specs

Roberto P.

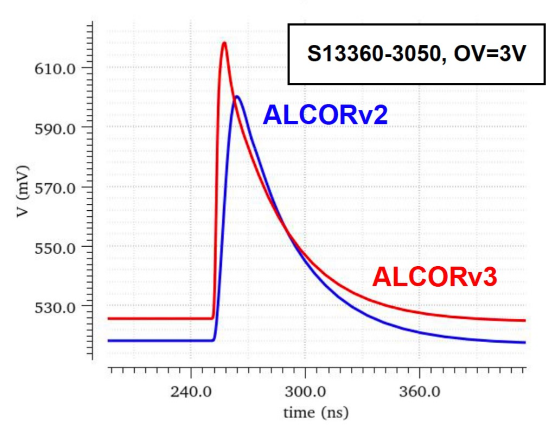
# ALCOR v3

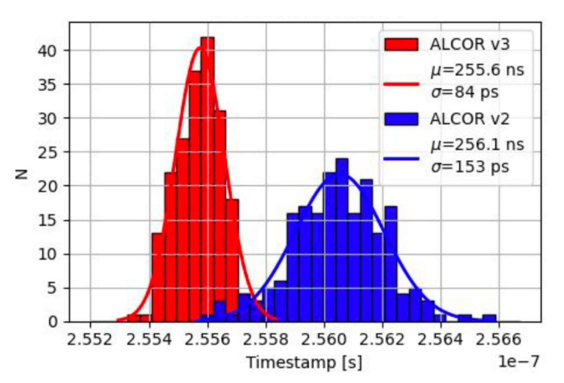
**ALCORv64** digitazing chip



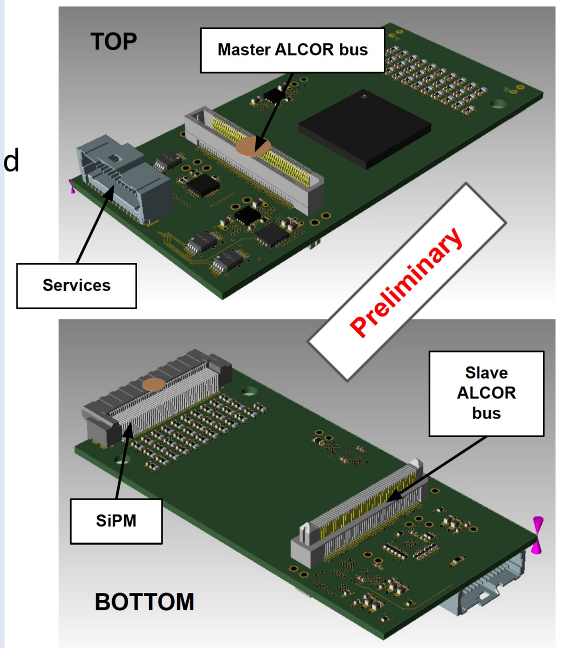


Improvements



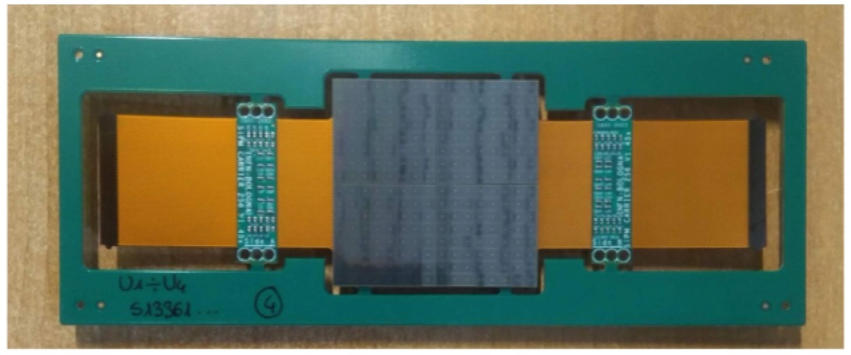

Font-End Board



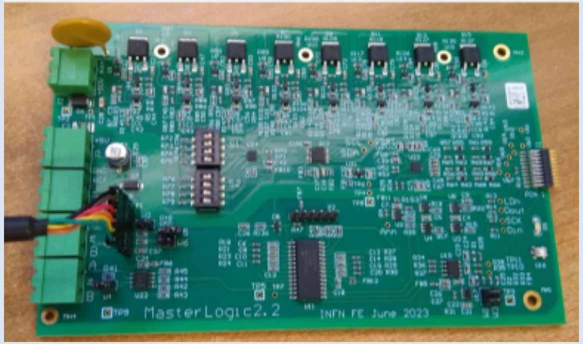

Program towards TDR:

- ✓ 2024: ALCOR v2.1 (32 ch)
- ✓ 2024: ALCOR v3 & FEB
- ✓ 2025: Production readiness

SiPM **carrier board** with 256 channels and flex connector circuits.

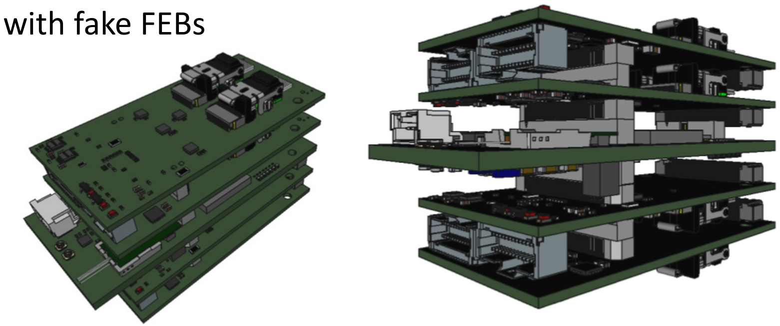


**MasterLogic card** to control SiPM bias voltage & monitoring service




**Readout Board** to configure and connet to the back-end

RDO stack
with fake FEBs



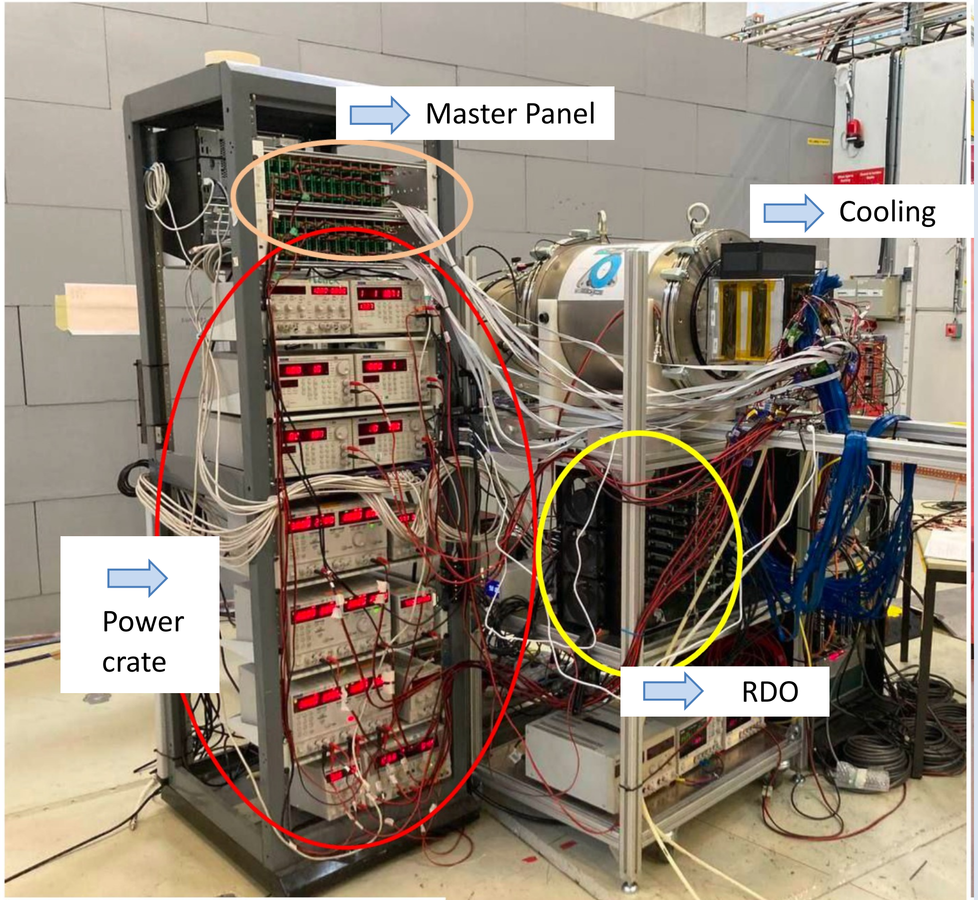
Program towards TDR:

- ✓ 2024: RDO prototype
- ✓ 2025: Carrier v3
- ✓ 2025: RDO
- ✓ 2025: Master Panel

Roberto P.

Davide F.

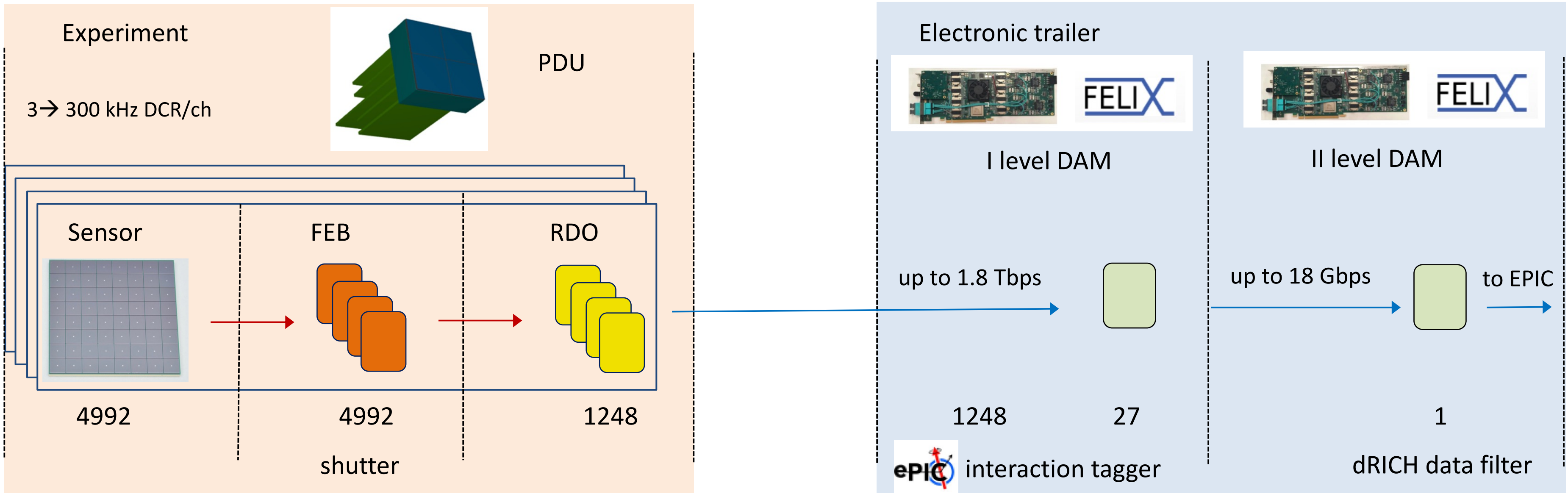
# Readout & Services




many table-top power supplies in 2023

# Streaming Data-Acquisition

Goals: **Maximise modularity** (detector shaping) and **capability** (data stream)

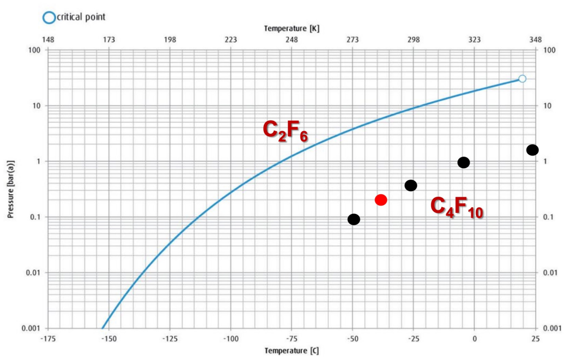


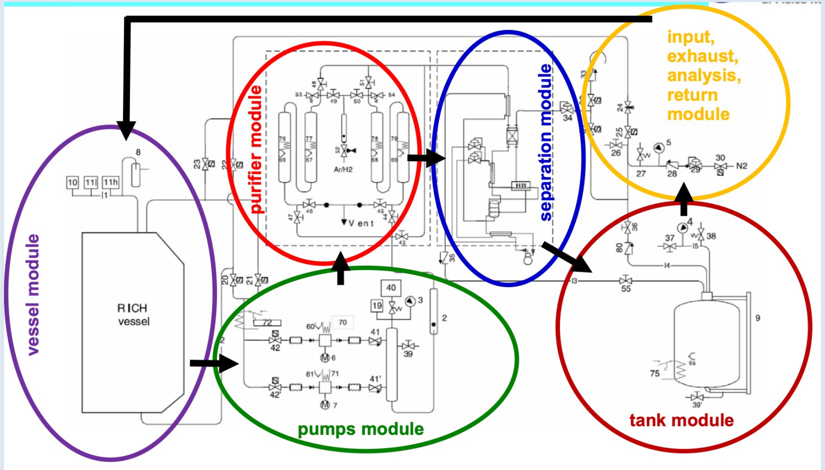

Program towards TDR:

- ✓ 2024: Feasibility study
- ✓ 2025: Interaction tagger
- ✓ 2025: Online data filter

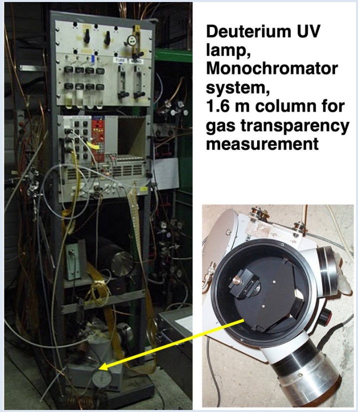
Tagger Workfest on July 26th

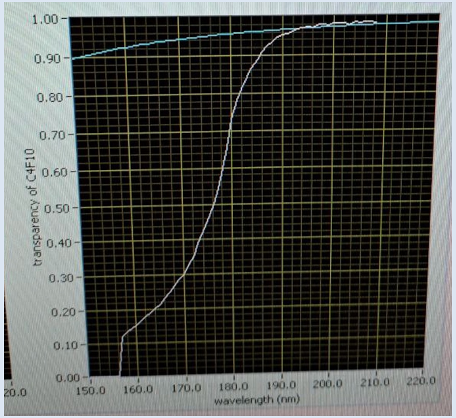
Gas system




Gas characterizaiton & optimization (synergy with AMBER/CERN)

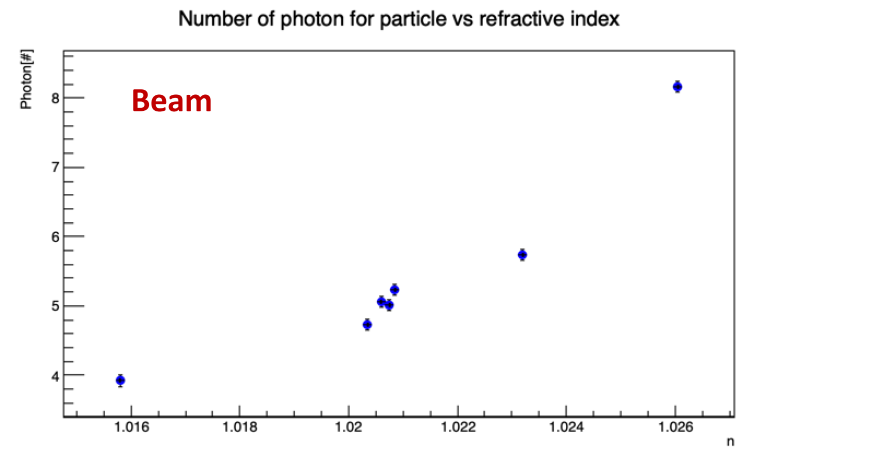


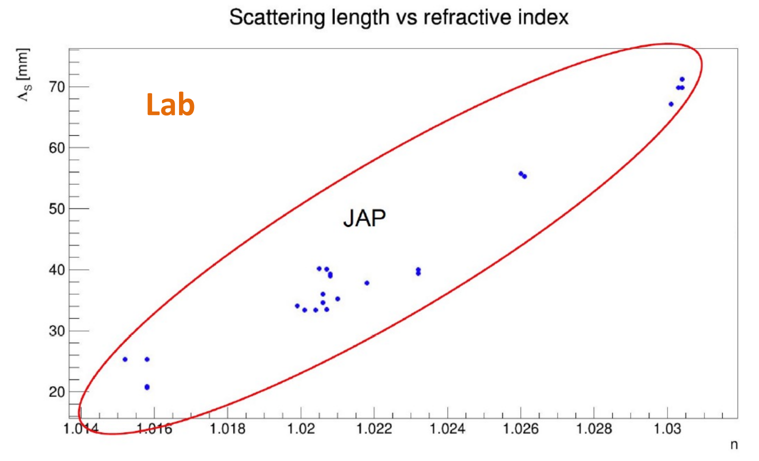



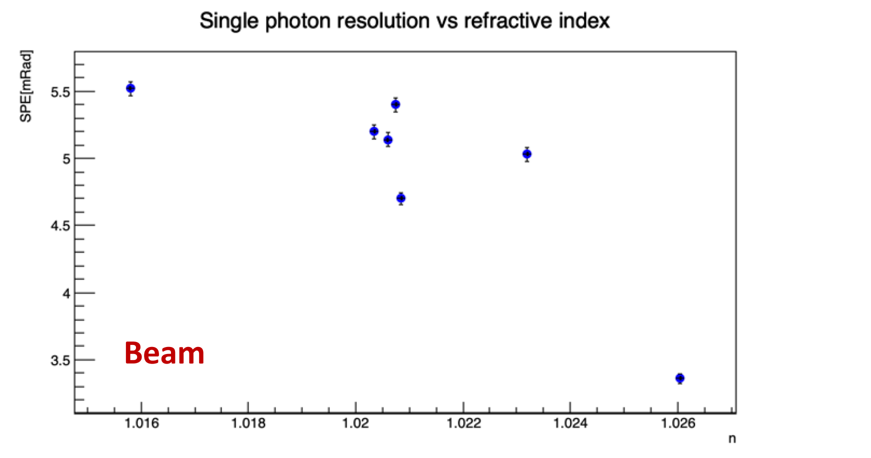

Program towards TDR:

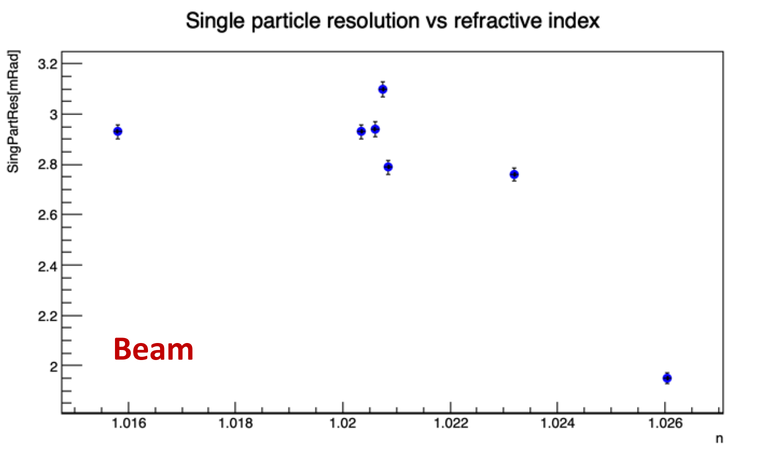
- ✓ 2024: Validated with prototype
- ✓ 2024: Transparency in UV
- ✓ 2025: Transparency in visible & near-UV
- ✓ 2025: gas system project

# Aerogel Radiator

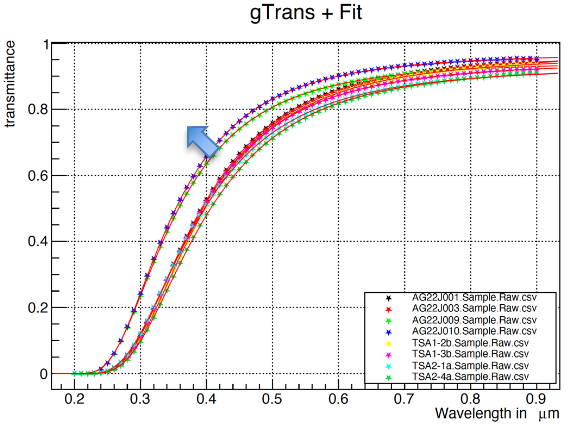


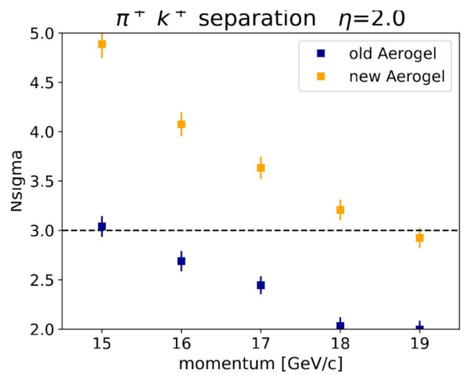



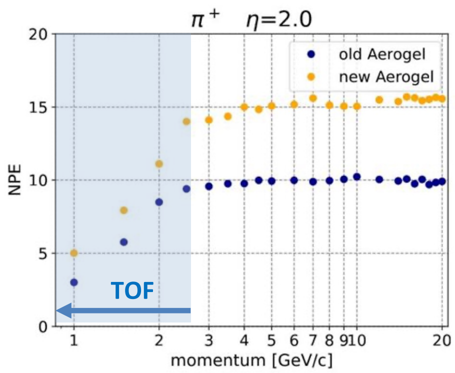



Aerogel characterization & optimization (synergy with ALICE3)




**ePIC simulations**



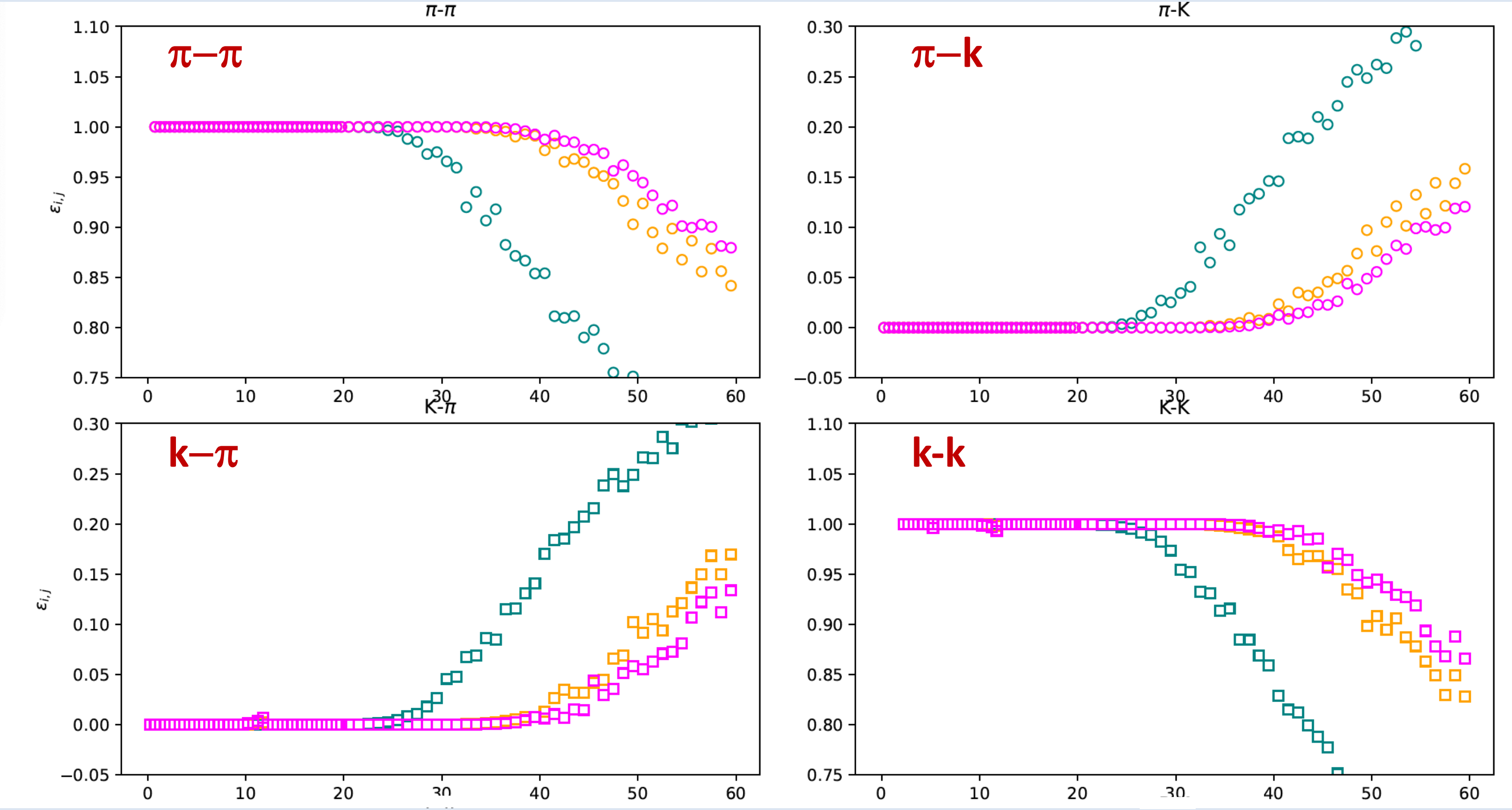




Program towards TDR:

- ✓ 2024: Validate n > 1.025
- ✓ 2024: Increase size (15-18 cm) or thickness (2-3 cm)
- ✓ 2025: define size (up to 20 cm) & production specs

# Performance

dRICH performance is studied within the ePIC simulation framework (with tracking resolution and magnetic bending)
An initiative has started to study impact on physics of ePIC PID subsystems



# Mirrors

Program towards TDR:

- ✓ 2024: Substrate & Coating
- ✓ 2024: Light structure
- ✓ 2025: Support & Alignment

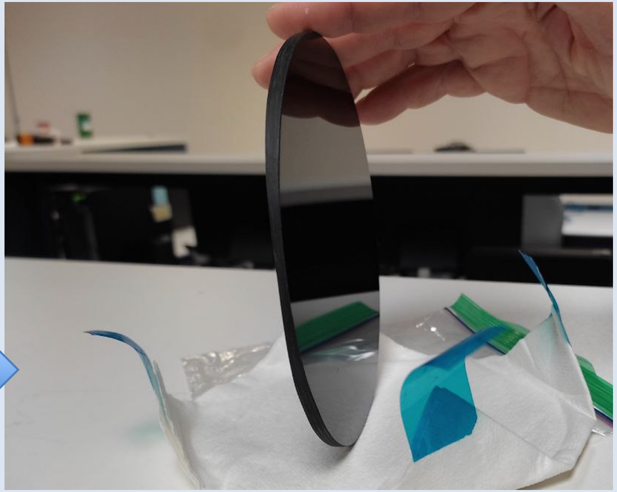
Optimization

Connor P.

Substrate samples for coating tests (ongoing at Stony Brook)

Small demonstrator

Mid-size demonstrator



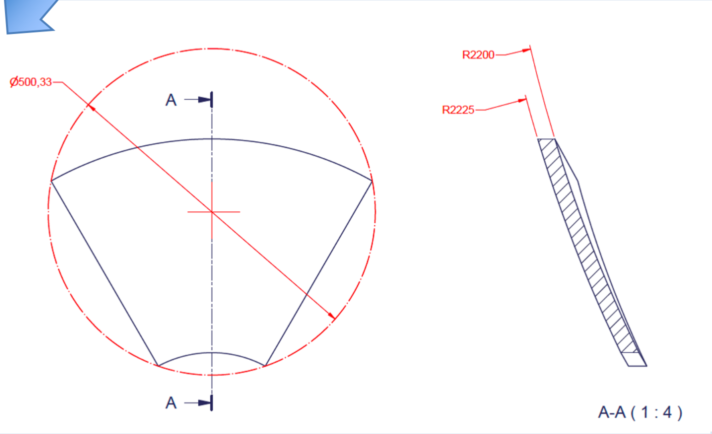
**Annex C. Technical Requisite**

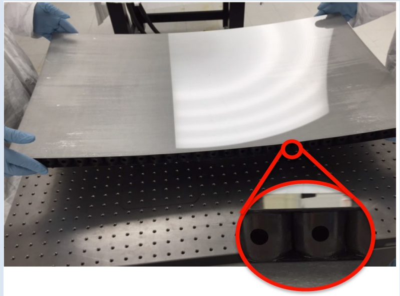
Each spherical mirror is supplied with

- a spot-size measurement,
- a report on dimensions,
- no reflective coating.

The spherical mirrors are replicated from the same mandrel. The latter is realized with the novel cost-effective technology that reduces the mandrel total mass and cost. Each mirror fulfills the following optical quality specification:

- Radius within 1% of nominal RoC value (the nominal RoC values is defined by the customer before production in the range 2000 mm +/- 10%),
- Roughness < 2 nm,
- Pointlike image spot size D0 < 2.5 mm,
- Compatibility with fluorocarbon gases ($C_2F_6$),
- Compatibility with $SiO_2$ reflecting coating.

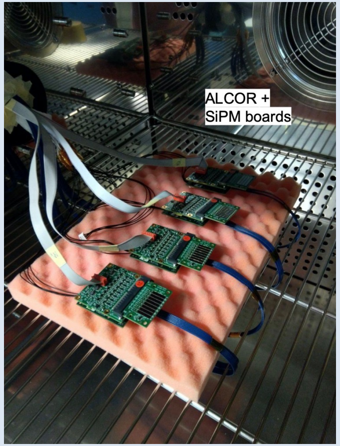


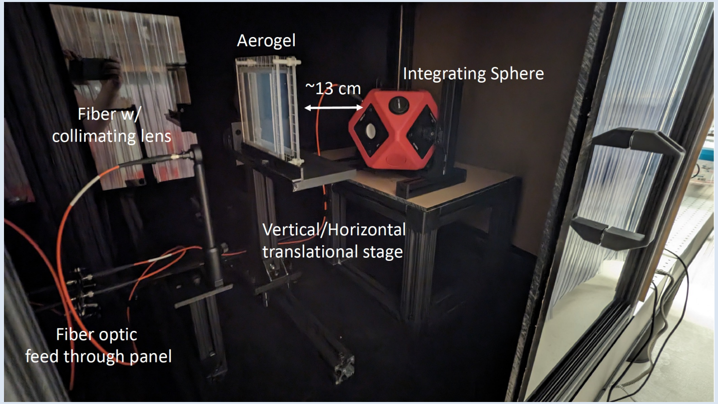



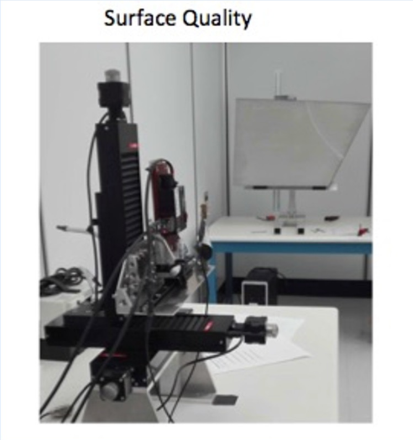
Sensors: INFN (CS/SA/CT) – TS – BO

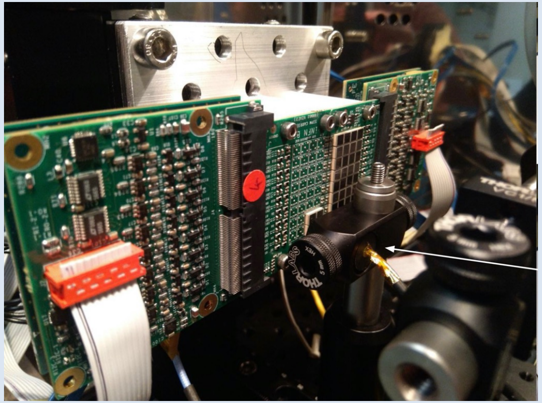
Aerogel: Temple - BNL – INFN (BA)

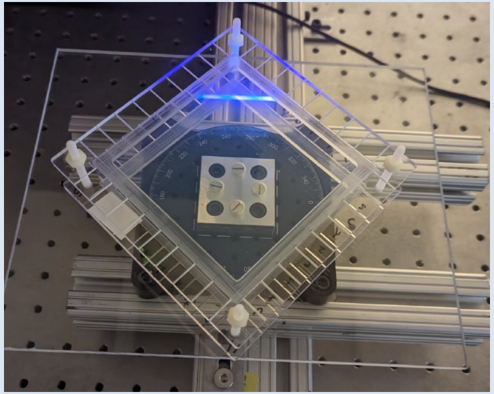
Mirror: JLab – Duke – INFN (FE)

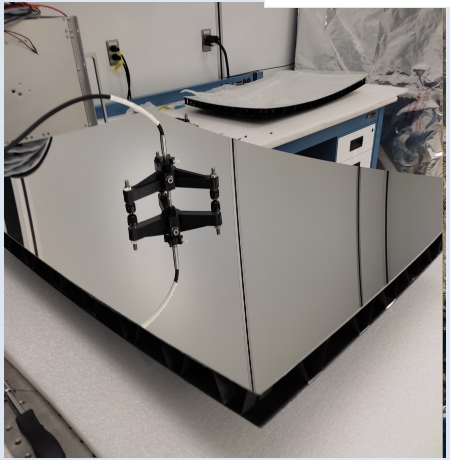


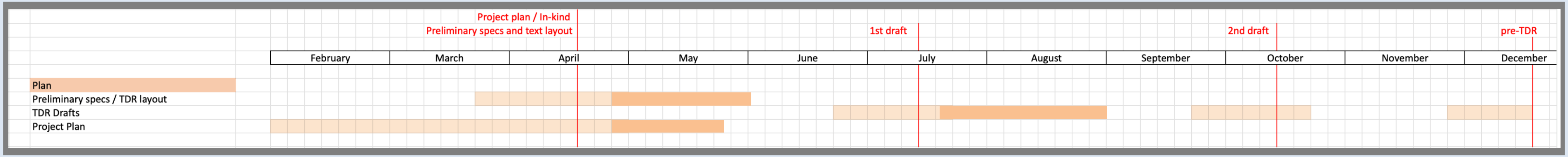







# TDR Effort in 2024




✓ April: Preliminary specs & text layout
Project plan / in-kind preview

✓ July: 1st draft

October: 2nd draft

December: Pre-TDR

Assumptions: Pre-TDR (CD2) required at the end of the year
Scheme driven by manpower/lead time: remains the same for a TDR (CD3)
Extra-time needed fo real-scale mechanics & RDO demonstrators

dRICH performance is studied within the ePIC simulation framework (with tracking resolution and magnetic bending)

An initiative has started to study impact on physics of ePIC PID subsystems