dRICH Collaboration

Compact cost-effective solution for particle identification in the high-energy endcap at EIC

dRICH

INFN: BA, BO, CS, CT, FE , GE, LNS, RM1, RM2, SA, TO, TS

Jefferson Lab, Duke University

Ramaiah University of Applied Sciences, NISER

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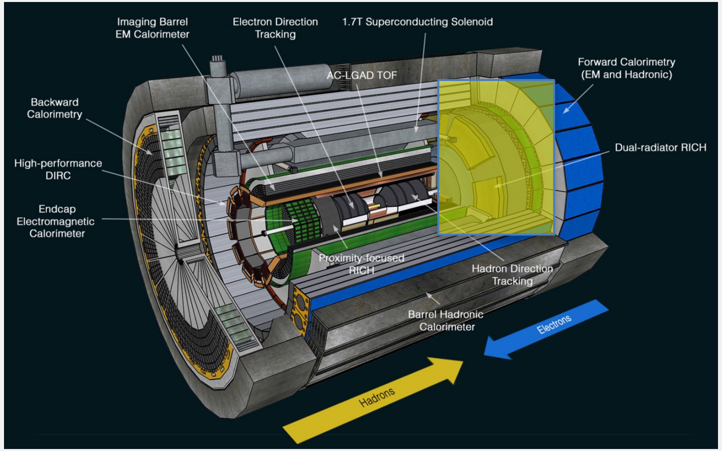
EPIC



EIC RICH Consortium

Brookhaven National Laboratory

Stony Brook University

Temple University

Univerza v Ljubljani

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Forward particle detection

Hadron ID in the extended 3-50 GeV/c interval

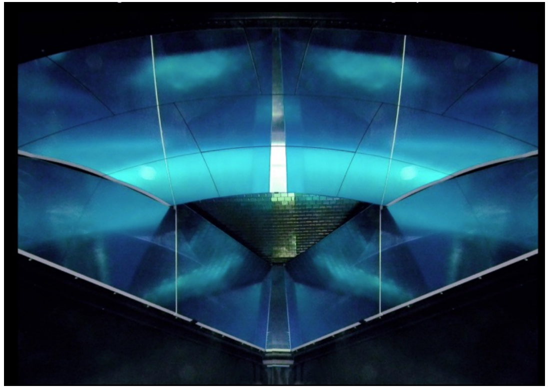
Support electron ID up to 15 GeV/c

Main challenges:

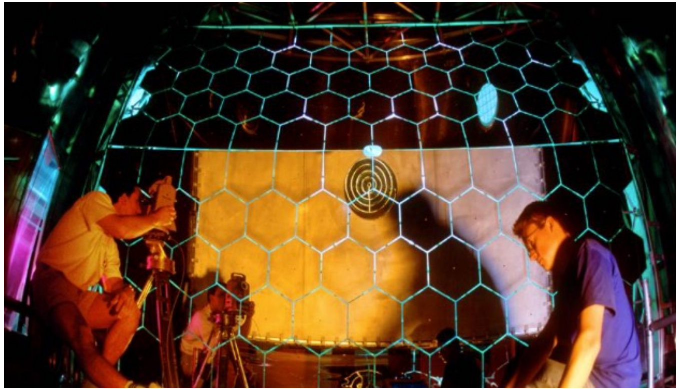
Cover wide momentum range 3 - 60 GeV/c -> dual radiator
Work in high (~ 1T) magnetic field -> SiPM
Fit in a quite limited (for a gas RICH) space -> curved detector

INFN Background

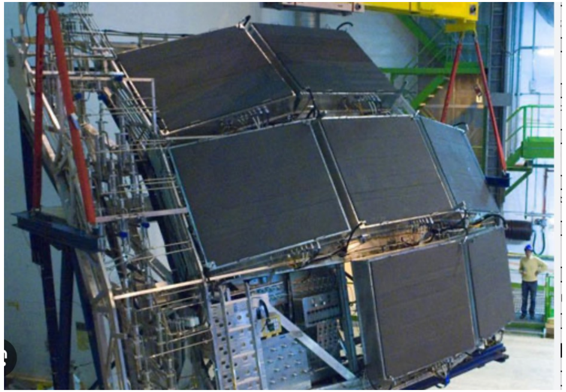
CLAS12 RICH



COMPASS RICH

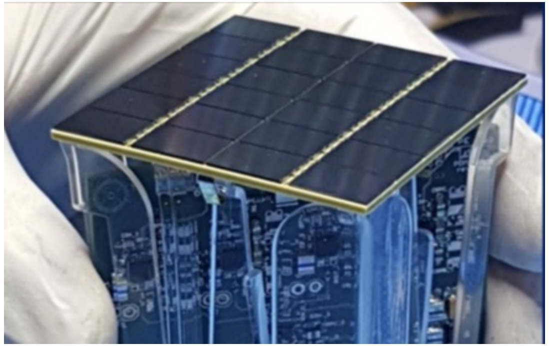


ALICE HMPID

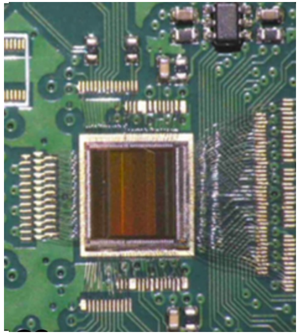


HERMES RICH

DARKSIDE



ALCOR



dRICH Sub-System Organization

6.10.04 Particle Identification	Level-3	CAM from Project
6.10.04.03 dRICH	Level-4	CAM from Project + DSTC from EPIC (**M. Contalbrigo**)

Work packages lead from EPIC

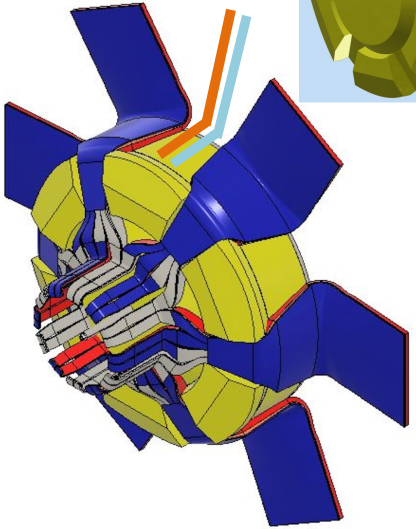
Photo-Detector	Level-5	**R. Preghenella**, INFN-BO, INFN-FE, INFN-CS, INFN-SA, INFN-LNF, INFN-CT, NISER
Front-end Asics	Level-5	**F. Cossio**, INFN-TO, INFN-BO
Data-acquisition	Level-5	**P. Antonioli**, INFN-BO, INFN-FE
Mechanics	Level-5	**A. Saputi**, INFN-FE, INFN-CT, INFN-GE, JLAB, BNL
Gas radiator	Level-5	**F. Tessarotto**, INFN-TS, BNL
Mirror	Level-5	**A. Vossen**, DUKE, INFN-FE
Aerogel Radiator	Level-5	**G. Volpe**, INFN-BA, INFN-FE, RICH Consortium
High-Pressure	Level-5	**S. Dalla Torre**, INFN-TS, INFN-FE, INFN-LNS
Simulation		**C. Chatterjee**, INFN-TS, DUKE, INFN-FE, RICH Consort.

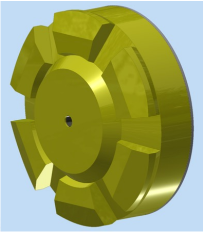
Work packages not yet active

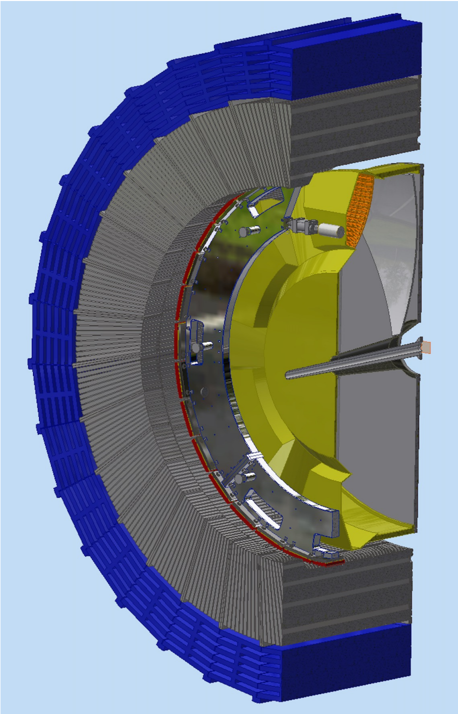
Interlock	Level-5
Slow Control	Level-5
Cooling	Level-5
Gas purging	Level-5
Detector box	Level-5
Alignment	Level-5
Power Supply	Level-5
……	Level-5

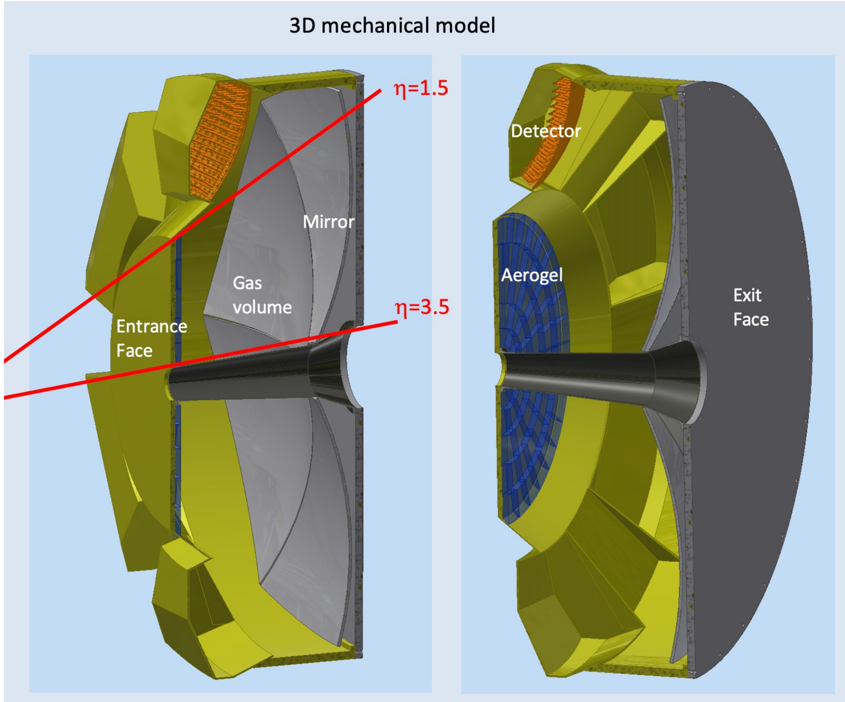
ePIC dRICH

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



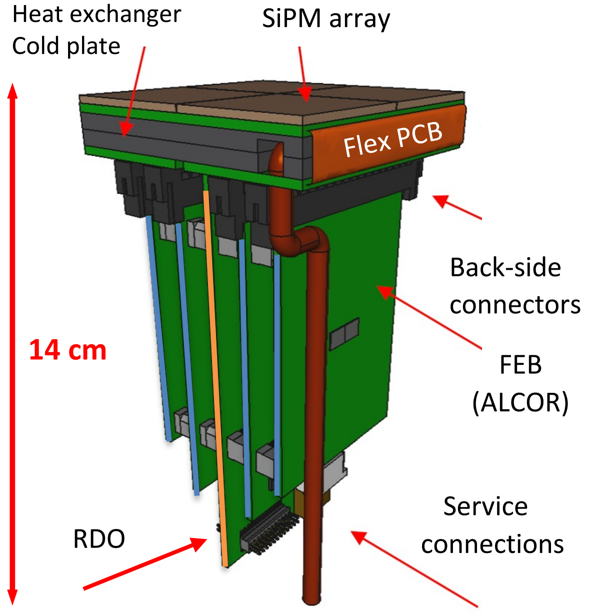


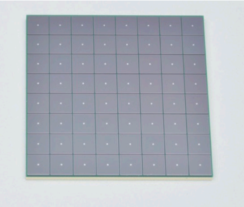




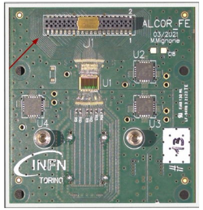
Interferences: material budget concentrated beheind the barrel ecal and its support ring
readout electronics design in order to minimize the detector box volume

Acceptance: defined by pipe and barrel ecal
minimize material budget with the use of composite materials





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:

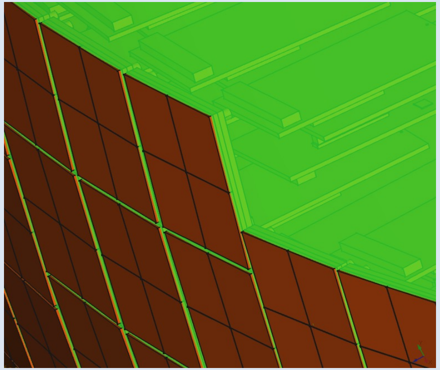
Shaped to fit the space

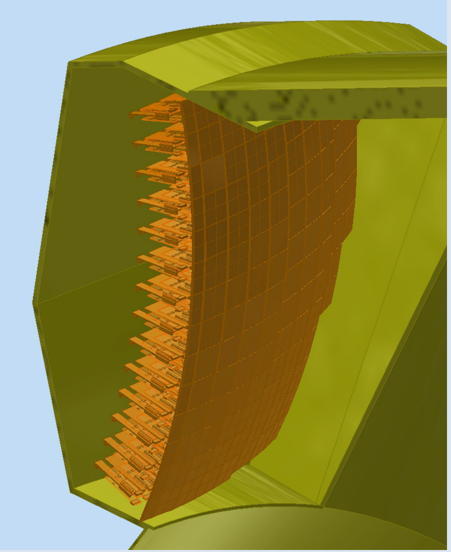
Quartz window

Cooling for sensors and electronics

Power distributing patch panel

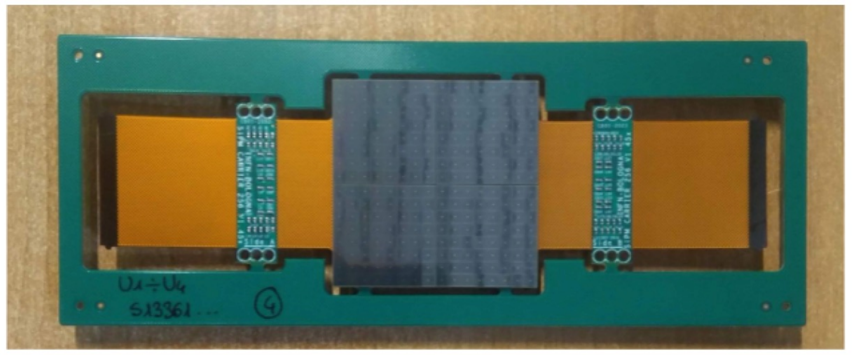
Heat insulation



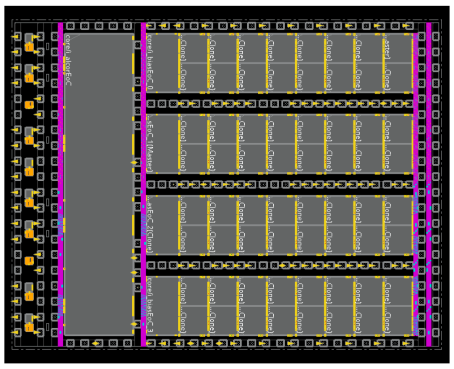


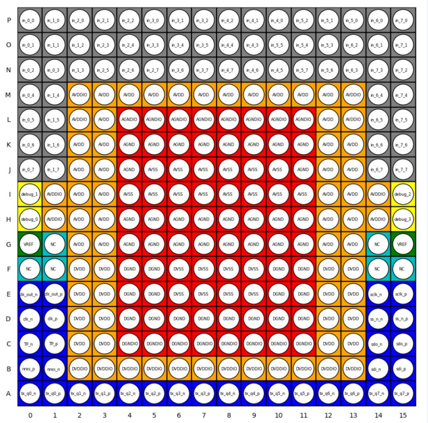
Readout Components

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

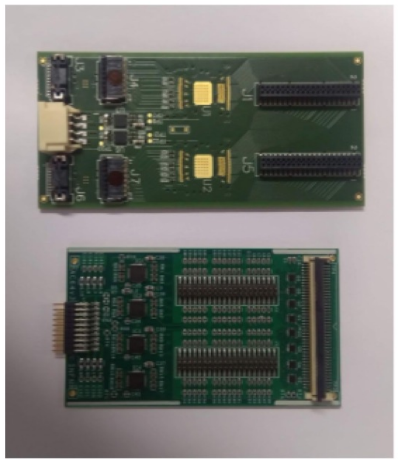


ALCORv64 digitazing chip

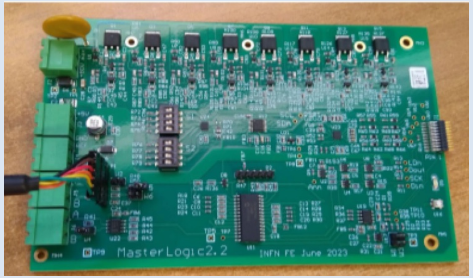




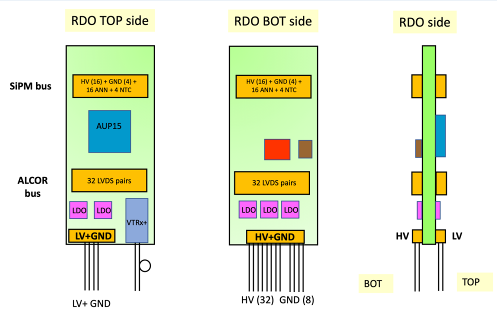
2x **ALCOR front-end card** and the **adapter board**



MasterLogic card to control SiPM bias voltage & monitoring service



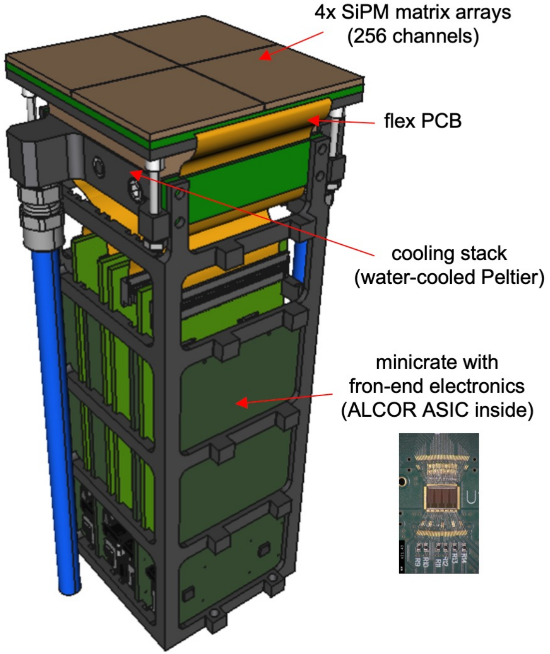
Readout Board to configure and connet to the back-end

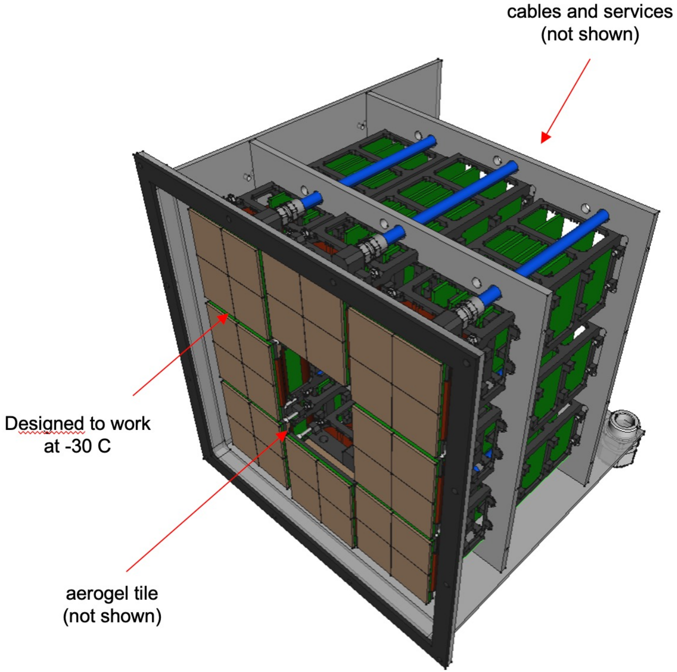


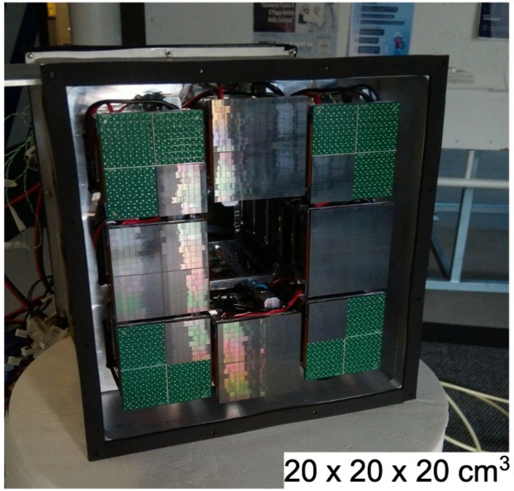
Photon Detection Unit
Streaming readout mode

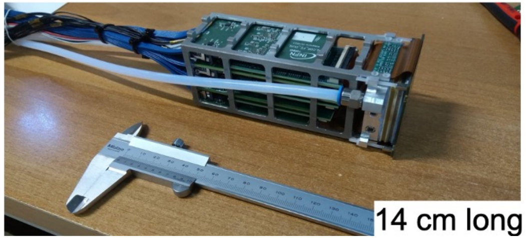
Readout Box
8 PDUs, 2048 channels

Prototype
Working Pooint -40:-20 C





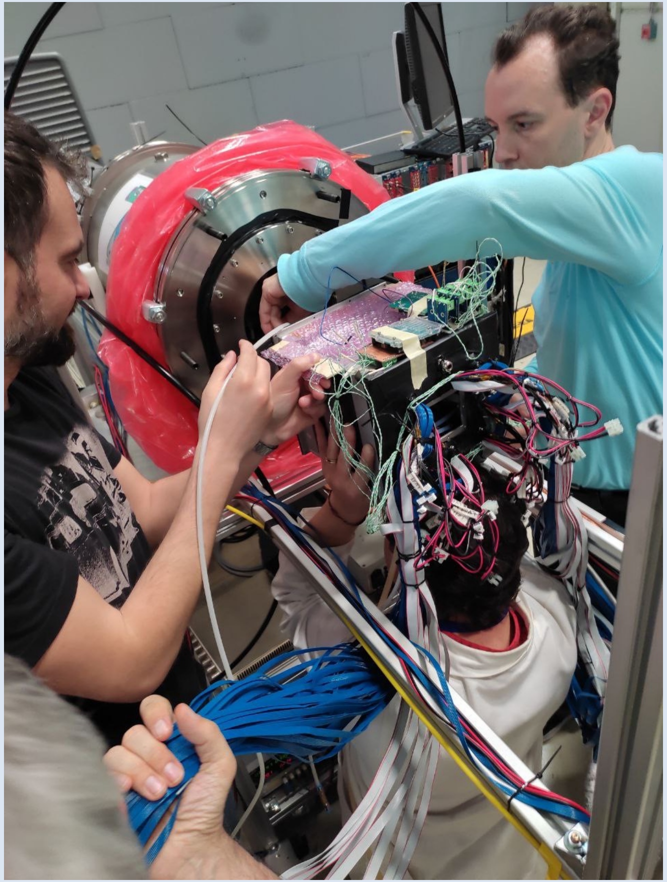




May 2024 Test-beam

SiPM Detector

Detector Mounting



Tracking GEM+SciFi

Successful campaign:

Mixed hadron beam 2-11 GeV/c

Various aerogel samples (1.020-1.026)

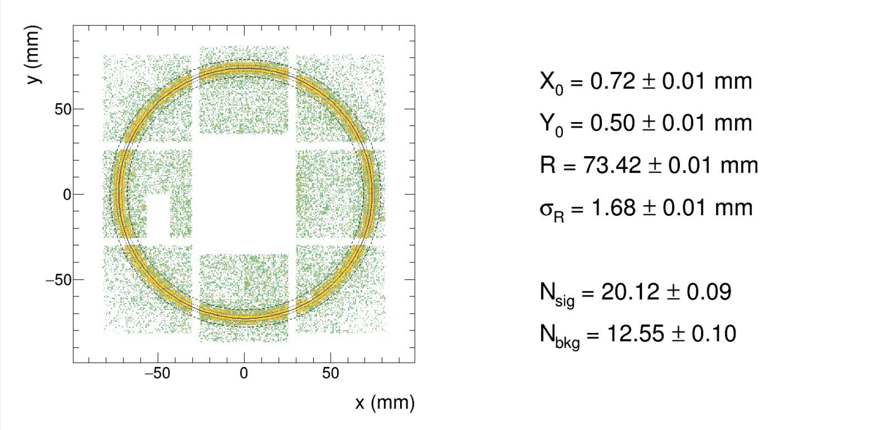
Two gas radiators (C_2F_6, C_4F_{10})

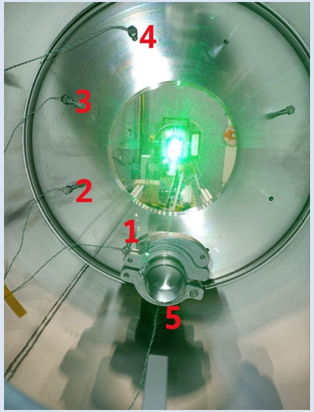
Two SiPM working points (-40 C and -20 C)

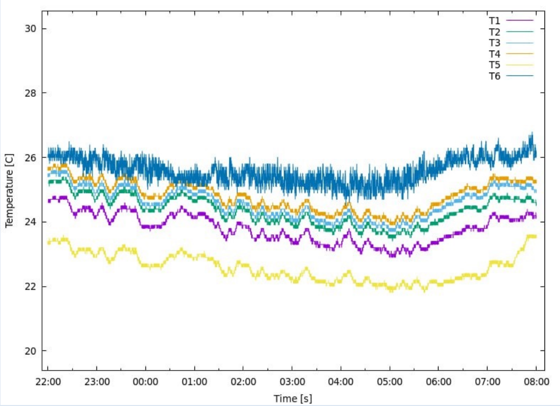
Two tracking systems (GEM & SciFi)

Many optical fiters

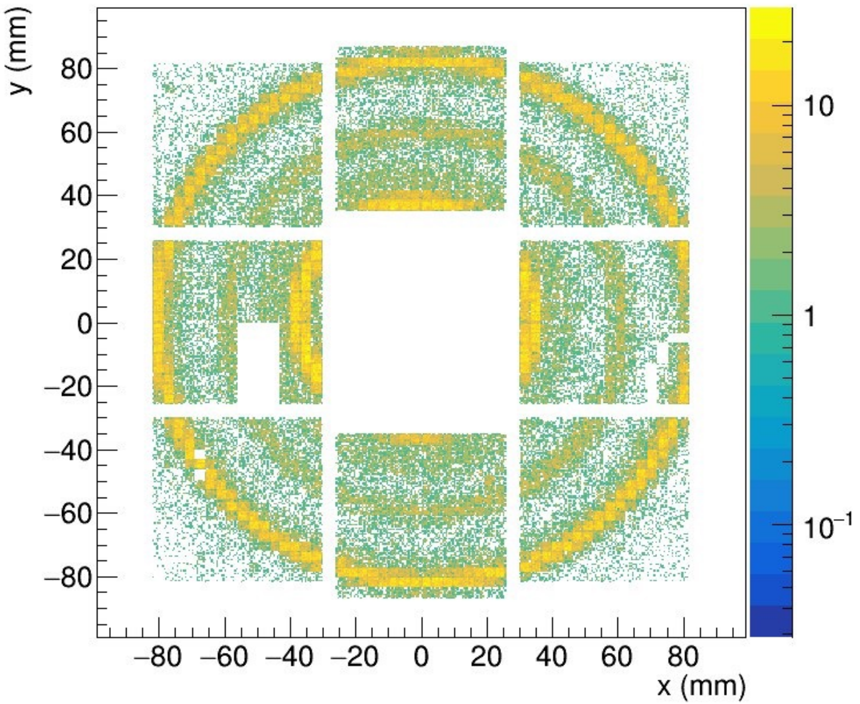
Beam line Cherenkov tagging



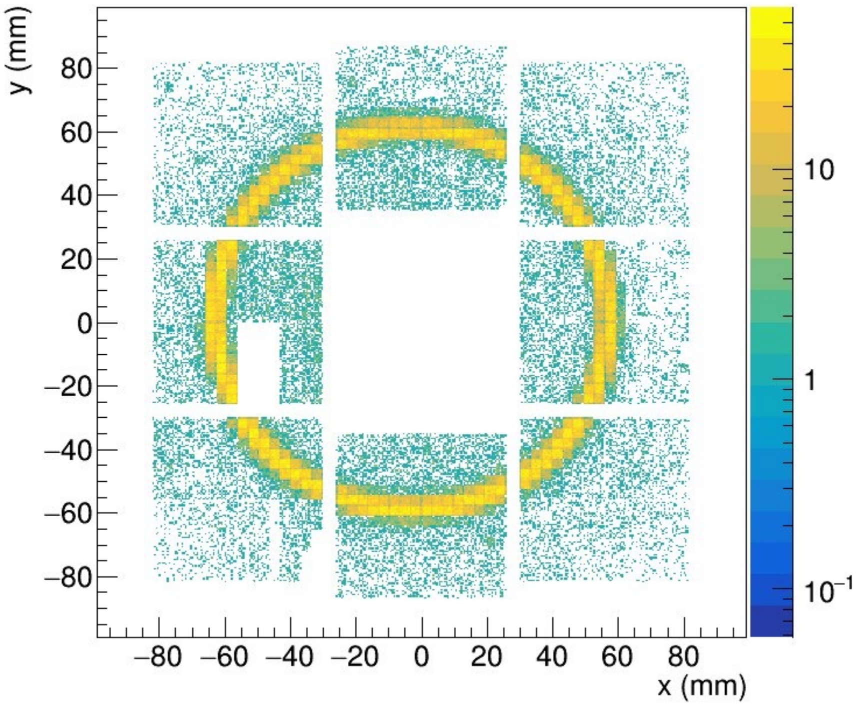




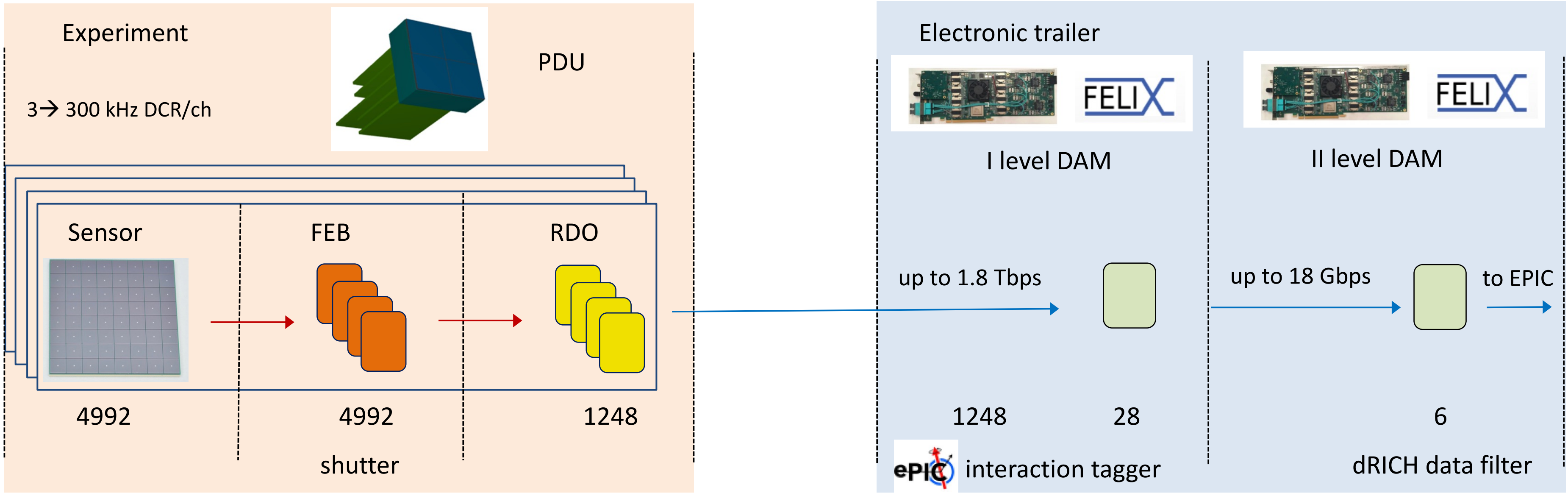
Aerogel + C_2F_6 radiators, positve beam, 8 GeV/c



C_4F_{10} radiator, negative beam, 11 GeV/c



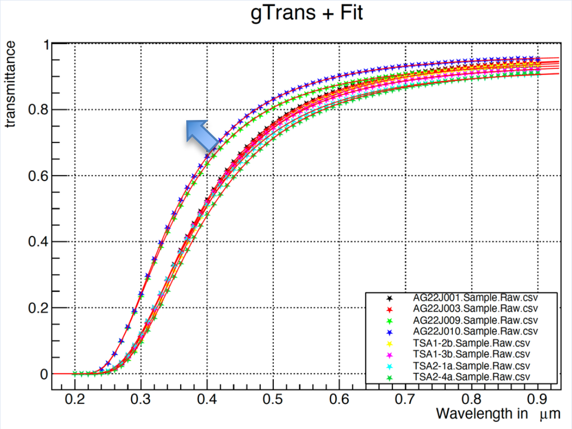
Streaming Data-Acquisition



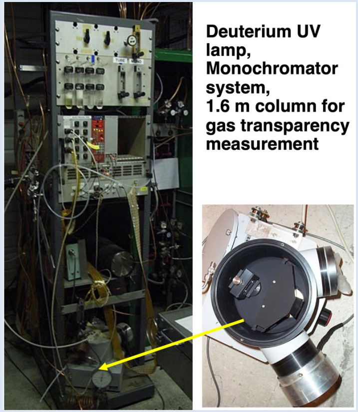
Goals: **Maximise modularity** (detector shaping) and **capability** (data stream)

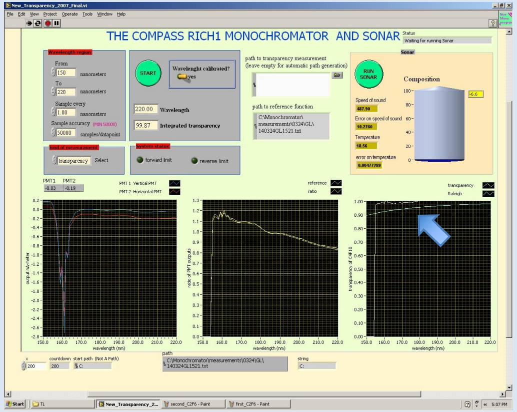
DAM Hierarchy: Maximum data rate capability till DAM-L1
Big data reduction at DAM-L1 with external input (2 μs latency interaction tagger)
DAM-L2 data aggregation per sector allows for effective data-reduction algorithms

Aerogel characterization & optimization

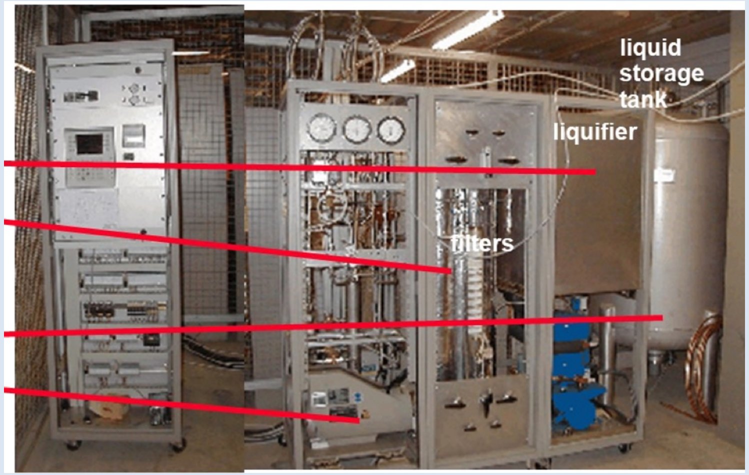


Gas characterizaiton & optimization



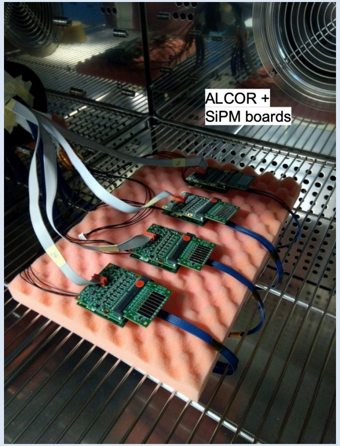


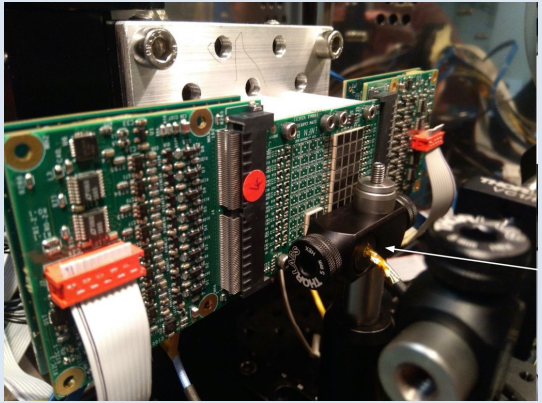
Gas system



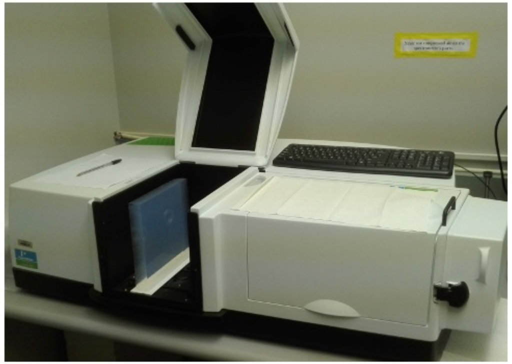
Quality Assurance

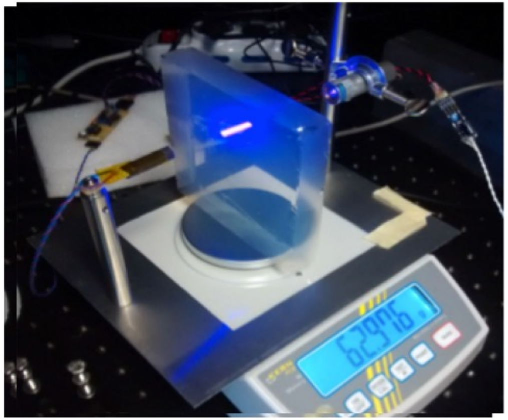
Sensors: INFN (CS/SA/CT) – TS – BO



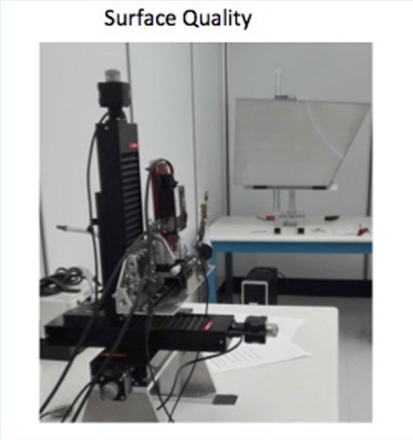


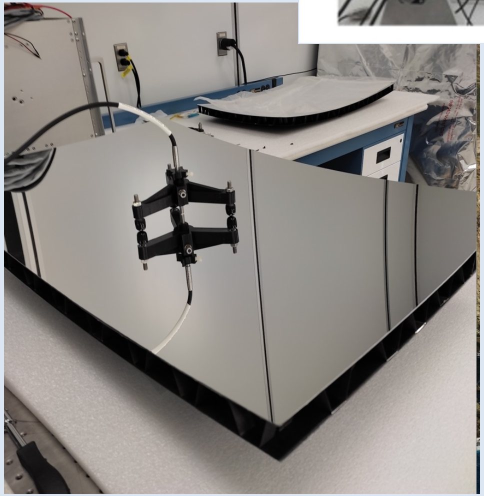
Aerogel: Temple - BNL – INFN (BA)





Mirror: JLab – Duke – INFN (FE)





dRICH Construction Items

	INFN	Shared	DOE
Mechanics	Detector box (FE, LNS)	Vessel (FE) Insulation (TS)	Gas & mirror supports (JLab) Installation tools (JLab/BNL
Photo-detector	Sensors (BO,CS,SA,CT,TS) PDU (cool plate) (BO)		
Readout	ALCOR (TO,….) FEB (TO,…..) Master Panel (FE)		
DAQ	RDO (BO)	Data stream (GE, RM1, RM2)	DAM (BNL)
Radiators	Aerogel (BA)		Gas (BNL) Aerogel QA (Temple, BNL)
Mirror			Mirror (JLab/Duke) Coating (Duke)
Services			Gas Plant (BNL) Cooling Plant (BNL) Power Plant (BNL)
Monitors	Gas monitor (TS)	Slow Control/Interlock (…) LED+Laser	

INFN Engagement

BO: new space under discussion (ex Tier1) & elec. + mech. support

CS: lab space

TS: lab space & tech. support

TO: micro-electronic workshop

LNS & CT: tech. support

RM1 & RM2: tech support

BA: lab (+new) space & tech. support

GE: lab space & electr. support

SA: lab (+new) space & tech. support

FE: lab space, clean room & elec. + mech. support

Assumptions:
- 6 months delay of CD3 (now on spring 2026)
- no delay of installation (now on Oct 30: unlikely)
- possibility to split the major procurements in bacthes/years

compressed (and aggressive) schedule