dRICH Collaboration

Going to call for few regular IB representative meetings

dRICH

INFN

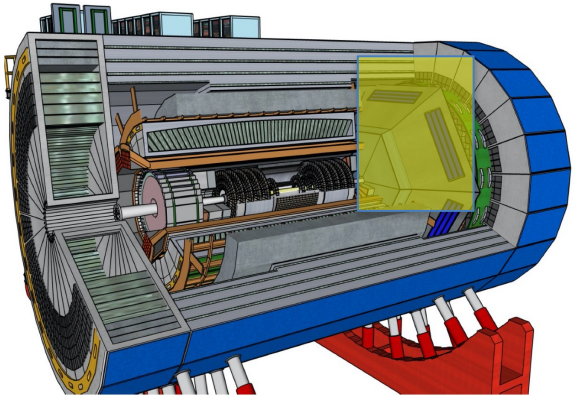
BA, BO, CS, CT, FE , GE, LNF, LNS, RM2, SA, TO, TS

Duke University

NISER

Jefferson Lab

EPIC



EIC RICH Consortium

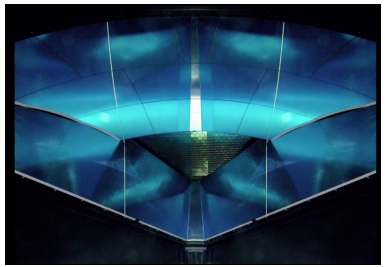
Brookhaven National Laboratory

Stony Brook University

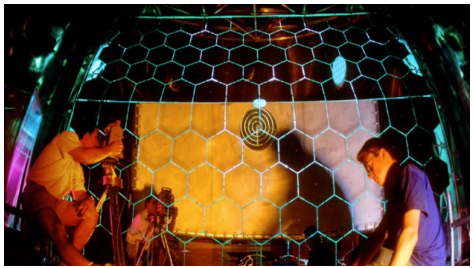
Univerza v Ljubljani

.....

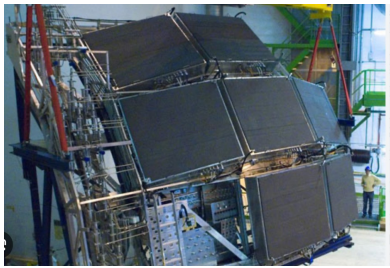
CLAS12 RICH



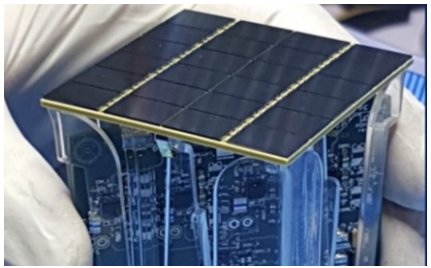
COMPASS RICH



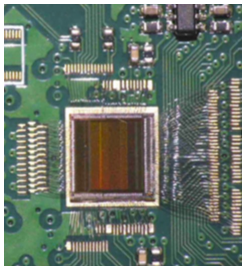
ALICE HMPID



DARKSIDE



ALCOR



PID Review – 5-6 July 2023, formal Project milestone with DOE representative

Preliminary outcome:

Generically positive

Lots of comments, few recommendations

Update and complement Yellow Report requirements to be tailored to ePIC

Account for the interface with tracking

PID performance with full ePIC simulation

dRICH specific:

Recommendation: Thermal simulation

Comments: quartz window optics and insulation

SiPM annealing (materials, PDE, replacement) and low-temperature working point

Next Steps

Targeted R&D Program: (submitted by July 7th)

eRD102: dRICH

eRD109: ALCOR chip

Generic R&D Program: (submitted by July 14th)

Pressurized RICH (C_2F_6 → Argon)

PED: (under discussion)

SiPM engineering

dRICH Simulations:

Prepare for the ePIC simulation campaigns (as soon as possible)

- export what was developed for the PID review in the dRICH private branch
- align with the latest reconstruction tools
- integrate with other system (PID, tracking)
- refine model (background, material budget, optical parameterization,…)

Next Steps

dRICH Simulations:

Prepare for the ePIC simulation campaigns (as soon as possible)

- export what was developed for the PID review in the dRICH private branch
- align with the latest reconstruction tools
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- refine model (background, material budget, optical parameterization,…)

Contact Person:

Chandradoy Chatterjee INFN-TS

dRICH 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

Work packages not yet active

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
Simulation	**C. Chatterjee**, INFN-TS, DUKE, INFN-FE, RICH Consort.

Interlock Level-5

Slow Control Level-5

Cooling Level-5

Vessel Level-5

Detector box Level-5

Mirror Alignment Level-5

Power Supply Level-5

Services and Readout:

Complete the ePIC share-point information (in 1-2 weeks) with

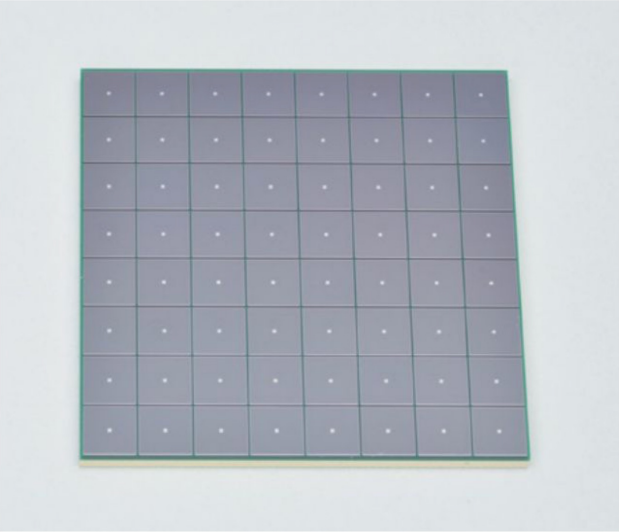
- LLP sensor specifications
- readout scheme & dimensions
- services and power

SiPM technical specs

baseline sensor device

64 (8x8) channel SiPM array

3x3 mm^2 / channel



Parameters (at Vop, T = 25 C, unless specified)	Symbol	Value	Notes
Package type		SiPM array	
Mounting technology		surface mount	wire bonding also acceptable
Number of channels		64 (8 x 8)	8 (2 x 4) also acceptable
Effective photosensitive area / channel		3 x 3 mm^2	
Package dimension		< 26 x 26 mm^2	
Fraction of active area in package		> 85 %	
Microcell pitch		50 or 75 um	
Number of microcells	Nspad	> 1500	
Protective window material		Silicone resin	radiation / heat resistant
Protective window refractive index		1.55 - 1.57	
Spectral response range		300 to 900 nm	
Peak sensitivity wavelength	Lambda	400 - 450 nm	
Photon detection efficiency at Lambda		> 40%	
Breakdown voltage	Vbreak	< 60 V	
Operating overvoltage	Vover	< 5 V	
Operating voltage	Vop	Vbd + Vover	
Max Vop variation between channels		< 100 mV	at T = -30 C
Dark count rate	DCR	< 500 kHz	
DCR at T = -30 C		< 5 kHz	at T = -30 C
DCR increase with radiation damage		< 500 kHz / 10^9 neq	at T = -30 C
Residual DCR after annealing		< 50 kHz / 10^9 neq	at T = -30 C
Terminal capacitance		< 500 pF	
Gain		> 1.5 10^6	
Recharge time constant	Tau	< 100 ns	
Crosstalk	CT	< 5%	
Afterpulsing	AP	< 5%	
Operating temperature range		-40 C to 25 C	
Single photon time resolution	SPTR	< 200 ps FWHM	

dRICH Services

Person to contact -

Cables, Fibers, etc.

Description	Quantity	Diameter	Estimated Length	Notes	Assumptions	Tray Rated? (Y/N)	Cable Rating	Responsibility
FEE ASIC digital low voltage	310	2 mm (core)	5 m	4 V, 1 A for each readout unit (256 ch) = 4 A + 2 A				
FEE ASIC analog low voltage	310	2 mm (core)	5 m	3 V, 1.2 A for each readout unit (256 ch) = 5 A				
FEE readout and control board low voltage	0	na	na	4 V, 2 A (common cable with digital FEE LV)				
Peltier power	310	2 mm (core)	5 m	10 V, 5 A				
SiPM bias voltage	310	0.1 (core)	5 m	70 V, 250 uA for each readout unit (256 ch) = 1 mA				
SiPM annealing voltage	310	1.5 mm (core)	5 m	70 V, 650 mA for each readout unit (256 ch) = 2.5 A				
piezoelectric mirror actuators	48		5 m	12 mirrors 2 angular movement (power + control)				
calibration lasers								
DAQ and configuration	620	2 mm (full)	5 m	optical fiber / bidirectional link				

Construction timeline and budgeting:

Revise the P6 information (by the end of August)

Relevant dates:

November 2023	Long Lead Procurement
November 2024	Technical Design Report
April 2025	CD2/CD3
April 2030	Ready for installation
October 2030	Installation

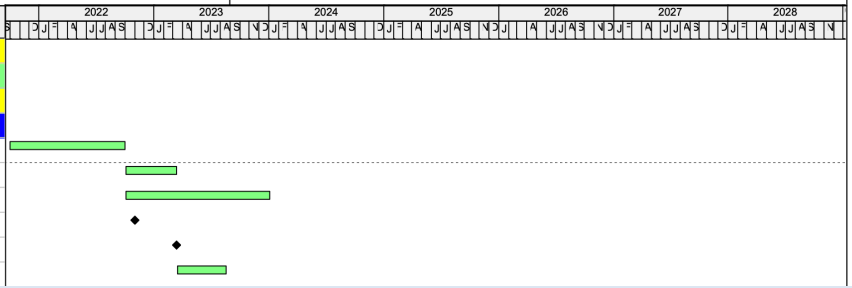
dRICH Construction Schedule

EIC - Working File
Data Date: 02-Jan-20

EIC - Activities with Gantt

TASK filter: WBS Path 06.10.04.02.

WBS Path	Activity ID	Activity Name	Original Duration	Start	Finish
Project: ECE06 EIC - Working File			1797	01-Oct-21	12-Dec-28
WBS: ECE06.10 EIC Detector			1797	01-Oct-21	12-Dec-28
WBS: ECE06.10.04 Particle Identification (PID)			1797	01-Oct-21	12-Dec-28
WBS: ECE06.10.04.02 Dual Ring Imaging Cherenkov Detector (dRICH)			1797	01-Oct-21	12-Dec-28
10.04.02	EIPICH _L_FY22	6.10.04.02 - EIPICH - FY22 Labor Actuals	250	01-Oct-21	30-Sep-22
10.04.02	E1004_20000	PDR - Preliminary Design, Beam Test & Assessment (dRICH)	110	03-Oct-22	15-Mar-23
10.04.02	E1004_20010	Prototyping (dRICH)	313	03-Oct-22	05-Jan-24
10.04.02	E1004_20020	Specifications 100% Defined for 3A Procurement (dRICH)	0		31-Oct-22
10.04.02	E1004_20030	PDR _ Preliminary Design Complete (dRICH)	0		15-Mar-23
10.04.02	E1004_20040	FDR - Final Design & Finalize dRICH Design with All Required Services (dRICH)	109	16-Mar-23	17-Aug-23



SiPM

10.04.02	E1004_20580	AWARD: Photo Sensors (dRICH)	1	02-Oct-23	03-Oct-23
10.04.02	E1004_20660	AWARD: SiPMs Cooling System (dRICH)	1	02-Oct-23	03-Oct-23
10.04.02	E1004_20730	AWARD: Mirror Alignment System (dRICH)	1	02-Oct-23	03-Oct-23
10.04.02	E1004_20800	AWARD: Cooling System (dRICH)	1	02-Oct-23	03-Oct-23
10.04.02	E1004_20590	VENDOR EFFORT: Photo Sensors (dRICH)	360	03-Oct-23	17-Mar-25
10.04.02	E1004_20080	Write SiPMs Requisition (dRICH)	0		31-Dec-24
10.04.02	E1004_20090	SiPMs Procurement Effort with Technical Support (dRICH)	410	02-Jan-25	19-Aug-26
10.04.02	E1004_20630	RCV: Photo Sensors (dRICH)	1	17-Mar-25	18-Mar-25

Aerogel

10.04.02	E1004_20530	AWARD: Aerogel (dRICH)	1	02-May-25	02-May-25
10.04.02	E1004_20320	Test & Q.C. First Article Mirror (Includes Developing Test Plan) (dRICH)	115	05-May-25	16-Oct-25
10.04.02	E1004_20490	VENDOR EFFORT: C2F6 Gas Recovery System (dRICH)	180	05-May-25	23-Jan-26
10.04.02	E1004_20540	VENDOR EFFORT: Aerogel (dRICH)	500	05-May-25	04-May-27

Installationl

10.04.02	E1004_20260	Ready for Installation (dRICH) (BNL)	0		09-May-28
10.04.02	E1004_20140	SiPMT & SiPMT Test, Final Acceptance (dRICH)	20	13-Nov-28	12-Dec-28
10.04.02	E1004_20130	SiPMT & SiPMT PCBoard Vendor Delivery (dRICH)	1	12-Dec-28	12-Dec-28
10.04.02	E1004_20150	Ready for Installation (dRICH)	0		12-Dec-28

dRICH mechanics:

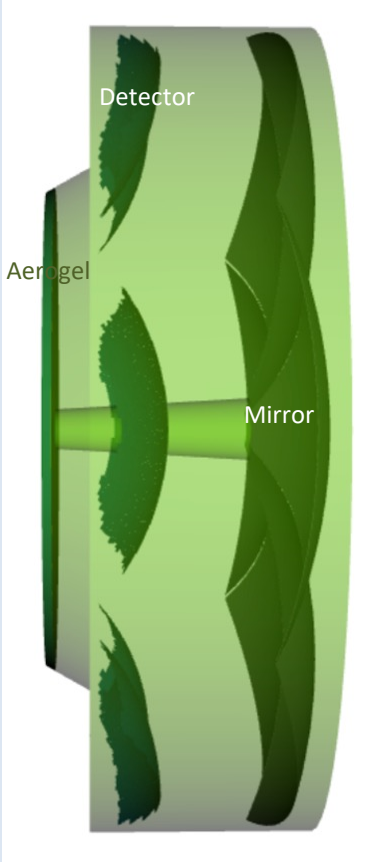
Advance with the model for the baseline configuration

Explore composite materials

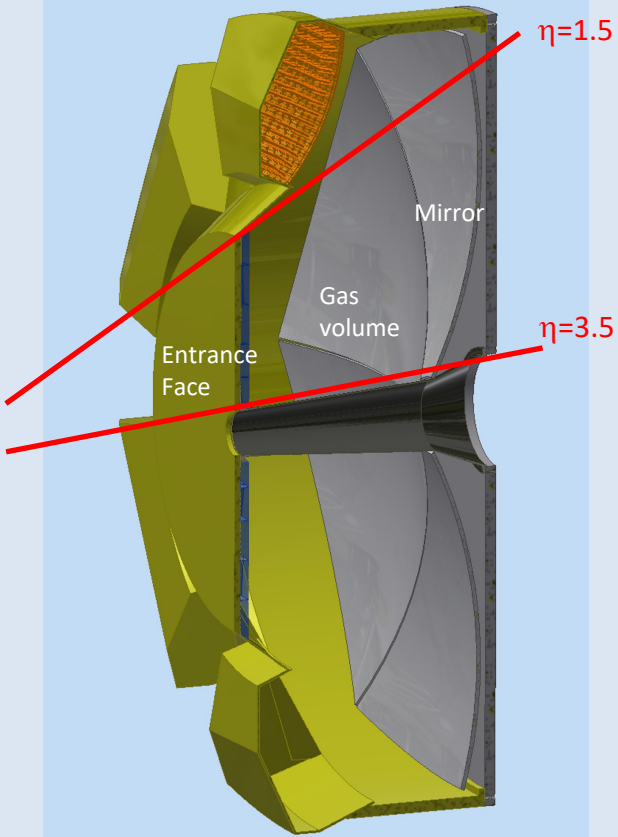
Study pressurized RICH option

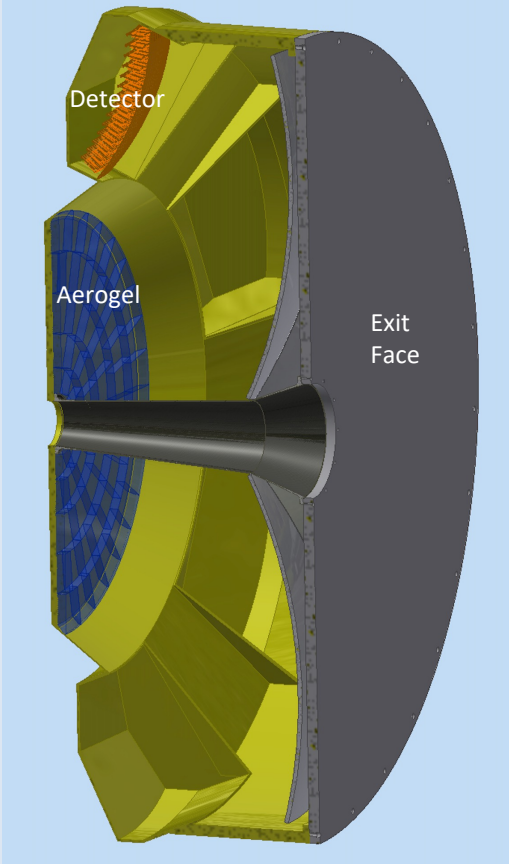
dRICH Layout

Simplified representation



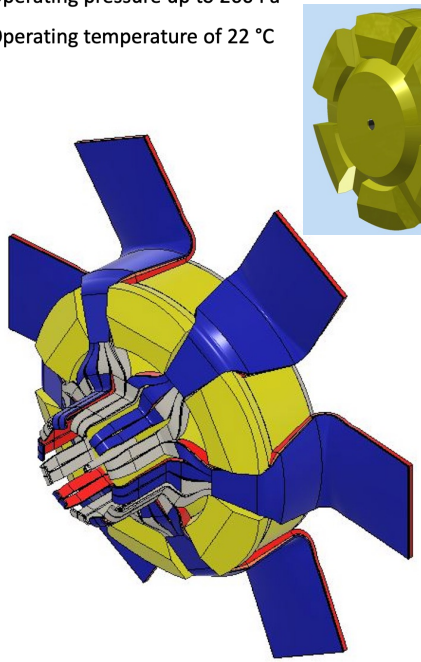
3D mechanical model

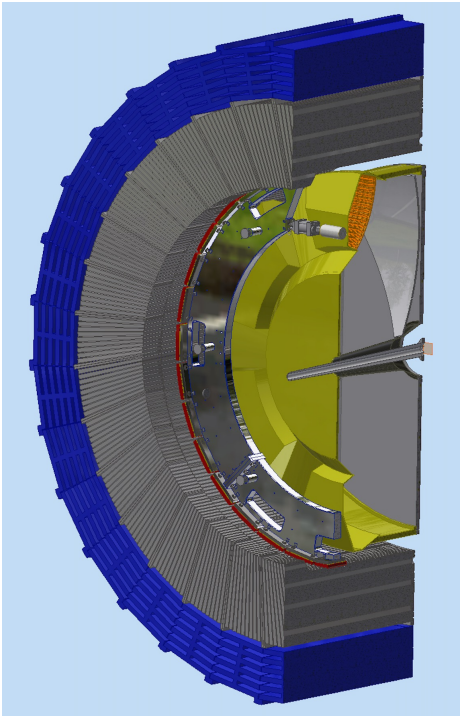


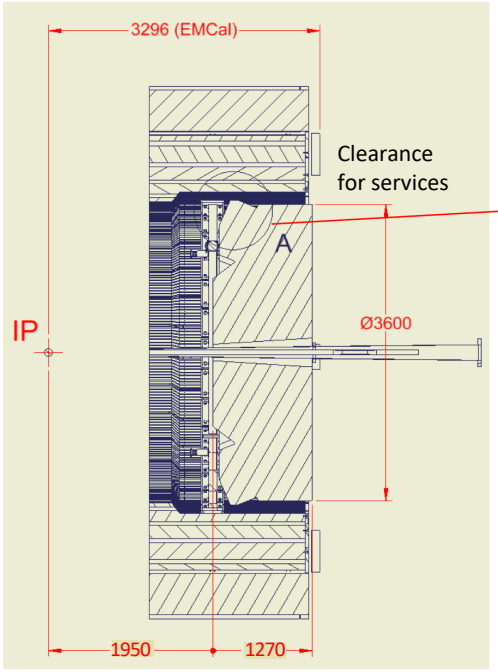


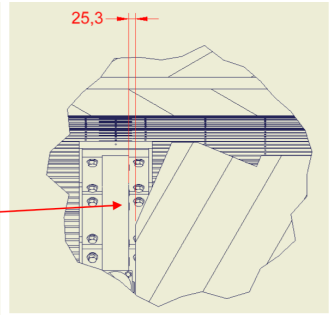
dRICH Vessel

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



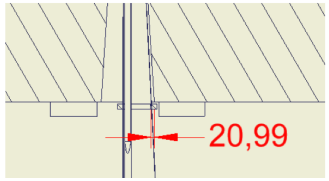






Clearance vs support ring

Clearance vs beam pipe

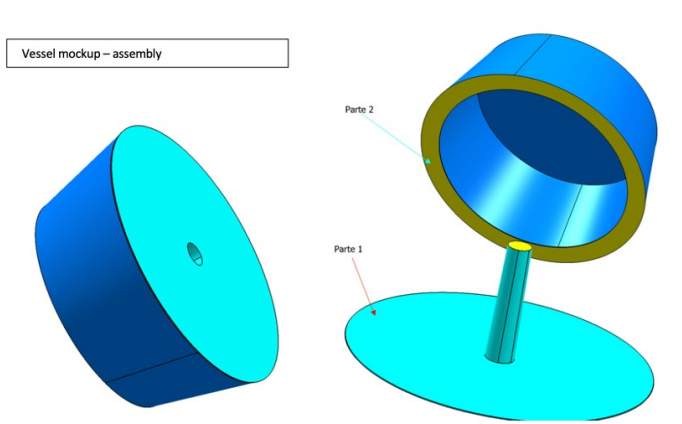


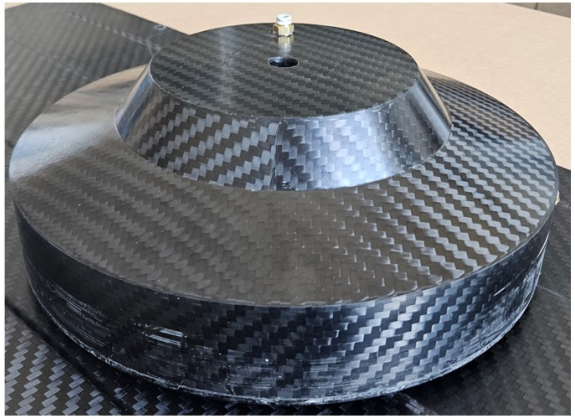
Windows: sandwich panel made of two ~1 mm carbon fiber reinforced epoxy skins separated by 30 mm PMI foam or Al honeycomb (~ 1% X_0)

Shells: 3 mm (inner tube) to 8 mm (outer tube) thick carbon fiber epoxy composite (~ 4% X_0)

Skins formed with two layers of balanced weave laminate with fibers at 0°/90° and +/- 45° for uniform stiffness

Carbon fiber 1:10 mockup
Preliminary successful leak test on July 12





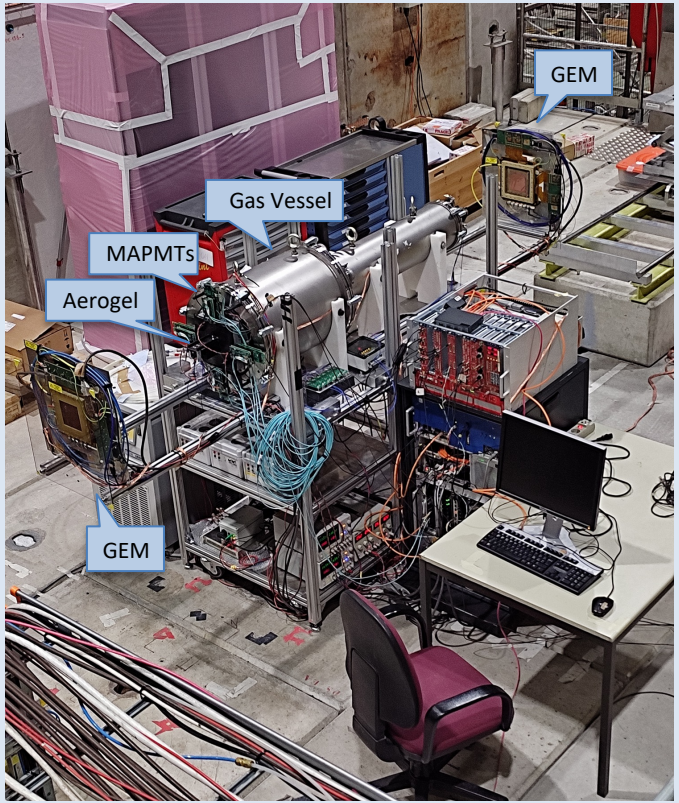
Next Steps

dRICH test-beams:

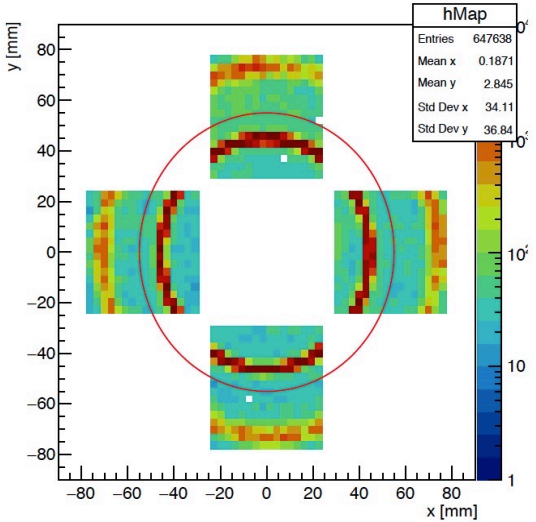
August 21-31: focus on aerogel

October 5-18: focus on new EIC-driven detector plane

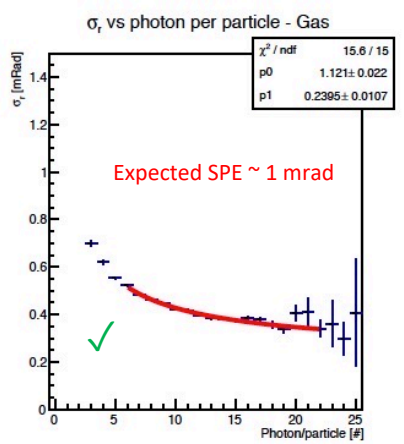
Operative prototype commissioned. Double ring imaging achieved. Performance in line with expectations except for aerogel single-photon angular resolution (worse by a factor ~ 1.5)

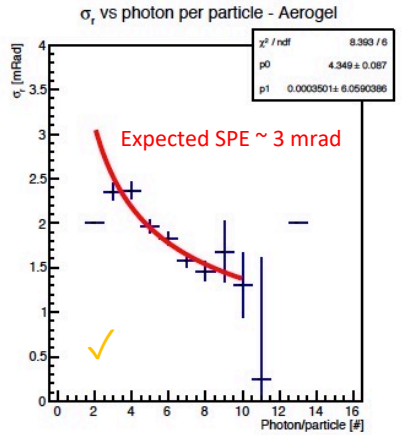


Reference readout from CLAS12 RICH:
H13700 MA-PMTs + ALCOR3 ToT chip



Gas ring coverage: 60%
Aerogel ring coverage: 40 %





Optics at variance with respect EIC

R&D: Highlight

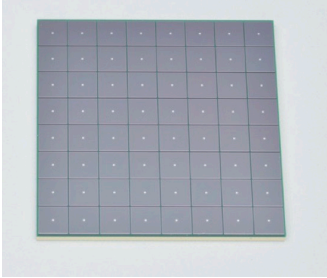
Realization of a suitable detector plane for the dRICH prototype (23/10): Design ready, procurement aligned to 2023 test-beam campaign.

Hamamatsu S13361-3050

✓

8x8 array
50 μm cell
Excellent fill factor
Best DCR

S14160 alternative

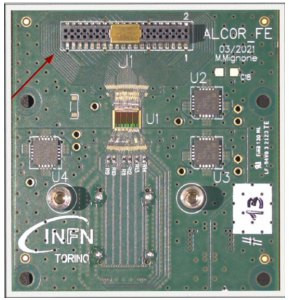


MPPC arrays selected with irradiation campaign

Front-end re-design completed

ALCOR v2 (bwetter dynamic range and rate)
ToT architecture, streaming mode ready
- 50 ps time bin
- 500 kHz rate per channel
- cryogenic compatible

ALCOR chip



✓

Multi-wafer run done

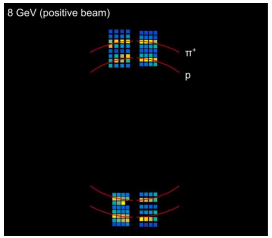
Version2:
32 channels
Extended dynamic range
Improved digital time

✓

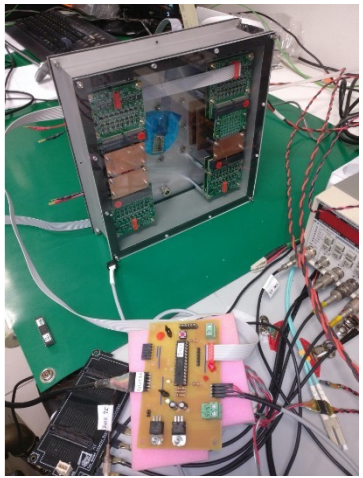
Cooling plate

Peltier cells

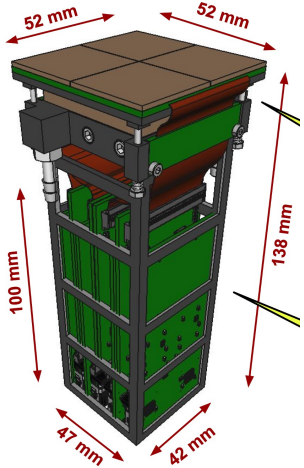
Annealing circuitry



Integrated Cooling/ In-situ annealing



New EIC-driven readout unit



Detector box