LONG TERM STABILITY AND PERSPECTIVE OF THE ALICE-HMPID DETECTOR AT LHC DURING RUN 3

G De Cataldo on behalf of ALICE Collaboration

OUTLINE

- ALICE-HMPID description
- HMPID readiness for the LHC Run 3 period (2022-2025)
- Short review on physics objectives in Run 3
- Summary

HMPID: HIGH MOMENTUM PARTICLE IDENTIFICATION DETECTOR

7 RICH modules ~1.3 x1.3 m^2 for a total CsI active area of ~11 m^2;
Proximity-focusing RICH;

PID range:
$1 < p < 3$ GeV/c π, K;
$1.5 < p < 5$ GeV/c p;

Participating Institutions:

INFN and Dep. Of Physics, Bari (Italy);

CERN Geneva (Switzerland);

Wigner Research Institute Budapest (Hungary);

University of Malta, Msida, (Malta);

Institute of Engineering and Transport Electrical and Electronics, Paola PLA9032 Malta ;

Universidad Nacional Autónoma de México

HMPID basic elements

Cherenkov Radiator

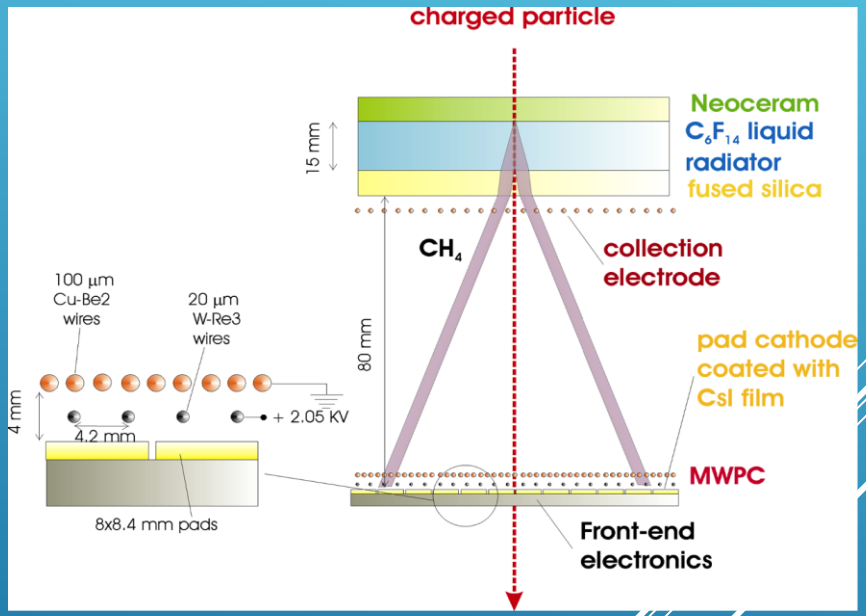
- 15 mm liquid C_6F_{14}; n=1.2989 @ 175 nm; $\beta_{th} = 0.77$.

Photon converter:

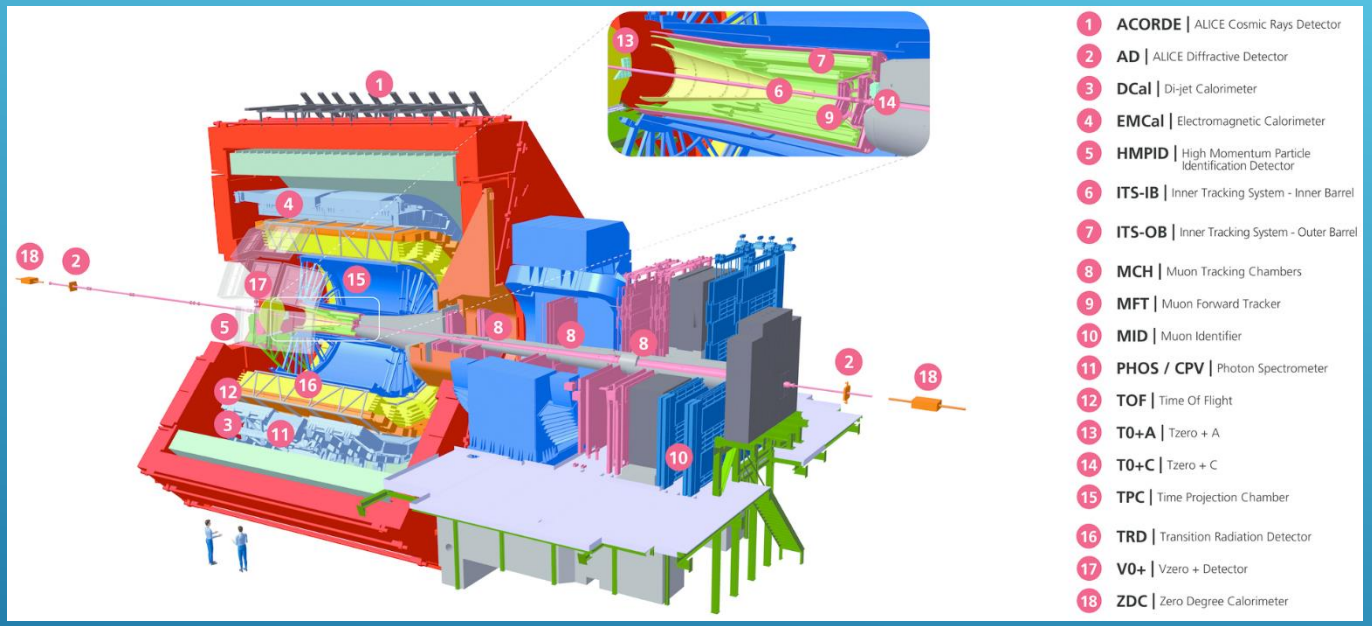
- 300 nm thick reflective layer of CsI; QE ≈ 25% @ 7.1 eV (175 nm)

Photoelectron detector:

- MWPC 2,2-2.5 mm asymmetric gap with CH_4 at atmospheric pressure, gas gain ≈ **4** 10^4 ;
- analogue pad read-out (pad size = 8x8.4 mm^2),
- total number of channels ≈ 160 K.

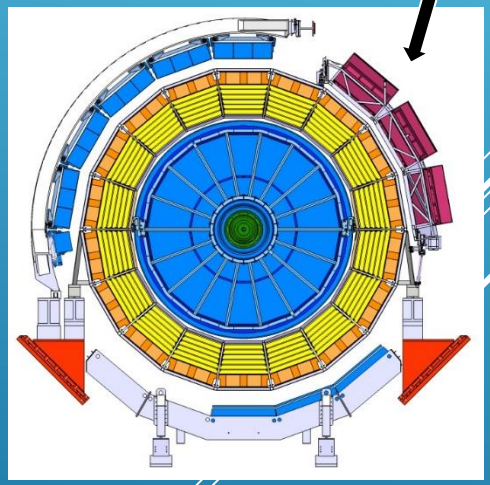


ALICE-HMPID



ALICE:
A
Large
Ion
Collider
Experiment

HMPID



A-side view

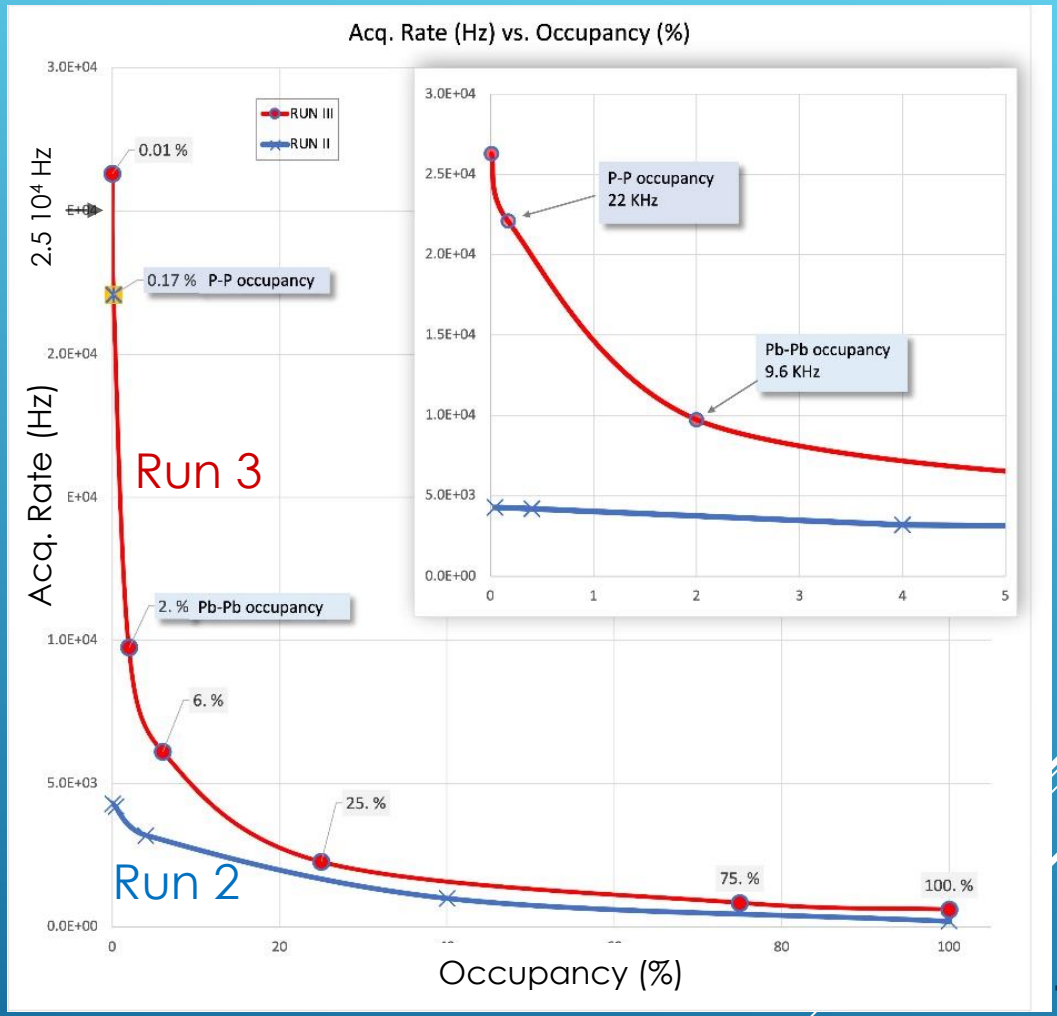
- ALICE was built to characterize the high-density,
- high-temperature phase of strongly interacting matter known as quark-gluon-plasma state;
- Excellent PID capabilities are required.

HMPID readiness for the LHC RUN 3 period (2022-2025)

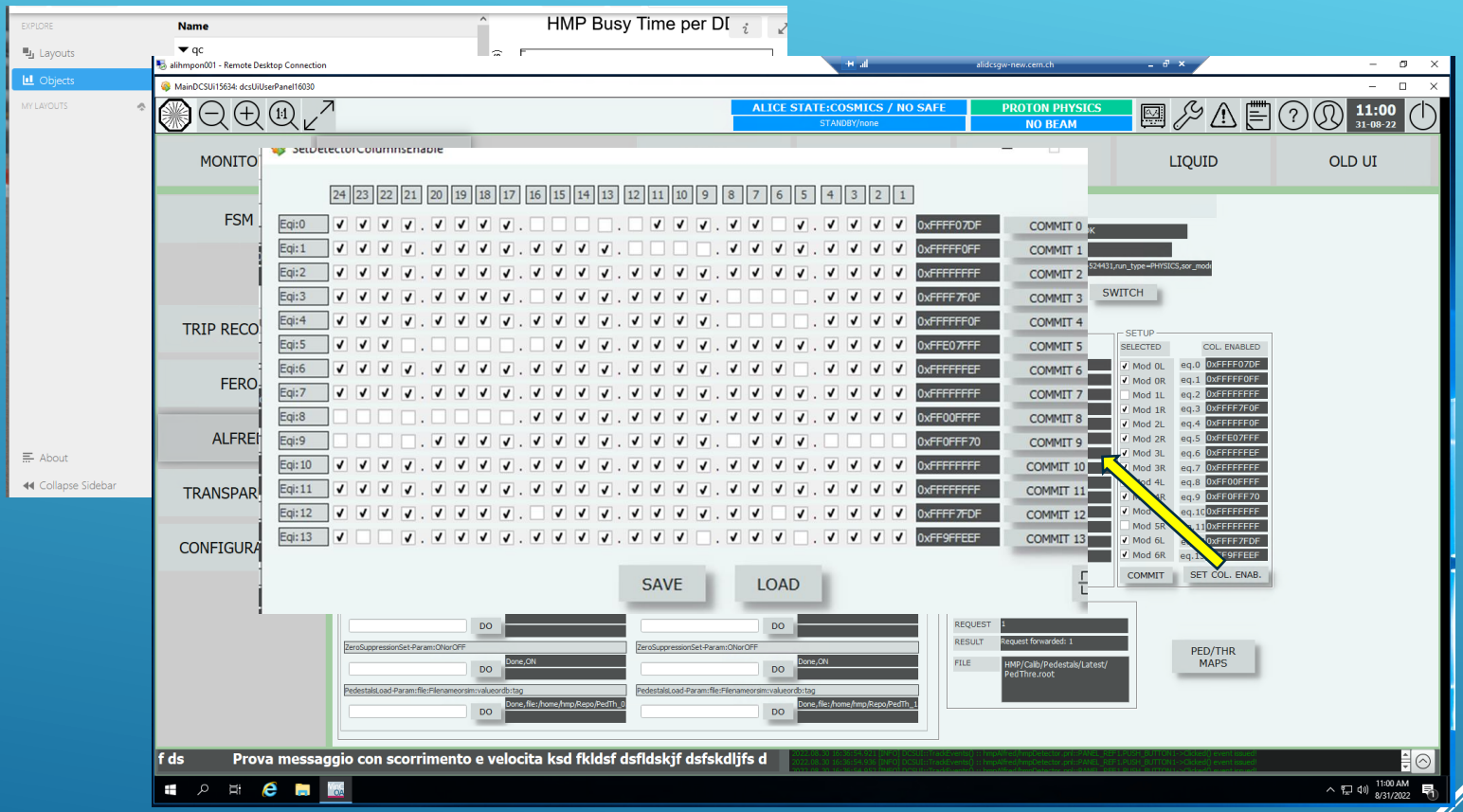
- Upgrading and performance of the HMPID RO electronics;
- The Charge dose on the CsI photocathodes ;
- C_6F_{14} radiator vessels and HV sectors at beginning of LHC Run 3;
- The Landau distributions of MIP's during the LHC proton fill 7920 of July 2022;
- C_6F_{14} transparency.
- Integration in the O2 (Online-Offline) computing system;

Readout rate vs. occupancy

- The new RO firmware, the QC and DCS tools are the key components of the excellent performance of the event readout rate;
- These components allow effective and rapid detector configuration and calibration.



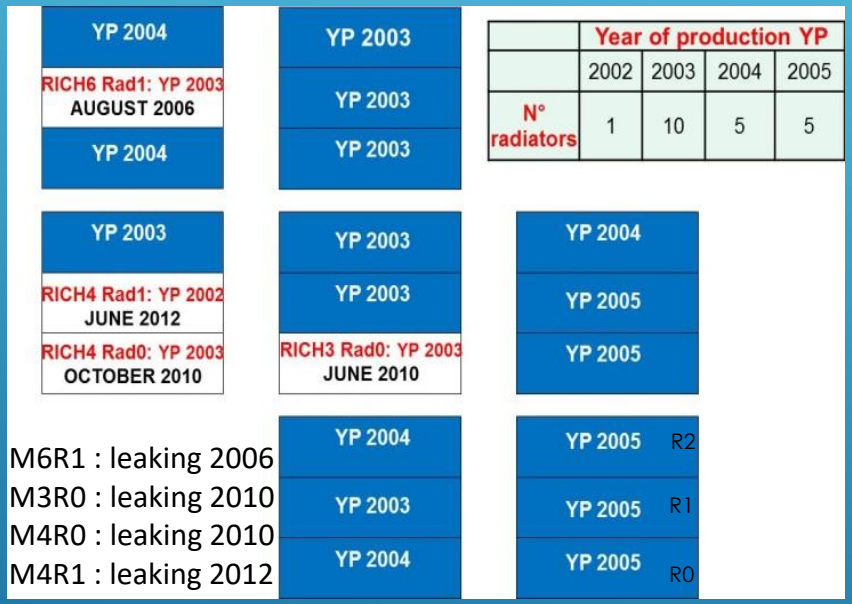
QC AND DCS TOOLS COMPONENTS



Some of QC and DCS components for the detector monitoring and calibration

Detector status 2022

Leaking radiator vessels



	Year of production YP			
	2002	2003	2004	2005
N° radiators	1	10	5	5

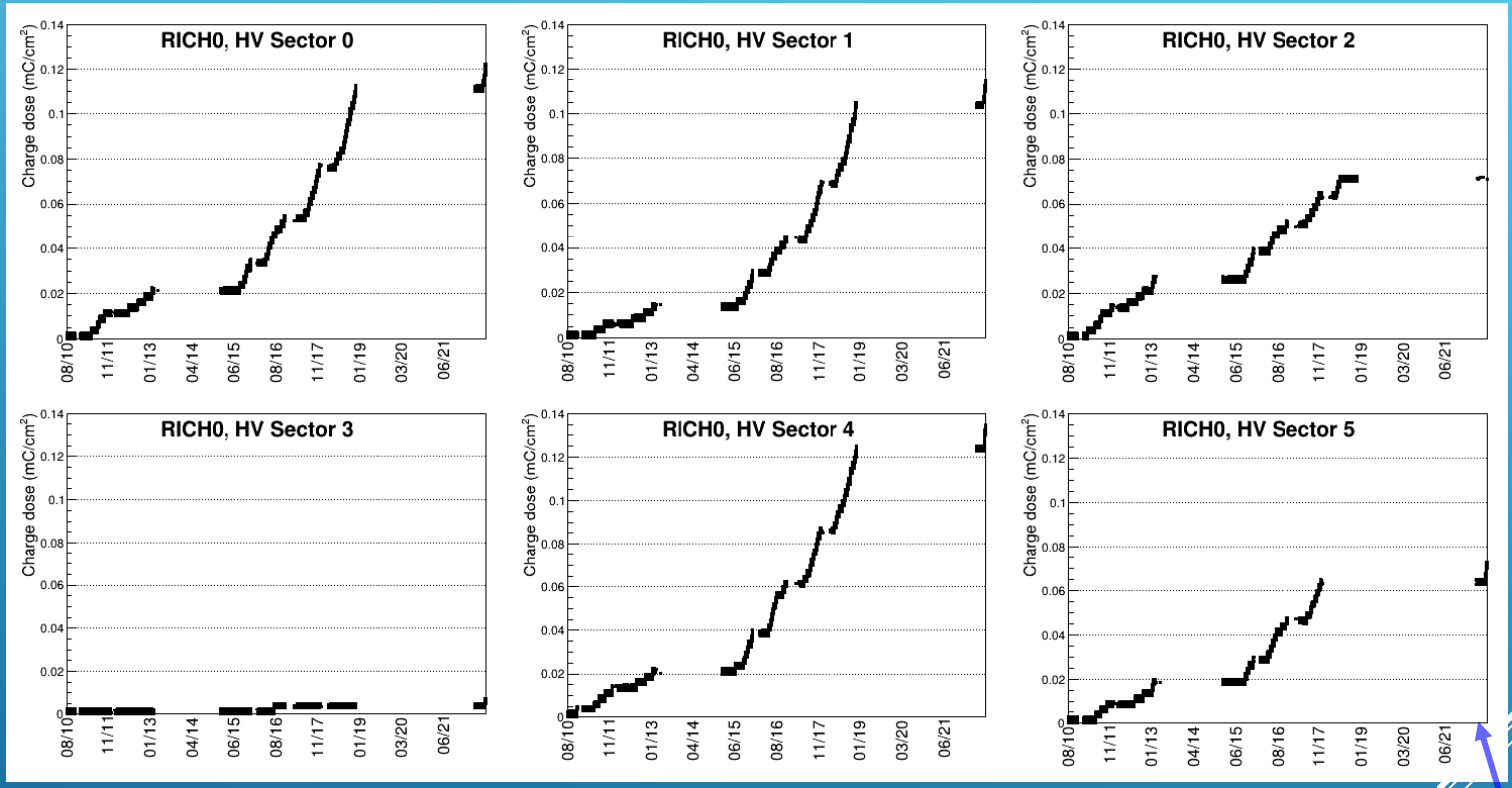
M6R1 : leaking 2006
M3R0 : leaking 2010
M4R0 : leaking 2010
M4R1 : leaking 2012

HV failing sector

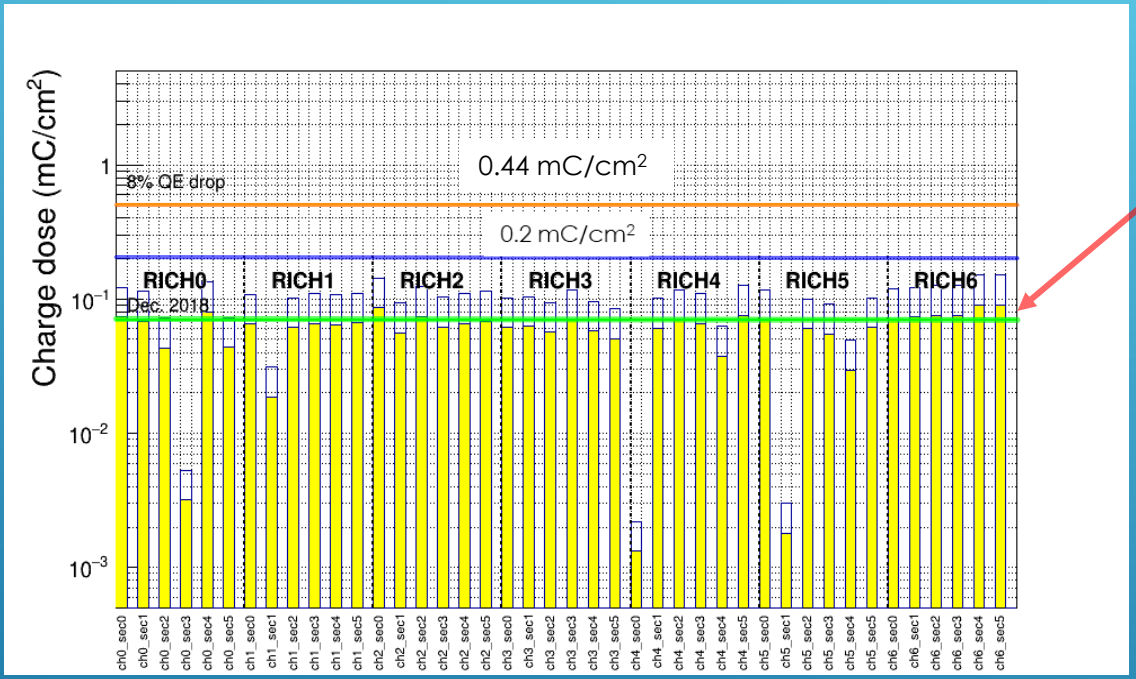
M5HV1 : failing 2006
M4HV0 : failing 2009
M0HV3 : failing 2009
M1HV1 : failing 2016
M5HV4 : failing 2022
M0HV2 : failing 2022

Faulty sub-system segments:
Combining leaking vessels and failing HV sectors, the detector acceptance is ~ 65%

Specific charge dose vs. time



Specific Charge dose on the CsI photocathodes



Since RUN1, Expected CsI charge dose at the end of RUN 2.

- Full yellow bars: measured CsI charge dose end of RUN 2 ; Empty bars: total anode charge.
- **Bleu line**: dose limit for possible CsI QE loss: 0.2 mC/cm^2; [NIM A553 (2015), NIM A574(2007)]
- **Orange line:** 0.44 mC/cm^2 Expected charge dose end RUN 3. Possible CsI QE loss of 8%.

The specific CsI charge dose vs. LHC program

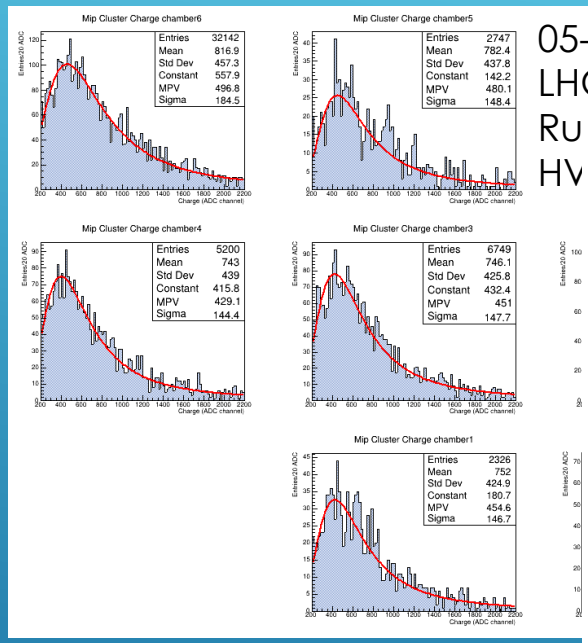
Specific CsI charge dose RUN 1-2

	Delivered Lumi	Measured <Specific Charge dose> mC/cm²	Measured <Tolal charge doose> mC/cm²	Expected CsI QE loss %
2010-2013 End of Run1	pp+Pb-Pb	0.002		0
2015 (Run2)	(pp) 7 pb^{-1} (Pb-Pb) 0.43 nb^{-1}	0.01 ~0.005	0.017	0
2016 (Run2)	(pp)13 pb^{-1} (p-Pb) 43 nb^{-1}	0.015 0.005	0.037	0
2017 (Run2)	(pp)18.9 pb^{-1} (Xe-Xe) 0.16 nb^{-1}	0.025 0.001	0.053	0
2018 (Run2)	(pp)27 pb^{-1} (Pb-Pb) 0.9 nb^{-1}	0.036 0.01	0.089 0.099	0
End Run2			**~0.1**	0

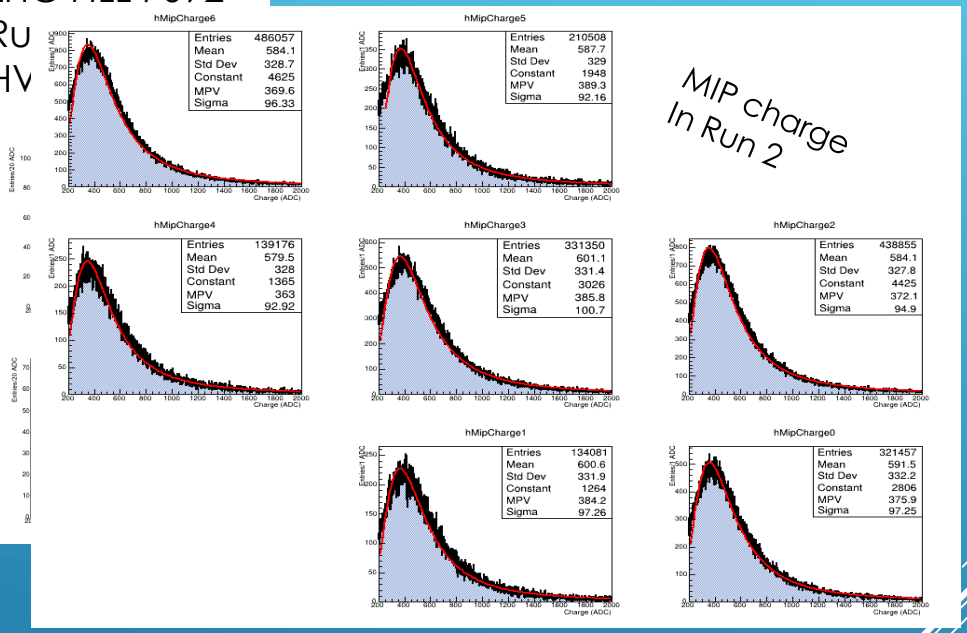
Expected CsI charge dose RUN 3

	Delivered Lumi	Measured <Specific Charge dose> mC/cm²	Measured <Tolal charge doose> mC/cm²	Expected CsI QE loss %
End Run2			0.1	0
2022 (Run 3)	(pp) 40 pb^{-1} (Pb-Pb) 3 nb^{-1}	0.054 0.034	0.188	
2023 (Run 3)	(pp)40 pb^{-1} (Pb-Pb ??) 3 nb^{-1}	0.054 0.034	0.276	5
2024 (Run 3)	(pp)40 pb^{-1} (Pb-Pb ?) 3 nb^{-1}	0.054 0.034	0.364	6
2025 (Run 3)	(pp)40 pb^{-1} (Pb-Pb) 3 nb^{-1}	0.054 0.034	0.452	8
End Run3			**~0.452**	

LHC RUN 3 FILL: MWPC'S LANDAU DISTRIBUTIONS!



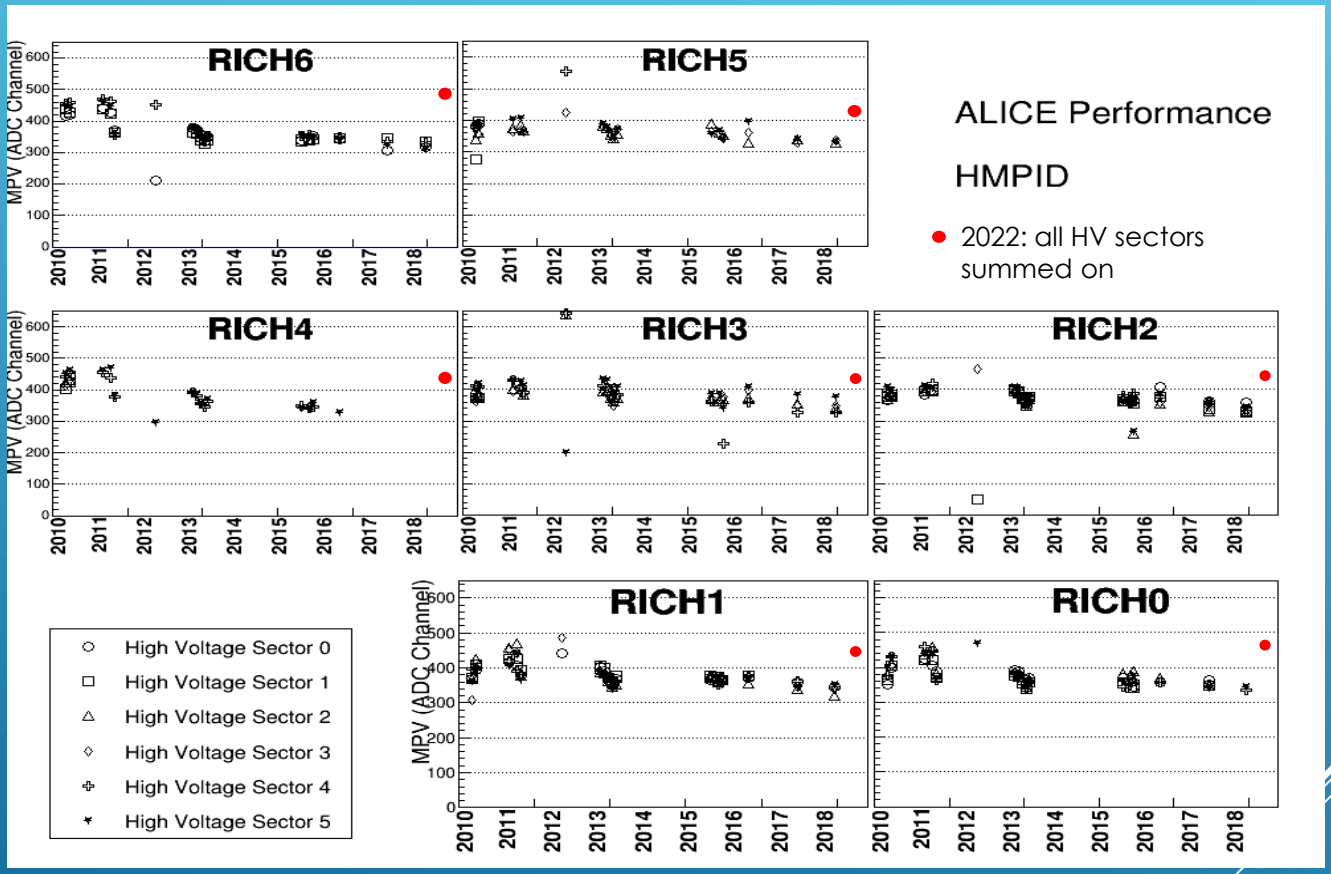
05-07-2022
LHC FILL 7092
Ru
HV



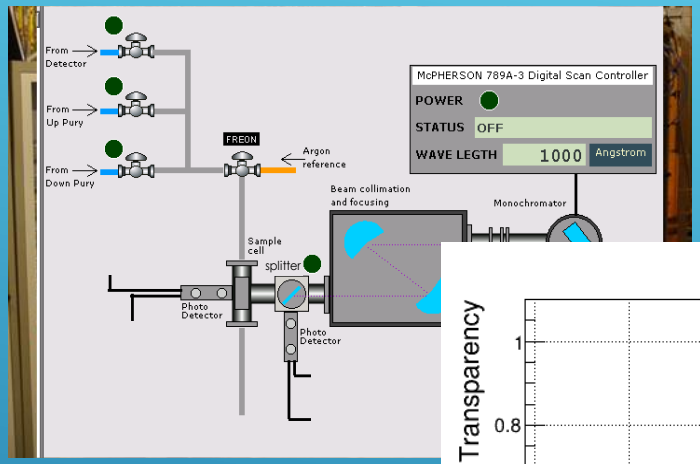
MIP charge
In Run 2

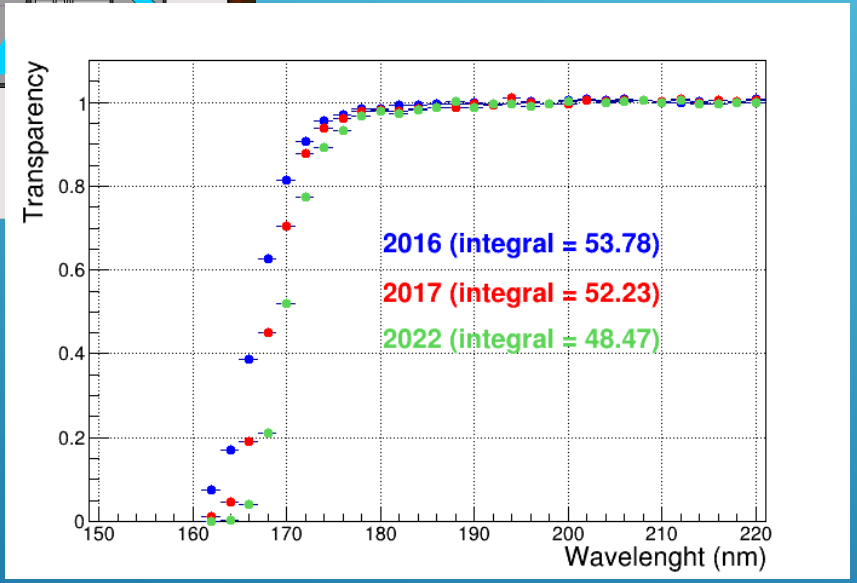
- MPV systematic higher value w.r.t. Run1-2: The selection criteria of MIP is not yet based on TPC tracks;
- The actual result is a successful check of the readout and data analysis chains.

LANDAU MPV VS. TIME



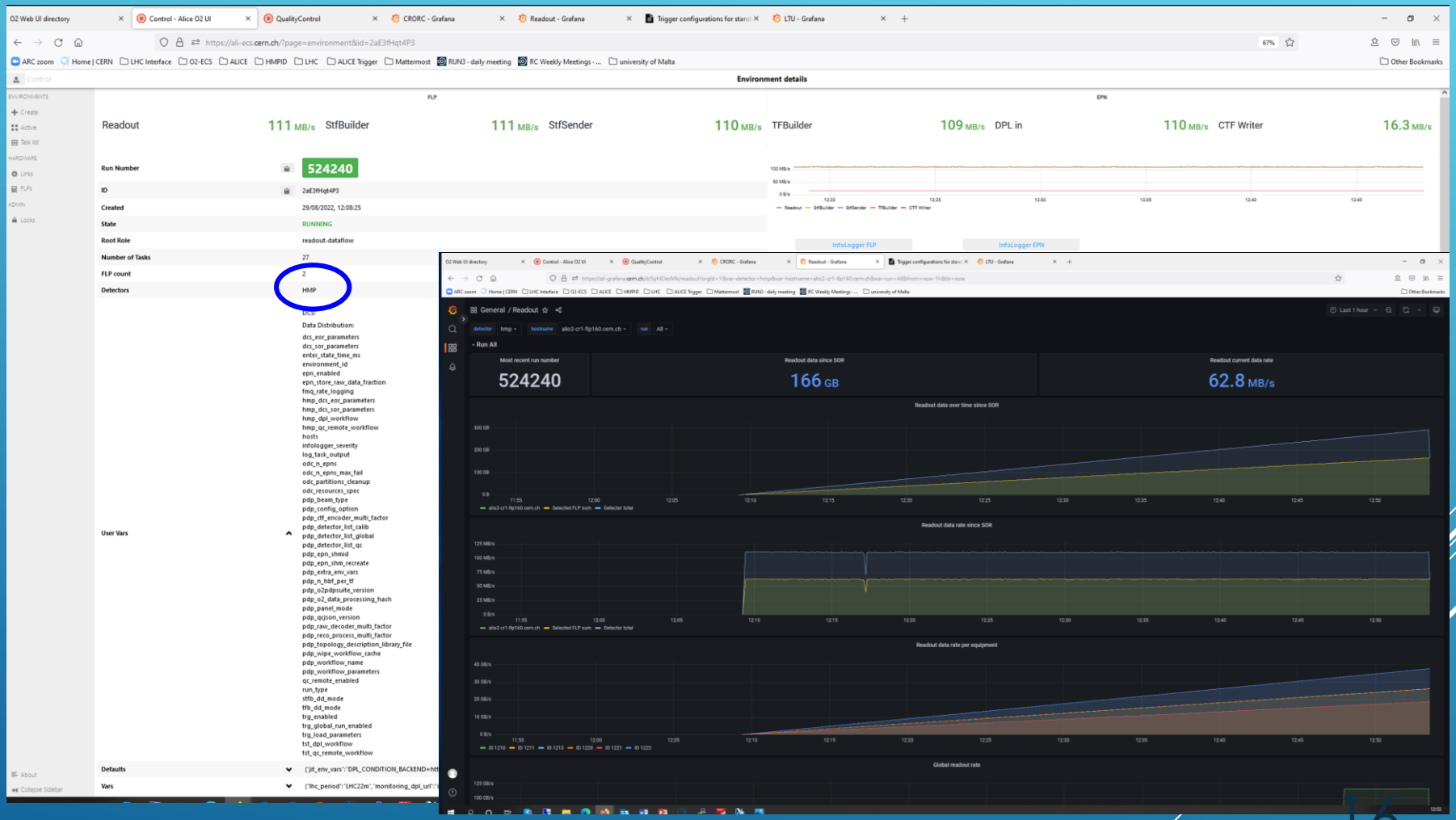
C_6F_{14} TRANSPARENCY MONITORING





We expect the C_6F_{14} transparency to improve with further re-circulation through the H_2O molecular severs, around the water absorber peak of 165 nm.

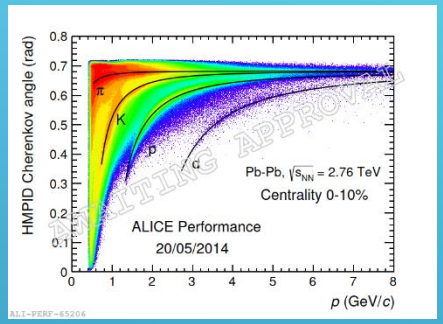
ECS integration and Grafana monitoring



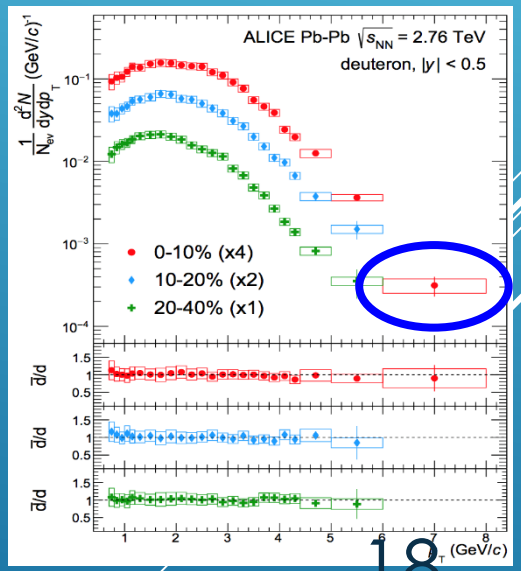
Short review on physics objectives in Run 3

LIGHT NUCLEI DETECTION

- **pp** collisions
  - In Run 3, ~10^{10} events are expected in the HMPID acceptance,
  - the **8 GeV/c** momentum bin for the **deuteron** can be filled in.This spectrum extension is of interest for the example in the quest of establishing the composition of the X(3872) particle;



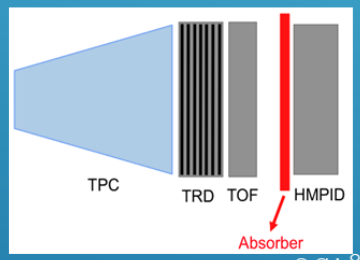
- **Pb-Pb collisions**
  - In Run 1 (2010-2013), HMPID filled in the **8 GeV/c** momentum bin for deuteron in 0-10% centrality interval (figure on the right);
    - The data analisys of the 2018 Pb-Pb data is not yet done. With its statistical abundance we expect to fill in the deuteron momentum bin at **10 GeV/c** (0-10% centrality);
    - In 2022, (with B=0.2 T) we expect also the **12 GeV/c** bin can be filled in. Contribution in other centalities, possible;
    - Triton and ^{3}He spectra up to 7 GeV/c using central collisions can also be measured. Cross-check with TPC-TOF mesurement to be done.



INELASTIC CROSS SECTION FOR ANTI-DEUTERONS

- Interesting for cosmic anti nuclei, multi-baryon state production...;

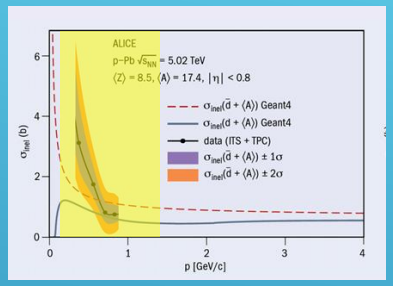
$$N = N_0 \times e^{-\frac{\Delta x}{\lambda_i}} \quad with \ \lambda_i = \frac{A}{\rho N_A \sigma_h}$$

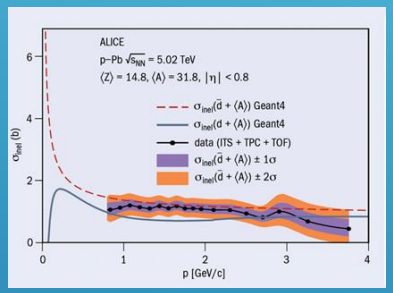


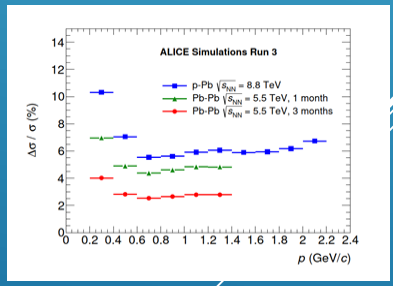
e.g.: 8 cm thick aluminium slab (0.5 λ_i)

$$N_A^{HMPID} = (N_{A,present}^{TPC} \times \ 0.05 \times f) \times \epsilon \times 10 \ (new \ acq.rate)$$

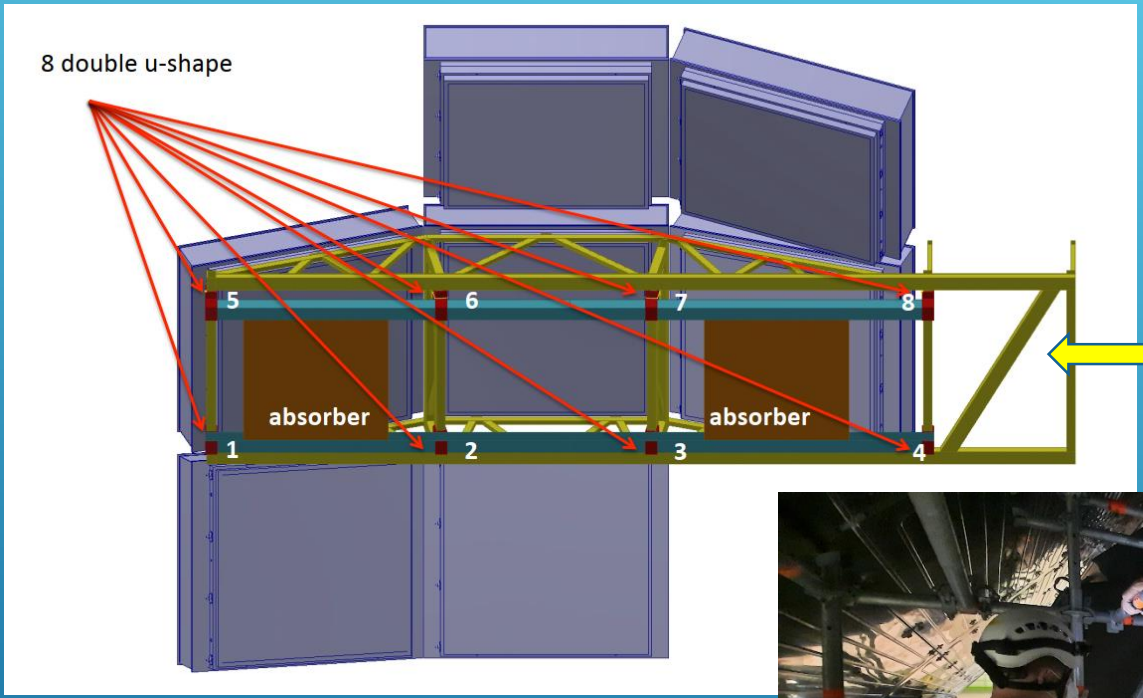
- expected statistical precision 2-4% in the momentum interval 0.2 .p < 1.4 GeV/c for Pb–Pb collisions at √sNN = 5.5 TeV (Run 3)
- A systematic uncertainties of 5.5% is expected based on conservative estimate (https://alice-notes.web.cern.ch/node/1015);







May 2021: installation of the absorbers



SUMMARY

- HMPID readout rate @20 KHz in pp collisions and 9 KHz in Pb-Pb, 10 times higher the rate limited by the triggered TPC in Run 1 and 2.
- Detector compliant with the new Online and Offline ALICE data taking and analysis environment (O2). Now the TPC is on continuous RO!!
- First Landau distributions for MIP's successfully measured in July 2022 in the LHC fill 7092, ALICE RUN#520145;
- The physics objectives in Run 3, were also mentioned.

AFTER RUN 1 AND RUN 2, NOW SAILING IN RUN 3!!

Motto of Italian tr
"Amerigo Ves

M e or phrase chosen as
beliefs or ideals guiding
mily, or institution

Thank you for your attention!!

BACKUP SLIDES

C_6F_{14} CIRCULATION AND PURIFYING SYSTEMS

- C_6F_{14} : 3M PF5060DL;
- Safe C_6F_{14} circulation by gravity flow;
- Separated control for each radiator vessel;

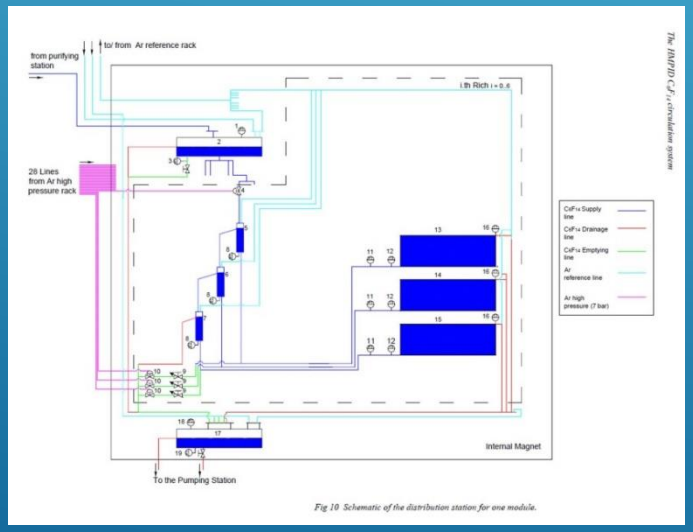


Fig 10 Schematic of the distribution station for one module.

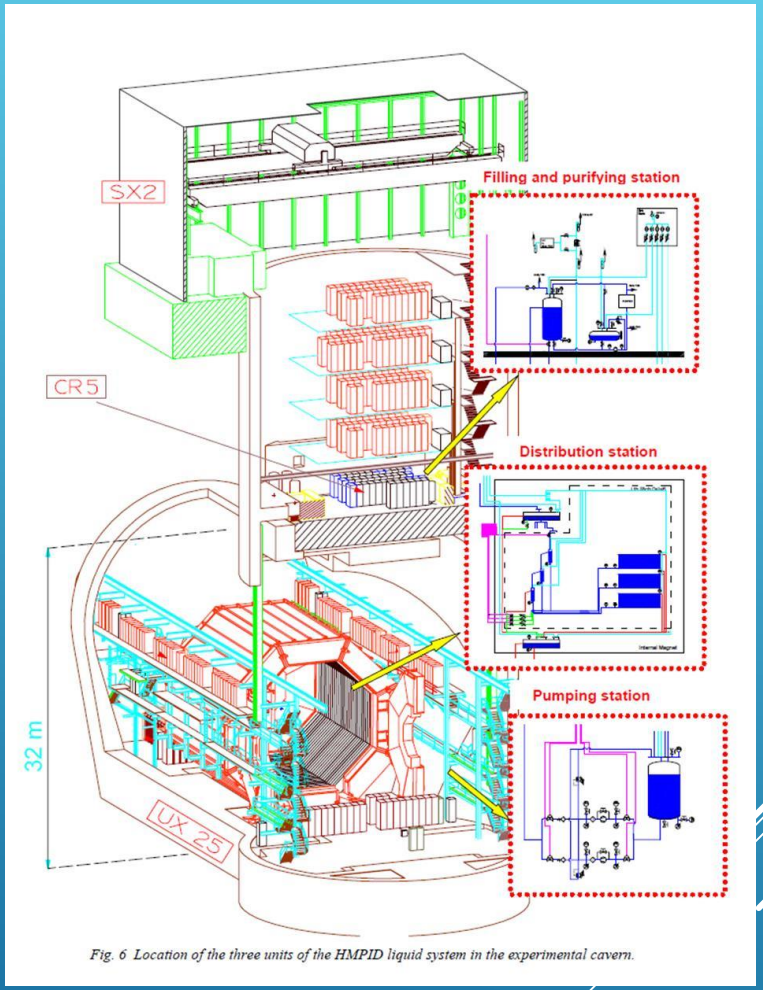


Fig. 6 Location of the three units of the HMPID liquid system in the experimental cavern.

ESTABLISHING THE COMPOSITION OF THE X(3872) PARTICLE