Muon IDentifier: status e richieste

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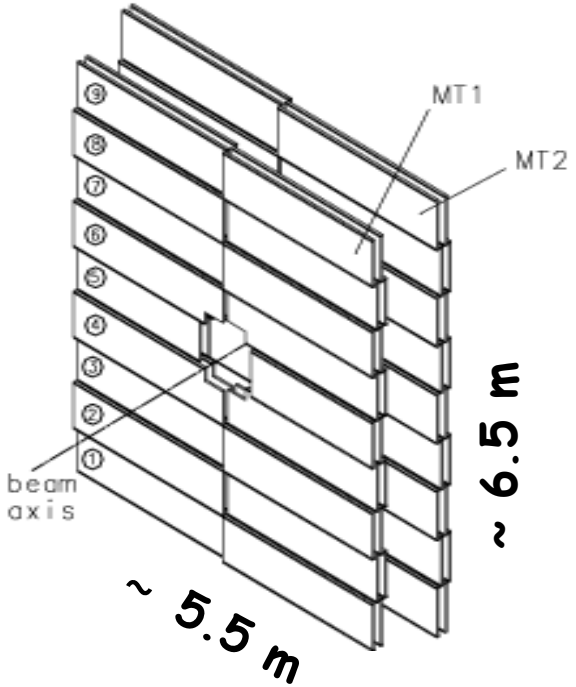
ALICE Muon Identifier

-72 Resistive Plate Chambers arranged in 4 detection planes
- Single RPC areas range from 72x223 cm^2 to 76x292 cm^2

- Main LS2 upgrades:
  - continuous read-out
  - new FEE with amplification
    → low-gain operation during Run3-4



Responsibilities:

Torino: Gas gaps, external mechanics, control system, gas system.

- ~ 7 FTE
- Ruoli di responsabilità in MID:

Muon Identifier Sub-Project Leader (A. Ferretti)

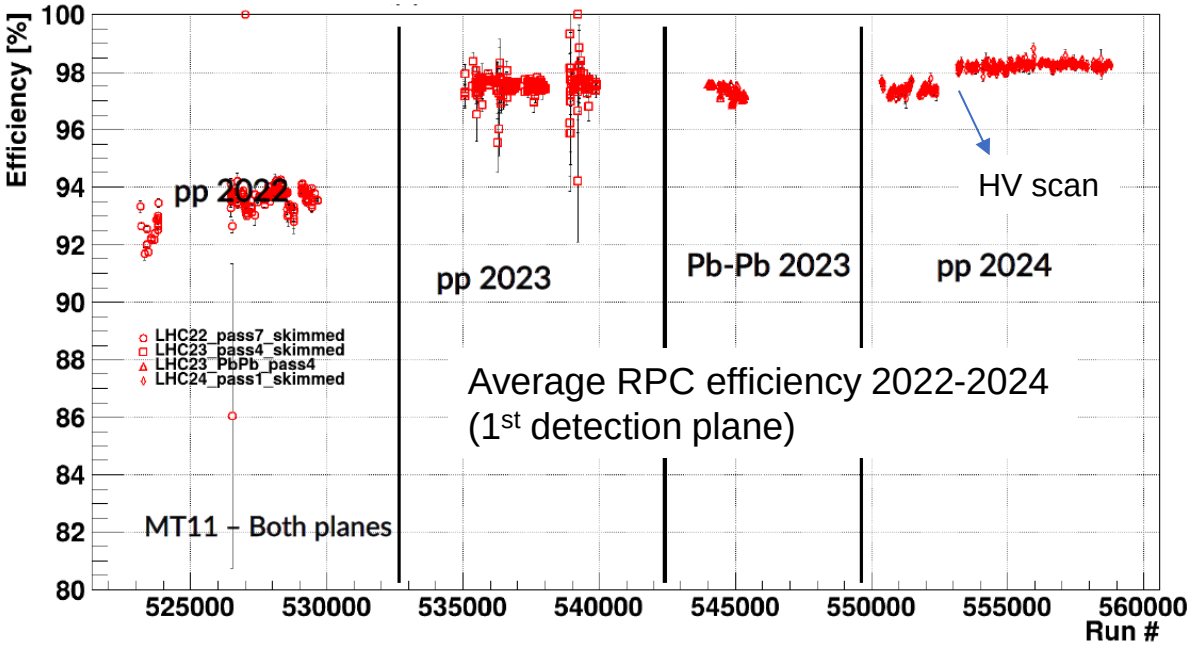
Muon Identifier Technical Coordinator (P. Mereu) + Deputy (L. Quaglia)

+ Muon Spectrometer Project Leader (M. Gagliardi)

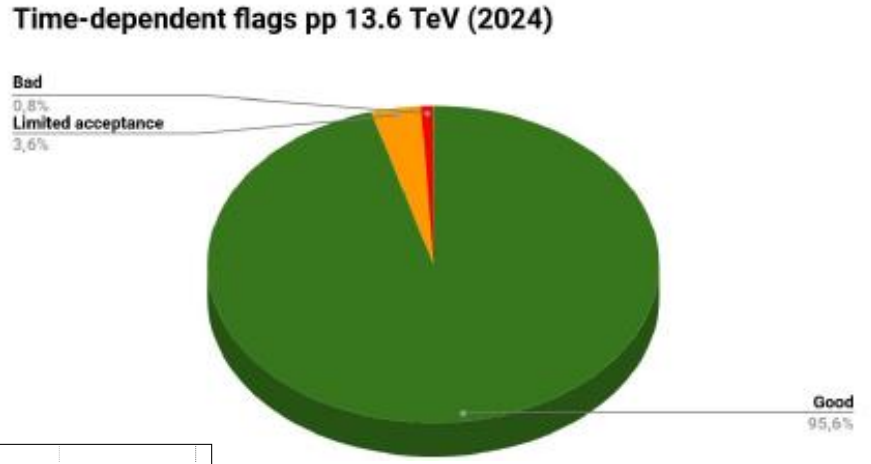
Clermont-Ferrand + Nantes (F), iThemba (SA):
front-end and readout electronics, software

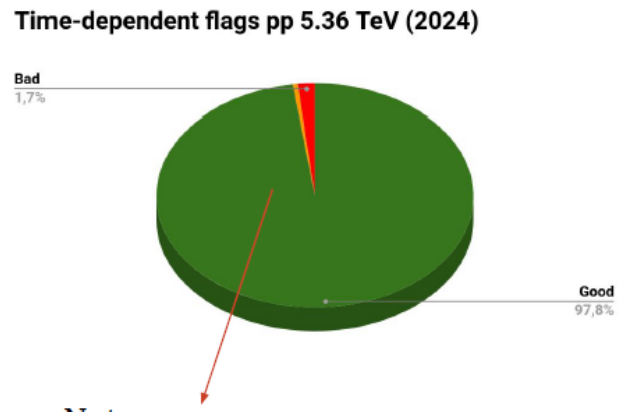
Detector status: 2024 data-taking and 2025 restart

- Participation in runs close to 100%
- Data quality after reconstruction:
  >99% of usable runs for pp high-energy
  ~98% of usable runs for pp reference
  > 96% usable runs for Pb-Pb
- Average RPC efficiency ~98%

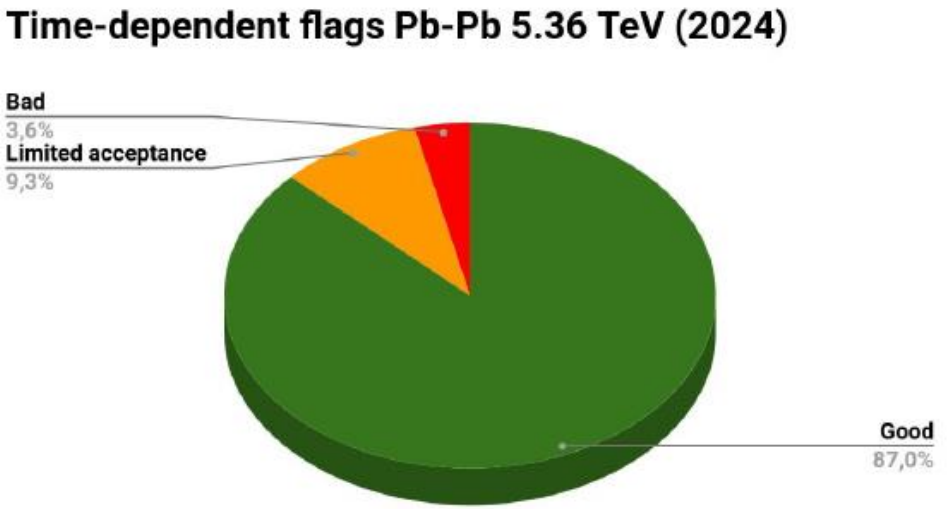


Average RPC efficiency 2022-2024
(1st detection plane)



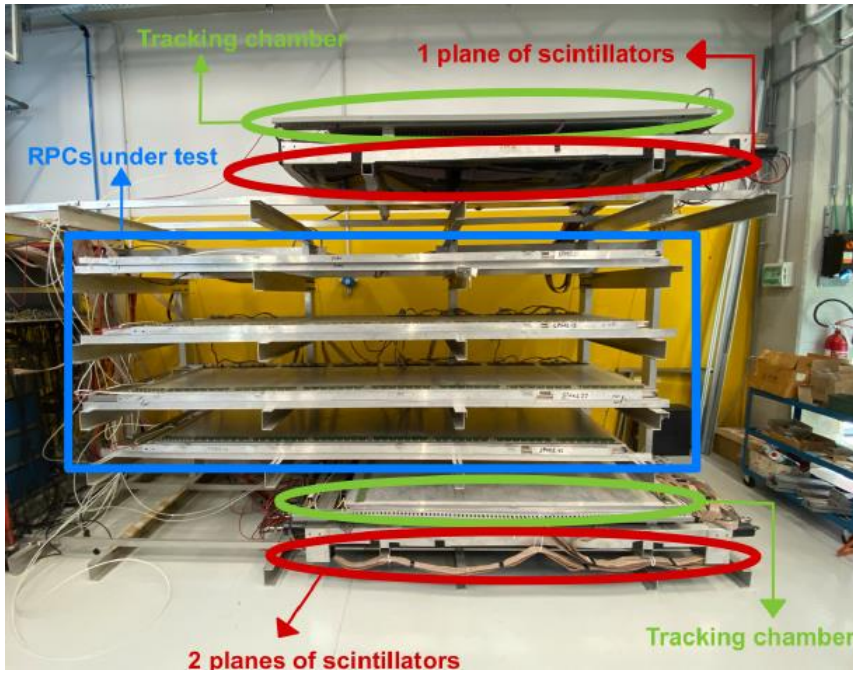


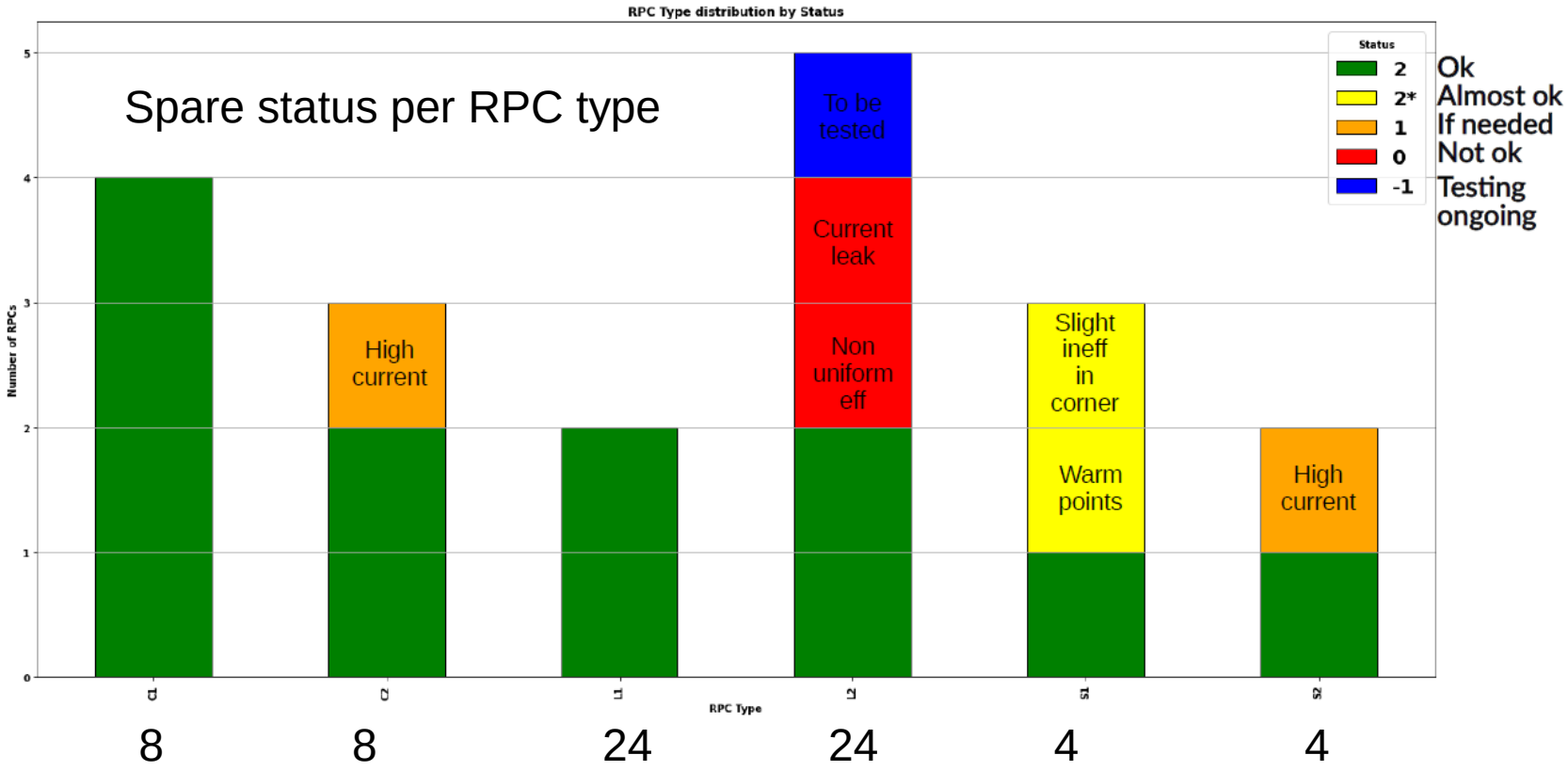
Note:
Limited acceptance percentage is not included in the legend as it is below 0.5%.

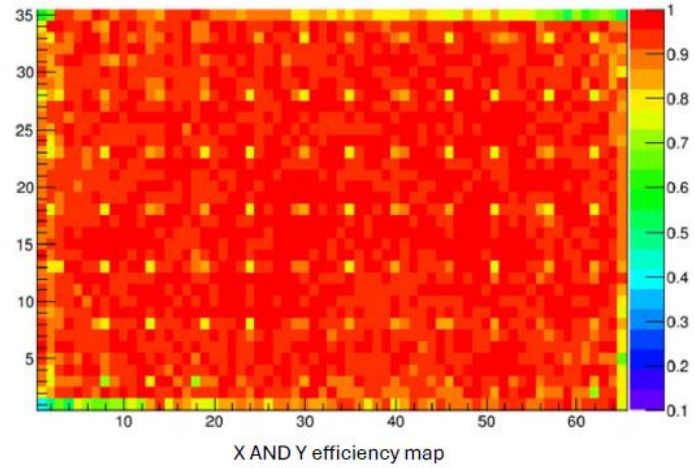


- Smooth restart of pp data-taking in 2025 (+ p-O, O-O, Ne-Ne)

LS2 RPC production – results from the tests at the INFN-TO lab







LS2 production of 27 RPCs
- 12 + 2+ 2 spares avaiable
- 4 already installed at P2 (not in the plot)

(numbers below each column indicate the number of RPCs of that type in the MID system)

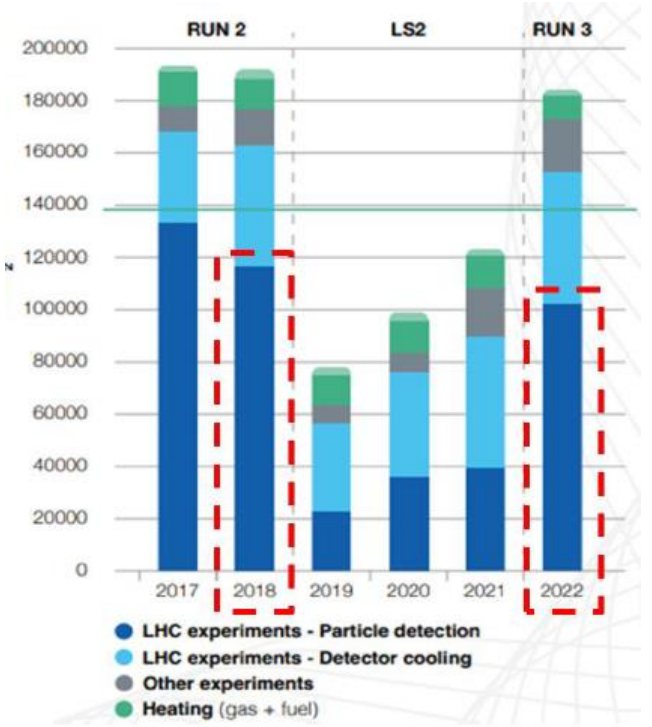
- Test results are satisfactory
- In view of Run 4, a larger number of spares is needed, especially for some RPC types

Fluorinated gases at CERN

EU is imposing progressive phase-down of fluorinated gases

Research infrastructures like CERN are (for now) exempt, but:

- moral and political obligation to reduce emissions from particle detectors
- cost increase or limited availability of traditional F-gases

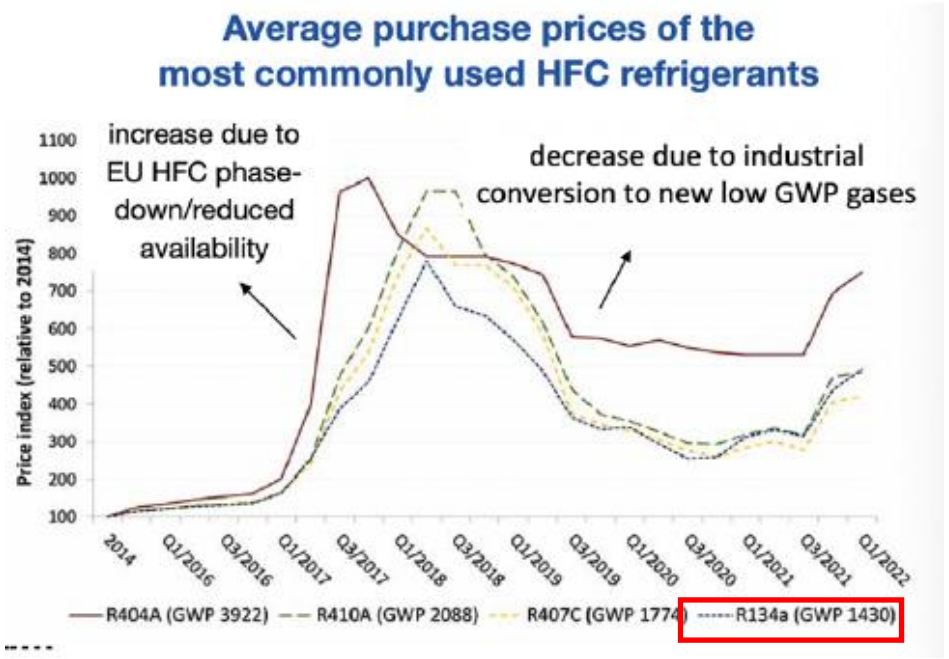


MID gas mixture: $C_2H_2F_4$ (89.7%) – iC_4H_{10} (10%) – SF_6 (0.3%)

215 l/h circulated in the detector, recirculation factor 87%
Fresh gas injection: 27.88 l/h (analysis 6 l/h, exhaust 15 l/h, leaks 7 l/h)
Leak rate 3%
All RPCs accessible for repair or replacement in case of leaks

Policy of CERN as of now (LHCC focus session June 2025):

- go on with “traditional” mixtures as much as possible for already existing detector systems
- try to purchase in advance the amount of gas needed (not trivial)
- show goodwill in limiting emissions by:
  - enforcing recirculation or recuperation systems
  - reducing leaks as much as possible
  - R&D on eco-friendly gas mixtures (as backup and for future facilities)



Activities on eco-friendly gas mixtures

High-rate tests on resistive plate chambers operated with eco-friendly gas mixtures

Regular Article - Experimental Physics | Open access | Published: 22 March 2024
Volume 84, article number 300, (2024) Cite this article

Performance of thin-RPC detectors for high rate applications with eco-friendly gas mixtures

Regular Article - Experimental Physics | Open access | Published: 11 June 2024
Volume 84, article number 605, (2024) Cite this article

Preliminary results on the long-term operation of RPCs with eco-friendly gas mixtures under irradiation at the CERN Gamma Irradiation Facility

Regular Article | Open access | Published: 15 January 2025
Volume 140, article number 40, (2025) Cite this article

The RPC ECOgas@GIF++ Collaboration:, L. Quaglia, D. Ramos, M. Abbr

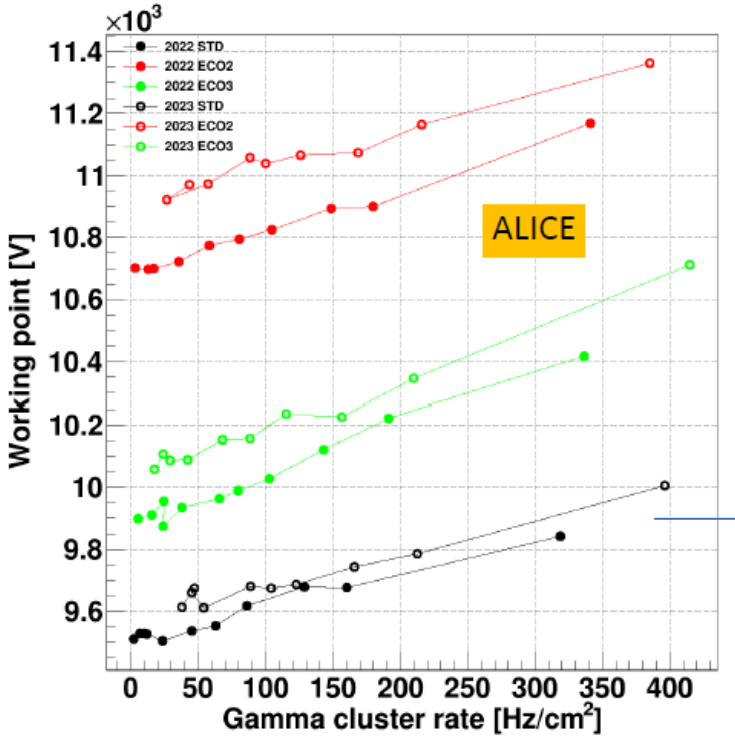
INFN-TO

2025: end of *AIDAINNOVA* project
supporting the RPC Ecogas@GIF++ collaboration

Three papers out, one in the making. Leading role of INFN units.

Main results:
- a few mixtures characterized, with $C_2H_2F_4$ → $C_3H_2F_4$-ze + CO_2
  - these have larger charge per hit, larger working point
    and worse ageing properties

Continuation of the activities and collaboration being defined,
also in light of LS3 shutdown of the CERN accelerators.
AIDAINNOVAnext proposal submitted to EU (Horizon INFRA 2025).



RPC working point vs cluster rate before and after irradiation

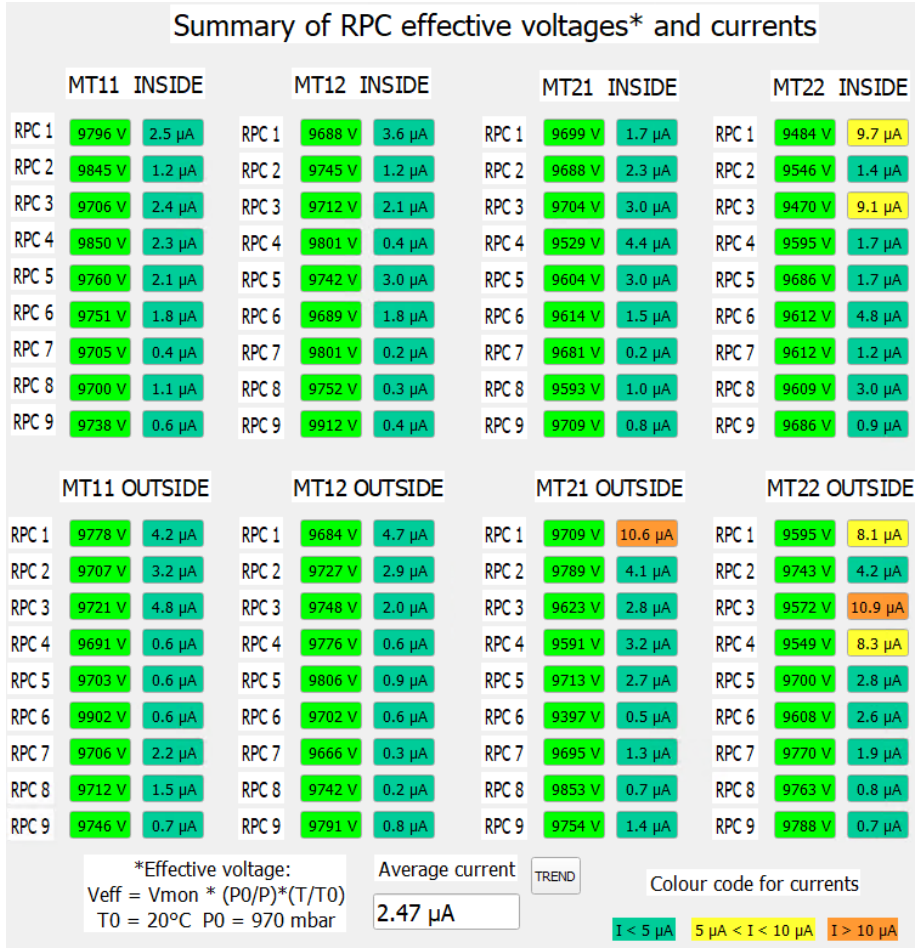
Activities 2026

At CERN:

Participation in pp + Pb-Pb run

Interventions during 25/26 winter shutdown
or technical stops, if needed

Start LS3 consolidation activities
→ check RPCs with high dark current
or suspected gas leaks



In Torino:

- test some of the RPCs removed from ALICE, to address in details the effect of large currents and possible emergence of ageing effects
- test new spare detectors as soon as available
- test new eco-friendly gas mixtures (beyond $C_3H_2F_4$-ze)

Milestones MID

Anno-ID	Milestone		Commenti
2024-29	Partecipazione costante e regolare alla presa dati con collisioni pp e Pb-Pb	Completamento (al 31/12/24) 100%	
2025-22	Partecipazione costante e regolare alla presa dati con collisioni pp e Pb-Pb		rivelatore stabilmente in presa dati
2026	Partecipazione costante e regolare alla presa dati con collisioni pp e Pb-Pb		

Richieste 2025

- Interventi di maintenance durante i technical stop e LS3:
  → 5 settimane al CERN per 2 tecnici + 1 fisico/tecnologo
  → *15 kEuro missioni*

- Attività di R&D su miscele eco-friendly al CERN (GIF++)
  → 3 settimane al CERN
  → *3 kEuro missioni*

- Acquisto gas per stazione raggi cosmici INFN-TO
  (test rivelatori spare, test su RPC invecchiate in ALICE, R&D miscele eco-friendly)
  → *2 kEuro consumo*

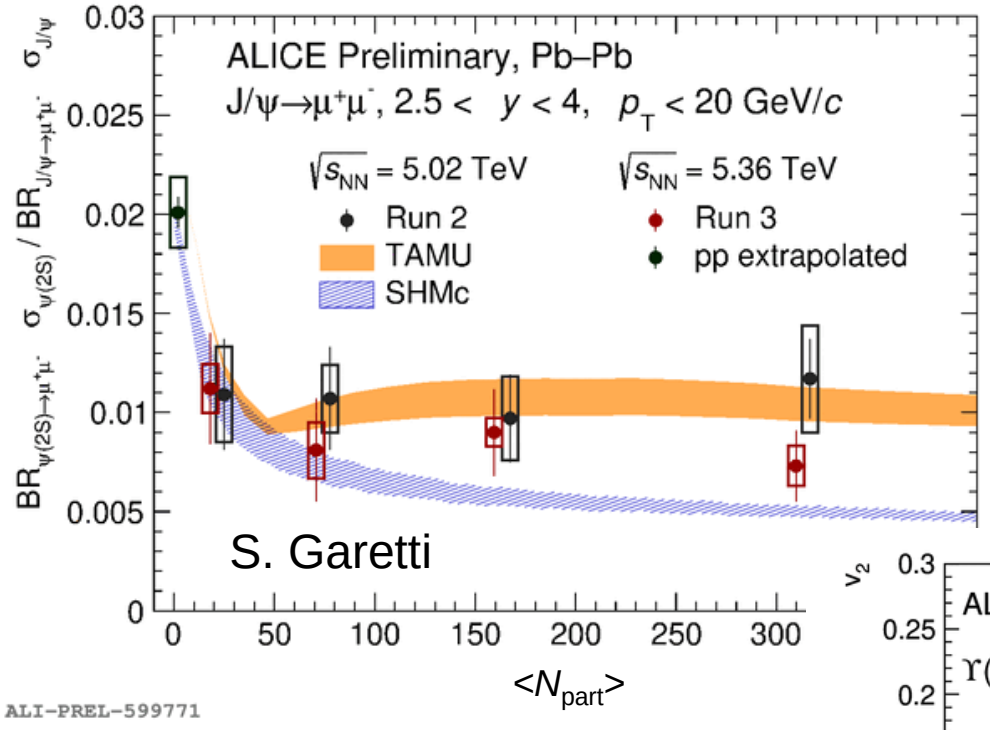
- Acquisto bakelite per produzione ~20 RPC spare per Run 4
  Una pressata da 40 lastre a ~1000 euro/lastra + IVA
  → *50 kEuro apparati*

- Costruzione 4 prototipi RPC 50x50 cm^2 per R&D miscele eco-friendly
  → *3 kEuro apparati*

- M&O-B: *36.1 kCHF Servizi*

Costruzione RPC ~ 20 kEuro in 2027 o 2027+2028.
Acquisto bakelite richiesto ora a fronte di futuri rincari e potenziale dismissione dello spessore 2 mm.
40 lastre = pressata minima

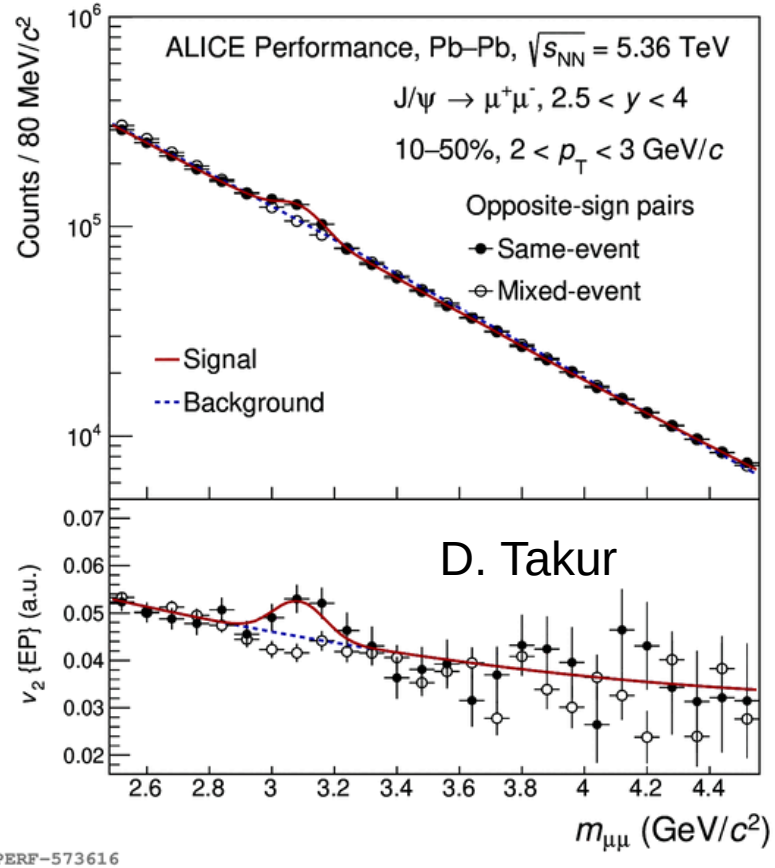
First muon physics results from Run 3 Pb-Pb collisions



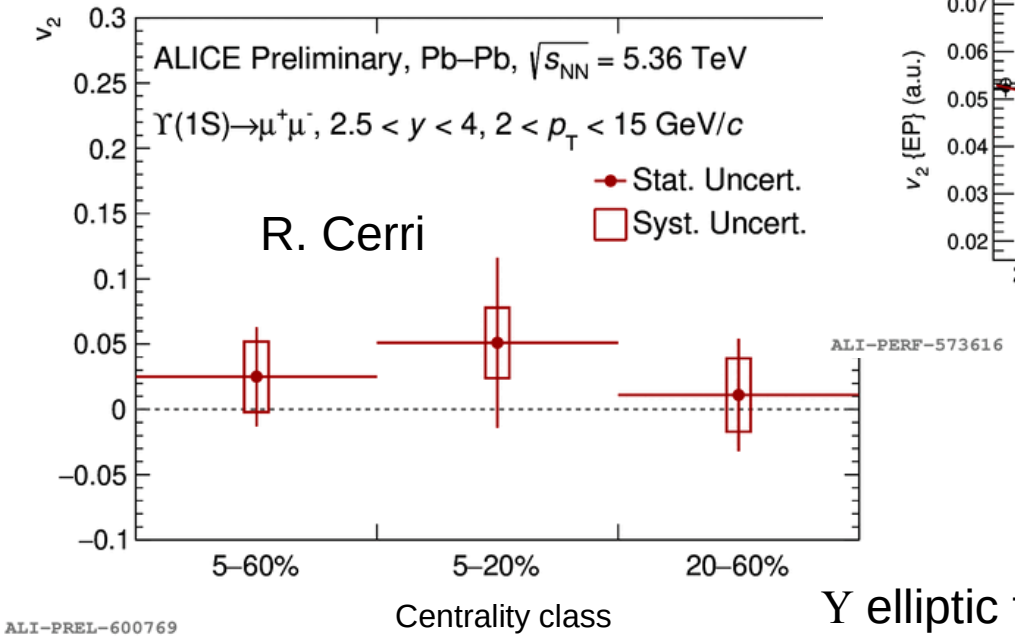
S. Garetti

ψ(2S)/ψ ratio

J/ψ elliptic flow



D. Takur



R. Cerri

ϒ elliptic flow

(main analysers for these plots are from INFN-TO)

Backup

MID M&O-B 2026

budget description	Spesa (kCHF)	Commenti
Mechanics	1	
Gas Systems	2	
Cooling Systems		
FEE spares		
Standard Electronics LV/HV PS	3	
Standard Electronics Crates	2	
Standard Electronics R/O modules		
Controls (DCS & DSS)		
Sub-Detector spares	3	
Areas		
Communications	2	
Store Items	1	
Technical Manpower @ CERN: Industrial Support		
Technical Manpower @ CERN: subsistence	68	
Totale	**82**	

INFN share in MID M&O-B: 44% → INFN contribution = 36 kCHF

Profilo di spesa RPC + gas system

	2015	2016	2017	2018	2019	2020	2021	Tot
MoU (kCHF)	41	17	7	37	0	0	0	102
Finanziamento INFN (kCHF)	41	17	7	0	23	5-9 (sblocco s.j. settembre)	13 s.j.	93-97+13 s.j.

Profilo di spesa FEERIC

	2015	2016	2017	2018	2019	2020	Tot
MoU (kCHF)	16.5	32	30.5	10	5	0	94
Effettivo (kCHF)	17.5	48		0	10	0	75.5
Finanziamento INFN (kCHF)	30	32	3.5	0	10	0	75.5