

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 $72 \times 223 \text{ cm}^2$ to $76 \times 292 \text{ cm}^2$

Responsibilities:

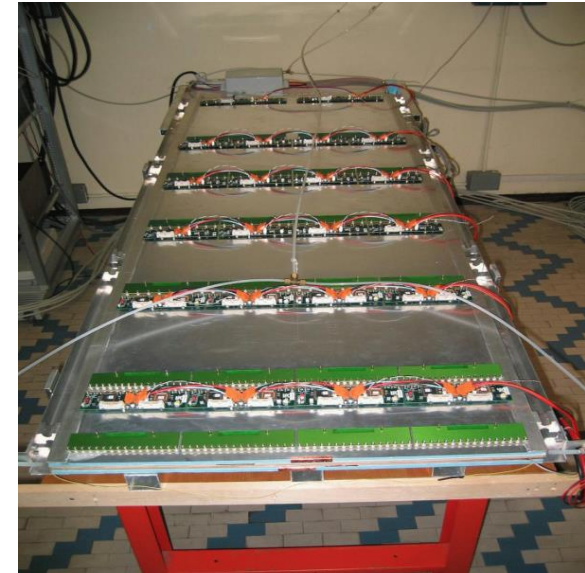
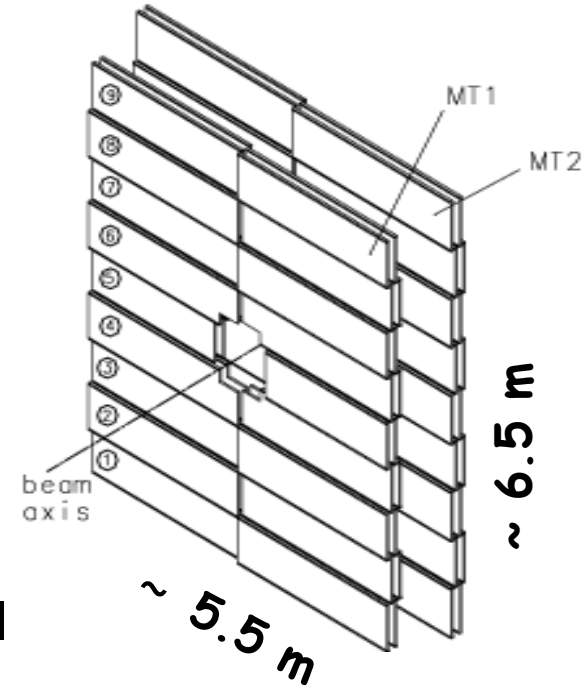
Torino: Gas gaps, external mechanics, control system, gas system.

- ~ 7 FTE
- Ruoli di responsabilità in MID:

Muon Identifier Sub-Project Leader (A. Ferretti)

Muon Identifier Technical Coordinator (P. Mereu)

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



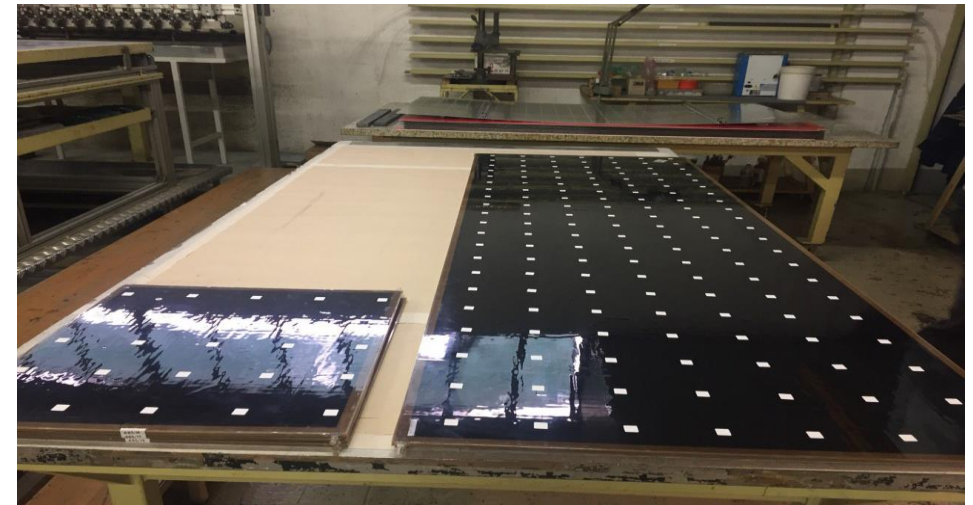
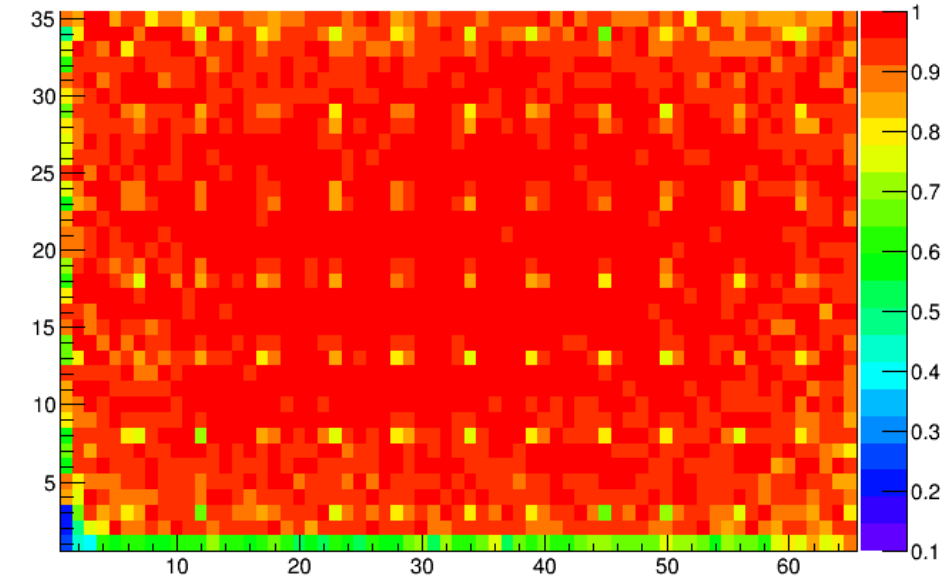
The Muon Trigger upgrade to Muon Identifier

- ❑ **Goal #1:** detector performance and safe long-term operation in such a scenario
 - > **detector and FEE upgrade** (INFN Torino, LPC Clermont-Ferrand)
 - a) reduce charge-per-hit by a factor 3-5 by developing FEE cards with amplification
 - b) replace ~30% most irradiated RPCs → **production of new RPCs**
- ❑ **Goal #2:** dead time-free readout (vs present 150 μ s)
 - > **readout electronics upgrade** (Subatech Nantes, LPC Clermont Ferrrand)

RPC production and status in INFN-TO lab (1)

- RPCs production before 2019 highly unsatisfactory
 - inefficiency holes at the HV working point (WP)
 - high currents
 - general carelessness in the production process
 - **not possible to use them in ALICE**
- New pre-production batch of 3 RPCs at the end of 2019, after several interactions with the firm
- All 3 RPCs tested in early 2020 showed:
 - an **efficiency higher than 95%** at working point
 - **low currents** (lower than $1\mu\text{A}$)
 - **can be used in ALICE**

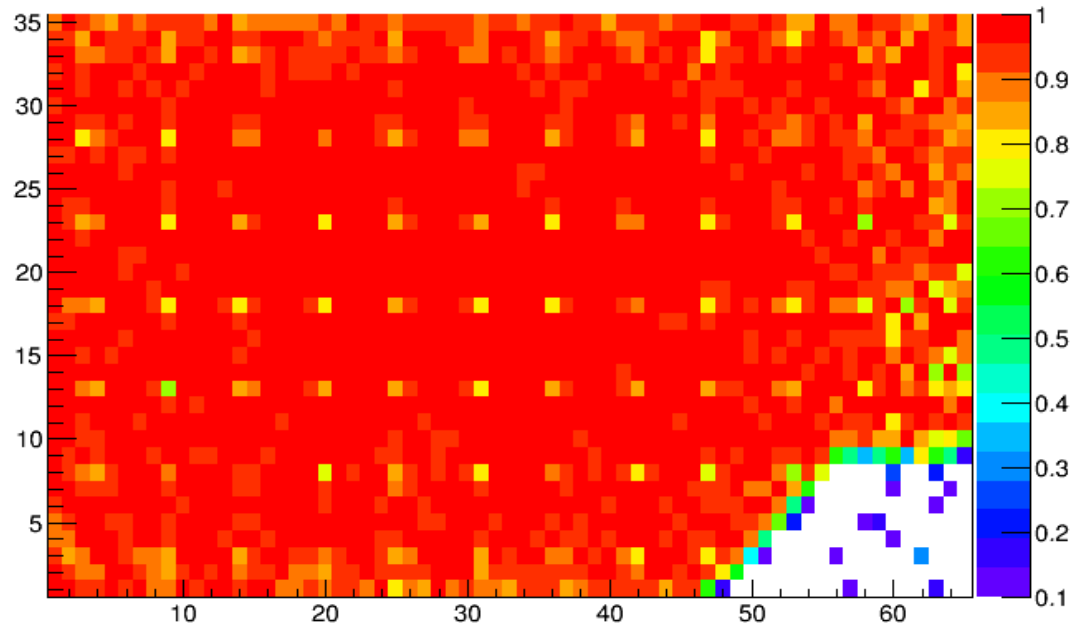
efficiency w/ no cuts x o y, tst2



RPC production and status in INFN-TO lab (2)

- New production batch of 30 RPCs in 2021
 - → **delayed at the firm** due to Covid-19 pandemic
- RPCs tests started in Spring 2022
 - **delay** due to the commissioning of the brand **new INFN-TO laboratory** and **re-assignment of manpower** to the commissioning at CERN

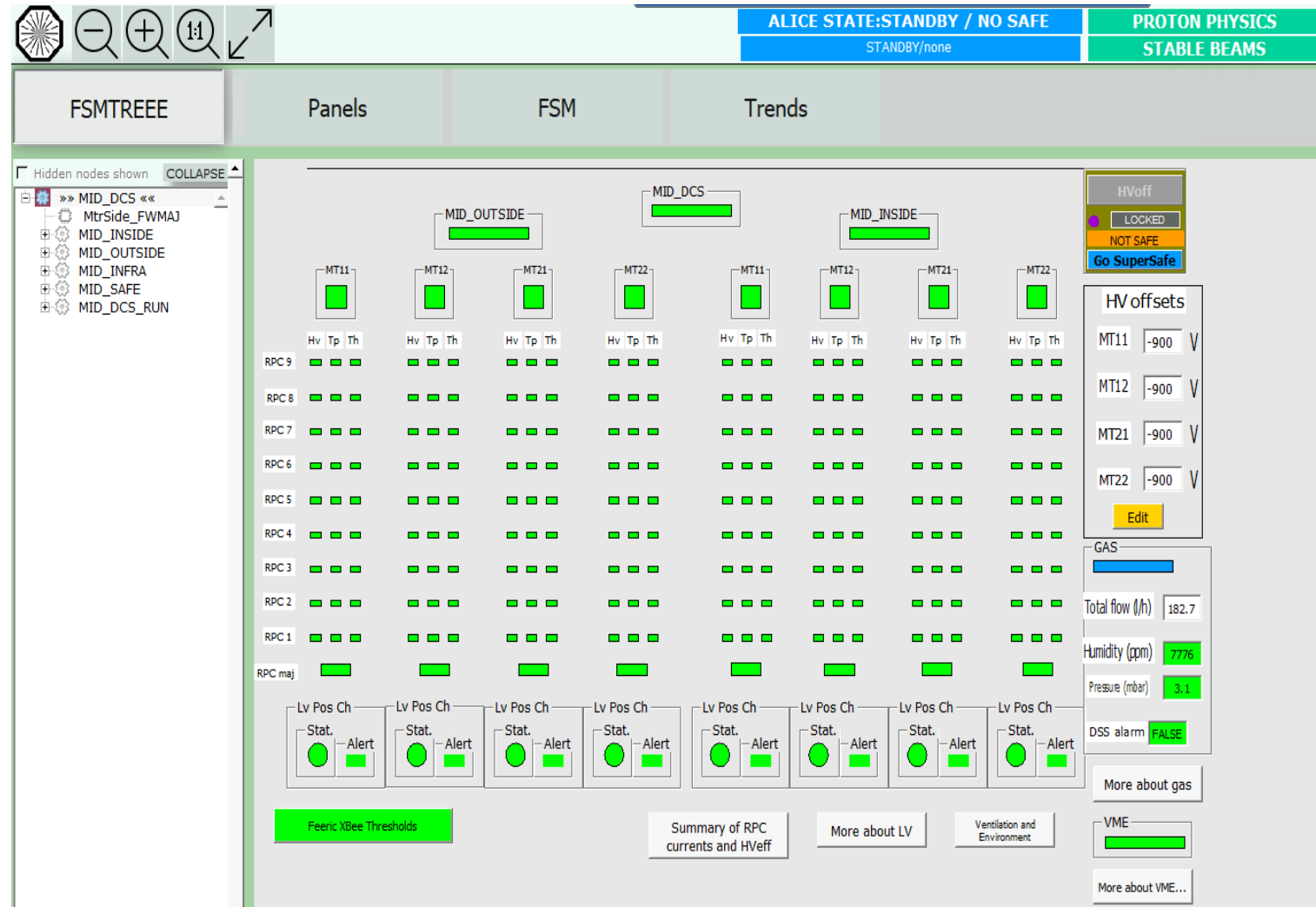
efficiency w/ no cuts x o y, tst2



- 4 RPCs tested so far. All of them show:
 - an efficiency even higher than the 2019 pre-production batch (lower working point)
 - **slightly higher currents**, between $2\mu\text{A}$ and $10\mu\text{A}$ (causes under investigation)
 - **can be used in ALICE**

MID re-commissioning and operation at CERN (1)

- Several **hardware interventions** during the first phase of the commissioning without beam (gas system, HV cables, gas leak recovery...)
- Online systems (RO, QC, DCS) re-commissioned (some with basic functionalities only), fine-tuning ongoing
- The entire system was **READY** during the first Run 3 STABLE BEAMS on July 5th
- **Commissioning with first pp collisions ongoing** → need to tune working parameters RPC by RPC
- Up to now, MID has **always been READY and taking data** with pp collisions



RPC currents at (tentative) working point

Mid\midQuickRpcSummary.pnl

— □ ×

Summary of RPC effective voltages* and currents

MT11 INSIDE		MT12 INSIDE		MT21 INSIDE		MT22 INSIDE	
RPC 1	9508 V 2.0 µA	RPC 1	9428 V 3.3 µA	RPC 1	9300 V 1.6 µA	RPC 1	9396 V 4.9 µA
RPC 2	9446 V 1.0 µA	RPC 2	9469 V 1.2 µA	RPC 2	9354 V 1.7 µA	RPC 2	9428 V 8.5 µA
RPC 3	9383 V 1.6 µA	RPC 3	9340 V 2.1 µA	RPC 3	9342 V 2.6 µA	RPC 3	9099 V 1.3 µA
RPC 4	9550 V 3.4 µA	RPC 4	9356 V 0.9 µA	RPC 4	9258 V 5.9 µA	RPC 4	9234 V 1.2 µA
RPC 5	9448 V 4.0 µA	RPC 5	9276 V 3.8 µA	RPC 5	9211 V 3.5 µA	RPC 5	9447 V 1.9 µA
RPC 6	9288 V 2.4 µA	RPC 6	9447 V 3.8 µA	RPC 6	9192 V 1.7 µA	RPC 6	9252 V 6.4 µA
RPC 7	9342 V 1.0 µA	RPC 7	9490 V 0.7 µA	RPC 7	9315 V 0.8 µA	RPC 7	9149 V 2.2 µA
RPC 8	9470 V 1.4 µA	RPC 8	9295 V 0.6 µA	RPC 8	9256 V 1.4 µA	RPC 8	9158 V 3.4 µA
RPC 9	9449 V 0.9 µA	RPC 9	9435 V 0.7 µA	RPC 9	9346 V 1.6 µA	RPC 9	9247 V 1.3 µA

MT11 OUTSIDE		MT12 OUTSIDE		MT21 OUTSIDE		MT22 OUTSIDE	
RPC 1	9402 V 2.8 µA	RPC 1	9497 V 4.0 µA	RPC 1	9321 V 6.0 µA	RPC 1	9342 V 6.2 µA
RPC 2	9446 V 3.1 µA	RPC 2	9485 V 3.0 µA	RPC 2	9460 V 2.8 µA	RPC 2	9342 V 2.9 µA
RPC 3	9247 V 3.9 µA	RPC 3	9369 V 1.8 µA	RPC 3	9303 V 2.1 µA	RPC 3	9254 V 7.7 µA
RPC 4	9464 V 1.5 µA	RPC 4	9427 V 1.4 µA	RPC 4	9203 V 3.2 µA	RPC 4	9187 V 5.5 µA
RPC 5	9251 V 1.1 µA	RPC 5	9415 V 1.5 µA	RPC 5	9356 V 2.5 µA	RPC 5	9277 V 4.3 µA
RPC 6	9447 V 1.5 µA	RPC 6	9299 V 1.5 µA	RPC 6	9097 V 17.3 µA	RPC 6	9285 V 9.6 µA
RPC 7	9246 V 3.3 µA	RPC 7	9212 V 0.8 µA	RPC 7	9296 V 1.9 µA	RPC 7	9325 V 2.1 µA
RPC 8	9240 V 1.0 µA	RPC 8	9504 V 0.8 µA	RPC 8	9400 V 1.2 µA	RPC 8	9326 V 1.1 µA
RPC 9	9359 V 0.9 µA	RPC 9	9501 V 0.9 µA	RPC 9	9361 V 1.9 µA	RPC 9	9348 V 1.0 µA

*Effective voltage:
 $V_{eff} = V_{mon} * (P_0/P) * (T/T_0)$
 $T_0 = 20^\circ\text{C}$ $P_0 = 970 \text{ mbar}$

Average current

TREND

2.79 µA

Colour code for currents

$I < 5 \mu\text{A}$ $5 \mu\text{A} < I < 10 \mu\text{A}$ $I > 10 \mu\text{A}$

CLOSE

MID plans 2022-2023

2022

- as stable as possible data-taking with pp collisions, fine-tuning of RPC HV and thresholds and improvement of online systems in parallel, with the goal to be in the best possible shape for the Pb-Pb run (November 2022)
- complete tests of the new RPC batch

Winter shutdown 2022-23

- installation of up to 10 new RPCs
(sblocco 4.5 kEuro s.j. a settembre)

2023

- stable data-taking with proton and heavy-ion beams
- maintenance interventions as needed (gas leaks, HV cables are typical culprits)
- installation of more RPCs from the new batch

Milestones

Anno	Milestone	Compl. al 30/06/22	Commenti
2021	Completamento test nuove RPC (dal 2020)	20%	test ancora in corso
2022	Partecipazione presa dati con collisioni pp e Pb-Pb	50%	presa dati Pb-Pb ancora da svolgere, rivelatore pronto e integrato in ALICE
2023	Partecipazione costante e regolare alla presa dati con collisioni pp e Pb-Pb		

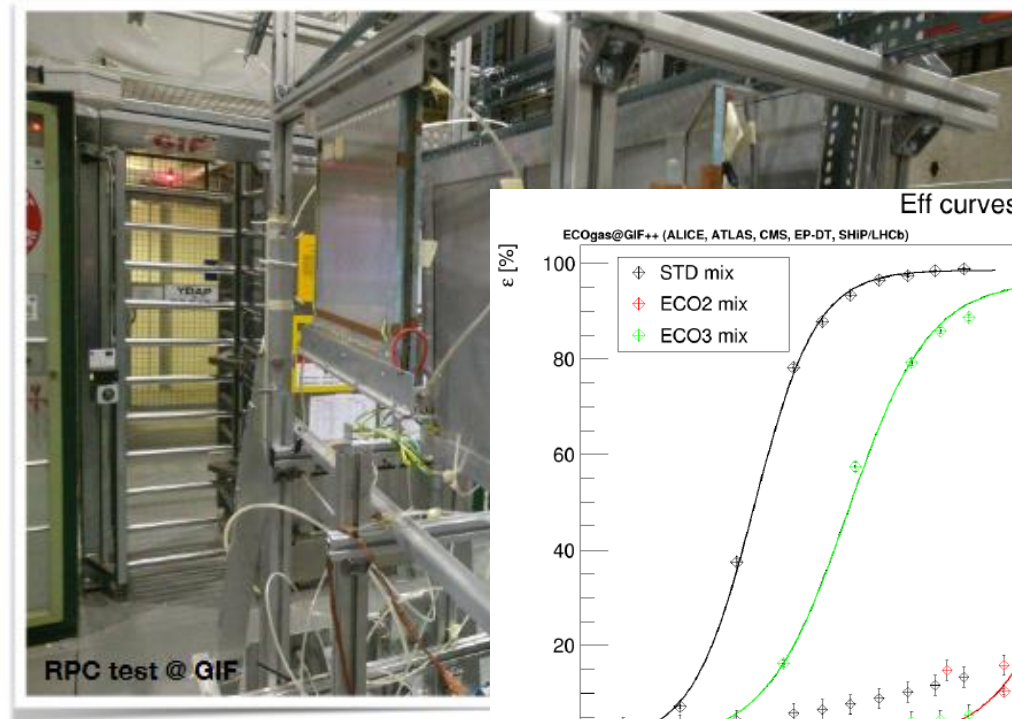
RPC activities @ GIF



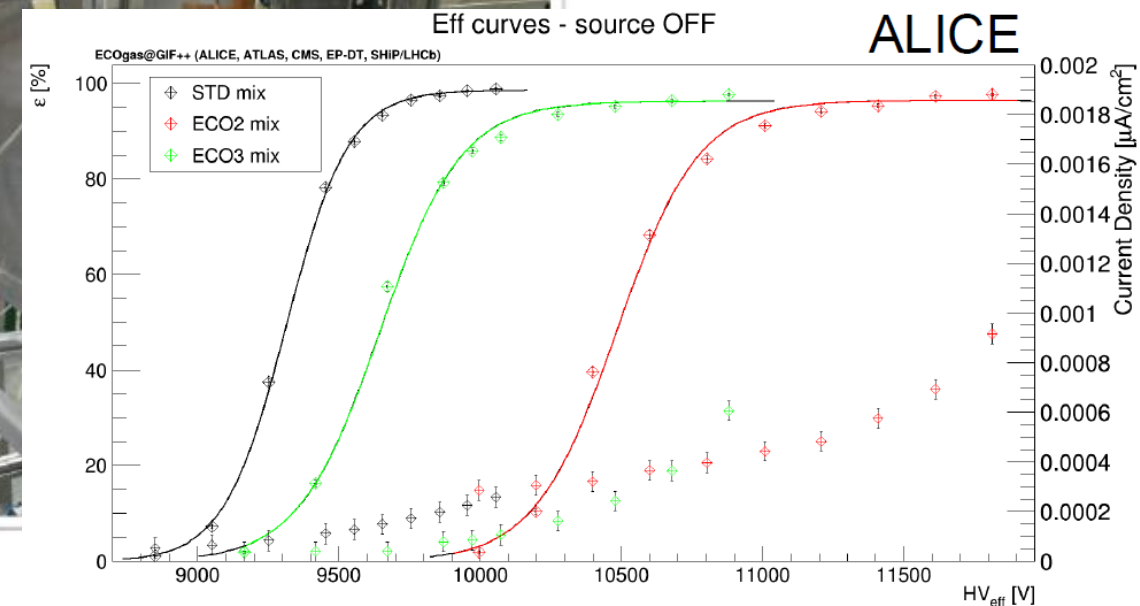
- RPC Gas R&D join effort (ATLAS, CMS, ALICE) in view of Run 4 and beyond
 - Replace tetrafluoroethane from the RPC gas mixture (high value of Global Warming Potential)
 - Tetrafluoropropene-CO₂-based gas mixtures already tested with cosmics with promising results

- Tests @ GIF

- Since 2020, prototype RPCs flushed with the new mixture have been exposed to gamma irradiation at CERN GIF to check the aging, working current and dark current have been monitored



- Several beam tests carried out in 2021 and 2022
 - cluster size, efficiency, rate capability...
 - systematic study vs gas mixture→ results are being analysed and will be presented at relevant conferences and workshops in the field in Autumn 2022



Richieste 2023

Richieste specifiche

- Interventi di maintenance durante i technical stop:
 - 3 settimane al CERN per 2 tecnici + 1 fisico/tecnologo
 - *9 kEuro missioni*
- Partecipazione ad attività progetto Ecogas@GIF++ (beam + ageing tests)
 - 2 settimane al CERN per 2 persone
 - *4 kEuro missioni*

+M&O-B: *29 kCHF Servizi*

Backup

MID M&O-B 2023

budget description	Spesa (kCHF)	Commenti
Mechanics	4	
Gas Systems	4	
Cooling Systems		
FEE spares		
Standard Electronics LV/HV PS	5	
Standard Electronics Crates	5	
Standard Electronics R/O modules		
Controls (DCS & DSS)		
Sub-Detector spares	5	
Areas		
Communications	3	
Store Items	2	
Technical Manpower @ CERN: Industrial Support		
Technical Manpower @ CERN: subsistence	38	
Totale	66	

INFN share in MID M&O-B: 44% → INFN contribution = 29 kCHF

MID status at ALICE at CERN (2)

Several improvements on the VME side:

- 1) GBTx links down by clock transition on Beam1
→ automatic “bring-up” done and working
- 2) Calibration run of the detector after the BEAM DUMP
→ done and working, took less than 4 min
- 3) Firmware update of LOCAL cards
→ restoring the default registers and masking corresponding channels done and working
- 4) CRU UL bug: logic broken because of timing issues, resource usage too large
→ bug fix to be validated and deployed

The screenshot displays the VME CRATES control interface, divided into two main sections: CAN8 (Inside) and CAN9 (Outside).

CAN8 (Inside):

- Top Panel:** Includes a "ReadOutConfig" section with "INIT" and "LOAD MASKS" buttons. Below it are "Check SETUP" and "Check CRU" buttons, all with "OK" status. To the right, a "VME CRATES" summary shows "Check LBs WRITE" (OK), "GBTX Status" (OK), "PULSE GBTX" (OK), and "CONFIG GBTX" (OK).
- Crates Grid:** A 2x4 grid of crate controls. Each crate (5R, 2R, 2-3R, 7R, 4R, 1R, 3R, 6R) has a "Crate ON / OFF" toggle (set to On), "Settings", "Alarm", and "SysRESET" buttons. A "More about Channels" link is present for each crate.
- Bottom Panel:** Labeled "INSIDE". It includes a "CAN9" status box (Nb of Connected Devices: 8) and a "All Vme crates" section with "ALLCratesON" and "ALLCratesOFF" buttons, both showing "LOCKED". To the right, a "12C BIND" button is "OK", and a "CLOCK" section shows "BEAM1" and a "Transition in 3 minutes" warning. A "RSSI MONITORING" button and a "Close" button are also visible.

CAN9 (Outside):

- Crates Grid:** A 2x4 grid of crate controls. Each crate (7L, 2-3L, 2L, 5L, 6L, 3L, 1L, 4L) has a "Crate ON / OFF" toggle (set to On), "Settings", "Alarm", and "SysRESET" buttons. A "More about Channels" link is present for each crate.
- Bottom Panel:** Labeled "OUTSIDE". It includes a "CAN9" status box (Nb of Connected Devices: 8) and a "All Vme crates" section with "ALLCratesON" and "ALLCratesOFF" buttons, both showing "LOCKED". To the right, a "12C BIND" button is "OK", and a "CLOCK" section shows "BEAM1" and a "Transition in 3 minutes" warning. A "RSSI MONITORING" button and a "Close" button are also visible.

MID status at ALICE at CERN (3)

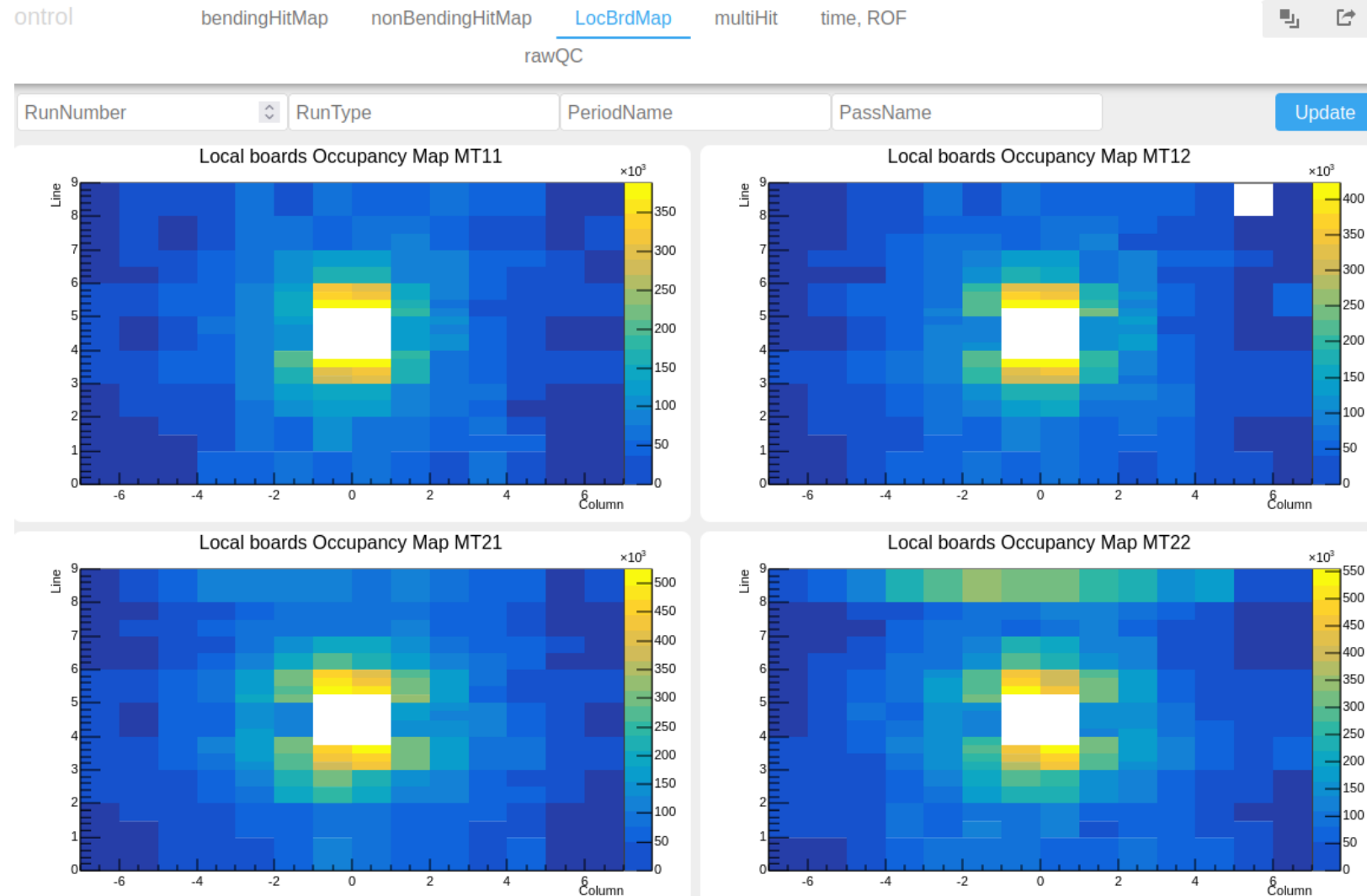
- Online Quality Control (QC)
development ongoing:

- **digits QC** done
- **raw QC** t.b.d.
- MID **tracks** t.b.d.
- **matching** between MID
and others ALICE muon

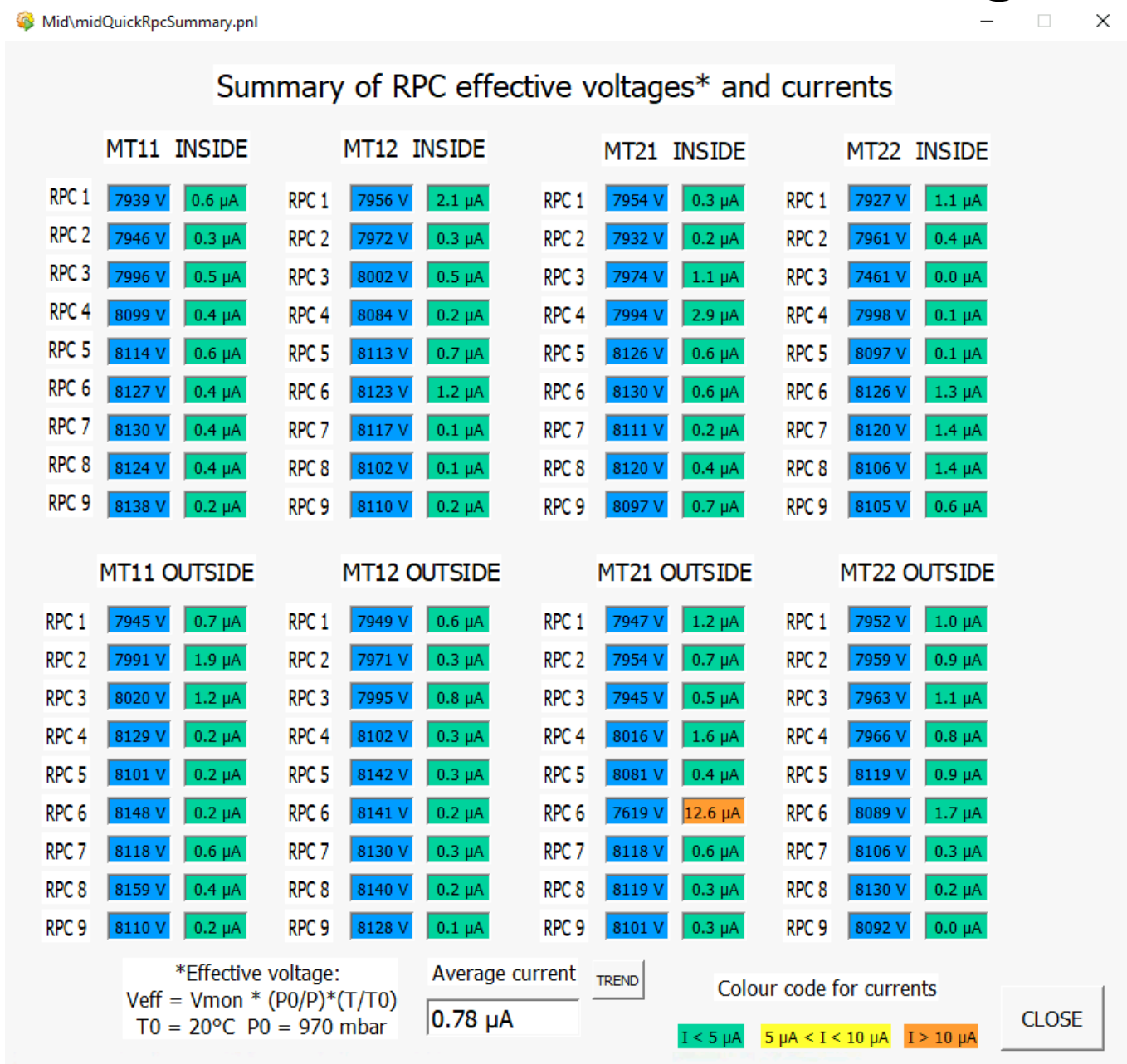
detectors ongoing

- Status sum-up:

- all 72 RPCs are
operational
- readout electronic is ok
- no issue on data taking
- QC under development



RPC currents at BEAM-SAFE voltage



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