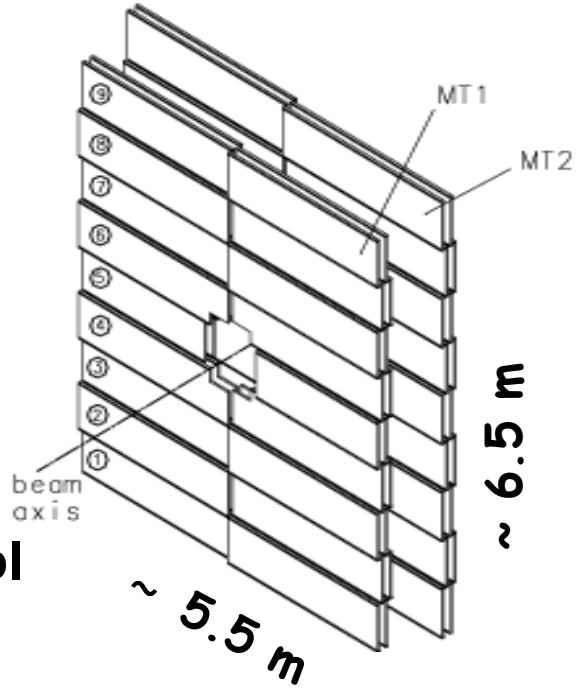
Muon IDentifier: status e richieste

A. Ferretti, M. Gagliardi, L. Terlizzi
(Università e Sezione INFN, Torino)

ALICE Muon Identifier

-72 Resistive Plate Chambers
arranged in 4 detection planes

- Single RPC areas range from
72x223 cm^2 to 76x292 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)
Muon Identifier (+MCH) Subsystem Run Coordinator (L. Terlizzi)
+ Muon Spectrometer Project Leader (M. Gagliardi)

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 μs)
  -> **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

- New pre-production batch of 3 RPCs at the end of 2019, after several interactions with the firm -> OK

- Production and test of new batch of RPCs (~20) delayed

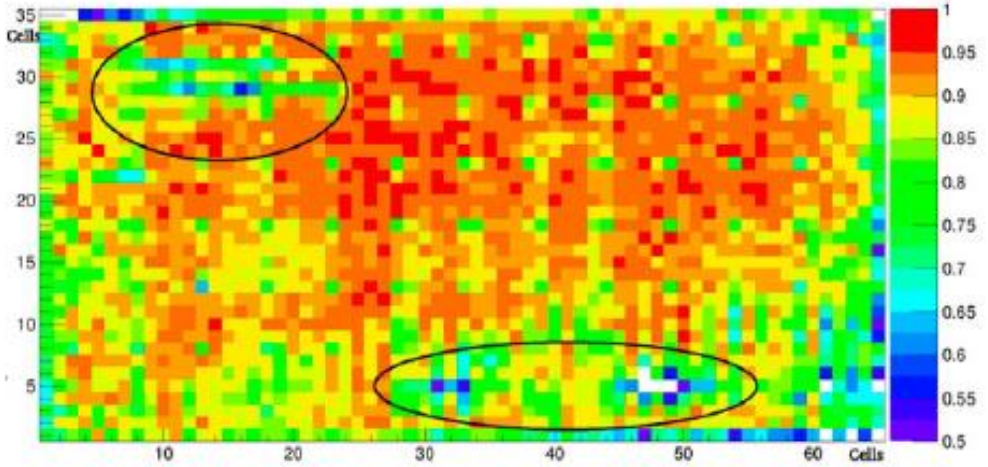
  by COVID + moving of INFN laboratories in Torino

  + manpower issues

- Tests went on (almost) full speed in Q1 and Q2 2023

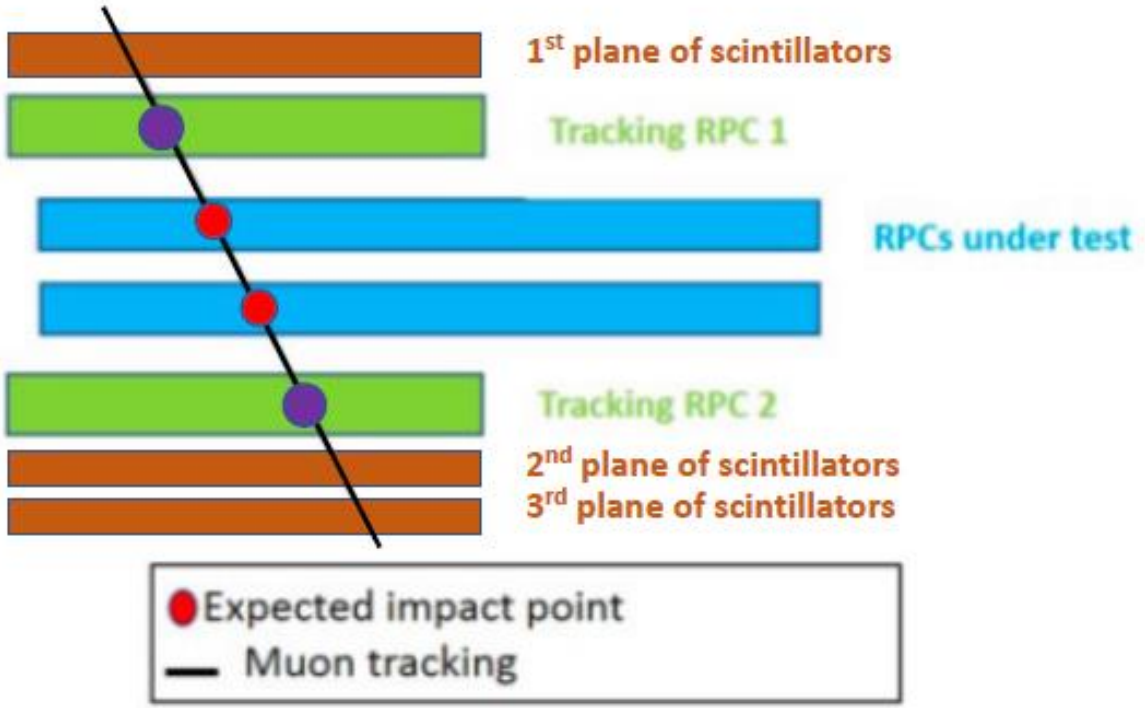
  14/18 RPCs tested

  12 OK (4 already installed), 2 OK but high current

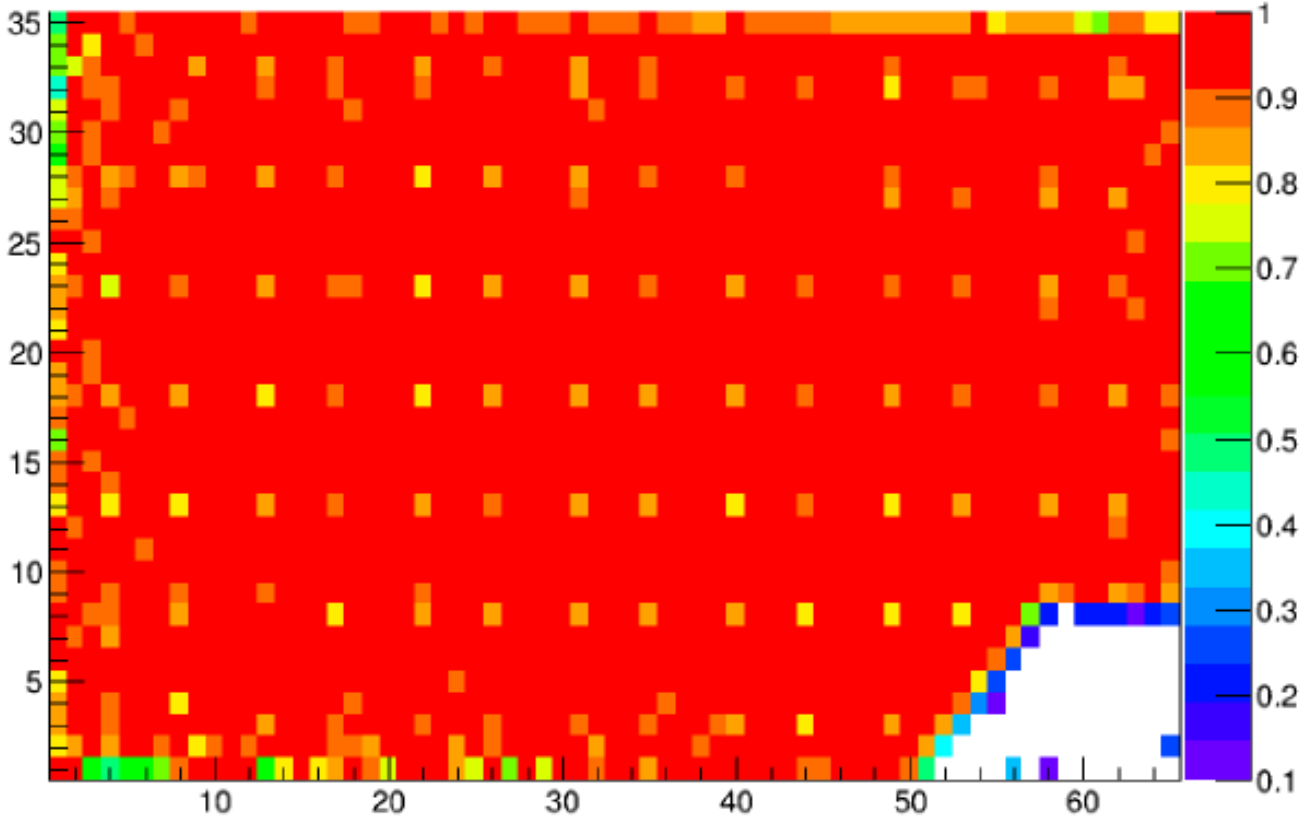


Example of inefficient chamber

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



scheme of the tracking system



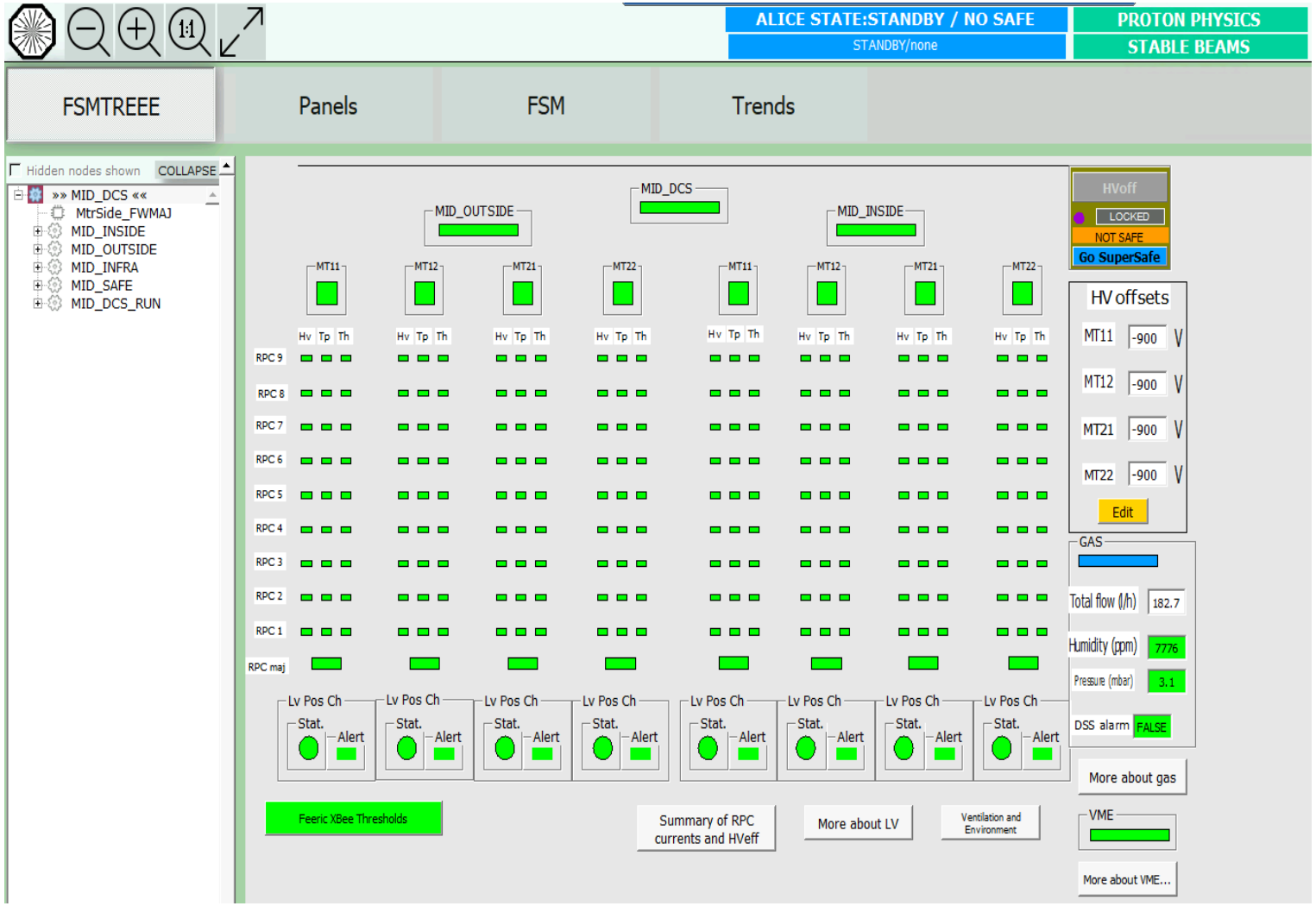
Efficiency map

Test of full production completed in 2023

New RPCs kept as spares or installed during YETS 2023/24

MID operation at CERN

- Commissioning and integration after LS2 overall successful
- Up to now, MID has **always been READY and taking data** with pp collisions
- TODO: HV and threshold scan to fine-tune working parameters
  -> delayed so far due to need for dedicated beam time (with MCH) and issues with threshold distribution system.
- Also TODO: optimization of Quality Control tools, both synchronous and asynchronous



MID performance 2022 – Charge per hit

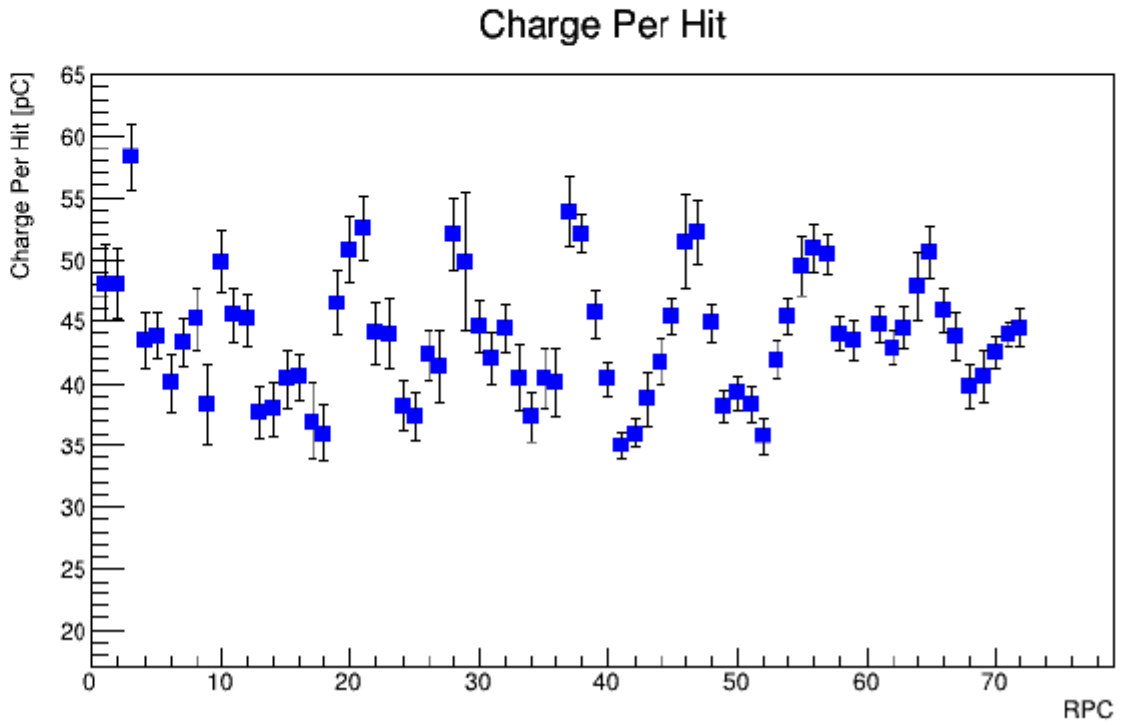
Charge per hit estimated from the slope of the current/counting rate correlation

- The average charge per hit is between ~35 pC and ~ 55 pC depending on the RPCs, with much larger uncertainty for those RPCs in which the current was more unstable

- The charge per hit must be compared to the one expected from FEERIC performance studies

  → it was expected that the charge released per hit should have been **4 times lower** for FEERIC equipped RPCs with respect to ADULT equipped ones

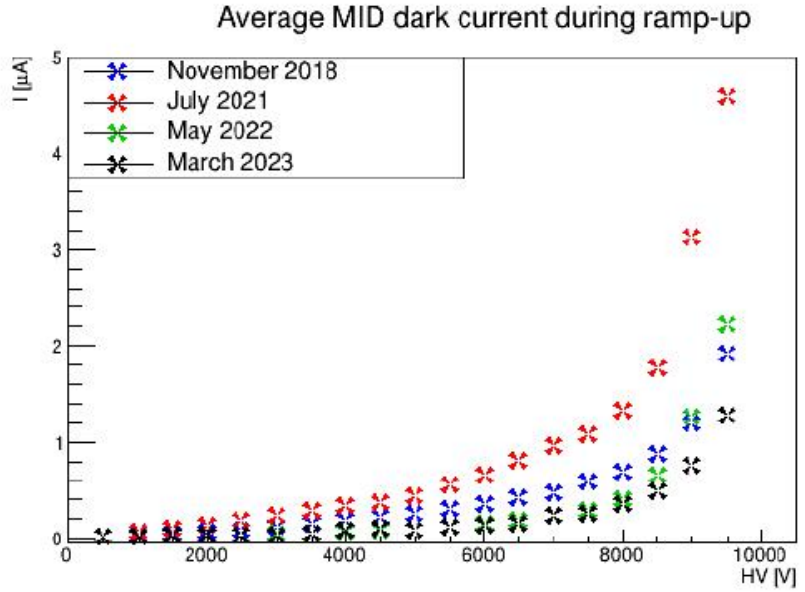
  → since during Run 1 and Run 2 the charge released per hit with ADULT was ~150 - 200 pC, then **with FEERIC ~ 35 - 50 pC is what expected**



MID YETS 2022/23 activities

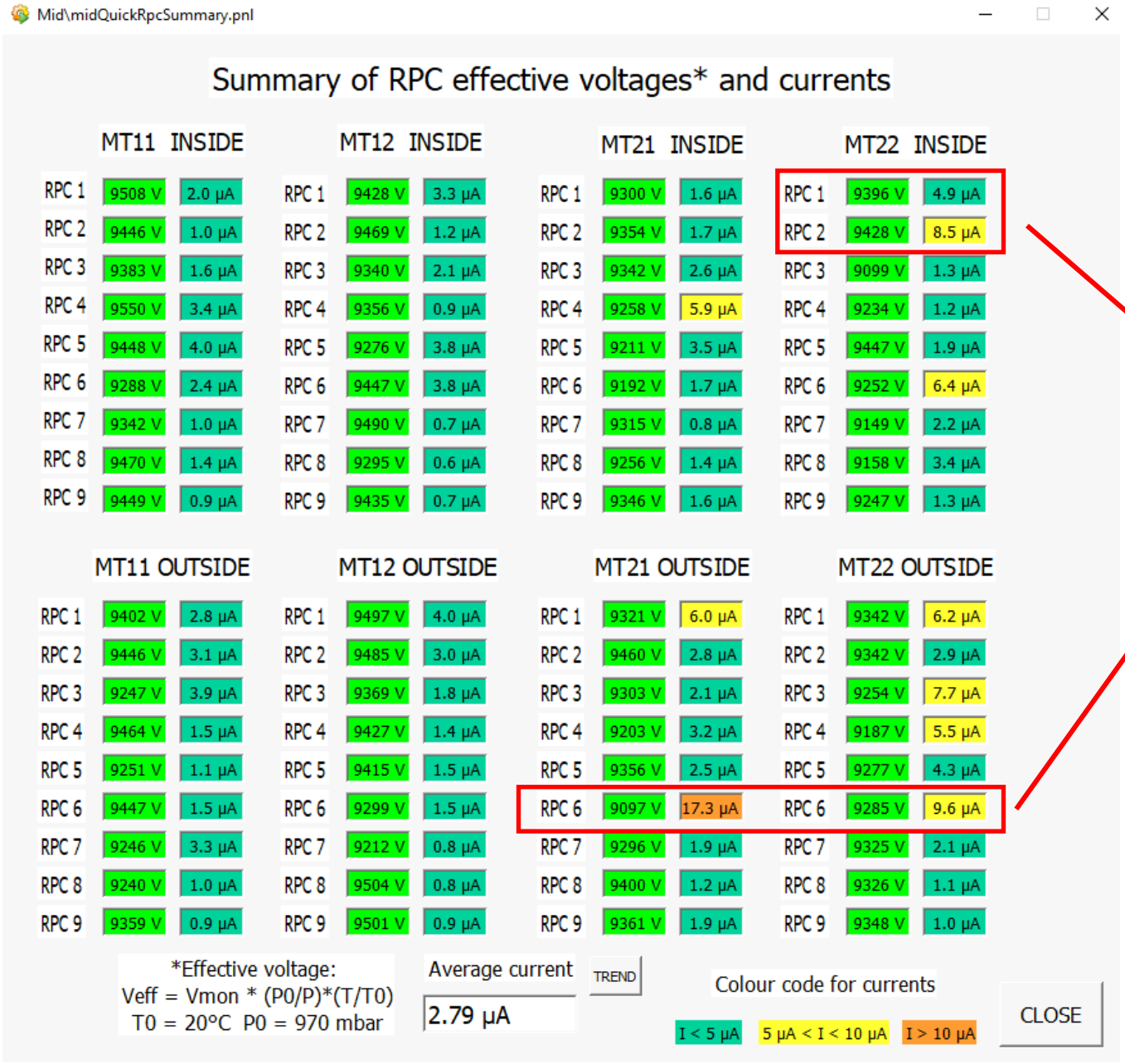
- Replacement of 4 gas gaps (the very first with the new bakelite installed in cavern):
  - 2 in December 2022, i.e. MT22IN1 and MT22IN2
  - 2 in March 2023, i.e. MT22OUT6 and MT22OUT6

- Average current value at 9500 V:
  - **1.92 µA in 2018 (end of Run 2)**
  - **4.59 µA in 2021 (first ramp-up after Run 2)**
  - **2.23 µA in 2022 (after the interventions)**
  - **1.28 µA in 2023 (after gas gaps replacement)**



- Deployment of several improvements in the online systems (mostly DCS)

RPC currents at (tentative) working point 2022



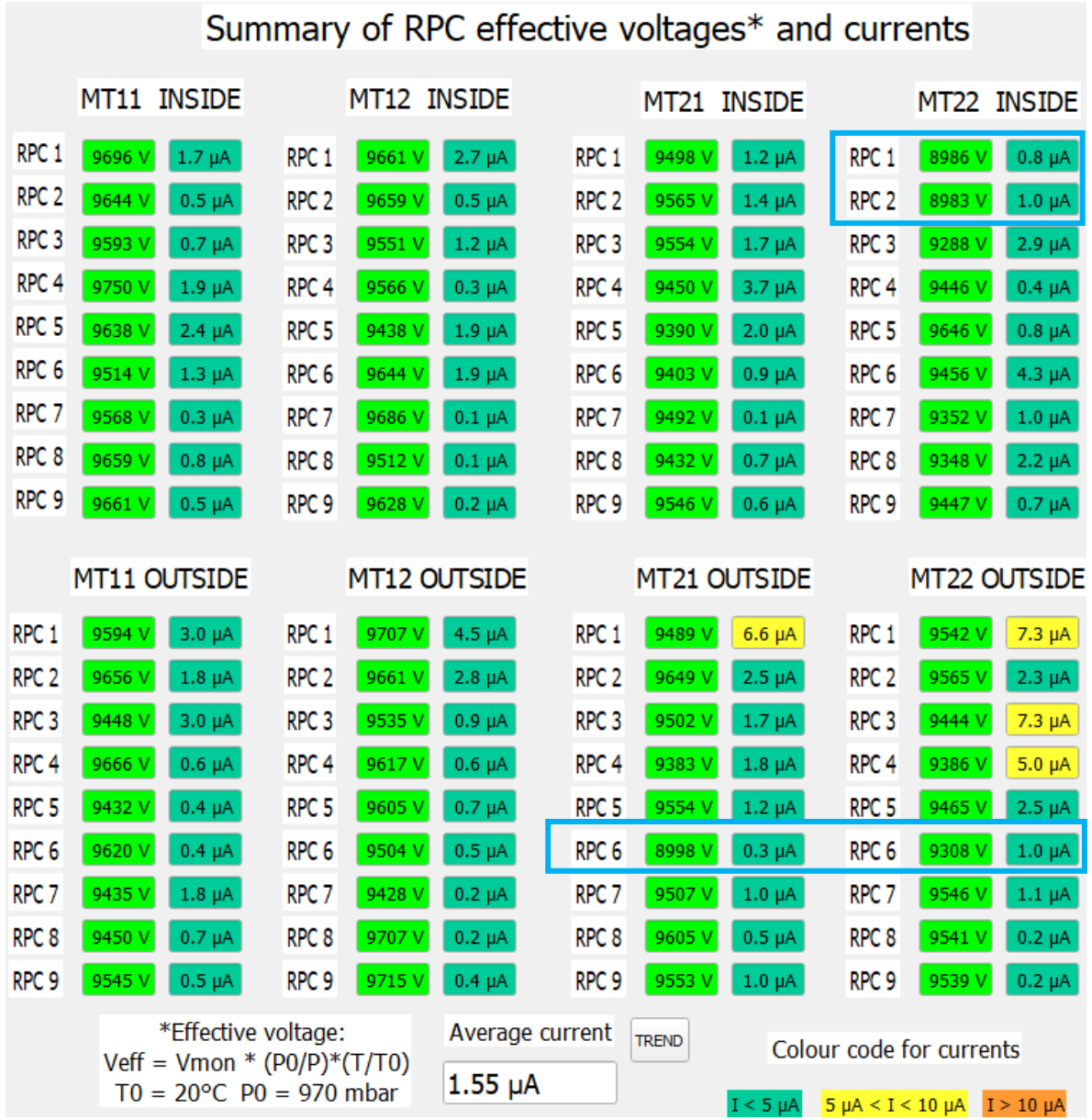
Replaced

RPC currents at (tentative) working point 2023

The performance of the 4 newly installed chambers is satisfactory:

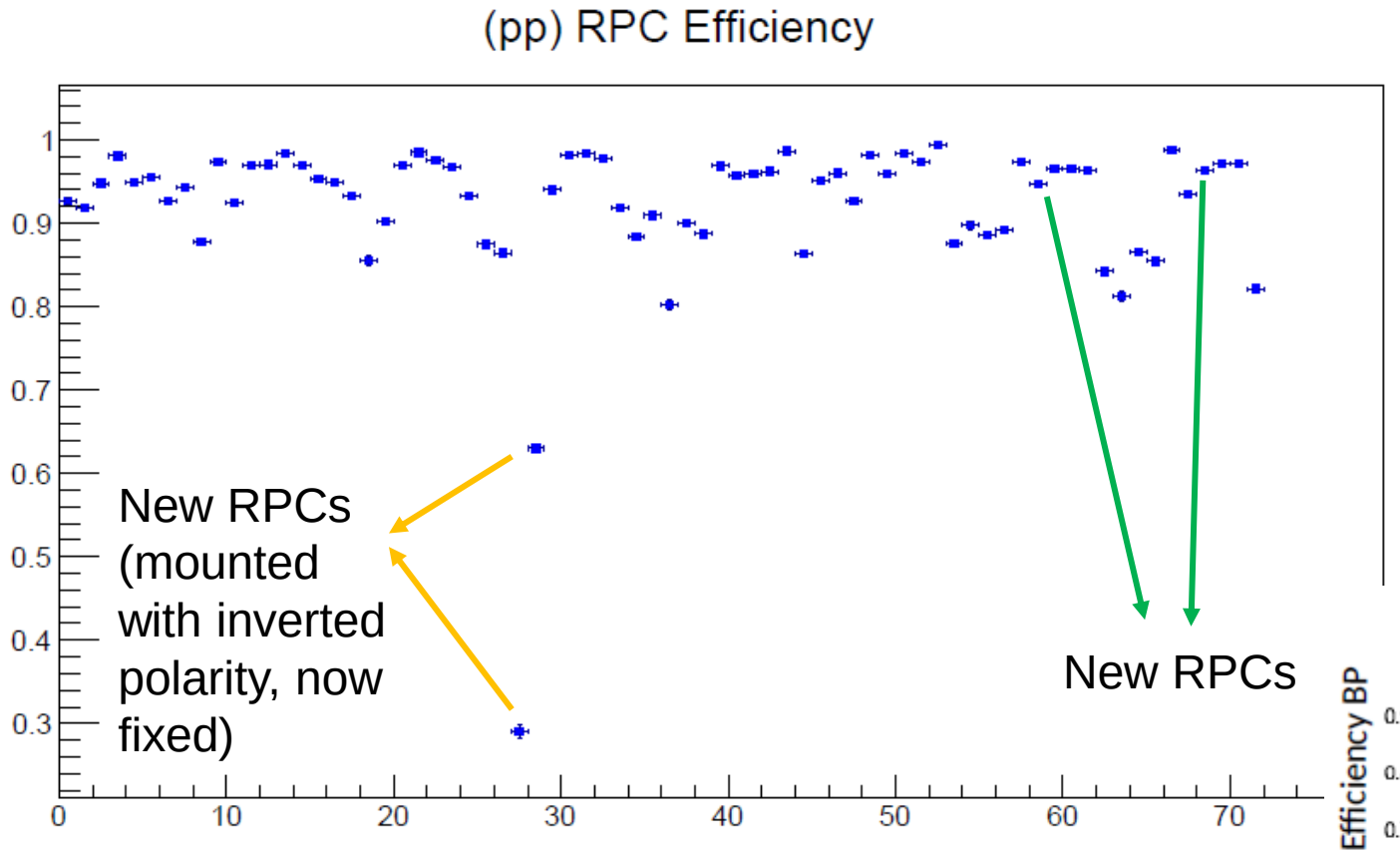
- Stable current
- Efficiency OK (see next slide)

- However, MT22_OUT6 shows noise in some spots that require strip-masking -> investigating

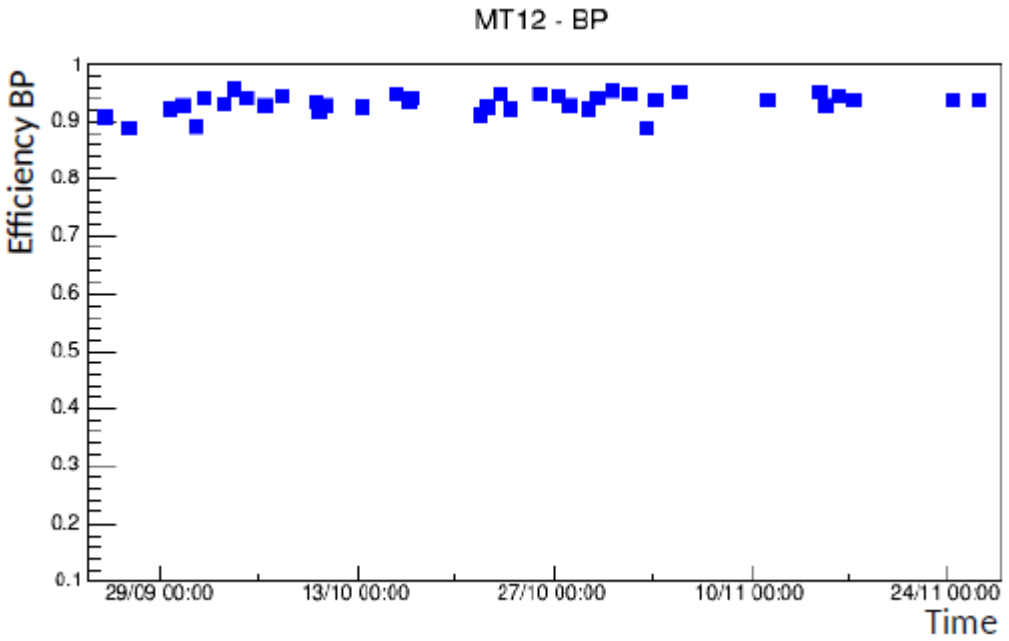


New

MID performance - Efficiency



- Efficiency better than 90% for most RPCs, and stable in time



- Caveats
  - HV/threshold not optimized yet (guessed from Run 2 working point + R&D with new FEE)
  - measurement is self-triggered -> algorithm needs tuning, geometrical biases still there

MID plans 2023-2024

2023

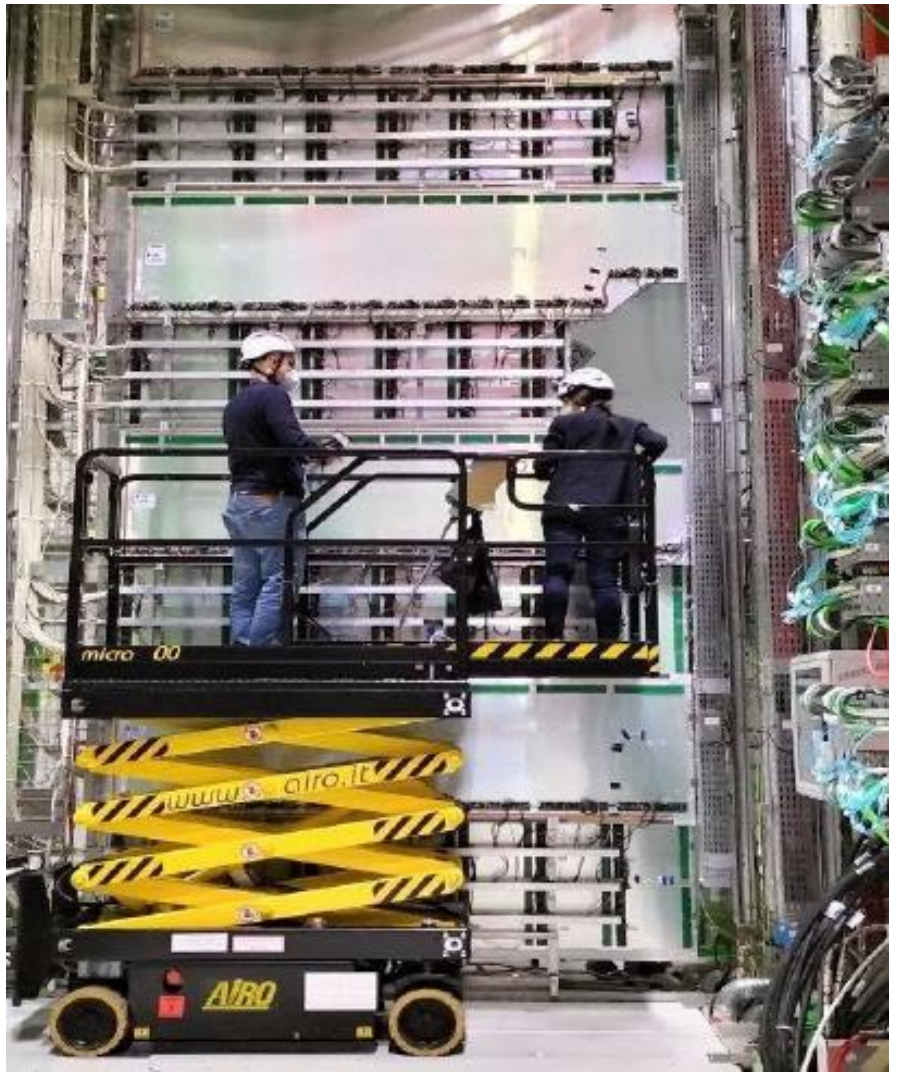
- as stable as possible data-taking with pp collisions, fine-tuning of RPC HV with the goal to be in the best possible shape for the Pb-Pb run (November 2022)
- complete tests of the new RPC batch

Winter shutdown 2023-24

- RPC maintenance + replacement of 2-4 RPCs
- New threshold distribution system

2024

- fine-tuning of thresholds
- stable data-taking with proton and heavy-ion beams
- maintenance interventions as needed



Milestones

Anno	Milestone	Compl. al 30/06/23	Commenti
2022	Partecipazione presa dati con collisioni pp e Pb-Pb	100%	
2023	Partecipazione costante e regolare alla presa dati con collisioni pp e Pb-Pb	50%	presa dati Pb-Pb ancora da svolgere, rivelatore stabilmente in presa dati
2024	Partecipazione costante e regolare alla presa dati con collisioni pp e Pb-Pb		

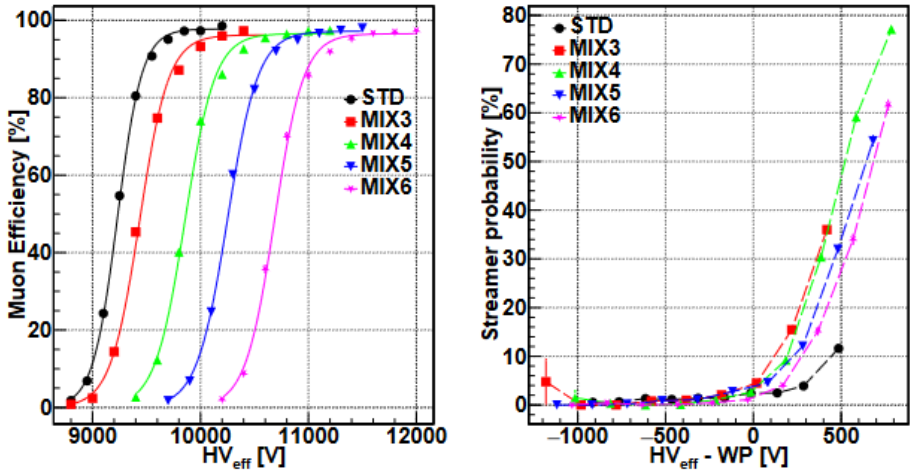
R&D on freonless gas mixtures

Investigating replacement (in Run4) of $C_2H_2F_4$
(subject to usage restrictions by EU
→ cost and availability affected)

Main candidate for replacement: $C_3H_2F_4$+CO_2

At CERN: beam and ageing tests at GIF++
in the framework of ECOgas@GIF++
collaboration (CMS, ATLAS, ALICE, SHiP, EP-DT)

In Torino: setting up a
cosmic-ray test station
devoted to new eco-friendly
mixture studies
with small prototypes



(a) Efficiency curves vs effective high voltage

(b) Streamer probability as a function of effective high voltage minus detector working point

Figure 4.42: Efficiency and streamer probability curves at source off. HFO/CO_2: 25/69,30/65,35/60,40/55 (MIX3, MIX4, MIX5, MIX6)

Richieste 2023

Richieste specifiche

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

- Partecipazione ad attività progetto Ecogas@GIF++ (beam + ageing tests)
  → 4 settimane al CERN
  → *4 kEuro missioni*

- Acquisto bombole di gas per test nuove miscele con raggi cosmici
  → *7 kEuro consumo*

+M&O-B: *36 kCHF Servizi*

Backup

More MID YETS 2022/23 activities

Readout cards:

- 5 regional card spares produced, but issues found => investigating
  - 4 out of 5 cannot bring the GBT links UP
  - 1 reg/5 can bring the GBT links UP but has stability issues

Slow control:

- Install remote power switching for AnywhereUSB => done and validated
- Configure RO electronics at SOR instead of whenever the GBT link goes down => done
  - Ensures clock is stable
  - Electronics is well configured right before data taking
- Change of run workflow => done
  - Calibration run at RAMP in SAFE
    - Brings links UP if down (~60 s)
    - Generates list of bad channels
  - Physics run => Since links are UP configuration takes ~10 s
  - Calibration at DUMP in READY => for “dark” hit rate measurements

MID M&O-B 2024

budget description	Spesa (kCHF)	Commenti
Mechanics	3	
Gas Systems	3	
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	56	
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