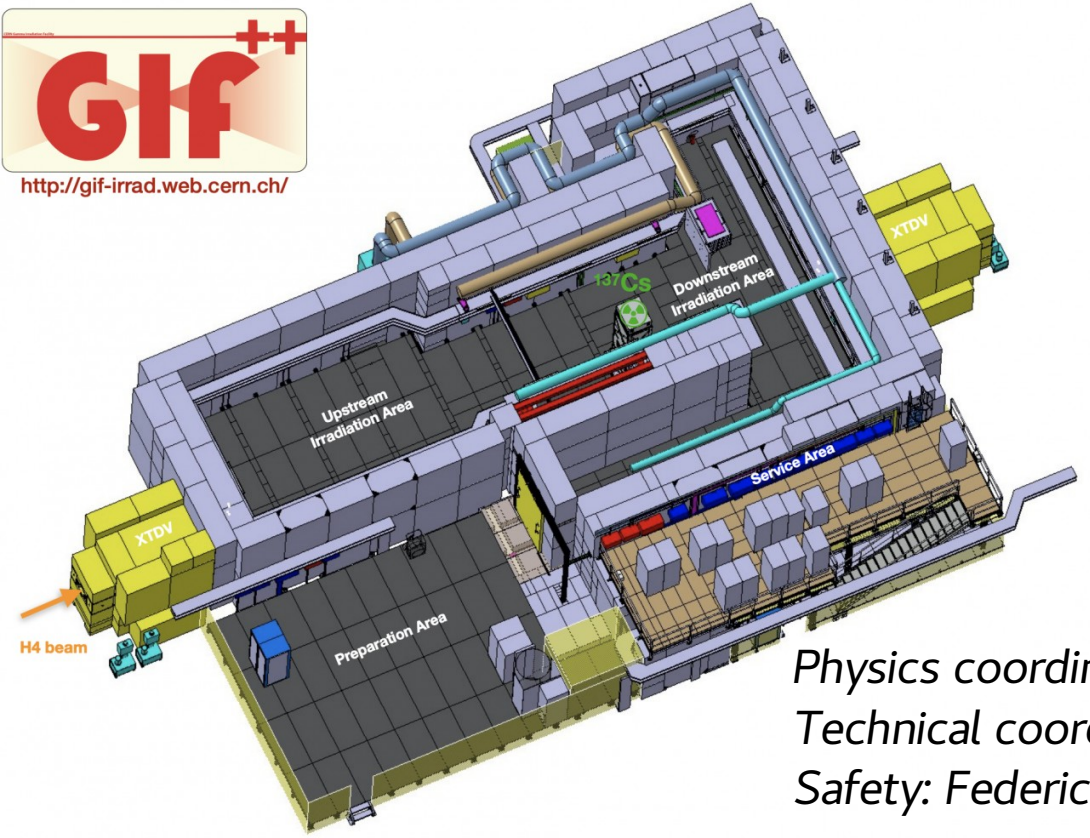
GIF++ status

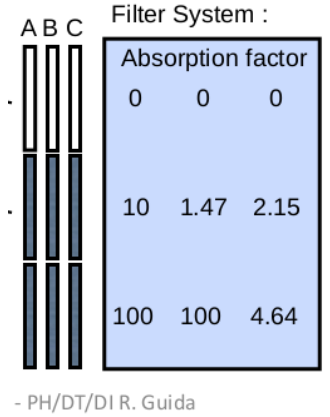
K.Kuznetsova on behalf of GIF++ Active Users

(measurements during the spring and summer TBs)

http://gif-irrad.web.cern.ch/



- ^{137}Cs source
  - ~12 TBq
  - different attenuation factors with set of filters (A*B*C) per each side independently



- PH/DT/DI R. Guida

- Muon beam of H4
  - In parallel with RD51/DRD1

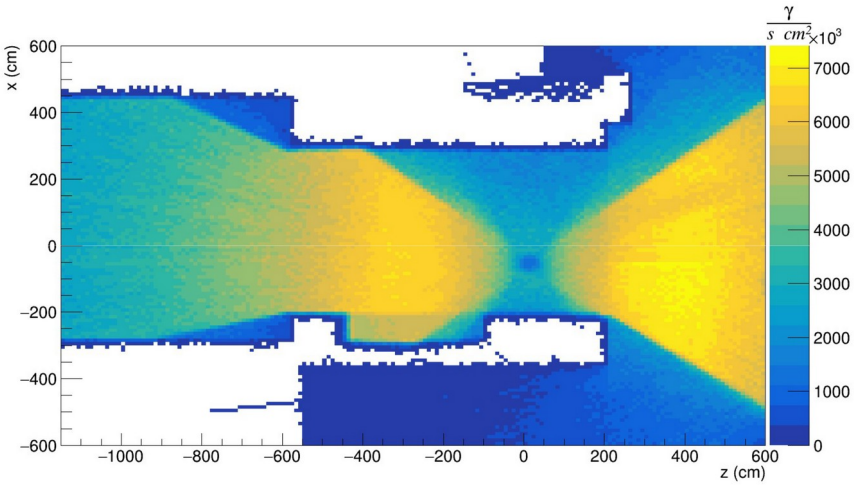
Physics coordinator: Paolo Martinengo
Technical coordinator: Giuseppe Pezzullo
Safety: Federico Ravotti

Irradiation at GIF++

- The activity of the source and the bunker length allows to perform longevity studies for HL-LHC conditions for almost all types of gaseous detectors located at the LHC experiments (ATLAS, CMS, ALICE, LHCb) in reasonable time (source attenuation factor 1-2)

Test Beam at GIF++

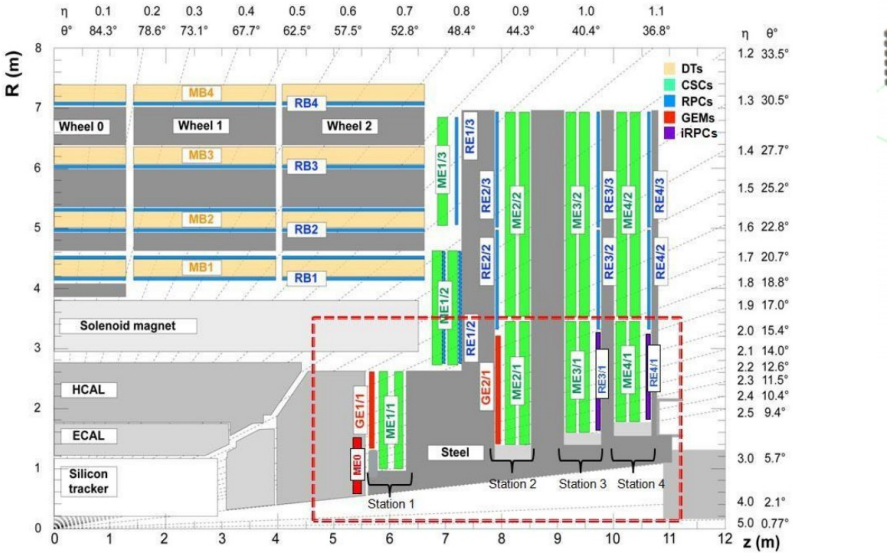
- The muon beam has about one order of magnitude less intensity wrt H4 RD51/DRD1 (O(10^4 mu/spill)) BUT
- Using the various attenuation factors of the source it is possible to emulate the realistic background conditions for HL-LHC and other future experiments (for example, CBM)



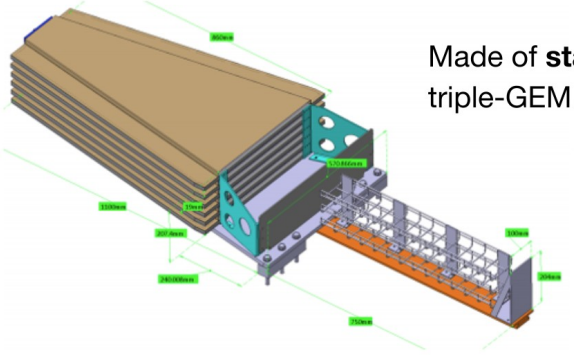
From **talk by Nicola Ferrara**

CMS Phase-2 GEM upgrade: ME0 station

Antonello Pellecchia

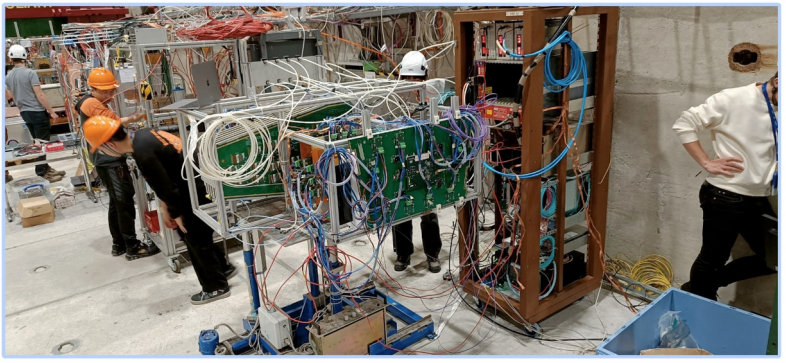


ME0 system: complementing and extending the CMS Muon system acceptance up to $|\eta| = 2.8$



Made of **stacks** of six triple-GEM detectors

Setup of ME0 test beam in April 2024 on H4 line



So far we have:

- Measured the **rate capability** of the ME0 detectors in GIF++ with a 4-layer stack

  Acceptable (~2.5%) efficiency loss at 250 kHz/strip

- Measured the **muon segment timing** with a 6-layer stack on H4 line

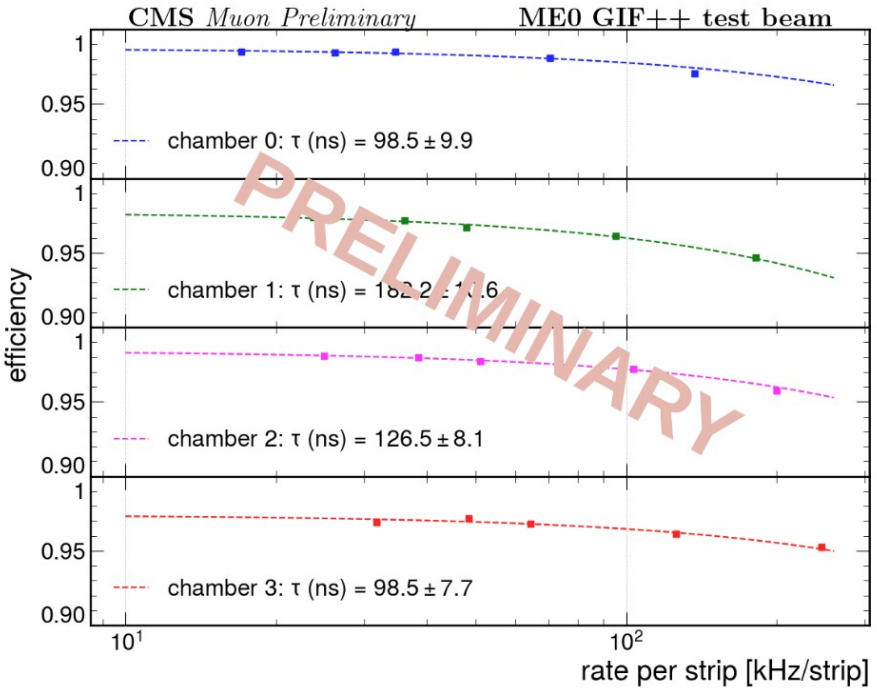
  Good BX identification (< 4 ns)

What we want to do in GIF++ in June/July 2024:

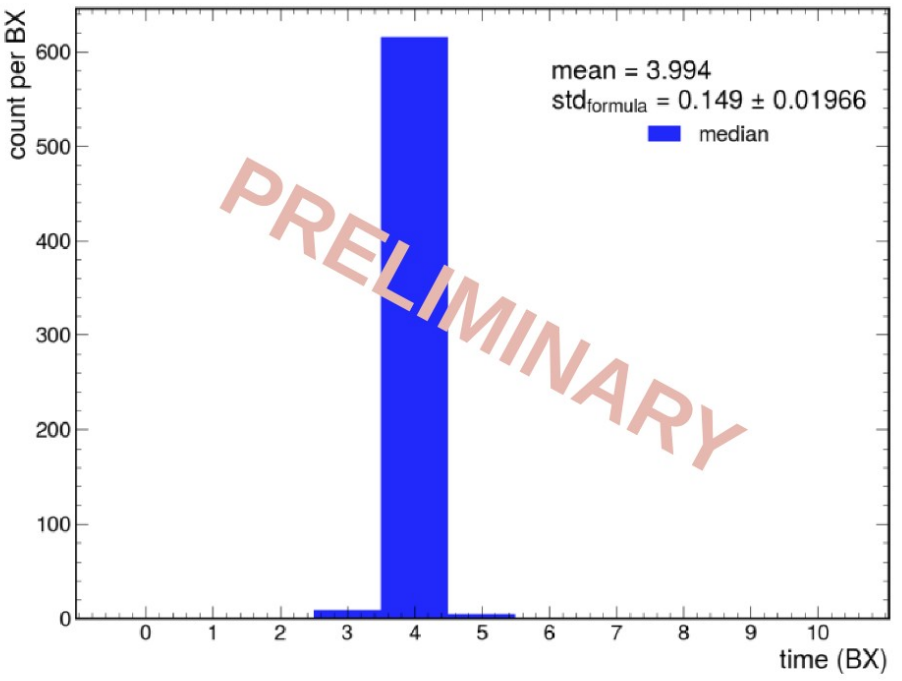
- Measuring the segment timing and rate capability in **high background** with a 6-layer stack

CMS Phase-2 GEM upgrade: ME0 station

Antonello Pellecchia



Rate capability of 4 ME0 detectors in GIF++



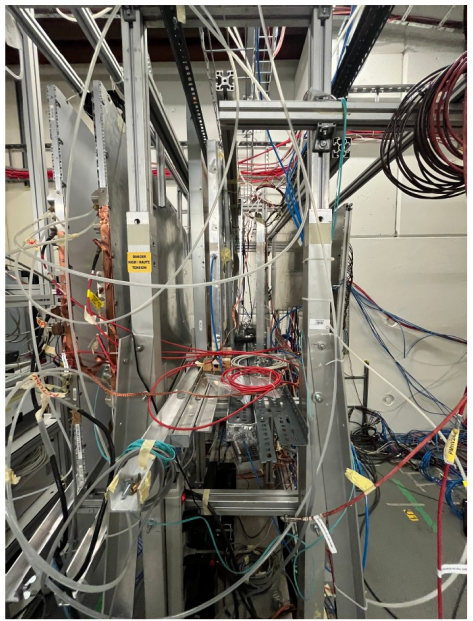
ME0 segment timing with 6-layer stack

Stefania Juks

Test Beam April 2024

Campaign Overview

EP-DT Chamber for the ECOGAS Collaboration



- In total, 6 runs of data were acquired for the 2mm HPL-RPC over 2 weeks
  - Standard Gas Mixture: 95.2% R-134a + 4.5% i-C_4H_{10} + 0.3% SF_6 —> x2
  - ECO2: 60% CO_2 + 35% R-1234ze + 4% i-C_4H_{10} + 1% SF_6 —> x2
  - ECO3: 69% CO_2 + 25% R-1234ze + 5% i-C_4H_{10} + 1% SF_6 —> x2
- Data was taken for Source Off and 5 upstream filters: ABS 100, ABS 69, ABS 22, ABS 10, ABS 6.9

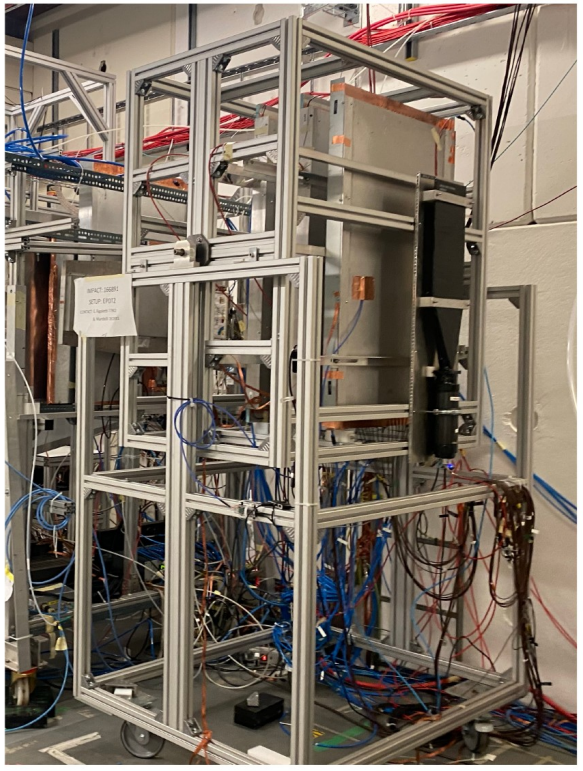
Summary

- Successful test beam campaign to observe the difference in performance between ECO2 and ECO3.
- Performance check compared to the last year's test beam data, following a period of irradiation.
- The detector continued its ageing campaign and will be involved in the next test beam.

Test Beam July 2024

Campaign Plans

EP-DT Chambers



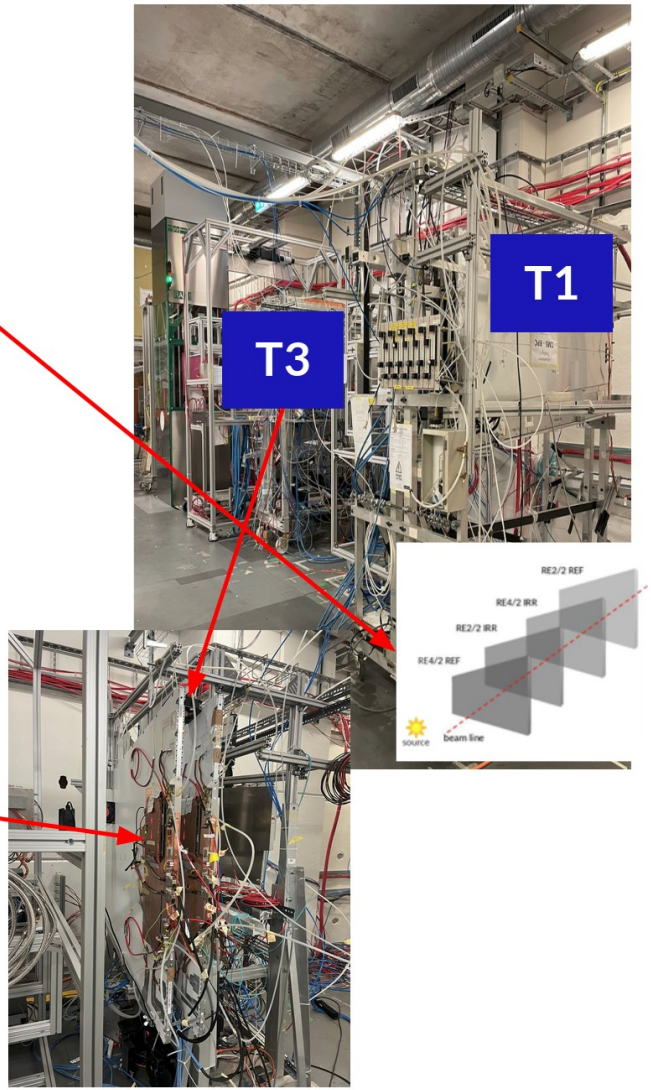
- Participate again with the 2mm HPL-RPC chamber for the ECOGAS collaboration to repeat the measurements of the April Test Beam for the three gas mixtures: STD, ECO2, ECO3.
- Participate with 4, 2mm HPL-RPC chambers from EP-DT to test:
  - The addition of CO_2 to the standard RPC gas mixture (30%, 40%).
  - Performance validation after an irradiation period.
  - Further improvements to the current ATLAS CO_2-based gas mixture
  - These tests will allow us to understand the status of the mixture currently in use in ATLAS and investigate other mixtures that would reduce the R-134a consumption and equivalent emissions of the mixture.

April 2024 Test Beam

- Longevity chambers in T1: Existing RPC chambers in CMS longevity with existing gas mixture
  - Integrating charge since 2016
  - Efficiency/current scans every Test Beam

- R&D on alternative gas mixtures in T3: Existing RPC and iRPC prototypes tests with eco friendly gas mixtures
  - iRPC prototypes:
    - Performance of HFO based mixture and CO2 based mixture with around 40 mC/cm2 integrated charge (started last year)
  - RPC chamber:
    - Performance of HFO based mixture every test beam

- Improved RPC chambers in T3: iRPCs for Phase-2 upgrade of CMS
  First mass production chambers (2) tested with final Front-end version and Back-end electronics with HL-LHC background levels
  - Trigger primitive studies



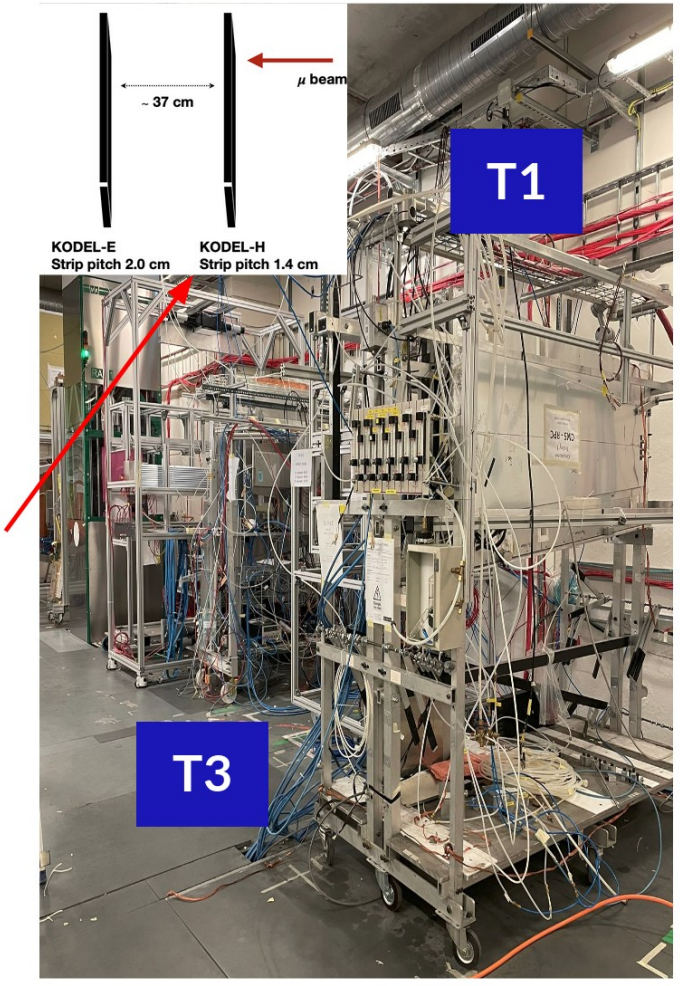
Joao Pinheiro

June/July 2024 Test Beam

- Longevity chambers in T1: Existing RPC chambers in CMS longevity with existing gas mixture
  - Integrating charge since 2016
  - Efficiency scans every Test Beam

- Alternative gas mixtures in T3: Existing RPC and iRPC prototypes tests with alternative gas mixtures
  - iRPC prototypes:
    - Timing resolution measurements with 2 identical chambers + tracking for HFO and CO2 based mixtures
  - RPC chamber:
    - Performance of HFO based mixture every test beam

- Improved RPC chambers in T3: iRPCs for Phase-2 upgrade of CMS
  - More mass production chambers performance with final Front-end version, latest firmware features and uTCA based Back-end electronics
  - Trigger primitive studies



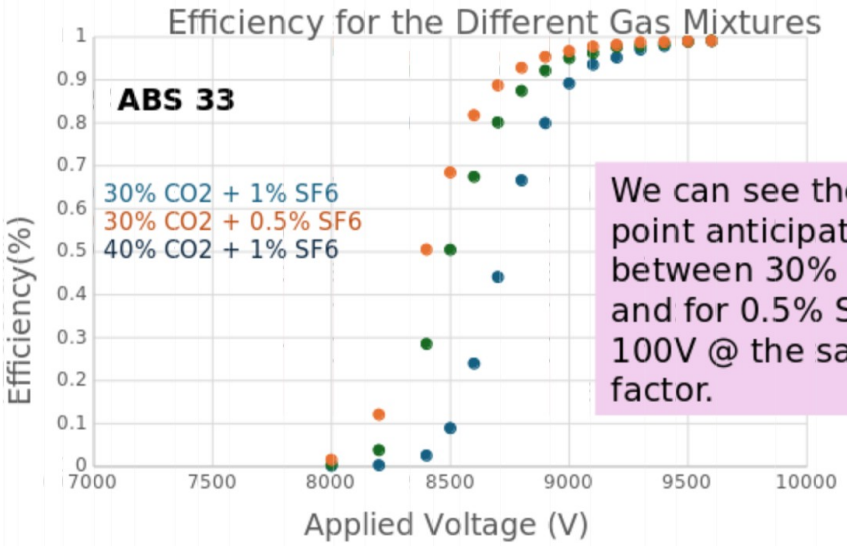
Sinem Simsek

ATLAS RPC Performance with Additional CO2

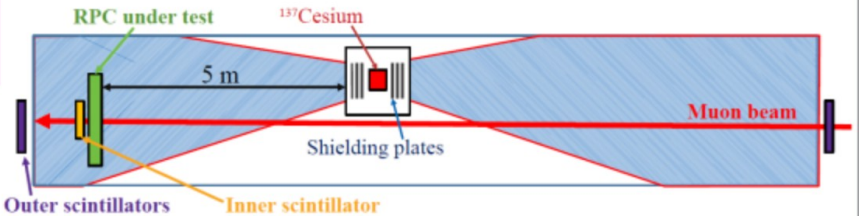
50 cm x 50 cm old (~20 years) ATLAS–RPC type doublet is used for the test

Gases:
Standard Gas Mixture: 0% CO2, 5% C4H10, 0.3% SF6 and 94.7% C2H2F4
30% Co2 Mixture: 30% CO2, 5% C4H10, 1% SF6 and 64% C2H2F4
40% Co2 Mixture: 40% CO2, 5% C4H10, 1% SF6 and 54% C2H2F4
0,5% SF6 Gas Mixture: 30% CO2, 5% C4H10, 0.5% SF6 and 64.5% C2H2F4

- The standard gas mixture of RPCs but has a very high GWP and the present leak rate is about 1000 l/h
- A method to provide an immediate reduction of the R134a equivalent emissions is to replace a fraction of R134a with a filler with adequate features
- The most obvious candidate is CO2 which was already added to ATLAS RPCs during LS2 (2021) as a solution to save R134A and allow HV operation for debugging
- We test the RPC behaviour while immersed in the photon background for which the RPC sensitivity is very low (about 0.3%)
- We consider the current induced by the photons as a function of the MIPS working point

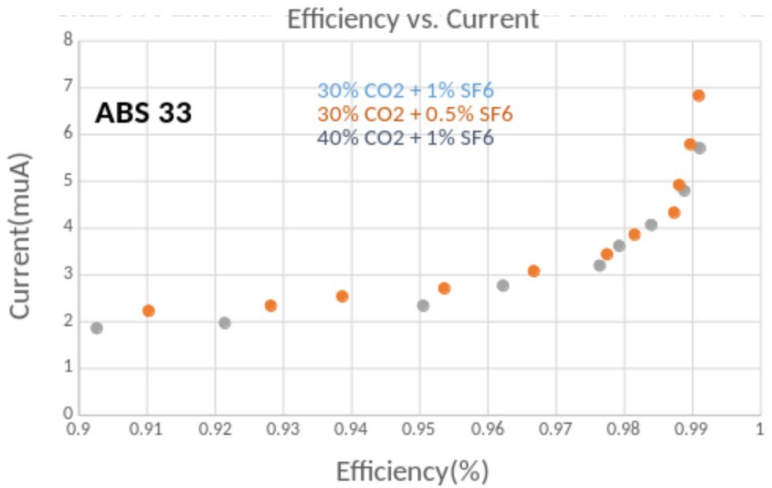


We can see the working point anticipation of 200 V between 30% - 40% CO2, and for 0.5% SF6 less than 100V @ the same ABS factor.

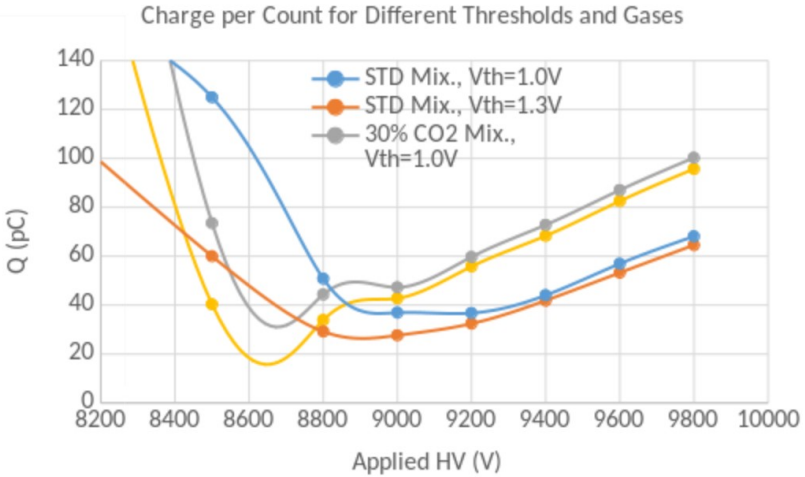


Sinem Simsek

ATLAS RPC Performance with Additional CO_2



For 40% CO2+ 1% SF6 and 30% CO2+ 0.5% SF6 gas mixtures @ same ABS factor, It was observed that the current is increasing by ~20% wrt. our gas of ageing, 30% CO2+ 1% SF6 .



For 30% CO2, the charge per count is 30% higher wrt STD gas mix. This is due to the presence of an higher amount of undetected photons (less counts).

- Ageing test is almost done with the mixture 30% CO_2 + 1.0 % SF6
- It can reduce the emissions by 16% with respect to the Standard gas mixture
- We integrated almost 60% of maximum expected charge without observing negative effects depending on the mixture up to now
- After the July test beam, a new ageing with 30% CO_2 + 0.5% SF6 will be started
- The test also will continue as a long term test with additional detectors, including 1mm gas gaps

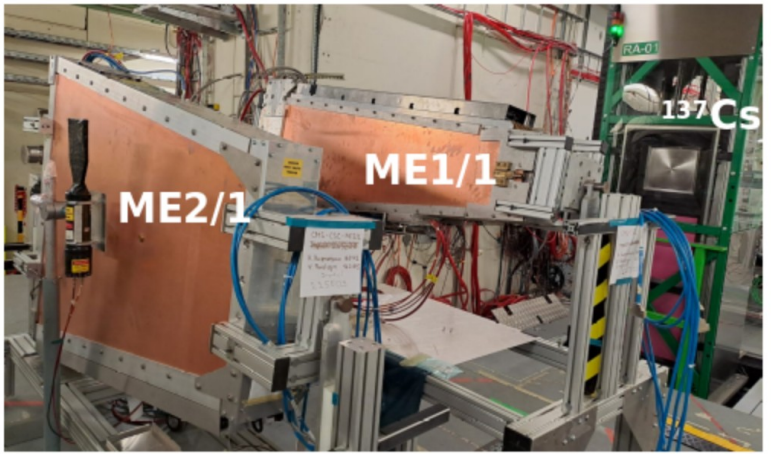
Victor Perelygin

CMS Cathode Strip Chamber Longevity Study @ GIF++

Goal: longevity studies with the nominal and reduced CF_4 content

Irradiation setup: ME1/1 and ME2/1 CSCs exposed with the 12 TBq ^{137}Cs gamma source at the GIF++ Facility (HV-ON on 4 layers and HV-OFF on 2 layers kept as reference).

Measurements: during inrradiation (basic) and during TB (performance in realictic conditions)

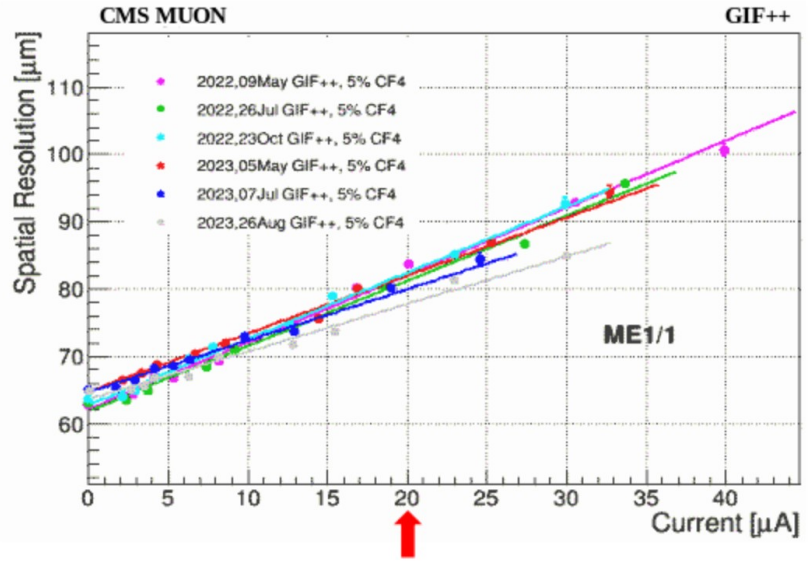


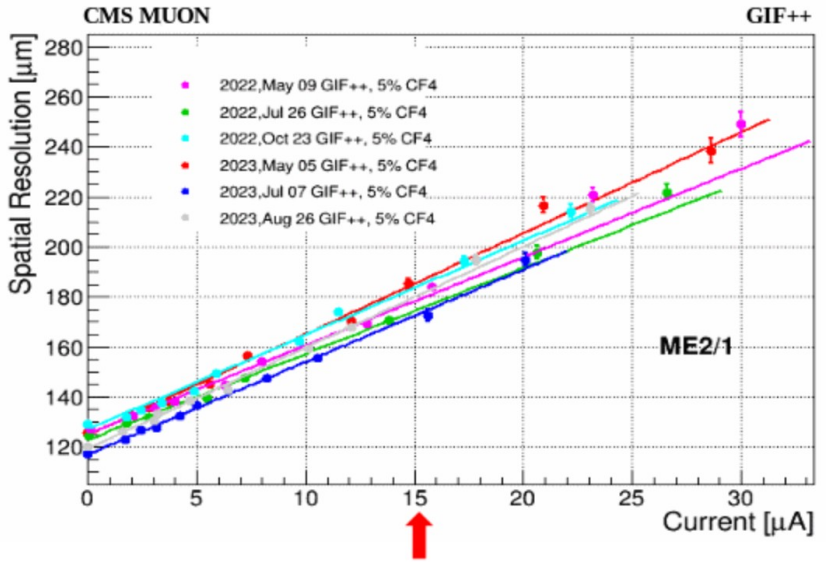
Accumulated charges before each TB

CSC	HL-LHC Expected (3000 fb^{-1}) mC/cm*	Accumulated charge Q (mC/cm)						
		before 2018	Nov.-2021	Oct.-2022	May-2023	19.07.23	25.08.23	30.04.24
ME1/1	200	330 (10% CF_4)	700 (2% CF_4)	725 (5% CF_4)	770	790	800	845
ME2/1	130	310 (10% CF_4)		420 (5% CF_4)	530	570	620	745

Victor Perelygin

CSCs spatial resolution study: μ beam with GIF++ filter scan.





Spatial resolution of ME1/1 (left) and ME2/1 (right) vs mean CSC layer current with 5%CF4 gas mixture. The measurements are performed with a muon beam, ^{137}Cs source is used to emulate the background at the experiment. The results are corrected for atmospheric pressure variation. The CSC current is used as the background intensity measure. The spatial resolution degrades linearly with the layer current increase. The HL-LHC background condition for L=5*10^{34}Hz/cm^2 corresponds to ME1/1 layer current of 20 μA, while for ME2/1s1 - 15 μA.

Summary

- GIF++ is a unique facility for longevity studies

- Longevity studies with high intensity ^{137}Cs
  - Ongoing CMS-RPC, CMS-CSC, ECOGAS, ATL-MM,...

- Unique combination beam+source
  - To emulate realistic BG occupancy for performance studies
  - To monitor detector performance as a function of the accumulated charge for longevity studies
    - This defines the traditional preference of spring-summer-autumn for the testbeam periods

- Very friendly, flexible and prompt user community

- Very friendly and prompt gas system support

- Outstending management and technical coordination