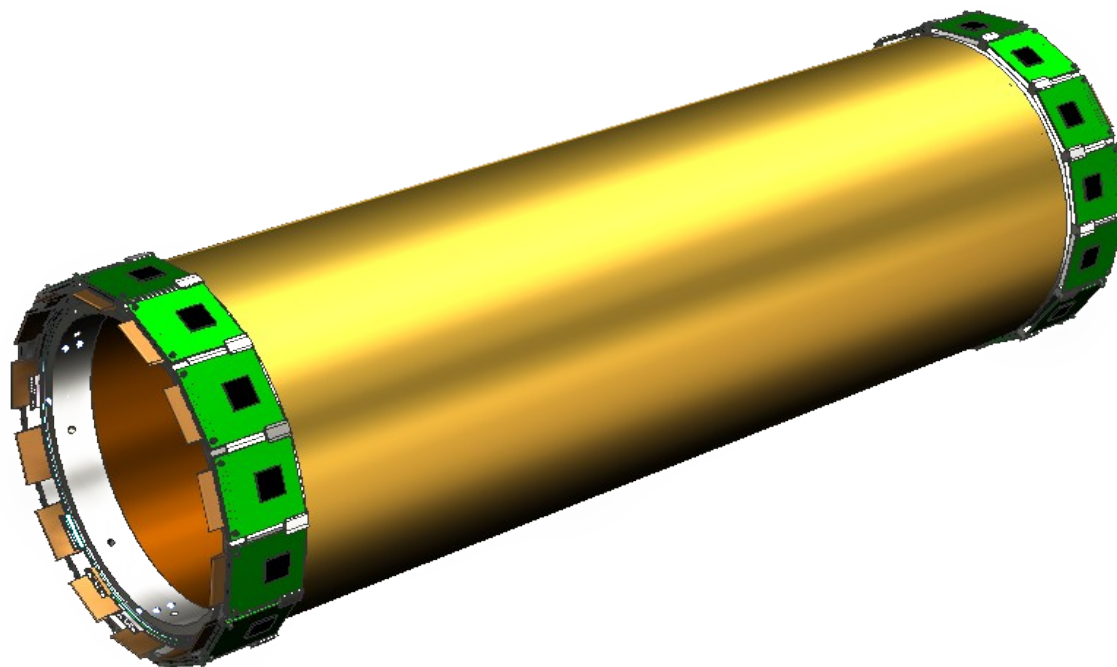


BESIII



# A Cylindrical GEM detector for BESIII Experiment

Riccardo Farinelli

University of Ferrara – INFN Ferrara



# Outline

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- BESIII experiment and aim
- CGEM project: completed the construction of a cylindrical layer
- Electrical test
- The first data acquisition with cosmic rays



# The BES III experiment

Drift Chamber:  
120  $\mu\text{m}$  resolution in  $r\text{-}\phi$  plane  
 $dp/p \sim 0.5\%$  at 1 GeV/c

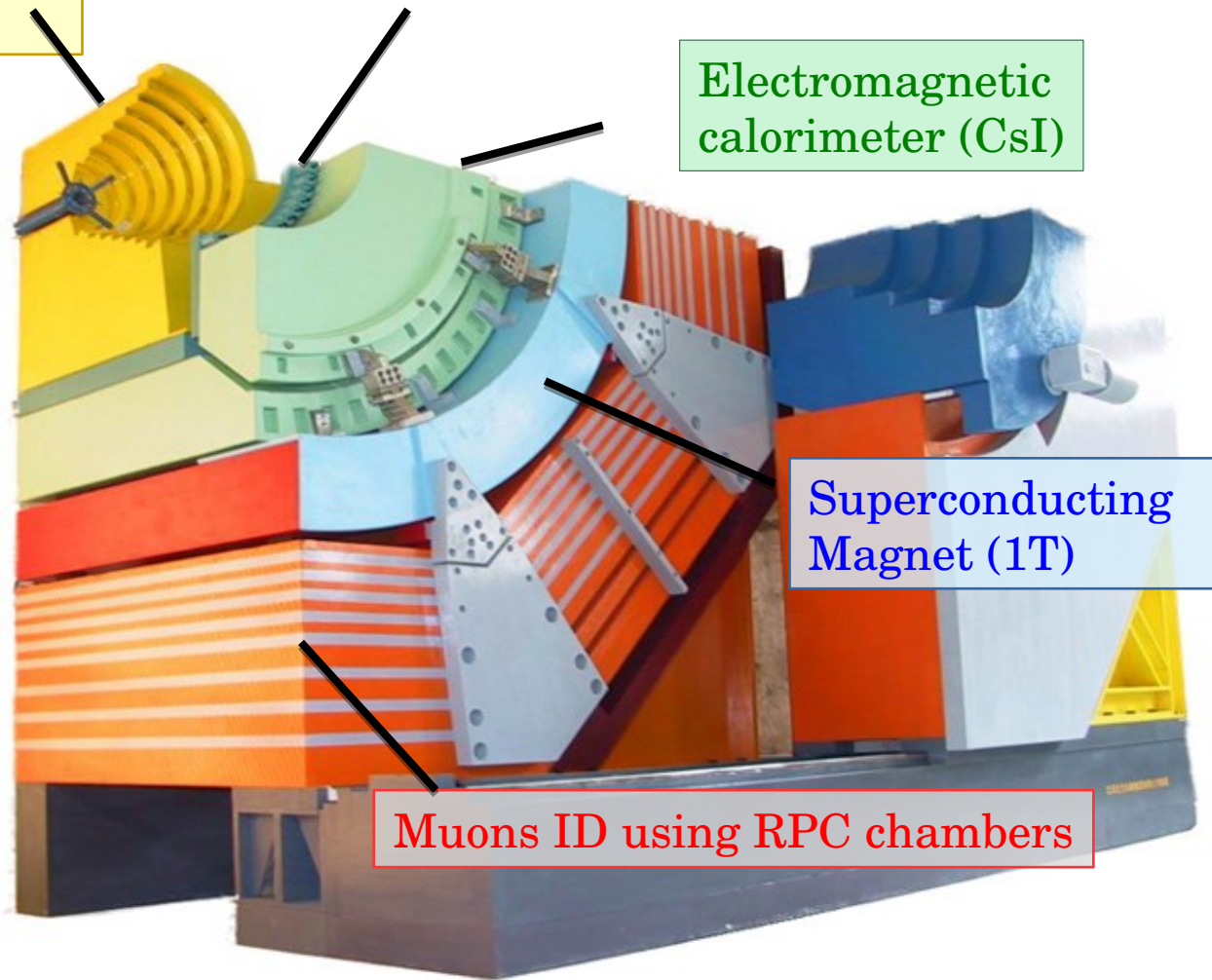
PID using time of flight technique

Electromagnetic  
calorimeter (CsI)

Superconducting  
Magnet (1T)

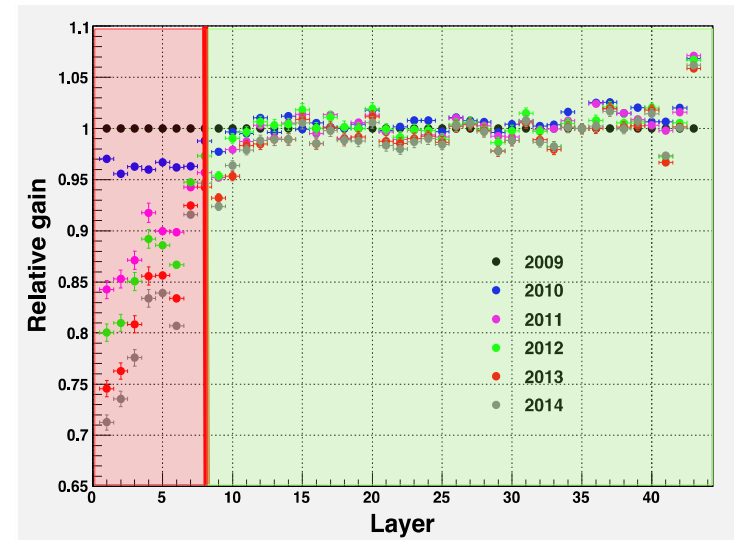
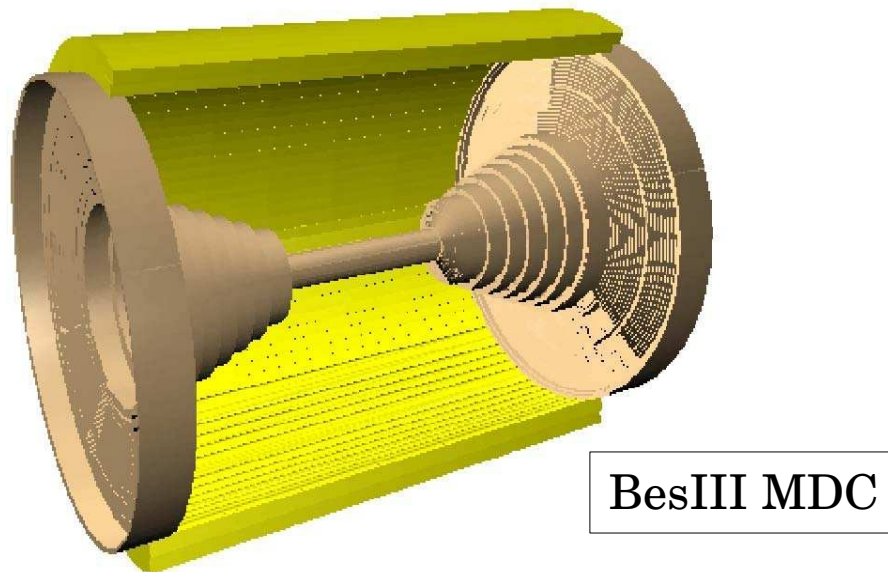
Muons ID using RPC chambers

- Angular coverage:
  - 93% of  $4\pi$  for the tracking system
  - 95% of  $4\pi$  for the calorimeter
- ~40,000 readout channels
- Data rate: 5 kHz, 50 Mb/s



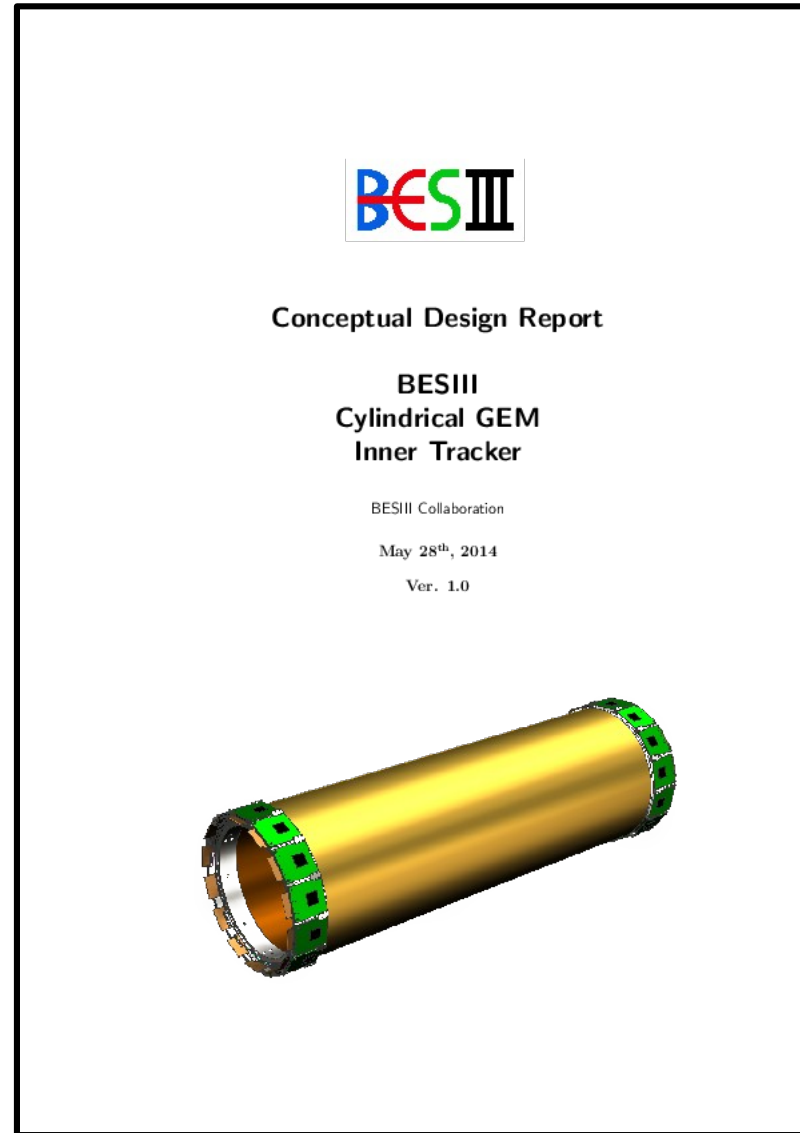
# Drift chamber aging

- MDC tracks low momentum particles and performs momentum and  $dE/dx$  measurement to identify charged particles
- Spatial resolution is  $120\ \mu\text{m}$  in  $r-\phi$  plane and  $2\ \text{mm}$  in the  $z$ -coordinate
- Inner and Outer MDC are two separate chambers sharing the same gas volume



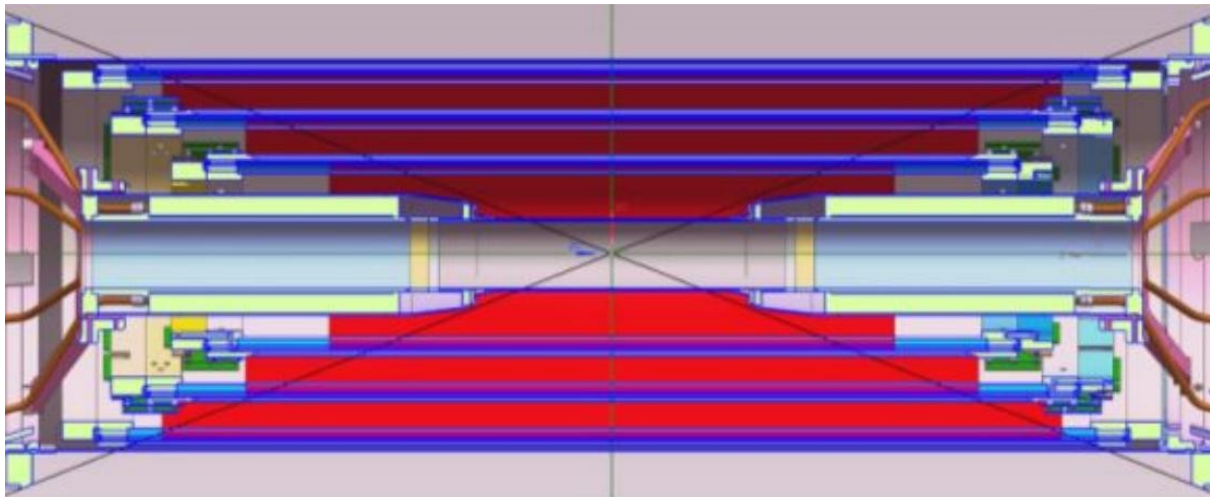
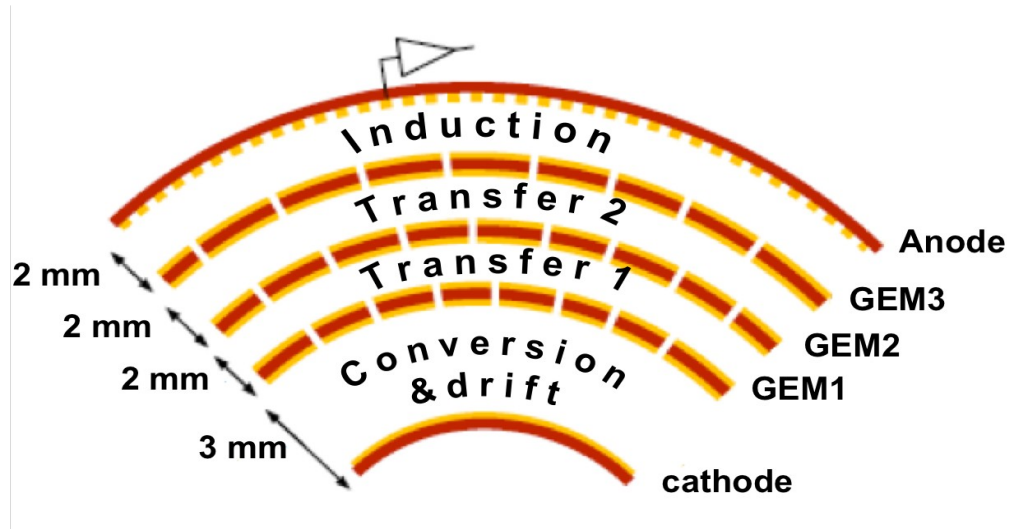
# CGEM proposal

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# A CGEM based Inner Tracker

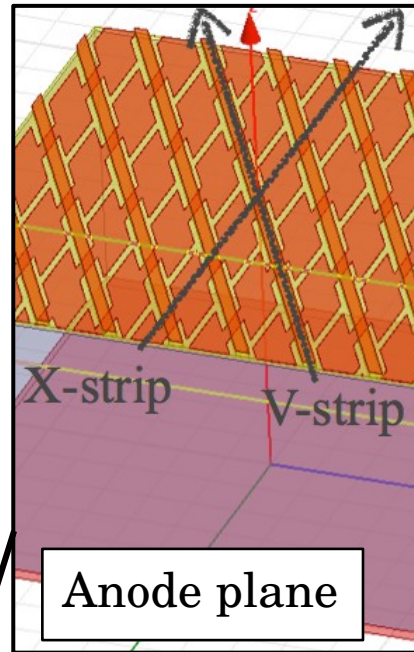
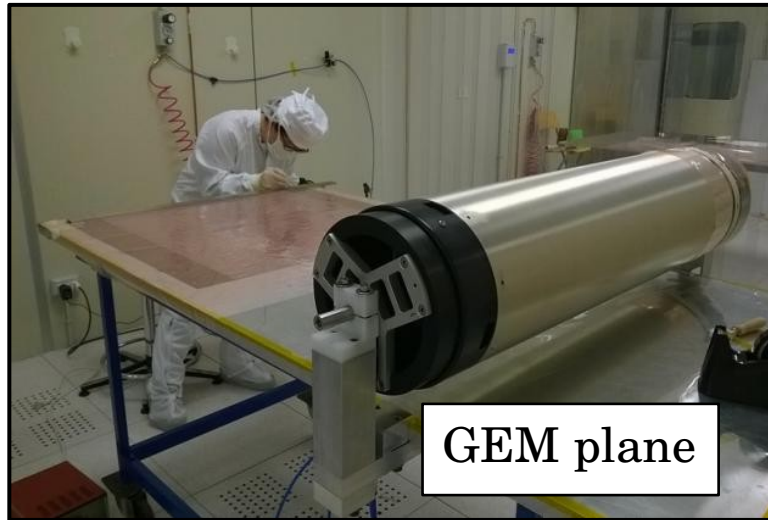


## BESIII requirements

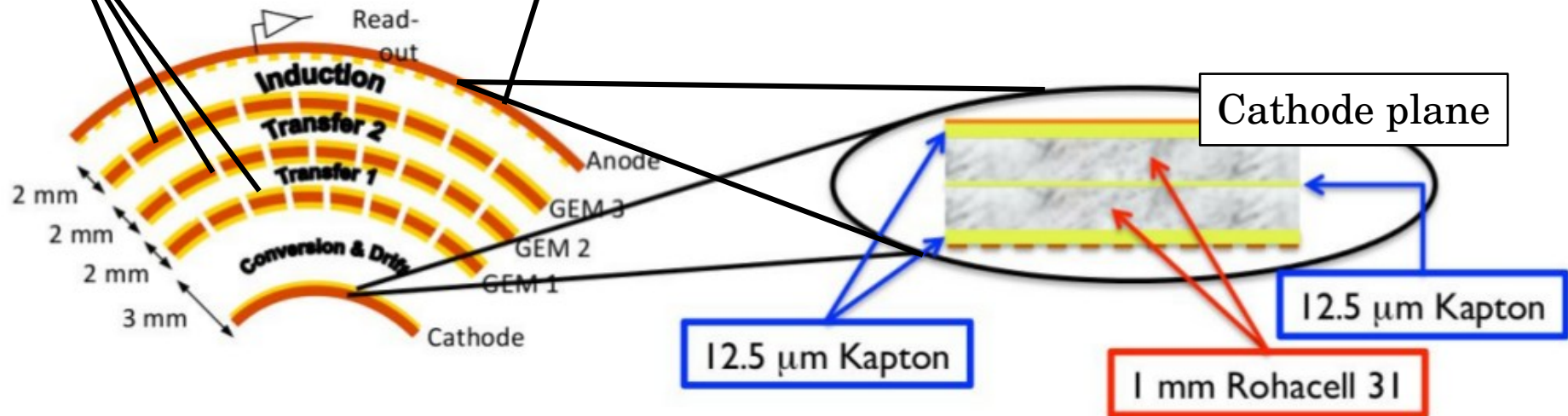
- Rate capability:  $\sim 10^4$  Hz/cm<sup>2</sup>
- Spatial resolution:  
 $\sigma_{r-\phi} = \sim 130 \mu\text{m} : \sigma_z = \sim 1\text{mm}$
- Momentum resolution:  
 $\sigma_{pt}/P_t = \sim 0.5\% @ 1\text{GeV}$
- Efficiency =  $\sim 98\%$
- Material budget  
 $\leq 1.5\% X_0$  in all layers
- Coverage:  $93\% 4\pi$
- 1 Tesla magnetic field



# Electrodes composition



- Each electrode can be shaped to the cylindrical form
- Cathode and anode have a mechanical support made by a rohacell structure
- The anode readout is due by stereo strips with jagged layout



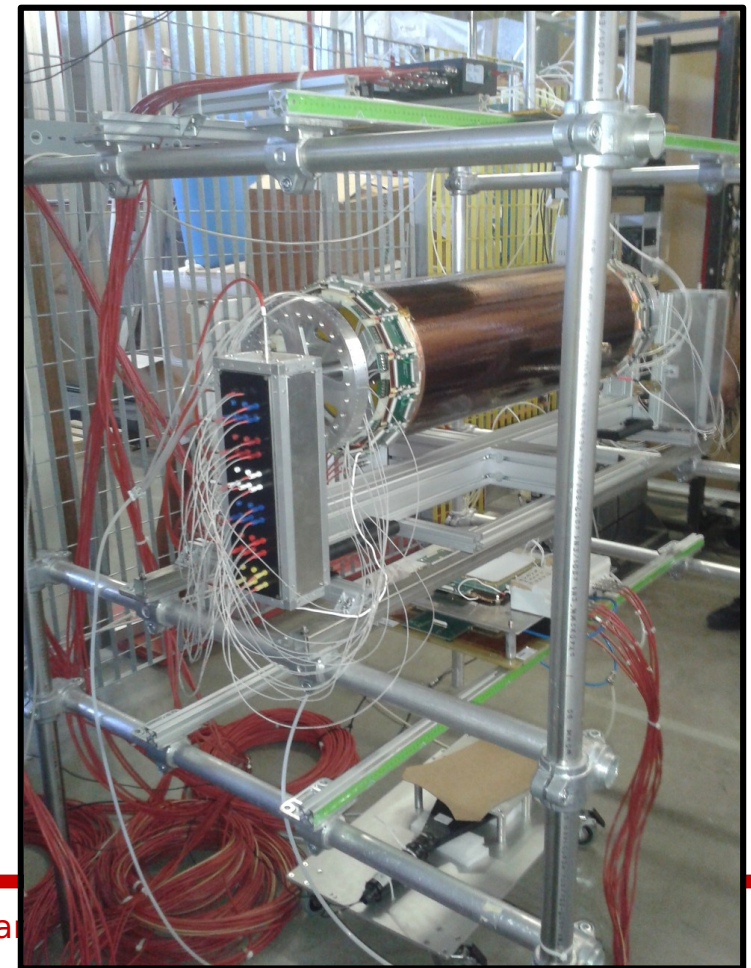
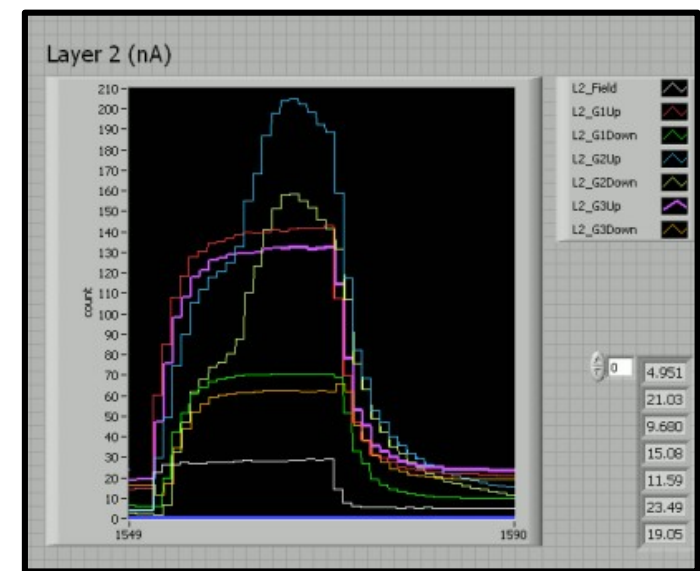
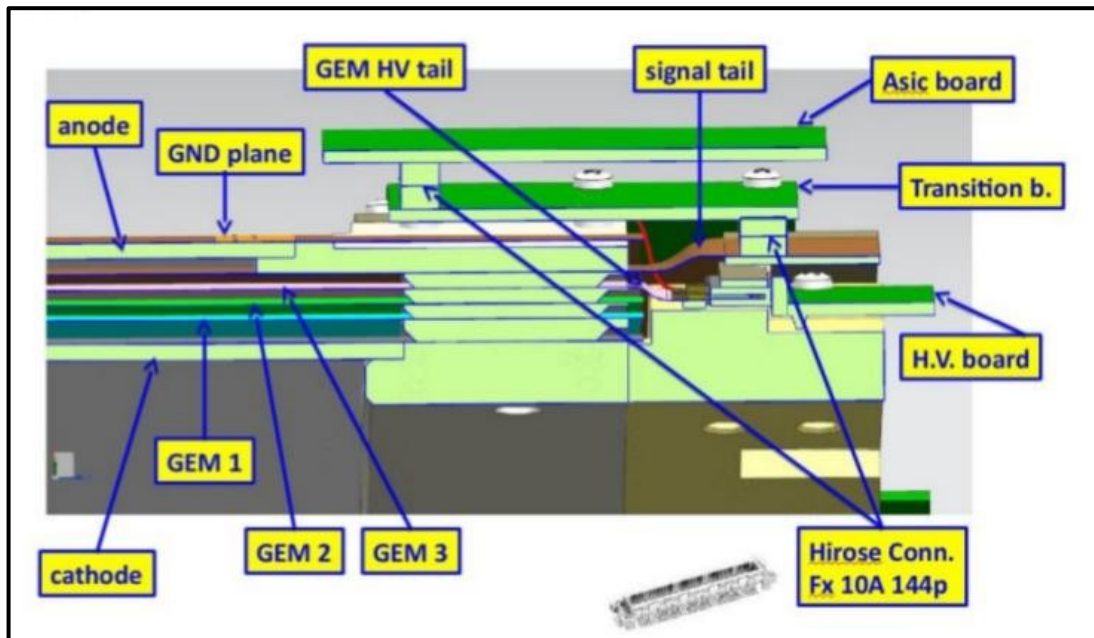
# Assembly





# Test: electric system

- Before the assembly each electrode has been tested: dark current of  $\sim$ nA and low discharge rate
- After the assembly no shortcut is present then we turn on the CGEM measuring  $\sim$ 100nA during the conditioning
- Where the electrical stability is reached a current of 5-30 nA on the electrodes is measured. The current is stable and no discharge have been measured



# Cosmic ray test

## Setup:

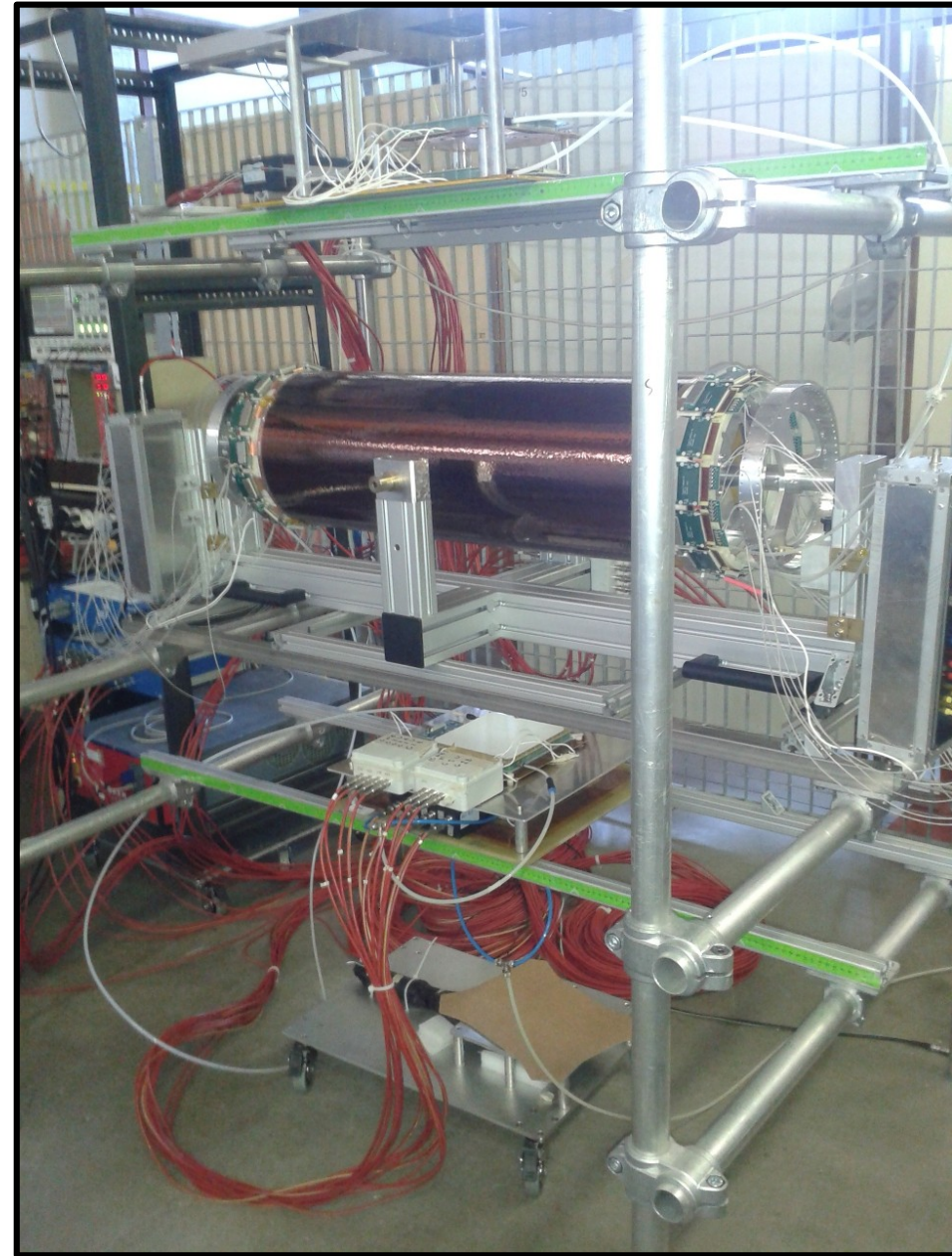
- 4 planar tripleGEM for the tracking system
- 1 cylindrical GEM to test

## Data acquisition:

- About 2 week of data acquisition
- APV25 and SRS have been used

180 strips are instrumented for each side of the cylinder to collect data from the top and the bottom side.

Only longitudinal strips are considered for the test.





# Cosmic ray test

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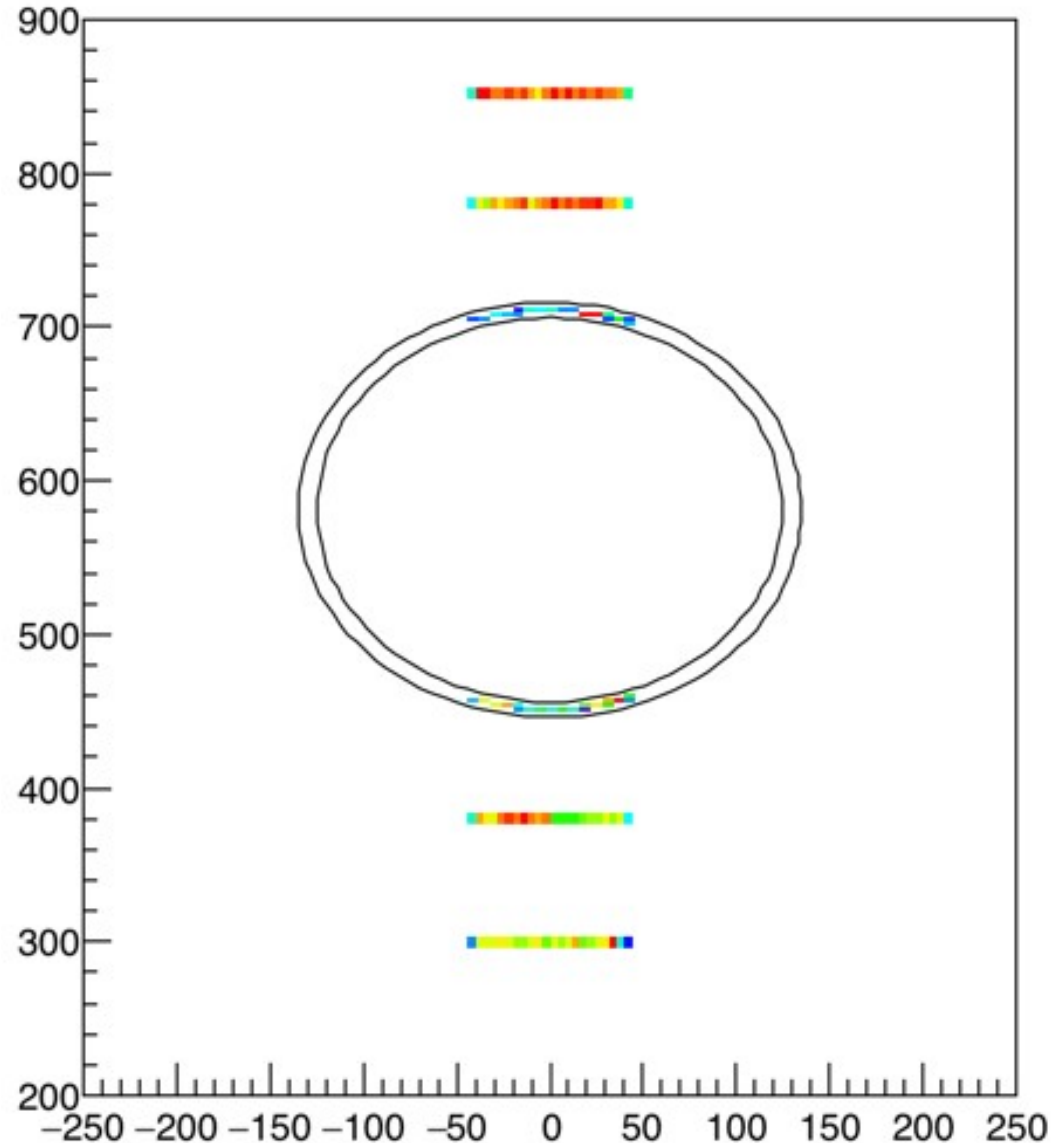
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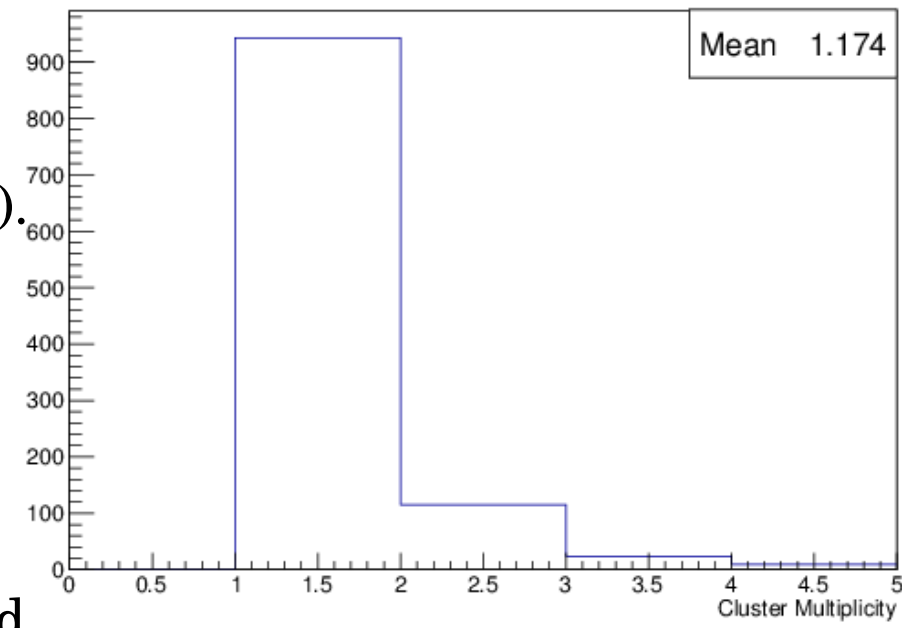
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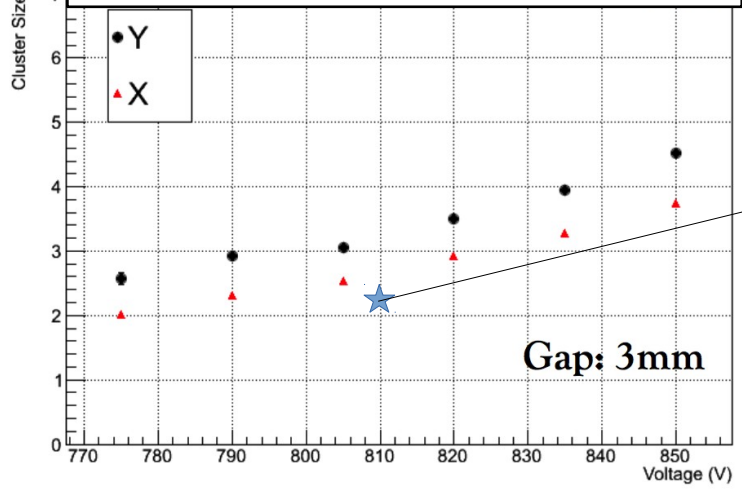
# Have a look to the data

- The gas mixture used is Ar-Isobutane (90/10).
- The electric field is 1.5/3/3/5 kV/cm and the gain is about 8000
- The tracking system is used to select good data and to reconstruct the event.
- A cluster size of about 2.18 allows to reconstruct a cluster with the charge centroid in the cylinder.

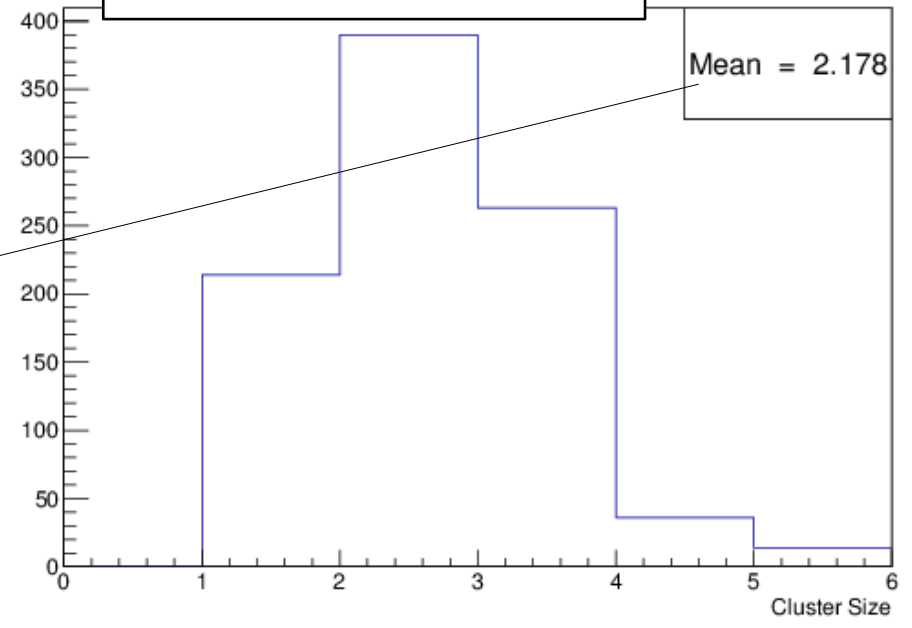
CYLINDER CLUSTER MULTIPLICITY



PREVIOUS TEST BEAM RESULTS



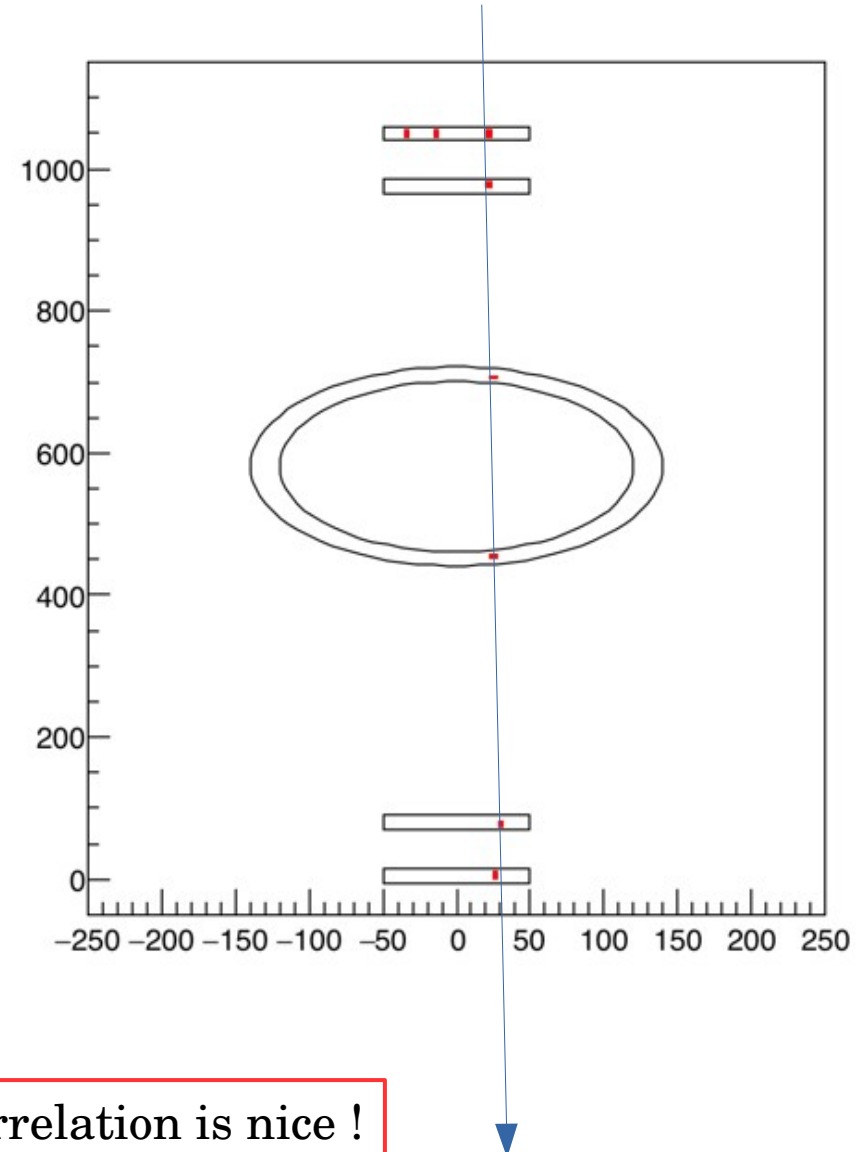
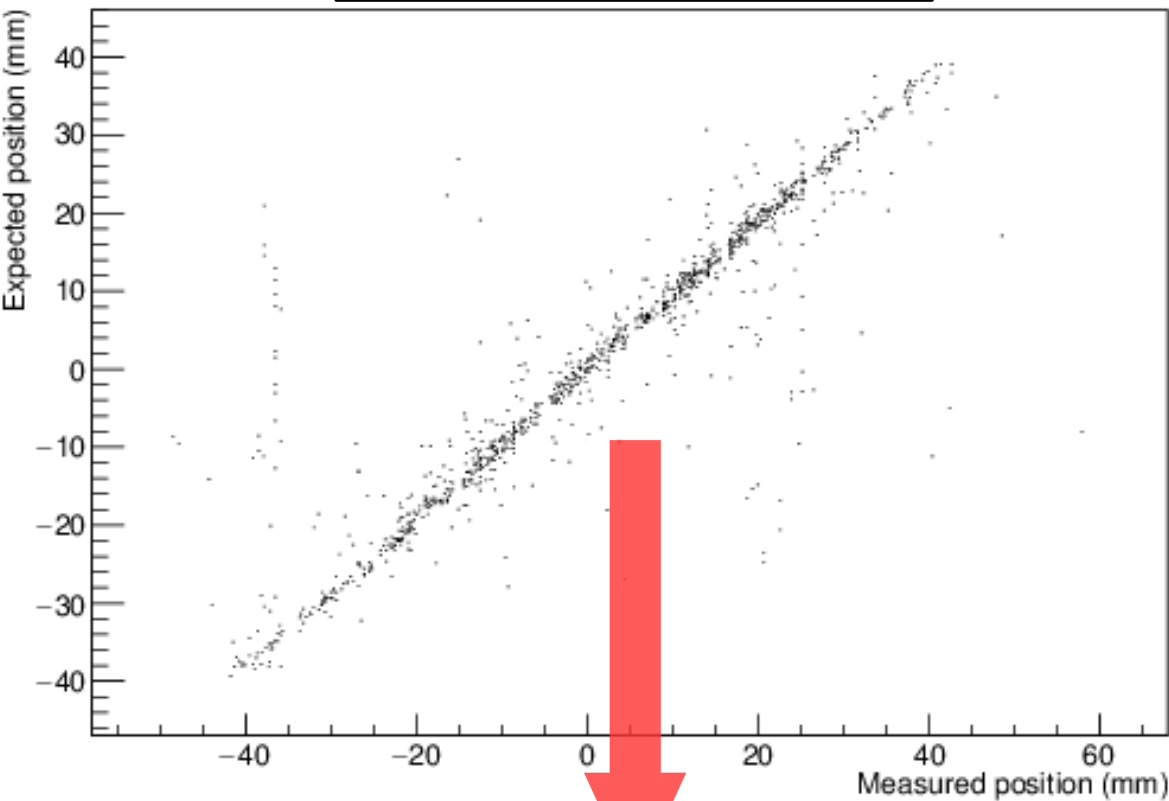
CYLINDER CLUSTER SIZE





# Have a look to the data

Correlation plot between trackers and the cylinder



The reconstruction works successfully and the correlation is nice !



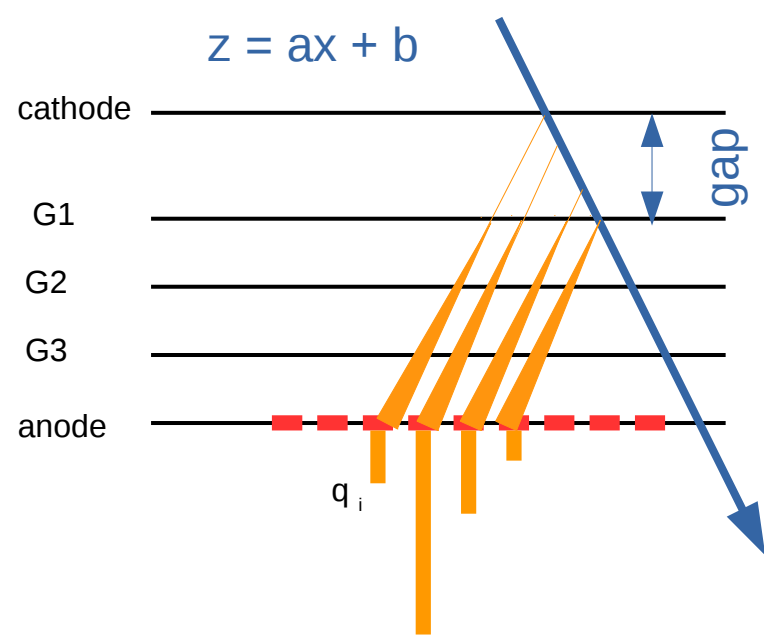
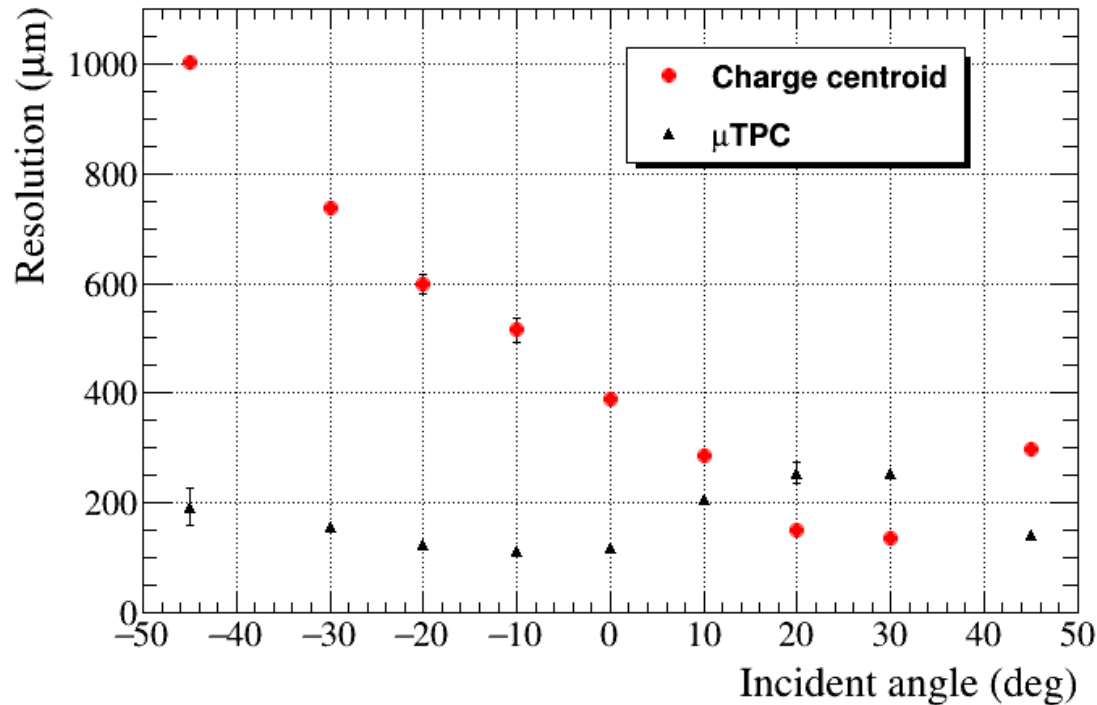
# Next studies

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- The aim of the test is to validate the construction.
- The statistic does not allow to perform a more accurate studies about efficiency and resolution.
- This preliminary approach will be extended during a test beam with the cylinder with and without magnetic field soon  
→ for more detail G.Mezzadri will present it tomorrow at WG7
- The performance expected from this detector have been measured by planar prototype of tripleGEM in previous test beam. A combination of  $\mu$ TPC and charge centroid reconstruction method can give a stable spatial resolution in the interested angular range as showed from data



# Expected performance in magnetic field



CHARGE CENTROID

$$x = \frac{\sum x_i * q_i}{Q_{TOT}}$$

μTPC

$$x = \frac{\frac{gap}{2} - b}{a}$$

The two algorithms are anti-correlated and provide a stable behavior of the chamber



# Conclusion

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- The construction method of a cylindrical tripleGEM has been tested and validated with a cosmic ray test
- A test beam at H4 in 2 weeks will provide more statistic to measure the performance of the apparatus
- Stay tuned for next updates





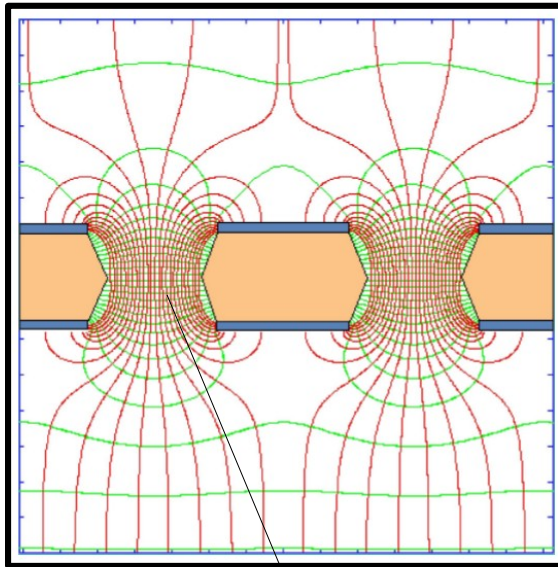
Thanks



# Backup slide



# The GEM technology



$E_{\text{field}} \sim 10^5 \text{ V/cm}$

Efficiency needs a gain of  $\sim 10^4$   
while safety a discharge probability below  $10^{-5}$

