First cosmic data analysis

Riccardo Farinelli
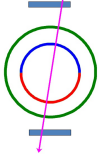on behalf of the working group

Milestone #3: Integration

Completion of the integration test of Layer-1 with TIGERv1

Operation of the electronics at a threshold of 3-4 fC

Efficient cosmic track reconstruction based on strip-clustering digitization
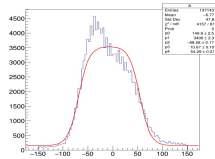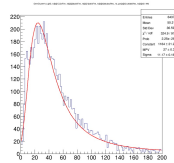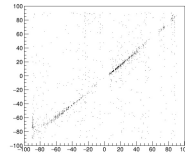
Outline

The cosmic **setup**

Decode, reconstruction
and analysis **codes**

Single strip behavior and
general status of the detector

Cosmic **tracks reconstruction** and
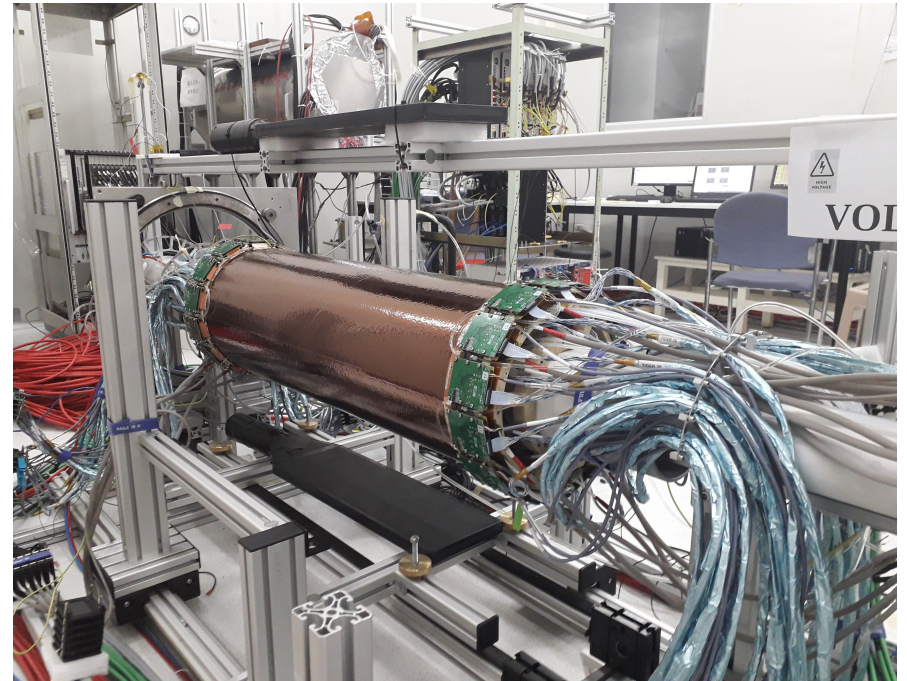signal shape: cluster charge and size on ϕ view

Residuals of the cosmic track

Cosmic setup

- CGEM Layer1 and Layer2 are assembled together, supplied at the working HV and readout by the TIGER-GEMROC chain

- Two scintillating bars are used to trigger the cosmic ray in volume that contains both CGEM detectors

- The bottom part of Layer1 has been partially electrically disconnected after the accident in 18/12

Cosmic setup

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Cosmic ray
Scintillating bar
Layer 1
Layer 2
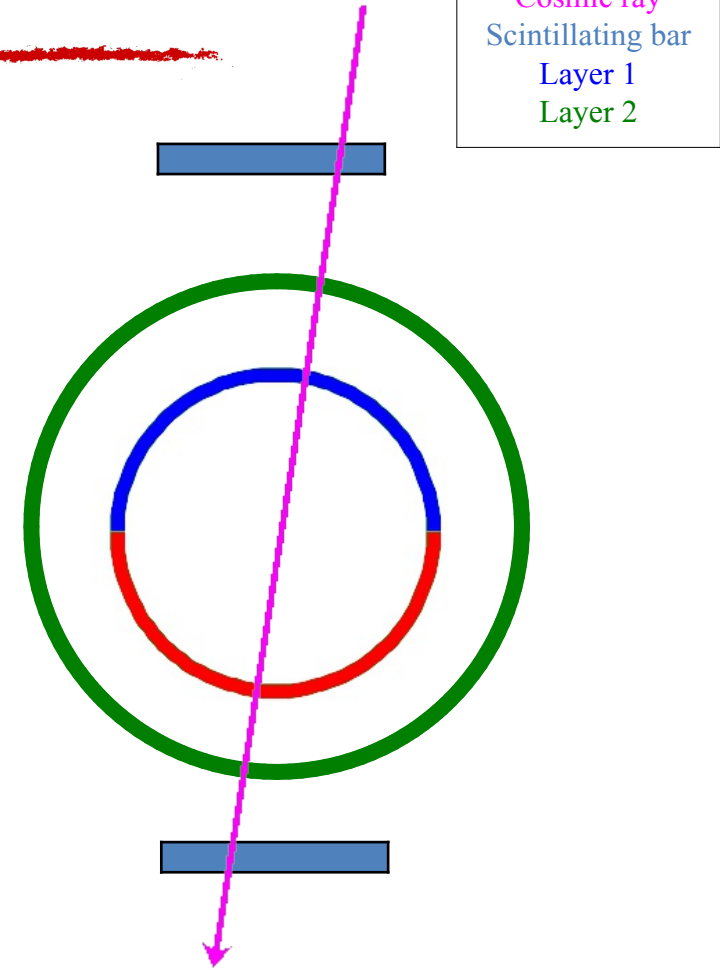
Decode, reconstruction and analysis codes

- For each trigger received by the GEMROC a test pulse (TP) is injected on a TIGER channel and a packet is sent to the computer through GUFI software.

- The binary data are decoded as first step and a first check on the consistency of the data stream is performed

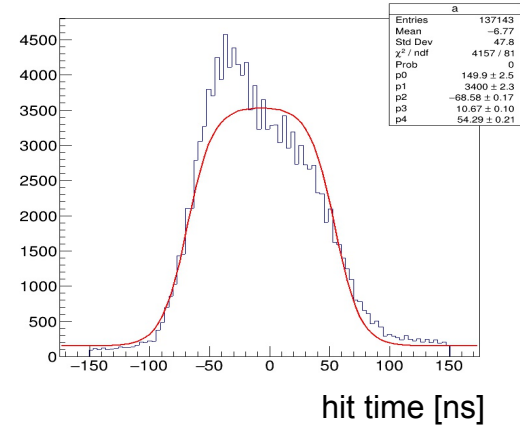- Calibration curves of each channel of the TIGERs are applied to charge and time measurements
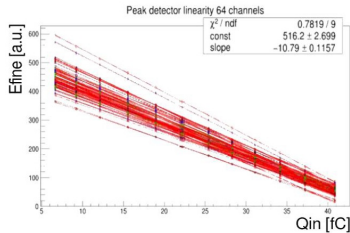
- Data from each GEMROC are merged and the *event* is reconstructed from the *total time* value

- The *local time* measurement is refered to the trigger time that it is measured from the TP injected in the TIGER
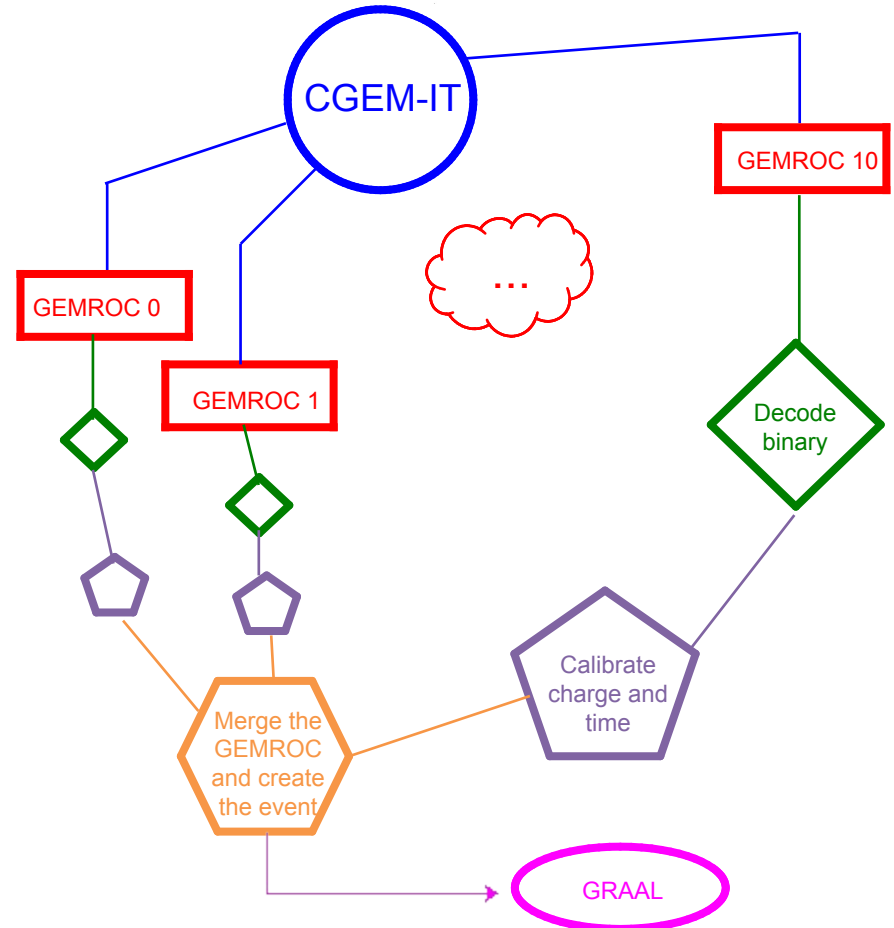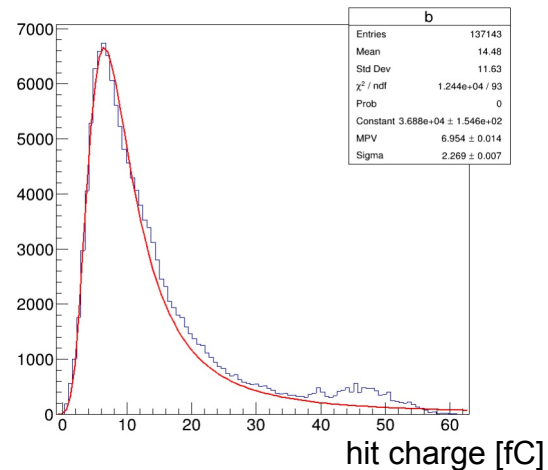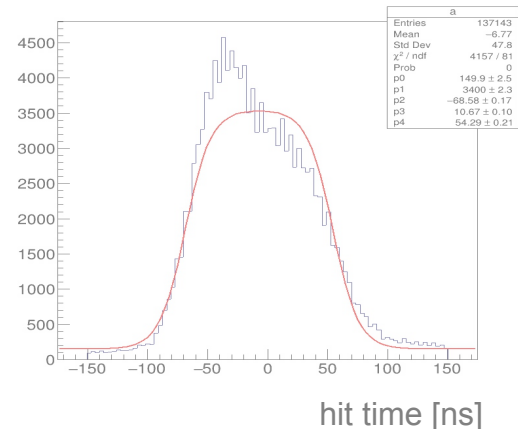
Single strip behavior: time

- **Good events have been selected**

- The time distribution is the first parameter to look at the goodness of the data: signal between -150 ns and +150 ns is evindent w.r.t. the flat noise in the entire temporal range

- Noise can be measured to be < 200 Hz/strip

- The width of the distribution is 120 ns and it is compatible with TB results with orthogonal tracks

| a	
Entries	137143
Mean	−6.77
Std Dev	47.8
χ² / ndf	4157 / 81
Prob	0
p0	149.9 ± 2.5
p1	3400 ± 2.3
p2	−68.58 ± 0.17
p3	10.67 ± 0.10
p4	54.29 ± 0.21

hit time [ns]

Single strip behavior: charge

- **Good events have been selected**

- The time distribution is the first parameter to look at the goodness of the data: signal between -150 ns and +150 ns is evindent w.r.t. the flat noise in the entire temporal range

- Noise can be measured to be < 200 Hz/strip

- The width of the distribution is 120 ns and it is compatible with TB results with orthogonal tracks

- Charge distribution ranges up to 60 fC

- The largest amount of hits has a charge of 5-10 fC above the noise range around 2-5 fC

- The saturation bump is visible above 40 fC

hit time [ns]

hit charge [fC]

Single strip behavior: spatial distribution

- **Good events have been selected**

- Only ϕ strips are considered here

- Layer1 and Layer2 entirely reconstructed (except some chips due to comunication problems)

- Hot areas between the scintillators while noise is everywhere
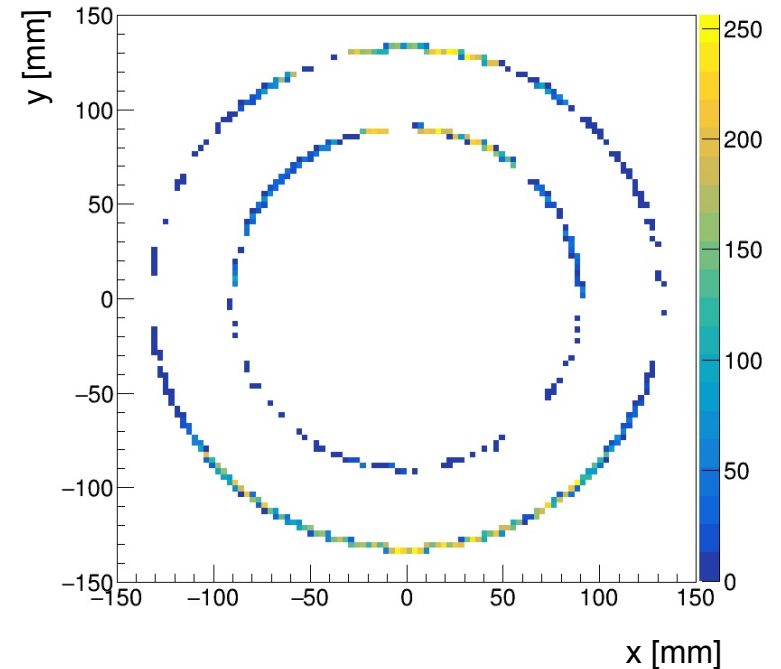
Tracking and mapping

- The top and the bottom parts of Layer2 are used to track and the expected position on Layer1 is compared with the position measurement on it

- Residual distribution has been obtained to select the good events

- Up to now the position is measured with the charge centroid algorithm only

Cosmic ray
Scintillating bar
Layer 1
Layer 2
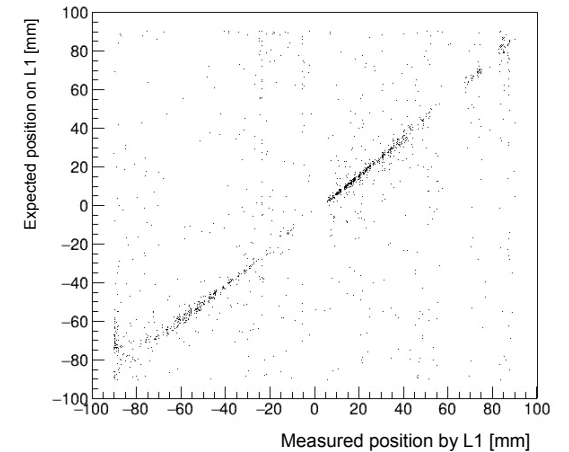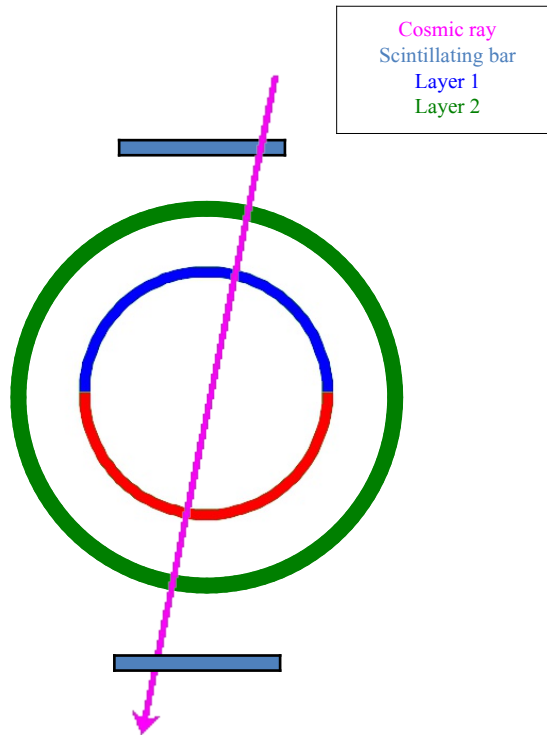
List of measurements

- Several configurations of Layer1 and Layer2 have been studied to check their performance:

  1. Three HV values on the GEMs

  2. Two different threshold values

  3. More noise vs less noise configurations

- Cluster charge and cluster size parameters will be shown to describe the status of the signal collected, therefore the status of the detectors

HV scan

- **Good events have been selected**

- Only ϕ clusters are considered here

- Three HV point have been analyzed

- Thresholds between 5 and 10 fC have been applied in these runs

- Detectors show a good behavior as a function of the HV: **both cluster size and charge increase with the HV on the GEMs**
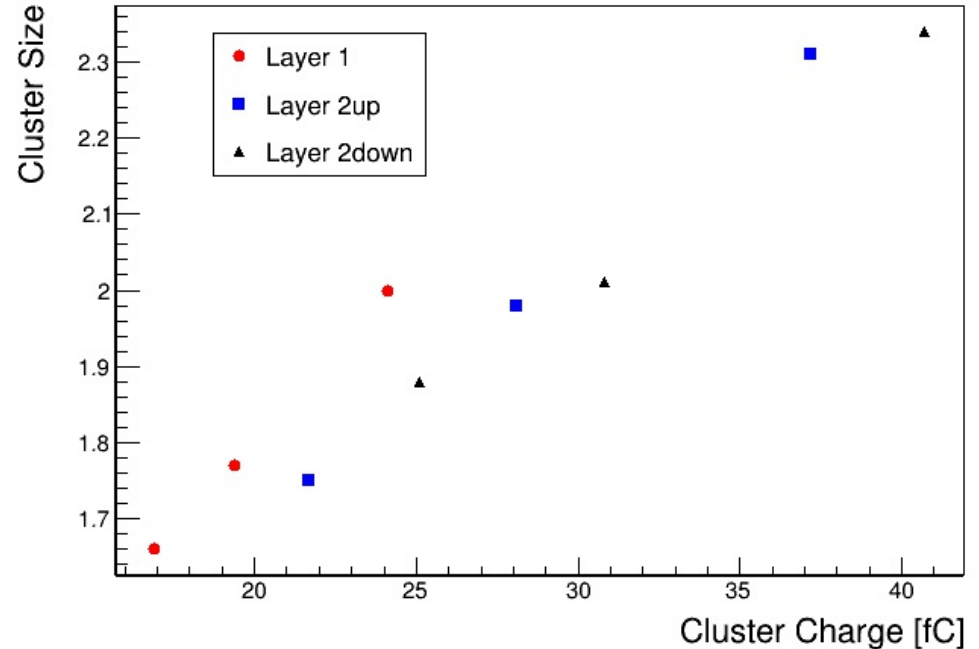
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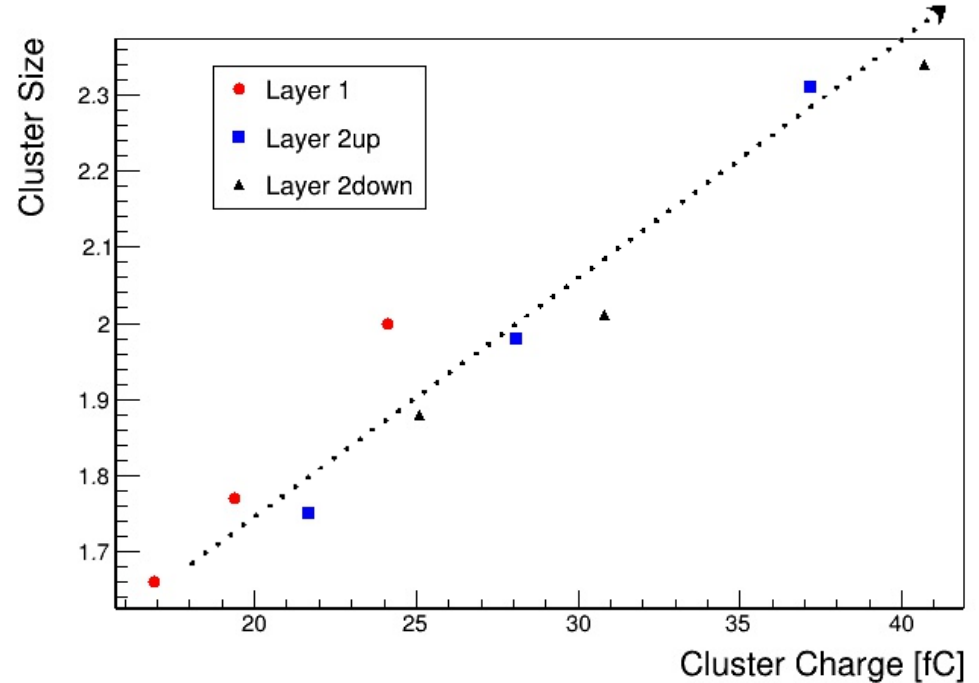
Threshold effects

- **Good events have been selected**

- Only φ clusters are considered here

- Two threshold configurations have been analyzed

- Threshold varies from a range 5-10 fC to 2-6 fC

- Reducing the threshold level it is possible to increase the cluster size and cluster charge while the background is higher
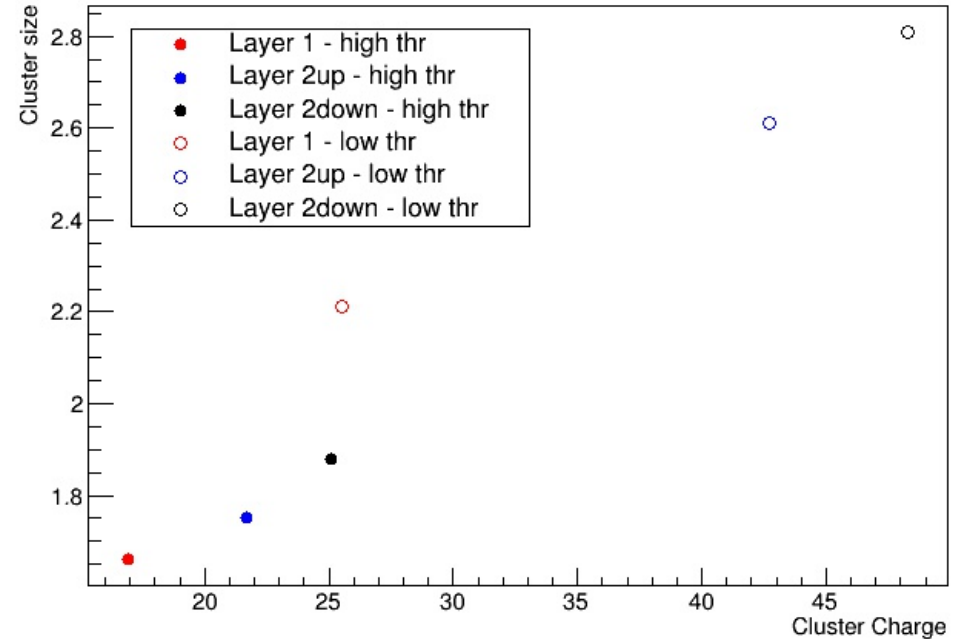
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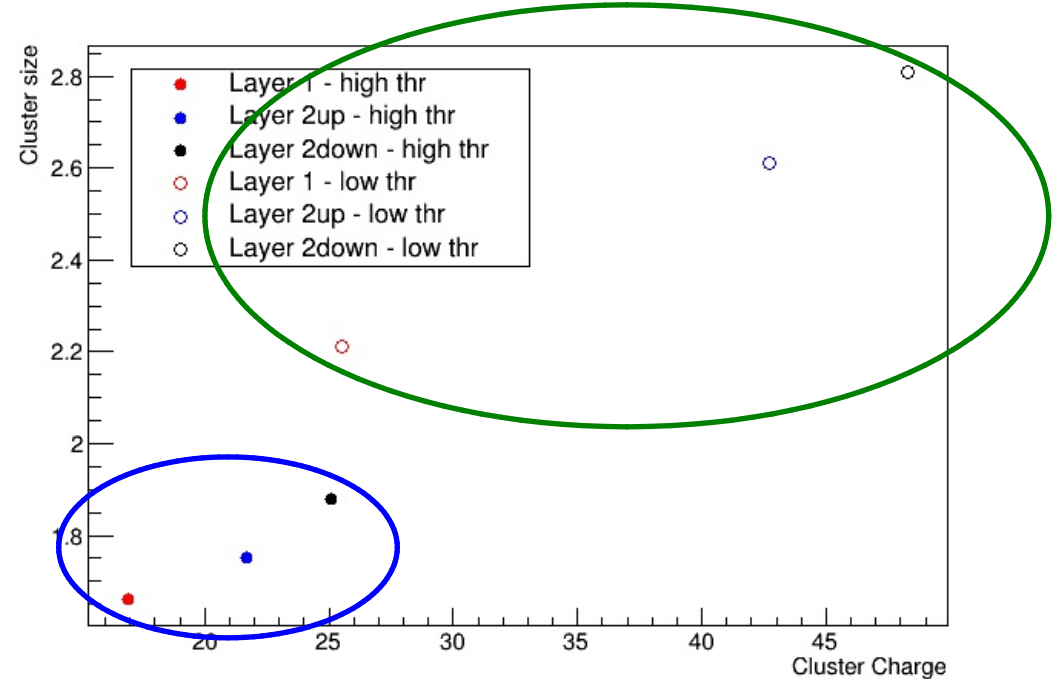
Noise effect

- **Good events have been selected**

- Only φ clusters are considered here

- Two configurations with different noise level have been analyzed

- Improving the ground level it is possible to be sensitive a lower charge on the strip and this increases the cluster charge and size
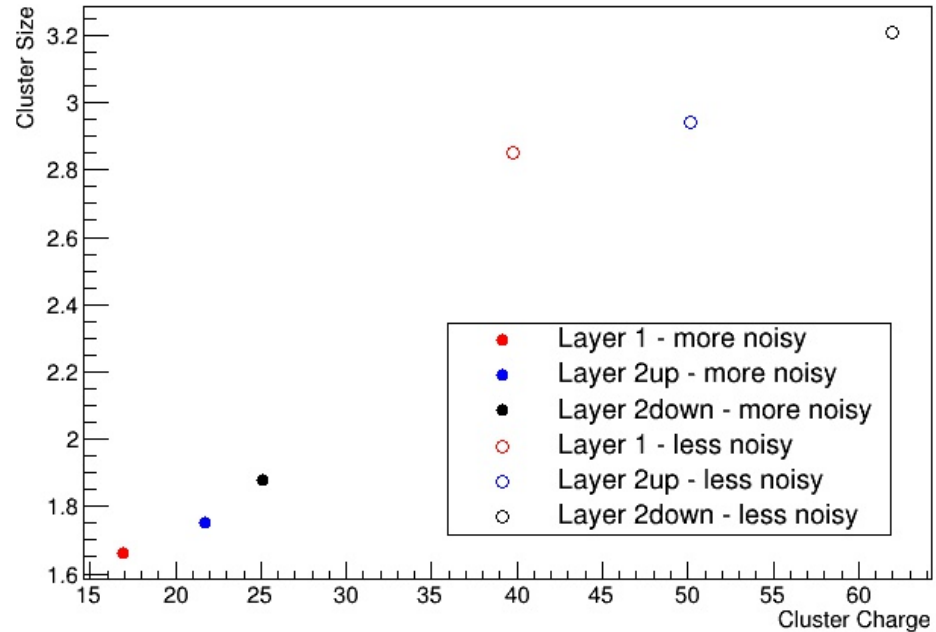
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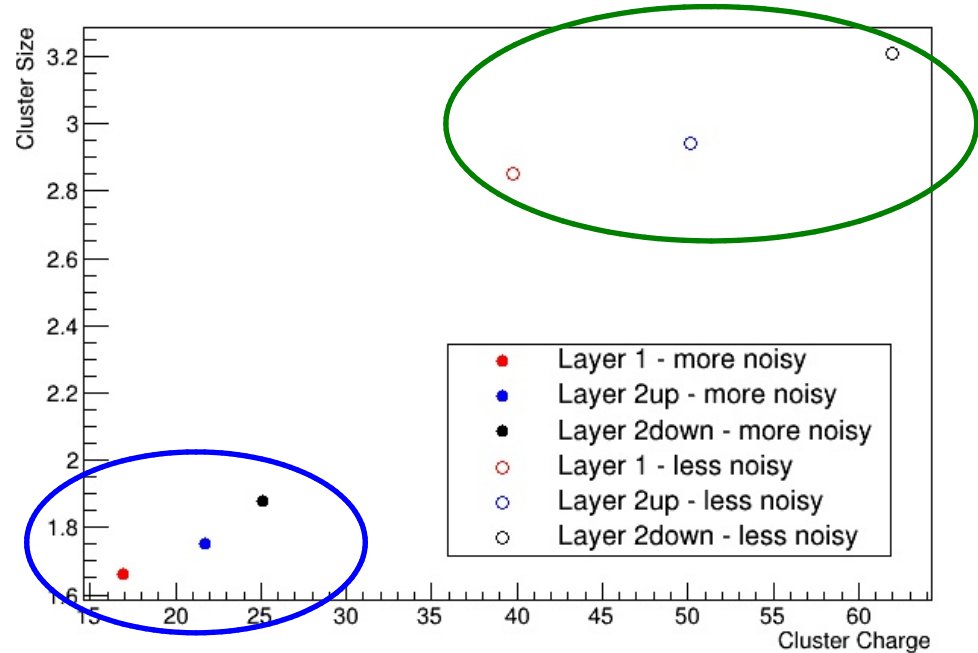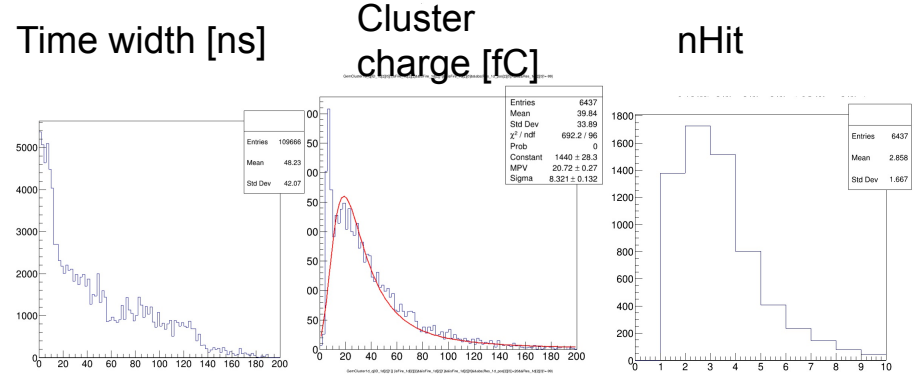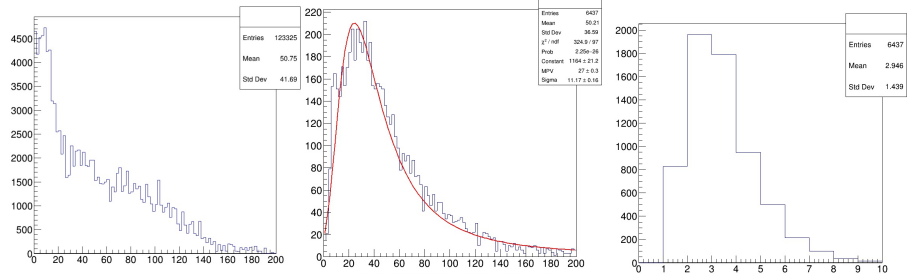
Cluster of φ strips

- **Good events have been selected**

- Only φ clusters are considered here

- On Layer1

  Q = 40 fC

  nHit = 2.8
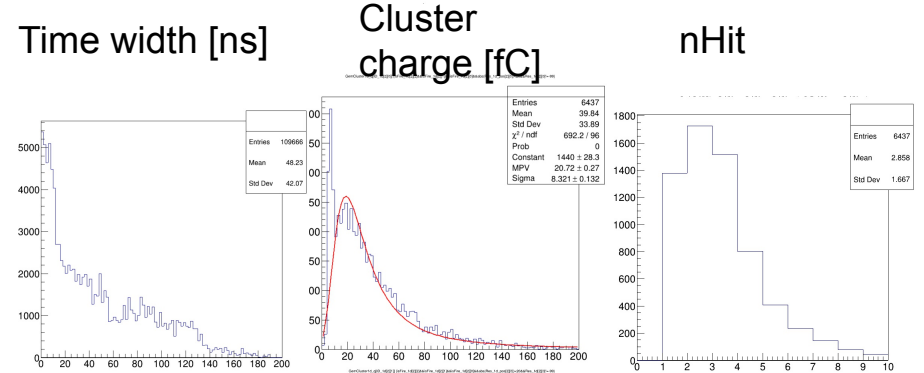
- On Layer 2
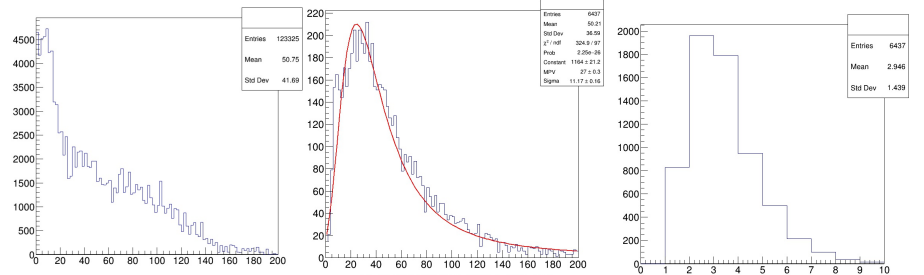
  Q = 50-60 fC
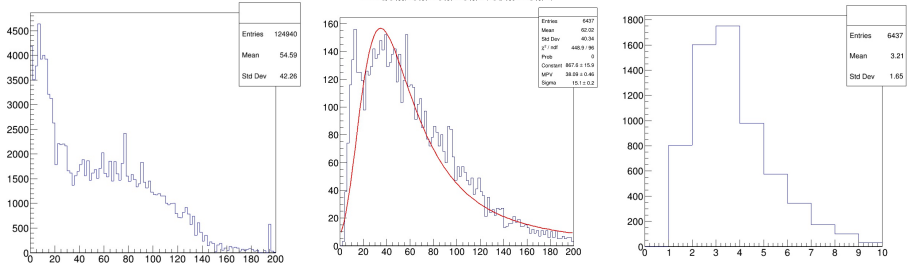
  nHit = 2.9-3.1

Cluster of ϕ strips

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- On Layer1

  Q = 40 fC

  nHit = 2.8

- On Layer 2

  Q = 50-60 fC

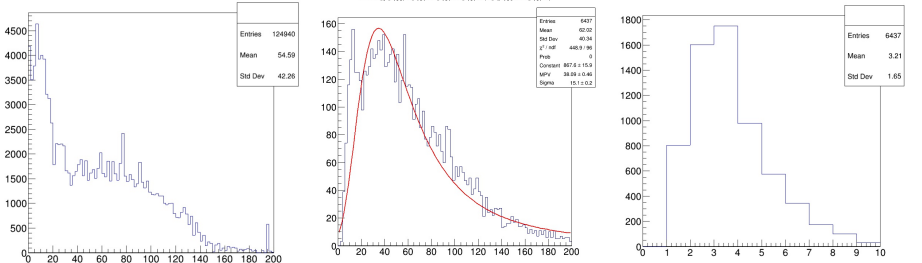 nHit = 2.9-3.1

- **Results in line with the TB measurements**


Time width [ns]　　Cluster charge [fC]　　nHit
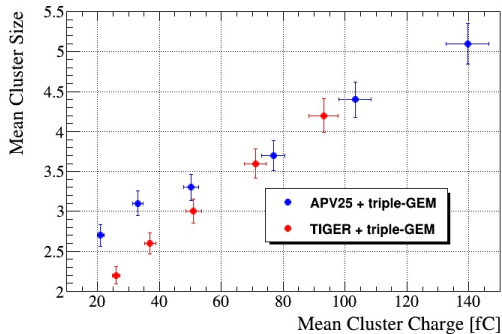
L1

L2 up

L2 down

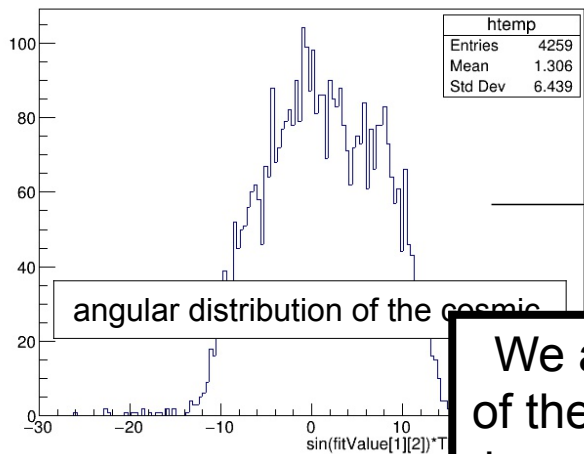# Residual and status of the reconstruction

- **Good events have been selected**

- Only ϕ clusters are considered here

- Residual distribution of the events has been measured

- A good correlation between the expected position and the reconstructed one has been observed

- Other studies are needed to improve the resolution, then the efficiency of system. See next slide
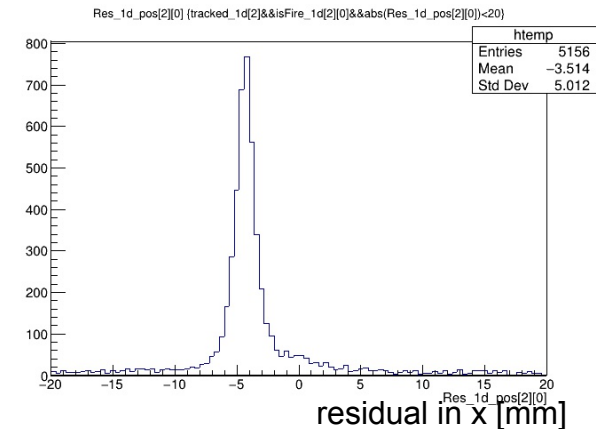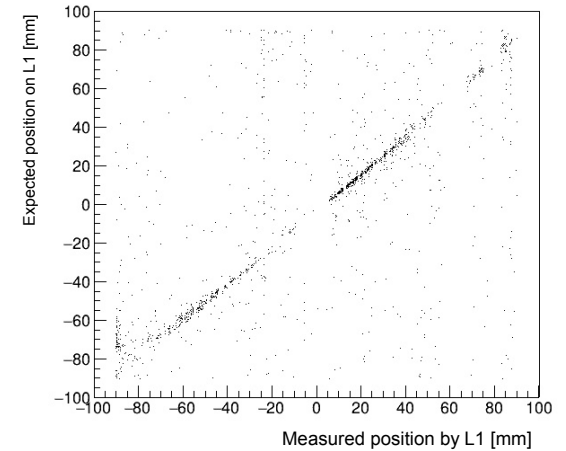

residual in x [mm]

Residual and status of the reconstruction

angular distribution of the cosmic

spatial distribution of Layer 1

residual in x [mm]

Residual and status of the reconstruction

angular distribution of the cosmic
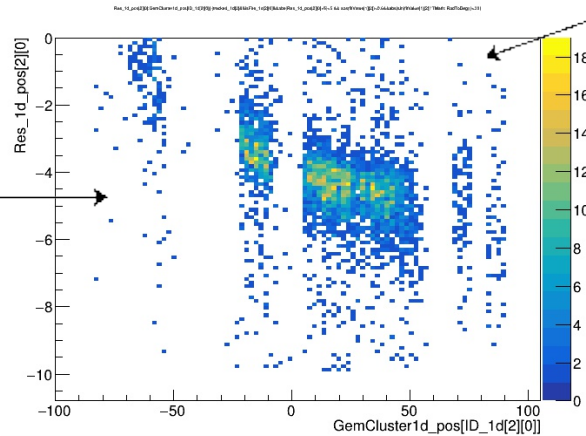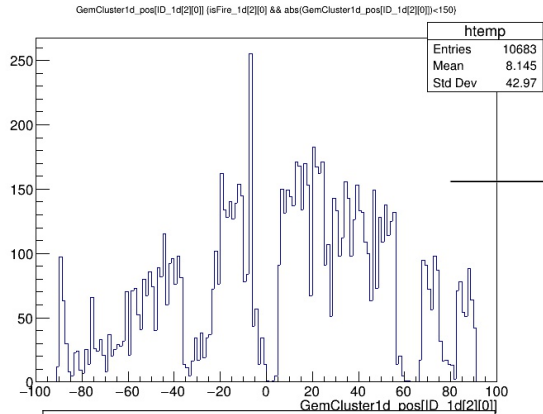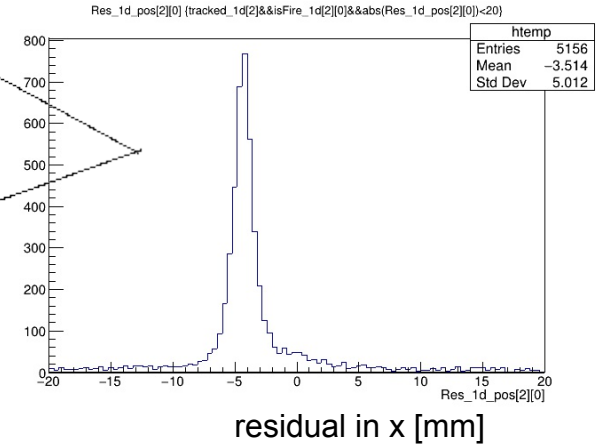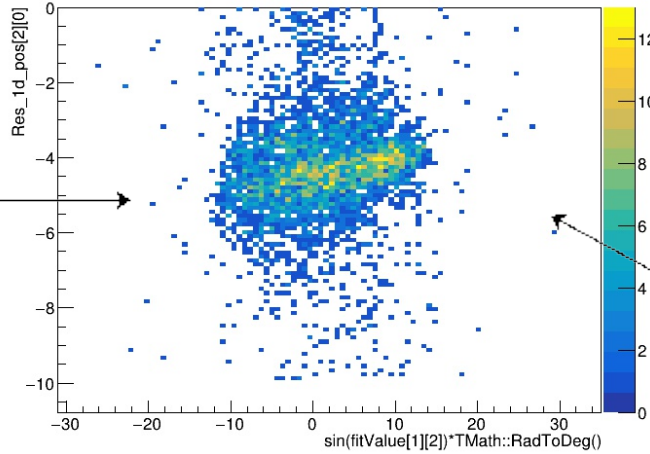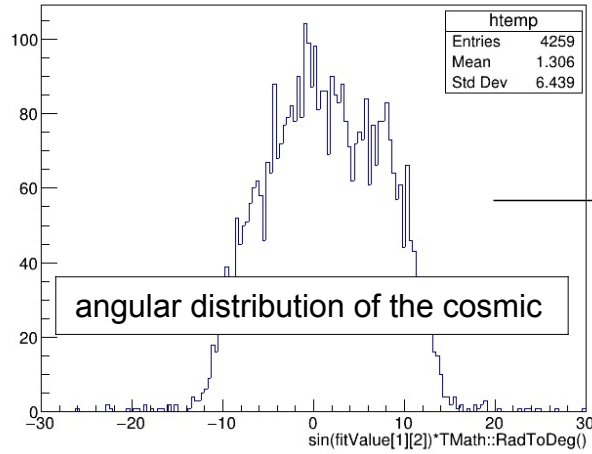
We are sensitive to misalignement of the residual distribution which can be used to improve the geometrical informations for the reconstruction

spatial distribution of Layer 1

residual in x [mm]
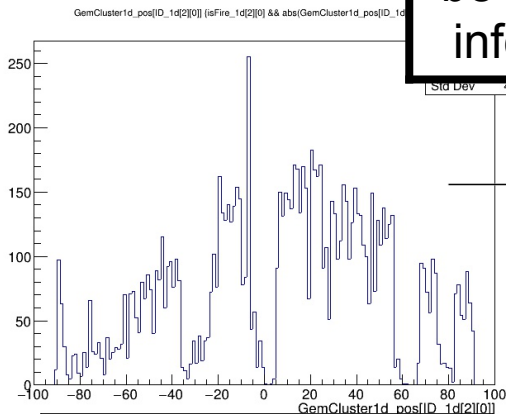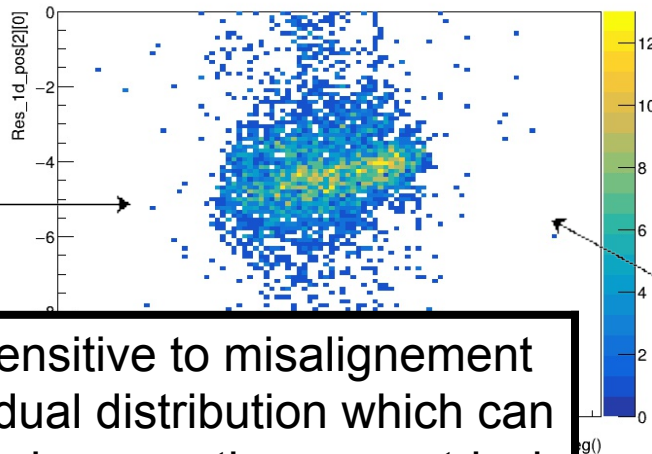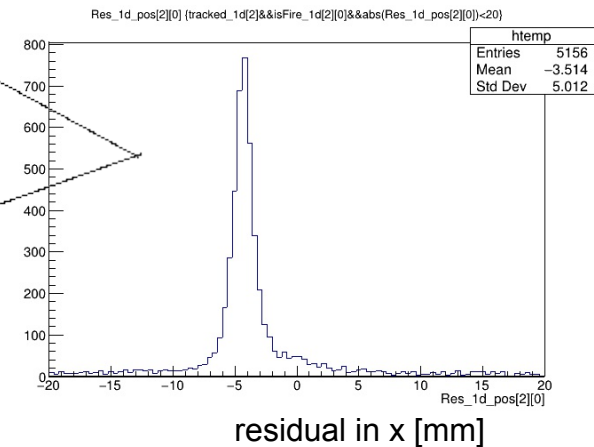
Conclusion

- A software to decode, reconstruct and analyze the data of the cosmic ray test has been developed and successfully tested

- Informations from the strips has a reasonable distribution and the system is under control

- Electrical and electronics configuration play an important role in the detector performace

- The cluster charge and cluster size have a value compatible with the TB data collected with planar triple-GEM and APV25/TIGER

- Residual distribution precision allows to improve the knowledge of the detector behavior

Thanks