A planar cosmic ray stand for the BESIII CGEM-IT

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Outlook

The Beijing cosmic ray stand
and the related questions

The Ferrara cosmic ray stand
and the studies to understand Beijing

Beam properties from the cosmic rays and the teambeam

Peculiarities of two readout system
What we have to study and what we understood

Next step

The Beijing Cosmic Ray Stand

A cosmic ray stand is under study since December 2019 in Beijing with **L1+L2**

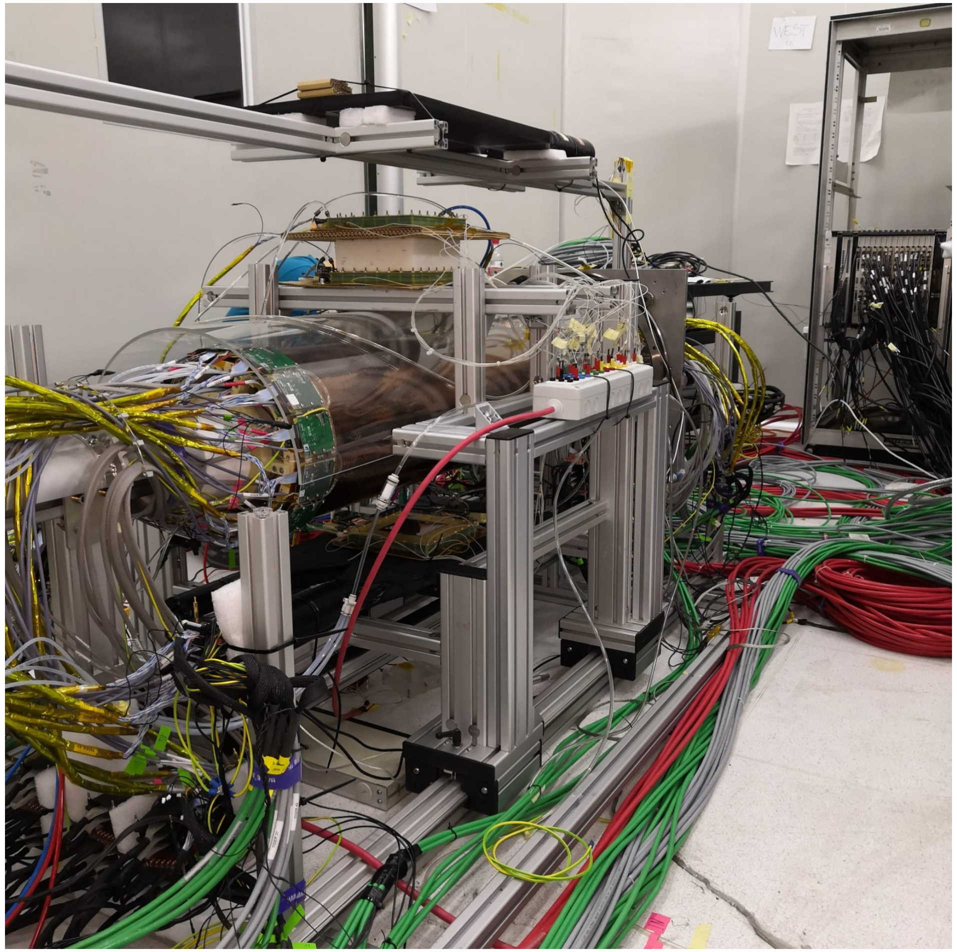
The setup consist of:

- 11 GEMROC
- 88 TIGER
- more than 5600 electronic channels
- final HV distribution system
- 340 HV channels

Cosmic ray data taking have been used to understand the behavior of the CGEM-iT

Results up to now addressed to some open question regarding their **mismatch** between the performance measured at the TB.

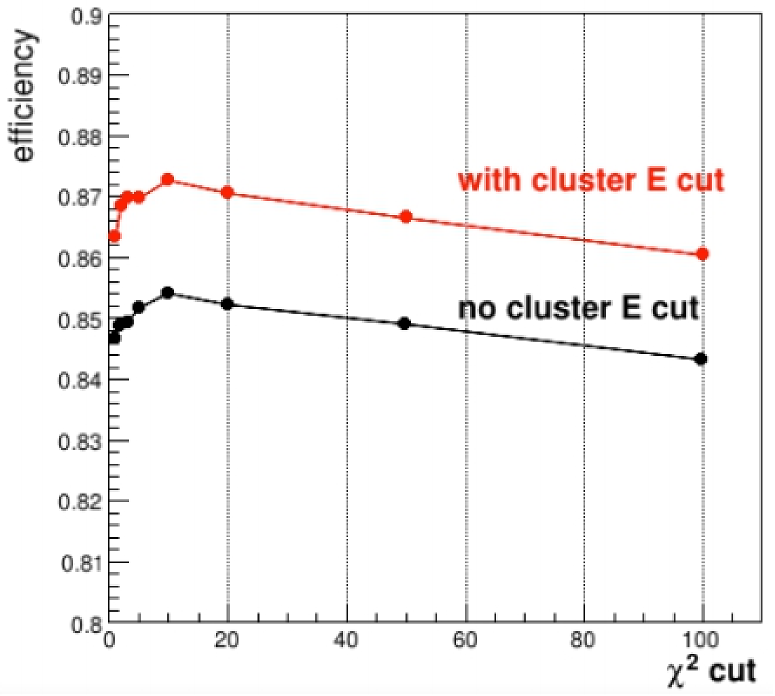
The difference are many and we will try to address some of them in this talk.



The Beijing Cosmic Ray Stand: efficiency

From the Lia's results shown in the past meeting, the **efficiency** measured on L1 and L2 are smaller than 90% even in the best case: well below from the 98% expected.

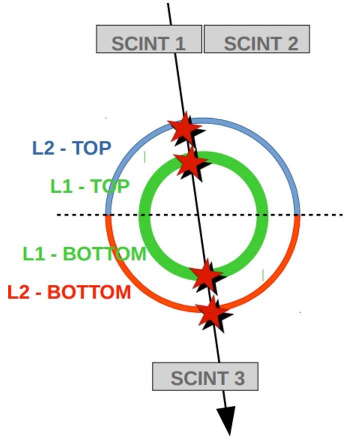
	Without cut	With E_{CUT}
LAYER 1, BOTTOM	0.83	0.85
LAYER 1, TOP	0.85	0.87
LAYER 2, BOTTOM	0.84	0.85
LAYER 2, TOP	0.83	0.84

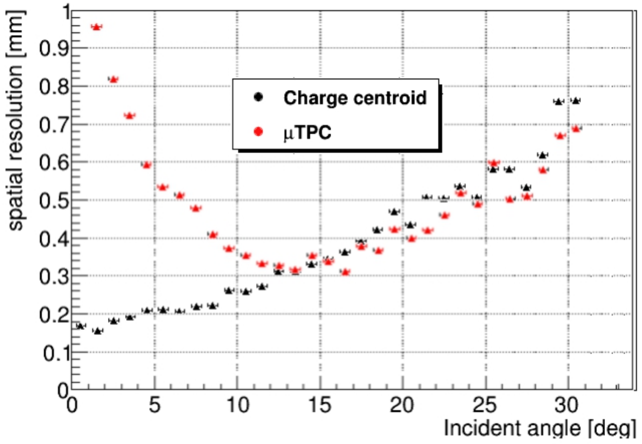


The Beijing Cosmic Ray Stand: spatial resolution

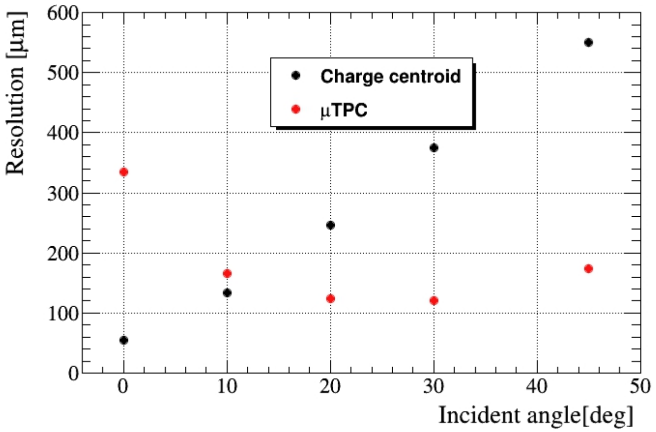
The CGEM-IT has been used as a tracker and a test chamber it-self to measure the spatial performance of the Charge Centroid and the micro-TPC.

Even if the **contribution of the tracking** system has been measured through a toy-MC and removed from the sigma estimated in the data; a component is still present (see behavior above 15°).





Cosmics CGEM-IT

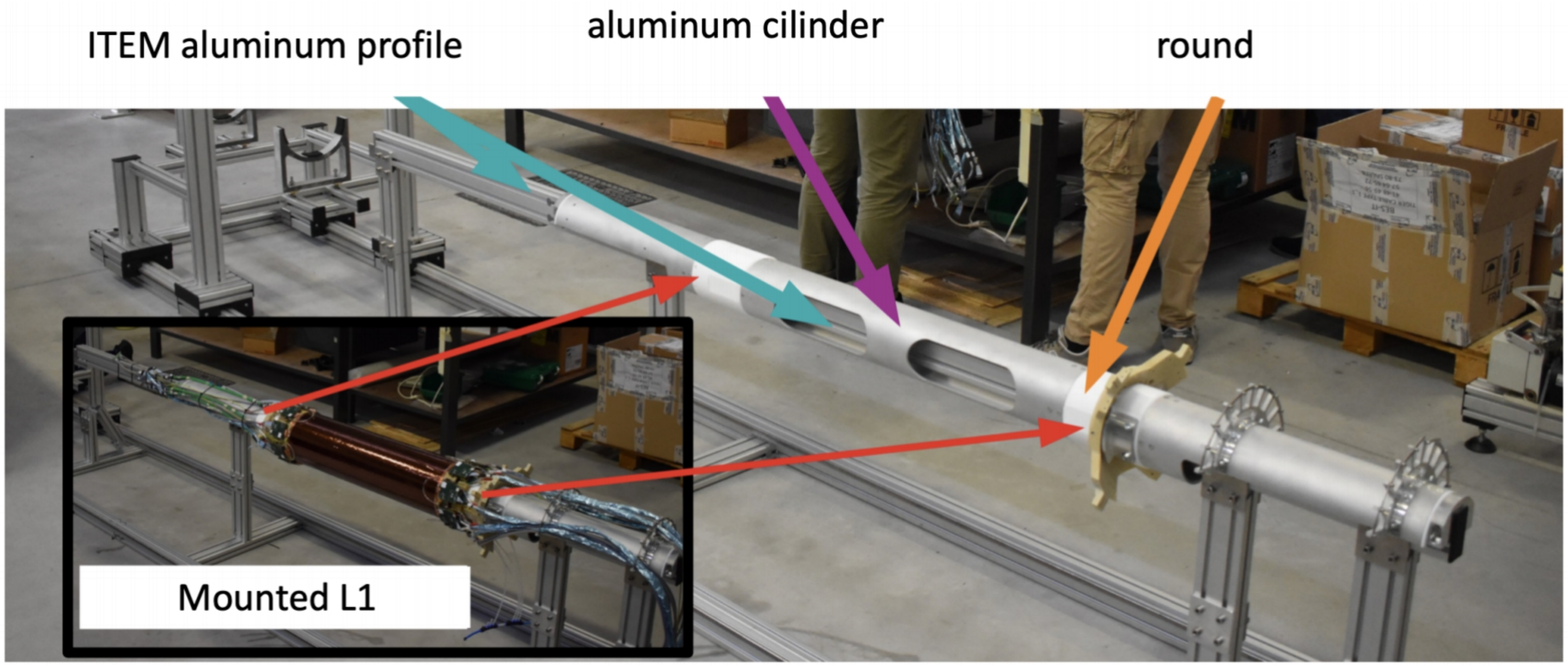


TB planars

Studies on the CC & µTPC resolution of the CGEM-IT are not completed: the differences from the TB planar results are visible.

The Beijing Cosmic Ray Stand: the pole

The presence of a pole inside the CGEM-IT of course interfere with its performance



The Beijing Cosmic Ray Stand

Stuff to be understood:

- The performance setup used: cosmic beam vs test beam
- The peculiarities of the two readout technologies (APV/SRS and TIGER/GEMROC)
- The impact of the noise
- Local fanout and system fanout

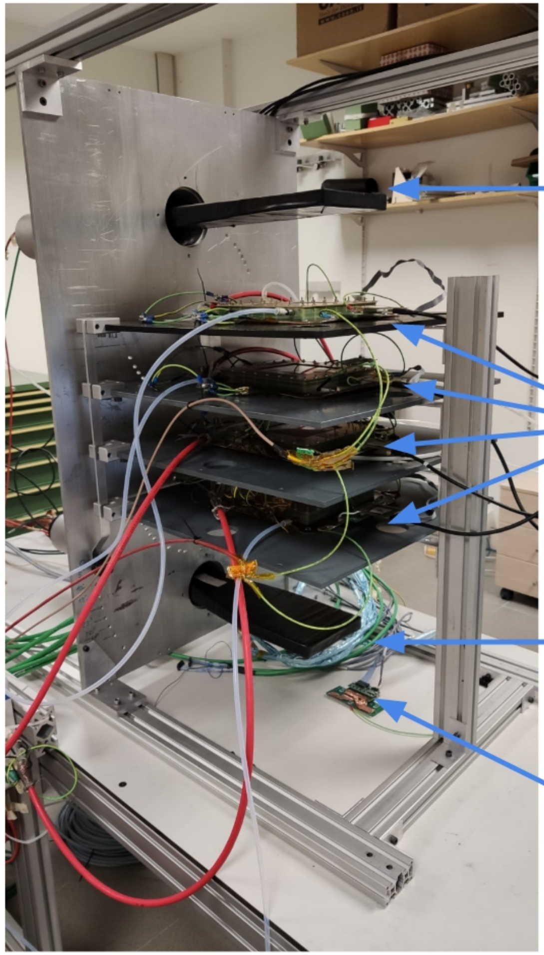
The Ferrara Cosmic Ray Stand: the setup

In Ferrara we have 4 planars and 2 electronics readout system and one cosmic ray beam

- four planar triple-GEM of 8x8 cm2 and 2D anode segmentation

- **two readout system** based on:
    + APV/SRS
        1 FEC, 8 chip
    + TIGER/GEMROC
        1 GEMROC, 16 tiger
        1 local fan-out (NEW) --> see Angelo's talk

- **simplified HV** distribution system



Scintillator for triggers

4 planar GEM detectors

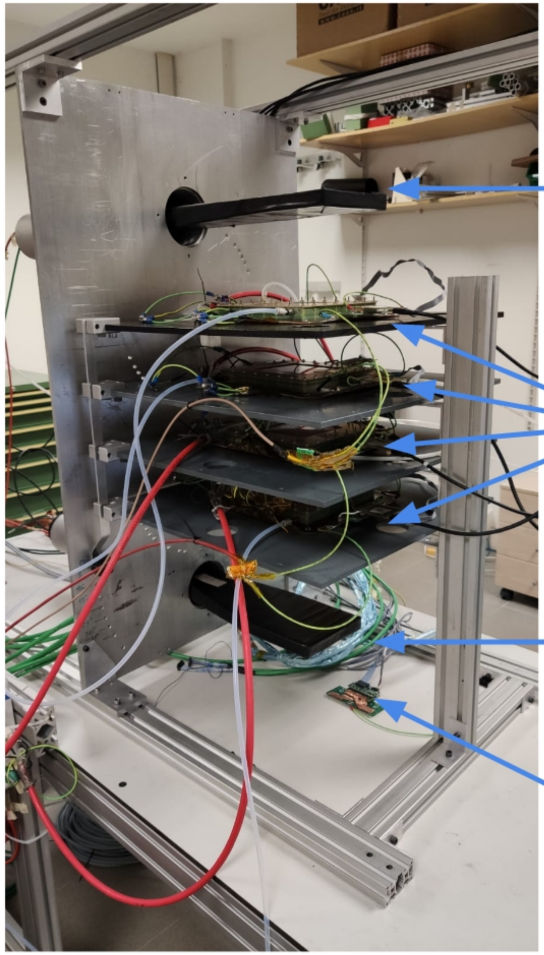
Scintillator for triggers

Plug and play electronics (APV 25 + SRS and TIGER + GEMROC)

The Ferrara Cosmic Ray Stand: tasks

Ongoing tasks:

- Noise studies
- Setup characterization to address some answer
- System fan-out (missing) --> see Angelo’s talk
- Optimization GEMROC firmware



Scintillator for triggers

4 planar GEM detectors

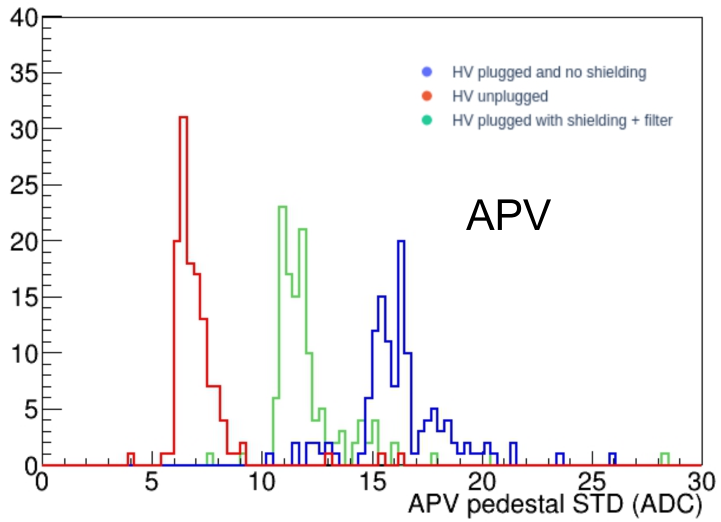
Scintillator for triggers

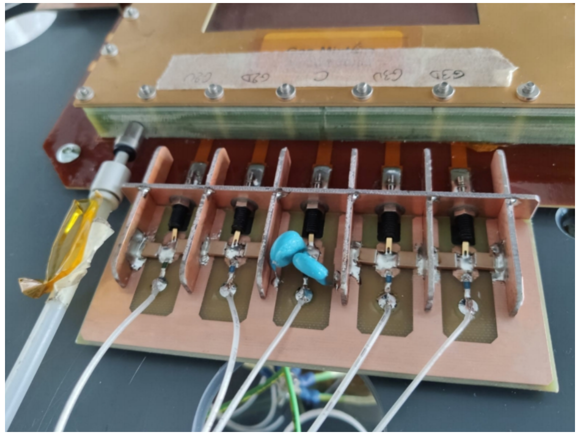
Plug and play electronics (APV 25 + SRS and TIGER + GEMROC)

Noise studies

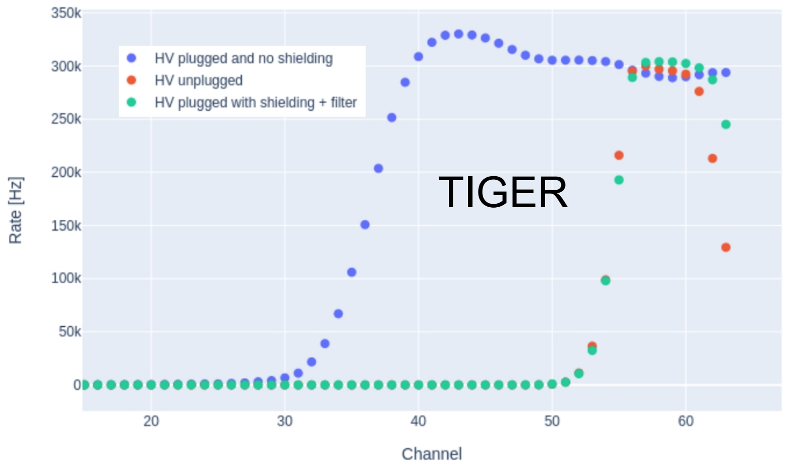
Pedestal with APV and noise scan with TIGER show an impact from the shielding and filter activities on the HV system.

We implemented LEGO HV distribution system to remove the pick-up noise source to remove this contribution in the setup characterization --> see Giulio's task @ last meeting





LEGO filters thanks to Robeto Malaguti



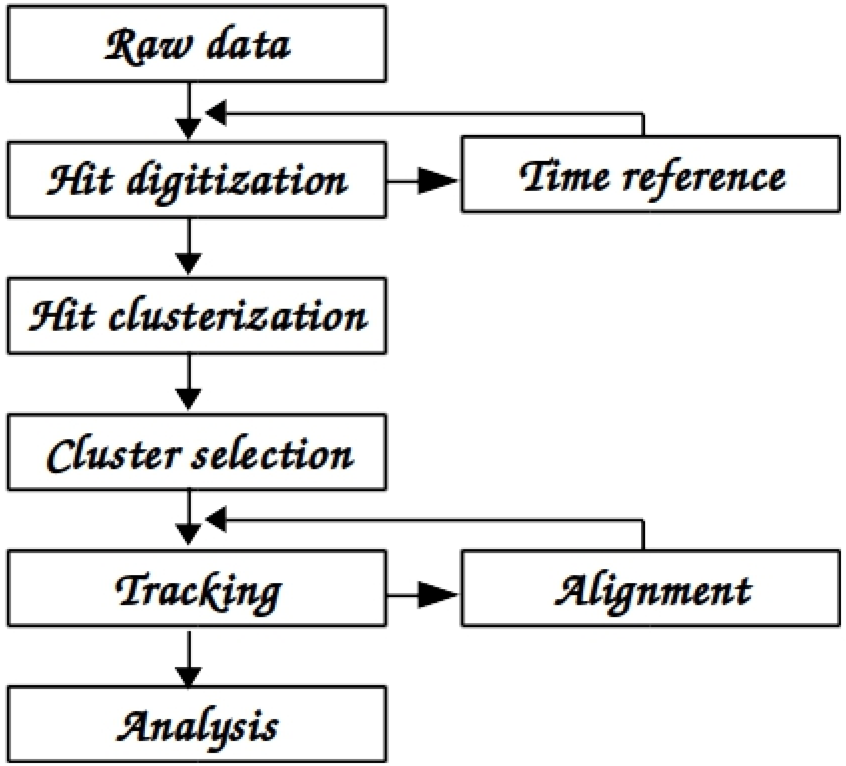
Reconstruction and analysis

Cluster selection:

- cluster with higher charge if alignment is not performed yet

- cluster with the smaller residual w.r.t. the track for best performance

NB: No large impact to evaluate cluster charge and size; fundamental to evaluate the efficiency and the resolution



Timeline of the tests

1° Preliminary data taking with APV - ArCO2 (noise, HV scan)
2° Preliminary data taking with TIGER - ArCO2 --> see Alberto talk (noise, integration time, drift scan)
3° Stable data taking with APV - ArCO2 (HV scan)

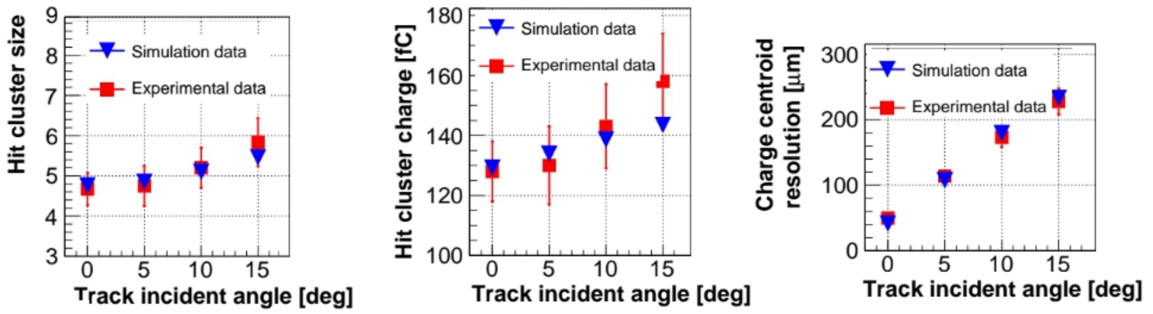
To do
4° APV w/ ArIso to compare w/ TB
5° Stable data taking with TIGER

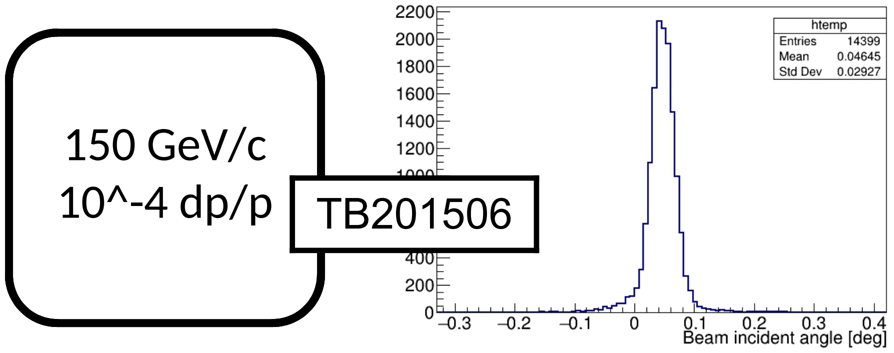
Cosmic ray peculiarities

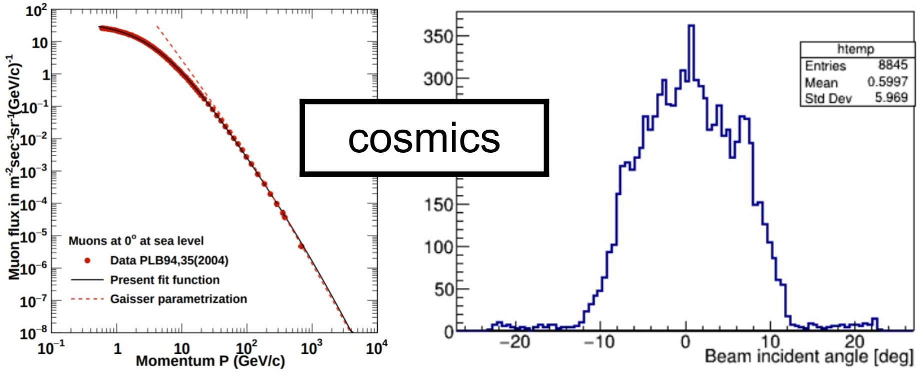
Energy distribution:
in the testbeam the particles are almost monochromatic while with the cosmic rays the MPV is 1GeV with a wide spread. The energy loss may change event by event

Angular distribution:
cosmic ray stand has a large incident angle and it needs more studies for alignment and performance evaluation

From TB201804 data (ArIso), used to the PARSIFAL tuning we have:







then performance measured with cosmics needs to be deconvoluted as a function of the incident angle --> see Alberto's talk

Cluster size and charge

Results with APV setup to be compared with the TB

Four different behavior of charge and size. How to compare those results with a TB?

Let's use the mean value?

charge1D: 900 ADC
size1D: 2.0
@ **360V** on GEMs

Detector N 0
Plane 0

** VIEW X **
Charge 645.53 ADC
Cluster Size 1.88965

** VIEW Y **
Charge 897.84 ADC
Cluster Size 2.45750

Detector N 1
Plane 1

** VIEW X **
Charge 698.34 ADC
Cluster Size 2.09981

** VIEW Y **
MISMAPPED

Detector N 2
Plane 2

** VIEW X **
Charge 844.49 ADC
Cluster Size 2.05101

** VIEW Y **
Charge 1139.2 ADC
Cluster Size 2.74636

Detector N 3
Plane 3

** VIEW X **
Charge 955.46 ADC
Cluster Size 2.14419

** VIEW Y **
Charge 1189.2 ADC
Cluster Size 2.81604

charge1D: 3000 ADC
size1D: 4.1
@ **380V** on GEMs

Detector N 0
Plane 0
N of view 2

** VIEW X **
Charge 2274.9 ADC
Cluster Size 3.24484

** VIEW Y **
Charge 3234.8 ADC
Cluster Size 4.35975

Detector N 1
Plane 1
N of view 2

** VIEW X **
Charge 2385.5 ADC
Cluster Size 3.95216

** VIEW Y **
MISMAPPED

Detector N 2
Plane 2
N of view 2

** VIEW X **
Charge 2702.5 ADC
Cluster Size 3.54023

** VIEW Y **
Charge 3569.0 ADC
Cluster Size 4.70277

Detector N 3
Plane 3
N of view 2

** VIEW X **
Charge 3049.5 ADC
Cluster Size 4.01486

** VIEW Y **
Charge 3825.6 ADC
Cluster Size 5.00670

Cluster size and charge

Results with APV setup to be compared with the TB

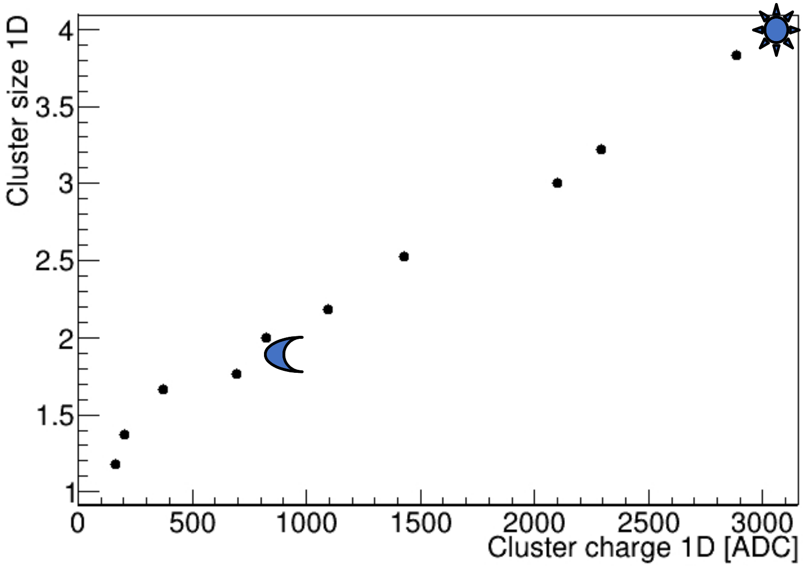
Let’s use the mean value

COSMICS - ArCO2
charge1D: 900 ADC
size1D: 2.0
@ **360V** on GEMs

TB201506 - ArCO2
charge1D: 1431 ADC
size1D: 2.53
@ **360V** on GEMs

COSMICS - ArCO2
charge1D: 3000 ADC
size1D: 4.1
@ **380V** on GEMs

TB201506 - ArCO2
charge1D: 3000 ADC
size1D: 4.0
@ **380V** on GEMs
(no data but a reasonable value)



The values of cosmics at 360V differs from the TB but they belong to the trend.

Cluster size and charge

The comparison between cosmic ray and a testbeam is a challenge

Should it be better to focus on one chamber?

Should we consider also the other chamber to understand the performance variability with “different” detectors?

The variables to consider increase too much if we consider all the chambers, then we focus only on the one in the middle

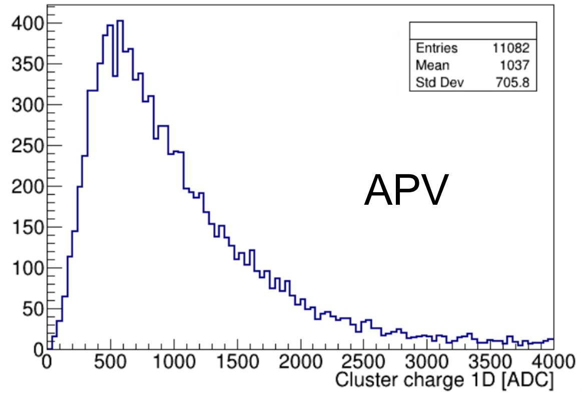
Cluster size and charge APV and TIGER

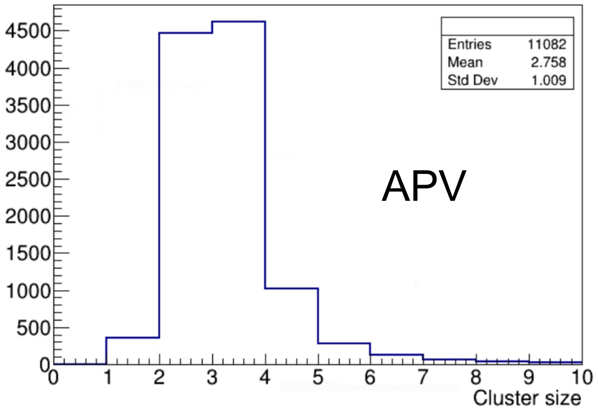
Let’s consider only chamber2 (in the middle of the setup) and look at the cluster charge and size.
The setup is almost the same (same chamber, same HV filter, same HV)

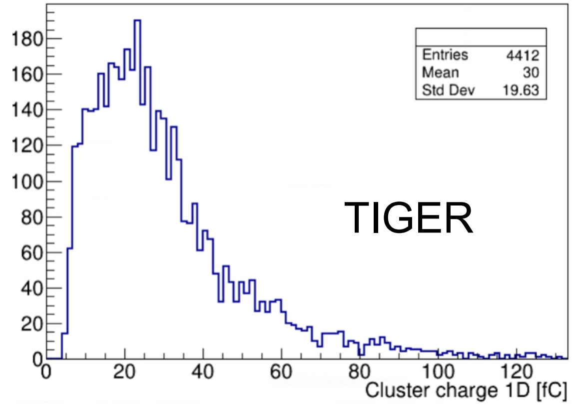
NB: to increase the statistic several TIGER runs with different integration time have been used

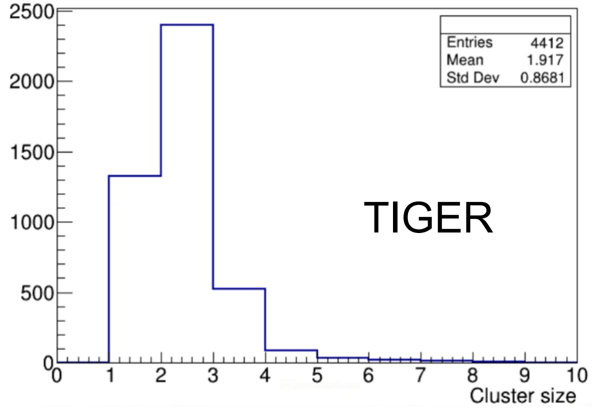
Variable under investigation:
- charge
- size
- efficiency (90-95% both setup)
- sigma residual (350-400μm both setup)

Open questions:
- integration time
- drift velocity
--> see Alberto’s presentation









Cluster size and charge APV and TIGER

Charge measurement differences are know:

APV samples the signal 27 times and the maximum value is used
TIGER use a fixed (settable) sampling time

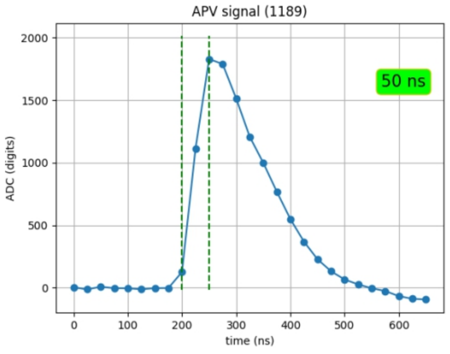
Parameter of interest:

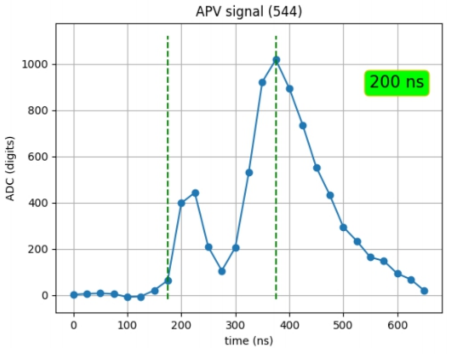
time distribution of the signal
electronics shaping time
noise and threshold

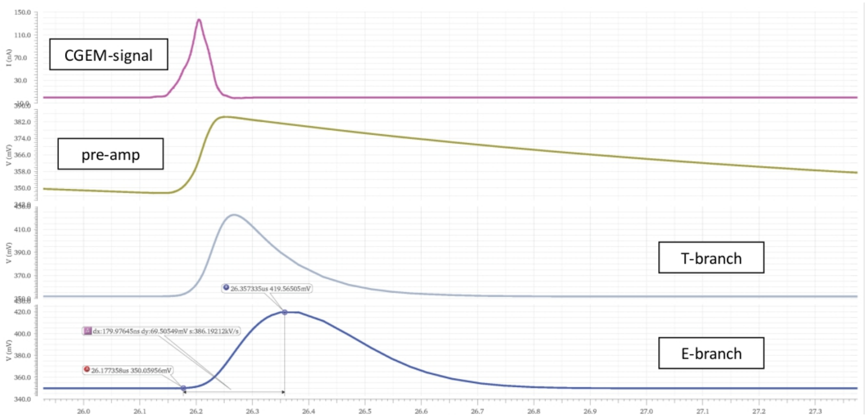
In order to complete the comprehension we plan to used the signal shape from the APV and to process it with the TIGER simulation. This study will also be performed with simulated signal from PARSIFAL.

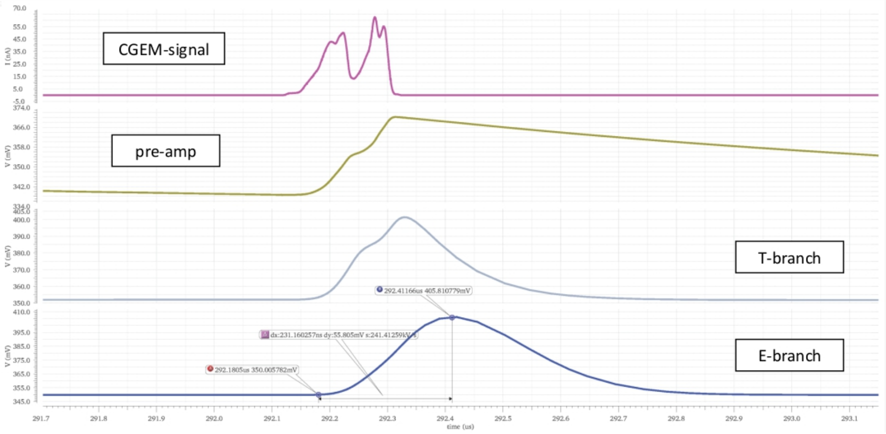
Saturation levels are different of about 5-10 fC and this impact on the charge measured at 0° where most of the charge is collected by the saturated channel.

Cluster size differences are under study. Possible reasons are the disconnected strip in the TIGER setup --> see Alberto's talk
We plan further studies to investigate the readout chain, if some hits are lost.









Conclusion

The cosmic ray stand in Ferrara is useful to understand the problems we are facing in the analysis of the PEK data.

Some improvements w.r.t. Beijing have been introduced (i.e. HV filter, local fanout).
We still have to understand their impact on the performance.

The efficiency measured with TIGER and the cosmics stand in Ferrara (90-95%) is greater than the Beijing setup (87%), but still smaller than the TB (98%).

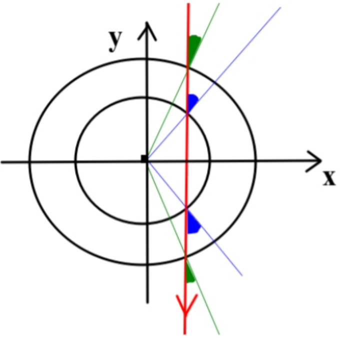
Spatial resolution and efficiency can be measured successfully only with a TB.

The charge difference between the two readout system is almost clear. Simulation of the TIGER will be used to complete this task.

Thanks

Backup: TOY-MC

Toy simulation



1. Randomize the position of the cosmic ray [0, R_L1]

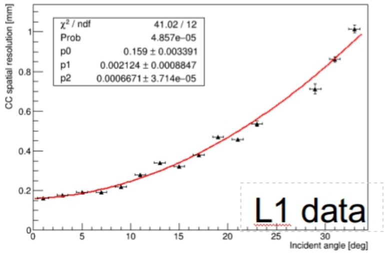
2. Smear the track incident angle of 0.36 deg (from Marco's calculation) for L1down and L2down

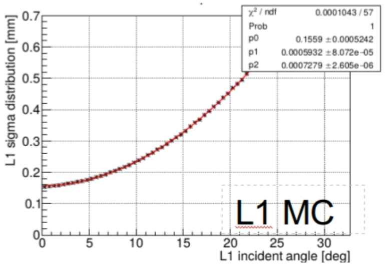
3. Evaluate the expected CC resolution at the impact point using the function
CC_res = 80 µm + 3.0 µm/deg * angle + 0.65 µm/deg^2 * angle^2

4. Smear the four point on the X direction and extract the corresponding Y

5. Use three point to reconstruct the track and measure the residual distribution and the constribution of the tracking system = sqrt(sigma_recon^2 - sigma_true^2)

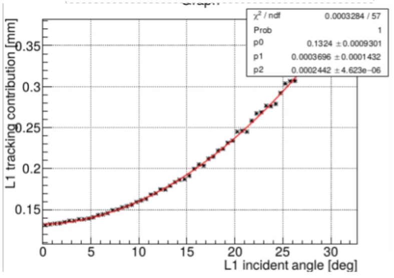
The function used to evaluate the CC_res has been calculated in order to match the reconstructed CC_res in the MC data with the experimental data below 20µm





Toy results

Contribution of the tracking system on L1



1. The thrend of the constribution of the tracking system now is reasonable with respect to the one shown on April 8

2. This results is important to understand the behavior of the µTPC once the incident angle is larger than 15° but it does not explain the difference between µTPC resolution of the CGEM and the planar GEM.
(See next slide.)

3. The MC resolution for L1 matchs the experimental data but the MC resolution of L2 does not. L2 seems to be different from L1 or the systematic are not measured properly. A different function could be used to estimate the CC resolution as a function of the angle for L2.
(Compare the plot of the previous slide with the one in the next.)

4. The CGEM CC resolution has a parabolic behavior as a function of the angle while in the planar GEM it has a linear behavior. This is not understood.