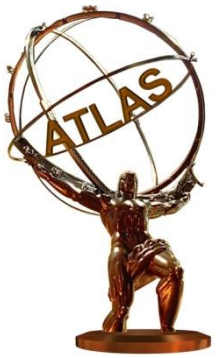


New results from MMSW Micromegas quadruplet

M. Bianco [a], H. Danielsson [a], J. Degrange [a], R. De Oliveira [a], F. Perez Gomez [a], P. Iengo [a], F. Kuger [a,c] Tai-Hua Lin [b], O. Sidiropoulou [a,c], M. Schott [b], G. Sekhniaidze [d], C Valderanis [b], M. Vergain [a] J. Wotschack [a]

[a] CERN, [b] University of Mainz, [c] University of Wuerzburg, [d] INFN Naples

Outline

- Introduction
- MMSW construction tooling
- First cosmic data
- X-Ray characterization
- Conclusions

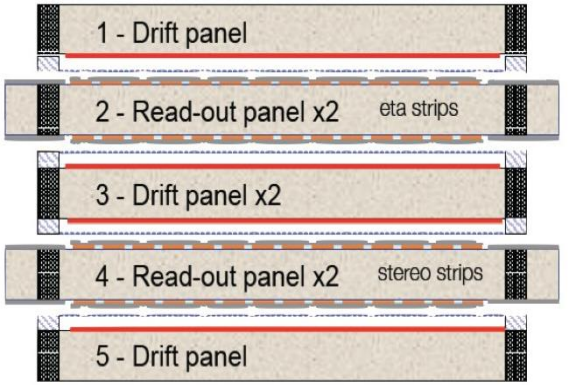
The Micromegas Small Wheel (MMSW) prototype

Two medium size Micromegas quadruplets prototype have been built at CERN in 2014

The 0,5m^2 prototype adopts the general design foreseen for the Micromegas detectors in the NSW project:

- A quadruplet structure with two double sided readout boards, one double sided and two single sided support (drift) panels equipped with the drift electrode and the micromesh.
- Readout comprises of 1024 strips per plane with a pitch of 415µm. The strips are rotated by ±1,5º on two planes to measure the second coordinate. Expected resolution: better than 100 microns in the precision coordinate, better than 2.5 mm in the second coordinate .
- The readout strips are covered by Kapton® foil with sputtered resistive strips to improve spark tolerance , the drift gap is 5 mm.
- The resistive strips are divided in the center and power from the two external side.

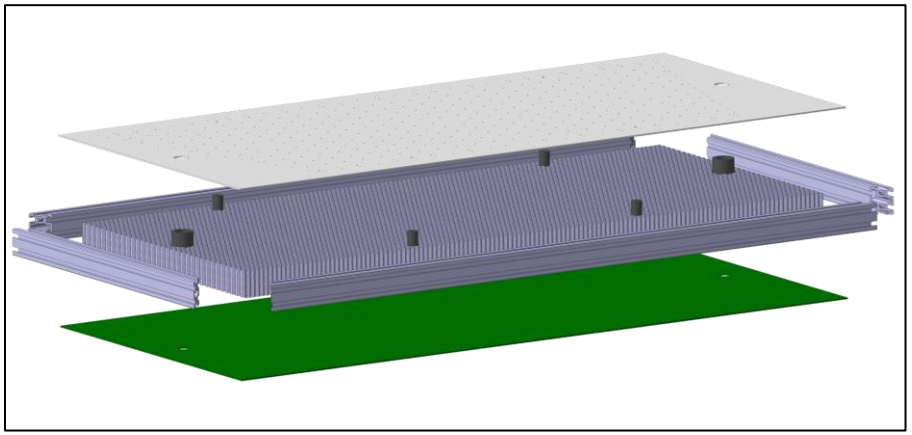
These chambers are the first MMs quadruplets ever built



MMSW: Tools & procedures for construction

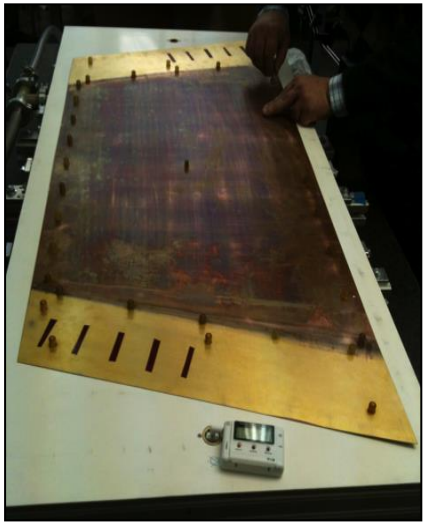
Two vacuum Stiff-backs are used to accurately position and fix the readout / drift boards during the gluing process.

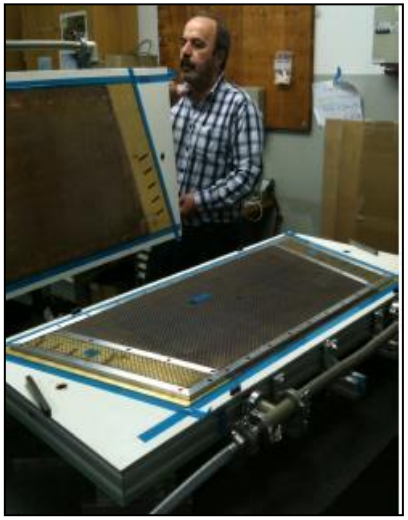
A Gel coat + glass fiber surface is meant to inherit the flatness of the marble table the Stiff-back is produced on. The honeycomb structure ensures stiffness and low weight.



Panel Construction procedure steps:

- PCBs placed face down on the upper and lower halves of the assembly table and sucked
- Glue distributed on the inner face of PCB1 and Al frame and honeycomb positioned together with reference pins for alignment
- Glue distributed on PCB2
- PCB2 glued on the top side of the Al honeycomb to get the full panel
- Glue curing
- More info, see talk RD51 June 2014



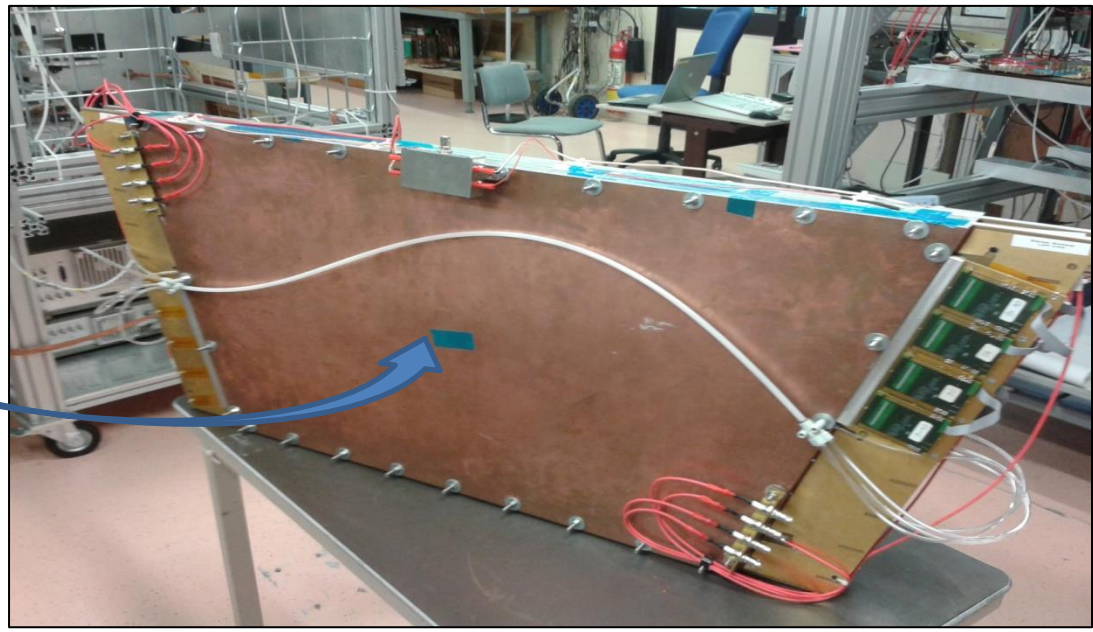


The Micromegas Small Wheel (MMSW) prototype

Chamber preparation and equipment:

- HV distributors for the resistive strips and drift panels are installed on the sides of the chamber
- Two gas manifolds allow to flush independently the four layers
- The APV25 boards are plugged on mezzanine cards inserted on the readout panels, connecting through Zebra connectors, the readout strips to the Panasonic connectors used by the APV25 boards.

A screw at the centre of the chamber prevents panel deformation due to the overpressure generated by the gas



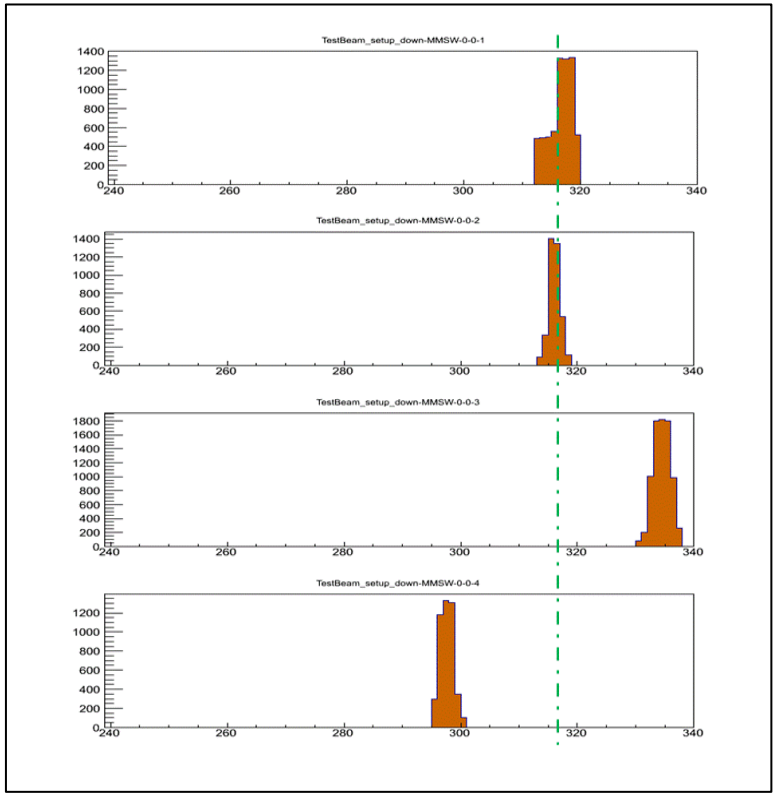
Test with cosmic rays

A preliminary chamber characterization has been carried out with cosmic rays with a dedicated cosmic-rays test-stand that was installed in the CERN laboratory of the RD51 Collaboration.

The cosmic-stand is composed of two planes of 12 plastic scintillators each, for a total active area of about 2.5 ×1.1 m^2 2m apart, providing large and uniform cosmic muon trigger.

The chamber was operated with Ar/CO_2 93/7% gas mixture with a flow of few l/hour, the drift field was set at 600V/cm while the high voltage on the resistive strips was changed according to the studies of interest

Test with cosmic rays



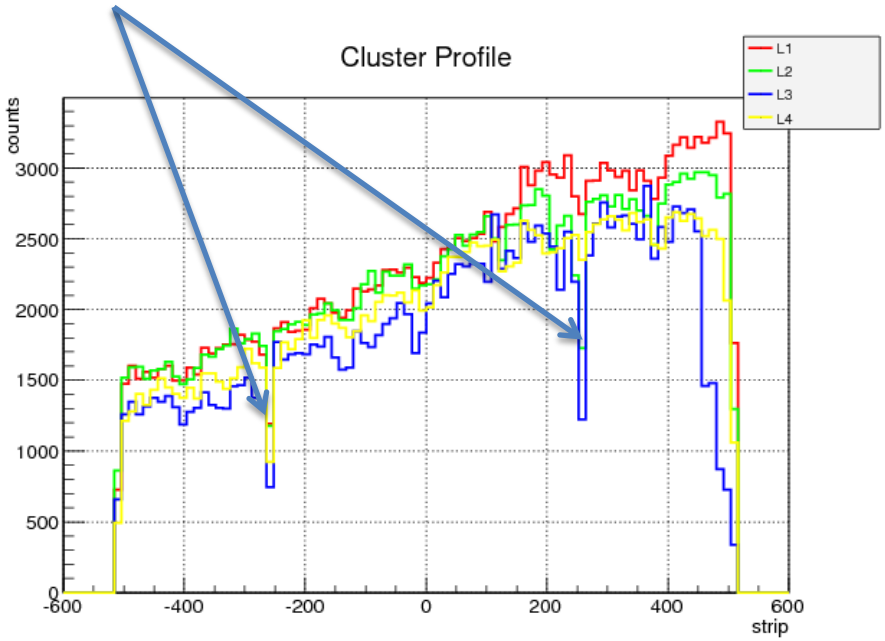
Using APV25 front-end ASIC, an SRS based readout system (multiple FECs) and the dedicated DAQ software (MMDAQ3) cosmic rays have been detected in all detector layers simultaneously.

Full track-events have been observed and successfully reconstructed.

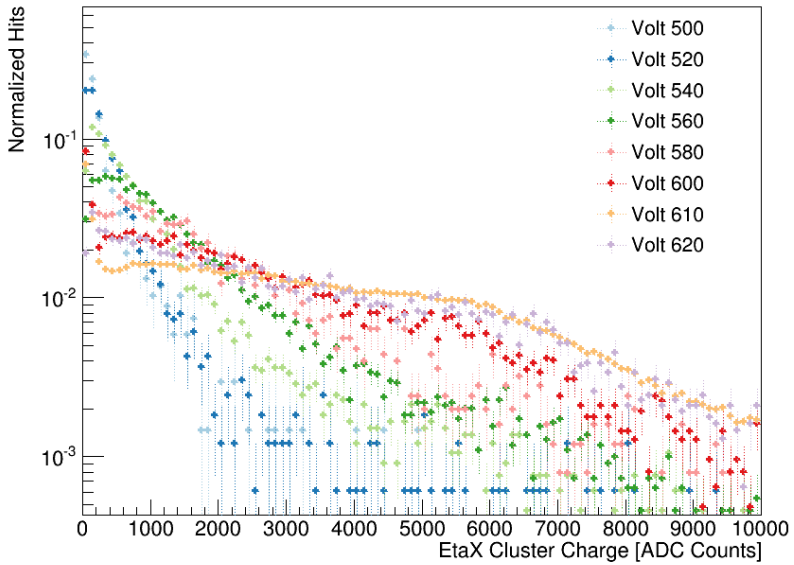
For a vertical track, while the clusters on the first and second layers look aligned, due to the presence of stereo strips on the third and fourth layers, the clusters can look to be far from the ideal vertical line.
This is an effect of the stereo strips.
The distance of the cluster from such a vertical line is a function of the distance of the incoming particle to the center of the chamber.

Test with cosmic rays

Bad connector contact



Cluster profile for the four active layers, the inclined shape is due to the chamber geometry, strips at higher number are longer.

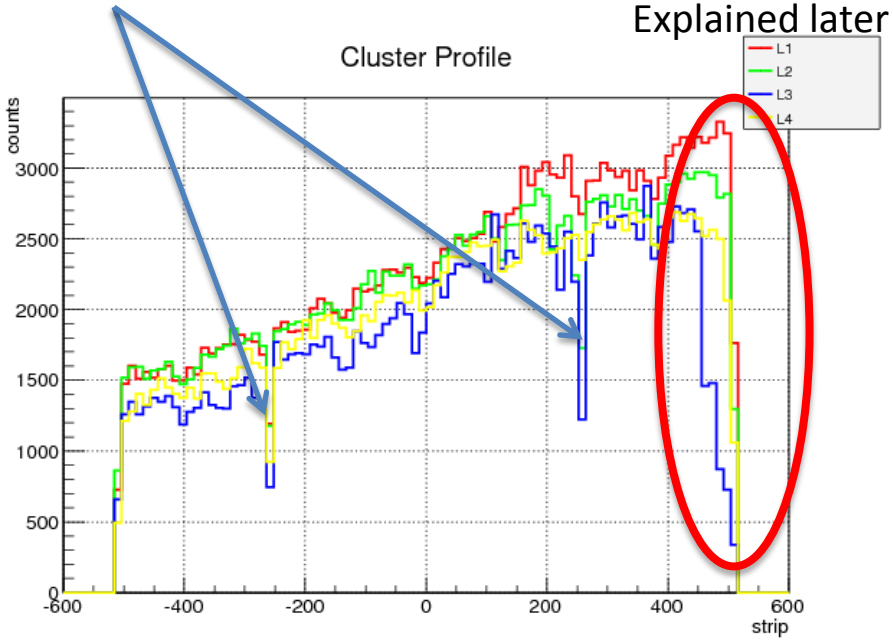


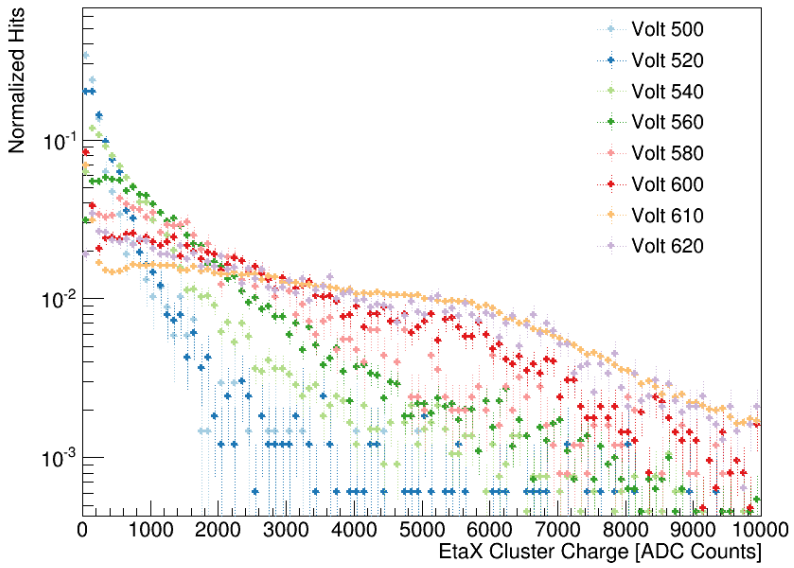
Cluster charge distribution for different HV value applied to the resistive strips

Test with cosmic rays

Bad connector contact

Amplification problem on Ly3
Explained later





Cluster profile for the four active layers, the inclined shape is due to the chamber geometry, strips at higher number are longer.

Cluster charge distribution for different HV value applied to the resistive strips

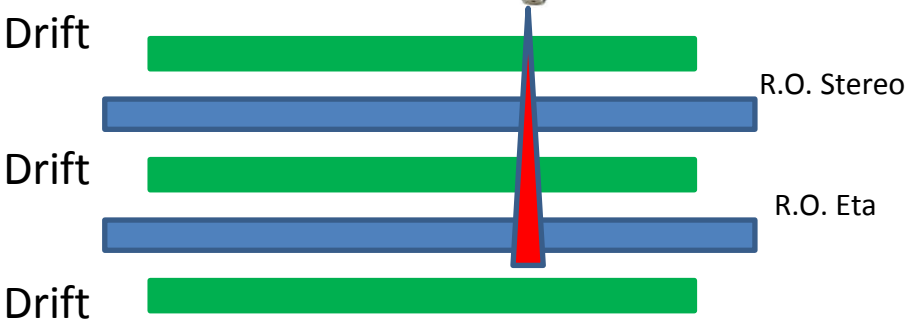
Test with X-Rays

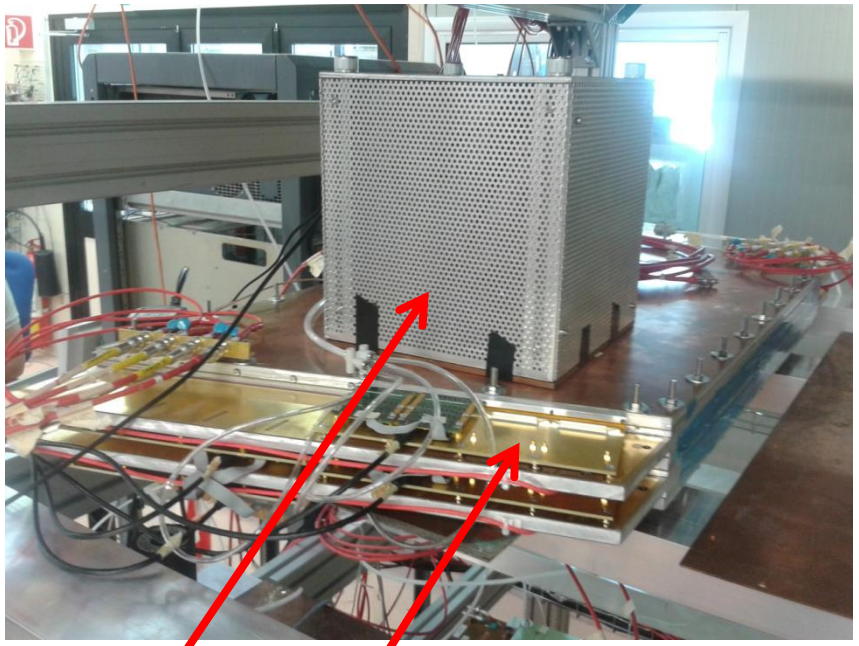
Why X-Ray test?

- Define a fast method to determine the gain uniformity reading the gap current under X-Ray irradiation
- Check the effect of the interconnection screw on the amplification
- Identify possible hot spot in the chamber
- Check the relative alignment of the readout planes

Test with X-Rays (Setup)

MiniX-Ray Gun (Ag),
HV up to 50 keV
Cur up to 79 microA
(with 50 KeV)





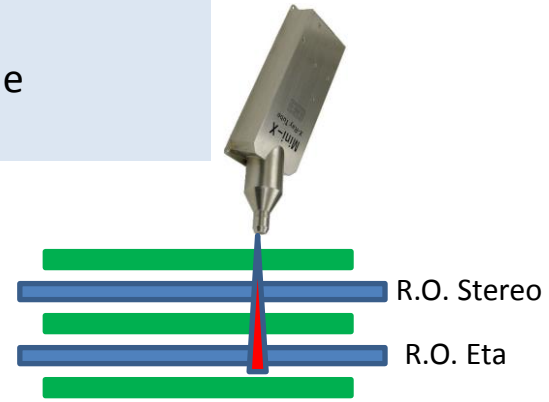
MMSW

Shielding Box for Ag Mini X gun

- **8 HV channels for the R.O. Panels**

Test with X-Rays (Setup)

- X-ray gun running at maximum energy and minimum current (50 KeV / 5 micro A) in order to produce X-rays able to go through all the panels with low flux.
- Readout plane 4 (stereo) closest to the X-ray gun
- HV adjusted in order to have small and similar currents in all gaps : HV L_4= 480 V, HV L_3= 515 V, HV L_2= 540 V, HV L_1= 550 V, Drift =300 V.
- With such HV settings the measurements are not affected by HV drop caused by strip resistivity.
- Several scans have been performed:
  - Coarse scan on the entire surface
  - Finer scan close to the centre in order to understand the effect of the interconnection.

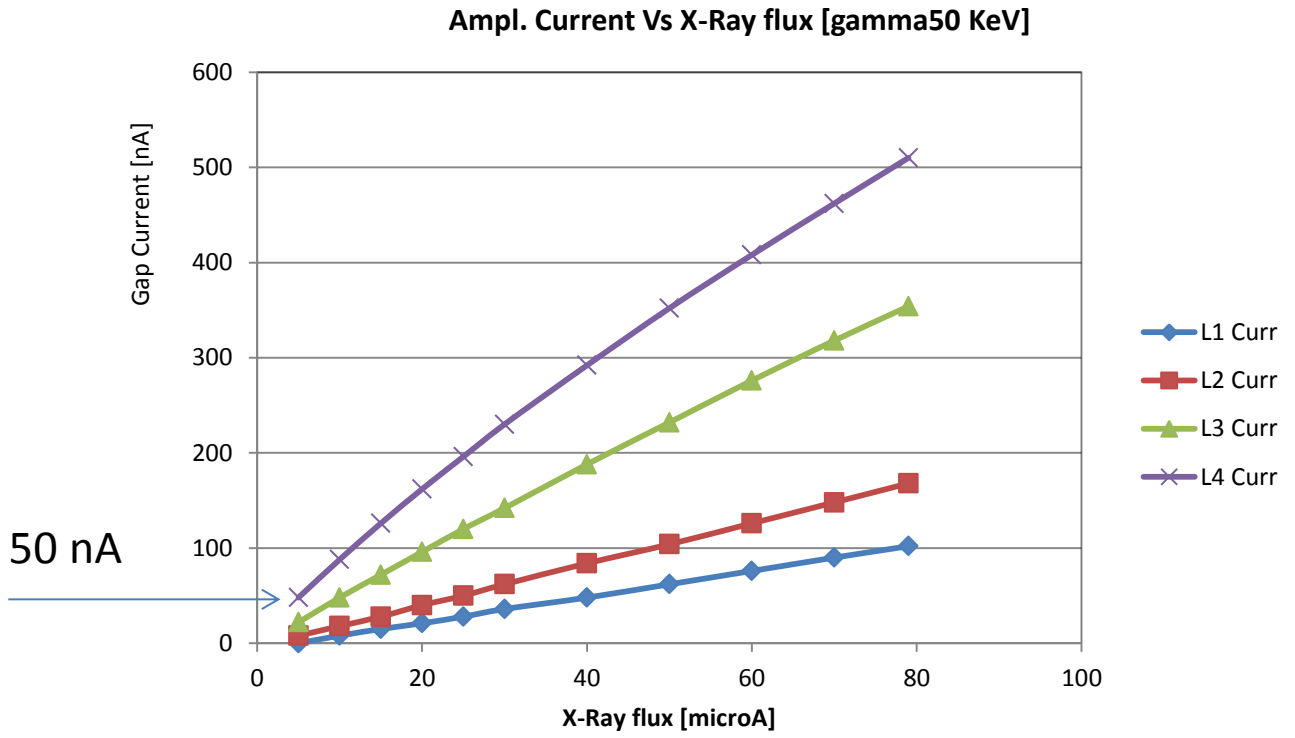


Test with X-Rays: HV drop estimation

Ampl. Curr. ~ 50 nA
Resistivity ~ 5/10 MΩ

Hv_{drop} = 50 nA x 5/10 MΩ ~ 0.25/0.5 Volts

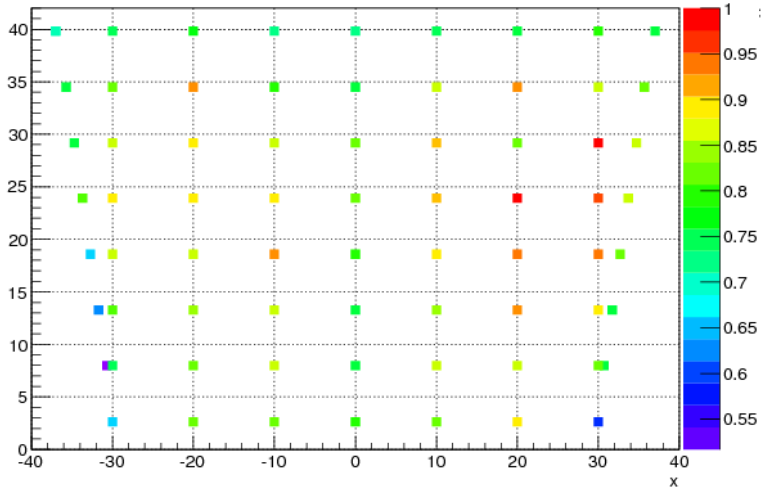
Working region ~ 50 nA



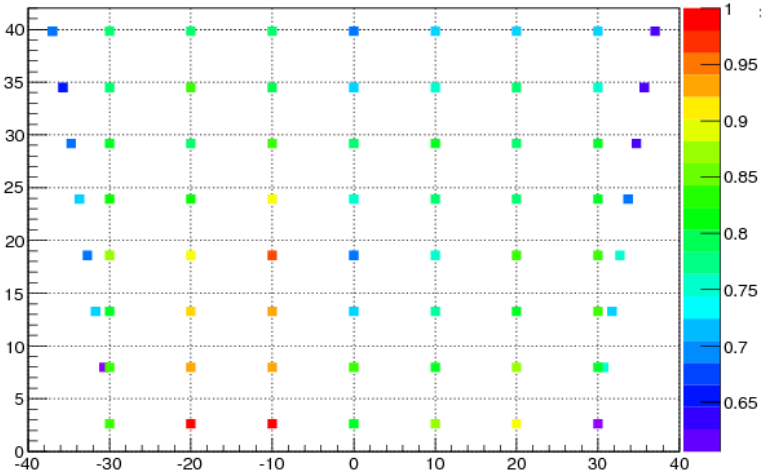
Test with X-Rays (2D maps)

Current values normalized independently on each layer

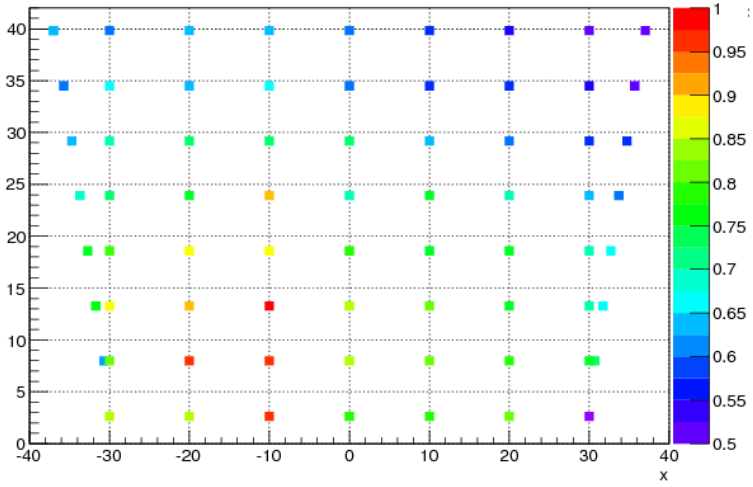
Layer 1



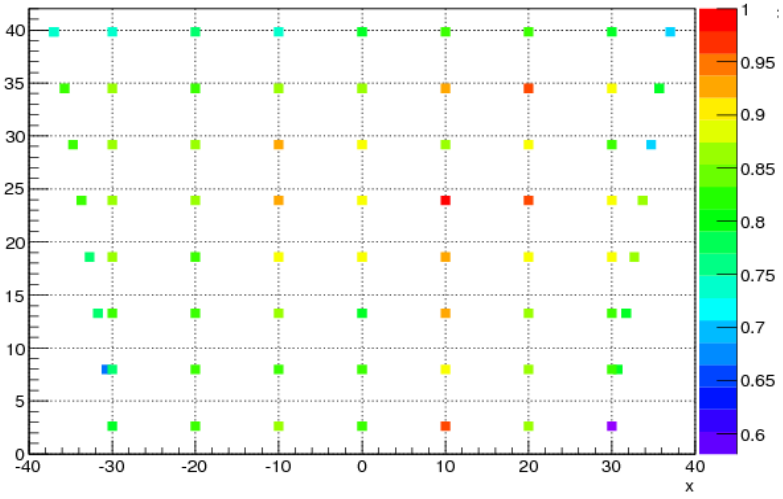
Layer 2



Layer 3

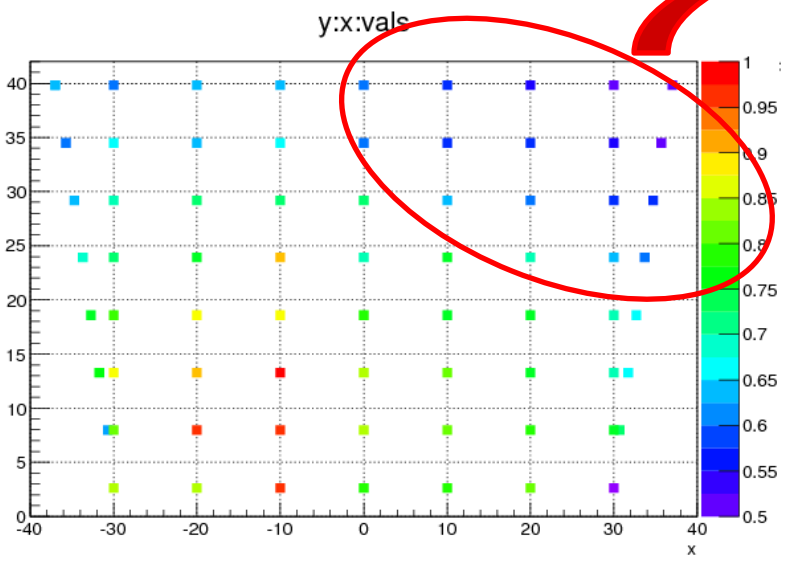


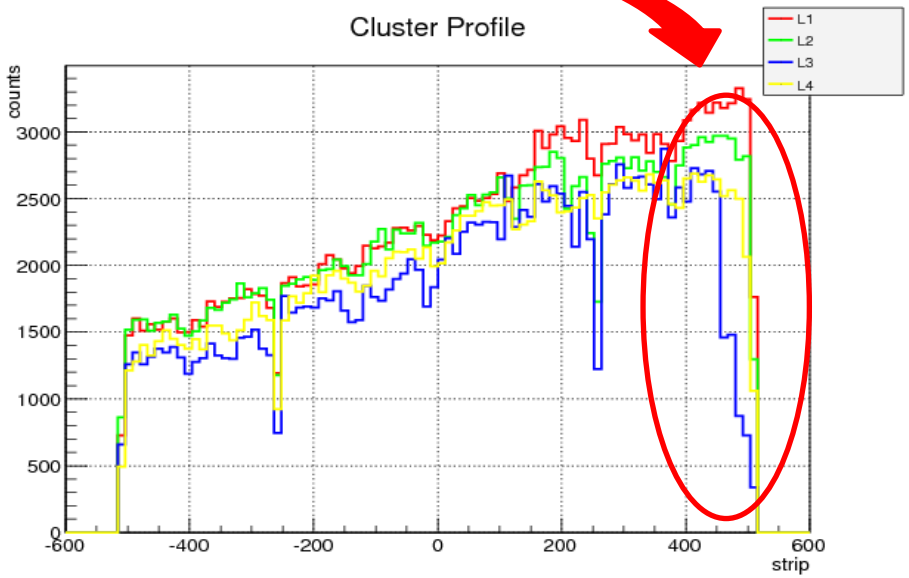
Layer 4



Comparison between X-Rays and Cosmic results

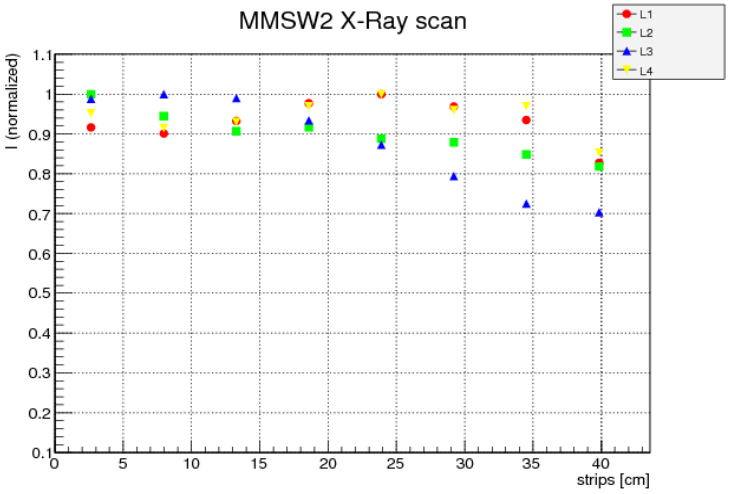
Layer 3 X-Rays current map

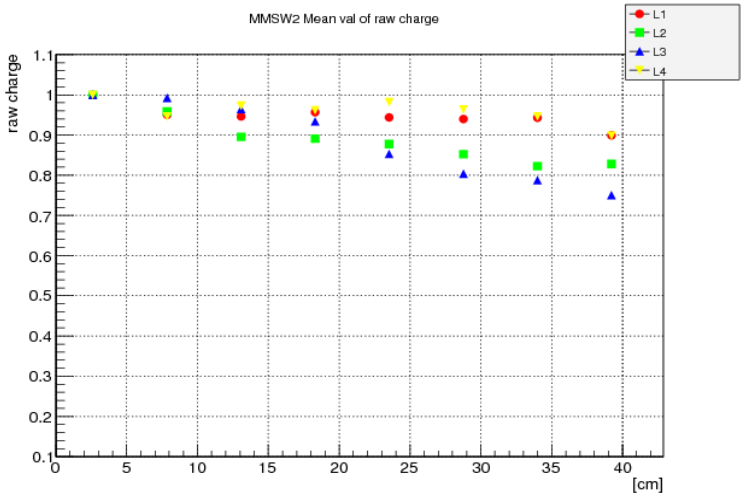




A drop of amplification current in the X-Ray surface scan corresponds to an anomalous drop of the cluster acquired with cosmic data

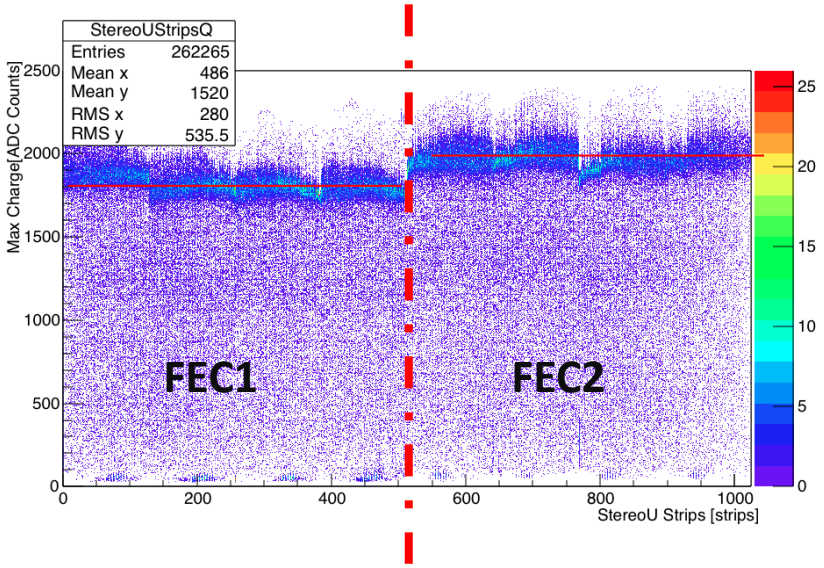
Comparison between X-Rays and Cosmic results





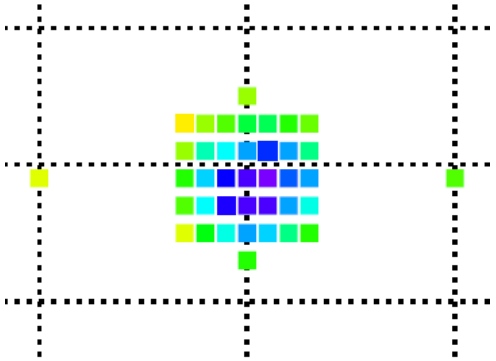
Quite similar behaviours between the amplification current induced by the X-Ray and the charge produced by the cosmic are observed

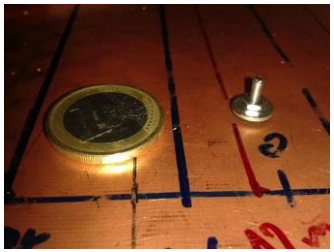
For a better comparison, calibration of all the front-end electronics (APV and FEC) is needed, not yet done in our analysis



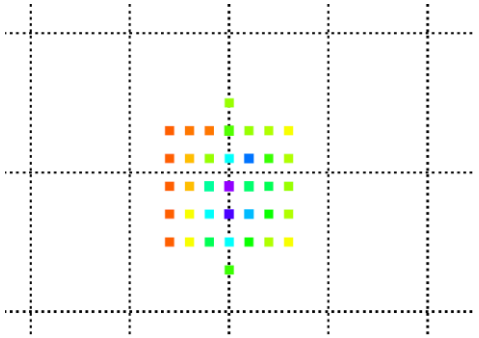
Test with X-Rays (Fine scan around the interconnection screw)

L2 current value closes to the interconnection; interconnection released.

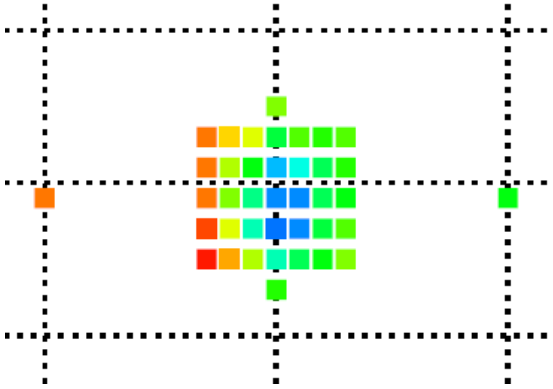


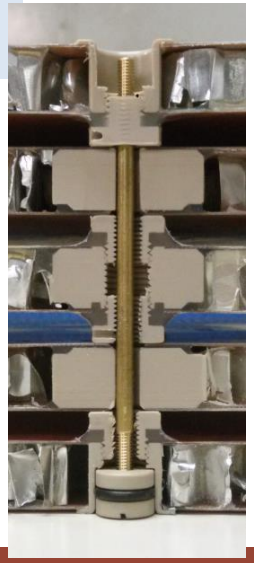


L2 current values close to the interconnection; interconnection tight.

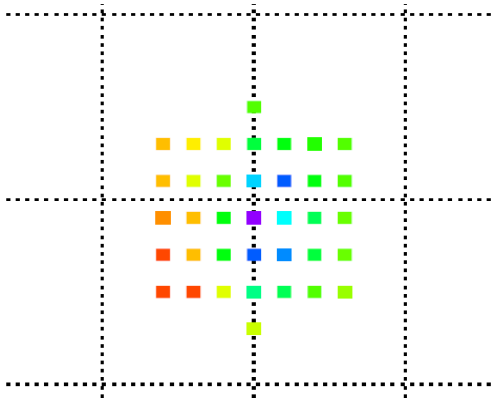


L3 current values close to the interconnection; interconnection released.



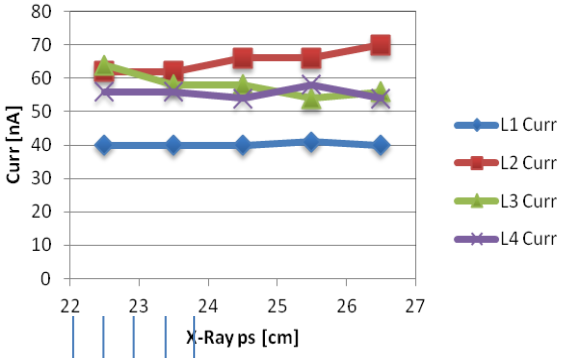


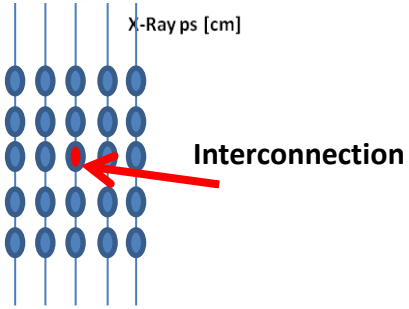
L3 current values close to the interconnection; interconnection tight.



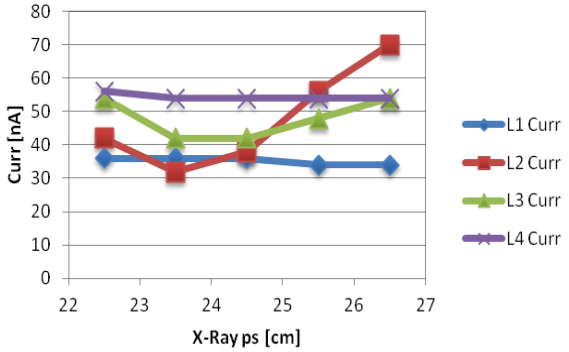
Test with X-Rays (Fine scan around the interconnection screw)

x = -2 cm

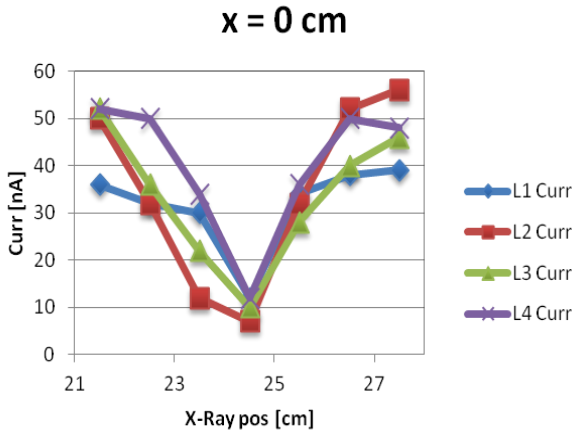




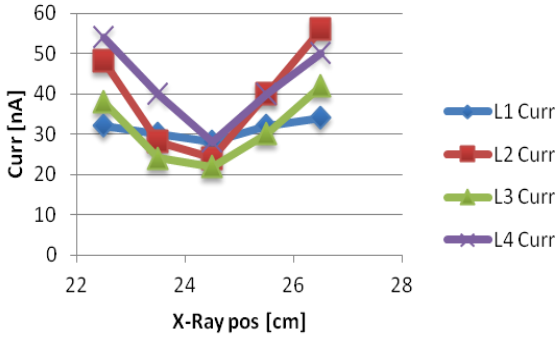
x = -1 cm



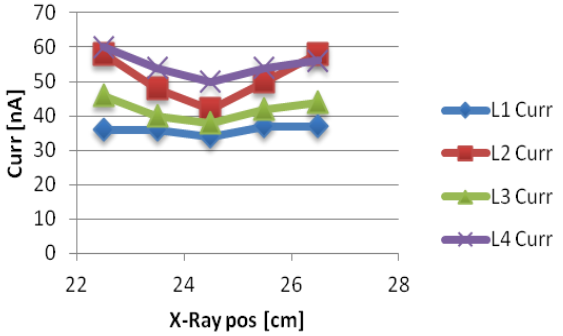
x = 0 cm



x = +1 cm

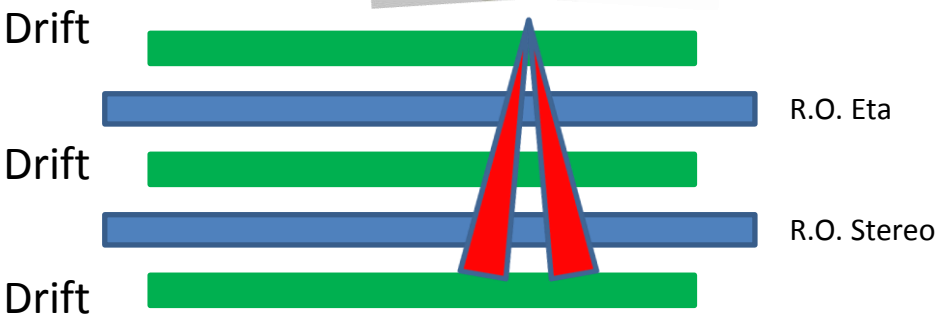


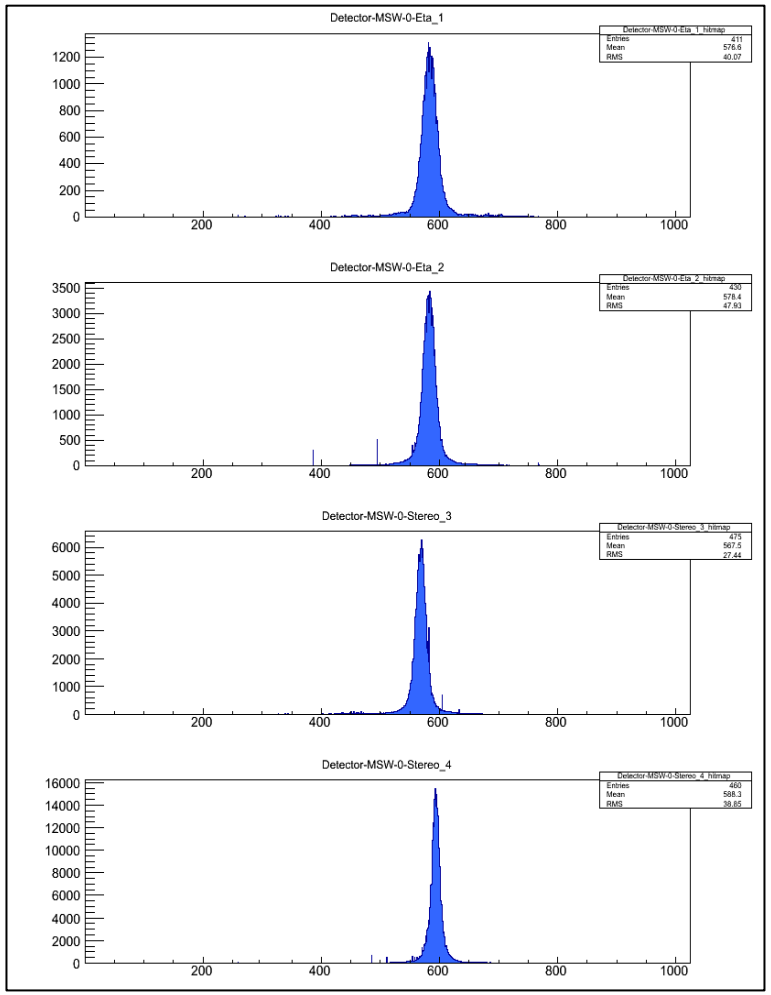
x = +2 cm



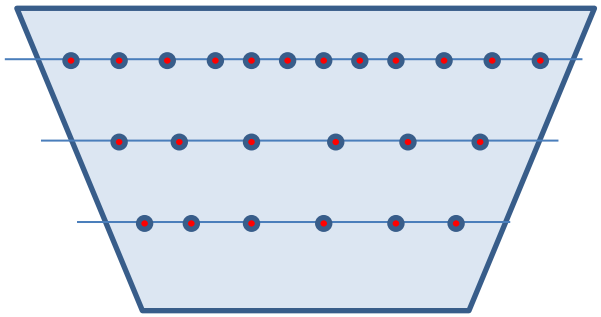
Alignment studies with the X-Rays

The idea is to use the Micromegas response at the X-Ray to check the relative alignment between the panels.
To correct the measurement for possible inclination of the X-Ray device w.r.t. the panel surface, two different runs for each point under measurement have been acquired in two different position 0° and 180°

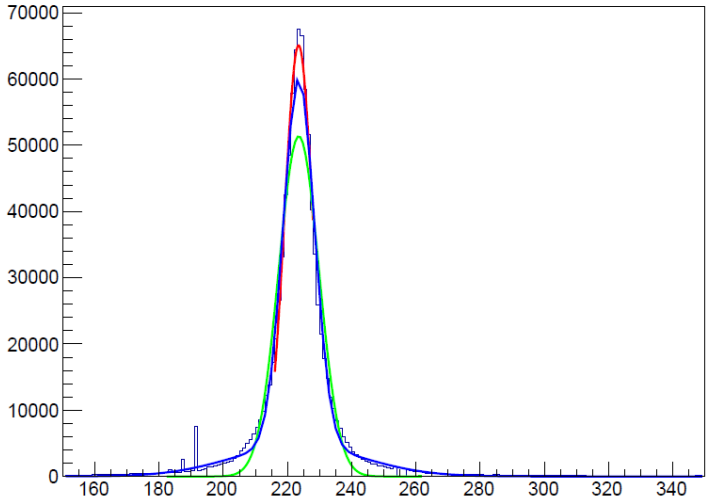


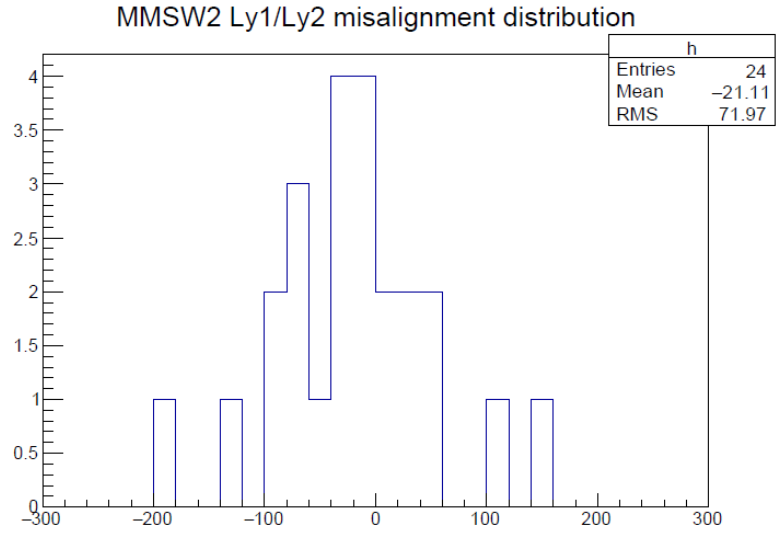


Alignment studies with the X-Rays



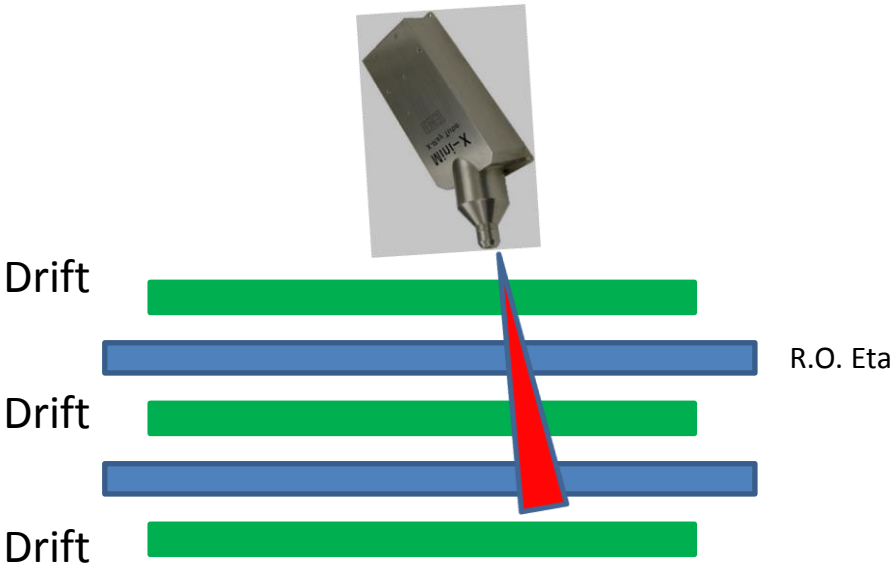
- The relative alignment of the panels has been tested in several points.
- In each case a double Gaussian fit at the data has been performed and the average between the mean value obtained from the fit at 0° and 180° has been evaluated.
- The difference from the mean value obtained in two adjacent panels represent the displacement for the specific point.
- A global distribution of the relative displacement shows an average misalignment at the level of 20 µm with 70 µm RMS

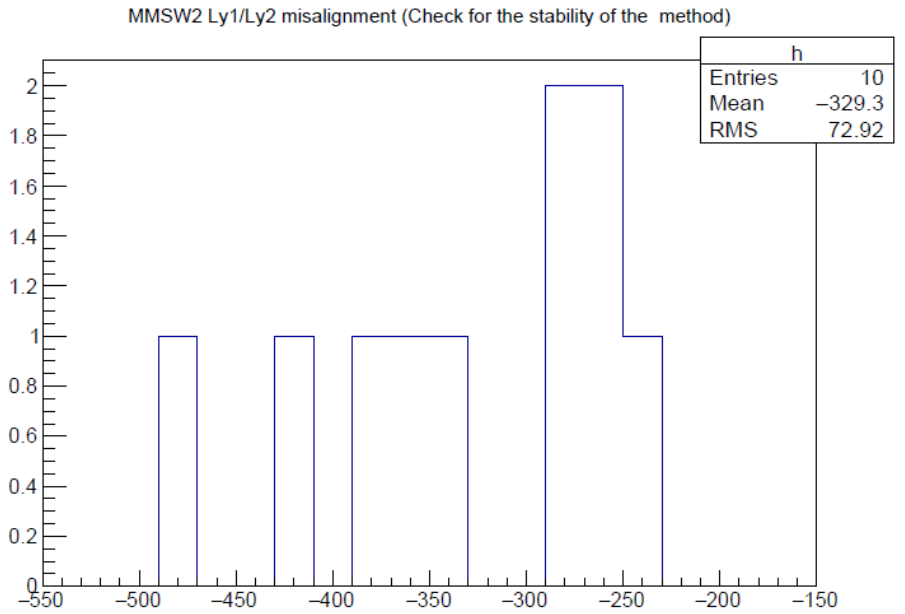




Alignment studies with the X-Rays

- In order to evaluate the systematic error of the method several runs have been acquired with the X-Ray in a fixed position
- The distribution of the differences shows an RMS at the level of 70 µm
- More tests are needed to understand the accuracy of the method.



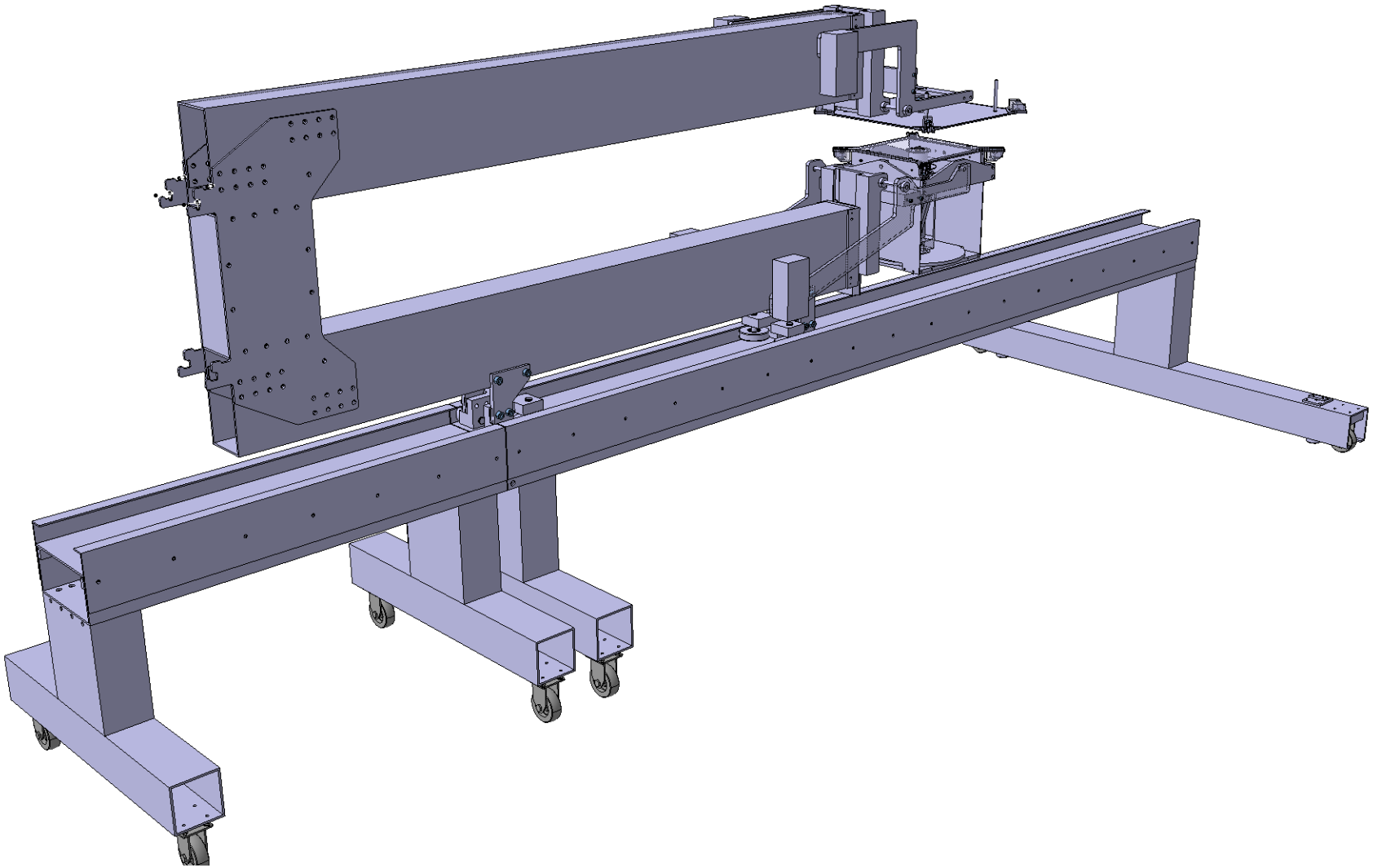


Summary and outlook

- We have constructed two 1 x 0.5 m2 Micromegas quadruplets chambers with 0.415 mm strip pitch and 4096 r/o channels, the first quadruplets built so far.
- Preliminary detector characterization has been performed, detailed analysis of cosmic data and test beam data is ongoing (see talk on MAMMA testbeam in the morning session)
- We have shown that monitoring the HV current under X-Ray irradiation is a fast method to check the gain uniformity across the chamber.
- The Amptek Ag Mini X-Ray device satisfies our requirements to test the ATLAS MMs with X-Rays.
- The internal chamber alignment can be tested with the X-Ray device, the accuracy of the method is under evaluation
- One MMSW will be installed at GIF++ middle of April for long term aging test.
- The second MMSW will be installed in the ATLAS Pit and fully integrated in the experiment.

Thanks for your attention

Backup slide



Test with cosmic rays