



MICROMEAS R&D FOR ATLAS MUON PHASE II UPGRADE

LHCC Meeting, February 2017

Introduction

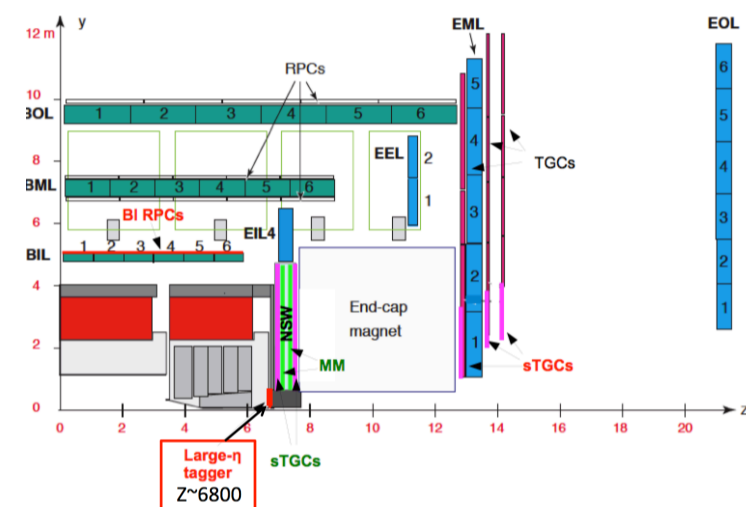
In the framework of the ATLAS Phase II Upgrade, the possibility to extend the detector acceptance of the muon system to high η has been investigated. The Micromegas technology represents one of the most promising candidate for the purpose [1].

The development of the first Micromegas prototype for the new detector, based on small readout pads aiming to efficiently work in high rate environments, is presented here.

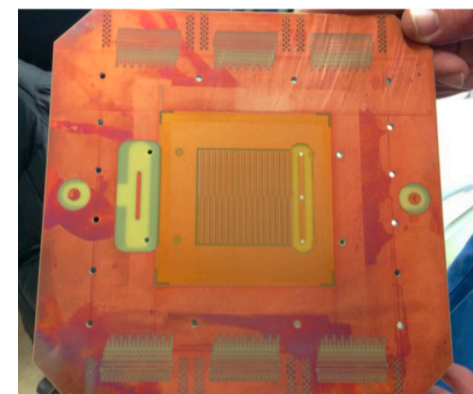
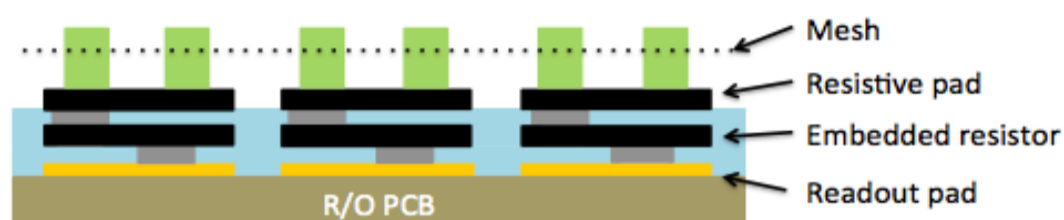
Muon Phase II Upgrade Proposal

Development of a new muon detector up to $\eta \sim 4$ in the forward region has been demonstrated enhancing physics performance [2].

The new solution should tag muons in extremely high rate environment (up to **10 MHz/cm²**) and in absence of magnetic field. The proposed location is between the end-cap calorimeter cryostat and the JD shielding. The allowed detector thickness is ~ 5 cm, with radial dimensions of 25 and 90 cm for the inner and outer radius, respectively.



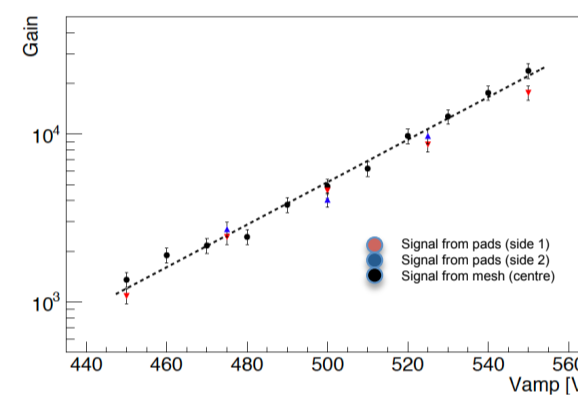
Small Pads Resistive Micromegas



Design is based on **resistive** Micromegas technology, with small pad pattern and embedded resistor [3, 4].

A first prototype has been built(*), composed of a matrix of 48x16 pads (0.8 mm x 2.8 mm each) for a total number of 768 readout channels. Pillars are created on the readout PCB, defining an amplification region of **128 μ m**. The drift plane is kept at **5 mm** from the mesh.

Characterization has been carried out with ⁵⁵Fe source and Ar/CO₂ (93:7) as gas mixture. The amplification factor has been measured to be $\sim 10^4$, with the chamber operated at $V_{amp} = 530$ V and $V_{drift} = 300$ V compatible with standard Micromegas chambers.

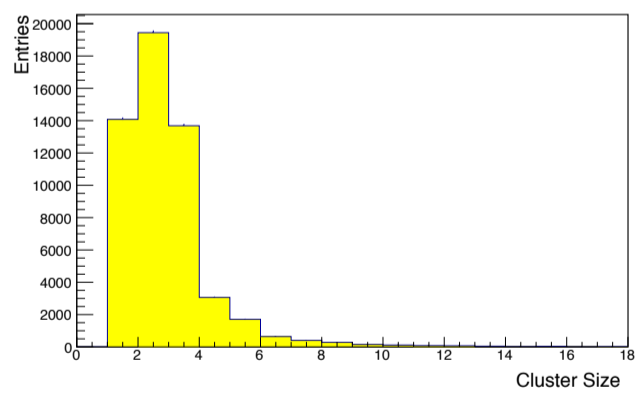


Performance Studies

Performance studies of the prototype have been carried out at SPS H4 beam line at CERN, with muons beam(**).

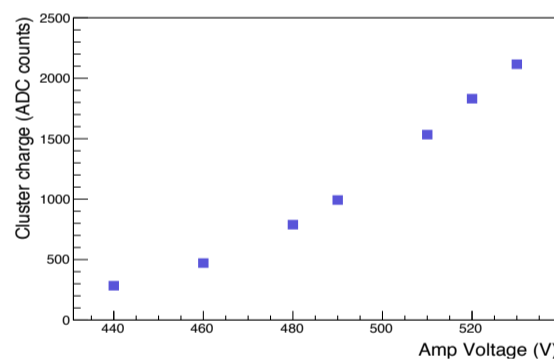
Tracking has been performed with 2 bulk double readout Micromegas chambers (X,Y) readout via APV25 and SRS [5].

The gas mixture used was Ar/CO₂ 93:7.

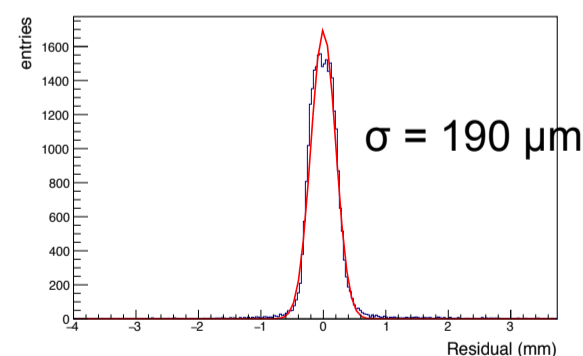


Event clusterization has been performed using **topological** reconstruction algorithm.

Cluster size distribution shows that in average **3 pads** are fired at 520 V_{amp} and 300 V_{drift} .



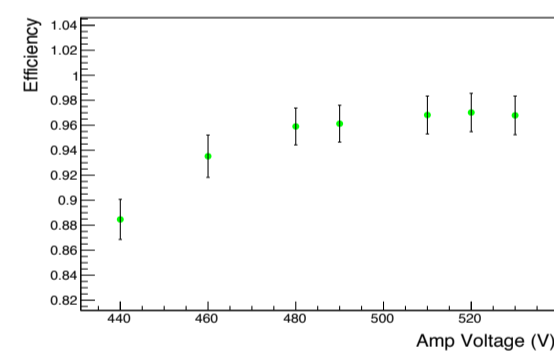
Mean value of the cluster charge as a function of the V_{amp} has been studied.



The **resolution** is evaluated comparing the measured and expected position of the cluster on the Pad Micromegas prototype.

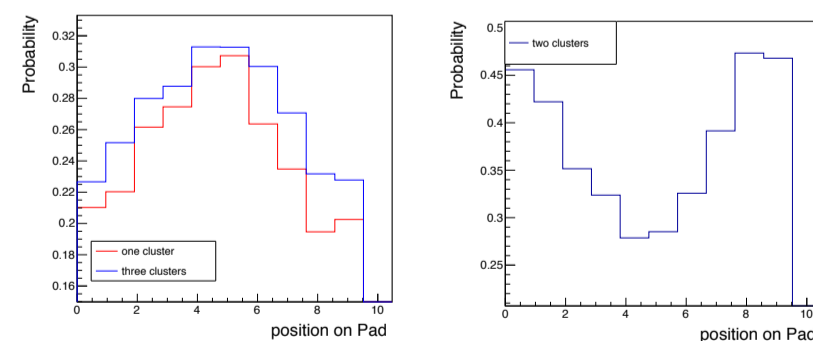
Tracks are reconstructed when one cluster is present on each tracking detector.

Resolution of $\sim 190 \mu$ m has been found, on the precise coordinate.



Efficiency of the detector is evaluated. Chamber is considered efficient if a cluster is found within 600 μ m from the expected position (Obtained according to tracking chambers).

Results show efficiency higher than **97%** from $V_{amp} = 480$ V and $V_{drift} = 300$ V.



Strong dependence of the **cluster dimension** on the **portion of the pad (center or edges)** hit by the particles has been found.

Conclusions

The first Pad Micromegas prototype has been built and characterized providing very promising performance.

X-ray studies are now ongoing to check the behaviour of the chamber at very high rate. In the meanwhile, development of new prototypes having the electronics directly embedded on the PCB is currently under study [4]. This would simplify the channels routing, allowing to build large scale prototypes.

References

- [1] Alexopoulos et al. A spark-resistant bulk-micromegas chamber for high-rate applications (doi: 10.1016/j.nima.2011.03.025)
- [2] ATLAS Collaboration, ATLAS Phase-II Upgrade Scoping Document
- [3] F. Thibaud et al., *Performance of large pixelised Micromegas detectors in the COMPASS environment*, *JINST* **9** (2014) C02005
- [4] C. Adloff et al., Construction and test of a 1x1 m² Micromegas chamber for sampling hadron calorimetry at future lepton colliders, *Nucl. Inst. Meth. A* **729** (2013) 90–101
- [5] M. Raymond, et al., Nuclear Science Symposium Conference Record **2** (2000) 9.