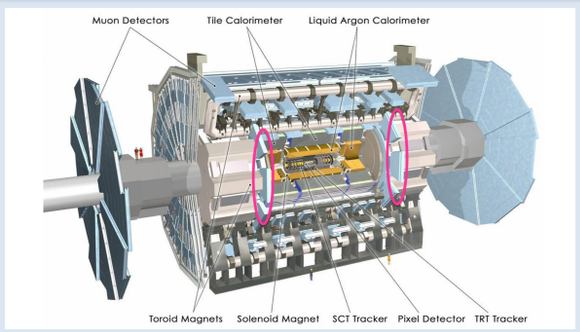
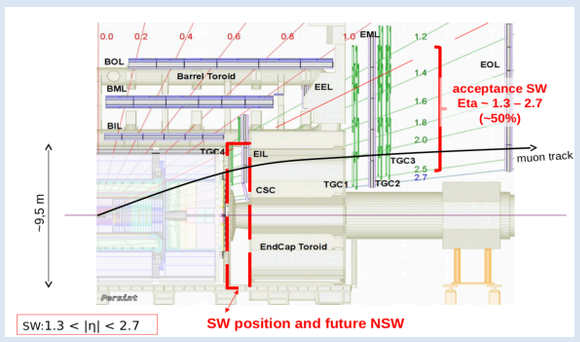
The Micromegas construction project for the ATLAS New Small Wheel

The Micromegas is one of the technologies selected by the ATLAS experiment for the upgrade of the Innermost station of the forward Muon Spectrometer, in order to maintain the precision tracking properties in the upcoming luminosity upgrade of the Large Hadron Collider. The New Small Wheel will have to operate in a high background radiation region, while reconstructing muon tracks as well as furnishing information for the Level-1 trigger. An overview of the design, construction and QA/QC procedures for the Micromegas panels is presented.

The New Small Wheel

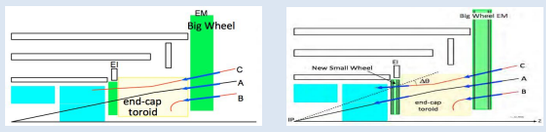




- High rate of tracks (increasing with η)
- Fake triggering
- Higher background rates

Present end-cap muon L1 trigger saturated by fake muons

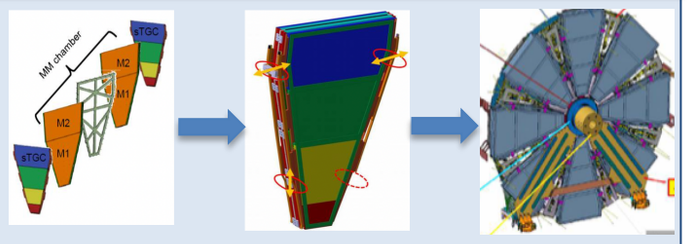
L1 trigger relies only on Big Wheel (fake triggers). Cannot distinguish cases:
- A (real high-p_T track)
- B (low-p_T particle created in toroid)
- C (multiple scattering)



New Small Wheel
- Allows fake tracks filtering by reconstruction of track direction at trigger level
- Extension of L1 trigger coverage with angular resolution of 1 mrad

Configuration

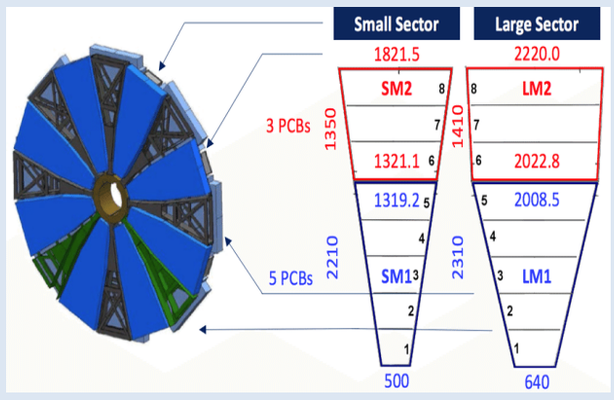
✓ Package of sTGC (small strip TGC) and Micromegas "wedges"



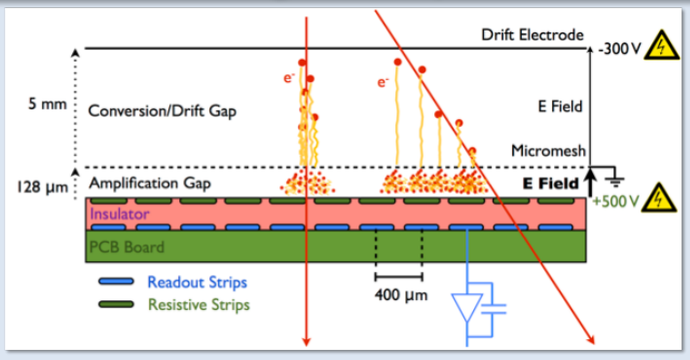
sTGC primary trigger detector
- Good timing resolution for bunch ID
- Online track vector with angle resolution <1 mrad
- pads: region of interest
- strips: track info (strip pitch 3.2 mm)
- wire groups: coarse azimuthal coordinate

Micromegas primary precision tracker
- Good Spatial resolution < 100 μm
- Good track separation (0.4 mm readout granularity)
- Resistive anode strips → suppress discharge influence on efficiency
- Provide online segments for trigger

16 Sectors:
8 Small + 8 Large



Micromegas Operation



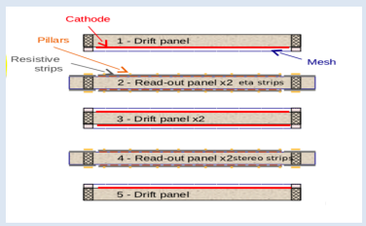
- Charged particles ionize the detector gas (100 pairs/cm in Ar:CO2 93:7 for muons)
- Ionization electrons produced in the conversion/drift gap drift towards the micro-mesh and pass through it due to the high field ratio. Then they are amplified in avalanches in the high field region between micro-mesh and the resistive anode strips, producing a large signal which is then collected on the anode strips
- Fast evacuation of the avalanche ions by the micromesh, thus allowing good operation in a high rate environment

Panel Construction

Structure of module

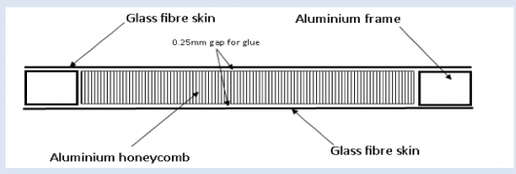
A Micromegas chamber is a quadruplet: 4 gaps provide 4 track measurement points. The 4 gaps are defined by 5 panels

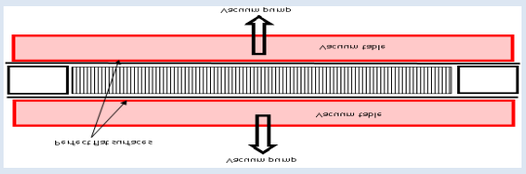
- 3 Drift panels
- 2 Resistive Read out panels



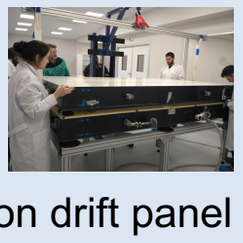
Structure of panel

- Panel is a sandwich of two skins glued on a stiff plane without mechanical constraints
- It consists of two PCBs (500μm) with aluminum made honeycomb and frame in between

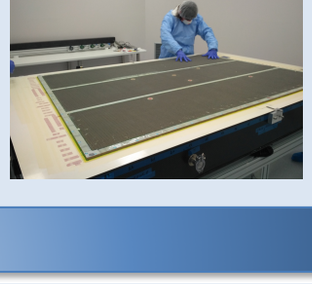




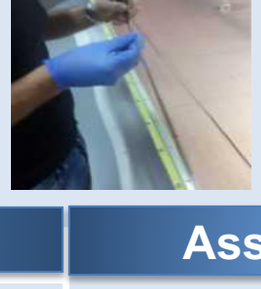
- Super – flat surfaces are required as reference planes
- Double Vacuum tables or Granite + Stiff – back
- Single or dual step processes

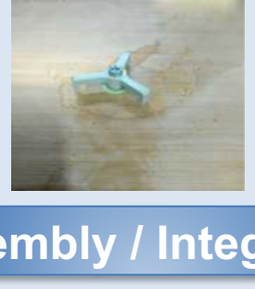


Gluing

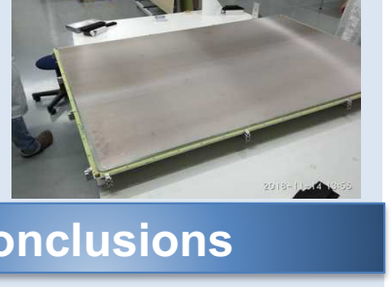


Panel Completion



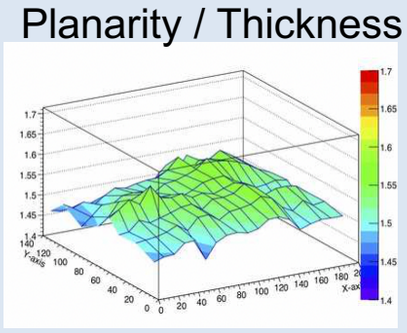


Mesh preparation and gluing on drift panel



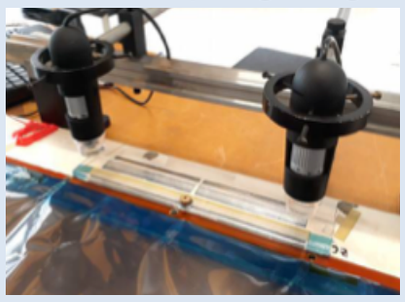
QA / QC

Planarity / Thickness

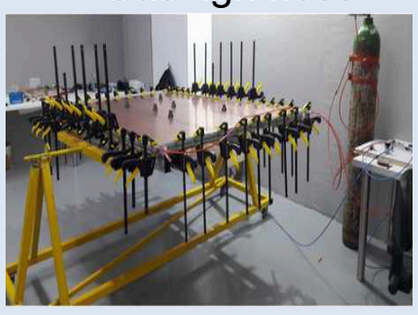


Components

FEB pin gluing

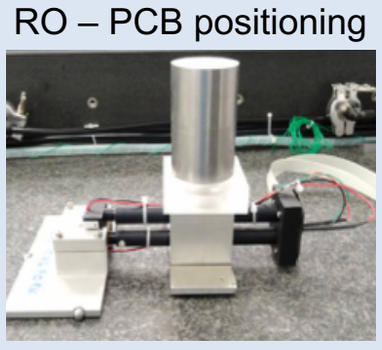


Gas tightness



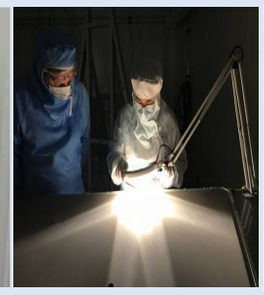
Mesh Tension

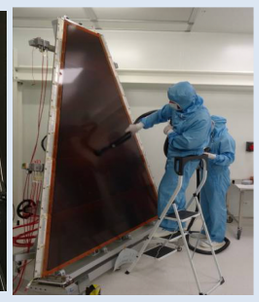
RO – PCB positioning



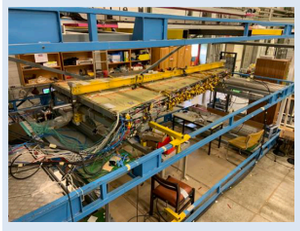
Assembly / Integration

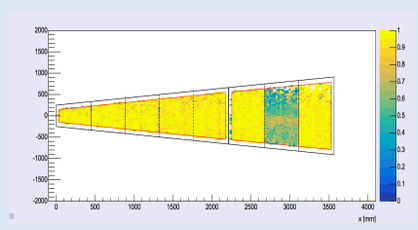
- Strict cleaning protocol before chamber assembly





- Integration@BB5: Cabling / electronics support / Cosmic data





Conclusions

- Complex construction and required mechanical precision of detectors is achieved
- Unprecedented use of large size Micromegas detectors
- Challenging issues and problems treated and solved applying engineering solutions

Bibliography

[1] Y. Giomataris, P. Rebourgeard, J. Robert and G. Charpak, A High granularity position sensitive gaseous detector for high particle flux environments, Nucl. Instrum. Meth. A 376 (1996) 29
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[3] T. Alexopoulos et al., A spark-resistant bulk-Micromegas chamber for high-rate applications, Nucl. Instrum. Meth. A 640 (2011) 110

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