LHCC Poster Session – CERN, 22 February 2017

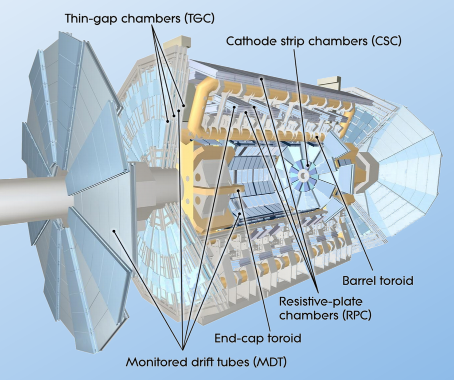
The first Module0 MicroMegas Chamber for the New Small Wheel Upgrade of the ATLAS Muon Spectrometer: Features and Performances

Abstract

After the second long shutdown (LS2) in 2019-2020, the LHC luminosity will be increased up to $2\text{-}3\cdot10^{34}$ cm^{-2} s^{-1} in Phase-1 and eventually to $\sim7\cdot10^{34}$ cm^{-2} s^{-1} in the High Luminosity LHC era. While higher luminosities will provide more data, it is essential that the ATLAS detectors will be able to operate in the higher background environment and maintain their performances at the level they were at lower luminosities. To obtain this, some of the detectors that are located nearest to the beam pipe have to be replaced. For the upgrade of the ATLAS Muon Spectrometer the present Small Wheel equipped with CSC, MDT and TGC chambers will be replaced the New Small Wheel. This will contain two new detector types: the MicroMegas (MM) and the small-strip TGC (sTGC). The first Module-0 of Micromegas quadruplet has been built by a consortium of several INFN groups in Italy and tested with high energy particles at the H8 SPS Test Beam experimental area at CERN in June 2016. The construction of the Module and the results obtained at the test-beam are reported.

1. The New Small Wheel Project for the ATLAS Upgrade

- Main ATLAS upgrade during the Long Phase 1 Shutdown (2019-2020)

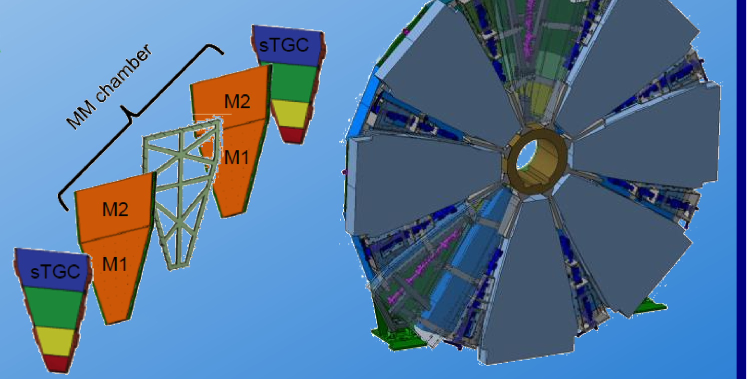


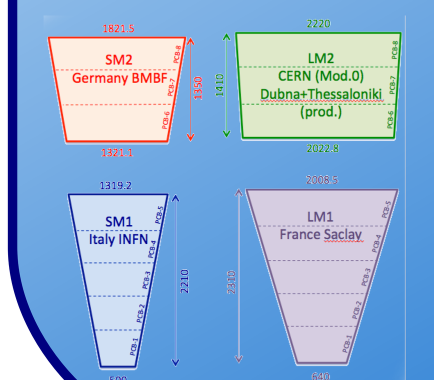
NSW will use two detector technologies:
- sTGC as primary trigger
- MicroMegas for primary precision tracker

Requirements:
- **Precision tracking**: 15% P_T resolution at 1TeV corresponding to ~100μm resolution per plane on a multilayer station
- **Trigger:** 1 mrad online angular resolution

New Small Wheel layout

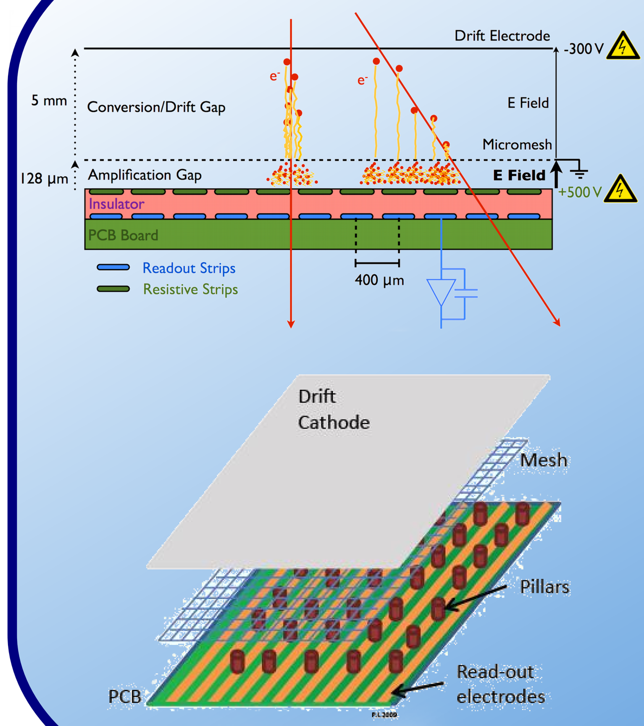
16 sectors for each NSW:
- 8 Large sectors
- 8 small sectors





4 different types of MM qudruplets:
- SM1 and SM2 in the small sectors (Italy and Germany)
- LM1 and LM2 in the large sectors (France & CERN/Greece)

2. The Micromegas technology: detector features



Drift region:

- This 5 mm thick region and filled with a gas mixture ($Ar:CO_2$ 93:7) acts as ionization and drift zone. It is bounded by a plane electrode (drift) on one side and by a metallic mesh on the other one. A typical electric field in the drift region is ~ 600 V/cm.

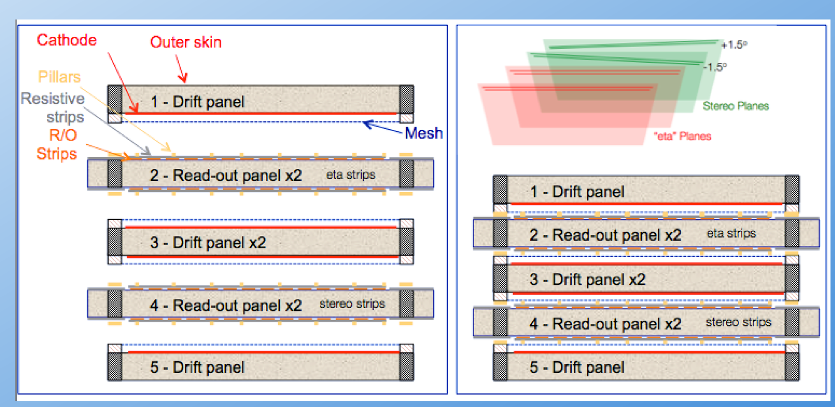
Amplification region:

- 100 - 150 μm thick. This region is bounded by a metallic mesh on one side and by a plan of copper **readout strips** on the other side. The thickness is kept constant by cylindrical spacers (**pillars**) of 200 μm of diameter, spaced 2 mm apart. The high electrical fields (50 kV/cm) yields the e-avalanches, inducing the signals on the readout strips. A layer of **resistive strips** on a thin isulator is placed on the top of reasout strips to protect the detector from damages due to sparks.

- A **PCB** (printed circuit board) carries the readout strips. Their **pitch** is in the range of 100 μm to 500 μm

3. ATLAS MicroMegas design

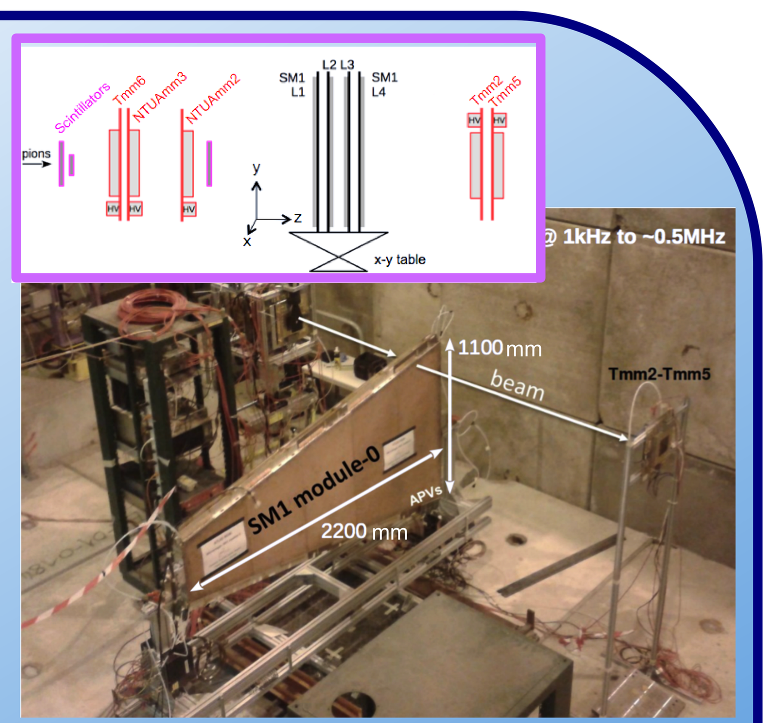
Components of a quadruplet:
- Two single drift cathode panels (external)
- One double drift cathode panels (central)
- One double readout eta panel "eta strips"
- One double readout stereo panel "stereo strips"



Eta and stereo strips
- Eta strips (parallel to the bases of the trapezoid and to the resistive strips) provide precision coordinate measurement
- Stereo strips (with inclination of ±1.5 deg respect to resistive strips) provide the second coordinate measurement.

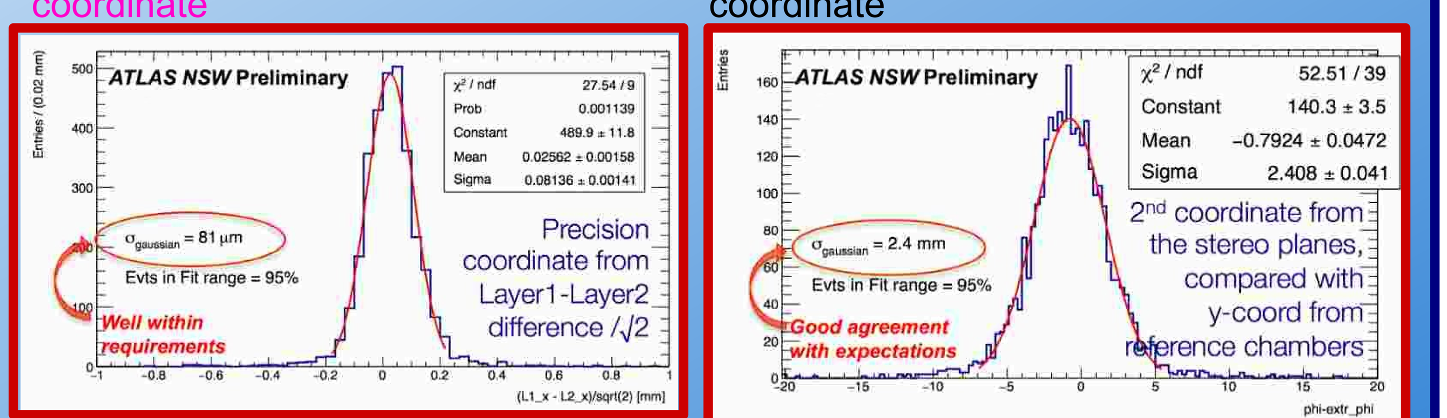
5. SM1 Module-0 Test beam

Test beam setup:
- H8 Beam line at CERN
- Pion beam of 150 GeV/c at a rate from 1KHz to 0.5 Mhz
- Beam spot of ~ 1 cm^2
- Scintillators trigger
- 5 MicroMegas chambers (Tmm) x-y readout used as reference
- SM1 Module-0 mounted on a x-y scanning table
- APV25+SRS readout (from RD51) [NOT FINAL NSW electronics]

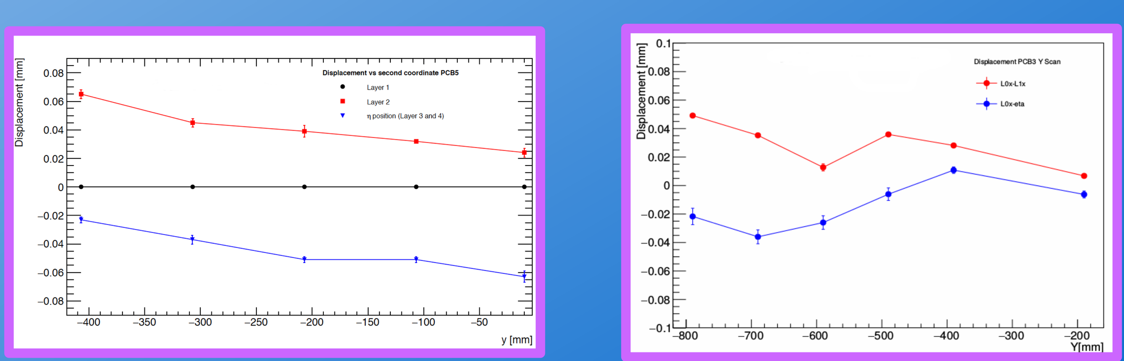


Spatial resolution of the precision coordinate

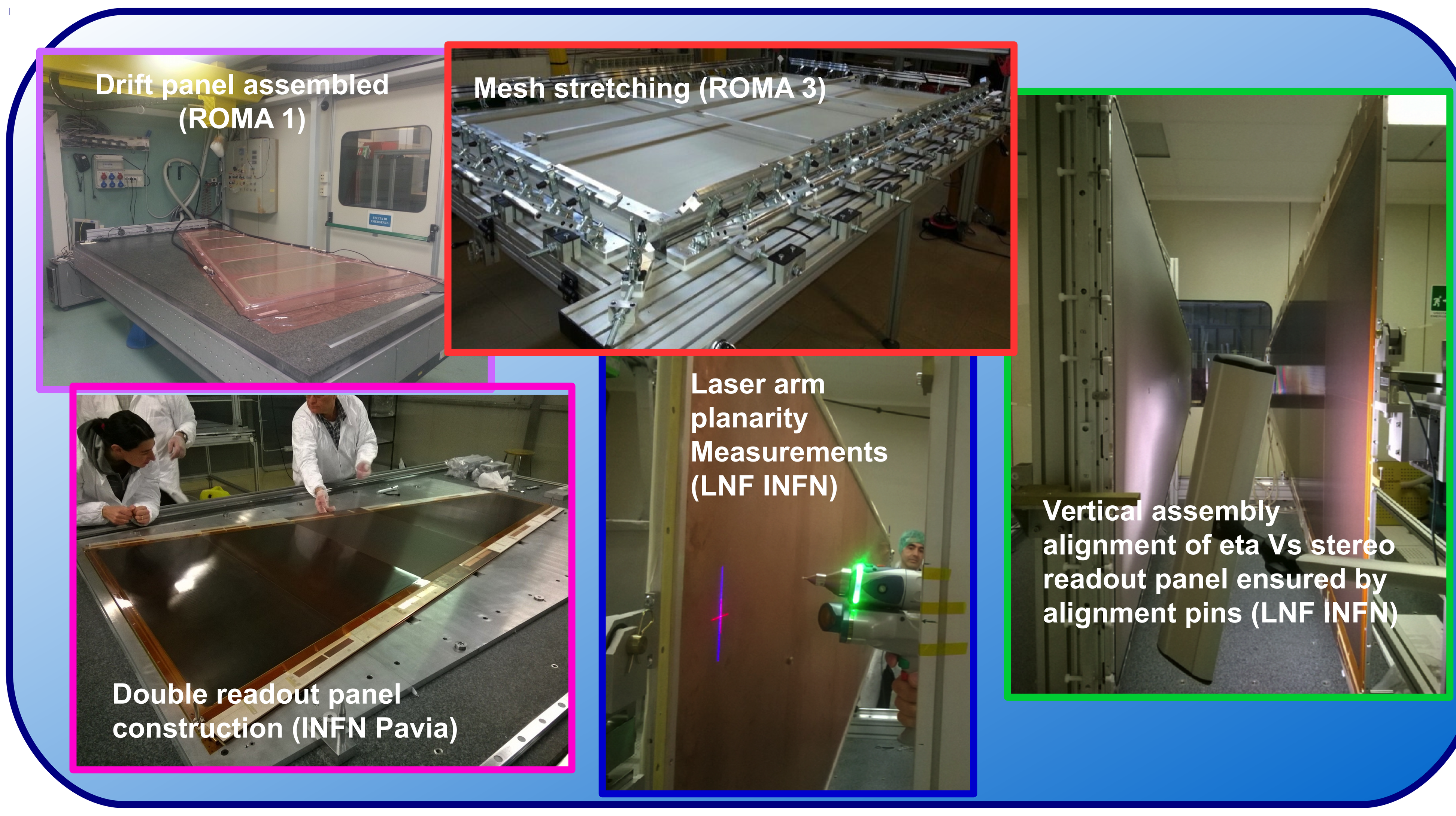
Spatial resolution of the second coordinate



The strips alignment is quoted from the difference of the cluster position in two adjacent layers. The displacements are reported for PCB5 and PCB3 as function of the Y coordinate and are within +/- 80 μm. The quoted precision of the Y coordinates corresponds to the scanned area with the beam.



4. First SM1 Module 0 assembly



6. Acknowledge and references

[1] The ATLAS Collaboration, New Small Wheel Technical Design Report, ATL-COM-MUON-2013-009

[2] C. Bini et al., Study of the performance of the Micromegas chambers for the ATLAS muon spectrometer upgrade, 2014 JINST 9 C02032

[3] M. Iodice. Resistive Micromegas for the Muon Spectrometer Upgrade of the ATLAS Experiment, ATL-MUON-PROC-2016-008

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