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# Construction and test of the MicroMegas chambers for the upgrade of the ATLAS Muon Spectrometer

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**Summary.** — MicroMegas (MM, MICRO MEsh GASeous structure chambers) are Micro-Pattern Gaseous Detectors, designed to provide a high spatial resolution, efficiency better than 95% per single plane, in a highly irradiated enviroment. MM chambers have been chosen as precision tracking detectors for the upgrade of the forward muon spectrometer of the ATLAS experiment (ATLAS Collaboration, *JINST*, **3** (2008) S08003) composing the New Small Wheel (NSW). MM modules are composed by 4 read-out layers, two used for the reconstruction of the precision coordinate and two inclined by $\pm 1.5^\circ$ for the reconstruction of the second one. The National Institute of Nuclear Physics (INFN) is deeply involved in the construction of these chambers and in their validation. Preliminary results on the INFN SM1 prototypes are presented.

## 1. – Introduction and operating principles

Micromegas (MM) chambers [1] operate in a gas mixture of Ar-$CO_2$ (93%-7%). The ionization by the charged particles in the detector gas produce ∼100 pairs/cm considering both primary and secondary ionization. A Micromegas chamber is formed by the read-out structure (anode) based on a Printed Circuit Board (PCB), a fine micro-mesh, which defines the separation between the conversion and the amplification region, and the cathode. Strips are 300 $\mu$m wide and with a pitch of 425–450 $\mu$m. A schematic view of the working principle of a MM chamber is shown in fig. 1 (right). The conversion drift region ($HV_{drift} = -300\,\mathrm{V}$) is 5 mm wide, while the amplification region ($HV_{read\text{-}out} = 590\,\mathrm{V}$) is 128 $\mu$m wide; such a small amplification gap is guaranteed by the insulating pillars height on top of the resistive layer. This structure guarantees a high transparency of the micromesh and a fast (∼100 ns) evacuation of positive ions produced in the avalanche through the micromesh.

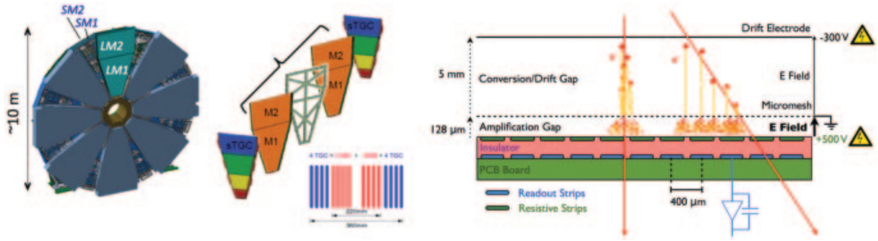


Fig. 1. – Left: wheel-like structure of the NSW. Right: working principle of a MM chamber.

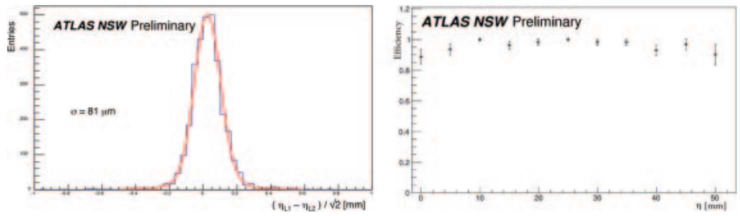


Fig. 2. – Left: resolution on the precision coordinate of Mod0. Right: efficiency on Mod0.5.

## 2. – MM chambers for the ATLAS upgrade (NSW) and preliminary results on first prototypes

The NSW [2, 3] has a wheel-like structure and it is composed by 8 large sectors (LM1, LM2) and 8 small ones (SM1, SM2), whose production is distributed between several industries and institutes: Italy (SM1), Germany (SM2), France (LM1), Russia-Greece-CERN (LM2). Two MM modules per sector are needed, corresponding to 4 MM quadruplets as shown in fig. 1 (left). The NSW upgrade project will have a significant impact on the trigger and tracking efficiency in view of the increasing luminosity for the next LHC Runs (up to $5–7 \cdot 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$). MM will be used for precision tracking and sTGCs for trigger purposes. The INFN group is responsible for the SM1 construction.

The first prototypes, Mod0 an Mod0.5 have been tested respectively at the CERN H8 beam line of the SPS ($\pi^+$ beam at 180 GeV/c) and at the CRS of the LNF. Results are well within the requirements: the resolution on the precision coordinate being 81 $\mu$m and the efficiency higher than 95% (fig. 2).

## 3. – Conclusions

MM chambers will be used for the precision tracking in the NSWs of the ATLAS experiment at LHC. The INFN group has been the first to construct 2 full size prototypes (SM1 Mod0 and Mod0.5) and the performances of those quadruplets have been found to be within expectations in terms of efficiency and resolution for perpendicular tracks.

## REFERENCES

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