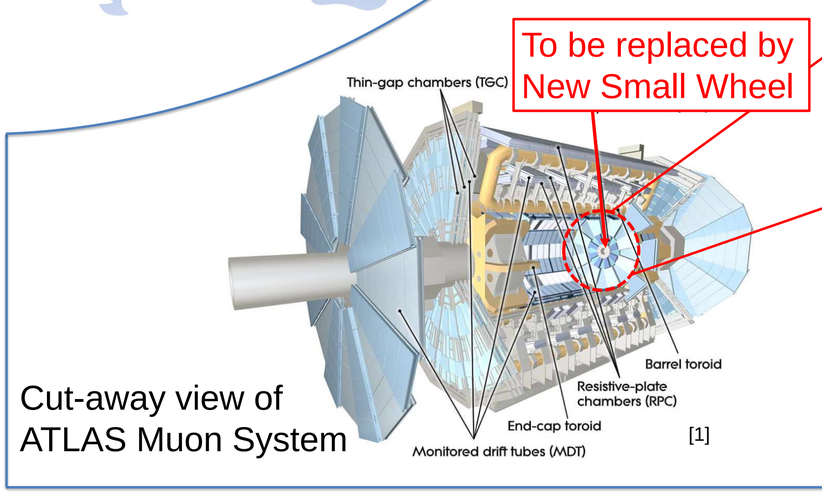
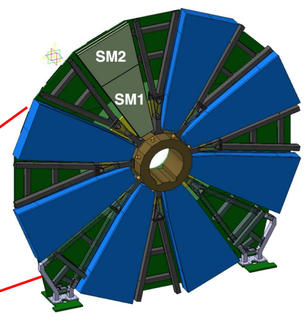
Performance of LM1 Micromegas Detectors for the ATLAS NSW Using Cosmic Muons

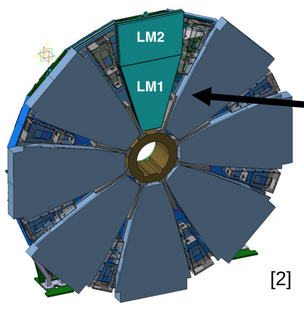
LHCC, 19 Feb. 2020

ATLAS NSW Micromegas

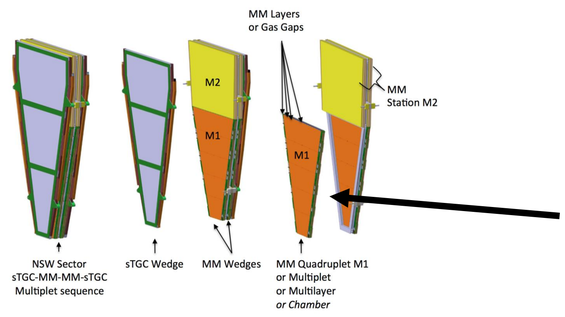


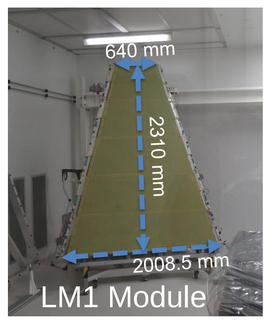
Cut-away view of ATLAS Muon System [1]





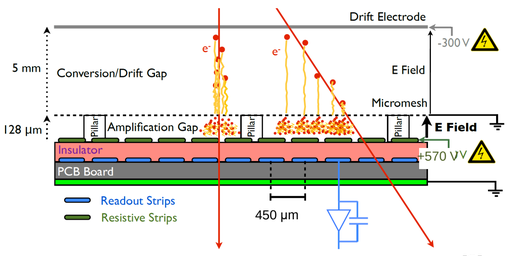
[2]



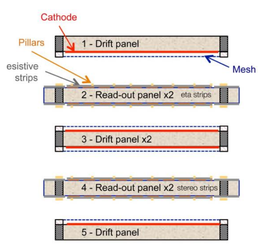


In order to fully exploit the physics potential provided by high luminosity after the on-going LHC upgrade, ATLAS muon end-cap system needs to be replaced by detectors with improved performance, such as Micromegas. The New Small Wheel (NSW) contains 4 types of Micromegas modules with different shapes, each type built by a different construction consortium: LM1 (Saclay), LM2 (Dubna, Thessaloniki), SM1 (INFN), SM2 (Germany). The overlaps between SM and LM ensure a full coverage of |η| from 1.3 to 2.7.
32 Micromegas modules of each type are required in total for the installation of two wheels.

LM1 Construction and Validation



[3]

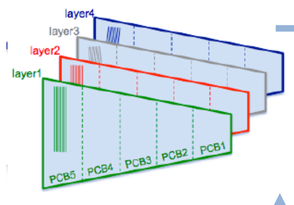


[4]

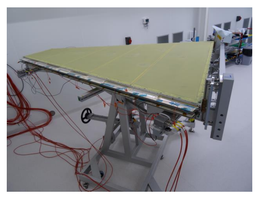
The Micro-Mesh GAseous Structure detector (Micromegas) is a type of parallel plate gaseous detector. Thanks to the metal mesh separating between conversion and amplification regions, Micromegas is able to track particles with a precision of order 100 µm per detection gap while withstanding a particle rate around 15 kHz/cm^2.
One Micromegas module is a quadruplet made of four Micromegas layers.

Panel construction

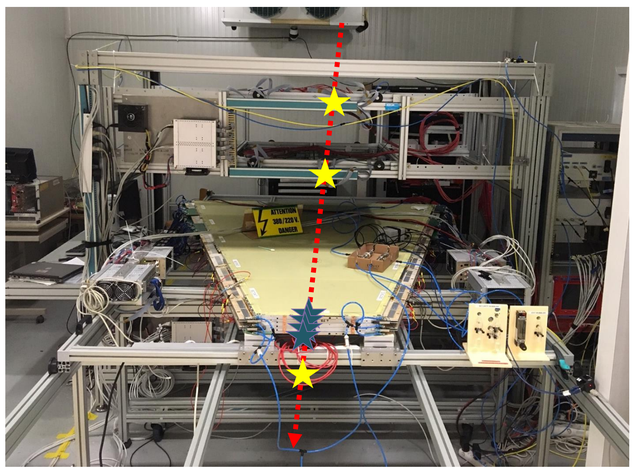
Assembly



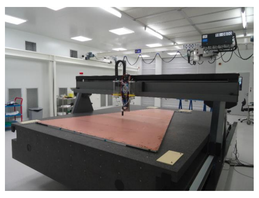
HV test



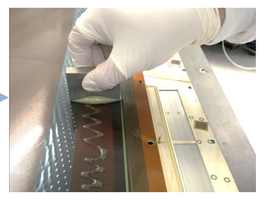
Cosmic ray test



Metrology



Passivation



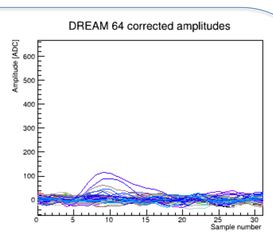
Heating

To reduce the humidity, the module is heated before cosmic ray test.

★ 4 Detection layers in one module
☆ 3 Planes of reference Micromegas
Cosmic ray muon

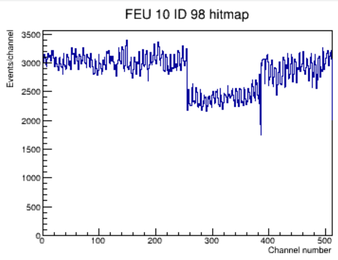
Performance on Cosmic Ray Test Bench

[5]



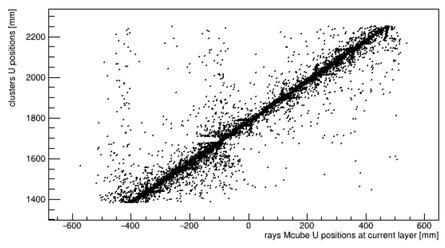
STEP 1

Signals are readout by DREAM electronics with multiplexing of 2.



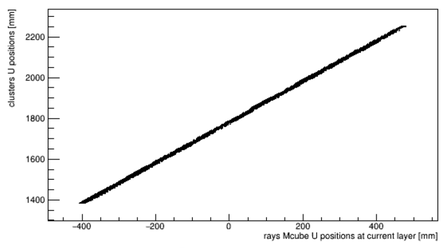
STEP 2

Hitmaps of electronics channels are obtained after the subtraction of noise.



STEP 3

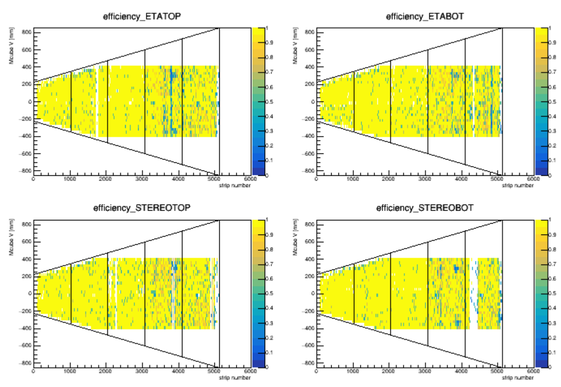
Clusters are reconstructed from hitmaps with demultiplexing algorithm. Correlation between reconstructed and predicted positions of all clusters is shown above.



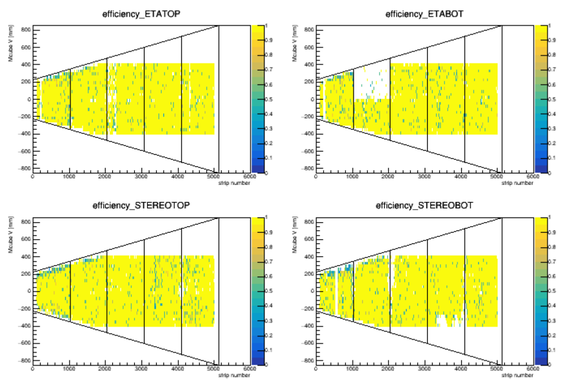
STEP 4

Select valid clusters in the module that are close enough to the positions predicted by the reference detectors. A linear correlation between reconstruction and prediction is thus achieved.

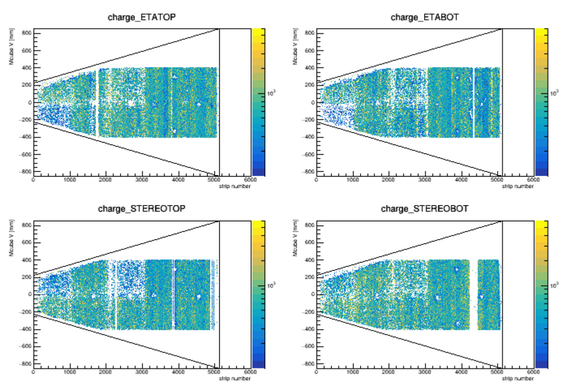
Module 12 efficiency map



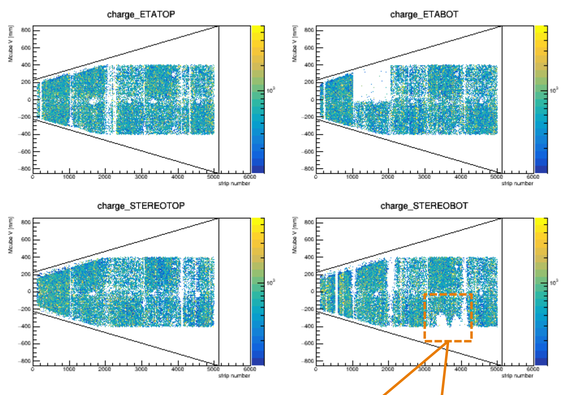
Module 14 efficiency map



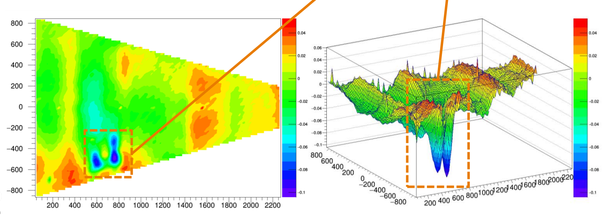
Module 12 charge map



Module 14 charge map



The result of cosmic ray test is verified by the measurement of panel thickness: The empty area on the map is caused by a planarity defect where the panel is 100 µm lower than expected.
The dead sector on Module 14 PCB 2 ETABOT is due to a HV problem.



The cosmic muons provide an extremely powerful tool for the validation of ATLAS New Small Wheel Micromegas detectors. The cosmic ray test bench in Saclay is capable of scanning LM1 modules, measuring the efficiency and gain of detectors.

[1] The ATLAS Collaboration et al 2008 JINST 3 S08003 [2] ATL-MUON-PROC-2016-004 [3] ATL-MUON-PROC-2015-016 [4] G. Sekhniaidze 2017 JINST 12 C03020 [5] DOI: 10.1109/RTC.2014.7097517

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