ATLAS
Attivita' Costruttive (micromegas) e studi di Performance (RPC Trigger)

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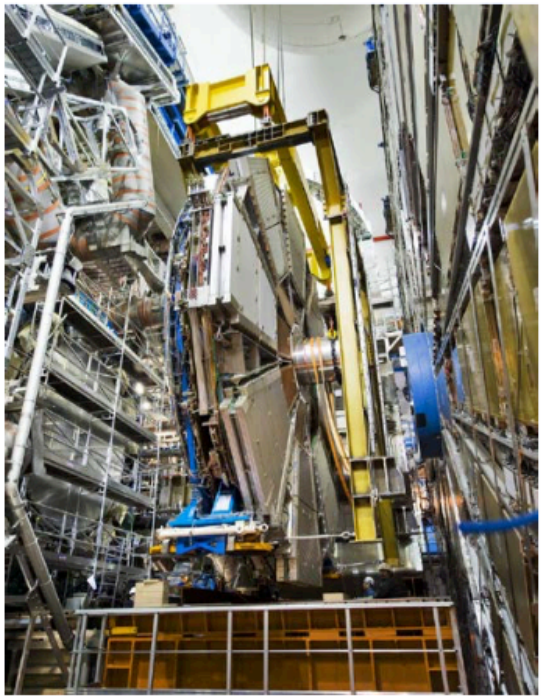
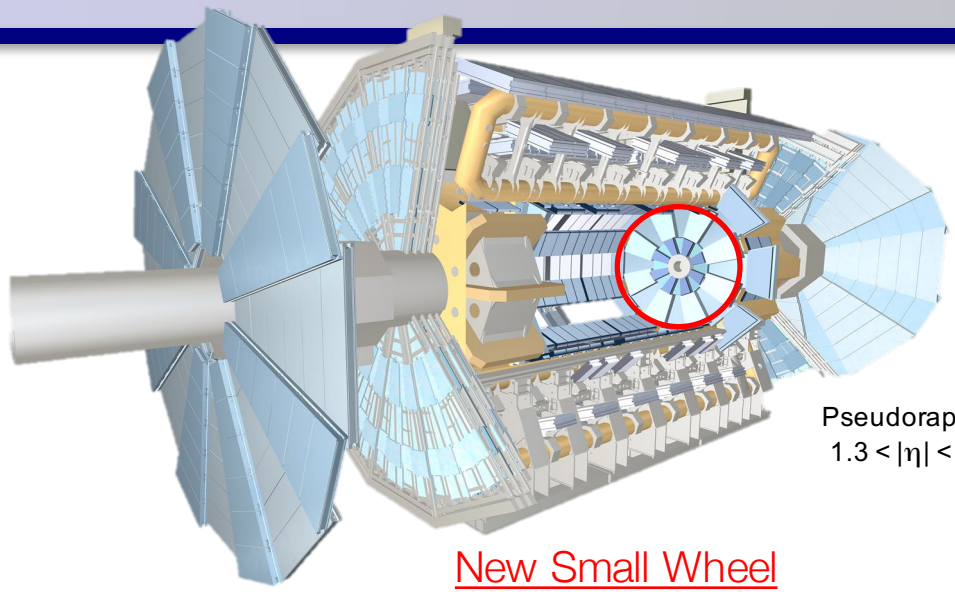
Congressino Scientifico INFN Roma Tre
13 Settembre 2016

Introduction: New Small Wheel Upgrade in a nutshell





Pseudorapidity coverage:
$1.3 < |\eta| < 2.7$

New Small Wheel

- Main ATLAS upgrade during the Long Shutdown 2 (2019/20) (Phase-1)
- Will replace the present Small Wheel, not designed to exceed 10^{34} $cm^{-2}s^{-1}$
- Will operate up to HL-LHC luminosity (Phase-2)
- Expected rates up to 15 kHz/cm2

- GOALs:
  - Maintain momentum resolution: 15% P_T resolution at 1 TeV
    → ~100 μm resolution per plane on a multilayer station
  - keep single muon trigger under control
    → 1 mrad online angular resolution

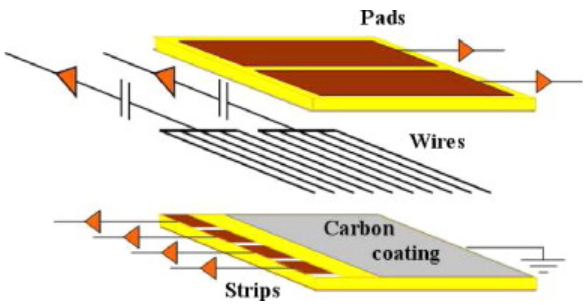
New Small Wheel Detector Technologies

Combination of sTGC and MicroMegas detector planes

Small Strips TGC (sTGC)

primary trigger detector

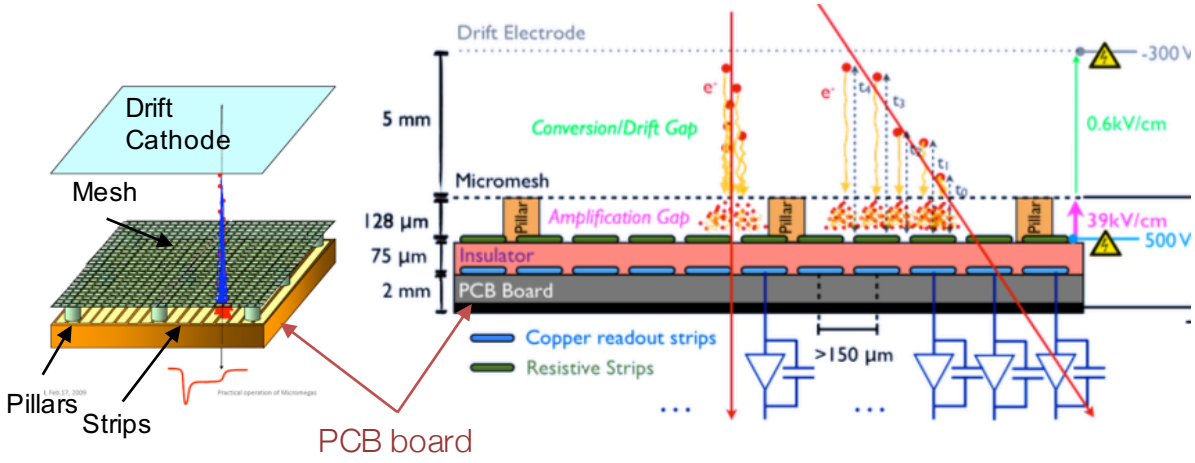
- Bunch iD with good timing resolution
- Online track vector with <1 mrad angle resolution
- pads: region of interest
- strips: track info (strip pitch 3.2 mm)
- wire groups: coarse azimuthal coordinate



Resistive strips MicroMegas (MM)

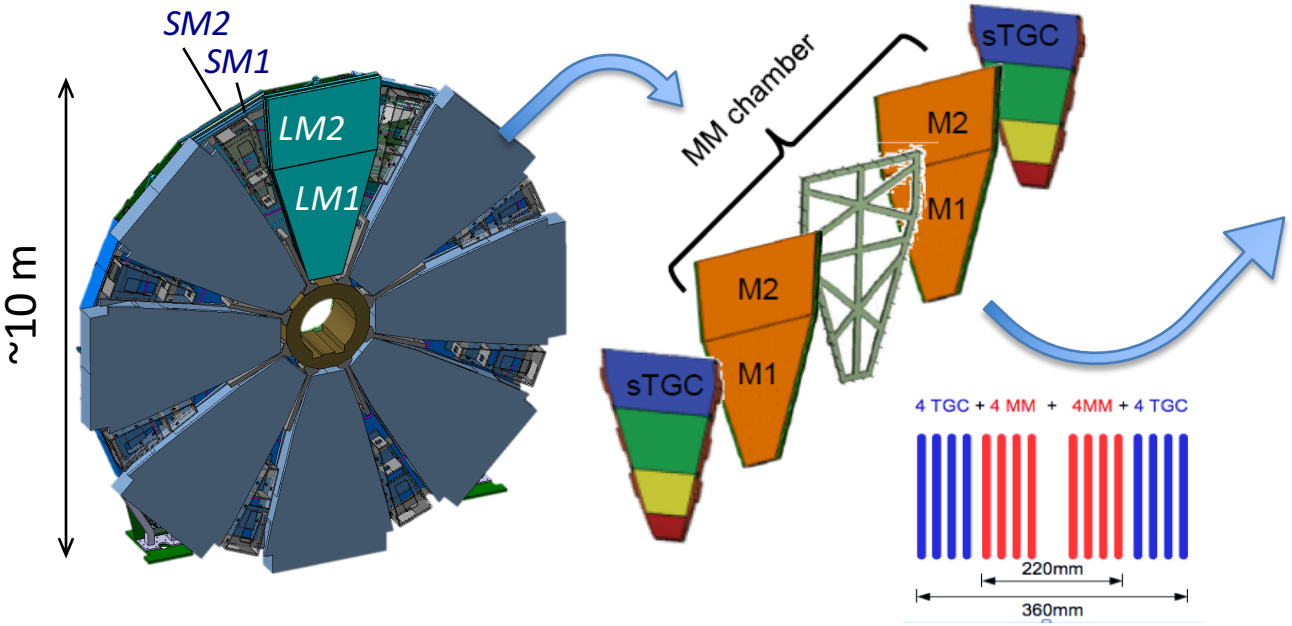
primary precision tracker

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



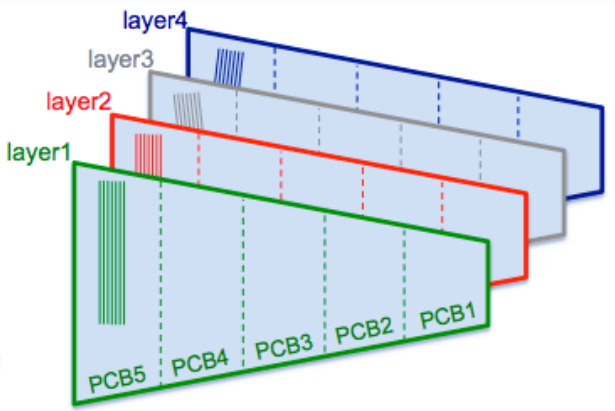
- Common front-end ASIC: VMM second prototype under tests

New Small Wheel Layout



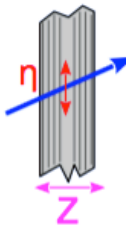
Each NSW has 16 sectors
8 Large + 8 Small

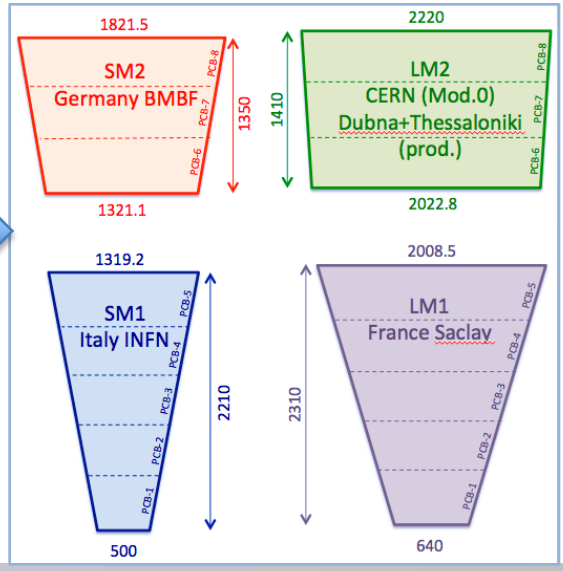
Each Sector is a sandwich of
sTGC and MM quadruplets



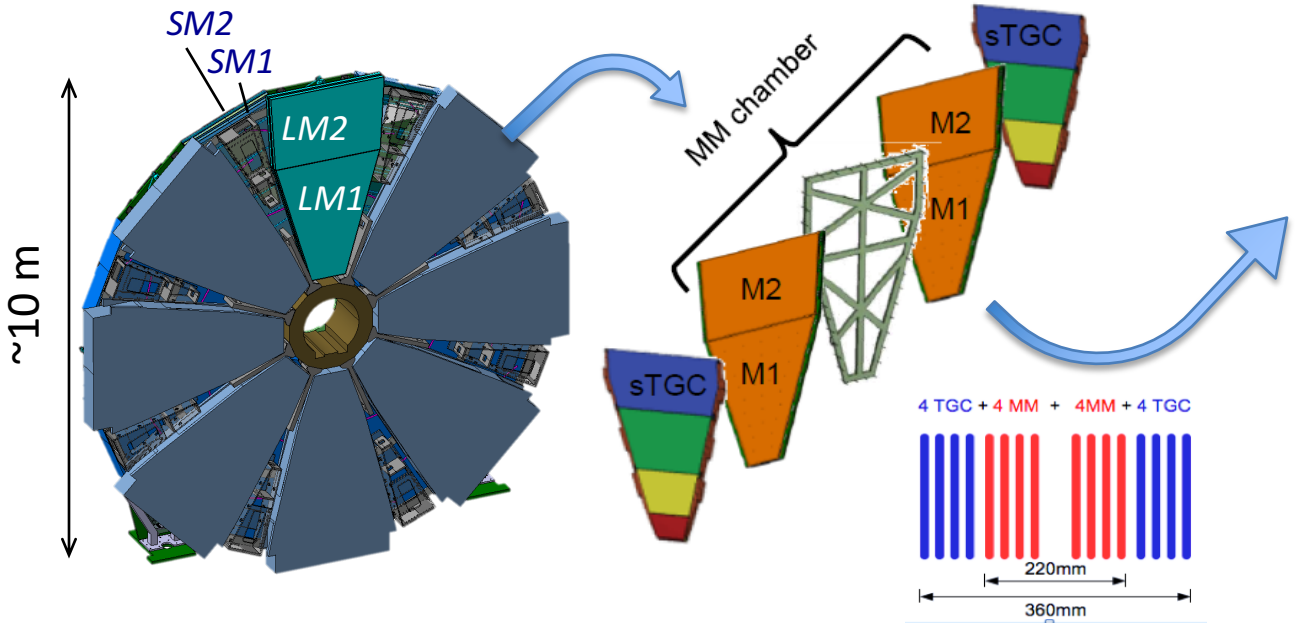
- Each MM module has 4 detection planes
- 2 planes with parallel strips (precision coordinate)
- 2 planes with +/-1.5° Stereo strips (2nd coordinate)

- Construction of MM Quads is distributed over several countries.
- Challenge in construction: alignment of the strips on each detection layer
  - 30 μm RMS in η
  - 80 μm RMS in z





New Small Wheel Layout



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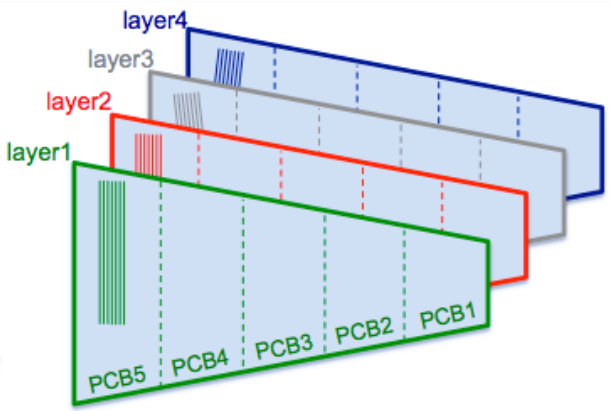

- Each MM module has 4 detection planes
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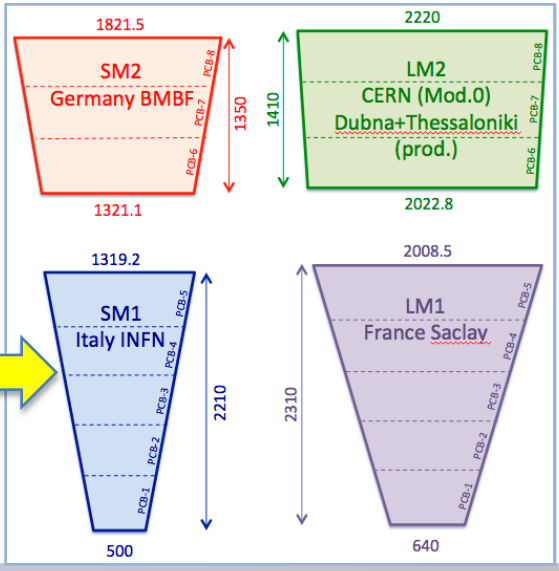
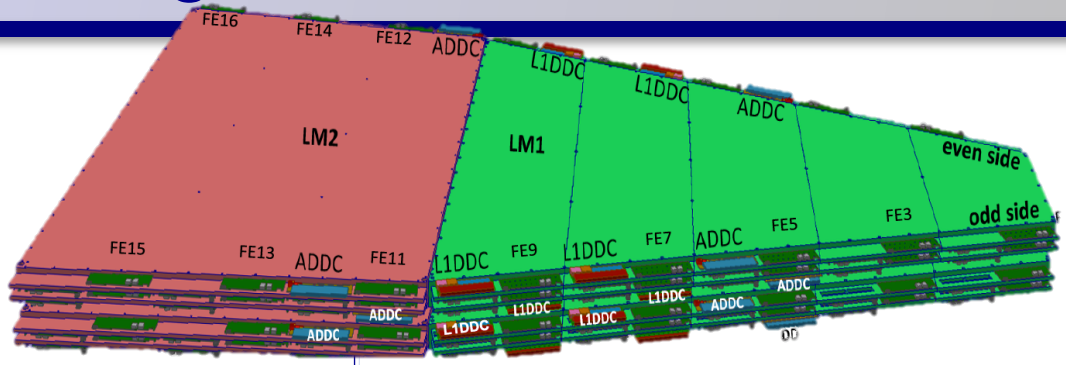
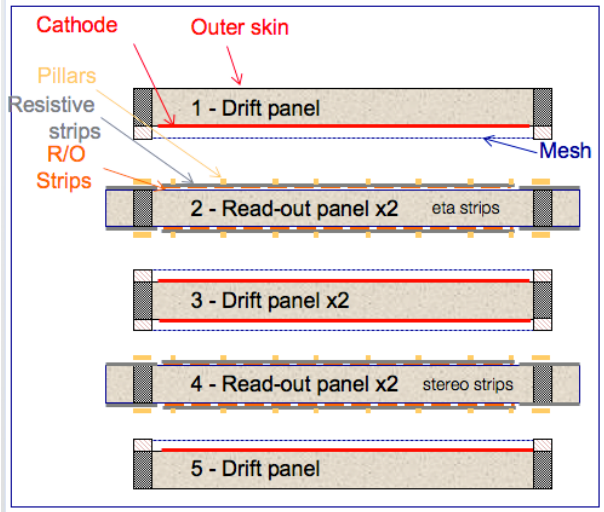
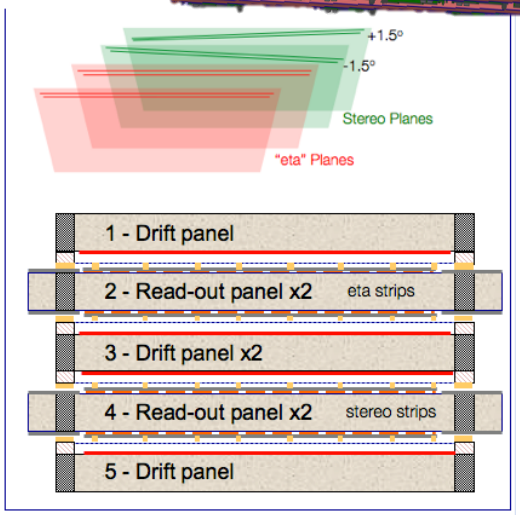
- SM1: Italy/INFN
- Pavia, Roma 1, Roma Tre, Frascati (LNF), Lecce, Cosenza, Napoli

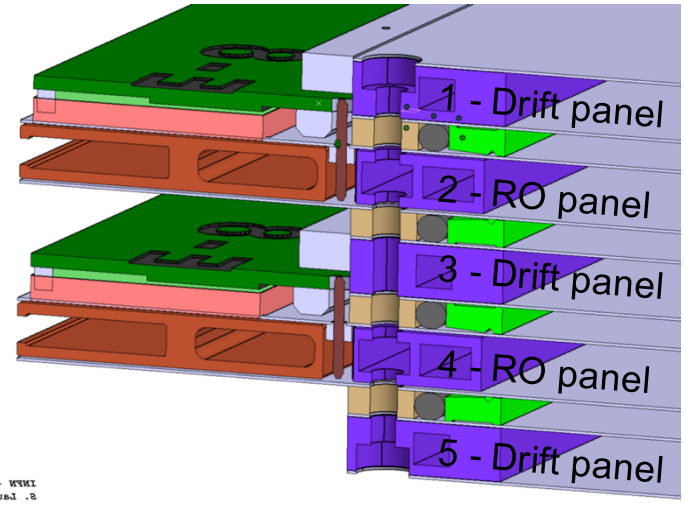


ATLAS Micromegas Design









COMPONENTI PRINCIPALI :

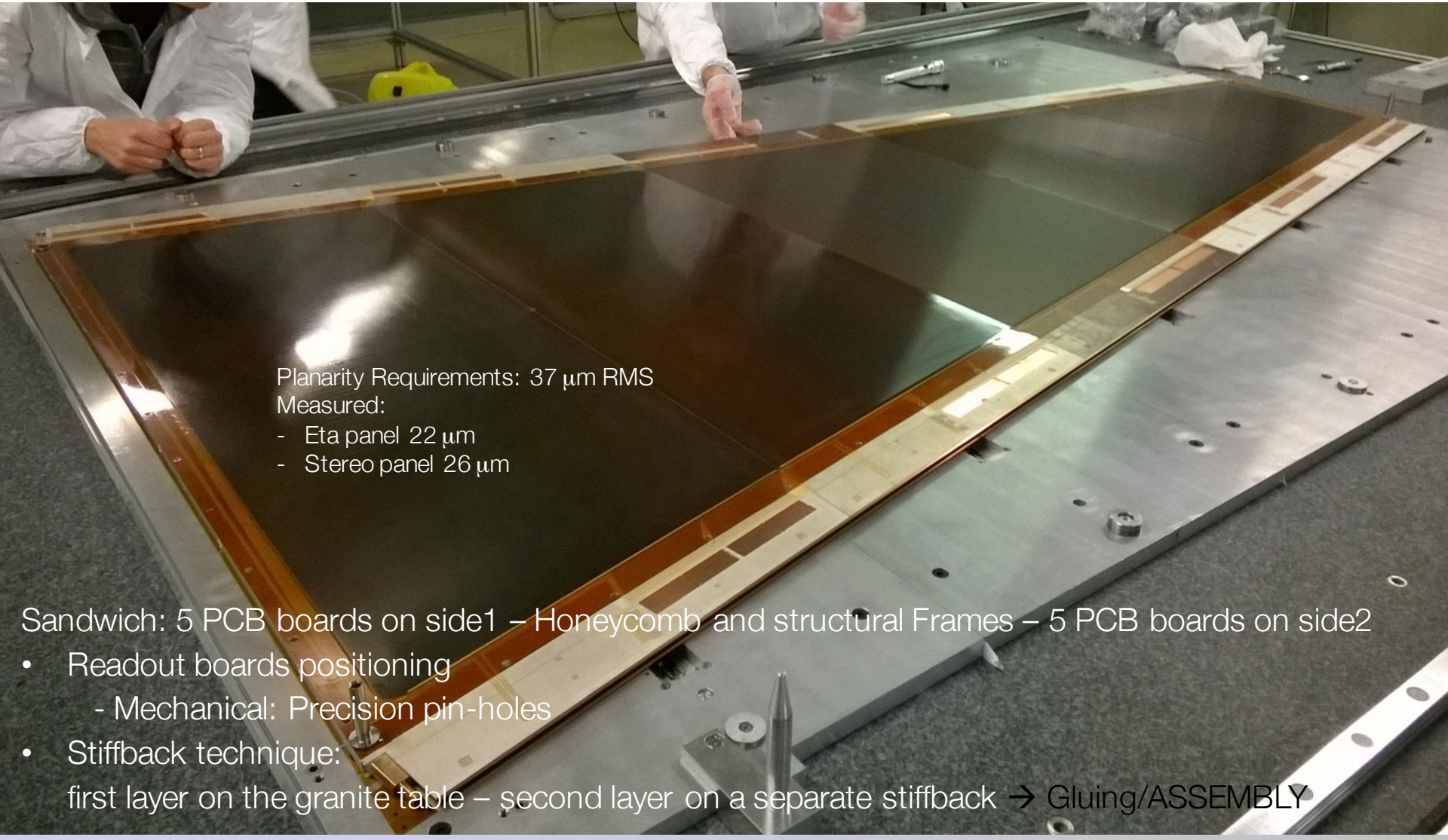
- 1 “eta-strips” double readout panel
- 1 “stereo-strips” double readout panel
- 1 central double drift cathode panels
- 2 external single drift cathode panels

First Micromegas Module-0 construction SM1 - INFN

SM1 Module-0 Readout Panels Construction

INFN Pavia

Double Side Readout panel built with 5+5 Readout boards – strips alignment < 40 μm



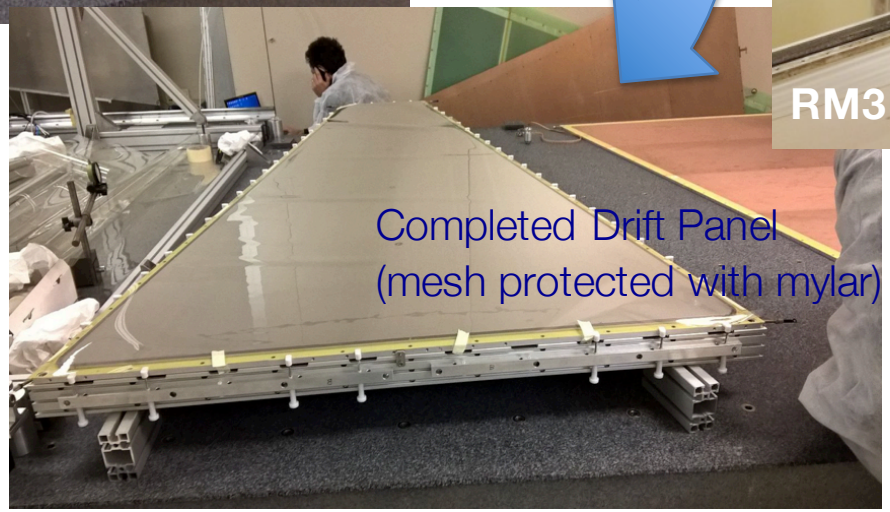
Sandwich: 5 PCB boards on side1 – Honeycomb and structural Frames – 5 PCB boards on side2

- Readout boards positioning
  - Mechanical: Precision pin-holes
- Stiffback technique:
  first layer on the granite table – second layer on a separate stiffback → Gluing/ASSEMBLY

SM1 Module-0 Drift Panels Construction

Similar construction Concept as for the readout panels

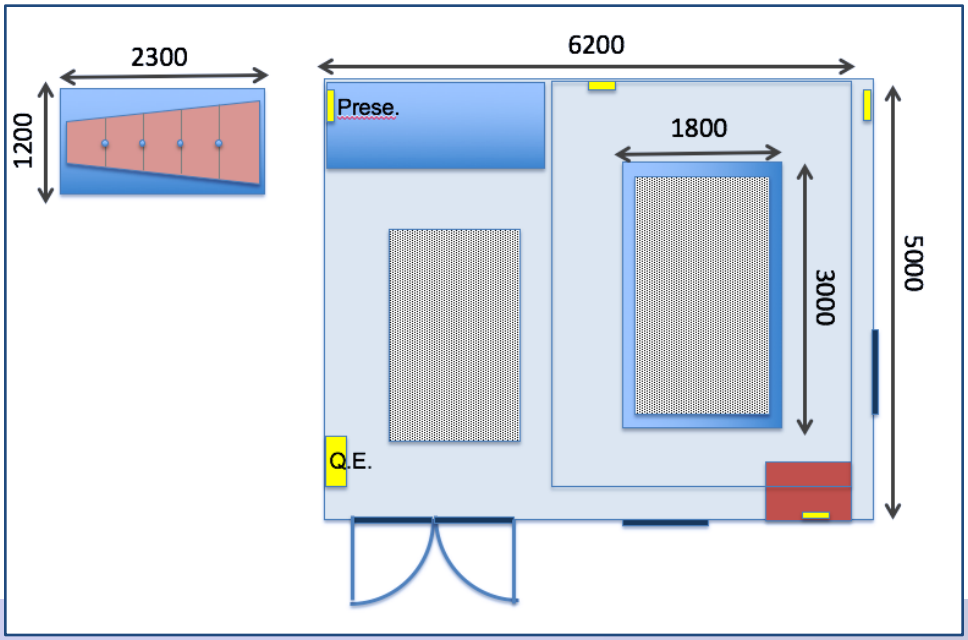
Mesh stretching and gluing



The drift panels must be "dressed" (completed) with a pre-stretched mesh

Alfredo & MAX
...MANY THANX !!!

INFN Roma Tre Activity @ Roma Tre : Mesh Stretching



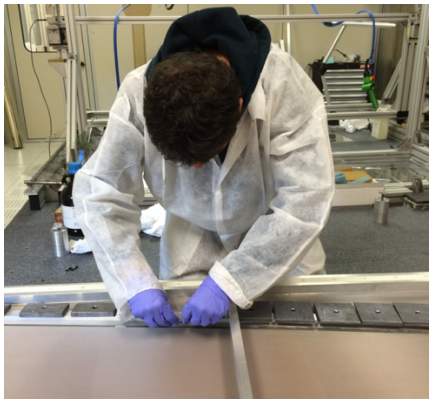
CLEANLINESS is a MUST in MM construction.

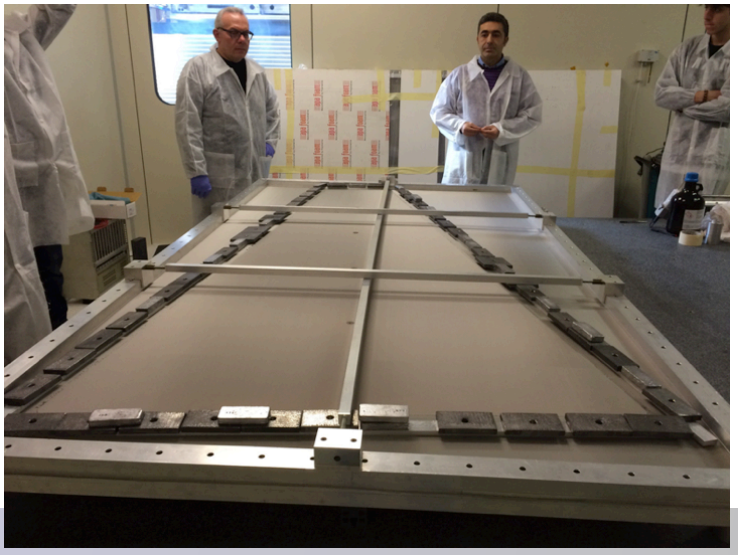
The mesh stretching tooling and other activities for the mesh preparation will be moved on the NEW “clean” room, soon to be built in the INFN LAB (RM3)

INFN Roma Tre Activity @ Frascati: Drift Panel Completion

Some steps of the Drift panel completion done for the Module-0 – NOT FINAL TOOLING

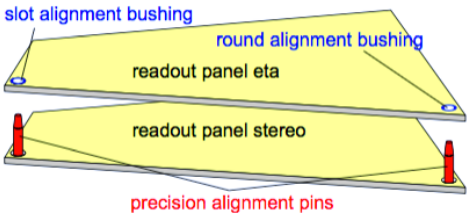
MESH GLUING





SM1 Module-0 Quadruplet assembly

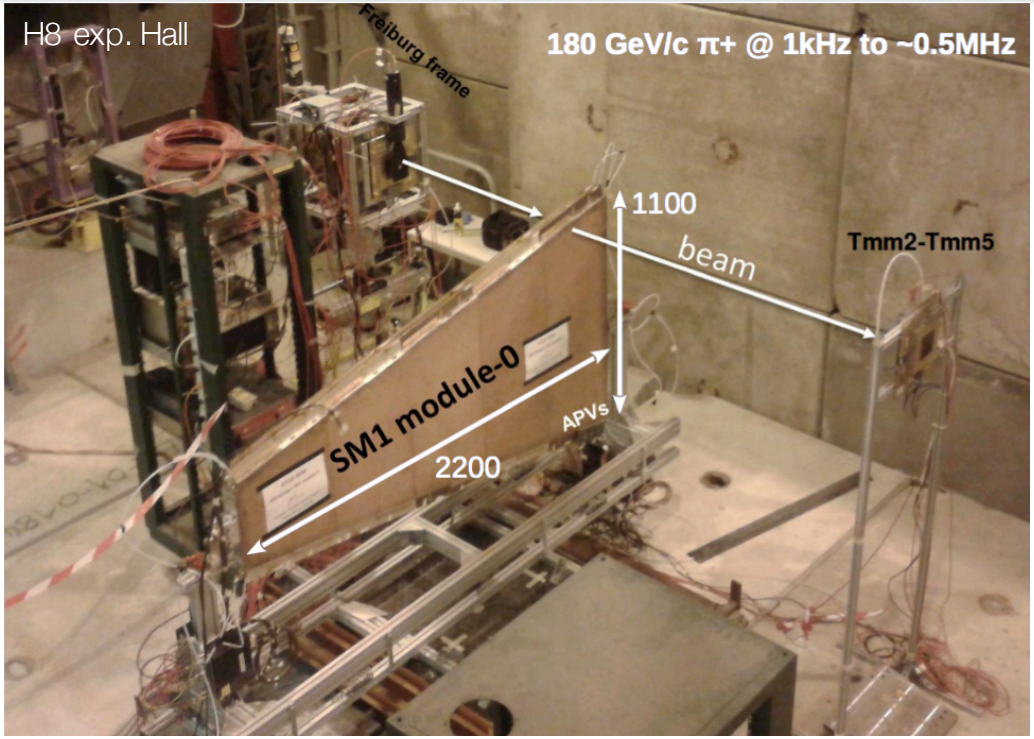
Crucial: Alignment of the two readout panels at < 60 μm precision



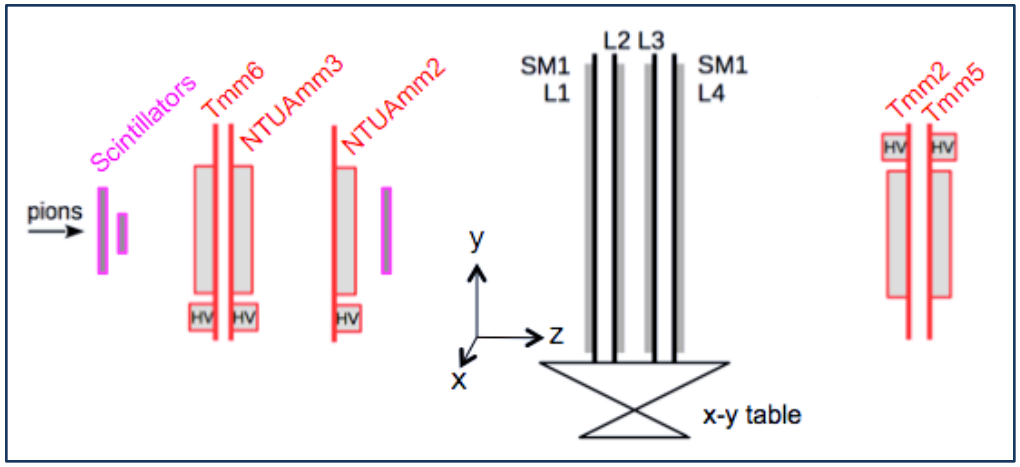
- Assembly completed in mid-May, then shipped to CERN for Test-Beam early June
  → **superb achievement !**

Micromegas Module-0 TEST BEAM

SM1 Module-0 Test-beam and PRELIMINARY Results

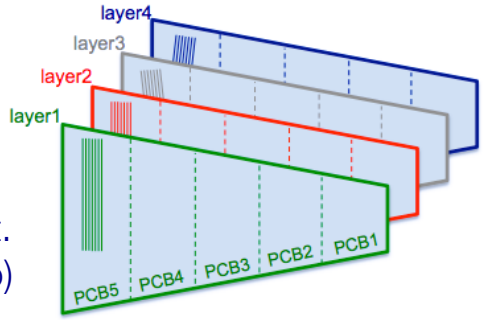


- 180 GeV/c pion beam
- Scintillators trigger
- Beam spot+trigger ~ 1x1 cm^2
- 5 micromegas with x-y readout (Tmm) used as reference
- SM1 Module-0 on a x-y scanning table
- Ar:CO_2 gas mixture (93:7)
- APV25+SRS readout (from RD51) [NOT FINAL NSW electronics]



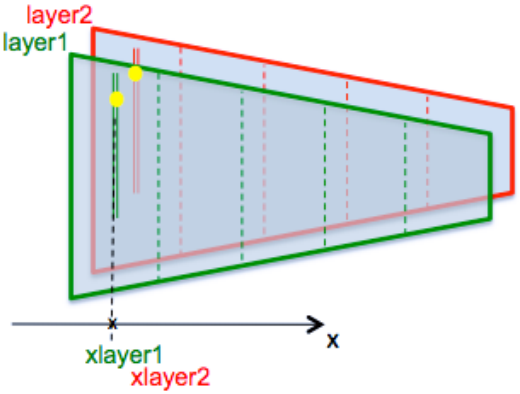
SM1 quadruplet:

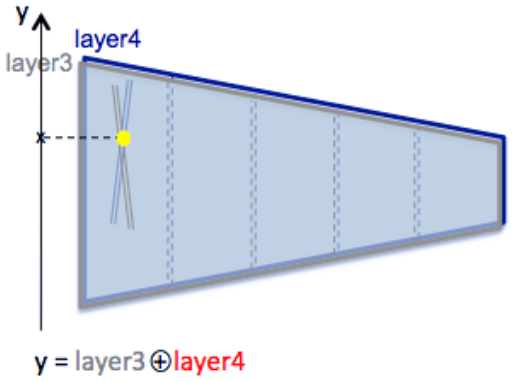
- 425 μm strip pitch
- L1 & L2 vertical strips (eta),
- L3 & L4 ±1.5° w.r.t. vertical axis (stereo)



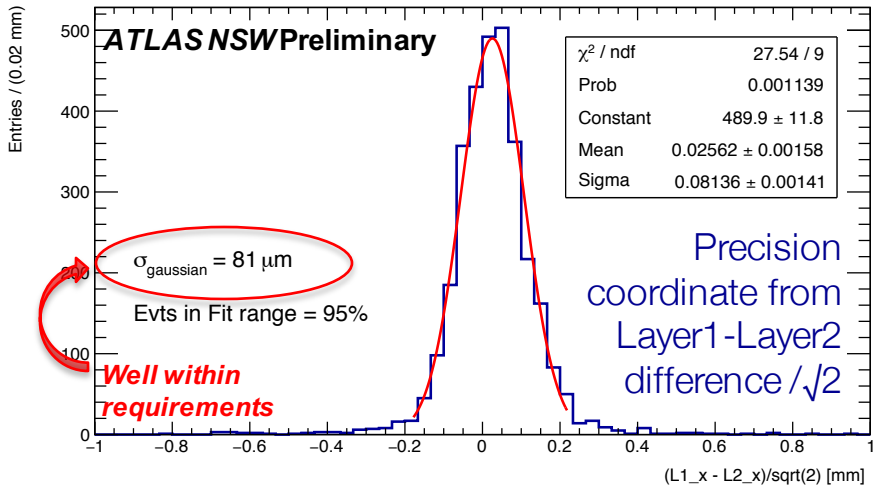
Module-0 PRELIMINARY Results on Spatial Resolution

- Perpendicular incident beam on PCB5 = longest strips
- Nominal High voltage settings:
  HV_ampl = 570 V (E= 4.4x10^7 V/cm)
  HV_drift = 300 V (E=600 V/cm)
- Ar/CO_2 93/7 @ 20 l/hour

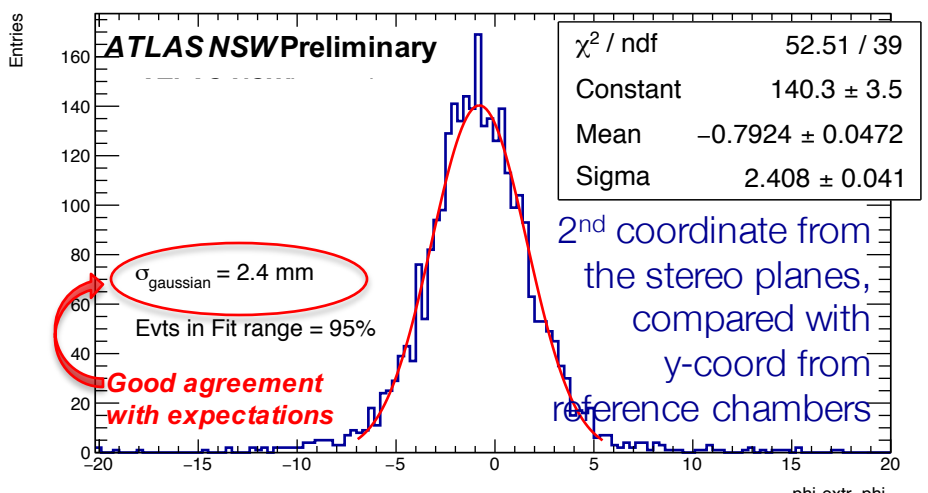




Preliminary result: Spatial Resolution of the precision coordinate

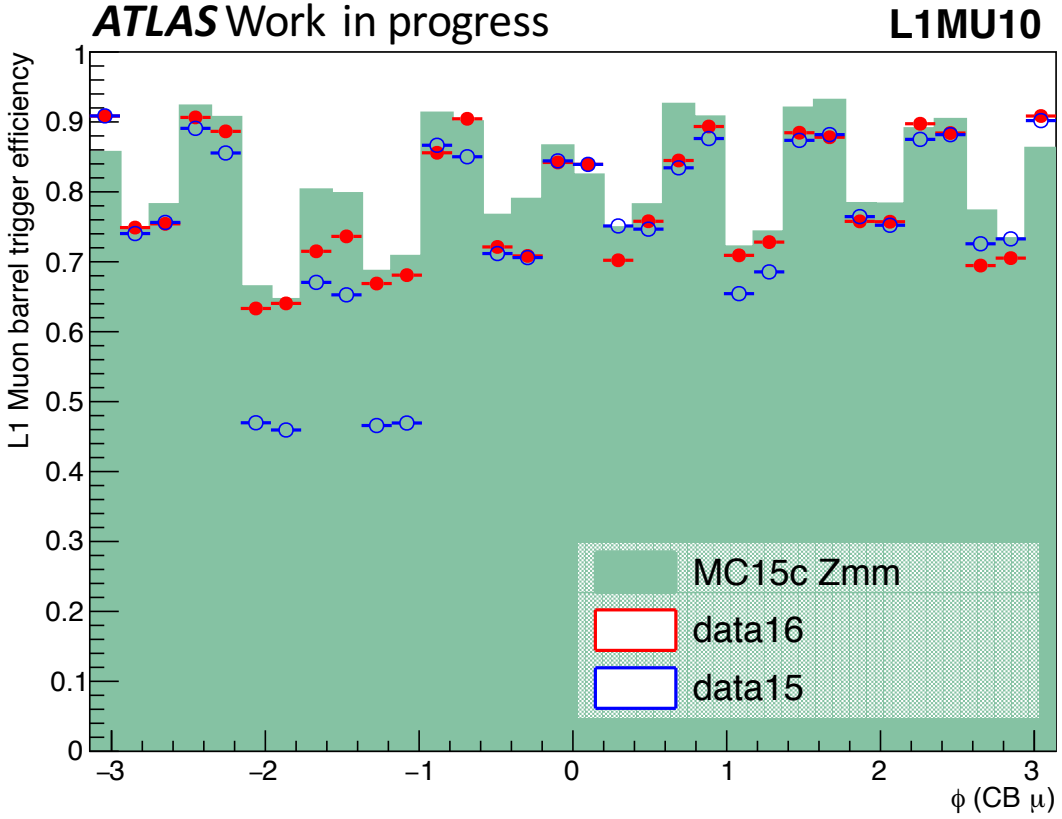


Preliminary result: Spatial Resolution of the second coordinate.



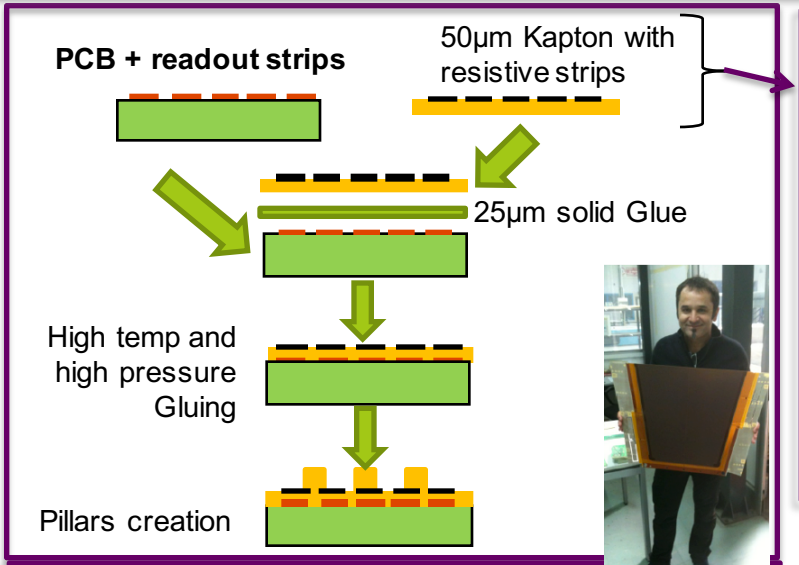
ATLAS Roma Tre Activity on the L1 RPC Trigger

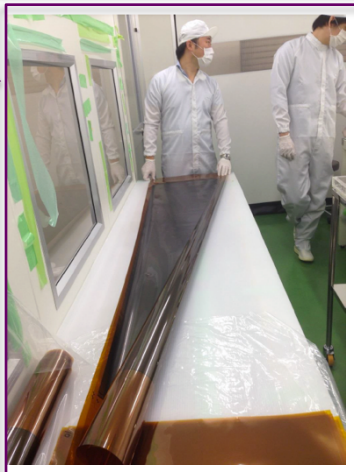
- RM3 works on calibration and performance of Level-1 muon trigger, using RPC detectors
- Correlation of trigger inefficiencies with RPC mal-functioning
- Commissioning of additional chambers for increased coverage



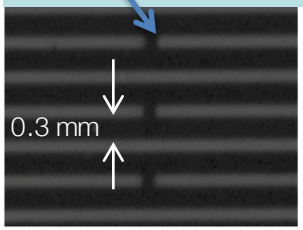
BACKUP slides

Micromegas Construction: Resistive strips Anode Boards

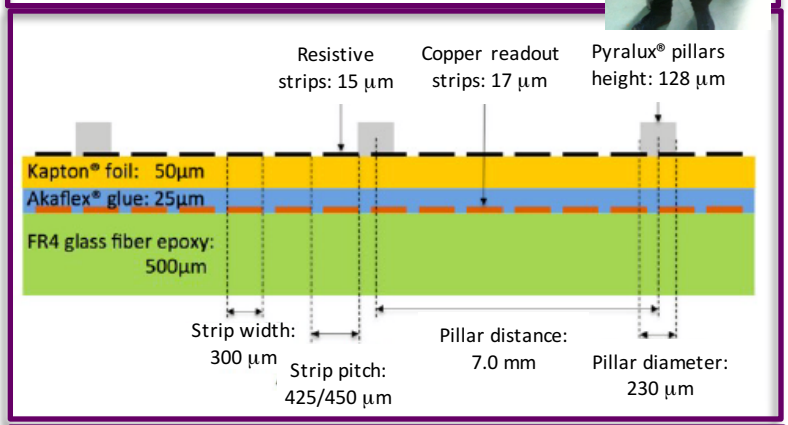


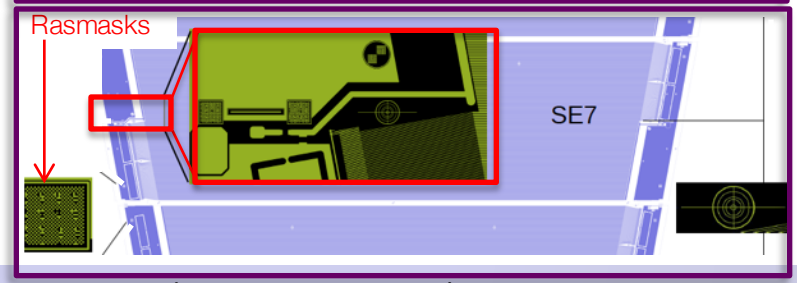


- Resistive strips on kapton by screen-printing
- "Ladder pattern" (connections every 10 mm):
  - Homogeneous resistivity (independent from distance)
  - Insensitivity to broken lines

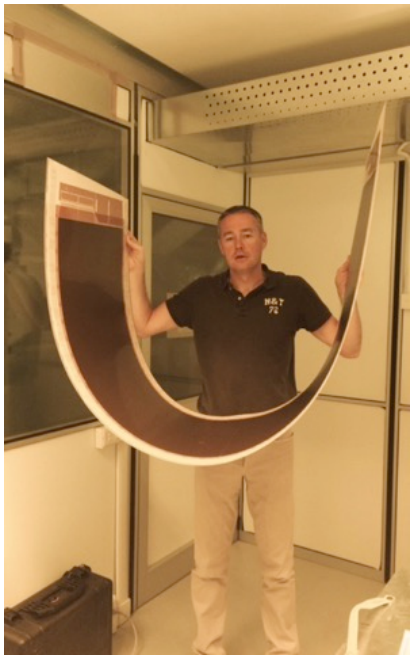


Typical resistivity:
~ 10-20 MΩ/cm
(~800 kΩ/□)





- Board dimensions: from 45x30 up to 45x220 cm^2
- 1022 strips/boards
- Readout strips pitch: 425 or 450 µm
- Pillars height: 128 µm
- Several types of alignment masks



Micromegas Construction: Readout PCBs

I. photolithographic creation of copper pattern
standard process.
complex due to: size of board & required precision.

II. cutting of Kapton foil with resistive pattern
non-standard but simple & required accuracy only ±1mm

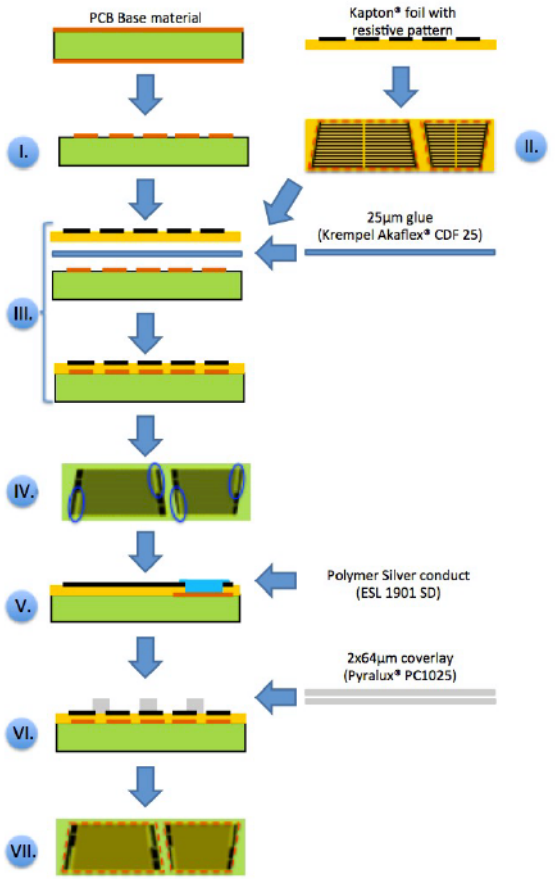
III. stacking and high-pressure & temperature gluing of Kapton foil, glue foil and board
standard process for small boards.
complex due to: size of board & required cleanliness.

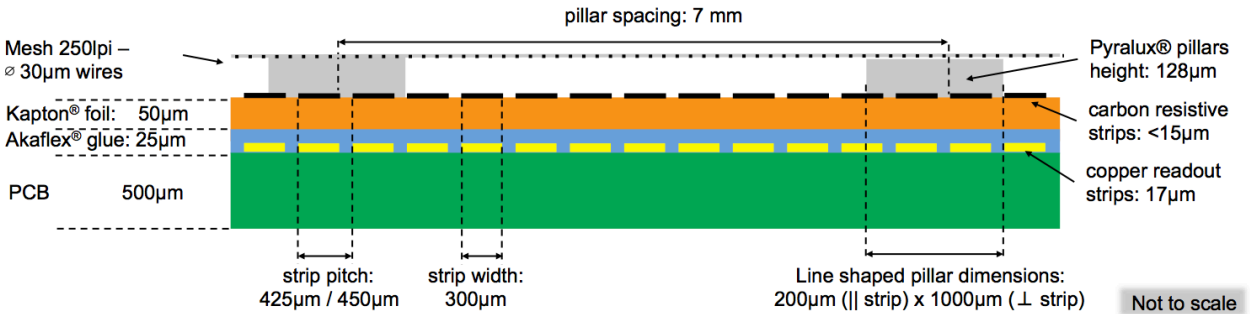
IV. chemical plating of copper pads
standard process

V. screen-printing of silver paste
non-standard but rather simple & required accuracy only ± 1mm

VI. lamination of coverlay & pillar creation
standard process for small boards.
complex due to: size of boards, highly non-standard pattern, required flatness

VII. cutting of boards and drilling of non-precision holes
standard process on CNC machine.
complex due to size of boards and required cutting precision

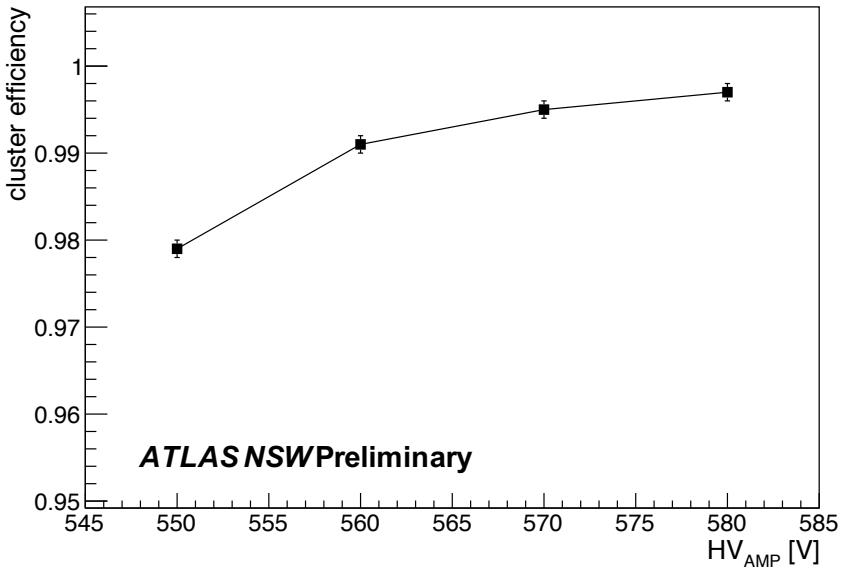




Module-0 PRELIMINAY Results on Efficiencies

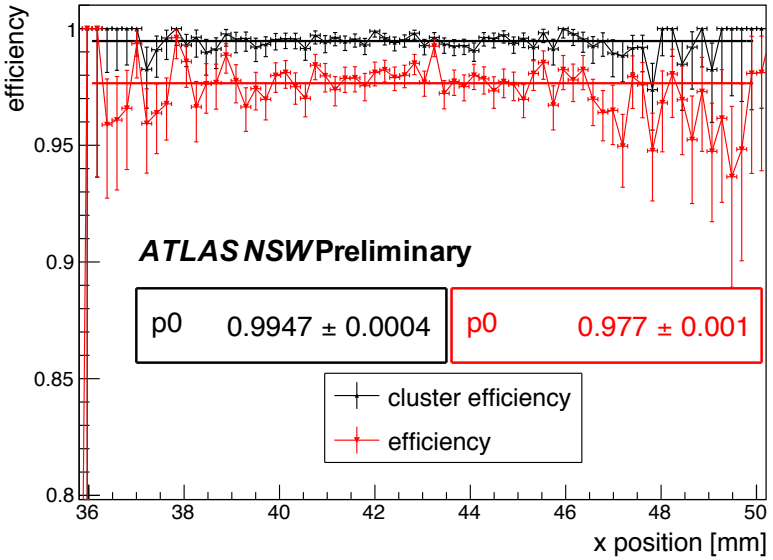
- Cluster efficiency: presence of a cluster for any reference track
- Track-based efficiency: one cluster within given distance from the reference track impact on SM1

Cluster efficiency Vs Amplification HV for Layer1



- Turn-on curve saturate at a cluster efficiency very close to 100%

Efficiency at 570 V vs x-pos in the beam-spot For Layer1

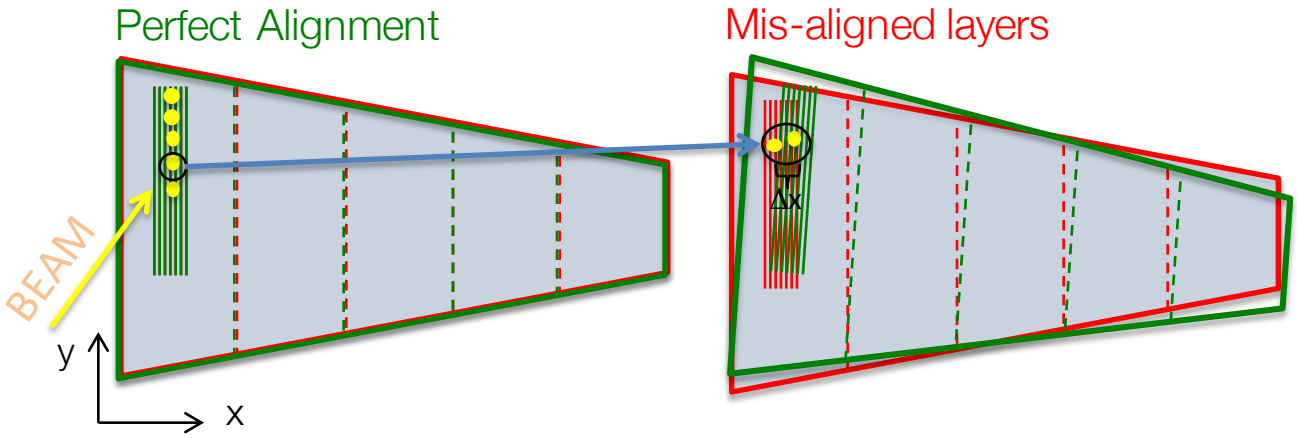


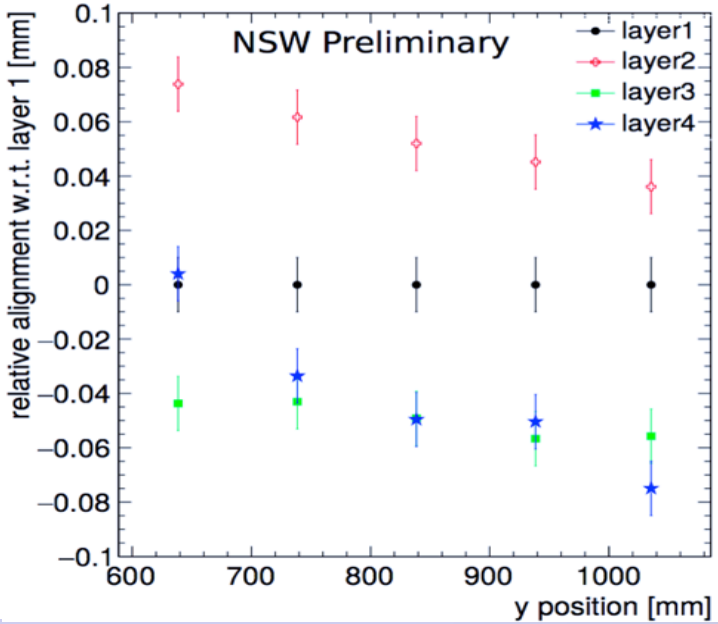
- Track based efficiency (+/-1.5 mm) ~98%
- 2% inefficiency mostly due to delta-rays

Module-0 PRELIMINARY Results on Strip Alignment

Measurements of layer-to-layer alignment

- Measurements at different vertical positions (along the strips)
- For each y-position measure Δx between *layer_i* and *layer-1* using reference tracks





Relative alignment wrt layer_1 :

- All layers aligned within a maximum deviation of +/- 80 μm
- Indication of layer-to-layer rotation or strip pattern global deformation under investigation at the construction site