Small-Strip Thin Gap Chambers
for the Muon Spectrometer Upgrade of the ATLAS Experiment

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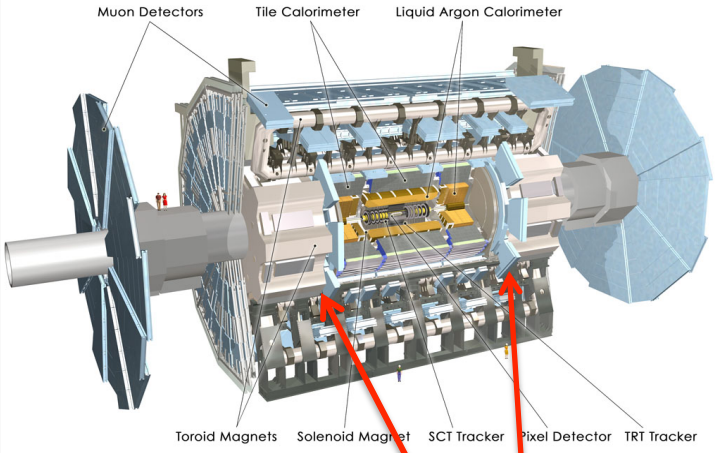
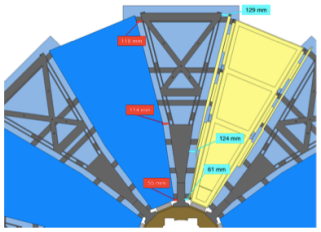
L1 muon trigger rate is high in the forward region: fakes are currently 90% of the trigger rate in the end-cap region

Fake rate increases with luminosity: After LS2 LHC's *instantaneous* luminosity will be 2-3 x 10^{34} cm^{-2} s^{-1} (and up to 5-7 x 10^{34} cm^{-2} s^{-1} at HL-LHC), one bunch crossing every 25 ns.

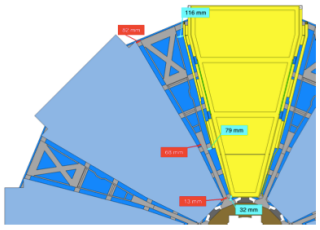
Goal of the NSW :
- **Reconstruct muon tracks with high precision** (Micromegas detectors, MM)
- **Provide information for the Level-1 trigger** (small-strip Thin Gap Chambers, sTGC)

Performance requirements:
- **1 mrad** angular resolution
- **100 µm** position resolution



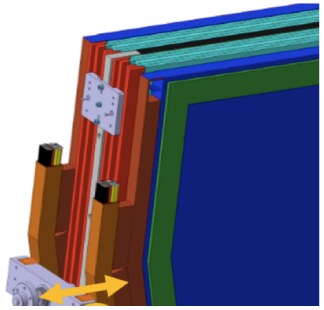


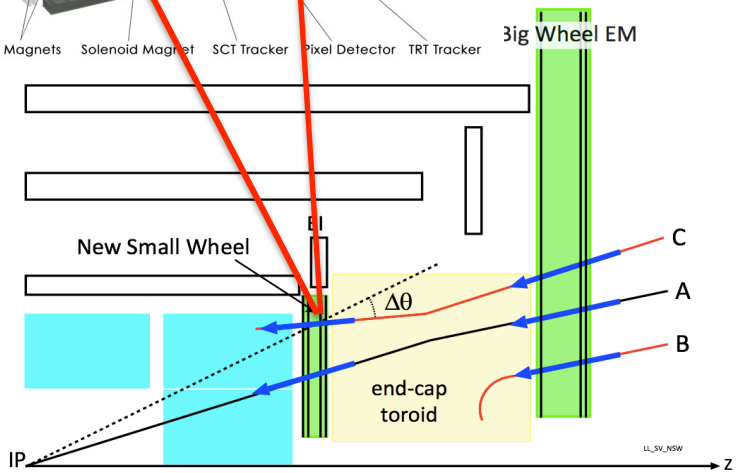
(a) sTGC (small sector).



(c) sTGC (large sector).

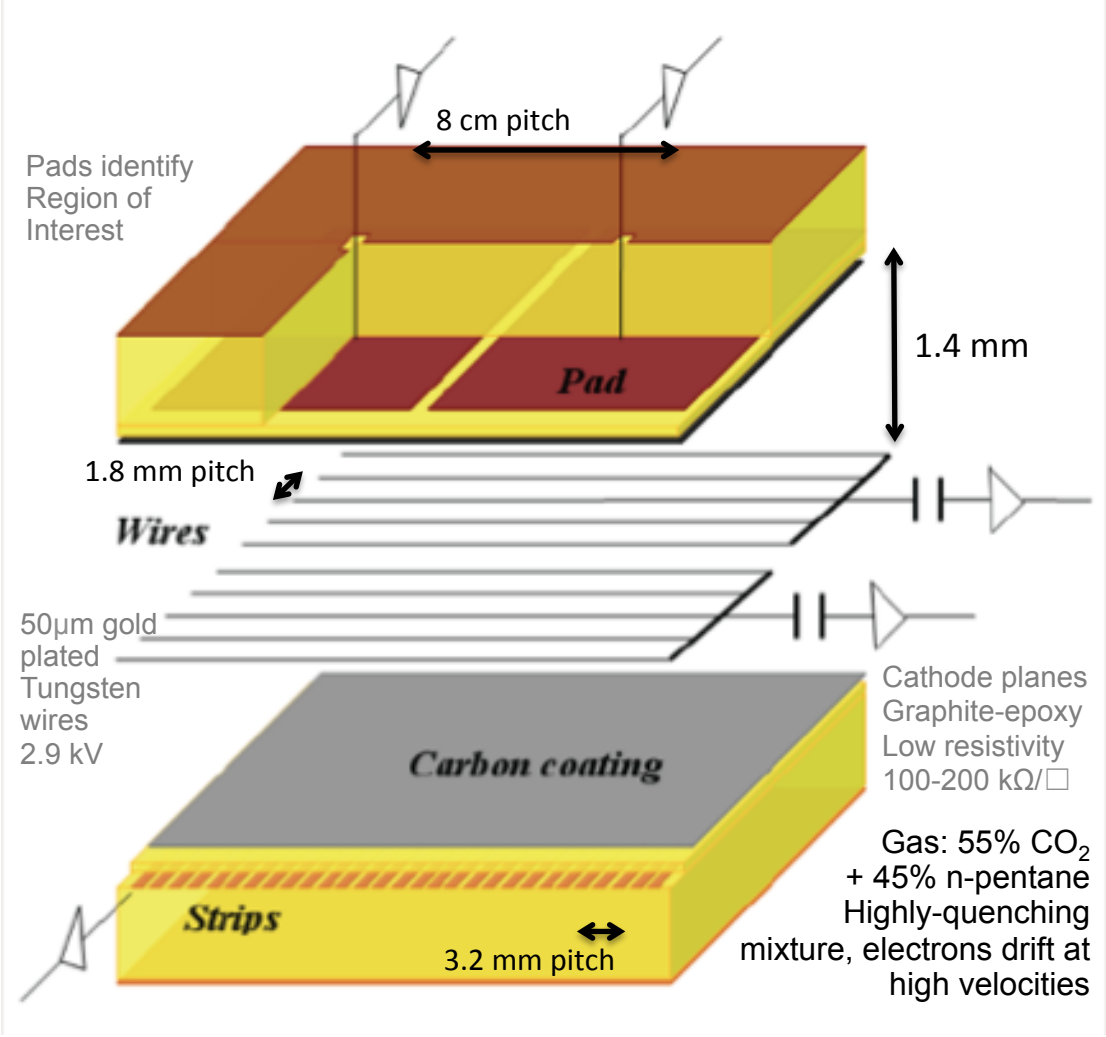
sTGC – MM – MM – sTGC

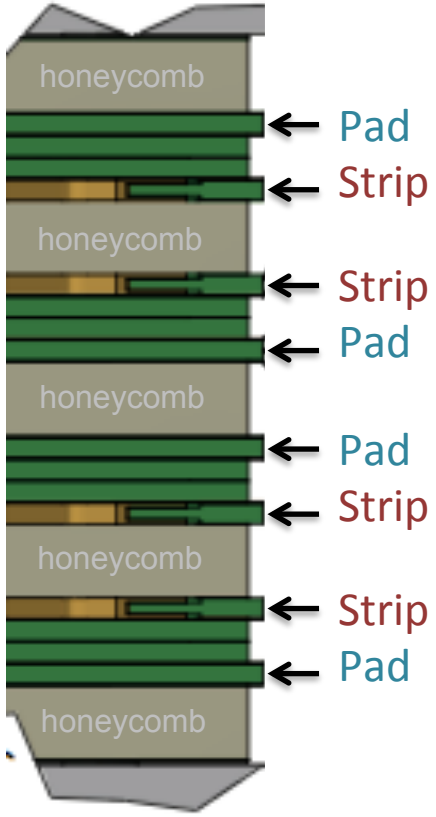




Small-Strip Thin Gap Chambers

Each module is built with **4 gaps** each containing: **Strips, wires, pads**
Important to measure the angle of the muon trajectory: need high resolution on the strips





Construction requirements and steps

- Precise (<40 μm) alignment between layers by machining together strips with **precision brass insert**

- Cathode boards flat and parallel to better than 80μm using **honeycomb filler**

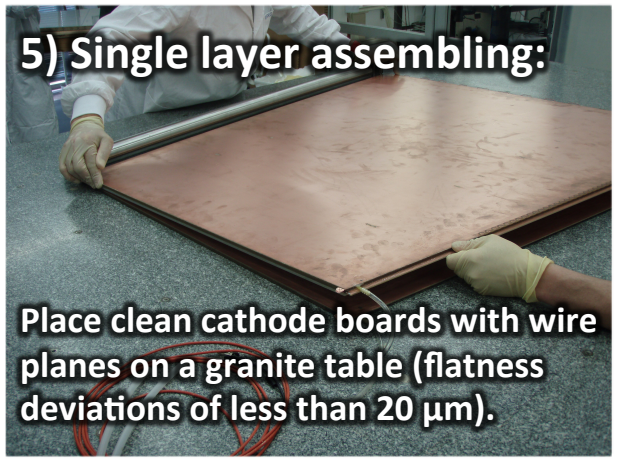
- Avoid mechanical deformations by using the **same** composite **material** (FR-4) **everywhere**

1) Components quality control: Check precisely thickness and dimensions

2) Part cleaning:
Use acetone and isopropyl-alcohol on strip boards and assembling parts to remove oily pollutants.
Remove dust with dry air.

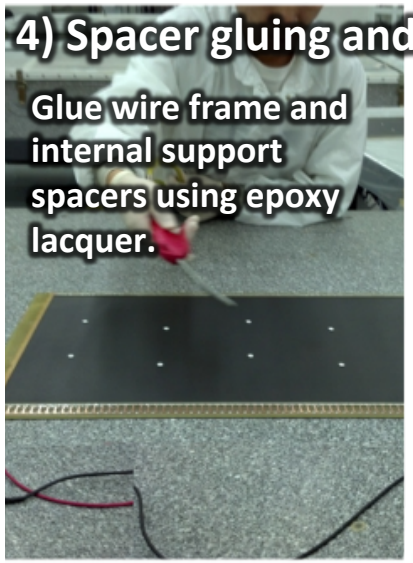
3) Cathode board preparation:
Laminate 0.1 (0.2) mm pre-preg on readout copper layers

Cover support and frame areas with jigs
Spraying graphite mixture.



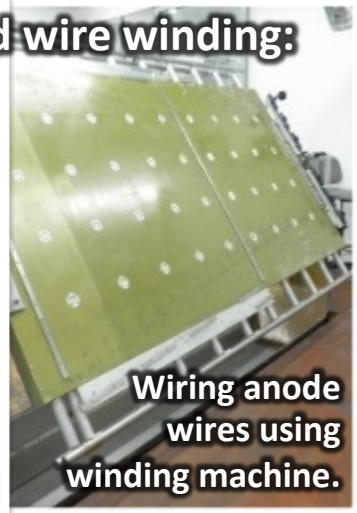
5) Single layer assembling:

Place clean cathode boards with wire planes on a granite table (flatness deviations of less than 20 μm).



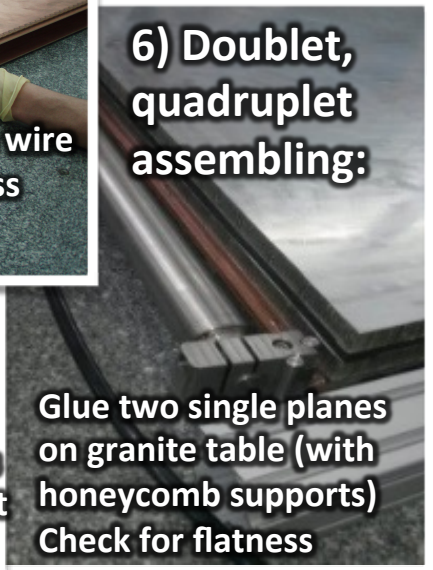
4) Spacer gluing and wire winding:

Glue wire frame and internal support spacers using epoxy lacquer.



Wiring anode wires using winding machine.

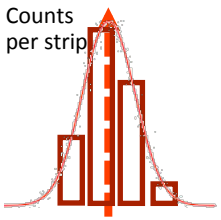
Close chambers with strip boards using precision pins for alignment
Apply vacuum on two sides



6) Doublet, quadruplet assembling:

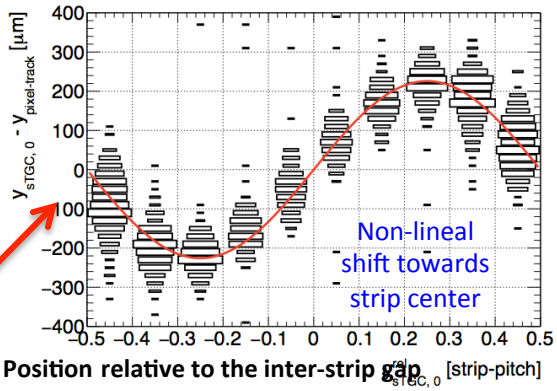
Glue two single planes on granite table (with honeycomb supports)
Check for flatness

Test Beam Data Analysis and Results



3-5 strips clusters
Gaussian fit to estimate position

Gaussian-mean shift

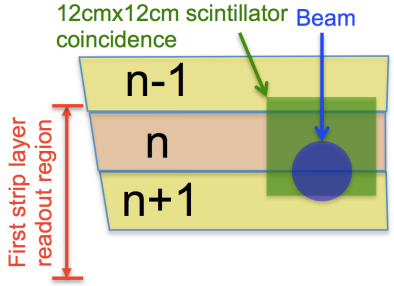


sTGC-telescope combined

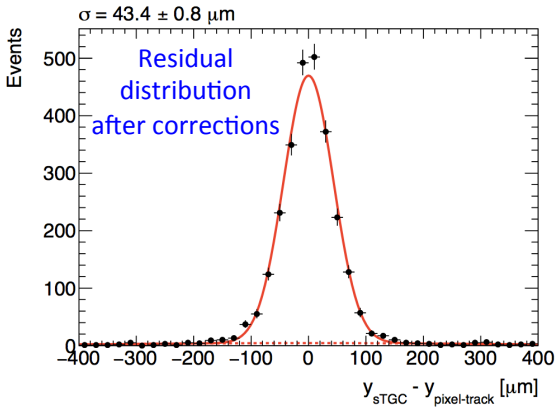
$\Delta y = y_{sTGC} - y_{telescope\text{-}track}$

Extract alignment and non-linearity corrections

Charge sharing between pads



$$F = \frac{PDO_n - PDO_{n+1}}{PDO_n + PDO_{n+1}}$$

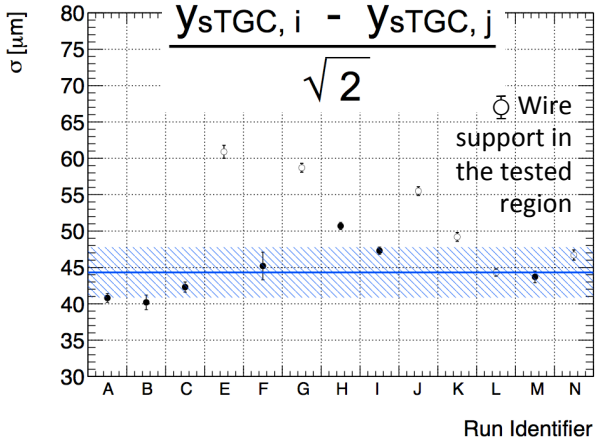


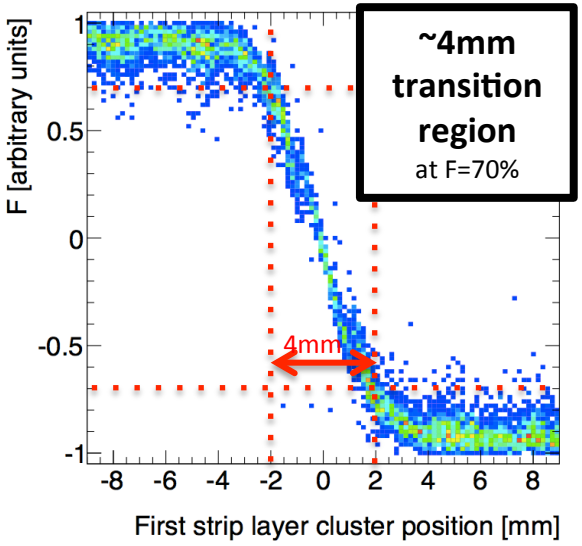
~45 μm resolution (perpendicular incidence) uniform within 3μm RMS in tested area (65×11 cm²)

sTGC standalone

Using two layers i & j

Check uniformity across chamber





~4mm transition region at F=70%

The **small-strip Thin Gap Chambers** will provide the Muon New Small Wheel with excellent **triggering** and **tracking** capabilities. The **construction** protocol has been **validated** by test beam experiments on a real-size prototype showing the **performance requirements are met**.