

ATLAS New Small Wheel Performance Studies with LHC Run-3 data

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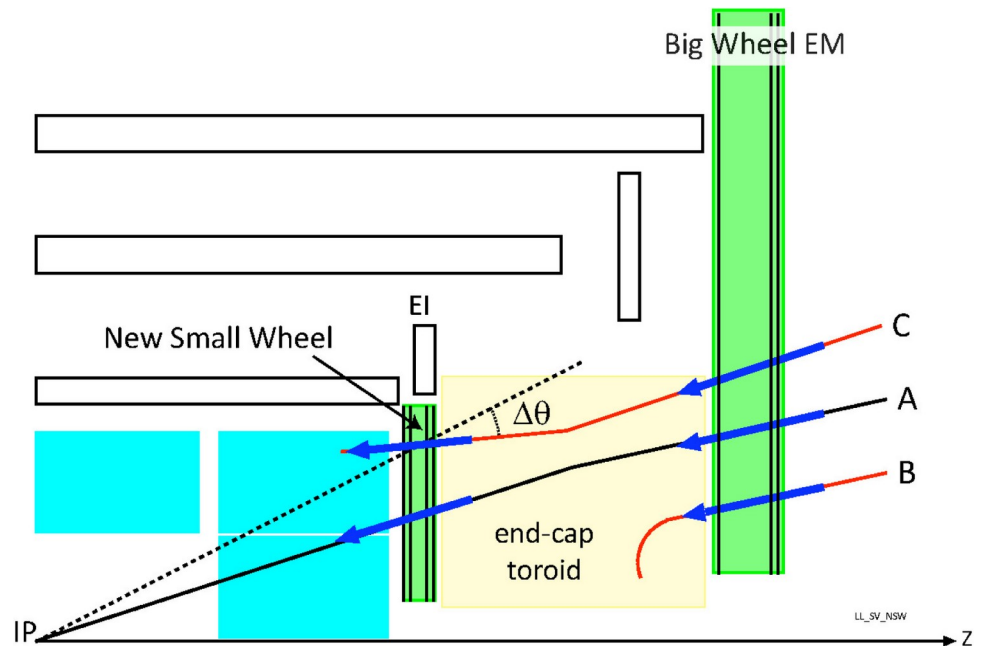
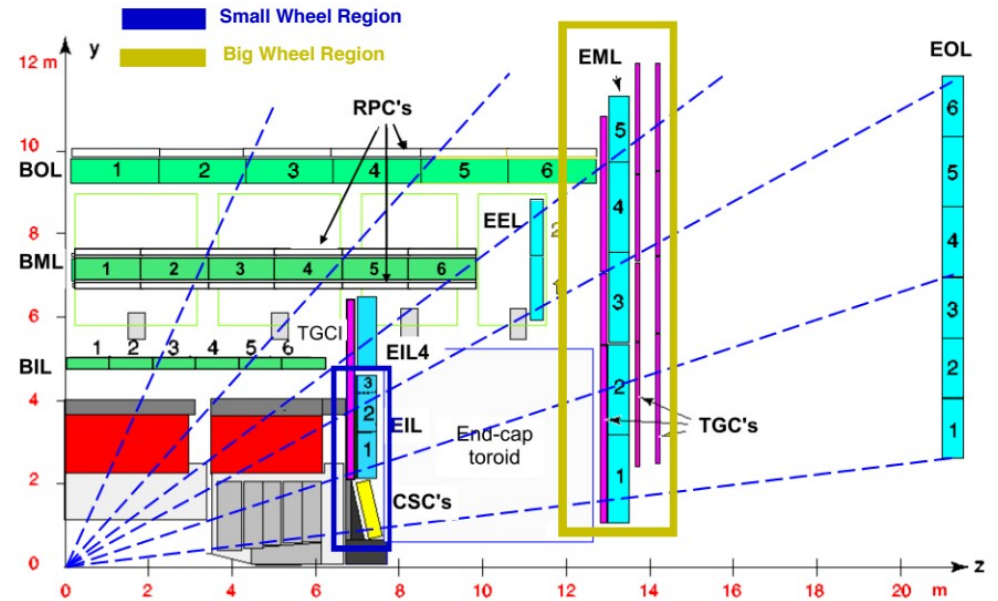
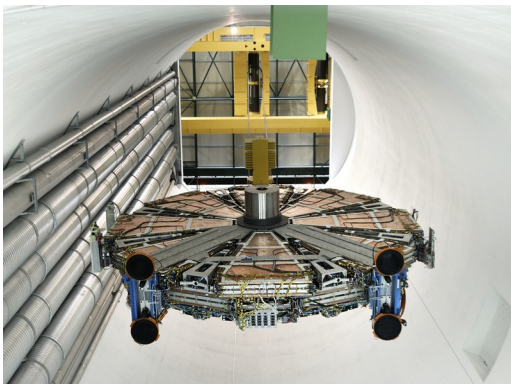
On behalf of
the ATLAS muon community



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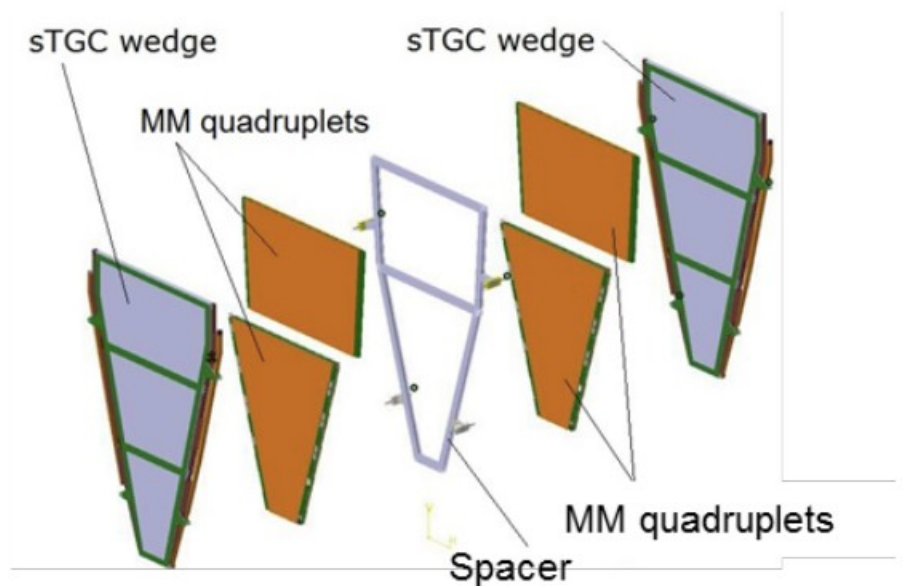
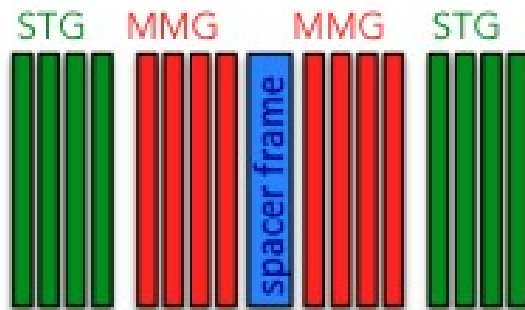
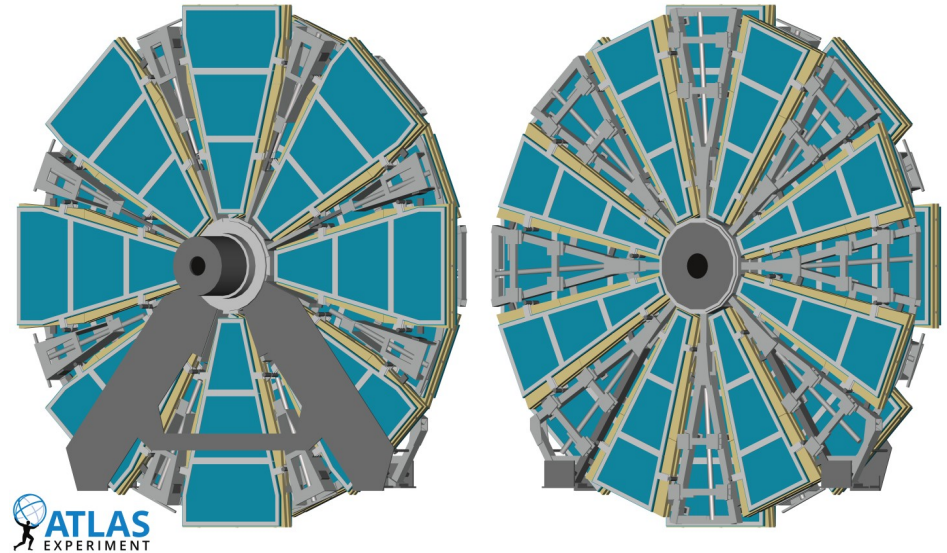
The New Small Wheel in ATLAS

- The NSW replaced the old small wheel in the inner muon endcap
- The goal is to provide precision position measurements in the increased hit rates of the high luminosity LHC
- Improve rejection of fake muon triggers from tracks that do not come from the interaction point
- Installed in the LS2 before run-3
- Fully integrated in the ATLAS trigger since 2024



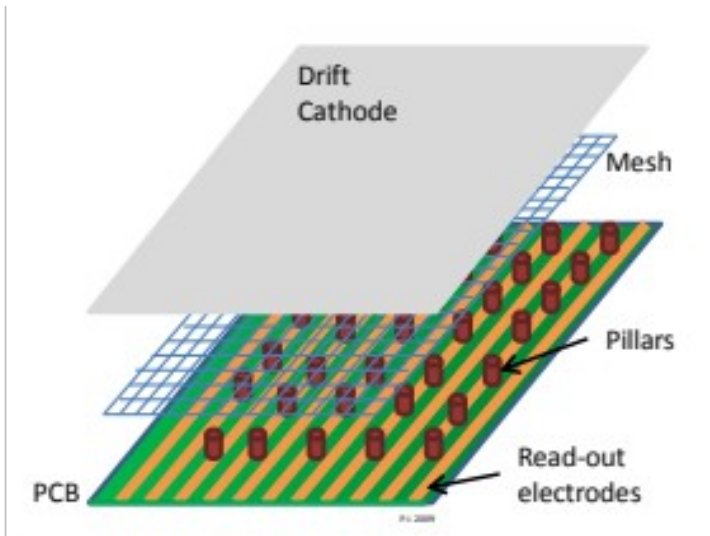
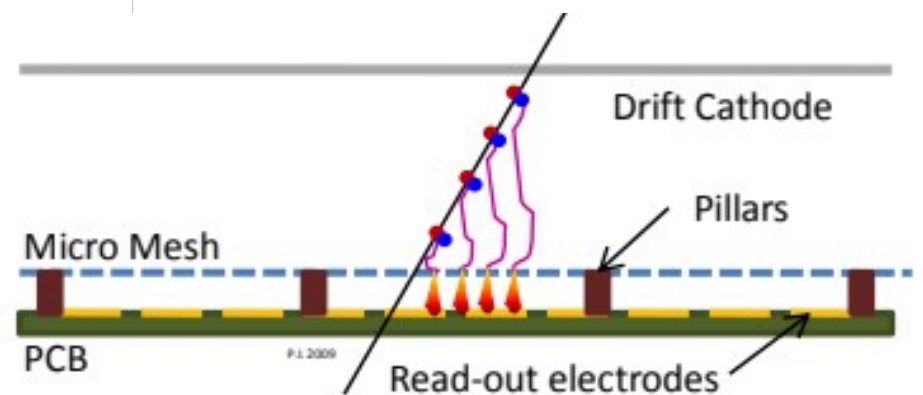
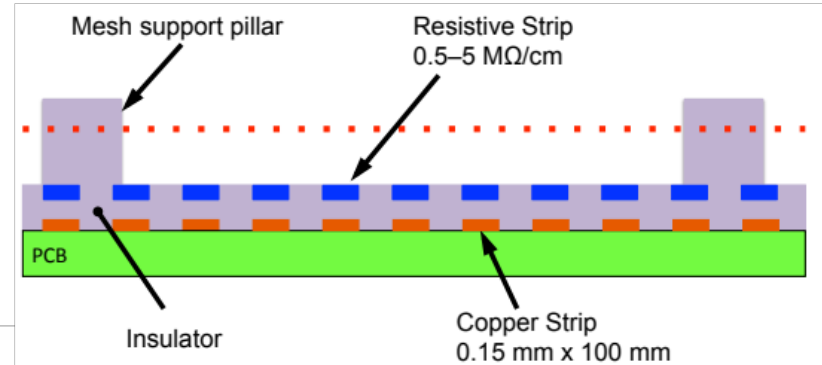
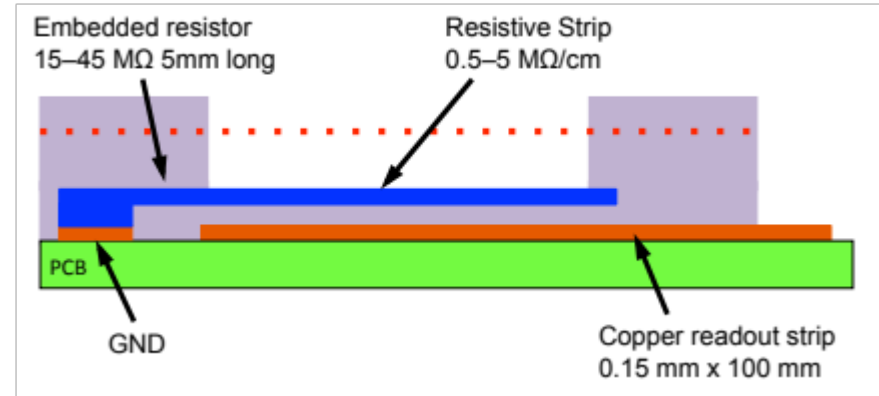
NSW components

- Two end-caps
- 16 sectors each with
- 8 layers Micromegas
- 8 layers sTGC



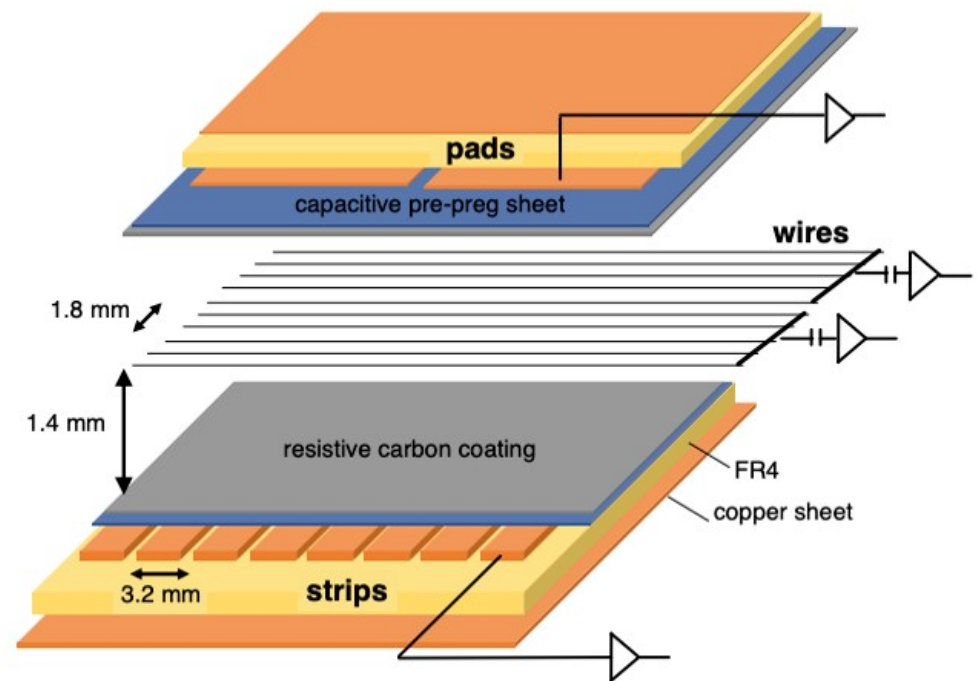
Micro mesh gaseous structure (Micromegas)

- Micro mesh gaseous structure (Micromegas)
- 5mm drift gap
- 128 micro meter amplification gap
- Readout strips with 425 and 450 micron pitch
- Ar : CO₂ : iC₄H₁₀ 93 : 5 : 2



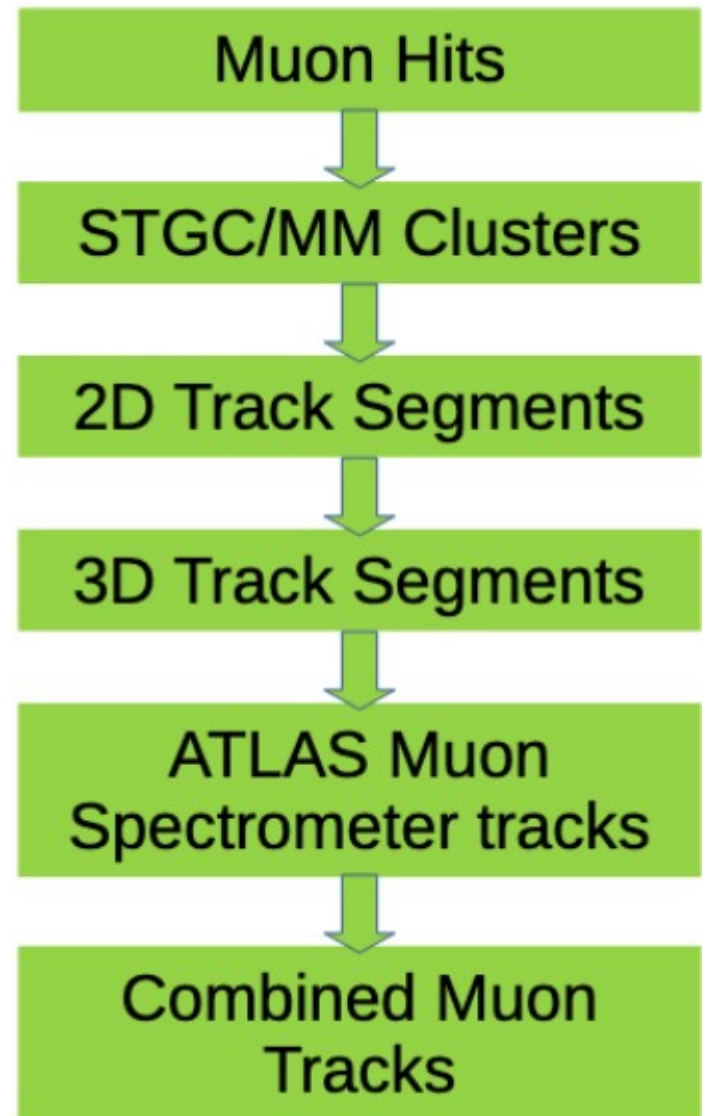
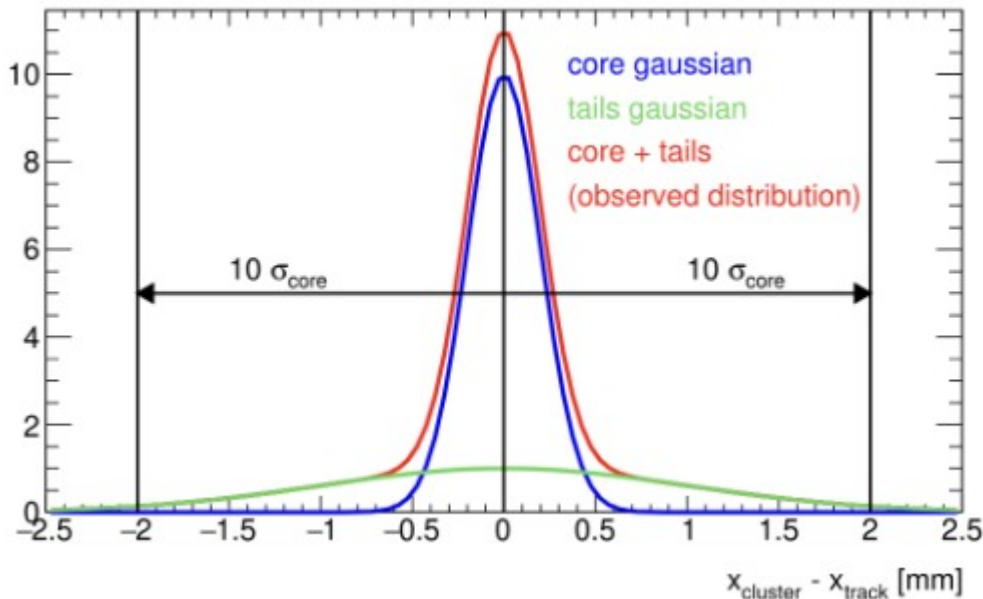
Small-Strip Thin Gap Chambers (sTGC)

- Multi wire proportional chamber
- Cathodes segmented in strips (precision position) and pads (trigger)
- 3.2 mm strip pitch with charge interpolation for precision position reconstruction
- 2.8 mm gas gap to reduce drift time and improve time resolution
- CO₂ : n-pentane 55 : 45



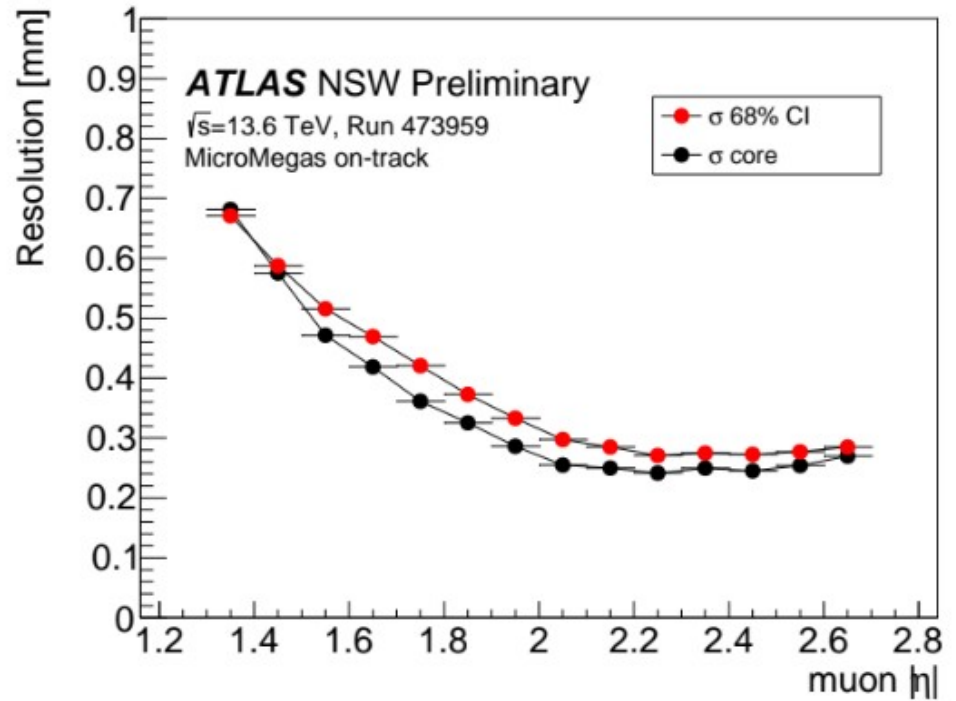
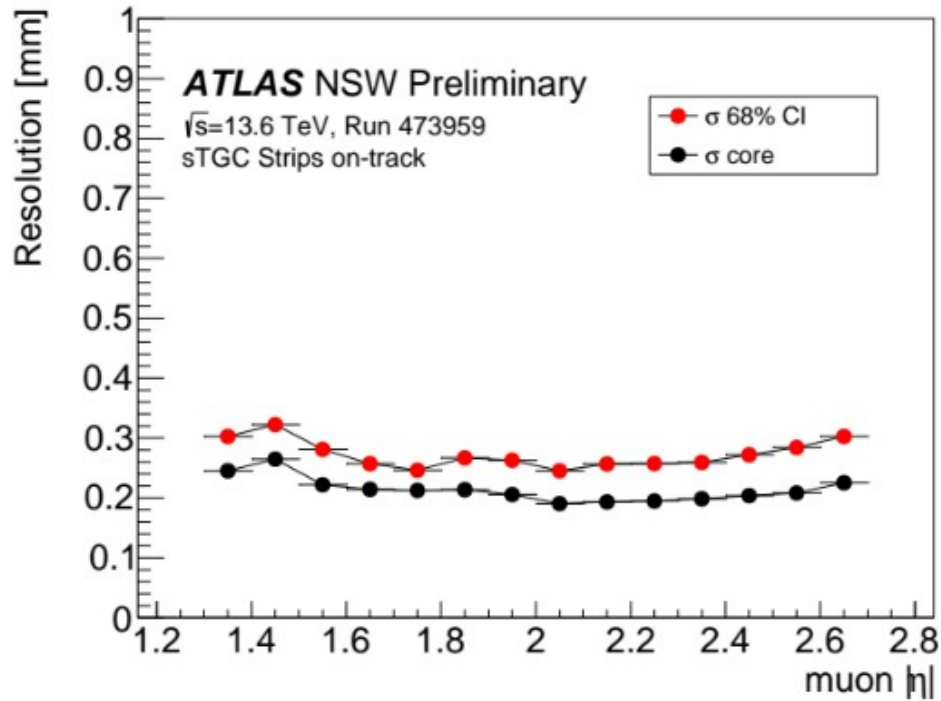
Muon reconstruction

- The cluster position is calculated as the charge centroid of the strip charges in MM and sTGC
- The resolution is obtained from a double Gaussian fit of the residual distribution
 - Standard deviation of the inner core Gaussian
 - 68% confidence level



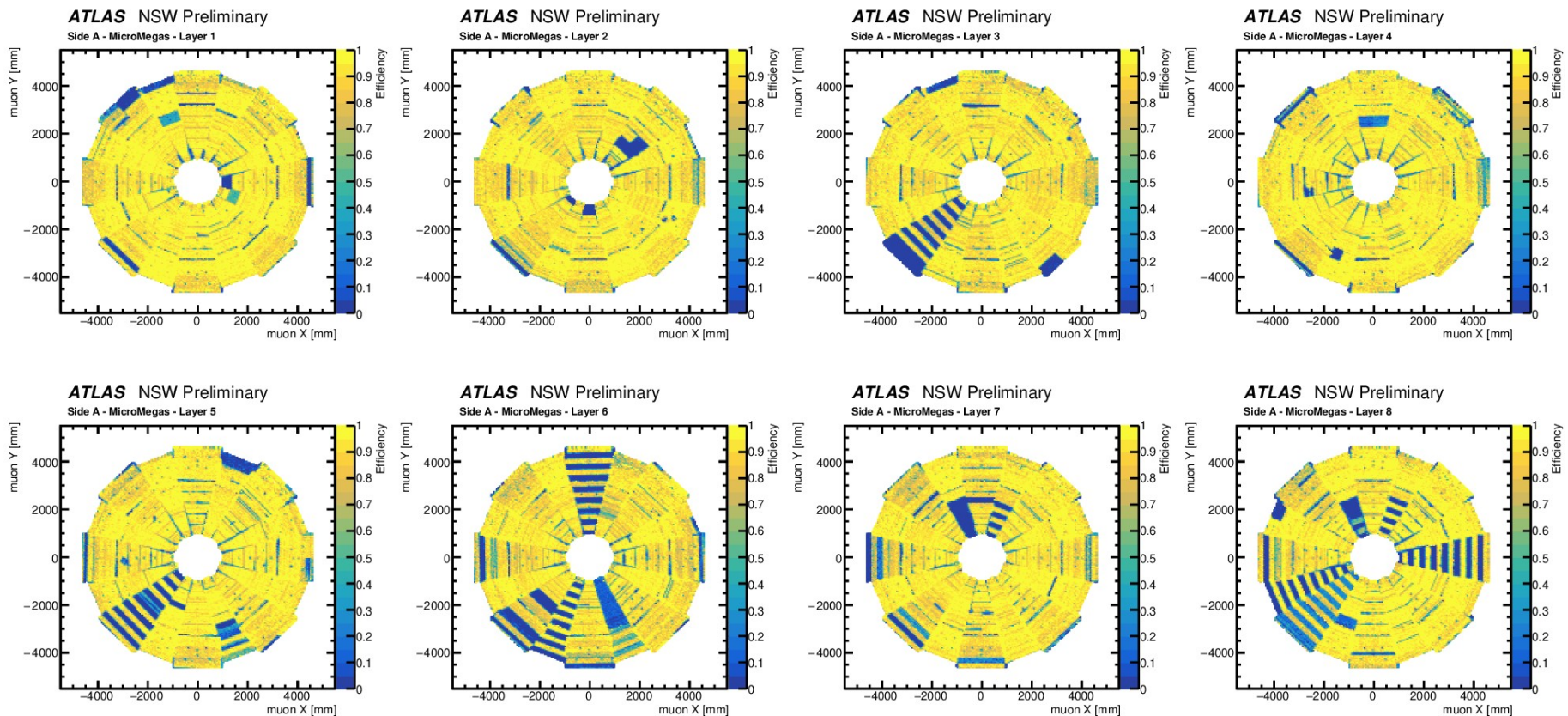
Position resolution

- Single layer resolution still under optimization
 - Global misalignment and layer-to-layer misalignment
 - Development of better reconstruction algorithms
 - MM: use the time information as micro-TPC
 - sTGC: use a Gaussian or parabola to find the center of the cluster profile



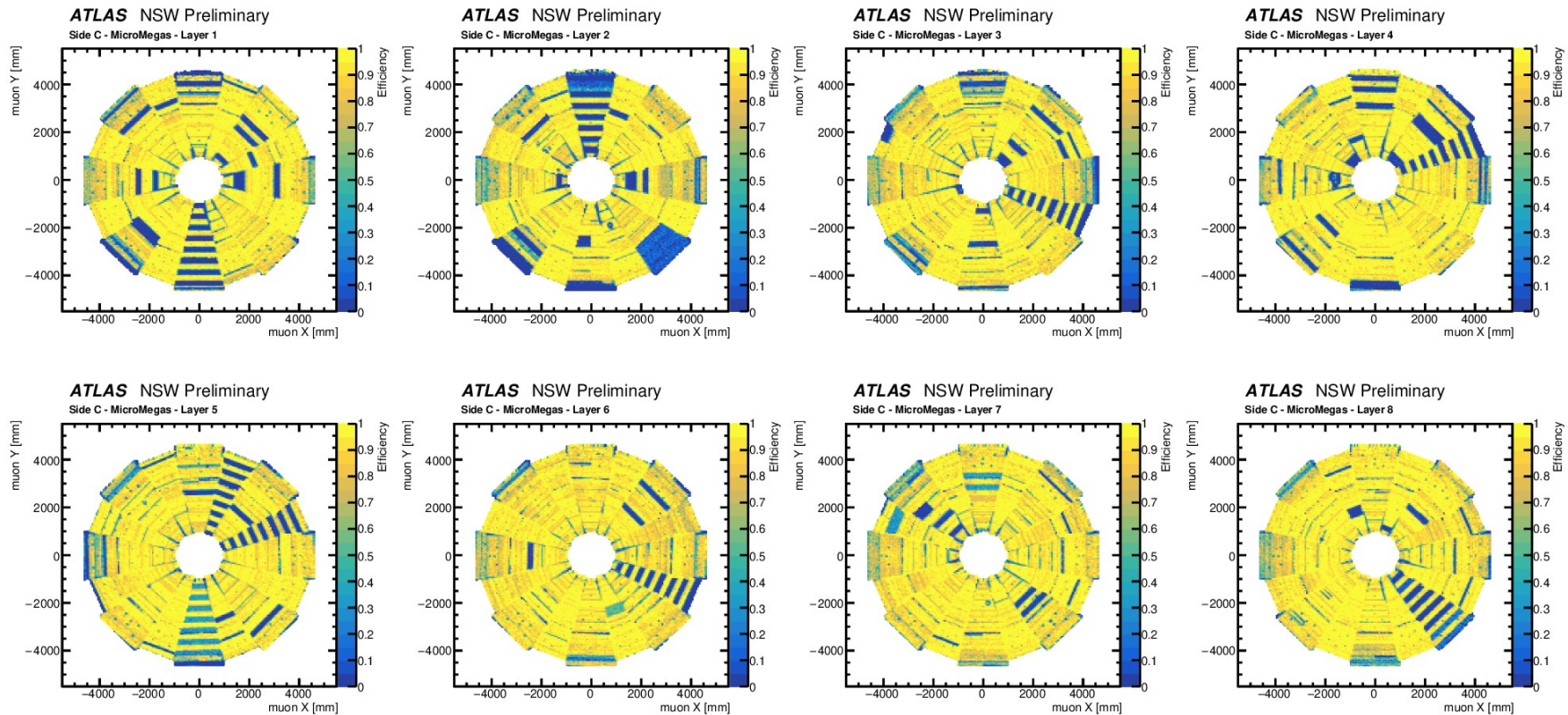
Micromegas layer efficiency endcap A

- Cluster-on-track efficiency
 - Count clusters on track that are not rejected as outliers
 - Inefficiencies due to readout issues, HV and LV problems



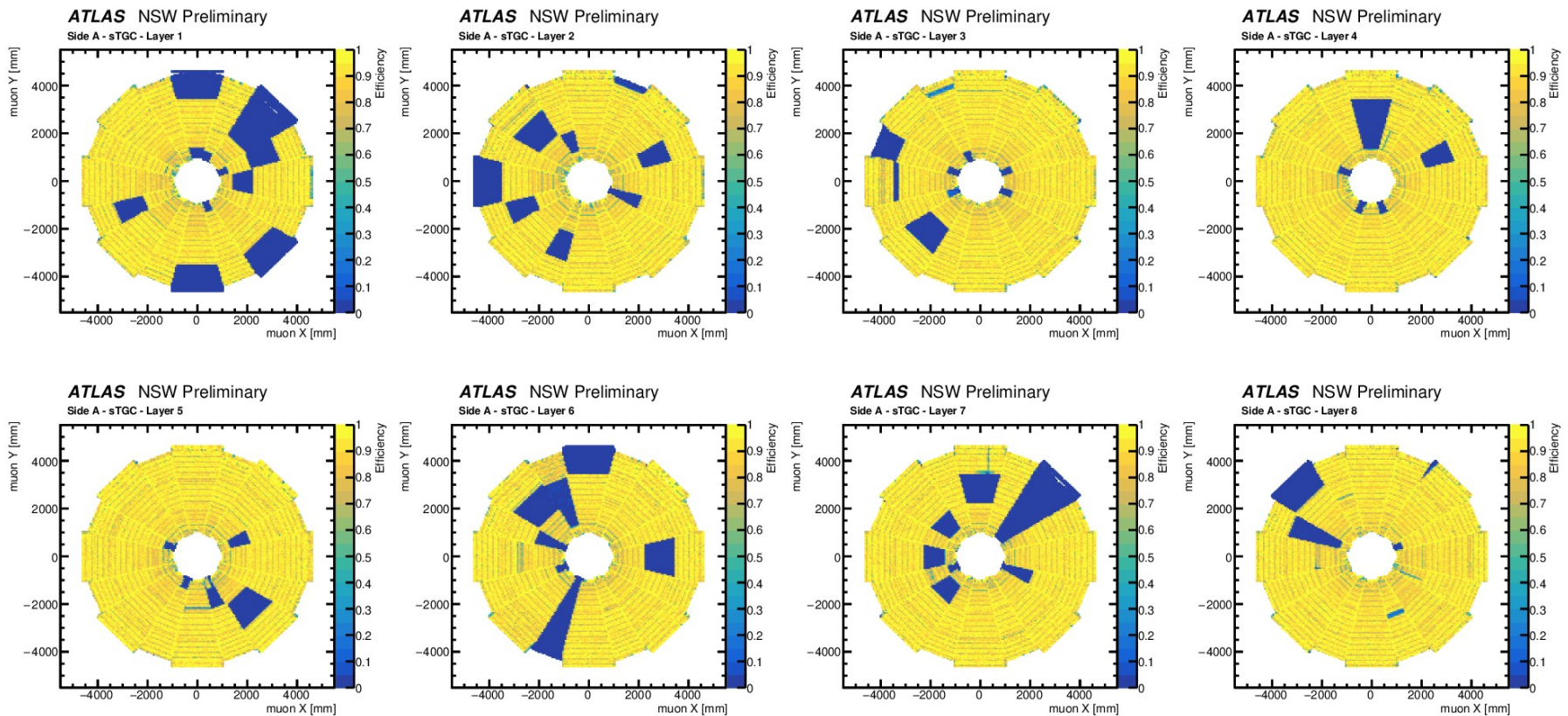
Micromegas layer efficiency endcap C

- Cluster-on-track efficiency
 - Count clusters on track that are not rejected as outliers
 - Inefficiencies due to readout issues, HV and LV problems



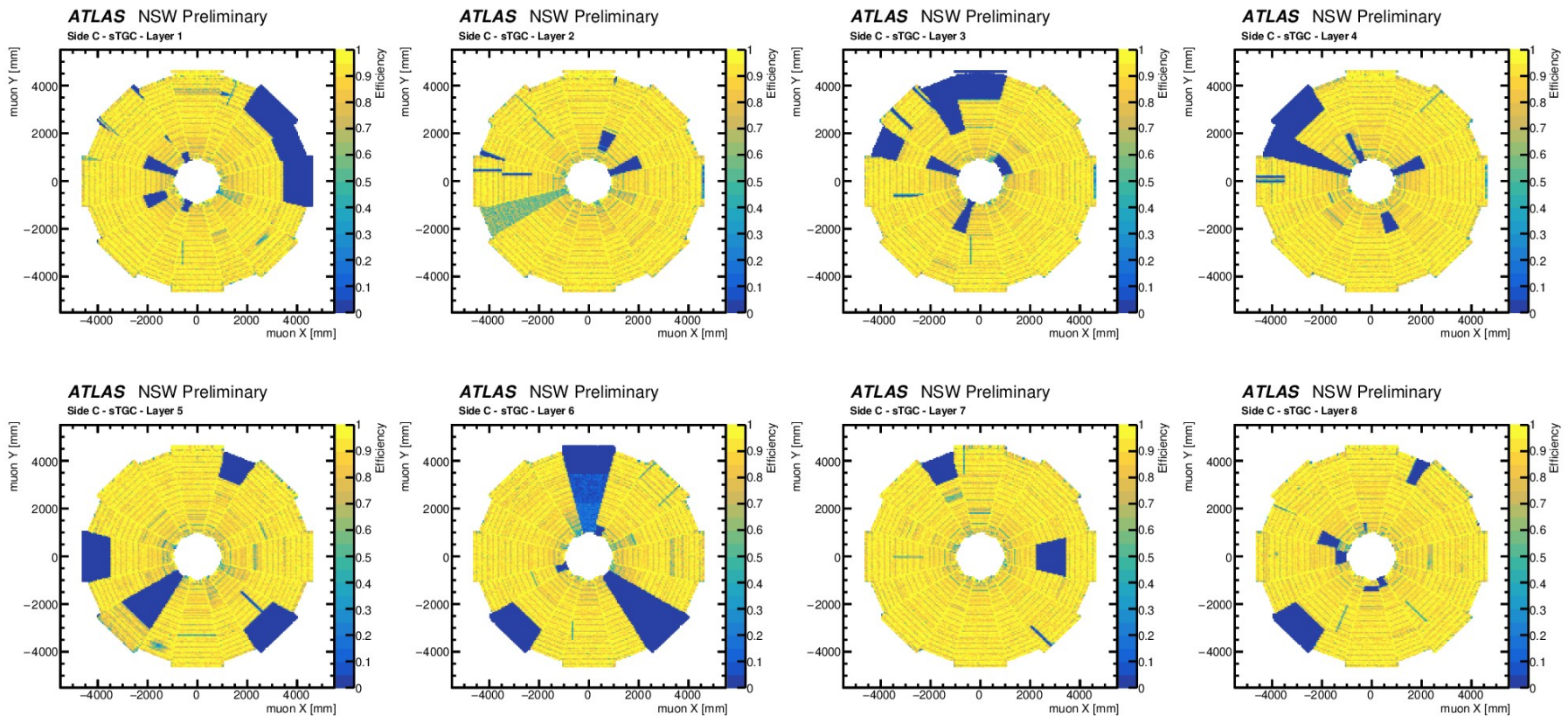
sTGC layer efficiency endcap A

- Inefficiencies due to readout issues, HV and LV problems



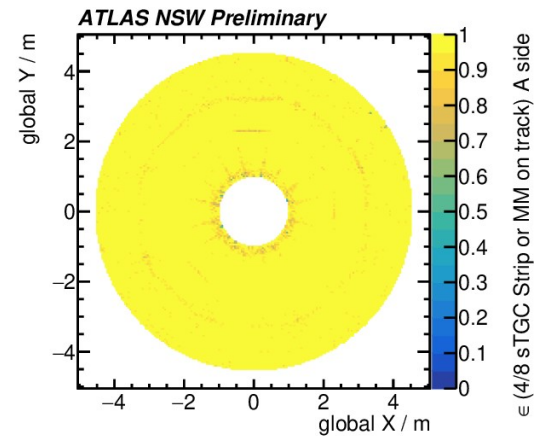
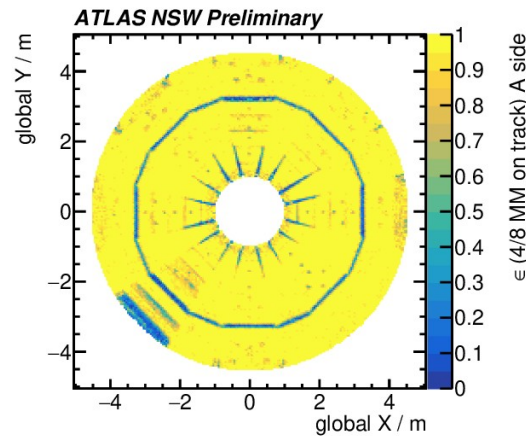
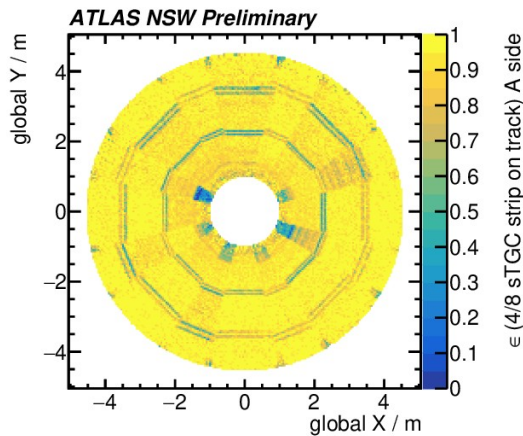
sTGC layer efficiency endcap C

- Inefficiencies due to readout issues, HV and LV problems

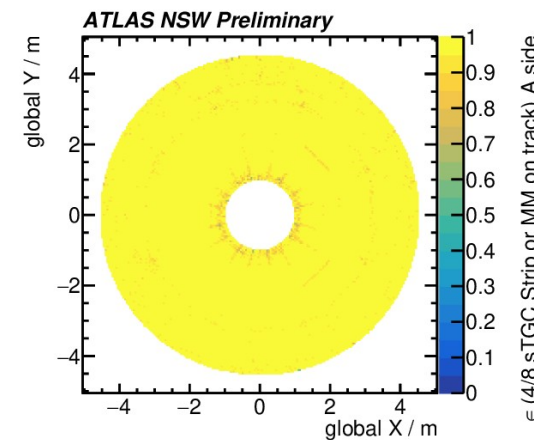
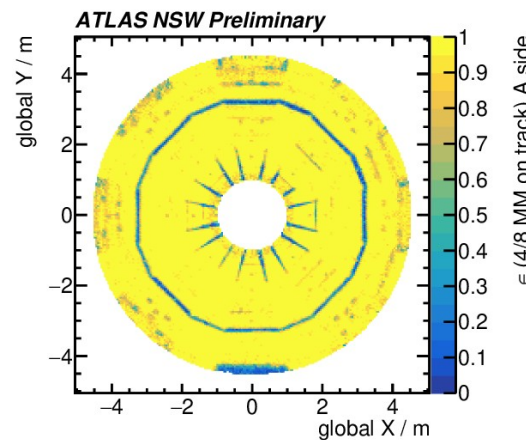
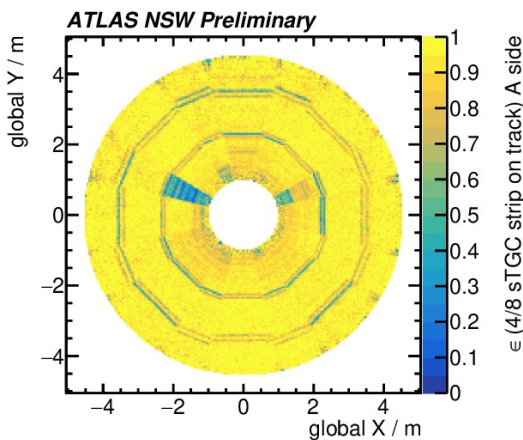


NSW combined on-track efficiency

- Requires at least 4 of 8 layers with a cluster on track in either MM or sTGC
- Due to the high redundancy, the efficiency is $> 95\%$



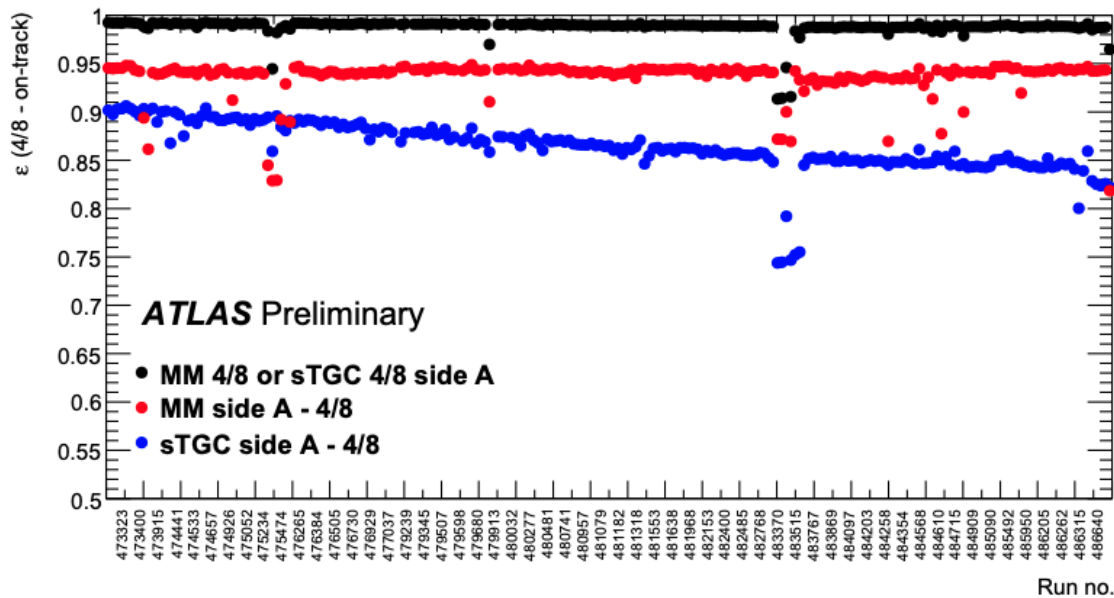
Endcap A



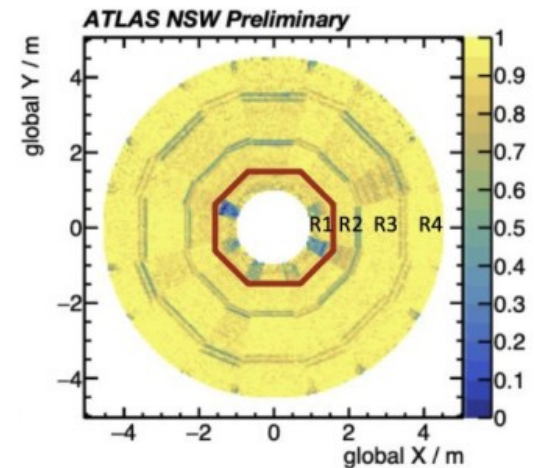
Endcap C

NSW combined efficiency

- NSW combined efficiency was stable during 2024, approximately 99%
- HV problems in sTGC chambers, mainly at the inner radius (R1)
- HV was lowered from 2.8 kV to 2.725kV (R1) and 2.75 kV elsewhere

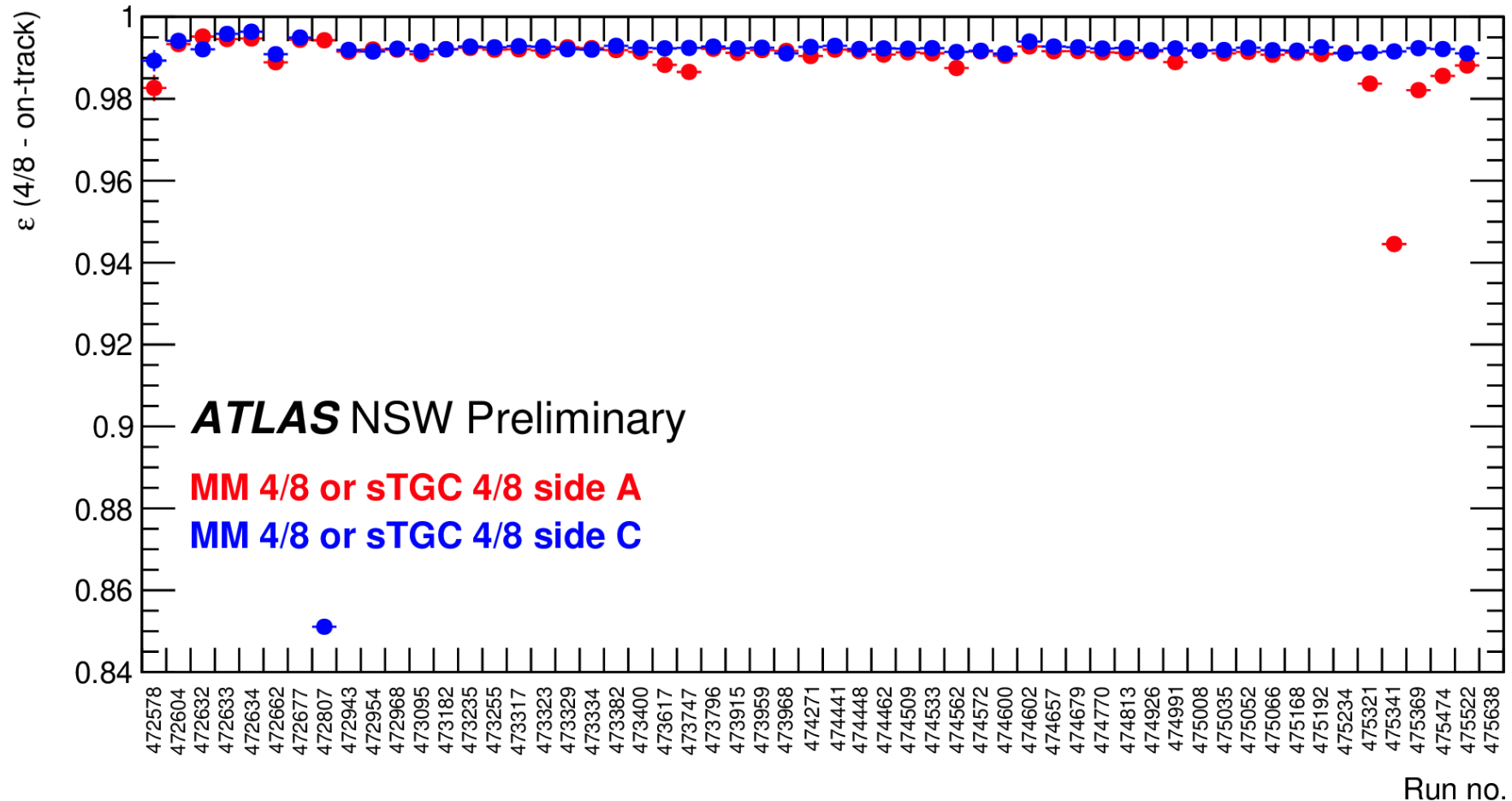


HV problems in chambers at the inner radius (R1)



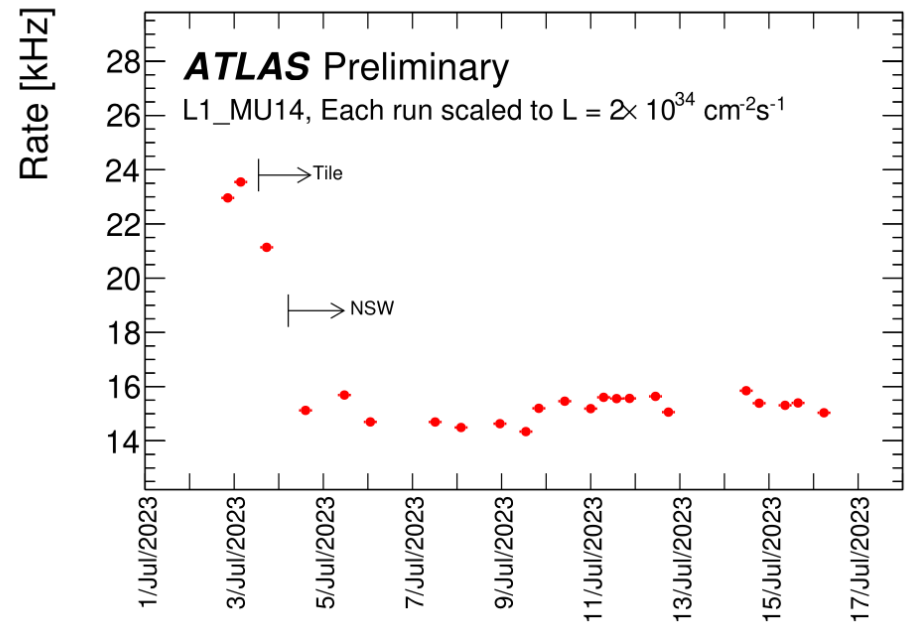
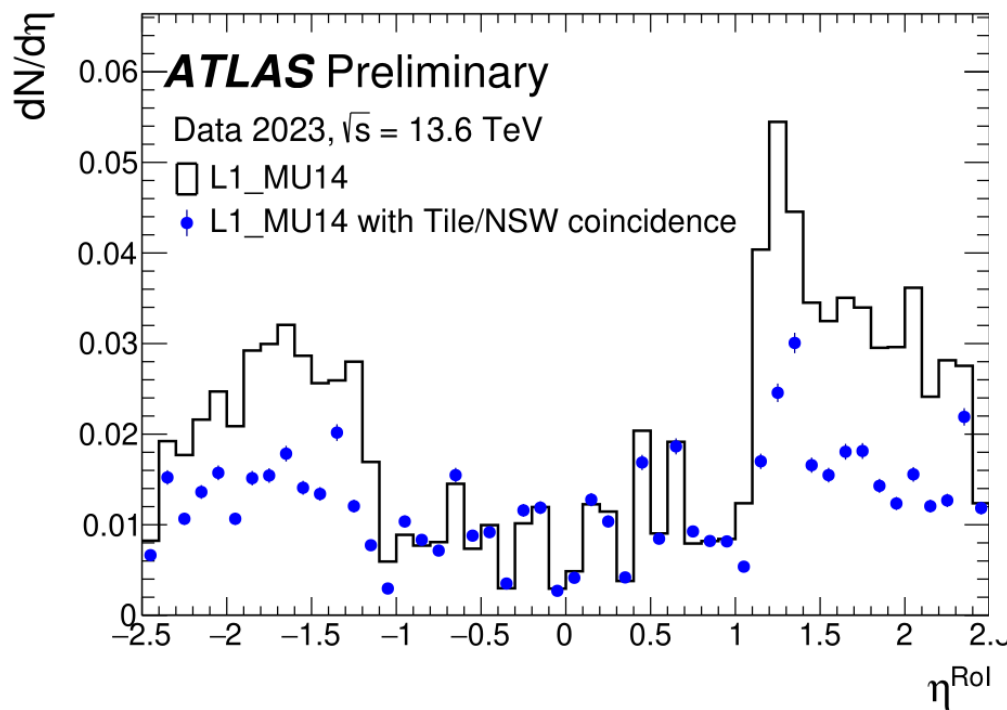
NSW combined efficiency

Despite small efficiency losses over time due to HV problems and running at lower HV, the NSW combined efficiency (4/8 clusters on track) was stable during 2024



NSW in ATLAS trigger

- The coincidence between the NSW, the outer wheel, and the Tile calorimeter reduced the muon trigger rate significantly
- NSW was fully integrated in the ATLAS trigger decision in all sectors in 2024



Summary

- The new small wheel was installed, commissioned, and is actively taking data in run-3
- The trigger system is fully integrated in the ATLAS trigger and improved the rejection of fake triggers
- The spatial resolution is undergoing optimizations for alignment and improvements of cluster reconstruction algorithms
- The efficiency is ~99% due to the high redundancy of two detector technologies with 8 layers each.