ATLAS New Small Wheel Performance Studies with LHC Run3 data

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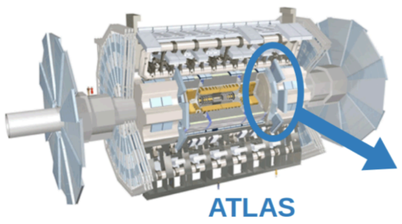
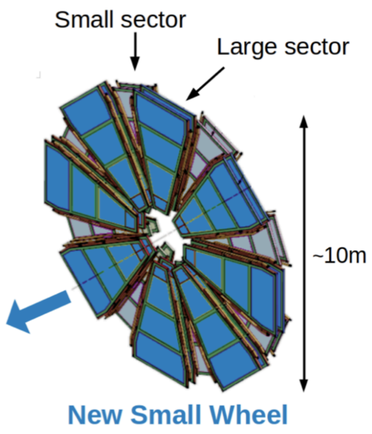
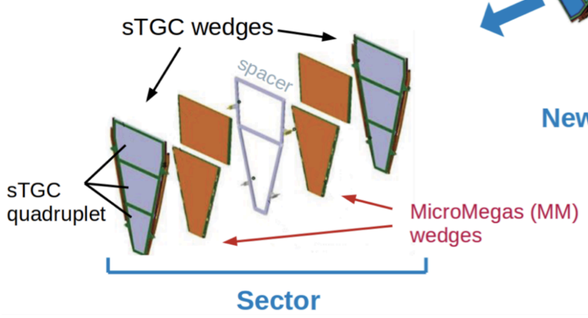
The most important ATLAS upgrade for LHC run-3 has been in the Muon Spectrometer, where the replacement of the two forward inner stations with the New Small Wheels (NSW) introduced two novel detector technologies: the small strip Thin Gap Chambers (sTGC) and the resistive strips Micromegas (MM). The integration of the two NSW in the ATLAS endcaps marks the culmination of an extensive construction, testing, and installation program. The NSW actively contributes to the muon spectrometer trigger and tracking, during the concurrent finalization of the commissioning phase of this innovative system and the optimization of its performances. This presentation will offer an overview of the strategies employed for simulation and reconstruction integration and optimization, followed by a detailed report on the performance studies of the NSW system during its initial operation with LHC Run3 data.

The New Small Wheel Upgrade





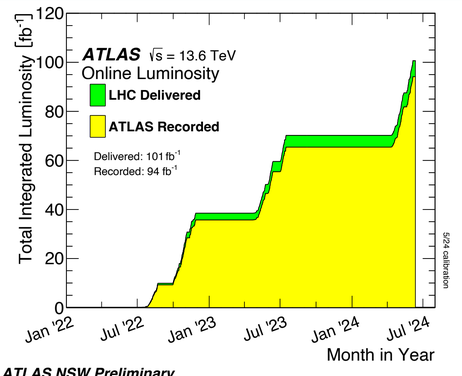


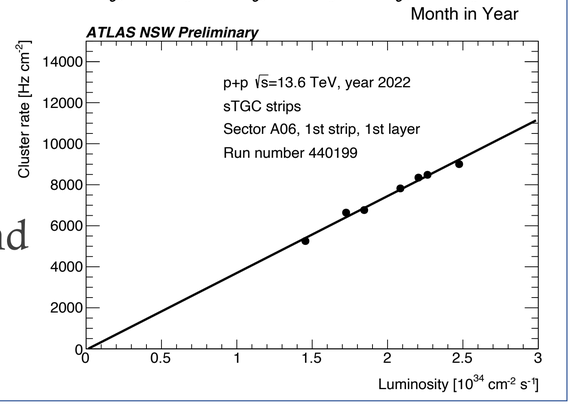
Designed to deal with increasing LHC luminosity expected for HL-LHC

- Reduce LVL1 muon trigger rates in the endcap
- Guarantee high tracking resolution for high p_T muons (~15% @ 1 TeV)

Start of Run 3 in July 2022

- Collected about 100 fb^{-1}
- NSW included in combined ATLAS DAQ and contributing to ATLAS tracking
- Observed rate in agreement with the expectation



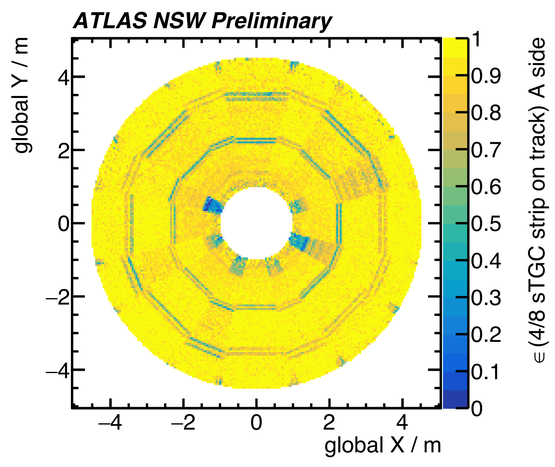


Detector Efficiencies

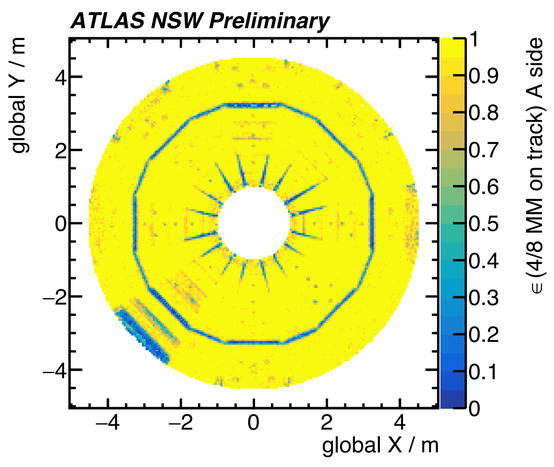
NSW fully integrated in ATLAS simulation and reconstruction framework

- MM and sTGC strips → clusters → track segments across detector layers → combined muon track fit
  - Second coordinate ϕ from MM stereo layers and sTGC pads/wires
  - B-field correction
- Single layer efficiencies affected by HV trips or DAQ/LV issues → average single-layer efficiency ~ 70/80 %
- Track reconstruction with clusters associated to the muon track (on-track efficiency with at least 4/8 detector layers)
- Better status in 2024 thanks to the huge work on improving DAQ stability

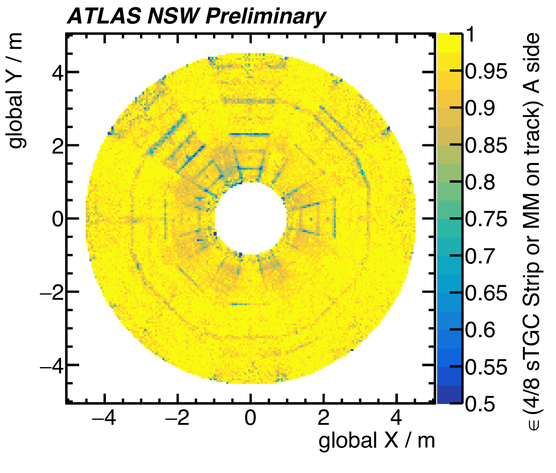
4/8 sTGC in 2024



4/8 MM in 2024



4/8 sTGC or MM in 2023
ε > 95%



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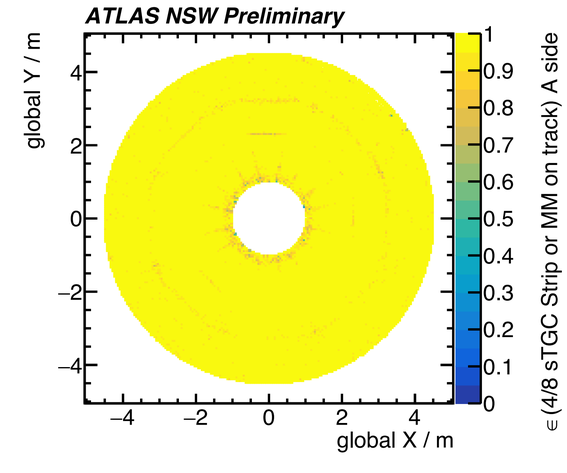


Trigger Performance

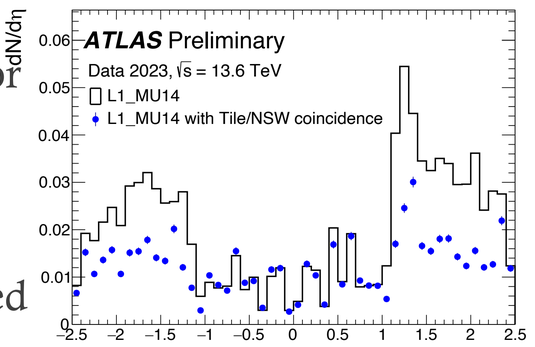
sTGC L1 Trigger

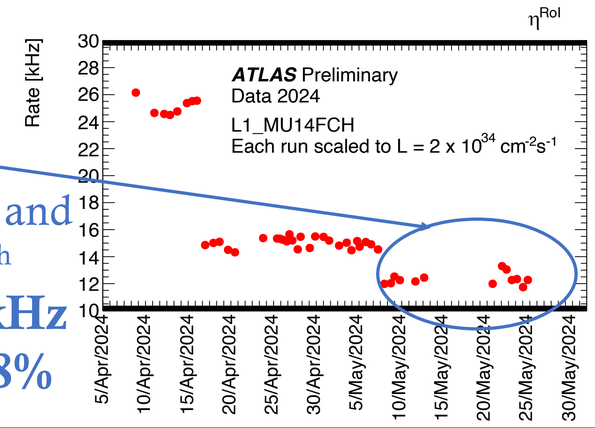
- Pad trigger coincidence 3/4 or 2/4 per wedge + strip charge

MM L1 Trigger

- Earliest strip in each VMM
- sTGC Pad trigger partially added to L1 in 2023 → Fakes rate rejection ~ 6 kHz in 2023
- Integration MM segments progressively included in TP coincidence → all sTGC Pad and MM sectors in since May 28th

Fakes rate rejection ~11 kHz
Tigger efficiency up to 98%





Detector Resolutions

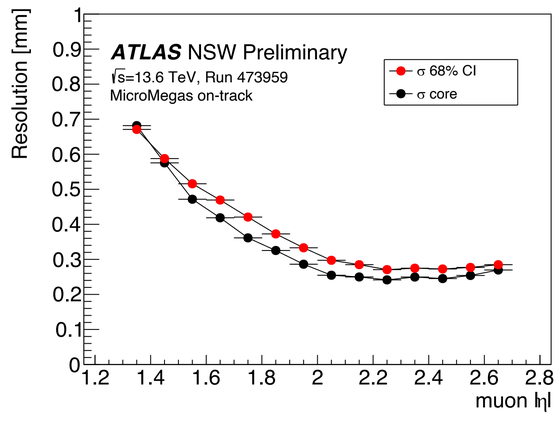
For the moment based on centroid cluster position (charge weighted average strip position)

- Alternative reconstruction method under investigation
  - MM time will improve the η dependency
  - cluster shape analysis for sTGC

Results with preliminary alignment

- Alignment uncertainty → Sagitta bias on the global muon track ~ 80-100 μm NSW region with toroid off

MM average resolution ~ 350 μm



sTGC average resolution ~ 250 μm