Charge Collection Performance Studies of sTGC Chambers of the ATLAS NSW

Alexandre Santana - CERN
Supervisor - José Pretel

Motivation

Small-strip Thin Gap Chambers **(sTGC)** are key components of the New Small Wheel **(NSW)**. Since the commissioning of the NSW in 2022, an increasing number of **high-voltage (HV) failures** have been observed in some sTGC layers. The goal of this project is to **analyze sTGC operational data** collected between 2022 and 2026 to monitor the performance of sTGC cluster charge reconstruction over time to identify potential degradation or failure patterns. This study will help to ensure long term reliability of the NSW during the High-Luminosity LHC period.

NSW Layout

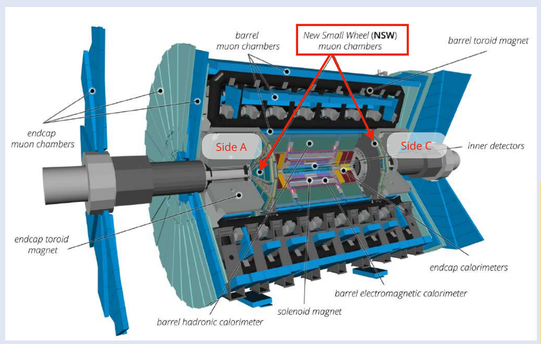

Fig. 1: Cutaway view of the ATLAS detector, highlighting the location of the NSW muon chambers. It is placed in the forward/endcap region, where the flux of background muons is the largest. [1]

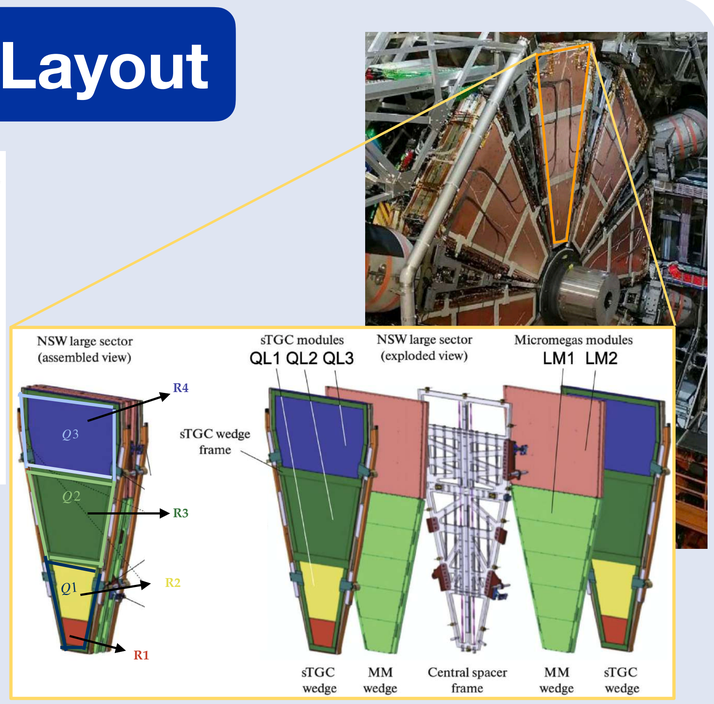

Fig. 2 NSW composition: sector decomposition, wedges, quadruplets and HV channels. [2]

2 sides (A and C) → 16 sectors each → large/small sectors → odd/even numbers → each with 2 wedges → each with 3 quadruplets

sTGC Technology

The gas gap structure is composed by a plane of anode wires at HV between one pad cathode board and one strip cathode board. One quadruplet has 4 layers. Layer numbering within a sector used in the analysis: $1 \rightarrow 4$ for inner wedge and $5 \rightarrow 8$ for outer wedge

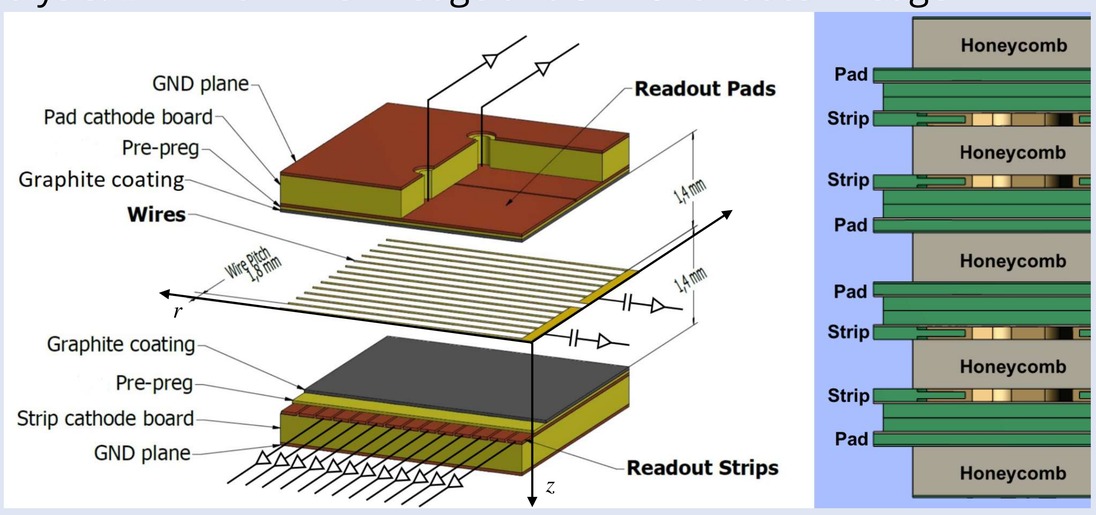

Fig. 3 sTGC technology layout. [1]

1 HV channel per layer → Q2: R3 and Q3: R4 → 2 in Q1: R1 and R2

Cluster Charge Monitoring

Trends of average cluster charge for full 2024 pp collision data at $\sqrt{s} = 13.6$ TeV were analyzed. In the R1 curve is visible the HV switching from 2.8 kV to 2.725 kV in run 480481 → 19 July.

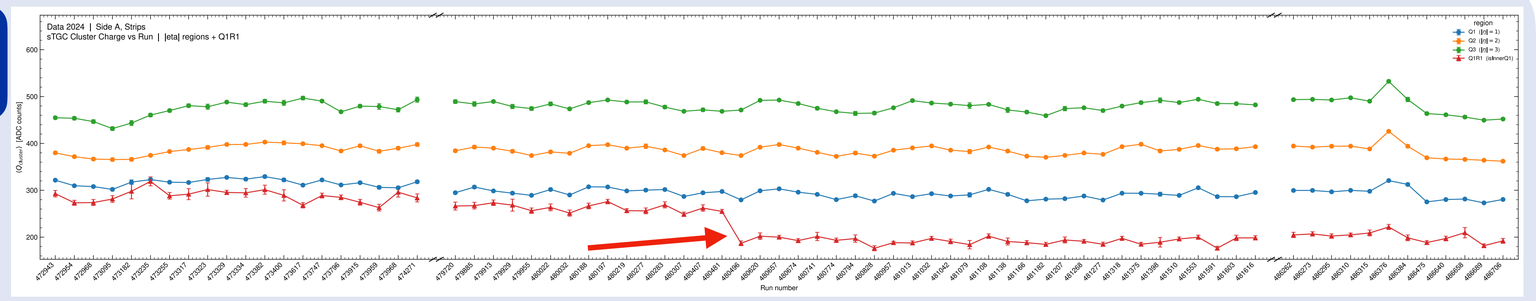

Fig. 4 Plot of 2024 sTGC data: average cluster charge (stgcOnTrack with ADC counts units) vs run number. Represented regions: Q1 (blue), Q2 (orange), Q3 (green) and R1 (red).

Patterns on Single Layers

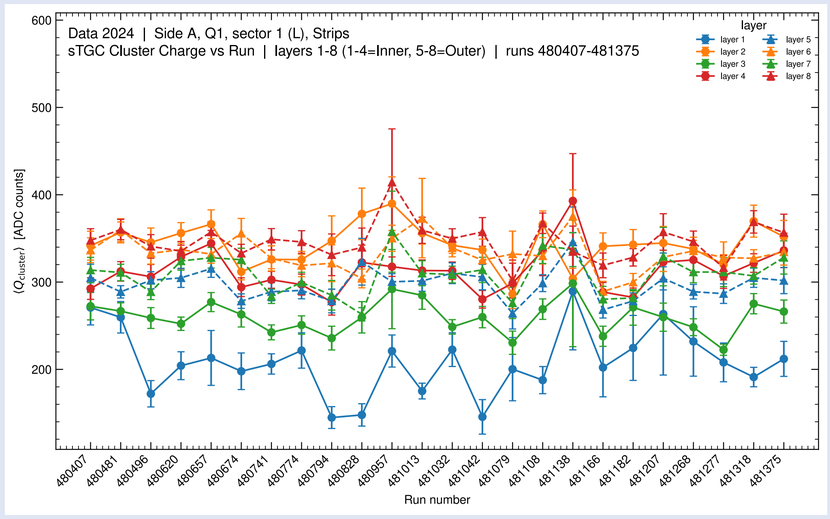

Fig. 5 Average cluster charge vs run number: Side A, Q1, S1 layer plot 480407 - 481375

After HV reduction on R1s, the behavior of layer 1 (Side A, S1, Q1 as example) clearly changed, hinting signs of degradation.

Critical HV Region: R1

Some HV channels stop acquiring data after few runs. Others only acquire data in certain runs.

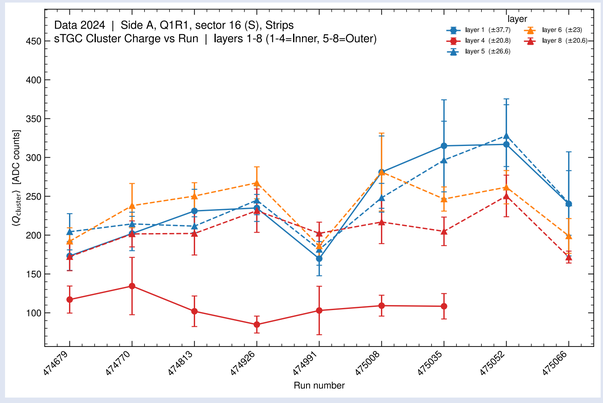

Fig. 6.a Side A, R1, S16 layer plot. Runs: 474679–475066

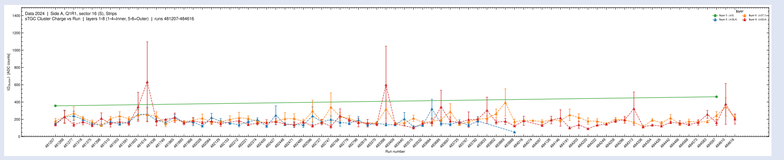

Fig. 6.b Side A, R1, S16 layer plot. Runs: 481207–484616

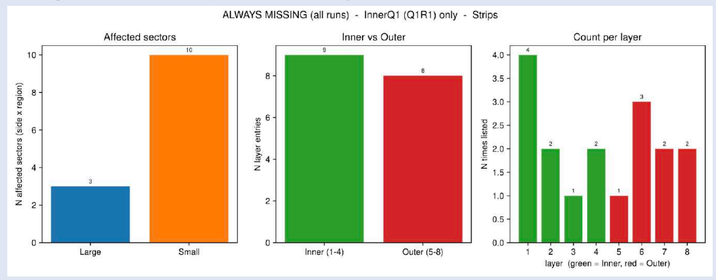

Fig. 7 Sectors and HV channels always missing: R1 region (2024)

R1 HV channels are the most affected ones due to their distance to the IP. In this region, small sectors are much more affected than the large ones and, in layer comparison, layer 1 (inner) shows the biggest flaws.

Conclusions 2024 cluster charge analysis shows all sectors active, with a clear large/small sector relation, layer-dependent patterns, and R1 as the most sensitive region.

Next Steps Analyze the full 2022–2026 dataset including missing gas gaps, cluster geometry (size, hits, distance to track) and expand to pads and wires.

[1] ATLAS Collaboration, "The ATLAS Experiment at the CERN Large Hadron Collider: A Description of the Detector Configuration for Run 3", 10th June 2024 , Section 5.2.5. https://arxiv.org/pdf/2305.16623

[2] Adapted from “sTGC Operations Report”, Pretel, José, June 15, 2026