Geometrical Validation of ATLAS New Small Wheel Simulation Software

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Many thanks to Andrea Dell'Aqua, Valentina Cairo and Verena Martinez

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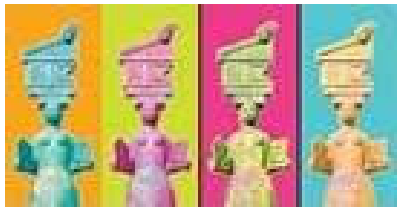
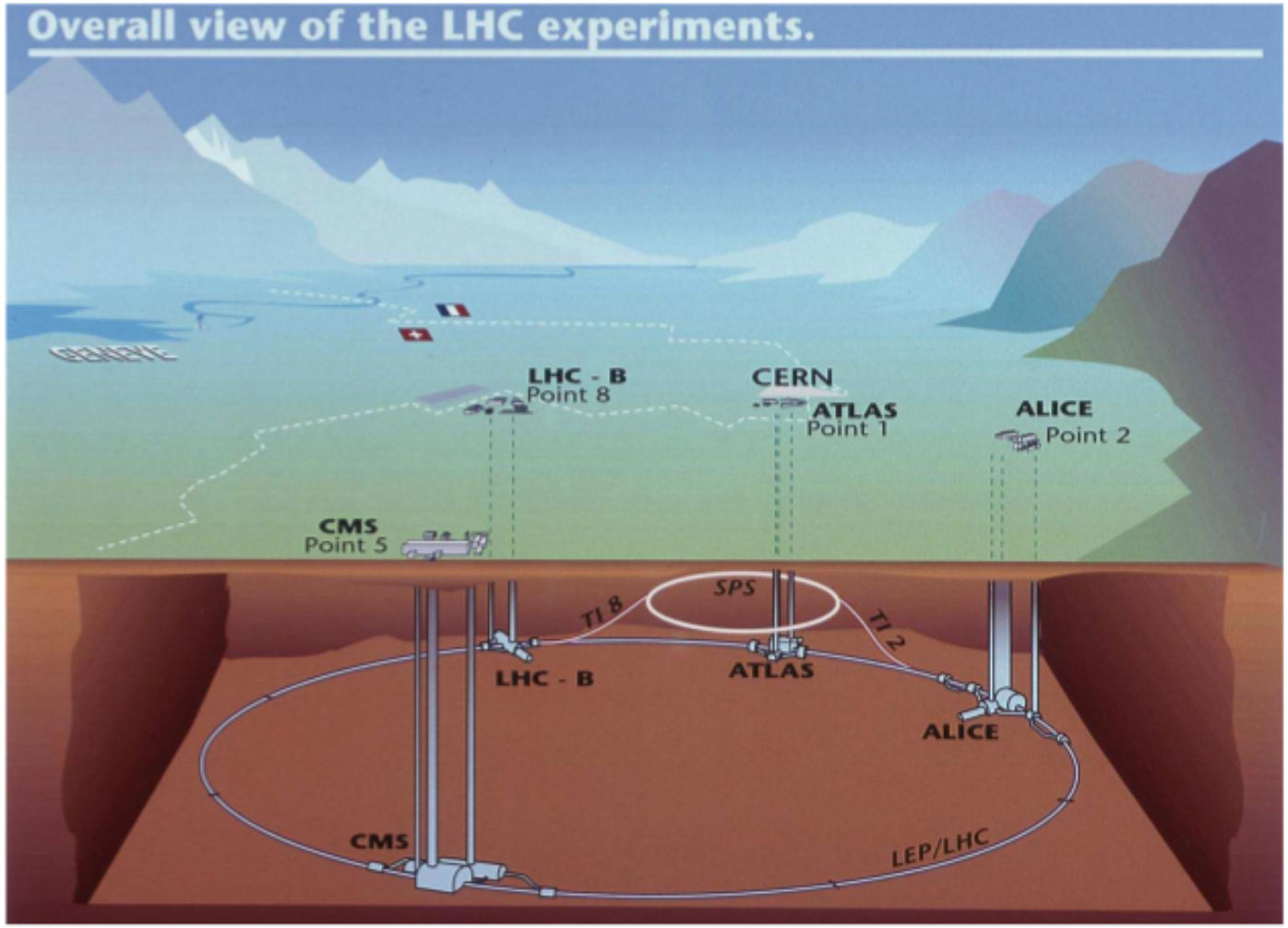


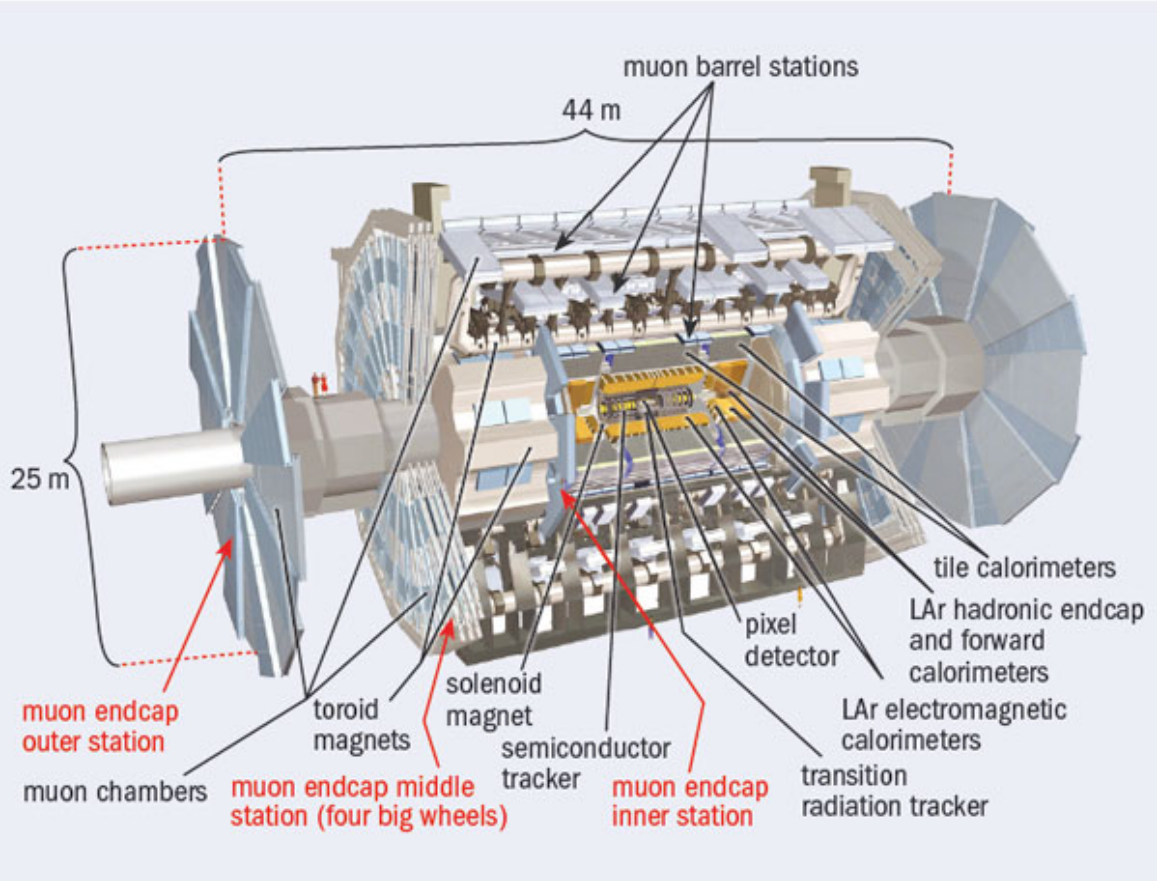
Outline

- Overview of LHC and ATLAS.
- LHC Timeline.
- Upgrade of the Muon Spectrometer.
- The New Small Wheel (NSW).
- NSW Simulation software.
- The Run Time Tester (RTT).
- RTT for NSW simulation and digitization.
- Summary.

The Large Hadron Collider

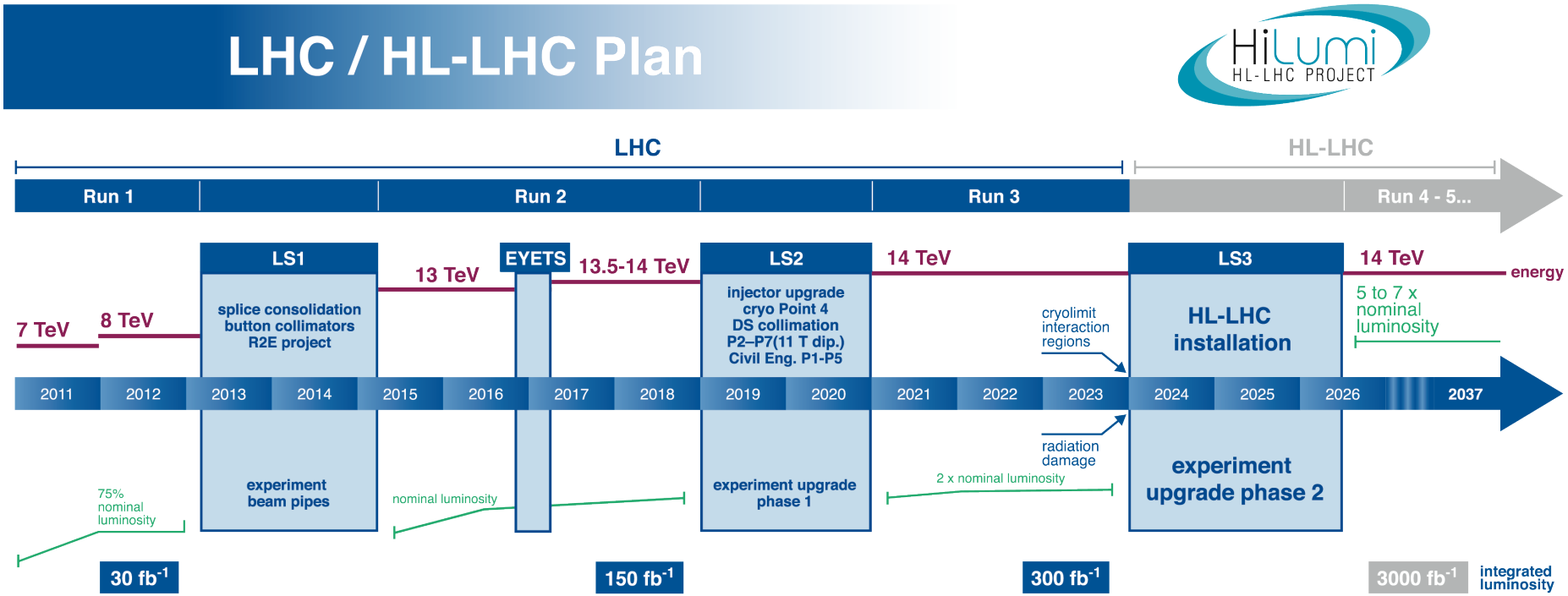


A Toroidal LHC Apparatus (ATLAS)



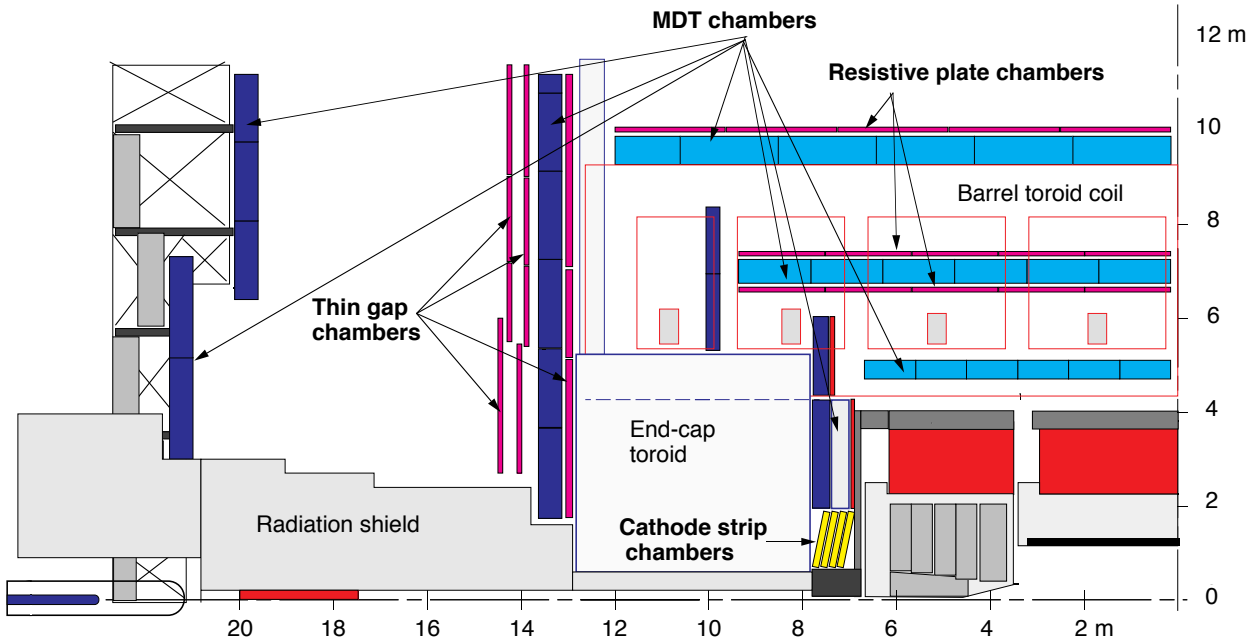
- Each particle leaves a distinct signature in the various parts of the detector.

LHC Timeline



- Instantaneous luminosity is the number of collisions produced per unit area per unit time.

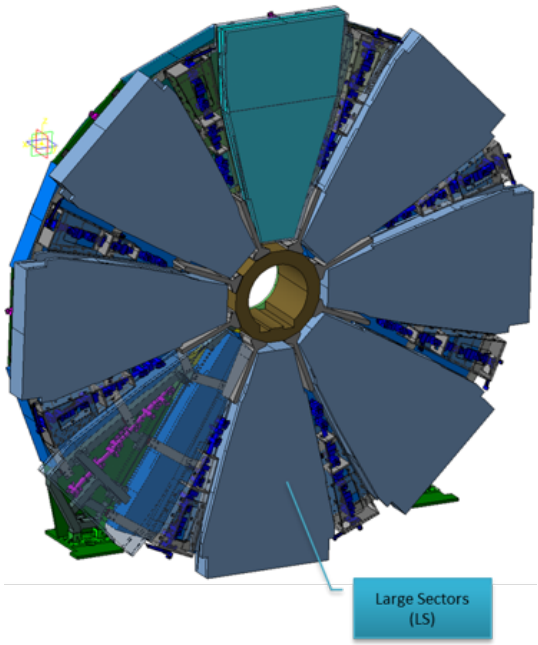
Muon Spectrometer Upgrade



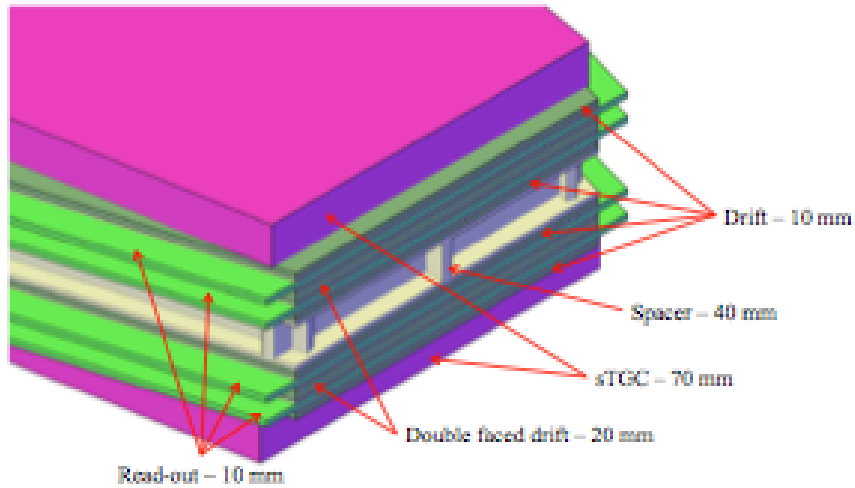
- High luminosity challenges: Current small wheels (innermost muon stations) won't be able to cope with increased rates. Triggering and tracking of muons will be affected.
- LS2 upgrade: Small wheels will be replaced by New Small Wheels.

The New Small Wheel Design

- Micomesh gaseous detectors (Micromegas) for precision tracking.
- Small Strip Thin Gap Chambers (sTGCs) for triggering.
- 16 detection layers per sector.



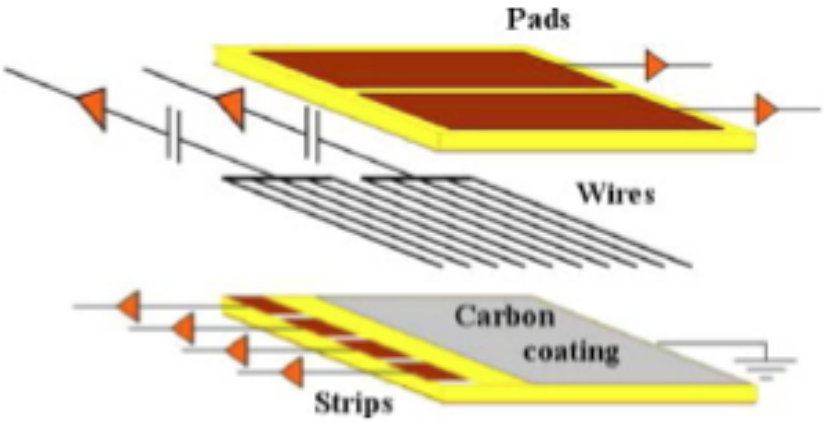
New Small Wheel



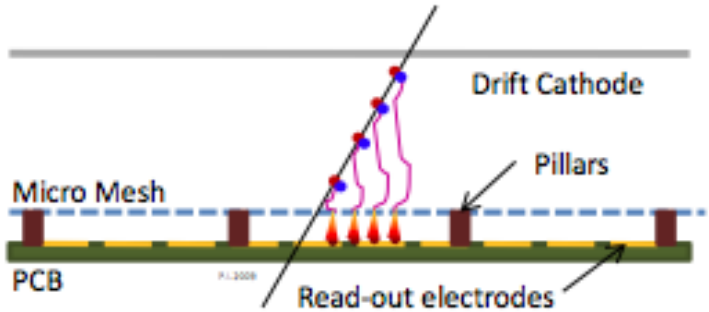
NSW sector

New Small Wheel Layers

- In general, gas is sandwiched between two electrodes (Printed Circuit Boards (PCBs)).
- 2 PCBs and a single gas gap per layer:



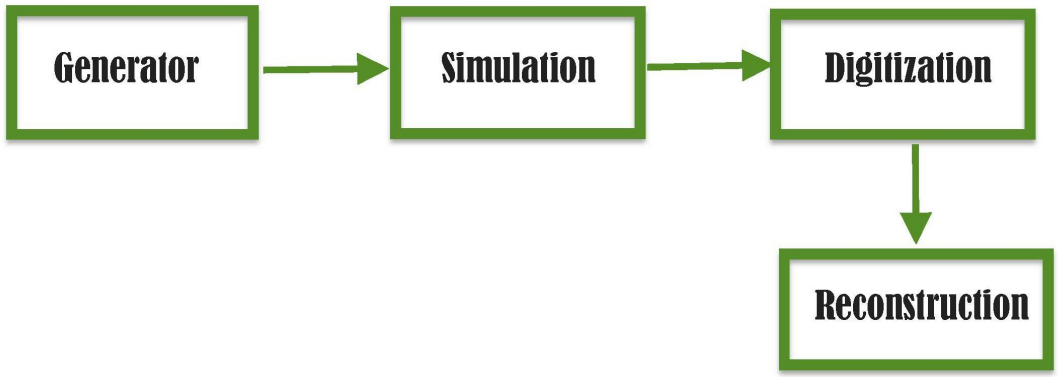
sTGC



MM

NSW Simulation Software

- Manufacturing and commissioning of NSW parts is currently underway in various parts of the world, including South Africa.
- Software to simulate the functionality of these parts is in place.
- Authorship task: Validate performance of the software - Primarily to ensure that the geometry is correctly depicted in the simulation and digitization and fix bugs when necessary.



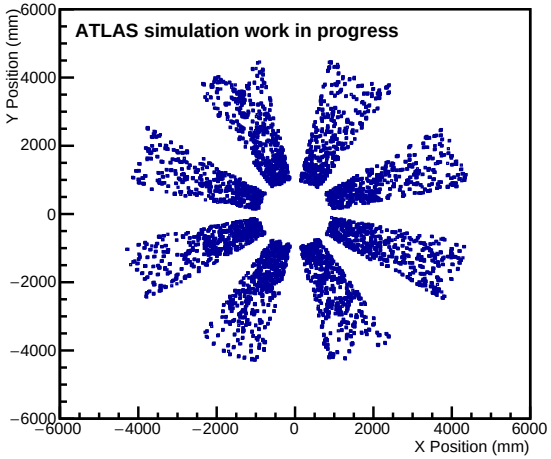
ATLAS simulation chain

The Run Time Tester

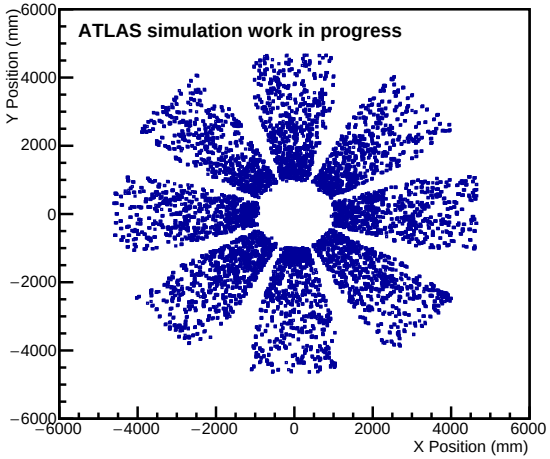
- A framework used to test ATLAS software for run time errors on a nightly basis.
- Goal of RTT for NSW: Ensure that the NSW geometry is correctly depicted in every nightly release and at each step of the simulation chain.
- Geometry is modelled by the MuonGeoModel software.
- ATLAS software and validation codes are written in both C++ and python (Athena).
- Various geometry histograms are plotted on a nightly basis.

Simulation RTT code -Example histograms

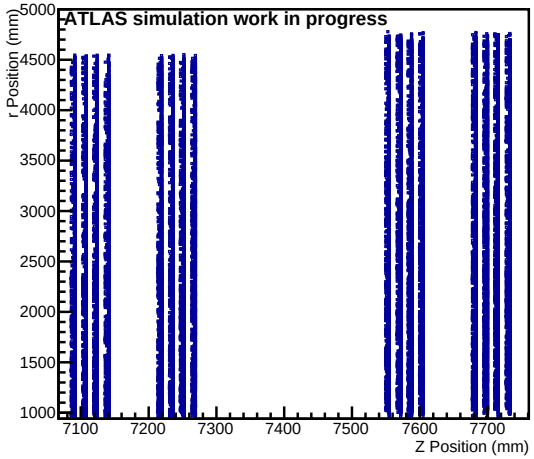
MM small sectors - XY view



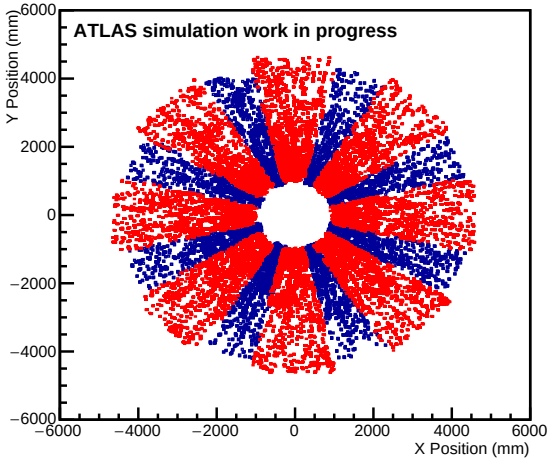
MM large sectors - XY view



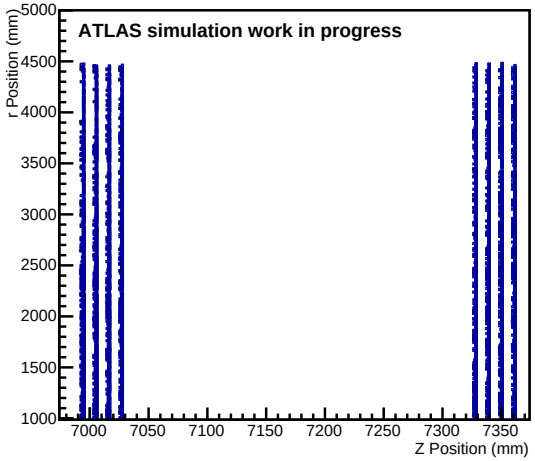
MM all sectors - rZ view



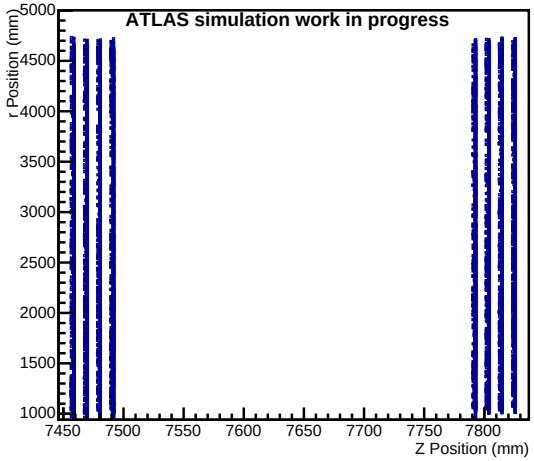
sTGC all sectors - XY view



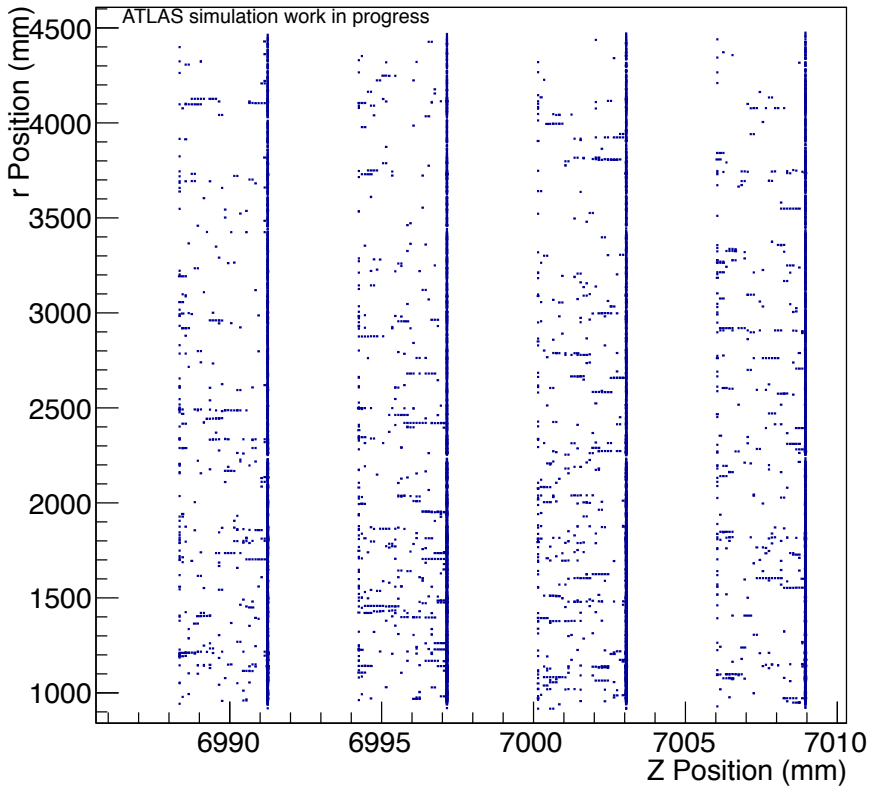
sTGC small sectors - rZ view



sTGC large sectors - rZ view



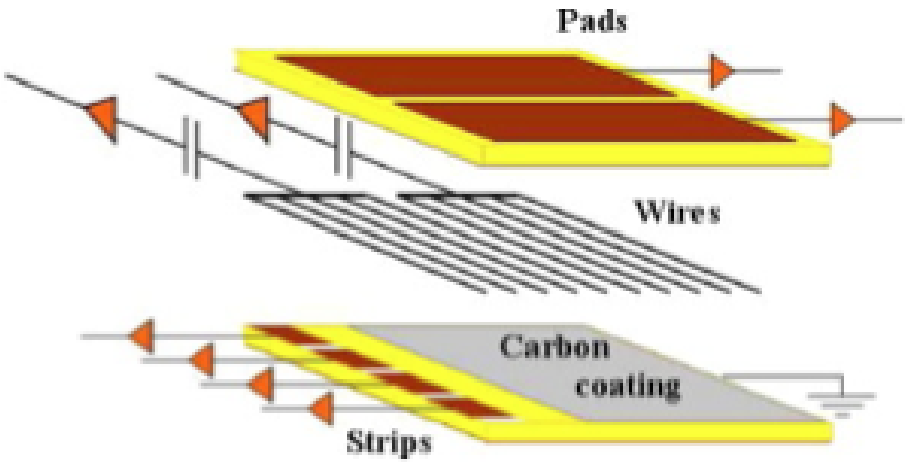
Longitudinal view of the sTGC Small Confirm Plane



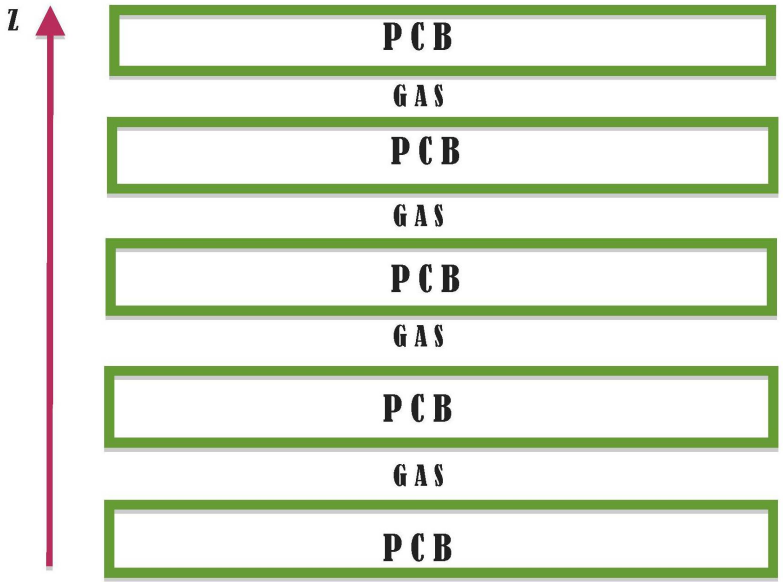
Quadruplet center $\approx$ 6998.5mm instead of 7010 mm

Model of an sTGC Quadruplet in MuonGeoModel

- GeoModel is a central geometry library for describing and constructing the ATLAS detector.

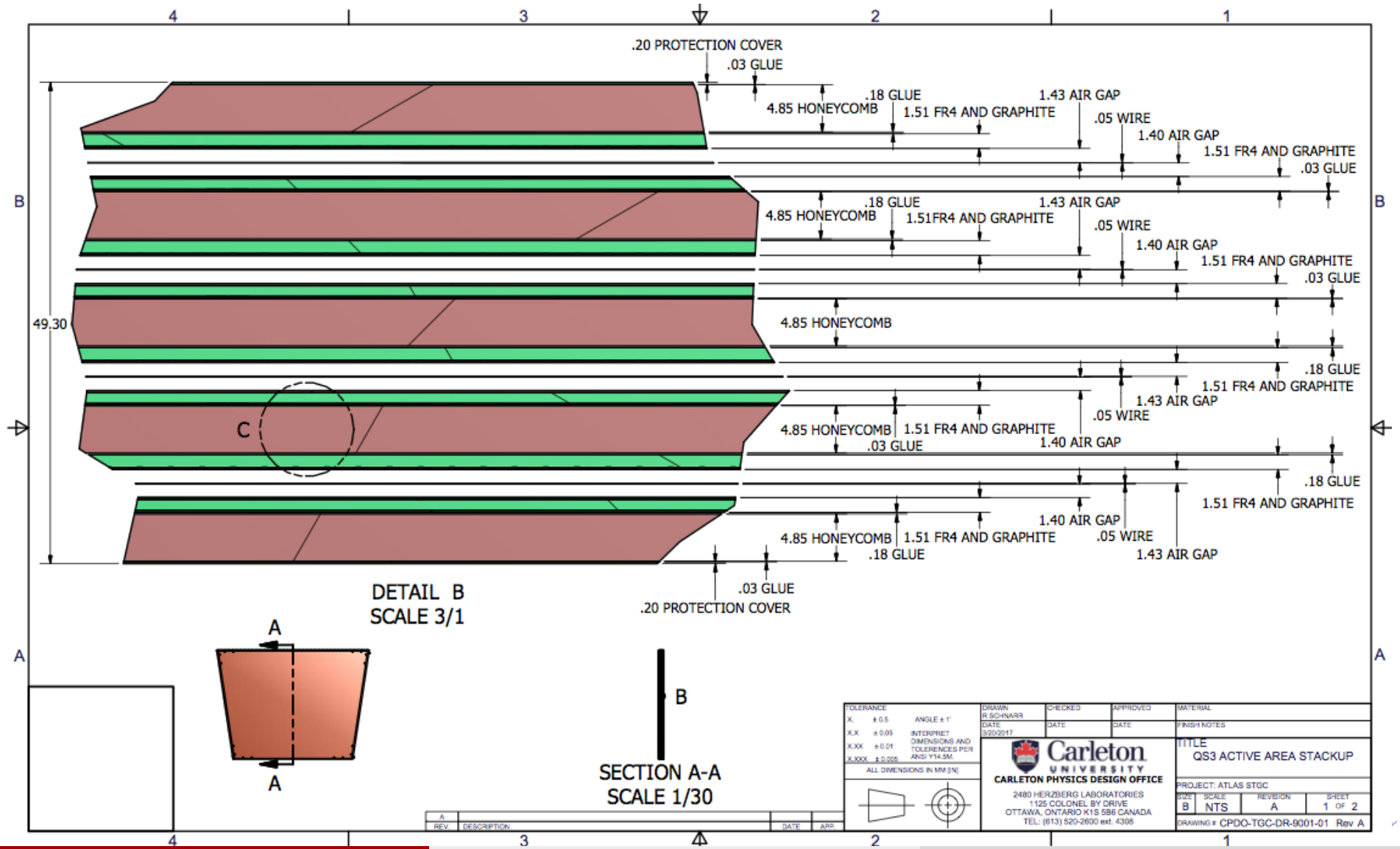


sTGC layer

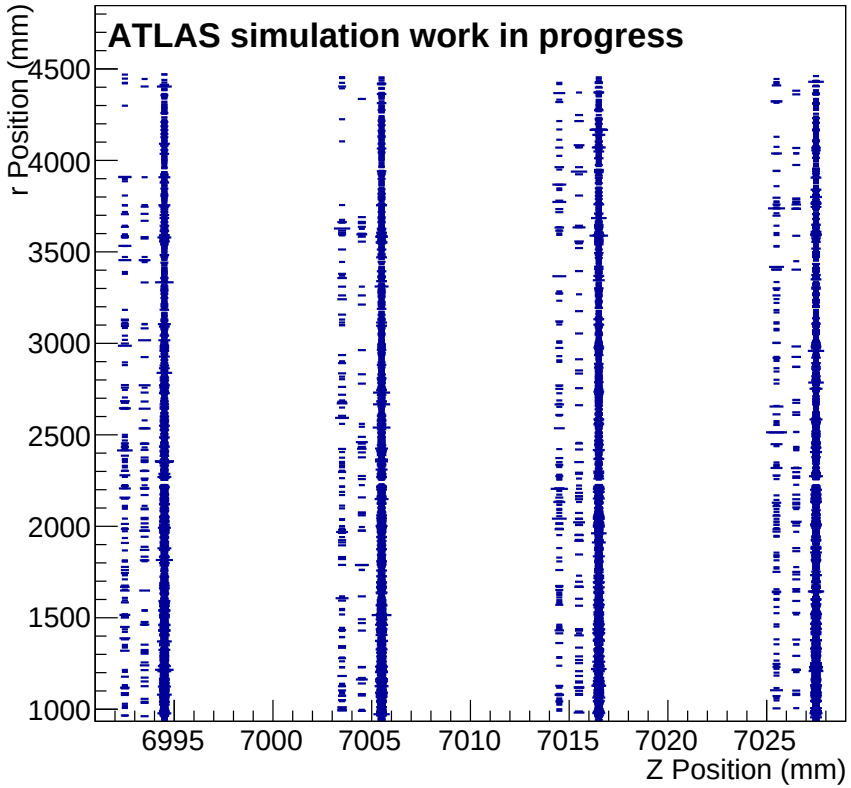


sTGC quadruplet

Engineering Drawing of an sTGC Quadruplet



A-side Longitudinal view of the sTGC Small Confirm Quadruplet (New GeoModel)



Quadruplet center = 7010 mm

Digitization RTT Code

- Currently, no histograms are created during RTT digitization.
- Jobs for the NSW are running in the digitization RTT.
- A histogram plotting code is being developed. NSW code will be added here.
- Validation for digitization is currently done outside the RTT.

ATLAS software development

- All ATLAS software is being moved from SVN to GitLab. Muon software has been successfully moved except for Micromegas.
- The RTT will soon be replaced by the new ATLAS Release Tester (ART).
- RTT code will be reused in ART.
- ART is still being developed and exact timelines of migration are not yet clear.

Summary

- This work was done in fulfillment of the requirements for ATLAS authorship.
- NSW simulation RTT code is completed and running.
- Validation of the digitization is currently done outside the RTT.
- Bugs in GeoModel for sTGCs have been fixed.
- Following up on Git and ART migration.
- Qualification for authorship has been completed.
- Continue to work on this validation and NSW software in general.

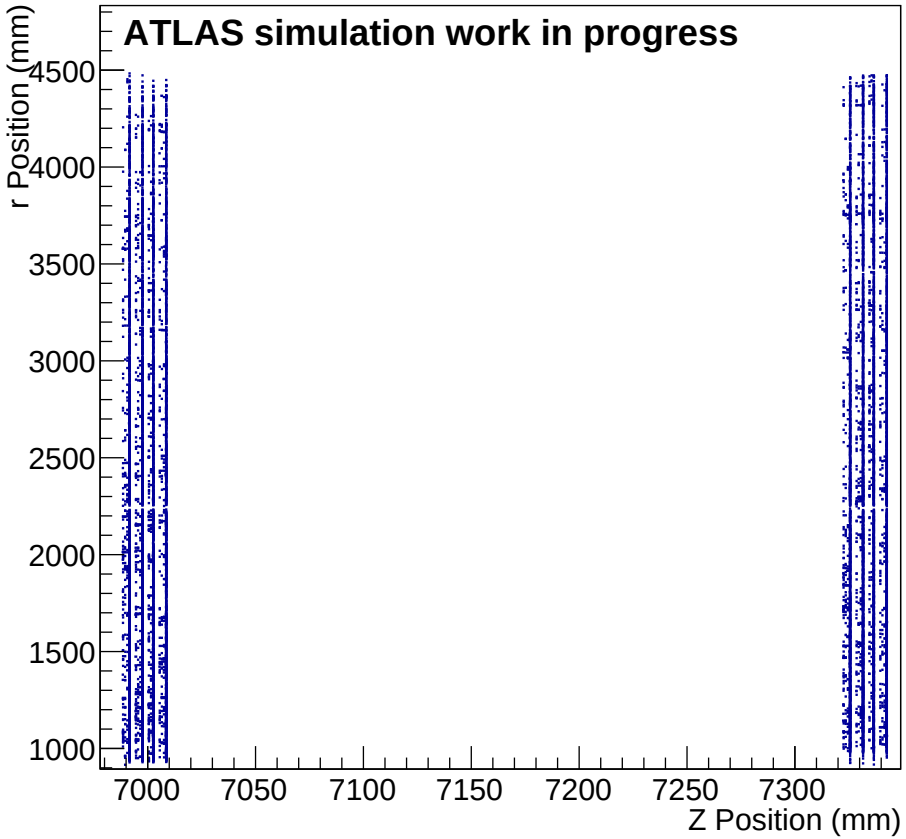

THANK YOU

Backup

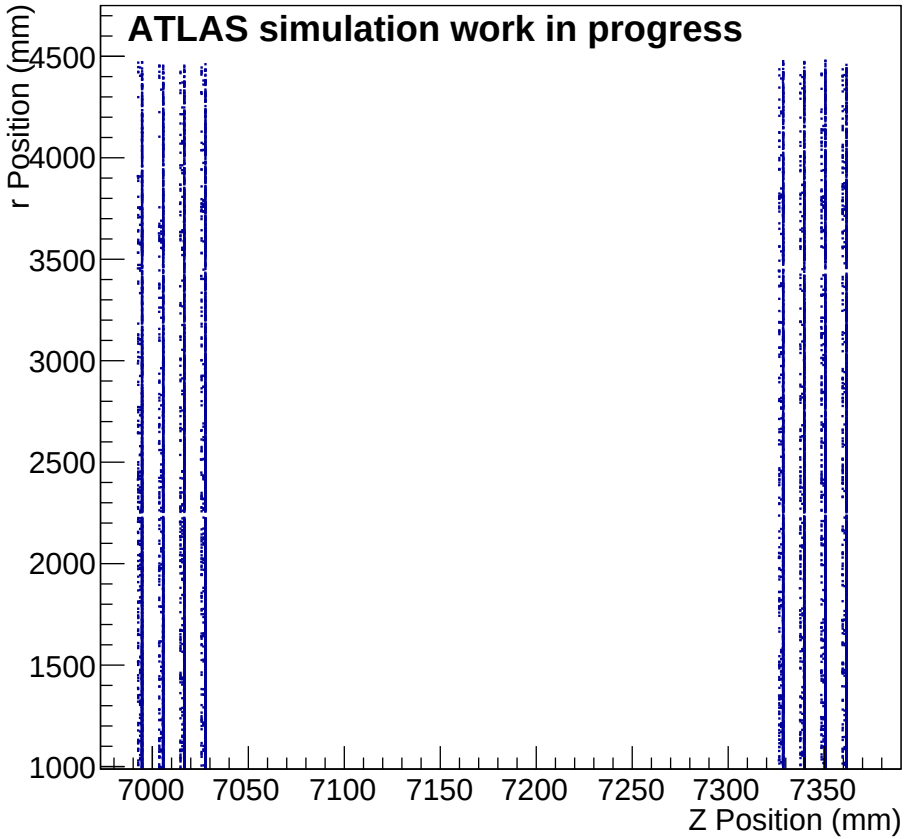
XML Parameters used in MuonGeoModel

- Xml parameters:
  1. NSW_sTGC _Tck =49.34mm
  2. NSW_sTGC _GasTck =2.85mm
  3. NSW_sTGC _pcbTck = 3.00mm
  4. Z center:
     - Small confirm: NSW_sTGC_ZSmallConfirm = 7010 mm
     - Small pivot: NSW_sTGC_ZSmallPivot = 7344 mm
     - Large pivot: NSW_sTGC_ZLargePivot = 7474 mm
     - Large confirm: NSW_sTGC_ZLargeConfirm = 7808 mm

A-side Longitudinal view of sTGC Small quadruplets

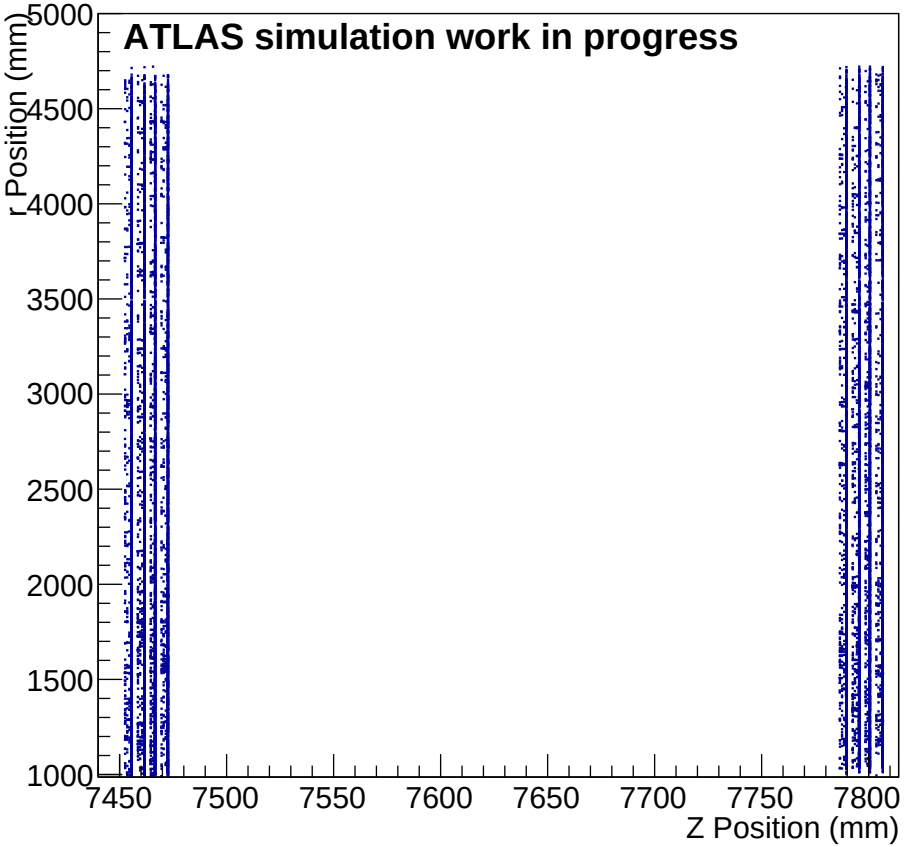


Old GeoModel

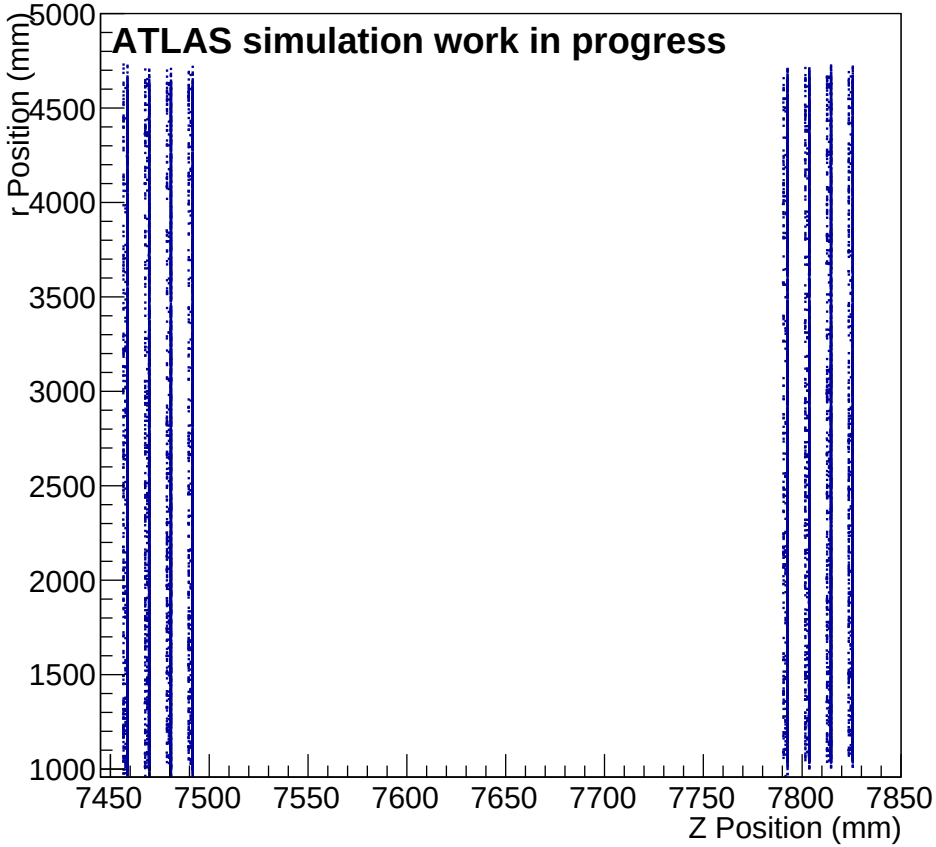


New GeoModel

A-side Longitudinal view of sTGC Large quadruplets

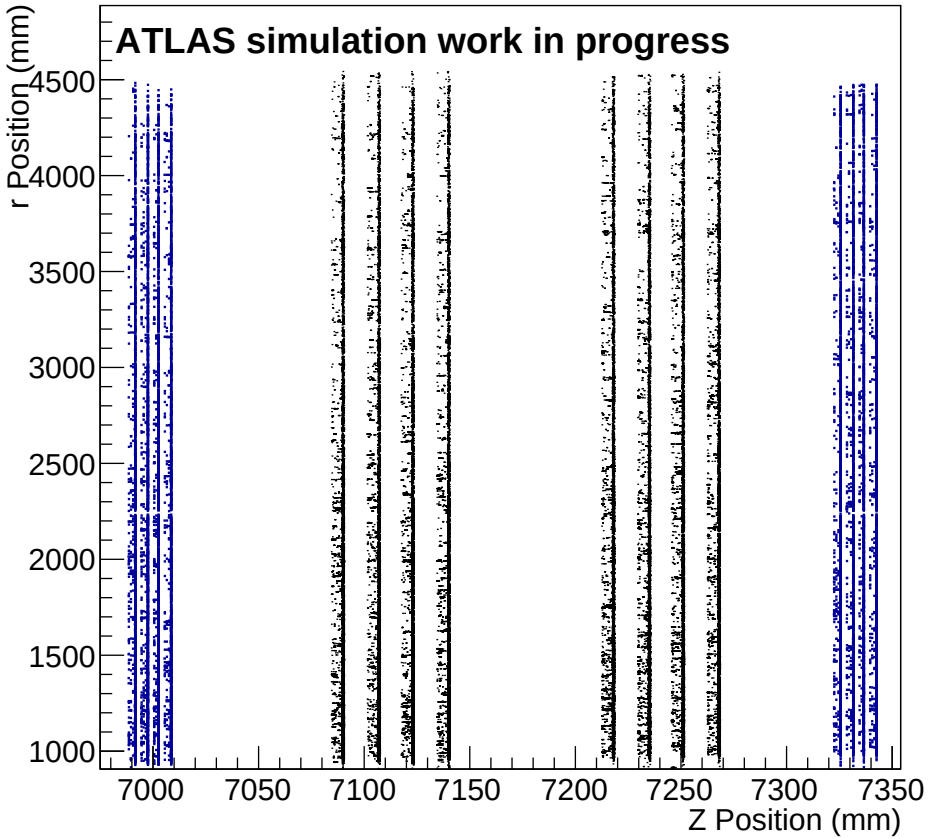


Old GeoModel

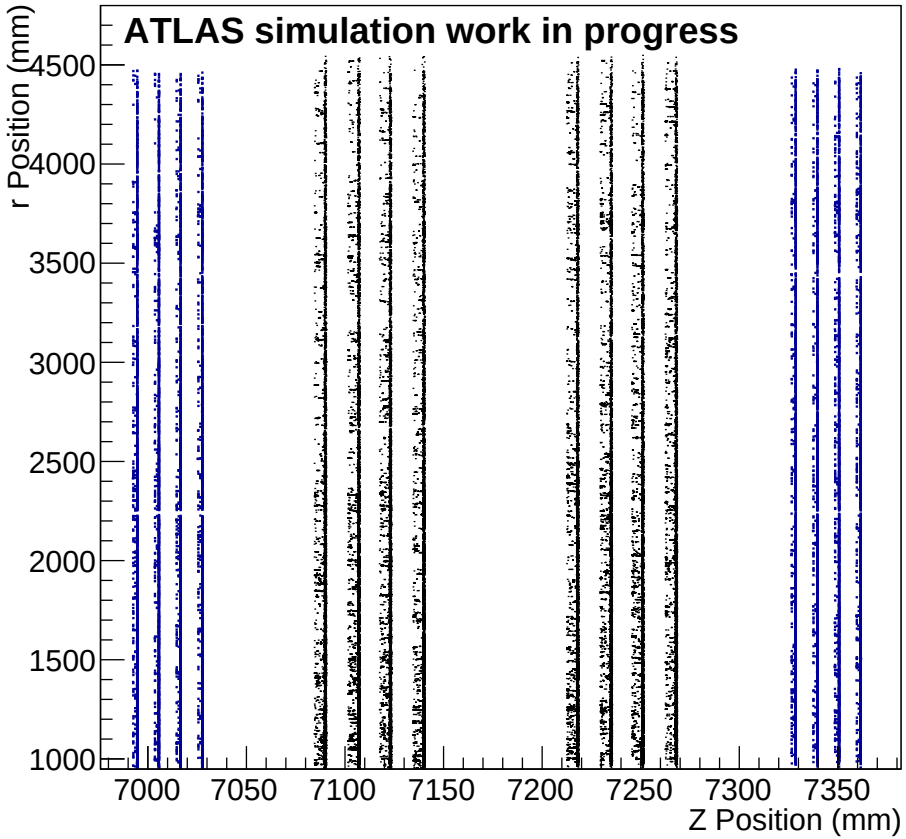


New GeoModel

A-side Longitudinal view of NSW Small Sectors

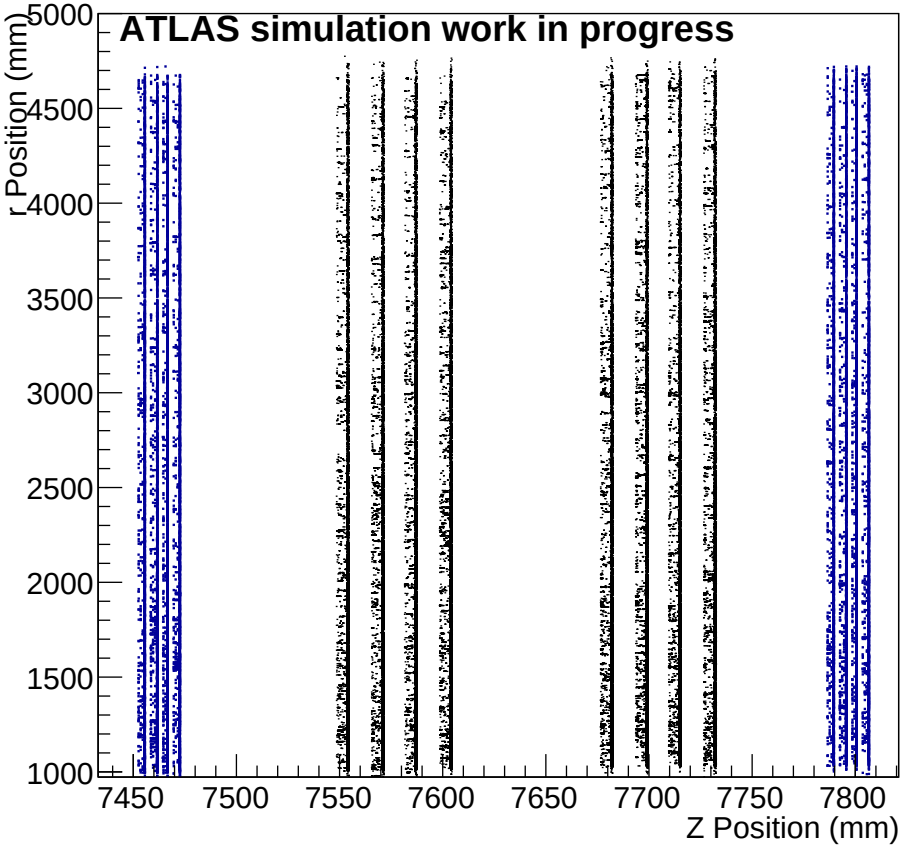


Old GeoModel



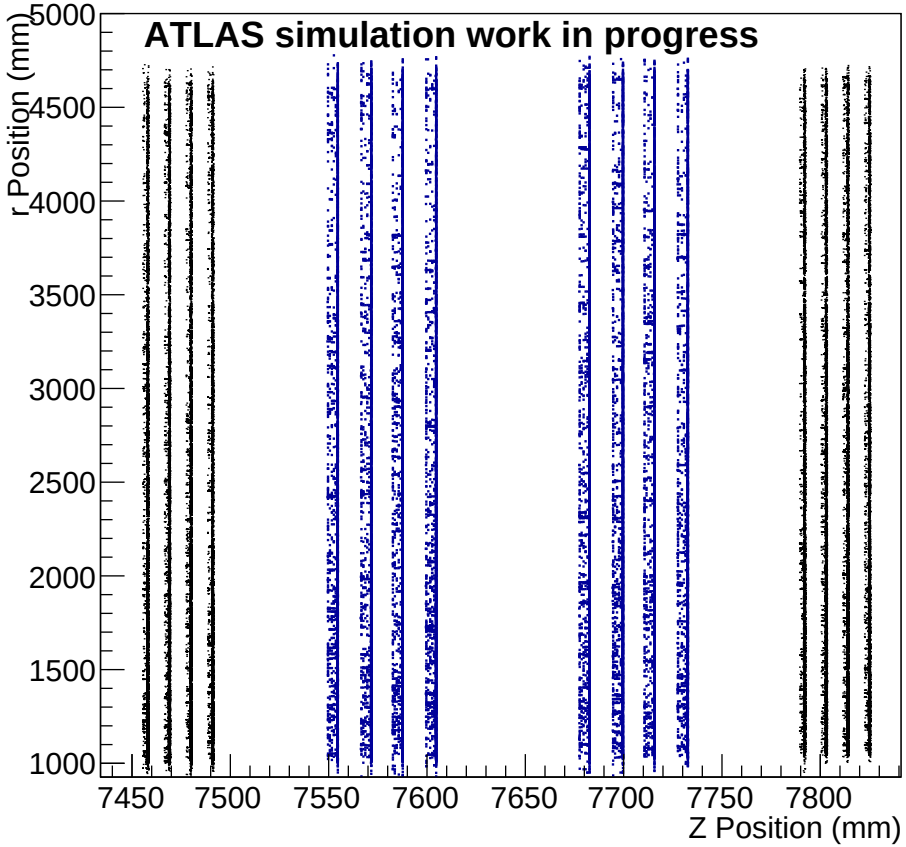
New GeoModel

A-side Longitudinal view of NSW Large Sectors



Old GeoModel

MM all sectors - rZ view



New GeoModel