Contribution ID: **1047** Type: **Oral (Student, In Competition) / Orale (Étudiant(e), inscrit à la compétition)**

ATLAS New Small Wheel (NSW) small-strip Thin Gap Chamber (sTGC) simulation in Athena

Wednesday 15 June 2016 09:15 (15 minutes)

The muon detector subsystem known as the small wheel of the ATLAS experiment will be completely replaced during the long shut down of the LHC starting in 2019. The replacement New Small Wheel (NSW) will have 16 sensitive layers, these layers are comprised of 2 different detector technologies: 2 quadruplet layers of small-strip Thin Gap Chambers (sTGC) and 2 quadruplet layers of MicroMegas detectors (MM). The NSW is built from trapezoidal segments being constructed at institutions around the world including Carleton University. The NSW will be situated in a background radiation dense region (up to 15 kHz/cm^2) where it will have to provide Level-1 online trigger information as well as accurately reconstructing muons. The required performance criteria are substantial, particularly a single hit resolution of roughly 100 μm and providing track segments reconstructed online with an angular resolution of roughly 1 mrad. These requirements are motivated by the need to reconstruct muons in the very forward region of ATLAS with high efficiency and high background rejection. The NSW will enable the ATLAS collaboration to study the standard model, in particular the decay of the Higgs Boson into 4 muons, throughout future LHC upgrades beyond 2022. The task of simulating the response of these sTGC chambers in the ATLAS Athena framework and the validation of the simulation is the focus of the research. The sTGC chambers consist of a gas gap with anode wires (1.8 mm pitch) and 2 distinct cathode planes: one with large area pads to serve as a fast trigger ($<$25 ns) and the other with 2.7 mm wide strips for precise tracking. The research involves simulating the behavior of the chamber due to energy deposition by ionizing radiation. This simulation includes the drifting of ionization electrons towards the anode wires, an analytic model of the charge dispersion on the cathode strips through a resistive graphite layer, the electronic response of the VMM readout chip, cross talk of neighboring channels and statistical response of the detector as a function of incident muon angle and energy. The simulation is used to perform detailed timing studies of the VMM reading chips including the effects of threshold, noise level and dead time. The simulation results are also used to perform a study of trigger efficiency from minimum ionizing muons, an efficiency of 96% was observed.

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Session Classification: W1-2 Energy Frontier: Standard Model and Higgs Boson (PPD) / Frontière d'énergie: modèle standard et boson de Higgs (PPD)

Track Classification: Particle Physics / Physique des particules (PPD)