Introduction

Muon triggers are necessary for both standard model measurements and searches for new physics at ATLAS. The ATLAS muon trigger system is composed of both hardware (Level 1) and software (High Level Trigger) components. This is an overview of how these components trigger on muons, their performance during Run 2 data taking, and improvements being prepared for Run 3.

Trigger System

- Coarse-grained calorimeter and muon spectrometer information is passed to the Level 1 (L1) Central Trigger Processor to form the L1 decision.
- The L1 topological trigger processor (L1Topo), commissioned in 2016, also packages topological information.
- The L1 trigger passes Regions of Interest (RoI’s) to the High Level Trigger (HLT), which then uses full-granularity detector information to make its decision.
- Events accepted by the HLT are exported to a Tier-0 facility for offline reconstruction.

Efficiency Measurements

Intermediate- (low-) $p_T$ measurements are made using offline-reconstructed muons from $Z \rightarrow \mu\mu$ ($J/\psi \rightarrow \mu\mu$) decays. Pairs of oppositely-charged muons from the same vertex are selected with an invariant mass criterion. The trigger efficiency measurement is made using a Tag-and-Probe method:

- Tag muon candidates must pass a quality requirement and have a $p_T$ greater than the tag trigger threshold. It is also required to be within $\Delta R < 0.01$ of the object which fired the trigger tag.
- The other muon, satisfying offline selection requirements corresponding to the working point of interest, is then a probe candidate. The probe is identified as triggered if it matches the trigger object.

Run 2 Summary

- Single-muon trigger efficiencies ~68% (~85%) in barrel (endcap) region
- Multi-muon trigger efficiencies ~75% (~87%) in barrel (endcap) region (higher than single-muon trigger efficiencies due to looser L1 requirements)
- Efficiencies in heavy-ion data are comparable
- L1Topo requirement significantly reduced low-$p_T$ thresholds for BLS program while maintaining efficiency

Future Improvements

In order to handle the higher luminosities of Run 3, several modifications will be made, including:
- Replacing the innermost muon chamber layers with higher-granularity New Small Wheels (NSW) in $1.3 < |\eta| < 2.7$ (Right: NSW trigger rate reduction extrapolation)
- New RPC chambers at $1.0 < |\eta| < 1.3$ to reduce L1 fakes
- Migration of the HLT software to a multi-threaded platform to decrease CPU memory usage; validations and performance evaluations are in progress

References:

ATL-DAQ-PROC-2016-003
NSW Preliminary: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/MuonTriggerPublicResults