# **ATLAS Muon Trigger performance**

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The ATLAS detector has two components for tracking: Muon Spectrometer with a toroid magnet system of 1-1.5 T and Inner Detector (ID) with a 2 T solenoid magnet [1].

#### Level 1 (L1) muon trigger:

- Employs Thin Gap Chambers (TGCs) and Resistive Plate Chambers (RPCs) with fast response.
- Selection based on coarse p<sub>T</sub> determination.
- Trigger logic implemented on dedicated hardware (FPGAs).

#### Muon High Level Trigger (HLT):

- · Software based algorithm searching for muons in a region defined by L1.
- Precise tracking with Monitored Drift Tubes (MDTs), Cathode Strip Chambers (CSCs), and ID.
- Combination of fast and precise algorithms to reduce trigger rates at every step.
- The isolation criteria to reject non-prompt muons.

## **Improvements during Run 2**

Improvements in L1 and HLT are introduced during Run 2 to keep the trigger rate acceptable while maintaining the efficiency as high as possible.



Muon trigger covers

with wide ranges of

 $|\eta| < 2.4.$ 

transverse momentum

from production of Higgs

bosons to physics

including B-hadrons.

#### **Coincidence with Inner TGCs**

- "Fake" L1 triggers by charged particles from the beam pipe.
- η range: 1.05<lηl<1.9.
- The rate reduction of ~20 % was achieved [2].

## **Measurement** Efficien

#### Methods for trigger efficiency measurement

- "Tag & Probe" method using  $Z \rightarrow \mu \mu$  event.
- It requires "tag" muons in events.
- A bias on the measured efficiency due to the trigger itself used to record the events is avoided.

#### Performance [2]

L1 efficiency is about 70%

Γ	performance
Ē	$\mathbf{ATLAS}$ Preliminary $\sqrt{s}=13$ TeV, Data 2018, 4.5 fb <sup>-1</sup>
	<sup>-</sup> Z → μμ - - m <sup>μ</sup> l < 1.05 -
1	
0.5	
0	L1 MU20 HLT mu26_ivarmedium or mu50 HLT mu26_ivarmedium or mu50 with respect to L1
0	0 20 40 60 80 10
	offline muon p <sub>T</sub> [GeV]
	- <b>ATLAS</b> Preliminary $\sqrt{s}=13$ TeV, Data 2018, 4.5 fb <sup>-1</sup>
	$^{-2} \rightarrow \mu\mu$
1	╴┉ <sup>┲</sup> ╋┉┉ <sub>┺</sub> ┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉┉ <sub></sub> ┉┉ <sub>╹</sub> ┿╊╻╻╹╄╊╻ ╴ ╴

#### Coincidence with Tile-calorimeter

- Suppress the fake triggers in 1.05<lηl<1.3.
- The rate reduction of ~6% was achieved [2].



#### Improvement of p<sub>T</sub> measurement

- CSCs are included in the fast  $p_T$ determination algorithm of HLT.
- Improvement of p<sub>T</sub> measurement in the forward region ( $|\eta|>2.0$ ) [2].



#### **Optimization of isolation criteria**

- Use tracks within dz < 2 mm.</li>
- Good efficiency in the high pileup environment.



#### $(|\eta| < 1.05)$ , and 90 % $(|\eta| > 1.05)_{0.5}$ due to the coverage of the trigger chambers. • HLT efficiency is ~100 %

Stable at high pile-up.



### **Upgrades towards Run 3**

Efficiency

- Higher luminosity in Run3 (L=2.0×10<sup>34</sup> cm<sup>-2</sup>s<sup>-1</sup>).
- New trigger hardware for L1:
  - Higher granularity detectors, New Small Wheels (NSW) (1.3<lnl<2.7) and new RPC  $(1.0 < |\eta| < 1.3)$  in the inner most layer of Muon spectrometer.
  - Coincidence with the outer layer of the TGCs.
  - Upgrade of trigger boards and trigger logic.
- Making use of multi-threading in the HLT.



Expected n distribution of the Run3 Muon Trigger [3]

#### Reference

[1] ATLAS Collaboration, The ATLAS Experiment at the CERN Large Hadron Collider [2] L1 Muon Trigger Public Results (https://twiki.cern.ch/twiki/bin/view/AtlasPublic/L1MuonTriggerPublicResults) [3] Muon Trigger Public Results (https://twiki.cern.ch/twiki/bin/view/AtlasPublic/MuonTriggerPublicResults)

