Performance of the ATLAS Muon Trigger in Run I and Upgrades for Run II

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Dai Kobayashi (Tokyo Institute of Technology)
on behalf of the ATLAS Collaboration

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ATLAS EXPERIMENT

TOKYO TECH Pursuing Excellence

ATLAS Experiment

Physics motivation

- Search for NEW phenomena and particles
- Observation and measurement of Standard Model including Higgs Boson

Many final state requires muon(s)
e.g. H→ZZ→4l, Z'→ μμ, B_s → μμ etc.
Muon trigger is very important!

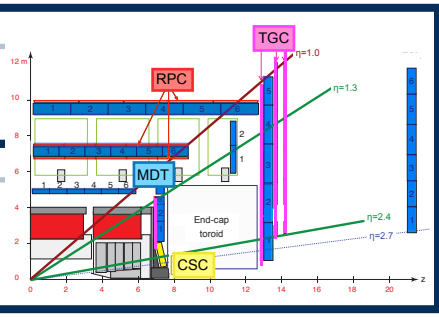
Muon Detector and Muon Trigger

Four kinds of muon detectors are used in muon trigger system

- RPC (Resistive Plate Chamber): $|\eta| < 1.0$
- TGC (Thin Gap Chamber): $1.0 < |\eta| < 2.4$
- MDT (Monitored Drift Tube): $|\eta| < 2.4$
- CSC (Cathode Strip Chamber): $2.4 < |\eta| < 2.7$

→ **Rapid response —> level-1 trigger decision**

→ **High Resolution —> Software trigger, precise measurement**



ATLAS Muon Trigger in Run I (- 2012)

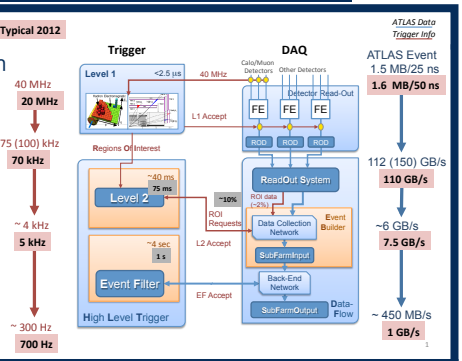
System Overview

3 steps in Run I trigger system

1st step : Level-1
Hardware based and using RPC and TGC
Six thresholds are set.

2nd step : Level-2
Selection with MDT hits around level-1 candidates
Inner detectors are also used.

3rd step : Event Filter
Full event data can be used
Almost same performance as the offline reconstruction.



Efficiency Measurement

Tag&Probe procedure

- To measure without bias using triggered event.

Di-muon from resonance

One-side (tag) ⟷ Another (probe)

Required to pass single muon trigger, which acquired the event

Free from trigger bias ! Measurement should be done for this side.

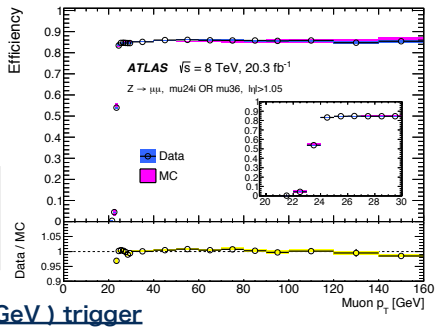
For high p_T threshold (> 10 GeV) trigger

- Di-muon from Z decay

Z

Tag : 24 GeV trigger
Probe : 10 - 160 GeV

- Clear turn-on curve
- Good agreement between data and MC



For low p_T threshold (< 10 GeV) trigger

- Di-muon from J/ψ decay BUT…

J/ψ

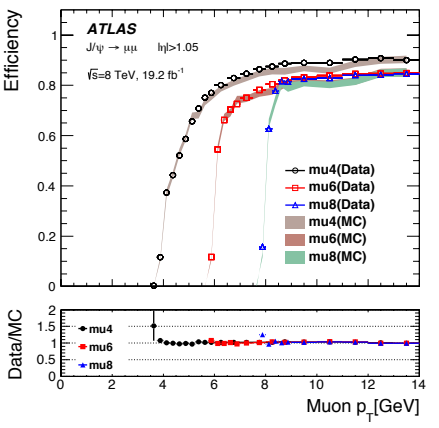
Tag : p_T < 10 GeV
—> Low statistics due to prescale

- Instead, "boosted" J/ψ

J/ψ

Tag : 18 GeV trigger
Probe : 2 - 14 GeV

- Precision: ~ 1 %
- Good data/simulation agreement

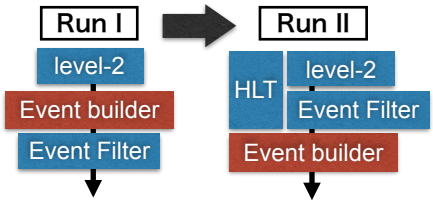


Upgrade for Run II (2015 -)

Software Level Construction

Level-2 and Event Filter merged into "HLT"

- Data access is suppressed
  ==> **Faster**
- Event builder after HLT
  ==> **Flexibility of rate reduction**

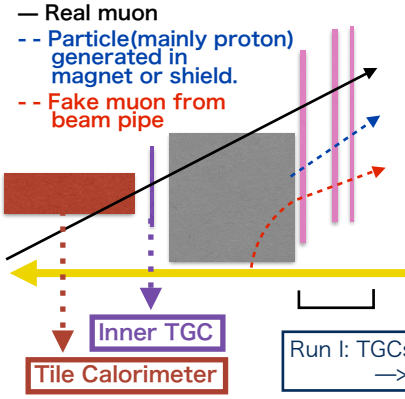


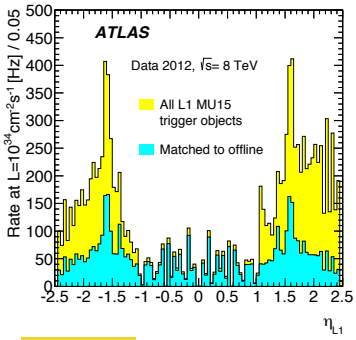
TGC Inner Coincidence

Fake muons in $|\eta| > 1.0$

- Big task from Run I

— Real muon
- - Particle(mainly proton) generated in magnet or shield.
- - Fake muon from beam pipe





Run I: TGCs out of magnetic field are used —> Fakes can not be reduced …

Run II: More backgrounds due to higher luminosity and beam energy —> Fake rate will increase !

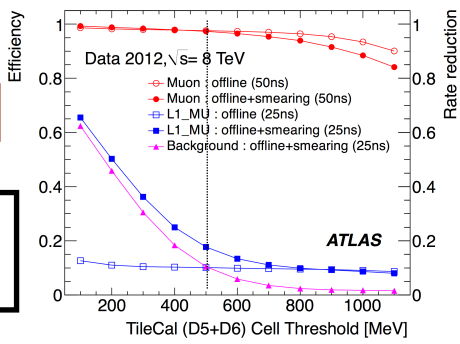
Coincidence with Inner TGC and Tile Calorimeter available in Run II

If we set Tile threshold to be 500 MeV..

Efficiency : ~97 %
Rate reduction: ~82 %

Even for high rate run

- Level-1 muons will be cleaner.
- Rate in Run II will be kept lower.



Conclusion

- Muon trigger performance in Run I was stable! These results are published as EPJC(2015),75:120.
- Performance in Run II expected to be more stable and better than Run I.