

ATLAS muon trigger performance studies on LHC Run 2 data

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Summary. — A detailed analysis of ATLAS muon trigger performance is continuously carried out in order to ensure an appropriate trigger response to the increasingly challenging data-taking conditions and, eventually, to point out possible issues in the trigger system. Muon trigger efficiencies and muon parameters resolution reconstructed at trigger level, evaluated with respect to offline muon reconstruction references, are presented as functions of the main kinematic variables.

1. – Introduction

Events with high-momentum muons in the final state are an important signature of many physics processes, both within the Standard Model and beyond, studied by the ATLAS experiment [1] at the Large Hadron Collider (LHC) [2]. Therefore, an efficient muon trigger system and a deep understanding of its performance play a crucial role in the ATLAS physics program.

Since the restarting of the LHC for the Run 2 data taking period at 13 TeV, a detailed analysis of the ATLAS muon trigger [3] is being continuously carried out in order to study its performance and promptly fix eventual problems.

2. – Muon trigger efficiency studies with respect to offline muon reconstruction

The ATLAS trigger system consists of an hardware-based level, named Level 1 (L1), and a software-based level, named High Level Trigger (HLT). This new two-stage system reduce the event rate from the bunch-crossing rate of 40 MHz to an average recording rate of a few hundred Hz. During the 2015 data taking period a few unprescaled muon trigger chains have been used. The lowest unprescaled HLT single muon trigger chain used was `HLT_mu20_i1oose_L1MU15_OR_HLT_mu50`, which is seeded by the L1 trigger `L1.MU15` (requiring candidates to pass the 15 GeV p_T threshold) and is obtained as logical OR of

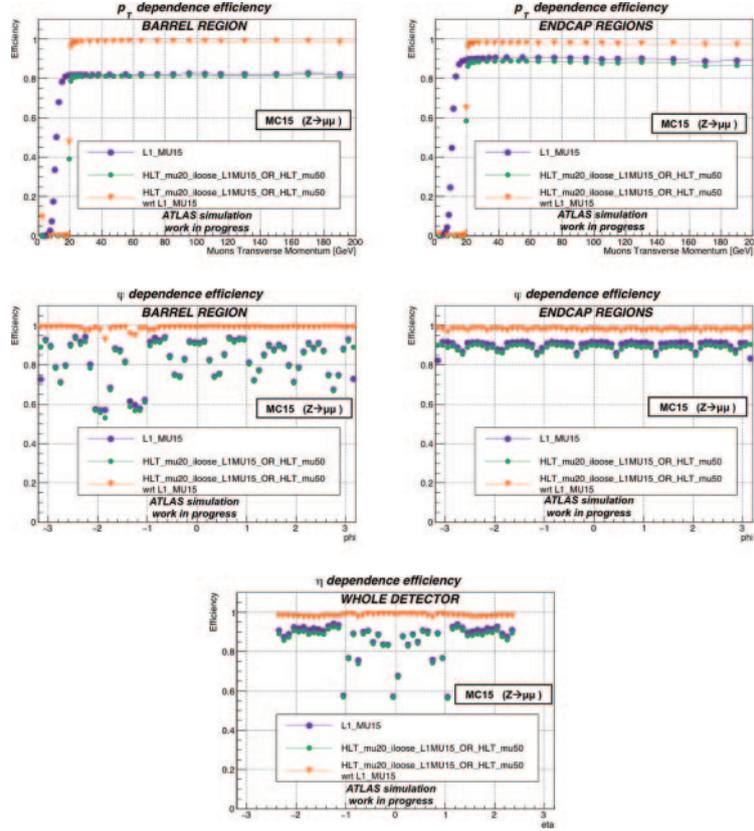


Fig. 1. – Absolute efficiency of the L1.MU15 threshold and absolute and relative (with respect to L1 trigger) efficiencies of the HLT_mu20_loose_L1MU15_OR_HLT_mu50 trigger item as a function of p_T , ϕ and η of offline muon candidates in the barrel and in the endcap regions.

HLT_mu20_loose_L1MU15 (requiring muons to satisfy a 20 GeV p_T threshold and to pass a loose isolation selection) and HLT_mu50 (requiring to satisfy a 50 GeV p_T threshold) trigger items in order to maximize the trigger efficiency. The absolute and relative (with respect to L1 trigger) efficiencies, together with the L1 seed efficiency, evaluated with respect to offline muon reconstruction references, are shown in fig. 1 for simulated $Z \rightarrow \mu\mu$ events. The L1 muon trigger efficiency is lower in the barrel ($|\eta| < 1.05$) with respect to the endcaps ($1.05 < |\eta| < 2.4$), due to the different geometrical coverage in terms of Resistive Plate Chambers (RPC) and Thin Gap Chambers (TGC) and to some local detector inefficiencies. The HLT efficiency relative to L1 is instead close to 100% in all the detector regions. Scale factors, needed for all the physics analyses in order to normalize Monte Carlo simulated samples to data, are defined as the ratio between the efficiencies obtained on data and on $Z \rightarrow \mu\mu$ simulated events, evaluated by a $Z \rightarrow \mu\mu$ Tag & Probe method.

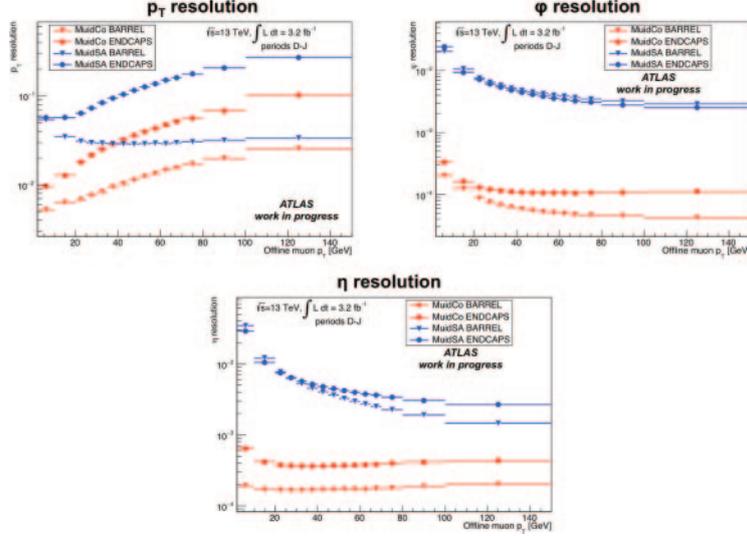


Fig. 2. – p_T , ϕ and η resolutions with respect to offline reconstruction as a function of muon offline p_T .

3. – Muon trigger resolution studies with respect to offline muon reconstruction

The muon HLT algorithms considered in this study are: *MuidSA* and *MuidCo*. While the first one performs track reconstruction only in the Muon Spectrometer (MS) extrapolating the track parameters of the muon to the interaction point, the second one combines the independent measurements from the Inner Detector (ID) and MS. The p_T , ϕ and η resolutions for both algorithms, evaluated by comparing online and offline muon track parameters, are shown in fig. 2 as a function of the muon offline p_T , separately for barrel and endcap regions.

In general, the *MuidCo* algorithm shows better performance than *MuidSA*, since it takes advantage of the combination of MS and ID information. This improvement is more evident in the case of low p_T , η and ϕ thanks to the excellent accuracy allowed by the ID. In addition, a better reconstruction can be observed in the barrel region with respect to the endcap regions, except for the *MuidSA* algorithm resolution on the second coordinate ϕ , that is uniform over all the detector regions: this is consistent with the fact that RPC and TGC are expected to have a comparable performance in the orthogonal direction to the toroid bending plane.

REFERENCES

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