Study of the Performance of the ATLAS Muon Spectrometer

Sara Borroni, on behalf of the ATLAS Collaboration
Sapienza Universitá di Roma & INFN
Roma, ITALY

1 Introduction

The assesment of the different objects reconstruction and identification are an essential component of each physics analysis of the experiment. Here the performance of the ATLAS muon trigger and track reconstruction efficiency, and muon momentum scale and resolution, are presented, using an integrated luminosity of 33 pb^{-1} from 2010 data. Z and W-bosons decay process are used as standard candles. These measurements are then used to the derive the corrections to be applied to the Monte Carlo simulation, used in all the analyses involving muons.

2 Muon Performances

The ATLAS Muon Spectrometer is based on four chamber technologies arranged in a multi-layer structure and embedded in a toroidal air-core magnetic field. Muons are curved in the longitudinal plane, allowing for a measurement of their transverse momenta in a pseudo-rapidity (η) range up to 2.7, with a resolution below 10% from 3 GeV up to 1 TeV. The system also provides a muon trigger up to a pseudo-rapidity of 2.4, using dedicated chambers [1].

Muon Reconstruction and Trigger A data-driven method has been develped to measure the muon reconstruction and trigger efficiencies, based on the kinematic of the $Z \to \mu\mu$ events. It allows to select one muon without using the Muon Spectrometer, when the other one has been tagged, which is then used to test the reconstruction and trigger efficiency of the muon system itself.

The efficiency of reconstructing a muon with more than 20 GeV of transverse momentum as combined muon, when it has been reconstructed in the inner tracker, is 95%, with a significant drop due to the acceptance, only at $\eta \sim 0$ where the MS is poorly instrumented (Figure **??**, up left plot). The efficiency is then almost flat on the whole acceptance and well described by the MC simulation. The systematic uncertainty on this measurement is 0.4%.

Muon trigger efficiency, when the muon has been reconstructed with a $p_T > 20$ GeV is about 80% overall (Figure 1, up right plot). This includes the acceptance of the trigger chambers, which is higher in the end-caps region and lower in the barrel due to the poorer coverage. Trigger efficiencies are known with a systematic error of 0.2%

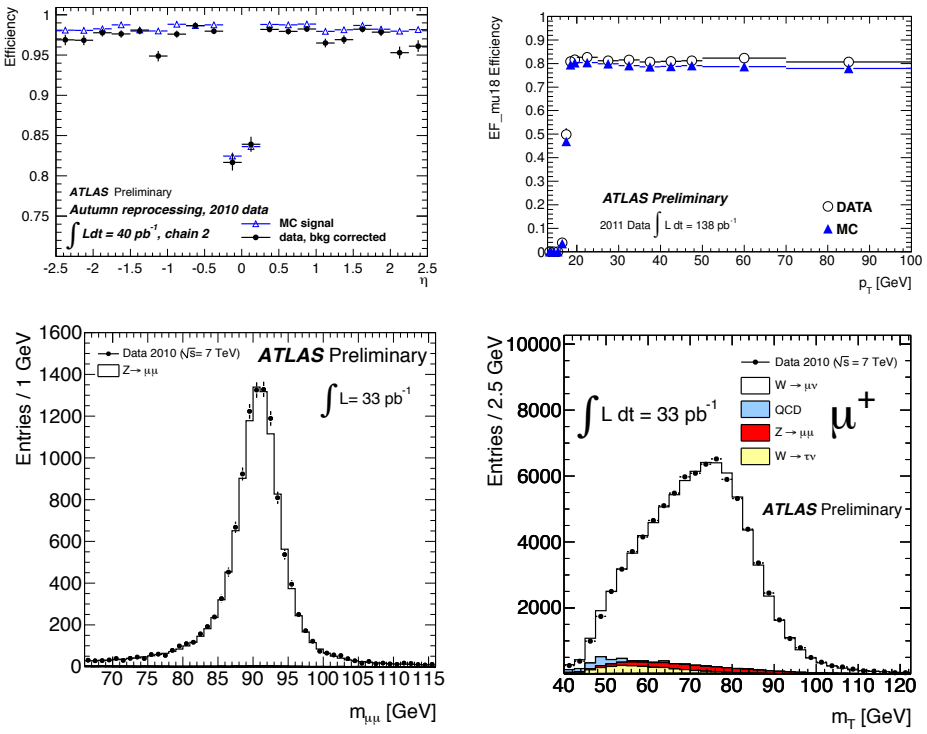

Figure 1: Up: Reconstruction efficiency vs muon pseudo-rapidity (left) and efficiency of the trigger with a 18 GeV threshold for reconstructed muons vs muon transverse momentum (upper part), and Z-boson invariant mass spectrum and transverse mass of the W^+-boson (lower part) with the full 2010 data luminosity.

Muon Momentum Scale and Resolution From a fit to the Z boson measured line-shape the fitted mass and experimental resolution in data and simulation can be determined. The data and MC fitted masses are in agreement within their statistical errors.

The resolution on the muon transverse momentum is measured using both single muons coming from W-boson decay, comparing the momenta measured by the inner tracker and the muon spectrometer, and the width of the Z-boson mass peak, as a function of the transverse momentum of the muon. Due to the non uniformity of the

detector coverage and performance, this is also done for differently instrumented eta regions. Data show a mean resolution on muon p_T in the 30 to 60 GeV around 4%, which translates in a resolution of about 2.6 GeV on the Z boson invariant mass.

Physics Objects Reconstruction The Z-boson invariant mass spectrum and the transverse mass of the W-boson have been reconstructed with 2010 data, and found very well described by the MC simulation (Figure 1, lower part). This agreement shows the good quality of the muon reconstruction.

References

[1] ATLAS Collaboration, "Expected Performance of the ATLAS Experiment - Detector, Trigger and Physics", arXiv.org:0901.0512

[2] ATLAS Collaboration, "Muon reconstruction efficiency in reprocessed 2010 LHC proton-proton collision data recorded with the ATLAS detector", ATLAS-CONF-2011-063

[3] ATLAS Collaboration, "Muon Momentum Resolution in First Pass Reconstruction of pp Collision Data Recorded by ATLAS in 2010", ATLAS-CONF-2011-046