Muon reconstruction performance in the ATLAS experiment

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1 Introduction

The ATLAS detector is designed to reconstruct muon with high efficiency providing a measurement of the muon momentum with a resolution better than 3% for $p_T < 200$ GeV and 10% for $p_T \sim 1$ TeV. The ATLAS detector is composed of two tracking systems: the Inner Detector (ID) and the Muon Spectrometer (MS). The Inner Detector measures tracks up to $|\eta| < 2.5$ exploiting the three types of detector operated in a solenoidal magnetic field of 2 T. The Muon Spectrometer consists of three large air-core superconducting toroidal magnetic systems providing a field of approximately 0.5 T·m. Precision and trigger chambers provide the reconstruction of charge particles, mainly muons.

Different algorithms are developed for the muon reconstruction. Muon Spectrometer tracks are entirely reconstructed in the MS, from trigger chambers hits and segments reconstructed in the precision chambers. The track is then extrapolated to the interaction point and the momentum is corrected for the energy loss due to the material crossed before reaching the MS. Combined muon tracks result from the combination of MS and ID measurements by a statistical combination or a refit of the entire track. Energy losses in the calorimeter are taken into account using parametrization and possibly calorimeter measurements. Segment tagged muons are based on the ID measurement. The muon is identified if at least one segment in MS matches with the ID track.

Measurements of the muon reconstruction efficiency as well as the muon momentum resolution have been carried out with LHC collision data recorded in 2010 by the ATLAS experiment. The comparison of the results with Monte-Carlo prediction is given.

2 Results

The muon reconstruction efficiency is measured with the so-called "$Z \rightarrow \mu\mu$ tag-and-probe method" [3]. The agreement between data and Monte Carlo simulation is evaluated by means of scale factors, which are the ratios of the efficiencies measured in experimental data and simulation data. Fig. 1 shows the efficiencies obtained from data (dots) and Monte Carlo simulation (open triangles) including backgrounds. The corresponding scale factors are shown in the lower part. Monte Carlo simulation well describes collision data, both in ID and combined reconstruction.

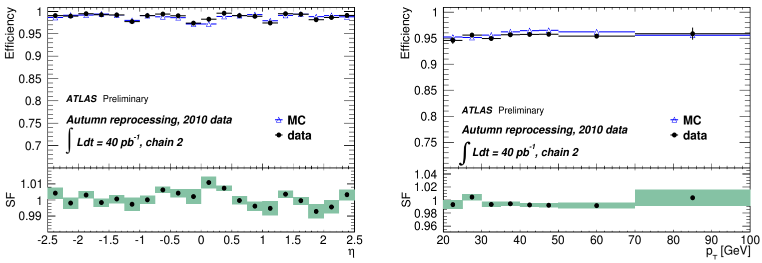

Figure 1: Reconstruction efficiencies and scale factors for ID tracks (left, as a function of η) and combined muons (right, as a function of p_T) [3].

The resolution is measured separately for Inner Detector and Muon Spectrometer from the width of the di-muon invariant mass in Z decays and from the momentum measurement in single muon events given by the two tracking systems.

The resolution is studied in four η regions and parametrized as a function of the muon momentum, depending on the energy loss in the calorimeter (for MS tracks only), the multiple scattering and the intrinsic resolution.

A combined fit procedure [4] is used to calculate the resolution parameters for data and Monte Carlo simulation. Correction factors are given to correct the Monte Carlo resolution to the one measured in data.

Fig. 2 shows the resolution curve in the barrel region as a function of the muon p_T for data and Monte Carlo simulation, measured in the Inner Detector. Higher resolution is observed in data with respect to Monte Carlo simulation due to the preliminary calibration constants and alignment costraints used for 2010 data analysis.

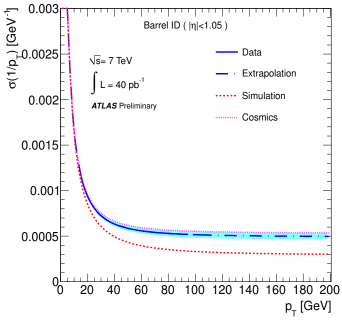

Figure 2: Resolution curve from the fitted parameter values of the Inner Detector in collision data and simulation as a function of the muon p_T, in the barrel region [4].

References

[1] ATLAS Collaboration, Inner Detector: Technical Design Report, CERN-LHCC-97-016/017, CERN, Geneva, 1997.

[2] ATLAS Collaboration, ATLAS muon spectrometer: Technical Design Report, CERN-LHCC-97-022, CERN, Geneva 1997.

[3] ATLAS Collaboration, Muon reconstruction efficiency in reprocessed 2010 LHC p-p collision data recorded with the ATLAS detector (ATLAS-CONF-2011-063), `http://cdsweb.cern.ch/record/1337280`.

[4] ATLAS Collaboration, ATLAS Muon Momentum Resolution in the First Pass Reconstruction of the 2010 p-p Collision Data at $\sqrt{s}$=7 TeV (ATLAS-CONF-2011-046), `http://cdsweb.cern.ch/record/1322424`.