

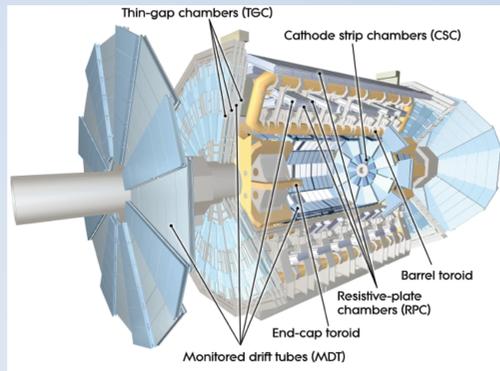
(27) Muon Reconstruction Efficiency, Momentum Scale and Resolution in pp Collisions at 8 TeV with ATLAS

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The ATLAS experiment identifies and reconstructs muons with two high precision tracking systems, the Inner Detector and the Muon Spectrometer, which provide independent measurements of the muon momentum. This poster summarizes the performance of the combined muon reconstruction in terms of reconstruction efficiency, momentum scale and resolution. Data-driven techniques are used to derive corrections to be applied to the simulation in order to reproduce the reconstruction efficiency, momentum scale and resolution observed in experimental data, and to assess systematic uncertainties on these quantities. The analysed dataset corresponds to an integrated luminosity of 20.4 fb^{-1} from pp collisions at $\sqrt{s} = 8 \text{ TeV}$ recorded in 2012.

MUON SPECTROMETER (MS)

The Muon Spectrometer is designed for muon detection in the range $|\eta| < 2.7$. Three large air core toroidal magnets with a mean magnetic field of 0.5 T allow for a precise measurement of muon momenta up to the TeV range.



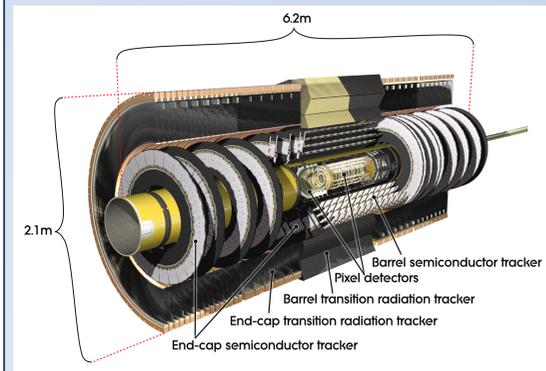
Precision tracking and momentum measurement using **Monitored Drift Tube** and **Cathode Strip Chamber** technologies.

Trigger and measurement of the ϕ angle using **Resistive Plate Chamber** and **Thin Gap Chamber** technologies.

Chamber alignment using an optical system.

INNER DETECTOR (ID)

The Inner Detector's task is to track charged particles and determine their charge and momentum within $|\eta| < 2.5$, as well as to identify vertices. A 2 T solenoid magnetic field allows for a precise momentum measurement.



Silicon Pixel detector (3 layers) and **semiconductor tracker** (4/9 layers in barrel / endcap) for precise vertexing and track seeding.

Transition Radiation Tracker for particle identification and pattern recognition.

MUON RECONSTRUCTION AND IDENTIFICATION IN ATLAS

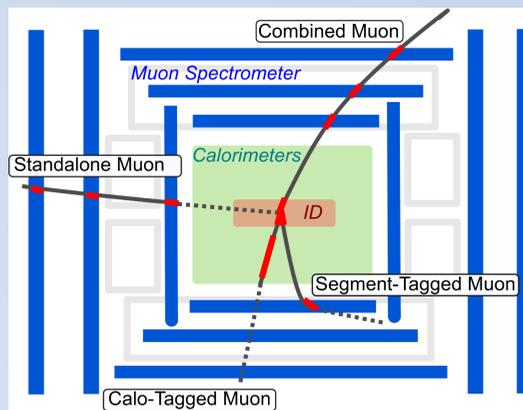
The ATLAS software provides four complementary types of reconstructed muons:

COMBINED

Muon tracks are reconstructed independently in both the Inner Detector and the Muon Spectrometer. A combined track is formed using a statistical combination or a global refit of the two tracks. This is the main muon type used in $|\eta| < 2.5$, and provides the highest precision and purity.

SEGMENT-TAGGED

A track in the Inner Detector whose extrapolation to the Muon Spectrometer is associated with at least one track segment in the MDT or CSC. Used to increase acceptance of low momentum muons that do not traverse the full spectrometer.



STAND-ALONE

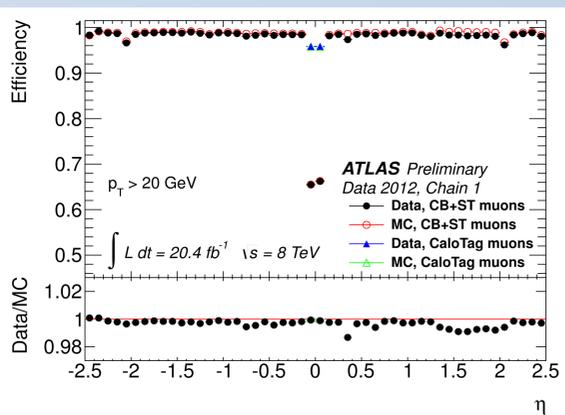
Muon tracks reconstructed only in the Muon Spectrometer. The track is extrapolated to the interaction point, taking into account muon energy loss in the calorimeters. Used to detect muons in the region $2.5 < |\eta| < 2.7$.

CALORIMETER-TAGGED

A track in the Inner Detector which has an energy deposit in the calorimeter compatible with a minimum ionizing particle. These tracks have a low purity. They are used to improve acceptance in the region of $|\eta| < 0.1$, where the Muon Spectrometer is not fully instrumented.

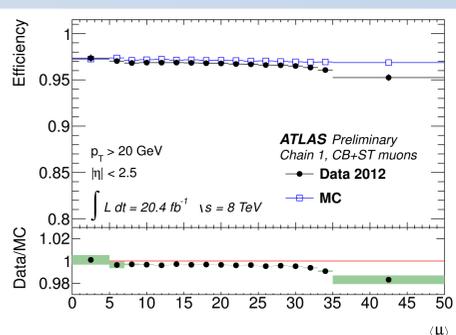
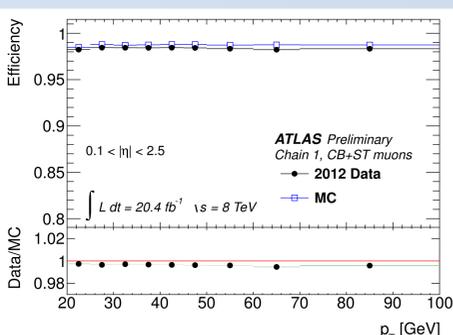
MUON RECONSTRUCTION EFFICIENCY

The **reconstruction efficiency** is measured using a **tag-and-probe method** based on $Z \rightarrow \mu\mu$ events. The measurement is carried out in both data and simulation, and a **scale factor** is derived as the ratio between the two. These scale factors are applied to the simulation in order to correct for a possible mismodeling of the muon reconstruction efficiency.



Left: Measured reconstruction efficiency as a function of η for muons with $p_T > 20 \text{ GeV}$.

Below: Muon reconstruction efficiency as a function of p_T (left) and as a function of the average number of inelastic pp collisions per bunch crossing, $\langle \mu \rangle$ (right).



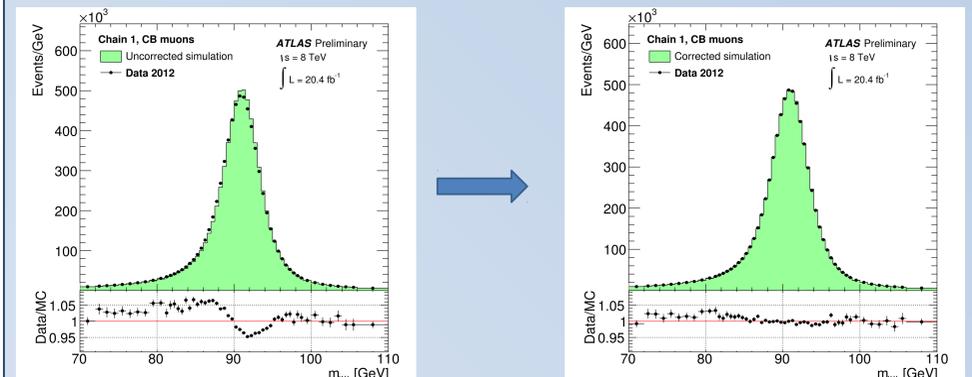
The measured muon reconstruction efficiency exceeds 97% for $0.1 < |\eta| < 2.5$. Excellent agreement between reconstructed efficiencies in data and simulation is observed.

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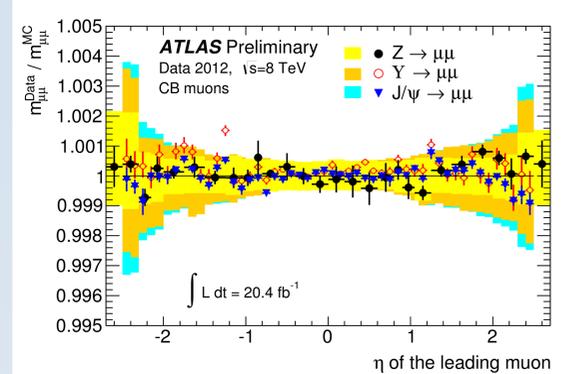
MUON MOMENTUM SCALE AND RESOLUTION

Muon momentum **scale and resolution corrections** are extracted separately for ID and MS tracks with a maximum likelihood **template fit** method using $Z \rightarrow \mu\mu$ decays in 16 bins of η .

Validation of the corrections is performed using the J/ψ , Y and Z resonances.



Invariant mass distribution for data and simulation of $Z \rightarrow \mu\mu$, before (left) and after (right) corrections.



Ratio of the reconstructed mean mass in data and the corrected simulation for the J/ψ , Y and Z resonance as a function of η for combined muons.

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