Muon reconstruction performance in ATLAS at Run-II

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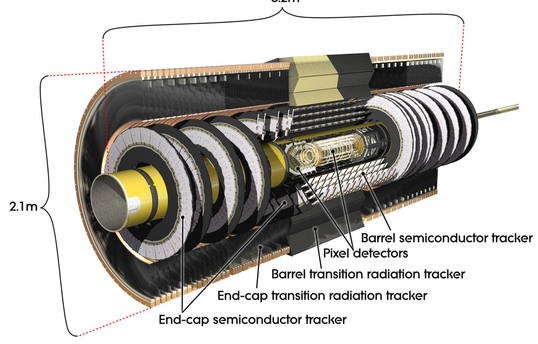
MUON RECONSTRUCTION AND SELECTION

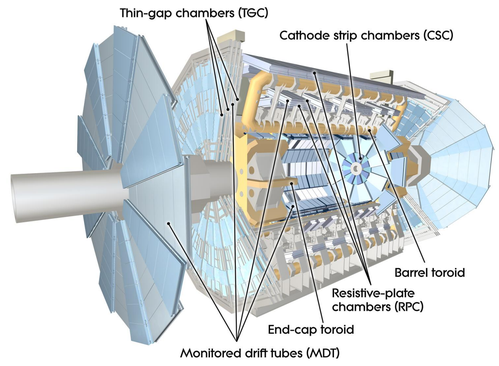
INNER DETECTOR - ID

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



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.

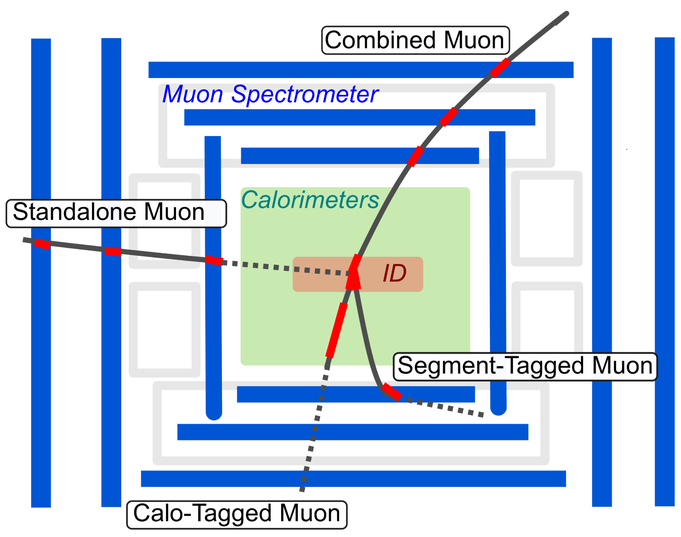


MUON SELECTION

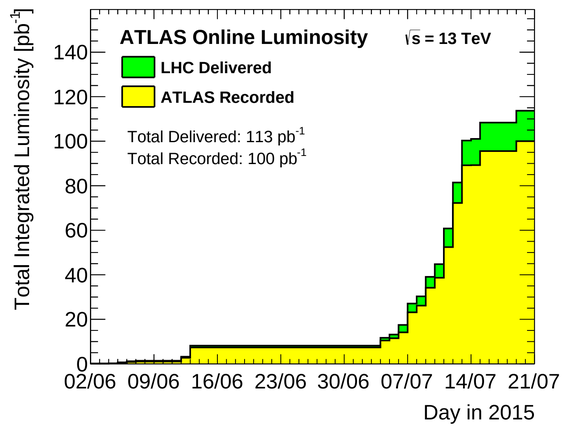
Combining tracks of the ID and MS, the ATLAS software provides four complementary types of reconstructed muons: Combined, Segment-tagged, Stand-alone and Calorimeter-tagged muons.

Depending on the kinematics and desired purity, these form four categories of muons:

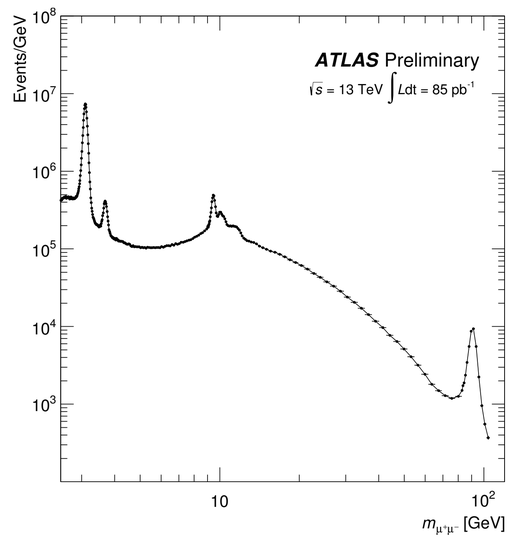
- **Loose** - maximized efficiency
- **Medium** - compromise between efficiency and purity, low systematic uncertainties
- **Tight** - strong rejection of misidentifications
- **High p_T** - maximized momentum resolution for $p_T > 100$ GeV



LHC RUN-II DATA



The ATLAS dataset taken at $\sqrt{s} = 13$ TeV comprises an integrated luminosity of 100 pb^{-1}, of which 85 pb^{-1} are suitable for physics analyses.



This dataset already allows for a precise determination of muon reconstruction efficiencies, momentum scale and resolution using the J/ψ and Z resonances.

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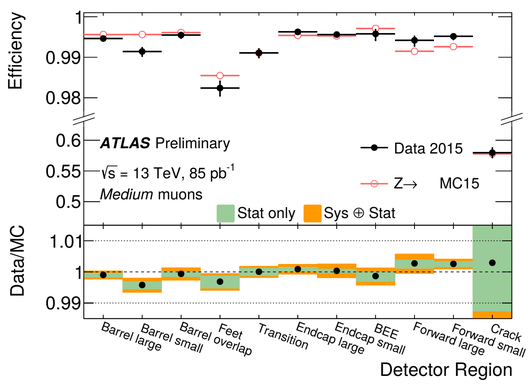
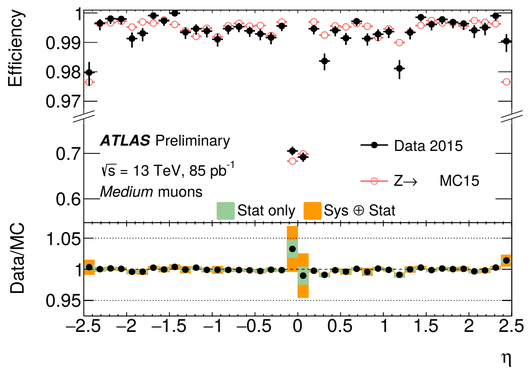
MUON RECONSTRUCTION EFFICIENCY

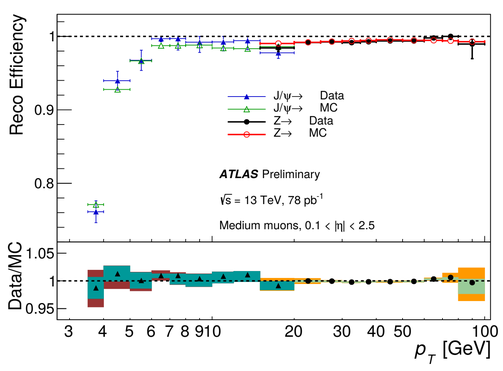
The **reconstruction efficiency** is measured using a **tag-and-probe method** based on $Z \to \mu^+\mu^-$ and $J/\psi \to \mu^+\mu^-$ events. The measurement is carried out in both data and simulation, and a **scale factor** is derived as the ratio between the two results. These scale factors are applied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



Left: Measured reconstruction efficiency in various regions of the ATLAS muon spectrometer for muons with $p_T > 10$ GeV.

Below: Muon reconstruction efficiency as a function of the pseudorapidity (left) and of the transverse momentum (right).





The measured muon reconstruction efficiency exceeds 98% for $0.1 < |\eta| < 2.5$ and $p_T > 10$ GeV. Excellent agreement between reconstructed efficiencies in data and simulation is observed.

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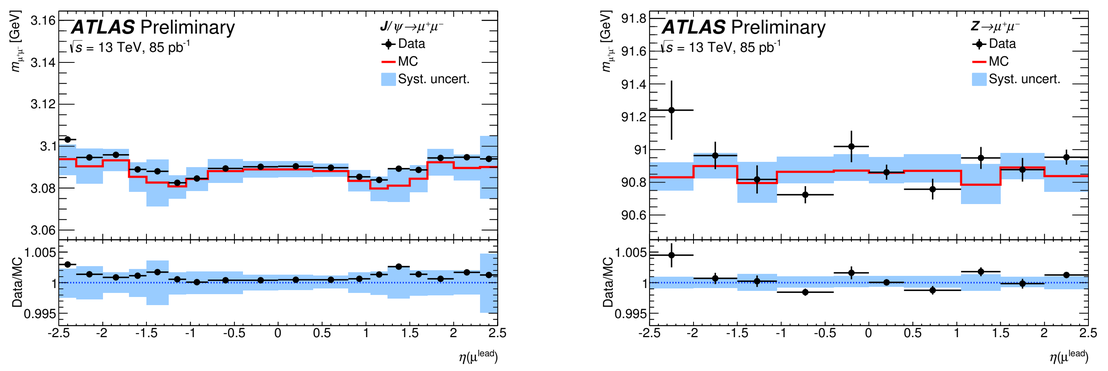
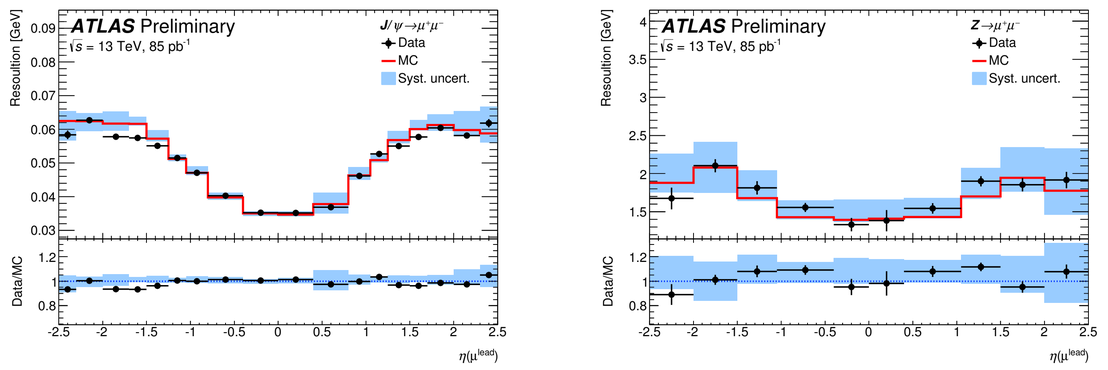
MUON MOMENTUM SCALE AND RESOLUTION

Corrections to the simulated muon momentum **scale and resolution** are extracted separately for ID and MS tracks using a template-based likelihood fit. The bulk of the corrections is derived from $Z \to \mu^+\mu^-$ and $J/\psi \to \mu^+\mu^-$ decays in 5 fb^{-1} of pp data collected at $\sqrt{s} = 8$ TeV in 2012. The data taken at $\sqrt{s} = 13$ TeV is used to validate and update the corrections to account for changes of the detector conditions.



Fitted resonance mass parameter for $J/\psi \to \mu^+\mu^-$ (left) and $Z \to \mu^+\mu^-$ decays (right) as a function of the leading muon pseudorapidity.



Fitted mass resolution for $J/\psi \to \mu^+\mu^-$ (left) and $Z \to \mu^+\mu^-$ decays (right) as a function of the leading muon pseudorapidity.

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