Performance of the ATLAS Muon Spectrometer in Run II

Despoina Sampsonidou,
on behalf of the ATLAS Collaboration

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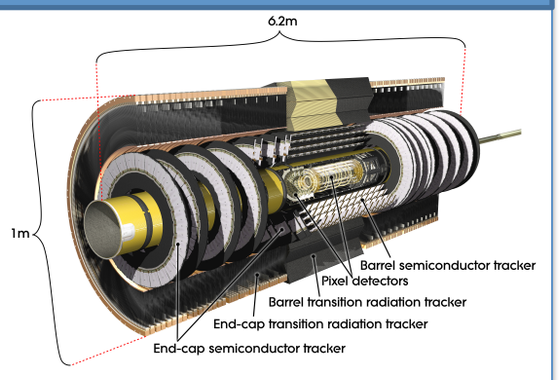
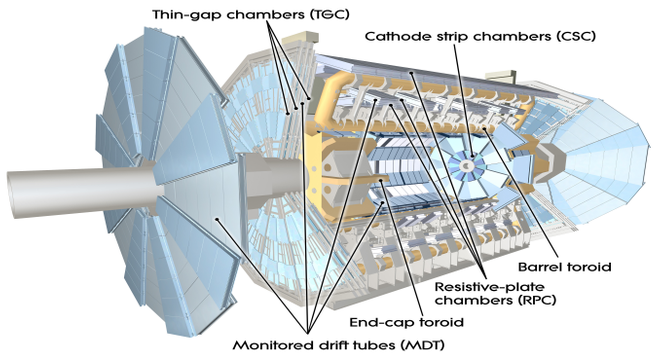
Inner Detector & Muon Spectrometer

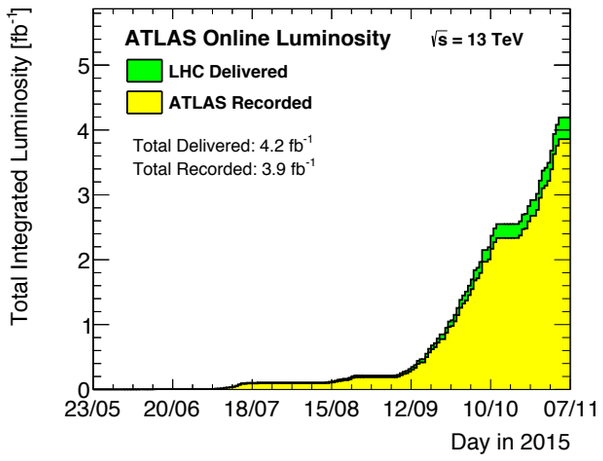
The Inner Detector tracks charged particles and determines their charge and momentum, covering the pseudorapidity range |η| < 2.5 using a 2 T magnetic field.

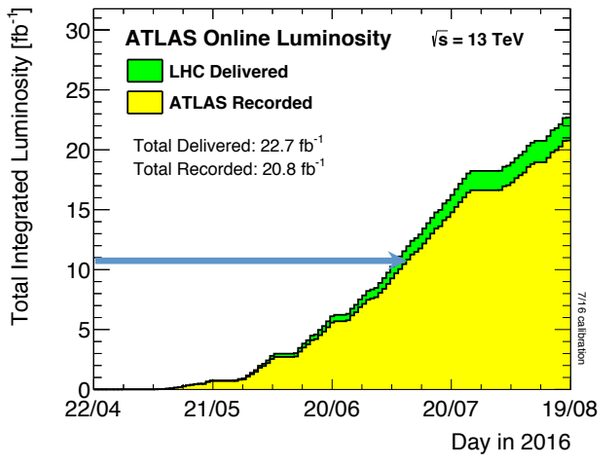




The Muon Spectrometer provides precise measurement of muon momenta up to the TeV range, covering the pseudorapidity range |η| < 2.7 using air core toroidal magnets a mean magnetic field of 0.5 T.

Run II: 2015 – 2016 ATLAS Data

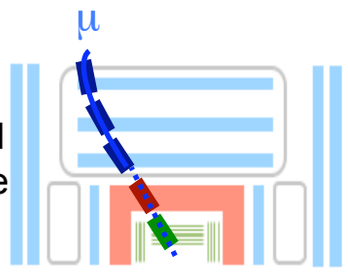




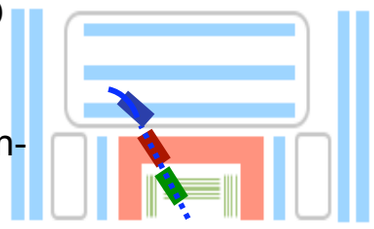
Muon Reconstruction

Muon reconstruction is performed by combining information from the ID and MS detectors, providing four complementary types of reconstructed muons:

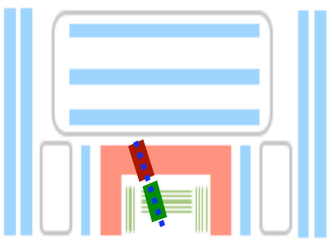
Combined
Muon tracks that are reconstructed in the MS and are associated to ID tracks



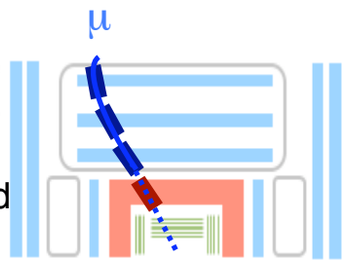
Segment-ID tracks associated with a station-segment in the MS



Calo-tagged
ID tracks associated with an energy deposit in the calorimeter

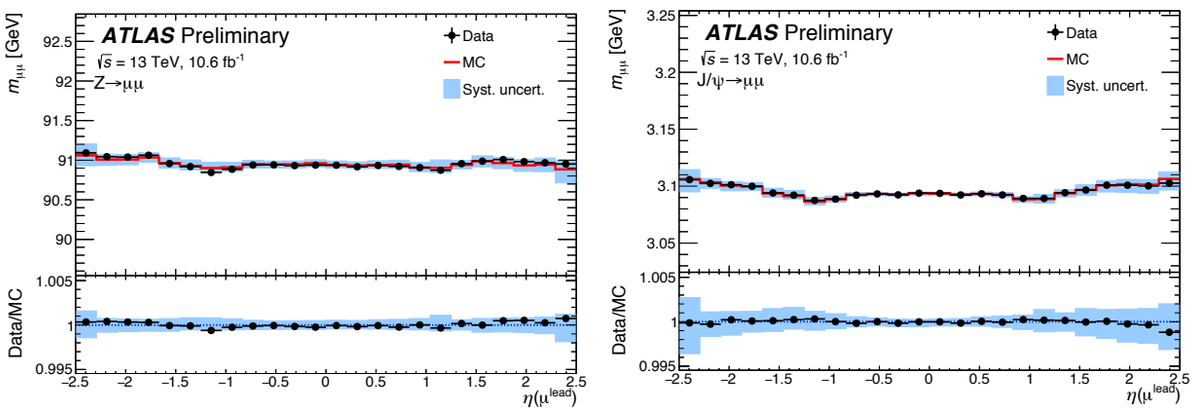


Stand-alone
Muon tracks that are reconstructed only in the MS

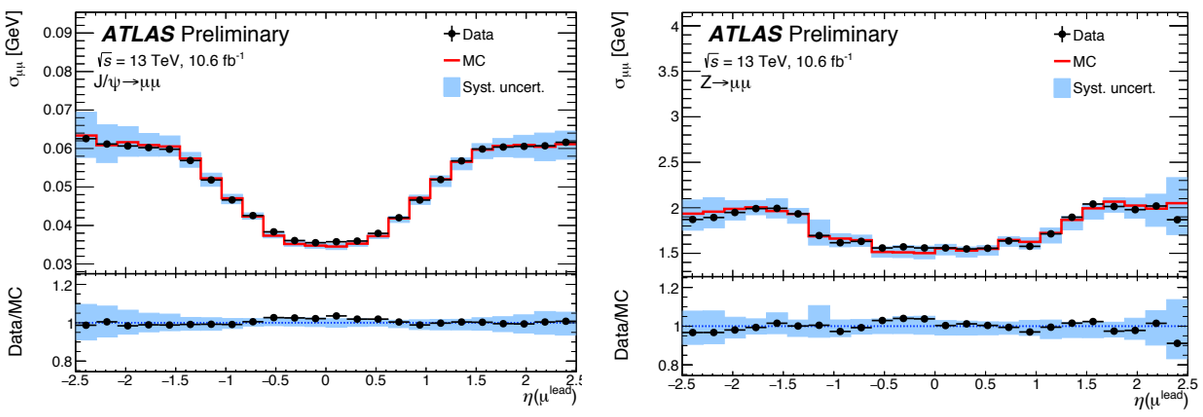


Momentum and Scale Resolution

Corrections to the simulated muon momentum scale and resolution are extracted separately for ID and MS tracks using a template-based likelihood fit.The parametrisation is validated by comparing the position and resolution of Z and J/ψ invariant mass distribution observed in Run II data.



Transverse momentum scale as a function of pseudorapidity from Z→μμ and J/ψ → μμ samples



Transverse momentum resolution as a function of pseudorapidity from Z→μμ and J/ψ → μμ samples

Muon Identification

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

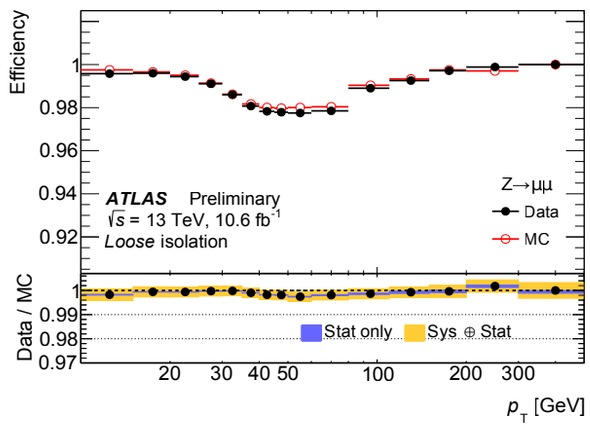
Loose –maximizes the reconstruction efficiency
Medium - the default selection for ATLAS, minimizes the systematic uncertainties
Tight -maximizes the purity of muons at the cost of 3-4% loss in efficiency
High p_T – maximizes momentum resolution for p_T > 100 GeV

Muon Reconstruction Efficiency

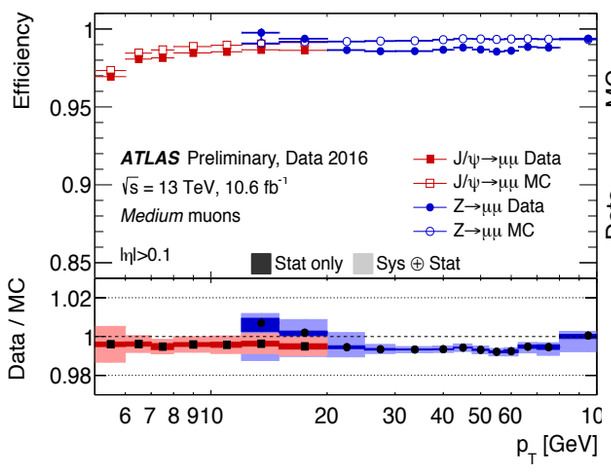
|η|<2.5:The reconstruction efficiency is measured using a tag-and-probe method on Zmumu and Jpsi mumu events:

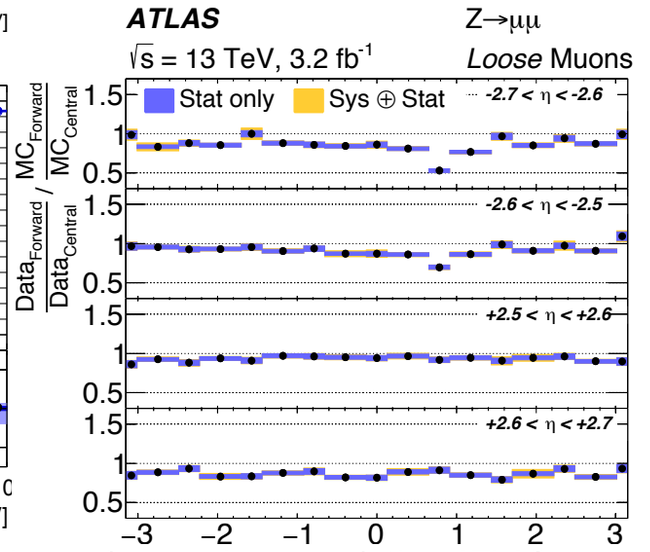
- selection of an almost pure muon sample from J/ψ → μμ or Z → μμ events
- Tag muon: medium muon that triggers the event
- Probe muon: an ID track with calorimeter tagging or an MS track
- Efficiency: the fraction of probe tracks also reconstructed as muons (ID tracks)

Z decays provide a sample of probes with **p_T > 10 GeV**
J/ψ decays provide a sample of probes with **5 GeV<p_T<15 GeV**
The measurement is carried out in data and simulation and the scale factor is computed as the ratio of the two. The scale factors are applied to the MC in order to correct for a possible mismodelling of the muon reconstruction efficiency.



|η|>2.5: The number of muons observed in Z → μμ decays in the high-η region is normalized to the number of muons observed in the region 2.2 < |η| < 2.5, both for data and simulation. The high-eta scale factor is derived as the double ratio of the two results.





Top left: Measured reconstruction efficiency for varying p_T of the ATLAS muon spectrometer for Loose muons, from *Z→ μμ sample*
Bottom left: Muon reconstruction efficiency as a function of the transverse momentum
Right: Double ratio for the forward muons for varying phi