Muon Reconstruction Performance in ATLAS at Run-II

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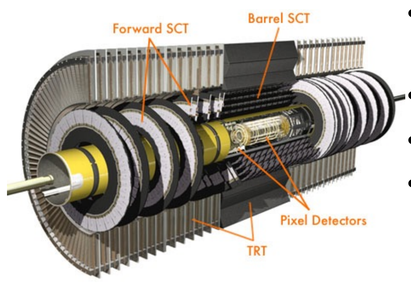
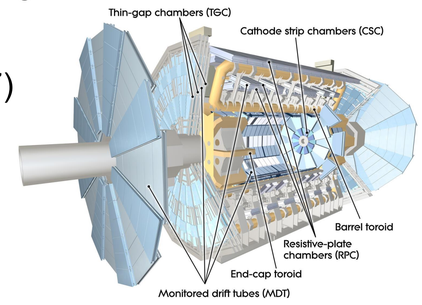
Inner Detector (ID) & Muon Spectrometer (MS)



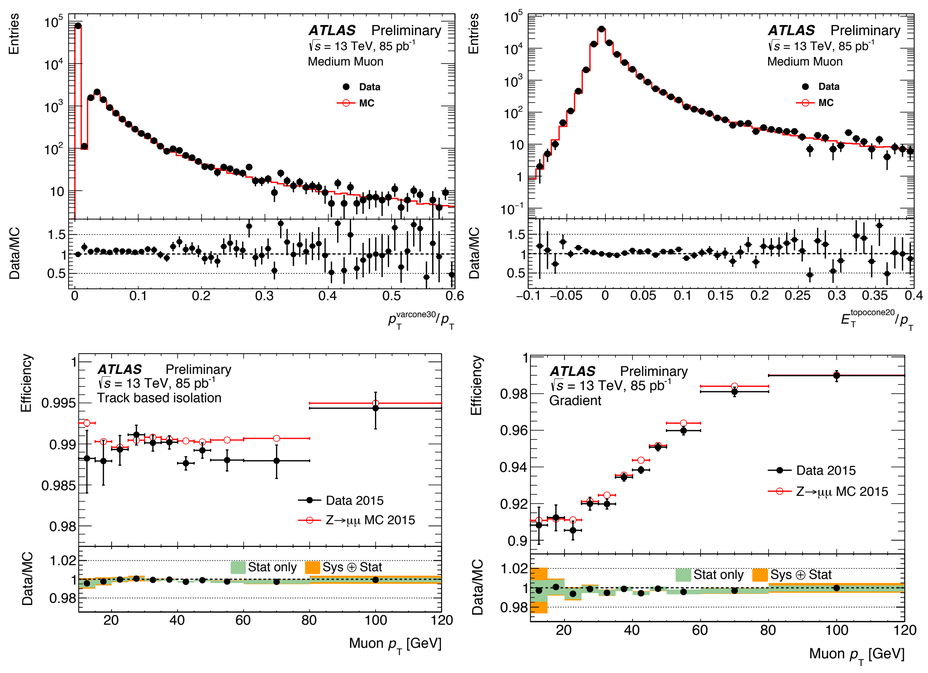
- Muon spectrometer with acceptance $|\eta|<2.5$ operating in a 2T solenoidal field.
- 3 layers of pixel sensors (50 cm < r < 12 cm)
- 4 layers of silicon strips (30 cm <r< 51 cm)
- 72 straw layers of transition radiation tracker modules (55 cm < r < 108 cm)

Muon tracking detector providing independent muon momentum measurements with acceptance $|\eta|<2.7$ using air core 0.5 T toroidal magnets:

- Precision chambers
  - 3 layers of Monitored Drift Tube chambers ($|\eta| < 2.7$)
  - Innermost layer replaced by Cathode Strip Chambers ($|\eta| > 2.0$)
- Trigger chambers
  - 3 layers of Resistive Plate Chambers ($|\eta| < 1.05$)
  - 3 layers of Thin Gap Chambers ($1.05 < |\eta| < 2.4$)

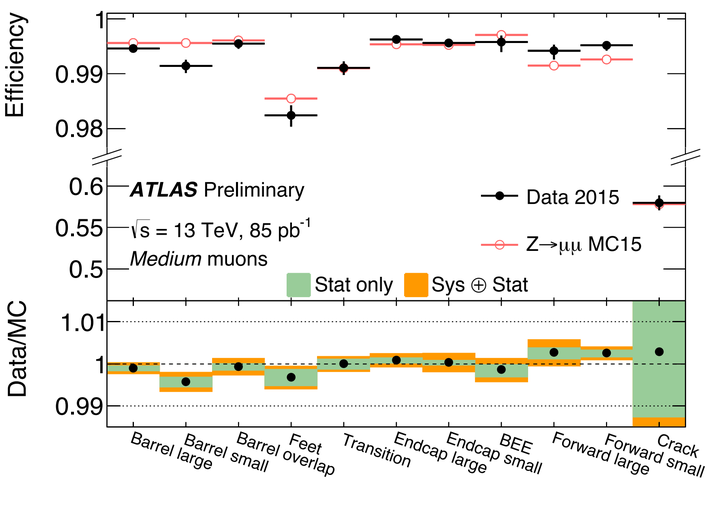


Isolation



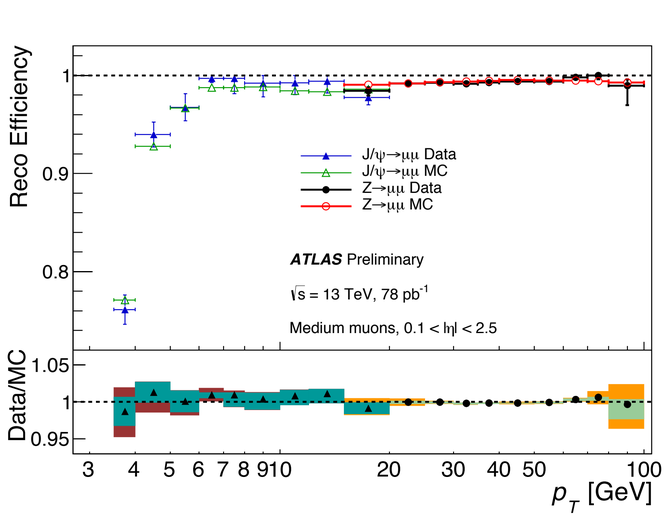
Muon isolation is both track-based (left) and calorimeter-based (right). The plots show efficiency as a function of p_T. data and simulation are in good agreement.

Reconstruction efficiency



The reconstruction efficiency is measured using the Tag and Probe method applied to the $Z\rightarrow\mu^+\mu^-$ and $J/\psi\rightarrow\mu^+\mu^-$ events.

- $Z\rightarrow\mu^+\mu^-$ decays provide a sample of probes with p_T > 15 GeV
- $J/\psi\rightarrow\mu^+\mu^-$ decays provide a sample of probes with 2.5 GeV < p_T < 20 GeV



Muon efficiencies are extracted separately from simulation and data for the uniform detector regions (top) and as a function of probe p_T (bottom).

The ratio between data and simulation efficiencies provides scale factors. They are close to unity as a result of an already good initial agreement observed in data and simulations. Efficiency is reduced in the MS crack region, $|\eta|$ < 0.1, on account of gaps between muon chambers for ID and calorimeter services.

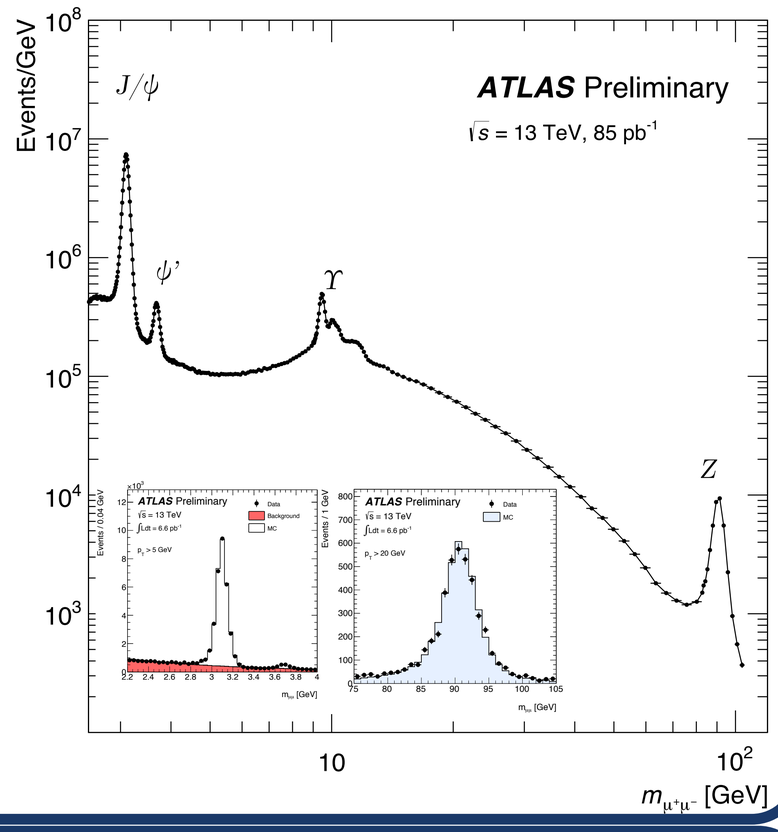
Muon reconstruction

Muons are identified by combining information from the ID and MS detectors. About 96% of muons are reconstructed by fitting hits from ID and MS tracks. The remainder are formed by tagging ID tracks with muon signatures in the calorimeter or the MS.

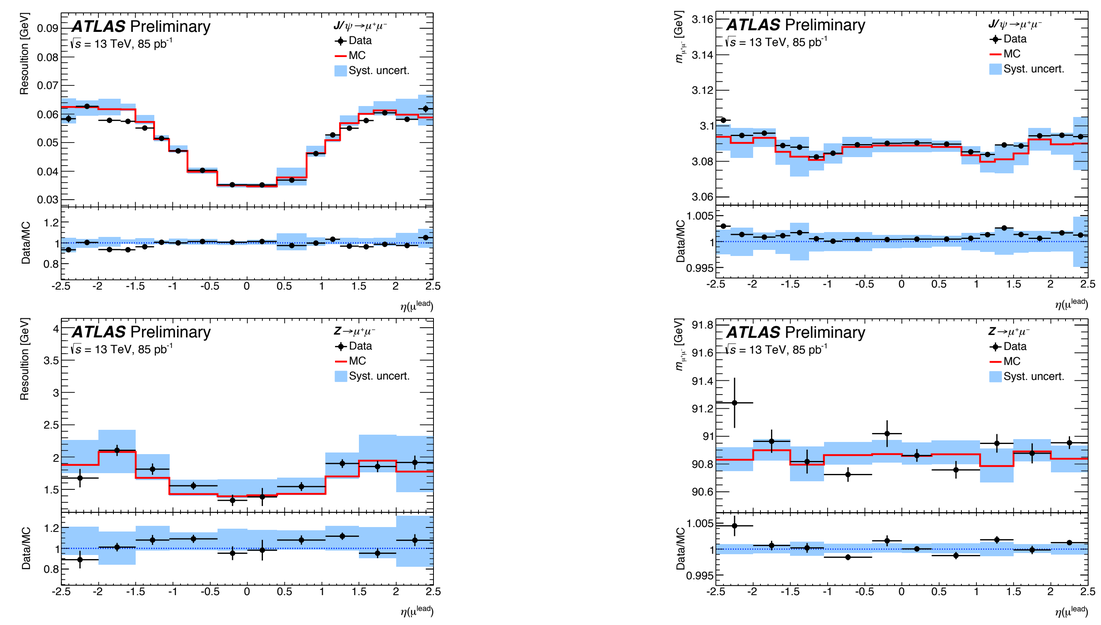
Run-II data first look

Dimuon invariant mass spectrum for oppositely charged, combined track pairs with p_T > 4 GeV, $|\eta|$ < 2.5 in data.

Data-to-simulation comparisons invariant mass distributions for $J/\psi\rightarrow\mu^+\mu^-$ and $Z\rightarrow\mu^+\mu^-$ decays



Momentum scale and resolution



Data-to-simulation agreement is improved by applying the following momentum corrections to the MC, separately for ID and MS tracks:

$$p_T \rightarrow \frac{\Delta s_0 + (1 + \Delta s_1) \bullet p_T}{G(1, \sqrt{(\Delta r_0 / p_T)^2 + \Delta r_1^2 + (\Delta r_2 \bullet p_T)^2})}$$

Δs_0 Offset of average energy loss in calorimeter & other materials (MS only)
Δs_1 Scale of magnetic field integral & global radial distortions of the detector
Δr_0 Energy loss fluctuations in the material (MS only)
Δr_1 Multiple scattering, local radial distortions, & local distortion of magnetic field
Δr_2: Intrinsic resolution and misalignments

Δs and Δr, are extracted by fitting the Z and J/ψ invariant mass peaks using Run I (8 TeV) data.

This parametrisation is validated by comparing the position and resolution of Z and J/ψ invariant mass distribution observed in Run II (13 TeV) data.

The agreement between data and simulation for the mean is within 0.1% in the barrel region ($|\eta|$<1.05) and 0.2% in the end caps (1.0<$|\eta|$ <2.5), where the alignment is still preliminary.

The resolution measured in data agrees with MC to within 3%.