LHCC Poster Session - CERN, 22 February 2017

MUON RECONSTRUCTION PERFORMANCE OF THE ATLAS DETECTOR IN 2016 DATA

Muons are of key importance to study some of the most interesting physics topics at the LHC. We show the status of the performance of the muon reconstruction in the analysis of proton-proton collisions at the LHC, recorded by the ATLAS detector in 2016. Reconstruction efficiency and momentum resolution have been measured using J/Ψ and Z decays for different classes of reconstructed muons.
Results are compared with the Monte Carlo simulation.

DETECTORS

The ATLAS detector has been designed to provide clean and efficient muon identification and precise muon momentum measurements over a wide range of energy and solid angle. The detectors used to achieve such tasks are:

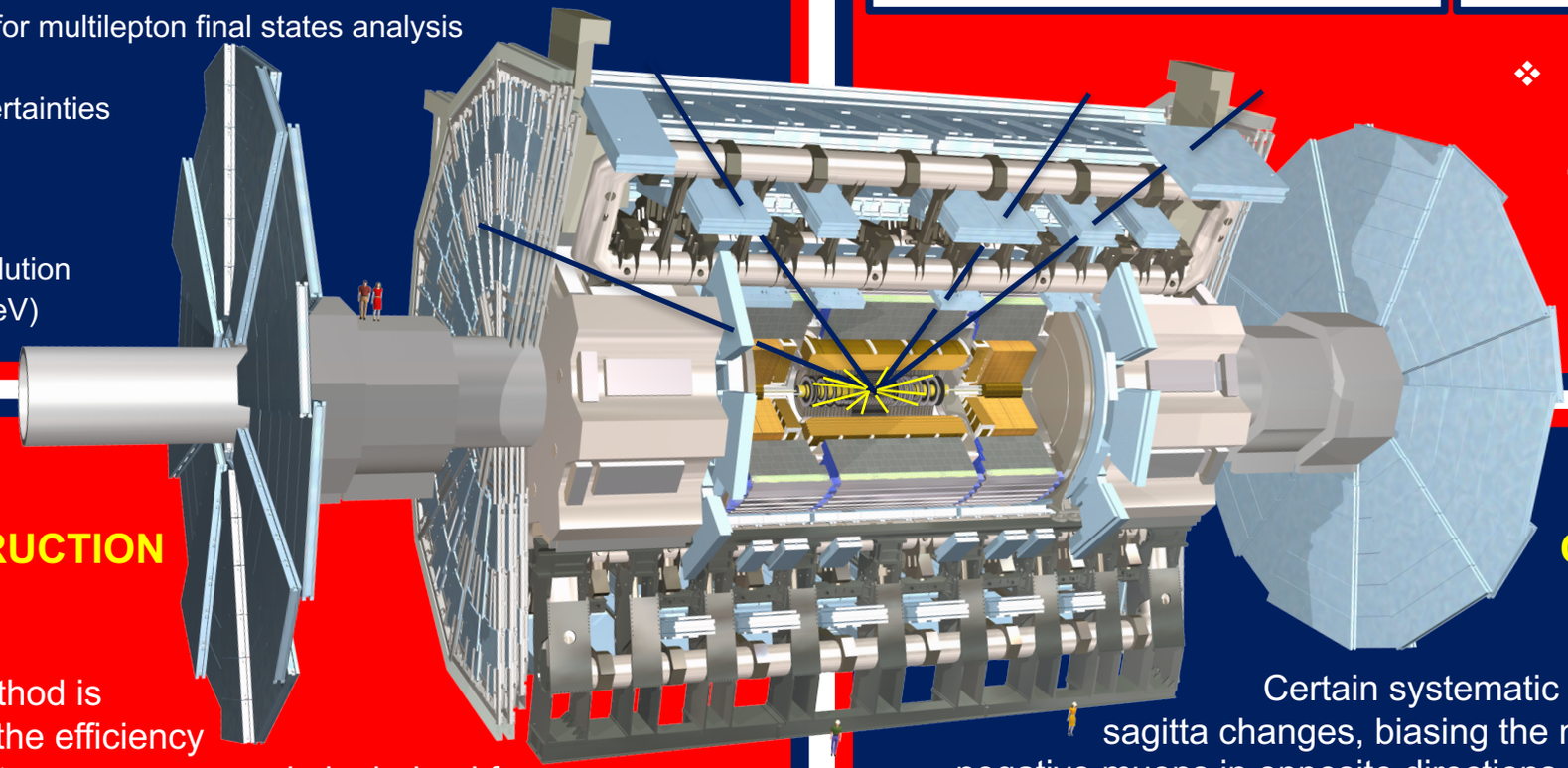
The Inner Detector (ID)
It measures tracks up to |η|<2.5 in a solenoidal field of 2 T.

The Muon Spectrometer (MS)
The largest of the ATLAS subdetectors, the MS measures muons up to |η|<2.7 providing momentum measurements with a design relative resolution of better than 3% over a wide p_T range and to 10% at 1 TeV .

MUON IDENTIFICATION

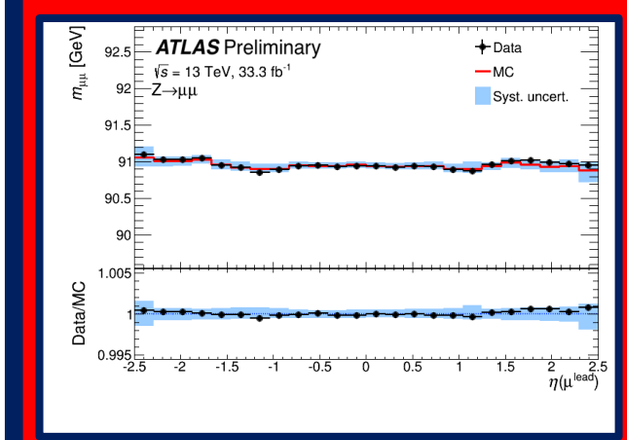
Four muon identification selections are defined in order to meet the specific needs of different physics analyses:

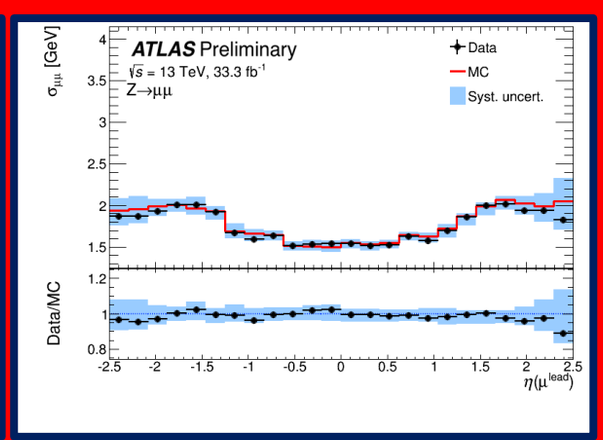
- ***loose* muons**
  maximize efficiency: ideal for multilepton final states analysis
- ***medium* muons**
  minimize systematics uncertainties
- ***tight* muons**
  optimize purity
- ***high-p_T* muons**
  maximize momentum resolution for high-p_T tracks (>100 GeV)



MUON MOMENTUM SCALE AND RESOLUTION

The ATLAS simulation includes the best knowledge of the detector geometry, material budget and modeling of muon interactions. However, additional corrections are needed in order to have a better match with data. Corrections to be applied to MC simulation are derived via a fit to the dimuon invariant-mass distribution at the Z and J/Ψ poles:





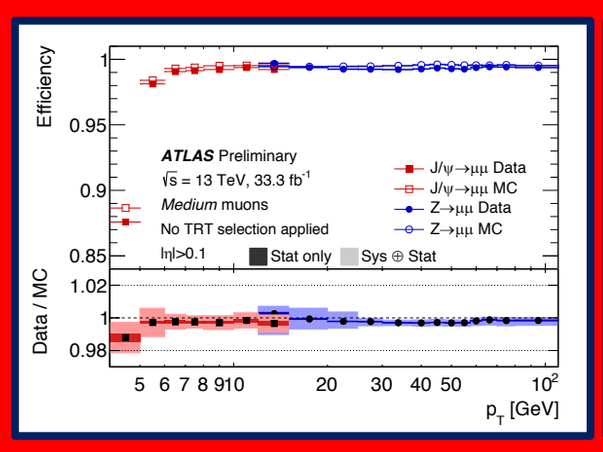
- **Data and MC agreement is within ~0.5 per mille for Z-mass scale in the barrel.**
- **Resolution is 0.9% for p_T~6 GeV in the barrel and 1.5% for p_T~45 GeV.**

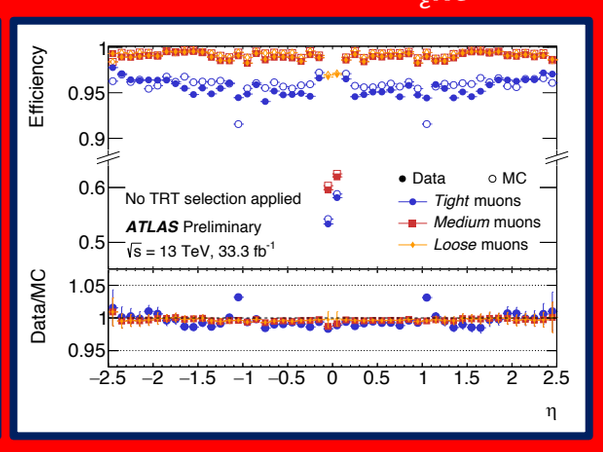
MUON RECONSTRUCTION EFFICIENCY

The tag-and-probe method is employed to measure the efficiency of the muon. An almost pure muon sample is derived from $J/\psi \to \mu\mu$ (after background subtraction) and $Z \to \mu\mu$ events, requiring:

- one leg of the decay (tag) to be identified as a Medium muon that fires the trigger;
- the second leg (probe) reconstructed by the ID independently from the MS.

The level of agreement of the measured efficiency in both data and simulation is expressed in terms of the "**S**cale **F**actor": $SF = \frac{\varepsilon^{DATA}}{\varepsilon^{MC}}$.



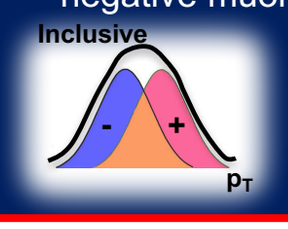


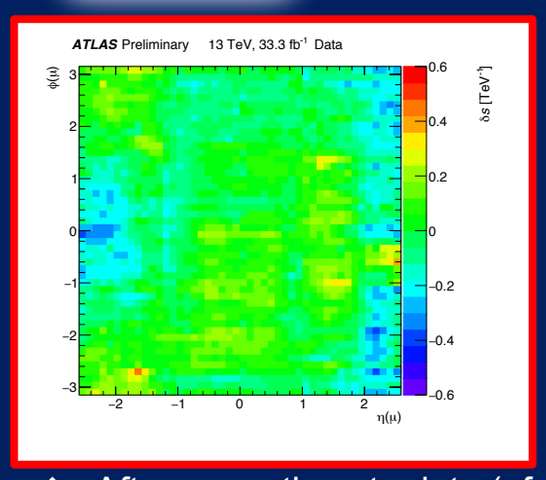
Isolation efficiency SF are also provided for the first time down to 4 GeV thanks to several improvements in the low-p_T background estimation.

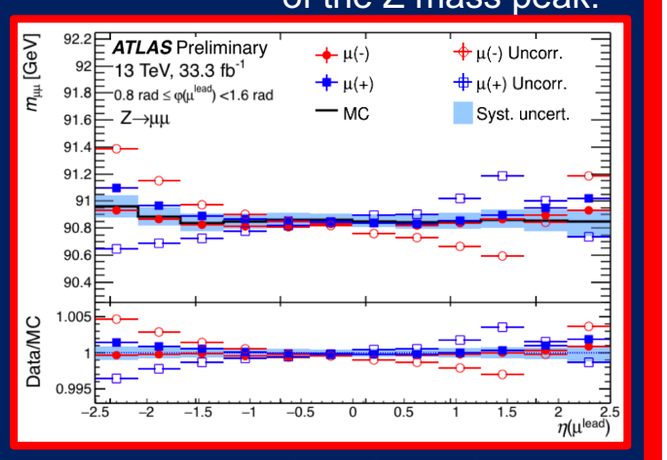
CHARGE-DEPENDENT EFFECTS

Certain systematic misalignment modes cause sagitta changes, biasing the measured p_T of positive and negative muons in opposite directions. Such effects are present in prompt data reconstruction. Sagitta biases:

- cause a mass shift for charge-asymmetric final states, and hence hard to see on the Z mass;
- very slightly increase the width of the Z mass peak.







- After corrections to data (of prompt reconstruction) the residual biases are reduced to 0.2‰ on the Z mass.

REFERENCES

Atlas Collaboration, Aad, G., Abbott, B. et al.
Eur. Phys. J. C (2016) 76: 292. doi:10.1140/epjc/s10052-016-4120-y

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ATLAS EXPERIMENT