Muons are central in the study of some of the most important physics topics at the LHC. The ATLAS muon spectrometer is designed to provide excellent momentum resolution up to 1 TeV. By using events containing J/ψ and Z bosons produced in pp collisions, the efficiency and resolution of the muon spectrometer are determined from data and do not rely only on Monte Carlo simulation. This poster summarizes the detector performance achieved during the 2012 LHC run and reports the measured muon efficiency and momentum resolution, compared with the Monte Carlo simulation.

### The Inner Detector

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

Three detectors exploited:
- Silicon pixel detector ensures a precise vertex reconstruction.
- Silicon strip detector (SCT) provides an accurate momentum measurement.
- Transition Radiation Tracker (TRT) plays a key role for pattern recognition and for particle identification.

### The Muon Spectrometer

The muon spectrometer (MS) measures muons up to |η|<2.7 in an air-core bore which provides a mean field of 0.5 T.

Four detector technologies:
- Monitored Drift Tubes (MDT) chambers and Cathode Strip Chambers (CSC) are used for the position measurement in the bending plane.
- Resistive Plate Chambers (RPC) and Thin Gap Chambers (TGC) provide the muon trigger and the position measurement in the non-bending plane.

### ATLAS Muon Types

- Strip Chambers (CSC): are used for the position measurement in the non-bending plane.
- Monitored Drift Tubes (MDT): chambers and Cathode Strip Chambers (CSC) are used for the position measurement in the bending plane.
- Resistive Plate Chambers (RPC): and Thin Gap Chambers (TGC) provide the muon trigger.

### Muon Activities During the Long Shutdown (LS1)

The long shutdown (LS1) will last about 2 years, from February 2013 to November 2014. Many activities will take place during this period:
- New ReadOut Drivers (RODs) for the CSCs, in order to reach a LVL1 trigger rate of 100kHz.
- New EE chambers will be installed and aligned on site (side A).
- Upgrade of the bottom region of the spectrometer (2 middle barrel chambers (BM) and 2 outer barrel chambers (BO) to recover acceptance loss).
- As reinforcement of the alignment system in Sector 12 and 14, new alignment bars in the barrel will also be installed.
- Activation of additional RPC chambers in fast region, increasing the trigger acceptance by 2.8%.
- Important maintenance of the gas system will be performed including repairs of the leaks due to broken gas inlets on chambers (in MDT and RPC) and hardening of the same.
- BEE chambers will link to the endcap alignment system (EES1/2 and EIS2) through additional alignment sensors.

### Muon Reconstruction Efficiency

J/ψ, Y and Z boson dimuon decays are processes with well known decay properties, especially useful for the muon performance measurement. They are the key ingredient for studying the muon reconstruction efficiency (as explained below) and resolution (column on the right).

The muon reconstruction efficiency is measured using a tag-and-probe method based on J/ψ and Z events. The technique allows to derive data/MC efficiency scale factors that are applied in physics analyses to correct the simulations.

Smearing and scale corrections that have to be applied to Monte Carlo simulations are derived via a fit to the dimuon invariant mass distribution at the Z pole region. This procedure guarantees an accurate description of muon momentum resolution and scale. The plot below shows the effect of smearing corrections (further improvements are being used for Moriond 2013 analyses).

The reconstructed mass scale offset is monitored using J/ψ, Y and Z decays into muon pairs, and comparing a fit to the observed mass with respect to the nominal PDG value. The plot below shows that this scale offset is found to be smaller than 1% for the full range of the leading muon. The results obtained with the three methods agree with each other.

### Data Quality 2012

To define a good dataset, suitable for physics analyses, Data Quality (DQ) information is derived through the use of dedicated lists of runs and luminosity blocks, known as “good run lists”.

A good run list is formed by DQ flags, obtained for each luminosity block by applying DQ criteria as issued by each sub-detector and the combined performance groups. Thanks to a constant detector maintenance, almost 100% of the acquired data was flagged as “good” throughout the 2012 run.

For combined muons, three different reconstruction chains are used in ATLAS:
- 1st CHAIN: combines an inner detector track with a muon spectrometer track using a statistical method.
- 2nd CHAIN: combines an inner detector track with a muon spectrometer track using a global refit of the two tracks.
- 3rd CHAIN: newest chain, combination of the previous two. It will soon become the default combined muons reconstruction chain.

Great efforts were made to put realistic alignment and resolution into the simulation. A comparison of the dimuon invariant mass in the Z peak region between data and Monte Carlo shows, in general, good agreement, with some small residual discrepancies due, for example, to imperfect description of the detector material in the MS, to residual misalignments in the ID, etc...