**Performance of the ATLAS Muon Spectrometer in Run II**

Despoina Sampsonidou, on behalf of the ATLAS Collaboration

XIIth Quark Confinement and the Hadron Spectrum, Thessaloniki, Greece, 28th August – 4th September 2016

---

**Inner Detector & Muon Spectrometer**

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

The Muon Spectrometer provides precise measurement of muon momenta up to the TeV range, covering the pseudorapidity range $|\eta| < 2.7$ 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

---

**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**

$n<2.5$: The reconstruction efficiency is measured using a tag-and-probe method on Zmumu and Jpsi muon events:

- Selection of an almost pure muon sample from $J/\psi \rightarrow \mu\mu$ or $Z \rightarrow \mu\mu$ 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 $p_T > 100$ GeV

$J/\psi$ 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.

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

---

**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 parametrization is validated by comparing the position and resolution of $Z$ and $J/\psi$ invariant mass distribution observed in Run II data.

Transverse momentum scale as a function of pseudorapidity from $Z \rightarrow \mu\mu$ and $J/\psi \rightarrow \mu\mu$ samples

Transverse momentum resolution as a function of pseudorapidity from $Z \rightarrow \mu\mu$ and $J/\psi \rightarrow \mu\mu$ samples

---

**Top left:** Measured reconstruction efficiency for varying $p_T$ of the ATLAS muon spectrometer for Loose muons, from $Z \rightarrow \mu\mu$ sample

**Bottom left:** Muon reconstruction efficiency as a function of the transverse momentum

**Right:** Double ratio for the forward muons for varying phi