Measurement of the performance of the muon reconstruction in ATLAS

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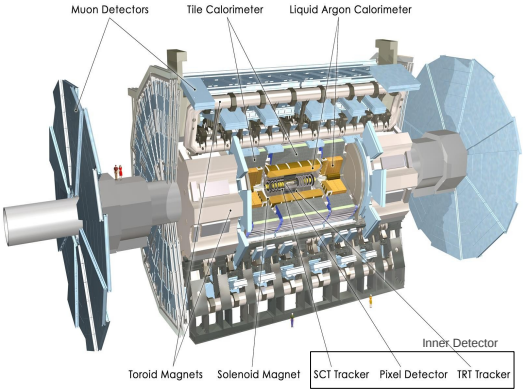
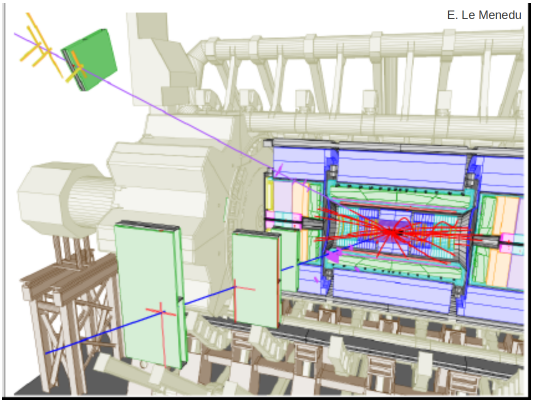
Muon identification with the ATLAS detector





Reconstruction strategies

Combined

- Use ID+MS
- Best momentum resolution

Standalone

- Use MS only
- Extend acceptance to $|\eta| < 2.7$

Segment tagged

- ID track tagged from MS
- Increase efficiency in poorly instrumented regions

Efficiency measurement: the Tag and Probe method

To measure muon reconstruction efficiency, dimuons decay of Z, J/ψ are used.
The total reconstruction efficiency can be factorized as $\epsilon^{reco} = \epsilon^{MS}\epsilon^{comb}\epsilon^{ID}$
Its measurement is performed in two steps, using the Tag and Probe method:

- One combined muon: TAG
- One track on the other side of the detector: PROBE

$\rightarrow$ Search for a reconstructed muon track associated to the probe: MATCH

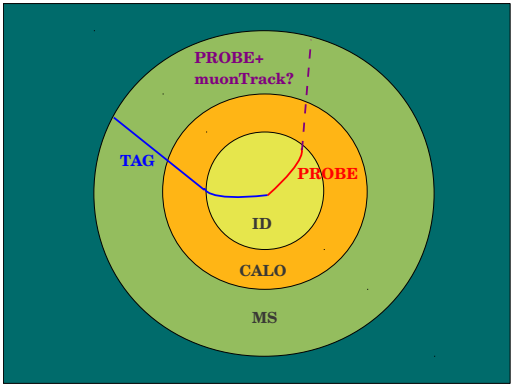
$$\epsilon = \frac{N^{Matched}_{Probes}}{N_{Probes}}$$

measure of $\epsilon^{MS}\epsilon^{comb}$

- Inner Detector track as probe
- Combined track as match

measure of ϵ^{ID}

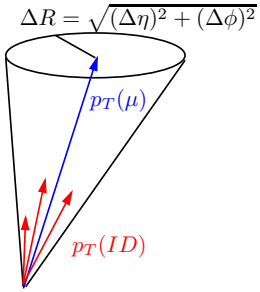
- Muon Spectrometer track as probe
- Inner Detector track as match



An example, with Inner Detector tracks used as probe and combined tracks as matching tracks

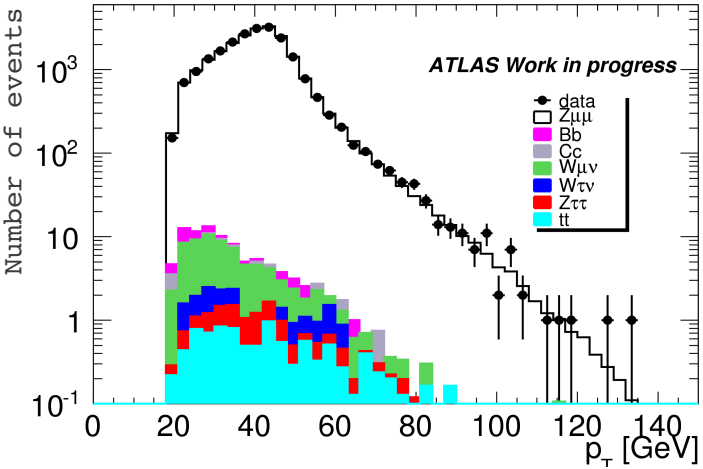
First step: measure $\epsilon^{MS}\epsilon^{comb}$ using Inner Detector tracks as probe:

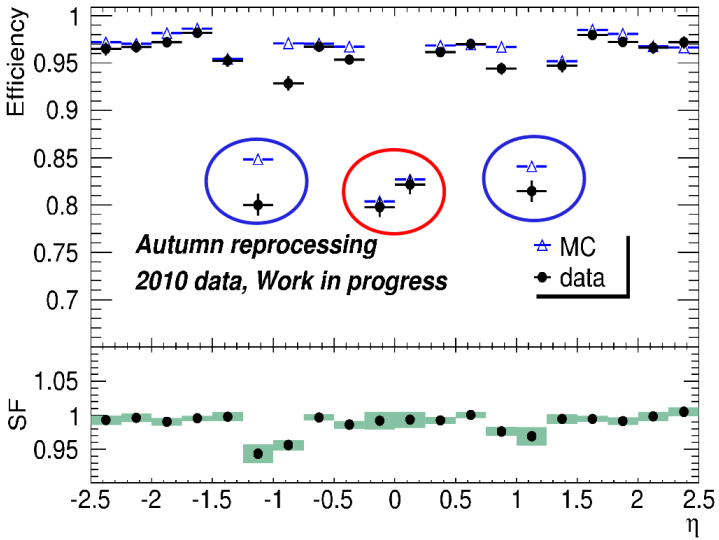
- Vertex with 3+ tracks (avoid cosmic background)
- TAG - Combined muon
  - $p_T > 20\ GeV$, $|\eta| < 2.4$
  - Muon fired trigger (to avoid biased efficiency)
  - Isolation cut: $\frac{\sum p_T^{\Delta R<0.4}}{p_T^{\mu}} < 0.2$
- PROBE - Inner Detector track
  - From same vertex as tag
  - Opposite charge
  - $p_T > 20\ GeV$, $|\eta| < 2.5$
  - Isolation cut: $\frac{\sum p_T^{\Delta R<0.4}}{p_T^{IDtrk}} < 0.2$
  - Invariant mass: $|m_{\mu\mu} - m_Z| < 10\ GeV$
  - Azimuthal separation of tag and probe tracks, $|\Delta\phi| > 2$
- MATCH - Combined Track associated to Probe
  - $\Delta R < 0.1$ between probe track and reconstructed muon



Sample	Contribute
$Z \longrightarrow \mu\mu$	99.62%
$W \longrightarrow \mu\nu$	0.21%
$b\bar{b}$	0.059%
$t\bar{t}$	0.042%
$W \longrightarrow \tau\nu$	0.029%
$Z \longrightarrow \tau\tau$	0.025%
$c\bar{c}$	0.021%

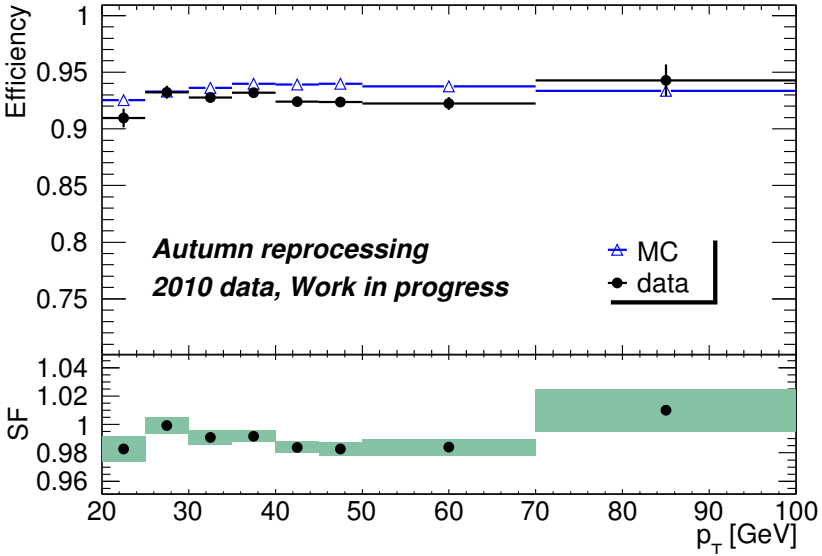
- High purity sample of $Z \longrightarrow \mu\mu$ is selected
- Small background contribution, most of it at low p_T
- Good data-MC simulation agreement





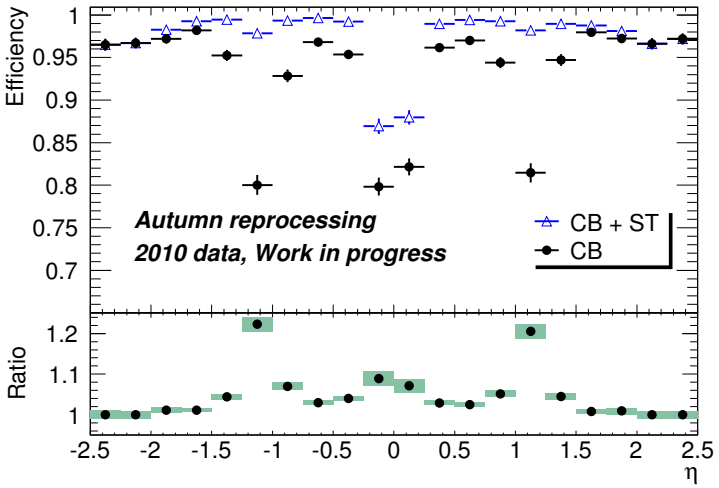
Efficiency vs η

- Data/MC ratio (Scale Factor, SF) flat and compatible with 1
- $|\eta| \approx 0$ Acceptance gap to allow space for services
- $|\eta| \approx 1.1$ Region with not enough chambers to provide momentum measurement in the Muon Spectrometer
- Inefficiency in those regions can be recovered with different reconstruction strategies



Efficiency vs p_T

- Efficiency very flat in p_T
- Very good agreement with MC simulations

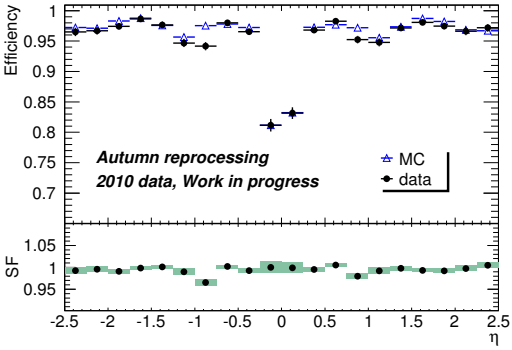


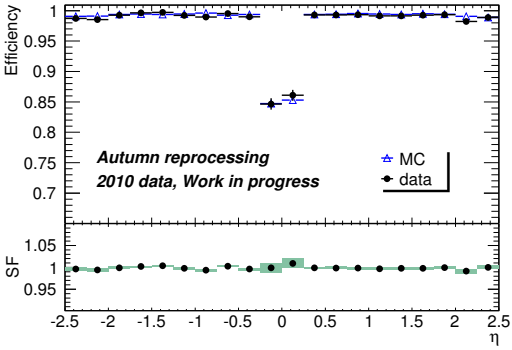
Efficiency recovery with Segment Tagged muons

- Adding Segment Tagged (ST) muons to Combined (CB) muons allow for a recovery of the efficiency in the poorly instrumented regions
- Full recovery around $|\eta| \approx 1.1$
- Partial recovery around $|\eta| \approx 0$
- CB+ST muons are the ones that will be used in physics analysis on 2010 and 2011 data

Efficiency with different muon tightness definition

Both plots show Combined + Segment Tagged muons.



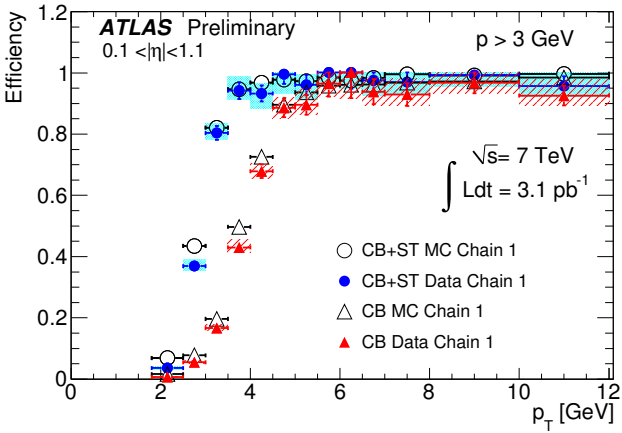


Tighter definition of muons

- High efficiency in the whole detector
- Very good agreement with MC

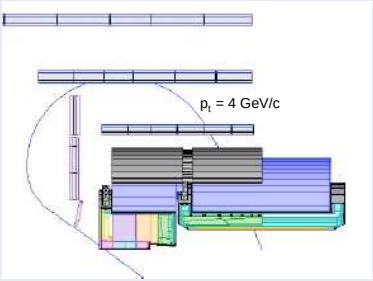
Looser definition of muons

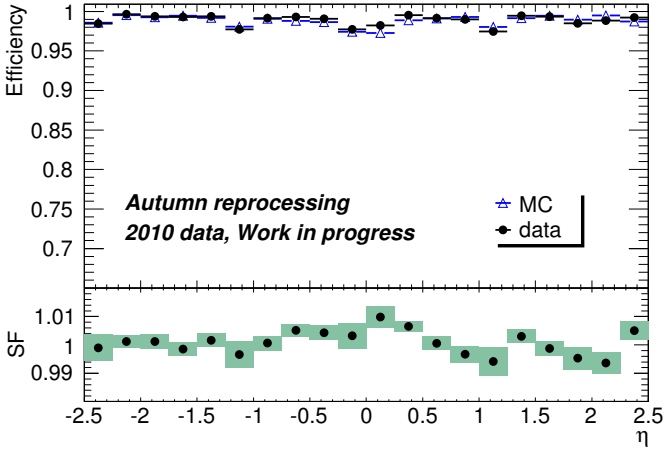
- Very high efficiency in the whole detector
- Perfect agreement with MC
- Efficiency flat in the whole detector (apart from acceptance gap at $\eta \approx 0$)



Efficiency at low p_T

- To study efficiency at low p_T , $J/\Psi \longrightarrow \mu\mu$ is used
- Allow for a measurement of the efficiency turn on curve
- Adding Segment Tagged muons to the Combined rises the efficiency especially for very low p_T muons





Inner Detector efficiency

- Average efficiency, $99.1\% \pm 0.1\%$
- Data/MC ratio compatible with 1 within less than 1%

Conclusions

- The muon efficiency was measured on data using the Tag and Probe method on dimuons decay of Z and J/Ψ
- Muons can be identified down to $p_T \approx 4\ GeV$
- Constant efficiency for $p_T > 6\ GeV$: $97.2\% \pm 0.2\%$
- Data and MC simulation in agreement between statistical error