HCP Poster Session - Paris, November 2011

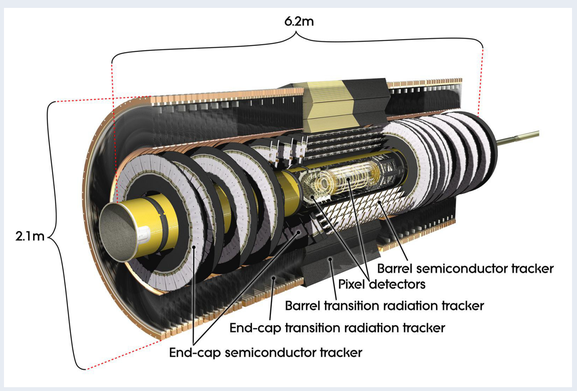
Measurement of muon momentum resolution of the ATLAS detector

Abstract

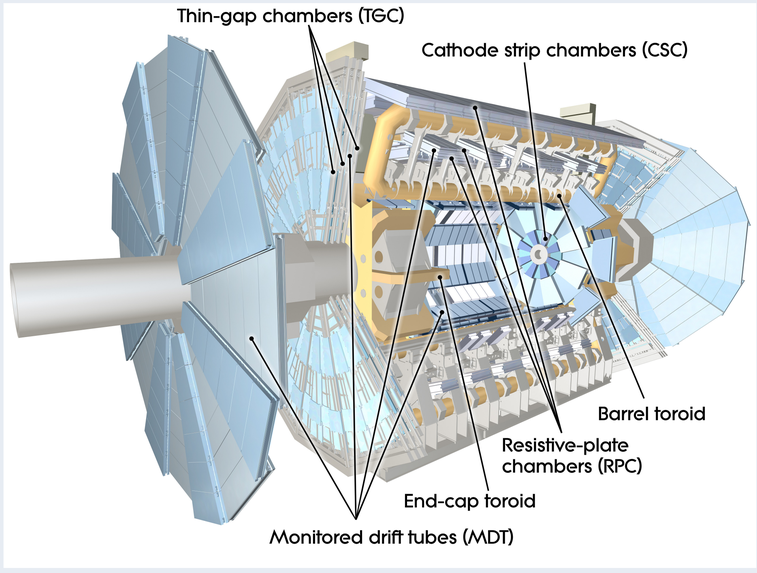
The ATLAS detector has been designed to have good muon momentum resolution up to momenta in the TeV range. The muon momentum resolution of the ATLAS spectrometer has been measured with p-p collision data recorderd in 2011. The measurement combines the dimuon mass resolution in $J/\psi \to \mu\mu$ and $Z \to \mu\mu$ decays with measurements of the alignment accuracy of the detector based on straight muon tracks, which are acquired with special runs without magnetic field in the ATLAS detector.

ATLAS Inner Detector

- Inside solenoid (2T)
- *Pixels, SemiConductor Tracker* (SCT), *Transition Radiation Tracker* (TRT)
- **Coverage** $|\eta| < 2.5$, except TRT ($|\eta| < 2.0$)



ATLAS Muon Spectrometer



- Use a toroidal field (about 0.5T)
- **Precision chambers**

  Monitored Drift Tube (MDT)

  3 layers for $|\eta| < 2.0$, 2 layers for $2.0 < |\eta| < 2.5$

  Cathod Strip Chambers (CSC)

  1 layer (inner) for $2.0 < |\eta| < 2.5$
- **Trigger chambers**

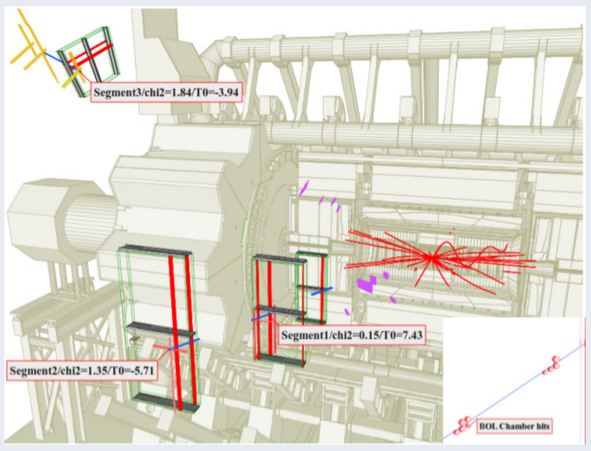
  Resistive Plate Chamber (RPC) in $|\eta| < 1.05$

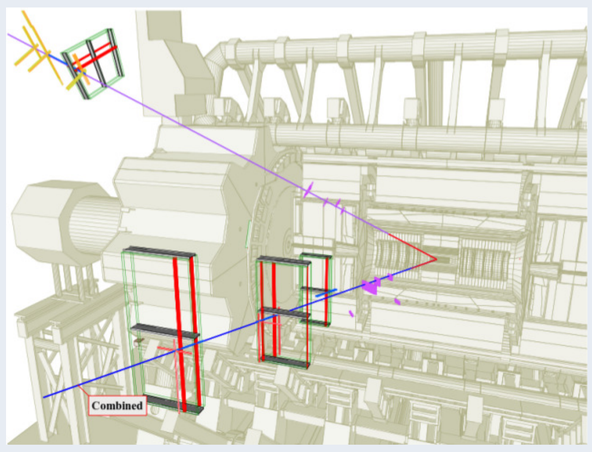
  Thin Gap Chambers (TGC) in $1.05 < |\eta| < 2.7$
- **Total coverage** $|n| < 2.7$

Muon Reconstruction principles

Standalone tracks

The track is ***entirely reconstructed in the MS***, from trigger chambers hits and segments reconstructed in the precision chambers.
The track is then extrapolated to IP and the muon momentum is corrected for the energy loss due to the material crossed before reaching the MS.





Combined tracks

The combined muon tracks results of the ***combination of MS and ID measurements*** by a statistical combination, or a refit of the entire track.
Energy losses in the calorimeter are taken into account using parametrisation and possibly calorimeter measurements.

The Fit Procedure

The muon momentum resolution can be determined from the **Z lineshape** in the process $pp \to Z \to \mu\mu$ with **data driven techniques**.

In ATLAS we perfomed a *'Global' Fit* procedure using:

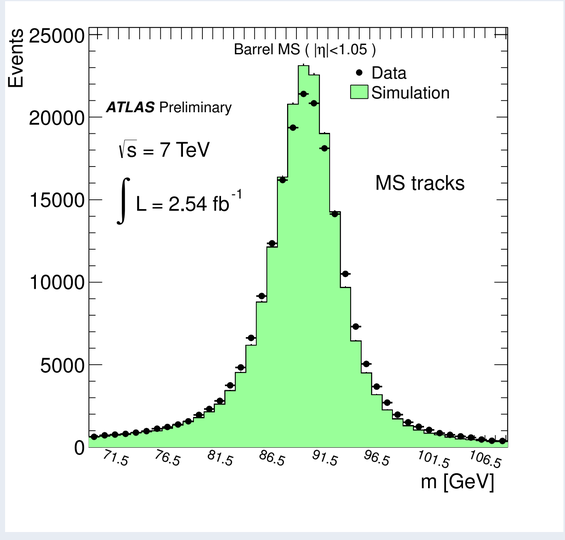
i) **Template-fit to reconstructed Z lineshape**
- ◇ allow for momentum smearing in the fit
- ◇ combined fit with events with muons in different detector regions
- ◇ fit separately Z lineshape obtained from MS and ID tracks
- ◇ sensitive to $\sigma_{mult.scat.} \oplus \sigma_{intrinsic}$

ii) **+ template-fit to $\left(q/p_T^{ID} - q/p_T^{MS}\right)$ distribution**
- ◇ same procedure as above
- ◇ fit several bins of p_T keeping regions separated
- ◇ sensitive to $\sigma_{ID} \oplus \sigma_{MS}$

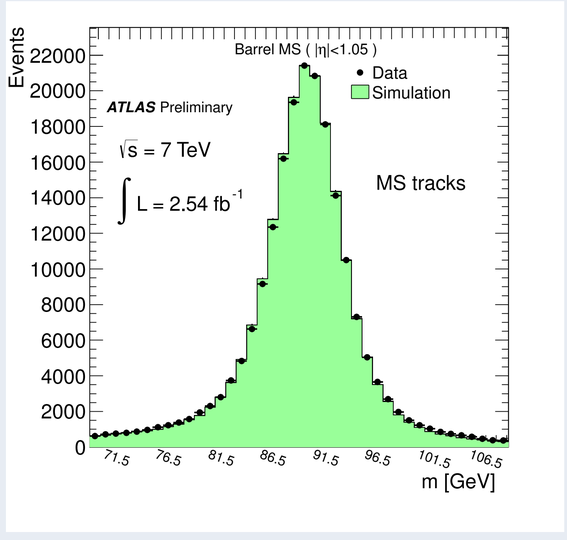
iii) use **constraints on MS alignment** from straight tracks measurements

Smearing of ID and MS momenta: $p_T = p_T\left(1 + g\Delta b + g\Delta a^{ID,MS} p_T\right)$ with g a gaussian number (0,1).

Examples of Z lineshape fit for MS tracks in the Barrel region:



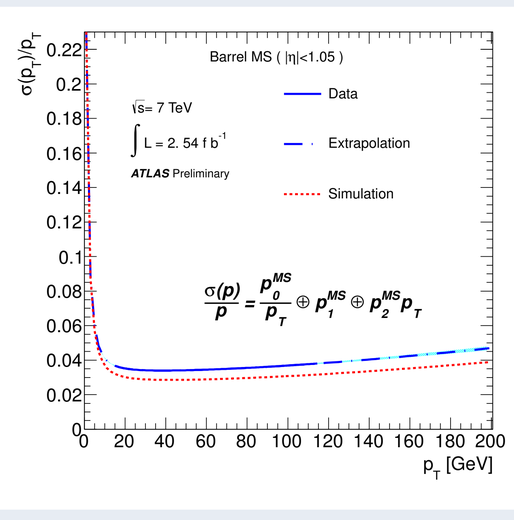
a) **before fit**

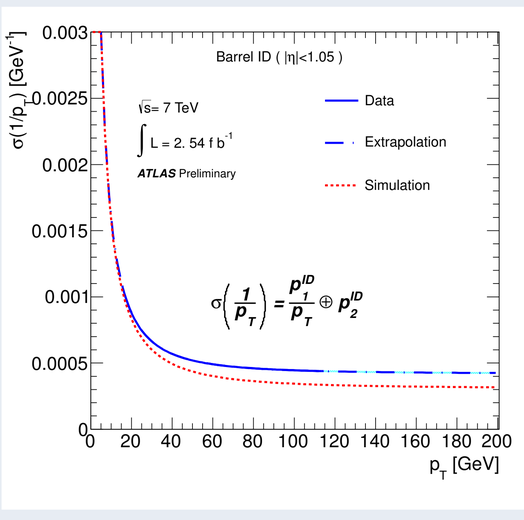


b) **after fit**

Momentum Resolution Results

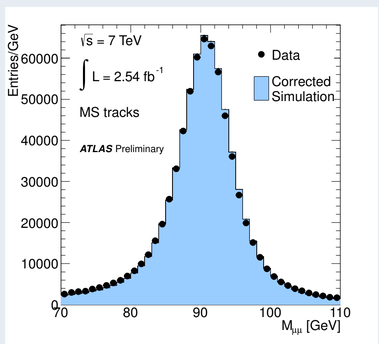
Results of the fit procedure are the resolution parameters and the smearing function.

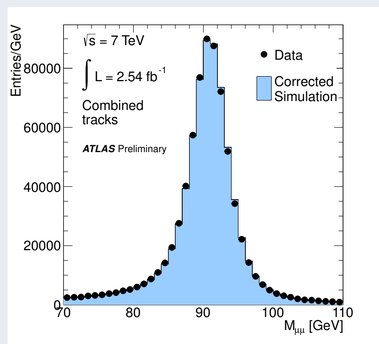


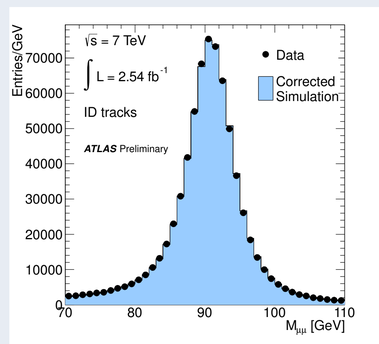


Main Contribution and results for the Barrel region

	p_0 (TeV) energy loss	p_1 (%) multiple scattering	p_2 (TeV^{-1}) intrinsic resolution
ID	n.a.	1.550 ± 0.005	0.417 ± 0.011
MS	0.250 ± 0.003	3.27 ± 0.05	0.168 ± 0.016







Conclusions

- The muon momentum resolution is well measured
- Improvement of the alignment with respect to 2010

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