Alignment of the ATLAS Muon Spectrometer with Tracks

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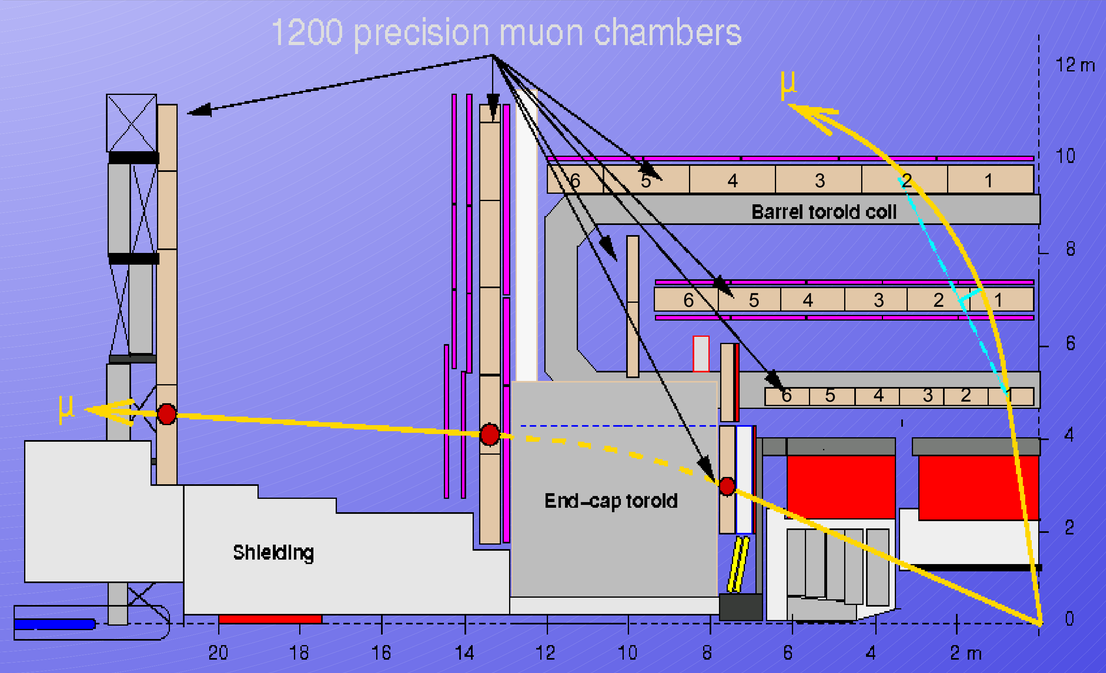
Muon spectrometer

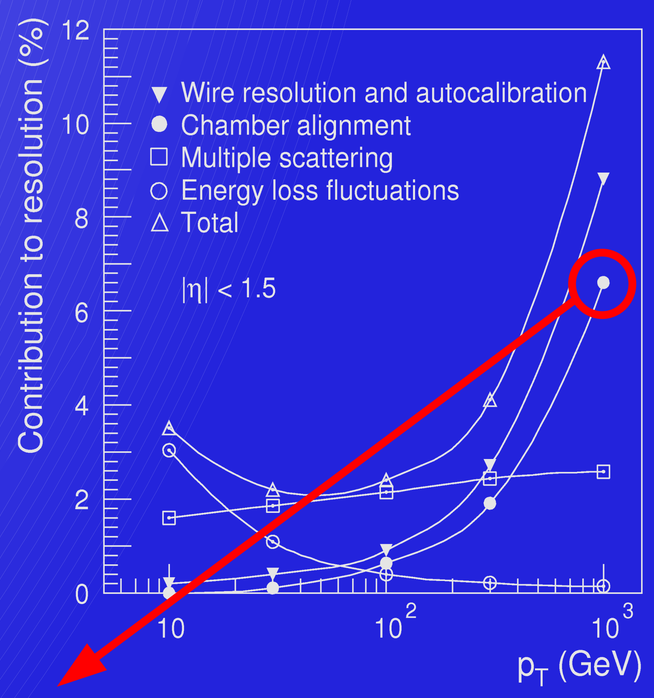


Air core toroid magnet to minimize multiple scattering:
barrel: B = 0.15 – 2.5 T end-caps: B = 0.2 – 3.5 T

Momentum resolution

Resolution goal:
~10% at p=1 TeV/c

- muon track sagitta: ~500μm
- contribution from MDT tube resolution: ~40μm
- contribution from MDT chamber alignment: ~30μm



Muon chamber alignment accuracy: ~30 μm

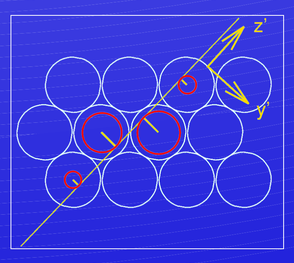
Alignment with straight tracks

MILLEPEDE method (V.Blobel http://www.desy.de/~blobel/mptalks.html) is used.

- Chamber positions and rotations are determined by minimizing global $\chi^2 = \sum_{hits\ k} \frac{(R_k - D_k)^2}{\sigma_k^2}$ simultaneously in the alignment and track parameters.

  R_k: drift radius of the *k*-th hit;
  D_k: distance from the track to the wire of the *k*-th hit.

- Linearization of the Euclidian distance D_k is applied:

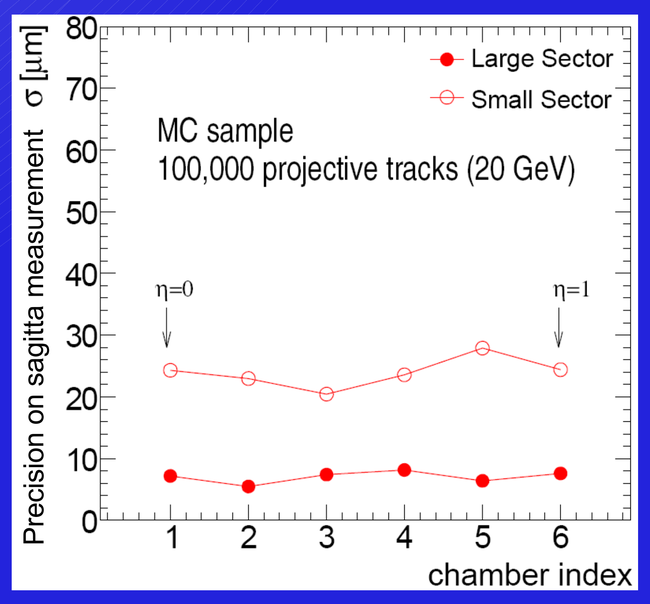


$$D_k = \boldsymbol{d}_k^T \boldsymbol{a} + \boldsymbol{\delta}_k^T \boldsymbol{\alpha}$$

a, α : vectors of the alignment and track parameters

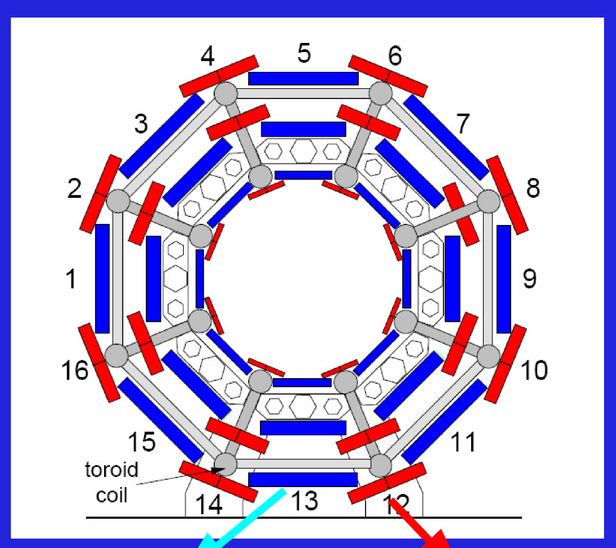
→ Analytic solution for the χ^2 minimization.

Performance on Monte-Carlo data



- 100,000 tracks per sector needed for 30 μm precision.
- Run with *pp* collisions with magnetic field switched off is planned to align the muon spectrometer.
- For 30 μm: 5 days at $L=10^{31}$ $cm^{-2}s^{-1}$.

Performance on cosmic muon data



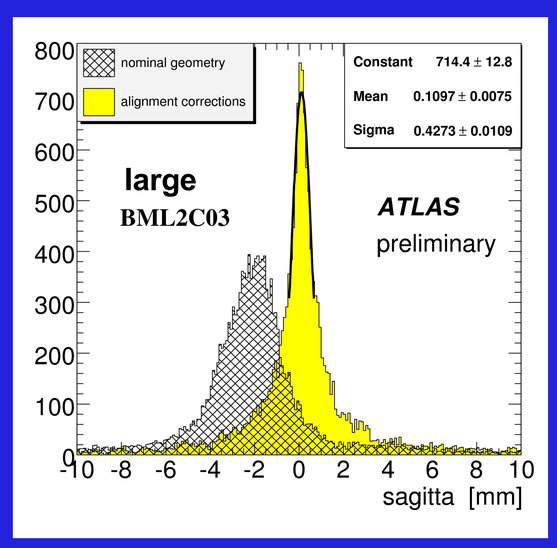
Geometry cross-check with cosmic muons:

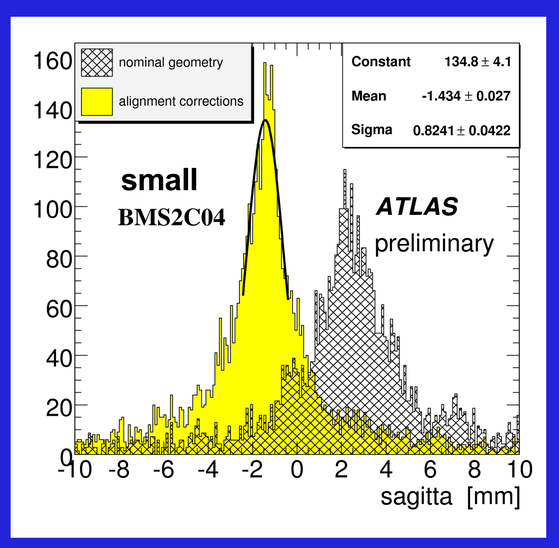
Track sagitta measured for straight cosmic muons collected with the toroid magnets switched off

- **optical corrections:**
  large sectors: ~200μm
  small sectors: ~1mm
- **track-based corrections:**
  large sectors: close to final ~30μm

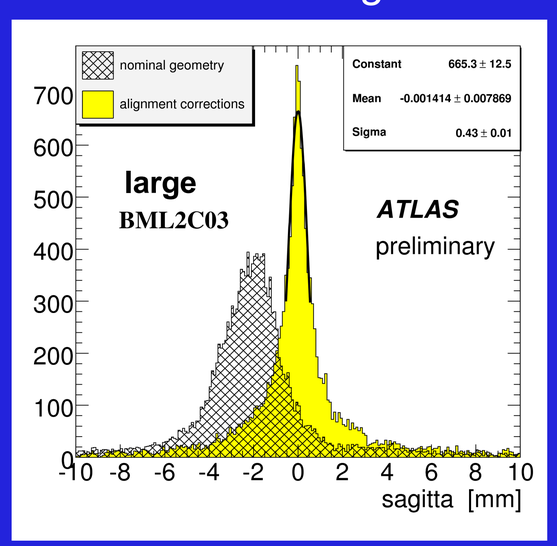
Width of the sagitta distribution after corrections is due to the multiple scattering

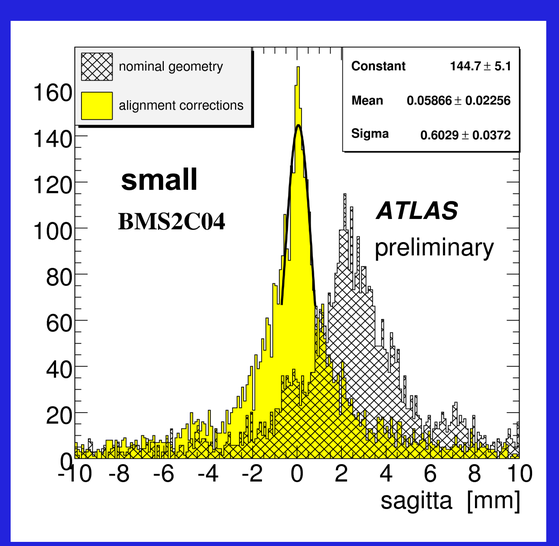
Cosmic track sagitta with the **optical** corrections





Cosmic track sagitta with the **track-based** corrections





Alignment corrections for the barrel part of the Muon Spectrometer:

- **optical:**
  - produced with the optical alignment system (top sectors from 1 to 9 for the moment)
- **track-based:**
  - produced with the 2008 cosmic data (all sectors except horizontal 1 and 9)

Alignment strategy:

- alignment with straight tracks to provide reference geometry for the optical system
- optical alignment system will work in the relative mode when magnetic field is switched on