I. Potrap, B. Bittner, S. Kaiser, O. Kortner, S. Kotov, H. Kroha,
Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München, Germany

**Alignment of the ATLAS Muon Spectrometer with Tracks**

Muon spectrometer

1200 precision muon chambers

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

**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 \( \sum R_k \) 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:
  \[ D_k \approx d_k^1 a + \delta_k^1 \alpha \]
  \( a, \alpha \): vectors of the alignment and track parameters
  \( \rightarrow \) Analytic solution for the \( \chi^2 \) minimization.

**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: \( \sim 200 \) µm
  - small sectors: \( \sim 1 \) mm
- **track-based corrections:**
  - large sectors: close to final \( \sim 30 \) µm

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

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

**Performance on Monte-Carlo data**

Cosmic track sagitta with the optical corrections:

- 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\(^{-1}\).

Cosmic track sagitta with the track-based corrections