Multiple Scattering Effects on Alignment with Straight Muon Tracks

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Calibration runs with toroid field switched off

Goal

use straight muon tracks to obtain corrections for optical projective alignment system sensor mispositioning in order to get the required overall alignment accuracy of 30 μm

Caveat

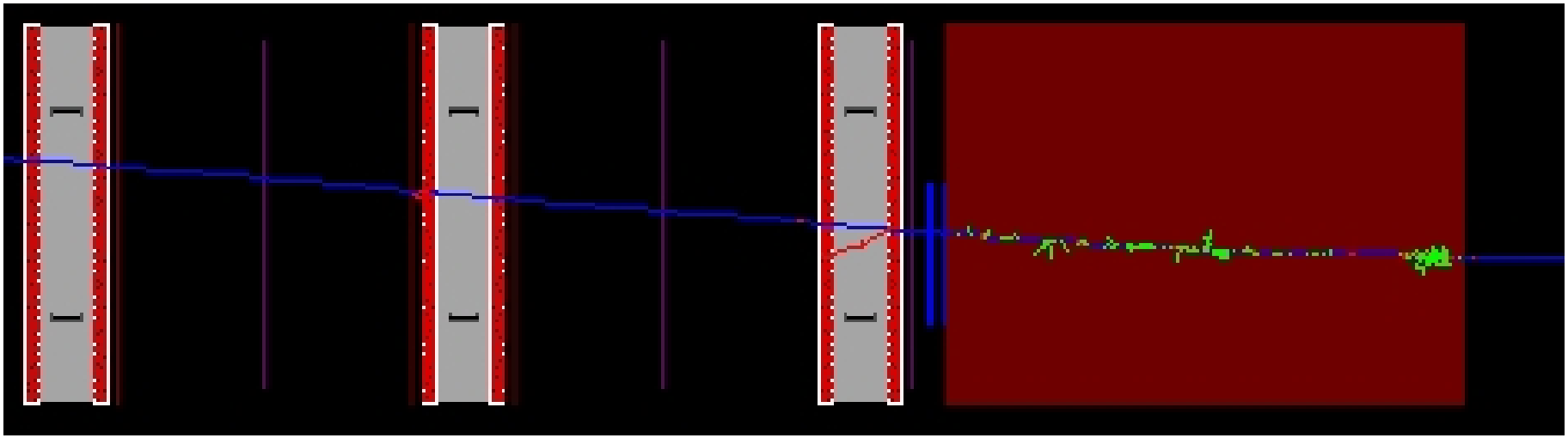
high p_t muon tracks should be used in this procedure to minimize effects from multiple scattering $\Rightarrow$ how to select high p_t muon tracks in absence of the magnetic field?

Quick study at MPI

Estimate effects of multiple scattering on straight track parameters using a simplified MC simulation

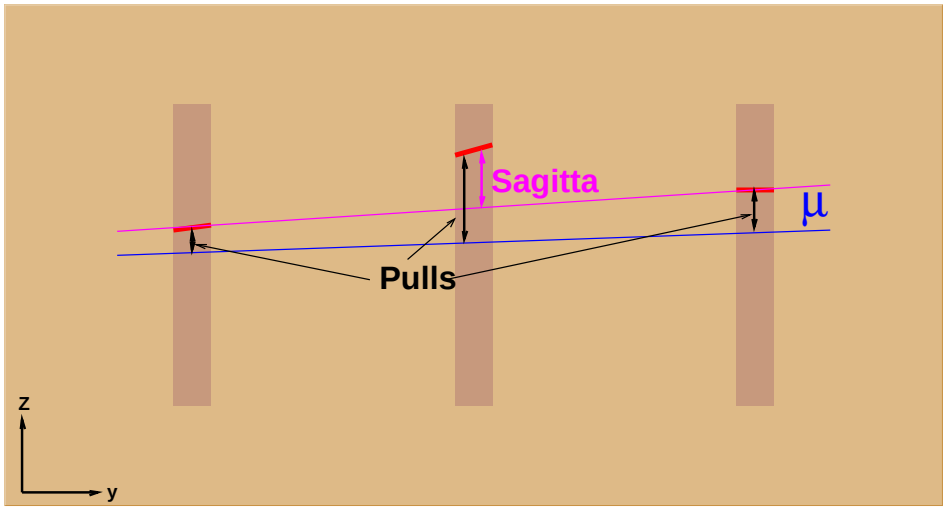
Simulation detector layout

mtGeant4 and mt-offline programs (both developed for LMU-MPI cosmic ray test facility and X5 testbeam data analysis) were used for simulation and reconstruction

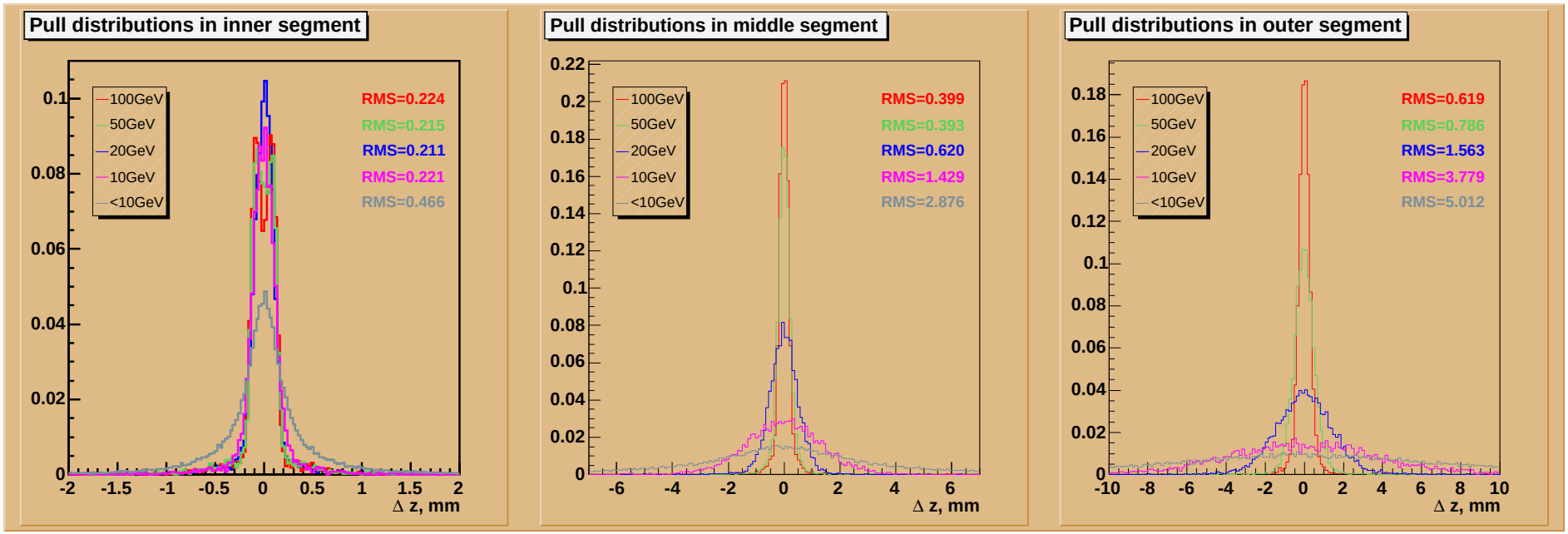


- a block of iron to simulate energy loss in calorimeters
- 3 BOS chambers separated by 2.3 m
- 14 mm of aluminum to simulate multiple scattering in RPCs
- several 10k samples of muons with energies from 4 GeV to 100 Gev were produced

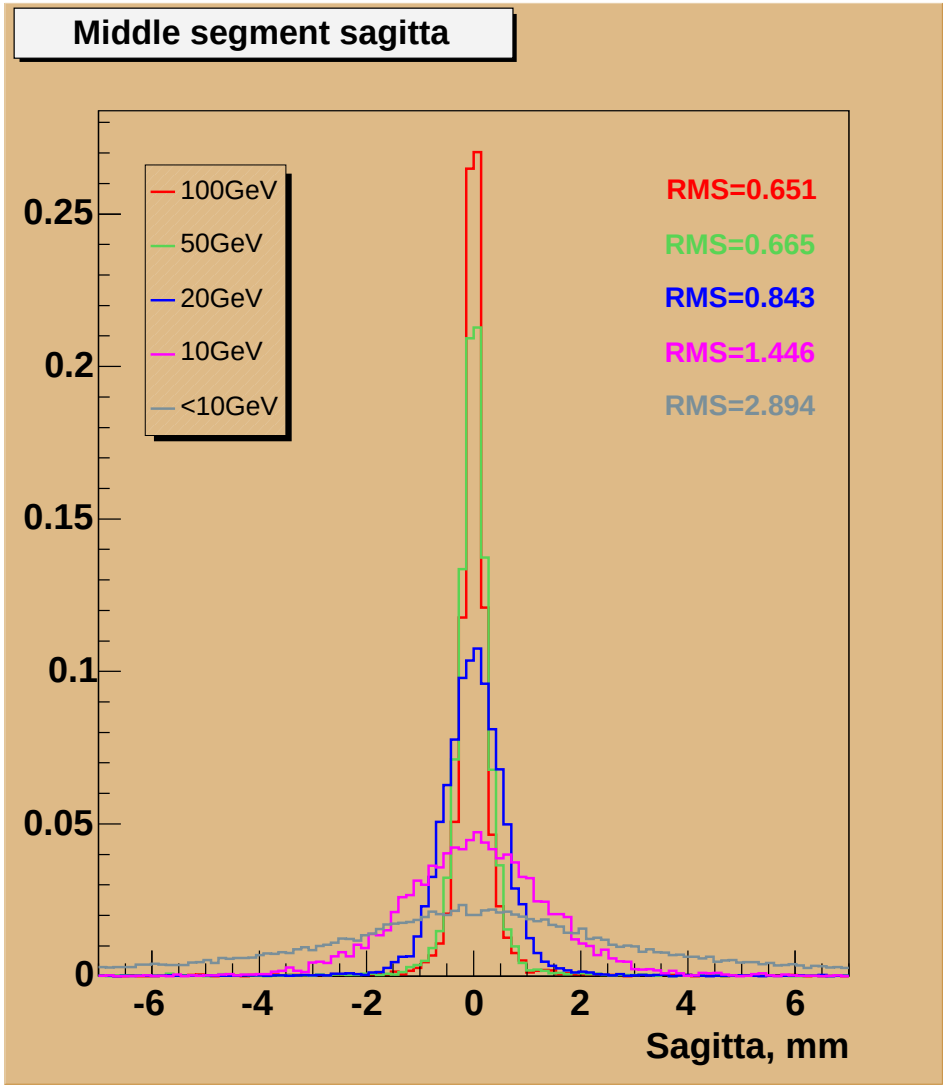
Pull distributions



- all pulls are well within the RPC trigger roads $\Rightarrow$ both high-p_t and low-p_t LVL1 trigger will fire on all tracks
- LVL2 and EF have to sort out tracks by their p_t (if needed)



Sagitta distributions



- how many track are needed to suppress multiple scattering effects if all tracks are used ($p_t > 4$GeV)
  $\sigma_{ms} = Sagitta/\sqrt{N} \Rightarrow$
  $N = (3mm/20\mu m)^2 = 22500$ (per projective tower)
- 48 towers will need 10^6 tracks
- how much of LVL2 trigger rate of 1kHz can be dedicated to muon tracks? $\Rightarrow$ 10% of it (100Hz) will mean 3 hours of data taking will be enough to get rid off multiple scattering
- TDR estimates of LVL1 single muon rates for start-up luminosity: 2.5kHz for $p_t > 6$GeV and 100Hz for $p_t > 20$GeV

Summary

- Multiple scattering doesn’t seem to pose a problem for alignment with straight tracks even with 100Hz LVL2 trigger rate for muons
- But still putting some cut on muon track sagitta in LVL2 or EF will benefit the alignment procedure