



Simulation of disk/wheel alignment with systematics studies

Jim Pivarski, Alexei Safonov

Texas A&M University

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Advertisement: Available data in 1_5_2

- ▶ 5000 $Z \rightarrow \mu\mu$

/castor/cern.ch/user/p/pivarski/AICaRecoMu/1_5_2/zmumu.root
(this is what I used for the following study)

- ▶ 15× more single-mu

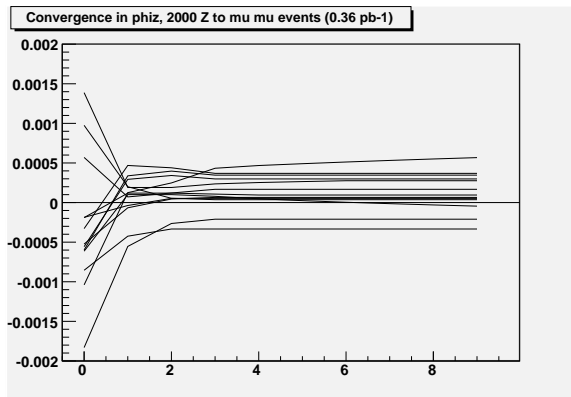
/castor/cern.ch/user/p/pivarski/AICaRecoMu/1_5_2/singlemu/*

Disk/Wheel alignment with internal misalignments

- ▶ CSC Layers $\Delta x = 191 \mu\text{m}$, $\Delta y = 335 \mu\text{m}$, $\Delta\phi_z = 40 \mu\text{rad}$
- ▶ All Chambers $\Delta x = \Delta y = \Delta z = 3 \text{ mm}$,
 $\Delta\phi_x = \Delta\phi_y = \Delta\phi_z = 1 \text{ mrad}$
- ▶ Disks/wheels $\Delta x = \Delta y = \Delta z = 1 \text{ cm}$,
 $\Delta\phi_x = \Delta\phi_y = \Delta\phi_z = 1 \text{ mrad}$
- ▶ Tracker 10 pb^{-1} scenario
- ▶ Align muon system to tracker with global Muons: x, y, ϕ_z
 - ▶ Check dependence on tracker alignment
- ▶ Nominally $2000 Z \rightarrow \mu\mu$ (0.36 pb^{-1})
 - ▶ Check dependence on statistics

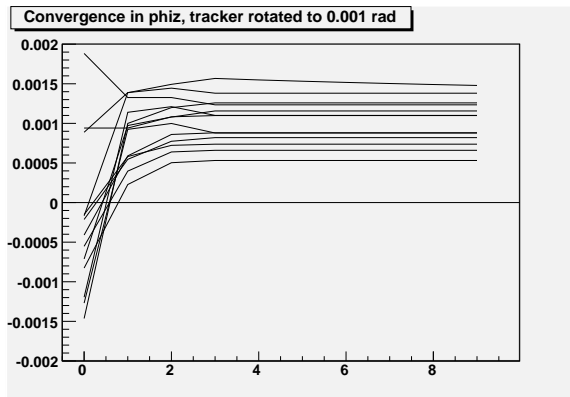
Nominal case

- ▶ Resolution is $\frac{1}{4}$ mrad due to internal misalignments
- ▶ The end of this alignment is a starting point for chamber-by-chamber alignments



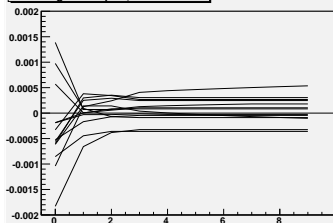
Is the simulation sensitive to tracker alignment? Yes!

- ▶ Roll tracker 1 mrad with tracks tightly fit to it
- ▶ Discovered that RPC hits will bias alignments toward ideal: we must always remove them!

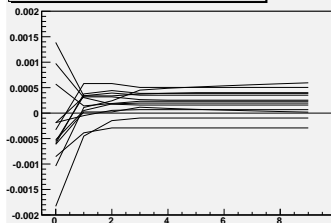


Multiply the tracker misalignment by 0, 2, 5, 10

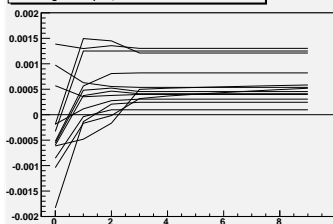
Convergence in ϕ_{Hz} , ideal tracker



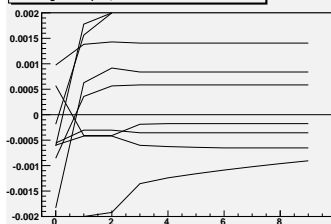
Convergence in ϕ_{Hz} , 2 times worse than short-term



Convergence in ϕ_{Hz} , 5 times worse than short-term

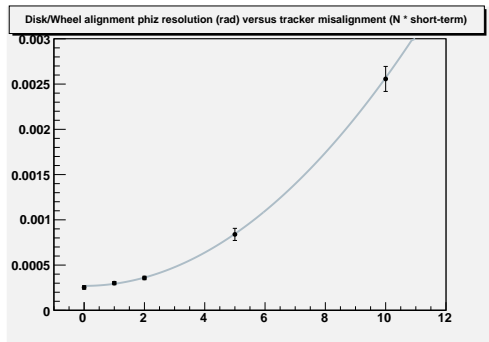


Convergence in ϕ_{Hz} , 10 times worse than short-term



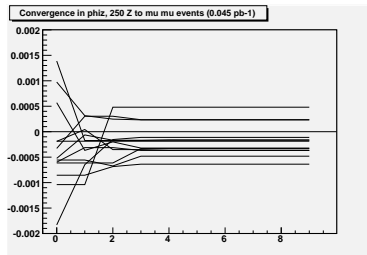
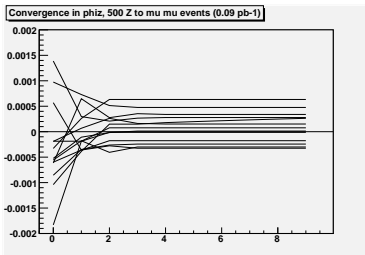
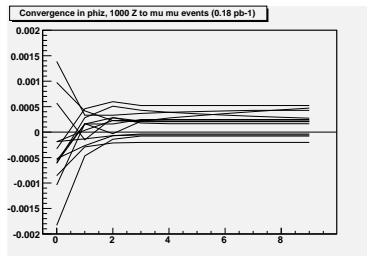
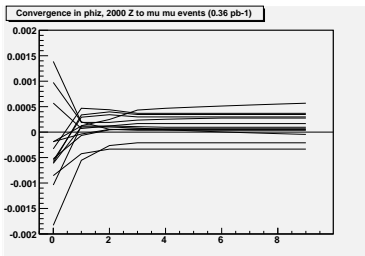
Muon alignment quality vs tracker misalignment

- RMS (not stdev!) of 13 disk/wheels times 10 trials, randomizing muon alignment with each trial



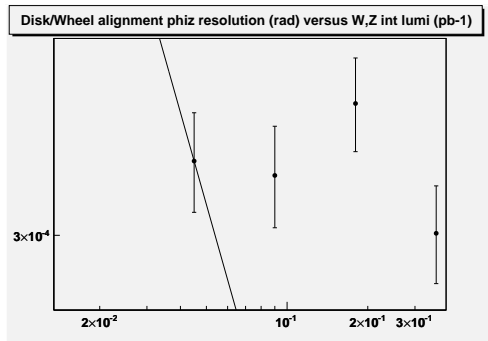
$\text{fit}(x) = 0.00027 + 0.000023x^2$ (χ^2 is too good because tracker trials are scaled up, not re-randomized)

Reduce statistics: $1\times$, $\frac{1}{2}\times$, $\frac{1}{4}\times$, $\frac{1}{8}\times$



Alignment quality vs data used

- ▶ RMS (not stdev!) of 13 disk/wheels times 10 trials, randomizing muon alignment with each trial
- ▶ Events used in each #events bin are independent.



Early brick wall comes from internal misalignments.



Conclusions

- ▶ Corrected all bugs, ready to move on to chamber-by-chamber alignments
- ▶ Disk/wheel alignments are relatively insensitive to tracker misalignment (up to a few times expected short-term level); we can rely on globalMuon method
- ▶ Chamber-by-chamber alignments ought to be more sensitive, but how much? If not much, we may consider aligning the muon system to the tracker at an early stage
- ▶ We need to be careful of RPC hits: they can bias alignments toward ideal