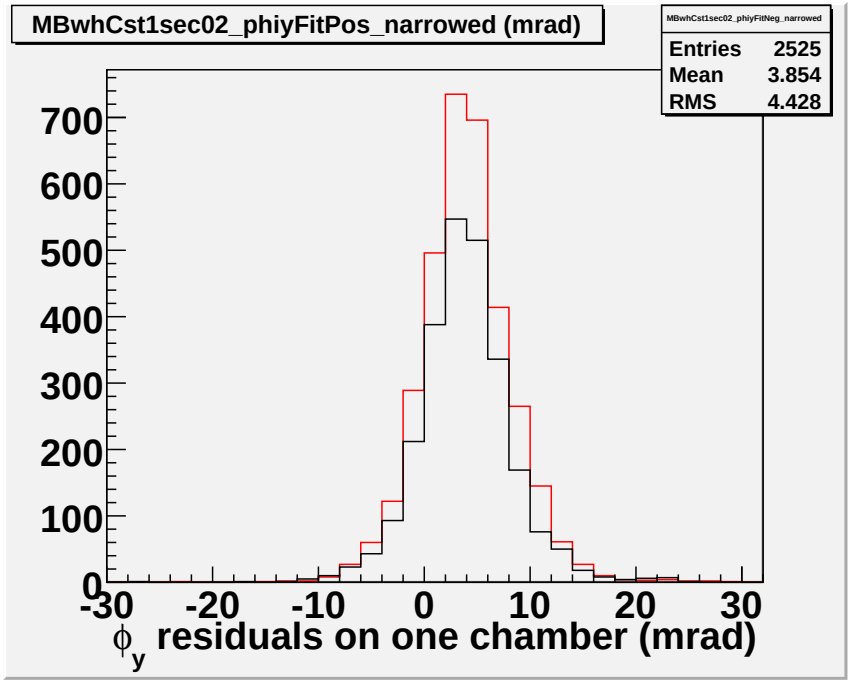
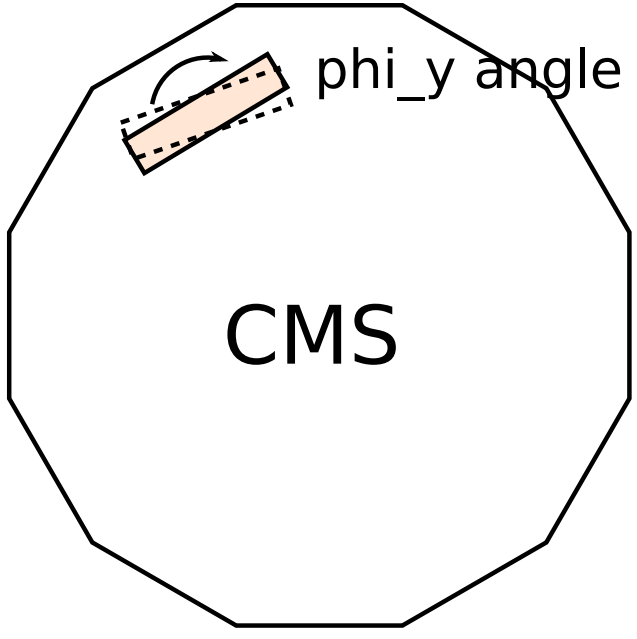
New alignment of ϕ_y angles

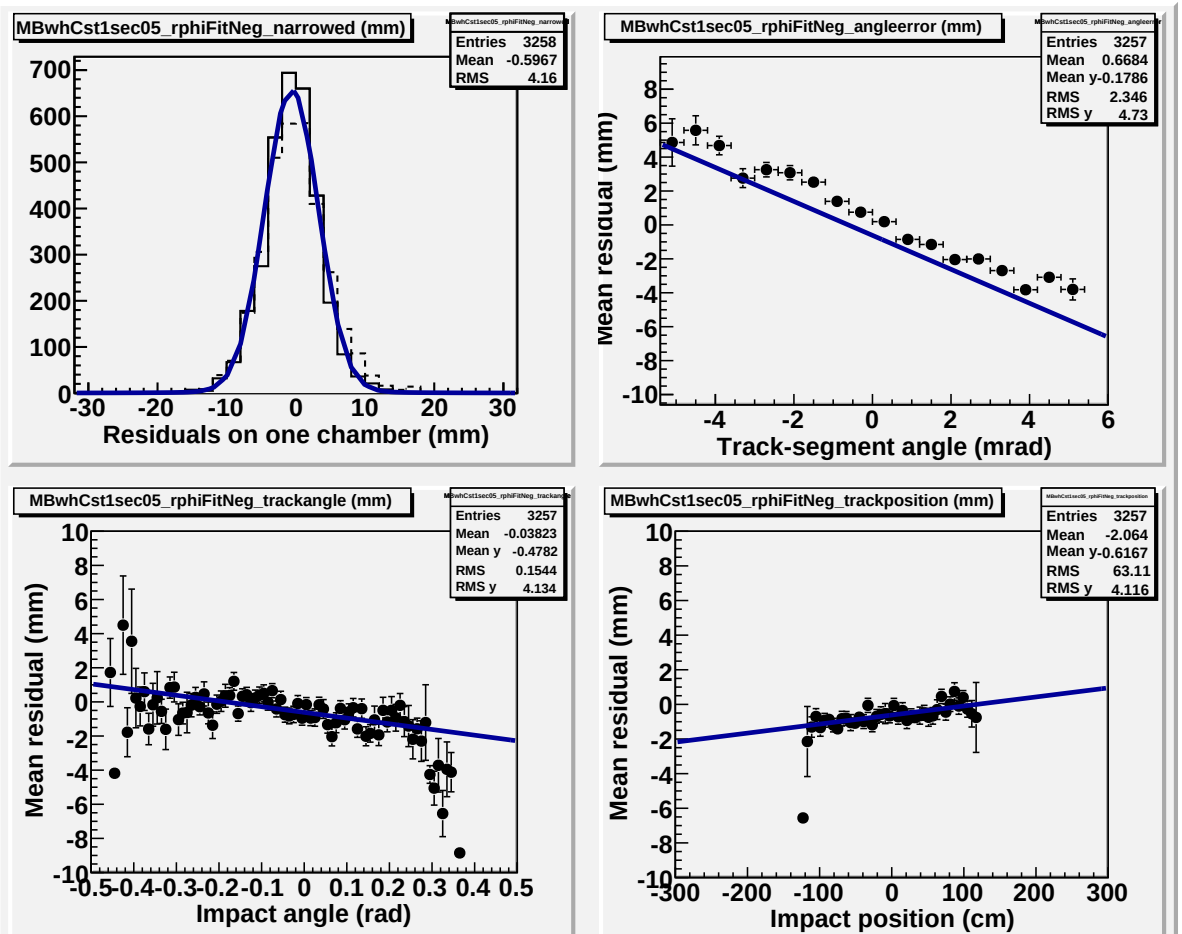
- This is the rotation angle of chambers in the transverse plane of CMS
- Important for p_T and q measurement (rotational analogue of local x translations)
- Alignment method inspired by $\vec{B}$-field measurements: track-minus-segment angle residuals
- Positive q is red, negative q is black: we see 4 mrad misalignment here



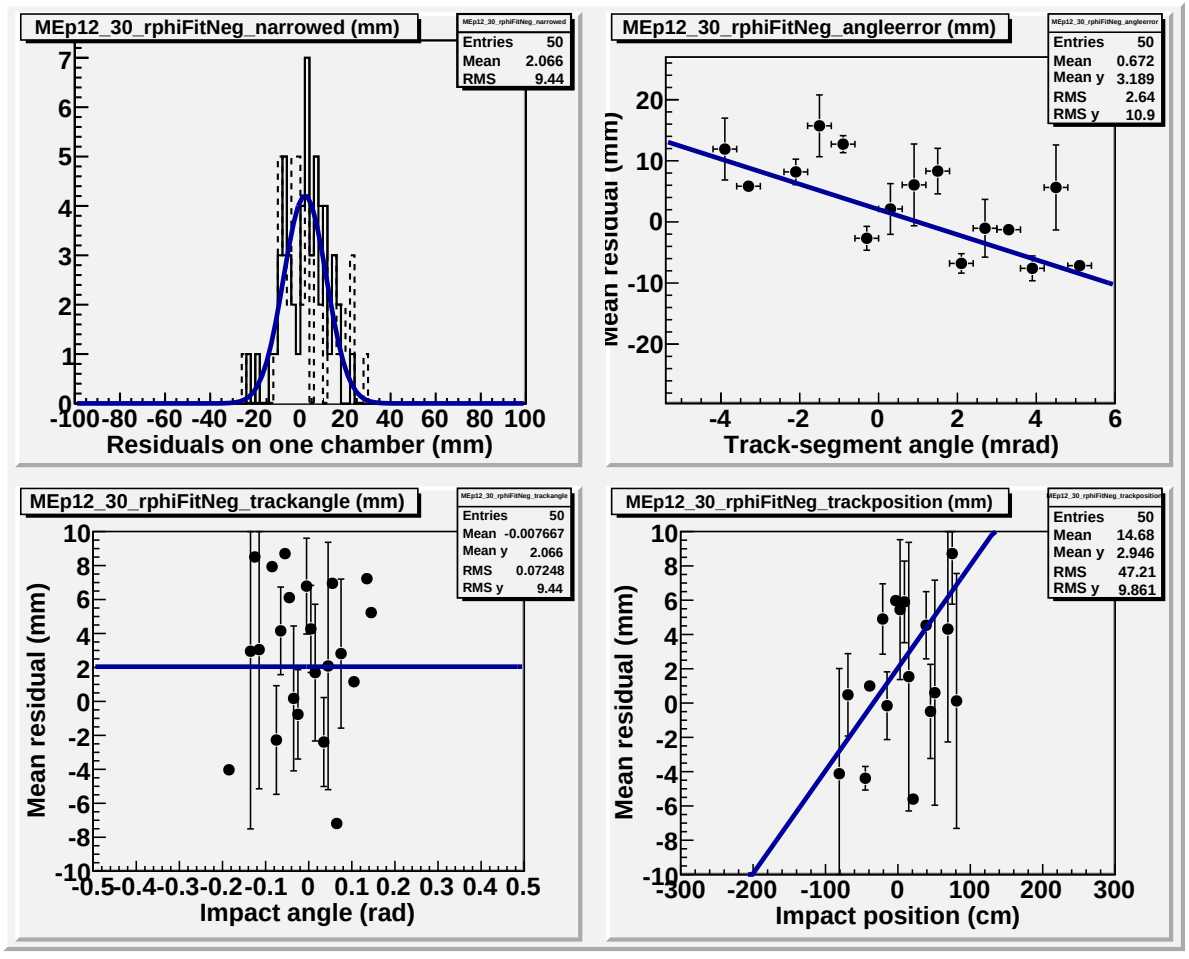


New alignment fits

- Combined fit to local x (top left), sawtooth correlation (top right), local z (bottom left), and ϕ_z (bottom right)
- Data are projections (simple profiles), line is hyperplane of fit crest
  - intersection with zero is not necessarily the mean (why we fit)
  - that's why top-right doesn't go through points



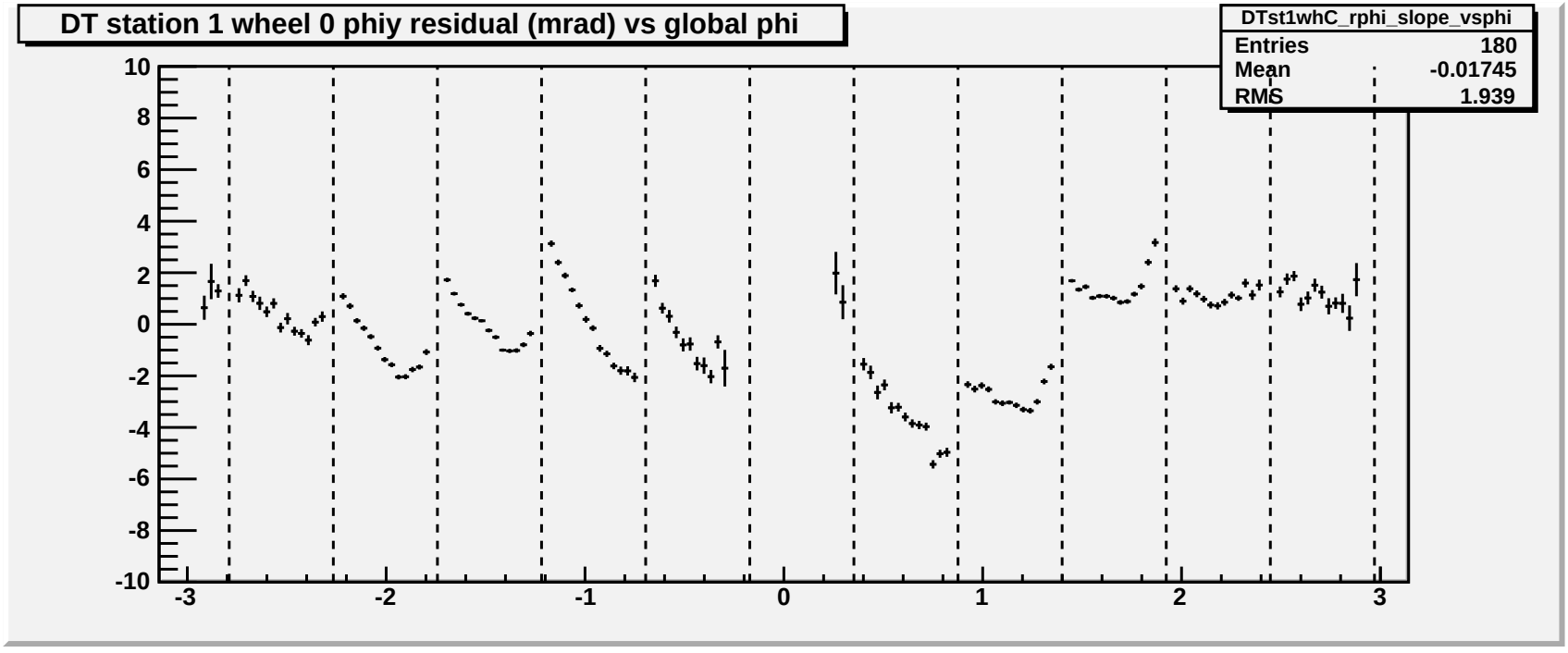
CSC example, for fun



- We can fix fit parameters (such as bottom-left, here)
- Real CSC alignment will come from tracker → barrel → endcap method
- Good to know that the machinery will work (more extensive MC tests)

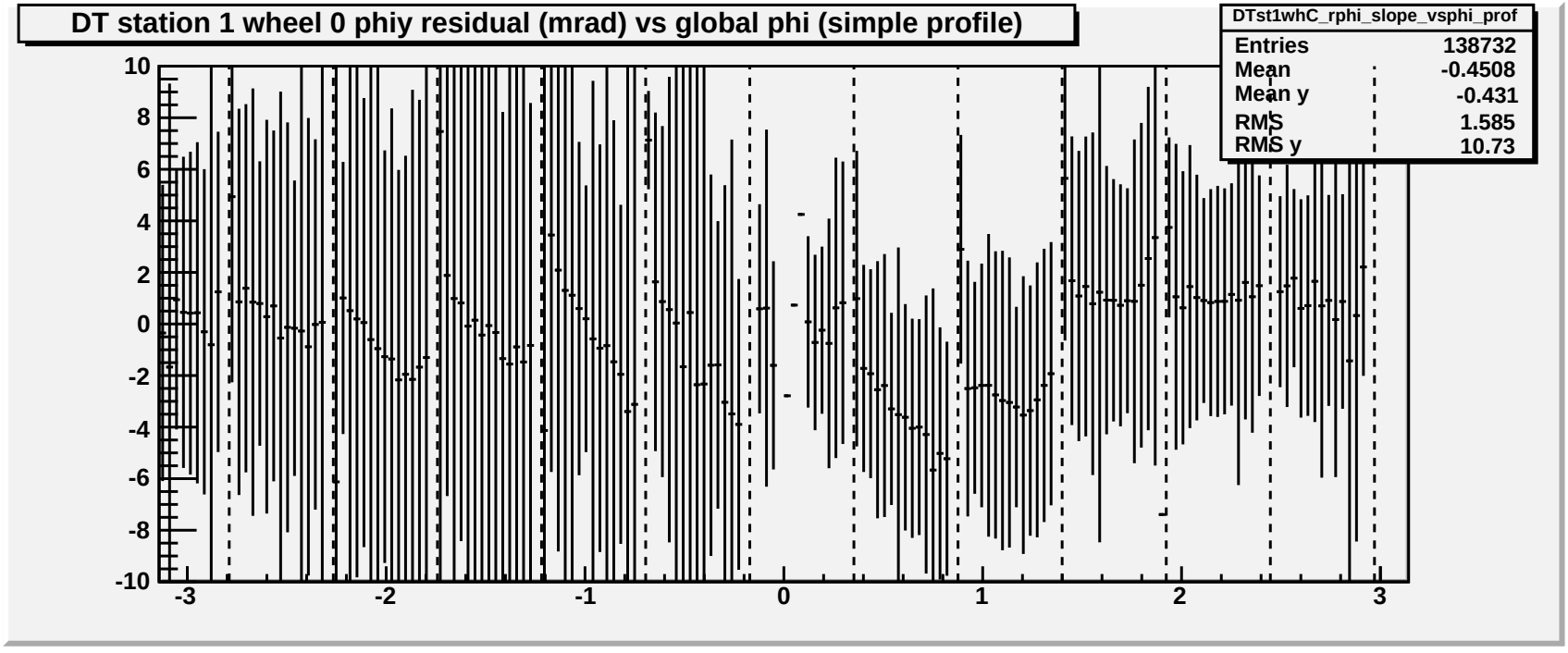
Interesting discovery

- These are ϕ_y corrections as a function of ϕ around CMS (dashed lines are the chamber boundaries)
- Not due to acoplanarity: that would be ϕ_y vs. local y (not seen)
- Likely related to the famous "sawtooth" effect: sawtooth was shown to be related to track-minus-segment residuals (ϕ_y error)
- Might be physically caused by superlayer 3 being wider than superlayer 1 (that's *only* a hypothesis!)



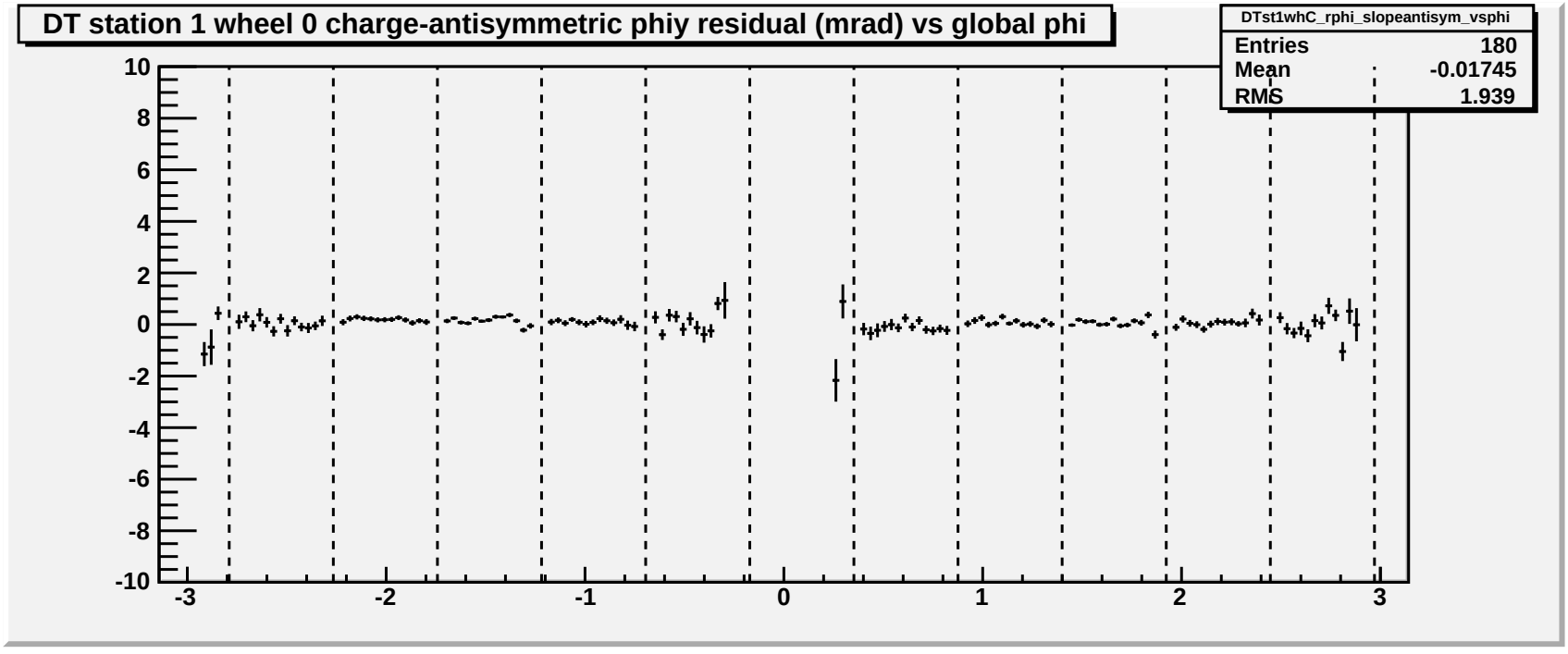
Is it real?

- Turn off the fancy fitting: do we see it with a simple profile plot? (each bin is just a mean, each error bar is just RMS/$\sqrt{N}$)
- Yes, we see the same trends
- RMS is huge because distribution has long non-Gaussian tails (that's why we do fancy fitting)



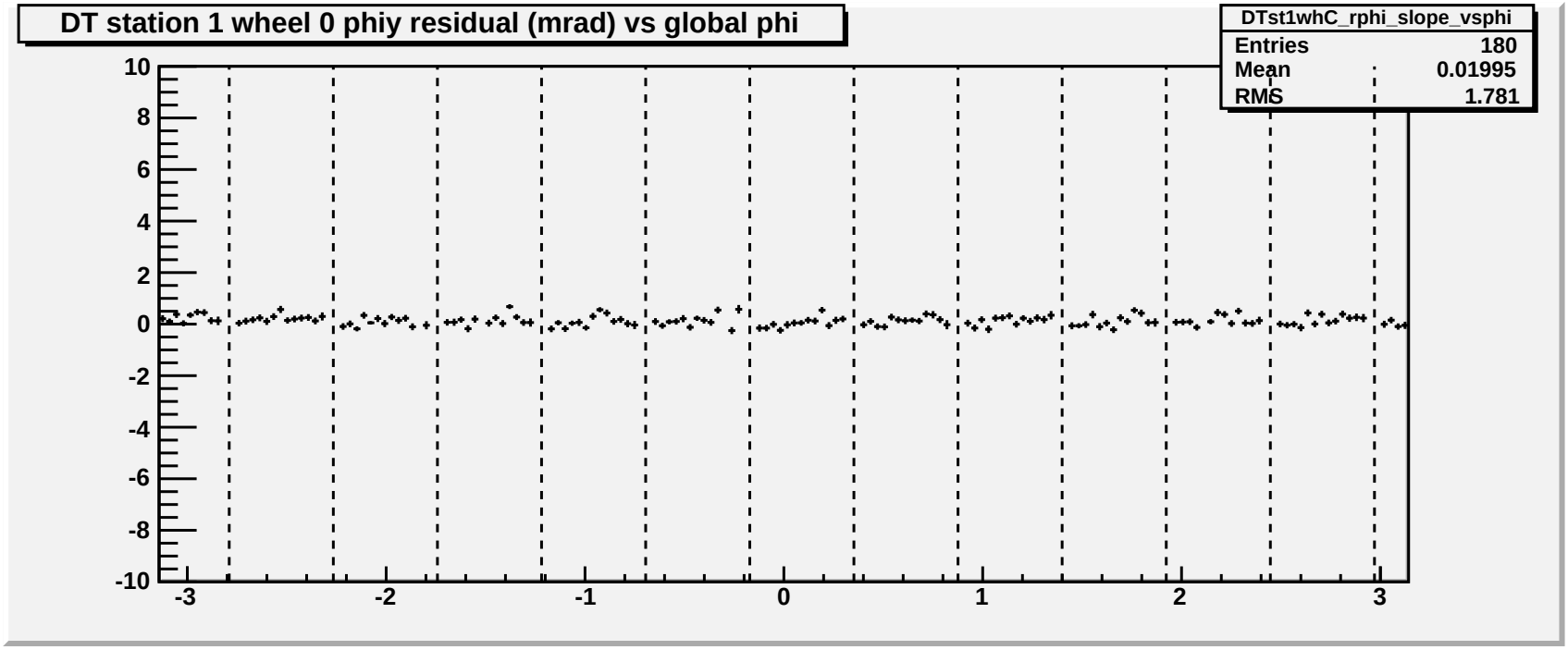
What about $\vec{B}$?

- ϕ_y angles are used to measure $\vec{B}$: is that an issue here?
- This is the $(R_+ - R_-)/2$ antisymmetric part: no trend at all



Do we see it in MC?

- Collisions MC, used to tune and debug the software
- No trend at all



Conclusions

- Most important addition to alignment procedure: ϕ_y angles
- Other improvements:
  - combined fits to manage correlations among parameters (I looked at all of them: none of them "went wild")
  - CSCs can, in principle, be aligned, which is an important step toward using this algorithm with standAloneMuons
  - (this is the 3_1_X MuonAlignmentAlgorithms update)
- Zoomed in on the surprising feature: ϕ_y measurements are not constant across the chamber face
  - it's real, and likely related to the outstanding "sawtooth" problem
  - short-term: algorithm aligns the central $\phi_y \to 0$, while we (with DT-DPG) see if this helps to solve the sawtooth problem