Update in Understanding the "Sawtooth" Effect

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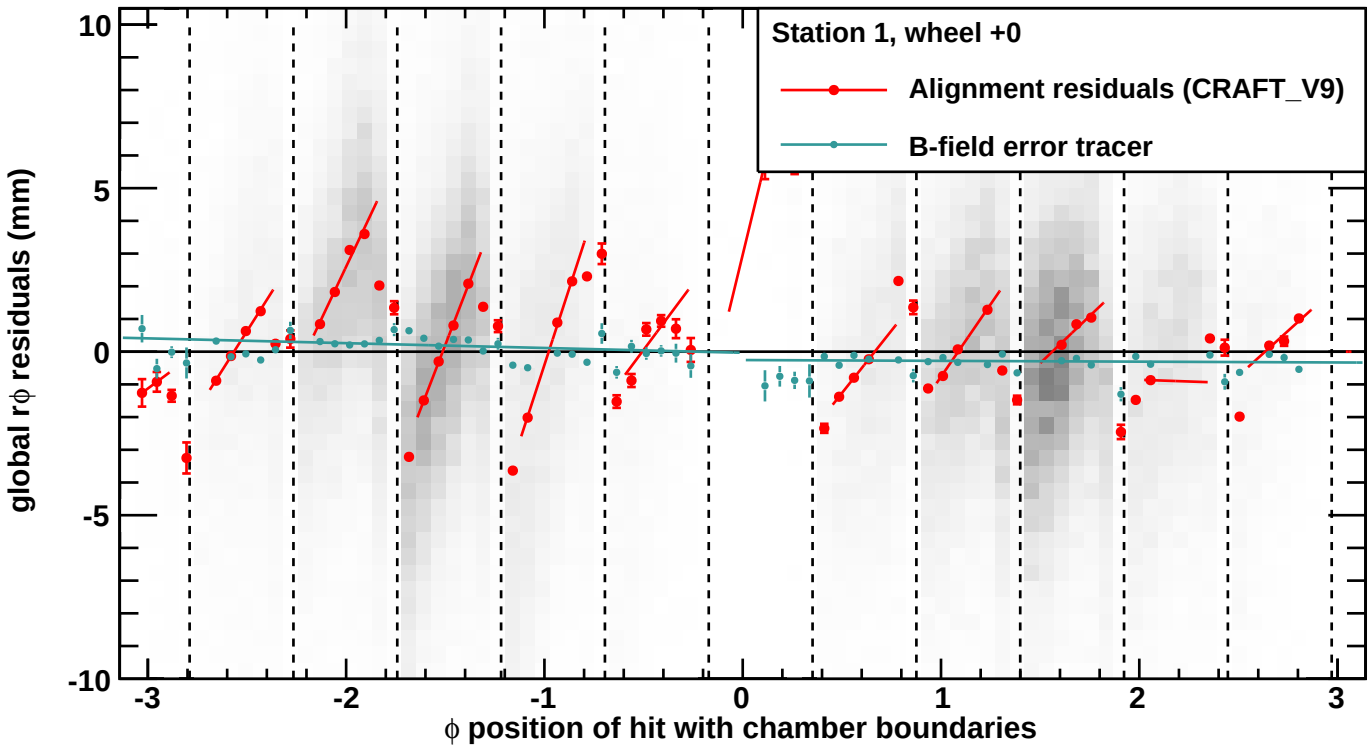
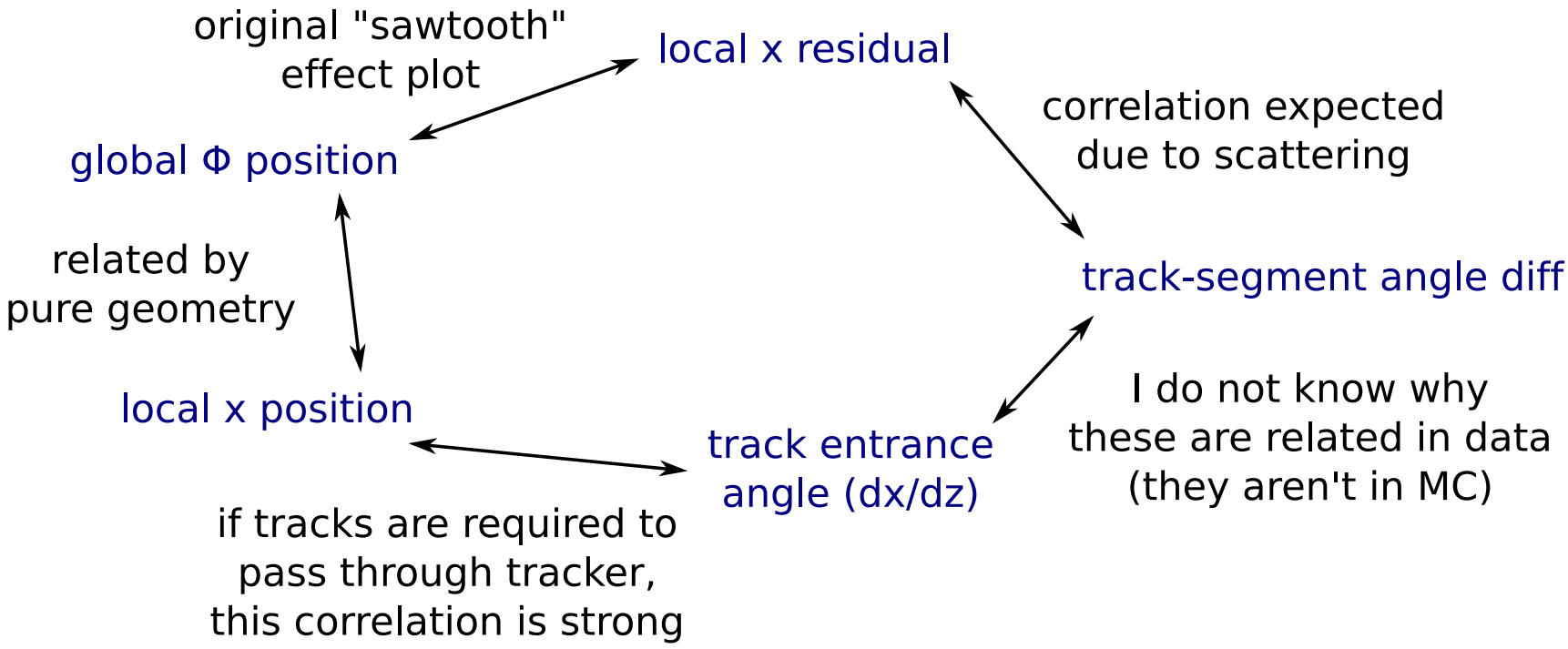
The "sawtooth" effect (review)

- Linear trend in $r\phi$ (superlayer 1&3) residual vs. global ϕ or local x
  - Formerly known as "DT stretching," before that was ruled out
- Can't be corrected by rigid body alignment (without introducing discrepancies elsewhere)
- Not corrected by internal glue layer corrections (factor of 10 too small)

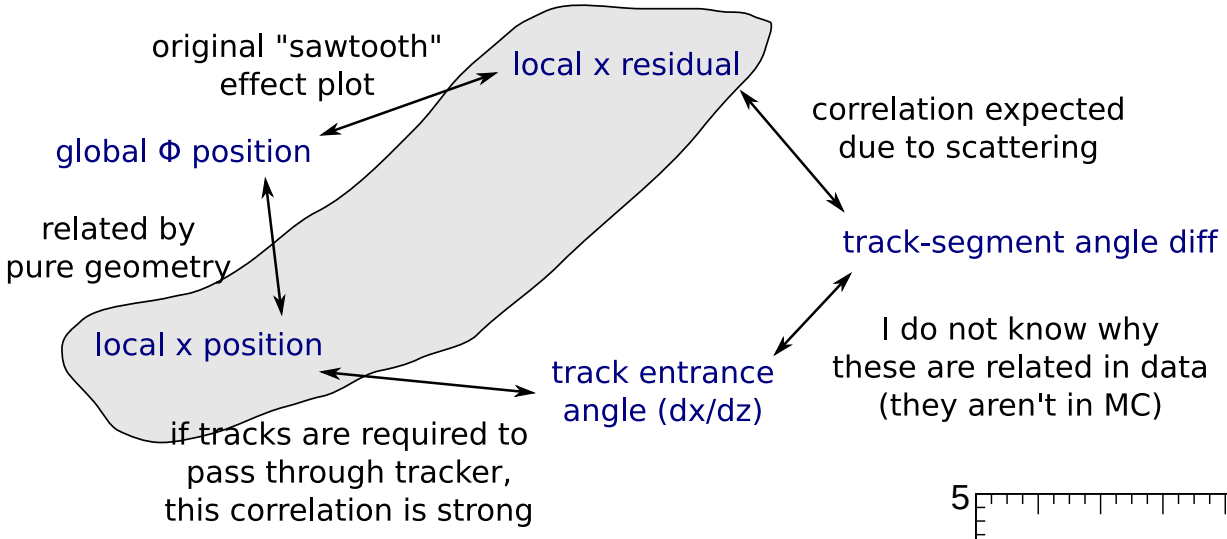


Single-chamber investigation

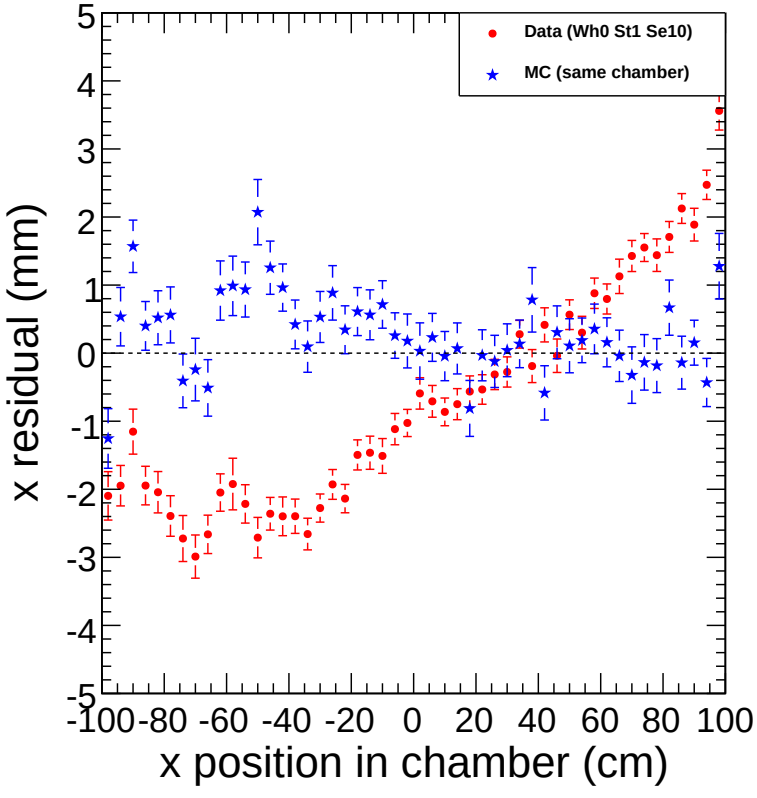
- Ntuple-based study of one chamber (wheel 0, station 1, sector 10)
- Correlations propagate transitively
  - each correlation will be explained on the following pages



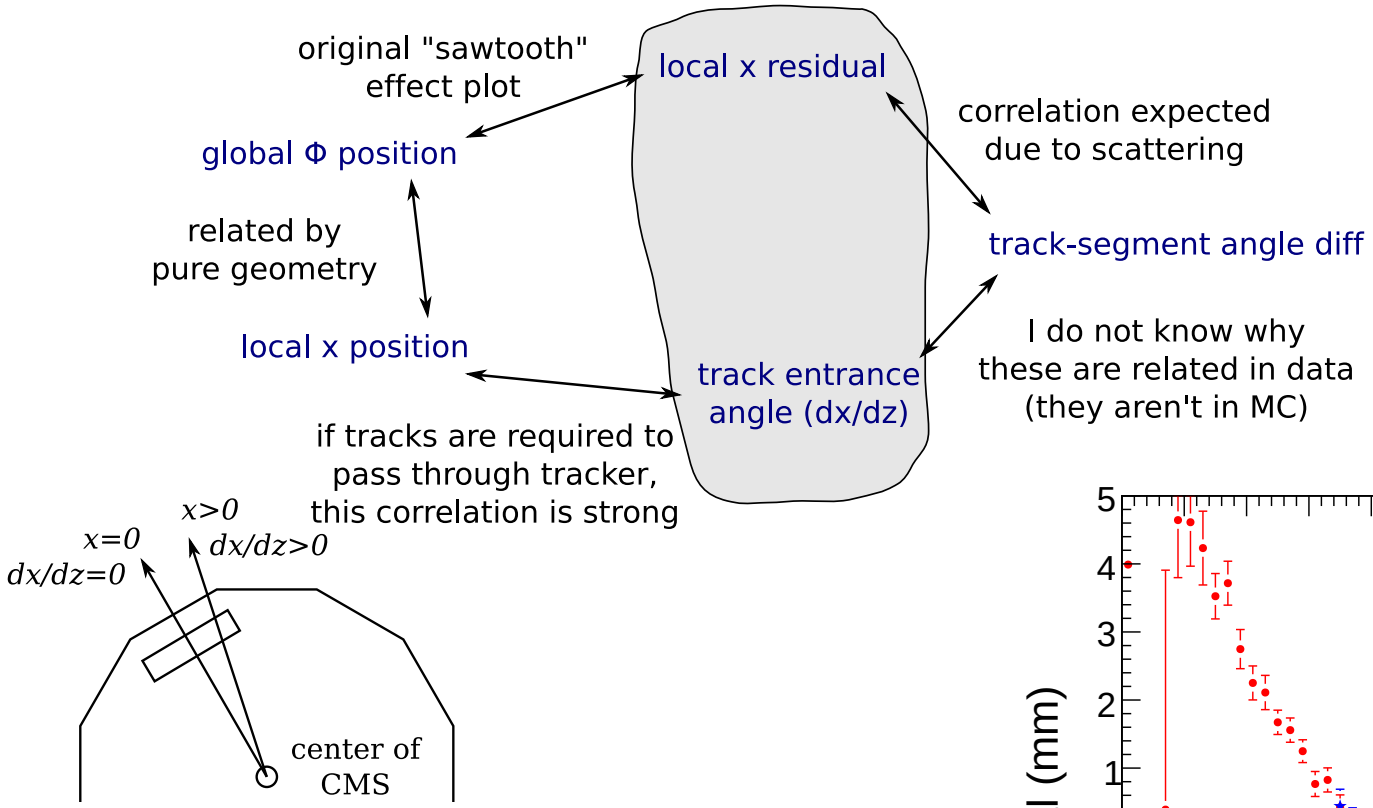
1. Recast in local variables



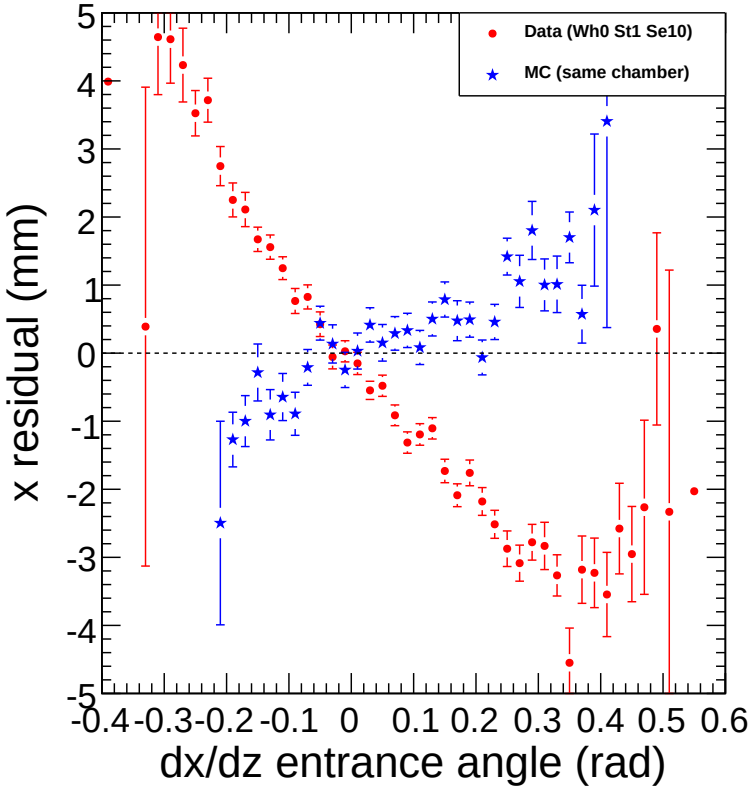
- Simple profile plots
  (each bin is a vertical mean)
- $p_T > 40$ GeV
- Red cosmic ray data,
  blue collisions MC (sorry)



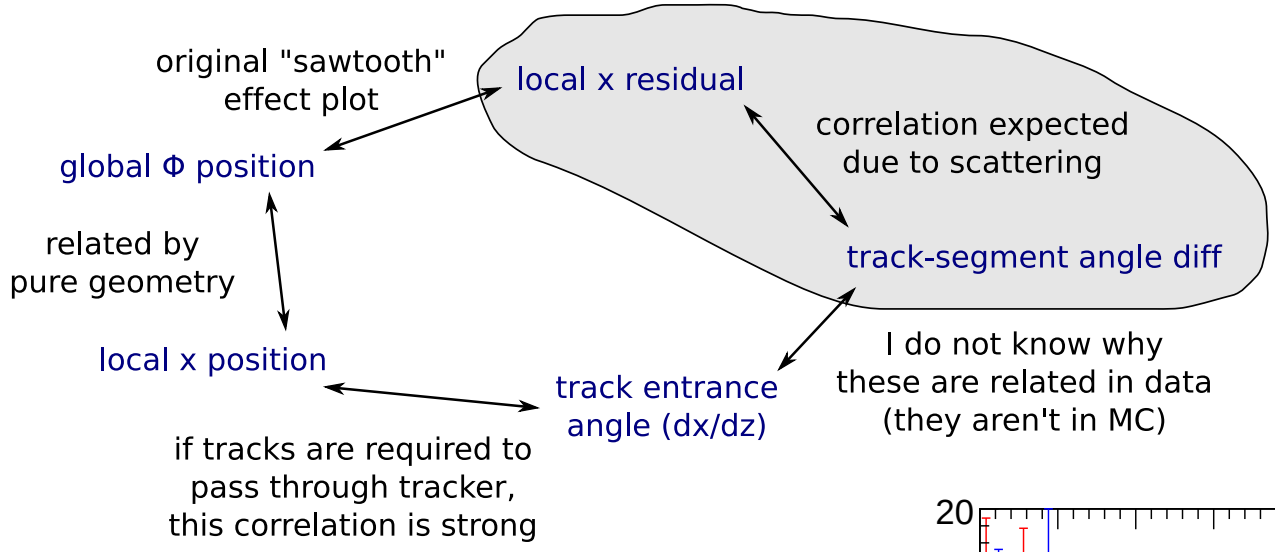
2. Stronger in entrance angle



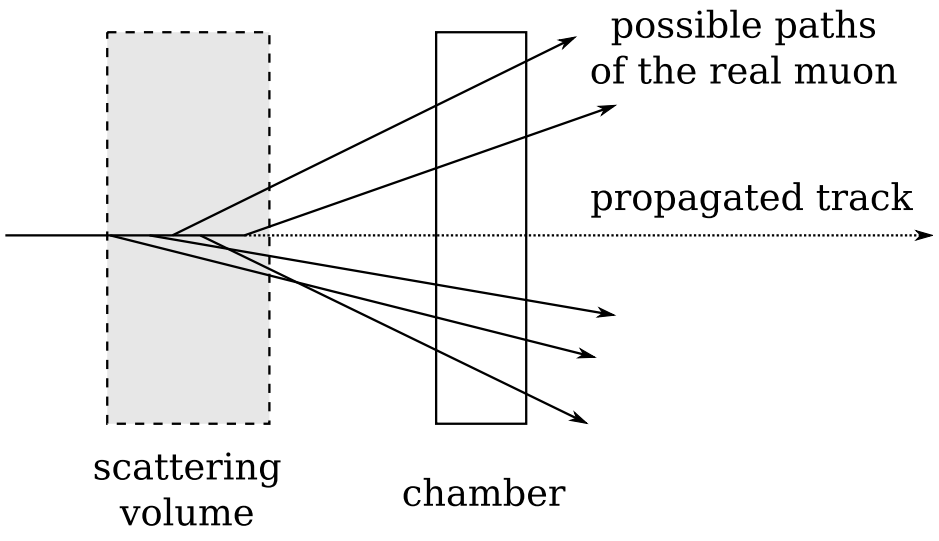
- x and dx/dz are correlated due to globalMuon selection
  - segments may be very different
- Residuals trend is twice as strong in dx/dz than in x

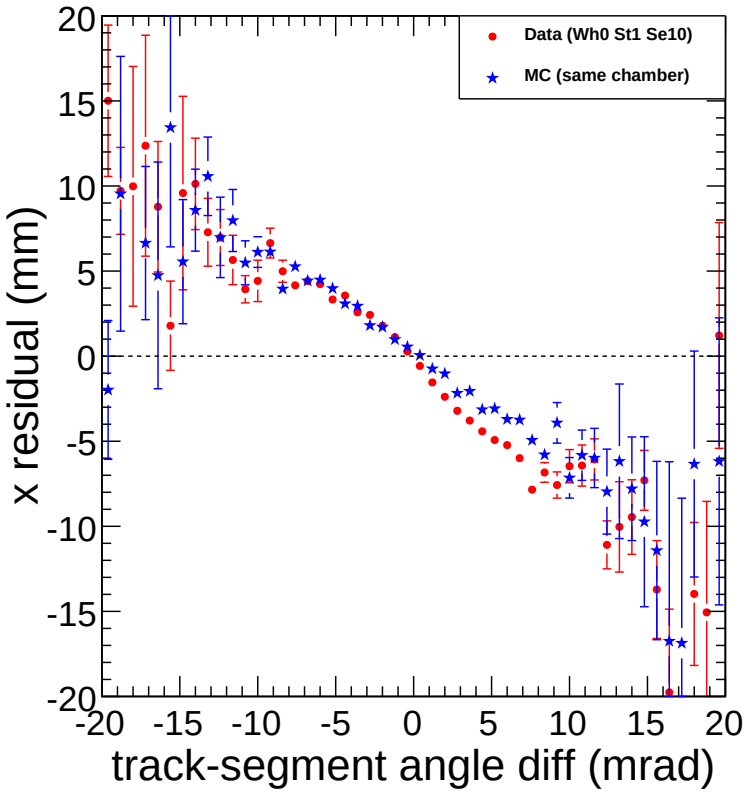


3. Related to known effect?

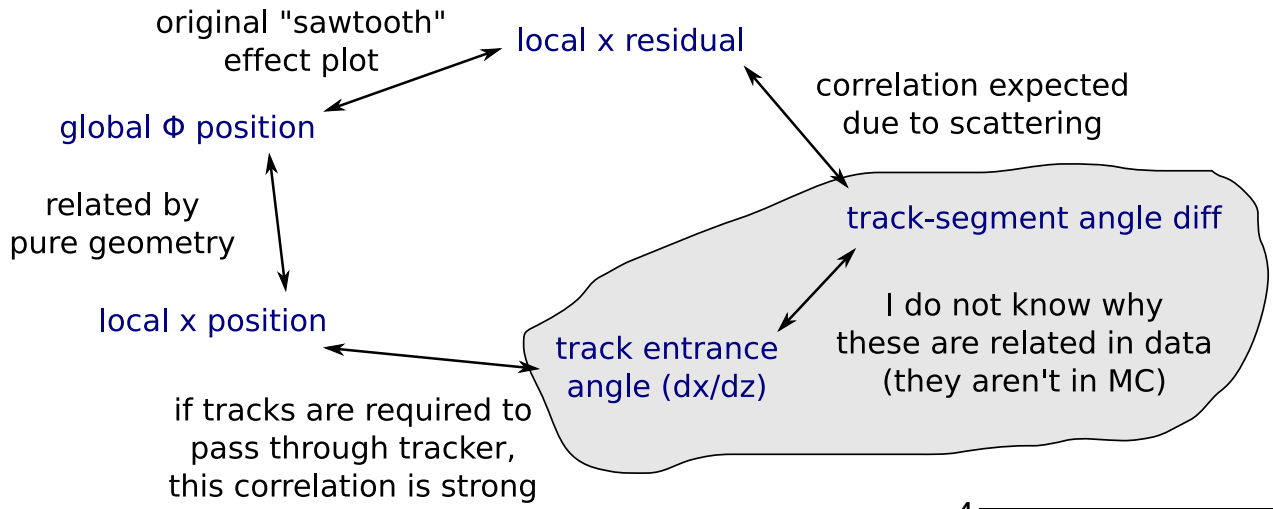


- Same size as correlation between position residual and angle residual

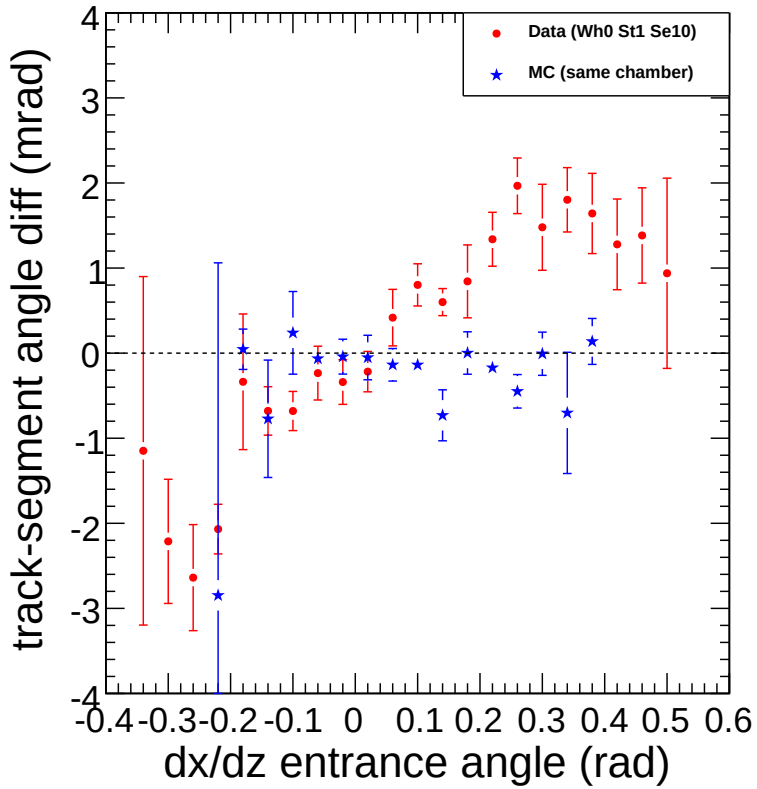




4. Linked through angle error?

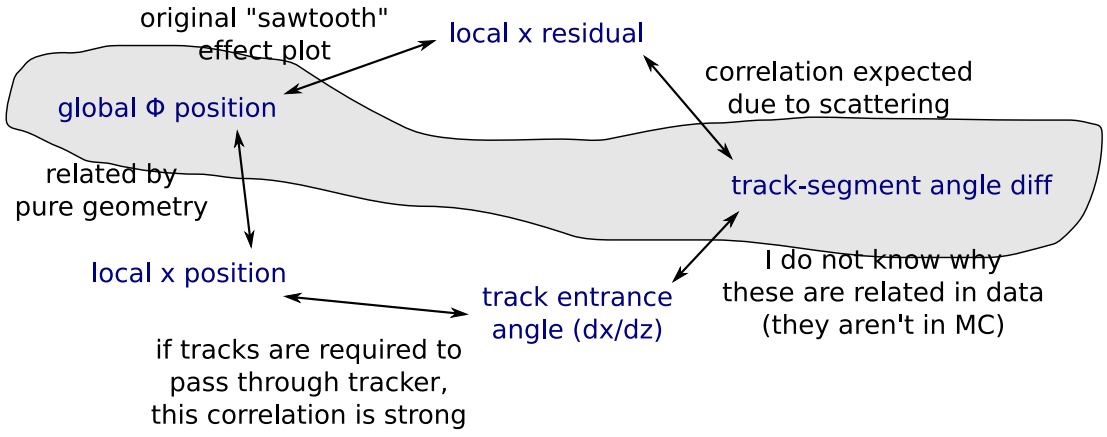


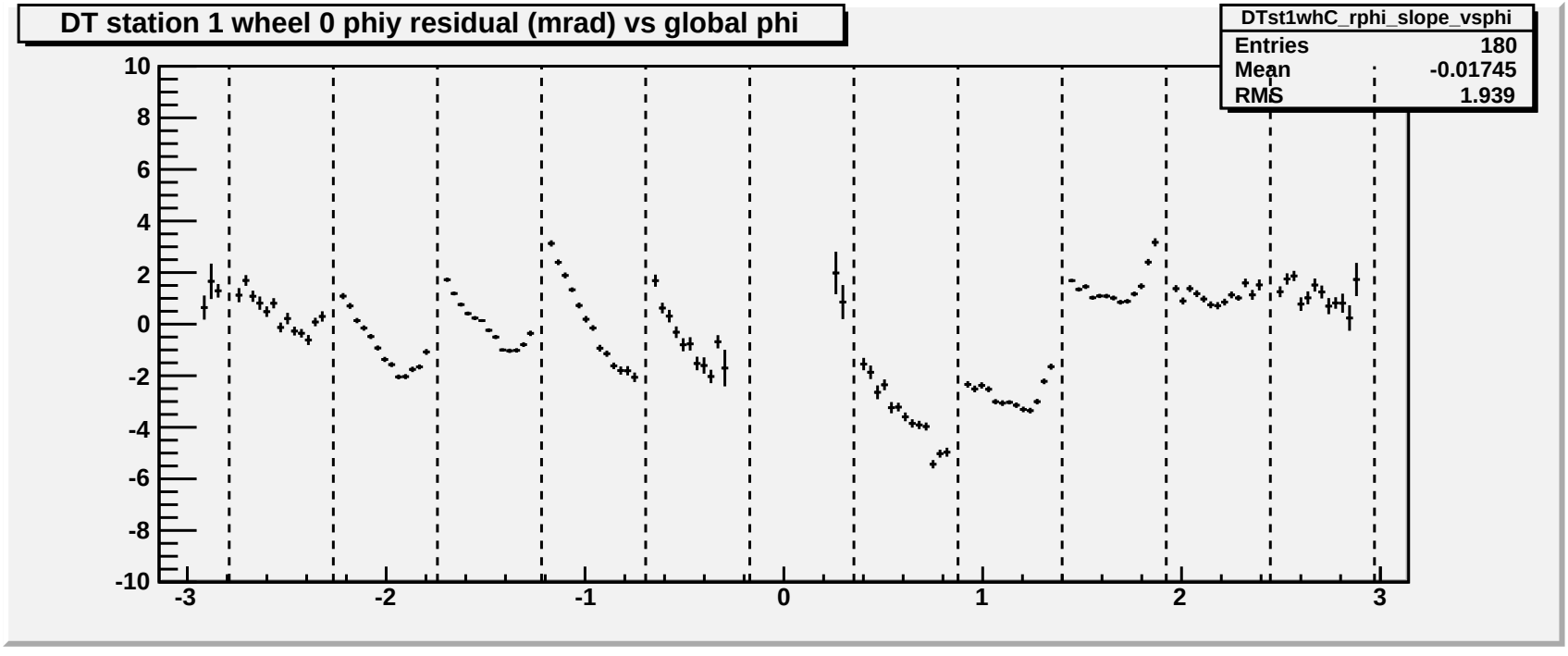
- Roughly the right magnitude to transmit scattering correlation to sawtooth
- Not seen in MC
- Observed equally in $\pm q$, higher p_T cuts
- Observable in 2-D distribution



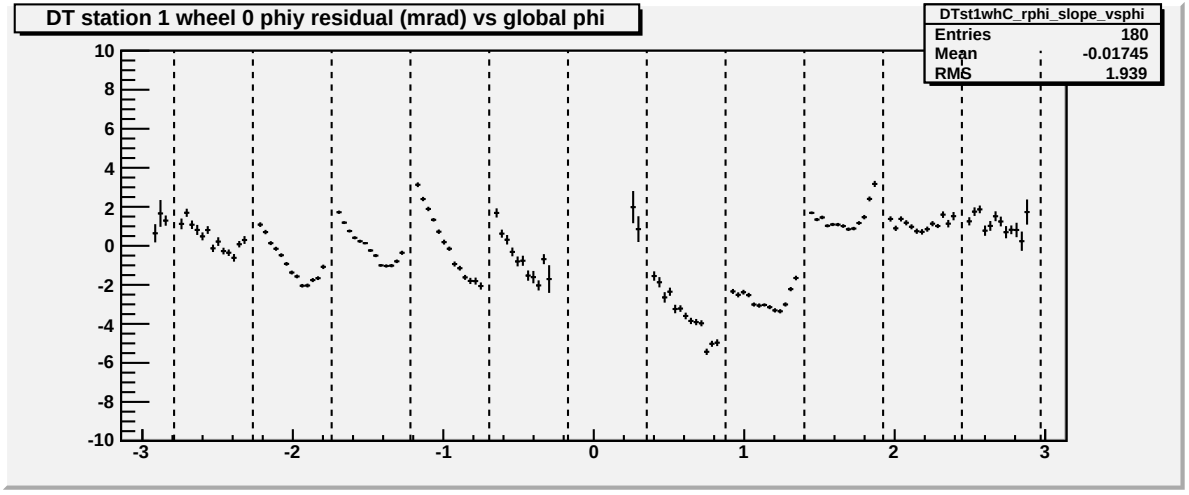
5. Seen in new alignment plots

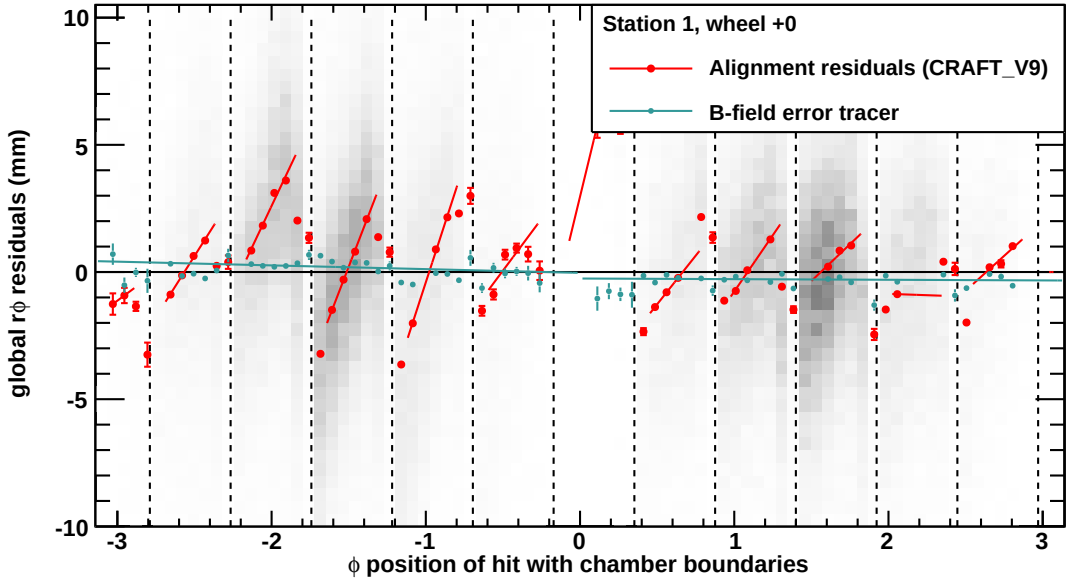
- Updated alignment procedure aligns and plots all 6 d.o.f.
- "ϕ_y residual" (below) is "track-segment angle diff"





Chamber-by-chamber correlation

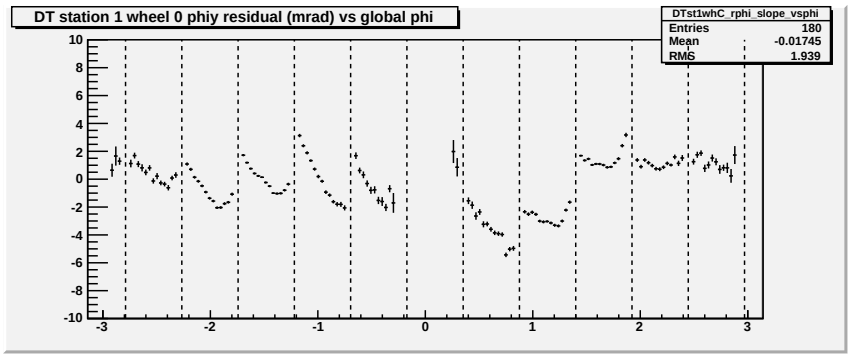




- ϕ_y effect varies from chamber to chamber, and agrees with original x sawtooth (page 2)
  - last 3 are flatter in both ϕ_y residuals and x residuals
- Discontinuities at chamber boundaries indicate a local phenomenon, rather than track source
  - old argument, now applied to ϕ_y as well as x

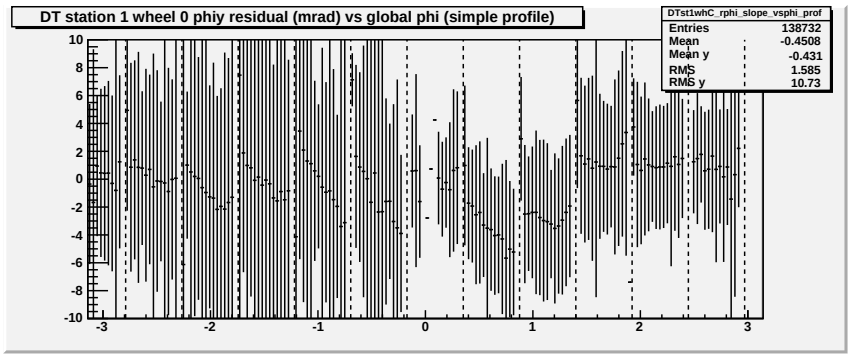
Sanity checks

The ϕ_y residual vs. global ϕ plot



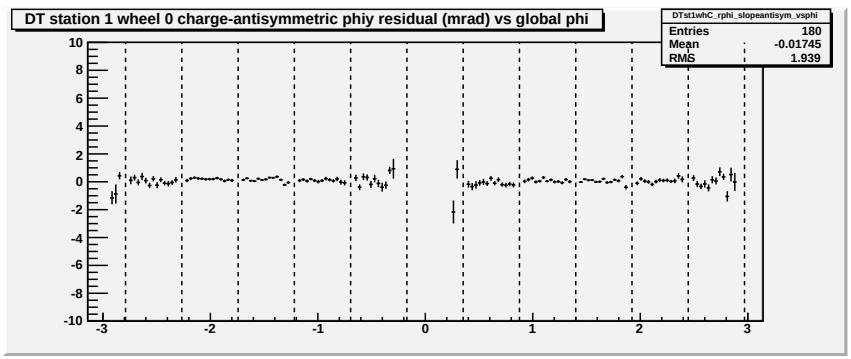
Turn off fancy fitting (simple profile)

Mean shows the same trends. Error on mean overestimated due to tails in distribution (that's why we do the fitting).



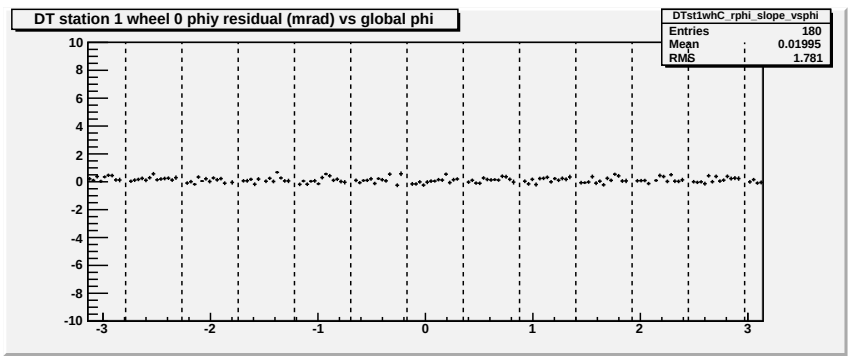
Antisymmetric "error tracer"

No significant $\vec{B}(\vec{x})$ or dE/dx errors



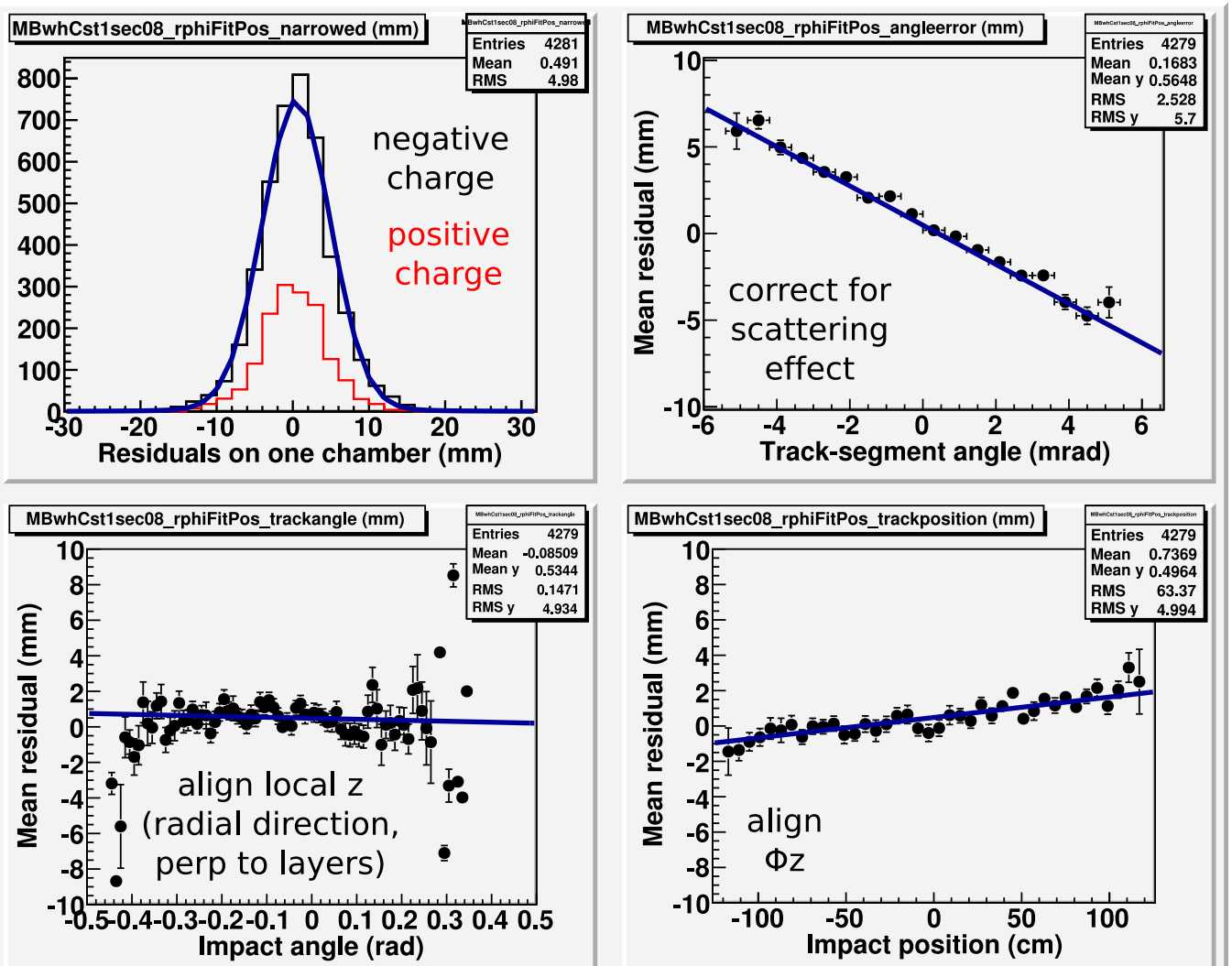
Plot in collisions MC, ideal geometry

No problems with the technique



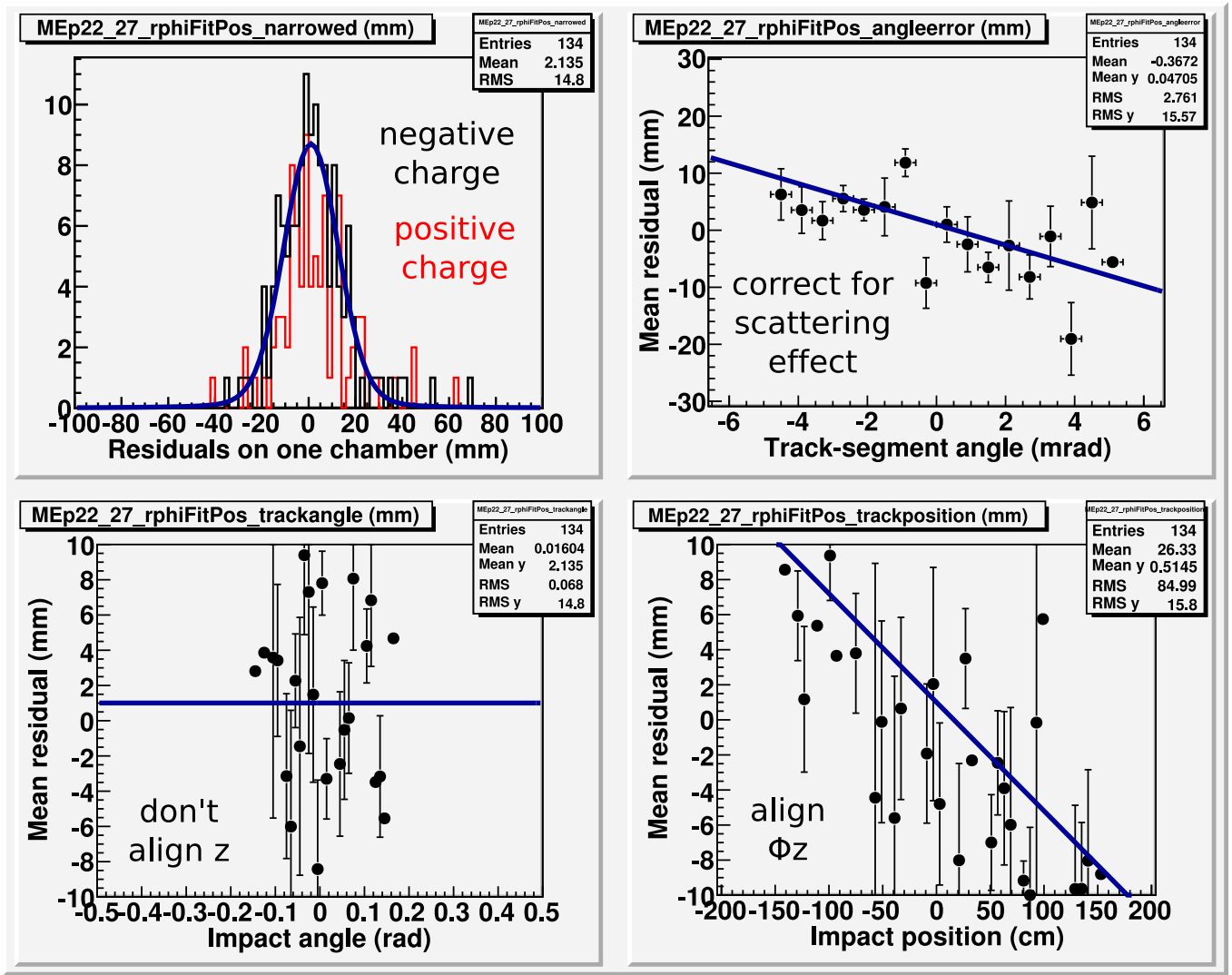
New alignment fits

- Local x, z, and ϕ_z are aligned in a combined fit (all one fit below)
- Local y (with redundant ϕ_z), ϕ_x, and ϕ_y in independent fits
- Well-understood scattering effect controlled as another parameter



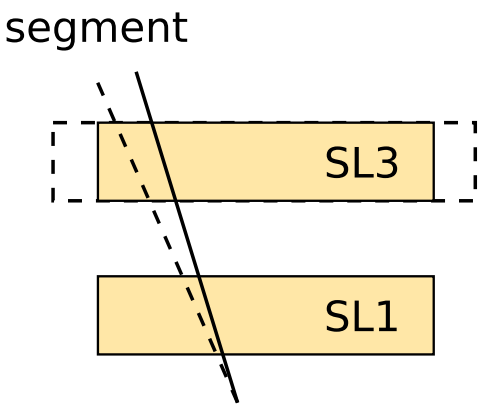
Endcap CSC example

- Hard to find one with such high statistics
- Endcaps will be aligned with this tool, using the aligned muon barrel as reference instead of the tracker (reason for the low statistics)



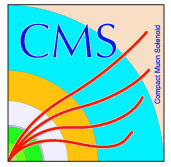
Possible cause of the correlation

- The mystery can be restated as: "why is the error in track entrance angle (track-segment angle difference) related to the value of track entrance angle?"
- A guess: could one superlayer be stretched, and not the other? (maybe that has already been ruled out?)



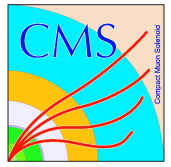
- We now control for the well-understood scattering effect in alignment
  - if that's the source of the large residuals, as it seems, then they can no longer affect alignment
  - however, they're still in track-reconstruction

Alignment schedule



- New methods to fit all 6 d.o.f. have been implemented (in 3_1_X)
- Studied with high-statistics Monte Carlo (barrel and endcap)
  - may have found a SteppingHelixPropagator bug affecting station 1, wheels ± 2 (highest η corner of barrel)
  - need to re-check with 3_1_X SteppingHelixPropagator updates
- Re-aligned CRAFT data, looking over results now
  - will probably require small corrections before sign-off
- In $\sim$2 weeks, coordinate with tracker alignment to provide coherent tracker and muon alignments to re-process tracker-pointing skim
- Use globally-aligned DT chambers as a reference to align as many DTs as possible
- Use aligned barrel as a reference to align endcap CSCs
- Re-processing of whole CRAFT dataset would then make sense
  - this end-deadline should be sufficiently before CRAFT-2009

Conclusions



- Some progress in understanding sawtooth effect
- Not complete (Paolo, Pablo, Ugo, Francesca, Alicia, and Anna are doing a more extensive study)
- New alignment plots shed some light on the same issues