A first look at CRAFT-2009 alignment tracks

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- ▶ Alignment framework automated   (V. Khotilovich, TAMU)
    - ▶ choice of what should be flexible and what should be fixed based on CRAFT-08 analysis

- ▶ First alignments of CRAFT-09 performed
    - ▶ observed few-mm translations, rotations in barrel wheels
    - ▶ and more interesting features in endcaps (subject of this talk)

- ▶ Interesting features in endcaps
    - ▶ unlike CRAFT-08 (or 2_2_11 CSCSkim reconstruction), we find globalMuons on both the bottoms *and tops* of the stations
    - ▶ even for top+bottom trigger
    - ▶ ϕ_y angles of individual chambers reproduced from 2008 → 2009, but with more complete coverage in 2009
    - ▶ alternating even-odd structure in $r\phi$ residuals???
    - ▶ ME+4/2 are well-aligned (with very low statistics :)

Reminder of method

- ▶ Propagate tracks from the tracker into the endcap

- ▶ Compare position and angle of track intersection with segment
  (actually linear-fit of single-hit residuals, to account for possible curvature)

- ▶ "$r\phi$" = direction perpendicular to CSC strips (no granularity)

- ▶ $\Delta r\phi$, $\Delta \frac{d(r\phi)}{dz}$ residuals interpreted as $r\phi$ translation, ϕ_y rotation
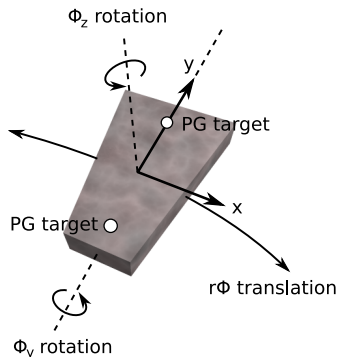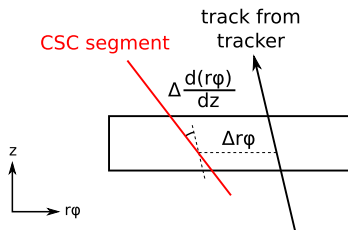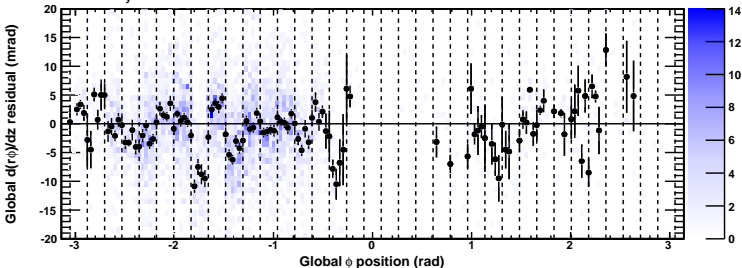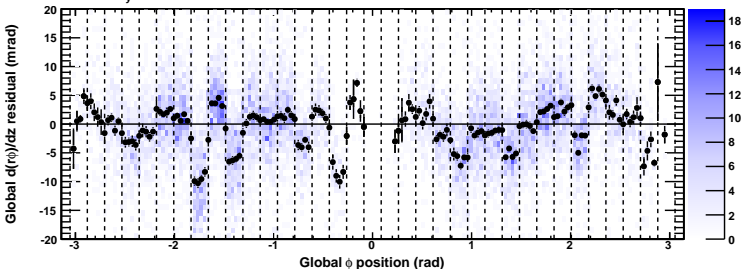
Chamber angles are independent of disk misalignment, more reproducible

ME+3/2 CRAFT-2008 ϕ_y measurements

ME+3/2 CRAFT-2009 ϕ_y measurements

Why do we now have top-of-CMS hits on our globalMuons?

- ▶ The cause has not been narrowed down: multiple changes

old	**new**
CRAFT-2008	CRAFT-2009
CMSSW_2_2_11	CMSSW_3_1_2
CSCSkim	prompt RECO

- ▶ Common features:
  - ▶ $100 < p_T < 200$ GeV (new to the analysis: not much is lost when also requiring high-quality oblique-angle tracks)
  - ▶ final CRAFT-2008 tracker alignment and APEs
  - ▶ most plots produced with DESIGN geometry
- ▶ These are *not* bottom-only trigger data: 109459–111136
- ▶ It is, of course a good thing: with this coverage, we should be able to reliably align disks (and many individual chambers)
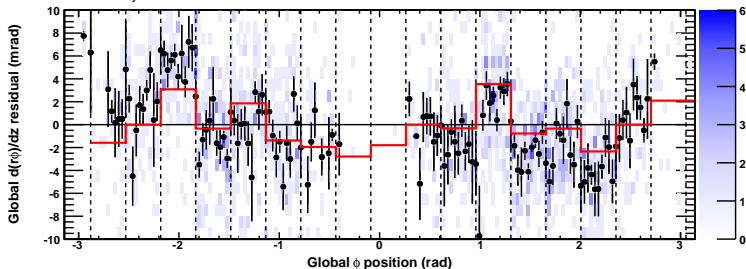
Wider coverage allows us to see that the correlation is real

ME-2/1 CRAFT-2008 ϕ_y measurements with beam-halo alignment (red) overlaid
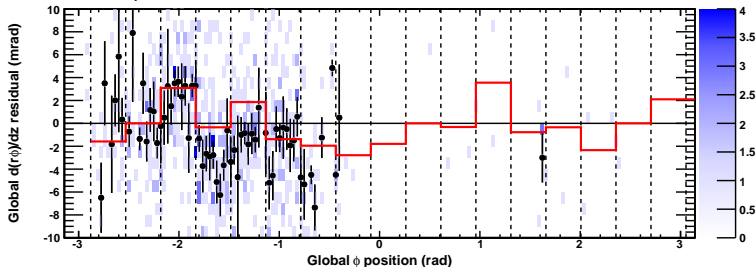
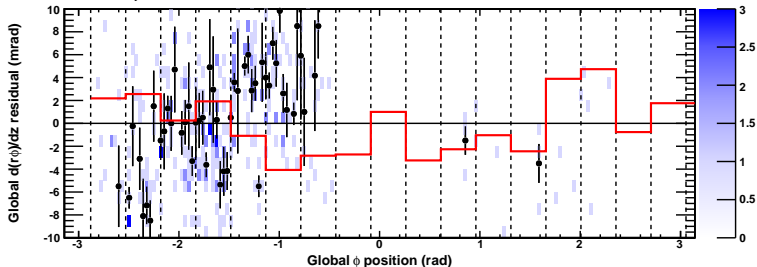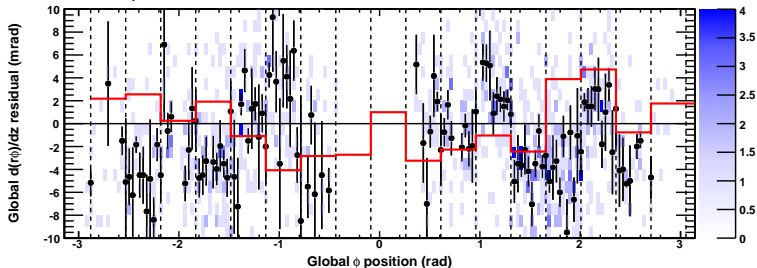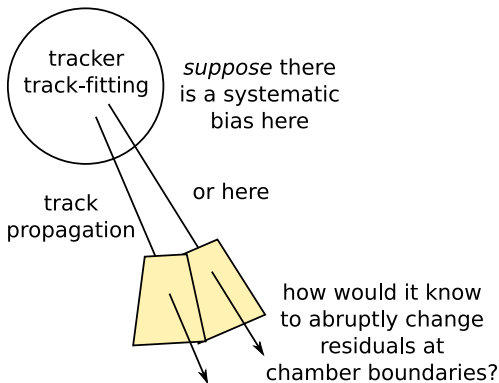ME-2/1 CRAFT-2009 ϕ_y measurements with beam-halo (red) overlaid

But there are some significant differences: likely real motion

ME-3/1 CRAFT-2008 ϕ_y measurements with beam-halo alignment (red) overlaid

ME-3/1 CRAFT-2009 ϕ_y measurements with beam-halo (red) overlaid

tracker
track-fitting

suppose there
is a systematic
bias here

or here

track
propagation

how would it know
to abruptly change
residuals at
chamber boundaries?

discontinuity at boundary
= difference in alignment

. . . or something else related to the chambers themselves, not
the track source

$\Delta r\phi$ position residuals

Nicely completed (const + $\sin\phi$ + $\cos\phi$) curve, but why the alteration?

ME-1/2 CRAFT-2008 rϕ measurements (relative to DESIGN geometry)
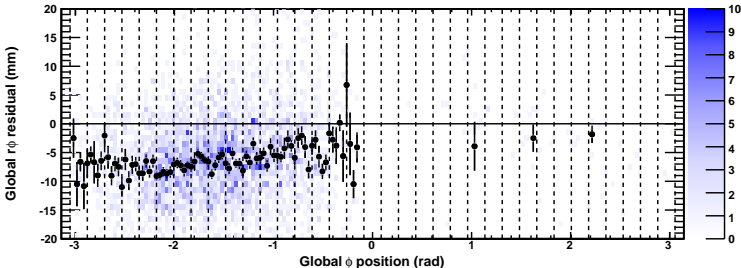
ME-1/2 CRAFT-2009 rϕ measurements (relative to DESIGN geometry)
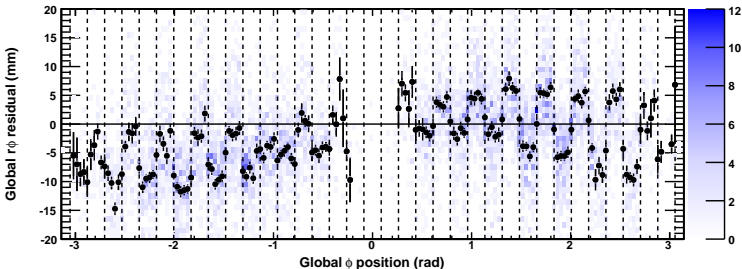
Also insensitive to a 1 cm translation in z

ME-1/2 CRAFT-2008 rϕ measurements (relative to HW/PG geometry)
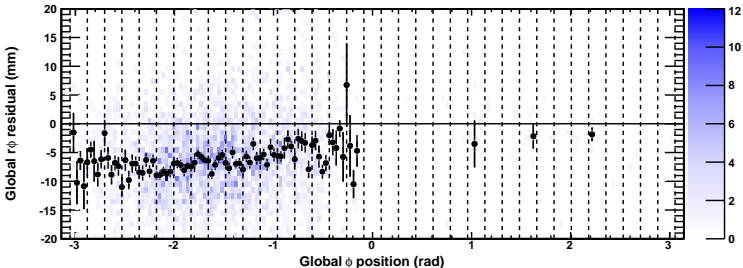
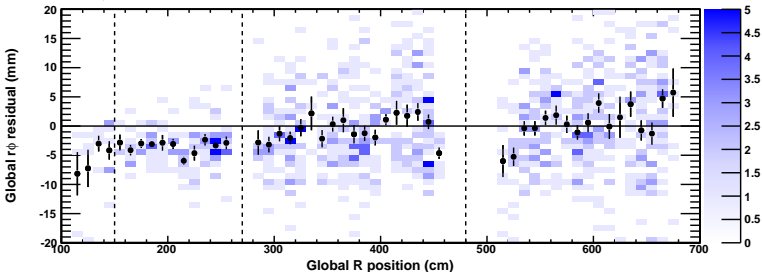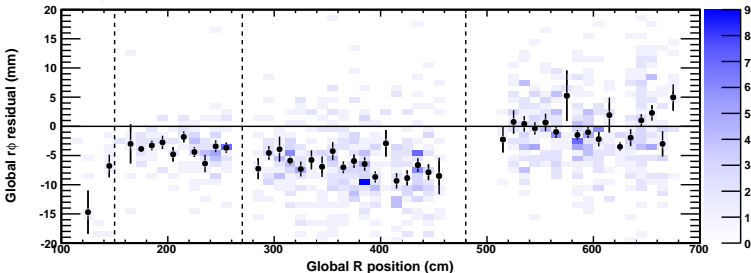ME-1/2 CRAFT-2009 rϕ measurements (relative to HW/PG geometry)
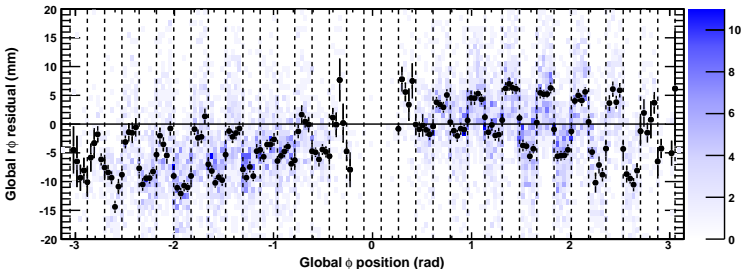
Selected two neighboring chambers and plot vs. R; nothing strange

Summary of alteration pattern

- Only affects ME$\pm x/2$. ME$\pm x/1$ look fine and ME$\pm 1/3$ has a pattern all of its own.

- Complete set of $\Delta r\phi$ vs. ϕ in backup at the end of this talk

- Are even-numbered chambers mechanically connected to each other in a different way from odd-numbered chambers? Could a real motion like this have been physically introduced?

  (I wouldn't think so)

- Reconstruction bug? Has something to do with local reconstruction or the local $\rightarrow$ global coordinate transformation...

  - alignment residuals constructed from CSCRecHit2Ds
  - same plotting code: only CMSSW version and primary dataset changed (see p. 5)

- Apart from this, we're in a position to do a high-quality disk alignment (unlike CRAFT-2008)
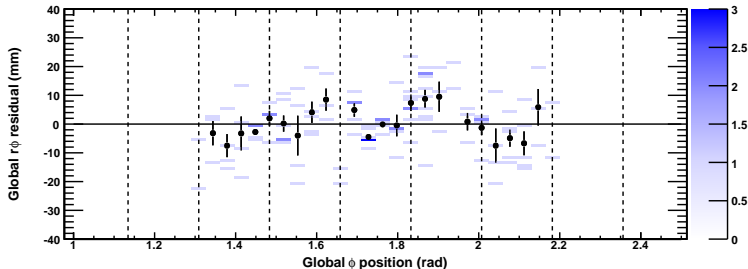
They exist and are not obviously misaligned; not clear if they alternate

ME+4/2, single+coincidence trigger (12222-112237)
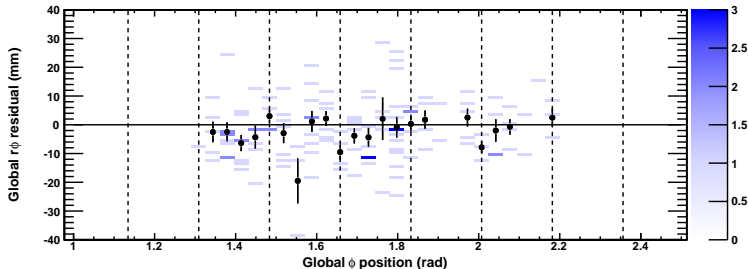
ME+4/2, coincidence-only trigger (112281)

- CRAFT-2009 dataset provides more complete coverage in ϕ, making it possible to do a real alignment

- Reason for improved coverage is unknown

- Can cross-check beam-halo ϕ_y measurements for the first time (photogrammetry could only cross-check $r\phi$ and ϕ_z)

- Likely that some ϕ_y angles changed by a few mrad in the past year

- $r\phi$ residuals vs. ϕ show clear $(\text{const} + \sin\phi + \cos\phi)$ curves (disk displacement and rotation), with a 1 cm alternation pattern superimposed

- Reason for alternation is unknown

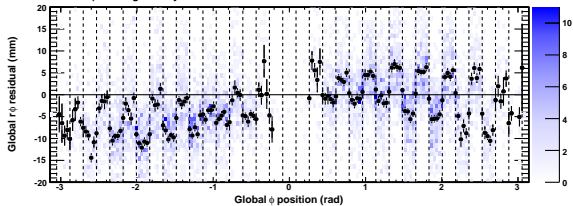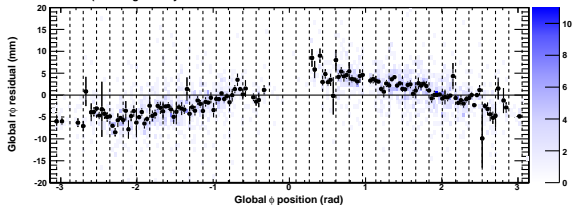ME-3/2 CRAFT-2009 (HW/PG geometry
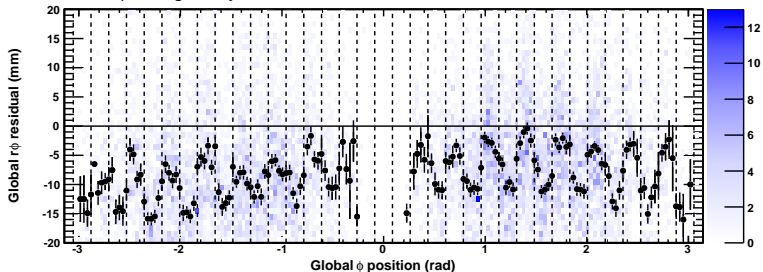
ME-3/1 CRAFT-2009 (HW/PG geometry
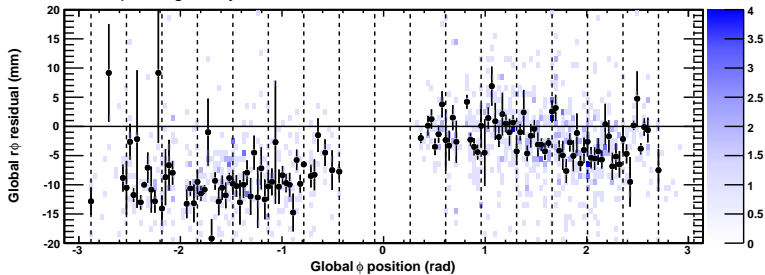
ME-2/2 CRAFT-2009 (HW/PG geometry)
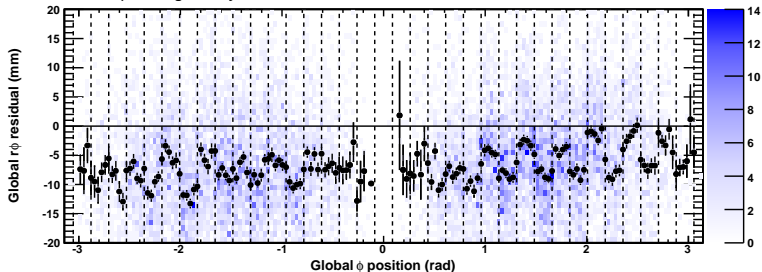
ME-2/1 CRAFT-2009 (HW/PG geometry)
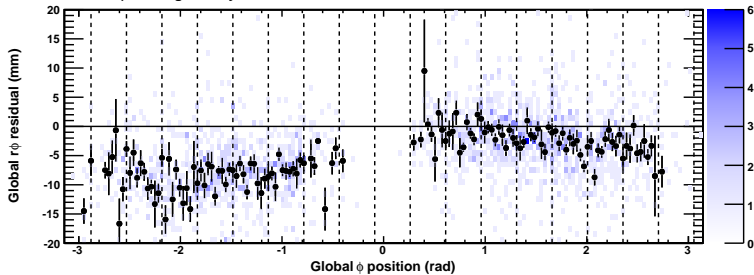
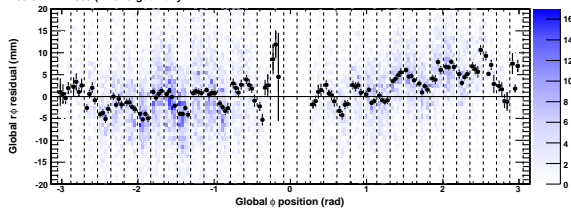**ME-1/3 CRAFT-2009 (HW/PG geometry**
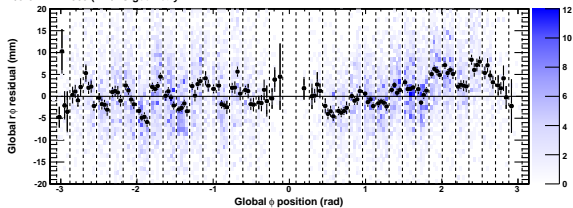
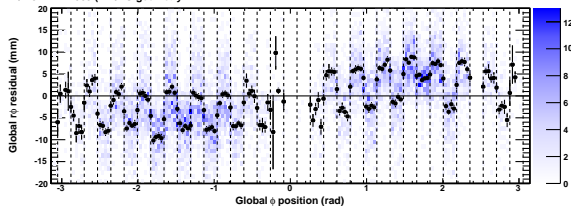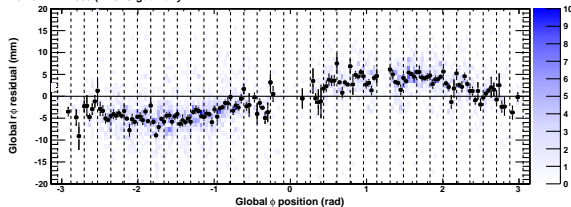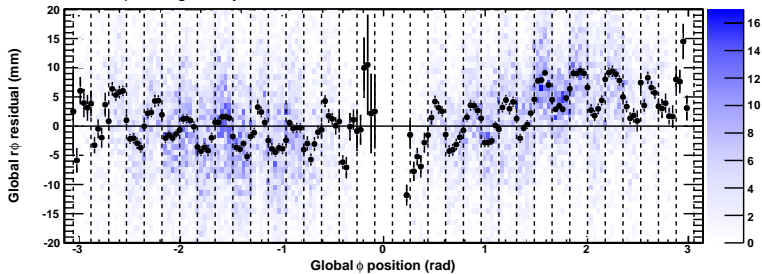**ME-1/2 CRAFT-2009 (HW/PG geometry**

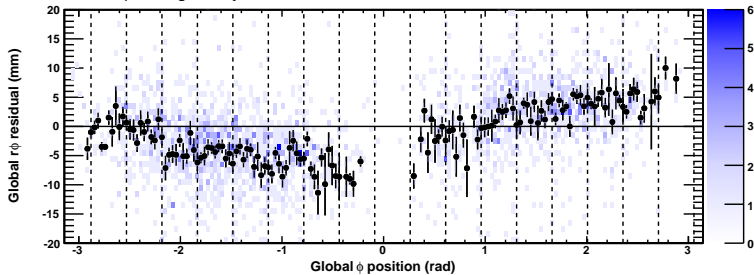**ME-1/1 CRAFT-2009 (HW/PG geometry**
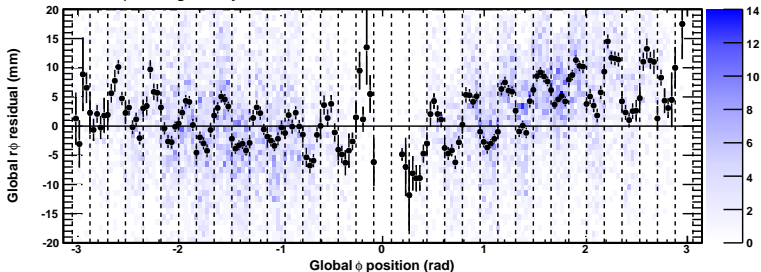
clear 5 mm
x translation

ME+2/2 CRAFT-2009 (HW/PG geometry)

ME+2/1 CRAFT-2009 (HW/PG geometry)

ME+3/2 CRAFT-2009 (HW/PG geometry)

ME+3/1 CRAFT-2009 (HW/PG geometry)