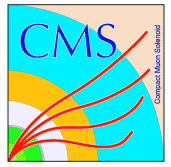


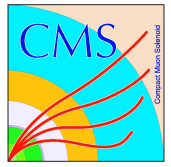
Muon Alignment from CRAFT-2009 Tracks

Jim Pivarski

Texas A&M University

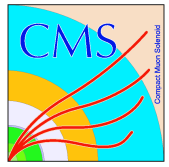
4 September, 2009

Outline



- Automated procedure for running MuonAlignmentFromReference
- DT chamber results from CRAFT-2009
- CSC alignment tracks in CRAFT-2009
- Work plan for the next steps

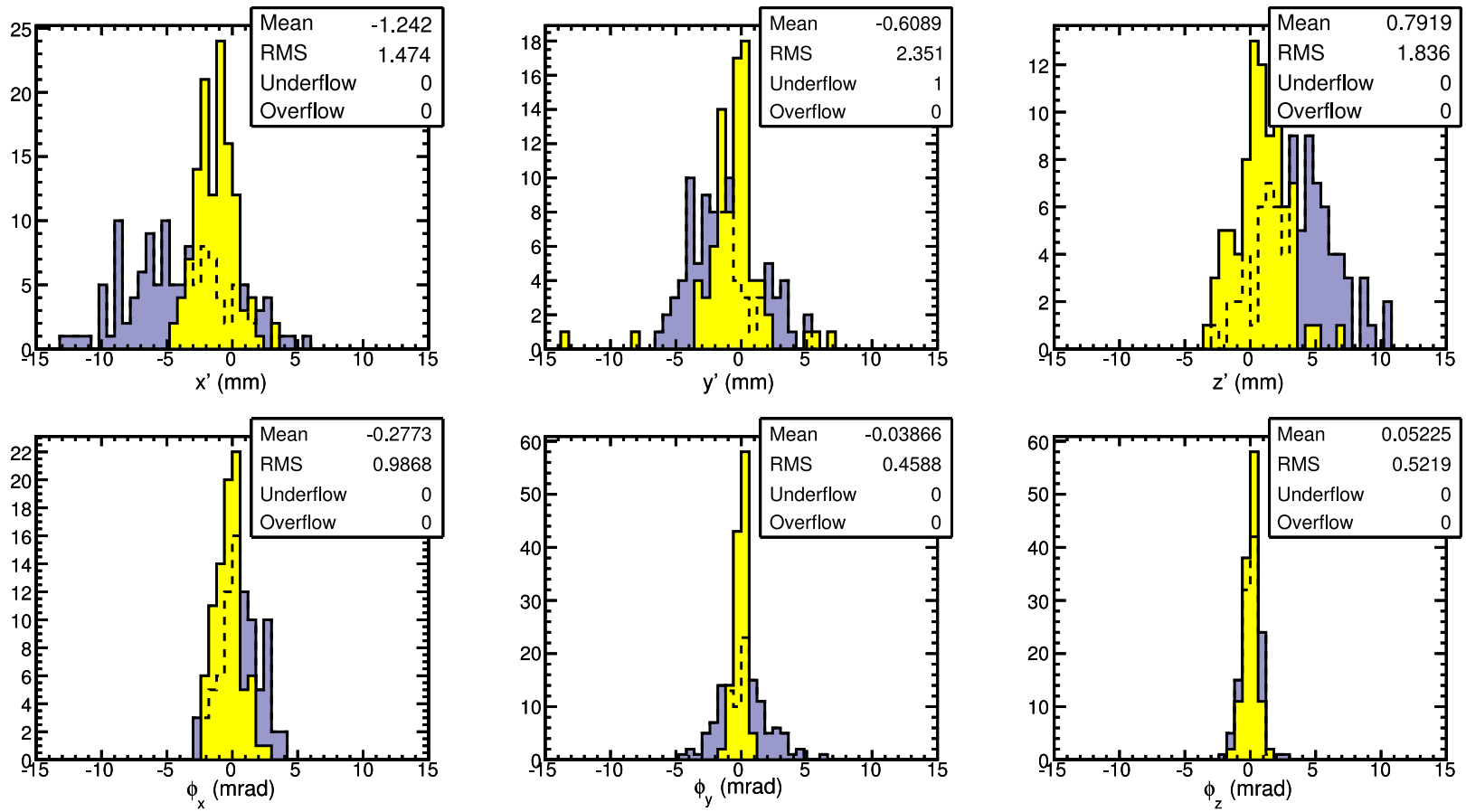
Automated procedure



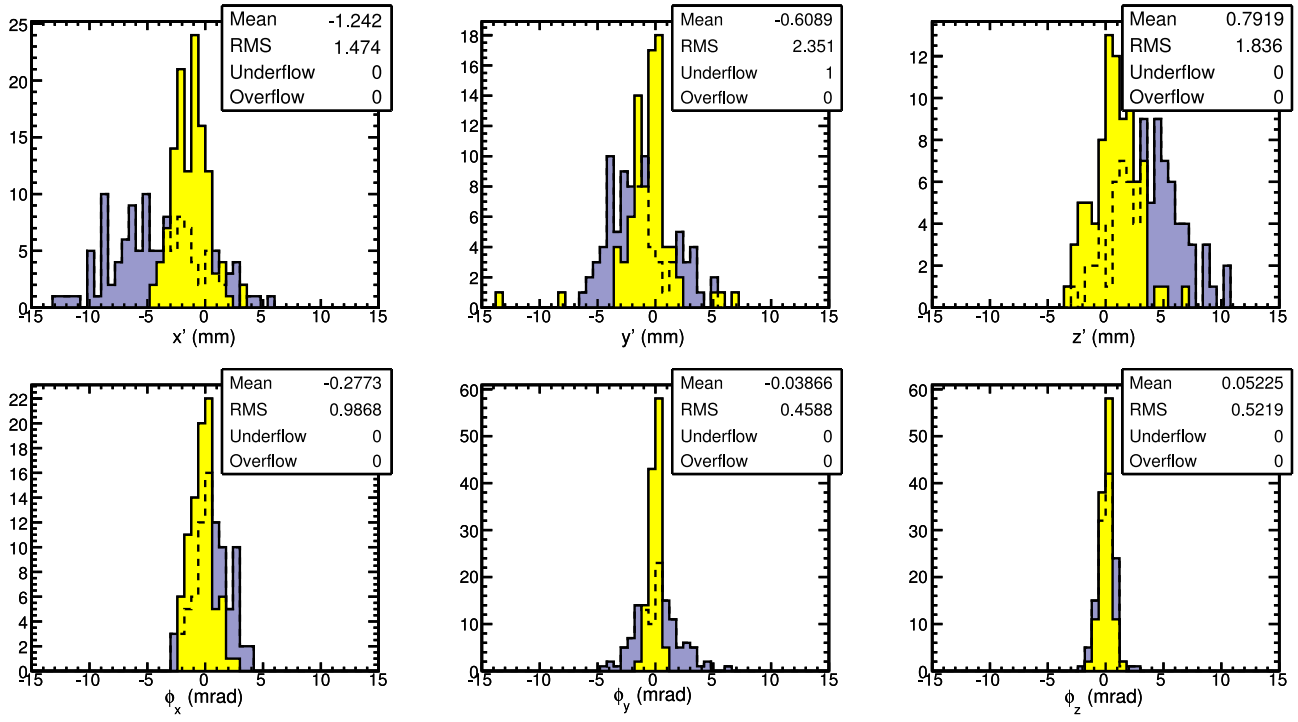
- Scripts in Alignment/MuonAlignmentAlgorithms/python
  - findQualityFiles.py: selects runs from the CMS Run Registry with a given magnetic field, and quality flags in chosen subsystems, such as "tracker and DT" or "tracker and CSC"
  - createJobs.py: creates a set of directories with scripts for running each iteration of alignment from commandline arguments (like cmsDriver.py, standardizes interface)
  - gather_cfg.py: collects muon residuals (about 50 jobs)
  - align_cfg.py: runs MINUIT on the residuals to compute a new geometry (1 job, must wait for the gatherers to be done)
  - submit.sh: submits the jobs with the right interdependencies, including 2 or more iterations (created by createJobs.py)
- Twiki page documenting their use still needs to be written
- Allows us to start alignment with CRAFT-2009 using everything we developed for CRAFT-2008

DT alignment

- Same parameters as CRAFT-2008 (except 2_2_11 → 3_1_2)
- We show differences between 2008 and 2009 below (yellow)
- Overlaid on differences between CRAFT_ALL_V4 (no *global* alignment) and aligned (grey), for comparison



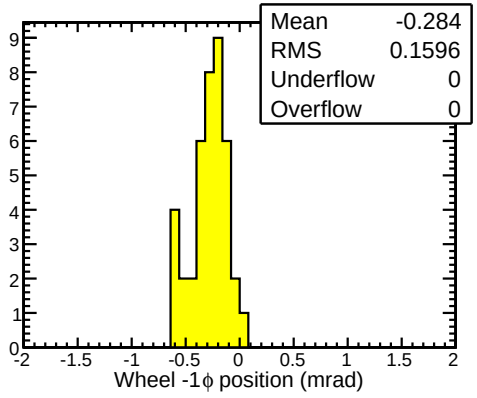
DT alignment

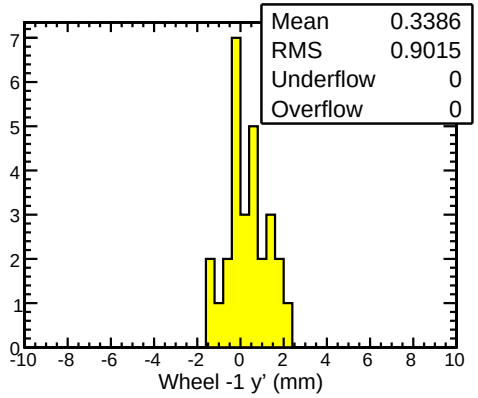


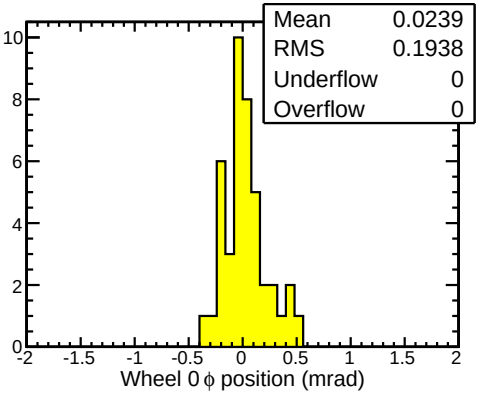
Observations:

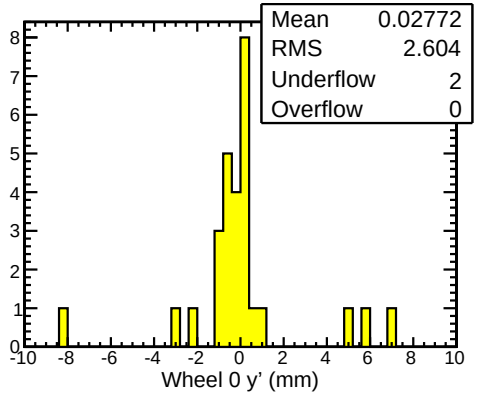
- Angles are reproduced within 0.5 mrad except for ϕ_x (hardest to align; see residuals median studies in CRAFT paper)
- Translations are on the order of 2 mm, not as large or systematic as CRAFT_ALL_V4 $\rightarrow$ aligned
- See HyperNews message for details about the sign of the changes

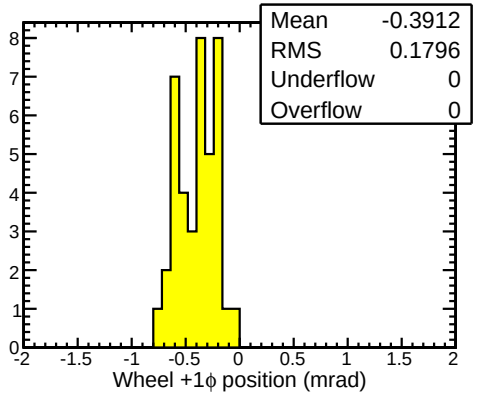
DT alignment, split by wheel

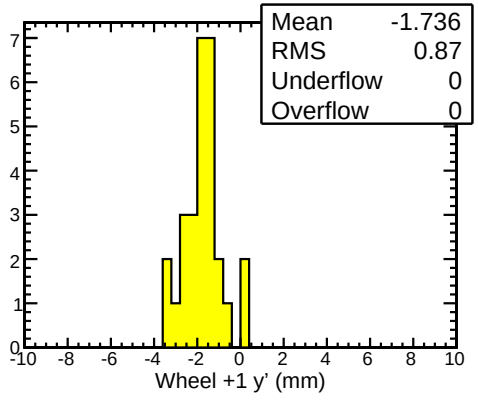








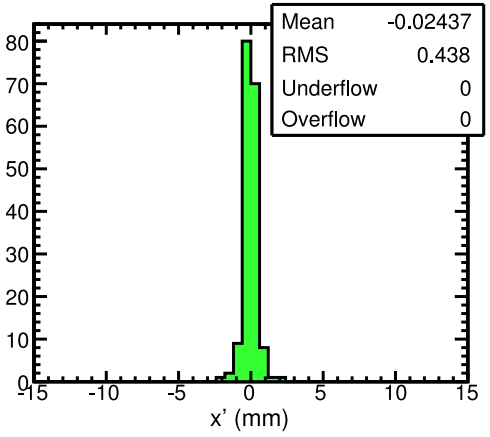


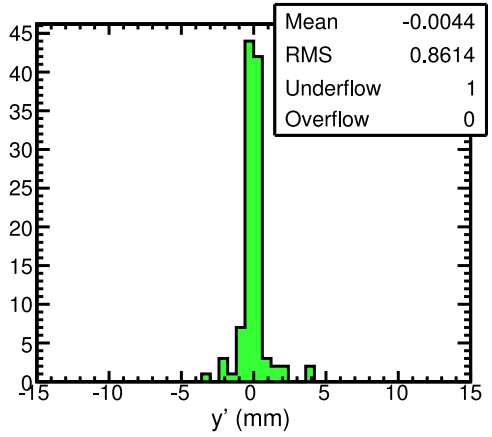


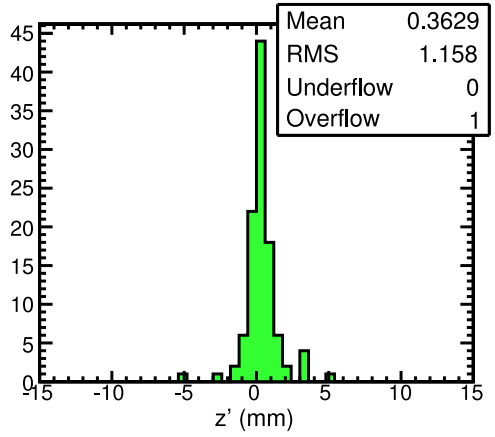
- Chamber differences are correlated by wheel
- Wheel 0 seems to be unchanged relative to the tracker (as expected)
- Wheels ± 1 rotated and translated on the order of 0.2 mrad, 2 mm
- Large translations parallel to beamline (y') in wheel 0 are not yet understood; could be 2008 or 2009 (or real?)

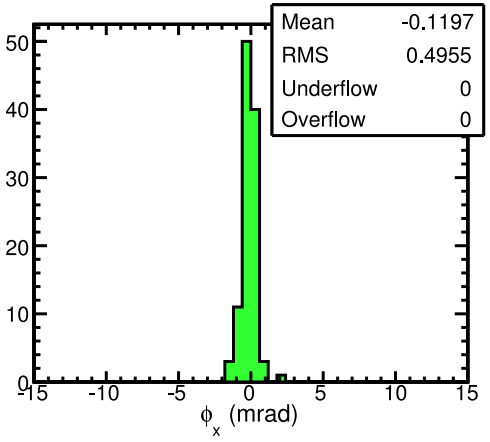
Dependence on tracker

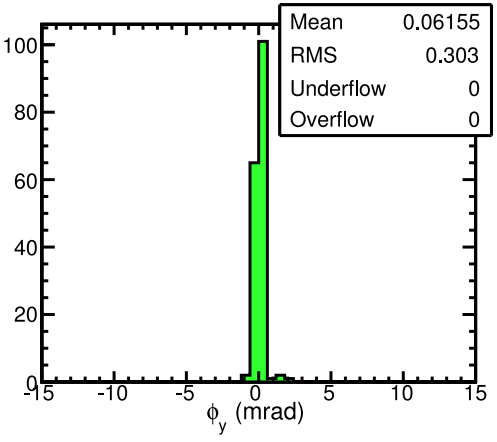
- Plots on previous pages maded with 2009 tracker alignment
- Difference between 2009 muon alignment using (a) 2008 tracker and (b) 2009 tracker shown below

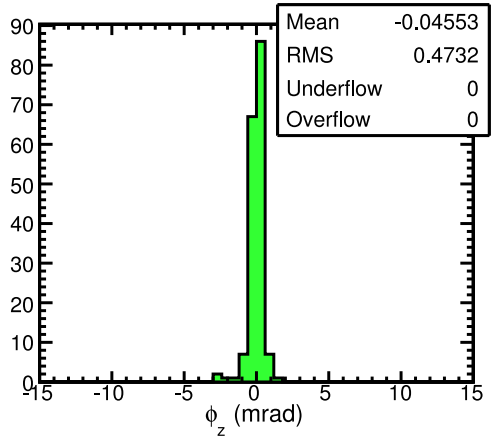








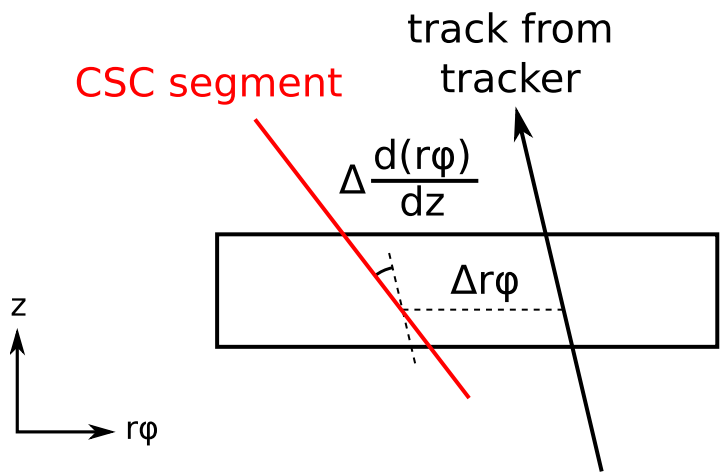


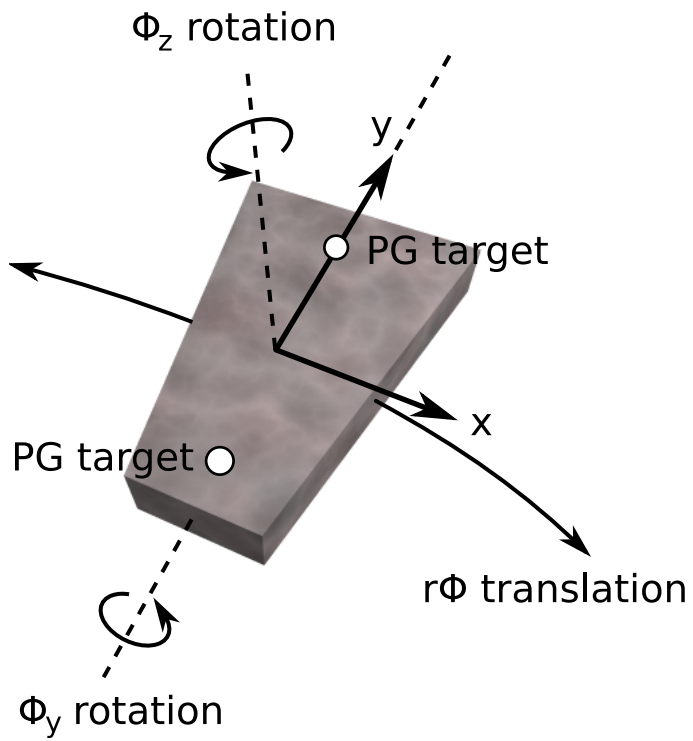


CSC Alignment (method)

- Propagate tracks from the tracker to muon chambers (same as barrel)
- Compare position and angle of track intersection with segment (same as barrel, but in $\Delta r\phi$ and $\Delta\frac{dr\phi}{dz}$, rather than Δx, Δy, $\Delta\frac{dx}{dz}$, $\Delta\frac{dy}{dz}$)

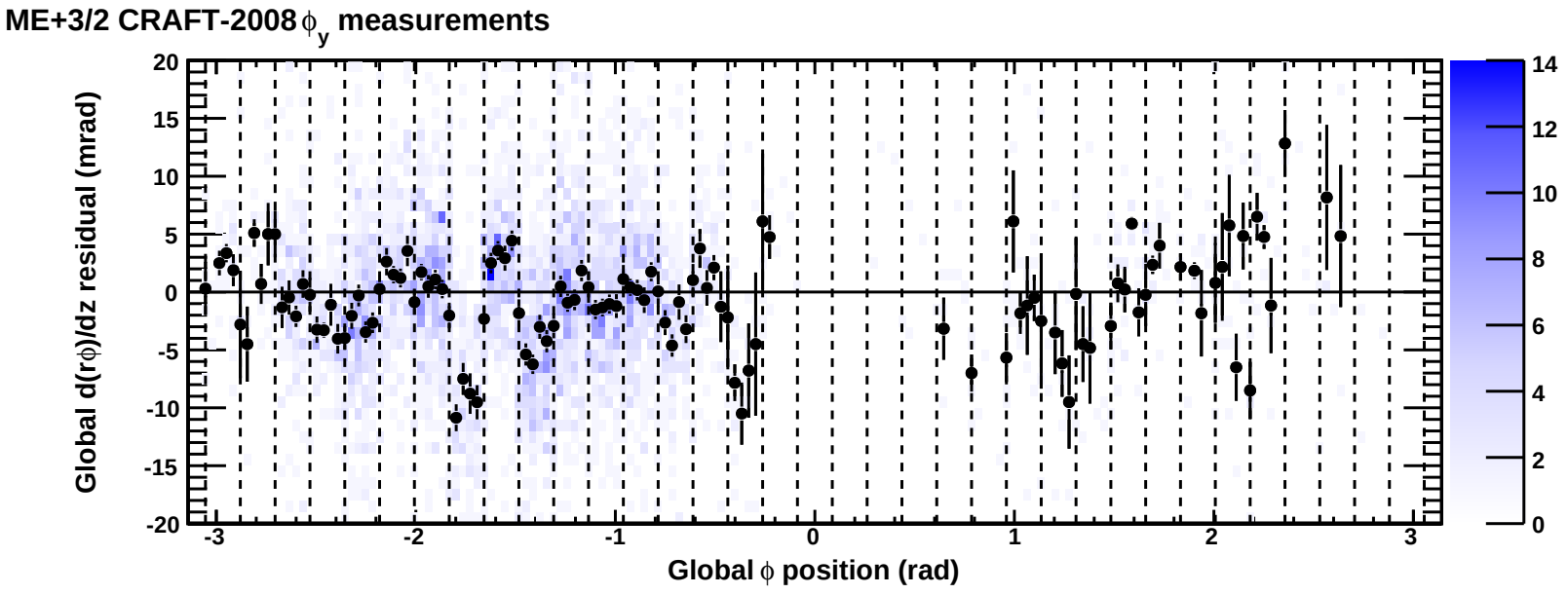
  (actually linear-fit of single-hit residuals, to account for possible curvature)
- "$r\phi$" = direction perpendicular to CSC strips (no granularity)
- $\Delta r\phi$, $\Delta\frac{d(r\phi)}{dz}$ residuals interpreted as $r\phi$ translation, ϕ_y rotation

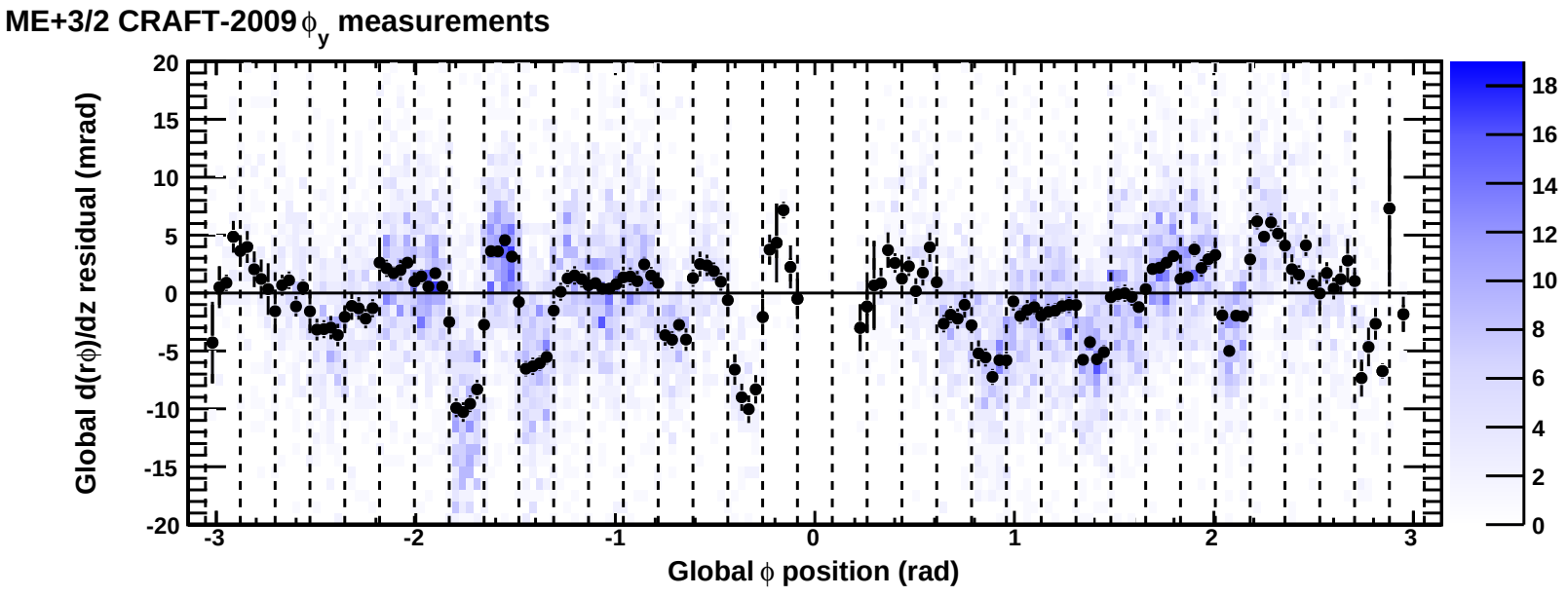




New data are more complete

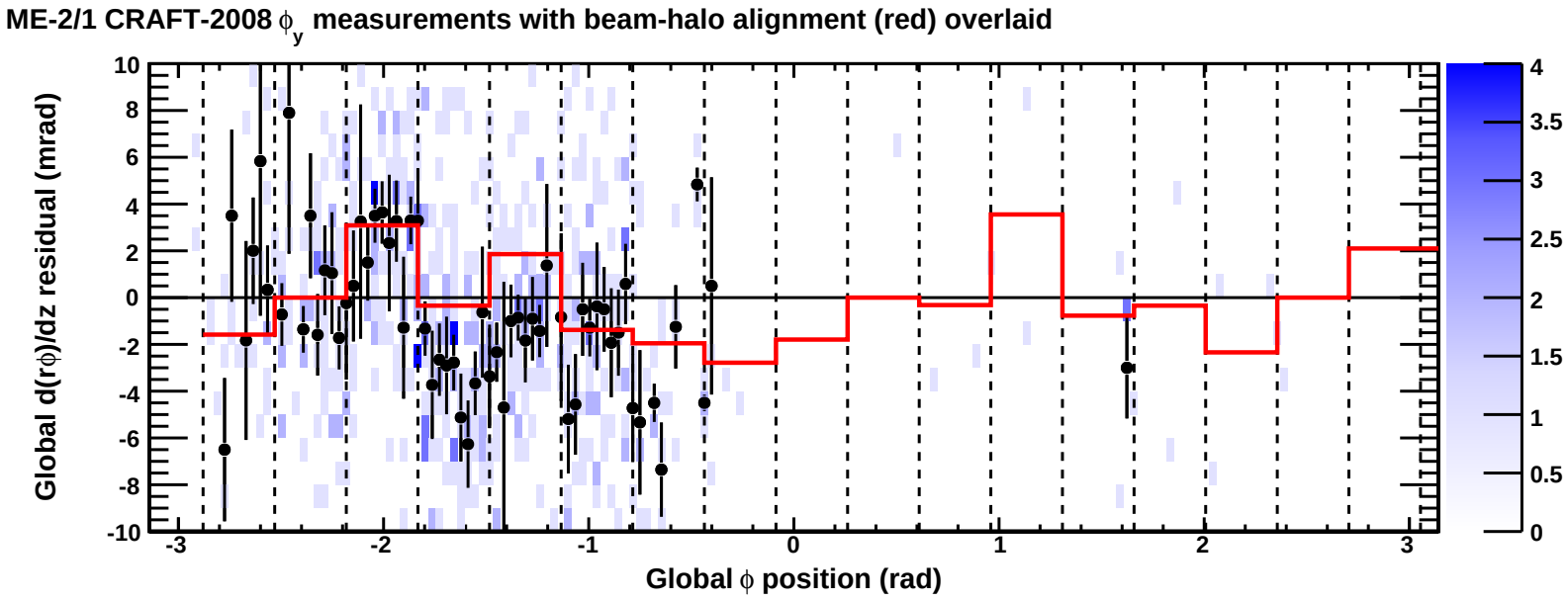
Chamber angles are independent of disk misalignment

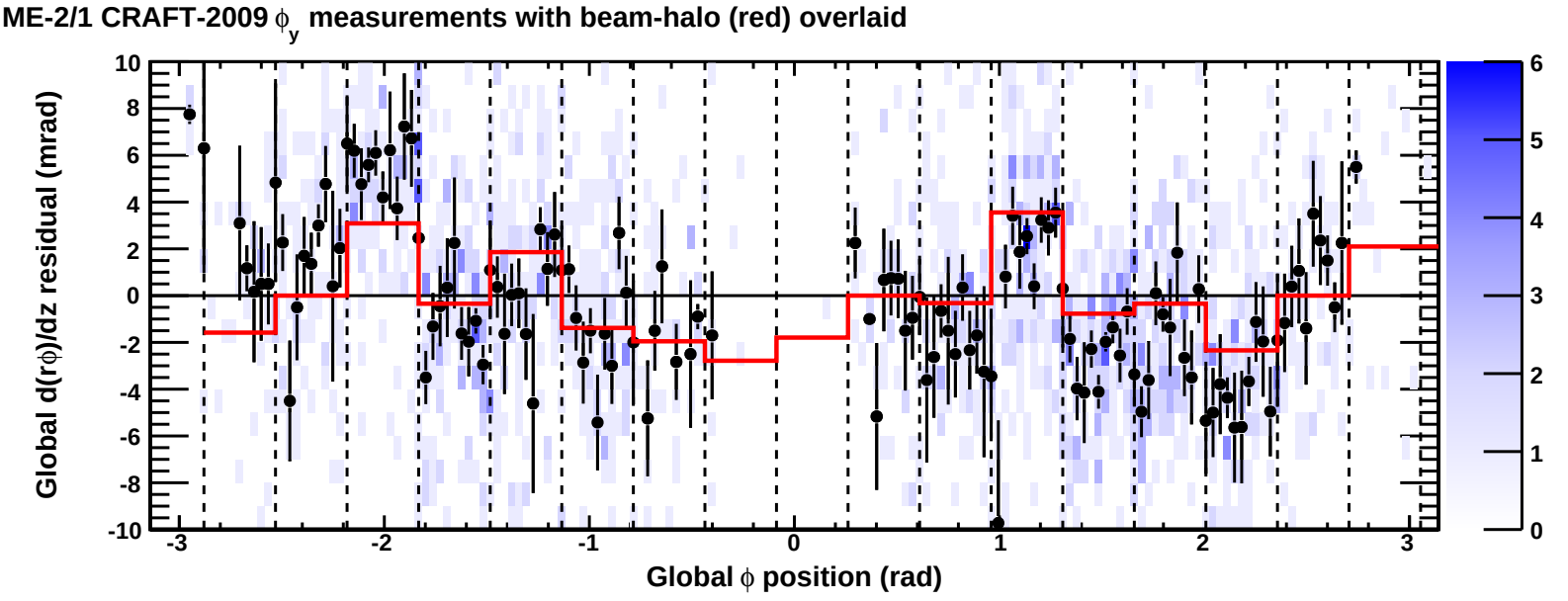




Agreement with beam-halo!

Wider coverage allows us to be sure that the correlation is real

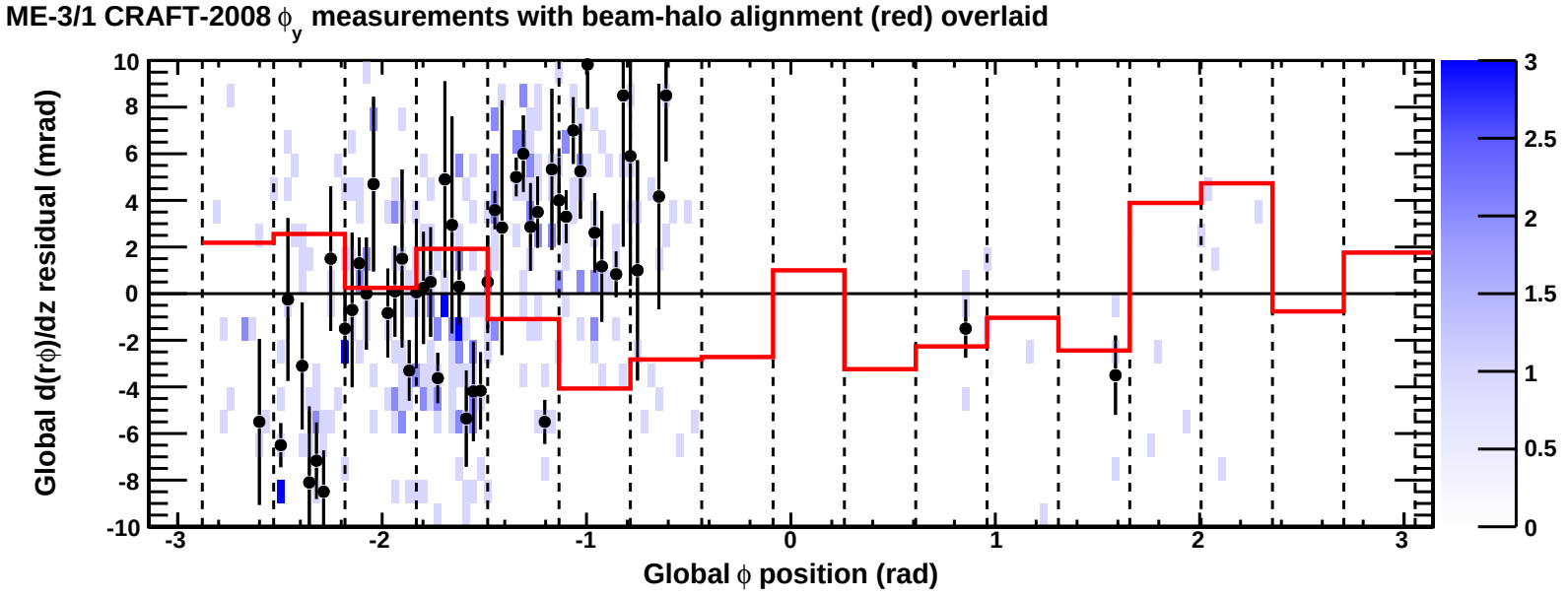


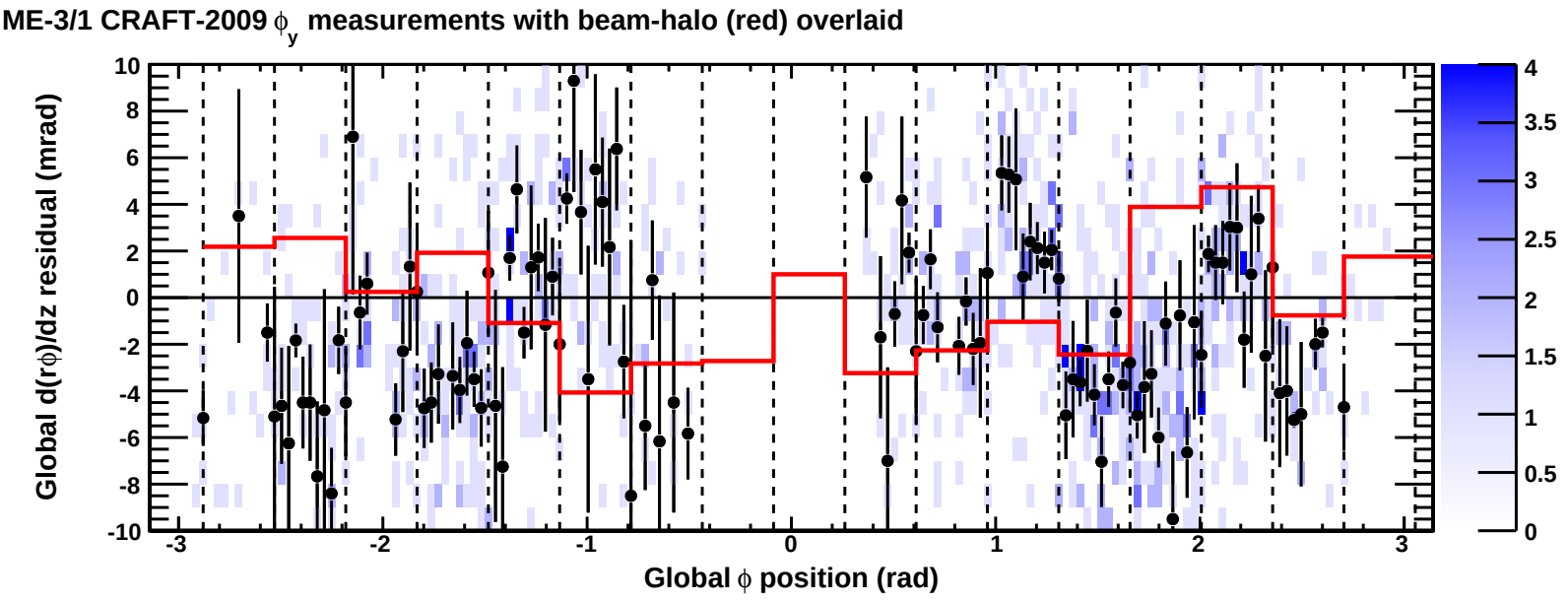


Agreement with beam-halo?

Jim Pivarski

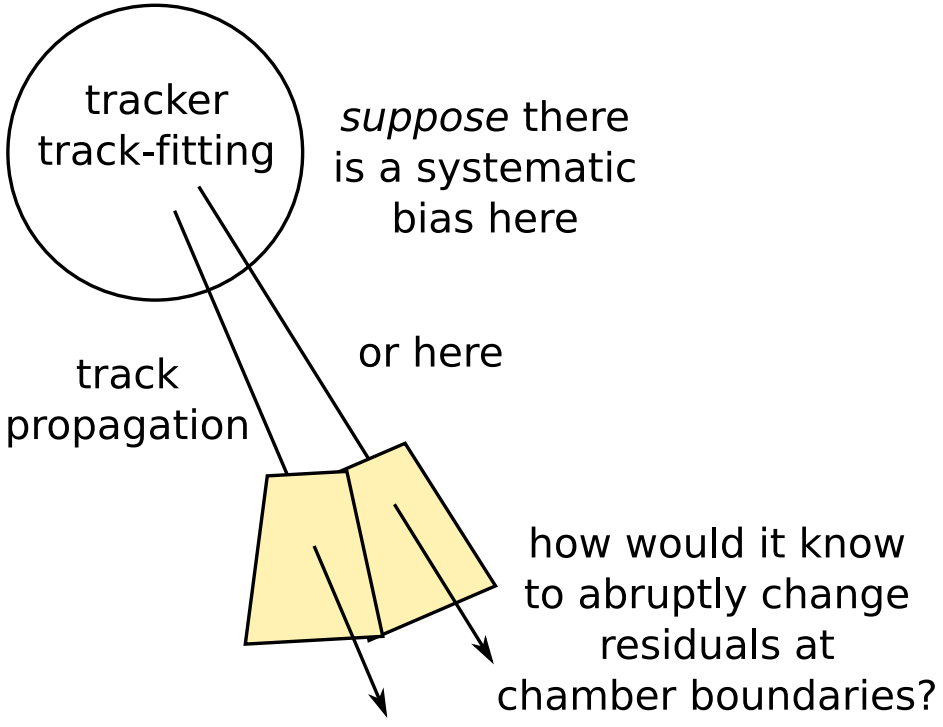
But there are some significant differences: likely real motion





Discontinuities at boundaries

Reminder of an argument about the interpretation of residuals vs. ϕ plots

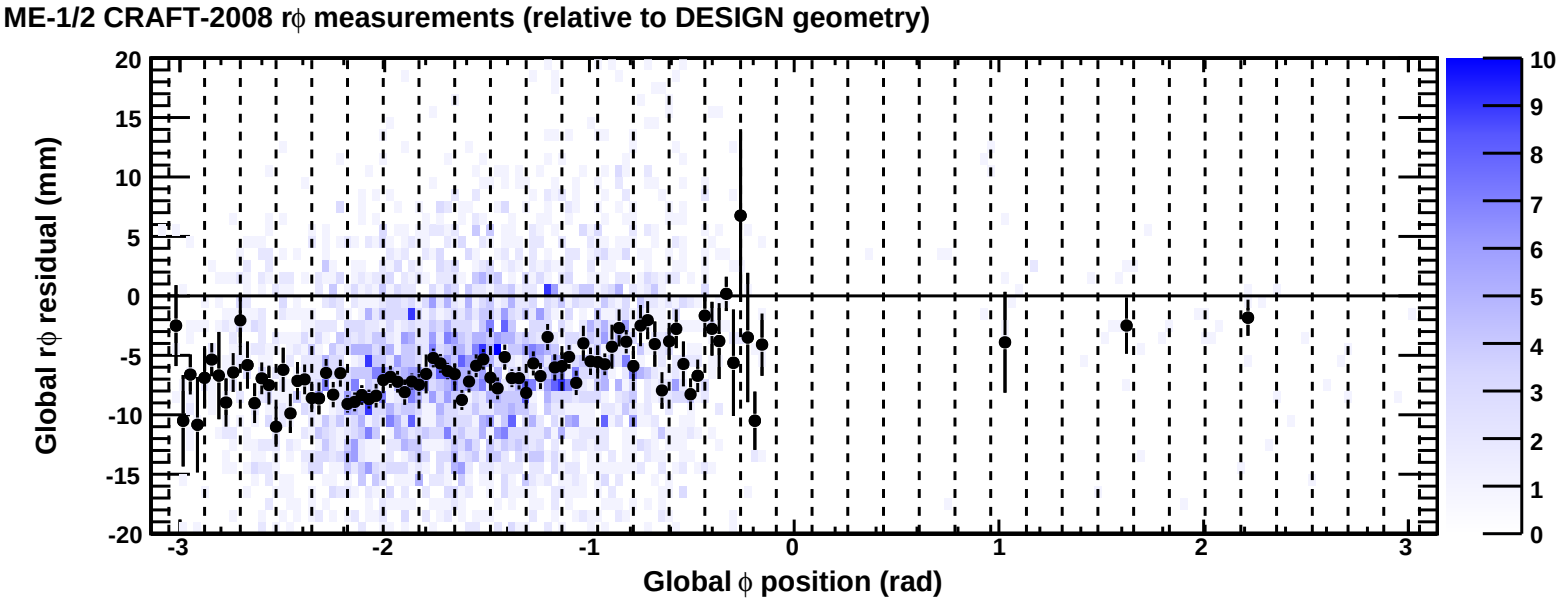


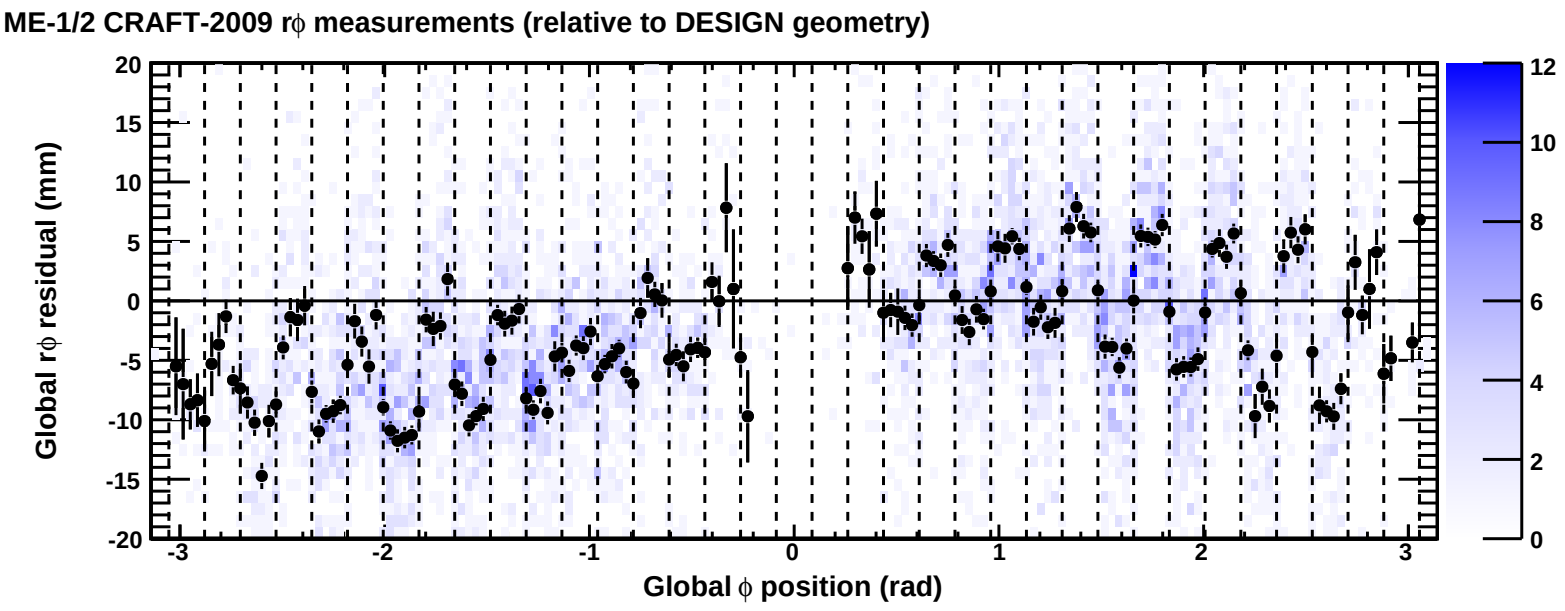
discontinuity at boundary
= difference in alignment

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

$\Delta r\phi$ position residuals

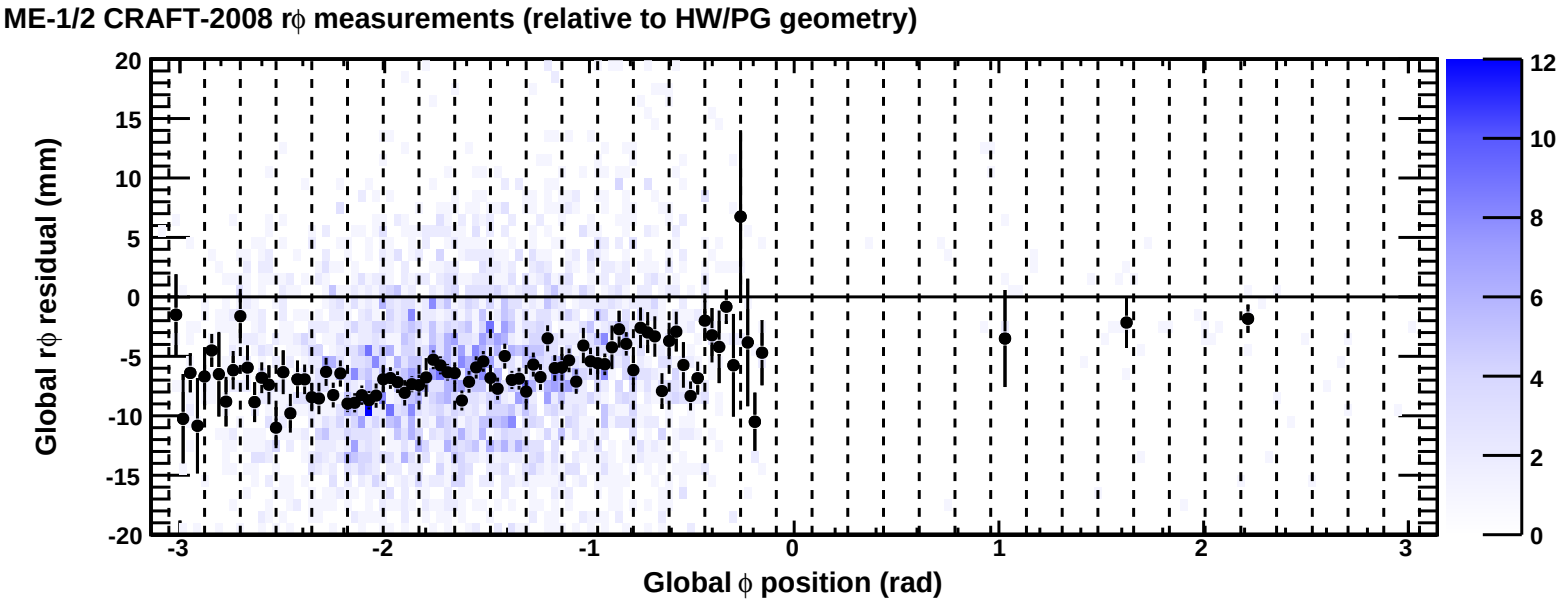
Nicely completed (const + $\sin\phi$ + $\cos\phi$) curve, but why the alteration?

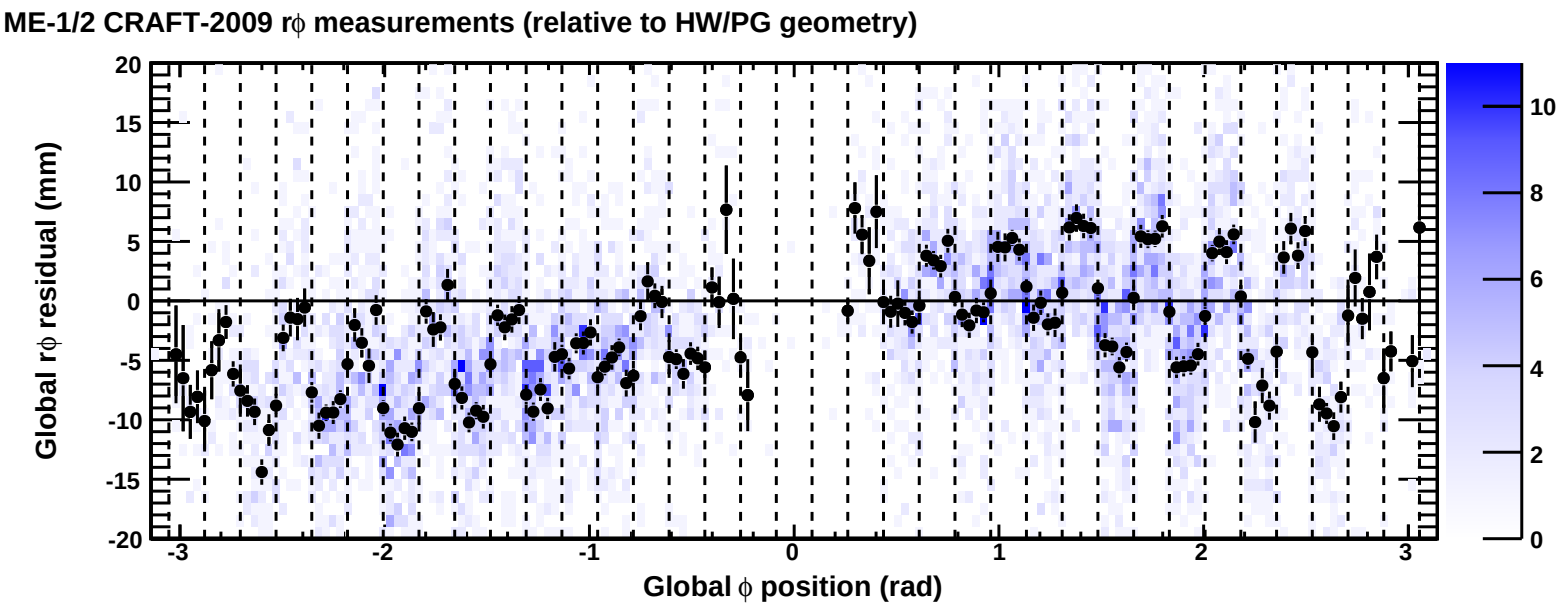




Now with HW/PG geometry...

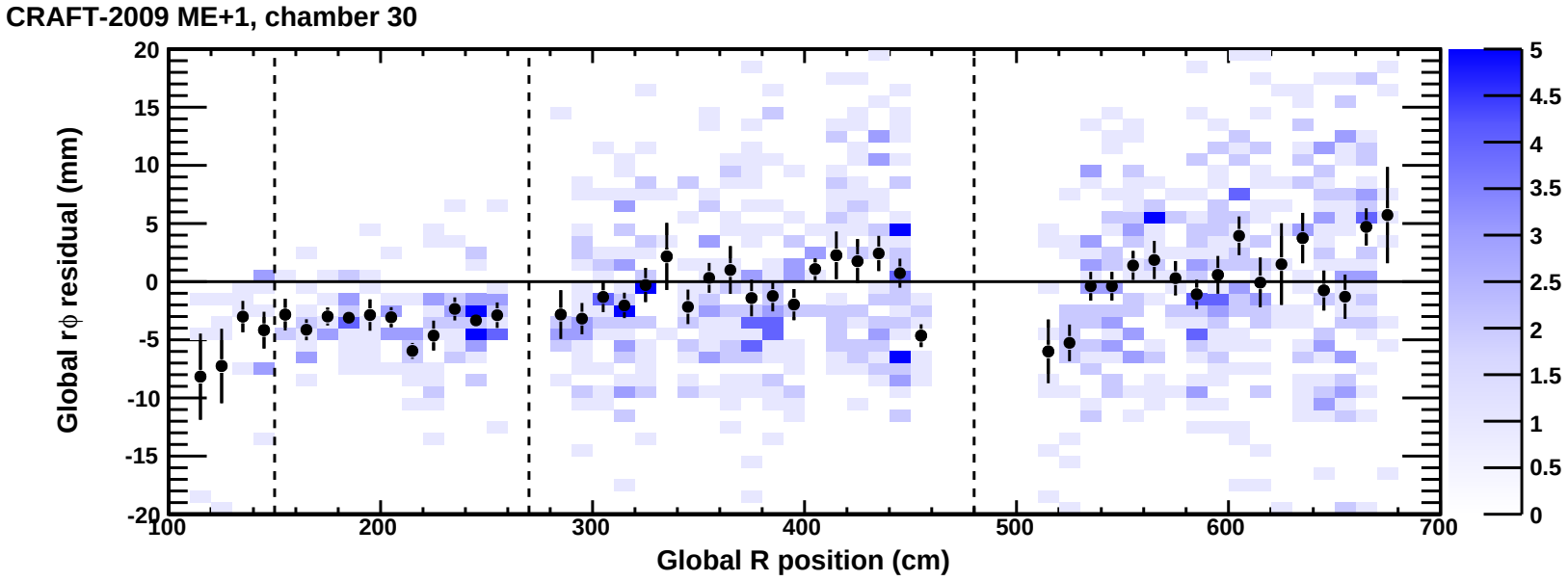
Also insensitive to a 1 cm translation in z

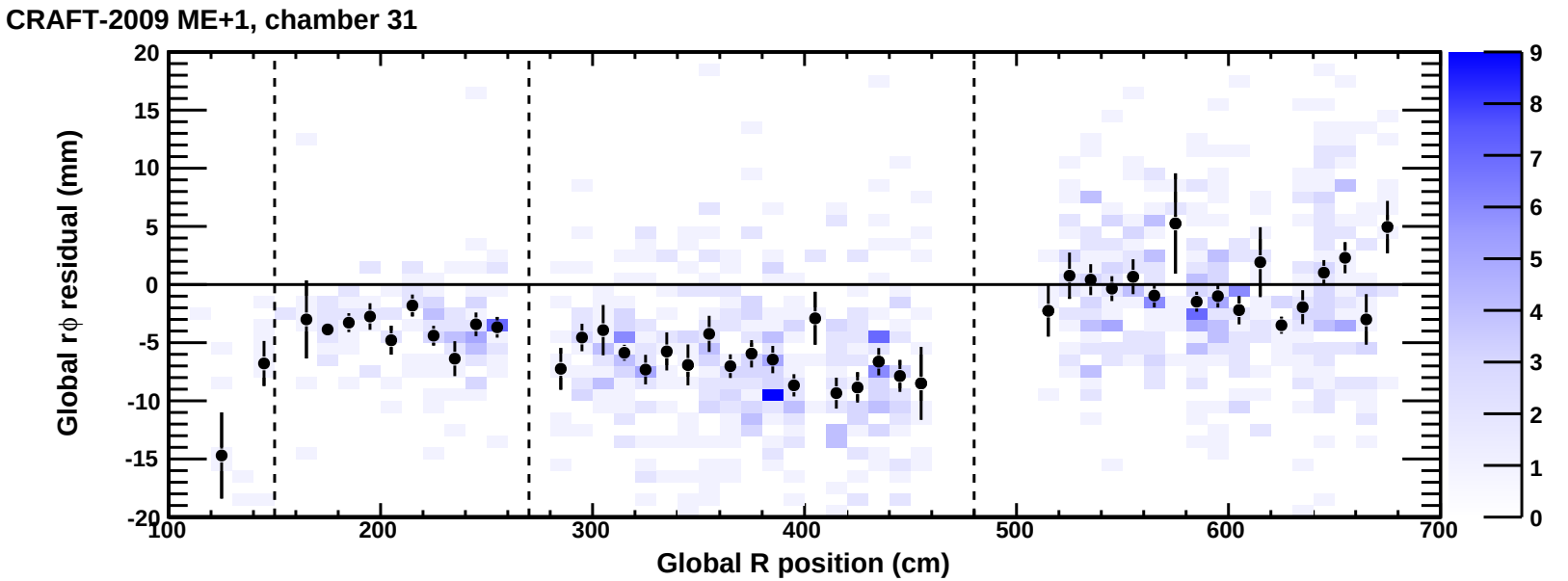




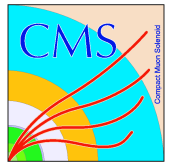
The other projection

Selected two neighboring chambers and plot vs. R; nothing strange





Summary of alteration pattern

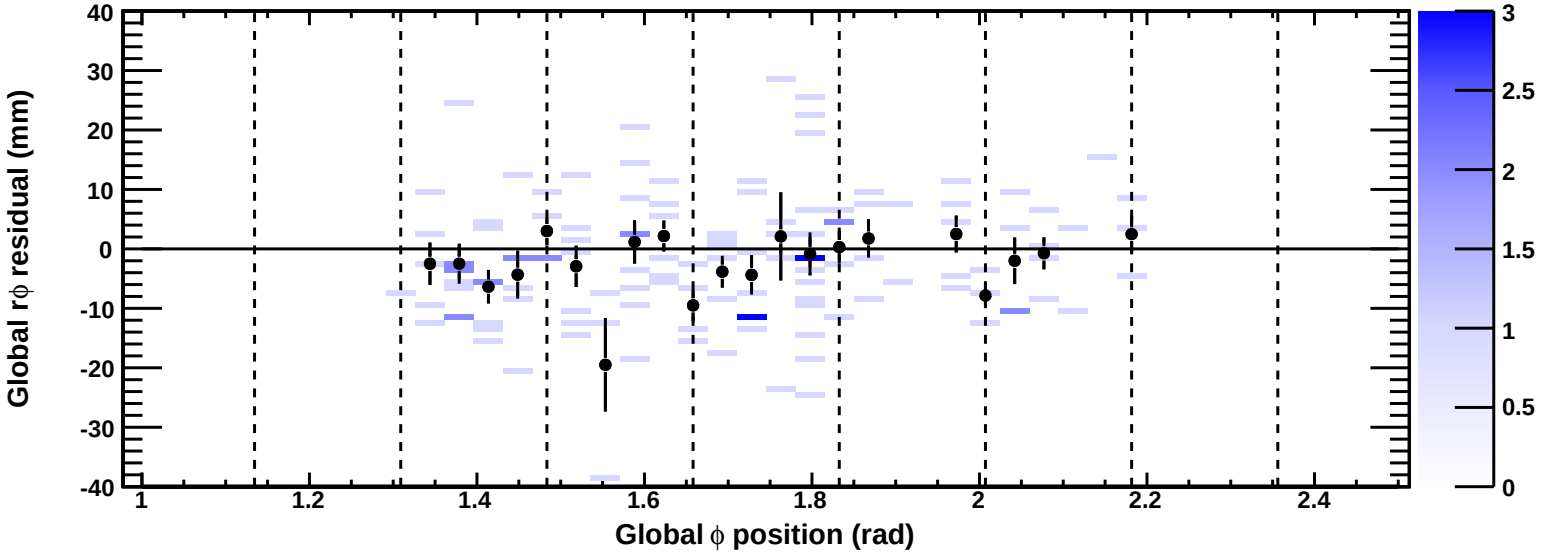


- Only affects ME$\pm x/2$. ME$\pm x/1$ look fine and ME$\pm 1/3$ has a pattern of its own
- Complete set of $\Delta r\phi$ vs. ϕ in backup at the end of this talk
- Reconstruction bug? Has something to do with local reconstruction or the local $\rightarrow$ global coordinate transformation...
  - alignment residuals constructed from CSCRecHit2Ds
  - same plotting code: only CMSSW version for tracks changed (CMSSW_3_1_2, rather than 2_2_11)
- Apart from this, we're in a position to do a high-quality disk alignment

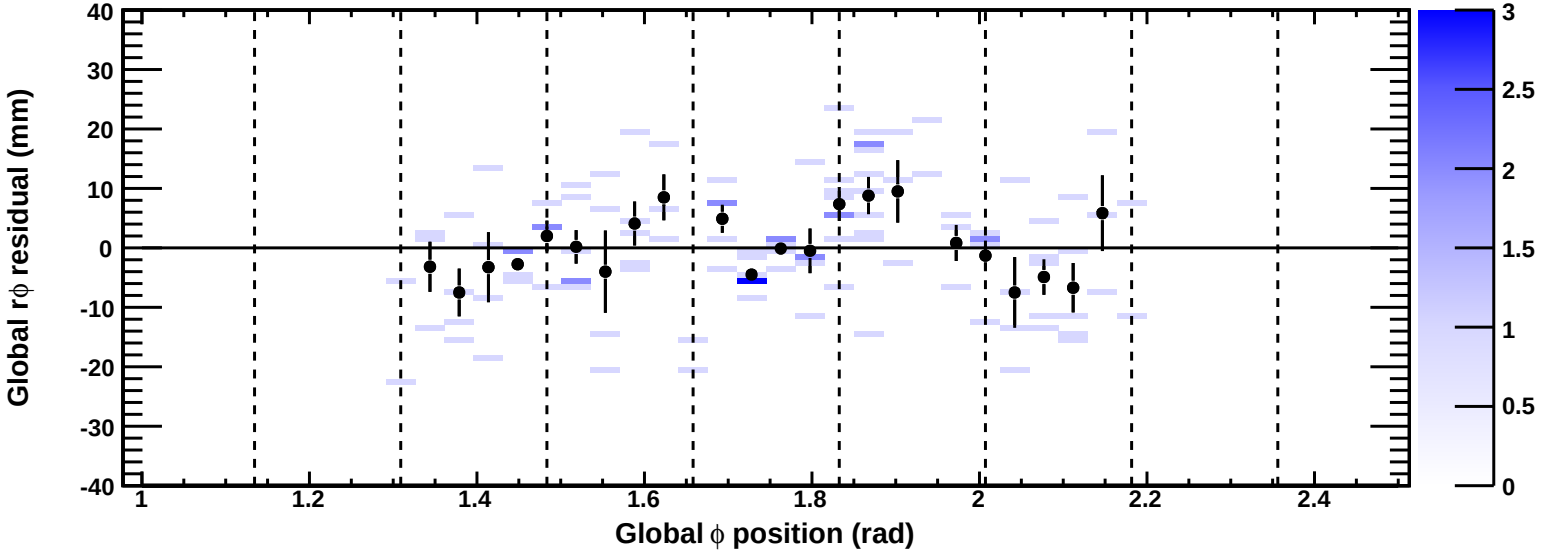
Alignment of ME+4/2?

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)



Work plans (conclusions)

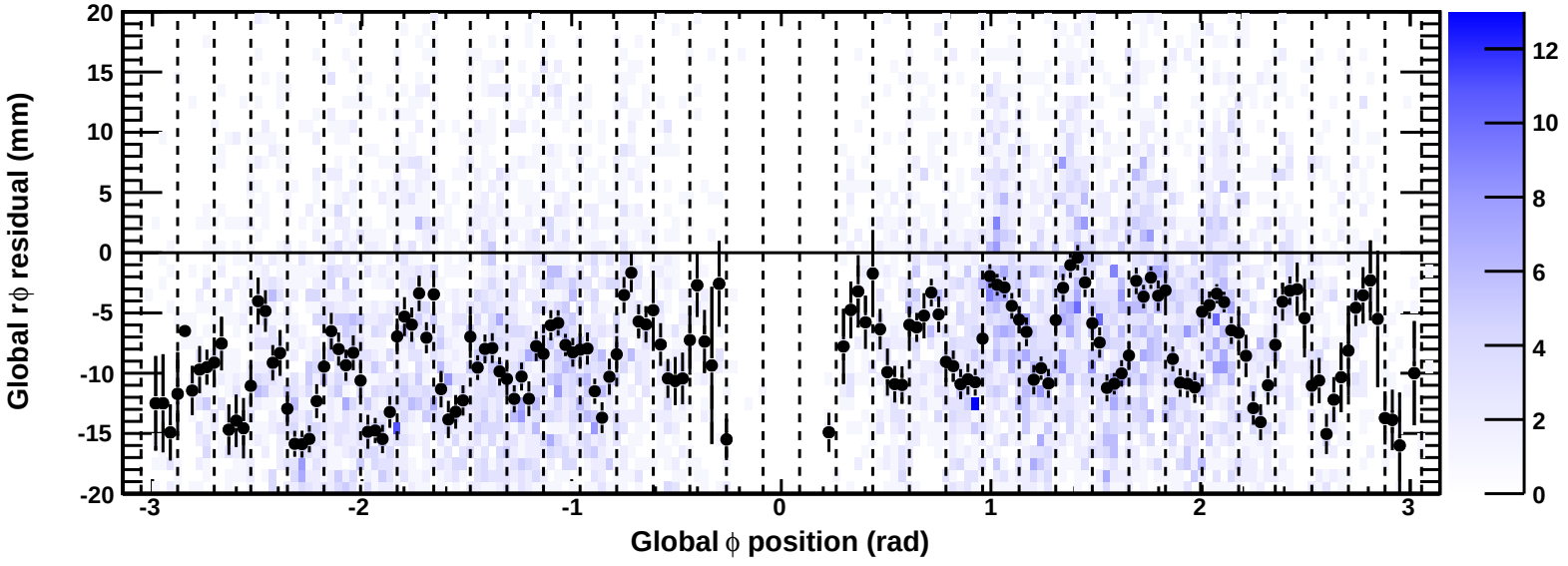
For the barrel

- Minimum of changes, try to deliver aligned geometry quickly
- Possible changes:
  - allow TID/TEC in track fits; if difference is small, include them
  - align parts of wheels ± 2
  - fix ϕ_x to their photogrammetry values (5 DOF alignment)
- Check compatibility of the three $\vec{B} = 3.8$ T periods

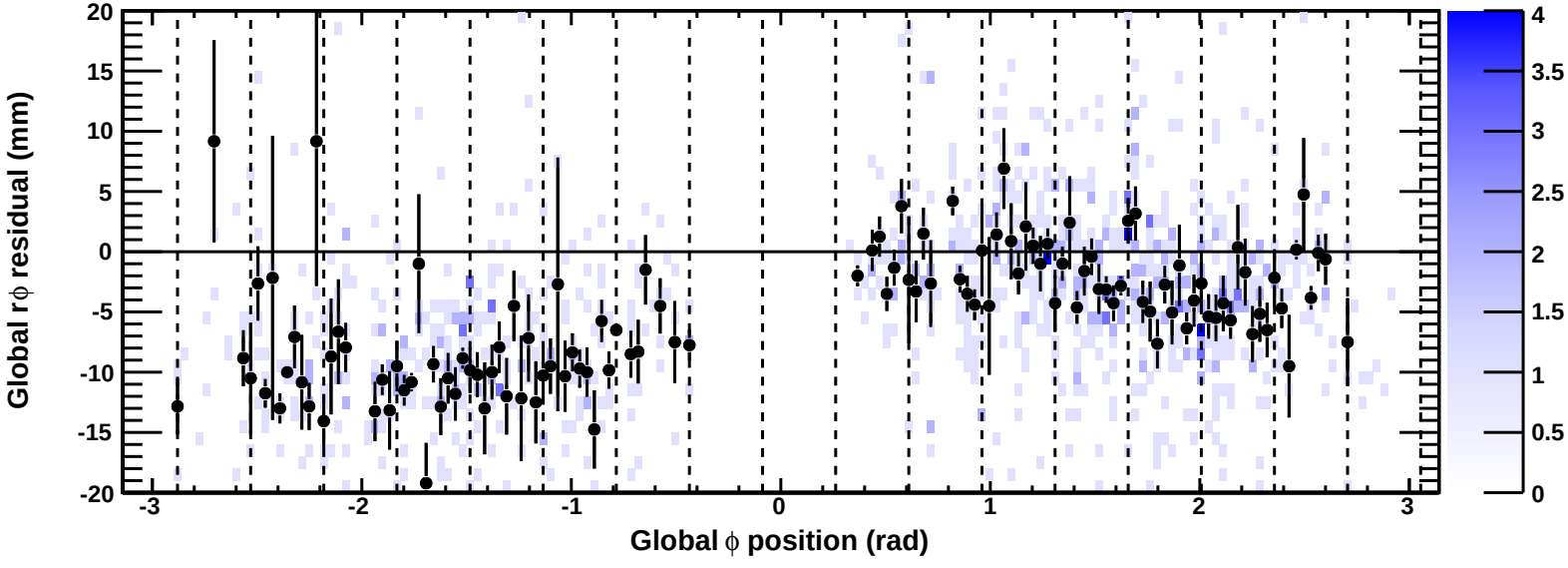
For the endcap

- Find and fix the alternation bug! Could be in geometry, local reconstruction, track reconstruction
- Align disks by hand in an interactive analysis (fit to const $+ \sin\phi + \cos\phi$ curve)
- Run automated procedure to align chamber x, ϕ_y, and ϕ_z (small chamber corrections after large disk correction)

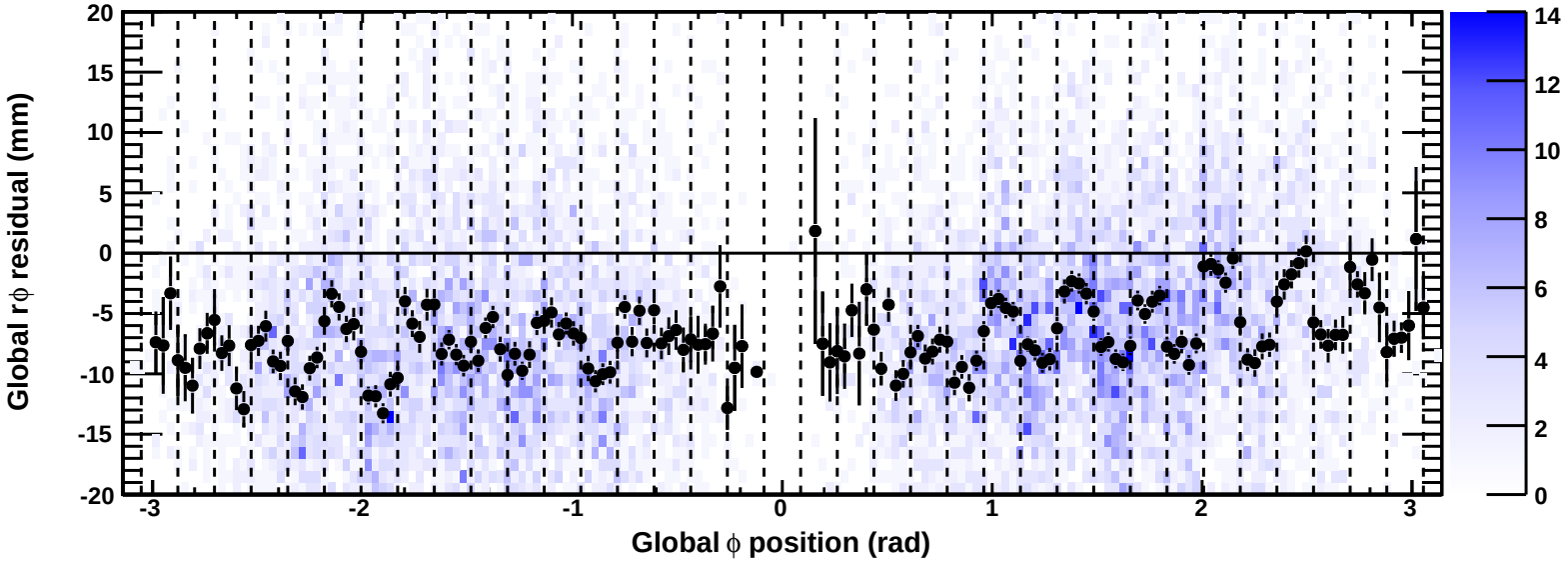
ME-3/2 CRAFT-2009 (HW/PG geometry



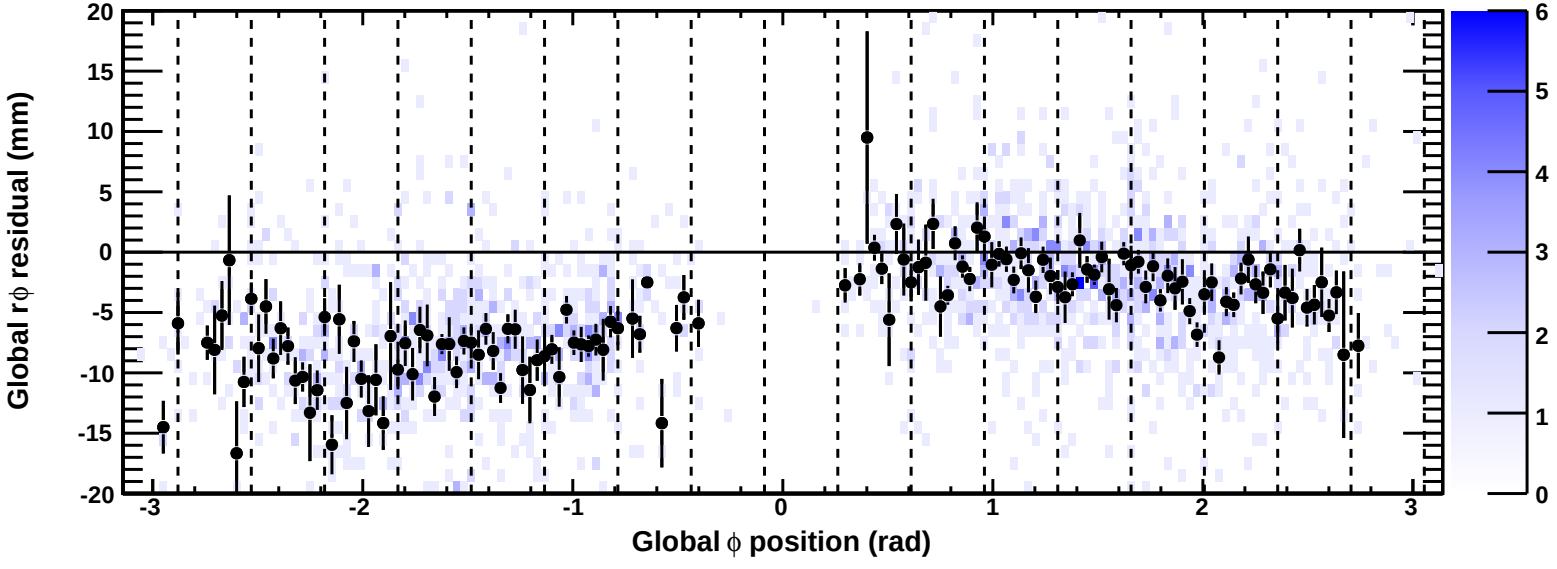
ME-3/1 CRAFT-2009 (HW/PG geometry



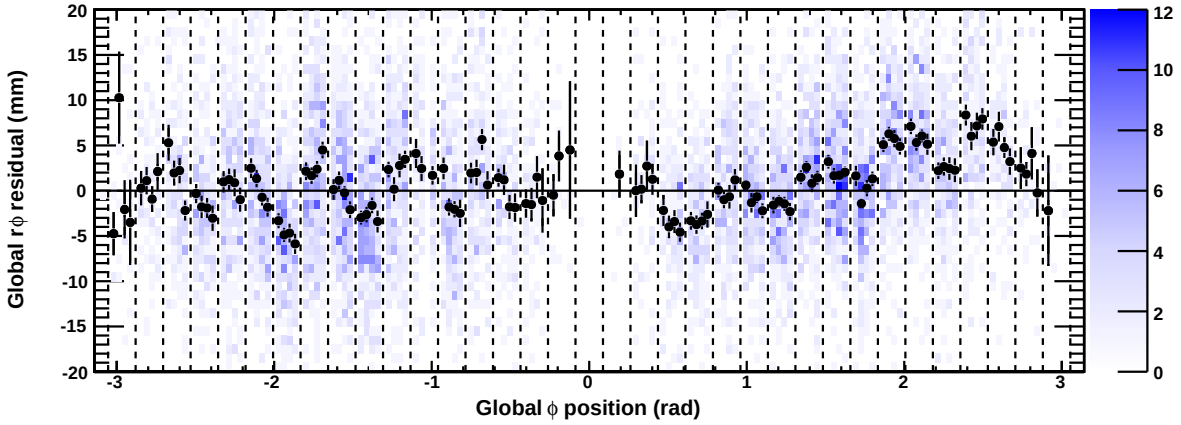
ME-2/2 CRAFT-2009 (HW/PG geometry



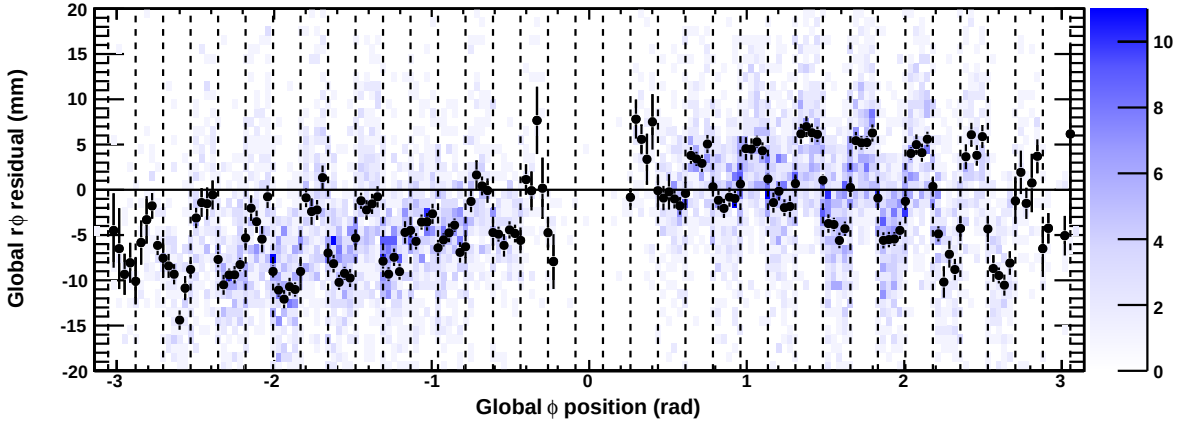
ME-2/1 CRAFT-2009 (HW/PG geometry



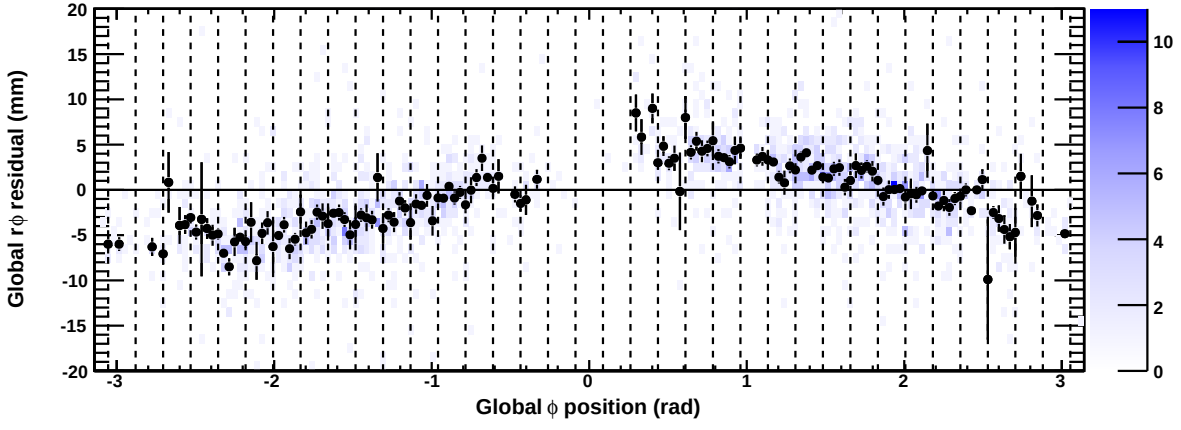
ME-1/3 CRAFT-2009 (HW/PG geometry



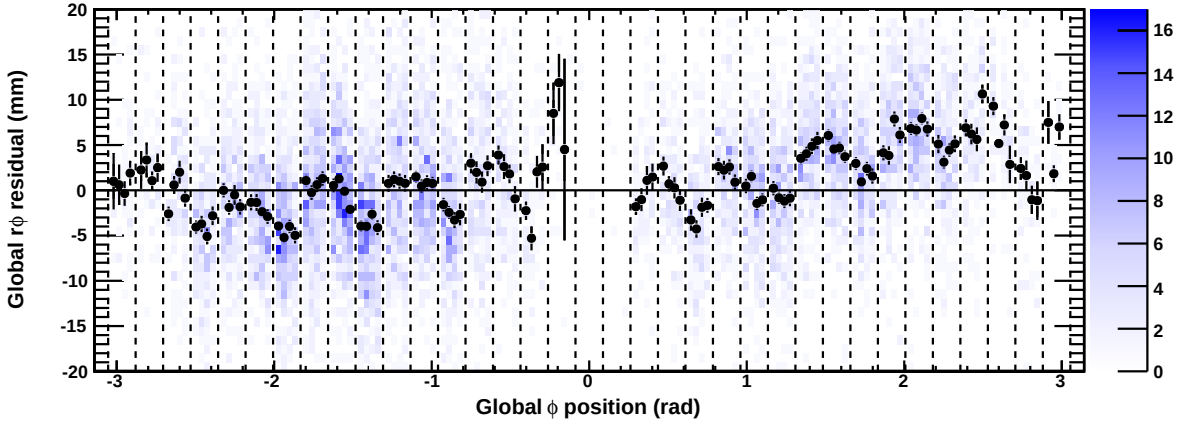
ME-1/2 CRAFT-2009 (HW/PG geometry



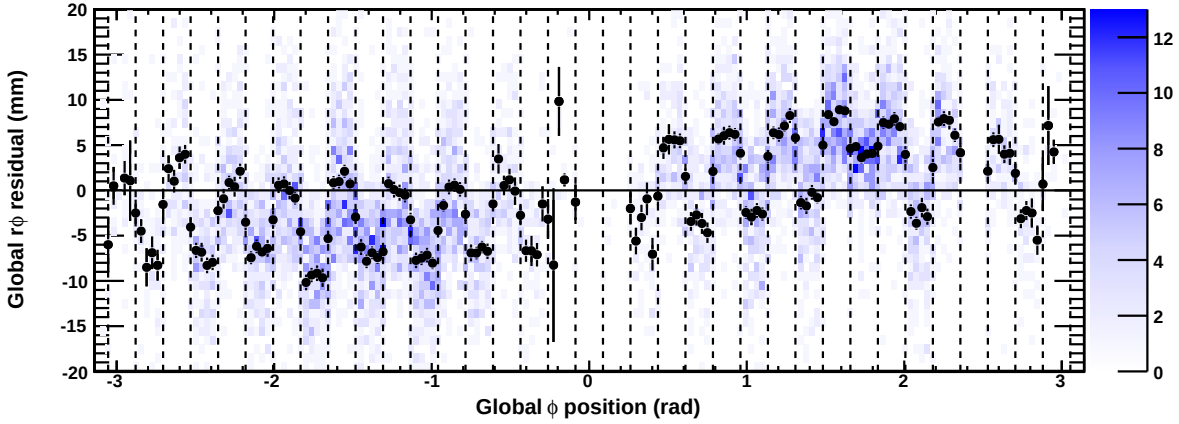
ME-1/1 CRAFT-2009 (HW/PG geometry



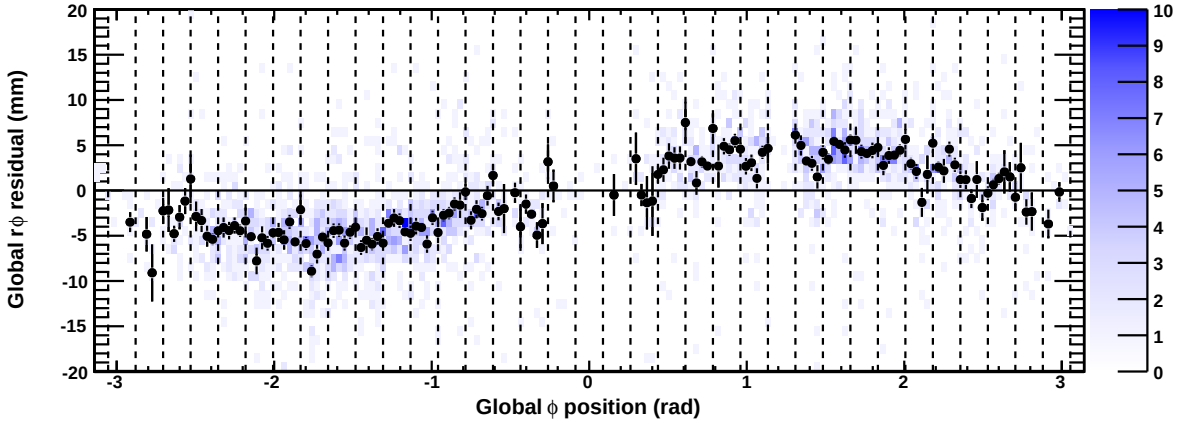
ME+1/3 CRAFT-2009 (HW/PG geometry



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

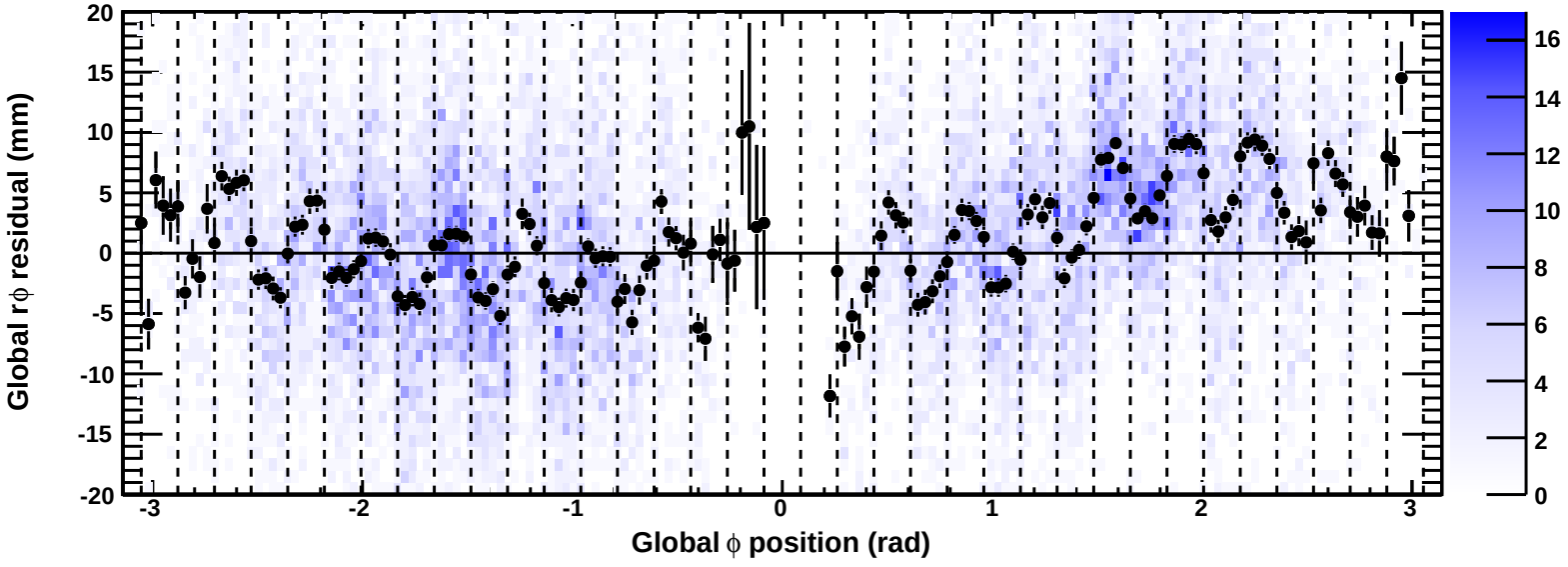


ME+1/1 CRAFT-2009 (HW/PG geometry

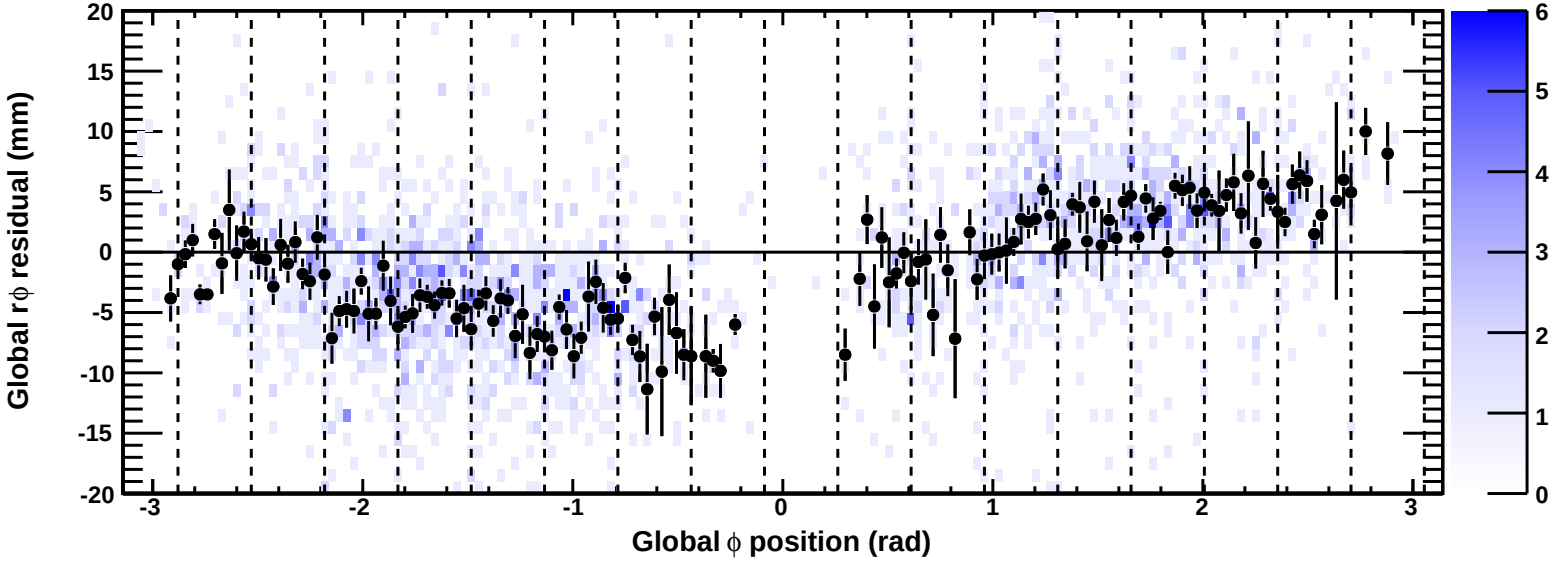


clear 5 mm
x translation

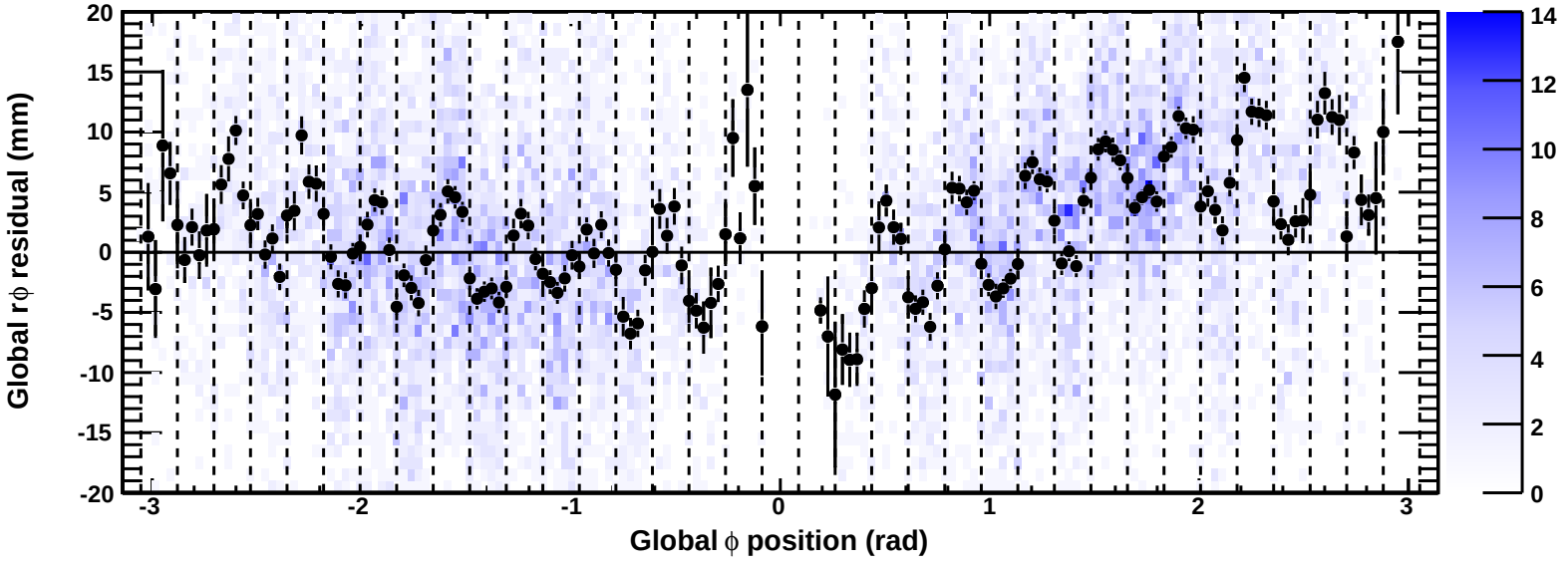
ME+2/2 CRAFT-2009 (HW/PG geometry



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



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



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