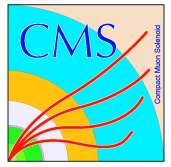


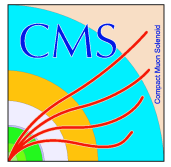
Muon Alignment with CRAFT-2009 Data

Jim Pivarski

Texas A&M University

8 September, 2009

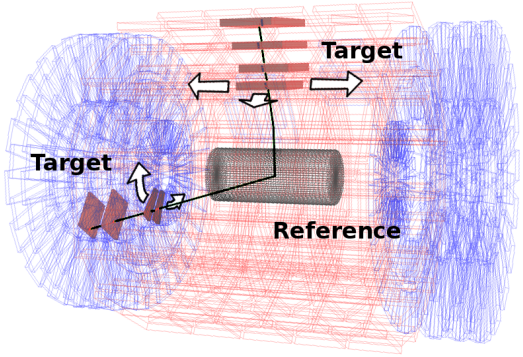
Outline



- Reminder of the methods
- Status of hardware alignment reconstruction
- Preliminary DT results from tracks
- Preliminary CSC results from tracks

Reminder of the methods

(with a new name)



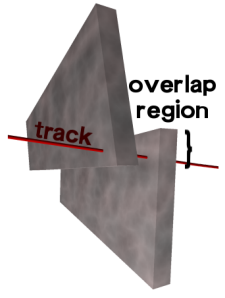
- Reference-Target (R-T): align a Target set of chambers using globalMuon tracks from a fixed Reference (tracker)

  (The Algorithm Formerly Known as "HIP")

  Came up in paper-draft process: spirit of the procedure is different from HIP

  Also, software module is named MuonAlignmentFromReference, not HIP

- Millepede (future): combine local segment and globalMuon data into one fit. (Now): reproduce R-T with globalMuons only



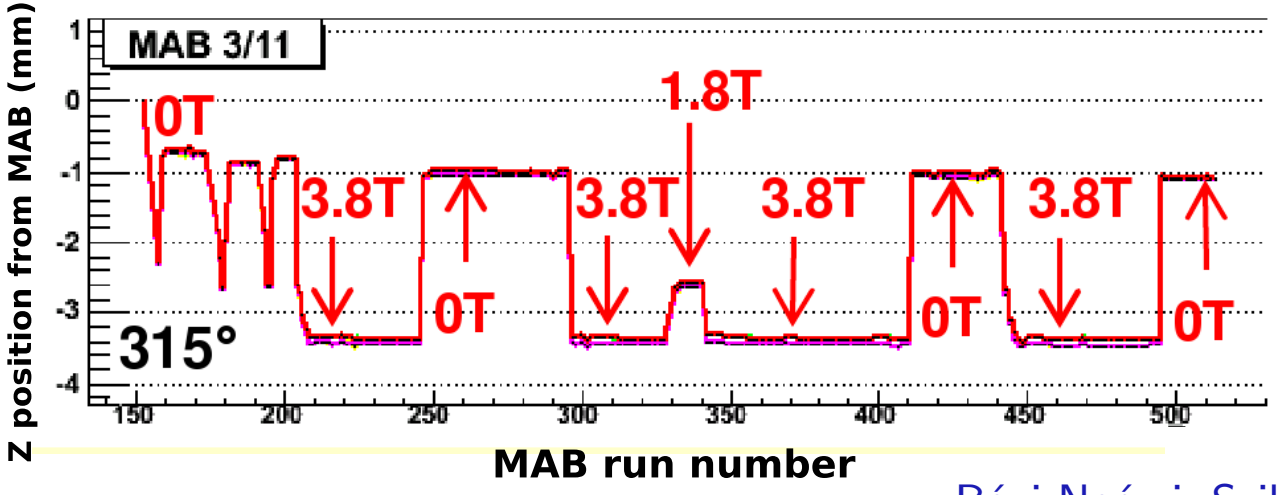
- CSC-Overlaps: reconstruct CSC ring geometry using local segments that overlap along the CSC edges

- Barrel, endcap, and link hardware systems: reconstruct geometry from external measurements

Status of hardware reco

- All systems read out for most of CRAFT-2009
  - endcap read out until Aug 25 (LV problem)
- Preliminary geometries built from barrel and link data, studies of stability and dependence on $\vec{B}$
  - soon will be in a form that can be compared with track-based results

CRAFT-2009 barrel response to $\vec{B}$:

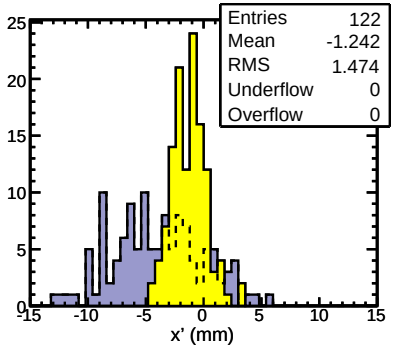


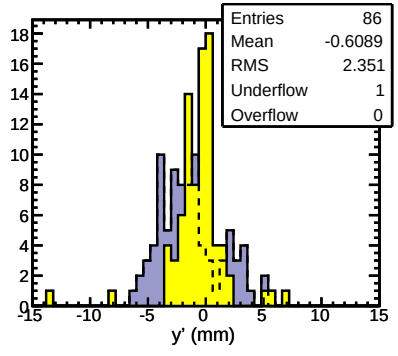
Béni Noémi, Szillási Zoltán

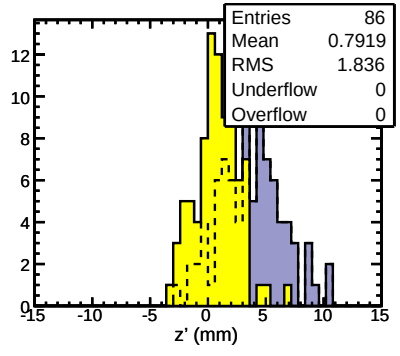
Prelim. track-based DT results

- Track-based procedures tuned in CRAFT-2008
  - identified and responded to the most important propagation effects in real data ($\vec{B}(\vec{x})$, non-Gaussian tails, x-$\frac{dx}{dz}$ correlation)
- Applied exactly the same procedure in 2009 (now an automated script)
  - below: differences in each degree of freedom, for each chamber
  - grey: unaligned 2008 $\longrightarrow$ aligned 2008 (broad, systematic)
  - yellow: aligned 2008 $\longrightarrow$ aligned 2009 (narrower, especially angles)

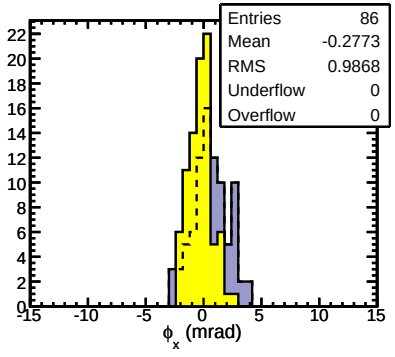
translational degrees of freedom

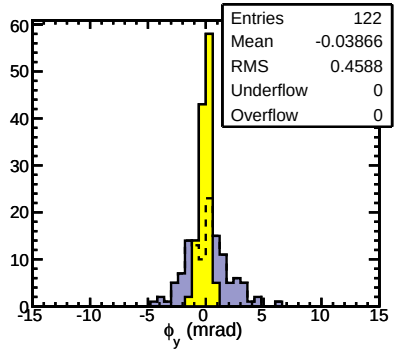


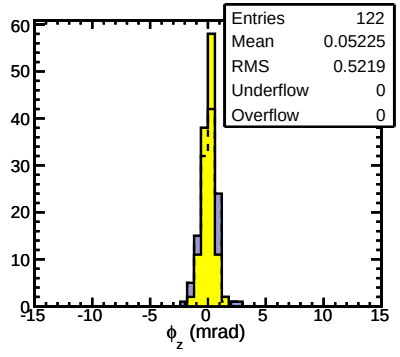




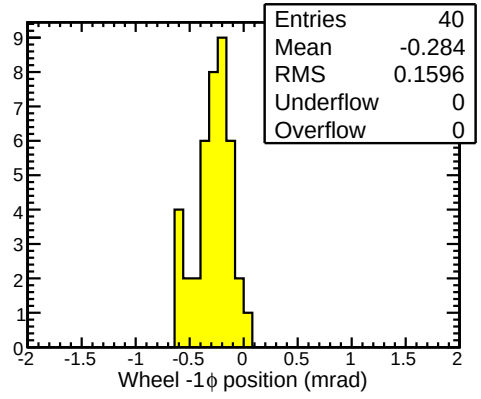
rotational degrees of freedom

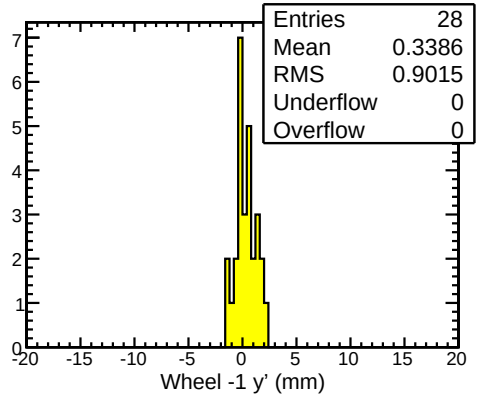


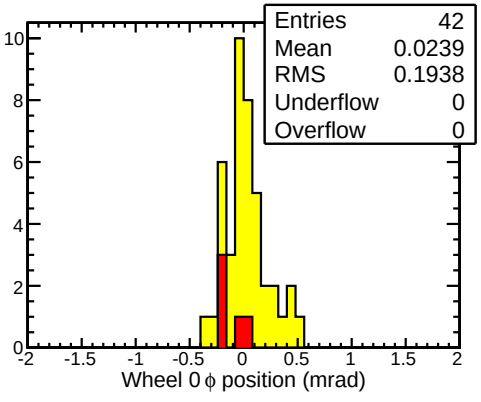


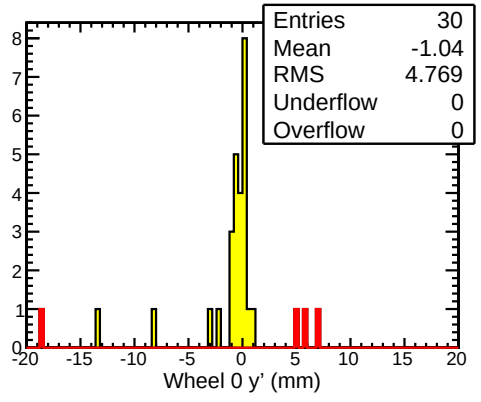


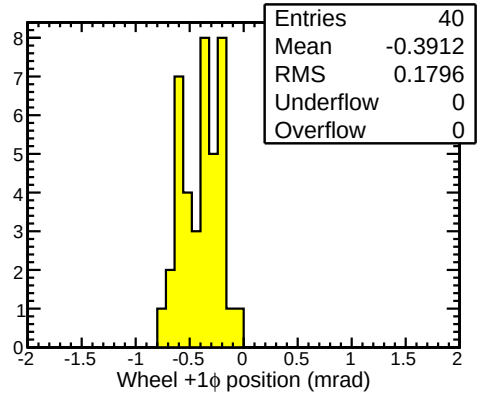
DT translations by wheel

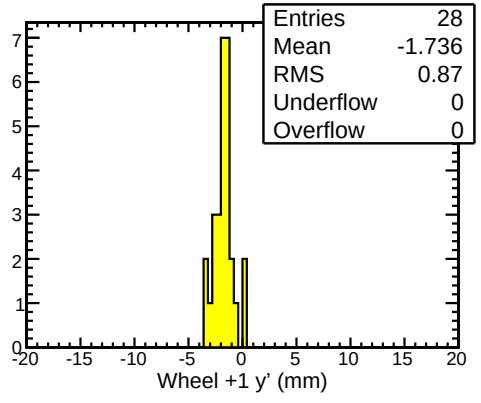












- Collective motion correlated by wheel

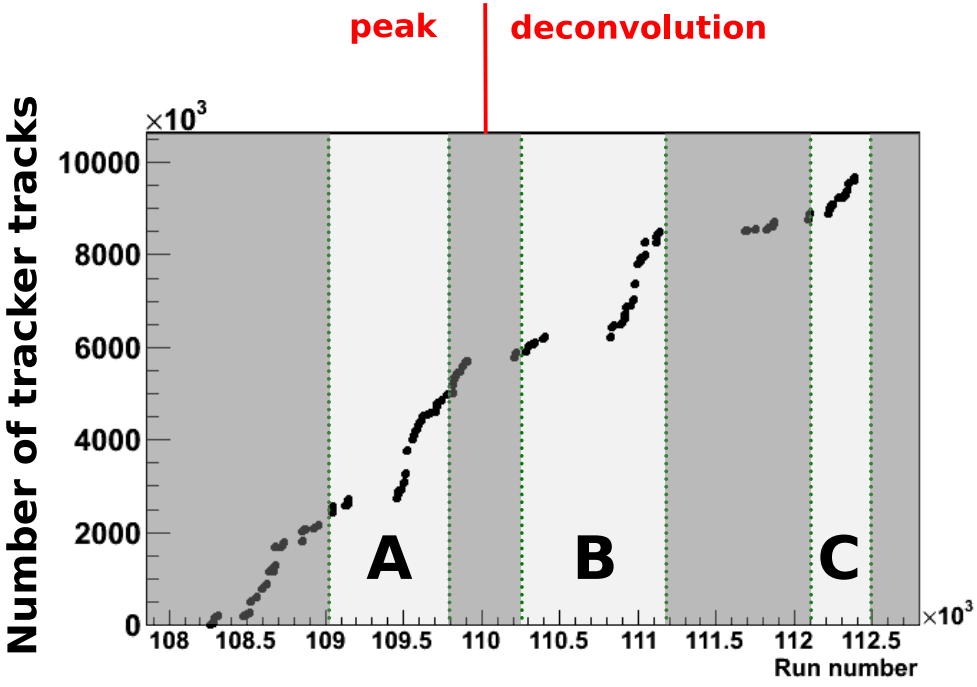
	ϕ (mrad)	z (mm)
wheel -1	-0.28	0.34
wheel 0	-0.02	-0.16*
wheel $+1$	-0.39	-1.74

*not including outliers

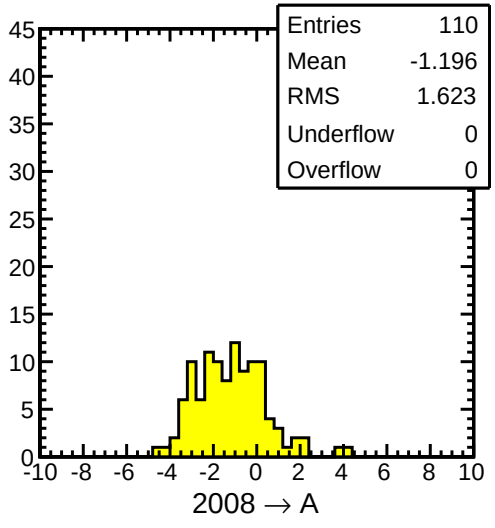
- Only wheel 0 stationary relative to tracker
- 4 out of 8 outliers identified as chambers that were moved between CRAFTs (red)

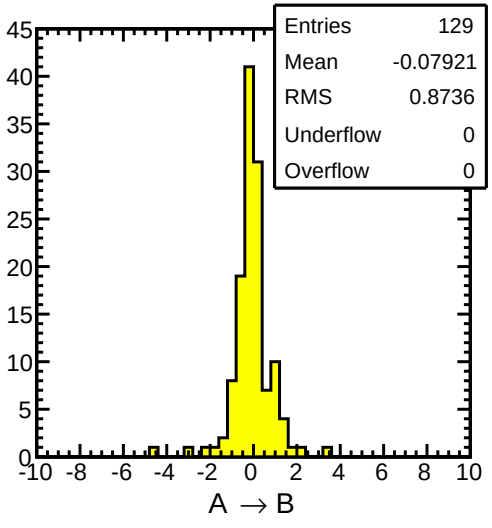
Alberto Benvenuti

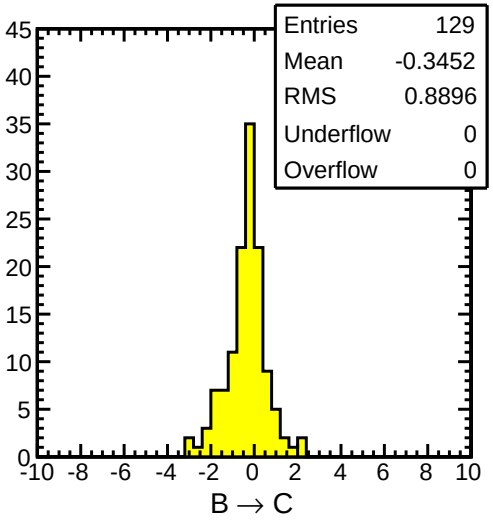
DTs vs. time



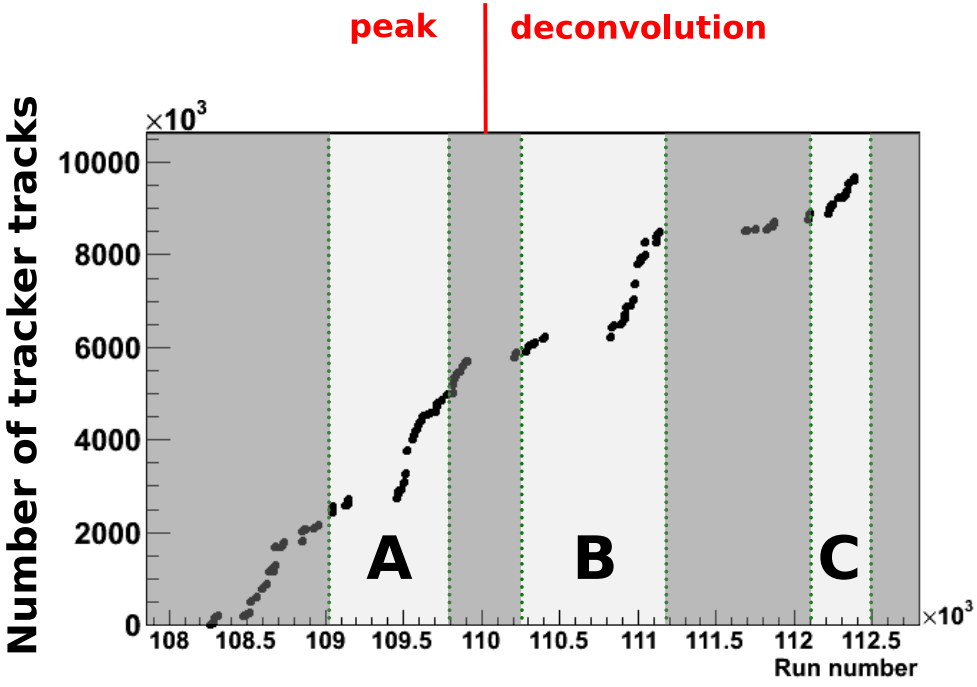
- Three $B = 3.8$ T periods in CRAFT-2009
- Align each independently, observe differences
- Below: $r\phi$ positions



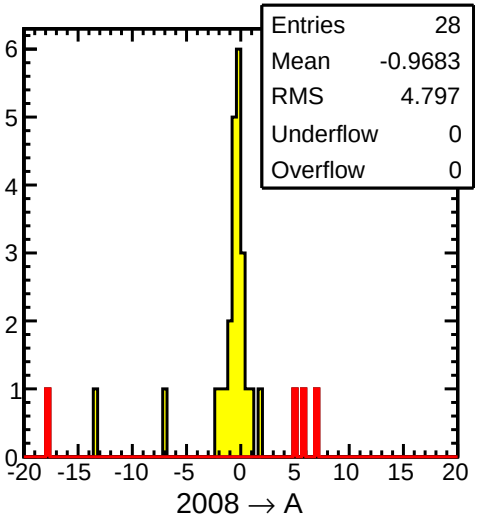


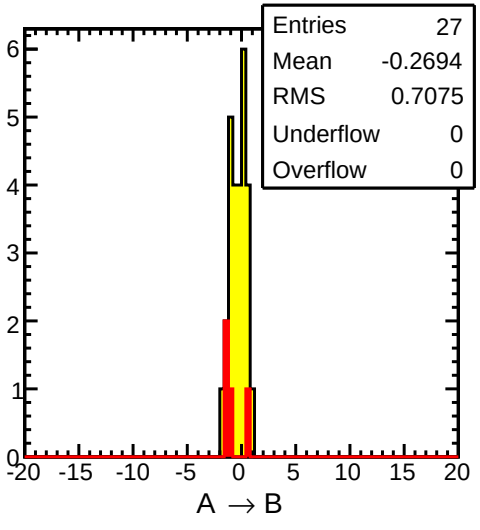


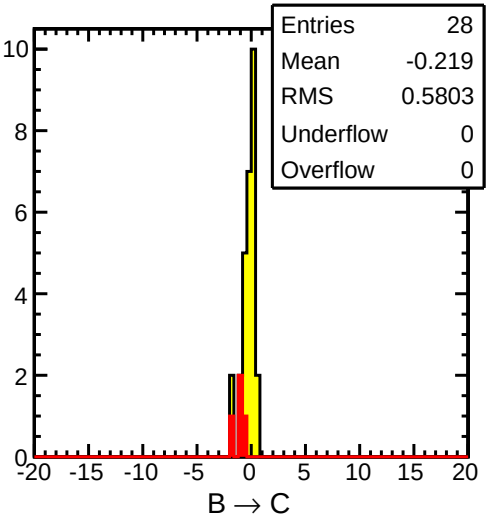
DTs vs. time



- Three $B = 3.8$ T periods in CRAFT-2009
- Align each independently, observe differences
- Below: z positions (moved chambers red)



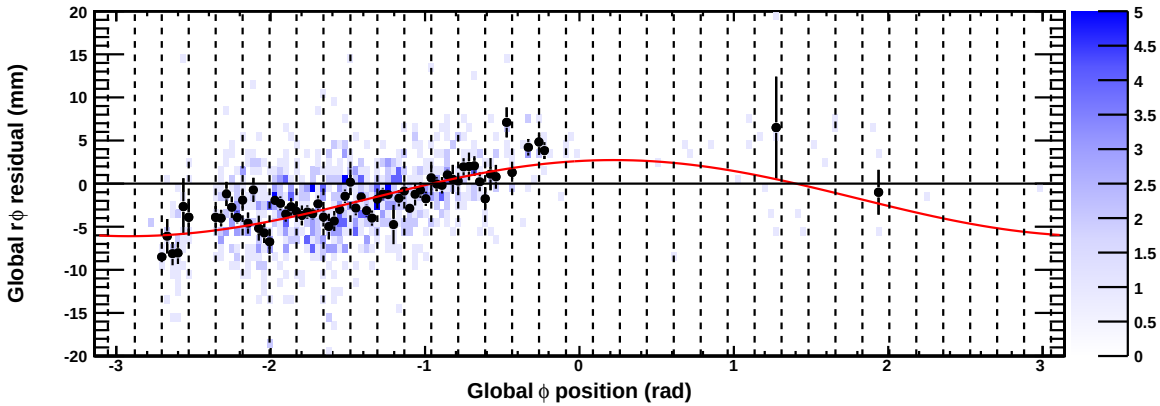




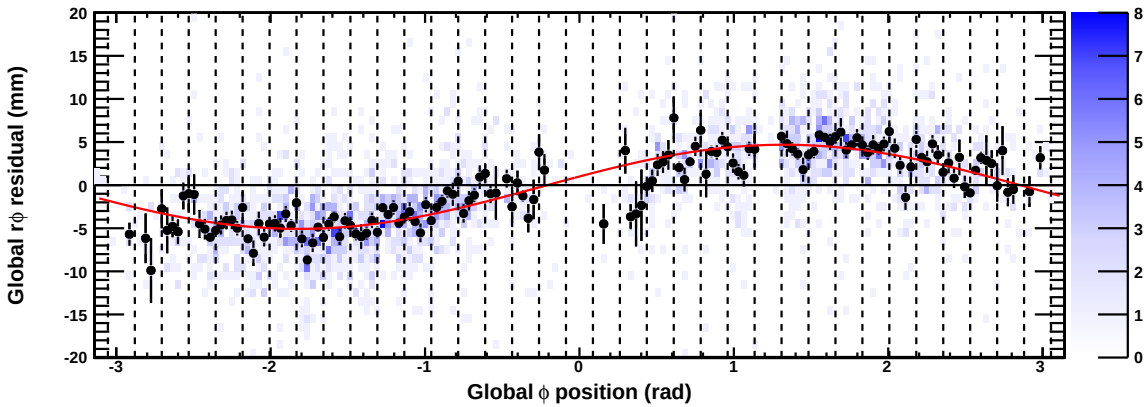
Prelim. track-based CSC results

- Largest misalignments are in the disk positions
- Standard diagnostic plot (used to understand DTs in 2008): residuals versus ϕ from $-\pi$ to π, with smaller binning than chambers

  Shades of blue are 2-D histogram, black points are profile, red curve is disk-fit
- Complete ϕ coverage makes disk fit ($\delta_{\phi_z} + \delta_x \sin\phi + \delta_y \cos\phi$) robust



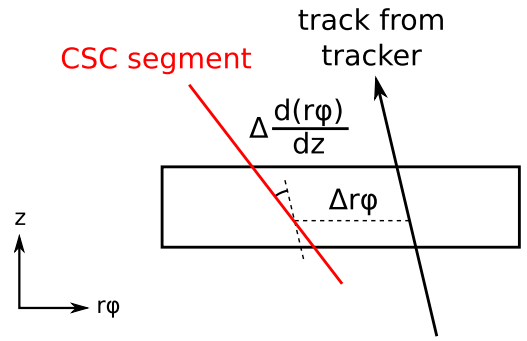
ME+1/1
CRAFT-2008
CMSSW_2_2_11

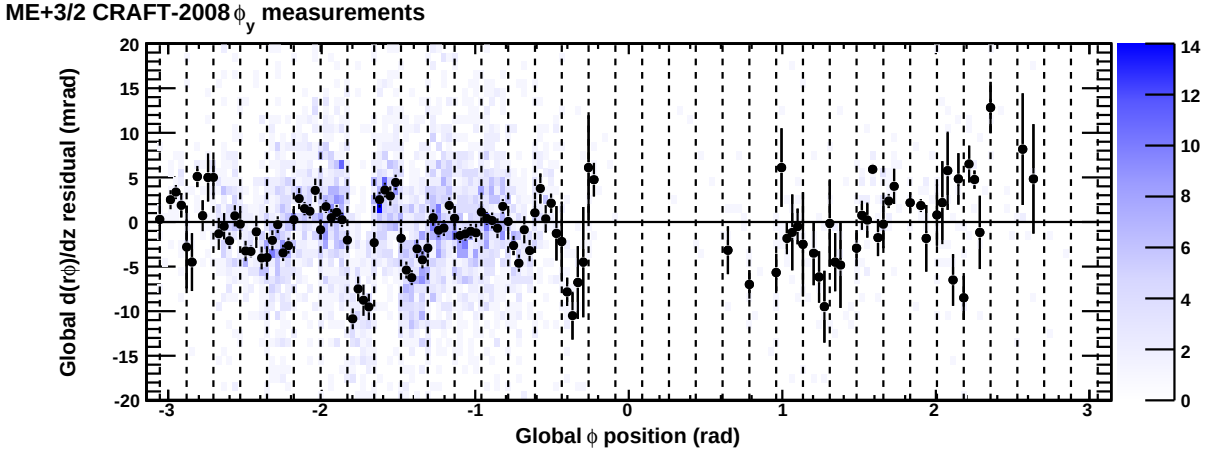


ME+1/1
CRAFT-2009
CMSSW_3_1_2

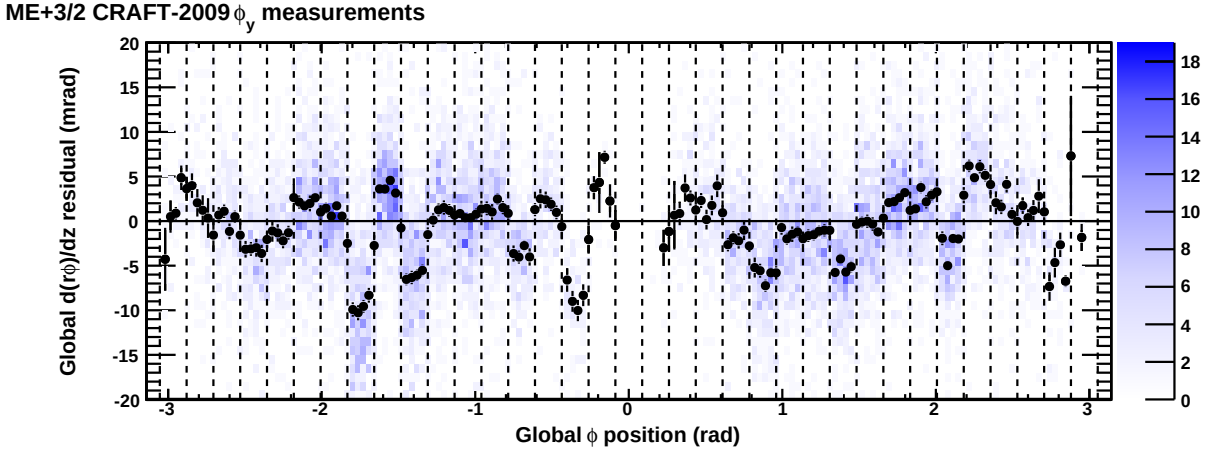
Prelim. track-based CSC results

- Chamber angles are (nearly) independent of disk position
- Can clearly observe individually rotated chambers from "angle residuals"





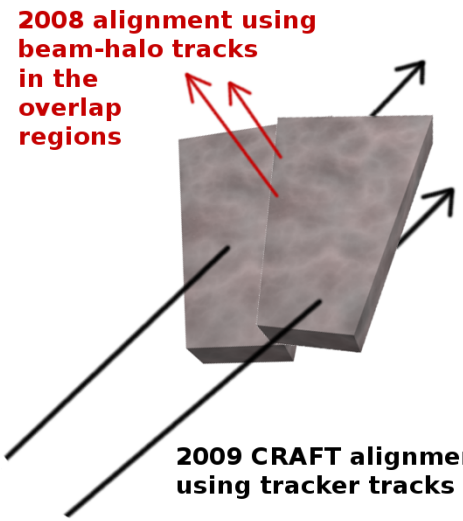
ME+3/2
CRAFT-2008
CMSSW_2_2_11



ME+3/2
CRAFT-2009
CMSSW_3_1_2

Correspondance with beam-halo

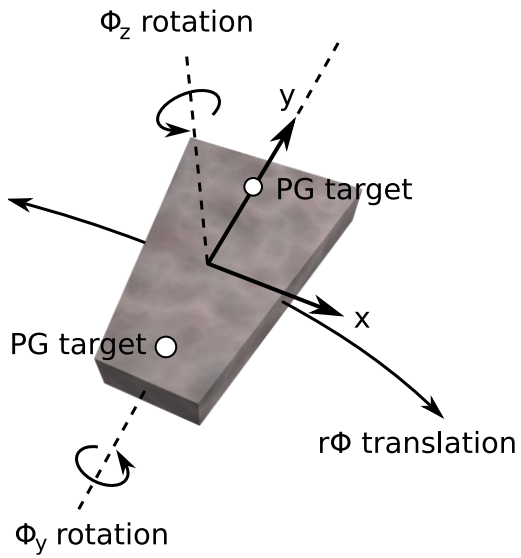
Jim Pivarski



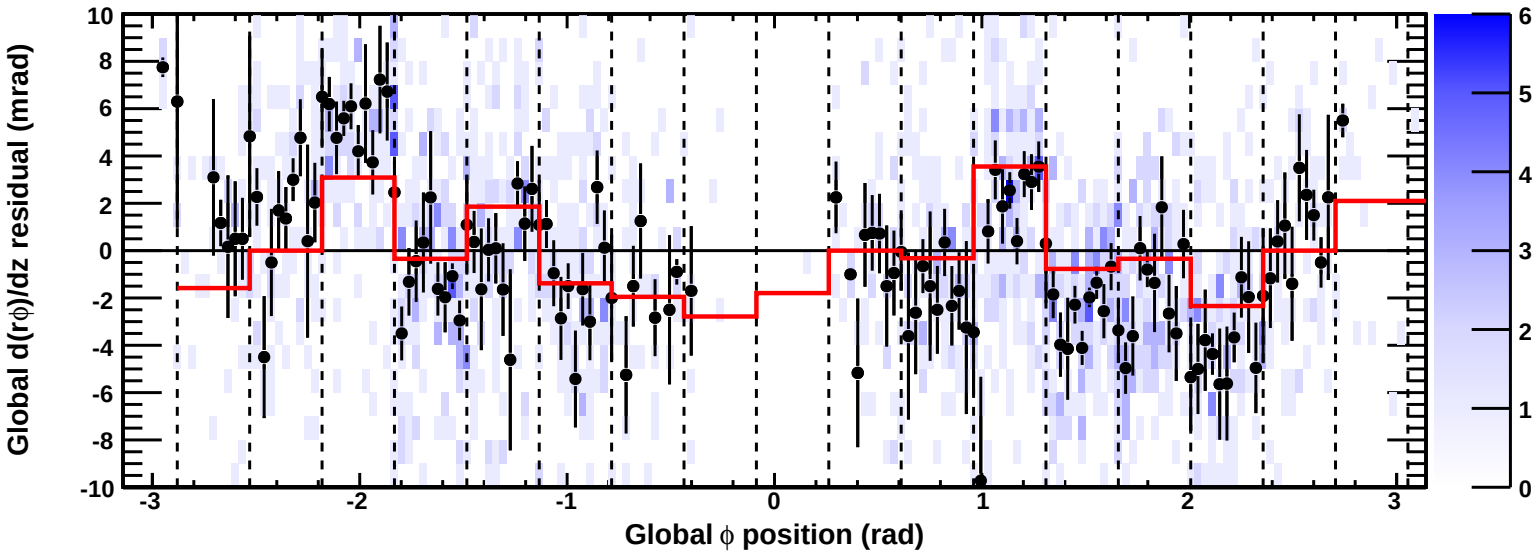
Correlation between globalMuon (cosmics) and local segments (beam-halo)

Some statistically significant changes 2008 → 2009

ϕ_y: the only parameter that couldn't be validated with photogrammetry (PG)

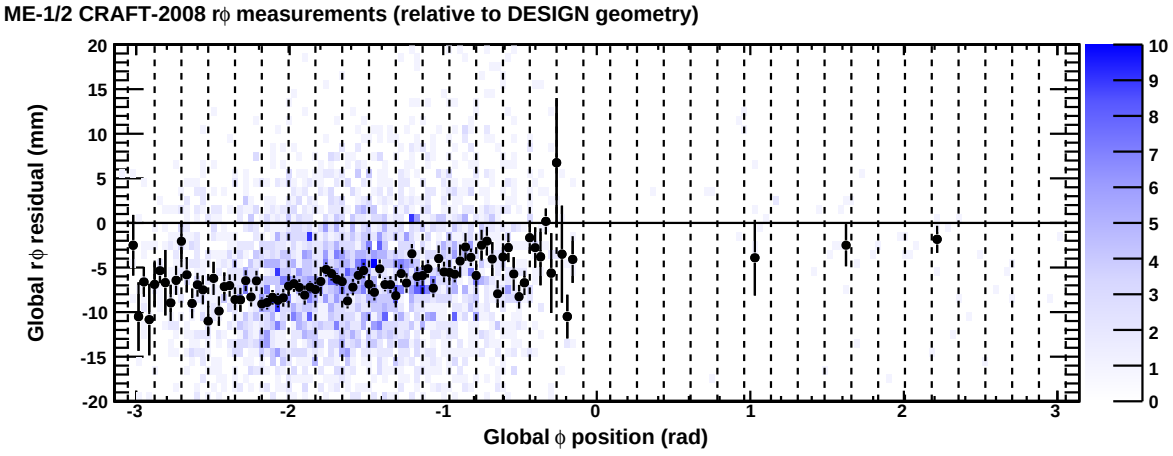


ME-2/1 CRAFT-2009 ϕ_y measurements with beam-halo (red) overlaid

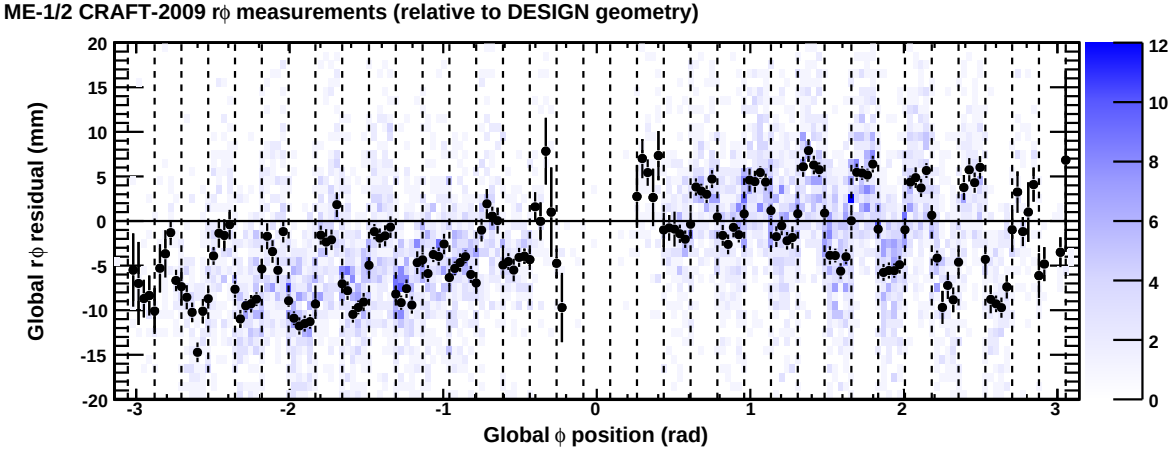


Problem to be solved...

- MEx/2 rings have disk displacement plus even-odd chamber alternation
- New in 2009 or 31X, not a likely physical motion
  - stands in the way of performing an endcap alignment
- It's bracketed between releases; currently ruling out culprits...

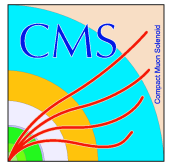


ME−1/2
CRAFT-2008
CMSSW_2_2_11

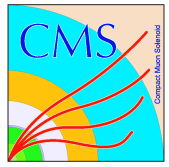


ME−1/2
CRAFT-2009
CMSSW_3_1_2

Conclusions



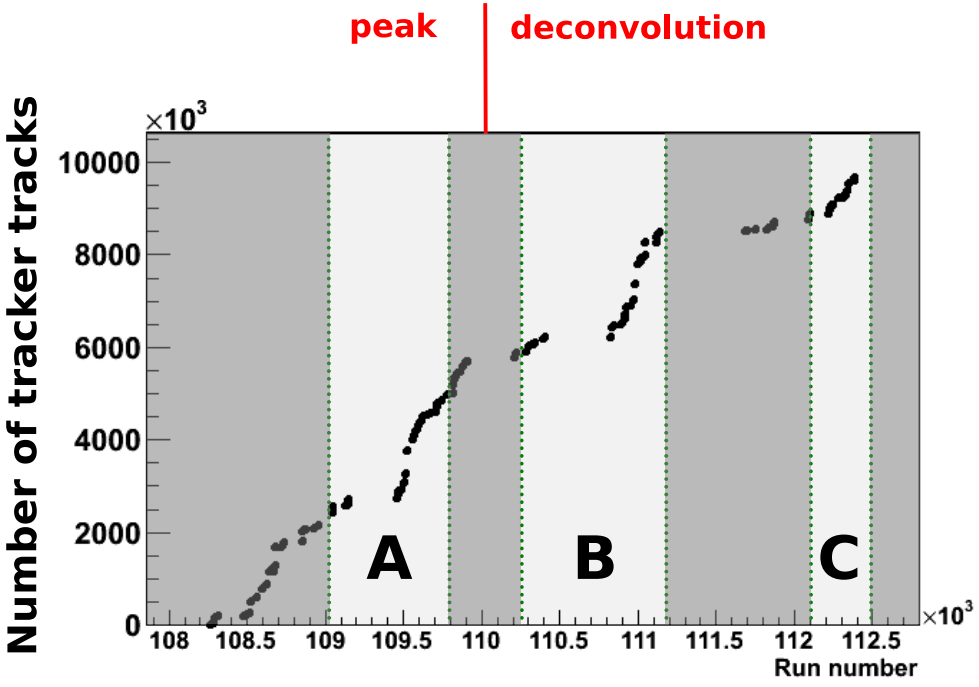
- Hardware alignment getting to the point where comparisons with track-based alignment will be possible
- Reference-Target (HIP) algorithm is stable, can now be used to trace time-dependencies in DT alignment
- Cosmic track reconstruction in endcap significantly improved (ϕ coverage), making disk alignment more robust
- Comparison of globalMuon method and local segment method is a stringent cross-check with different systematics
  - ideally suited to $pp \rightarrow \mu X$, where we can apply both methods at the same time (with the same tracks or exclusive sets)
- Constants readiness:
  - DTs: some tweaks, but essentially ready
  - CSCs: need to find and fix a (likely) bug


CMS
Compact Muon Solenoid

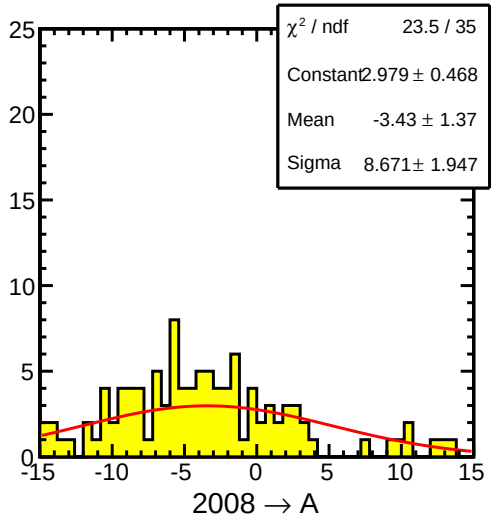

THE TEXAS A&M UNIVERSITY SYSTEM
1876

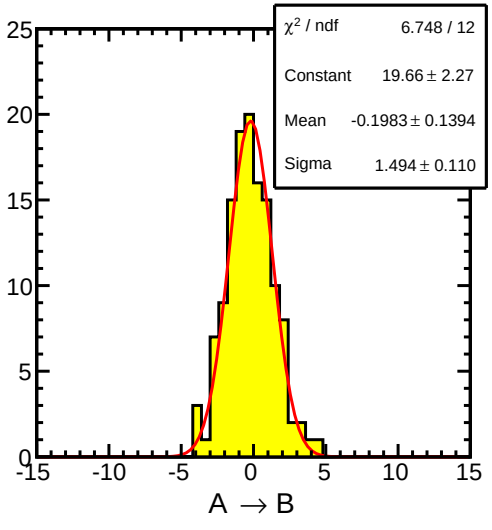
Backup

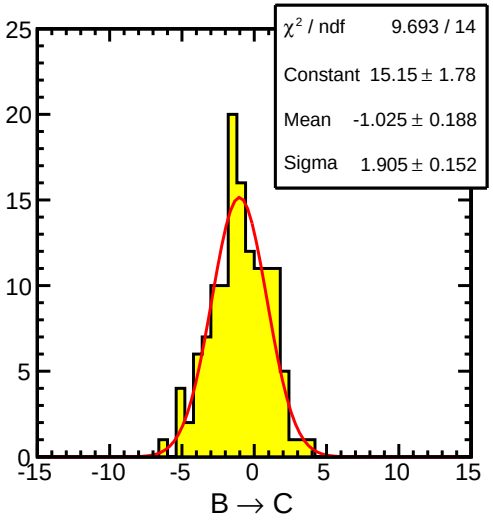
DTs vs. time



- Three $B = 3.8$ T periods in CRAFT-2009
- Align each independently, observe differences
- Below: normalized $r\phi$ positions







Prelim. track-based CSC results

Station	Rotation (mrad)	x translation (mm)	y translation (mm)	χ^2/N_{dof}
ME+3	-0.2 ± 0.1	4.3 ± 0.2	-2.1 ± 0.3	3.6663
ME+2	-0.5 ± 0.1	4.3 ± 0.2	-2.0 ± 0.2	2.2600
ME+1	-0.11 ± 0.04	4.7 ± 0.1	1.2 ± 0.1	2.8728
ME−1	-0.22 ± 0.05	2.9 ± 0.1	3.0 ± 0.1	3.4355
ME−2	-2.3 ± 0.1	3.4 ± 0.2	3.2 ± 0.2	2.4004
ME−3	-2.6 ± 0.1	3.2 ± 0.2	4.0 ± 0.2	3.0024

- ME2 and ME3 are consistent with each other (they are attached to the same disk)
- Large YE−2 rotation was observed in 2008, also
- χ^2 suggest chamber misalignment in addition to disk misalignment