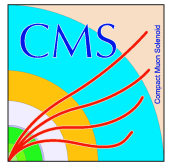


# MC-Generated STARTUP Scenario

Jim Pivarski

*Texas A&M University*

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# Motivation

- The current muon misalignment scenarios (MC) are:
  - STARTUP (DTCRAFTScenario310_v2_mc and CSCCRAFTScenario310me42_v2_mc), produced by randomly misaligning chambers with an RMS consistent with cross-checks in CRAFT
  - 50 $pb^{-1}$ (DT50InversepbScenario3XYv1_mc and CSC50InversepbScenario3XYv1_mc), produced by running the Reference-Target algorithm on appropriate MC samples
- These are qualitatively different things: the latter includes internal correlations introduced by the procedure, the former does not

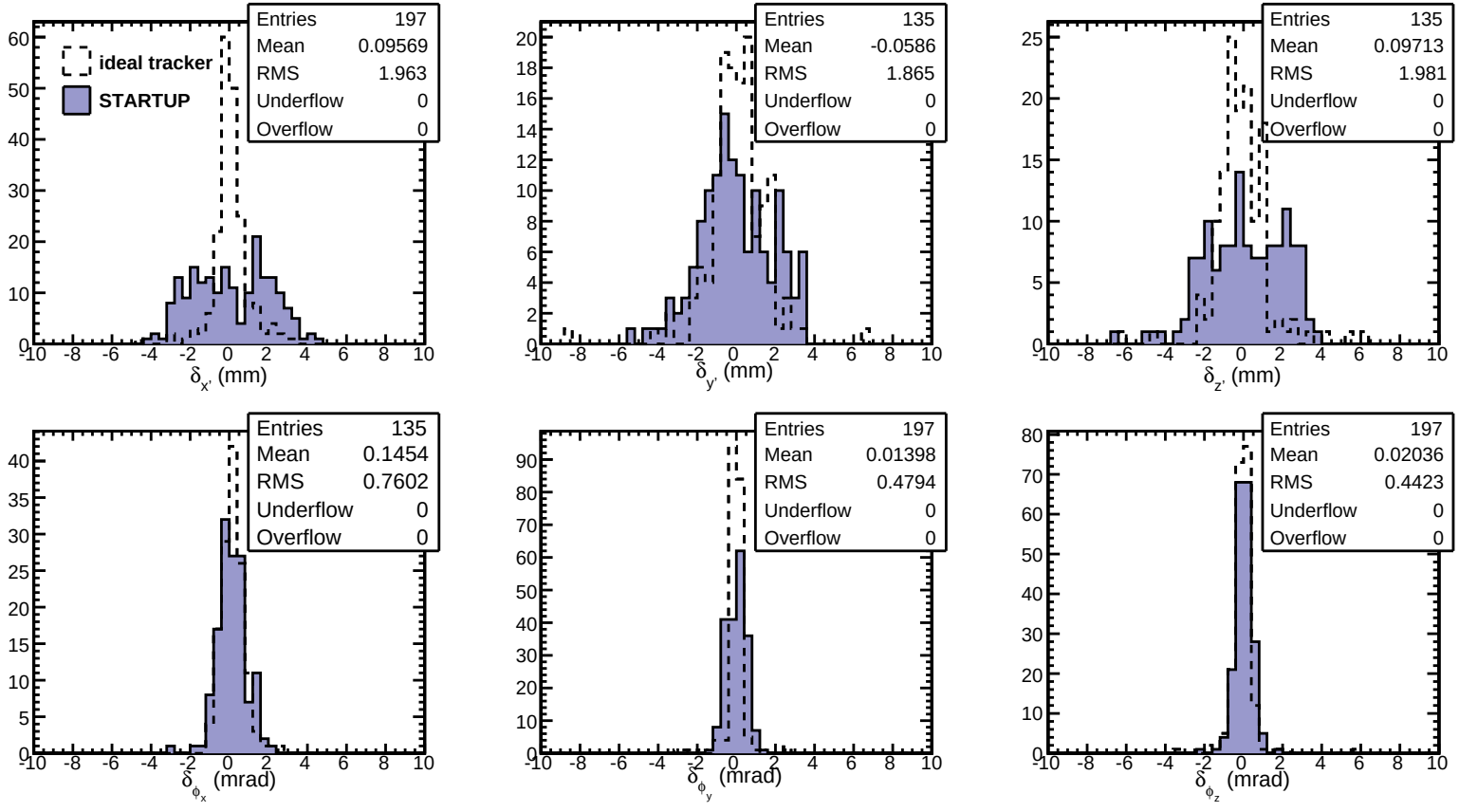
# What is presented here

- MC-generated STARTUP DTAlignmentRcd
  - tracker misalignment: produced by running the tracker alignment procedure on cosmics MC
  - DT misalignment: produced by running Reference-Target alignment on cosmics MC, using the above as input

# MC-generated STARTUP



- Below: comparisons of muon chamber positions with MC truth
  - $\delta_{x'}$, $\delta_{y'}$, $\delta_{z'}$ are local coordinates with consistent sign conventions
- Aligned chamber positions are very sensitive to tracker misalignment

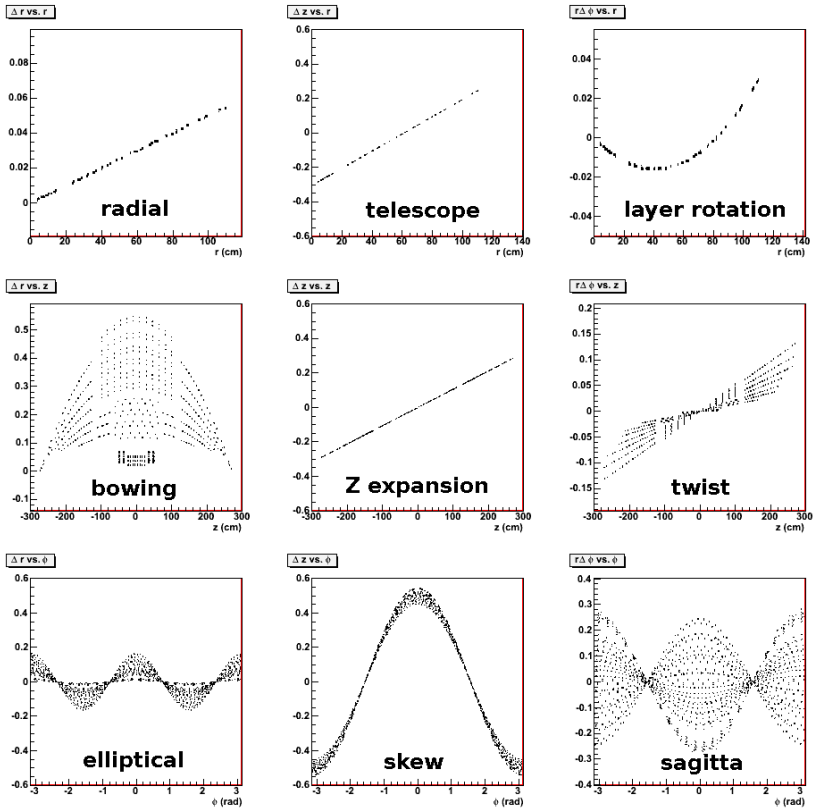


# Tracker alignment systematics

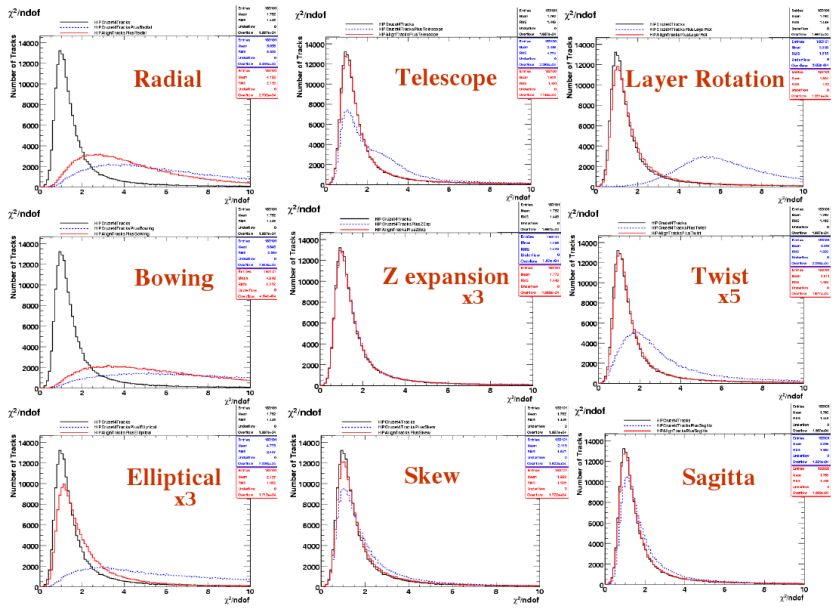


(Background for a muon systematics study on the following pages)

- 9 cannonical modes: $\{R,\ z,\ r\phi\}$ displacements vs. $\{R,\ z,\ \phi\}$
- Left: tracker module positions in each mode




- $\chi^2$ sensitivity of each mode
- Cosmic rays are insensitive to Z expansion, skew, and sagitta

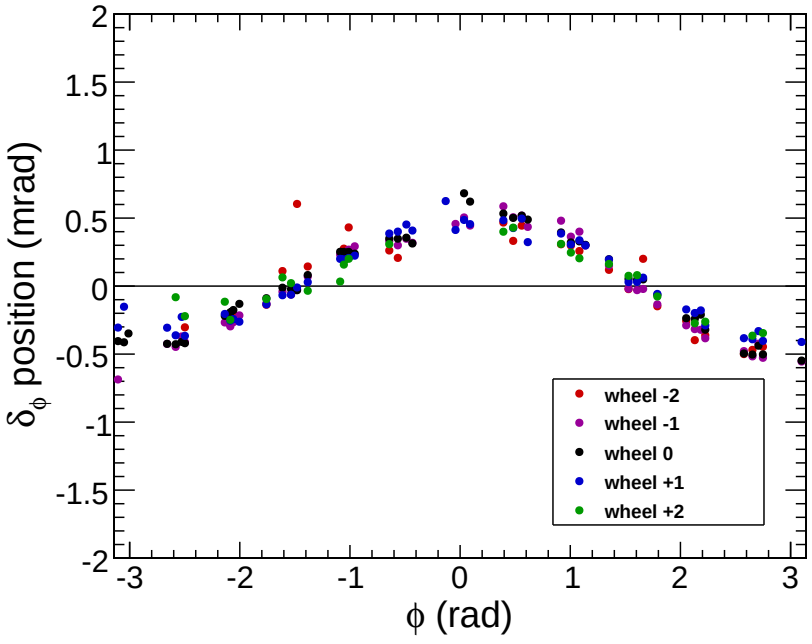


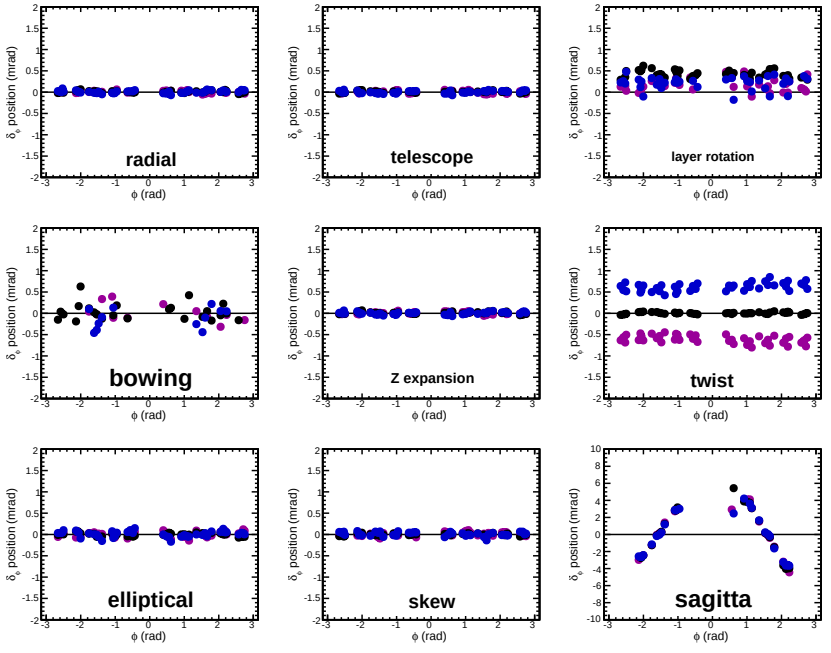
# Muon systematics study



All plots are $\delta_\phi$ (rotation around beamline) versus $\phi$

- Left: muon chamber positions in MC-generated STARTUP
- Right: muon chamber positions for each cannonical tracker mode
- STARTUP most resembles "sagitta" (10× smaller than cannonical)
  - in cannonical scenarios, some chambers at extremes fail to fit



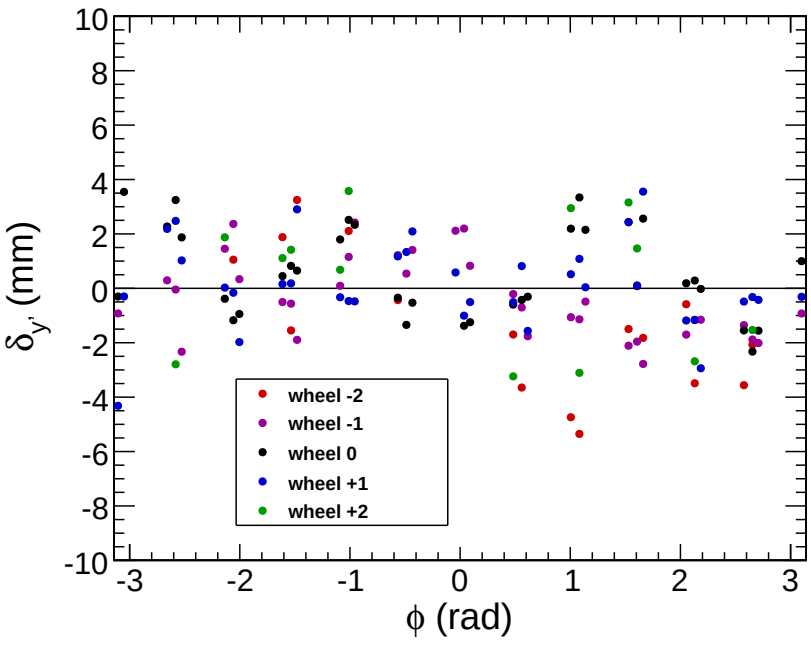



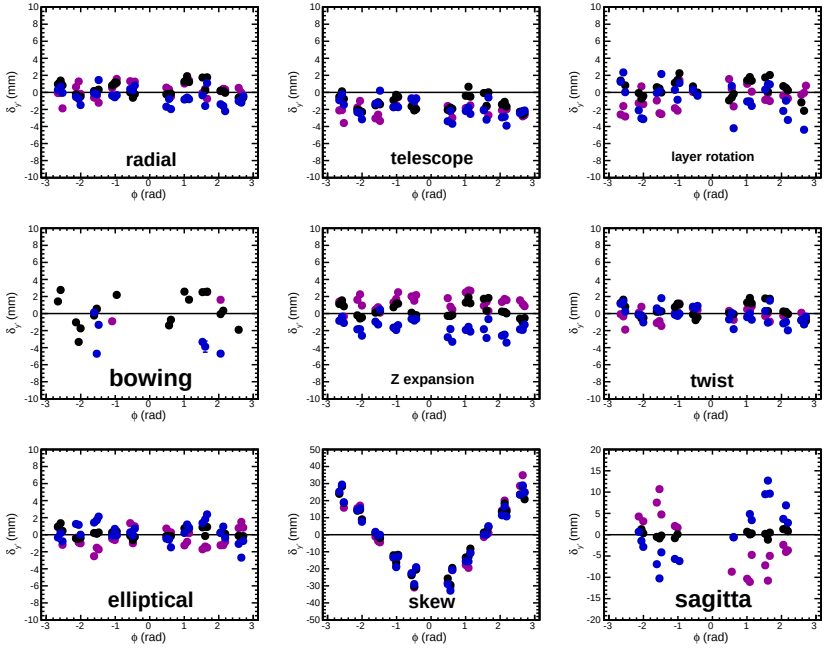
# Muon systematics study



All plots are $\delta_{y'}$ (displacements parallel to beamline) versus $\phi$

- Left: muon chamber positions in MC-generated STARTUP
- Right: muon chamber positions for each cannonical tracker mode
- STARTUP is not pure "sagitta," but no sign of "skew"



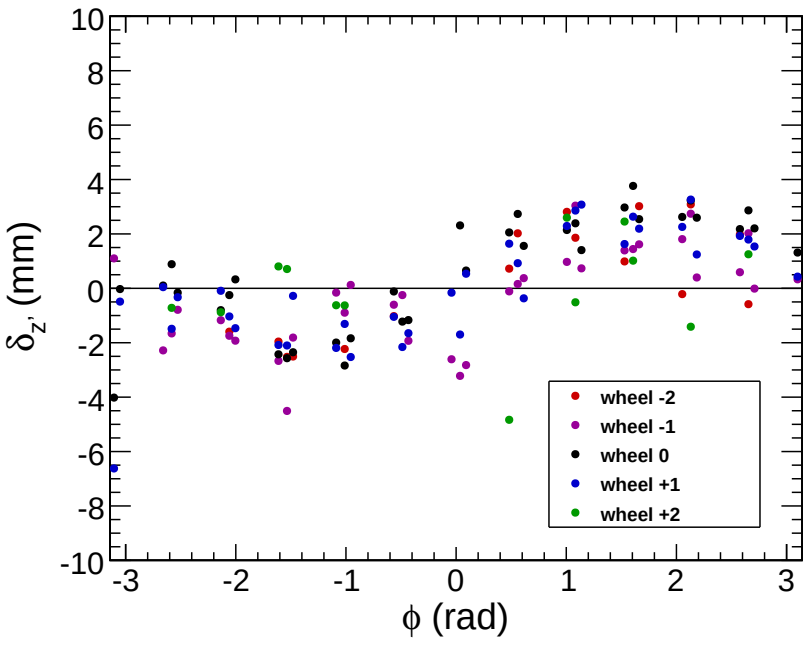



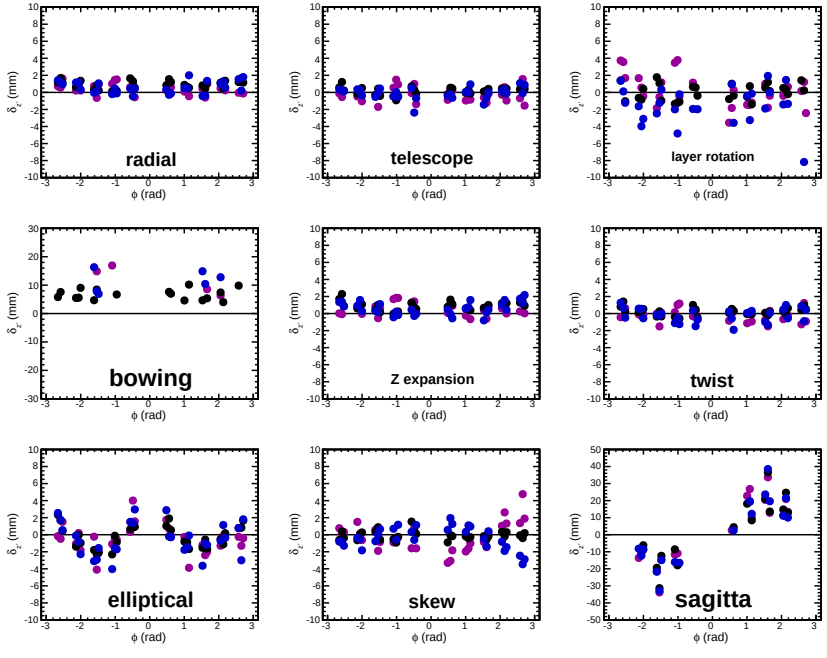
# Muon systematics study



All plots are $\delta_{z'}$ (radial displacements) versus $\phi$

- Left: muon chamber positions in MC-generated STARTUP
- Right: muon chamber positions for each cannonical tracker mode
- We see the "sagitta" pattern dominating here, too

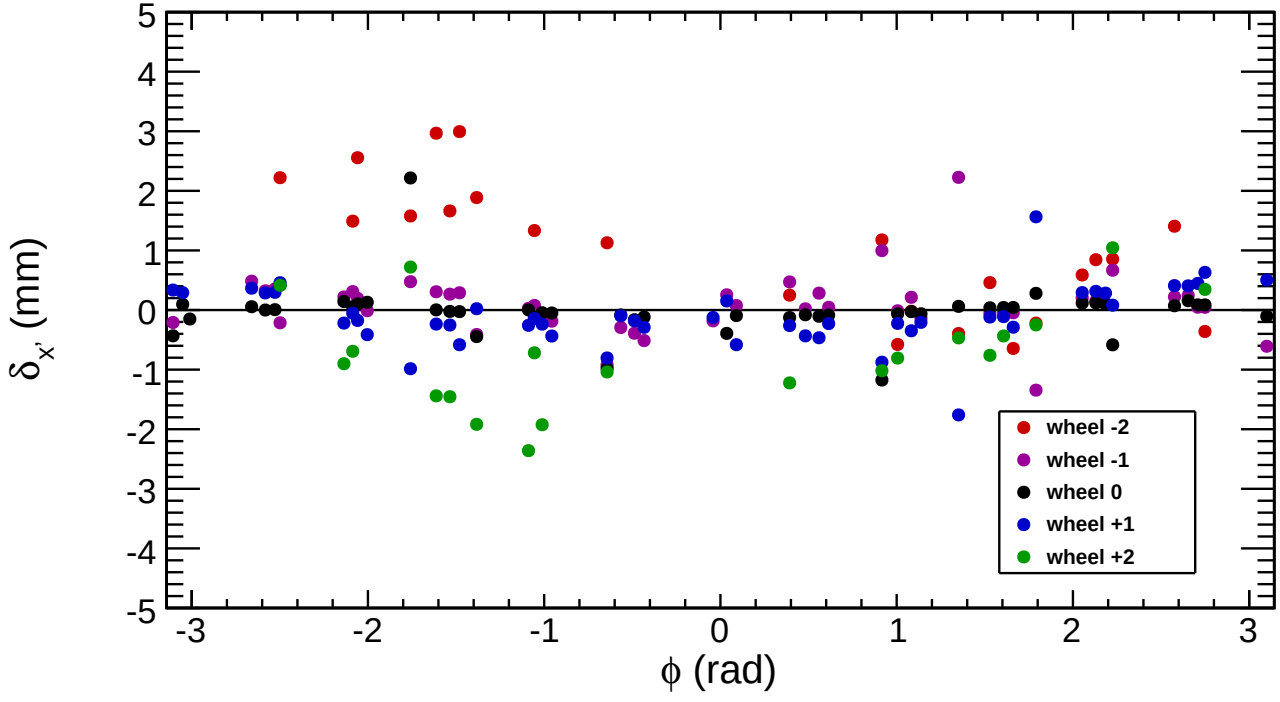


# More tracker dependence



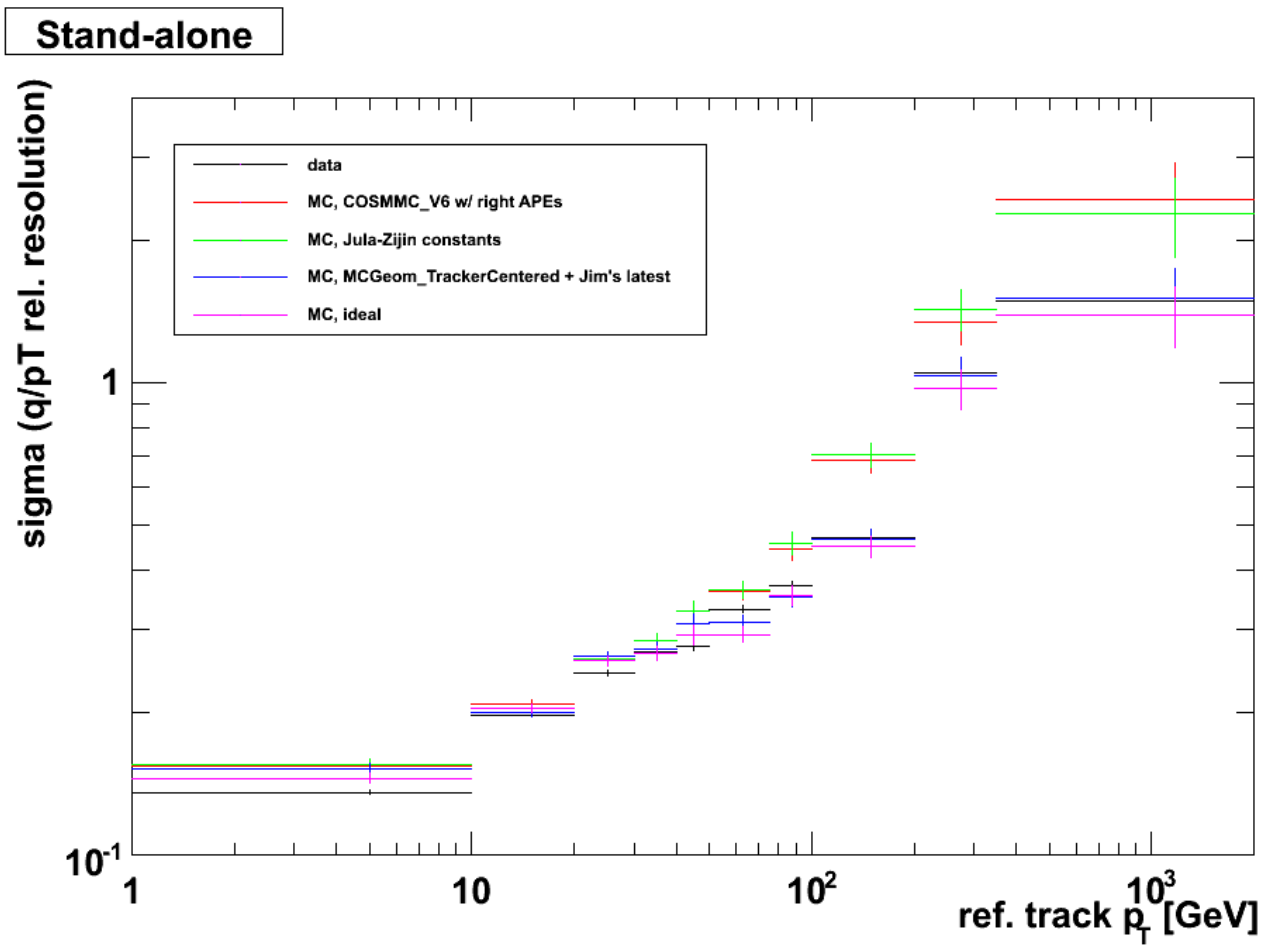
- Final (official) tracker alignment differs from the first one we were given by a translation and rotation (centered on pixel instead of whole tracker)
- Repeated muon alignment with final tracker alignment:
  - *final* results shown on previous pages
  - difference between the two shown below, looks like a rotation around global Y ($\delta_{x'} \propto z \sin\phi$)



# Cosmic splitting validation



- Vertical axis is $(\frac{q}{p_T}^{\text{top}} - \frac{q}{p_T}^{\text{bottom}})/(\sqrt{2}\frac{q}{p_T})$ for each split cosmic ray
  - $10^{-1}$ means top-minus-bottom curvature difference is 10% of the curvature (and therefore $p_T$ error is approximately 10% of $p_T$)
- COSMMC is random tracker, random muon, Jula-Zijin is MC-aligned tracker, MCGeom + Jim's latest is MC-aligned tracker and muon



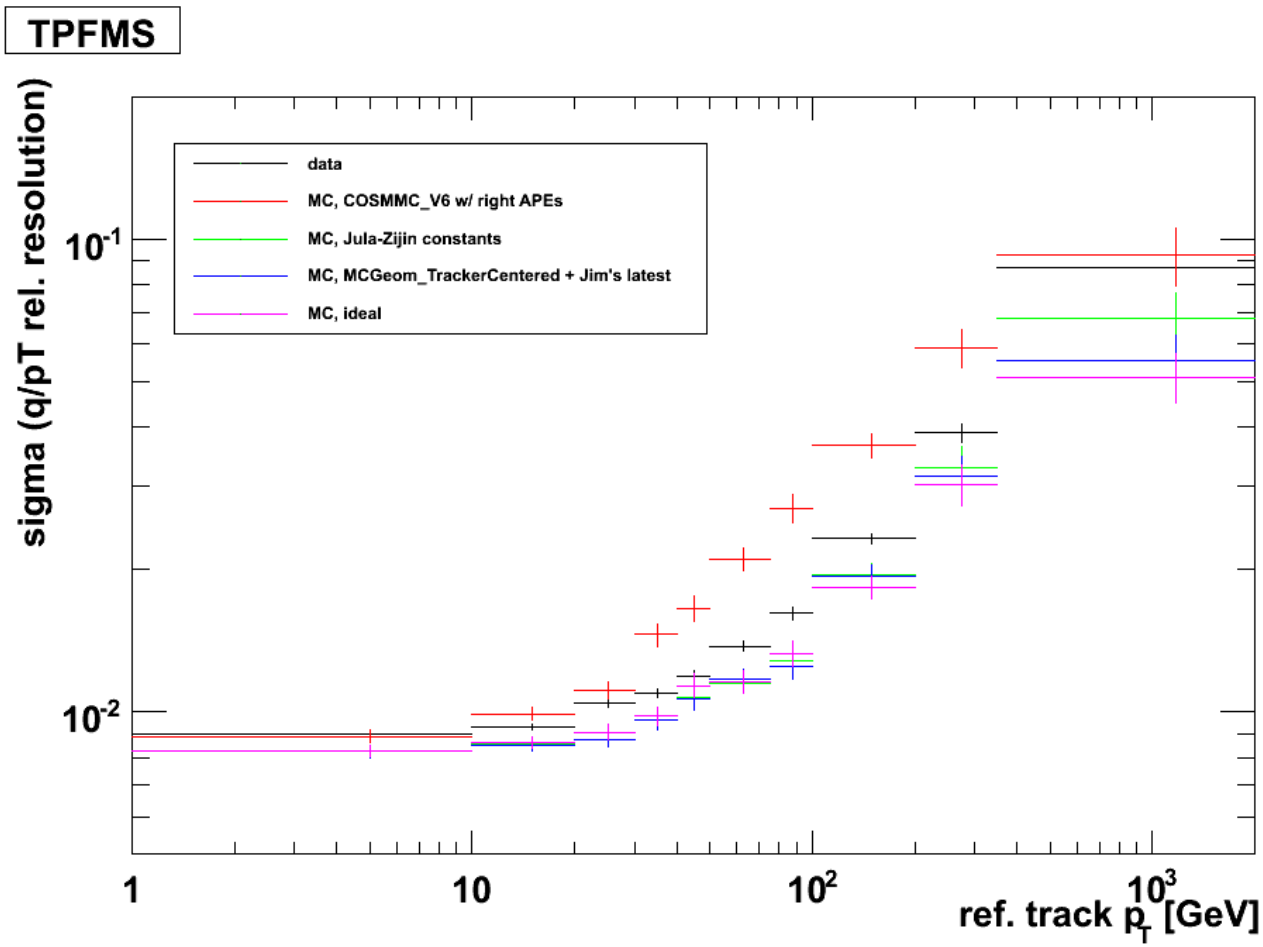

J. Tucker

Non-final tracker alignment and non-final muon alignment, but mutually consistent

# Cosmic splitting validation



- Vertical axis is $(\frac{q}{p_T}^{\text{top}} - \frac{q}{p_T}^{\text{bottom}})/(\sqrt{2}\frac{q}{p_T})$ for each split cosmic ray
- COSMMC is random tracker, random muon, Jula-Zijin is MC-aligned tracker, MCGeom + Jim's latest is MC-aligned tracker and muon
- "TPFMS" are track fits using the tracker and the first muon station




J. Tucker

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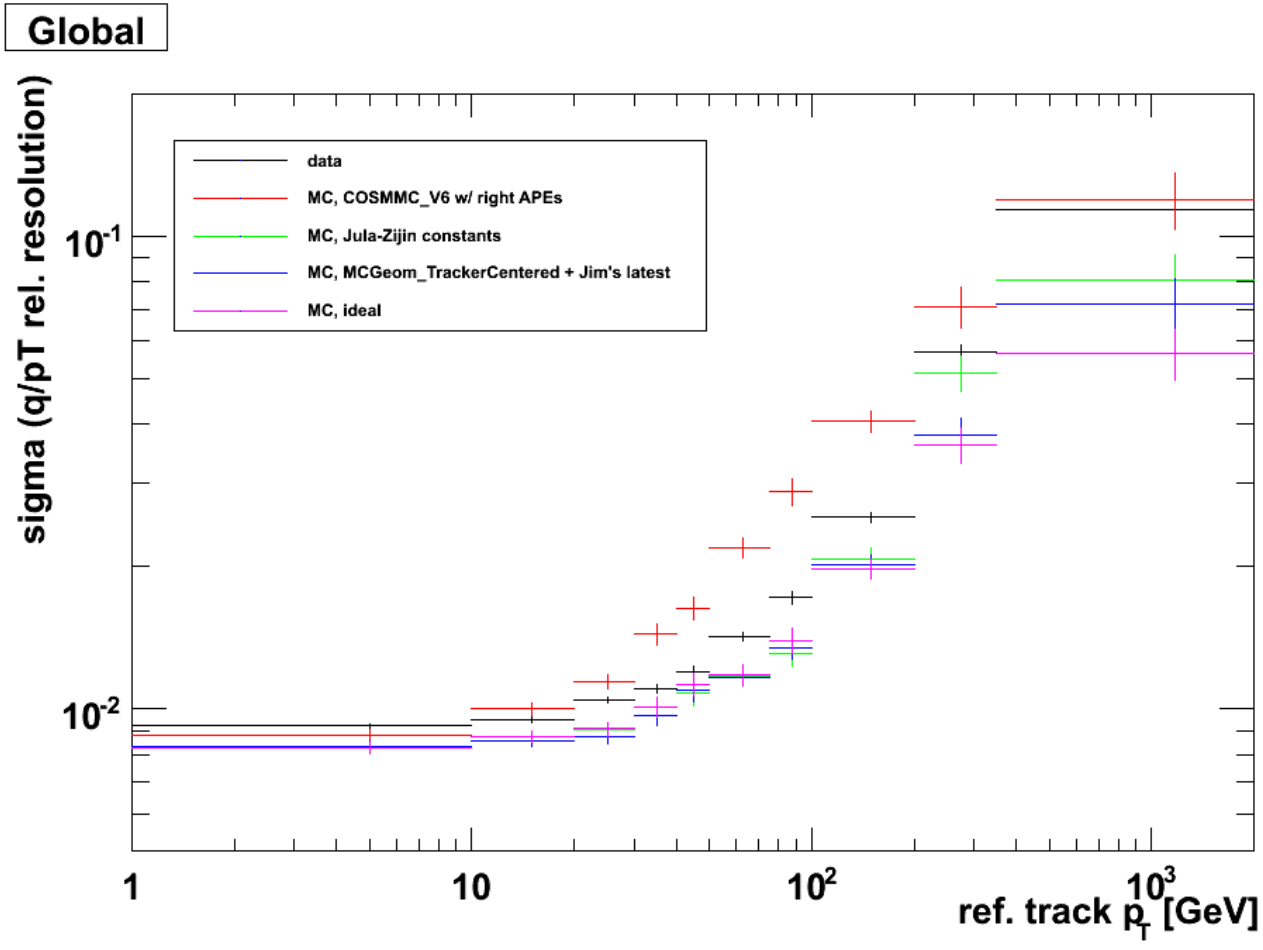


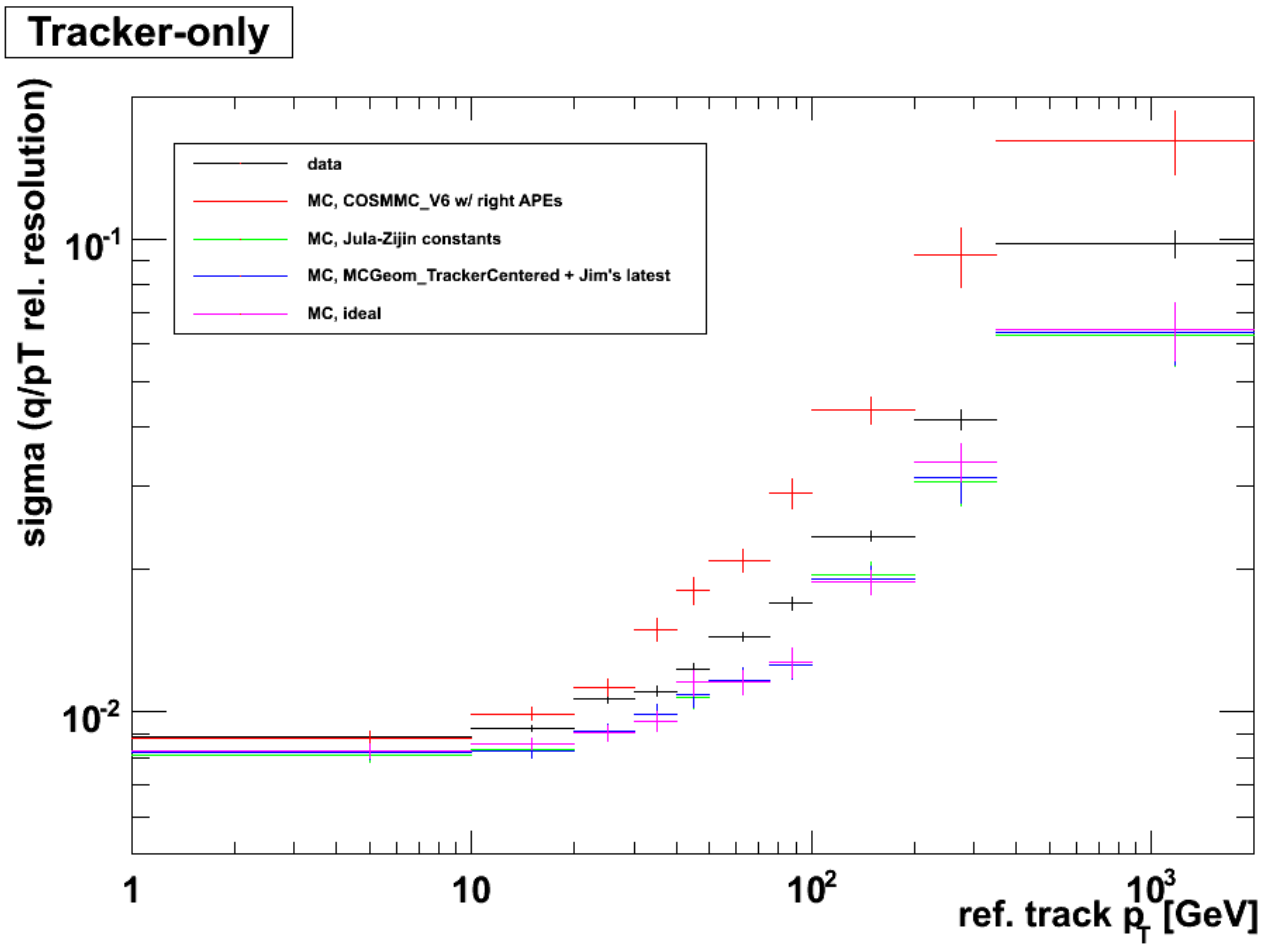

J. Tucker

Non-final tracker alignment and non-final muon alignment, but mutually consistent

# Cosmic splitting validation



- Vertical axis is $(\frac{q}{p_T}^{\text{top}} - \frac{q}{p_T}^{\text{bottom}})/(\sqrt{2}\frac{q}{p_T})$ for each split cosmic ray
- COSMMC is random tracker, random muon, Jula-Zijin is MC-aligned tracker, MCGeom + Jim's latest is MC-aligned tracker and muon
- Muon alignment has a small effect on tracker-only through the selection of tracks (globalMuon must be present to appear in this analysis)




J. Tucker

Non-final tracker alignment and non-final muon alignment, but mutually consistent

# DB comparison conclusions

- MC-generated tracker misalignment is globally distorted
- We've characterized the muon alignment's response to all of the cannonical global distortions: this one is "sagitta" (not surprising: tracker $\chi^2$ is insensitive to sagitta distortions in cosmic rays)
- Near-ideal momentum resolution with a systematically-distorted tracker and muon system: an example of an "effective detector"

# Cosmic splitting conclusions

- MC-generated scenarios underestimate resolution, related to unmodeled detector effects in alignment step or track-fitting
- But MC now has a more similar shape as a function of $p_T$
- Ideal MC agrees with PTDR Figure 1.5 ($(p^{\text{reco}} - p^{\text{gen}})/p^{\text{gen}}$ in $0 < \eta < 0.2$) and tracker-only agrees with Nhan's analysis ($p_T$ instead of $q/p_T$)
- Tracker + first muon station is only a little better than tracker-only in the highest bin (5.5% vs. 6%), similar to what we see in data (9% vs. 10%)

# Currently in the database

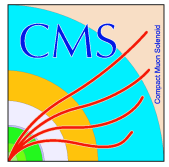
- MC-generated tracker scenario approved and uploaded as TrackerAlignment_CRAFT08Realistic_mc
  - intended to become new STARTUP scenario, but not in any globalTags yet
- Current DTAlignmentRcd: randomly-generated constants whose scale is based on CRAFT validation
- Current CSCAlignmentRcd: randomly-generated constants whose scale is based on hardware validation

# Recommendation

- Upload MC-generated DTAlignmentRcd/DTAlignmentErrorRcd
- Combine MC-generated tracker, MC-generated DT, and hardware estimated CSC into one globalTag
  - asymmetry between DT and CSC is related to the fact that they're handled differently with cosmic rays, and this is a STARTUP scenario

# Where to find them







```
/afs/cern.ch/user/p/pivarski/public/DTAlignmentRcd_cosmics-finaltracker_22X_v1.db
/afs/cern.ch/user/p/pivarski/public/DTAlignmentRcd_cosmics-finaltracker_3XY_v1.db

/afs/cern.ch/user/p/pivarski/public/DTAlignmentRcd_cosmics-finaltracker_v1.xml
```

"22X" is only compatible with 22X, "3XY" is only compatible with 3XY

Usual tagnames: "DTAlignmentRcd" and "DTAlignmentErrorRcd"
(ignore the CSCAlignmentRcd/CSCAlignmentErrorRcd)

"DTAlignmentErrorRcd" masks out unaligned chambers