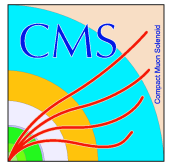


Status of HIP Track-Based Alignment in the Endcap

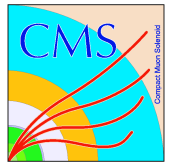
Jim Pivarski

Alexei Safonov

Texas A&M University

26 June, 2009

Two unrelated topics



- Status of cosmics-during-collisions trigger
- Updates in endcap disk alignment

Cosmics-during-collisions

Motivation

- Cosmic rays resolve ambiguities in collisions muons by the fact that they don't all point to the same spot
  - "small-scale" track-source biases (within a small region of $\Delta\phi$, $\Delta\theta$) are averaged over by cosmic rays, leaving only "global distortions" (broad pattern across the whole detector)
- Cosmic rays provide an ample source of high-momentum tracks
  - cosmic spectrum is $(\text{energy})^{-2.7}$, rather than exponential
  - allows for $p_T > 100$ GeV alignments, $p_T > 500$ GeV diagnostics
  - Cosmic track-splitting is the only known way to quantify track resolution in all 5 track parameters
- Despite the cosmic rays' "verticalness" disadvantage...

Both tracker and muon alignment would be poorer if we stopped collecting cosmic rays when the LHC turns on

Cosmics-during-collisions

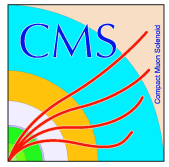
Trigger issues

- Strange as it is to say it, cosmic ray signal is dwarfed by the $pp \longrightarrow \mu X$ background rate
- CMS triggers are not optimized for cosmic ray timing, either: $t(\text{bottom leg}) - t(\text{top leg}) \approx 3$ bunch crossings
- Same problem with hit read-out: even given a trigger decision, it is not clear to me whether top and bottom hits would be put into the same event
  - I need to ask the DT DAQ experts
- Trigger time is discrete: we can only accept cosmic ray events that overlap bunch crossings, and therefore have pile-up

Cosmics-during-collisions

Trigger status

- RPC L1 technical trigger has all of the elements needed to select 4-station coincidences on both sides of the barrel (roughly tracker-pointing), with the appropriate timing
- Such a requirement should strongly discriminate against beam collision products: at most 10's of Hz, more likely 3–7 Hz
- Quality cuts on standAloneMuon can be applied at HLT, though most of the rate reduction should happen at L1
- Currently:
  - high-level logic would need to be programmed in firmware
  - L1 emulator implemented in 3_1_0_preX, but without the above
  - HLT path does not do any selection
  - efficiency (for cosmics) and fake-rate (for InclusiveMu) studies have begun (which will guide development of HLT cuts)
- People responsible:
  - L1 logic: RPC group (Flavio Loddo has offered)
  - Emulator: Andrés Osorio Oliveros (Universidad de Los Andes)
  - HLT and testing: Yohann Tschudi (Université Claude Bernard)



Endcap alignment

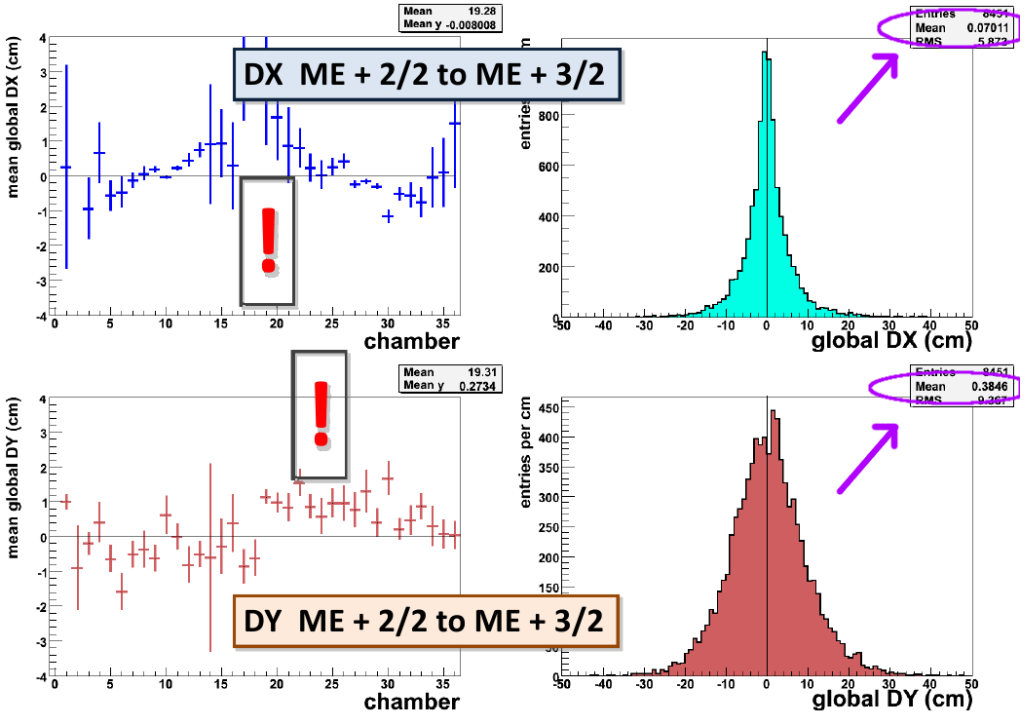
Collected data

- Jump to the summary first: comparison of results from different sources
- Any column might have an overall minus sign (differences in definitions)

	Segments (strip+wire) M. Schmitt (8 June)	globalMuons (strip only) J. Pivarski	Survey R. Goudard	Transfer Lines J. Bellinger (19 June)
+1/2 to +2/2				
x (mm)	−0.2	−1.6	−0.1	1.9
y (mm)	1.1	2.7	1.0	2.7
phiz (mrad)		−0.1	0.0	−0.4
+2/2 to +3/2				
x (mm)	0.7	−0.7		
y (mm)	3.8	−0.5		
phiz (mrad)		0.1		
+3/1 to +4/1				
x (mm)	0.6		−1.6	0.4
y (mm)	−1.7		0.8	1.1
phiz (mrad)			0.9	0.8
-1/2 to -2/2				
x (mm)	1.1	1.2	0.2	
y (mm)	3.9	3.6	0.6	
phiz (mrad)		0.4	1.0	
-2/2 to -3/2				
x (mm)	−2.3	−0.5		
y (mm)	0.9	−0.8		
phiz (mrad)		0.1		
-3/1 to -4/1				
x (mm)	−3.7		−1.4	
y (mm)	−1.6		1.6	
phiz (mrad)			−0.9	

Where the data came from

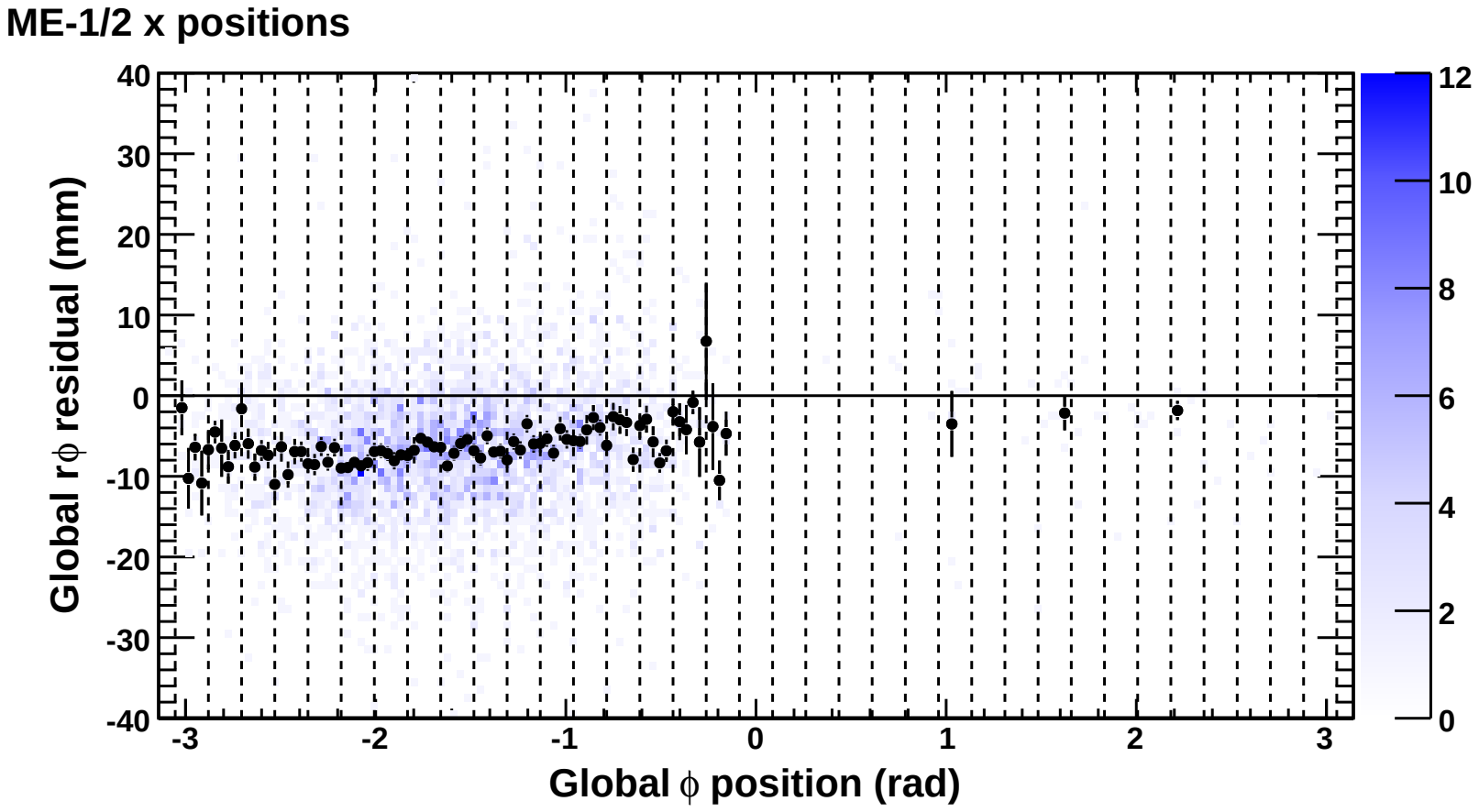
- Segments (strip+wire): means of the histograms (ignores sine trend from ϕ_z)



- globalMuons (strip only): station 2 $\rightarrow$ 3 are residuals *differences*
- Survey: soon-to-be-published note, Raphaël says they are preliminary, but x, y, ϕ_z are fairly well established
- Transfer lines: table in presentation

Map plots for CSCs

- These are like the maps of the barrel (showing all MEn/2)
  - raw hit distribution is the blue scale
  - black points are the means
  - dashed lines are the chamber boundaries
- Note agreement between 2/2 and 3/2 in x (not ϕ_y)



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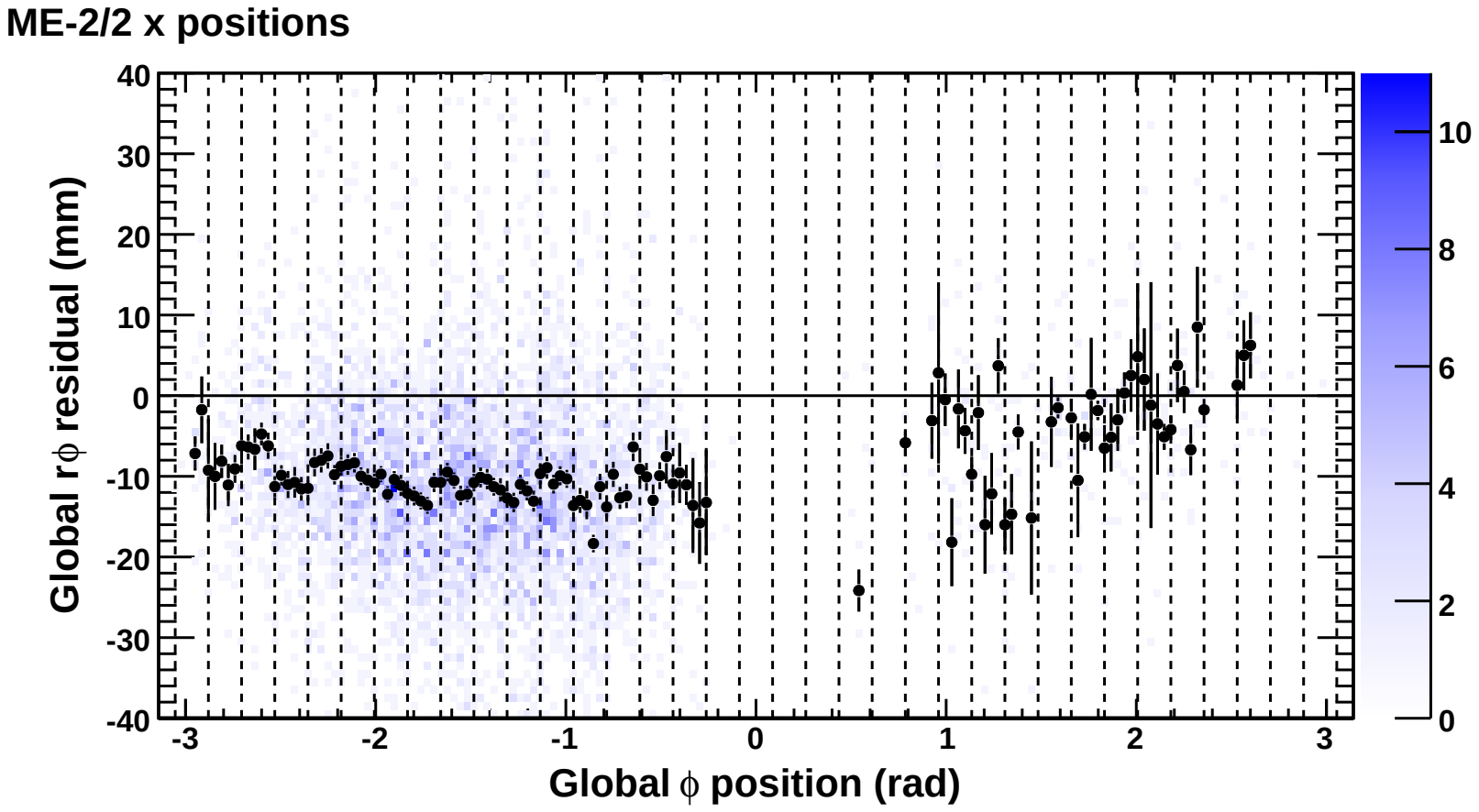

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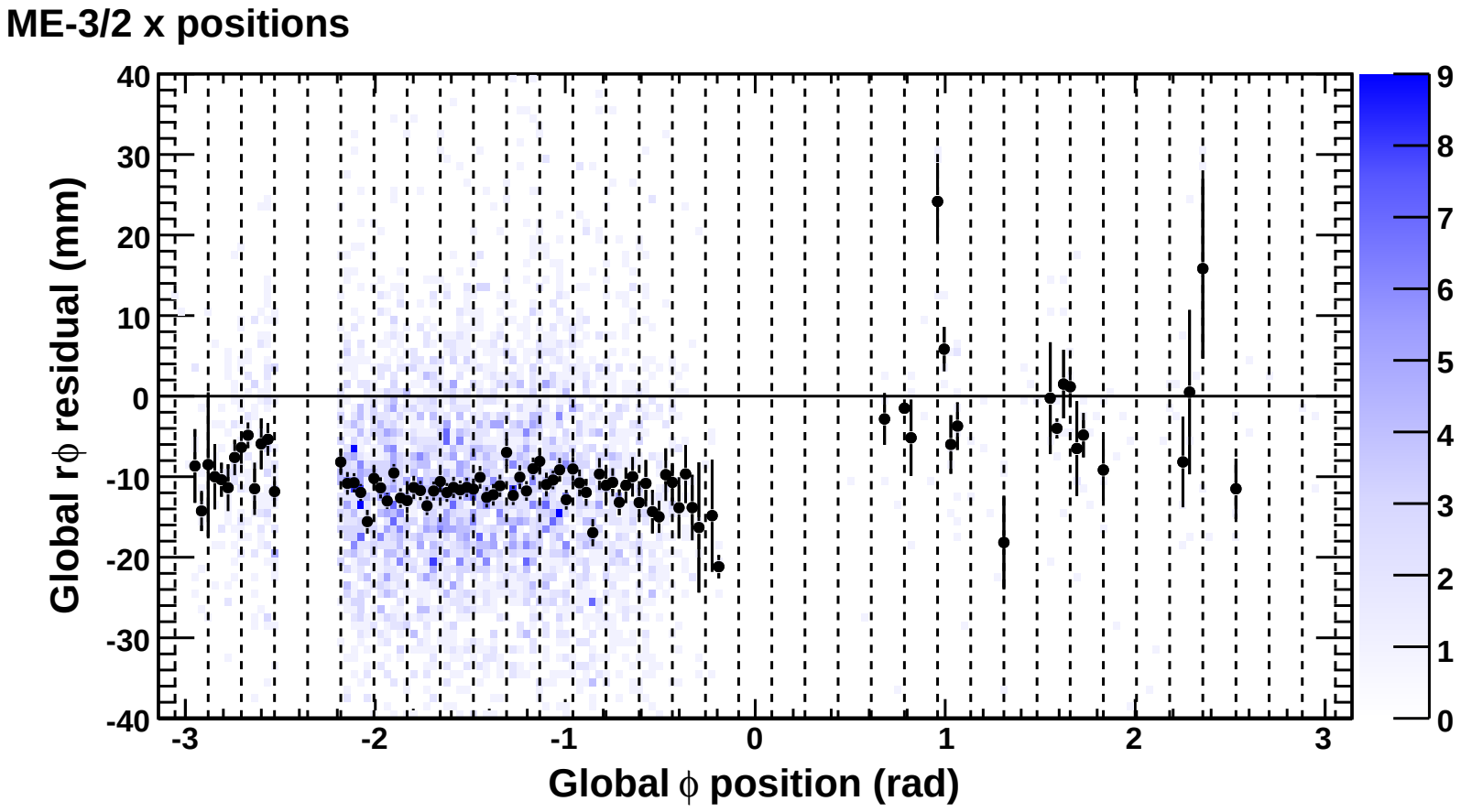

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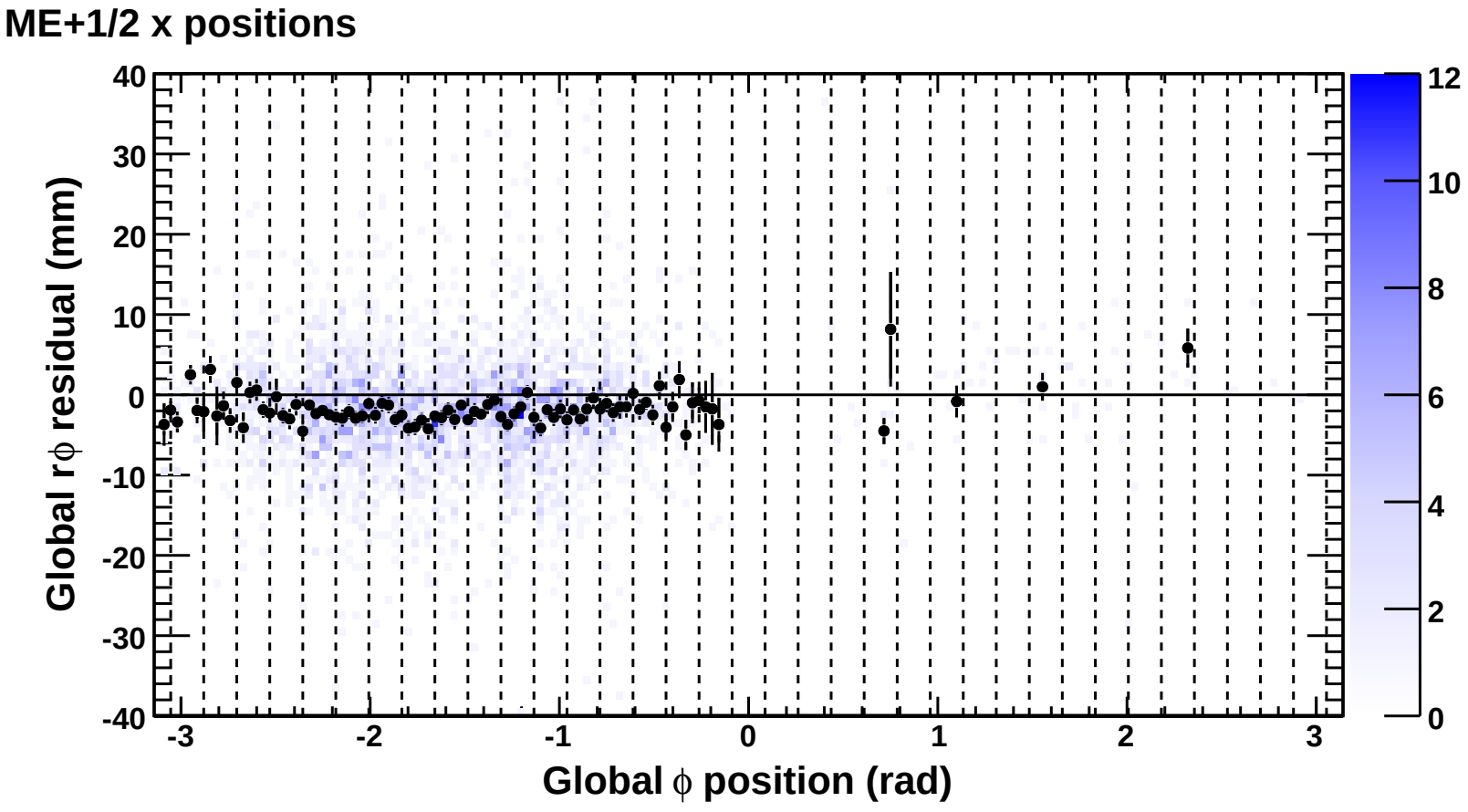

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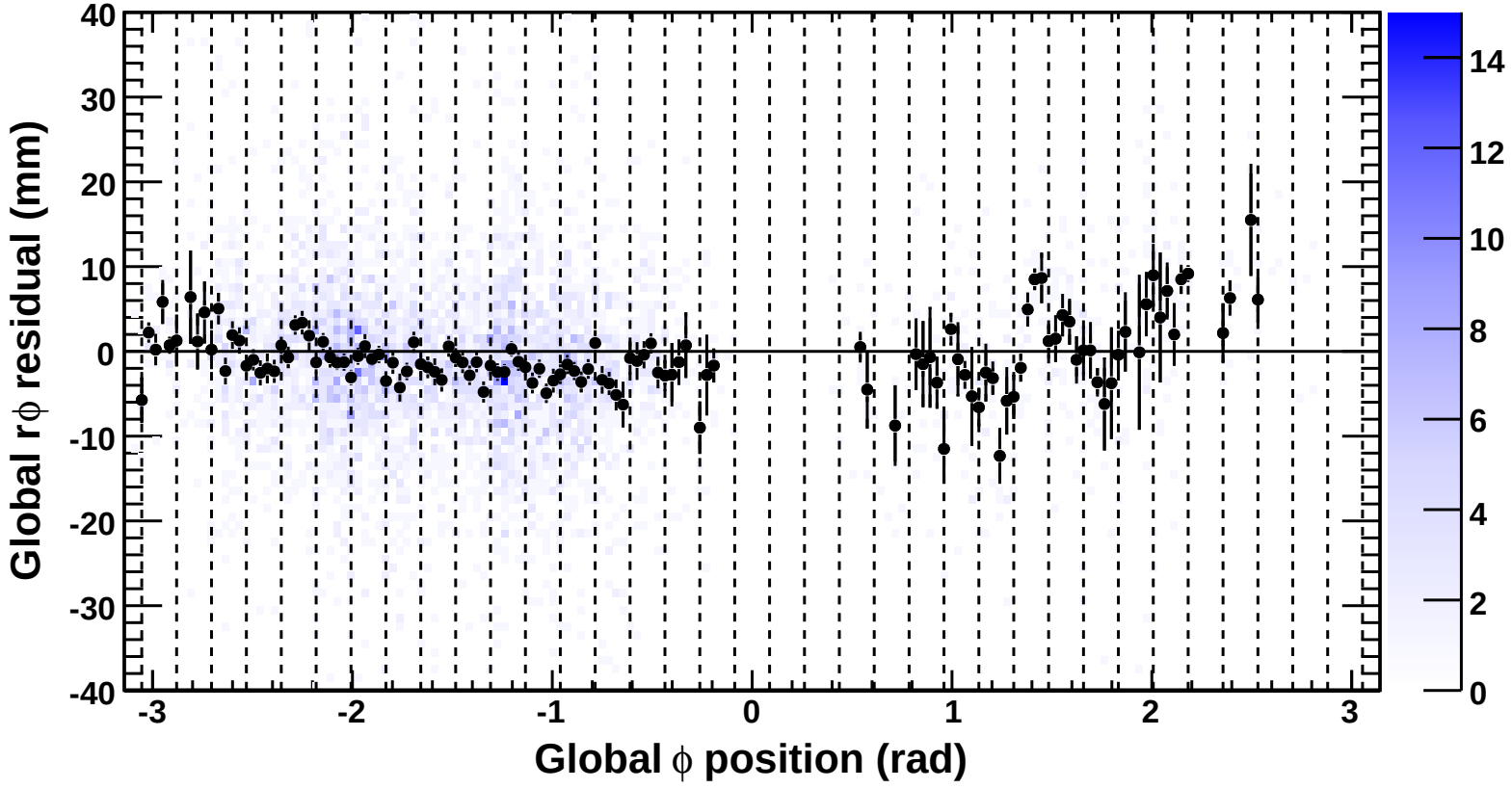
ME+2/2 x positions



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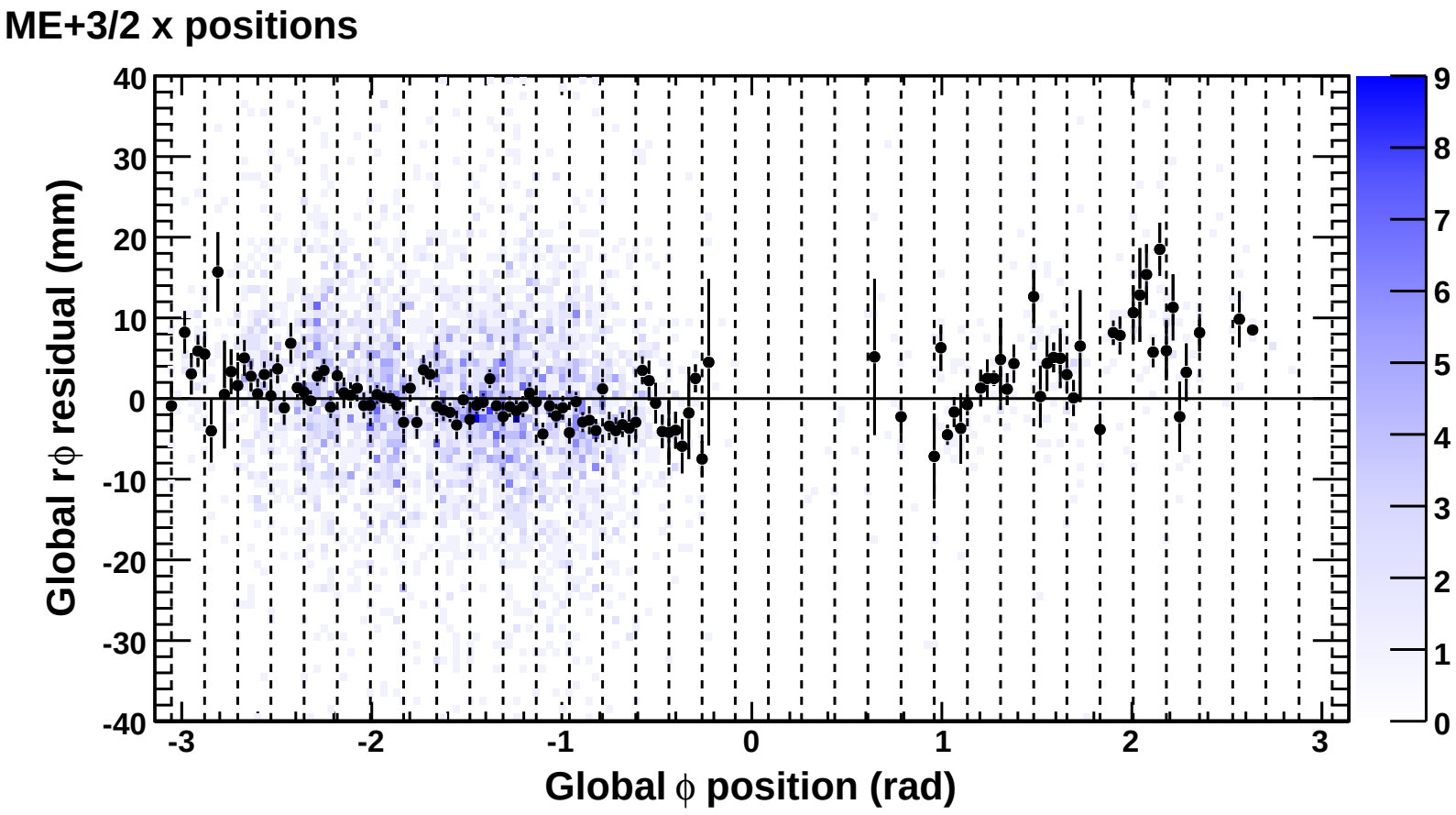

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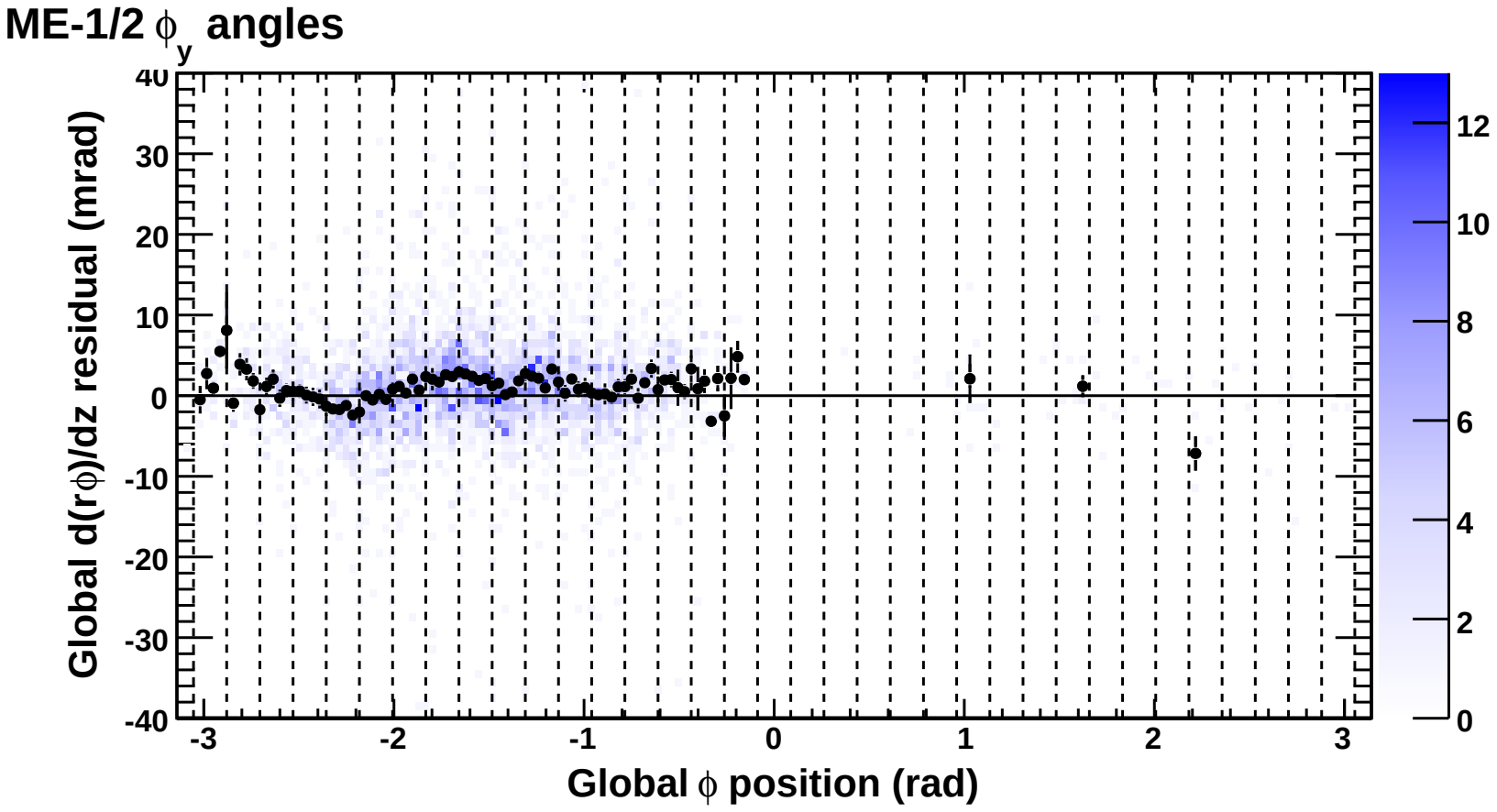

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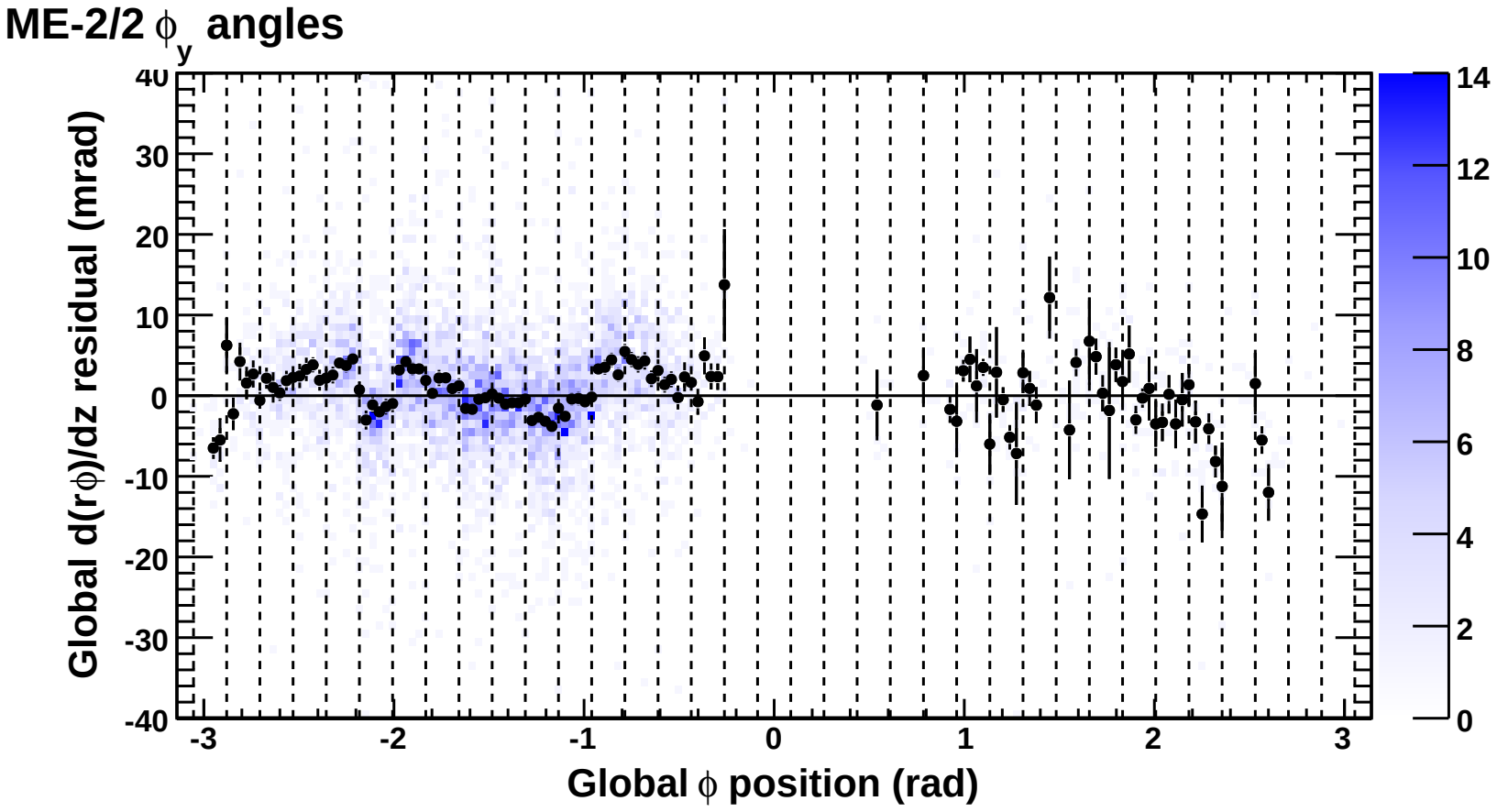

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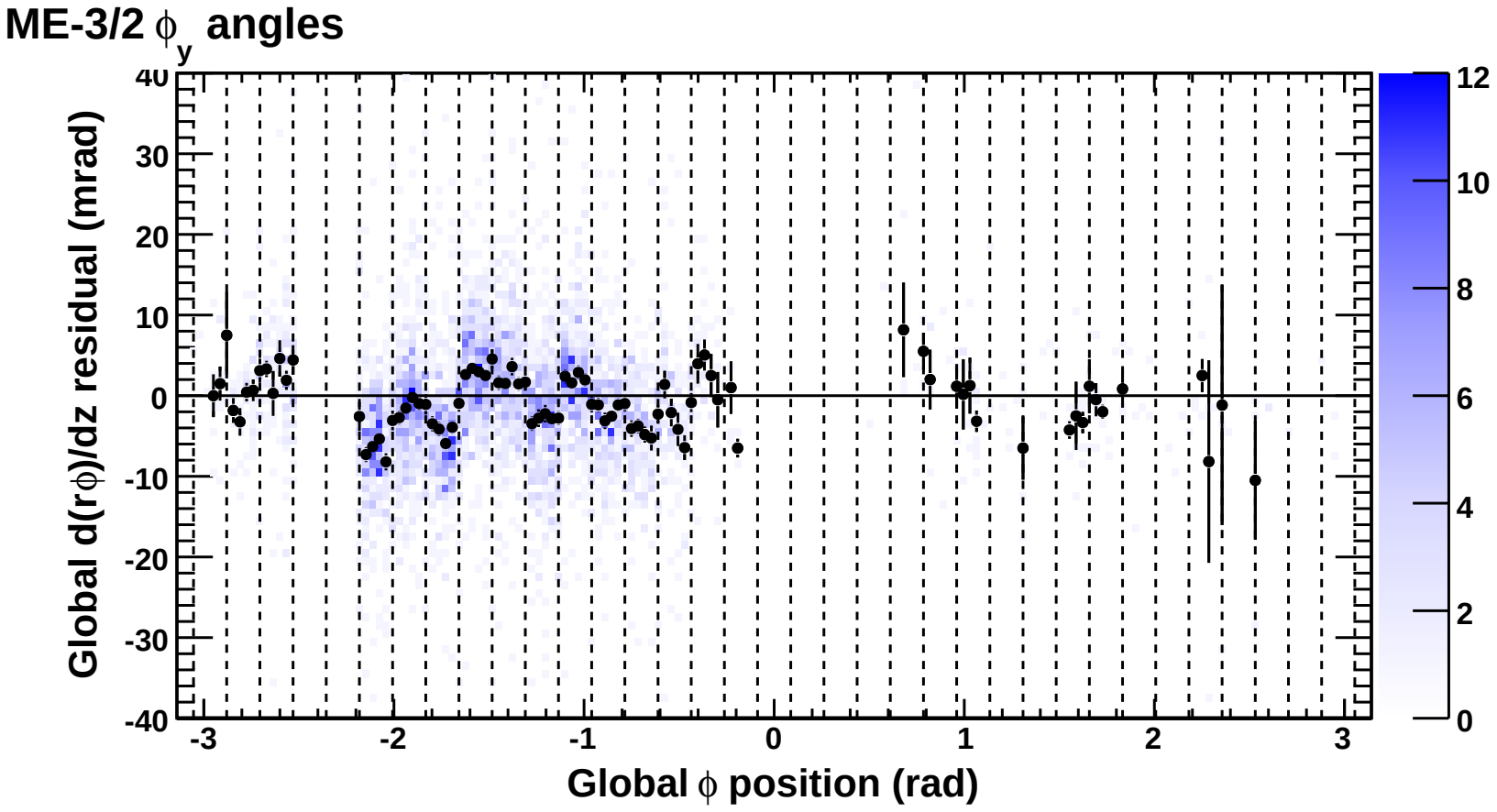

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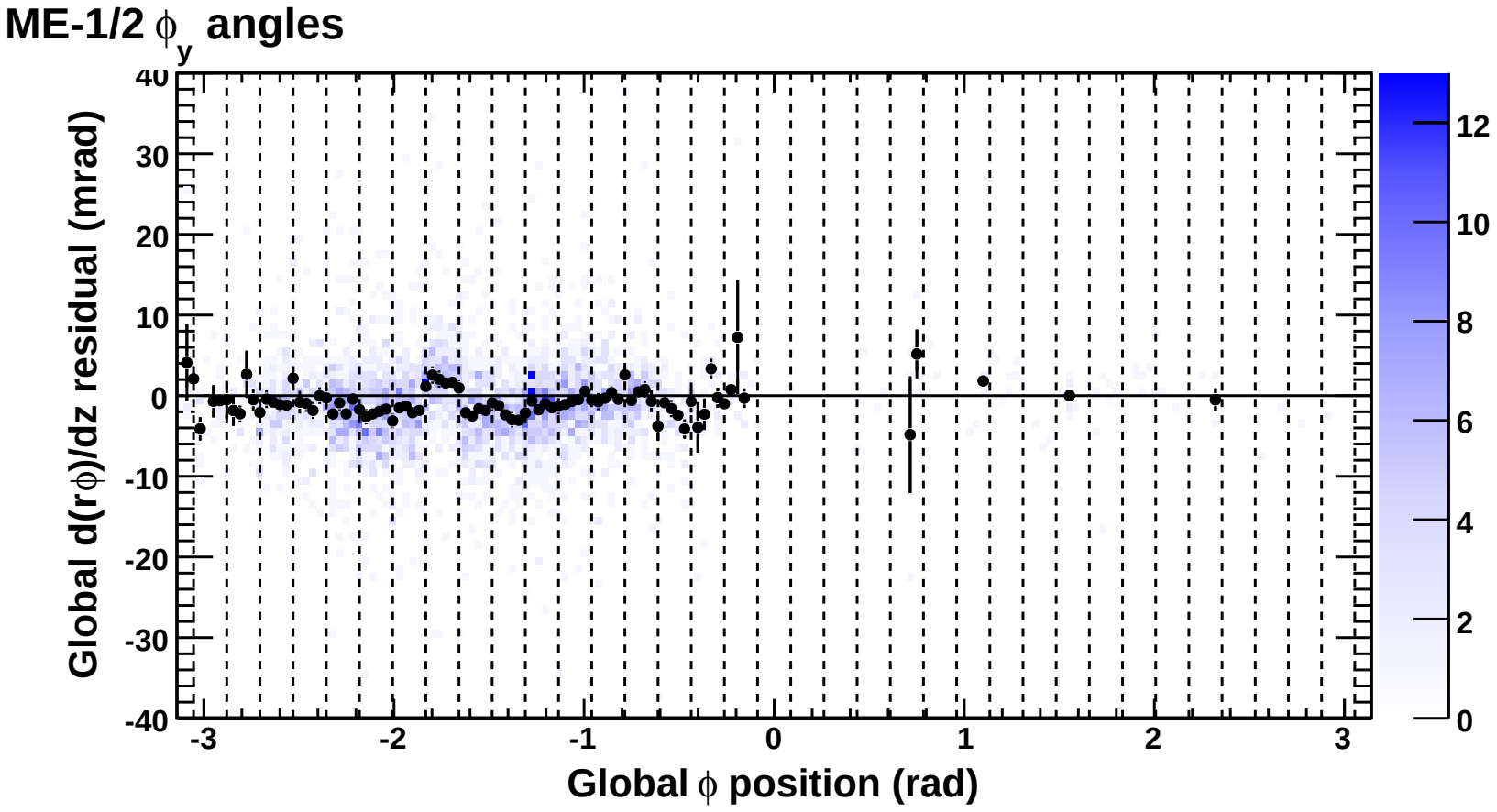

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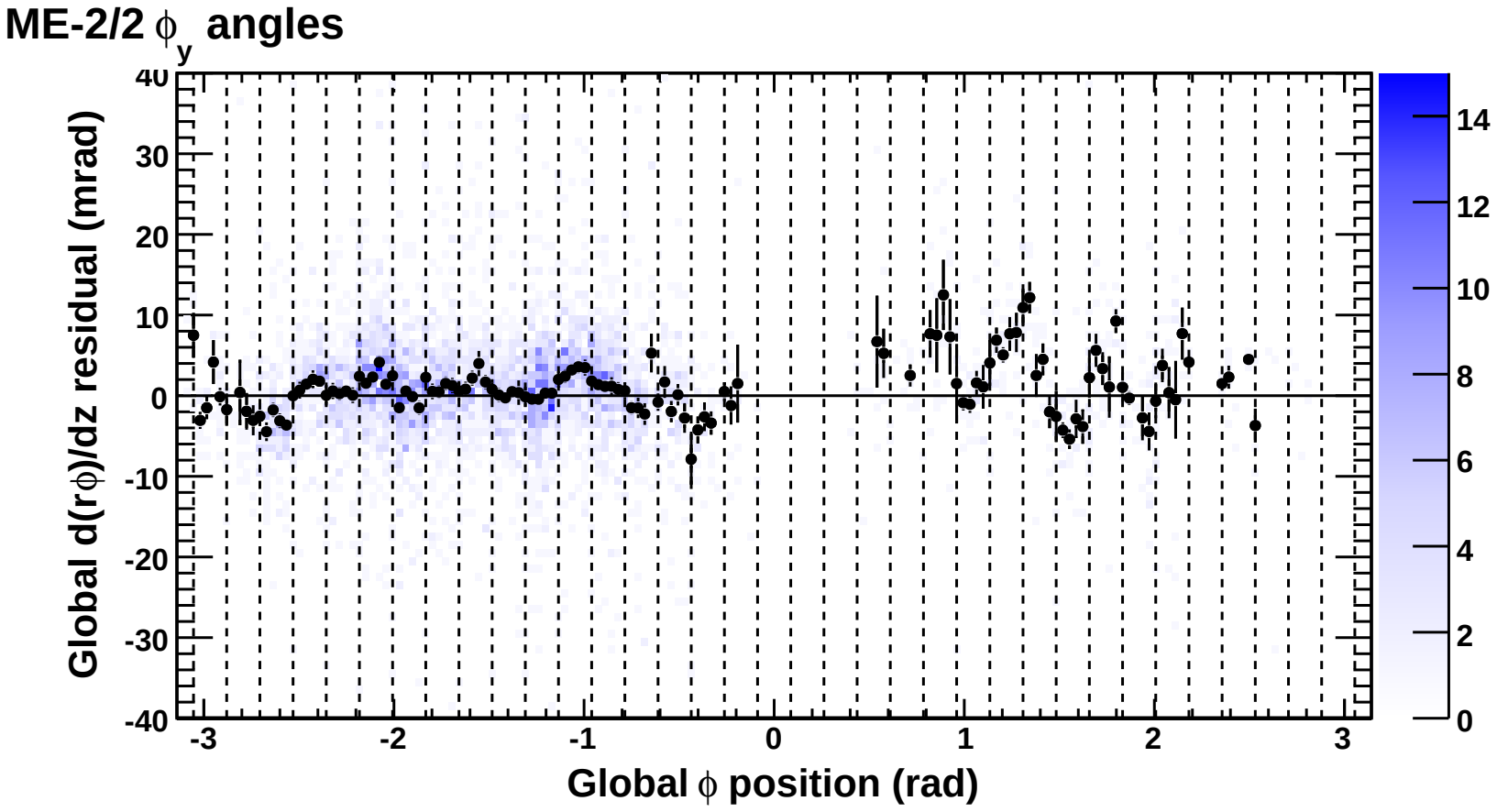

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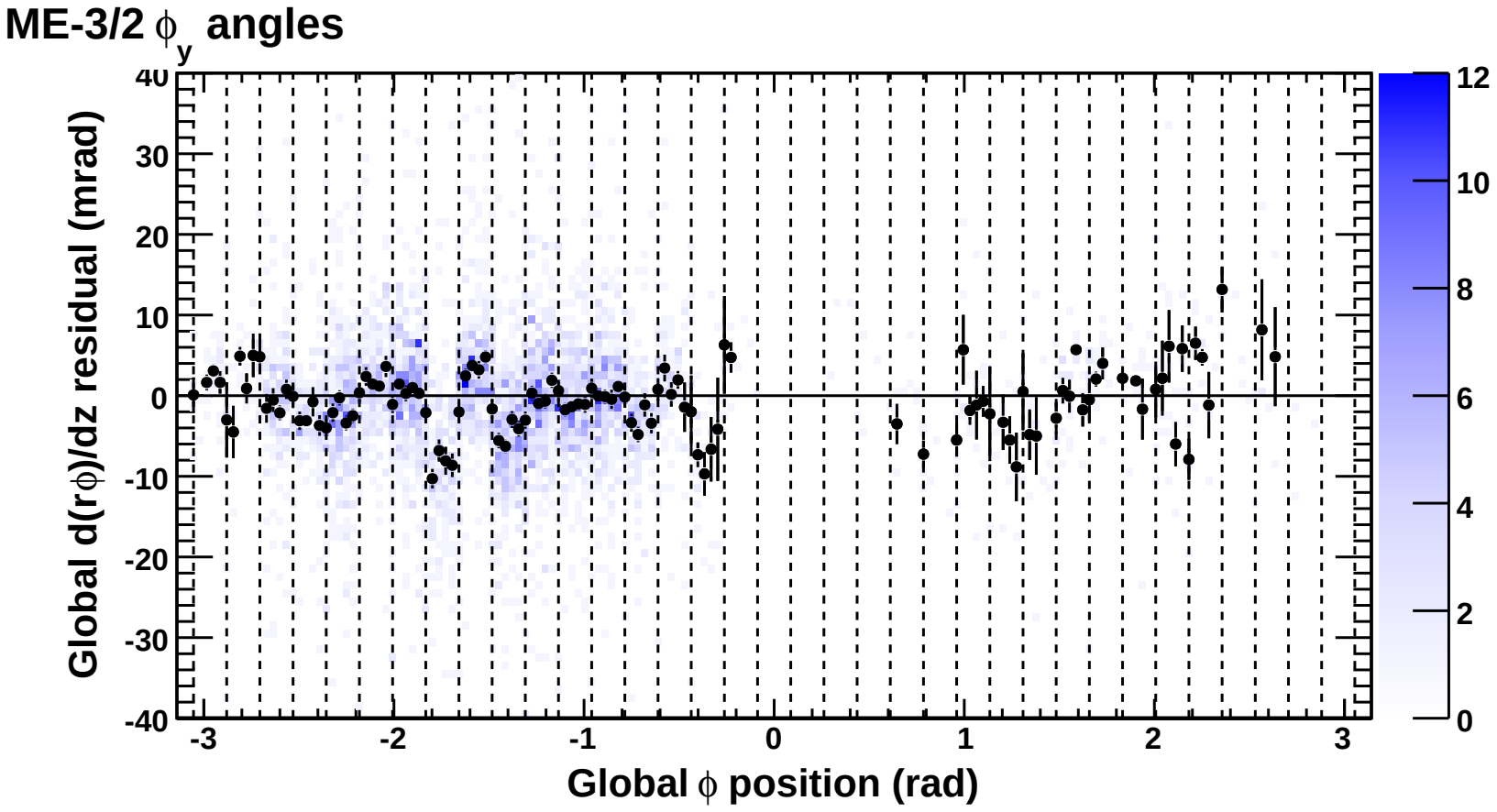
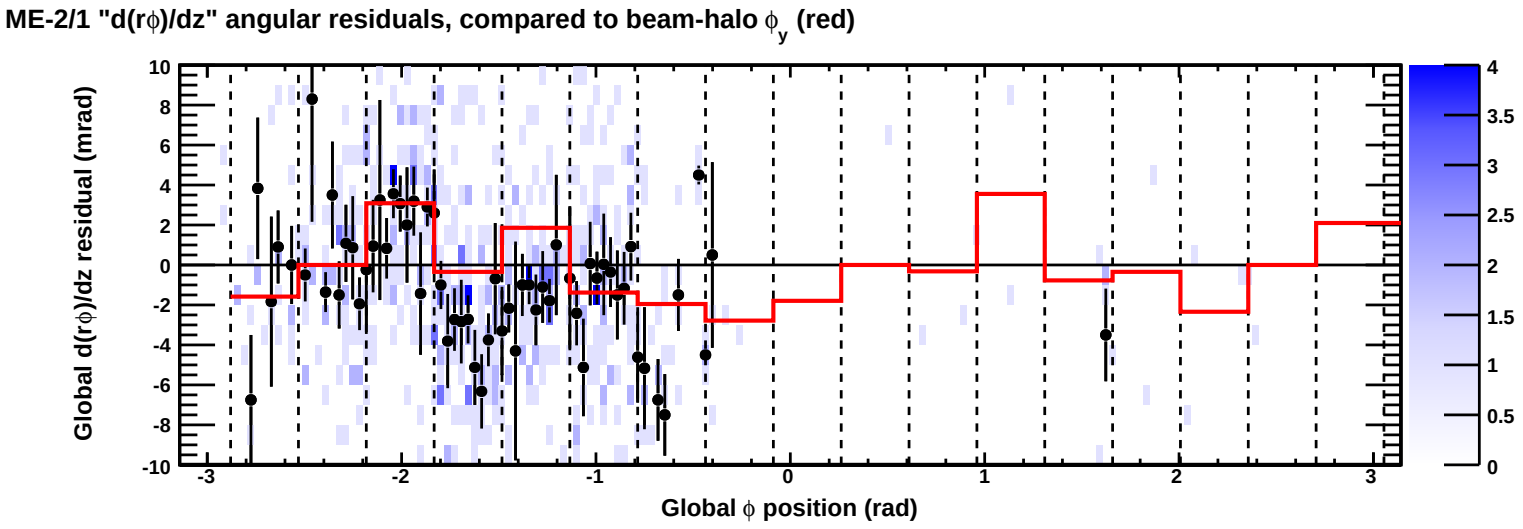


Comparison with beam-halo

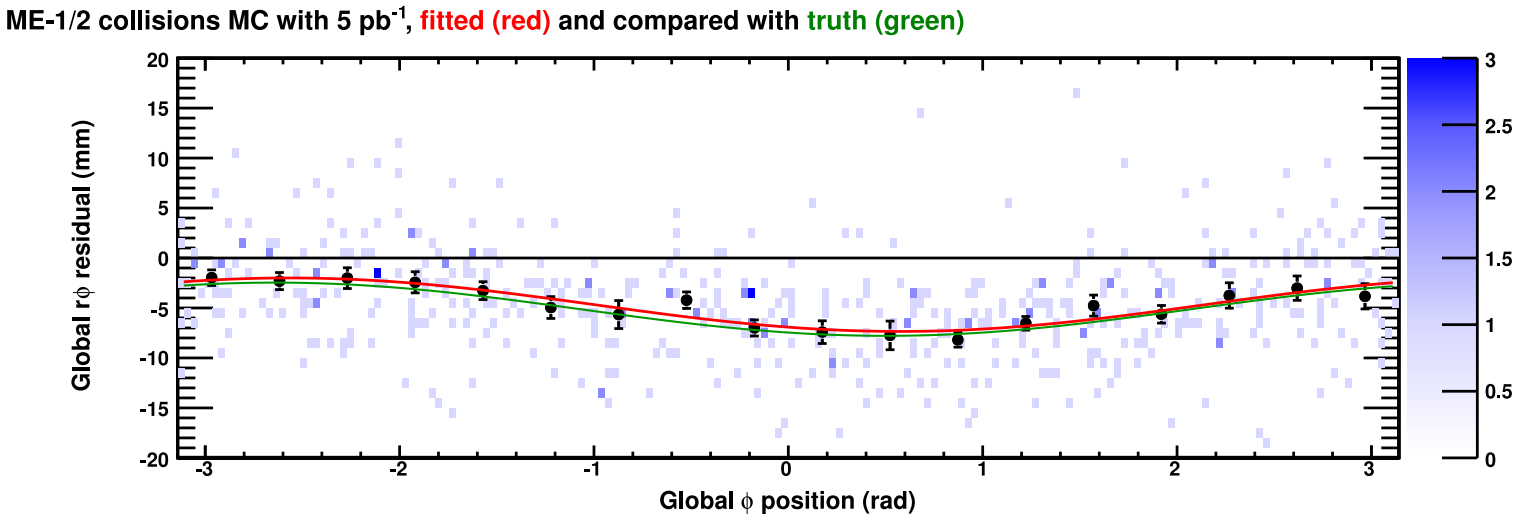
- Difficult to actually compare tracker-to-disk and beam-halo directly, because very few cosmic rays connect ME−2/1 with the tracker
- Nevertheless, we can try: these are ϕ_y with beam-halo overlaid



- To allow for tracker distortions and propagator errors, we can focus on the discontinuities at the chamber boundaries
- The discontinuities do not agree in detail with beam-halo: can form an argument that chambers have rotated between $\vec{B} = 0$ and CRAFT

How does it look in MC?

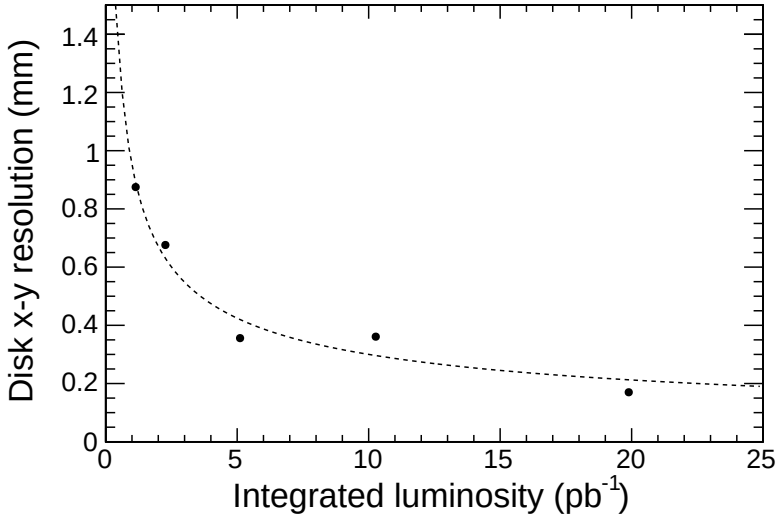
- Collisions MC (5 pb^{-1}): tracks uniform in ϕ but not more numerous
- Much easier to fit const + sine + cosine, accurate results
- Roughly the same residuals widths

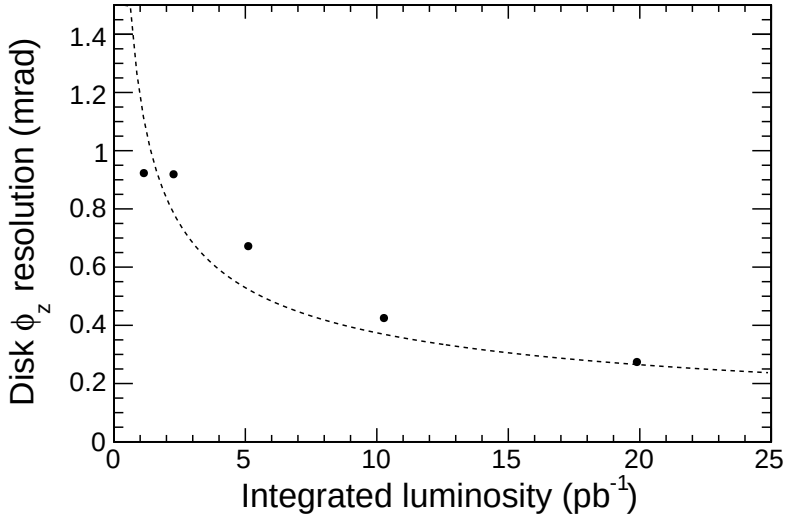


- Cosmic-ray MC (full sample): zero tracks (probably a generator-level cut)

MC disk-fitting study

- With ϕ-symmetric collisions, how much data do we need to align the disks?
- Includes residual misalignments after CSC Overlaps alignment (assuming same resolution as 2008)
- Independent samples scale with $\sqrt{N}$

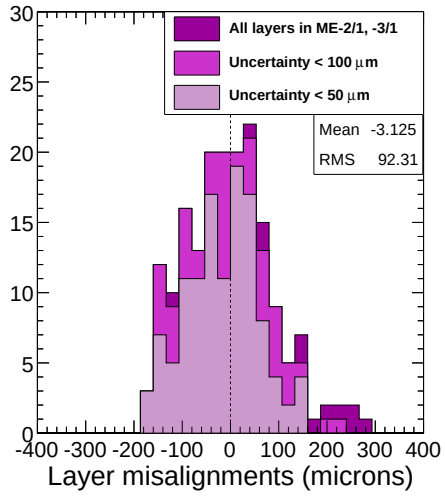




- This is a walk-through of what we'll need to do after CSC Overlaps

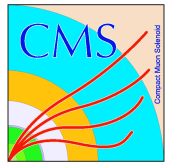
Timeline for beam

- Now and CRAFT-2009
  - validate cosmic ray tracker-to-disk procedures with CRAFT-2008 and -2009
  - automate all procedures and monitoring for CRAFT-2009, then simply run them
- Month of beam-halo only
  - re-run beam-halo procedure on new samples
  - kludge incomplete rings if necessary
  - any corrections needed for $\vec{B} \neq 0$?
  - one-time layer alignment with full dataset (low-statistics 2008 pilot study on right)



- First collisions: 5 pb^{-1}
  - run Overlaps procedure on collisions data, compare with beam-halo result
  - use tracker-to-disk method to connect internally-aligned rings to tracker
- Later collisions: 50 pb^{-1}
  - run Baseline procedure with same tracks: do they agree? If not, do track-by-track comparisons to diagnose the problem
  - do collisions alignments agree with cosmic rays in the barrel?

Conclusions



- Cosmics-during-collisions trigger is important, and it's getting built
- No clear convergence on endcap alignment yet, but hints of regional agreement
- globalMuons ME2/2 and ME3/2 agree with each other
- ϕ_y misalignments clearly seen, on the scale of what we saw in beam-halo, but not a good correlation: movement when $\vec{B} \rightarrow 3.8$ T?
- Collisions MC yields a much easier-to-fit disk due to ϕ symmetry of hits