



# Status of CSC Beam-Halo Alignment

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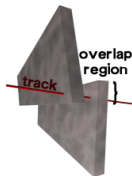
24 November, 2009



- ▶ We have beam-halo data! But at the end of the chain, not many events (about 150)
  - ▶ this might have been clarified in Andy, Gian Piero, and Jinzhong's talk
  - ▶ I haven't found any leaks in the offline pipeline
- ▶ No alignment yet, but we can see that the raw distributions agree well with intuition and expectations from Monte Carlo
- ▶ New features in the algorithm
  - ▶ if a CSC chamber or CLCT 1 or 5 is missing, breaking the ring, we can now use the closure ( $\sum \text{residuals} = 0$ ) as a constraint to perform an alignment
  - ▶ ME1/1a and ME1/1b are now treated as rigidly-connected
  - ▶ additional anti-cosmic and beam-splash cuts
  - ▶ lots of new plots to keep an eye on things (especially the cuts)
- ▶ Thorough Monte Carlo tests with the same parameters as data



- ▶ Reminder: we're looking for tracks that pass through the overlap region of pairs of CSC chambers—about 7% of the total beam-halo rate because of geometric acceptance
- ▶ MuAlBeamHaloOverlaps (dedicated alignment sample): about 170 events (as of yesterday)
  - ▶ prompt reco: includes data up to 122281 (Monday 9:30 GMT)
  - ▶ trigger configuration:
    - ▶ HLT\_CSCBeamHalo\* only until Monday morning
    - ▶ all muon triggers (including HLT\_L1OpenMuon\*) thereafter
  - ▶ almost all events are in three runs only:
    - ▶ 121964, 20 Nov 21:30, 72 events
    - ▶ 122269, 23 Nov 4:50, 61 events
    - ▶ 122270, 32 Nov 5:20, 35 events
- ▶ ExpressMuon/ExpressPhysics: the MuAlBeamHaloOverlaps selection algorithm (without HLT requirement) returns 20 events because most of them have zero “cosmicMuon” tracks
- ▶ ZeroBias: selection returns 1380, but nearly all are cosmic rays

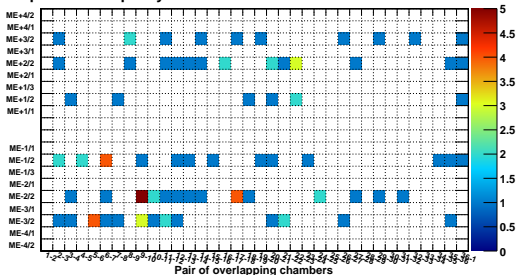


# Occupancy distributions

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Overlap-track occupancy



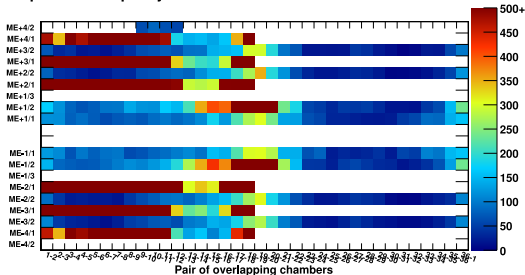
- ▶ Tracks crossing *pairs* of chambers (multiply by 2 for total segments)

- ▶ Top: data  
Bottom: MC

- ▶ Only low-rate ring-2 collected because ring-1 was at low voltage (STANDBY) for safety

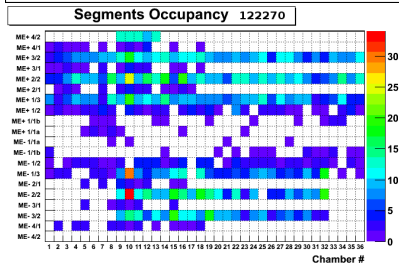
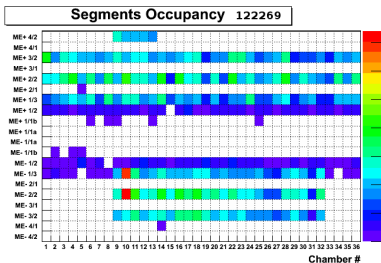
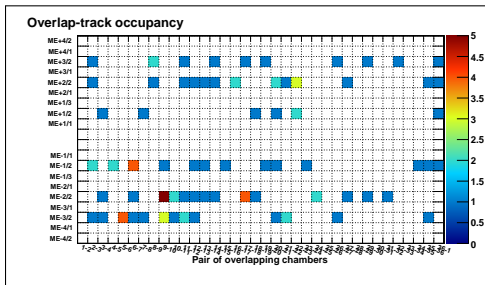
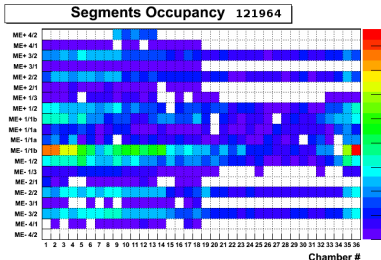
- ▶ MC  $\phi$  and  $R$  distributions are not realistically simulated (ATLAS cavern)

Overlap-track occupancy



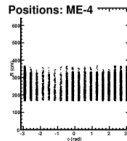
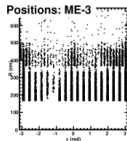
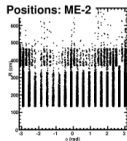
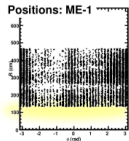
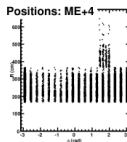
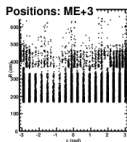
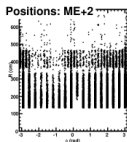
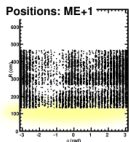
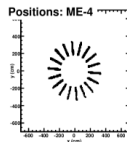
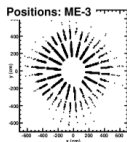
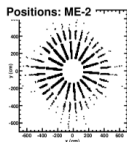
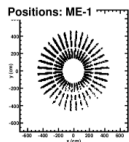
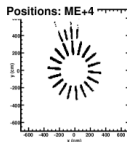
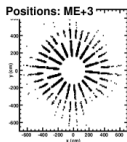
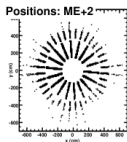
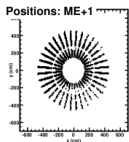


- CSCValidation segment occupancy plots for the three runs
- Confirms higher rate in ring-2



# Hit distributions (MC)

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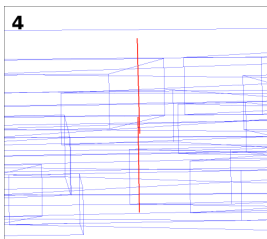
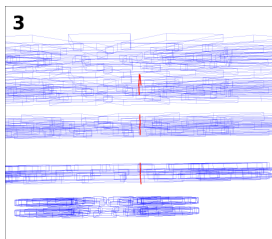
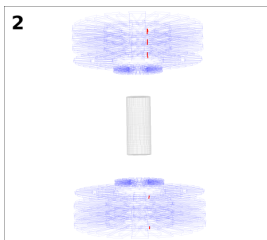
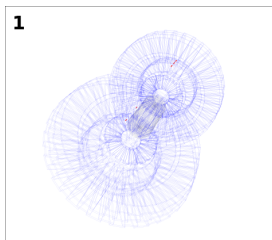
- ▶ Top:  $Y$  vs.  $X$   
Bottom:  $R$  vs.  $\phi$
- ▶ Both are MC
- ▶ Radial spokes along CSC edges indicate that overlap selection works
- ▶ ME1  $R < 140$  cm missing due to beam-halo trigger requirements (highlighted in yellow)
- ▶ ME1/1a chambers must be glued to ME1/1b or they'll be lost!

# Event display pictures (data)

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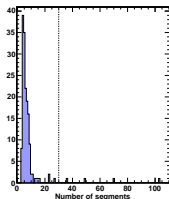
- ▶  $\sim 90$  beam-halo/gas,  $\sim 10$  beam-splashes, and  $\sim 70$  cosmics
- ▶ Zooming into a nice beam-halo event:



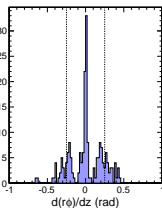


► Top plots: data, bottom plots: pure beam-halo Monte Carlo

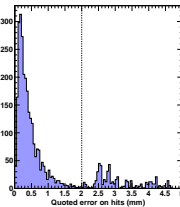
Anti-beam-splash:  
# segments  $< 30$



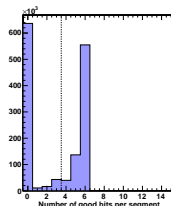
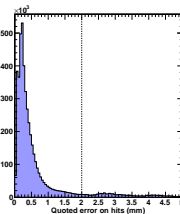
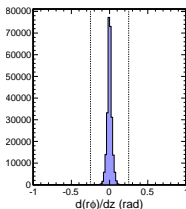
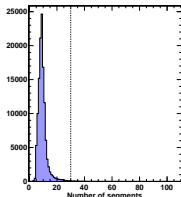
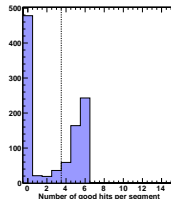
Anti-cosmic:  
point to beamline  
( $\pm 2.5$  mrad)



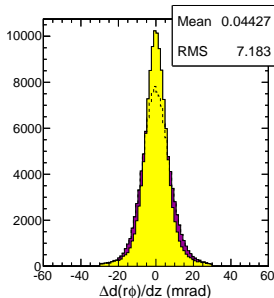
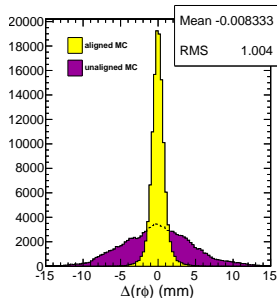
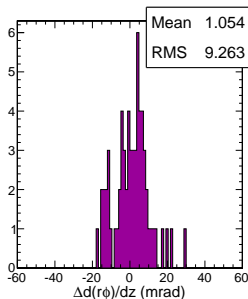
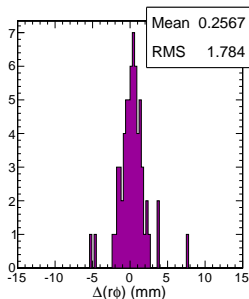
Exclude last  
cathode strip: hit  
error  $< 2$  mm



Fiducial segments:  
#hits/segment  $\geq 4$   
(usually require 6)

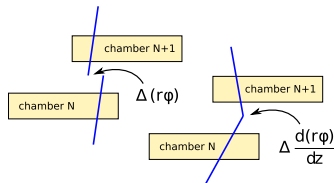






► Top: data, bottom: MC

►  $\Delta(r\phi)$  and  $\Delta \frac{d(r\phi)}{dz}$ :



► Error in  $\Delta(r\phi)$  dominated by  $\Delta \frac{d(r\phi)}{dz}$  resolution

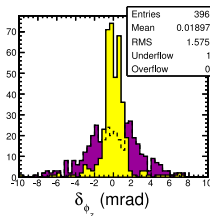
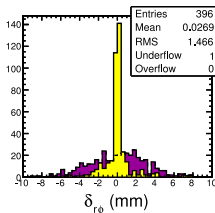
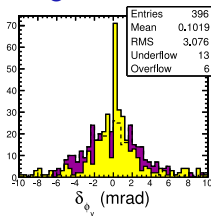
► If #hits/segment = 6 (all segments must be fiducial), MC resolutions improve by 20%

# MC alignment accuracy

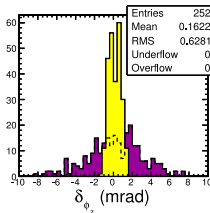
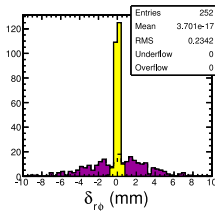
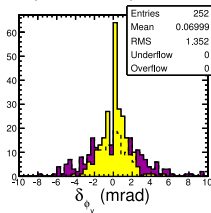
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All rings:



ME2/1, ME3/1, ME4/1



- ▶ Grain of salt needed: MC  $\phi$  and  $R$  distributions are unrealistic
- ▶ Bottleneck seems to be  $\phi_y$  (mean of  $\Delta \frac{d(r\phi)}{dz}$  residuals), which can be determined better with tracker tracks from cosmics or collisions

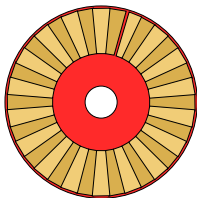


- ▶ New feature: can now align incomplete rings by *assuming*

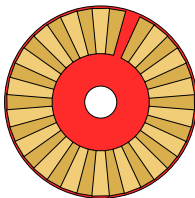
$$\sum_i^N \Delta(r\phi)_i = 0 \quad \text{and} \quad \sum_i^N \Delta \frac{d(r\phi)}{dz}_i = 0$$

- ▶ Closure test is no longer available as a cross-check for these rings
- ▶ Only works for certain topologies:

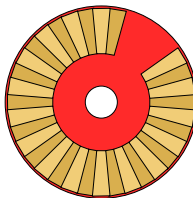
part of a chamber missing  
(CLCT problem): okay



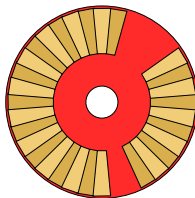
whole chamber missing:  
okay



consecutive chambers  
missing: okay



more than one group  
missing: **not okay**



- ▶ For example, we can align ME+4/2 (third case)



- ▶ New feature: ME1/1a chambers and their corresponding 1/1b chambers are now treated as rigidly connected physical objects
- ▶ ME1/1a and 1/1b chambers are separate entities in the software, and therefore separate in the alignment framework
- ▶ They share the same coordinate system (in ideal geometry), so residuals from each 1/1a and its 1/1b counterpart can be put in the same bin, with the resulting alignment corrections applied to both
- ▶ This implementation behaves properly
  - ▶ 1/1a and 1/1b do not get out of sync

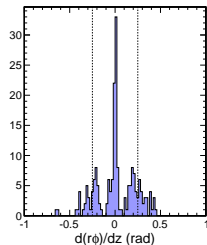


- ▶ Beam-halo overlaps sample still has too low statistics for alignment
  - ▶ tried to find the events in ExpressMuon, ExpressPhysics, and ZeroBias, but they aren't supersets of MuAlBeamHaloOverlaps
- ▶ The events we have make sense
  - ▶ most events in ring-2 because ring-1 not at high voltage
  - ▶ individual event displays look like the overlap events we want
  - ▶ plots differ by beam-splash and cosmic ray backgrounds
  - ▶ fewer hits per segment than MC: inefficiency due to lower voltage?
  - ▶ residuals consistent with  $\sim 1$  mm misalignment relative to ideal
- ▶ The alignment machinery will work when needed
  - ▶ tested in MC, including the new features

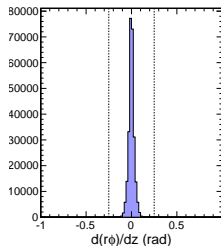


- ▶ The ZeroBias sample is  $\sim$ all cosmic rays:
- ▶ MuAlBeamHaloOverlaps and beam-halo MC shown on page 8

MuAlBeamHaloOverlaps



Pure beam-halo MC



ZeroBias sample

