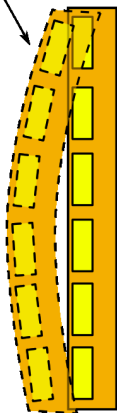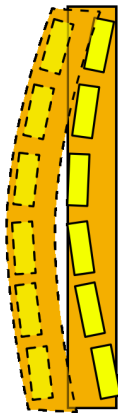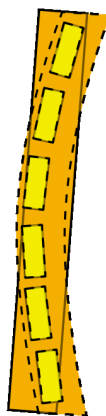# Very early CSC alignment with HIP

real positions   geometry in CMSSW

initial
configuration
(ideal geometry
in CMSSW)

align chambers
to each other
on a given disk with
beam-halo/cosmics

align disks as
rigid bodies
with 1 pb^{-1}

Role of beam-halo/cosmics

Goal A-1: align chambers (x, y, ϕ_y, ϕ_z) in each station

- ▶ requires beam-halo in the overlap regions (no ME1/3)
- ▶ track propagation is short and avoids iron; beam-halo orientation is perfect
- ▶ whole-station parameters are unconstrained (the whole station can rotate, and that's okay)

Goal A-2: align chambers (x, y, z, ϕ_x?, ϕ_y, ϕ_z) on each disk

- ▶ (alternative to A-1)
- ▶ additionally requires cosmic rays to access z and ϕ_x and to connect chambers in different rings
- ▶ track propagation still avoids iron
- ▶ whole-disk parameters are unconstrained (that's okay)

Goal B: align layers (x, y, ϕ_y, ϕ_z) in each chamber

- ▶ requires overlap beam-halo with large statistics (no ME1/3)
- ▶ constrain whole-chamber parameters by combining with A-1 or A-2 (above)
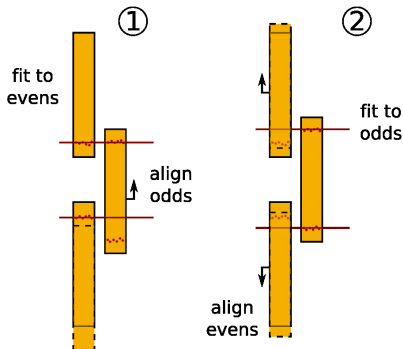
Procedure for goal A-1:

Split station by even- and odd-numbered chambers


one iteration is enough if evens are initially aligned

fit tracks to evens

beam-halo tracks

align odds
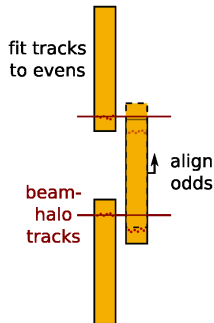
in general, alternate and iterate

① fit to evens

align odds

② fit to odds

align evens

relative alignment converges exponentially, though whole station may wander

- ▶ Overlap hits are now included on tracks (Rick Wilkinson)
- ▶ Need to set APEs of even-numbered chambers in chosen station to 0, all others to ∞

Extend procedure to cover goal B?
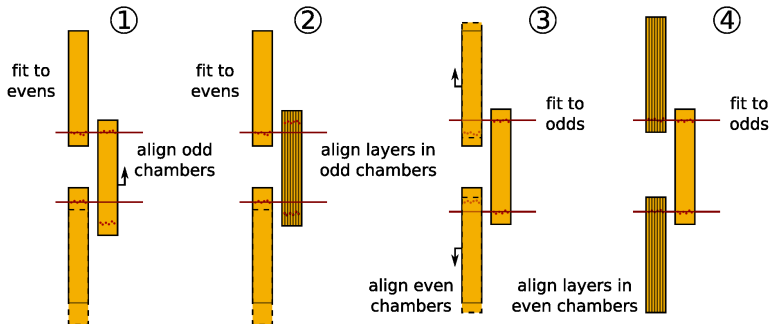
- ▶ Add another step for layer alignment, after centering chamber position
- ▶ Requires higher statistics because we now have 1 hit per alignable per track, rather than 6
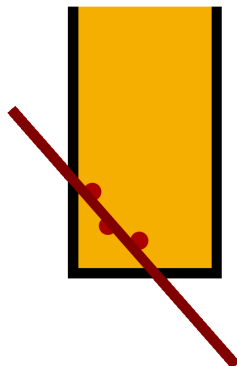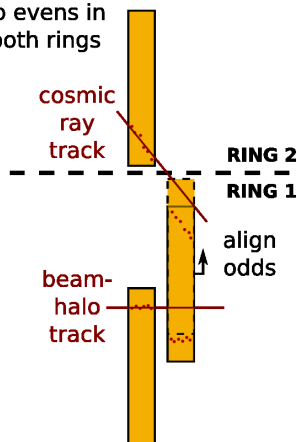
Even/odd structure of the muon system
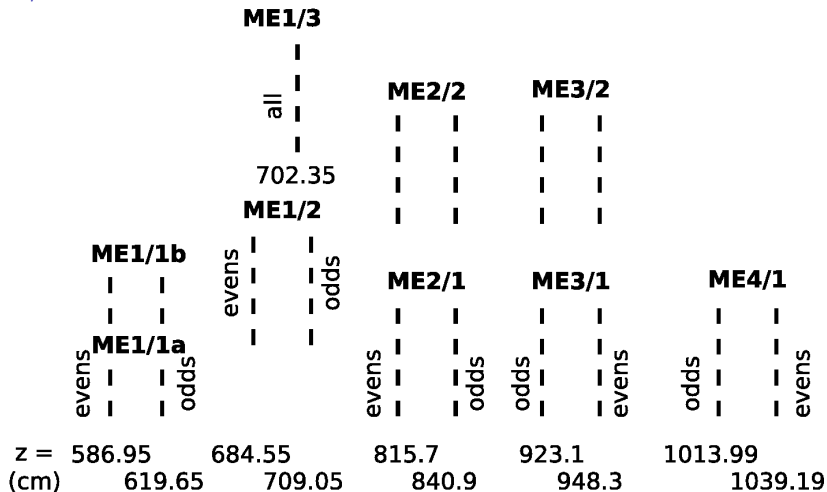
- ▶ Cosmic rays could connect ring 2 even with ring 1 odd
- ▶ All ME1/3 chambers must be treated as "odds"
- ▶ No way to connect ME1/1 with ME1/2, 1/3

Extend procedure to cover goal A-2?

▶ Mix cosmic rays with beam-gas and group sets of chambers appropriately

fit all tracks to evens in both rings

cosmic ray track

RING 2

RING 1

align odds

beam-halo track

must be able to fit partial tracks through chambers

how few hits is too few hits?

Role of 1 pb^{-1}

- Align whole-station or whole-disk structures to tracker coordinate system using globalMuons
- Very few tracks (hundreds) are needed for full 6 d.o.f.
- BUT...Software infrastructure can only align whole disks, where ME1/1a, ME1/1b, ME1/2, and ME1/3 are one disk
  - If goal A-2 is achieved, we still wouldn't be able to align ME1/1 relative to ME1/2-ME1/3 structure
  - If goal A-2 is unattainable, we would need to rely on 1 pb^{-1} for relative alignment of stations on a disk
- This is a rather significant modification to the code— unclear if I can do this by 2_0_0 and it's late to ask

Potential role of hardware alignment

- Straight-line monitors were designed to connect inner ring with outer ring (z deformation)
- I don't know of any connection between ME1/1 and ME1/2-ME1/3