


Status Report on Track-based Alignment

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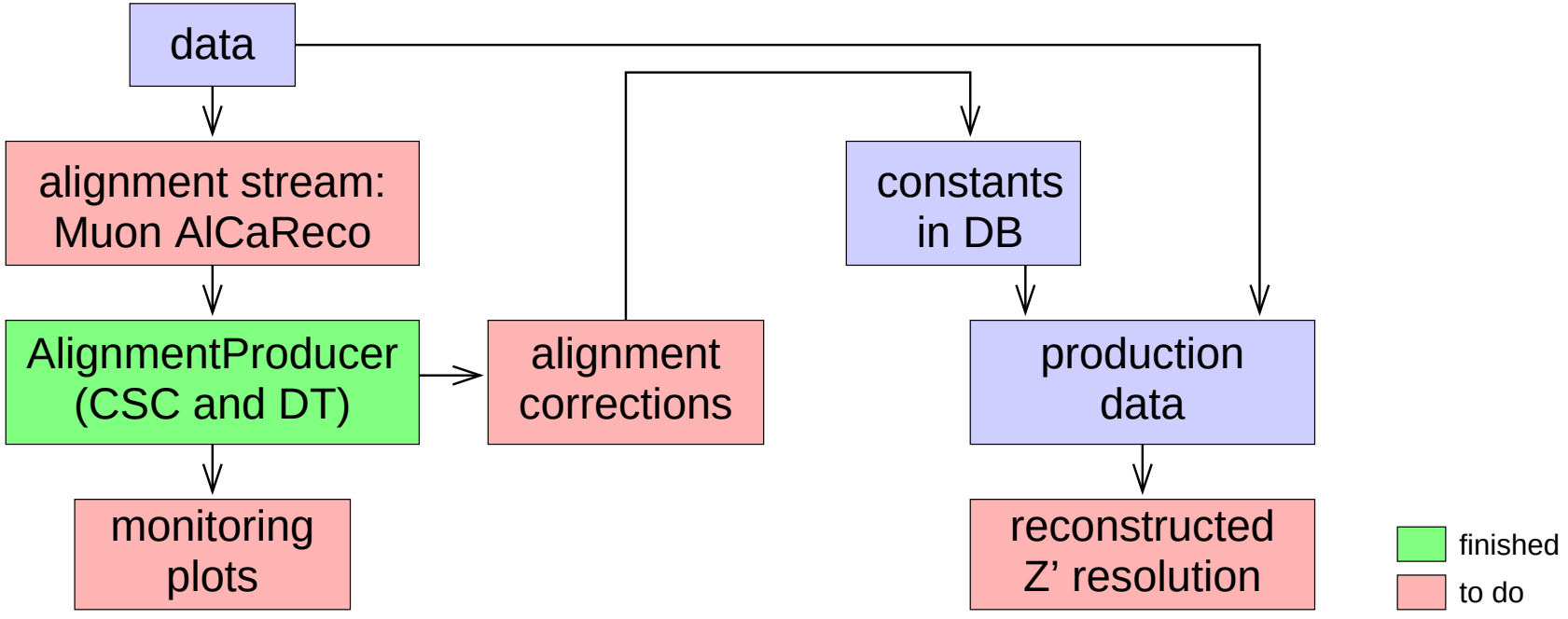
Overview

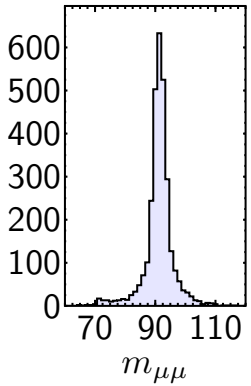
Our goal: to improve high-p_T muon resolution at 14 TeV (primary) and 0.9 TeV (secondary)

Deliverables: muon alignment data stream, software, well-studied HIP procedure, and alignment constants



Alignment Stream

- Events of interest
  - $W \to \mu\nu$ and $Z \to \mu\mu$ for 14 TeV
  - $b \to \mu X$, beam halo, and/or cosmics for 0.9 TeV
  - Just $Z \to \mu\mu$ for now



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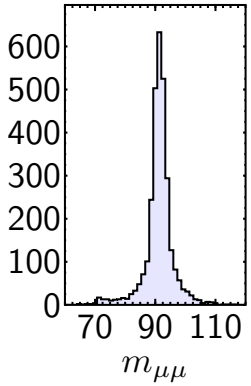
- Background studies
  - Define cuts, optimize signal/rate
  - $Z \to \mu\mu$ like sign minus opposite sign



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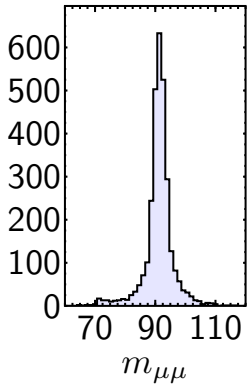

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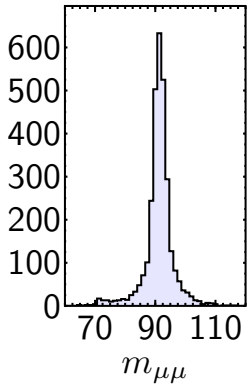

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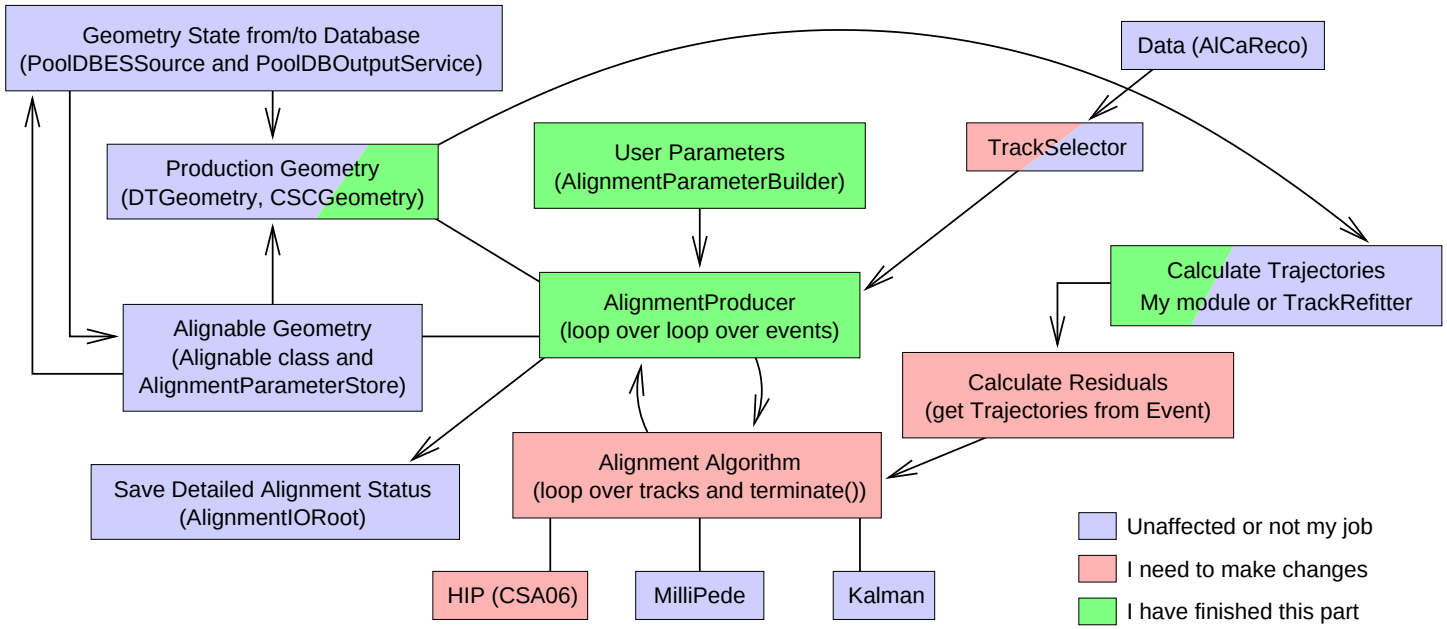
- AlCaReco format
  - Currently includes only local muon reconstruction
  - We need tracker fits and global muons!

Software: updated AlignmentProducer

- Included muon chamber alignables and removed tracker-dependent assumptions
- Requred a reorganization of track refitter and Trajectory-calculating code CMS Week



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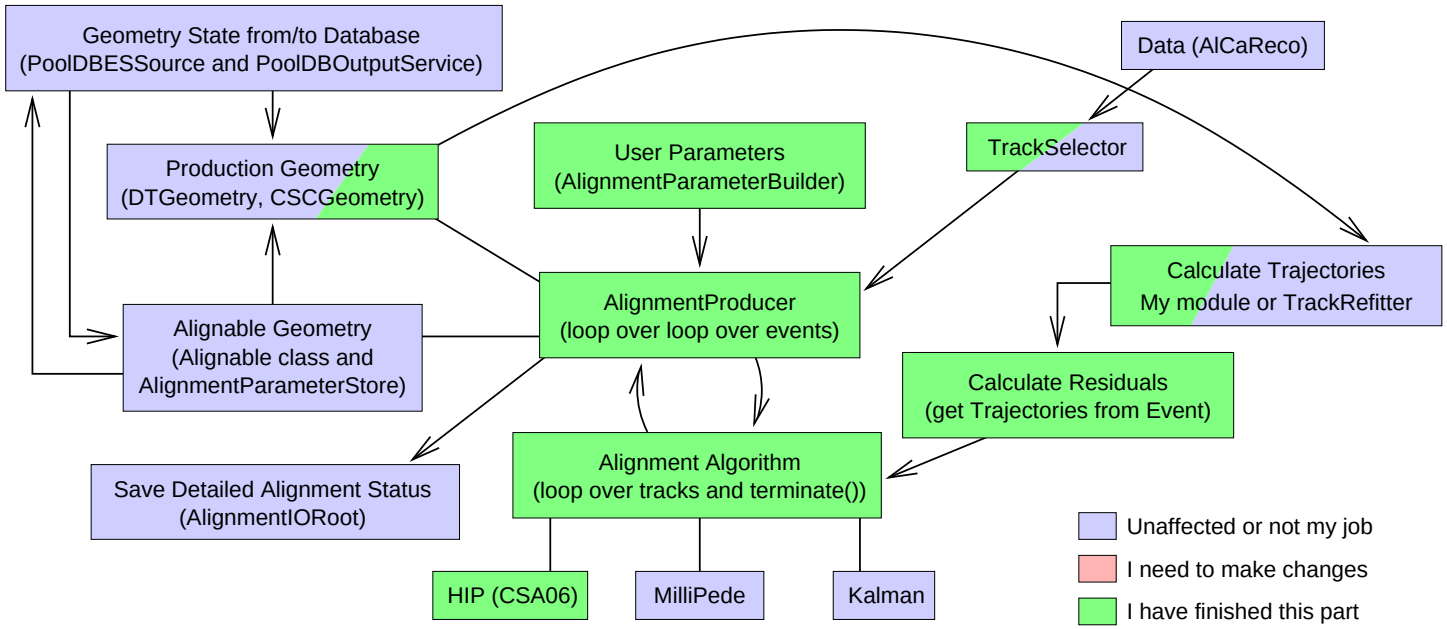
Now



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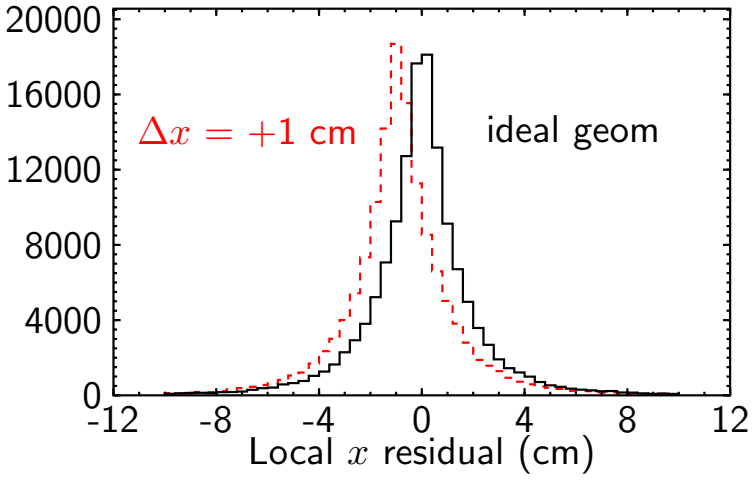
CommonAlignment framework can now. . .

- move muon geometry (DT and CSC)
- calculate muon residuals.

Accessible to all 3 algos:
HIP, MillePede, and Kalman



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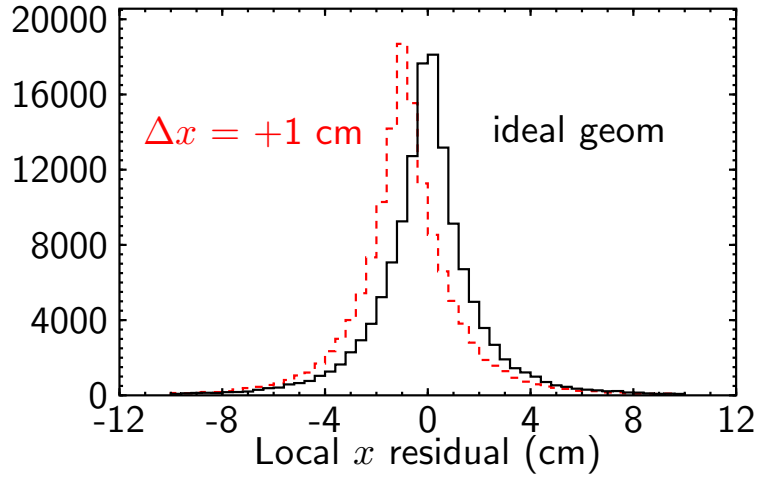


HIP Algorithm: move geometry to weighted mean of residuals (track minus hit), transformed to parameter space (x, y, z, ϕ_x, ϕ_y, ϕ_z),

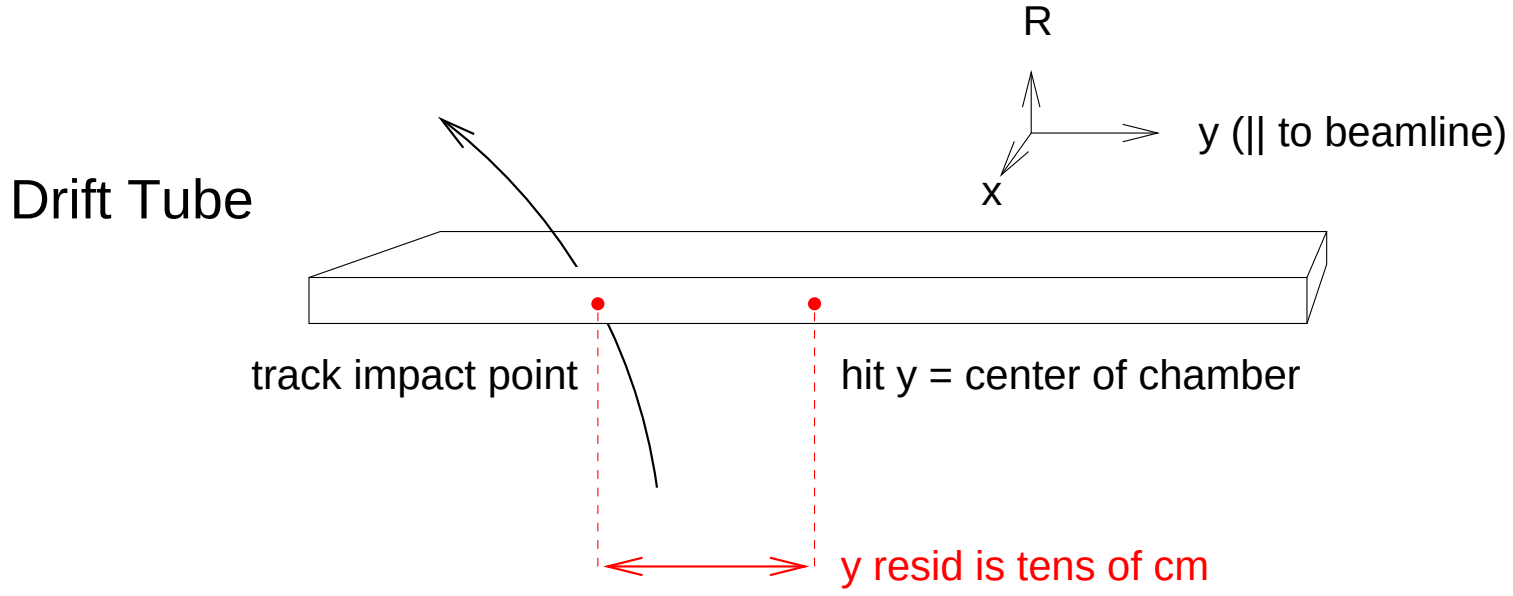
$$\begin{pmatrix} \text{alignment} \\ \text{corrections} \end{pmatrix} = \begin{pmatrix} \quad \end{pmatrix} \begin{pmatrix} \text{weighted mean} \\ \text{of residuals} \end{pmatrix} \begin{pmatrix} \quad \end{pmatrix}^{-1},$$

chamber-by-chamber.

Corrected treatment of 1-dimensional hits

Our first alignment moved DTs by tens of cm, but not CSCs...

- CSA06 HIP assumed all sensors are 2D
- Axial DT hits have no y information

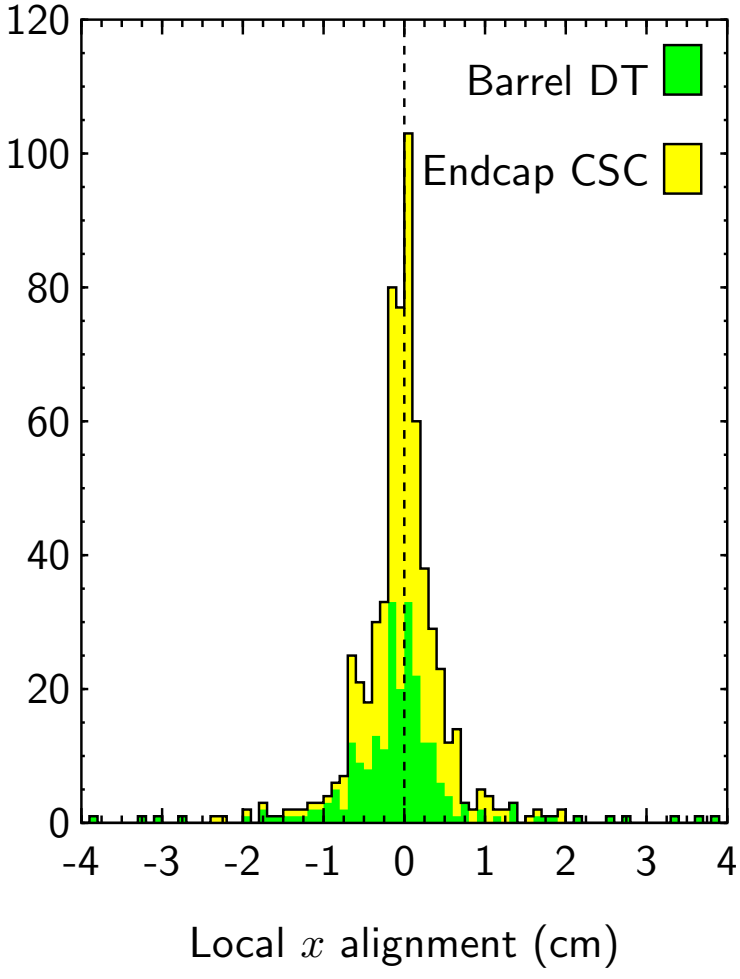


- We modified the algorithm such that these hits contribute to x alignment but not y alignment (we set $1/{\sigma_{r_y}}^2 = 0$)

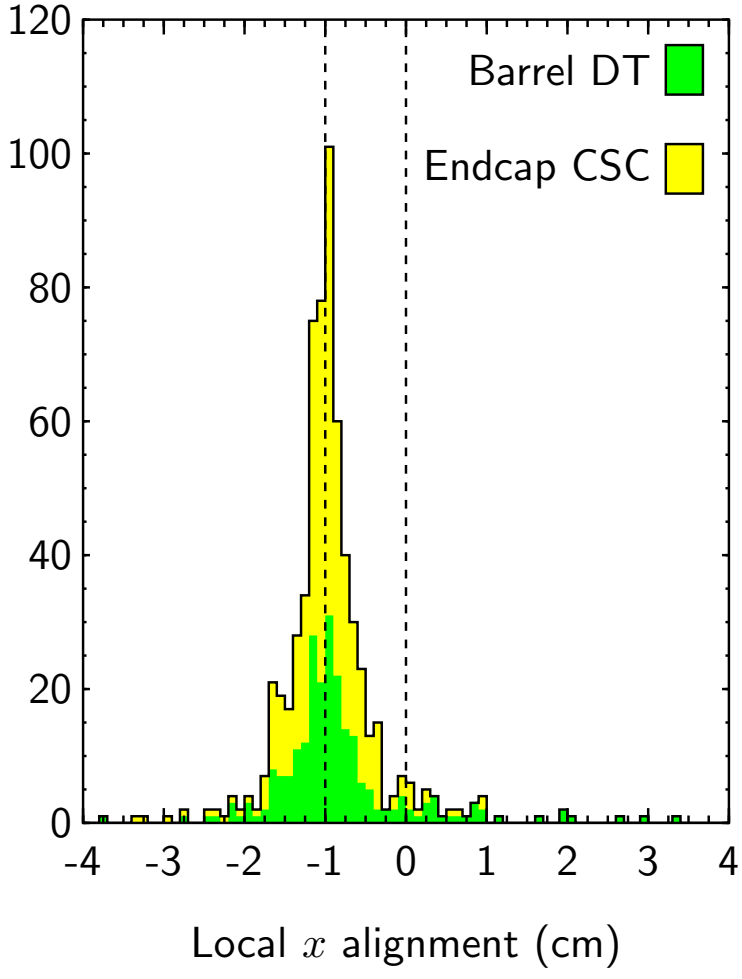
Demonstration of muon alignment!

Alignment output, starting from...

an ideal alignment



all chambers $\Delta x = +1$ cm



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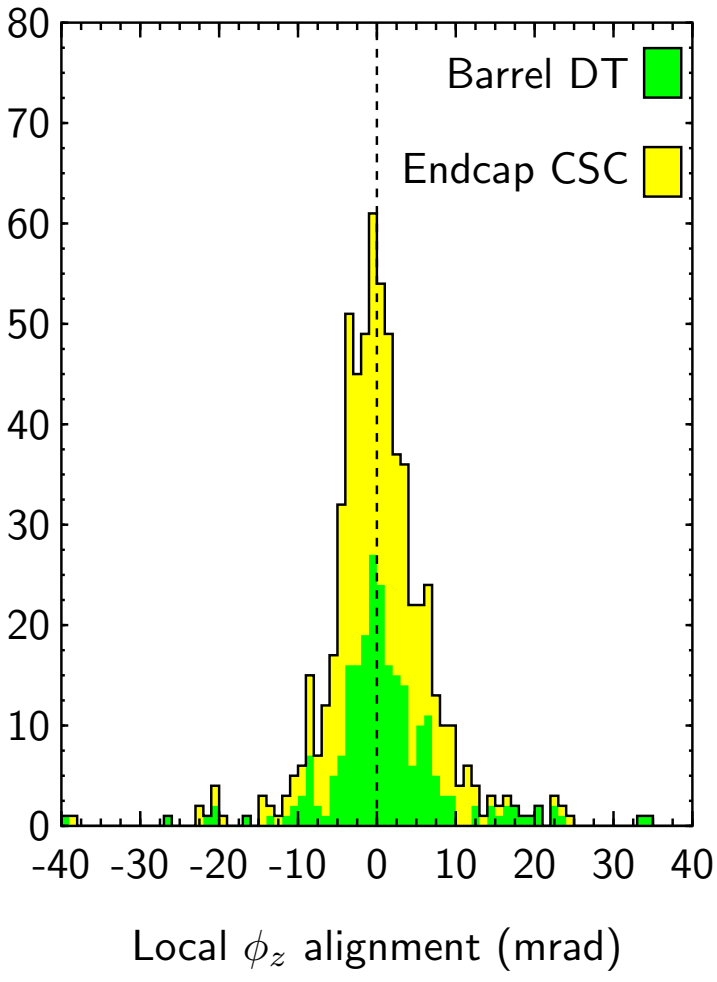
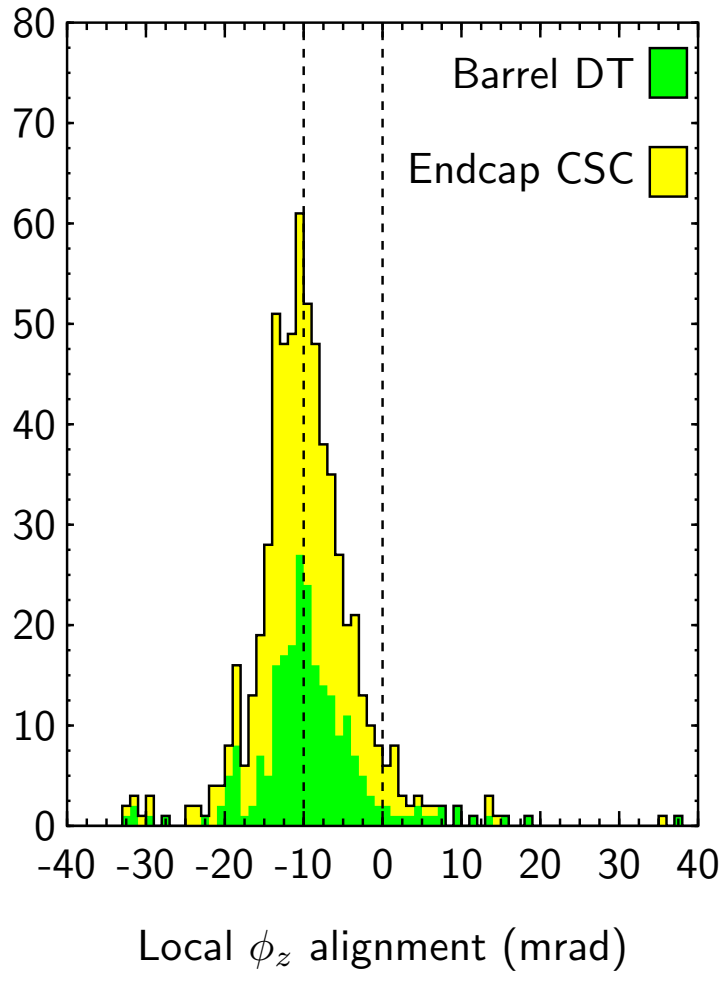
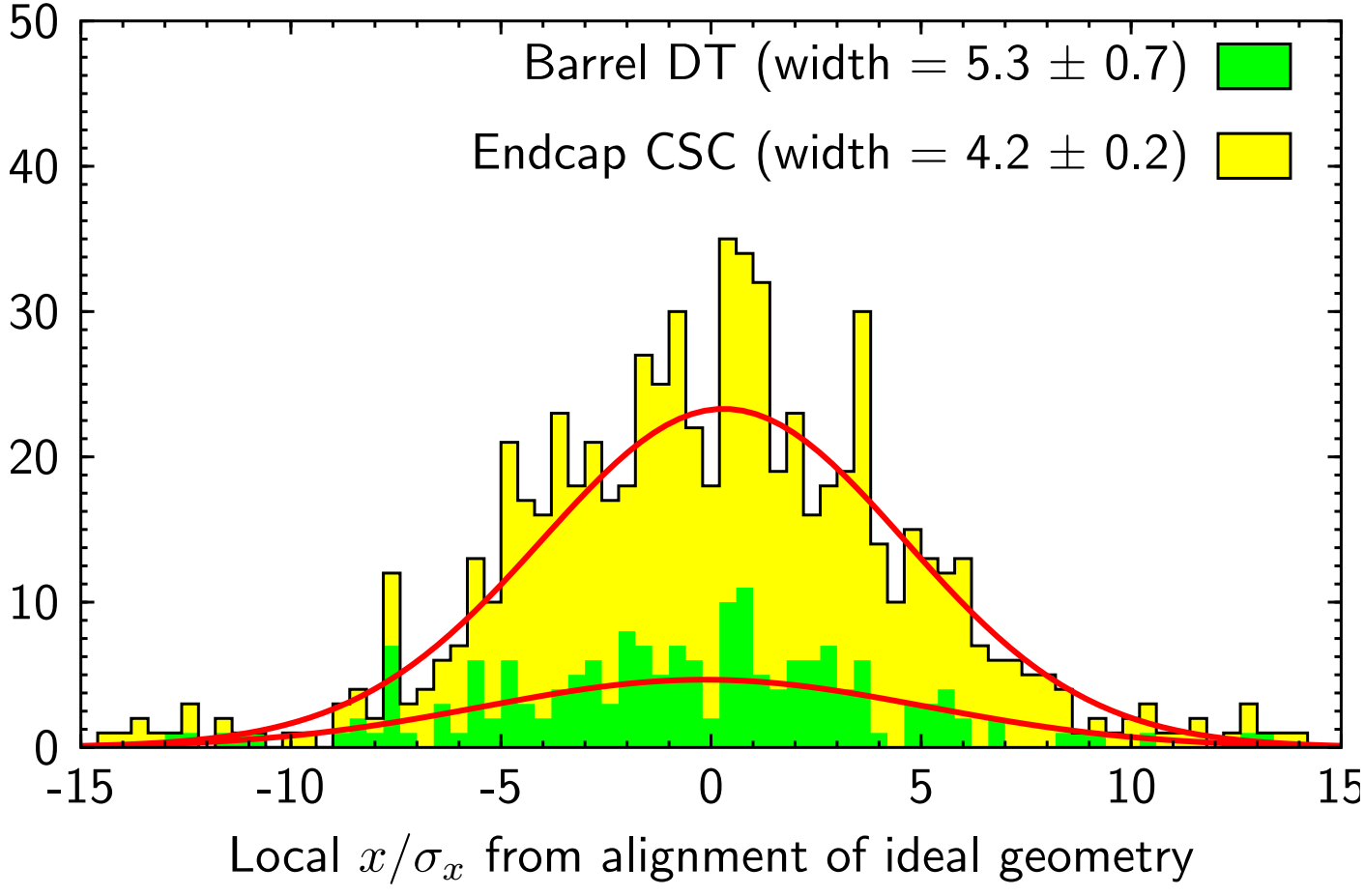


all $\Delta\phi_z = +10$ mrad



Alignment Uncertainties

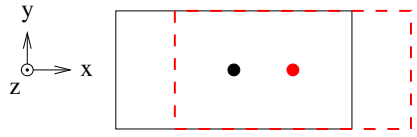
- Derive purely from residual uncertainties
- Too small to account for RMS of chamber corrections



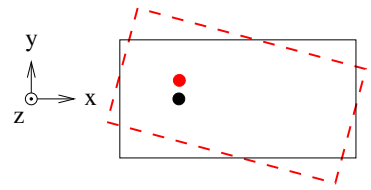
Monitoring Alignment for Quality Control

- Need to produce constants *and* confidence that they are correct, on a regular basis
- Include all helpful plots in the HIP alignment package
- Present the most useful for routine monitoring
- HIP can diagnose and validate MillePede and Kalman

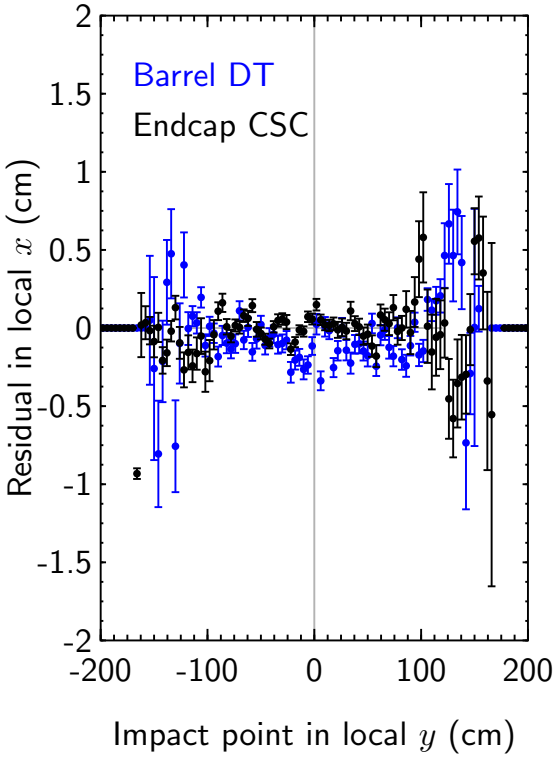
Monitoring: Trends in Residual Profiles

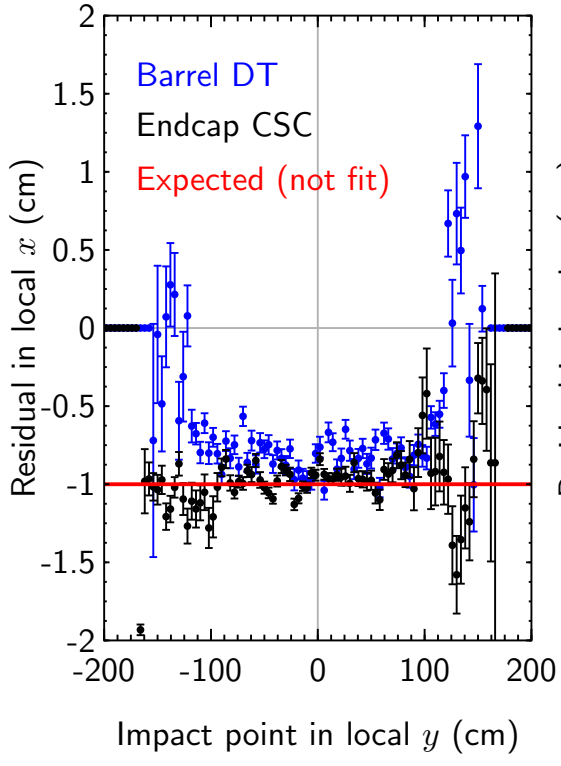


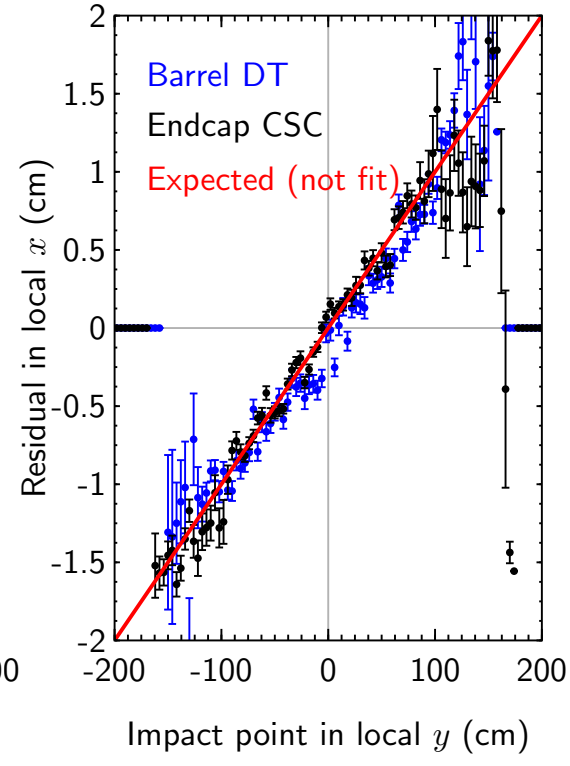
x: offset in r_x



ϕ_z: r_x linear in y

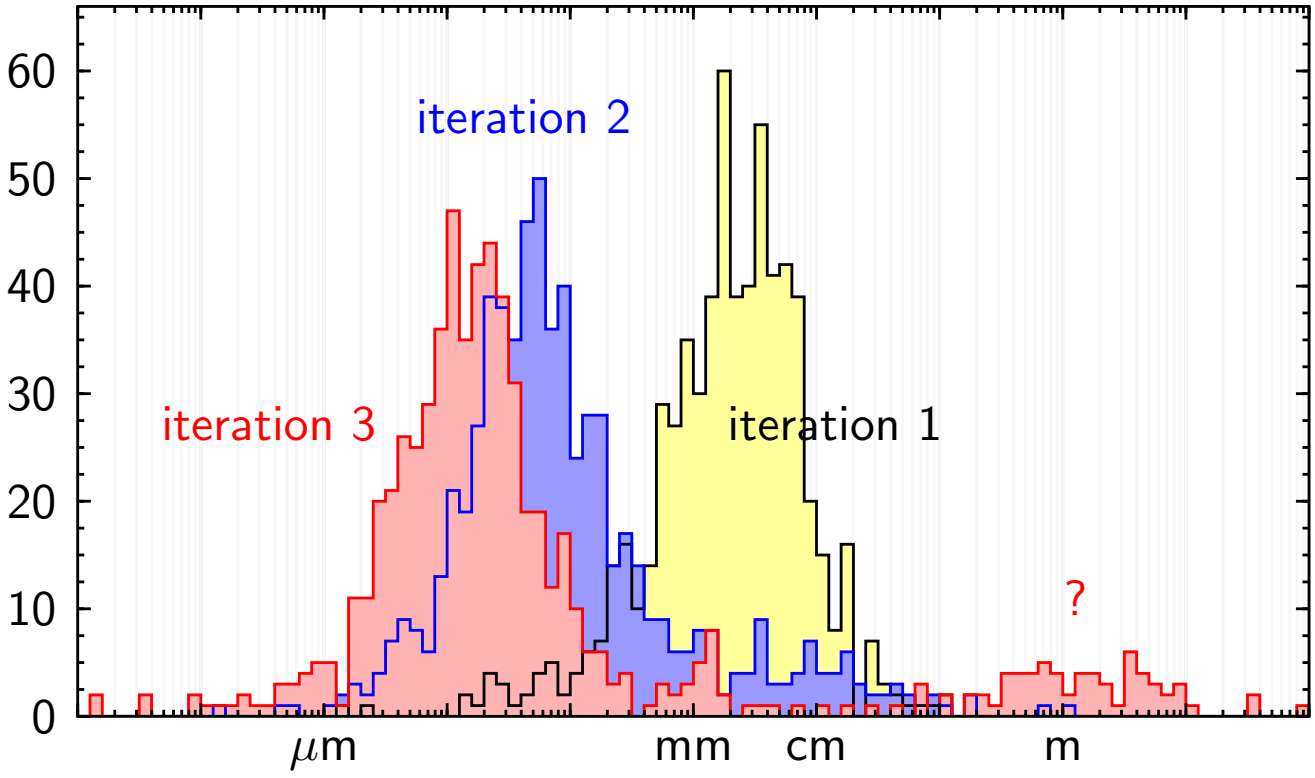






Monitoring: Convergence

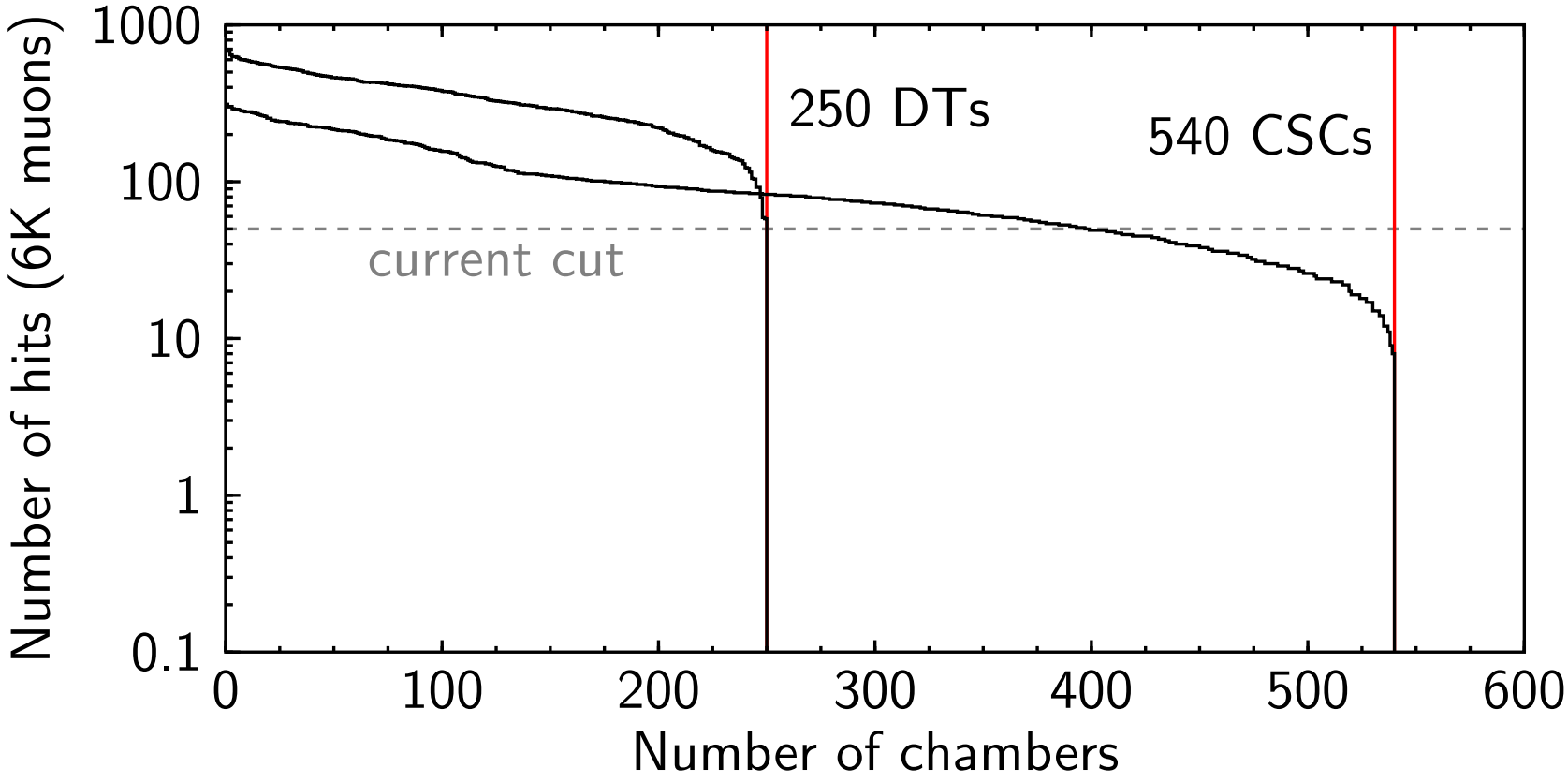
- Corrections should get smaller with every iteration



Local $|x|$ alignment corrections at each iteration (log-x)

- Unknown problem with some chambers in iteration 3...

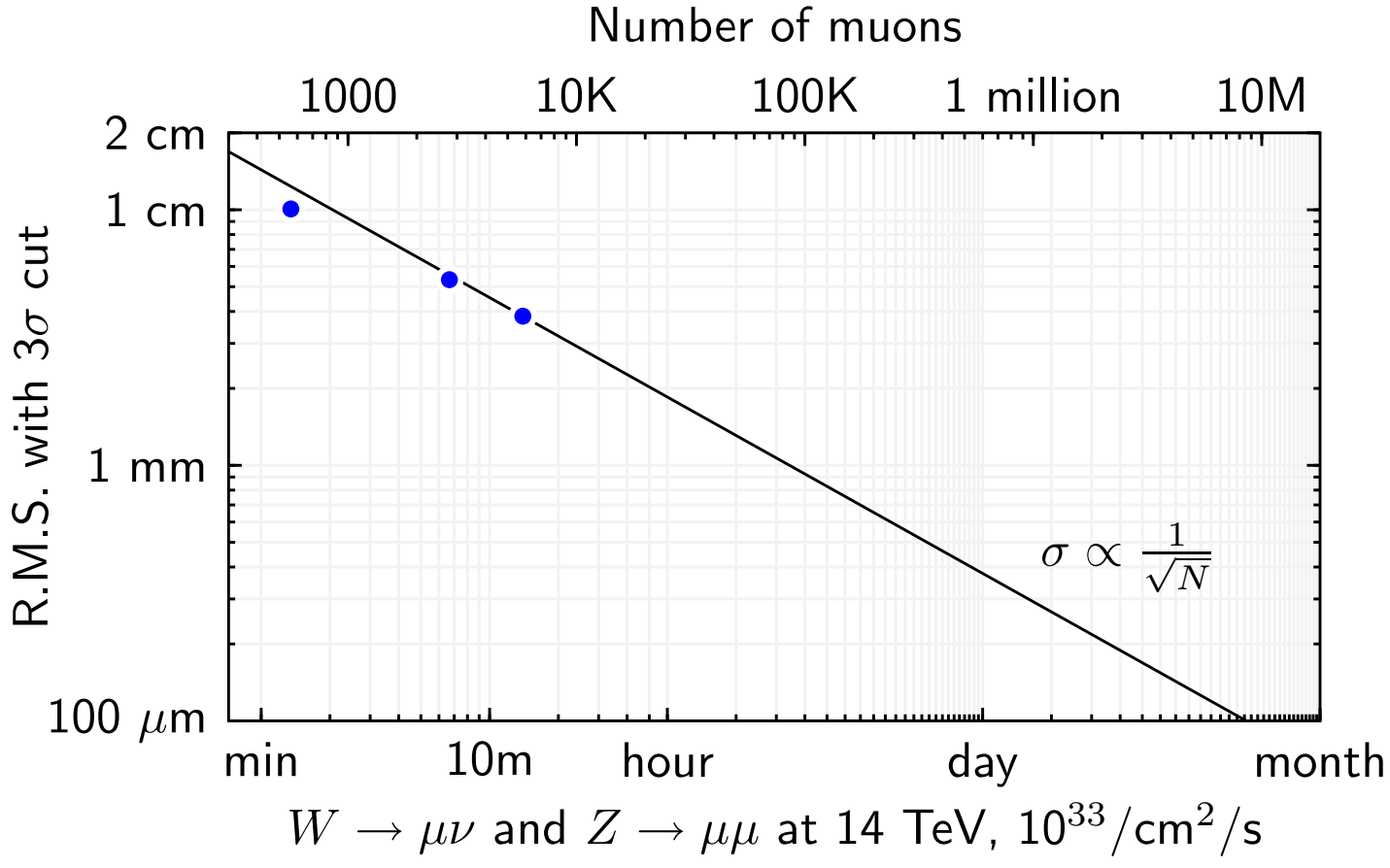
Monitoring: Coverage



- Keep track of which chambers see no/too few hits
- Versus η and ϕ

W and Z data needed at 14 TeV

- First projection using a complete alignment simulation!



- Conservative: muon chambers excluded from track-fit

Schedule (copied from CMS Week talk)

Deadline	Task
1 Jan, 2007	Finish integrating muon chambers into alignment framework
1 Mar, 2008	Transition CSA06Alignment to HIPAlignment and develop low-level diagnostics suite
1 Apr	Prototype and study realistic alignment procedure, assuming a source of muons
1 May	Evaluate possible sources ($W \rightarrow \mu\nu$, $Z \rightarrow \mu\mu$, cosmics, or good muon) and finalize routine
1 Jun	Document everything

Relationship with hardware alignment

- Limitations of track-based alignment for 2007 data (0.9 TeV, low lumi) are still unknown

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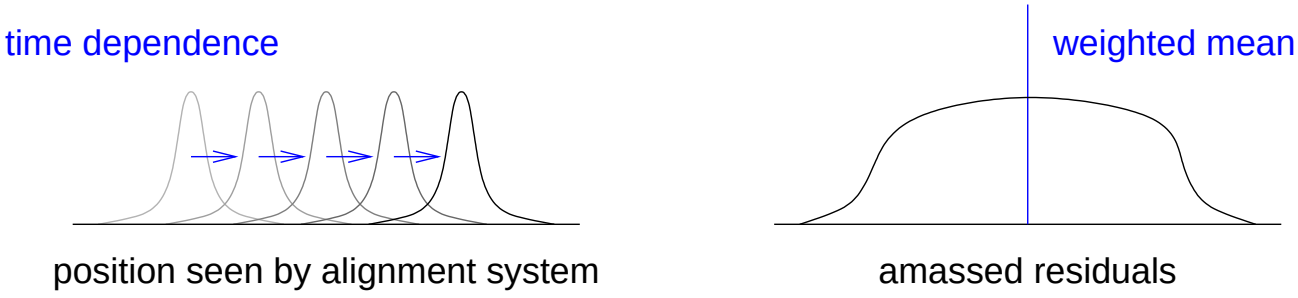

Alignment system can resolve edges of natural alignment datasets

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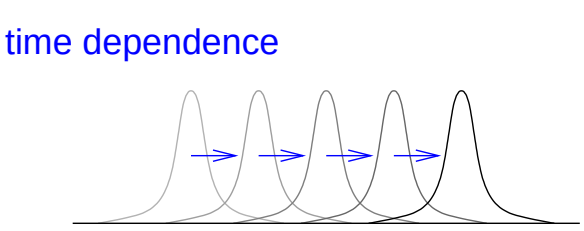
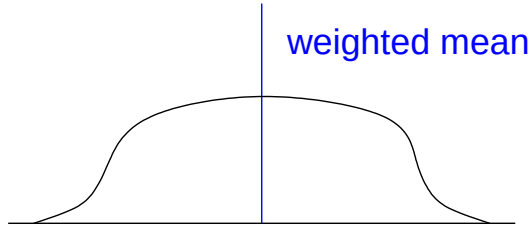


position seen by alignment system



amassed residuals

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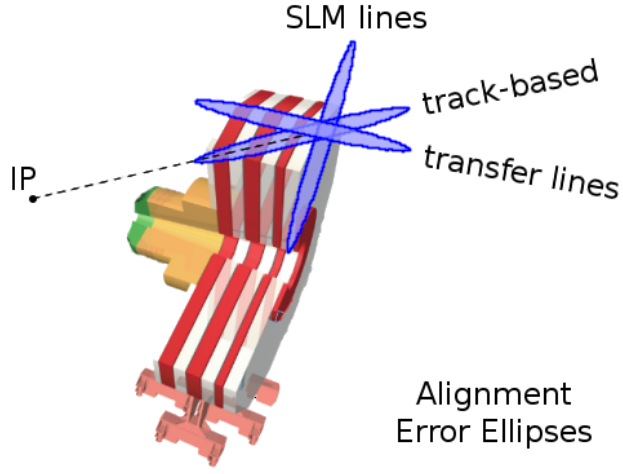

- Error ellipses are not collinear
- Different systematic uncertainties