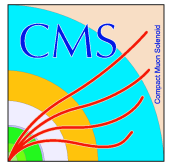
General things

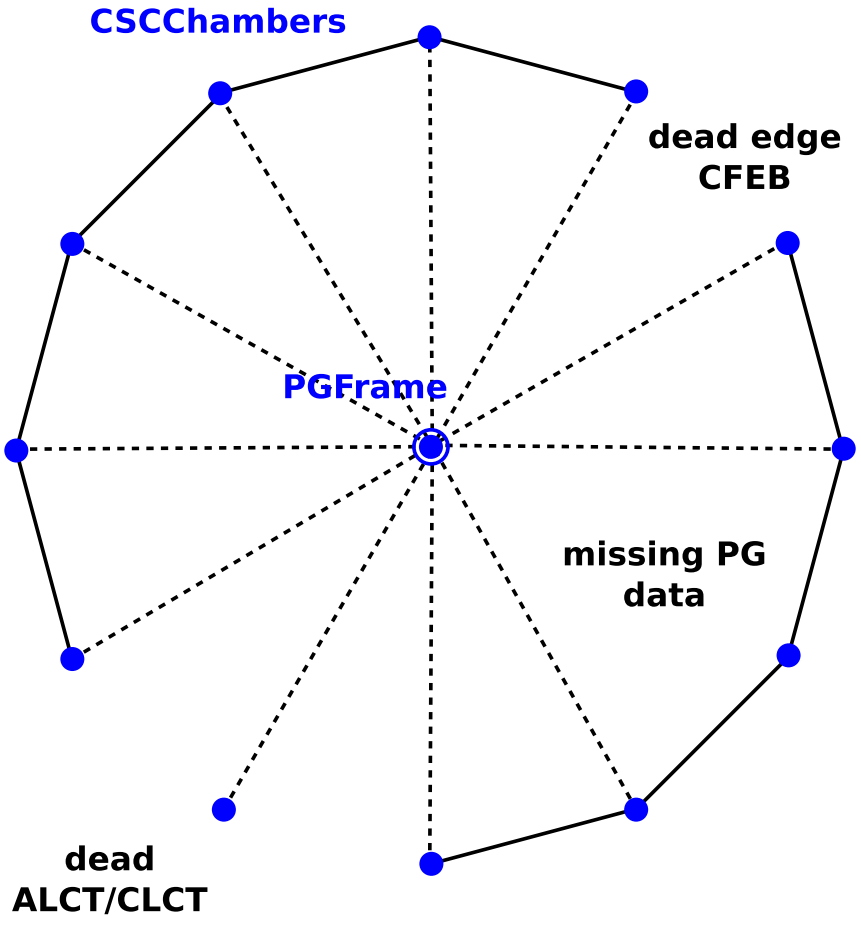


- Our $h \to aa \to 4\mu$ paper has been accepted to PRD (without revisions)!
- I've booked a flight to Houston: arrive Mon, Apr 5 (12:50 PM), depart Sat, Apr 10 (6:25 PM)
  - still need rental car and hotel
- List of current alignment projects:
  - Aysen: optimize collisions alignment $|\vec{p}|$ cut. If $p_T < 10$ GeV muons are useful, we'll need to revise MuAlCalIsolatedMu data stream, which requires a new CMSSW release— must be done well in advance of first 7 TeV reprocessing!
  - Aysen: align DT chambers and CSC rings with 2010 cosmics
  - Vadim: making alignment monitor public (e.g. for hardware alignment)
  - Vadim: separate CSC ring alignment script
  - Jim: help everyone with everything
  - Jim: CSC-Overlaps alignment procedure re-write (next pages)

CSC-Overlaps status

- Mathematical generalization has been fully tested in a sandbox (little Python scripts to make sure that I know what I'm doing)
  - details on next pages
  - cross-checked linear algebra solution with Minuit
- Implemented and tested the above in CMSSW
  - fully configurable by _cfg
  - yields same results as scripts
- Building the rest of the package around that
  - CSC-Overlaps procedure is (and has always been) more complicated than Reference-Target
  - this is a procedure that really needs abstraction; classes to perform neighboring-chamber track fits, matrix-based alignment solution, separation of the calculation from the monitoring plots...
  - not much to show right now because I'm programming
- There will be a detailed Note describing both the mathematical formalism and the C++ implementation

Mathematical formalism



relative positions measured by beam-halo tracks

relative positions measured by photogrammetry (PG)

chamber position

frame position

Schematic diagram of alignment constraints: dots are alignable elements and lines are measurements relating pairs. PG and track-based data are treated the same way. Must be a connected graph to be meaningful (for existence of a solution).

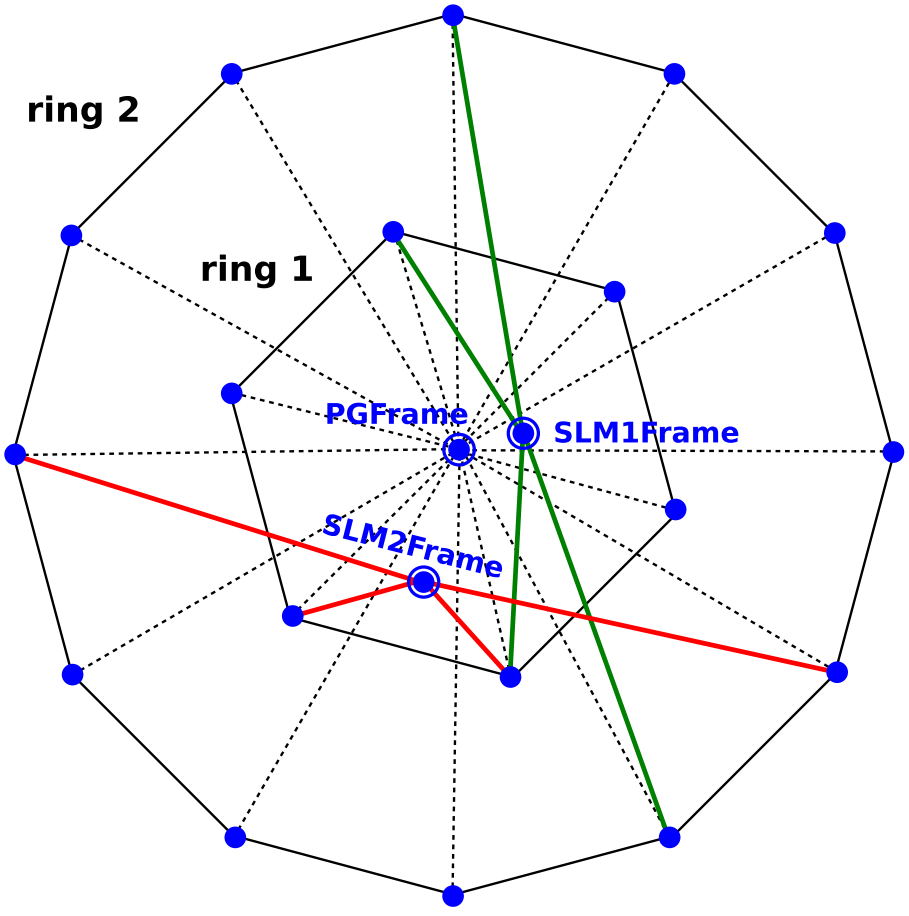
"PGFrame" is an alignable element but not a physical chamber; it is included to allow for possible difference in PG and track-based coordinate frames.

- Solution is a minimization of $\chi^2 = \sum_{\text{constraints}} \frac{(m_{ij} - A_i + A_j)^2}{{\sigma_{ij}}^2} + f(\lambda, A)$

  with respect to alignment corrections A (blue dots, above) where m_{ij} and σ_{ij} are measurements with uncertainties (lines).

- $f(\lambda, A)$ is a Lagrange multiplier to fix the overall reference frame.

Mathematical formalism



relative positions measured by beam-halo tracks

relative positions measured by photogrammetry (PG)

relative positions measured by hardware system

chamber position

frame position

Fits can be performed at the ring level, the disk level, or the whole endcap (using transfer line data) by changing settings in the configuration file.

Hardware alignment input can come from a CSCAlignmentRcd, converted by us into constraints in the configuration file with a script. Weight in combined fit is determined by measurement uncertainties.

- Formalism is general enough to include any statistically independent two-chamber constraints, in any configuration— options for the future.
- CSCRing-to-tracker alignment should also include a CSCDisk-to-tracker mode to preserve relative positions of ring 1 and 2. Vadim and I have talked about this— it shouldn't be difficult.