MVTX Half to Half Alignment

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Overview

- Half to half alignment strategy and implementation details
- Comparisons for different strategies
- Issues and questions

Half to half alignment

- Separated from measured geometry implementation
  - Performed (1st pass) using ideal geometry
- Uses ~12 hours of cosmics data (4 days, for a few hours each evening)
- MVTX clusters used to form cosmic tracks in one half of MVTX
- Track is extrapolated to opposite half, and 3D dca + xyz residuals computed
- Collection of tracks and points are accumulated over all comics events
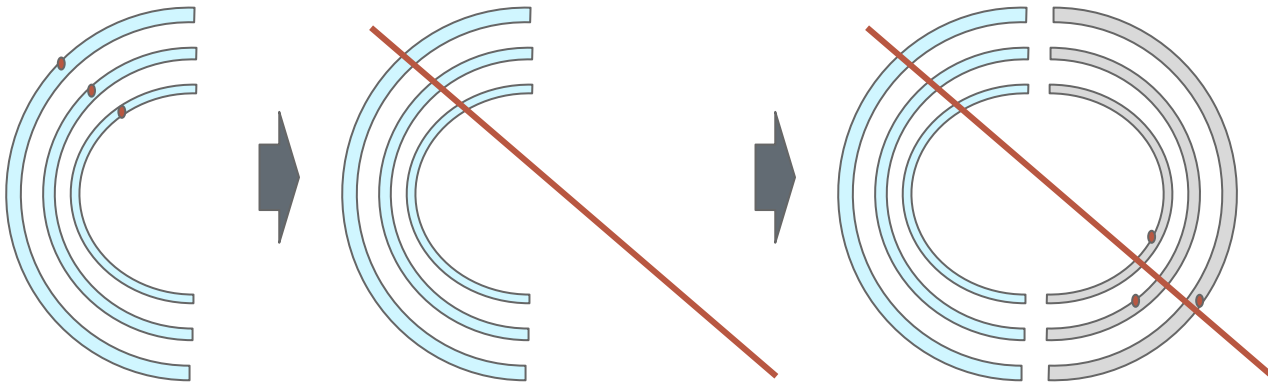
Cosmic tracks building and 3D DCA

- Track half: half detector in which tracks are fit
- Cluster half: half detector in which residuals are extracted
- Require at least 3 hits in track half
  - Cosmics can hit overlapping staves, this is not rejected
- 3D DCA is calculated as the DCA in the cluster half wrt the cosmic track
- To avoid including noise hits, 3D DCA must be less than 0.3 cm
- Accumulated for all clusters in cluster half

| Requirement	Level
N cluster in track half	>2
Cluster size in cluster half	>0
Track hit distance tolerance	<0.5 cm
3D track DCA in cluster half	<0.3 cm

3D DCA
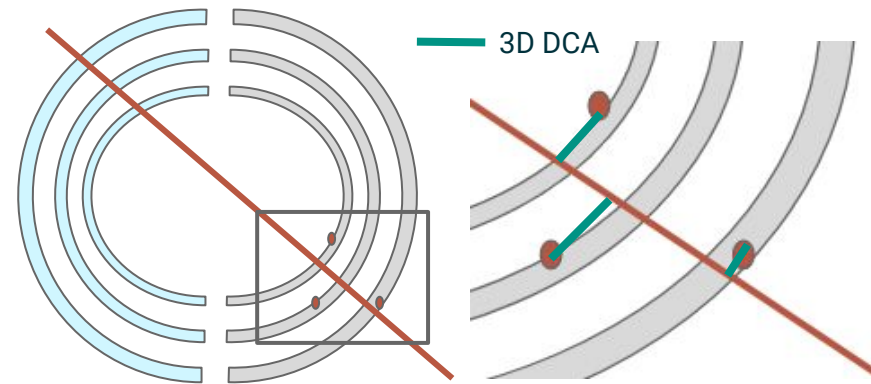
Half to half minimization

- To determine half to half alignment, need to minimize a function
- Function must be of form f(R, T, trks, pts)
  - R and T are the rotation and translation of on half of the detector (cluster half) wrt to the fixed opposite half (track half)
  - Trks are the straight line cosmic tracks, pts are the clusters in the opposite half of the detector (cluster half)
- Optimal values of R and T that minimize f are found using python package (scipy.optimize.differential_evolution)
- 3D DCA and xyz residuals are recalculated with relative transformation of half detector
- Follwing slides show cosmics in east half (track half) extrapolated to the west half (track half)

XYZ residuals

- Residuals are computed in ideal geometry and with transformations from minimized coordinates
- R = [-0.0168, 0.0024, -0.0007]
- T = [0.0251, 0.0317, 0.0341]

Dim	μ baseline [cm]	μ min [cm]	σ baseline [cm]	σ min [cm]
X	- 0.051	-0.009	0.098	0.088
Y	0.055	0.011	0.058	0.059
Z	-0.032	-0.002	0.053	0.050
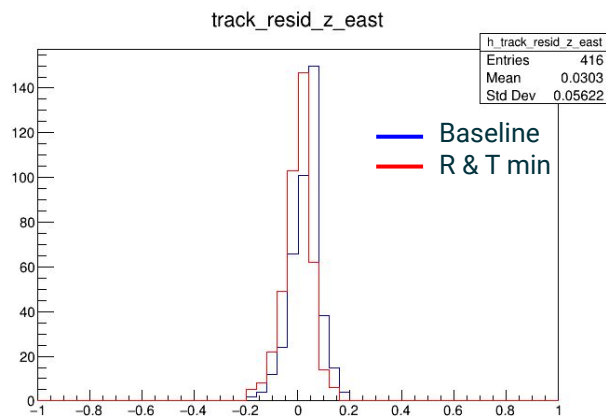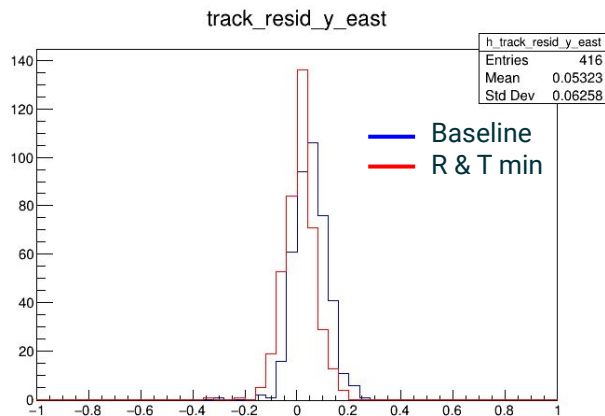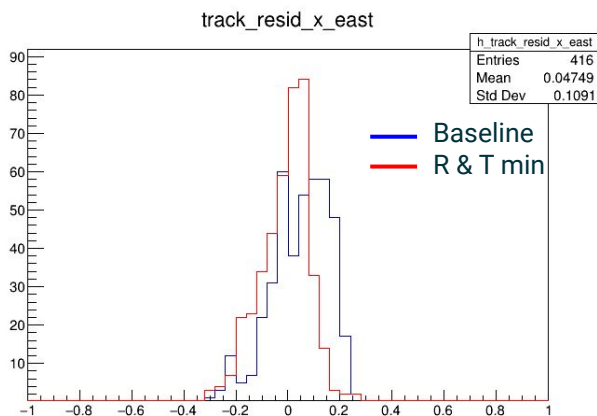
Residual [cm]

Issue: Statistics

- Full statistic are now available from all MVTX cosmic runs ([here](#))
- ~200 reconstructed cosmic tracks in east half, with ~500 corresponding hits in west half

Cut	N Events
Baseline	1,509,948
> 4 clusters in event	284,137
> 0 hits in east and west half	268,075
> 2 hits in east half	80,161
Track fit success	12,335
> 0 cluster in west half w/ DCA < 0.3 cm	205

Conclusions

- Still have not reached a final alignment
  - Widths of residuals are ~500um and should be closer to ~40um
- Lots of tunable parameters, in particular, which DCA cut for hits in the cluster half has a large impact on R and T
- Progress has been made on reducing and understanding residuals
- Ultimately may be somewhat limited by statistics

Backup