Alignment of the Silicon Vertex Tracker (SVT)
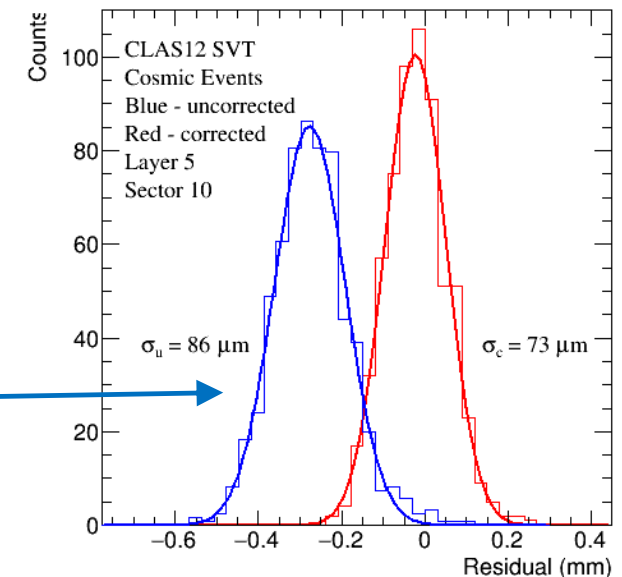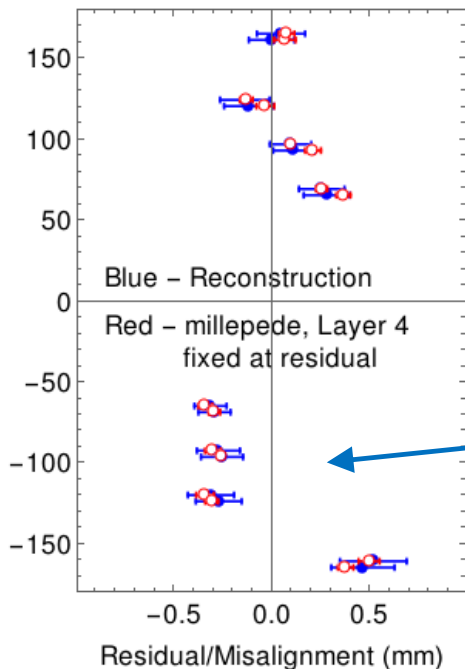
- Track-based alignment of SVT requires fitting many parameters: $N_{sectors} \times N_{layers} \times N_{trans} \times N_{rot} = 66 \times 2 \times 3 \times 2 = 792$
- Program **millepede** does linear least squares with many parameters.
    - Uses matrix form of least squares method and divide the elements into two classes.
        - Global parameters – the geometry misalignments. Same in all events.
        - Local – individual track fit parameters. Change event-to-event.
    - Calculate first partial derivatives of the fit residuals with respect to the local (i.e. fit) parameters and global parameters (geometry misalignments).
    - Manipulate the linear least squares matrix to isolate the global parameters (geometry) and invert the results to obtain the solution.
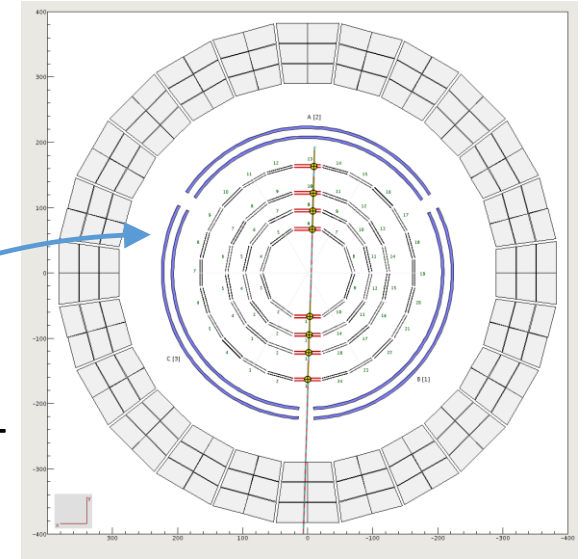
Type 1 tracks – sensors are horizontal.

- Apply to a 'simple' example – Type 1 tracks.
    - Use gemc cosmics for testing and validation.
    - Shift layers 1-2 (Region 1) by 2-500 microns in *x*.
    - millepede reproduces all shifts.
- Apply to Type-1 cosmic ray sample from SVT.
    - 5.9M events collected May 11-18.
    - Fixed layer 4 in millepede fit to SVT residual.
    - Good agreement between millepede mis-alignment and residuals.
    - Fit residual and resolution improve.
- Analysis chain for full set of events complete.
    - First millepede fits obtained.
    - Testing on Type 1 events now.

Type 1, May 11–18

Blue – Reconstruction

Red – millepede, Layer 4 fixed at residual

CLAS12 SVT
Cosmic Events
Blue - uncorrected
Red - corrected
Layer 5
Sector 10

$\sigma_u = 86$ μm $\sigma_c = 73$ μm

Geometry of the Silicon Vertex Tracker (SVT)

- Ideal Geometry Validation and Testing
    - Calculate ideal fiducial location on each module.
    - Observed significant difference with engineering drawings - up to 100 μm. Now reduced to < 3μm
    - Ideal geometry defined by engineering drawings.
    - Used by simulation and reconstruction codes.

- Geometry package
    - Common Java utility for gemc and reconstruction.
    - Detailed reproduction from engineering drawings.
    - Full inventory of material in SVT for gemc.
    - CLAS-NOTE nearly done.
    - Charles Platt - new Surrey masters student.
    - Sereres Johnston – ANL postdoc.

Deltas – Factory **Ideals** from Survey **Ideals**

Legend: **1 Cu+ 2 Cu- 3 Pk**

Differences < 3 μm

Side view of upstream end of module in gemc

rohacell, pitch adapter, chip, copper heat sink, epoxy/bus cable, heat sink ridge, sensor, pc board, carbon fiber, epoxy/bus cable