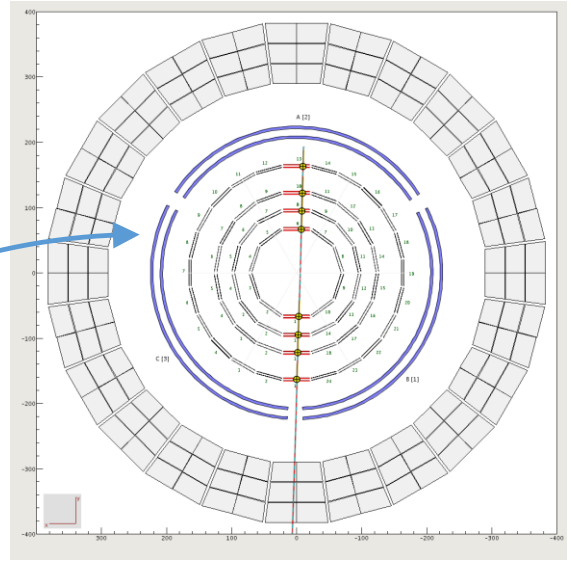
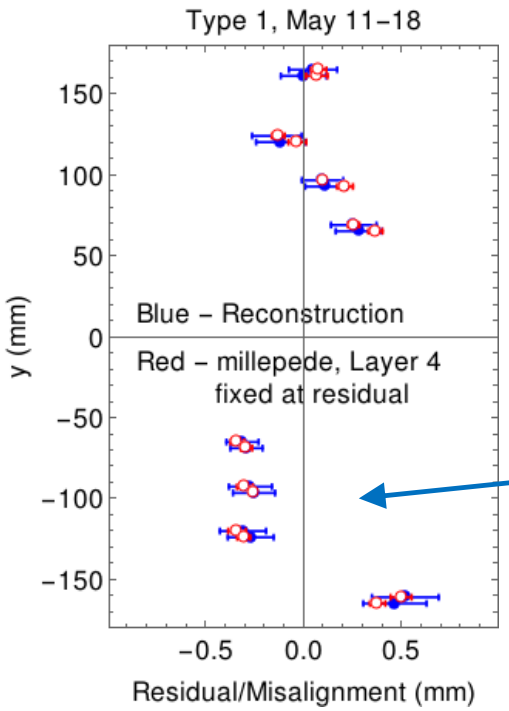
# Alignment of the Silicon Vertex Tracker (SVT)

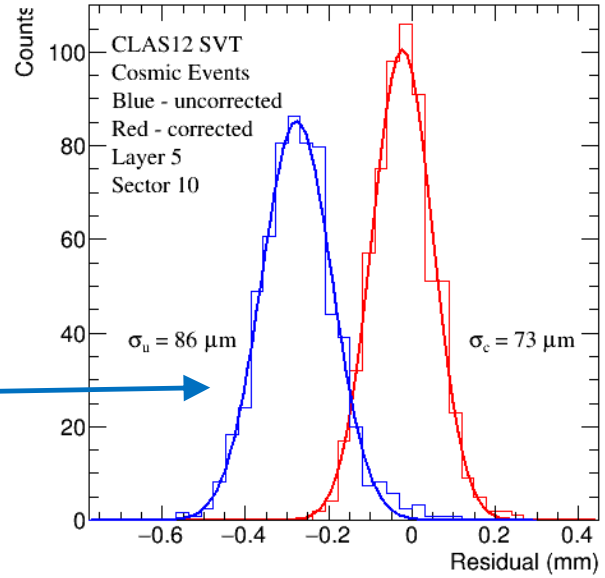
- Track-based alignment of SVT requires fitting many parameters: $N_{sectors}$ x $N_{layers}$ x $N_{trans}$ x $N_{rot}$ = 66 x 2 x 3 x 2 = 792
- Program **millepede** does linear least squares with many parameters.
  - Uses matrix form of least squares method and divide the elements into two classes.
    - 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.



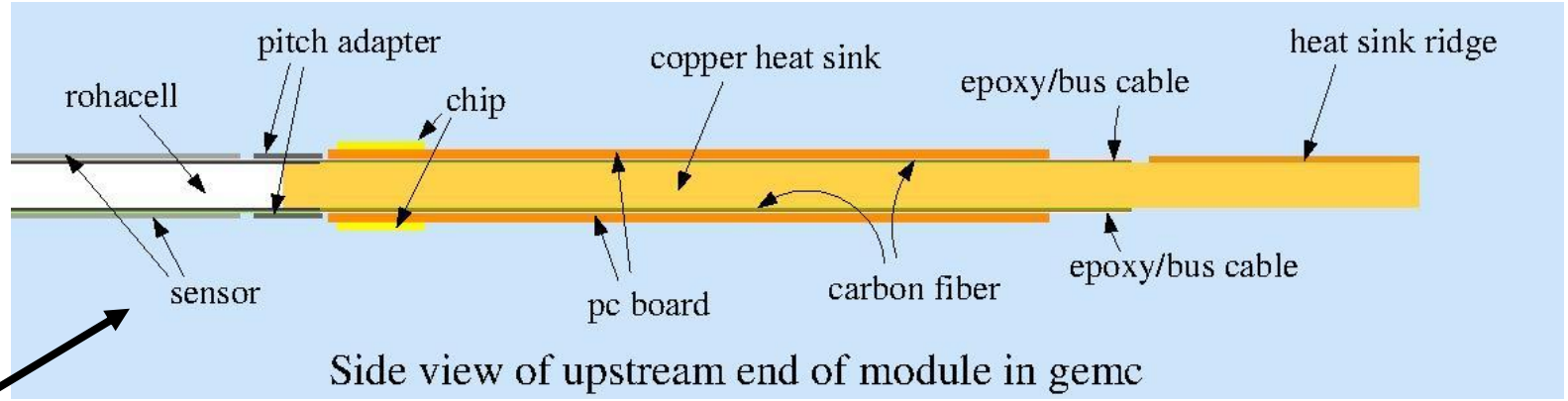
Type 1 tracks – sensors are horizontal.

- 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 millipede fit to SVT residual.
  - Good agreement between millipede mis-alignment and residuals.
  - Fit residual and resolution improve.
- Analysis chain for full set of events complete.
  - First millipede fits obtained.
  - Testing on Type 1 events now.



- Ideal Geometry Validated – less than 3μm difference between engineering drawings and ideal geometry.
- Geometry package
  - Common Java utility for gemc and reconstruction.
  - Full inventory of material in SVT plus survey data.
  - CLAS-NOTE 2017-008.
- Contributors
  - Sereres Johnston – ANL postdoc, see summary below.
  - Charles Platt – University of Surrey masters student.
- Type-2 Events
  - Include non-horizontal modules.
  - Type-2 code written and tested first with type-1 events.
  - Using gemc.4a.2.0/coatjava.7.5.
  - For ideal geometry, misalignments < 5 μm as expected.
  - Testing with full-fledged type-2 events reveals some issues with the reconstruction - under investigation.



Side view of upstream end of module in gemc