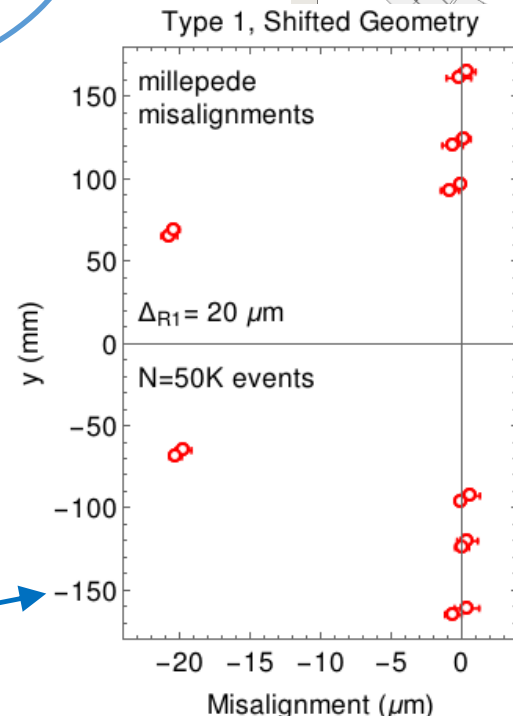# Alignment of the Silicon Vertex Tracker (SVT)

- Goal: reach the SVT spatial resolution specification of 45-60 microns.
- SVT Alignment requires fitting large number of parameters: $N_{regions}$ 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.
  - Start with a matrix formulation of the least squares method and divide the matrix 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).
  - Isolate the global parameters and invert to obtain the solution.
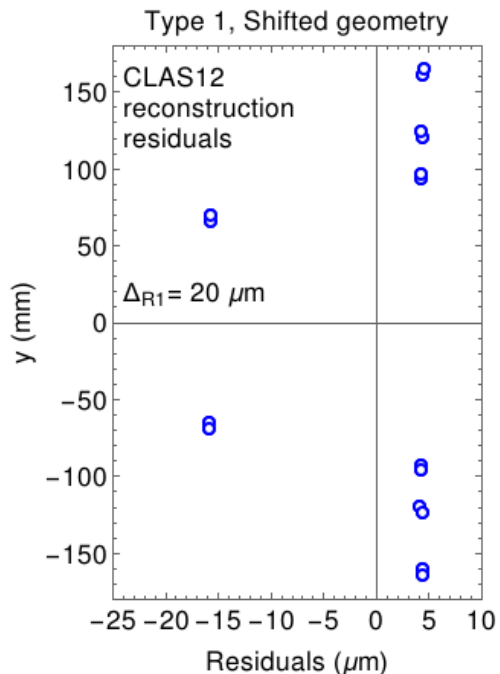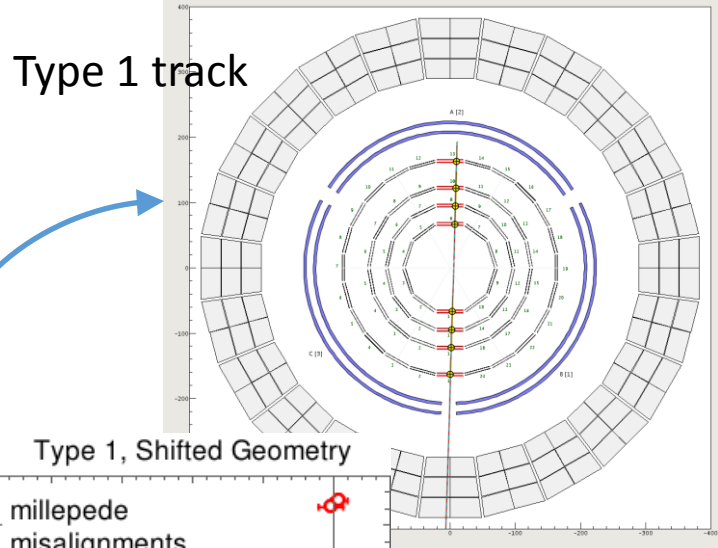
Type 1 track

- Apply to a 'simple' example – Type 1 tracks.
  - Use gemc cosmics for testing and validation.
  - Initially restrict fit to x direction.
  - Use coatjava reconstruction results.
  - C++ code to prepare file for fitting.
  - Run **pede** to extract misalignments.
- Validate by inserting known shift in gemc.
  - Shift layers 1-2 (Region 1) by 20 microns in *x*.
  - Shift clearly visible in residuals from reconstruction.
 - Millepede reproduces the shift.

G.P.Gilfoyle (Richmond) and P.Davies (Surrey)

Type 1, Shifted geometry

CLAS12 reconstruction residuals

$\Delta_{R1} = 20 \; \mu m$

y (mm)

Residuals (μm)

Type 1, Shifted Geometry

millepede misalignments

$\Delta_{R1} = 20 \; \mu m$

N=50K events

y (mm)

Misalignment (μm)

Alignment of the Silicon Vertex Tracker (SVT)

- Nominal Geometry Validation
  - Calculate nominal fiducial location.
  - Compare with mechanical engineering drawings.
  - Observe a significant difference between the two up to a maximum of 100 µm – bigger than resolution requirement.
  - Collaborating with engineering division to rationalize differences between the two (ongoing).
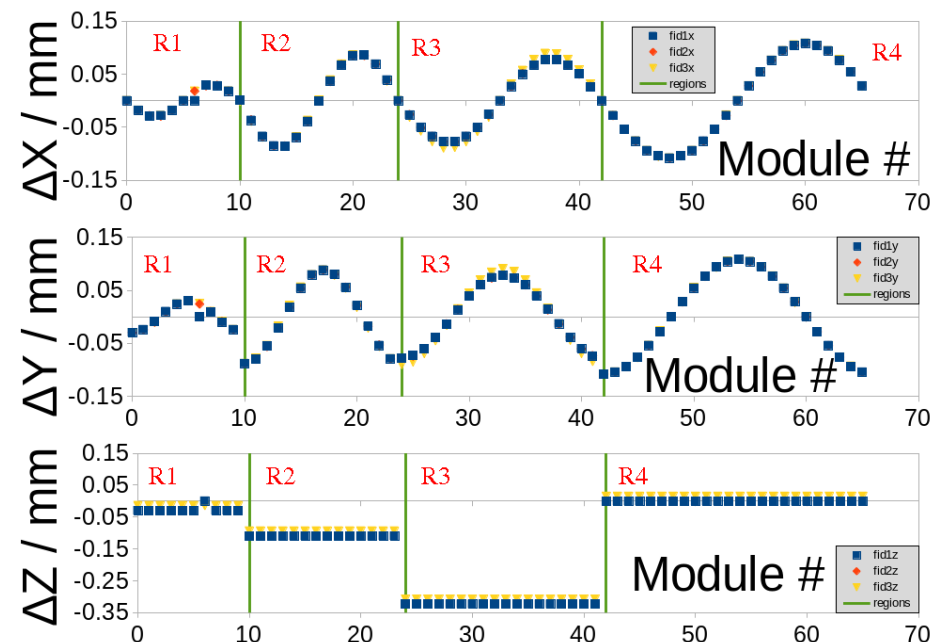
- Geometry and alignment package
  - Common utility to access geometry and alignment.
  - Built on previous work by Andrey Kim on FTOF.
  - Provide same source of geometry and alignment for simulation and reconstruction.