Updates on CGEM alignment package

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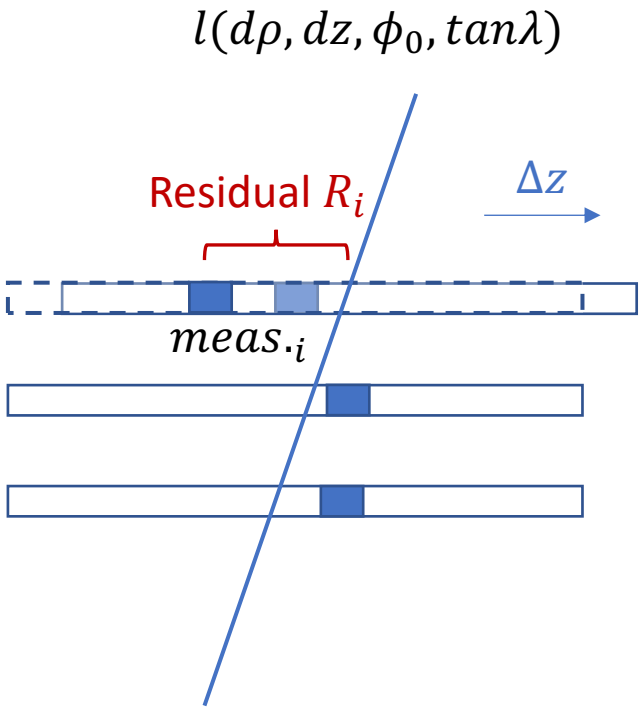
Cgem Software meeting, 2019-12-10

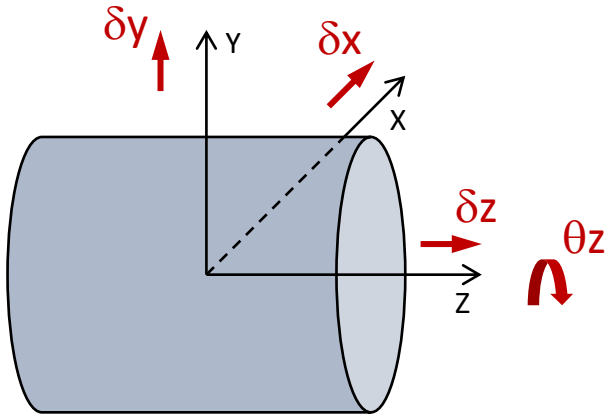
Track based alignment – Millipede for Cgem

- Strategy: obtain the mis-alignment information by fit the track with least-square method.

$$R_i = f(x_i, d\rho, dz, \phi_0, tan\lambda, \Delta z) - meas._i$$

- To reduce the computing time, we transfer the local information (track parameters) to the global (detector mis-alignment parameters) Hessian C (“Schur complement”)
- For each layer, 4 possible parameters: δx, δy, δz, θz





Status at the last workshop

- Millipede alignment algorithm is tested with MC with different mis-alignment effect on layer1
- Output results are consistent with the input
- Next step: study more complex mis-alignment situations.

Mis-alginment	Input (mm)	Output (mm)	Error (mm)
Shift in x	2.0	2.0009	0.0008
Shift in y	2.0	1.9010	0.002
Shift in z	1.5	1.5003	0.002
Rotation around z	0.06	0.0600	0.00001

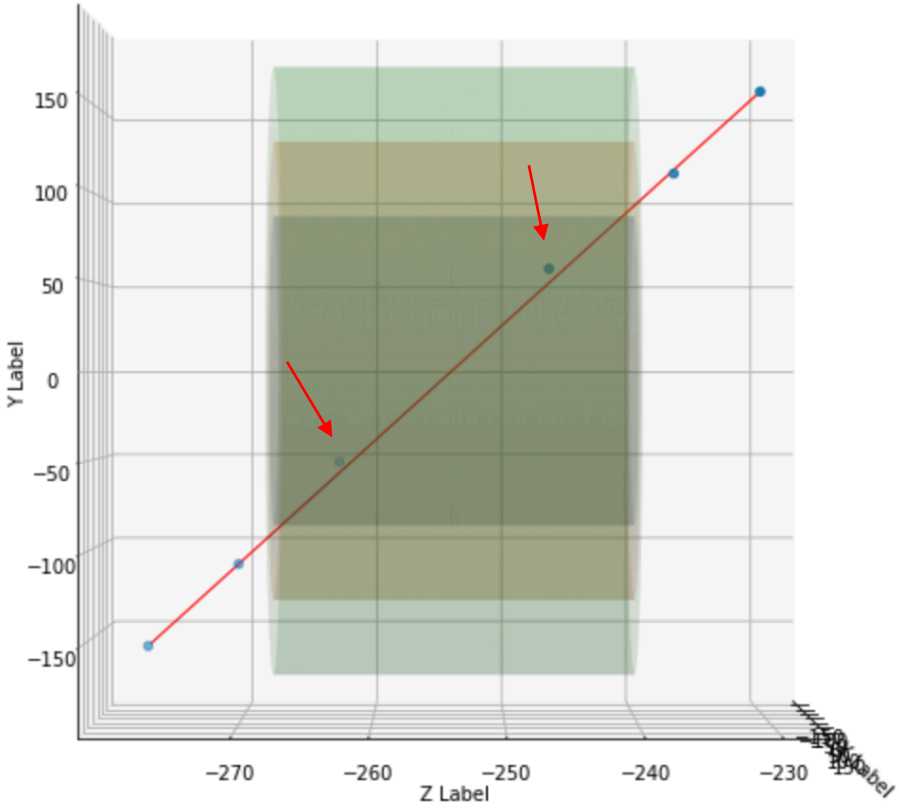
3 sets of MC samples with multiple mis-alignment effects

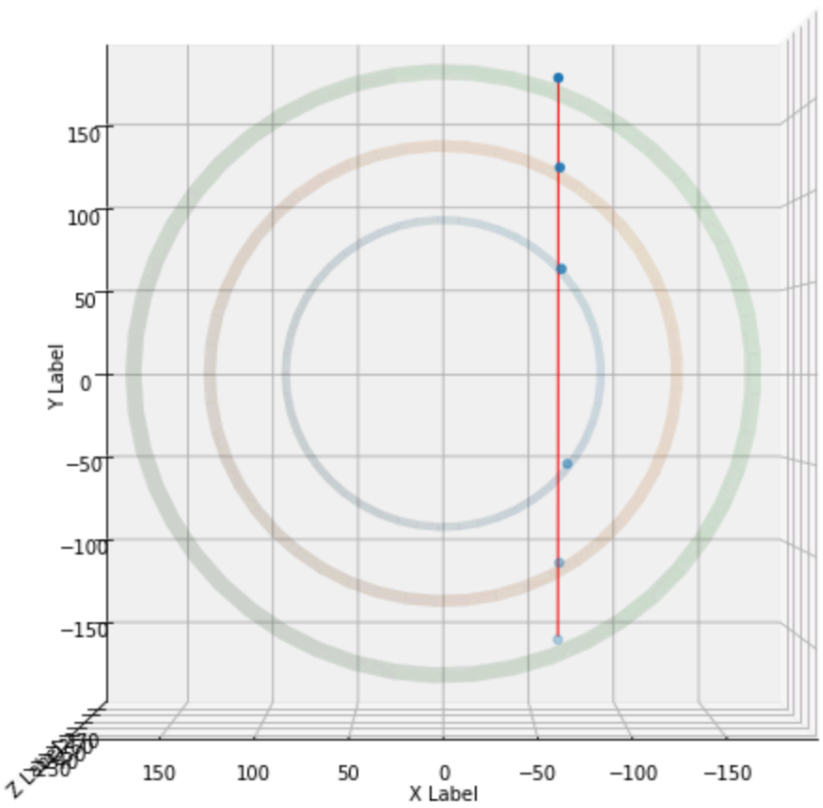
- Parameters of generator
  - 10000 single muon events
  - Initial position: Y = 200 mm X ∈ [-40, 40]mm Z ∈ [-200, 200]mm
  - Incident angle: $\theta \in [65°, 115°]$ $\phi \in [-151°, -29°]$
  - P ∈ [1.5, 4] GeV
- Input mis-alignment effects

	δx	δz	θz
sample1	L1: 1mm	L1: 1mm	L1: 0.03 rad
sample2	L2: 1mm	L2: 1mm	L2: 0.03 rad
sample3	L1: 1mm & L2:-1 mm	L1: 1mm & L2:-1 mm	L1: 0.03 rad & L2:-0.03 rad

Cluster position and track trajectory

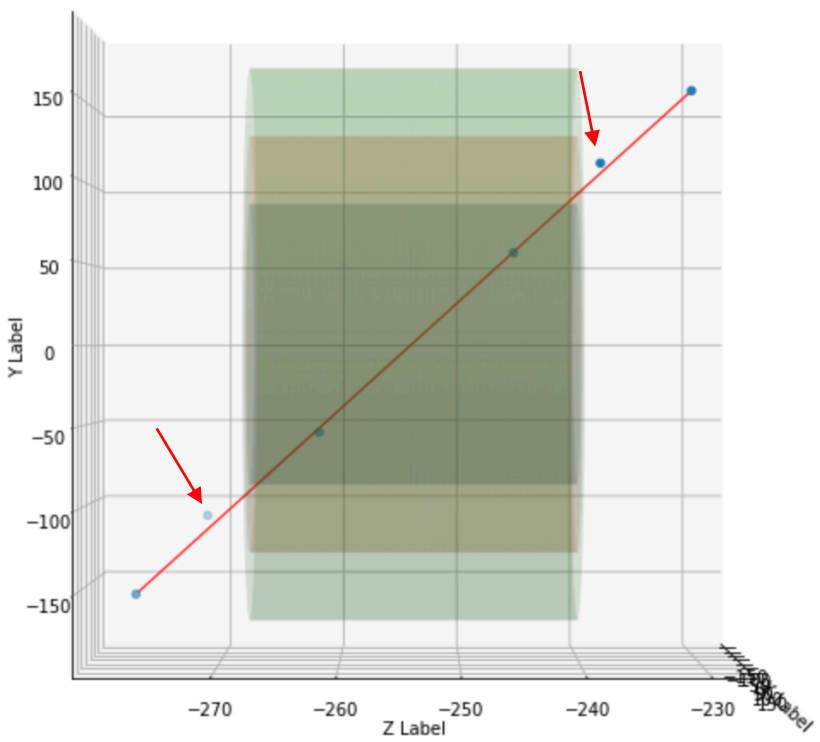
Input mis-alignment:
Layer1: dz = 1.0 mm, dx = 1.0 mm, θz = 0.03 rad

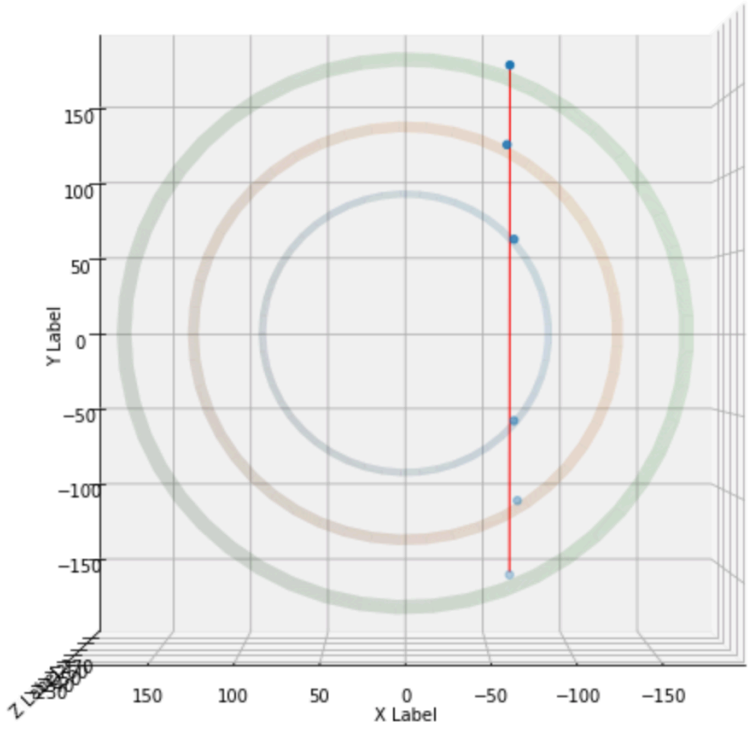




Cluster position and track trajectory

Input mis-alignment:
Layer2: dz = 1.0 mm, dx = 1.0 mm, θz = 0.03 rad



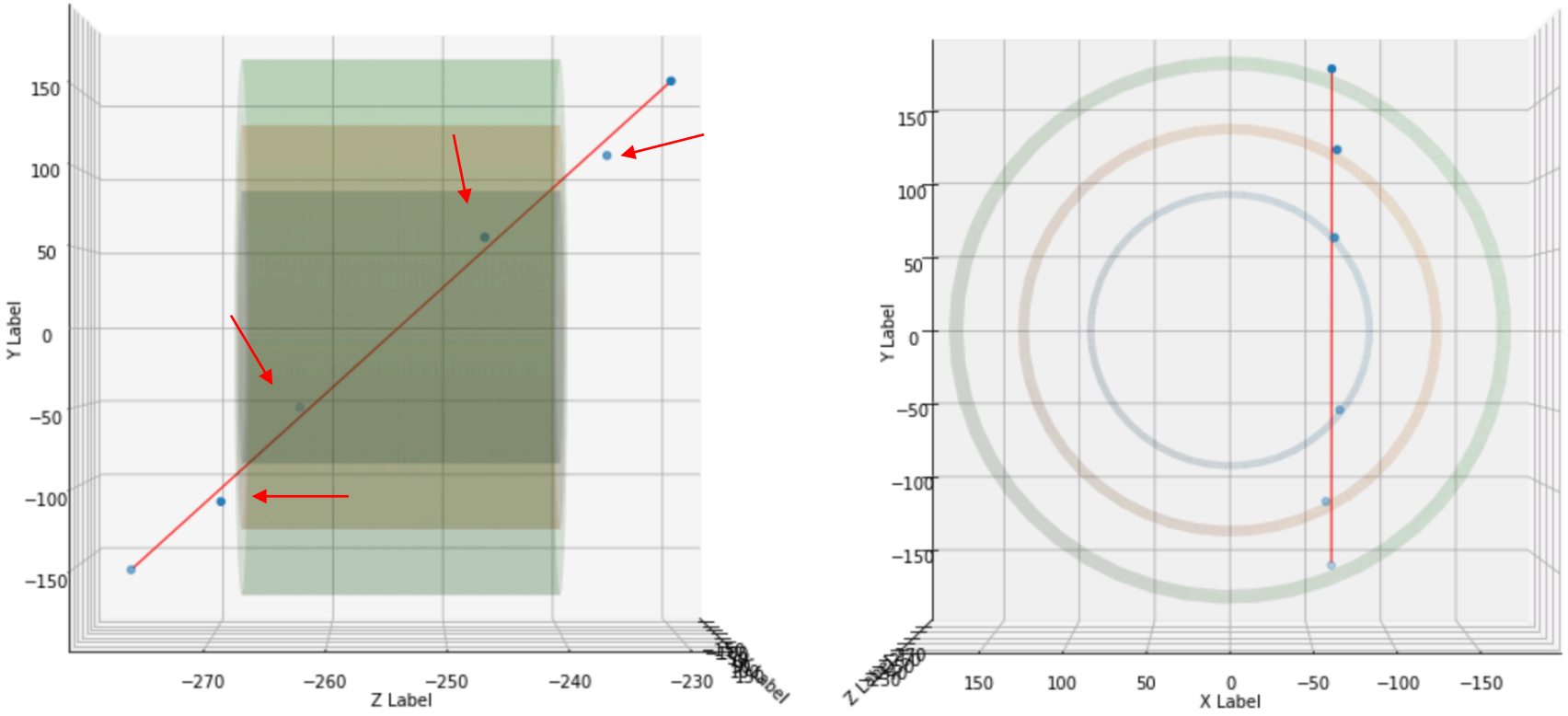


Cluster position and track trajectory

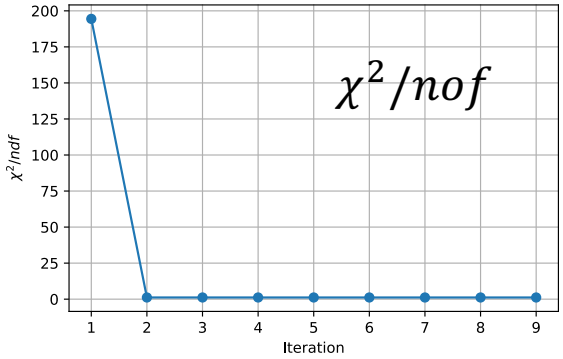
Input mis-alignment:

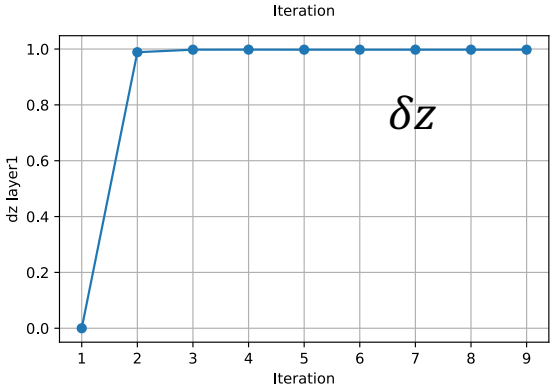
Layer1: dz = 1.0 mm, dx = 1.0 mm, θz = 0.03 rad

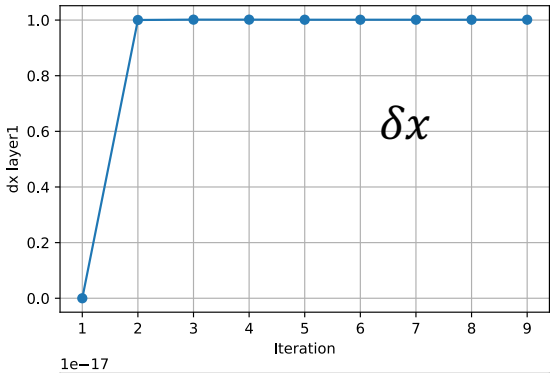
Layer2: dz = -1.0 mm, dx = -1.0 mm, θz = -0.03 rad

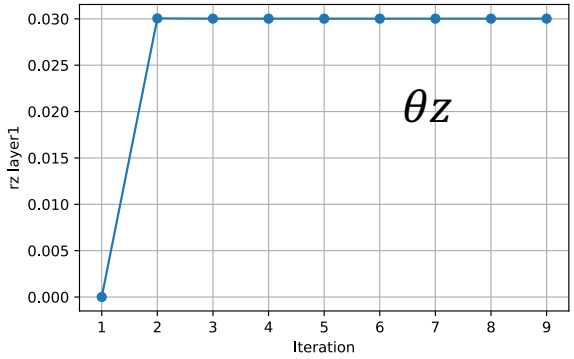


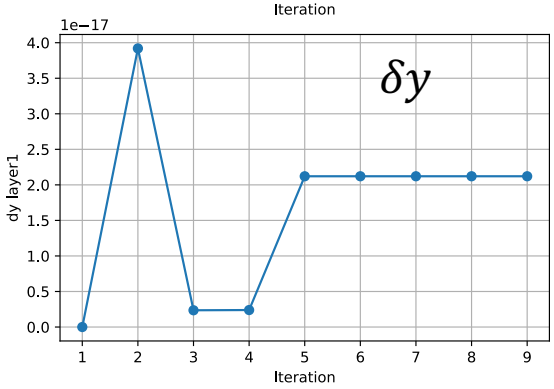
$\chi^2/_{nof}$ and solution vs iteration (sam1)

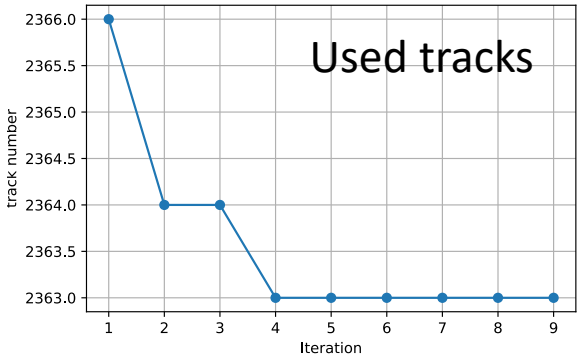












Input output comparison

- By ~2400 tracks

		δx	δz	θz
sample1	input	L1: 1mm	L1: 1mm	L1: 0.03 rad
	output	L1: 1.0012±0.0025	L1: 0.9977±0.0067	L1: 0.03±0.00003
sample2	input	L2: 1mm	L2: 1mm	L2: 0.03 rad
	output	L2: 0.9940±0.0022	L2: 1.0036±0.0076	L2: 0.03±0.00002
sample3	input	L1: 1mm & L2:-1 mm	L1: 1mm & L2:-1 mm	L1: 0.03 rad & L2:-0.03 rad
	output	L1: 0.9984±0.0024 L2: -1.0033±0.0020	L1: 0.9981±0.0067 L2: -1.0002±0.0077	L1: 0.03±0.00003 L2: -0.03±0.00002

Summary and outlook

- Millipede alignment algorithm is tested by more complex mis-alignment situations.
  - Multi-misalignment effect on one layer
  - Multi-misalignment effect on multi-layer
- Output results are consistent with the input!

Next step:

- Use the upcoming cosmic ray data to study the alignment

Thank you !