Pilot Beam : first look / Alignment

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Crude Tracking / Feature understanding

- Alignment

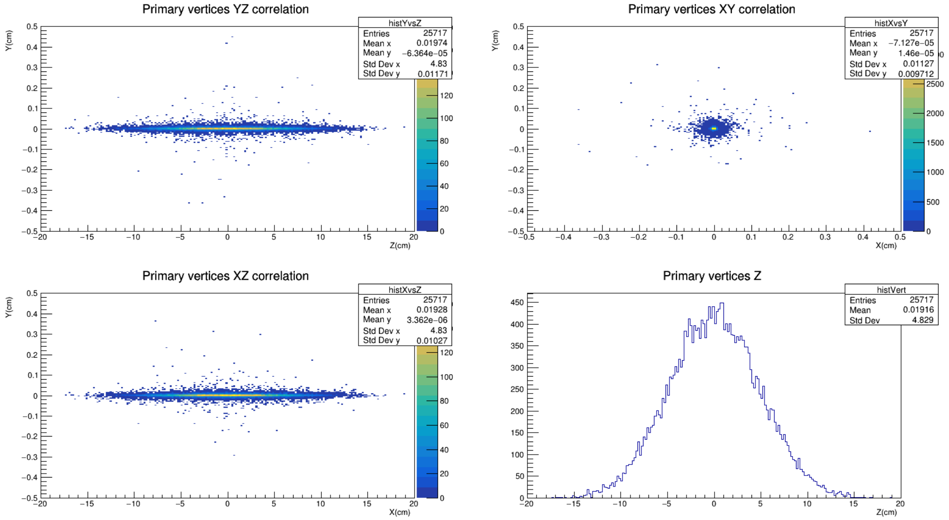
Module development for ITS full detector

Module test for MC data(pythia8pp)

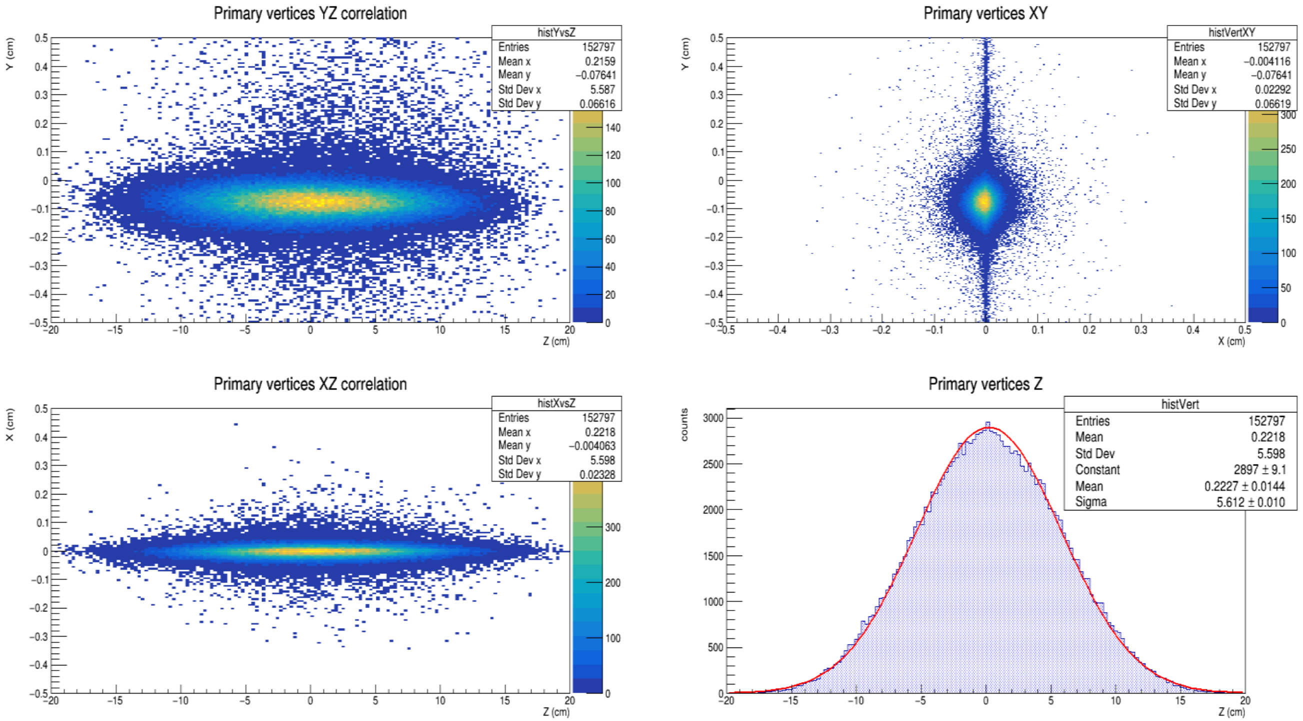
Pilot Beam

- Stable beams Oct. 27-31
- 12 fills with different filling schemes
- Interaction point shifted on Oct. 27 and corrected on Oct. 28
- **19 GOOD runs (~58M events)**

Pythia8pp

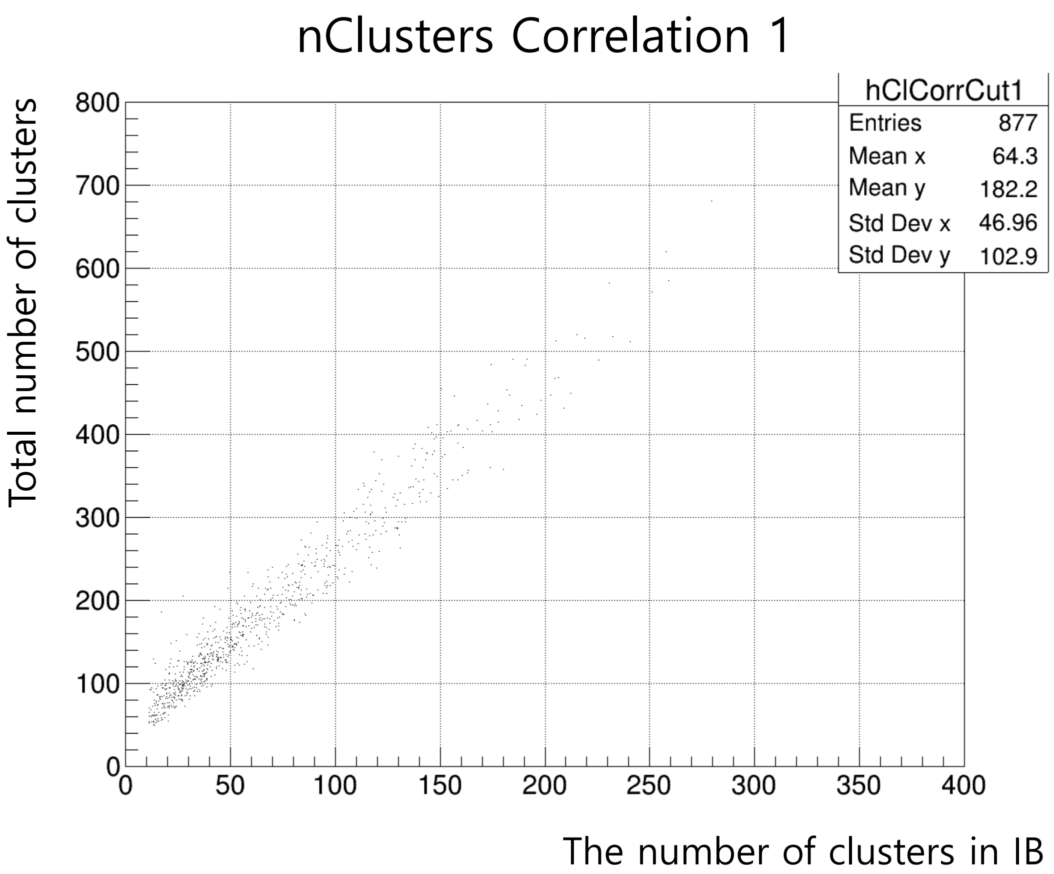


- Field on Run
  → ~30M events



01/11/2021 I. Ravasenga & J. Liu

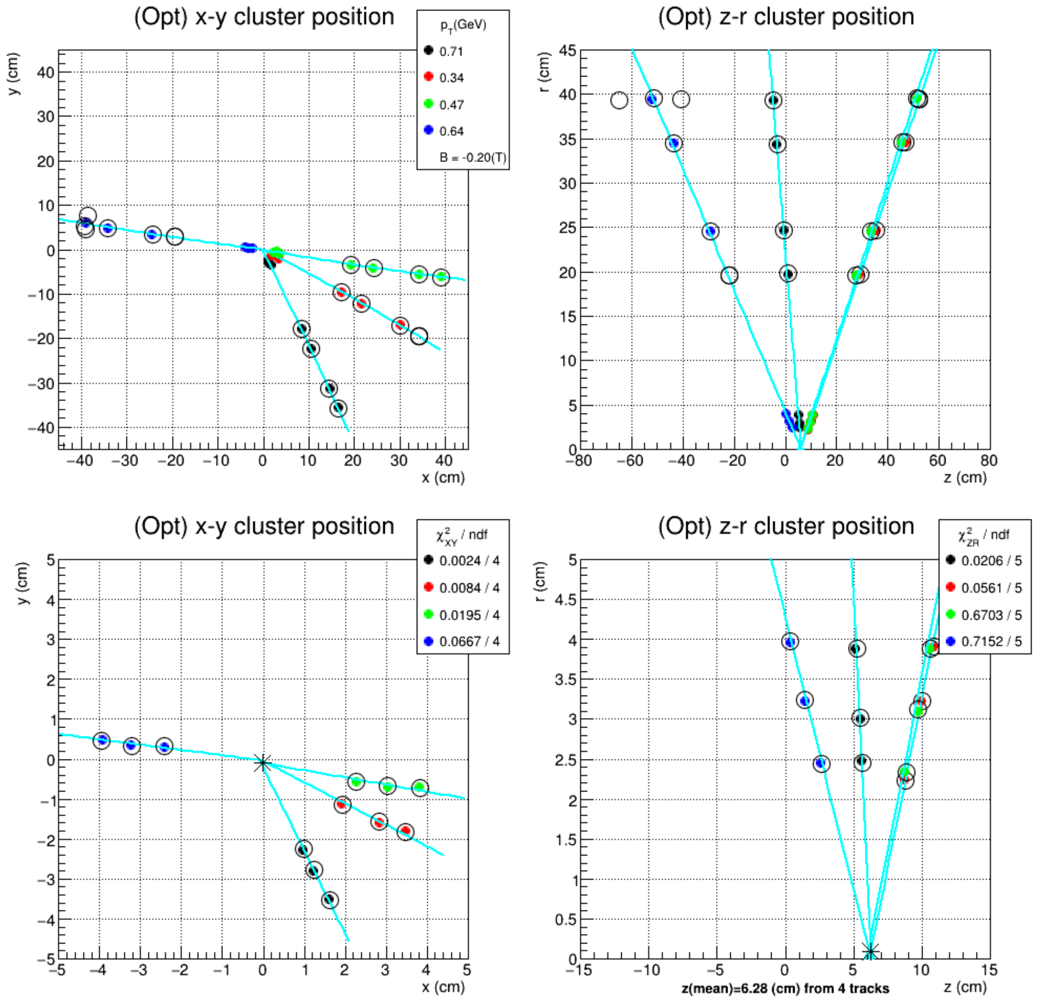
nClusters Correlation between IB and Full detector by ROF



Only a small fraction, 1~2%(877/56320), of ROFs show a good correlation between the number of clusters in the IB ($N_{cl}(IB) > 10$) and the total number of clusters.

This suggests most of the ROFs are empty events.

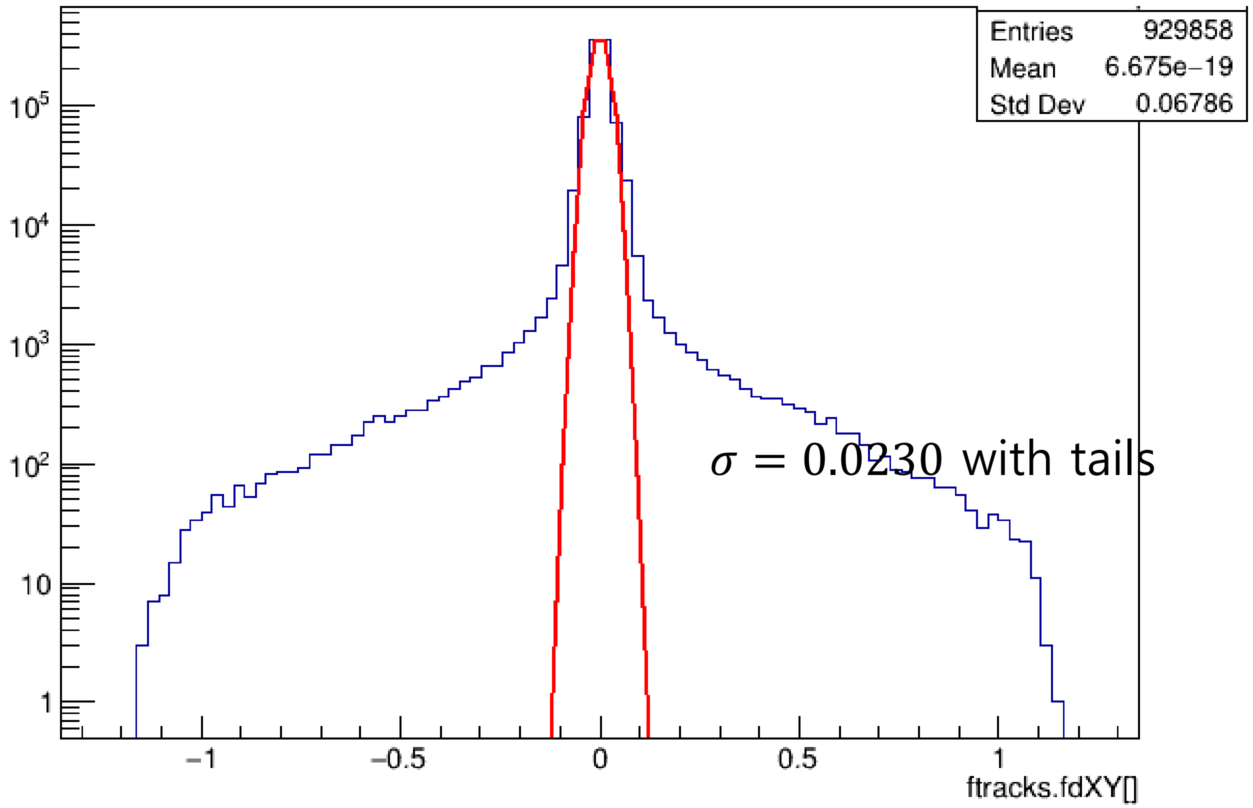
Crude Tracking
based on collision location assumption



RUN	: 505600
Orbit	: 417241089
BC	: 1782
Z(Assumed)	: 6.50 cm

Crude Tracking
based on collision location assumption

Fit residuals in XY plane

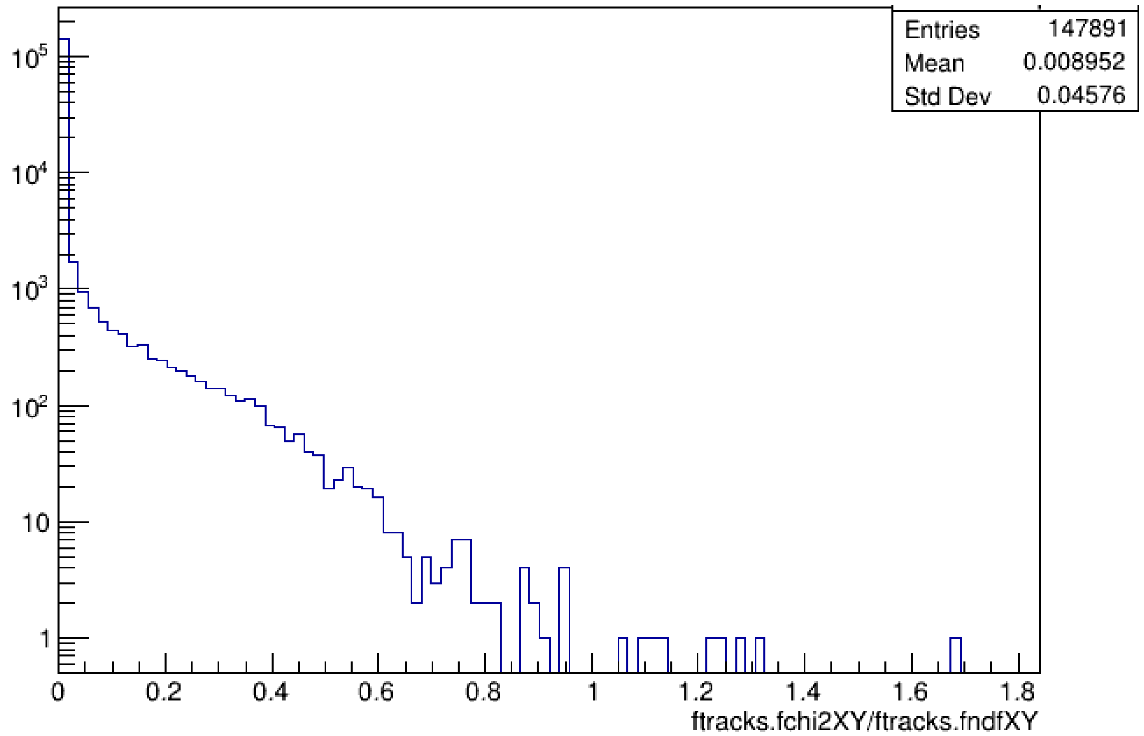


Currently estimated alignment level

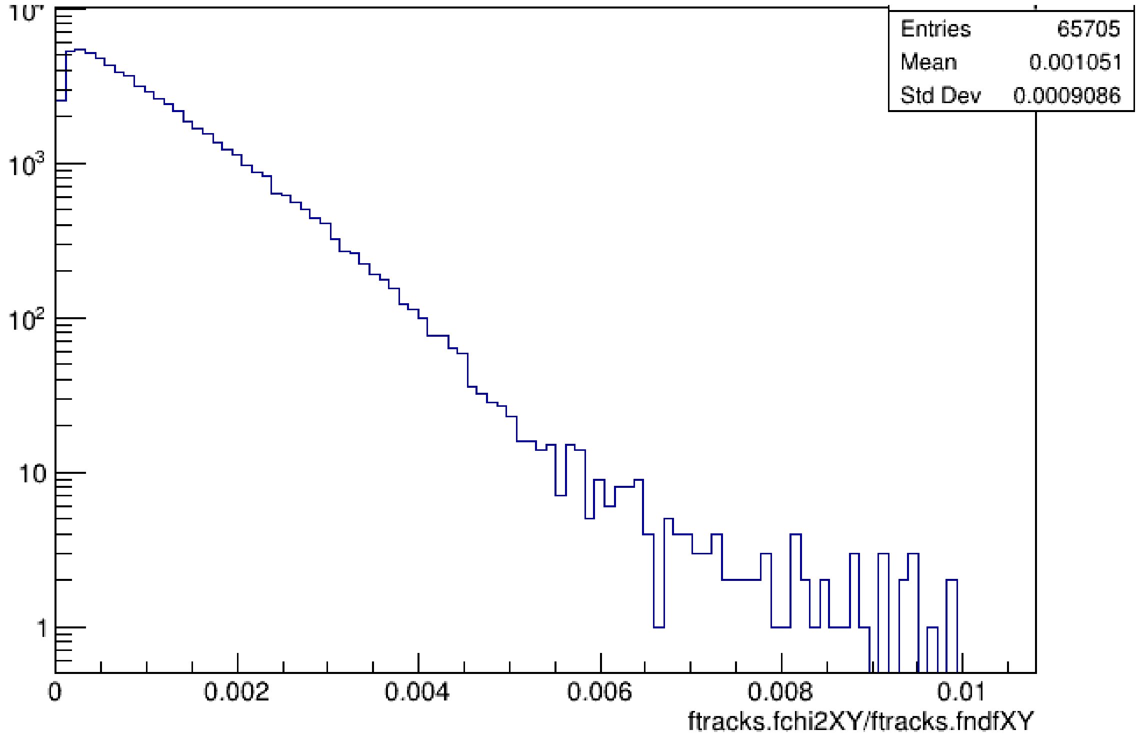
~ hundred microns

Crude Tracking
based on collision location assumption

χ^2_{XY}/ndf



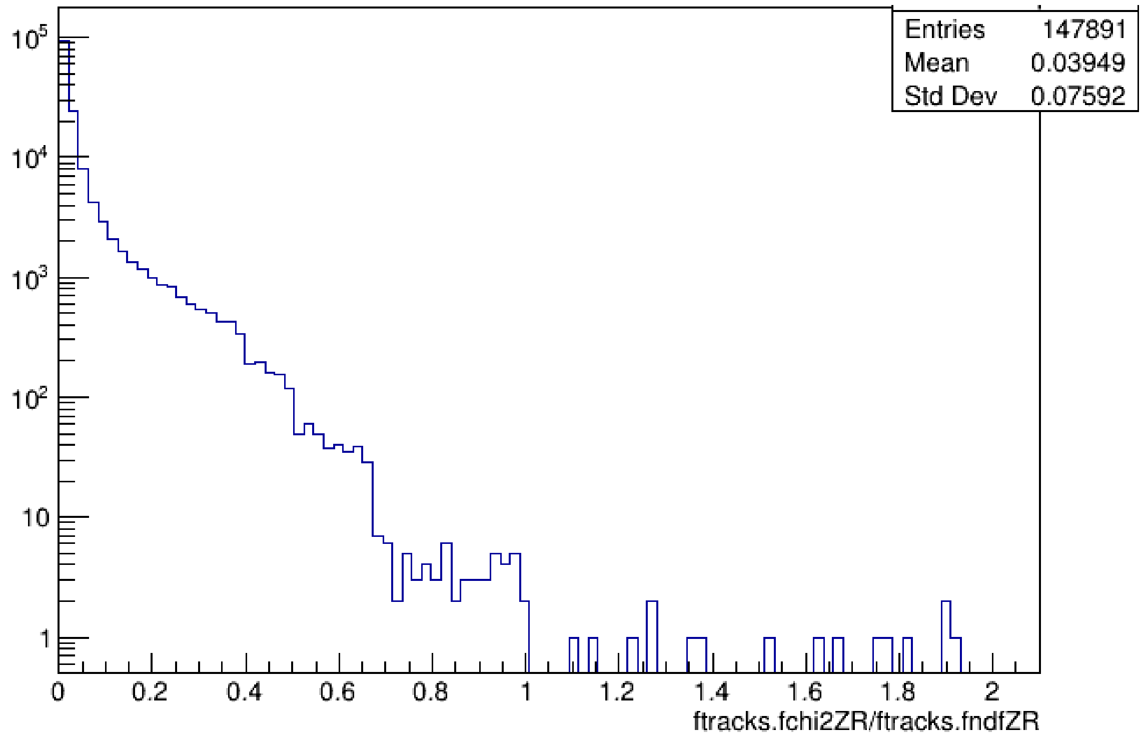
χ^2_{XY}/ndf with fit residual-based cut



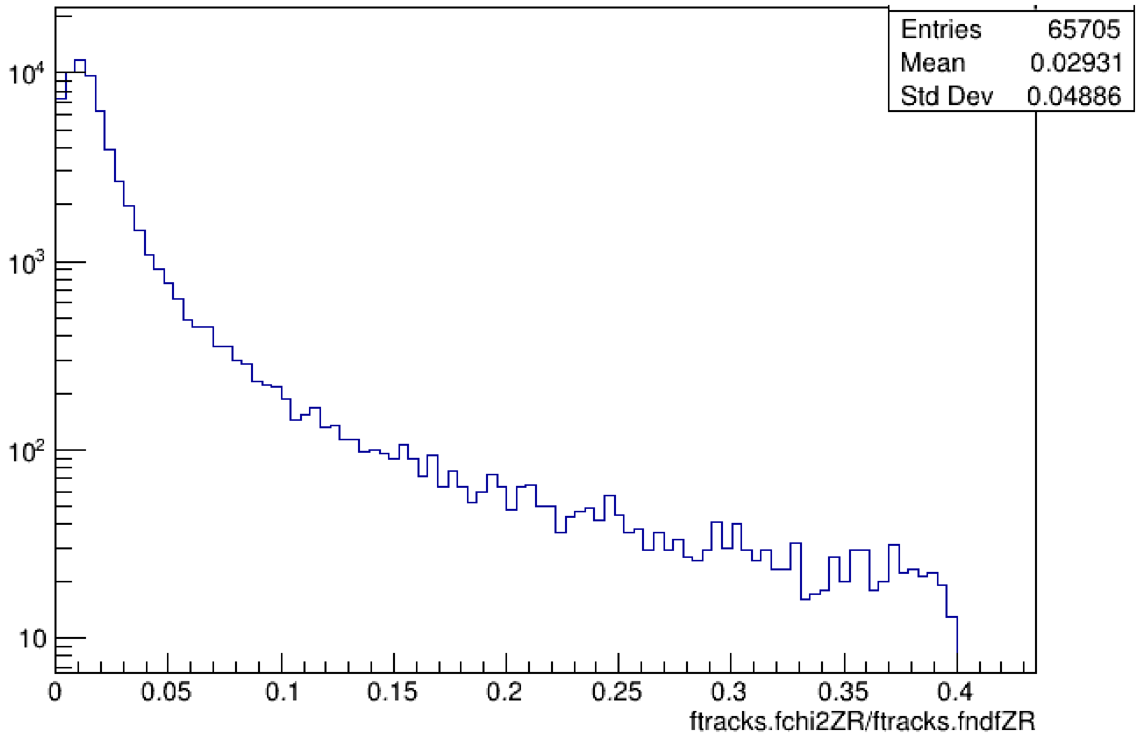
RUN 505673 / 0640, 0650, 0720, 0730 , 16000 files

Crude Tracking
based on collision location assumption

χ^2_{ZR}/ndf



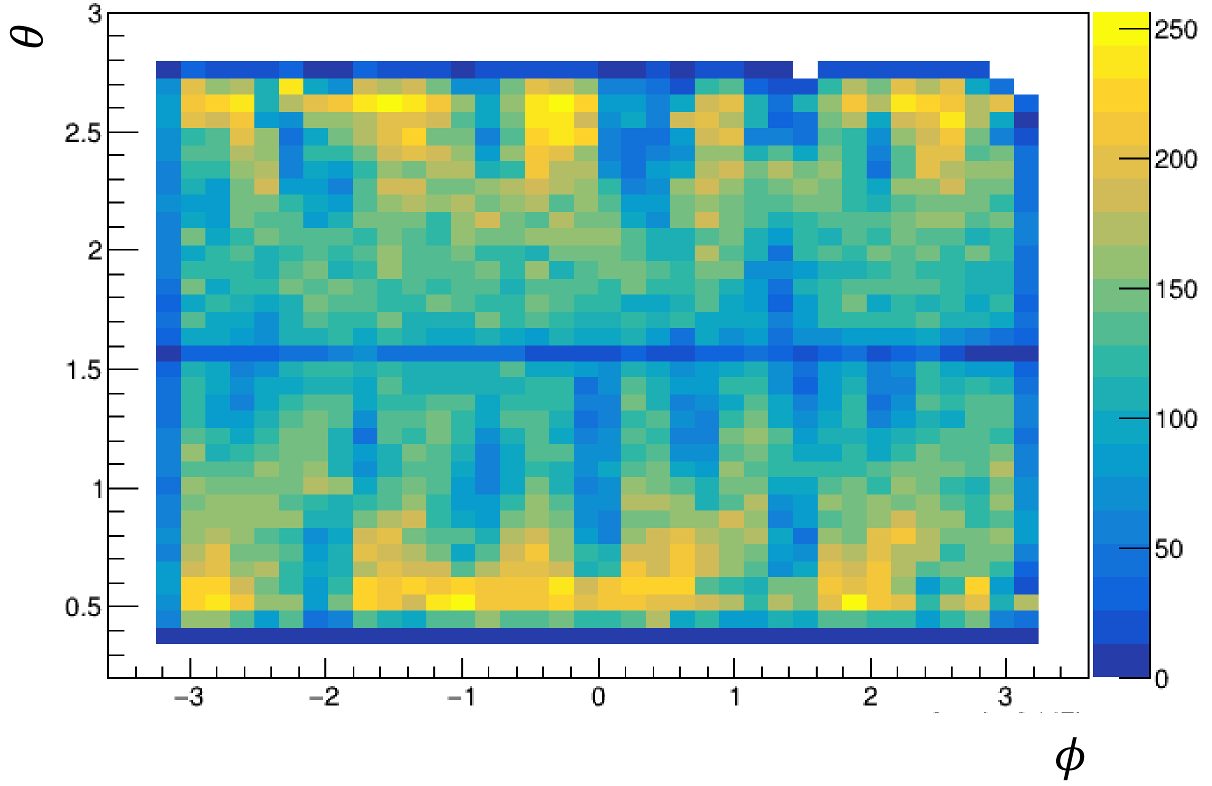
χ^2_{ZR}/ndf with fit residual-based cut



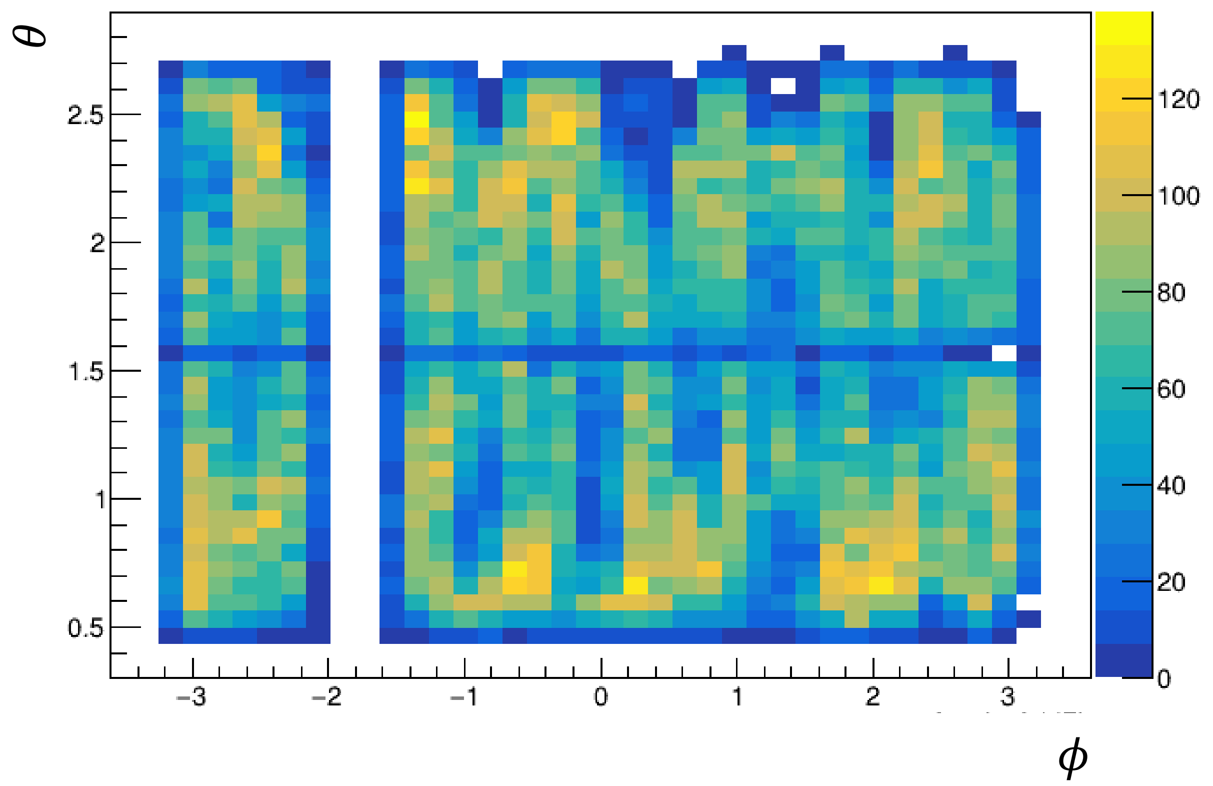
RUN 505673 / 0640, 0650, 0720, 0730 , 16000 files

Crude Tracking
based on collision location assumption

$\theta_{fit} - \phi_{fit}$ distribution

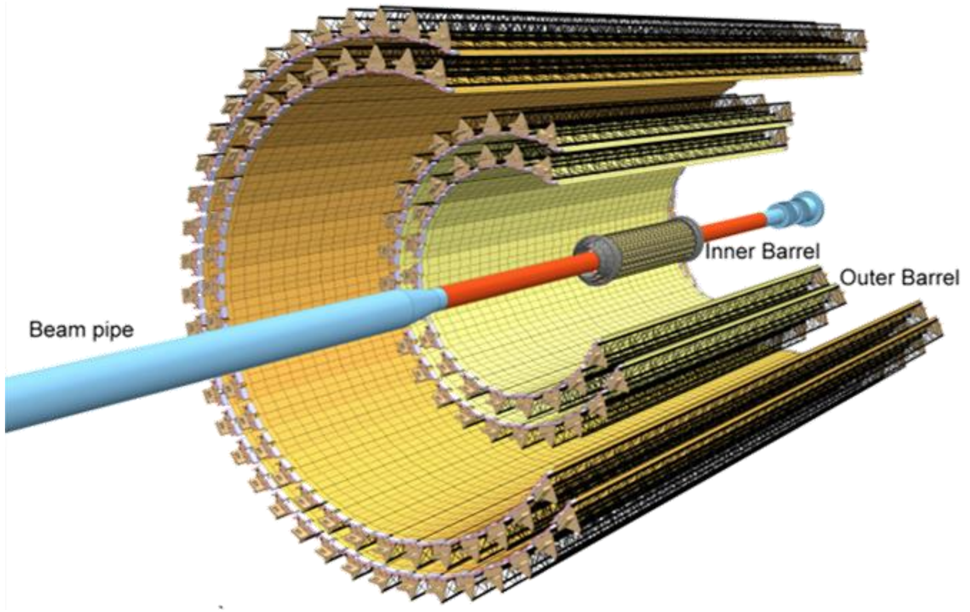


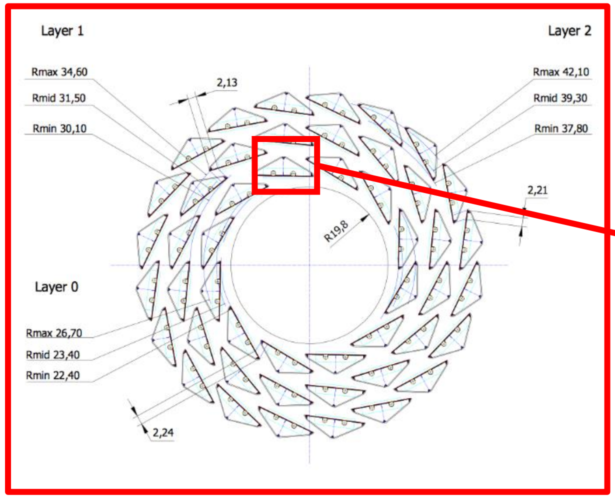
$\theta_{fit} - \phi_{fit}$ distribution
with fit residual-based cut

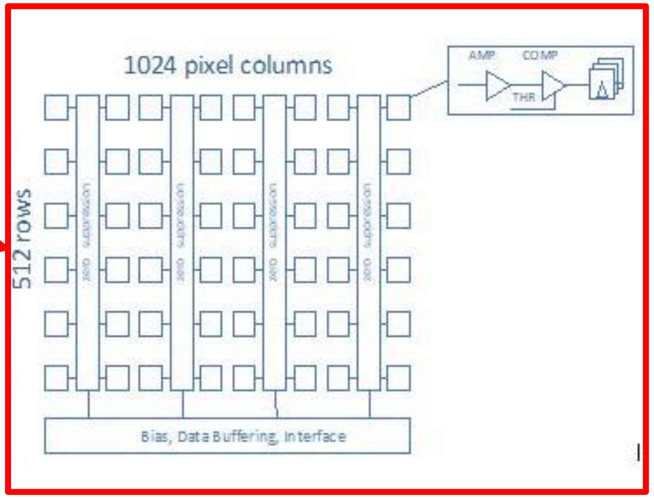


RUN 505673 / 0640, 0650, 0720, 0730 , 16000 files

Introduction
ALICE Experiment : Inner Tracking System(ITS)





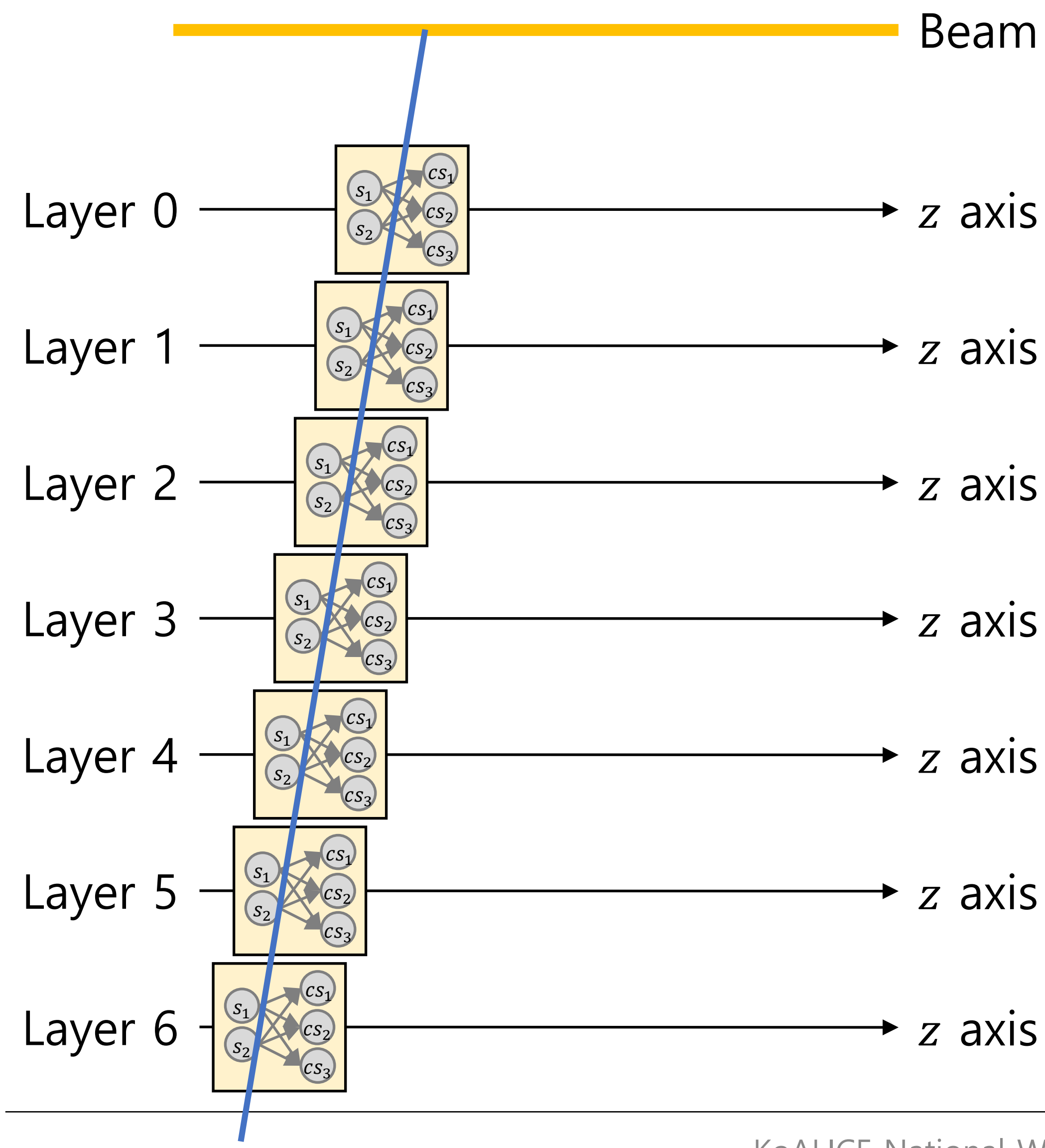


The new ITS is an all-pixel silicon detector based on CMOS monolithic active pixel sensor (MAPS).
https://ep-news.web.cern.ch/content/alice-its-upgrade-pixels-quarks

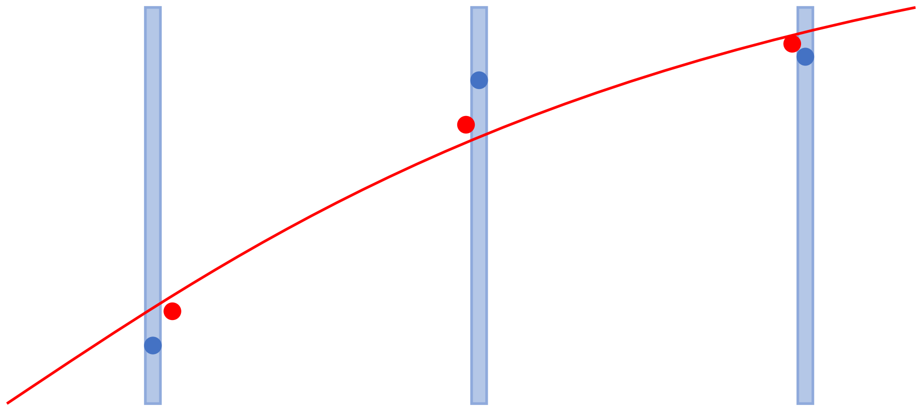
- Precision trackers are used for the high energy and nuclear physics.
- The trackers measure precise positions of the hits produced by the particles and associate hits to a trajectory when the associated positions are consistent.
- Any small misalignment or deformation of detector caused by various factors significantly affects the precise position measurements and its correction frequently appears as a major issue in the tracker operation.

Ⅲ

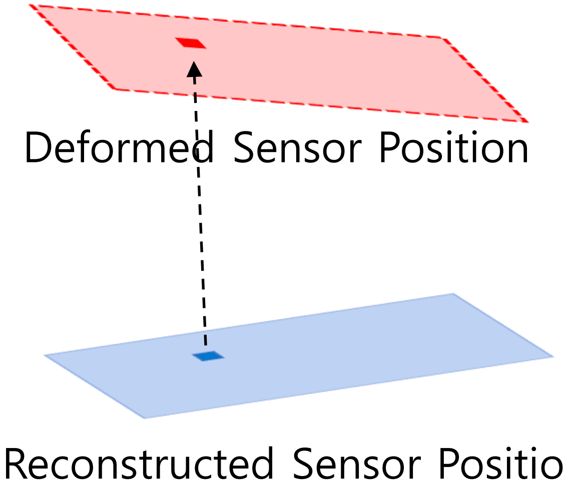
Network Construction



Track Fit in the global coordinate



Alignment in the sensor coordinate



$$s' = s + f(s_1, s_2)$$
$$= (s_1, s_2, 0) + \boxed{(cs_1, cs_2, cs_3)}$$

Correction Function

$$s = (s_1, s_2, 0)$$

Alignment module development

The alignment module of a full ITS geometry(24,120 sensors) is successfully constructed with reasonable computing resources. The resource is depending on the input data structure, the size of the multiple tracks by event. (e.g. 2~3 GB with 4~9 multiple tracks)

We have currently implemented a working alignment module for charged tracks under the B-Field

- Field Off tracks (cosmic runs) will get less priority due to a few considerations.

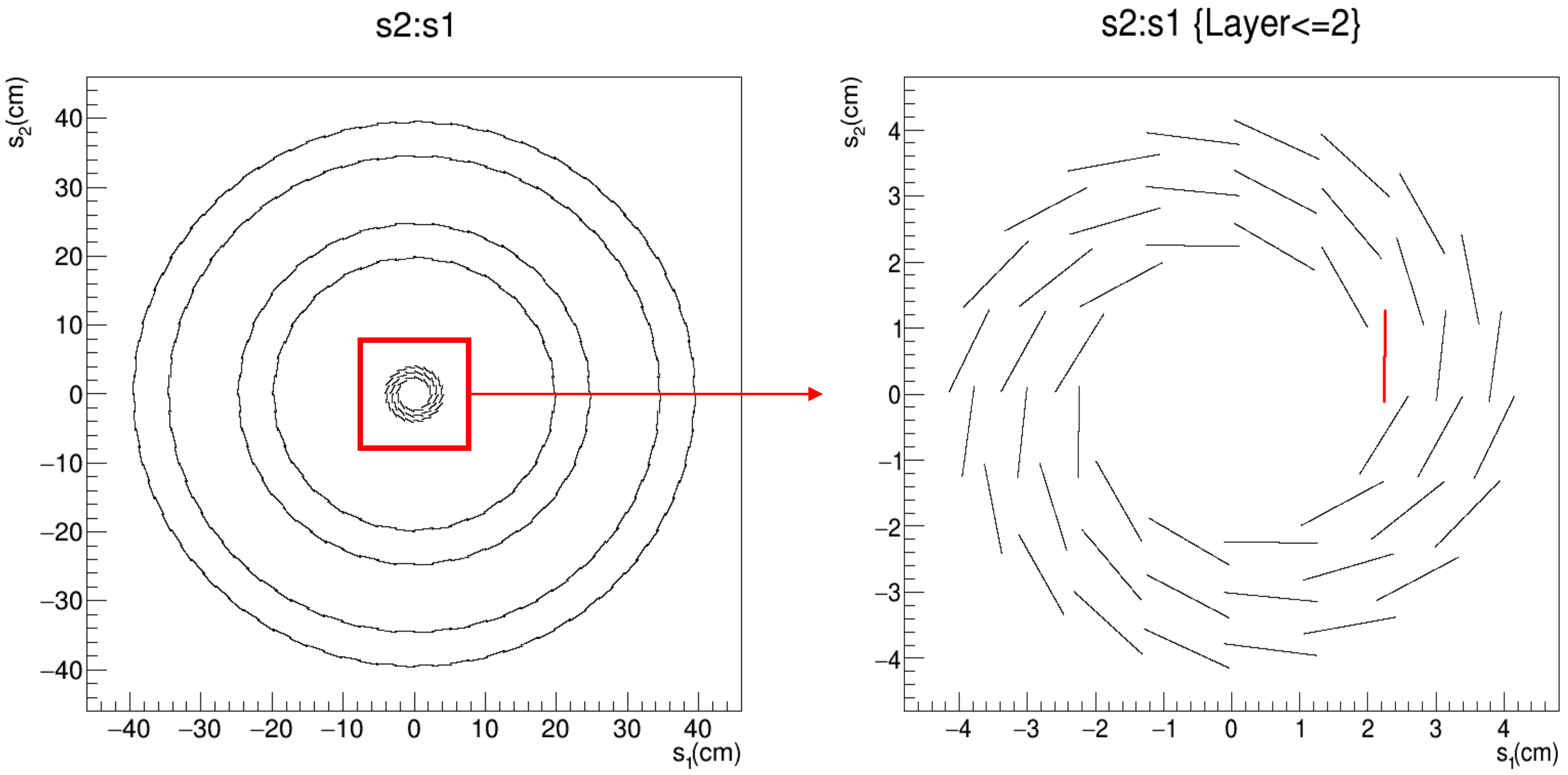
- **Field On tracks** (low multiplicity pp events) get more priority with a few reasons including
  - Crude trajectory momenta can be estimated.
  - Multiple tracks sharing the event vertex along the collision axis.

Alignment Module Test(MC)

- Event Generation : Pythia8pp(14TeV pp with collision vertex width 5cm)

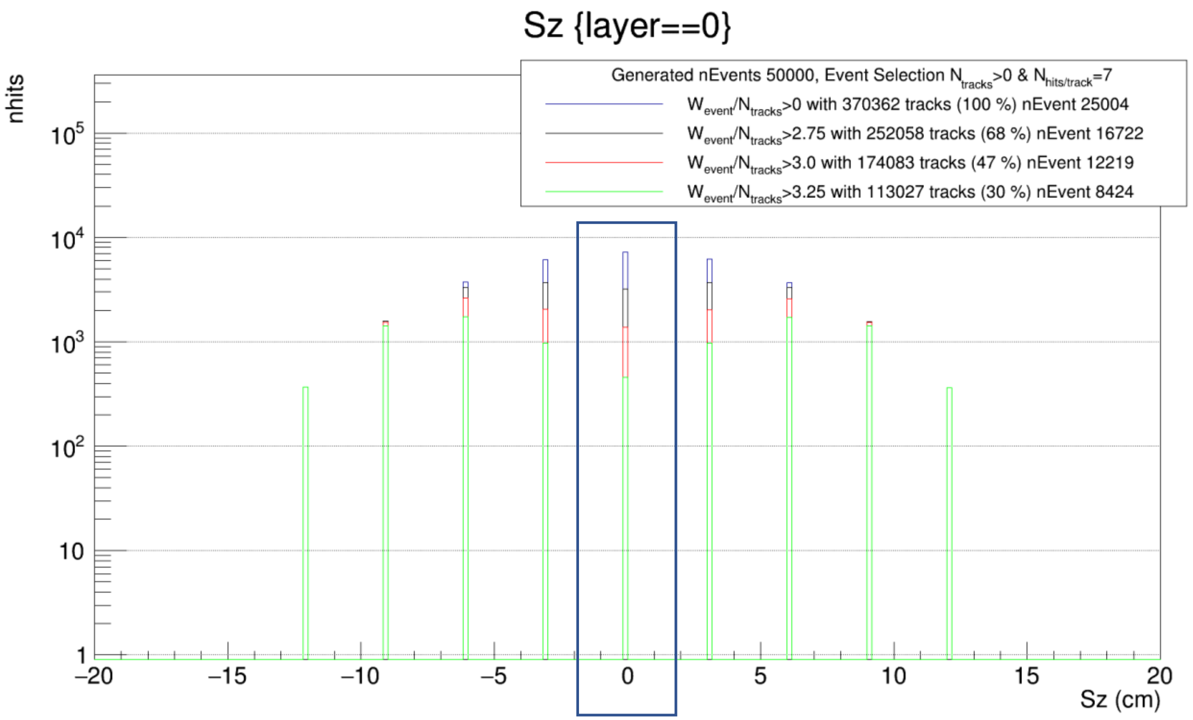
  o2-sim –g pythia8pp –configKeyValues “Diamond.position[2]=0;Diamond.width[2]=5;…”

- Deformation : Layer0, Chip4 (ChipID=4) $s_1 (= z)$ $500 \mu m$, one sensor



Alignment Module Test(MC)

- # of hits / sensor profile (Layer 0)



- pythia8pp 14 TeV, $W_{event}/N_{track} > 3.0$: 12000 events

# of hits / sensor at deformed sensor : ~1000 hits

Found : 478μm , (~1.5h) → 500μm , 20~30 μm accuracy

Cost : 1.2527 → 1.208

$$\frac{\chi^2}{\nu} = \frac{1}{\nu}\left(\sum_{t=track}\left[\sum_{j=layer}\left(\sum_{i=1,2}\left(\frac{1}{\sigma_{ij}^2}\left(\bar{s}_{ij} - \left(s_{ij} + cs_{ij}\right)\right)^2\right)\right) + \frac{\left(V_t - \tilde{V}_{track}\right)^2}{\sigma_t^2}\right]_t + \frac{\left(V_{evt} - \tilde{V}_{track}\right)^2}{\sigma^2}\right) \rightarrow \textit{will be updated}$$

sensor vertex

Summary

Pilot Beam

There are issues to apply the pilot beam directly into alignment module due to the unknown collision location.

We have introduced the crude-tracking algorithm to find tracks based on the collision location assumption.

We are now studying pilot beam data features and will use processed pilot beam data to alignment.

Alignment Module

Implementation	: ITS Full detector alignment module based on neural network
Correction Function	: reduction on spatial fitting offsets → improvement on detector resolution
Cost Function	: (Sensor region) + (Vertex region) , under B-field (circle fit)
Input data	: MC events(pythia8pp 14 TeV), pilot beam data

Required # of data to alignment

Target	: $\boldsymbol{N_{hits}}$ (OB) ~ $\mathbf{10^3}$
Required Total Events	: $\sim\mathbf{10,000,000}$

Target : End of January