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CEPC Drift Chamber Simulation and Reconstruction

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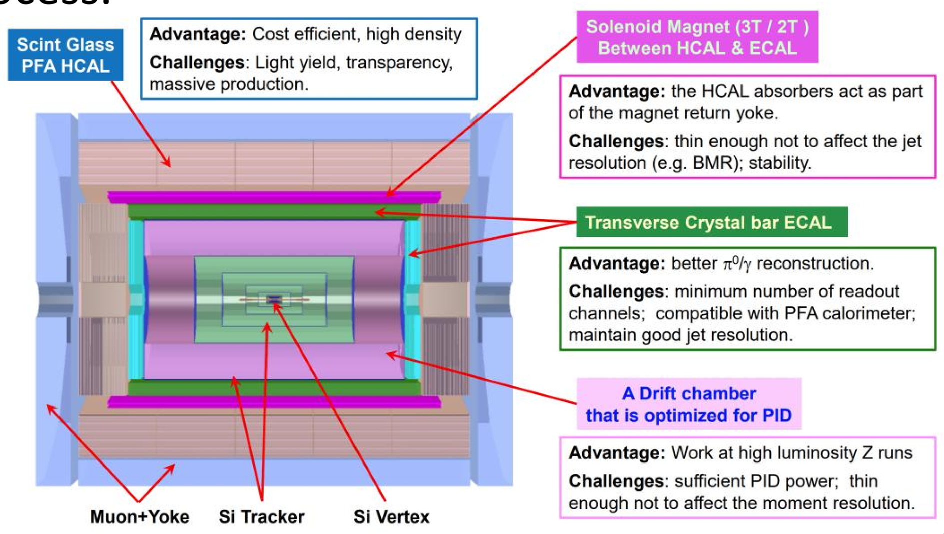
Introduction

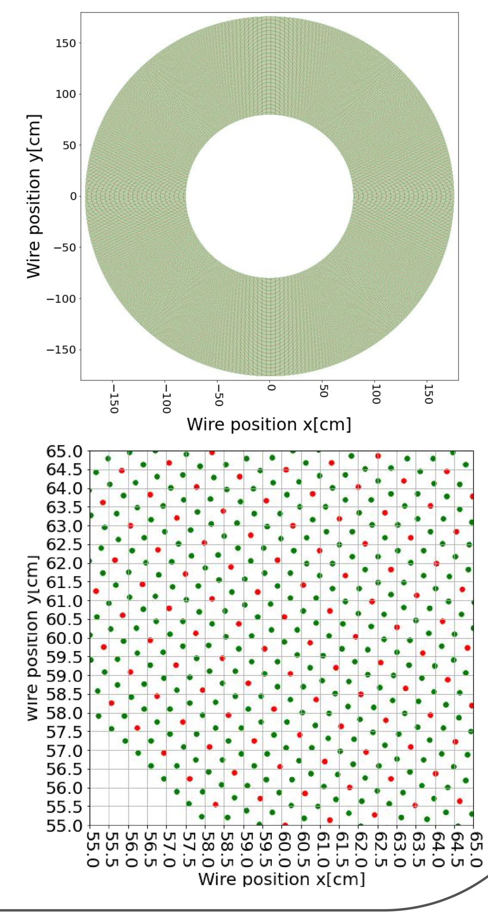
- Drift Chamber (DC) is an important sub-detector of CEPC, and its main function is to accurately measure the momentum and energy loss of charged particles (for particle identification).
- The track reconstruction of charged particles is an important link in the CEPC offline data processing process.
- At present, the track fitting algorithm has been completed, and the tracking algorithm is being developed.
- CKF (Combined Kalman Filter) is used to track finding.



DC Parameters in CEPCSW

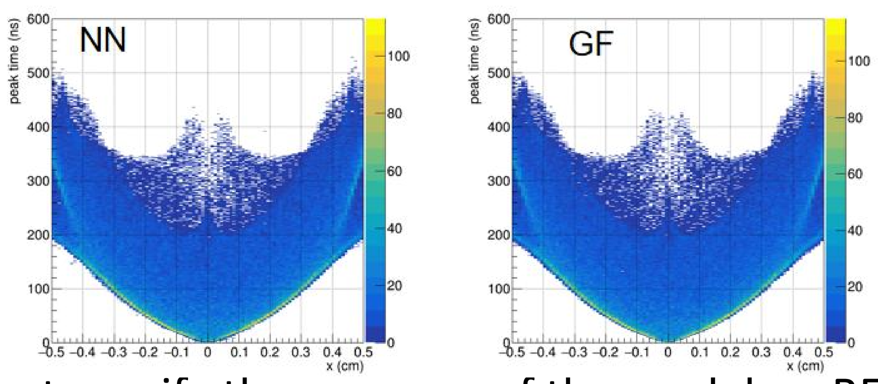
- The base line configuration of DC in CEPCSW

Half length	2980 *mm*
Inner and outer radius	800 to 1800 *mm*
# of Layers	100/55
Cell size	~10x10mm/18x18mm
Gas	He:C_4H_{10}=90:10
Single cell resolution	0.11 *mm*
Sense to field wire ratio	1:3
Total # of sense wire	81631/24931
Stereo angle	1.64~3.64 *deg*
Sense wire	Gold plated Tungsten ϕ=0.02*mm*
Field wire	Silver plated Aluminum ϕ=0.04*mm*
Walls	Carbon fiber 0.2 *mm*(inner) and 2.8 *mm*(outer)



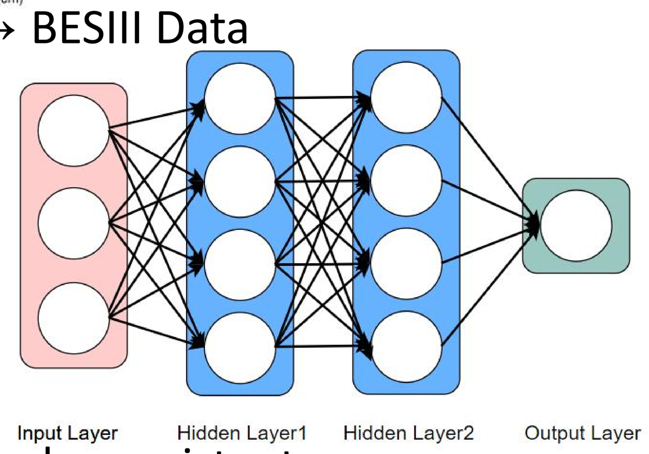
X-T simulations using DNN

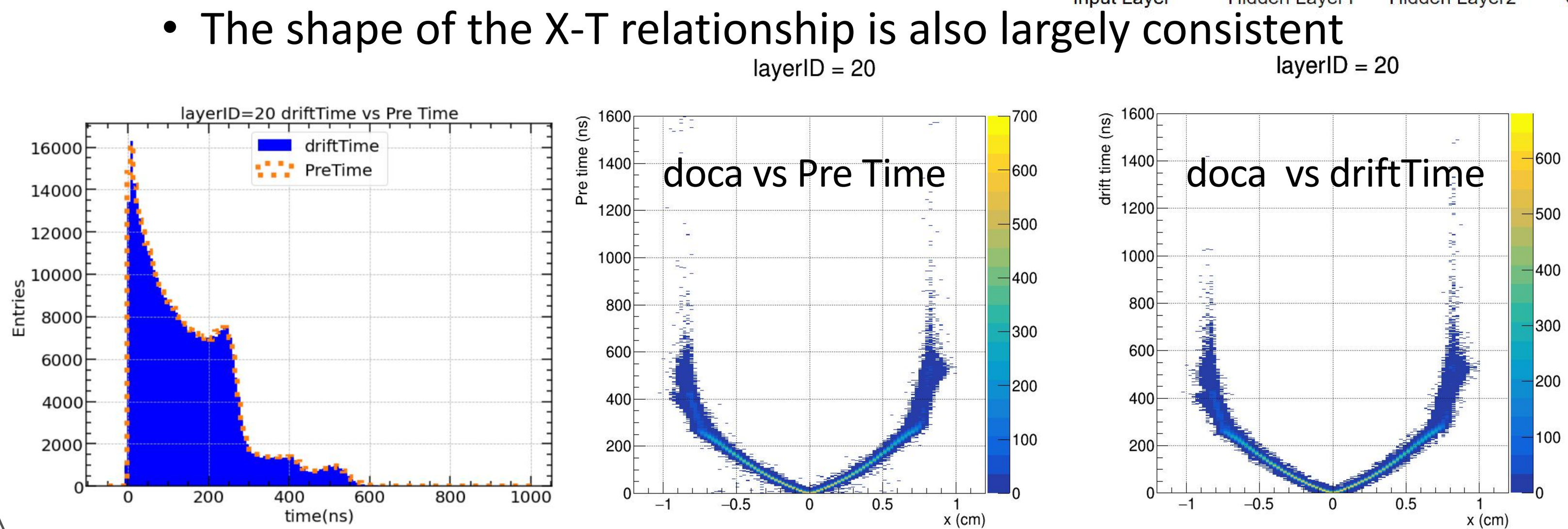
- Garfield++ is used for the simulation in the drift chamber
- Using a machine learning model to learn Garfield simulation ⇒ fits well



by Wenxing Fang

- Use data to verify the accuracy of the model ⟶ BESIII Data
- Use DNN networks to learn X-T relationship
  - Input Layer:doca,eangle,N(0,1)
  - Hidden Layer:814 x 814 x 814
  - Output Layer:Time
- Take layerID=20 as an example:
  - The time distribution is the same
  - The shape of the X-T relationship is also largely consistent





- We get similar results using flow

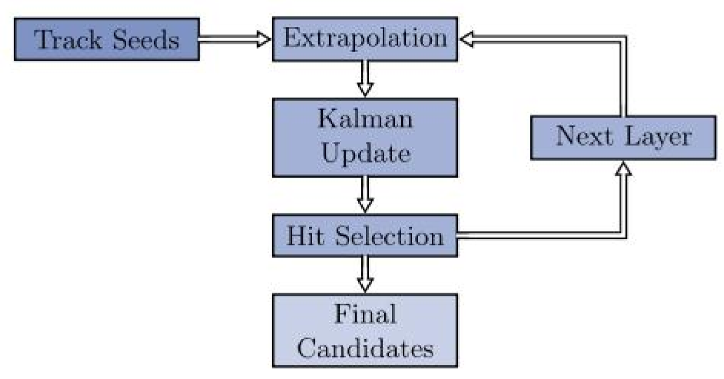
Summary

- Preliminary results show that the predicted value is consistent with the training value when using BESIII data for DNN
- Track fitting algorithm inspection is complete and ready for release
- Track finding algorithm completed the investigation and successfully compiled and ran in CEPCSW environment. Our next step is to test the tracking efficiency

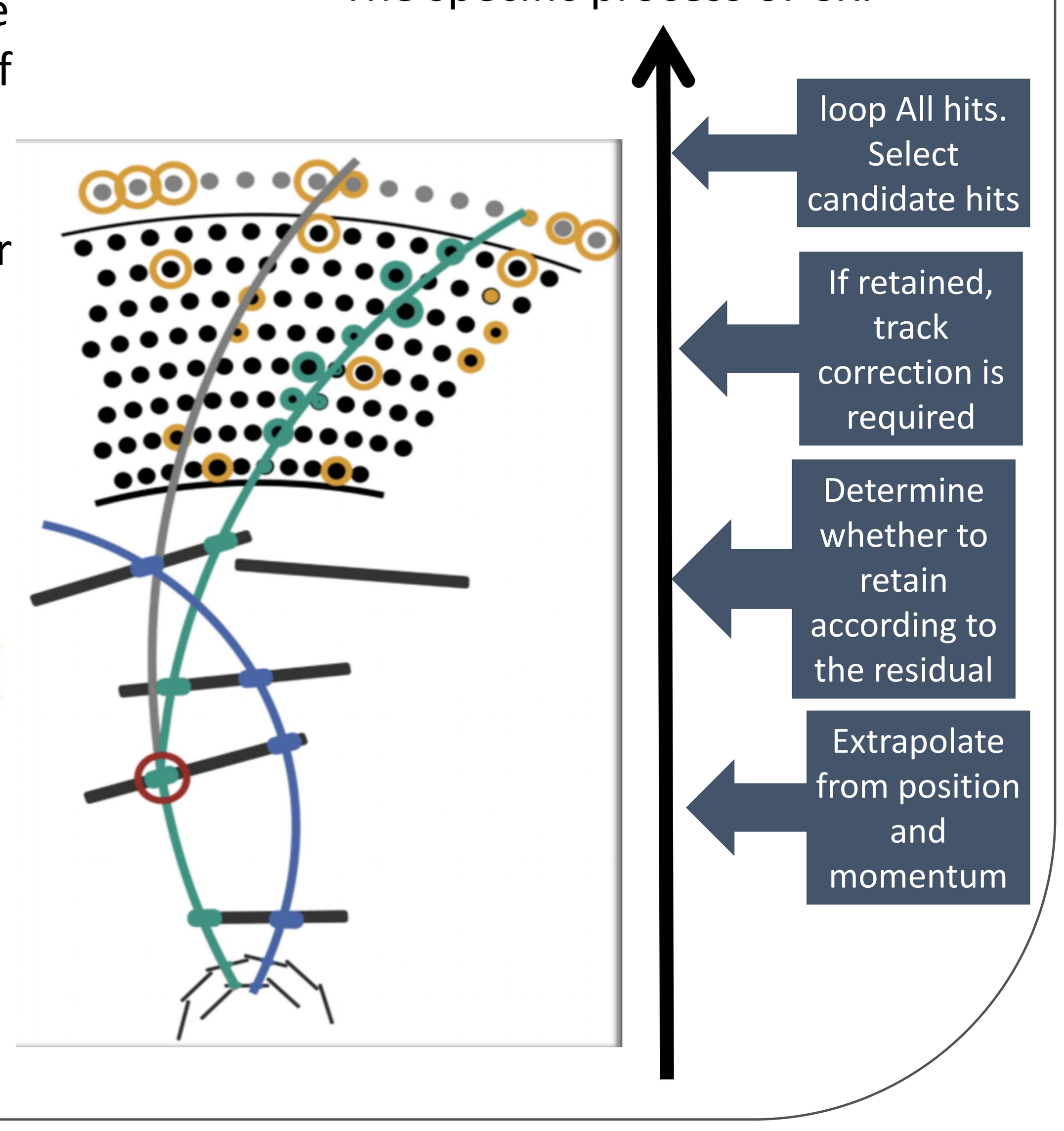
DC Track Finding

- CKF(Combinatorial Kalman Filter):
  - a tracking concept that combines track finding and track fitting in a search-tree-based algorithm.
  - It is used by many high energy physics experiments
  - can give precise results leading to high purities as well as high efficiencies
- Track finding using CKF in Drift hamber
  - Used MC Truth
  - Purpose: Select hits belonging to this track through the existing track seed
  - Methods: The reconstructed SiTrack is selected as seed to select DC hits belonging to the same Track
- Current progress:
  - DCTrackFinding algorithm is improved based on the track finding algorithm of Belle II
  - Have preliminary results, and they look good so far

Basic procedure behind the CKF

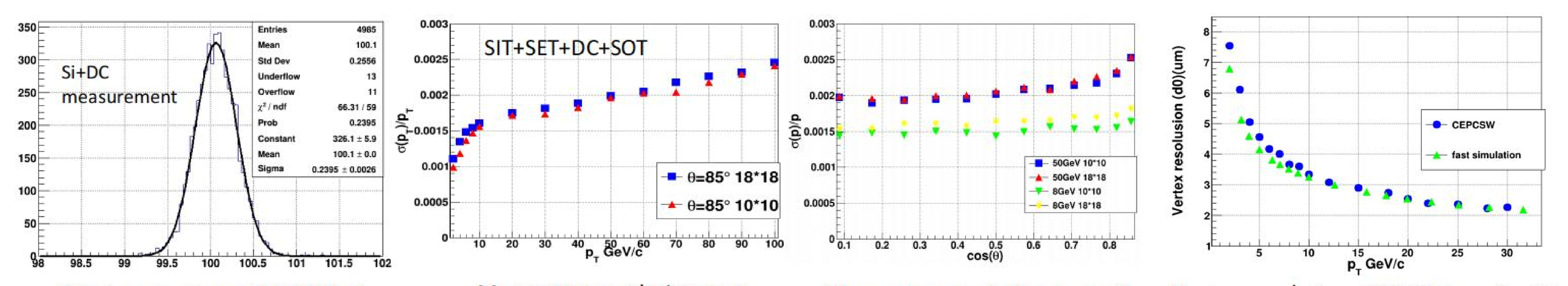


The specific process of CKF



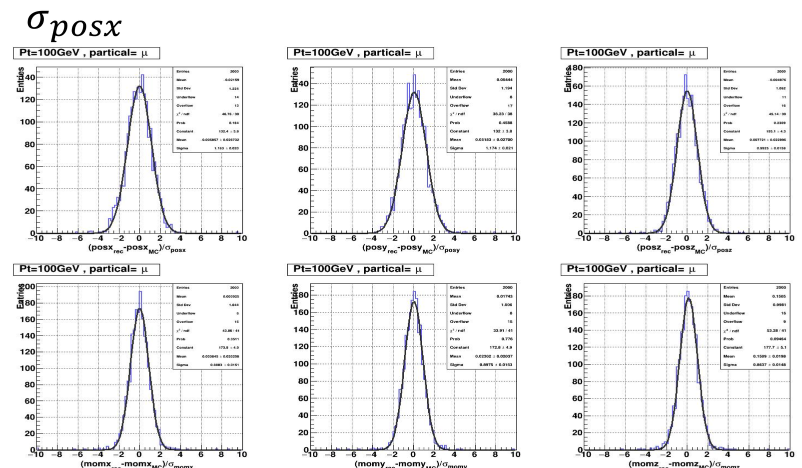
DC Track Fitting

- The track fitting is ready for release in CEPCSW
  - Use a Genfit as external libraries to do kalman track fitting
  - Intergrate Bfield, material and geometry from DD4hep and EDM4hep
- Track fitting with detector measurements is implemented
  - Track fitting combines the silicon detector and drift chamber
  - The preliminary result is consistent with fast simulation



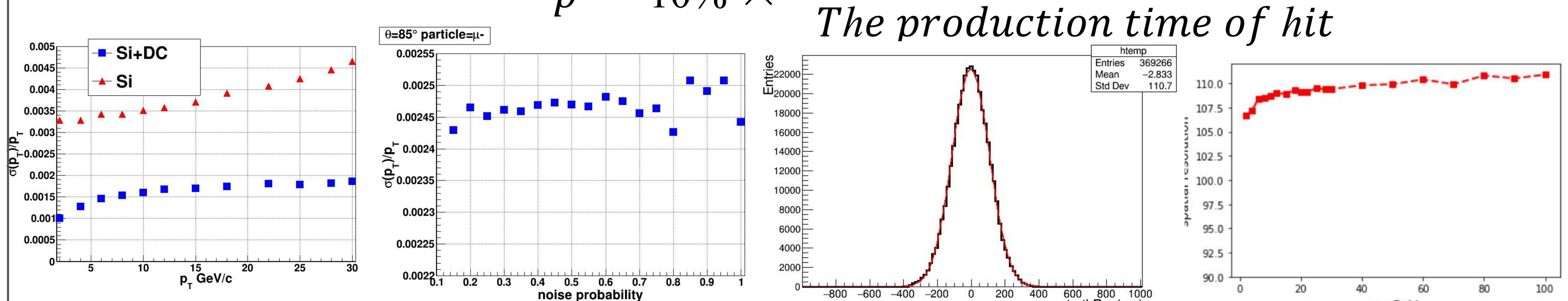
Fitted momentum of 100GeV μ^- Momentum resolution v.s. p_T Momentum resolution v.s. cosθ Vertex resolution CEPCSW v.s. FastSim

- Check of track fitting algorithm
  - 6 parameters($pos_x, pos_y, pos_z, Mom_x, Mom_y, Mom_z$) distribution
    - $\frac{posx - posx_{MC}}{\sigma_{posx}}$



- Momentum resolution of Si vs Si+DC
  - With a drift chamber, the momentum resolution is significantly better
- Add noise
  - If 10% of cells in each layer may generate noise, the probability that noise may overwrite hit is:

$$p = 10\% \times \frac{\textit{The time of noise generation}}{\textit{The production time of hit}}$$



- Spatially resolved distribution
  - Residual = the closest distance of fitting track - the closest distance (doca)
  - The spatial resolution set in the drift chamber is 110um, and the spatial resolution of the reconstructed tracks is about 110um, and the difference is within 2um