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Precise simulation of drift chamber in the CEPC experiment

Thursday, 2 December 2021 11:00 (20 minutes)

The Circular Electron Positron Collider (CEPC) [1] is one of future experiments which aims to study the properties of Higgs boson and to perform searches for new physics beyond the Standard Model. The drift chamber is a design option for the outer tracking detector. With the development of new technology in electronics, employment of primary ionization counting method [2-3] to identify charged particles becomes feasible. In order to evaluate particle identification performance, development of a powerful simulation tool is a necessity, which can be used to precisely simulate the response of the gaseous particle detector.

Combining Geant4 and Garfield++ to do this precise simulation has already been studied[4], in which Geant4 is responsible for the primary particle generation and Garfield++ deals with the drift of ions and electrons, amplification via electron avalanches and final signal generation.This contribution will present the integration of Geant4 with Garfield++ in the Gaudi-based CEPCSW software framework. In this implementation, the model used by Geant4 simulation can be configured as either Geant4 PAI or Heed PAI.

Being extremely time-consuming, it is not practical to add Garfield++ into the CEPC simulation chain. To overcome the barrier, data from the Garfield++ simulation is used to train a fully-connected neural network. And the achieved neural network model is then used to transform the information of an ionized electron to its corresponding hit pulse on the signal wire. After the conversion completes, the waveform is created just by piling up the pulses according to their arrival time. This contribution will introduce the details of the above development. Performance studies show that consistent physics results have been obtained and about 200 times speedup makes it possible to apply the machine-learning method to the full detector simulation.

Reference:
[1] CEPC Study Group Collaboration, M. Dong *et al.*, *CEPC Conceptual Design Report: Volume 2 - Physics & Detector*, arXiv:1811.10545
[2] Jean-Fraņcois Caron, *et al.*, *Improved Particle Identification Using Cluster Counting in a Full-Length Drift Chamber Prototype*, 10.1016/j.nima.2013.09.028
[3] F. Cuna, *et al.*, *Simulation of particle identification with the cluster counting technique.* arXiv:2105.07064
[4] Dorothea Pfeiffer, *et al. Interfacing Geant4, Garfield++ and Degrad for the Simulation of Gaseous Detectors.* 10.1016/j.nima.2019.04.110

Significance

Ideas/methods from this talk make the precise simulation of drift chamber in CEPC experiment become possible which could benefit other future collider experiments such as Future Circular Collider (FCC) and Super Tau Charm Factory (STCF) which are also working on exploring the primary ionization counting method for drift chamber. Moreover, experiments require precise simulation of gaseous particle detector could also be benefit from this talk.

References

Speaker time zone

Compatible with Asia

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Session Classification: Track 2: Data Analysis - Algorithms and Tools

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