Contribution ID: **27** Type: **Talk**

CyberPFA: Crystal Bar ECAL Reconstruction in CEPC

Saturday, 26 October 2024 10:00 (20 minutes)

The precise measurements of the Higgs, W and Z boson properties at future electron-positron collider will provide critical tests of the Standard Model (SM) and are essential in the exploration of new physics beyond the SM (BSM). To distinguish the hadronic decays of W and Z bosons, a 3-4% boson mass resolution(BMR) for jet systems is required. The particle flow approach, which aims to measure individual particles in jets using imaging calorimeter system, is a very promising method to achieve the unprecedented BMR.

A novel electromagnetic calorimeter (ECAL) with orthogonally arranged crystal bars has been proposed in CEPC reference TDR. The crystal bar design is expected to provide optimal intrinsic energy resolution and three-dimensional shower information for the particle flow algorithm (PFA). Additionally, the long bar design will significantly reduce the cost of electronics. However, the crystal bar ECAL also presents challenges, such as the potential ambiguity problem for multiple particles due to the perpendicular arrangement of crystal bars in adjacent layers and increased shower overlap from different particles caused by the larger R_M and $X_0/_I$ for crystals.

This report presents recent progress on CyberPFA, a dedicated particle flow algorithm for the crystal bar ECAL. The ambiguity problem has been addressed through the implementation of multiple optimized pattern recognition approaches, while the issue of shower overlap has been mitigated by an energy splitting module. The development of CyberPFA takes into account various aspects including electronics, heat dissipation, mechanical support, and digitization processes of ECAL. The algorithm’ s performance, including a boson mass resolution of approximately 3.8%, will be demonstrated. These results underscore the potential of the proposed ECAL design and the PFA in enhancing detector capabilities and reconstruction methodologies for future electron-positron collider experiments.

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Session Classification: Software

Track Classification: Detector and System: 18: Offline & Software