

Detectors and Physics at a Future Linear Collider

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An electron-positron linear collider is an option for future large particle accelerator projects. Such a collider would focus on precision tests of the higgs boson properties. This thesis describes several studies related to the optimisation of high granular calorimeters. Three main areas were covered.

The performance of photon reconstruction is improved. Photon reconstruction algorithms were developed within PandoraPFA, a world-leading pattern-recognition software for particle flow calorimetry. A sophisticated pattern recognition algorithm was implemented, which uses the topological properties of electromagnetic showers to identify photon candidates and separate them from nearby particles. It performs clustering of the energy deposits in the detector, followed by topological characterisation of the clusters, with the results being considered by a multivariate likelihood analysis. This algorithm leads to a significant improvement in the reconstruction of both single photons and multiple photons in high energy jets.

Reconstruction and classification of tau lepton decay modes were studied. Tau decay products, such as photons, were reconstructed as separate entities. Utilising high granular calorimeters, the resolution of energy and invariant mass of the tau decay products is improved. A hypothesis test was performed for expected decay final states. A multivariate analysis was trained to classify decay final states with a data-driven machine learning method. The performance of tau decay classification is used for the electromagnetic calorimeter optimisation at the ILC or CLIC.

Sensitivity of higgs couplings at the CLIC was studied, using simulated double Higgs boson production. Algorithms were developed to identify isolated high energy leptons, and results were fed into a multivariate analysis. The study was done for two CLIC energy scenarios. This sensitivity study of triple and quartic Higgs self-couplings is a part of scientific cases for the CLIC. This work provides further motivation for high granular particle flow calorimetry for a future electron-positron linear collider.