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 three studies related to the optimisation of high granular calorimeters and one study on the sensitivity of higgs couplings at CLIC.

Photon reconstruction algorithms were developed for high granular calorimeters of a future linear collider detector. 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.

The reconstruction and classification of tau lepton decay products was studied. Utilising high granular calorimeters, the high resolution of energy and invariant mass of the tau decay products enabled high classification rate. A hypothesis test was performed for expected decay final states. A multivariate analysis was trained to classify decay final states with a machine learning method. The performance of tau decay classification is used for the electromagnetic calorimeter optimisation at the ILC or CLIC. A proof-of-principle analysis of using the correlation

between the polarisations of the tau pair from a boson decay as a signature to differentiate the Higgs boson from the Z boson is presented.

Sensitivity of higgs couplings at CLIC was studied using the double Higgs production process. Algorithm were developed for signal event selection. The event selection relies on the jet reconstruction and the flavour tagging. A multivariate analysis is performed to select signal events. An attempt at extracting Higgs trilinear self-coupling and quartic coupling was conducted.