Detectors and Physics at a Future Linear Collider

Boruo Xu

University of Cambridge

I. SUMMARY 300 WORDS

The next large accelerator project will almost certainly be a linear electron-positron collider for precision studies of the higgs boson. This research project has two three strands:

Particle reconstruction is improved for the next generation high granular calorimeter. I have worked on the pattern recognition of photons, within PandoraPFA, a world-leading pattern-recognition software. A sophisticated pattern recognition algorithm is implemented, which uses the topological properties of electromagnetic showers to identify photon candidates and separate them from other, 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 multi-variate likelihood analysis. This algorithm leads to a significant improvement in the reconstruction of both single photons and multiple photons in a dense collider environment.

Second aspect is a detailed simulation study on reconstruction and classification of the tau lepton decay modes. The essential step is to reconstruct tau decay products as separate entities, such as photons. Using my photon reconstruction algorithm, the resolution of energy and invariant mass of the tau decay products is improved. I performed a hypothesis test for expected decay final states, and a multivariate analysis to classify decay final states with a data-driven machine learning method. The high classification rate of the final state of the tau lepton would provide a precision test of the Standard Model and provides a stronger physics case for future linear colliders, ILC or CLIC. My work is also an important benchmark for the optimisation of the electromagnetic calorimeter, to be used at the ILC or CLIC.

Third aspect is a simulation study of double Higgs boson production in the context of the CLIC. By characterising complex events, I developed algorithms to identify isolated high energy leptons and fed the results into a multivariate analysis. Events with two Higgs bosons were extracted from background events for two CLIC energy scenarios. This leads to my sensitivity study of the Higgs self-triple coupling and quartic coupling, using a two-dimensional template fitting method. This work would feed into the proposal for the CLIC detector.