



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The Standard Model (SM) of particle physics has successfully explained the fundamental forces of nature and was solidified with the discovery of the Higgs boson. However, various theoretical and experimental motivations drive us to explore beyond the SM (BSM). Statistical analysis plays a crucial role in this exploration, applied to different collider experiments to search for different BSM scenarios. Chapter 1 of the thesis introduces the SM particle spectrum, its limitations, and discusses approaches to address these limitations. It also outlines the outlook for past, present, and future colliders, focusing on lepton colliders. Chapter 2 delves into two statistical techniques: binned analysis and the optimal observable technique (OOT). Chapter 3 explores OOT in a BSM-dominated scenario, particularly in estimating Z boson couplings at e^+e^- collider and studying dark matter phenomenology. Chapter 4 shifts focus to scenarios where the SM dominates, investigating the determination of anomalous neutral triple gauge couplings (nTGCs) through di-boson production and dimension-6 effective couplings through top-quark pair production at the e^+e^- collider. Chapter 5 examines experimental constraints on dimension-6 four-Fermi SMEFT operators and explores flavor probes through flavor-changing top-charm production at the muon collider. Chapter 6 studies optimal sensitivity of NP couplings in the presence of SM background using numerical techniques. Finally, Chapter 7 provides a summary of the thesis and suggests potential future directions.