Abstract

Despite the Standard Model's ability to describe collider data from all experiments conducted around the world, several questions about the history of the Universe, including the hierarchy problem, the baryon asymmetry, and the dark matter density, remain open. To address these unresolved issues, the particle physics community agrees on the need to construct a next-generation collider that could probe the Standard Model with higher accuracy and potentially reveal deviations from the predictions of this fundamental theory. Future lepton colliders, operating at energies from the Z pole up to the multi-TeV scale, could probe the electroweak sector in various ways. In this thesis, the influence of radiative corrections on the modelling of electroweak processes is investigated.

The thesis first introduces the necessary concepts, including the construction of the Standard Model, future collider proposals and their physics capabilities, and Monte Carlo generators. It then examines three topics. First, a method to measure the electroweak couplings of light quarks is presented as an example showing how processes with photon radiation should be modelled for experimental analyses. Projected results for different facilities operating at the Z pole improve current precision by an order of magnitude. Second, the framework of collinear factorisation is introduced, and its application in the form of the Equivalent Vector Boson Approximation for multi-TeV collisions is re-evaluated. It is shown under what conditions the approximated framework provides a good description of the full process. Third, an extension of the factorised approach that resums large logarithmic contributions is introduced within the framework of Electroweak Parton Distribution Functions, together with its implementation in the Monte Carlo generator Whizard. Several examples are presented, suggesting that this approach may be a promising way to speed up computations and improve the precision of measurements at future colliders.