Study of Electroweak Interactions at the Energy Frontier

Conveners: A. Kotwal and D. Wackeroth

M. Baak, A. Blondel, A. Bodek, R. Caputo, T. Corbett, C. Degrande, O. Eboli, J. Erler, B. Feigl, A. Freitas, J. Gonzalez Fraile, M.C. Gonzalez-Garcia, J. Haller, J. Han, S. Heinemeyer, A. Hoecker, J. L. Holzbauer, S.-C. Han, B. Jäger, P. Janot, W. Killan, R. Kogler, P. Langacker, S. Li, L. Linssen, M. Marx, O. Mattelaer, J. Metcalfe, K. Mönig, G. Moortgat-Pick, M.-A. Pleier, C. Pollard, M. Ramsey-Musolf, M. Rauch, J. Reuter, J. Rojo, M. Rominsky, W. Sakumoto, M. Schott, C. Schwinn, M. Sekulla, J. Stelzer, E. Torrence, A. Vicini, G. Weiglein, G. Wilson, L. Zeune

Abstract

With the discovery of the Higgs boson, the spectrum of particles in the Standard Model (SM) is complete. It is more important than ever to perform precision measurements and to test for deviations from SM predictions in the electroweak sector. In this report, we investigate two themes in the arena of precision electroweak measurements: the electroweak precision observables (EWPOs) that test the particle content and couplings in the SM and the minimal supersymmetric SM, and the measurements involving multiple gauge bosons in the final state which provide unique probes of the basic tenets of electroweak symmetry breaking. Among the important EWPOs we focus our discussion on M_W and $\sin^2\theta_{eff}^i$ and on anomalous quartic gauge couplings probed by triboson production and vector boson scattering. We investigate the thresholds of precision that need to be achieved in order to be sensitive to new physics. We study the precision that can be achieved at various facilities on these observables. We discuss the calculational tools needed to predict SM rates and distributions in order to perform these measurements at the required precision. This report summarizes the work of the Energy Frontier Precision Study of Electroweak Interactions working group of the 2013 Community Summer Study (Snowmass).

1.1 Introduction

Particle physics research at the energy frontier has entered an exciting era: Experiments at the CERN Large Hadron Collider (LHC) are exploring the fabric of matter at an unprecedented level of precision and are expected to provide answers to some of the most fundamental questions in science. The recent discovery of a Higgs boson with SM-like properties at the LHC marks the beginning of an exciting journey with the goal to fully reveal the nature of the mechanism responsible for the generation of mass and its messenger, the Higgs boson. Besides the study of the Higgs boson at the LHC and future collider experiments, these experiments at the energy frontier strive to discover new particles and to gain new insights in the fundamental principles that govern all dynamics and properties of matter, i.e. beyond what is described by the Standard Model (SM) of particle physics.

The SM is a thoroughly tested framework for describing electromagnetic, weak and strong interactions of the fundamental constituents of matter, based on a symmetry principle and mathematically formulated as

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