During more than 10 years, from 1989 until 2000, the LEP accelerator and the four LEP experiments, ALEPH, DELPHI, L3 and OPAL, have taken data for a large amount of measurements at the frontier of particle physics. The main outcome is a thorough and successful test of the Standard Model of electroweak interactions. Mass and width of the Z and W bosons were measured precisely, as well as the Z and photon couplings to fermions and the couplings among gauge bosons.

The first part of this work will describe the most important physics results of the LEP experiments. Emphasis is put on the properties of the W boson, which was my main research field at LEP. Especially the precise determination of its mass and its couplings to the other gauge bosons will be described. Details on physics effects like Colour Reconnection and Bose-Einstein Correlations in W-pair events shall be discussed as well. A conclusive summary of the current electroweak measurements, including low-energy results, as the pillars of possible future findings will be given. The important contributions from Tevatron, like the measurement of the top quark and W mass, will round up the present day picture of electroweak particle physics.

In the Standard Model, the close relationship between W and Z masses and the electroweak couplings is a consequence of the Higgs mechanism and electroweak symmetry breaking. This mechanism provides gauge invariant mass terms for all known elementary particles. The spectrum of particles is however extended by a scalar Higgs boson which has not been observed, yet. At LEP and at the Tevatron collider, searches for this particle were up to now not successful. The hunt for the Standard Model Higgs boson is therefore one of the main activities at future experiments. A new era will begin with the operation of the LHC collider. The ATLAS and CMS experiments have the potential to discover the Higgs boson in all theoretically possible mass ranges.

The second part of this volume will introduce the expected electroweak measurements as well as Higgs searches at the LHC. The experimental tools of the ATLAS and CMS detectors for the various measurements are described. At the LHC, the mass of the W boson and of the top quark will be determined with even greater precision than today’s measurements. There is also the opportunity to improve the knowledge about the weak mixing angle and the triple gauge boson couplings.

One of the primary goals of the LHC experiments is the search for the Standard Model Higgs boson. The identification of the Higgs is summarised together with
the measurement of its fundamental properties like its spin and behaviour under CP transformation, which will possibly be subject of future research. Eventually, conclusions and an outlook to possible future findings at the LHC will be given.

The measurements and the knowledge about particle physics presented in this work reflect the status of Summer 2009. It is expected that there will be new, maybe surprising findings in the near future. The electroweak data will however remain the cornerstone of particle physics to which new theories always need to be compared to.

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