

Preface

Early in 2013, shortly after the beginning of the first long LHC shutdown and after the discovery of a Higgs-like particle, there seemed to be a common desire to take stock of the scientific harvest of Run 1 and to aim for a modest extrapolation into the future. It was clear from the start that such a summary could only be a snapshot—in spite of its size, inertia is small at CERN and discussions are moving fast at the LHC—and that most results presented would very quickly be “outdated” after their publication—at the latest once first results from Run 2 would start to appear.

We—the authors and the editor—therefore decided to take a slightly relaxed view, concentrating on the impact of the LHC for its main fields of investigation, on the most striking results of Run 1, and on the basic methods and techniques that were used to achieve the latter—methods and techniques that were independent of time and would still be in use for later data-taking periods. All this should be presented in a modestly pedagogical way, taking a slightly historical perspective (e.g. by comparing LHC achievements with results achieved previously at the Tevatron or elsewhere), and garnishing everything with the relevant references. We hoped that a few “text book” results could also be included, and time will show.

In short, we wanted to write a book that was comprehensive, easy and fun to read, and useful both for younger scientists with a wish to familiarise them with certain aspects of LHC physics and for more senior physicists who were looking for an overview on specific topics or for a rather complete set of references. It is now up to the reader to decide whether or not we succeeded with this ambitious goal.

The structure of the book is as follows: A first part, consisting of Chaps. 1–3, describes the basics of the LHC: The first chapter—“The Large Hadron Collider—Background and History”—discusses the motivation for and the genesis of the LHC project. It also sketches the history of proton–proton (or proton–antiproton) collider physics and the relevant predecessor machines and projects, and it gives an overview of the LHC financing and of the history of the experimental LHC collaborations. The second chapter—“A Journey to the Heart of the LHC”—presents the technical side of the LHC construction, commissioning and operation. The third chapter—“The LHC Detectors”—discusses the involved technologies and the performances of the main LHC experiments.

The following Chaps. 4–11 cover the main physics topics at the LHC, from the well-established (the electroweak Standard Model and QCD, Higgs physics, top, flavour and heavy-ion physics) to the more speculative (searches for supersymmetry and searches for other, more exotic physics beyond the Standard Model). The book concludes with an outlook chapter—“Perspectives on the Energy Frontier”—that tries to bundle the conclusions of all other chapters and to translate them into a look into the future of our field of high energy physics.

A few technical remarks: We tried to be as consistent in the notation throughout the whole book as possible—failure to achieve this is entirely due to the editor, as are all other shortcomings and mistakes that might have escaped the editing and proofreading process (please send any errors you find to thomas.schoerner@desy.de). Sticking to the guidelines set by the LHC experimental collaborations, and in order to prepare a book which presents final results that will not be obsolete tomorrow, we decided to only use published and publicly available results as references. This rule has only been violated in very few, well-motivated places, e.g. in cases where journal publications do not exist and are also not foreseen. Throughout the book, the convention $\hbar = c = 1$ is used.

Writing a book like the present one is a major challenge, and it involves the engagement and goodwill of many people who deserve deepest appreciation and gratefulness. First and foremost, I would like to thank all authors who—despite their numerous other demanding commitments and responsibilities—have shown great enthusiasm and a strong will to endure the inconveniences imposed upon them by their editor until the end of the project. The editor is in particular indebted to the following persons for their support, information and critical comments (in alphabetical order): Eckhard Elsen, Lyn Evans, Peter Jenni, Burton Richter, Herwig Schopper, Volker Sörgel, Florian Sonnemann. Then, of course, a lot of technical and organisational support is required. I would specifically like to thank Claus Ascheron from Springer Publishing for his readiness to constantly answer questions. Ian Brock (Bonn University) provided his LaTeX framework, which has served me extremely well for the third book project in a row. Thanks Ian! I am very grateful for Kati Brock’s superb work on the layout and style of the figures—Kati, thanks a lot for our by now well-established cooperation! A very warm “thank you” goes to Jorge Cham for his intriguing title picture. I finally would like to thank my family for their endurance during the final editing of the book, which did not always perfectly match our family agenda.

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Harvest of Run 1

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