

# Introduction

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This document is a collection of contributions to the series of workshops, having taken place during the years 2006 – 2008 at CERN and DESY, on aspects of heavy quark physics relevant at the transition from the HERA to the LHC eras of experimentation. In three sections we review recent experimental results from HERA, describe the plans for coming analyses at the LHC and collect various reports about new results from theoretical work. The present report extends the proceedings of a previous workshop which are available online <sup>1</sup> and contain also a general theoretical review of various approaches in heavy quark production to which we refer for further reference.

The first section below reviews recent measurements of charm and beauty production in  $ep$  collisions at HERA. Heavy quark tagging methods used by the ZEUS and H1 experiments are described. Cross section results in both photoproduction and deep inelastic scattering are compared with NLO QCD predictions. In general the data are well described by the calculations. Studies of charm fragmentation yield compatibility with the assumption of universality at large transverse momenta, but illustrate some problems with this assumption in the threshold region. The DIS cross sections receive large contributions from the charm and beauty content of the proton,  $F_2^{c\bar{c}}$  and  $F_2^{b\bar{b}}$ . The corresponding most recent measurements are compared to next-to-leading order QCD predictions using different parameterisations of the theory, and of the gluon density in the proton.

The tests of the fragmentation function, the gluon density, and details of the theoretical treatment of the charm and beauty masses performed on the basis of HERA experimental data are of direct interest to corresponding applications at the LHC. In section two, after reviewing the main heavy flavour results from experiments at the Relativistic Heavy Ion Collider (RHIC), we present the expected performance for some of the most significant measurements in the heavy flavour sector at the Large Hadron Collider (LHC), for the experiments ALICE, ATLAS, and CMS.

A proper inclusion of heavy quark mass effects in parton distribution function fits has proved crucial. In the theory part of this document, we present a review of these effects in DIS and their impact on global analyses and lay out all elements of a properly defined general mass variable flavor number scheme (GM VFNS) that are shared by all modern formulations of the problem. We also report about progress in a number of theoretical problems related to exclusive measurements of heavy flavors. These topics include fragmentation functions for charmed mesons including finite mass effects, fragmentation functions including non-perturbative corrections based on an effective QCD coupling, a discussion of the status of higher-order calculations for top quark production and for polarized structure functions, heavy quark and quarkonium production in the Regge limit, double heavy baryon production, tests of time reversal and CP symmetry in  $\Lambda_b$  decays, as well as a study of the general properties of massive exotic hadrons that will be relevant for an understanding of their detection at the LHC.

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<sup>1</sup><http://www.desy.de/~heralhc/proceedings/proceedings.html>

