Preface

CP violation is introduced in the Standard Model through the Cabibbo–Kobayashi–Maskawa mechanism (CKM) which requires that all *CP* violating phenomena originate from the same complex phase in the CKM quark-mixing matrix. The unitary constraint on the CKM matrix results in relations on its elements which can be conveniently represented as sums of complex numbers: the most important relation for *B*-physics defines a triangle (Unitary Triangle) on the complex plane, whose area is proportional to the amount of *CP* violation introduced by the CKM mechanism. An independent measure of the sides and the angles α, β, and γ of the Unitary Triangle is therefore crucial to test the validity of the Standard Model. At present, the CKM angles α and β are measured with good (<5 %) accuracy, while the best value of γ is still affected by a large experimental uncertainty. The LHCb experiment is expected to improve considerably the error on γ due to the large datasets it expects to collect.

The LHCb detector is a single-arm spectrometer situated on the Large Hadron Collider at CERN. It is optimised to select and reconstruct the *b* and *c* hadrons produced in high energy *pp* collisions, in order to study *CP*-violating processes and rare decays with unprecedented precision.

This thesis focuses its attention on the measurement of *CP* violation in $B^{\pm} \to D\,h^{\pm}$ decays, which can be used to determine the CKM phase γ at tree level. Charged $B \to DK$ and $B \to D\pi$ decays are reconstructed with the *D* meson decaying into a final state accessible by both D^0 and $\bar{D}^0$ flavour eigenstates: the resulting charge asymmetries and branching fraction ratios are directly related to and can be used in its extraction. The *D* intermediate state is reconstructed here into two-body charged final states: $K^{\pm}\pi^{\mp}, K^{+}K^{-}, \pi^{+}\pi^{-}$ and $\pi^{\pm}K^{\mp}$.

This thesis presents the most recent version of the analysis and it uses the full 2011 LHCb dataset of 1.0 fb^{-1}. The author has been responsible for the analysis from its early stages. The analysis has evolved considerably with time, from the very first attempts to reconstruct the favoured $B \to [K\pi]_{D}\pi$ mode in Spring 2010 to the full simultaneous strategy described in this document. The key milestones of the analysis are summarised here:

- Winter 2010
  The first branching fraction and asymmetry measurements are based on the 35.7 pb^{-1} collected in 2010 by the LHCb detector. A preliminary measurement of the ratio of branching fractions $\mathcal{B}(B^{\pm} \to DK^{\pm})/\mathcal{B}(B^{\pm} \to D\pi^{\pm})$ for the most abundant $D \to K\pi$, KK modes has been presented to the 2010 winter conferences [LHCb-CONF-2011-031].
- Summer 2011
  The first attempt to observe the suppressed $B \to [\pi K]_D K$ peak is based on the 342.7 pb^{-1} collected in the first half of 2011. This result is preliminary. The suppressed $B \to D\pi$ mode is confirmed and evidence for the suppressed $B \to DK$ mode is seen with a significance of 4.0 [LHCb-CONF-2011-044]. A background was missed from this preliminary analysis.
- Winter 2011
  A full simultaneous approach is adopted for the full 2011 dataset. The suppressed $B \to DK$ mode is observed with a significance $>10\sigma$. This is the analysis presented in this thesis and it has been published in [Phys.Lett.B712 (2012) 203].

This thesis is divided into six chapters:

- Chapter 1 provides the theoretical framework used to describe CP violation in the Standard Model (SM). After a brief overview on the CKM matrix and its parameterisations, a detailed description of the tree-level determination of the CKM angle γ using $B \to DK$ decays is given. The formalism used in the rest of the thesis is derived here.
- Chapter 2 gives a short overview of the LHCb detector, the experimental apparatus used to perform the analysis described in this thesis.
- Chapter 3 describes the selection strategies developed for the analysis. Signal candidates are selected exploiting the topology of the decays of interest. As LHCb is a high background environment, the choice of a high performance selection is crucial to ensure an adequate signal efficiency and background rejection. The selection is tuned in order to maximise the significance of the suppressed $B \to DK$ peak, with the goal of its observation.
- Chapter 4 includes a detailed background description for all the signal modes considered. Background studies are performed using both simulated events and, where possible, data. Extra care is taken in describing peaking backgrounds coming from charmless modes and internal cross feed. All the PDFs used in the fit to the CP observables are described here.

- Chapter 5 presents a detailed description of the simultaneous maximum likelihood fit used in the extraction of the *CP* physics observables. The fitter is designed to consider all the different signal modes at the same time and take advantage of a large set of parameters in common. This chapter concludes with a detailed study of the systematic uncertainties on the measured quantities.
- Chapter 6 summarises the numerical results of the fit to data, including a comparison with the existing results and a preliminary fit to the CKM phase γ.

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