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B meson decays into neutral kaons in the LHCb experiment

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Summary. — In what follows we report the first steps of the search in the LHCb experiment for the decays of B_d and B_s mesons into $K_s K^*(892)$ final state which have not yet been observed before, aiming at a branching ratio measurement relative to the well established $B^0 \to K_s \pi^+\pi^-$ mode.

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1. – Introduction

The study of B decays into double neutral kaons is a fertile ground in the search for new physics. These pure penguin decays allow for measurements of CP violation which are sensitive probe for phases from non-standard model physics.

The LHCb experiment has an exciting potential for B physics studies due to its excellent charateristics. It is a single arm forward spectrometer optimized for precision studies on CP violation and rare decays of hadrons containing b quarks. A high precision vertex locator (VELO) enables efficient detection of displaced vertices. Together with a spectromer consisting of a dipole magnet and a tracking system this leads to an excellent momentum resolution. Two ring imaging Cherenkov detectors (RICH) provide highly efficient particle identification for decays into charged hadrons.

This paper presents a search for the $B^0_{d,s} \to K^0_s(\pi^+\pi^-)K^*(892)(K^\pm\pi^\pm)$ decays using 2011 data from pp collisions at a centre-of-mass energy of $\sqrt{s} = 7\,\text{TeV}$ with the LHCb detector. This study aims at a branching fraction measumerement relative to the $B^0 \to K^0_s\pi^+\pi^-$ decay, already well measured by the B-factories [1,2]. Monte Carlo (MC) events from LHCb full event and detector simulation have been used for signal and background studies and to estimate reconstruction and selection efficiencies.

2. – Analysis

The purpose of the analysis is the measurement of the following branching ratio:

$$\frac{\mathcal{B}(B^0_{d,s} \to K^0_s K^{*0})}{\mathcal{B}(B^0_d \to K^0_s \pi^+\pi^-)} = \frac{\epsilon^{sel}_{B^0_d \to K^0_s\pi^+\pi^-}}{\epsilon^{sel}_{B^0_{d,s} \to K^0_s K^{*0}}} \frac{N_{B^0_{d,s} \to K^0_s K^{*0}}}{N_{B^0_d \to K^0_s\pi^+\pi^-}} \frac{f_d}{f_{d,s}}, \tag{1}$$

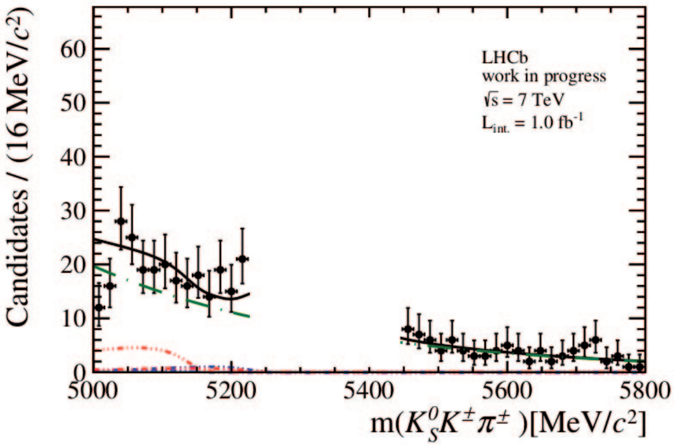

Fig. 1. – $K_S K\pi$ spectrum. The 2011 data are described by the points. Each component of the fit model is displayed on the plot.

where N is the number of signal candidates, ϵ is the total efficiency for signal decay including acceptance, reconstruction, selection and trigger and $f_{d,s}$ is fragmentation fraction of a b quark into $B^0_{d,s}$ mesons. The analysis is blind in order to not introduce any bias since these decays have not yet seen before.

2˙1. *Selection.* – The selection aims to suppress different sources of background. A veto has been applied to reduce peaking background coming from $b \to c$ transitions with the very same final state. Particle identification requirements on the daughter tracks strongly suppress any background involving particle misidentification.

Finally a selection based on a multivariate discriminant has been placed in order to reduce the combinatorial background from random combinations of pions and kaons which form a good vertex and have an invariant mass in the accepted range. The discriminant is based on a Boosted Decision Tree [3] (BDT) build with vertex reconstruction quality variables, pointing estimators and lifetime observables. The BDT has been trained using MC signal samples and data from the right sideband of the control channel. The cut value on the BDT has finally been chosen optimising the Punzi figure of merit [4].

2˙2. *Fit model.* – The number of signal candidates will be extracted with an unbinned maximum likelihood fit to the B spectrum. Figure 1 displays the blind fit result of the selected $K_s K\pi$ spectra. The overall fit is represented by the black line. In particular, combinatorial background (green) is described by an exponential and partially reconstructed backgrounds are dominated by charmed transitions (red). After the unblinding procedure we expect to see 35 and 115 events for the B_d and B_s mesons respectively.

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