Search for Wrong-Sign $D^0 \longrightarrow K^+\pi^-\pi^0$ decay at Belle II

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Abstract

In the standard model, mixing and CP violation in the charm sector are expected to be very small, and thus they constitute a sensitive probe for potential new physics contributions. The "wrong-sign" $D^0 \to K^+\pi^-\pi^0$ decay is one of the most promising channels at Belle II, as this can be produced through two interfering processes: a direct doubly Cabibbo-suppressed decay of the D^0 meson, or through D^0-$\bar{D}^0$ mixing followed by a Cabibbo-favored decay of the $\bar{D}^0$ meson.

In this work, we report the WS-to-RS ratio of the "wrong-sign" $D^0 \to K^+\pi^-\pi^0$ decay in the simulation of the integrated luminosity of 1ab^{-1} at Belle II. The Belle II is the upgraded experimental facility at SuperKEKB, KEK, Japan. This study will be used to measure the mixing and CP Violation of the "wrong-sign" $D^0 \to K^+\pi^-\pi^0$ decay.

1 Introduction

Neutral charm mesons can change their flavor and turn into anti-mesons, and vice versa, before they decay. This phenomenon, known as flavor oscillation or D^0-$\bar{D}^0$ mixing [1]. The "wrong-sign" (WS) decay $D^{*+} \rightarrow D^0\pi^+$ with $D^0 \rightarrow K^+\pi^-\pi^0$ is the best channel, arise from the direct doubly Cabibbo-suppressed $D^0 \rightarrow K^+\pi^-\pi^0$ transition and from the Cabibbo-favored $D^0 \rightarrow K^-\pi^+\pi^0$ decay that follows D^0-$\bar{D}^0$ oscillation. Measuring the decay-time-dependent rate of wrong-sign decays allows us to separate the two processes and measure the mixing rate [2]. In this work, a detailed background study is performed, and develop a fit strategy for $D^0 \rightarrow K^+\pi^-\pi^0$ decay to determine signal yield at Belle II. The Belle II [2] is the upgraded experimental facility at SuperKEKB [3], KEK, Japan.

2 Reconstruction of $D^0 \rightarrow K^+\pi^-\pi^0$

The analysis uses $D^{*+} \rightarrow D^0(\rightarrow K^+\pi^-\pi^0)\pi^+$ candidates, which are reconstructed in the simulation of the integrated luminosity of 1 ab^{-1}. The $D^0 \rightarrow K^+\pi^-\pi^0$ candidates are reconstructed using charged kaon, and pion has at least one hit in SVD and 20 hits in CDC, combined with $\pi^0 \rightarrow \gamma\gamma$, satisfying the range [0.12, 0.145] GeV/c^2. The D^0 thus reconstructed is combined with low momentum pions and has at least one hit in CDC to form $D^{*+} \rightarrow D^0\pi^+$ decay. The criteria on the center of mass momentum of D^{*+} is applied to be greater than 2.5 GeV/c to remove the D^0 meson from B decays.

3 Results

All the background components are identified for $D^0 \rightarrow K^+\pi^-\pi^0$, and a two-dimensional binned fit ($m(D^0)$, $m(D^0\pi^+)$) is performed to determine the signal yield, where $m(D^0\pi^+)$ is the mass of the D^* but with no mass hypothesis on the D^0 daughters [4]. The Probability Density Function (PDF) for signal component corresponding to $m(D^0)$ and $m(D^0\pi^+)$ are Double Gaussian and Johnson[5]. The fit results of $m(D^0)$ and $m(D^0\pi^+)$ distribution for WS sample are reported in Figure 1. All fit parameters are fixed to the values obtained from separate fits to all signal and background components. The measured signal Yield is 11116 ± 200.

4 Summary

Reconstruction of $D^0 \rightarrow K^+\pi^-\pi^0$ decay is performed in simulation. All the background components are identified and separated from the signal. The signal Yield for $D^0 \rightarrow K^+\pi^-\pi^0$ is measured to be 11116 ± 200.

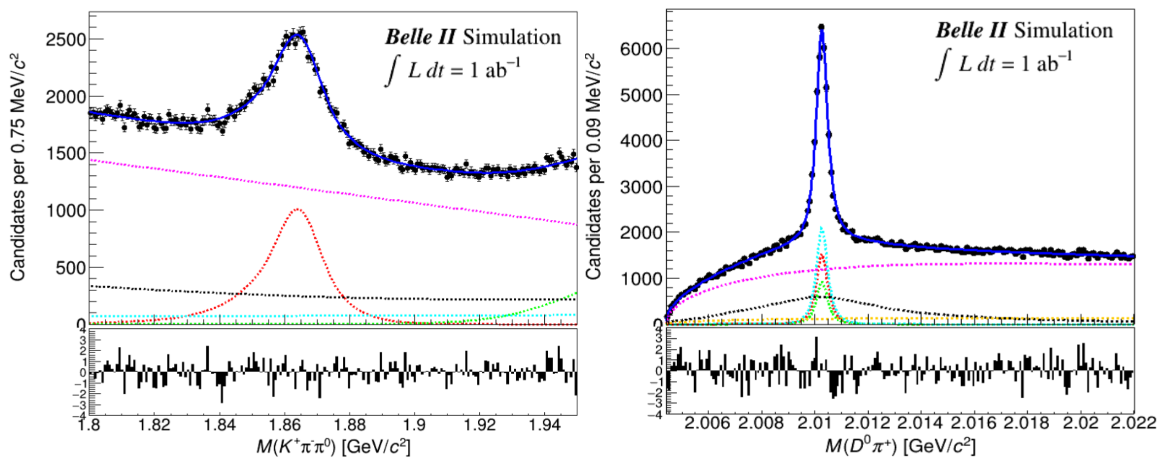

Figure 1: Distribution of $m(D^0)$ (left) and $m(D^0\pi^+)$ (right) for WS $D^0 \to K^+\pi^-\pi^0$ candidates reconstructed in simulation, with fit projections overlaid. The projection of the signal and backgrounds are shown in different colors: signal (red), Signal + random pion (orange), singly misidentified (green), multibody (black), and combinatorial backgrounds (magenta).

References

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