Measurements of the ratio of partial widths: $\Gamma(D_s^{*+} \to D_s^+\pi^0)/\Gamma(D_s^{*+} \to D_s^+\gamma)$

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Abstract

We demonstrate the feasibility studies to measure the ratio of partial widths $\Gamma(D_s^{*+} \to D_s^+\pi^0)/\Gamma(D_s^{*+} \to D_s^+\gamma)$ with the Belle II detector.

1 Introduction

The exited strange charmed meson, $D_s^{*+}(c\bar{s})$, decays dominantly through its radiative decay process $D_s^{*+} \to D_s^+\gamma$ and kinematically through $D_s^{*+} \to D_s^+\pi^0$ decay mode which violates isospin symmetry. Many theoretical models predicted the decay width of $D_s^{*+} \to D_s^+\gamma$ and $D_s^{*+} \to D_s^+\pi^0$, but precise experimental measurements of these decay widths are very important to explore QCD and constraint the parameters of theoretical models. Previously, branching fraction of $D_s^{*+} \to D_s^+\pi^0$ with respect to $D_s^{*+} \to D_s^+\gamma$ have been measured by CLEO [1], BABAR [2] and BESIII [3] experiments.

Belle II detector [4], situated at KEK laboratories, Japan is a hybrid detector designed for the SuperKEKB [5] accelerator to perform precision measurements and to look for new physics. Good vertex resolution, improved $K\pi$ separation, better performance with neutral particles and higher statistics in Belle II provides us an opportunity to precisely measure these branching fractions and improve the existing results.

2 Results with Monte Carlo samples

For this study, we use two decay modes of D_s^+: $D_s^+ \to \phi\pi^+$ and $D_s^+ \to \bar{K}^{*0}K^+$.
$\mathcal{B}(D_s^{*+} \to D_s^+\pi^0)/\mathcal{B}(D_s^{*+} \to D_s^+\gamma)$ is calculated as

$$\frac{\mathcal{B}(D_s^{*+} \to D_s^+\pi^0)}{\mathcal{B}(D_s^{*+} \to D_s^+\gamma)} = \frac{N(D_s^{*+} \to D_s^+\pi^0)}{N(D_s^{*+} \to D_s^+\gamma)} \times \frac{\epsilon(D_s^{*+} \to D_s^+\gamma)}{\epsilon(D_s^{*+} \to D_s^+\pi^0)}$$

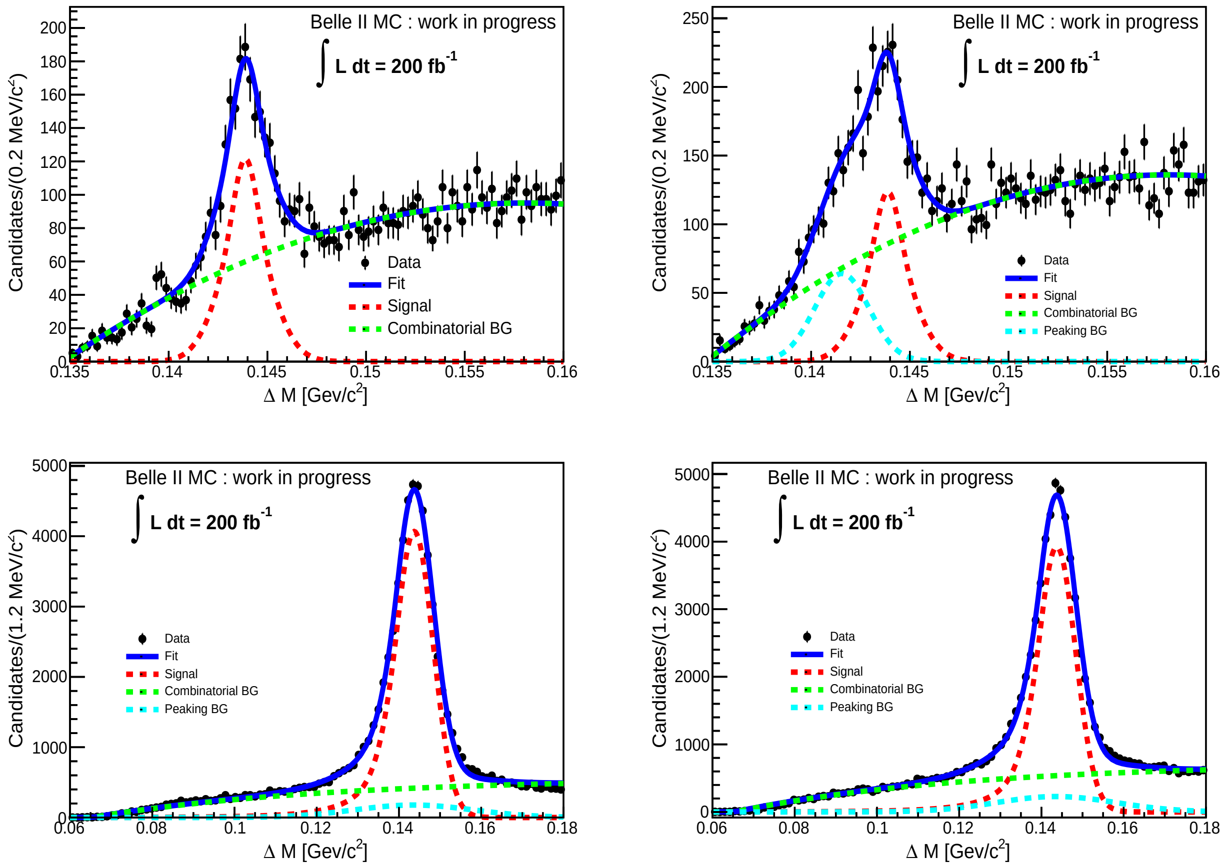

Figure 1: Simultaneous fitting of ΔM distributions. Upper plots shows ΔM distributions for (a) $D_s^{*+} \to D_s^+(\phi\pi^+)\pi^0$ and (b) $D_s^{*+} \to D_s^+(K^+\bar{K}^{*0})\pi^0$ decay channels. Lower plots shows ΔM distributions for (c) $D_s^{*+} \to D_s^+(\phi\pi^+)\gamma$ and (d) $D_s^{*+} \to D_s^+(K^+\bar{K}^{*0})\gamma$ decay channels

Signal yields, for $D_s^{*+} \to D_s^+\pi^0$ and $D_s^{*+} \to D_s^+\gamma$, are extracted by simultaneous fitting of ΔM distributions for two decay modes D_s^+ as shown in Figure 1. Signal selection efficiencies are calculated using signal events.

From simulations,

$$\frac{\mathcal{B}(D_s^{*+} \to D_s^+\pi^0)}{\mathcal{B}(D_s^{*+} \to D_s^+\gamma)} = 0.063 \pm 0.003$$

Results obtained from the simultaneous fitting of simulations are consistent with the expectation from Monte Carlo and there is about a 40% reduction in statistical uncertainty as compared with previous measurements. This feasibility study gives confidence in the Belle II simulations and reconstruction methodology. Stay tuned for the measurement of the partial width ratio with Belle II data.

References

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