Study of photon energy bias using $\pi^0 \longrightarrow \gamma\gamma$ decays from $D^{*+} \longrightarrow D^0(\longrightarrow K^-\pi^+\pi^0)\pi^+$ at Belle II

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Abstract

Photon energy bias is used to compute the corrections to the reconstructed photon energy and improve data-simulation agreement in analyses having final states with photons.

In this study, we reconstruct clean samples of $\pi^0 \rightarrow \gamma\gamma$ decay from the $D^{*+} \rightarrow D^0(\rightarrow K^-\pi^+\pi^0)\pi^+$ decay chain in both simulation and data collected by Belle II experiment. The Belle II is the upgraded experimental facility at SuperKEKB, KEK, Japan. We present the comparison of mean π^0 mass and π^0 mass resolution in data recorded at 207 fb^{-1} as well as in simulation in different bins of photon energy.

1 Introduction

The Key feature of the Belle II experiment [1] is to achieve an improved performance of reconstructed photon and neutral pion compared to the previous generation B-Factory experiments. The Belle II [1] is the upgraded experimental facility at SuperKEKB [2], KEK, Japan. The High-performance photon and π^0 reconstruction is a central component of the various analyses planned at Belle II [1]. Photon energy bias is used to compute the corrections to the reconstructed photon energy and improve data simulation agreement in analyses having final states with photons. The goal of this work is to determine the data-simulation differences resulting from biases in the measurement of photon energies using $\pi^0 \to \gamma\gamma$ decay from $D^{*+} \to D^0(\to K^-\pi^+\pi^0)\pi^+$ decay chain at Belle II [3].

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

The analysis uses $D^{*+} \to D^0(\to K^-\pi^+\pi^0)\pi^+$ candidates, which are reconstructed in both data and simulation. The two photons are ordered by polar angle, with the leading photon (γ_1) corresponding to the one with a larger polar angle, and are combined to form $\pi^0 \to \gamma\gamma$ decay. The two photons are required to have energies within 5%, which is defined by relative difference $|[E(\gamma_1) - E(\gamma_2)]/E(\gamma_1)| < 0.05$. This selection criteria is used to account for the shift in the π^0 mass position to a bias in the reconstruction of the photon energy [4]. Further, candidates with π^0 masses in the range $[0.08, 0.2]$ GeV/c^2 are combined with two oppositely charged tracks to form $D^0 \to K^-\pi^+\pi^0$ candidates. The criteria on signal region of $m(D^0)$ $[1.84, 1.88]$ GeV/c^2 and difference between the D^{*+} and D^0 masses, Δm $[0.1445, 0.1465]$ GeV/c^2 are used to select the π^0 candidates. For detailed selection criteria, one can refer [3].

3 Results

Unbinned maximum-likelihood fits to the π^0-mass distributions in both data and simulation are used to determine the variation of the π^0-mass peak position and width as a function of leading photon energy as shown in Figure 1. In each fit of π^0-mass distributions, the signal component is described by a Gaussian distribution and the background component by an exponential distribution.

4 Summary

The ratio of data simulation for both the π^0-mass peak and π^0-mass width are obtained in different bins of the leading photon energy. The results are observed within the $\approx 1\%$ from unity. This study has improved data-simulation agreement in analyses having final states with photons by correcting the reconstructed photon energy.

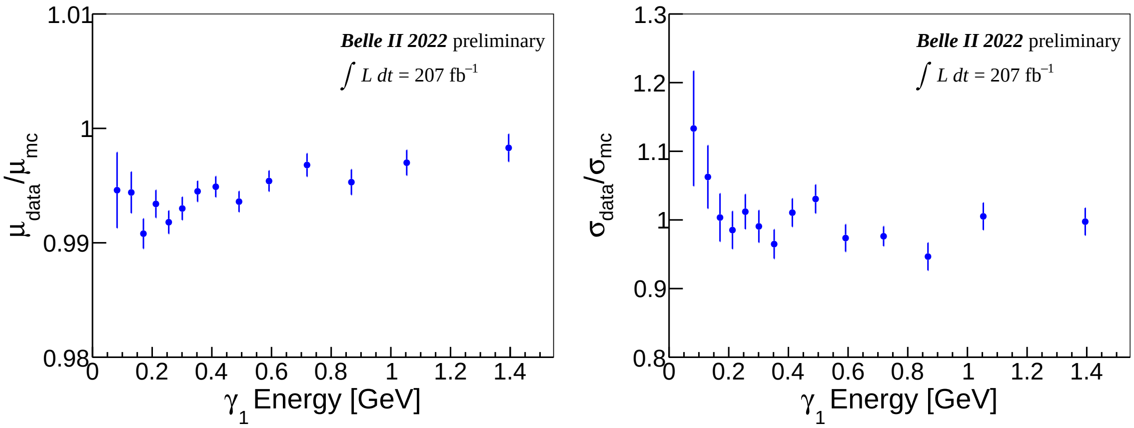

Figure 1: Variation of the data/simulation ratios of mean π^0 mass μ (left) and π^0-mass resolution σ (right) for $D^{*+} \to D^0(\to K^-\pi^+\pi^0)\pi^+$ candidates as a function of leading photon energy for all candidates.

References

1. Altmannshofer W et al. The Belle II Physics Book. 2018. Ed. by Kou E and Urquijo P.

2. Akai K, Furukawa K, and Koiso H. SuperKEKB Collider. Nucl. Instrum. Meth. 2018;A907:188–99.

3. Study of photon energy bias using $\pi^0 \longrightarrow \gamma\gamma$ decay. BELLE2-NOTE-PL-2022-002.

4. Tamponi U. Study of the η meson transitions from $\Upsilon(4S)$ and $\Upsilon(5S)$ with the Belle Experiment. inspirehep 2014;2014.