Approved plots of R_2 distribution in Early Phase 3 Data

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Abstract

We present the approved plots of the event shape variable R_2 represented by the ratio of the second and zeroth Fox-Wolfram moment. The variable R_2 is a good indicator to understand if the collision data of the SuperKEKB are occurring at the $\Upsilon(4S)$ resonance. The study on the shape variable R_2 is used to derive the total number of produced $B\bar{B}$ pairs and is summarized in the physics note BELLE2-NOTE-PH-2019-025.

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1. R_2 DEFINITION AND PLOT

The Fox-Wolfram moments H_l, $l = 0, 1, 2, ...$ are defined by

$$H_l = \sum_{i,j} \frac{|P_i||P_j|}{E_j^{vis}} P_l(cos\theta_{ij}) \tag{1}$$

where θ_{ij} is the opening angle between charged tracks or photons i and j, E_{vis} is the total visible energy of the event, P_l are the Legendre polynomials and $|P_i|$ and $|P_j|$ are the momenta of the charged tracks or photons. R_2 is defined as the ratio of the second and zeroth moment, H_2/H_0.

Results presented here are obtained with Phase 3 data collected in 2019 corresponding to the following run numbers and luminosities:

- bucket 4, $\Upsilon(4S)$: runs 1135-1155, 1375-1587 (integrated luminosity: 69 pb^{-1})

- bucket 6, $\Upsilon(4S)$: runs 3128-3847 (integrated luminosity: 344 pb^{-1})

- exp 7, off-resonance: runs 1705-1835 (integrated luminosity: not estimated at the time of this analysis)

for a total luminosity of 413 pb^{-1} (rounded to 410 pb^{-1}) on-peak. On-peak data have been reprocessed and calibrated, the used global tags are data_reprocessing_prompt_bucket4b and data_reprocessing_prompt_bucket6b for the two buckets.
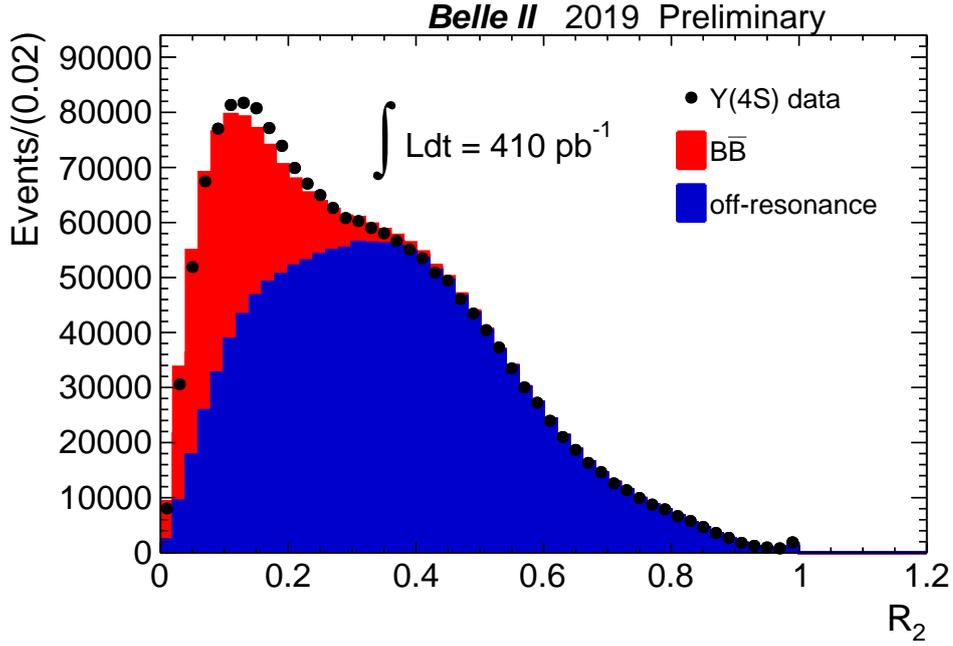
FIG. 1: R_2 distribution for $\Upsilon(4S)$ data, $B\bar{B}$ MC simulation and off-resonance data. The event selection requires at least three tracks and two clusters in the event, with transverse momentum greater than 100 MeV and cluster energy greater than 100 MeV, respectively. Additional requirements on tracks, clusters and event variables are described in detail in the note BELLE2-NOTE-PH-2019-025. The overall selection efficiency on the $B\bar{B}$ sample is 98.8%. The MC and off-resonance contributions are normalized to the yields obtained from a template fit to this variable.