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.
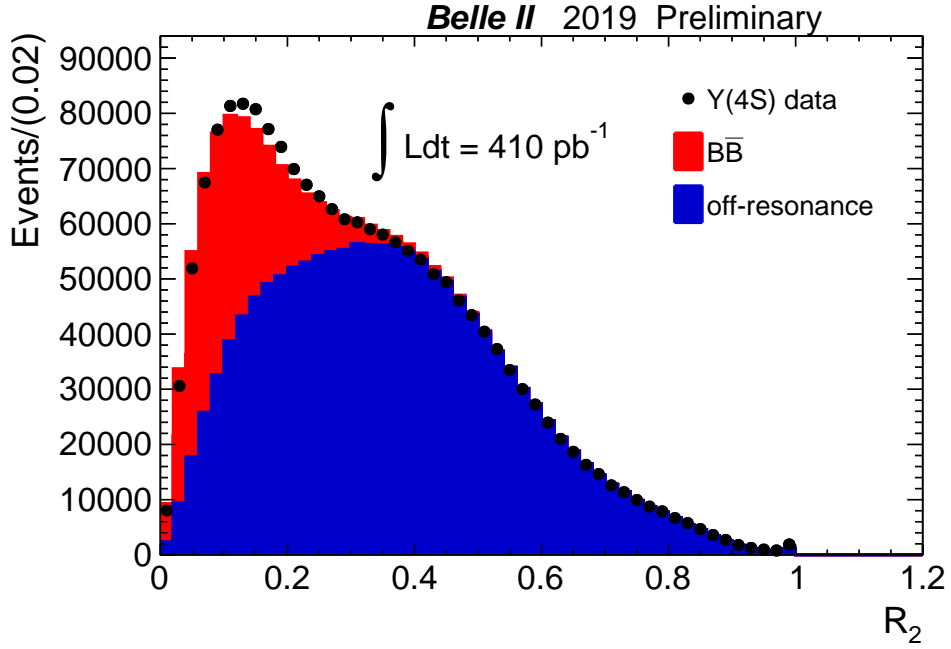
FIG. 1: R_2 distribution for $\Upsilon(4S)$ data, $B\overline{B}$ MC simulation and off-resonance data. The event selection requires at least three tracks and two clusters in the event, with transverse momentum greater than 100 MeV/c and cluster energy greater than 100 MeV, respectively. Additional requirements on tracks, clusters and event variables are described in detail in the note BELLE2-NOTE-PH-2019-025. The overall selection efficiency on the $B\overline{B}$ sample is 98.8%. The MC and off-resonance contributions are normalized to the yields obtained from a template fit to this variable.