BELLE2-NOTE-PL-2020-026
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Inclusive $B \to X_u e \nu_e$ endpoint analysis: Approved plots for ICHEP2020

The Belle II Collaboration

Abstract

This note contains the approved plots associated with the note BELLE2-NOTE-PH-2019-013. This is an untagged analysis of $B \to X_u e \nu_e$ inclusive decay in Phase 3 data, with the initial aim of rediscovering the charmless B-meson decays using the Belle II detector. The used well-known inclusive technique examines the endpoint region of the inclusive charged-lepton center-of-mass momentum distribution to seek evidence for CKM-suppressed $B \to X_u e\nu$ processes in a space where $B \to X_c e\nu$ background channels are kinematically disfavoured. The full ICHEP dataset was used. The resulting plots of the fit to the off-resonance data to estimate the continuum contributions, and of the excess in data in the electron spectrum in the $B \to X e\nu$ endpoint region are shown. The excess is consistent with that from $B \to X_u e\nu$ decay.

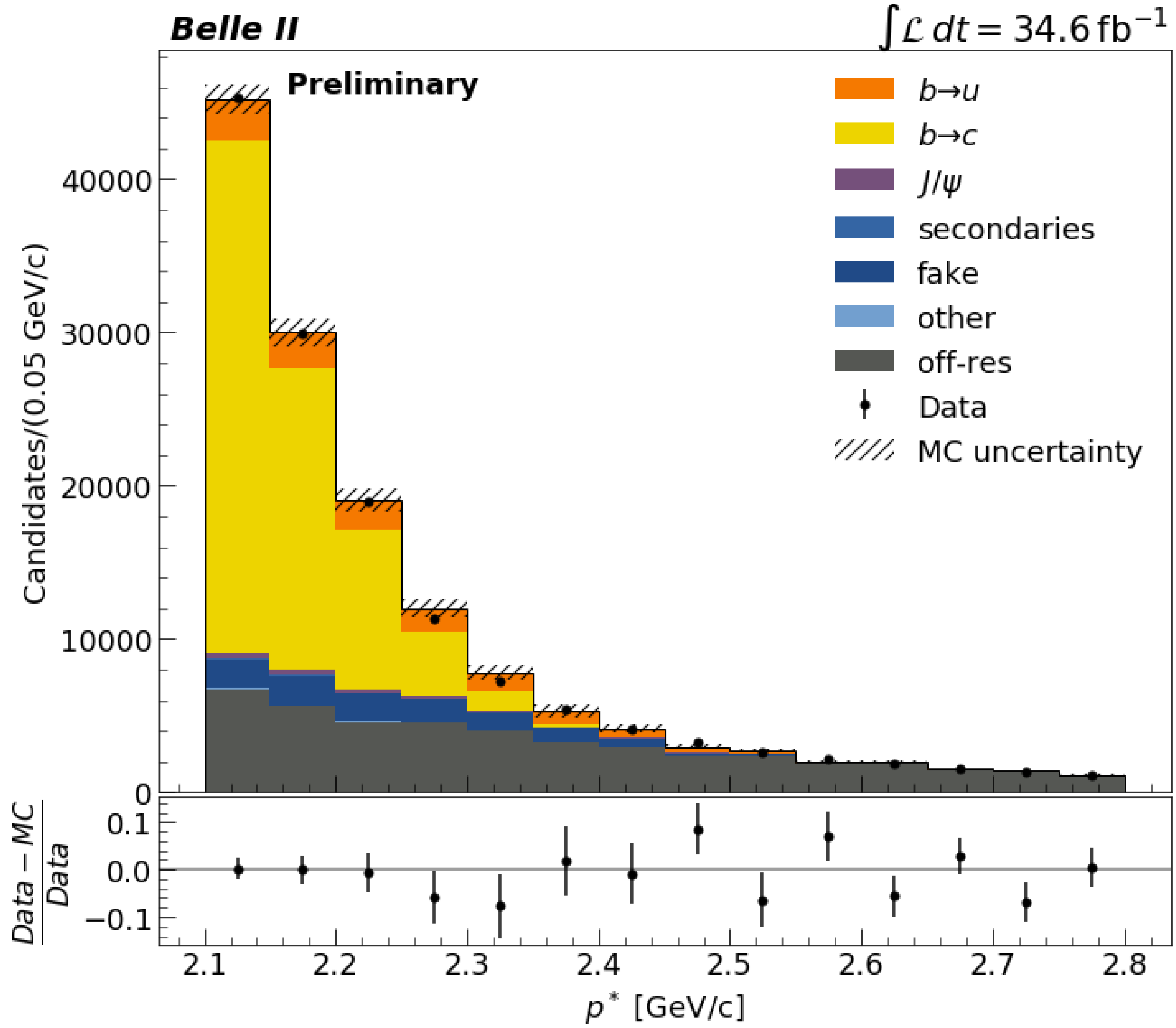

FIG. 1: Data/MC comparison in the electron center-of-mass momentum endpoint region. The $B\bar{B}$ Monte Carlo contribution was divided as follows: $b \to u$ – electron candidates from true $B \to X_u e\bar{\nu}_e$ decays; $b \to c$ – electron candidates from true $B \to X_c e\bar{\nu}_e$ decays; J/ψ – electron candidates from a J/ψ meson decay; *secondaries* – other electron candidates which are not coming from a B-meson decay; *fake* – electron candidates that are not true electrons; *other* – candidates not belonging to any previous category. The signal $b \to u$ MC was constructed using a 'hybrid' approach, combining simulated exclusive and inclusive $B \to X_u e\bar{\nu}_e$ final states into a single prediction. Off-resonance data was used to estimate the continuum background. The hashed MC uncertainty combines statistical uncertainty and systematics from $B \to X_u e\bar{\nu}_e$, $B \to De\bar{\nu}_e$, $B \to D^* e\bar{\nu}_e$, $B \to D^{**} e\bar{\nu}_e$ and other $B \to X_c e\bar{\nu}_e$ branching fraction uncertainties, and PID systematic uncertainty.

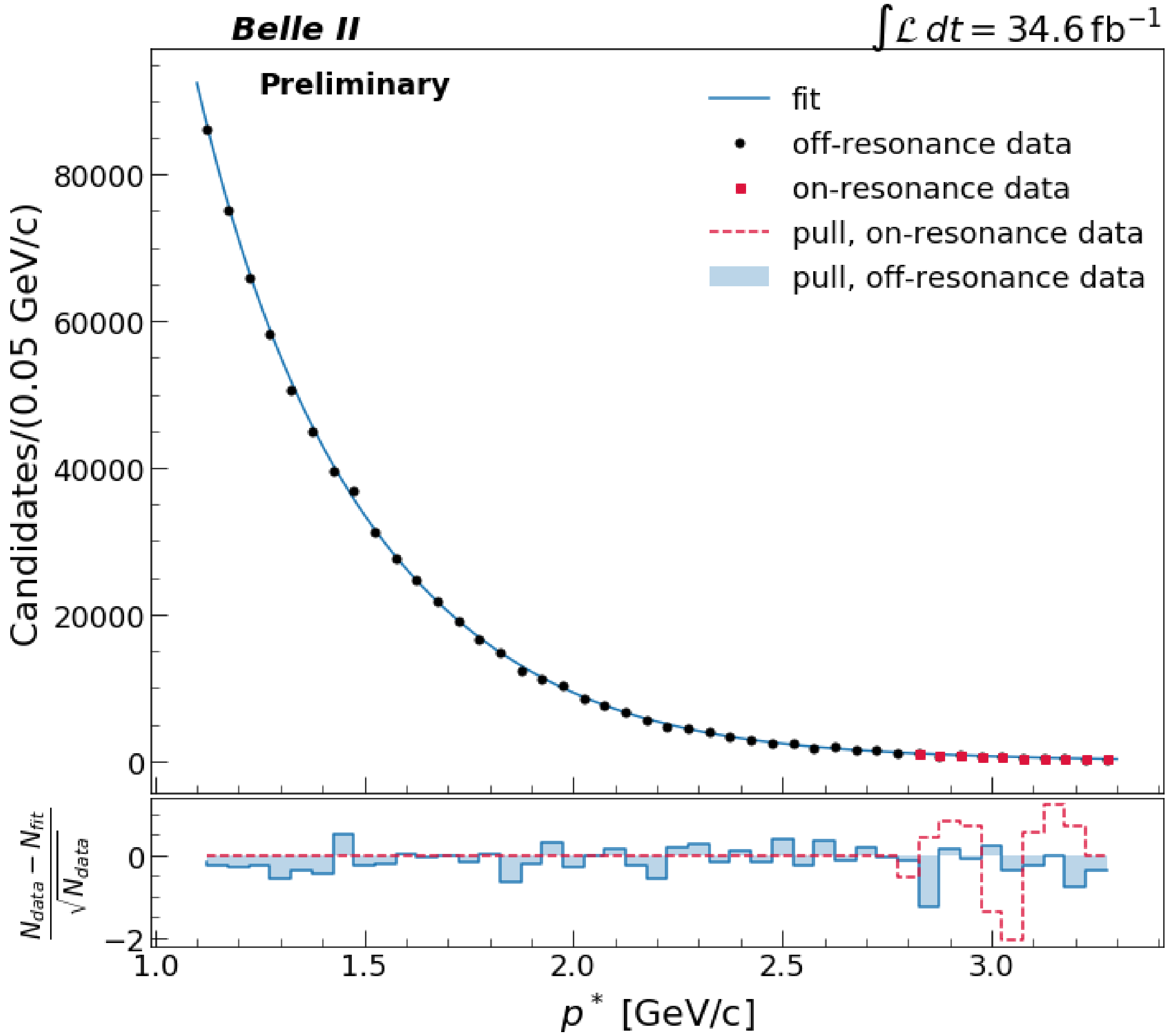

FIG. 2: Binned χ^2 fit to the electron center-of-mass momentum was performed on the off-resonance data in the region [1.1, 3.3] GeV/c and on-resonance data in the region [2.8, 3.3] GeV/c to estimate the continuum distribution. The lower panel shows the pull of the off-resonance data (blue) and of the on-resonance data (dashed red line).

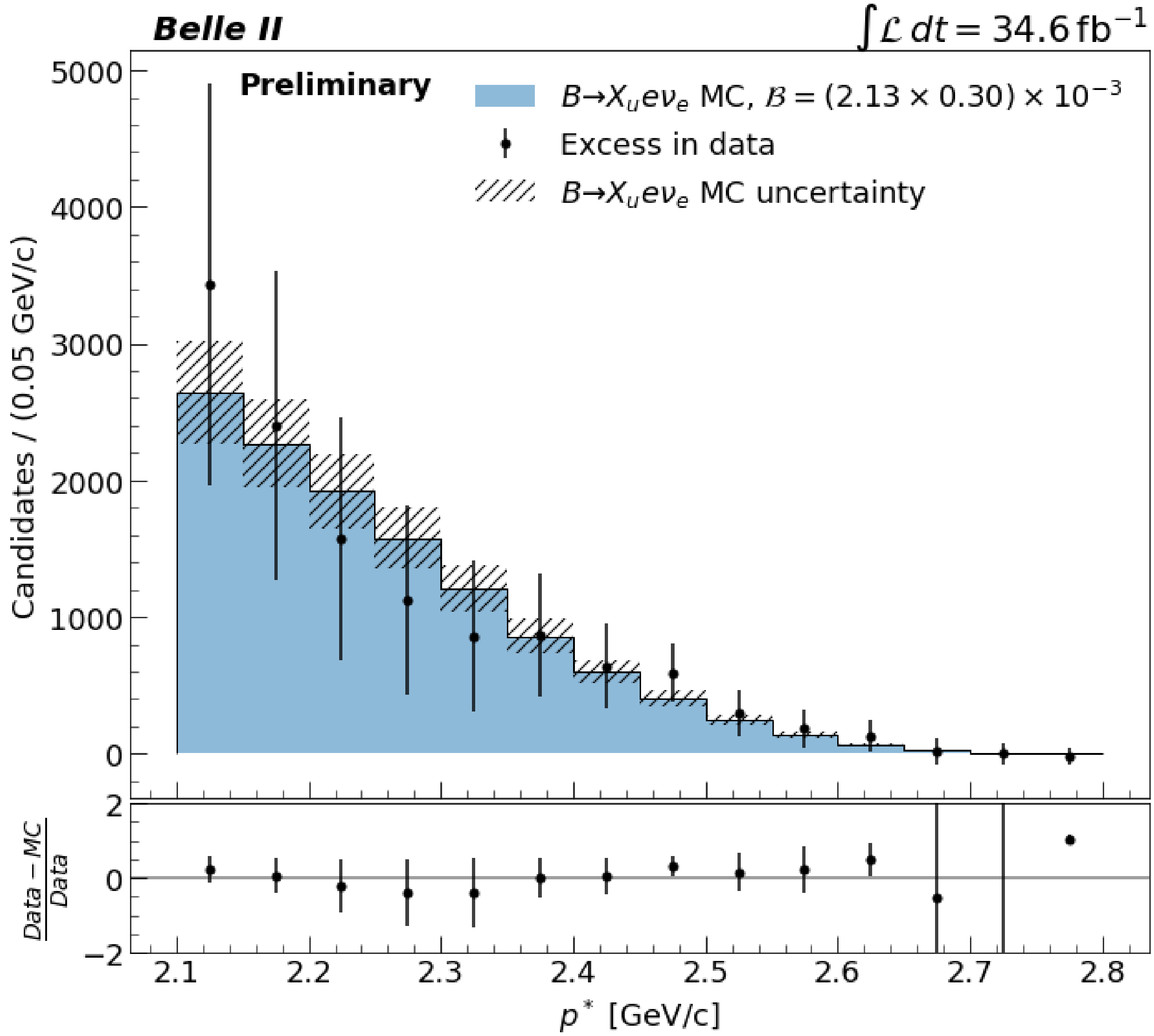

FIG. 3: Excess in the data in the $B \to X e \bar{\nu}_e$ electron center-of-mass momentum endpoint region, assuming zero $b \to u$ contributions. The continuum and $B\bar{B}$ MC(without $B \to X_u e \bar{\nu}_e$ contributions) contributions were subtracted from the data. The continuum distribution was estimated using the fit to the off-resonance data and on-resonance data above 2.8 GeV/c. The charmed and other $B\bar{B}$ backgrounds were estimated using a fit to the data in the sideband region [1.6, 2.1] GeV/c, using Monte Carlo distributions as templates. The expected distribution from $B \to X_u e \bar{\nu}_e$ Monte Carlo is shown in blue. The signal $B \to X_u e \bar{\nu}_e$ MC was constructed using a 'hybrid' approach, combining simulated exclusive and inclusive $B \to X_u e \bar{\nu}_e$ final states into a single prediction. The signal MC is scaled to correspond to $\mathcal{B}(B \to X_u \ell \bar{\nu}_\ell) = (2.13 \times 0.30) \times 10^{-3}$. The hashed error on the expected $B \to X_u e \bar{\nu}_e$ electron momentum distribution is combined Monte Carlo statistical uncertainty and uncertainty from the $B \to X_u e \bar{\nu}_e$ branching fraction. The error on the observed excess in data combines the statistical uncertainty and systematics from PID corrections, continuum fit and $B \to X_c e \bar{\nu}_e$ branching fraction uncertainties. By combining the excess in the full range, significance of this observation is calculated to be greater than 3σ.