



BELLE2-NOTE-PL-2020-007
DRAFT Version 1.0
July 29, 2020

Approved plots of $B \rightarrow X_s \ell^+ \ell^-$ study with MC simulation

The Belle II Collaboration

Abstract

This note contains approved plots of $B \rightarrow X_s \ell^+ \ell^-$ process with MC simulation. More details on BELLE2-NOTE-PH-2019-064.

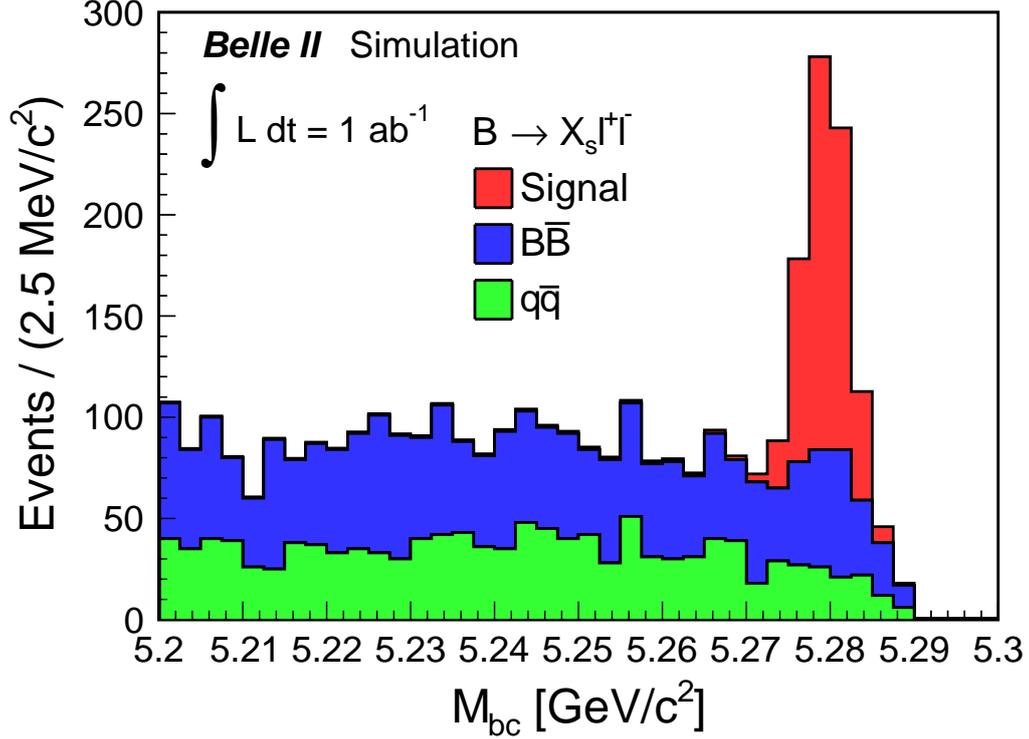


FIG. 1: The beam-constrained mass (M_{bc}) distribution of $B \rightarrow X_s \ell^+ \ell^-$ decay candidates with MC samples. The red histogram contains the signal process, the blue contains backgrounds from $e^+e^- \rightarrow B\bar{B}$ process and the green contains backgrounds from $e^+e^- \rightarrow q\bar{q}$ process.

The charged particles are selected from tracks originating from the interaction point ($dr < 0.5$ cm and $|dz| < 2.0$ cm). A requirement on the particle-identification likelihood ratio of > 0.9 is applied to electrons and muons, > 0.6 is applied to pions and kaons. Electrons and muons are required to have momenta greater than 0.4 GeV/ c and 0.7 GeV/ c , respectively. K_s^0 candidates are formed by combining two oppositely charged tracks, assuming both are pions with requirements on their invariant mass and flight length. π^0 candidates are formed from pairs of photons that have an invariant mass within $[0.120, 0.145]$ GeV/ c^2 .

X_s candidates are reconstructed from $Kn\pi$, with $n \leq 4$, and $3K$ final states allowing for at most one π^0 and one K_s^0 . The invariant mass of X_s is required to satisfy $M_{X_s} < 2.0$ GeV/ c^2 . A B meson candidate is formed by combining X_s with two oppositely charged leptons. To identify the signal, the following selection criteria is applied on B meson candidates: $M_{bc} > 5.2$ GeV/ c^2 and -100 MeV $< \Delta E < 50$ MeV (-50 MeV $< \Delta E < 50$ MeV) for the electron (muon) channel.

To reject large contamination from charmonium backgrounds $B \rightarrow J/\psi(\psi(2S))X_s$ followed by $J/\psi(\psi(2S)) \rightarrow \ell^+\ell^-$, events having dilepton invariant mass in the following veto regions are rejected: -0.40 to 0.15 GeV/ c^2 (0.25 to 0.10 GeV/ c^2) around the J/ψ mass and 0.25 to 0.10 GeV/ c^2 (0.15 to 0.10 GeV/ c^2) around the $\psi(2S)$ mass for the electron (muon) channel. To reject backgrounds from $B \rightarrow DX$, which produce a peak on M_{bc} due to the mis-identification of pions as leptons, the events having invariant mass of orbital combination of X_s daughters and dileptons in the following regions are rejected: 1.85 to 1.89 GeV/ c^2 .

To suppress remaining $B\bar{B}$ background and continuum background, boosted decision trees (BDT) are trained using 36 variables, exploiting the different event shapes of $B\bar{B}$ and $q\bar{q}$ events. A likelihood of ΔE is used as an input variable. When multiple B candidates are found in an event, the most signal-like candidate is selected based on the BDT output.