# Belle II - Spring 2020 Physics Results

The Belle II Collaboration analyzed the 8.7 $fb^{-1}$ of Y(4S) data collected in 2019, to produce the following results. Although none of these are competitive with previously published results on the same topics, these analyses demonstrate the performance and readiness of detector, data processing, and analysis of the experiment.



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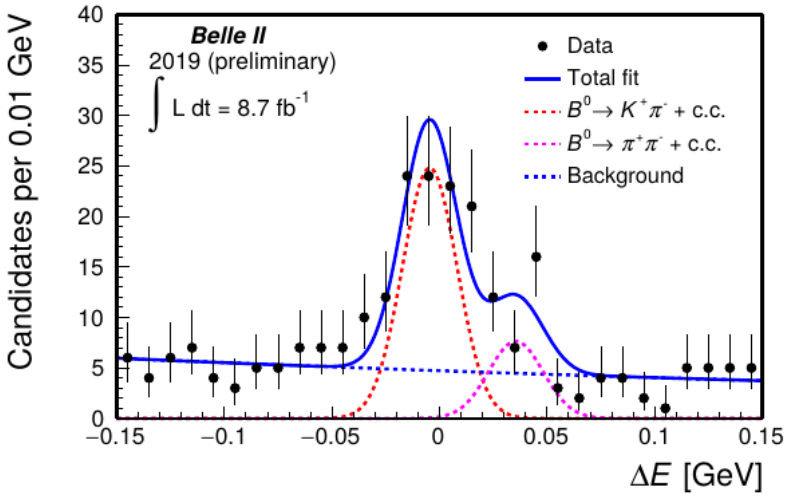
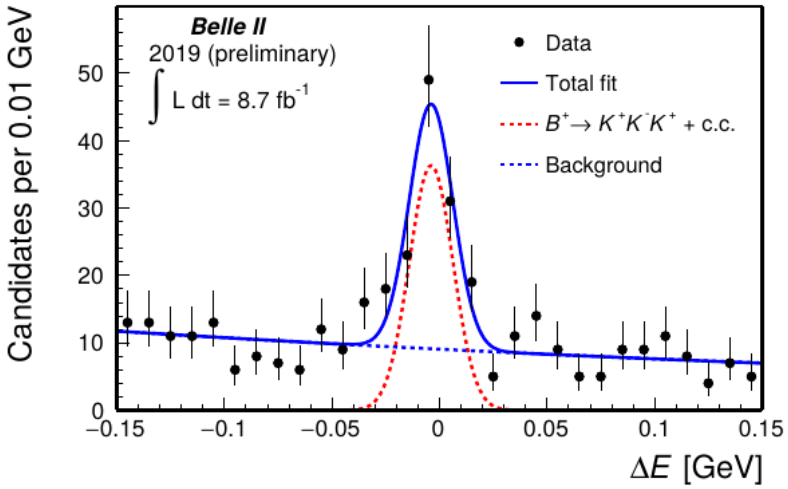
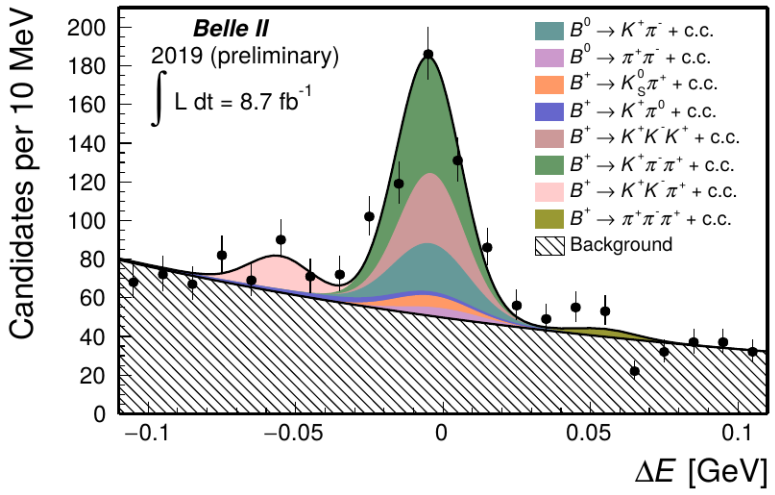
## Conference Papers

### Charmless B decay reconstruction

arXiv:2005.13559 [hep-ex] - BELLE2-CONF-PH-2020-001




Difference between the reconstructed and expected energy of the B meson candidates for the $B^0$ $K^{+-}$, $B^+$ $K^+K^-K^+$, and all the modes investigated in this work.

Decays of B mesons to charmless hadronic final states are essential to measure the quark-mixing parameter $/_2$ and perform stringent tests of the standard model based on flavor symmetries and QCD sum rules.

The chief experimental challenge is to isolate them from abundant continuum backgrounds since charmless B decays are suppressed, with branching fractions $O(10^{-5})$ or lower, have final states hardly distinctive from the continuum, and lack narrow intermediate resonances.
Particle Identification, effective reconstruction of neutral particles, and strong continuum-background suppression are key.

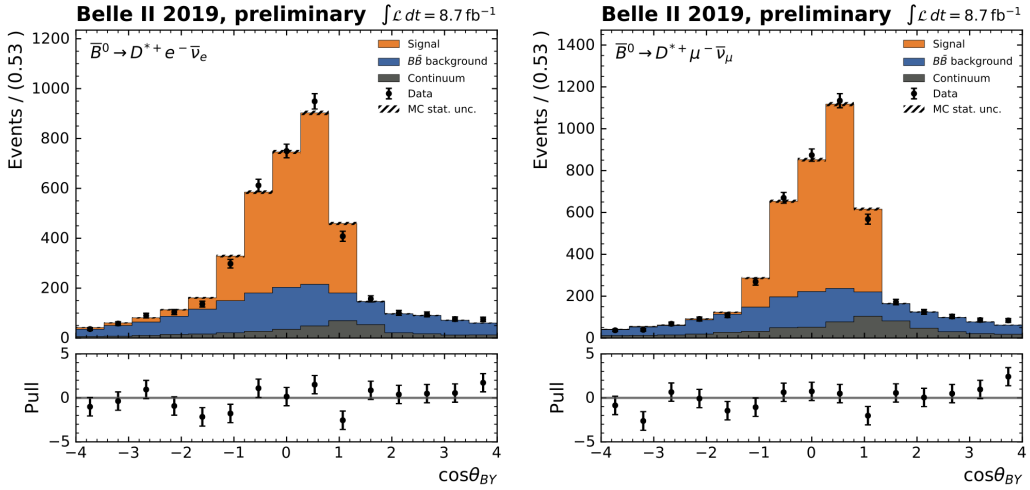
We report the first reconstruction of several 2- and 3-body final states, totaling 400 decays. Observed yields match the expectations from simulation. The performance in signal efficiency and purity is comparable with the best Belle performance.

## Measurement of the branching fraction B(anti-$B^0$ $D^{*+}$ $l^-$ $_l$)

arXiv:2004.09066 [hep-ex] - BELLE2-CONF-PH-2020-002

The decays $\overline{B}^0 \to D^{*+} \ell^- \bar{\nu}_\ell$ are one of the cleanest channels for future measurements of the magnitude of the matrix element $V_{cb}$ of the Cabibbo-Kobayashi-Maskawa matrix.

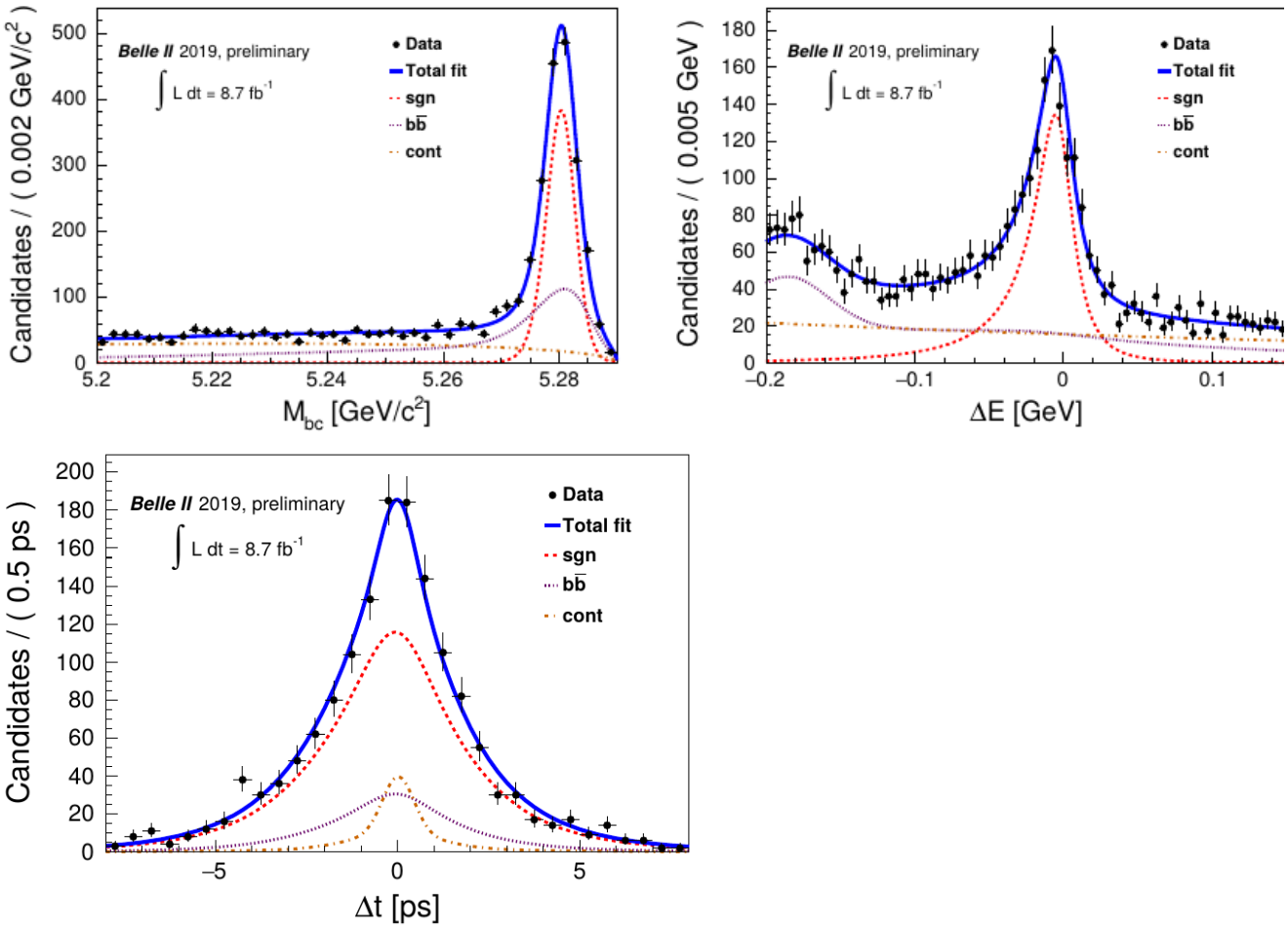
Due to the relative large branching fraction of this decay, it is also an excellent benchmark channel to test the capabilities of the Belle II experiment to reconstruct leptons and final states with neutrinos. We report a first preliminary measurement of the branching fraction of these decays, where we observe about 2200 and 2500 signal events in the electron and muon mode, respectively. The obtained branching fractions are consistent with each other and with the World average. This preliminary work paves the way towards the measurement of the more difficult $\overline{B} \to D^{(*)} \tau \bar{\nu}_\tau$ decays, where previous measurements are in tension with the Standard-Model predictions.




The plots show the distribution of $\overline{B}^0 \to D^{*+} e^- \bar{\nu}_e$ (left) and $\overline{B}^0 \to D^{*+} \mu^- \bar{\nu}_\mu$ (right) candidate events (data points) in a variable called $\cos\theta_{BY}$. The overlaid histograms show the distributions of simulated signal and background events. The signal and background yields are obtained by fitting the data with the simulated distributions.

## Measurement of the $B^0$ lifetime using fully reconstructed hadronic decays

arXiv:2005.07507 [hep-ex] - BELLE2-CONF-PH-2020-003




Beam-constrained mass ($M_{bc}$), difference between the reconstructed and the expected energy of the B candidate, and proper decay time difference of the two B mesons in the event

B mesons are relatively long lived particles, their lifetime being on average ~1.5 ps.

A large part of the Belle II Physics program relies on our the ability of accurately measuring the lifetimes of particles, so measuring the lifetime of the B0 particle is a crucial milestone.

At the SuperKEKB Collider, B mesons are produced in pairs. We fully reconstruct one of them into a final state containing a D meson, and of the other B meson in the event, we determine the position of its decay vertex, utilizing the charged particles not associated to the other B.

From the position of the decay vertices of the two B mesons, we derive the distribution of the proper decay time difference t, from which we extract the $B^0$ meson lifetime.

The result is consistent with the World Average and this preparatory work will be important for the first measurements of time dependent CP violation.

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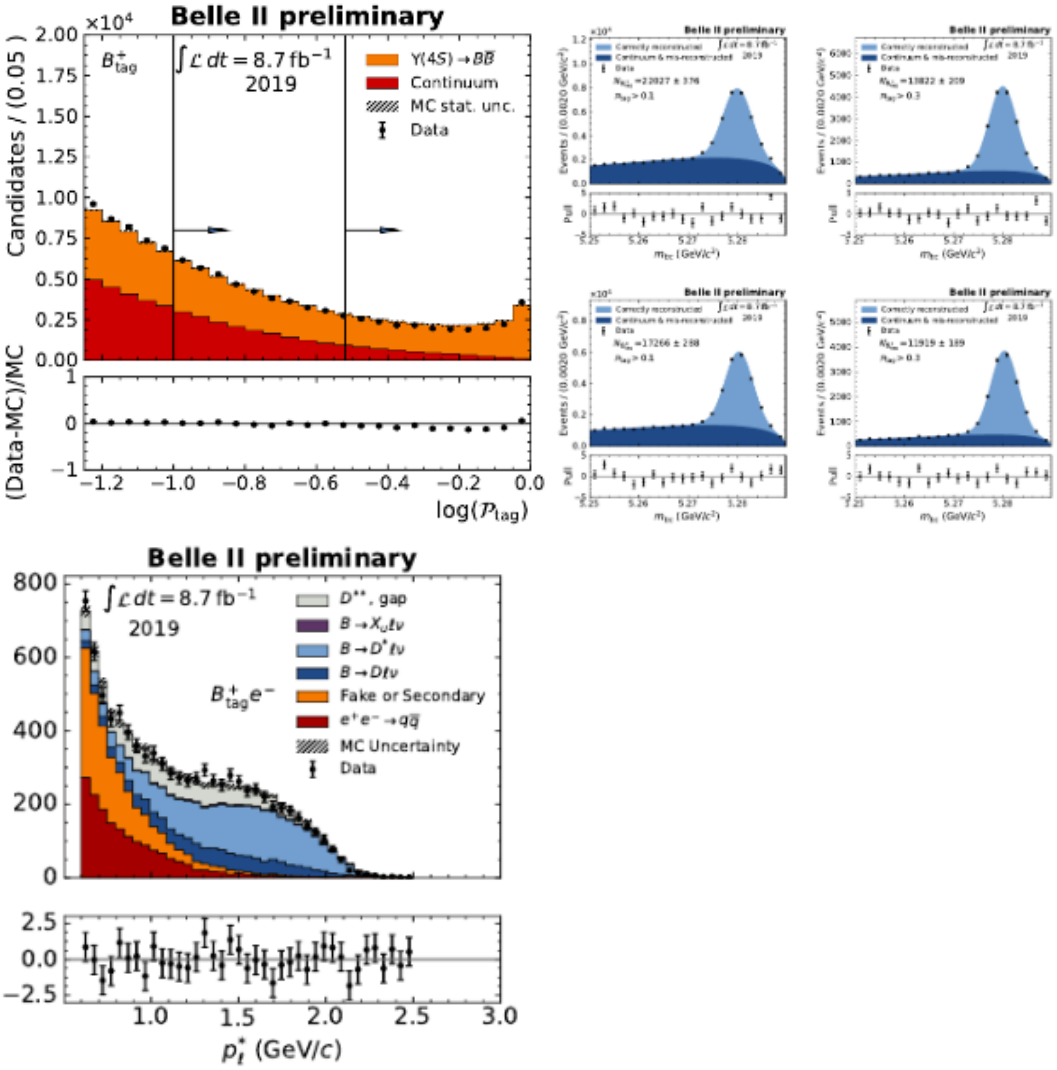
## Performance Plots

### Full Event Interpretation Reconstruction Performance

BELLE2-NOTE-PL-2020-002




Signal probability (left), beam-constrained mass distributions (center), and inclusive electron momentum spectrum for candidates recoiling against a fully reconstructed B (right)

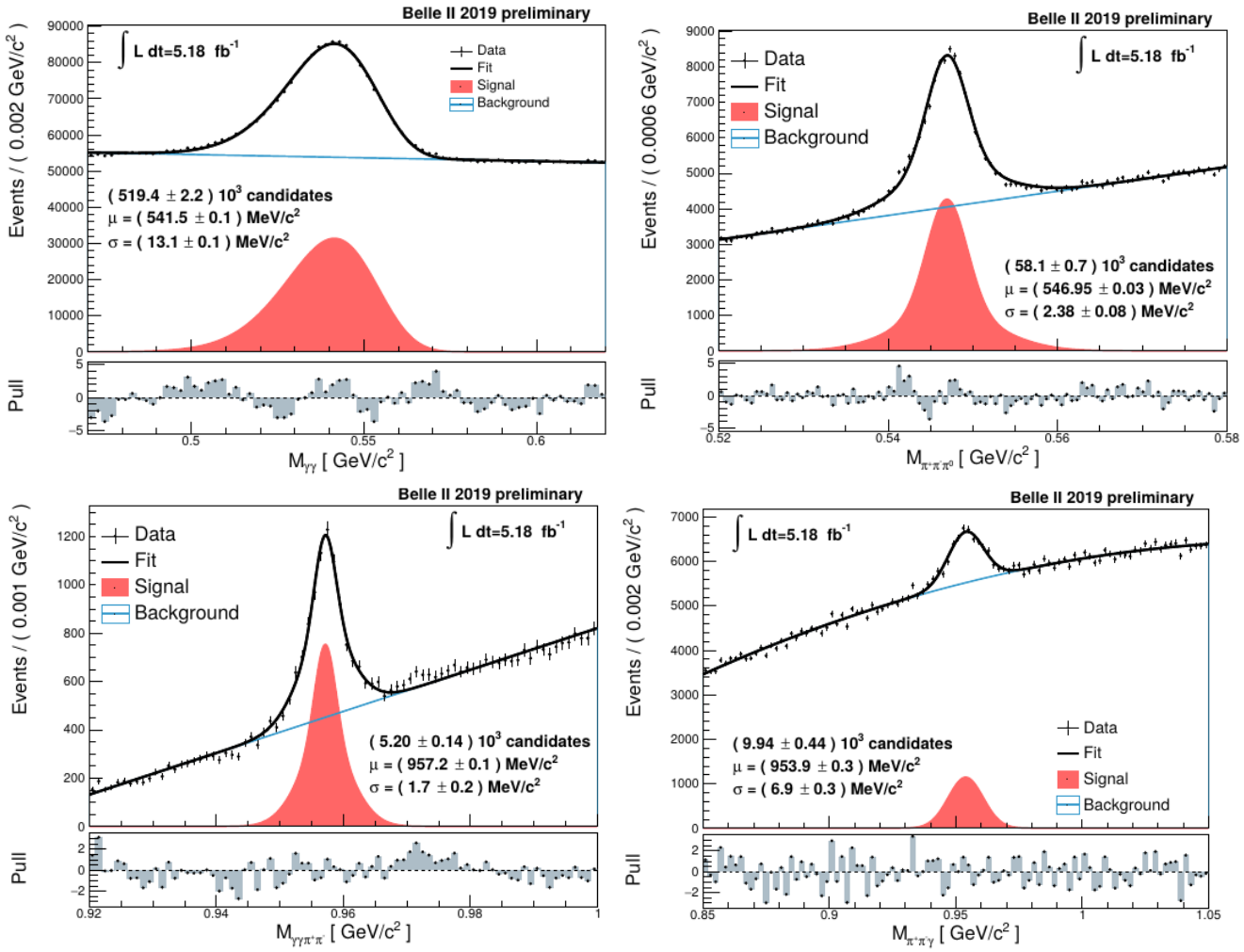
The Full Event Interpretation (FEI) is a technique utilized to analyze B decays that are very difficult to detect, typically because of the presence of neutrinos in the final state.

In this work, one of the B mesons in the event is fully reconstructed into one of many hadronic final states, and the spectrum of a lepton that might be present among the decay products of the unreconstructed B is measured. This signature can be used to calibrate the reconstruction efficiency of the FEI using a data-driven approach. In addition to the previous results, also baryonic modes were included into the FEI reconstruction chains, to further increase the overall sensitivity.

This technique will be a fundamental tool for the precision study of the $\overline{B} \to D^{(*)}\,\tau\bar{\nu}_\tau$ and $\overline{B} \to \tau\bar{\nu}_\tau$ decays.

### Rediscovery of  and ' mesons

BELLE2-NOTE-PL-2020-003




Invariant masses of the , $^{+-0}$, ' $()^{+-}$, and ' $^{0}$.

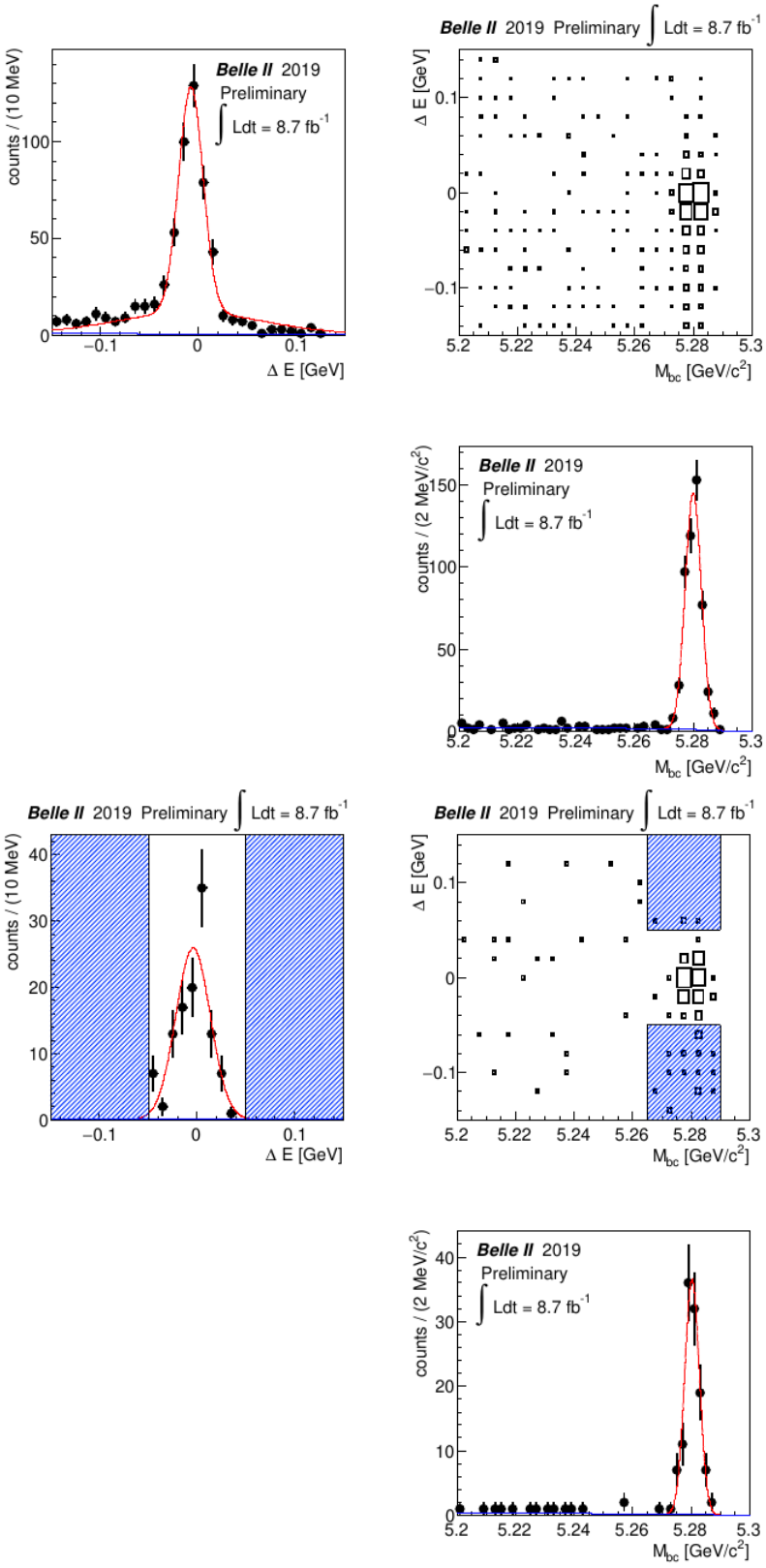
Final states containing or ' mesons are very important for the Belle II experiment.

Here we present the rediscovery of the meson into the and $^{+-0}$ final states, and ' $()^{+-}$, $(^{+-0})^{+-}$, and $^{0}$ final states.

This is a preliminary step before the time dependent CP violation analysis of $B^0$ ' $K^0$, which is one of the most promising for the discovery of New Physics.

## Reconstruction of $B^0$ J/ $K^0_S$ and $B^+$ J/ $K^+$

BELLE2-NOTE-PL-2020-004




Difference between the reconstructed and expected energies of the B candidate, beam-constrained mass (and scatter plot of these two variables) for the $B^0$ J/ $K^0_S$ and $B^+$ J/ $K^+$ candidates.

The $B^0$ J/ $K^0$ decays were the "golden modes" that motivated the construction of the first generation of B-factories.

The analysis of time dependent CP violation in these modes provides access to the fundamental parameter $\sin 2_1$ (or sin2) of the Cabibbo-Kobayashi-Maskawa matrix.

In this analysis, the channels $B^0$ J/ $K^0_S$ and $B^+$ J/ $K^+$ are searched for and reconstructed.

The obtain yields match our expectations based on the simulation.

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Contact the Belle II Physics Coordinator

Link to Belle II Publications page