Study of lepton flavor violating B→hlτ decays at Belle/Belle II experiment

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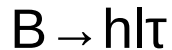
12 April, 2024

Outline

- Introduction

- Analysis strategy

- Results for signal and generic MC

- Control channel study

- Summary

Introduction

- Every lepton family is assigned a quantum number, which is called lepton family/flavor number.

- In the SM, it is conserved.

- Decays which we are searching violates it.

$$B \rightarrow hl\tau$$

- Current upper limit is ~10^{-5}.

- Any evidence for these decays, will be a clear signal of new physics.

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Experimental setup

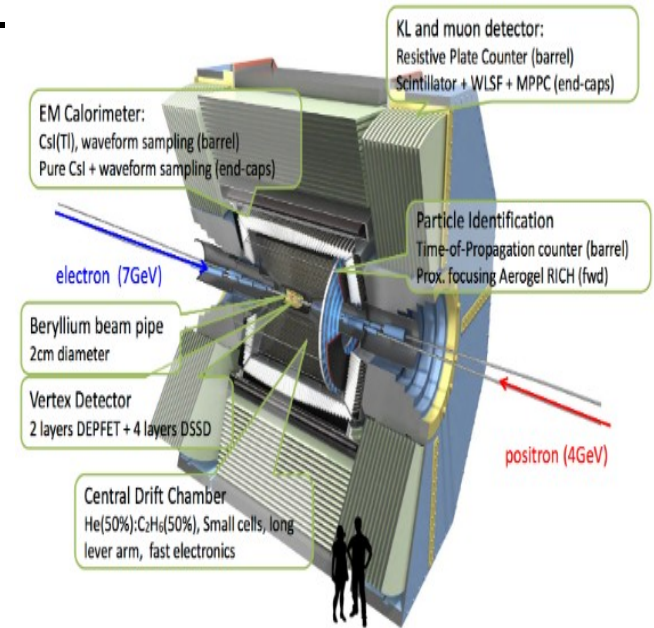- Belle II is an upgraded version of Belle experiment.

- Both are based on the asymmetric lepton colliders.

- Most of the data is collected at Y(4S).

$$e^+e^- \rightarrow Y(4S) \rightarrow B\bar{B}$$
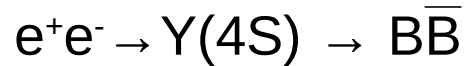
- One B is termed as B_{sig} and other as B_{tag}.

- In our approach, we will first reconstruct B_{sig} and then form the B_{tag} candidate for further analysis.

KL and muon detector:
Resistive Plate Counter (barrel)
Scintillator + WLSF + MPPC (end-caps)

EM Calorimeter:
CsI(Tl), waveform sampling (barrel)
Pure CsI + waveform sampling (end-caps)

Particle Identification
Time-of-Propagation counter (barrel)
Prox. focusing Aerogel RICH (fwd)

electron (7GeV)

Beryllium beam pipe
2cm diameter

Vertex Detector
2 layers DEPFET + 4 layers DSSD

positron (4GeV)

Central Drift Chamber
He(50%):C$_2$H$_6$(50%), Small cells, long
lever arm, fast electronics

Analysis strategy

- In B factories, when we have a missing particle, we can constrain the momentum on a cone.

$$B \to X l \nu_l$$

- Missing energy can be calculated by

$$E_{miss} = E_B - E_{Xl}$$

- Our complete decay has the following form.
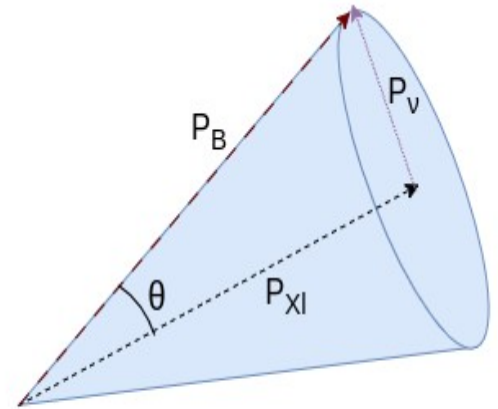
$$e^+ e^- \to Y(4S) \to B^+ B^-$$

B_{sig} $\Longrightarrow$ $B^+ \to K^+ \tau^- \mu^+$

$$\tau^- \to \pi^- \nu_\tau$$

B_{tag} $\Longrightarrow$ $B^- \to X l^- \nu_l$

Signal side reconstruction

- Our B_{sig} contains a missing neutrino.

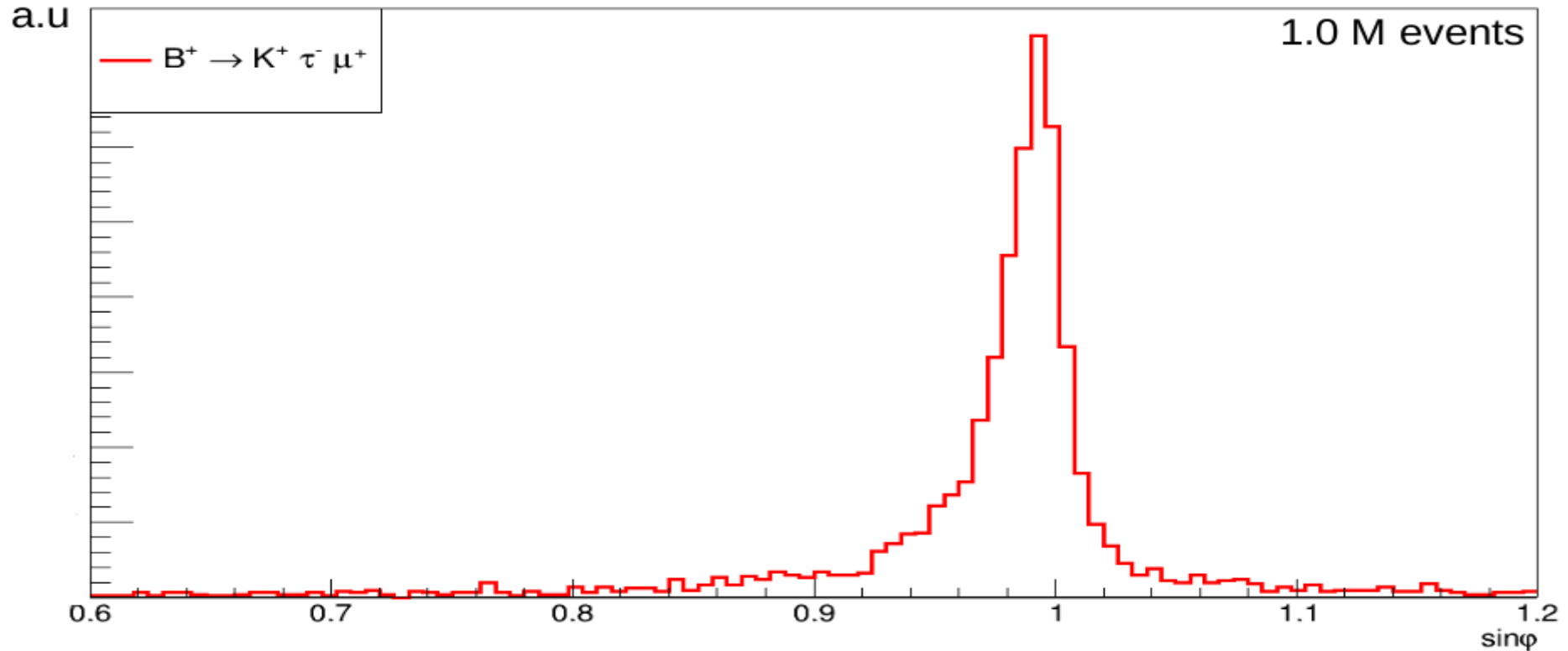$$B^+ \rightarrow K^+\tau^-\mu^+$$

$$\tau^- \rightarrow \pi^-\nu_\tau$$
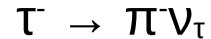
- First we will constrain the momentum around Kμ cone and then around Kμπ cone.
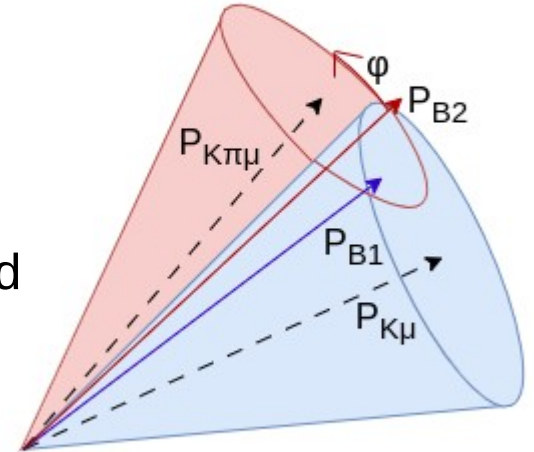
- These two kinematic conditions, will lead to the intersection of two cones.

- It will provide us the B_{sig} momentum with two folds ambiguity, and also provide us a discriminator variable (sin φ).
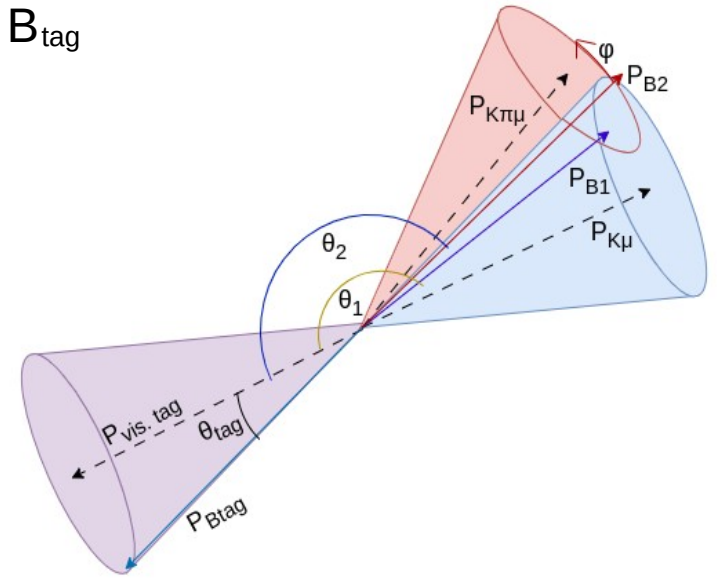
Signal side reconstruction

- We can recover the B_{sig} momentum **independent of the B_{tag} reconstruction**.

Tag side reconstruction

- We are using the inclusive semileptonic approach for B_{tag} reconstruction.

$$B^- \rightarrow X l^- \nu_l$$

- We also have, a missing neutrino on tag side.

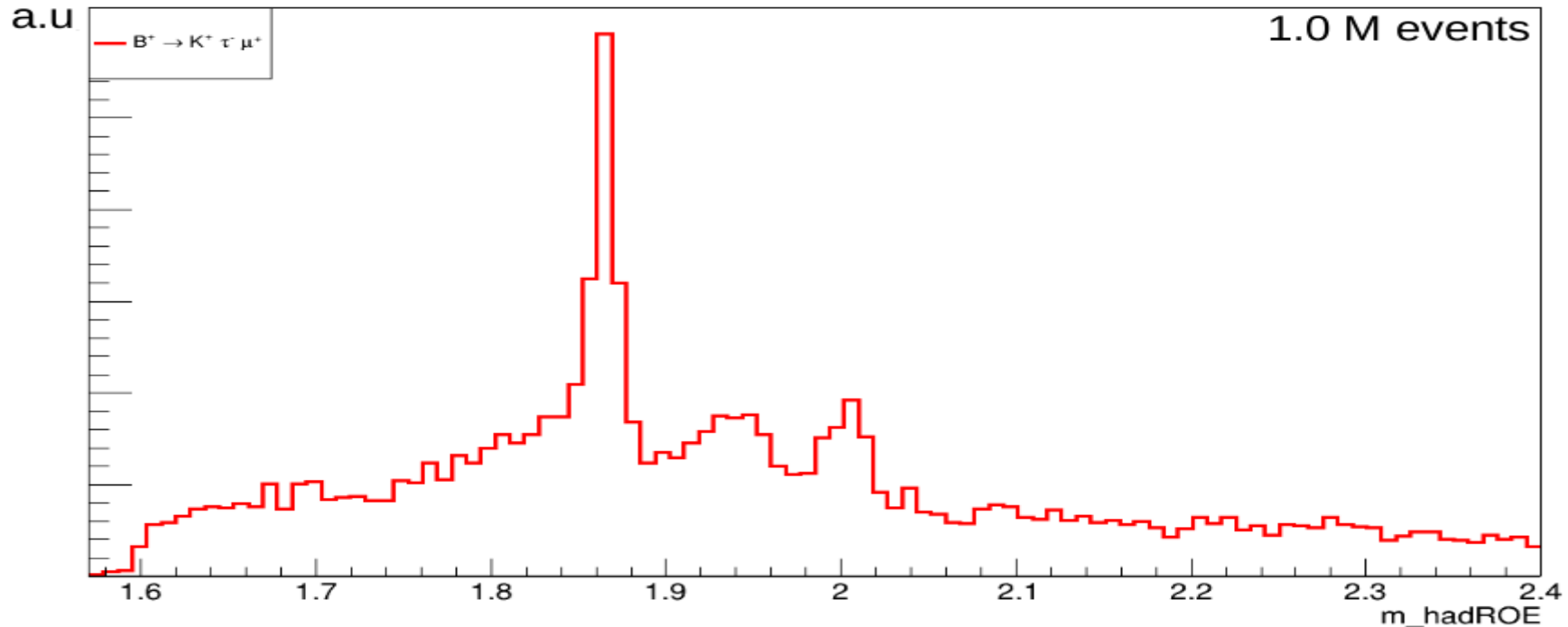- Some interesting kinematical variables can be formed to use further.

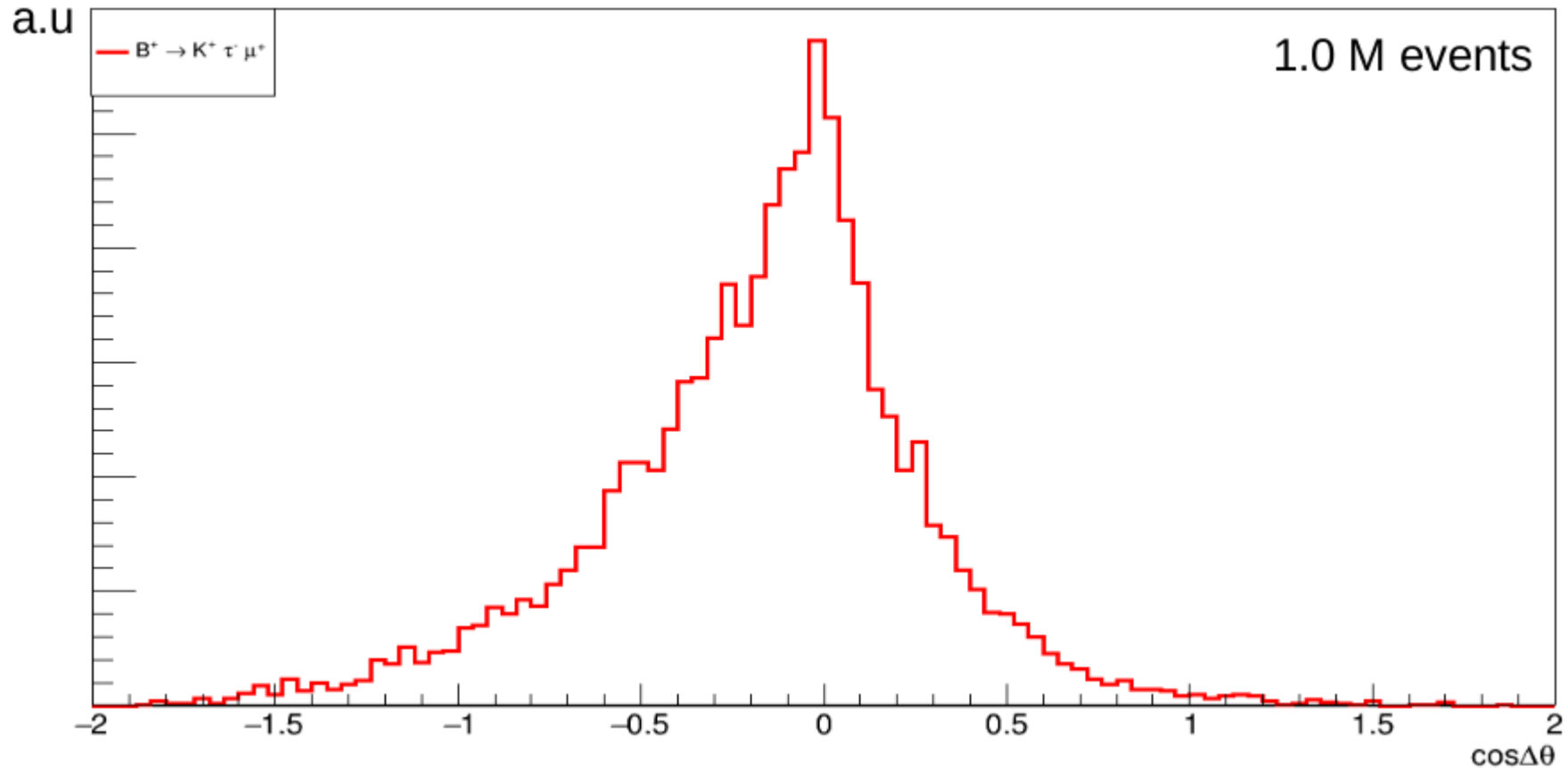$$\cos\Delta\theta = \min|\cos\theta_{1,2} + \cos\theta_{tag}|$$
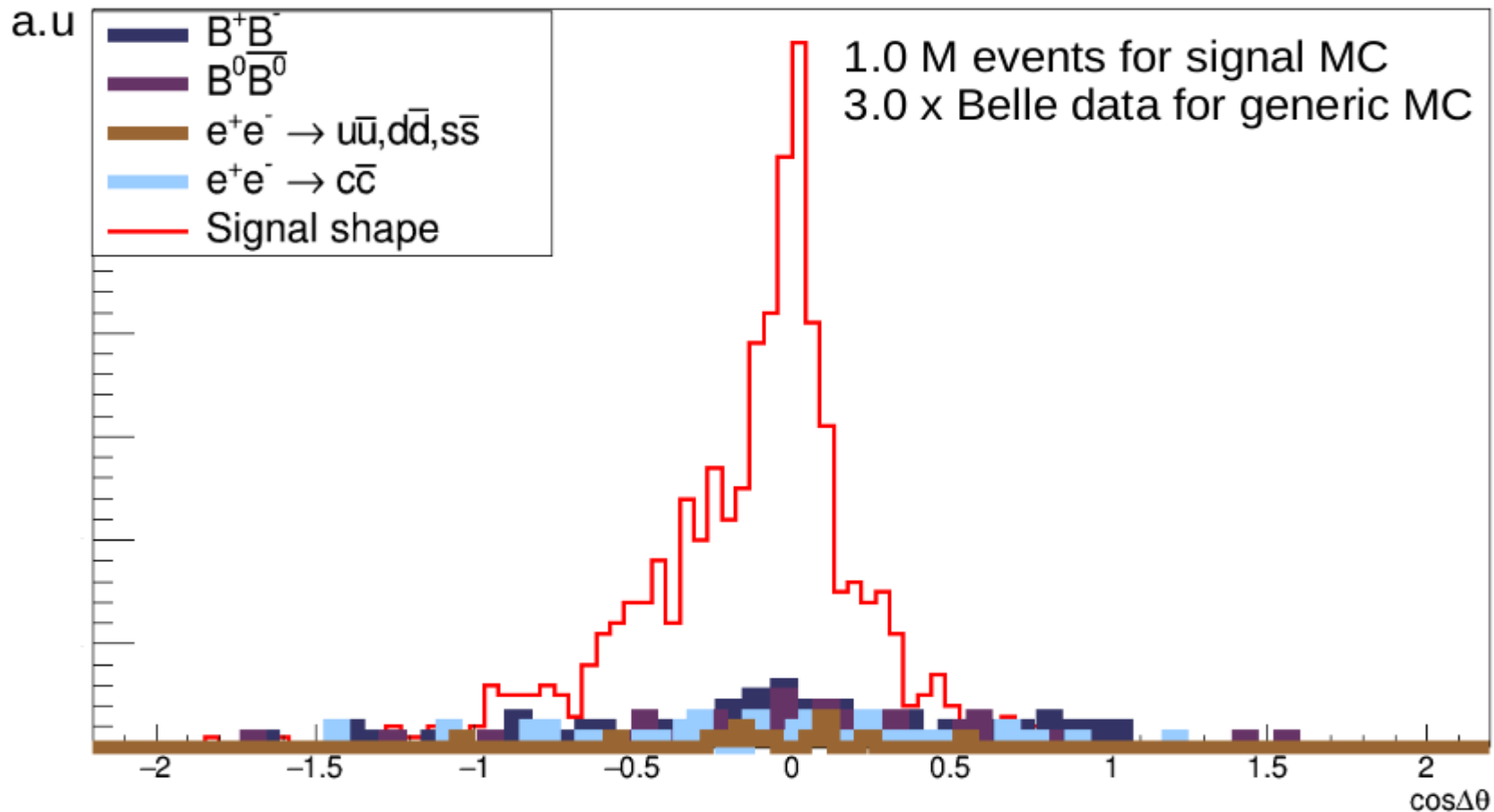
Tag side reconstruction

- We can check the tag side reconstruction approach by the mass of the hadronic part of tag side.

Dedicated signal MC Result

Dedicated signal and generic MC
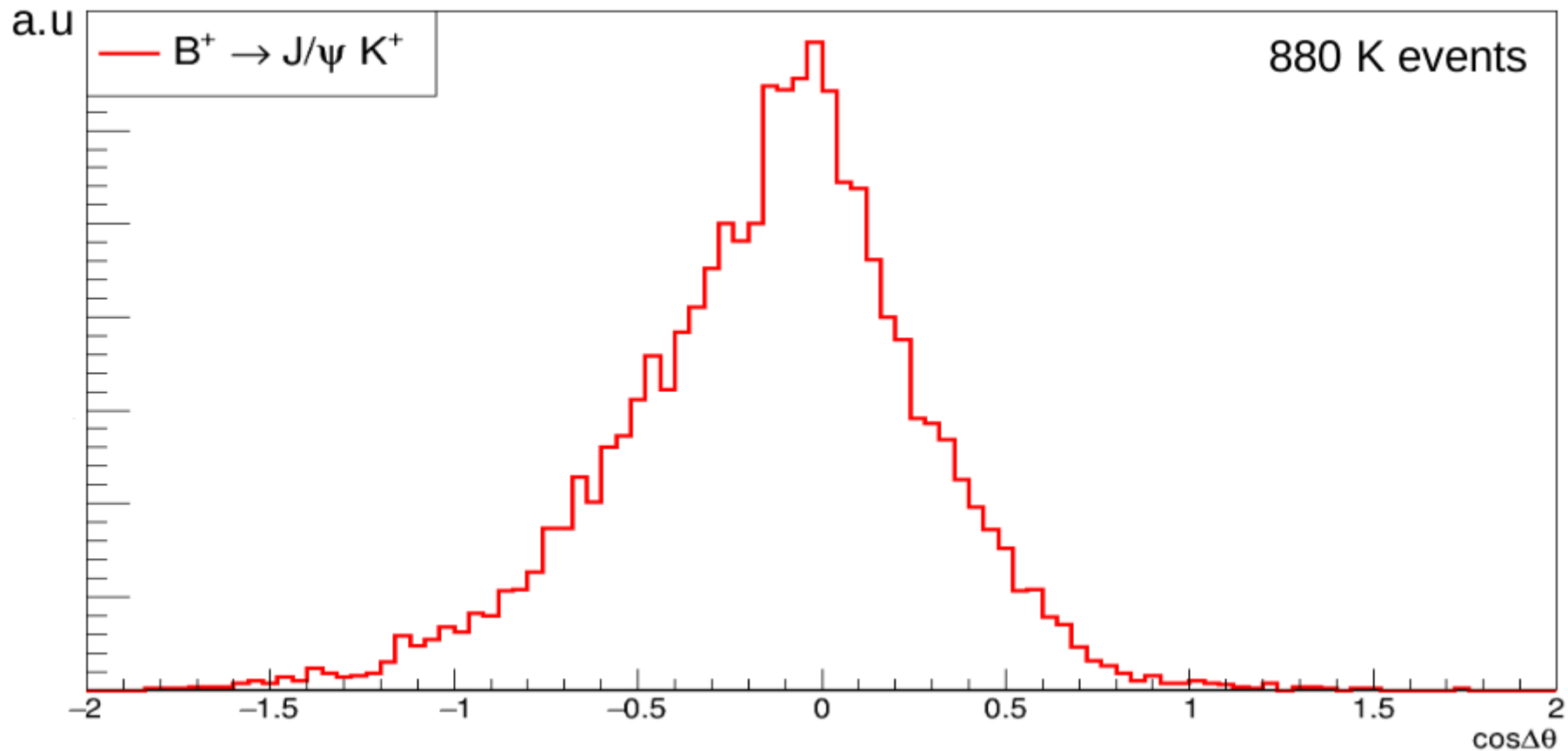
Control channel studies

- To further validate our results, we have to use different control channels.

- The first control channel which we are considering is following.
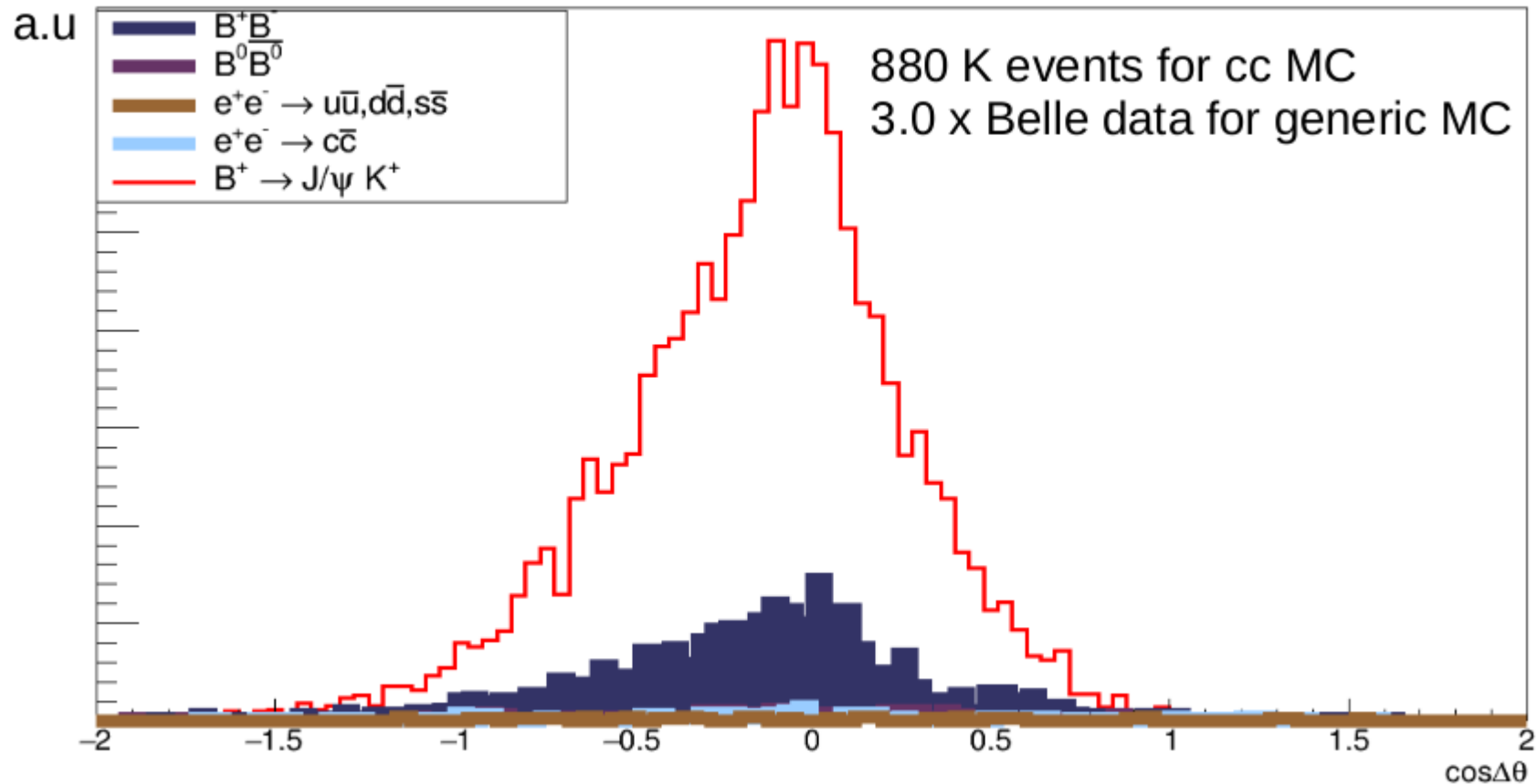
$$B^+ \rightarrow J/\psi \; K^+$$

$$J/\psi \rightarrow \mu^+ \; \mu^-$$

- Here, we don't have any missing particle and the decay is well known.

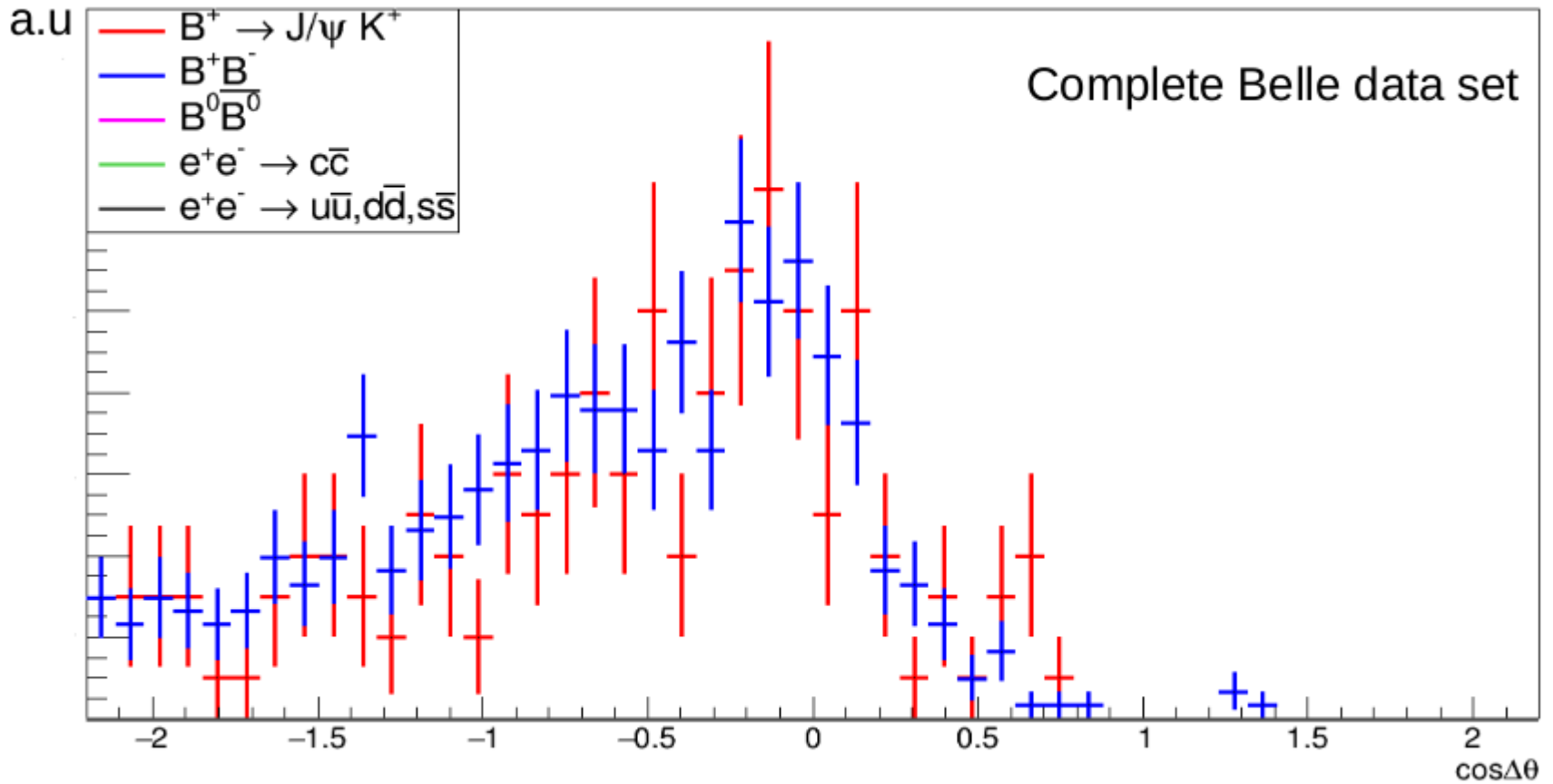- Again, we have a lot of variables at our disposal to check our approach.

Dedicated control channel MC

Dedicated signal and generic MC

880 K events for cc MC
3.0 x Belle data for generic MC

Belle data

Summary

- We are studying the B→hlτ decays by using the basic kinematic constrains provided by B factories.

- Initial results for dedicated signal and generic MC are promising.

- First control channel studies and check on Belle data are also encouraging.

- We have to add more control channels and work on detector systematics to finally run the analysis program on the available Belle and Belle II data set.

Thanks