

1 Search for the decay $B \rightarrow D^*\eta\pi$ in Belle II

2 Vismaya V S^{1*}, S. Sandilya², and K. Trabelsi³

3 ¹On Behalf of Belle II Collaboration

4 ¹Department of Physics, IIT Hyderabad, India

5 *ph20resch11010@iith.ac.in

6 July 12, 2023

7 **Abstract**

8 Recent measurements of semileptonic decays show a difference between the
9 branching ratio of the sum of exclusive decay rates and the inclusive $b \rightarrow c\ell\nu$
10 decay rate (the so-called Semi-Leptonic (SL) gap) which affects the interpretation
11 of the CKM element $|V_{cb}|$. Large contributions from not-yet measured
12 $B \rightarrow D^*\eta\ell\nu$ decays could explain such difference. We present a study of the
13 $B \rightarrow D^*\eta\pi$ decay on the simulated data sample of the Belle II experiment.
14 This measurement will provide valuable information to predict its semileptonic
15 counterpart $B \rightarrow D^*\eta\ell\nu$. If $B \rightarrow D^*\eta\pi$ decay is found to be large, it could
16 contribute significantly to the hadronic B-tagging, and consequently enhance
17 the sensitivity for searching rare B decays with missing energy.

18 **1 Introduction**

19 Approximately 25% of B decays involve semileptonic $b \rightarrow c$ transitions, with a sig-
20 nificant unexplored region. Our study intends to search the decay $B \rightarrow D^*\eta\pi$ for the
21 first time, using Belle II[1] experiment data. The PYTHIA-generated branching frac-
22 tion for this decay in the Belle II simulation is estimated at 0.34%. The measurement
23 of the decay $B \rightarrow D^*\eta\pi$ in Belle II data can provide insight into the Semi-Leptonic
24 (SL)[2] gap problem, impacting the interpretation of the CKM[3, 4] element $|V_{cb}|$.

2 Discussion

We have studied the decay $B \rightarrow D^*\eta\pi$ in simulations. We select a kaon and a pion track to form a D-meson, and then a D^* candidate is reconstructed with the D candidate and with a selected π meson. The η -meson candidate is selected in a two-photon final state. Then ultimately a B-meson candidate is reconstructed by combining D^* , η and a pion. After applying all the selections the ΔE ($E_B^* - E_{beam}^*$) distribution in Belle II simulated sample size of 400 fb^{-1} is shown in Figure 1. Unbinned maximum likelihood fit is performed for the distribution ΔE to extract the signal events. The branching fraction in the simulated sample was found to be $(3.54 \pm 0.17) \times 10^{-3}$, which is about the same value put in the simulation.

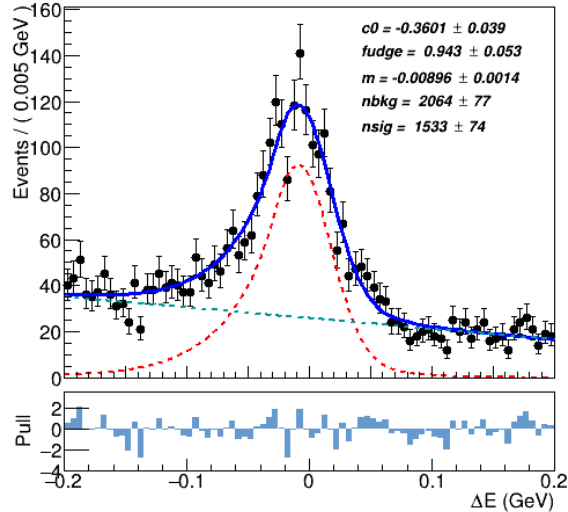


Figure 1: ΔE fit distribution in generic MC.

3 Conclusion

We have studied the decay $B \rightarrow D^*\eta\pi$ in Belle II simulations. The calculated branching fraction, after selection and fitting the distribution, is about the same input value in the simulation, which validates our method. We plan to perform the study by using the Belle II data sample in the near future. We anticipate that the branching fraction for this decay observed in the Belle II data will resemble what we observed in our simulation study.

42 **References**

- 43 1. Abe T. Belle II Technical Design Report. arXiv 2010.
- 44 2. Florian U. Bernlochner ZL and Turczyk S. A proposal to solve some puzzles in
45 semileptonic B decays. PHYSICAL REVIEW D 2012.
- 46 3. Cabibbo N. Unitary Symmetry and Leptonic Decays. PHYSICAL REVIEW LET-
47 TERS 1963.
- 48 4. Kobayashi M and Maskawa T. CP-Violation in the Renormalizable Theory of
49 Weak Interaction. Progress of Theoretical Physics 1973.