ABSTRACT

We study single production of heavy vector-like bottom (VLB) quark partner and its decay to a top quark and W boson at the Future Circular Hadron Collider (FCC-hh) with high center of mass energy of 100 TeV. The results show that the mixing between the vector-like quark and third generation quarks can largely enhance the production cross section. We analyze the total state kinematic distributions for all hadronic mode. Studying the observability of single VLB quark through the process pp→bq+X, we set attainable mass limits depending on different coupling strength relevant to the single production at FCC-hh.

INTRODUCTION

In recent years, many natural extensions of the Standard Model has been proposed. Some examples are Little Higgs model or Composite Higgs models, in which additional top quark partners with masses at the TeV scale are predicted. Some of these models postulate the existence of vector-like quarks (VLQs). Since the left-handed (LH) and right-handed (RH) chiral components of these particles transform in the same way under the SM electroweak symmetry group. In contrast to a fourth chiral quark generation, their impact on the Higgs properties is small, such that VLQs have not been excluded by the measurements of H-mediated cross sections.

SINGLE PRODUCTION OF VLB AND CROSS SECTIONS

As expected in the signal events, we have seven jets mostly, events with four jets and five jets and six jets have enough size. Events including b-jets have the size one mostly, and two and three.

KINEMATIC DISTRIBUTIONS

We consider the background processes: tW, W+jets, and t+jets. We add them as the total background.

RESULTS

When we check the jet masses in the events as shown in Fig. 5, some events have large jets (known as ‘W-jets’ or ‘top-jets’): showing a peak around m_h or m_b. We reconstruct the VLB mass from jets with large jet mass or light jets. To select events following cuts are applied:
- N_j > 6 and b-jet > 0
- p_T(jets) > 30 GeV and |y(jets)| < 4

Selected events are separated into categories exploiting the large jet properties. For leading large jet p_T > 400 GeV and sub-leading large jet p_T > 200 GeV are required.

For reconstruction a jet assignment is tested using a χ^2 keeping in mind an optimisation in simulation. Invariant mass distributions are presented in Fig. 7 for signal and background.

In order to calculate statistical significance, we take the mass bin width of 200 GeV of each benchmark mass points. Signal (S) and background (B) events are calculated with mass intervals normalizing histograms to the cross sections times integrated luminosity.

CONCLUSION

A study on single vector-like B quark production at FCC-hh has been carried out with detector fast simulation. We find signal significance greater than 7 at an integrated luminosity of 10 ab^{-1} for x_b=0.5 and x_b=0.3 in the range of VLB masses from 1 TeV to 3 TeV. For a value of significance 3σ we find a limit x_b=0.24 at m_b=1 TeV. High energy FCC-hh extends the new particles search limits to TeV scale.

ACKNOWLEDGEMENT

Authors are grateful to O. Cakir for valuable discussions.

REFERENCES