

DRAFT-001
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Feasibility Study for the Final State $hh \rightarrow (b\bar{b})(b\bar{b})$

This is a feasibility study for the final state $hh \rightarrow (b\bar{b})(b\bar{b})$ using reconstruction techniques for both resolved and boosted topologies as well as multivariate methods.

1 Introduction

2 Samples

3 Object and Event Selection

3.1 Resolved Topology

The resolved selection requires the presence of at least four b-tagged anti- k_T $R = 0.4$ jets with $p_T > 25$ GeV and $|\eta| > 2.5$. *Pre-cut* histograms are written out for various kinematic distributions for all events with at least four b-tagged jets but before applying further kinematic cuts. *Post-cut* histograms contain only events where the four jets also pass the above kinematic cuts.

The di-Higgs system is reconstructed by considering all possibilities of forming two pairs of jets with invariant masses $m_{j_1j_2}$ and $m_{j_3j_4}$, respectively, and choosing the configuration that minimises their difference $|m_{j_1j_2} - m_{j_3j_4}|$. Only the four leading- p_T jets are considered here.

3.2 Boosted Topology

In the boosted topology, the decay products of each Higgs boson are merged into a single large- R jet with a two-prong substructure. These Higgs jets are reconstructed as anti- k_T $R = 1.0$ jets for which two substructure variables, the first k_T splitting scale d_{12} and the 2-subjettiness ratio τ_{21} , are calculated. *Pre-cut* histograms are written out after requiring the presence of at least two large- R in the event but without applying any further kinematic cuts. *Post-cut* histograms are filled after the following additional cuts: Both jets are required to have $p_T > 100$ GeV and $|\eta| > 2.5$. Moreover, each jet is required to have at least two b-tagged anti- k_T $R = 0.3$ jets matched to it via *ghost association*: To this end, the constituents of a given large- R jet is reclustered using the jet algorithm and radius parameter of the original jet and so-called *ghost jets*, each corresponding to a small- R jet in the event, are added to the input for the cluster sequence. The 4-vector of a ghost jet is obtained from a given small- R jet by setting its transverse momentum and mass to negligibly small values but retaining its direction in η and ϕ . A small- R jet is considered matched to the large- R jet if its ghost is found among the constituents of the reclustered jet. Ghost association allows to unambiguously match small- R to large- R jets, even in dense environments where a simple matching based on the distance ΔR between jets may lead to multiple matchings.

3.3 Boosted Topology with Variable- R Jets

The same selection as in Subsection 3.2 is applied but this time using Variable- R jets with the following parameters: $\rho = 500$ GeV, $R_{max} = 1.0$, $R_{min} = 0.2$.

4 Multivariate Tools

5 Results

6 Conclusion