High Energy Higgs Signal Predictions

Keston Smith, University of Alabama at Birmingham-SIST Intern
Jennet Dickinson-Fermilab, Nhan Tran-Fermilab

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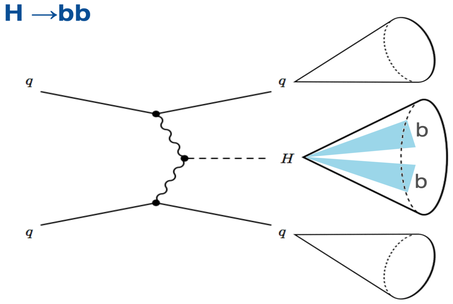
Introduction

Since the discovery of the Higgs Boson in 2012, there has been many efforts to understand more about the theorized member of the standard model. The most ubiquitous form of Higgs production is gluon-gluon fusion derived from the events following proton collisions, but this fact doesn't hold in the high p_T regime. My project focuses on the vector boson fusion production mode (VBF), and bottom quark decay channels of Higgs cross sections. A downside to high energy Higgs productions, is that they're packaged with large QCD backgrounds; estimating top quark processes of signal prediction. It is imperative these processes are well understood in order to make accurate high energy Higgs measurements.

VBF, H →bb



Feynman Diagram of vector boson fusion Higgs production and its decay into b-shower jets.

Analysis Tools

My studies required me to use python and the coffea module to create histograms and compute the event yields of the MC simulations for each successive VBF cuts.

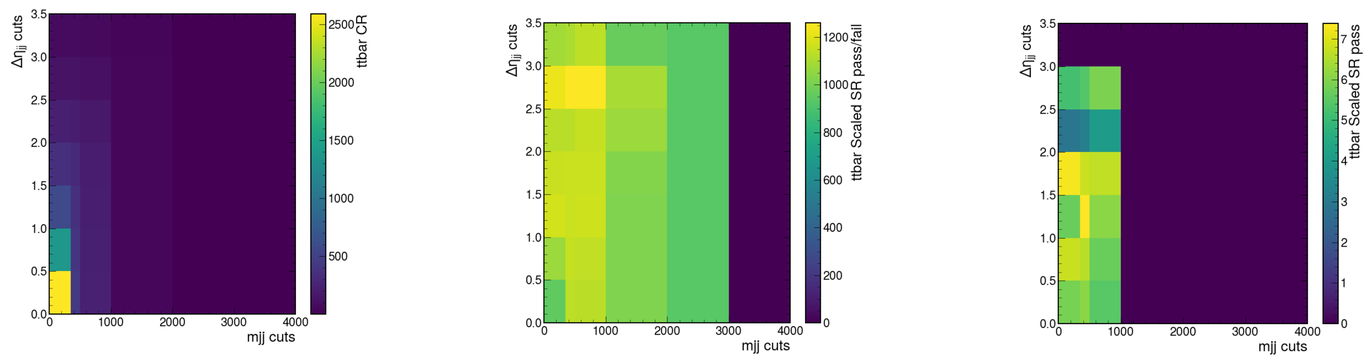
python

Analysis Strategy

In our offline analysis, we've used data from previous 2016-2018 LHC runs ; MC event generators were used to emulate LHC conditions from these years. We define a signal region that contains the Higgs jet candidate and a control region that is similarly defined, except that it contains a "loose" muon. We use this control region to estimate the ttbar process in the signal region to then extract Higgs cross sections; this extraction is done by computing a scale factor to then renormalize the ttbar prediction as close to the data as possible; if the two agree, then we've correctly predicted the ttbar process in the signal region.

Results and Statistical Analysis

We use tailored cuts in the signal region to distinguish H-like jets candidates from the actual Higgs jet candidates. We attempted to give the control region a similar treatment, but we soon discovered that we end up with low event counts. This causes a large statistical uncertainty in the scale factor and signal ttbar prediction as the VBF cuts become more strict. To combat this issue, we now use a control region with looser cuts to generate larger event counts; we use the large systematic uncertainties to cover any potential bias in the difference.



2d histogram plots of ttbar event counts in the signal and control region for successive mjj and deta cuts.

Acknowledgements

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