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Optimal selection for charged Higgs analysis in the fully hadronic channel

The Standard Model (SM) of particle physics is one of the most precise theoretical descriptions of fundamental physics. Even the discovery of the Higgs boson in 2012 by CMS and ATLAS experiments at CERN gave evidence of how most elementary particles gain their masses in the SM. However, the SM is still incomplete according to observations as it fails to explain phenomena such as dark matter, neutrino masses, and the matter-antimatter asymmetry in the Universe.

One viable way of trying to explain this new physics beyond the SM is by extending the Higgs sector. Many of these theories predict the existence of electrically charged Higgs bosons ($H^{\pm}$). The observation of the $H^{\pm}$ could be done in multiple decay modes. However, this thesis focuses on the fully hadronic channel aka where $H^{\pm}$ decays into tau particle ($\tau^{\pm}$) and a tau neutrino (ν_{τ}). This channel is interesting because in the low mass region, its branching fraction is remarkably high compared to other channels. In the high mass region, the branching fraction might not be the highest, but it offers major discrimination compared to the SM background processes.

The goal of this thesis is to deduce the most optimal selection for the $H^{\pm}$-analysis. This can be deduced from exclusion limit plots (aka limit plots). These exclusion limits in $H^{\pm}$-analysis represent the constraints within which $H^{\pm}$ is excluded based on experimental data. Producing these limit plots, the program can be divided into three main parts which can be further subdivided into smaller parts. First part is simply the data analysis part aka going through events to see if there is a fully hadronic decay. Second part is background measurement, where the program distinguishes if the observed $\tau^{\pm}$ was a genuine one or a "fake" one. The third part is producing the limit plots and cannot be done without the first two.

In this thesis, the most optimal selection is examined using the total number of jets and the number of bottom-tagged jets in an event. Through different combinations for these two parameters, the program will produce different results for limit plots. By comparing these results, one can then deduce the most optimal selection for the $H^{\pm}$-analysis in the fully hadronic channel.

Note that this thesis work is ongoing, and results are still being produced.