

Summer Student Program CERN 2015

Final report

Student: Anmol Arora

Department of Physics, Panjab University, Chandigarh, India

Supervisor: Priscilla Pani

Topic : Supersymmetric Top Quarks and Systematic Uncertainties

1. Introduction:

In this project, the most important kinematic variables of $t\bar{t}b\bar{b}$ events will be studied at truth level. The behaviour of each distribution by changing the choice of the matrix element or showering generators or the choice of renormalisation or factorization scales will be investigated. The aim of this project is to identify those variables that show large difference for different generator or scales choices, and therefore are characterized by large theoretical uncertainties, and provide useful recommendation to the analysis with a dominant $t\bar{t}b\bar{b}$ background.

2. Top Quarks

The top quark is the heaviest of all quarks and has a mass of 173.3 ± 0.8 GeV. At hadron colliders, top quarks are produced either in pairs, predominantly through the strong interaction, or singly through the weak interaction. Due to its mass, the top quark decays in a two body decay $t \rightarrow W b$ before hadronising. we classify the $t\bar{t}b\bar{b}$ decays as in the following:

- . (a) hadronic modes (44%):
- . (b) single lepton modes (30%)
- . (c) hadronic or leptonic tau modes (20%)
- . (d) dileptonic modes (4%)

3. STOP

A stop squark is the superpartner of the top quark as SUSY. It is a sfermion, which means it is a spin-0 boson (scalar). The top squark production cross section in proton-proton collisions depends on the stop mass. It decays through these modes:

- a) $\tilde{t} \rightarrow t \tilde{\chi}^0$
- b) $\tilde{t} \rightarrow b \tilde{\chi}^{\pm} \rightarrow b W^{\pm} \tilde{\chi}^0$
- c) $\tilde{t} \rightarrow b W^{\pm} \tilde{\chi}^0$

4. SYSTEMATIC UNCERTAINTIES

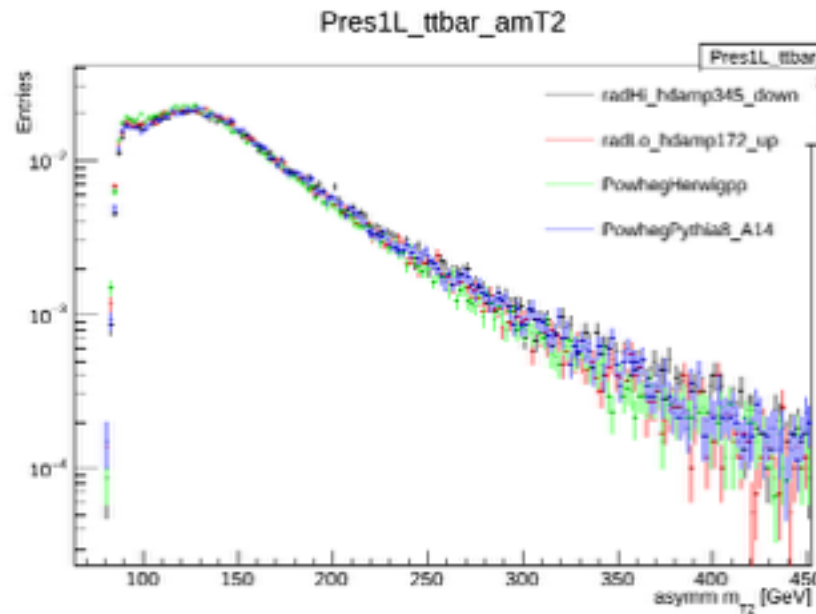
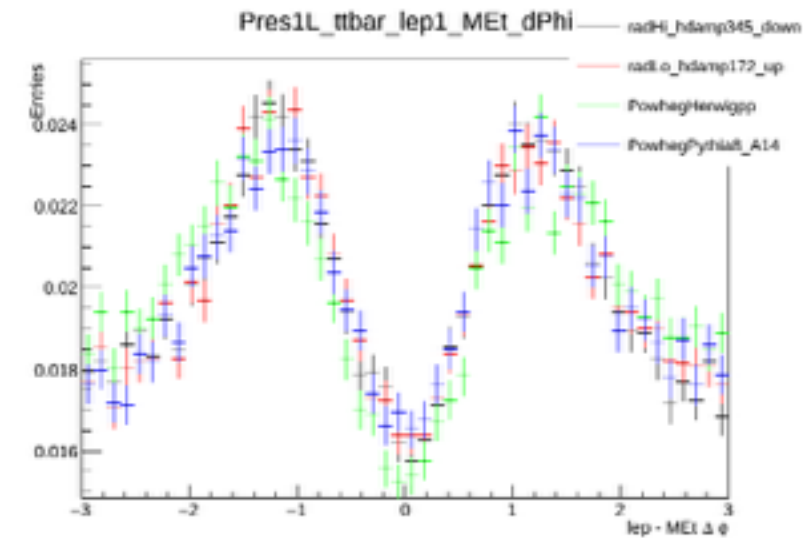
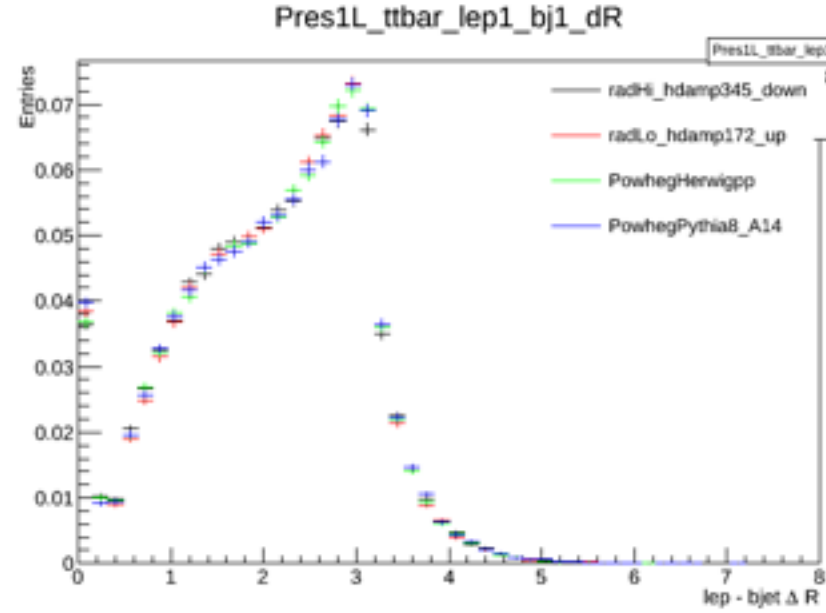
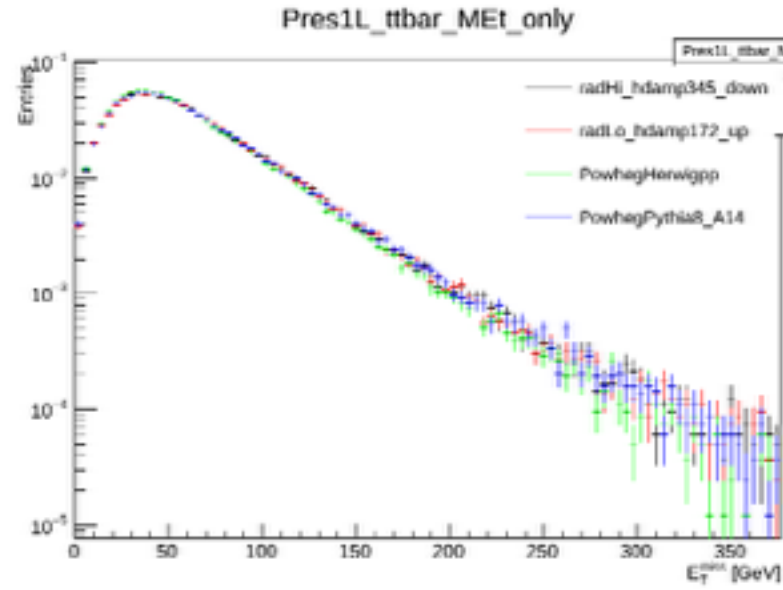
Systematic uncertainties in high energy physics and astrophysics are often significant contributions to the overall uncertainty in a measurement. Systematic uncertainties, arise from uncertainties associated with the nature of the measurement apparatus, assumptions made by the experimenter, or the model used to make inferences based on the observed data.

5. PROJECT

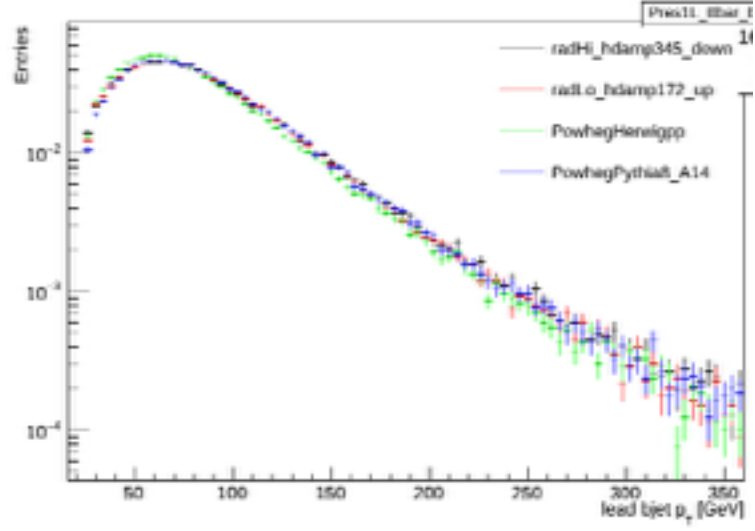
I was here in CERN from 8th june 2015 - 31st july 2015. My supervisor Priscilla Pani, gave me some material to read before i arrived here. After arriving here she started giving me the basic tasks like learning how to plot histograms from a file and how to read a code and many more. There were Two different meetings of us every week where everyone presented the work they did. The first was stop1L meeting that was on every monday and the other one was 3rd generation analysis meeting that took place every Thursday. Everyone in the meetings was very supportive, encouraging and helpful. I learned python, root etc. till first week of july. After the first week, I was introduced to the main project that was to identify the variables that cause large uncertainties. I have to work on the code processTRUTH.py and plot the histograms out of it with different input files, there were a number of different variables in the code and 4 input directories. I have to plot for each variable, the output from each input file on same plot. That means basically i have to compare samples in the same plot. The other tasks included :

- Adding a panel at the bottom with the bin-by-bin ratio of each sample over the nominal (RATIO PLOTS)
- Adding another panel with the bin-by-bin variation for each sample over the nominal.
- Calculate the var for bC_high1 and bC_high2 total integral of events.

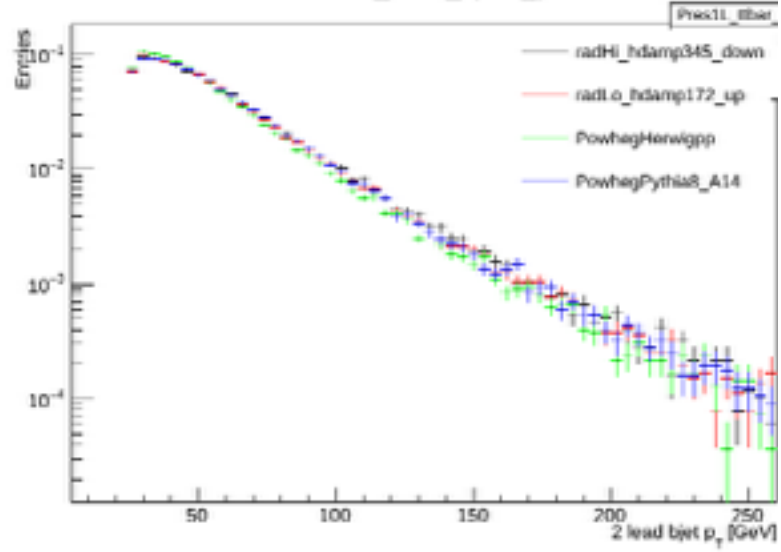
But unfortunately due to shortage of time and very hectic schedule including lectures, visits and workshops ,I was able to complete only few tasks from above . I plotted the samples in same plot so that i can compare them . some of the plots from these are shown below:



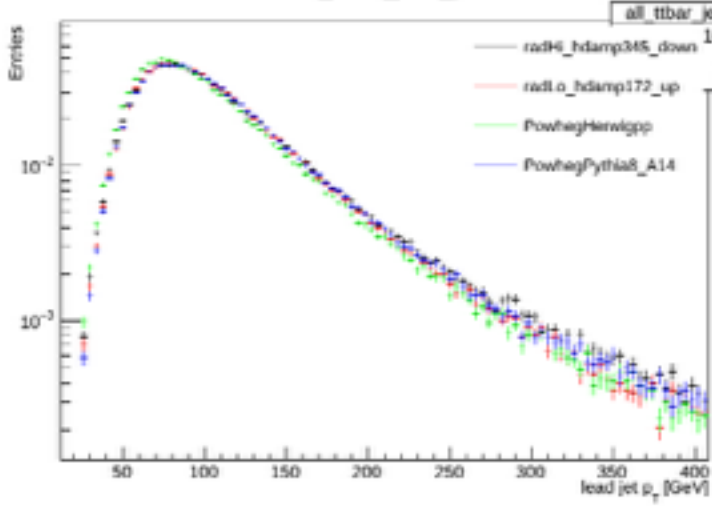
Pres1L_ttbar_bjet1_pt



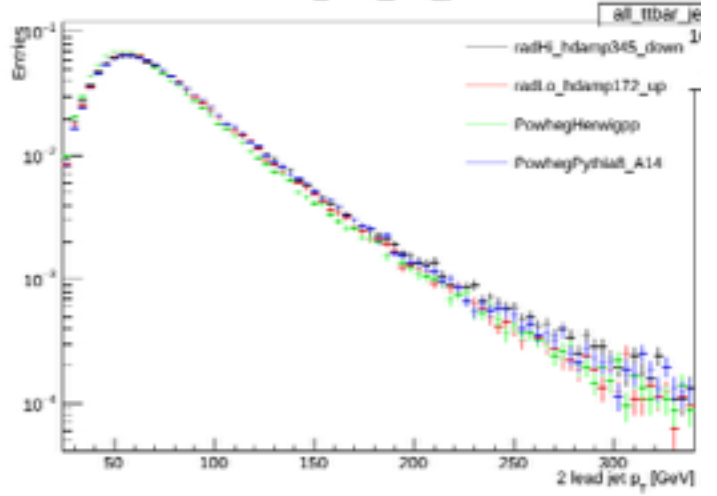
Pres1L_ttbar_bjet2_pt



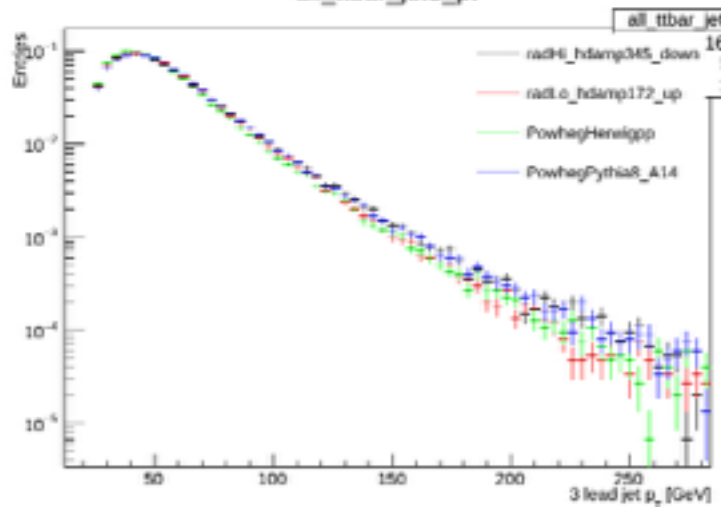
all_ttbar_jet1_pt



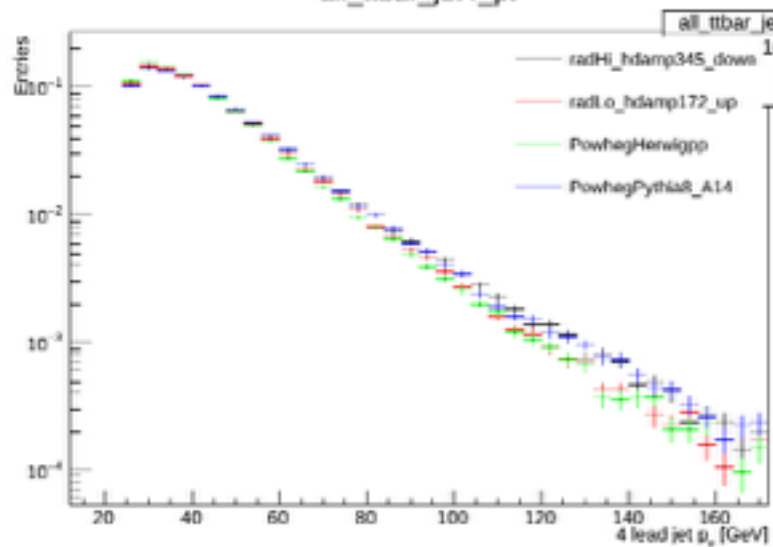
all_ttbar_jet2_pt



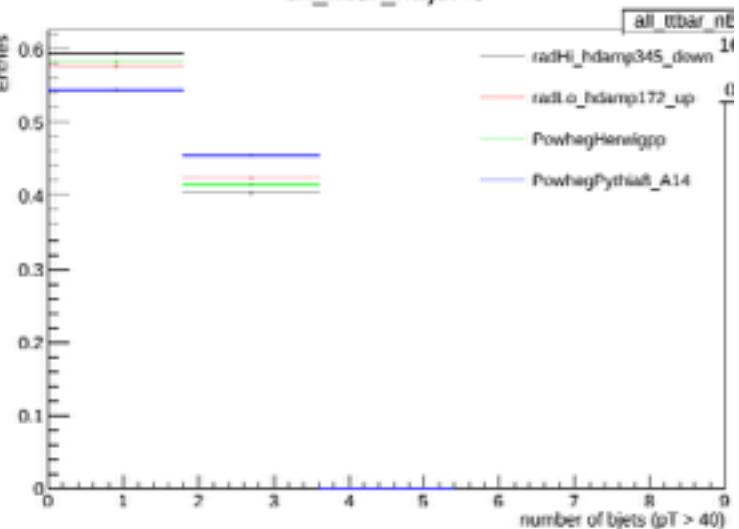
all_ttbar_jet3_pt



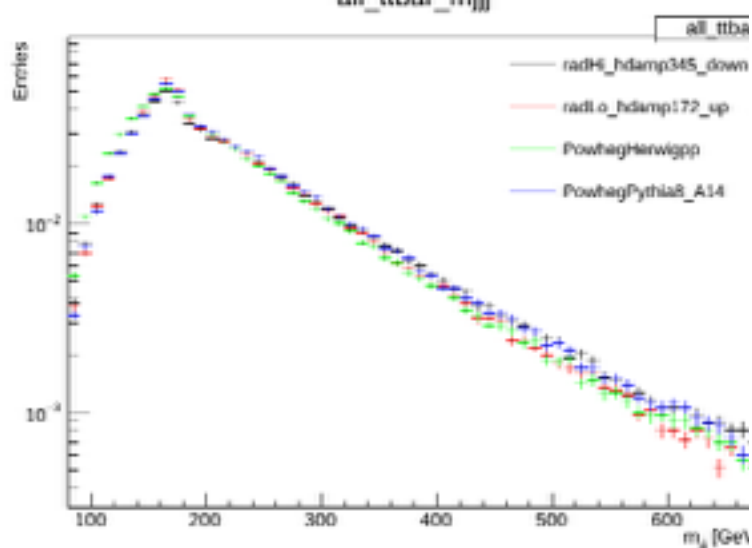
all_ttbar_jet4_pt



all_ttbar_nBjet40



all_ttbar_mjii



6. ACKNOWLEDGEMENT

At the end of this period of 56 days, i would like to thank many people without whom all this would not have been possible. First and above all I would like to thank my Supervisor, Priscilla Pani for her continuos guidance and support , Then i would also thank her PhD student Anya, who helped me a lot in learning new things. Also, i would thank my colleague, Kenny for being so helpful. I also thank the CERN authorities for giving me a lifetime opportunity.

My hearty Thanks to Professor Suman Beri, without her this was not possible. At last my biggest thanks to my parents, my family and friends for being so supportive.