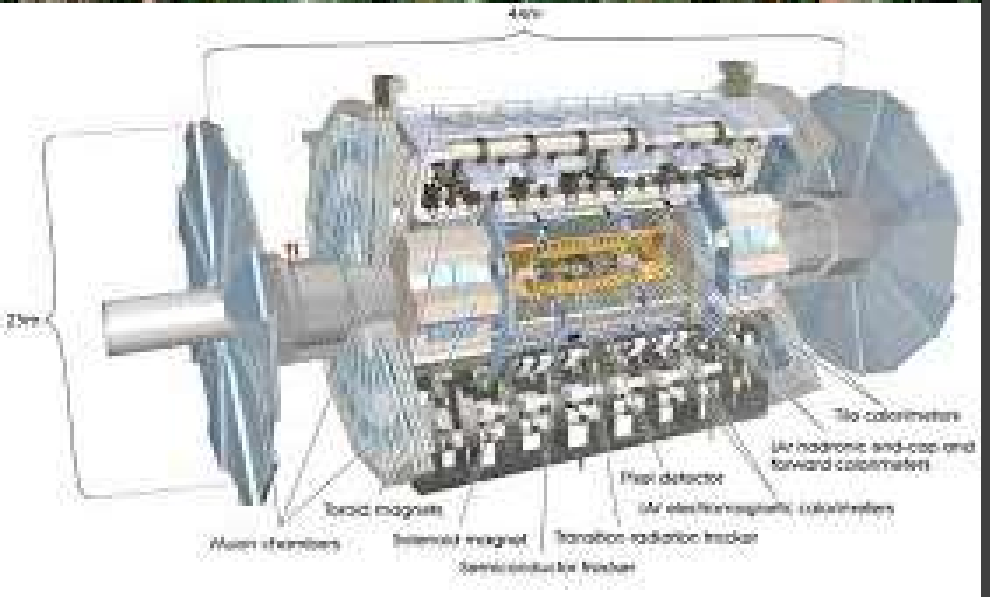
Analysis of a Higgs decay Control Region

Katherine Sloan
Mentor: Dr. Strauss
University of Oklahoma

Introduction

- The Standard Model unifies 3 of the elementary forces and classifies elementary particles
- Higgs boson-the last Standard Model particle to be discovered
- Decay channels
- Higgs->WW->eυμυ
- SM predicts how often different decays happen
  - We want to confirm/find deviations from SM



LHC and ATLAS

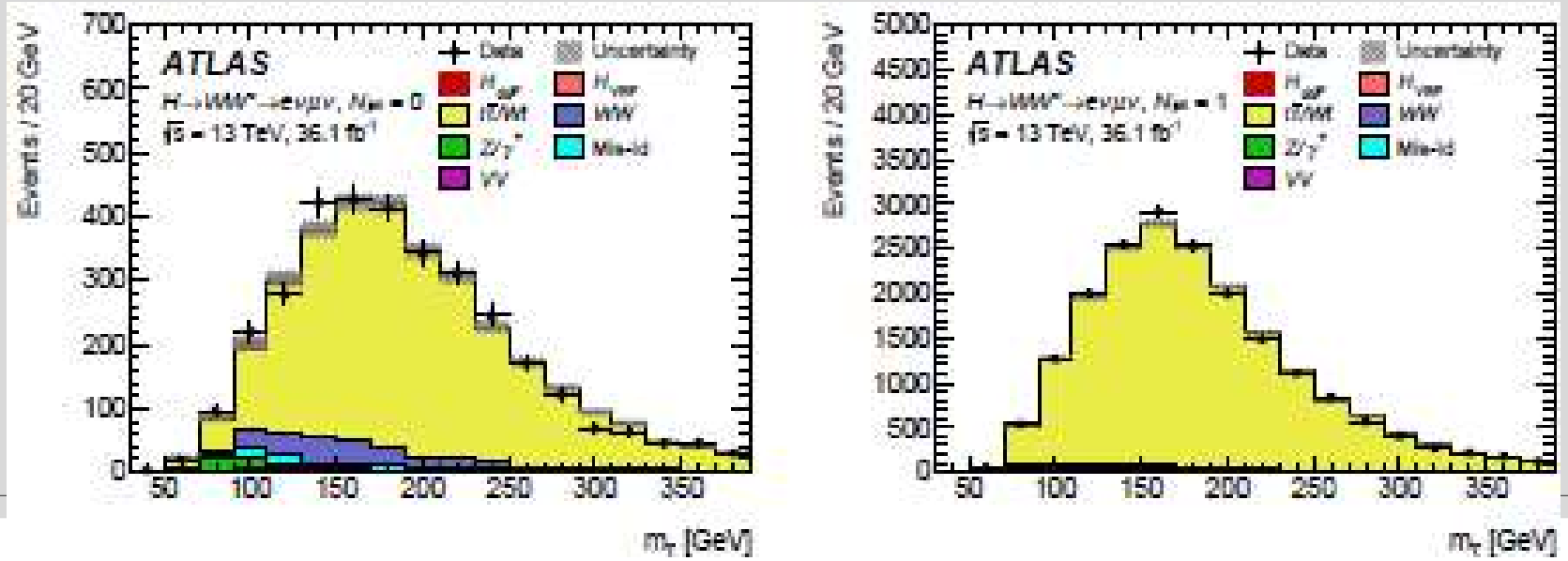
- The LHC collides protons
- Energy = 13 TeV
- $E = mc^2$

- ATLAS sees the collision debris
- Cylindrical detector
- Transverse momentum

Data Analysis Techniques

- Monte Carlos
- Orthogonal cut/selection criteria to data
- Signal vs control regions
  - Control regions are dominated by a single particle

ttbar control region, 0 jets (left) and 1 jet (right)

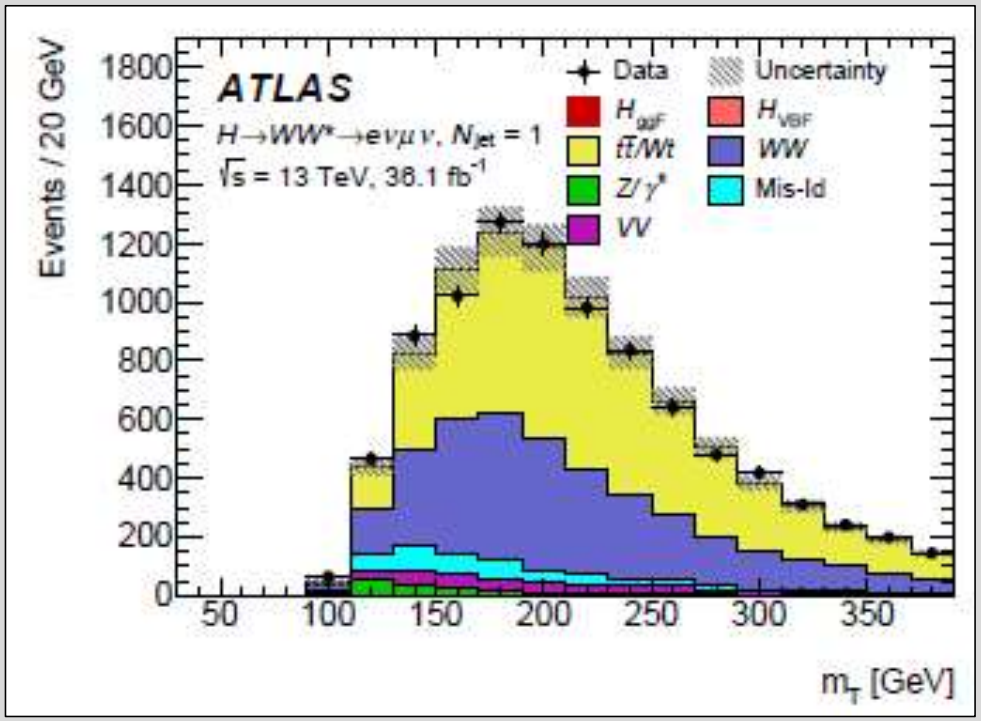


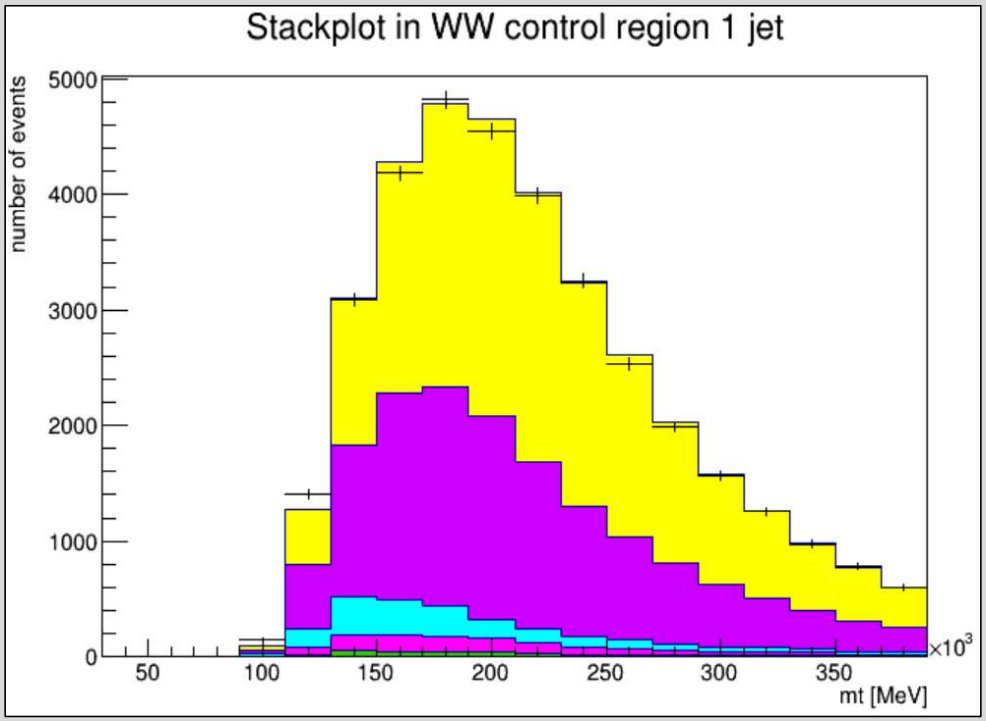
Programming Tools

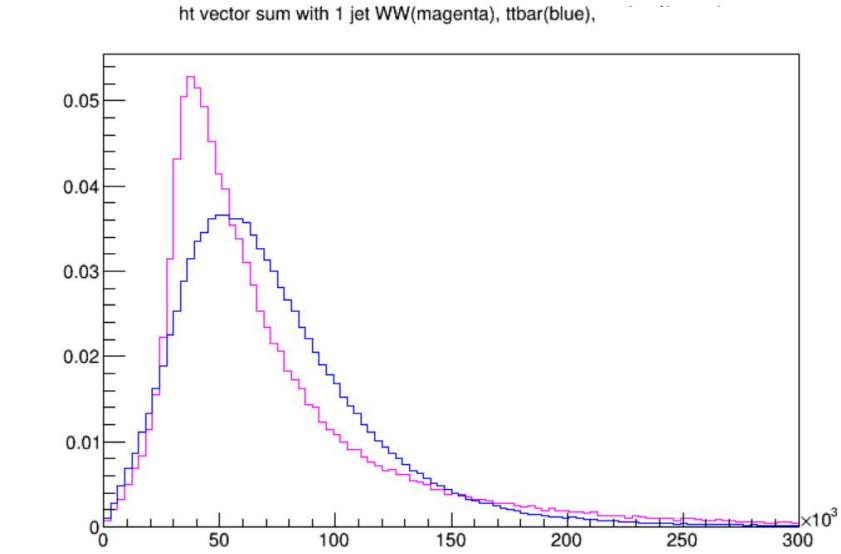
- ROOT
  - C++ coding
  - Different graphing methods
- ROOT tuples and trees
  - Preselections
  - Chaining
  - Stackplots

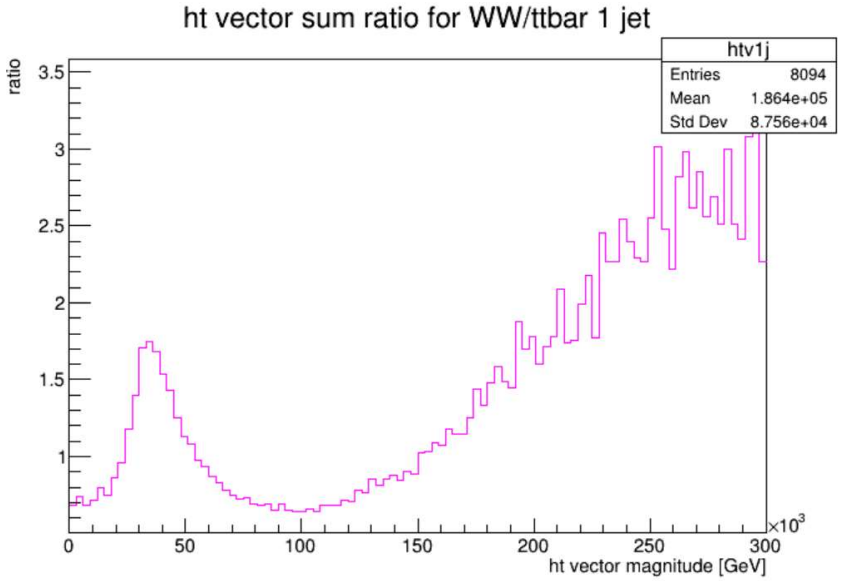
WW 1 jet Control Region

- About three times the data used in the original graph
- Colors for the right plot are similar to those for the left one
- These graphs were each made using different programs and data formats



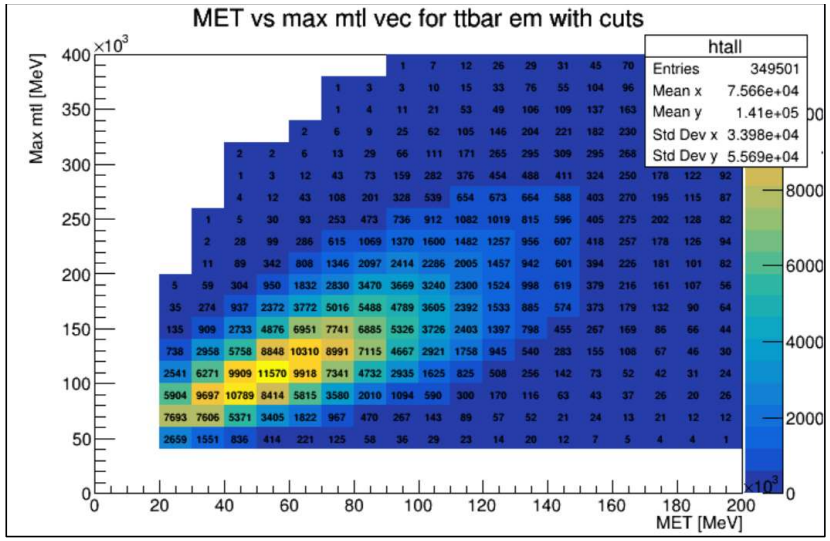


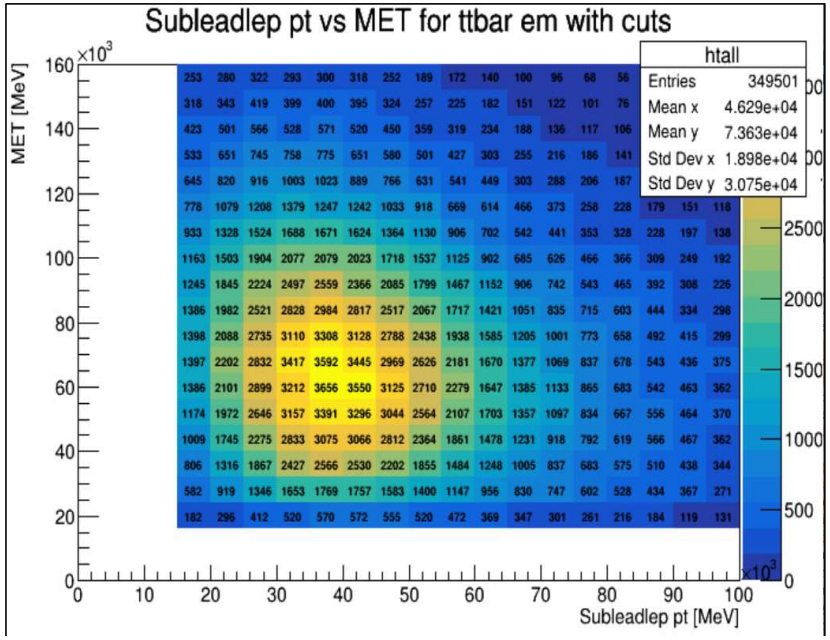




Variable Distributions

- Applied Cuts corresponding to the WW 1 jet control region
- Normalized to same area
- These were analyzed for all variables in the root tuples and for combinations of variables, meaning that over 80 of these pairs of graphs were created





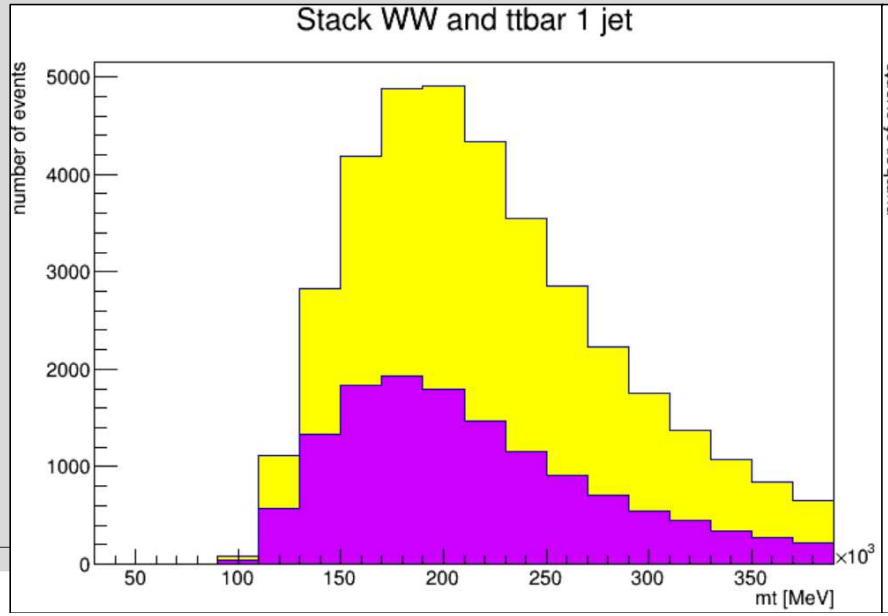
Variable Correlation Check

- Yellow = more events
- Blue = less events
- Top graph shows a good deal of correlation
- Bottom graph shows much less correlation, as both variables have a somewhat uniform distribution centered around a number

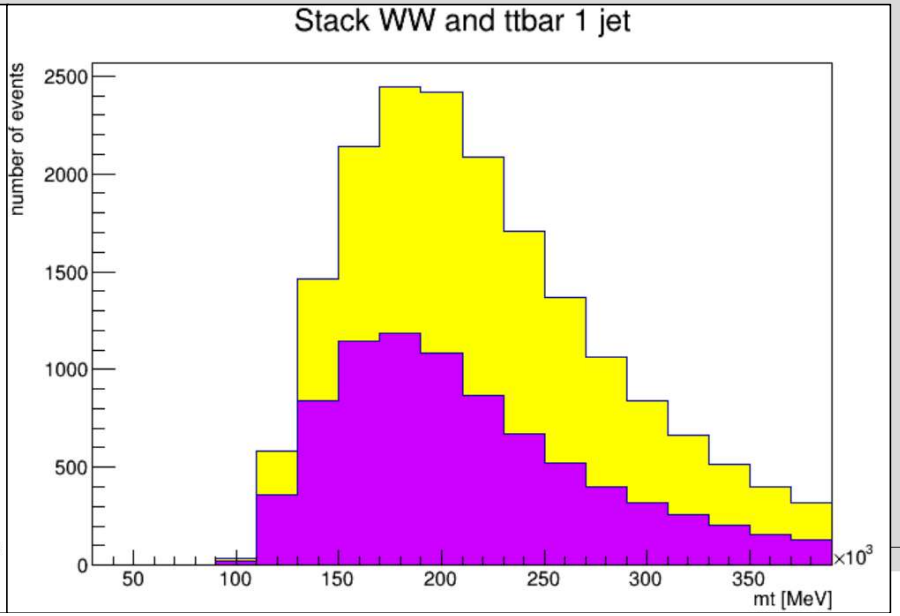
Attempted New Cuts

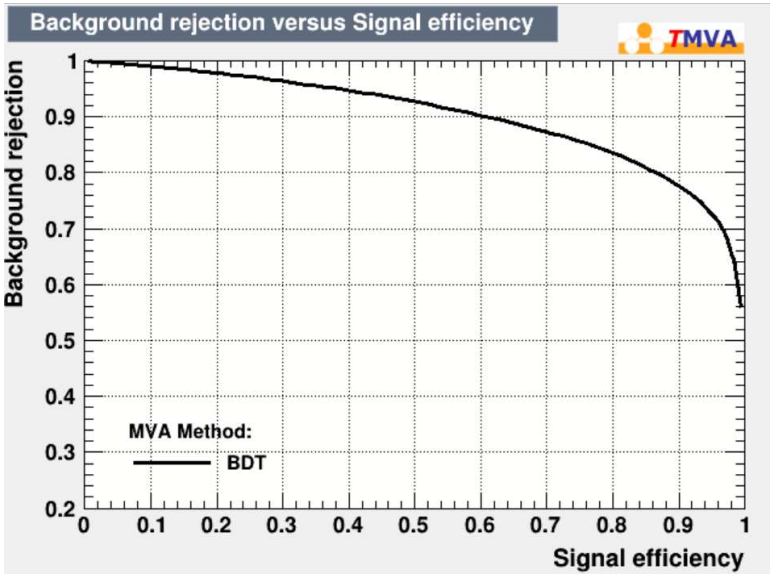
- Second plot has slightly greater percentage of WW (from 37% to 45%)
- Overall number of events was halved
- Probabilistic indicator, $\frac{s}{\sqrt{s+b}}$, where s is signal (WW) and b is background (ttbar) favored the original
- Yellow = ttbar; purple = WW

Original stackplot



Plot after ht vector and jet pt cuts





Moving to a More Complex Analysis

- Making New ROOT tuples
  - Include the original cuts only
- Multivariate Analysis (MVA)
  - Boosted Decision Trees (BDT)
- Outputs like this graph inform overall efficacy of certain BDT cuts

My Next Steps Are…

- Running the BDT multiple times to determine which variables are best to use in the analysis
- Adding data to the BDT results
- Expanding the MVA analysis to other control regions for this same decay channel

Acknowledgements

- Dr. Strauss
- University of Oklahoma

QUESTIONS