Modeling Top-Quark Background for Di-Higgs Search at the Large Hadron Collider

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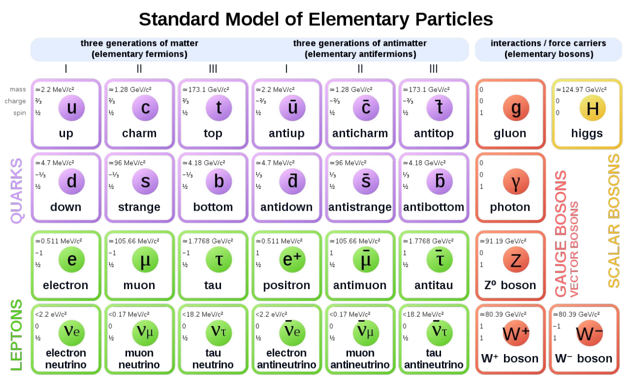
Standard Model Theory:

Today, the Standard Model is one of the most widely accepted theories used by physicists to explain phenomena in particle physics.

The Standard Model, however, has gaps and shortcomings.

The discovery of the Higgs Boson broadened the horizons of particle physics once again - it's properties may hold the key to entirely new physics.

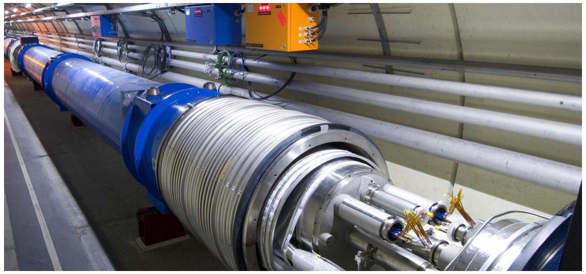
Studying Higgs Boson properties and cross checking the findings with predictions made by the Standard Model is one way of testing its validity.



Standard Model Particles (image credit : Wikimedia Commons))

LHC and ATLAS Experimental Setup:

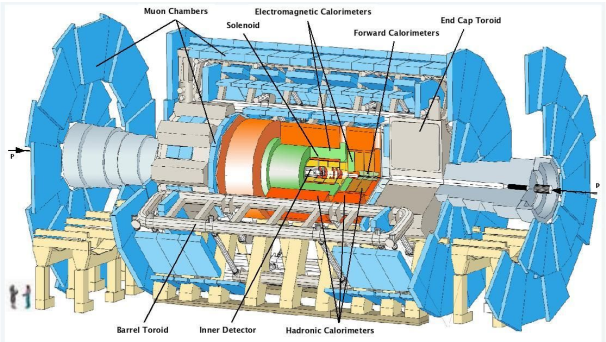
The Large Hadron Collider(LHC) at CERN, Geneva is the largest, most powerful particle accelerator in the world today. It is a 27 kilometre sized complex of different detectors



LHC accelerator at CERN, Geneva (image credit : CERN)

The ATLAS detector is one of the detectors in the LHC complex of detectors.

It is at the heart of Higgs Boson studies and was the source of data used in this project.



ATLAS Detector (image credit : sites.uci.edu)

Higgs and Di-Higgs:

Higgs Bosons (produced at the Large Hadron Collider in CERN,Geneva) are extremely rare particles.

Di-Higgs events (containing two Higgs bosons), are even rarer.

The Standard Model makes certain predictions about Di-Higgs events, and if we make different measurements, it can be a sign of new physics.

Large background processes make the rare processes even harder to observe.

If we can accurately model and identify the top-quark background, it becomes easier to more accurately detect Di-Higgs events.

The goal of this summer's project was to model the top-quark processes for this purpose.

Procedure:

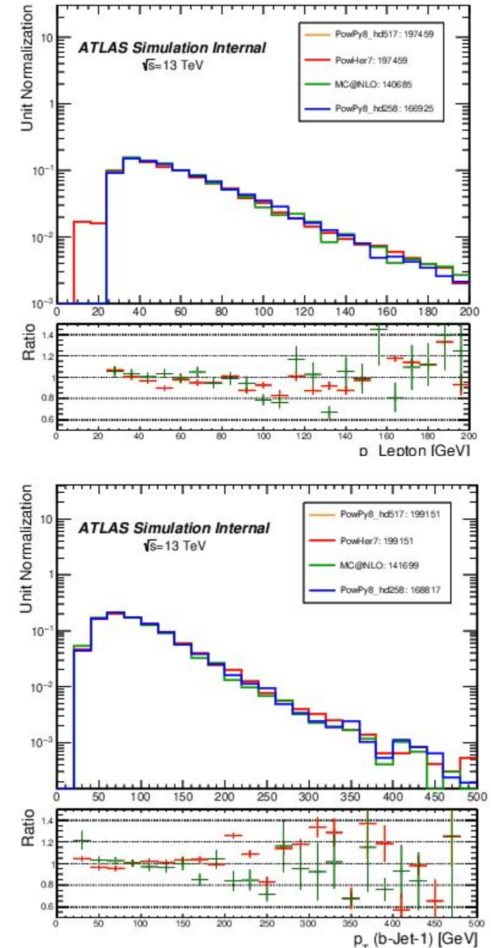
This involved running Monte Carlo simulated top-quark data, observing the distributions, and then designing strategies to reduce error on top-quark estimates. It included learning from CERN lectures and building on the work of a previous Toll Fellow.

Conclusion:

As part of the fellowship, I followed CERN lectures and hands-on tutorials on particle physics and computing & data analysis.

I reproduced previous results and the project is a work in progress. I successfully checked out and worked with the C++ based data analysis framework called ROOT.

The work I have done so far will be built upon in the future. Now that the framework has been set up, I will be trying new uncertainty reduction methods in the future.



Tools for Analysis : Plots produced this summer