FYST17 ATLAS Open Data Lab Instructions - Lund University, 2017-03-08

Today you will be using the ATLAS Open data platform - that is, you will analyse data taken from the LHC during the 8 TeV run. **This data contains Higgs bosons**!

http://atlas.cern/updates/atlas-news/explore-lhc-data-new-atlas-educational-platform

Once we have installed your virtual machines through which you can reproduce working with the tools we use for data analysis daily, you will be following the Software Book. It can be found here:

https://cheatham1.gitbooks.io/openatlasdatatools/content/

Read the web pages, take some notes, ask questions - and when you get to “Setup your environment” go straight to “Take a look at the data”. Read the material about your own analysis and try things out as the instructions suggest. There are some specific instructions and modifications you can/should make for your own analysis.

1) ttbar analysis.

1) Here you will look at the kinematic variables in the various processes that either are or mimic top pair production.

2) Can you also add a plot of the invariant mass of each of the top systems? Think of how you would pair the objects from each of the the top decays to obtain a (crude) version of the invariant mass of the original top, and use a TLorentzVector object (https://root.cern.ch/doc/master/classTLorentzVector.html) to do the addition of the four-vectors of the objects involved.

2) Z’ analysis.

1) This analysis requires a small modification in the datasets that you analyse so that they include the signal as well. When you plot them on top of the background, do you see anything? Try to scale it by 10 and by 100 in the plotting scripts.

2) After including the signal, you will look at the kinematic variables in the various processes that either are or mimic top pair production. Only the signal will “bump”. Are there any other variables that you could use to to distinguish signal and background?

3) The plots in the default version of the analysis miss an important plot for a bump-hunt, that is the invariant mass of the t-tbar system. What is this system made of, in a semileptonic ttbar decay? Sum all the objects you can think of in a TLorentzVector object (https://root.cern.ch/doc/master/classTLorentzVector.html), and add a histogram. There are files in the pen drive in your computer, but they contain the answer already so try and think first.

3) Z analysis

1) Here you will look at the kinematic variables of Drell-Yan Z production. Since the Z decays into leptons, the emphasis is on the variables relevant for leptons. Ask away what those variables are and mean (Else is the expert here!)

2) How does the relative width of the Z resonance compare to the intrinsic width that you find on the Particle Data Group website: http://pdg.lbl.gov/2016/listings/rpp2016-list-z-boson.pdf

4) Higgs analysis

1) Here you will look at the kinematic variables of Higgs bosons and its backgrounds for all the objects involved in this search.

2) Can you see the Higgs signal at all? Modify the plotting configuration to scale the Higgs process by 10 and by 100.

3) After seeing the Higgs signal, you can look at the kinematic variables again. Are there any other variables that you could use to to distinguish signal and background? If there is still time you can modify the analysis and try to add selections to remove the background further.

When you are done, you can move on to the interactive analysis here, and try to find a selection that enhances the Higgs signal on top of the backgrounds:
http://opendata.atlas.cern/visualisations/analyser-js.php