

Preparing for Final Project: Working with ROOT on the lifshitz cluster Using LHC Olympics files

We're going to set ourselves up to look at the LHC Olympics calibration files and an example analysis "macro" in ROOT. Bob McElrath has set up some code to get people started here at Davis. We will begin with this, although below I've done some modifications to make things easier for you and to work on lifshitz. The intro web page is linked from the 252b Projects webpage:
http://www.physics.ucdavis.edu/Classes/Physics252b/bob_lhc_olympics.htm

To begin, log into one of the nodes on the lifshitz cluster. If you've not already done so, copy my .bashrc file to your area. If you've already set up your .bashrc how you like it, then you need only copy a couple of lines.

```
student@lifshitznode> cp ~erbacher/.bashrc .  
student@lifshitznode> ll -a (You should see the .bashrc file.)  
student@lifshitznode> more .bashrc
```

You should see the following lines in your .bashrc, or if you didn't copy my whole rc file, you should copy these lines:

```
#Root setup  
export ROOTSYS=/usr/local/root  
export PATH=$PATH:$ROOTSYS/bin  
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:$ROOTSYS/lib
```

Create a directory in your area where you will do this work. Then copy the files from my area to your working directory:

```
student@lifshitznode> cp ~erbacher/252/final/* .
```

Here I've already converted the LHC Olympics text files to .root ntuple format using a ROOT macro originally written by my colleague, Gordon Watts from U. Washington, and modified/updated by Bob.

Next you want to look at the program SampleAnalysis.C to see what's inside of it.

```
student@lifshitznode> emacs SampleAnalysis.C &
```

The code is based on C++ but is a strange version that works with the ROOT C-interpreter called CINT. Here I'll go through a few of the pieces for ROOT beginners. Look for lines that begin with the text:

```
TFile * f = new TFile          Here we read in the .root file we want to look at.  
TH1F *h_nele = new TH1F      Here we are defining a histogram that we will fill  
while (t->GetEntry(event_number) > 0)  Here we loop over all the events  
h_nele->Fill (e->_electrons.size()); Here we fill the histogram with a variable  
corresponding to # electrons in the event.
```

We want to compile the program SampleAnalysis.C to obtain an executable called SampleAnalysis, then run the executable:
student@lifshitznode> make -f Makefile (or just type “make”)
student@lifshitznode> ./SampleAnalysis

Once the executable runs successfully, you should have a plots.root file in your working directory. Then launch root. You can either launch root and then load the file, or launch it with the file loaded:

```
student@lifshitznode> root  
root[0] TFile *f = new TFile{"plots.root"}; OR  
student@lifshitznode> root plots.root
```

Either way, root should be launched and the file plots.root should be loaded. If you then type “**TBrowser b;**” from the ROOT command line, a new window will open and here you can browse your .root files. The behavior of the browser is sometimes odd, but works in general. Click on “ROOT files” and you will find plots.root. You can click further and launch automatic histograms of the quantities in the branches and leaves of the tree, so it gives you an idea of what quantities you have to work with.

Most of these histograms are boring. Two of the histograms have physics content: **dijet_mass** and **dilep_mass** which are the invariant masses of all the jets pairs and lepton pairs, respectively. You can see W and Z peaks if you click on these. Read the code in SampleAnalysis.C to see what goes into the histogram. [Go to the ROOT website to learn about TH1F and TLorentzVector: <http://root.cern.ch/root/html/doc/TLorentzVector.html> .]

You can construct more meaningful quantities by performing more analysis cuts and selection criteria. To help you do this, first answer some questions about this analysis and what you’ve done so far. Some of these should be obvious and are stated above. Others are

not so obvious. For some we will discuss this in class. Make sure you can answer all of these.

Questions:

- 1) What is the name of the file that you are looking at with these histograms?
- 2) What are all the physics processes that might be represented in these events we are plotting?
- 3) What does the dijet invariant mass reconstruct?
- 4) What does the dilepton invariant mass reconstruct?
- 5) These events are all “signal” events (no backgrounds) of a calibration sample for the LHC Olympics. Why are there dijet invariant masses outside of the main physics mass peaks?
- 6) Why is the main dijet peak below the PDG value? (What’s the PDG value? Why is one process dominating to make this peak?)
- 7) Look at the `ele_pt` and `muo_pt` (electron and muon transverse momentum). They look similar and have a peak. Why? What is the peak?
- 8) How can you improve the dijet plot to make the “main peak” sharper?
- 9) How would you make the dilepton peak cleaner?
- 10) How would you make a histogram of the W in its leptonic decay channel, $W \rightarrow \ell \nu$?
- 11) How can you find out whether or not a jet contains a b-quark? (Note: this one is tricky, and may involve information not yet available in `plots.root`. You can make it available. How?)

Next you can copy `SampleAnalysis.C` to a different filename, `MyAna.C` (or some such). Try making changes to the analysis to implement some of these “cleanup” ideas such as in Questions 8 and 9, and try making the peak in Question 10. What other interesting things are there to look at? You will have to change the Makefile to point to `MyAna.C` and recompile, then run again. You may want to change the output file to `myplots.root` or some such.

Have fun!