ISP220 Honors Project: Analyzing LHC Collisions in the ATLAS Detector
Spring 2017

Document 2, March 14, 2017

Due: April 22, 2017

The Data Analysis

By this point, you've been through Exercises 1 and 2, and so you're beginning to get a feel for what events of particular kinds would be like in the ATLAS detector. We do not scan these things by eye – there are billions of them every month. Rather we train computers to do "pattern recognition" analyses and only look at the displays when things go wrong, or when things go very right. Science is much more the former, than the latter.

We're doing the "Z-Path analysis" from http://atlas.physicsmasterclasses.org/en/zpath.htm It involves calculations that the computer will do…just like for us…and identification of the kinds of events that you see. Note: these are real events, there is no correct answer in the back of the book. You make your best evaluation!

I hope you've read all of the information gotten by clicking on each of the side tabs from Introducing the Z Boson through Search and Discover Through Mass.

We're about to do the last one, Get to Work!

You'll find everything you need in,

http://www.pa.msu.edu/~brock/file_sharing/QSandBB/2017homework/honors_project_2017/

so ignore any instructions to get something else from their web page. In my directory are:

• The "groupA-etc" directories are your data…see below.
• The tally2017 directory contains 11 tally sheets that you'll fill out by hand as you analyze. One for each of you…see below.
• The spreadsheet is the assignments, which are duplicated below.

In the tally sheets, count using whatever stick-marks you use to keep track of counting. To me, that means for "7" I'd have made the marks: 卌 ||. Get what I mean?

What you'll turn in is:

1. Your paper (see the first instructions)
2. Your tally sheets filled out
3. Your invariant mass plots (see below)
4. Your invariant mass export to Invariant_Masses.txt

Here are your measurements:

1. **Count and categorize your events.** You'll have a total of 100 to analyze into Z, Z', Higgs (in gamma-gamma and/or eeee, eemumu, or mumumumu), or background. Follow the suggestions on the Analyzing Your Result page.
2. **Invariant mass calculations.** HEPATIA does this for you.

Your Data

Your data sets are found at:

http://www.pa.msu.edu/~brock/file_sharing/QSandBB/2017homework/honors_project_2017/

Each of the group directories contain 50 real LHC events taken by our ATLAS detector. They're randomized. You're each assigned 100 events, from two of the directories according to the assignments in the spreadsheet (and the table below). The assignment is like this, alphabetically. Mr Chen, you get the 50 events in groupA and the 50 events in groupA-2. The rest of you get them in that same way.

I've made a 25 minute movie that shows you exactly what to do. You can find it as

http://www.pa.msu.edu/~brock/file_sharing/QSandBB/2017homework/honors_project_2017/Zpathintro.mp4

I think I've done everything you need. So you don't have to follow the links on the Data samples and Tools page. Furthermore, the last line of the Do It! page…hold off on that.

Your Workflow:

1. Fire up your HYPATIA tool.
2. Arrange your windows so you can see everything, as per the movie.
3. Download your two directories into local directories near your HYPATIA JAVA tool.
4. Choose the first directory and start analyzing.
5. You can save your work and go do something else and then come back. In File, you can save your HYPATIA project and then when you come back, open HYPATIA and load the saved file.
6. When you're done (or maybe before…just to play), save out the histograms that you made and include them in your writeup after you've done all 100 events. Remember some will be backgrounds (not interesting physics) and so your final results will probably be fewer than 100 events.
7. Export your histograms to the file that it does for you in File/Export Invariant Masses.
8. I want to manage a dropbox folder where you can dump your results, so send me the email address you prefer to use with **HONORS dropbox** in the subject line. I'll then send you an invitation to access the folder.[1]

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[1] If you know Dropbox, then you know how useful it is. If you don't know Dropbox, then consider this a part of your education! You're welcome. I live in Dropbox.

9. COPY your Invariant_Masses.txt file to a second file called Invariant_Masses-A.txt…or whatever is your letter. So you've got two.
10. MOVE your Invariant_Masses-A.txt file into the dropbox directory that I will have confirmed for your use.

Do this by April 22, 2017. I'll combine all of your results together and we'll see what you discovered.

One caveat: I'll be in touch with the UN/PW that you'll need to upload your results as per the last line in the Do It! page.

What you should turn in is enumerated on the first document. Include your worksheets and the spreadsheet if you use it. If you print out any events, include them. Remember, keep a narrative like you're really doing an experiment…which you are!

Have fun! Here's the table:

Student_Name	Datasets	
Chen, Jason Jiang	A	A-2
Durocher, Devin William	B	B-2
Faustino, Daena Alison	C	C-2
Geizer, Zack	D	D-2
Joseph, Taylor Lynn	E	E-2
Ketola, Morgan Nicole	F	F-2
Mcpeak, Kat	G	G-2
Morse, Spencer Michael Duane	H	H-2
Pero, Airn Wisdom	I	I-2
Purdue, Owen David	J	J-2
Roth, Drew Douglas	K	K-2