ISP220 Honors Project: Analyzing LHC Collisions in the ATLAS Detector

Spring 2019

Document 2, March 22, 2022

Two due dates:
1. Final paper: May 3, 2019
2. Data text file (see below): ready to upload on April 26, 2019

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.

You'll find everything you need in,

https://qstbb.pa.msu.edu/storage/QS&BB2019/Homework_Projects/honors_project_2019/

so ignore any instructions to get something else from their web page.

In our directory are:

- The "groupA-etc" zipped directories are your data…see below.
- The "tally" directory contains tally sheets that you'll fill out by hand as you analyze. One for each of you…see below.
- This document and document #1
- inspirational talk
- how-to video

Your Data

Your data sets are assigned to each off you at the end of this document and you'll find the actual data at:

https://qstbb.pa.msu.edu/storage/QS&BB2019/Homework_Projects/honors_project_2019/

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 Garner, you get the 50 events in groupH and the 50 events in group H-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

https://qstbb.pa.msu.edu/storage/QS&BB2019/Homework_Projects/honors_project_2019/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.

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.

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

2. **Invariant mass calculations.** HEPATIA does this for you.

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 from the zipped files in the directory.
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. This is for your report.
8. COPY your Invariant_Masses.txt file to a second file called Invariant_Masses-A.txt…or whatever is your letter. This one's for uploading.
9. I will tell you where and how to upload your results to an on-line tool that will combine them. I'll be in touch with the UN/PW that you'll need. But uploading needs to be done by April 26, 2019.

What you'll turn in at the final exam are:

1. Your paper (see the first instructions)
2. Your tally sheets filled out
3. If you print out any events, include them.
4. Remember, keep a narrative like you're really doing an experiment...which you are!

5. Your invariant mass plots
6. Your invariant mass export to Invariant_Masses.txt

Have fun! Here's the table of assignments:

NAME	**Datasets**	
Andrews, Benjamin	A	A-2
Bassett, Mark Francis	B	B-2
Burdick, Caroline N	C	C-2
Cismesia, Nadia R	D	D-2
Crosser, Madison Marie	E	E-2
Czajka, Brenden Michael	F	F-2
Dailey, Jack Walsworth	G	G-2
Delgado, Antonio Christopher	H	H-2
Eberle, Alison Reine	I	I-2
Feather, Nathan	J	J-2
Feldman, Jacob Matthew	K	K-2
Freitag, Christian	L	L-2
Gettel, Justin Andrew	M	M-2
Hobson, Alyssa Jordan	N	N-2
Huang, Qi	O	O-2
Kada, Myrna Mahir	P	P-2
Maceri, Tommy	Q	Q-2
Mansour, Ellia Noelle	R	R-2
Mccallum, Erin Margaret	S	S-2
Poe, Jeralyn Megan	T	T-2
Richard, Bre	U	U-2
Rodas-Mazariegos, Paulo Gerardin	V	V-2
Steffke, Madeline May	W	W-2
Warner, Mikayla Erin	X	X-2