Direct Comparison of ATLAS and CMS Data

Matthew Snape
Supervisor: Achim Geiser

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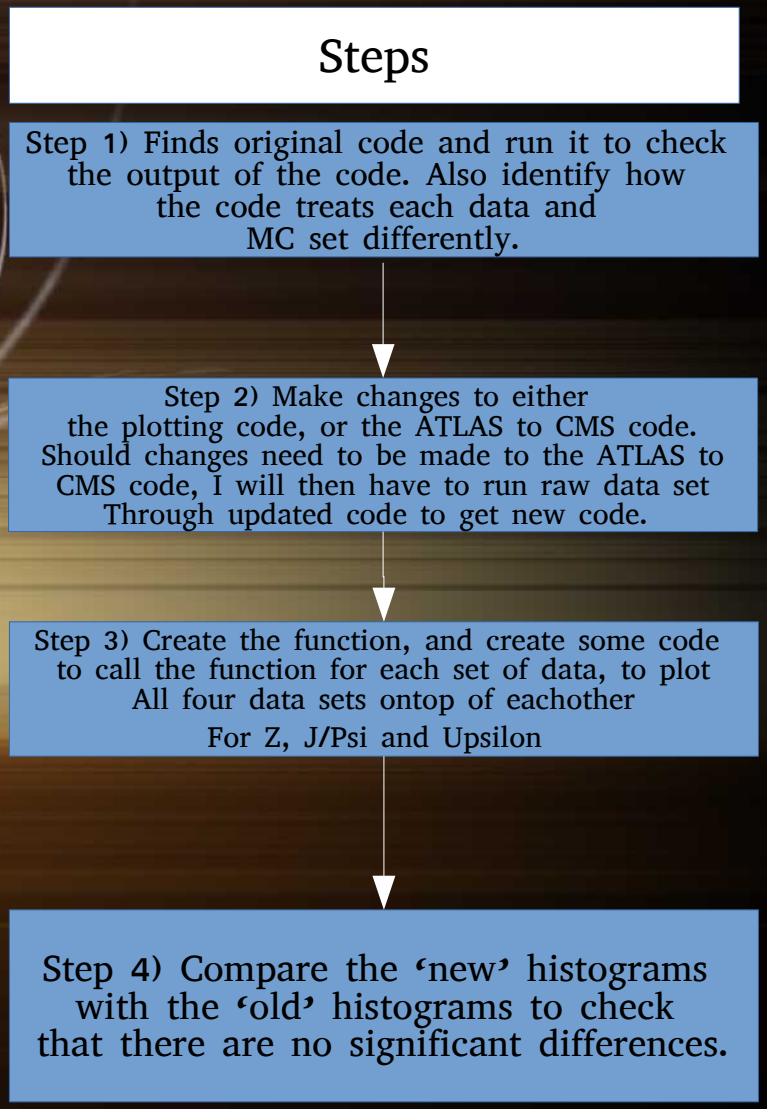
UNIVERSITY OF LIVERPOOL

Introduction

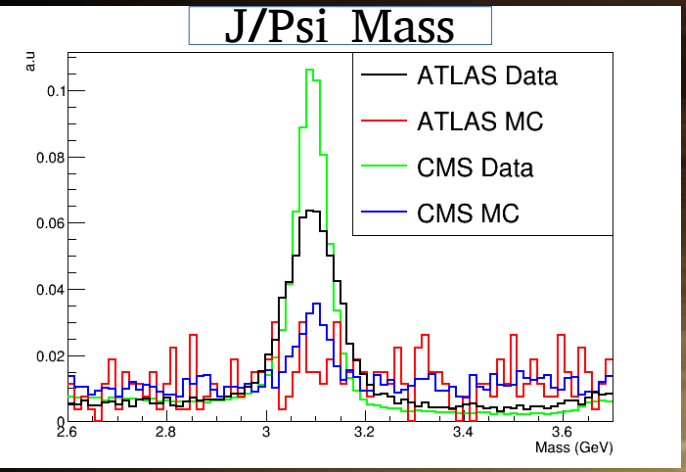
- The final goal was to create code that could analyse both ATLAS and CMS data/MCs using the same function.
- Used only ATLAS and CMS open data.
- Data is freely available for anyone to use, including students ranging from high school to students doing their masters degree, and Researchers.
- CERN open data is available from: http://opendata.cern.ch/



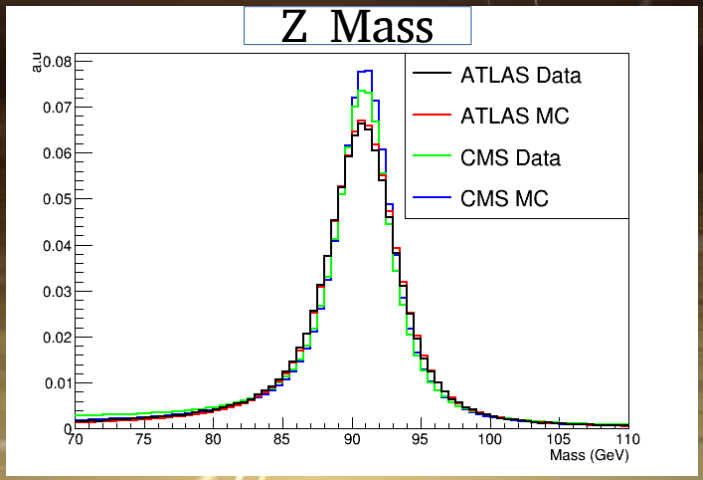
Step 1: Finding and running the original code

- Original code (identicalmass.C) needed to be found and ran, so I could see what the code produced (which is what im aiming to replicate) and if some changes needed to be made.

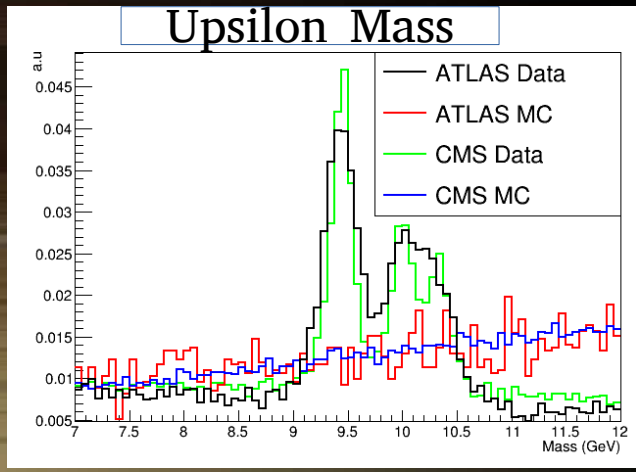
J/Psi Mass



Z Mass



Upsilon Mass



Looking at original code, we can see that each set of data is processed slightly differently.

Difference between ATLAS and CMS

ATLAS: Different energy scale convention

```
hmu_mmu1at->Fill(mass_dimuon/1000.);
hmu_mmu2at->Fill(mass_dimuon/1000.);
hmu_mmu3at->Fill(mass_dimuon/1000.);
```

CMS: Selection of cuts needed to be tighter

```
if ((Muon_pt[bb]>25 && Muon_pt[cc]>5)||(Muon_pt[bb]>5 && Muon_pt[cc]>25))
```

Step 2: Converting ATLAS data to usable a format

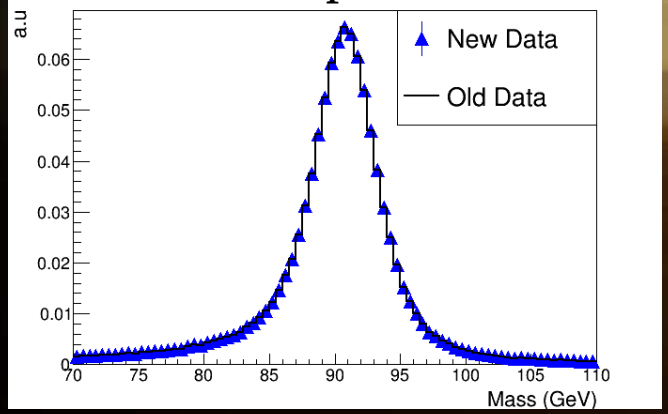
The first step to achieving the main goal, is to look at the script that converts ATLAS data into CMS like data. (atlastocms.C)

```
Muon_pt.push_back(lep_pt[bb]);
Muon_eta.push_back(lep_eta[bb]);
Muon_phi.push_back(lep_phi[bb]);

Muon_charge.push_back(lep_charge[bb]);
Muon_E.push_back(lep_E[bb]);

Muon_pfRelIso03_all.push_back(lep_etcone20[bb]);
Muon_pfRelIso03_chg.push_back(lep_ptcone30[bb]);
Muon_dxy.push_back(lep_trackd0pvunbiased[bb]);
```

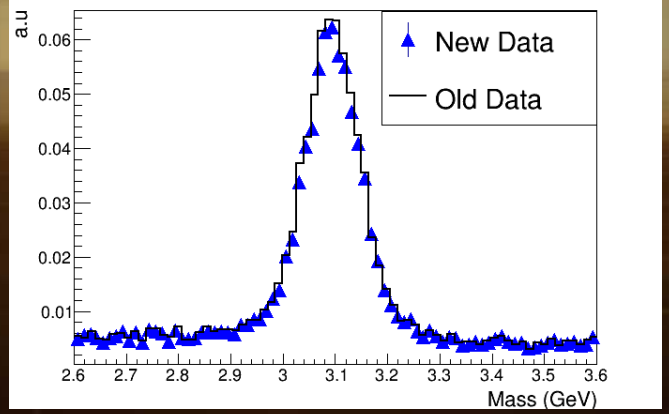
```
Muon_pt.push_back(lep_pt[bb]/1000.);
Muon_eta.push_back(lep_eta[bb]);
Muon_phi.push_back(lep_phi[bb]);

Muon_charge.push_back(lep_charge[bb]);
Muon_E.push_back(lep_E[bb]/1000.);

Muon_pfRelIso03_all.push_back(lep_etcone20[bb]/1000.);
Muon_pfRelIso03_chg.push_back(lep_ptcone30[bb]/1000.);
Muon_dxy.push_back(lep_trackd0pvunbiased[bb]);
```

Relatively simple change, only required to divide some variable by a factor of 1000 to convert ATLAS data from MeV to GeV.

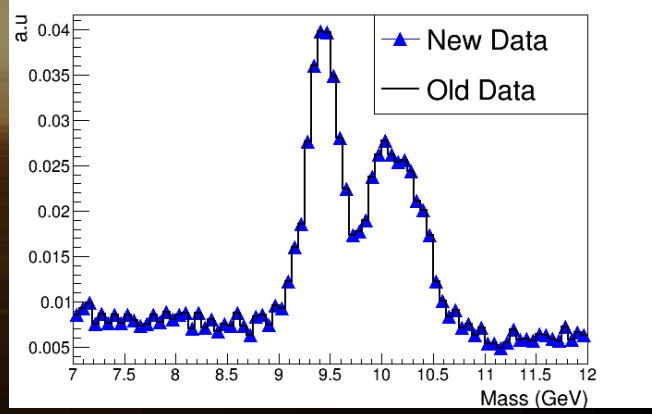
Z Mass Comparison (Data)



J/Psi Mass Comparison (Data)



Upsilon Mass Comparison (Data)



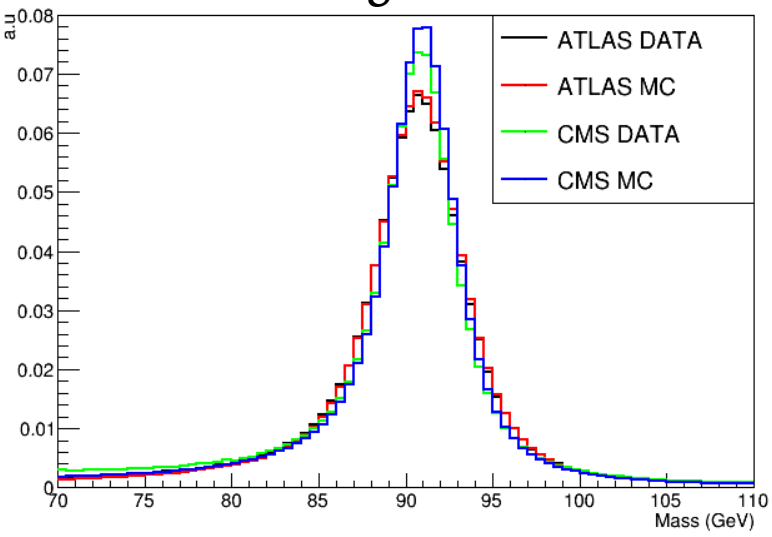
Creating the new Histograms

- Since, the ATLAS data was already all muons, I simply applied the cuts to the ATLAS Data and MC.
- I now had all 4 datasets being analysed the same way, so it was then time to create a single function that could be called 4 times for each data set.

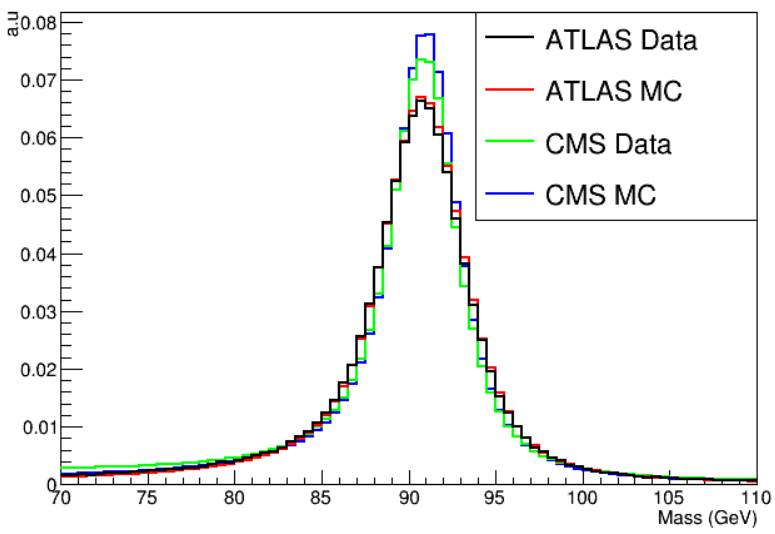
```
//////////Insert filepath as string and whether it is Data or a monte carlo, 1 = data, 0 = monte carlo//////////
void new_analysis(){

  analyse("cms_atlas_data_new.root",1,"ATLAS DATA");

  analyse("cms_atlas_mc_new.root",0,"ATLAS MC");

  analyse("/nfs/dust/cms/user/geiser/nanoAOD/2011/Data/Data11_DoubleMu.root",1,"CMS DATA");

  analyse("/nfs/dust/cms/user/geiser/nanoAOD/2011/MC/MC11_DY50.root",0,"CMS MC");


}
```

I called this file new_analysis.cxx, and now I had to run it and then Compare it to the original Histograms

New Histogram (Z Mass)

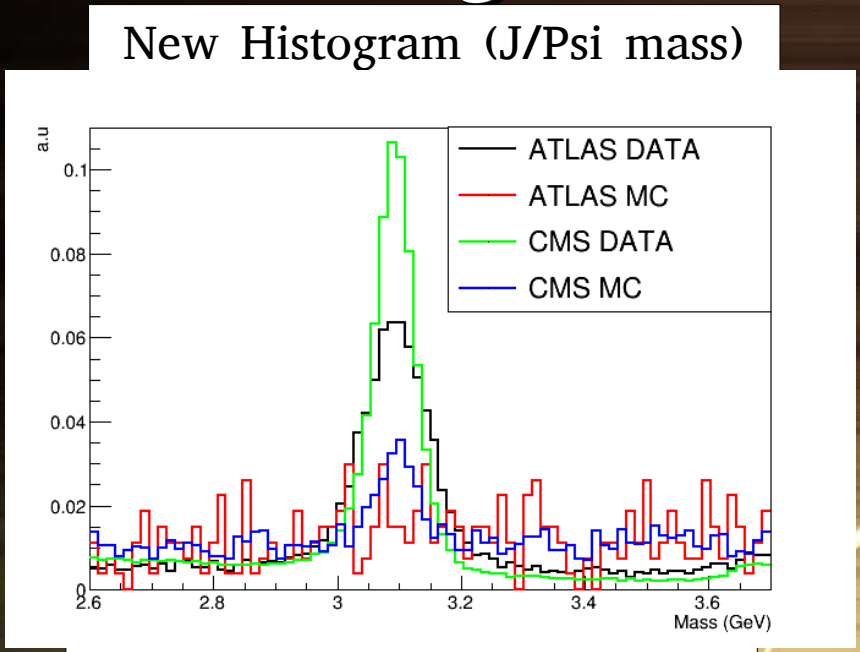


Old Histogram (Z Mass)

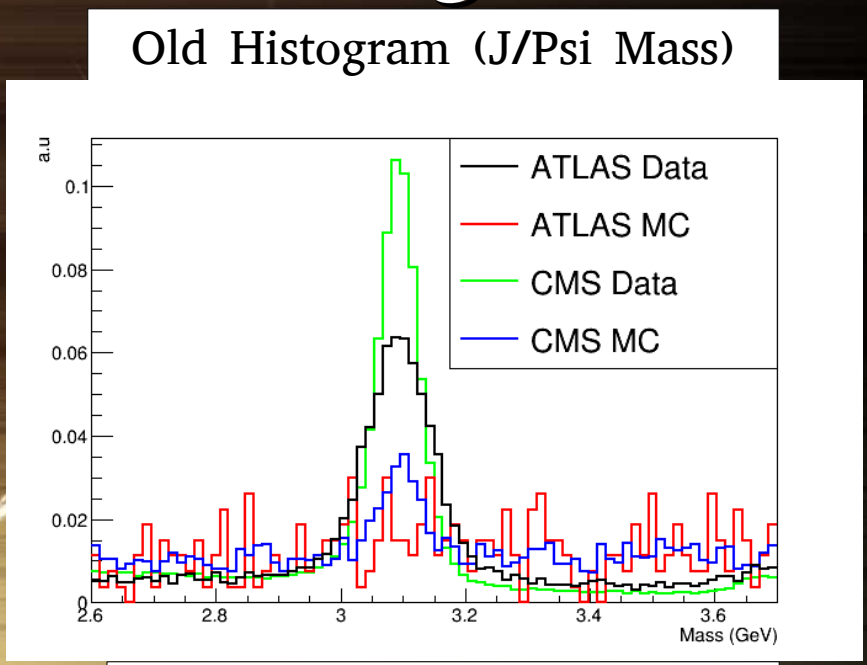


Creating the new Histograms

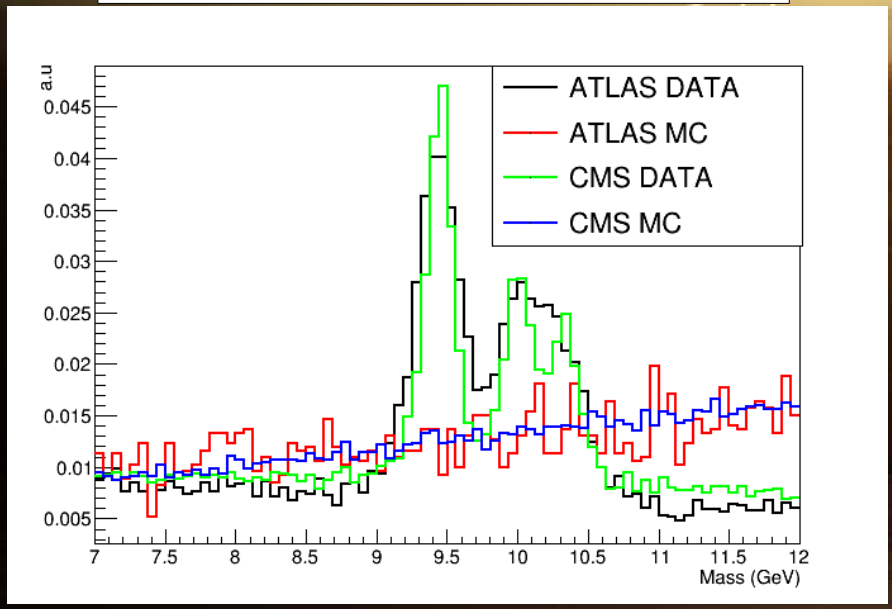
New Histogram (J/Psi mass)



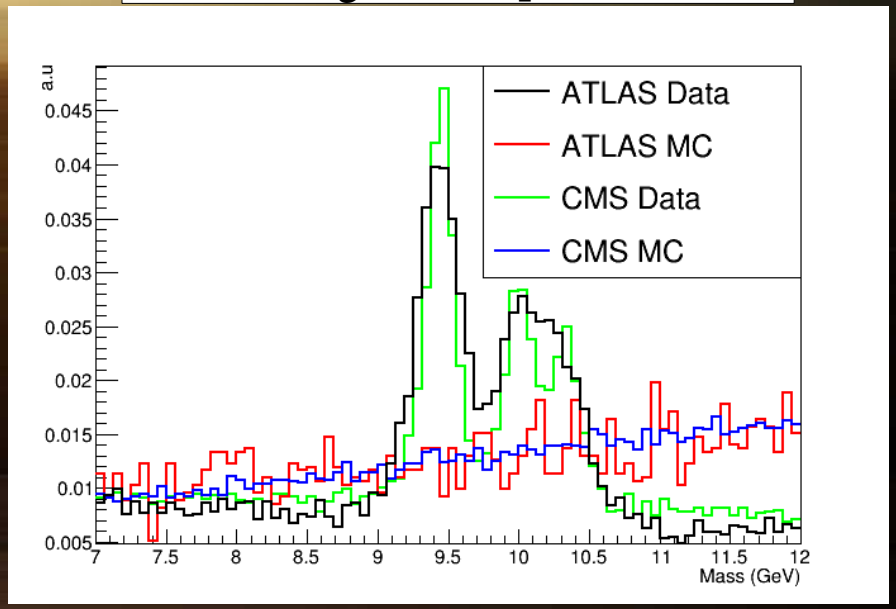
Old Histogram (J/Psi Mass)



New Histogram (Upsilon Mass)



Old Histogram (Upsilon Mass)



Conclusion

- Can directly compare ATLAS and CMS data using same method
- Z mass spectrum was used, as it is well known. J/Psi and upsilon were chosen, due to the fact that decay channels are easy to reconstruct even at low C.O.M energy
- Decay channnels of two muons chosen as muons are easy to identify in both CMS and ATLAS detectors
- Final goal was achieved

Backup

Some information

- General selection to reconstruct dimuon:
  - no. of muon > 2
  - Total charge muon1 & muon2 = 0
- Datasets used:
  - ATLAS MC: Zmumu + Jets
  - ATLAS Data: Muons dataset
  - CMS MC: DY Jets to LL
  - CMS Data: DoubleMuon

Mass spectrums from dielectrons