

Z Boson Electron Identification

Marshall Rogers
Columbia University

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Introduction to the LHC and ATLAS

The LHC, or Large Hadron Collider is both the largest and highest energy particle accelerator in the world and is located in Geneva, Switzerland at CERN, the European Organization for Nuclear Research. The ATLAS Experiment is one of the seven experiments that use the LHC to investigate new physical phenomenon.

The main goal of CERN and the ATLAS experiment is to investigate the validity of the Standard Model. By colliding a large number of protons, the basic units of matter can be examined more closely. To examine the results of such high energy and complex collisions, detectors like the ATLAS experiment or CMS are used.

The ATLAS detector is...

Z Boson and the Randall-Sundrum Graviton

Describe the process you are looking at – Z and Randall-Sundrum Graviton (2-3 pages) – how are the Z and G produced in proton-proton collisions? (feynman diagrams) – what is the final state we are looking at - electron positron pair (what are the decay channels for Z and G? why look at $e^+ e^-$?) – what are the cross-sections for Z and G ? — what is the best measurement of the Z cross-section, and best limit on G production? — plot invariant mass of the Z MC and a few mass points of G MC overlaid with the proper cross-sections for 100/pb – what backgrounds would you see for this channel? (just describe the physics processes)

Electron Identification and Selection

How would you see the electrons in the detector? (3-6 pages) – electron ID - what are the cuts? — explain loose/medium/tight (make a table?)

— show eta vs phi 2D plot to look at detector coverage for Z MC

— explain pt and eta bins of ID, show some 2D eta vs cut plots - Z MC – how do we use the data to estimate the background? — describe anti-cuts, data sample — show some plots of electron ID variables for loose Z MC and background from data – how do these

Table 1: Loose, Medium and Tight Cuts

Type	Description	Variable Name
Loose Cuts		
Acceptance of the detector Hadronic leakage	$ \eta < 2.47$ Ratio of E_T in the first sampling of the hadronic calorimeter to E_T of the EM cluster	
Second layer of EM calorimeter	Ratio in η of cell energies in 3×7 versus 7×7 cells. Ratio in ϕ of cell energies in 3×3 versus 3×7 cells. Later Width of the shower.	R_η R_ϕ
Medium Cuts (includes Loose cuts)		
First layer of Em Calorimeter	Difference between energy associated with the second largest energy deposit and energy associated with the minimal value between the first and second maxima Second largest energy deposit normalised to the cluster energy. Total shower width. Shower width for three strips around maximum strip. Fraction of energy outside core of three central strips but within seven strips.	ΔE_s R_{max2} w_{tot} w_{s3} F_{side}
Track quality	Number of hits in the pixel detector (at least one). Number of hits in the pixels and SCT (at least nine). Transverse impact parameter (< 1 mm).	
Tight Cuts (isol) (includes Medium cuts)		
Isolation	Ratio of transverse energy in a cone $\Delta R < 0.2$ to the total cluster transverse energy.	
Vertex-layer	Number of hits in the vertexing-layer (at least one).	
Track matching	$\Delta\eta$ between the cluster and the track (< 0.005). $\Delta\phi$ between the cluster and the track (< 0.02). Ratio of the cluster energy to the track momentum.	E/p
TRT	Total number of hits in the TRT Ratio of the number of high-threshold hits to the total number of hits in the TRT.	
Tight (TRT) (includes tight (isol) except for isolation)		
TRT	Same as TRT cuts above, but with tighter values corresponding to about 90% efficiency for isolated electrons.	

electron ID cuts change as a function of pT in the MC? — overlap histos for loose variables in a particular eta for a few pts - Z MC, G MC * — quantify agreement/disagreement - do we need to reoptimize these cuts? *

Results

Looking at the data (2-3 pages)

– list event level cuts (Good Run List, OTX, etc)

I applied the Good Runs List to my data

– show a Z peak for all the data that we have compared with Z MC – a few plots of the Z data and Z MC electron ID variables overlapped (even those the statistics will be low)

Conclusions

5) Conclusions - do we need to change our loose cuts for looking at electrons from Z's and from G's? (j= 1 page)

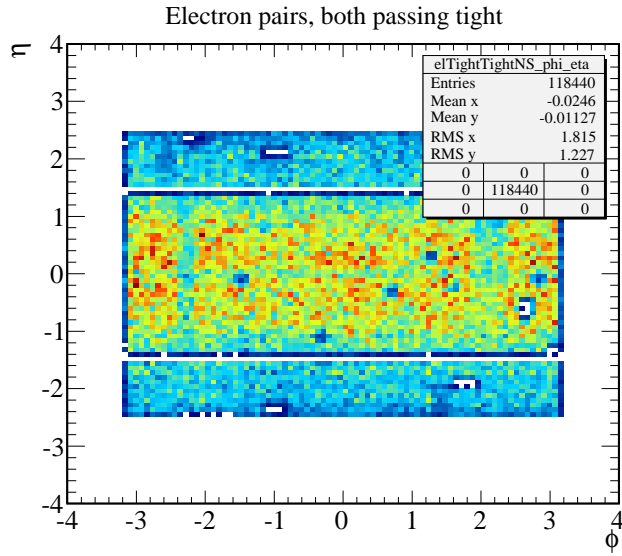


Figure 1: η vs ϕ showing detector coverage for Z Boson

References

- Latex will help you do them easily

Appendices

- any extra plots, tables that are too detailed to put into the text

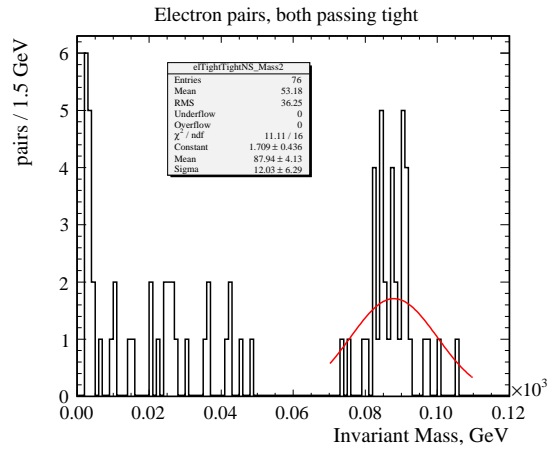
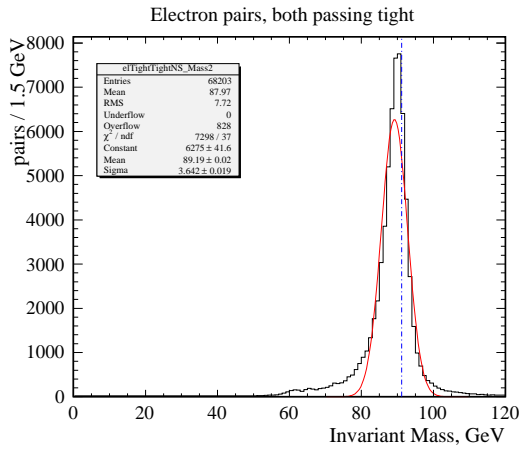


Figure 2: Z Mass Peak, in Monte-Carlo (left) and from Data (right)

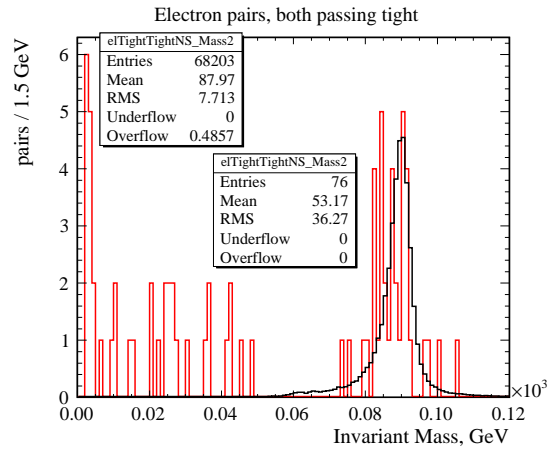
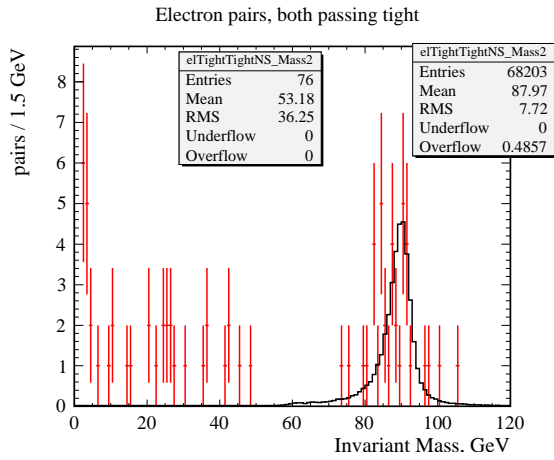


Figure 3: Z Mass Peak, Data Overlaid Monte-Carlo