$Z \to ee$ ANALYIES

INTRODUCTION

The analysis I'm doing is finding Z particle from the process $Z \to e+e-$
Analyzing a real data sample produced at Fermi lab from colliding p and $\bar{p}$.

The study of the production properties of the Z boson began in 1983 with its discovery at CERN $p\,\bar{p}$ collier together with the discovery of the W boson earlier that year.

The observation of the Z bosons provided a direct confirmation of the unified model of the weak and electromagnetic interactions, which together with QCD is now called the standard model.

The measurement of the production cross sections multiplied by the leptonic branching Fractions for W & Z bosons can be used to test predictions of QCD for W&Z production and extract the width of the W&Z bosons with new decay modes, which might indicate of the existence of any new particles.

The ratio: $R=\sigma w*B\ (w \to l\,\nu)/\sigma z*B\ (z \to ll)$

σ: Cross section

B: Branching ratio.

The intrinsic properties of the Z bosons would be known by examining the electro weak character of its production and decay in e+e- collisions.

My study now is finding the signal proving Z existence by determining its mass and then plot the number of jets that associated with its production.

THE DETECTOR

D0 is a multipurpose detector designed to study $p\bar{p}$ collisions at the Fermi lab tevatron Collider, and it consists of three primary components:

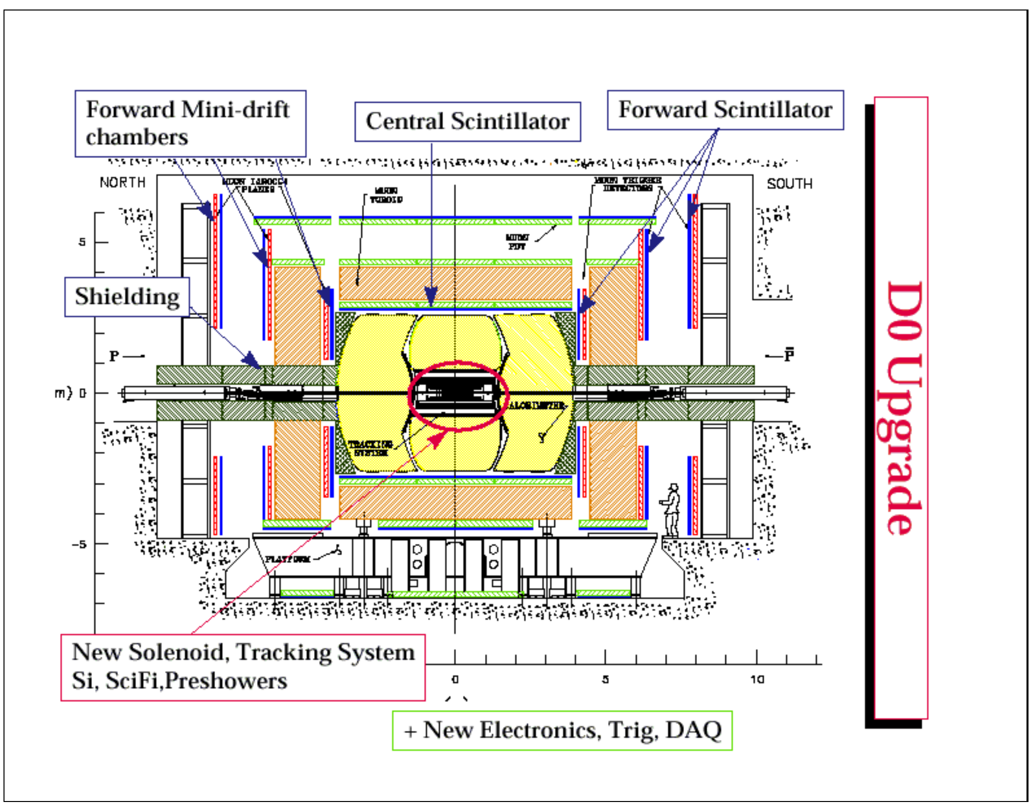
1) Solenoid tracking system, which consists of four-detector subsystem:
a) A vertex drift chamber.
b) A transition radiation detector
c) A central drift chamber.
d) Tow forward drift chambers.

The system provides charged particle tracking, and measures the iosination of tracks and can be used to distinguish single charged particles and e+e- pairs from photon conventions.

2) Calorimeter:
It's nearly a hermetic uranium and liquid argon and it is surrounding the central tracking system and it's divided into three parts:
a) Central calorimeter
b) EM section
c) Hadronic section

The electrons are identified primarily by the presence of an electromagnetic shower in the Calorimeter. And the jets in hedonic section.

3) Magnetic muon spectrometer: It is out side the calorimeter and since muons from Wand Z bosons decays populated predominantly the central region this work uses the Space-angle muon spectrometer.



DESCRIPTION OF THE DATA SET

I'm analyzing events passing the filter requirement:

1) Dielectron, tow or more electrons with pt>10 Gev.

2) The quality requirements for electrons are:

a) HMx8 < 200.
b) Emf > 0.9.
c) Abs (id) = 10 or 11.

The location: cleud0/rooms/sauna/higgs/skim/

TMBTree/TMB files

My references:

a) The article: measurement of W & Z bosons production cross sections in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 Tev (1999).

b) The article: measurements of the inclusive differential cross section for bosons as a function of transverse momentum in $p\bar{p}$ collisions at $\sqrt{s}$=1.8 Tev (2000).

c) Selection cuts from EM id group and JET id group.

DESCRIPTION OF THE CUTS

1) For electrons:

To be acceptable candidates for Z production both electrons required to be isolated and satisfy the cluster shape requirements and both electrons are required to have a matching track associated with the reconstructed calorimeter cluster to separate electrons from photons, and the total amount of energy that deposited in electromagnetic cone to be greater than 90%so that I will eliminate the jets because their electromagnetic deposition around 60%.
These will pick out the interesting electrons I want by reducing the background.

THE CUTS ARE:

a) Abs (emcl->id ()) = 11.
b) Emcl pt > 25.
d) 0.15>emcl iso >-0.05.
e) Emcl HMx8 < 40.
f) Emcl Emfrac > 0.9.
g) And trks.

2) For jets:

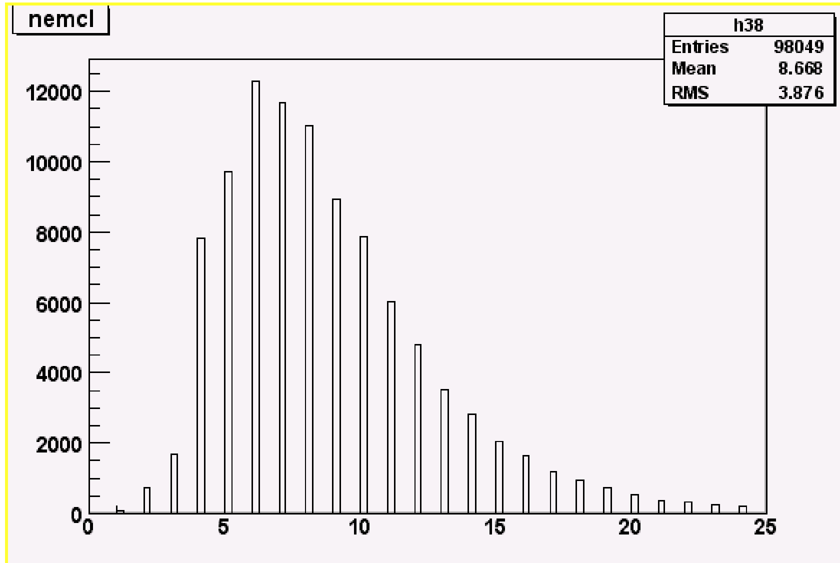
I ask for the ratio of energy deposition in the hadronic is very low so will eliminate the possibility of hot cells and specify the electromagnetic fraction in the hadronic Calorimeter.

THE CUTS ARE:

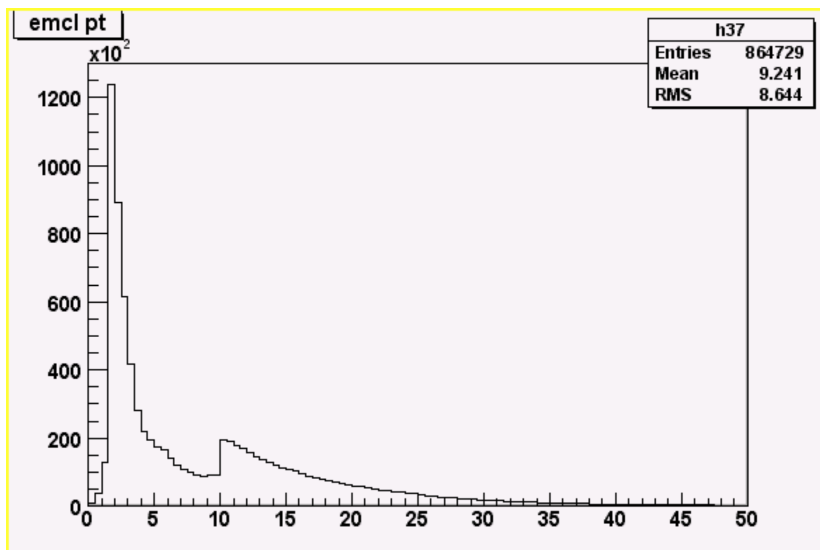
a) Jets hot < 10.
b) 0.95 > jets emf >0.05.
c) Jets n 90 >1.
d) Jets pt > 20.

THE DESCRIPTION OF THE SAMPLE BEFORE THE CUTS

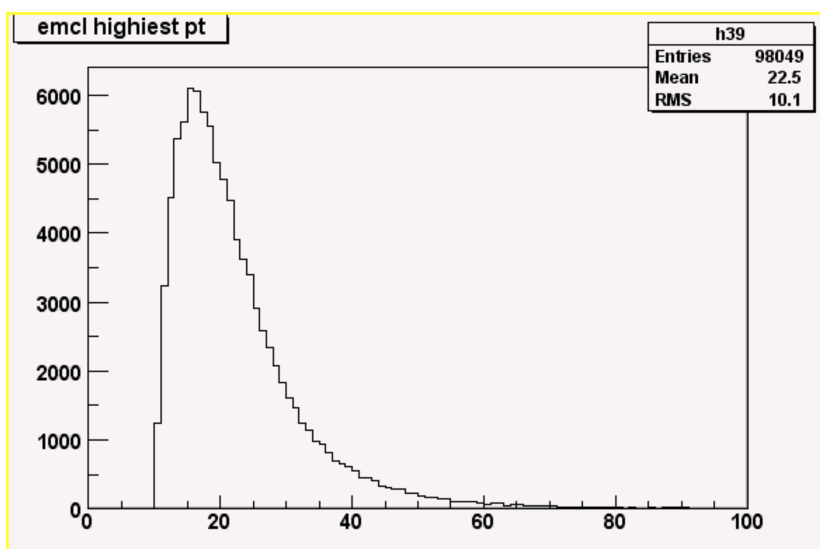
1) # of events = 98049



2) Pt distribution of all emcl objects

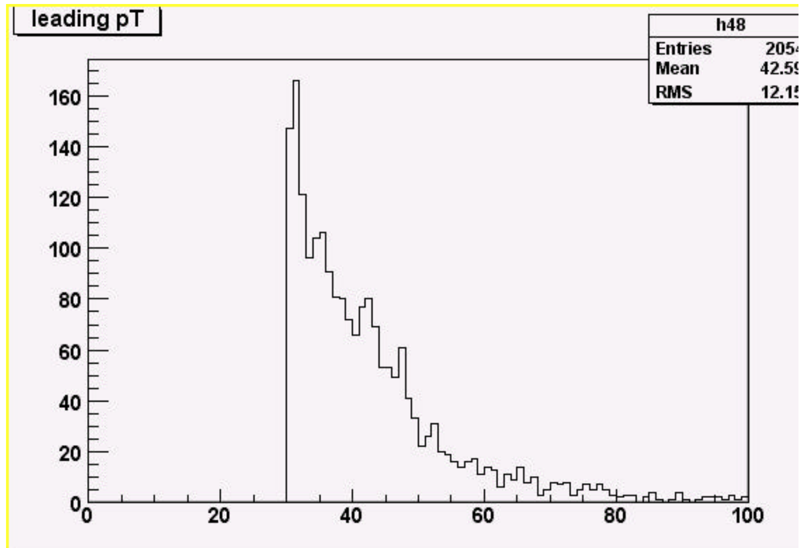


3) The highest pt of the emcl objects

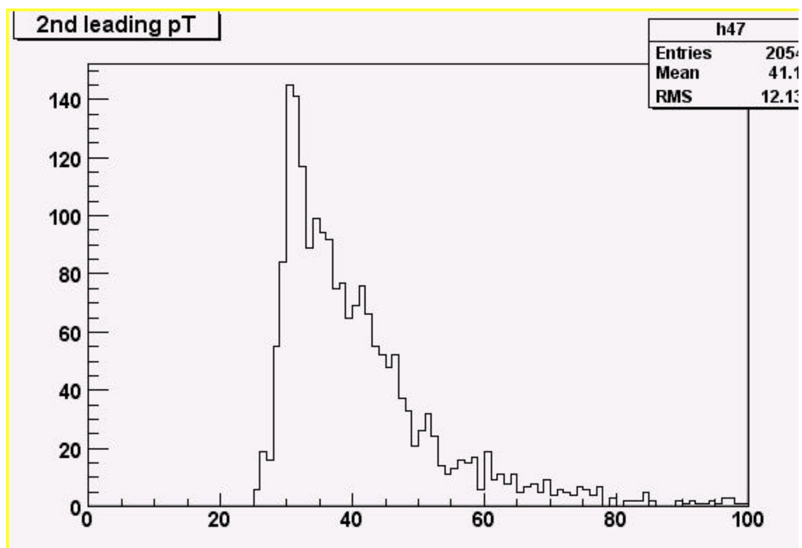


THE DISTRIBUTIONS AFTER THE CUTS

After the electrons passing the cuts and looking for two or more electrons,
and requesting the pt for the leading electron to be more than 30 Gev and the second leading higher than 25 Gev I have these distributions:

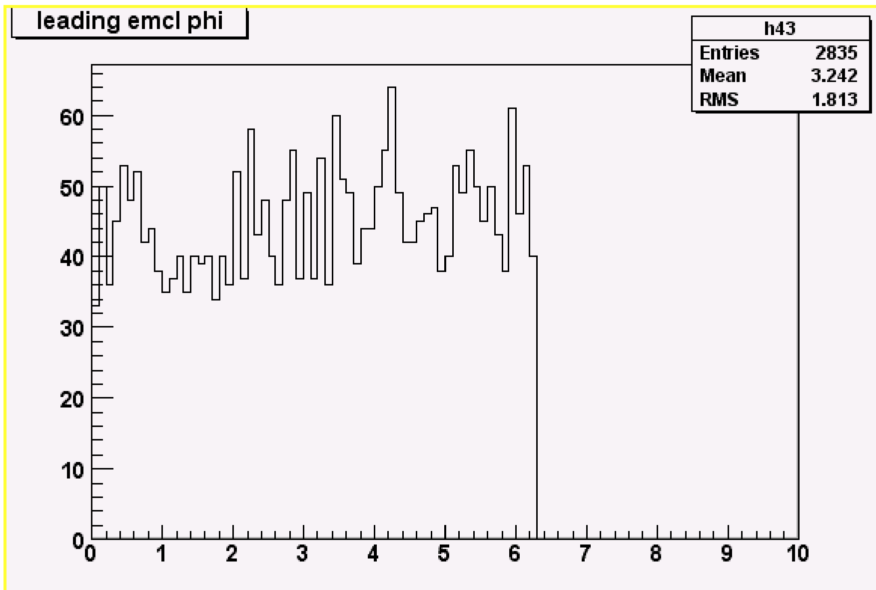


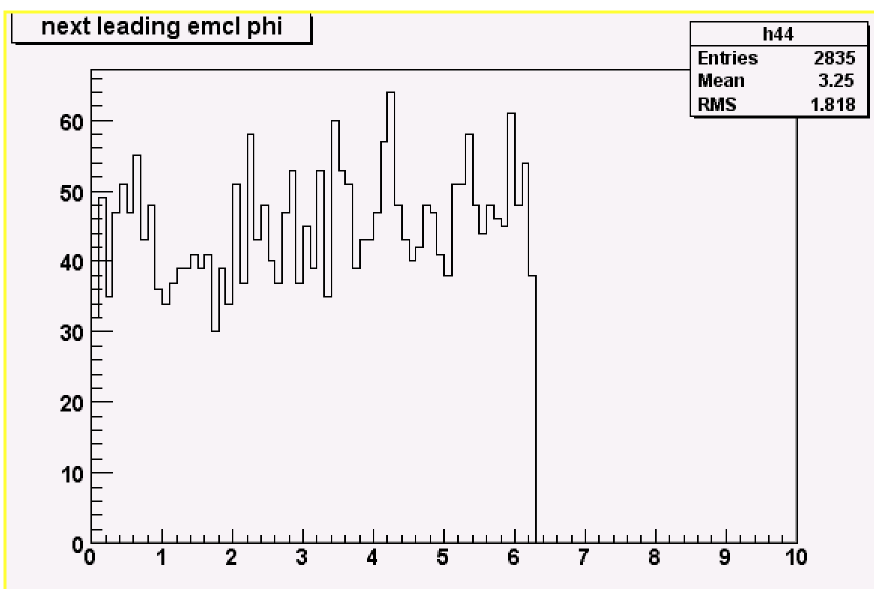
So the number of events went down to:
The third almost.
My expectation that I have to see a peak around 40 Gev in both Histogram, but it is not clear yet.
My explanation would be because the number of the Z particles is low so could be hidden and difficult to see it now.
My solution to this problem is plotting back these Histograms again
After calculating the Z mass.



THE PHI DISTRIBUTIONS

Phi is the azimuth angle and I can see kind flat distribution for both

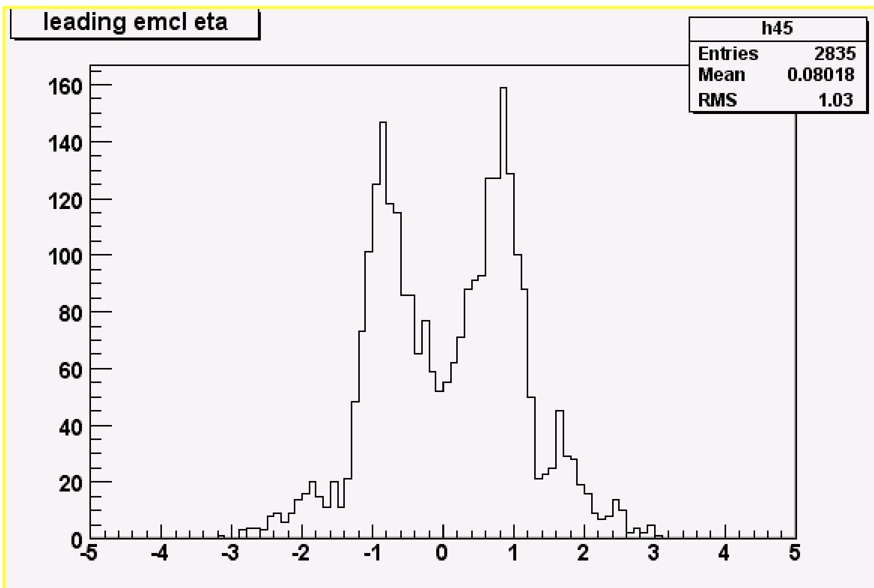


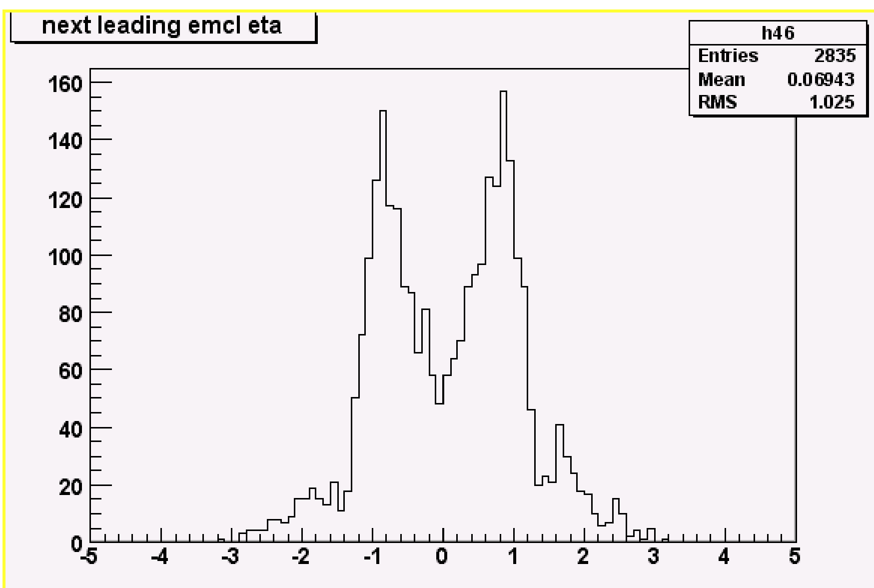


THE ETA DISTRIBUTION

$Eta = - \ln(\tan\theta/2)$ and $Pt = E \sin\theta$

Eta distribution is connecting with the physics process and it will go down at 2.2 and –2.6 Because I cannot have detector with infinite energy take it further than that.
So these two histograms gives me an idea about the energy distribution of my electrons.





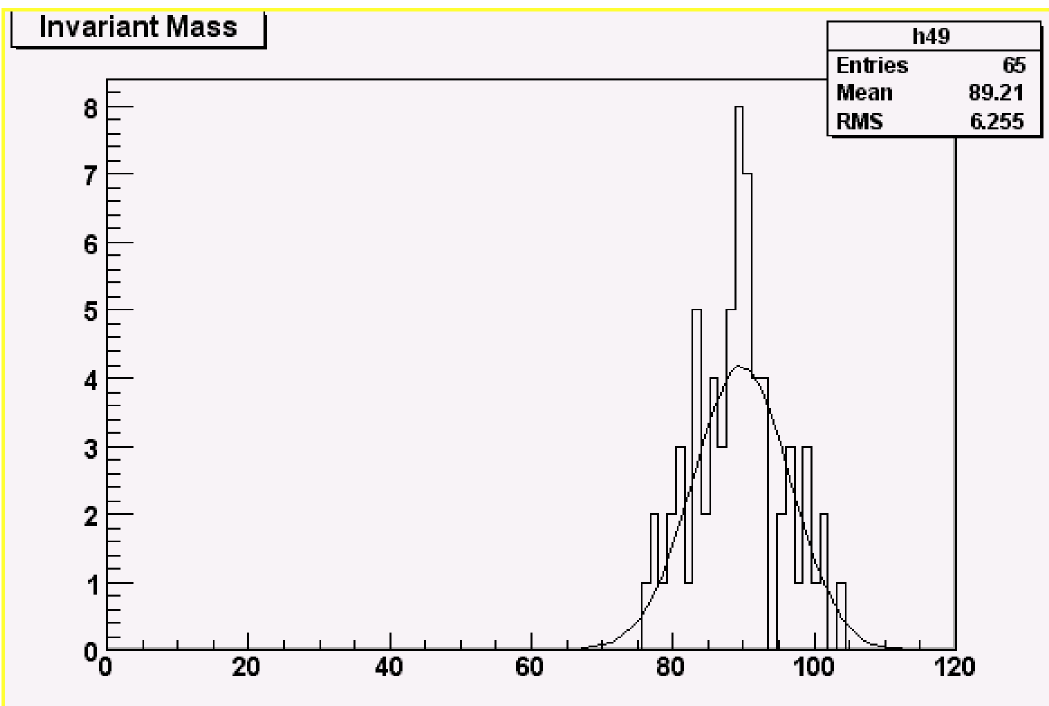
PROOF OF THE Z EXISTENCE

In the parton model, at lowest order Z bosons are produced in head-on collisions of $q\ \bar{q}$ constituents of the protons and anti protons and cannot have any transverse momentum so The Z is at the rest frame and it's invariant mass around 90 Gev.
So my signal is by finding a peak in that region, and my formula I did use is:

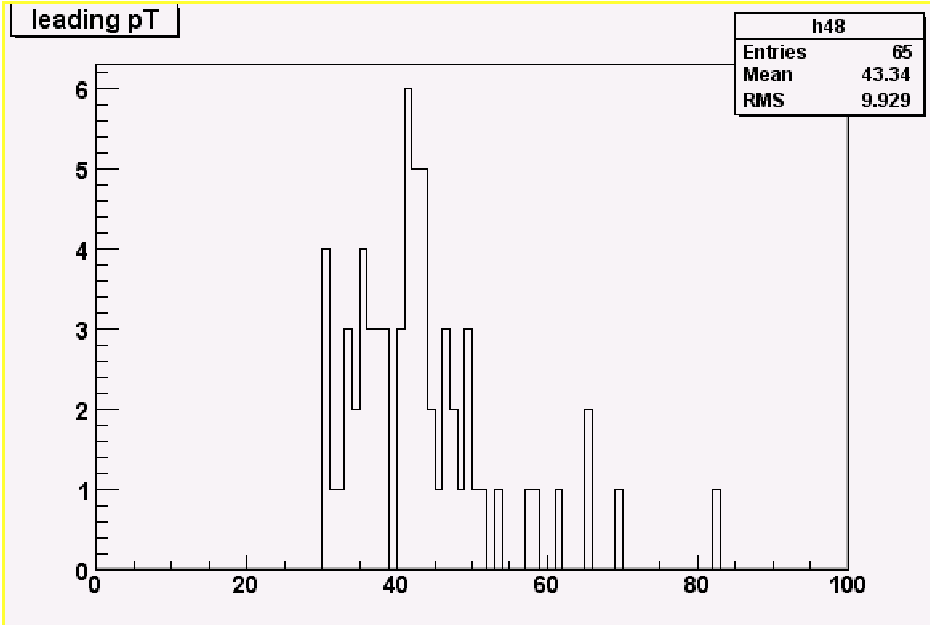
Z Mass = $\sqrt{}$ (Ee1+Ee2)^2 – (Pxe1 + Pxe2)^2 – (Pye1 + Pye2)^2 – (Pze1 + Pze2)^2.

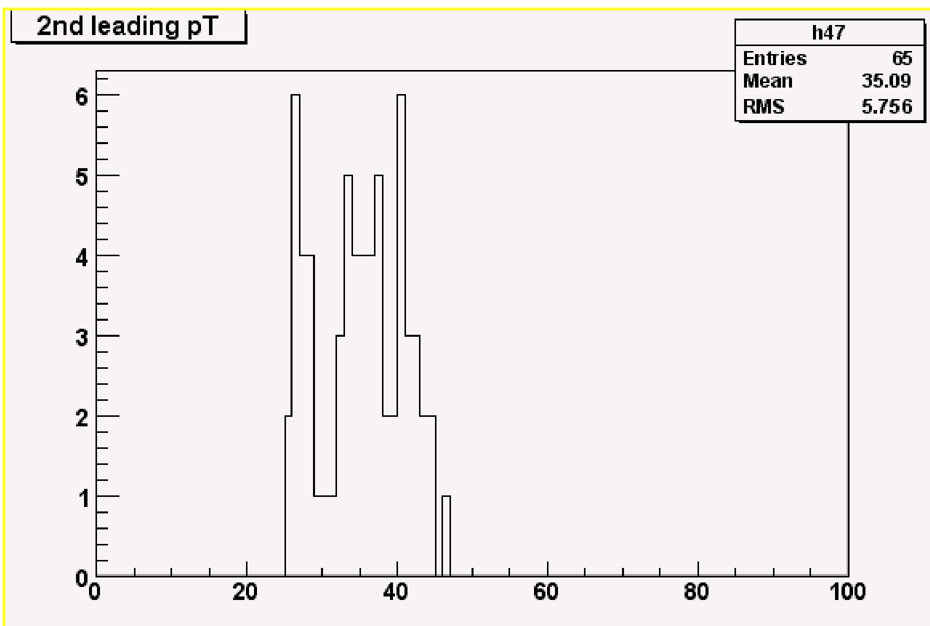
With (Pte1 > 25 Gev and Pte2 > 30 Gev)
And choosing the Mass range between (75→105) Gev.
And making (? phi > 0.25).

RESULT



So I'm getting the signal, and I have Z bosons in my sample.
Now plotting back the histogram for the first leading electron and the next leading electrons for the same region of the Z mass I found the expected peak which was hiding because the large background that I'm talking about next.





THE BACKG ROUND

They are two kinds of backgrounds:

1) Physics background: they are processes. which have a signature as $Z \rightarrow e^+e^-$ and the more likely ones are:

a) The process $Z \rightarrow \iota+\iota-$

Where the taus decay to electrons

b) Process $Z \rightarrow t\ \bar{t}$

Where the top quark decay to W Boson and b quark

$$t \rightarrow W + b$$

And then

$$W \rightarrow e + \nu$$

c) Drell-Yan pairs: $\gamma \rightarrow e+\ e-$ is coherent with $Z \rightarrow l+\ l-$

2) Detector background:

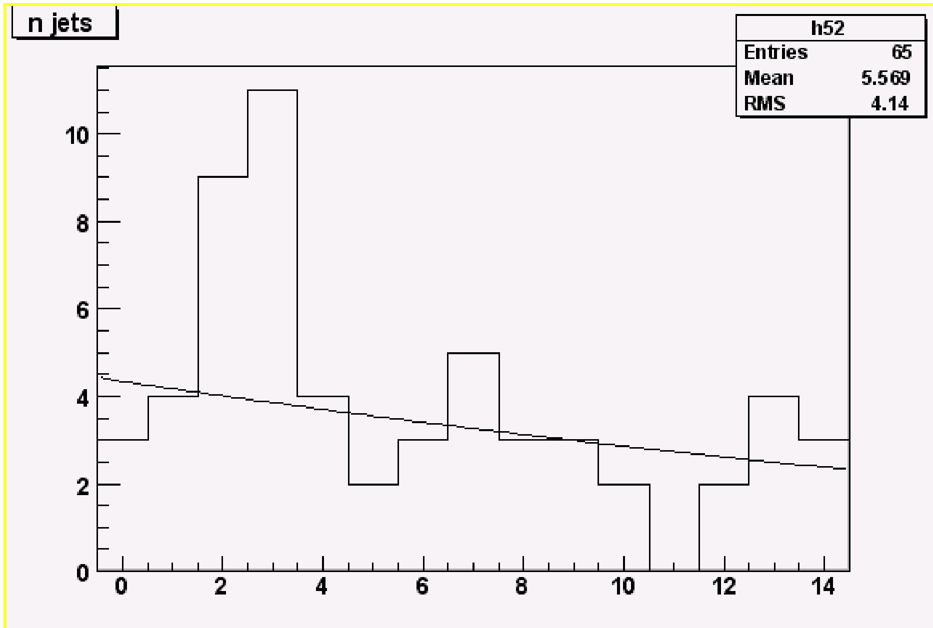
The primary background to dielectron production is from multi jet production from QCD processes in which the jets have a large electromagnetic component so that the most of the energy is deposited in the EM section of the calorimeter or they are mismeasured in some way that causes them to pass the electron selection criteria.

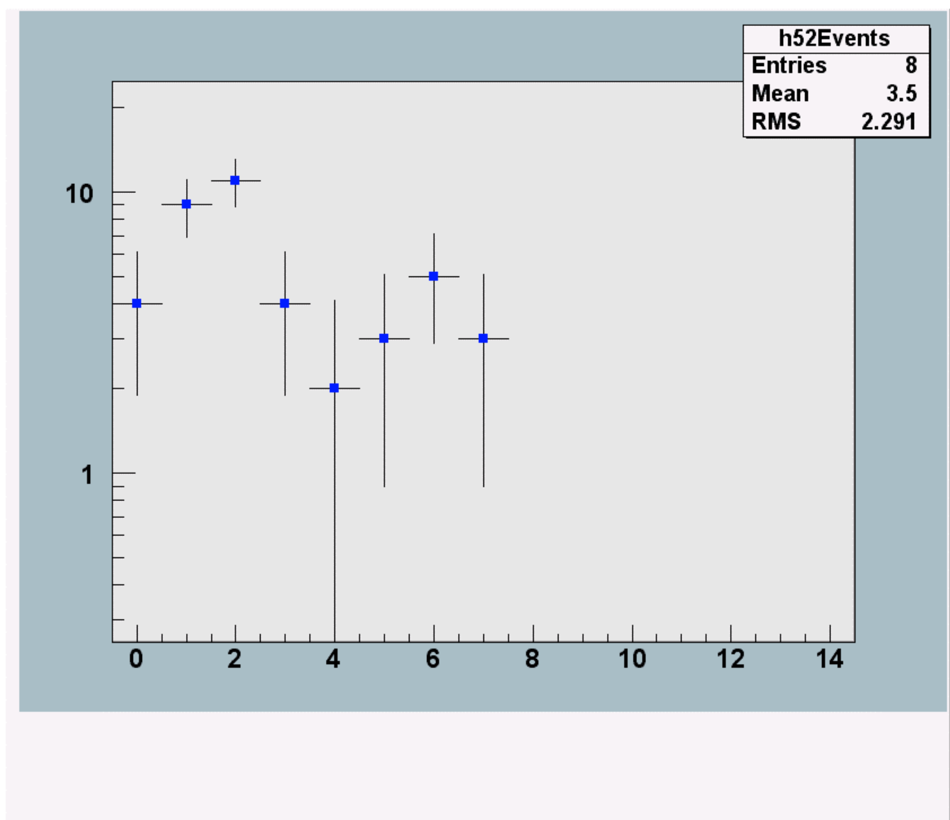
The way to eliminate much of them by the cuts I did but still some leaking in and I need to estimate them.

One of the ways is first to identify the biggest background in my process, which is the Drell_Yan. And then compare my result with MC signals for the same process and results and then estimate the amount of background in my sample.

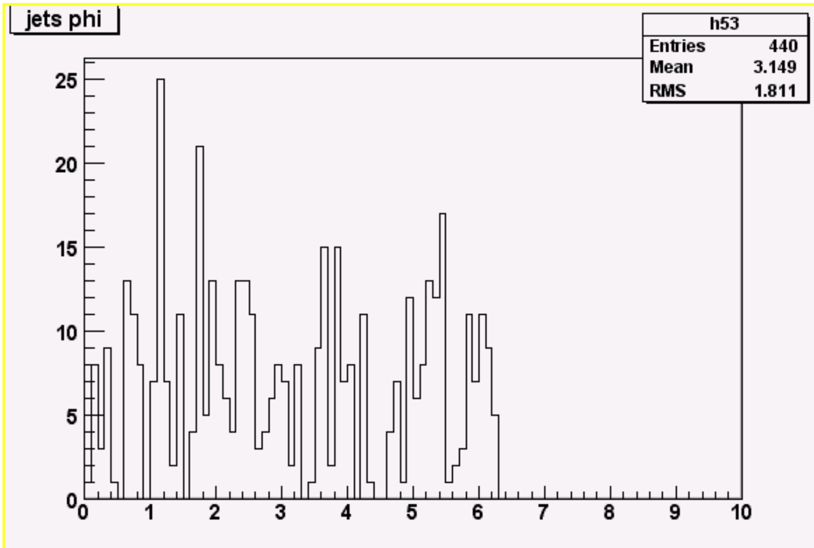
But now I will look for the number of jets associated with the Z bosons.

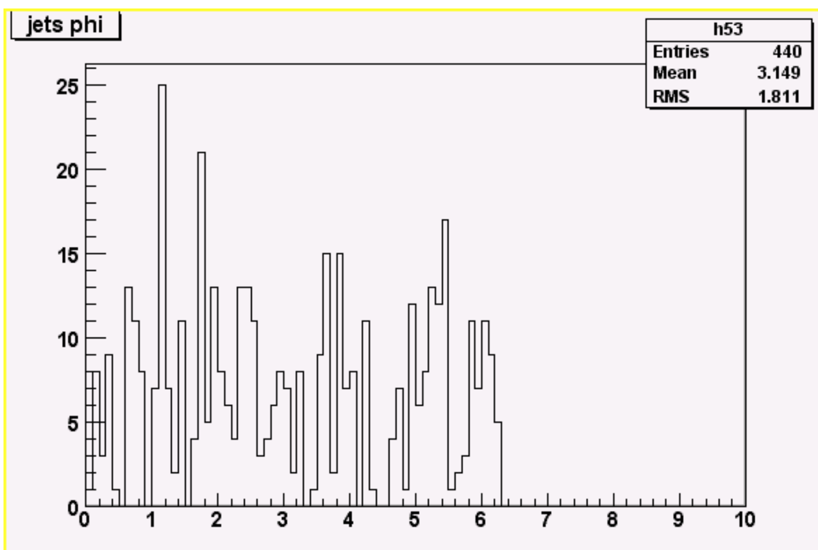
NUMBER OF JETS ASSOCIATED WITH Z





THE PHI AND ETA DISTRIBUTIONS


jets phi
h53
Entries 440
Mean 3.149
RMS 1.811
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10


jets phi
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Entries 440
Mean 3.149
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25
20
15
10
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0
0 1 2 3 4 5 6 7 8 9 10

THE ERRORS

There are two kinds of errors in this kind of analysis:

1) Statistical error:

And it is coming from my sample size.
Which will be calculated by taking the $(1/\sqrt{N})$ where N: is the number of events.

2) Systematic error:

Can be coming from different sources
a) From estimating the cross section for the Drell-Yan process
or my presses

b) Error estimating the luminosity for the processes.

c) The detector measurement of the electron energy or any other parameter.

To estimate this kind of error we need to take the central value of it and then run MC many times then take the variation of my result and this would be my systematic error and then collect all the parameters that have this kind of error
making sure there is no correlation between these errors and then add them and take the square root of the their square

CONCLUSION

After this analysis with 98049 events I found 65 events has a Z boson
With a lot of background
Also anther problem here is to understand why I did not get most of my jets at
The zero, even the number of jets associated with the Z production is matching
That could be a logical error in my program.

My suggestions are to extract more data and figure out a better way to get rid of the background. and figure out where the problem in the jets distribution.