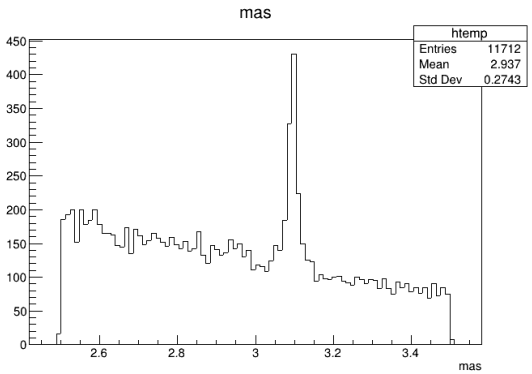
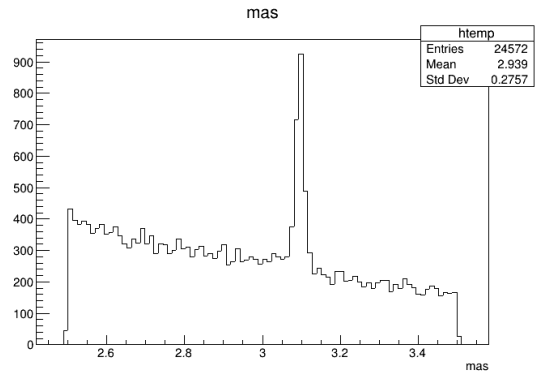
J/ψ Analysis

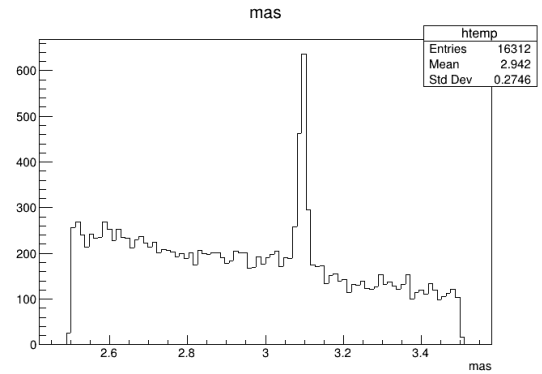
October 7, 2021

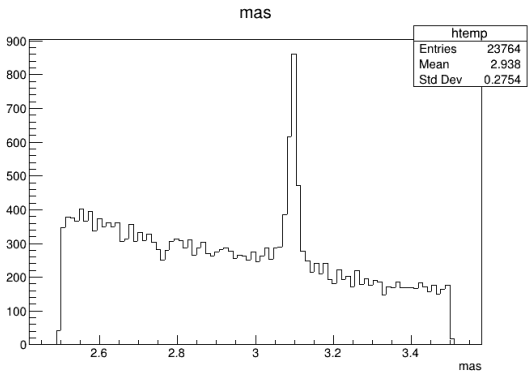
The Data - I

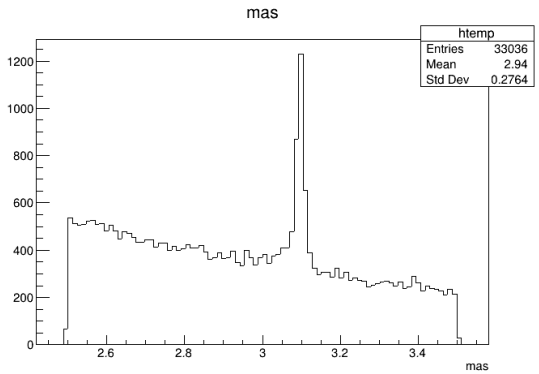
- The MC Data - scattered across 10 data files (`datapsiskim-61-*.root`).
- NOTE: The following plots are directly taken from TBrowser.
- y axis: entries/0.0116
  x axis: mass (in GeV)

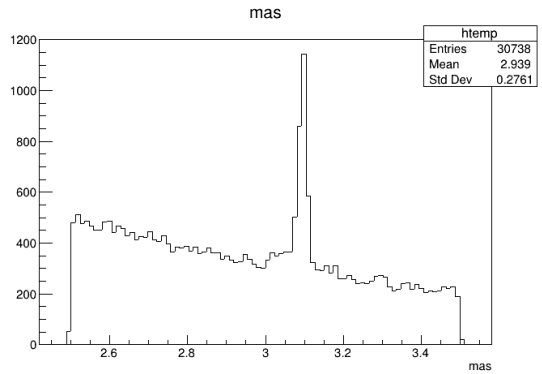




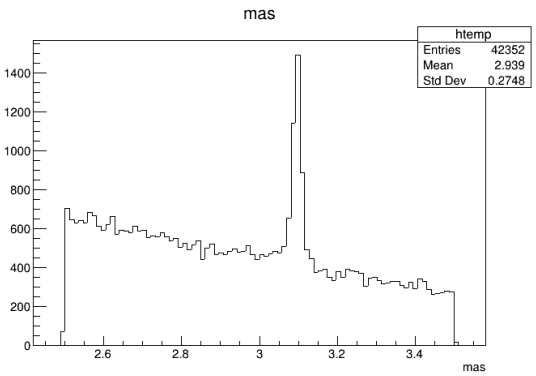


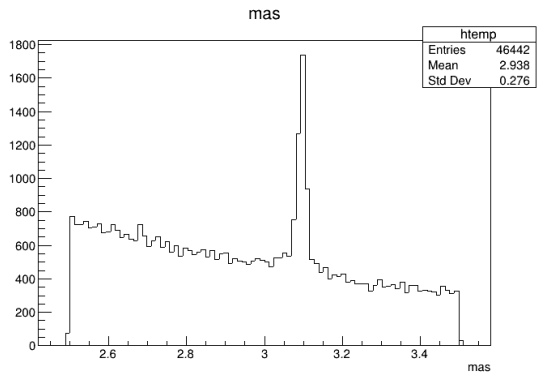


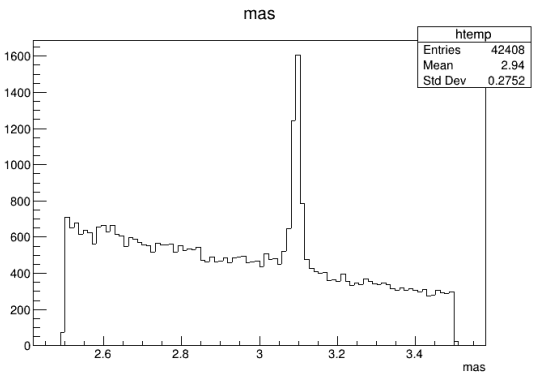


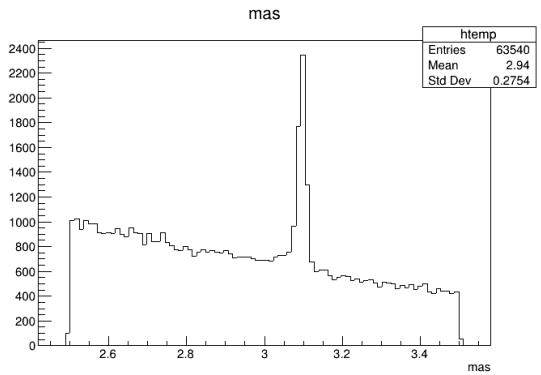


The Data - II









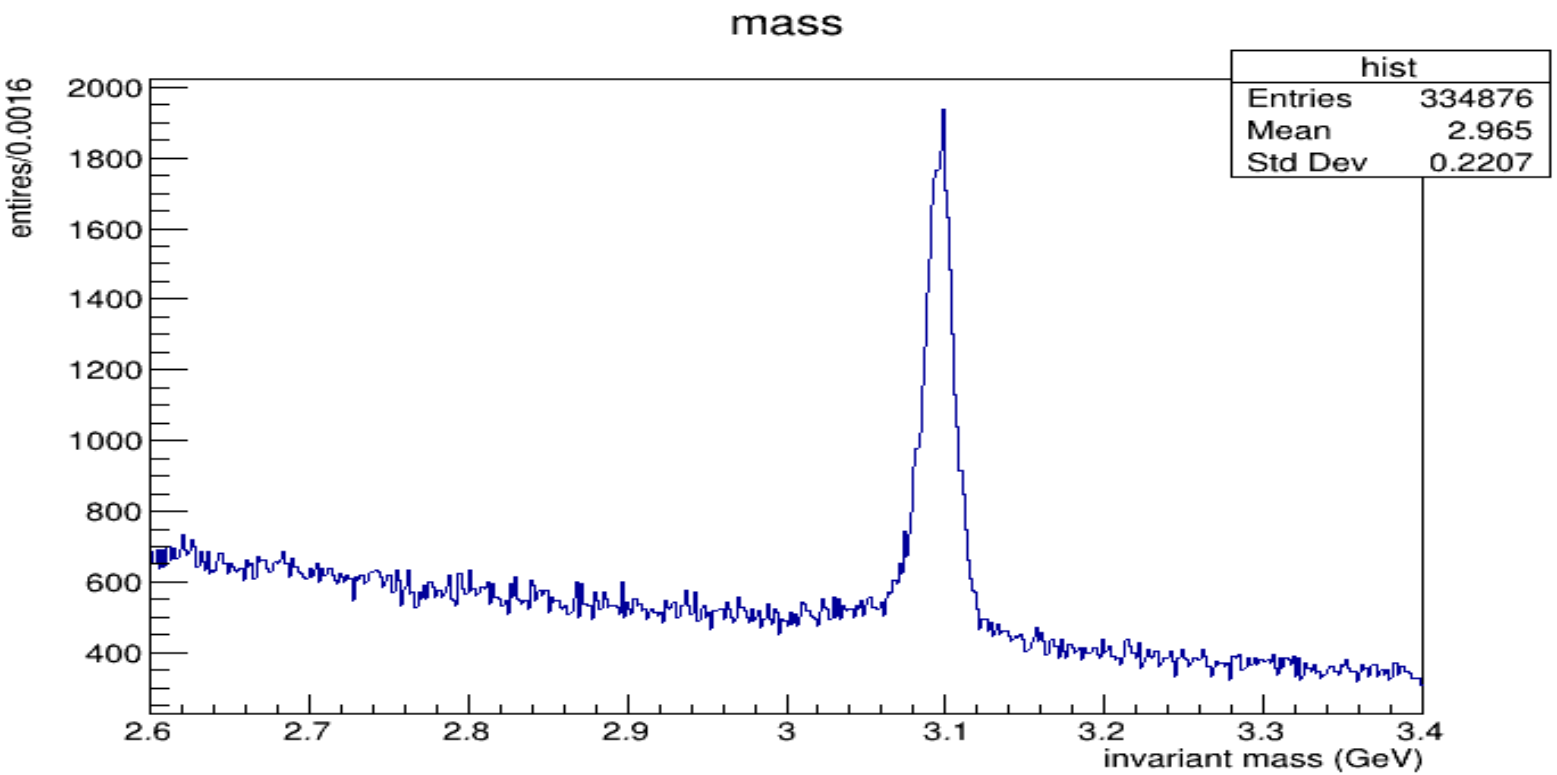
Total Entries

Counted from the previously shown 6+4 images:

334876

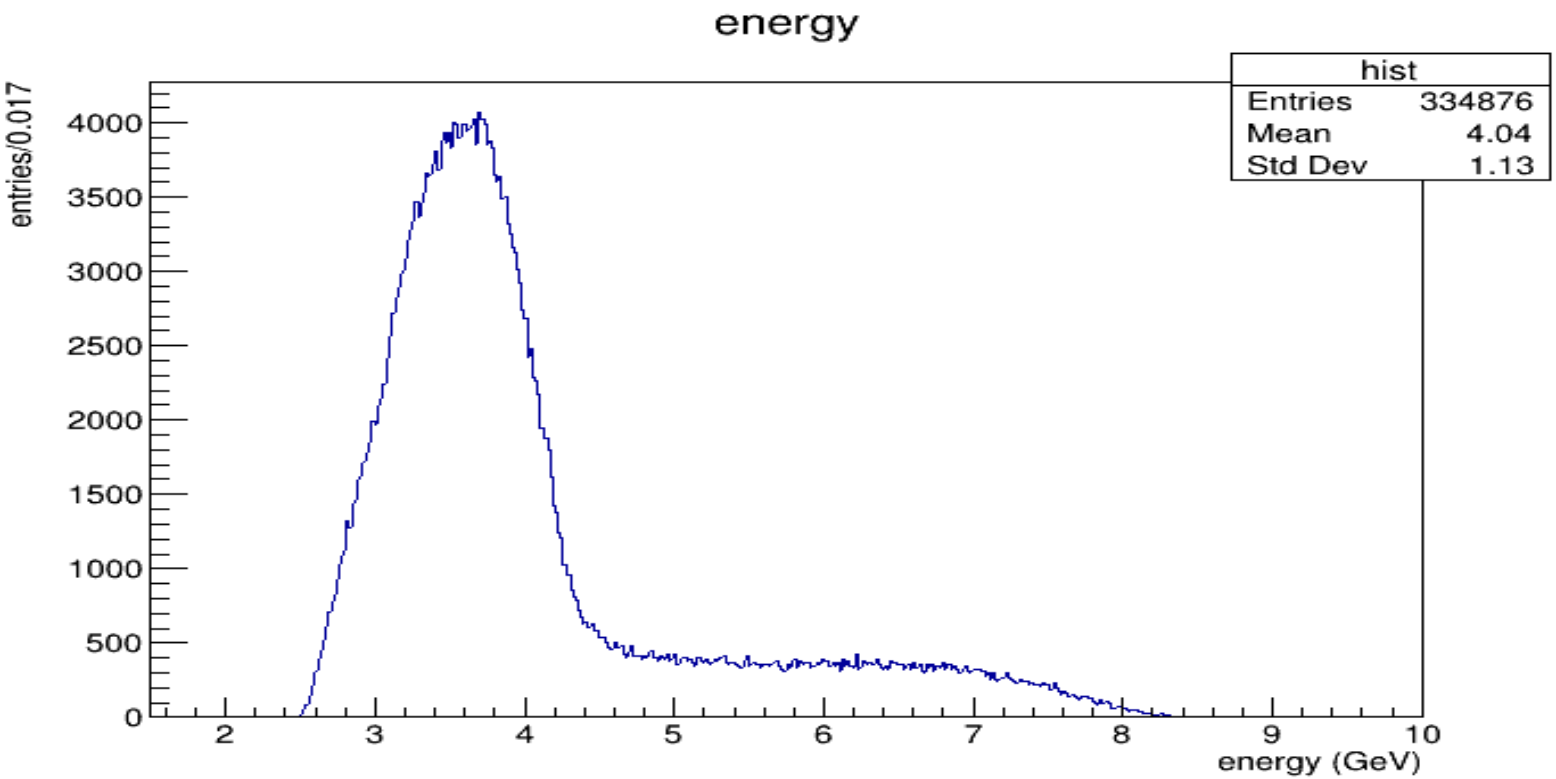
The Chained Data - I

- Used TChain class to analyse a single .root file.
- The "Chained" histogram for the mass is (Total entries: 334876 - chained successfully):



$\exists$ a sharp peak at $3.0 - 3.1 Gev$ - as expected.

The Chained Data - II



Specifically depicted the histograms for mass and energy because they were used in defining the cuts for selecting the candidates.

The Analysis - I: Making the cuts

- CUT 1 (on Mass):
  - From Page 4: peak of the signal lies within

$$\text{mass} \in [2.9, 3.2]$$

  - Code snippet:

```
for (int i = 0; i < jentry; i++)
{
if (mas < 2.9 && mas > 3.2) continue;
Nj -> Fill(mas);
}
```

  - where
    - ★ `jentry`: an `int` variable that gets the entries from the leaf `iloop`
    - ★ `Nj`: an `Ntuple` that stores the signal(data) points from the cuts thus made
    - ★ `mas`: the leaf that stores the mass entries

The Analysis - II: Making the cuts

- CUT 2 (on Energy):
  - From Page 5: peak of the signal lies within

$$\text{energy} \in [3.2, 4.0]$$

  - Code snippet:

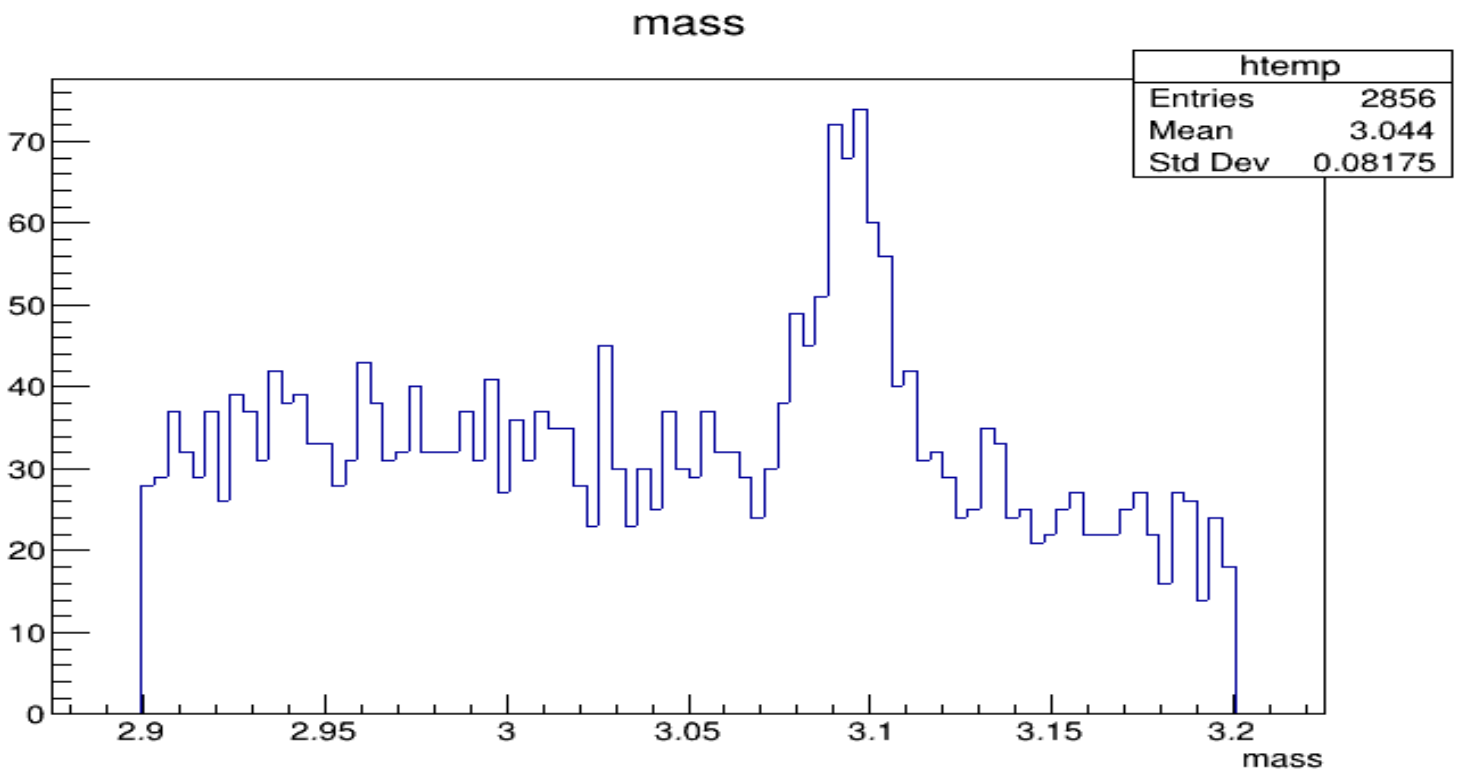
```
for (int i = 0; i < jentry; i++)
{
if (ene < 3.2 && ene > 4) continue;
if (mas > 2.9 && mas < 3.2)
Nj -> Fill(mas);
}
```

  - where

    `ene`: the leaf that stores the energy entries

The Analysis - III: The data after the cuts

- x axis: entries/0.003
  y axis: mass (in GeV)



The Analysis - IV: ROOFIT

- Seeds for the Fit:
  - Invariant mass $\in [2.9, 3.2]$
  - Signal type assumed: Gaussian
    - ★ Mean of the signal peak, `mean` $= 3.0$
    - ★ Width of the peak, `width` $= 0.1$
  - Background type assumed: 3rd order Chebyshev Polynomials
  - Signal to noise ratio, `fsig`$= 0.5$
  - Binning : 75 bins
- RooFit's results:

Variable	**Value**	**Error/Tolerance**
`fsig`	9.92460e-02	1.13378e-02
`mean`	3.09523e+00	1.01232e-03
`width`	9.29170e-03	1.05897e-03

The Analysis - V: The Final Plot

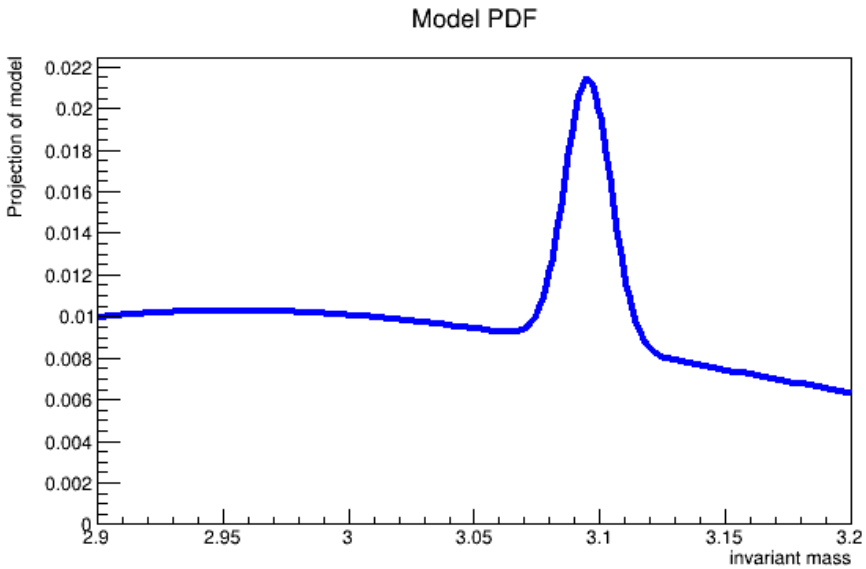


Figure: Model's PDF

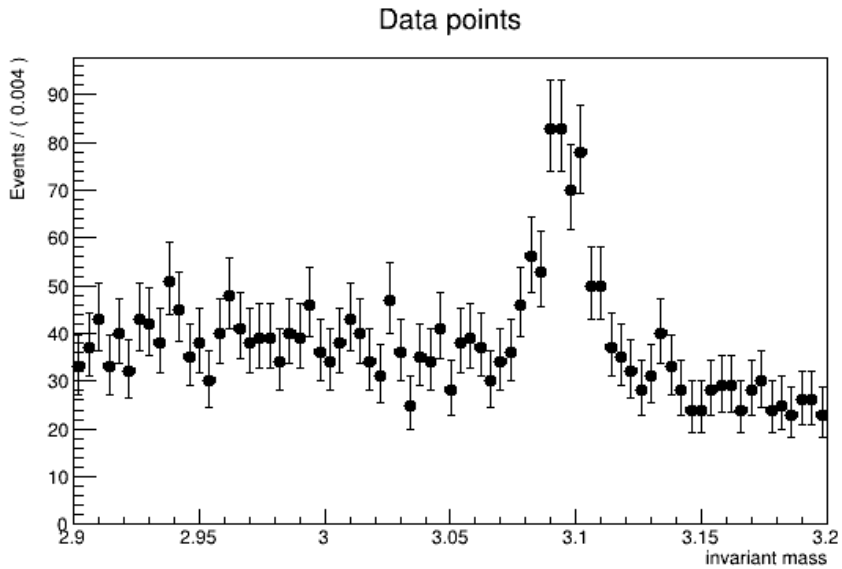
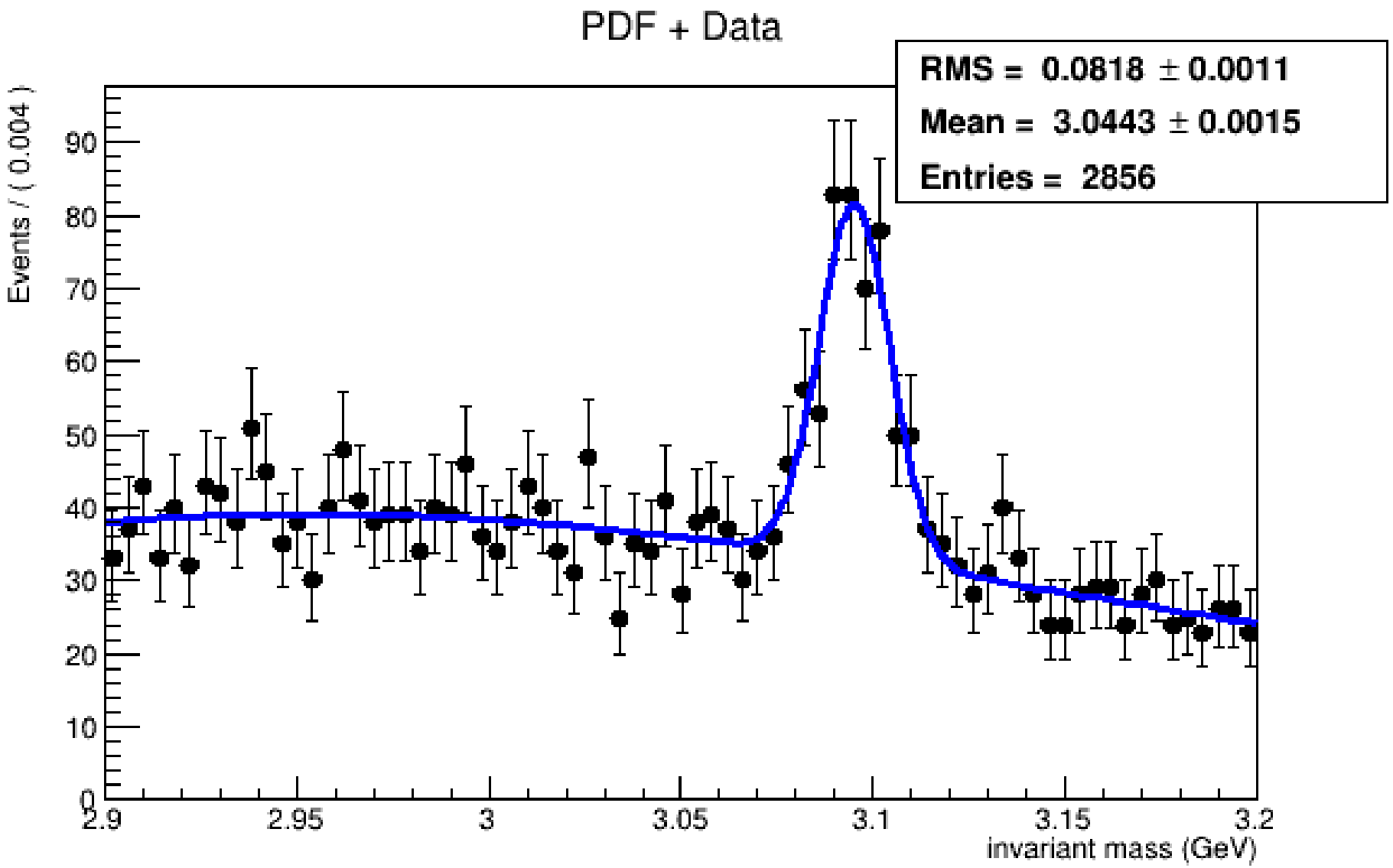


Figure: Plotted data points with error bars

The Analaysis - VI: The Final Plot



The Comparison

- From the PDG database (natural units):

$$m^{\text{PDG}}{}_{J/\psi} = 3.0969 \pm 0.006 \text{ GeV}$$

$$\sigma^{\text{PDG}}{}_{J/\psi} = 92.9 \pm 2.8 \text{ keV}$$

- From the fit (natural units)(rounded off to the same number of significant digits as in the PDG database):

$$m^{\text{fit}}{}_{J/\psi} = 3.0952 \pm 0.001 \text{ GeV}$$

$$\sigma^{\text{fit}}{}_{J/\psi} = 92.9 \pm 1.1 \text{ keV}$$