

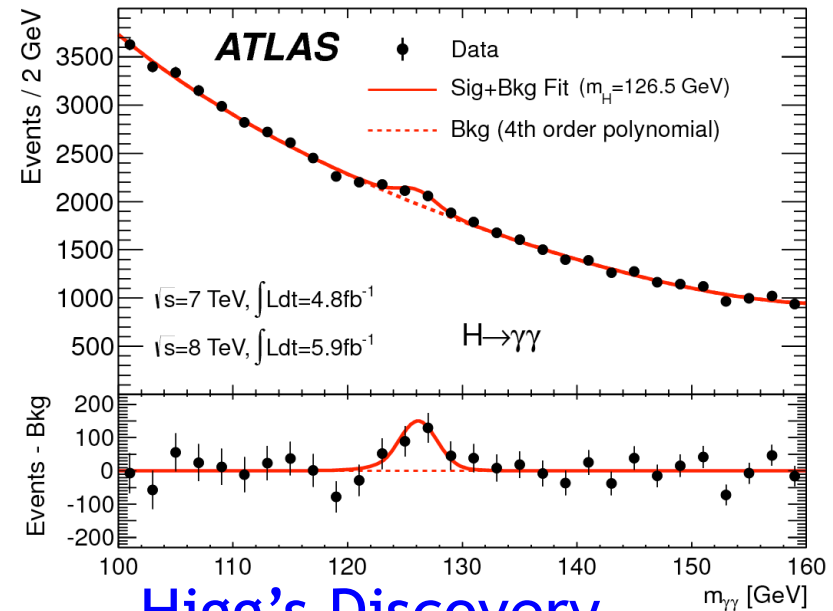


Introduction to ROOT

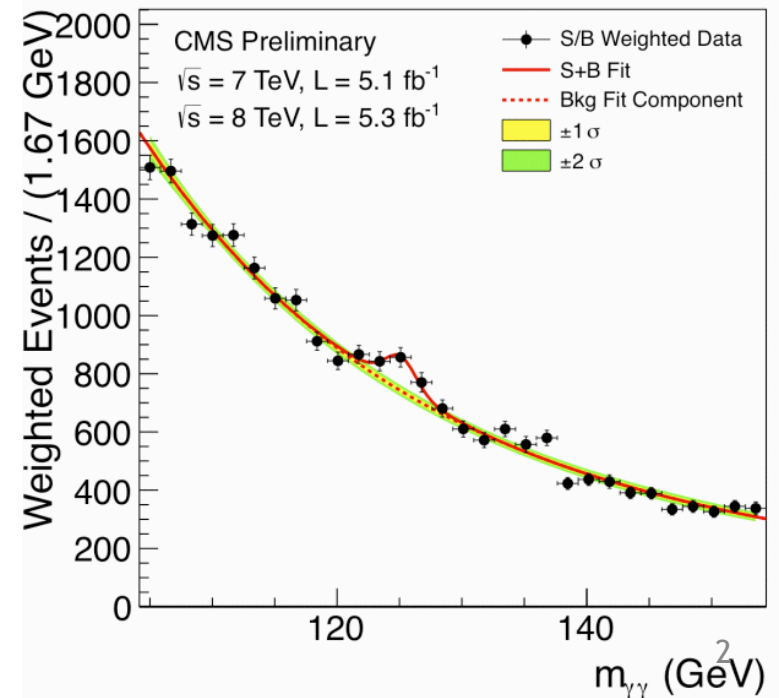
Robert Heitz
Physics 403
September 5th 2017

What is ROOT?

- ROOT is an objected oriented framework for large scale data handling and analysis.
- It is originally developed for high physics experiments (still used by most particle physics experiments), but now also finds application in astronomy, data mining, etc.
- For example, the analysis and plots of recent Higg's discovery are mostly done using ROOT.



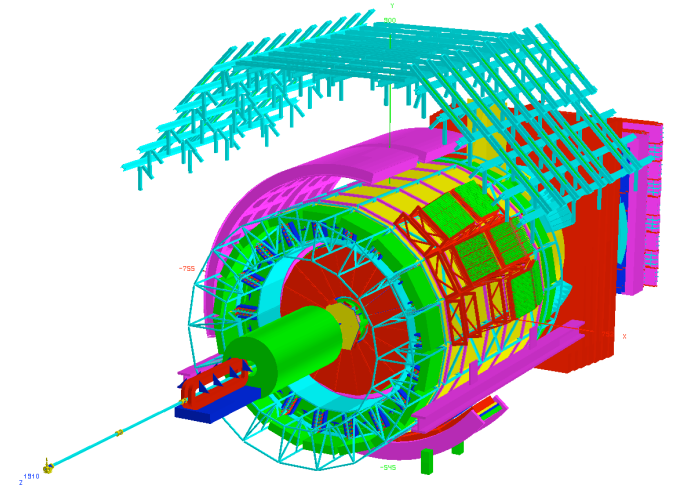
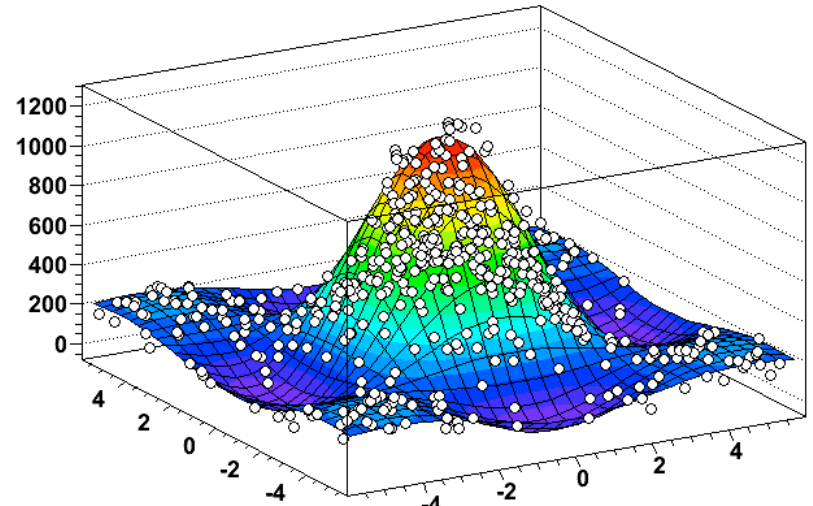
Higg's Discovery



Why use ROOT?

- ROOT can efficiently handle structured large data sets (PetaBytes)
- ROOT has advanced statistical analysis algorithms (multi-dimensional fitting, neural network, etc)
- ROOT has scientific visualization tools with 2D and 3D graphics.
- ROOT is an open-source project. It is free, and available for Windows, Mac and Linux.

Minuit fit result on the Graph2DErrors points



Alice Detector

Using ROOT

Script

```
void histEfficiency() {  
  const Int_t nPer = 5;  
  Double_t U2efficiency[nPer] = {92.8, 39.72, 40.61, 40.77, 36.35};  
  Double_t U1efficiency[nPer] = {93.79, 39.72, 40.61, 40.77, 36.35};  
  
  Double_t V2efficiency[nPer] = {, 39.72, 40.61, 40.77, 36.35};  
  Double_t V1efficiency[nPer] = {93.79, 39.72, 40.61, 40.77, 36.35};  
  
  Double_t X1efficiency[nPer] = {93.79, 39.72, 40.61, 40.77, 36.35};  
  Double_t X2efficiency[nPer] = {93.79, 39.72, 40.61, 40.77, 36.35};  
  
  Double_t Y2efficiency[nPer] = {46.50, 39.72, 40.61, 40.77, 36.35};  
  Double_t Y1efficiency[nPer] = {46.50, 39.72, 40.61, 40.77, 36.35};  
}
```

TBrowser

```
Welcome to ROOT 6.04/06 http://root.cern.ch  
 (c) 1995-2014, The ROOT Team  
| Built for macosx64  
| From heads/v6-04-00-patches@v6-04-00-12-g9436735, Oct 13 2015, 12:34:29  
| Try '.help', '.demo', '.license', '.credits', '.quit'/'.'q'  
  
ot [0] TH1D* h1 = new TH1D("h1", "h1", 100, -5, 5)  
lass TH1D *) 0x7fcb60181030  
ot [1] h1->FillRandom("gaus")  
ot [2] h1->Fit("pol1")
```

CLI

Three user interfaces

- Graphic User Interface
- Command line
- Macros and scripts

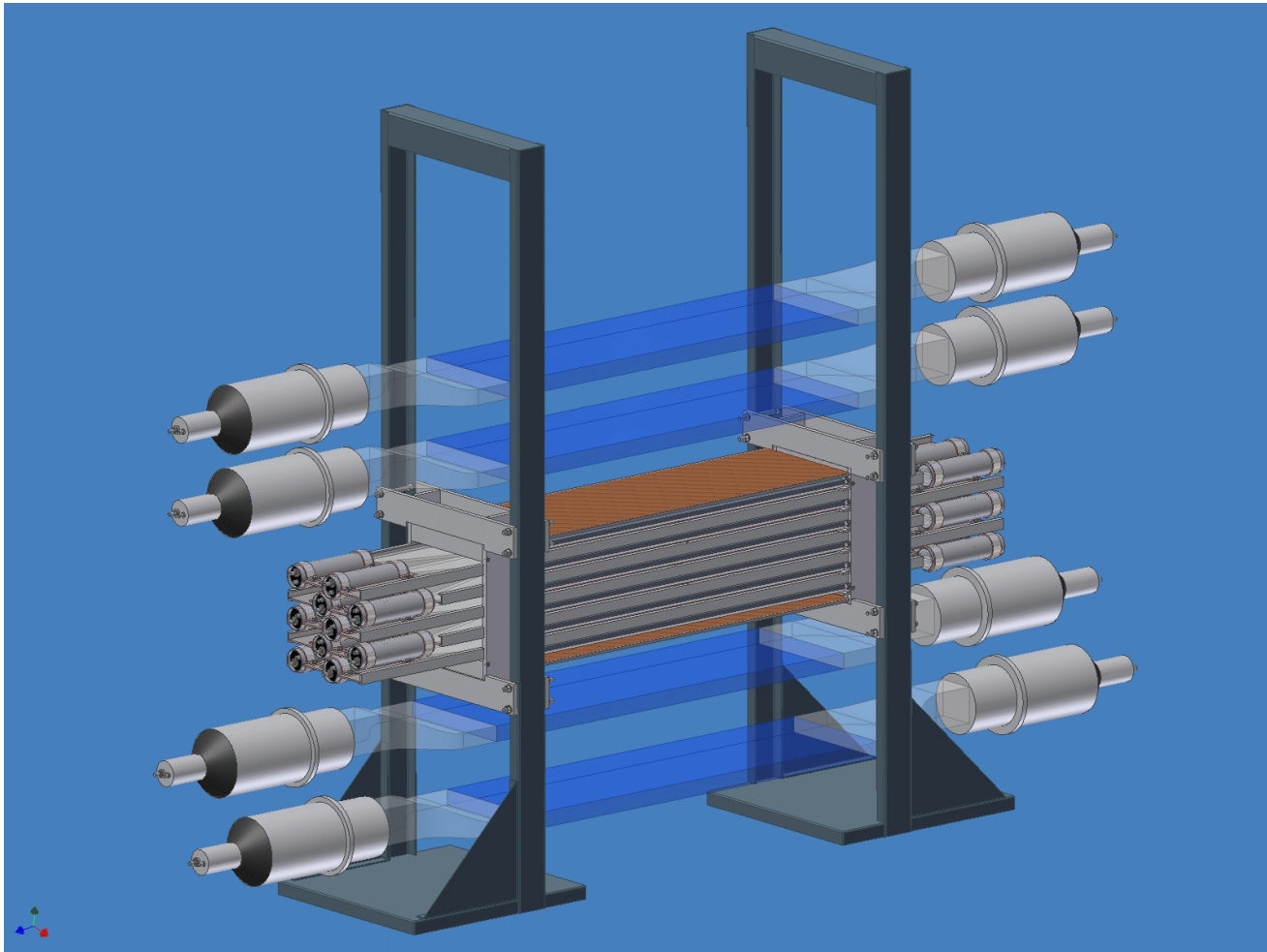
(written in c++, python, ruby, ...)

We will use all of them to help us with the analysis , you will write your own (or modify existing) analysis scripts

ROOT is installed on the LINUX machine in lab.
You can do your work by remotely logging into the machine.

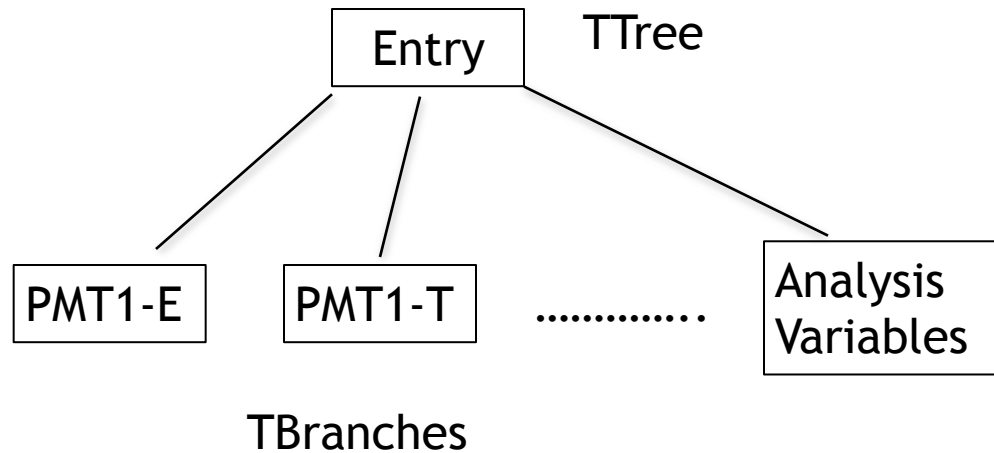
You can also install it on your own computer.

Muon Experiment



16 PMT signals, both energy and timing information, are recorded by the data acquisition system (DAQ). An analyzer program converts the binary data into a ROOT tree.

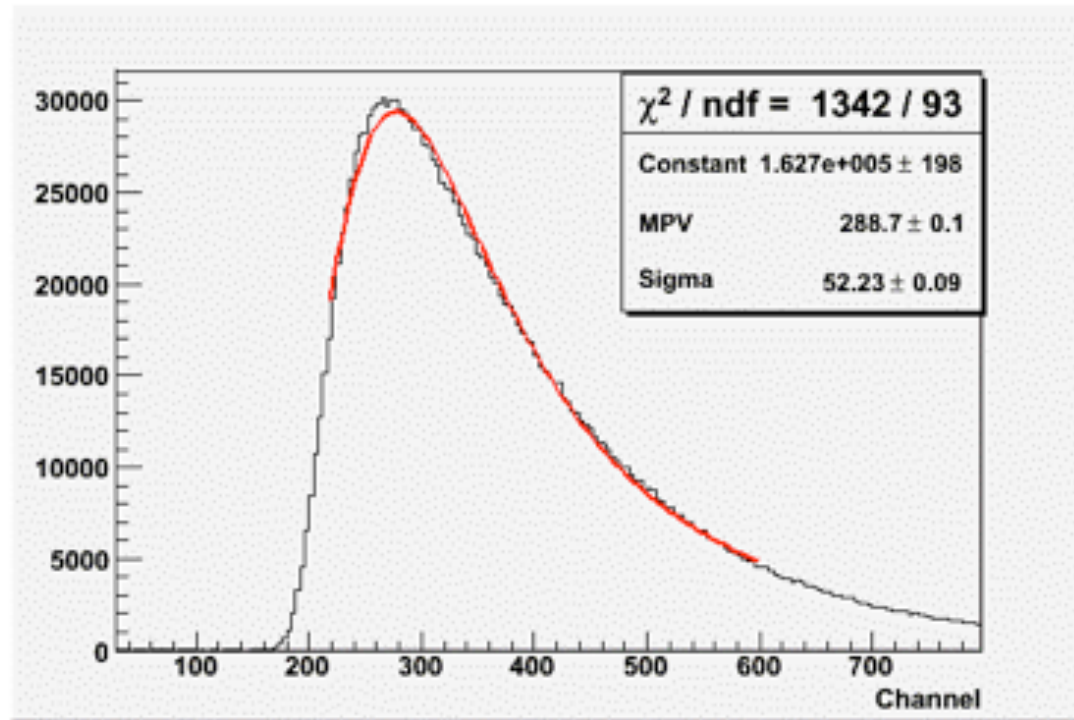
Data Structure (TTree)



Entry 0
Entry 1
Entry 2
...
....
....
.....

- TTree is one of the most commonly used structures in ROOT.
- One can store variables, arrays and data structure in the tree branches.
- In this class, we only store floating number in the branches. This simple tree structure is also called TNtuples.

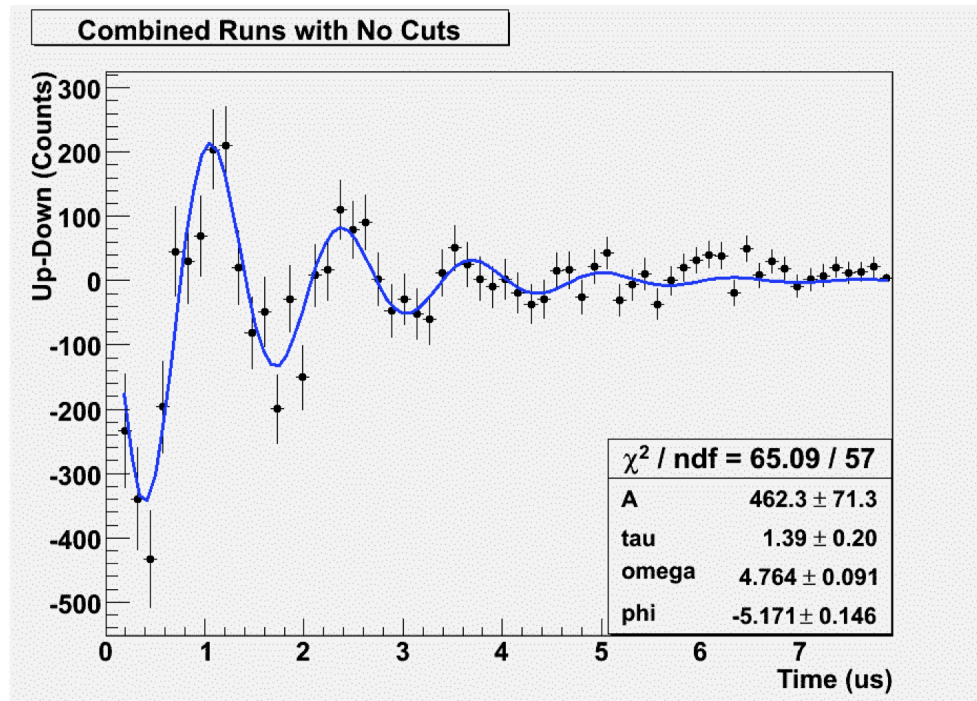
Histogram and Fitting



Histogram of a PMT energy signal

- From the root tree, one can extract information on each PMT, and make histograms.
- You can then fit them with appropriate functions.

Data Cuts and Analysis



Muon g factor measurement.

- Data analysis involves the selection of interesting events, called data cuts.
- You will also perform fitting and other analysis work to extract important physics quantities.

Where to find more information?

- Users Guide and Reference Manuals are available at <http://root.cern.ch>
- Online tutorials are very useful, <http://root.cern.ch/root/html/tutorials/>
- Sample scripts can also be found in MyRoot on the course portal (for plotting MCA spectrum, γ - γ coincidence experiments, etc)
- Online forums, such as roottalk <http://root.cern.ch/phpBB3/>, are where you can ask help from the user community.