Introduction to ROOT

Daniel R. MacLean
Physics 403
January 25th, 2022
What is ROOT?

- **ROOT** is an object-oriented framework for large-scale data handling & analysis.

- It is originally developed for high energy 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 Higgs Boson discovery are mostly done using ROOT.
Why use ROOT?

➢ ROOT can efficiently handle structured large data sets (PetaBytes ⚠).

➢ ROOT has advanced statistical analysis algorithms (multi-dimensional fitting, neural networks, etc).

➢ ROOT has scientific visualization tools with 2D and 3D graphics; not as ‘pretty’ as e.g. Origin, but functional.

➢ ROOT is an open-source project. It is free, and available for Windows, Mac, and Linux machines.
Using ROOT

Three user interfaces:
- Graphic User Interface
- Command line
- Macros and scripts

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 5103

→ You can also do your work by remotely logging into the machine (ask Daniel)

→ Finally, you can install it on your own computer - requires WSL (i.e. Ubuntu) + handful of external packages (again, ask Daniel if you need help)
→ 16 PMT signals, w/both **energy** and **timing** information, are recorded by the data acquisition system (DAQ). An analyzer program converts the binary data into a ROOT tree.
➢ TTree is one of the most commonly used structures in ROOT.

➢ One can store variables, arrays and any other C++ datatype in the tree ‘branches’

➢ If we store only floating number variables in the branches, this tree structure is also called a Tntuple

➢ Usually we “loop” over a TTree to obtain relevant information from each entry and make plots
Histogram and Fitting

➢ From the ROOT tree, one can extract information recorded by each PMT & make histograms.

➢ You can then fit them with appropriate functions – this will be a major task of most groups.
Data Cuts and Analysis

Data analysis involves the selection of interesting events, called data cuts.

You will also perform fitting and other analysis work to perform calibrations & extract important physics quantities.
Where to find more information?


- Sample scripts can also be found in MyRoot on the course portal (for plotting MCA spectrum, \(\gamma-\gamma\) coincidence experiments, etc)

- Online forums, such as roottalk: [http://root.cern.ch/phpBB3/](http://root.cern.ch/phpBB3/), where you can ask help from the user community.