Introduction to ROOT CERN as an analysis tool for particle physics

Research in physics requires the use of not only statistical tools but also computational to manage and handle the analysis of data sets. In particular for research in high-energy particle physics, the ROOT-CERN is a framework used for data analysis because of its graphical interface and its capability to analyze large sets of data. ROOT is also equiped with a C++ compiler, making the analysis efficient.
When introducing new students to particle physics research, this framework is not entirely explained or understood. The main goal of this workshop is to provide an easy way to understand the tools provided in this framework.

1. BASIC INFORMATION

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Modality of the course	Online		
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Number of sessions	See schedule below	Language	Spanish

2. Introduction to ROOT CERN as an analysis tool for physics

This worshop is intended as introduction to the framework ROOT CERN: basic analysis tools, lists, graphs, histograms and statistical tools like the package RooFit and it is also intended to connect these tools to general research in physics and introduce physics concepts.

2.1 Objective

Introduce the main tools used for the analysis in ROOT CERN

2.2 Specific goals

Introduce calculations in ROOT-CEN.
Show the use of the graphical interface.
Introduce basic elements: graphs, histograms.

Open, close, save files, store data. Brief description of the RooFit as a tool for fitting. Let students applied the learnt concepts in an open exercise.

3. Method

This worshop requires the people to have their own computer where the framework ROOT will be installed. The workshop willl be divided in a number of sessions of 2 hours long in which the basics of the tools included in the framework will be explained. During each session two exercises will be given to students: one intended as guide (participation marks) and the second one intended to apply what was learnt. The marking scheme is shown in the presentation document. The final exercise is a project to analyze the assymetries in a B meson decay.

4. Schedule

Session name	Objectives	Content
0. Introduction to the ROOT framework	• Show the process of installation of the framework • Get started with the simple functionalities of ROOT • Manage the graphical interface tools	• Installation of the framework ROOT • Data types: integers, float, char, lists, vectors, booleans; declare variables in ROOT. • Basic operations: sums, products, exponentials, mathematical symbols, concatenate elements. • Graphical interface. • A document will be delivered to students as a pre-exercise with basics about installation, graphical interface and data classes. • An exercise will be given to students, it will be graded over 10.
1. Macros and files	• Be able to write, execute, open Macros. • Handle root files.	• For, while loops (15 min). • Create Macros (10 min) • Open, close files, save root objets in files (10 min) • Macro exercise: Fibonacci sequence (20 min) • TTree class, declaration, branches, reading and writing a TTree (20 min). • TRandom. (5 min)

		• Exercise about data sets: store energy and momentum distribution of classical particles in a box. (30 min)
2. Histograms and graphs	• Be able to create histograms and graphs. • Learn how to change features and properties of histograms	• TH1 class, declaration, important comands: get number of bins, bin content, modify format of histograms. (20 min) • TF1 class, declaration examples. (10 min) • TgraphErrors, TCanvas, TPad, TLegend class (10 min) • Graphs and histograms exercise: 2D graph of temperature as a 2D function, parabolic motion with drag-force (20 min)
3. Fitting	• Understand the concept of object oriented programming • Use the basic commands in RooFit. • Create lineshapes and composite models.	• Introduction to RooFit: model creation, importing data, fitting, parameters. (30 min). • Lineshapes and fitting exercise (using the data from previous exercise) (30 min) • Composite models. (15 min) • Lineshapes in RooFit and create new lineshapes, reparametrizing line shapes, convolution (20 min). • Exercise: creating lineshapes, integral of a Breit-Wigner with variable width. (25 min)
4. Final exercise	• Apply all learnt concepts	• Explanation of the physics background: standard model basics, interactions, QED, flavour physics, CP violation. (45 min) • Analyze open data set of the LHCb (90 min).