Derivative used to find maximum

Sometimes finding the position of the maximum of a distribution is not easily achievable by mean of a fit. In these cases the derivative of the distribution can be used.

Goal of these exercises

The aim of these exercises is to determine the maximum of a distribution using the derivative and to compare it with the maximum obtained by fitting the distribution.

Basic informations: you will work on a set of events coming out from a PAMELA experiment simulation. The given file

`/home/mocchiut/pamela/data/pamsimu2013.root`

contains the TTree pamcalotree, storing data with the PamCalo class, header file:

`/home/mocchiut/pamela/PamCalo/inc/PamCalo.h`

so library:

`/home/mocchiut/pamela/PamCalo/lib/Linux/libPamCalo.so` .

The ROOT file contains a mixture of different particles: protons, antiprotons, electrons and positrons in an energy range from about 1 to about 20 GeV.

In these exercises, we will create a variable from the sample (var≡beta/dEdx) and we will save it together with other variables on a different file for positive particles. Then we will use a script to calculate and plot the derivative of the variable distribution. Finally, we will find the position of the maximum of the variable distribution by looking at its derivative and we will compare it to the same obtained fitting the distribution.

Exercise 1

Write an an executable compiled program which reads the input file

`/home/mocchiut/pamela/data/pamsimu2013.root`

and gives as output a new ROOT file containing a TTree with two variables (a TBranch for each one):

- pID
- var (≡beta/dEdx)

Save into the new file events which satisfy the following condition:

1. each event has energy greater than zero.

Hints:

- to compile, remember to add also the compilation flags:

```
-I/home/mocchiut/pamela/PamCalo/inc
-L/home/mocchiut/pamela/PamCalo/lib/Linux/
-lPamCalo
```

- to run, remember to export LD_LIBRARY_PATH:

```
export LD_LIBRARY_PATH=/home/mocchiut/pamela/PamCalo/lib/Linux/:$LD_LIBRARY_PATH
```

Exercise 2

Write a ROOT-CINT script which reads the output file of exercise 2 (should be similar to this one: `/home/mocchiut/scripts/EM_output_010316.root` use this file if you are not able to complete or run exercise 1) and gives as output on the screen and on the disk (pdf format) a TCanvas divided into two pads (one column, two rows – hint: `TCanvas::Divide`) which contain from top:

1. the distribution of events (`TH1D,X` range [0.2,2.], 80 bins) for which `pID` is equal to zero.
2. the derivative of the "var" distribution drawn using a TGraph (hints: calculate the derivative [`(y2-y1)/(x2-x1)`] with a loop over the number of bins of the previous histogram [`TH1D::GetBinCenter(Int_t), TH1D::GetBinContent(Int_t)`].
3. find the x-value for which "var" distribution is at its peak, that it the x-value for which the derivative is equal to zero and print it to the STDOUT (hints: while over a variable `xx` which start at `xx=0.4` and it increments of `1e-6` each iteration; each time evaluate the TGraph interpolation [`TGraph::Eval()`] and if its value is smaller than `1` the zero crossing has been found) .

Exercise 3

Update the script of exercise 2 in order to draw a new TCanvas which contains the `var` distribution (TH1D) fitted with a Gaussian function (draw the fit on the plot together with fit parameters in the statistics pad).

Print on the STDOUT the value of the difference between the mean of the Gaussian and the position of the peak as determined in exercise 2.

Save the output on the disk as pdf file.

Preparing the output

- create a directory and put inside this directory ALL the files you want me to correct and look at.
- create a README text file (named like EM_README.txt), inside the file write:
  - **your name and surname**
  - a list of the files you are submitting
  - **in details** how to compile and run the programs
  - any other comment and answer to question(s)
- create a compressed tarfile containing the directory:

```
bash> ls
Mocchiutti/
bash> tar zcf Mocchiutti.tar.gz Mocchiutti/
```

- copy the tarzipped file on the USB key I will circulate

Timing and rules

- You have four hours time to do your work.
- You can search the web, look at manuals, look at any note you wrote during the course, etc.
- We will discuss what you have written at the oral examination on 2016/03/02, until that (if needed) you can change and improve your programs. In that case prepare an electronic version we can look at during the oral examination, we will compare it to the one handed in today and we will discuss any change and/or correction.