LHCb Public Data and Outreach

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LHCb Masterclasses

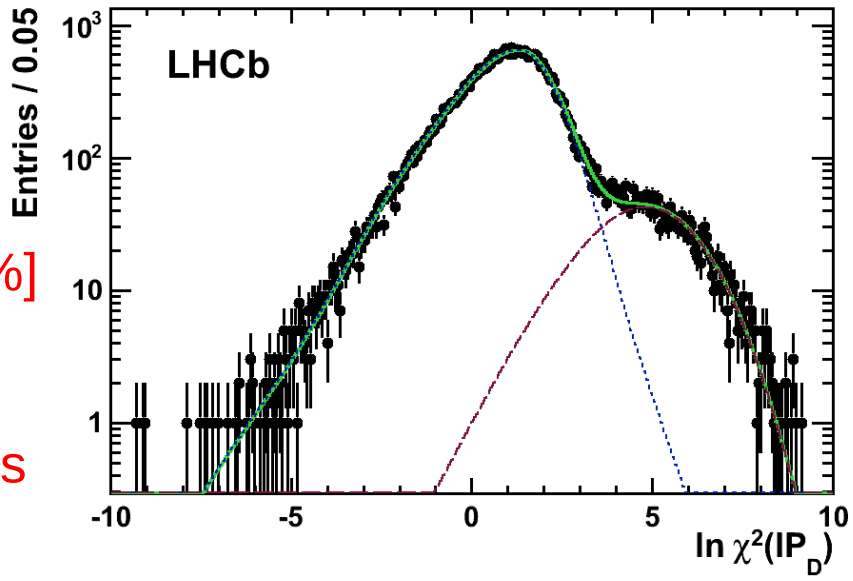
Main goal of the LHCb experiment is to study CP violation in Beauty and Charm particle decays and to search for rare decays.

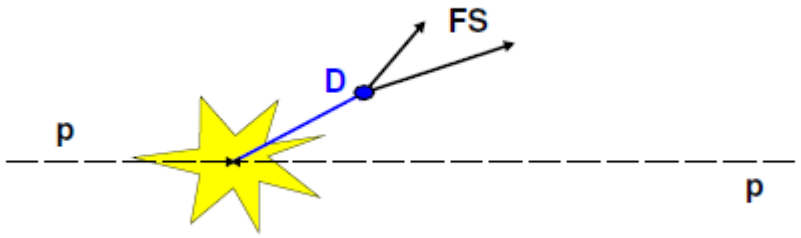
We decided to make exercises which are specific for our scientific program, like different properties of matter and antimatter, Charm and Beauty particle lifetimes etc…

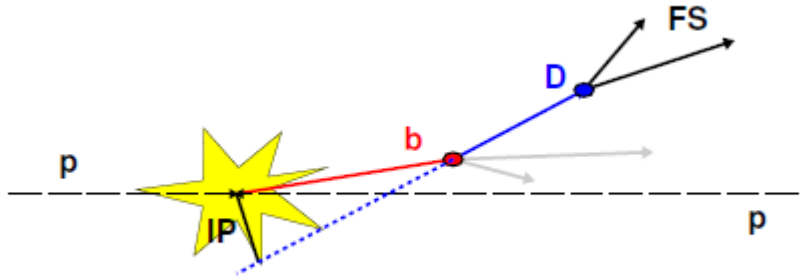
D^0 lifetime measurement exercise for masterclasses (19/3/2013)

Two types of charm production:
Prompt : Charm produced directly in the primary pp interaction
Secondary : Charm produced in B decays [B(B->DX) > 50%]

Prompt charm is much more abundant because the LHC charm cross-section is ~20x higher than the B cross-section
Discrimination :
use the D impact parameter $\chi 2$ (IP χ^2)

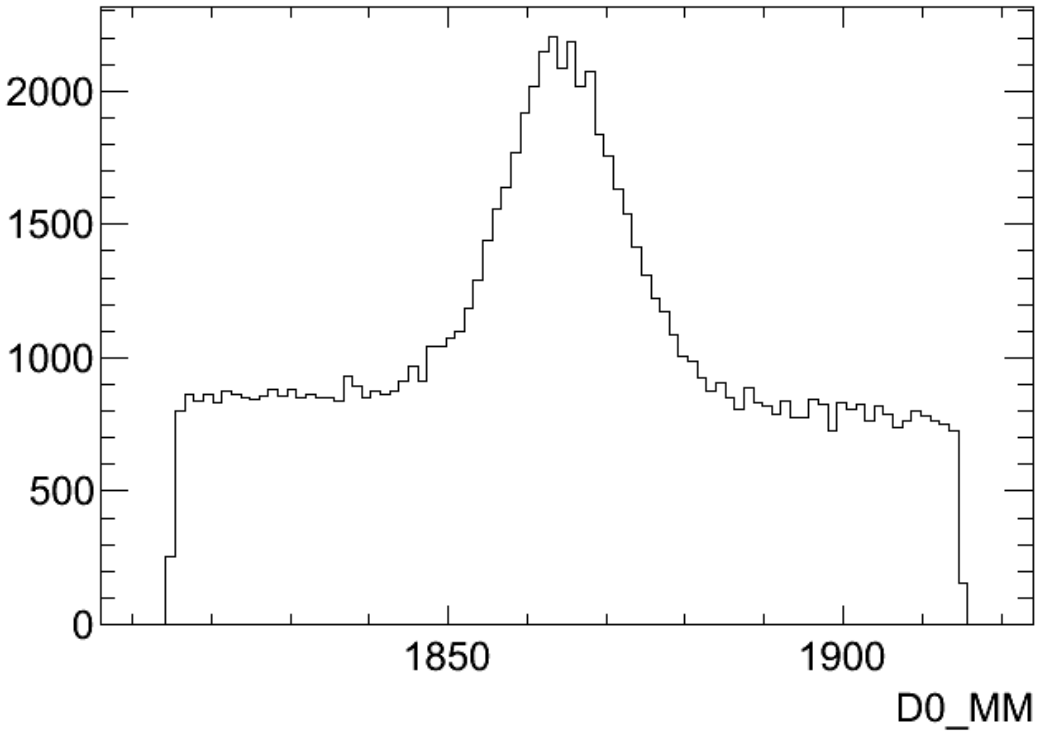






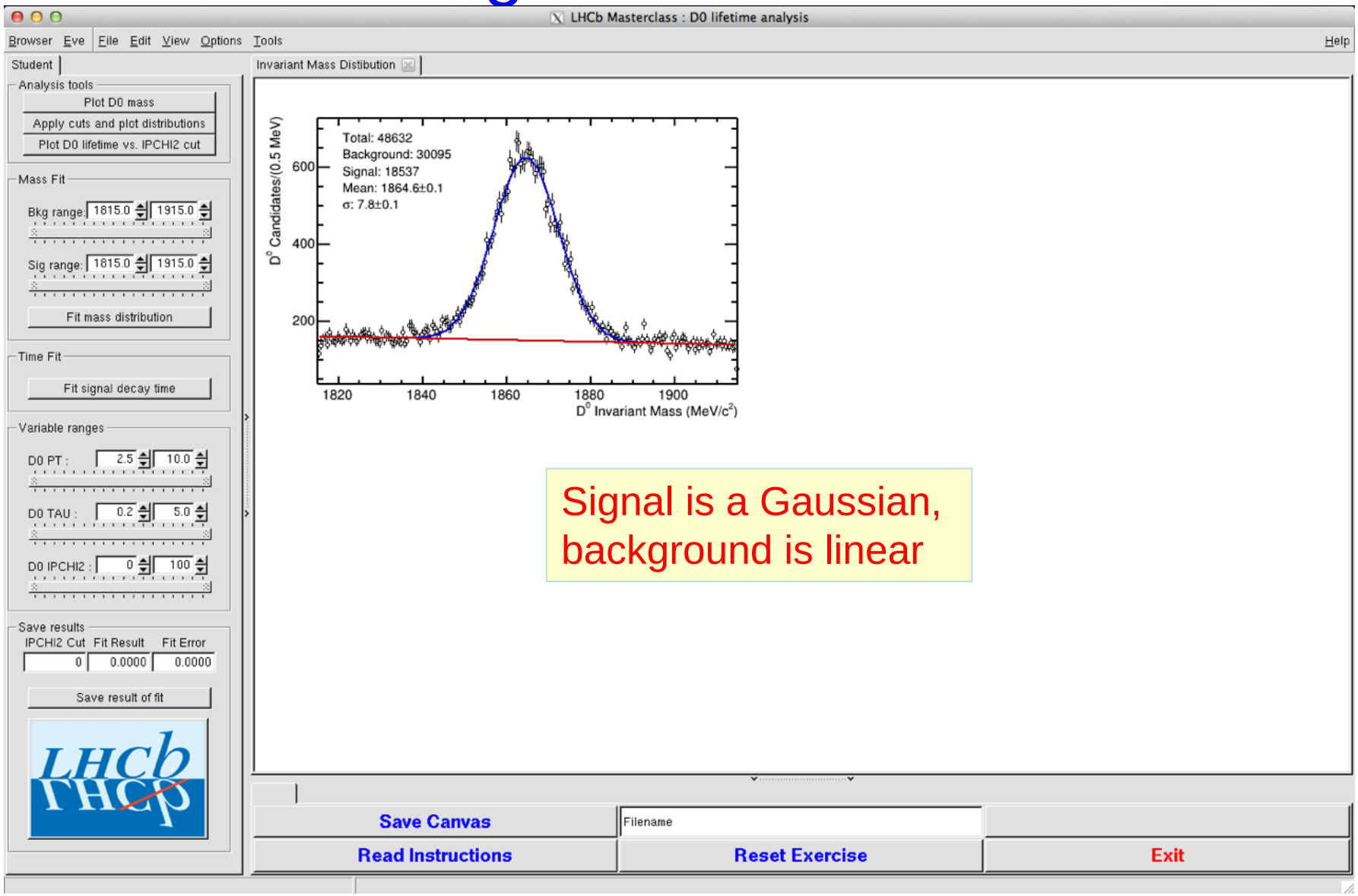
D^0 lifetime measurement exercise for masterclasses (19/3/2013)

$D^0 \rightarrow K\pi$ decays, 2010 data



Starting with the mass distribution above.
Kinematic/geometric/PID/event variables are available in the ntuple.

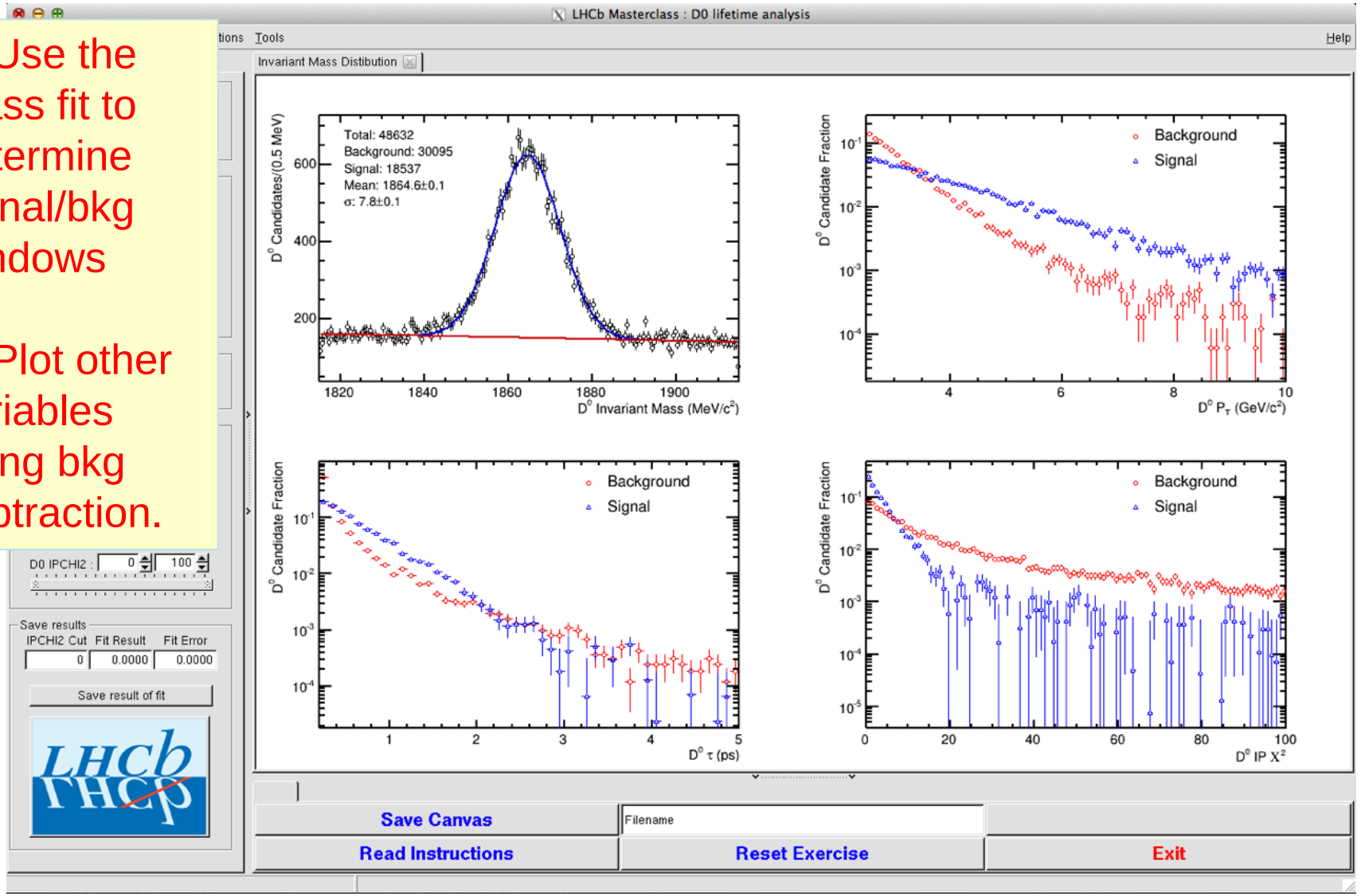
Fitting the D^0 mass



Plotting the distributions

1. Use the mass fit to determine signal/bkg windows

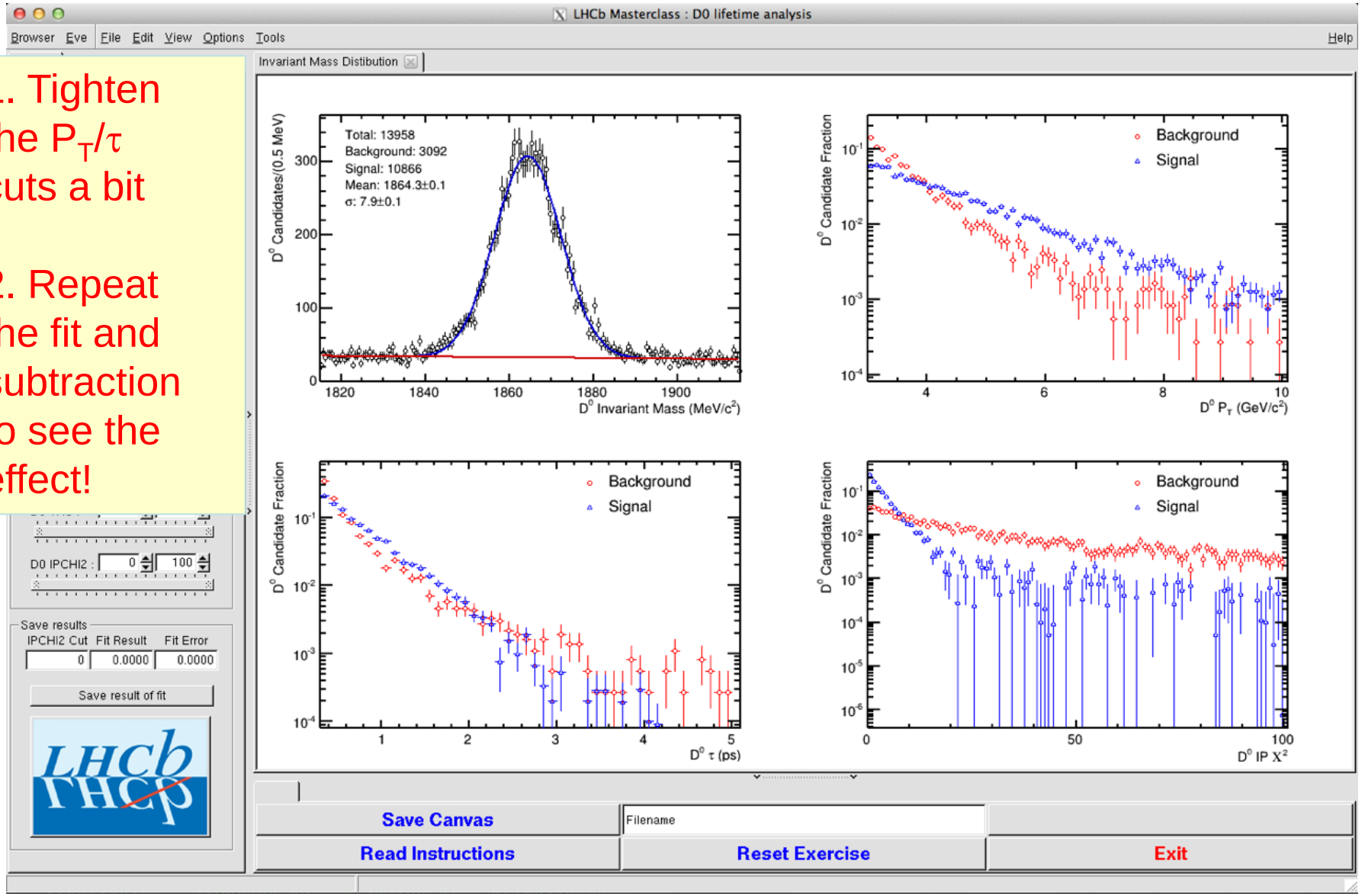
2. Plot other variables using bkg subtraction.



Playing with cuts

1. Tighten the P_T/τ cuts a bit

2. Repeat the fit and subtraction to see the effect!

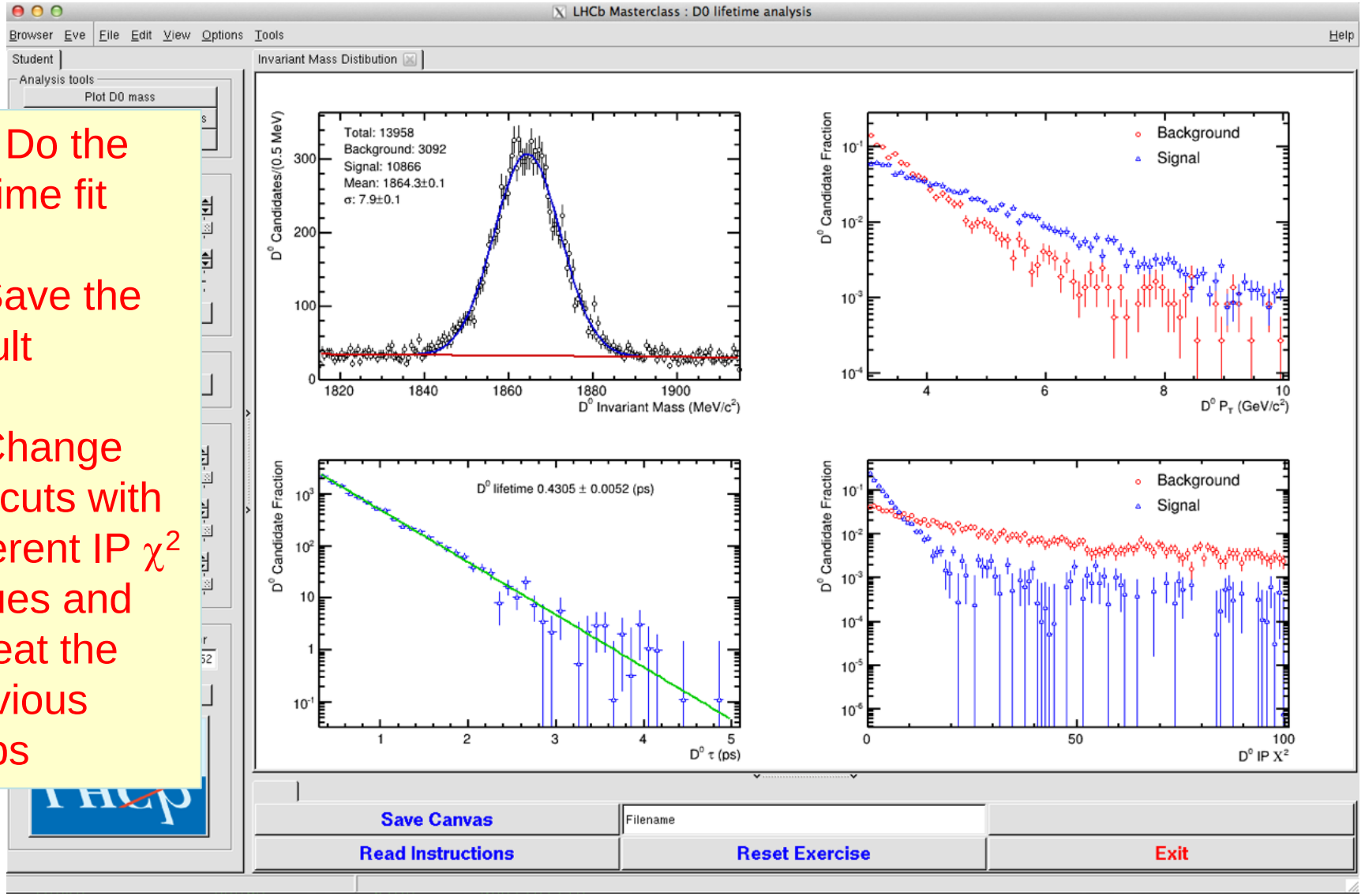


Fitting the lifetime

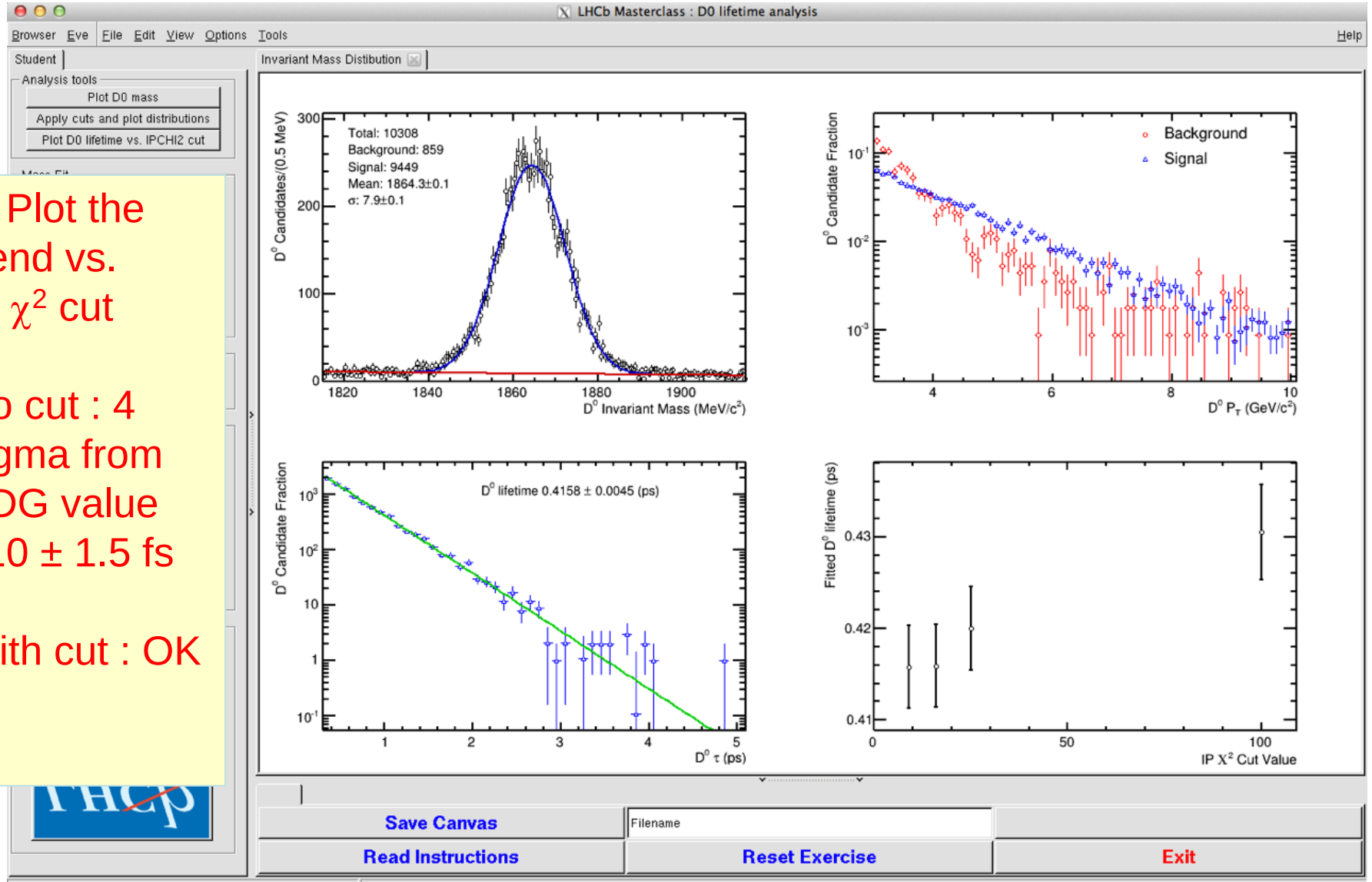
1. Do the lifetime fit

2. Save the result

3. Change the cuts with different IP χ^2 values and repeat the previous steps



Plot the trend



1. Plot the trend vs. IP χ^2 cut

No cut : 4 sigma from PDG value 410 ± 1.5 fs

With cut : OK

Why is this a nice exercise?

- Students begin by separating signal from background in mass.
- They are able to use this to deduce the signal and background distributions in other variables and use cuts to purify the signal, thus showing that the method is working.
- But when they fit the lifetime it comes out wrong!
- There was a hidden background (secondary charm) which looks just like signal in mass, but can be revealed in other variables.
- Can be used to discuss systematics, how to protect against such hidden backgrounds, how to check if background extrapolations are working, etc.
- All this can be done “abstractly”, i.e. without particle physics jargon, but accesses some pretty fundamental aspects of experimental technique.

Future plans

- We are just starting. This is our first exercise.
- We would like to prepare an exercise showing different properties of matter and antimatter.
- We plan to develop an event display suitable for masterclass exercises.
- We store data in ntuples.