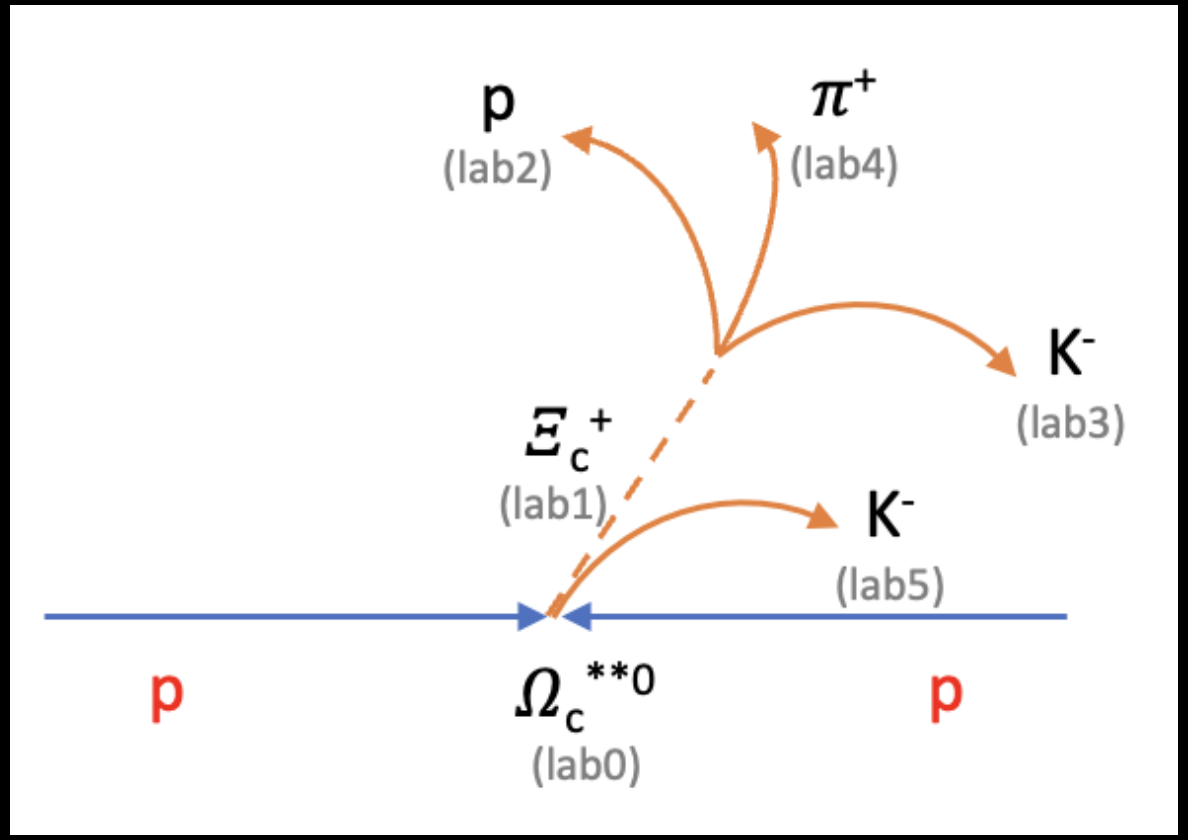
The (re-)discovery of the excited Ω_c^0 particles using the LHCb data

Purpose of the analysis

Find experimental evidence of the existence of the charmed baryon Ω_c^0 through the analysis of the tracks left by the products of its decay at an integrated luminosity of 281.5 pb^-1 and an energy of 13 TeV.

This particle is made of one quark charm and two quarks strange and it is unstable. After its production it decays in a negative kaon K^- and a positive charmed cascade Ξ_c^+ which later produces a proton p, a negative kaon and a positive pion π^+.

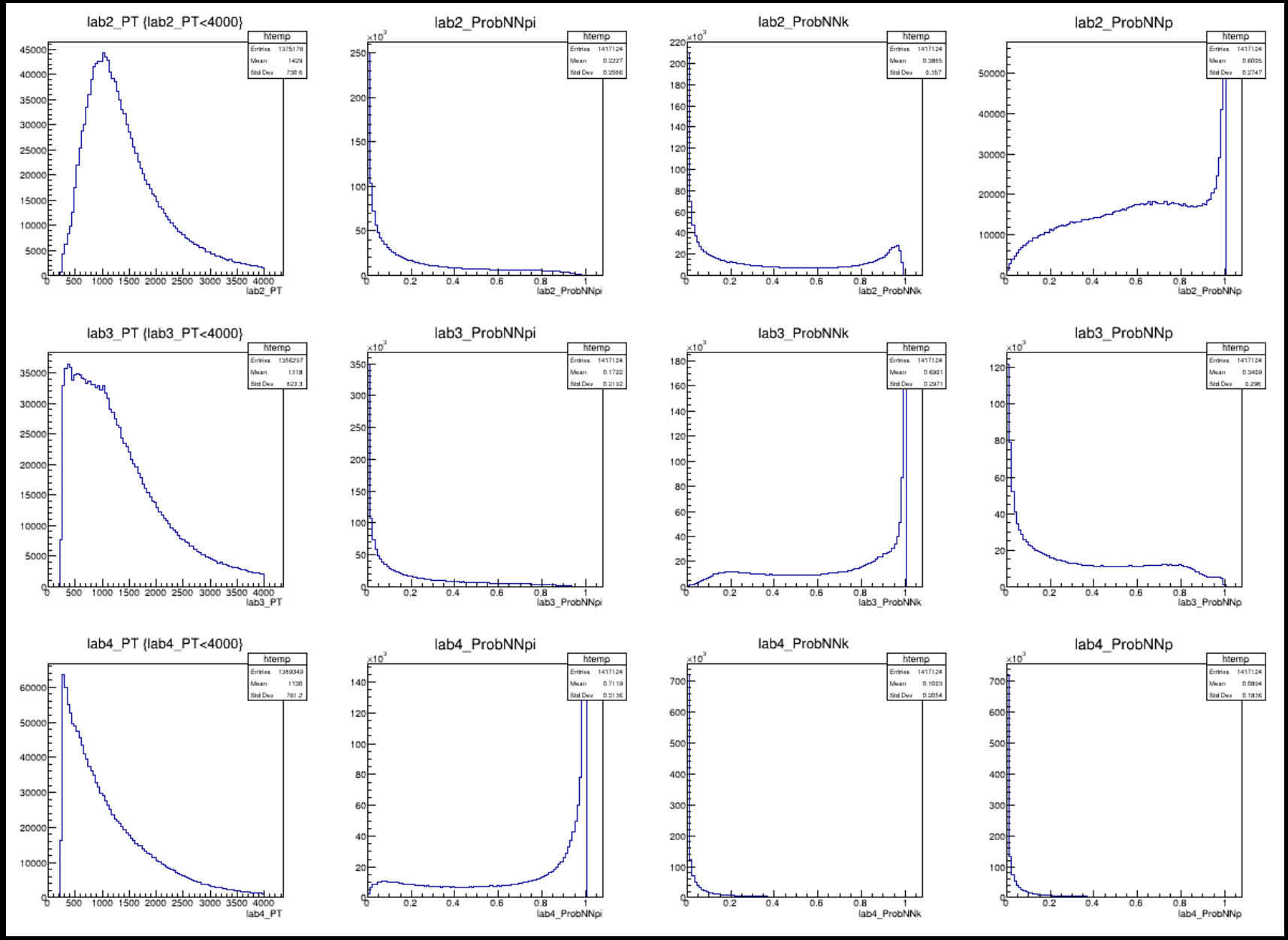


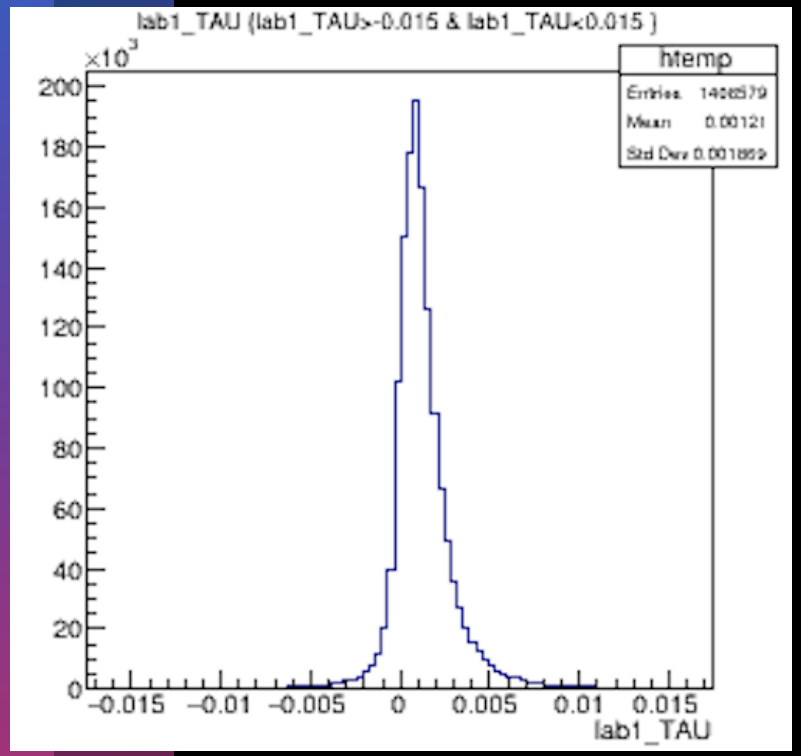
Interaction scheme

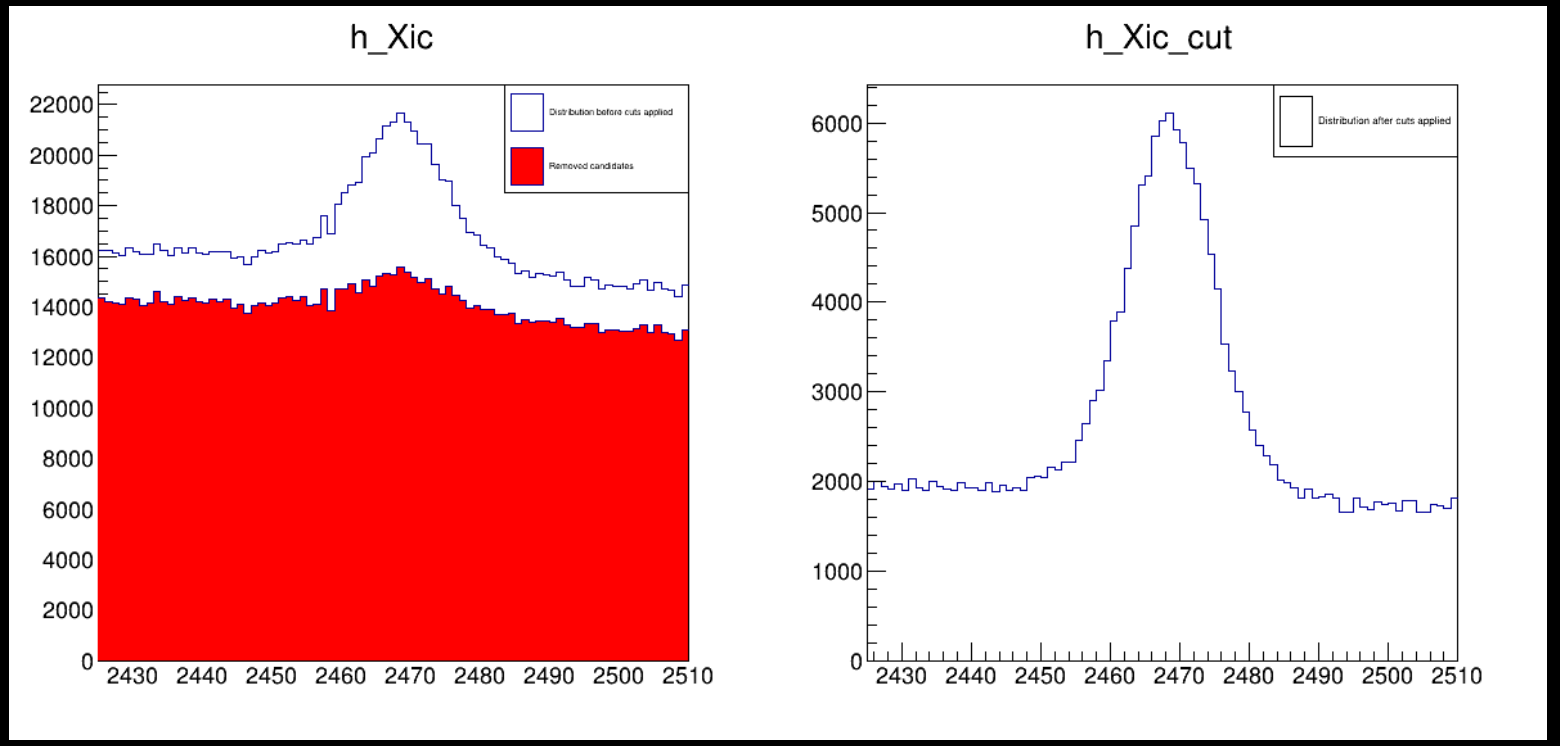
First step

First of all we looked for the candidate "daughters" of Ξ_c^+, using as interest parameters the momentum of each particle corresponding to a signal and the probability of the track being p, K^- or π^+ through neural nets algorithm.

Then we made a cut on the events based on vertexing, on the invariant mass of the products of decay and Ξ_c^+'s lifetime. By these means we removed the background noise caused by the selection of random combinations of particles.


lab2_PT {lab2_PT<4000}
htemp
lab2_PT
lab2_ProbNNpi
htemp
lab2_ProbNNpi
lab2_ProbNNk
htemp
lab2_ProbNNk
lab2_ProbNNp
htemp
lab2_ProbNNp
lab3_PT {lab3_PT<4000}
htemp
lab3_PT
lab3_ProbNNpi
htemp
lab3_ProbNNpi
lab3_ProbNNk
htemp
lab3_ProbNNk
lab3_ProbNNp
htemp
lab3_ProbNNp
lab4_PT {lab4_PT<4000}
htemp
lab4_PT
lab4_ProbNNpi
htemp
lab4_ProbNNpi
lab4_ProbNNk
htemp
lab4_ProbNNk
lab4_ProbNNp
htemp
lab4_ProbNNp

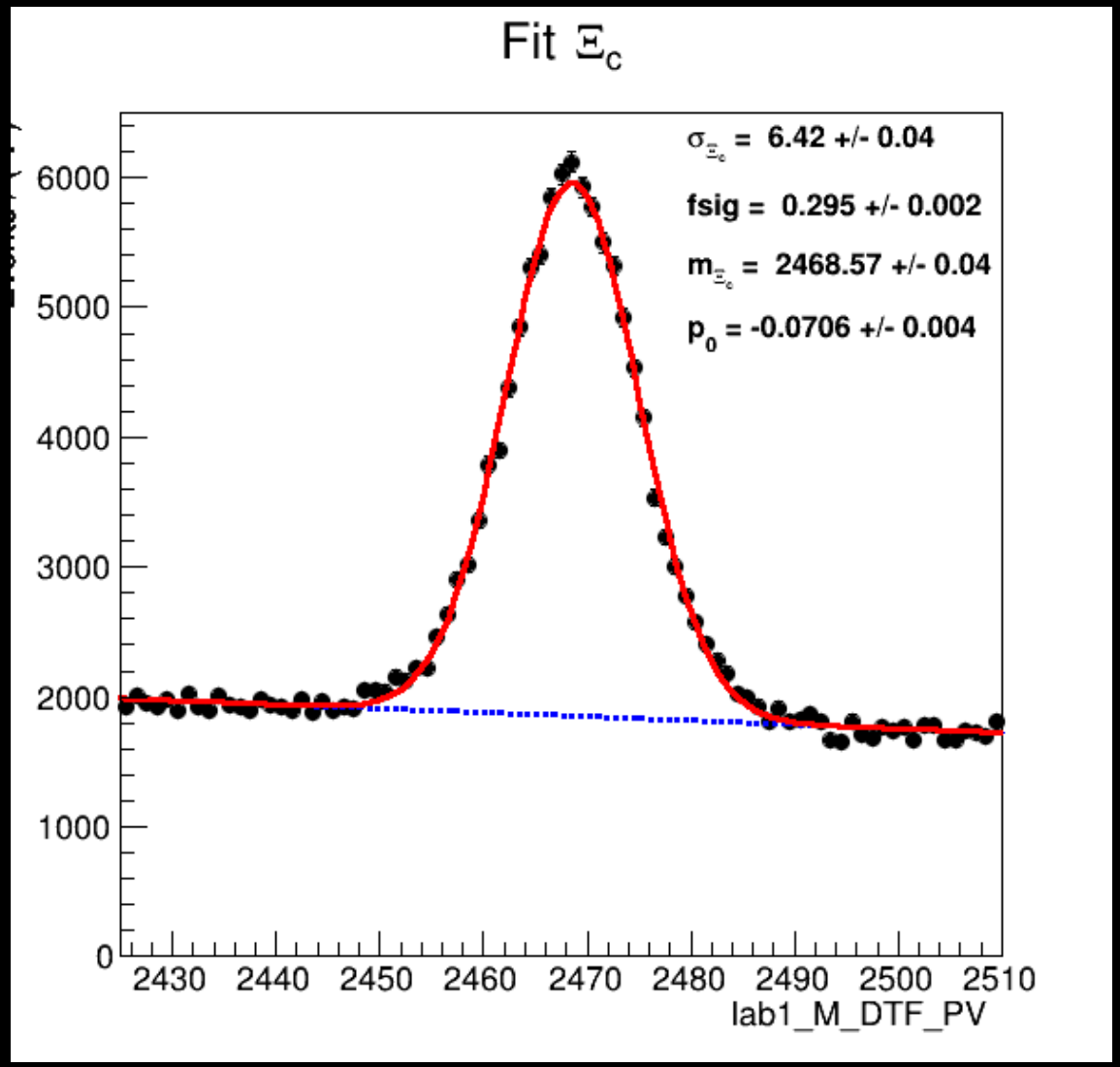

lab1_TAU (lab1_TAU>-0.015 & lab1_TAU<0.015)
×10³
200
180
160
140
120
100
80
60
40
20
0
−0.015
−0.01
−0.005
0
0.005
0.01
0.015
lab1_TAU
htemp
Entries 1466579
Mean 0.00121
Std Dev 0.001869


h_Xic
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2430
2440
2450
2460
2470
2480
2490
2500
2510
Distribution before cuts applied
Removed candidates

h_Xic_cut
6000
5000
4000
3000
2000
1000
0
2430
2440
2450
2460
2470
2480
2490
2500
2510
Distribution after cuts applied

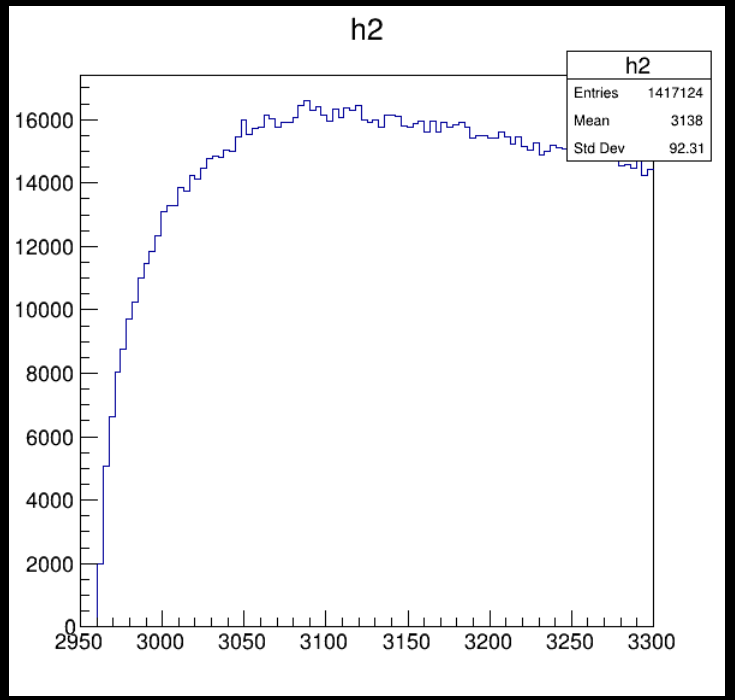
Second step

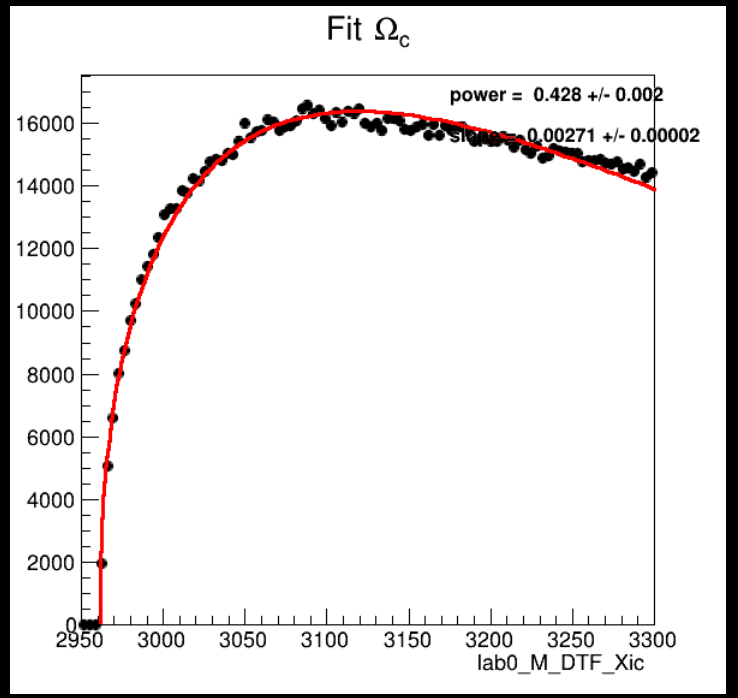
We proceeded the analysis fitting the curve of the invariant mass of Ξ_c^+ with a Gauss function and the background with a polynomial fuction.



Third step

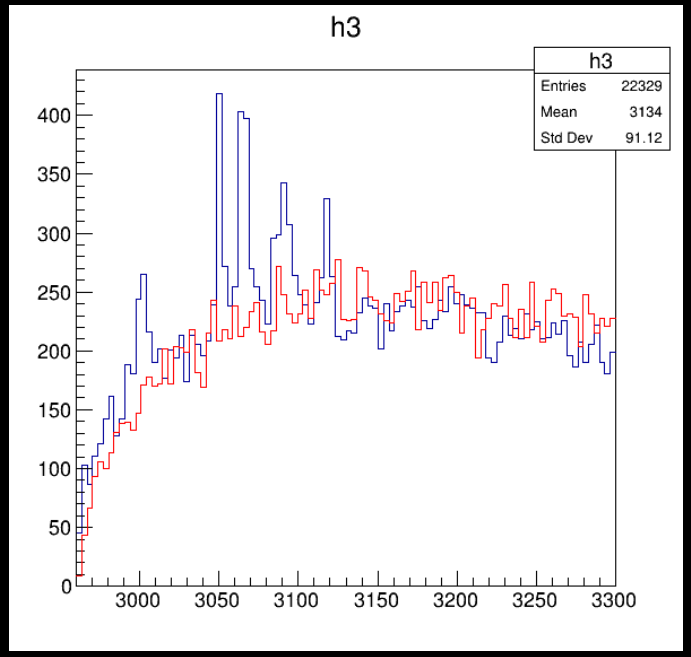
Then we selected the system Ξ_c^+ and K^- that originated from the "mother" particle. We obtained a very noisy signal that we proceeded on cutting as we did before with Ξ_c^+'s signal. The background was fitted with a threshold function.

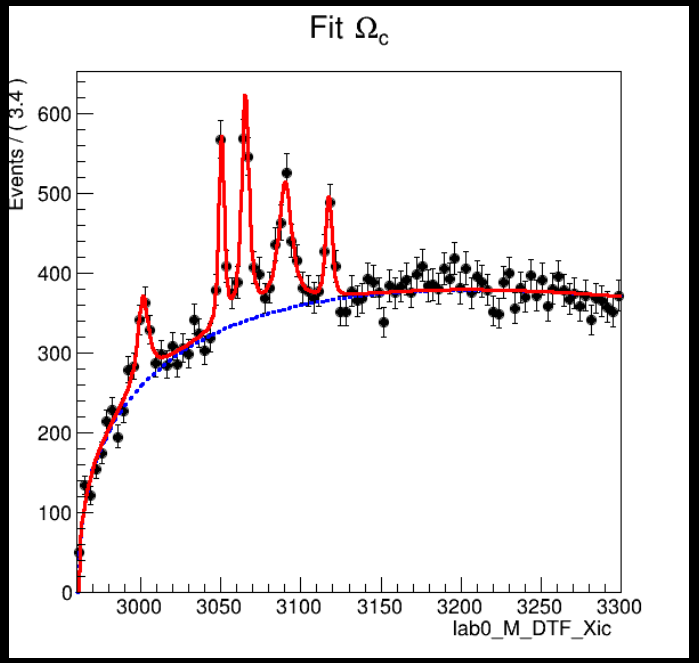




Final step

In order to identify the background events we compared the events due to the decay of Ω_c^0 in Ξ_c^+ and K^- with the events due to a fictional system made of Ξ_c^+ and a positive kaon K^+. Using this process we were able to identify the five different conventional states of Ω_c^0 fitting the datas with a convolution between a Breit-Wigner function and a Gaussian function.





Thanks for your attention!