Λ kinematic analysis

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Why do i study Λ-hyperon?

According to the article „Possible studies at the first stage of the NICA collider operation with polarized and unpolarized proton and deuteron beams“ it will be possible to study:

- Spontaneous polarization in transversive plane
- Spin transfer in polarized collisions

Event and track selection for the Λ analysis

Sample

- SPDRoot version from Jul 26 2023
- Generation: Pythia 8 , (p+p) at √s = 27 GeV, minbias = all
- 1 500 000 events

Event selection:

- In sample searching for pairs of particles using package KFparticle:

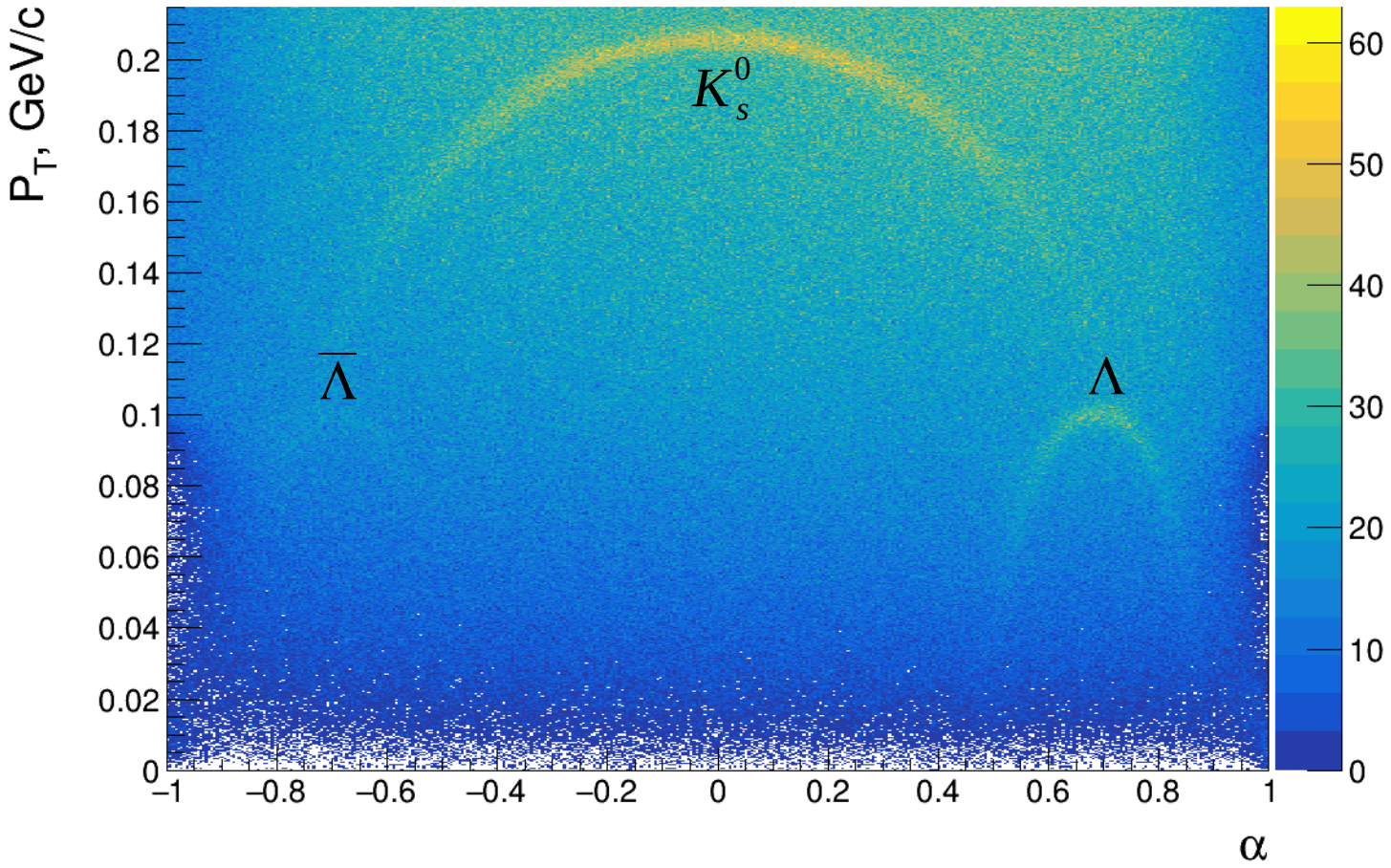
  Λ:(-211,2212),

  Background: (-211,211), (-2212,211), (-321,321), (-211,321), (-321,211)

- General quality creteria was applied:

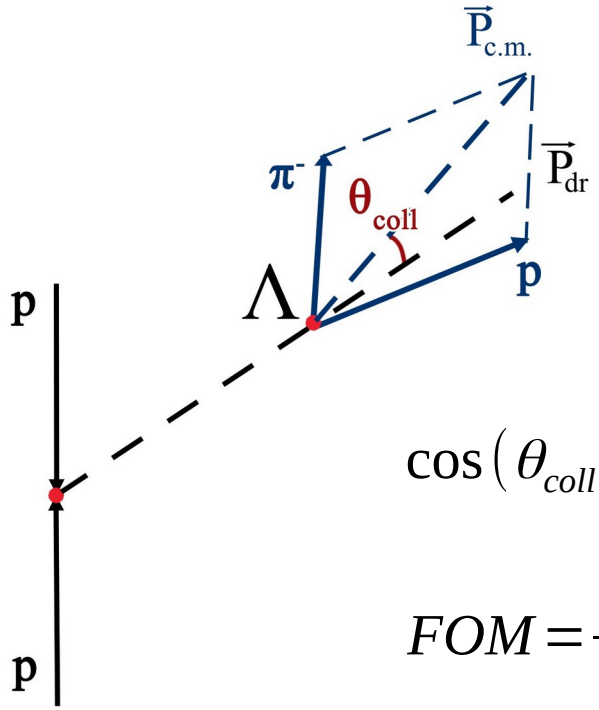
  Isgood and χ^2/NDF of track < 6

Podolanski-Armenteros plot before kinematic cuts



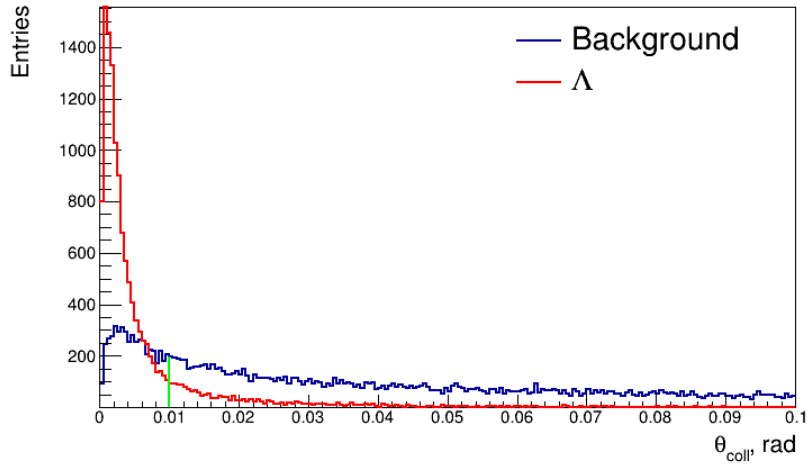
$$\alpha = \frac{P_L^+ - P_L^-}{P_L^+ + P_L^-}$$

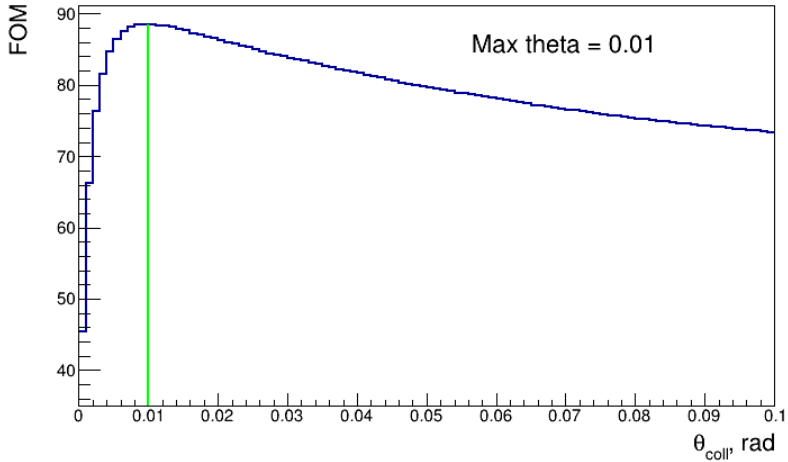
Colliniarity angle cut



$$\cos(\theta_{coll}) = \frac{(\vec{P}_{dr}, \vec{P}_{c.m.})}{|\vec{P}_{dr}||\vec{P}_{c.m.}|}$$

$$FOM = \frac{S}{\sqrt{S+B}}$$

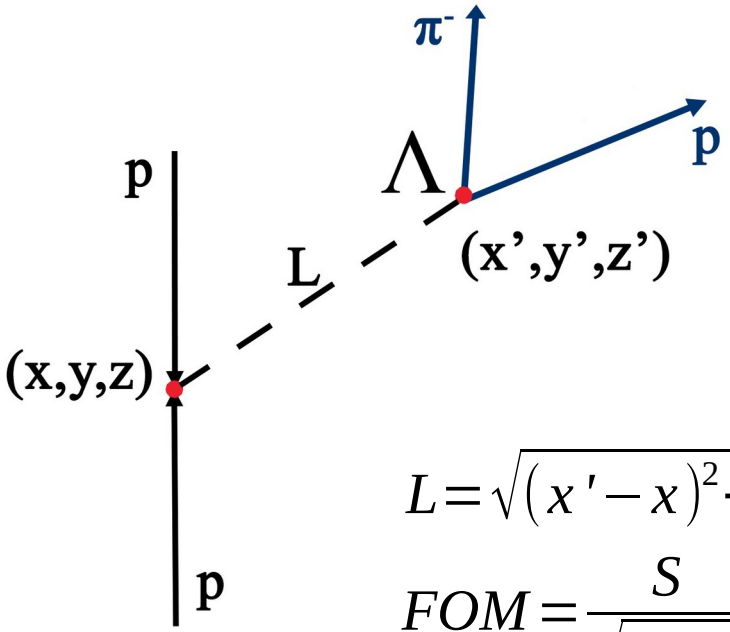




This cut selects Λ candidates with momentum looking in direction of primary vertex.

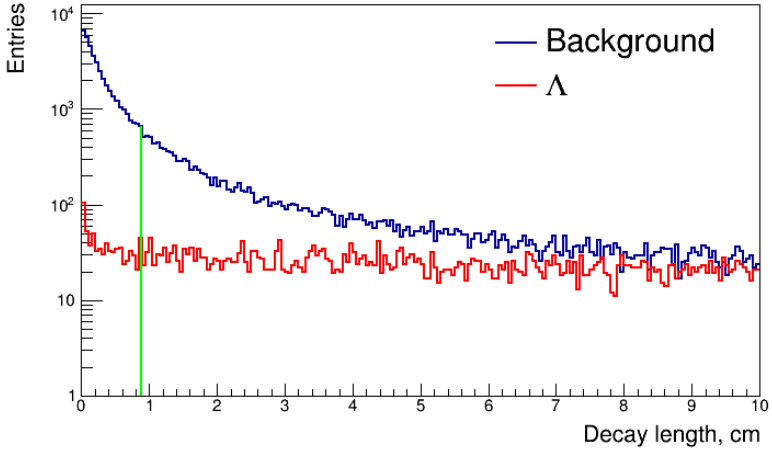
$\theta_{coll} < 0.01$ rad.

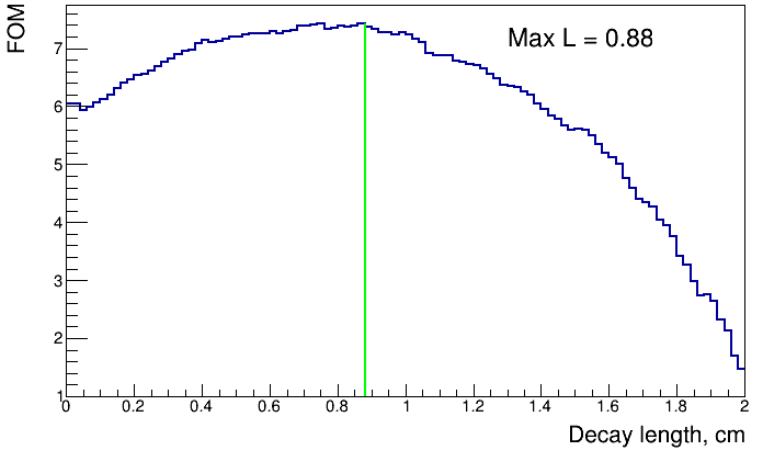
Decay length cut



$$L=\sqrt{(x'-x)^2+(y'-y)^2+(z'-z)^2}$$

$$FOM=\frac{S}{\sqrt{S+B}}$$

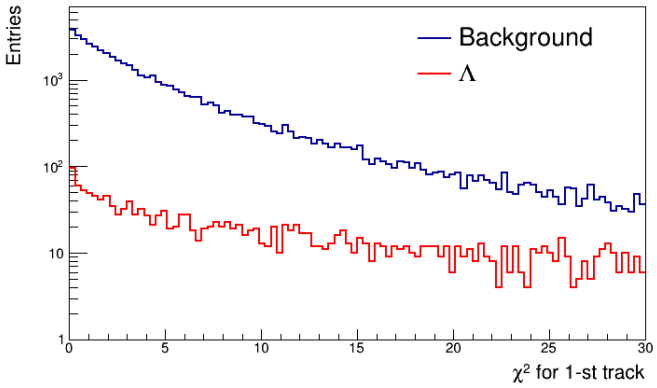


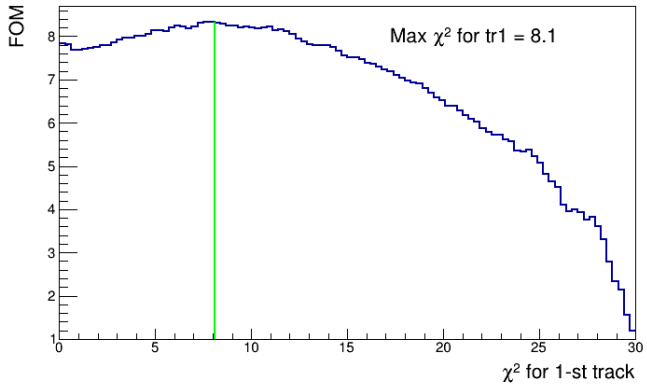


This criterion cuts events with short decay distance.
L>0.88 cm.

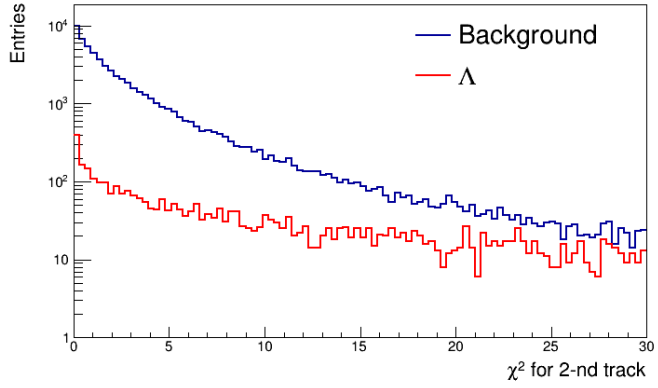
χ^2 to PV cut

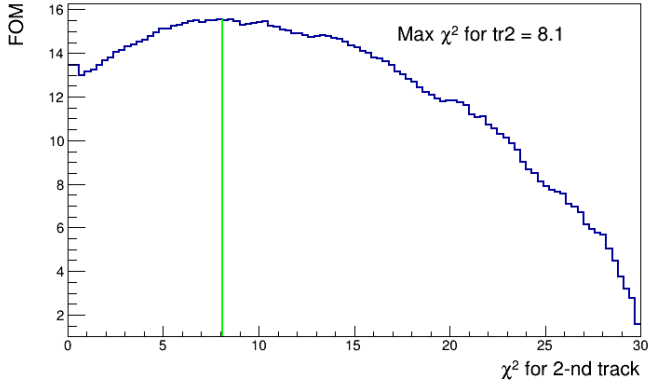
Track 1





Track 2

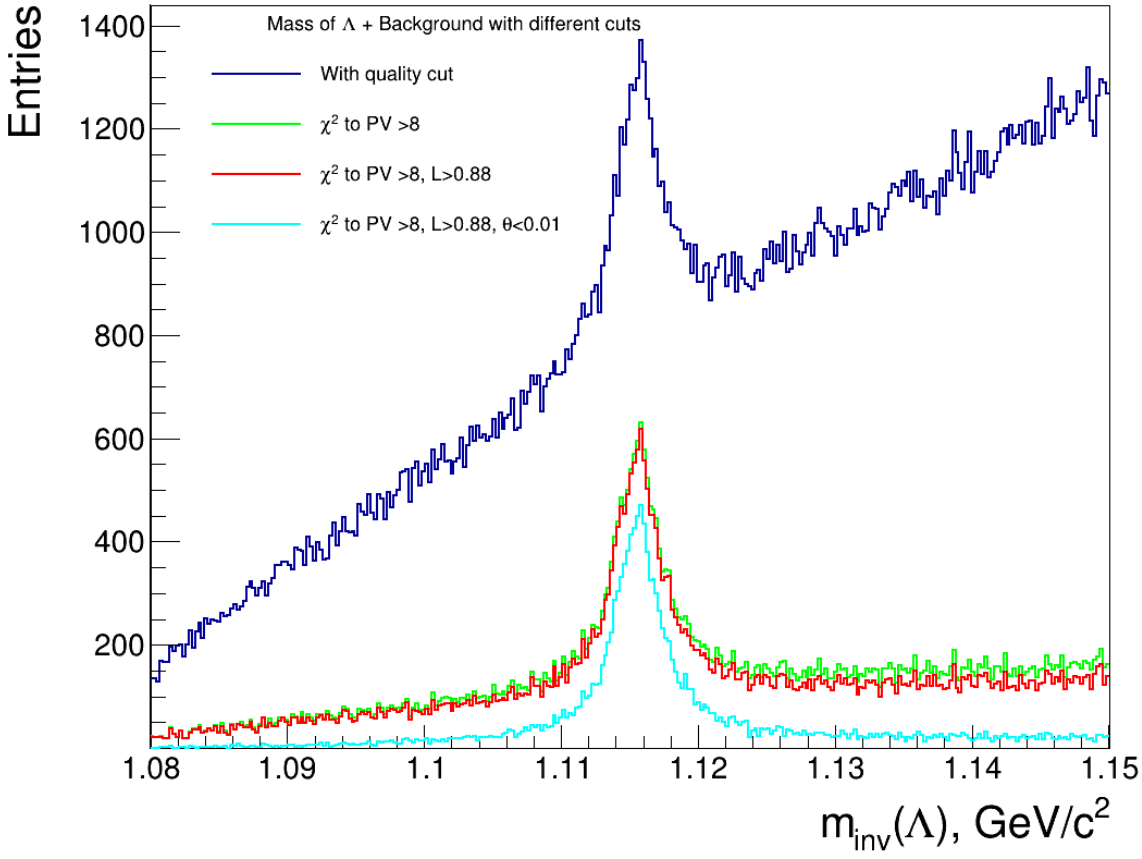




$$FOM = \frac{S}{\sqrt{S+B}}$$

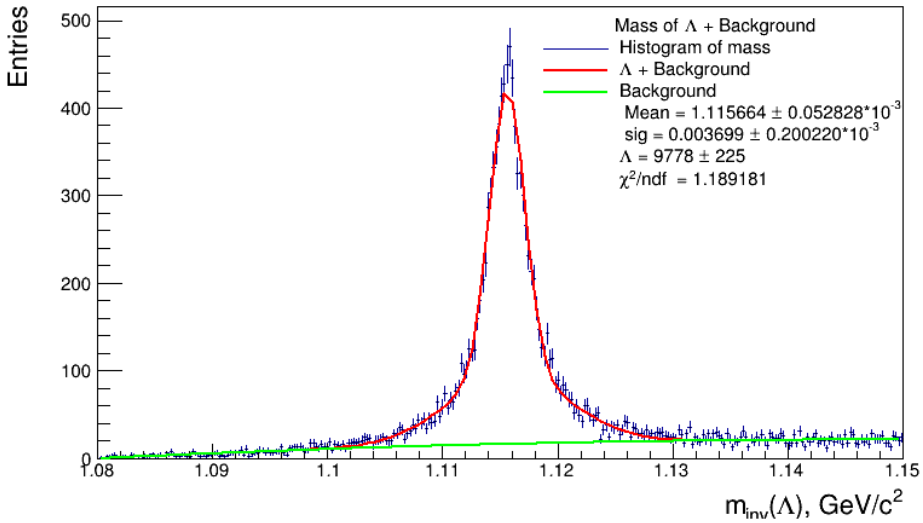
χ^2 for track extrapolation to primary vertex.
This cut selects
Λ candidates with bad track extrapolation to PV.
χ^2 >8

Invariant Mass of Λ with different cuts



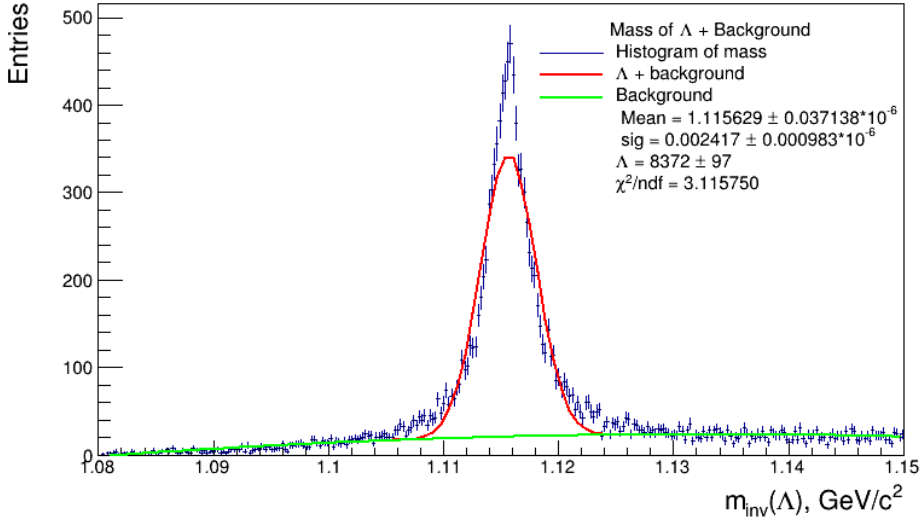
Cuts	Λ	Background	FOM
1	13797	72449	46.9802
2	11504	10352	77.815
3	11443	8892	80.245
4	10029	1300	94.2241

Fitting of invariant mass of Λ



f(x) = Double Gauss + 3rd order polynomial

N_{Λ} = 9778 ± 225



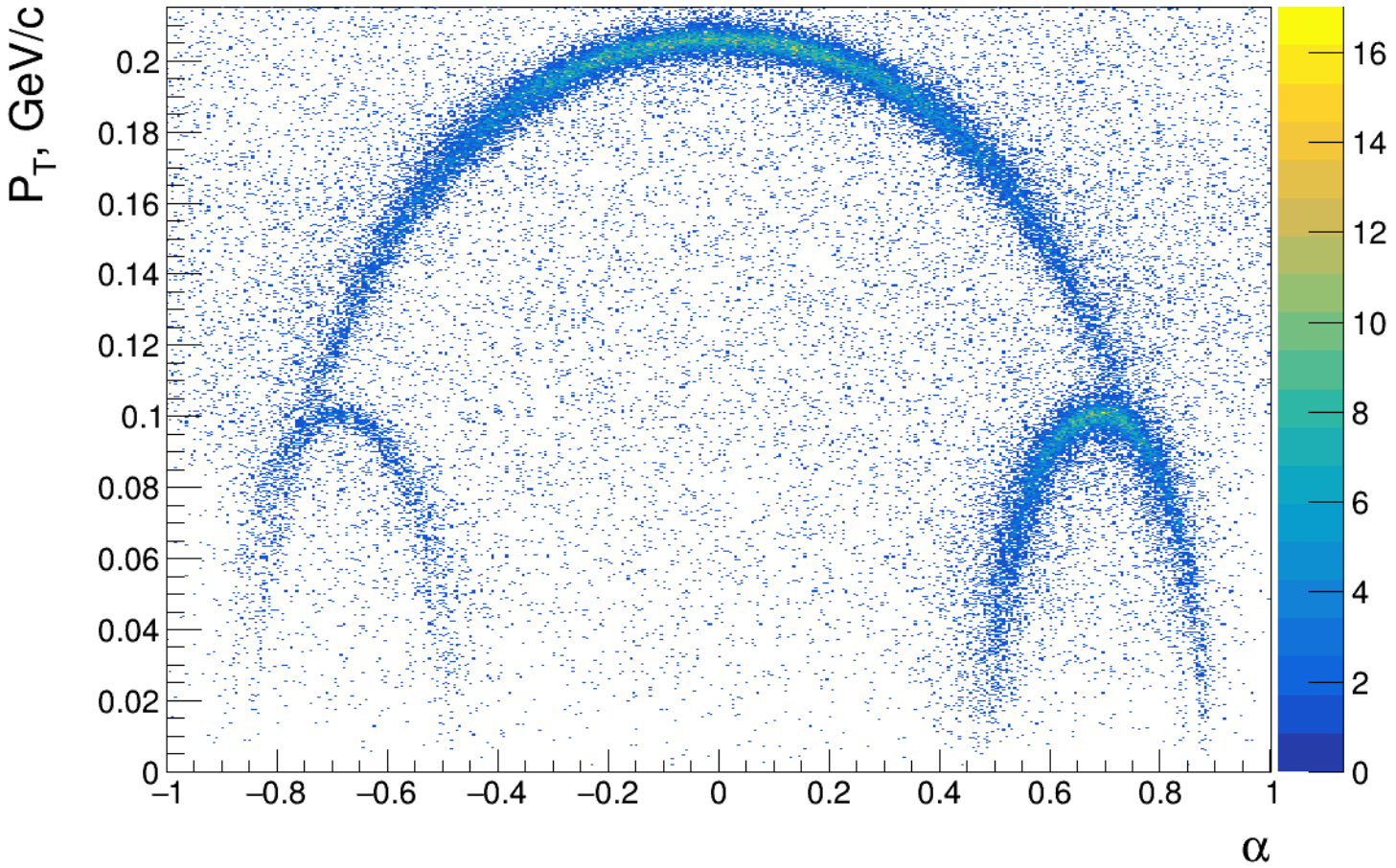
f(x) = Single Gauss + 3rd order polynomial

N_{Λ} = 8372 ± 97

N_{true} of Λ for this cuts: 10911

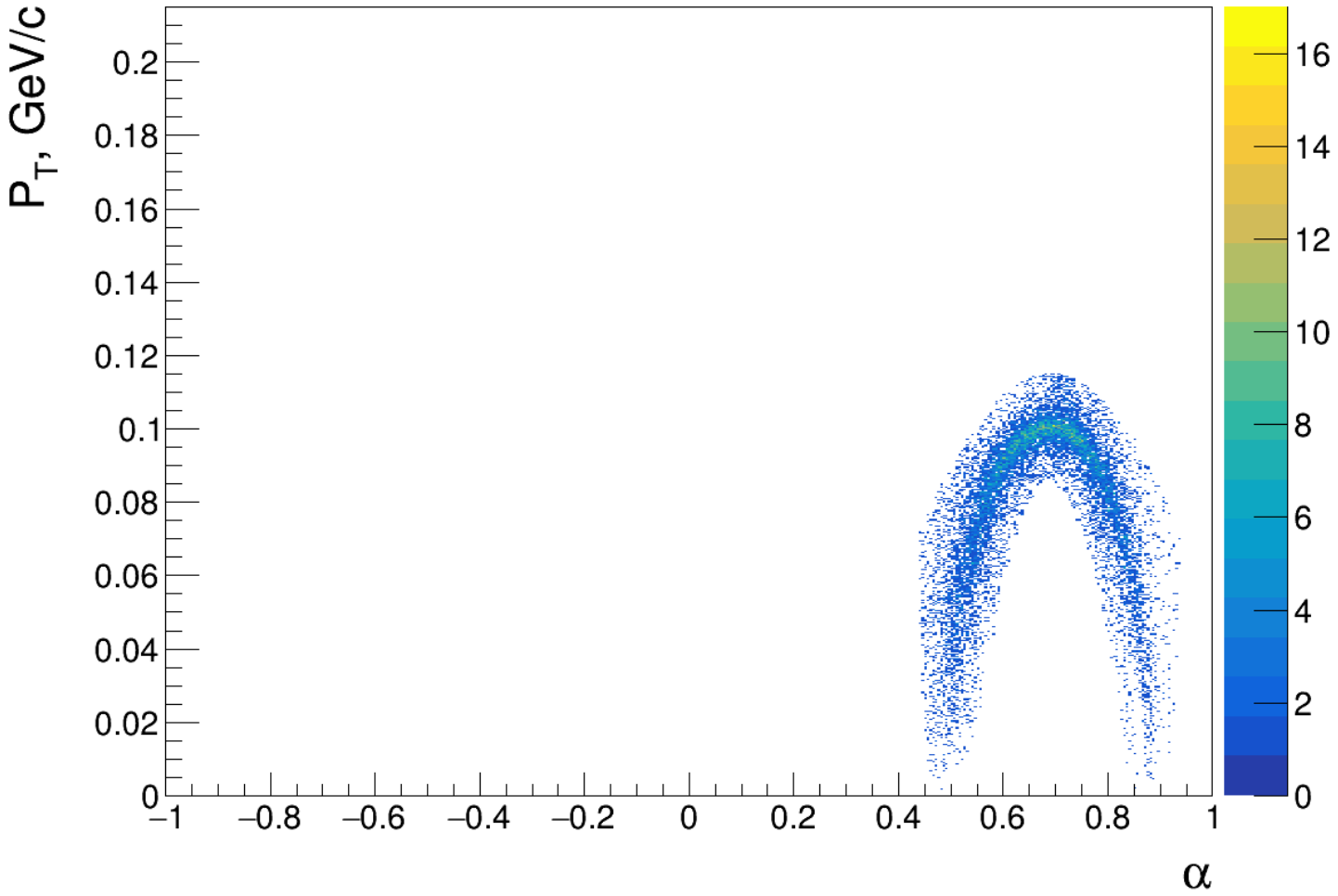
N_{true} of Λ in ±3σ: 10029

Podolanski-Armenteros after kinematic cuts

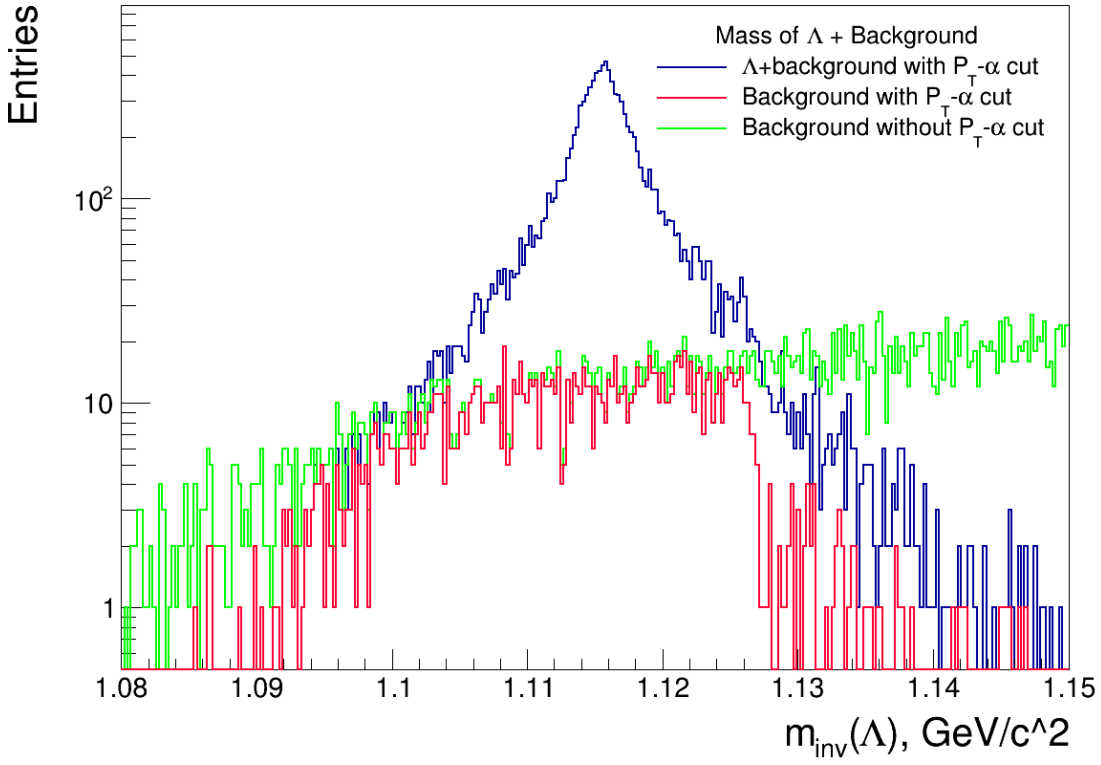


$$\alpha = \frac{P_L^+ - P_L^-}{P_L^+ + P_L^-}$$

Kinematic cut $P_T(\alpha)$

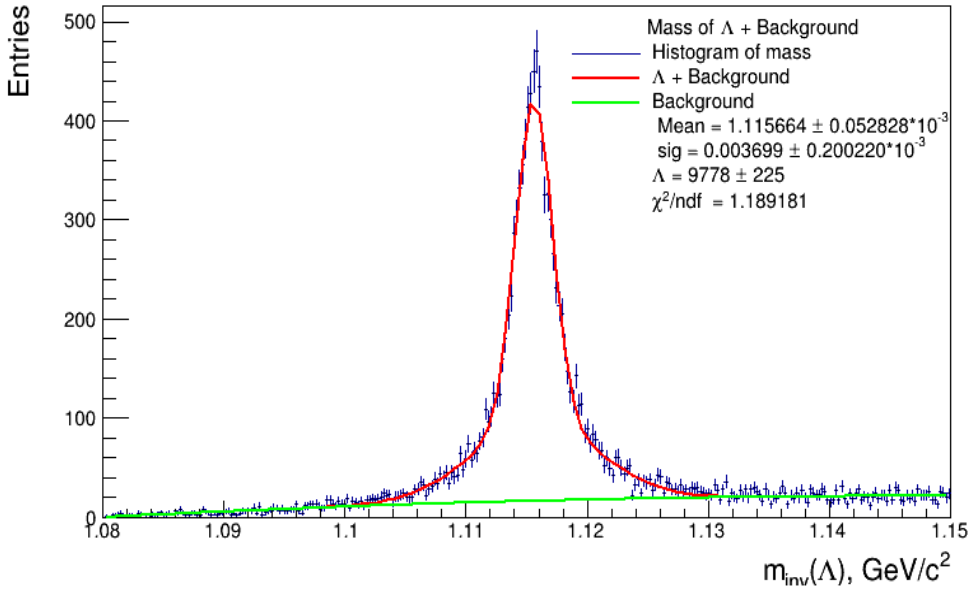


Kinematic cut $P_T(\alpha)$



Graph	Λ	Background	FOM
In whole range of graph			
With cut	10337	1442	95.2445
Without	10911	3503	90.8808
In ±3σ of invariant mass mean			
With cut	9895	1083	94.431
Without	10029	1300	94.2241

Results



From fit

$m_{inv}(\Lambda) = 1.1157 \pm 0.1*10^{-3}$ GeV

$\sigma = 0.0037 \pm 0.2*10^{-3}$ GeV

	Λ	Background	FOM
Without quality cut	39651	715531	45.6277
With quality cut	13797	72449	46.9802
With kinematic cuts: $L > 0.88$ cm, $\theta_{coll} < 0.01$ rad, $\chi^2 > 8.1$	10029	1300	94.2241

Conclusion & To Do

- Analysis of kinematic cuts was perfomed.
- Kinematic cut $P_T(\alpha)$ is inefficient.
- Main cuts are the following: $L > 0.88$ cm, $\theta < 0.01$ rad, $\chi^2 > 8.1$

Next step

- Calculate reconstruction efficiency.
- Generate more events.