Studying the possibility of hyperon reconstruction in the BM@N experiment at the NICA complex

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Goal of the work

Search for hyperons in the data of the BM@N experiment.

Tasks

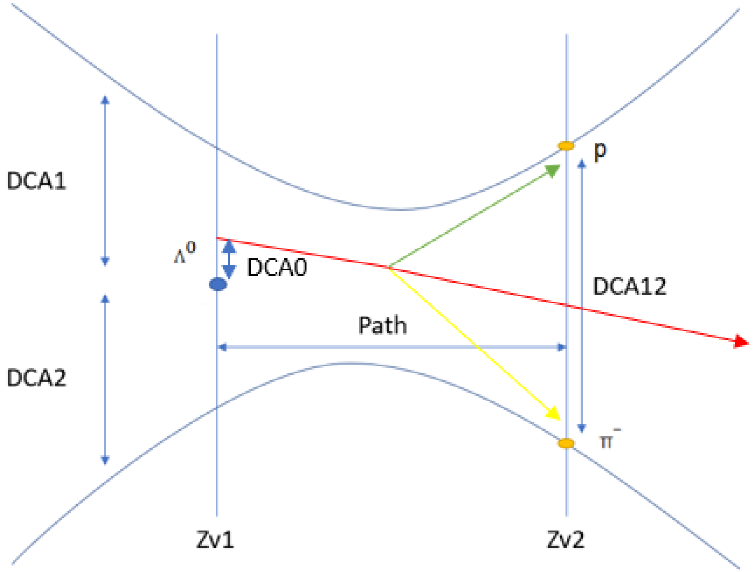
- Modelling and reconstruction of data for analysis.
- Development and implementation of a hyperon reconstruction algorithm in bmnroot.
- Determination of the sources of background increment in the mass distribution.
- Investigation of the influence of background sources on the quality of reconstruction.

Data

- Data obtained from the Monte Carlo generator DCMSMM was used for the analysis. 100,000 events were simulated and reconstructed by employing VF.

Data processing

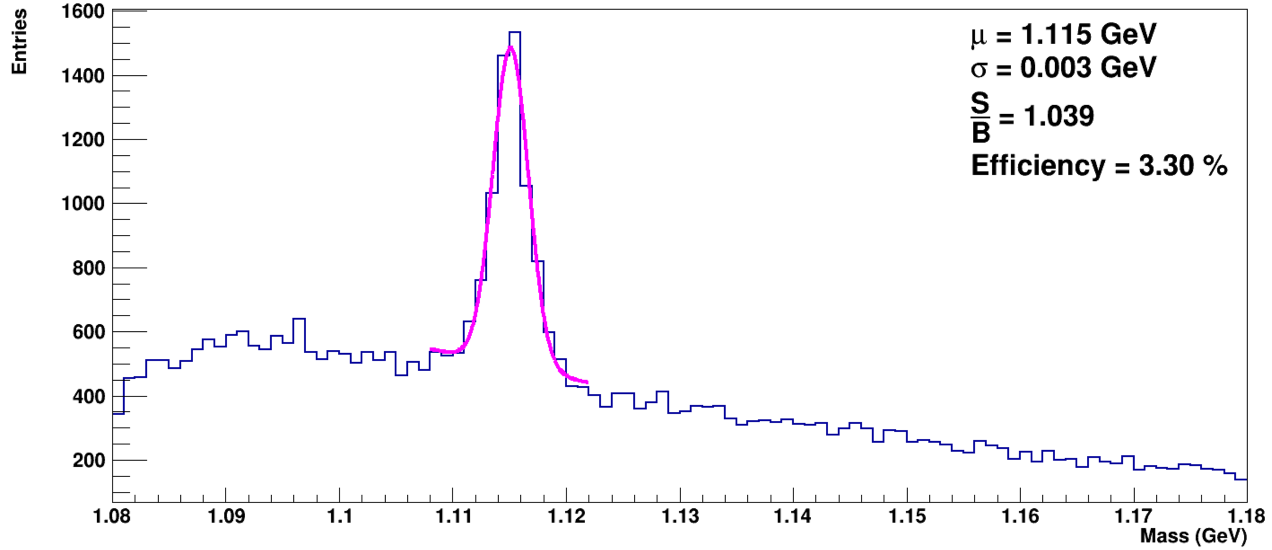
- Algorithms were developed and implemented to enable the search for the trajectories of lambda hyperons along the decay channel into a proton and negative pi-meson and short-lived neutral kaons along the decay channel into positive and negative pi-mesons:
  - Sorting of pairs of particles with different signs.
  - Calculating the invariant mass.
  - Imposing a number of geometric restrictions on the parameters of each pair.



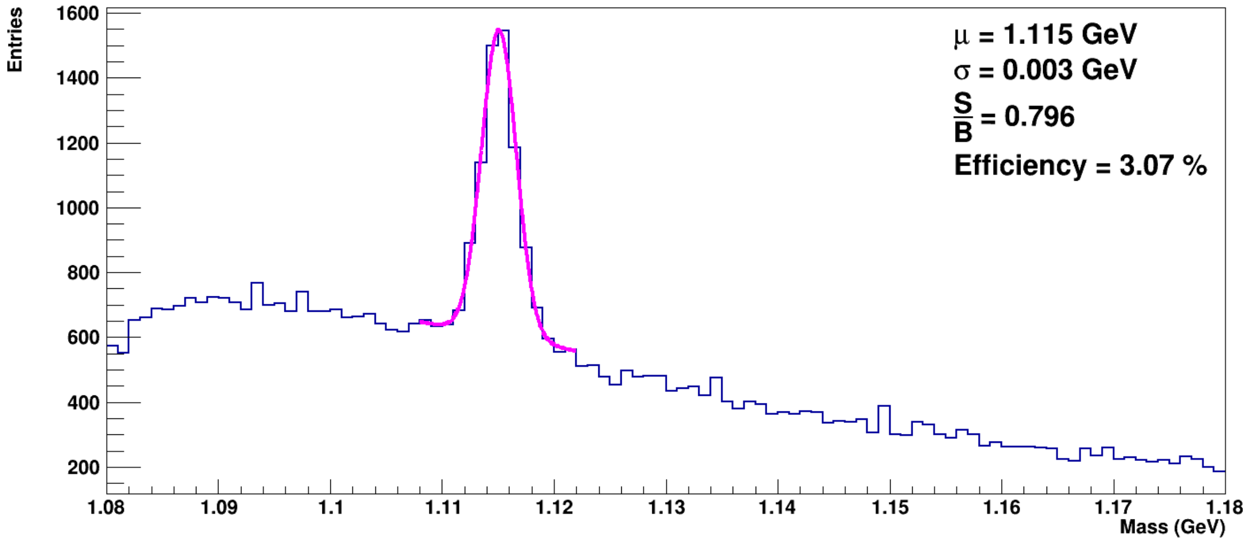
Sources of background increment

- Blurring of the beam
  - In the least realistic case, the beam is assumed to be point like. In reality, there is beam blurring in the transverse plane, as well as a small spread in angle.
- SiMD, BD
  - The production of secondary particles and, as a consequence, an increase in the background in the mass distribution of lambda hyperons, can be affected by the presence of the substance of trigger detectors located after the target and before the track detectors.
- Target
  - Since the target is an extended object, in addition to the primary interaction of the beam with the target, there will be interactions of secondary particles with the target nuclei. This might also be a source of the background increment in the mass spectra.

Results
Lambda hyperons



Ideal case

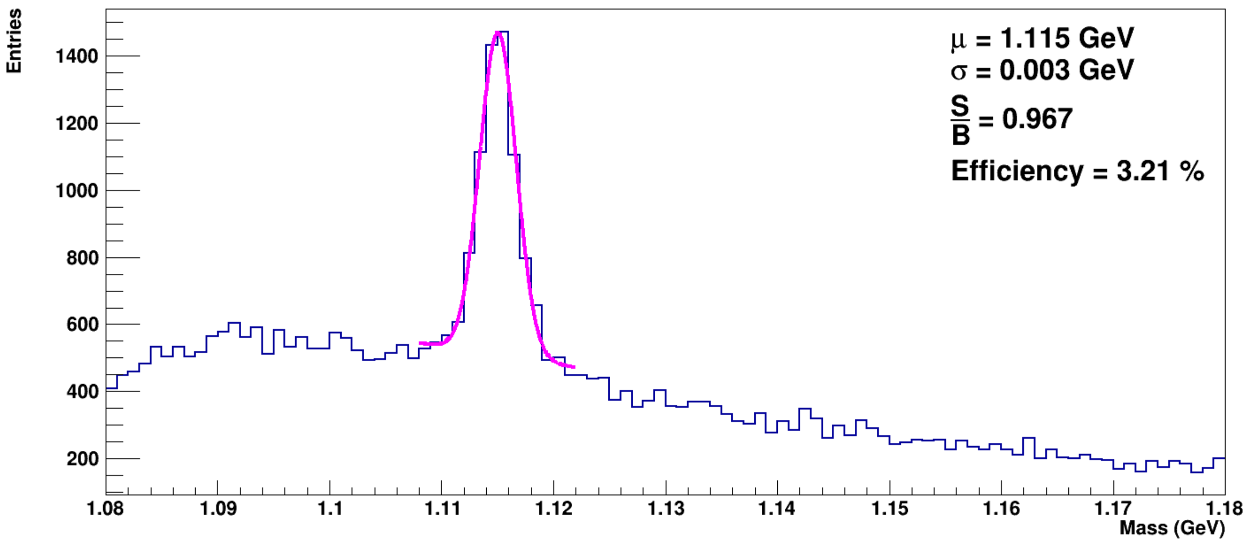


SiMD, BD, target and beam blurring

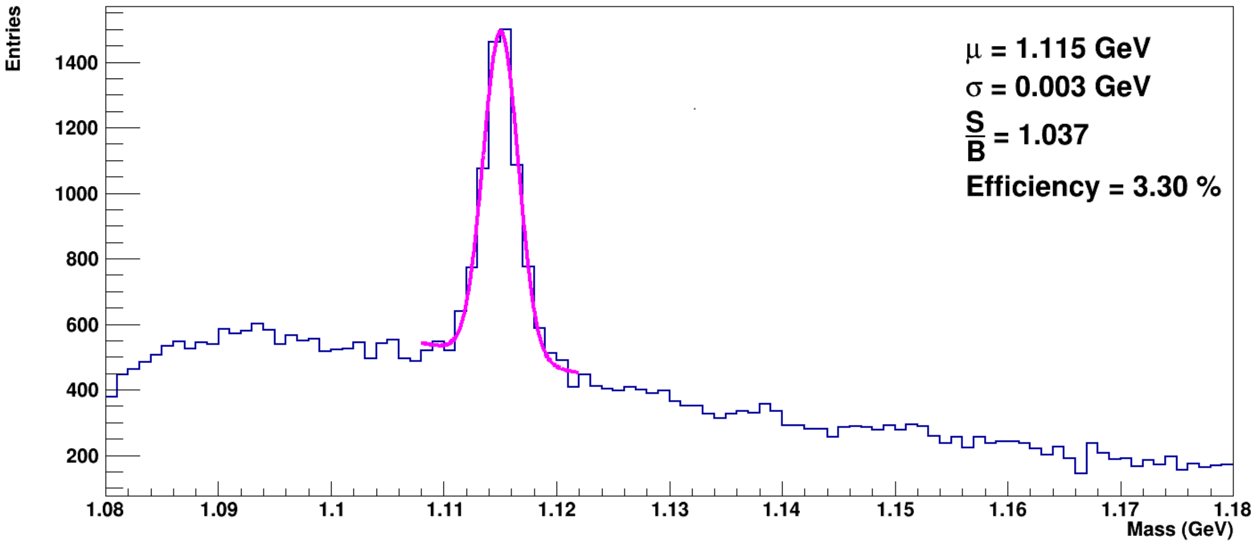
- Cuts
  - 3.0 < path < 20
  - 0.0 < DCA12 < 0.4
  - 0.0 < DCA0 < 0.2
  - 0.1 < DCA1 < 3.0
  - 0.3 < DCA2 < 3.0

Results

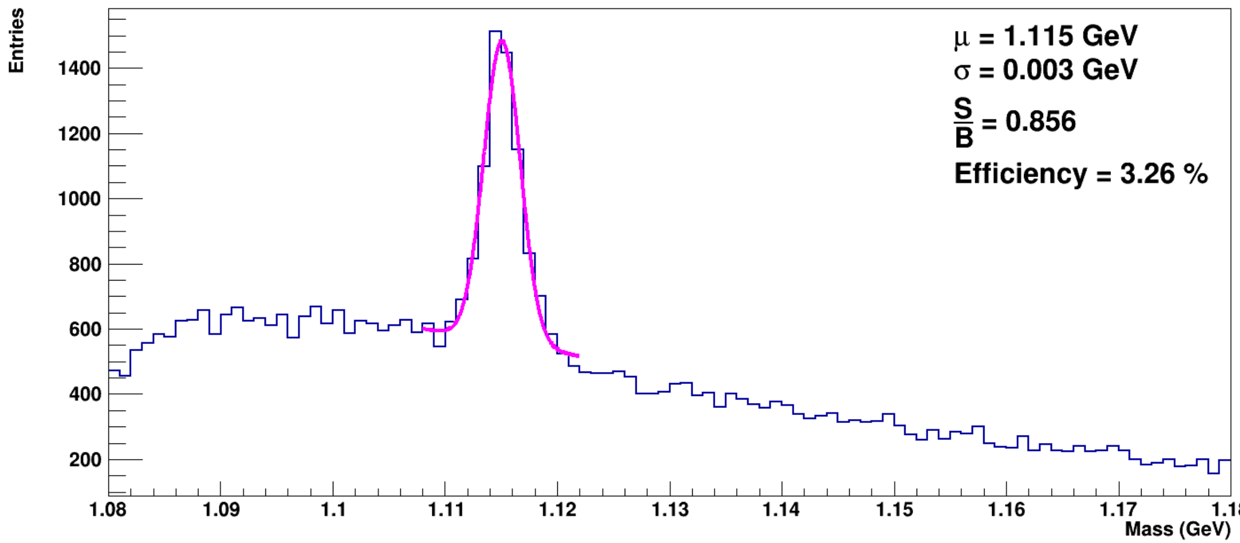
Lambda hyperons



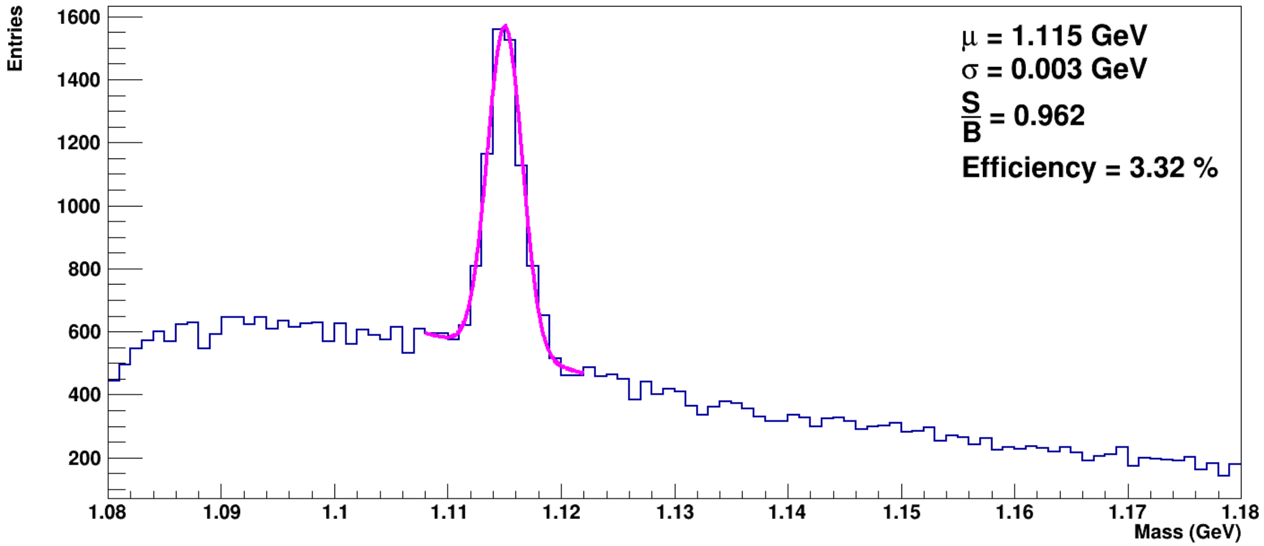
SiMD



BD



Beam blurring



Target

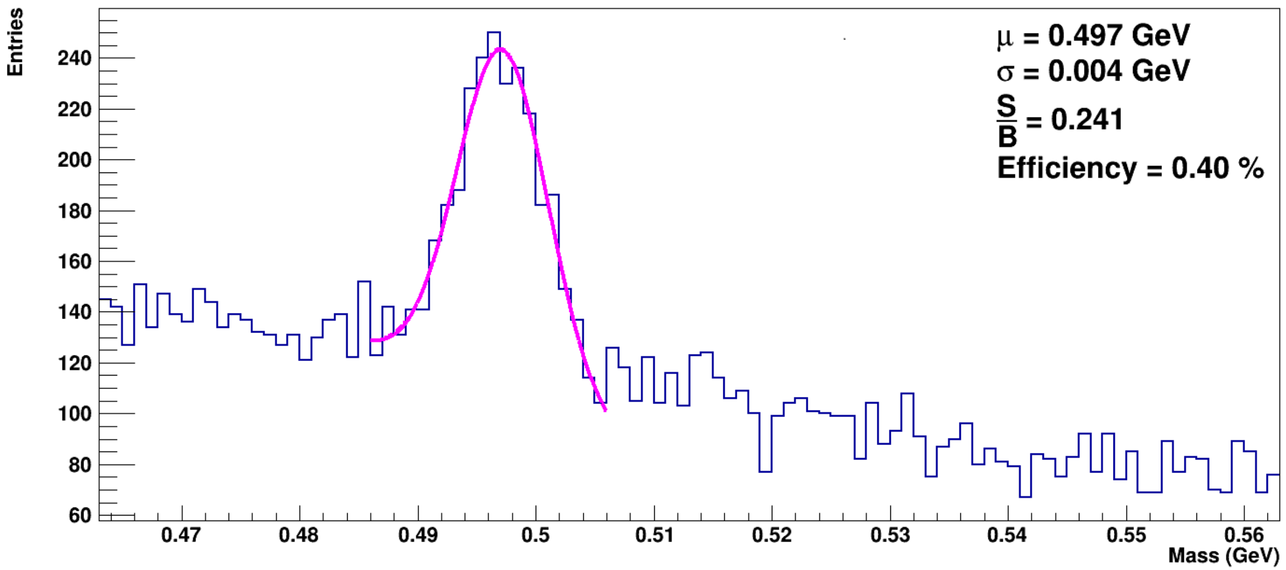
Results

Lambda hyperons

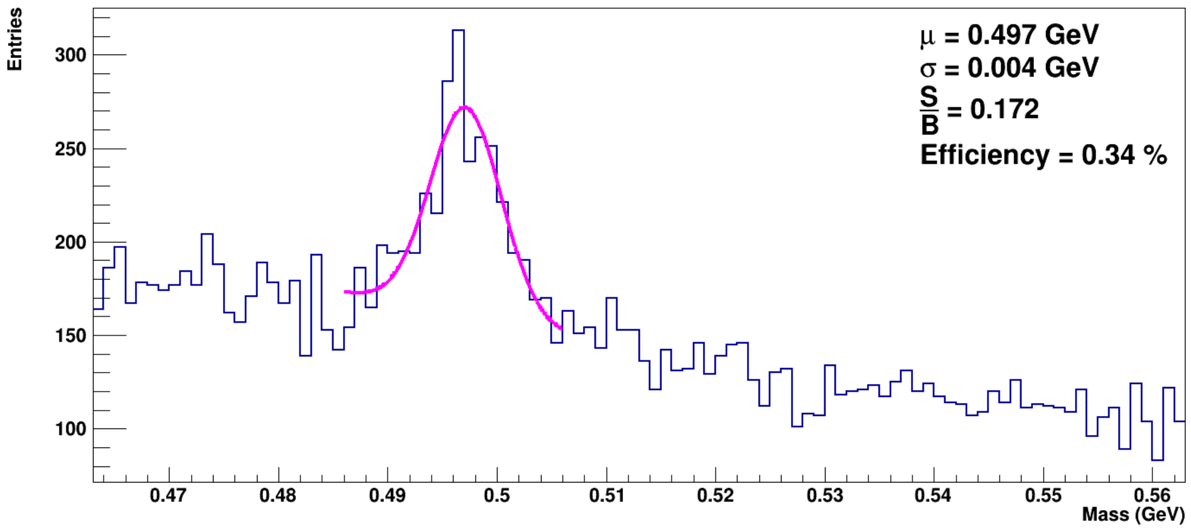
	Ideal case	SiMD, BD, target и размытие пучка	SiMD	BD	Target	Beam blurring
μ (GeV)	1.115	1.115	1.115	1.115	1.115	1.115
σ (GeV)	0.003	0.003	0.003	0.003	0.003	0.003
S	3713	3466	3606	3720	3733	3480
B	3574	4353	3730	3588	3881	4067
S/B	1.039	0.796	0.967	1.037	0.962	0.856
Efficiency (%)	3.30	3.07	3.21	3.30	3.32	3.26

Results

K_S^0



Ideal case

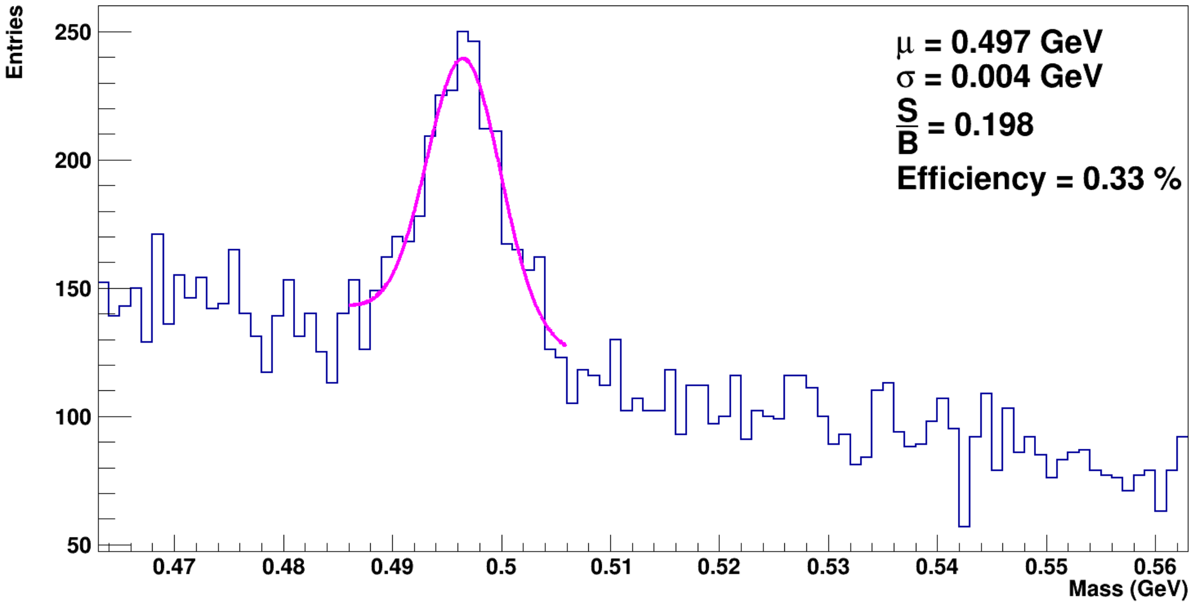


SiMD, BD, target and beam blurring

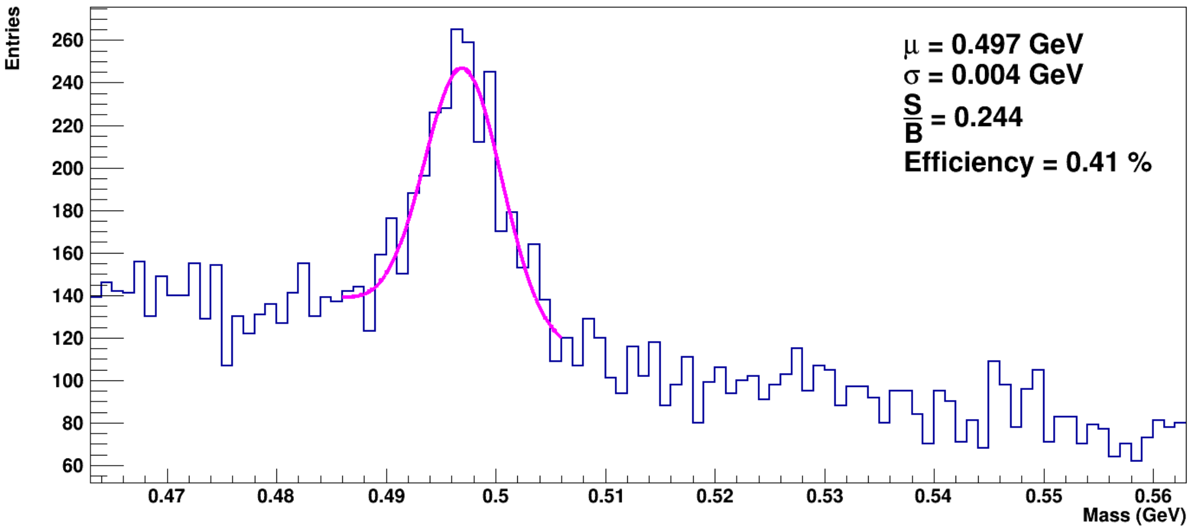
- Cuts
  - 1.0 < path < 20
  - 0.0 < DCA12 < 0.3
  - 0.0 < DCA0 < 0.2
  - 0.2 < DCA1 < 3.0
  - 0.2 < DCA2 < 3.0

Results

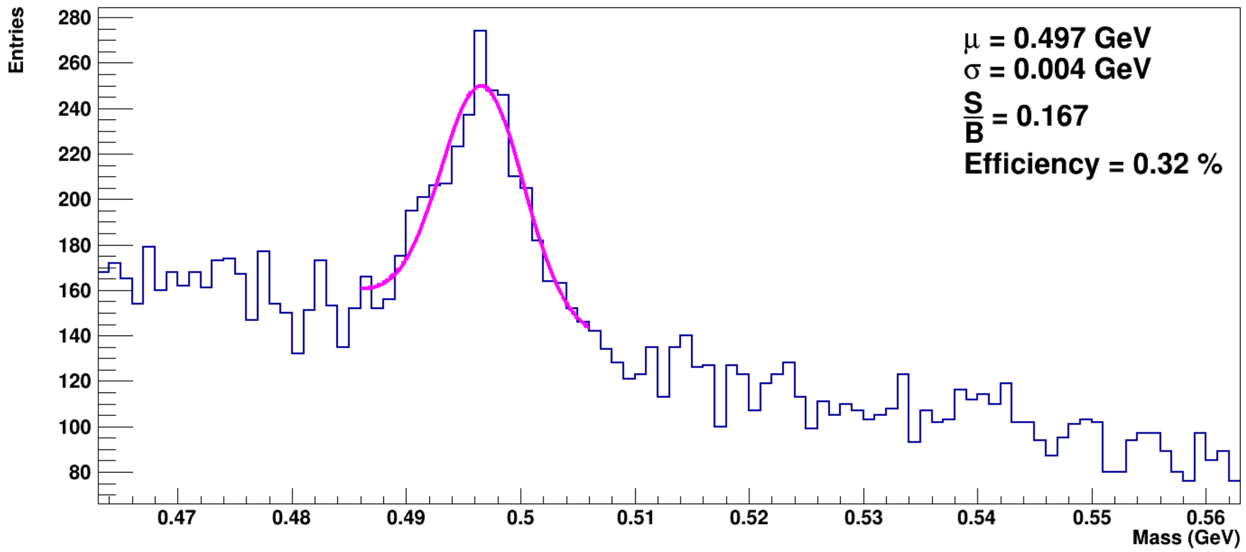
K_S^0



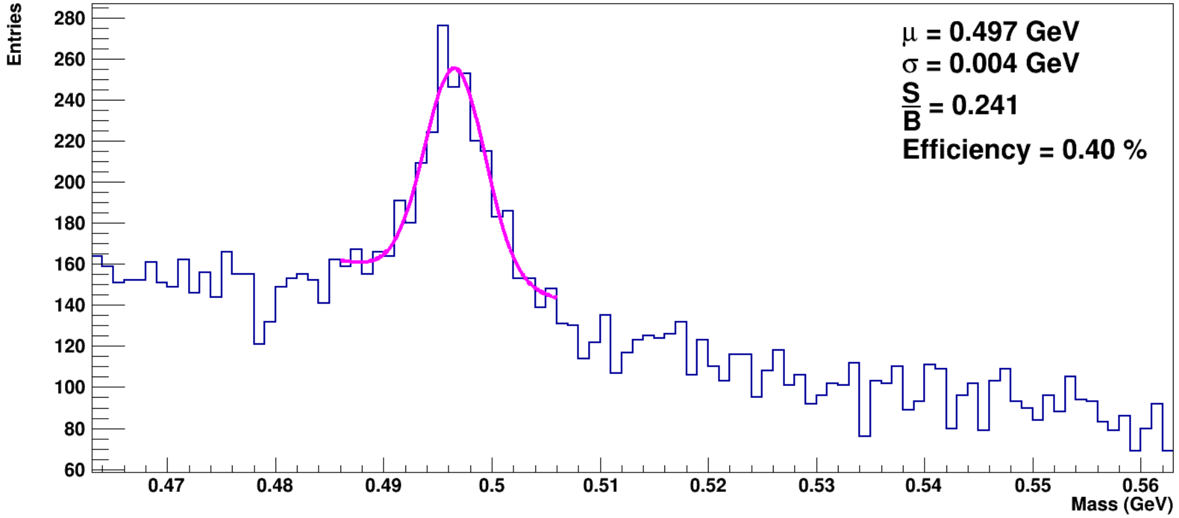
SiMD



BD



Beam blurring



Target

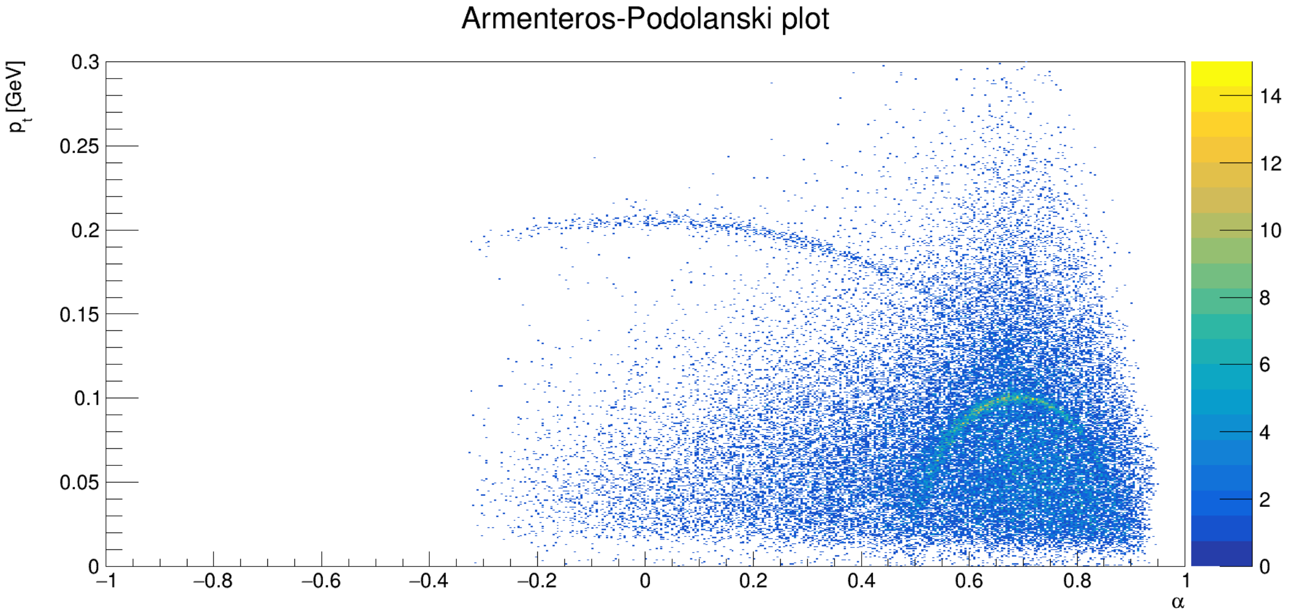
Results

K_S^0

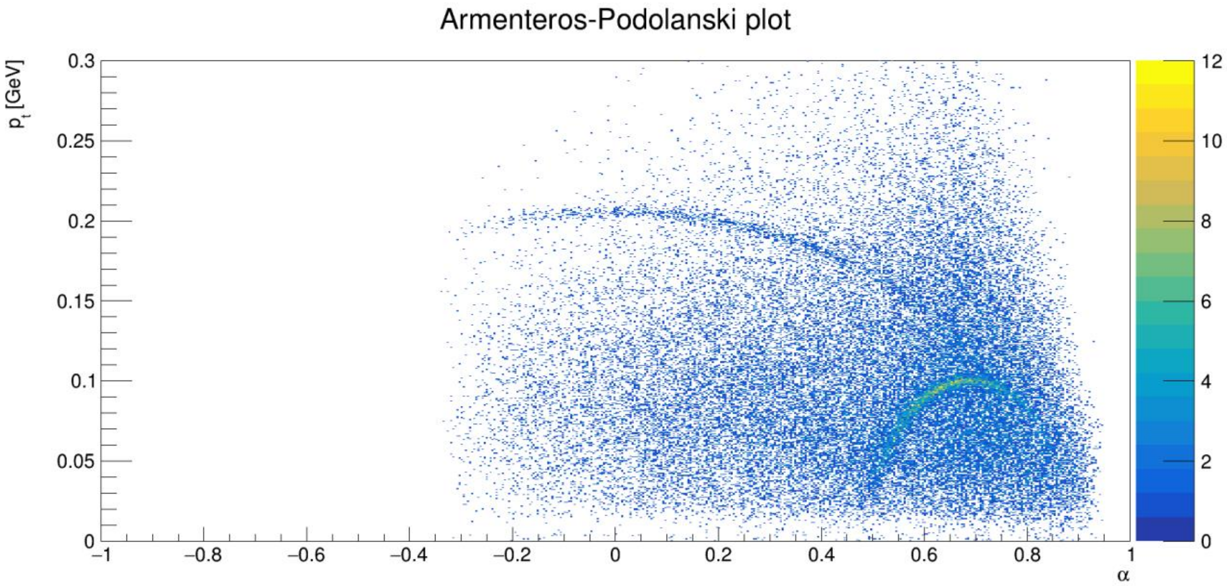
	Ideal case	SiMD, BD, target и размытие пучка	SiMD	BD	Target	Beam blurring
μ (GeV)	0.497	0.497	0.497	0.497	0.497	0.497
σ (GeV)	0.004	0.004	0.004	0.004	0.004	0.004
S	380	323	318	391	389	295
B	1574	1882	1607	1598	1617	1761
S/B	0.241	0.172	0.198	0.244	0.241	0.167
Efficiency (%)	0.40	0.34	0.33	0.41	0.40	0.32

Results

Armenteros-Podolanski plots



Algorithm for lambda hyperon reconstruction

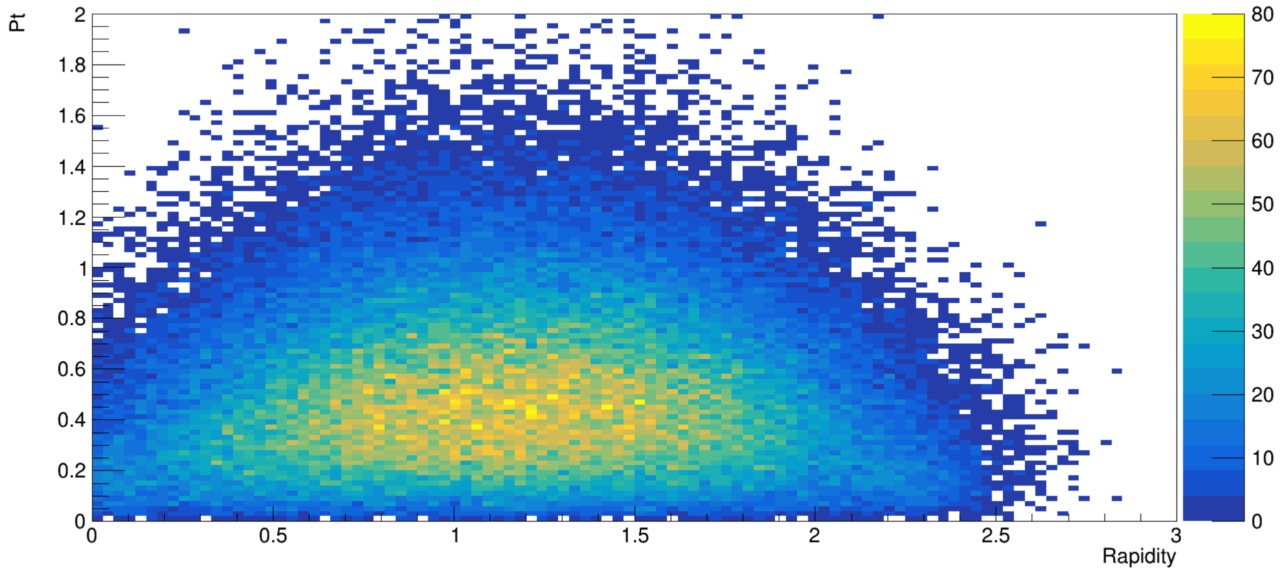


Algorithm for K_S^0 reconstruction

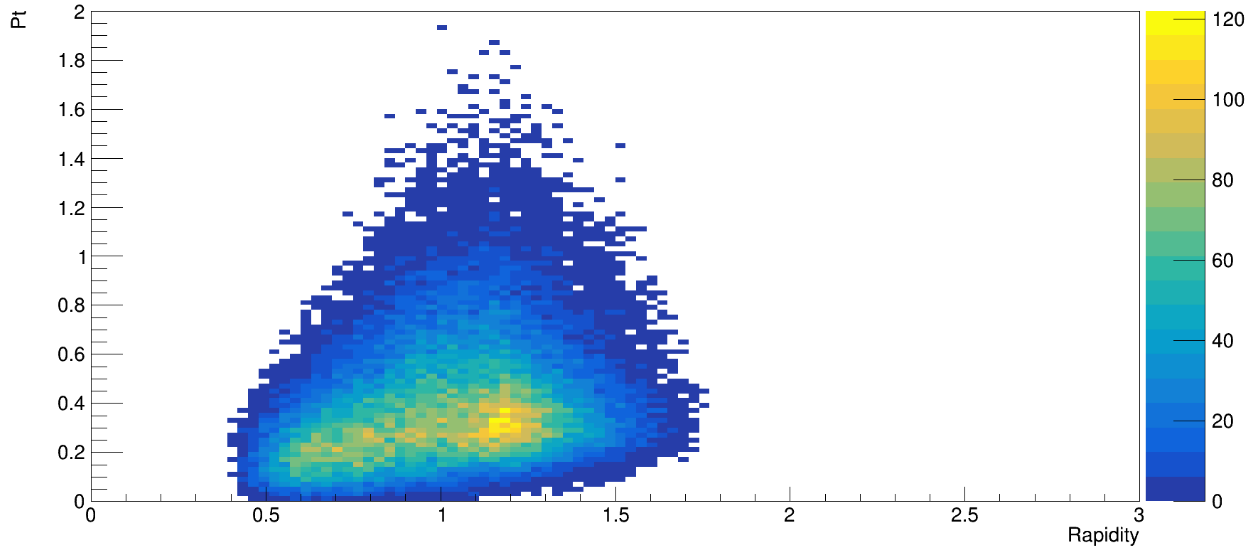
Results

Lambda hyperons

Pt vs rapidity lambda's after simulation

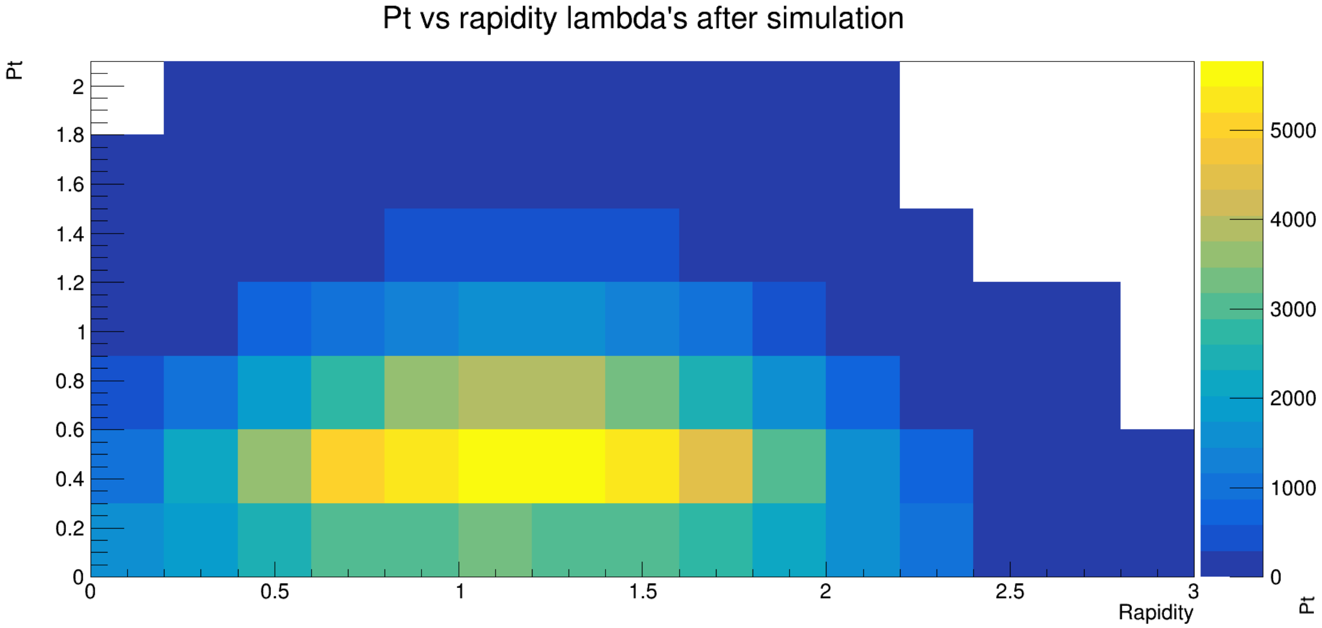


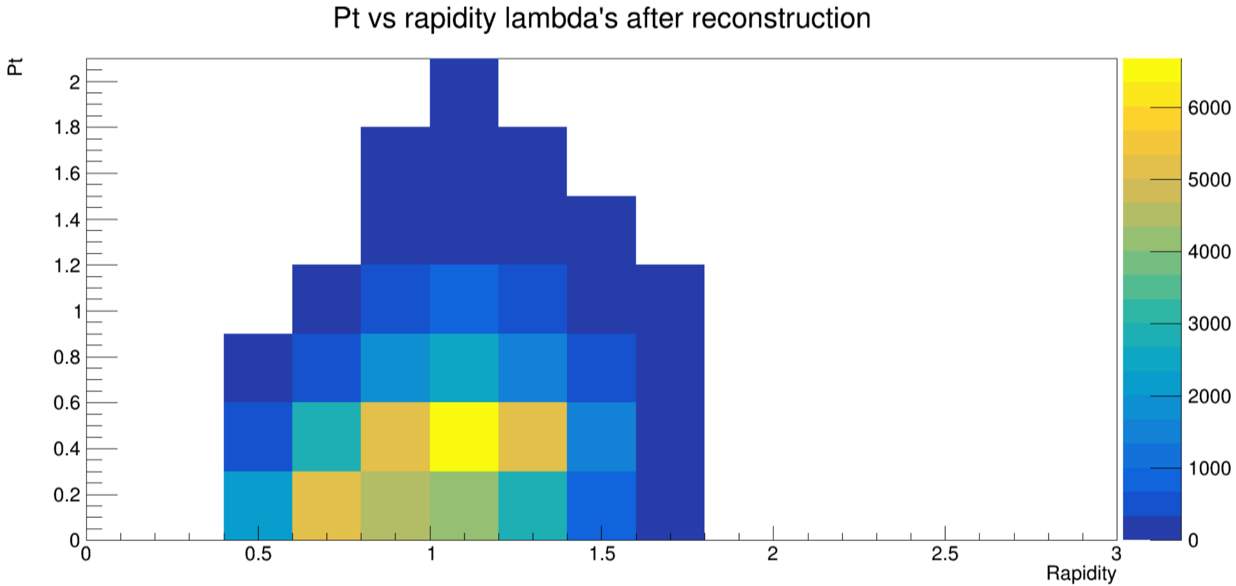
Pt vs rapidity lambda's after reconstruction



Results

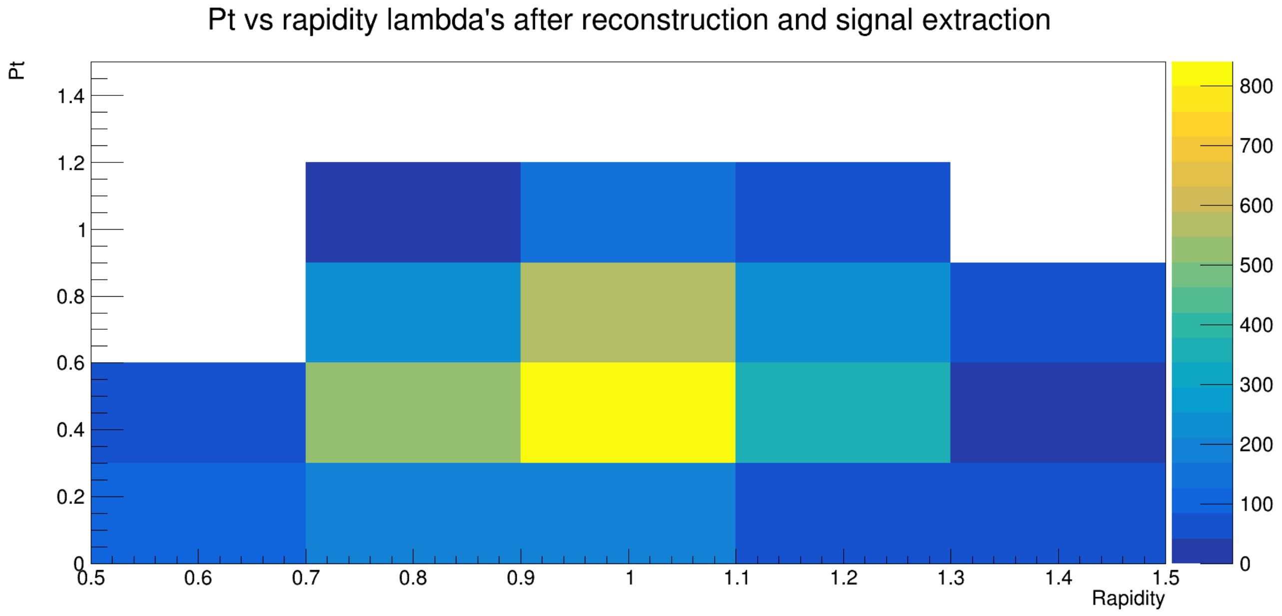
Lambda hyperons

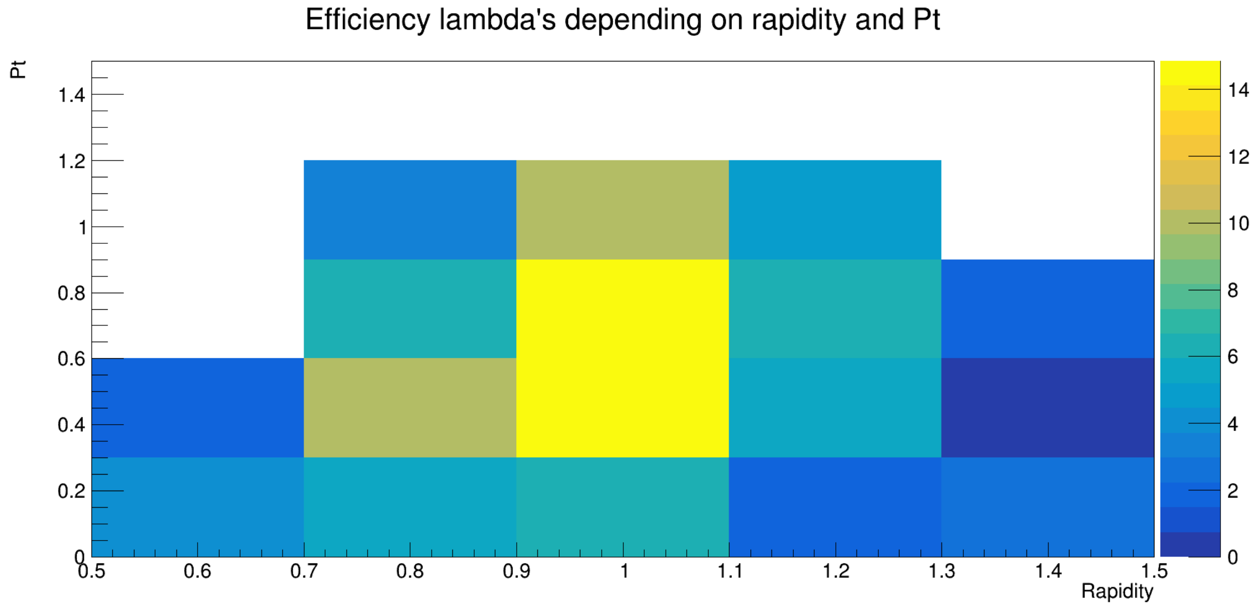




Results

Lambda hyperons





Conclusion

- Simulation and analysis of 100,000 events for the ideal case and cases with different sources of background increment were carried out.
- The presence of lambda hyperon and K_S^0 were revealed in both cases.
- Analysis of the influence of each source of background increment was carried out individually on 100,000 events.
- Efficiency depending on rapidity and transverse momentum and on both was derived for lambda hyperons.

Future work

- Deriving 2D distributions and efficiency depending on rapidity and Pt for K_S^0 .
- Calculation of “purity”.
- Study of the effects of rotating the silicon stations by a certain angle on the recovery of strange particles.
- Verification of the algorithm on experimental data.

Thank you for your attention!