JÜLICH
FORSCHUNGSZENTRUM

Study of Excited Cascade Baryons

$\overline{\text{P}}$ANDA – Collaboration Meeting Vienna, November 30th 2015 | Jenny Puetz

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Outline

- Motivation
- Simulation
- Reconstruction
- Summary and Outlook

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Motivation

- Understanding excitation pattern essential for better understanding of non-perturbation QCD
- Up to now: studies only for nucleon excitation spectrum
- Very little known on excited states of double or triple strange baryons
- $\bar{P}$ANDA gives simultaneous access to excited states for baryons and anti-baryons in $\bar{p}p \rightarrow$ baryons + antibaryons + meson(s)
- μb cross section for $\bar{p}p \rightarrow \Xi\,\bar{\Xi}$ allows collection high-statistics in reasonable time

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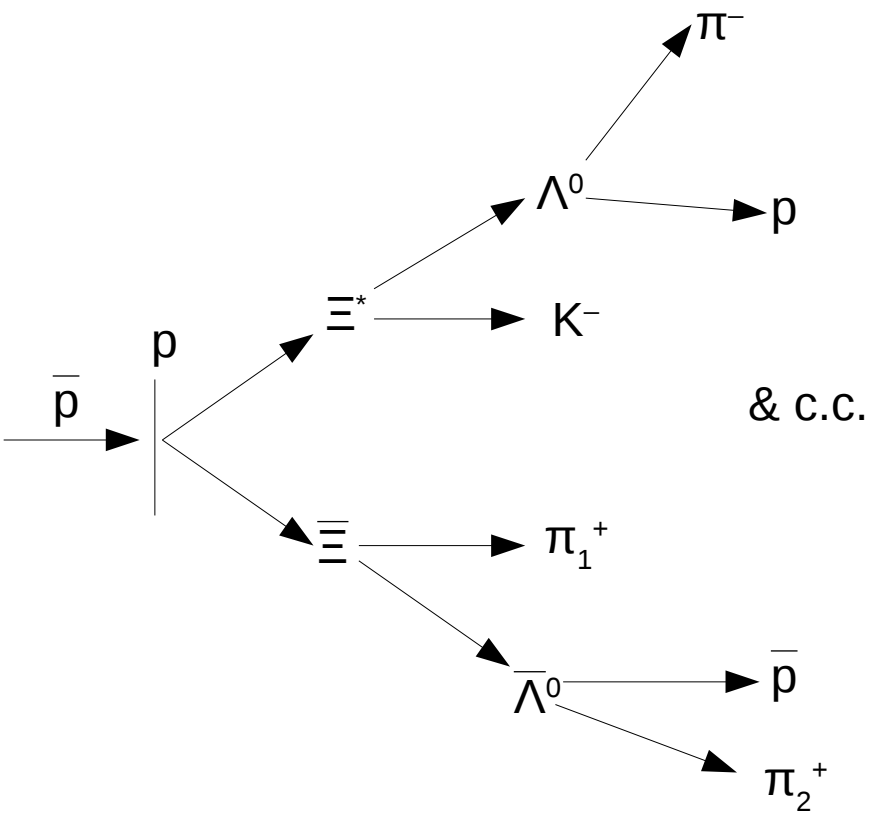
Simulation

- 1.5 million signal events
- $\bar{p}p \rightarrow \Xi(1820)\,\bar{\Xi}$ and c.c.
- Mass of Ξ(1820): $m_{\Xi(1820)} = 1.823\ \mathrm{GeV/c^2}$
- Width: $\Gamma = 24$ MeV
- Spin of Ξ(1820): 3/2 but used: Spin ½ (due to EvtGen bug)
- $p_{\bar{p}} = 4.6$ GeV/c (approx. 100 MeV above production threshold)



Ξ* denotes for Ξ(1820)

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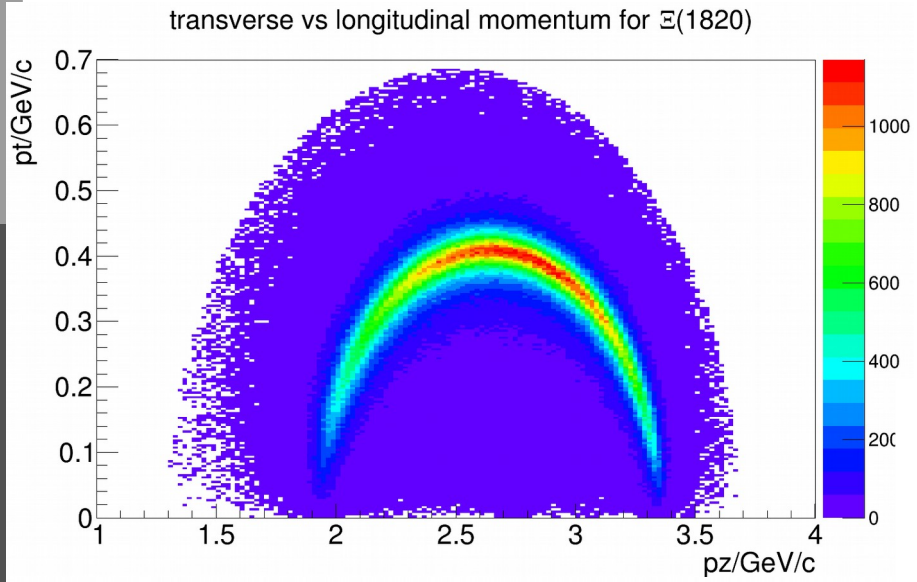
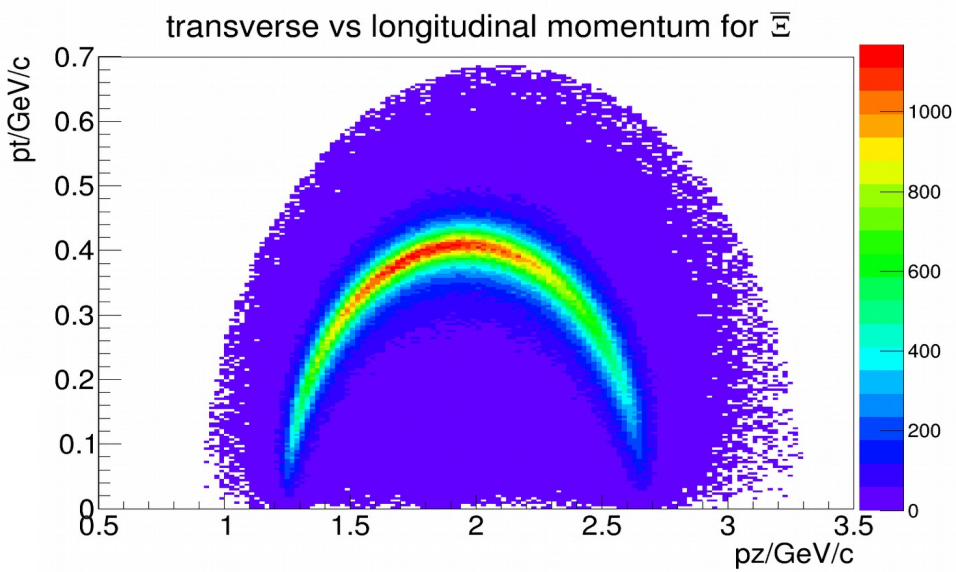
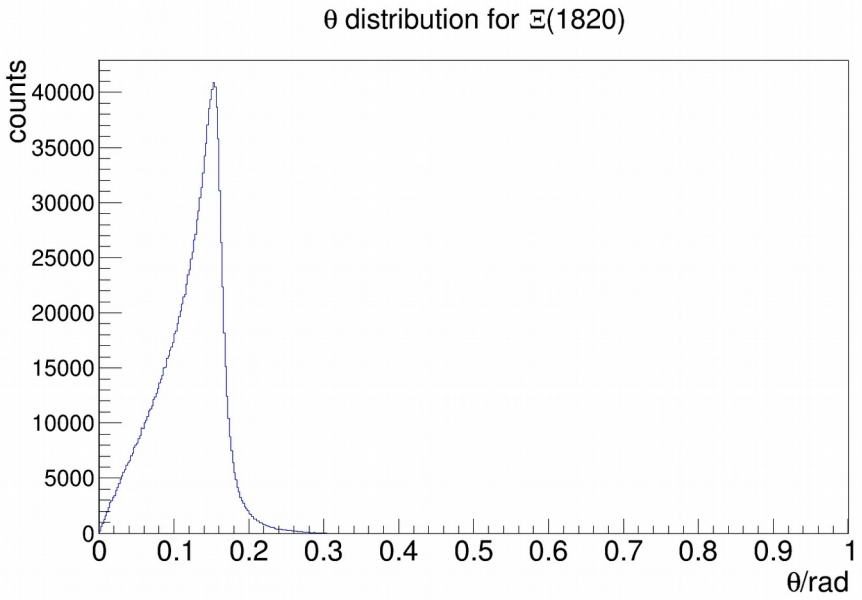
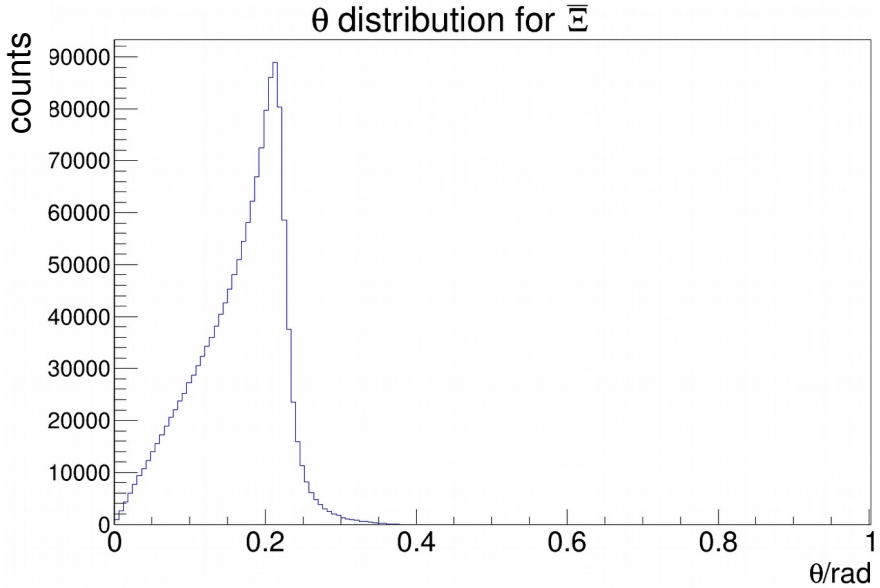
Simulation: Generated Events









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Reconstruction
Final State Particles

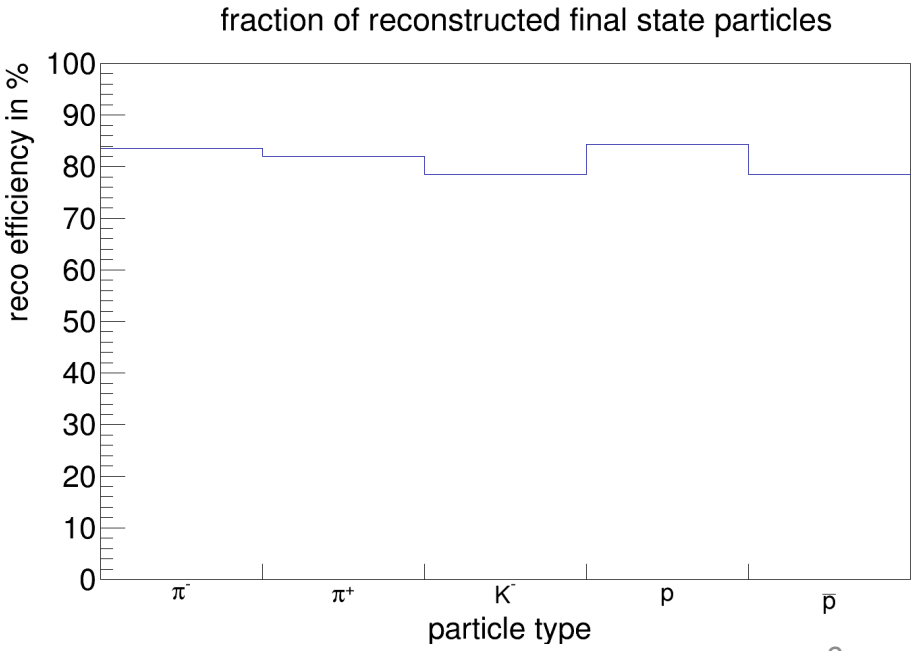
- Used ideal tracking and “best” particle identification (PID)
- Selected only final state particles with $N_{Hits} \geq 4$ in any inner tracking detector (MVD, STT, GEM)
- Reconstruction efficiency for final state particles:

Reco eff. $\bar{p}p \rightarrow \Xi^* \bar{\Xi}$

particle	Reco. eff. in %
π^-	83.54
π_2^+ ($\bar{\Lambda}^0$)	83.06
π_1^+ ($\bar{\Xi}$)	80.85
K^-	78.52
p	84.33
$\bar{p}$	78.49

Reco eff. $\bar{p}p \rightarrow \Xi \bar{\Xi}^*$

particle	Reco. eff. in %
π^+	82.95
π_2^- (Λ^0)	82.57
π_1^- (Ξ)	80.33
K^+	83.19
p	80.77
$\bar{p}$	81.02



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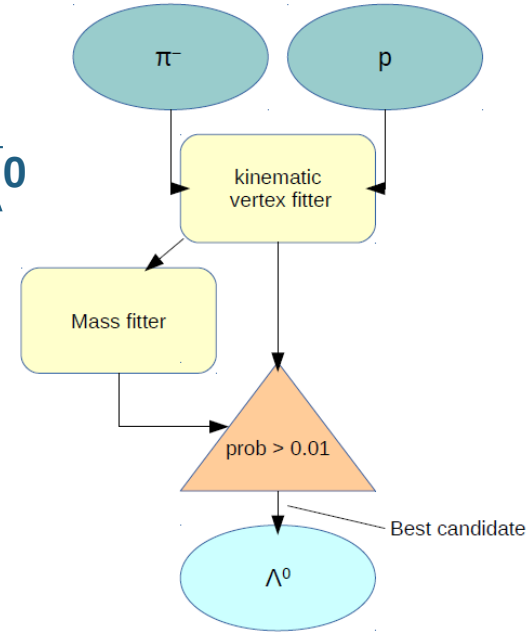
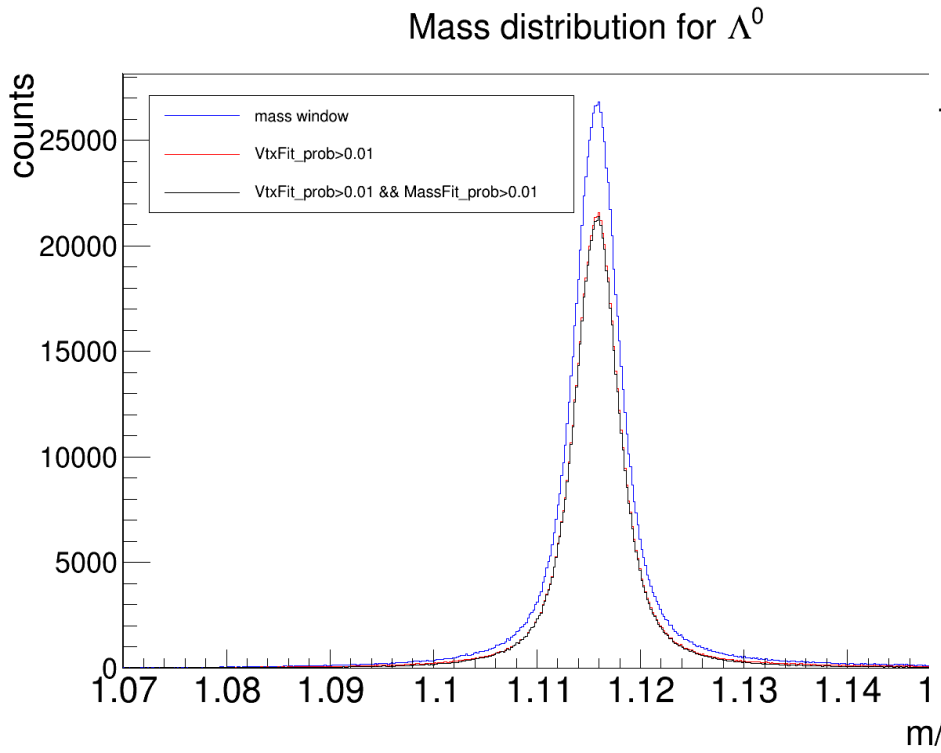
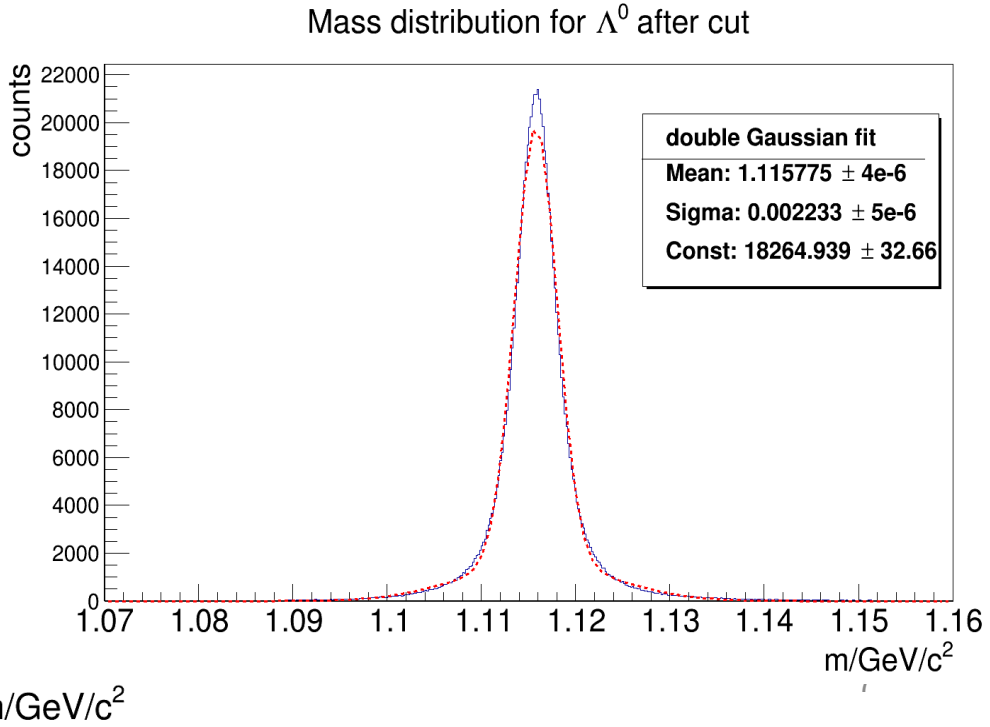
Reconstruction of Λ^0 & $\bar{\Lambda}^0$

- Λ^0 mass = 1.116 GeV/c²
- Select candidates within a mass window of 0.15 GeV/c²
- Fitted mass: $m_{\Lambda 0}$ = 1.1158 GeV/c²

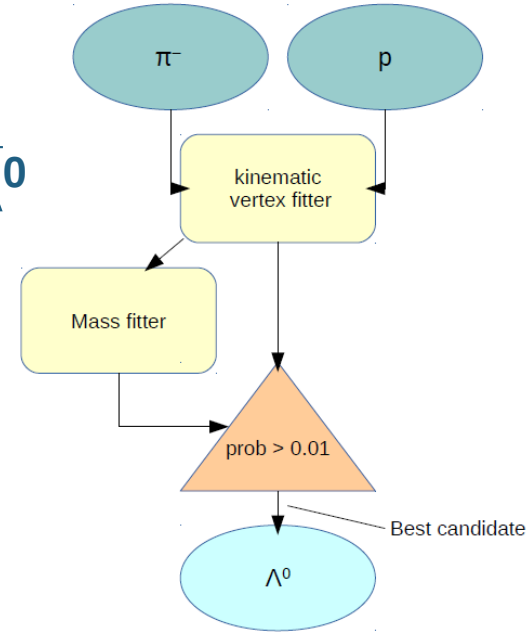


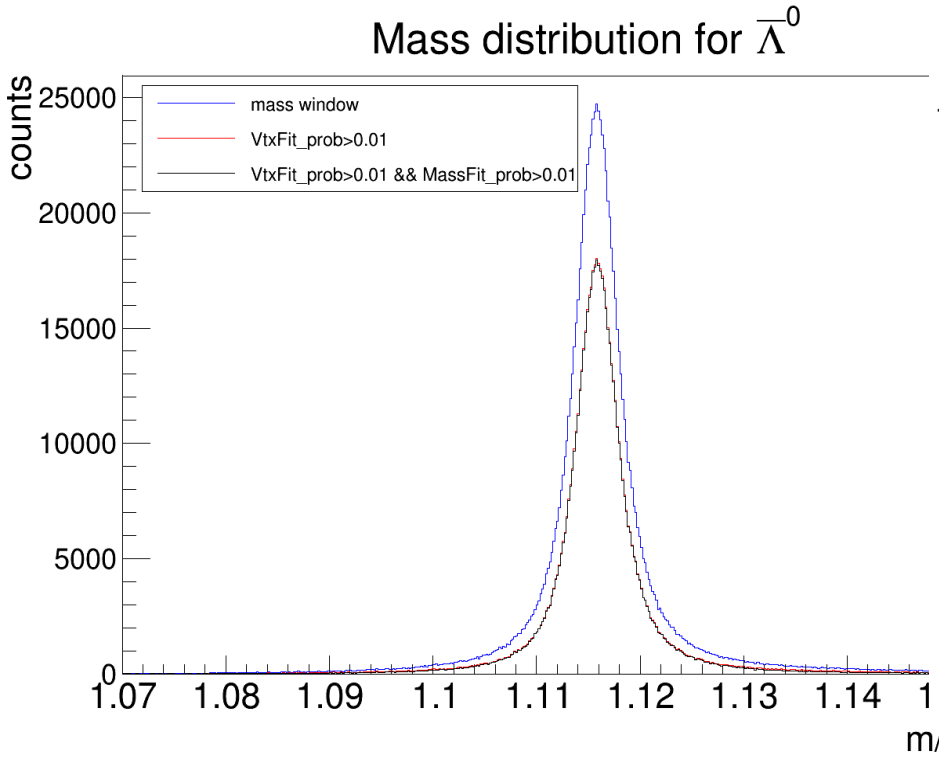


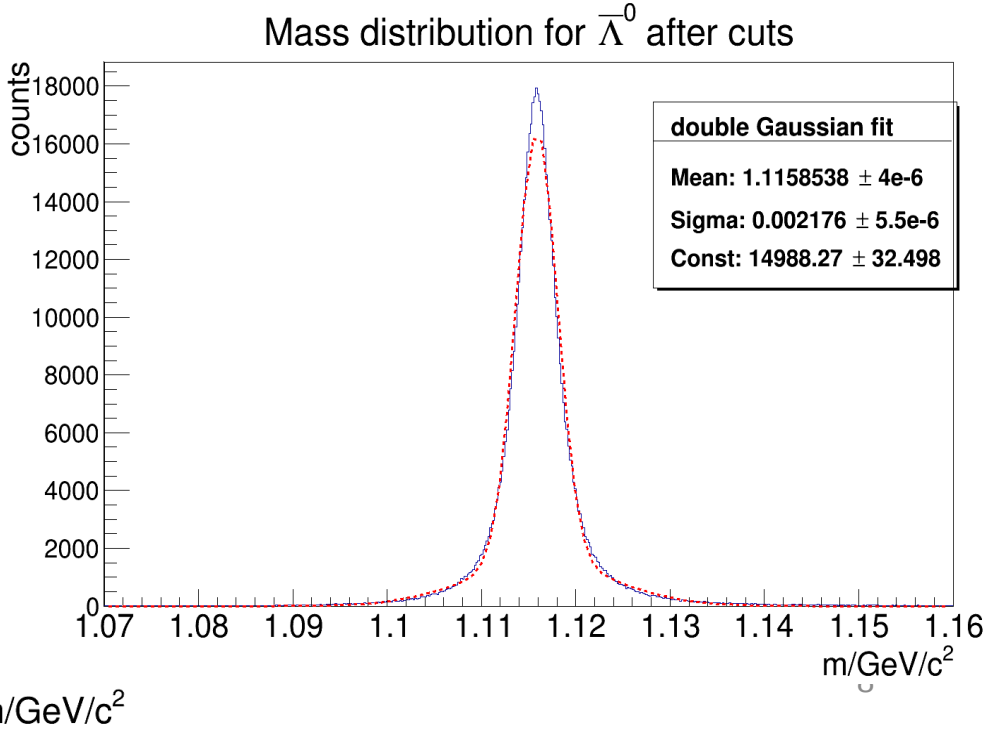


Reconstruction of Λ^0 & $\bar{\Lambda}^0$

- Fitted mass: $m_{\bar{\Lambda}0} = 1.1158$ GeV/c^2
- Error of fitted mass is of order 10^{-6}

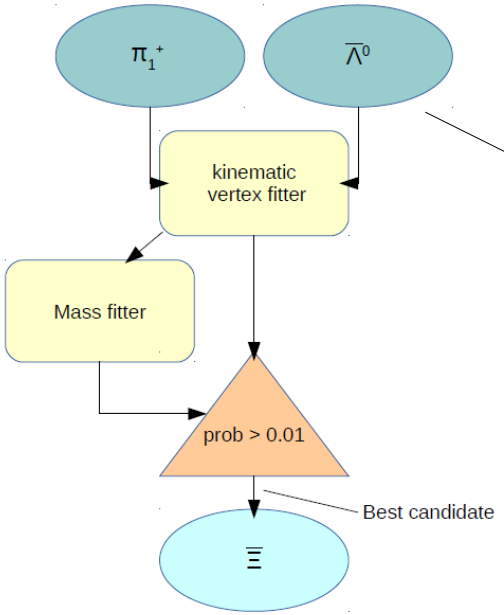




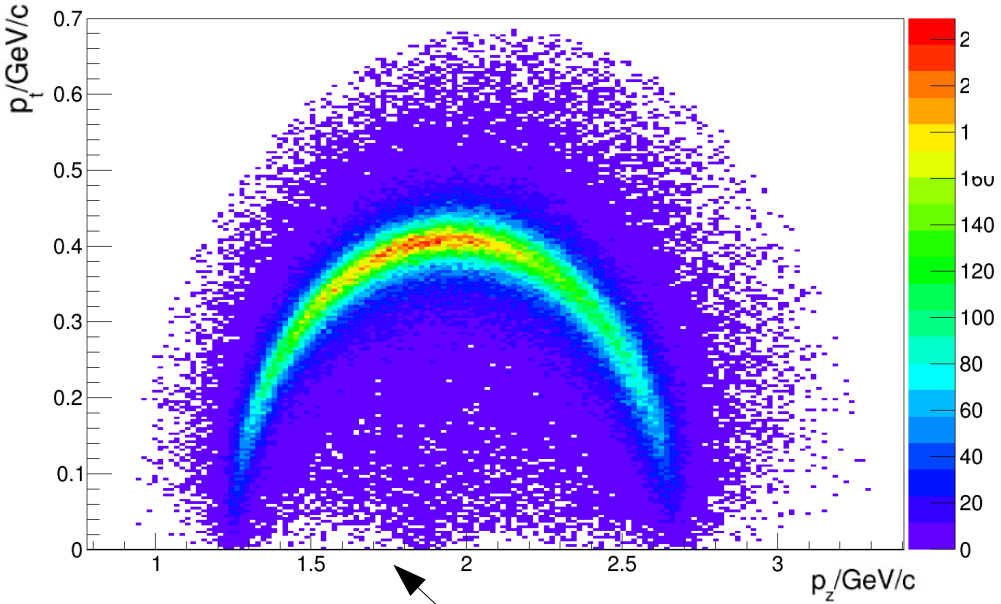


Reconstruction of $\bar{\Xi}$

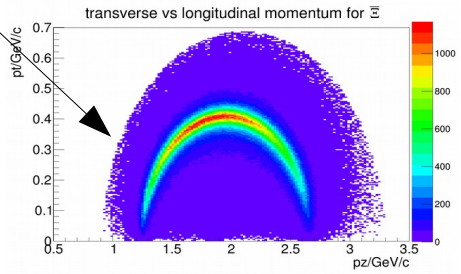
- Combine $\bar{\Lambda}^0$ and π_1^+
- Mass window 1.321 ± 0.15 GeV/c²



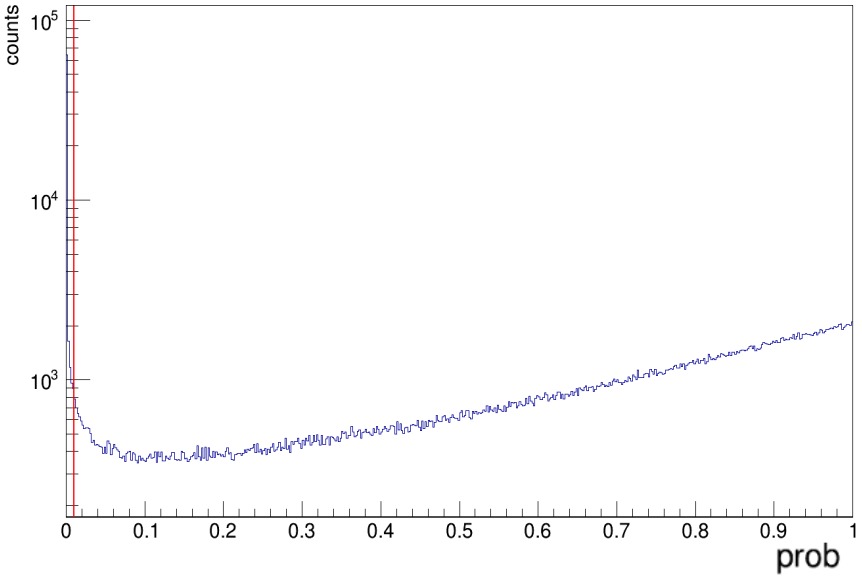
See “Vertex fitting with neutrals“ Tue Dec 1st Computing session



comparison with simulation



probability distribution for $\bar{\Xi}$



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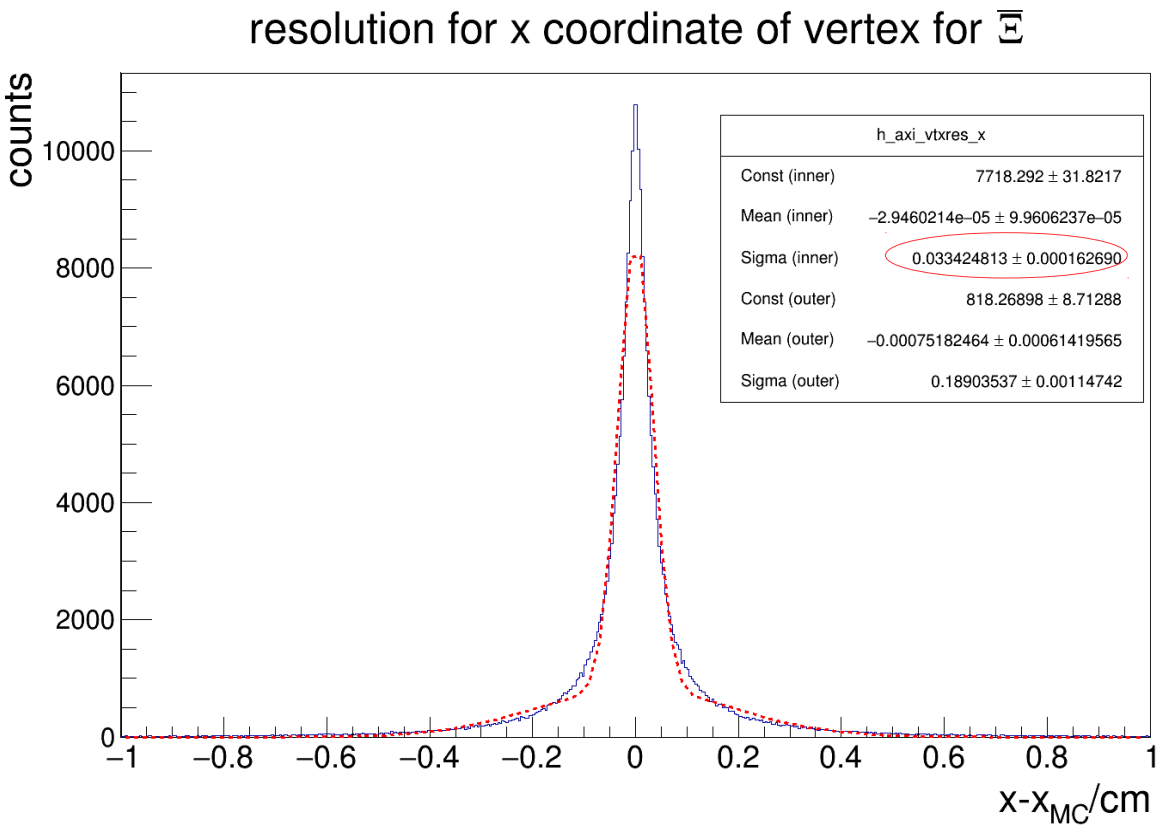
Reconstruction of $\bar{\Xi}$ Vertex resolution

- used “inner” and “outer” Gaussian fit
- Vertex resolution is given by “inner” sigma

position	Vertex resolution	
	$\bar{\Xi}$	Ξ (c.c. channel)
x/mm	0.334 ± 1.6e-3	0.341± 1.5e-3
y/mm	0.336 ± 1.7e-3	0.352 ± 1.7e-3
z/mm	1.214 ± 1.8e-3	4.472 ± 0.023



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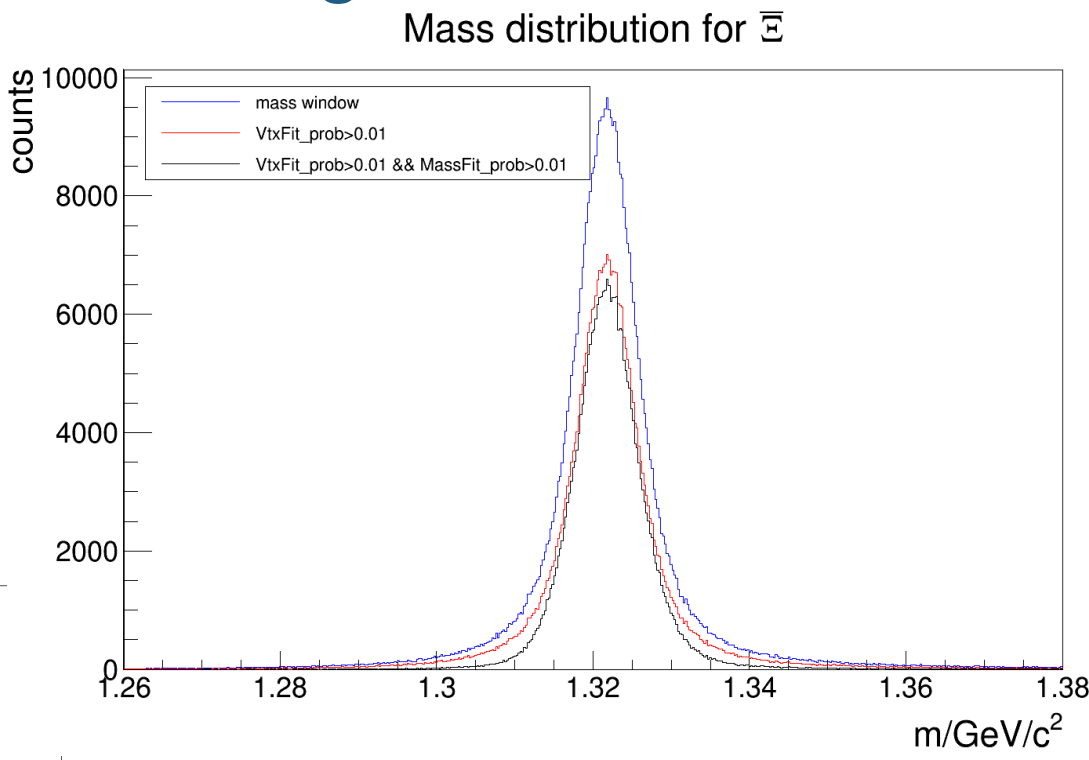
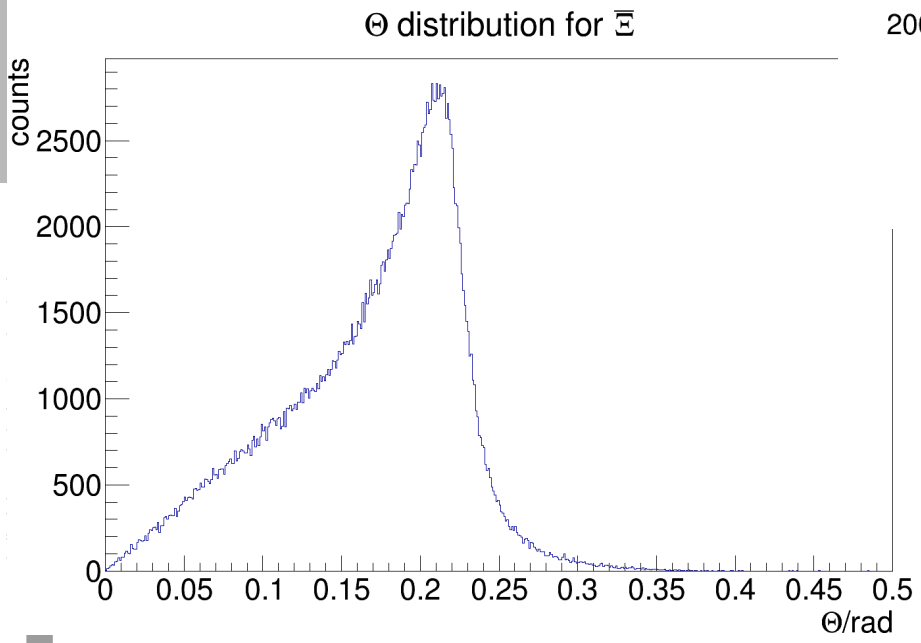
Reconstructed mass and angle of $\bar{\Xi}$

particle	reco. mass
$\bar{\Xi}$	1.322 GeV/c^2
Ξ (for c.c. channel)	1.322 GeV/c^2

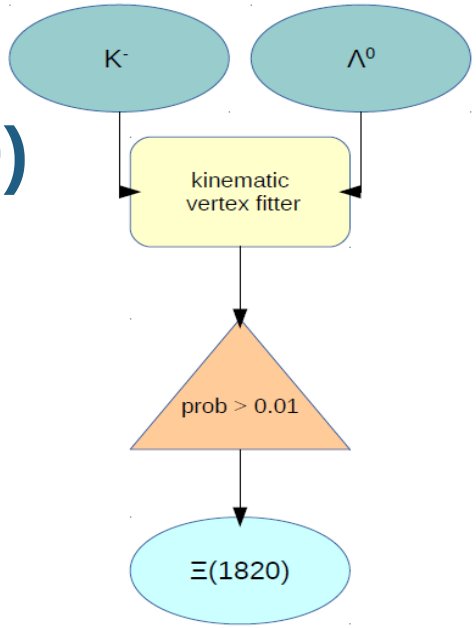




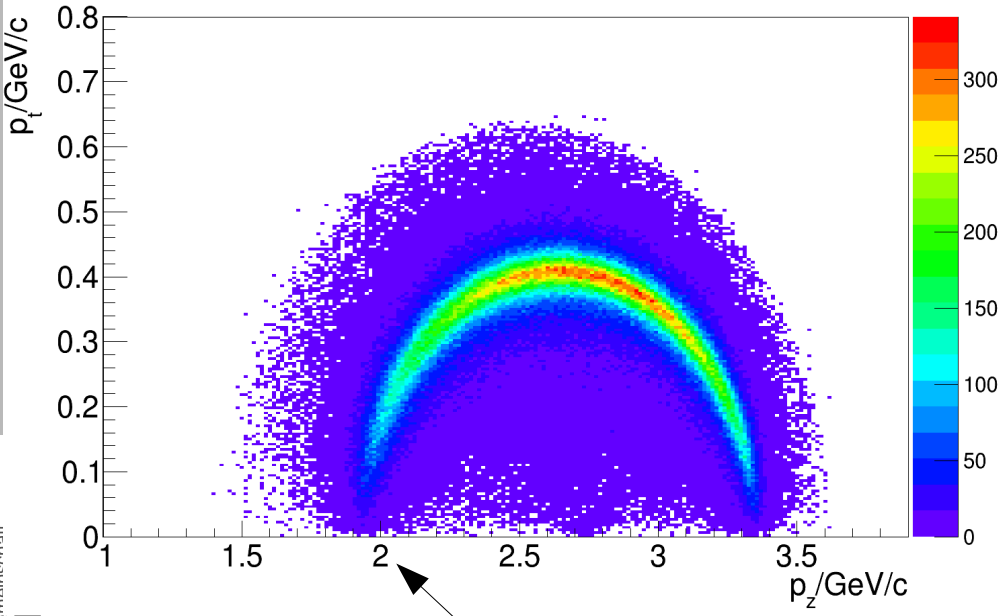
- $\bar{\Xi}$ is strongly boosted forward
- Same for Ξ in c.c. channel

Reconstruction of Ξ(1820)

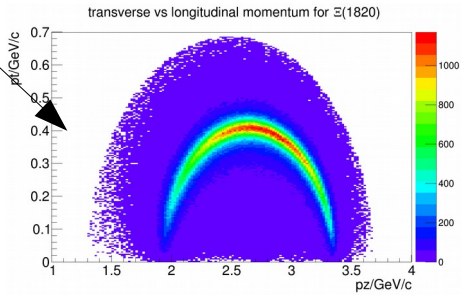
- Combine Λ^0 and K^-
- Mass window 1.823 ± 0.15 GeV/c^2



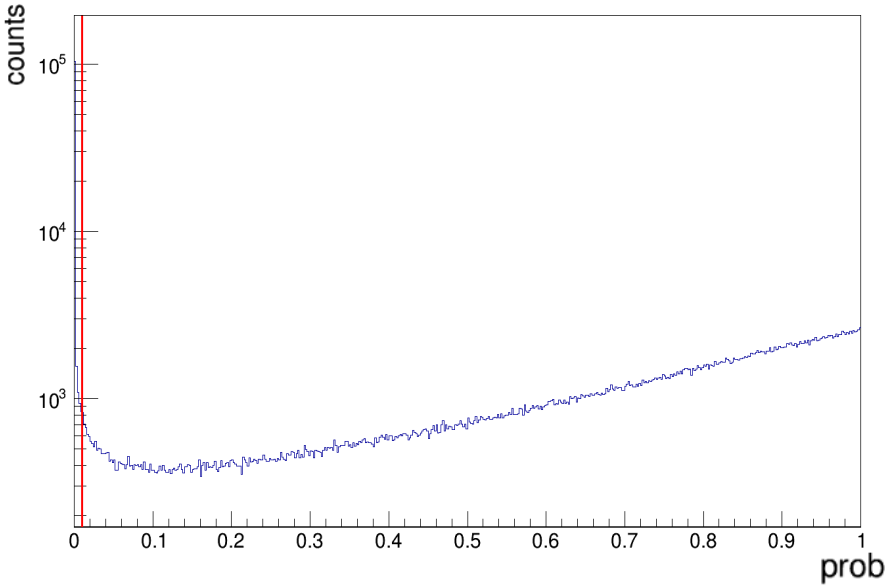
Transverse vs. longitudinal momentum for Ξ(1820)$^-$



Comparison with simulation



probability distribution for Ξ(1820)$^-$



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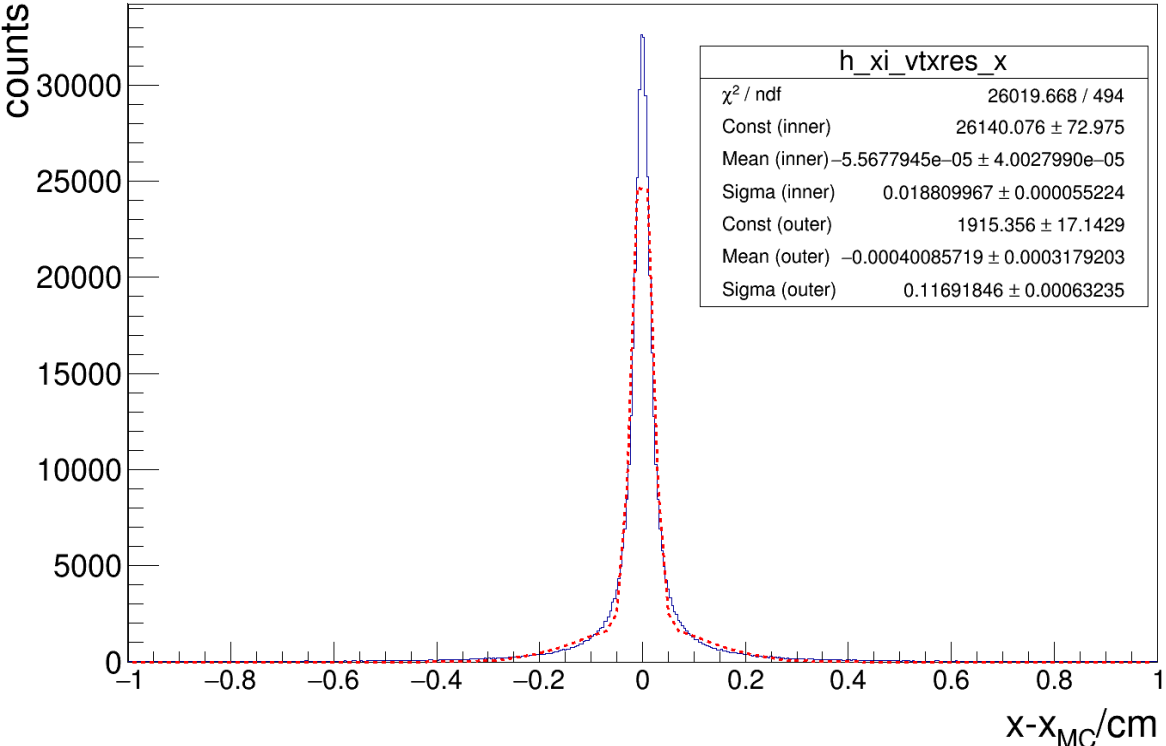
Reconstruction of Ξ(1820) Vertex resolution

- using double Gaussian fit
- Vertex resolution is given by inner sigma

position	Vertex resolution	
	Ξ(1820)	$\bar{\Xi}$(1820) (c.c. channel)
x/mm	0.184 ± 6e-4	0.185 ± 5.4e-4
y/mm	0.184 ± 5.3e-4	0.183 ± 5.5e-4
z/mm	0.564 ± 1.7e-3	0.556 ± 1.8e-3

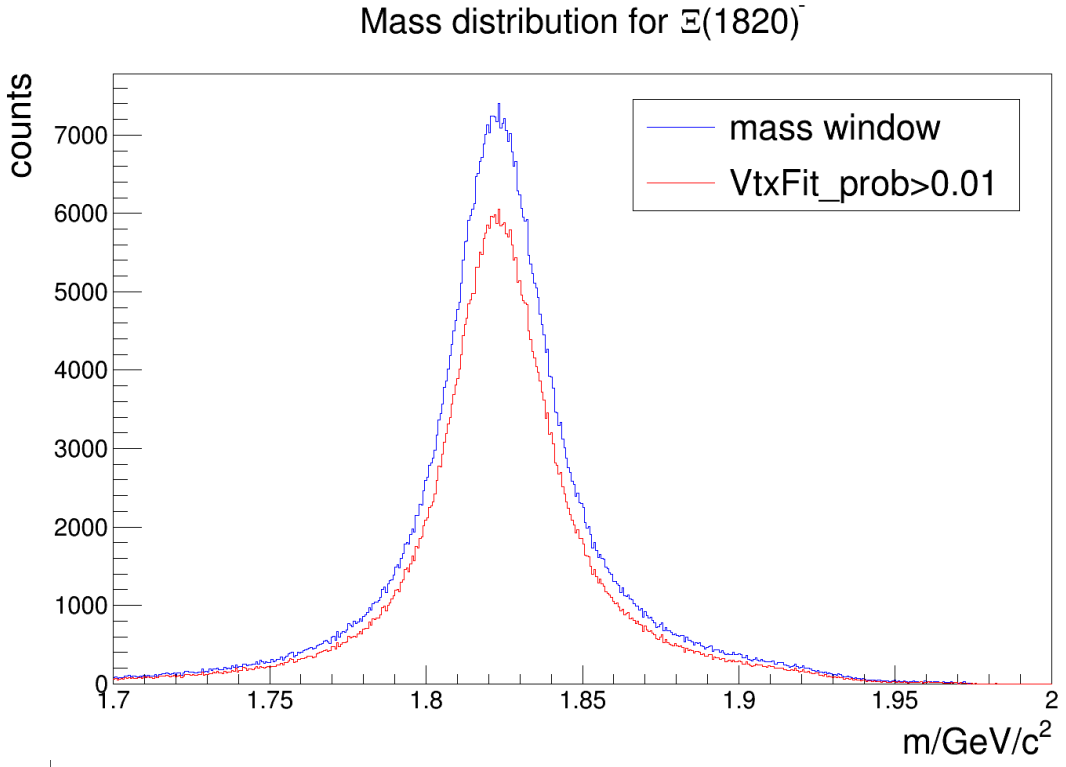
resolution for x coordinate of vertex for $\bar{\Xi}(1820)^+$

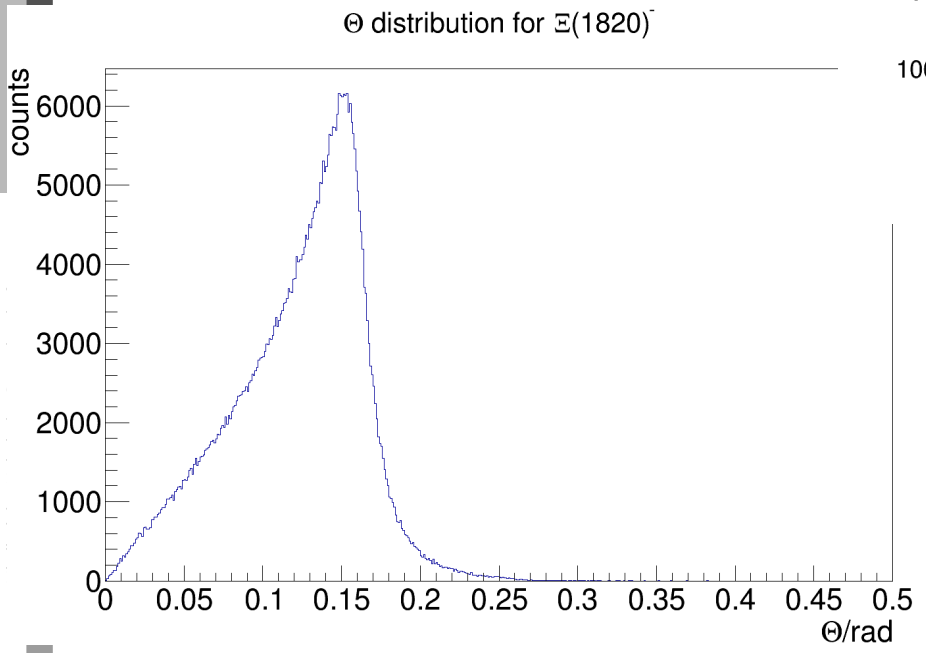


Reconstructed mass and angle of Ξ(1820)

particle	fitted mass
Ξ(1820)	1.823 GeV/c^2
$\bar{\Xi}$(1820) (for c.c. channel)	1.823 GeV/c^2

error of fitted mass in order 10^{-5}

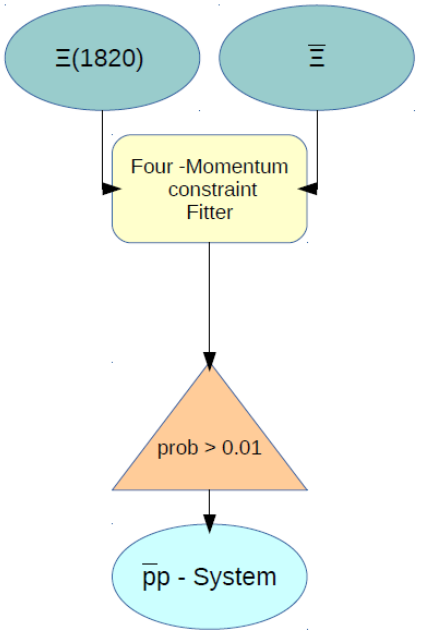


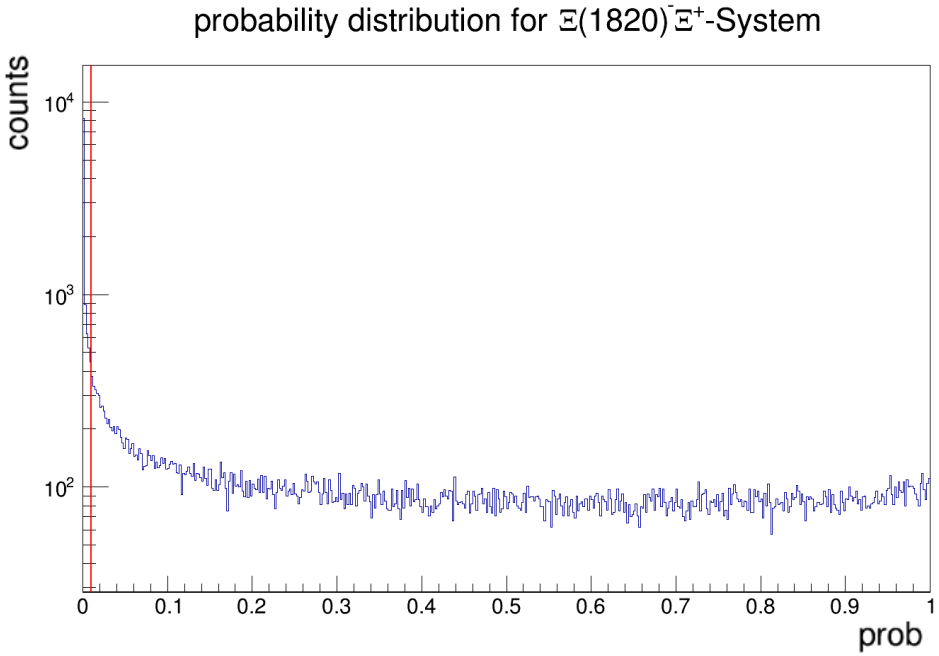


- Ξ(1820) is strongly boosted forward
- Same for $\bar{\Xi}$(1820) in c.c. channel

Reconstruction of Ξ(1820) $\bar{\Xi}$

- Combine Ξ(1820) and $\bar{\Xi}$
- Perform four momentum constraint fit
- Select candidates with p>0.01





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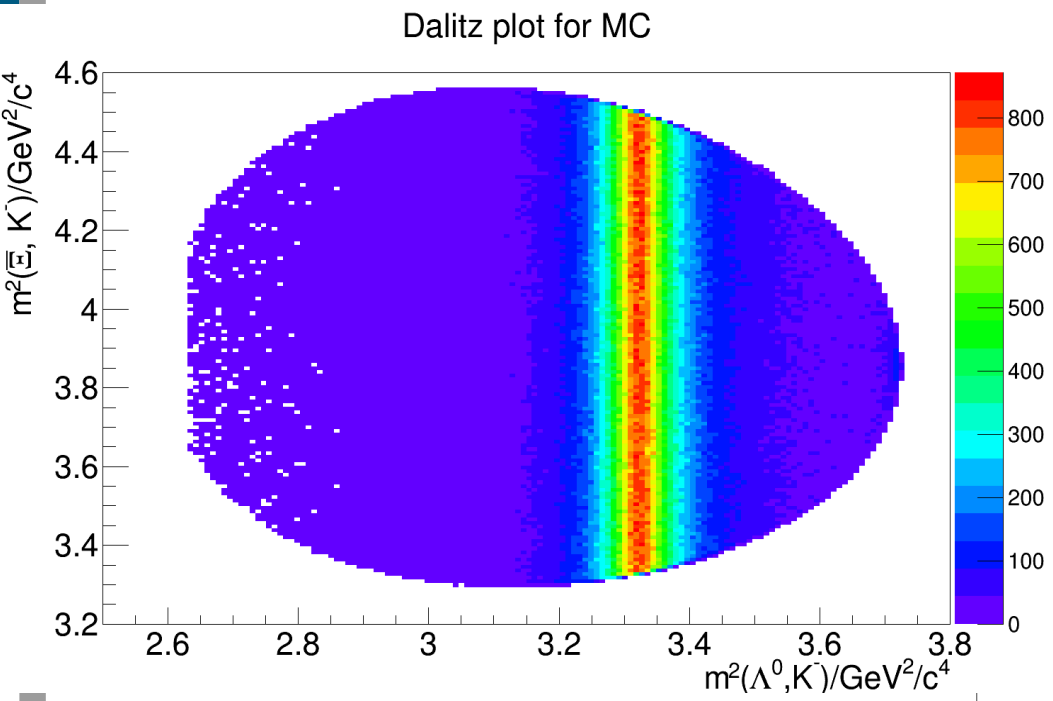
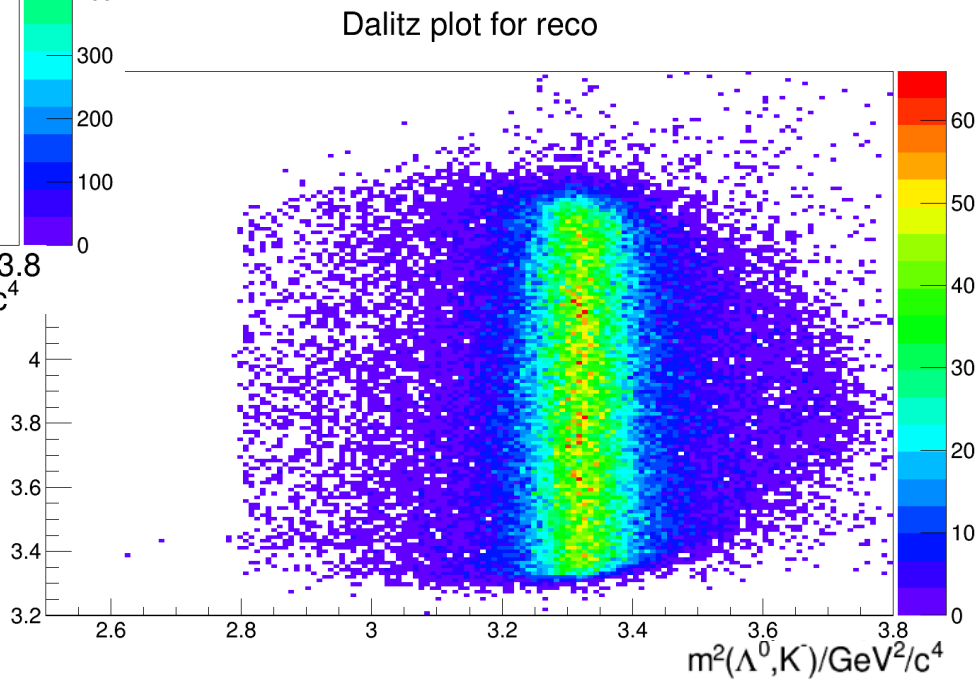
Dalitz plots





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Reconstruction efficiencies

Reco efficiency $\bar{p}p \rightarrow \Xi^* \bar{\Xi}$

Particle	Reco eff. in %
Λ^0	50.31
$\bar{\Lambda}^0$	41.61
$\bar{\Xi}$	18.39
$\Xi(1820)$	31.94
$\Xi(1820)\ \bar{\Xi}$ sys	4.67

Reco efficiency $\bar{p}p \rightarrow \Xi\ \bar{\Xi}^*$

particle	Reco eff. in %
Λ^0	42.51
$\bar{\Lambda}^0$	49,03
Ξ	18.62
$\bar{\Xi}(1820)$	33.11
$\Xi\ \bar{\Xi}(1820)$ sys	4.86

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Summary & Outlook

- Simulated 1.5 million signal events for $\bar{p}p \rightarrow \Xi(1820)\,\bar{\Xi}$
- Used selection criteria discussed
- Mass of Ξ(1820) (reco eff. approx 32%) can be well reconstructed
- Reconstruction efficiency for full reaction chain 4.67% (4.86% for c.c.)

- Simulation with Spin 3/2 for Ξ(1820)
- involving “Lambda Disks” could improve the reconstruction efficiency for Λ^0 and $\bar{\Lambda}^0$
- Background simulation will be done as next step
- Partial wave analysis of $\Lambda^0\,K^-\,\bar{\Xi}$ (& c.c) final state will be explored

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Thank you for your attention!

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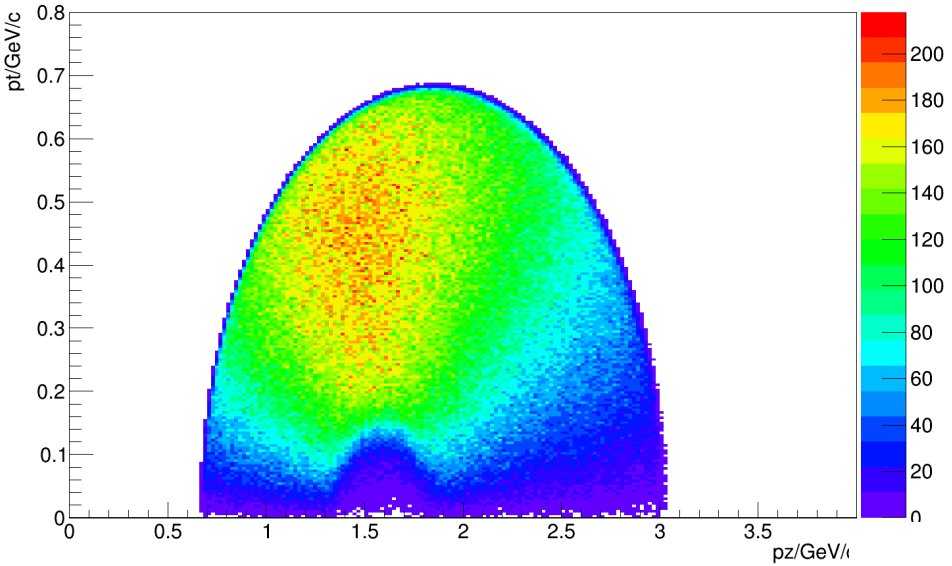
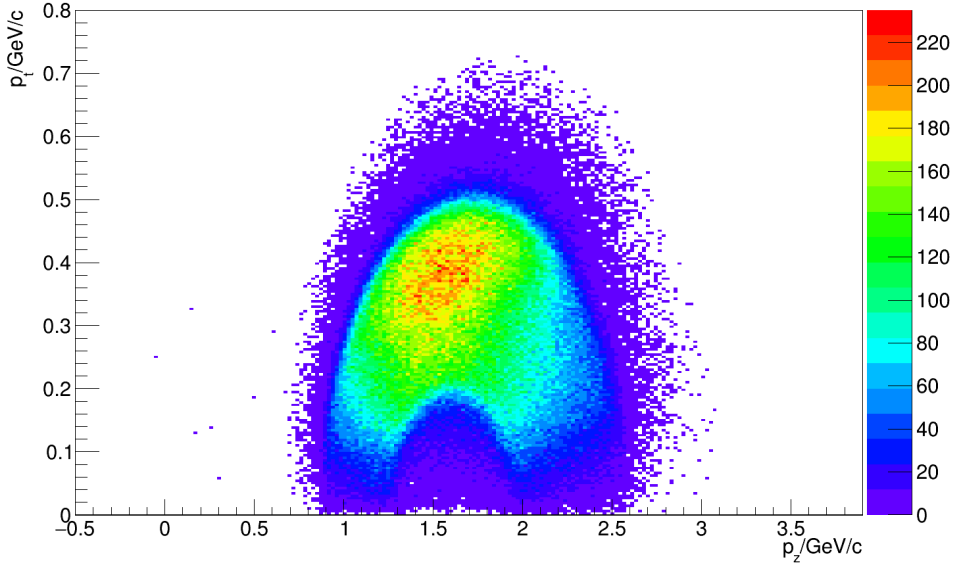
Backup

Λ^0: transverse vs. Longitudinal momentum



Transversal vs. longitudinal momentum for Λ^0 with cut



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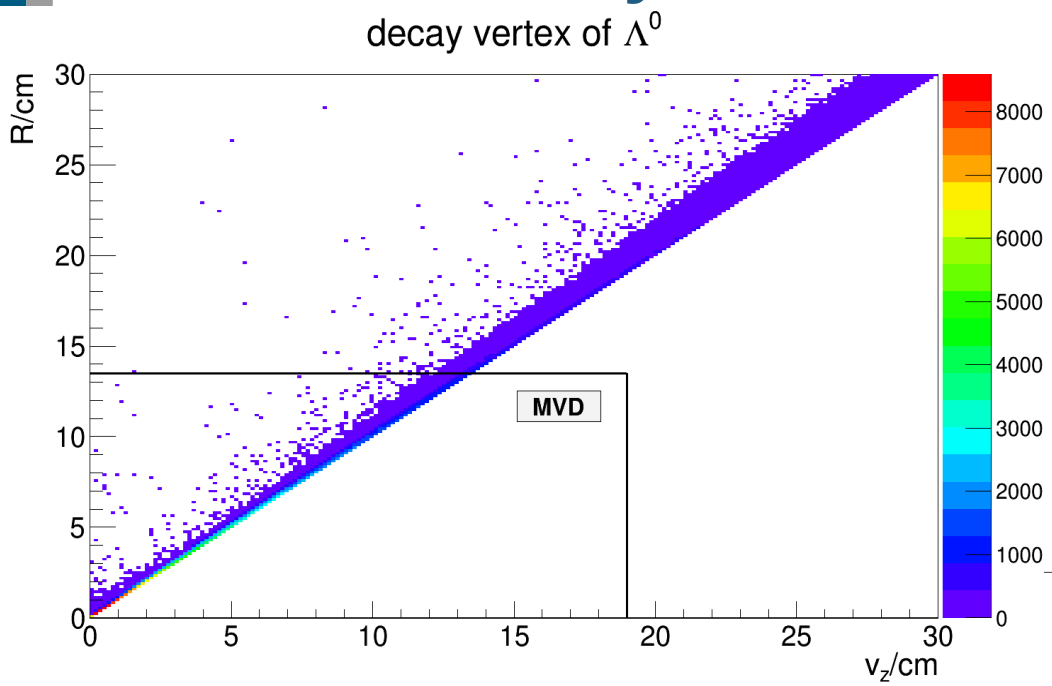
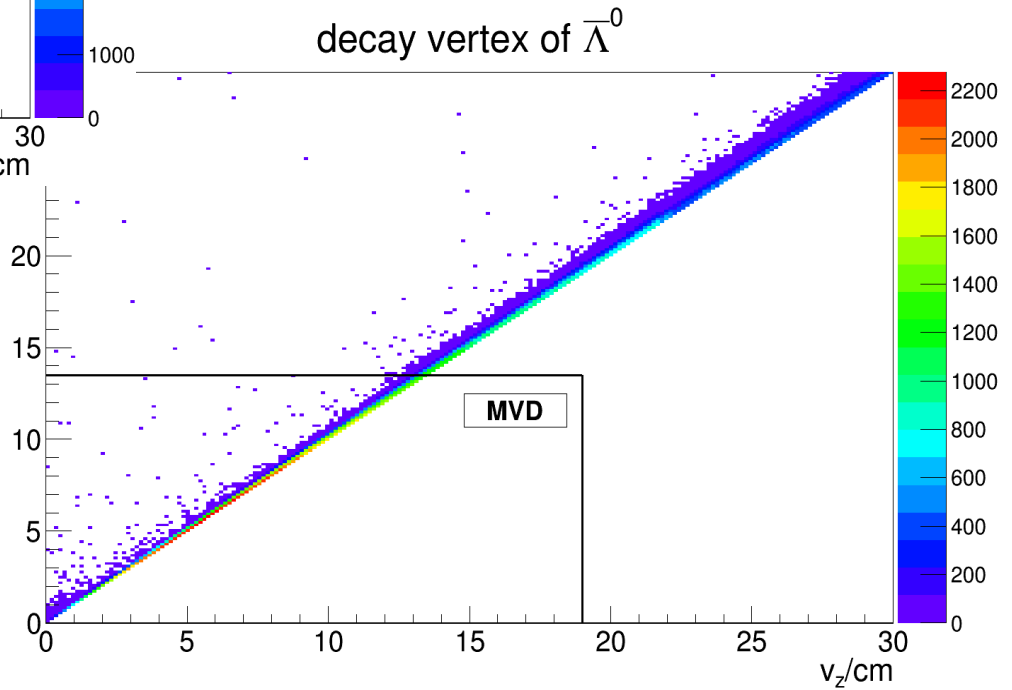
Λ^0 & $\overline{\Lambda}^0$: decay vertex





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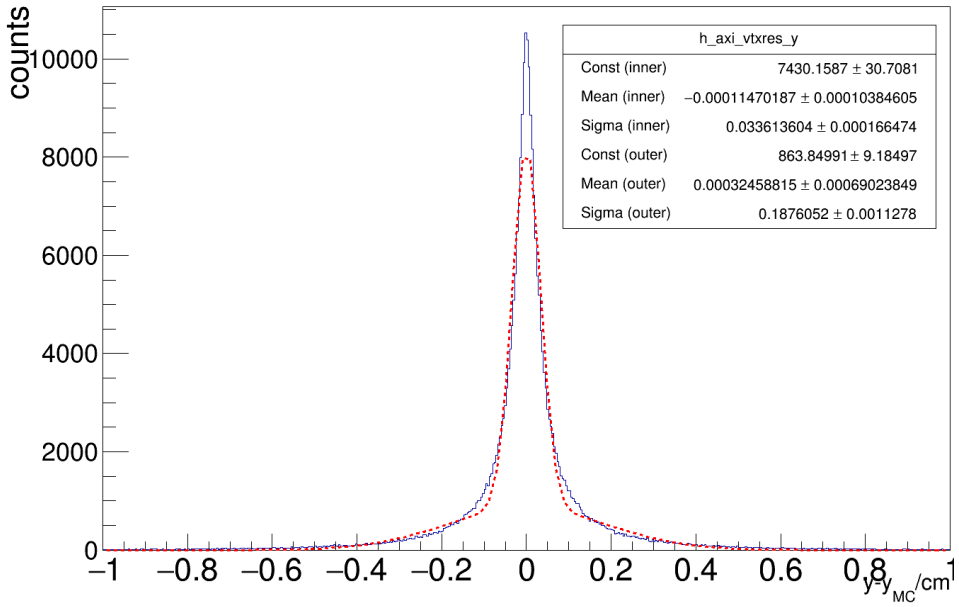
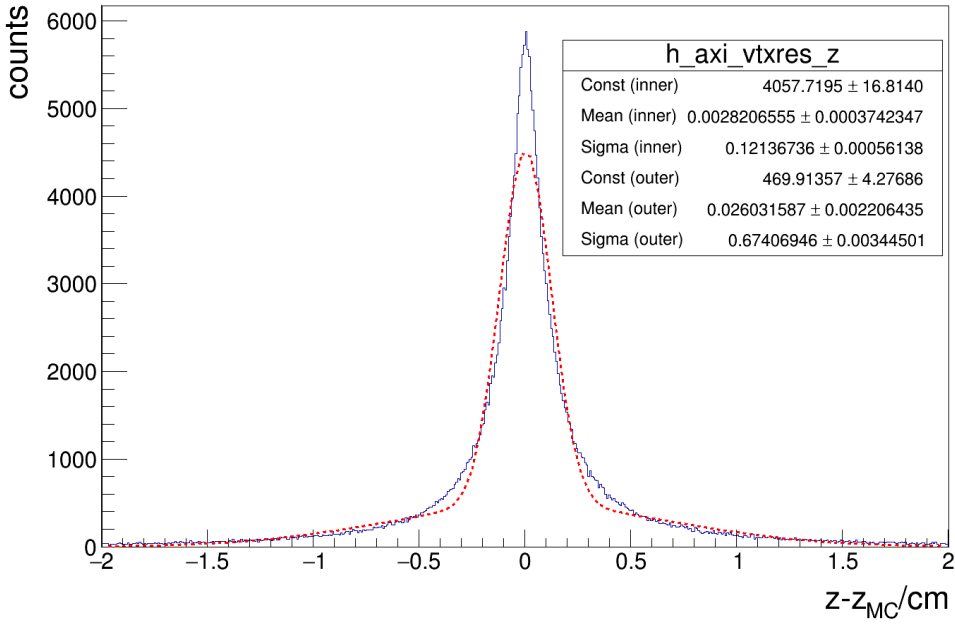
Vertex fit $\bar{\Xi}$

resolution for y coordinate of vertex for $\bar{\Xi}$



resolution for z coordinate of vertex for $\bar{\Xi}$



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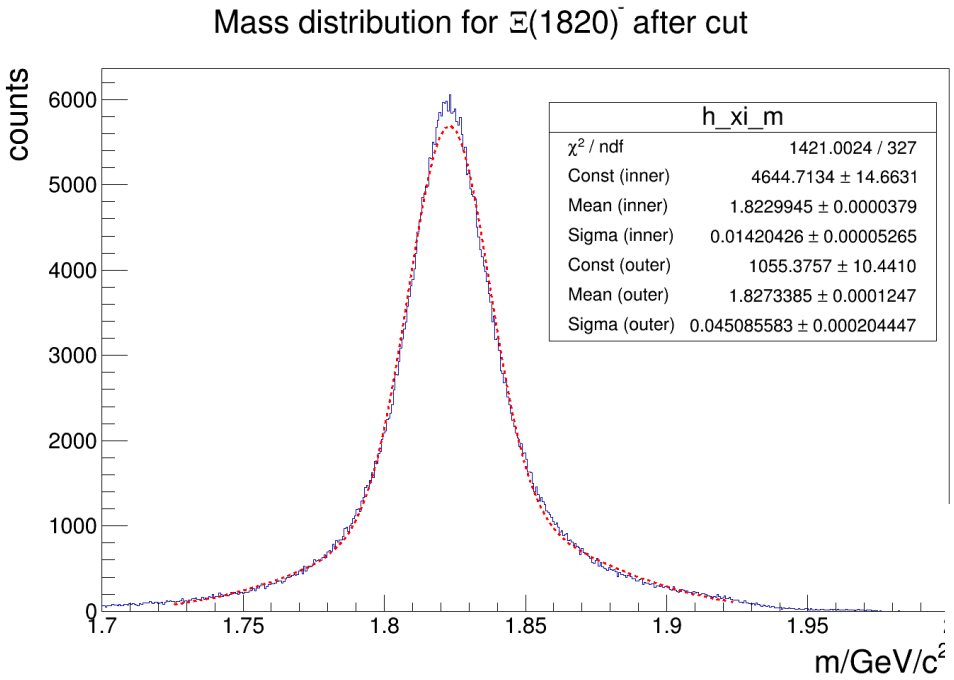
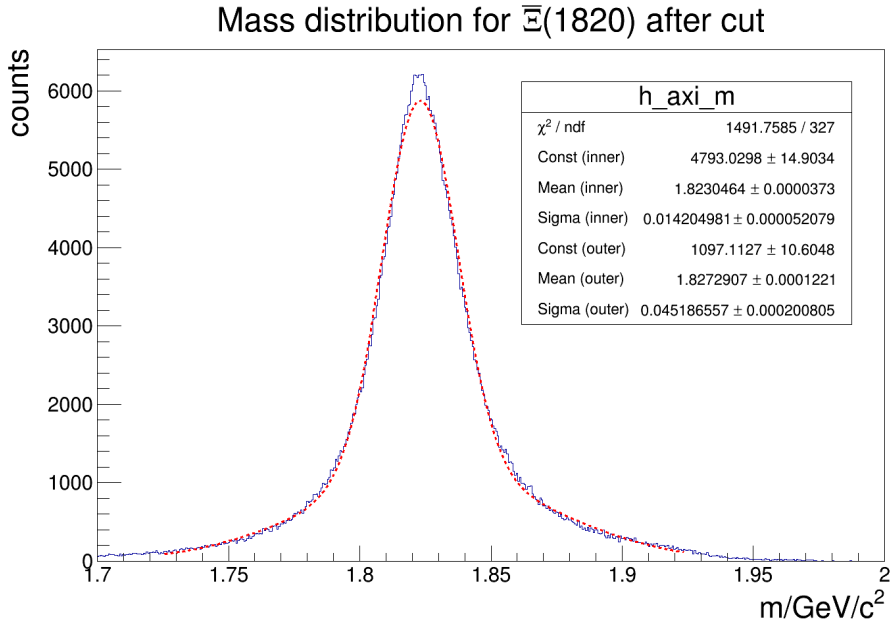
Mass fit Ξ(1820) and $\bar{\Xi}$(1820)





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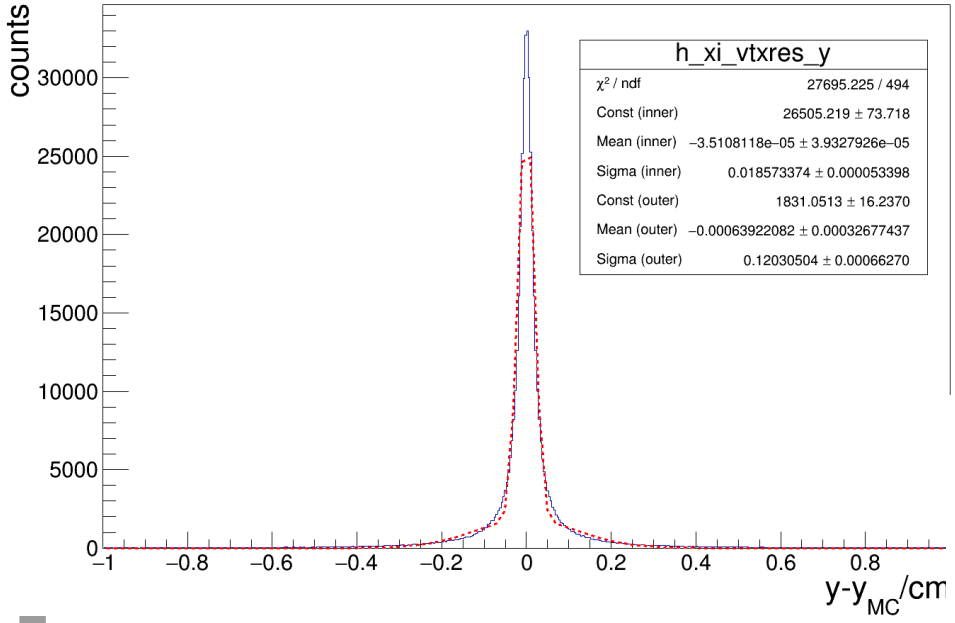
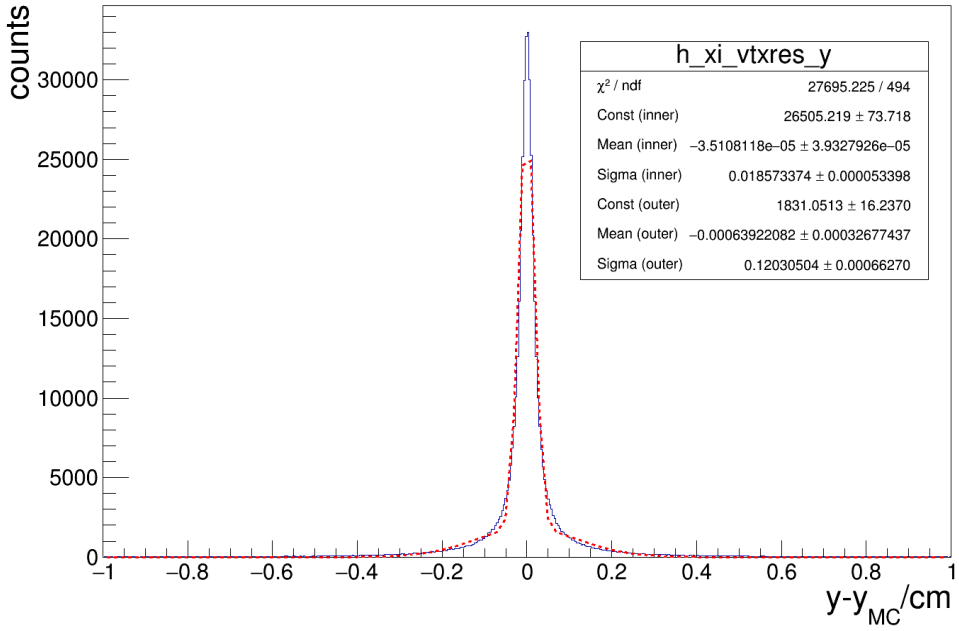
Vertex fit Ξ(1820)

resolution for y coordinate of vertex for $\Xi(1820)^-$



resolution for y coordinate of vertex for $\Xi(1820)^-$



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