UPDATE ON THE STUDY OF EXCITED Ξ BARYONS

CM MEETING 2018 GSI – HYPERON SESSION | MARCH 7TH 2018 I

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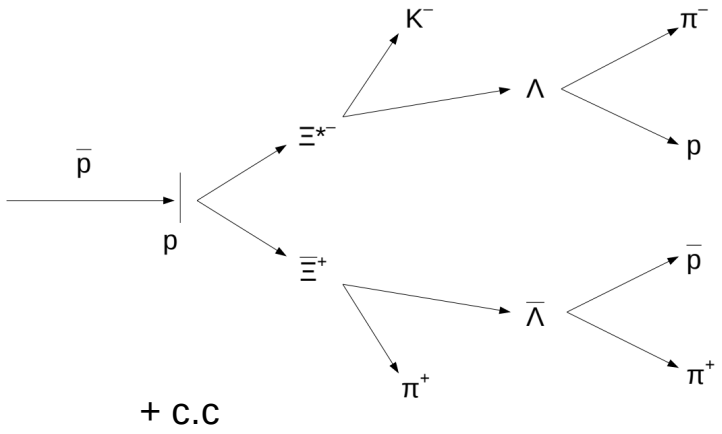
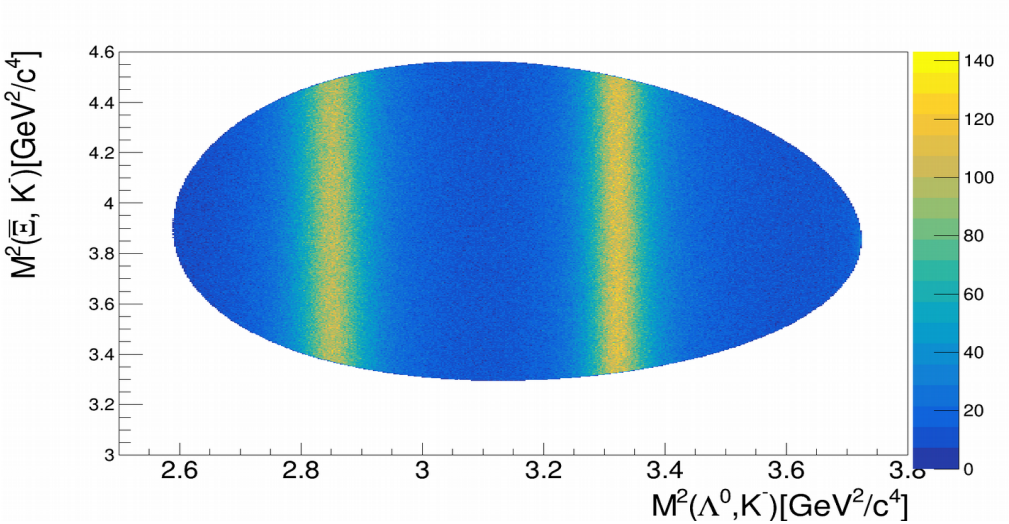
Event Generation

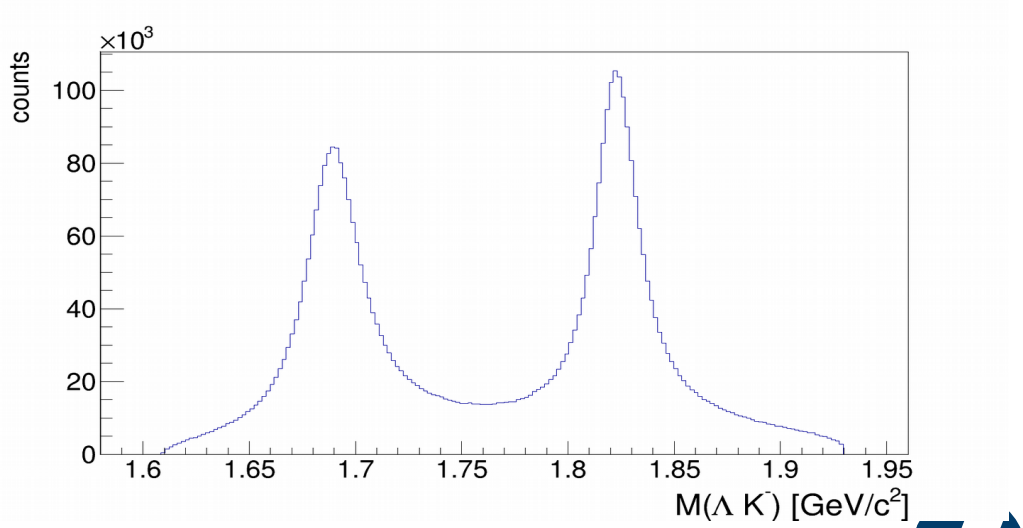
- Two Ξ Resonances + $\Xi\Lambda K^-$ (continuum) (+c.c.)
  - Ξ(1690):
    M=1.690 GeV/c², Γ=30 MeV/c²
  - Ξ(1820):
    M=1.823 GeV/c², Γ=24 MeV/c²



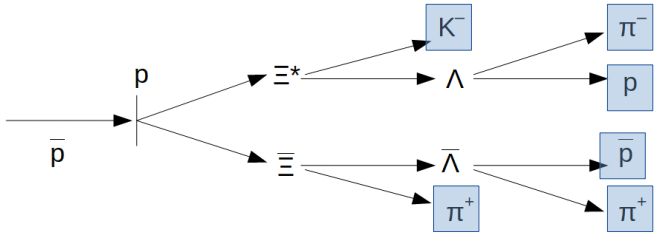
- Generated signal events: $4.47445 \cdot 10^6$
- Isotropic angular distribution
- Beam momentum $p_{\bar{p}}$ = 4.6 GeV/c
  (~100 MeV above threshold for Ξ(1820) production)
- BR($\Lambda \rightarrow p\pi$) = 100% to avoid unwanted final states

Event Generation

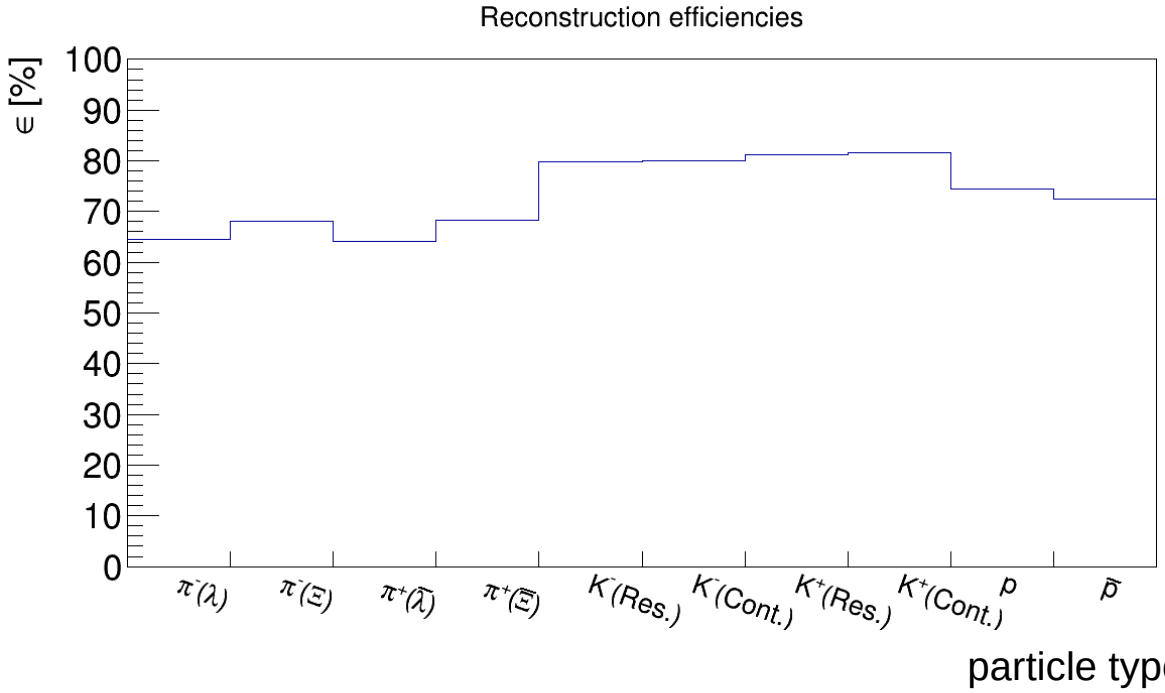




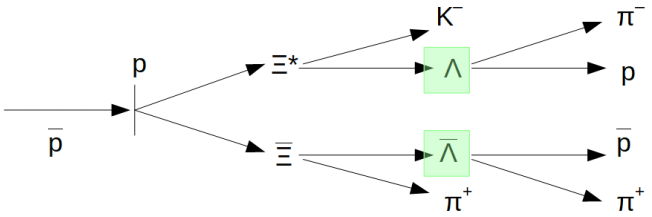
Reconstruction
Final State Particles



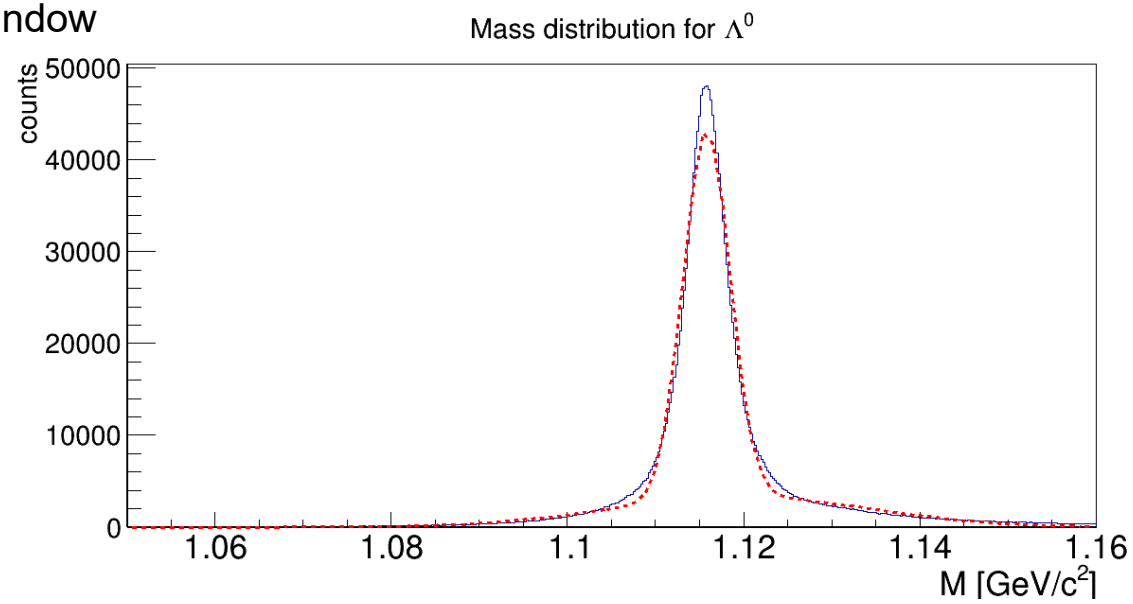
- Using ideal pattern recognition and ideal particle identification (PID)
- Select only final state particles with $N_{hits} \geq 4$ in either MVD, STT or GEM



Reconstruction
Λ & $\bar{\Lambda}$



- Select candidates within a mass window of m = (1.116 ± 0.15) GeV/c²
- Perform vertex fit
- Kinematic fit with mass constraint performed on fitted candidate
- Select best candidate of mass constraint fit with condition: vertex fit prob>0.01



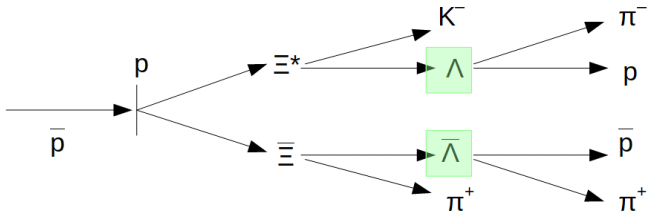
$M_{\Lambda} = (1.11604 \pm 3 \cdot 10^{-6})$ GeV/c²

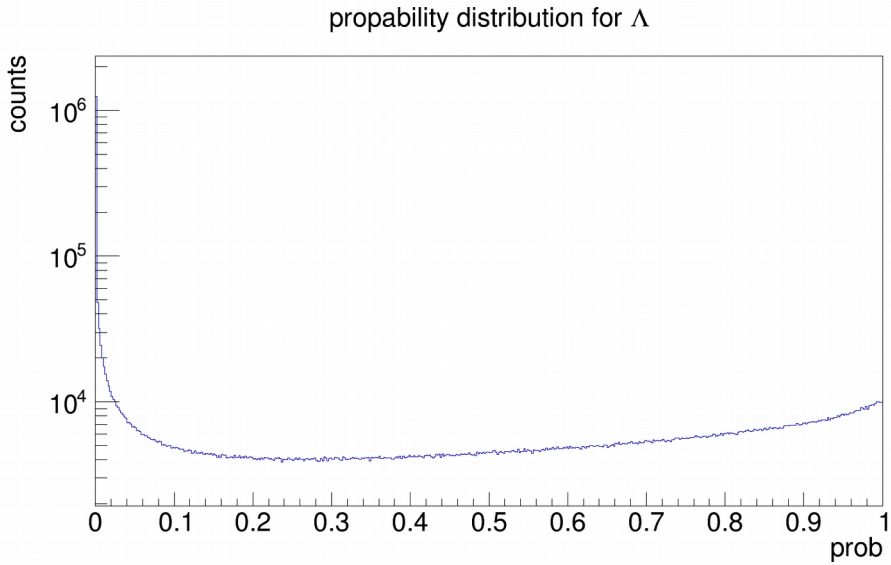
$\sigma = (2.588 \pm 0.003)$ MeV/c²

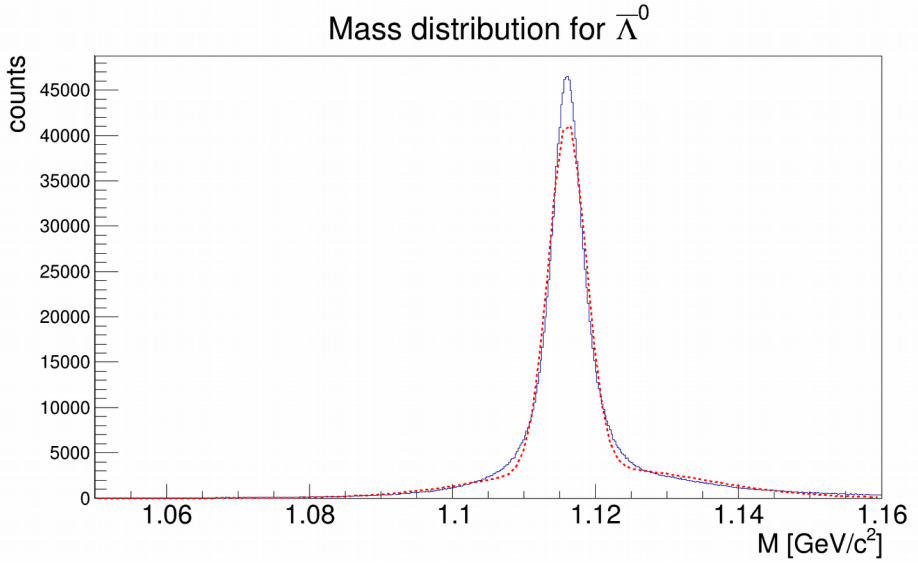
errors purely statistical

Reconstruction

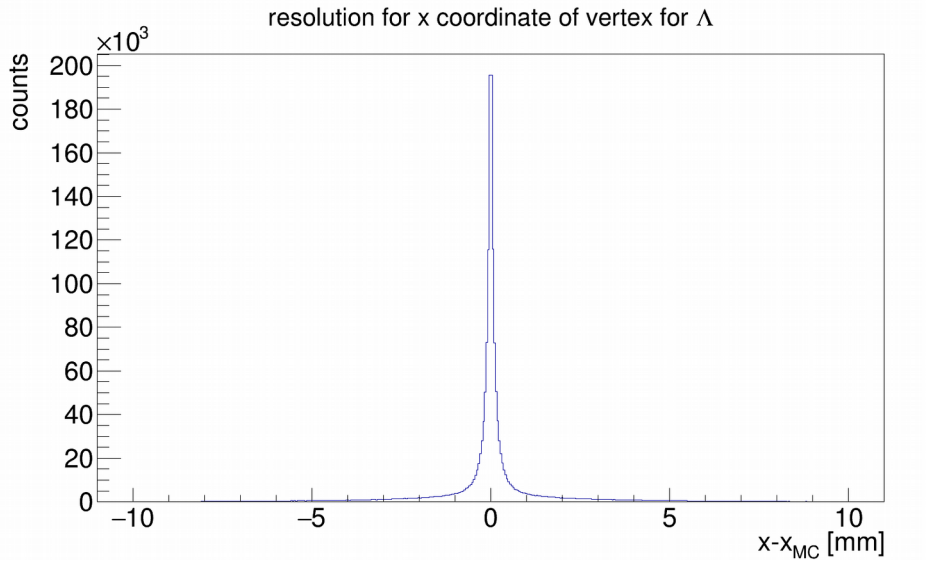
Λ & $\bar{\Lambda}$





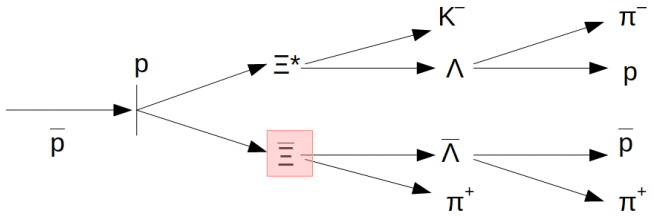


FWHM	Λ	Λ
x pos	0.132 mm	0.132 mm
y pos	0.132 mm	0.132 mm
z pos	0.484 mm	0.484 mm

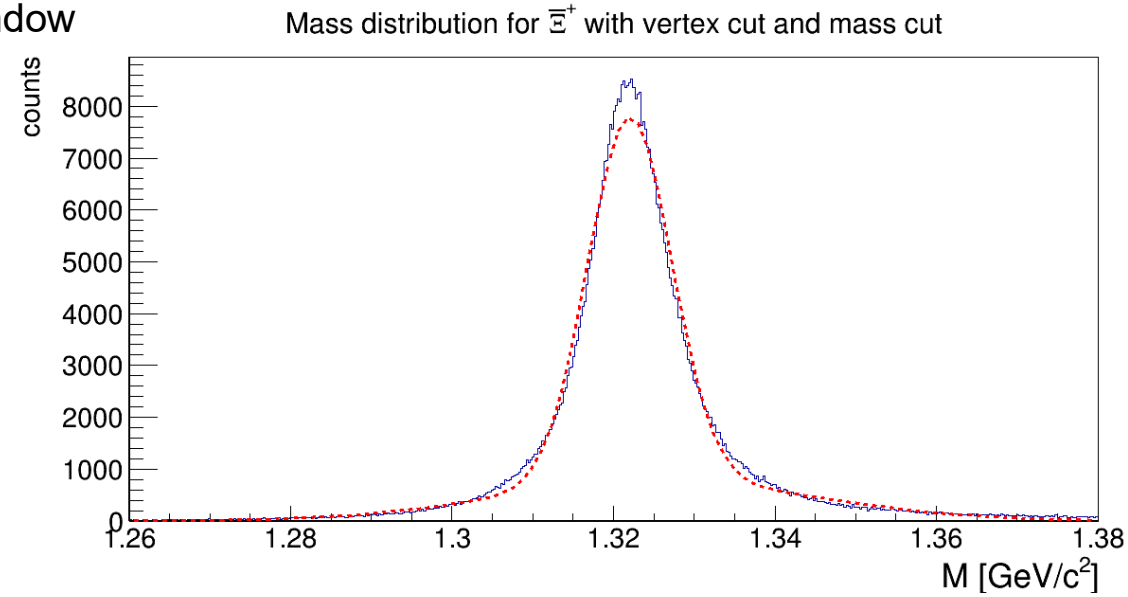


Reconstruction

$\bar{\Xi}^+$ & Ξ^-



- Select candidates within a mass window of m = (1.321 ± 0.15) GeV/c²
- Perform vertex fit:
- Kinematic fit with mass constraint performed on fitted candidate
- Select best candidate of mass constraint fit with condition: vertex fit prob>0.01



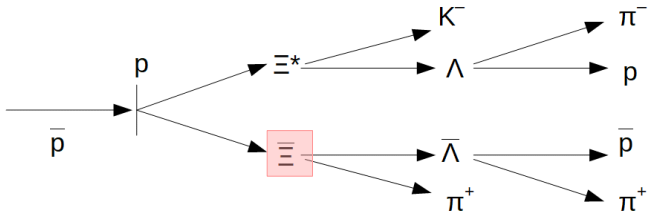
$M_{\Xi} = (1.32261 \pm 1 \cdot 10^{-5})$ GeV/c²

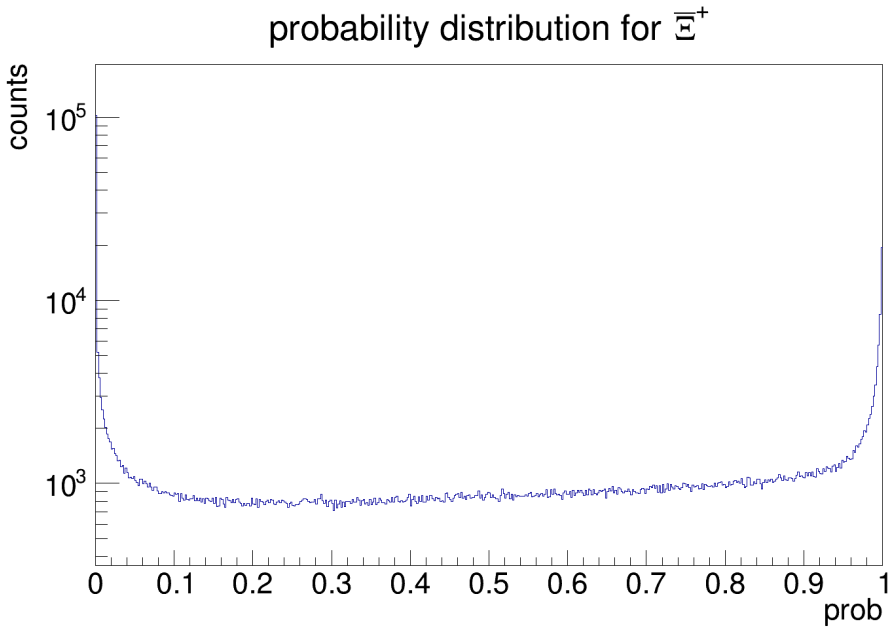
$\sigma = (5.04 \pm 0.01)$ MeV/c²

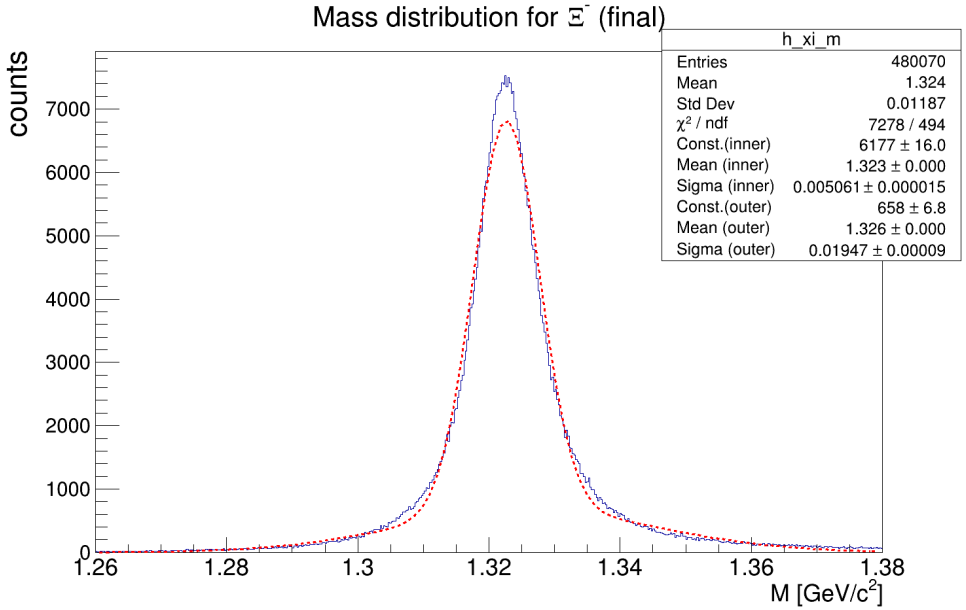
errors purely statistical

Reconstruction

$\bar{\Xi}^+$ & Ξ^-



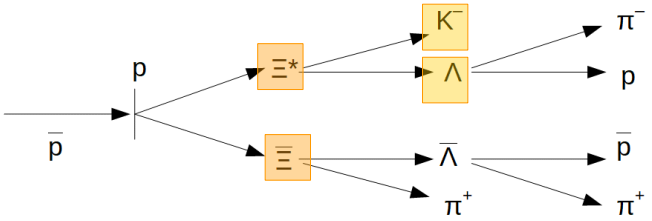




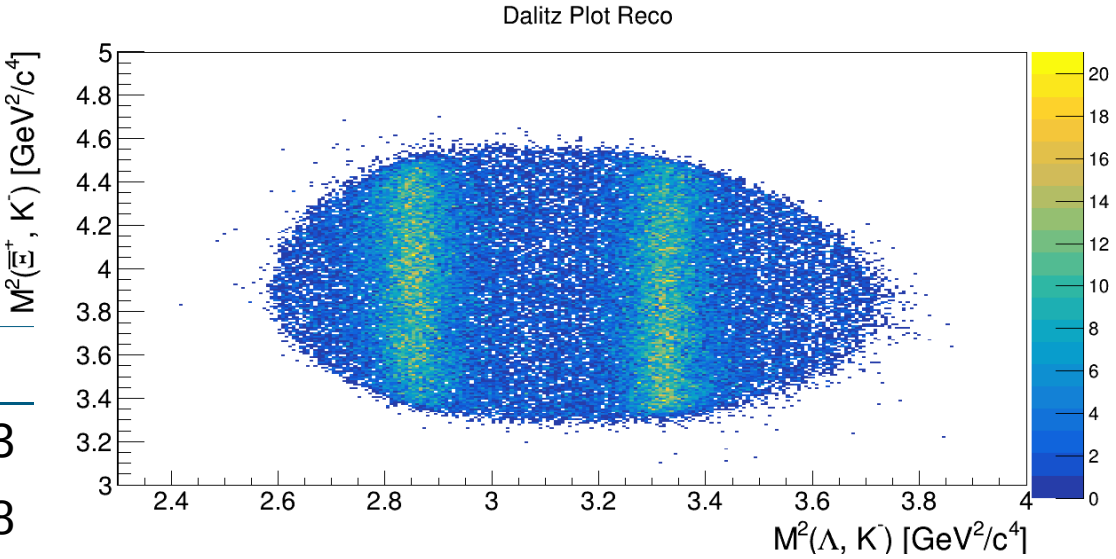
	$\bar{\Xi}^+$	Ξ^-
x [mm]	0.28	0.28
y [mm]	0.28	0.28
z [mm]	1.12	1.16

Reconstruction

$\bar{\Xi}^+ \Lambda K^-$



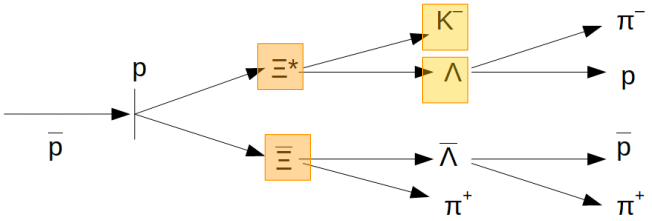
- Vertex fit
- Kinematic fit with 4-momentum constraint (4C-fit)
- Select candidate with vertex fit prob > 0.01 and 4C-fit prob > 0.01

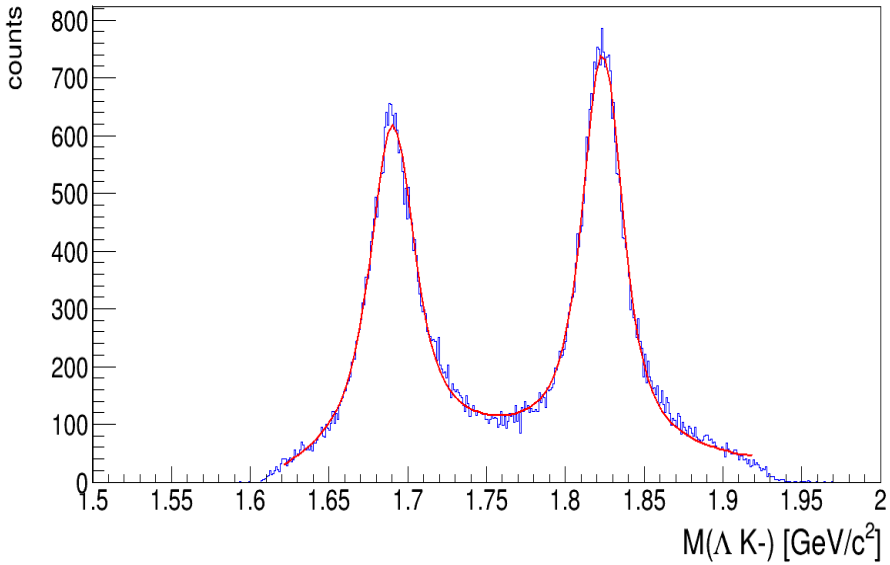


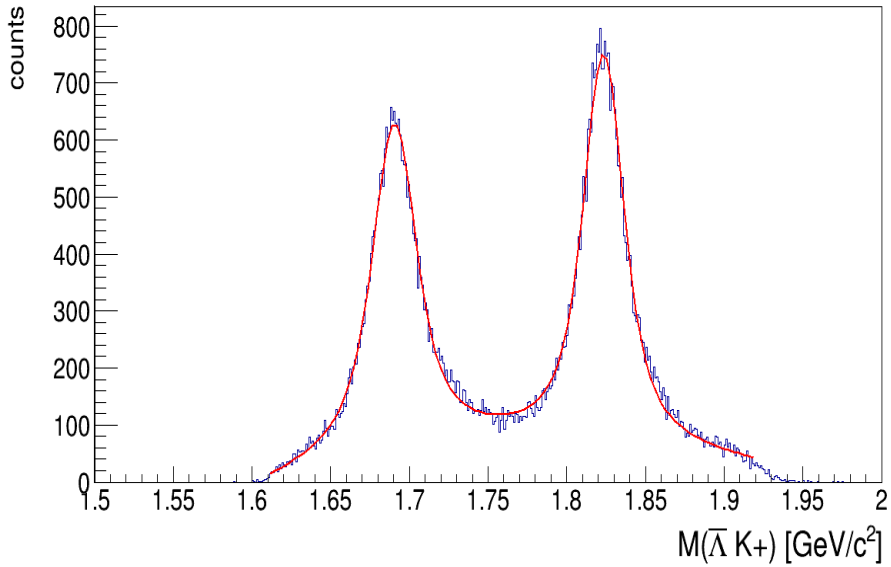
Particle	Reco. eff.[%]
Λ	37.3
$\bar{\Lambda}$	36.8
Ξ^-	19.7
$\bar{\Xi}^+$	19.3
$\bar{\Xi}^+ \Lambda K^-$	3.0
$\Xi^- \bar{\Lambda} K^+$	3.1

Reconstruction

$\bar{\Xi}^{+}\,\Lambda\,K^{-}$ + c.c.







		Mean [GeV/c²]	Γ [MeV/c²]
$\Lambda\,K^{-}$	$\Xi(1690)^{-}$	1.6902 ± 0.0002	25.9 ± 0.6
	$\Xi(1820)^{-}$	1.8236 ± 0.0001	21.9 ± 0.5
$\bar{\Lambda}\,K^{+}$	$\bar{\Xi}(1690)^{+}$	1.6905 ± 0.0002	26.4 ± 0.6
	$\bar{\Xi}(1820)^{+}$	1.8234 ± 0.0001	22.6 ± 0.5

For both resonances:

σ = 7 MeV/c² fixed

Background Studies

- $9.6565 \cdot 10^7$ background events generated with Dual Parton Model
- Number of selected Background Events: 0 → 2.3 events at 90% C.L.
- Cross sections: σ_{sig} = 1μb and σ_{bg} = 60 mb; $\varepsilon_{sig} \approx 0.031$ and $b_{sig} = 0.4083$

- Signal-to-background ratio: $S/B = \frac{\sigma_{sig} \cdot b_{sig} \cdot \epsilon_{sig}}{\sigma_{bg} \cdot \epsilon_{bg}} > 8.7$
- Significance: $S = \frac{N_{sig}}{\sqrt{N_{sig} + N_{bg} \cdot F_{bg}}} > 247$ with $F_{bg} = \frac{N_{sig}^{gen} \cdot \sigma_{bg}}{N_{bg}^{gen} \cdot \sigma_{sig} \cdot b_{sig}}$

Summary & Outlook

- Simulated ~ 4.5 million signal events for $\bar{p}p \rightarrow \Xi^{*-}\ \bar{\Xi}^{+}$ and its c.c.
- Reconstructed Masses in agreement with input values
- Reconstruction efficiency for full reaction chain ~3% ($\bar{\Xi}\Lambda\, K^{-}$ and $\Xi\bar{\Lambda}K^{+}$)
- No background events out of 97 million generated survive applied cuts
- Lower limit for significance: S > 247
- Intermediate state of analysis looks promising

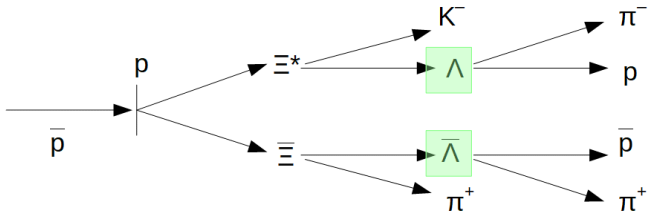
- Implementation of realistic PID and pattern recognition
- Partial wave analysis of $\bar{\Xi}\Lambda\, K^{-}$ (& c.c) final state will be explored

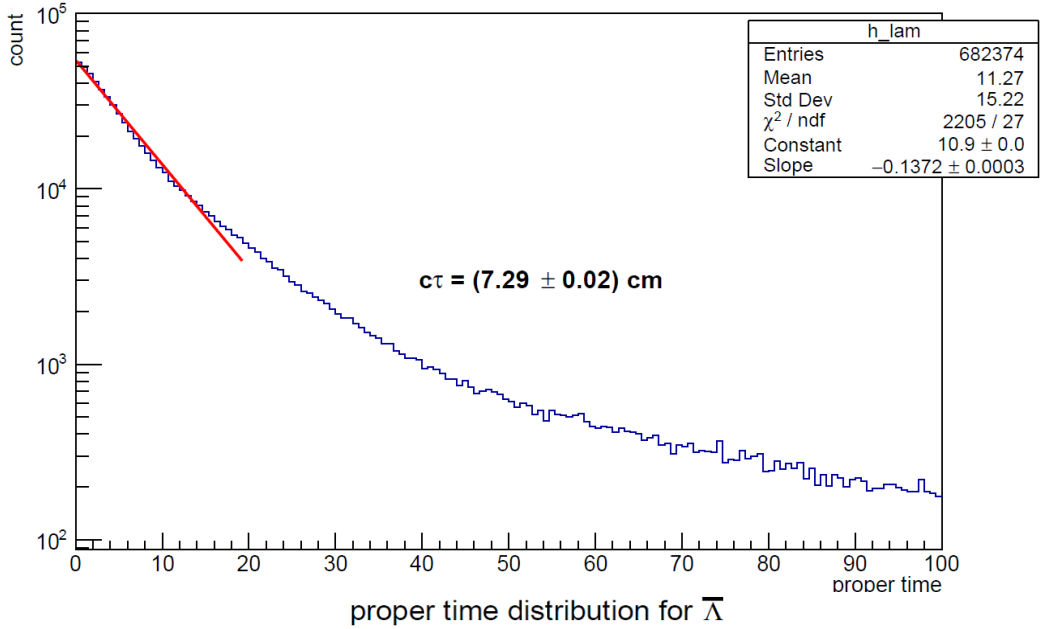
Thank you for your attention!

Backup

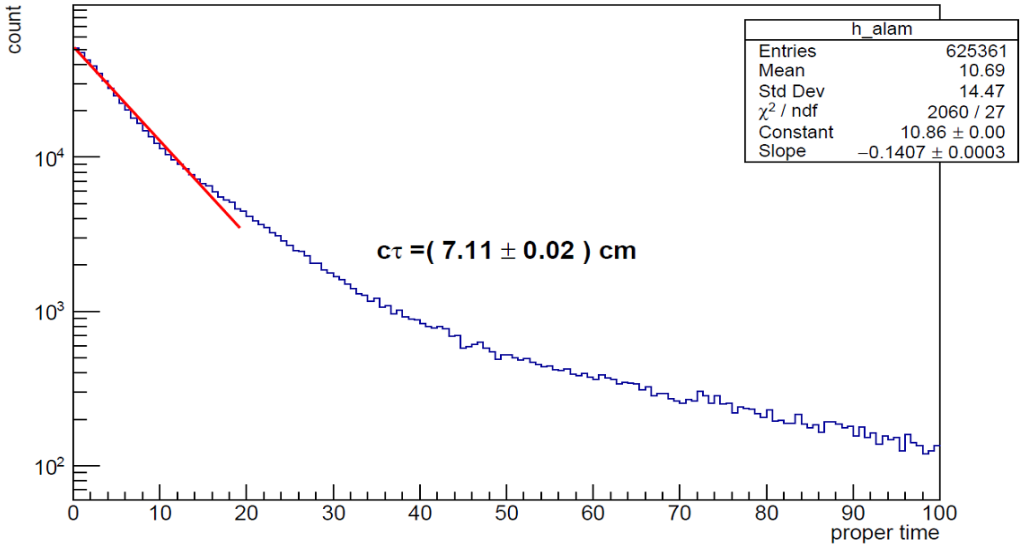
Reconstruction

Λ & $\bar{\Lambda}$



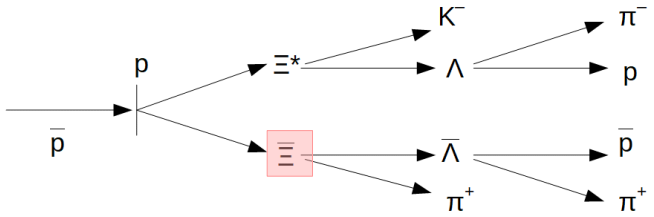


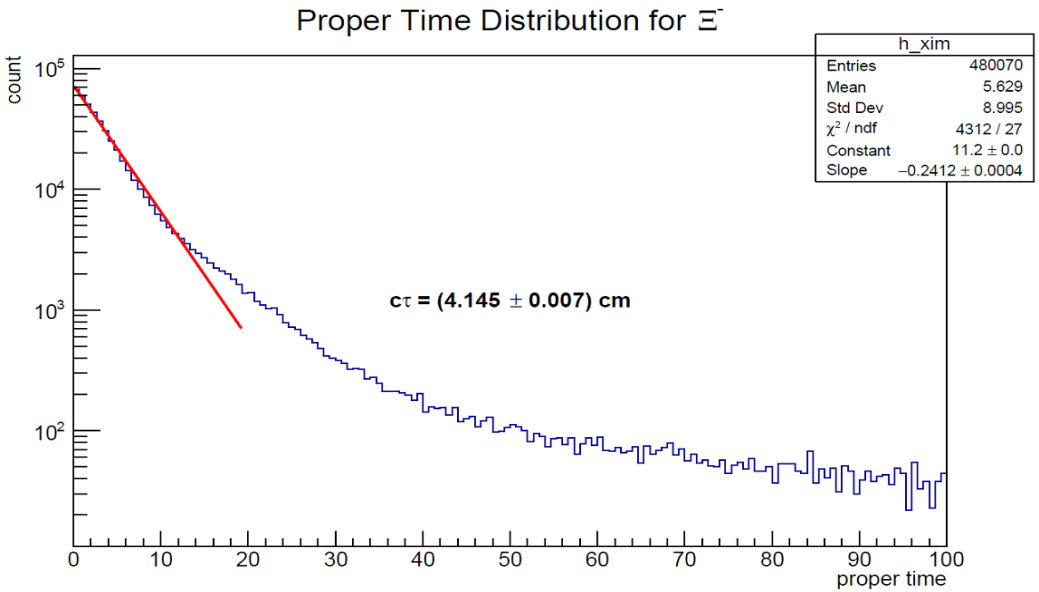
proper time distribution for $\bar{\Lambda}$

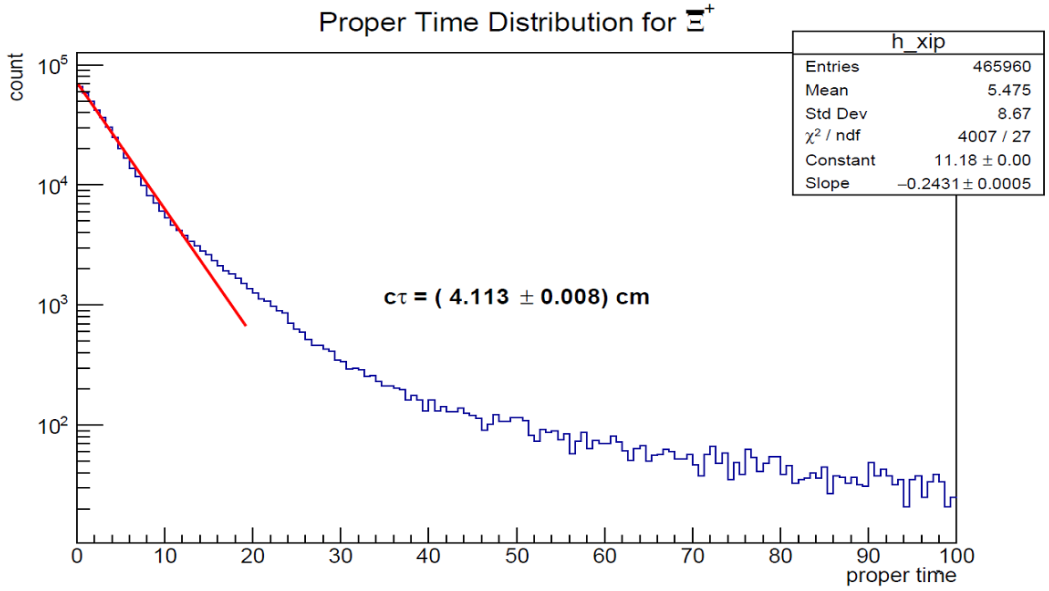


Reconstruction

Ξ^- & $\bar{\Xi}^+$







Reconstruction

$\bar{\Xi}^{+}\,\Lambda\,K^{-}$ + c.c.