Ξ^0_c production in pp collision at $\sqrt{s}$ =13TeV with ALICE

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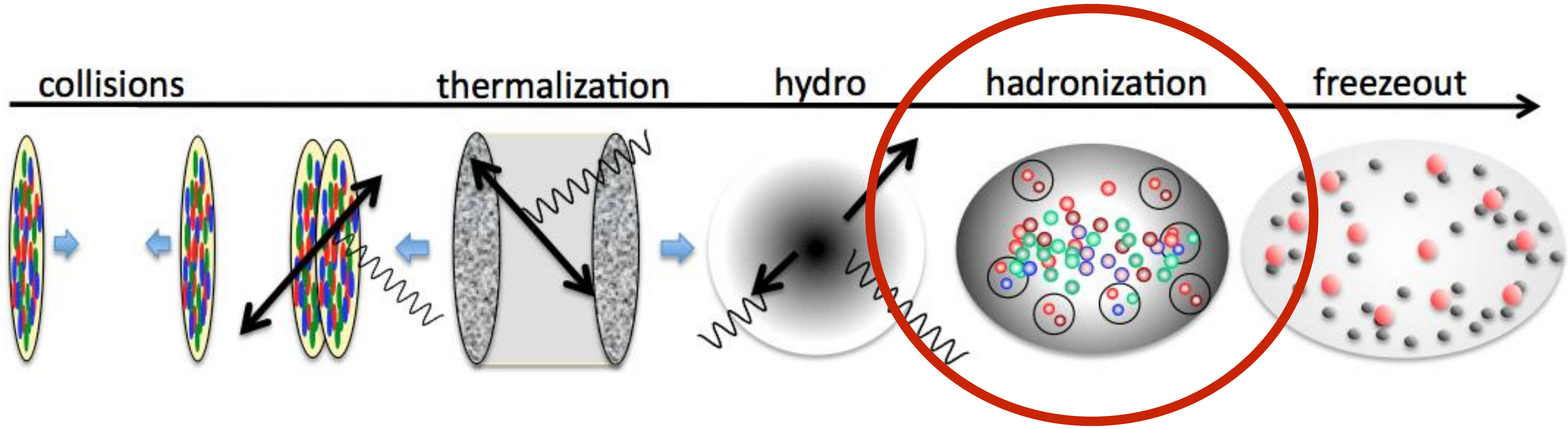
2020.01.05
KoALICE Meeting

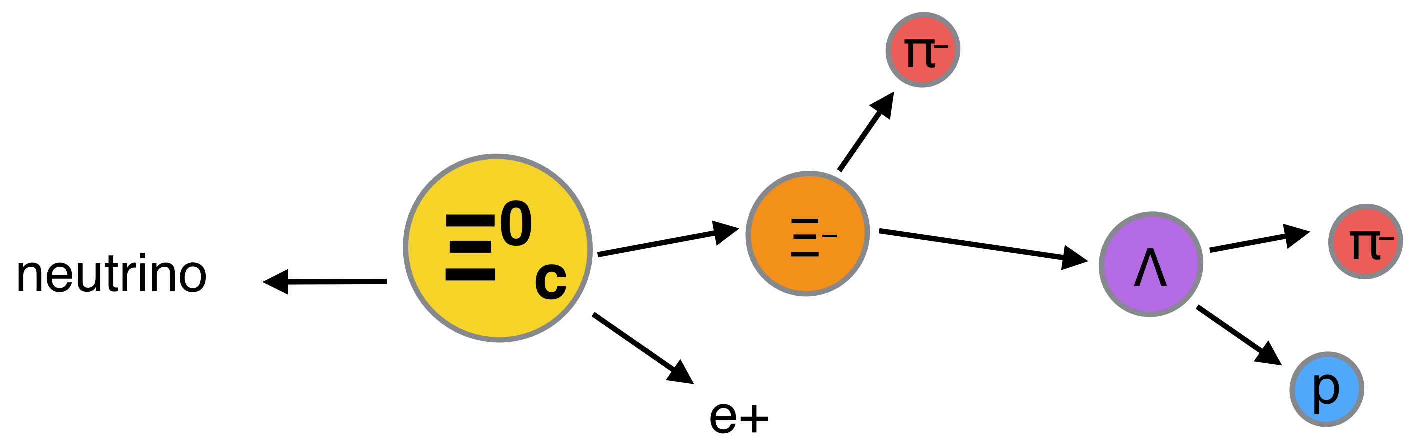
Motivation

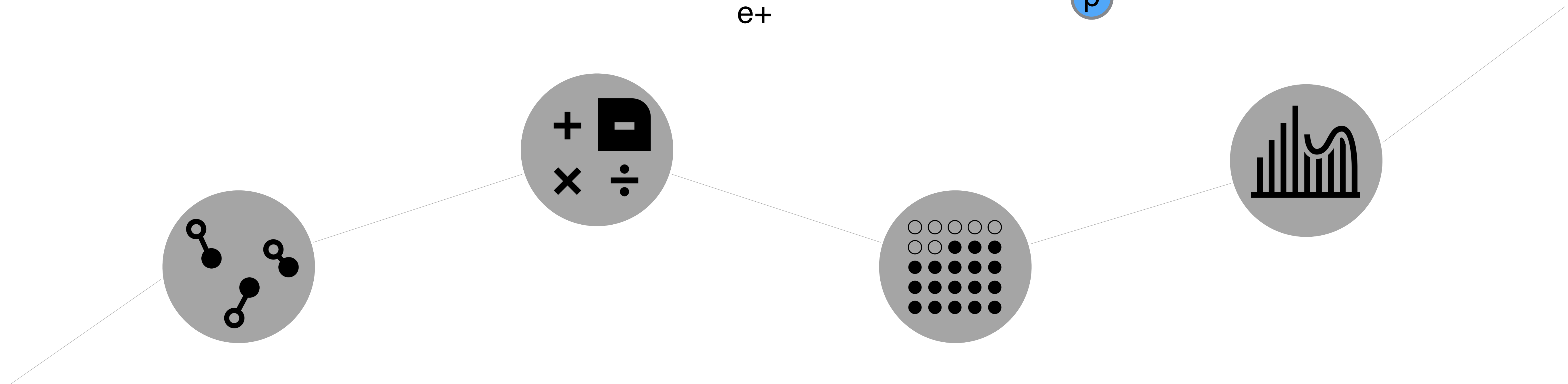
- **QGP probe with Heavy quarks**
  - Charm and beauty quarks are heavier than light quarks (u,d,s) and are produced in initial hard-scattering processes with high Q^2 , transported through the full medium created in the collisions.
  - Production cross sections calculable with perturbative QCD.
  - Traversing the medium while interacting with its constituents.
  - Study charm and beauty hadronization mechanisms using meson and baryon production D, Λ_c, Ξ_c,…



- **pp collisions**
  - Reference for p-Pb and Pb-Pb collisions.
  - Testing ground for perturbative QCD calculations.

Analysis flow





STEP. 1

Select e and Ξ and Make pair of Right Sign and Wrong Sign

STEP. 2

Subtract the Wrong Sign spectra from Right Sign Spectra

STEP. 3

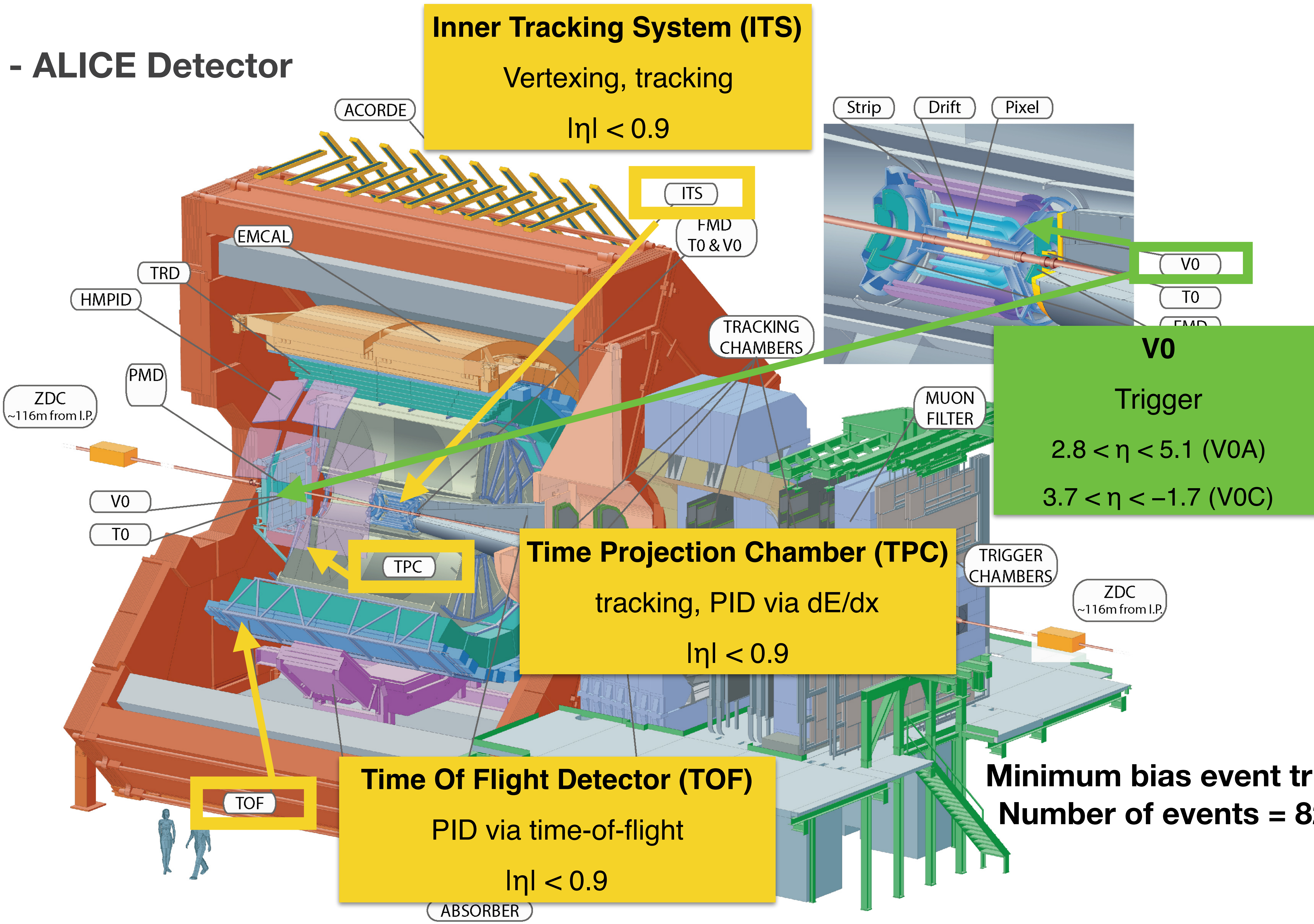
Using Unfolding technique to correct missing neutrino momentum

STEP. 4

Efficiency correction and event normalization

Detector

- ALICE Detector



Minimum bias event trigger
Number of events = 820M

Dataset

- Dataset (# of events : 820M)

- Data : LHC16d, pass1 (pp collision, 13 TeV, 12.5M events, 10 runs)
  LHC16e, pass1 (pp collision, 13 TeV, 44.5M events, 11 runs)
  LHC16g, pass1 (pp collision, 13 TeV, 24M events, 17 runs)
  LHC16h, pass1 (pp collision, 13 TeV, 32M events, 67 runs)
  LHC16j, pass1 (pp collision, 13 TeV, 41M events, 34 runs)
  LHC16k, pass2 (pp collision, 13 TeV, 112M events, 161 runs)
  LHC16l, pass2 (pp collision, 13 TeV, 29M events, 58 runs)
  LHC16o, pass1 (pp collision, 13 TeV, 31M events, 71 runs)
  LHC16p, pass1 (pp collision, 13 TeV, 20M events, 42 runs)
  LHC17c, pass1 (pp collision, 13 TeV, 1.5M events, 5 runs)
  LHC17e, pass1 (pp collision, 13 TeV, 4M events, 5 runs)
  LHC17f, pass1 (pp collision, 13 TeV, 4M events, 5 runs)
  LHC17h, pass1 (pp collision, 13 TeV, 120M events, 88 runs)
  LHC17i, pass1 (pp collision, 13 TeV, 26M events, 52 runs)
  LHC17j, pass1 (pp collision, 13 TeV, 34.5M events, 10 runs)
  LHC17k, pass1 (pp collision, 13 TeV, 90M events, 105 runs)
  LHC17l, pass1 (pp collision, 13 TeV, 68M events, 127 runs)
  LHC17m, pass1 (pp collision, 13 TeV, 91M events, 108 runs)
  LHC17o, pass1 (pp collision, 13 TeV, 97M events, 148 runs)
  LHC17r, pass1 (pp collision, 13 TeV, 22.5M events, 28 runs)

- MC : LHC17c3b1 (anchored to LHC16k, HF2ELE)
  LHC17c3b2 (anchored to LHC16l, HF2ELE)
  LHC17h8b(anchored to LHC16deghjop, HF2ELE)
  LHC18l5a (anchored to LHC17x, HF2ELE)

Cut list

- Cut list

Event cut

Cut variables	Cuts
Physics selection	AliVEvent::kAnyINT
Trigger class	kINT7
Primary vertex	Within 10cm
Pile up	Rejection

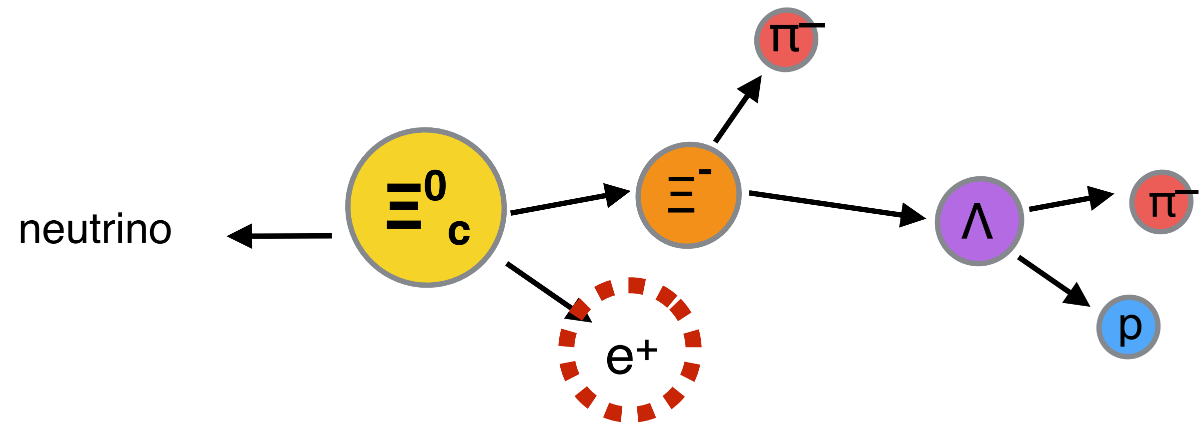
eID cut

Cut variables	Cuts
AOD Filtering version	208
Number of TPC clusters	>100
Number of TPC PID clusters	>80
Ratio to findable cluster	>0.6
ITS/TPC refit	TRUE
Number of ITS cluster	>=4
pt	>0.5
$\lvert\eta\rvert$	<0.8
SPD hit	Both
$\lvert$TOF n$\sigma\rvert$	<3
TPC nσ	$f(P_T) \sim 3$

$f(P_T) = -3.9+1.2P_T-0.094P_T^2$

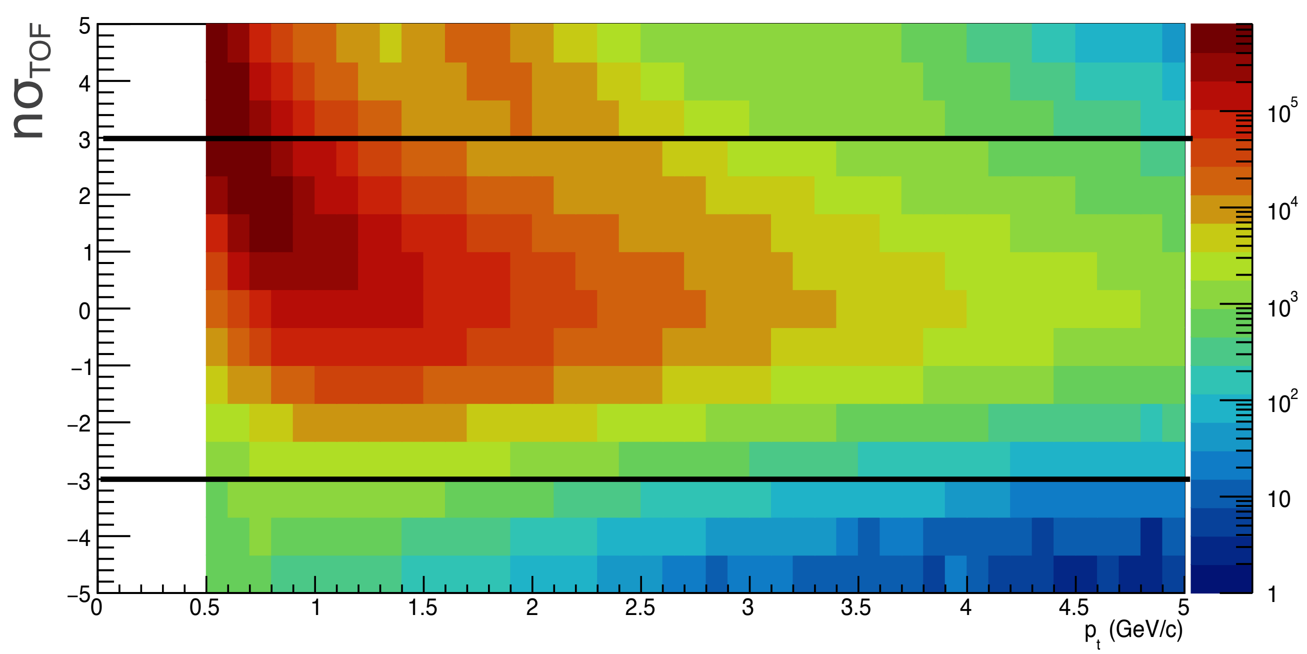
Ξ cut

Cut variables	Cuts
Number of TPC cluster	>80
Λ Mass tolerance	7.5
Ξ Mass tolerance	8
DCAof V0 to PV(cm)	>0.03
DCA f V0 daughters PV (cm)	>0.073
V0 cosine pointing angle to Ξ vertex	>0.983
DCA of bachelor track to PV (cm)	>0.0204
V0 decay length (cm)	>2.67
Ξ decay length (cm)	>0.38
TPC nσ (proton)	<4
TPC nσ (pion)	<4

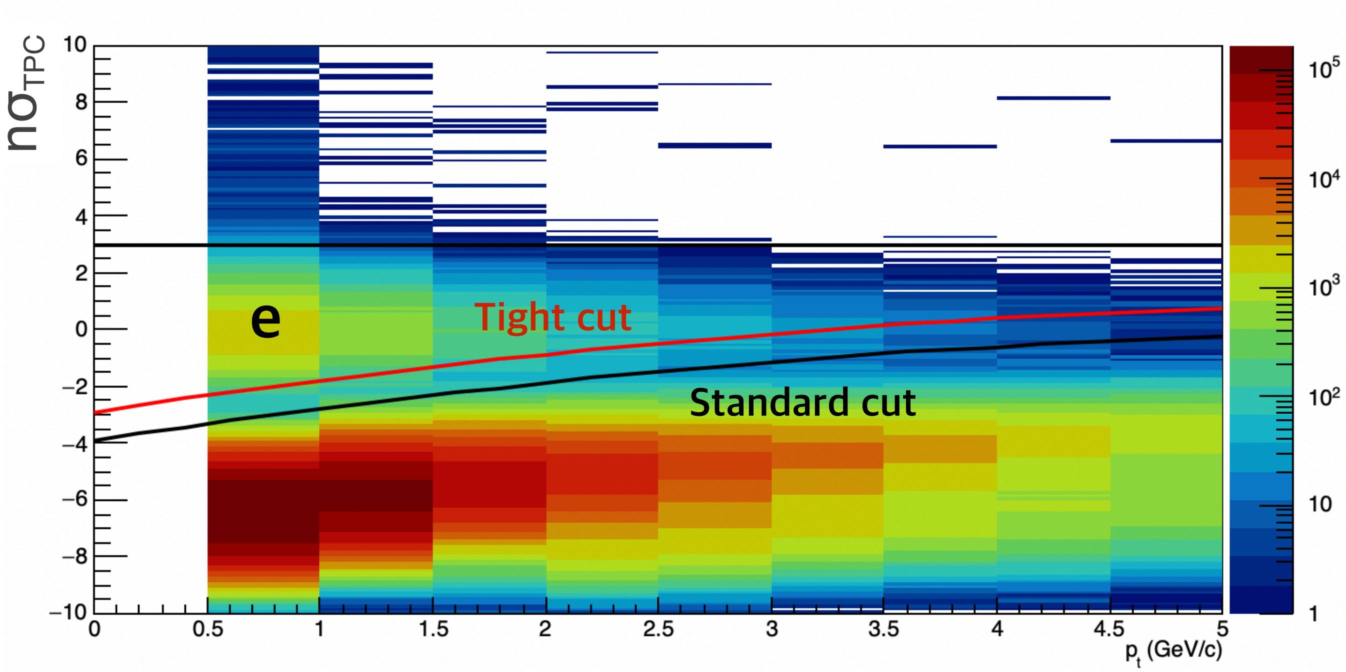


- Select electrons

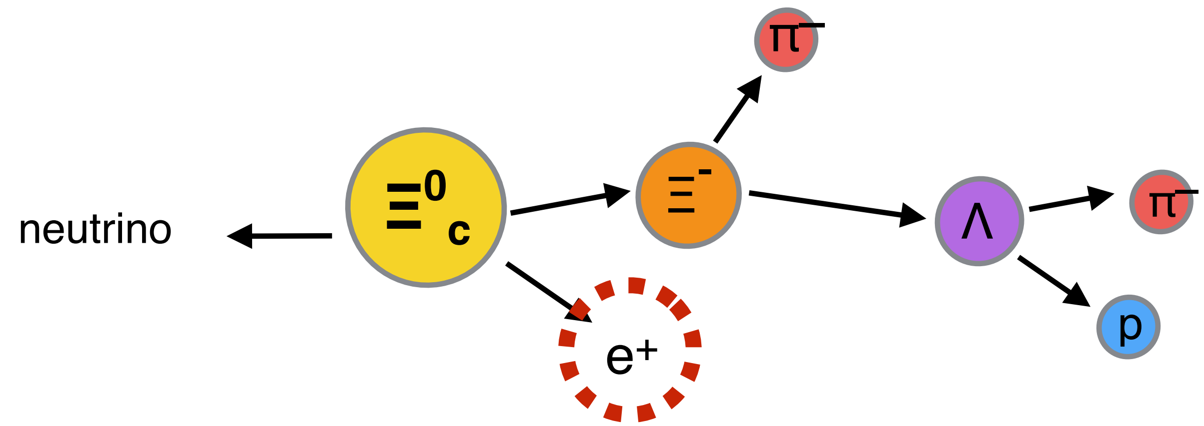
- Time-Of-Flight(TOF) and Time Projection Chamber(TPC) detector are used to identify electron.
- The $n\sigma_{TOF}$ and $n\sigma_{TPC}$ distributions of electrons from real data.
- eID Cuts applied in this analysis : $|TOF\ n\sigma| < 3$, $-3.9+1.2P_T-0.094P_T^2 < TPC\ n\sigma < 3$



TOF nσ as function of p_T. The purple line is the cut values.

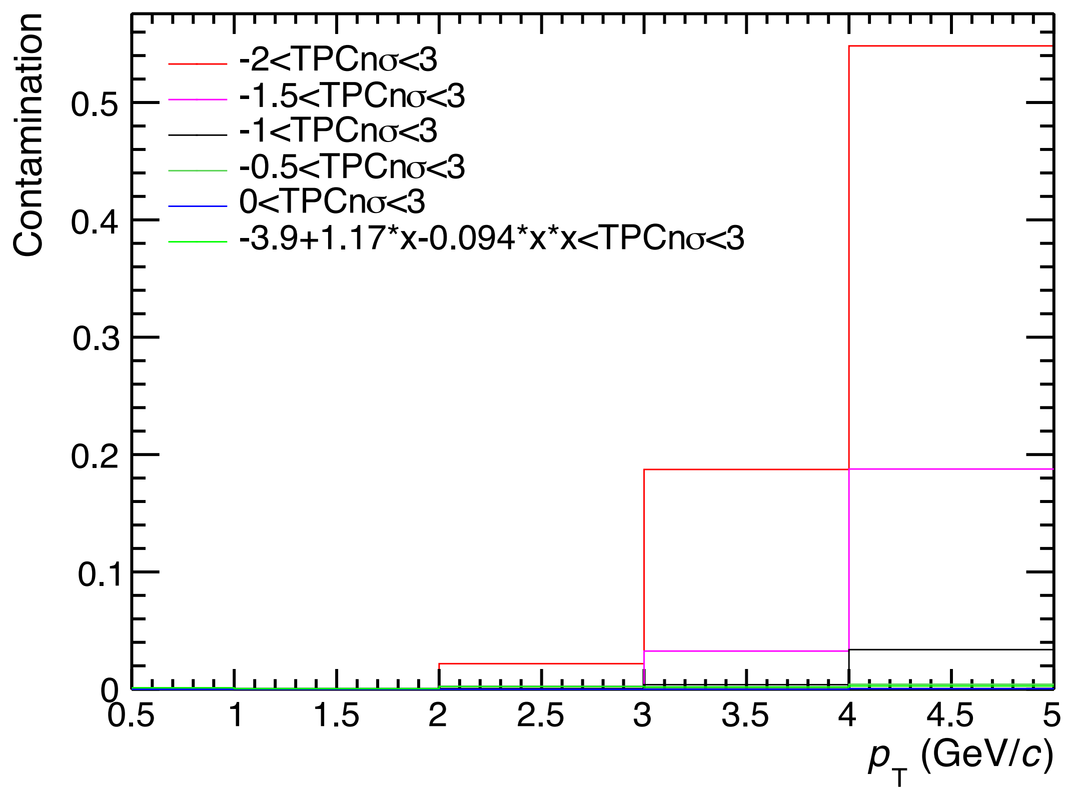


TPC nσ as function of p_T. The black line is the cut values.

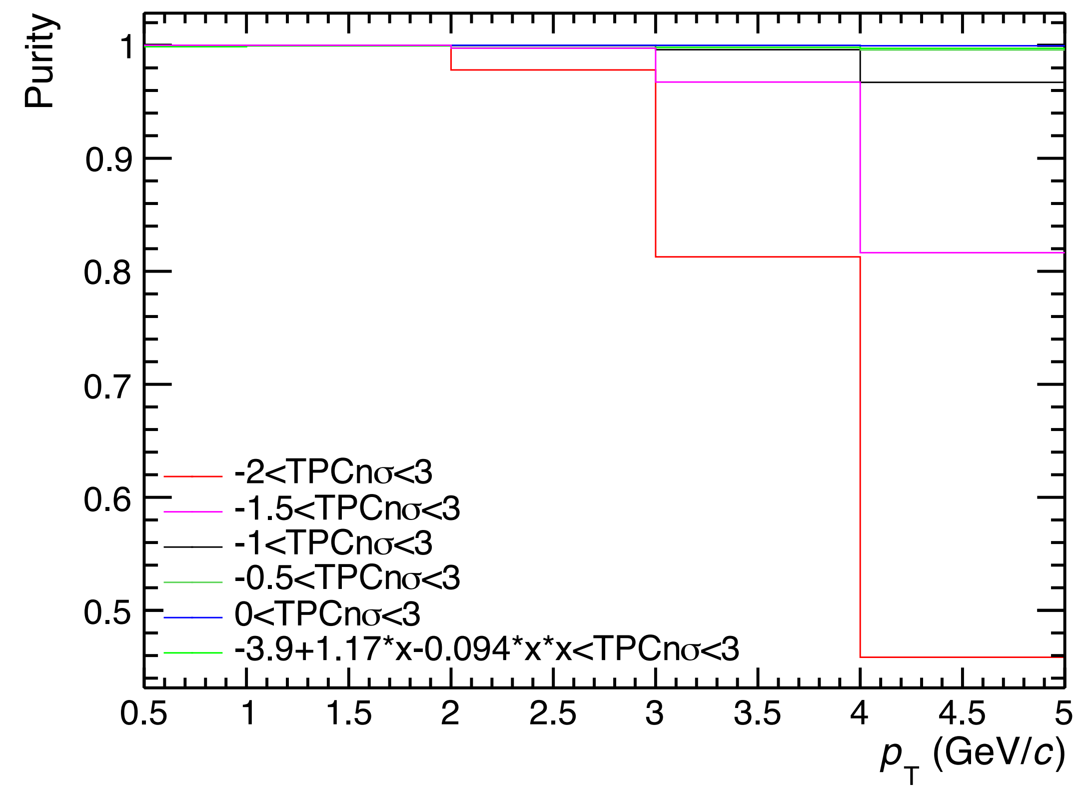


- Select electrons

- The $n\sigma_{TPC}$ is varied as a function of p_T to avoid unneeded efficiency loss at low p_T.
- The applied cut achieves the electron purity of more than 99%.



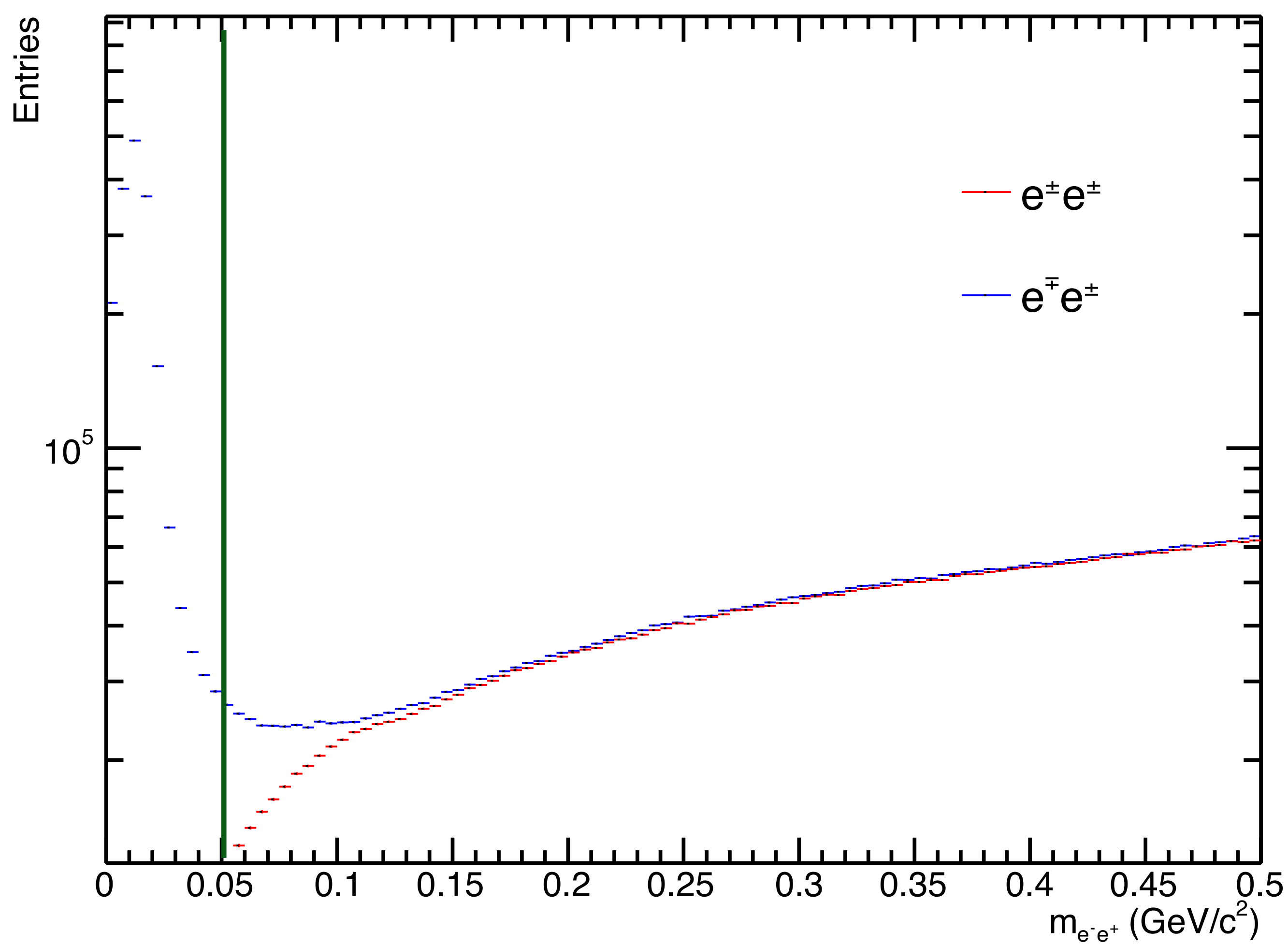
Contamination of electron



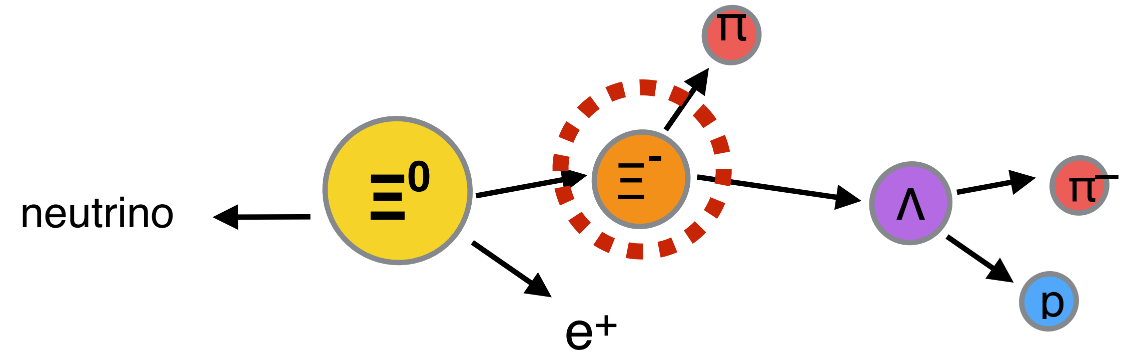
Purity of electron

- Remove background electrons

- Electron backgrounds from Dalitz decay and gamma conversions can be removed using electron pair mass information.
- The invariant mass distribution of such pairs has a peak around 0 GeV/c^2, which corresponds to the contributions from π^0 Dalitz decays and γ conversions.
- The 50 MeV/c^2 mass cut is applied to reject the background electrons.

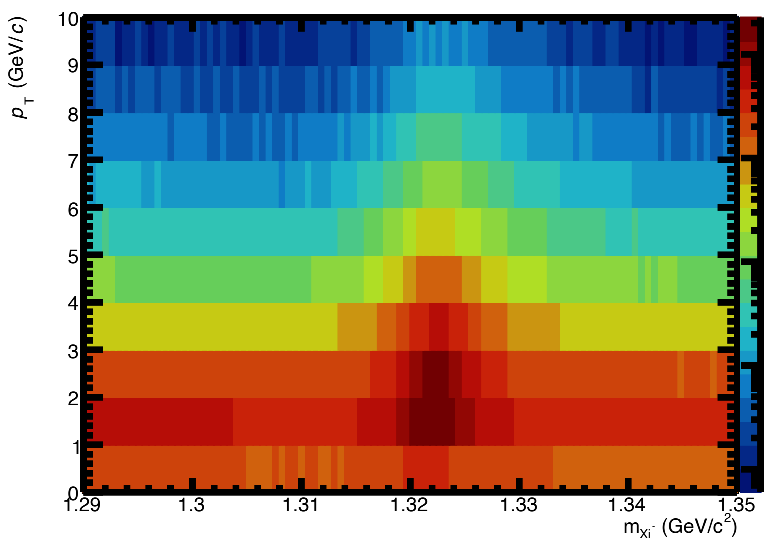


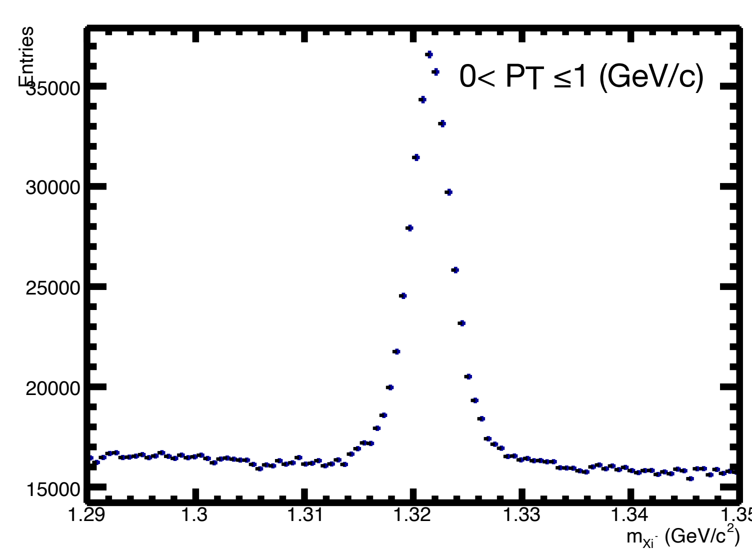
Electron pair mass in whole pt

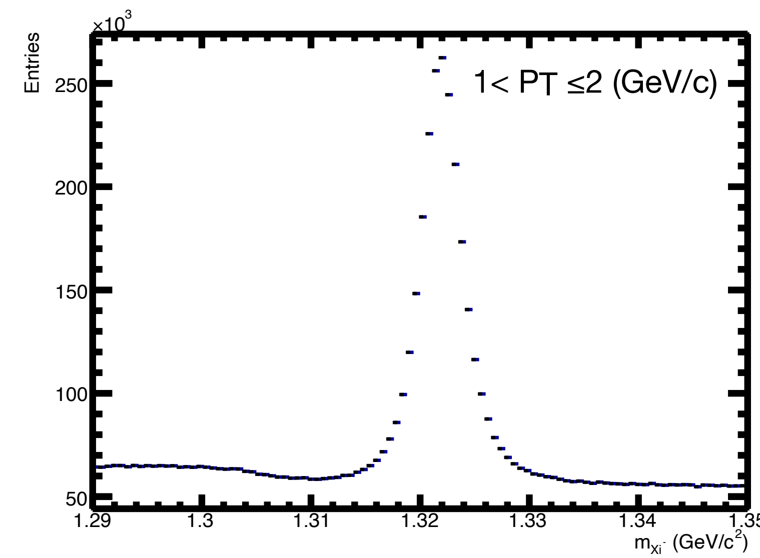


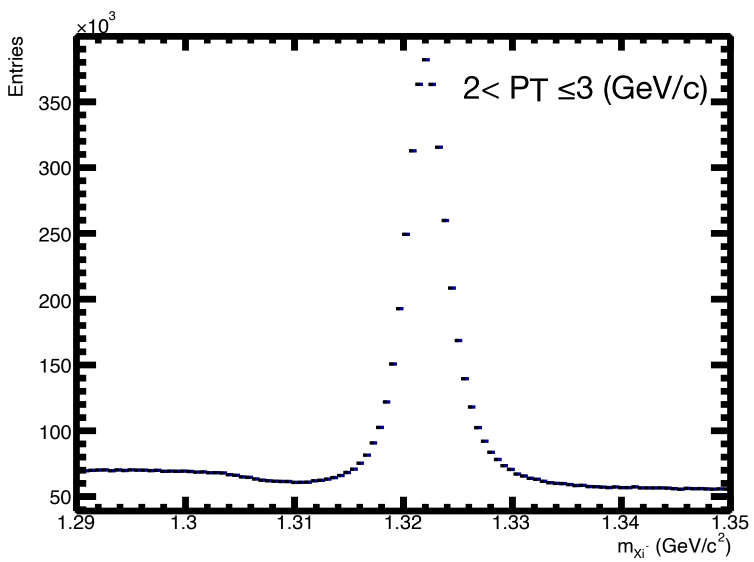
- Select Ξ

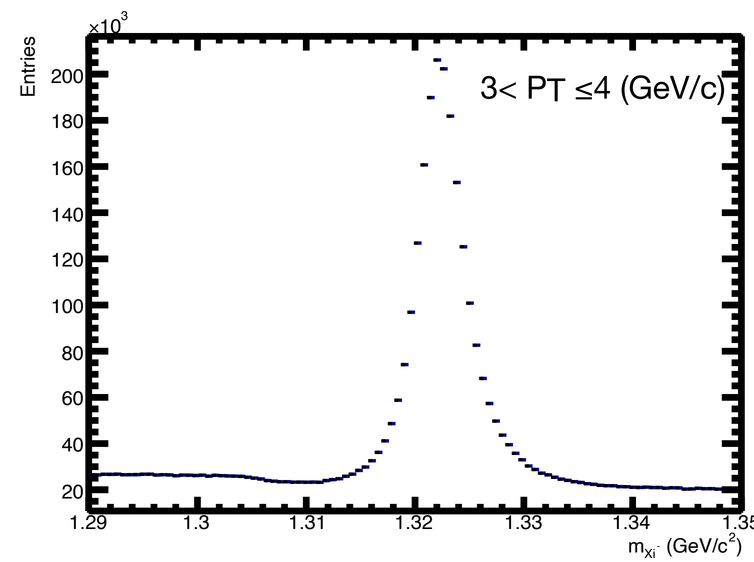
- Ξ^- baryons are reconstructed using the decay chain $\Xi^- \rightarrow \pi^-\Lambda$, followed by $\Lambda \rightarrow p\pi^-$.
- Ξ cuts are applied to remove the backgrounds.
- Ξ^- peak is shown around at 1.322 GeV which is theoretical Ξ^- mass.

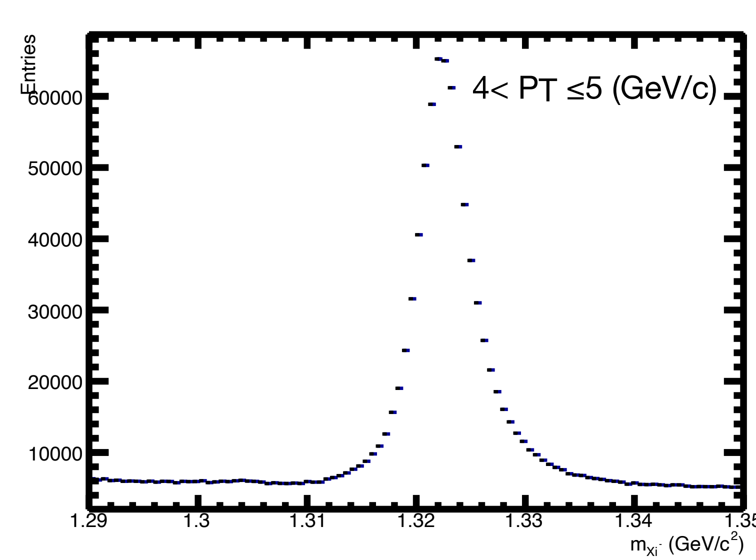












Get raw yield

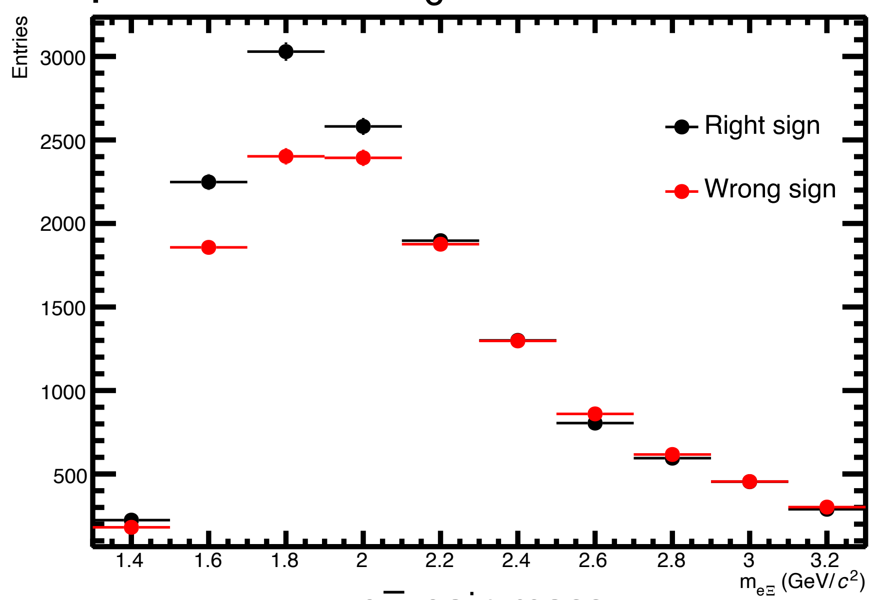
- Make eΞ pair and subtraction

- Make the pairs of $e^+\Xi^-$(RS), $e^-\Xi^+$(RS), $e^+\Xi^+$(WS), $e^-\Xi^-$(WS) when they satisfy the following two conditions

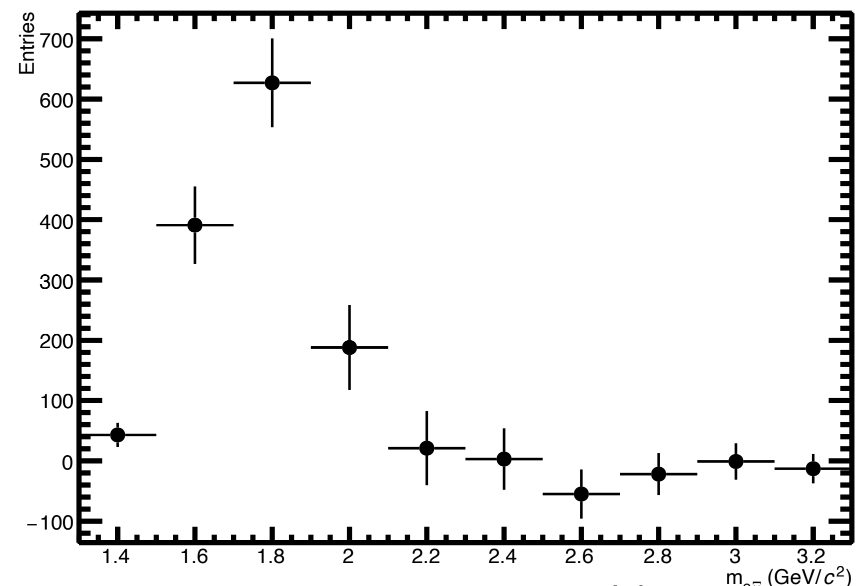
  1) The opening angle between e and Ξ is less than 90 degrees

  2) The invariant mass of pair is less than 2.5 GeV/c^2

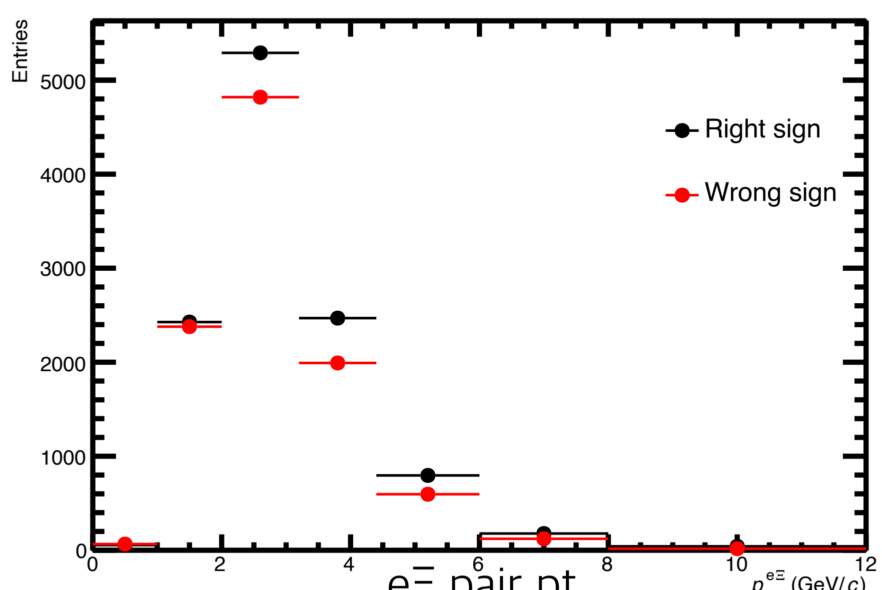
- Due to the missing momentum of neutrino, the invariant mass distribution of the $e^+\Xi^-$ and $e^-\Xi^+$ pairs does not have a peak at the Ξ^0_c mass.



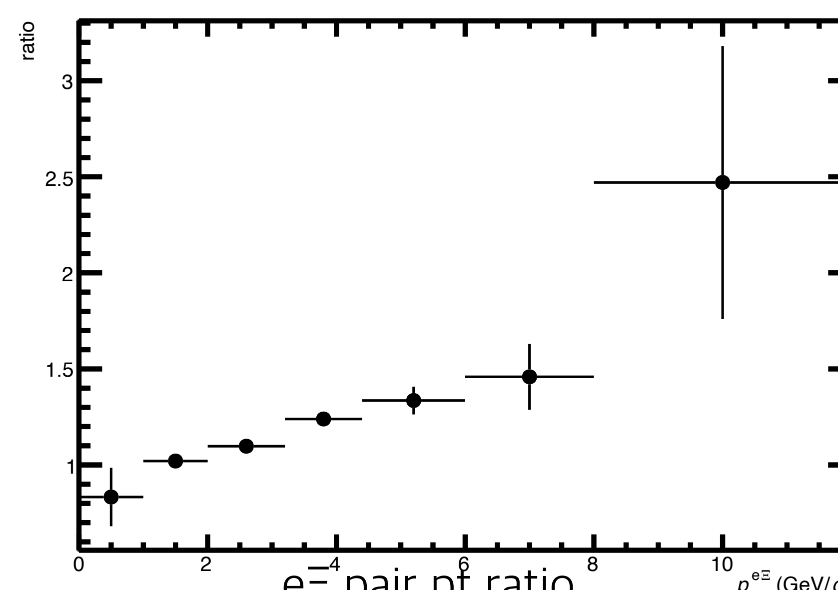
eΞ pair mass



eΞ pair mass raw yield



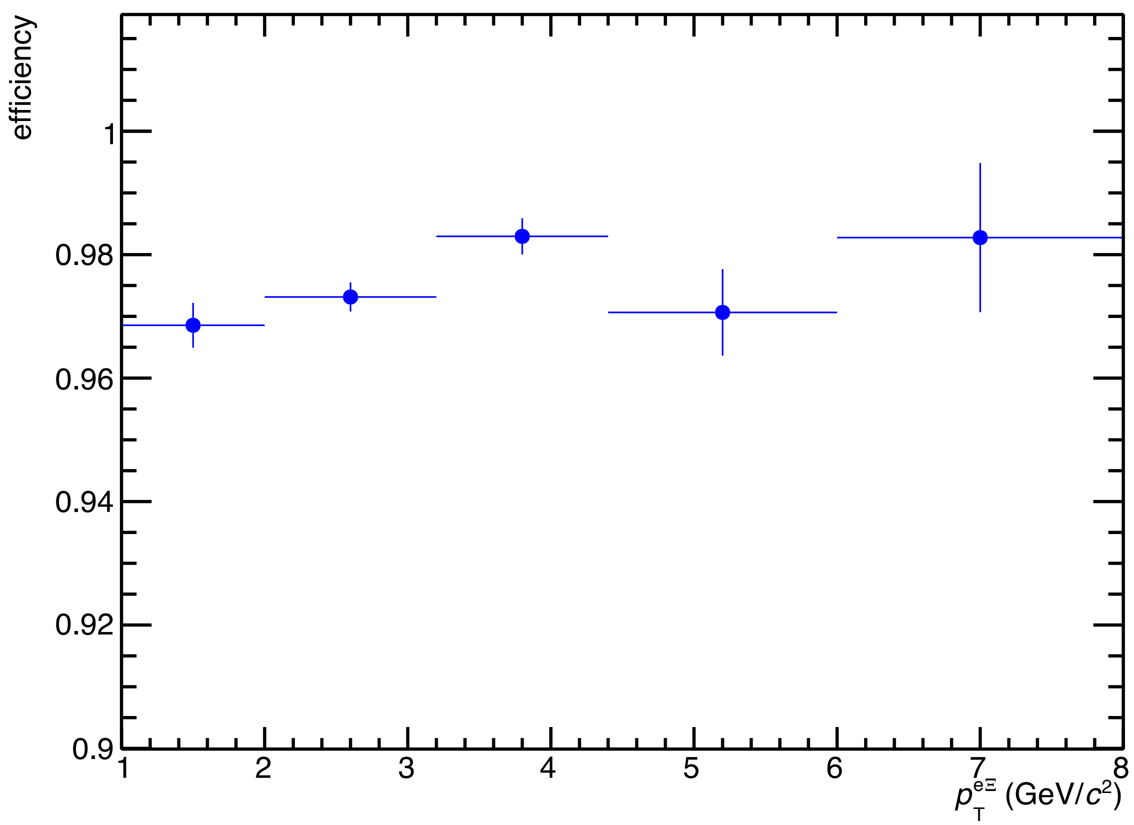
eΞ pair pt



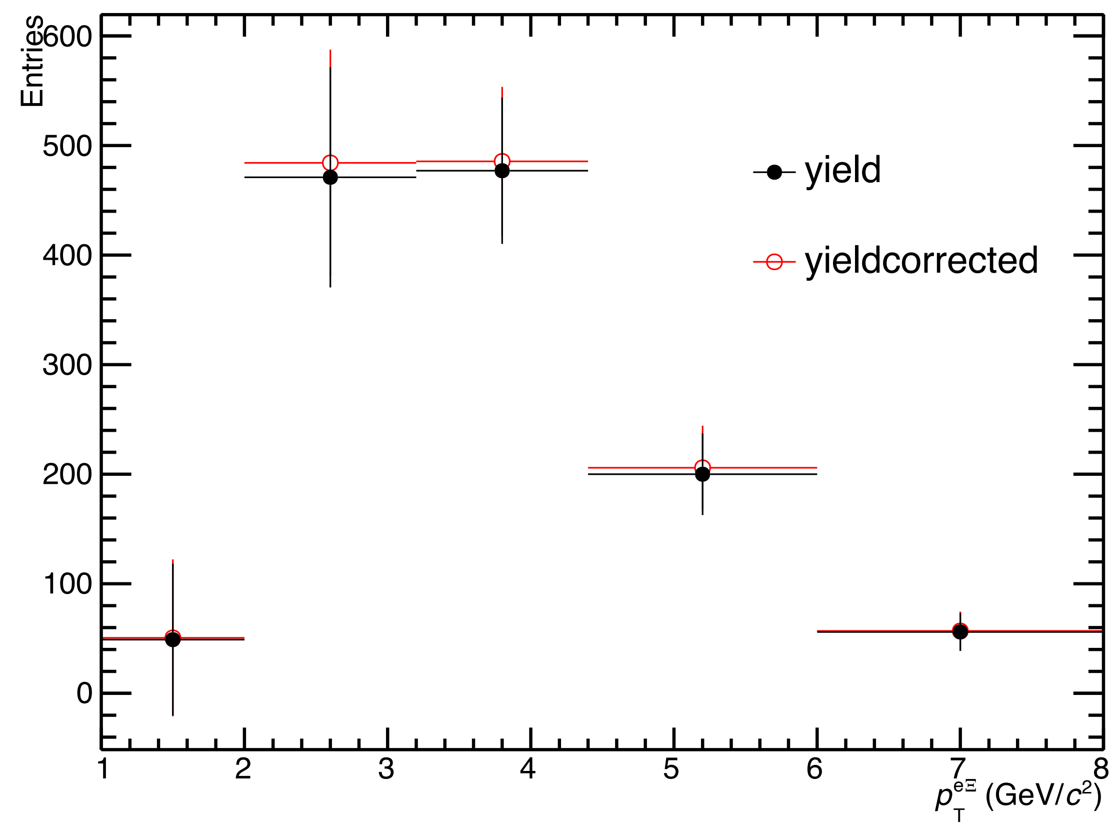
eΞ pair pt ratio

- Remove background electrons

- Electron mass cut can reject the signal electrons, prefilter cut efficiency should be corrected.
- As shown as electron pair mass plot, It is expected that prefilter has large efficiency due to same sign distribution.
- The efficiency $\varepsilon_{prefilter}$ is calculated using real data as $\epsilon_{Prefilter} = \frac{N_{e\Xi}(same\ sign\ mass\ cut\ on)}{N_{e\Xi}(mass\ cut\ off)}$
- The efficiency which average value 97% is applied to correct the yield bin by bin.



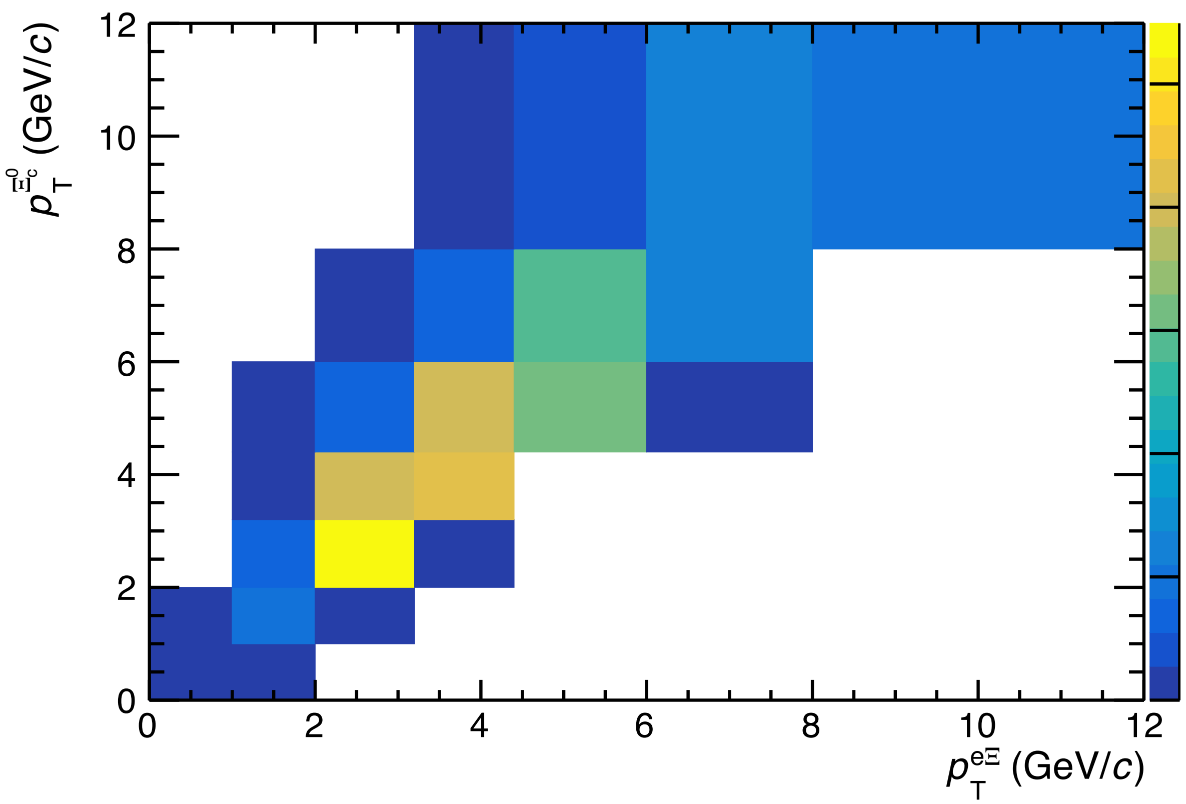
Cut efficiency



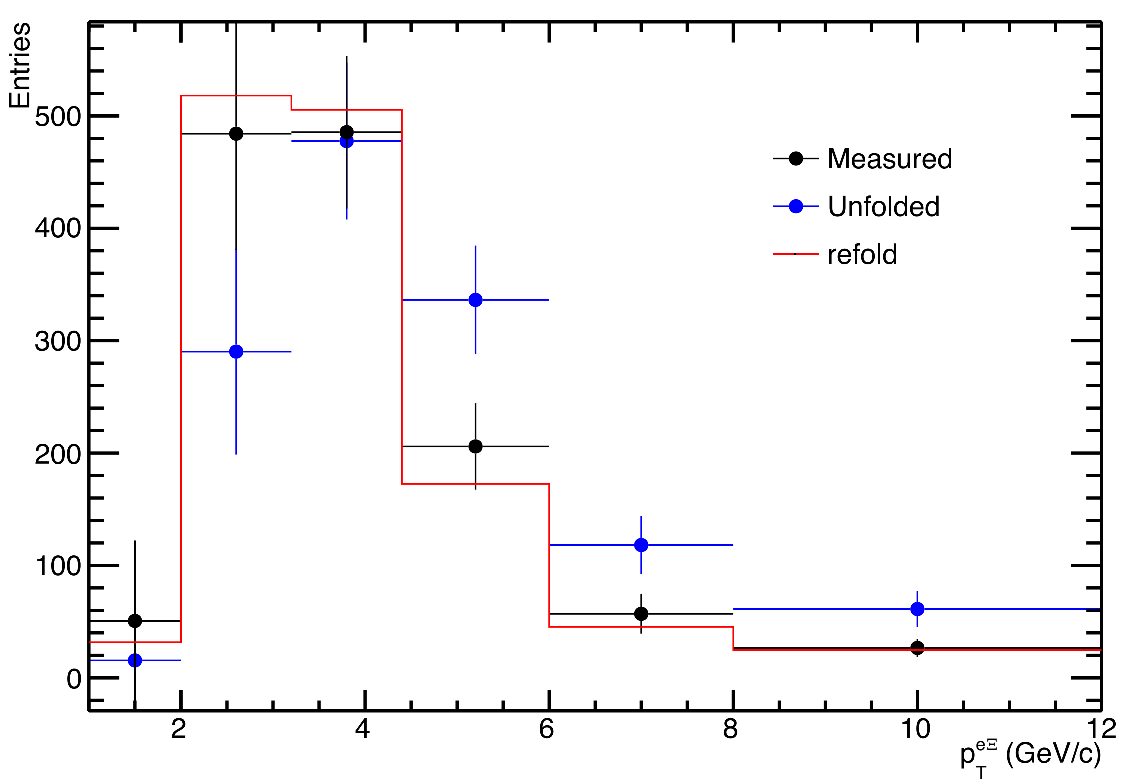
Yield comparison

- Unfolding

- The transverse momentum distribution of eΞ pairs is corrected for the missing momentum of the neutrino using unfolding techniques.
- The response matrix are prepared in two steps
  1) The response matrix is obtained using the Ξ^0_c p_T distribution generated with MC.
  2) The resulting Ξ^0_c p_T distribution with weighting is used to produce the response matrix for the second iteration.
- The unfolding is performed with the RooUnfold implementation of the Bayesian unfolding technique with 3 iterations.
- Refolding procedure is proceed to check the unfolding stability.



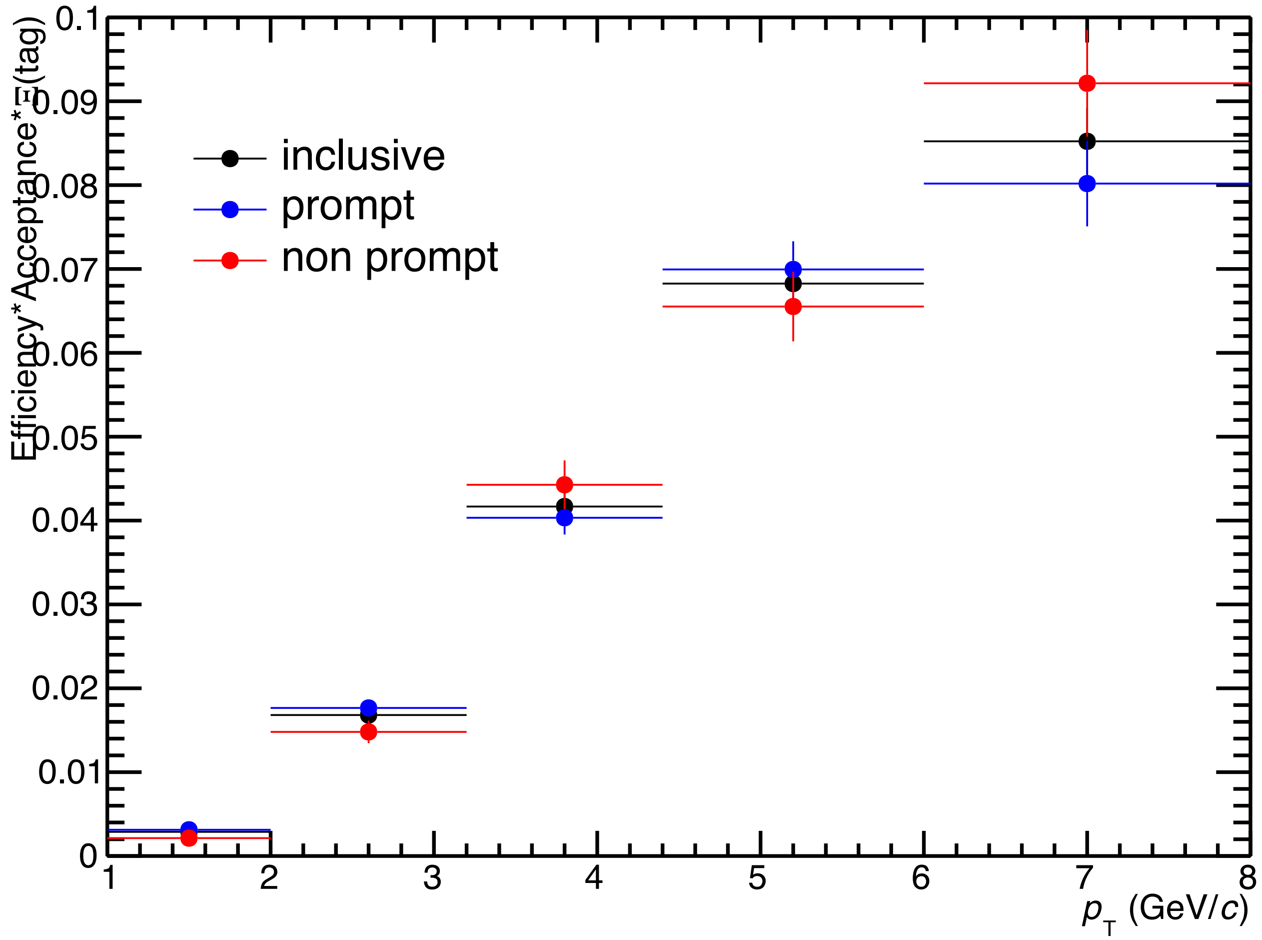
Weighted response matrix



unfolded spectrum

- Efficiency correction

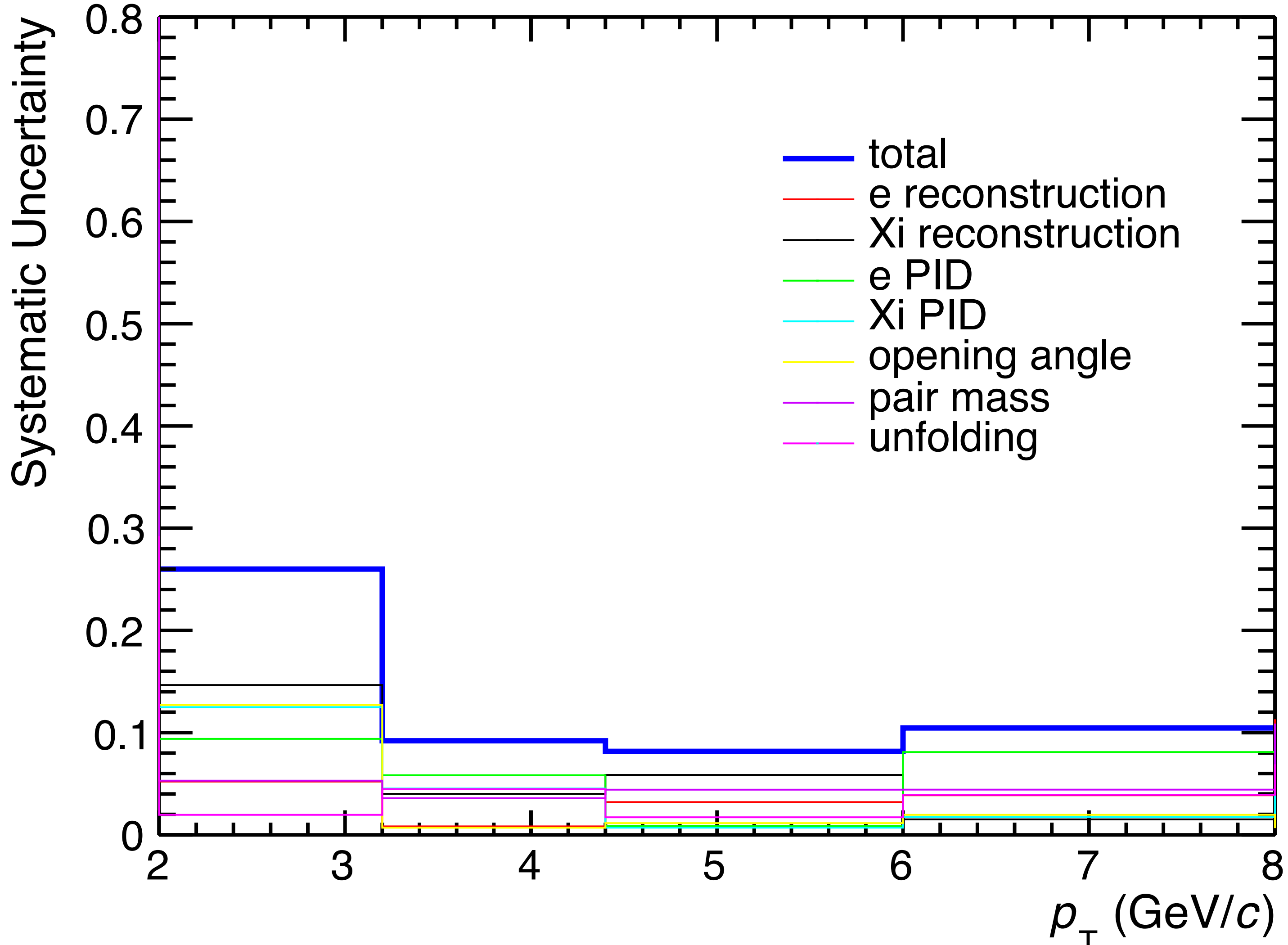
- The efficiency ε_{total} is calculated as $Acc * \epsilon * \epsilon_{\Xi tag} = \left.\frac{N_{\Xi_c^0}(MC, Reco)}{N_{\Xi_c^0}(MC, Gen)}\right|_{|y|<0.5}$
- To obtain the corrected spectra from the raw counts, the acceptance and efficiency correction factors as a function of pt have to be computed.
- At 13TeV, inclusive, prompt and non prompt total selection efficiency have tiny difference which occurred by decay length of Λ.



Total efficiency at 13 TeV

- Systematic uncertainties

- The systematic uncertainties are estimated by repeating the analysis with different selection criteria for electrons, Ξ^- and $e^+\Xi^-$ pairs and number of iteration for unfolding by comparing the corrected yields.
- The RMS of the deviations of the cross section is assigned as uncertainties.
- The uncertainty is summed in quadrature, resulting in a systematic uncertainty on the ($A \times \varepsilon$) correction factor ranging from 8% to 26% depending on p_T.



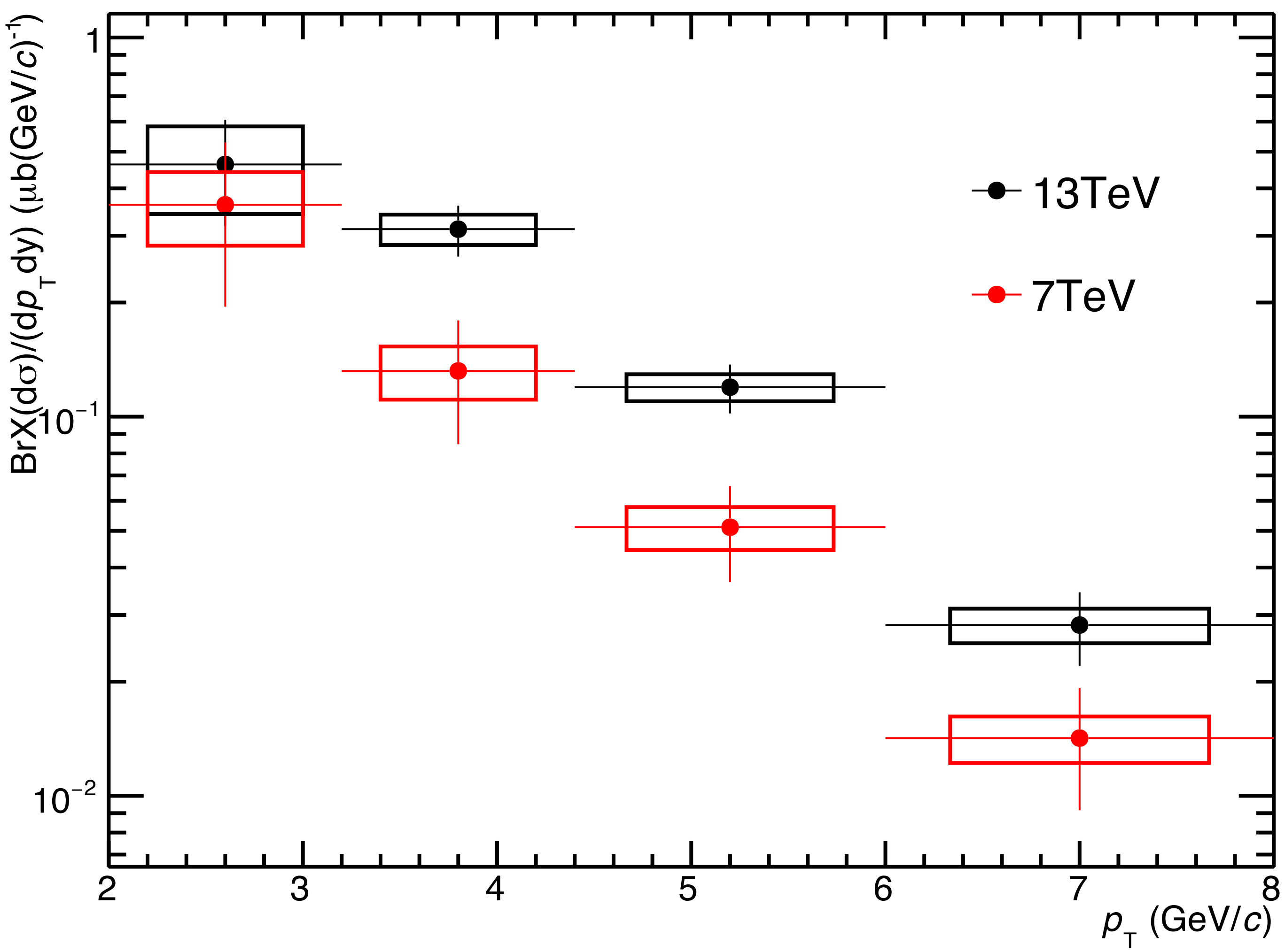
Systematic uncertainties

- Differential cross section

- The p_T differential cross sections of Ξ^0_c is calculated as

$$Br\frac{d\sigma^{\Xi^0_c}}{dp_{\mathrm{T}}dy} = \frac{N^{raw}_{\Xi^0_c}}{2 \cdot \Delta p_{\mathrm{T}} \Delta y \cdot (Acc \times \epsilon \times \epsilon_{\Xi_{tag}}) \cdot L_{int}}$$

- The p_T distribution of the Ξ^0_c baryon for $|y| < 0.5$, corrected for the efficiency and acceptance.
- The spectrum is not corrected for the branching ratio of $\Xi^0_c \rightarrow e\Xi\nu$ and not the feeddown from Ξ_b.



Differential cross section 7 TeV and 13 TeV

Summary and Plan

- Summary

- Xic0 production is being studied via semi-leptonic decay in pp collision at 13 TeV.
- Electrons and Ξ^{-} candidates are selected using PID cut information.
- Background electrons are removed using electron pair mass information.
- The electron loss caused by the misidentification of photonic electrons is confirmed via cut efficiency.
- The eΞ pair subtraction method is used to remove the background and get raw yield.
- The unfolding is used to corrected missing momentum of neutrino.
- Because p_{T} distributions of the MC Ξ^{0}_{c} and real data are different, weighting procedure is performed.
- The systematic uncertainties are assigned with different selection criteria.

- Plan

- Further systematic study will be done such as variations of unfolding method and weighting factor effect.
- All of 13 TeV data will be included.

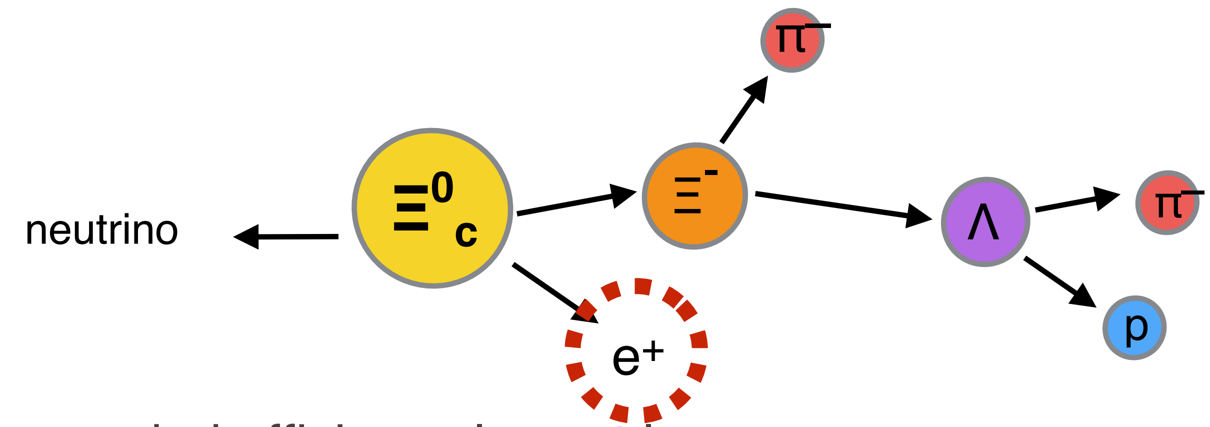
- ALICE service work

- I participated the ITS commissioning shift once a month, and reception test.

Thank you

Back up

Select electrons



- Select electrons

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- The applied cut achieves the electron purity of more than 98%.