Strangeness production in jets and underlying events in pp collisions at $\sqrt{s}$ =13 TeV with ALICE

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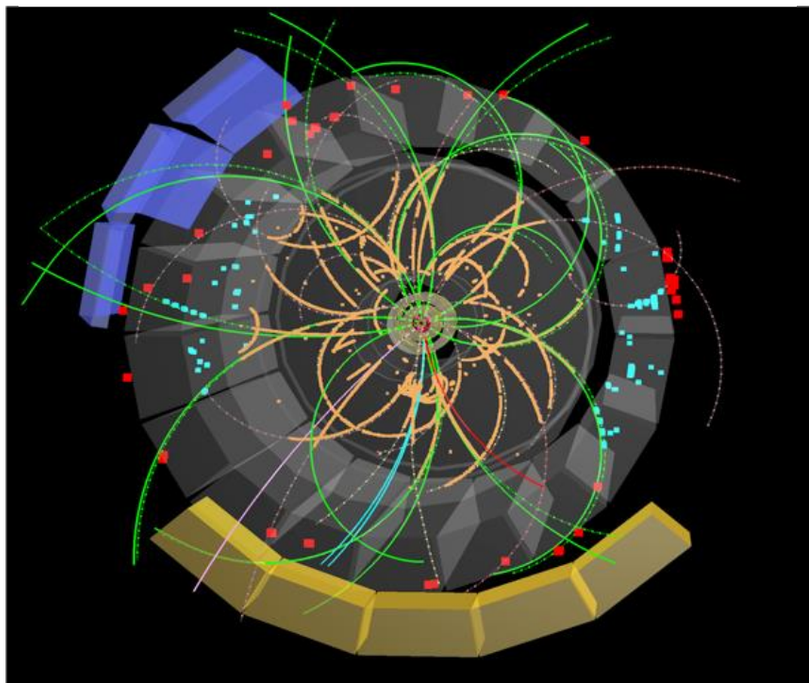
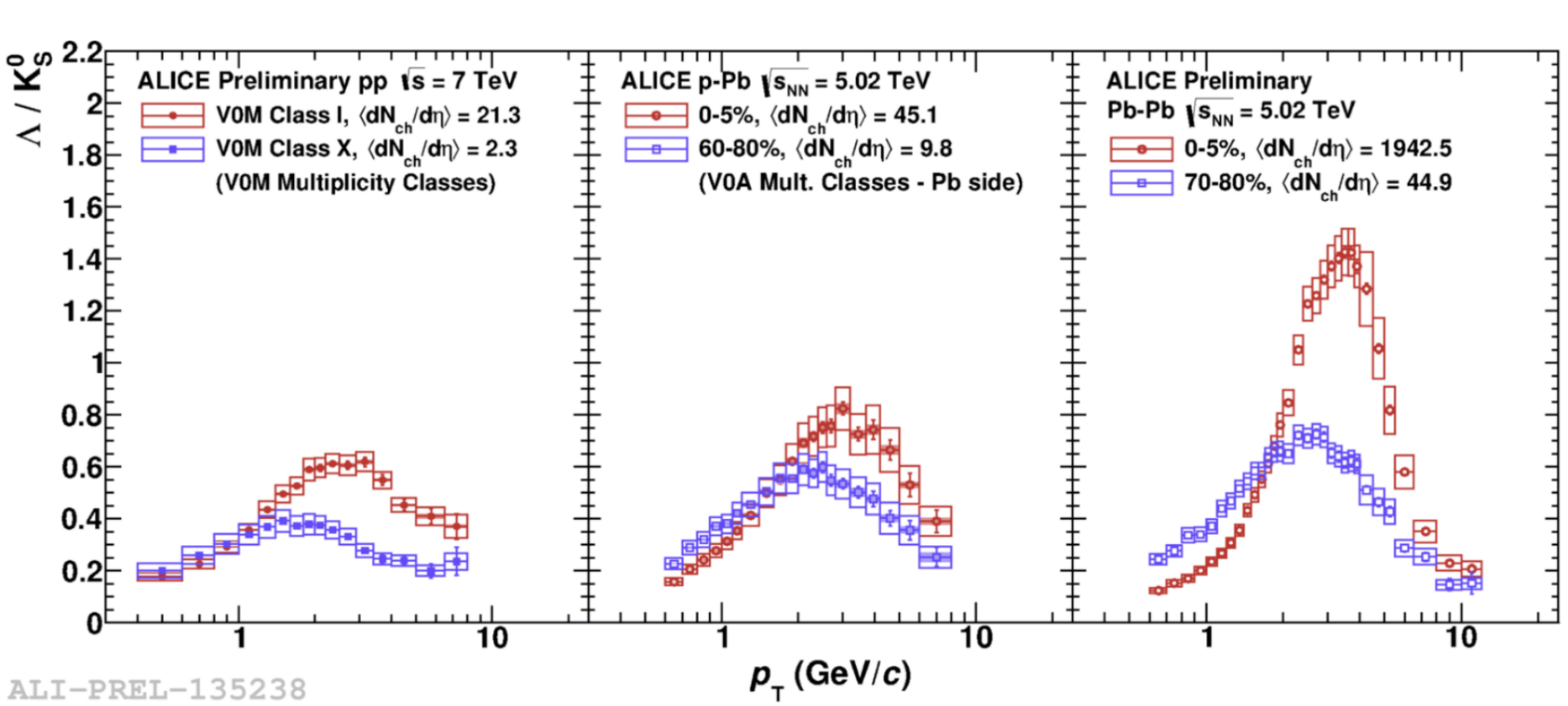
Outline

- Motivation
- ALICE setup and data sample
- Analysis strategy
- Results and discussion
- Summary

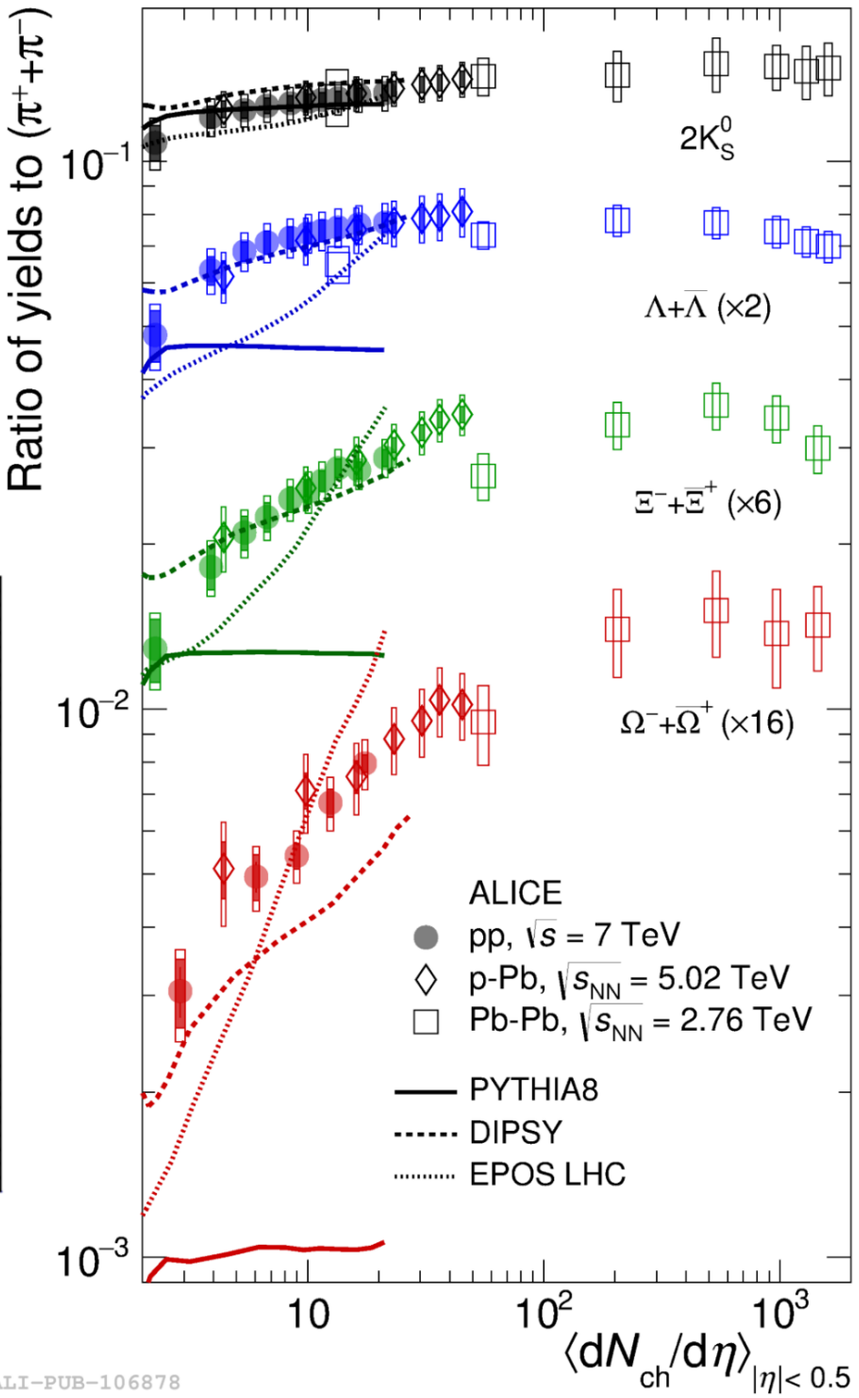


Motivation

- Enhancement of Λ/K^0_S ratio observed at intermediate p_T at high multiplicity in pp, p-Pb and Pb-Pb collisions w. r. t that at low multiplicity
- Production of (multi)-strange particles increases with multiplicity
  - ➢ Similar behavior among different systems



Nature Phys. 13 (2017) 535-539



Motivation

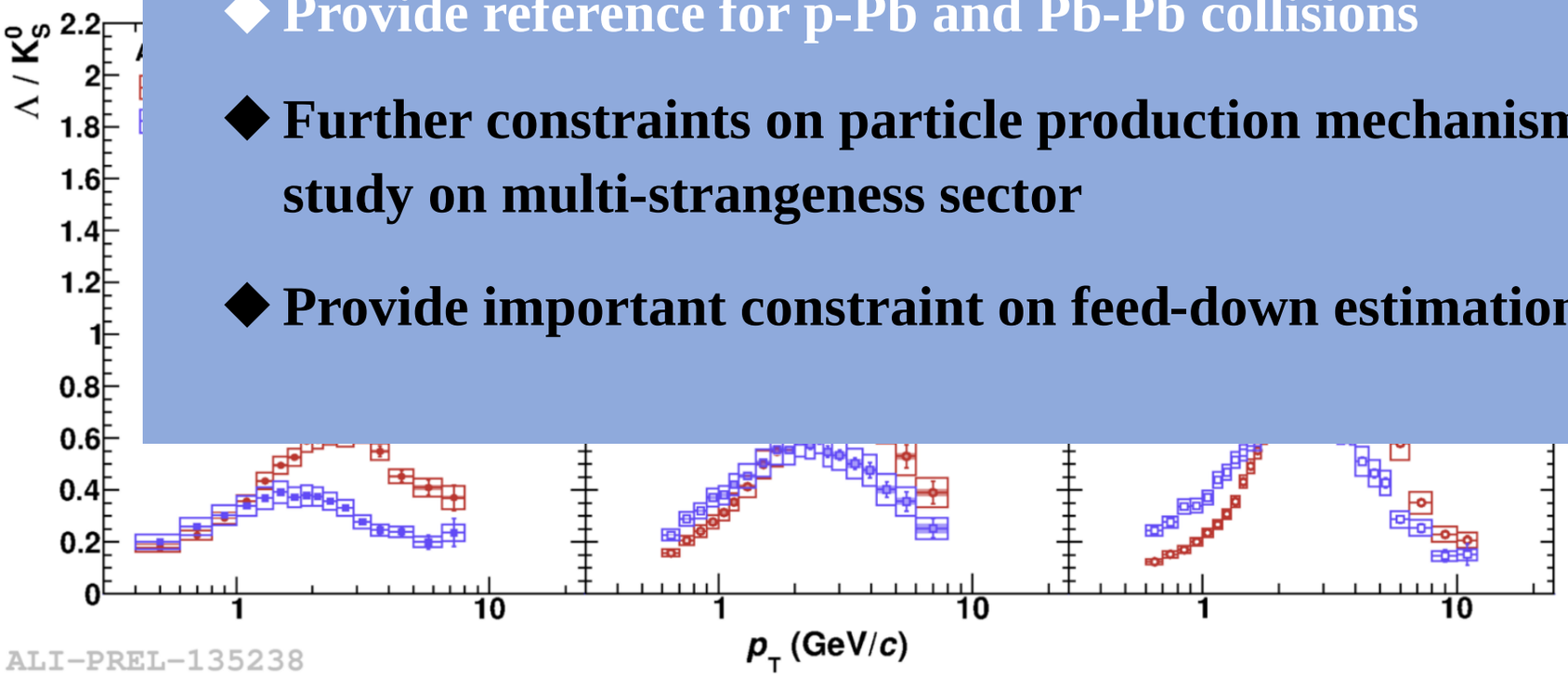
- Enhancement of Λ/K^0_S ratio observed at intermediate p_T at high multiplicity in pp, p-Pb and Pb-Pb collisions w. r. t that at low multiplicity

- Pr

  ➢

Study of (multi-)strangeness production in jets

- ◆ **Study jet fragmentation properties in vacuum**
- ◆ **Provide reference for p-Pb and Pb-Pb collisions**
- ◆ **Further constraints on particle production mechanisms in jets by extending the study on multi-strangeness sector**
- ◆ **Provide important constraint on feed-down estimation of $\Lambda(\bar{\Lambda})$ in jets**



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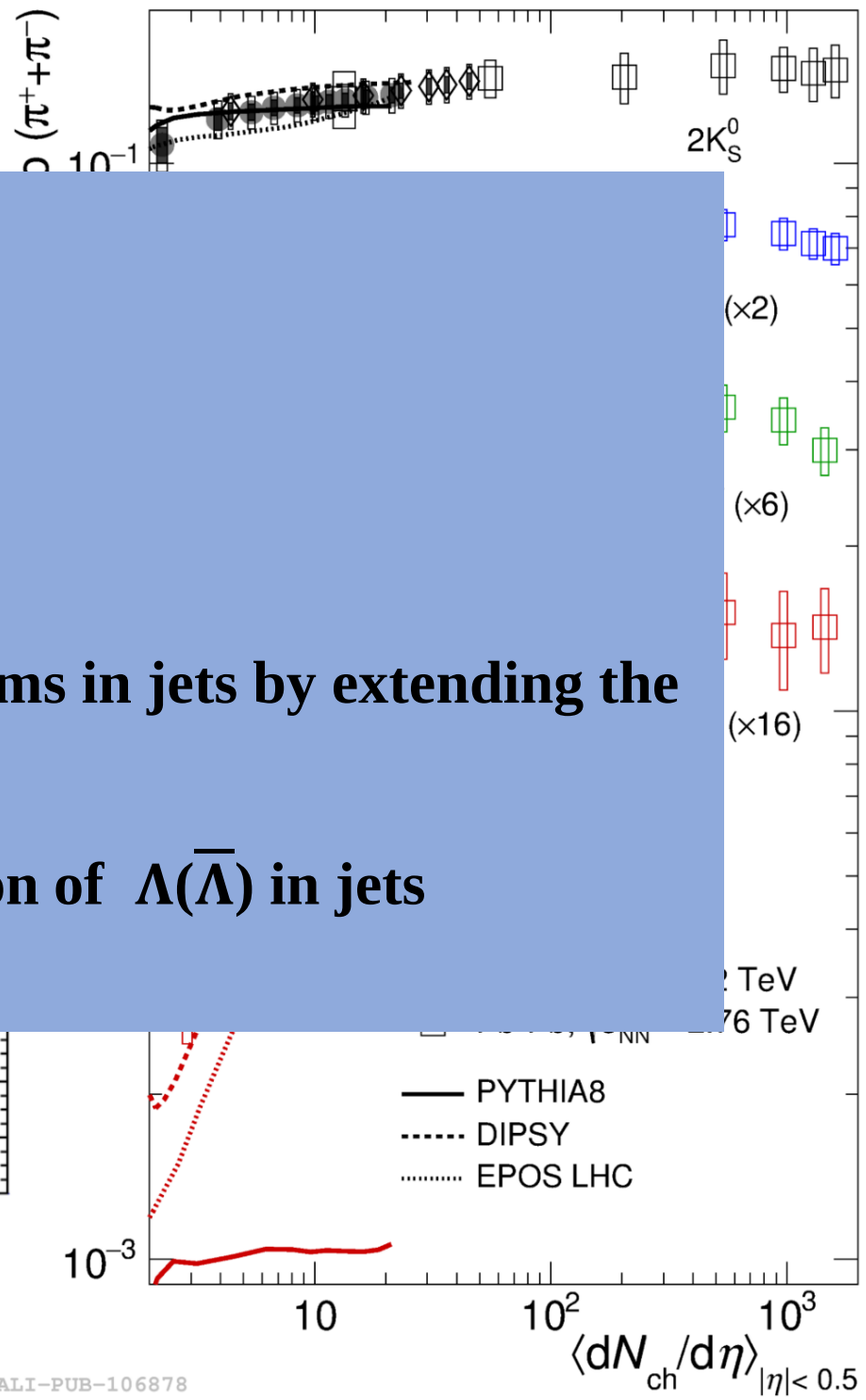
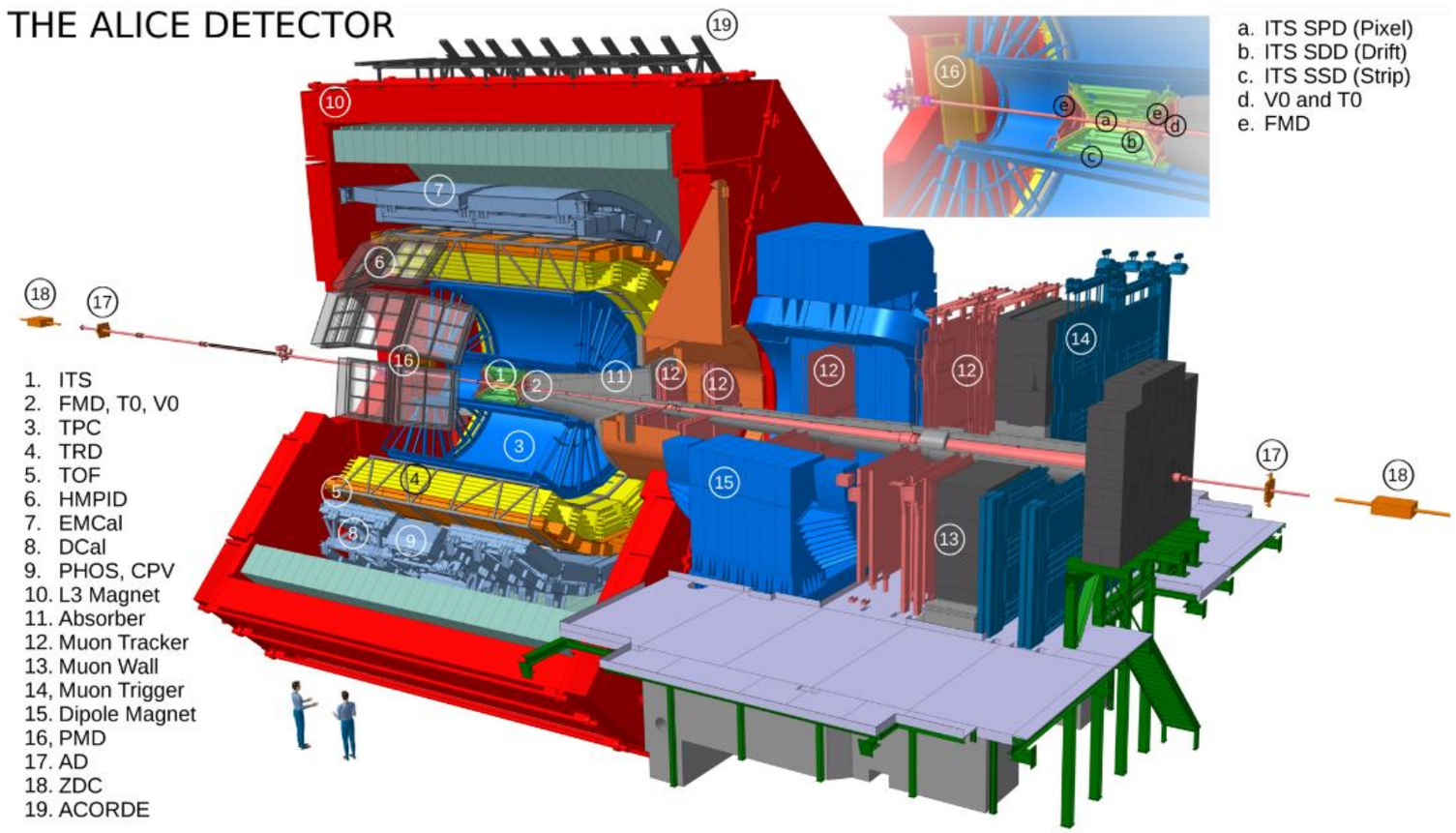


ALICE setup and data sample



- **TPC (Time Projection Chamber)**
  - $|\eta|<0.9$
  - Charged particle reconstruction and identification
- **ITS (Inner Tracking System)**
  - $|\eta|<0.9$
  - Vertex reconstruction
  - Event trigger

- **Data samples**
  - pp collisions at $\sqrt{s}$ =13 TeV with 260 million MB events collected in 2016

- **Strangeness reconstruction**
  - $K_S^0 \rightarrow \pi^+ + \pi^-$ (BR 69.2%)
  - $\Lambda \rightarrow p + \pi^-$ (BR 63.9%)
  - $\Xi^- \rightarrow \Lambda + \pi^- \rightarrow p + \pi^- + \pi^-$ (BR 63.9%)

Analysis strategy

- **Tag hard scatterings with charged particle jets ($p_{\mathrm{T}}^{\mathrm{jet}}$> 10 GeV/$c$)**

- **Jet reconstruction**
  - Charged track selection: $|\eta| < 0.9,\ p_{\mathrm{T}} > 0.15$ GeV/c
  - Jet finder: anti-k_{T}, $R = 0.4$, $|\eta_{\mathrm{jet}}| < 0.35$

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- **Signal: reconstructed V^{0}s (Λ and $\mathrm{K}_{\mathrm{S}}^0$) and Ξ in the "jet region"**
  - $\boldsymbol{R}(\mathrm{V}^0/\Xi, \mathrm{jet}) < \boldsymbol{R}_{\mathrm{match}}$

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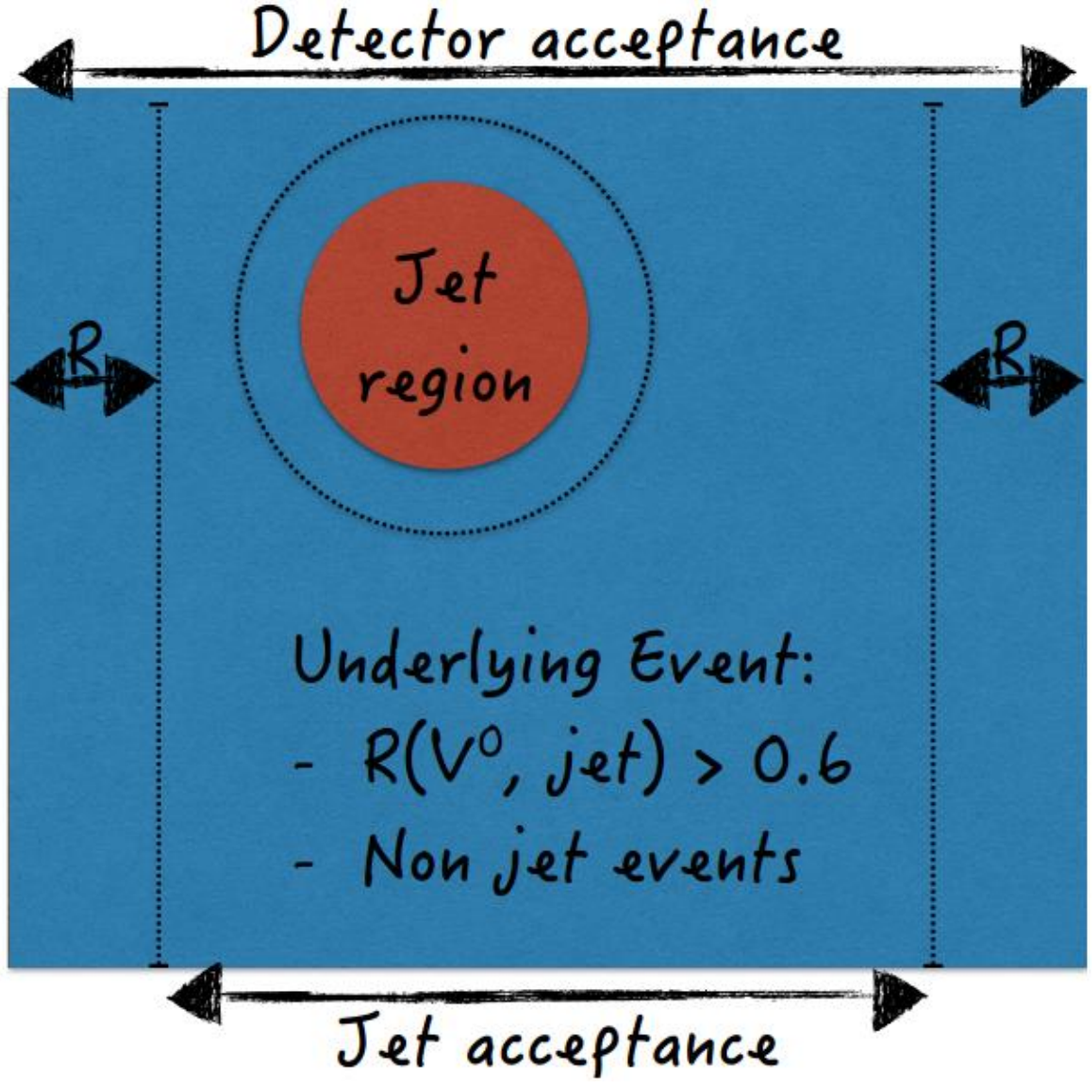

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  - ➢ $\boldsymbol{R}(\mathrm{V}^0/\Xi, \mathrm{jet}) < \boldsymbol{R}_{\mathrm{match}}$
- **UE background: reconstructed V^0s and Ξ in the UE region**
  - ➢ **PC:** cones in perpendicular direction of jet axis
  - ➢ **OC:** outside the jet cone
  - ➢ **NJ :** events without jet with p_{T} larger than a given threshold

JE = JC - UE

- **Jet reconstruction**
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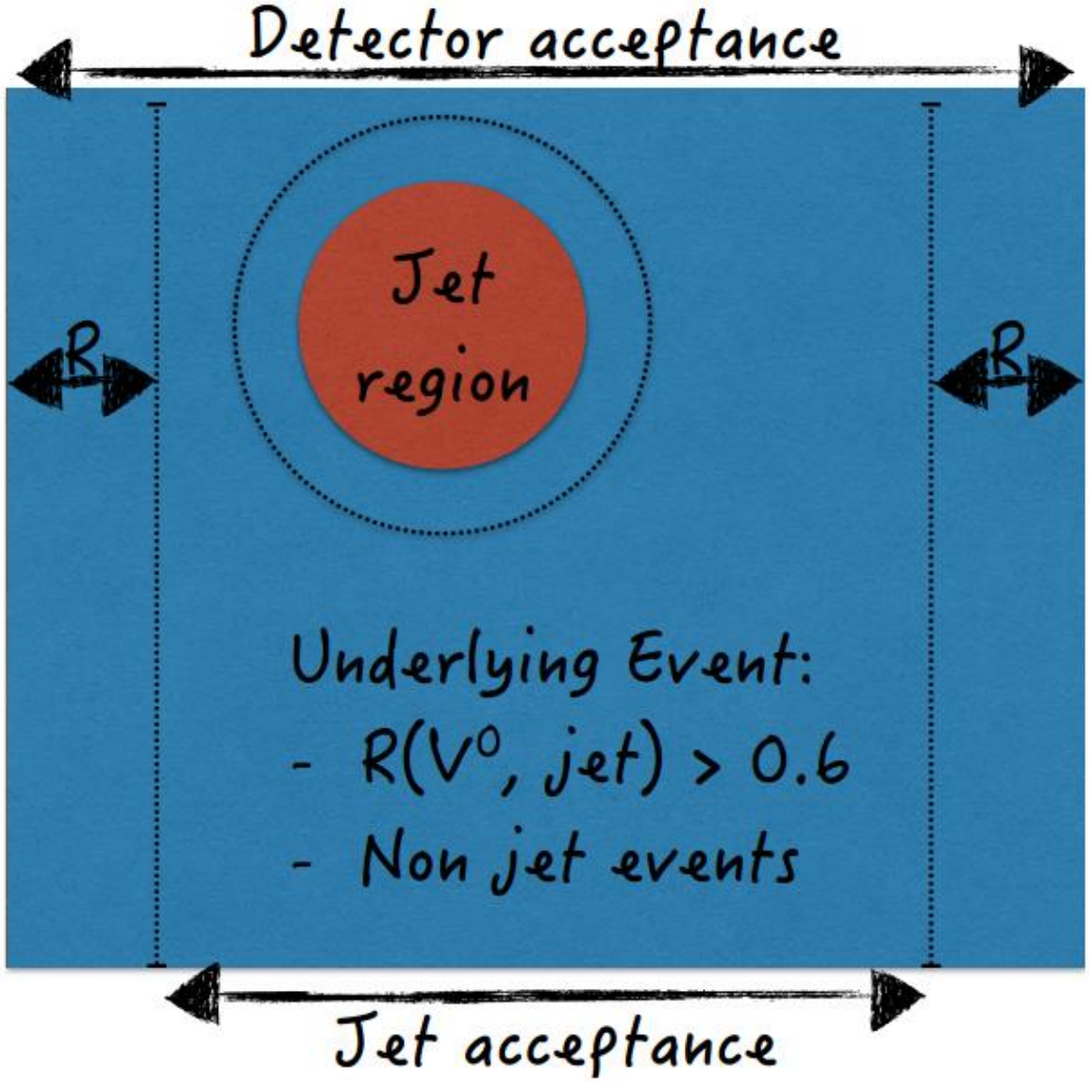


Analysis strategy

- **Tag hard scatterings with charged particle jets ($p_{\mathrm{T}}^{\mathrm{jet}}$> 10 GeV/$c$)**

- **Signal: reconstructed V^0s (Λ and $\mathrm{K}_{\mathrm{S}}^0$) and Ξ in the "jet region"**
  - $\boldsymbol{R}(\mathrm{V}^0/\Xi, \mathrm{jet}) < \boldsymbol{R}_{\mathrm{match}}$

- **UE background: reconstructed V^0s and Ξ in the UE region**
  - **PC:** cones in perpendicular direction of jet axis
  - **OC:** outside the jet cone
  - **NJ :** events without jet with p_{T} larger than a given threshold

JE = JC - UE

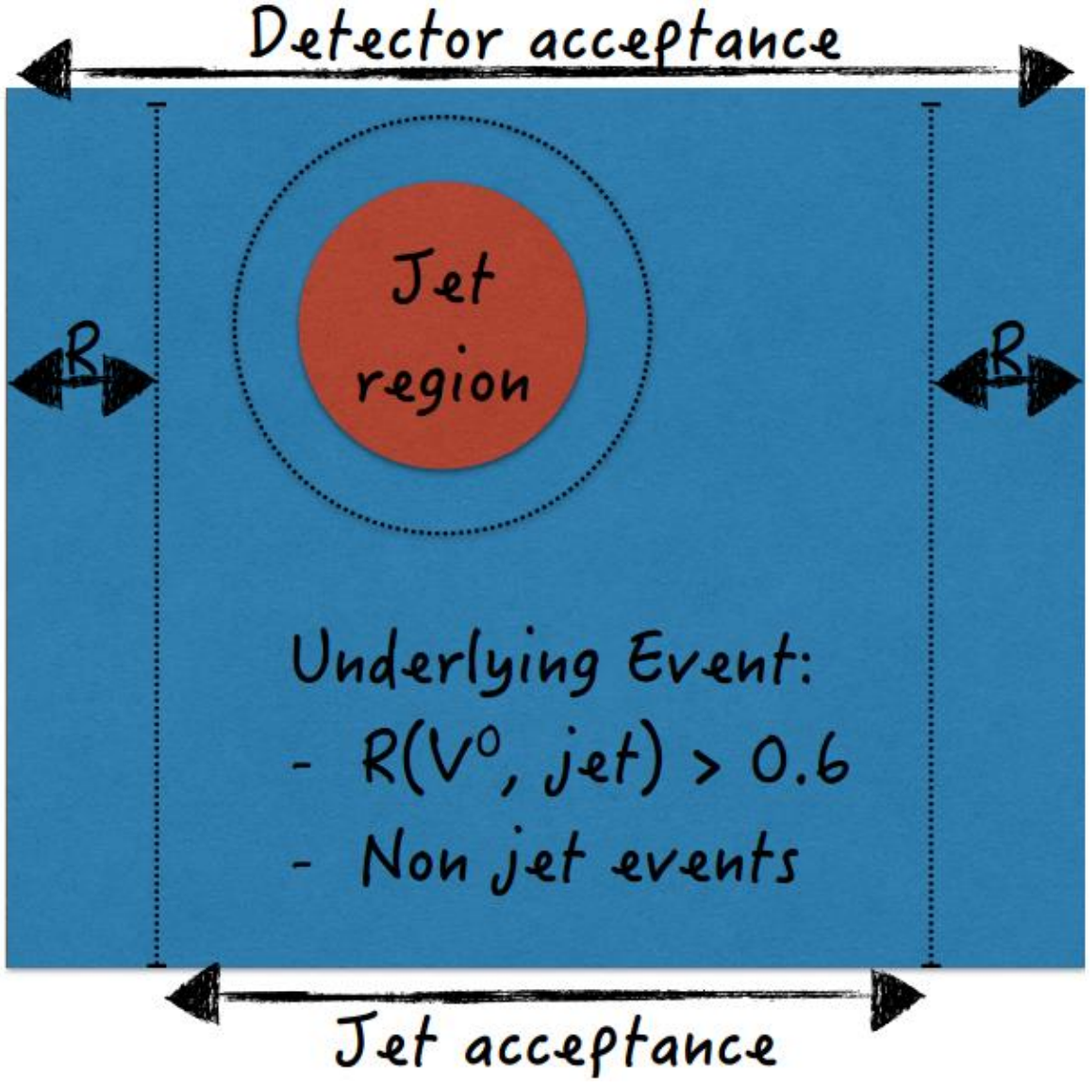
- **Normalization**

$$\frac{d\rho}{dp_{\mathrm{T}}} = \frac{1}{N_{ev}} \times \frac{1}{< \textbf{Area} >} \times dN/dp_{\mathrm{T}}$$

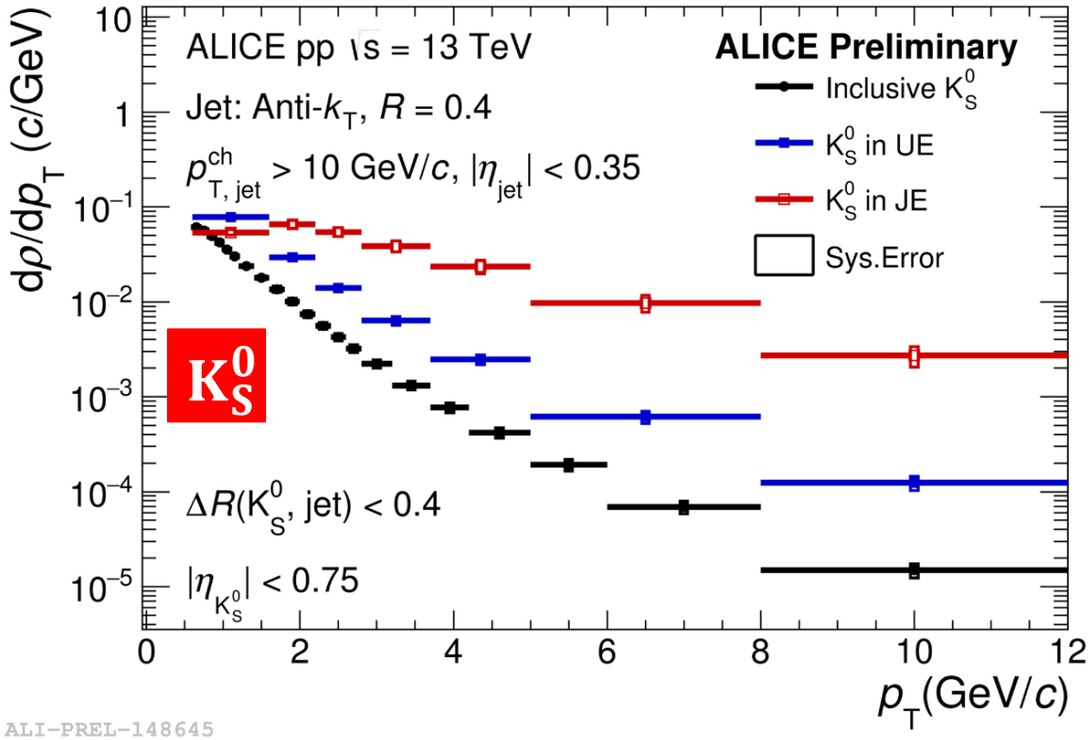
- **Efficiency correction**

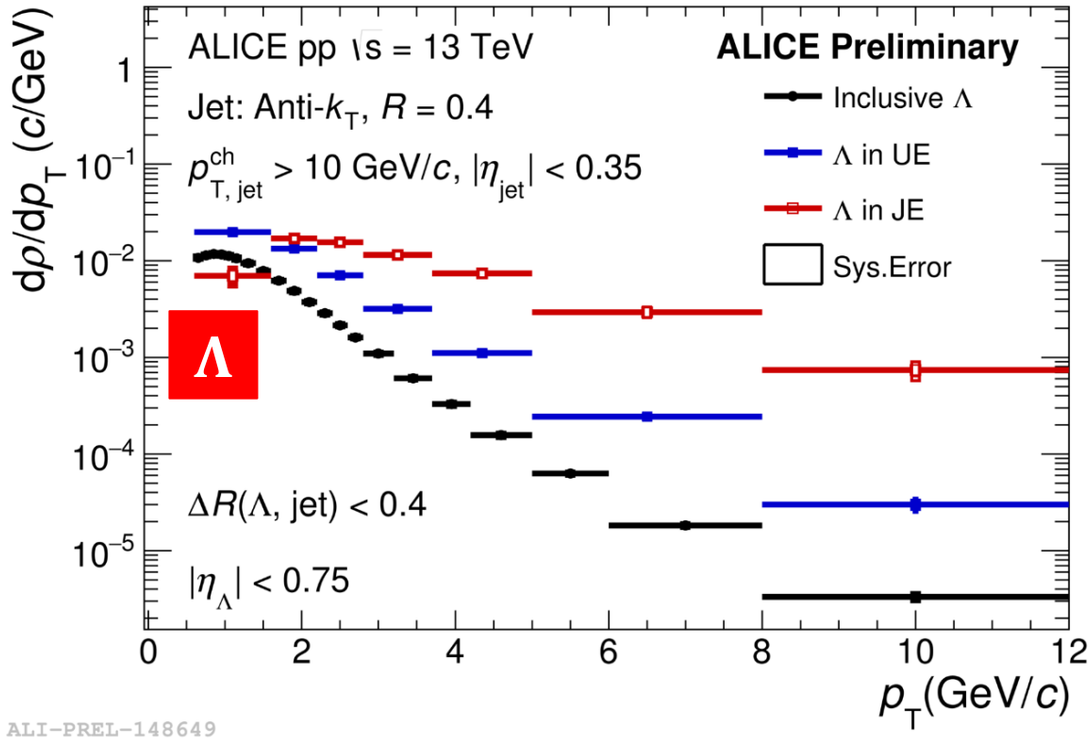
- **Feed-down correction (for $\Lambda(\bar{\Lambda})$)**

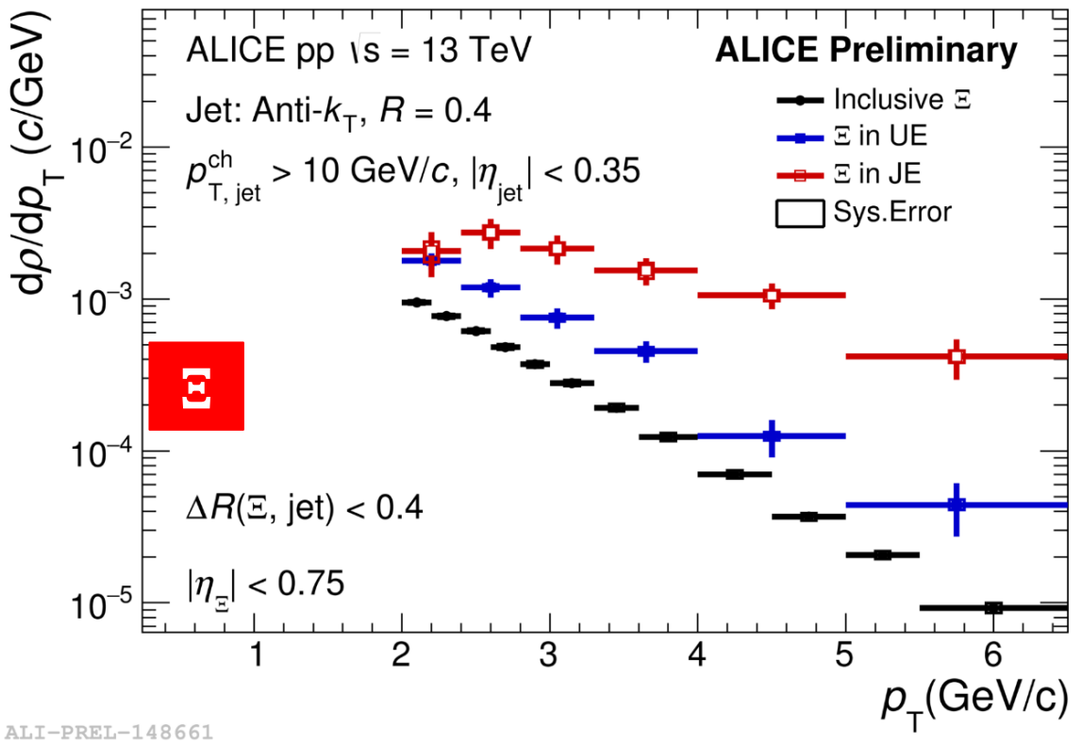
- **Jet reconstruction**
  - Charged track selection: $|\eta| < 0.9$, $p_{\mathrm{T}} > 0.15$ GeV/c
  - Jet finder: anti-k_{T}, $R = 0.4$, $|\eta_{\mathrm{jet}}| < 0.35$



Production of strangeness



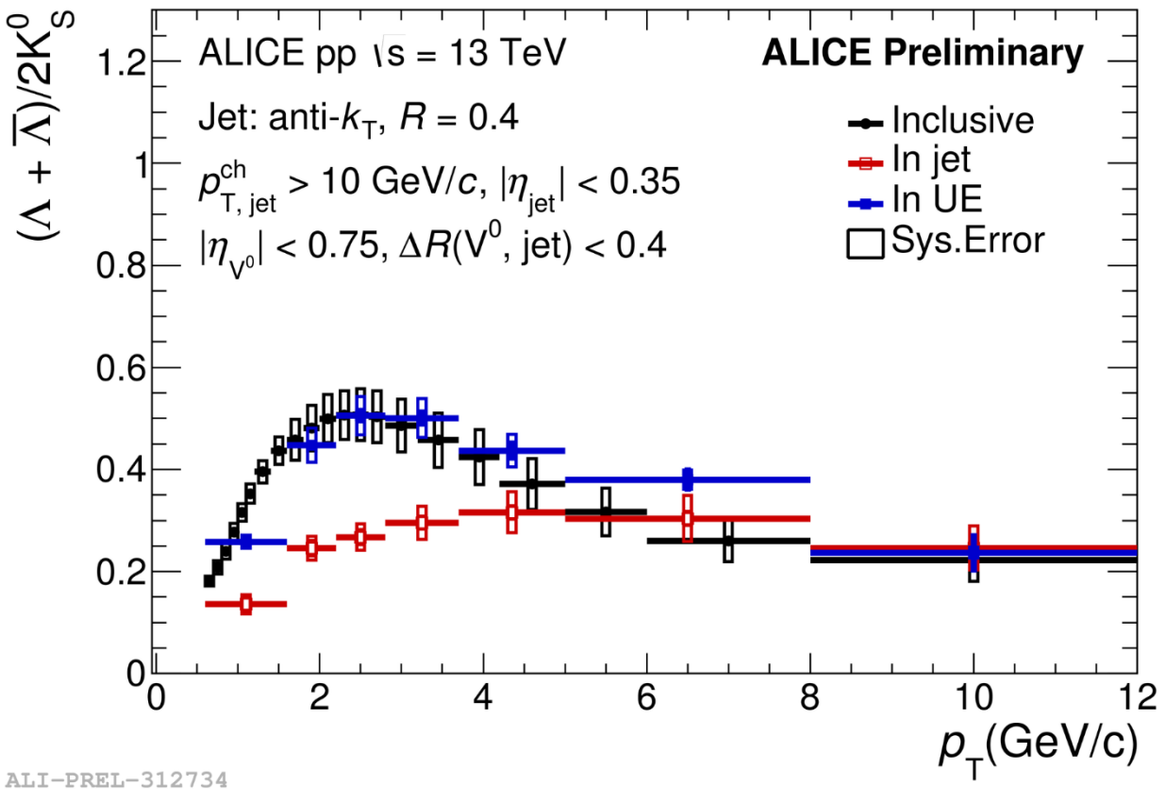




$$\frac{d\rho}{dp_T} = \frac{1}{N_{ev}} \times \frac{1}{< \text{Area} >} \times dN/dp_T$$

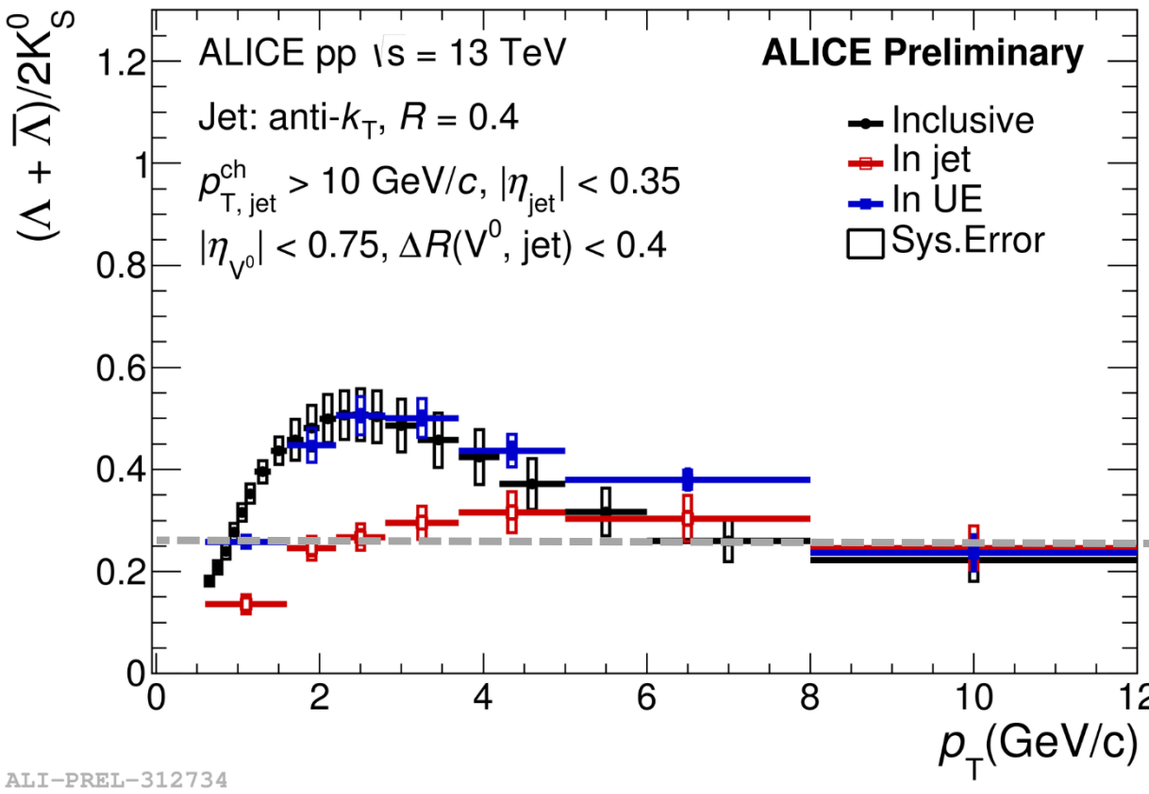
- The p_T spectra of strange hadrons in jets (**JE**) is harder than in the underlying event (**UE**)
- UE distributions is harder than in inclusive - bias in events with the presence of jets

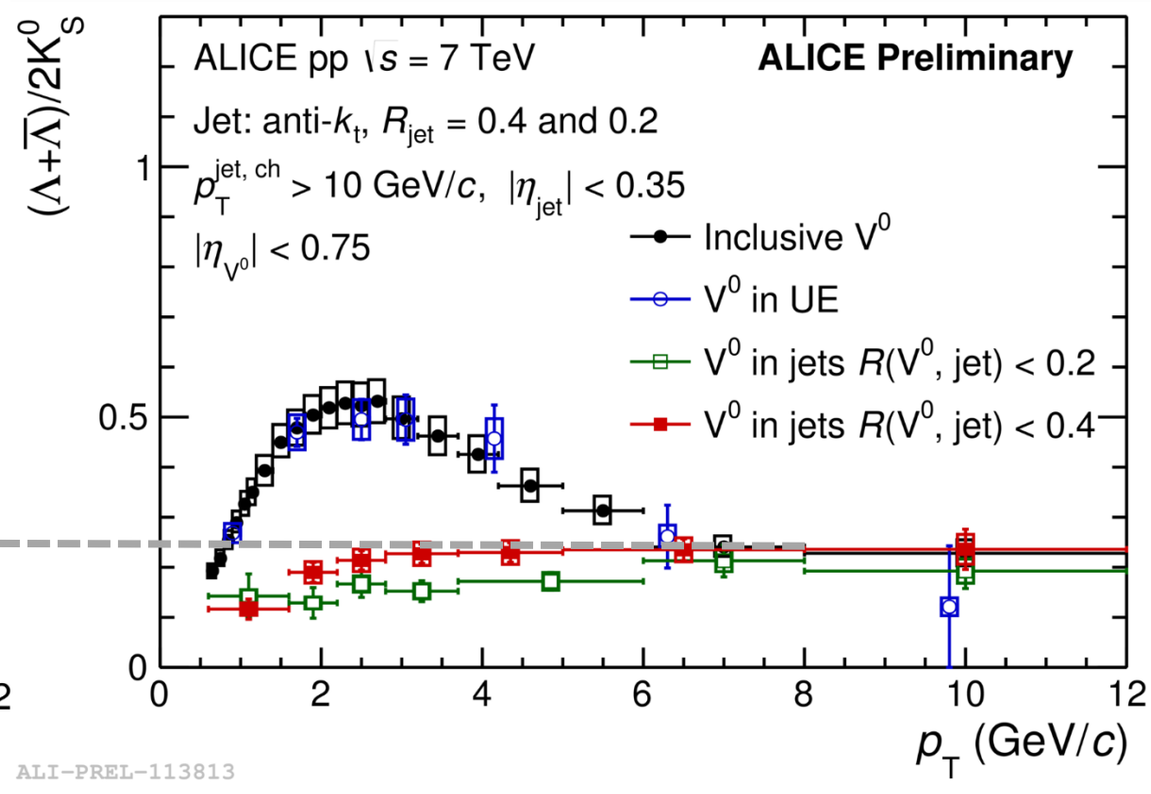
Λ/K^0_S ratio



- The Λ/K^0_S in UE is consistent with the ratio of inclusive V^0s
- The ratio in jets is clearly different with the ratio of inclusive V^0s at low and intermediate p_T

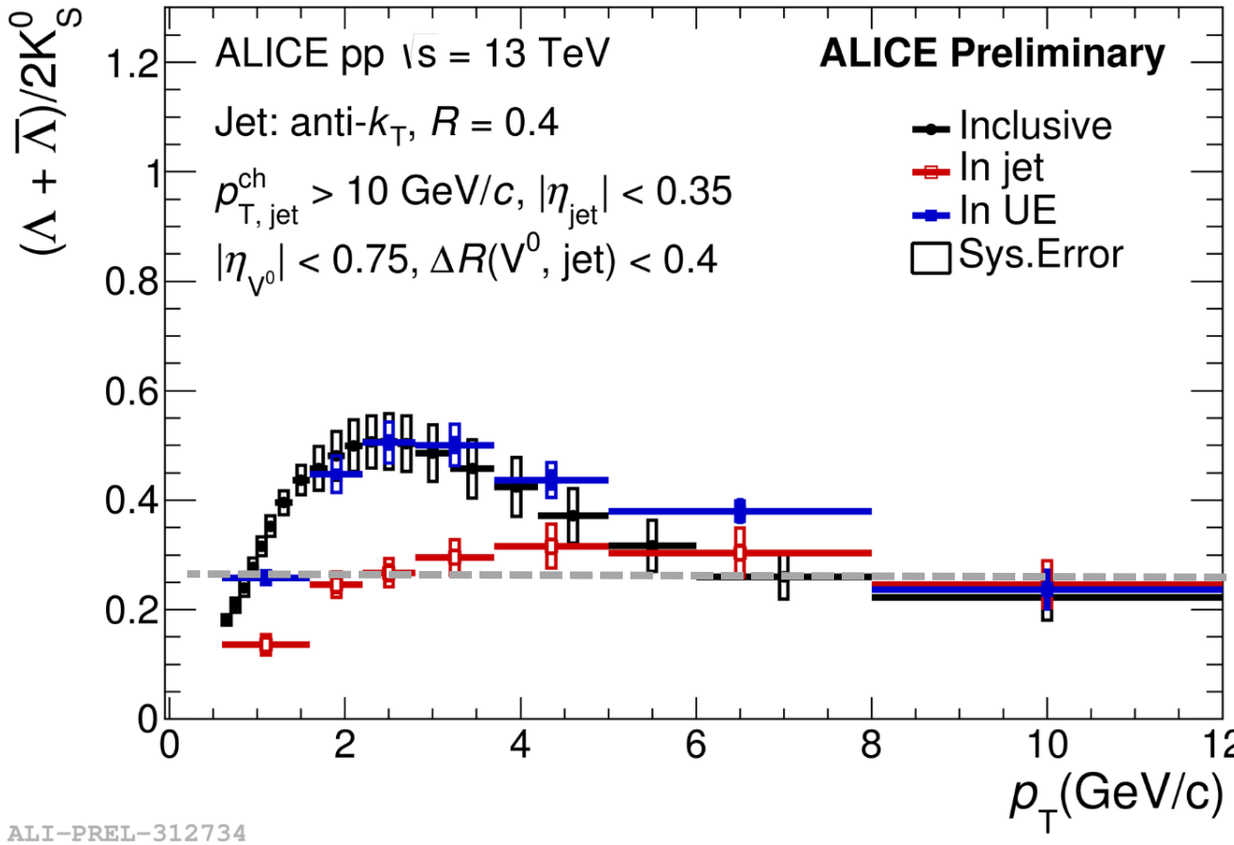
Compare to 7 TeV

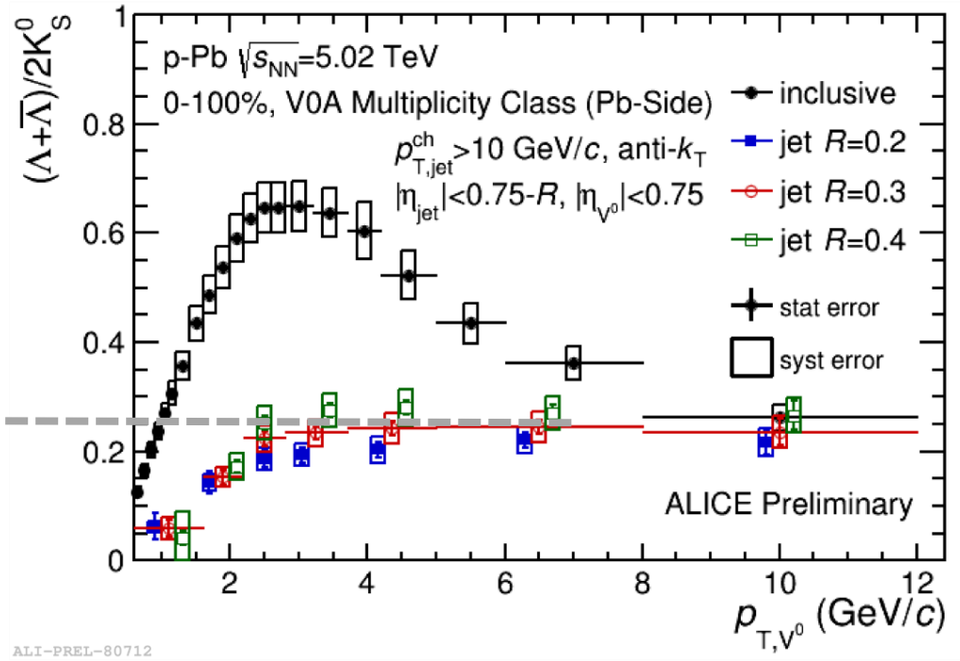




- The Λ/K^0_S in UE is consistent with the ratio of inclusive V^0s
- The ratio in jets is clearly different with the ratio of inclusive V^0s at low and intermediate p_T
- Results at $\sqrt{s}$ = 7 TeV are consistent with that at $\sqrt{s}$ = 13 TeV within uncertainties
- Measurements at $\sqrt{s}$ = 7 TeV: a hint of R_{jet} (V^0, jet) dependence
  - ➢ Caveat: the potential residual UE background effect (?)

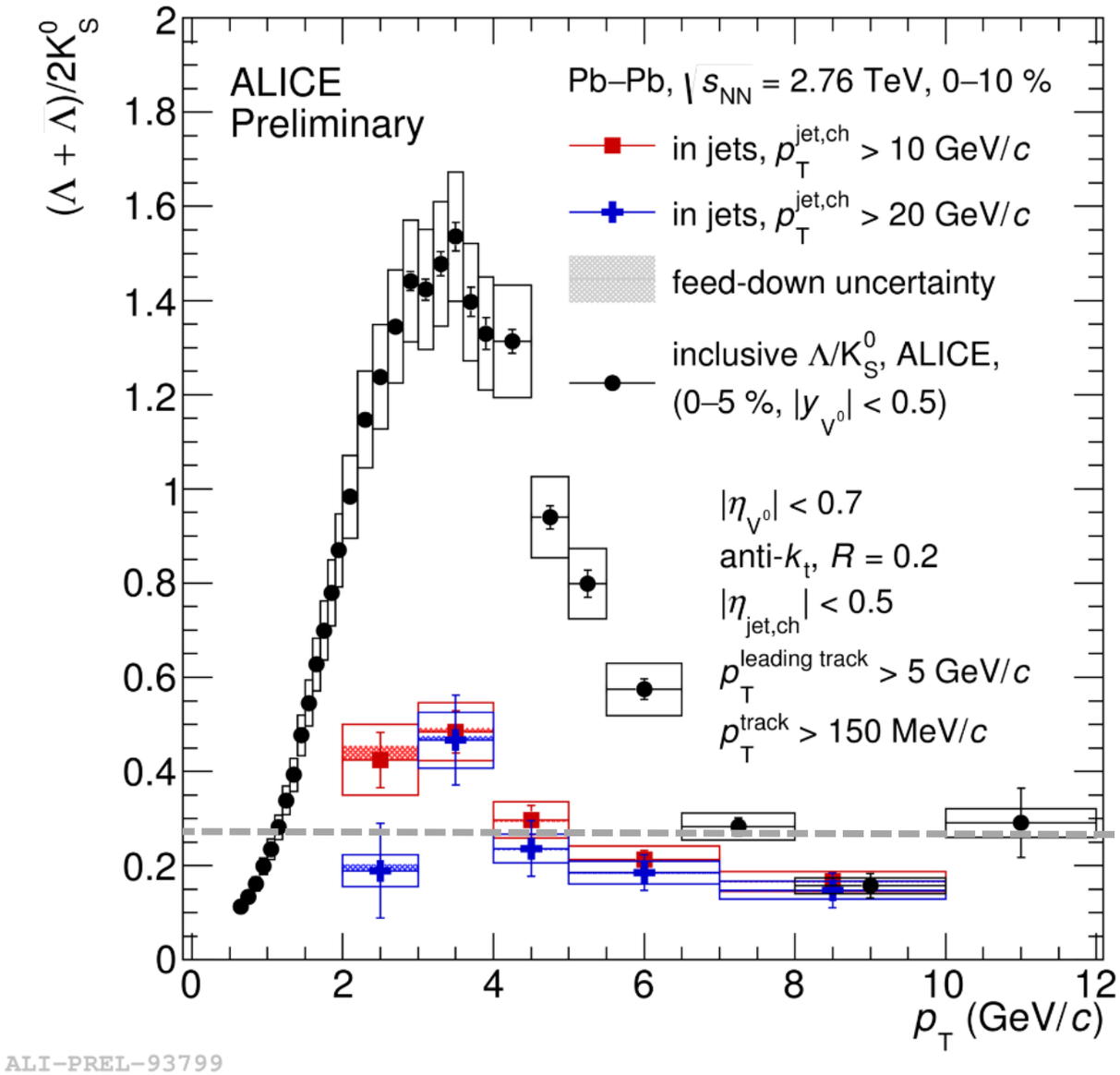
Compare to p-Pb system

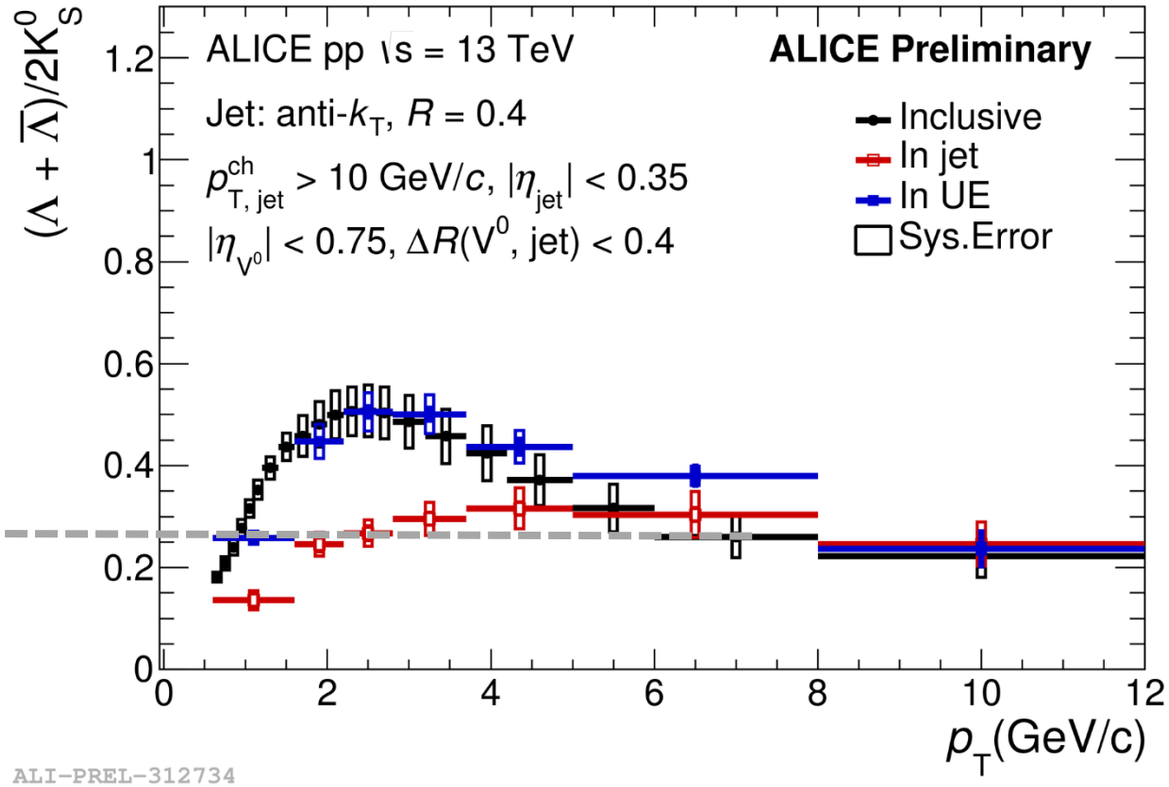




- The Λ/K^0_S in UE is consistent with the inclusive ratio
- The ratio in jets is clearly different from the inclusive ratio at low and intermediate p_T
- Results at $\sqrt{s}$ = 7 TeV are consistent with that at $\sqrt{s}$ = 13 TeV within uncertainties
- Measurements at $\sqrt{s}$ = 7 TeV: a hint of R_{jet} (V^0, jet) dependence
- The Λ/K^0_S in JE in pp consistent with p-Pb within uncertainties

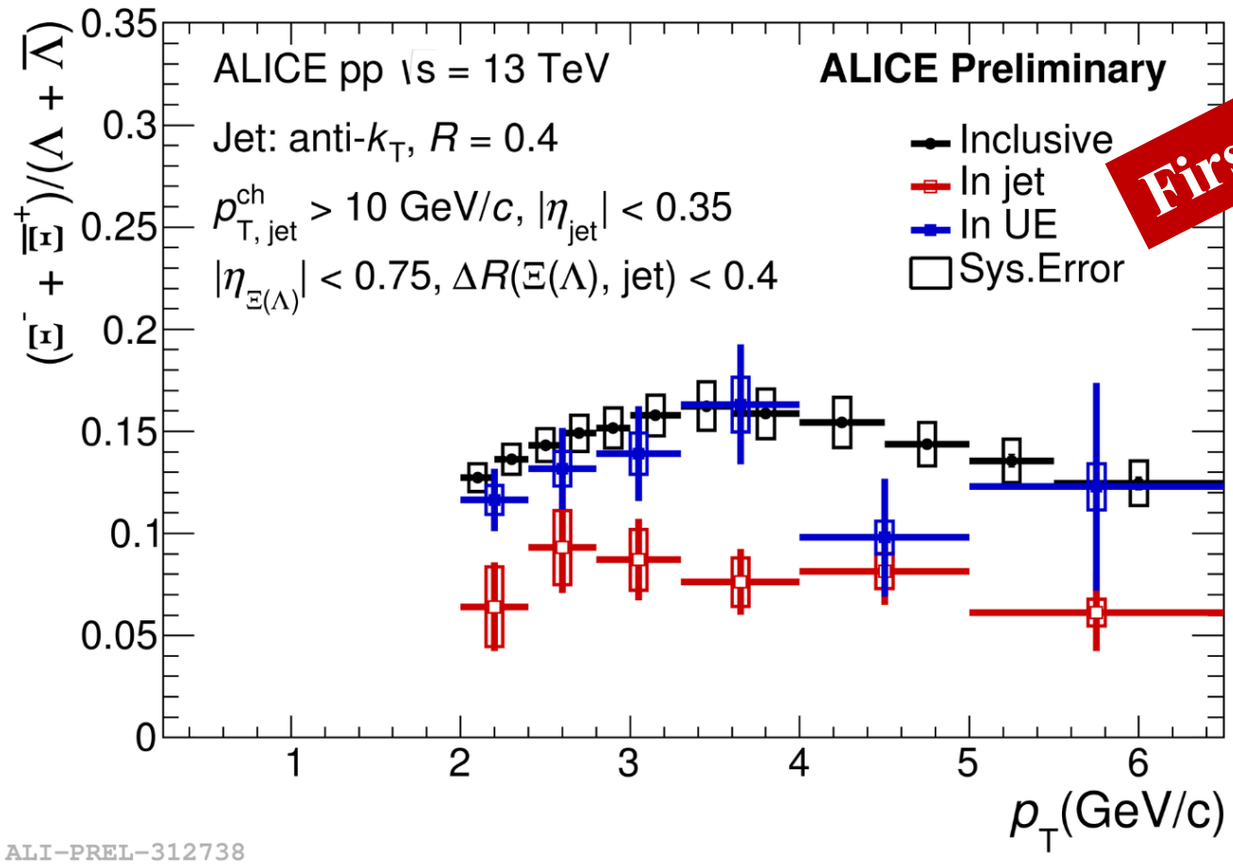
Compare to Pb-Pb system





- The ratio in jets in Pb-Pb collisions is compatible within combined systematic and statistic errors with that in pp collisions

Ξ/Λ ratio



First Measurement

- Exploration of production mechanisms in jets and UE with multi-strange particles
- Ξ/Λ is almost p_T independent in JE

Summary

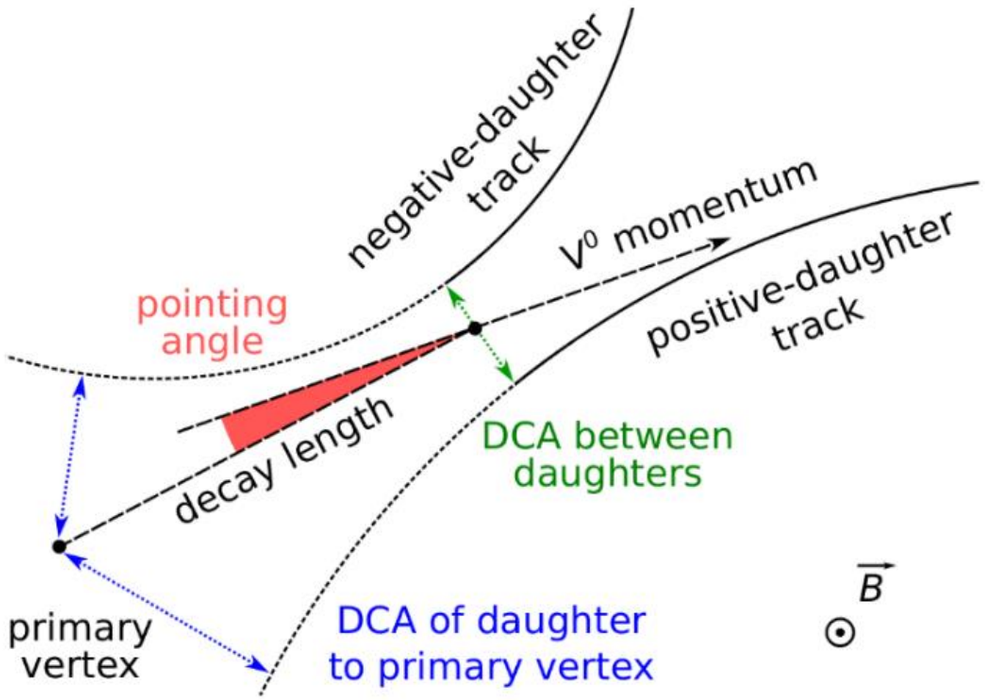
- Production of V^0s (K^0_S and Λ) and Ξ has been investigated in jets and the UE in pp collisions at $\sqrt{s}$ =13 TeV
- Λ/K^0_S ratio enhancement is not present when the particles are within an energetic jet in pp, p-Pb and Pb-Pb collision systems
- The Ξ/Λ has been investigated, at the first time, in jet and the UE in pp collisions with ALICE
- Provide a new constrain on Ξ production mechanism

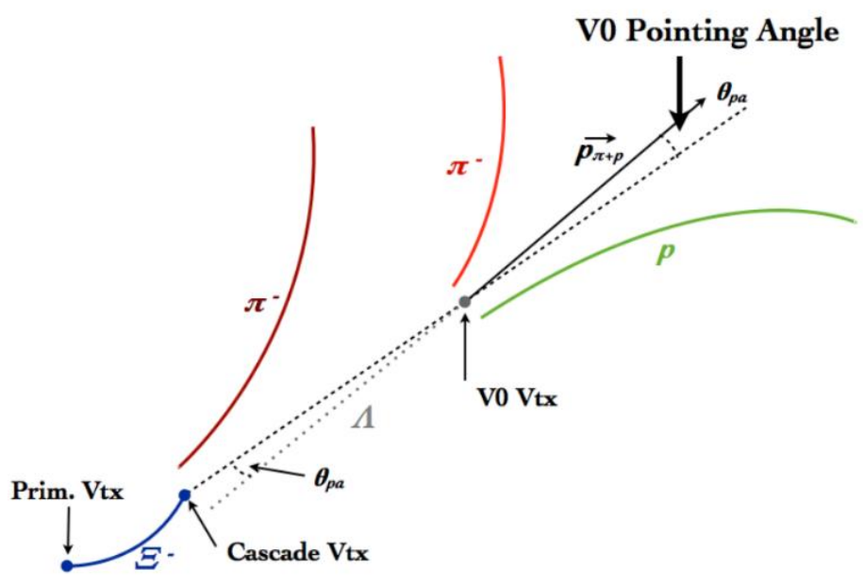
Thanks

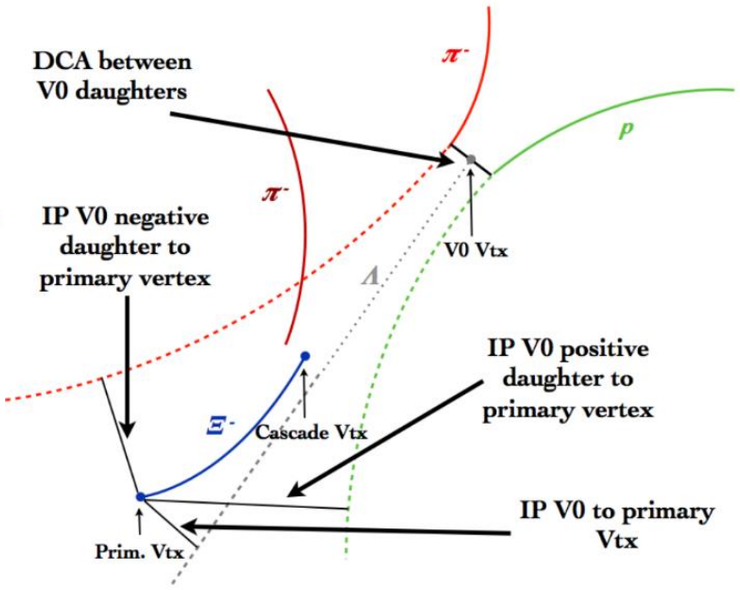
Backup

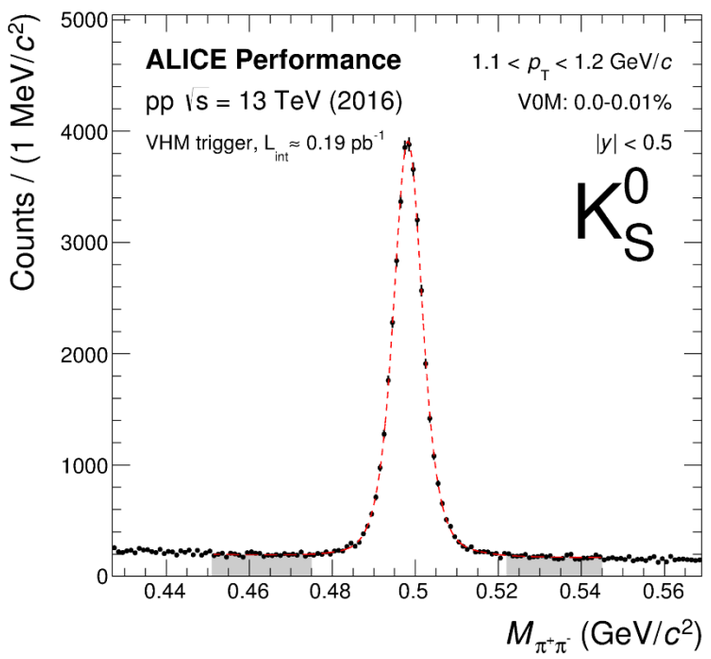
V^0s and Ξ reconstruction

- **Channels**
  - $K_S^0 \rightarrow \pi^+ + \pi^-$ (BR 69.2%)
  - $\Lambda \rightarrow p + \pi^-$ (BR 63.9%)
  - $\Xi^- \rightarrow \Lambda + \pi^- \rightarrow p + \pi^- + \pi^-$ (BR 63.9%)
- **Strategy: based on decay topology selections**
- **Acceptance:** $|\eta| < 0.75$

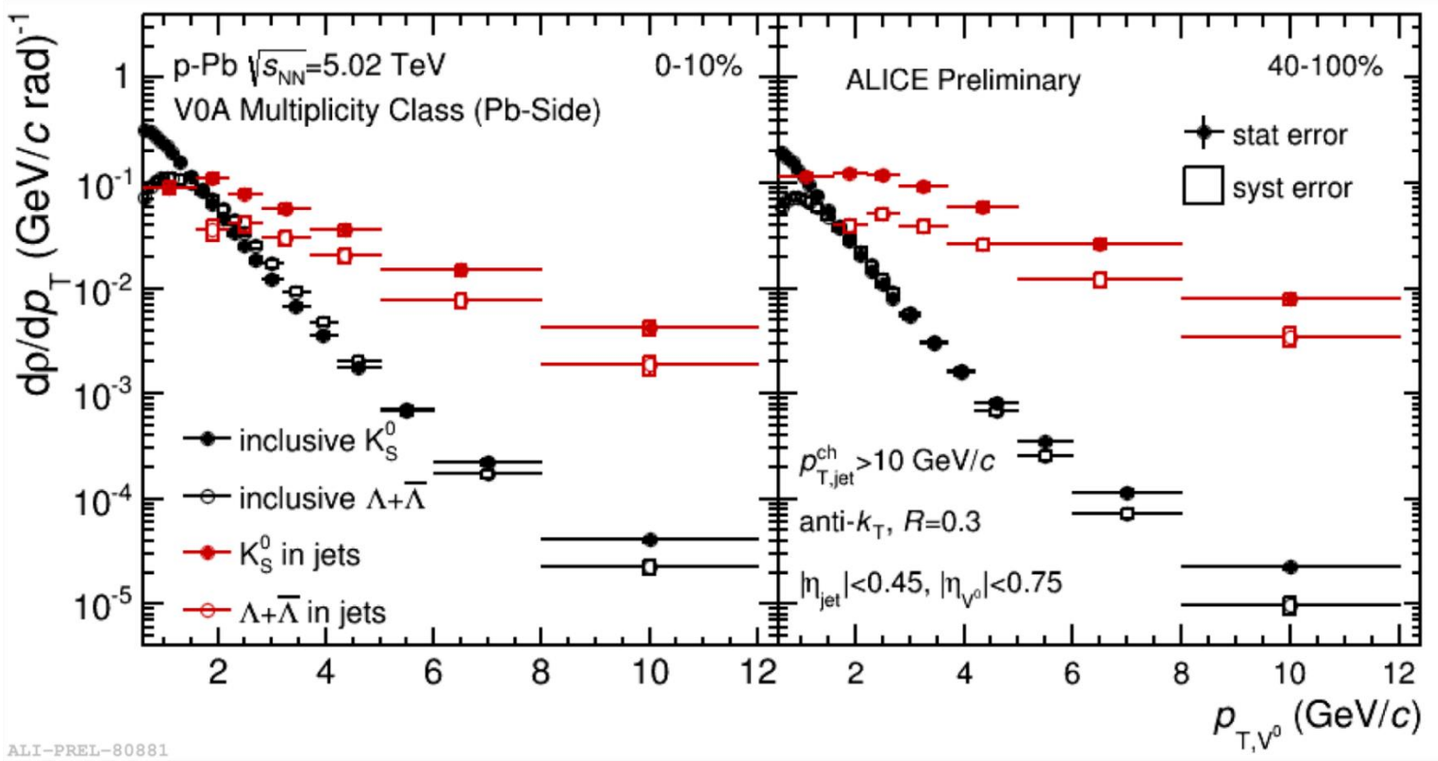


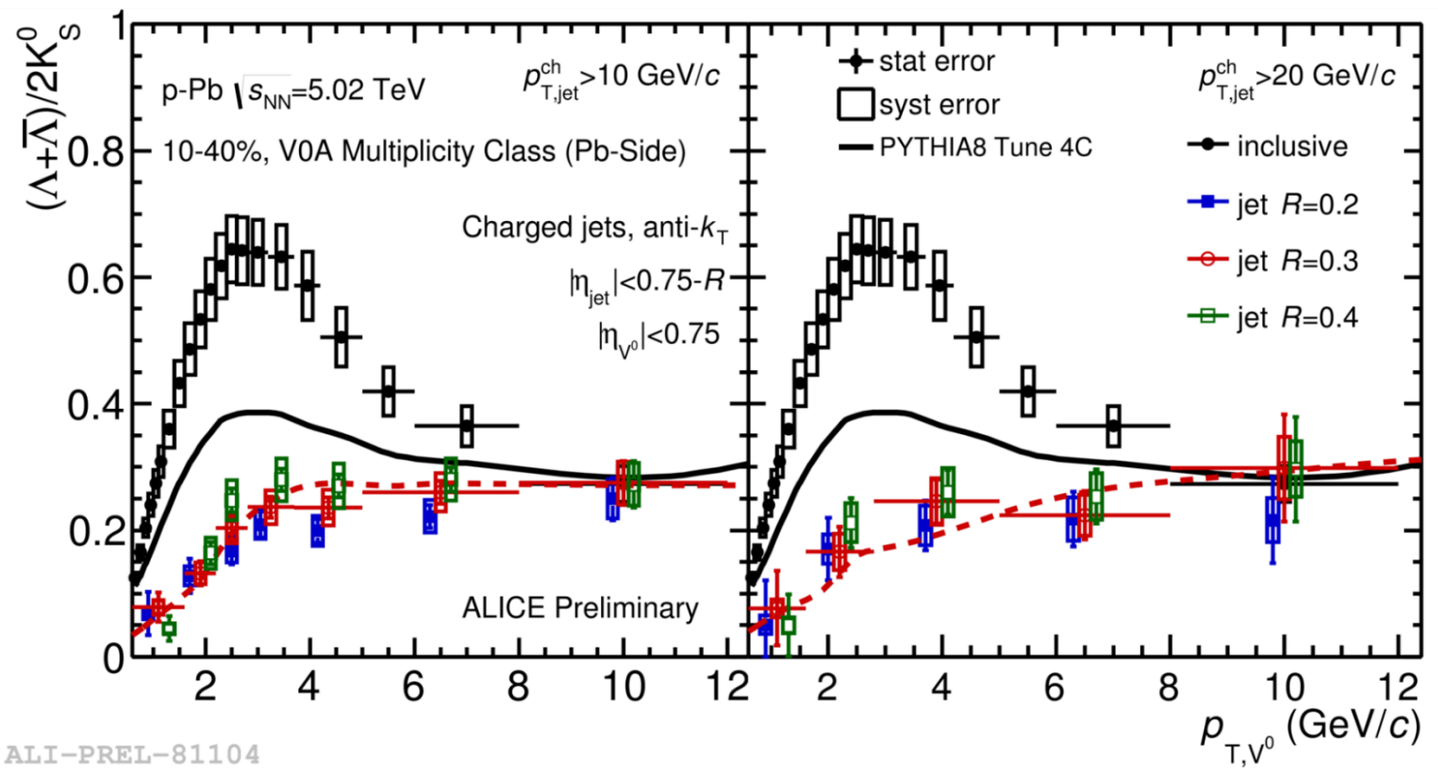






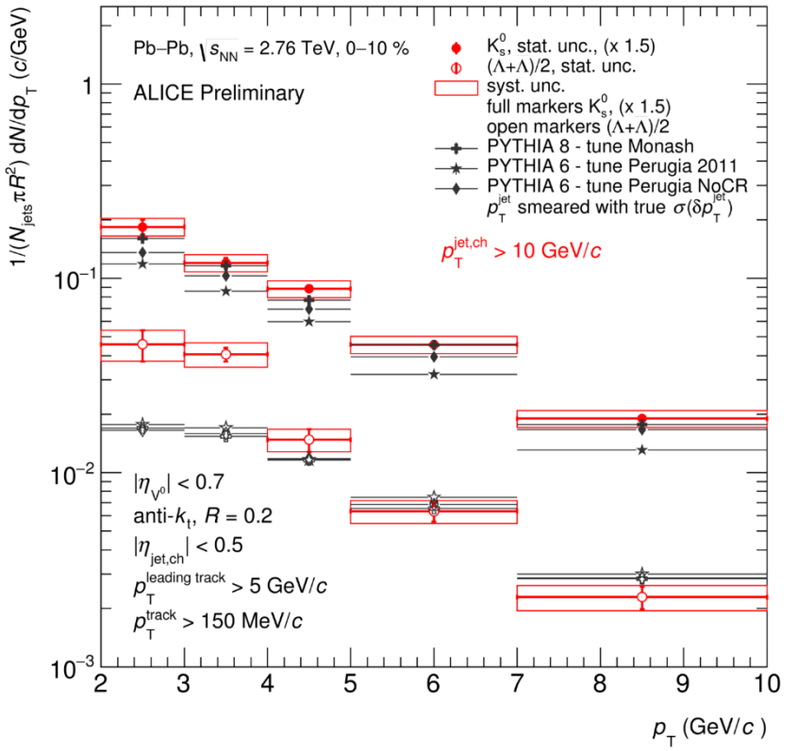
Results of p-Pb collisions





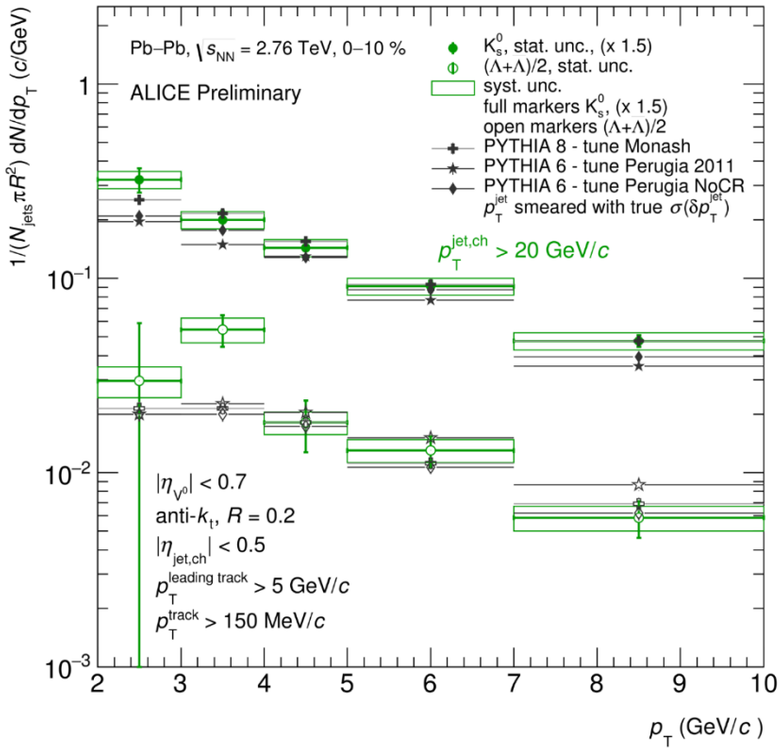
Results of Pb-Pb collisions

$p_{\mathrm{T}}^{\mathrm{jet,ch}} > 10$ GeV/c



ALI-PREL-112798

$p_{\mathrm{T}}^{\mathrm{jet,ch}} > 20$ GeV/c



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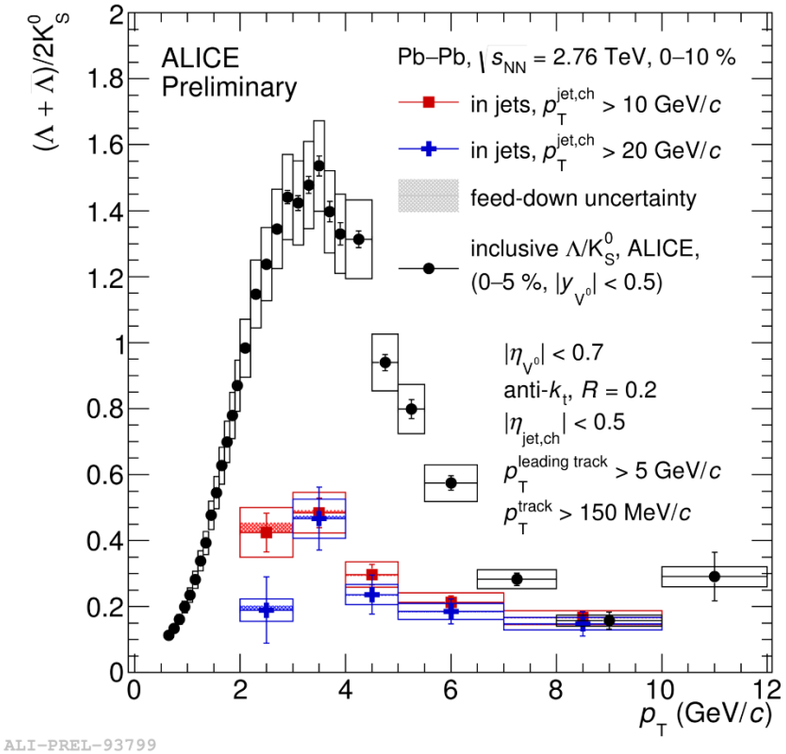

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- The different behavior from PYTHIA is seen in both K^0_S and Λ at low p_{T} in Pb-Pb central
- The ratio in jets is far below the inclusive one in Pb–Pb collisions
- The ratio in jets is compatible within systematical and statistical errors to that in pp collisions