Production of strange particles in jets and underlying events in pp and p-Pb collisions with ALICE

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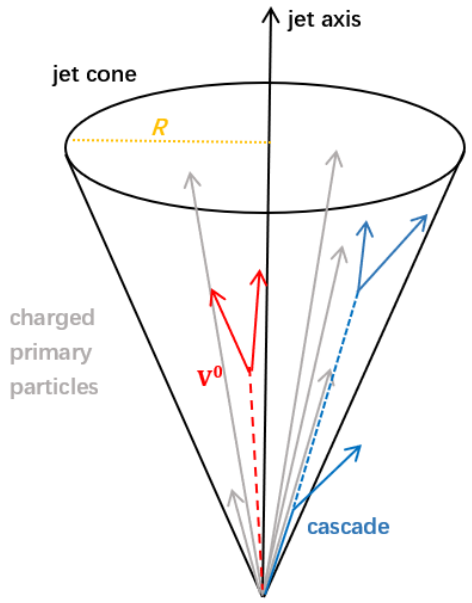
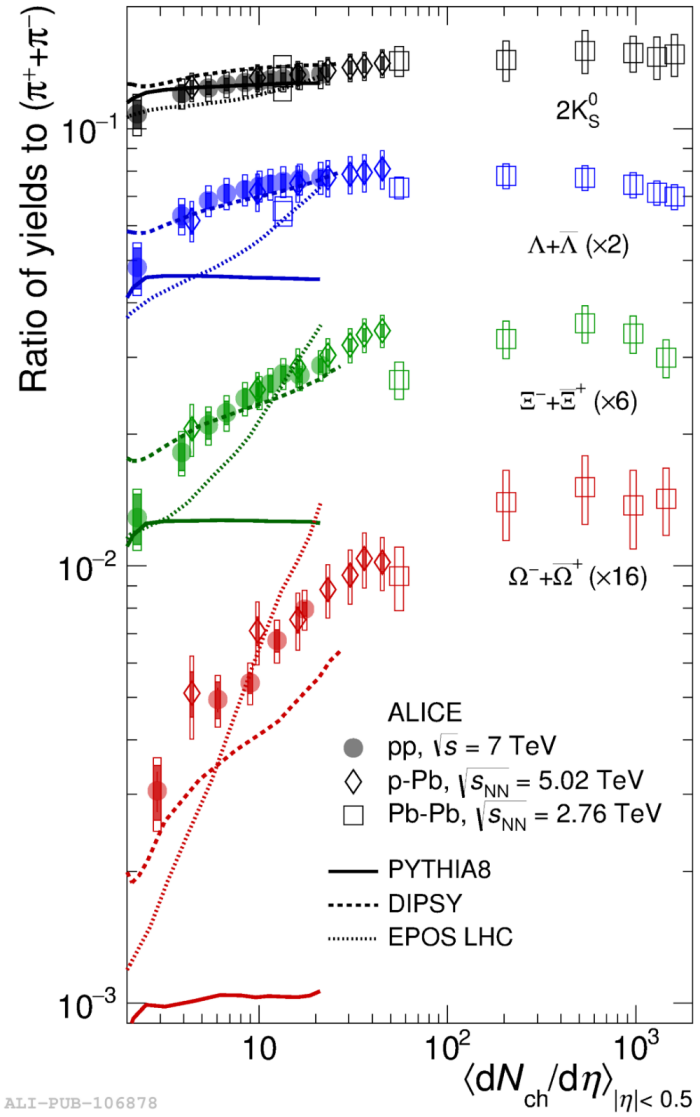


Motivation



Strangeness enhancement:

- The ratio between (multi-)strange hadron and $\pi^{\pm}$ yields increase with multiplicity in pp, p-Pb and Pb-Pb collisions
- Smooth evolution with charged-particle multiplicity across different collision systems
- No dependence on the collision energy
- The enhancement is larger for particles with larger strangeness content ($\Omega > \Xi > K^0_S$)

Nature Phys. 13 (2017) 535-539, Eur. Phys. J. C 80, 167 (2020)

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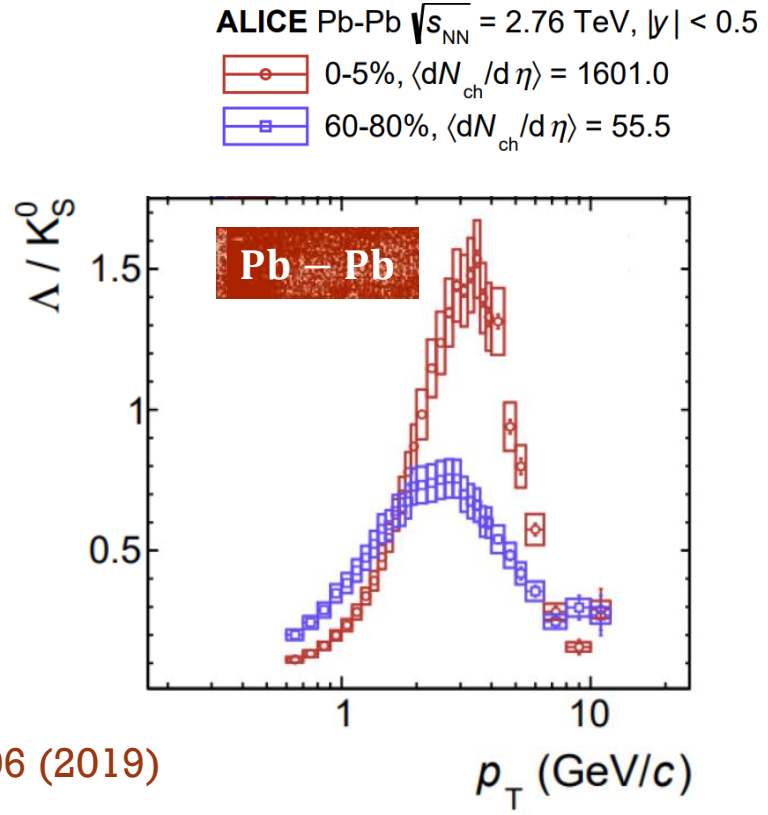
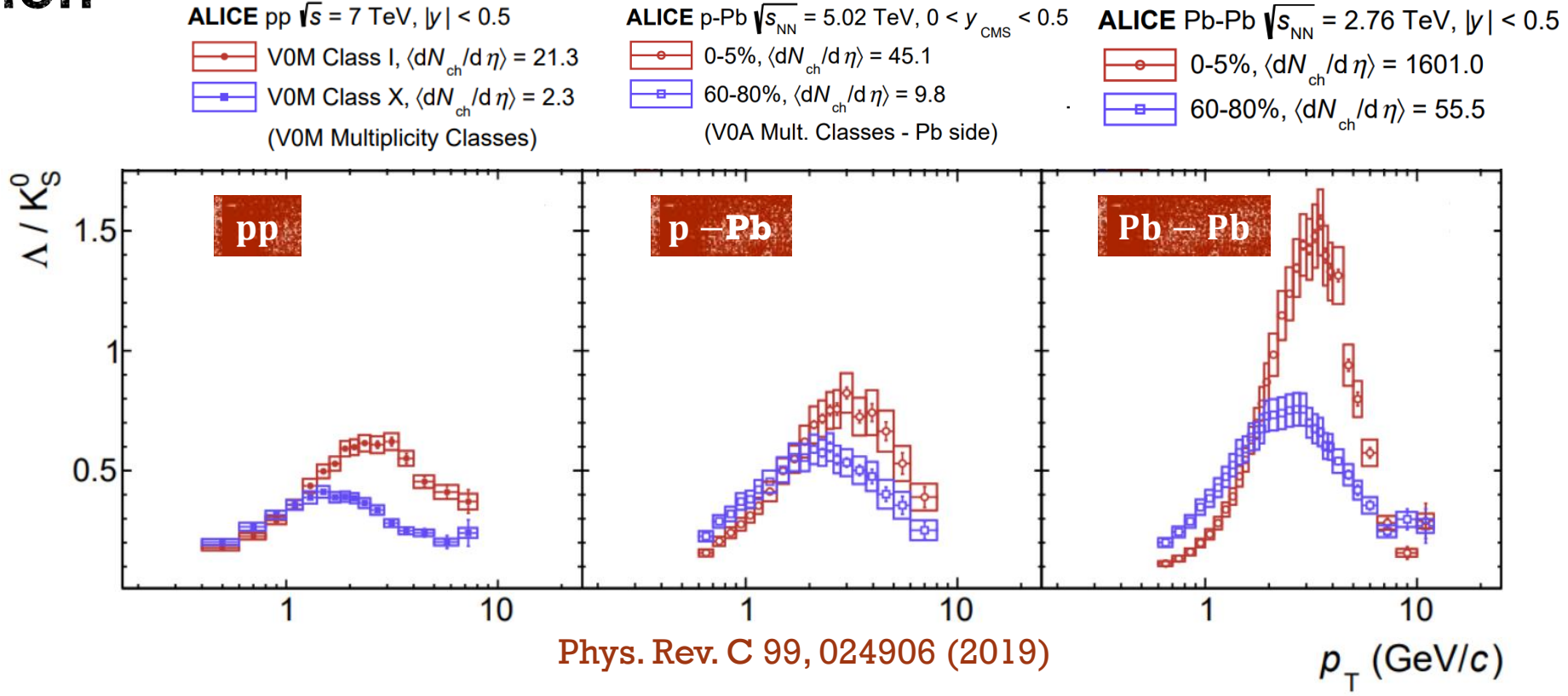


Phys. Rev. C 99, 024906 (2019)

Enhancement of Λ/K^0_S ratio

- Baryon-to-meson ratio (Λ/K^0_S) increases at intermediate p_T in central Pb-Pb collisions w. r. t. peripheral ones
  - Interplay of radial flow and coalescence
  - Reflect QGP effects in heavy-ion collisions

Motivation



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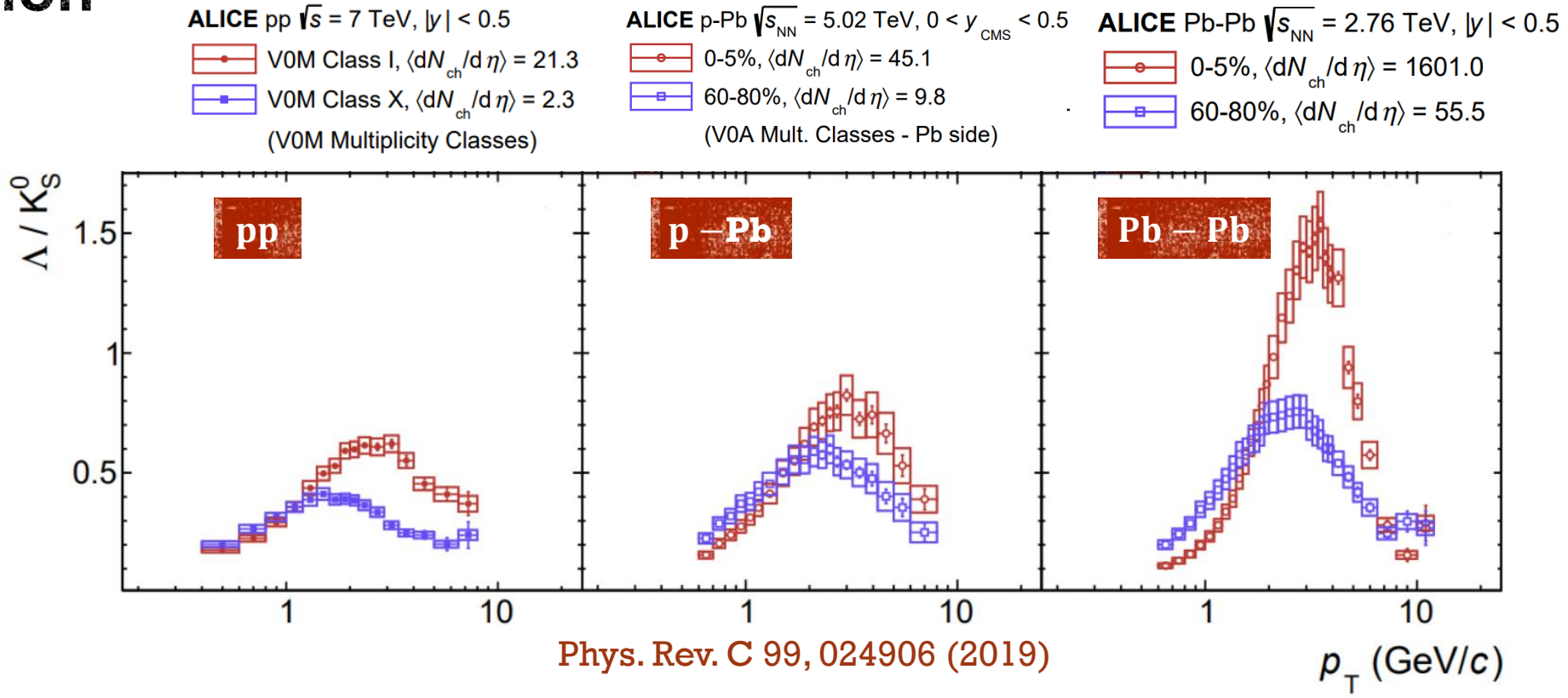
Enhancement of Λ/K^0_S ratio

- Baryon-to-meson ratio (Λ/K^0_S) increases at intermediate p_T in central Pb-Pb collisions w. r. t. peripheral ones
- Λ/K^0_S ratio enhancement at intermediate p_T (~ 3 GeV/c) in high multiplicity pp and p-Pb collisions w.r.t low multiplicity collisions
- This effect grows with $< dN_{ch}/d\eta >$

Motivation



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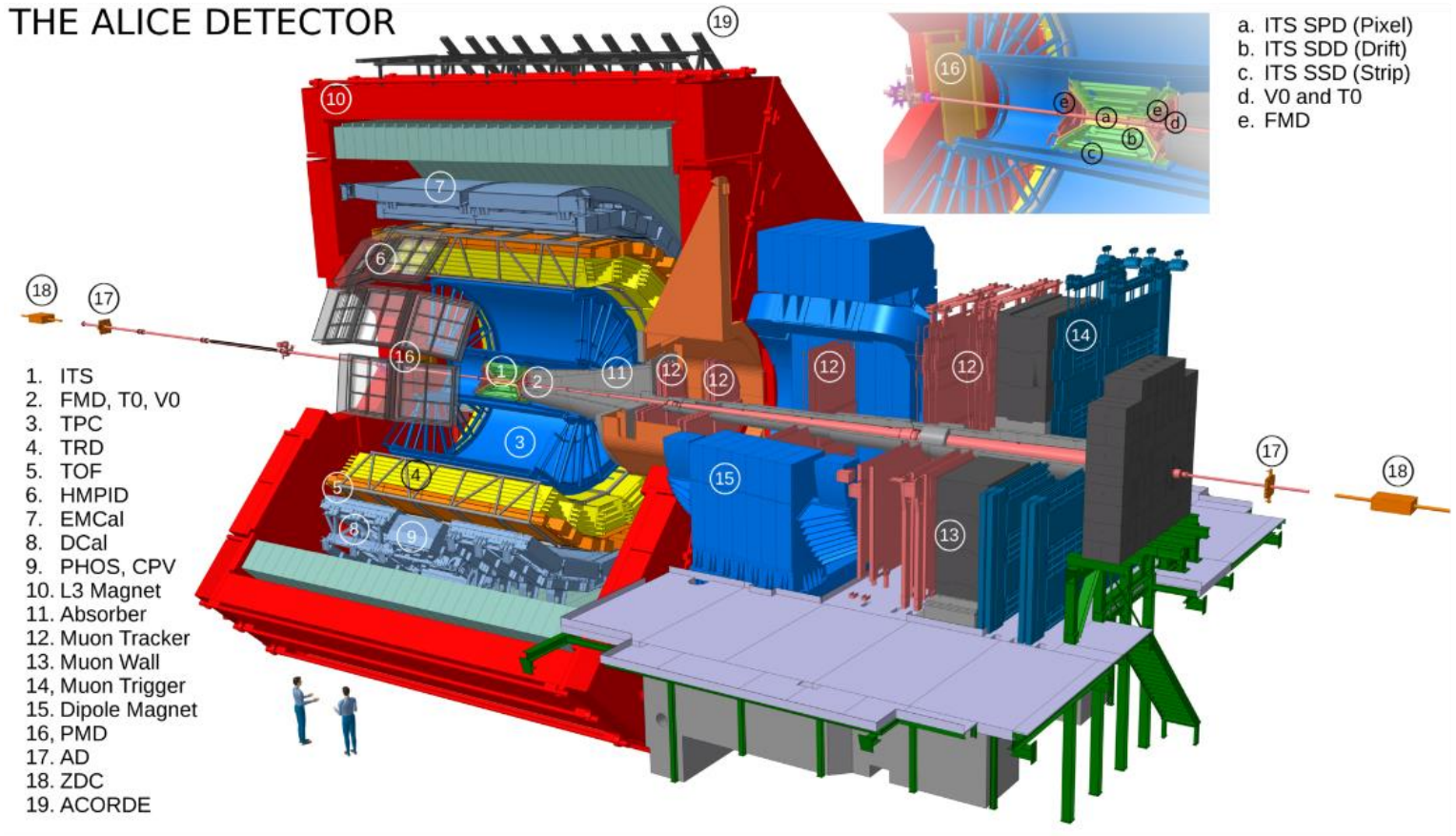
Study of strange particles in jets and the UE in pp and p-Pb collisions

Jets provide a natural reference to separate particles produced in hard processes and the underlying event

Experimental setup



- TPC (Time Projection Chamber)
  - $|\eta|<0.9$
  - Charged particle tracking
  - Particle identification
- ITS (Inner Tracking System)
  - $|\eta|<0.9$
  - Vertex reconstruction
  - Event trigger
- V0A + V0C
  - $2.8 < \eta < 5.1$ and $-3.7 < \eta < -1.7$
  - Event multiplicity class determination
  - Event trigger

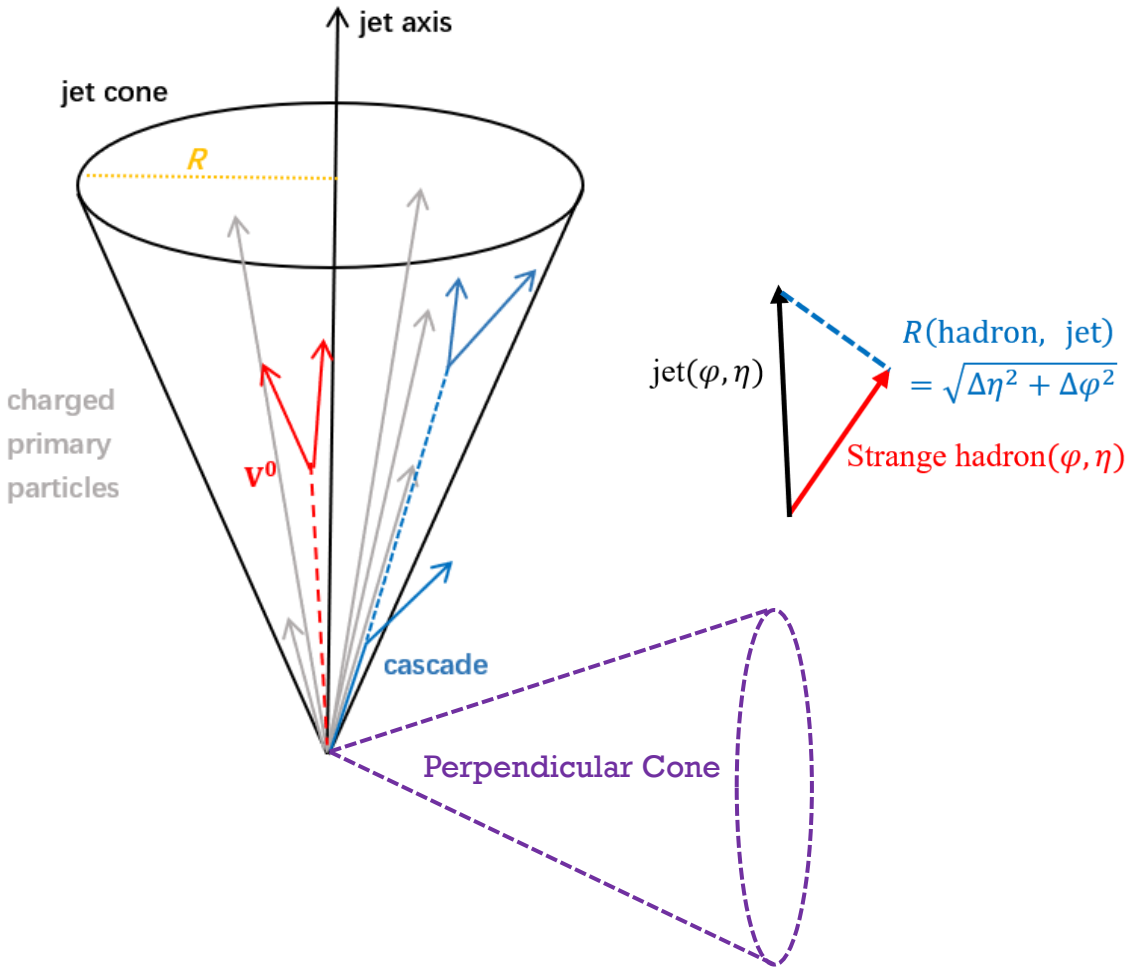
Analysis strategy

- Jet reconstruction
  - Charged track selection: $|\eta| < 0.9,\ p_{\mathrm{T}} > 0.15$ GeV/c
  - Jet finder: anti-k_{T}, $R = 0.4$, $|\eta_{\mathrm{jet}}| < 0.35, p_{\mathrm{T,jet}} > 10$ GeV/c
- Strangeness reconstruction
  - $\mathrm{K}^0_{\mathrm{S}} \rightarrow \pi^+ + \pi^-$ (BR 69.2%)
  - $\Lambda \rightarrow \mathrm{p} + \pi^-$ (BR 63.9%)
  - $\Xi^- \rightarrow \Lambda + \pi^- \rightarrow \mathrm{p} + \pi^- + \pi^-$ (BR 63.9%)
- Strangeness-jets matching
  - Strange particles found in **J**et **C**one (**JC** particles)
    - $R(\text{Strange hadron, jet})\left(=\sqrt{\Delta\eta^2+\Delta\varphi^2}\right) < 0.4$
  - Strange particles from the Underlying Event (**UE**) obtained with perp. cone method

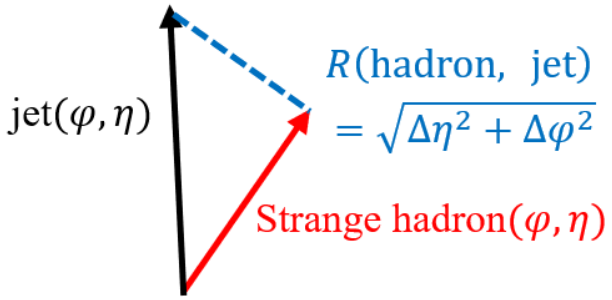
JE = JC - UE

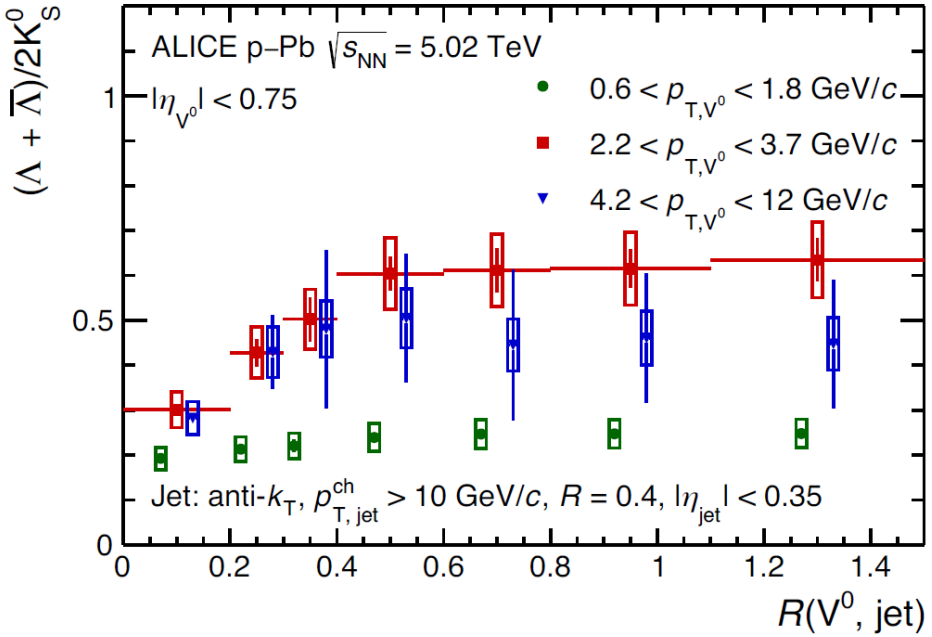
- Normalization

$$\frac{\mathrm{d}\rho}{\mathrm{d}p_{\mathrm{T}}} = \frac{1}{N_{ev}} \times \frac{1}{< \text{Acc Area} >} \times \mathrm{d}N_{\mathrm{S}}/\mathrm{d}p_{\mathrm{T}}$$



Λ/K^0_S ratio with $R(V^0, \text{jet})$ in p-Pb collisions





Intermediate p_T

High p_T

Low p_T

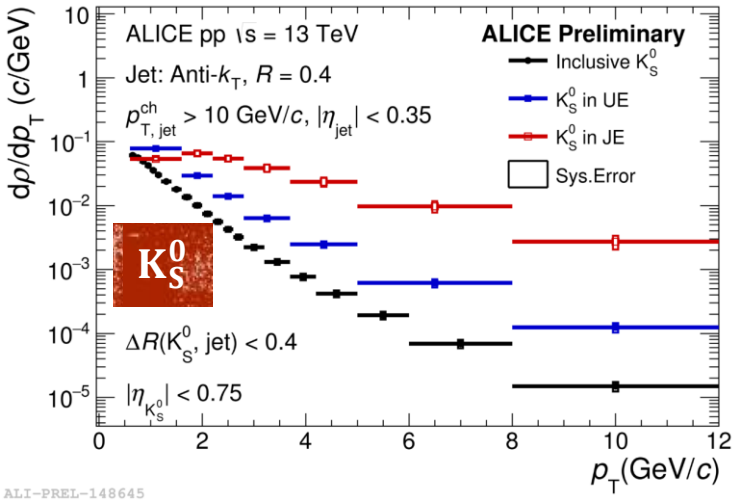
Hard process dominant → UE dominant

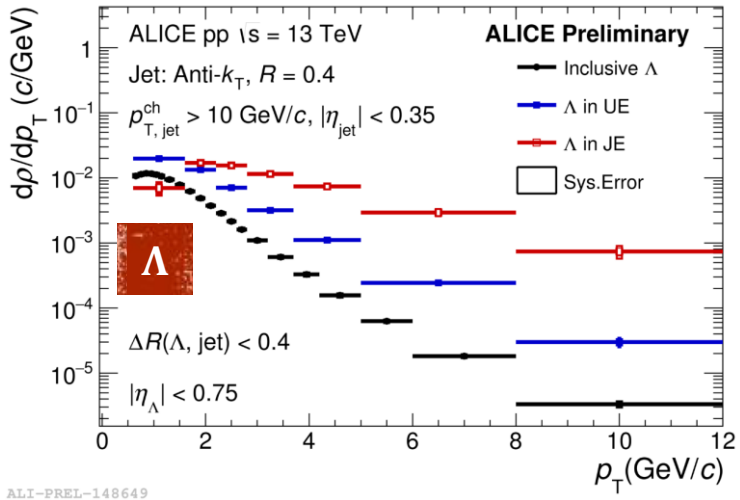
arXiv:2105.04890v1

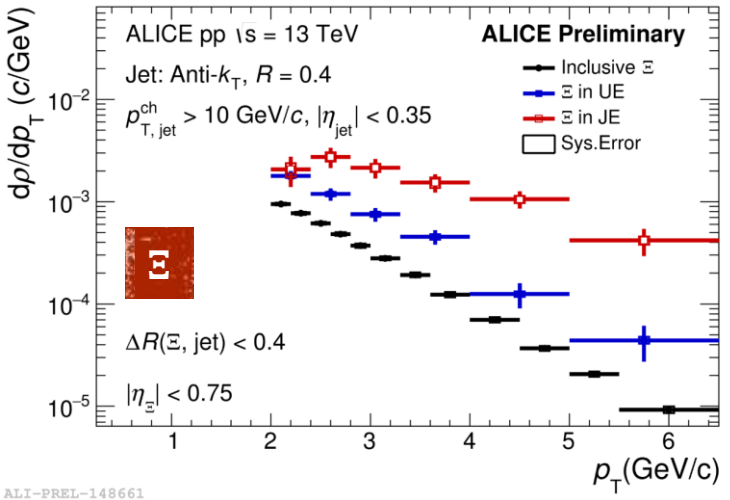
Λ/K^0_S (baryon/meson)

- Λ and K^0_S in jet cone without UE subtraction
- The ratio at low p_T is independent of the distance to the jet axis
- The ratio at intermediate-p_T shows an increase at small $R(V^0, \text{jet})$
- For $R(V^0, \text{jet}) > 0.5$ the ratio remains constant
- Lack of enhancement close to the jet axis

Strange particle spectra





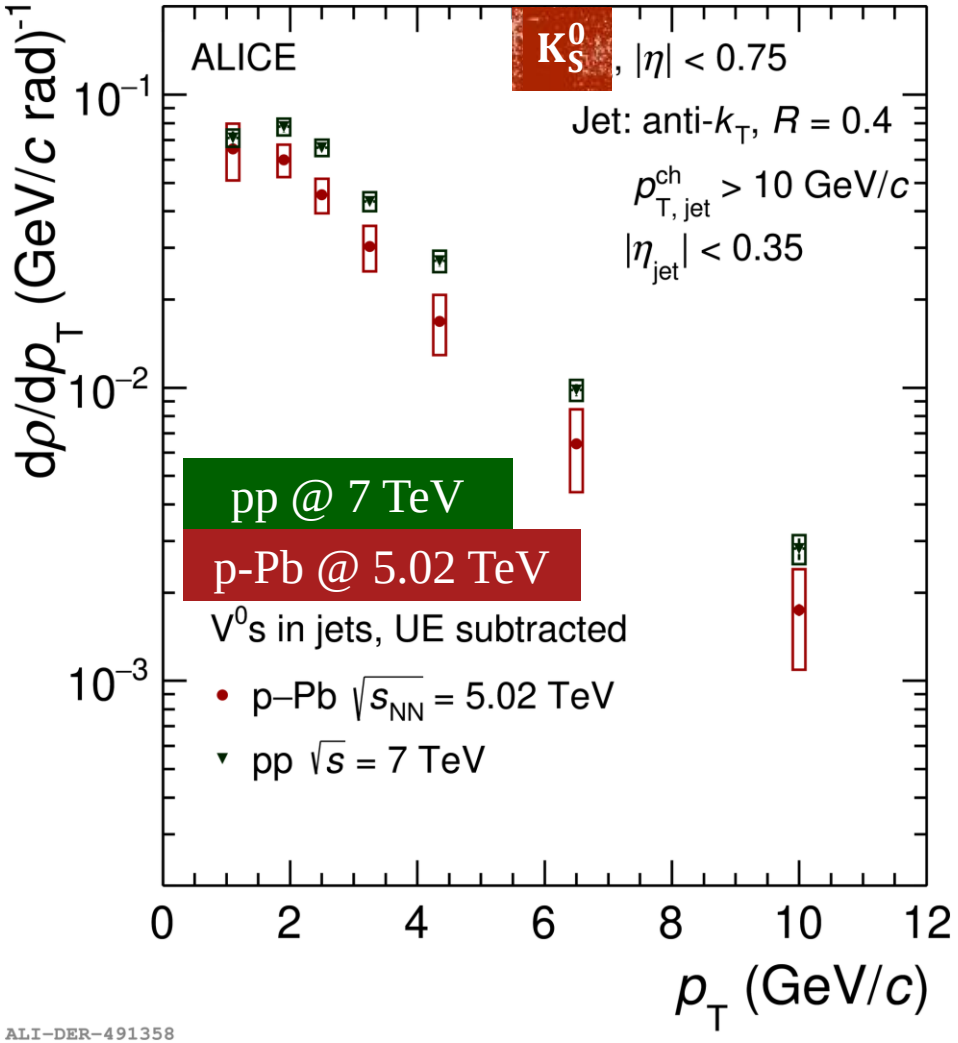


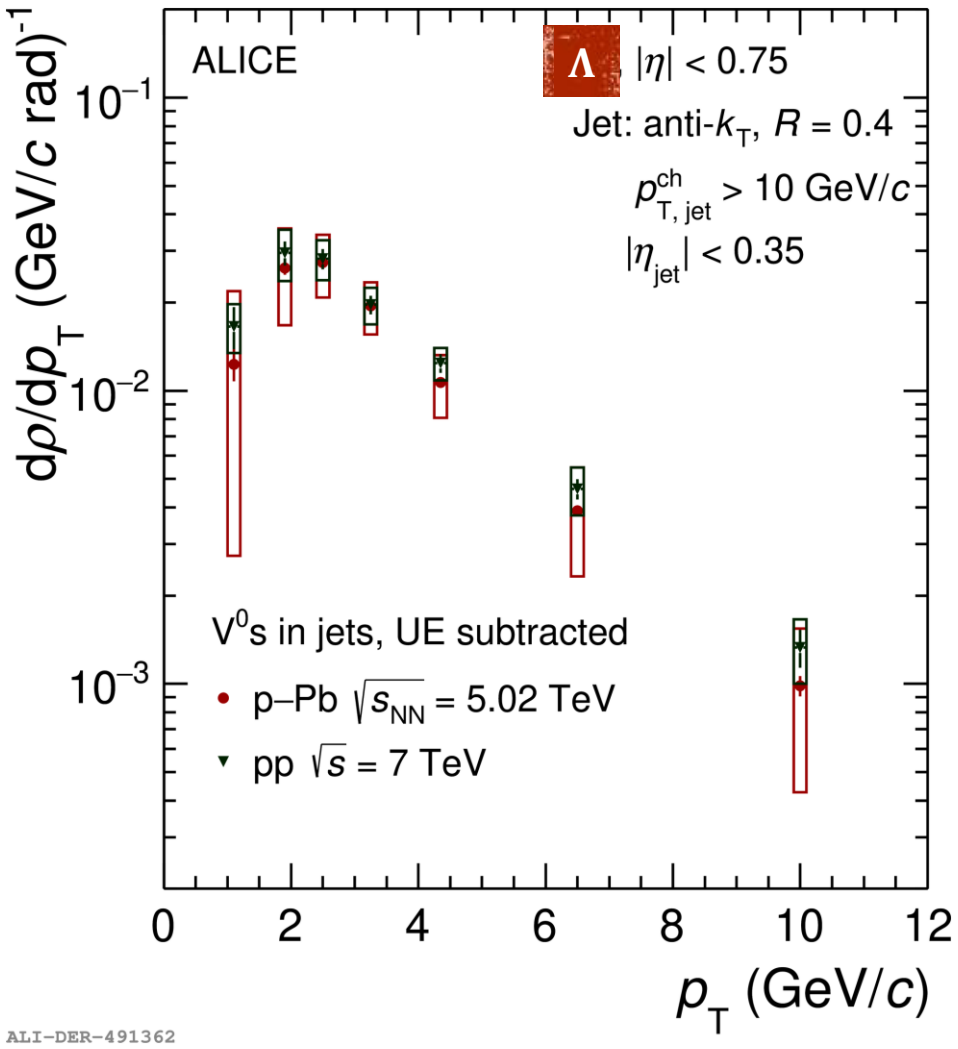
The spectra are fully corrected for instrumental effects

$$\frac{\mathrm{d}\rho}{\mathrm{d}p_\mathrm{T}} = \frac{1}{N_{ev}} \times \frac{1}{< \mathrm{Acc\ Area} >} \times \mathrm{d}N_\mathrm{S}/dp_\mathrm{T}$$

- UE background is dominant at low p_T
- The production density of strange hadrons in jets (JE) is harder than in the underlying event (UE)
- UE distributions are harder than **inclusive** --- presence of jets biases events

K^0_S and Λ spectra in jet in pp and p-Pb



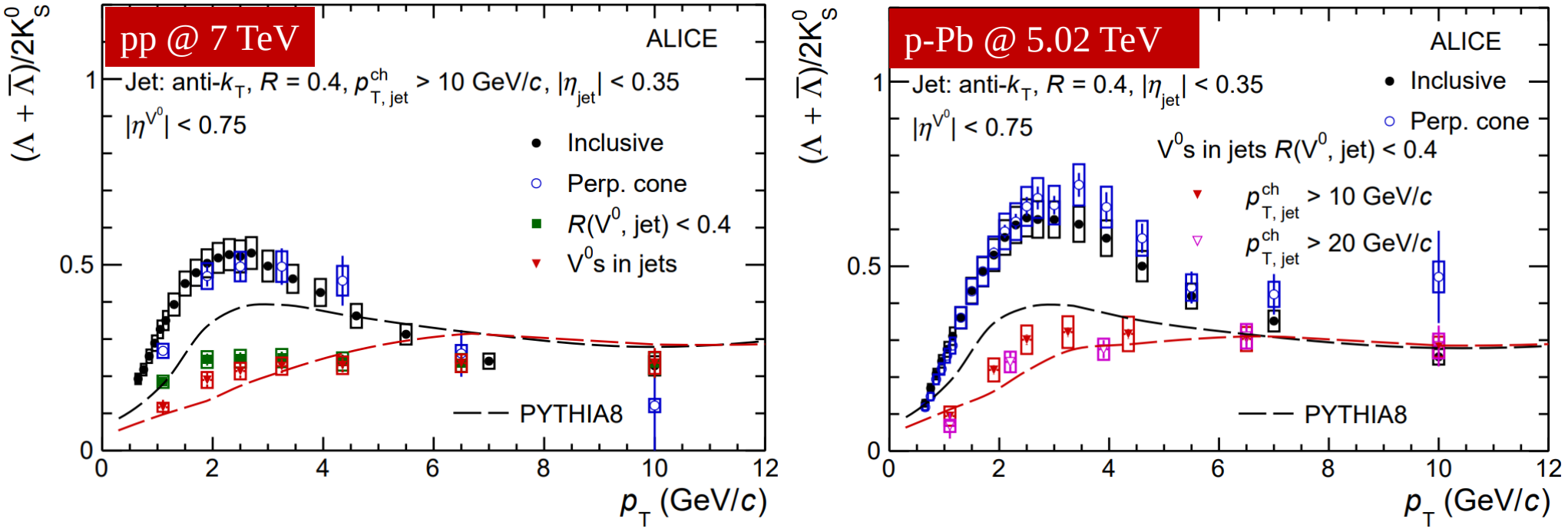


- Weak collision system dependence for particles produced in jets

arXiv:2105.04890v1

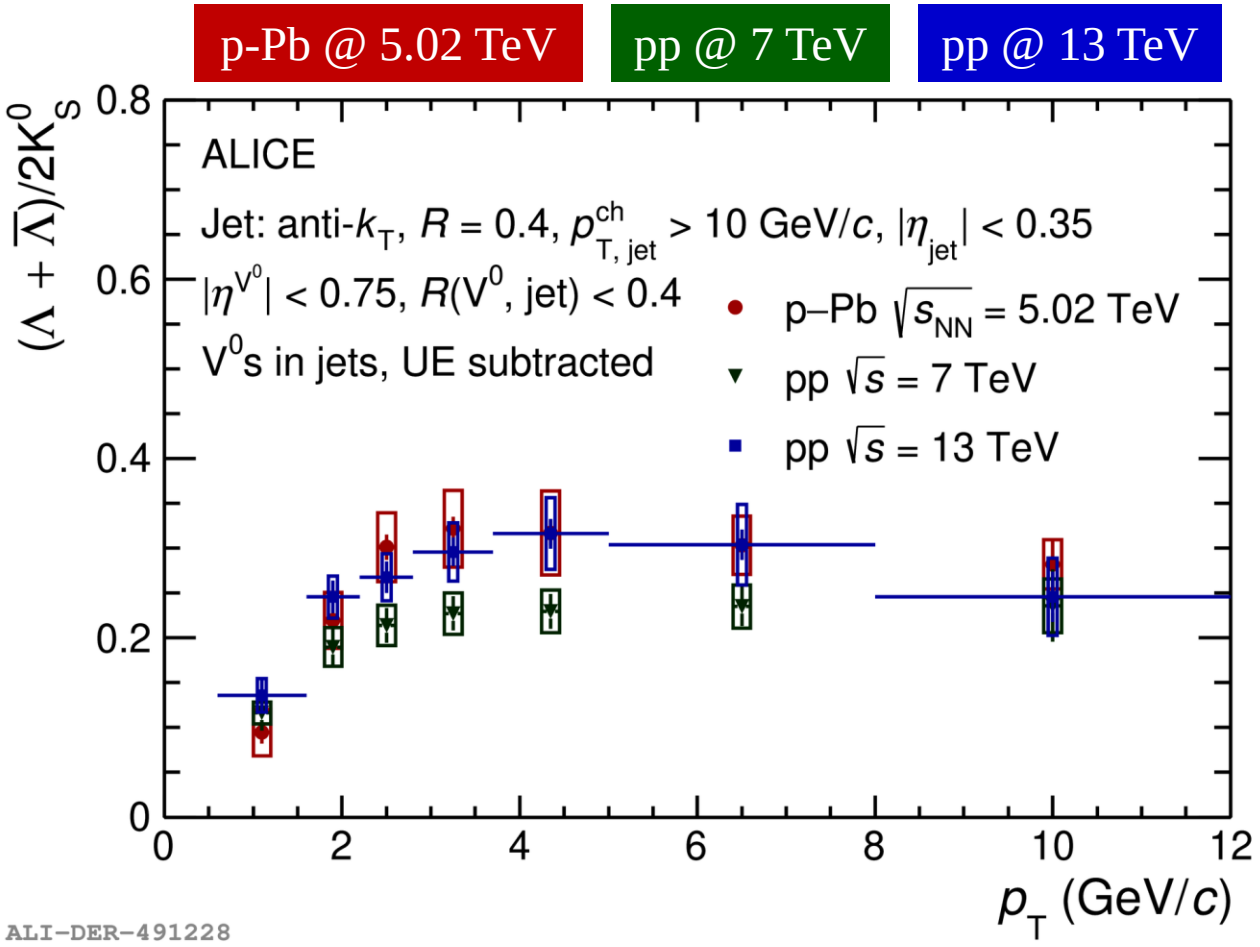
Λ/K^0_S ratio in pp and p-Pb

arXiv:2105.04890v1



- Ratio in jets does not show a maximum at intermediate p_T, ratio with UE selection is systematically higher than the inclusive in 2 < p_T < 5 GeV/c
- PYTHIA 8 hard QCD is consistent with ratio in jets but does not reproduce the inclusive ratio at low and intermediate p_T

Λ/K^0_S ratio in jet in pp and p-Pb

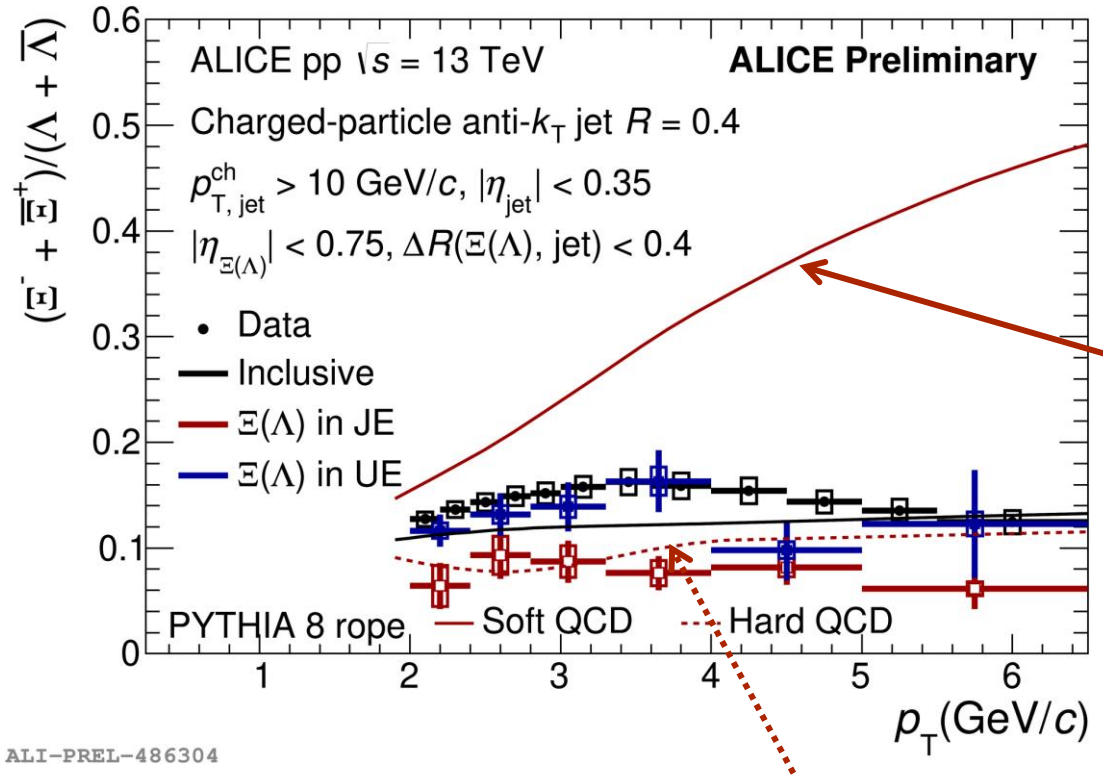


ALI-DER-491228

- In pp collisions: results at 7 TeV are consistent with those at 13 TeV within uncertainties — no (visible) energy dependence
- $< 2\sigma$ deviation at intermediate p_T between pp and p–Pb

arXiv:2105.04890v1

Ξ/Λ ratio in pp collisions



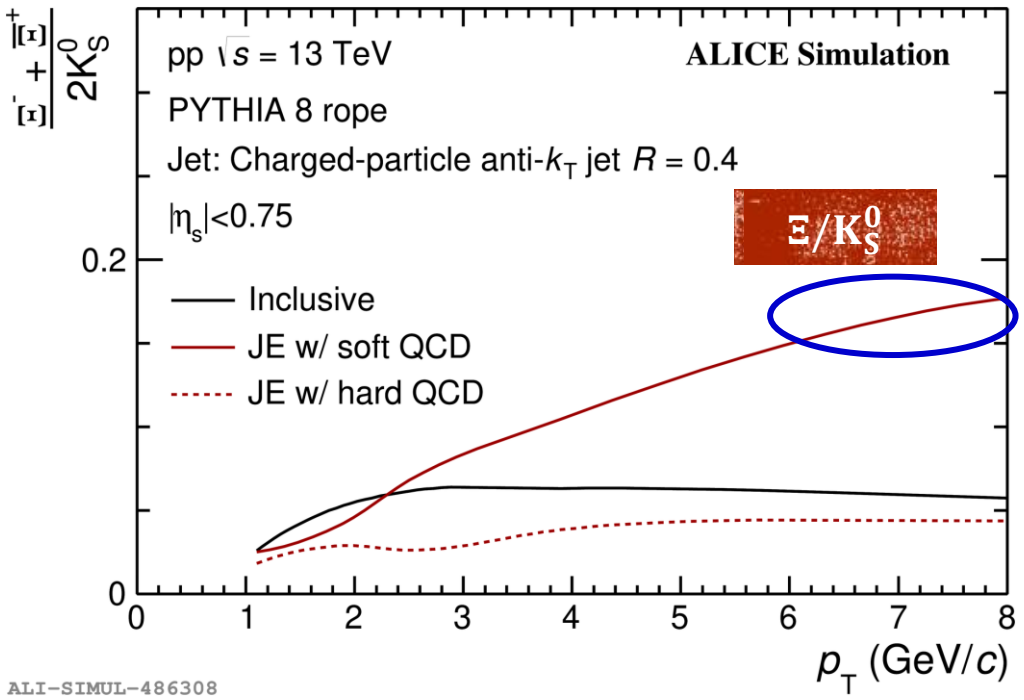
PYTHIA 8 soft QCD prediction in jets

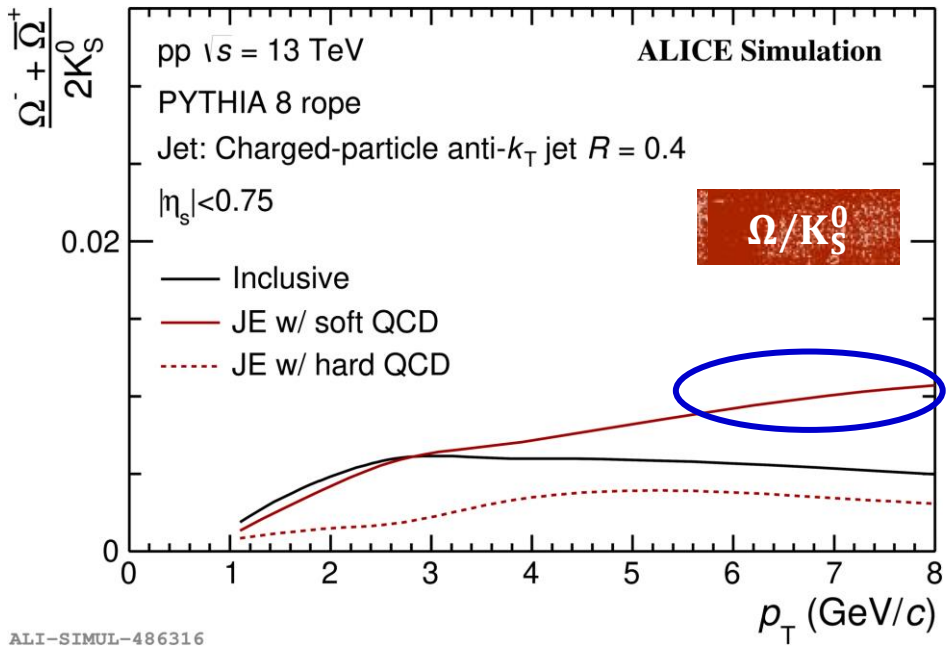
PYTHIA 8 hard QCD prediction in jets

Ξ/Λ (baryons with different strangeness content: |S|=2/|S|=1)

- UE ratio is consistent with the **inclusive** one
- Ratio in jet is almost independent of p_T
- PYTHIA 8 hard QCD generally reproduces ratio in jets
- PYTHIA 8 soft QCD shows a strong increase, inconsistent with data

Multi-strange baryon prediction in PYTHIA





baryons/meson with different strangeness content: |S|=2 (3)/|S|=1

- PYTHIA 8 soft QCD mode gives a strong increase in particle ratios at high p_T when multi-strange particles are considered, not consistent with data
- Next step extend the study to Ω-baryon

Summary

- Production of strange particles have been investigated in jets and the UE in pp and p-Pb collisions
- $\Lambda/\mathrm{K}^0_\mathrm{S}$ ratio
  - The inclusive $\Lambda/\mathrm{K}^0_\mathrm{S}$ ratio enhancement is not present within the jets, but is related to the Underlying Event (UE)
  - $\Lambda/\mathrm{K}^0_\mathrm{S}$ ratio as a function of $R(\mathrm{V}^0,\ \mathrm{jet})$: lack of enhancement close to the jet axis

  ↘ **Enhancement is not associated with the jets**
- Ξ/Λ ratio
  - The Ξ/Λ ratio in jet is almost independent of p_T

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