Update on strangeness and resonance production in p-Pb collisions at 8.16 TeV recorded with ALICE

ALICE-STAR India Collaboration meeting
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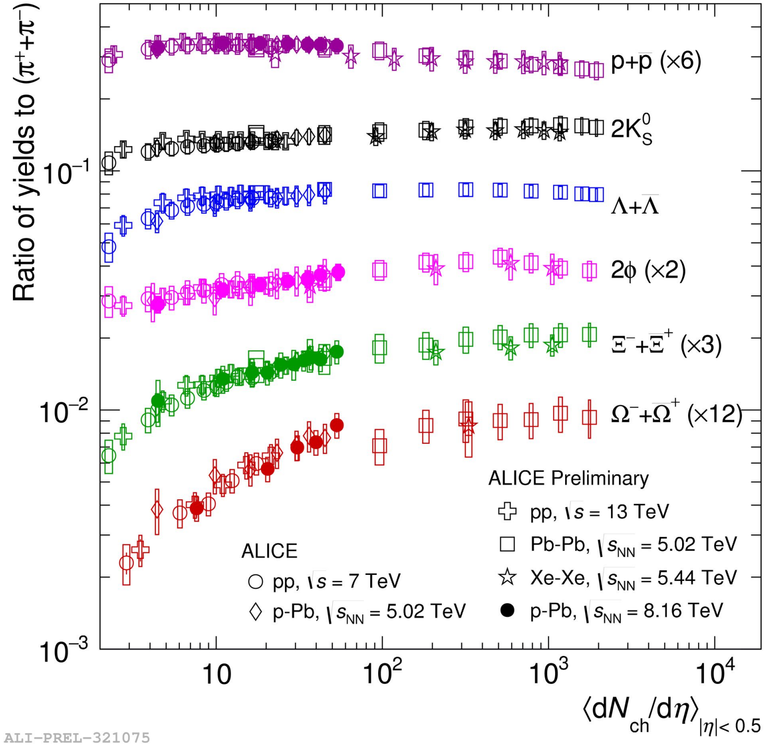
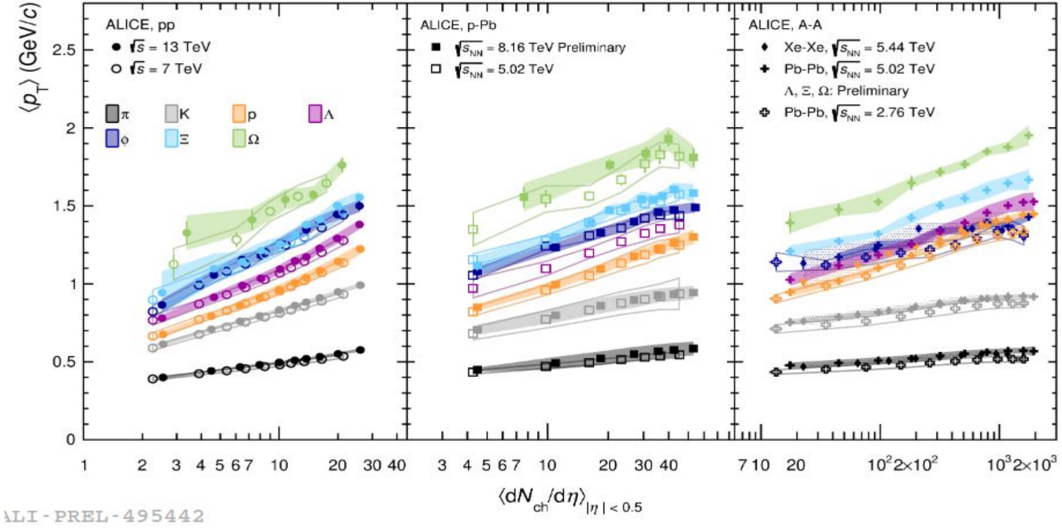
Outline

- **Motivation**
- **Earlier results with comments from ARC and Physics Forum**
- **Updated results**
- **Summary**

Motivation

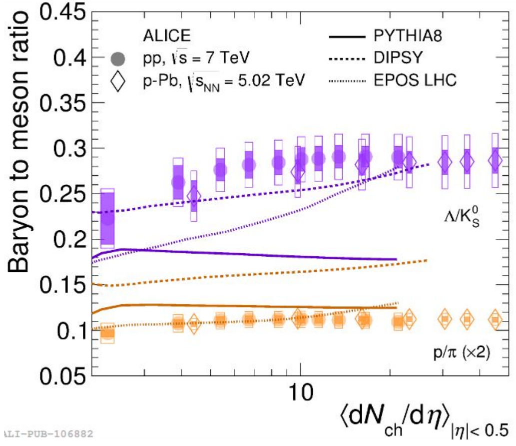


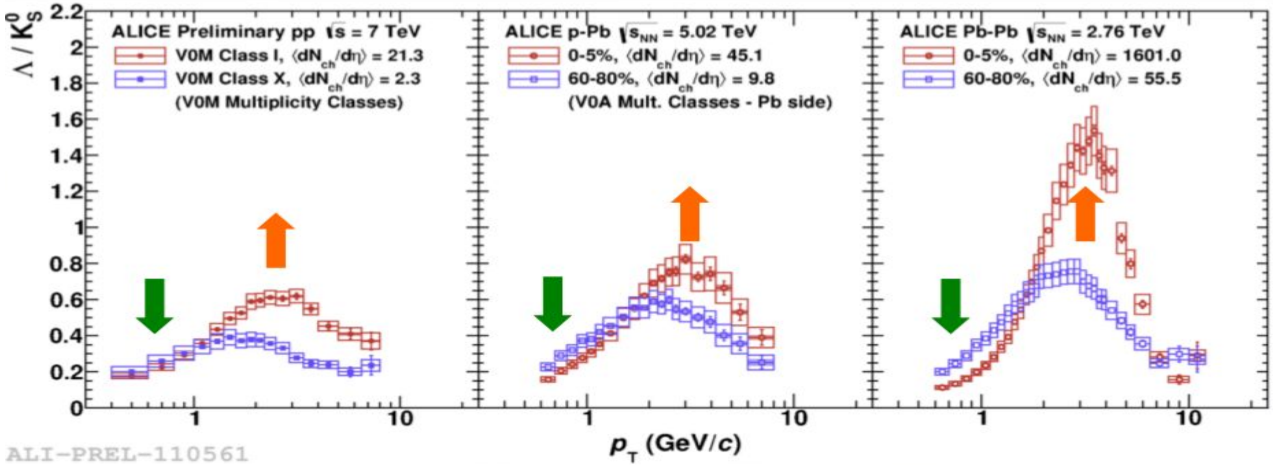
- ➔ Strange to non-strange ratios with multiplicity
  - ➢ **Enhancement of strange to non-strange hadron production from low multiplicity pp to central Pb-Pb collisions.**
  - ➢ **Smooth evolution between pp, p-Pb and Pb-Pb collisions.**
  - ➢ **Strange to non-strange ratios saturated for all particles in central Pb-Pb collisions.**
- ➔ Mean pt increases with multiplicity.



Motivation

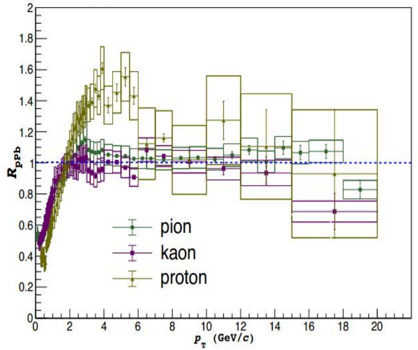
- ➔ The p_T differential ratios of baryon over meson shows peak at intermediate p_T ➡ **Interplay of radial flow and parton recombination at intermediate p_T**
- ➔ Baryon over Meson ratio shows no significant change as a function of multiplicity ➡ **Strangeness enhancement is not driven by mass nor it is a baryon/meson effect**
- ➔ Mass ordering of R_{pPb} at intermediate p_T which is qualitatively similar to that in Pb–Pb collisions ➡ **Mass ordering or Baryon meson splitting?**





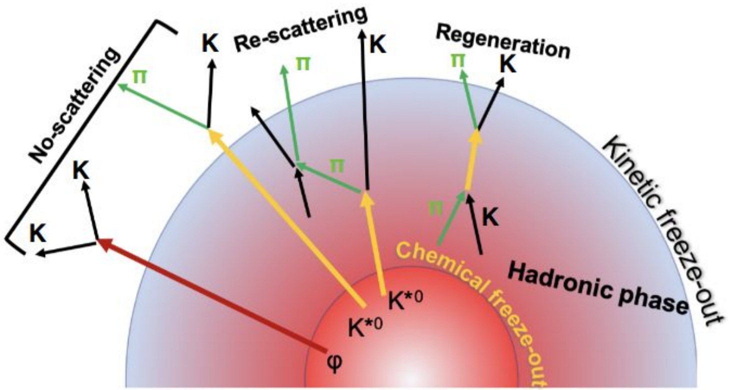
RpPb

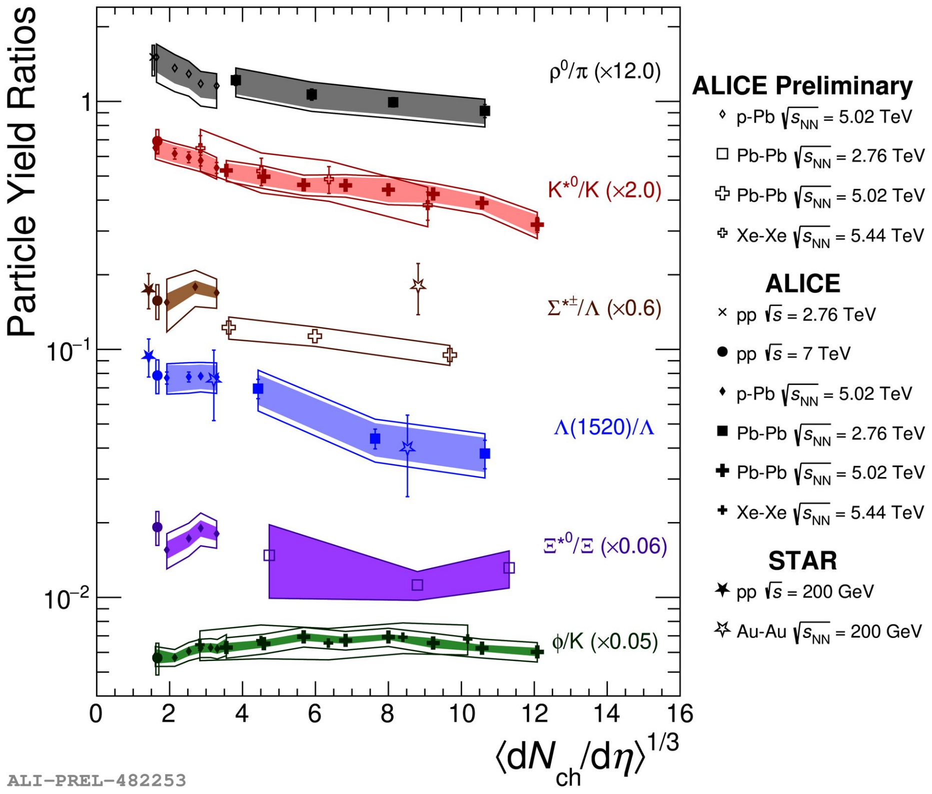
Result for paper



Motivation

- ➔ Suppression or enhancement in yields depend upon
  - ➢ Lifetime of resonance particle
  - ➢ Interaction cross section of decay daughters
  - ➢ Lifetime of hadronic phase
- ➔ Their lifetimes are exploited for the estimation of lifetime of the hadronic phase

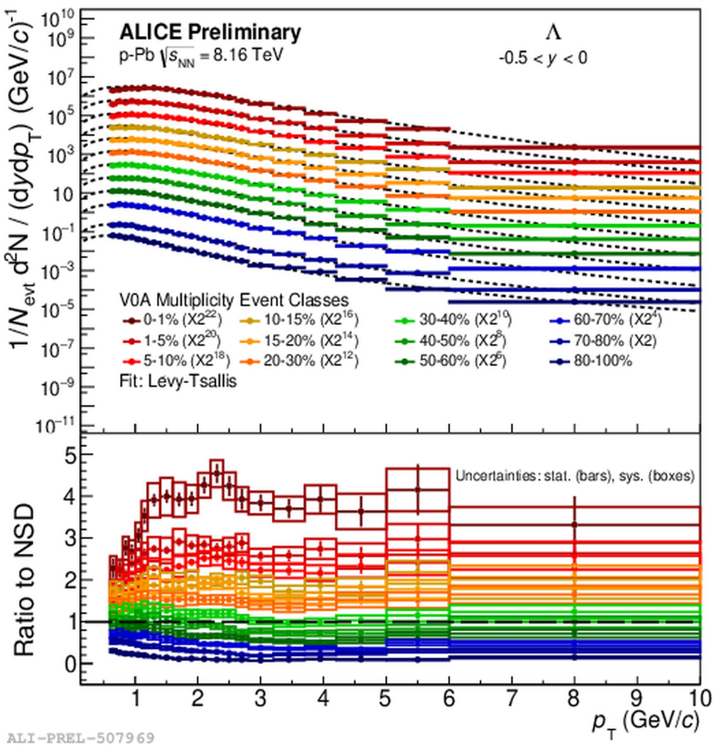


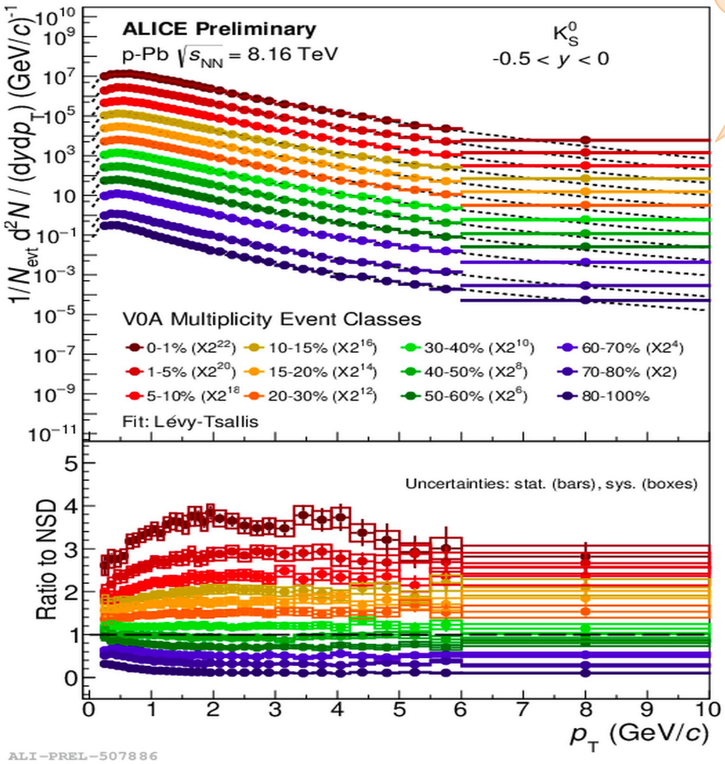


Earlier Results …..

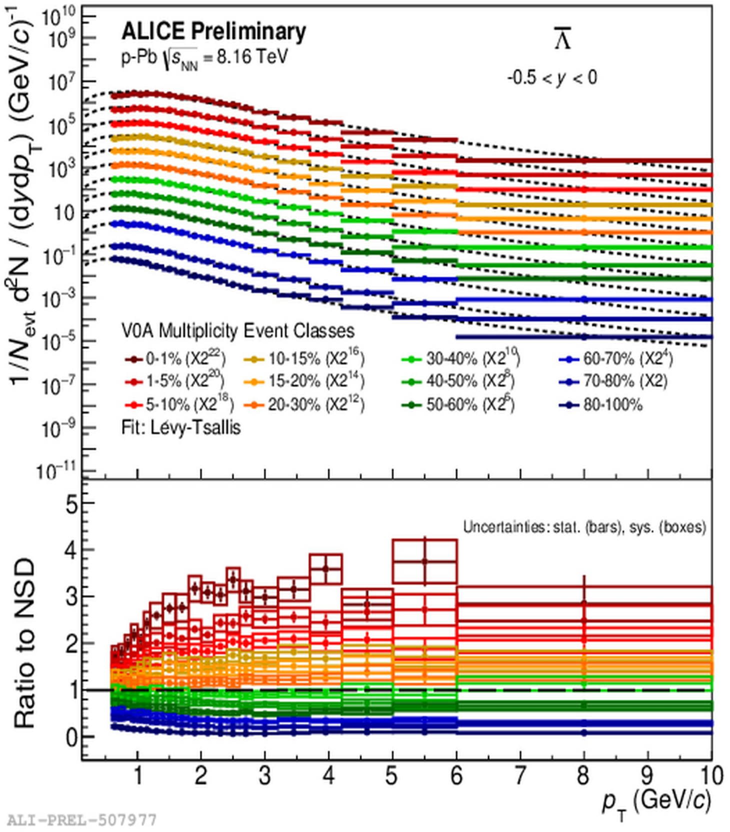
Corrected p_T spectra

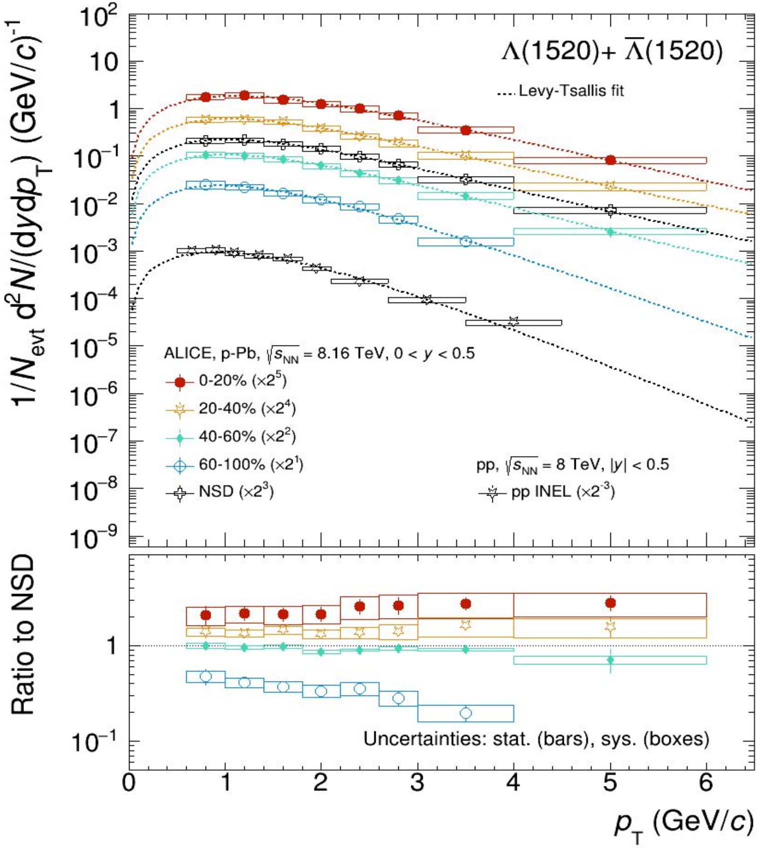
PF comment: It is noticed that in the most central bin, the yield of $K0_S$ decreases towards high p_T which is not expected for mesons.



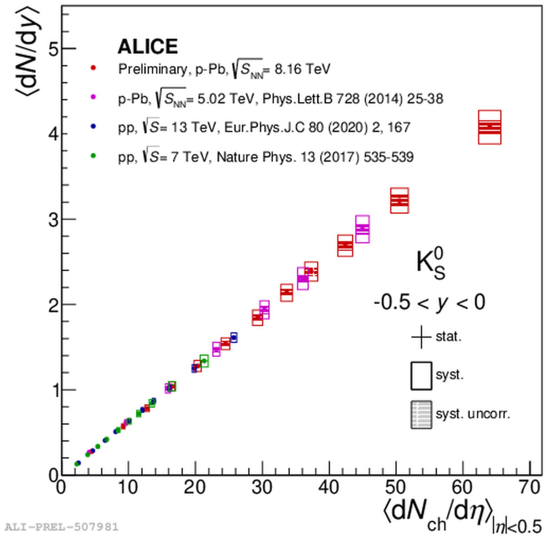


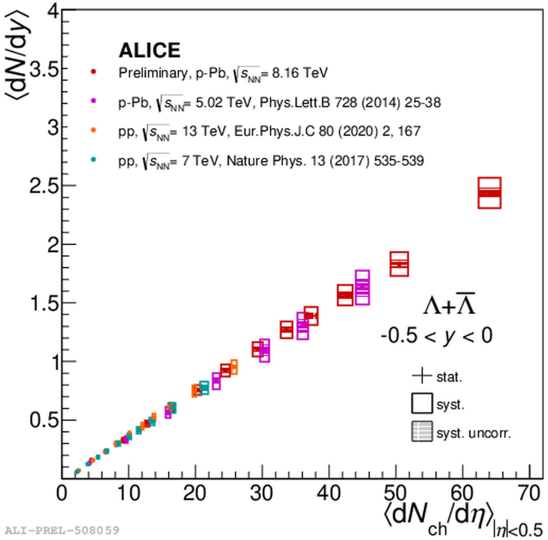
Corrected p_T spectra

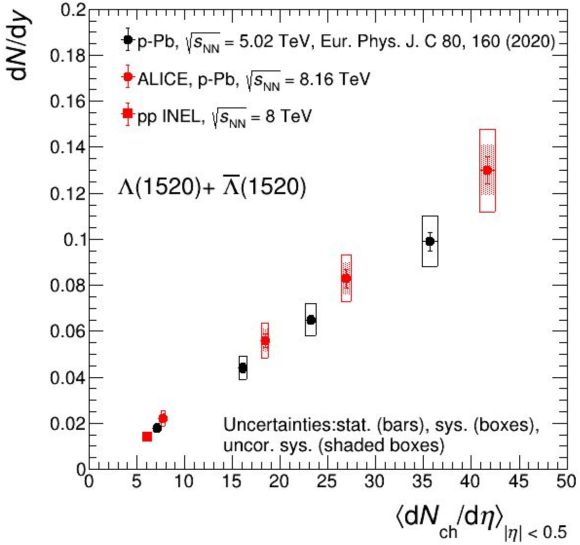




Integrated yield (d*N*/dy)

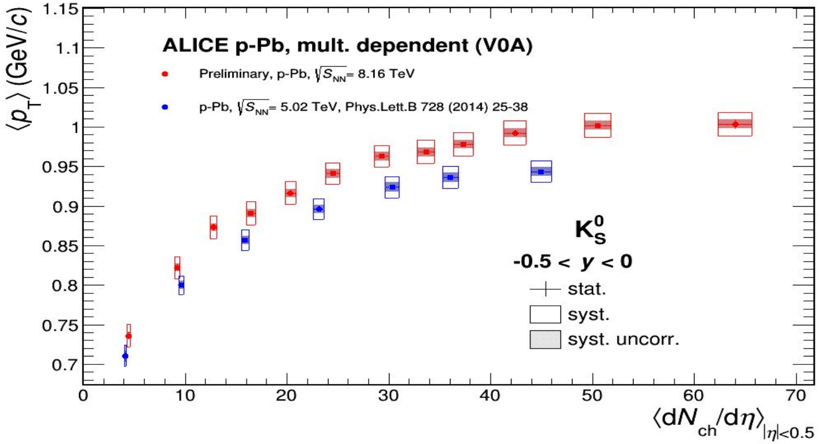


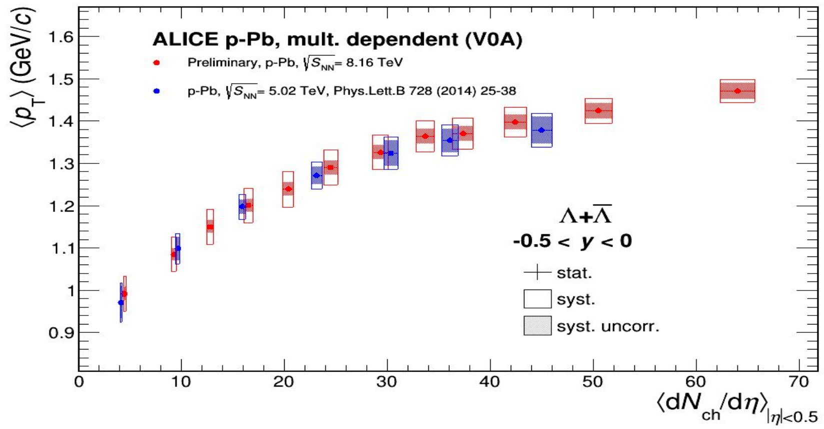


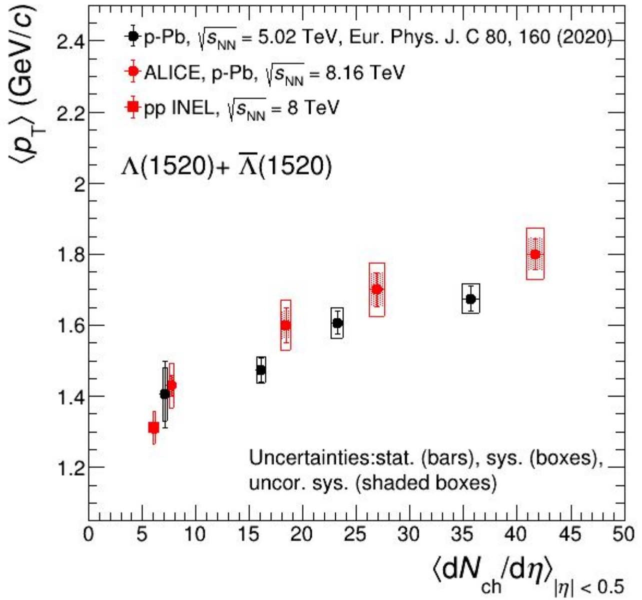


- No dependence on system size or energy of collision ⟹ multiplicity drives particle production.

Average p_T

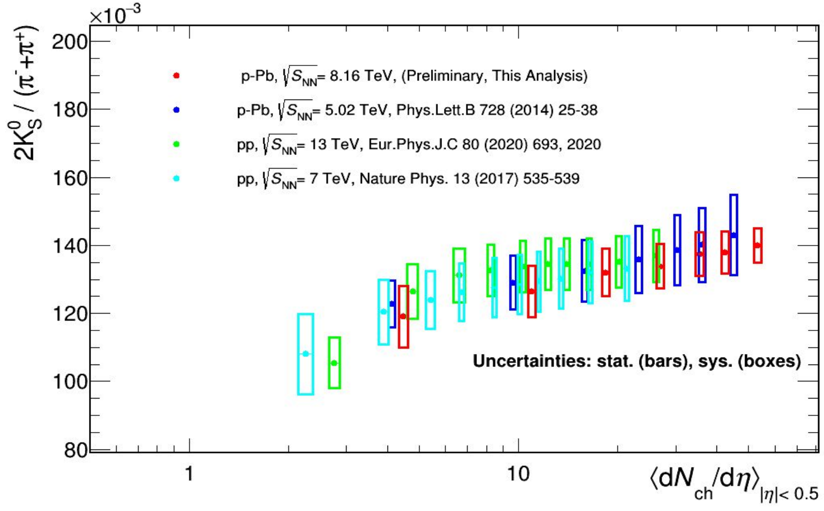


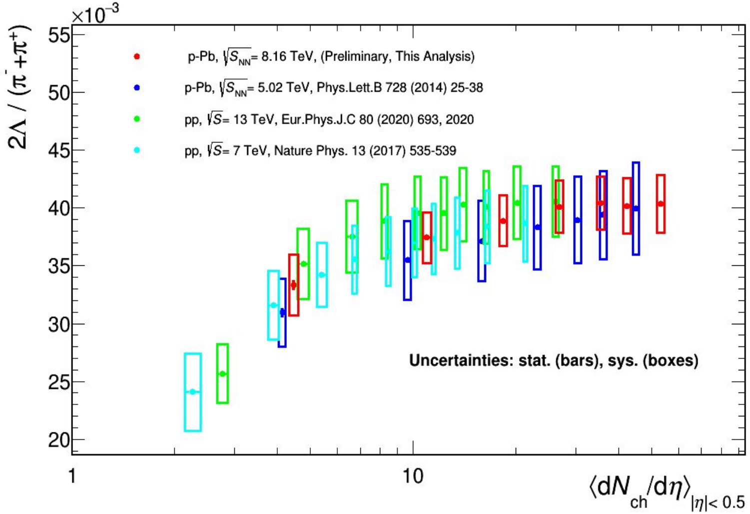




- $\langle p_T \rangle$ increases with multiplicity
- Collision energy dependence of $\langle p_T \rangle$ is observed more for mesons than for baryons.

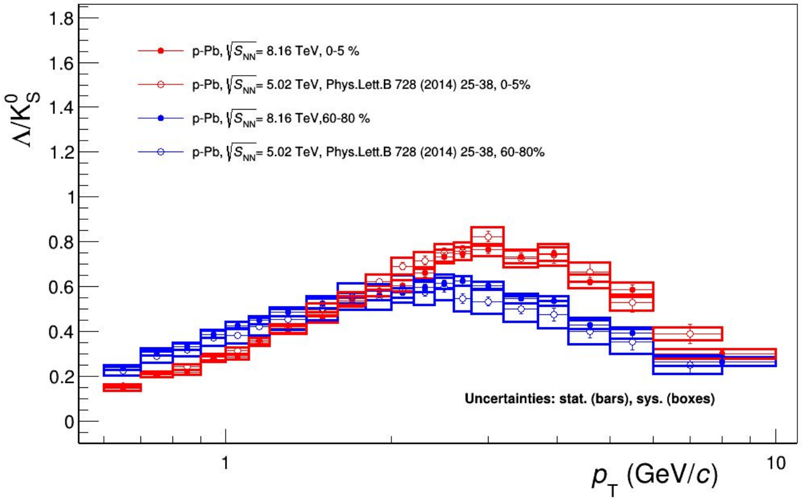
Ratio to pions vs multiplicity

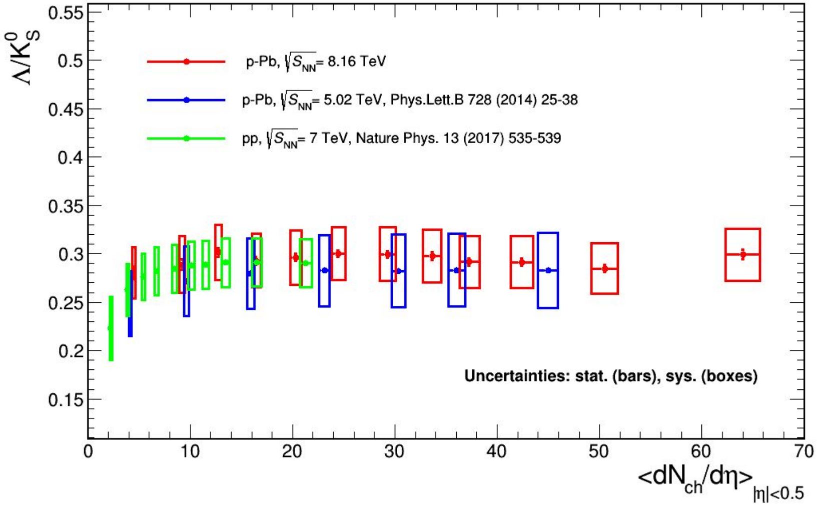




- Ratio of K0s and Λ with respect to pions show enhancement with multiplicity.
- Enhancement is consistent in pp and p-Pb systems at various energies ⟹ multiplicity effect on strangeness production in small systems.

Λ / K^0s ratio

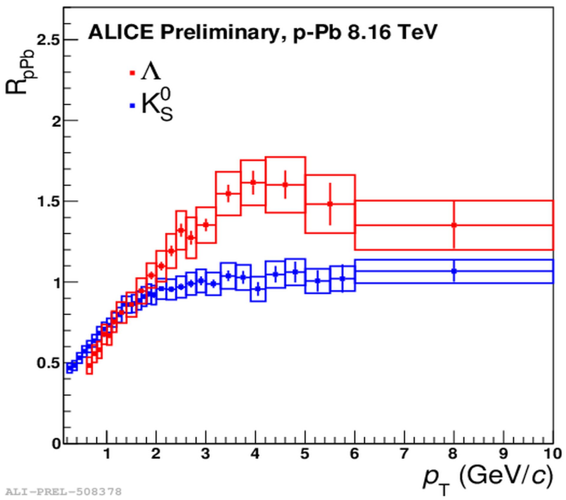


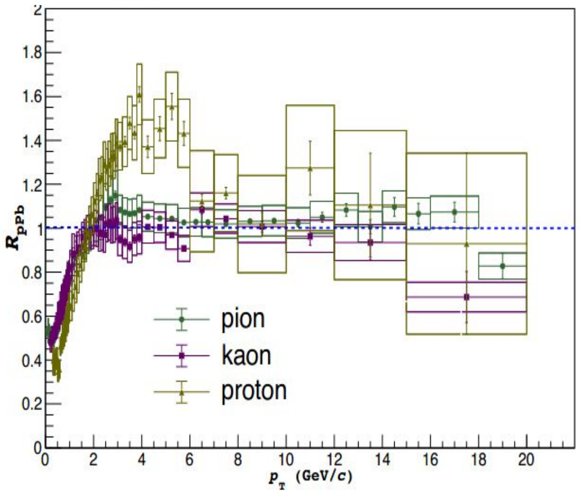


- Λ/K^0_s ratio with pt shows a peak at mid pt which is more enhanced in high multiplicity collisions.
- No energy dependence of the ratios.
- No evolution in the Λ/K^0_s with multiplicity.
- Ratios are consistent across small systems at various energies.

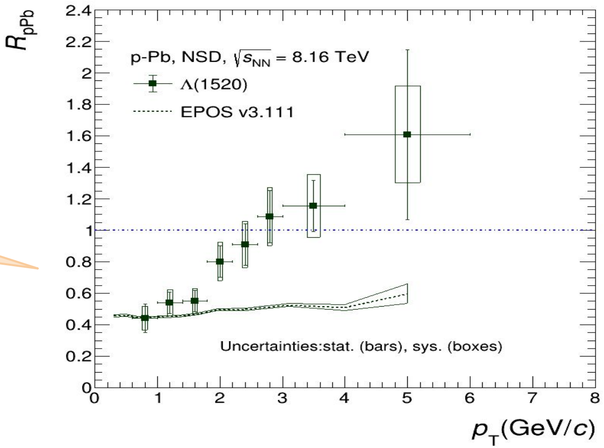
R_{pPb}

- R_{pPb} shows suppression in the low p_T.
- In high p_T, R_{pPb} is equal to 1 within systematic uncertainty.
- Cronin like enhancement for baryons at mid pt.
- EPOS3 prediction shows no evolution with p_T .

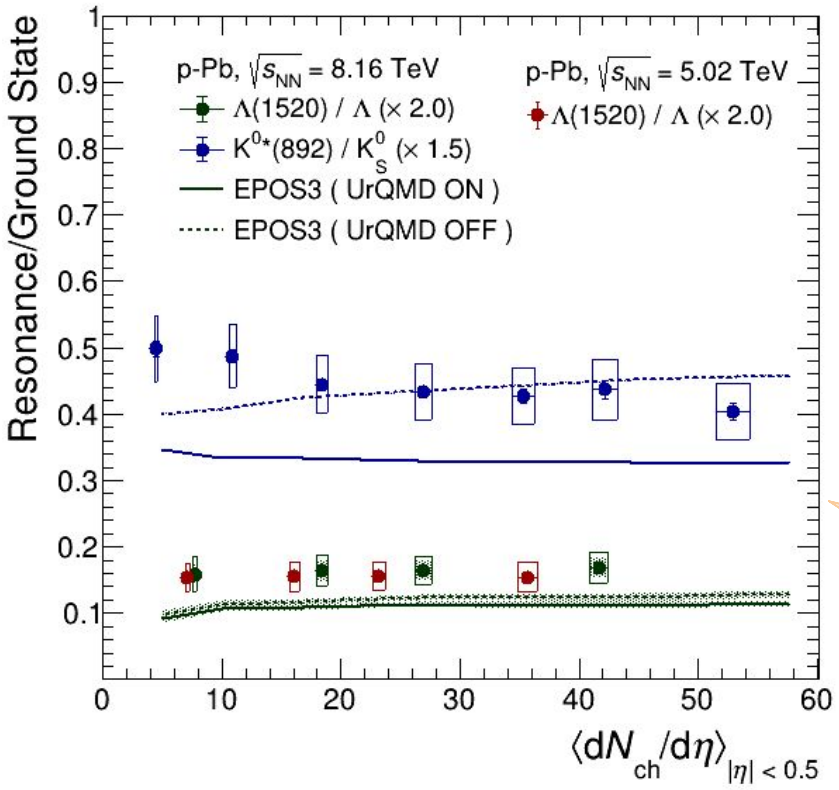




PF comment: Why flat trend in R_{pPb} with EPOS3?



Resonance to non-resonance ratios



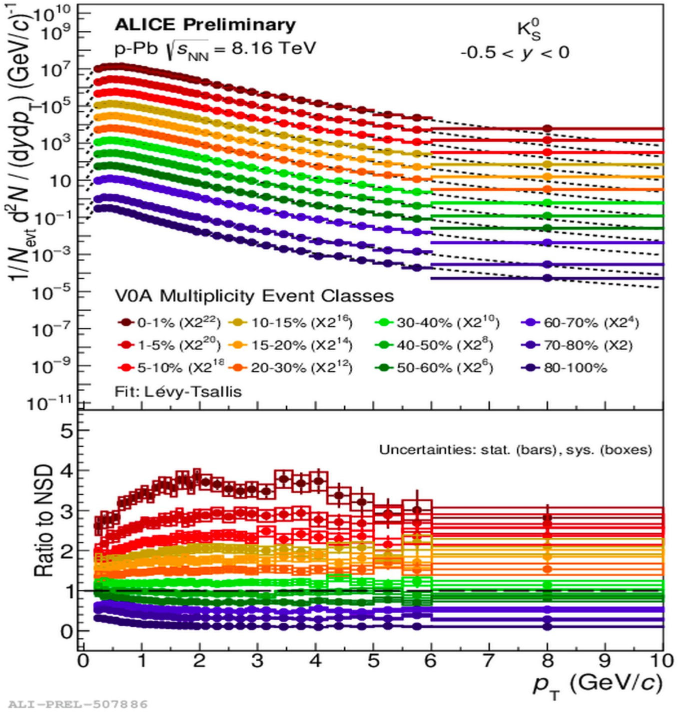
- Hint of formation of hadronic phase in p-Pb system as K^*/K^0s shows suppression.
- Λ^*/Λ show no evolution with multiplicity.
- EPOS3 predicts small suppression for K^*/K^0s ratio with UrQMD ON
- Small enhancement in the Λ^*/Λ ratio predicted by the EPOS3 model with and without UrQMD.

PF comment: There is less of an impression of suppression in the K^*/K^0s ratio shown here. Compare with other available results.

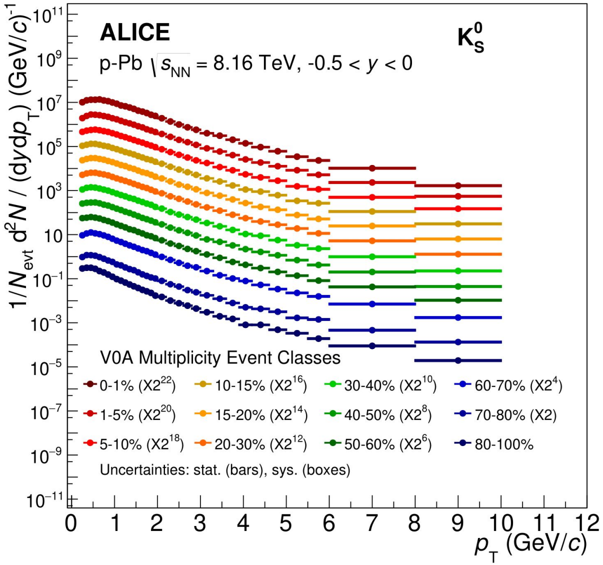
ARC comment: Show p_T differential ratios of Λ^*/Λ in the low and high multiplicity collisions.

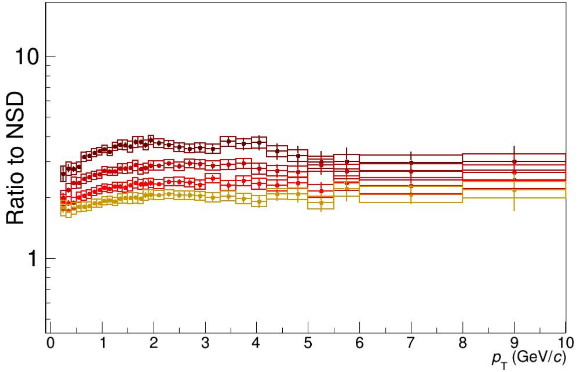
Updated Results …..

Corrected p_T spectra

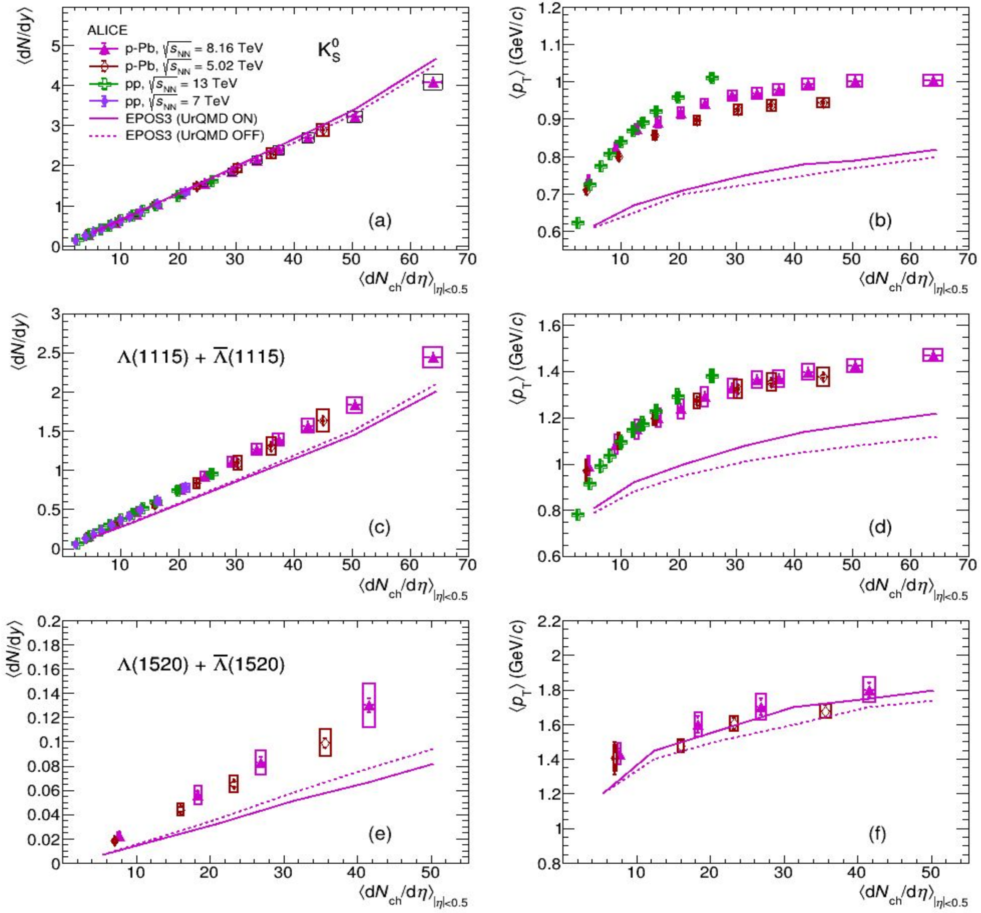


Splitting the last p_T bin



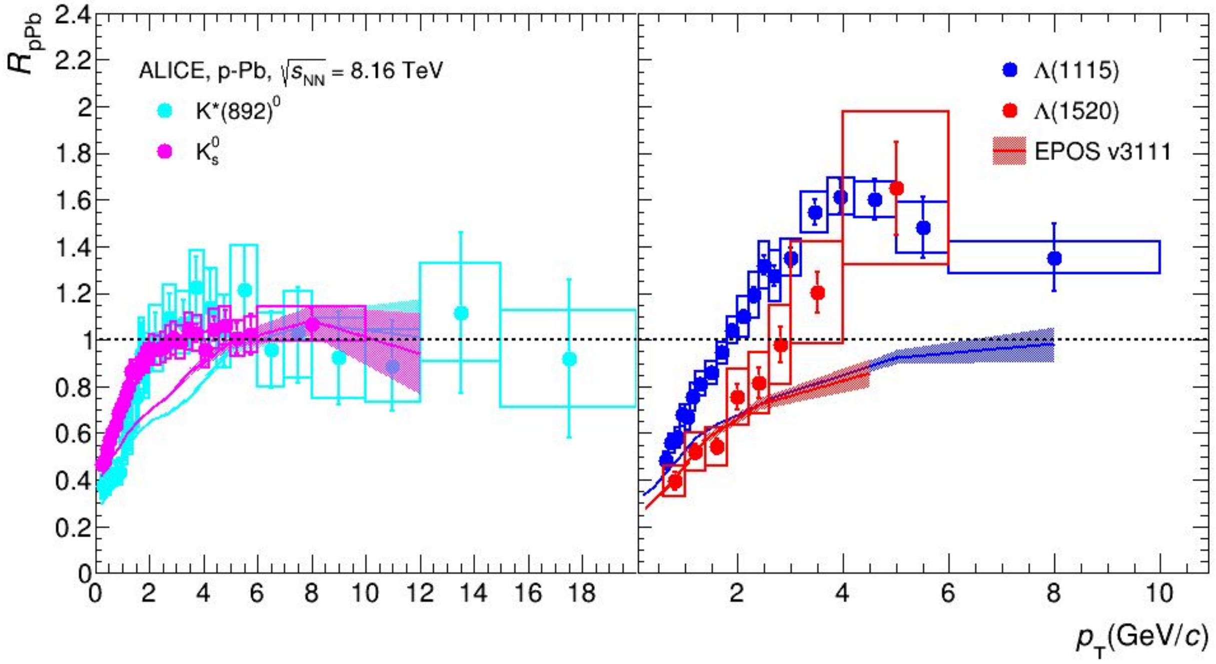


Integrated yield and average p_T



- EPOS3 predictions for average p_T are added.
- EPOS3 underestimates the <p_T> for K0s and Λ(1115), but shows consistency with Λ(1520) within the systematic uncertainties.
- EPOS3 without UrQMD estimates lower results compared to EPOS3 with UrQMD.

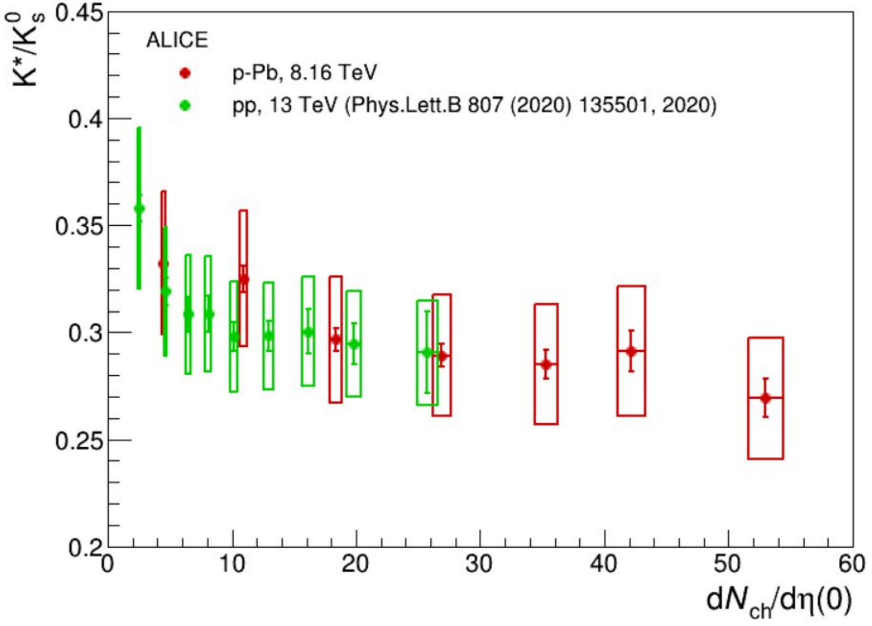
R_{pPb}

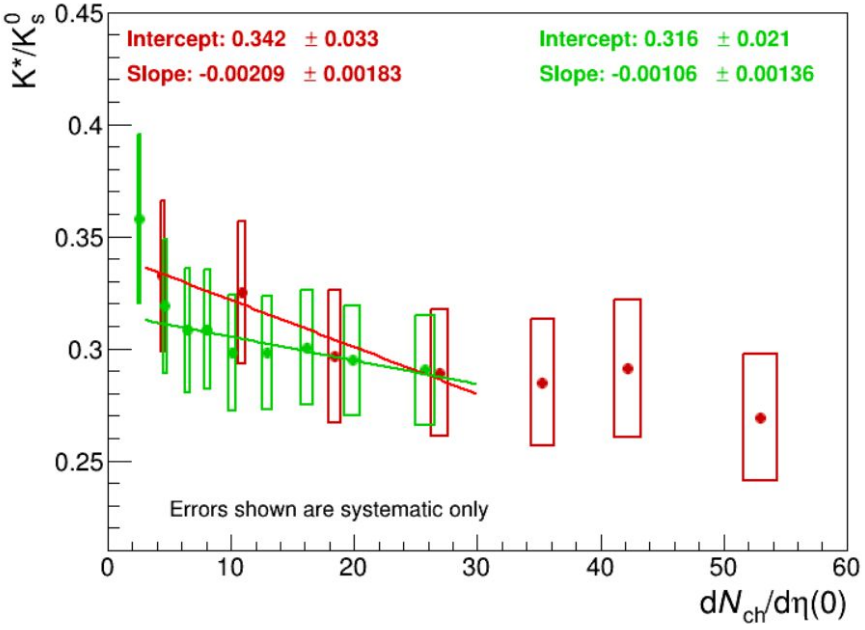


- EPOS3 estimates for R_{pPb} are showing evolution now and approaches to unity at high p_T (This picture was absent earlier due to event generation without hydro in EPOS3)

- EPOS3 in the full hydro+cas simulation does not show any peak above unity for baryons.

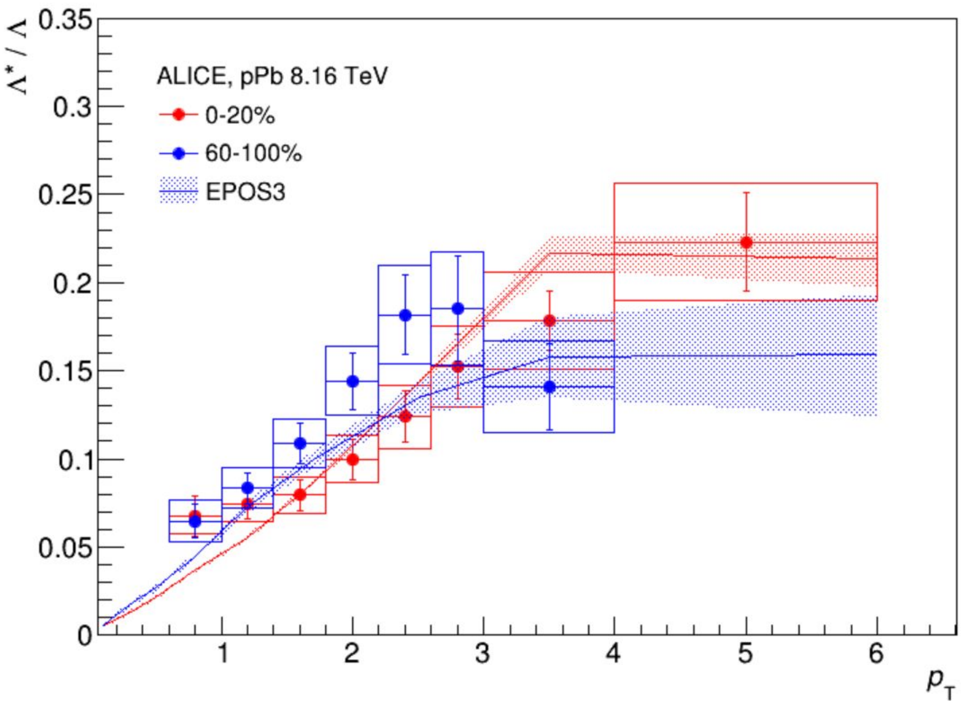
Resonance to non-resonance ratios





- The K^*/K^0s ratios are consistent between pp and p-Pb systems across common multiplicity values within systematic uncertainties.
- The slope of the K^*/K^0s ratio is steeper for p-Pb compared to pp in the common multiplicity region.

Resonance to non-resonance ratios



- The p_T spectral ratio of Λ^*/Λ does not change significantly in the central collisions compared to peripheral collisions.

Summary

- Updated results for measurement of K^0_s, $\Lambda(1115)$ and $\Lambda(1520)$ for p-Pb system at 8.16 TeV are shown.

- Comments from the ARC and Physics Forum are addressed.

- The first draft of the paper is submitted.

Thank you.....

Backup …. .

Dataset

- Analysing Minimum Bias LHC16r CENT low interaction rate runs (comparable with 5TeV rates):
- 265594, 265596, 265607, 266318, 266317, 266316 (40% full triggered statistics)

	No. Events
No. Events Processed	15.9×10^6
No. Events After Trigger Selection	12.5×10^6
No. Events After Event Selections	11.4×10^6

Trigger: AliEvent::kINT7
DAQ Rejection: IsIncompleteDAQ()
Pileup Rejection: IsPileupFromSPDInMultBins()
Vertex quality: $|Z_{SPD} - Z_{Track}|$ < 0.5 cm, Resolution < 0.25 cm
Z-vertex selection: $|Z_{Vtx}|$ < 10 cm
Multiplicity Selection: AliMultSelection::GetMultiplicityPercentile("V0A")

- MC: Using merge of same 6 low interaction runs in GP EPOS-LHC and GP DPMJET
  - LHC17f3a_cent_fix - GP EPOS-LHC: https://alice.its.cern.ch/jira/browse/ALIROOT-7100
  - LHC17f3b_cent - GP DPMJET: https://alice.its.cern.ch/jira/browse/ALIROOT-7100
- MC: ~ 2.2×10^6 events after event selections

Dataset

System@energy	p-Pb@8.16 TeV	pp@8 TeV
Dataset	LHC16r_CENT_wSDD, LHC16r_FAST	LHC12a, LHC12b, LHC12c, LHC12d, LHC12f, LHC12h, LHC12i
Data type	Pass1, ESD	Pass2, ESD
Trigger	kINT7	kINT7
Events	28, 7 M	13.5, 5.4, 4, 14.3, 4.4, 16, 2.4 M
Anchored MC production	LHC17l7a2_cent, LHC17l7a2_fast	LHC15h2a, LHC15h2b, LHC15h2c, LHC15h2d, LHC15h2f, LHC15h2h, LHC15h2i

- ❑ Event selection:
  - Trigger: kINT7
  - Pileup rejection
  - $|v_z| < 10$ cm
- ❑ Analysis cuts
  - StandardITSTPCTrackCuts2011
  - $|\eta| < 0.8$
  - $0 < y_{pair} < 0.5$ for p-Pb
    $-0.5 < y_{pair} < 0.5$ for pp
  - $p_T > 0.15$ GeV/c
  - PID

    Track not present in TOF, (Nσ) TPC =2

    Proton:0 <p(GeV/c)< 1.1

    and Kaon: 0 <p(GeV/c)< 0.6

    Track present in TOF, (Nσ) TOF =3 with (Nσ) TPC =5 as veto

Signal extraction

For K^0_s

p_T range -> 0.2 to 10 (GeV /c)

Multiplicity = {0, 1, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 100}%

(Multiplicities based on V0A estimator)

For $\Lambda(\bar{\Lambda})$

p_T range -> = 0.6 to 10 (GeV /c)

Multiplicity = {0, 1, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 100}%

(Multiplicities based on V0A estimator)

Decay Channel used:

$K^0_s \rightarrow \pi^+ \pi^-$ (B.R 69.2%) $\Lambda \rightarrow p\pi^-$ (B.R 63.9%)

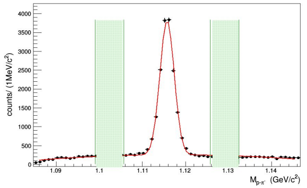
Method for signal extraction:

The invariant mass distributions are fitted with a gaussian peak and second order polynomial for background

Signal region defined as **[M − 4σ, M + 4σ]**, where

- M = Mean of fitted Gaussian (mass of V0)

- σ = standard deviation of fitted Gaussian



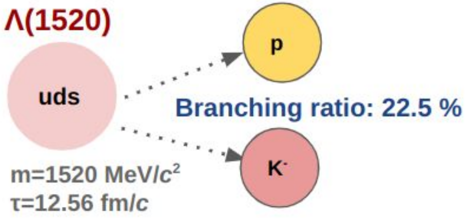
- Background region defined as **[M − 10σ, M − 6σ]** and

[M +6σ, M + 10σ];

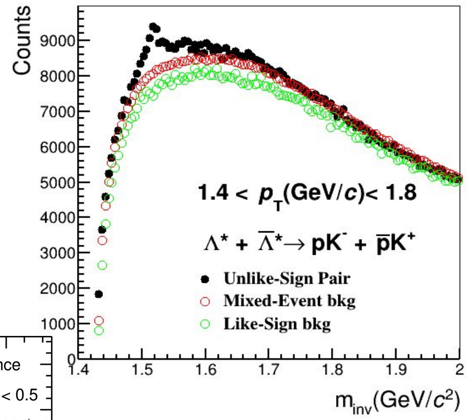
- signal counts determined by subtracting the sum of the background counts in the sidebands from the total counts in the signal region

(Bin Counting Method)

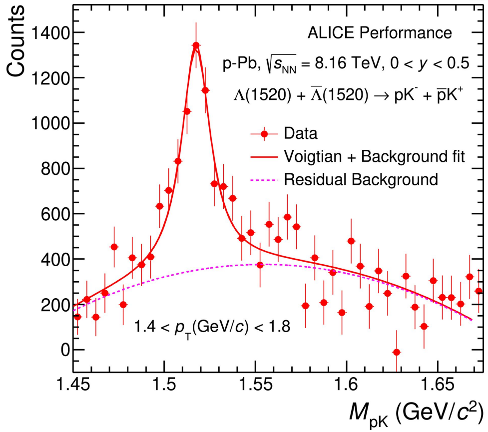
Signal extraction



- **Invariant mass method:** Resonances reconstructed by their decay products, adding their 4-momenta
- **Combinatorial background :** Removed using mixed event technique (10 events are mixed)
- **Residual background :** Correlated pairs or misidentified decay products removed by fitting with polynomial function
- **Signal :** Fit with Voigtian function, yield calculated by integrating the fitting function



$$\frac{\Gamma/_{2\pi}}{(m-m_0)^2+\Gamma^2/_4}\;\frac{e^{-(m-m_0)/_{2\sigma^2}}}{\sigma/_{\sqrt{2\pi}}} + Am^2 + Bm + C$$



Here, Γ is the FWHM of the peak, σ is resolution and m_0 is mass peak position
NR→1.75 – 1.85 GeV/c^2
FR→1.45 – 1.65 GeV/c^2
p_T range pp → (0.5 – 4.5) GeV/c
p_T range p–Pb → (0.6 – 6.0) GeV/c
V0A multiplicity classes for p–Pb in percentile→ 0–20, 20–40, 40–60, 60–100