Exploring the strangeness enhancement and collective-like effects in small collision systems with ALICE at LHC

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1.Motivation

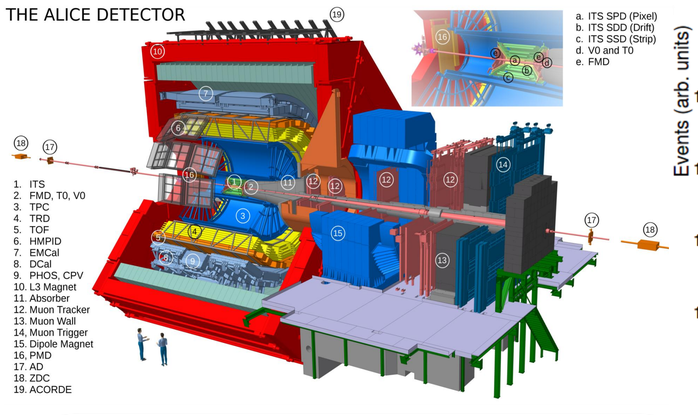
- **Production of strange hadrons**: Key tool for understanding hadronization in different collision systems
- **Strangeness enhancement**: Originally proposed as a signature of quark gluon plasma (QGP) in nuclear collisions [1]

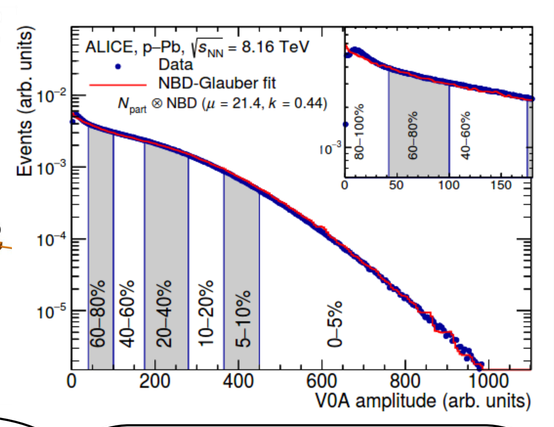
Several similarities observed recently between heavy ion and high multiplicity pp and p–Pb collisions

Hadrochemistry in p–Pb collisions

- Benchmark for heavy ion physics.
- p–Pb collisions are a valuable tool to study initial-state effects, which are present as a consequence of the nucleons being bound into nuclei
- Intermediate collision system which can help to disentangle the physics processes going on in heavy ion and pp collisions

2.Detector setup



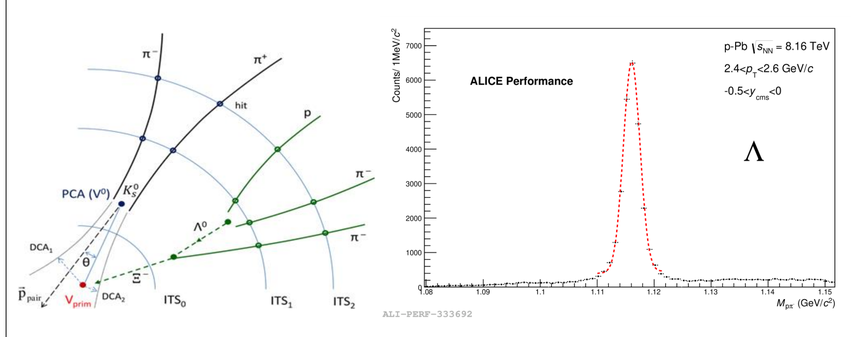


- **ITS:** Triggering, Vertexing, Tracking, PID (d*E*/dx)
- **TPC:** Vertexing, Tracking, PID (d*E*/dx)
- **V0A (Scintillator):** Triggering, Background Rejection, Multiplicity estimation.
- **ZDC:** Forward energy percentile classes

More details in [2]

Figure: Distribution of the sum of amplitudes in V0A (Pb-going side) and the NBD-Glauber fit in red. Centrality percentile classes are indicated by vertical lines.

3.Identification of (multi-)strange hadrons



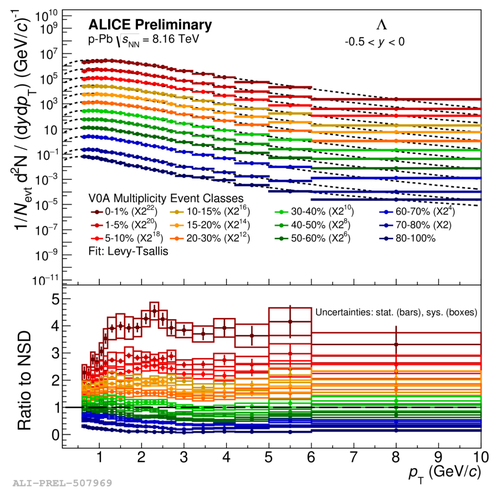
V0→ neutral particle decaying weakly into a pair of charged particles (V-shaped)

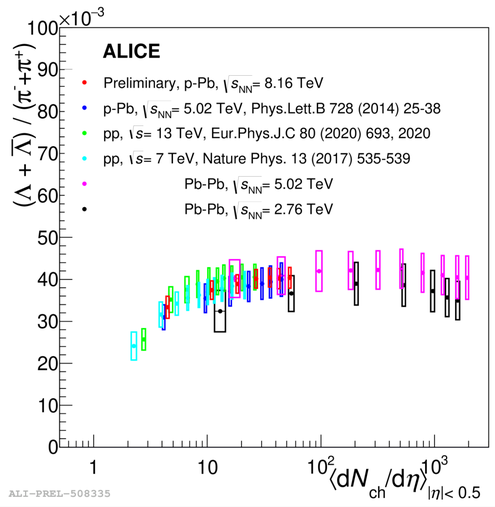
Cascade→ charged particle decaying weakly into a V0 + charged particle

(Multi-)strange baryons in ALICE are reconstructed via their (V^0 or cascade) decay topology, through the following steps:

- charged tracks are reconstructed in the Inner Tracking System (ITS) and Time Projection Chamber (TPC);
- specific ionization energy loss (in the TPC) is used to identify daughter particles;
- at the reconstruction level, cascade candidates are found by combining reconstructed tracks and applying loose selections on geometry and kinematics;
- selection cuts are finally tightened to reduce background at the analysis level

4.p_T spectra and Integrated Yield Ratio

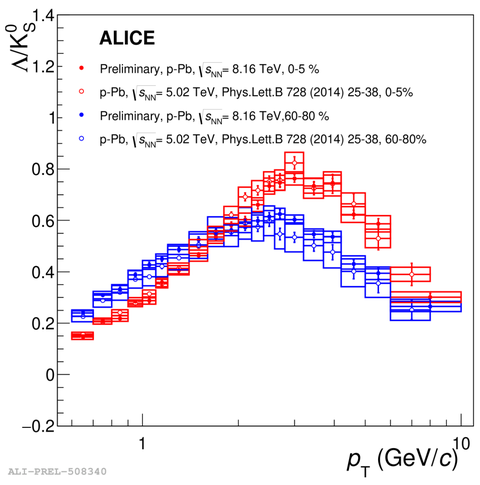




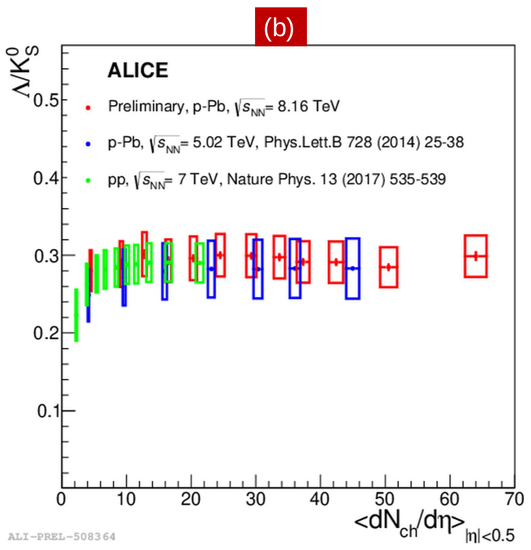
- The p_T spectra become harder as the multiplicity increases
- Possible interpretation: particle emission from a collectively expanding system
- p_T integrated yield ratio to pions shows enhancement [3] from low multiplicity pp to central Pb–Pb collisions
- Smooth evolution between pp, p–Pb and Pb–Pb collisions
- Yield ratios show a saturation in central Pb–Pb collisions

5.Results on strangeness studies with ALICE

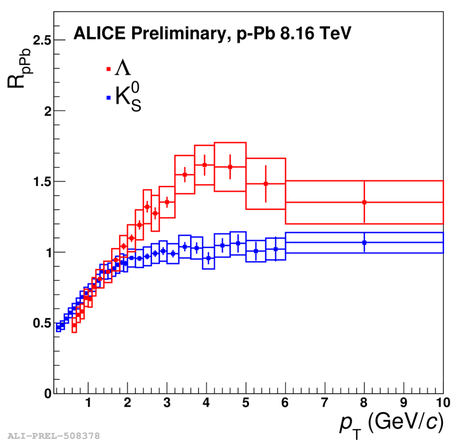
(a)



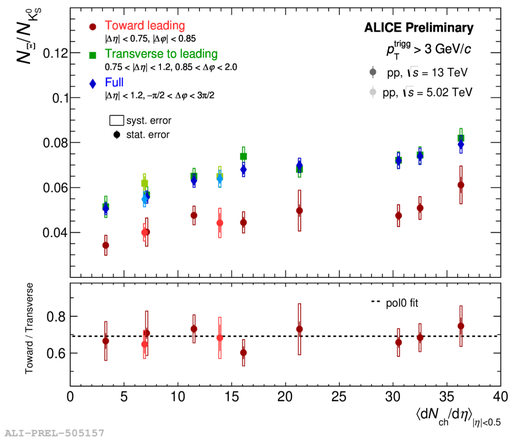
(b)



(c)



(d)



(e)

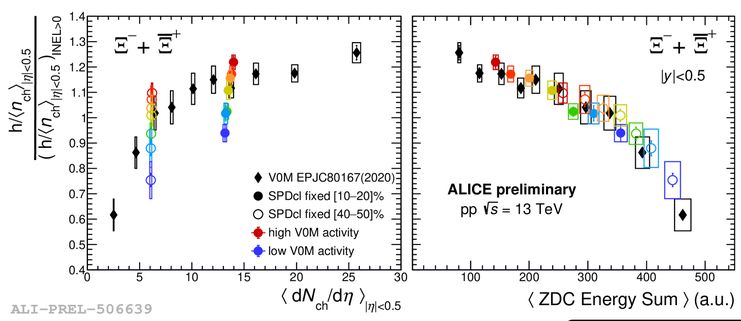


Figure (a): Λ/ K^0_S ratio as a function of p_T shows a peak at around 2-4 GeV/*c*

(Baryon enhancement)

--> *interplay of radial flow and parton recombination at intermediate* p_T

Figure (b): p_T integrated Λ/ K^0_S ratio shows no significant evolution as a function of multiplicity

--> *Strangeness enhancement is not driven by mass nor it is a baryon/meson effect*

Figure (c): Mass ordering of R_{pPb} at intermediate p_T qualitatively similar to that in Pb–Pb collision

--> *Mass ordering or Baryon meson splitting?*

Figure (d): Ξ /K^0_S yield ratio as a function of charged-particle multiplicity produced at midrapidity, choosing the leading particle having the highest p_T

--> transverse to leading (soft) processes are the dominant contribution to strange particle production

Figure (e): $\Xi^{\pm}$ yield normalised to the charged particle multiplicity fixing the multiplicity at midrapidity or forward energy using ZDC

--> *strangeness enhancement in pp collisions is observed at fixed final state multiplicity at midrapidity and shows a strong correlation with the effective energy, which reflects the initial state of the collision.*

6.Summary and conclusions

- Ratios of neutral strange hadrons to pions increase with multiplicity and then saturate (strangeness enhancement). The ratios are found to be independent of the collision system and center-of-mass energy
- Λ / K^0_S : Baryon enhancement at intermediate p_T
- p_T integrated Λ / K^0_S as a function of multiplicity shows no significant evolution
- R_{pPb} : peak at intermediate p_T visible for Λ.
- Strangeness production in the transverse to leading (soft) processes dominates at high multiplicity
- Effective energy [4] can be used to study how strangeness enhancement is affected by initial state conditions

7.References:

[1] J. Rafelski and B. Müller, PRL48, 1066 (1982)

[2] The ALICE Collaboration, JINST 3 S08002 (2008)

[3] ALICE Collaboration, Nature Physics 13, 535–539 (2017)

[4] A.Akindinov et. al., Eur. Phys. J. C 50, 341-352 (2007)