STRANGENESS PRODUCTION AT LHC ENERGIES WITH ALICE

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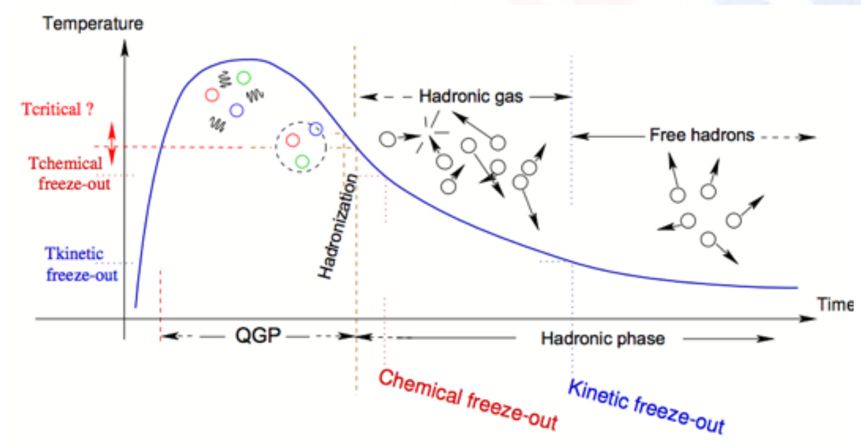
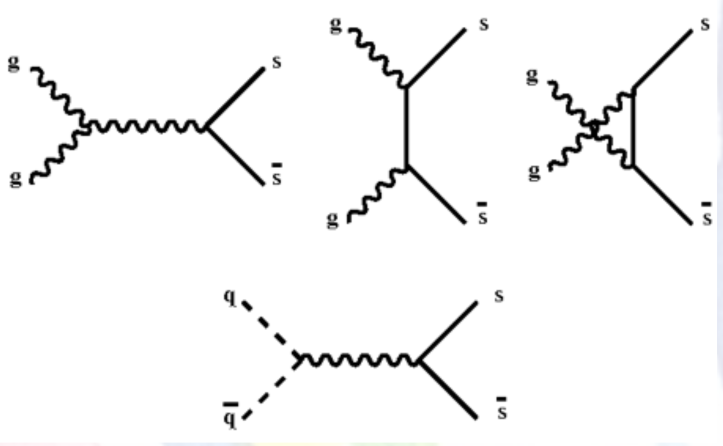
INTRODUCTION AND PHYSICS MOTIVATIONS

- **A-A collisions: evolution and QGP**
  Reaching sufficient high energy densities (ε ~ 1 GeV/fm³), it becomes possible to create a state of partonic matter, the so-called **Q**uark-**G**luon **P**lasma, where quarks and gluons are not confined in hadrons





- **Strangeness enhancement**
  The enhanced production of strangeness in nuclear collisions with respect to hadron collisions was one of the first proposed signatures of QGP formation ∗

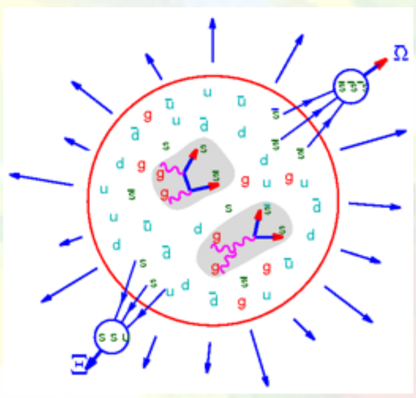
s quarks are not present as valence quarks in ordinary matter, but since their mass (~ 150 MeV/c²) is comparable with QGP temperature (T ≥ 160 MeV) they can be abundantly produced in thermal processes like $g\bar{g} \rightarrow s\bar{s}$, $q\bar{q} \rightarrow s\bar{s}$

Strangeness saturation is also possible in hadron gas but the time required for chemical equilibrium is much longer (~ 10 fm/c) and strangeness production is much more energetically demanding than in QGP

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

- **Importance of pp collisions**
  Proton-proton collisions have been used extensively as a reference for the study of interactions of larger colliding systems at the LHC

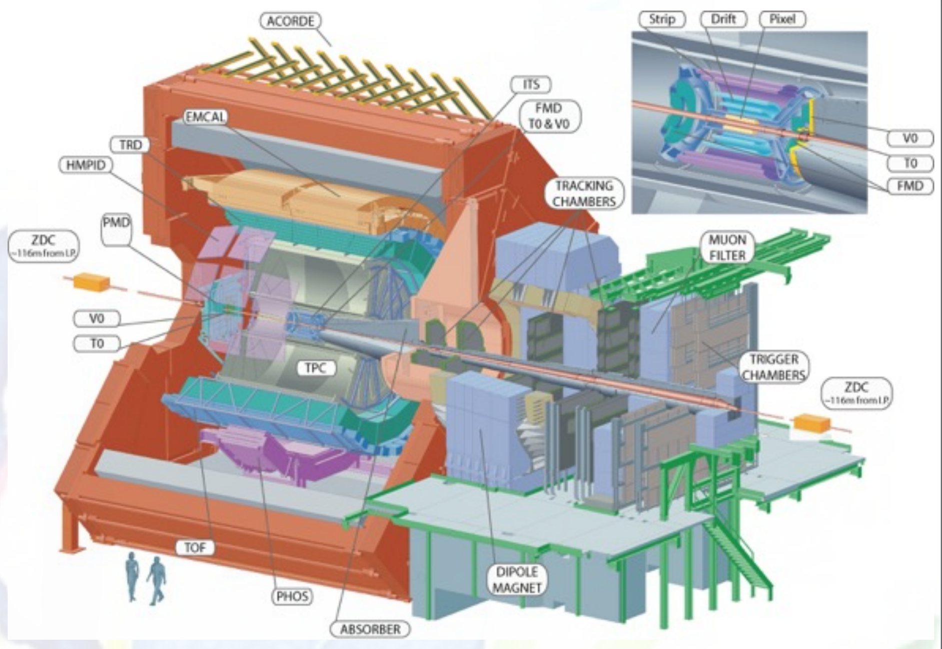
The systematic study of identified particle production as a function of charged particle multiplicity in pp can provide further insights into dynamics of small systems



THE ALICE EXPERIMENT

Main detectors used in the analyses of strange particles :

- Inner Tracking system (ITS, |η| <0.9)
  - tracking and vertexing
    resolution better than 100 μm
- Time Projection Chamber (TPC, |η| <0.9)
  - main tracking device
  - momentum measurement
    0.1 GeV/c < p_T < 100 GeV/c
  - particle identification (dE/dx) resolution is ~ 7 % in central Pb-Pb collisions
- VZERO [V0A(2.8<η <5.1)&V0C(-3.7<η<-1.7)]
  - triggering, beam gas rejection
  - centrality (Pb-Pb) and multiplicity (pp, p-Pb) class definition



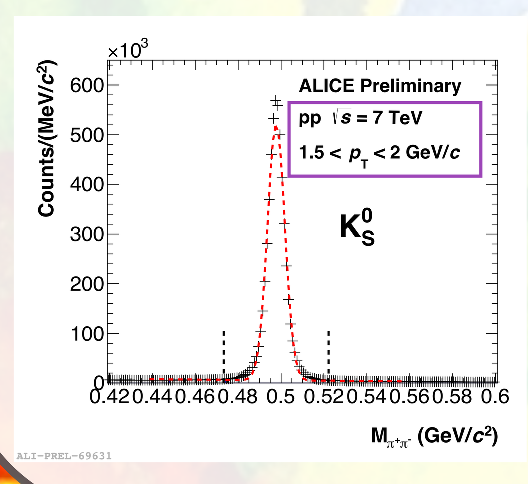
Low material budget in the central region (13% X_0 for ITS+TPC), good momentum resolution (~1.5%)@ p_T = 0.1 - 20 GeV/c

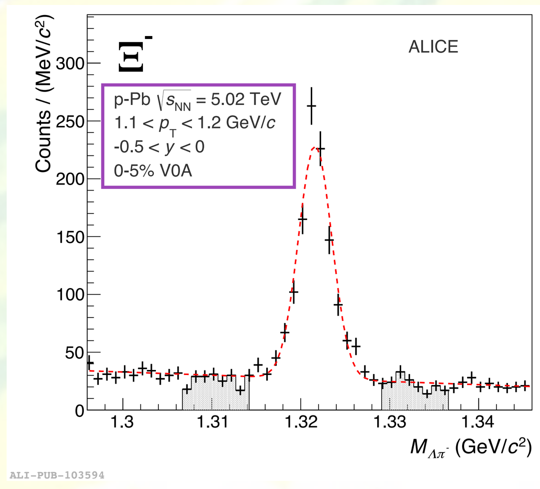
[The ALICE Collaboration et. al. 2008 JINST 3 S08002]

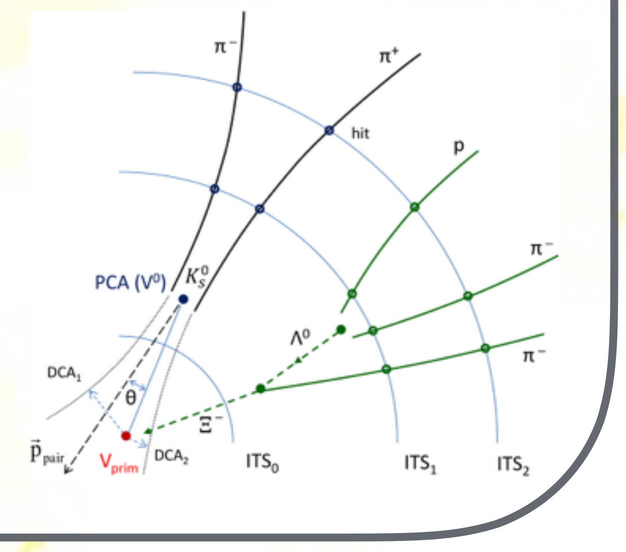
PARTICLES RECONSTRUCTION

- Reconstruction of strange and multi-strange particles via decay topology

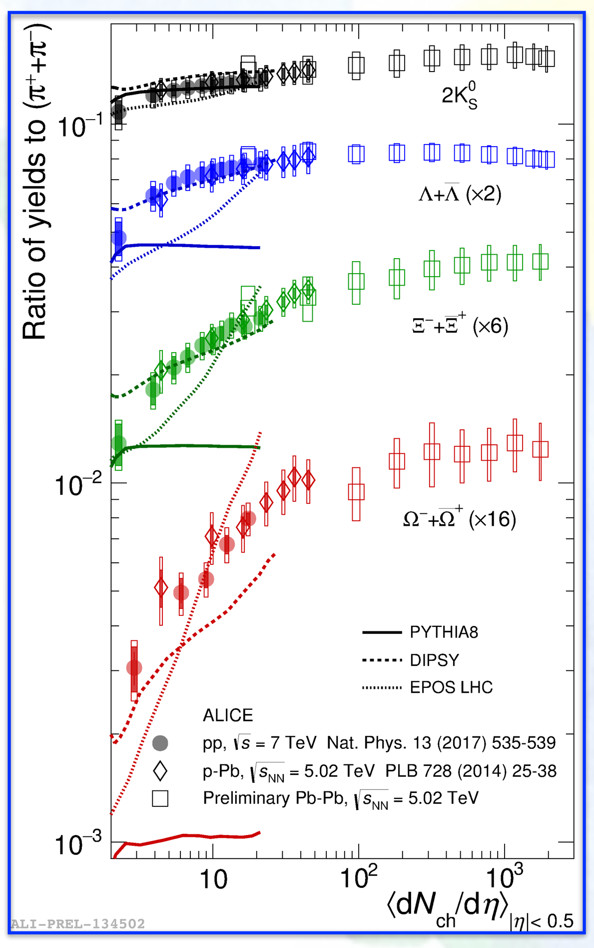
$K^0_S \rightarrow \pi^+ + \pi^-$	$\Lambda \rightarrow p + \pi^-$	$\Xi^- \rightarrow \Lambda + \pi^-$	$\Omega \rightarrow \Lambda + K^-$
mass : 497.61 MeV/c²	mass : 1115.68 MeV/c²	mass : 1321.71 MeV/c²	mass : 1672.45 MeV/c²
cτ : 2.68 cm	cτ : 7.89 cm	cτ : 4.91 cm	cτ : 2.46 cm
B.R. : 69.2 %	B.R. : 63.9 %	B.R. : 99.9 %	B.R. : 67.8 %





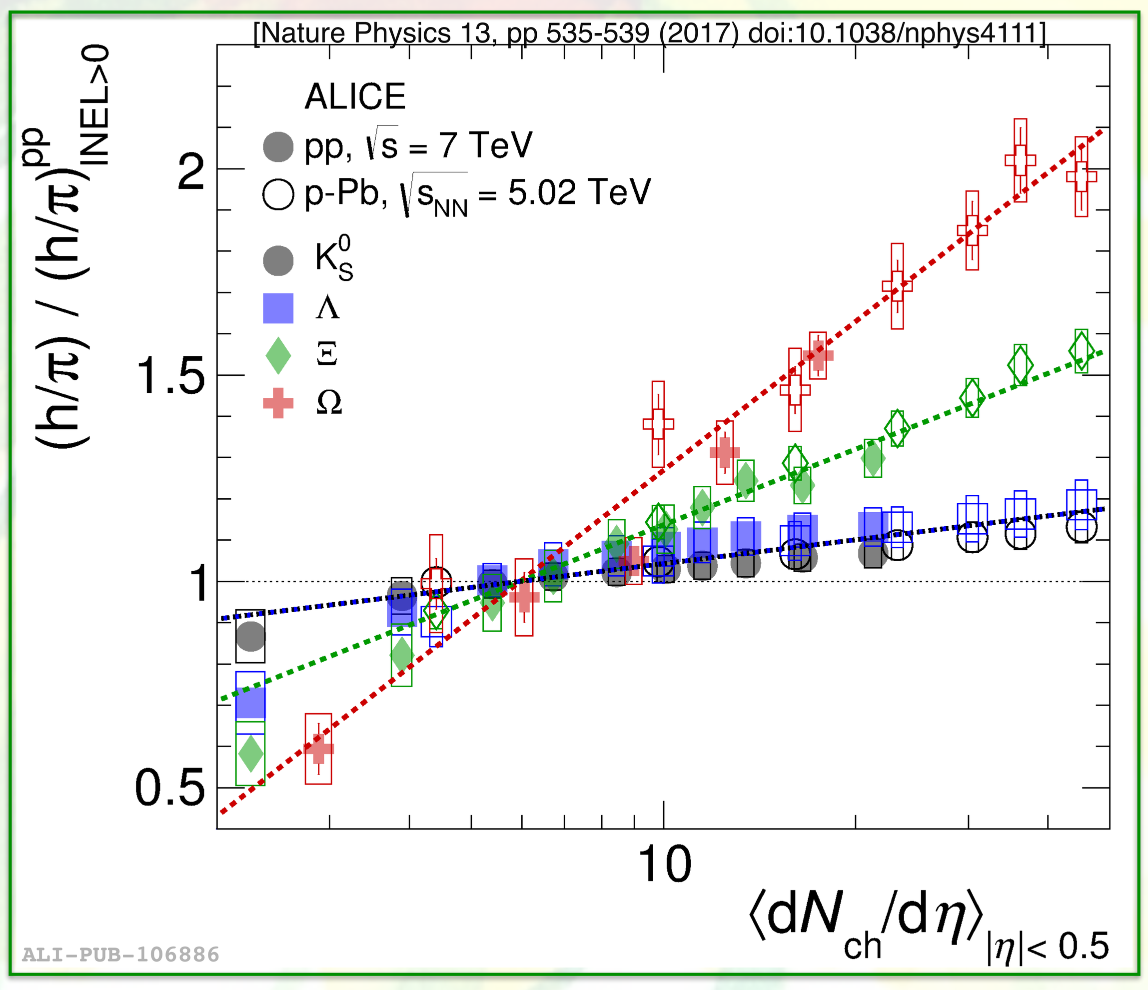


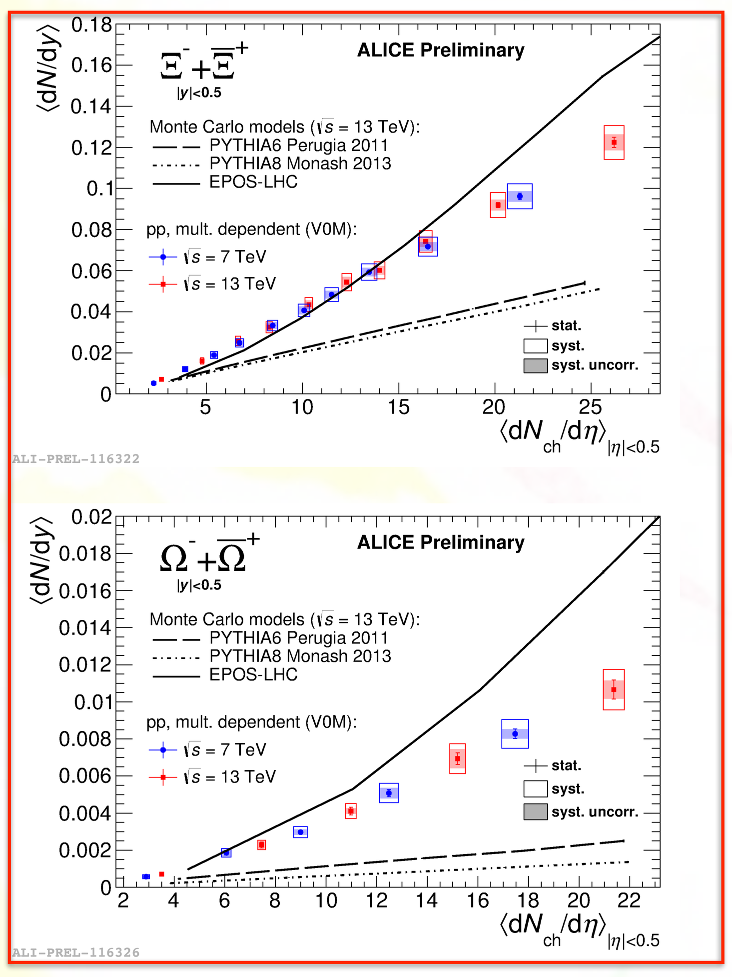
RESULTS

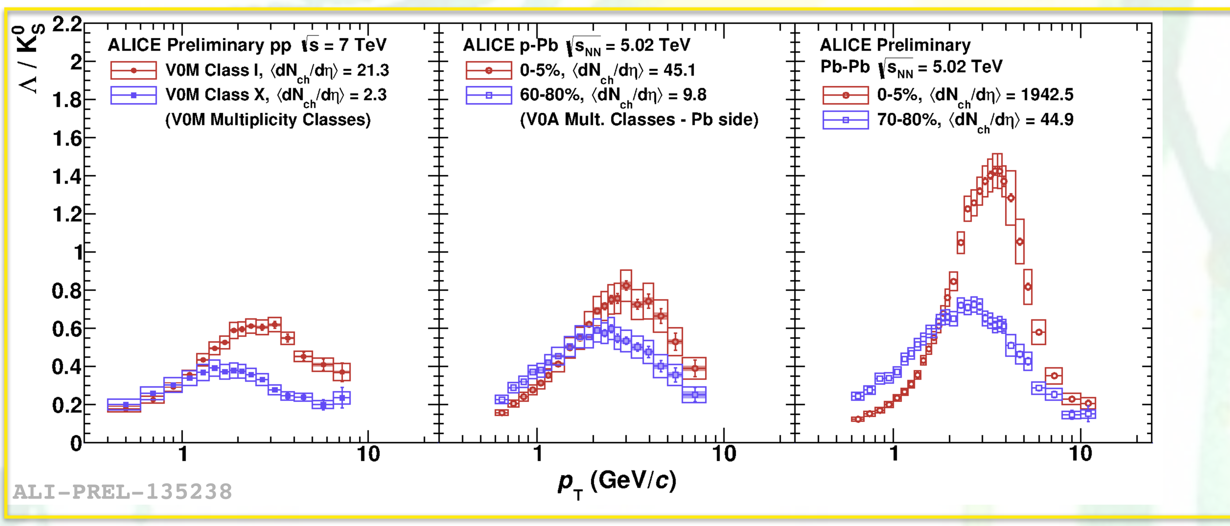


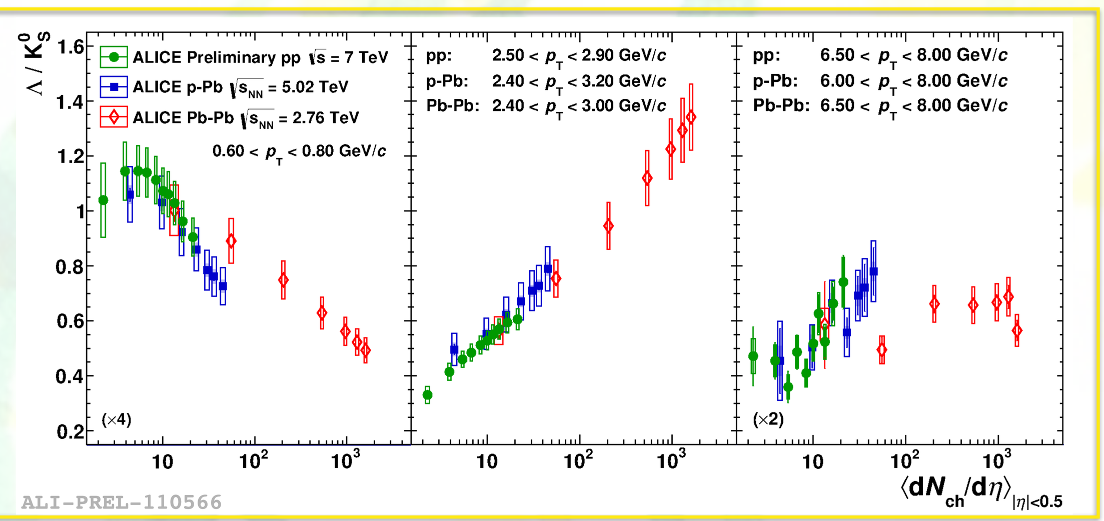
- Significant enhancement of strange to non-strange particle yields for high-multiplicity pp
- Consistent pattern between pp, p-Pb and Pb-Pb, with agreement in the overlapping multiplicity regions
- Models do not describe experimental observations satisfactorily

- Double-ratio in pp collisions (and in p-Pb) evolves smoothly with multiplicity density
- The larger the valence strange quark content, the steeper the slope (dashed lines are linear fits)









- Scaling of strange particle yields with multiplicity in pp at √s = 7 and 13 TeV

- The Λ / K^0_S ratio shows a qualitatively similar dependence on multiplicity for pp, p-Pb and Pb-Pb collisions

SUMMARY AND OUTLOOK

- The multiplicity dependence of strangeness production is strikingly similar in pp and p-Pb, and approaches values corresponding to central Pb-Pb
- Enhancement of strange and multi-strange hadron production is observed towards high multiplicity pp events
- Several strangeness dependencies and relations among different types and energy collisions indicate discrepancies between experimental data and models
- Will the relative strangeness production in pp saturate ? (stay tuned for High-Mult. Trigger in pp@13 TeV)

133rd LHCC Meeting

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