Multiplicity dependence of strangeness production in proton-proton collisions at $\sqrt{s}$ = 5.02 TeV with ALICE at the LHC

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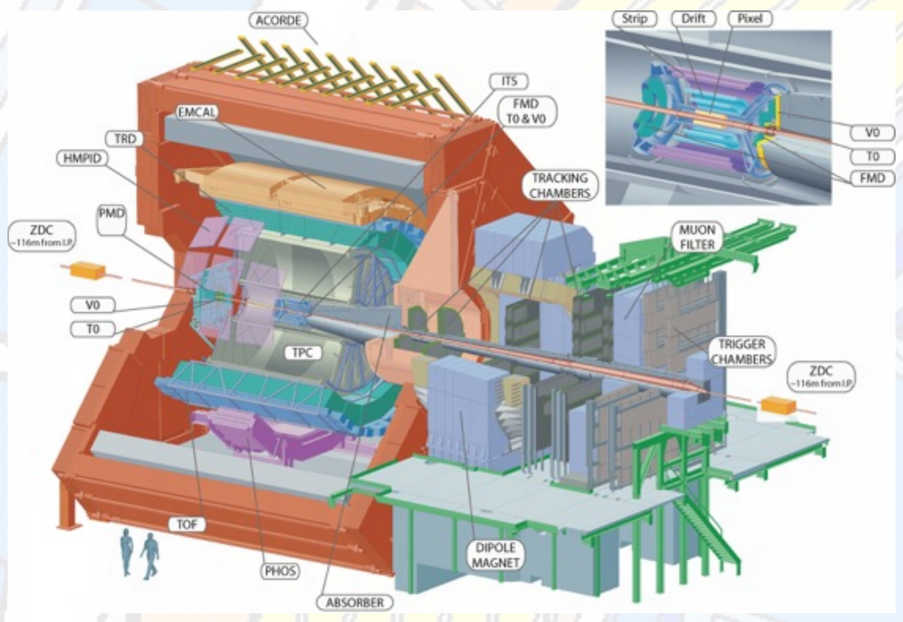
Introduction and Physics motivations

- **A-A collisions: evolution and QGP**
  Reaching sufficient high energy densities ($\varepsilon \sim 1$ GeV/fm^3), 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. [1]
- **Strangeness enhancement**
  Higher yields per participant nucleon for strange and multi-strange particles relative to those in pp collisions has been predicted as a signature for QGP. [1]
  s quarks are not present as valence quarks in ordinary matter, but since their mass after partial chiral restoration (~ 150 MeV/c²) is comparable with QGP temperature (T ≥ 160 MeV) they can be abundantly produced in thermal processes like $g\bar{g} \rightarrow s\bar{s}$ or $q\bar{q} \rightarrow s\bar{s}$.
- **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 has demonstrated to provide further insights into dynamics of small systems.

Measuring strange particles in ALICE

- VZERO [V0A($2.8<\eta<5.1$)&V0C($-3.7<\eta<-1.7$)]
  - triggering, beam gas rejection
  - centrality (Pb-Pb) and multiplicity (pp, p-Pb) class determination



Low material budget in the central region (13% X/X$_0$ for ITS+TPC), good momentum resolution (~1.5%)@ p_T = 0.1 - 20 GeV/c [2]

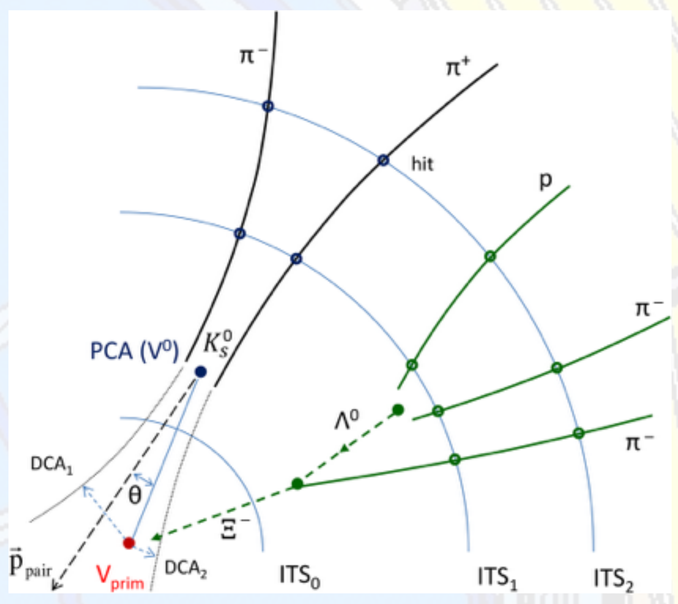
- Time Projection Chamber (TPC, $|\eta| < 0.9$)
  - main tracking detector
  - momentum measurement
    0.1 GeV/c < p_T < 100 GeV/c
  - particle identification (dE/dx) resolution is ~ 7 % in central Pb-Pb collisions
- Inner Tracking system (ITS, $|\eta| < 0.9$)
  - tracking and vertexing
  - vertex resolution better than 100 μm

Candidates are reconstructed via their decay topology, through the following steps:

1. charged tracks are reconstructed in the ITS and TPC
2. specific ionisation (in the TPC) is used to identify daughter particles
3. candidates are selected combining reconstructed tracks and applying loose cuts on geometry and kinematics
4. selection cuts are finally tightened to reduce background at the analysis level
5. invariant mass spectrum of the candidates is used for signal extraction

Sample
- **pp**: about 180×10⁶ minimum bias collisions at $\sqrt{s}$ = 5.02 TeV taken in 2015

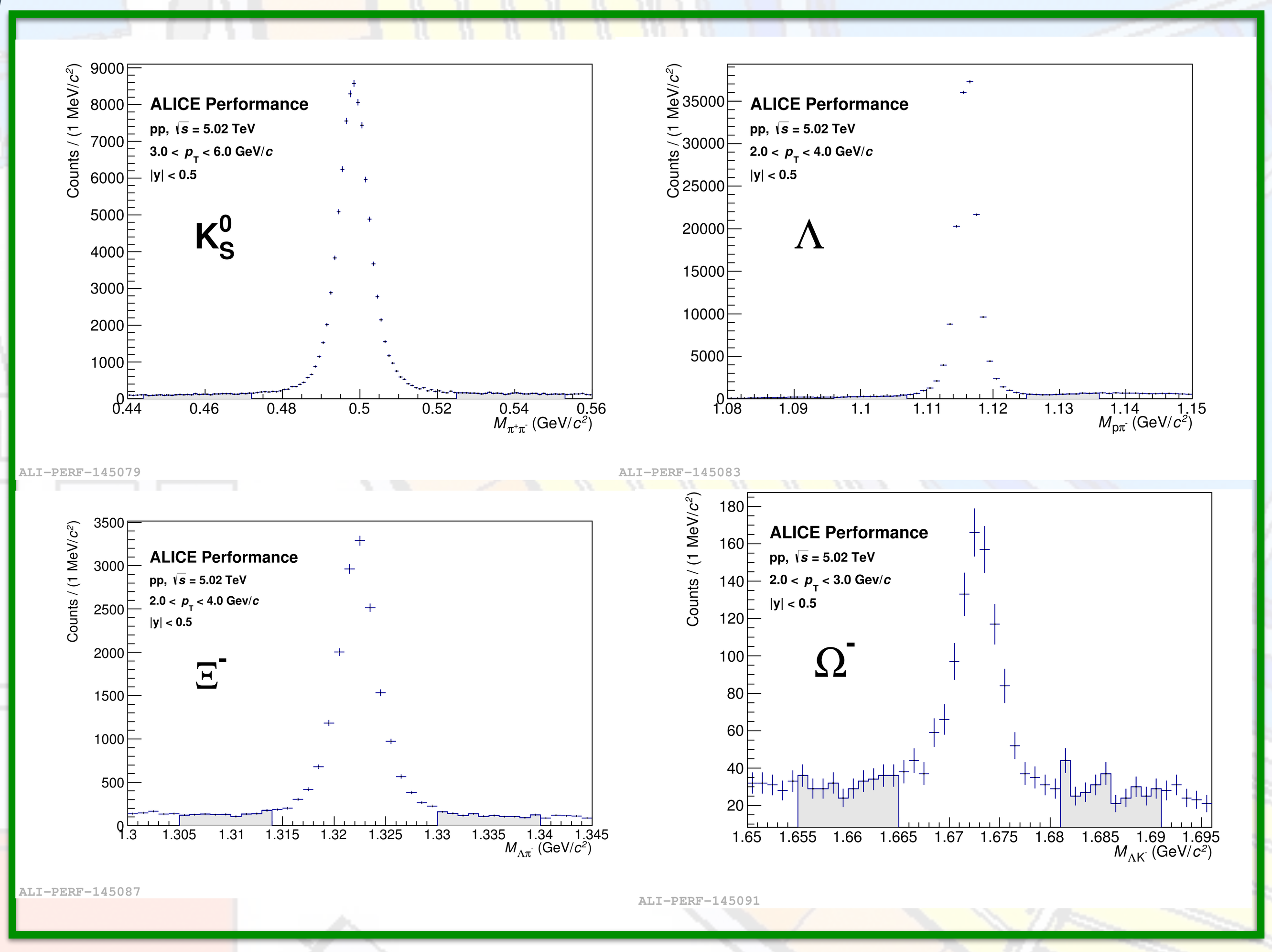
Signal extraction
1. polynomial+gaussian fit of the signal region in invariant mass region to extract the value of the mean and σ
2. bin counting in the signal region (± 3 σ)
3. fit background sampled on both sides of the signal region
4. integral of background fit function in the signal region



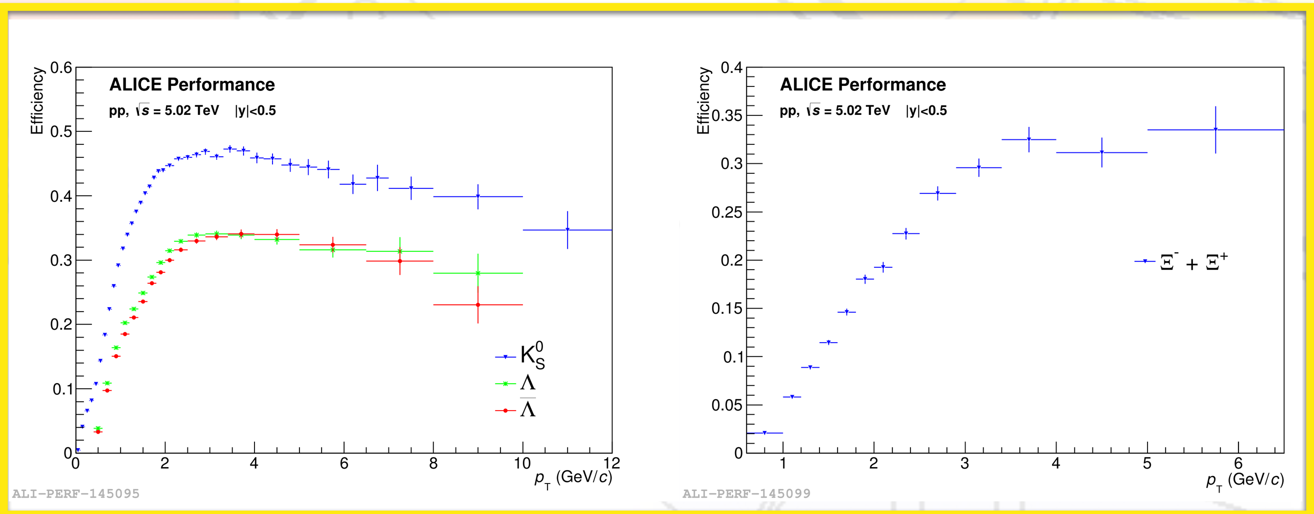
V⁰ - neutral particle decaying weakly into a pair of charged particles
Cascades - decay of charged particle into one charged and **V⁰** particle
V⁰s and **Cascades** decaying modes :

$K^0_S \rightarrow \pi^+ + \pi^-$ B.R. : 69.2 %
$\Lambda \rightarrow p + \pi^-$ B.R. : 63.9 %
$\Xi^- \rightarrow \Lambda + \pi^-$ B.R. : 99.9 %
$\Omega \rightarrow \Lambda + K^-$ B.R. : 67.8 %

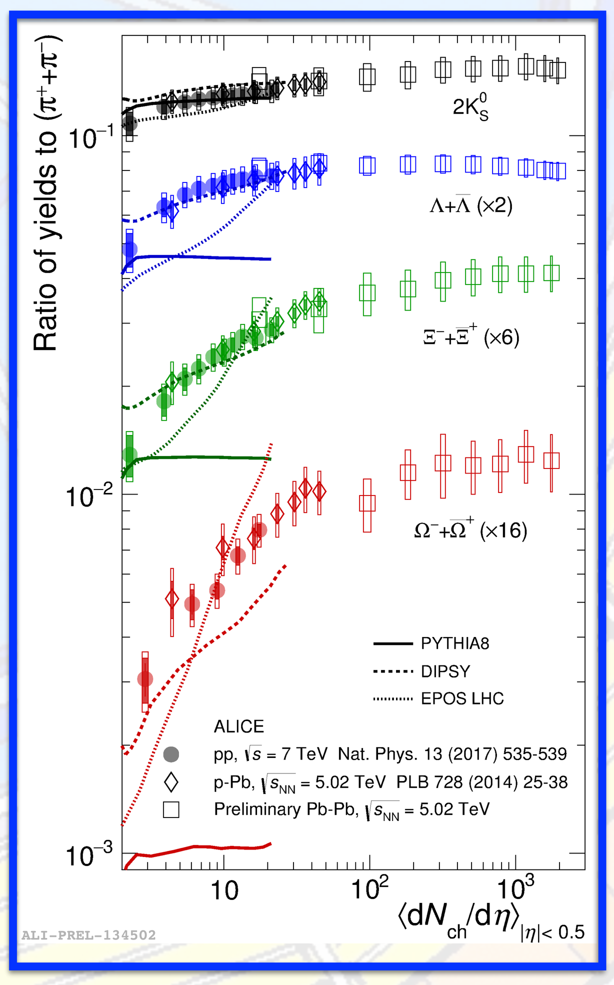
RESULTS



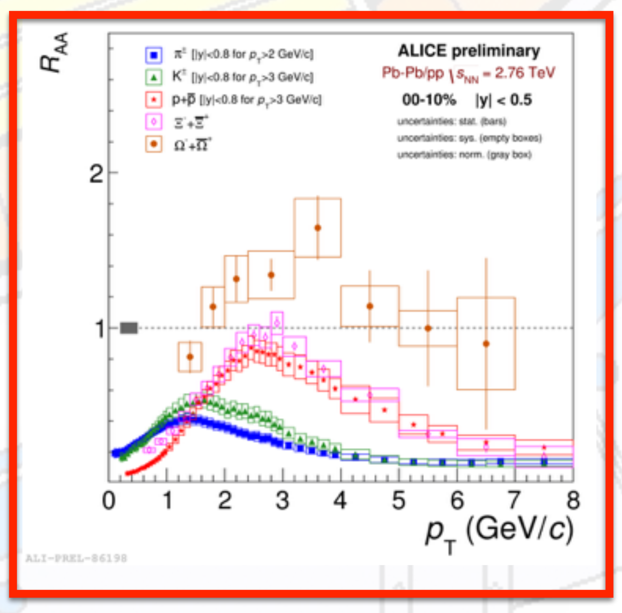
- Invariant mass distributions for V⁰s and Cascades reconstructed for selected p_T bins
- Clear signal observed for all strange hadrons $K^0_S, \Lambda, \Xi, \Omega$ in minimum bias data sample

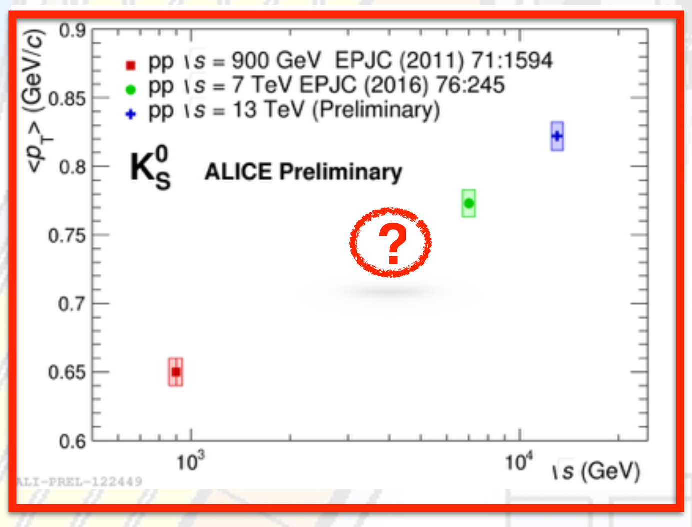


- Detector efficiency dependence on p_T was estimating with QCD-inspired MC model, namely PYTHIA8 with Monash tune [3]

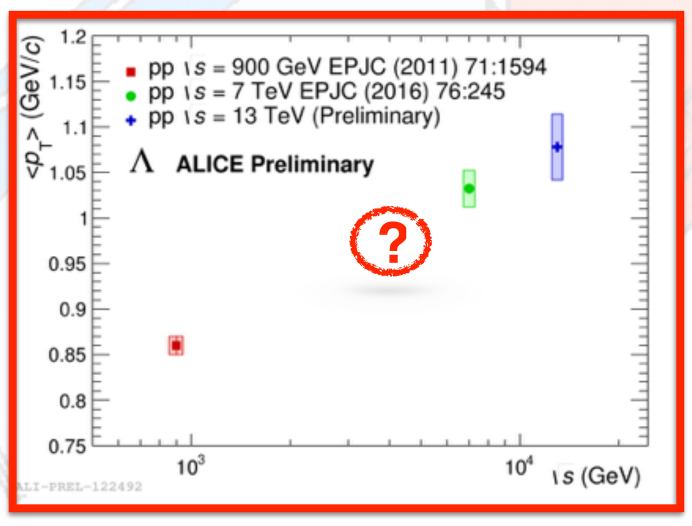


- Significant enhancement of strange to non-strange particle yields for high-multiplicity pp
- Consistent pattern between pp, p-Pb and Pb-Pb, with agreement in the overlapping multiplicity regions
- Models do not describe experimental observations satisfactorily





- Average transverse momentum of K^0_S as a function of collision energies shows increasing trend
- Nuclear modification factor for strange particles at the LHC provides additional constraints to parton energy loss models
- pp collisions at $\sqrt{s}$ = 5.02 TeV can complement existing results



SUMMARY AND OUTLOOK

- Enhancement of strange and multi-strange hadron production is observed towards high multiplicity pp events
- Results from pp@5.02 TeV will complement the current trends observed in the other energies and colliding systems
- Stay tuned for high-statistic data in pp@5.02 TeV from 2017

[1] J. Rafelski and B. Müller, PRL48, 1066 (1982); [2] [The ALICE Collaboration et. al. 2008 JINST 3 S08002]; [3] P. Skands,S. Carraza,J. Rojo, 1434-6052,(2014)

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