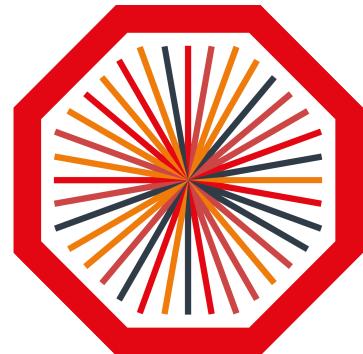
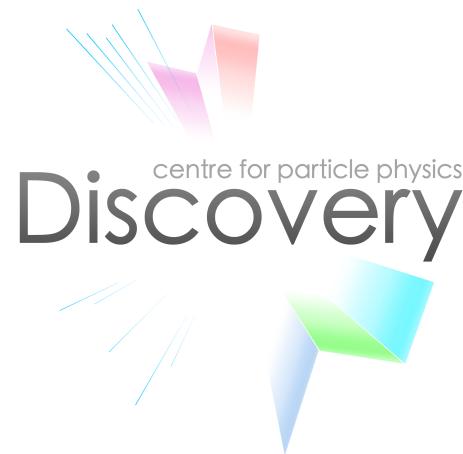


Multiplicity dependence of light flavor hadron production in proton-proton collisions measured with ALICE

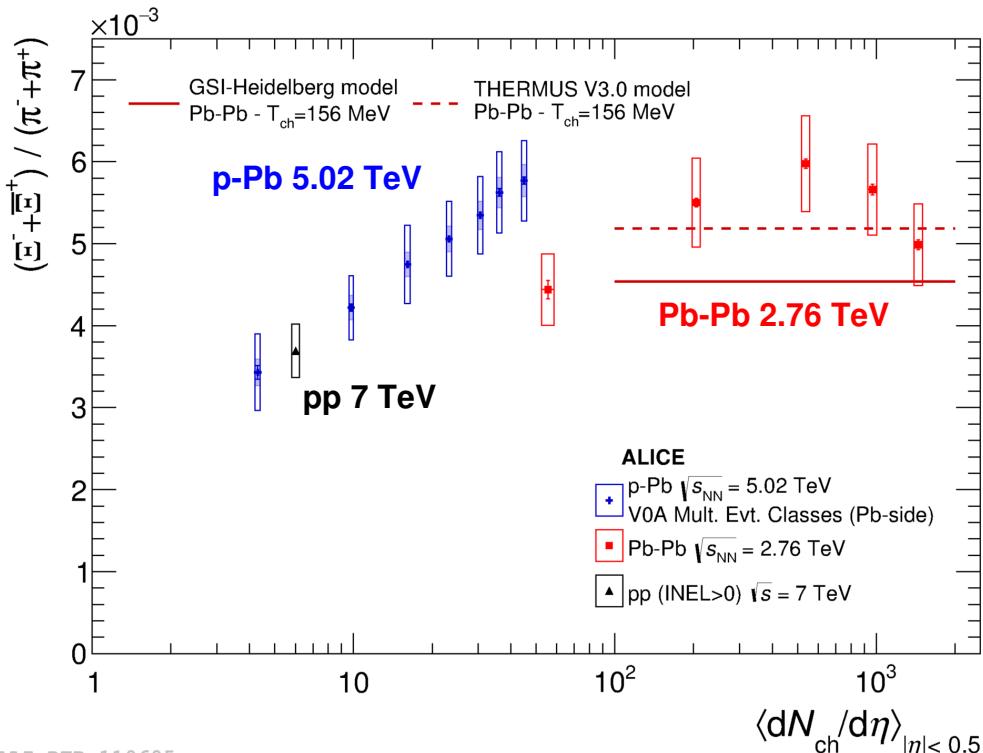
Marek Chojnacki
Niels Bohr Institute
for the ALICE Collaboration



ALICE



Hyperon-to-pion ratio pp->p-Pb->Pb-Pb



ALI-DER-110605

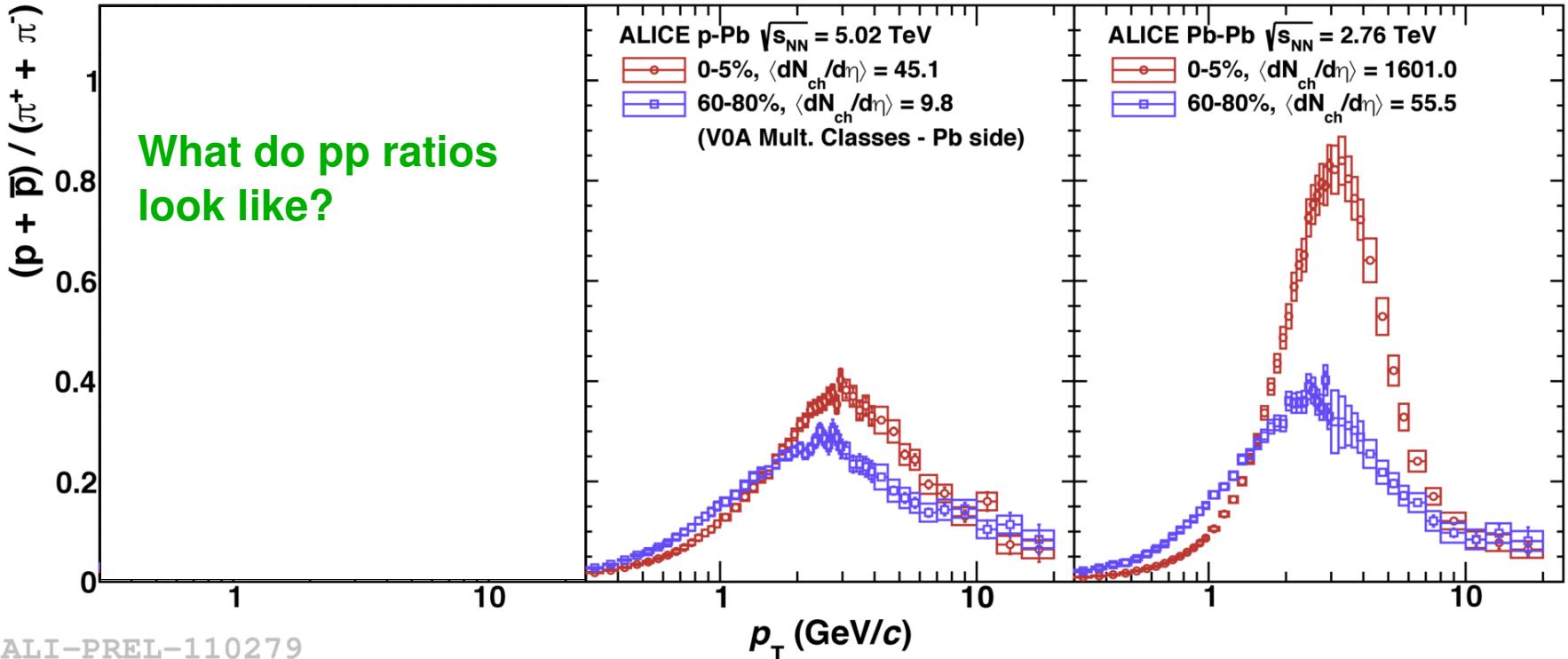
→ Strangeness enhancement is one of the oldest signatures of the QGP formation in HI collisions

(J. Rafelski and B. Muller, PRL 48 (1982) 1066)

→ It is described by thermal models

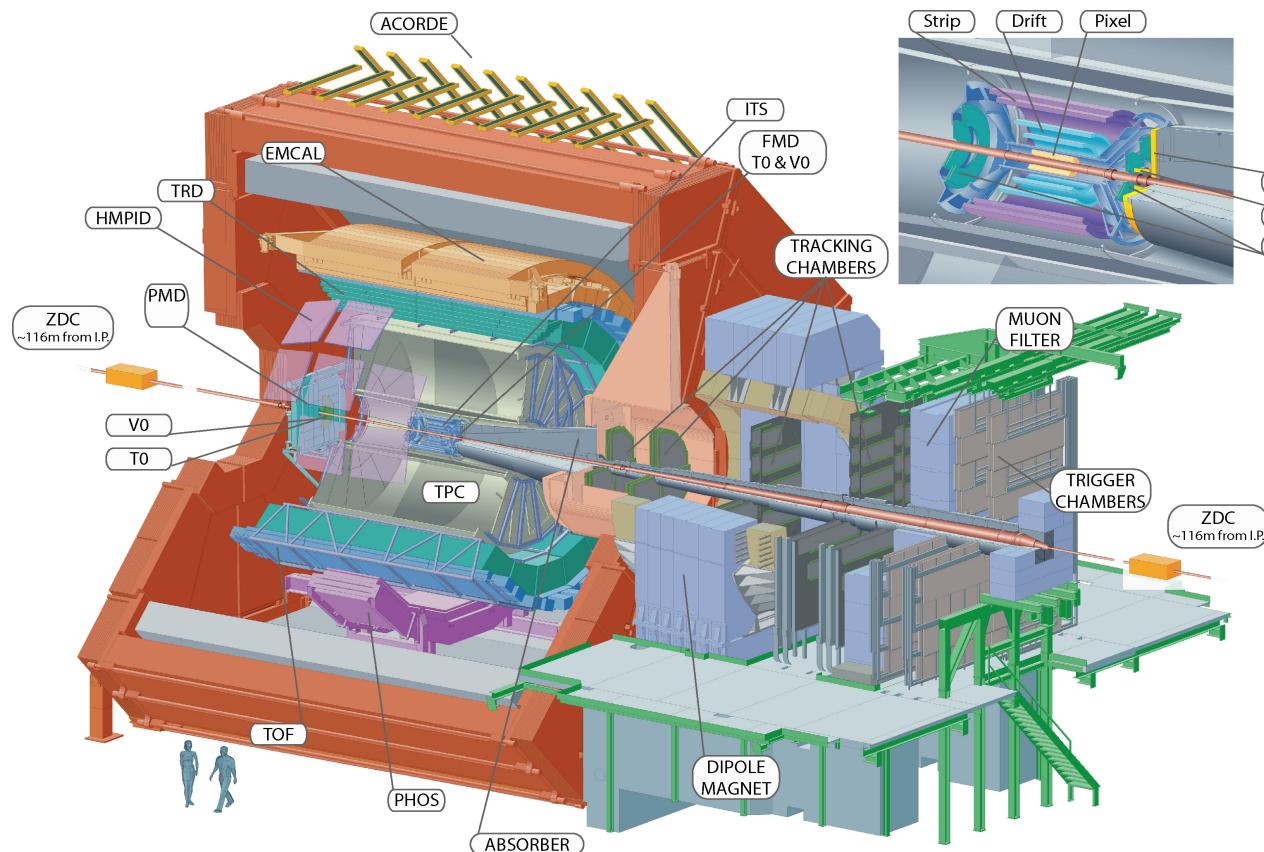
→ The ratio for **p-Pb** increases with multiplicity (arXiv:1512.07227) and makes a bridge between **pp** and **Pb-Pb**

p_T -dependence of ratio shapes



- The multiplicity dependence of baryon to meson ratios in Pb-Pb collisions is a consequence of radial flow
- Similar trends in p-Pb collisions
- What about pp collisions?

ALICE sub-detectors



Key ALICE sub-detectors for light flavor hadron measurement:

→ **Inner Tracking System (ITS)**

- › vertex and track reconstruction
- › PID based on dE/dx

→ **Time Projection Chamber (TPC)**

- › High-precision tracking
- › Weak decay reconstruction
- › PID based on dE/dx

→ **Time of Flight (TOF)**

- › PID based on velocity measurement

→ **HMPID Ring Imaging Cherenkov detector**

- › PID at high p_T

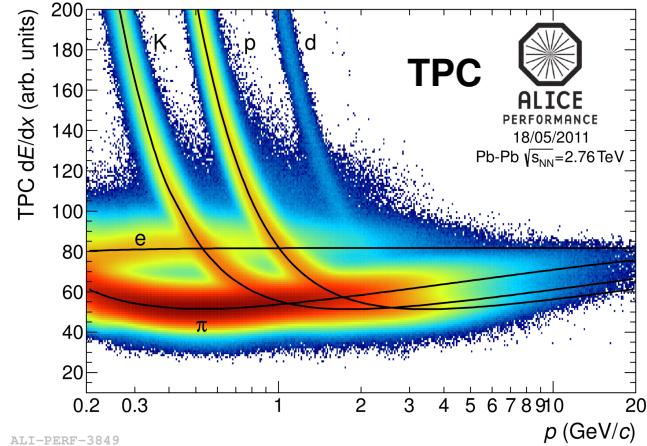
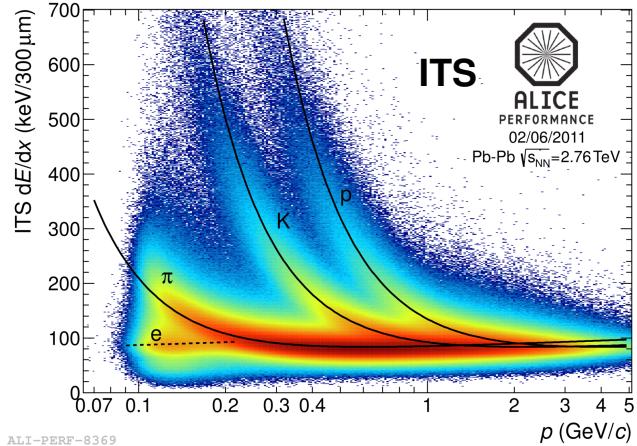
→ **V0 scintillators ($2.8 < \eta < 5.1$ & $-3.7 < \eta < -1.7$)**

- › Triggering

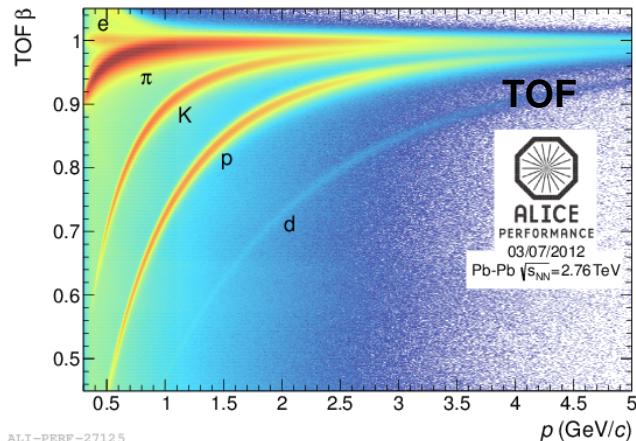
- › Multiplicity estimation

Direct light flavor identification

Specific ionization energy loss in silicon and gas



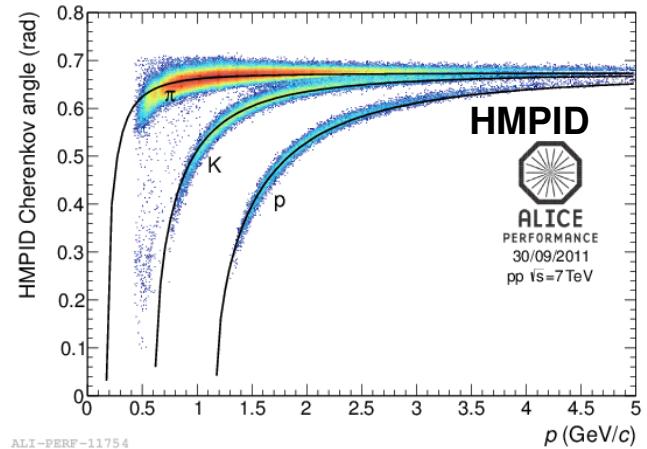
Time-of-Flight



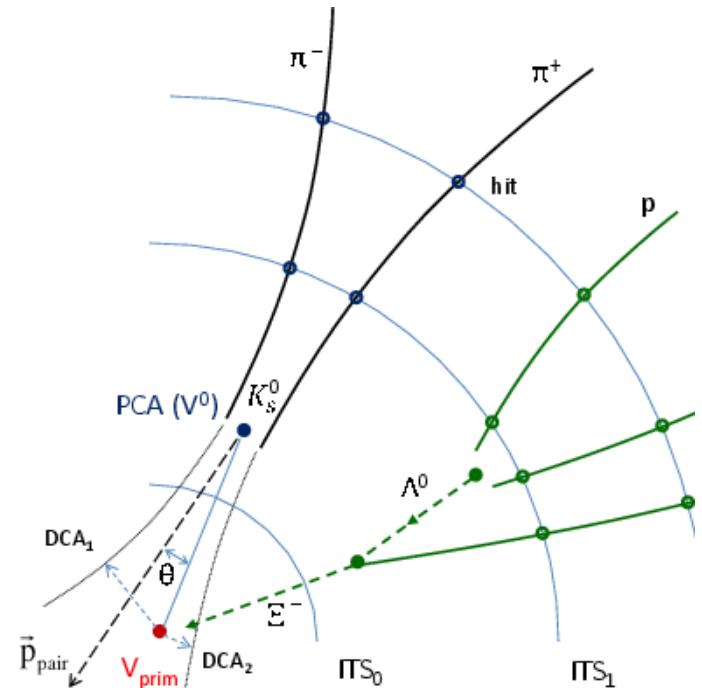
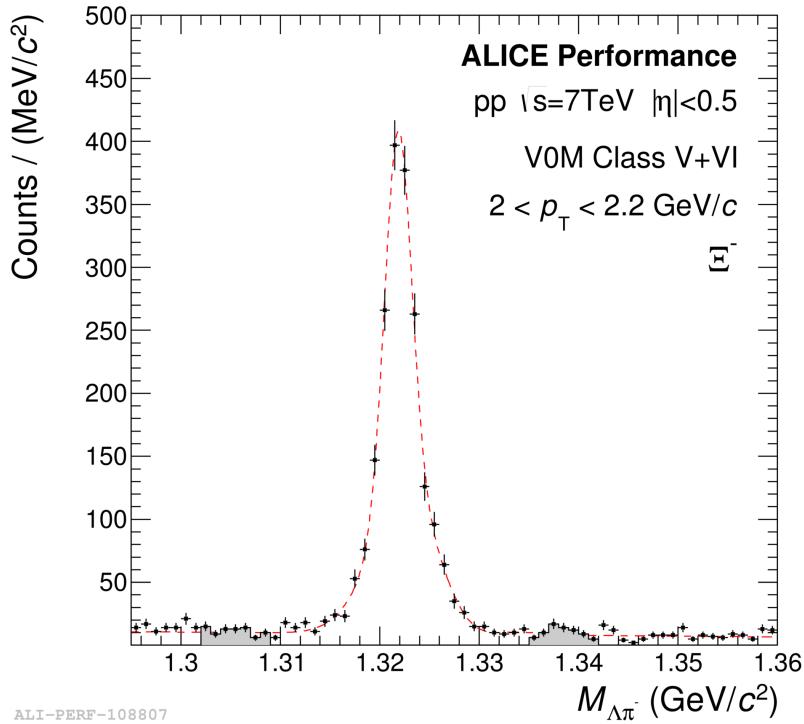
Range of sub-detectors for the direct identification:

- **ITS** $0.1 < p < 0.5$ GeV/c
- **TPC** $0.25 < p < 0.8$ GeV/c & $3 < p < 20$ GeV/c
- **TOF** $0.5 < p < 3.0$ GeV/c
- **HMPID** $1.5 < p < 5.0$ GeV/c

Cherenkov radiation



Topological selection

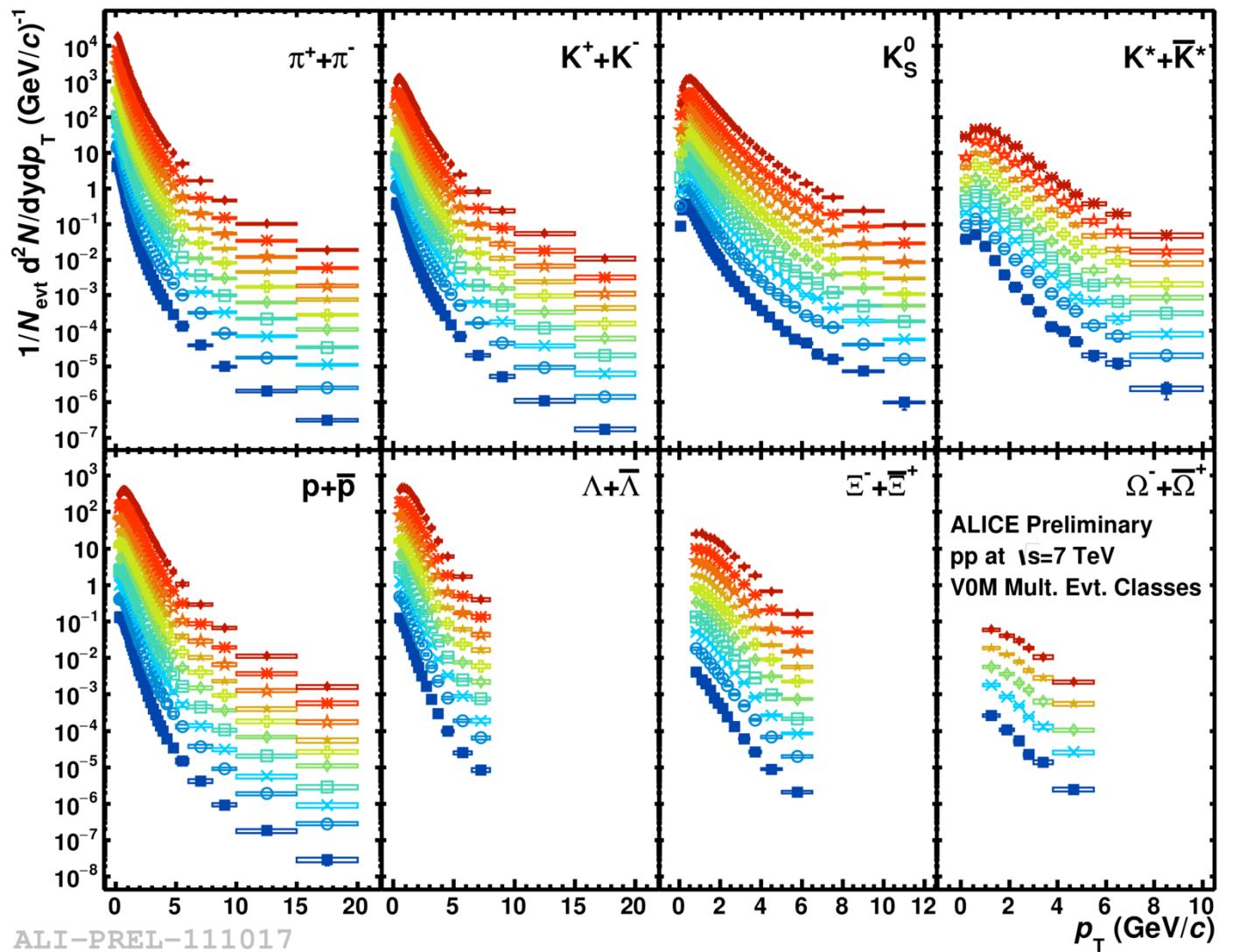


Solid lines show the reconstructed charged particle tracks

Multiplicity selection in pp collisions

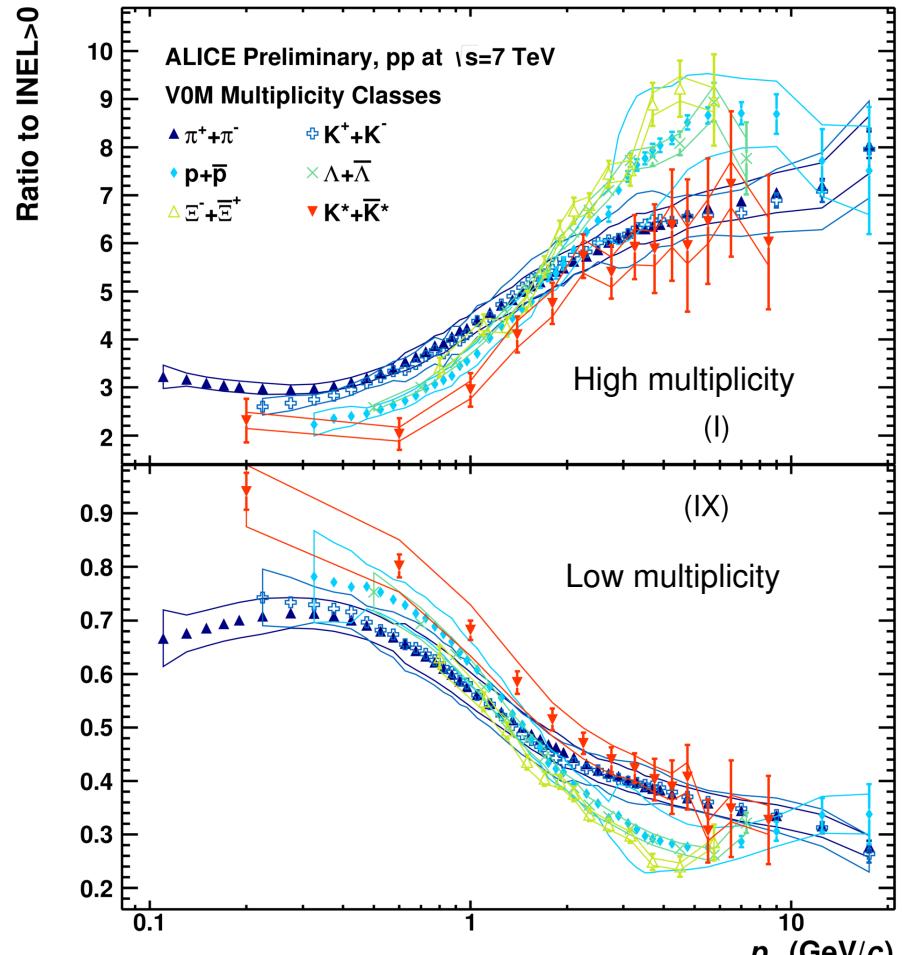
- Events were classified using the total charge deposited in the V0 scintillators (in $2.8 < \eta < 5.1$ & $-3.7 < \eta < -1.7$). Measurements on light flavor hadrons were carried out at mid-rapidity ($|y| < 0.5$).
- This event classification scheme avoids auto-correlation biases.
- Measurements were performed in the **INEL>0** class (at least one charged particle with $p_T > 0$ and $|\eta| < 1$) where $\langle dN_{ch}/d\eta \rangle_{INEL>0} \approx 6$ for $|\eta| < 0.5$.
- The **INEL>0** cross-section was divided into 10 classes according to decreasing value of $\langle dN_{ch}/d\eta \rangle$: $\langle dN_{ch}/d\eta \rangle_1 = 21.3 \dots \langle dN_{ch}/d\eta \rangle_x = 2.3$.

p_T -spectra



Modification of p_T -spectra with multiplicity

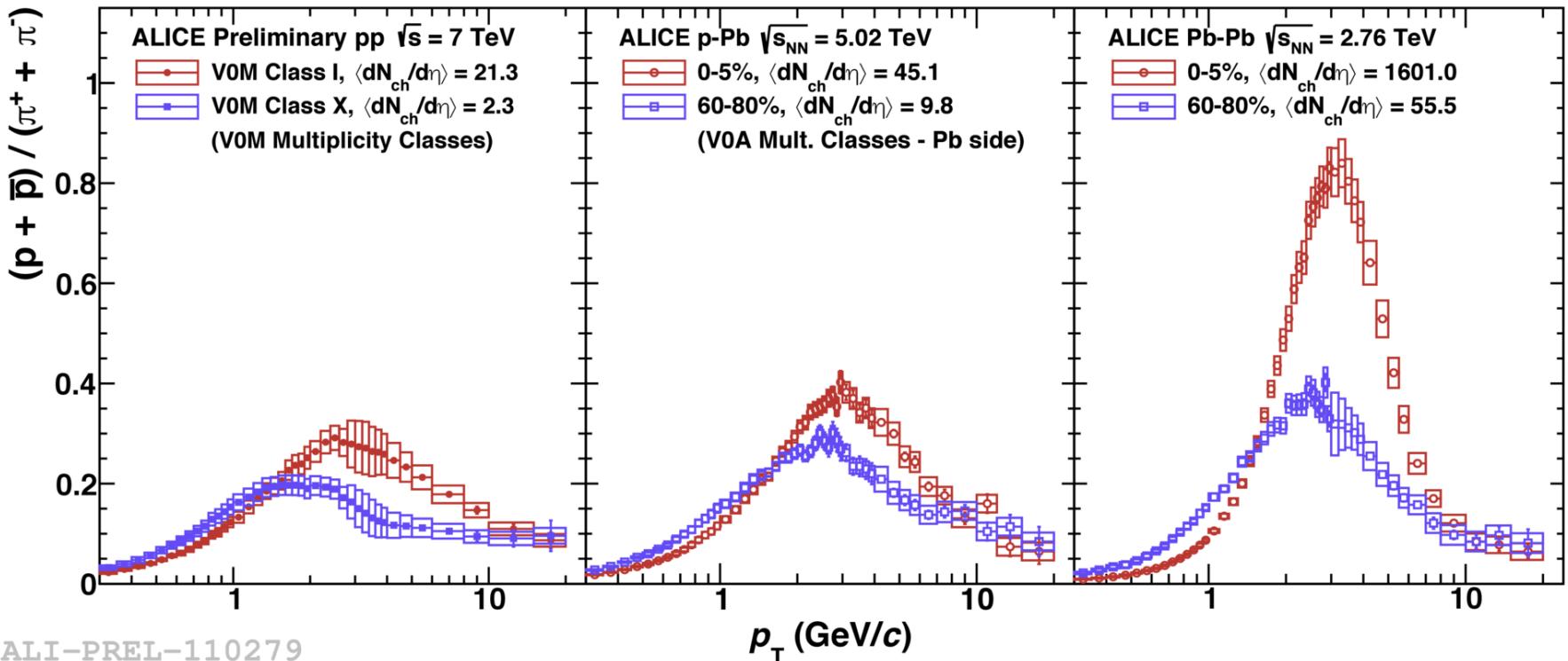
Ratios of spectra in multiplicity bins over full INEL>0 spectra



M.Cchojnacki (NBI)

- › Spectra get harder with increasing multiplicity
- › Effect is more pronounced for baryons (p , Λ , Ξ) than mesons (π , K , K^*)

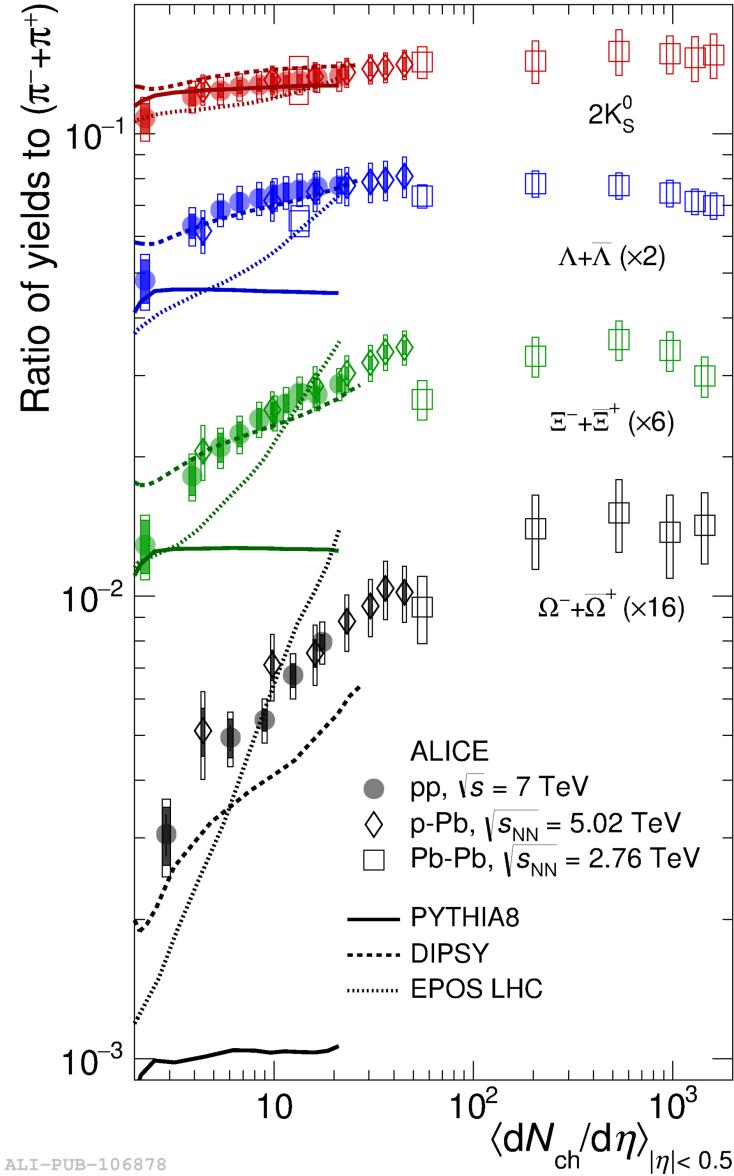
p_T -dependence of ratio shapes



Qualitatively the same changes of ratios from low to high multiplicity bins in pp, p-Pb and Pb-Pb collisions but quantitatively different.



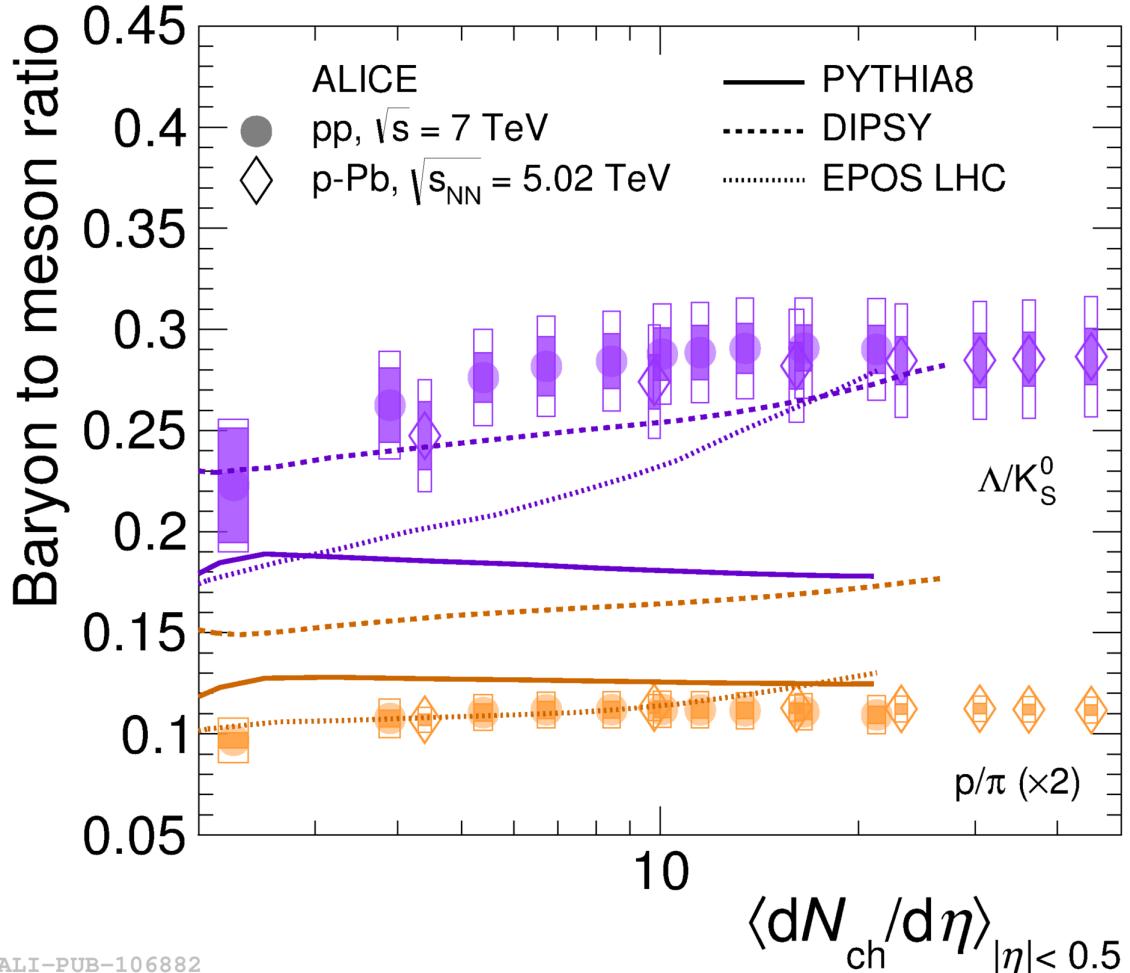
ALICE



Evolution of yield ratios

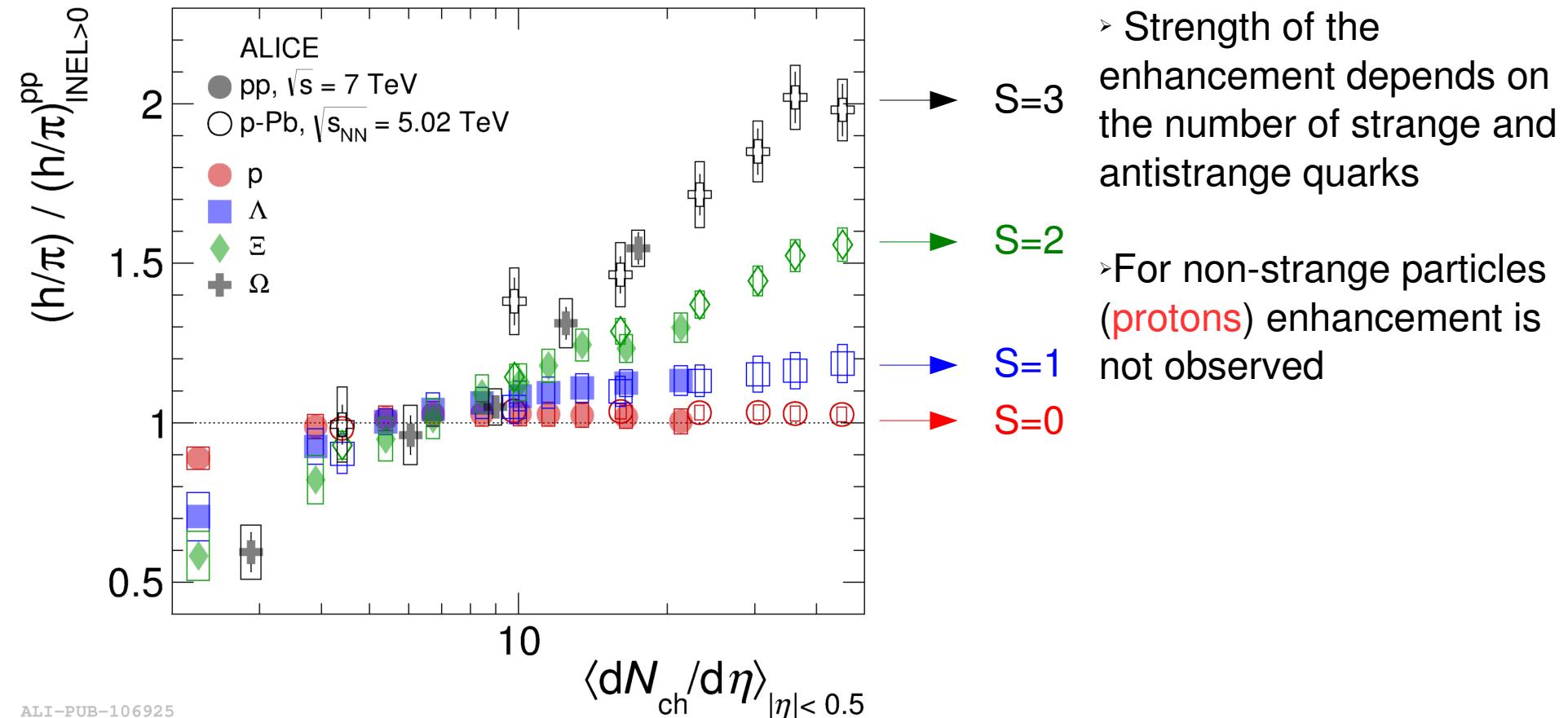
- For pp collisions ratios of strange and multi-strange particles increase with multiplicity
- MC models do not fully describe those trends
- Results for all systems follow one trend, despite different initial conditions

Integrated baryon to meson ratios



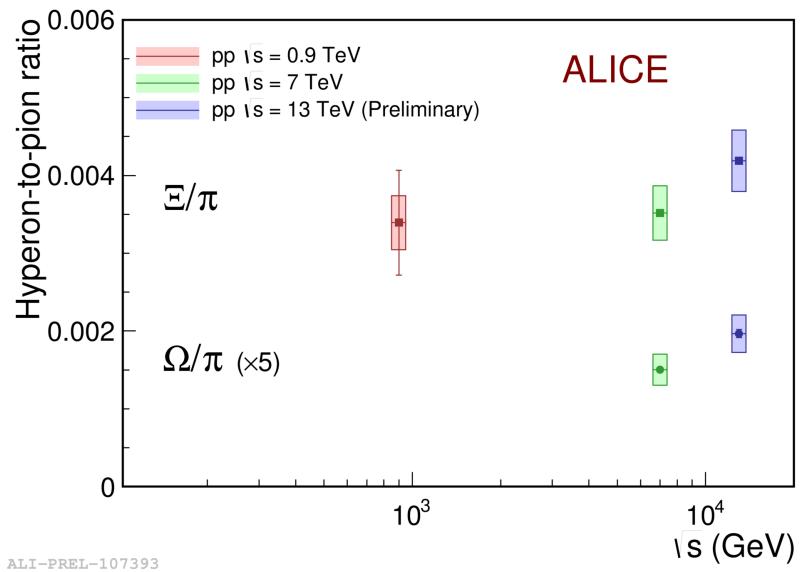
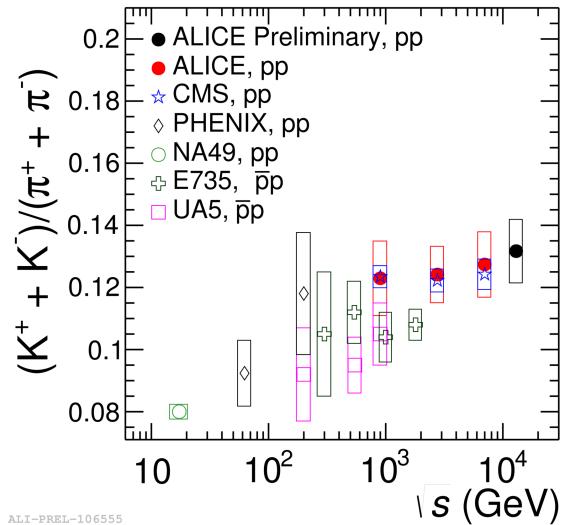
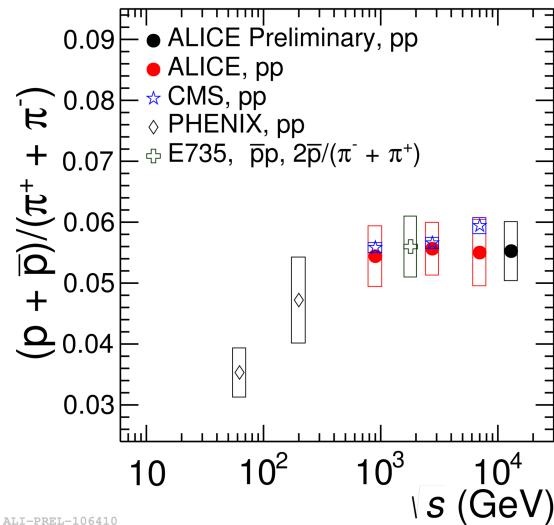
- Baryon to meson ratios do not change significantly with multiplicity => strangeness content, and not mass, drives the observed enhancement
- Not reproduced by MC models

Strength of the enhancement



ALI-PUB-106925

pp at $\sqrt{s}=13$ TeV



- Does the relative particle production in pp collisions saturate? Seems to be the case for kaons and protons but not for hyperons.
- What is the key factor for the strangeness enhancement in pp collisions: charged particle multiplicity or collision energy?

Summary



- ALICE has observed an enhanced production of strange and multi-strange particles in high-multiplicity pp collisions
(arXiv:1606.07424)
- The multiplicity dependence of strangeness production in pp and p-Pb collisions looks similar and approaches the Pb-Pb values
- None of the MC models describe all observed features