Production of pions, kaons and protons in p-Pb collisions at $\sqrt{s_{NN}}$ = 8.16 TeV with ALICE at LHC

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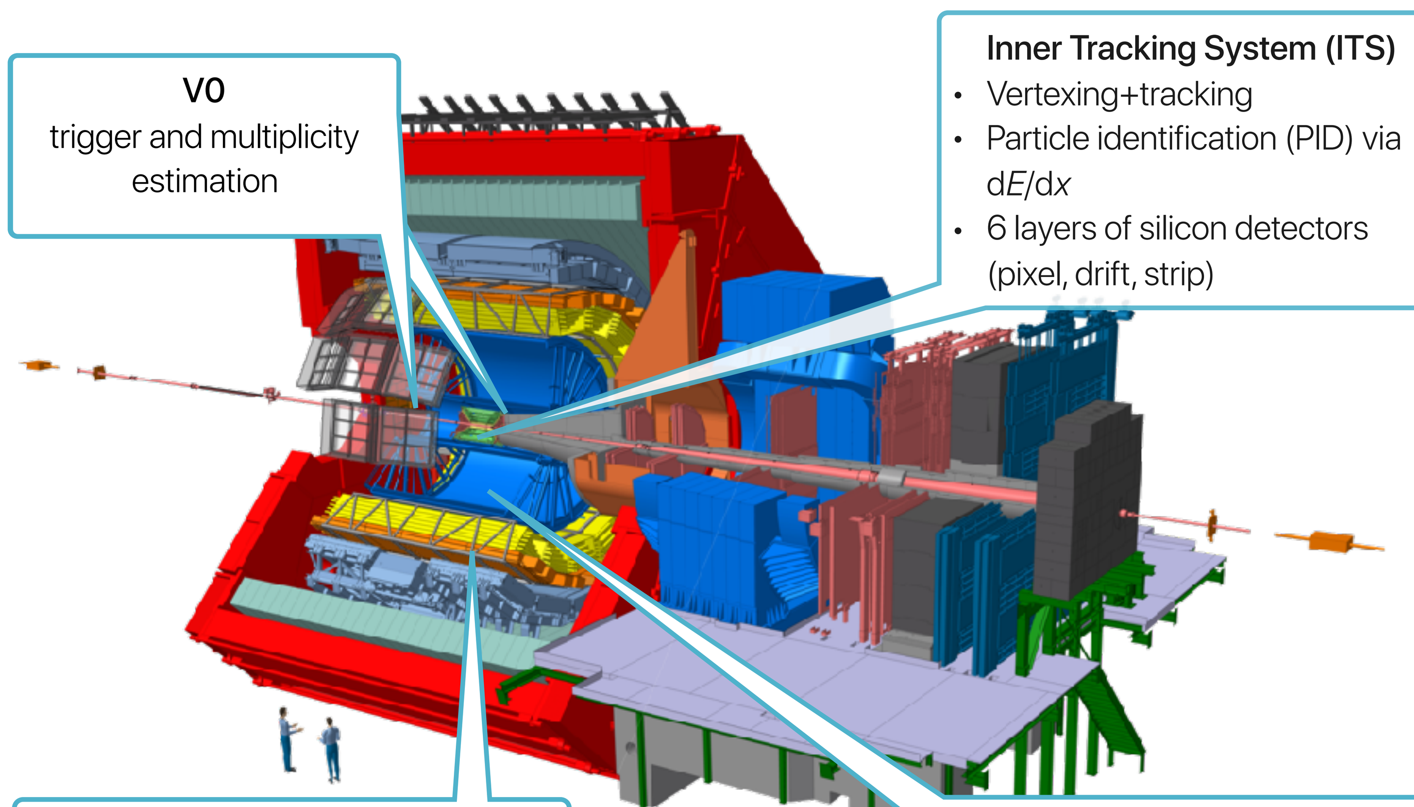
Quark Matter 2019

ALICE

ALICE detector

V0
trigger and multiplicity estimation

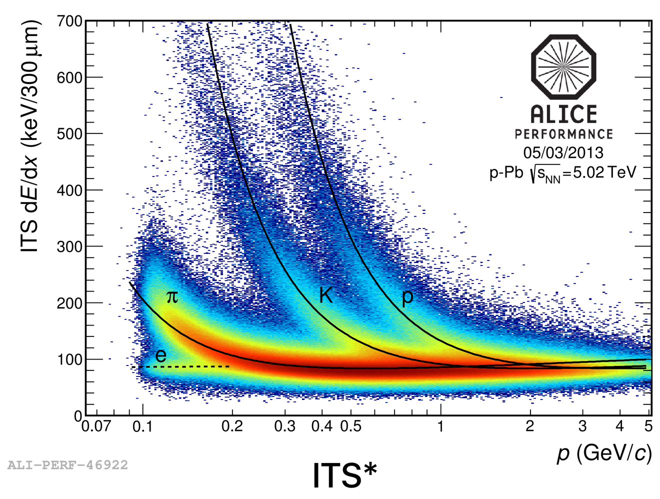
Inner Tracking System (ITS)
- Vertexing+tracking
- Particle identification (PID) via d*E*/d*x*
- 6 layers of silicon detectors (pixel, drift, strip)

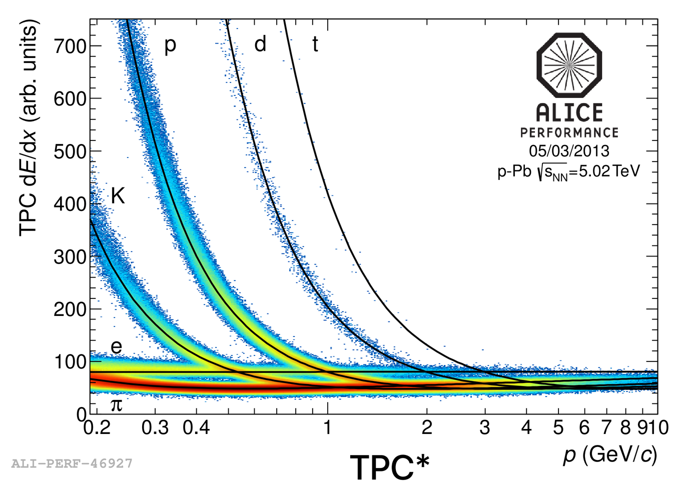


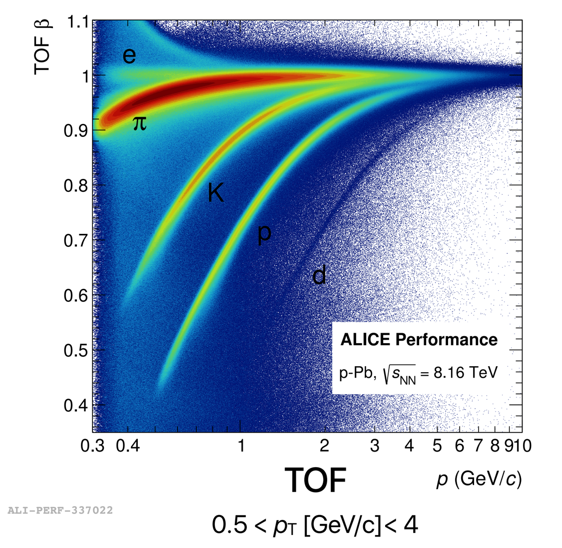
Time of Flight (TOF)
- Particle identification via time-of-flight measurement
- Detector based on Multi-Gap Resistive Plate Chambers (MRPC)

Time Projection Chamber (TPC)
- Tracking
- PID via energy loss (d*E*/d*x*)
- Gaseous detector

Particle identification


ITS*
$0.1 < p_T$ [GeV/c]< 0.8


TPC*
$0.25 < p_T$ [GeV/c]< 0.8

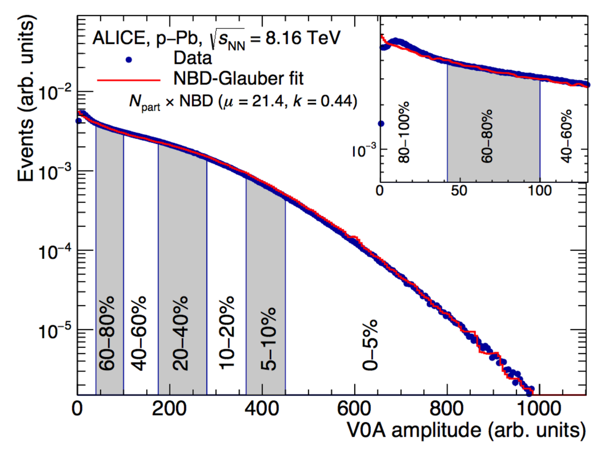

TOF
$0.5 < p_T$ [GeV/c]< 4

ITS:
- Specific energy loss in 4 layers of silicon detectors, $\sigma_{dE/dx} \approx 10\,\%$

TPC:
- Specific energy loss in TPC gas, $\sigma_{dE/dx} \approx 5\,\%$

TOF:
- PID via time-of-flight measurement, $\sigma_{TOF} \approx$ 60–80 ps

Multiplicity estimation
- Events are classified based on the amplitude measured by the V0A detector (Pb-going direction)

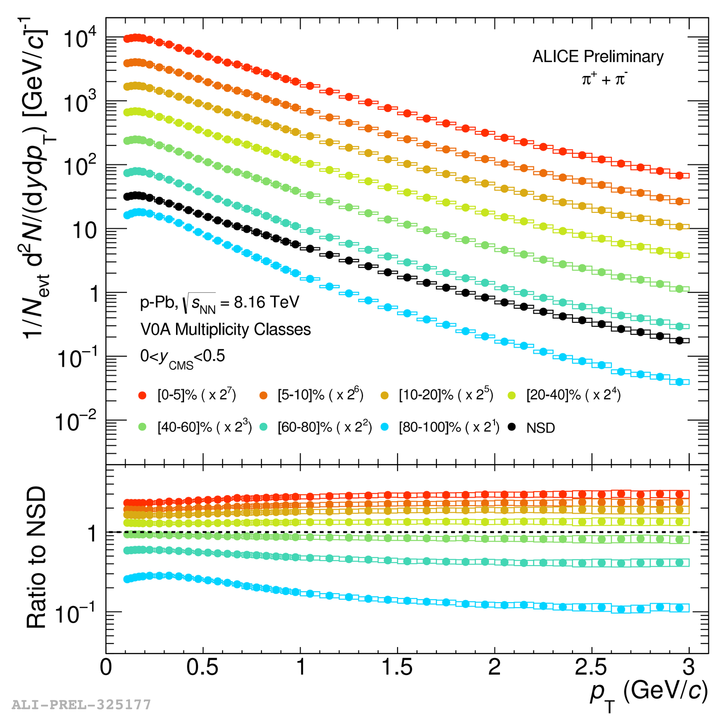

LO ← HI

* Figures show the PID performance in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV

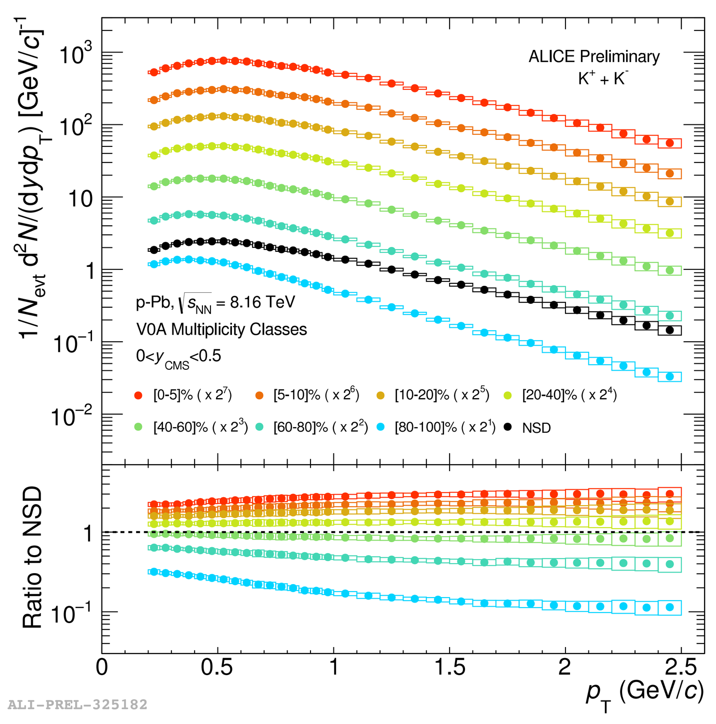
Results

Identified particle spectra

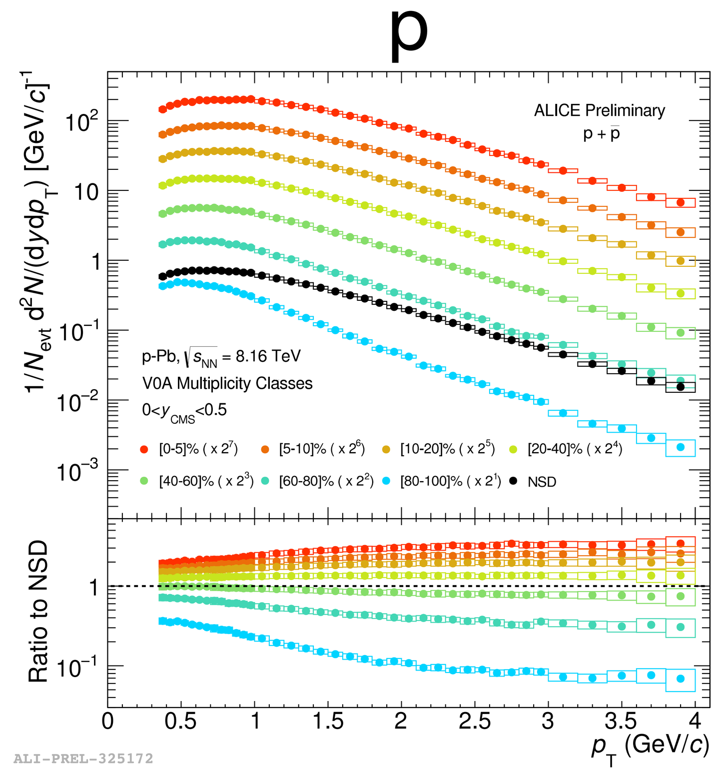
π



K



p

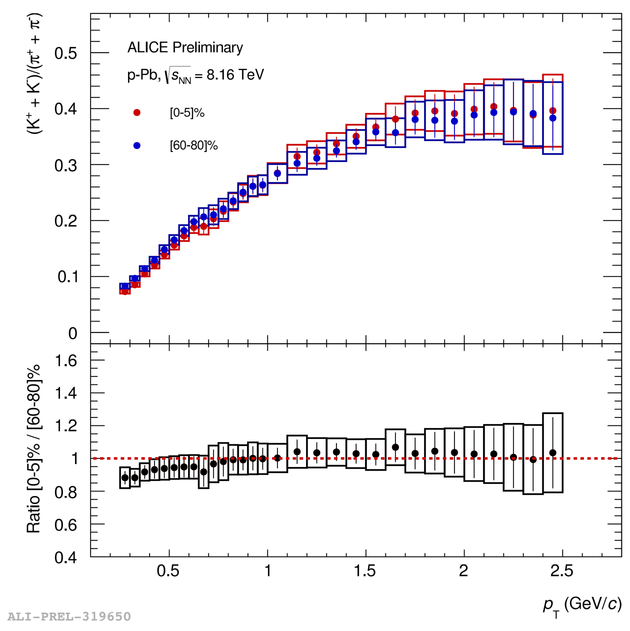


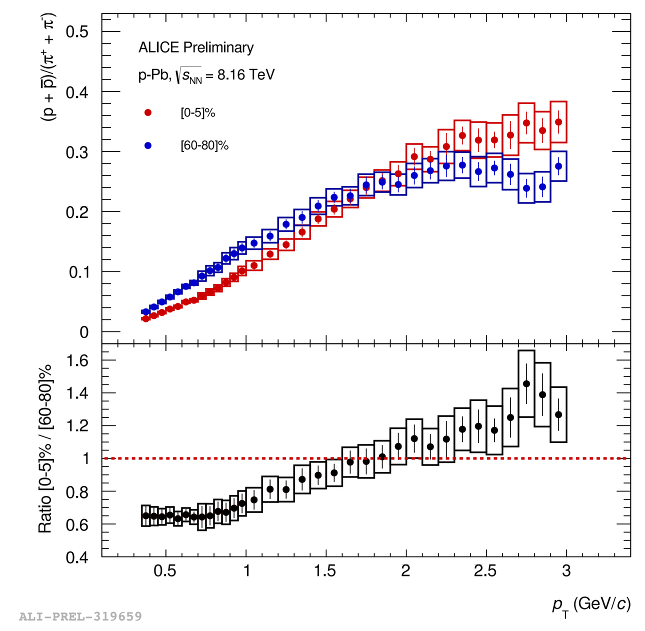
- Combined spectra: **individual ITS, TPC, TOF spectra** obtained in the corresponding p_T intervals **were combined** using the uncorrelated systematic uncertainties as weights (in the plot the total systematic uncertainties are shown)

- Spectra become harder as the multiplicity increases
- The hardening is more pronounced for heavier particles
- Similar effect observed previously in both Pb-Pb [1] pp [2] collisions and p-Pb collisions at lower energy [3]

➡ Hint of a collective-like behaviour
➡ Mass ordering as expected from hydrodynamics

Particle ratios (K/π and p/π)

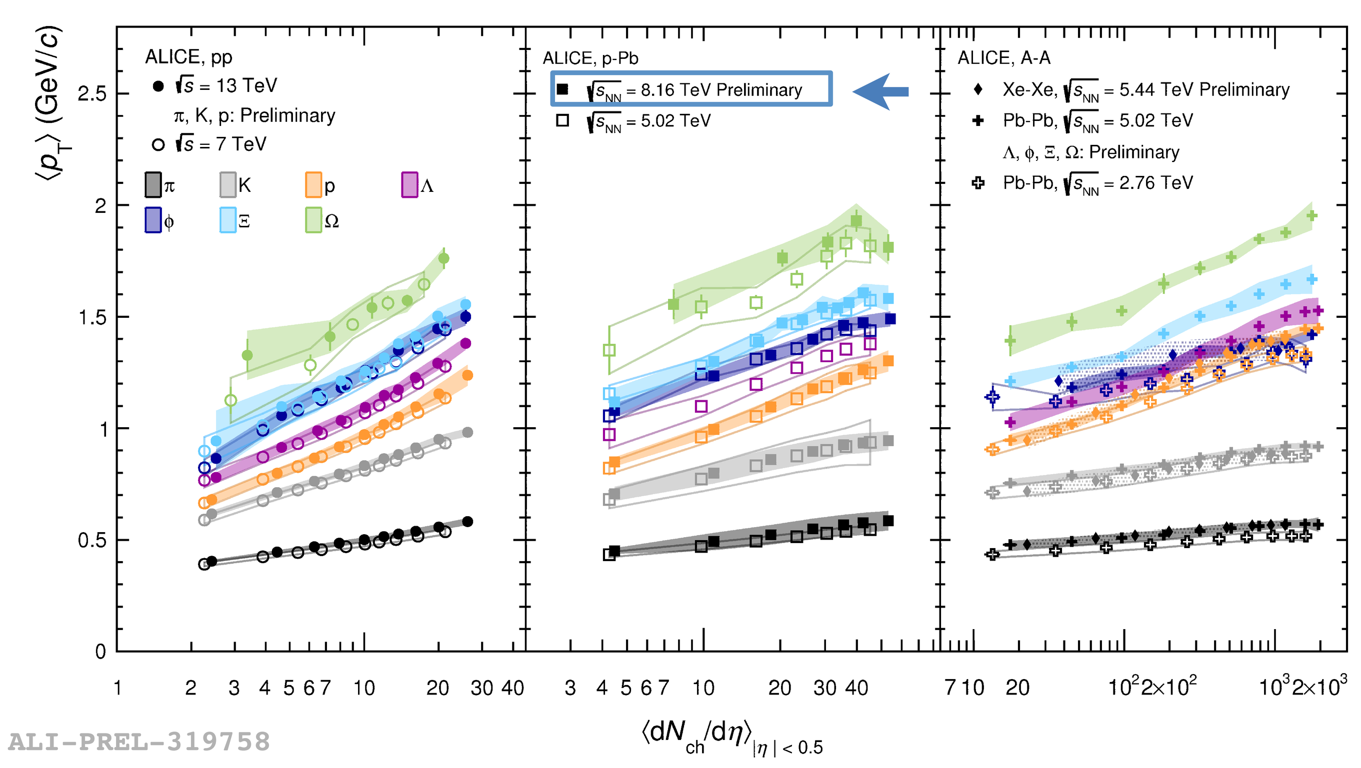




K/π ratio:
- Comparison between low and high multiplicity classes
- Weak evolution with multiplicity

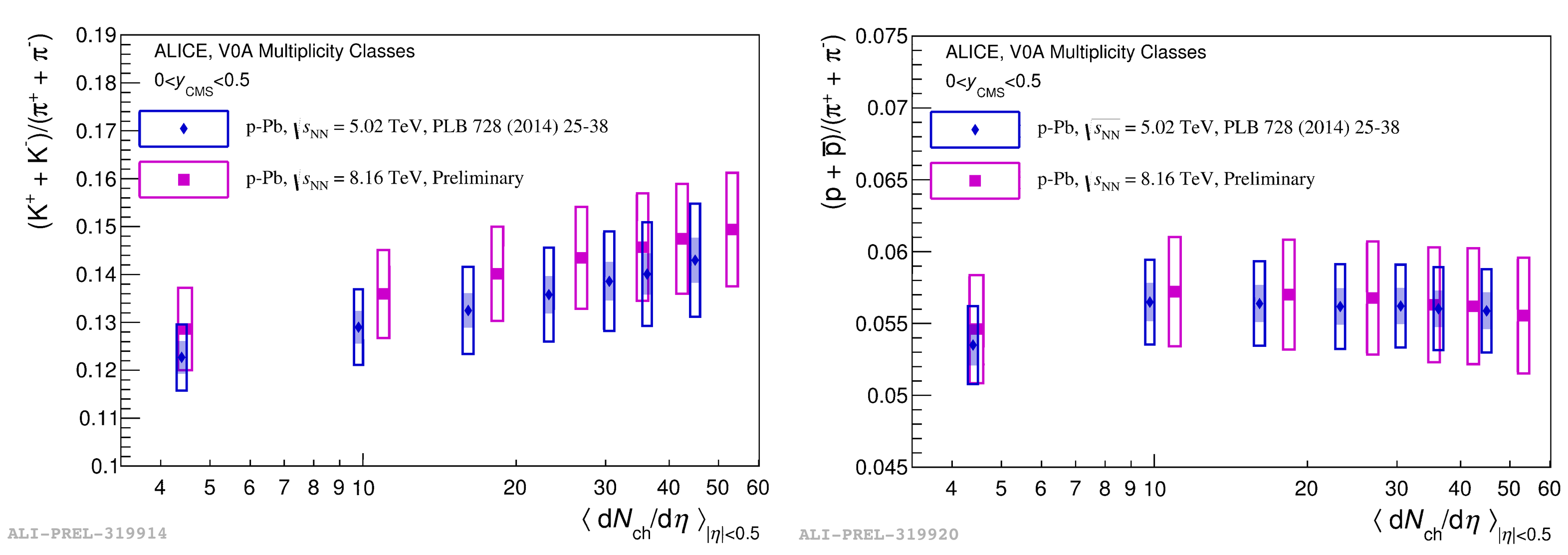
p/π ratio:
- Spectra is pushed towards higher momentum at high multiplicity
- Reminiscent of radial flow observed in Pb-Pb collisions [1]
- Similar trend is observed in p-Pb collisions at 5.02 TeV [3]

Mean p_T



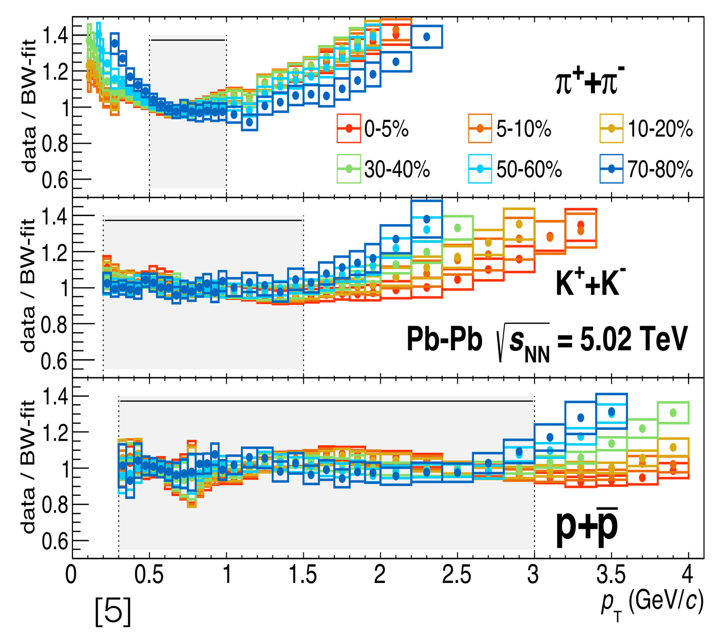
- Mean p_T values are calculated after fitting the differential p_T spectra for each multiplicity class with a Blast-Wave function [4]
- Well pronounced mass-dependent hardening of the spectra
- Agreement with 5.02 TeV p-Pb data within systematic uncertainties, no dependence on the collision energy for a given multiplicity

p_T integrated yield ratios



- d*N*/d*y* ratio of K/π and p/π vs. $\langle dN_{ch}/d\eta \rangle$
- Comparison with the lower energy data: the integrated particle yields exhibit a continuous evolution with the charged-particle multiplicity independent of the collision energy

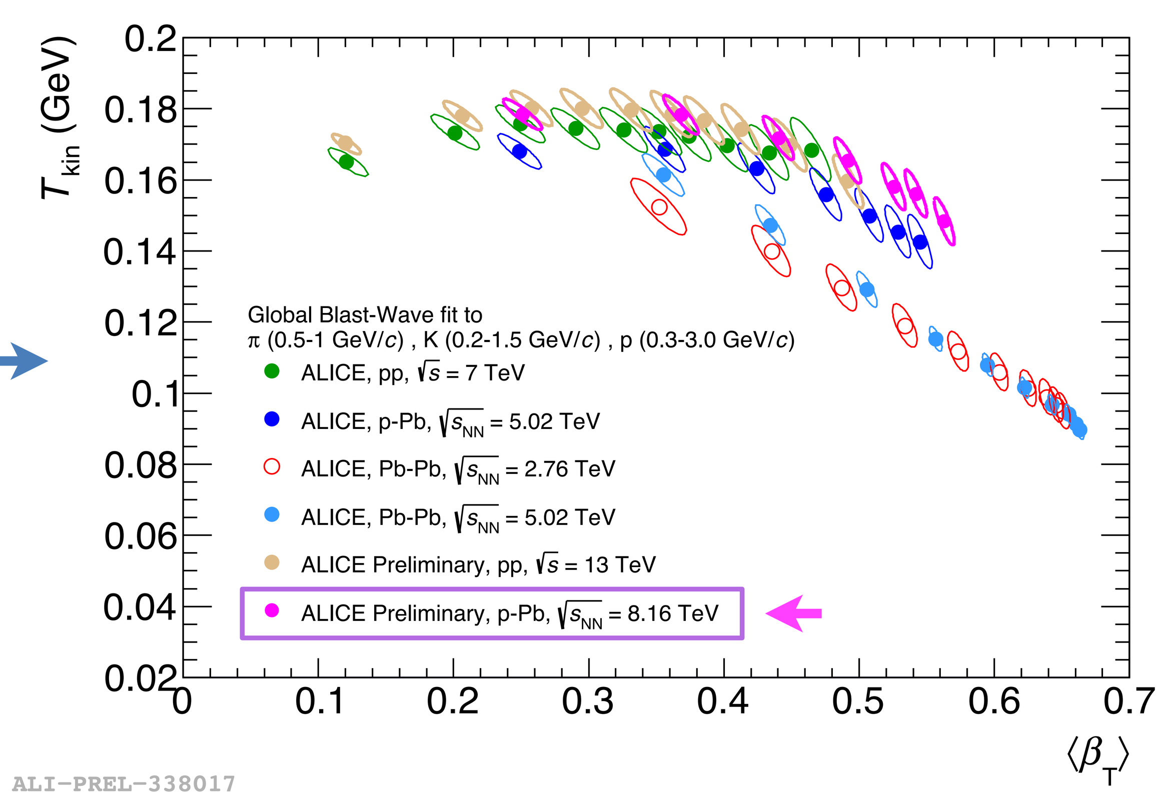
Blast-Wave fits to spectra


[5]

- Blast-Wave model : simplified hydrodynamical model with three fitting parameters*:
  - T_{kin} = kinetic freeze-out temperature
  - $\langle \beta_T \rangle$ = transverse radial flow velocity
  - n = velocity profile,

  considering a superposition of the individual thermal sources with common expansion velocity β_T and freeze-out temperature T_{kin}
- Free parameters are obtained from a **simultaneous fit** to the measured π/K/p spectra

*also uses three normalization factors



- Contours correspond to 1σ uncertainties: statistical and systematic uncertainties are added quadratically
- p-Pb data at 8.16 TeV: higher T_{kin} is observed w.r.t lower energy data
- At high multiplicity p-Pb data show similar trend as observed in Pb-Pb collisions. However, such behaviour can be reproduced by PYTHIA with colour reconnection [3][6]

Summary

- Measurements of **π, K and p spectra** as a function of multiplicity in p-Pb collisions at $\sqrt{s_{NN}}$ = 8.16 TeV has been presented
- The spectra exhibit a hardening tendency towards high multiplicity collisions → radial flow, MPI or something else?
- The p_T-differential p/π ratio is boosted towards higher p_T with increasing multiplicity
- Blast-Wave analysis: the p-Pb data, compared to Pb-Pb, show a weaker correlation between T_{kin} and $\langle \beta_T \rangle$: only at very high multiplicity the trend is similar to the one of Pb-Pb

References

[1] ALICE collaboration, Phys. Rev. C **88**, 044910 (2013)
[2] ALICE collaboration, Phys. Rev. C **99**, 024906 (2019)
[3] ALICE collaboration, Phys. Lett. B **728** (2014) 25-38
[4] E. Schnedermann, J. Sollfrank, and U. Heinz. Phys. Rev. C **48**:2462–2475, Nov. 1993
[5] ALICE collaboration, arXiv:1910.07678 [nucl-ex]
[6] T. Sjöstrand *et al.* Comput.Phys.Commun. 191 (2015) 159-177