Light flavour hadron production in Xe-Xe collisions at $\sqrt{s_{NN}}$ = 5.44 TeV

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Motivation

■ The measurement of a comprehensive set of **light-flavor hadrons** in heavy-ion collisions provides input to determine the properties of the **bulk of the system**

Particle yields and ratios: **Chemistry of the system**

Chemical freeze-out → Thermal model fit to particle yield

Strangeness enhancement → by looking at the strange and multistrange particle productions

Hadronic re-scattering → by studying short-lived resonances

p_T differential spectra and ratios, mean p_T: **Dynamics of the system**

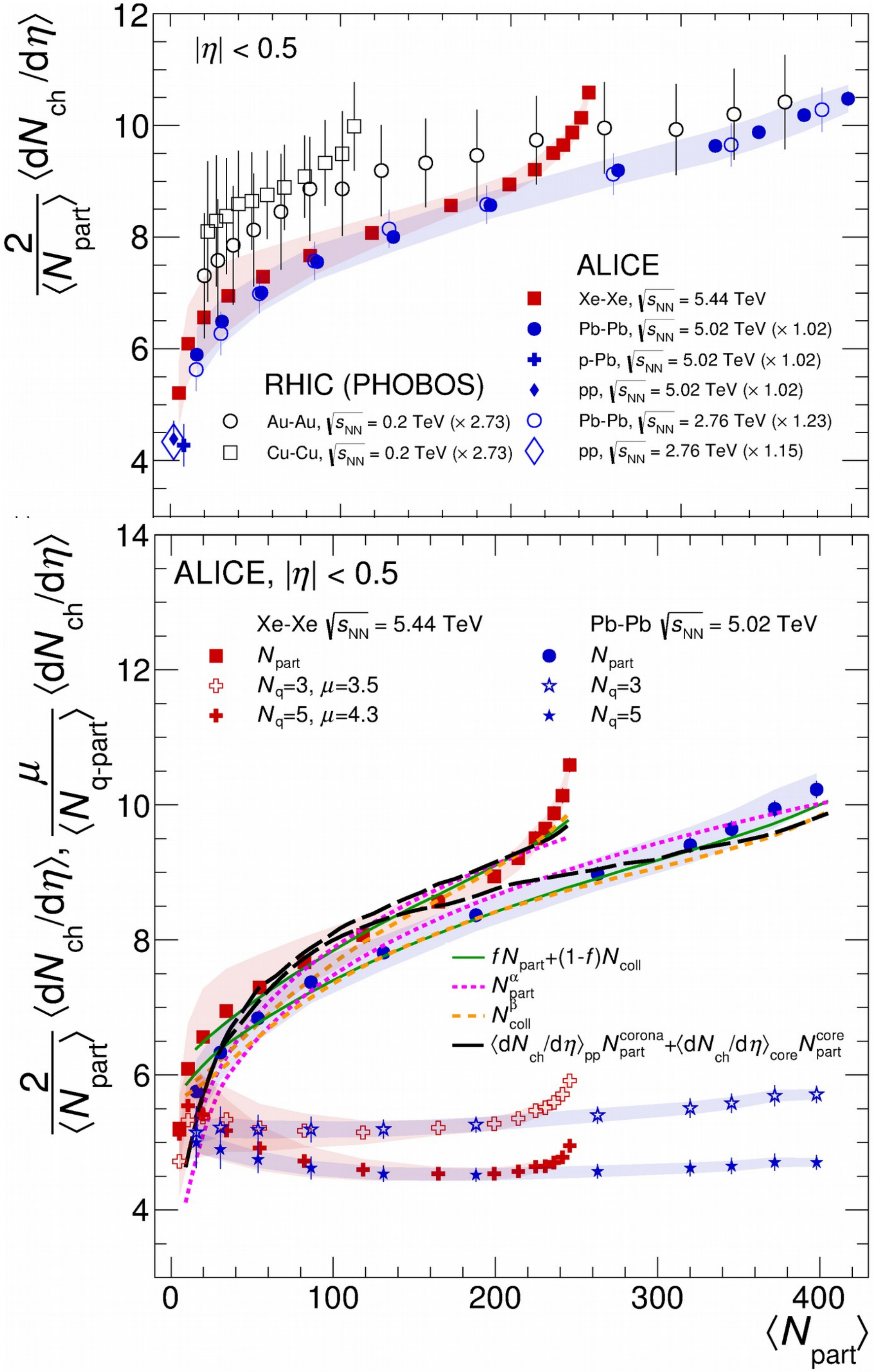
Radial flow → Comparison to Hydrodynamical model

Kinetic freeze-out → Blast-Wave model fit

Energy loss in the medium → by measuring nuclear modification factor (R_{AA})

Run-2 Xe-Xe collisions will allow us to investigate the system size dependency of bulk properties of the system with an intermediate system between p-Pb and Pb-Pb

Charged particle multiplicity



- N_{part} scaling is violated, now confirmed by new measurements in Xe-Xe collisions

  --- About a factor of two increase from peripheral to central collisions

  --- Reproduced by several models

- Central collisions of Xe-Xe produce more particles per participant than semi-central collisions of Pb-Pb at similar N_{part}

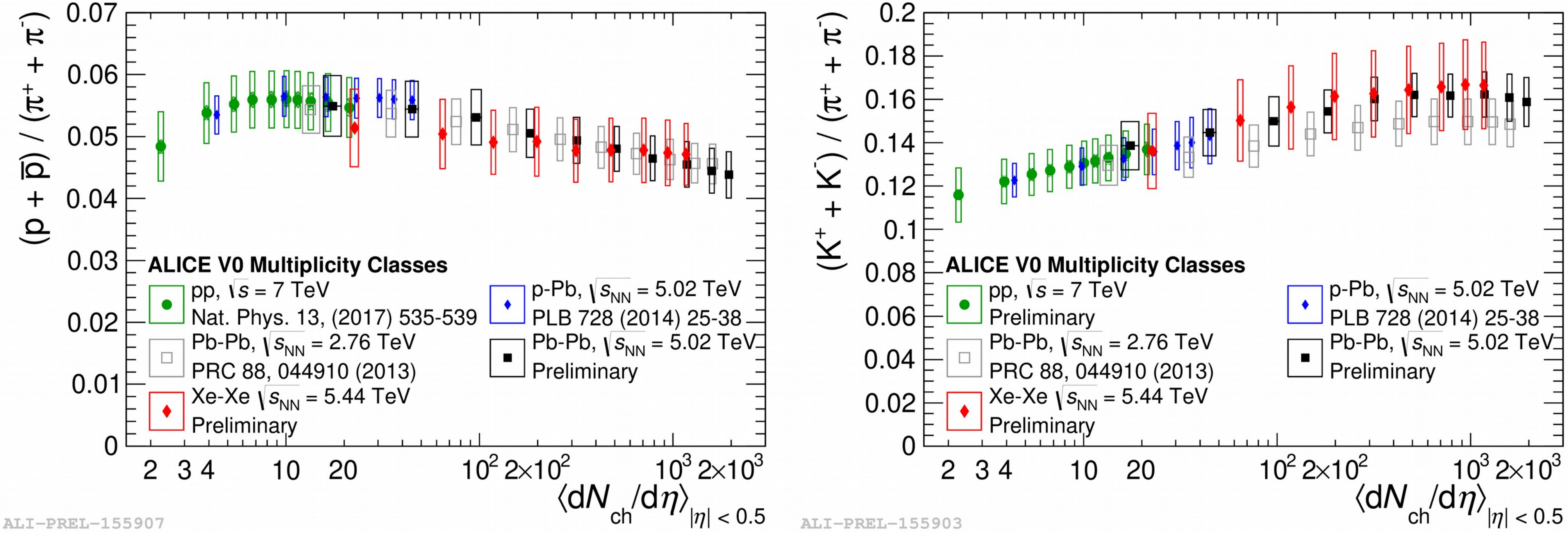
  --- Not explained by participant-quark scaling

  --- Not reproduced by models

  --- Hint of similar behavior in Cu-Cu/Au-Au

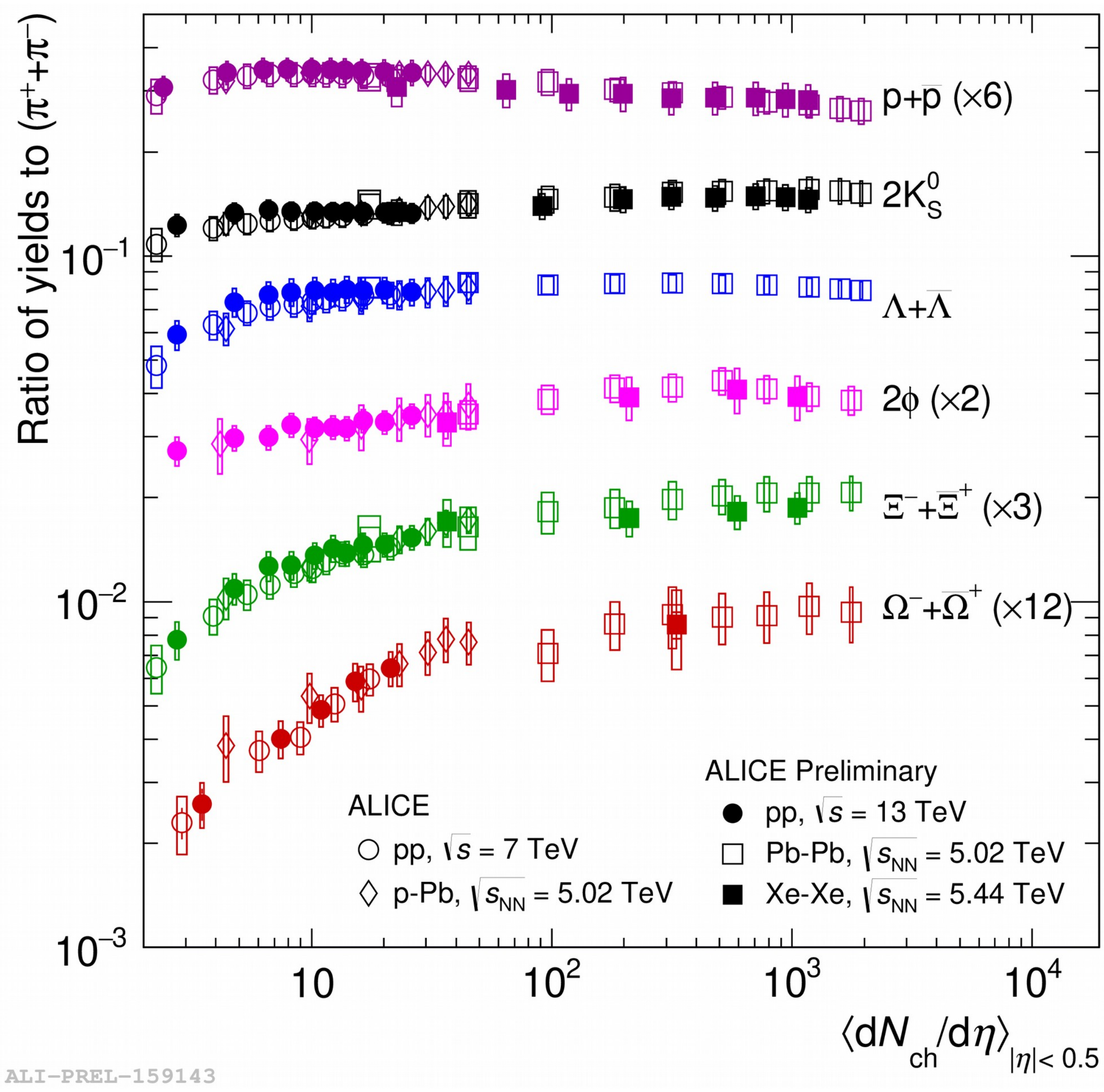
ALICE, arXiv:1805.04432

Particle ratios: pp, p-Pb, Xe-Xe and Pb-Pb



- Particle ratios (K/π, p/π etc.) are consistent for Pb-Pb and Xe-Xe collisions at similar multiplicities
- Smooth evolution of particle ratios from pp → p-Pb → Pb-Pb collisions
- No significant energy dependence of the ratios at similar multiplicities

Strangeness production: pp, p-Pb, Xe-Xe and Pb-Pb



- Smooth evolution of the ratios vs. multiplicity from pp, p-Pb, Xe-Xe to Pb-Pb collisions at different energies

  --- No energy dependence

  --- Hadron chemistry is driven by the multiplicity (system size)

- Strangeness enhancement is seen with increasing multiplicity in small and large systems and saturate in central heavy-ion collisions

  --- Magnitude of strangeness enhancement increases with strange-quark content

Resonance suppression

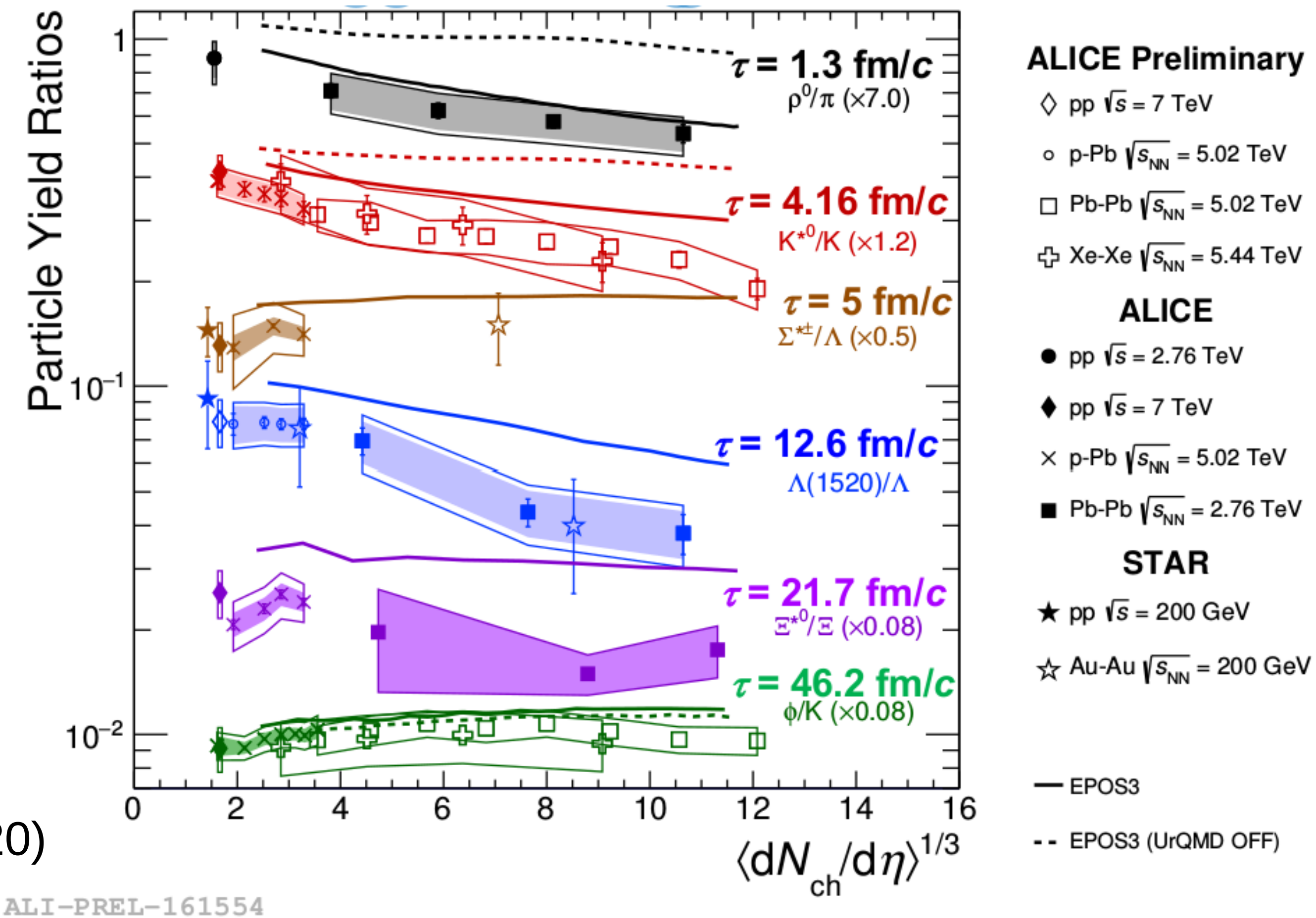
- Smooth evolution of ratios across different collision systems (PP, P-Pb, Xe-Xe, Au-Au, Pb-Pb) and consistency of results at RHIC and LHC energies

- Suppression of K^{*0} w.r.t. pp and thermal model values

  --- Re-scattering of decay products in hadronic medium

  --- Hint of K^{*0} suppression in high-mult. pp and p-Pb

- Similar suppression of ρ^0 & $\Lambda(1520)$

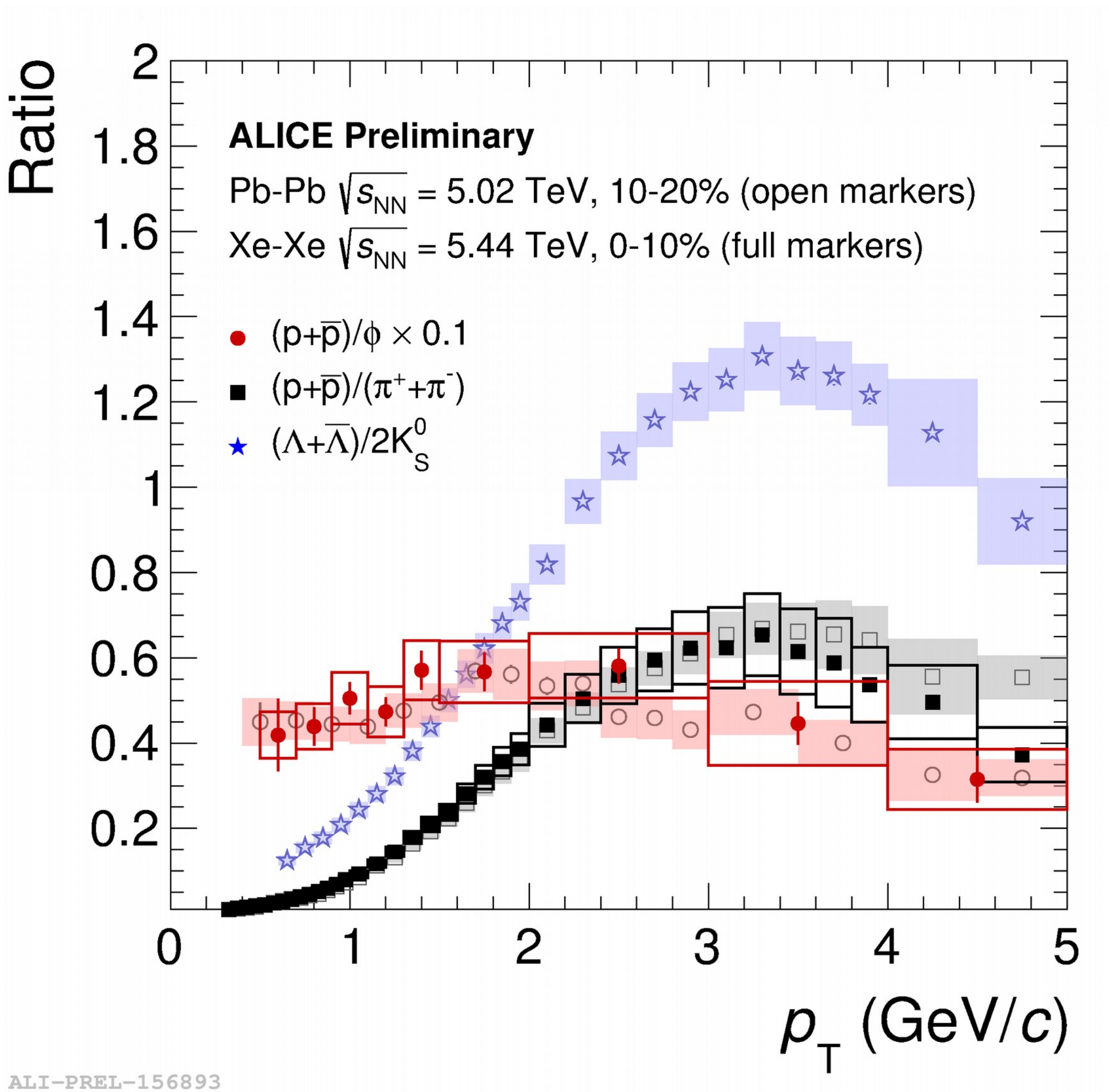


- Possible weak suppression of Ξ^{*0} w.r.t. pp collisions

- No ϕ suppression: lives longer, decays outside fireball

- Trends qualitatively decribed by EPOS which includes scattering effects modeled with UrQMD

Baryon to meson ratio: Pb-Pb & Xe-Xe



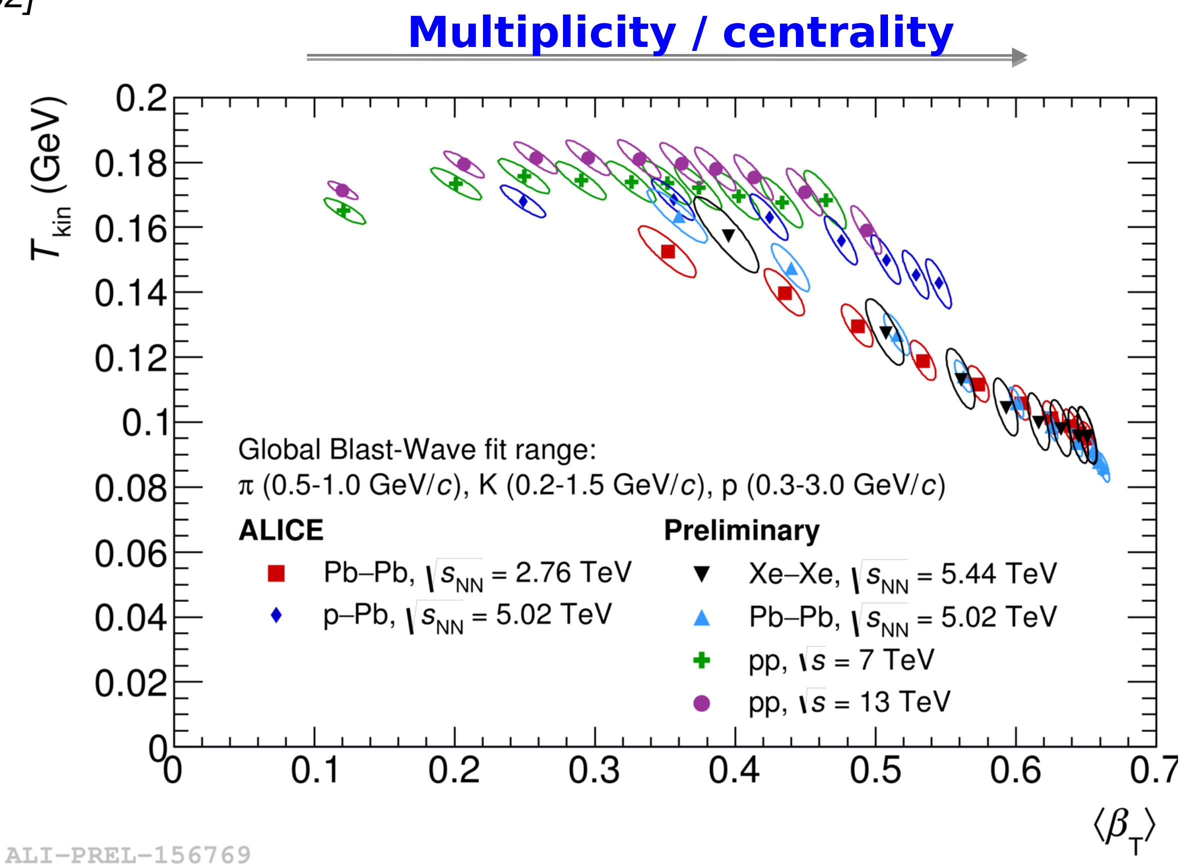
- Baryon to meson ratios are consistent between Pb-Pb and Xe-Xe at similar multiplicities
- Baryon-to-meson ratios for particles of similar masses ($m_{\phi} \sim m_{p}$) help to study the interplay between hydrodynamics and recombination mechanisms
- p/ϕ ratio is flat vs. p_{T} at intermediate momenta in Pb-Pb and Xe-Xe collisions

- Spectra shapes are driven by particle masses:
  --- consistent with hydrodynamics
  --- can be accommodated by models with recombination *[V. Greco et al., PRC 92 (2015) 054904]*

Blast-Wave model fits to ALICE data

- Boltzmann-Gibbs Blast-Wave used to quantify radial flow
  [E. Schnedermann et al., Phys. Rev. C48 (1993) 2462]

- A simplified hydrodynamic model with 3 free fit parameters,
  T_{kin}: kinetic freeze-out temperature
  $\langle\beta_T\rangle$: transverse radial flow velocity
  n: velocity profile
  to describe particle production from a thermalized source + radial flow boost



- Simultaneous fit to the π, K, p spectra

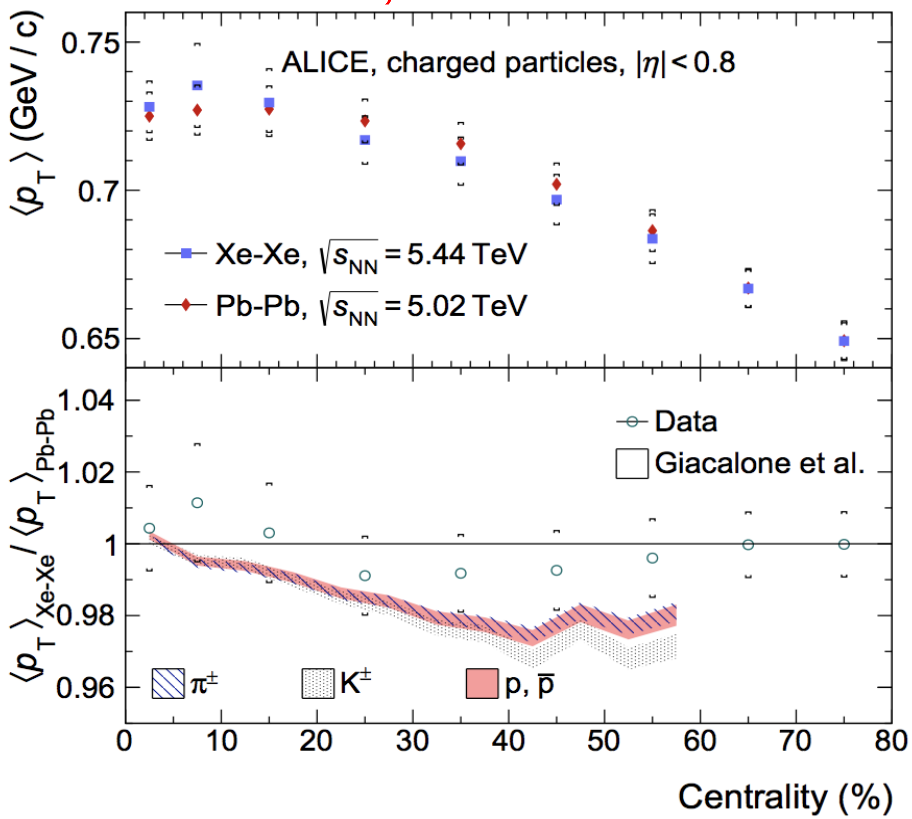
  --- $\langle\beta_T\rangle$ increases with multiplicity/centrality in small and large collision systems; T_{kin} reduces with centrality in AA collisions

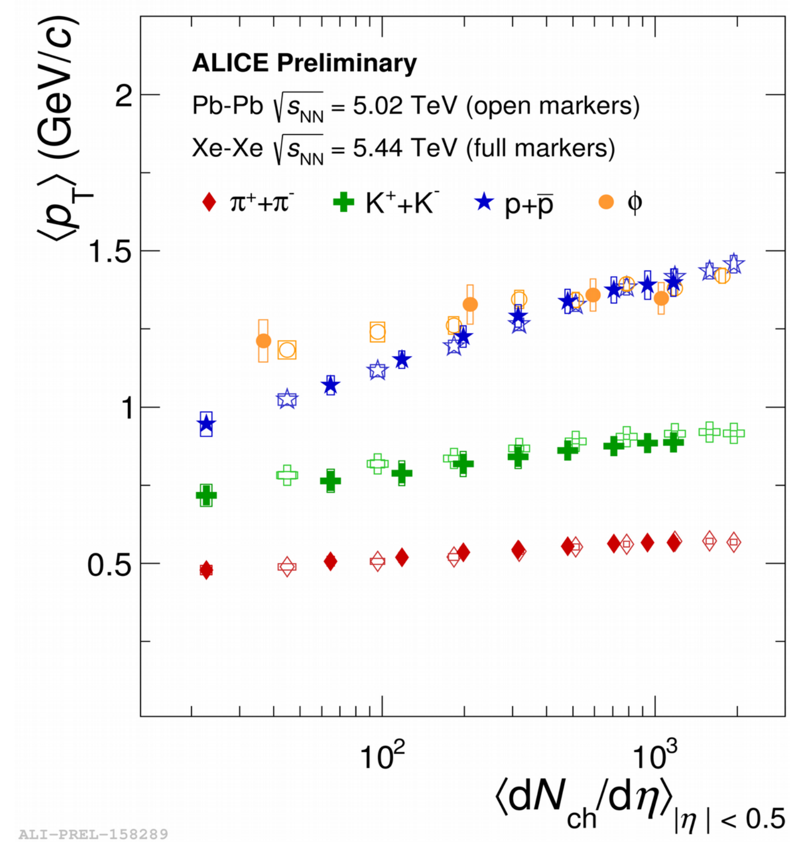
  --- In pp and p-Pb, similar evolution of the parameters towards high multiplicity

  --- At similar multiplicity, $\langle\beta_T\rangle$ is larger for small systems

Mean transverse momentum ($\langle p_T \rangle$)

ALICE, arXiv:1805.04399





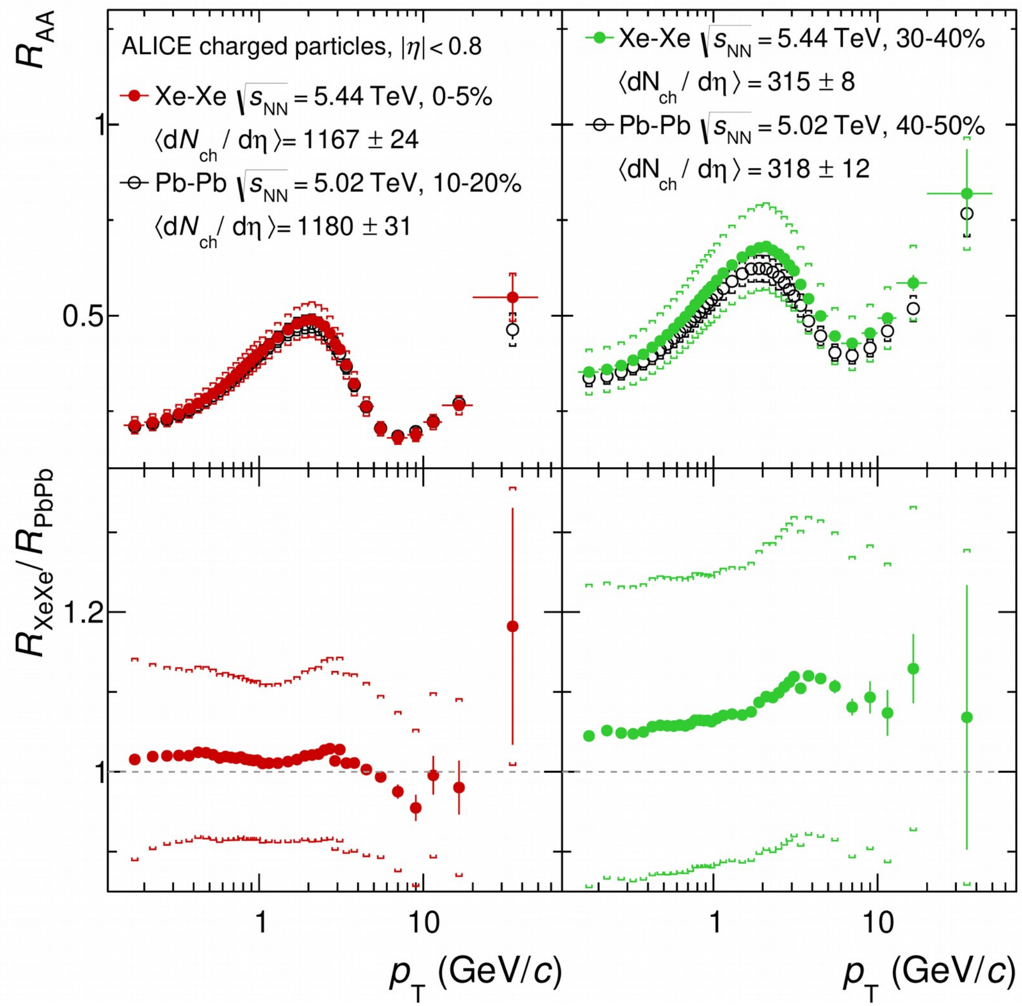
- Hydrodynamics predicts weak dependence on centrality in AA collisions and mass scaling of $\langle p_T \rangle$, but small (O(3%)) difference between Xe-Xe and Pb-Pb *[G. Giacalone et al., PRC 97, 034904 (2018)]*
  --- Measurements in Xe-Xe for charged hadrons show consistency with Pb-Pb

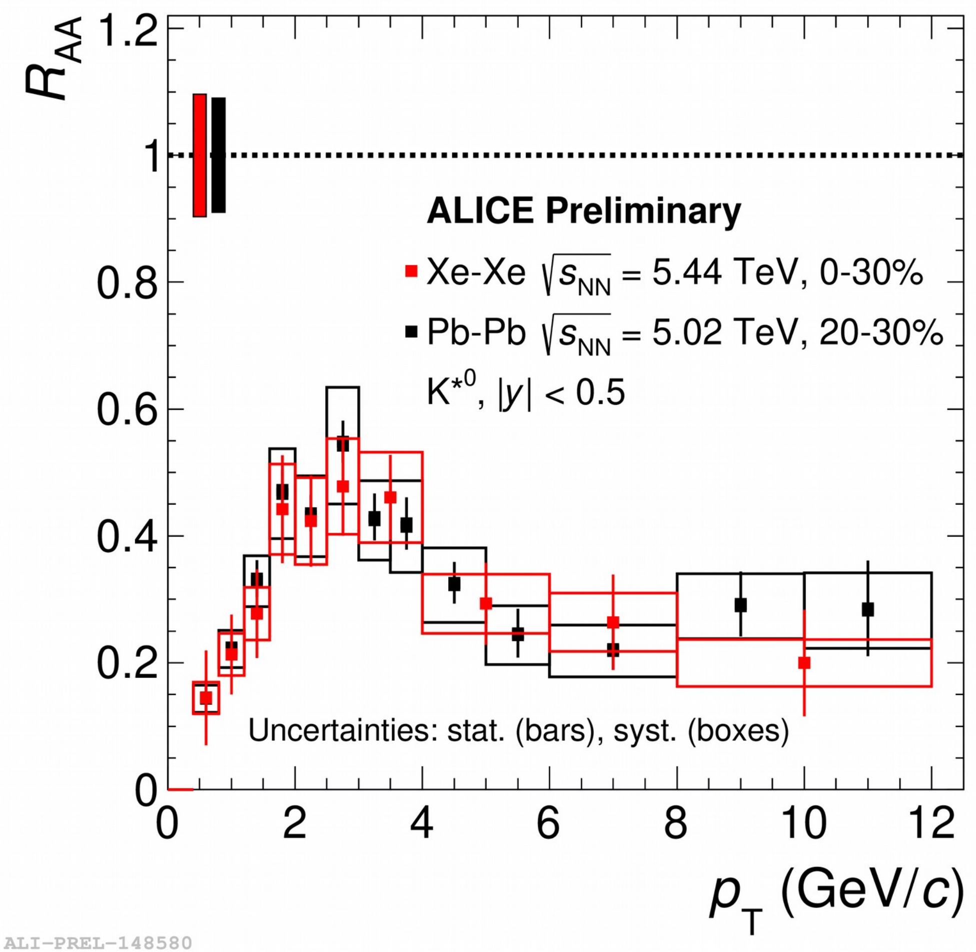
- New data in Xe-Xe for identified hadrons suggest a consistent picture between Xe-Xe and Pb-Pb

- For identified hadrons mass ordering holds at most central AA collisions but breaks down for peripheral AA collisions

Nuclear modification factors: Xe-Xe vs. Pb-Pb

ALICE, arXiv:1805.04399





- R_{AA} in Pb-Pb and Xe-Xe collisions are consistent at similar multiplicities

---interplay of system geometry and path length dependence of the parton energy loss

Summary

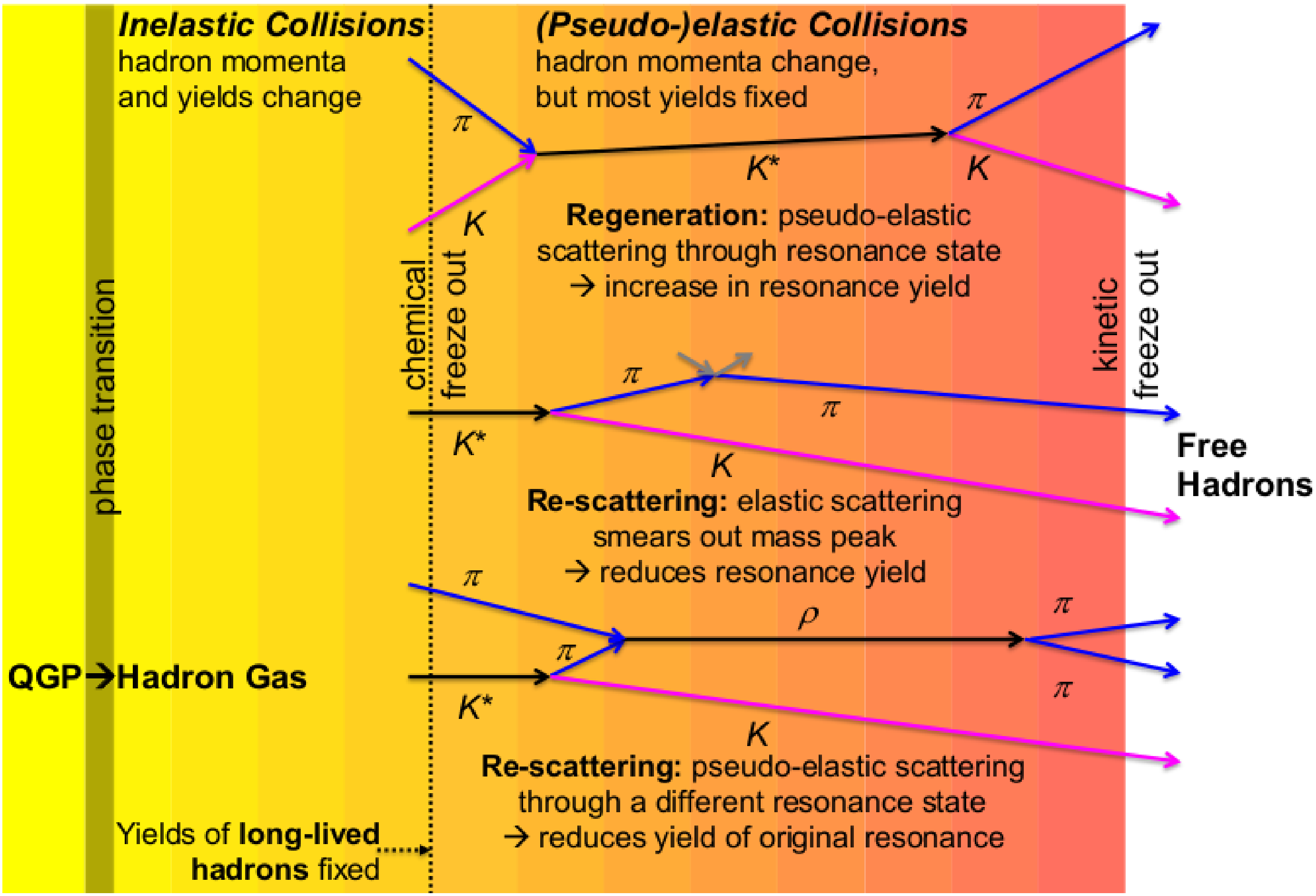
- N_{part} scaling is violated: confirmed by new measurements in Xe-Xe collisions
- Central collisions of Xe-Xe produce more particles per participant than semi-central collisions of Pb-Pb at similar N_{part}
- Relative production of the light flavour hadrons is independent of collision system and energy and is driven by event multiplicity
- Strangeness enhancement is observed in small and large collision systems, it increases with multiplicity and strangeness content, no energy or collision system dependence
- Rescattering in the hadronic phase significantly reduces reconstructed yields of the short-lived resonances
  --- Level of suppression is similar in Xe-Xe and Pb-Pb collisions at similar multiplicities
- R_{AA} in Pb-Pb and Xe-Xe collisions are consistent at similar multiplicities

THANK YOU

Back Up

Short-lived resonances

	ρ(770)	K^*(892)	Λ(1520)	Ξ(1530)	φ(1020)
cτ (fm/c)	1.3	4.2	12.7	21.7	46.2
$\sigma_{rescatt}$	$\sigma_\pi\sigma_\pi$	$\sigma_\pi\sigma_K$	$\sigma_K\sigma_p$	$\sigma_\pi\sigma_\Xi$	$\sigma_K\sigma_K$



Final state yields of resonances depend on:
- ✔ resonance yields at chemical freeze-out
- ✔ lifetime of the resonance and the hadronic phase
- ✔ type and scattering cross sections of daughter particles

Charged particle multiplicity : Model comparisson