Suppression of Λ(1520) resonance production in central Pb-Pb collisions at the LHC

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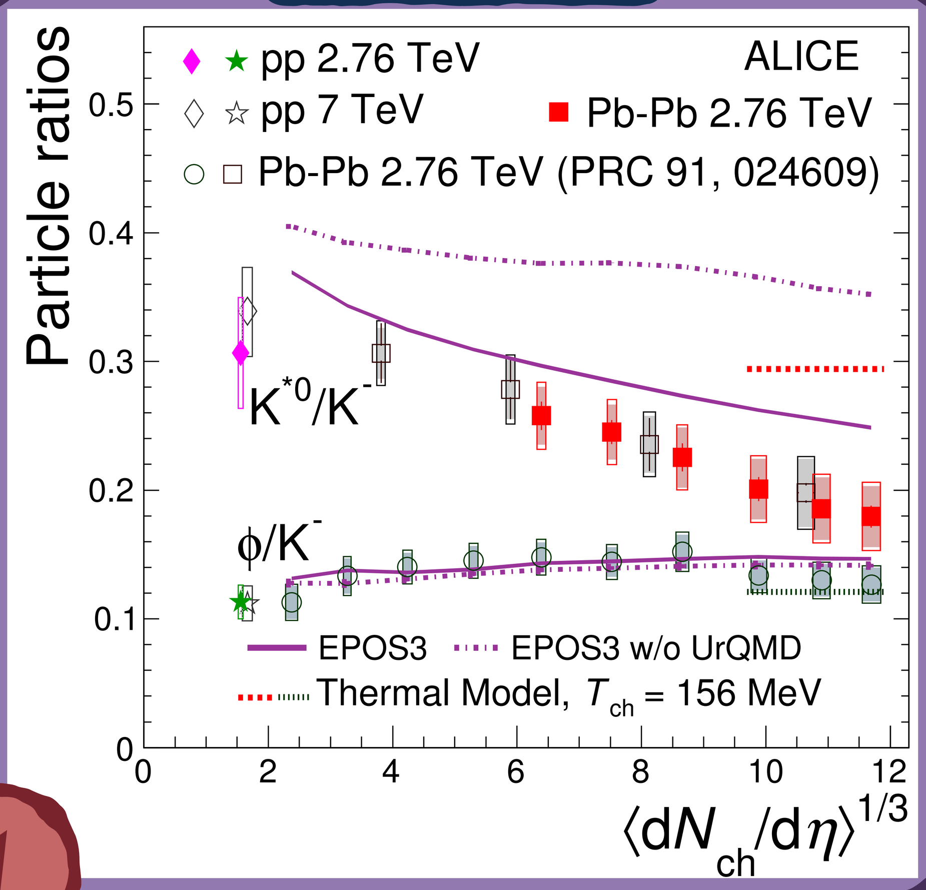
motivation



1. A deconfined Quark Gluon Plasma (QGP) state is created in high energy heavy-ion collisions. As the initial hot and dense partonic system rapidly expands and cools, it eventually transitions back from the QGP to a hadronic gas phase. After hadronisation, the system continues to expand until all elastic interactions cease (kinetic freeze-out).

2. Due to their short lifetimes ($\tau \sim$ few fm/c), resonances can decay within the hadronic medium. This can alter their final reconstructible yields by destroying the correlation of decay products due to interaction (re-scattering) with the surrounding hadrons.

3. The relative abundances of stable particles are successfully described by Statistical hadronisation models (SHM's). Resonances are expected to be produced with abundances consistent with the chemical equilibrium parameters (T_{ch}, μ_B).

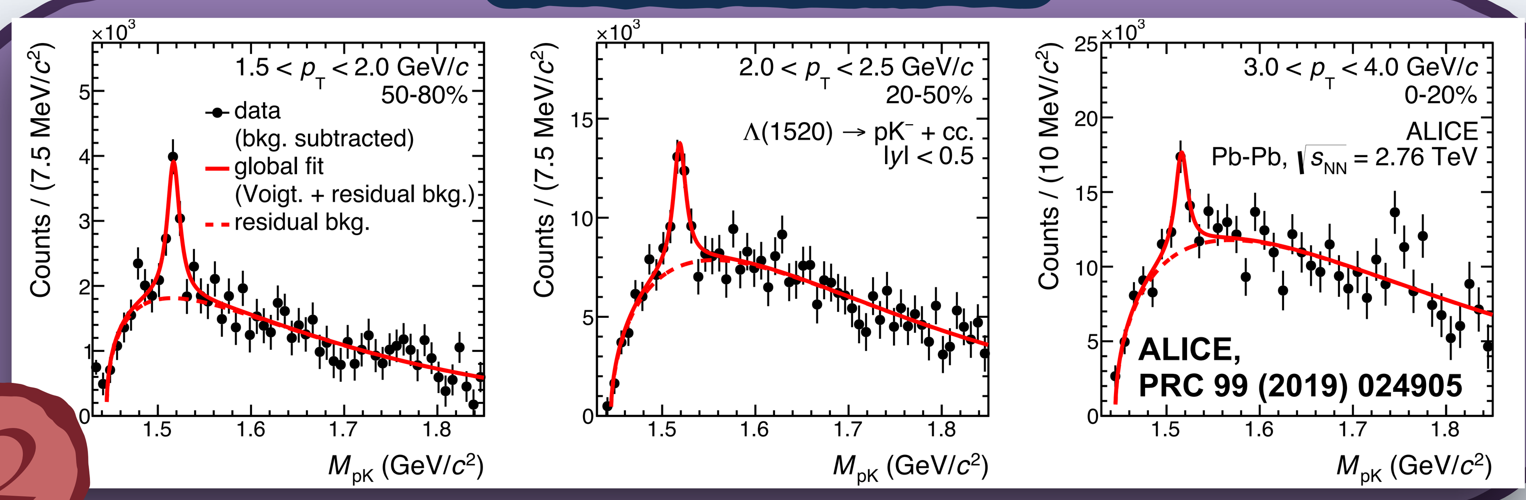
4. The production yields of the short-lived K*(892)^0 ($\tau \sim 4$ fm/c) and ρ(770) mesons ($\tau \sim 1.3$ fm/c) are suppressed in central Pb-Pb collisions [1, 2], suggesting that the phenomenon might be due to the re-scattering of the decay products within the dense hadronic medium before the kinetic freeze-out.

5. No suppression is observed for the ϕ(1020) meson ($\tau \sim 46$ fm/c) which could indicate that it decays outside the fireball due to its longer lifetime [1]. Both observations are in agreement with EPOS3 model [4] predictions employing UrQMD, which includes a microscopic description for the hadronic phase evolution in heavy-ion collisions (Figure 1).

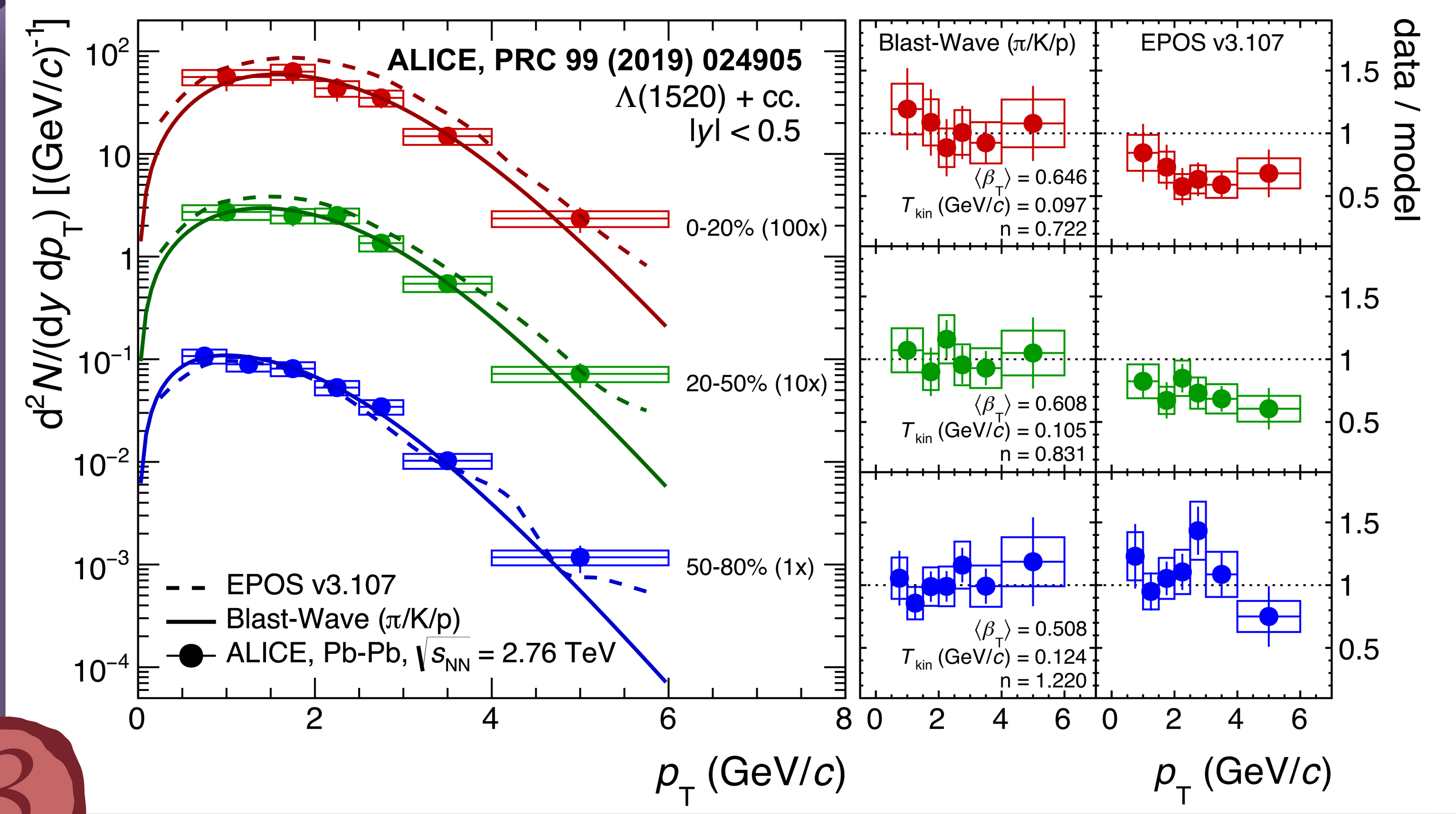
6. It is important to extend these measurements to other resonances to further probe the evolution of the dense hadronic matter after hadronisation. A good candidate is the Λ(1520), having a lifetime of $\tau(K^{*0}) < 12.6$ fm/c $< \tau(\phi)$.

7. The yield of Λ(1520) measured by the ALICE Experiment in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV is presented. The resonance is reconstructed via invariant-mass analysis in the Λ(1520) → pK$^-$ and charge conjugate decay channel. The p_T-differential yield is extracted with a combined fit (Voigtian signal + residual background, Figure 2).

invariant mass



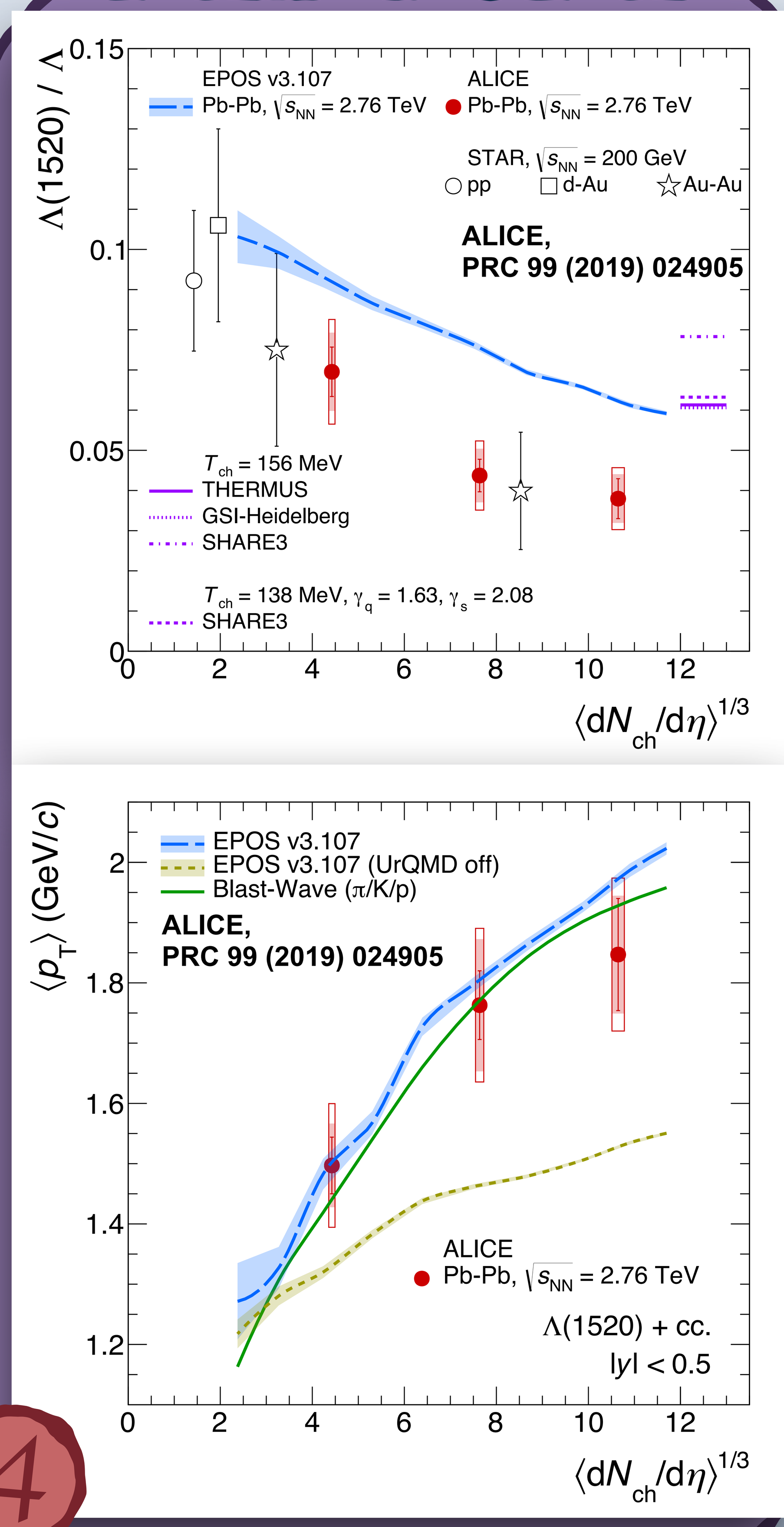
p_T spectra & predictions



8. The fully corrected Λ(1520) p_T-differential yield measured at mid-rapidity ($|y| < 0.5$) in three centrality classes is shown in Figure 3 and compared to predictions from the Blast-Wave [3] and EPOS3 models.

9. The spectral shapes show good agreement with the Blast-Wave (based on the parameters obtained from π/K/p fits [5]) and EPOS3 predictions. The EPOS3 model slightly over-predicts the yield for the central collisions.

Λ(1520)/Λ & ⟨p_T⟩

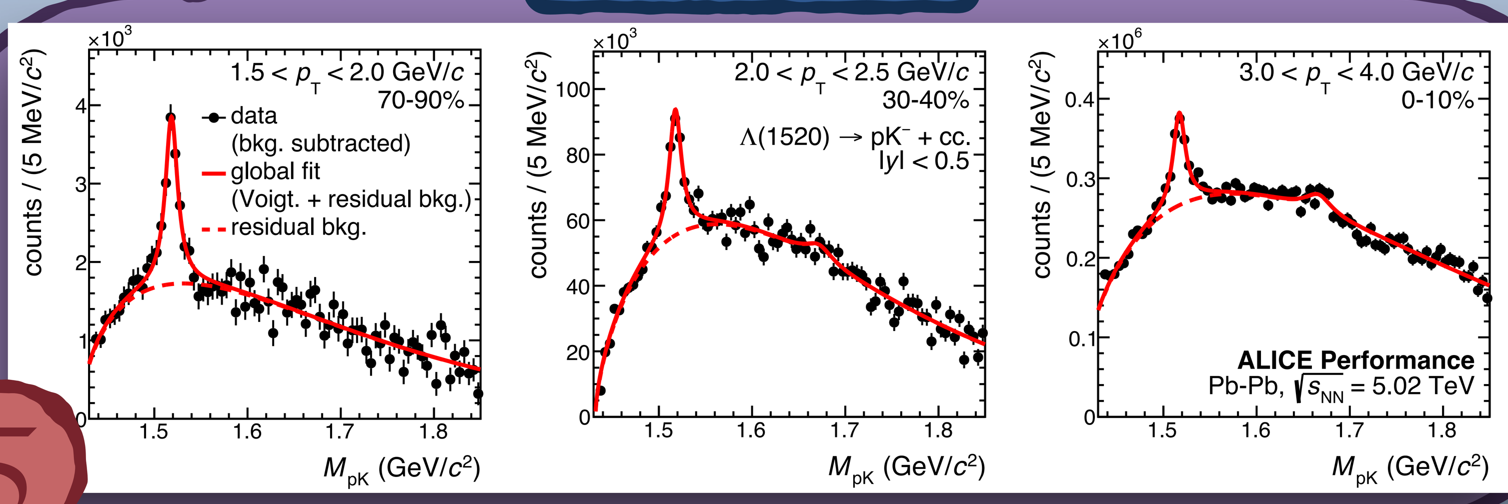


10. The p_T-integrated Λ(1520)/Λ yield ratio is shown in Figure 4 (top). The ratio is suppressed in central collisions by 45% as compared to peripheral collisions, pp collisions and predictions from SHM's [7, 8, 9]. EPOS3 reproduces this multiplicity suppression trend showing the importance of a microscopic description of the late hadronic interactions.

11. The ⟨p_T⟩ increases by 23% from peripheral collisions to central collisions (Figure 4, bottom) and is in agreement with the Blast-Wave and EPOS3 model predictions. This observation confirms the common hydrodynamic evolution picture. EPOS3 fails to reproduce the data if the UrQMD stage is not enabled.

12. This measurement provides further support to the formation of a dense hadronic phase lasting long enough to cause a significant reduction of the observable yield of short-lived resonances.

perspectives



13. A Large LHC Run-2 data sample collected in Pb-Pb collisions widens the perspectives for the measurement of Λ(1520) production with improved statistical significance and to perform the study more differentially and in narrower centrality classes than the currently published data.

references

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