Multiplicity evolution of the $K^{*}(892)^{\pm}$ production in pp at $\sqrt{s}$ = 13 TeV and in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with the ALICE detector

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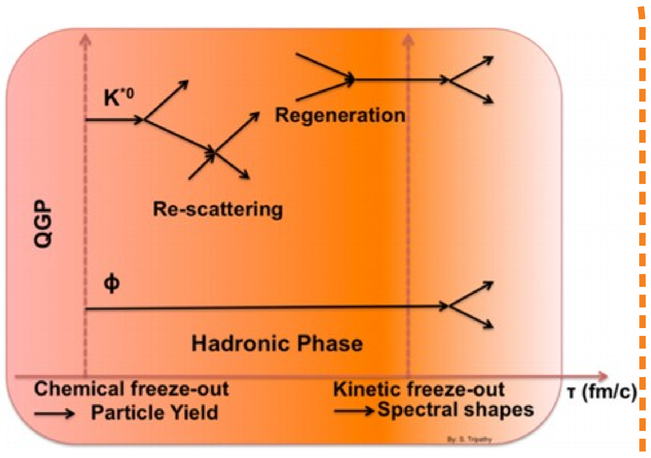
Introduction

- **Hadronic resonances** → ideal probes to characterize heavy-ion collisions
- **Resonances** with a **lifetime comparable** to the one of the **hadronic phase** (~ 1-10 fm/*c*) may be **sensitive** to **rescattering** and **regeneration**
- **Small** collision systems:
  - used as a **baseline** for heavy-ion collisions
  - **Recent results** on resonance production show some **typical phenomena of heavy-ion collisions**, like collective behaviour and suppression of the resonance measured yield.



Particle yield ratios

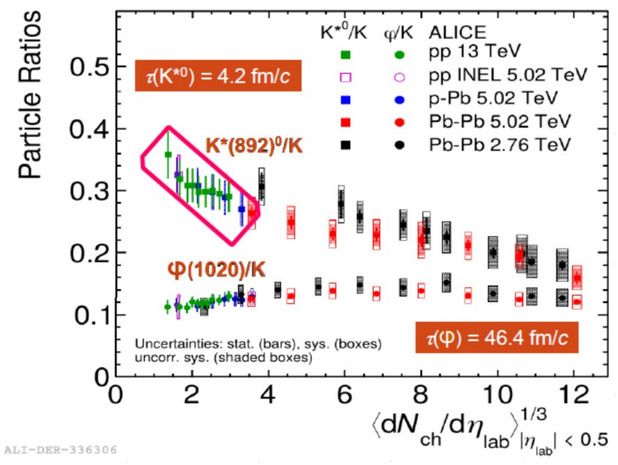
- Ratio of resonance yields to ground state hadrons: important tool to characterize the hadronic phase properties

Longer-lived φ resonances

- no evidence of multiplicity evolution

Short-lived K*⁰ resonance

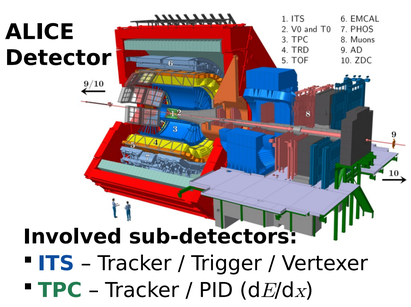
- **Pb–Pb:** K^{*0}/K ratio suppressed with increasing multiplicity → dominance of rescattering
- **pp and p–Pb:** hint (~2σ level) of decreasing trend → increased precision is needed: this can be obtained with **charged** K* measurements

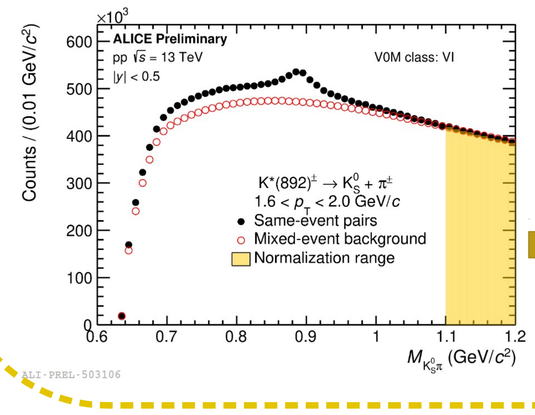


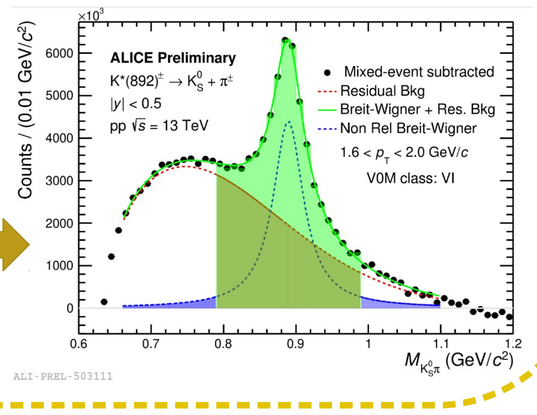
- Some models, like PYTHIA 8 [1] and EPOS-LHC [2] can reproduce the suppression without a hadronic phase → colour reconnection and core/corona effects

Resonance reconstruction

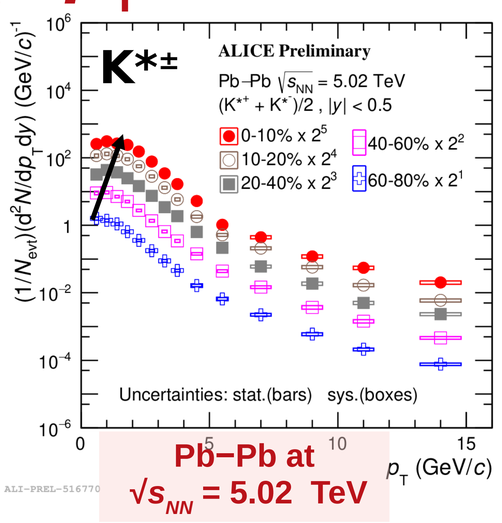
- Resonance yield extraction from invariant mass distribution of the decay daughters identified by PID (TPC, TOF) and topological selection criteria
- Uncorrelated background calculated via event mixing technique or like-sign pair method
- Remaining distribution fitted with a Breit-Wigner (signal) + exponential polynomial (residual background)



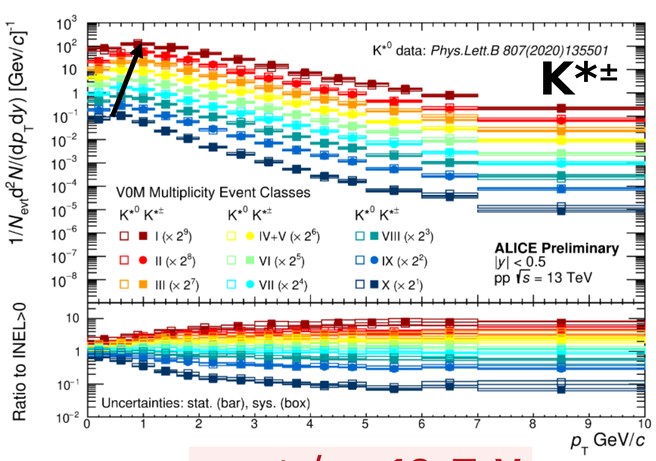




p_T distributions vs multiplicity



Pb–Pb at $\sqrt{s_{NN}}$ = 5.02 TeV

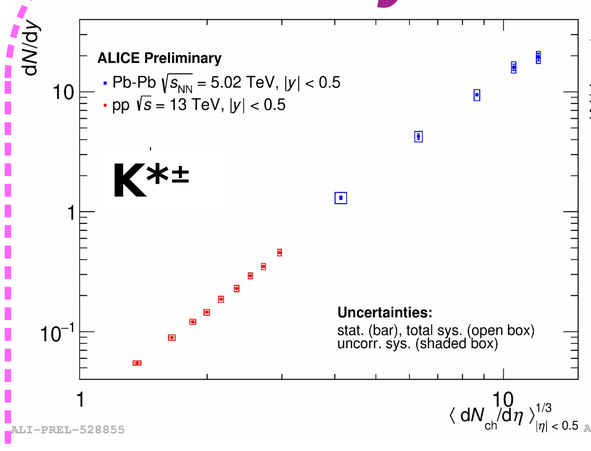


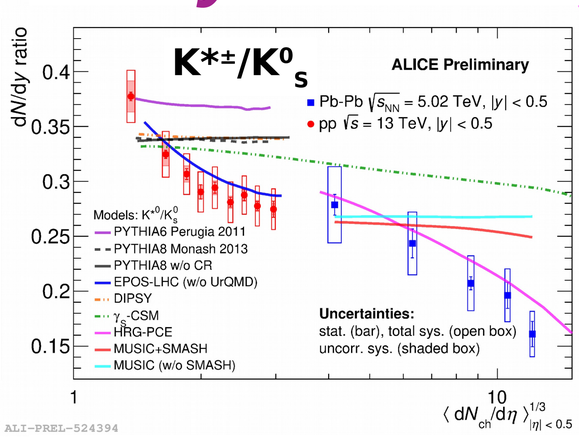
pp at √s = 13 TeV

- p_T spectra **get harder** with increasing multiplicity and **shift of the maximum** of the distributions towards higher p_T values → expected in Pb–Pb collisions: radial flow
- Same behaviour also in pp collisions: **flow-like** effect
- **Lower panel (pp):** ratios of p_T spectra to INEL>0. For p_T < 5 GeV/*c* spectra increase from low to high multiplicity. Same spectral shape for p_T > 5 GeV/*c* → Process dominant at low p_T

Results are consisistent with the neutral K* measurements

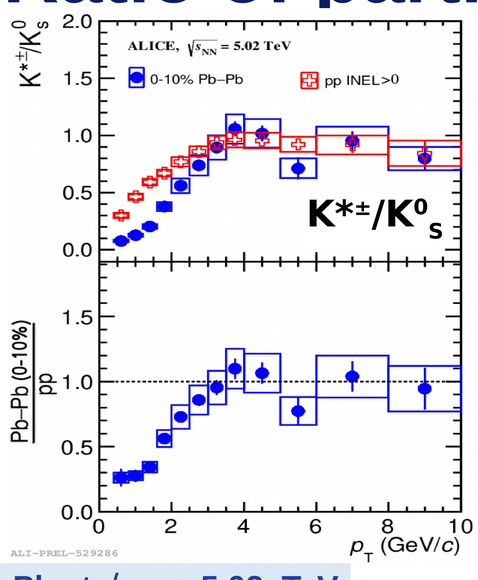
d*N*/d*y* and d*N*/d*y* ratio





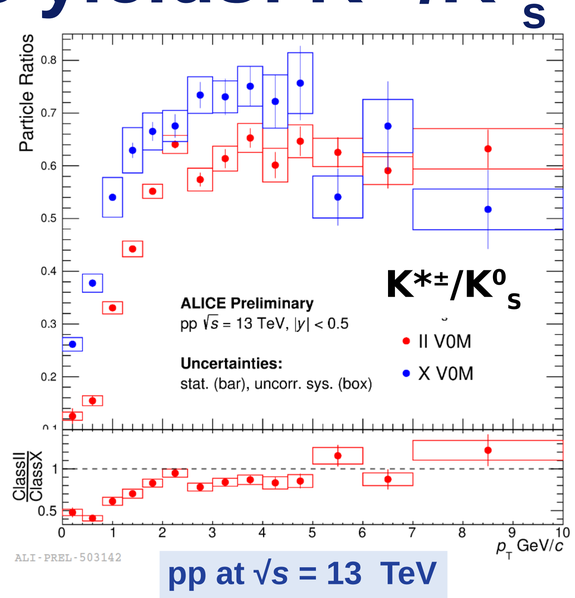
- The d*N*/d*y* spectra exhibit a linear increase with increasing $\langle dN_{ch}/d\eta \rangle$
- Consistent with the K*⁰ measurements
- As observed for other hadron species, resonance production rate does not depend on collision energy or system → it is driven by the event multiplicity
- Suppression of $K^{*\pm}/K^0_s$ with increasing multiplicity in pp and Pb–Pb collisions
- $K^{*\pm}/K^0_s$ trend in pp collisions at $\sqrt{s}$ = 13 TeV confirms the K^{*0}/K^0_s suppression even accounting for the systematic uncertainties (~7σ in pp and ~9σ in Pb–Pb)
- EPOS-LHC for pp and HRG in Partial Chemical Equilibrium [3] for Pb–Pb collisions: best description

Ratio of particle yields: $K^{*\pm}/K^0_s$



Pb–Pb at $\sqrt{s_{NN}}$ = 5.02 TeV

- Ratios increase at low p_T and saturate for $p_T \gtrsim$ 2.5 GeV/c
- For $p_T \lesssim$ 2.5 GeV/c the ratio in **central collisions** is smaller than in **pp reference**
- Suppression in the d*N*/d*y* ratio and in the p_T-differential ratio at low p_T ➔ signature of rescattering effects



pp at √s = 13 TeV

- Same trend as Pb–Pb collisions
- Significant $K^{*\pm}/K^0_s$ suppression for $p_T \lesssim$ 2.5 GeV/*c*
- Consistent with K*⁰ results and with the hypothesis of rescattering effects ➔ hint of a (short-lived) hadronic phase in pp collisions?

References

[1] R. Acconcia et al., Phys. Rev. D 97, 036010 (2018)
[2] T. Pierog et al., Phys. Rev. C 92, 034906 (2015)
[3] A. Motornenko et al., Phys. Rev. C 102, 024909 (2020)