

1. Physics Motivation

- Short-lived hadronic resonances are considered as sensitive probes of the hadronic medium present in the late stages of heavy-ion collisions.
- As their lifetimes are comparable to that of hadronic medium, the measurable yields of hadronic resonances can be affected by elastic re-scattering of their decay daughters and regeneration in the hadronic phase.
- The study of the nuclear modification factor (R_{AA}) provides information on parton energy loss in the medium.
- Recently, measurements of the ρ , K^{*0} , ϕ , $\Lambda(1520)$ and Ξ^{*0} resonances have been carried out in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV using ALICE at the LHC.

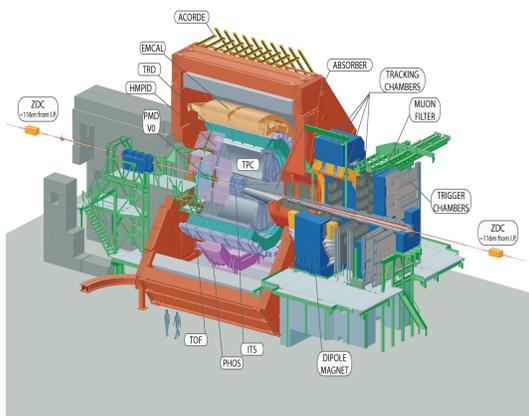
Particle	ρ	K^{*0}	ϕ	$\Lambda(1520)$	Ξ^{*0}
Mass (GeV/c^2)	0.775	0.891	1.019	1.519	1.531
Mean Lifetime (fm/c)	1.3	4.2	46.2	12.6	21.7

2. A Large Ion Collider Experiment (ALICE)

Detectors used for these analyses

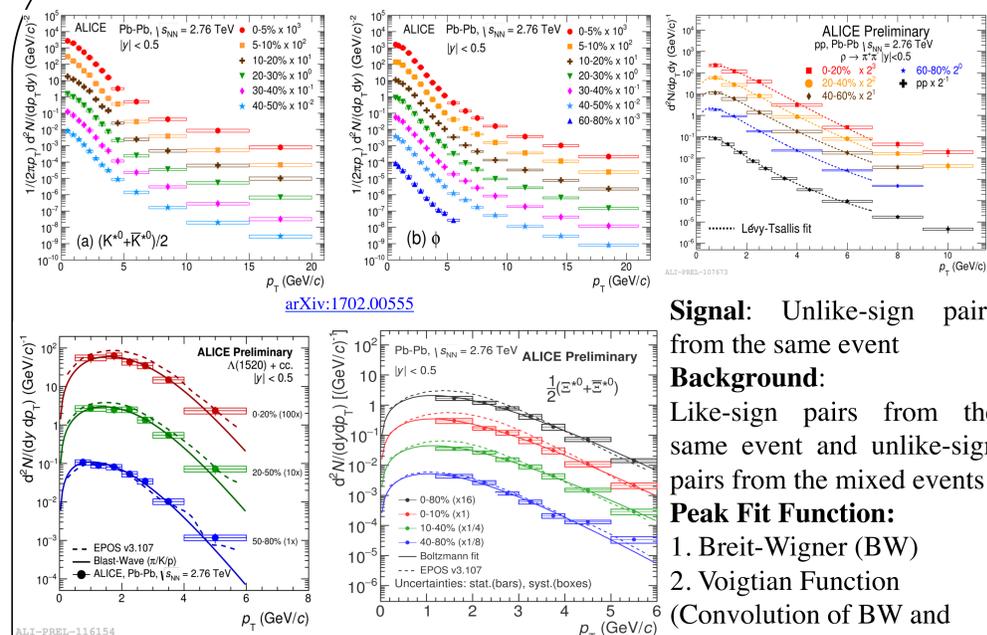
Inner Tracking system (ITS)

- Tracking
- Vertexing
- V0 detectors (V0A & V0C)
- Centrality determination in Pb-Pb collisions
- Time Projection Chamber (TPC)
- Main tracking detector
- Particle identification (PID)
- Momentum measurement
- Time of Flight (TOF)
- PID via time of flight measurement



Schematic drawing of the ALICE detector at the LHC

3. Hadronic resonance production



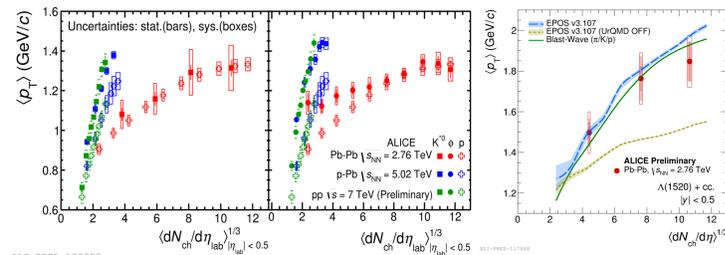
Signal: Unlike-sign pairs from the same event
Background: Like-sign pairs from the same event and unlike-sign pairs from the mixed events
Peak Fit Function:
 1. Breit-Wigner (BW)
 2. Voigtian Function (Convolution of BW and Gaussian)

- Measurement performed in the rapidity range $|y| < 0.5$ for different centrality classes.

7. Summary

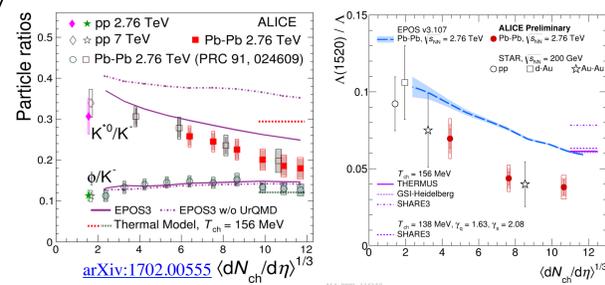
- New results on hadronic resonances in Pb-Pb collisions at 2.76 TeV are presented.
- Steeper increase in $\langle p_T \rangle$ is observed in small systems compared to Pb-Pb collisions.
- Suppression of short-lived resonance yields is observed from peripheral to central Pb-Pb collisions, which suggest the presence of re-scattering effects in hadronic phase. ϕ behaves instead as a long-lived particle.
- The study of nuclear modification factor for light flavor hadrons is suggestive of flavor-independent parton energy loss at high p_T .

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

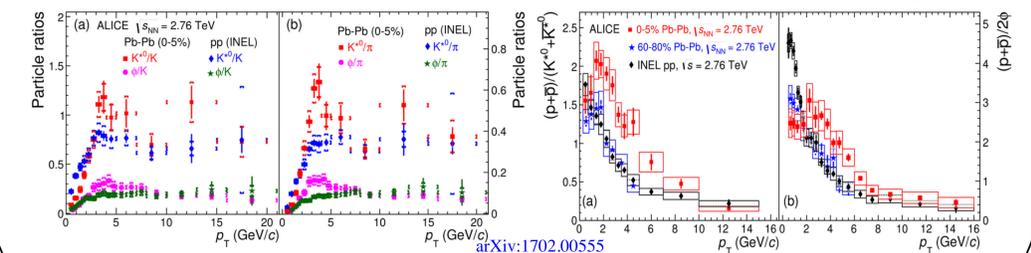
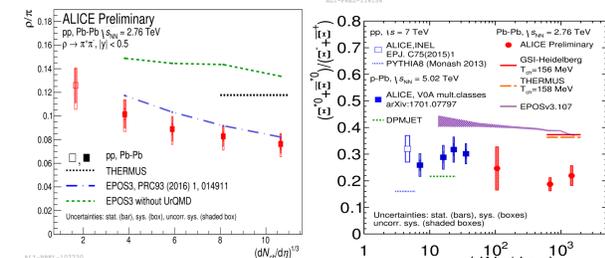


- Steeper increase of $\langle p_T \rangle$ is observed for K^{*0} and ϕ in smaller systems compared to Pb-Pb collisions.
- $\langle p_T \rangle$ is same for K^{*0} , proton and ϕ in central Pb-Pb collisions, which is consistent with what we would expect from a common hydrodynamical expansion of the system.
- Splitting of $\langle p_T \rangle$ is observed for proton and ϕ in peripheral Pb-Pb collisions.
- $\langle p_T \rangle$ of $\Lambda(1520)$ increases with system size, which is well described by EPOS with UrQMD. Without re-scattering interactions in the hadronic phase (UrQMD off), the EPOS model fails to describe the data.

5. Particle Ratios



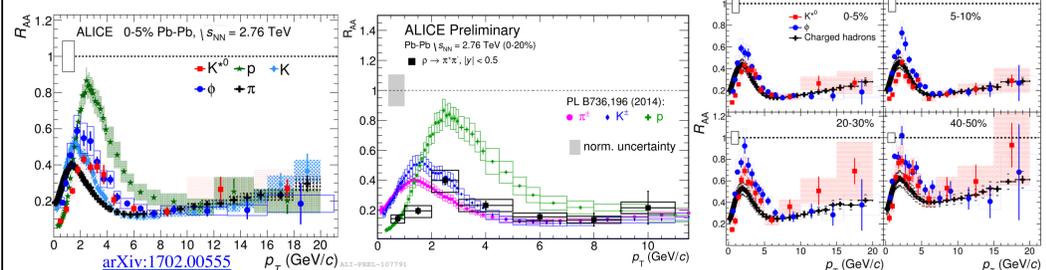
- Suppression of ρ/π , K^{*0}/K and $\Lambda(1520)/\Lambda$ increases with system size but ϕ/K^- shows no significant suppression.
- No significant dependence of Ξ^{*0}/Ξ^- on system size, significant suppression with respect to thermal model is observed.
- EPOS can qualitatively describe the suppression of the ρ/π , K^{*0}/K and $\Lambda(1520)/\Lambda$ ratios as well as the flat behavior of the ϕ/K^- and Ξ^{*0}/Ξ^- ratios.
- Suppression in Pb-Pb collisions can be interpreted as dominance of re-scattering.
- K^{*0}/K and K^{*0}/π ratios at low p_T are lower in Pb-Pb than in pp. However, the ϕ/K and ϕ/π ratios at low p_T are consistent for pp and Pb-Pb. These results suggest re-scattering for K^{*0} .



- The p/ϕ ratio shows flat behavior for $p_T < 4$ GeV/c, which is consistent with what we would expect from a common hydrodynamical expansion of the system.

6. Nuclear Modification factor (R_{AA})

- R_{AA} is defined as the ratio of yields in Pb-Pb collisions to those in pp, scaled by number of binary nucleon-nucleon collisions.
- $R_{AA} = 1$ implies no medium modification.



- Strong suppression with respect to pp collisions is observed for K^{*0} , ϕ and ρ as well as for stable hadrons.
- At high p_T , all the light-flavor hadrons are suppressed by the same amount.

8. References

- ALICE Collaboration, J. Adam *et al.*, "K*(892)0 and phi(1020) meson production at high transverse momentum in pp and Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV", arXiv: 1702.00555 [nucl-ex].
- ALICE Collaboration, B. Abelev *et al.*, "K*(892)0 and phi(1020) production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV", Phys. Rev. C 91 024609 (2015).
- A. G. Knospe, C. Markert, K. Werner, J. Steinheimer, and M. Bleicher, "Hadronic resonance production and interaction in partonic and hadronic matter in the EPOS3 model with and without the hadronic afterburner UrQMD", Phys. Rev. C 93 014911(2016).
- J. Stachel, A. Andronic, P. Braun-Munzinger, and K. Redlich, "Confronting LHC data with the statistical hadronization model," J. Phys. Conf. Ser. 509 (2014).