Measurement of K*± production in p-Pb collisions with ALICE at the LHC

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1. Motivation

❖ Due to their short lifetime (few fm/c) resonances are used as a probe to understand the hadronic phase and the evolution of the system [1].

❖ Study of light flavor (K*±) production in p-Pb is important to disentangle the cold nuclear matter effects (shadowing, gluon saturation, k_T broadening, energy loss) from hot nuclear matter effects in Pb-Pb collisions.

Properties	K*±
Mass	891.6 MeV/c²
Width	50.8 ± 0.9 MeV/c²
Quark conetnts	$u\bar{s}, \bar{u}s$
Decay mode	$K_s^0\pi^+$, $K_s^0\pi^-$
Life time	~ 4 fm/c
Branching ratio	0.33

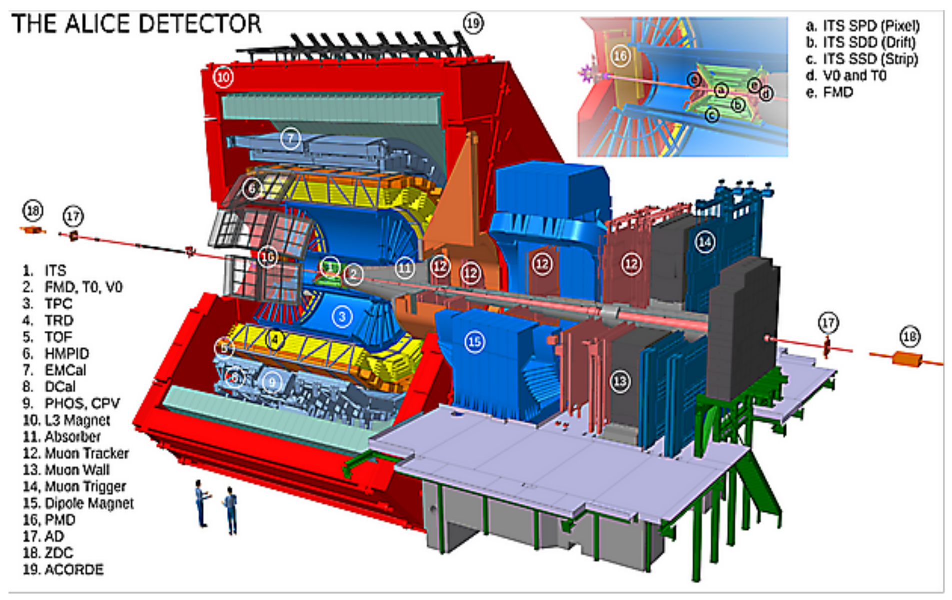
❖ The nuclear modification factors in p-Pb collisions are defined as:

$$R_{\mathrm{pPb}}(p_T) = \frac{Yield_{\mathrm{pPb}}(p_T)}{Yield_{\mathrm{pp}}(p_T) \times < N_{coll} >}$$

❖ Model comparision of studies in p_T spectra also helps to understand different physics processes related to initial state effects.

2. Experiment and analysis details

Data : p-Pb at $\sqrt{s_{NN}}$ = 5.02 and 8.16 TeV recorded in 2016
MC : EPOS-LHC
Multiplicity estimator : Using V0A multiplicity classes.
PID : TPC + TOF



ALICE detector setup [2]

K*+- are reconstructed via their hadronic decay channel by invariant mass method.

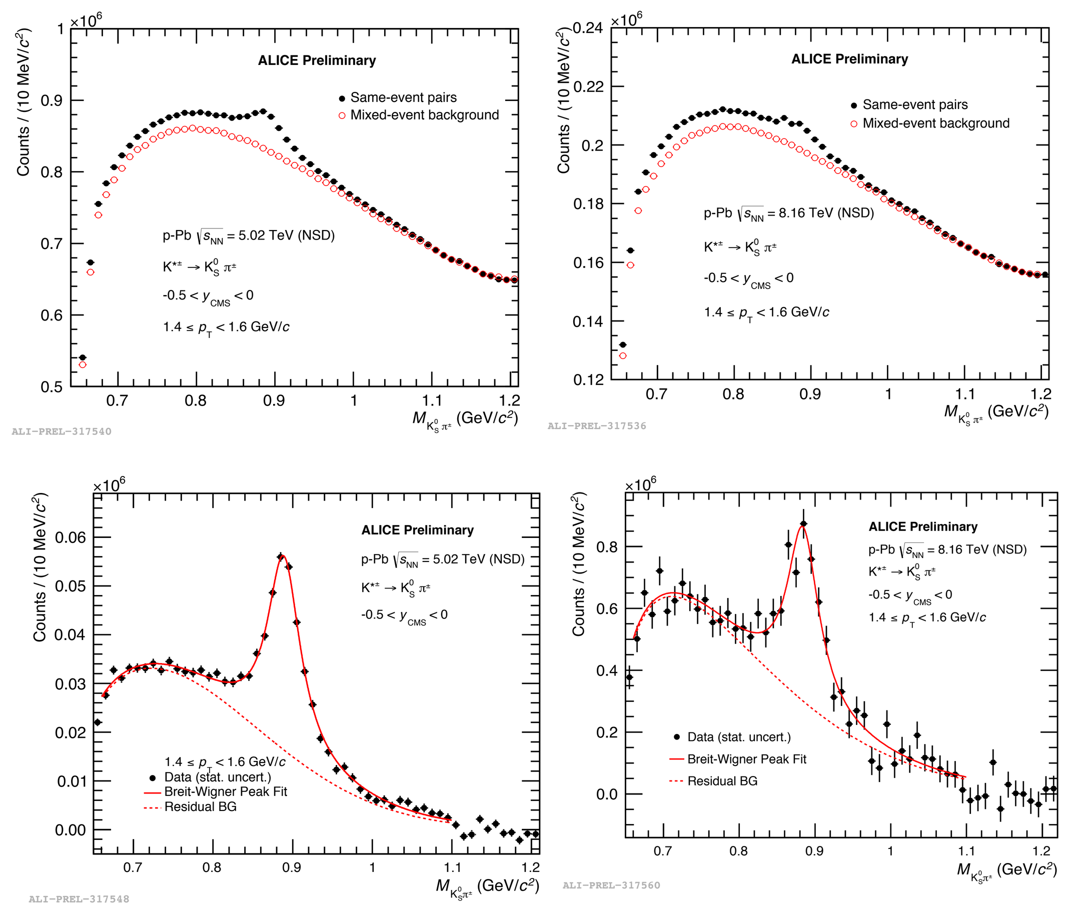
$$K^{*\pm} \rightarrow \pi^{\pm} + K_s^0$$

$$K_s^0 \rightarrow \pi^{+} + \pi^{-}$$

1. **Invariant mass method** : For each event, the invariant mass ($M_{K_s^0\pi}$) distributions are constructed using all combinations of charged π and K^0_s.
2. **Combinatorial background:** Event mixing technique.
3. **Event Mixing:** (10 events, z-Vertex difference < 1 cm, V0A Multiplicity difference (%) < 5).
4. **Combinatorial background normalization:** Normalized to the region outside the mass peak (1.1 -1.2) (GeV/c²) of the invariant mass distribution.
5. **Signal** = Same event invariant mass distribution – scaled mixed event invariant mass distribution.
6. **Combined fit** : Breit -Wigner (K*±) for signal and combination of exponential and polynomial function for the residual background.
7. **Corrected p_T spectra :**

$$\frac{d^2N_{corrected}}{dp_T dy} = \frac{N_{raw}}{N_{evt} \times BR \times dp_T dy} \times \frac{1}{\varepsilon_{ff}} \times f_{norm} \times f_{SL} \times f_{vtx}$$

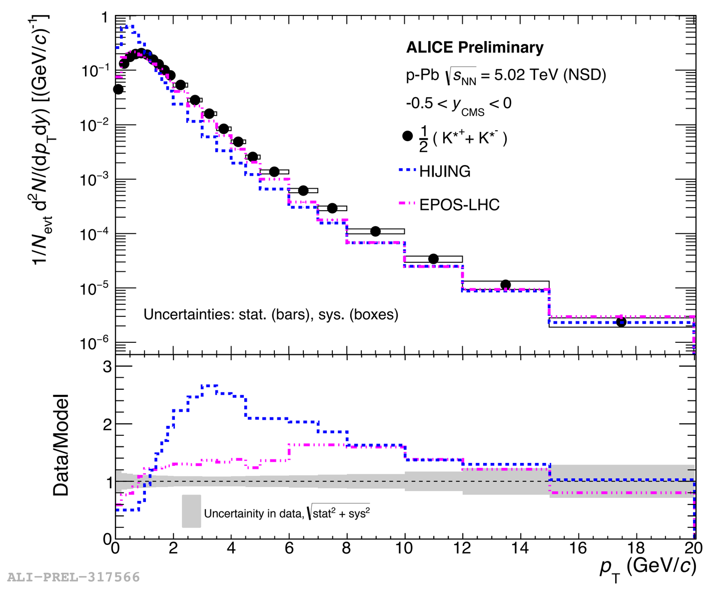
N_{raw} = Raw yield counts: Area under the peak.
Efficiency x acceptance correction (ϵ_{ff}) = N^{rec}/N^{gen}
Where f_{norm}, f_{SL} and f_{vtx} are normalisation, signal loss and vertex correction factors, respectively.

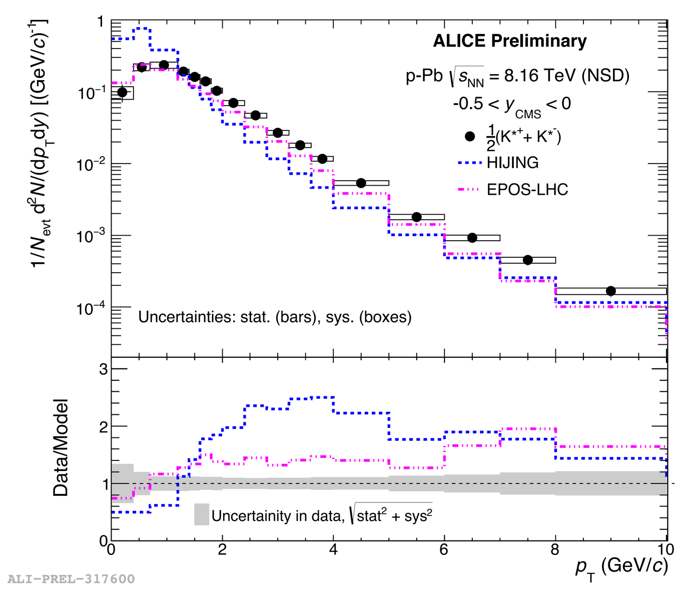


✓ Invariant mass distribution of πK^0_s pair before and after background subtraction (for 1.4 < p_T < 1.6 GeV/c).

where N^{rec} = No. of reconstructed K*±
N^{gen} = No. of generated K*±

3. p_T spectra



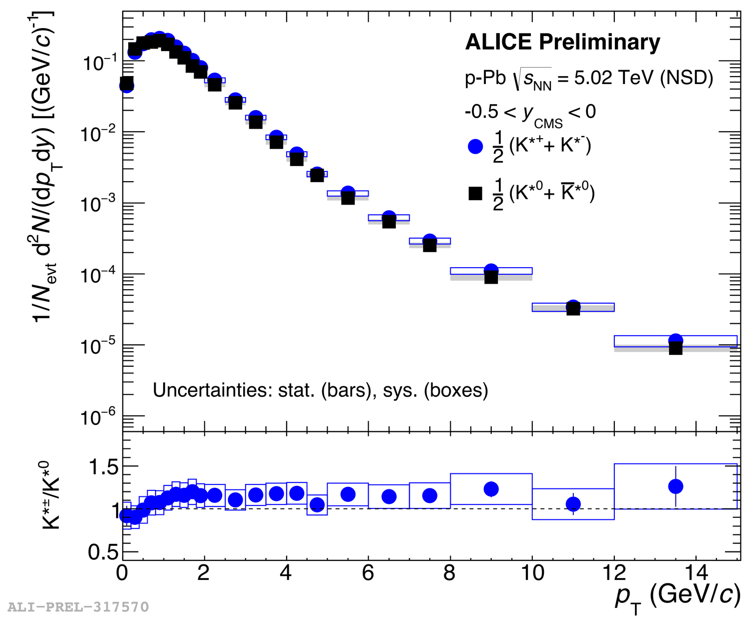


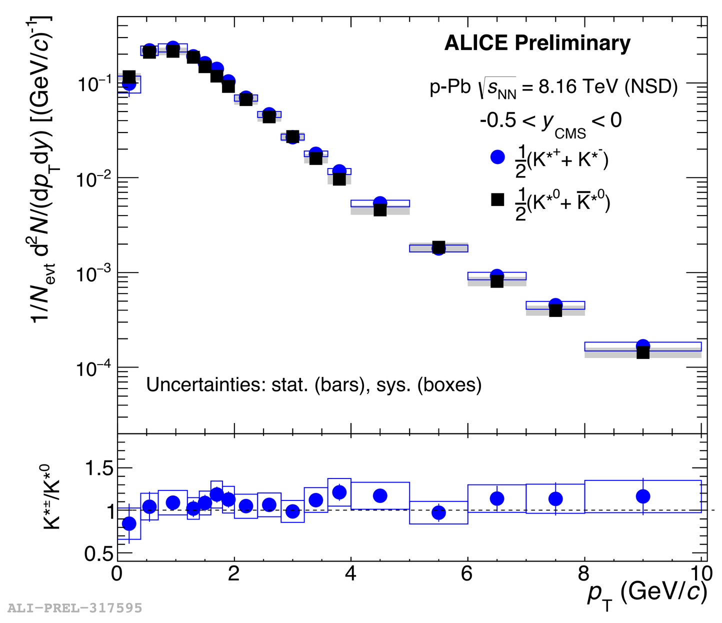
✓ p_T spectra are measured for the NSD event class in p-Pb at $\sqrt{s_{NN}}$ = 5.02 (left figure) and 8.16 (right figure) TeV, respectively.

✓ Lower panel plot shows ratio of spectrum of data to different model spectra (EPOS-LHC and HIJING).

✓ Models do not describe measured p_T spectra for both energies, results from EPOS-LHC model give better description of the data than HIJING.

4.Comparison of p_T spectra with K*0





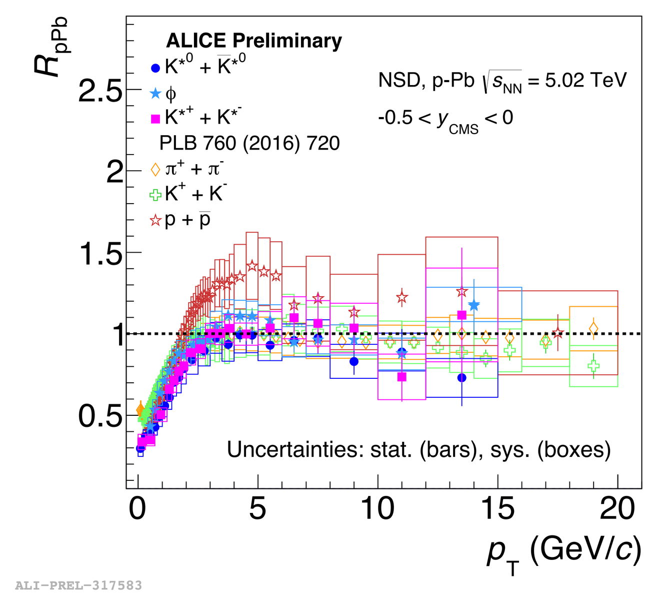
✓ Comparisons of p_T spectra of K*± and K*0 are shown in p-Pb at $\sqrt{s_{NN}}$ = 5.02 (left figure) and 8.16 (right figure) TeV, respectively.

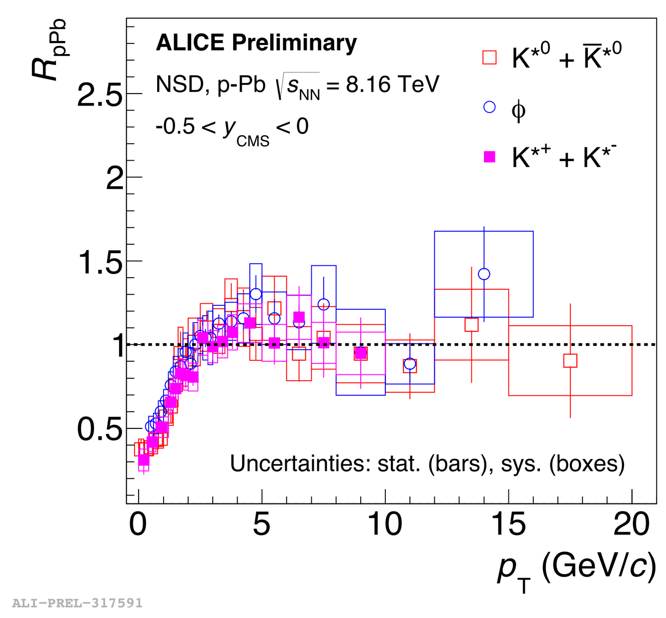
✓ Lower panels show ratio of spectrum of K*± to K*0.

✓ Results are consistent within uncertainties for both energies.

5. Nuclear modification factor

✓ Nuclear modification factors (R_{pPb}) are measured for NSD event class for K*± along with π/K/p/ϕ/K*0 in p-Pb at $\sqrt{s_{NN}}$ = 5.02 (left figure) and for 8.16 TeV (right figure) with ϕ/K*0.





p-Pb at $\sqrt{s_{NN}}$ = 5.02 TeV :
✓At low p_T : Mesons (π/K/ϕ/K*0/K*±) show similar behavior whereas proton shows a different trend.
✓At high p_T : (> 8 GeV/c) all results are consistent within uncertainties. -> No flavor dependence.
✓R_{pPb} of K*0 and K*± are consistent within uncertainties.

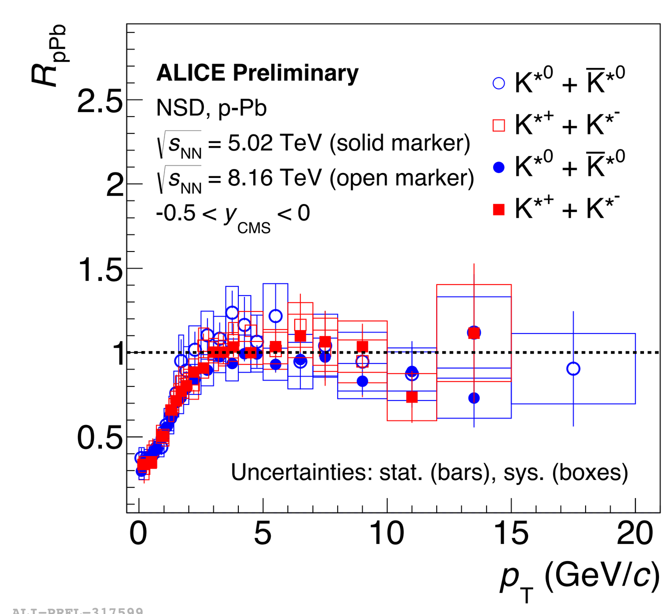
p-Pb at $\sqrt{s_{NN}}$ = 8.16 TeV :
✓ Mesons with similar masses (ϕ/K*0/K*±) show similar parton energy loss (R_{pPb}).

6.Nuclear modification factor: energy dependence

✓Nuclear modification factors (R_{pPb}) of K*± and K*0 are shown for the NSD event class in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 and 8.16 TeV

✓R_{pPb} of K*± and K*0 and are consistent within uncertainties

✓No significant energy dependence is measured in p-Pb collisions for K*± and K*0.



7. Summary

❖ K*± minimum bias (NSD) spectra are measured in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 and 8.16 TeV.

❖ p_T spectra are compared with corresponding results from EPOS-LHC and HIJING -> Models do not describe the data.

❖ p_T spectra results are compared with corresponding results from K*0 -> Results are consistent within uncertainties.

❖ Nuclear modification factors (R_{pPb}) are measured for K*± along with π/K/p/ϕ/K*0 in p-Pb at $\sqrt{s_{NN}}$ = 5.02 and 8.16 TeV with ϕ/K*0 :
- At low p_T mesons show similar behavior whereas proton shows different trend.
- At high p_T (> 8 GeV/c) all results are consistent within uncertainties. -> No flavor dependence observed.
- K*± and K*0 have similar R_{pPb}
- No significant energy dependence is observed in R_{pPb} for K*± and K*0

References

1. Adam, J., Adamová, D., Aggarwal, M.M. et al. Eur. Phys. J. C (2016) 76, 245 (2016).
2. B. Abelev et al., (ALICE Collaboration), Phys. Rev. C 91, 024609 (2015).

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