Angular correlations of neutral to charged kaons in Pb–Pb collisions with ALICE

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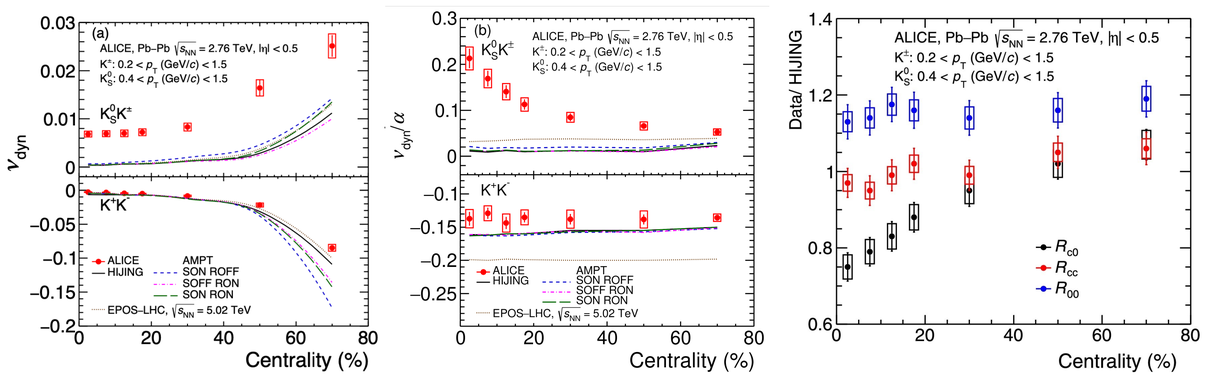
1. MOTIVATION

- ALICE observed large dynamical correlations between the produced neutral and charged kaons in Pb–Pb collisions. The fluctuations of relative yields of kaons were measured using the robust fluctuation correlator, $\nu_{\rm dyn}$ [1].
- Two theoretical approaches that can describe this behavior are DCC (Disoriented Chiral Condensate) and DIC (Disoriented Isospin Condensate) [2,3].

- DCC arises from chiral symmetry restoration in the QGP, which breaks during the phase transition to form a condensate which coherently emits hadrons.
- DIC event-by-event fluctuations of the $\langle \bar{u}u \rangle$ vs. $\langle \bar{d}d \rangle$ condensates.



*Unlike data, the scaled values of $\nu_{\rm dyn}$ in $K^0_S K^\pm$ predicted by models are invariant with centrality.

*R_{c0} shows significant dependence on centrality.

$$\alpha \equiv (\langle K^0_S \rangle^{-1} + \langle K^\pm \rangle^{-1}) \qquad \nu_{dyn} = R_{cc} + R_{00} - 2R_{c0}.$$

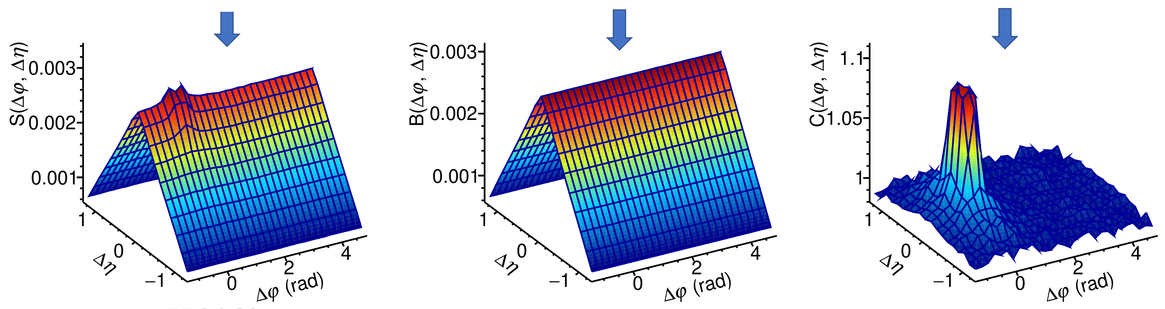
$$R_{aa} = \frac{< N_a^2 > - < N_a >^2 - < N_a >}{< N_a >^2} \qquad R_{c0} = \frac{< N_c N_0 > - < N_c >< N_0 >}{< N_c >< N_0 >}$$

2. ANALYSIS STRATEGY

- The correlation function is defined as the ratio of signal and background distributions.
- **Signal**: Distribution of correlated pairs of particles from the same events.
- **Background**: Reference distribution constructed by the event-mixing procedure using uncorrelated particle pairs that reflects single particle acceptance effects.

C = 1 : No Correlation
C > 1 : Correlation
C < 1 : Anti-correlation

$$S(\Delta\eta,\Delta\varphi) = \frac{1}{N^{signal}_{pairs}} \frac{d^2 N^{signal}_{pairs}}{d\Delta\eta d\Delta\varphi}, \quad B(\Delta\eta,\Delta\varphi) = \frac{1}{N^{mixed}_{pairs}} \frac{d^2 N^{mixed}_{pairs}}{d\Delta\eta d\Delta\varphi}, \quad C(\Delta\eta,\Delta\varphi) = \frac{S(\Delta\eta,\Delta\varphi)}{B(\Delta\eta,\Delta\varphi)},$$



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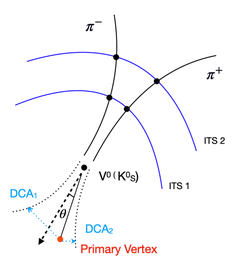
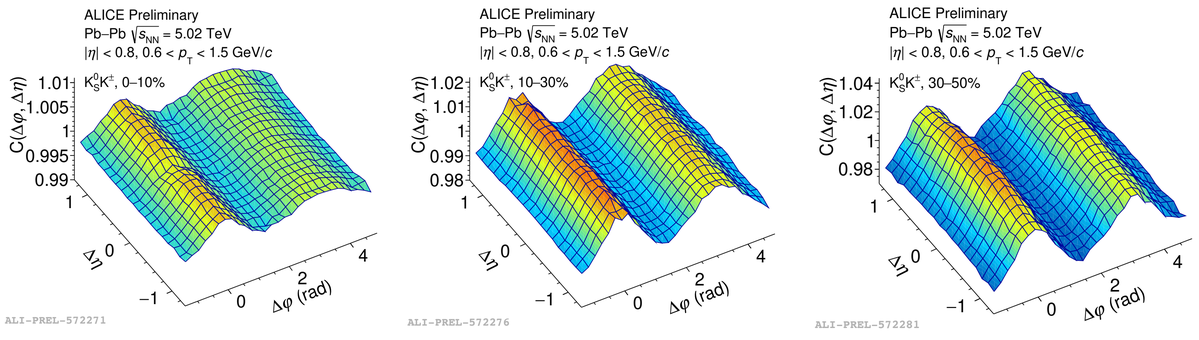
- ✓ Charged kaons ($K^\pm$) are identified using information from both the TPC (Time Projection Chamber) and TOF (Time Of Flight) detectors.
- ✓ Neutral kaons (K^0_S) are reconstructed based on their weak decay topology where they decay into oppositely charged pions with a BR of 69.20%.



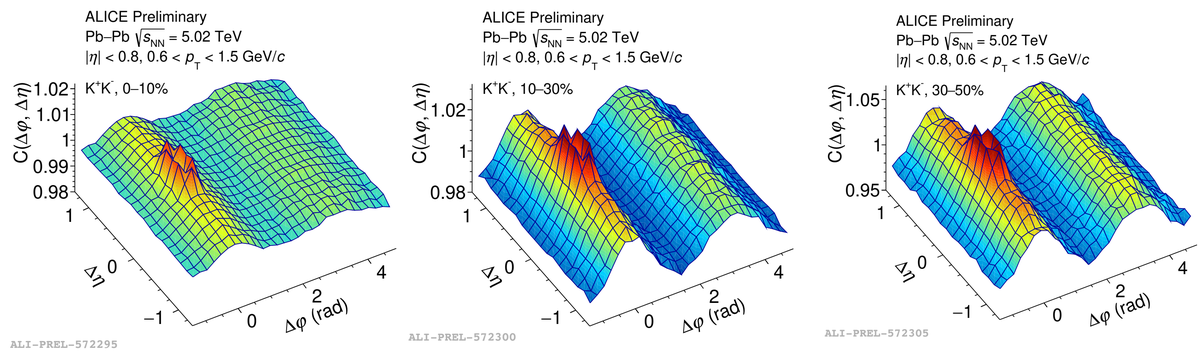
- ✓ To verify the selection criteria for K^0_S and $K^\pm$, closure test is performed using the HIJING Monte-Carlo model at both the generated and reconstructed (detector transport) levels.
- ✓ The final correlation functions are corrected for PID+reconstruction efficiencies and secondary contamination.

3. RESULTS – I

2D $K^0_S K^\pm$ Correlation Function



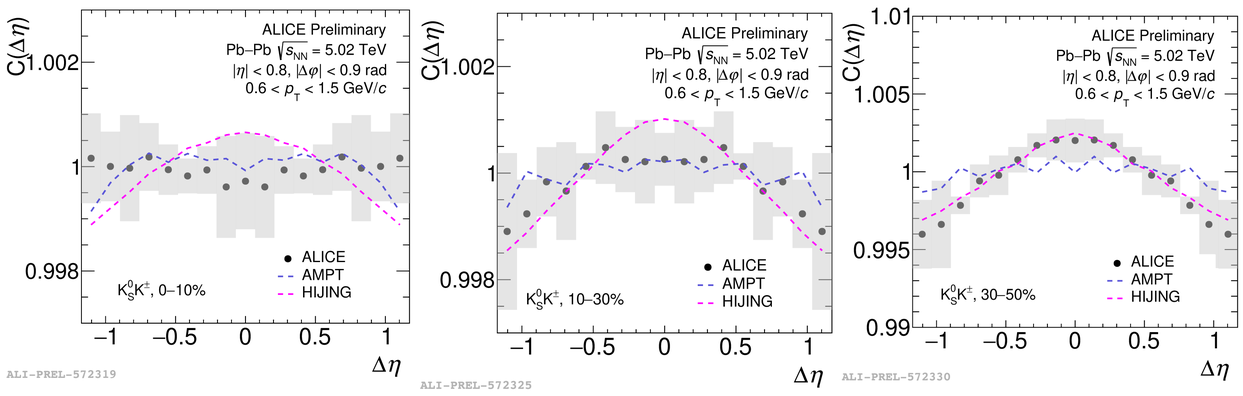
2D K^+K^- Correlation Function



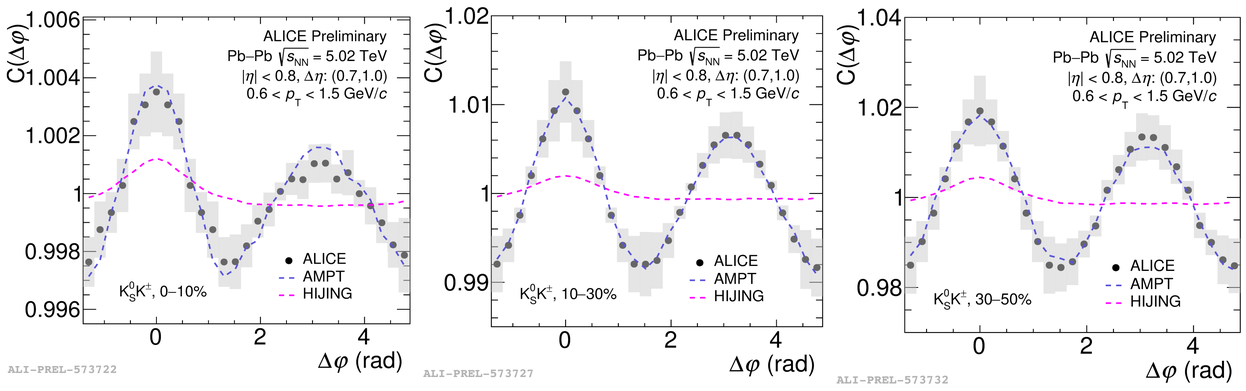
4. RESULTS – II

→ The Δη projections of $K^0_S K^\pm$ correlation function are compared with HIJING and AMPT model predictions.

HIJING – Heavy Ion Jet INteraction Generator
AMPT – A Mult-Phase Transport model (Includes collective effects)

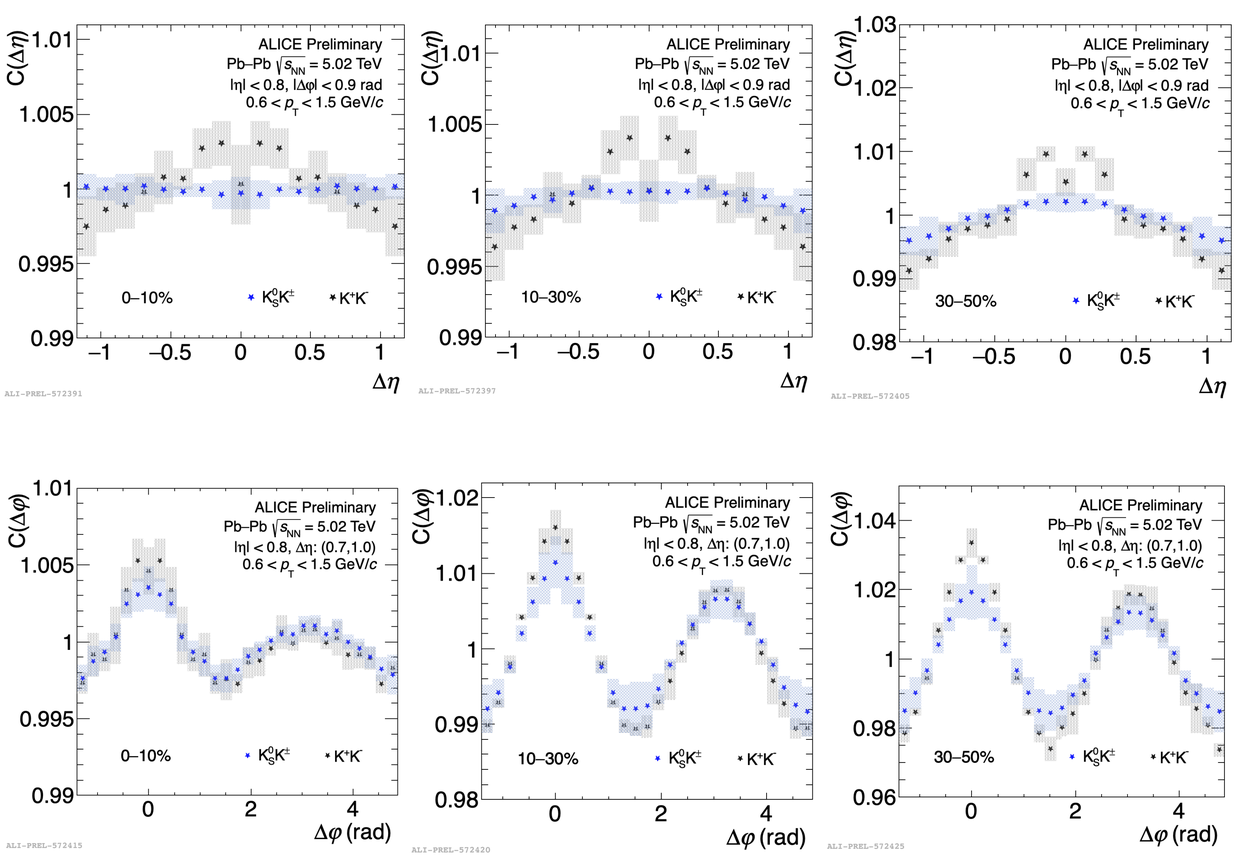


→ The Δφ projections of $K^0_S K^\pm$ correlation function are compared with HIJING and AMPT model predictions.



5. RESULTS – III

→ The comparison of Δη and Δφ projections of $K^0_S K^\pm$ correlation function to that of K^+K^- in 0–10%, 10–30% and 30–50% centralities are given below.



6. CONCLUSIONS

- The $K^0_S K^\pm(\Delta\varphi,\Delta\eta)$ angular correlation functions using Run2 Pb–Pb data (collected in 2018) are compared with the AMPT and HIJING model predictions.
- The angular correlations do not exhibit anomalous behavior in the production of neutral and charged kaons, an observation in contrast to the integrated balance function ($\nu_{\rm dyn}$) measurement.
- AMPT model provides a better description compared to the HIJING.
- The anisotropic flow in $K^0_S K^\pm$ is comparable to that of K^+K^-.
- Δη correlations of K^+K^- shows dominant contributions from Phi(1020) meson resonance. Jet and resonance contributions in both $K^0_S K^\pm$ and K^+K^- correlations require further investigation.

REFERENCES

[1] S. Acharya et al. (ALICE),Phys. Lett. B 832, 137242 (2022)
[2] J. I. Kapusta, S. Pratt and M. Singh, Phys. Rev. C 107, no.1, 014913 (2023)
[3] J. I. Kapusta, S. Pratt and M. Singh, arXiv:2306.13280