Insight into K*(892)^0 production in pp collisions as a function of collision energy, event-shape and multiplicity with ALICE at the LHC

Rutuparna Rath (for the ALICE collaboration)

Indian Institute of Technology Indore, India

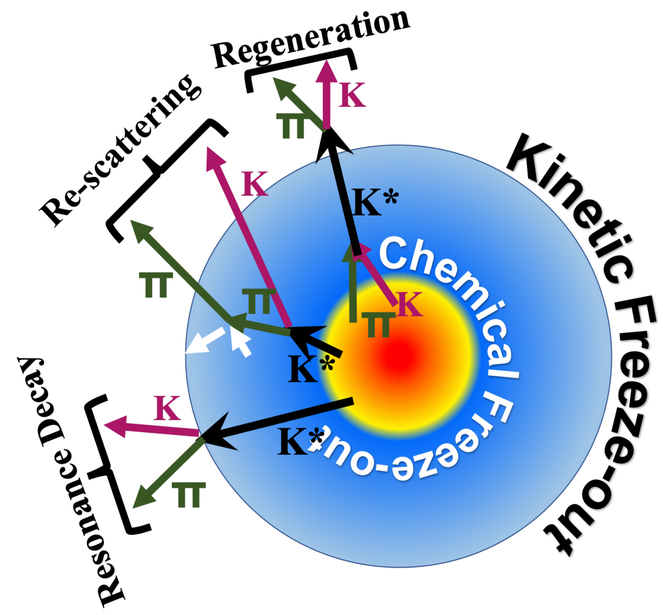
1. Physics Motivation:

- Resonances are short-lived particles, whose lifetime is comparable to the lifetime of hadronic phase of the medium produced in high-energy collisions
- Resonance yields and transverse momentum (p_T) spectra shapes can be affected by regeneration and re-scattering processes during the hadronic phase

Re-scattering:
- daughter particles undergo elastic scattering → reduced yield

Regeneration:
- pseudo-elastic scattering through resonance state → enhanced yield

- Hadronic resonances are very good probes to understand the properties of hadronic phase in small systems
- Multiplicity dependent study in small system allows us to bridge the gap between minimum bias pp and peripheral heavy-ion collisions
- In small systems, event shape observables like transverse spherocity are sensitive to hard and soft QCD processes and they are useful to disentangle such processes



2. A Large Ion Collider Experiment (ALICE)

- At the LHC, ALICE has collected data in pp collisions at $\sqrt{s}$ = 0.9, 2.76, 5.02, 7.0, 8.0 and 13.0 TeV
- Global tracking is performed using ITS and TPC
- The kinematic cuts for track acceptance: $|\eta| < 0.8$ with $p_T > 0.15$ GeV/c

Detectors used :

- Inner Tracking System (ITS)

Tracking and Vertexing

- Time Projection Chamber (TPC)

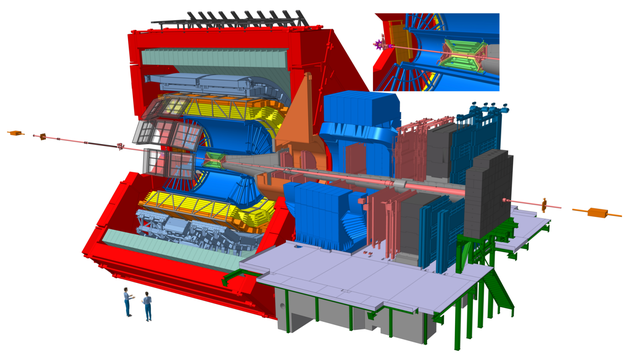
Particle Tracking
Particle Identification (PID)

- Time of Flight (TOF)

PID via time of flight measurement

- V0(V0A and V0C)

Trigger and multiplicity estimator

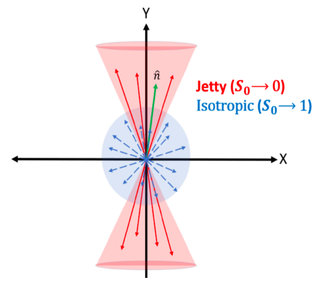


3. Transverse spherocity

Transverse spherocity is defined as

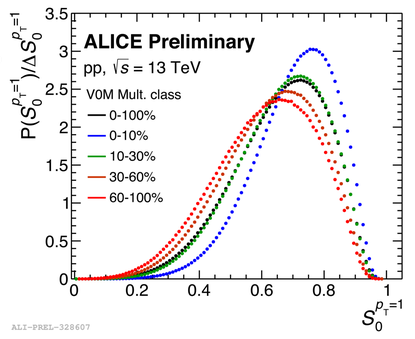
$$S_0^{p_T=1} = \frac{\pi^2}{4}\left(\frac{\sum_i |\vec{p_{T}}_i \times \hat{n}|}{\sum_i |\vec{p_{T}}_i|}\right)^2$$

- The limit $S_0(p_T=1) \rightarrow 0$ defines a jetty event, which is dominated by hard QCD processes
- The limit $S_0(p_T=1) \rightarrow 1$ defines an isotropic event, which is dominated by soft QCD processes



Multiplicity Dependence:

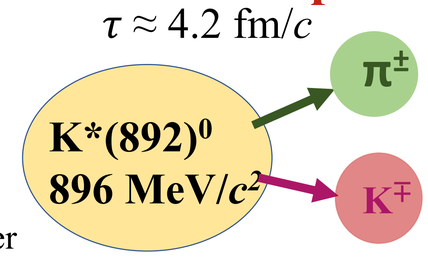
- High multiplicity pp collisions are primarily dominated by isotropic events, whereas events with low multiplicity are mostly of jetty type

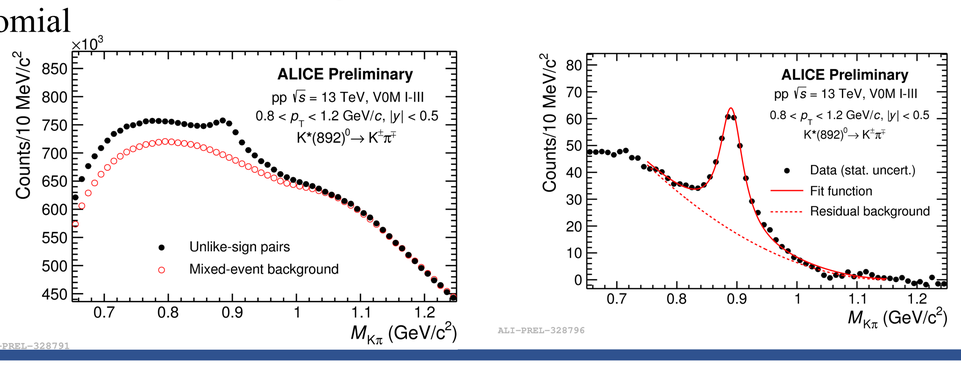


4. K*^{0} Reconstruction and Invariant Mass Spectra

- K*^{0} is reconstructed through its hadronic decay channel K*^{0} → $\pi^{\pm}K^{\mp}$ with BR 66%
- Uncorrelated background is calculated using unlike-sign pairs from two different events
- For K*^{0}, the peak is fitted with a Breit-Wigner function and the residual background is fitted with a second order polynomial

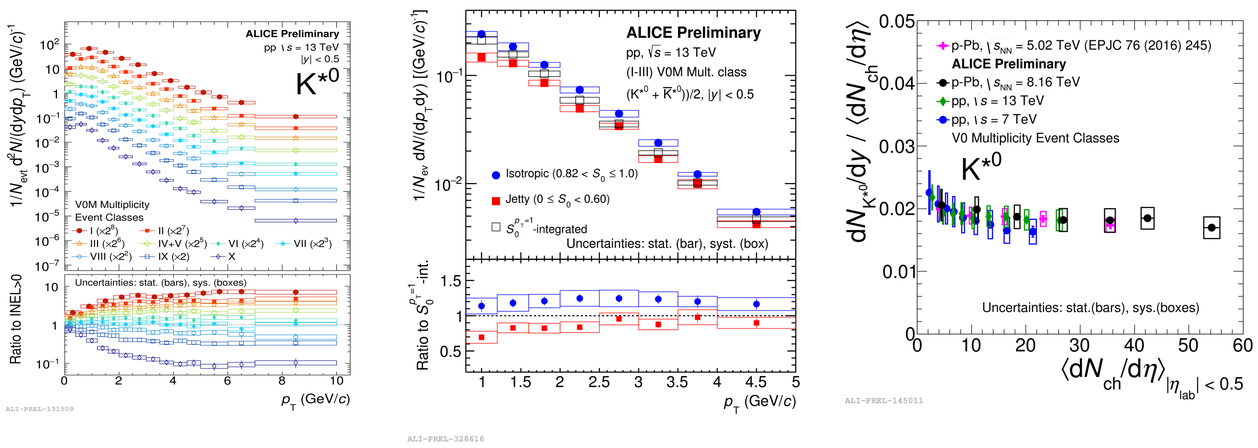
$\tau \approx 4.2$ fm/c





5. Transverse momentum (p_T) spectra, yields and $\langle p_T \rangle$

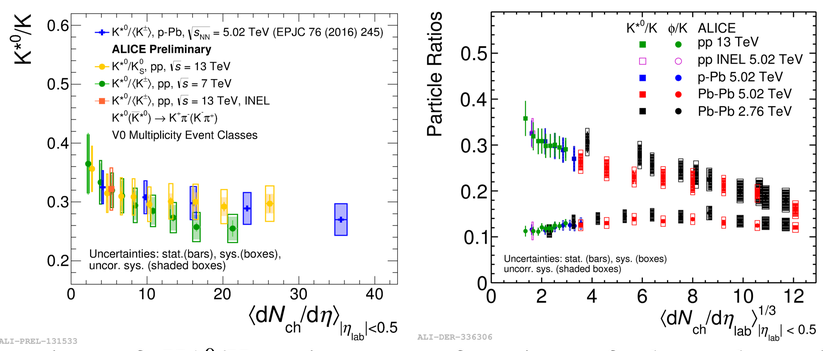
- Evolution of the spectral shape with increasing multiplicity for $p_T < 5$ GeV/c in pp collisions → consistent with the radial flow
- The spectral shape is similar across multiplicity for $p_T > 5$ GeV/c
- As a function of S_0 event classes, low-p_T region is dominated by isotropic like event, whereas, the high-p_T region is dominated by the jetty like events



- Yield of K*^{0} normalized to $\langle dN_{ch}/d\eta \rangle$ is independent of collision systems and energy → event multiplicity drives particle production, irrespective of collision system and energy at LHC energies
- For spherocity classes, the yield is the highest for isotropic events whereas $\langle p_T \rangle$ is the highest for jetty like events

6. Particle Ratios

- No strong energy dependence of the K*^{0}/K ratio in pp collisions
- Results for pp collisions are consistent with p–Pb results in the overlap region
- Highest-multiplicity pp and p–Pb results are consistent with Pb–Pb results



- Suppression of K*^{0}/K ratios as a function of charged particle multiplicity is observed

→ possible presence of the hadronic phase in high-multiplicity pp collisions

7. Summary

- Hardening of p_T spectra with charged particle multiplicity in pp collisions
- p_T spectra as a function of transverse spherocity classes show the dominance of low-p_T particles for isotropic events whereas jetty events are dominated by high-p_T particles
- The K*^{0} yield normalized to the mean charged particle multiplicity is independent of collision energy and collision system

→ K*^{0} production is independent of collision system and energy for a given multiplicity class

- No strong energy dependence for multiplicity-dependent K*^{0}/K ratio in pp collisions
- Suppression of K*^{0}/K ratio as a function of charged particle multiplicity is also observed in small collision systems

→ likely formation of hadronic phase in high-multiplicity pp collisions