Recent results on event shape and multiplicity dependent identified particle production in pp collisions with ALICE at the LHC

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Introduction

To understand the recently discovered collective-like behavior in small collision systems at the LHC [1], the studies of the production of identified hadrons, such as the π, K, and ϕ mesons and the p, Λ, and Ξ baryons, constitute interesting probes. The collective-like behavior could be attributed to multiple hard scatterings, underlying light flavor production mechanisms etc. The underlying mechanisms of light flavour production are currently not well understood. pQCD models based on hard scatterings include a phenomenological description of light flavour particle production via string fragmentation and rope hadronization. Statistical models predict a mechanism for the production of light flavour particles based on mass hierarchies in (grand) canonical ensembles. Event shape observables, like transverse spherocity along with the final state charged-particle multiplicity allow the classification of pp collisions either as jetty (originated from hard processes) or isotropic events (originated from soft processes) in different multiplicity classes.

This contribution focuses on studies of the event shape, charged-particle multiplicity and collision energy dependence of identified particle production in pp collisions with ALICE at the LHC. We report the measurement of transverse momentum ($p_{\rm T}$) spectra of identified hadrons in different spherocity and multiplicity classes. The $p_{\rm T}$-differential and $p_{\rm T}$-integrated particle ratios will also be discussed. Most of the results are obtained by exploiting the data collected with ALICE in pp collisions at the highest center-of-mass energy, $\sqrt{s}$ = 13 TeV. The results will also be compared with pQCD inspired event generators like PYTHIA.

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Results and discussion

Transverse spherocity (S_0) [2] is an event shape observable, which is used to isolate jetty ($S_0 \simeq 0$) and isotropic ($S_0 \simeq 1$) events. The isotropic and jetty events are associated with enhanced or suppressed activity in the underlying event as evident in Fig. 1, where spherocity dependence of the leading-hadron azimuthal correlations for pp collisions at $\sqrt{s} = 7$ TeV is shown. Here, the transverse spherocity was calculated considering events with more than two primary charged particles with $p_{\rm T}$ > 0.15 GeV/c and $|\eta|$ <0.8. For the study of identified particle production, the events considered have more than 9 primary charged particles. In order to study the multiplicity dependence of identified hadron production, the total sample is divided based on the total energy deposited in both of the V0 detectors (V0M amplitude). Here, only the 10% highest V0M multiplicity events are considered, which corresponds to about 97% of the events with at least 10 charged tracks. Out of the selected events, 20% of the events are selected with the highest (lowest) measured S_0.

Fig. 2 shows the $p_{\rm T}$ spectra of $\pi^{\pm}$ and p($\bar{\rm p}$) in V0M multiplicity class I-III (S_0-integrated) events, jetty events and isotropic events. The bottom panels show the ratio of spectra in jetty and isotropic events to the V0M class I-III. The ratio of the spectra in isotropic events to the inclusive spectra suggests that

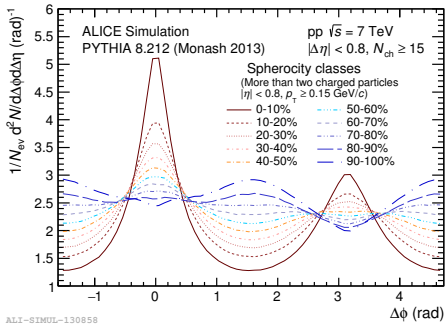

FIG. 1: Spherocity dependence of the leading-hadron azimuthal correlations for pp collisions at $\sqrt{s} = 7$ TeV.

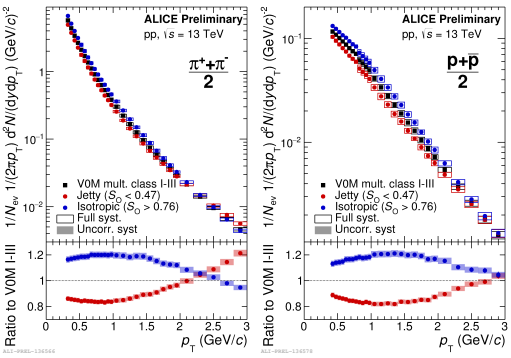

FIG. 2: p_T spectra of charged pions (left) and (anti-)protons (right) as a function of different spherocity classes for high multiplicity pp collisions.

the yields of both particles are enhanced at low p_T. For jetty events, an opposite trend is observed where the yields of both particles are enhanced at high p_T. The crossing point of the spectra for the jetty and isotropic events increases towards larger p_T for heavier particles, which indicates clear mass-dependent spectral modification. Fig. 3 shows the p_T-differential ratio of p($\bar{p}$) to $\pi^{\pm}$ for different spherocity classes and they are compared with Monte Carlo models such as PYTHIA8 and EPOS-LHC. The p/π ratio exhibits suppression for jetty events, which corresponds to the jet fragmentation process. The MC models describe quantitatively the experimental data at $p_T \sim$ 0.5-0.8 GeV/c. PYTHIA8 under-predicts p/π ratio and it only tends to show marginal agreement at higher p_T. EPOS-LHC over-predicts the measurement. PYTHIA8 predicts the observed trends for the double ratios but underestimates the magnitude of the modification. The deviation might be due to the underestimation of the underlying event component of the particle production. EPOS-LHC, which incorporates hydrodynamics, describes the double ratios accurately.

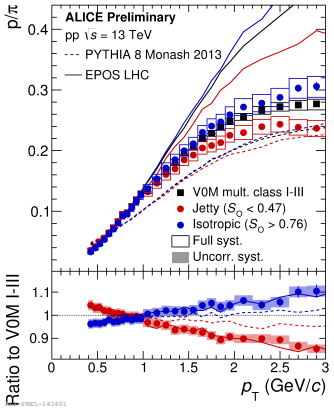

FIG. 3: Top panel: p_T-differential p/π ratio in V0M multiplicity class I-III events, jetty and isotropic events. Bottom panel: p/π double ratios in jetty and isotropic events to V0M multiplicity class I-III events. The results are compared with PYTHIA8 and EPOS-LHC.

In the conference presentation, more details on the event shape and multiplicity dependent study of identified particle production such as π, K, and ϕ mesons and the p, Λ, and Ξ baryons in pp collisions will be given.

ST acknowledges DST-INSPIRE program of Govt. of India for the financial support.

References

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