Study of D^+ meson yield as a function of charged-particle multiplicity at $\sqrt{s} = 13$ TeV using PYTHIA8.

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1. Introduction

The Heavy flavours like charm and beauty play a crucial role in the study of properties of strongly interacting color medium. They are produced in the initial stages of the hard scattering collisions. Since they have longer life time than the Quark Gluon Plasma(QGP) medium, so they observe all the stages of its formation and evolution. A study of production mechanisms of heavy quarks is helpful to explore the perturbative QCD(pQCD) because their mass(m_Q) provide a scale at which the strong interaction coupling constant(α_s) is generally evaluated.
The aim of this research paper is to perform simulation study of D^+ meson yield as a function of charged-particle multiplicity at $\sqrt{s} = 13$ TeV with the help of PYTHIA8 event generator. In this paper measurements of identified primary charge particles has been presented at mid pseudo-rapidity region, $|\eta| < 0.9$. The measurement of charged-particle multiplicity is also important since the initial energy density can be estimated through the measurement of the transverse energy and charged-particle multiplicity. In high multiplicity pp collisions we expect the sufficiently high production of charm quarks due to more central nature of the collisions which favours the Multi-partonic interactions(MPI). The simulation study of D^+ meson yield as a function of charged-partilce multiplicity in pp collisions, provides necessary reference for the results from pp, p-A and A-A collisions in real experiments.

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2. A brief introduction to Pythia

Pythia is a general-purpose Monte Carlo event generator. It is a software package for the simulation of high-energy-physics events where a large statistics of particles is produced in a single collision. It simulates collisions between particles like electron and positron, proton and antiproton, muon and anti-muon etc. It simulates physical phenomenon like MPI, Hard and soft events, initial-State radiations(ISR) and final-state radiations(FSR), parton shower , fragmentation and decay processes. In PYTHIA, MPI and CR are two default settings and both have significant affect on charged-particle multiplicity. From recent experimental results, it has been seen that inclusion of MPI increases the charge-particle multiplicity by an amount more than double and inclusion of CR reduces the charged-particle multiplicity to 2/3rd of the original.

3. Results

About 50 million $c\bar{c}$ simulated events are generated using PYTHIA8 event generator within pseudorapidity region $|\eta| < 0.9$. The PDGs Monte Carlo particle numbering scheme used to identify and select primary charged particles. The multiplicity distribution for primary charged particles produced is shown in Fig 1 . D^+ mesons following the decay channel $D^+ \rightarrow K^-\pi^+\pi^+$ are selected for the analysis. The evolution of p_T spectra for D^+ meson is investigated within the selection criteria as shown in Fig 2. To see D^+ yield as a function of multiplicity, the normalised D^+ yield, which is calculated by the equation (1) is plotted as a function of charged-particle multiplicity within $|\eta| < 0.9$. The relative yield was measured in five p_T intervals from 2 to 24 Gev/c. Different charged-particle multiplicity bins chosen for analysis are [1,20], [20,60] and

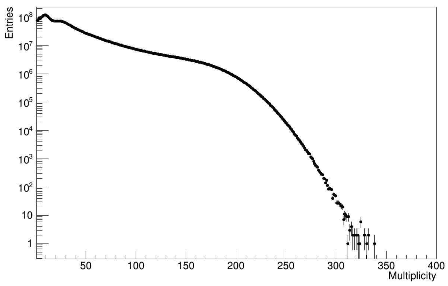

FIG. 1: Total charged-particle multiplicity distribution.

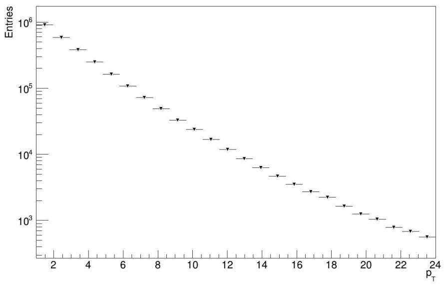

FIG. 2: p_T distribution of D^+ mesons.

[60,100] and the corresponding transverse momentum (p_T) bins chosen are [2,4], [4,6], [6,8], [8,12] and [12,24] GeV/c. The normalised D^+ yield is obtained as a function of charged-particle multiplicity as shown in Fig. 3. The results for normalised D^+meson yield, indicates that the D^+ relative yield increases as a function of the charged-particle multiplicity.

$$Y = \frac{N^{D^+}_{mult.bins} * N^{mult.int}_{events}}{N^{D^+}_{mult.int} * N^{mult.bins}_{events}} \tag{1}$$

$N^{D^+}_{mult.bins}$: D^+ mesons in different mult bins.
$N^{D^+}_{mult.int}$: D^+ mesons in integrated mult bin.
$N^{mult.bin}_{events}$: total events in different mult bins.
$N^{mult.int}_{events}$: total events in integrated mult bin.

4. Summary and Conclusion

D^+ mesons decaying via hadronic channel $D^+ \rightarrow K^-\pi^+\pi^+$ are analysed in the present

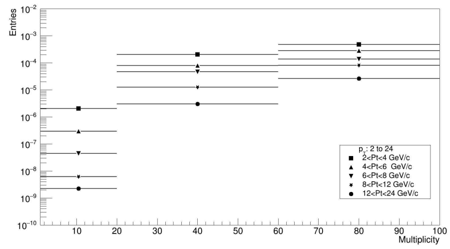

FIG. 3: D^+ yield as a function of charge-particle multiplicity.

analysis. The D^+ yield is obtained in different multilicity bins [1,20], [20,60] and [60,100]and in five p_T intervals from 2 to 24 GeV/c. D^+ relative yield is plotted as a function of charged particle multiplicity. Fig. 3 is showing that relative D^+ yield increases as a function of charged-particle multiplicity. The results might indicate that the D^+ production in pp collisions is connected with strong hadronic activities and also MPI could have affect on the harder momentum scales. At low charged-particle multiplicity, D^+ yield is low, might be due to the soft hardronic activities and at large charged-particle multiplicity, D^+ yield is high due to hard events favouring the production of massive charm quark. The increase is similar as observed with J/ψ at forward and mid-rapidity at $\sqrt{s} = 7$ TeV[2].

Acknowledgments

We thankfully acknowledge all the authors of PYTHIA8 for their support.

References

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