Intermittent Pattern of Produced Particles in Simulated Proton-Proton Collisions at Large Hadron Collider Energy

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Introduction

One of the main motivations of ultra-relativistic heavy ion collisions is to produce Quark Gluon Plasma (QGP) and study its properties through various probes. High p_T hadron suppression dubbed as 'jet quenching' at RHIC energies indicates that the matter produced in such collisions, is in a deconfined state. However, in order to search for a definitive evidence of QGP formation, one requires a thorough and deep understanding of the background existing at the time of QGP formation. It is important to mention that the transition from QGP state to normal hadronic matter may be accompanied by large fluctuation in the number of produced particles in local regions of phase space [1]. The most instructive aspect of multiparticle production is to study the nature of multiplicity fluctuations and correlations in restricted domain of phase space.

A bulk of observations have revealed the existence of large nonstatistical fluctuations in the particle density. Varying the resolution the density irregularities turned out to be self-similar reminiscent of the intermittent fluctuation of a turbulence [2–6]. According to most popular belief the intermittent patterns of the particle density are generated by some kind of self-similar cascading dynamics underlying the hadronization [4]. At the same time, there are arguments that under certain circumstances the intermittency effect can serve as a signature of a quark-gluon plasma phase-transition [7].

In this work we carry out such a study to look for intermittency, if there is any, in p-p collisons at $\sqrt{s} = 10$ TeV by analysing the simulated data.

The Generated Data

The data used in the present analysis was generated using HIJING event generator and ALICE simulation framework, AliRoot. The events have been stored on the GRID as the Physics Data Challenge of 2009 (PDC09). We have selected 15000 minimum biased p-p events for the current analysis. The details of the simulation procedure can be found at alice MonALISA GRID monitoring webpage [*http://pcalimonitor.cern.ch/job_details.jsp*]. The PDC data are regularly generated to carry out different physics analysis tasks before the start up of LHC.

Method of Analysis

The formula used to calculate the factorial moments is given by (the details of analysis method will be reported [8]):

$$< F_q >= \frac{M^{q-1}}{N_{evt}} \sum_{N_{evt}} \sum_{m=1}^{M} \frac{n_m(n_{m-1})..(n_m - q + 1)}{< N >^q} \quad (1)$$

Where $< F_q >$ is the average factorial moment, M is the partition number in the available rapidity window into which a given rapidity interval is binned and n_m is the number of particles falling in the m^{th} bin and the symbol $< .... >$ represents vertical average obtained for the entire event. Here N and N_{evt} denote the total number of of particles in an event and the number of events in the sample, respectively .

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Results and Discussion

When a large set of high energy interactions of whatever type (h-h, h-A, A-A) is considered, the variables to be studied are multiplicities, rapidities and transverse momenta of the secondaries. In the present data set the observed mean values of total charged particles multiplicity and transverse momentum are found to be 17.50±0.23 and (0.51±0.08) GeV/c, respectively. We have found the normalised multiplicity and pseudorapidity distributions of all the charged particles produced in the interactions under study. The normalized multiplicity distribution (shown in Fig.1) indicates that most of the events are of low multiplicity and the pseudorapidity distribution shows large fluctuations.

The variations of ln$< F_q >$ with -ln$\delta\eta$ for the data for various orders of moments are shown in Fig.2. It is observed that ln$< F_q >$ tends to increase linearly with -ln$\delta\eta$ (increasing resolution or decreasing bin size) and this trend is more clearly depicted for the higher order of moments.

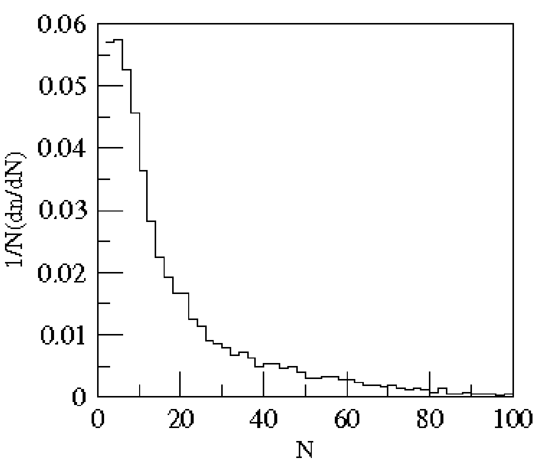

FIG. 1: Multiplicity distribution of the produced charged particles.

Conclusions

The average multiplicity of the produced charged particles in the eta interval, $0.9 \leq \eta \leq 0.9$ (acceptence of ALICE Central Barrel), turns out to be 17.50±0.23. F_q-moments shows an increasing trend with decreasing bin width thereby showing the intermittent beahviour of the multiplicity distributions of the produced particles. However, the intermittency strength is weak. A more strong intermittent behaviour could have been obtained if the analysis for the only high multiplicity events are carried out. This needs a larger data set and currently this work is in progress.

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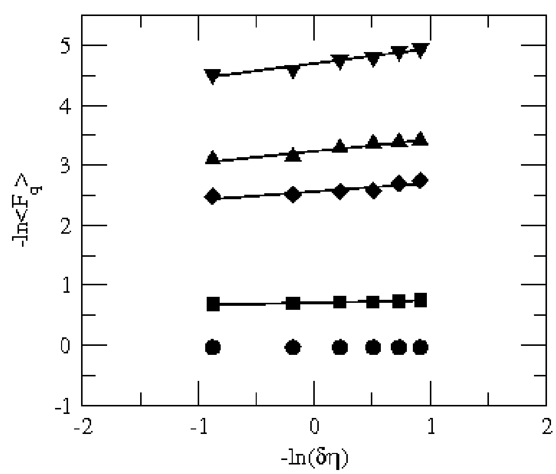

FIG. 2: Variation of ln$< F_q >$ with ln$< \delta\eta >$.