# A Search for Dynamical Fluctutations in $^{208}$Pb-$^{208}$Pb Collisions at 158 A GeV/c

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## Introduction

The study of fluctuations and correlations in heavy-ion collision experiments at relativistic high energies provide us an opportunity to study exotic phenomenon such as possibility of formation of Quark-gluon plasma (QGP)[1, 2]. A key problem in this serach is the identification of signatures of QGP formation via the study of experimental obsrevables. Any physical quantity measured in collision experiments is subject to fluctuations. These fluctuations are believed to depend on the property of the system under study and are expected to provide some useful information about the system formed during the collision. In the context of heavy-ion collisions, a considerable advancement has been made in recent years on the event-by-event study of the fluctuation due to the availability of heavy-ion beams for wide range of energies (such as SPS, RHIC and now available LHC energies). Analysis of single events with large statistics can reveal different physics than studying averages over a large statistical sample of collision events. In order to extract new physics associated with the fluctuations, it becomes customery to understand the role of statistical fluctuations. of In this serach, investigation of experimental observables, like, transverse energy ($E_t$), transverse momentum ($p_t$), $k/\pi$ ratio, electric charge, etc. on ebe basis are found to provide much needed information about the existence and nature of phase transition. Several attempts have been made to investigate ebe fluctuations using SPS and RHIC data in terms of these variables and mesurements at LHC energies too indicate their origin in the QGP phase. Further, dynamical calculations are indeed required to have a better understanding of the results

In this work, an attempt is made to analyze few high multiplicity individual events produced in 158 A GeV/c $^{208}$Pb-$^{208}$Pb interactions selected from EMU01 data[3]. The findings based on the experimental data are compared with the predictions of Monte Carlo model, HIJING[4]. In order to test the origin of fluctuations in global observables characterizing an event, the measured pseudo-rapidity distributions of charged particles are compared with the corresponding distributions obtained by event-mixing technique (serves as a reference distribution).

## Results and Discussion

By studying, the dik -distributions, the rare events having spikes were identified. Further, the $\eta$- and $\phi$-distributions of the four marked experimental events (on the basis of the $d_{ik}$ distributions) are compared with the mixed event sets. Two events which exhibit distinct spikes in their $\eta$- and $\phi$-distributions have been selected for analysis referred to as Event-1 and Event-2. In order to test whether these spiky events exhibit some unusual characteristics, another two events with their $\eta$- and $\phi$-distributions nearlysimilar to those obtained for the entire sample are also analyzed and referred to as Event-3 and Event-4. It is obvious that both $\eta$- and $\phi$-distributions for Event-1 and Event-2 exhibit more pronounced peaks and valleys as compared to those arising in the case of mixed events. Whereas, no such regions are observed for Events-3 and -4, and the magnitude of fluctuations in the

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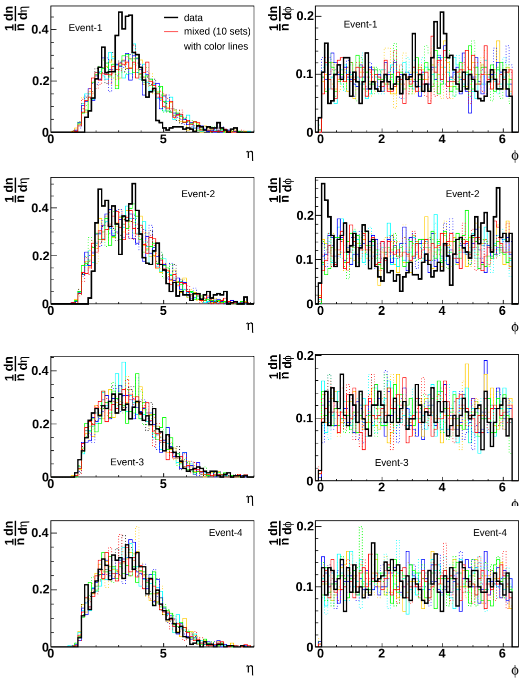


FIG. 1: $\eta$ and $\phi$ distributions of charged particles for the two spiky and two non-spiky experimental events along with the mixed events.

particle densities appear to be rather smaller than those exhibited by the mixed event sets. These observations, thus indicate the presence of some 'hot regions' in the first two real events. Particle densities in these hot regions are found to be higher than the expected average value by a factor of $\sim$ 2. Such inhomogeneity in pseudo-rapidity may arise either due to a very strong jet, i.e., large number of particles having their azimuthal and polar angle values very close to each other or due to several jets, each with rather smaller number of particles having similar values of polar angles but differ in azimuthal angles. A comparitive study with the reference distributions suggest that the significant fluctuations are present in Event-1 and Event-2 having the dynamical components. Such inhomogeneity in pseudo-rapidity may arise either due to a very strong jet, i.e., large number of particles having their azimuthal and polar angle values very close to each other or due to several jets, each with rather smaller number of particles having similar values of polar angles but differ in azimuthal angles. In order to investigate that the observed fluctuations are the event characteristics and are not due to the statistical reasons, a parallel analysis of the events reproduced by event mixing has also been performed. Thus these observations further support that the significant fluctuations observed in Event-1 and Event-2 are mainly of the dynamical origin.These two spiky events out of real data sample clearly suggest the presence of spikes in their $\eta$ and $\phi$ distributions as the particle densities are larger by a factor of $\sim$ 2. On qualitative level, there is a noticeable difference between experimental data and simulated events and tends to suggest towards the presence of dynamical fluctuations in the spiky-events (Experimental data). A comparative analysis of the experimental results with those obtained from the simulated mixed events further suggests that the observed fluctuations in the particle densities of the two spiky events might have dynamical contents. Such regions in the HIJING events were also observed but with rather smaller magnitude. Thus, the method adopted here is suitable for further analysis regarding some exotic phenomena occuring during the heavy-ion collisions. The method adopted here, can provide us a useful hint towards the possibilty of formation of the Quark-gluon plasma (QGP) and/or DCC.

## References

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