# On maximum pseudorapidity gap distribution of charged particles produced in high energy nuclear interactions

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## Introduction

Study of global observables related to the produced particles in high energy hadron-hadron, hadron-nucleus and nucleus collisions seems to play an important role in understanding the under lying dynamics of multiparticle production. It can also shed light on the properties of the de-confined hot and dense nuclear matter produced in these collisions which further helps physicists to understand the features of the phase transition among normal nuclear matter and the de-confined nuclear matter and vice versa. After the proven possibilities of the creation of the quark-gluon plasma(QGP) at the RHIC and LHC these studies have got further impetus[1-5].

Various studies at SPS, RHIC and LHC have indicated that such observations are useful tools to understand the signatures of the phase transition and might be helpful to study the properties of QGP formation[2,5] Further, such studies when carried out on event-by-event basis become even more powerful tools to address the issues related to the occurrence of collective phenomena, correlations and fluctuations. High energy nuclear collisions may effectively offer an opportunity of carrying out event-by-event analysis because multiplicity of the produced particle per event are quite high. In state of affairs of carrying out such event-by-event analysis, study of rapidity gaps has been carried out extensively starting from cosmic ray events to SPS,BNL, RHIC and to LHC data. Study of rapidity gaps of the particles produced in relativistic nuclear collisions also help in understanding the underlying short- and long-range correlation and fluctuations. It also helps to find out whether the particles produced are strongly correlated or weakly correlated. in the $\eta$-space.. In high energy nuclear collisions these observations are not easy to point out due to the imposement of the correlation arising due to the kinematical conditions by the conservation laws which can overshadow the correlation occurring due to the dynamical conditions. That is why event-by-event analysis of the correlation among the produced particles may provide significant information about the mucltiparticle dynamics. In this context, **the maximum pseudorapidity($\eta$) gap, $\Delta_{max}$** distribution turns out to be very important characteristic of multiparticle production and qualifies for the special attention in an eventt-by-event analysis[3]. A number of studies have predicted the large pseudorapidity gaps between neighboring particles and the maximum pseudorapidity gap distribution has been generally used as a measure to find the extent of diffractive dissociation/pomeron exchange in the relativistic nuclear collision data[3]. It was emphasized that the maximum pseudorapidity gap distributions do separate into two region of diffractive or non-diffractive mechanism domination. Following this understanding, studies have been carried out on maximum pseudorapidity gaps for hadron-hadron, hadron-nucleus collisions and first such study for nucleus-nucleus collisions were carried out by Dipak Ghosh et al.[3] for $^{16}$O-AgBr system. The present study is an attempt to carry out this study for the experimental and HIJING simulated $^{208}$Pb-Em. Interactions at 160 A GeV/c and for the HIJING simulated Pb-Pb events at $\sqrt{S_{NN}}$ = 2.76 TeV.

## Details of the Data

The present analysis has been carried out for the two experimental samples of the data comprising 285 minimum bias events and 58 high multiplicity events( $N_{ch}$>100) obtained in the interactions of Pb-Pb at 160A GeV/c. These events are taken from the emulsion experiment performed by EMU01 Collaboration. For comparing the experimental results with the simulated data 1000 high multiplicity events have been generated using HIJING stand alone at 160A GeV/c. To compare present results with the data at LHC energy 1000 Pb-Pb events have also been simulated using HIJING standalone at $\sqrt{S_{NN}}$ = 2.76 TeV. The other details of the data and the procedure of selecting events can be found elsewhere[4].

## Results and Discussion

The maximum η-gap, $\Delta_{max}$ is calculated on event-by-event basis by picking the maximum of the 2-particle η-gaps for each events in the data samples. For calculating the 2-particle η-gaps, first we arranged the η values of the produced particles in each events in the increasing order and then calculated the differences between consecutive η values($\eta_{i+1-}$ $\eta_i$). Fig.1 shows the distributions of the $\Delta_{max}$ for the experimental and the HIJING simulated data. The lowest graph of Fig.1 shows the $\Delta_{max}$ distributions for the experimental data sets comprising minimum bias and high multiplicity events. A prominent peak in the $\Delta_{max}$ distribution in the low $\Delta_{max}$ region is observed for the minimum bias data whereas for the high multiplicity data, no such prominent peak is seen in the distribution. The middle graph in Fig.1 is the $\Delta_{max}$ distribution for the HIJING generated events at 160A GeV/c, these events are generated corresponding to the minimum bias experimental data, it can be seen that here also we observed a peak at low values of $\Delta_{max}$ and the simulated result shows an almost similar trend of $\Delta_{max}$ distribution. The top most plot in Fig.1 shows the $\Delta_{max}$ distribution for the simulated Pb-Pb collision data at an LHC energy ($\sqrt{S_{NN}}$ = 2.76 TeV). Here the peak is observed in the mid $\Delta_{max}$ region. It is interesting to mention that at TeV energy the peak in the $\Delta_{max}$ distribution shifts towards higher values of $\Delta_{max}$ in comparison to its position at GeV energy. It will be interesting to carry out this analyses in an energy region covering a wide range from GeV to TeV energies. The results obtained in the present study are suggestive of the strong short range and long range correlation in pseudorapidity space of the produced charged particles in the nuclear collisions at GeV and TeV energies. Similar trends have been reported by other workers[3].

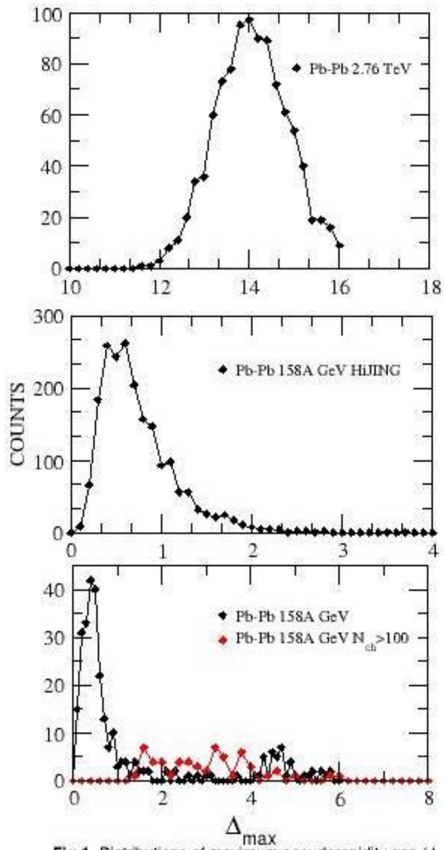


**Fig.1** Distributions of maximum pseudorapidity gap ($\Delta_{max}$).

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## References

[1] L.W. Lin et al., Phys. Rev. Lett. C 72 064901 (2005).
[2] ALICE Collab.(K. Aamodt et al.),Eur. Phys. J. C 68 89 (2010).
[3] Dipak Ghosh, Argha Deb. et al., FIZIKA B (Zagreb) 12 133 (2006).
[4] S. Khan and S. Ahmad, Int. J. Mod. Phys. E 27 1850004 (2018).
[5] S. A. Bass, P. Danielwicz and S. Pratt, Phys. Rev. Lett. 85 2689 (2000).