# Intermittency analysis of generated charged particles in central Pb-Pb collisions at LHC energies using EPOS model

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## Introduction

Positive signals on the formation of hot and dense matter, as predicted by QCD, have been obtained from the high energy heavy ion collider experiments. Presently most of the studies in this field of research are motivated by curiosity to learn the dynamics of particle production mechanism and the properties of the compressed matter created. One of such methodologies is to study the scaling properties of multiplicity fluctuations over wide range of bin sizes by studying the spatial patterns in the events by looking at the clustering of produced particles of various sizes.

Scaled factorial moments, which have the property to filter out statistical component, are suggested [1] to study the multiplicity distributions in smaller and smaller phase space bins. The power law behaviour of factorial moments of particle density fluctuations with decreasing rapidity bin width is termed as intermittency. As an improvement over the conventional intermittency analysis Hwa and Yang [2] proposed the event factorial moments in two dimensional $(\eta, \phi)$ phase space to investigate quark-hadron phase transiton at present accelerator energies and determine the numerical value of the scaling exponent at LHC energies.

Here we analyse charged particle multiplicity distributions in the 2D $(\eta, \phi)$ phase space for the events generated using EPOS [3] model at LHC energies and compare the scaling properties for different kinematic cuts. Fig. 1 shows the pseudorapidity distribution of the generated data compared to ATLAS data for Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV.

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## Methodology

For an $e^{th}$ event, the horizontal factorial moment is defined as

$$F_q^e(M) = \frac{f_q^e(M)}{[f_1^e(M)]^q}, \qquad (1)$$

where $q$ is the order of moment $\geq 2$ and $M$ is the number of bins. In Eq. (1)

$$f_q^e(M) = \langle n_m(n_m-1)......(n_m-q+1)\rangle_h, \qquad (2)$$

Then vertically averaged horizontal factorial moments are,

$$F_q(M) = \langle F_q^e(M)\rangle_v \qquad (3)$$

$\langle ....\rangle$ is averaging over whole event sample. If $F_q$ has power law dependence on $M$ as,

$$F_q(M) \propto M^{\varphi_q}, \qquad (4)$$

the phenomenon is referred to as *intermittency* and $\varphi_q$ is called *intermittency index.* This is also referred as M-scaling. For the second order phase transition, $F_q$ is observed to satisfy the power-law behavior.

$$F_q \propto F_2^{\beta_q}, \qquad (5)$$

where

$$\beta_q = (q-1)^\nu, \qquad \nu = 1.304\ . \qquad (6)$$

Eq.(5) is referred as F-scaling.

The scaling exponent $\nu$ can be used to characterize the scaling properties of multiparticle production.

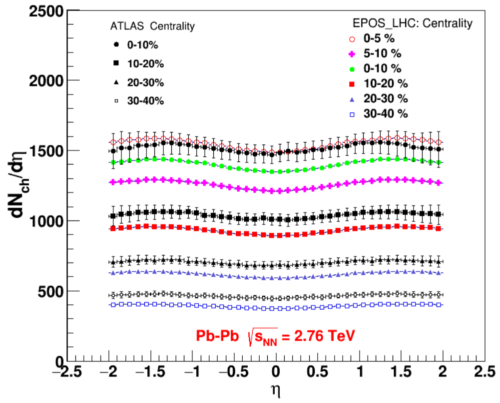


FIG. 1: Pseudorapidity distribution of the EPOS (LHC tunning) data compared with ATLAS data for Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76 TeV$.

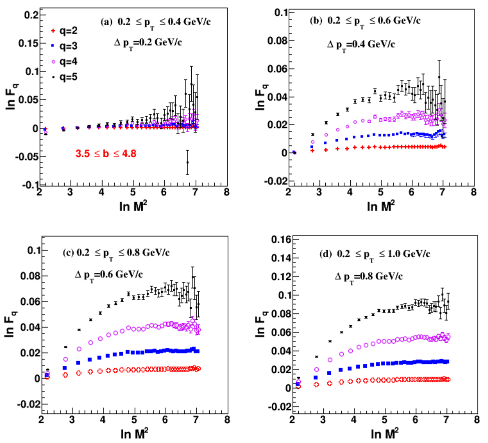


FIG. 2: M-scaling plot for the EPOS data for different $p_T$ bins in midrapidity region $|\eta| \leq 1.0$

## Observations

M-scaling and F-scaling of the generated charged particles are studied. $F_q$ moments are determined for small $p_T$ bins for $p_T \leq 1$ GeV/c in the 2D $(\eta, \phi)$ phase space for $|\eta| \leq 1.0$ in full azimuth. Dependence of $F_q$ on the number of bins referred to as M-scaling is shown in Fig. 2. Slopes so obtained by the linear fits are plotted against $(q-1)$ to obtain the scaling index $\nu$ which is a dimensionaless quantity and is characteristic of the system. The results for dependence of scaling exponent on the various kinematic cuts and centrality will be presented.

## Summary

Charged particle multiplicity distributions for Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV using EPOS model at LHC energies, are studied for their local multiplicity fluctuations. $\nu$ the scaling index value obtained for the model is the characteristic of the generator. The scaling index $\nu$ serves as an insight into the fluctuations in the particle production in the heavy ion collisions. The intermittency index $(\varphi_q)$ and the scaling index $\nu$ for the data generated using EPOS is also compared with that from the AMPT generated data at same energy and for the same system. Results obtained here for the model can be used to better understand the experimental results and hence to gain a better understanding of physics of multiparticle production in the heavy ion collisions at these energies.

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## References

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