A study of local multiplicity fluctuations in charged particle production in Xe–Xe collisions at $\sqrt{s_{\rm NN}} = 5.44$ TeV using ALICE

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I. INTRODUCTION

A fundamental characteristic of the critical behaviour of a system undergoing phase transition is that it exhibits fluctuations of all scales [1]. The most efficient way to address fluctuations of a system created in a heavy-ion collision is to investigate event-by-event (E-by-E) fluctuations, where a given observable is measured on an event-by-event basis, and the fluctuations are studied over the ensemble of the events. To detect such fluctuations in a system, a study of the scaling behaviour of the normalized factorial moments $F_q(M)$ with the number of bins (M) in (η, φ) space is performed. The normalized factorial moments are defined as

$$F_q(M) = \frac{\frac{1}{N_{evt}}\sum_{e=1}^{N_{evt}}\frac{1}{M}\sum_{m=1}^{M} f_q(n_{me})}{\frac{1}{N_{evt}}\sum_{e=1}^{N_{evt}}\frac{1}{M}\sum_{m=1}^{M} f_1(n_{me})} \quad (1)$$

with $f_{q(nme)}$=$\prod_{j=0}^{q-1}(n_{me} - j)$, where e stands for the event, q $\geq$ 2 is the order of the moments, and $n_{me} \geq$ q is the number of particles in a given phase space bin [2]. A power-law behaviour of $F_q(M) \propto M^{\phi_q}$ is defined as M-scaling, where the scaling index $\phi_q \geq 0$ is a constant for any given q [3]. Observation of this scaling implies the absence of any spatial scale in the system, which has been observed in many collision systems with positive scaling index value [4, 5].

For the second-order phase transition in the Ginzburg-Landau (GL) formalism, F_q satisfies with high accuracy the following power law behavior

$$F_q \propto F_2^{\beta_q}. \quad (2)$$

This scaling, which is referred to as F-scaling, can be valid even if the M-scaling is not valid [6, 7]. The scaling exponent ν, which is a universal quantity characterizing the scaling properties of the system, is derived from

$$\beta_{\rm q} = (q-1)^{\nu}. \quad (3)$$

It is essentially independent of the details of the Ginzburg-Landau parameters, where temperature is not a controlling parameter; therefore, the numerical value of ν can be considered as an average value over all temperatures at which the phase transition occurs.

II. ANALYSIS

The analysis is performed for charged particles produced in central events in the midrapidity region $|\eta| \leq 0.8$ with full azimuthal coverage ($0 \leq \varphi \leq 2\pi$) in the $p_{\rm T}$ intervals $0.4 \leq p_{\rm T} \leq 0.6$ GeV/c and $0.4 \leq p_{\rm T} \leq 1.0$ GeV/c. The factorial moments are calculated using the charged particles mapped into the two-dimensional (η, φ) space, where the total number of bins is M^2.

In this contribution, observations and results from the intermittency study of charged particles produced in Xe–Xe collisions at $\sqrt{s_{\rm NN}}$ = 5.44 TeV, recorded with ALICE detector at LHC.

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III. OBSERVATION AND RESULTS

The data from ALICE show the presence of M-scaling behavior for q = 2, 3, 4, and 5, indicating the presence of an intermittency signal in the data. The M- and F-scaling for the p_{T} interval of $0.4 \leq p_{\mathrm{T}} \leq 1.0$ GeV/c are shown in Fig. 1 and Fig. 2, respectively. In addition, the value of the scaling exponent (ν) for two different p_{T} intervals is calculated as a function of collision centrality, as shown in Fig. 3.

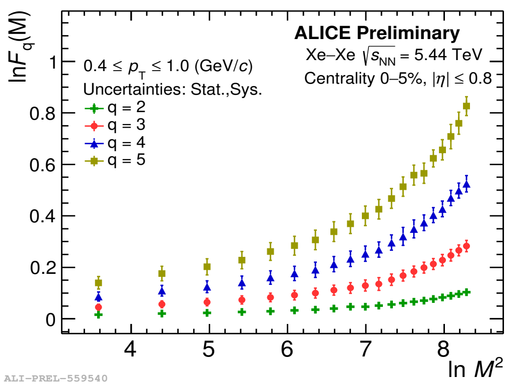

FIG. 1: M-scaling for the p_{T} interval $0.4 \leq p_{\mathrm{T}} \leq 1.0$ GeV/c.

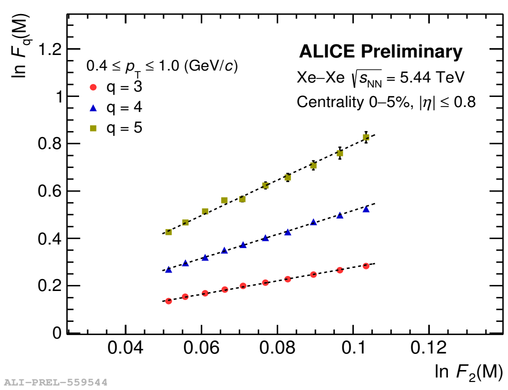

FIG. 2: F-scaling for the p_{T} interval $0.4 \leq p_{\mathrm{T}} \leq 1.0$ GeV/c.

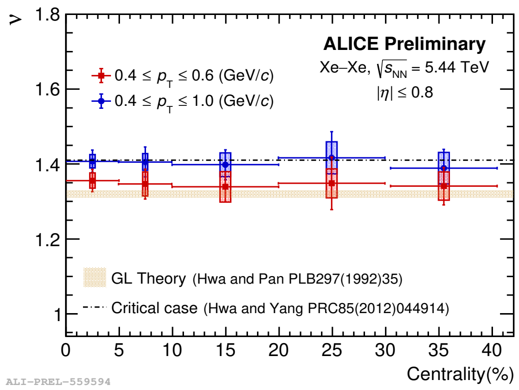

FIG. 3: Centrality dependence of scaling exponent (ν) for the p_{T} intervals $0.4 \leq p_{\mathrm{T}} \leq 0.6$ GeV/c and $0.4 \leq p_{\mathrm{T}} \leq 1.0$ GeV/c.

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