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Disentangling sources of momentum fluctuations in Xe+Xe and Pb+Pb collisions with the ATLAS detector

The ATLAS Collaboration

High-energy nuclear collisions create a quark-gluon plasma, whose initial condition and subsequent expansion vary from event to event, impacting the distribution of the event-wise average transverse momentum ($P([p_{\mathrm{T}}])$). Distinguishing between contributions from fluctuations in the size of the nuclear overlap area (geometrical component) and other sources at fixed size (intrinsic component) presents a challenge. Here, these two components are distinguished by measuring the mean, variance, and skewness of $P([p_{\mathrm{T}}])$ in ^{208}Pb+^{208}Pb and ^{129}Xe+^{129}Xe collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 and 5.44 TeV, respectively, using the ATLAS detector at the LHC. All observables show distinct changes in behavior in ultra-central collisions, where the geometrical variations are suppressed as the overlap area reaches its maximum. These results demonstrate a new technique to disentangle geometrical and intrinsic fluctuations, enabling constraints on initial condition and properties of the quark-gluon plasma, such as the speed of sound.

High energy nuclear collisions at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) create a strongly-interacting state of matter known as quark-gluon plasma (QGP) [1]. The hydrodynamic expansion of the QGP induces a significant boost to the transverse momentum (p_{T}) of the final-state particles. This boost transforms the shape anisotropies and size variations in QGP's initial state into final state anisotropies known as anisotropic flow [2–4] and variations in the average p_{T} in each event, $[p_{\mathrm{T}}]$ [5]. Comparisons of data with theoretical models of anisotropic flow have provided crucial insights about the QGP's initial condition such as the overlap area, nucleon/subnucleonic fluctuations, as well as QGP's transport properties such as shear and bulk viscosities [1, 6]. However, quantitative extractions of these properties remain subject to large uncertainty due to a lack of detailed knowledge about the initial conditions of the QGP [7, 8].

Naturally, progress in this area can be made by studying the $[p_{\mathrm{T}}]$ and its distribution $P([p_{\mathrm{T}}])$ for events with similar impact parameters between the centers of the two colliding nuclei. Since the $[p_{\mathrm{T}}]$ in each event is sensitive to the radial flow of the QGP, $P([p_{\mathrm{T}}])$ offers a sensitive probe of the initial-state variations and properties of the plasma, such as the equation of state (EOS) and the associated speed-of-sound squared (c_s^2) in the QGP [9–15]. $P([p_{\mathrm{T}}])$ can be characterized through moments, such as the mean, $\langle [p_{\mathrm{T}}] \rangle$, variance, $\left\langle (\delta p_{\mathrm{T}})^2 \right\rangle$, and skewness, $\left\langle (\delta p_{\mathrm{T}})^3 \right\rangle$, where $\delta p_{\mathrm{T}} = [p_{\mathrm{T}}] - \langle [p_{\mathrm{T}}] \rangle$. The notation "$\langle\rangle$" indicates an average over an ensemble of events.

Most sources of $P([p_{\mathrm{T}}])$ appear stochastic, encompassing fluctuations in transverse size, R, of the overlap region, nucleon and parton positions in the initial state, energy deposition, and temperature of the QGP fluid in its local rest frame. These sources can be categorized into "geometrical fluctuations" that capture the hydrodynamic response to event-by-event variations in R, following $\delta p_{\mathrm{T}} / \langle [p_{\mathrm{T}}] \rangle \approx -\delta R / \langle R \rangle$ [5], and "intrinsic fluctuations" that include other sources of δp_{T} at fixed R [11]. If nuclear collisions are considered as a superposition of independent particle production from participating nucleons, followed by final state interactions, both geometrical and intrinsic fluctuations are expected to scale with the number of participating nucleons (N_{part}), or approximately with charged particle multiplicity: $\left\langle (\delta p_{\mathrm{T}})^2 \right\rangle \propto 1/N_{\mathrm{part}}$ and $\left\langle (\delta p_{\mathrm{T}})^3 \right\rangle \propto 1/N_{\mathrm{part}}^2$. This scaling expectation is referred to as the independent superposition scenario [16, 17].

It was proposed to separate geometric and intrinsic fluctuations using moments of $P([p_{\mathrm{T}}])$ in ultra-central collisions (UCC) [11, 12]. As the impact parameter approaches zero in UCC, N_{part} and R reach their maximum values. Subsequently, geometrical fluctuations are suppressed, leading to a deviation from the anticipated $1/N_{\mathrm{part}}$ scaling. In contrast, intrinsic fluctuations still follow the expected scaling behavior. The interplay between the reduced geometrical and residual intrinsic fluctuations gives rise to complex behaviors in the moments of $P([p_{\mathrm{T}}])$. Therefore, measurements in UCC can constrain the properties of the intrinsic fluctuations, which were shown to be sensitive to c_s^2 [9] in the QGP, as implemented in hydrodynamic model simulations.

The multiplicity dependence of the mean and variance of $P([p_{\mathrm{T}}])$ has been measured across various system sizes and collision energies [18–27]. These studies reveal an increase of $\langle [p_{\mathrm{T}}] \rangle$ towards more central collisions, while the variance follows the anticipated power-law scaling. Recently, ALICE reported measurements of skewness and kurtosis in Xe+Xe and Pb+Pb collisions [28] but only in broad multiplicity ranges. CMS performed a detailed study of the behavior of $\langle [p_{\mathrm{T}}] \rangle$ in Pb+Pb UCC and claimed to extract the c_s^2 [29] but with caveats [13–15]. These measurements were not able to disentangle the geometrical and intrinsic components of $P([p_{\mathrm{T}}])$. A precise measurement of higher-order moments in UCC is necessary to achieve this goal and connect more precisely to the initial condition of the QGP and its properties.

This Letter reports the measurement of the mean, variance, and skewness of $P([p_T])$ as a function of charged particle multiplicity in ^{208}Pb+^{208}Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and ^{129}Xe+^{129}Xe collisions at $\sqrt{s_{NN}}$ = 5.44 TeV. A smaller multiplicity range and transverse size in Xe+Xe than Pb+Pb provide a unique lever arm to test the impact of system size on the scaling behavior of $[p_T]$-moments. The much-improved precision of variance and skewness over previous measurements [28] enables a detailed investigation of their behavior.

The measurements are performed using the ATLAS inner detector (ID), forward calorimeter (FCal), and zero-degree calorimeters (ZDCs) along with the trigger and data acquisition systems [30–32]. The ID detects charged particles within $|\eta| < 2.5$[1] using a combination of silicon pixel detectors, silicon microstrip detectors, and a straw-tube transition-radiation tracker, all immersed in a 2T axial magnetic field [31]. The FCal consists of three sampling layers, covering $3.2 < |\eta| < 4.9$. The ZDCs are positioned at ±140 m from the interaction point (IP), and detect neutrons with $|\eta| > 8.3$. The ATLAS trigger system [32] consists of a hardware-based level-1 (L1) trigger and a software-based high-level trigger (HLT). A software suite [33] is used in data simulation, in the reconstruction and analysis of real and simulated data, in detector operations, and in the trigger and data acquisition systems of the experiment.

This analysis uses 470 μb^{-1} of Pb+Pb data collected in 2015 and 3 μb^{-1} of Xe+Xe data collected in 2017. The Pb+Pb events are selected by requiring the total transverse energy deposited in the calorimeters over $|\eta| < 4.9$ at L1 (E_T^{L1}) to be greater than 50 GeV. Additionally, dedicated central collision triggers are included to improve event statistics for the largest values of FCal transverse energy [34]. The Xe+Xe events are selected by requiring $E_T^{L1} > 4$ GeV.

Charged-particle tracks are reconstructed from hits in the ID using a reconstruction and selection procedure optimized for heavy-ion collisions [35]. Tracks used in this analysis must have $p_T > 0.5$ GeV and $|\eta| < 2.5$, and the total number of such tracks in each event is denoted by N_{ch}^{rec}. Events containing multiple inelastic collisions (pileup) are suppressed by exploiting the correlation between N_{ch}^{rec} and the transverse energy measured in the FCal, ΣE_T. The pileup probability is 0.17% in Pb+Pb collisions and a factor of ten smaller in Xe+Xe collisions. In the Pb+Pb dataset, pileup is further suppressed by exploiting the correlation between the energy deposited in the ZDCs and ΣE_T [36]. The residual pileup fraction is less than 0.01% in central collisions (see Appendix).

Events are categorized into centrality intervals using a Glauber model [37] parameterization of the ΣE_T distribution [34]. Each interval represents a range in ΣE_T, starting at 0% for the most central collisions with the highest ΣE_T value and ending at 80%. In this analysis, events within the top 5% centrality, where observables display strong deviations from power-law scaling, are denoted as UCC. These events correspond to $\Sigma E_T > 3.62$ TeV and 2.27 TeV in Pb+Pb and Xe+Xe collisions, respectively.

Unless specified, the results are presented for charged particles with $0.5 < p_T < 5$ GeV. The track reconstruction efficiency, $\epsilon(p_T, \eta, N_{ch}^{rec})$, is assessed using Monte Carlo (MC) simulated events from Pb+Pb and Xe+Xe collisions generated with Hijing [38]. The detector response is simulated with Geant4 [39, 40], and events are reconstructed using the same algorithms as applied to the data. For charged particles with $p_T > 0.8$ GeV, where the efficiency varies very slowly, the efficiency in UCC Pb+Pb collisions ranges from 71% at $\eta \approx 0$ to about 40% for $|\eta| > 2$. The efficiency decreases by 12% from 0.8 GeV to 0.5 GeV, when averaged over the full η range. In peripheral collisions, the efficiency is less dependent on η and is up

[1] ATLAS uses a right-handed coordinate system with its origin at the nominal IP in the center of the detector and the z-axis along the beam pipe. The x-axis points from the IP to the center of the LHC ring, and the y-axis points upward. Cylindrical coordinates (r, ϕ) are used in the transverse plane, ϕ being the azimuthal angle around the beam pipe. The pseudorapidity is defined in terms of the polar angle θ as $\eta = -\ln\tan(\theta/2)$.

to 4% higher. The rate of falsely reconstructed ("fake") tracks, $f(p_{\rm T}, \eta, N_{\rm ch}^{\rm rec})$, is found to be significant for $p_{\rm T} < 1$ GeV in UCC collisions, where it ranges from 2% for $|\eta| < 1$ to 8% at larger $|\eta|$. The fake-track rate drops rapidly for higher $p_{\rm T}$ and more peripheral collisions. Within the $N_{\rm ch}^{\rm rec}$ range spanned by UCC events, the efficiency drops by 1% with increasing $N_{\rm ch}^{\rm rec}$, while the fake rate increases by 4%. The behavior of efficiency and fake rate in Xe+Xe collisions have similar $p_{\rm T}$, η, and $N_{\rm ch}^{\rm rec}$ dependence as Pb+Pb. At the same $N_{\rm ch}^{\rm rec}$, the Xe+Xe efficiency is about 2% lower than the Pb+Pb efficiency, and fake rates agree within 1%.

The moments of $P([p_{\rm T}])$ are calculated by taking advantage of computational methods developed for the study of anisotropic flow [41, 42]. The $[p_{\rm T}]$ and n-particle correlators in a single event are computed as $[p_{\rm T}] = \sum_i w_i p_i / \sum_i w_i$, $c_2 = \sum_{i\neq j} w_i w_j \delta p_i \delta p_j / \sum_{i\neq j} w_i w_j$ and $c_3 = \sum_{i\neq j\neq k} w_i w_j w_k \delta p_i \delta p_j \delta p_k / \sum_{i\neq j\neq k} w_i w_j w_k$. Here, $\delta p_i \equiv p_{{\rm T},i} - \langle [p_{\rm T}] \rangle$, and w_i represent weights applied to track i to correct for reconstruction efficiency ϵ_i and fake track rate f_i: $w_i \equiv (1 - f_i)/\epsilon_i$ [43]. The $n^{\rm th}$ central moment of the corresponding $P([p_{\rm T}])$ is obtained by averaging c_n over a given event ensemble in unit $N_{\rm ch}^{\rm rec}$ intervals, denoted as $\langle c_n \rangle = \langle (\delta p_{\rm T})^n \rangle$. We also calculate the charged particle multiplicity, corrected for detector effects, in $0.5 < p_{\rm T} < 5$ GeV and $|\eta| < 2.5$ as $N_{\rm ch} = \sum_i w_i$. The results are presented as a function of $N_{\rm ch}$.

This analysis focuses on the mean, $\langle [p_{\rm T}] \rangle$, variance, $\langle c_2 \rangle$, and skewness, $\langle c_3 \rangle$. The variance and skewness are normalized into dimensionless quantities [44]:

$$k_2 = \frac{\langle c_2 \rangle}{\langle [p_{\rm T}] \rangle^2}, \quad k_3 = \frac{\langle c_3 \rangle}{\langle [p_{\rm T}] \rangle^3}, \quad \gamma = \frac{\langle c_3 \rangle}{\langle c_2 \rangle^{3/2}}, \quad \Gamma = \frac{\langle c_3 \rangle \langle [p_{\rm T}] \rangle}{\langle c_2 \rangle^2}. \tag{1}$$

These quantities have reduced sensitivity to efficiency and fake rates. The "standard skewness", γ, is equivalent to the skewness for a distribution with unit variance, whereas Γ is referred to as the "intensive skewness". Statistical uncertainties for these observables are computed using a standard Poisson bootstrap method [45]. Since $N_{\rm ch}$ is approximately proportional to $N_{\rm part}$, in the independent superposition scenario, it is expected that $k_2 \propto 1/N_{\rm ch}$, $k_3 \propto 1/(N_{\rm ch})^2$, $\gamma \propto 1/\sqrt{N_{\rm ch}}$, whereas Γ should be roughly independent of $N_{\rm ch}$.

Systematic uncertainties stem from track selection, reconstruction efficiency, residual pileup, centrality definition, and MC consistency check. Their values in the 0–60% centrality range are summarized as follows. Uncertainties related to track selection are assessed by comparing nominal results against those obtained with stricter criteria, resulting in deviations of < 0.5% for $\langle [p_{\rm T}] \rangle$, 0.5–3% for k_2, 0–1.5% for k_3, 0.5–4% for γ, and 0.5–1.5% for Γ. Due to potentially inaccurate modeling of the detector material in GEANT4, the reconstruction efficiency has up to 4% uncertainty [43]. The impact on the analysis is evaluated by varying the efficiency within its uncertainty range, resulting in changes of around 1% for $\langle [p_{\rm T}] \rangle$, 0.5% for k_2, 2–2.5% for k_3, 1–1.5% for γ, and 1.5–2.5% for Γ. The effect of residual pileup is estimated by varying the pileup rejection criteria, leading to uncertainties less than 0.5% for all observables. Uncertainties for the centrality definition are estimated by varying the Glauber model parameters. These uncertainties are applicable only when results are presented in centrality intervals, and are less than 0.5% in UCC for all observables. The HIJING MC samples are used to evaluate the consistency of the $P([p_{\rm T}])$ moments, obtained using truth particles or the reconstructed tracks with the same correction procedures for the real data applied [34, 46]. The differences are less than 0.25% for $\langle [p_{\rm T}] \rangle$ and k_2, and are around 1.2% for k_3, γ and Γ.

Total systematic uncertainties for each observable are obtained by adding the individual sources in quadrature. Among these sources, the track selection dominates the total systematic uncertainties in mid-central and central collisions. The uncertainties are less than 1% for $\langle [p_{\rm T}] \rangle$, 2–4% for k_2, 2–5% for k_3, and 2–4% for γ and Γ in both systems; they are smaller than the statistical uncertainties except for

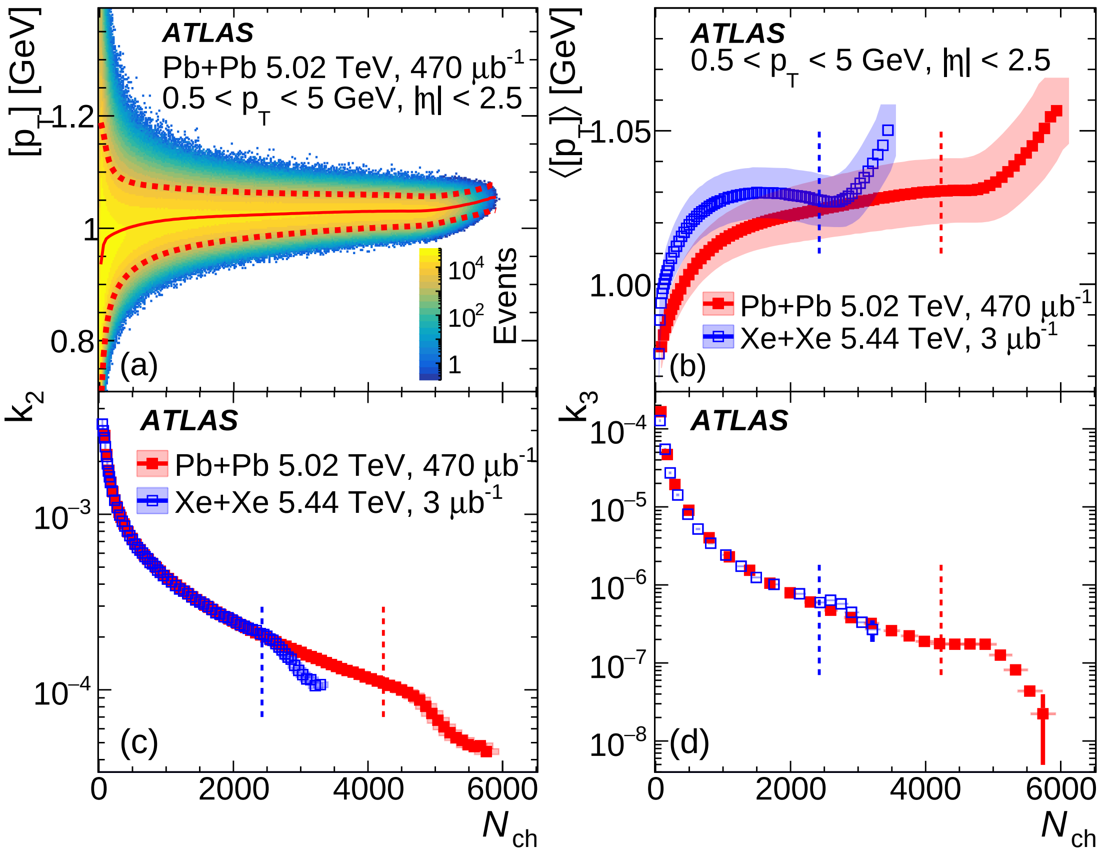

Figure 1: Panel (a) depicts the 2D distribution of $[p_T]$ versus N_{ch} in Pb+Pb collisions, where the solid and dashed lines indicate the mean and two standard deviations, respectively. Panels (b), (c), and (d) show the N_{ch} dependence of $\langle[p_T]\rangle$, k_2, and k_3, respectively. The error bars represent statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties in both x- and y-axes. The vertical dashed lines mark the N_{ch} values 4230 and 2425, corresponding to 5% centrality in Pb+Pb and Xe+Xe collisions, respectively.

$\langle[p_T]\rangle$. The uncertainty for N_{ch} is dominated by the correction for tracking efficiency and fake tracks, and is about 3% in Pb+Pb UCC.

The two-dimensional (2D) distribution of $[p_T]$ versus N_{ch} is illustrated in Figure 1(a) for Pb+Pb collisions, whose mean and widths at fixed N_{ch} are indicated by the solid and dashed lines, respectively. The data shows a mild increase of the means and a narrowing of the widths with increasing N_{ch}.

The measured moments for both systems are shown in Figure 1(b)-(d) for $\langle[p_T]\rangle$, k_2, and k_3, respectively. An increase of $\langle[p_T]\rangle$ with N_{ch}, consistent with the onset of radial flow, is observed in peripheral collisions, which weakens in mid-central collisions. The values of k_2 and k_3 show a power-law-like decrease with increasing N_{ch}. In UCC, all three observables show sudden deviations from their mid-central behaviors. Specifically, $\langle[p_T]\rangle$ increases while k_2 and k_3 decrease towards higher N_{ch} values.

To test the expected power-law scaling behavior, the values of $(N_{ch})^{n-1}k_n$ and Γ are shown as a function of N_{ch} in Figure 2. The $N_{ch}k_2$ rises sharply until up to $N_{ch} \approx 1500$ in both systems. This growth saturates gradually over $2000 \lesssim N_{ch} \lesssim 4000$ in Pb+Pb collisions. The rapid increase at low N_{ch} has been associated with the onset of radial flow [47] and thermalization [16, 48]. The $(N_{ch})^2k_3$ also displays a rapid increase in both systems followed by saturation in mid-central Pb+Pb collisions, driven by the same mechanisms

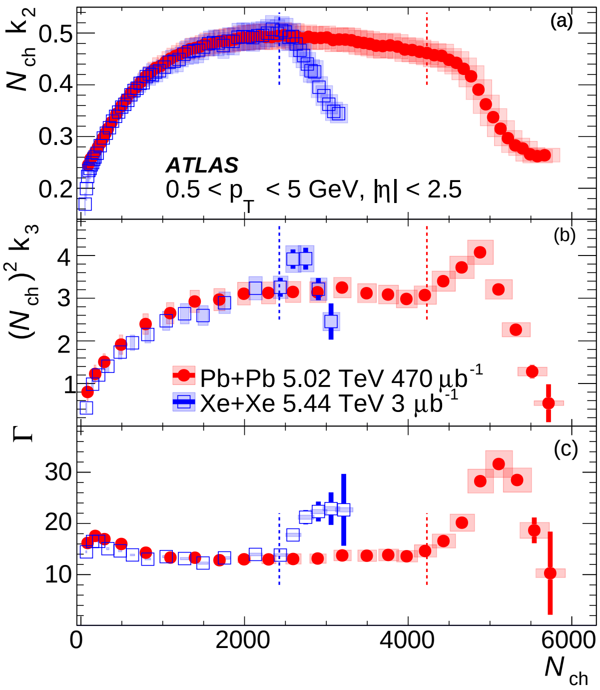

Figure 2: The values of (a) $N_{\mathrm{ch}}k_2$, (b) $(N_{\mathrm{ch}})^2k_3$, and (c) Γ, as a function of N_{ch} in Pb+Pb and Xe+Xe collisions. The error bars represent the statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties of the data along the x- and y-axes. The vertical dashed lines mark the N_{ch} values corresponding to 5% centrality in Pb+Pb and Xe+Xe collisions respectively.

responsible for the increase in $N_{\mathrm{ch}}k_2$. Γ decreases slightly from peripheral to mid-central collisions, after which it is flat until the UCC region.

In UCC, $N_{\mathrm{ch}}k_2$ displays a notable decrease as a function of N_{ch}. The values of $(N_{\mathrm{ch}})^2k_3$ and Γ show an abrupt increase followed by a sharp decrease as a function of N_{ch}. These shape variations are consistent with the expected suppression of the distribution of R, $P(R)$, from the larger R side [11]. This suppression first leads to a positive skew which then vanishes as the variance for $P(R)$ approaches zero.

To better visualize these non-monotonic behaviors in UCC, Figure 3 presents $\langle[p_{\mathrm{T}}]\rangle$ and the normalized observables from Eq. (1), scaled by their values at 5% centrality. Such scaling highlights their behavior in UCC and partially cancels systematic uncertainties. The observables are plotted as a function of N_{ch} normalized by its value at 5% centrality, $N_{\mathrm{ch}}/N_{\mathrm{ch}}^{5\%}$, which enables comparing the two systems at a similar scale along the x-axis.

Qualitatively similar behavior is observed in the two collision systems for all observables. However, the variations in Xe+Xe collisions are generally weaker as a function of $N_{\mathrm{ch}}/N_{\mathrm{ch}}^{5\%}$. This is expected due to the smaller mass number of Xe compared to Pb, which leads to a larger spread in $N_{\mathrm{ch}}/N_{\mathrm{ch}}^{5\%}$ for the same centrality range in Xe+Xe collisions, resulting in a weaker suppression of the geometrical component expected in smaller systems. This argument demonstrates the importance of comparing data using nuclei of different sizes.

Recently, Refs. [11, 12] studied the fluctuations of $[p_{\mathrm{T}}]$ by modeling $P([p_{\mathrm{T}}])$ as a 2D Gaussian function of N_{ch} and impact parameter, where the fluctuations of $[p_{\mathrm{T}}]$ at a given N_{ch} are driven solely by the variations in the impact parameter and R. The increase of $\langle[p_{\mathrm{T}}]\rangle$ arises from enhanced intrinsic fluctuations at fixed

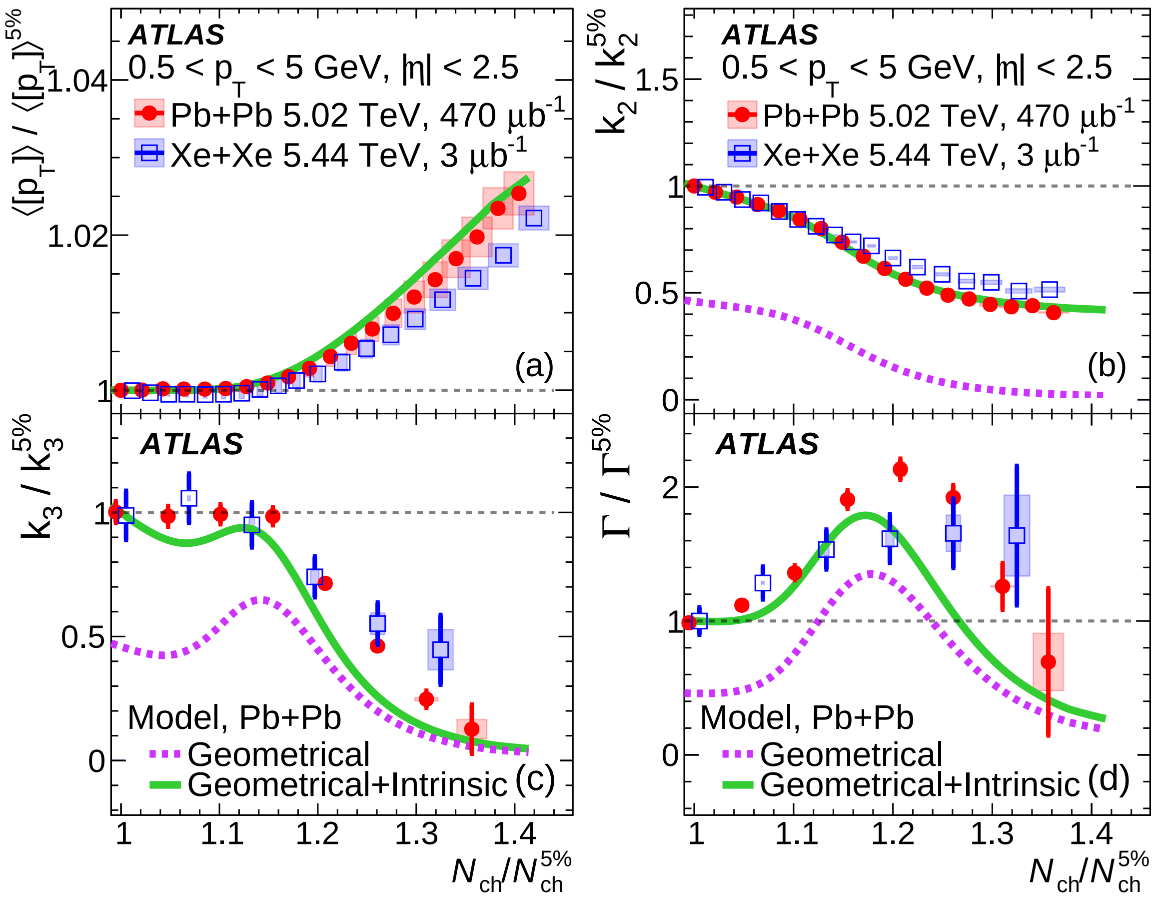

Figure 3: The (a) $\langle[p_{\mathrm{T}}]\rangle$, (b) k_2, (c) k_3 and (d) Γ, scaled by their values at 5% centrality as a function of $N_{\mathrm{ch}}/N_{\mathrm{ch}}^{5\%}$ in Pb+Pb and Xe+Xe collisions. The error bars represent statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties of the data along the x- and y-axes. The data are compared to predictions from Ref. [12], where the estimated geometrical component is also shown.

R, whereas the k_2 in the model arises from geometrical and intrinsic contributions. The k_3 in the model originates from a geometrical contribution and a cross-term between geometrical and intrinsic components, but has no contribution from the pure intrinsic component [12].

Figure 3 compares the model predictions previously described to the Pb+Pb data. The model describes reasonably the increase of $\langle[p_{\mathrm{T}}]\rangle$ and the decrease of k_2. The predicted k_3 values exhibit a steeper decrease with $N_{\mathrm{ch}}/N_{\mathrm{ch}}^{5\%}$, a trend also observed for Γ. The larger k_3 and Γ values in the data require the model to include additional sources of skewness in $P([p_{\mathrm{T}}])$ [44]. Most variations in k_2, k_3 and Γ can be largely attributed to the geometrical component as indicated by the dashed lines.

For a more direct study of the correlation between $[p_{\mathrm{T}}]$ and N_{ch} in UCC, a detailed analysis of the 0–1% most central events is performed. The $[p_{\mathrm{T}}]$ and N_{ch} values averaged over these events are denoted by $\langle[p_{\mathrm{T}}]\rangle_{0-1\%}$ and $\langle N_{\mathrm{ch}}\rangle_{0-1\%}$. Then, $\langle[p_{\mathrm{T}}]\rangle$ is calculated by averaging $[p_{\mathrm{T}}]$ over events in narrow N_{ch} slices to obtain $\Delta p_{\mathrm{T}}/\langle[p_{\mathrm{T}}]\rangle_{0-1\%}$ as a function of $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$, where $\Delta p_{\mathrm{T}} = \langle[p_{\mathrm{T}}]\rangle - \langle[p_{\mathrm{T}}]\rangle_{0-1\%}$ and $\Delta N_{\mathrm{ch}} = N_{\mathrm{ch}} - \langle N_{\mathrm{ch}}\rangle_{0-1\%}$. Figure 4 shows the correlation between $\Delta p_{\mathrm{T}}/\langle[p_{\mathrm{T}}]\rangle_{0-1\%}$ and $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$ for Pb+Pb and Xe+Xe collisions in two p_{T} ranges. The correlation is observed to be positive and nearly linear, and with similar slopes in both systems. The slope, however, varies with the p_{T} range selection,

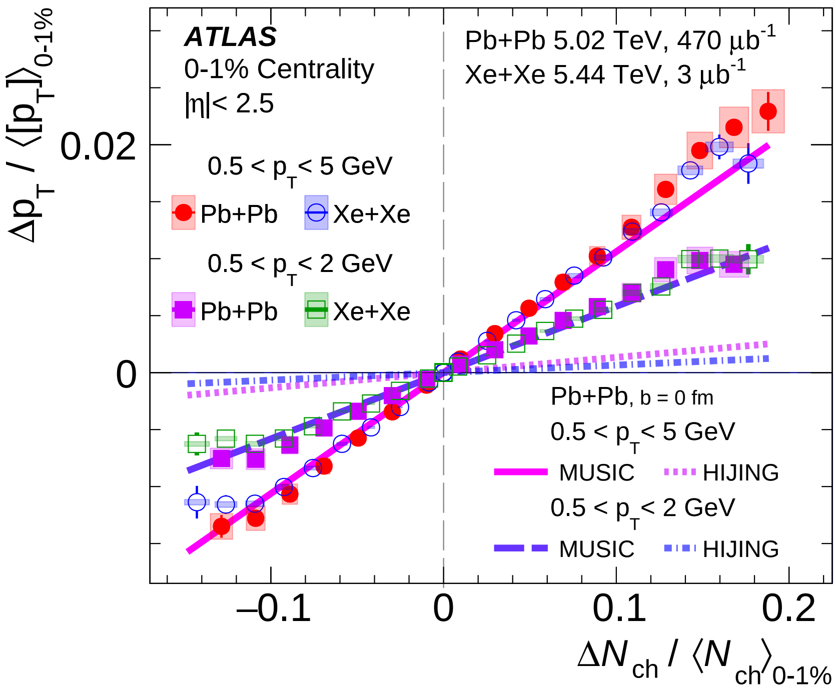

Figure 4: Correlation between $\Delta p_{\mathrm{T}}/\langle [p_{\mathrm{T}}]\rangle_{0-1\%}$ and $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$ in the 0–1% most central Pb+Pb and Xe+Xe collisions for two p_{T} ranges. The error bars represent the statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties of the data along the x- and y-axes. The data are compared to calculations from the MUSIC hydrodynamic model and the HIJING model at zero impact parameter (b = 0 fm) [11].

reflecting the kinematic sensitivity to the radial flow.

The Pb+Pb data are compared to the HIJING model [38], which has no final-state interactions, and the state-of-the-art MUSIC model [49], which includes the full hydrodynamic response of the QGP to its initial-state geometry. The HIJING model grossly underpredicts the slope of the data while the MUSIC model quantitatively captures the slopes in both p_{T} ranges. This behavior suggests that the slopes characterized the hydrodynamic response of the QGP in UCC, where its initial transverse size is fixed and its energy density varies strongly.

A recent model study [10] related the increase of $[p_{\mathrm{T}}]$ in UCC to the speed of sound of the QGP [9], calculated as $c_s^2(T) = d\ln T/d\ln s$ where T and s are the medium temperature and entropy density, respectively. Although T evolves over the lifetime of the QGP, c_s^2 was estimated at an effective temperature T_{eff}, corresponding to approximately 1/3 of the average p_{T} calculated for all particles [9, 10]:

$$c_s^2(T_{\mathrm{eff}}) \propto \frac{d\ln(\langle [p_{\mathrm{T}}]\rangle)}{d\ln(N_{\mathrm{ch}})} \approx \frac{\Delta p_{\mathrm{T}}/\langle [p_{\mathrm{T}}]\rangle}{\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle} .$$

According to this model, the measured slope in Figure 4 can be used to estimate $c_s^2(T_{\mathrm{eff}})$. A reasonable agreement of the MUSIC model with the Pb+Pb data, including its p_{T} dependence, is achieved by using $c_s^2 \approx 0.23$ with $T_{\mathrm{eff}} \approx 222$ MeV [9], values consistent with those reported by the CMS Collaboration [29]. However, the extraction of the c_s^2 was shown to be sensitive to several aspects of analyses, including the kinematic selection of the particles used to define the centrality and $\langle [p_{\mathrm{T}}]\rangle$ [13, 15].

Understanding the initial-state geometry of the QGP and how it drives the hydrodynamic response is a key objective in high-energy nuclear physics. This aim can be pursued by analyzing the moments of event-by-event transverse momentum distribution $P([p_{\mathrm{T}}])$. This Letter presents the first experimental differentiation between geometrical and intrinsic fluctuations using the mean, variance, and skewness of $P([p_{\mathrm{T}}])$ in ^{208}Pb+^{208}Pb and ^{129}Xe+^{129}Xe collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV and 5.44 TeV, respectively. Across a wide N_{ch} range, the variance and skewness exhibit an approximate power-law scaling with N_{ch}, consistent with expectations from an independent superposition scenario. However, in ultra-central collisions , as a result of suppressed geometrical fluctuations and unhindered intrinsic fluctuations, all observables depart from such scaling. Notably, there is a distinctive rise in the mean, a sharp decline in the variance, and a pattern of increase followed by a sharp decrease in the skewness. Moreover, the linear rise in $\langle [p_{\mathrm{T}}] \rangle$ with increasing N_{ch} is reproduced by a hydrodynamic model using $c_s^2 \approx 0.23$ at an effective temperature $T_{\mathrm{eff}} \approx 222$ MeV. The centrality dependence of these observables in ultra-central collisions is slightly weaker in the smaller Xe+Xe collisions, and colliding even smaller nuclear species could probe this effect further. The study of $[p_{\mathrm{T}}]$ fluctuations offers an effective tool for constraining the initial-state fluctuations and the final-state hydrodynamic response in heavy-ion collisions.

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1 Appendix

The pileup probability is $\langle\mu\rangle = 0.0017$ in Pb+Pb collisions and 0.00019 in Xe+Xe collisions. The pileup events have a non-uniform distribution in N_{ch} and tend to have a larger contribution in UCC. The impact of pileup events can be estimated and rejected based on the anti-correlation between ZDC energy (E_{ZDC}) and FCal ΣE_{T} as shown in Figure 5(a). A typical pileup event in the UCC region consists of a genuine central event with small E_{ZDC} and large ΣE_{T} and a peripheral or mid-central event with large E_{ZDC} and small ΣE_{T}, contributing to the satellite band. The good events are selected within a six standard deviation from the peak value of E_{ZDC} at a given ΣE_{T}, as indicated by the red line. A convolution of the distribution of good events according to the pileup probability then yields an estimate of the distribution for pileup events in Figure 5(b).

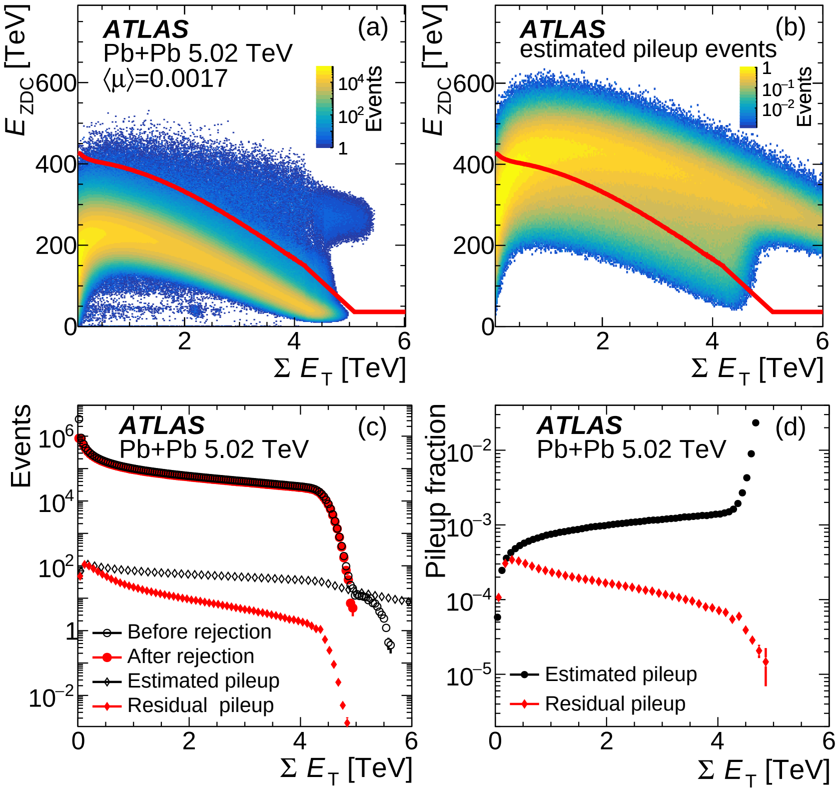

Figure 5: Top: The distributions of energy deposited in the ZDCs vs FCal for (a) all events, and (b) estimated pileup events, the red line represents the line used for selection of good events. Bottom: As a function ΣE_{T}, (c) the distributions of all events, pileup events, good events, and residual pileup events and (d) the fraction of pileup events before and after pileup rejection. The results are obtained for 5.02 TeV Pb+Pb collisions.

Figure 5(c) shows the distributions of all events and estimated pileup events as a function of ΣE_{T}, as well as the good events and residual pileup events after applying the selection criteria. The pileup events are greatly reduced and its fraction is $\lesssim 0.01\%$ in UCC, as shown in Figure 5(d). The pileup rejection criteria have been relaxed to vary the residual fraction of the pileup events, the results are insensitive to this variation.

Figure 6(a) shows the correlation between ΣE_{T} and N_{ch}. The correlation is smeared, implying that the 0–1% most central events selected on ΣE_{T} would span a large range of N_{ch} as indicated by the shaded box. Correspondingly, the $[p_{\mathrm{T}}]$ for these events span a large range $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$ as shown by the x-axis in Figure 4.

Figure 7 displays the multiplicity dependence of γ and scaled-γ in the two systems. They can be derived from Figures 1 and 3, but are shown here for completeness.

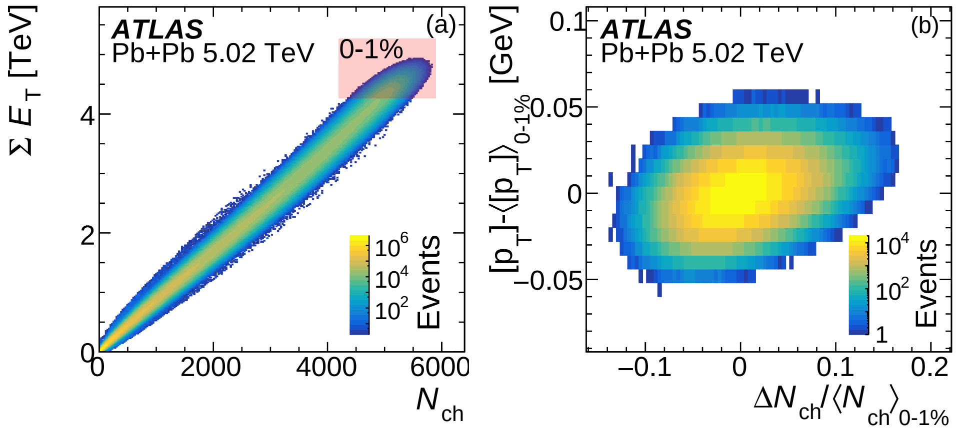

Figure 6: (a) Correlation between FCal ΣE_{T} and N_{ch} in Pb+Pb collisions, where the shaded region covers 0–1% most central events, and (b) correlation between $[p_{\mathrm{T}}]$ and $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$.

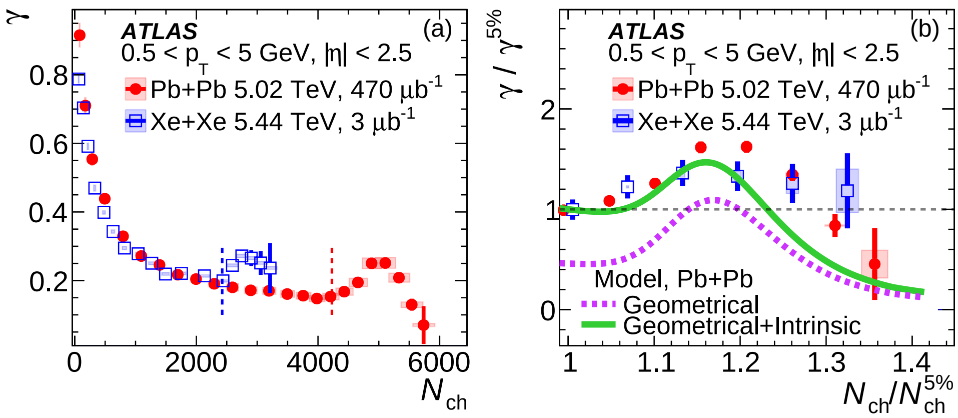

Figure 7: (a) γ as a function of N_{ch} and (b) scaled-γ as a function of $N_{\mathrm{ch}}/N_{\mathrm{ch}}^{5\%}$ in Pb+Pb and Xe+Xe collisions compared to predictions from Ref. [12]. The error bars and shaded area represent statistical and systematic uncertainties, respectively. The vertical dashed lines in (a) mark the N_{ch} values corresponding to 5% centrality in Pb+Pb and Xe+Xe collisions.

References

[1] W. Busza, K. Rajagopal and W. van der Schee, *Heavy Ion Collisions: The Big Picture, and the Big Questions*, Ann. Rev. Nucl. Part. Sci. **68** (2018) 339, arXiv: 1802.04801 [hep-ph].

[2] D. Teaney and L. Yan, *Triangularity and dipole asymmetry in relativistic heavy ion collisions*, Phys. Rev. C **83** (2011) 064904, arXiv: 1010.1876 [nucl-th].

[3] F. G. Gardim, F. Grassi, M. Luzum and J.-Y. Ollitrault, *Mapping the hydrodynamic response to the initial geometry in heavy-ion collisions*, Phys. Rev. C **85** (2012) 024908, arXiv: 1111.6538 [nucl-th].

[4] H. Niemi, G. S. Denicol, H. Holopainen and P. Huovinen, *Event-by-event distributions of azimuthal asymmetries in ultrarelativistic heavy-ion collisions*, Phys. Rev. C **87** (2013) 054901, arXiv: 1212.1008 [nucl-th].

[5] P. Bożek and W. Broniowski, *Transverse-momentum fluctuations in relativistic heavy-ion collisions from event-by-event viscous hydrodynamics*, Phys. Rev. C **85** (2012) 044910, arXiv: 1203.1810 [nucl-th].

[6] P. Romatschke and U. Romatschke, *Relativistic Fluid Dynamics In and Out of Equilibrium*, Cambridge Monographs on Mathematical Physics, Cambridge University Press, 2019, arXiv: 1712.05815 [nucl-th].

[7] J. E. Bernhard, J. S. Moreland and S. A. Bass, *Bayesian estimation of the specific shear and bulk viscosity of quark–gluon plasma*, Nature Phys. **15** (2019) 1113.

[8] G. Nijs, W. van der Schee, U. Gürsoy and R. Snellings, *Bayesian analysis of heavy ion collisions with the heavy ion computational framework Trajectum*, Phys. Rev. C **103** (2021) 054909, arXiv: 2010.15134 [nucl-th].

[9] F. G. Gardim, G. Giacalone, M. Luzum and J.-Y. Ollitrault, *Thermodynamics of hot strong-interaction matter from ultrarelativistic nuclear collisions*, Nature Phys. **16** (2020) 615, arXiv: 1908.09728 [nucl-th].

[10] F. G. Gardim, G. Giacalone and J.-Y. Ollitrault, *The mean transverse momentum of ultracentral heavy-ion collisions: A new probe of hydrodynamics*, Phys. Lett. B **809** (2020) 135749, arXiv: 1909.11609 [nucl-th].

[11] R. Samanta, S. Bhatta, J. Jia, M. Luzum and J.-Y. Ollitrault, *Thermalization at the femtoscale seen in high-energy Pb+Pb collisions*, Phys. Rev. C **109** (2024) L051902, arXiv: 2303.15323 [nucl-th].

[12] R. Samanta, J. P. Picchetti, M. Luzum and J.-Y. Ollitrault, *Non-Gaussian transverse momentum fluctuations from impact parameter fluctuations*, Phys. Rev. C **108** (2023) 024908, arXiv: 2306.09294 [nucl-th].

[13] G. Nijs and W. van der Schee, *Ultracentral heavy ion collisions, transverse momentum and the equation of state*, Phys. Lett. B **853** (2024) 138636, arXiv: 2312.04623 [nucl-th].

[14] F. G. Gardim, A. V. Giannini and J.-Y. Ollitrault, *Accessing the speed of sound in relativistic ultracentral nucleus-nucleus collisions using the mean transverse momentum*, (2024), arXiv: 2403.06052 [nucl-th].

[15] G. Soares Rocha, L. Gavassino, M. Singh and J.-F. Paquet, *Analytical insights into the interplay of momentum, multiplicity and the speed of sound in heavy-ion collisions*, (2024), arXiv: 2405.10401 [hep-ph].

[16] S. Gavin and G. Moschelli, *Fluctuation Probes of Early-Time Correlations in Nuclear Collisions*, Phys. Rev. C **85** (2012) 014905, arXiv: 1107.3317 [nucl-th].

[17] M. Cody et al., *Complementary two-particle correlation observables for relativistic nuclear collisions*, Phys. Rev. C **107** (2023) 014909, arXiv: 2110.04884 [nucl-th].

[18] NA49 Collaboration, *Event-by-event fluctuations of average transverse momentum in central Pb + Pb collisions at 158 GeV per nucleon*, Phys. Lett. B **459** (1999) 679, arXiv: hep-ex/9904014.

[19] PHENIX Collaboration, *Event-by-event fluctuations in mean p_T and mean E_T in $\sqrt{s_{\text{NN}}}$ = 130 GeV Au+Au collisions*, Phys. Rev. C **66** (2002) 024901, arXiv: nucl-ex/0203015.

[20] PHENIX Collaboration, *Measurement of non-random event-by-event fluctuations of average transverse momentum in $\sqrt{s_{\text{NN}}}$= 200 GeV Au+Au and p+p collisions*, Phys. Rev. Lett. **93** (2004) 092301, arXiv: nucl-ex/0310005.

[21] STAR Collaboration, *Event-wise $\langle p_T \rangle$ fluctuations in Au - Au collisions at $\sqrt{s_{\text{NN}}}$ = 130 GeV*, Phys. Rev. C **71** (2005) 064906, arXiv: nucl-ex/0308033.

[22] NA49 Collaboration, *Transverse momentum fluctuations in nuclear collisions at 158 A GeV*, Phys. Rev. C **70** (2004) 034902, arXiv: hep-ex/0311009.

[23] CERES Collaboration, *Event-by-event fluctuations of the mean transverse momentum in 40, 80 and 158 A GeV Pb - Au collisions*, Nucl. Phys. A **727** (2003) 97, arXiv: nucl-ex/0305002.

[24] STAR Collaboration, *Incident energy dependence of p_t correlations at RHIC*, Phys. Rev. C **72** (2005) 044902, arXiv: nucl-ex/0504031.

[25] STAR Collaboration, *System-size dependence of transverse momentum correlations at* $\sqrt{s_{\text{NN}}}$ = 62.4 *and 200 GeV at the BNL Relativistic Heavy Ion Collider*, Phys. Rev. C **87** (2013) 064902, arXiv: 1301.6633 [nucl-ex].

[26] ALICE Collaboration, *Event-by-event mean p_{T} fluctuations in pp and Pb-Pb collisions at the LHC*, Eur. Phys. J. C **74** (2014) 3077, arXiv: 1407.5530 [nucl-ex].

[27] STAR Collaboration, *Collision-energy dependence of p_T correlations in Au + Au collisions at energies available at the BNL Relativistic Heavy Ion Collider*, Phys. Rev. C **99** (2019) 044918, arXiv: 1901.00837 [nucl-ex].

[28] ALICE Collaboration, *Skewness and kurtosis of mean transverse momentum fluctuations at the LHC energies*, Phys. Lett. B **850** (2024) 138541, arXiv: 2308.16217 [nucl-ex].

[29] CMS Collaboration, *Extracting the speed of sound in quark–gluon plasma with ultrarelativistic lead–lead collisions at the LHC*, Rept. Prog. Phys. **87** (2024) 077801, arXiv: 2401.06896 [nucl-ex].

[30] ATLAS Collaboration, *The ATLAS Experiment at the CERN Large Hadron Collider*, JINST **3** (2008) S08003.

[31] ATLAS Collaboration, *The ATLAS Inner Detector commissioning and calibration*, Eur. Phys. J. C **70** (2010) 787, arXiv: 1004.5293 [physics.ins-det].

[32] ATLAS Collaboration, *Performance of the ATLAS trigger system in 2015*, Eur. Phys. J. C **77** (2017) 317, arXiv: 1611.09661 [hep-ex].

[33] ATLAS Collaboration, *Software and computing for Run 3 of the ATLAS experiment at the LHC*, (2024), arXiv: 2404.06335 [hep-ex].

[34] ATLAS Collaboration, *Fluctuations of anisotropic flow in Pb+Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV with the ATLAS detector*, JHEP **01** (2020) 051, arXiv: 1904.04808 [nucl-ex].

[35] ATLAS Collaboration, *Measurement of charged-particle spectra in Pb+Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 2.76$ TeV with the ATLAS detector at the LHC*, JHEP **09** (2015) 050, arXiv: 1504.04337 [hep-ex].

[36] ATLAS Collaboration, *Charged-hadron production in pp, p+Pb, Pb+Pb, and Xe+Xe collisions at $\sqrt{s_{NN}} = 5$ TeV with the ATLAS detector at the LHC*, JHEP **07** (2023) 074, arXiv: 2211.15257 [hep-ex].

[37] M. L. Miller, K. Reygers, S. J. Sanders and P. Steinberg, *Glauber Modeling in High-Energy Nuclear Collisions*, Ann. Rev. Nucl. Part. Sci. **57** (2007) 205, arXiv: nucl-ex/0701025.

[38] M. Gyulassy and X.-N. Wang, *HIJING 1.0: A Monte Carlo program for parton and particle production in high-energy hadronic and nuclear collisions*, Comput. Phys. Commun. **83** (1994) 307, arXiv: nucl-th/9502021.

[39] S. Agostinelli et al., *GEANT4 – a simulation toolkit*, Nucl. Instrum. Meth. A **506** (2003) 250.

[40] ATLAS Collaboration, *The ATLAS Simulation Infrastructure*, Eur. Phys. J. C **70** (2010) 823, arXiv: 1005.4568 [physics.ins-det].

[41] A. Bilandzic, R. Snellings and S. Voloshin, *Flow analysis with cumulants: Direct calculations*, Phys. Rev. C **83** (2011) 044913, arXiv: 1010.0233 [nucl-ex].

[42] S. Bhatta, C. Zhang and J. Jia, *Higher-order transverse momentum fluctuations in heavy-ion collisions*, Phys. Rev. C **105** (2022) 024904, arXiv: 2112.03397 [nucl-th].

[43] ATLAS Collaboration, *Measurement of flow harmonics correlations with mean transverse momentum in lead-lead and proton-lead collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV with the ATLAS detector*, Eur. Phys. J. C **79** (2019) 985, arXiv: 1907.05176 [nucl-ex].

[44] G. Giacalone, F. G. Gardim, J. Noronha-Hostler and J.-Y. Ollitrault, *Skewness of mean transverse momentum fluctuations in heavy-ion collisions*, Phys. Rev. C **103** (2021) 024910, arXiv: 2004.09799 [nucl-th].

[45] ATLAS Collaboration, *Evaluating statistical uncertainties and correlations using the bootstrap method*, ATL-PHYS-PUB-2021-011 (2021), URL: https://cds.cern.ch/record/2759945.

[46] ATLAS Collaboration, *Measurement of the azimuthal anisotropy of charged-particle production in $Xe + Xe$ collisions at $\sqrt{s_{\mathrm{NN}}} = 5.44$ TeV with the ATLAS detector*, Phys. Rev. C **101** (2020) 024906, arXiv: 1911.04812 [nucl-ex].

[47] S. A. Voloshin, *Transverse radial expansion in nuclear collisions and two particle correlations*, Phys. Lett. B **632** (2006) 490, arXiv: nucl-th/0312065.

[48] S. Gavin, *Traces of thermalization from transverse momentum fluctuations in nuclear collisions*, Phys. Rev. Lett. **92** (2004) 162301, arXiv: nucl-th/0308067.

[49] B. Schenke, S. Jeon and C. Gale, *(3+1)D hydrodynamic simulation of relativistic heavy-ion collisions*, Phys. Rev. C **82** (2010) 014903, arXiv: 1004.1408 [hep-ph].

[50] ATLAS Collaboration, *ATLAS Computing Acknowledgements*, ATL-SOFT-PUB-2023-001, 2023, URL: https://cds.cern.ch/record/2869272.

The ATLAS Collaboration

G. Aad [104], E. Aakvaag [17], B. Abbott [123], S. Abdelhameed [119a], K. Abeling [56], N.J. Abicht [50], S.H. Abidi [30], M. Aboelela [45], A. Aboulhorma [36e], H. Abramowicz [154], H. Abreu [153], Y. Abulaiti [120], B.S. Acharya [70a,70b,l], A. Ackermann [64a], C. Adam Bourdarios [4], L. Adamczyk [87a], S.V. Addepalli [27], M.J. Addison [103], J. Adelman [118], A. Adiguzel [22c], T. Adye [137], A.A. Affolder [139], Y. Afik [40], M.N. Agaras [13], J. Agarwala [74a,74b], A. Aggarwal [102], C. Agheorghiesei [28c], F. Ahmadov [39,y], W.S. Ahmed [106], S. Ahuja [97], X. Ai [63e], G. Aielli [77a,77b], A. Aikot [166], M. Ait Tamlihat [36e], B. Aitbenchikh [36a], M. Akbiyik [102], T.P.A. Åkesson [100], A.V. Akimov [38], D. Akiyama [171], N.N. Akolkar [25], S. Aktas [22a], K. Al Khoury [42], G.L. Alberghi [24b], J. Albert [168], P. Albicocco [54], G.L. Albouy [61], S. Alderweireldt [53], Z.L. Alegria [124], M. Aleksa [37], I.N. Aleksandrov [39], C. Alexa [28b], T. Alexopoulos [10], F. Alfonsi [24b], M. Algren [57], M. Alhroob [170], B. Ali [135], H.M.J. Ali [93], S. Ali [32], S.W. Alibocus [94], M. Aliev [34c], G. Alimonti [72a], W. Alkakhi [56], C. Allaire [67], B.M.M. Allbrooke [149], J.F. Allen [53], C.A. Allendes Flores [140f], P.P. Allport [21], A. Aloisio [73a,73b], F. Alonso [92], C. Alpigiani [141], Z.M.K. Alsolami [93], M. Alvarez Estevez [101], A. Alvarez Fernandez [102], M. Alves Cardoso [57], M.G. Alviggi [73a,73b], M. Aly [103], Y. Amaral Coutinho [84b], A. Ambler [106], C. Amelung[37], M. Amerl [103], C.G. Ames [111], D. Amidei [108], B. Amini [55], K.J. Amirie [158], S.P. Amor Dos Santos [133a], K.R. Amos [166], S. An[85], V. Ananiev [128], C. Anastopoulos [142], T. Andeen [11], J.K. Anders [37], A.C. Anderson [60], S.Y. Andrean [48a,48b], A. Andreazza [72a,72b], S. Angelidakis [9], A. Angerami [42], A.V. Anisenkov [38], A. Annovi [75a], C. Antel [57], E. Antipov [148], M. Antonelli [54], F. Anulli [76a], M. Aoki [85], T. Aoki [156], M.A. Aparo [149], L. Aperio Bella [49], C. Appelt [19], A. Apyan [27], S.J. Arbiol Val [88], C. Arcangeletti [54], A.T.H. Arce [52], J-F. Arguin [110], S. Argyropoulos [55], J.-H. Arling [49], O. Arnaez [4], H. Arnold [148], G. Artoni [76a,76b], H. Asada [113], K. Asai [121], S. Asai [156], N.A. Asbah [37], R.A. Ashby Pickering [170], K. Assamagan [30], R. Astalos [29a], K.S.V. Astrand [100], S. Atashi [162], R.J. Atkin [34a], M. Atkinson[165], H. Atmani[36f], P.A. Atmasiddha [131], K. Augsten [135], S. Auricchio [73a,73b], A.D. Auriol [21], V.A. Austrup [103], G. Avolio [37], K. Axiotis [57], G. Azuelos [110,ad], D. Babal [29b], H. Bachacou [138], K. Bachas [155,p], A. Bachiu [35], F. Backman [48a,48b], A. Badea [40], T.M. Baer [108], P. Bagnaia [76a,76b], M. Bahmani [19], D. Bahner [55], K. Bai [126], J.T. Baines [137], L. Baines [96], O.K. Baker [175], E. Bakos [16], D. Bakshi Gupta [8], L.E. Balabram Filho [84b], V. Balakrishnan [123], R. Balasubramanian [117], E.M. Baldin [38], P. Balek [87a], E. Ballabene [24b,24a], F. Balli [138], L.M. Baltes [64a], W.K. Balunas [33], J. Balz [102], I. Bamwidhi [119b], E. Banas [88], M. Bandieramonte [132], A. Bandyopadhyay [25], S. Bansal [25], L. Barak [154], M. Barakat [49], E.L. Barberio [107], D. Barberis [58b,58a], M. Barbero [104], M.Z. Barel [117], T. Barillari [112], M-S. Barisits [37], T. Barklow [146], P. Baron [125], D.A. Baron Moreno [103], A. Baroncelli [63a], A.J. Barr [129], J.D. Barr [98], F. Barreiro [101], J. Barreiro Guimarães da Costa [14], U. Barron [154], M.G. Barros Teixeira [133a], S. Barsov [38], F. Bartels [64a], R. Bartoldus [146], A.E. Barton [93], P. Bartos [29a], A. Basan [102], M. Baselga [50], A. Bassalat [67,b], M.J. Basso [159a], S. Bataju [45], R. Bate [167], R.L. Bates [60], S. Batlamous[101], B. Batool [144], M. Battaglia [139], D. Battulga [19], M. Bauce [76a,76b], M. Bauer [80], P. Bauer [25], L.T. Bazzano Hurrell [31], J.B. Beacham [52], T. Beau [130], J.Y. Beaucamp [92], P.H. Beauchemin [161], P. Bechtle [25], H.P. Beck [20,o], K. Becker [170], A.J. Beddall [83], V.A. Bednyakov [39], C.P. Bee [148], L.J. Beemster [16], T.A. Beermann [37], M. Begalli [84d], M. Begel [30], A. Behera [148], J.K. Behr [49], J.F. Beirer [37], F. Beisiegel [25], M. Belfkir [119b], G. Bella [154], L. Bellagamba [24b], A. Bellerive [35], P. Bellos [21], K. Beloborodov [38], D. Benchekroun [36a], F. Bendebba [36a], Y. Benhammou [154], K.C. Benkendorfer [62], L. Beresford [49], M. Beretta [54], E. Bergeaas Kuutmann [164], N. Berger [4], B. Bergmann [135], J. Beringer [18a], G. Bernardi [5], C. Bernius [146], F.U. Bernlochner [25], F. Bernon [37,104], A. Berrocal Guardia [13], T. Berry [97], P. Berta [136], A. Berthold [51], S. Bethke [112], A. Betti [76a,76b], A.J. Bevan [96], N.K. Bhalla [55], S. Bhatta [148], D.S. Bhattacharya [169], P. Bhattarai [146], K.D. Bhide [55], V.S. Bhopatkar [124], R.M. Bianchi [132], G. Bianco [24b,24a], O. Biebel [111], R. 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