Event-by-event fluctuation of mean transverse momentum in Xe–Xe and Pb–Pb collisions with ALICE

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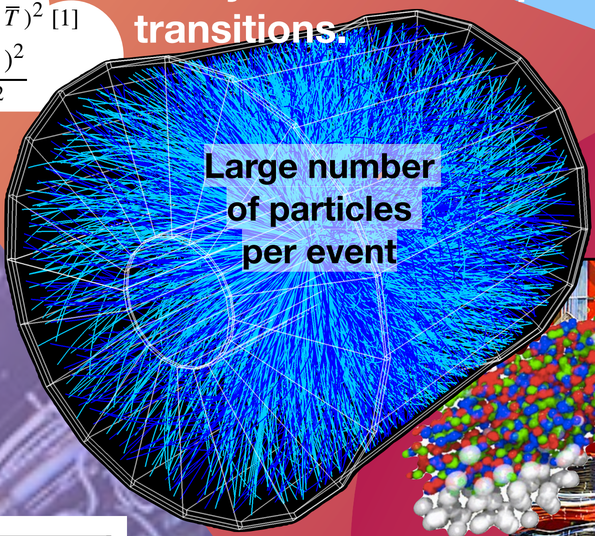
$\langle p_T \rangle$ acts as a proxy for the local temperature of the system

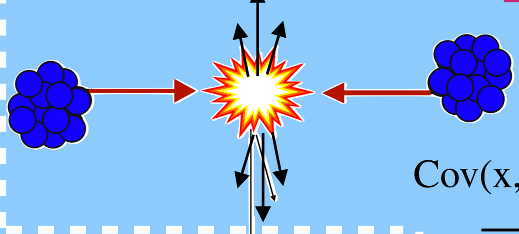
$$(\Delta T)^2 = \overline{(T-\overline{T})^2}\ [1]$$
$$C^{-1} = \frac{(\Delta T)^2}{T^2}$$

Why e-by-e fluctuation?

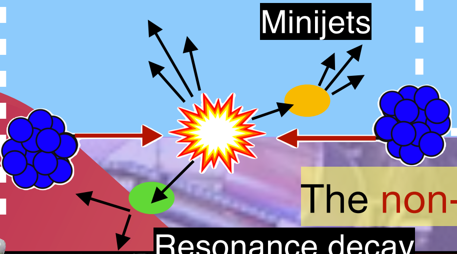
- They help to characterise the properties of the "bulk" of the system.
- Fluctuations are closely related to the **dynamics of the phase transitions.**



Statistical fluctuation:



Presence of correlation:



Observable

→ Defined by Poisson distribution

$$F(k) = e^{-\lambda}\frac{\lambda^k}{k!} \implies \langle F(k) \rangle = \lambda$$

$$Cov(x,y) = E[x,y] - E[x]E[y] \rightarrow C_m$$

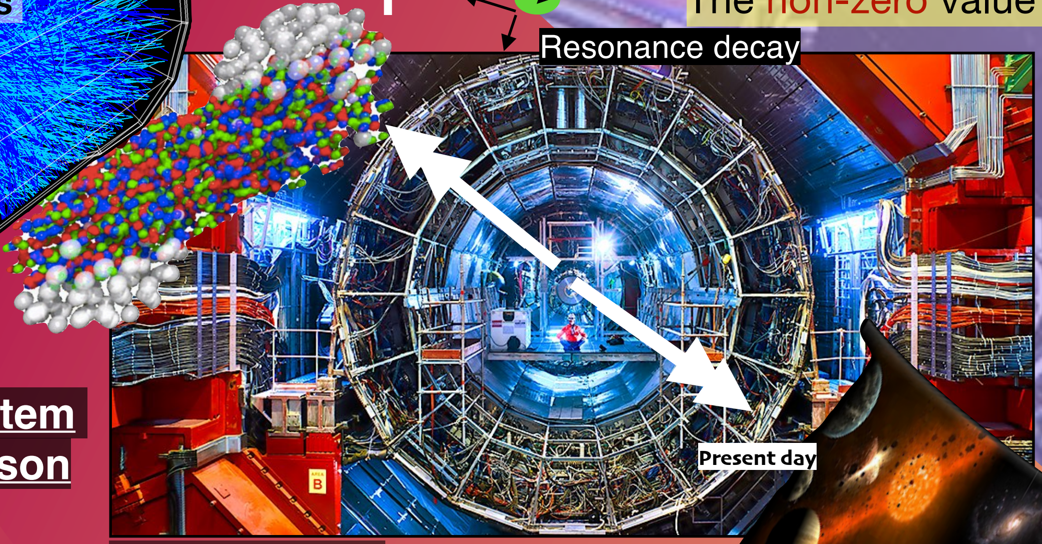
$$\implies \lambda_1\lambda_2 - \lambda_1\lambda_2 = 0 \rightarrow C_m$$

$$C_m = 0$$

→ Two particle correlator

The non-zero value of C_m indicates contribution from non-statistical fluctuations.

- Hence C_m helps probing dynamics of the system



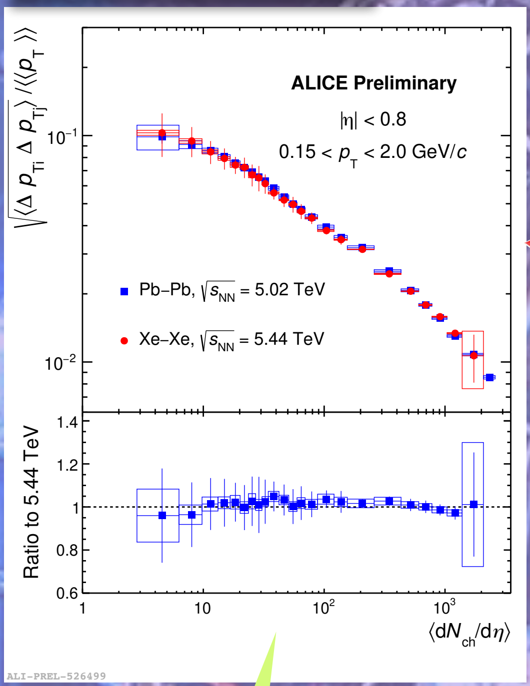
Two-particle correlator

$$\langle \Delta p_i \Delta p_j \rangle = \left\langle \frac{\sum_{i,j\neq i}(p_i - \langle p_T \rangle)(p_j - \langle p_T \rangle)}{N_{ch}(N_{ch}-1)} \right\rangle$$

$$\sqrt{\langle \Delta p_{Ti} \Delta p_{Tj} \rangle} / \langle \langle p_T \rangle \rangle$$

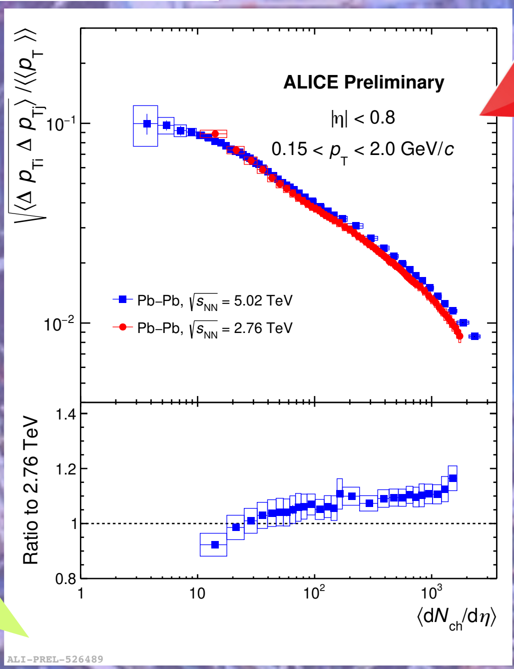
Results and discussion

Collision system size comparison



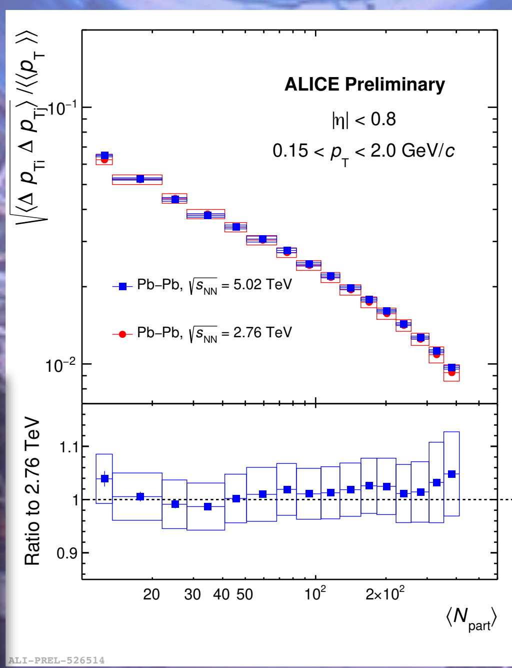
There is NO system size dependance

Collision energy comparison in Pb—Pb collisions



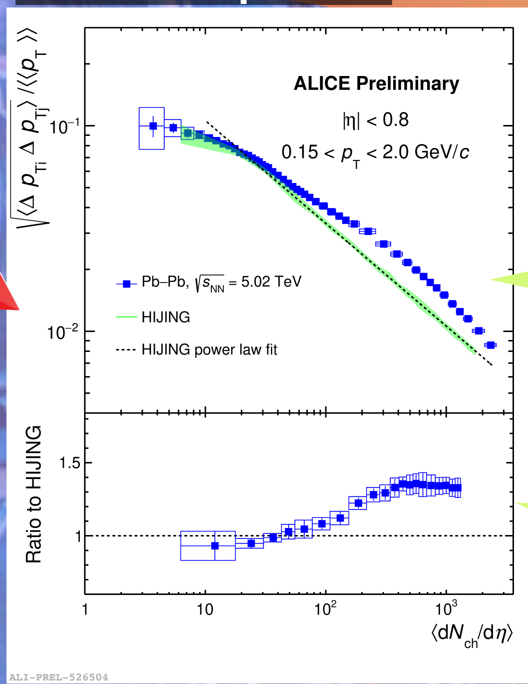
Does the $\sqrt{\langle \Delta p_{Ti} \Delta p_{Tj} \rangle / \langle\langle p_T \rangle\rangle}$ depend on the collision energy??

Collision energy comparison as a function of $\langle N_{part} \rangle$



- Collision energy dependence is observed as a function of $\langle dN_{ch}/d\eta \rangle$ in Pb—Pb collisions [2]. The dependence disappears when plotted as a function of $\langle N_{part} \rangle$.

Model comparison



HIJING shows perfect scaling
↓
Simple superposition of A-A collisions

The data clearly deviates from the model at high multiplicity

Summary and outlook

- In heavy-ion collisions, a clear deviation from simple superposition scenario of particle emitting sources is observed as a function of multiplicity.
- The source of deviation from perfect scaling in heavy-ion collisions could be looked at by investigating the events on the basis of their hardness and softness.

References

[1] L. Stodolsky, Phys. Rev. Lett. 75, 1044–1045 (1995).
[2] S. T. Heckel Eur. Phys. J. C (2014) 74:3077(2014).

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