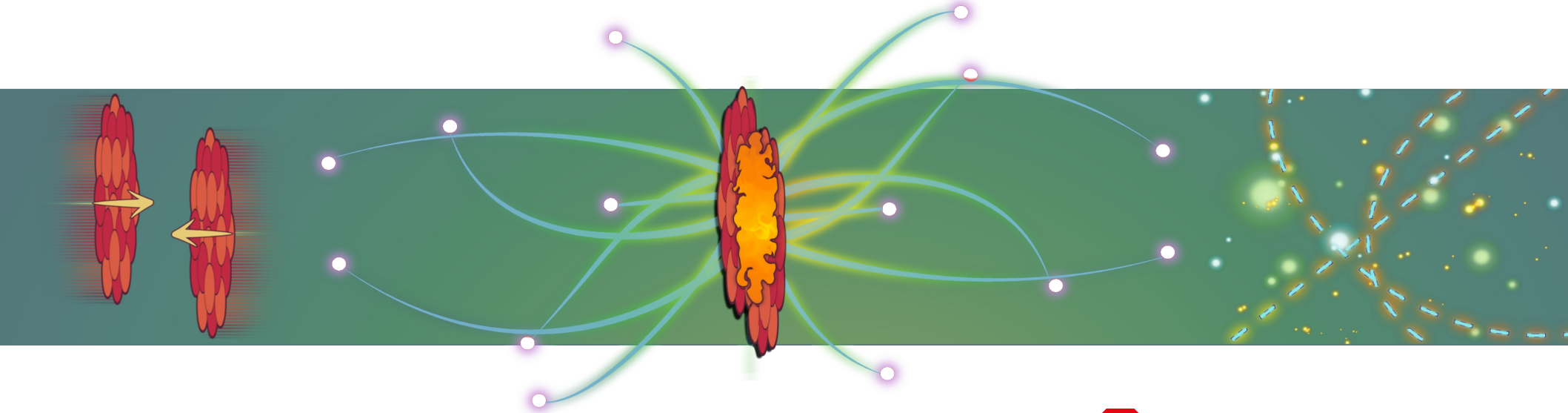
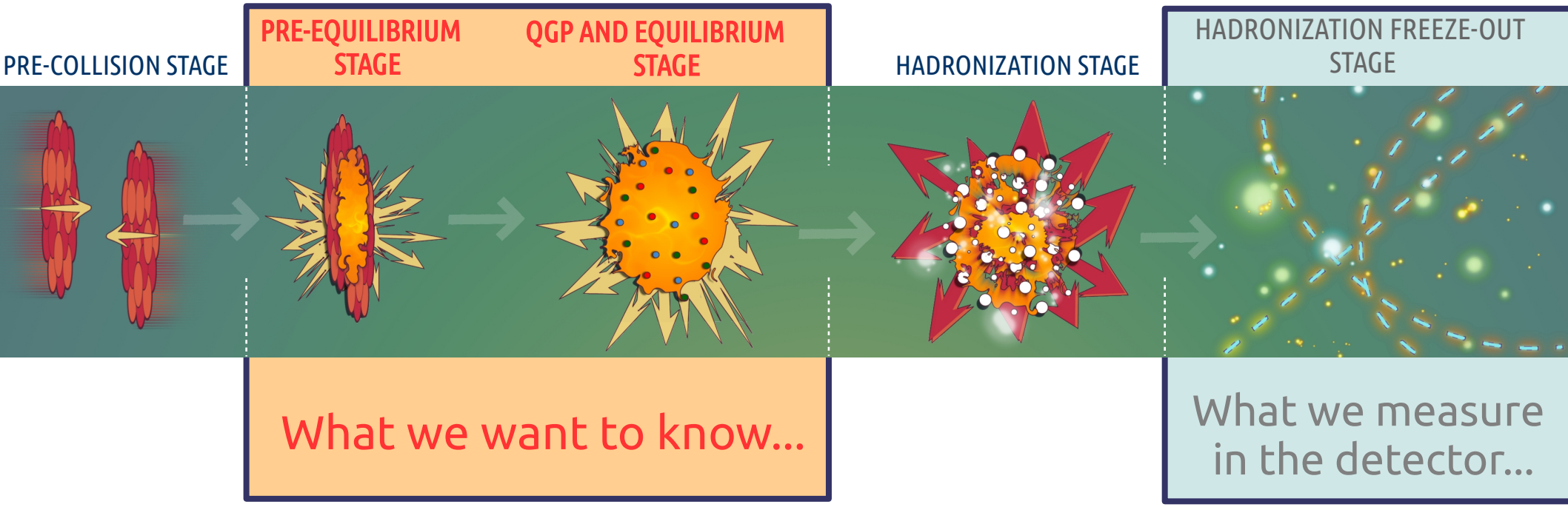
Forward-backward correlations and multiplicity fluctuations in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV from ALICE at the LHC



IWONA SPUTOWSKA
for the ALICE Collaboration
H. Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences

Motivation: Why do we study correlations and fluctuations?

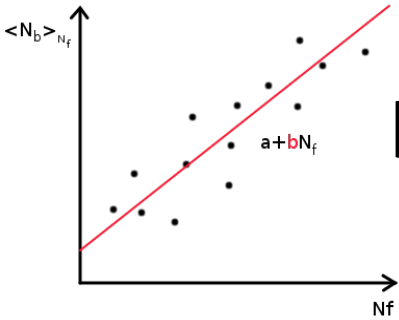


The aim of the analysis:

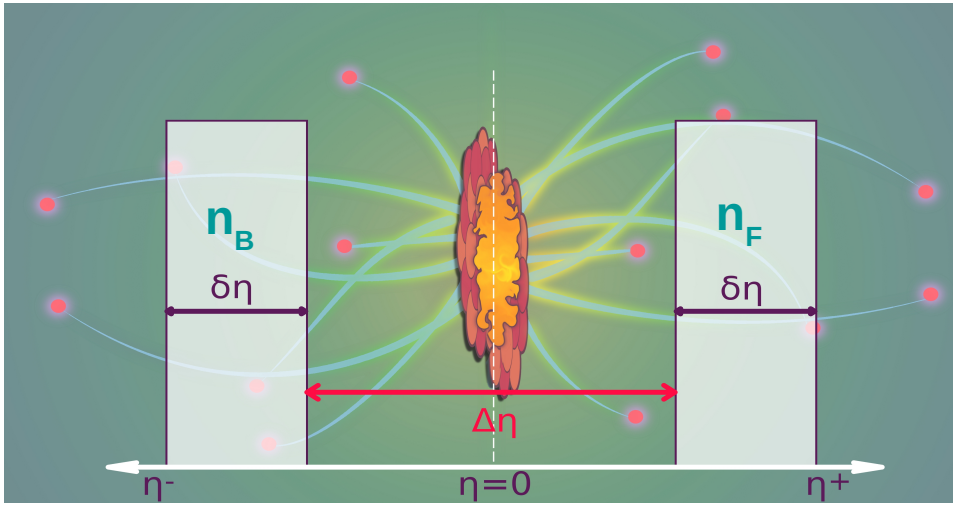
→ Forward-backward correlation coefficient b_{corr}

→ Strongly intensive quantity sigma Σ

Forward-backward correlations b_{corr}

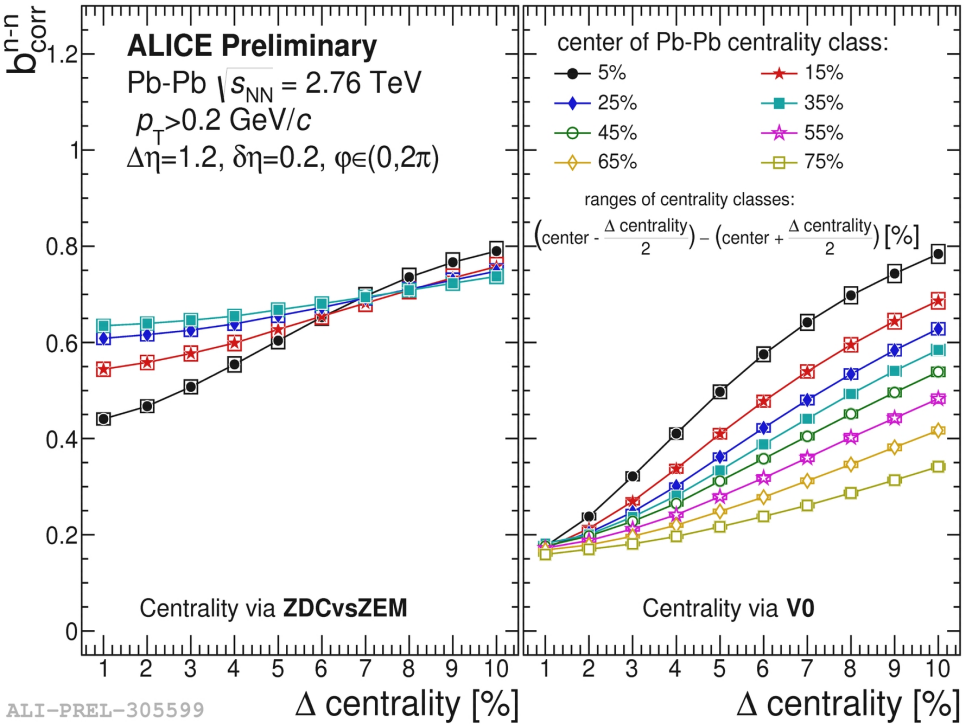


$$b_{corr} = \frac{Cov(n_F, n_B)}{\sqrt{Var(n_F)\,Var(n_B)}}$$

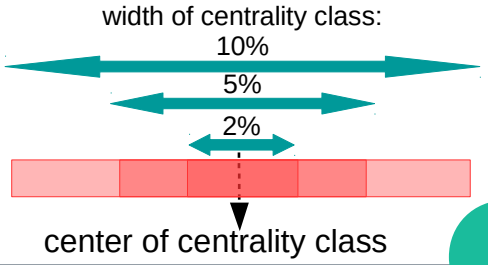


Centrality estimator: spectators in ZDC

Centrality estimator: charged particles in V0



geometrical fluctuations



- Dependence on centrality estimator;
- Drop of the value of b_{corr} (**reduced fluctuations of N_{part}**).

Strongly intensive quantity Σ

Gaździcki, Gorenstein,Phys.Rev. C84 (2011) 014904

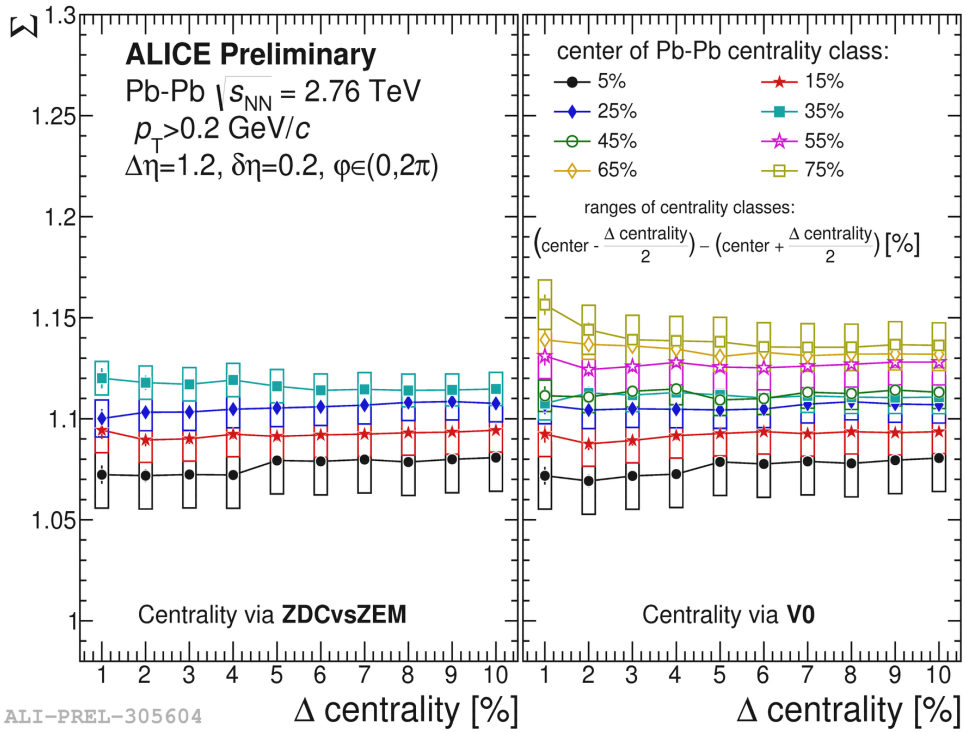
Strongly intensive quantity Σ for a symmetric collision, like Pb-Pb:

$$\Sigma \approx \omega(1-b_{corr})$$

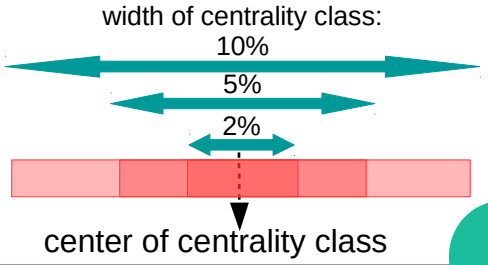
$$\text{scaled variance} = \frac{\text{variance}}{\text{mean}}$$

Centrality estimator: spectators in ZDC

Centrality estimator: charged particles in V0



geometrical fluctuations



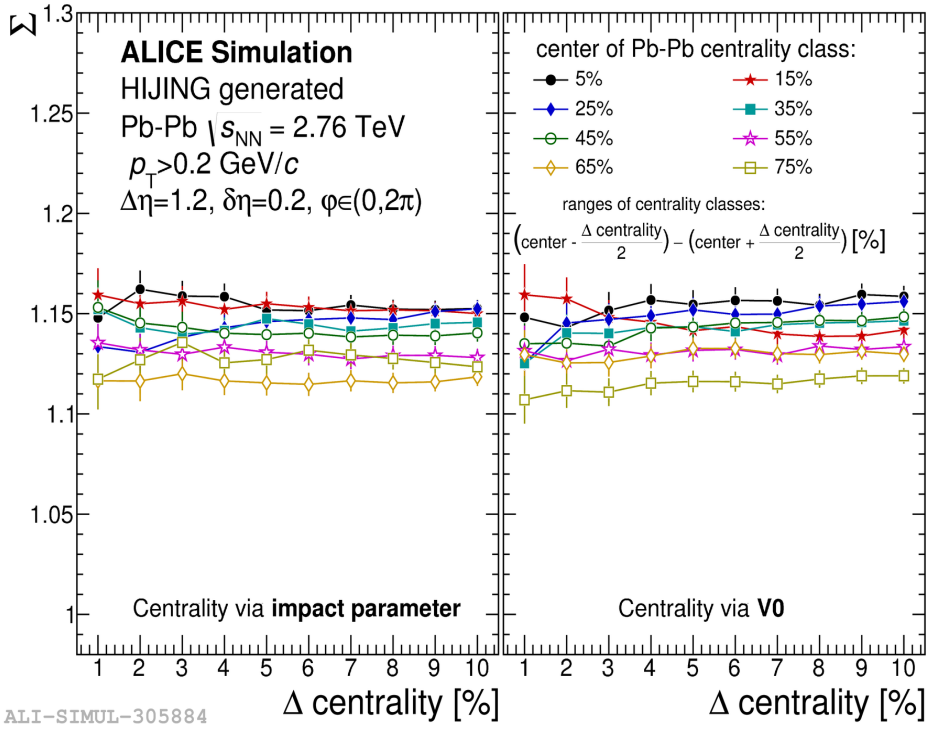
Σ does:

→ **not depend on centrality estimator;**

→ **not depend on centrality bin width.**

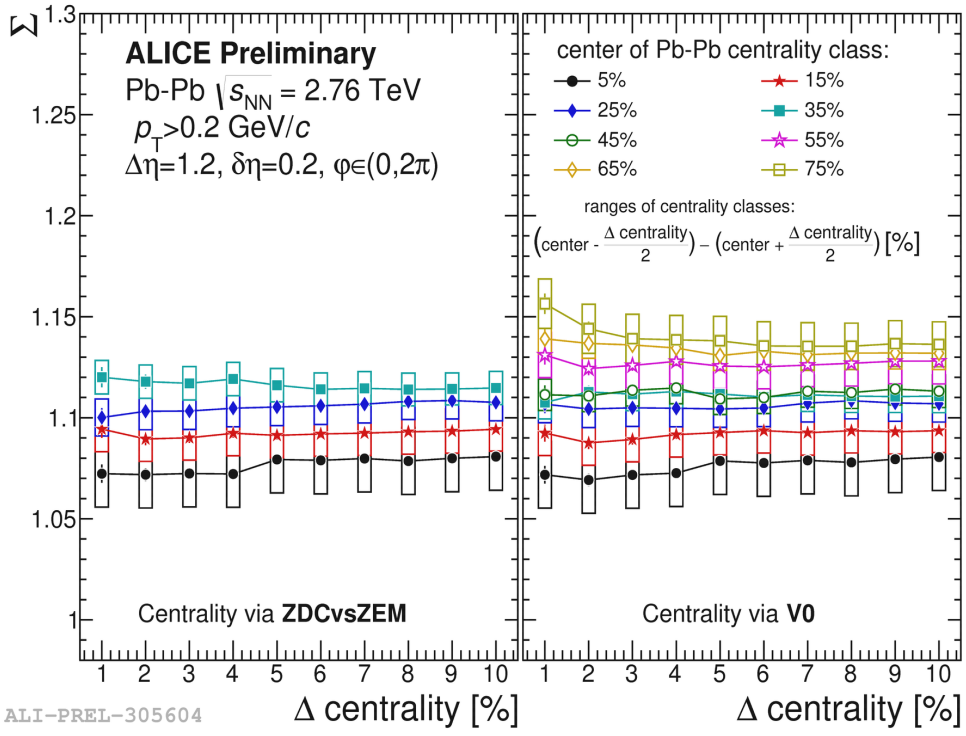
Strongly intensive quantity Σ

MC simulations



geometrical fluctuations

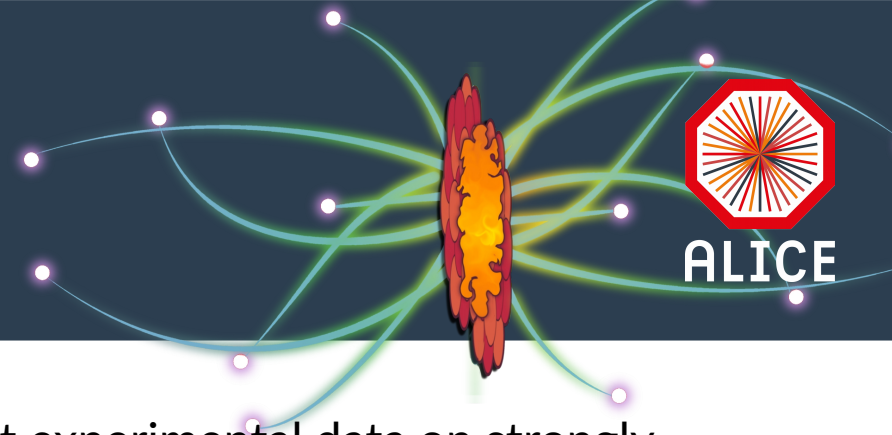
Experimental data



geometrical fluctuations

Different ordering of the values of Σ with centrality→ possible hint about the early dynamics?

Summary



1. Data on forward-backward correlations (b_{corr}) and first experimental data on strongly intensive (Σ) quantity in Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV:

→ b_{corr}: large dependence on centrality bin width and estimator!

→ b_{corr}: information on early dynamics is mixed with trivial geometrical fluctuations.

→ Σ: does not depend on centrality selection method nor on centrality bin width

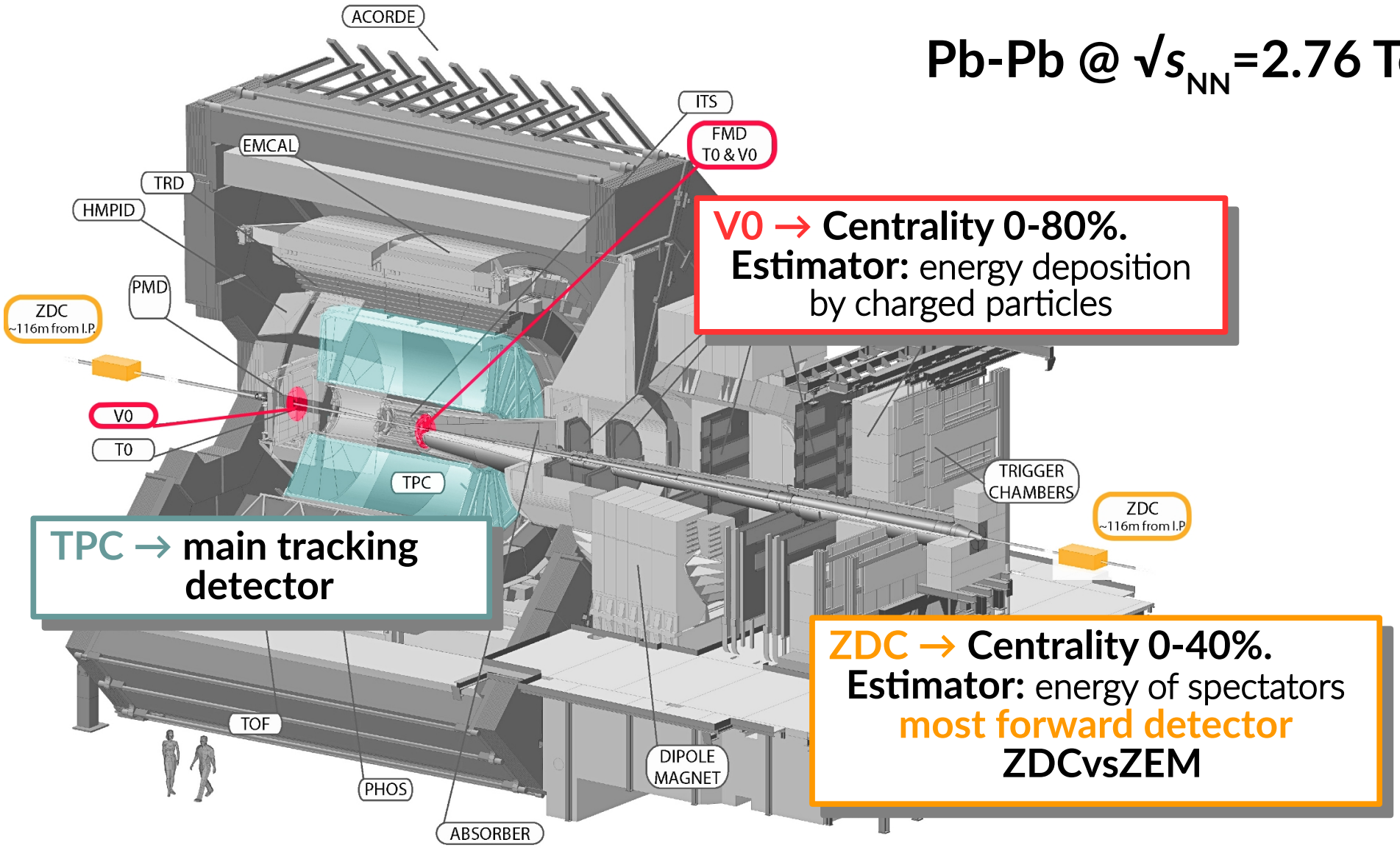
→ these are properties of a strongly intensive quantity!

2. The comparison between experimental data and MC simulations for the strongly intensive quantity Σ shows different ordering of the values of Σ with centrality→ possible hint about the early dynamics?

Thank you!

The Analysis: ALICE Experiment

Pb-Pb @ $\sqrt{s_{NN}}$=2.76 TeV



V0 → Centrality 0-80%.
Estimator: energy deposition by charged particles

TPC → main tracking detector

ZDC → Centrality 0-40%.
Estimator: energy of spectators
most forward detector
ZDCvsZEM

Strongly intensive quantity Σ

Intensive quantities do not depend on system volume.

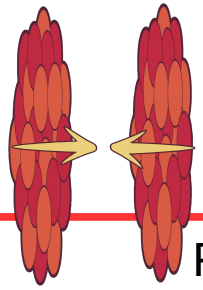
Scaled variance: $\omega_{B(F)} = \frac{\mathrm{Var}(n_{B(F)})}{\langle n_{B(F)} \rangle}$

Gaździcki, Gorenstein, Phys.Rev. C84 (2011) 014904

Strongly Intensive quantities do not depend on system volume nor system volume fluctuations (i.e. $\mathrm{Var}(N_s), \omega_s$) → **Σ**

$$\Sigma = \frac{1}{\langle n_B \rangle + \langle n_F \rangle} \left[\langle n_F \rangle \omega_B + \langle n_B \rangle \omega_F - 2\,\mathrm{Cov}(n_F, n_B) \right]$$

For a symmetric collision, like Pb-Pb:



$\omega_B = \omega_F$ and $\langle n_F \rangle = \langle n_B \rangle$

$\Sigma \approx \omega(1 - b_{corr})$

For Poisson distribution: $\omega = 1$ & $b_{corr} = 0$ → $\Sigma = 1$