Multiplicity fluctuations and Negative binomial distributions

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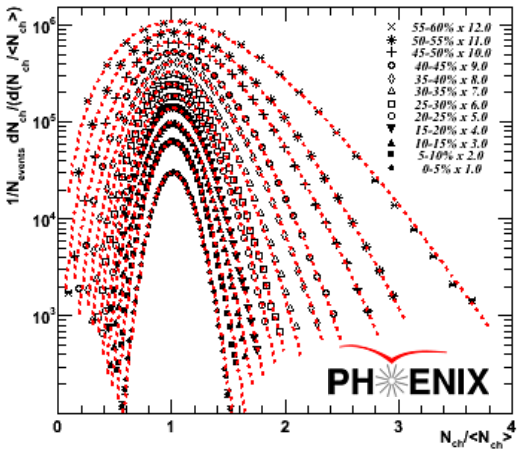
Contents

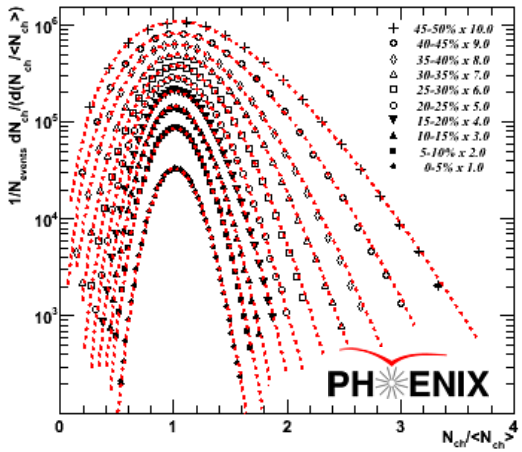
- Multiplicity distributions for
  Au+Au 200GeV/62.4GeV,
  Cu+Cu 200GeV/62.4GeV and NBD fit.
- Comparison of Clan model parameters
  with past experiments.
- Density correlations in heavy-ion collisions.
- Centrality dependence of density correlations.

Multiplicity and NBD in Au+Au, Cu+Cu at RHIC energy

200 GeV Au+Au



62.4 GeV Au+Au

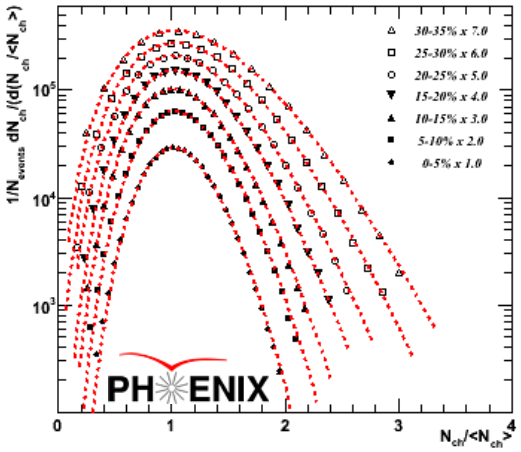


NBD:

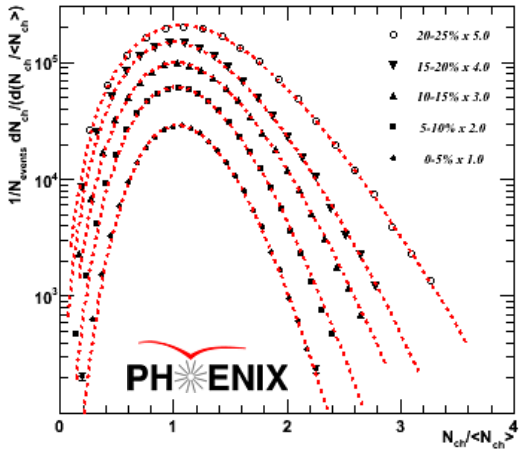
$$P(n) = \frac{\Gamma(n+k)}{\Gamma(n+1)\Gamma(k)} \frac{(\mu/k)^n}{(1+\mu/k)^{n+k}}$$

μ:	mean of the distribution
***k*$^{-1}$**:	deviation from Poissonian width
k:	multiplicity of B. E. emission source

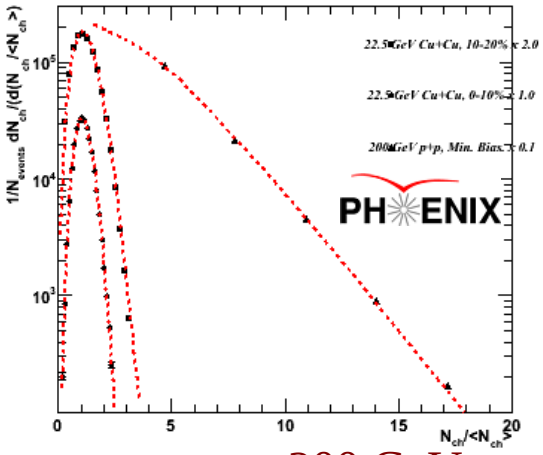
200 GeV Cu+Cu



62.4 GeV Cu+Cu

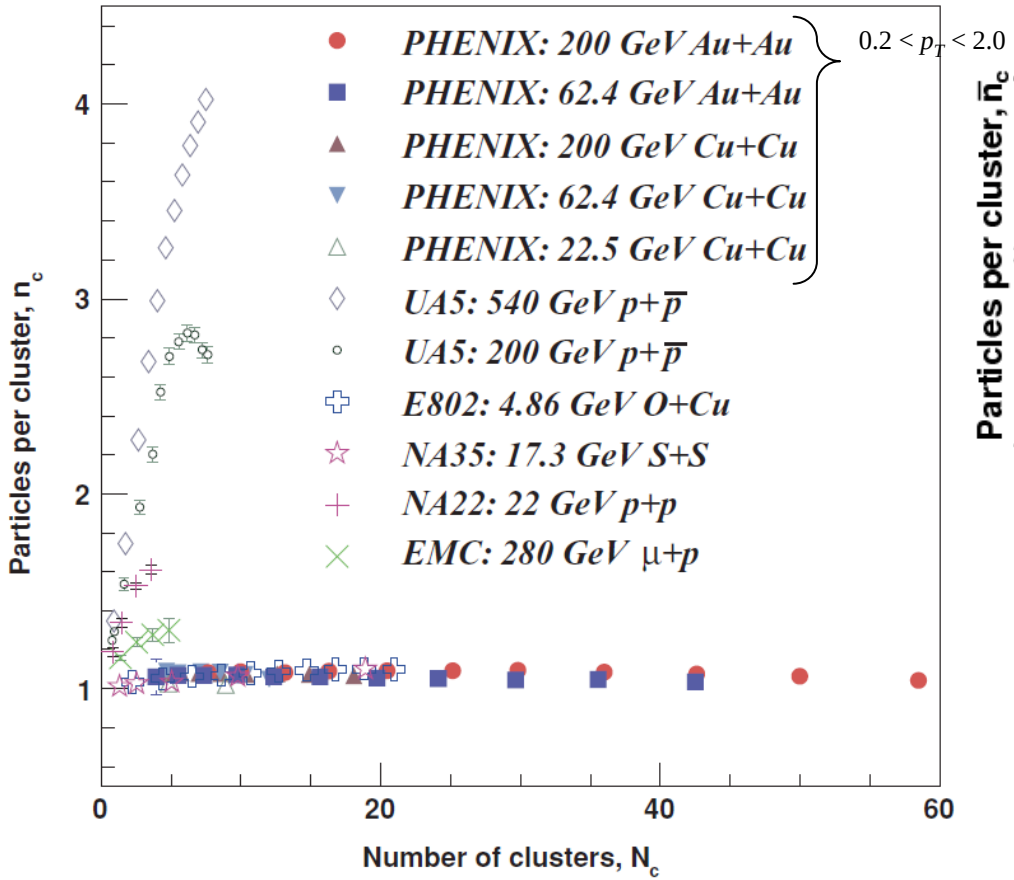


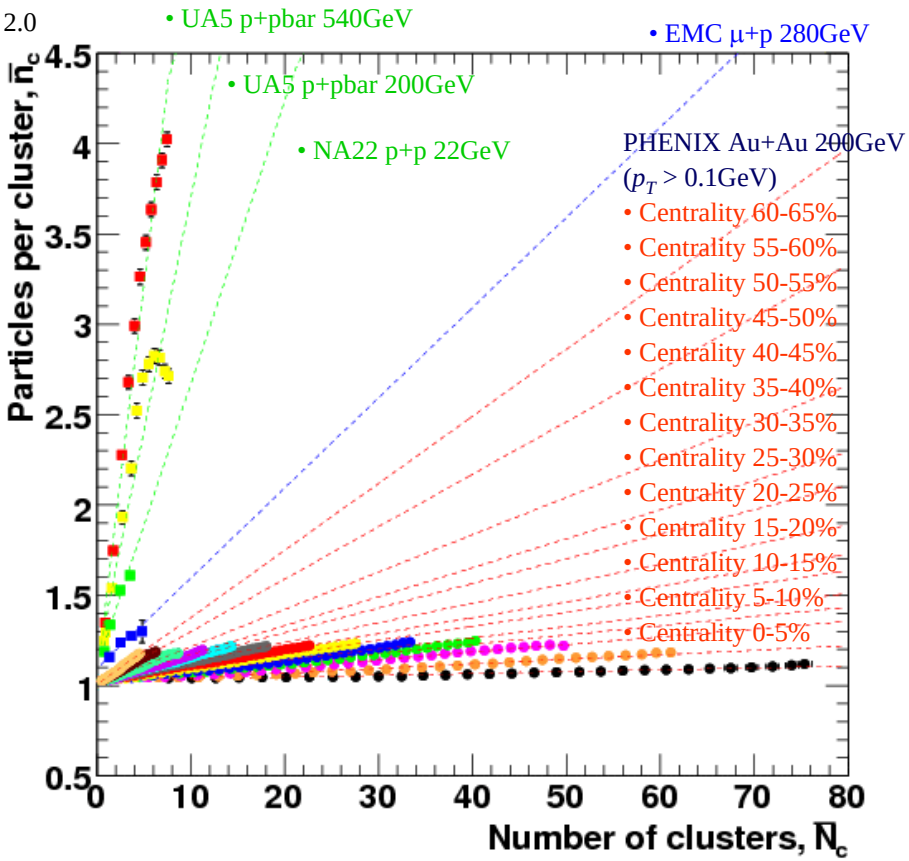
22.5 GeV Cu+Cu



200 GeV p+p

Clan model varying collision systems and δη





PHENIX: Phys. Rev. C78, 044902

PHENIX: Phys. Rev. C76, 034903

Clan model parameters A. Giovannini et al.: Z. Phys. C30, 391

$$\bar{N}_c = k \ln(1 + \mu / k)$$

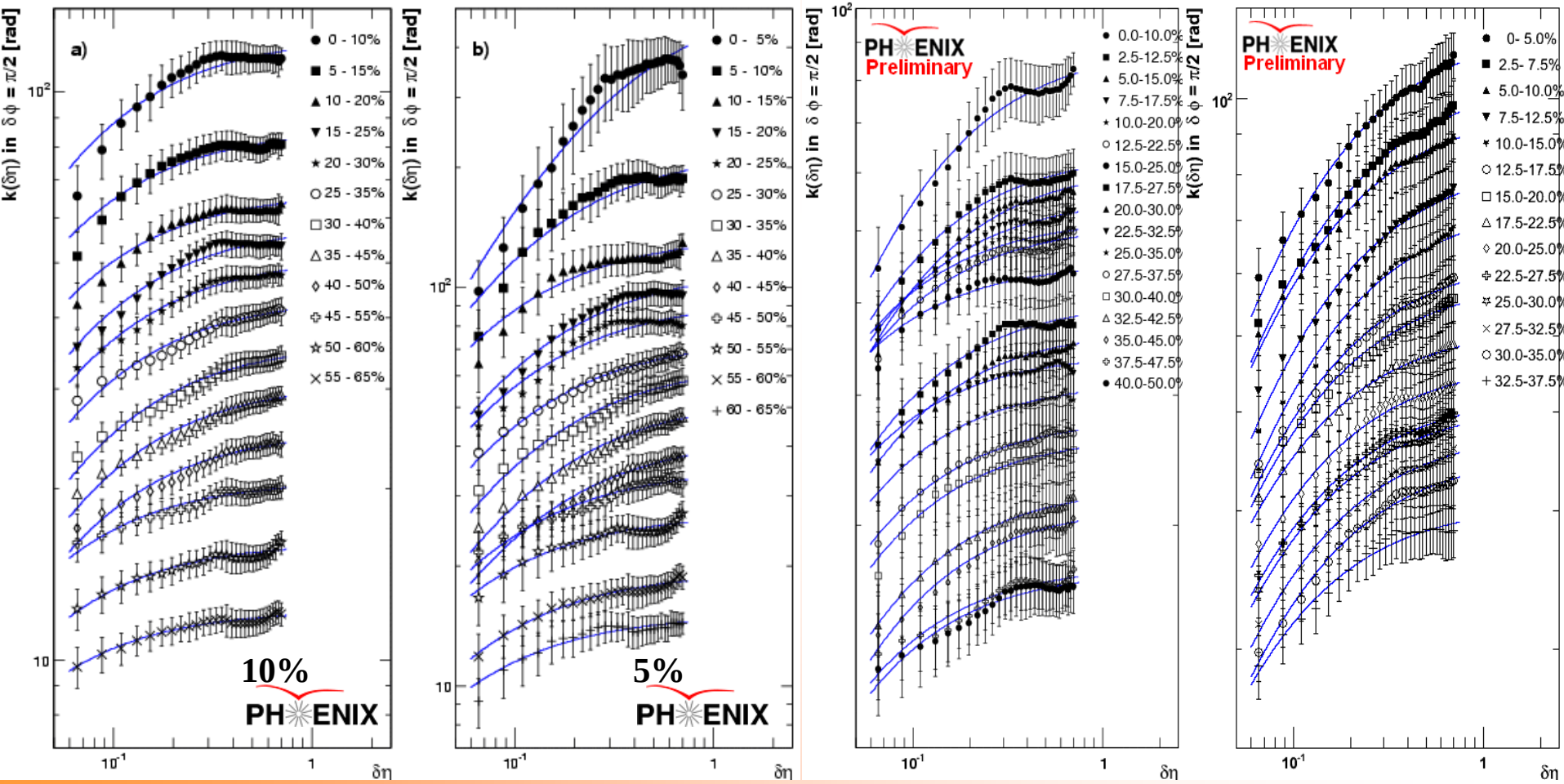
$$\bar{n}_c = (\mu / k) / \ln(1 + \mu / k)$$

A+A collisions exhibit weak clustering characteristics, independent of collision energy.

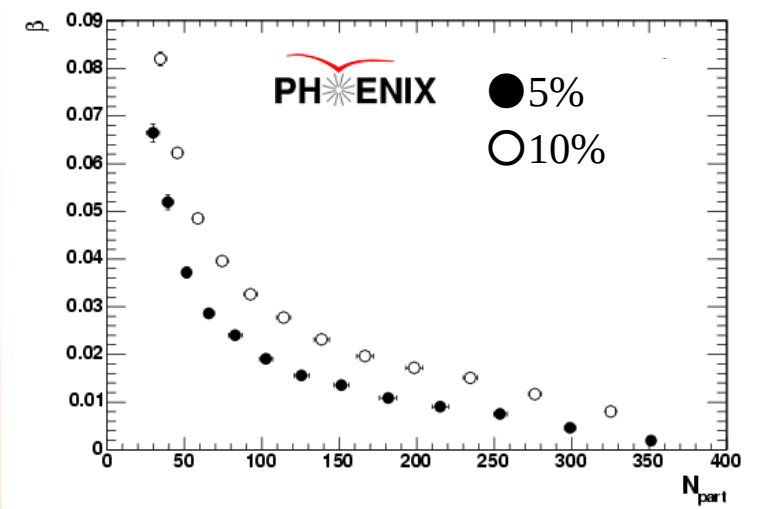
Extraction of the density correlations

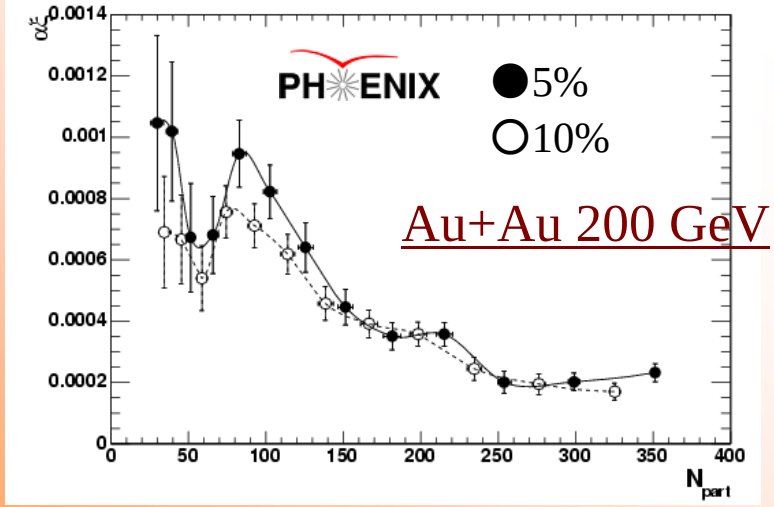
$$k^{-1}(\delta\eta) = F_2 - 1 = \frac{\int_0^{\delta\eta}\int_0^{\delta\eta} C_2(\eta_1,\eta_2)\,d\eta_1 d\eta_2}{\delta\eta^2 \overline{\rho_1}^{\,2}} = \frac{2\alpha\xi^2(\delta\eta/\xi - 1 + e^{-\delta\eta/\xi})}{\delta\eta^2} + \beta$$

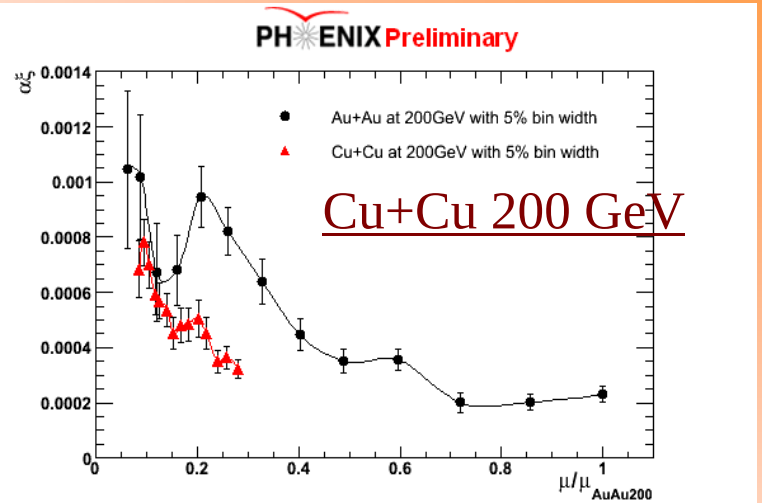
Au+Au 200 GeV | Au+Au 62.4 GeV | Cu+Cu 200 GeV

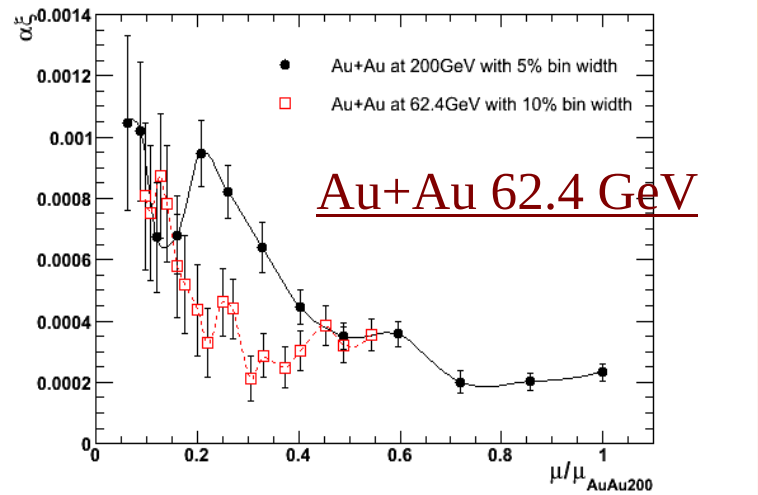


Centrality dependence of density correlations









α: correlation strength
ξ: correlation length
β: rapidity independent correlation

$$\alpha\xi = \chi_{k=0} T / \bar{\rho}_1^{\,2} \propto \bar{\rho}_1^{\,-2} \frac{T}{|T - T_C|}$$

Summary

- **The multiplicity fluctuations** have been measured for all available datasets. It may be related the isothermal compressibility in grand canonical ensemble but no critical behavior was seen as a function of the centrality.
- **The longitudinal density correlations** have been measured via the functional form for pseudorapidity density fluctuations derived in the Ginzburg-Landau thermodynaical theory. The functional form can reasonably fit NBD k parameters as a function of pseudorapidity window sizes $\delta\eta$ not only for Au+Au 200 GeV but also for Cu+Cu 200 GeV and Au+Au 62.4 GeV.
- **The $\alpha\xi$ product** in the correlation function, which is monotonically related to susceptibility $\chi_{k=0}$ of the system, have been measured as a function of the number of participant nucleons N_{part}. No critical behavior was seen without any physical assumptions at the present precision.
- **A possible indication** of a local maximum is seen at $N_{part} \sim 90$ [$\varepsilon_{Bj}\tau \sim 2.4$GeV/(fm^{-2}c)] as compared to the power law baseline only for the Au+Au 200GeV dataset. This might be a hint to search for the critical behavior at the QCD phase transition.
- **PHENIX** carries on to survey the multiplicity fluctuations for further different collision systems (5, 7, 39 GeV). Now we are taking the data at RHIC Run10.