Higher Moments of Net-Proton Multiplicity Distributions in Cu+Cu Collisions at $\sqrt{s_{NN}}$= 22.4, 62.4 and 200 GeV from STAR

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Abstract

Fluctuation of conserved charges is important tool for studying the properties of QCD phase structures in high-energy nuclear collisions. Previously, the STAR experiment has reported the energy dependence of the cumulants of net-proton, net-charge and net-kaon distributions in Au+Au collisions at RHIC. Non-monotonic energy dependence has been observed in the 4th-order net-proton fluctuations in the top 5% central Au+Au collisions at RHIC. In this poster, we report the efficiency-uncorrected collision energy and centrality dependence of net-proton higher moments for Cu+Cu collisions at $\sqrt{s_{NN}}$= 22.4, 62.4 and 200 GeV at RHIC.

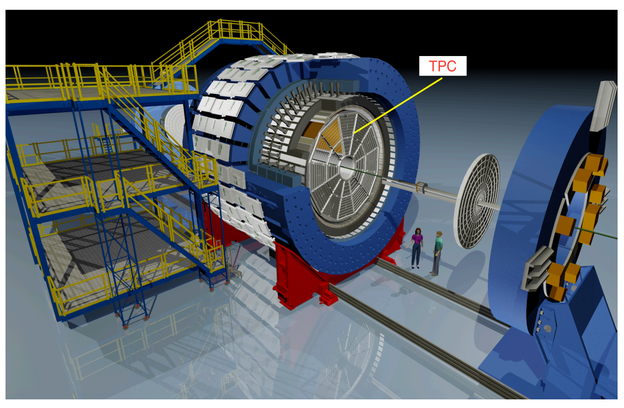
Introduction

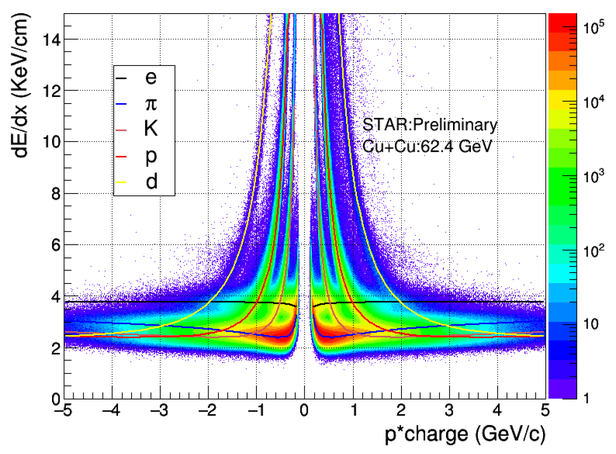
- Higher moments of the distribution of conserved quantities are predicted to be sensitive to the correlation length, and thus are suitable for the search for the QCD critical point[1,2,3].
- Main observables:
  Volume independent cumulant ratios:

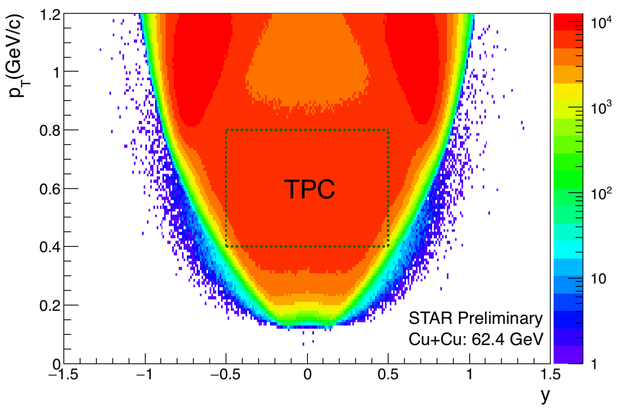
$$\kappa\sigma^2 = \frac{C_4}{C_2} = \frac{\chi_4}{\chi_2},\ S\sigma = \frac{C_3}{C_2} = \frac{\chi_3}{\chi_2},\ \frac{\sigma^2}{M} = \frac{C_2}{C_1} = \frac{\chi_2}{\chi_1}$$

- Cumulant ratios of Cu+Cu collisions from RHIC similar to those of the Au+Au collisions present a new opportunity to measure the system size dependence[4].

Particle Identification



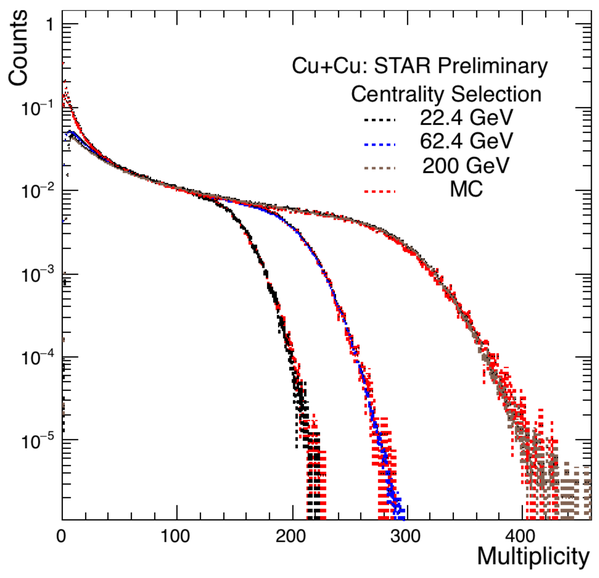




- PID: Energy Loss (dE/dx) in the Time Projection Chamber is used to identify protons within $0.4<p_T<0.8$ (GeV/c) and $|y|<0.5$.

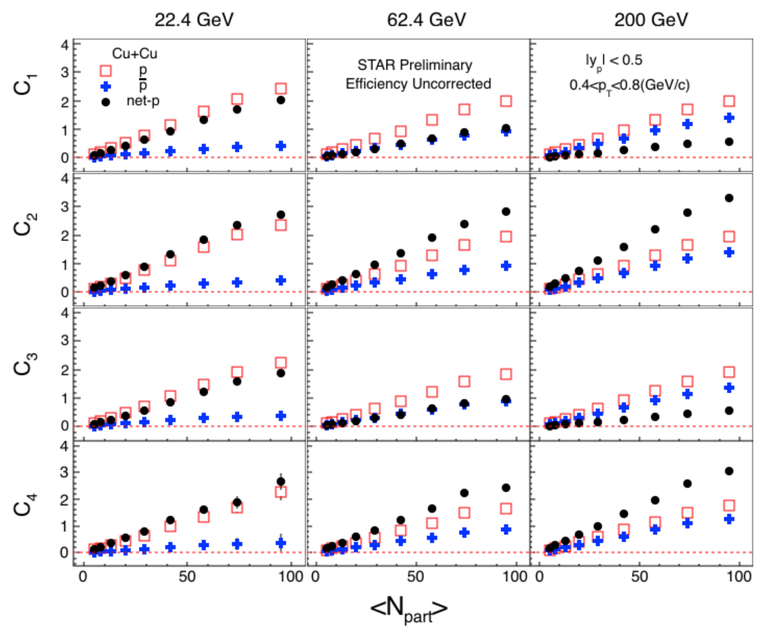
Centrality Determination

$\sqrt{s_{NN}}$(GeV)	Statistics(Million)
22.4	0.6
62.4	14.6
200	5.4



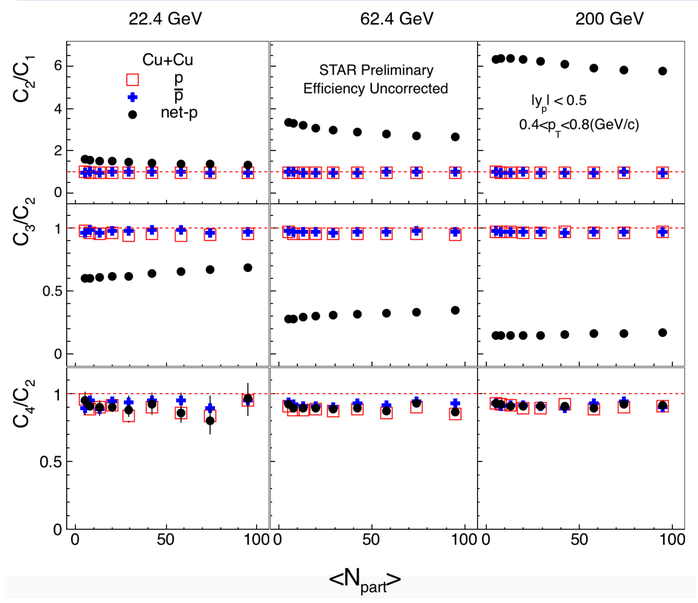
- Collision centrality was estimated via the charged particle multiplicity.
- In order to avoid auto-correlations, (anti)protons were excluded from centrality estimation.

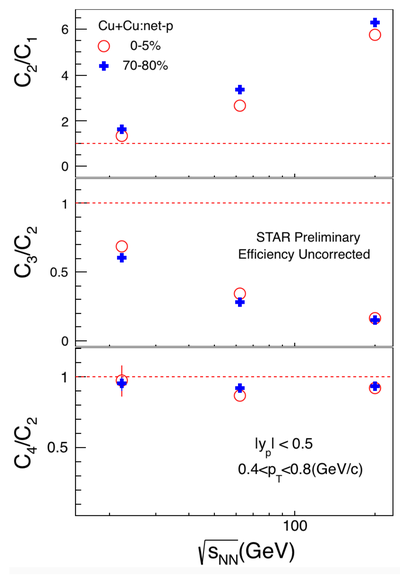
Efficiency Uncorrected Cumulants



- The cumulants of proton, anti-proton and net-proton multiplicity distributions linearly increase with the number of participant.

Efficiency Uncorrected Cumulant Ratios





- The ratios of proton, anti-proton are close to unity.

Summary

- The efficiency-uncorrected cumulants and their ratios of net-proton have been measured in Cu+Cu collisions at $\sqrt{s_{NN}}$=22.4, 62.4 and 200 GeV.
- The values of $C_2/C_1(C_3/C_2)$ of net-proton increase (decrese) with increasing collision energy, while the C_4/C_2 values are flat as a function of energy.
- Efficiency corrections and systematic uncertainty estimation are in progress.

Reference

1.S.Gupta, X.Luo, B.Mohanty, H.G.Ritter, N.Xu, Science 332, 1525 (2011).
2.L.Adamczyk *et al.*, (For the STAR Collaboration), Phys.Rev.Lett.113(2014) 92301.
3.L.Adamczyk *et al.*, (For the STAR Collaboration), Phys.Rev.Lett.112(2014)32302.
4.B.I.Abelev *et al.*, (For the STAR Collaboration), Phys.Rev.C 81, 044902 (2010).

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