Dynamical net charge fluctuations at RHIC energies in STAR

Bhanu Sharma (for the STAR Collaboration)
Panjab University, Chandigarh

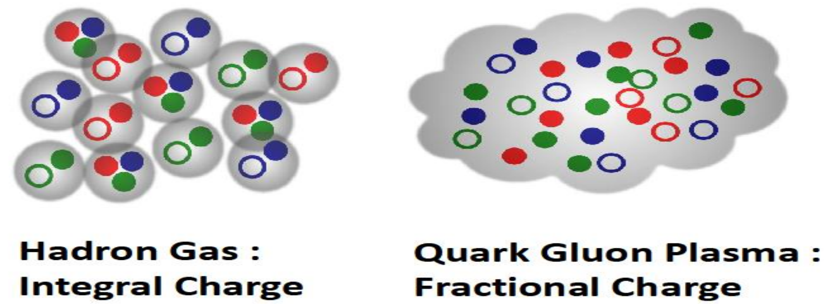
Outline :

- Motivation
- STAR Detector system
- Analysis Method
- Results
- Observations

Motivation

Net Charge Fluctuations :

- Depend upon the square of charges present in the system.
- Strongly depend upon the phase from which it originates.
- Dramatic reduction in the Quark Gluon Plasma phase.

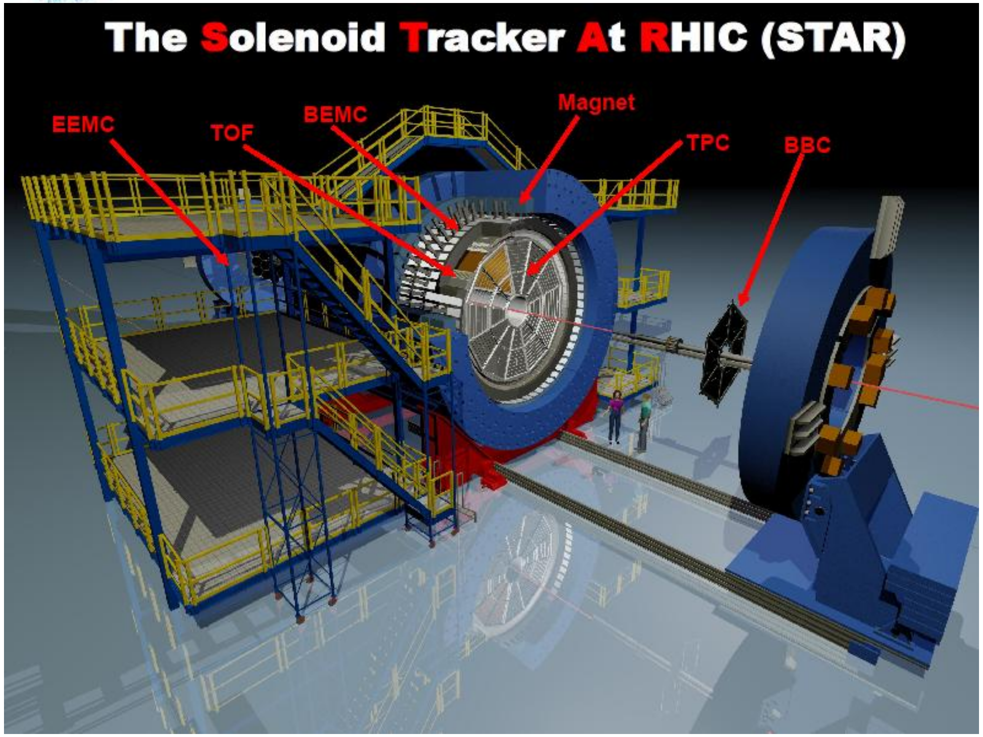


For QGP, the variance of the ratio of positive and negative particles scaled by the total charge particle multiplicity (D) is four times smaller than a gas of pions.

$$D = \begin{cases} 4 & PionGas \\ 2.8 & HRG \\ 1 & QuarkGluonPlasma \end{cases}$$

S. Jeon, V. Koch, Phys. Rev. Lett. 83, 5435 (1999).
S. Jeon, V. Koch, Phys. Rev. Lett. 85, 2076 (2000).
M. Bleicher, S. Jeon, V. Koch, Phys. Rev. C 62, 061902 (2000).

STAR Detector



- **Transverse momentum :**
  0.2 GeV/c < p_T < 5.0 GeV/c
- **Distance of closest approach :**
  DCA < 3.0 cm.
- **Z vertex :**
  -30 cm < V_Z < 30 cm.
- **Pseudorapidity :**
  Positive and negative charged particle multiplicity within -0.5 < η < 0.5 for analysis.

STAR Detector has full 2π coverage and uniform acceptance .

Energy (in GeV)	no. of events	Year
39	~ 92 Million	2010
27	~ 31 Million	2011
19.6	~ 15 Million	2011
11.5	~ 7 Million	2010
7.7	~ 2 Million	2010

Analysis Method

Dynamical Net Charge Fluctuations are measured using a robust variable :

$$\nu_{\pm,dyn} = \frac{\langle N_+(N_+-1)\rangle}{\langle N_+\rangle^2} + \frac{\langle N_-(N_--1)\rangle}{\langle N_-\rangle^2} - 2\times\frac{\langle N_+N_-\rangle}{\langle N_+\rangle\langle N_-\rangle}$$

related to D as:

$$D = 4 + \langle N_{ch}\rangle \nu_{\pm,dyn}$$

To avoid a dependence on the value of bin-width, dynamical fluctuations are calculated for each multiplicity and then averaged across the selected bin width with weights corresponding to relative cross section p(m)

$$\nu_{\pm dyn}(m_{\min} \le m < m_{\max}) = \frac{\sum \nu_{\pm dyn}(m)p(m)}{\sum p(m)}$$

Analysis Method

Charge conservation implies a minimum value of $-4/\langle N_{total}\rangle$, where $\langle N_{total}\rangle$ is the total charged particle multiplicity produced over 4π.

$$\nu_{\pm,dyn}^{corr} = \nu_{\pm,dyn} + \frac{4}{\langle N_{total}\rangle}$$

C. Pruneau, S. Gavin, and S. Voloshin, Phys. Rev. C 66, 044904 (2002).

The formula used to calculate $\langle N_{total}\rangle$ is :

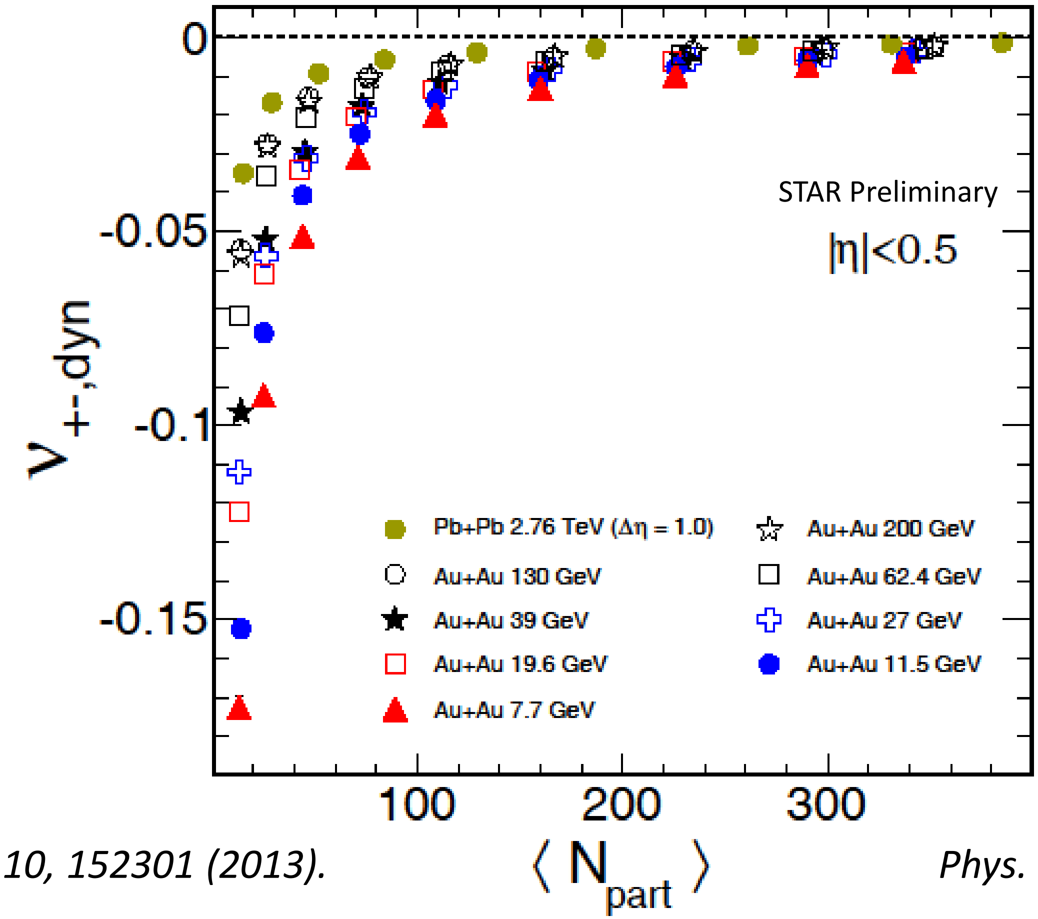
$$\frac{N_{total}}{\langle N_{part}\rangle/2} = 0.26(\ln s)^2 + 0.12$$

Valid for energy range from 2.4 GeV to 200 GeV.

Phys. Rev. C 83, 024913 (2011).

Results

Dynamical net-charge fluctuations as a function of number of participating nucleons.



(Statistical error only)

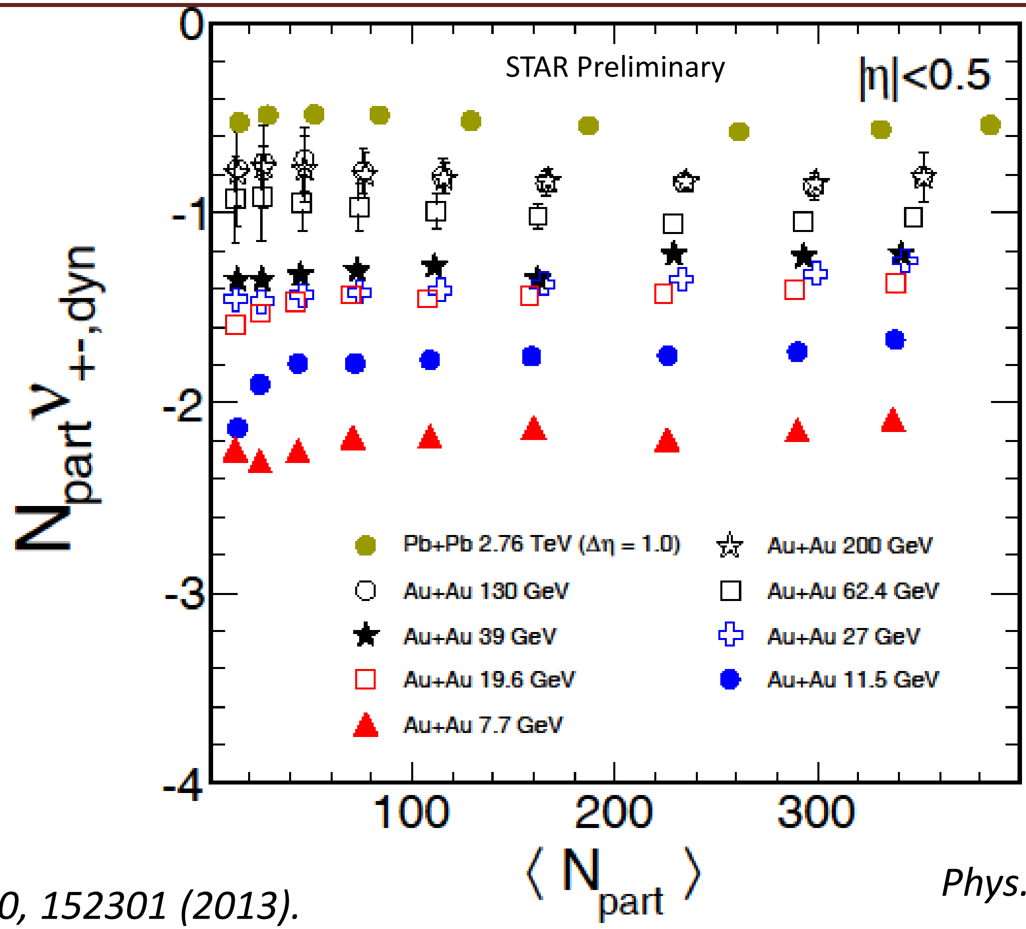
Phys. Rev. Lett. 110, 152301 (2013).

Phys. Rev C 79 024906 (2009).

Monotonic reduction in magnitude of net-charge fluctuations with increase in number of participating nucleons.

Results

Dynamical net charge fluctuations scaled by no. of participating nucleons as a function of N_{part}



(Statistical error only)

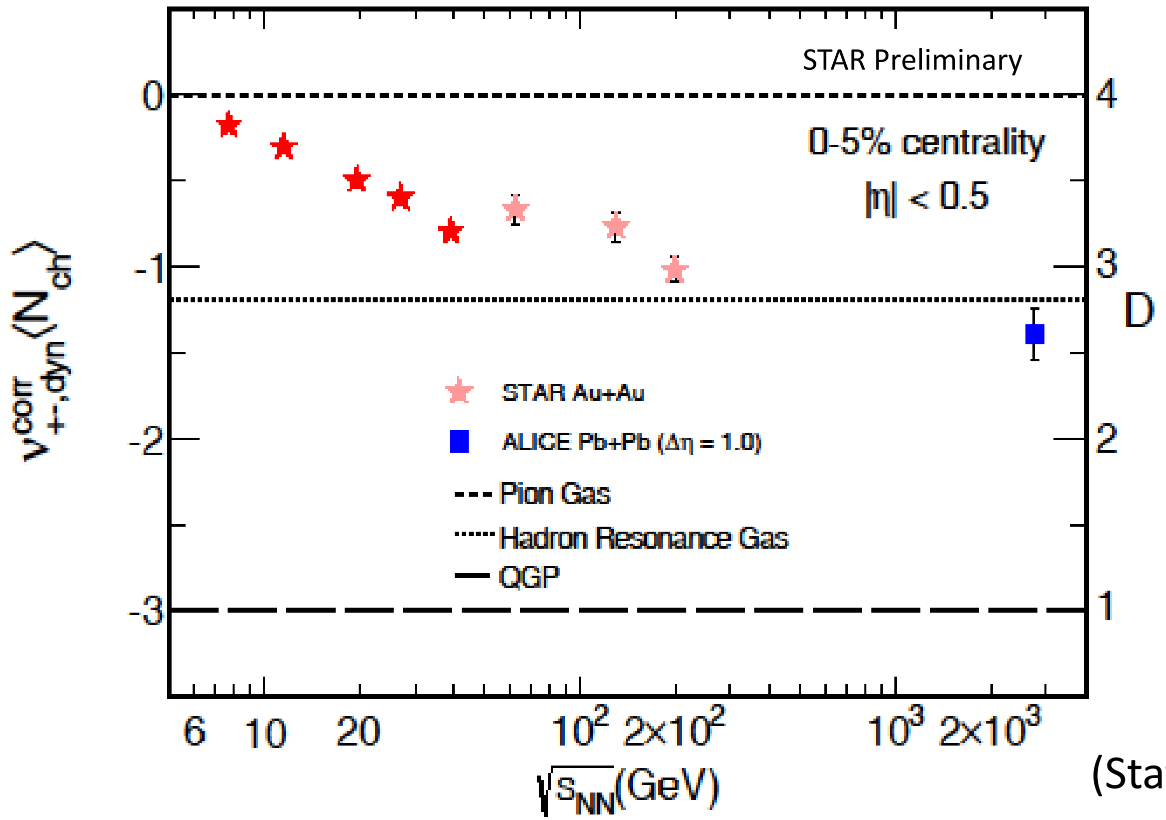
Phys. Rev. Lett. 110, 152301 (2013).

Phys. Rev C 79 024906 (2009).

N_{part} scaling with weak or no centrality dependence

Results

N_{ch} $\nu_{\pm,dyn}$ (left y-axis) and D (right y-axis) as a function of beam energy for 0-5 % collisions



(Statistical error only)

N_{ch} $\nu_{\pm,dyn}$ generally decreases with increase in energy and reaches Hadron Resonance Gas predictions at 200 GeV (RHIC) and 2.76 TeV (LHC) energies.

Observations

- We report recent results of the net-charge fluctuations for Au+Au collisions at 7.7, 11.5, 19.6, 27 and 39 GeV.

- Negative values at all centralities and monotonic reduction in magnitude of dynamical net-charge fluctuations with increasing number of participants.

- Dynamical net charge fluctuations follow approximate N_{part} scaling.

- Top 5% central collisions results show that $N_{ch}\nu_{\pm,dyn}$ generally decreases with increase in energy and reaches Hadron Resonance Gas predictions at 200 GeV (RHIC) and 2.76 TeV (LHC) energies.

Thank You