Charge Fluctuations at Mid-Rapidity in Au+Au Collisions in the PHENIX Experiment at RHIC

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Event-by-event fluctuations in

- Charged particle multiplicity, $n_{ch} = n_+ + n_-$
- Net charge, $Q = n_+ - n_-$
- Transverse momentum, p_T

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Measures of net charge fluctuations

Charged particle multiplicity

$$n_{ch} = n_+ + n_-$$

Net charge

$$Q = n_+ - n_-$$

Define:

$$v(Q) \equiv \sigma^2_{(Q)} / \langle n_{ch} \rangle$$

For stochastic emission, v(Q) = 1

Globally, one expects v(Q) = 0 – charge conservation

If we observe a fraction p of all produced particles $\Rightarrow$
v(Q) = (1 – p) from global charge conservation

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Hadron gas: $v(Q) \approx 0.7\,(1 - p)$ QGP: $v(Q) \approx 0.25\,(1 - p)$

in a rapidity window $\Delta y \sim 1$

Other measures have been proposed:

$v(R) = \langle n_{ch} \rangle \sigma^2(R)$, where $R = n_+ / n_-$

$\Gamma = \langle (Q - \varepsilon\, n_{ch})^2 \rangle / \langle n_{ch} \rangle$

$\nu = 4 \langle (n_+ (1 - \varepsilon) - n_- (1 + \varepsilon))^2 \rangle / \langle n_{ch} \rangle^2$

ε is the charge asymmetry, $\varepsilon = \langle Q \rangle / \langle n_{ch} \rangle$

v(R) not suitable for small accpetances

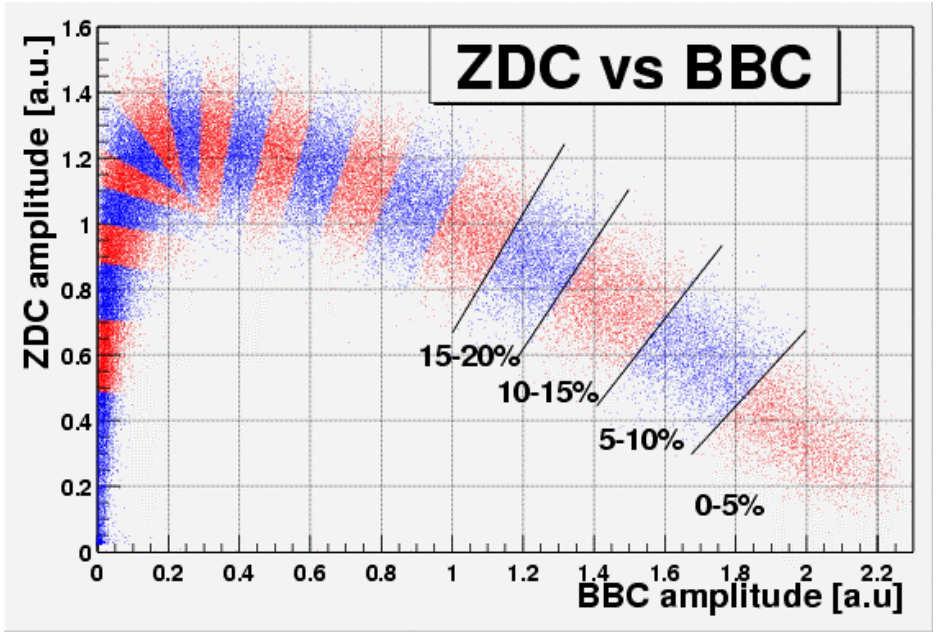
Γ, ν similar to v(Q), for ε=0

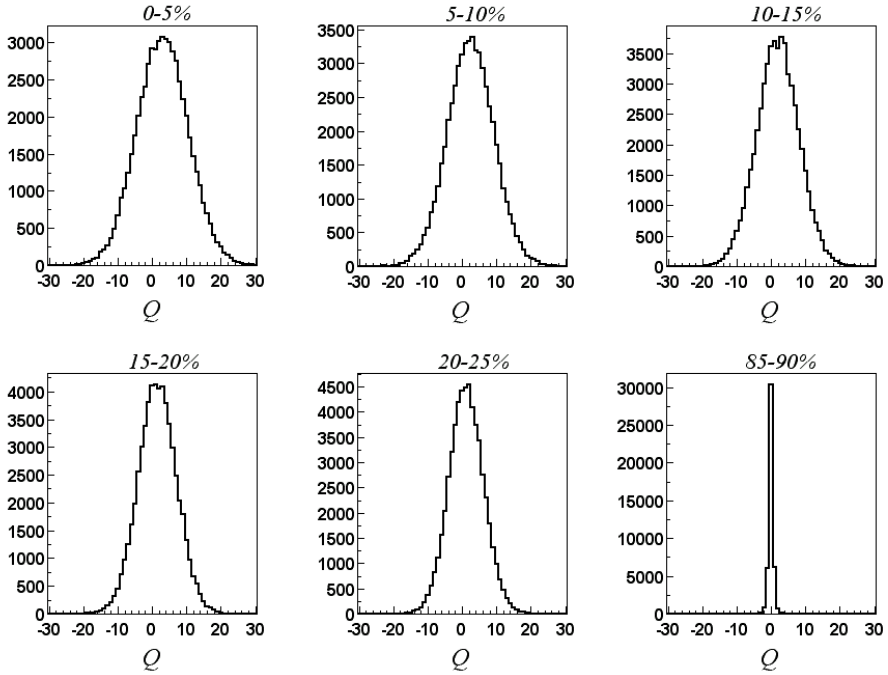
$v(Q) = \Gamma = \langle n_{ch} \rangle \nu / 4$

Centrality Selection

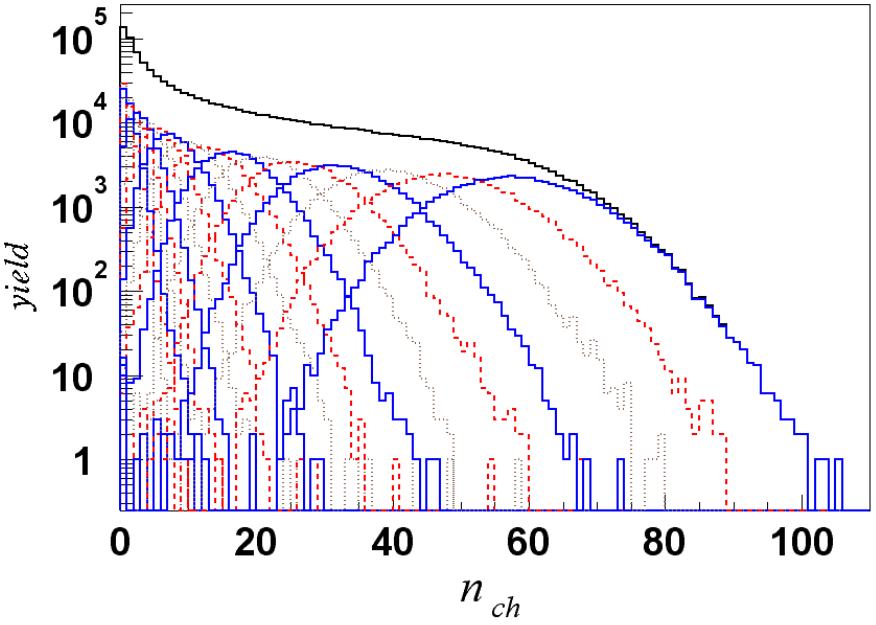
Select events based on ZDC and BBC information.

n_{ch} and Q distributions for centrality classes (5% bins).

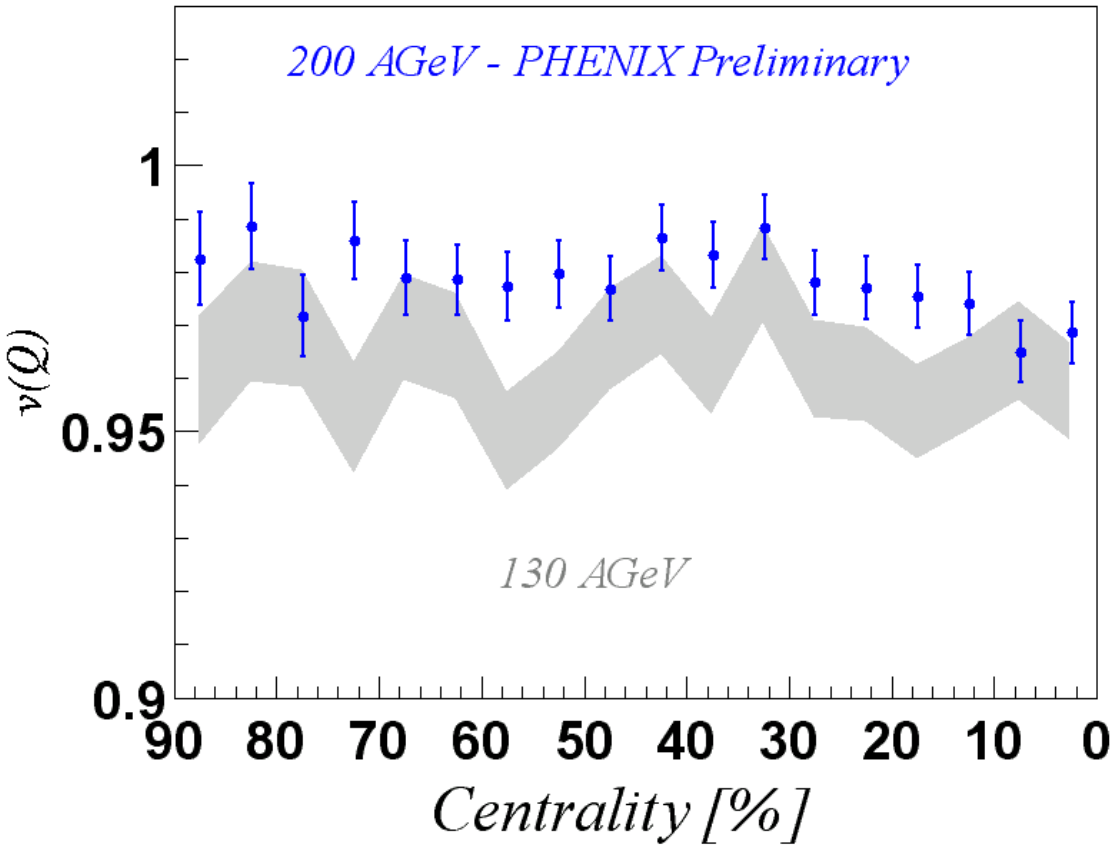




$\Delta\Phi=\pi/2 \quad \Delta\eta=0.7$



v(Q) as a function of collision centrality

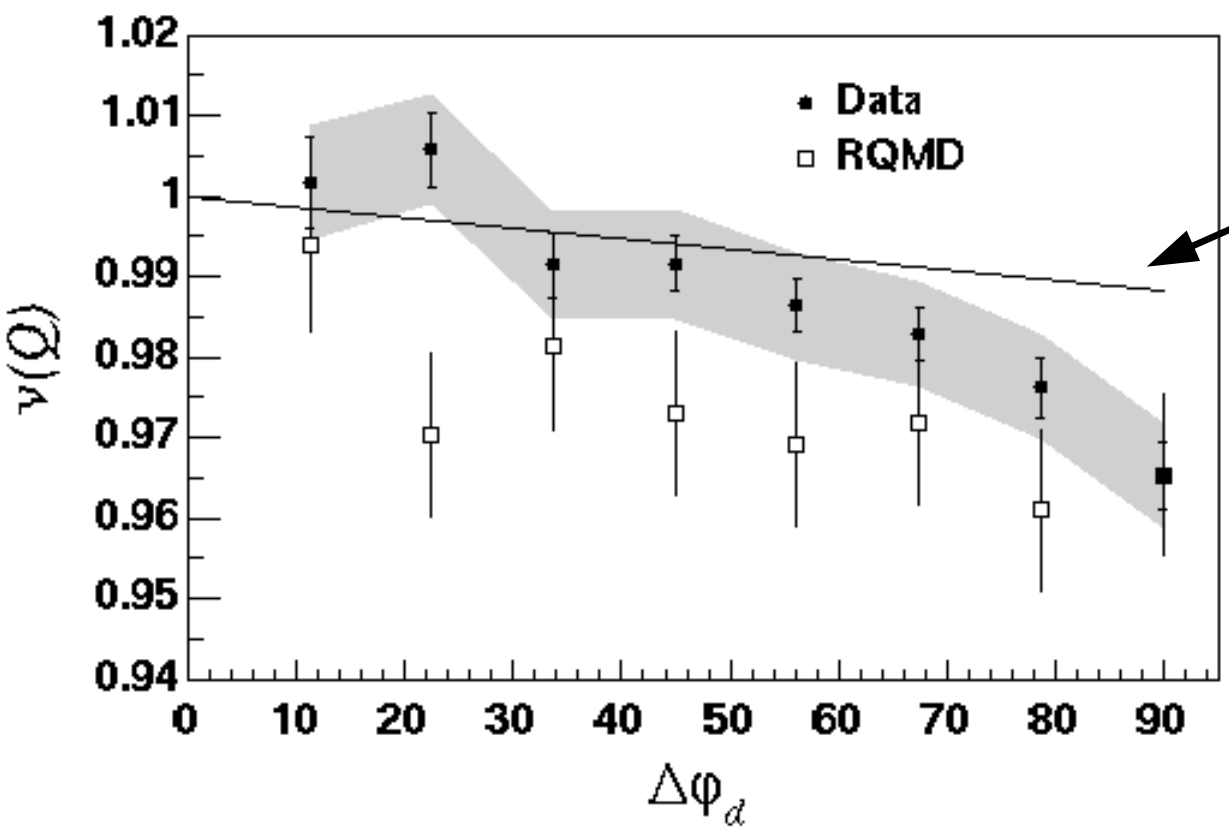


A small deviation from stochastic emission observed at 130 GeV
K. Adcox et al. (PHENIX) nucl-ex/0203014 to appear in PRL

No dramatic change at 200 GeV - the upward shift of ~0.01 units can be explained by harder track quality cuts leading to a reduced acceptance.

Decrease $\Delta\varphi$ v(Q) vs. $\Delta\varphi_d$

130 A GeV - 10% most central events



(1 – p)

Band shows total statistical error; error bars show errors bin-by-bin.

Nearly linear decrease in v(Q) with $\Delta\varphi_d$, well reproduced by RQMD--presumably due to correlations from resonance decay. Stronger decrease than expected from charge conservation.

Result for v(Q)

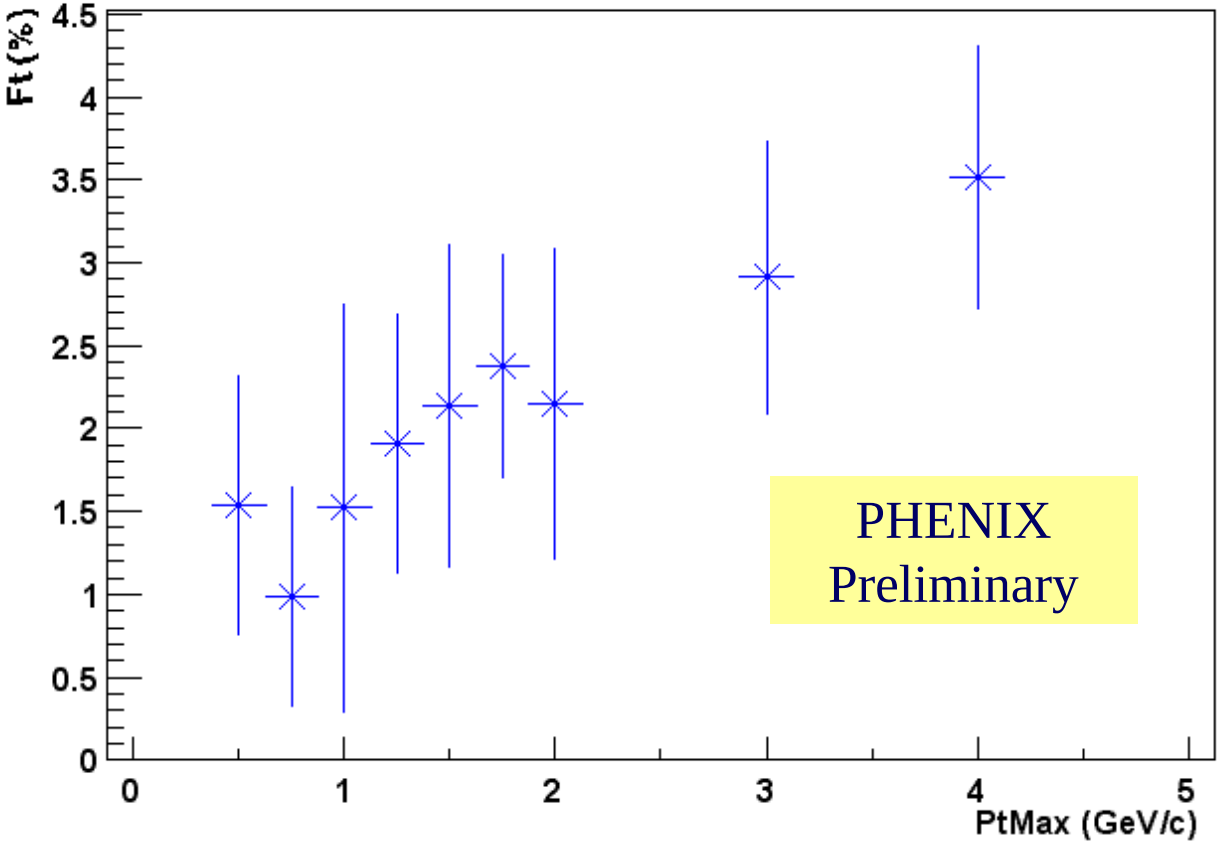
For $|\eta|<0.35$, $p_T > 200$ MeV/c, $\Delta\varphi=\pi/2$

$v(Q) = 0.965 \pm 0.007(\text{stat.}) - 0.019\ (\text{syst.})$ $\sqrt{s_{nn}} = 130$ GeV

$v(Q) = 0.969 \pm 0.006(\text{stat.}) \pm 0.020\ (\text{syst.})$ $\sqrt{s_{nn}} = 200$ GeV (PRELIMINARY)

Systematical error estimated from geant simulations (reconstruction efficiency and contribution from background tracks), and by comparing the results for the 2 arms (200 GeV).

The fluctuation magnitude tends to increase as the p_T range used to calculate $\langle p_T \rangle$ is extended to higher values.



F_T vs. P_T range ($0.2<p_T<p_{T,\,max}$)

Centrality and p_T dependence similar to elliptic flow.

Simulations using PHENIX preliminary p_T-dependent v_2 measurements wrt to the reaction plane can, however, not reproduce the signal.