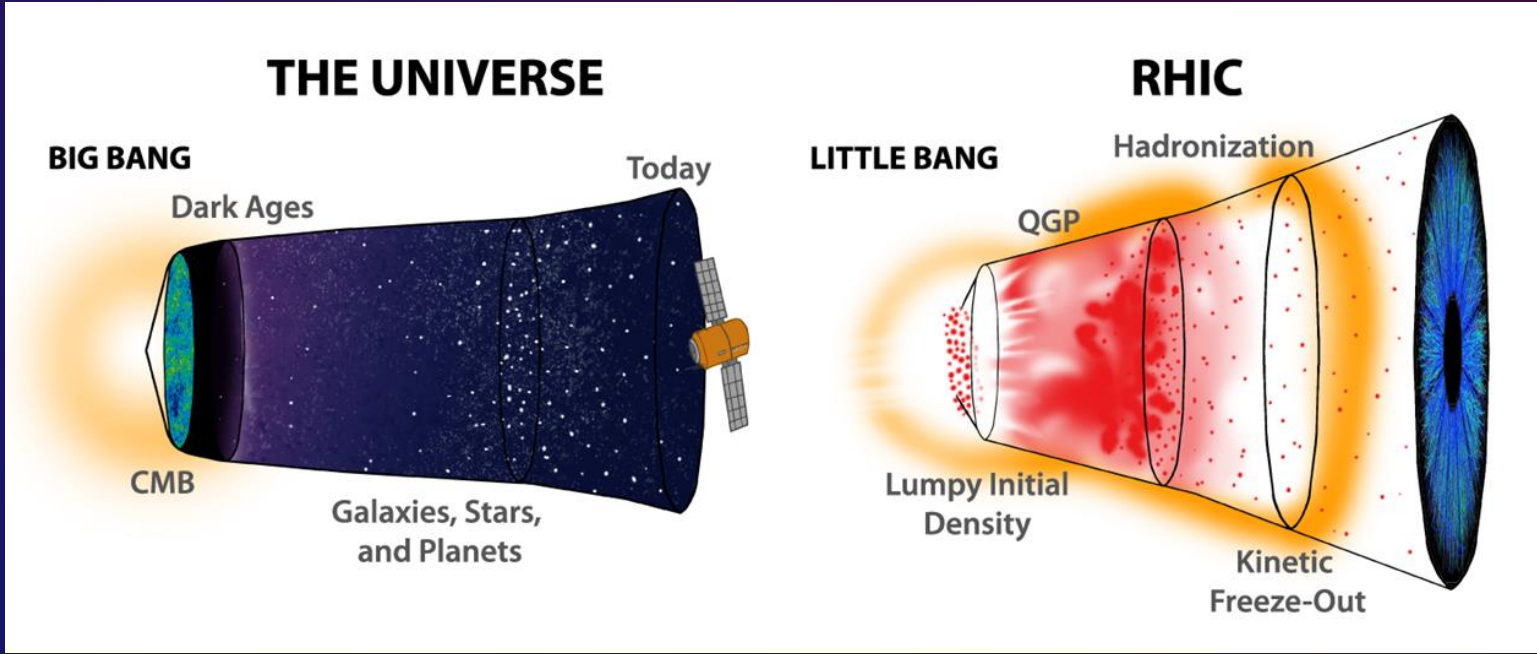
Study of the second order azimuthal anisotropy for π^0 mesons in Cu+Au collisions at $\sqrt{S_{NN}} = 200\ GeV$

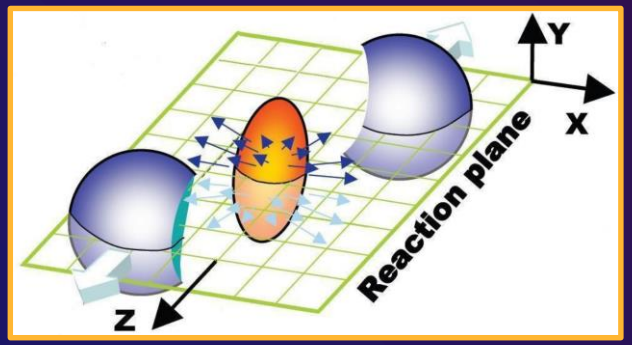
E.V. Bannikov, A.Ya. Berdnikov, Ya.A. Berdnikov, D.O. Kotov, Iu.M. Mitrankov, M.M. Mitrankova, D.M. Larionova

Peter the Great St.Petersburg Polytechnic University, Saint-Petersburg, Russia

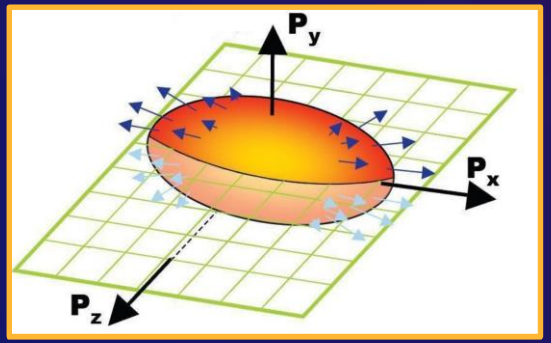


- Azimuthal anisotropy is one of the main observables allowing to investigate the properties of QGP.

*Agnes Mocsy(Pratt Inst. and Frankfurt U., FIAS), Paul Sorensen(Brookhaven) (Aug, 2010)



Pressure gradient

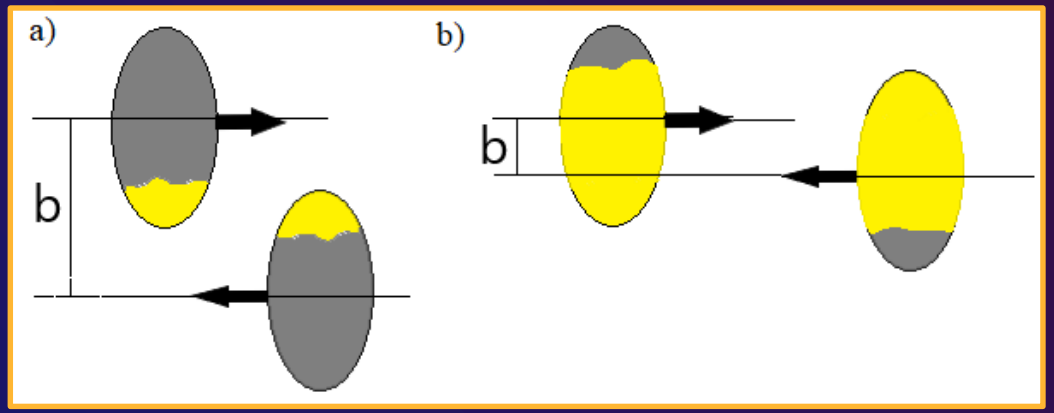


- $f(\varphi, p_T) \propto 1 + 2\sum_{n=1}^{\infty} v_n(p_T)\cos(n\varphi)$

  The azimuthal angle distribution of particle transverse momentum relative to the reaction plane

- $v_2 = \langle \cos(2(\varphi - \Psi_{RP})) \rangle$

- $v_2 = \left\langle \frac{p_x^2 - p_y^2}{p_x^2 + p_y^2} \right\rangle$



CENTRALITY.

a) Central collisions;
b) Peripheral collisions.
b – impact parameter.

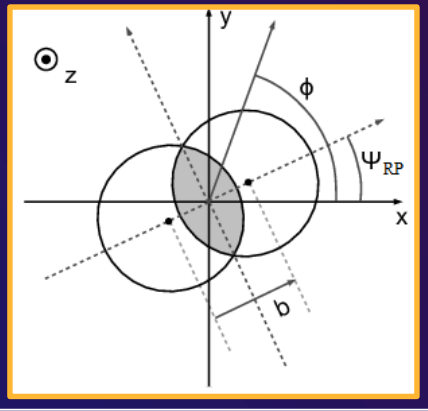
participants

spectators

COLLISION SYSTEM.

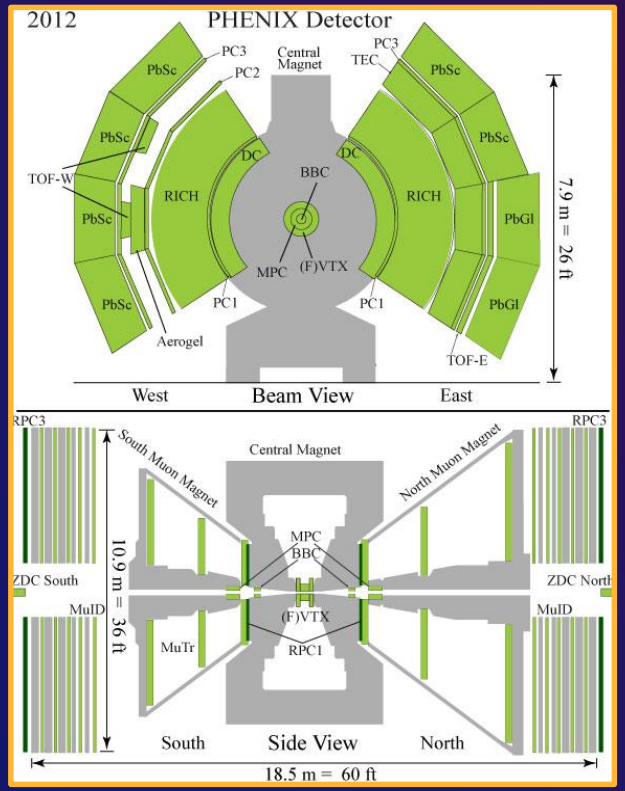
Symmetric collisions (Au+Au)

Asymmetric collisions (Cu+Au)

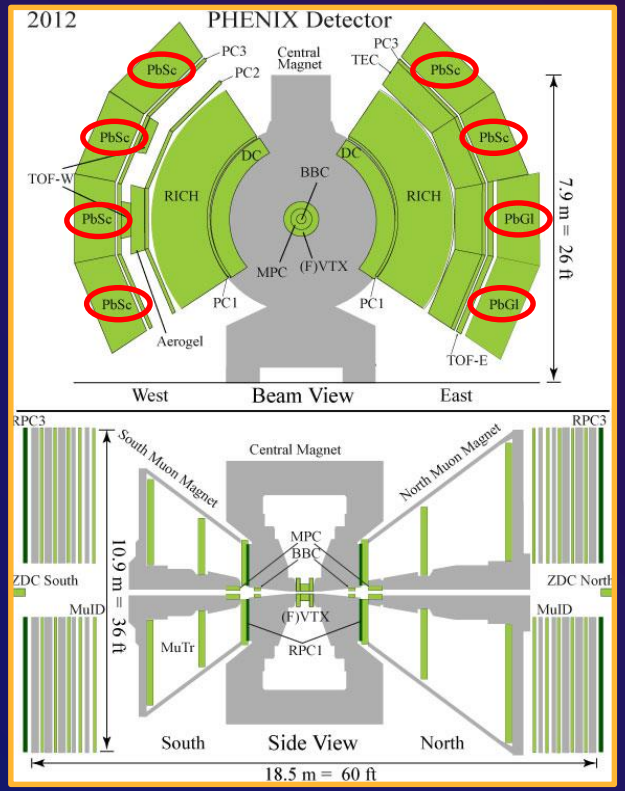


REACTION PLANE (RP).

φ – particle angle,
z – beam direction,
b – impact parameter,
Ψ_{RP} - reaction plane angle.



- Two central arms (East and West);
- Located at Brookhaven National Laboratory (BNL) at the RHIC;

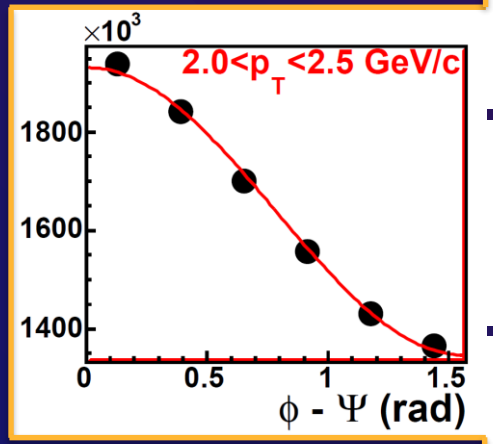


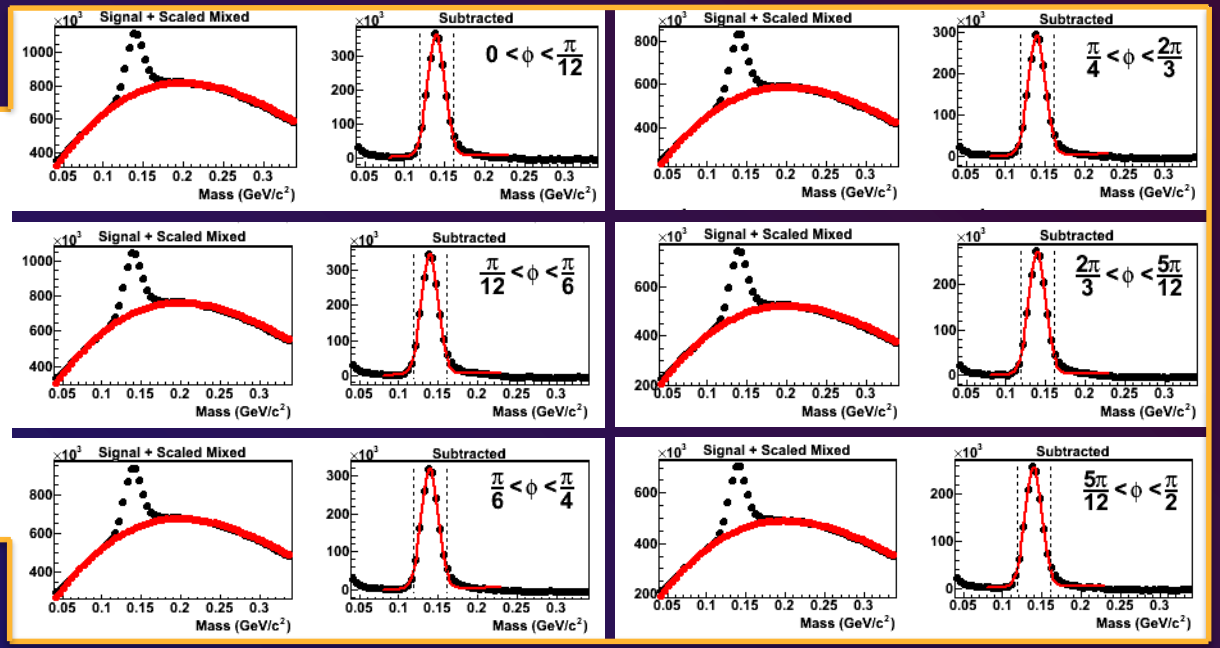
- Two central arms (East and West);
- Located at Brookhaven National Laboratory (BNL) at the RHIC;
- The kinematic properties of the photons are determined using the electromagnetic calorimeter (EMCal);
- EMCal consists of 6 lead-scintillator (PbSc) and 2 lead-glass (PbGl) sectors.

v_2 MEASUREMENTS METHODS

Subtraction method

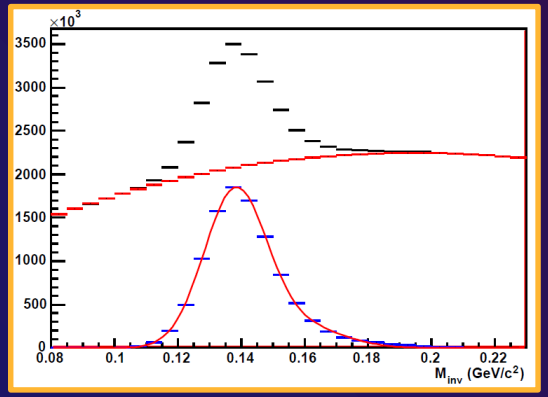
Invariant mass fit method



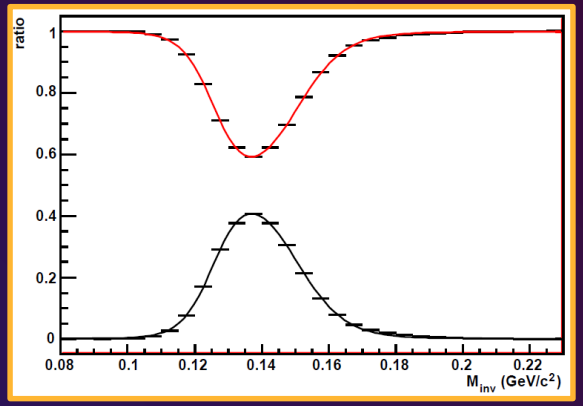


* A. Adare *et al.* 2010 *Phys.Rev.Lett.*105:142301

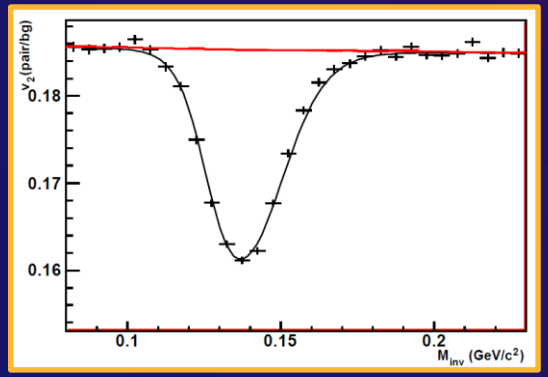
a)



b)



c)



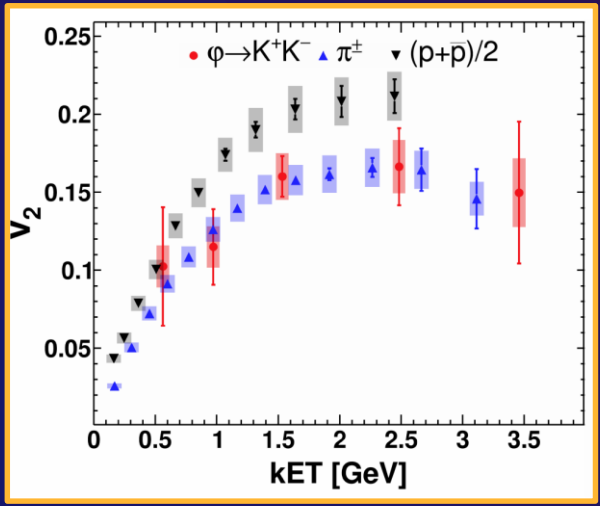
a – invariant mass distribution for total pairs (black line), background (BG – red line) and signal (blue points fitted with Gaussian);

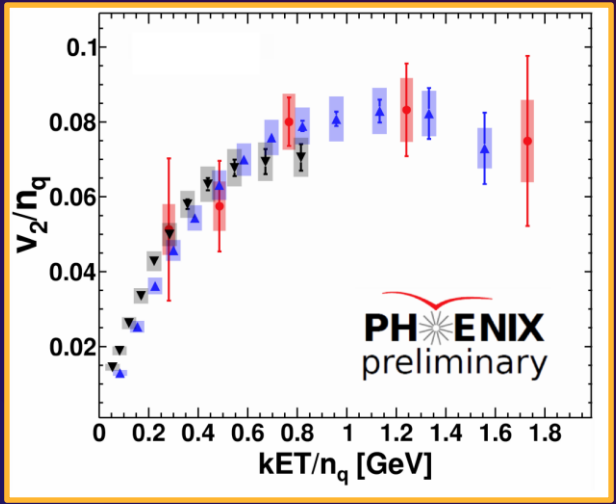
b – ratios N_{BG}/N_{pair} (red line), N_{signal}/N_{pair} (black line);

c – the fit to v_2^{pair} (black line) and to v_2^{BG} (red line).

* A. Adare *et al.* 2013 *Phys.Rev.C* 88, 064910

1. v_2 for φ, $\pi^{\pm}$ and for $p/\bar{p}$ as a function of kinetic energy (kE_T) and those scaled with number of quarks (n_q) in Cu+Au collisions at 200 GeV

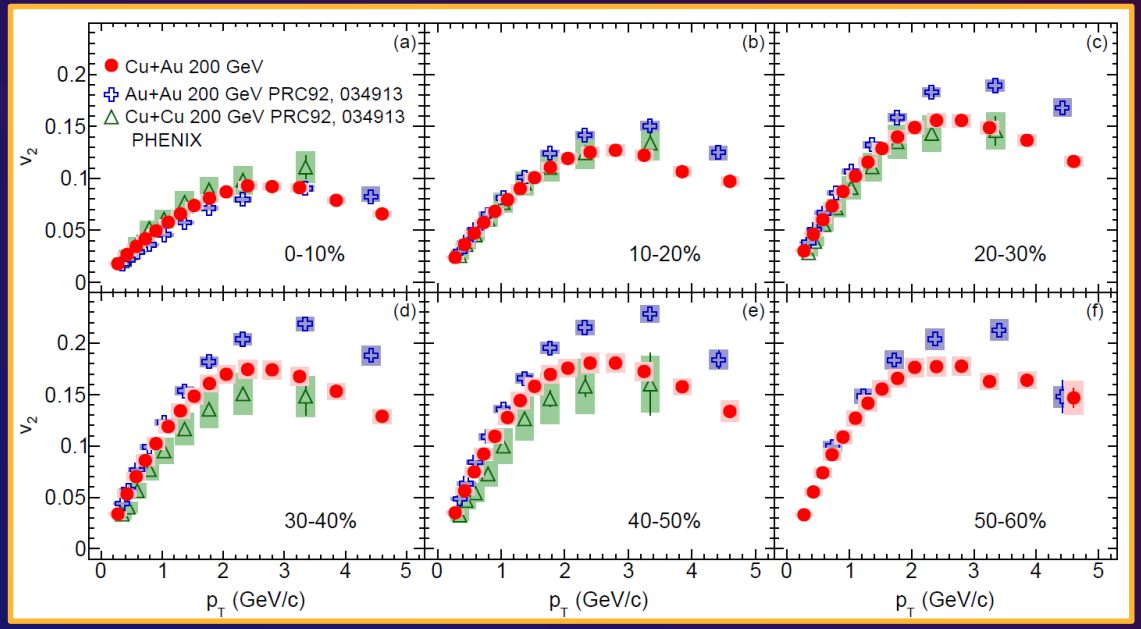




- n_q scaling is observed

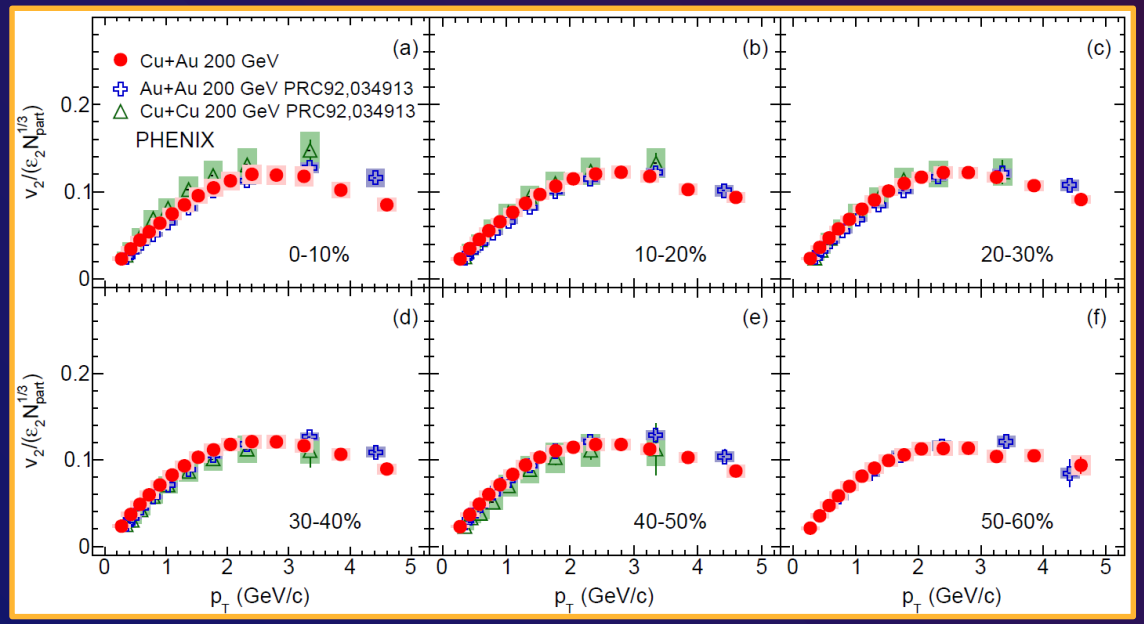
* Iu M Mitrankov *et al* 2021 *J. Phys.: Conf. Ser.* **2103** 012133

2. Charged hadrons as a function of transverse momentum (p_T) in Cu+Cu, Cu+Au and Au+Au collisions at 200 GeV



* A. Adare *et al.* 2016 *Phys. Rev. C* 94, 054910

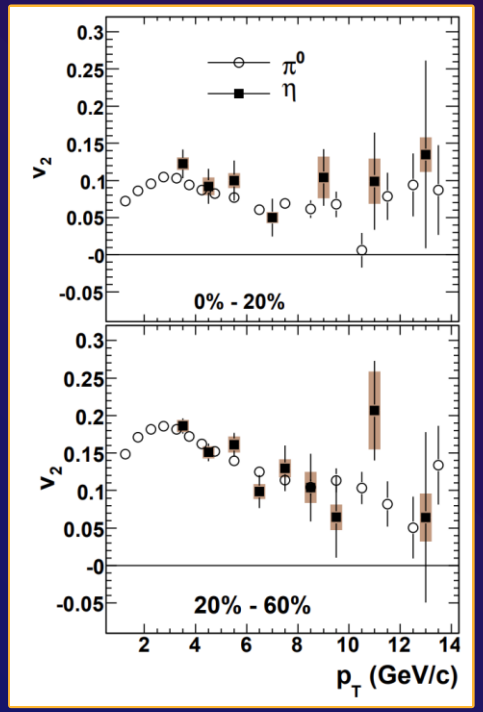
3. Previously measured dependency scaled with eccentricity and the third root of the number of participants nucleons ($\varepsilon_2 N_{part}^{1/3}$)



- $\varepsilon_2 N_{part}^{1/3}$ **scaling is observed in these systems**

* A. Adare *et al.* 2016 *Phys. Rev. C* 94, 054910

4. v_2 for π^0 and η as a function of transverse momentum (p_T) in Au+Au collisions at 200 GeV



- v_2 for π^0values decreases gradually for $3 \leq p_T \leq 7 - 10\ GeV/c$;
- There are nonzero v_2 for π^0 values at high $p_T > 5\ GeV/c$.

* A. Adare *et al.* 2010 *Phys.Rev.Lett.*105:142301

Summary:

- The scaling of v_2 for $\pi^{\pm}, \varphi$ and $p/\bar{p}$ with n_q was observed in Cu+Au collisions at 200 GeV;

  It may indicate that the elliptic flow occurs in QGP.

- The v_2 for charged hadrons in Cu+Cu, Cu+Au, Au+Au collisions scaling with $\varepsilon_2 N_{part}^{1/3}$ do not depend on initial size of the system;

  This fact means that the impact collision geometry on the elliptic flow can be considered by scaling it with $\varepsilon_2 N_{part}^{1/3}$.

- The v_2 for π^0 is well-measurable up to high $p_T > 5\ GeV/c$.

  It might be explained in terms of QGP model predictions, assuming partonic energy loss.

Summary:

- The scaling of v_2 for $\pi^{\pm}, \varphi$ and $p/\bar{p}$ with n_q was observed in Cu+Au collisions at 200 GeV;
  It may indicate that the elliptic flow occurs in QGP.
- The v_2 for charged hadrons in Cu+Cu, Cu+Au, Au+Au collisions scaling with $\varepsilon_2 N_{part}^{1/3}$ do not depend on initial size of the system;
  This fact means that the impact collision geometry on the elliptic flow can be considered by scaling it with $\varepsilon_2 N_{part}^{1/3}$.
- The v_2 for π^0 is well-measurable up to high $p_T > 5\ GeV/c$.
  It might be explained in terms of QGP model predictions, assuming partonic energy loss.

The analysis devoted to the measurement of v_2 for π^0 in Cu+Au collisions is in progress. Stay tuned!