Azimuthal anisotropy with respect to the reaction plane in $\sqrt{s_{NN}}$ = 200 GeV d+Au collisions at RHIC – PHENIX

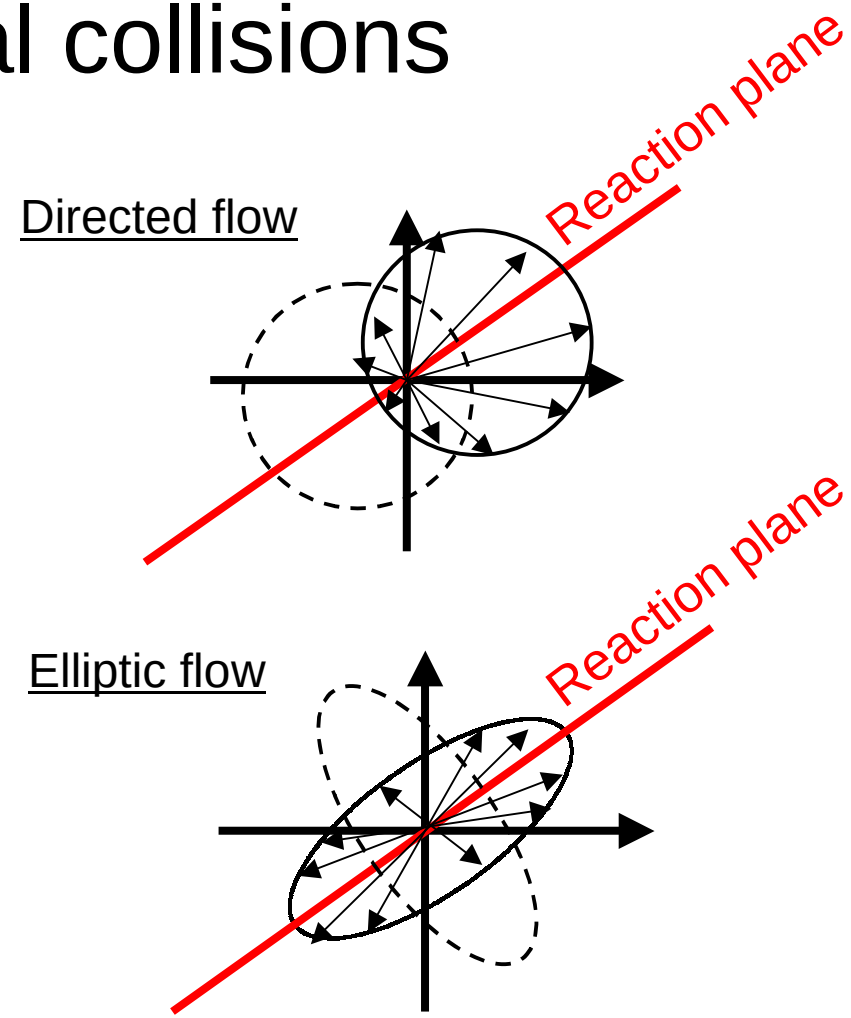
Hiroshi Masui

for the PHENIX collaboration

University of Tsukuba

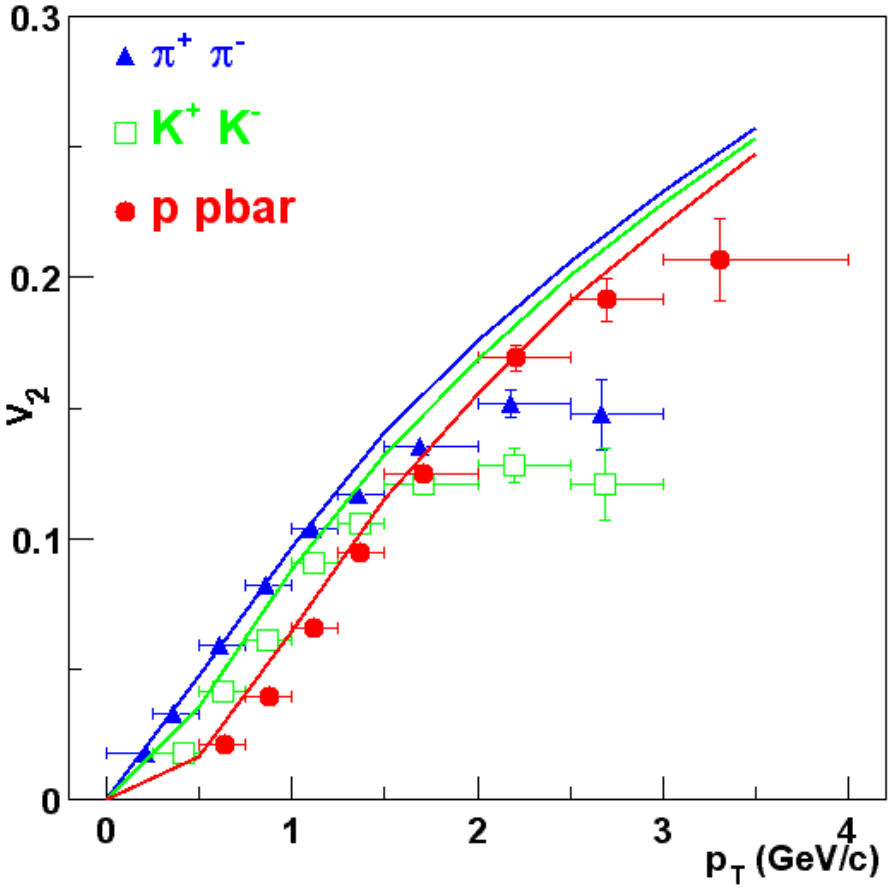
Azimuthal Anisotropy in non-central collisions

- Initial anisotropy in coordinate space → momentum space in the final state.
- Low p_T
  - Hydrodynamical behavior
  - Pressure gradient
- High p_T
  - Parton energy loss in the medium.



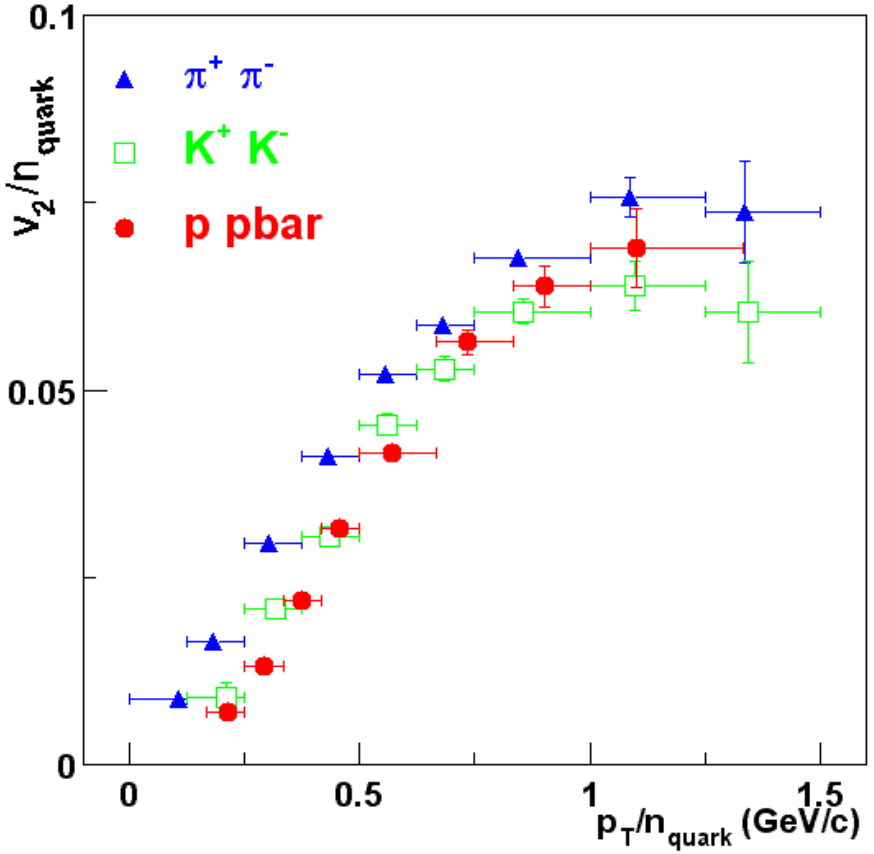
Recent result in $\sqrt{s_{NN}}$ = 200 GeV Au+Au collisions

- p_T < 2.0 GeV/c
  - $v_2(\pi) > v_2(K) > v_2(p)$
  - Consistent with calculation of hydrodynamical model .
- p_T > 2.0 GeV/c
  - $v_2(p) > v_2(\pi)$, $v_2(K)$
  - Clear departure from hydrodynamical behavior is observed.

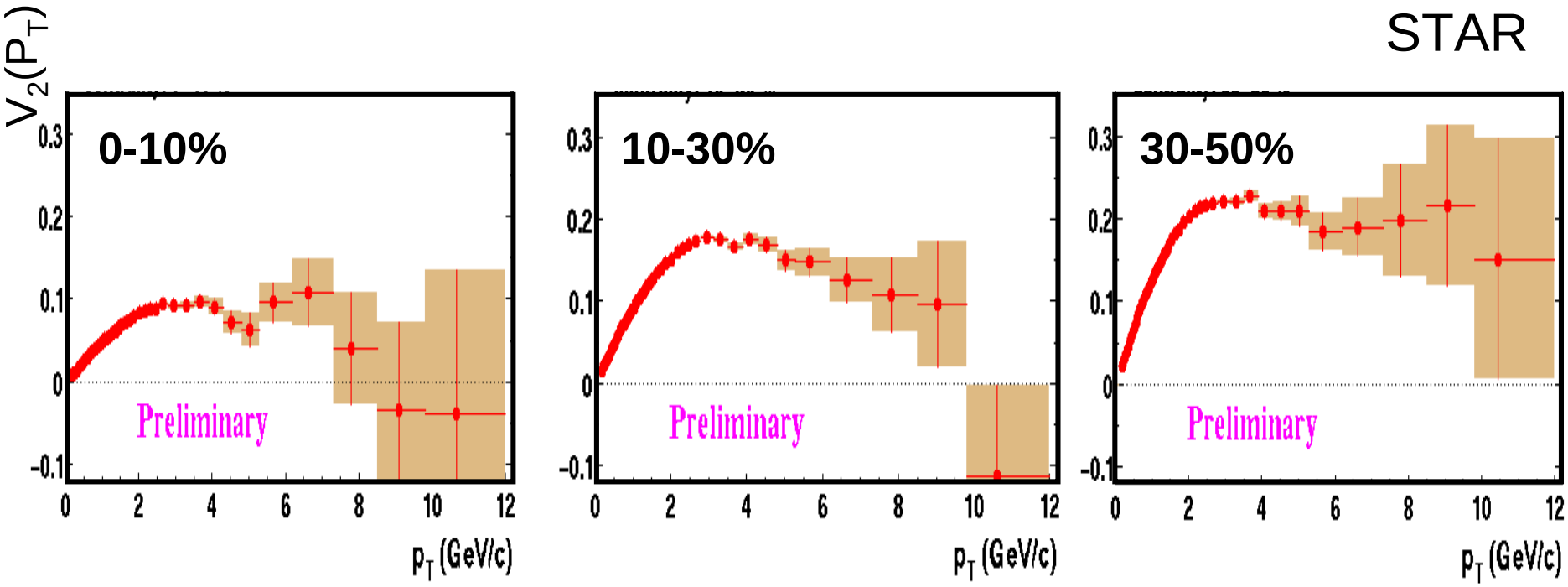


Scaling with the n_{quarks}

- The quark coalescence model predict a simple scaling behavior. [D. Molnar and S. Voloshin, nucl-th/0302014]
  - Scaling both v_2 and p_T with the number of quarks.
- An indication that v_2 of measured hadrons is already established in a quark-matter phase.



High p_T v_2



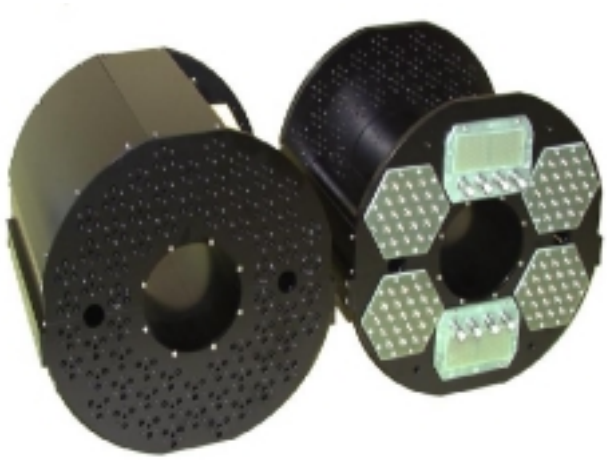
- High p_T v_2 is finite.
  - Jet should be correlated with the reaction plane.

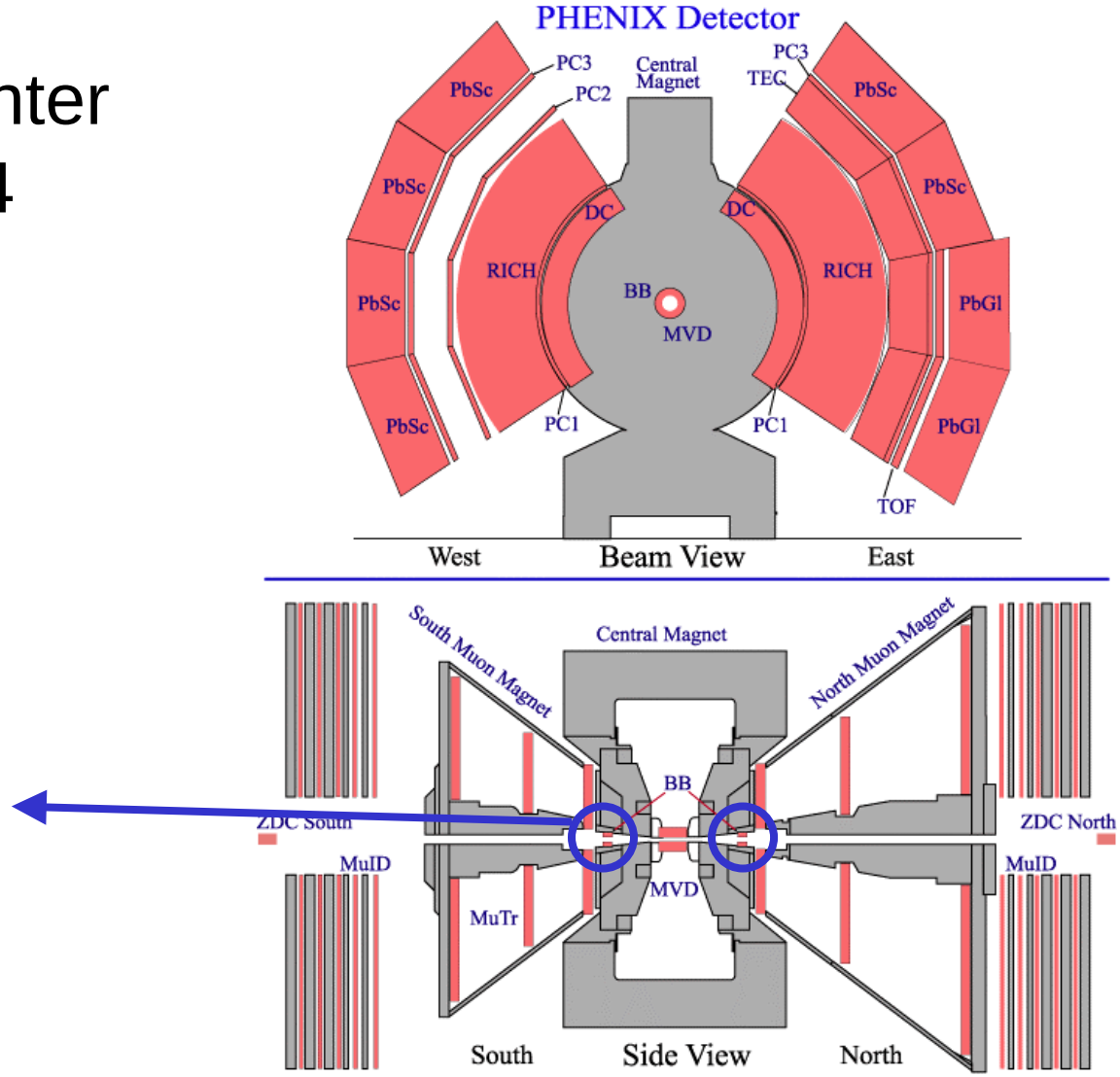
Motivation

- v_2 in Au+Au collisions has been measured.
  - Different behavior for different particle species.
  - Finite v_2 @ high p_T.
- It is important to measure azimuthal anisotropy in d+Au collisions (also p+p) for systematic checks.

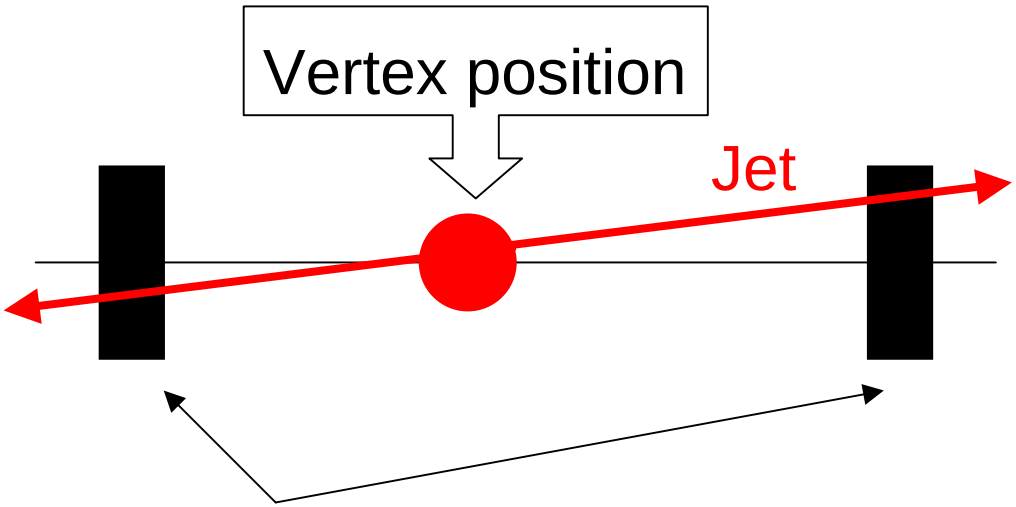
PHENIX experiment

- Beam Beam Counter (BBC) $|\eta| \sim 3 - 4$
  - 64 PMT in each counter.
  - Determine the reaction plane





Method
“Reaction plane” in d+Au collisions



- Event anisotropy (ex. Jet) is observed.
- Assume reaction plane from following equation.

$$\tan(\Psi_{measured}) = \frac{\sum N_{ch} \sin(\phi_{PMT})}{\sum N_{ch} \cos(\phi_{PMT})}$$

$\Psi_{measured}$: measured azimuthal angle of reaction plane

N_{ch} : multiplicity

ϕ_{PMT} : azimuthal angle of each PMT

Method
azimuthal anisotropy

$$\frac{dN}{d\phi} = N(1+\sum_{n=1}^{\infty} 2v_n \cos[n(\phi - \Psi)]) \qquad (\text{n} = 1,2,\ldots)$$

ϕ : azimuthal angle of each PMT (BBC)

Ψ : azimuthal angle of reaction plane

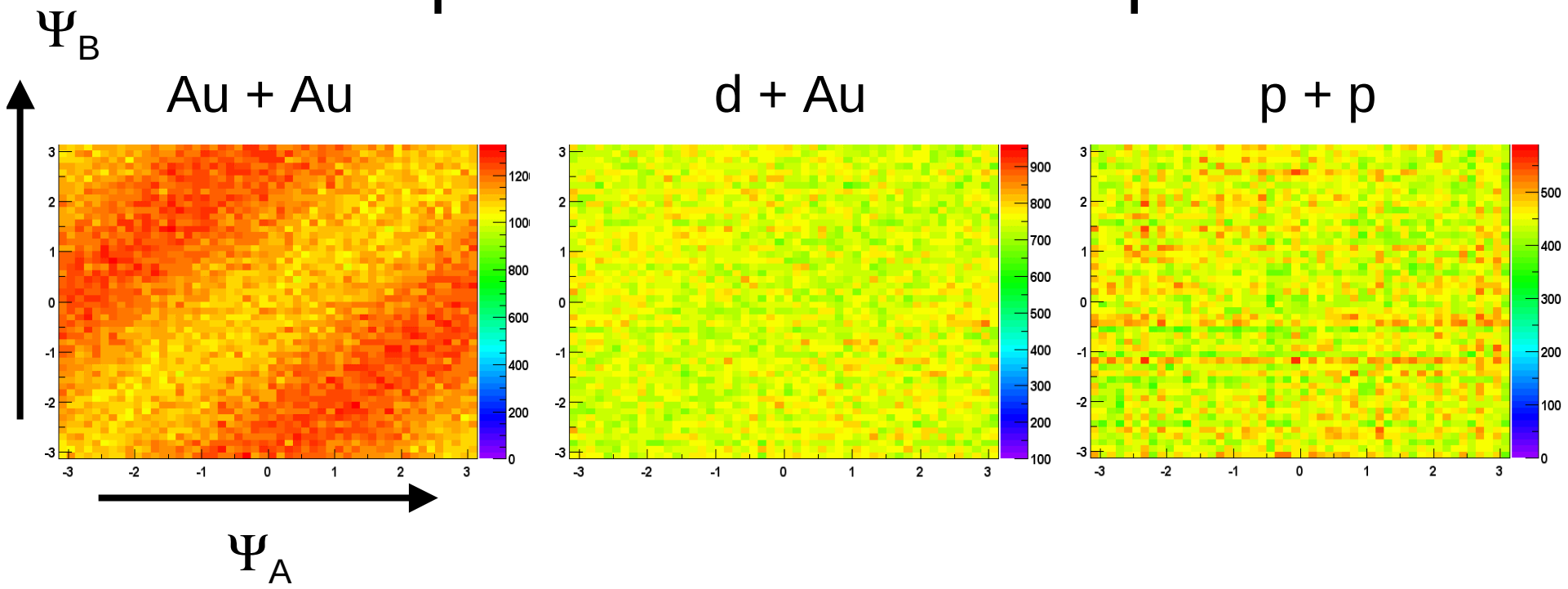
v_n : anisotropy parameter

$$v_n = \frac{v_n^{measured}}{resolution}$$

$$resolution = < \cos[n(\Psi_{measured} - \Psi_{true})] > \sim \sqrt{< \cos[n(\Psi_A - \Psi_B)] >}$$

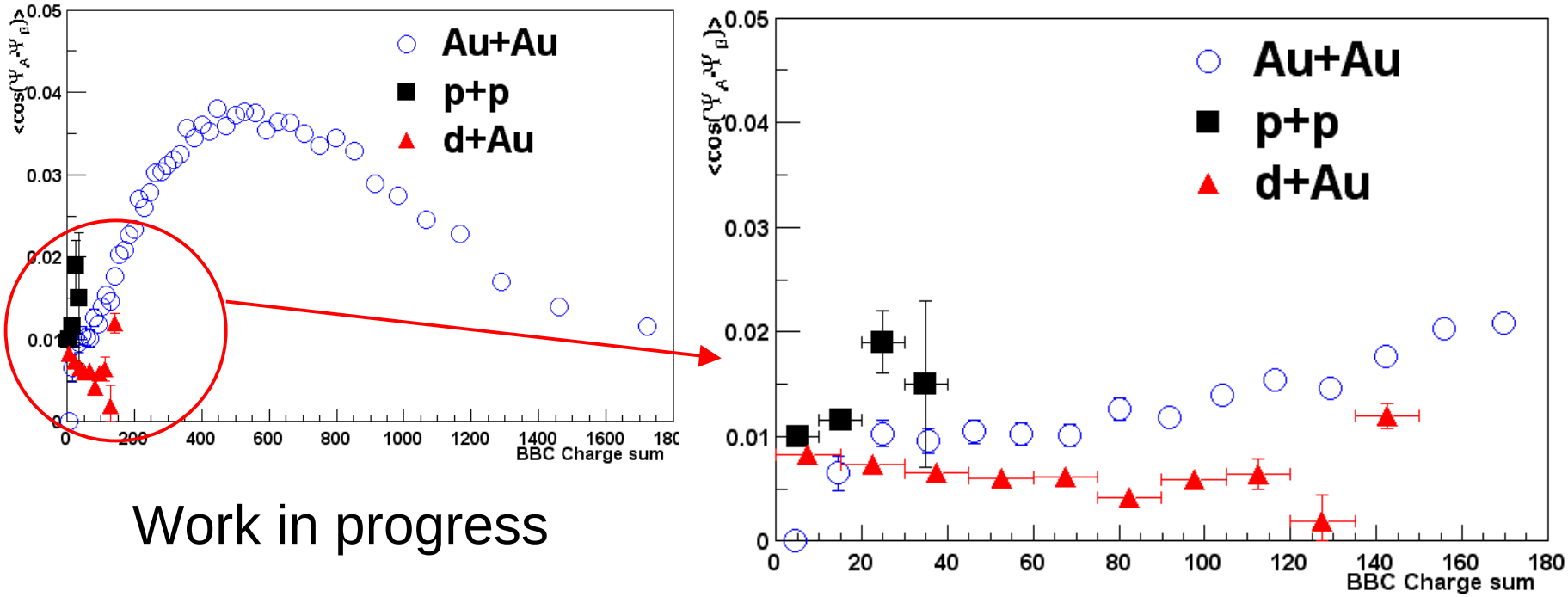
$\Psi_{A,B}$: reaction plane determined for each sub sample.

Comparison of Reaction plane



- Clear correlation can be seen in Au+Au collisions.
- d+Au and p+p resolution is less than Au+Au

$<\cos(\Psi_A - \Psi_B)>$



Work in progress

- The d+Au result is consistent with the Au+Au and p+p.

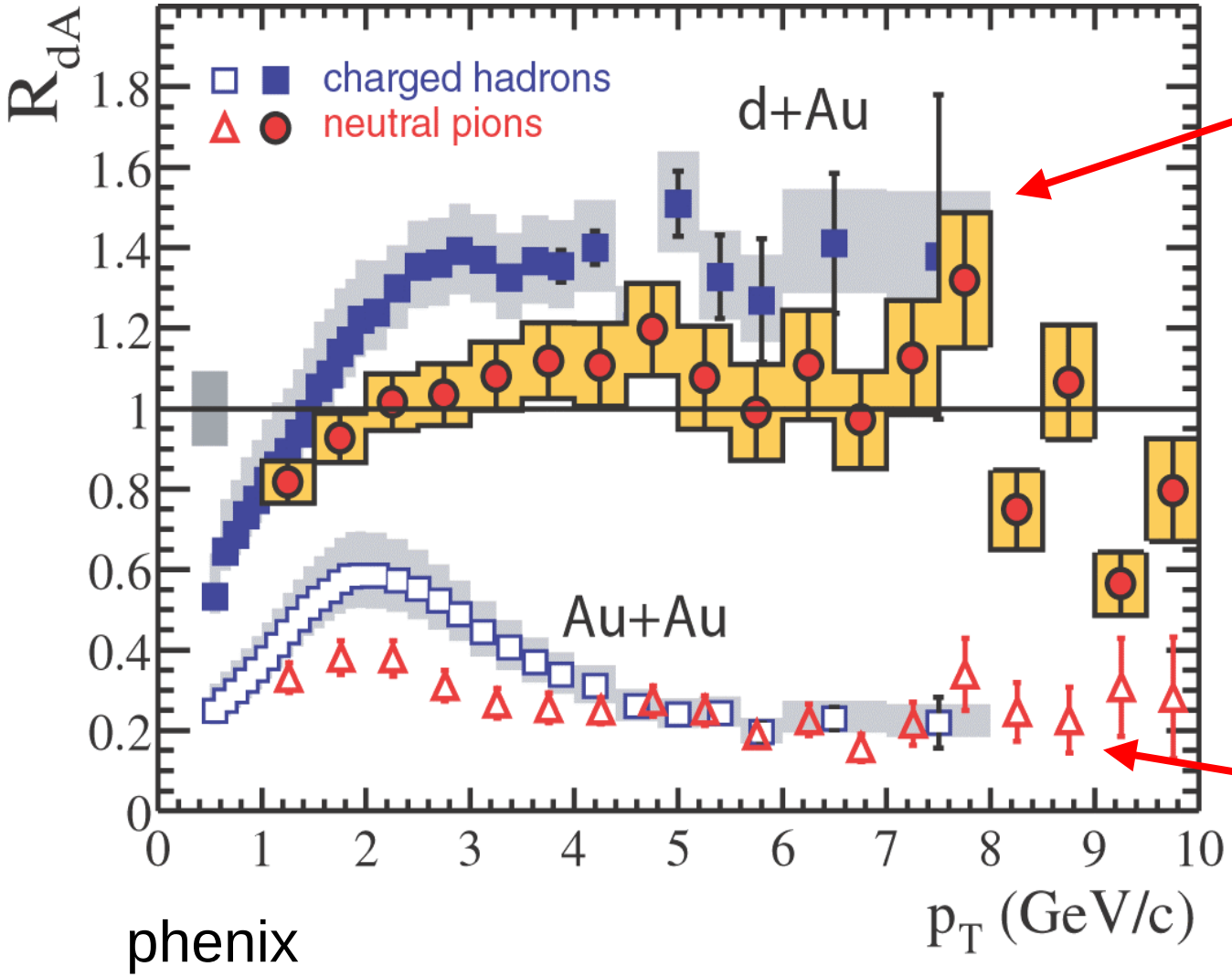
Summary and Outlook

- Analysis of azimuthal anisotropy in d+Au collisions has been started.
- The result of d+Au is consistent with the Au+Au and p+p.

- Forward calorimeter might be useful to determine the reaction plane and improve resolution.

Back up

Charged hadrons vs neutral pion



d+Au

Initial State Effects Only

Au+Au

Initial + Final State Effects