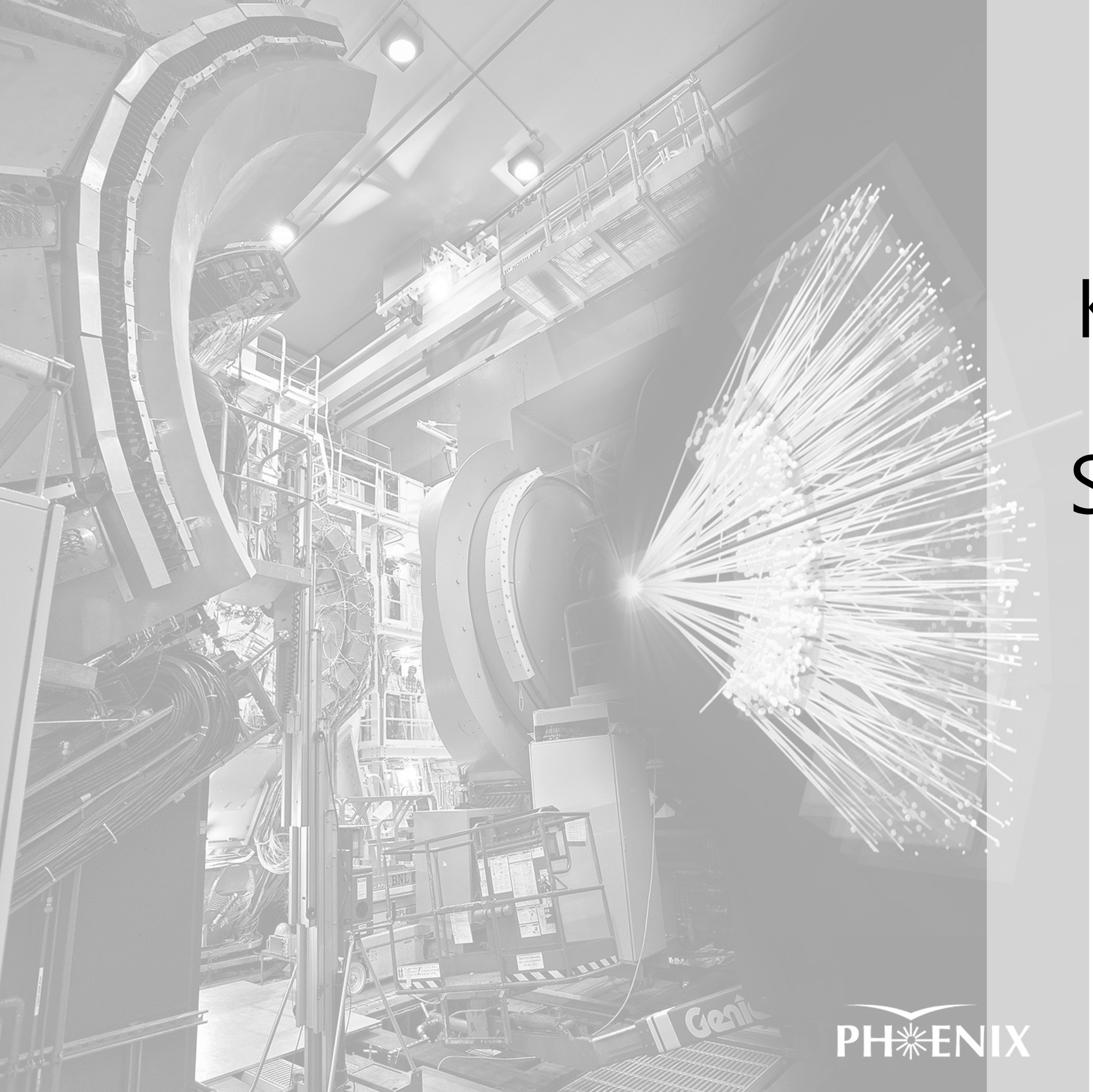
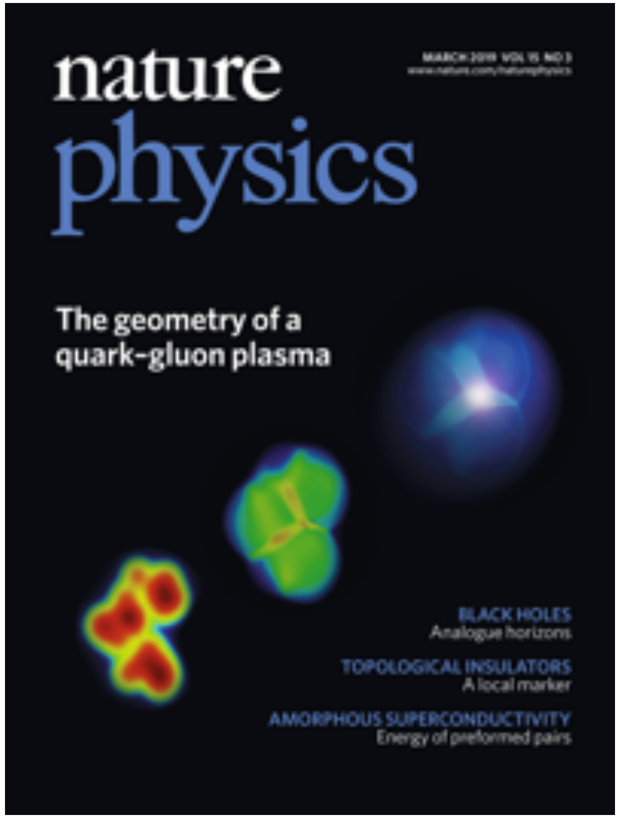


Kinematic Dependence of the Elliptic Flow in Small Collision Systems Observed by PHENIX Experiment

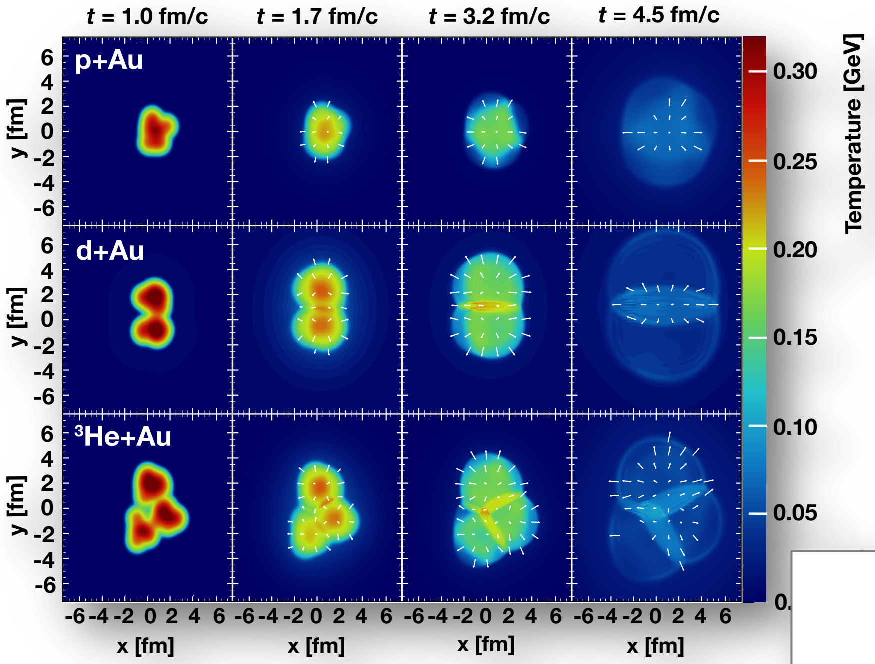
Seyoung Han

CENuM, Korea University, Seoul

Initial geometry effect observed by PHENIX, 2019

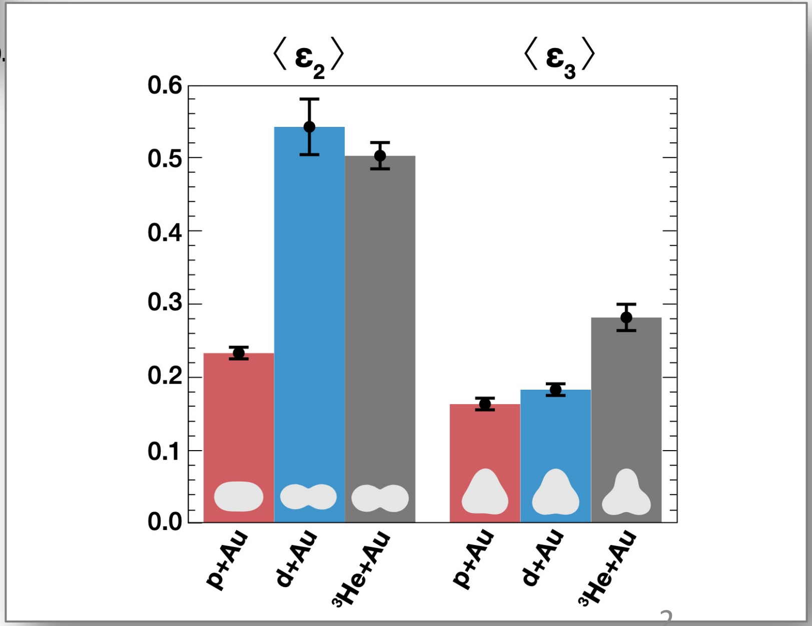


Aidala, C., Akiba, Y., Alfred, M. *et al.* Creation of quark–gluon plasma droplets with three distinct geometries. *Nat. Phys.* **15,** 214–220 (2019).

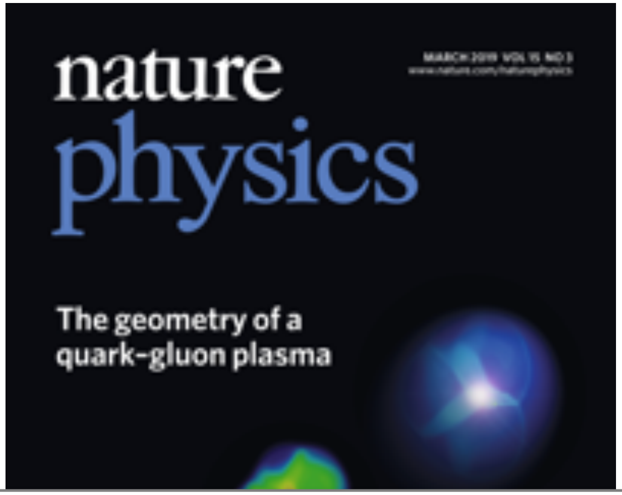


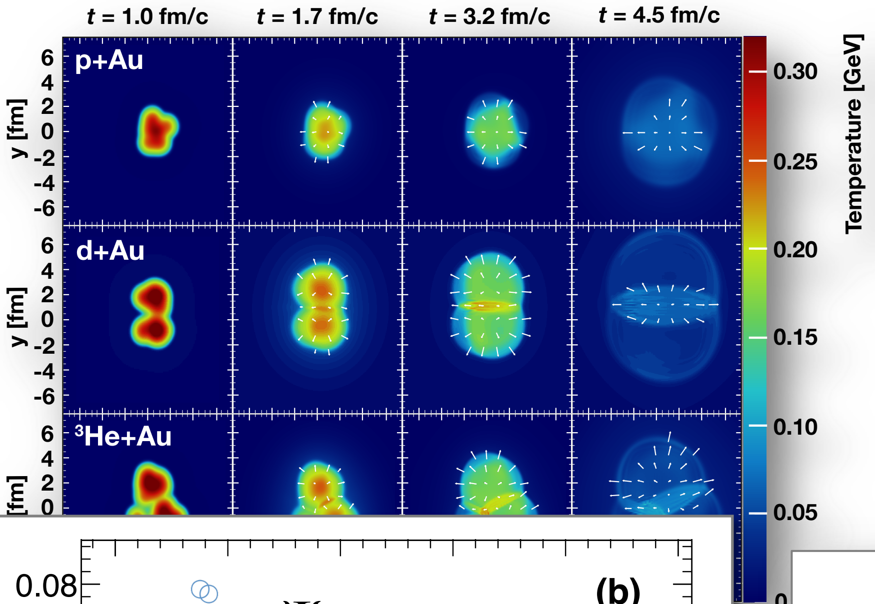
Initial stages of the collision turns in to the developed velocity

Hydrodynamic model expects the hierarchy in eccentricity of each collision systems



Initial geometry effect observed by PHENIX, 2019

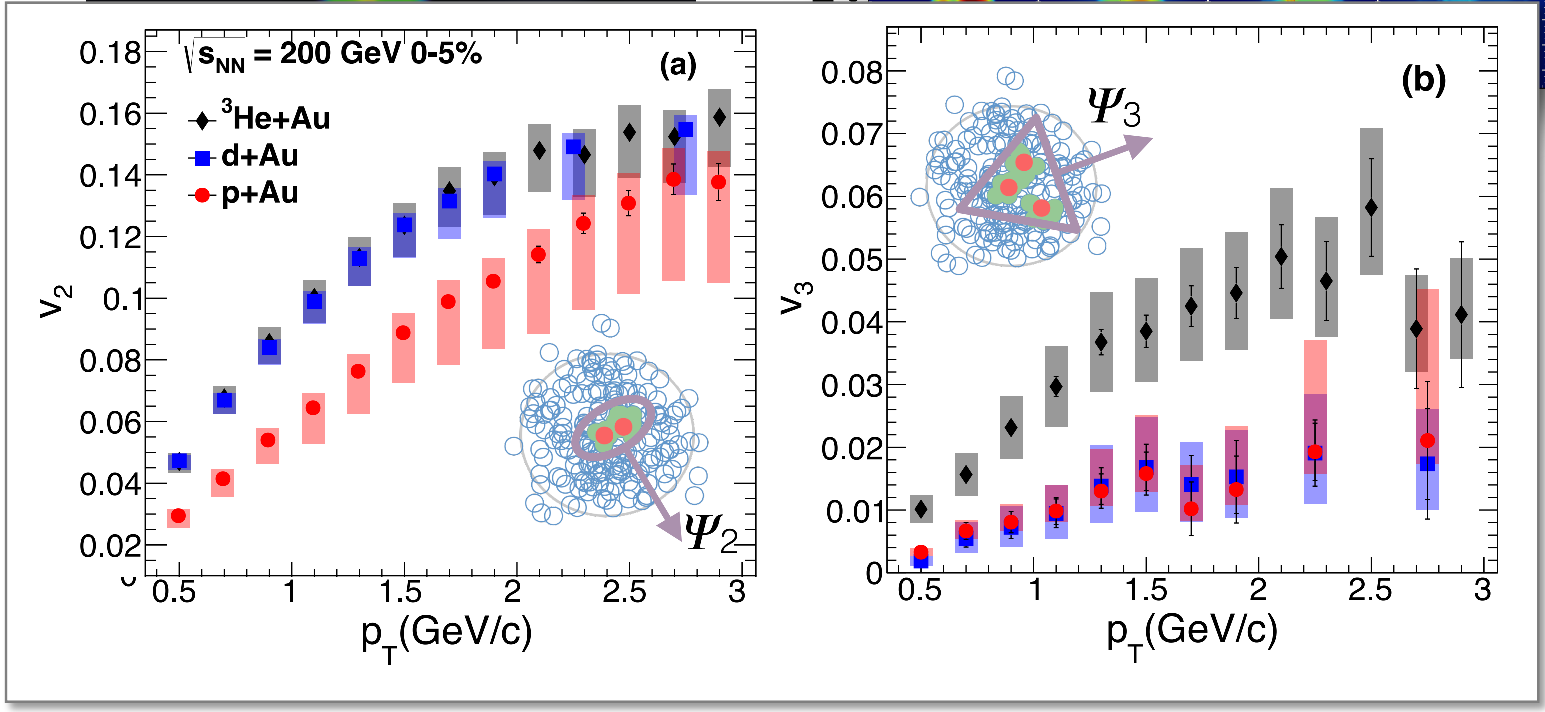


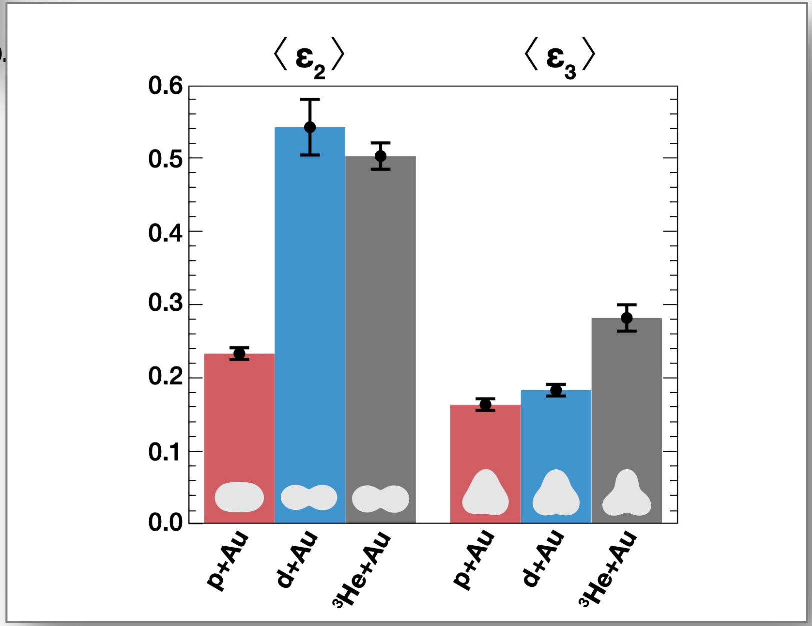


Consistent hierarchy shown in eccentricity and measured flow

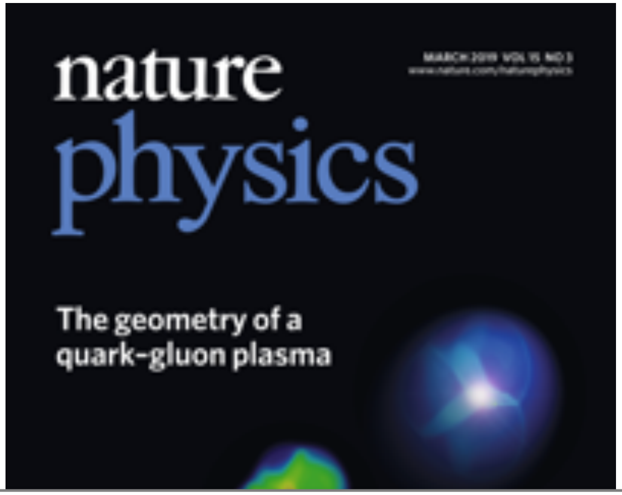
Initial geometry effect propagates to the final stages

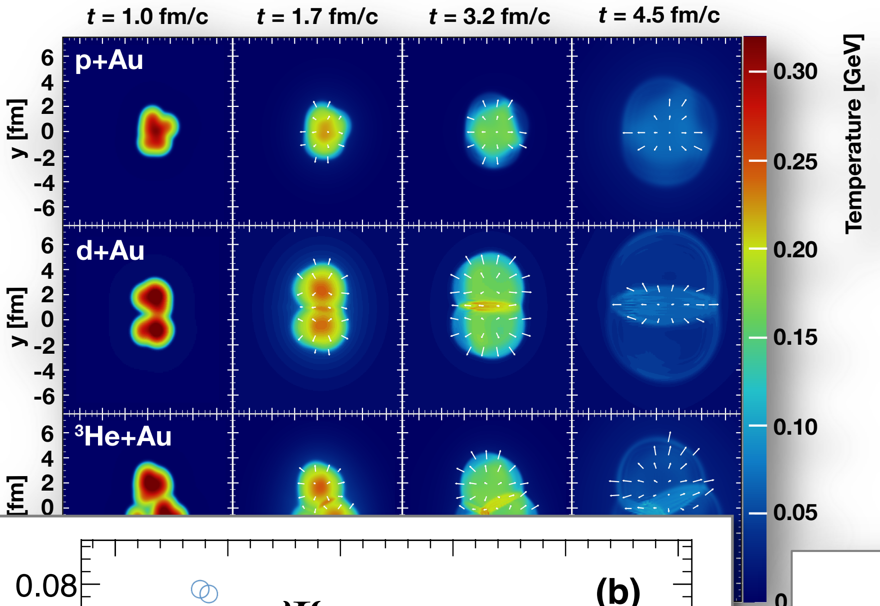
Hydrodynamic calculation has a good estimation in measured data

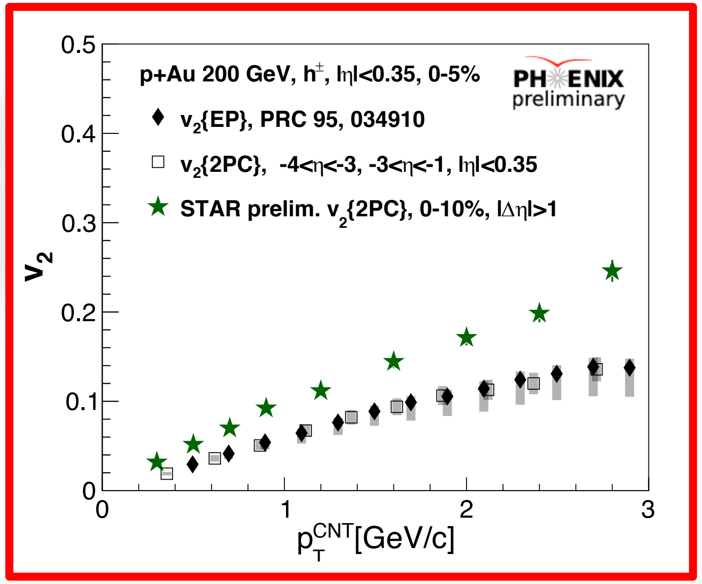


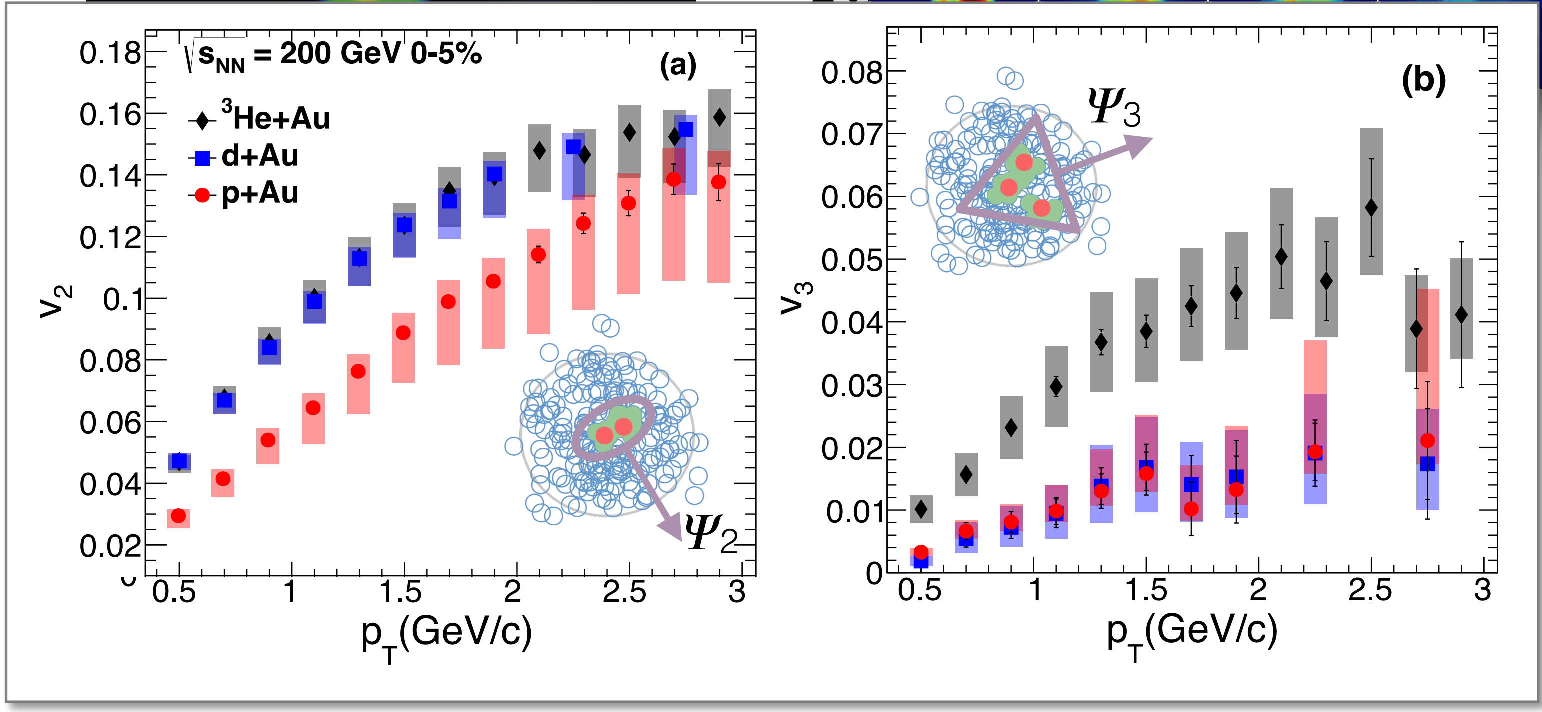


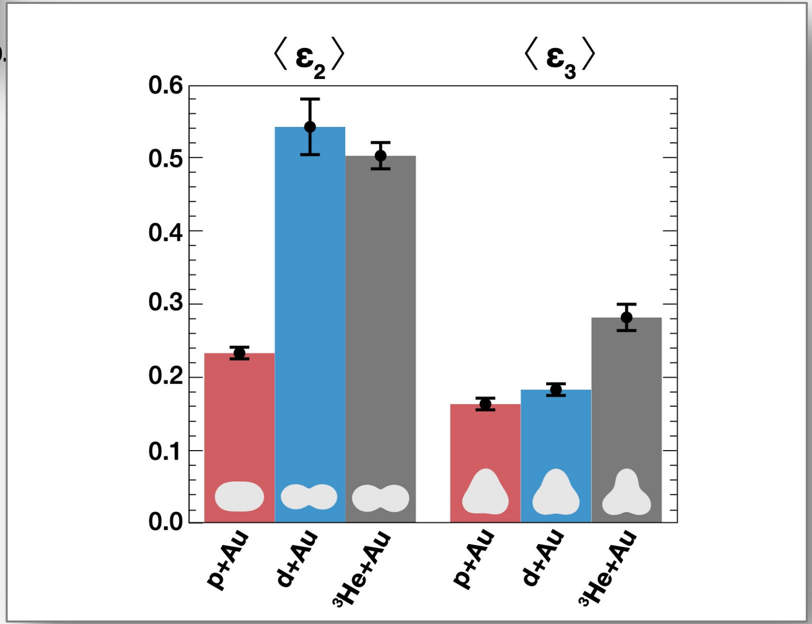
Initial geometry effect observed by PHENIX, 2019



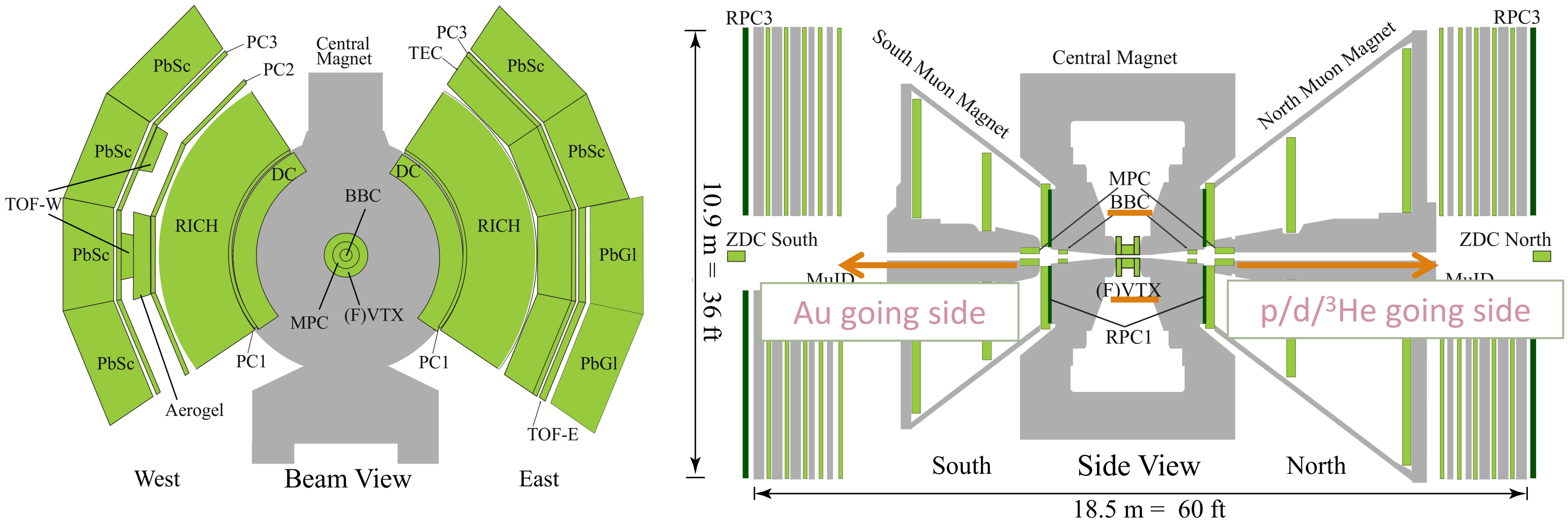








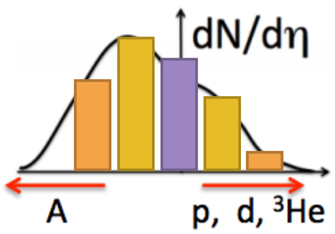
PHENIX detectors

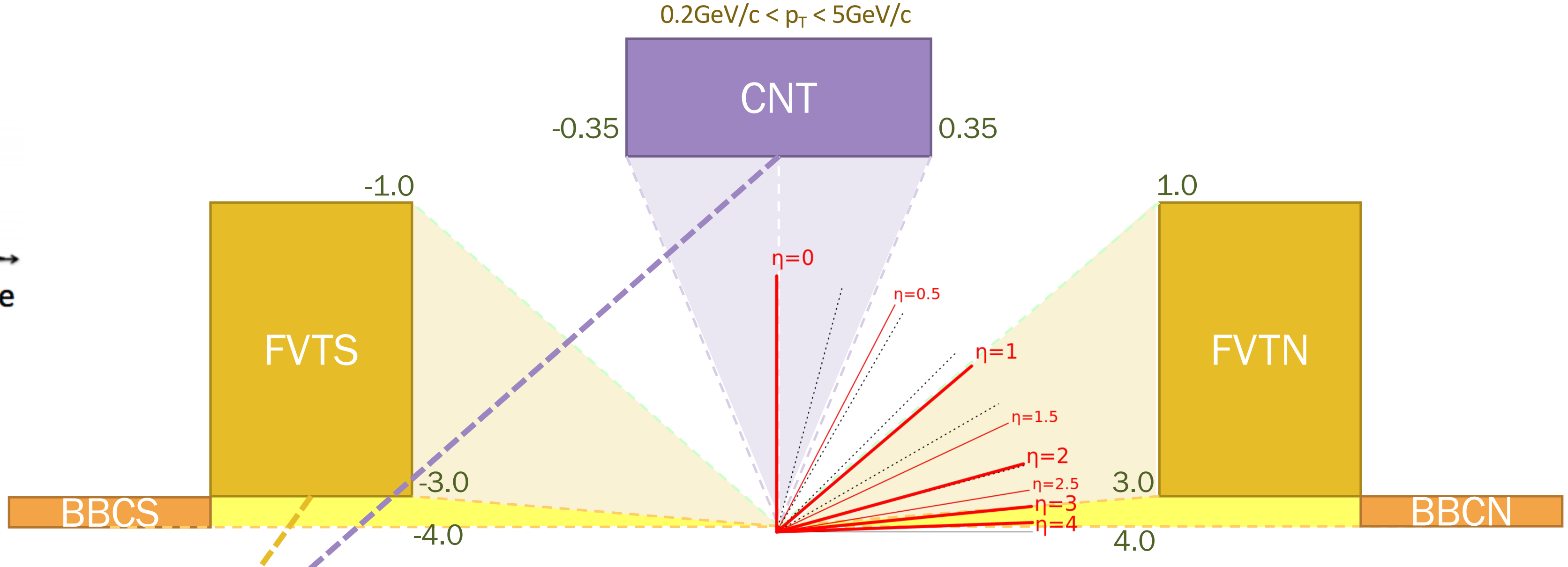


Central arm :
charged particle measurement,
particle identification

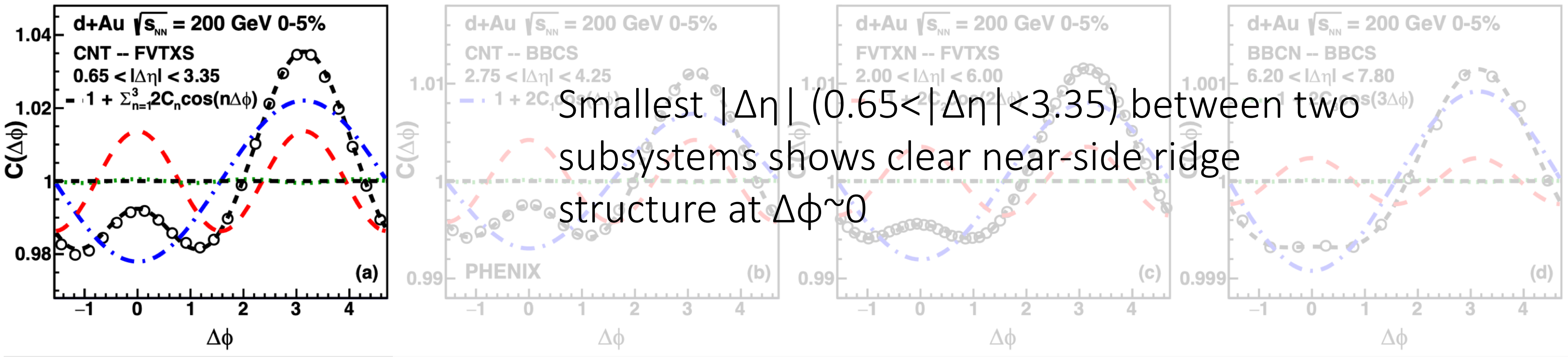
Forward-backward arm :
charged particle measurement,
triggering, event-plane determination

Two-particle correlations



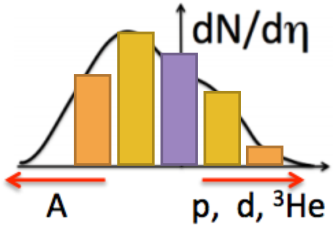


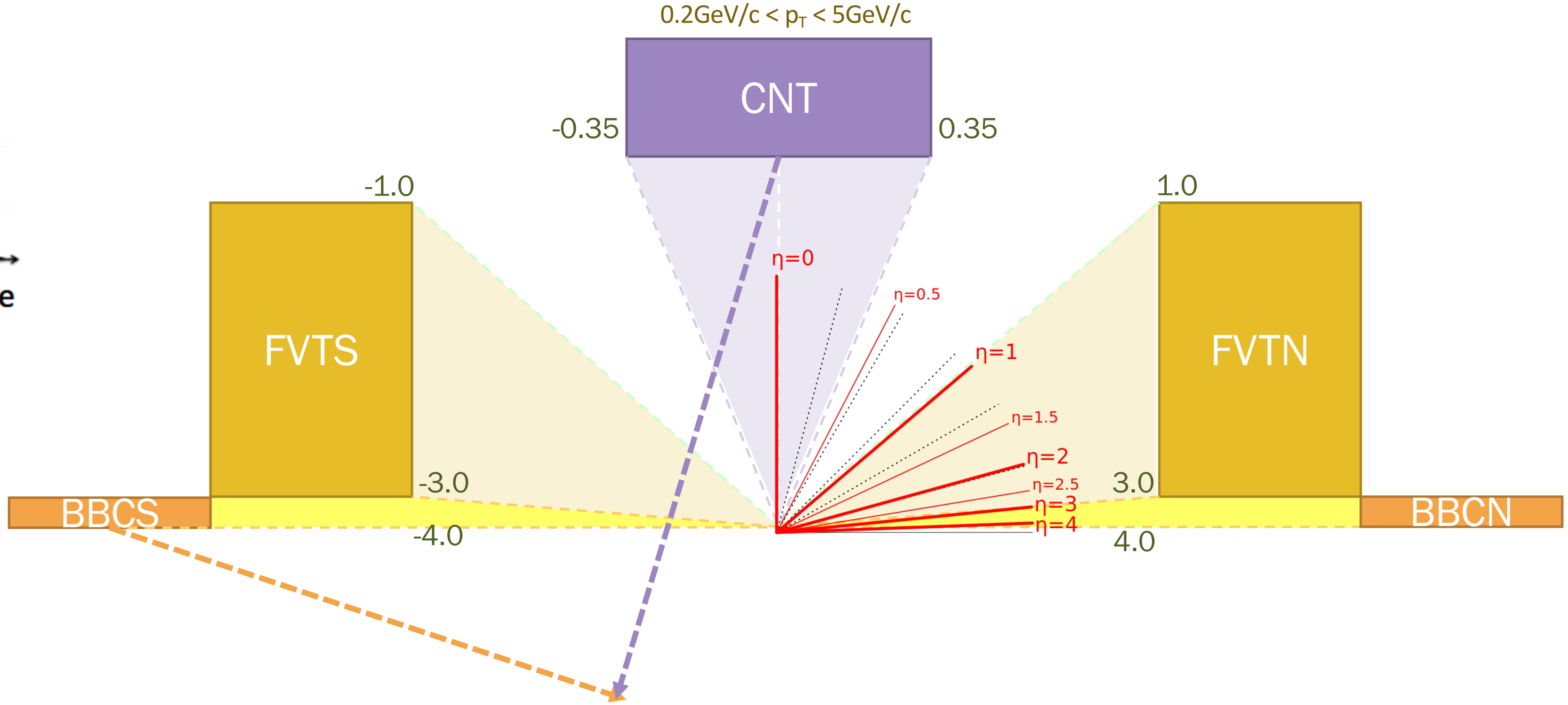
$$c_2^{CNT-FVTXS} = v_2^{CNT} * v_2^{FVTXS}$$

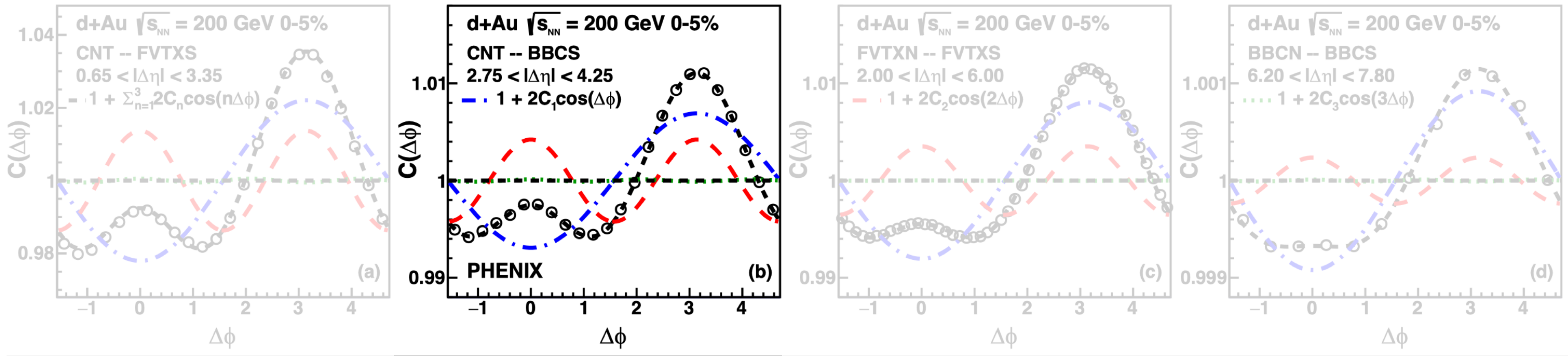


Smallest |Δη| (0.65<|Δη|<3.35) between two subsystems shows clear near-side ridge structure at Δϕ~0

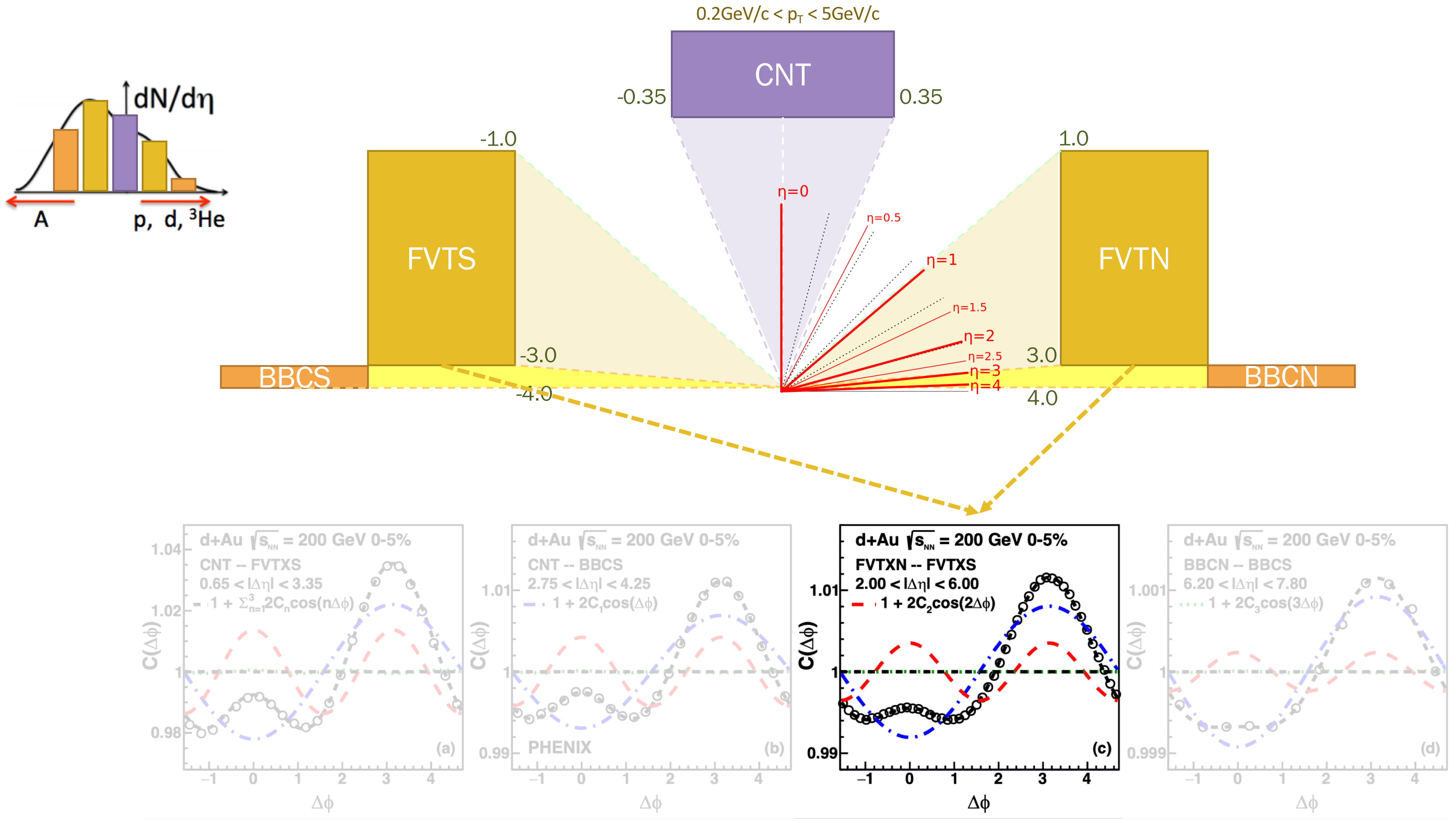
Two-particle correlations



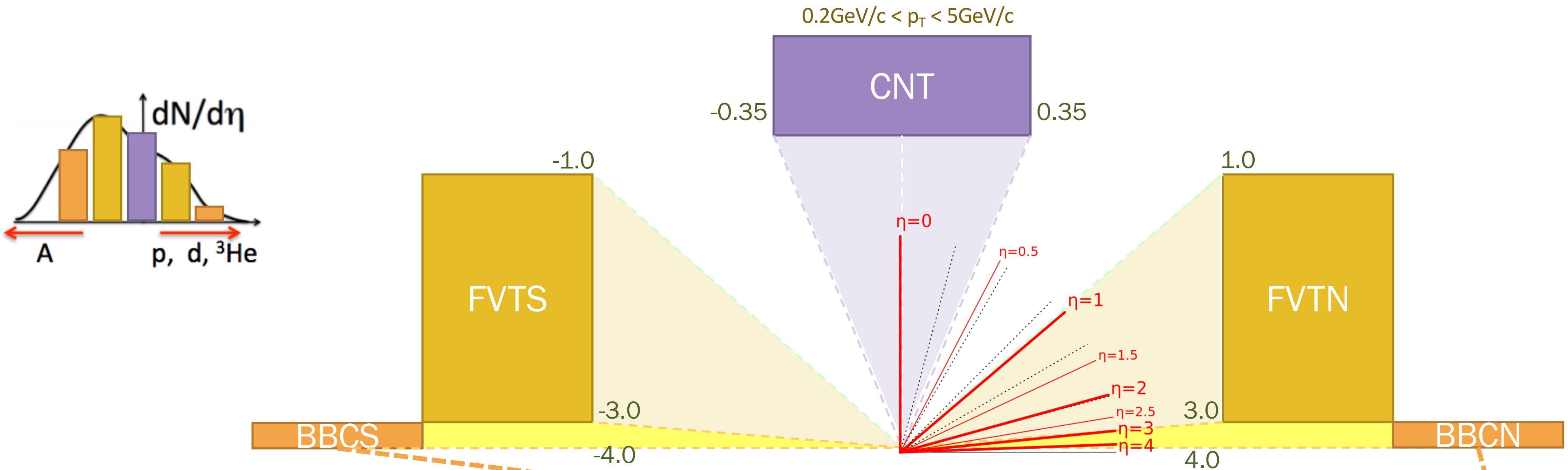




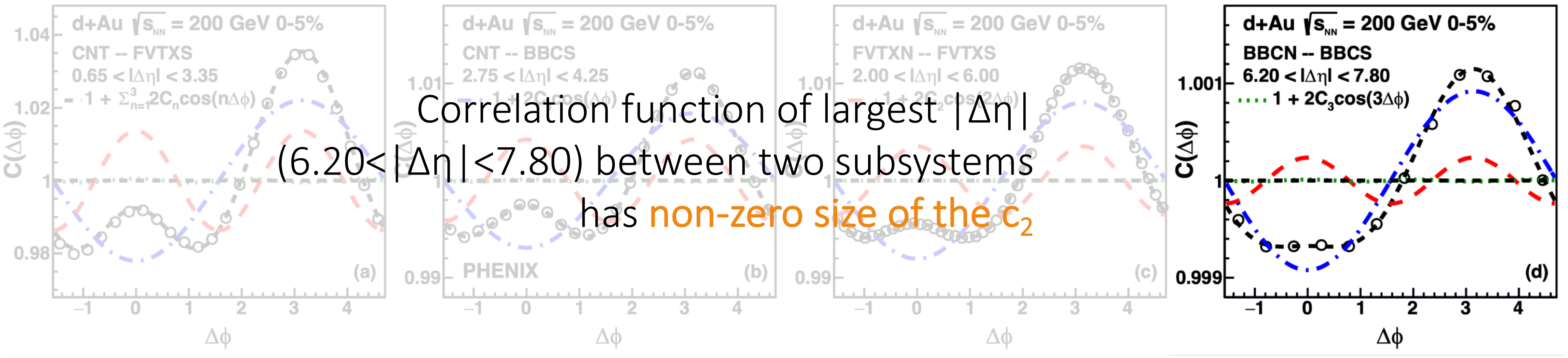
Two-particle correlations



Two-particle correlations



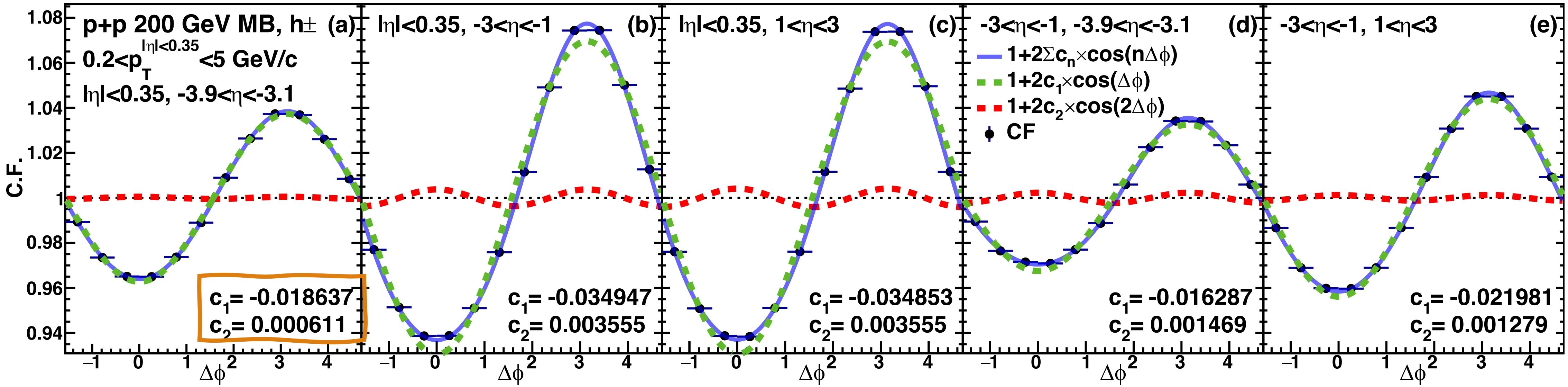
$$c_2^{BBCN-BBCS} = v_2^{BBCN} * v_2^{BBCS}$$



Correlation function of largest |Δη| (6.20<|Δη|<7.80) between two subsystems has non-zero size of the c_2

Measurement of the elliptic flow - v_2

Two-particle correlations



3-subsystems combinations; kinematic dependence

$$v_2^{CNT} = \sqrt{\frac{c_2^{CNT-A} c_2^{CNT-B}}{c_2^{A-B}}} = \sqrt{\frac{c_2^{CNT-FVTXS} c_2^{CNT-BBCS}}{c_2^{FVTXS-BBCS}}} = \sqrt{\frac{c_2^{CNT-FVTXS} c_2^{CNT-FVTXN}}{c_2^{FVTXS-FVTXN}}}$$

if the flow factorizes

if the flow factorizes

Flow factorization

$$c_2^{AB} = v_2^A * v_2^B$$

Medium particles are correlated each other
but are uncorrelated with the nonflow (jet, etc) particles.

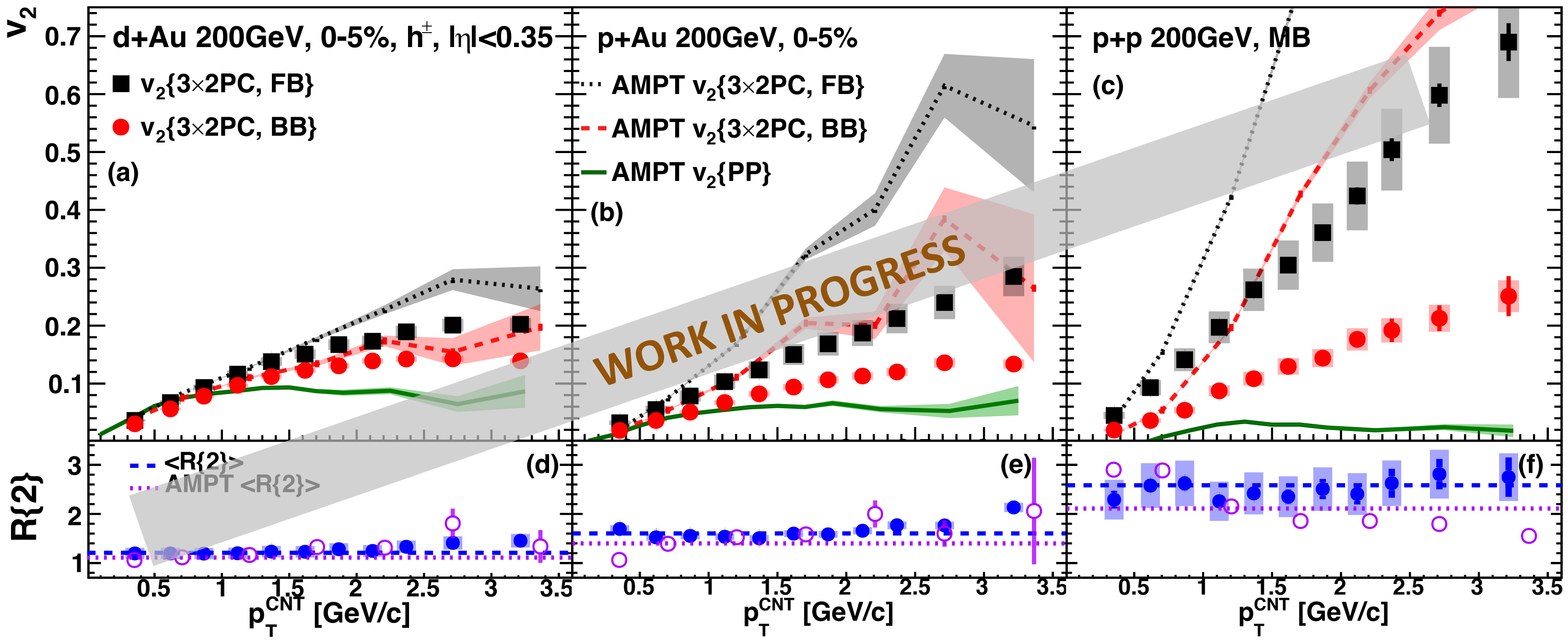
Larger multiplicity events ;
Larger fraction of the particles are expected to be from the medium
Influences of the jet particles are reduced

$$R^{CNT} = \frac{v_2^{CNT-FVTXS-FVTXN}}{v_2^{CNT-FVTXS-BBCS}} = \sqrt{\frac{c_2^{CNT-FVTXN} c_2^{FVTXS-BBCS}}{c_2^{FVTXS-FVTXN} c_2^{CNT-BBCS}}} = 1$$

PHENIX kinematic selections

if the flow factorization works

System size dependence

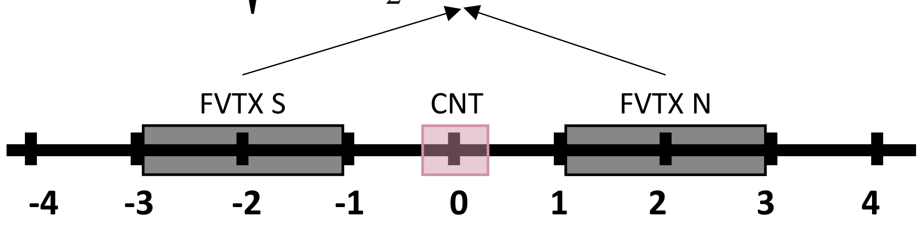


v$_2$ from STAR kinematic selections
- Larger size of flow+nonflow
- EP decorrelation effect at the denominator

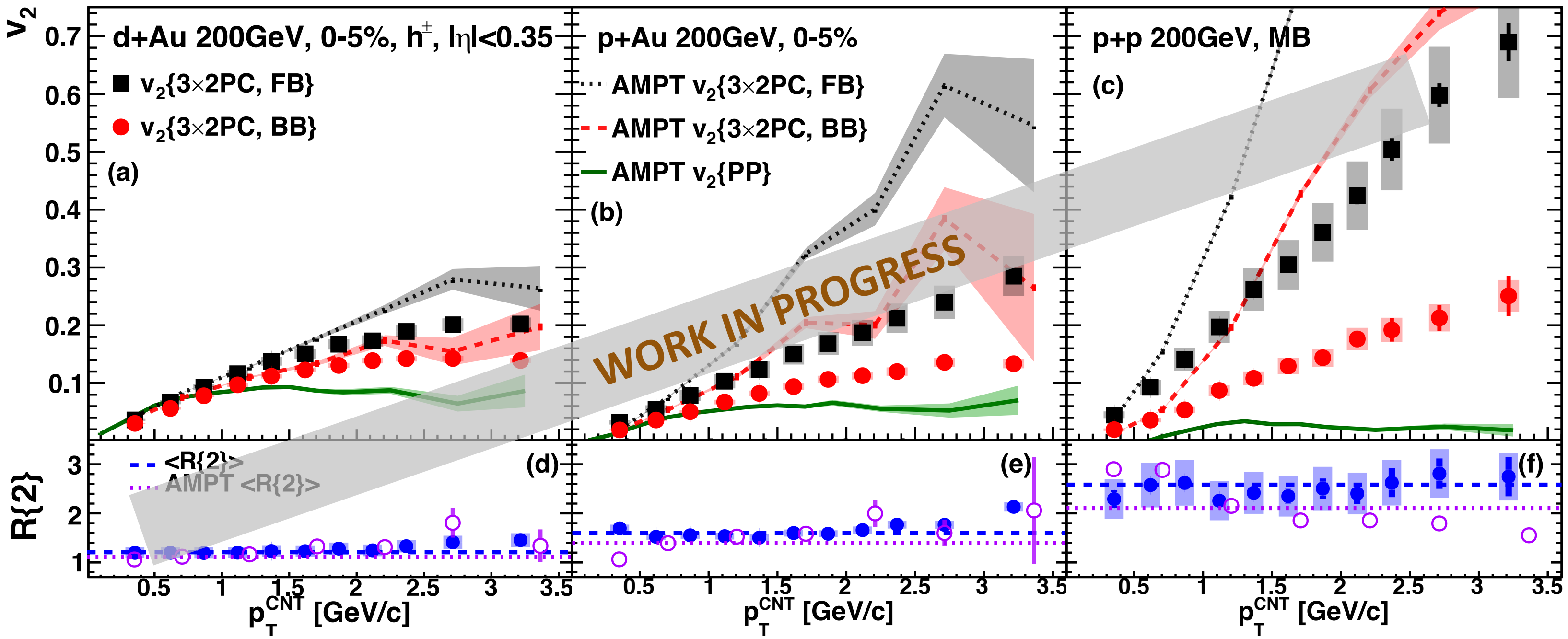
v$_2$ from PHENIX kinematic selections
- smaller size of flow+nonflow
- Nonflow effect at nominator

STAR prelim. : FVTXS-CNT-FVTXN

$$\sqrt{\frac{c_2^{CNT-FVTXS}c_2^{CNT-FVTXN}}{c_2^{FVTXS-FVTXN}}}$$



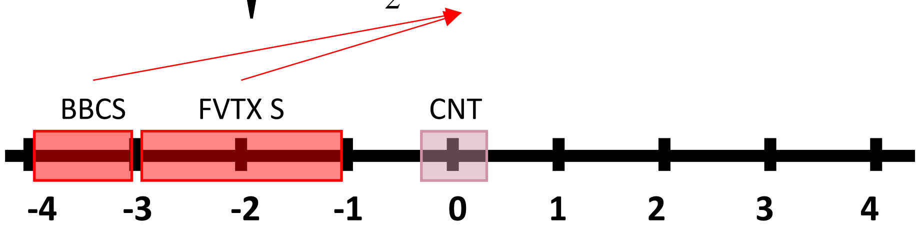
System size dependence



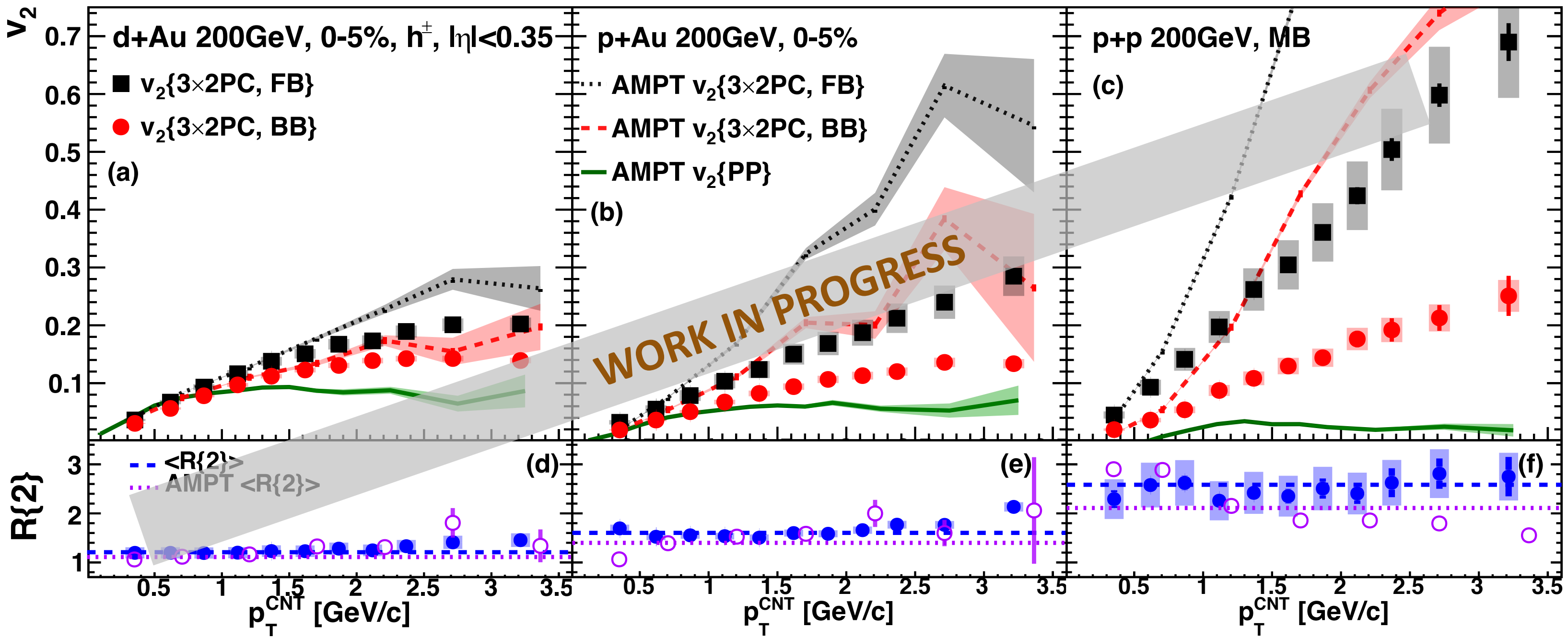
- v₂ from STAR kinematic selections
  - Larger size of flow+nonflow
  - EP decorrelation effect at the denominator
- v_2 from PHENIX kinematic selections
  - smaller size of flow+nonflow
  - Nonflow effect at denominator

PHENIX : BBCS-FVTXS-CNT

$$\sqrt{\frac{c_2^{CNT-FVTXS}\, c_2^{CNT-BBCS}}{c_2^{FVTXS-BBCS}}}$$



System size dependence



$$R^{CNT} = \frac{v_2^{CNT-FVTXS-FVTXN}}{v_2^{CNT-FVTXS-BBCS}} = \sqrt{\frac{c_2^{CNT-FVTXN} c_2^{FVTXS-BBCS}}{c_2^{FVTXS-FVTXN} c_2^{CNT-BBCS}}} \neq 1$$

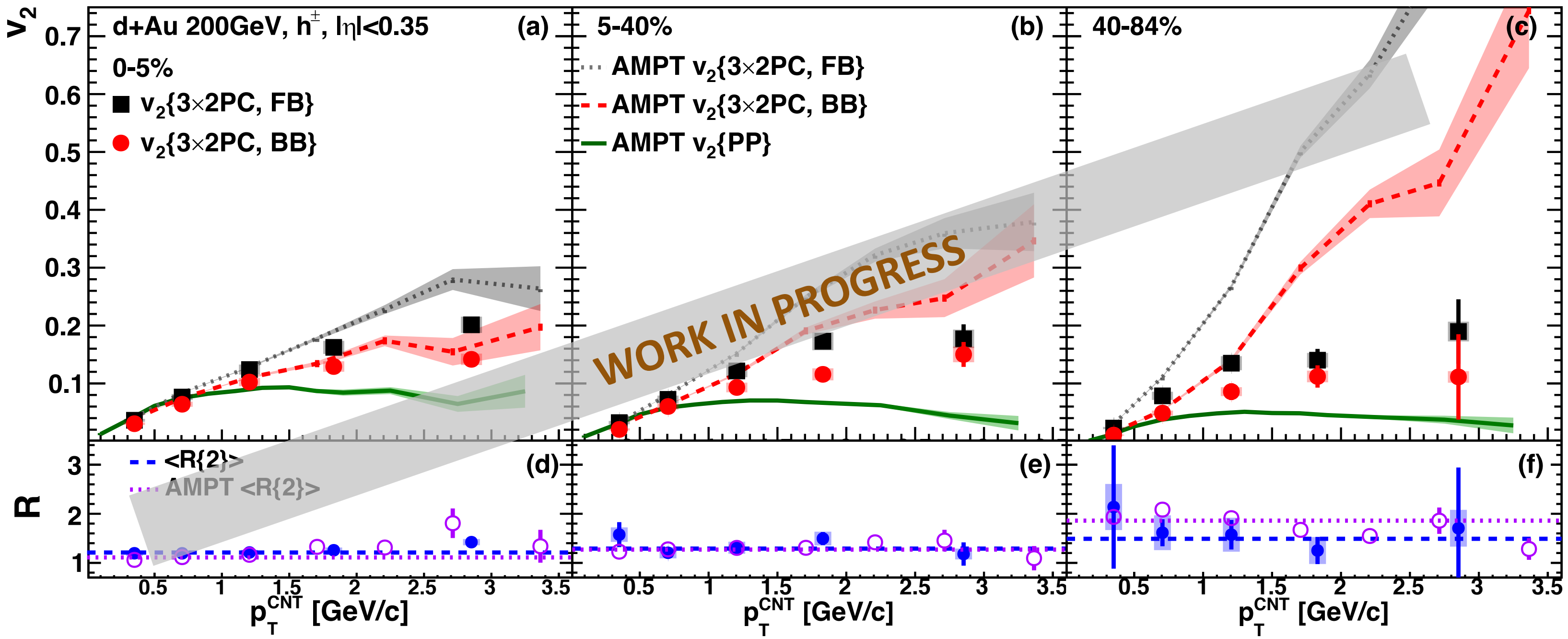
v_2 from STAR kinematic selections
- Larger size of flow+nonflow
- EP decorrelation effect at the denominator

v_2 from PHENIX kinematic selections
- smaller size of flow+nonflow
- Nonflow effect at denominator

Clear system size(multiplicity) dependence shown

AMPT prediction overshoots the v_2 – qualitatively reproduce the kinematic dependence

d+Au 200 GeV centrality dependence

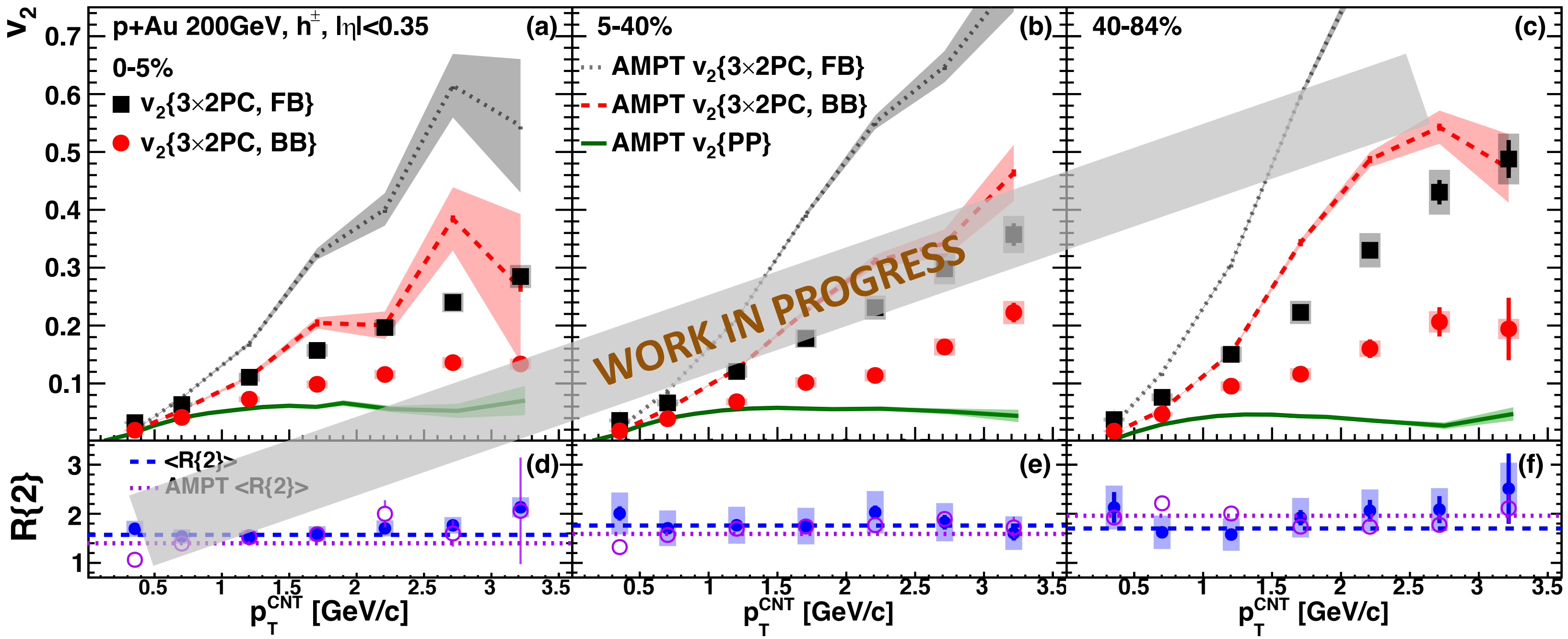


$$R^{CNT} = \frac{v_2^{CNT-FVTXS-FVTXN}}{v_2^{CNT-FVTXS-BBCS}} = \sqrt{\frac{c_2^{CNT-FVTXN} c_2^{FVTXS-BBCS}}{c_2^{FVTXS-FVTXN} c_2^{CNT-BBCS}}} \neq 1$$

Clear centrality dependence shown

AMPT prediction overshoots the v_2 – qualitatively reproduce the kinematic dependence

p+Au 200 GeV centrality dependence

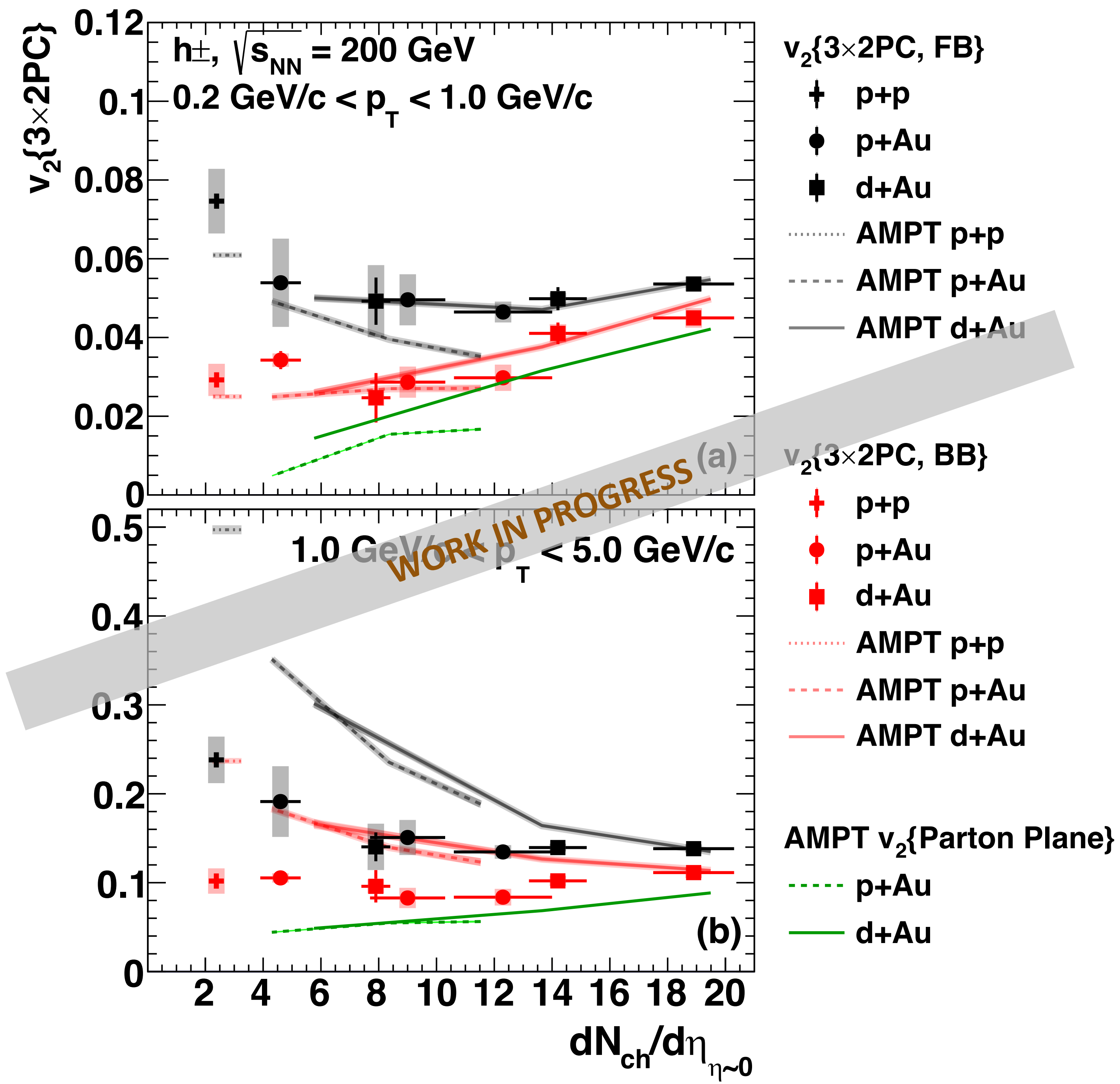


$$R^{CNT} = \frac{v_2^{CNT-FVTXS-FVTXN}}{v_2^{CNT-FVTXS-BBCS}} = \sqrt{\frac{c_2^{CNT-FVTXN} c_2^{FVTXS-BBCS}}{c_2^{FVTXS-FVTXN} c_2^{CNT-BBCS}}} \neq 1$$

Clear centrality dependence shown

AMPT prediction overshoots the v_2 – qualitatively reproduce the kinematic dependence

v_2^{CNT} vs. $dN/d\eta_{\eta\sim0}$

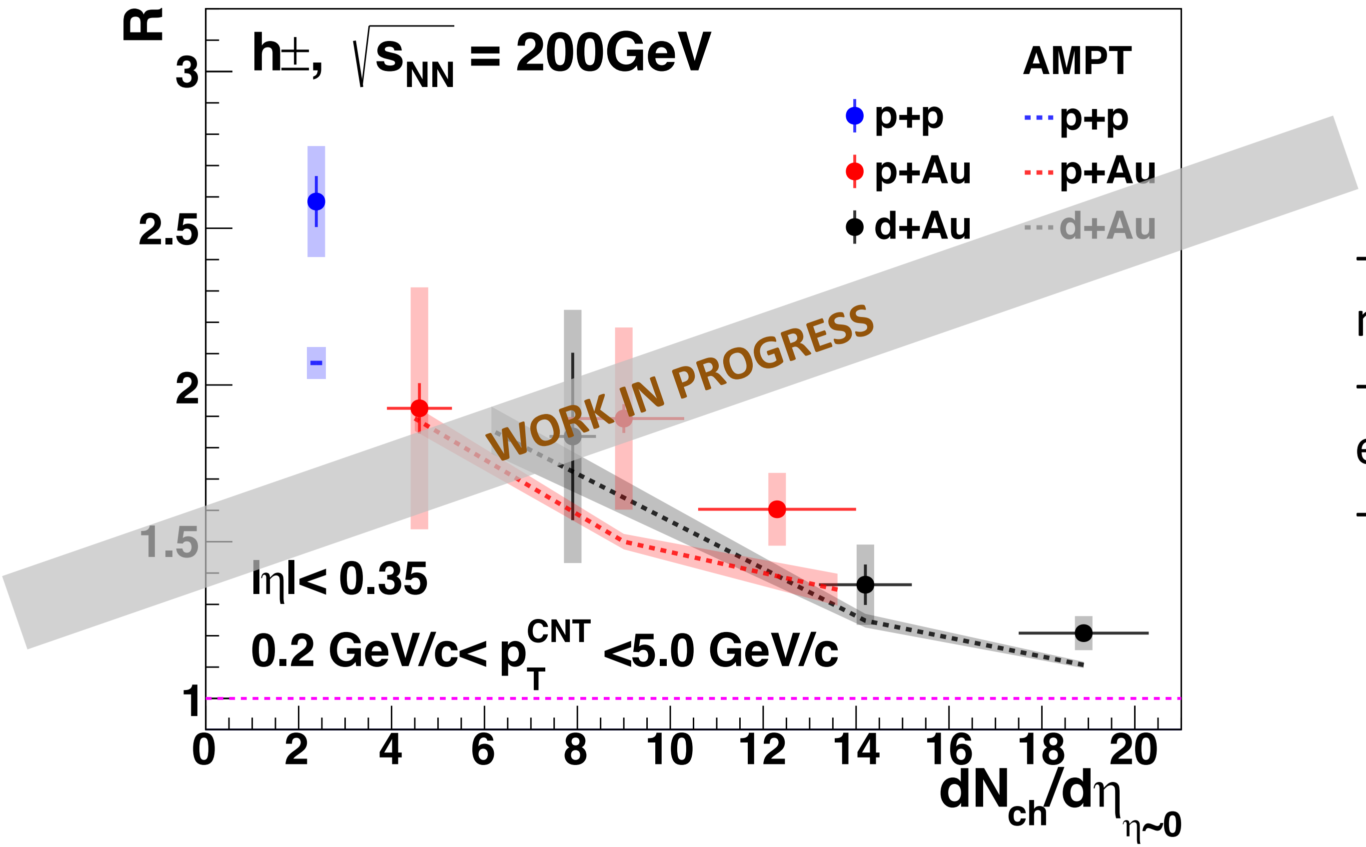


- Clear kinematic dependence is shown in experimental data & AMPT

- d+Au v_2\{parton plane\} reproduce the v_2\{BB\}
- v_2\{FB\} increases as a function of multiplicity
- v_2\{BB\} shows a stable trend in the low multiplicity

AMPT calculation
- predicts system size dependence in low p_T
- no system size dependence predicted in high p_T

R vs. $dN/d\eta_{\eta\sim0}$



- Recovering of flow factorization in high-multiplicity events
- Almost no system size dependence in experimental data and the AMPT calculation
- AMPT reproduces the experimental data

Summary

- Clear kinematic dependence is found at v_2 in small collision systems
- Good complement for the current issue between PHENIX and STAR analysis
- Paper preparation group formation accepted by the PHENIX collaboration