QUARK MATTER 2015
The XXVth International Conference on Ultrarelativistic Nucleus-Nucleus Collisions

PHENIX

Measurements of elliptic and triangle flow in ^{3}He+Au collisions at 200 GeV

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for PHENIX collaboration

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Outline

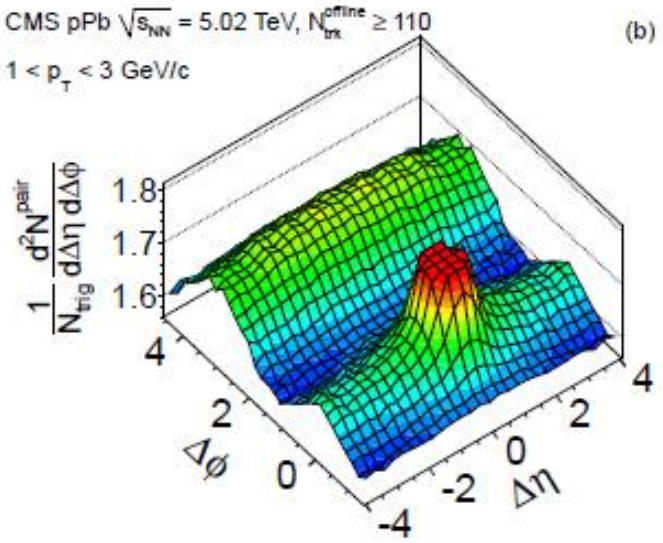
1)Physics Motivation

2)Results and Discussions

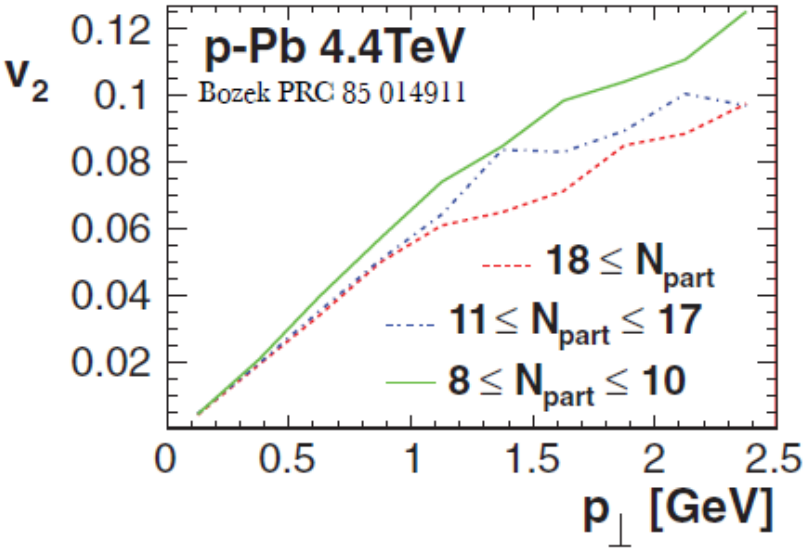
- ✓ Long-range angular correlation in ^{3}He+Au 200 GeV
- ✓ Charged hadron v_2 and v_3 in ^{3}He+Au 200 GeV
- ✓ Comparison between theoretical calculations and different systems: Au+Au, d+Au and p+Au 200 GeV
- ✓ Identified particle v_2 in ^{3}He+Au

3)Summary

What is the origin of the ridge in p+A?

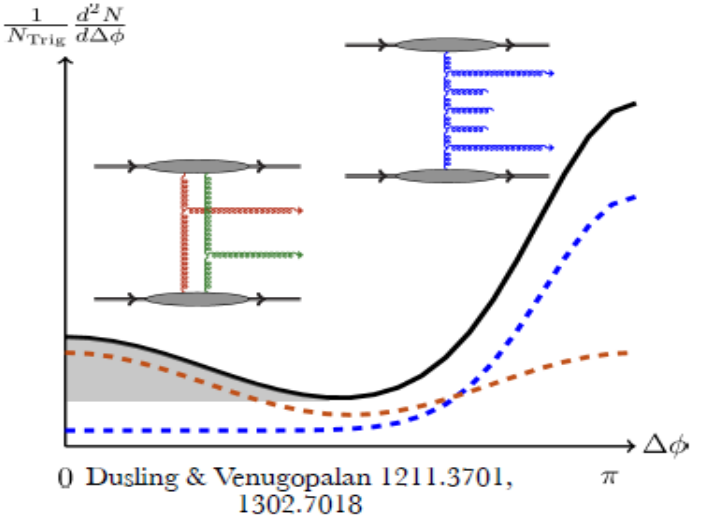


CMS: Phys. Lett. B 7198(2013)



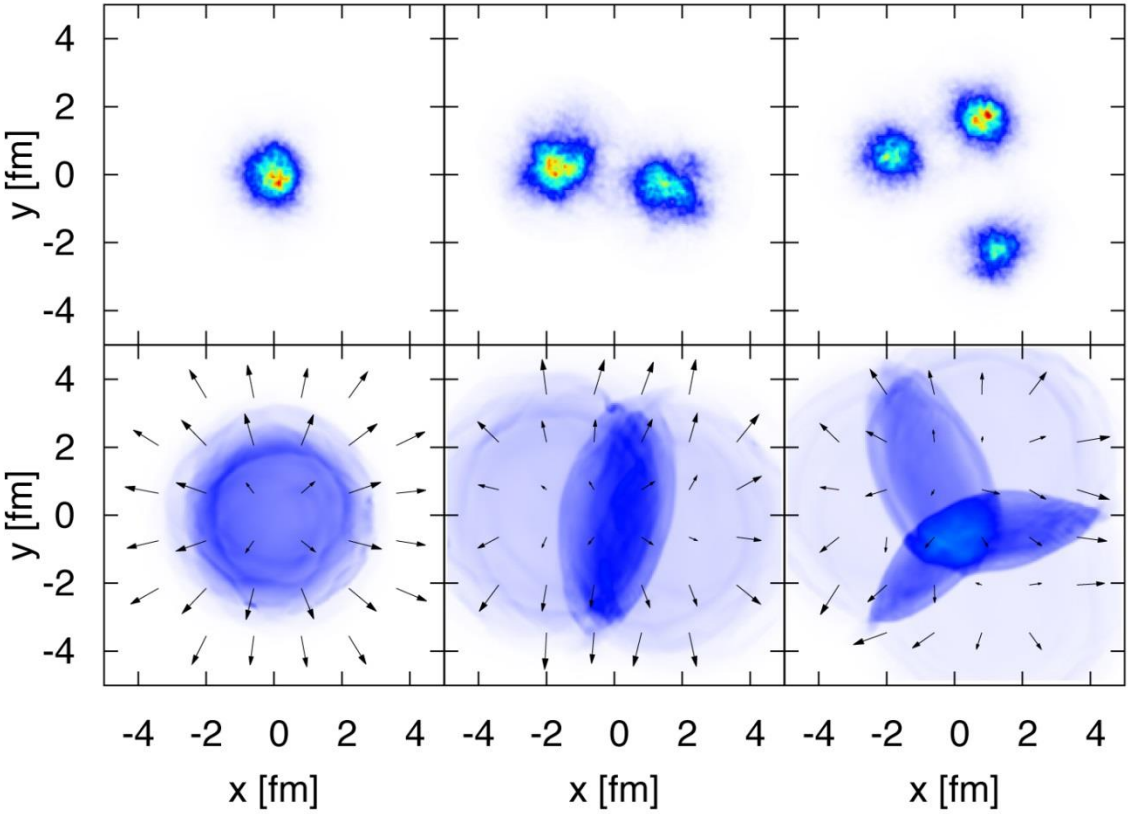
Key Question: What generates the ridge in small collision systems?

- ✓ Final state interaction: Hydrodynamics?
- ✓ Initial momentum correlation: CGC?



Geometry engineering

p+Au(2015) d+Au(2008) ^{3}He+Au(2014)



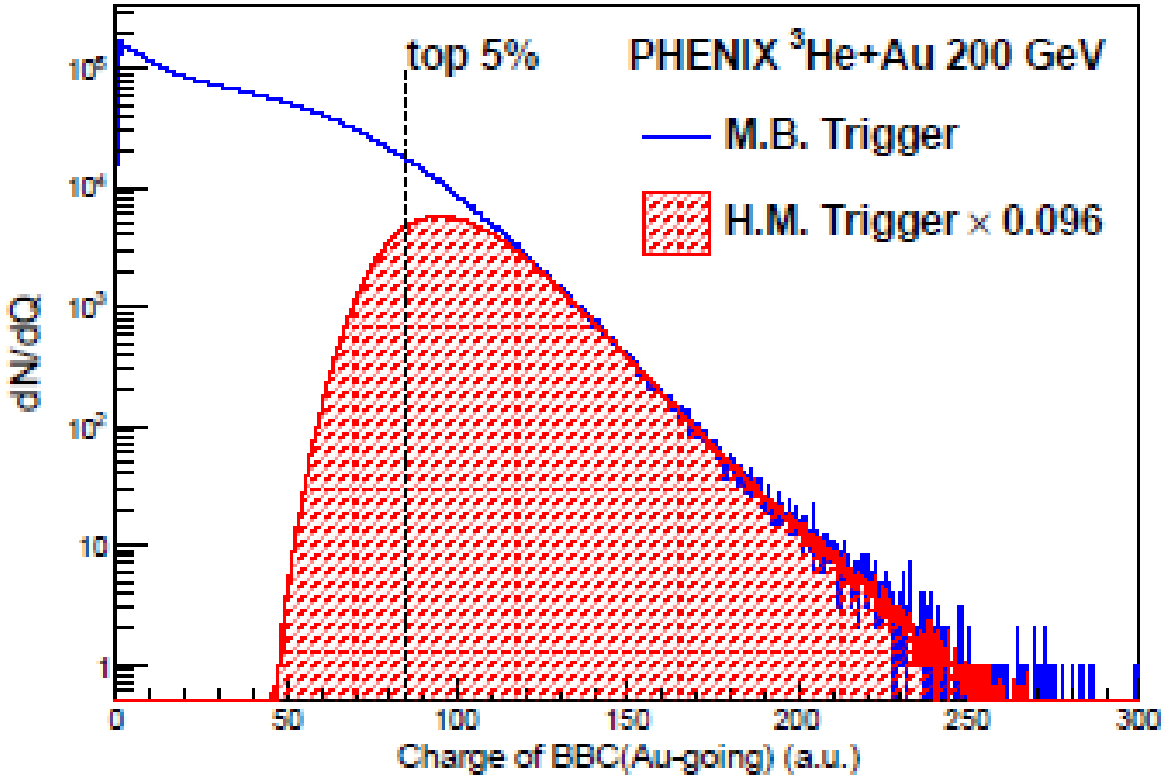
Initial State

Final State

graphic from Bjoern Schenke

- Different initial geometry → different final state particle emission for p+Au, d+Au and ^{3}He+Au collisions
- The dedicated heavy ion machine RHIC can provide this kind of test with its unmatched versatility

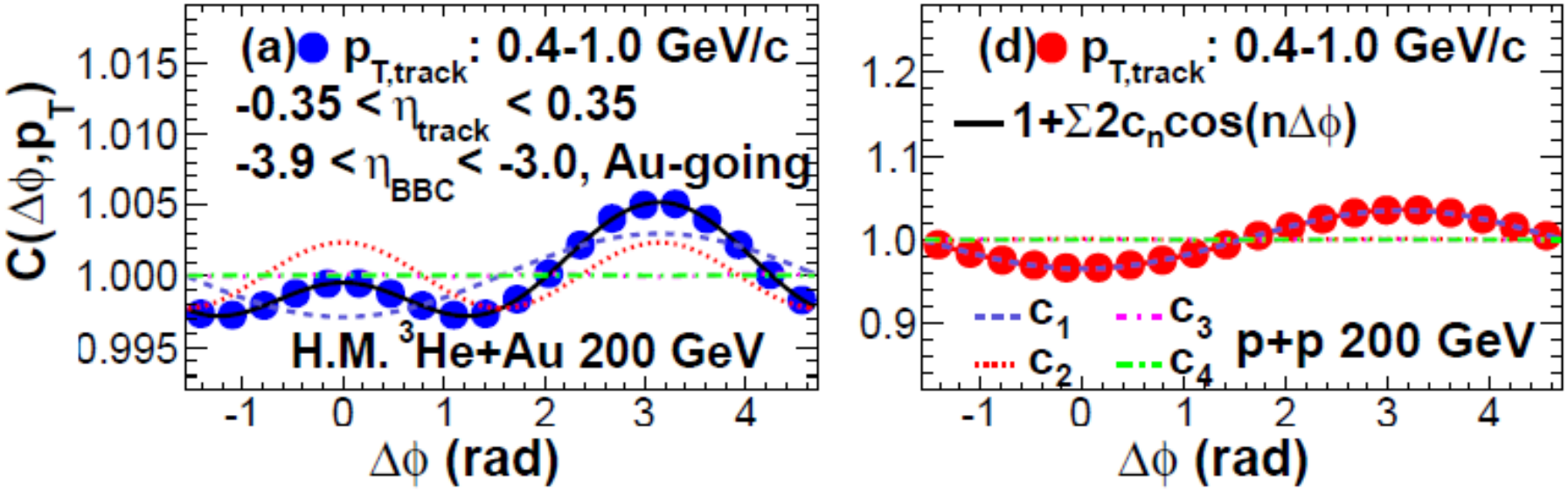
High-Multiplicity trigger in ^{3}He+Au



The Au-going BBC charge distribution in min-bias (M.B.) and high-multiplicity triggered (H.M.) events

H.M trigger increases the statistics by a factor of around 10

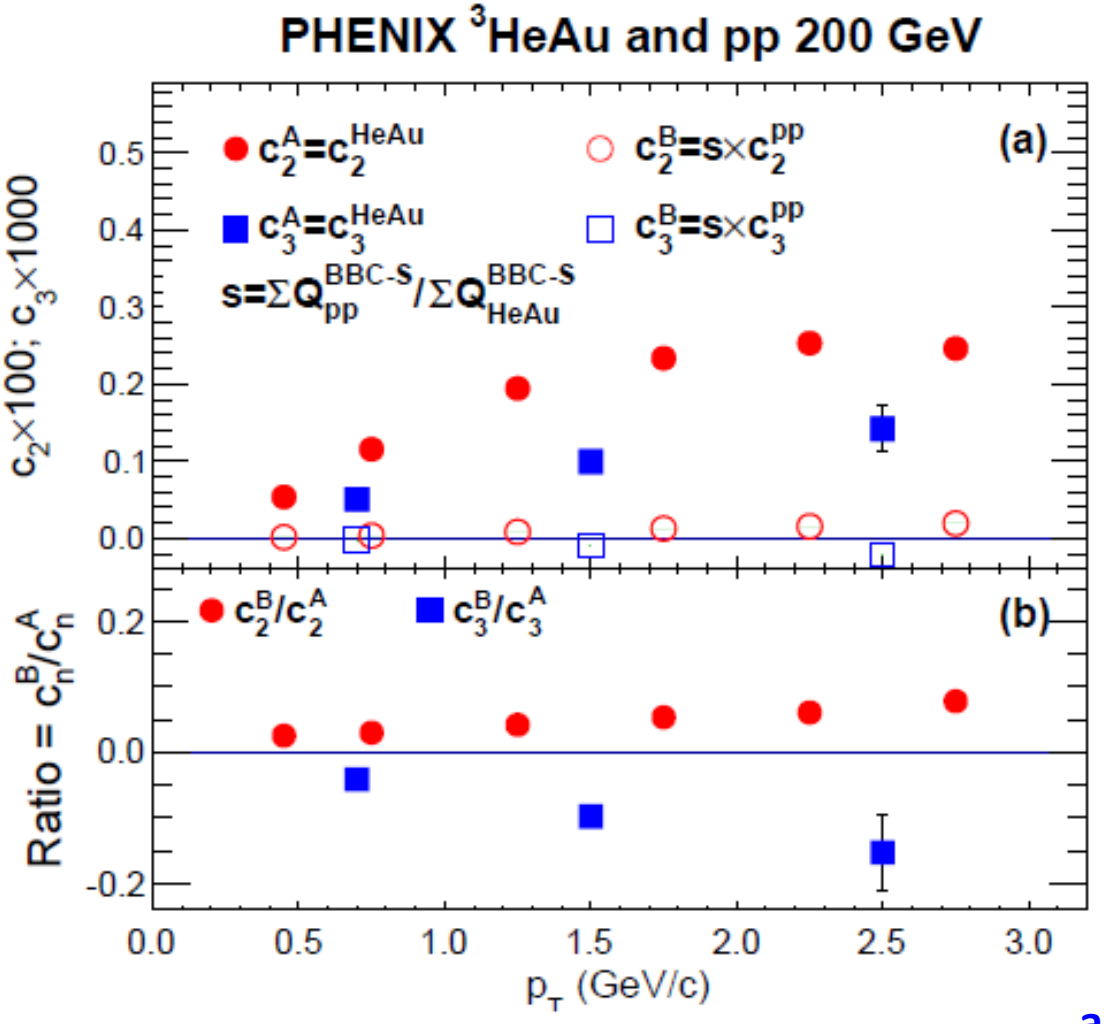
Ridge in 0-5% ^{3}He+Au 200 GeV



arXiv:1507.06273, **Accepted by PRL (Editor's suggestion highlight)**

- ✓ A ridge is observed in high multiplicity(0-5%) ^{3}He+Au collisions
- ✓ In the reference pp collision, the correlation is dominated by momentum conservation (including di-jets)
- ✓ A Fourier expansion function is fitted to extract the c_n

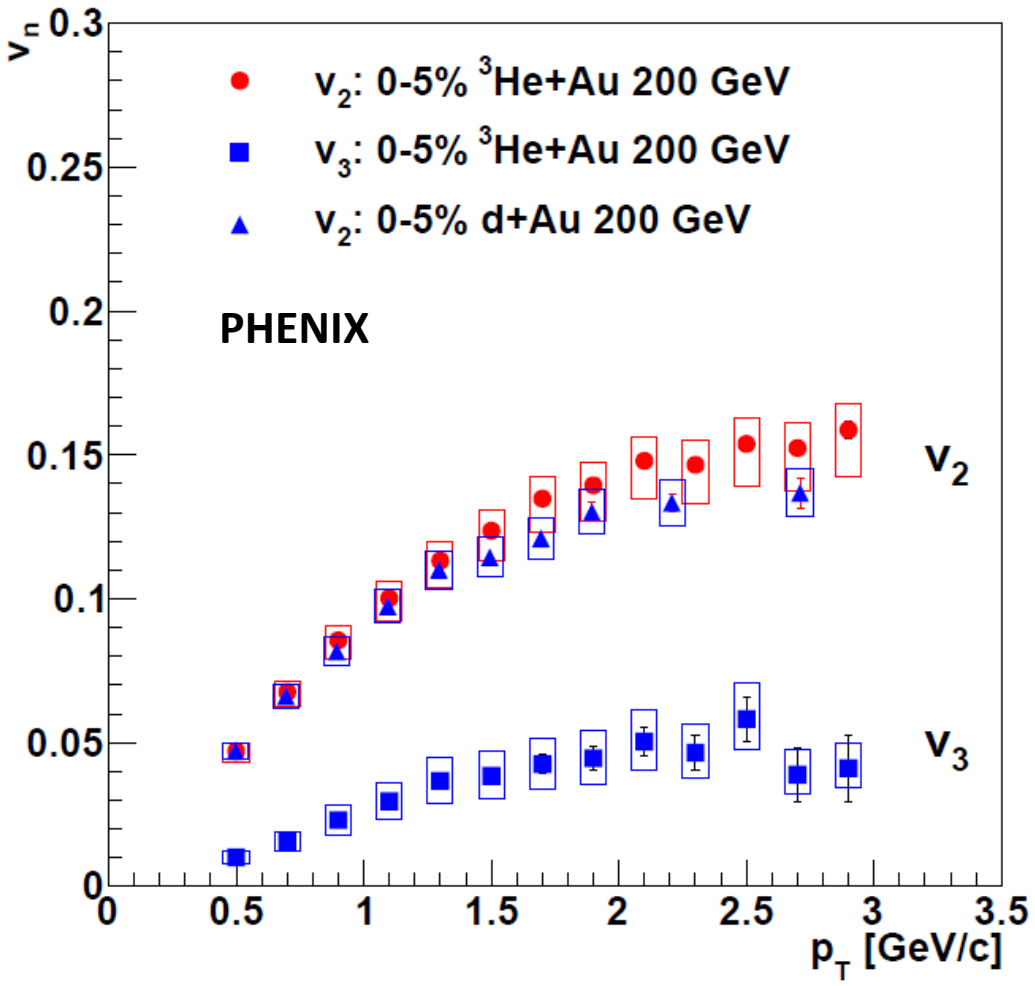
Estimation of non-flow contribution



arXiv:1507.06273

In 0-5% ^{3}He+Au collisions, the non-flow contribution estimated using p+p correlation is <7% for c_2 and <15% for c_3

v_2 and v_3 in 0-5% ^{3}He+Au



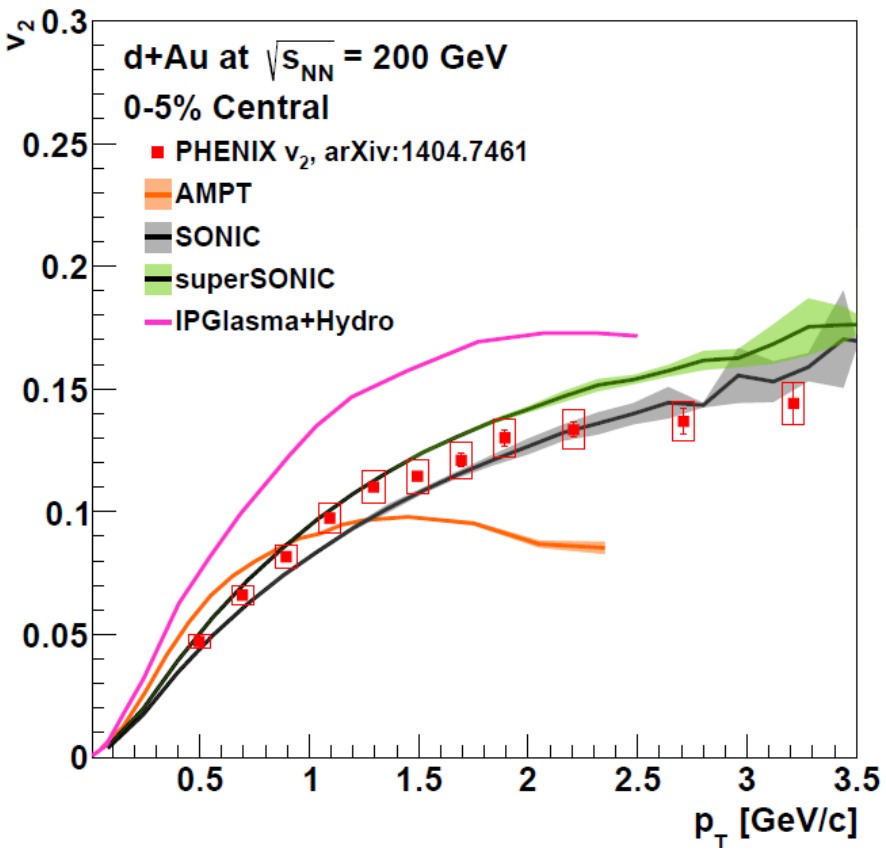
A sizeable v_2 and v_3 are observed in 0-5% ^{3}He+Au collisions, extracted by event plane method

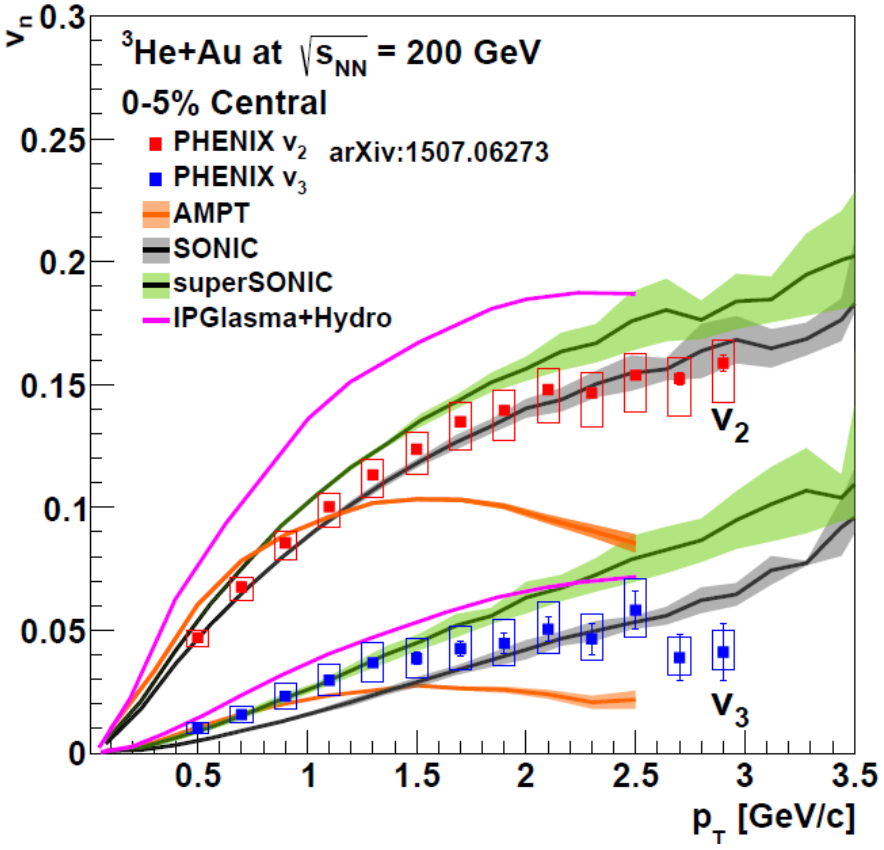
The v_2 in 0-5% ^{3}He+Au and 0-5% d+Au collisions are very similar

^{3}He+Au: arXiv:1507.06273
d+Au: Phys. Rev. Lett. 114, 192301

} Both PRL highlights

Comparison with theory calculations

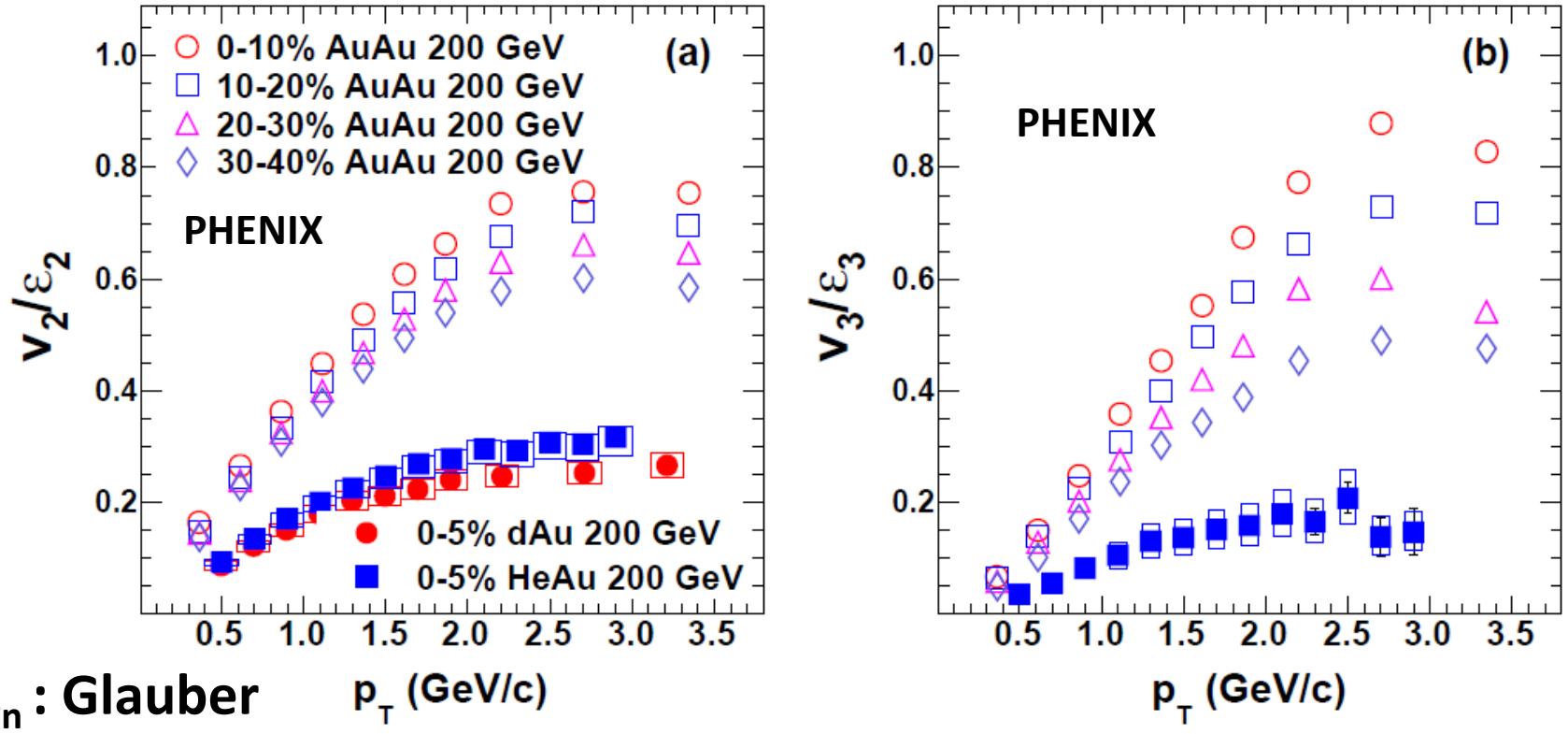




AMPT: arXiv:1501.06880 SONIC: arXiv:1502.04745 IP+Hydro:arXiv:1407:7557

Several models can reproduce the v_n measurements in d+Au and ^{3}He+Au collisions simultaneously

Comparison with Au+Au

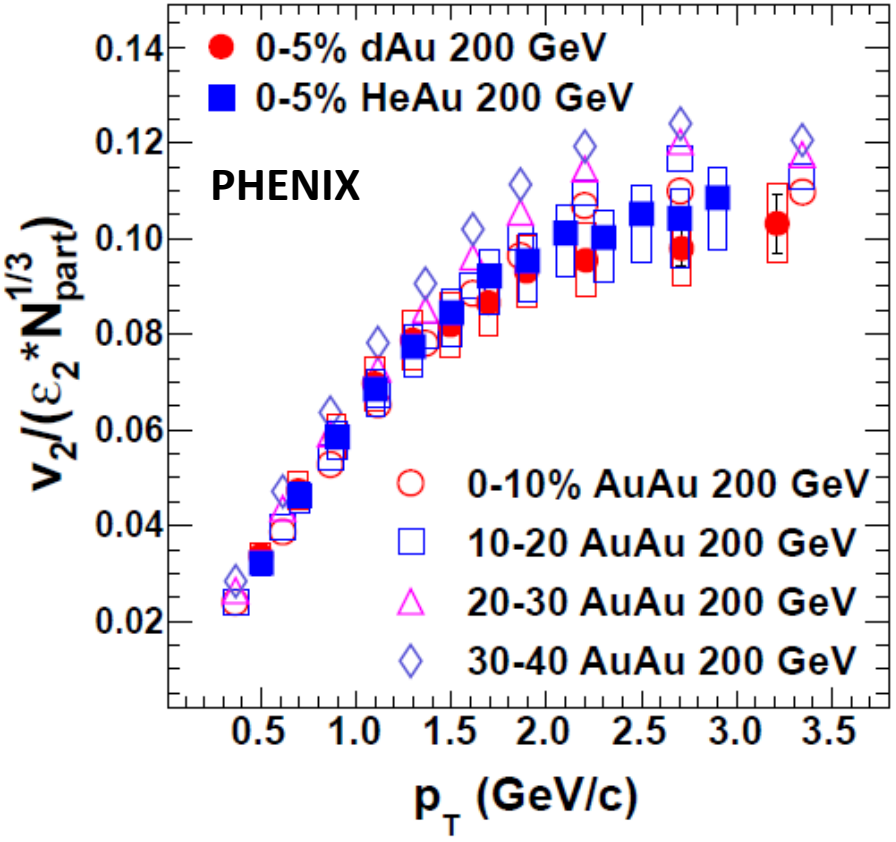


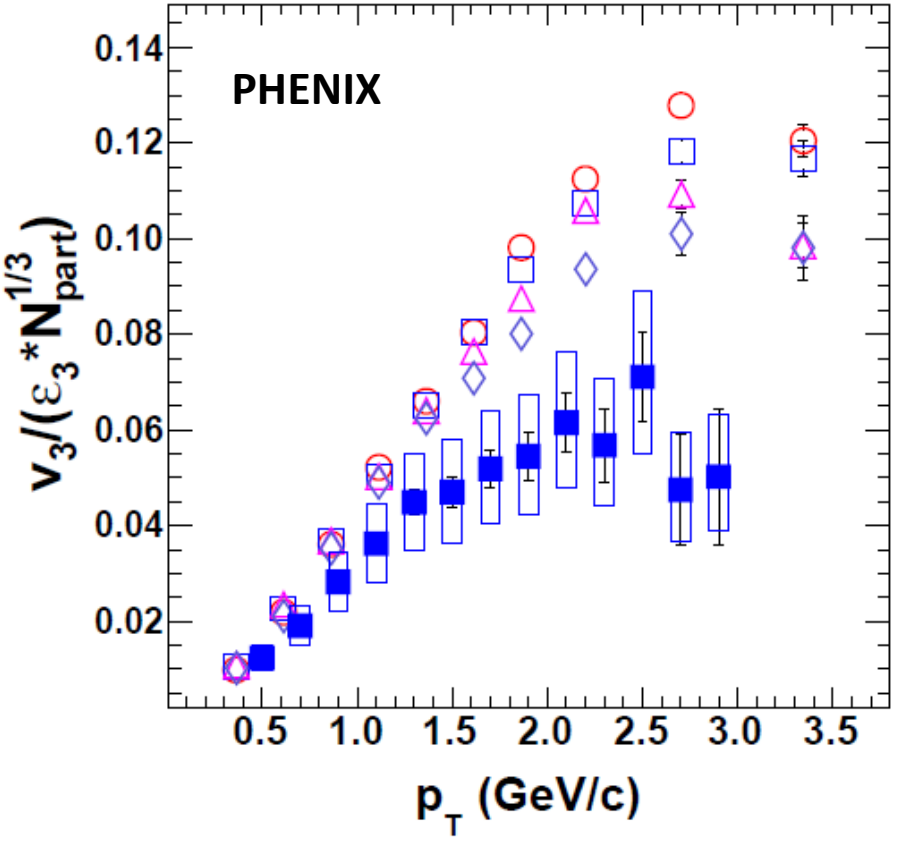
ε_n : Glauber

Au+Au $v_{2,3}$ Phys. Rev. Lett. 107, 252301

- v_n/ε_n decreases from large collision system such as Au+Au to small collision system as d+Au and ^{3}He+Au
- Small system with shorter lifetime would not fully reflect initial geometry information

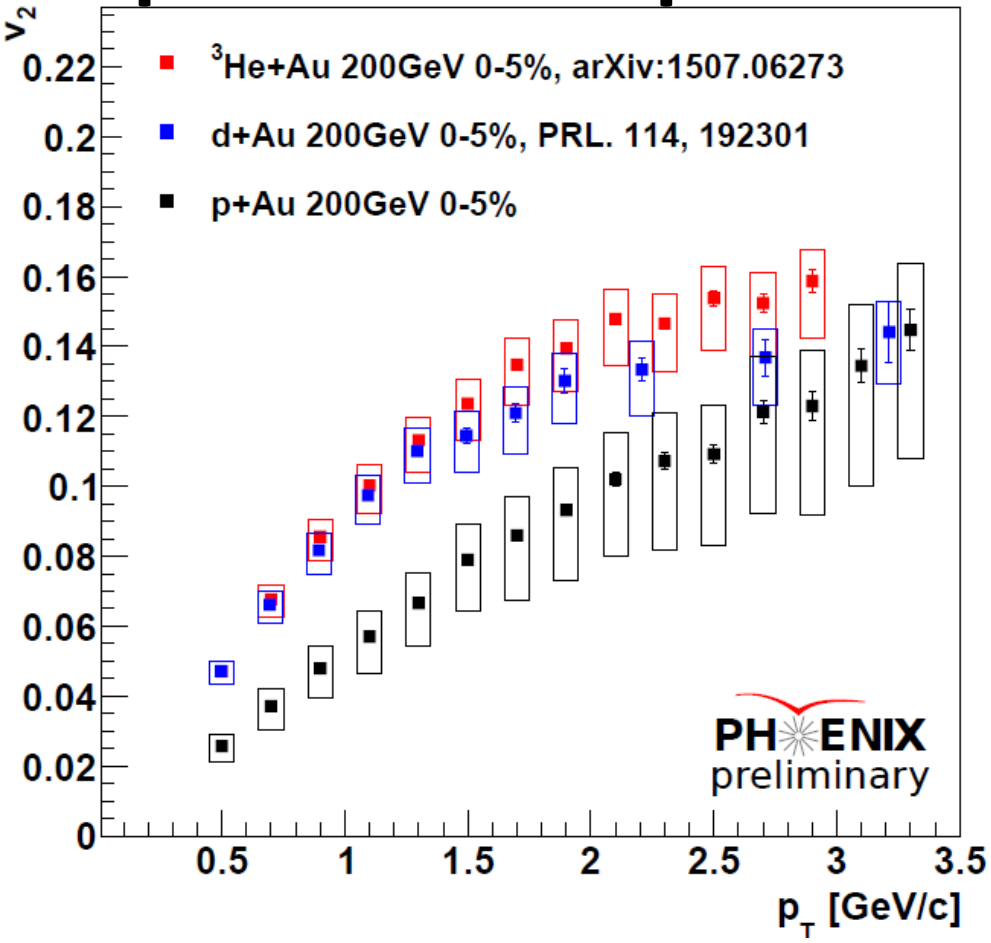
$V_n/(\varepsilon_n * N_{part}^{1/3})$ scaling





An empirical scaling of $v_n/(\varepsilon_n * N_{part}^{1/3})$, seen for A+A in PHENIX arXix:1412.1043(accepted by PRC), works for v_2 but *not* v_3 in the small system

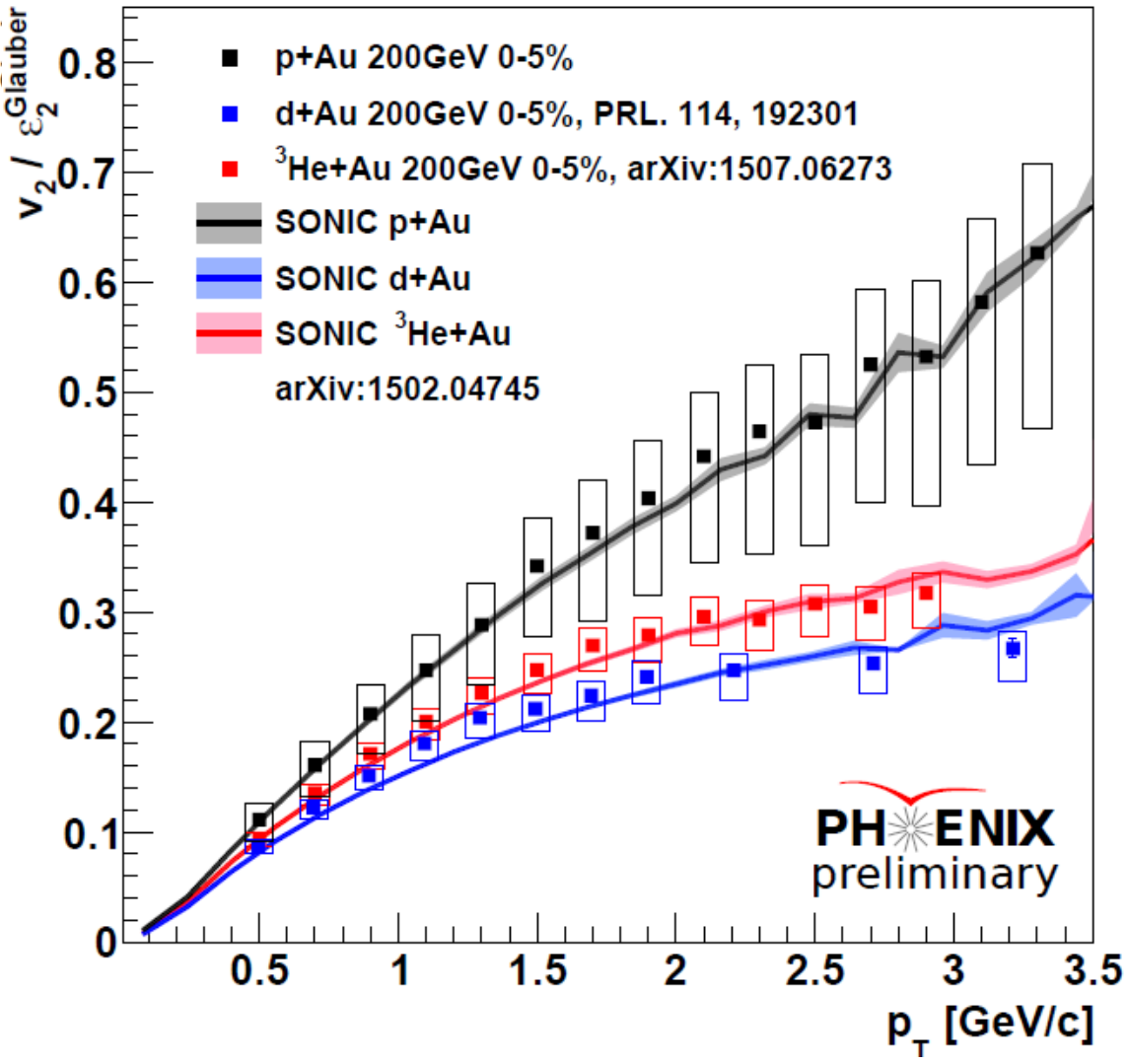
Comparison with p+Au 200 GeV



More detail:
Itaru Nakagawa talk (14:20 QGP in Small Systems II)
Qiao Xu poster (0218)

- The new measured v_2 from **RUN15** central **p+Au** collisions is lower than that of central d+Au and ^{3}He+Au collisions
- Smaller initial geometry eccentricity → smaller v_2

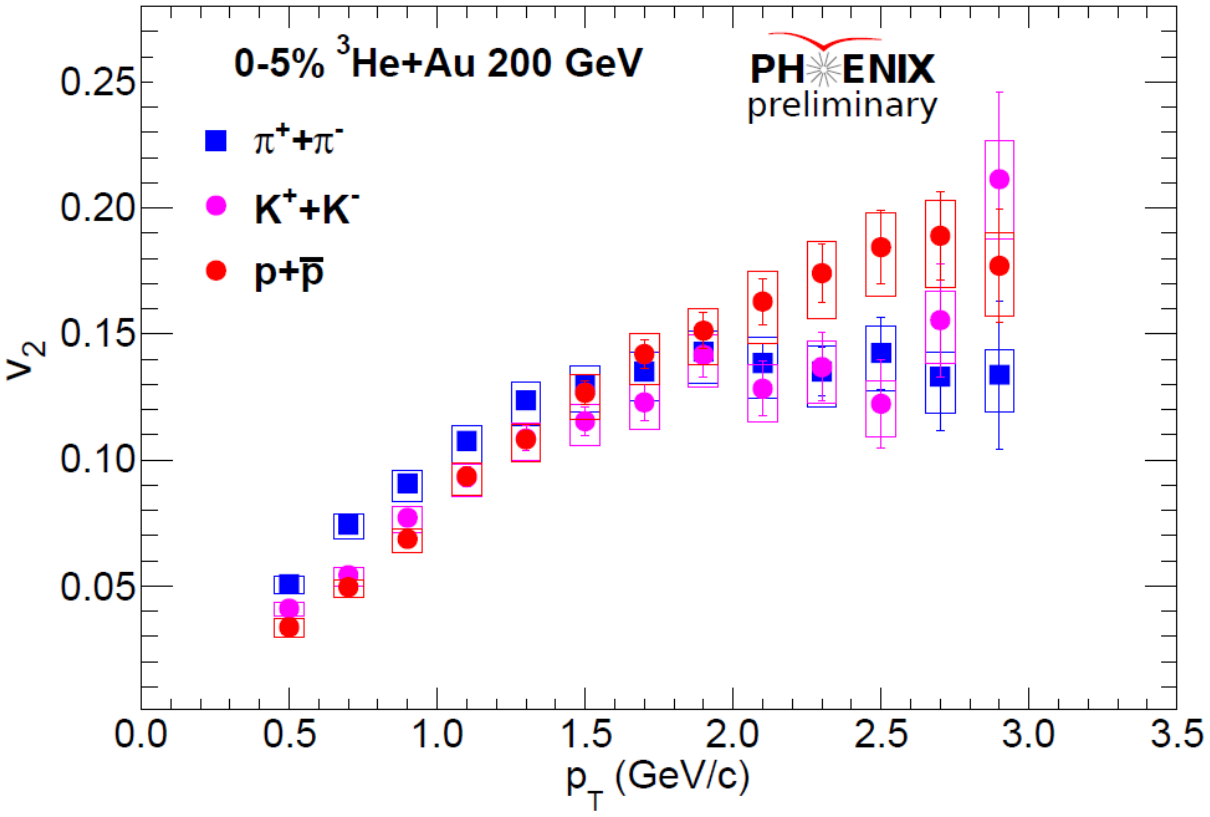
v_2/ε_2 in small collision systems



The v_2/ε_2 in p+Au is higher than that of d+Au and ^{3}He+Au collisions

This behavior is within the expectation of SONIC model, which includes Glauber initial geometry and viscous hydro evolution.

Identified particle v_2 in ^{3}He+Au

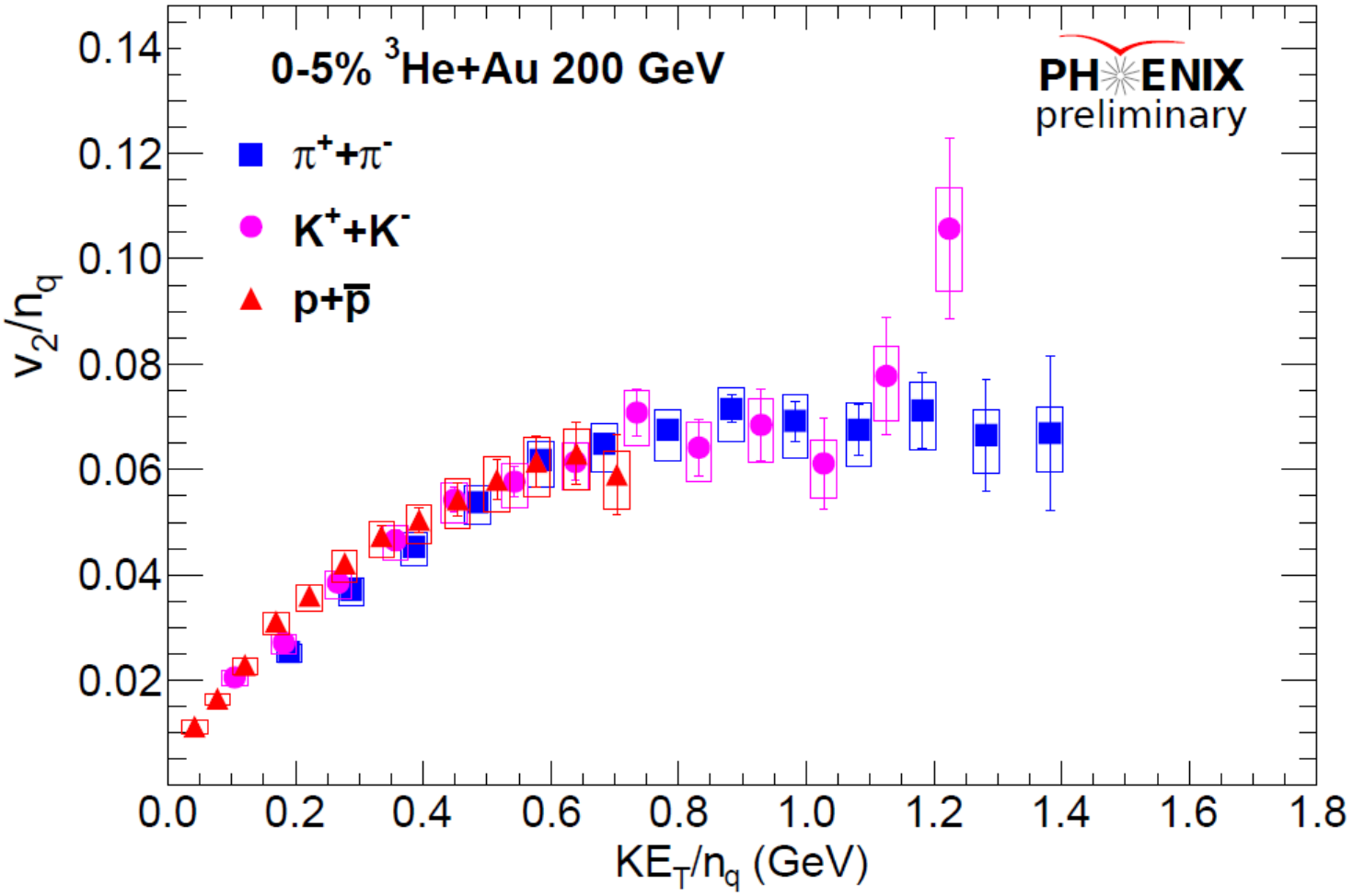


At p_T < 1.5 GeV/c: mass order -- v2(proton)< v2(kaon)< v2(pion)

At p_T> 2.0 GeV/c: difference for meson and baryon

These behaviors are very similar to that in Au+Au collisions and calculations of viscous hydro.

Number of Quark Scaling in ^{3}He+Au



The familiar behavior of number of quark scaling observed in Au+Au collisions is also seen in the small ^{3}He+Au system

Summary

- The v_2 and v_3 anisotropies have been measured in 0-5% ^{3}He+Au collisions via event plane methods
- The number of quark scaling is also observed in ^{3}He+Au collisions
- The comparison of v_n in ^{3}He+Au with that in other systems, and theoretical calculations, indicates that the initial geometry plays an important role in the small systems' evolution