Elliptic flow of light nuclei in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV

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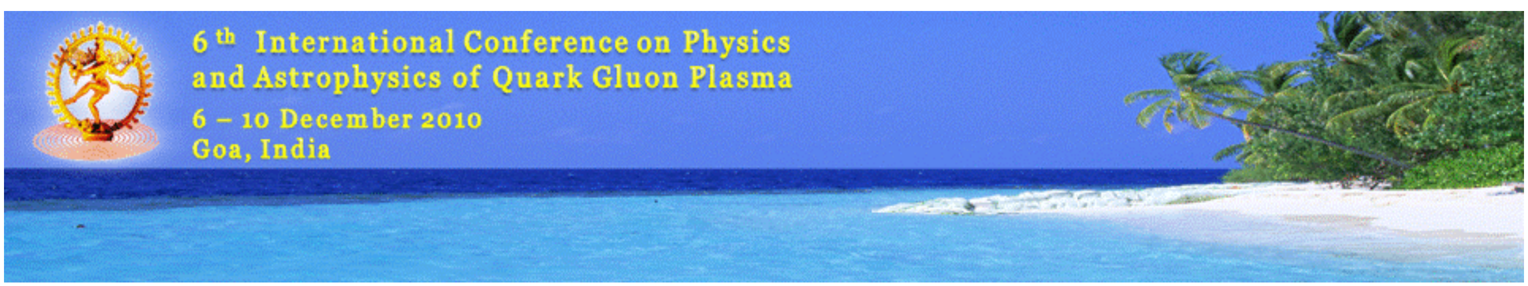

Outline

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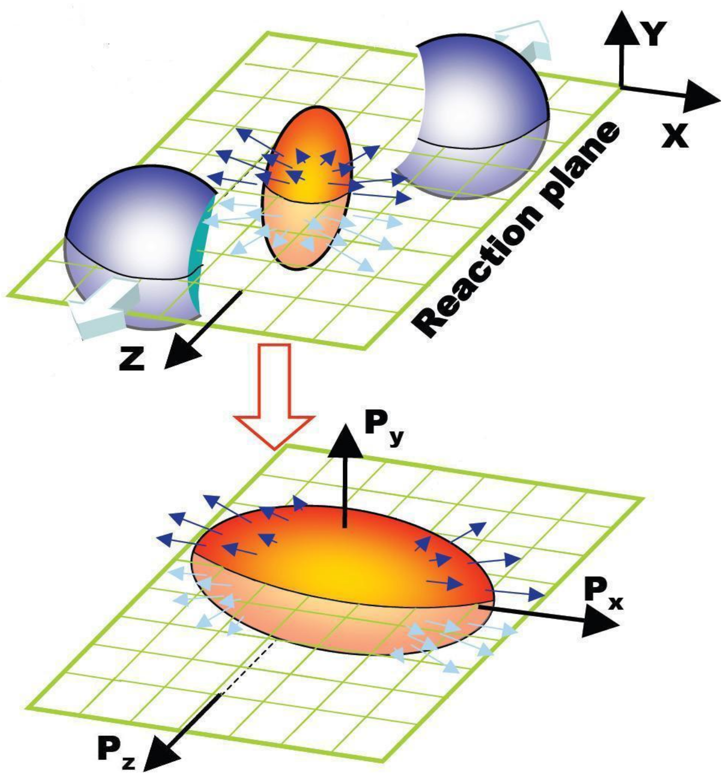
- Summary

Introduction



$$\varepsilon = \frac{< y^2 - x^2 >}{< y^2 + x^2 >}$$

Coordinate-Space Anisotropy

Momentum-Space Anisotropy

$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_T dp_T dy}\left(1 + 2\sum_{n=1}^{\infty} v_n(p_T, y)\cos\left(n(\phi - \Psi_r)\right)\right)$$

$$v_n = \left\langle \cos(n(\phi - \Psi_r)) \right\rangle \qquad \phi = \tan^{-1}\left(\frac{p_y}{p_x}\right)$$

➢Elliptic flow (v_2) is a good probe of the early stage of the collision.

Motivation

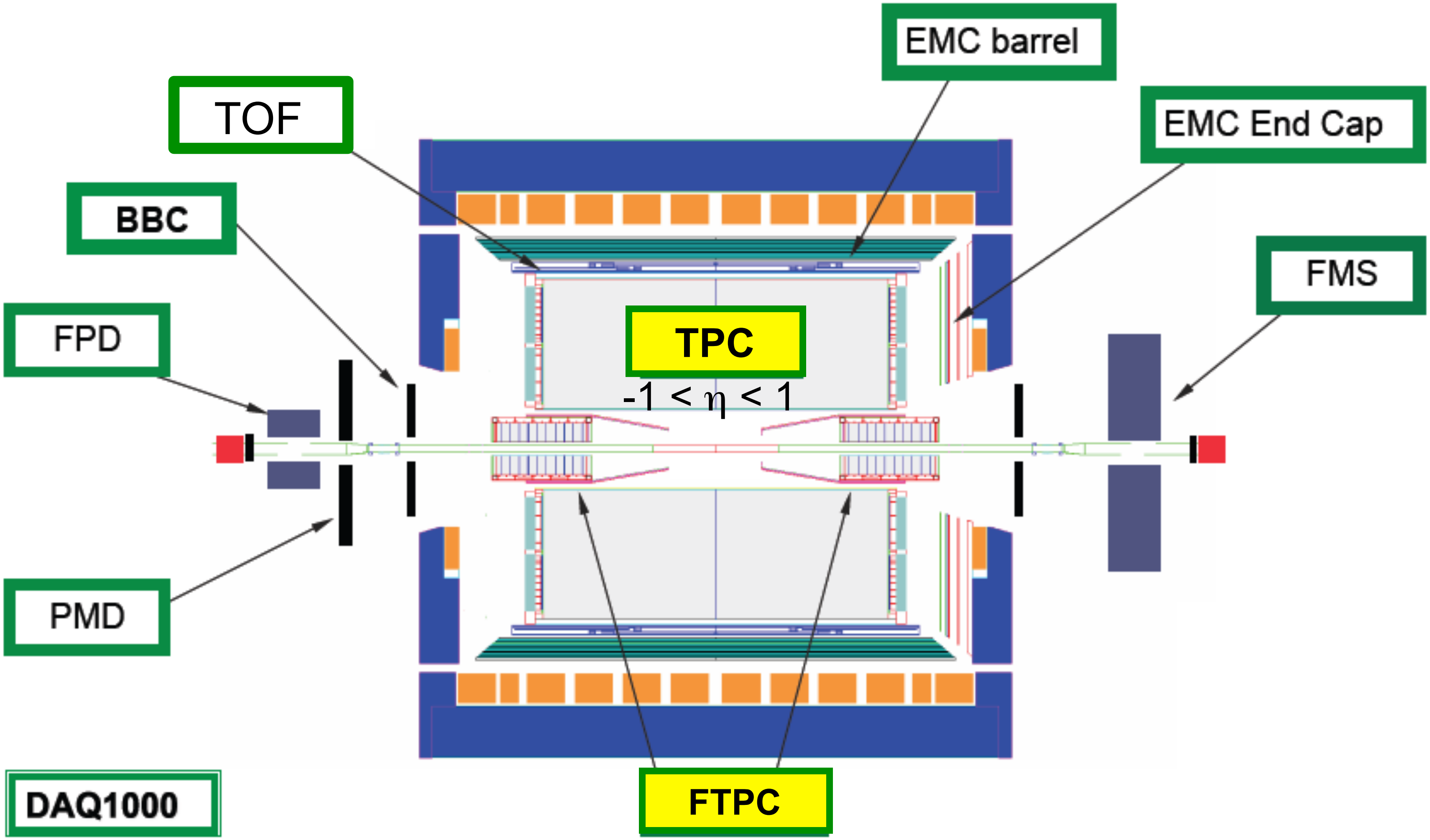
- Light nuclei and anti-nuclei are formed through coalescence of nucleons (produced/participant) and anti-nucleons*. This formation process is generally believed to happen at a late stage of the evolution due to their small binding energy.

- Production of light nuclei provides information of space-momentum correlation among these nucleons.

- By studying the v_2 of light nuclei and comparing to that of their constituent nucleons, we will have a better understanding of coalescence process for hadronization.

*H.H. Gutbrod et al., Phys. Rev. Lett. 37, 667 (1976).

STAR Detector

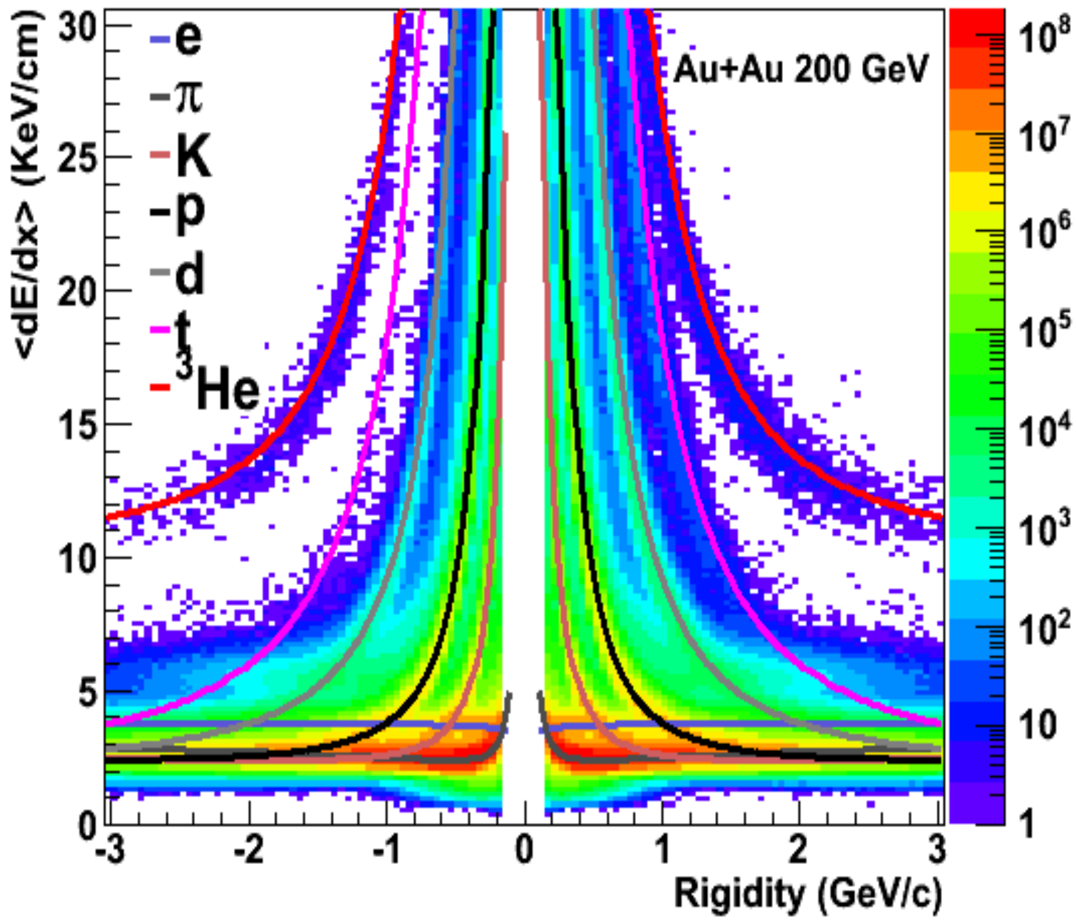


Full azimuthal particle identification!

Data Set

Data : Run 7 Au+Au 200 GeV
Number of events: ~62 M
(~2.5 times more statistics compared to previous run)

➢Measurement of the ionization energy loss (dE/dx) of charged tracks in the TPC gas are used to identify the light nuclei.

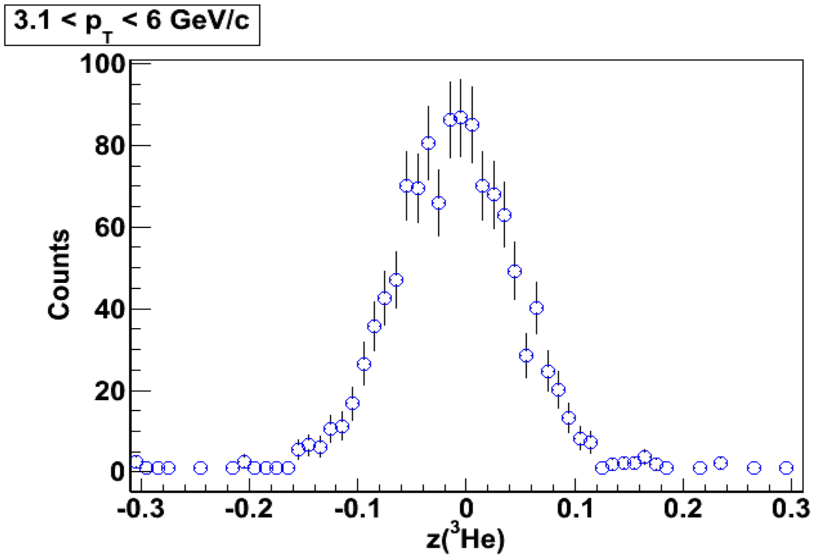


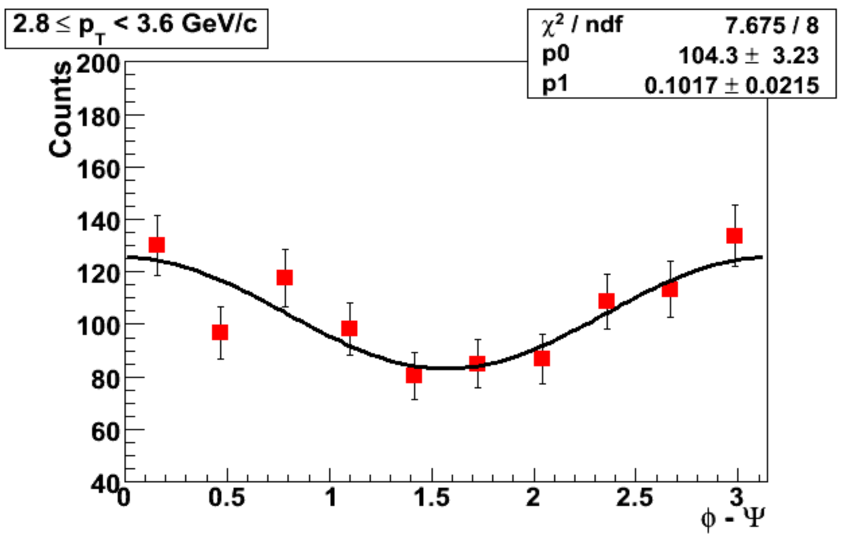
Analysis Method

➢ ^{3}He signal is almost background free for p_T > 1.4 GeV/c.

$$Z = \ln\left(\frac{(dE/dx)_{measure}}{(dE/dx)_{predict}}\right)$$

➢ TPC is used to determine the event plane.



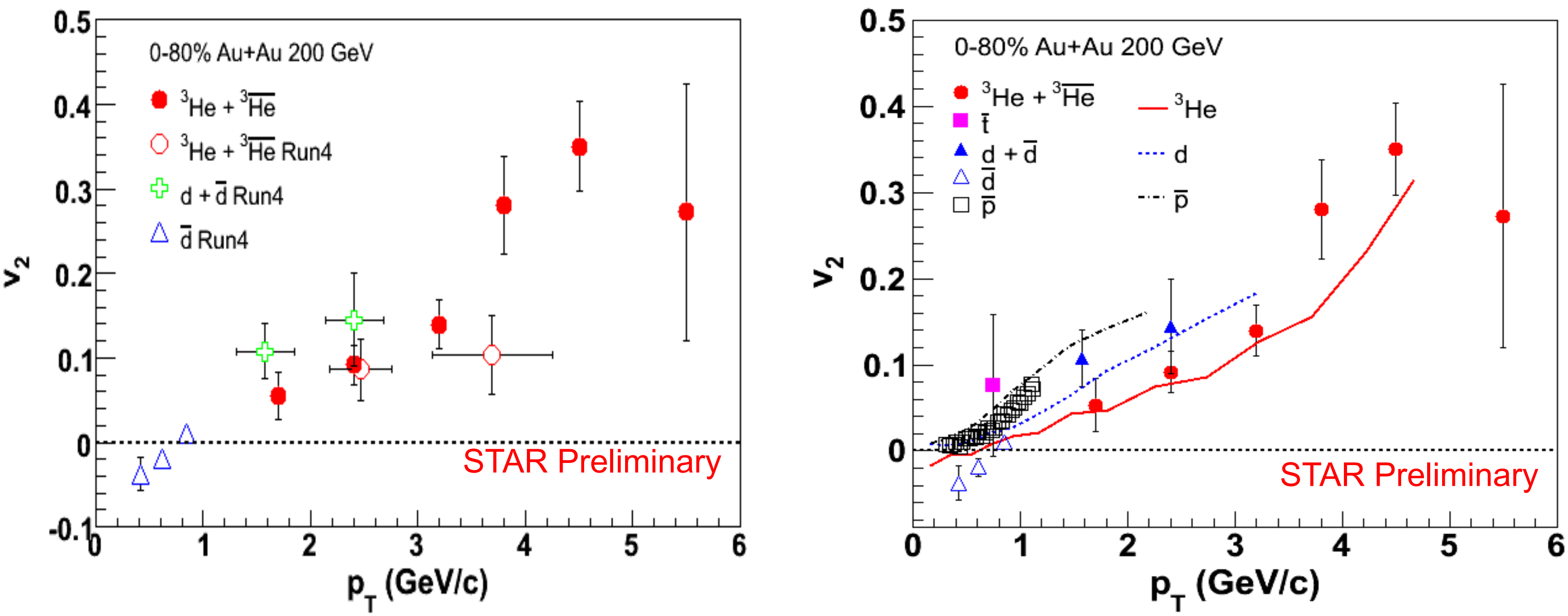


$$\frac{dN}{d\phi} \propto 1 + 2v_2^{obs}\cos[2(\phi - \Psi_R)]$$

$$v_2^{final} = \frac{v_2^{obs}}{R_2}$$

R_2 is the second order event plane resolution

v_2 vs. p_T

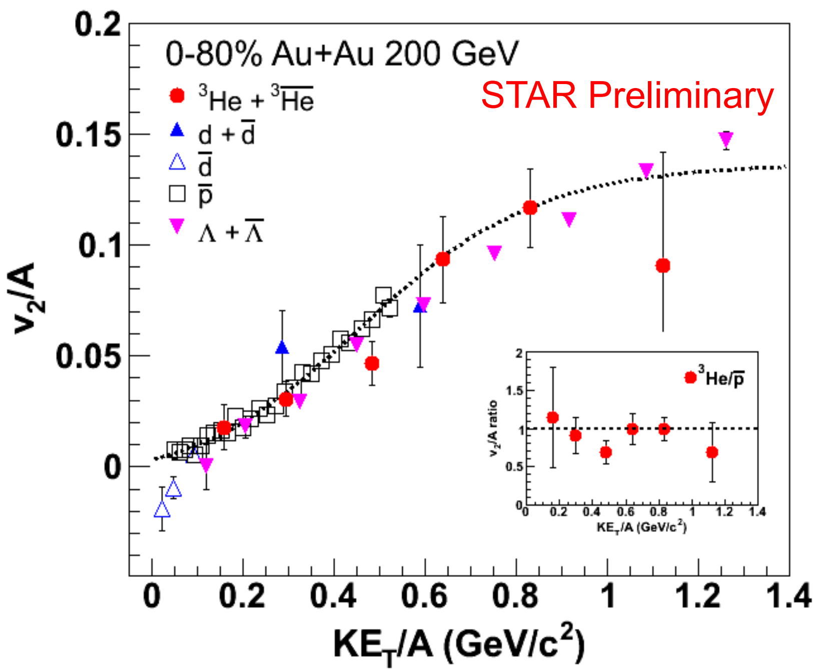


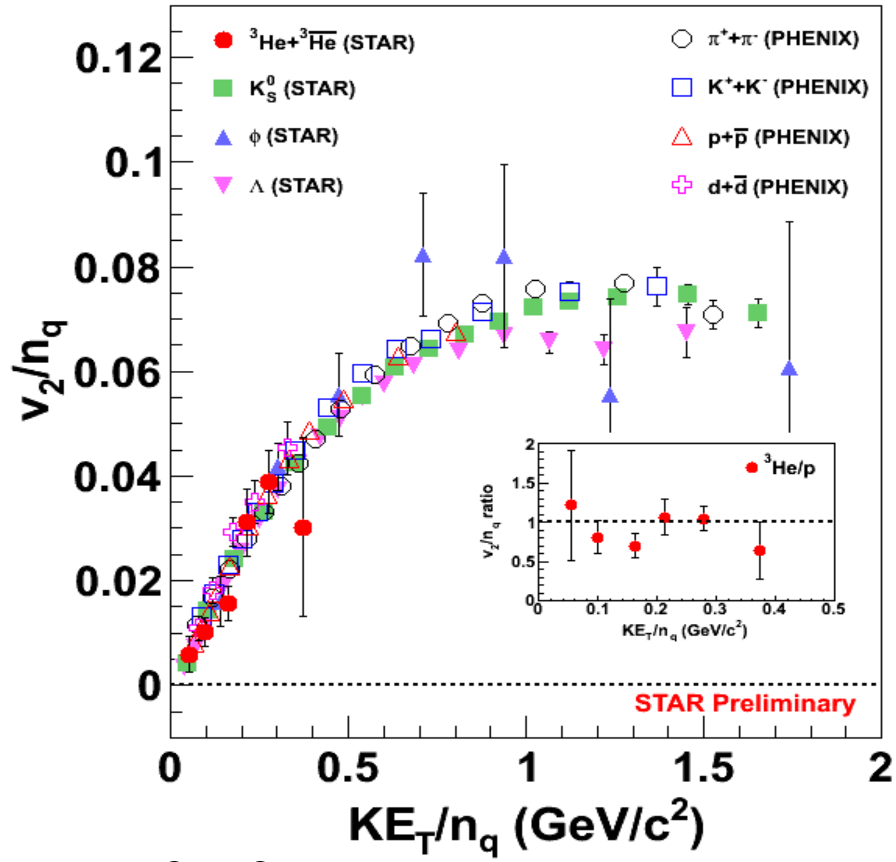
STAR, arXiv:0909.0566 [nucl-ex]

- v_2 of ^{3}He is well described by the dynamical coalescence model.
- Anti-triton v_2 has been shown for $0.3 < p_T < 1.2$ GeV/c.

Model Calculations: S. Zhang et al., Phys. Lett. B 684 (2010) 224

NCQ Scaling



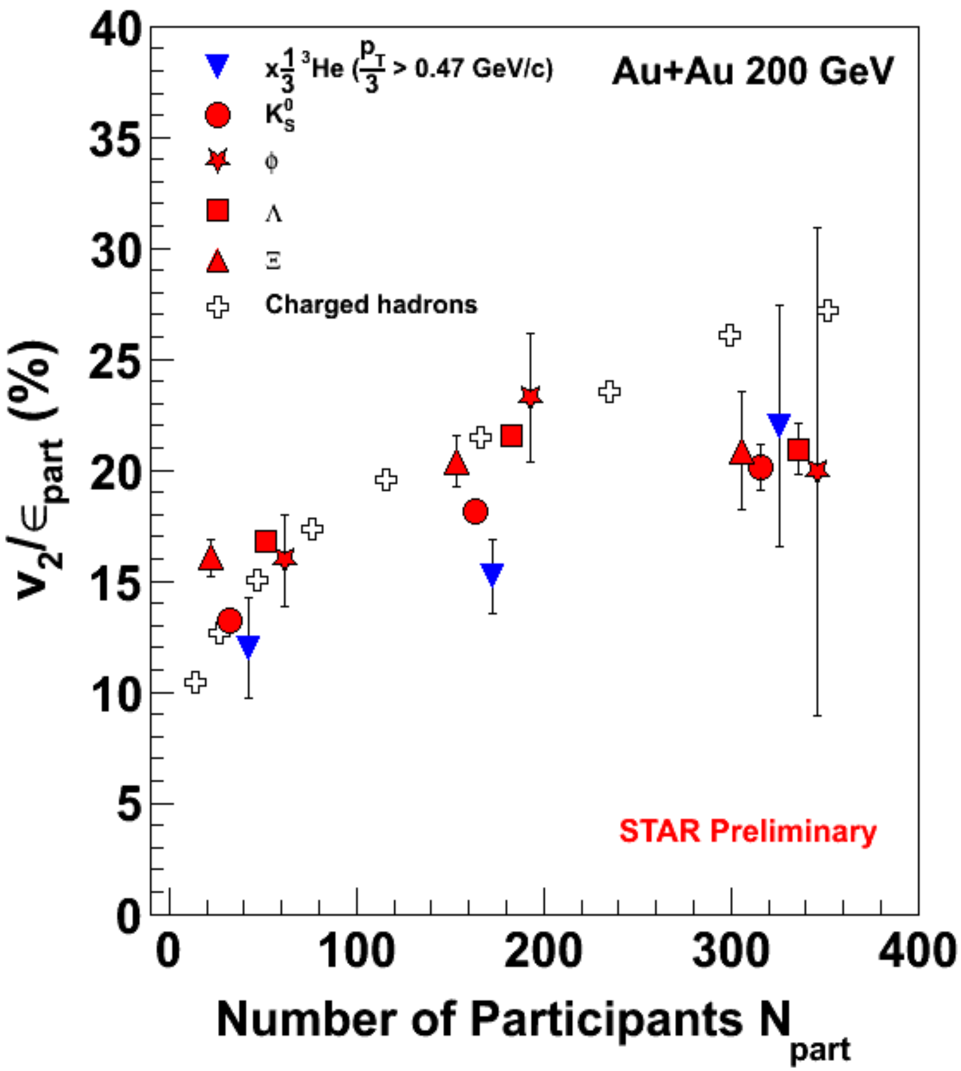


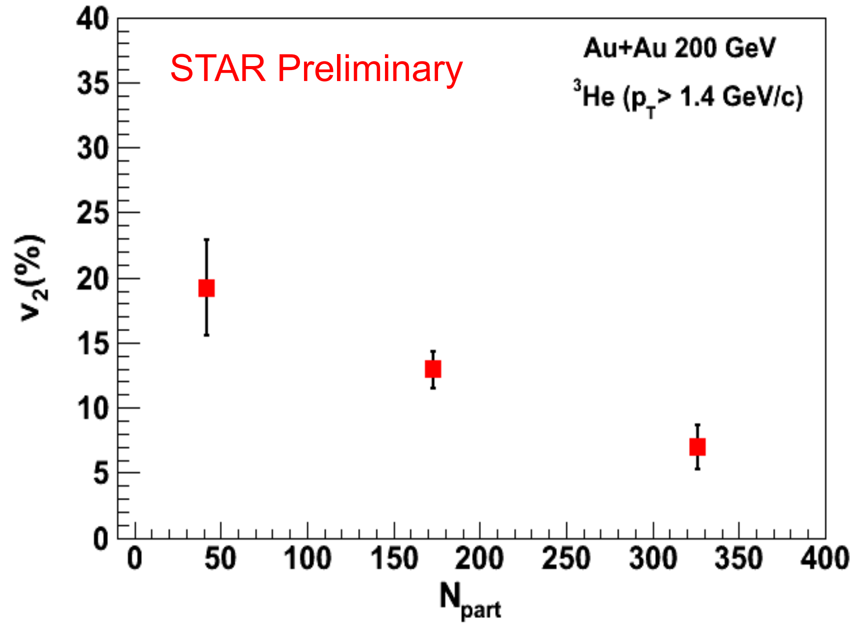
STAR, PRC 72, 014904 (2005)
STAR, arXiv:0909.0566 [nucl-ex]
PHENIX, PRL 99, 052301 (2007)

d(p+n) : n_q = 2 x 3 ^{3}He(2p+n) : n_q = 3 x 3

- v_2 of ^{3}He seem to follow the atomic mass number (A) scaling.
- Number of constituent quark (NCQ) scaling holds good for v_2 of ^{3}He.

Centrality Dependence

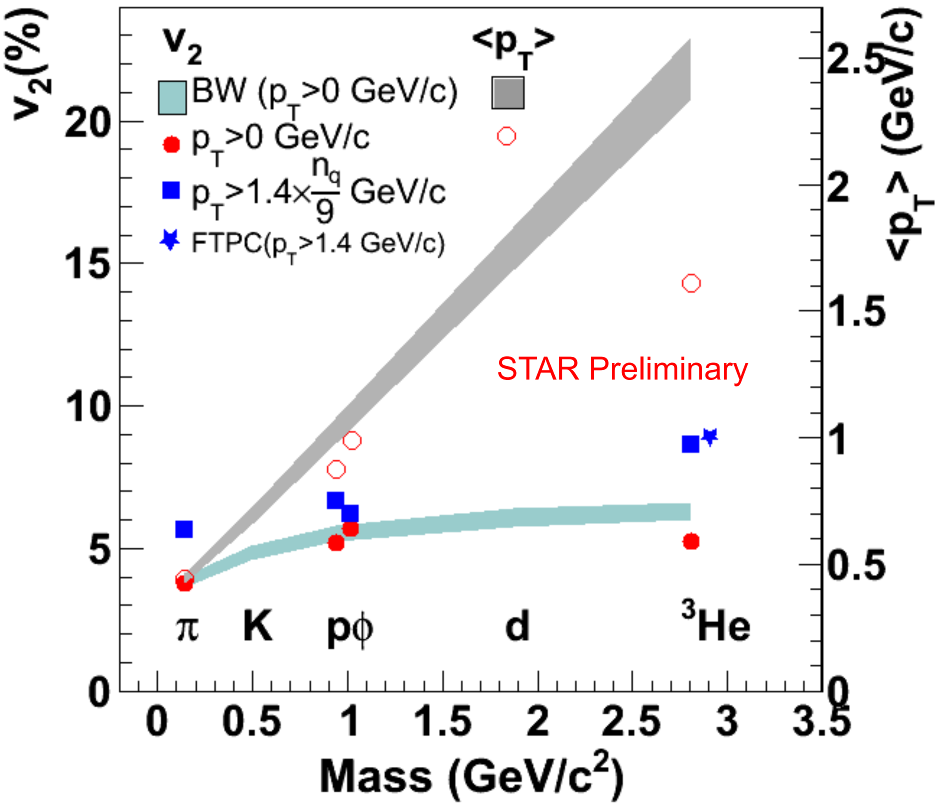




STAR, PRC 77, 054901 (2008)

Similar to other hadrons, at more central collision the larger value of v_2/ε indicates stronger collective expansion.

Mass Dependence



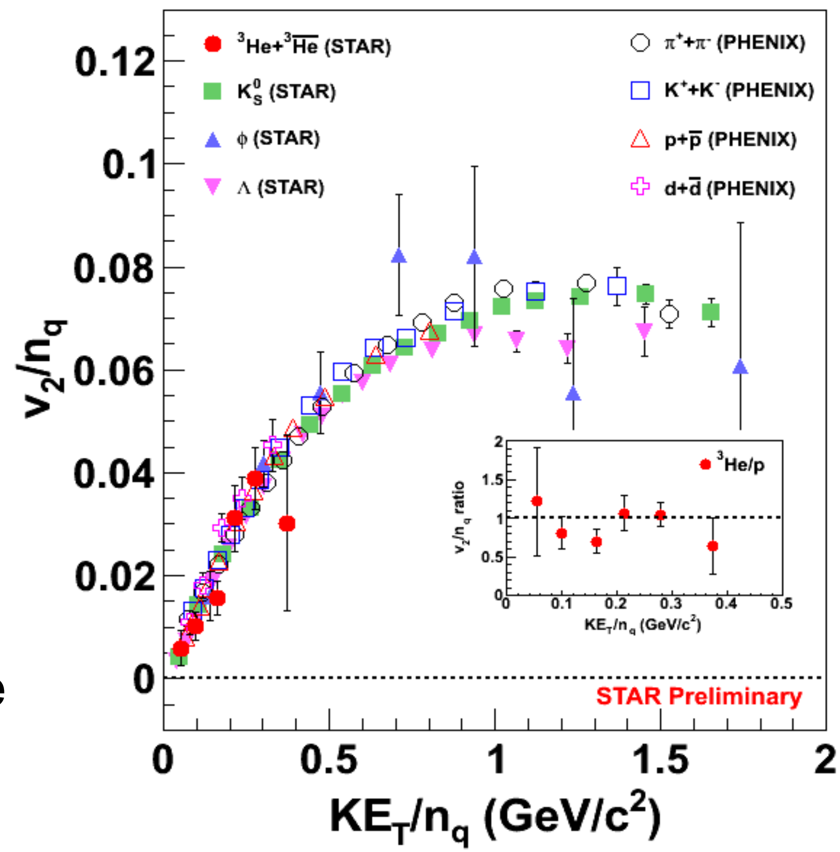
- Both v_2 and $\langle p_T \rangle$ trends are consistent with expectations from Blast-wave (BW) model fit.
- v_2 values up to ^{3}He mass has reasonable agreement within the Blast-wave formalism but differences seen in $\langle p_T \rangle$ beyond proton mass.

- *Statistical and systematic uncertainties are under study.*

π, *p* spectra: STAR, PRL 97, 152301 (2006)
π, *p* v_2: STAR, PRC 72, 014904 (2005)
STAR, PRC 77, 054901 (2008)
ϕ spectrum and v_2: STAR, PRL 99, 112301 (2007)
^{3}He spectrum: STAR, arXiv:0909.0566 [nucl-ex]
BW: Z. Tang et al., PRC 79, 051901 (2009)
M. Shao et al., JPG 37, 085104 (2010)

Summary

- v_2 of light nuclei are measured in Au+Au@200 GeV using event plane method.
- p_T dependence of v_2 is well described by Dynamical Coalescence Model.
- v_2 of light nuclei seem to follow the atomic mass number scaling.
- Number of constituent quark scaling holds good for v_2 of light nuclei.
- At more central collision the large value of v_2/ε indicates stronger collective expansion.
- Both v_2 and $\langle p_T \rangle$ trends are consistent with expectations from Blast-wave model fit.



Backup

v_2 Comparison