Collective flow in ^{3}He-Au collisions

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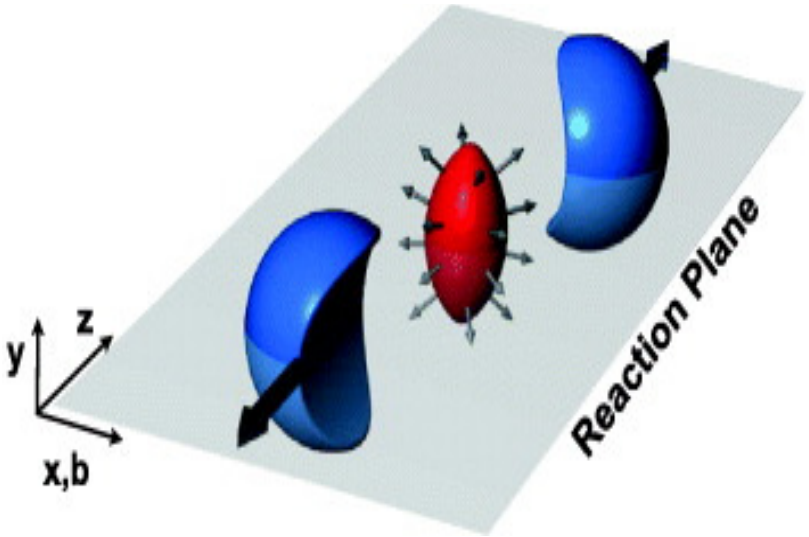
with Wojtek Broniowski

asymmetry in the transverse plane at finite impact parameter

Glauber model, KLN model, IP-Glasma

eccentricity - $\epsilon_2 = -\frac{\int dxdy(x^2-y^2)\rho(x,y)}{\int dxdy(x^2+y^2)\rho(x,y)}$



Snellings 2011

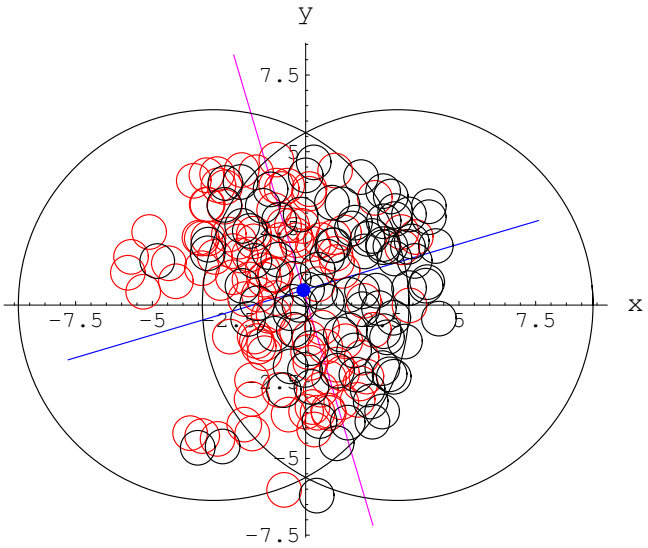
larger gradient and stronger flow in-plane - $v_2 > 0$ - **elliptic flow**

$$\frac{dN}{d\phi} \propto 1 + 2v_2 cos(2\phi)$$

$$\epsilon_2 + \mathrm{HYDRO\ RESPONSE} \longrightarrow \mathrm{v_2}$$

Event Plane (Reaction plane) must be reconstructed in each event

Initial profile



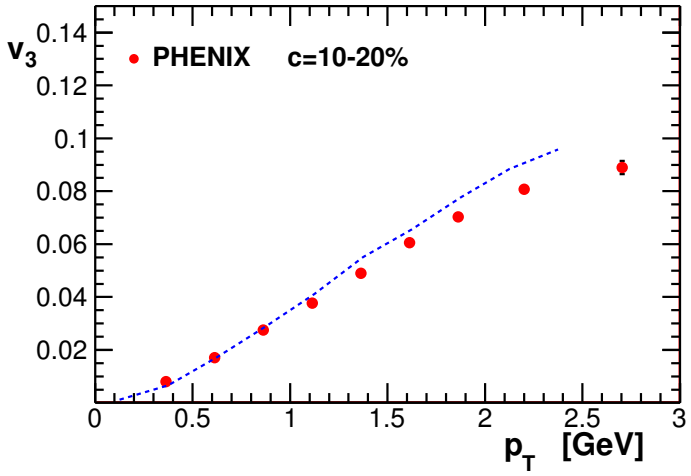
Glauber $\leftrightarrow$ fKLN

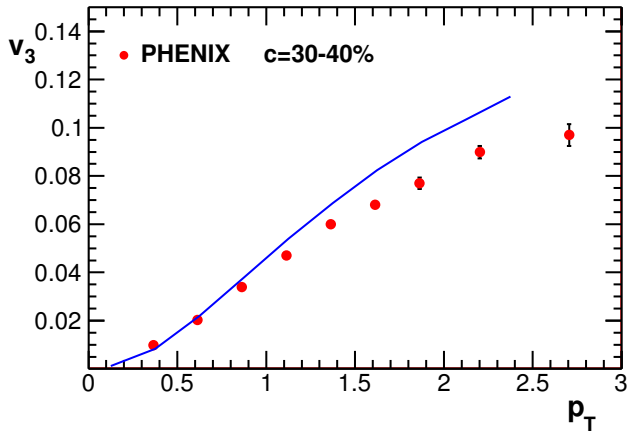
fluctuating initial density

$\rightarrow$ larger eccentricity

$\rightarrow$ fluctuating eccentricity

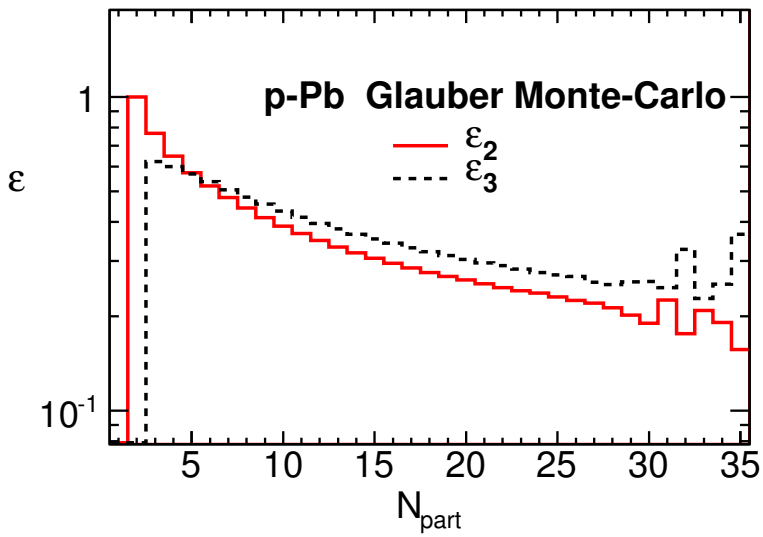
$\rightarrow$ triangular deformation ϵ_3



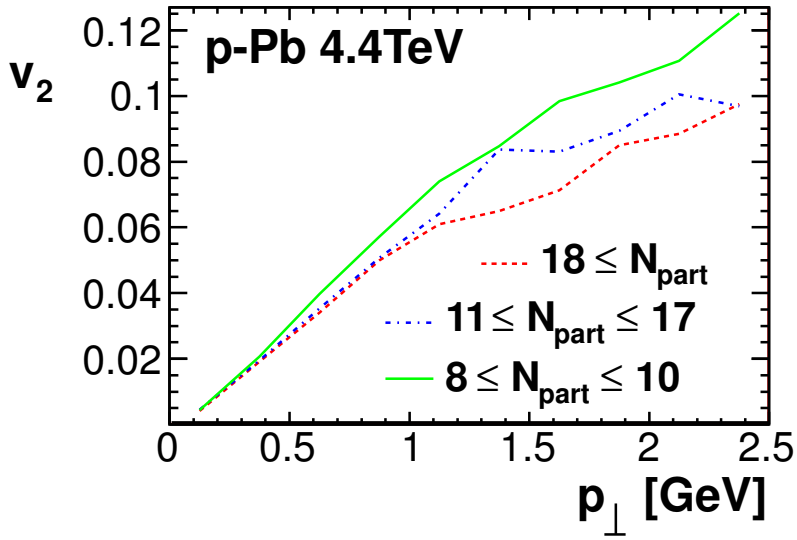


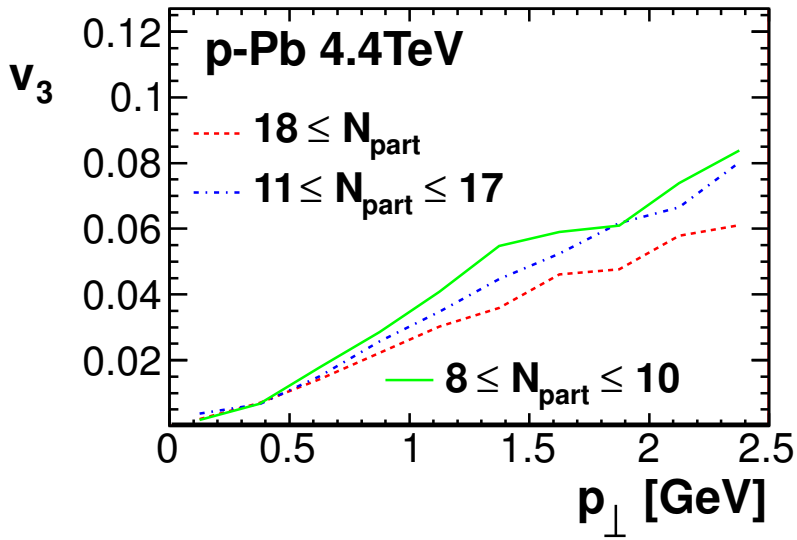
triangular flow - event by event

Fireball in p-Pb



PB, arXiv:1112.0912

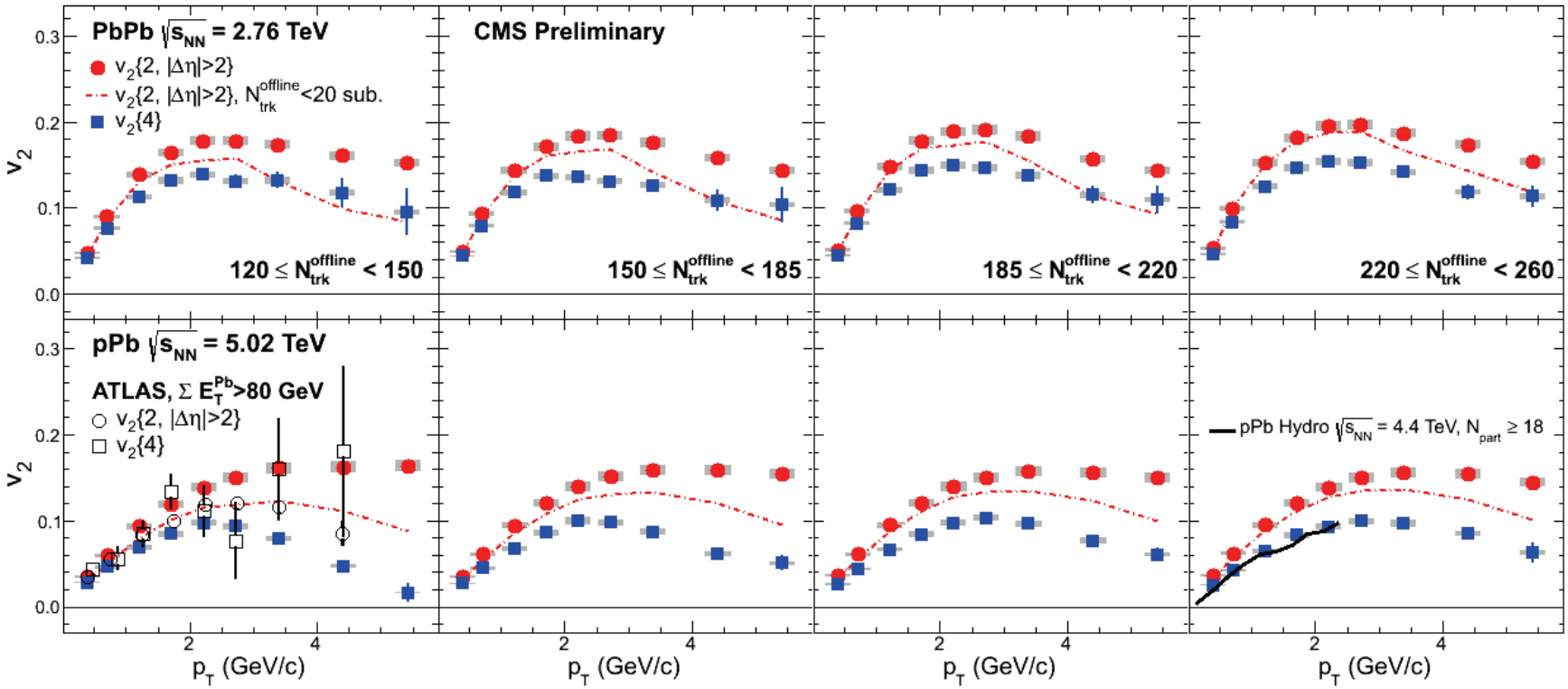




v_2 in pPb and PbPb

Dash-dot line: peripheral subtracted

multiplicity →



PbPb

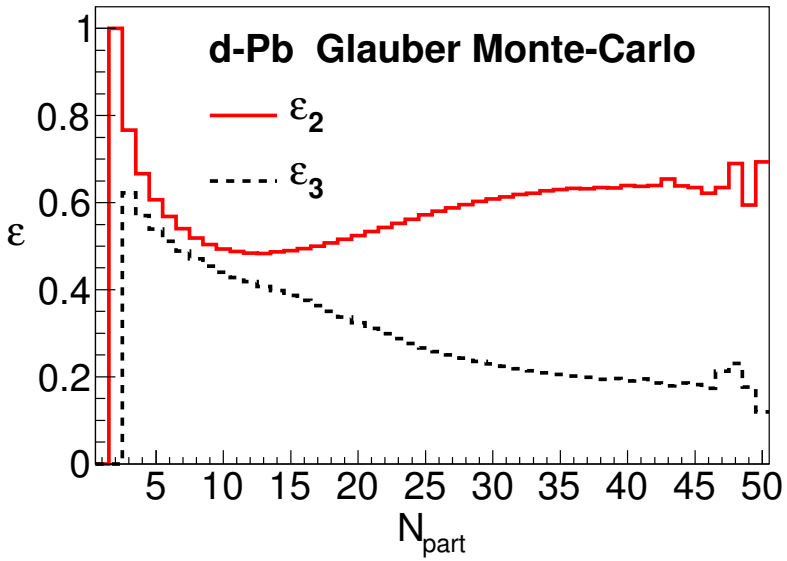
pPb

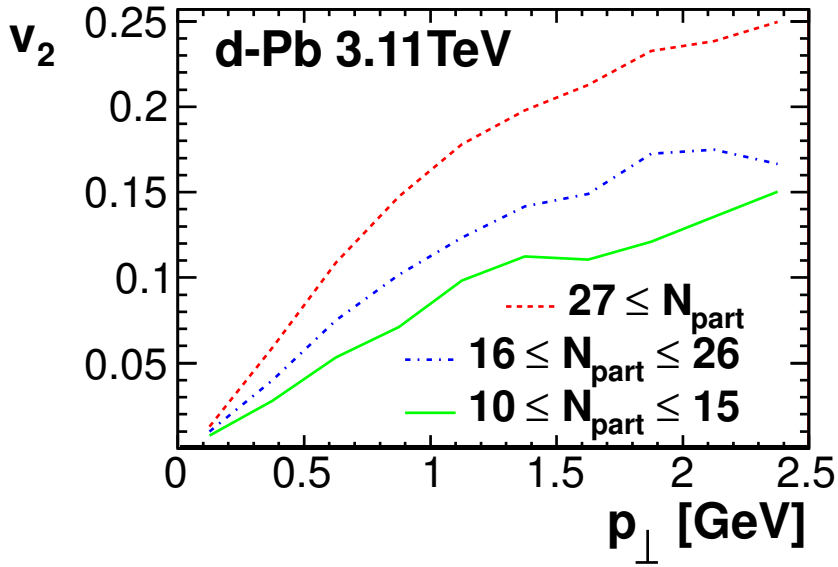
v_2 shows similar shape in pPb and PbPb, but is smaller in pPb

$v_2\{4\}$ is only 20% smaller than $v_2\{2\}$ below 2 GeV/c

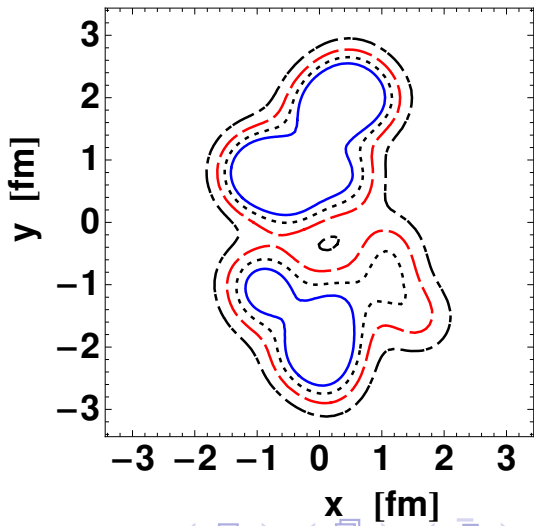
"Peripheral subtraction" has small effect at high multiplicity

d-Pb





large elliptic flow

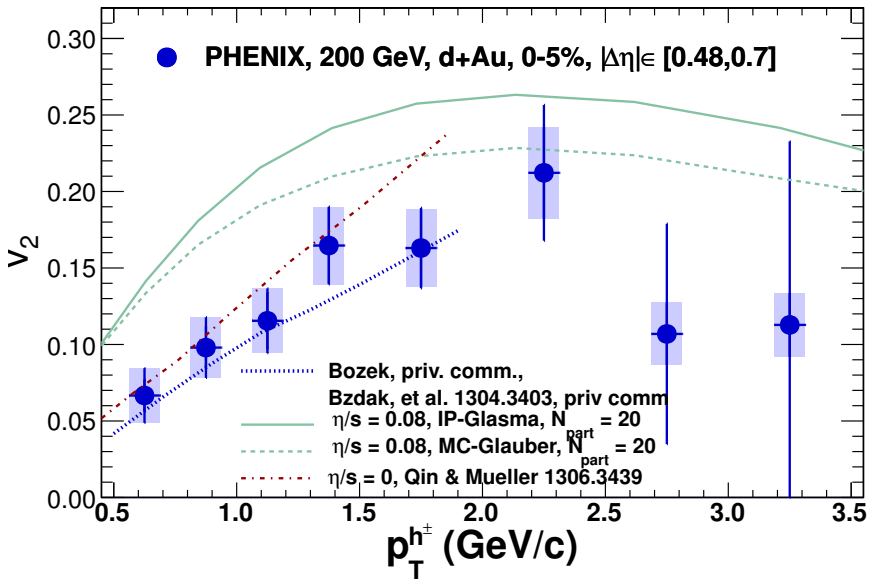


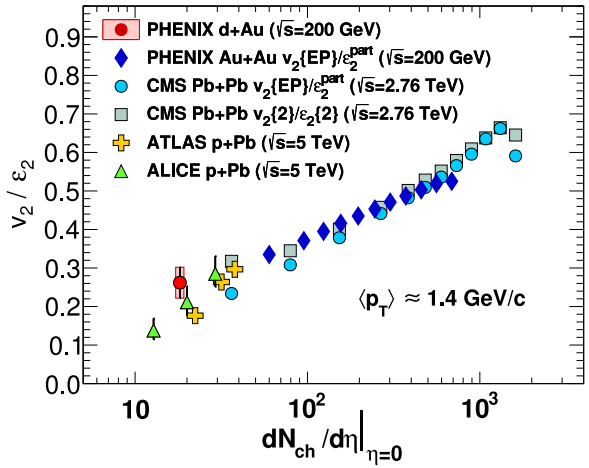
PB, arXiv:1112.0912

. . . collective effects in d-Au collisions at $\sqrt{s_N} = 200$GeV

in RHIC experiments ?! . . .

d-Au at 200GeV

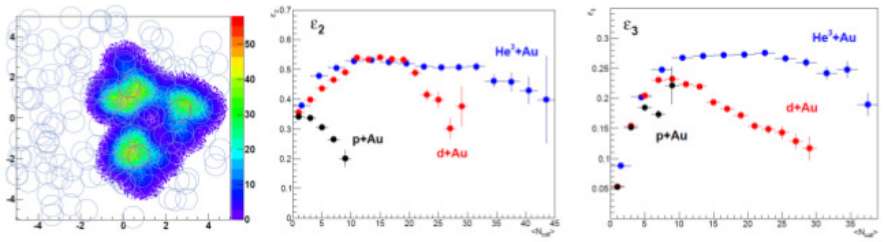




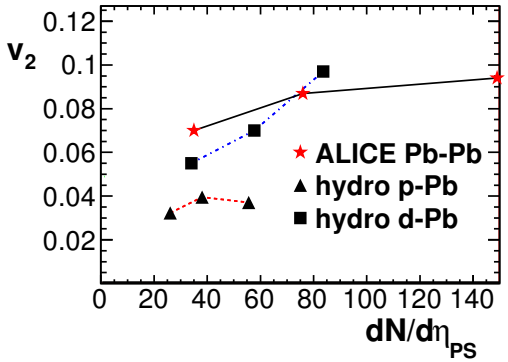
PHENIX, arXiv:1303.1794

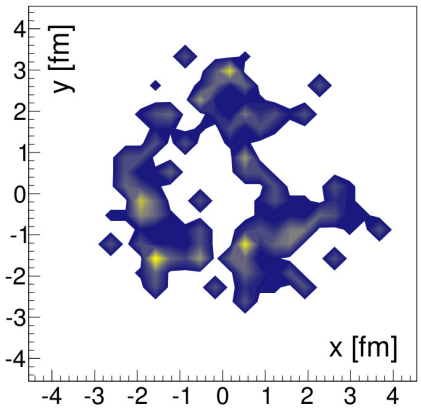
large eccentricity - large elliptic flow

small on big collisions



PHENIX proposal $\longrightarrow$ v_3, Sickles et al. arXiv:1401.2432





α clusters in ^{12}C Broniowski, Arriola arXiv:1312.0289

PB, arXiv:1112.0912

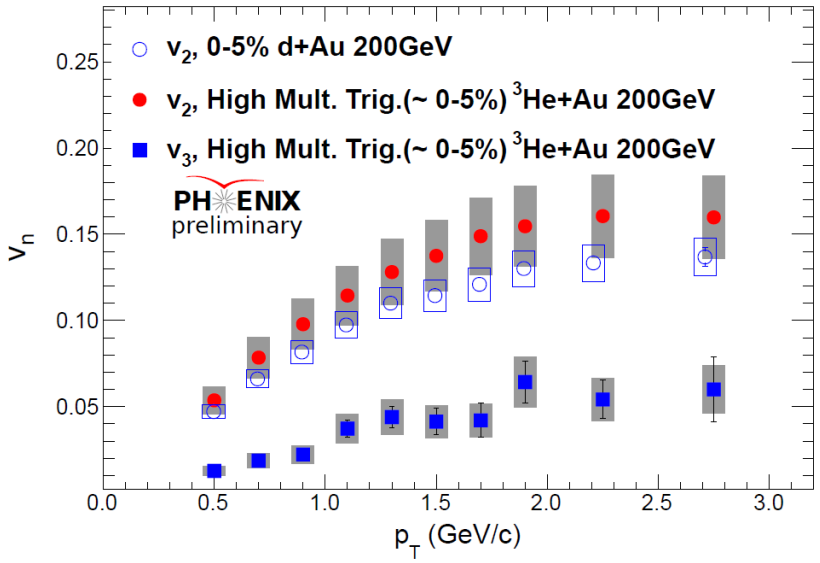
strong effect for d-A

intrinsic deformation dominates over fluctuations

some effect for v_3 in ^{3}*He*-*A*,

Nagle et al. arXiv:1312.4565

Triangular flow in ^{3}He-Au

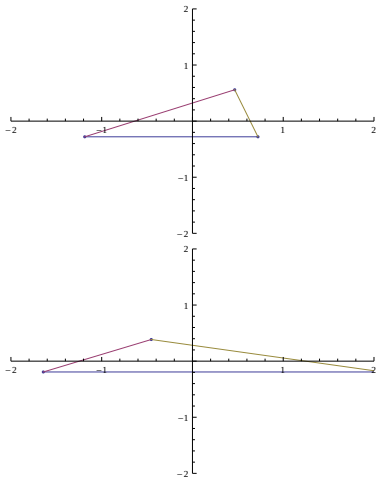


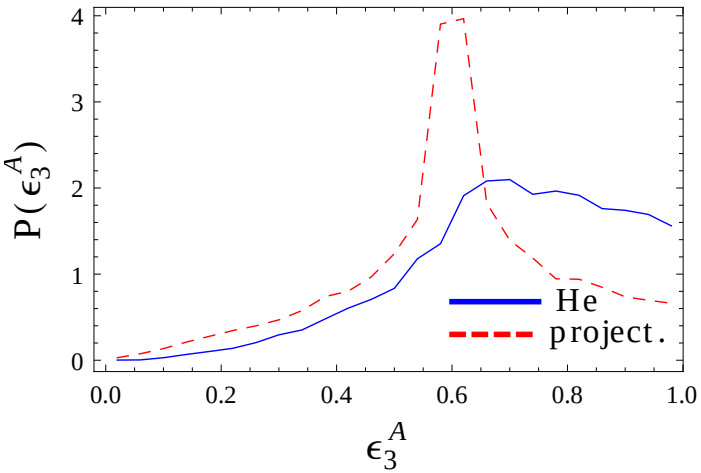
-strong v_2 in d-Au **and** ^{3}He-Au
-strong v_3 in ^{3}He-Au

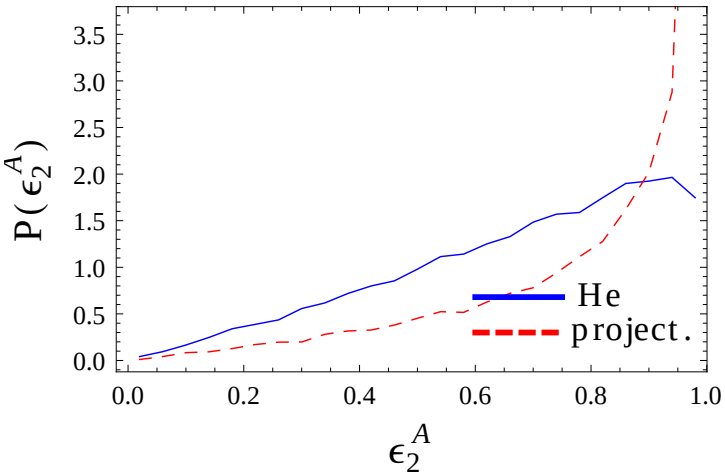
- observed $v_3 \longrightarrow$ collectivity
- hierarchy of v_2 and v_3 consisent with collective response on fireball geometry
- large v_2 in He-Au (?)

^{3}He configurations

elongated He configurations

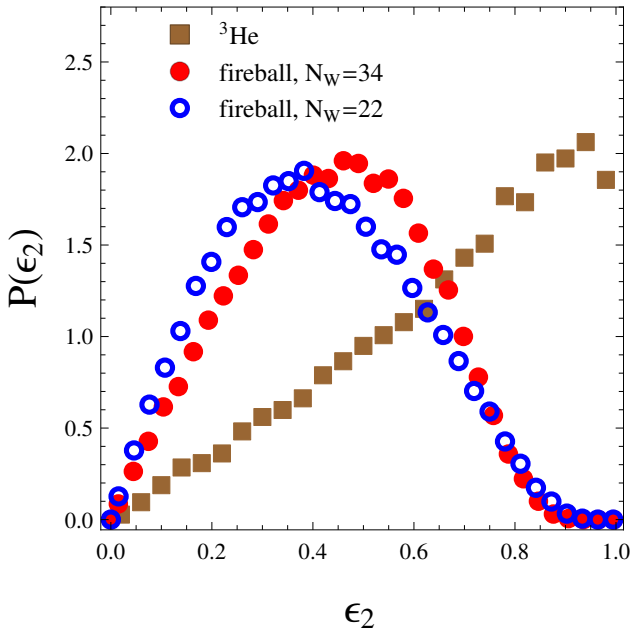


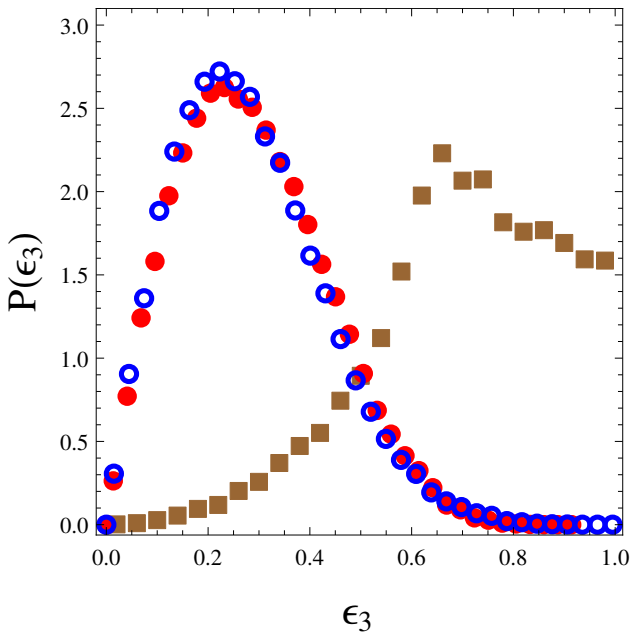




- large ϵ_2
- even larger after projection
- broad distribution of ϵ_3
- after projection $\epsilon_3 \simeq 0.6$

^{3}He-Au fireball

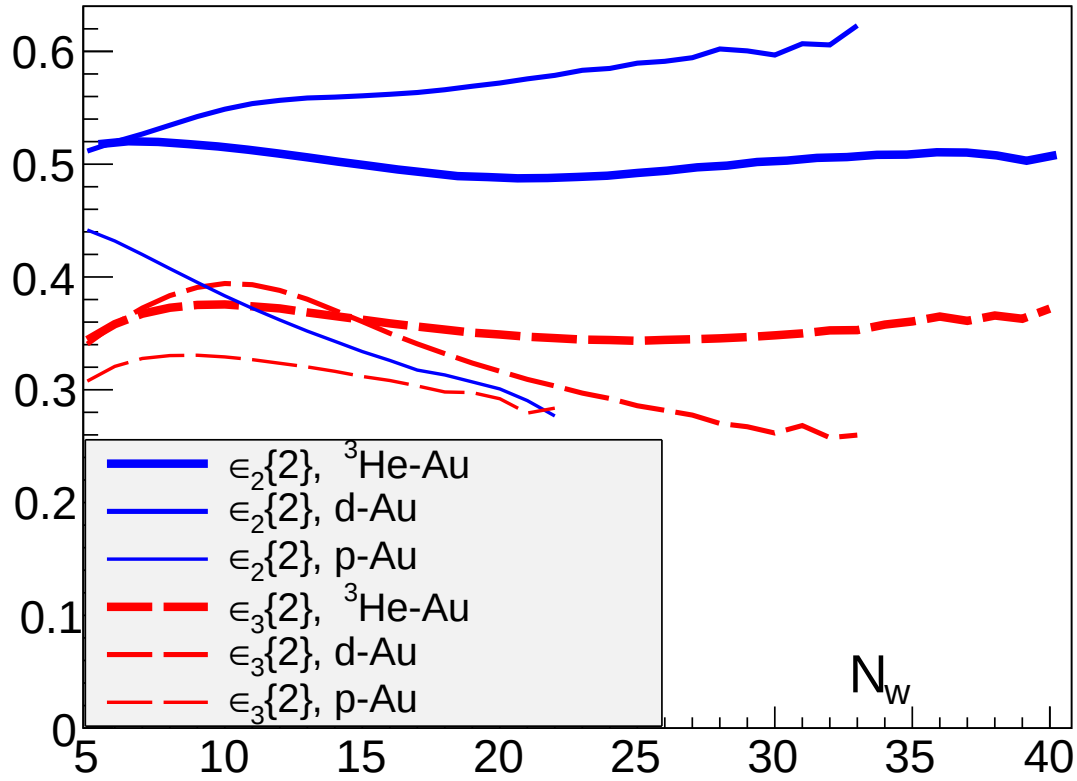




strong ellipticity !!
explains observed large v_2

significant triangularity
$\longrightarrow$ observable v_3

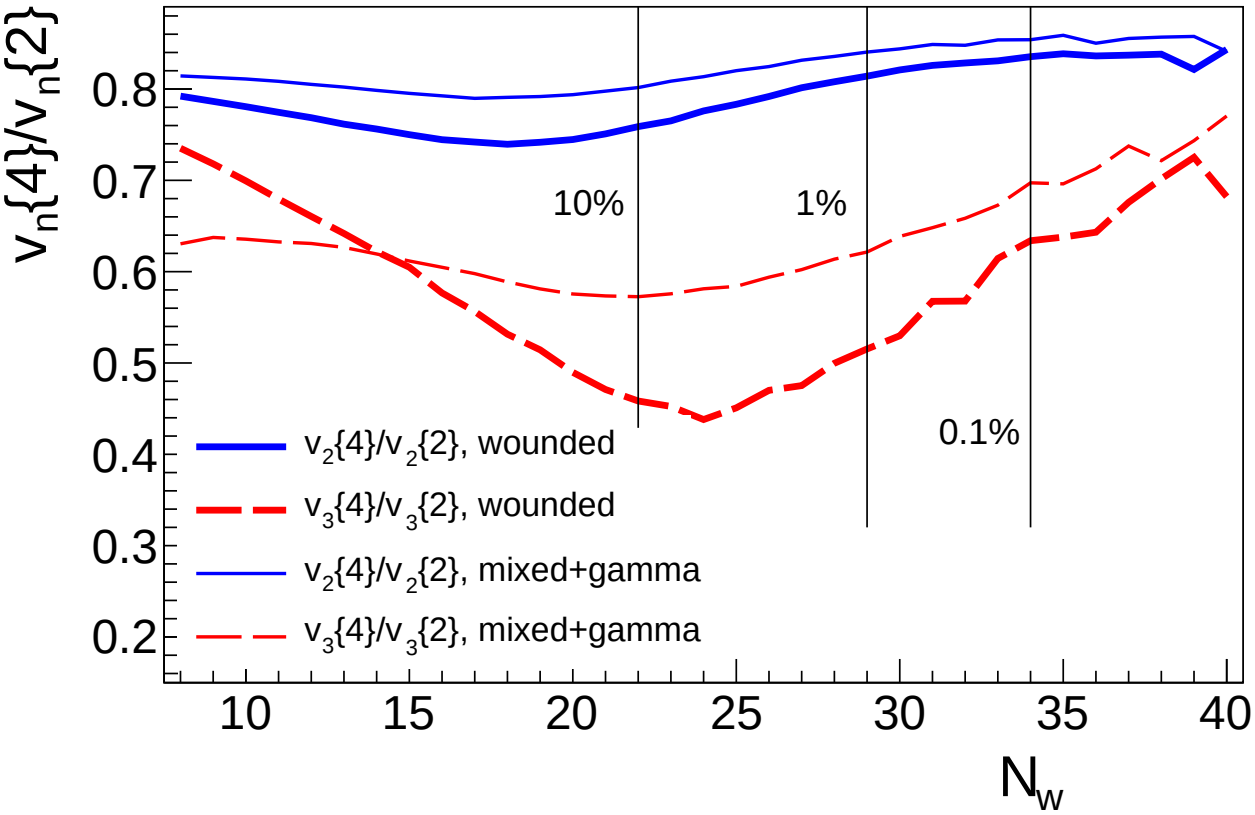
ϵ_2, ϵ_3 hierarchy



linear hydrodynamic response $\longrightarrow$ EXPERIMENT

$$v_n = \kappa \epsilon_n$$

observable senisitive to triangular geometry



- ratio $v_3\{4\}/v_3\{2\}$ - nonmonotonic
- fluctuations $v_3\{4\}/v_3\{2\} \longrightarrow 0$
- geometry $v_3\{4\}/v_3\{2\} \longrightarrow 1$

Summary

- collectivity in p-A, d-A, ^{3}He-A
- hierarchy of v_2 and v_3 consistent with fireball geometry
- observed effect - dynamical response to geometry
- $v_3\{4\}/v_3\{2\}$ - observable to look for geometric triangularity