

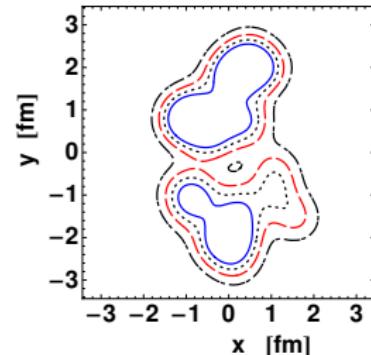
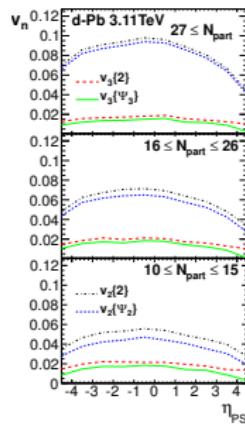
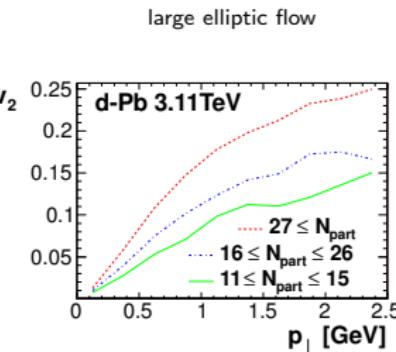
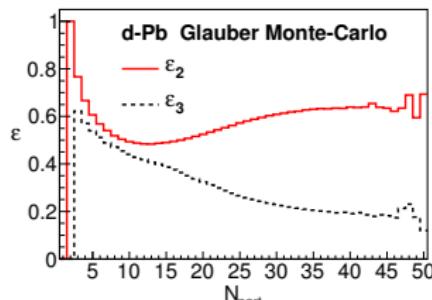
Femtoscopy in d-Au collisions

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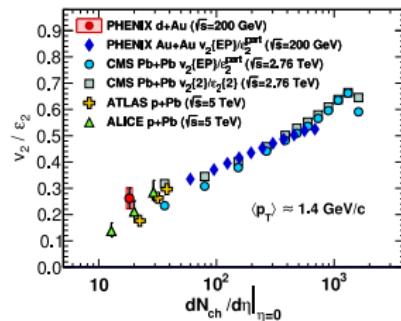
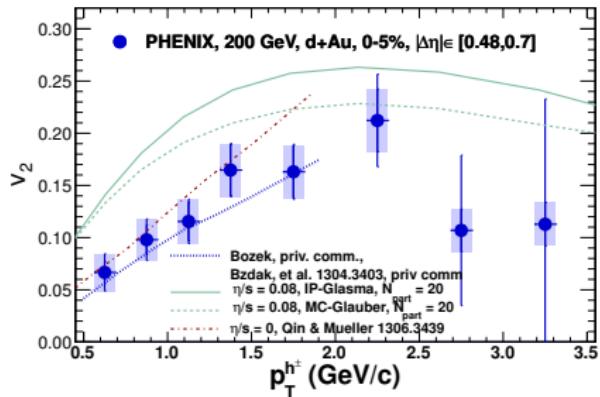


d-Pb (small system with geometrical eccentricity)



PB, arXiv:1112.0912

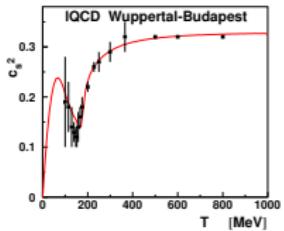
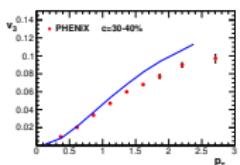
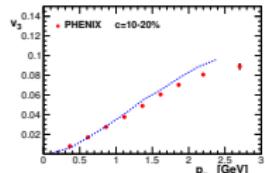
d-Au at 200GeV



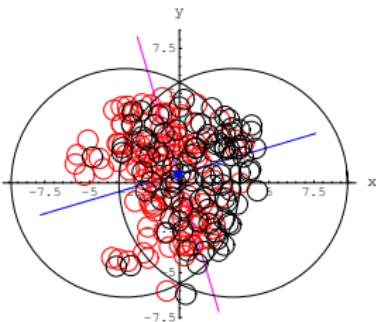
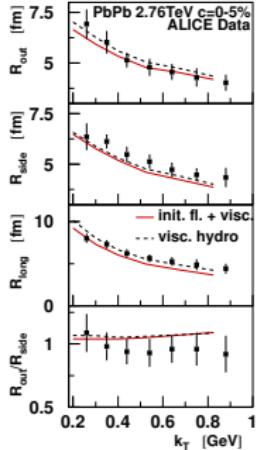
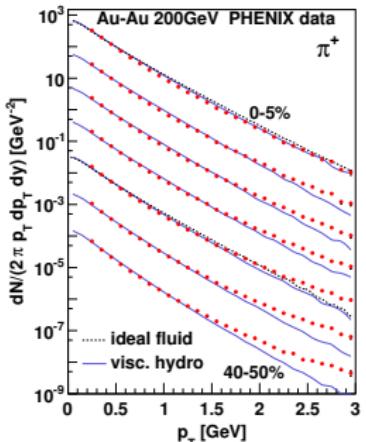
PHENIX, arXiv:1303.1794

large eccentricity - large elliptic flow

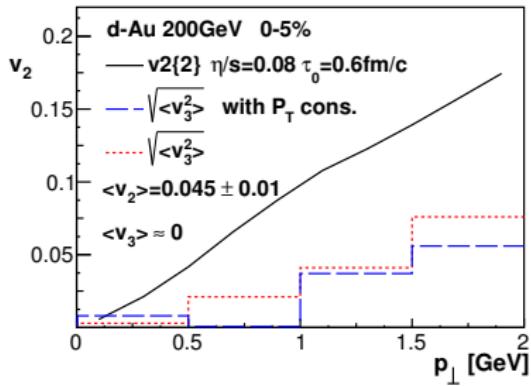
3+1D hydrodynamics



IQCD + Hadron Gas

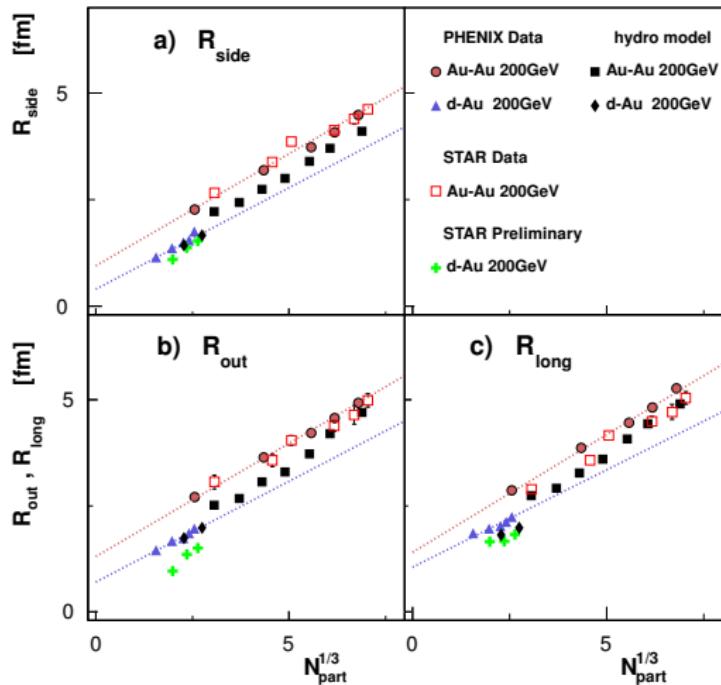


v_2 and v_3 in d-Au



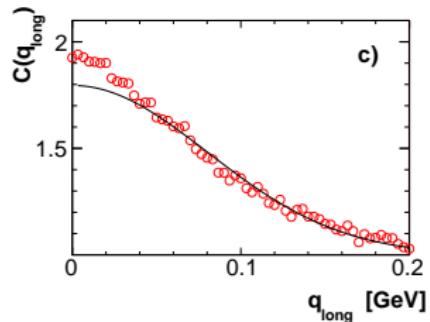
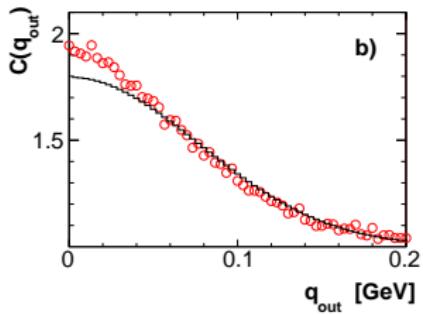
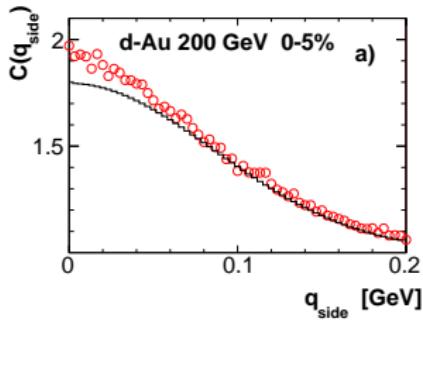
large v_2 , small v_3

$$C(q, k_{\perp}) = 1 + \lambda e^{-R_o^2 q_o^2 - R_s^2 q_s^2 - R_l^2 q_l^2}$$



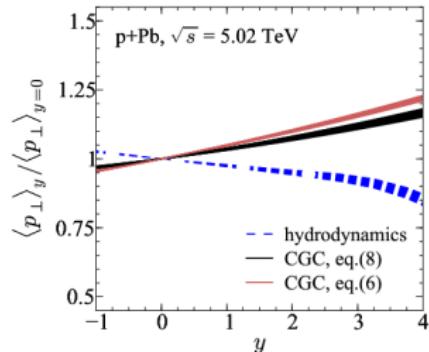
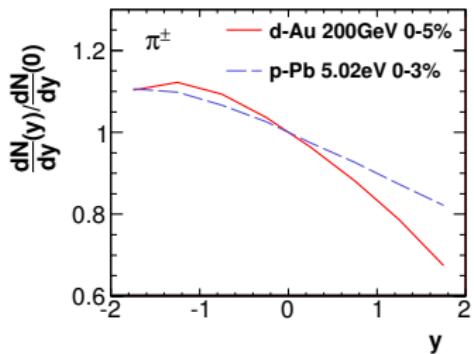
HBT in d-Au well described by hydro

Non-Gaussian correlation functions



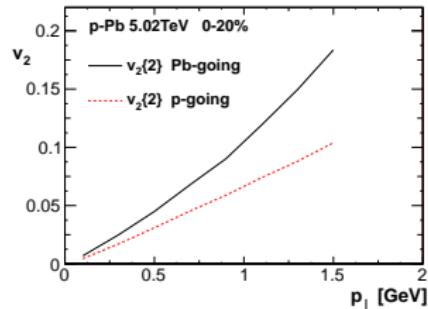
Non-Gaussian shape
Fitted radii stable for $q \simeq 150 \text{ MeV}$

Forward-backward asymmetry

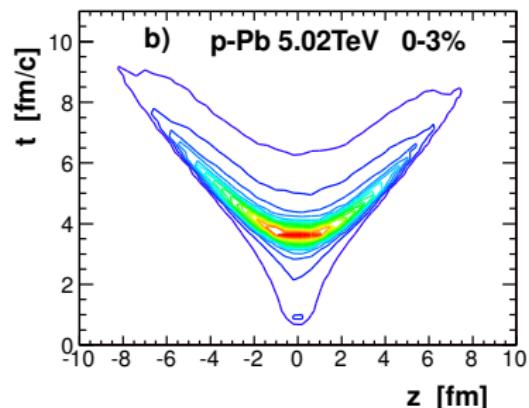
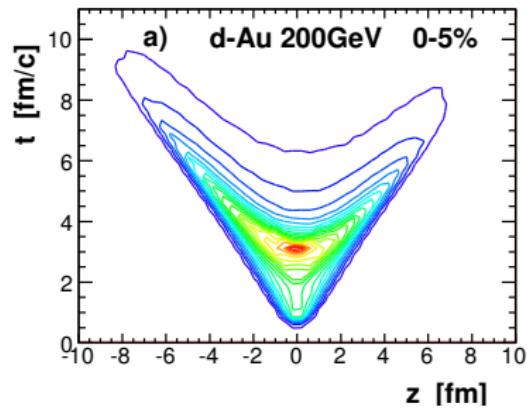


(PB, Bzdak, Skokov)

Larger fireball on Pb going side
Stronger flow on Pb going side



different emission times in forward-backward hemispheres



lcms of the pion

symmetry constraints (Heinz, Hummel, Lisa, Wiedemann)

$$\frac{1}{2} \left((\langle x^2 \rangle - \langle x \rangle^2) + (\langle y^2 \rangle - \langle y \rangle^2) \right) =$$

$$A_0 + 2 \sum_{n=2,4,\dots} A_n \cos(n\Phi)$$

$$\frac{1}{2} \left((\langle x^2 \rangle - \langle x \rangle^2) - (\langle y^2 \rangle - \langle y \rangle^2) \right) =$$

$$B_0 + 2 \sum_{n=2,4,\dots} B_n \cos(n\Phi)$$

$$\langle xy \rangle - \langle x \rangle \langle y \rangle = 2 \sum_{n=2,4,\dots} C_n \sin(n\Phi)$$

$$\langle t^2 \rangle - \langle t \rangle^2 = D_0 + 2 \sum_{n=2,4,\dots} D_n \cos(n\Phi)$$

$$\langle tx \rangle - \langle t \rangle \langle x \rangle = 2 \sum_{n=1,3,\dots} E_n \cos(n\Phi)$$

$$\langle ty \rangle - \langle t \rangle \langle y \rangle = 2 \sum_{n=1,3,\dots} F_n \sin(n\Phi)$$

$$\langle tz \rangle - \langle t \rangle \langle z \rangle = G_0 + 2 \sum_{n=2,4,\dots} G_n \cos(n\Phi)$$

$$\langle xz \rangle - \langle x \rangle \langle z \rangle = 2 \sum_{n=1,3,\dots} H_n \cos(n\Phi)$$

$$\langle yz \rangle - \langle y \rangle \langle z \rangle = 2 \sum_{n=1,3,\dots} I_n \sin(n\Phi)$$

$$\langle z^2 \rangle - \langle z \rangle^2 = J_0 + 2 \sum_{n=2,4,\dots} J_n \cos(n\Phi)$$

$$R_s^2 = A_0 - B_2 - C_2 + (2A_2 - B_0 - B_4 - C_4) \cos(2\Phi)$$

$$R_o^2 = A_0 + B_2 + C_2 - 2E_1\beta_\perp - 2F_1\beta_\perp + D_0\beta_\perp^2 \\ + (2A_2 + B_0 + B_4 + C_4 - 2\beta_\perp(E_1 + E_3 - F_1 + F_3)) \cos(2\Phi)$$

$$R_{os}^2 = (-B_0 + B_4 + C_4 + \beta_\perp(E_1 - E_3 - F_1 - F_3)) \sin(2\Phi)$$

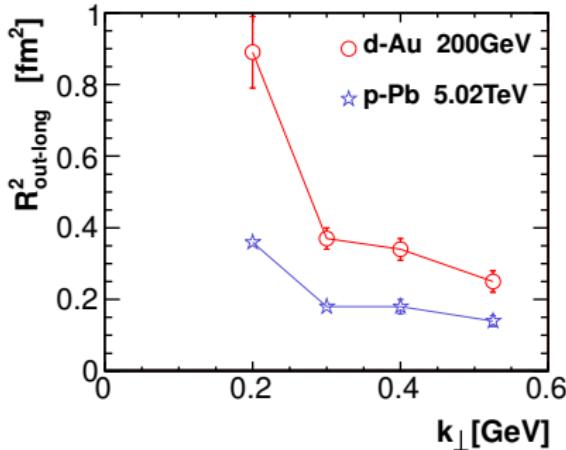
$$R_I^2 = J_0 + 2J_2 \cos(2\Phi)$$

$$R_{ol}^2 = H_1 + I_1 - G_0\beta_\perp + (I_1 + I_3 - H_1 + H_3) \cos(2\Phi)$$

$$R_{sl}^2 = (I_1 + I_3 - H_1 + H_3) \sin(2\Phi),$$

additional terms for asymmetric systems
(PB 1408.1264)

$R_{out-long} \neq 0$ in asymmetric collisions

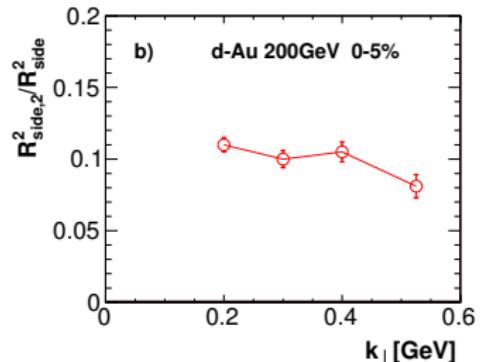
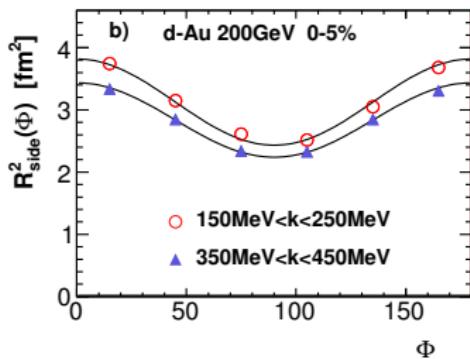


$$C(q, k_\perp) = 1 + \lambda e^{-R_o^2 q_o^2 - R_s^2 q_s^2 - R_l^2 q_l^2 - 2R_{ol}^2 q_o q_l}$$

$$R_{ol}^2 = H_1 + I_1 - G_0 \beta_\perp + (I_1 + \dots) \cos(2\Phi)$$

azimuthally sensitive HBT in d-Au

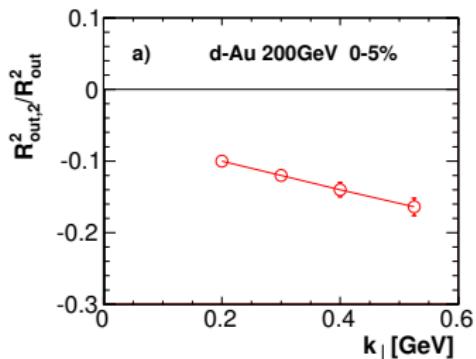
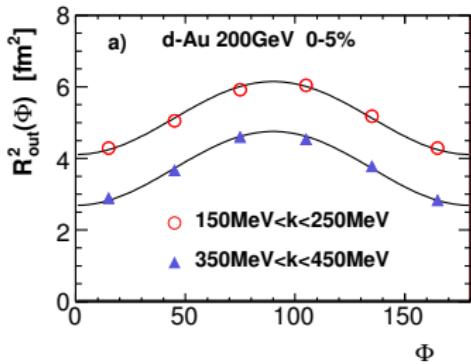
$$R_s^2(\Phi) = R_{s,0}^2 + 2R_{s,2}^2 \cos(2\Phi)$$



R_{side} larger in-plane

azimuthally sensitive HBT in d-Au - R_{out}

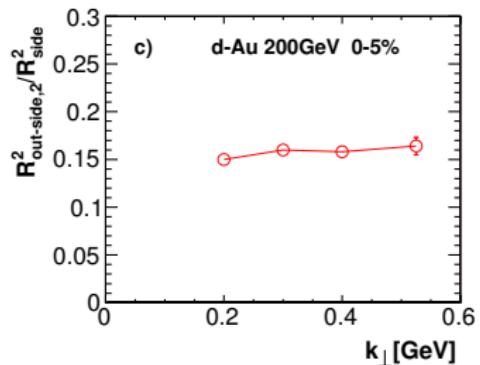
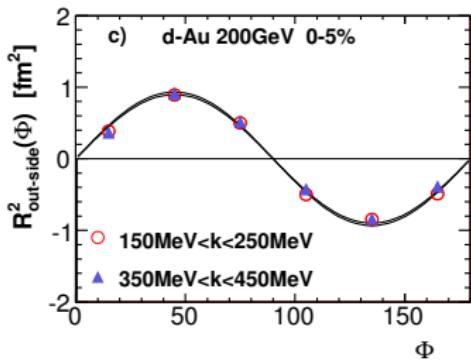
$$R_o^2(\Phi) = R_{o,0}^2 + 2R_{o,2}^2 \cos(2\Phi)$$



R_{out} smaller in-plane

azimuthally sensitive HBT in d-Au - $R_{out-side}$

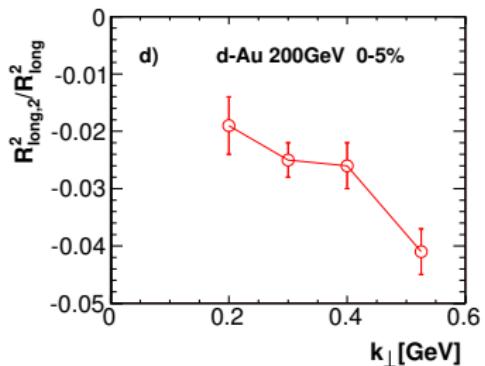
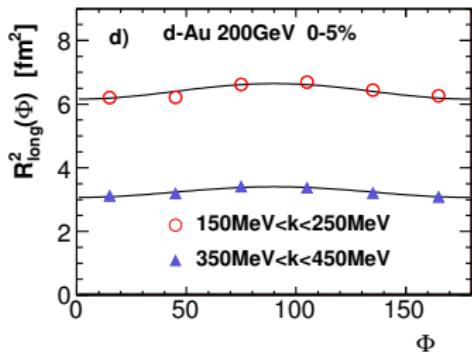
$$R_{os}^2(\Phi) = 2R_{os,2}^2 \sin(2\Phi)$$



$$R_{out-side} \neq 0$$

azimuthally sensitive HBT in d-Au - R_{long}

$$R_I^2(\Phi) = R_{I,0}^2 + 2R_{I,2}^2 \cos(2\Phi)$$



$$R_{long,2} \neq 0$$

Summary

- ▶ hydrodynamics in d-Au + large eccentricity → large v_2
- ▶ small v_3 in d-Au
- ▶ significant $R_{out-long}$
 - ▶ large forward-backward asymmetry in d-Au (p-Pb)
 - ▶ $R_{out-long}$ decreases for peripheral events
 - ▶ can be estimated exp.
- ▶ azimuthally sensitive HBT in d-Au
 - ▶ HBT radii angle dependent
 - ▶ large second order coefficients, $R_{s,2}$, $R_{o,2}$, $R_{os,2}$, $R_{l,2}$
 - ▶ would be a nice confirmation of the geometrical origin of the observed collective-like behavior
 - ▶ difficult exp.?