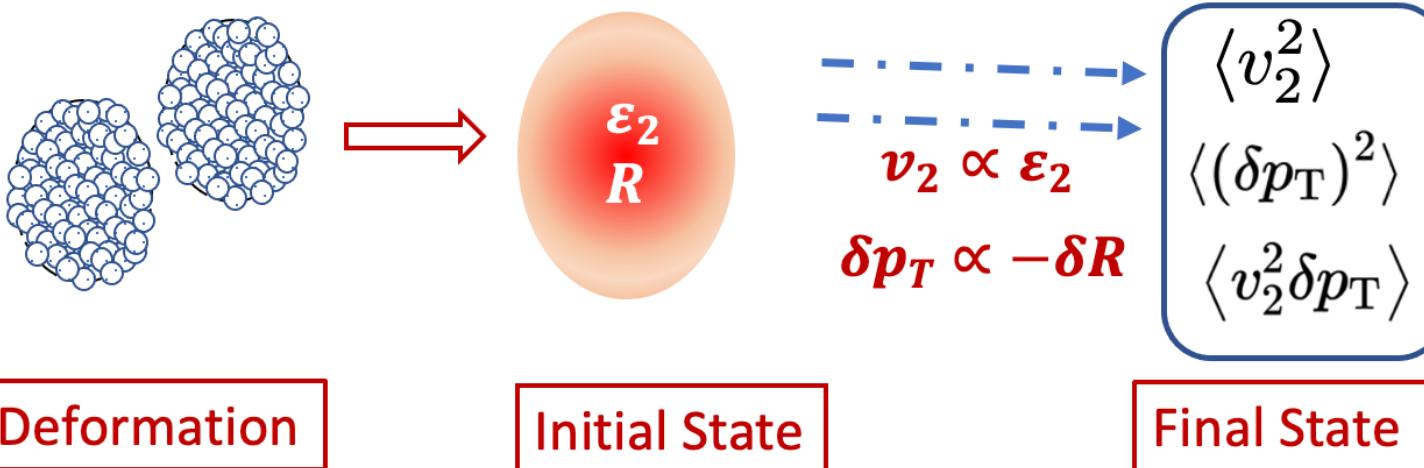


Probing initial state using higher order fluctuations: v_2 -[p_T] and [p_T] correlations in ATLAS

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Content of talk:

1. Impact of nuclear deformation on flow fluctuations
2. Probing the thermalization via [p_T] fluctuation in ultra-central collisions



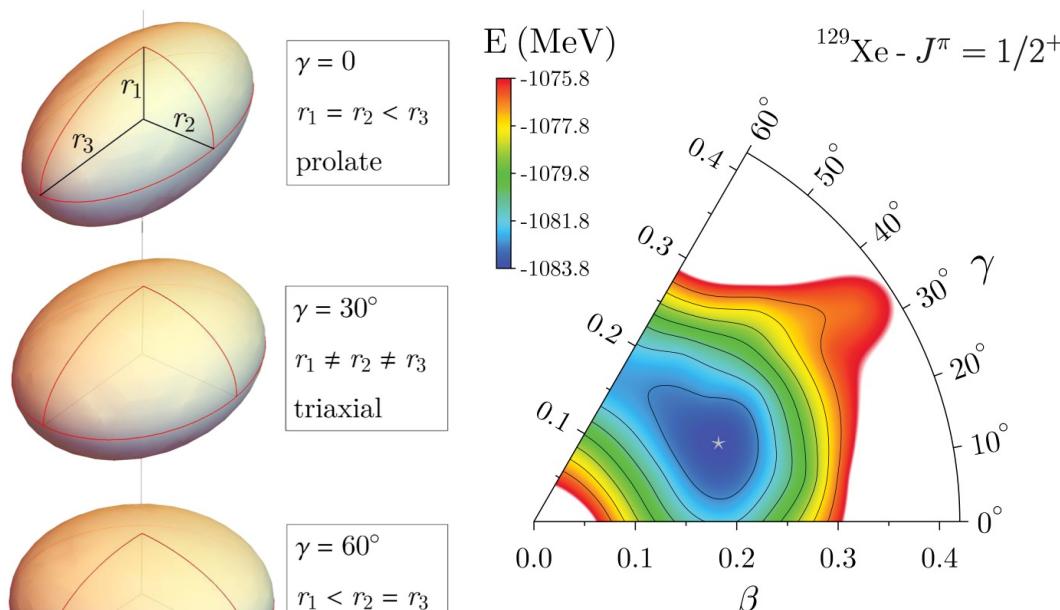
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Deformation in ^{129}Xe

$$\rho(r) = \frac{\rho_0}{[1 + \exp(r - R(\theta, \phi))/a]}$$

$$R(\theta, \phi) = R_0(1 + \beta[\cos\gamma Y_{2,0} + \sin\gamma Y_{2,2}])$$

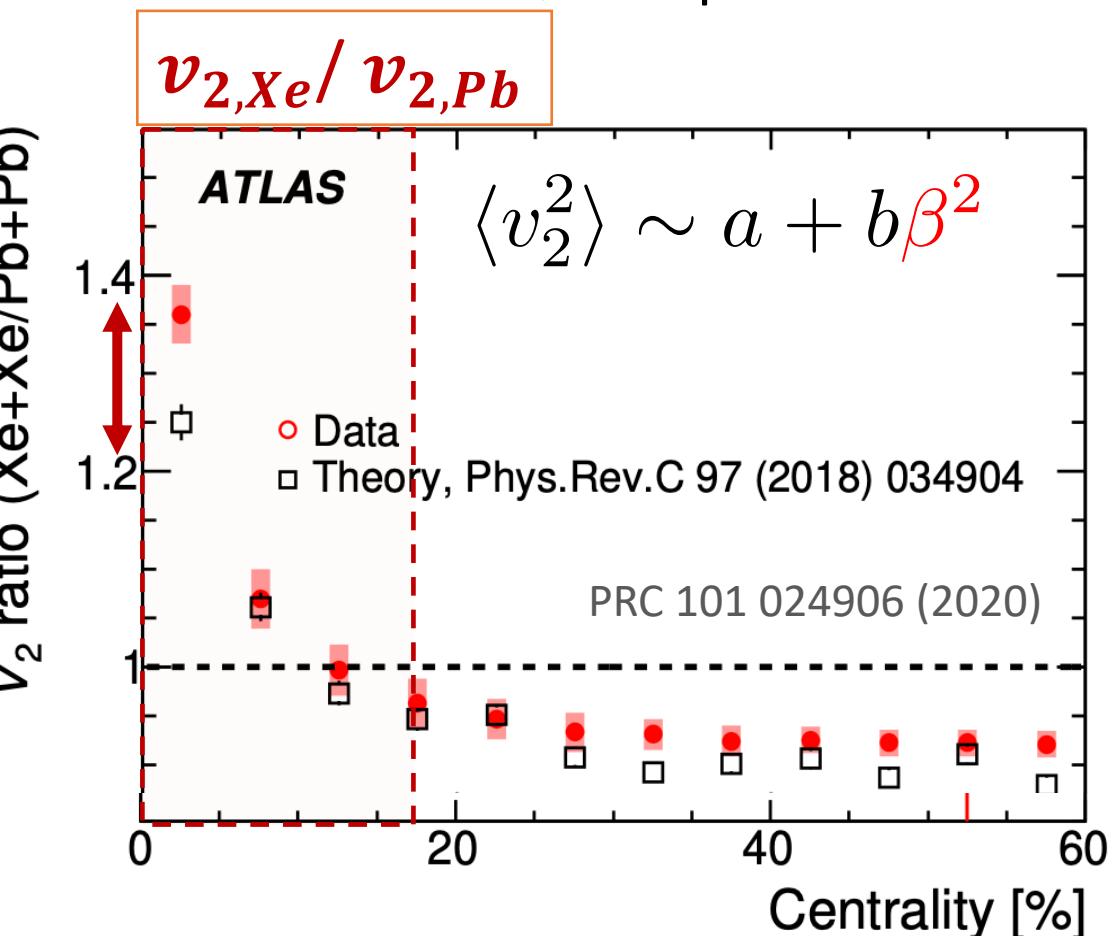
(a) deformed nucleus ($\beta > 0$)



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DFT Calculations predict
 $\beta_{Xe} \sim 0.2$, $\gamma_{Xe} \sim 30^\circ$.

➤ v_2 sensitive to overall Quadrupole deformation β .



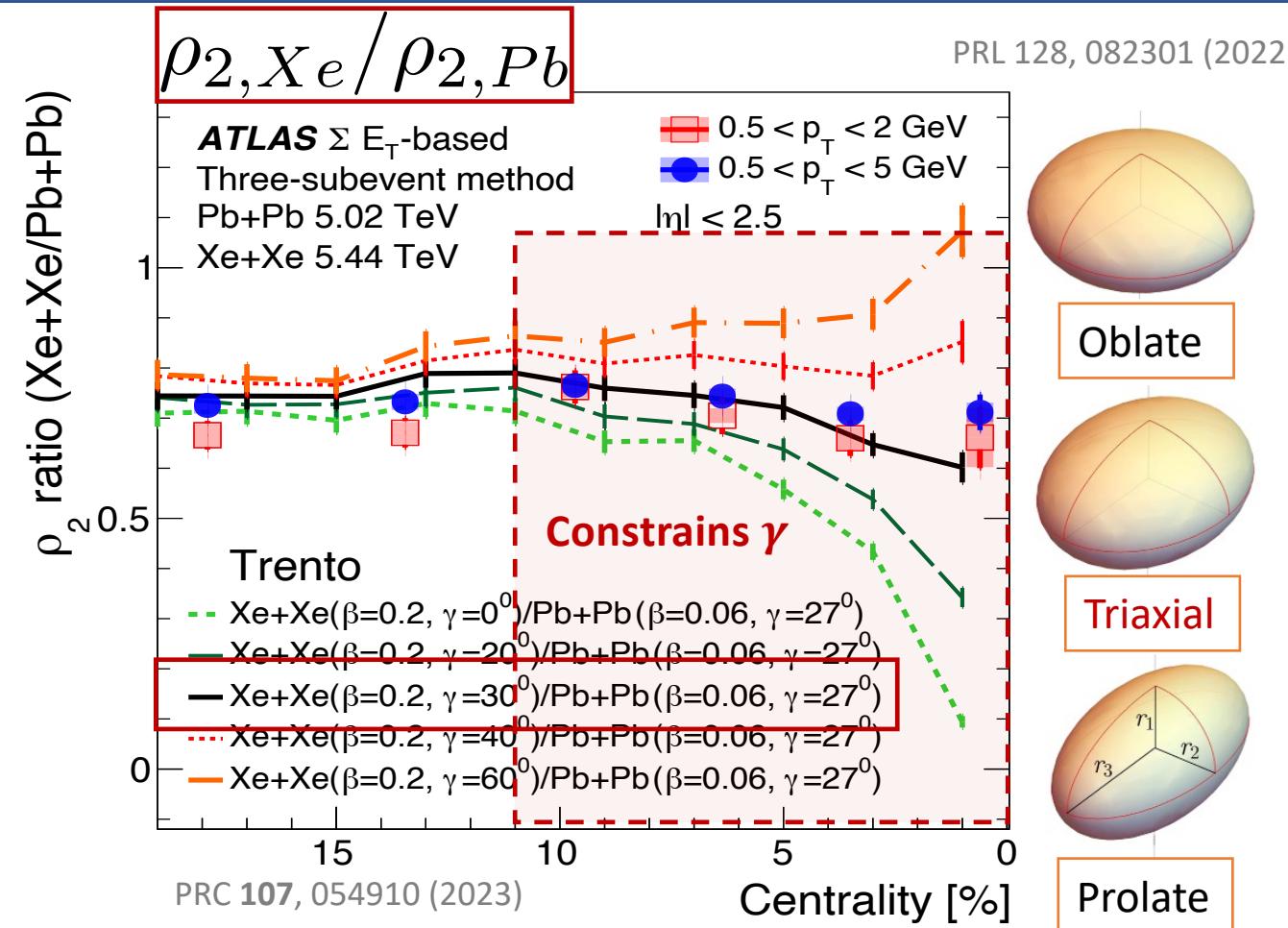
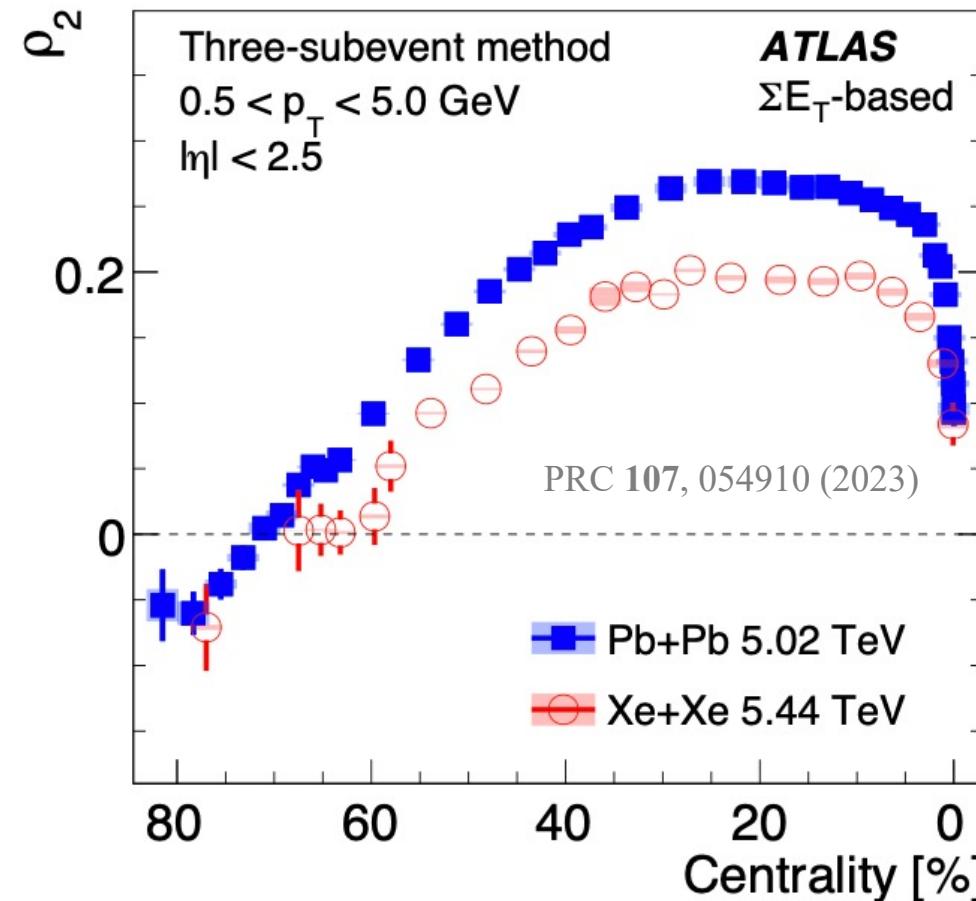
- Enhancement $v_{2,Xe}/v_{2,Pb}$ at LHC is combined effects of smaller system and deformation.

See J.Jia's Parallel Talk from Tuesday, 20/06
 See C. Zhang/J.Jia's Plenary Talk from Wednesday, 21/06

Constraining triaxiality of ^{129}Xe using $v_2 - [p_T]$ correlation

$$\langle v_2^2 \delta p_T \rangle \sim a - b \langle \beta^3 \cos(3\gamma) \rangle$$

$$\rho_2 \equiv \frac{\langle v_2^2 \delta p_T \rangle}{\sqrt{\text{var}(v_2^2)} \sqrt{\langle (\delta p_T)^2 \rangle}}$$



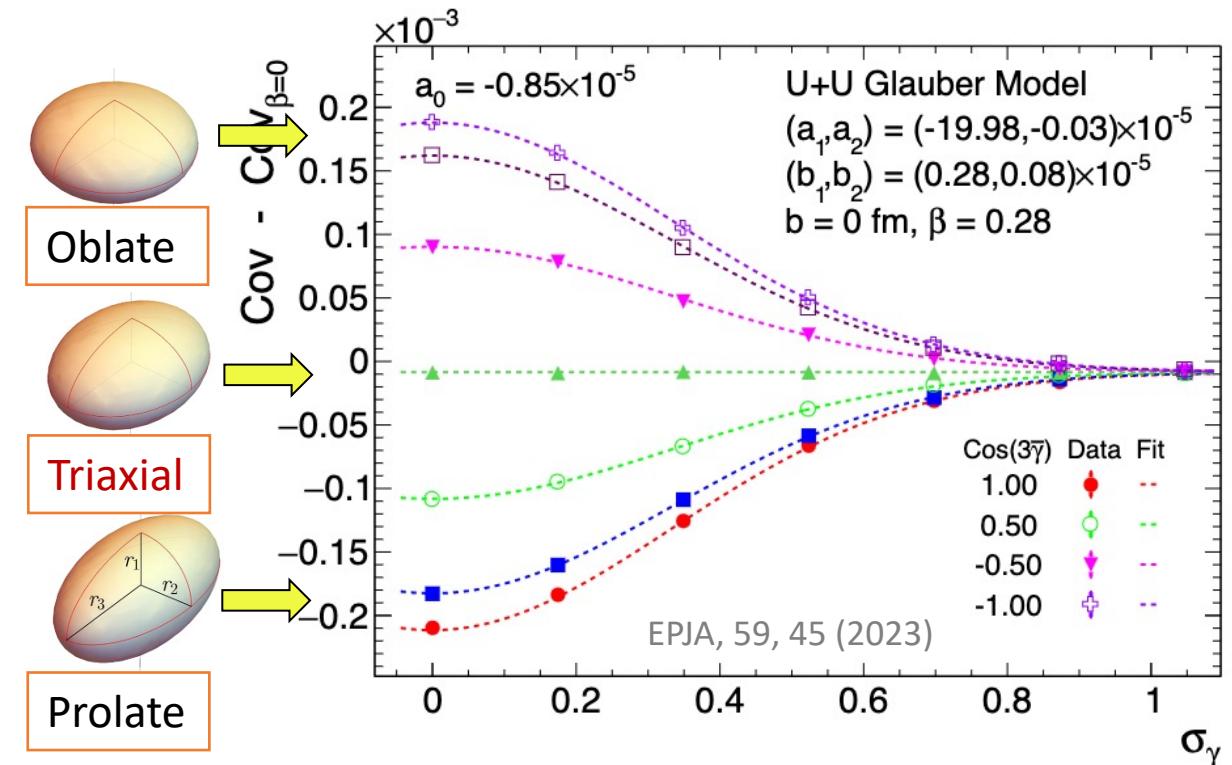
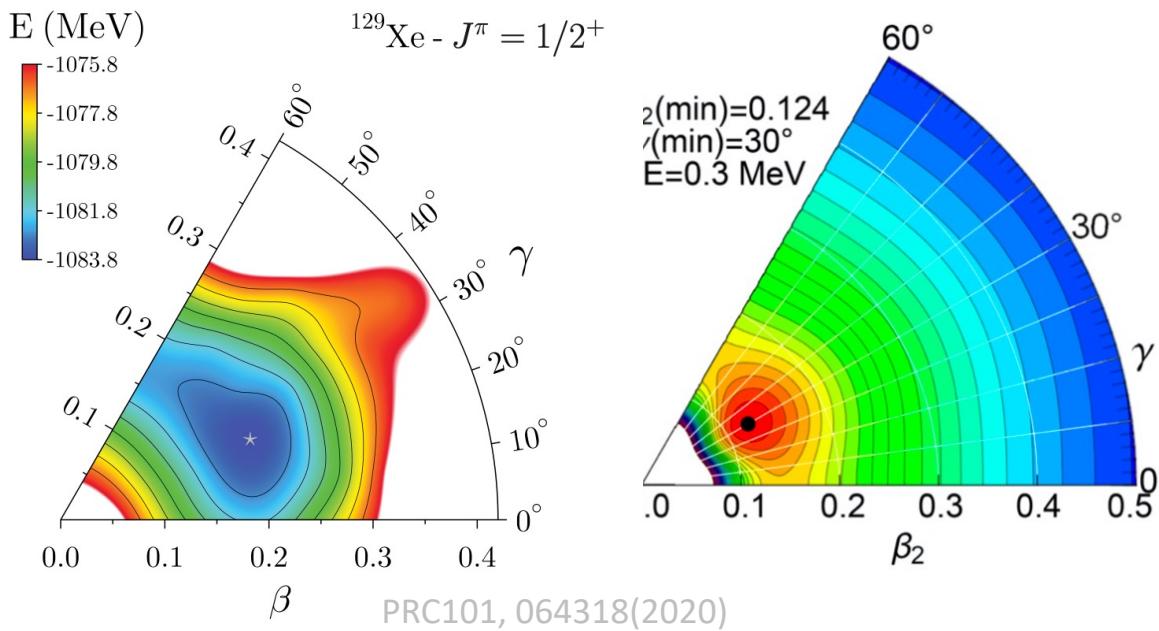
Using $\beta=0.2$ constrained by the $v_{2,Xe} / v_{2,Pb}$,
 ρ_2 constrains $\langle \gamma_{Xe} \rangle \sim 30^\circ$;
consistent with low-energy predictions.

See both J.Jia's, E Nielsen's Parallel Talks from Tuesday, 20/06

See C. Zhang's Plenary Talk from Wednesday , 21/06

Caveat: Role of nuclear shape fluctuations

$$\langle v_2^2 \delta p_T \rangle \sim a - b \langle \beta^3 \cos(3\gamma) \rangle$$



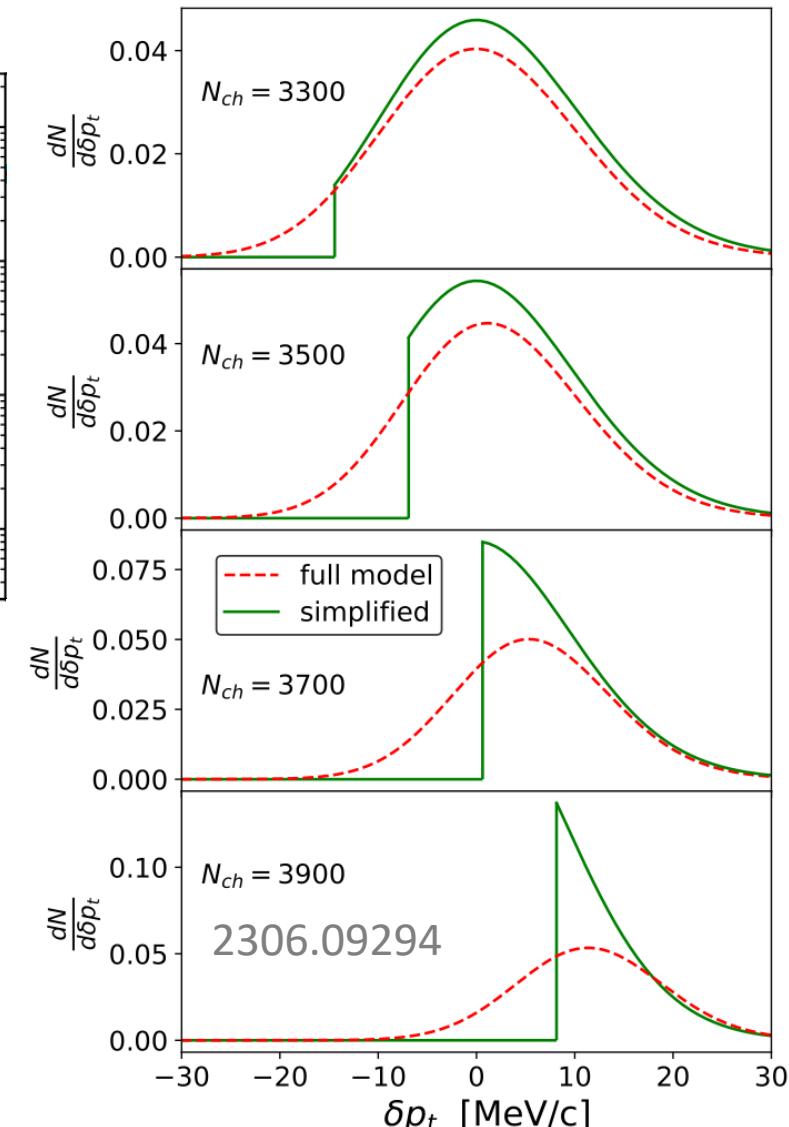
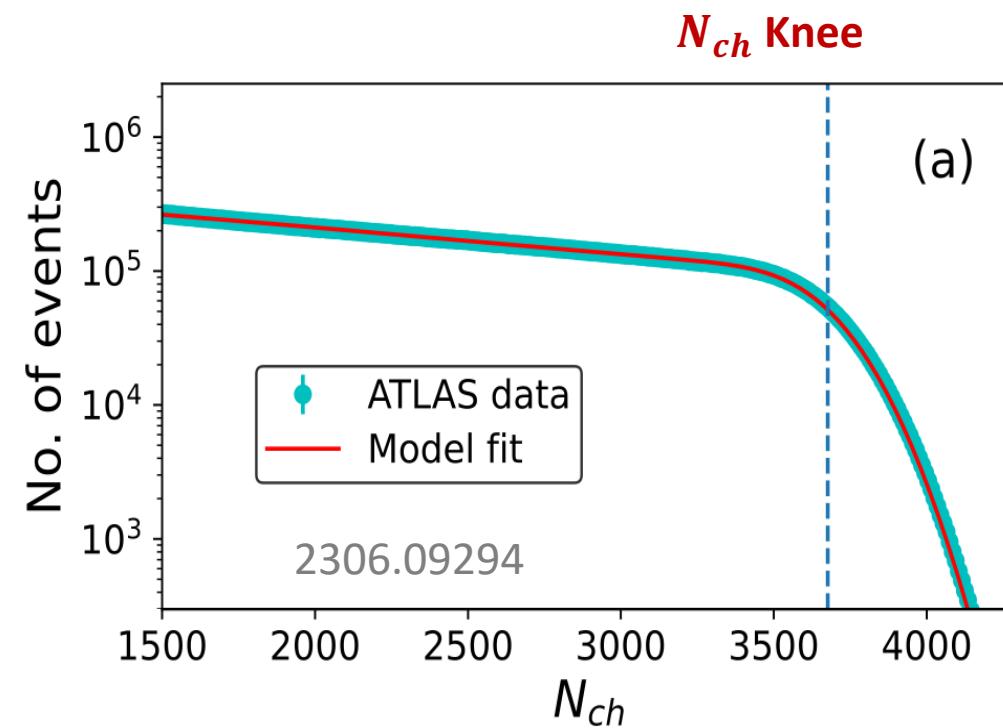
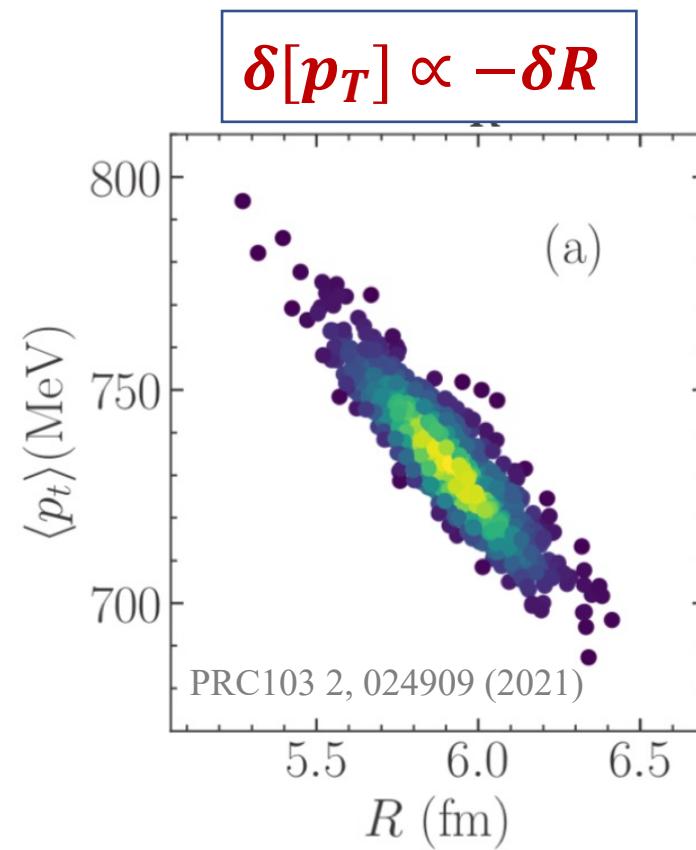
$$\langle \cos(3\gamma) \rangle \approx \exp(-9\sigma_\gamma^2/2) \cos(3\bar{\gamma}) \quad \sigma_\gamma^2 = \langle (\gamma - \bar{\gamma})^2 \rangle$$

- Fluctuation in γ washes out difference between prolate and oblate shapes, all results approach triaxial case.

$\rho_{2,Xe}/\rho_{2,Pb}$ ratio supports triaxial shape of ¹²⁹Xe: Only if fluctuation of γ_{Xe} not large.

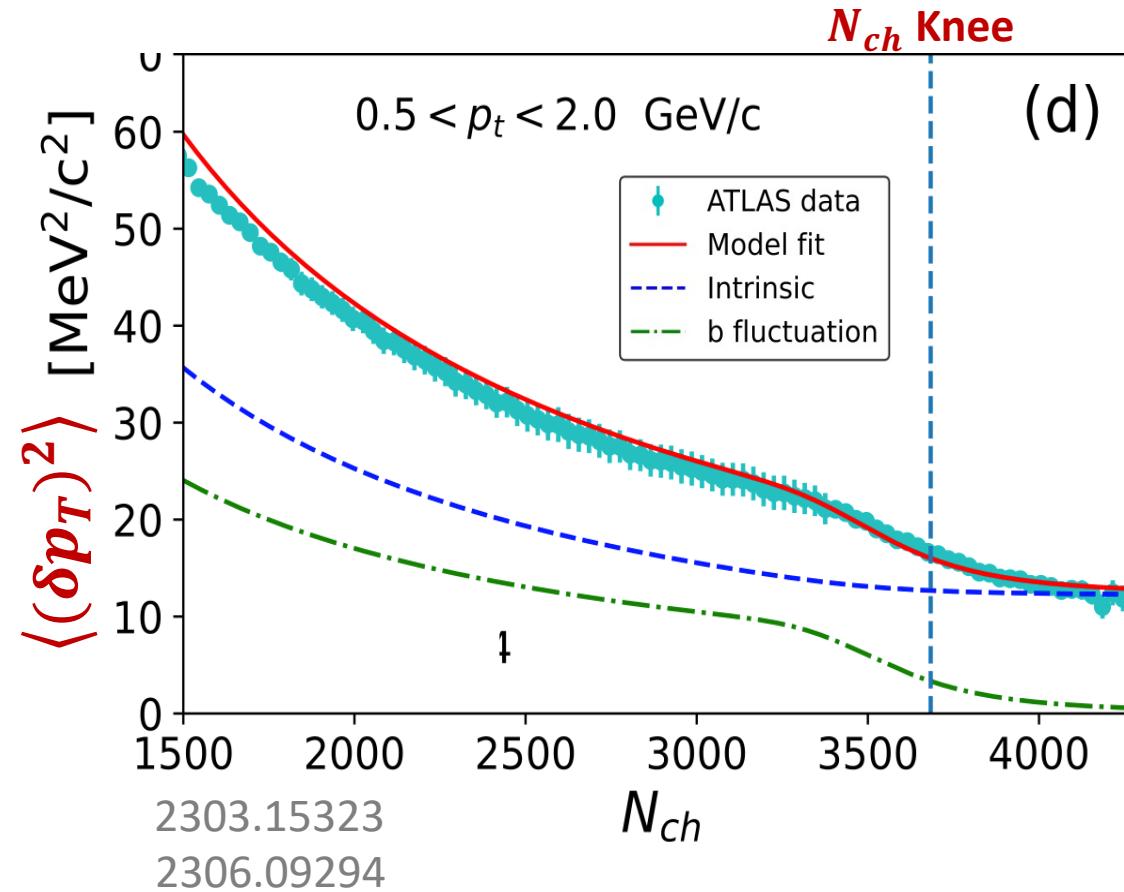
Impact of collision geometry on $[p_T]$ fluctuations in UCC

- Model assumption: At fixed N_{ch} , b , $[p_T]$ fluctuation is Gaussian.



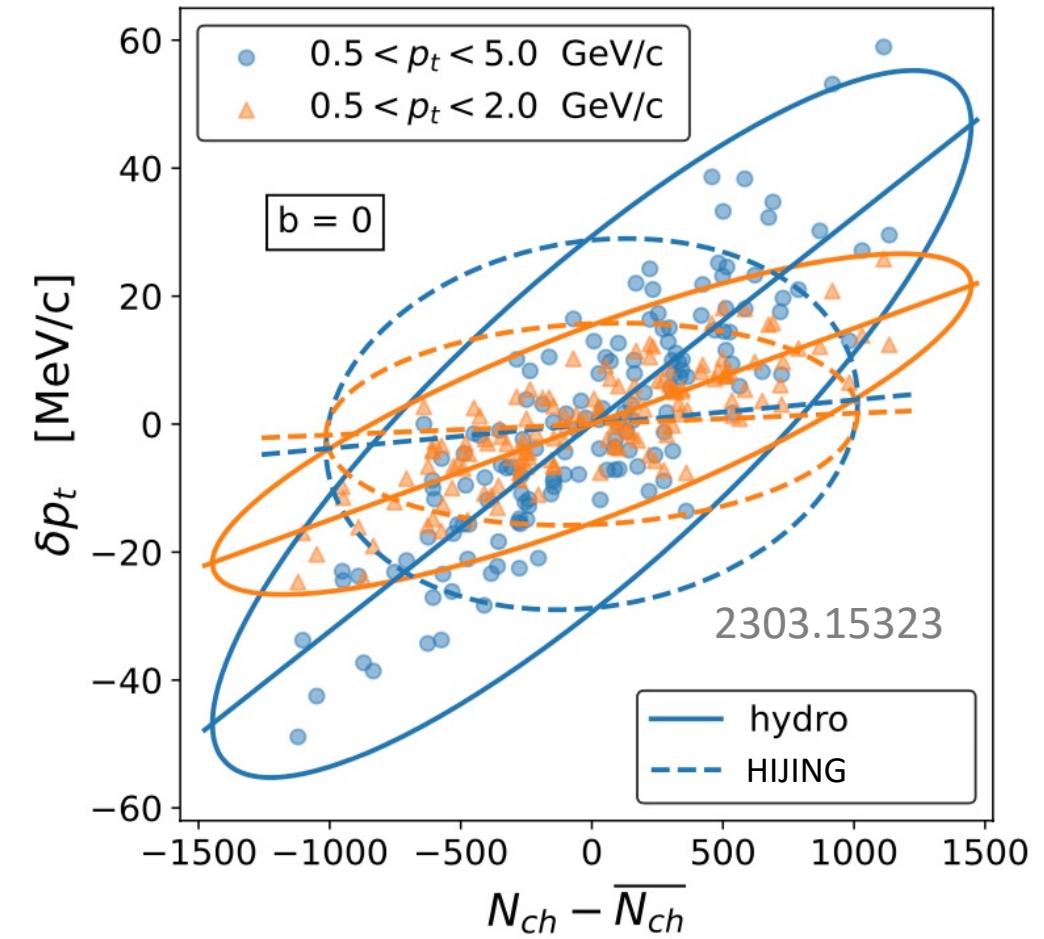
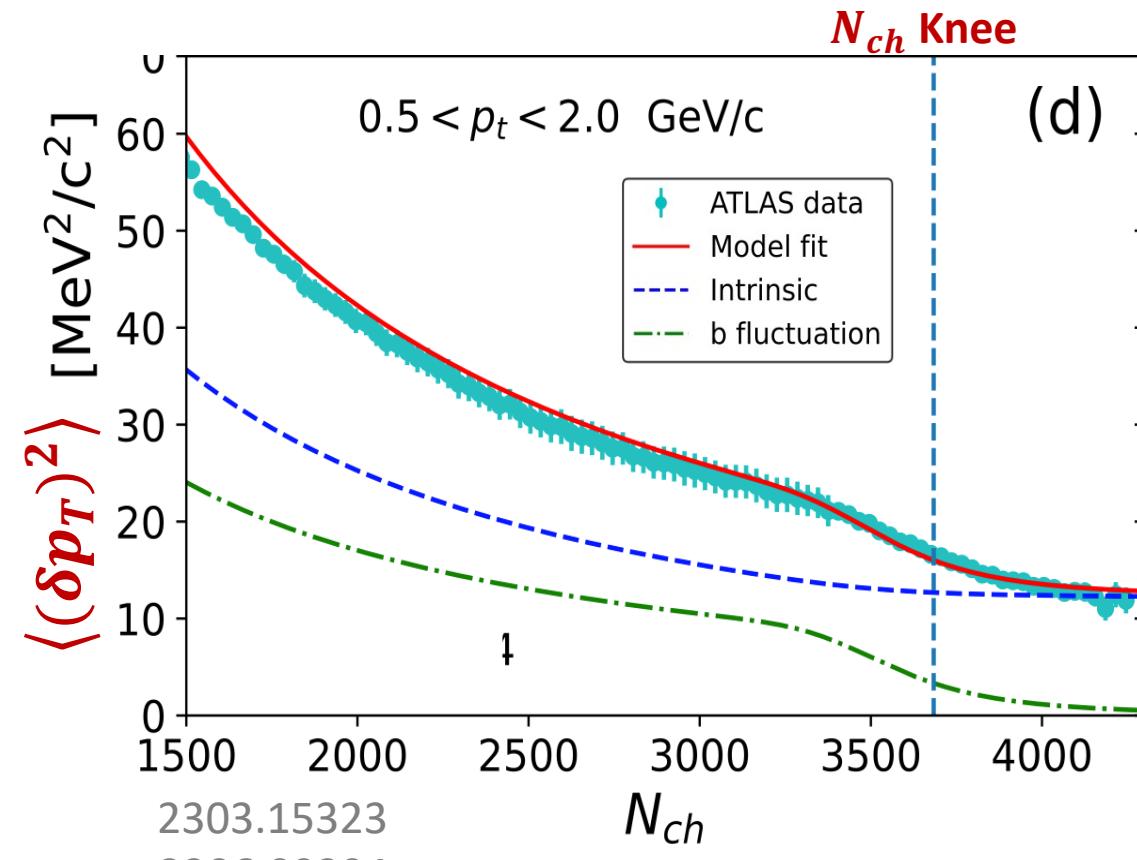
- A lower limit on impact parameter sets lower limit on $[p_T]$.
- Beyond knee, the variance of δp_t becomes progressively smaller due to truncation from the lower limit.

Separating impact of geometry fluctuations from intrinsic "thermal" fluctuations



- Reducing contribution from 'b' fluctuations:
Sharp drop in $\langle(\delta p_T)^2\rangle$ in Ultra central collisions.

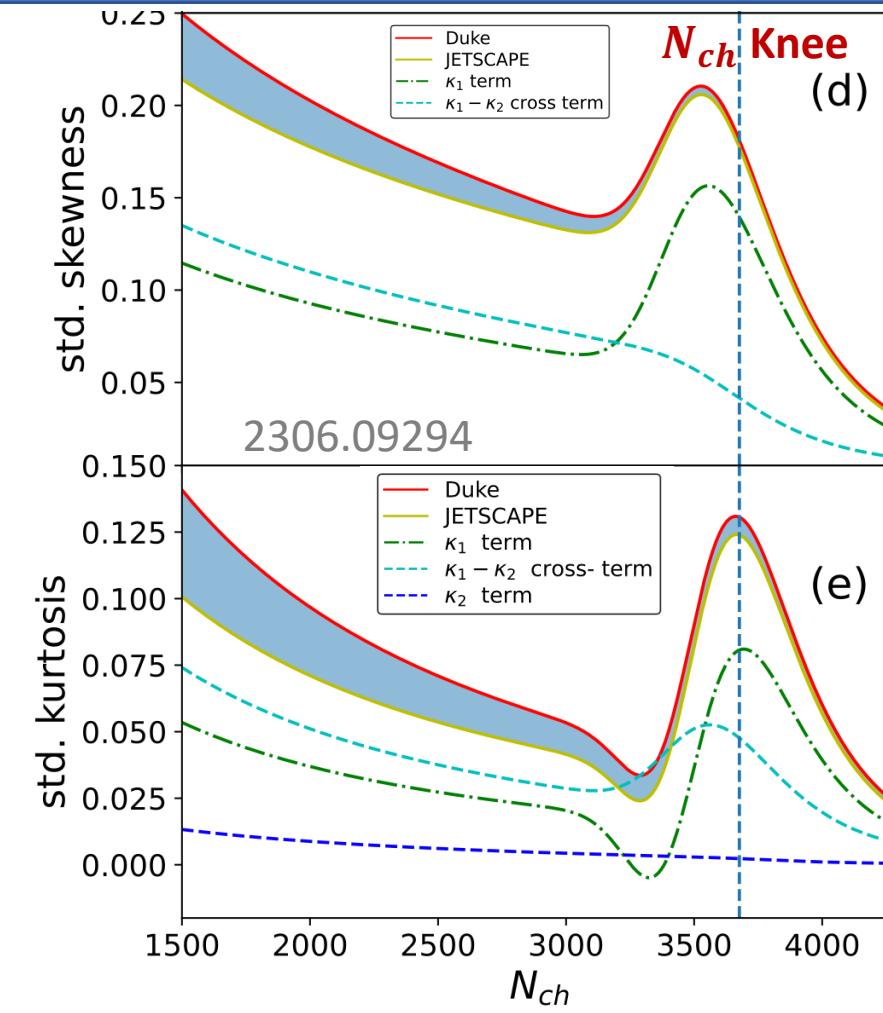
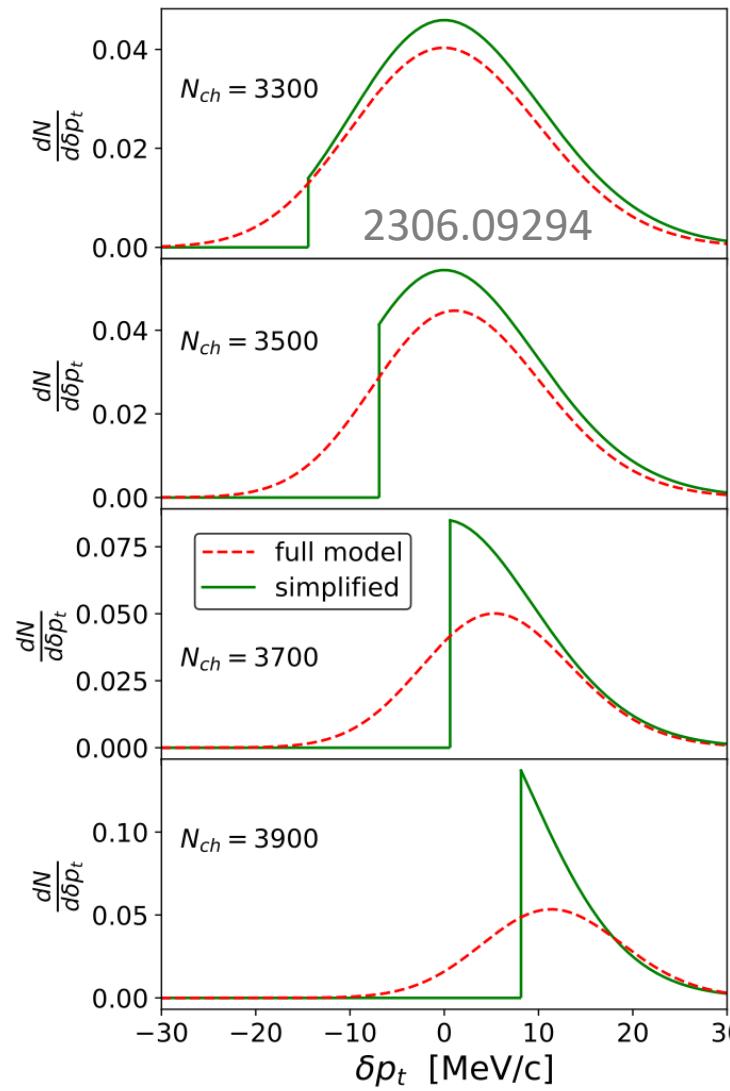
Separating impact of geometry fluctuations from intrinsic "thermal" fluctuations



- Reducing contribution from 'b' fluctuations:
Sharp drop in $\langle (\delta p_T)^2 \rangle$ in Ultra central collisions.

- Prediction: Increase in $\langle p_T \rangle$ with increase in N_{ch} :
Evidence of thermalization.

impact of geometry fluctuation on high-order [p_T] fluctuations in UCC



➤ Future measurements of higher order [p_T] fluctuations will help further establish influence of maximal overlap area in ultra-central collisions.

Conclusion

- Using ATLAS measurement of $\rho(v_2^2, \delta p_T)$ in central heavy ion collisions, we constrain the triaxiality of ^{129}Xe to be $\langle\gamma\rangle \sim 30^\circ$.
- Higher order [p_T] fluctuations provide a clear evidence of reaching maximal overlap area for the ultra-central heavy-ion collisions.
- Future measurement of rise of [p_T] in ultra-central heavy-ion collisions can provide important details on thermalization of the formed medium.

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THANK YOU!!