Comparing initial states of 96Ru+96Ru and 96Zr+96Zr collisions at 200 GeV using a LEXUS inspired model

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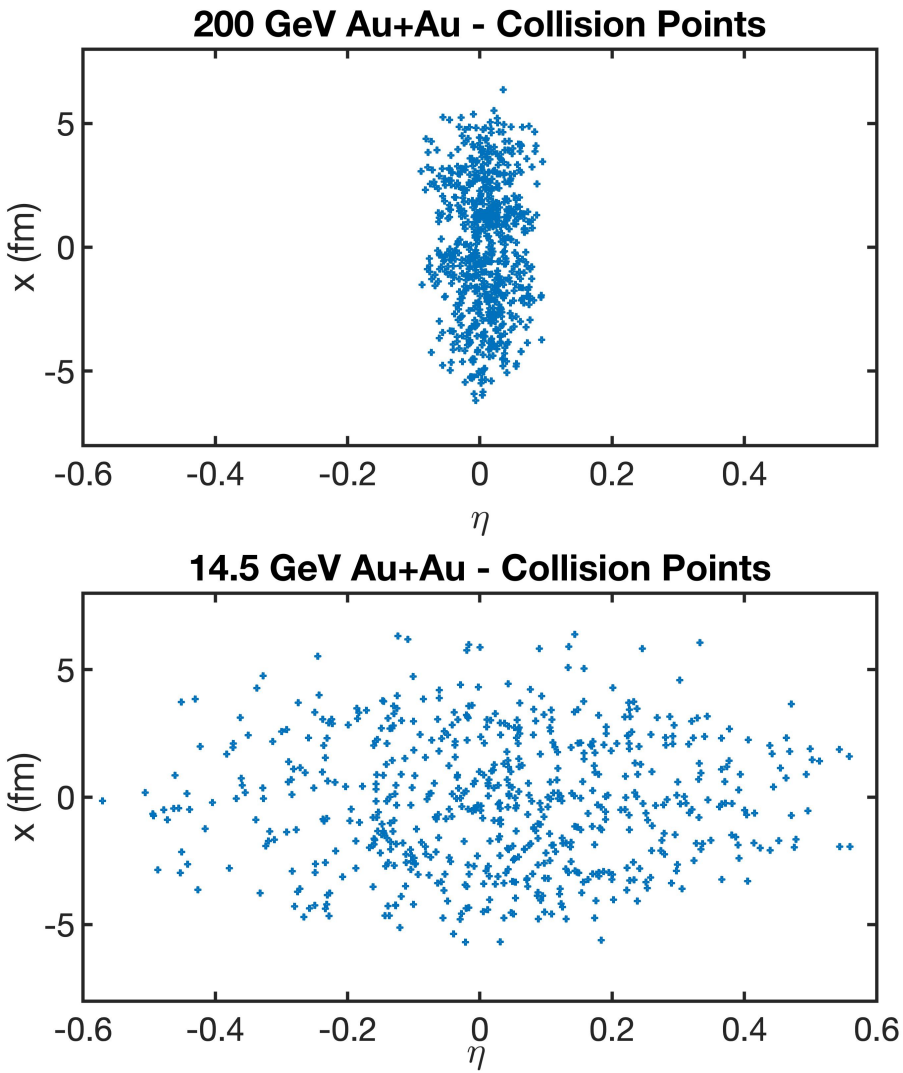
Initialization of Nuclei using Monte Carlo Sampling

- Monte-Carlo sampling of Woods-Saxon distribution for nucleons.
- LEXUS (Linear EXtrapolation of Ultrarelativistic nucleon-nucleon Scattering to nucleus-nucleus collisions) initial state.
- LEXUS was formulated in momentum space, but information on coordinate space need to be specified.



(LEXUS) Jeon and Kapusta (1997)

Initial State Model

- An approach to describe energetic nucleus-nucleus collisions as a sequence of binary nucleon-nucleon collisions.
- All information comes from simple parametrizations of nucleon-nucleon collision data.
- Energy lost in a collision is sampled from the distribution:
  $P(y_{\text{loss}}) = \frac{\cosh(2y_{\text{rest-frame}} - y_{loss})}{\sinh(2y_{\text{rest-frame}}) - \sinh(y_{\text{rest-frame}})}$
- $y_{\text{rest-frame}}$ is the absolute value of the incoming nucleons' rapidity in the pair rest frame and rapidity loss is y_{loss}.
- Particles are produced with a Gaussian distribution with width given by $\ln(\frac{\sqrt{s}}{2m_N})$.
- After their final collisions, baryons are propagated by a fixed time 0.5 fm/c in their own rest frame and inputted as a source in the baryon current.

Woods Saxon parametrization

Nuclear deformation is described by a deformed Woods-Saxon form.

$$\rho(r,\theta,\phi) = \frac{\rho_0}{1+e^{[r-R(\theta,\phi)]/a_0}}$$

$$R(\theta,\phi) = R_0\left(1+\beta_2 Y_2^0+\beta_3 Y_3^0\right)$$

β parameters are the following with the references.

	β_2	β_3
Ru	0.154	0
Zr	0.062	0.235

- B. Pritychenko, M. Birch, B. Singh, and M. Horoi, "Tables of E2 Transition Probabilities from the first 2+ States in Even-Even Nuclei," Atom. Data Nucl. Data Tabl. 107, 1–139 (2016), [Erratum: Atom.Data Nucl.Data Tabl. 114, 371–374 (2017)].
- T Kibedi and R.H. Spear,"reduced electric-octupole transition probabilities, B(E3;0+1 $\Rightarrow$ 3-1) an update," Atom. Data Nucl. Data Tabl. 80, 35–82 (2002).

ϵ_n Calculation

The initial stage energy anisotropies are characterized by ϵ_n.

$$\epsilon_n = \frac{\sqrt{\langle r^n \cos(n\phi)\rangle^2 + \langle r^n \sin(n\phi)\rangle^2}}{\langle r^n \rangle}$$

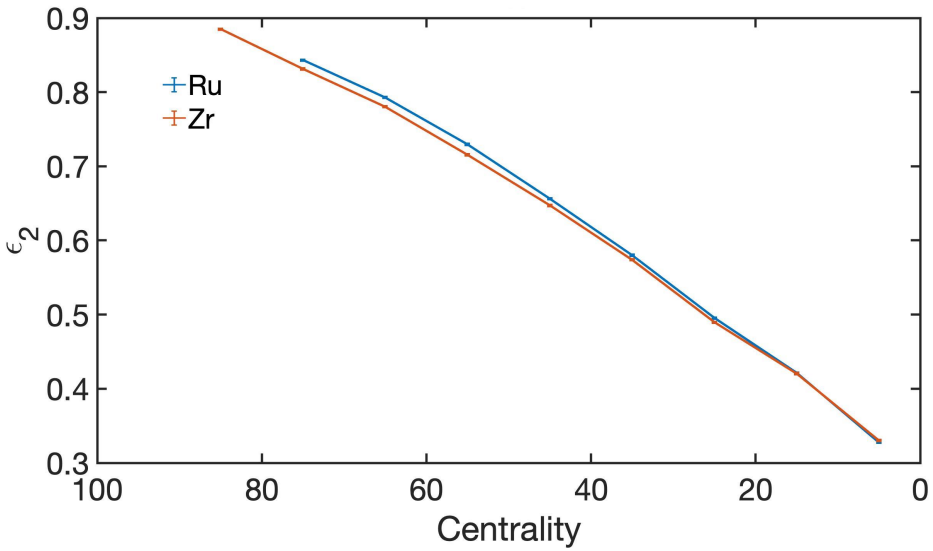
Averaged quantities are the energy density weighted averages over the transverse plane.

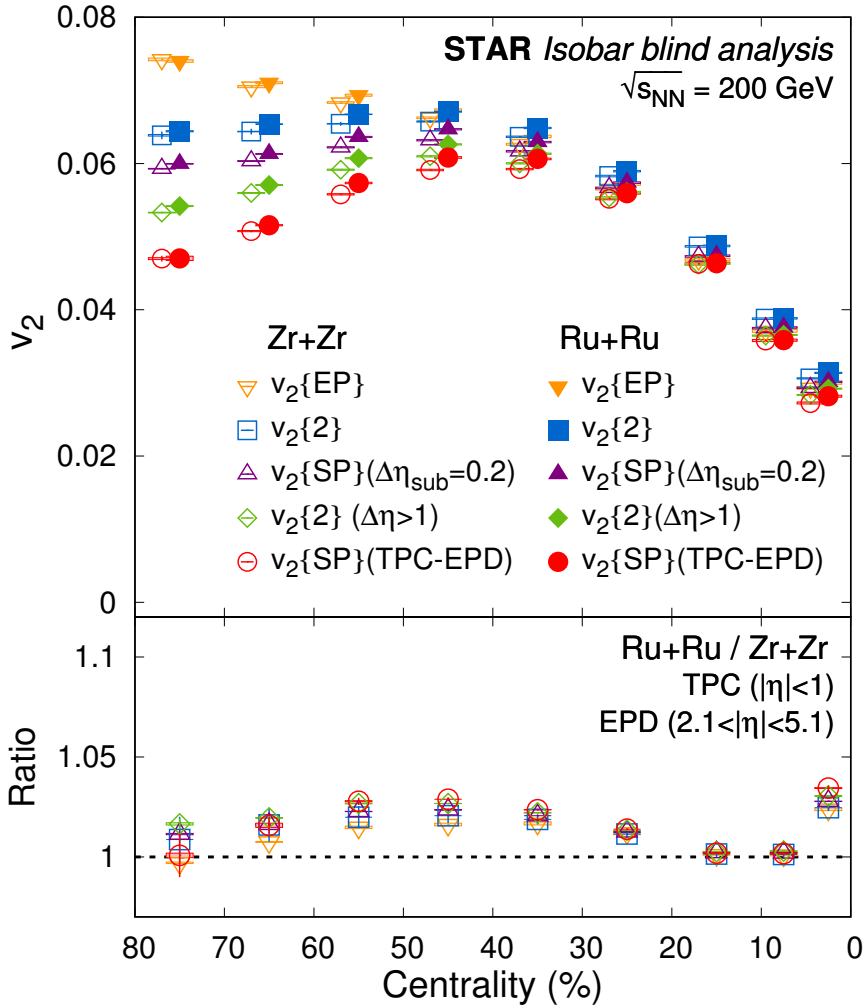
$$\langle A \rangle = \frac{\int dx^2\ A\ \epsilon(x)}{\int dx^2\ \epsilon(x)}$$

Spatial anisotropies will act as a proxy for the momentum anisotropies.

And $v_n \sim \epsilon_n$

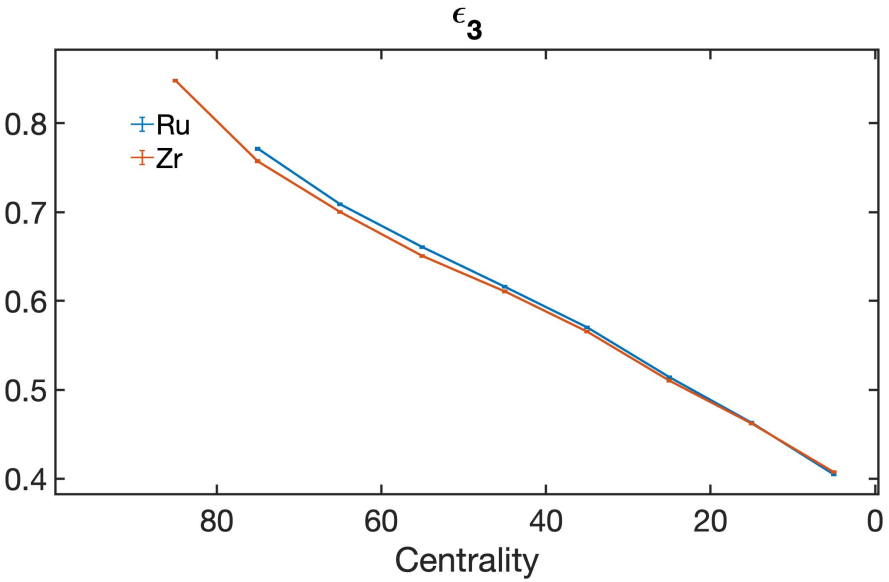
ϵ_2 FOR 10^6 EVENTS AND v_2

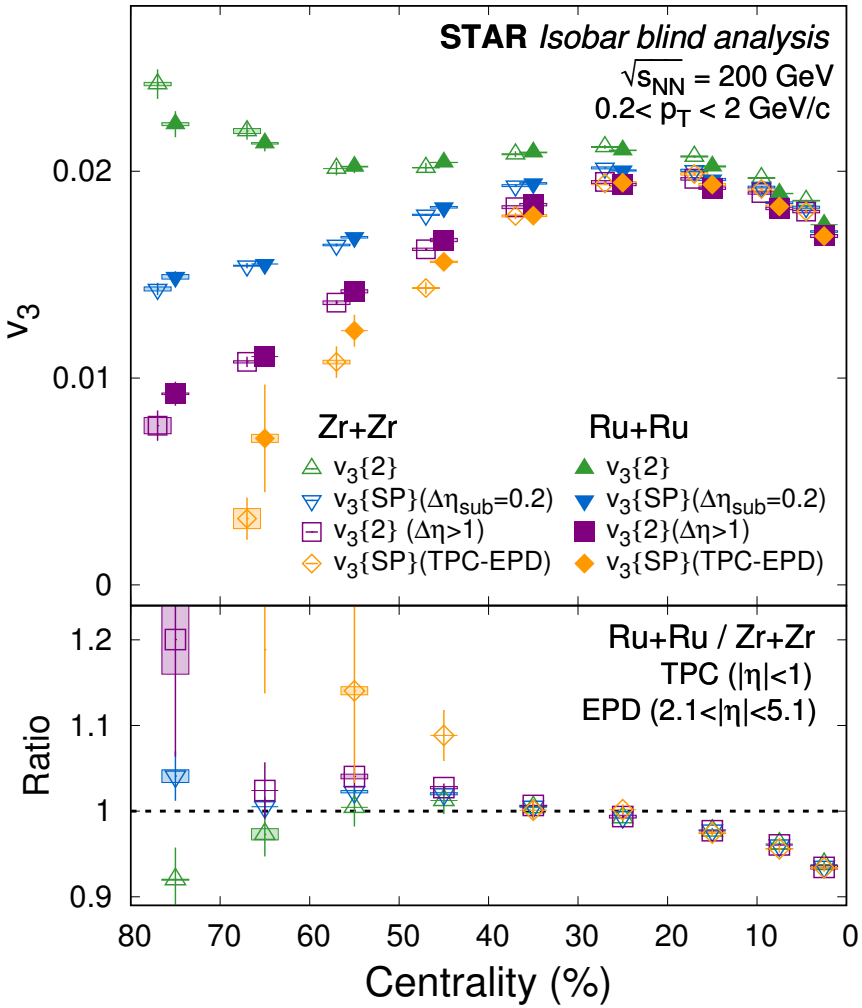




(STAR) Abdallah et al (2021)

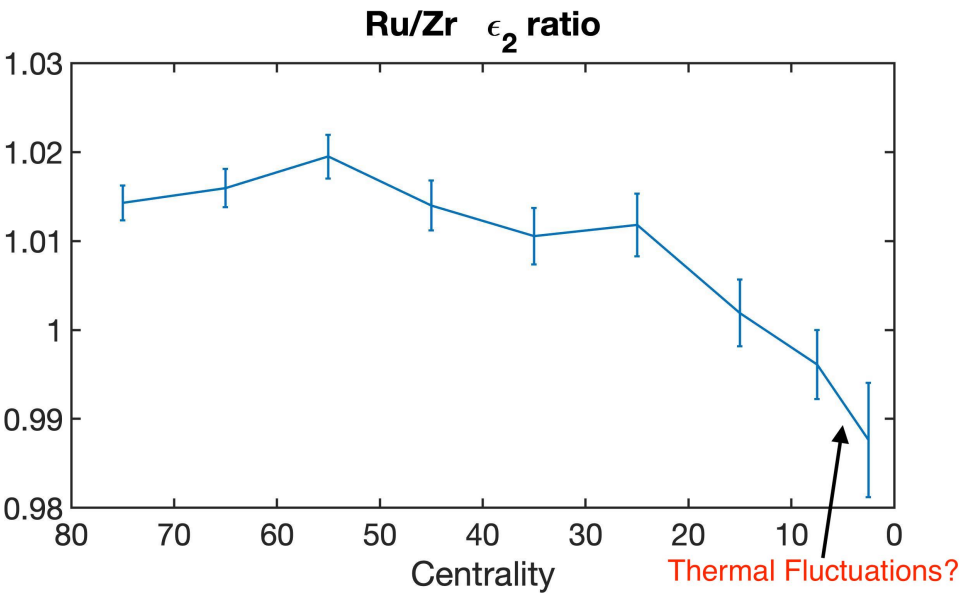
ϵ_3 FOR 10^6 EVENTS AND v_3

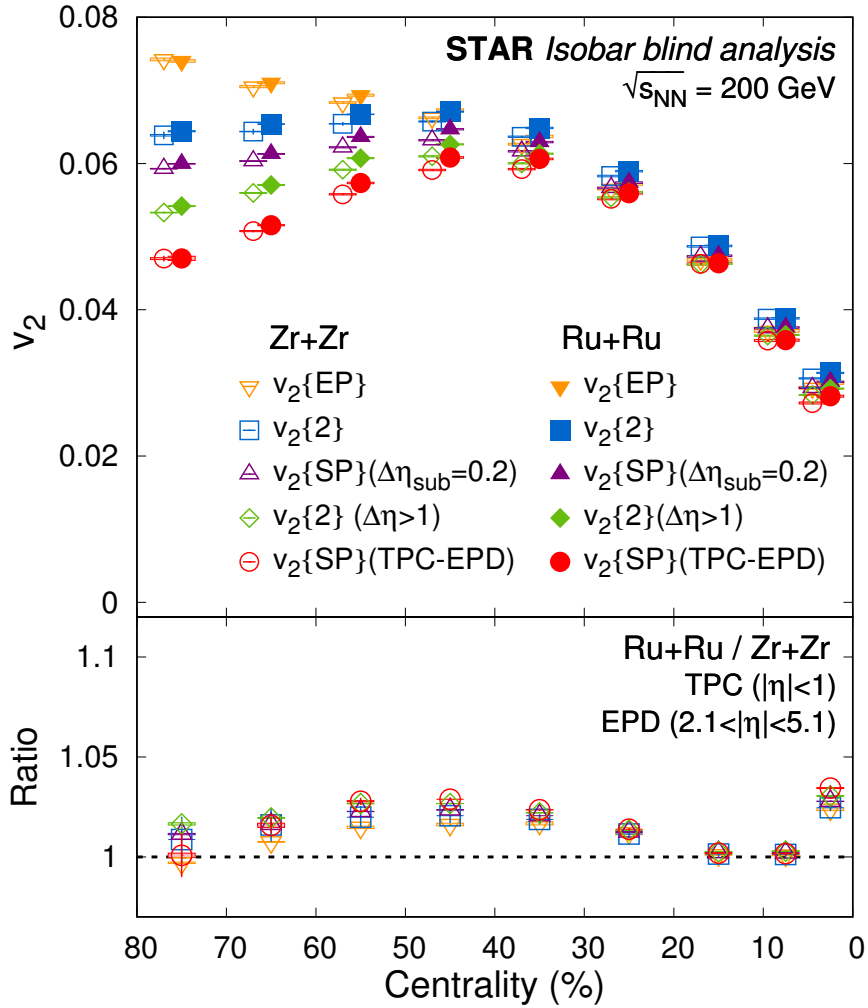




(STAR) Abdallah et al (2021)

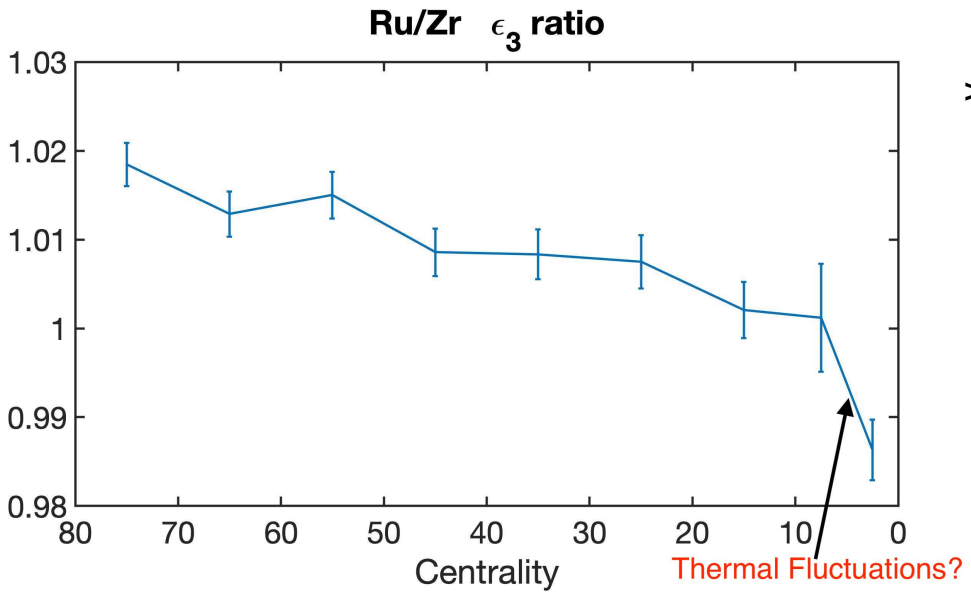
ϵ_2 RATIO FOR 10^6 EVENTS

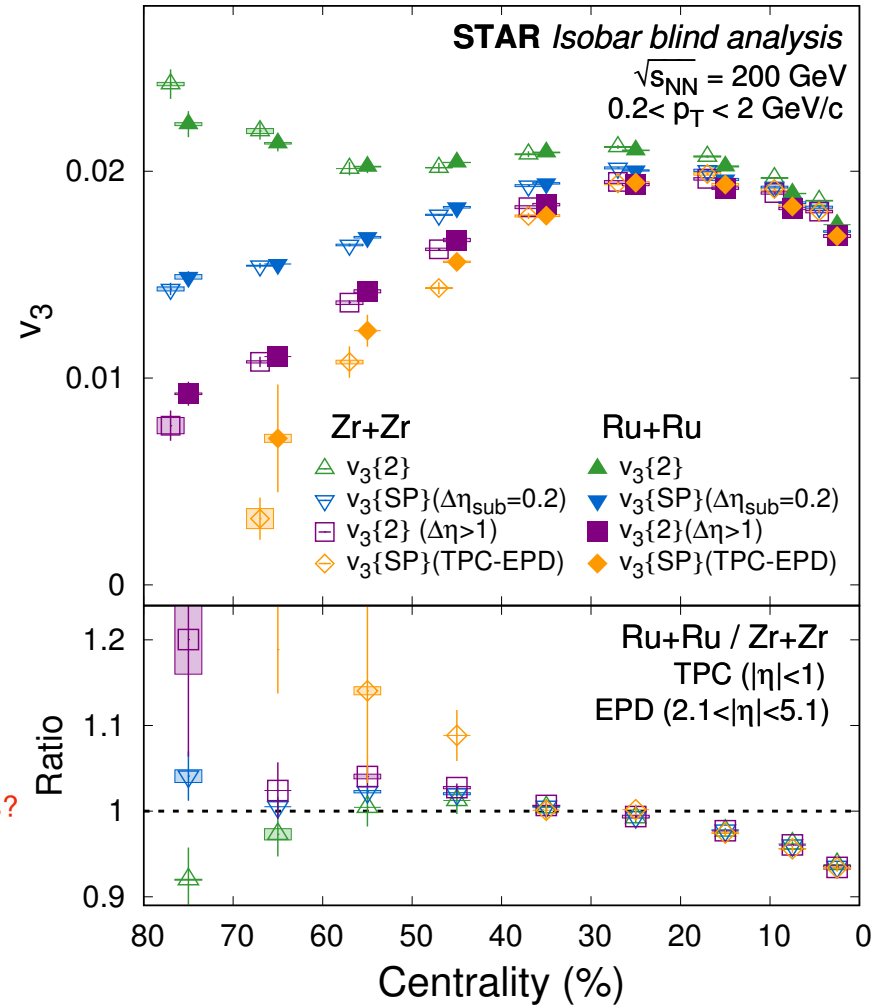




(STAR) Abdallah et al (2021)

ϵ_3 RATIO FOR 10^6 EVENTS



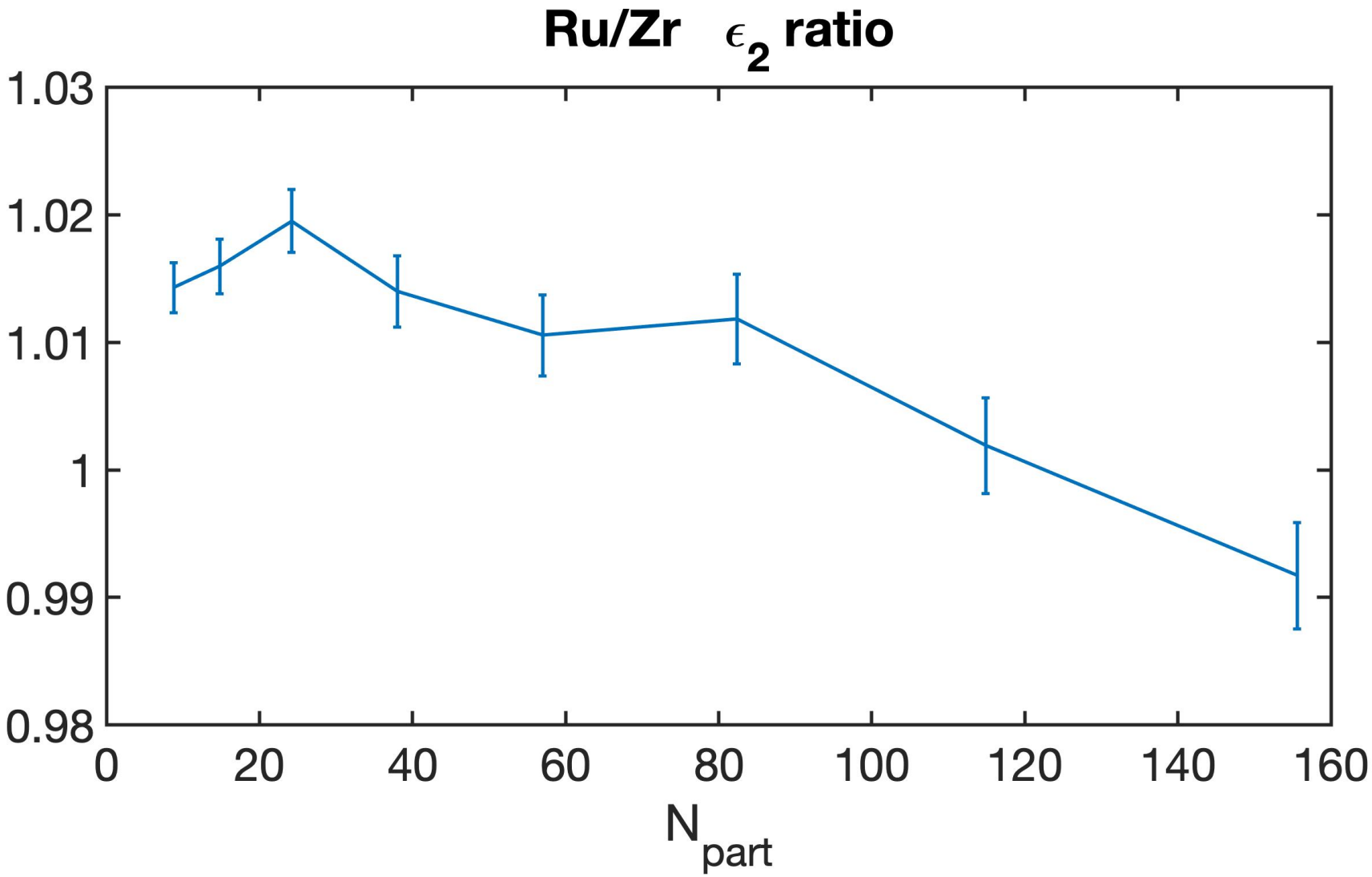


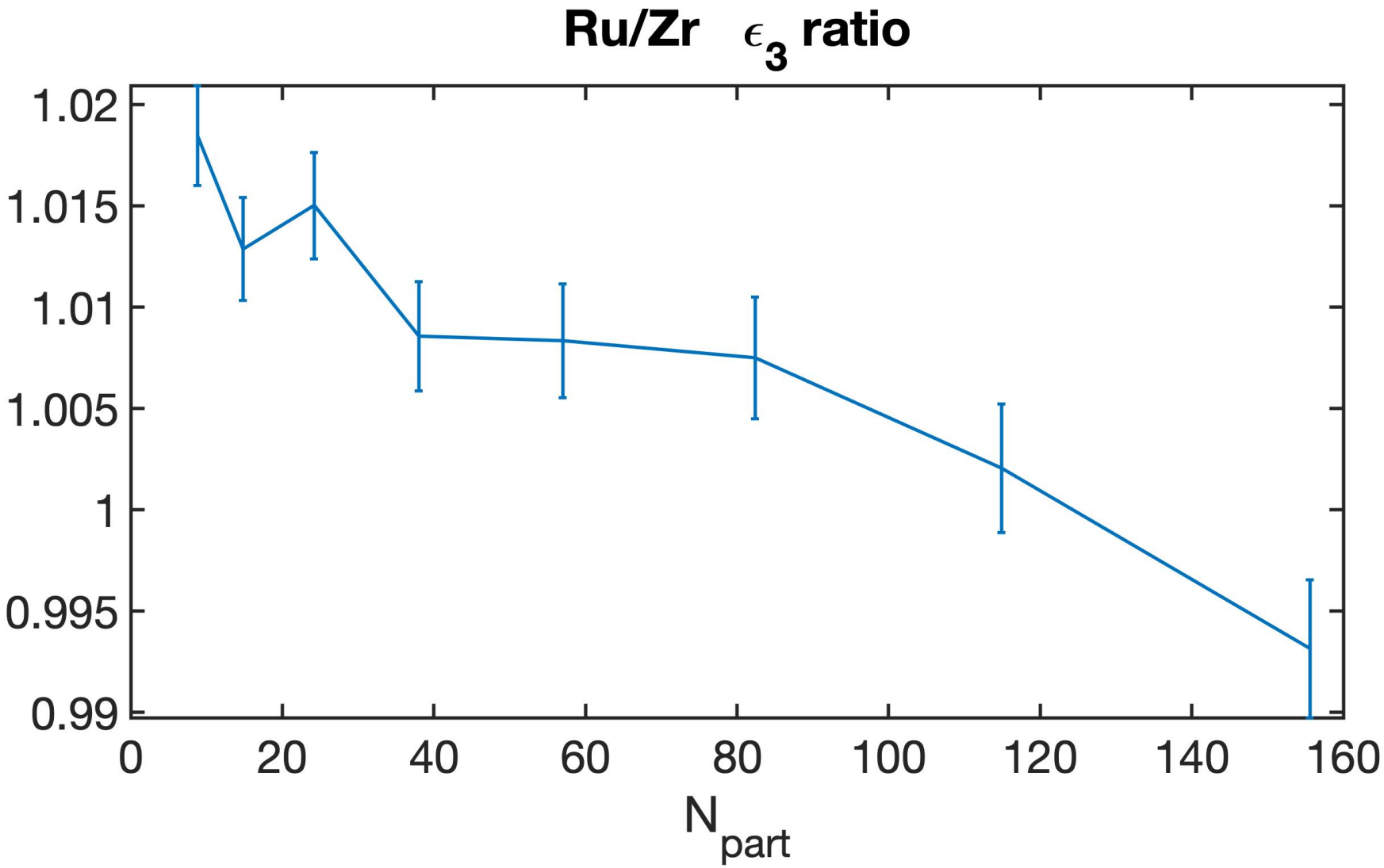
(STAR) Abdallah et al (2021)

Conclusions

- We have proposed a new LEXUS inspired initial state model. Investigation of this initial state with quadrupole and octupole deformations.
- We get a qualitative match for ϵ_2, ϵ_3 ratios with STAR (v_2 and v_3 ratios) data.
- At low centralities, we expect significant differences in these ratios from v_2 and v_3 ratios respectively because of thermal fluctuations.
- Final goal of this project is to run the initial state through hydrodynamics.

Thank You for Listening!


Ru/Zr ϵ_2 ratio
1.03
1.02
1.01
1
0.99
0.98
0
20
40
60
80
100
120
140
160
N_{part}


Ru/Zr ϵ_3 ratio
1.02
1.015
1.01
1.005
1
0.995
0.99
0
20
40
60
80
100
120
140
160
N part