Impact of the nuclear structure on the isobar run at RHIC

Nuclear structure

- Investigate potential maximal effect of **deformation** for Ru

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

$$R'(\theta) = R_0(1+\beta_2 Y_2^0(\theta))$$

Nucleus	R_0 [fm]	d [fm]	β_2
$^{96}_{40}$Zr	5.02	0.46	0
$^{96}_{44}$Ru	5.085	0.46	0.158

- And **neutron skin** for Zr, use halo

$$\Delta r_{np} = \langle r_n^2\rangle^{1/2} - \langle r_p^2\rangle^{1/2}$$

$$\Delta r_{np}\Big|_{^{96}_{40}\mathrm{Zr}} = 0.12 \pm 0.03 \text{ fm}$$

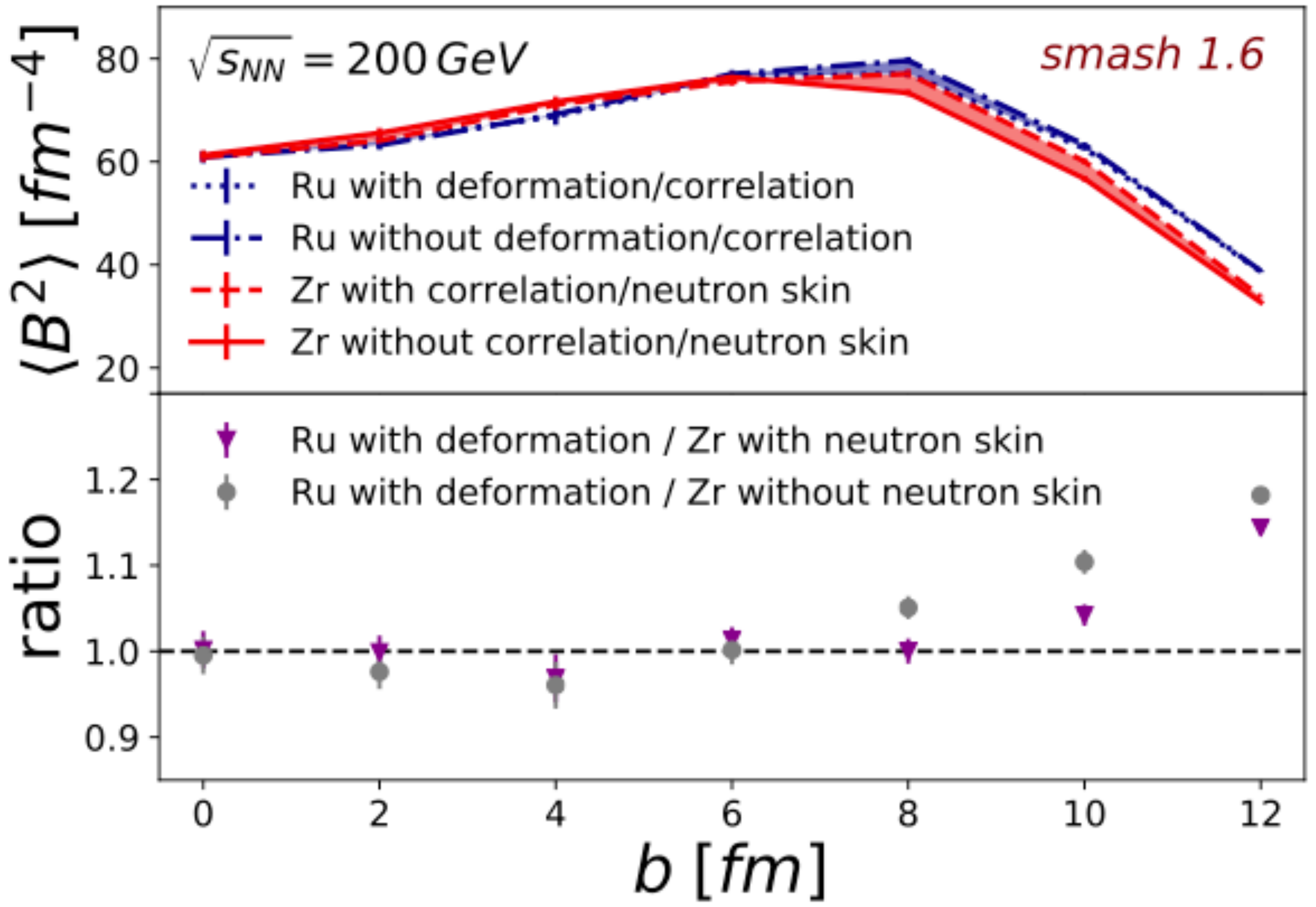
Nucleon in $^{96}_{40}$Zr	R_0 [fm]	d [fm]
p	5.08	0.34
n	5.08	0.46

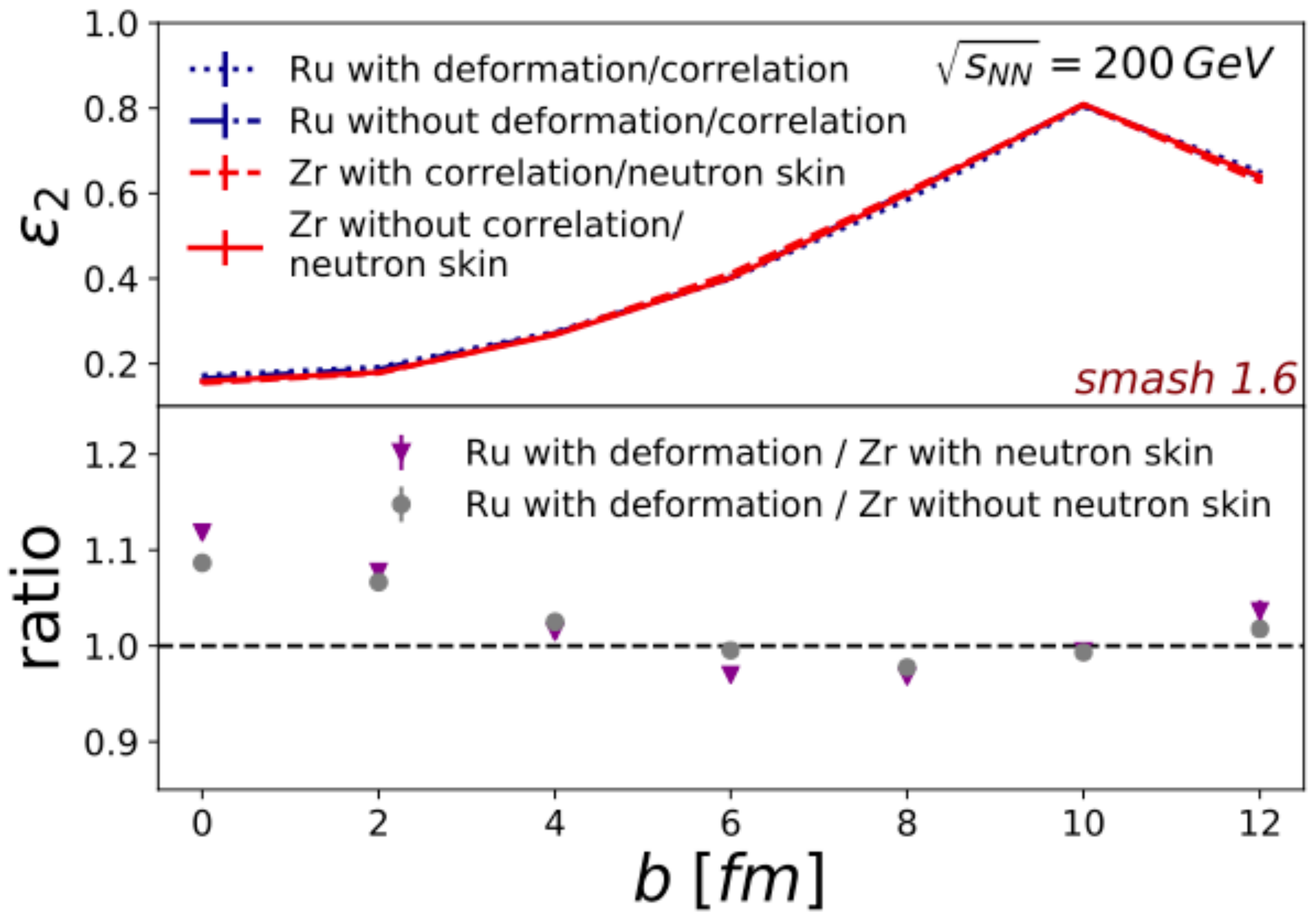
Methodology

- Including **nuclear structure** effects and nucleon-nucleon correlations with initial state from full wave function

M. Alvioli, M. Strikman, PRC 100 (2019)

- Hadronic transport approach **SMASH** is applied until full overlap of nuclei





Conclusions

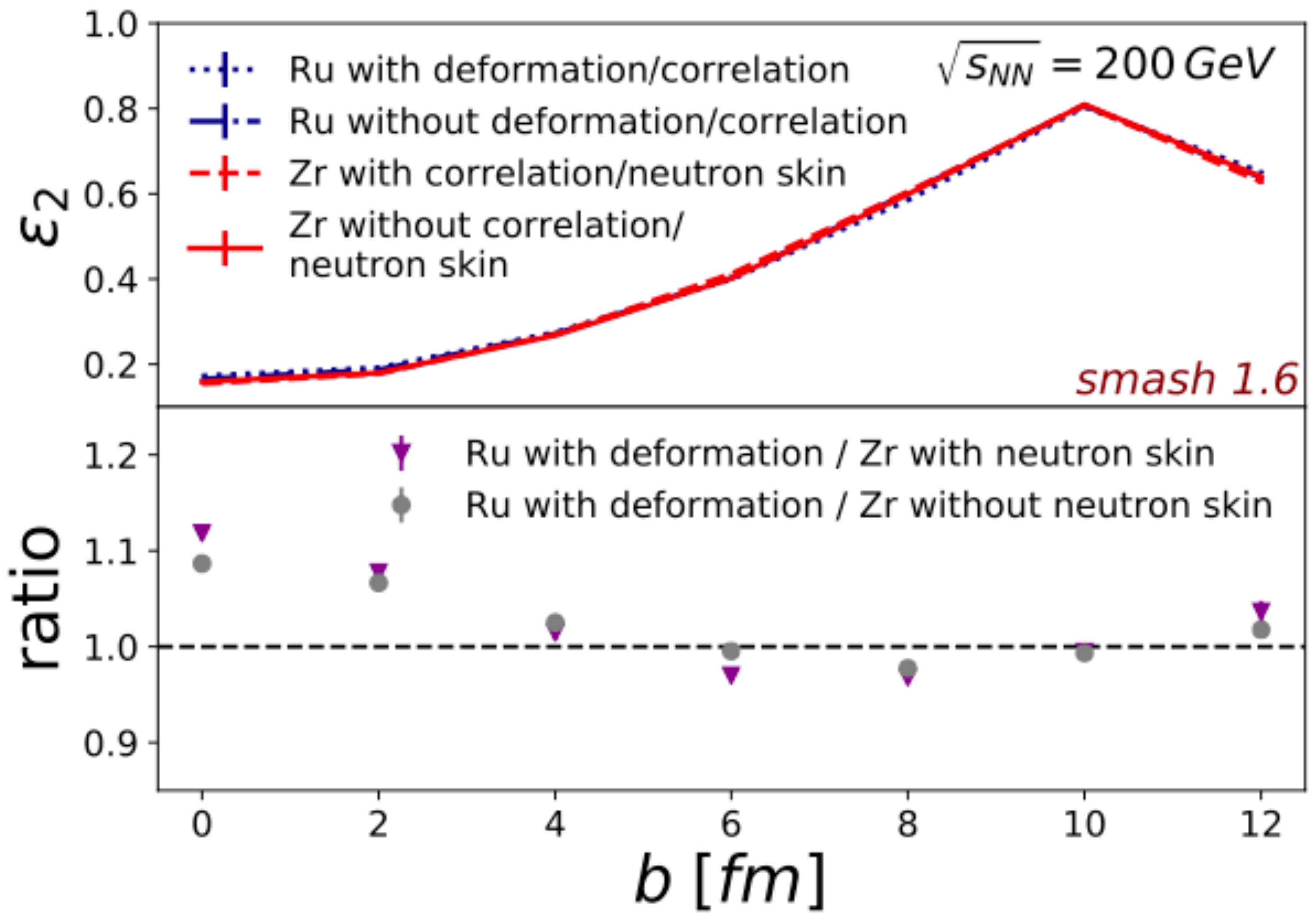
- Participant **eccentricity** shows differences due to deformation at small impact parameters
- Neutron skin reduces difference for **magnetic field**
- **Confirmed** by measurements of STAR collaboration

In collaboration with Jan Hammelmann, Alba Soto Ontoso, Massimliano Alvioli and Mark Strikman, Phys.Rev.C 101 (2020) 6, 061901

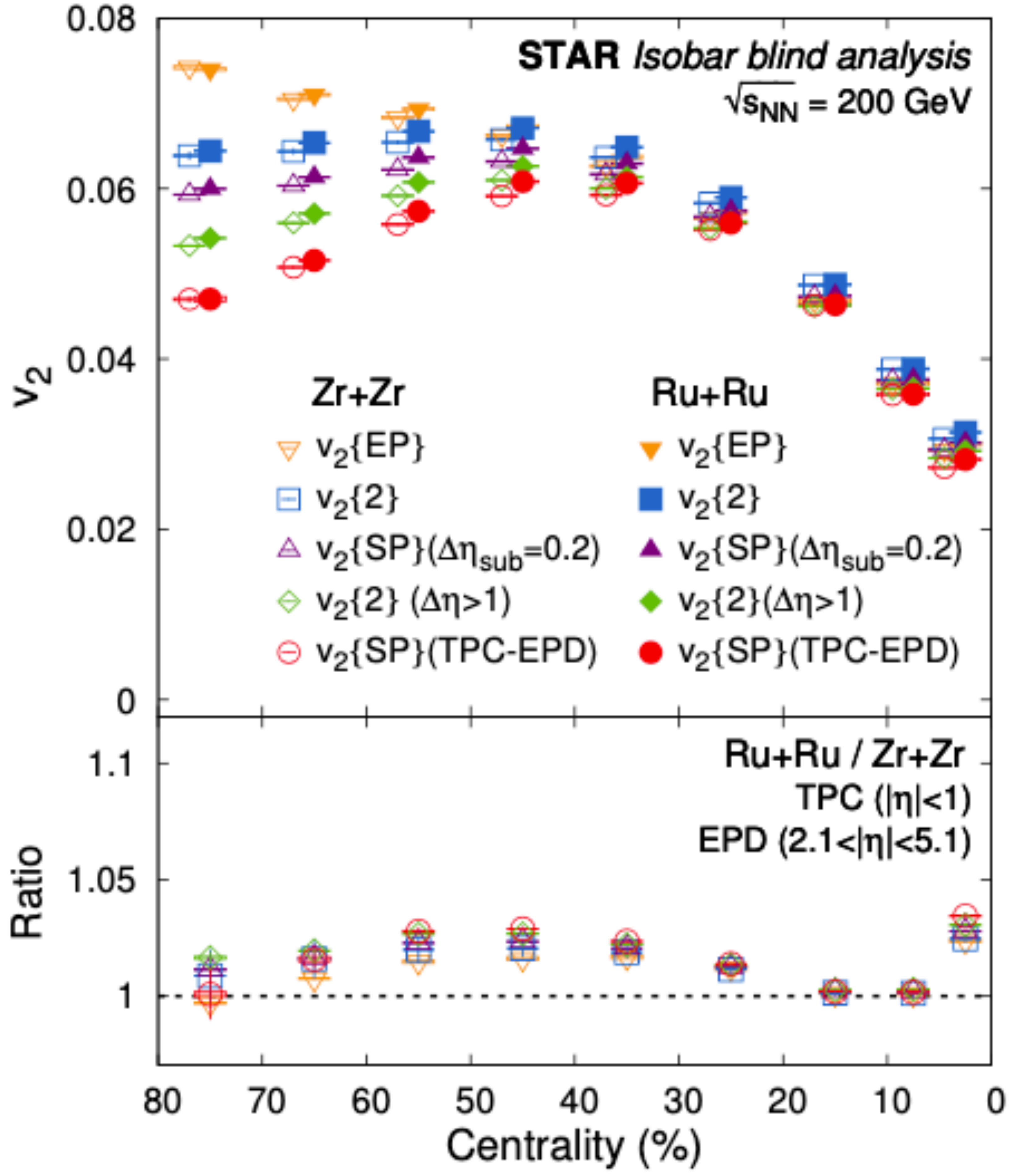
STAR collaboration, *Phys.Rev.C* 105 (2022)

Participant Eccentricity

- Deformation of Ruthenium leads to larger eccentricities in most central collisions



- The increase in mid-central collisions seen by STAR has more complex reasons

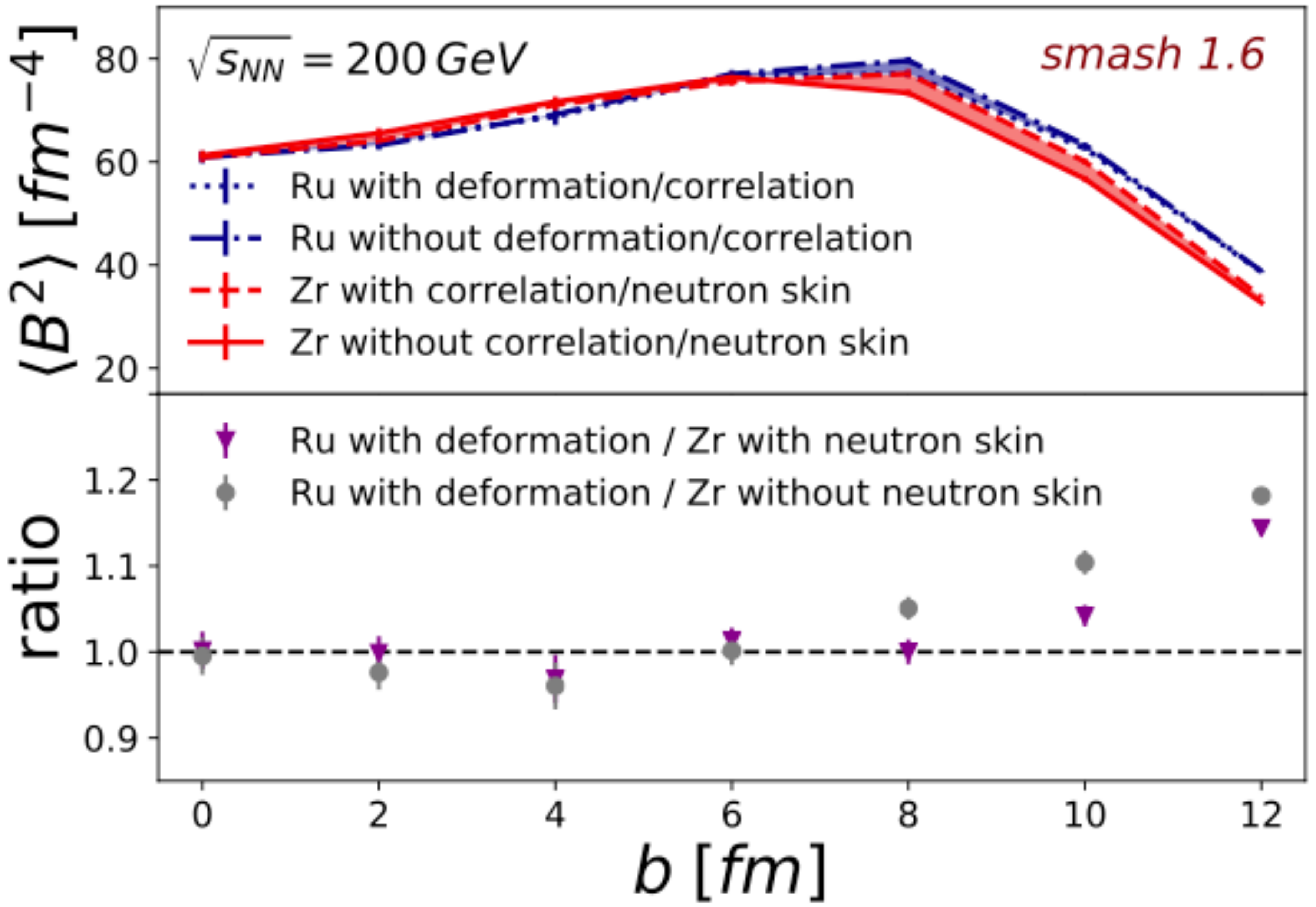


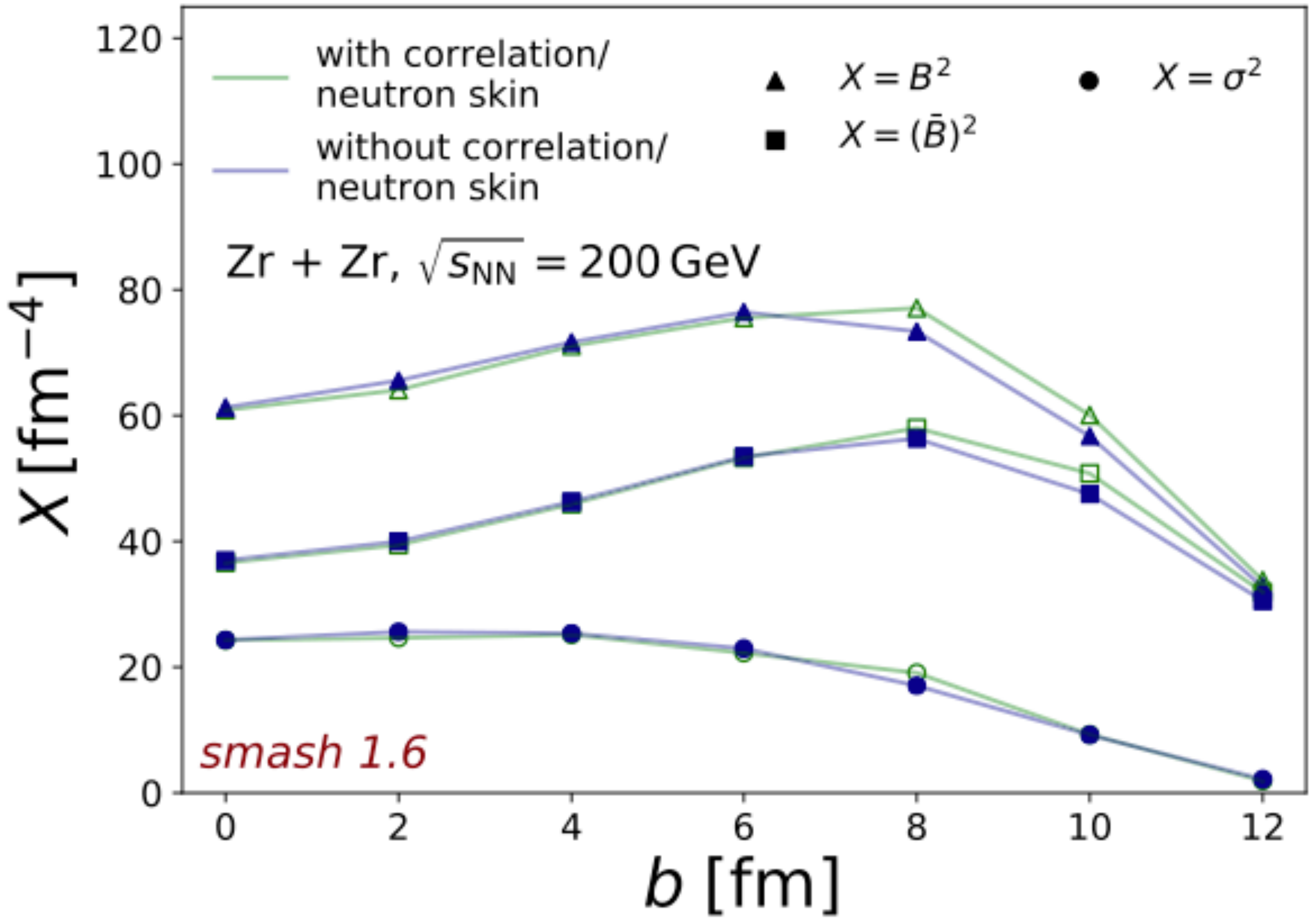
STAR collaboration, *Phys.Rev.C* 105 (2022)

In collaboration with Jan Hammelmann, Alba Soto Ontoso, Massimliano Alvioli and Mark Strikman, Phys.Rev.C 101 (2020) 6, 061901

Magnetic Field

- Due to the neutron skin, the charge is more concentrated in the middle -> differences in the magnetic field





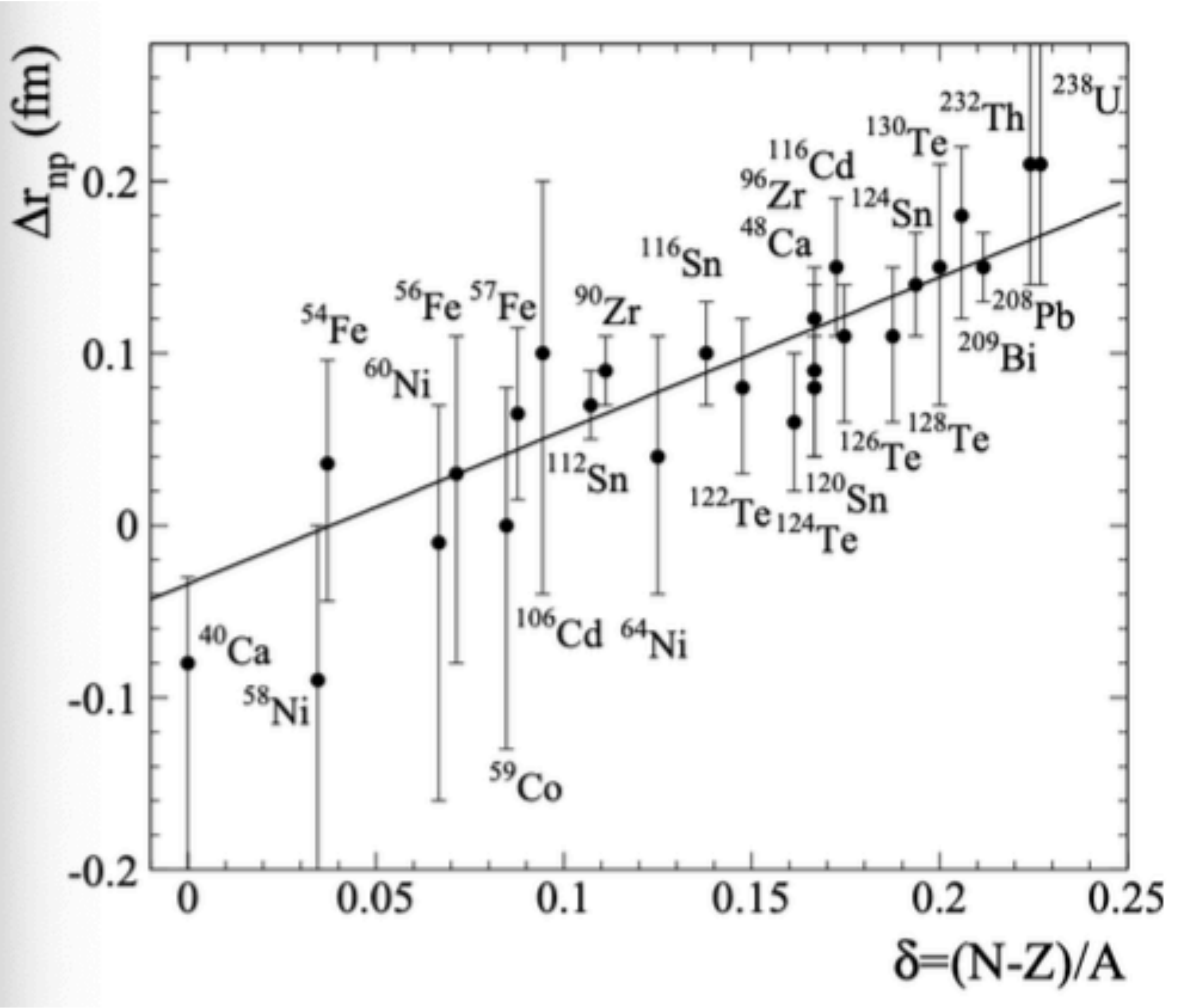
- The difference is really in the average field and not in the fluctuations
- One reason for missing difference between Ru/Zr results for CME correlators

STAR collaboration, *Phys.Rev.C* 105 (2022)

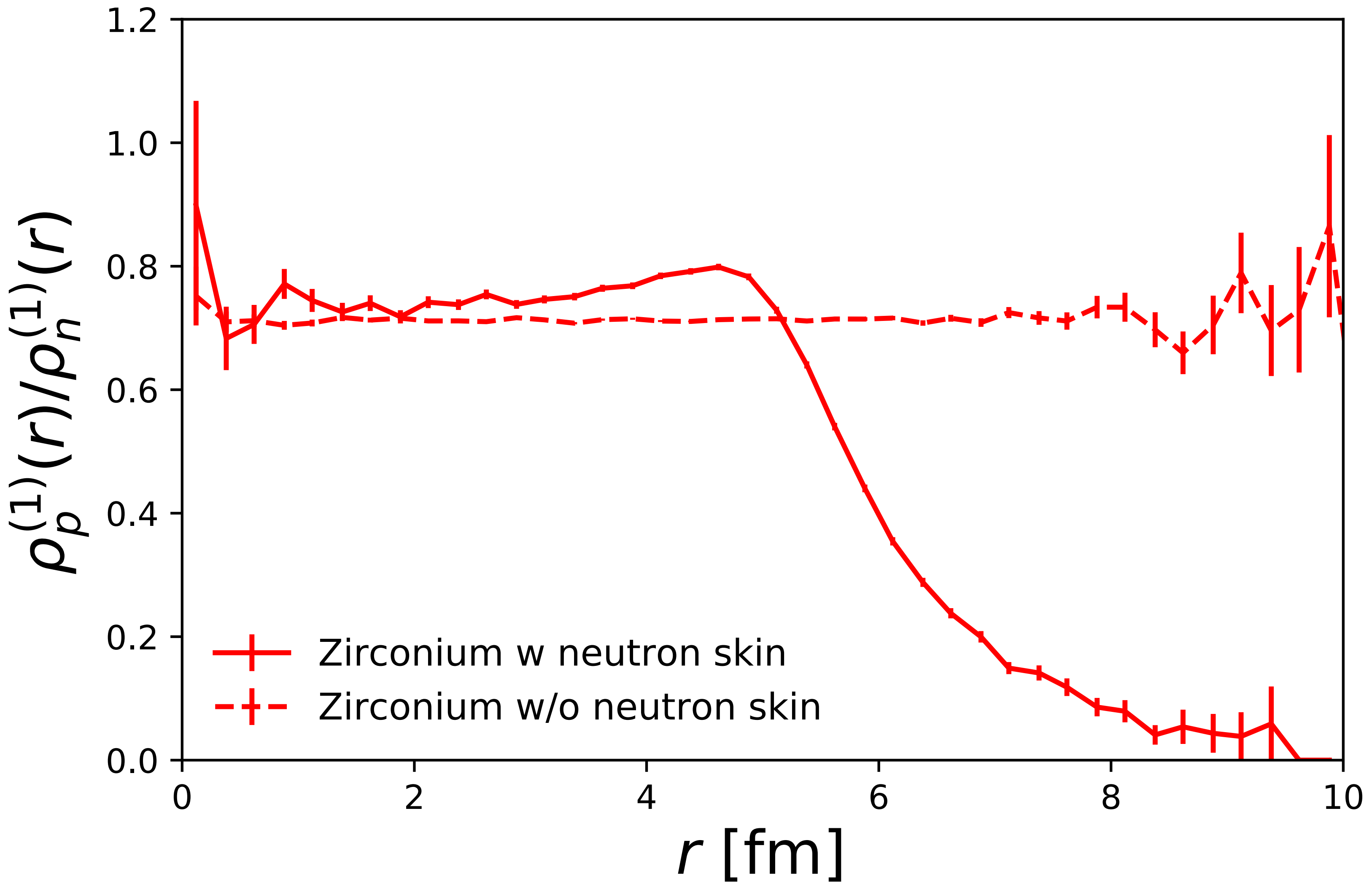
In collaboration with Jan Hammelmann, Alba Soto Ontoso, Massimliano Alvioli and Mark Strikman, Phys.Rev.C 101 (2020) 6, 061901

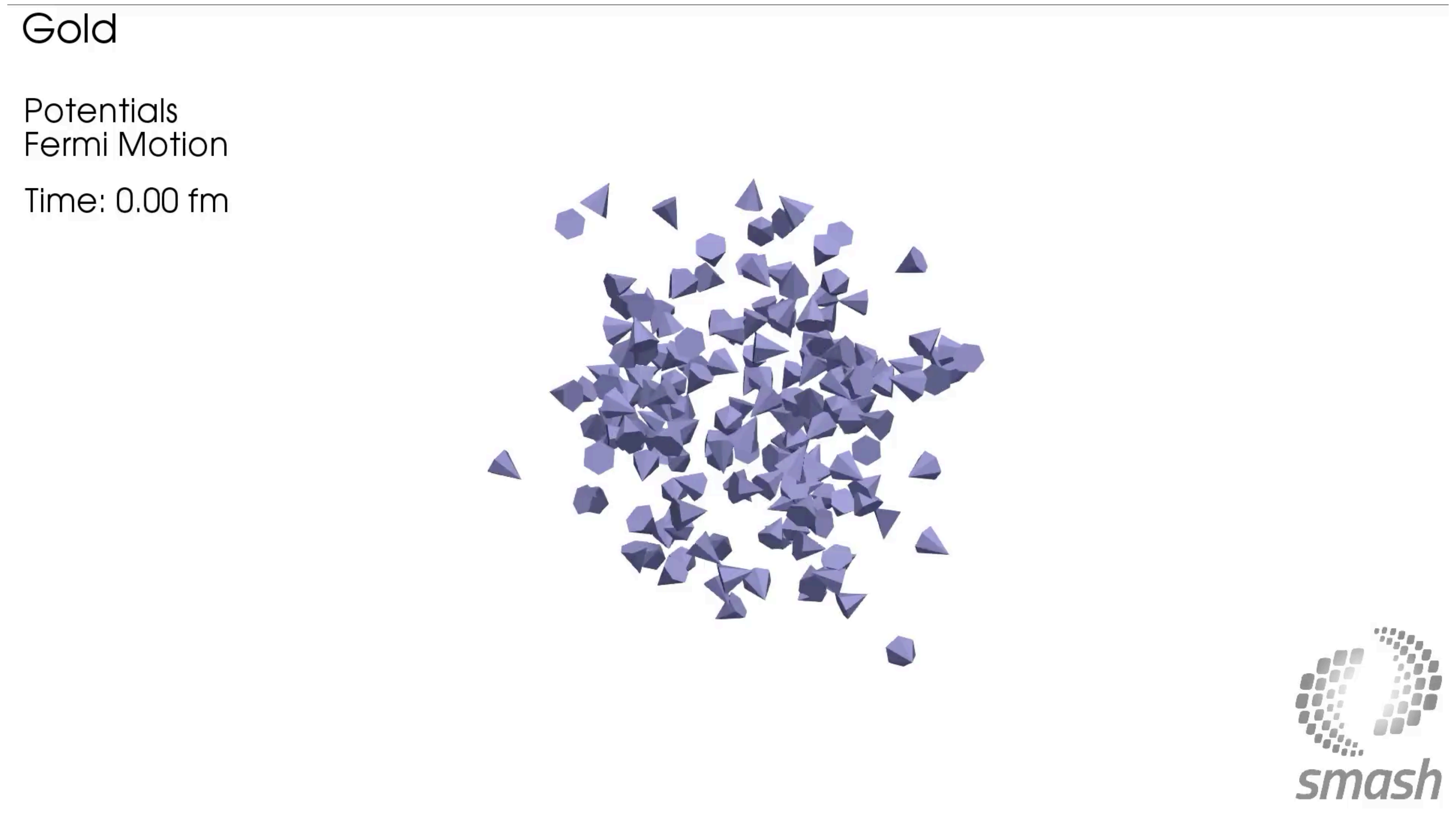
Initial Conditions

- Nuclear Collisions
  - Woods-Saxon distribution in coordinate space



LEAR Collab. IJMP E 13 (2004)





  - *optional:* deformed nuclei and (frozen) Fermi motion
  - *optional*: read-in of more realistic initial states with correlations, neutron skin

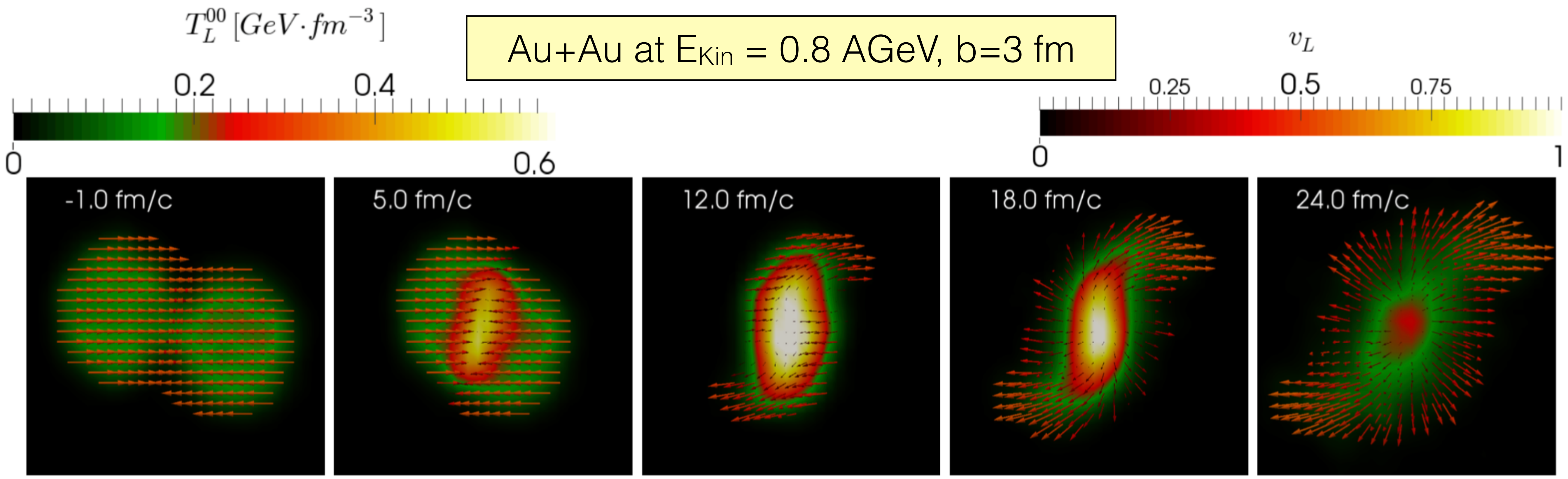
Gold nucleus with potentials and Fermi motion

In collaboration with Jan Hammelmann, Alba Soto Ontoso, Massimliano Alvioli and Mark Strikman, Phys.Rev.C 101 (2020) 6, 061901

SMASH*

* Simulating Many Accelerated Strongly-Interacting Hadrons

- Hadronic transport approach: J. Weil et al, PRC 94 (2016)
  - Includes all mesons and baryons up to ~2 GeV
  - Geometric collision criterion
  - Binary interactions: Inelastic collisions through resonance/string excitation and decay
  - Infrastructure: C++, Git, Doxygen, (ROOT)



- Visit the webpage to find publications and link to SMASH-2.1 results

  https://smash-transport.github.io

- Download the code at https://github.com/smash-transport/smash
- Checkout the Analysis Suite at https://github.com/smash-transport/smash-analysis
- Find user guide and documentation at https://github.com/smash-transport/smash/releases
- Animations and Visualization Tutorial under https://smash-transport.github.io/movies.html

In collaboration with Jan Hammelmann, Alba Soto Ontoso, Massimliano Alvioli and Mark Strikman, Phys.Rev.C 101 (2020) 6, 061901