Impact of the nuclear structure on the isobar run at RHIC

**Nuclear structure**
- Investigate potential maximal effect of deformation for Ru
  \[
  \rho(r, \theta) = \frac{\rho_0}{e^{(r-R'(\theta,\phi))/d} + 1}
  \]
  \[
  R'(\theta) = R_0(1 + \beta_2 Y_2^0(\theta))
  \]

<table>
<thead>
<tr>
<th>Nucleus</th>
<th>(R_0) [fm]</th>
<th>(d) [fm]</th>
<th>(\beta_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^{96}_{40})Zr</td>
<td>5.02</td>
<td>0.46</td>
<td>0</td>
</tr>
<tr>
<td>(^{96}_{44})Ru</td>
<td>5.085</td>
<td>0.46</td>
<td>0.158</td>
</tr>
</tbody>
</table>
- And neutron skin for Zr, use halo
  \[
  \Delta r_{np} = \langle r_{np}^2 \rangle^{1/2} - \langle r_n^2 \rangle^{1/2}
  \]
  \[
  \Delta r_{np} \big|_{^{96}_{40}Zr} = 0.12 \pm 0.03 \text{ fm}
  \]

**Methodology**
- Including nuclear structure effects and nucleon-nucleon correlations with initial state from full wave function
- 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, Massimiliano Alvioli and Mark Strikman, Phys.Rev.C 101 (2020) 6, 061901

STAR collaboration, Phys.Rev.C 105 (2022)
• Deformation of Ruthenium leads to larger eccentricities in most central collisions

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

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

- Nuclear Collisions
  - Woods-Saxon distribution in coordinate space
  - optional: deformed nuclei and (frozen) Fermi motion
  - optional: read-in of more realistic initial states with correlations, neutron skin

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

* Simulating Many Accelerated Strongly-Interacting Hadrons

- Hadronic transport approach:
  - 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

**J. Weil et al, PRC 94 (2016)**

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