Glauber Monte Carlo predictions for ultra-relativistic collisions with ^{16}O

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Motivation

- The cosmic-ray community argues for a p + O run, because such a new input is crucial to reproduce EAS data consistently: too large uncertainties in model for forward spectra and light ion interactions
- In the heavy-ion community, the origin of collectivity in small collision systems remains a central question that needs a timely answer
- A one-week exploratory O + O run at RHIC is already done

The goal of this presentation is to provide some physics opportunities of oxygen-oxygen and proton-oxygen collisions from the Glauber Monte Carlo perspective.

Outline

Attempt of outlook to the future:

- Glossary of Glauber Monte Carlo results for collisions with ^{16}O (O + O, O + A, p + O)
- A way to look at correlations in nuclear distributions

Based on

MR, WB, Phys. Rev. C 100, 064912

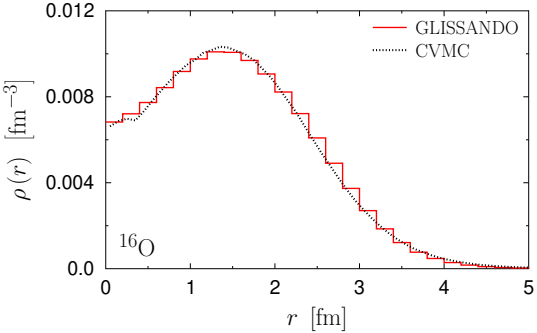
All simulations from GLISSANDO, wounded + admixture of binary collisions
[Comput. Phys. Commun. 245, 106850]

Proper parameterization of NN cross-sections as well as NN wounding profiles for $\sqrt{s_{NN}} > 5$ GeV!
NN wounding profiles obtained from fits of the COMPETE parametrization implemented in the PDG review

^{16}O nuclear distribution

We consider:

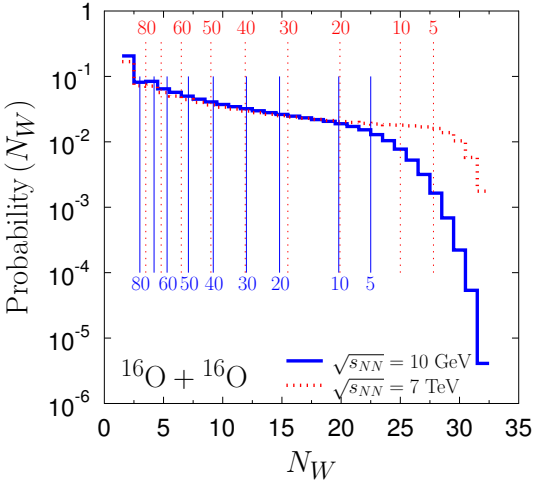
- Correlated distributions from cluster Variational Monte Carlo (CVMC) [Lonardoni et al., Phys. Rev. C 96, 024326]
- "Mixed" distributions, with correlations broken



`GLISSANDO` and CVMC radial distributions matched!

O + O collisions

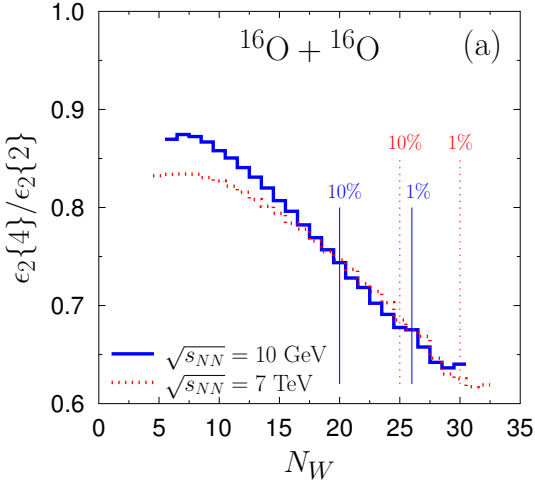
Probability distributions of the number of wounded nucleons

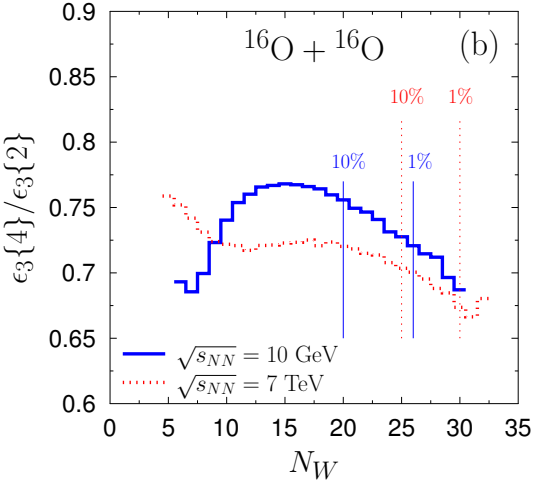


At the higher energy the distribution is more flat at higher N_W

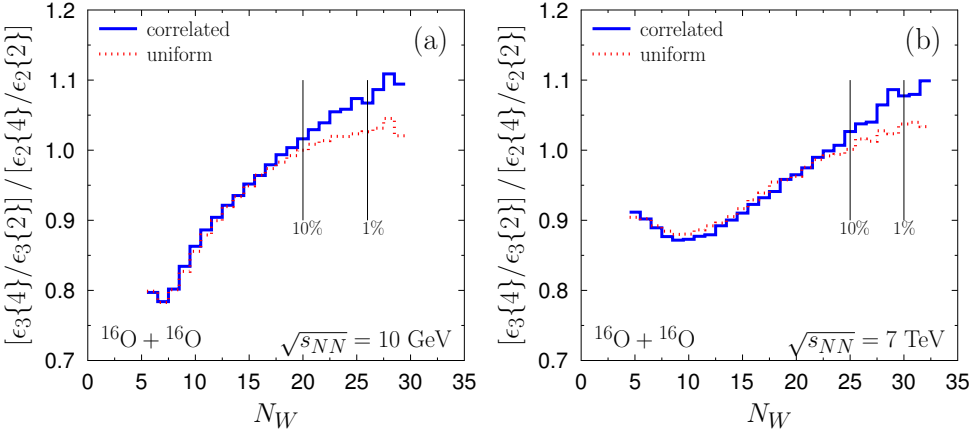
Higher value of the inelastic cross section makes it easier to wound more nucleons

Eccentricity ratios in O + O collisions





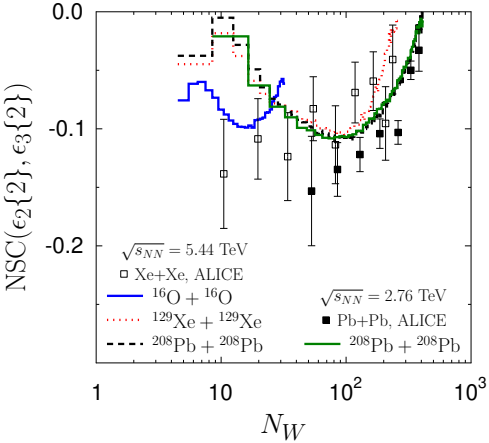
Eccentricity ratios in O + O collisions

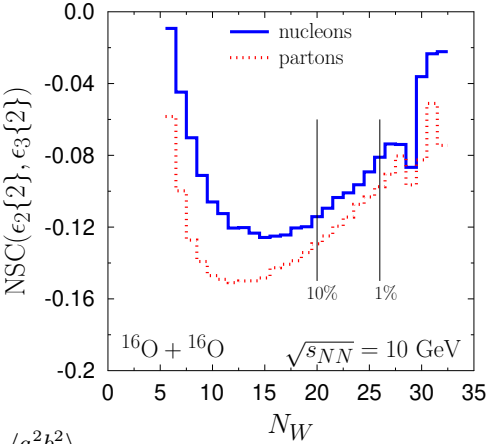


(correlated = CVMC, uniform = mixed)

Some quantitative but not qualitative effect for most central collisions

Flow correlation, normalized symmetric cumulant, wounded quarks





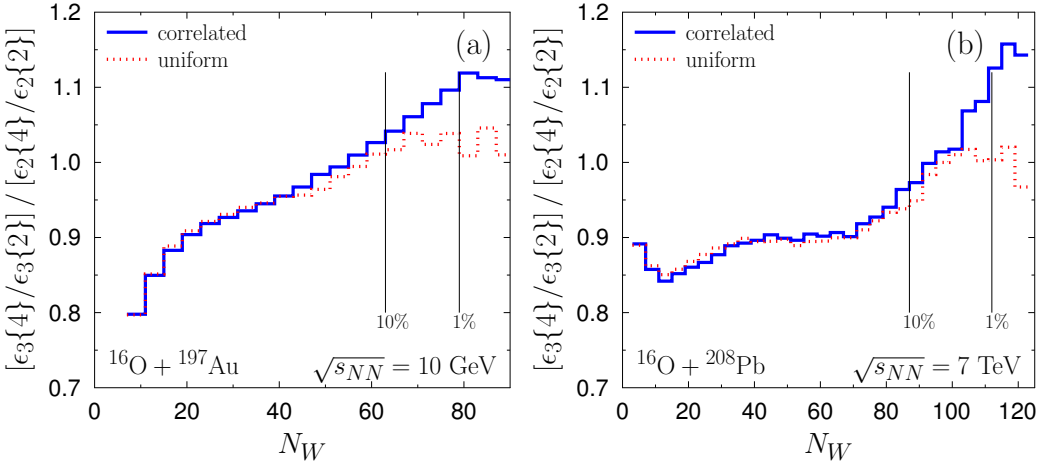
$$NSC\,(a,b) = \frac{\langle a^2 b^2 \rangle}{\langle a^2 \rangle \langle b^2 \rangle}$$

[see also Sievert, Noronha-Hostler, Phys. Rev. C 100, 024904]

O + O compared to p + Pb at the same N_W → more dilute initial condition

O + heavy collisions

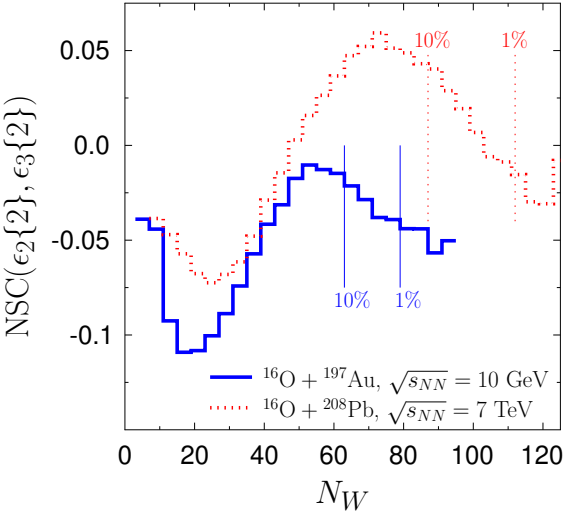
O + A, double ratios



(correlated = CVMC, uniform = mixed)

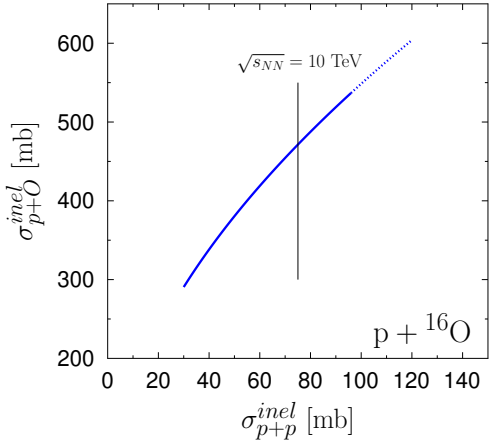
Effect of correlations for hyper-central collisions

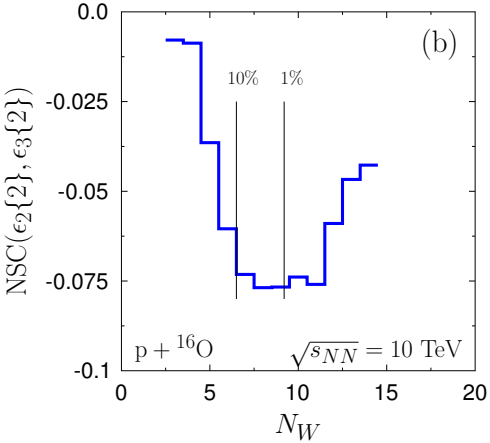
O + A, normalized symmetric cumulant



p + O collisions

p + O from GLISSANDO





GLISSANDO: $\sigma^{inel}_{p+O}(\sqrt{s_{NN}} = 57 \text{ TeV}) = 507$ mb

Pierre Auger: $\sigma^{inel}_{p+air}(\sqrt{s_{NN}} = 57 \text{ TeV}) = 505^{+28}_{-36}$ mb [P. Abreu et al., Phys. Rev. Lett. 109, 062002]

Summary

1. A comprehensive Glauber Monte Carlo analysis of ultrarelativistic reactions with ^{16}O nuclei, including O + O, p + O, and ^{16}O collisions on heavy targets.
2. No major qualitative differences should be expected from comparisons of flow characteristics in O + O collisions to the case of the earlier-studied heavy-ion collisions, such as Xe + Xe or Pb + Pb.
3. If confirmed experimentally, it would hint to a similar collectivity-based mechanism of the fireball evolution across these systems, from small to large.

THANKS FOR YOUR ATTENTION!