Predictions for Transverse momentum spectra and Elliptic flow of identified particles in Xe-Xe collisions at $\sqrt{s_{NN}} = 5.44$ TeV using AMPT

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Introduction

- On October 12th 2017, an 8 hour run of collisions between $^{129}$Xe nuclei at $\sqrt{s_{NN}} = 5.44$ TeV was carried out at the LHC.

- The mass number being halfway between that of a proton and that of a Pb nucleus, this will help in bridging the gap of final state multiplicity between Pb-ion systems and smaller systems like pp and p-Pb collisions.

- Xenon being deformed nucleus would uncover features seen in U-U collisions at RHIC in much higher energy.

- It has been shown recently that intrinsic deformities may affect particle flows for central collisions while for peripheral collisions this effect is negligible.

- We perform a comprehensive study of transverse momentum spectra, particle ratios and elliptic flow of identified particles using a multi-phase transport model (AMPT).

A Multi-Phase Transport Model (AMPT)

- A hybrid transport model which contains four components.

1. **Initialization of collisions**: HIJING model (The produced partons calculated in pp collisions are converted to p-A and A-A by incorporating parameterized shadowing function and nuclear overlap function using in-built Glauber model)

2. **Parton transport after initialization**: Zhang’s Parton Cascade (ZPC) model transports partons using Boltzmann transport equation

3. **Hadronization mechanism**: AMPT String melting (AMPT-SM) version uses coalescence mechanism while the default version uses fragmentation mechanism via Lund fragmentation

4. **Hadron transport**: A relativistic transport (ART) model via meson-meson, meson-baryon and baryon-baryon interactions

Nuclear Deformation

- In case of spherical nucleus, Woods-Saxon distribution is used to define the distribution of nucleons in HIJING.

- For the deformed nucleus like Xenon, deformation parameter is used along with spherical harmonics in Woods-Saxon density distribution.

\[ \rho(r) = \frac{\rho_0}{1 + e^{\left((r - R)/a\right)}} \]

- As Xenon has a prolate shape, the Woods-Saxon nuclear radius has been modified.

- We have done the calculations for random orientation of nuclei which means random values of polar and azimuthal angle.

Transverse Momentum ($p_T$) Spectra

$p_T$-spectra sheds light into the kinetic freeze-out of the medium and helps to obtain the temperature at the kinetic freeze-out and radial flow of the system.

Can be used to test the hydrodynamic models.

As the particle production mechanisms are highly dependent on $p_T$-range, $p_T$-differential particle ratios has major importance.

$K/\pi$ ratio has enhancement with $p_T$ suggesting enhanced strangeness production from low to intermediate-$p_T$.

Weak dependence on centrality at low-$p_T$ while centrality dependence is observed at intermediate-$p_T$.

Nuclear deformation has no effect on particle ratios although particle yield in central collisions vary with deformation.

For $p/\phi$ ratio, AMPT-Default is closer to experimental data at low-$p_T$ while AMPT-SM does a better job at intermediate-$p_T$.

p$_T$-integrated particle ratios

- Measurements of the relative abundances of identified light-flavored hadrons can be used to infer of the system at the chemical freeze-out

- The p$_T$-integrated K/π ratio for Xe-Xe collisions is consistent with experimental data for pp@7 TeV and Pb-Pb@2.76 TeV suggesting the relative yield are driven by the charged-particle multiplicity regardless to collision energy and system type

- Although dependence of differential particle ratios on centrality is observed, we do not observe centrality dependence of integrated particle ratios.

Mass ordering of elliptic flow at low-$p_T$ is observed.

At intermediate-$p_T$, elliptic flow of proton is higher compared to pions and kaons. This could be a hint of baryon and meson separation at this region.

Number of quark participant ($n_q$)-scaling of elliptic flow is violated.

Conclusion

- $p_T$-differential ratios show weak dependence on centrality at low-$p_T$ while centrality dependence is observed at intermediate-$p_T$.

- Nuclear deformation has no effect on particle ratios although particle yield in central collisions vary with deformation.

- The relative yield are driven by the charged-particle multiplicity regardless to collision energy and system type.

- Mass ordering of elliptic flow at low-$p_T$ is observed.

- Number of quark participant ($n_q$)-scaling of elliptic flow is violated.

Thank You