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Transverse momentum spectra and Nuclear Modification factor in Xe-Xe collisions at 5.44 TeV under HYDJET++ framework

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Transverse momentum p_T spectra of charged hadrons at mid-pseudorapidity in deformed Xe-Xe collisions at 5.44 TeV center-of-mass energy under the Monte Carlo HYDJET++ model (HYDrodynamics plus JETs) framework is reported. Results have been presented in $|\eta| < 0.8$ kinematic and (0-60)% centrality range. The nuclear modification factor in Xe-Xe collisions is calculated for most central, semi-central, semi-peripheral, and most peripheral collision centralities. Transverse momentum spectra and nuclear modification factor R_{AA} show strong p_T, and centrality dependence. Average transverse momentum $\langle p_T \rangle$ as a function of collision centrality is presented. The results have been compared with ALICE experimental data.

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1. Introduction

High transverse momentum quarks and gluons (jets), created from early stage hard scatterings are very useful probes of such highly excited nuclear matter [1]. Transverse momentum p_T spectra of charged hadrons is a suitable observable for studying these hard partonic jets [2]. One of the major signals of QGP formation is the strong suppression of these high-p_T particles (called as jet quenching) observed in heavy ion collisions at RHIC and LHC. The suppression of particle spectra in A+A collisions is measured by the nuclear modification factor R_{AA}.

2. Model Formalism

HYDJET++ is a Monte Carlo model of relativistic heavy ion collisions which simultaneously simulates two independent components: soft hydro-type (also called as hydro part) state and the hard (also called as jet part) state resulting from the medium-modified multiparton fragmentation. The details of the model and the corresponding simulation procedure can be found in the paper [3] and the references therein. The hard state of an event in HYDJET++ is treated using Pythia Quenched (PYQUEN) model [4] which modifies a jet event produced by PYTHIA by producing nucleonic collision vertices using Glauber model at a certain impact parameter [5–8]. The hard state in HYDJET++ is separated from the soft state by a free parameter named p_T^{min}. The soft state of a HYDJET++ event is a thermal hadronic state created on the chemical and thermal freeze-out hypersurfaces derived from the parameterization of relativistic hydrodynamics with preset freeze-out conditions [9, 10].

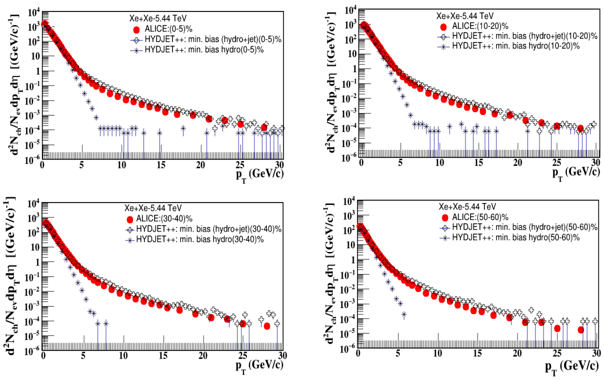

Figure 1: Transverse momentum spectra of all charged paricles with and without jet part for minimum bias collisions over centrality along with ALICE experimental data for comparison[11]. Here we have used $|\eta| < 0.8$ pseudorapidity cut.

Xenon is a moderately deformed nucleus. The deformation is incorporated via the modification of the Woods-Saxon Nuclear density profile function as explained in references [12, 14]. The values of different parameters have been taken from the reference [15]. The deformed structure permits us to have many collision geometries such as minimum bias (θ =random (0 to 2π)), body-body ($\theta = \pi/2$), and tip-tip ($\theta = 0$) collisions with respect to the collision axis.

3. Results and Discussion

We find a suitable match of model p_T-spectra (see figure 1) including jet part with ALICE experimental results [11] while without jet part the model completely underpredicts the data. Below 3.0 GeV/c, the collective flow hydrodynamics dominates the spectra but beyond that, hard scatterings come into play. p_T spectra decreases as we move from most-central to most-peripheral results. Without jet part, the transverse momentum distribution is very small and completely underestimates the experimental data.

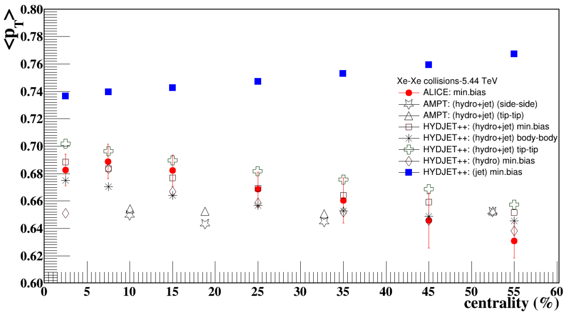

Figure 2: Variation of average transverse momentum $\langle p_T \rangle$ with respect to collision centrality at $|\eta| < 0.8$ for minimum bias, body-body and tip-tip collisions[12]. The results show average p_T for hydro, jet and hydro+jet part separately comparing them with ALICE experimental data [11] and AMPT model results in string melting version[13].

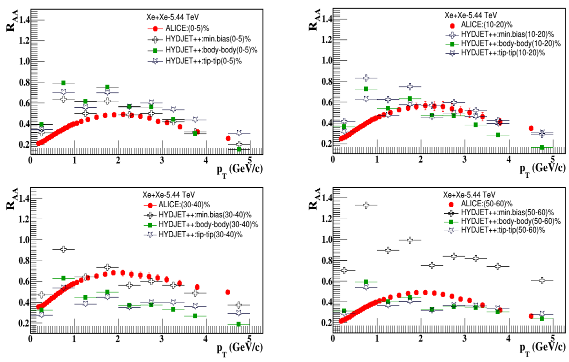

Figure 3: Nuclear Modification Factor R_{AA} of charged hadrons with respect to p_T for minimum bias, body-body and tip-tip collisions over centrality along with ALICE experimental data for comparison [11]. Here we have used $|\eta| < 0.8$ pseudorapidity cut.

Minimum bias HYDJET++ results for total and hydro part (see figure 2) show suitable match with ALICE experimental data whereas jet part shows opposite behaviour. At a given collision centrality, $\langle p_T \rangle$ is higher for tip-tip collisions than for body-body collisions. In the AMPT model [13] (string-melting version), $\langle p_T \rangle$ shows a weak centrality dependence compared to HYDJET++ model. The minimum bias nuclear modification factor R_{AA} from HYDJET++ model (in figure 3) shows a suitable match with ALICE experimental results [11]. Tip-tip R_{AA} is higher than body-body R_{AA}. The suppression increases at low p_T, reaches its maximum at around $p_T \simeq 2$ GeV/c. Nuclear modification factor R_{AA} or suppression increases with collision centrality and then decreases in most-peripheral collisions.

4. Conclusions

Minimum biased transverse momentum distribution of charged hadrons show suitable match with ALICE experimental yield from low to high p_T region. $\langle p_T \rangle$ shows strong dependence on centrality with and without jet part. HYDJET++ model shows a suitable match with the experimental data within error bars. However, $\langle p_T \rangle$ for only jet part is somewhat centrality independent. This behaviour is in good agreement with results from the AMPT model in string-melting version. Minimum bias R_{AA} of charged hadrons shows a suitable match with the ALICE experimental data, tip-tip R_{AA} being higher than body-body R_{AA}.

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