Elliptic and triangular flows of reconstructed jets in Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76TeV in a multiphase transport model

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Introduction

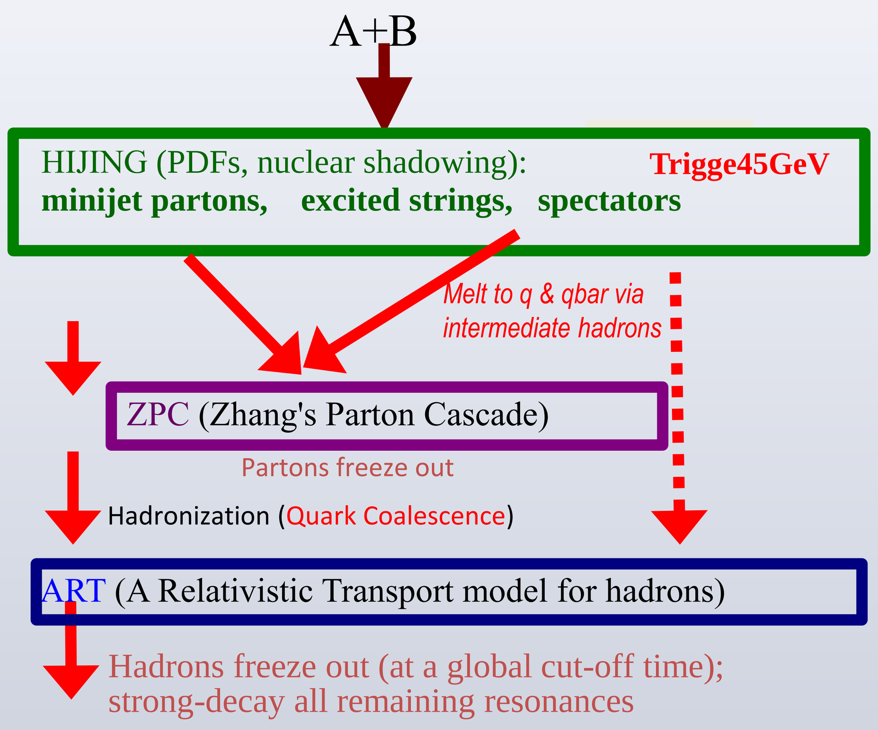
The recent studies of higher orders of harmonic flow, especially for triangular flow v_3, have deepened our understanding of many aspects of high energy heavy-ion collisions . It would be interesting to study the third order of anisotropy v_3 of reconstructed jets, as it serves as the jet response to the initial geometry triangularity which could provide a greater constraint on jet quenching models.

In this poster, the elliptic anisotropy v_2 and triangular anisotropy v_3 of reconstructed jets are investigated in Pb+Pb collisions at $\sqrt{s_{NN}}$=2.76TeV within a multiphase transport (AMPT) model. We observe that the jet energy loss fraction is dependent on the azimuthal angle with respect to the different orders of event plane. We further propose azimuthal anisotropies of a reconstructed jet as a good probe to study the initial spatial fluctuations, and expect that jet v_n provides constraints on the path-length dependence of jet quenching models.

The AMPT Model

The AMPT model with string melting scenario is utilized in this work. It consists of four main stages of high-energy heavy-ion collisions: the initial condition, parton cascade, hadronization, and hadronic rescatterings.

In order to increase the simulation efficiency of jets with p_T>45GeV/c, a dijet of p_T~40GeV/c is triggered in the initial condition based on the HIJING model.

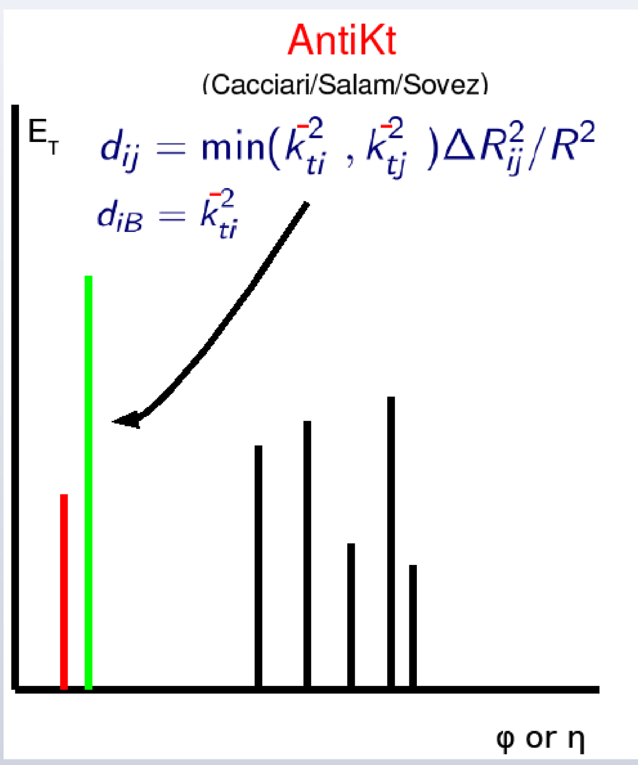


Jet reconstruction

To reconstruct jets, the kinematic cuts are chosen to be the same as in the ATLAS experiment. An anti-kt algorithm from the standard Fastjet package is used to reconstruct full jets, in which the jet cone size R is set to be 0.2.

A pseudorapidity strip of width Δη=1.0 centered on the jet position, with two highest-energy jets excluded, is used to estimate the background ("average energy per jet area"), which is subtracted from the reconstructed jet energy in Pb+Pb collisions.

Only jets within a mid-rapidity range of |η|<2 are considered in this analysis.



Results and Discussions

To calculate the n-th Fourier coefficient v_n, the n-th event plane ψ_n^r can be defined as:

$$\Psi_n^r = \frac{1}{n}\left[\arctan\frac{\langle r^n \sin(n\varphi)\rangle}{\langle r^n cos(n\varphi)\rangle} + \pi\right]$$

where r and φ are the coordinate position and azimuthal angle of each parton in the AMPT initial state and the average ⟨⋯⟩ denotes density weighting. Then the n-th harmonic coefficient of jets, v_n^{jet}, can be obtained by the following equation

$$v_n^{jet} = \langle cos[n(\phi^{jet} - \Psi_n^r)]\rangle$$

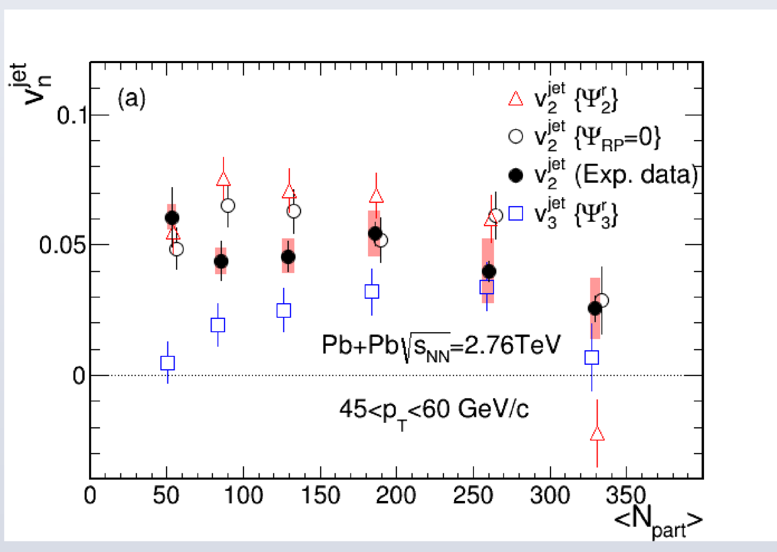


Fig. 1 $v_n^{jet}(n = 2\ and\ n = 3)$ as functions of N_{part} for jet p_T bins of 45<p_T<60 GeV/c in Pb+Pb collisions at $\sqrt{s_{NN}}$=2.76TeV.

Jet v_2 and v_3 as functions of N_{part} for a typical p_T bin of 45< p_T <60 GeV/c are calculated, denoted as $v_2^{jet}\{\Psi_2^r\}$ and $v_3^{jet}\{\Psi_3^r\}$, are shown in Fig. 1, respectively. For jet v_3, it is smaller than jet v_2. By comparing jet v_3 between two different jet p_T bins, jet v_3 tends to vanish with increasing jet p_T.

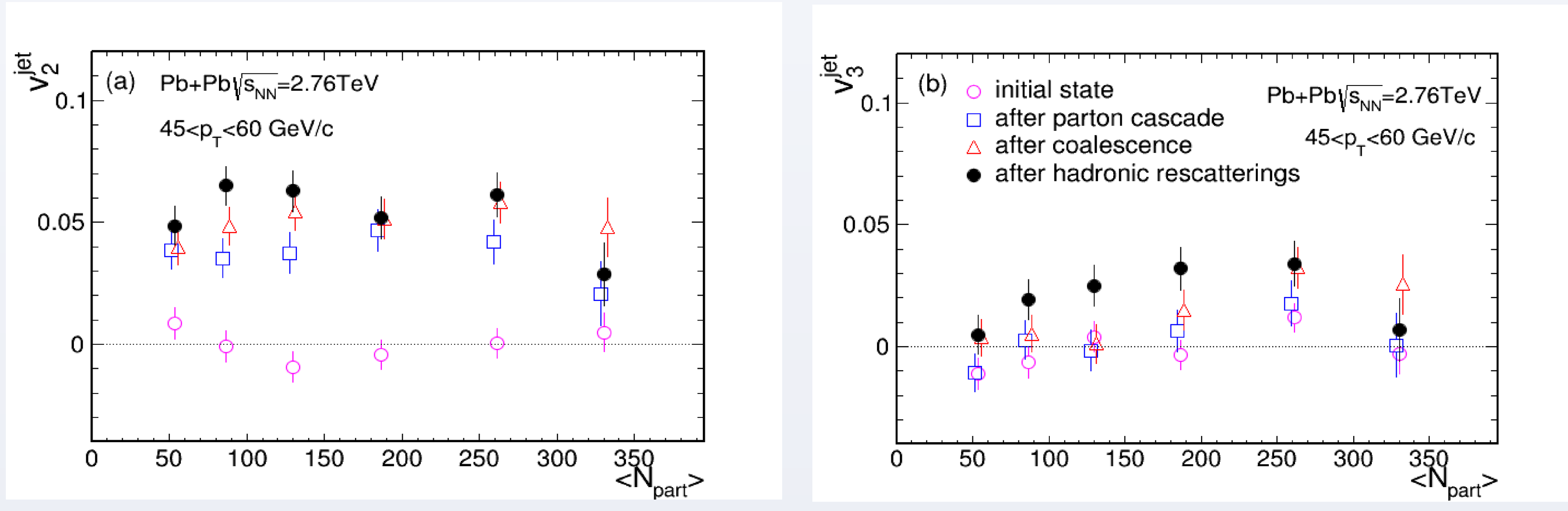
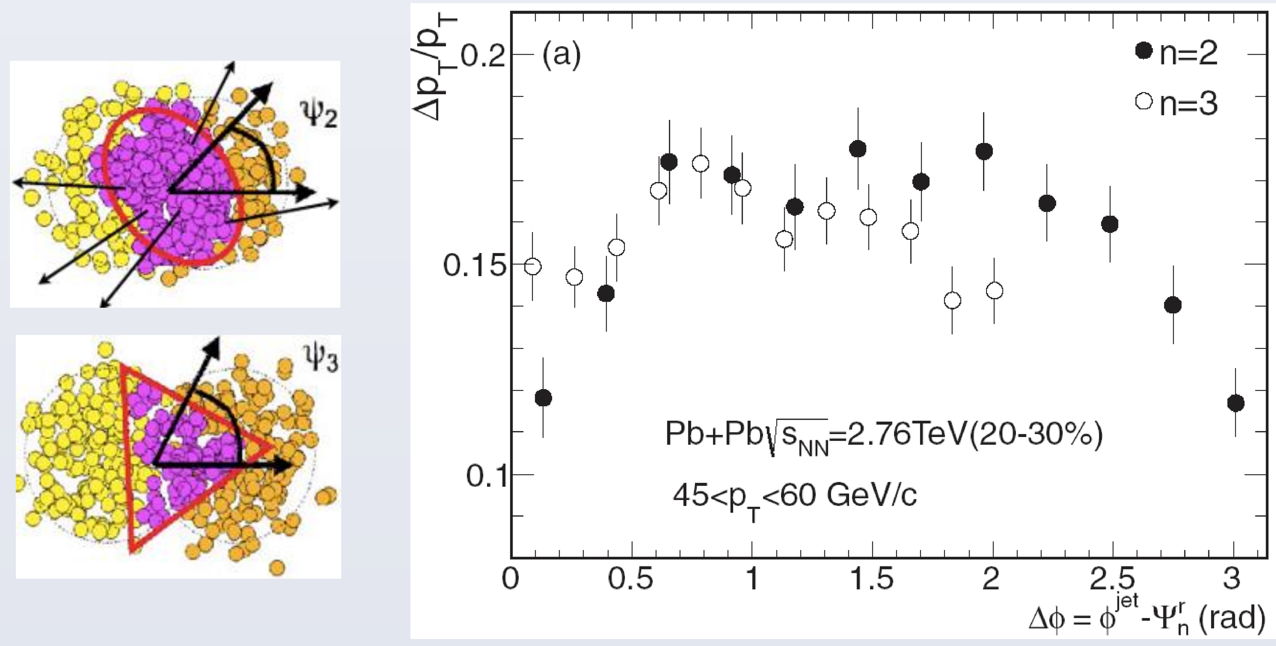


Fig. 2 $v_n^{jet}(n = 2\ and\ n = 3)$ as functions of N_{part} for jet p_T bins of 45<p_T<60 GeV/c in Pb+Pb collisions at $\sqrt{s_{NN}}$=2.76TeV.

Figs.2(a) and 2(b) display the jet v_n is nearly zero in the initial state. However, jet v_n arises from the process of parton cascade, which indicates jet v_n is generated owing to the strong interactions between jet and the paronic medium.



Figs.3 The AMPT results on jet energy loss fraction, $\Delta p_T/p_T$, as functions of $\Delta\phi = \phi^{jet} - \Psi_n^r$ [n=2 (solid circles) and 3 (open circles)] for the jet p_T bins of 45<p_T<60 GeV/c in the centrality bin of 20-30%.

The averaged jet energy loss fraction $\Delta p_T/p_T = (p_T^{jet,initial} - p_T^{jet,final})/p_T^{jet,initial}$ as functions of the relative azimuthal angle $\Delta\phi = \phi^{jet} - \Psi_n^r$ for jet p_T bin of 45<p_T<60 in their first azimuth periods for the centrality bin of 20-30%. Fig.3 shows jets lose more energy at $\Delta\phi \sim \pi/2$ with respect to the second order of event plane or$\Delta\phi \sim \pi/3$ with respect to the third order of event plane. It can be reasonably understood because jets transverse a longer path length through the medium in the direction of $\Delta\phi \sim \pi/2$ or $\Delta\phi \sim \pi/3$ for an elliptic or triangle shape profile, which are consistent with the path-length effect of jet energy loss.

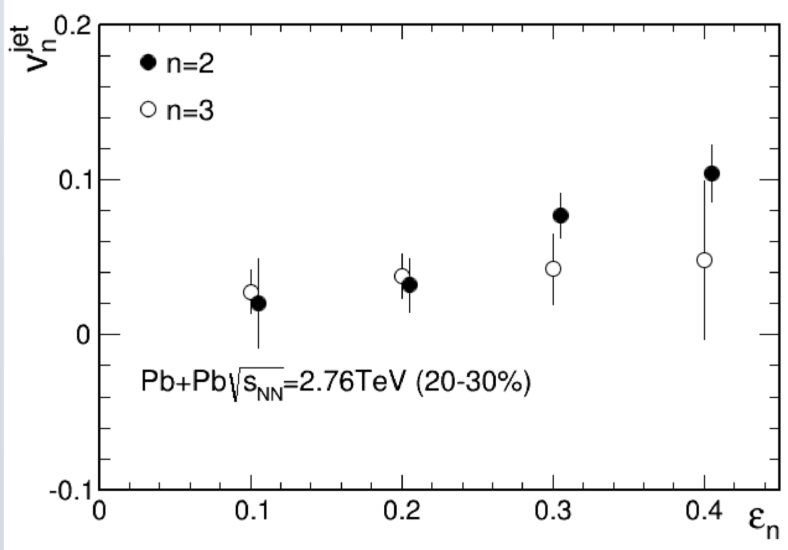


Fig.4 the AMPT results on v_n^{jet}/ε_n as functions of N_{part} for the jet p_T bin of 45<p_T<60GeV/c

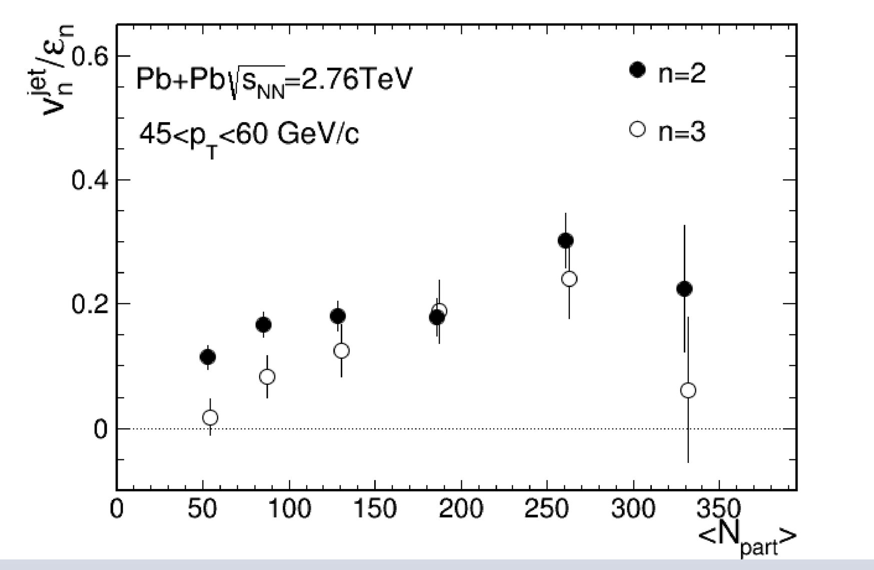


Fig.5 presents jet v_n as functions of the eccentricity ε_n for the jet p_T bin of 45<p_T<60 GeV/c

Fig.4 shows the v_n^{jet}/ε_n increases with N_{part} except the most central centrality bin where jet v_n is close to zero, which reveals that azimuthal anisotropies of jets is more easily formed in more central collisions owing to a larger jet energy loss in a denser partonic matter.

Fig.5 presents jet v_n as functions of the eccentricity ε_n for the jet p_T bin of 45<p_T<60 GeV/c in a selected centrality bin of 20-30% in Pb+Pb collisions. It is shown that the final jet v_n increases with the initial spatial eccentricity or triangularity, which indicates that jet azimuthal anisotropies are produced by the interactions between jets and the partonic medium with different asymmetrical geometry shapes.

Conclusions

- v_3 of a reconstructed jet, which has a smaller magnitude than its v_2.
- The dynamical stage evolution of reconstructed jet discloses that jet v_n mostly arises from a strong parton cascade process with little effect from the final stages.
- The ratio v_n^{jet}/ε_n increases with N_{part} in non-central Pb+Pb collisions; furthermore, jet v_n increases with the initial spatial asymmetry (ε_n) for a given centrality bin.
- These behaviors indicate that jet v_n is produced by the strong interactions between jet and the partonic medium with different initial asymmetrical geometry shapes.
- The azimuthal anisotropies of reconstructed jet can be utilized as a good probe to study the initial spatial asymmetry, and imposes constraints on the path-length dependence of jet quenching models.

*more details see Phys. Rev. C **90**, 014907(2014)