Inclusive Charged Hadron v_2 in Au+Au Collisions at $\sqrt{s_{NN}}$=7.7 - 39 GeV in STAR

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Introduction

One of the main goals of the STAR experiment at Relativistic Heavy Ion Collider (RHIC) is to study the properties of the QCD matter at extremely high energy and parton densities, created in the heavy-ion collisions [1]. Recently RHIC has undertaken a Beam Energy Scan (BES) program to look for changes in observation of various measurements as a function of beam energy to study the QCD phase structures.

In the non-central nucleus nucleus collisions, the overlapping area is not spherical. This initial spatial anisotropy is then transformed into momentum anisotropy because of the pressure gradients developed by the subsequent interactions among the constituents [2]. The elliptic flow (v_2) is a measure of anisotropy in momentum space. The elliptic flow parameter is defined as the second Fourier coefficient of the particles distributions in emission azimuthal angle (ϕ) with respect to the reaction plane angle (Ψ). For a given rapidity window the second coefficient is

$$v_2 = \langle \cos(2(\phi - \Psi)) \rangle. \quad (1)$$

The BES program at RHIC allows to study elliptic flow at different baryonic chemical potential (μ_B) from 20 to about 400 MeV [3]. Lattice QCD calculations suggest that the quark-hadron transition is cross-over at small μ_B or high $\sqrt{s_{NN}}$ and other model calculation suggest that at higher μ_B or lower $\sqrt{s_{NN}}$ the transition is expected to be first order [4]. According to the reference [5], a non-monotonic behavior of v_2 could be observed around the "softest point of the EOS". Measurement of v_2 as function of $\sqrt{s_{NN}}$ and collision centrality could be used to search for the softest point of the EOS in the heavy ion collisions. In addition the v_2 measurement using several methods would be helpful to understand non-flow contributions and flow fluctuations.

Data sets and Analysis methods

In this presentation we will report the inclusive charged hadron v_2 at midrapidity ($|\eta| < 1.0$) in Au+Au collisions at$\sqrt{s_{NN}}$= 7.7, 11.5, 19.6, 27 and 39 GeV, data was collected in the years 2010 and 2011 by the STAR experiment.The upper panels of Figure 1 show the p_T dependence of v_2 from various methods for the 20-30% collision centrality [6]. The v_2{FTPC/BBC} means v_2 measured using event plane reconstructed from the tracks recorded by FTPC($2.5 < |\eta| < 4.0$)/BBC($3.8 < |\eta| < 5.2$) detectors and v_2{EtaSubs} implies v_2 using η sub-event method where the event plane are taken from opposite hemisphere in pseudorapidity. Details of v_2{EtaSubs}, v_2{2}, and v_2{4} can be found in [6]. The lower panels of figure 1 show ratio of v_2 of all other methods to that of the 2-particle cumulant method. It can be seen that the difference of v_2{2} compared to v_2{FTPC/BBC}, v_2{4} and v_2{EtaSubs} depends on p_T range. A relatively larger difference is observed in the low p_T region ($p_T < 1$ GeV/c) while the difference between v_2{FTPC/BBC} and v_2{4} is relatively small and less dependent on the p_T. It suggests the non-flow contribution to the event plane and 2-particle correlation methods depends on p_T.

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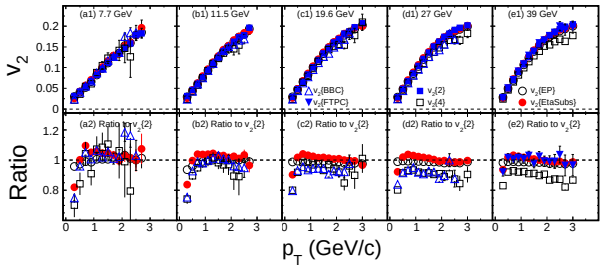

FIG. 1: The transverse momentum dependence of charged hadron v_2 for 20-30% central Au+Au collision at midrapidity for$\sqrt{s_{NN}}$= 7.7, 11.5, 19.6, 27 and 39 GeV [6].

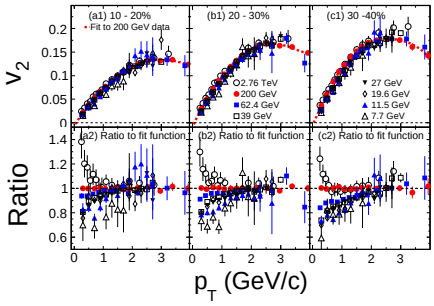

FIG. 2: Charged hadron $v_2\{4\}$ vs. p_T for various centrality at midrapidity for$\sqrt{s_{NN}}$= 7.7 GeV - 2.76 TeV [6]. The results for $\sqrt{s_{NN}}$ = 7.7 to 200 GeV are for Au+Au collisions and those for 2.76 TeV are for Pb + Pb collisions [7].

Results

Upper panels of figure 2 show the energy dependence of charged hadron v_2 vs. p_T for different centrality from top LHC energy (2.76 TeV) [7] to lowest RHIC energy (7.7 GeV) [6]. For comparison, the v_2 from other energies are divided by a fit to the v_2 at 200 GeV. For p_T < 2 GeV/c, the v_2 values rise with increasing collision energy while beyond p_T = 2 GeV/c the v_2 results show comparable values within statistical error.

We will present centralty and η dependence of the inclusive charged hadron v_2. To understand the physical mechanism behind the measurement, we will also compare v_2 results from the different collision energies to transport model calculation like a multiphase transport model (AMPT) and the ultrarelativistic quantum molecular dynamics (UrQMD) model.

References

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