A measurement of intrinsic transverse momentum of parton (k_T) from two particle correlations for pp collisions at RHIC

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Introduction

Partons are the constituents of nucleons which carry a fraction of the nucleon momentum described by parton distribution function [1]. 2→2 partonic hard scattering processes are manifested as jets of particles back to back in azimuth. These processes are described well by QCD predictions but there are some difficulty in explaining the predictions of the cross sections at high p_T regions and the behavior of the scaling laws [2] and one needs to introduce an extra p_T kick to the scattered partons to explain the data. It is true that since partons are confined inside a hadron of finite dimension they have a certain amount of intrinsic motion [3]. This intrinsic motion gives rise to an effective transverse momentum vector k_T of each of the two colliding partons undergoing hard scattering in proton-proton collisions. k_T measurement have been performed by ISR [4, 5], CCOR [6], PHENIX [7] collaborations at various centre of mass energies and at various kinematic regions. The measuments contain the intrinsic k_T and the additional smearing of the partonic k_T that comes from initial and final state gluonic radiation.

Analysis and results

In the present analysis we have measured the k_T for pp collisions at $\sqrt{s}$ = 200 GeV in STAR from di-hadron correlation, the method of which is similar to PHENIX but in an extended kinematic region. We have used tracks form Time Projection Chamber (TPC) for associated particles (p_{Ta}) and neutral clusters from Barrel Electromagnetic Calorimeter (BEMC) as trigger particle (p_{Tt}) for getting

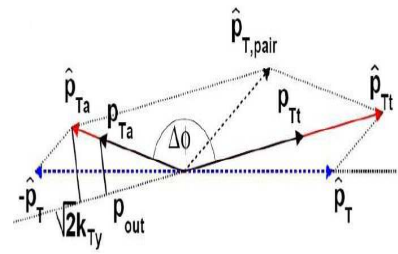

FIG. 1: Transverse momentum balance in hard scattering process. ˆ denotes for partons while without hat denote for particles after fragmentation

π^0-charge correlation function. We have also used TPC only for getting charge-charge correlation function. Hence we have extracted extracted k_T from π^0-charge and charge-charge azimuthal correlations. Each BEMC tower subtends 0.05 in η by 0.05 in ϕ covering $|\eta| \leq 1$ in full azimuth. π^0's are constructed from BEMC tower signal with no charge tracks falling in it.

Fig.1 shows the schematic where the av-

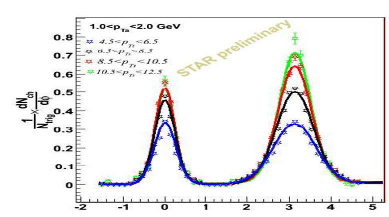

FIG. 2: π_0-ch correlation function

erage transverse momentum of particles in a jet relative to the jet axis (j_T) is directly related to the measurement of k_T by correlation method, since p_{out} measured from the ex-

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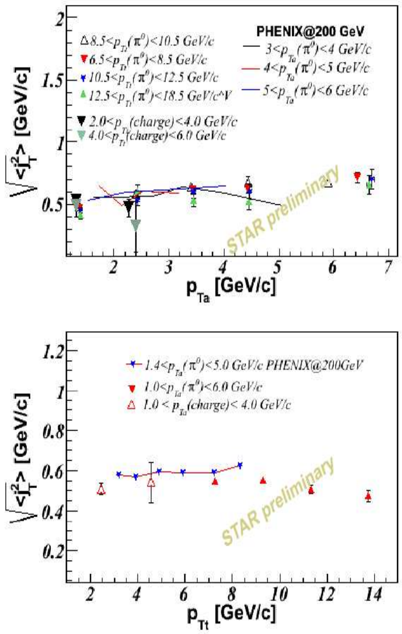

FIG. 3: Above : j_T with p_{Ta}; Below : j_T with p_{Tt}

periment comprises the effect of both j_T and k_T. We have the equations for finding $\langle j_T^2 \rangle$ and $\langle z_t(k_T, x_h)\rangle \sqrt{\langle k_T^2\rangle}/\hat{x}_h(k_T, x_h)$ which were used by PHENIX [7].

$$\sqrt{\langle j_T^2\rangle} = \sqrt{2}\frac{p_{Ta}p_{Tt}}{\sqrt{p_{Ta}}^2 + p_{Tt}{}^2}\sigma_N{}^2 \qquad (1)$$

$$\frac{\langle z_t(k_T, x_h)\rangle\sqrt{\langle k_T^2\rangle}}{\hat{x}_h(k_T, x_h)} = \frac{1}{x_h}\sqrt{\langle p_{out}^2\rangle - \langle j_{Ty}^2\rangle(1 + x_h^2)} \qquad (2)$$

Here $\langle z_t\rangle = \langle p_{Tt}/\hat{p_{Tt}}\rangle$, $x_h = \langle p_{Tt}\rangle/\langle \hat{p_{Tt}}\rangle$, p_{out} = p_{Ta} sin$\Delta\phi$, and σ_N is the near side ($\Delta\phi$ = 0) width of the correlation function (Fig.2).

We have calculated $j_T{}^2$ (Fig.3) and $\langle z_t(k_T, x_h)\rangle\sqrt{\langle k_T^2\rangle}/\hat{x}_h(k_T, x_h)$ (Fig.4 &5) as a function of p_{Tt} and p_{Ta}. The values of $\sqrt{\langle j_T^2\rangle}$ is found to be independent of p_{Tt} and p_{Ta}. On the other hand $\langle z_t(k_T, x_h)\rangle\sqrt{\langle k_T^2\rangle}/\hat{x}_h(k_T, x_h)$ is found to be strongly dependent on p_{Tt} and p_{Ta}. It increases with p_{Tt} while decreases with p_{Ta}. The factor, $\langle z_t(k_T, x_h)\rangle/\hat{x}_h(k_T, x_h)$ can be calculated using PYTHIA which basically takes care of fragmentation of partons and one can finally have the value of $\sqrt{\langle k_T^2\rangle}$. $\sqrt{\langle k_T^2\rangle}$ values and their p_T(factor) dependence will be presented after obtaining the corrections from PYTHIA.

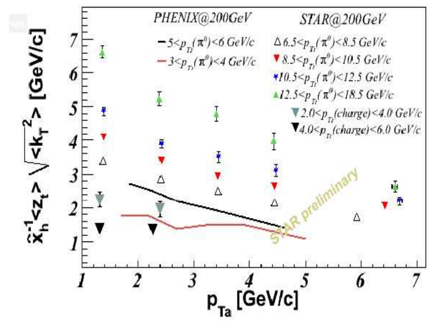

FIG. 4: k_T with p_{Ta}

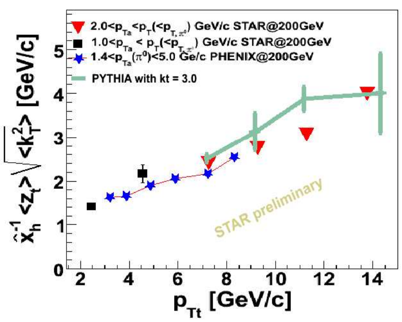

FIG. 5: k_T with p_{Tt}

References

[1] N. Werner, hep-ex/0305109.

[2] J. F. Owens, Rev. Mod Phys **59**, 465 (1980).

[3] R. P. Feynman, R. D. Field and G. C. Fox, **CALT-68-651**.

[4] C. Kourkoumelis et al., Nucl. Phys. **B158** , 39 (1979).

[5] A. G. Clark et al., Nucl. Phys. **B160**, 397 (1979).

[6] A. L. S. Angles et al., Phys. Let. **B97**, 163 (1980).

[7] S. S. Adler et al, Phys. Rev. **D74**, 072002 (2006).