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Kt-Jets and Jet Structure and Fragmentation at CDF

CDF Collaboration

Abstract. $k_\perp$ algorithms applied to charged tracks are now used by CDF to study jets. A preliminary study of jet structure for data during run Ia is presented. The CDF measurement of inclusive charged particle momentum distributions taken during run 1b is in agreement with the Modified Leading Log Approximation (MLLA).

INTRODUCTION

In this paper, I report on two jet analyses done at the Tevatron [1] [2]. The data were taken by CDF in run I (1992-95). In the first analysis, CDF has found that the subjet radius for high E_T jets decreases as the subjet momentum increases. In the second analysis, the inclusive momentum distribution of charged particles in jets is measured using the CDF detector. $E_{Jet}\theta$ scaling is observed in agreement with the MLLA [3].

SUBJETS AT CDF

Perturbative Quantum Chromodynamics predicts differential inclusive-jet and multi-jet cross sections by identifying hard final state partons with the energy flow in real events. A comparison of the internal properties of high-E_T jets with parton shower Monte Carlo predictions tests the physical ideas embodied in the evolution of the parton shower and the hadronization model. A set of high E_T (corrected $E_T > 140$ GeV) central jets ($0.1 < \mid \eta \mid < 0.5$) are selected for this analysis. The jets are found using a cone algorithm with radius 0.7 in $\eta - \phi$ space. The charged tracks are clustered into subjets using a $k_\perp$ algorithm. Fig. 1 shows the collimation of these high-E_T subjets as a function of the transverse momentum of the subjets. The width of subjets is defined as

$$r_{RMS} \equiv \frac{1}{n}\sqrt{\sum_{i=1}^{n}(\phi_i - \overline{\phi})^2 + (\eta_i - \overline{\eta})^2} \qquad (1)$$

where n is the number of charged tracks in the subjet. The decrease in the subjet width as a function of subjet momentum is reproduced by HERWIG (5.6).

CDF Preliminary

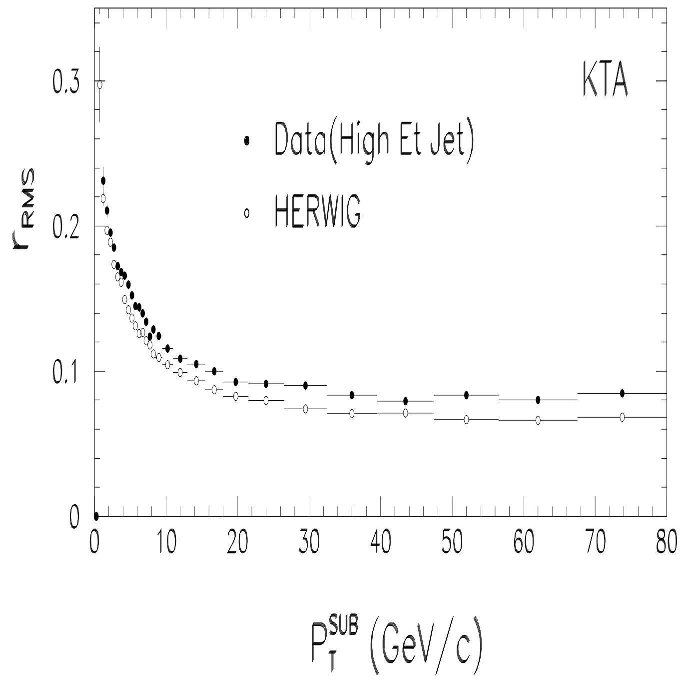

FIGURE 1. Subjet RMS radius versus subjet p_T^{SUB} (relative to the beam) for jets of E_T^{jet} > 140 GeV/c^2.

INCLUSIVE CHARGED PARTICLE MOMENTUM DISTRIBUTIONS AT CDF

Inclusive charge particle momentum distributions have been measured at CDF. An analytic formula to describe these distributions has been derived in the framework of the Modified Leading Log Approximation. The important ideas are the angle ordering (partons can not be radiated at angles exceeding the angle of the proceeding emission) and that emission terms that contain both collinear and soft divergences can be summed. The data sample which consists of about 190,000 events is divided into

45 subsamples. These 45 subsamples contain 9 different dijet mass ranges from a low of 72 < M_{JJ} < 95 GeV/c^2 to a high of 570 < M_{JJ} < 740 GeV/c^2, and 5 different opening angles (θ_{cone} = 0.168, 0.217, 0.280, 0.361, and 0.466). A typical sample consists of events where the dijet mass is in the range 340 < M_{JJ} < 440 GeV/c^2 and all tracks are contained within a cone of opening angle θ = 0.466. The opening angles are relative to the jet axes. The data is fit with a analytic formula that contains two parameters Q_{eff} and const. Q_{eff} is the cutoff scale, and const is the number of hadrons to the number of final partons. For the typical curve ($\frac{1}{N_{events}}\frac{dN_{track}}{d\xi}$) versus ξ = ln(E_{jet}/p_{track}) we obtain Q_{eff} = 234 ± 2 (stat) ± 20 (syst) MeV, const = 0.538 ± 0.002 (stat) ± $^{0.080}_{0.040}$ (syst), with a χ^2/D.F. = 85.2/56 = 1.52 (see Fig. 2).

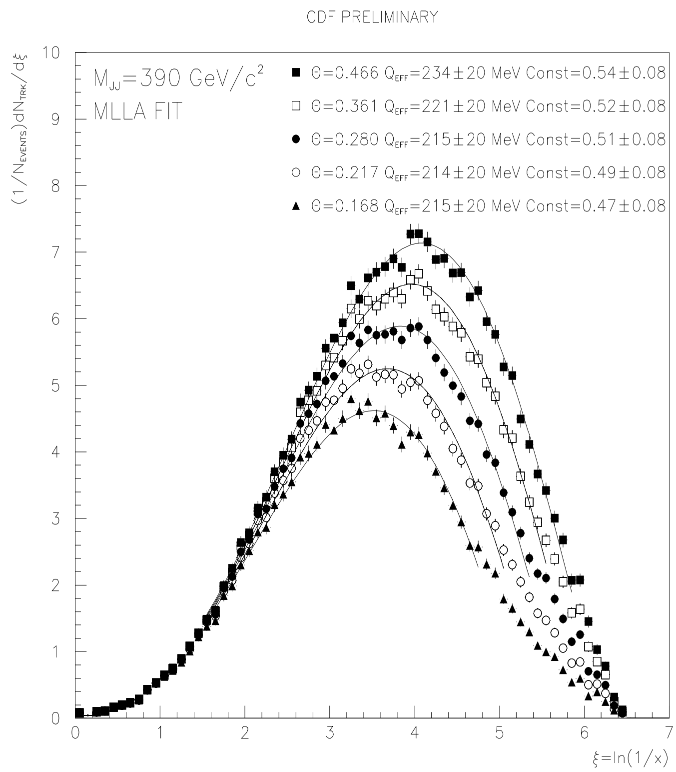

FIGURE 2. Evolution of inclusive momentum distributions with opening angle varying from 0.168 to 0.466. Fits are done according to the MLLA Limiting Spectrum.

Figure 3 shows the MLLA fits for six different dijet masses for a fixed opening angle. The left boundary for the fits is ξ = 1.5 and the right boundary corresponds to p = 0.5 GeV/c. The plot shows the statistical errors. However, the fit is dominated by the systematic errors. We expect the charged track multiplicity to be greater in gluon jets then in quark jets by the ratio of the color

factor $C_A/C_F = 9/4$. The HERWIG Monte Carlo predicts that the fraction of gluon jets decreases as the dijet mass increases. As the dijet mass increases from 83 GeV/c^2 to 490 GeV/c^2 the percentage of gluon jets is predicted to change from 76% to 24%. Thus the const is expected to decrease as the dijet mass increases. This is what is observed in Fig. 3.

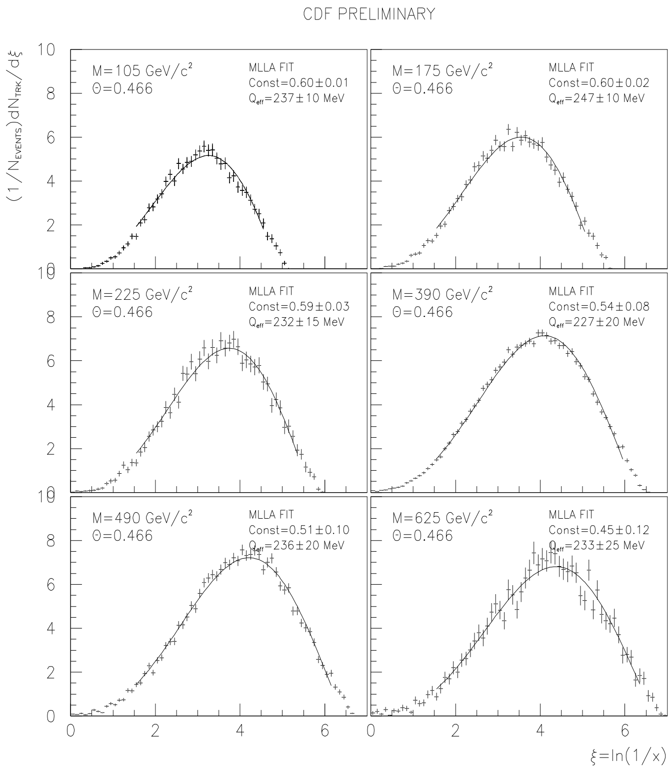

FIGURE 3. Inclusive momentum distributions for a range of dijet masses at a fixed opening angle. Fits are done according to the MLLA Limiting Spectrum.

Figure 2 shows the MLLA fits for five different opening angle cuts for a fixed dijet mass. Fits to the different subsets yield values almost identical to that of the typical sample. However, for a given dijet mass as the opening angle increases the peak of the curve shifts towards higher values of ξ. Figure 4 shows the peak position as a function of $M_{JJ}\ \Theta$. The data plotted show our data and points from TASSO, OPAL and ALEPH. Points from all 9 of the dijet mass ranges are plotted, showing scaling.

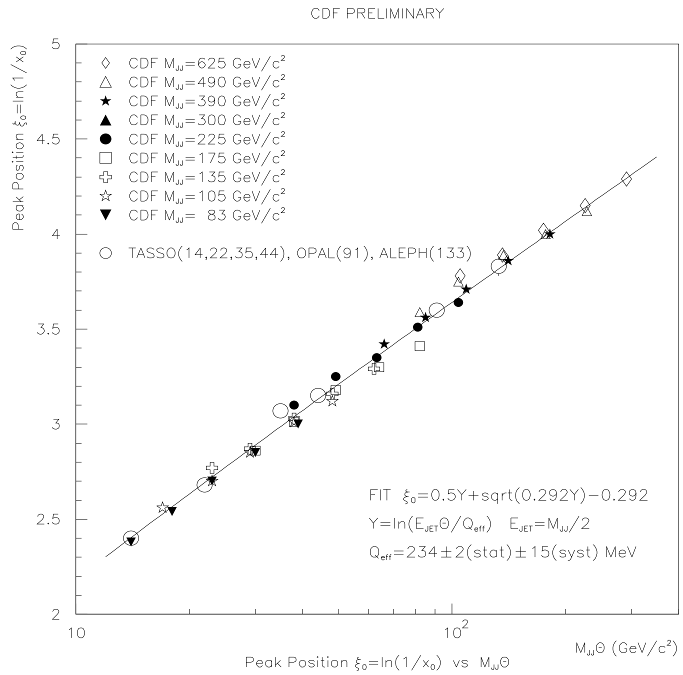

FIGURE 4. Evolution of the peak position vs. $M_{JJ}\Theta$. One can see that E_{Jet} scaling is observed. Fit is done according to the MLLA prediction.

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