2 The Tevatron jet cross section for CTEQ6 with uncertainty

Contributed by Dan Stump and Hung-Liang Lai ....

Joey, et al,

Liang and I have calculated the jet cross section for CTEQ6 with uncertainty, using the Hessian method. The results are shown in these figures.

So far I have the results for the CDF kinematic range. The cross section is calculated as a function of p_T, integrated over the rapidity range $0.1 < |\eta| < 0.7$.

In Figure 1 the red curves are the cross section calculated for the 40 eigenvector sets. The spread in these curves is a measure of the PDF uncertainty. The points are the CDF data. The error bars are statistical errors only; however, the systematic shifts have not been subtracted.

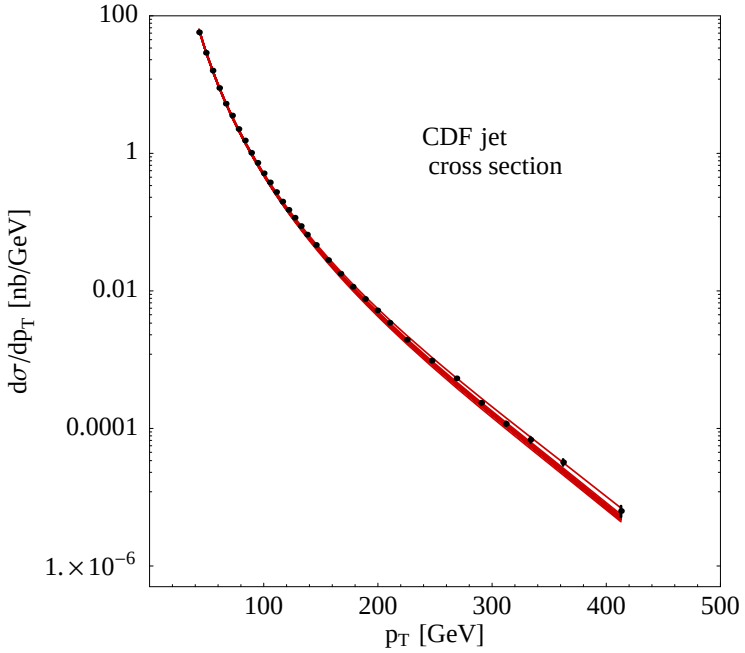

Figure 1: Calculations for the 40 eigenvector sets.

Figure 2 is the same information as Fig. 1, but plotted as the fractional differences (ev set minus CTEQ6 over CTEQ6) between the 40 sets and the standard prediction (CTEQ6). The points are data minus theory over theory, again showing data *without* the systematic shifts.

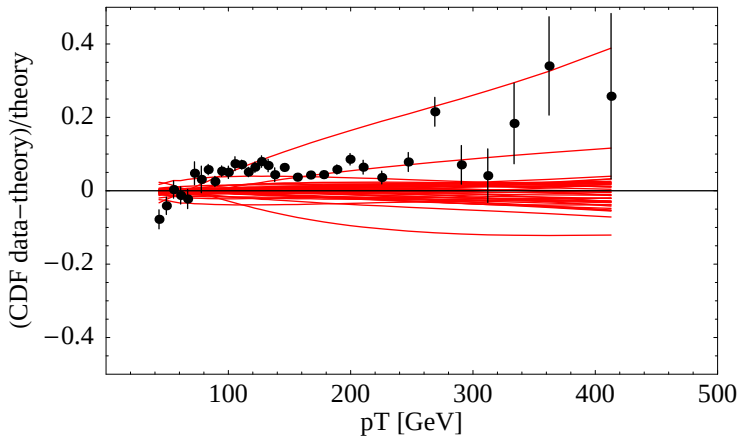

Figure 2: Calculations for the 40 eigenvector sets, plotted as fractional differences.

Figure 3 shows the 20 eigenvectors separately. One curve is the positive displacement, and the other is the negative displacement. The Hessian method assumes the variations are appromately linear. If the linear approximation is valid, then the curves would be mirror images about zero. The linear approximation is not quite accurate, but not too bad.

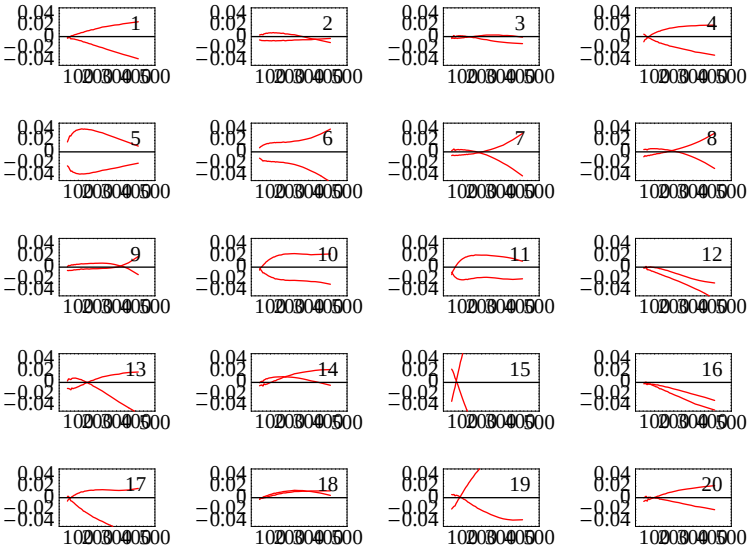

Figure 3: The cross sections for + and − displacements along the 20 eigenvectors, plotted as fractional differences compared to CTEQ6.

Figure 4 shows the overall PDF uncertainty calculated from the "Master Formula," but asymmetrically for positive and negative differences. The blue curves are the upper and lower bounds of the uncertainty band. The red curve is CTEQ6.

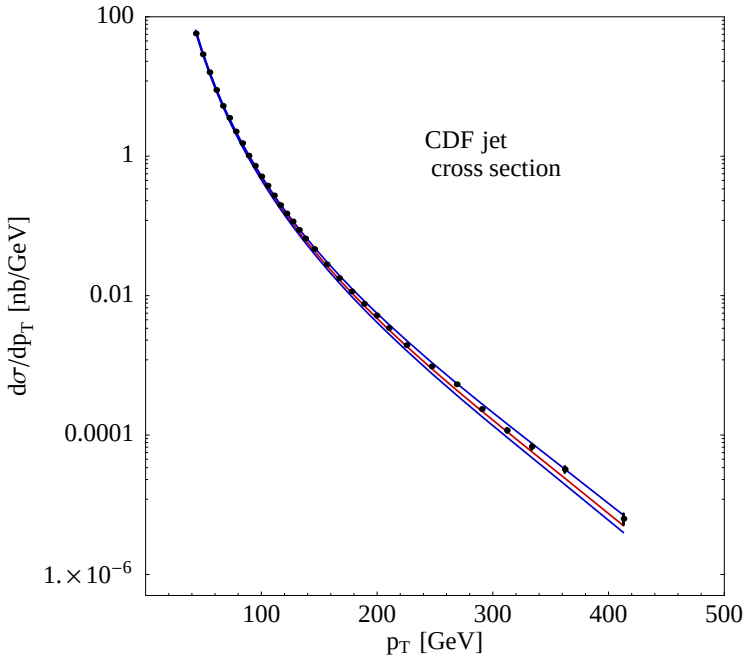

Figure 4: The overall PDF uncertainty is bounded by the blue curves.

Figure 5 shows the overall PDF uncertainty band in the form of fractional differences compared to the standard prediction of CTEQ6.

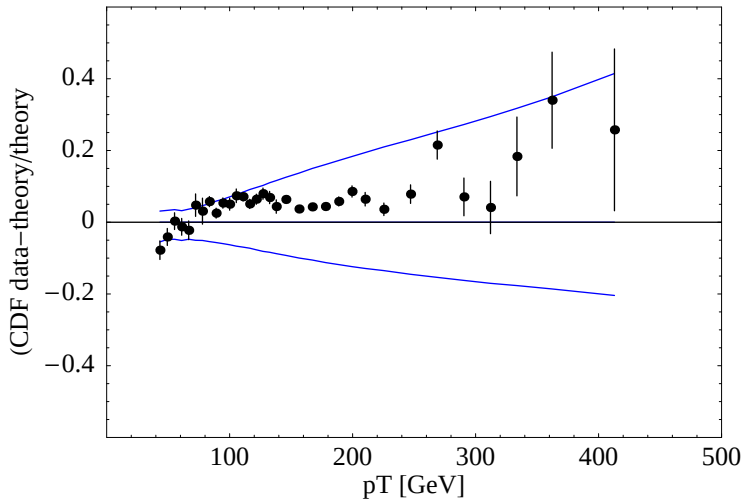

Figure 5: The overall PDF uncertainty

Figure 6 is the superposition of Figs. 2 and 5.

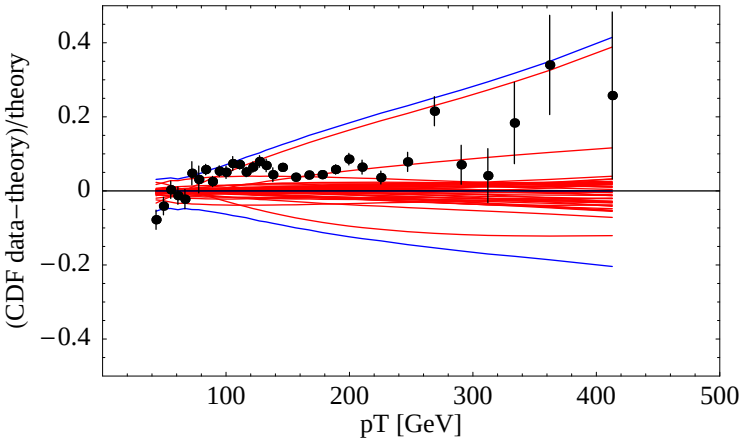

Figure 6: The overall PDF uncertainty

Interestingly, there is one eigenvector (eigenvector 15) that dominates the PDF uncertainty. It would be interesting to plot the gluon distribution, say at $Q = 2$ and 100 GeV, of the plus and minus displacements along eigenvector 15. (These are ev sets 29 and 30.) Also, what parameters are changing from CTEQ6 to Set 29 or 30?

The uncertainty band in Fig. 5 is relevant to Steve Kuhlmann's calculation of the effect of a contact interaction. Figure 5 shows how much the cross section can vary due to allowed changes in PDF's. Any new physics must be larger than this to be outside of PDF uncertainty.

It may be useful to calculate the uncertainty in the jet cross section by the Lagrange multiplier method. Based on experience from previous cases the result should be about the same as the Hessian method.