

# K factor for the one jet cross section

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ABSTRACT: About the K-factor from the EKS program.

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## 1 The K factor

The EKS program for the one jet inclusive cross section produces predictions at either LO or NLO for  $d\sigma/dE_T$  evaluated at  $E_T$  points that can be specified in the main program. I have set up a version that uses the  $E_T$  points of the CDF run 1b. Here the rapidity range is chosen as  $0.1 < |y| < 0.7$ , in accordance with the experimental cuts. Furthermore, the program does two runs, one for the full NLO cross section and one for the Born cross section. Then it divides the NLO results at each  $E_T$  by the Born result at the same  $E_T$  to produce a  $K$ -factor. The program writes the  $K$ -factors to a file for later use in parton fitting.

One can choose the jet definition to use and the parton distribution. In the example that follows, I use  $R = 0.7$  with the “Snowmass” definition, that is  $R_{\text{sep}}/R$  is set to 2. I suppose that  $R_{\text{sep}}/R = 1.3$  might be better as a way to mimic the actual operation of the CDF jet definition, with all of its complications.

There are two ways to compute  $K$  at each  $E_T$ . The most reliable, I think, is to use what is called **Corrected XSECT** in the program output. This result has, essentially, only statistical errors.<sup>1</sup> If you run the program for about an hour, the statistical fluctuations are around 1% generally and about 2% at the lowest  $E_T$  point. These statistical fluctuations can be a problem since they are likely to be comparable in size to the statistical fluctuations in the data. The second possibility is to use what is called **Unsmearred Fit XSECT**. Thus uses a fit to the results that is a part of how the program works. The number of parameters in the fit is adjustable. In the example that follows, I use six parameters. Using the fit introduces some extra systematic error, on the order of 1% to 2%. On the other hand, it makes the results a smooth function of  $E_T$ . A six parameter fit does not

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<sup>1</sup>There are some systematic errors, particularly from “smearing” the cross section over a  $E_T$  points, but these are typically less than 0.5%. The statistical fluctuations are correlated between neighboring  $E_T$  points.

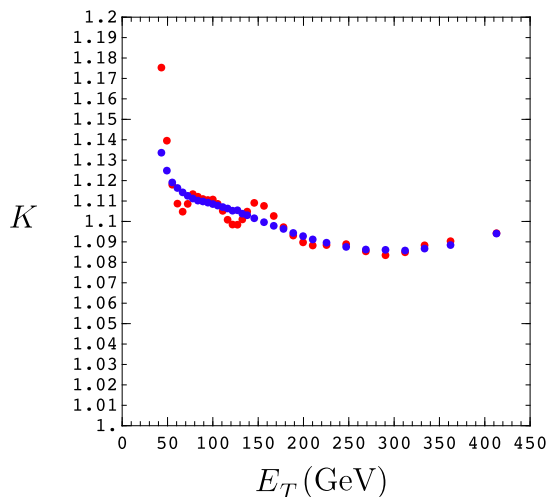


Figure 1: Prediction for the  $K$ -factor at the CDF Run 1b values of  $E_T$ . The red points are produced with **Corrected XSECT**. Evidently there are some statistical fluctuations. The blue points are produced with **Unsmearred Fit XSECT**. That introduces a small amount of systematic error, but smoothes out the curve.

have enough parameters to produce a small bump that might have arisen from a statistical fluctuation in the integration.

I tried this with a one hour run (100 M points). This is short enough to leave some statistical noise in the results, which are displayed in Fig. 1. The  $K$ -factors produced with **Corrected XSECT** exhibit some small bumps, which are not statistically significant since they are within the statistical errors reported by the program. In the  $K$ -factors produced with **Unsmearred Fit XSECT**, the bumps are smoothed out. At the lowest  $E_T$  point, it appears that there was a  $2\sigma$  upward fluctuation (compared to a quoted statistical error of about 2%) in the **Corrected XSECT** result. I know this because I have results with ten times as many integration points in which  $K(43.3 \text{ GeV}) = 1.130 \pm 0.005$ . I should try some more runs to check the reliability of the first point. Assuming that the first point did fluctuate up, it appears that the fit did a good job of ignoring it.

## 2 Comparison to other plots

The results in Fig. 1 are not consistent with those in Fig. 1 of J. Pumplin, CTEQ66Note34, “Jet  $K$ -factors for Tevatron Run I.” It appears that choosing  $R_{\text{sep}}/R = 2.0$  instead of  $R_{\text{sep}}/R = 1.3$  makes the  $K$ -factor bigger.

## 3 Other data sets

With a little work, I could produce code to produce the same sort of  $K$ -factor tables for the  $E_T$  points and other rapidity ranges of other sets of experimental results.

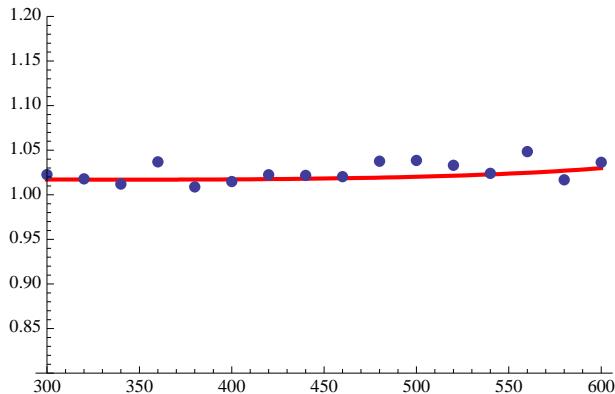


Figure 2: The numerical comparison of the two programs. The horizontal axis is  $E_T$  in GeV. The vertical axis is the ratio of the NLOJET++ result to the EKS result for each bin. The curve is the correction factor  $F(E_T)$ , that is the expected value for this ratio given the different definitions of what is calculated. Thus the points should agree with the curve.

## 4 Comparison to NLOJet++

In an earlier note with Zoltan Nagy, I reported results of a comparison with NLOJet++. We chose to compare at a high  $E_T$  range (but for central rapidities) because it was reported that there might be difficulties there. Briefly, the comparison is reported in Fig. 2. The points are NLOJet++ results divided by EKS results. Since the NLOJet++ are averaged over bins while the EKS results are the cross section at the bin centers, there is a small correction factor to be applied. If the two programs agree, points should agree with the red curve.

It would be good to have results from FastNLO for this range. Although FastNLO is based on NLOJet++, they are not the same. The FastNLO program makes approximations that I think can be thought of as making a fit (in a clever way) to NLOJet++ results. Thus I think FastNLO results should be checked against a primary calculation, either EKS or NLOJet++. In particular, I would like to see FastNLO points on Fig. 2. One would have to be careful that we are using the same parton distributions and jet definitions.

## 5 Theoretical errors in the one-jet cross section

I am working with Fred Olness on this. We do not have results ready yet, but I can report that (our estimate of) the correlated theoretical systematic errors are much bigger than the 1%-2% errors seen in the plots of these notes.