requirements on the fourth jet are less stringent than the first three jets in order to enhance the efficiency for detecting all four jets from the $t\bar{t}$ decay. There are 99 such events in the CDF sample prior to requiring a b-tagged jet, and 88 of these pass the χ^2 cut on the best jet-parton assignment and kinematic fit. The additional requirement of at least one SVX or SLT-tagged jet leaves 19 events.

The background of non-$t\bar{t}$ events in this sample is estimated in the same manner used in the cross section analysis. One assumes that the 88 event sample is a mixture of background and $t\bar{t}$ signal, and then applies the known background tag rates to determine how many of the non-$t\bar{t}$ events would be tagged. This results in a estimated background in the 19 events of $6.9^{+2.5}_{-1.9}$ events. This background is expected to be a combination of real W+jet events and events where an energetic hadron fakes the lepton signature. Studies of the Z+jet events, candidate events where the lepton is not well-isolated, and W+jet Monte Carlo events show that the resulting top quark mass distribution for these different background events are all similar. The CDF collaboration therefore uses the W+jets Monte Carlo sample to estimate the background shape in the top quark mass distribution.

The resulting top quark mass distribution is shown in Fig. 13. One sees a clear peak around 170-180 GeV/c^2 with relatively long tails. The dotted distribution represents the shape of the non-$t\bar{t}$ backgrounds, normalised to the estimated background rate. The top quark mass is determined by performing a maximum likelihood fit of this distribution to a linear combination of the expected $t\bar{t}$ signal shape determined by Monte Carlo calculations for different top quark masses and the background. The background rate is constrained by the measured rate of non-$t\bar{t}$ events in the sample. The negative log-likelihood distribution for this fit is shown in the inset in Fig. 13. It results in a top quark mass of 176 ± 8 GeV/c^2.

The largest systematic uncertainties in this measurement arise from uncertainties in the modelling of gluon radiation in jets in the final state, absolute jet energy scale, variations in fitting procedures, and the shape of the non-$t\bar{t}$ background. A number of other potential sources of uncertainty have been studied, and have been found to contribute a total of 2.0 GeV/c^2 to the total systematic uncertainty. A summary of these uncertainties is given in Table 8, and total to ± 10 GeV/c^2.

One can quantify the significance of the shape of the mass distribution by performing an unbinned Kolmogorov-Smirnov test. The probability that the observed mass distribution could arise from purely background sources is 2×10^{-2}. This test is conservative in that it only compares the shape of the background with the observed data. Other measures of significance can be used. For example, one can define a relative likelihood for the top+background and background-only hypotheses and then ask how often a background-only hypothesis would result in a relative likelihood as significant as that observed. This test gives a probability for a background fluctuation of less than 10^{-3}. However, it is more model-dependent as it assumes a specific shape for the non-background hypothesis.