8.2.2 The DØ Mass Measurement

The DØ collaboration estimates the top quark mass using their sample of lepton + ≥ 4 jet events. In their analysis, they select 4-jet events by requiring that all jets have a corrected transverse energy > 15 GeV with $|\eta| < 2.4$. They also require the events to have $H_T > 200$ GeV and to have aplanarity > 0.05. They find 14 events that satisfy these requirements.

They then perform a χ^2 fit of the observed kinematics in each event to the $t\bar{t} \rightarrow W^+W^-b\bar{b}$ hypothesis, requiring that the mass of the assumed $t \rightarrow l\nu_l b$ system equal the mass of the $t \rightarrow q\bar{q}b$ system making all possible parton-jet assignments in the final state. As in the CDF technique, they only consider the four highest E_T jets, and only fits with $\chi^2 < 7$ are considered acceptable. There are 11 events that have at least one configuration that gives an acceptable fit. For each event, they assign a top quark mass by averaging the top quark mass from the three best acceptable fits for that event, weighting the mass from each fit with the χ^2 probability from the fit. The resulting histogram of the invariant mass of the three-parton final state (the hypothesised top quark) is shown in Fig. 14(a). They performed the same analysis on a "looser" data sample of 27 events, where the H_T and aplanarity requirements were removed. This yielded similar results, as shown in Fig. 14(b), although with significantly larger backgrounds. The mass distribution shows an enhancement at a three-parton invariant mass around 200 GeV/c^2, as expected from $t\bar{t}$ production (shown as the higher mass curve in both plots). The corresponding mass distribution expected from the QCD $W+$ jet background is shown in Fig. 14(a)-(b) as the dashed curve at lower mass. It peaks at small values of three-parton invariant mass and together the combined background and signal hypothesis model the data well.

The mass distribution obtained using the looser selection is fit to a combination of $t\bar{t}$ signal and background, yielding a top quark mass of.

$$M_{\text{top}} = 199^{+19}_{-21} \pm 22 \text{ GeV/c}^2, \tag{17}$$

where the two uncertainties are statistical and systematic, respectively. A similar fit to the mass distribution using the 11 event sample results in a consistent result, but with larger statistical uncertainties. The negative log-likelihood distributions for the fits to the standard and loose selection are shown in Fig. 14(c) and (d), respectively. The systematic uncertainty is dominated by the sensitivity of this analysis to the DØ jet energy scale.

9 Future Work

The observation and study of the top quark is currently statistics limited. Both the DØ and CDF collaborations are accumulating additional data at the Collider. By the end or Run 1, currently scheduled for the February 1996, both collaborations expect to at least double their datasets. This will improve both the statistical uncertainties