transverse energy arises from the undetected neutrino, and that four of the jets come from the b and $\bar{b}$ quarks and the two quarks from the $W^{\pm}$ decay.

Perhaps the most serious complication to this procedure is the difficulty of associating final state jet clusters with the partons from the $t\bar{t}$ decay. The jets are only approximate measures of the initial state parton, and there is often not a 1-to-1 correspondence between partons resulting from the $t\bar{t}$ decay and observed jets. This is due to gluon radiation that can cause one parton to be observed as two jet clusters, and overlap of jet clusters, where two partons merge into a single jet cluster. To complicate matters further, additional partons are produced by initial and final state radiation, so the number of observed jet clusters may readily exceed four.

The number of combinatorial possibilities for assigning partons to jets in the case where only four jets are observed is 12 (we only have to identify the two jets associated with the $W^{\pm}$ decay and not have to permute these two). If we can identify one of the jets as arising from a bottom quark, the number of possible assignments reduces to six. Any technique that reconstructs the $t\bar{t}$ decay in this mode has to reduce the effect of these combinatorial backgrounds on the expected signal.

8.2.1 CDF Mass Analysis

The CDF collaboration measures the top quark mass by selecting a sample of lepton+jet events with at least four jets, and then making the parton-jet assignment that best satisfies a constrained kinematic fit. The fit inputs are the observed jet momentum vectors, the momentum vector for the charged lepton, the transverse energy vector for the neutrino and the vector sum of the momentum of the unassigned jets in the event. The uncertainties in these quantities are determined from the measured response of the detector. The fit assumes that the event arises from the process

$$\begin{aligned} p\bar{p} \;\rightarrow\; & t\bar{t}X, \\ & \hookrightarrow q\bar{q}'\,\bar{b} \\ & \hookrightarrow l^{+}\nu_l\, b \end{aligned} \tag{16}$$

The fit constrains the $W^{\pm}$ decay daughters to have an invariant mass equal to the $W^{\pm}$ mass and constrains the t and the $\bar{t}$ to have the same mass. The unknown recoil system X is observed in the detector as unassociated jets and the "unclustered" energy in the calorimeter, *i.e.* the energy not associated with a jet. Only the four highest E_T jets are considered, reducing the possible combinations at the cost of some degradation in top quark mass resolution (in those cases where the $t\bar{t}$ daughter jets are not the four highest E_T jets in the event).

Formally, there are two degrees of freedom in the fit when we take into account the number of constraints and the number of unmeasured quantities. A χ^2 function including the uncertainties in the measurements is minimised subject to the kinematic constraints for each possible parton-jet assignment. The b-tagged jets in the event