recent compilation of data [4] indicates that the standard model top quark has a mass of

$$M_{top} = 169^{+16}_{-18}\ ^{+17}_{-20}\ \mathrm{GeV/c^2}. \tag{1}$$

The second uncertainty corresponds to variations of the unknown Higgs boson mass between 60 and 1000 GeV/c^2 (its nominal value is 300 GeV/c^2).

Taken together, these observations make a strong case for the top quark's existence. They also imply that our understanding of nature via the standard model would be profoundly shaken if the top quark was shown not to exist with its expected properties. The observation of the top quark is therefore of considerable significance.

1.2 Earlier Top Quark Searches

Direct searches for the top quark have been performed at virtually all of the high-energy collider facilities that have operated in the last twenty years[5]. The most model-independent searches have taken place at e^+e^- colliders, where one looks for the production and decay of a pair of massive fermions. Because of the relatively large mass of the top quark, its decay yields events that are quite spherical and are relatively easy to separate from the background of lighter quark production. The most stringent limits have been set by the LEP collaborations, which require that $M_{top} > 46$ GeV/c^2 at 95% confidence level (CL). These limits are insensitive to the decay modes of the top quark and the coupling of the top quark to the electroweak bosons.

Another relatively model-independent limit is set by measurements of the width of the W boson. Direct and indirect measurements of Γ_W[6] indicate that the top quark is massive enough that the decay channel $W \rightarrow t\bar{b}$ does not contribute to Γ_W. The limit set is $M_{top} > 62$ GeV/c^2 at 95% CL.

Direct searches for the top quark at hadron colliders have focused on two specific models for top quark decay: i) the minimal supersymmetric model (MSSM) where the decay mode $t \rightarrow H^+b$ is also allowed, and ii) the standard model where the top quark decays directly to $t \rightarrow Wb$. The most stringent limit set assuming the MSSM requires that $M_{top} > 96$ GeV/c^2 at 95% CL for the case where $t \rightarrow H^+b$ always and $BR(H^+ \rightarrow \tau\nu_\tau) = 1.0$ [7]. This limit, however, depends on the overall width of the decay $t \rightarrow H^+b$, the Higgs branching fractions (H^+ is expected to preferentially decay to $c\bar{s}$ and $\tau\nu_\tau$ final states) and the H^+ detection efficiency. The DØ collaboration has published the most sensitive standard model search using a 15 pb^{-1} dataset, and has excluded a top quark with mass less than 131 GeV/c^2 at 95% CL [8].

On the other hand, the CDF collaboration published a study of $\sim$ 20 pb^{-1} of data in April 1994 that claimed evidence for top quark production [9]. A total of 12 events were observed in several decay modes above a predicted background of approximately 6 events. The probability that the observed event rate was consistent with a background fluctuation was estimated to be 0.25%. In addition, evidence was presented that the events in the sample were consistent with arising from the