Fermi National Accelerator Laboratory

FERMILAB-Conf-93/286

Electro-Weak, QCD and Top Physics at the Tevatron

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September 1993

Presented at the *SSC Workshop on Physics at Current Accelerators and the Supercollider*, Argonne National Laboratory, June 2-5, 1993

Operated by Universities Research Association Inc. under Contract No. DE-AC02-76CHO3000 with the United States Department of Energy

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ABSTRACT

The 1992-1993 Tevatron collider run ended yesterday. ~ 21 $(16)pb^{-1}$ of $p\bar{p}$ collisions at $\sqrt{S} = 1800$ GeV were collected at CDF (D0). New measurements of the W and Z cross section $\times$ branching ratios indicate that $\Gamma(W)$ is $2.033 \pm 0.069 \pm 0.057$ GeV. The upper limit for the top quark mass, if it is produced in W decays, is 62 GeV/c^2. Gauge boson pair production studies are beginning to constrain electro-weak parameters. No neutral gauge bosons with mass $> M_Z$ have appeared. Inclusive jet production and angular distribution studies are compared to NLO perturbative QCD predictions. A new topological jet analysis from CDF is sensitive to the low x gluon distribution. The direct photon cross section shows a steeper fall-off with E_t than does the theory prediction. D0 has one candidate $t\bar{t}$ event in the dilepton mode. The lower limit on M_{Top} has been raised to 99 GeV/c^2.

1 Introduction

The June 1st end of the 1992-1993 Tevatron collider run signaled the beginning of a new, rich period in Fermilab high energy physics at the Tevatron for two reasons. First, the accelerator delivered world-record luminosity which will enable the experimenters to push the limits of physics. Second, there were two general purpose detectors taking advantage of that luminosity; for this was the inaugural run of the D0 detector[1] which joined CDF[2] in studying proton-antiprotons collisions at the Tevatron. This conference is the first which has occurred since the end of the run.

This paper describes new measurements in Electro-Weak and QCD physics at CDF and D0 as well as top quark physics at D0. In selecting among the topics available I chose to give preference to those which either show substantial improvement over previous measurements, offer interesting comparisons between the two experiments or take advantage of innovative analysis methods. Time and space constraints require me to resort to merely mentioning some analyses. While this is the first opportunity to see results which have been compiled with the full data sample, many results are presented from analysis of partial data sets. For CDF, the full data set represents about $21pb^{-1}$ of collisions. For D0, the necessity of inhibiting triggers during Main Ring injection and ramping reduced that to about $16pb^{-1}$. All results which are shown are presumed to be preliminary unless otherwise stated.

2 Electro-Weak Physics at D0 and CDF

CDF and D0 are studing a variety of electro-weak topics. These include W and Z production and branching ratios, W width, gauge boson pair production, Z' search, and the W mass measurement.

2.1 Summary of W and Z Production at D0 and CDF

D0 has analyzed 3.45 pb^{-1} of their $16pb^{-1}$ dataset in looking for decay modes involving electrons. 2824 $W \to e\nu$ and 172 $Z \to ee$ decays were found. The cross section times branching ratio for $W \to e\nu$, $\sigma \cdot B(W \to e\nu)$, is $2.48 \pm 0.05 \pm 0.26 \pm 0.30$ where the error bars are based on statistical, systematic, and luminosity uncertainties. For the $Z \to ee$ decays, $\sigma \cdot B(Z \to ee)$ is $0.235 \pm 0.019 \pm 0.040 \pm 0.028$. The ratio $\sigma \cdot B(W \to e\nu)/\sigma \cdot B(Z \to ee)$ is $10.55 \pm 0.87 \pm 1.07$. The uncertainty in the luminosity has cancelled in taking this ratio.

D0 has found 1576 $W \to \mu\nu$ and 93 $Z \to \mu\mu$ in a $7.3pb^{-1}$ data subset. The combination of a tight event selection with a trigger prescale at high luminosities caused a lower efficiency than for the electron channels. For W decays, $\sigma \cdot B(W \to \mu\nu)$ is $2.0 \pm 0.07 \pm 0.41 \pm 0.24$. For the Z, $\sigma \cdot B(Z \to \mu\mu)$ is $0.20 \pm 0.02 \pm 0.05 \pm 0.02$. The ratio is $10.0 \pm 1.1 \pm 2.4$.

CDF has analyzed $18.4pb^{-1}$ in the decay modes involving electrons. They ha\ found 10991 $W \to e\nu$ and 1146 $Z \to ee$ events. They have quoted the ratio of the cross section times branching fractions as $10.65 \pm 0.36 \pm 0.27$ where the uncertainties are statistical and systematic, respectively. In the full data set, CDF reports 7612 $W \to \mu\nu$ and 710 $Z \to \mu\mu$ decays.

2.2 W Width

The ratio $\sigma \cdot B(W \to e\nu)/\sigma \cdot B(Z \to ee)$, R, provides a measurement of the W boson width. For,

$$\Gamma(W) = \frac{1}{R}\frac{\sigma(p\bar{p} \to W + X)}{\sigma(p\bar{p} \to Z + X)}\frac{\Gamma(W \to l\nu)}{\Gamma(Z \to ll)}\Gamma(Z) \quad (1)$$

The ratio of cross sections is taken from Martin, Stirling and Roberts[3] to be 3.23 ± 0.03. The uncertainty is mainly from uncertainty in the structure functions and W and Z masses. Measurements of $sin^2\theta_W$ and the W and Z masses provide[4] the ratio of the partial widths. $\Gamma(Z)$, taken from LEP measurements,[5] is 2.487 ± 0.010. The CDF result for $\Gamma(W)$ is $2.033 \pm 0.069 \pm 0.057$ GeV. Solving instead for $\Gamma(W)/\Gamma(W \to l\nu)$ and using the value,[5] 29.97 ± 0.20, for the total width over the partial width of the Z, R provides $\Gamma(W)/\Gamma(W \to l\nu) = 9.09 \pm 0.30 \pm 0.25$.

The ratio $\Gamma(W)/\Gamma(W \to l\nu)$ is sensitive to non-standard W decays. For example, if the top quark was lighter than the W, $W \to t\bar{b}$ would be possible. The heavier the top, the less phase space available for the decay. Measurement of R allows a lower bound to be set on the top quark mass at 62 GeV/c^2, independant of decay modes, by CDF. Figure [1] shows the standard model prediction for $\Gamma(W)/\Gamma(W \to l\nu)$ as a function of the top mass as well as the new measurement.

2.3 Gauge Boson Pair Production

Gauge boson pair production cross sections and final state kinematics provides the strength of the trilinear gauge boson couplings and measurements of the electromagnetic multipole moments of the W and Z.

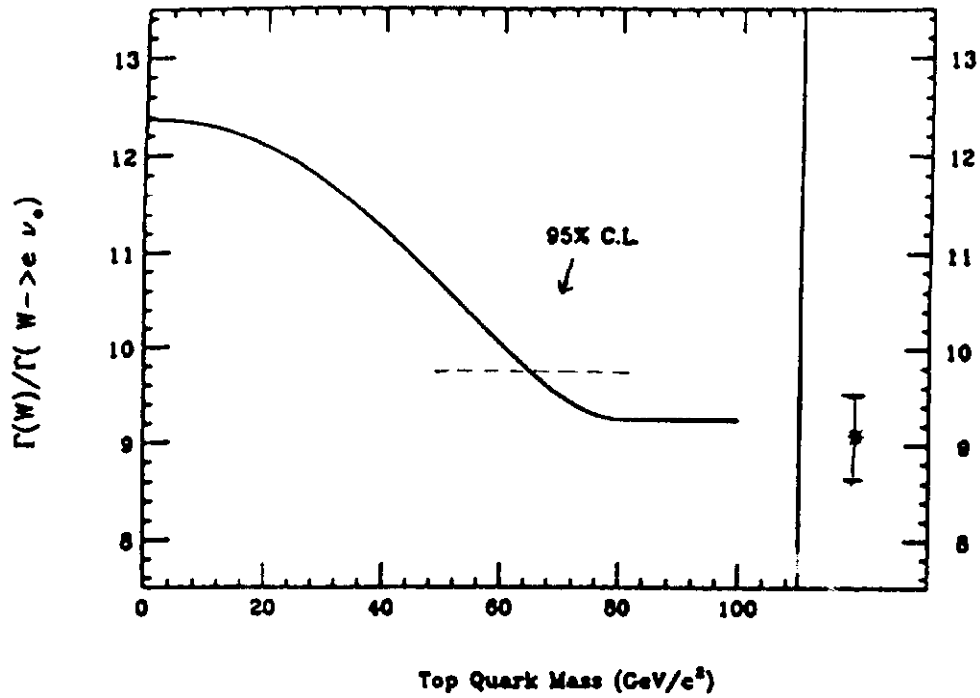


Figure 1: The standard model prediction for $\Gamma(W)/\Gamma(W \rightarrow l\nu)$ is shown as a function of M_{Top} for tops with mass $< M_W$. The new CDF result is shown.

The $W\gamma$ and $Z\gamma$ photon angular distributions are particularly sensitive to the electromagnetic multipole moments. The magnetic dipole moment and electric quadrupole moment of the W are parameterized by λ and κ. The W magnetic moment is written $\frac{e}{2M}(1+\kappa+\lambda)$ and the electric quadrupole moment $-\frac{e}{M^2}(\kappa-\lambda)$. In the standard model $\kappa = 1$ and $\lambda = 0$. The multipole moments of the Z are expected to be zero. Departures of electromagnetic moments from expectations has a long history as a signal of compositness. For example, that the magnetic dipole moments of the proton and neutron were not consistent with point-like charged (uncharged) particles was an early signal that these particles have a structure. CDF has a new result from analysis of the 1988-89 data. Fixing $\kappa = 1$, $\lambda = 0.0 \pm 2.0 \pm 0.3$. Fixing $\lambda = 0$, $\kappa = 0.0^{+4.7}_{-4.2} \pm 0.6$. These limits are comparable to those from UA2[5]. Both D0 and CDF are expected to have results from the new data fairly soon.

WZ production has an predicted[6] cross section of 0.9 to 1.4pb, It was expected that D0 or CDF might observe one event in some trilepton mode. CDF has observed one WZ event where the W decayed to $e\nu$ and the Z decayed to ee.

W pair production has an predicted[7] cross section of about 10pb. Therefore, CDF and D0 should have a few W pairs in dilepton decay modes. Once thought to be smothered by top, W pairs can be distinguished by the lack of two b jets. Work is progressing on both D0 and CDF on the new data.

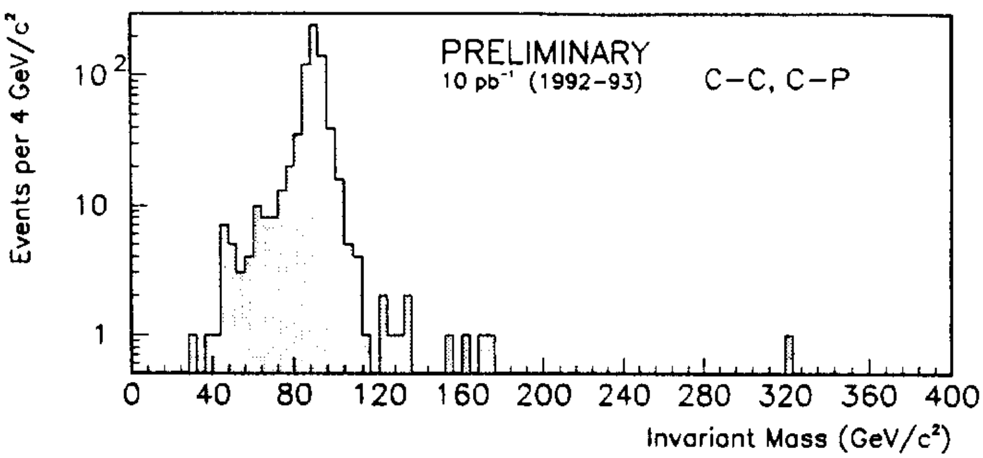


Figure 2: Z' Search. The two electron mass spectrum from CDF is shown. There is 1 event with $M_{ee} > 200$ GeV/c². Drell-Yan processes are expected to produce 1.5 events with $M_{ee} > 200$ GeV/c².

2.4 Z' Search

CDF has searched $10pb^{-1}$ of the new data for a neutral gauge boson, in addition to the Z, which decays to high transverse energy electron pairs. The mass plot of electron pairs is shown in Figure [2]. There is one event with a two electron mass above 200 GeV/c². Drell-Yan production is expected to contribute 1.5 events with two electron mass greater than 200 GeV/c². One concludes that no new resonances are appearing in this data.

2.5 W Boson Mass

The plum and principal goal of the electro-weak studies at both D0 and CDF is the measurement of the W boson mass. This provides a handle[8] on the size of electro-weak radiative corrections involving the top quark and Higgs boson and, as a consequence, an estimate of their masses. The radiative corrections grow logarithmically with the Higgs mass and quadratically with the top mass. The W mass measurement is made by understanding the shape of the transverse mass of the lepton-neutrino pair. CDF will be using the electron and muon decay modes. D0 will rely the electron mode for the present. Neither experiment has made an announcement of the W mass based on the new data. They have set the goal of an uncertainty of $250MeV$ in each W decay mode. With $100pb^{-1}$ of data, a precision of $100MeV$ will be possible. The largest uncertainties will be due to the parton distribution functions and the contribution of the underlying events to the energy due to multiple interaction crossings.

3 Jet and PDF Studies at D0 and CDF

CDF and D0 have rich programs in the study of QCD, jets, and parton distribution functions (PDFs) which span a wide variety of topics including jet production cross section and angular distribution, direct photon production, W + jet production, and a search of 4 jet events for double parton interactions. Among the topics I have skipped are color coherence, direct photon pair mass distribution, W charge asymmetry, and the photon-jet angular distribution. Rapidity gaps are treated elsewhere in this conference[9].

Despite the differences in the calorimeters, D0 and CDF use very similar jet identification techniques. A cone of radius $R \equiv \sqrt{\Delta\phi^2 + \Delta\eta^2} = 0.7$ is defined around a 3 GeV seed tower. The energy within the cone is summed to form the jet. If two jets share more than 50% (75%) of their energy D0 (CDF) merges them into one, otherwise the energy is divided between the two. D0 has a minimum jet E_t of 8 GeV. D0 uses a jet energy correction from photon-jet events which was invented at CDF. They use similar dijet balancing algorithms and make energy scale corrections.

3.1 Inclusive Jet Production and Dijet Angular Distribution

Measurement of the inclusive jet cross section and dijet angular distribution provides a fundamental test of QCD. The inclusive cross section is sensitive at low E_t to the PDFs and at high E_t provides a measure of quark compositness. The angular distribuition is sensitive to compositeness independant of the PDFs. Because of the strong E_t dependance of the cross section, CDF and D0 use a variety of triggers with overlapping E_t range in this measurement. Each has a different effective cross section. CDF has analyzed $15pb^{-1}$ and D0 has analyzed a subsample of $4pb^{-1}$ as of this time.

Figure [3] shows the inclusive jet cross section at CDF and D0. It is difficult to compare the two plots for two reasons. First, they are different η ranges. CDF requires that the jets have absolute detector η from 0.1-0.7. D0 requires that $|\eta| < 0.9$ or that $2 < |\eta| < 3$ and promises to fill in the hole before very long. Second, while CDF unsmears their data, D0 is, for now, smearing the theory predictions. The CDF data is compared to the NLO theory prediction[10] with HMRSB PDFs. There is good agreement below 300 GeV. For E_t above 300 GeV the data is slightly higher than the theory prediction. Also superimposed is the theory prediction with a contact term with $\Lambda = 1.4$ TeV, which corresponds to the previously published limit[11], included in the Lagrangian. The D0 results are compared to and are in good agreement with the HMRS B0 theory prediction.

In the dijet angular distribution analysis, the jet pseudorapidities, η_1 and η_2, are calculated in dijet center-of-mass reference frame. Defining η^* as $\frac{1}{2}(\eta_1 - \eta_2)$ then $\cos\theta^*$ is $\tanh\eta^*$. The angular distributions are displayed as $d\sigma/d\chi$ vs. χ where $\chi \equiv (1+\cos\theta^*)/(1-\cos\theta^*)$. For pointlike scattering of spin 1/2 objects, $d\sigma/d\chi$ vs. χ is proportional to a constant. QCD must account for the difference between

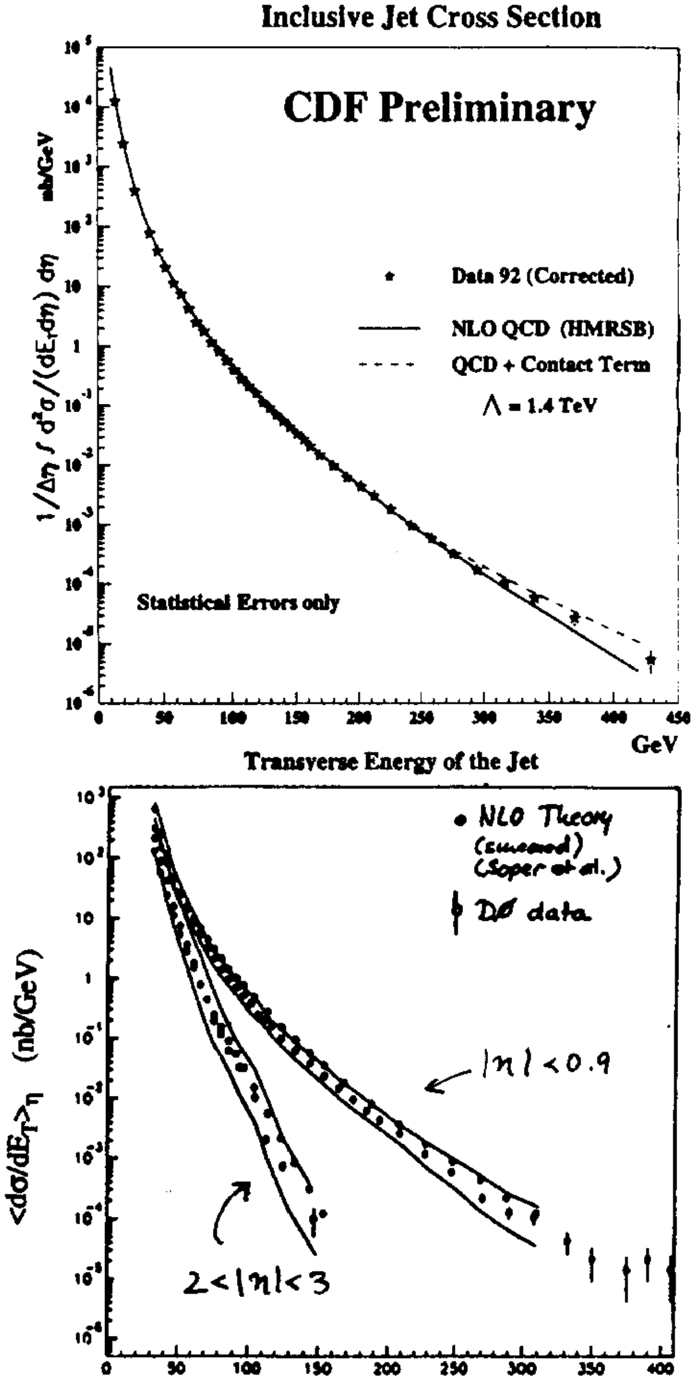


Figure 3: Plot a) is the inclusive jet cross section for $0.1 < |\eta| < 0.7$ as measured by CDF compared with a NLO QCD and QCD + contact term predictions. Plot b) is from D0 for a larger η range. CDF unsmears the data. D0 has smeared the theory prediction.

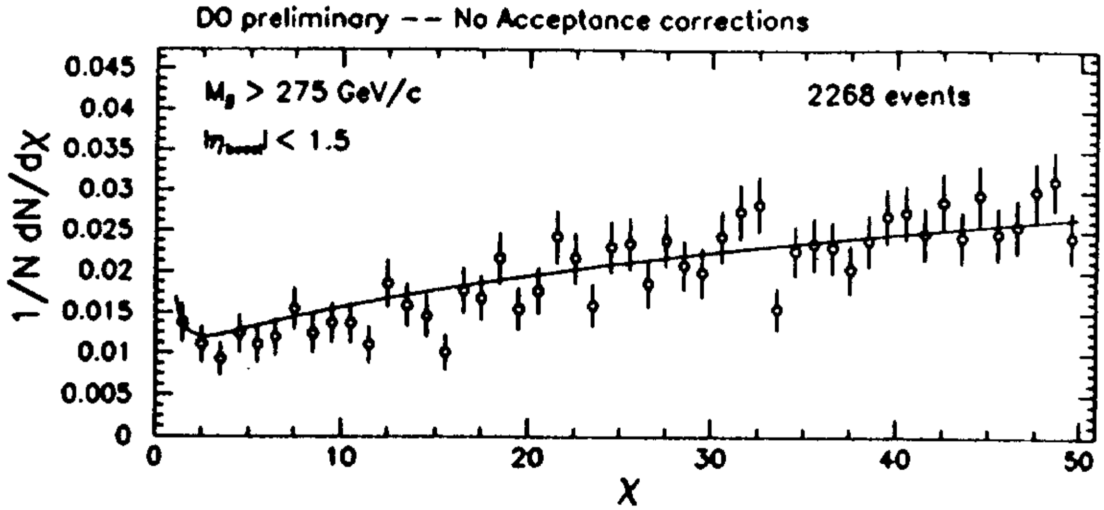


Figure 4: Dijet angular distribution measured by D0 for $M_{jj} > 275$ GeV/c^2 compared to leading order QCD predictions.

Rutherford scattering of a quark and antiquark and the measured cross section.

The D0 measurement of the dijet angular distribution for $4pb^{-1}$ of data is shown in Figure [4]. The dijet mass was required to be greater than 275 GeV/c^2. The leading order QCD prediction is shown for comparison. This curve represents more than a factor of 2 improvement in χ range over previous results[12] with only 1/4th of the data.

The CDF jet sample provides the highest energy event seen at the Tevatron. It is a 4 jet event with 1237 GeV of total energy and 964 GeV E_t ! It is shown in Figure [5].

3.2 Two Jet Differential Cross Section

A new topological jet analysis from CDF is very sensitive to low x PDFs. After requiring that $|\eta_1| = |\eta_2|$ there are two possible event toplogies. If the jets are back-to-back in η, i.e. $\eta_1 = -\eta_2$, the topology is called "opposite sign" (*O.S.*). If the jets have $\eta_1 = \eta_2$, they are called "same sign" (*S.S.*). Same sign events probe large $|x_1 - x_2|$ and the low x region. Dividing by the opposite sign events cancels detector fiducial effects such as the transition regions between calorimeters. This is done by forming the ratio, R, defined as $\#S.S./\#O.S.$. Figure [6a] shows R as a function of η_1 for $8.4pb^{-1}$ integrated from $27 < E_t < 60$ GeV. Also shown is the LO QCD calculation for $E_t = 35$ GeV, which is a guess at the average parton E_t of the data,

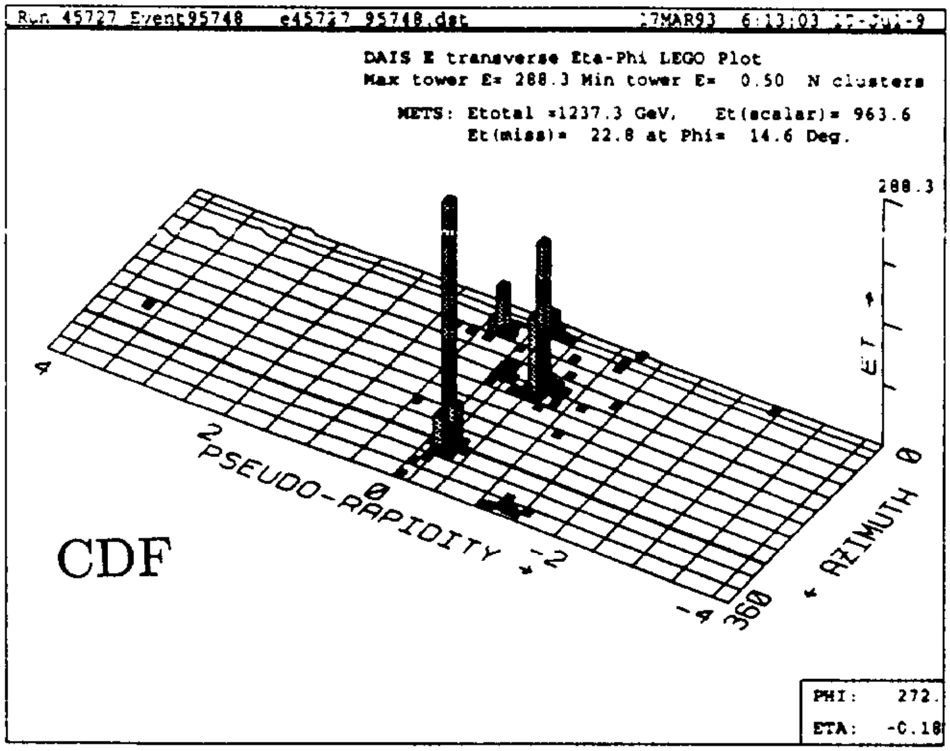


Figure 5: This is the highest transverse energy collision observed at the Tevatron.

with various structure functions. One sees that R is very sensitive to the PDFs. On the other hand Figure [6b], which displays the theory calculation for R vs. η at four different parton energies, shows that it is important to correctly unsmear the jet energies because low energy jets which feed up and increase the contribution to R at high values of η cause the gluon distribution at low x to be overestimated.

3.3 Direct Photon Production

Both D0 and CDF have studied the direct photon cross section. The new data samples extend the E_t range at both the high and low E_t ends compared with previous measurements[13]. Figure [7] shows the CDF and D0 direct photon cross sections along with NLO predictions. The CDF data has a steeper fall-off with E_t than does the theory. The D0 data exhibits similar behavior.

3.4 4 Jet Events and Double Parton Interactions

CDF has completed a study of four jets events including a search for double parton interactions in their 1988-89 data. Events with 4 jets with E_t greater than 25 GeV/c and with $\Sigma E_t > 140$ GeV are selected. The jets are ordered by E_t. The highest E_t jet is paired with the second highest and the 3rd highest with the 4th. The pair of jet axes are required to have separation $\Delta R > 1.0$. Of the surviving events $5.4^{+1.6}_{-2.0}\%$ are double parton interactions. The rest are double bremsstrahlung. Based on this

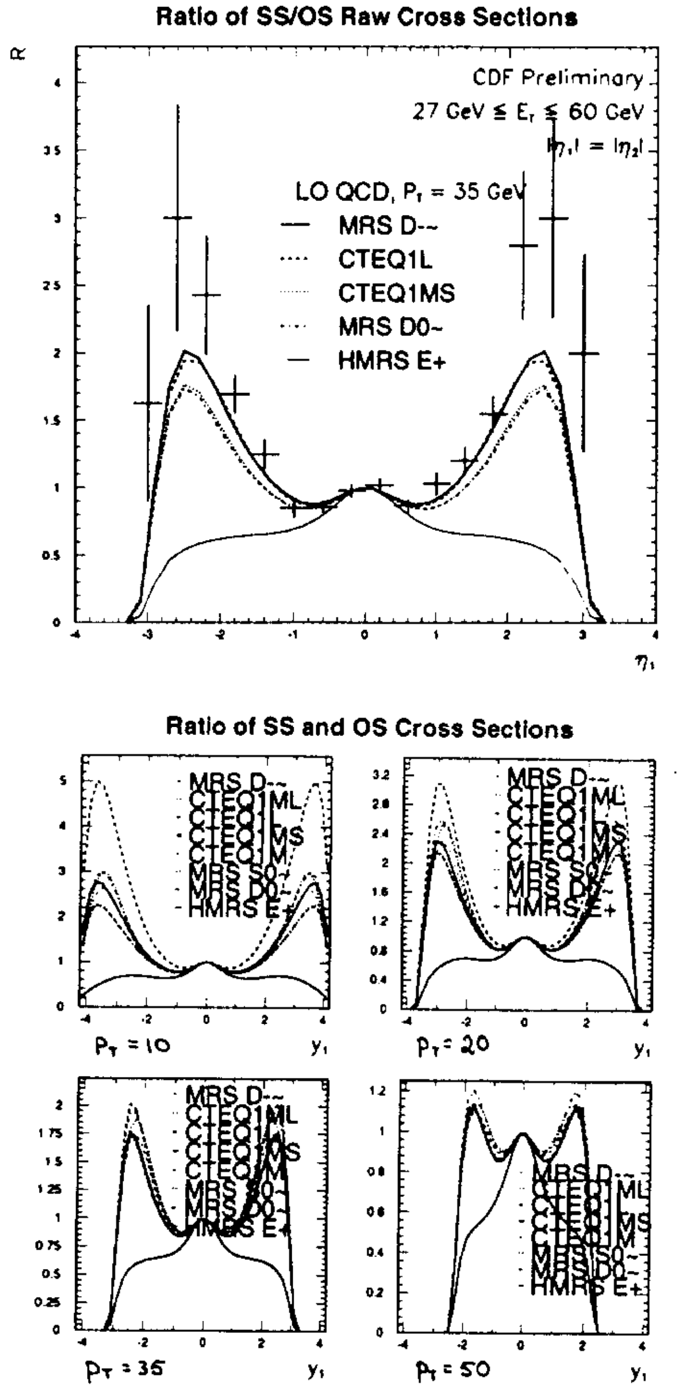
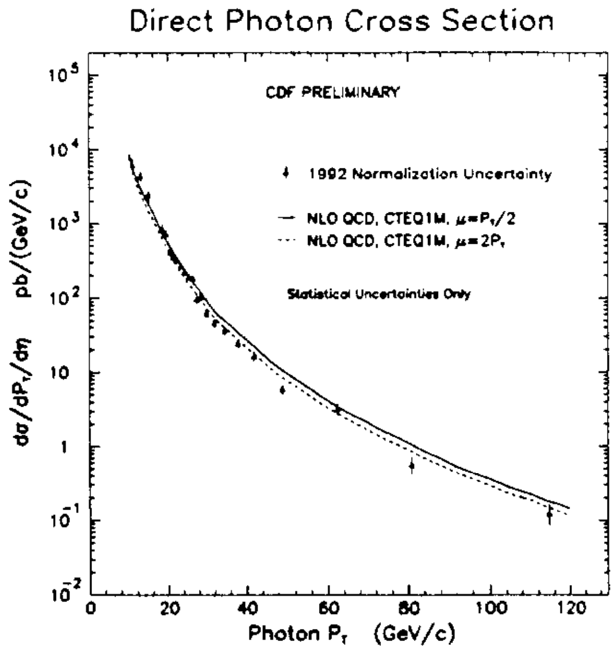


Figure 6: Jet topological analysis. Figure a) shows R vs. η for a E_t range 27-60 GeV and the LO QCD prediction for parton $E_t = 35$ GeV using various PDFs. Figure b) shows the LO QCD predictions for R vs. η with various PDFs for a range of parton E_t values.



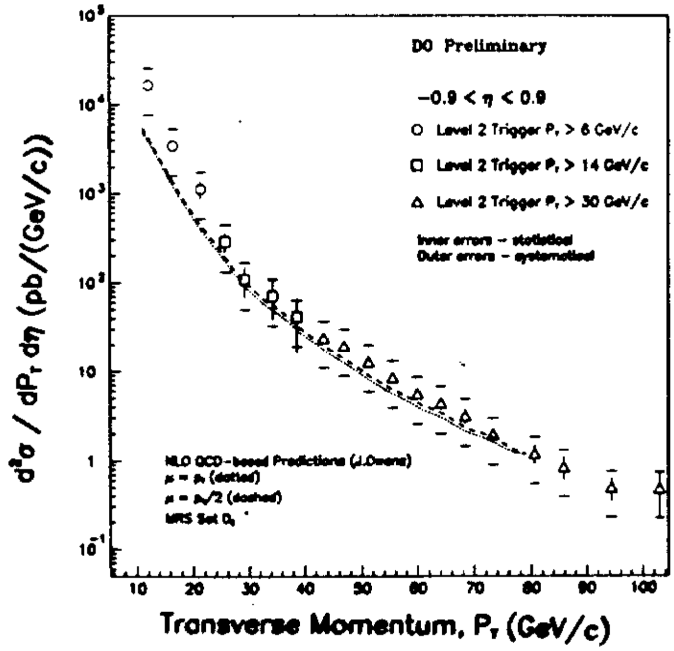


Figure 7: Direct photon production cross section from D0 and CDF. Both are compared with the NLO theory prediction.

M_{Top} GeV/c^2	No Jet Cuts Eff'y %	3 j>20 GeV Eff'y %	4 j>20 GeV Eff'y %	5 j>20 GeV Eff'y %
100	22	8.8	3.4	0.6
120	25	19	10	2.6
140	28	21	12	3.1

Table 1: Efficiency vs. Jet Cuts for various top quark masses. The strong dependance of the efficiency on the energy of the b-quark jets is apparent. The cross section times branching ratio assumed for M_{Top} = 100, 120, and 140 GeV/c^2 is $14.8, 6.0$ and $3.0pb^{-1}$.

result, double parton interactions will dominate the cross section below $E_t \sim 40$ GeV at the SSC. CDF published this result[14] shortly after the conference.

4 Top Quark search at D0

D0 assumes the top quark is substantially heavier than the W boson and decays via Wb. The different final states are determined by the different W decay modes. The final state signatures are: dilepton + 2 b-quark jets + $\not{E}_T$, lepton + jets + 2 b-quark jets + $\not{E}_T$, and 4 jets + 2 b-quark jets. It is possible to require a low-pt lepton to identify one or more the jets as b-quark candidates. CDF has the additional handle of using their SVX to identify a jet as a b-jet candidate. D0 is searching for top in all of these possible decay modes. I report on results from analysis of the dilepton and the lepton + jets decay modes. Analysis of the all jets decay mode, which has the highest branching ratio but is the hardest to distinguish from multi-jet QCD backgrounds, is proceeding and results are expected soon.

D0 takes the predictions for the top production cross section from Berends, Tausk and Giele[15].

4.1 Lepton + Jets

D0 searches for top to electron + jets by analyzing triggers which have a 20 GeV electromagnetic cluster and 20 GeV of $\not{E}_T$. In $10.2 \pm 1.2pb^{-1}$ there were 61000 such triggers. Adding the requirement that the cluster have a matching track and that the angle, $\Delta\phi$, between the electron and the highest E_t jet be $< 165°$ reduces the sample to 8478 candidates. Next, jet requirements are imposed on the candidates. Jets are formed using a cone of size $R = 0.5$. One then counts the number of events with n jets above 20 GeV. The efficiency for identifying top events comes from Monte Carlo simulation. It is shown in Table [1]. Figure [8] shows the cross section vs. number of jets in the candidates which survive a 20 GeV E_t cut. Also shown is a VECBOS[16] Monte Carlo simulation for the background due to $W + n$ jet production. The data is consistent with the expected background. The need for

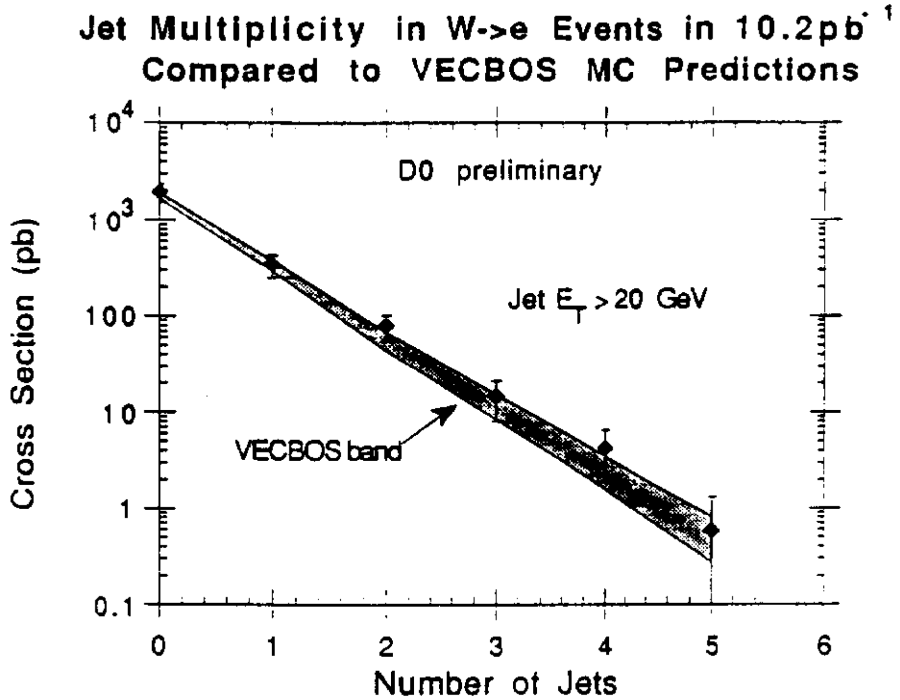


Figure 8: The jet multiplicity in W + jets events is shown. The jets have a 20 GeV E_t cut.

the addition of a b-tag is obvious. D0 is making rapid progress towards that end from identifying low p_t muons. The efficiency is expected to vary from 5 to 25 % depending on the jet p_t.

The muon + jets analysis is proceeding and results are expected in the early fall.

4.2 Dileptons

D0 uses three triggers in the two electron top decay mode. The single electron trigger requires a 20 GeV E_t electromagnetic cluster and 20 GeV of $\not\!\!E_T$. The two electron trigger requires 2 *em* clusters with more than 20 GeV E_t. The electron + jets trigger requires an *em* cluster with more than 15 GeV E_t, $\not\!\!E_T > 20GeV$, and 2 jets with $E_t > 16$ GeV. $7.3pb^{-1}$ has been analyzed as of this conference. Offline requirements start by demanding at least one electromagnetic cluster has a track match which identifies it as an electron. This reduces the sample to 1159 candidates. Next, requiring at least two jets (cone size = 0.5) where the highest energy jet has more than 12.5 GeV E_t and another has at least 10 GeV E_t reduces the sample to 70 candidates. The $\not\!\!E_T$ vs. $M(ee)$ for these candidates are shown in Figure [9]. The final event selection, which requires that $M(ee)$ is not consistent with the Z boson mass and that $\not\!\!E_T > 20$ GeV, eliminates all of these as top candidates. The efficiency and expected number of events are shown in Table [2]. The backgrounds come from two general sources. The primary physics backgrounds include W pair

M_{Top} GeV/c^2	$\sigma \cdot B$ (pb)	Efficiency %	$\langle N_{ee} \rangle$ in $7.3 pb^{-1}$
80	4.6	11	3.7
100	1.3	18	1.7
120	0.5	28	1.0
140	0.2	32	0.5

Table 2: Efficiency vs. top quark mass for $t\bar{t} \rightarrow ee + X$.

M_{Top} GeV/c^2	$\sigma \cdot B$ (pb)	Efficiency %	$\langle N_{e\mu} \rangle$ in $7.5 pb^{-1}$
80	9.1	9.0	6.1
100	2.5	15	2.8
120	1.0	22	1.7
140	0.5	26	1.0

Table 3: Efficiency vs. top quark mass for $t\bar{t} \rightarrow e\mu + X$.

production, $Z \rightarrow \tau\tau$, and high mass Drell-Yan τ pairs. The other backgrounds arise from misidentifying jets as electrons. The total background expected in this sample is 0.22 candidates.

The dimuon analysis is proceeding and results are expected in the early fall.

D0 uses three triggers in the $e\mu$ mode. The first requires an electron with $E_t > 7$ GeV and an muon with $P_t > 5$ GeV. The muon + jets trigger requires a muon with $P_t > 5$ GeV, $\not\!\!E_T > 12$ GeV and 2 jets with $E_t > 15$ GeV. The electron + jets trigger requires an *em* cluster with $E_t > 12$ GeV, $\not\!\!E_T > 20$ GeV and 2 jets with $E_t > 20$ GeV. 7.5 pb^{-1} has been analyzed as of this conference. Only 77 events remain after offline event selection which requires that the muon and *em* cluster have more than 15 GeV E_t. A muon isolation cut is applied; events where $\Delta R(\mu - \text{jet}) < 0.5$ are eliminated. Requiring $\not\!\!E_T > 20$ GeV and eliminating events with collinear and wide-angle muon bremsstrahlung photons reduces the sample to 6 candidates. Finally, requiring at least 2 jets (cone size = 0.5) where one has at least 12.5 GeV E_t and the other at least 10.0 GeV E_t reduces the sample to one event. The efficiencies and expected number of events as function of the top mass are shown in Table [3]. The physics backgrounds arise from sources similar to the di-electron mode. The fakes include contributions from fake muons as well as fake electrons. The expected background after $7.5 pb^{-1}$ is 0.65 events.

Much ado has been made about the one top candidate in the $e\mu$ sample. The *em* cluster has a track match indicating it is an electron. The electron E_t is 96.9 ± 2.0 GeV. It is well isolated from the nearest jet. The muon has $101^{+\infty}_{-50}$ GeV p_t. The error bars are asymmetric because it comes from uncertainty in the bend angle in

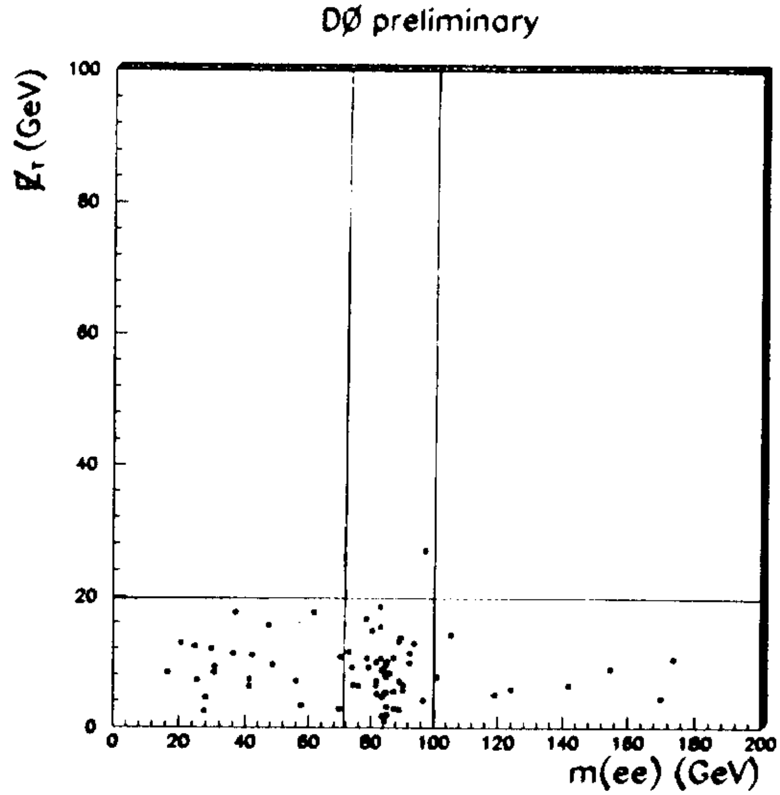


Figure 9: Missing E_t vs. dielectron mass. Event selection removes candidates with missing E_t < 20 GeV or which are near the peak.

the toroid magnet. The p_t is 6 σ above the 15 GeV cut. The muon has a track match and calorimeter confirmation. It is also well isolated from the nearest jet. The $\not{E}_T$ is $74^{+\infty}_{-8.0}$ GeV and is directed nearly perpendicular to the leptons in ϕ. Two jets, one with $E_t = 29.5 \pm 5.3$ and the other with $E_t = 27.6 \pm 5.0$, are found using the cone size 0.5. If the conesize is increased to 0.7, a third jet, with $E_t = 13.6 \pm 2.4$ GeV is found. The ϕ integral view of this event is shown in Figure [10]. A note of caution must be injected at this stage. D0 does not say this event is a top quark event. It is merely a candidate.

A lower limit can be placed on the top quark mass from the dileptons analysis. With one candidate event in the combined ee and $e\mu$ analyses, $M_{Top} > 99$ GeV/c^2 with 95% confidence. If one subtracts the expected 0.87 event background, the limit is 103 GeV/c^2 with 95 % confidence. If the $e\mu$ candidate is interpreted as a top quark event, M_{Top} is not likely to be lower than 115 GeV/c^2. A Dalitz-like analysis places the mass peak in the neighborhood of 150 GeV/c^2.

5 Conclusion

I have discussed some of the newest results in Electro-weak, QCD and Top quark physics at the Tevatron. D0 and CDF have unprecedented numbers of W bosons from which to estimate its mass. The lower limit on the mass of a top quark produced

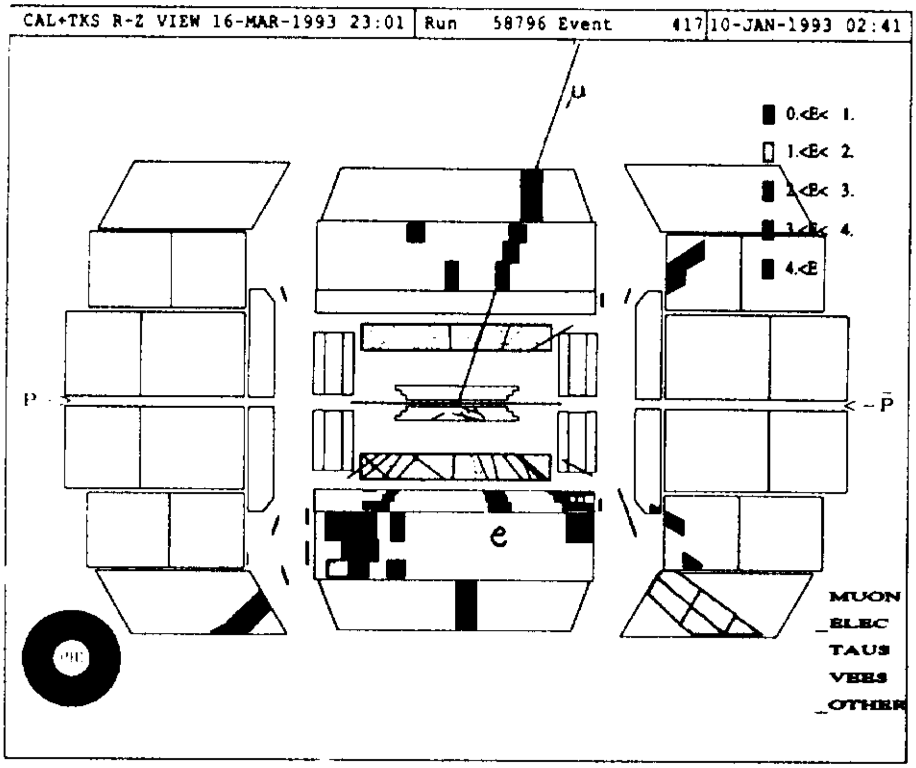


Figure 10: ϕ integral view of the $t\bar{t} \rightarrow e\mu$ candidate. The muon and electron are indicated.

in W decay has been raised to 62 GeV/c^2. Gauge boson pair production is closing-in on constraints to W and Z structure and is opening the door to measuring electroweak couplings. A rich and varied program of jet studies is enhancing QCD and constraining PDFs. The topological-based two jet analysis is an innovative way for CDF to take better advantage of their calorimeter coverage than past analyses. The double parton interaction study shows promising potential for penetrating the correlation between parton distributions. The top quark is not yet discovered. D0 has set a lower limit on the mass at 99 GeV/c^2. After analysis of the rest of the dilepton data and including the lepton + jets decay modes, the limit could be as high as 120 GeV/c^2. Even though a few interesting events exist, D0 or CDF would have to be very lucky to discover a 150 GeV/c^2 Top when the limits are at 110-130 GeV/c^2.

The 1992-1993 Tevatron collider run ended yesterday. Early indications are that this is merely the beginning of a rich period of discovery at Fermilab.

6 Acknowledgements

I would like to thank the organizers of this conference for their hospitality. I am grateful to Brenna Flaugher, Jimmy Proudfoot, Eve Kovacs, Sarah Eno, Jerry Blazey, Steve Wimpenny and Jae Yu for their help with various questions I had in preparation for the conference.

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