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Boaz Klima
for the DØ Collaboration

*Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510*

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TOP QUARK SEARCH IN DØ FROM THE LEPTON + JETS MODE

Boas KLIMA, for the DØ Collaboration
Fermi National Accelerator Laboratory
P.O. Box 500, Batavia Illinois 60510

ABSTRACT

The DØ collaboration has searched for Top quark production at $\sqrt{s} = 1.8$ TeV in $p\bar{p}$ collisions at Fermilab using a data sample corresponding to an integrated luminosity of 1.1 pb^{-1} , collected during the 1992 Tevatron run. We report the preliminary results of a search for $t\bar{t}$ production in which the Top quark decays to a W boson plus a b quark where one W decaying leptonically and the other decaying hadronically. Future prospects for extending the search for Top in the lepton plus jets channel are discussed.

1. Introduction

The Top quark is the only quark within the Standard Model (SM) which is yet to be observed. In $p\bar{p}$ collisions at Tevatron energies ($\sqrt{s} = 1.8$ TeV) the dominant Top quark production process is the QCD creation of $t\bar{t}$ pairs. According to the SM each Top quark is expected to decay via the weak charged current into a b quark and a W boson, which can decay into leptons or light quarks. In this study we concentrated on the e+jets final state which has a branching ratio of 15%. The signature for these events is a high missing transverse energy, a high transverse momentum electron, and a few jets. Because of quark and gluon bremsstrahlung and the experimental definition of a jet the number of expected jets is not necessarily four. The physics processes which are the main background source for this channel are W+jets, QCD (mainly $b\bar{b}$), and $Z^0 \rightarrow e^+e^-$ where one electron was missed.

The detector, newly commissioned in the current run of the Fermilab Tevatron, is well-suited for identifying electrons and jets, and measuring the missing transverse energy of an event.¹

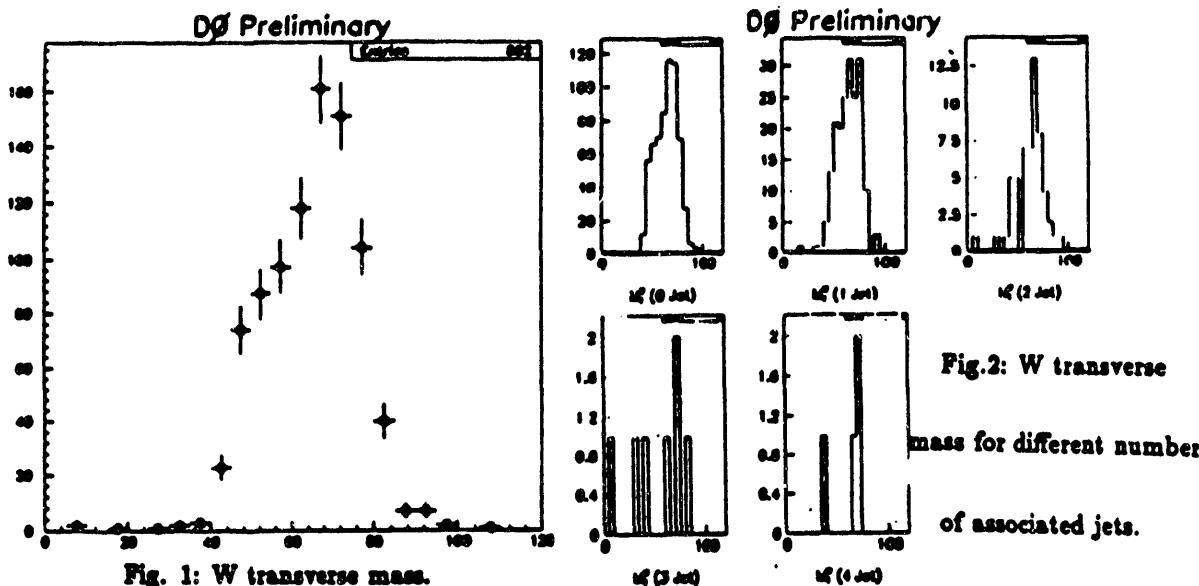
2. Data Sample

The data used in this analysis were collected in September and October of this year (1992), after a 3 month commissioning period for the detector. The integrated luminosity was 1.1 pb^{-1} , representing less than 5% of the total expected for this collider run (Ia). The data were from that subset of triggers chosen to be analyzed immediately (Express Line) for topical physics results. A hardware trigger (Level 1) required at least one electro-magnetic (EM) trigger tower (0.2×0.2 in $\eta - \phi$ space) with $E_t > 14 \text{ GeV}$. A software trigger (Level 2) required at least one EM cluster with $E_t > 20 \text{ GeV}$ (with some electron cluster shape cuts) and missing $E_t > 20 \text{ GeV}$. There was no particular requirement about jets at the trigger level. The efficiency of these triggers (including geometric acceptance) is estimated to be 56%.

We have studied the trigger efficiency as a function of the number of associated jets and found that the efficiencies were similar, within our estimated errors, up to 4 associated jets per event.

Offline cuts were imposed to define $W \rightarrow e + \nu_e$ candidate sample. We required missing $E_T > 20$ GeV, one electron candidate with $p_T > 20$ GeV, and we imposed a few electron quality cuts (Details were reported elsewhere.²). Taking into account all the aforementioned online and offline cuts the final efficiency was $31\% \pm 5\%$. The number of events satisfying those criteria in that data sample was 882. Fig. 1 shows the transverse mass of those W candidates. We have estimated the contamination from $W \rightarrow \tau + \nu_\tau$ (where the τ decays into $e\nu_e\nu_\tau$) to be about 5%, from QCD events to be much less than 1%, and from Z^0 events (where one misidentifies one of the two electrons) to be much less than 1% (Details were reported elsewhere.³).

Fig. 2 shows the transverse mass of the W candidates for different number of associated jets. We used a fixed cone ($R=0.5$) jet finding algorithm with minimum E_T cutoff of 15 GeV. The observed distributions are consistent with a full Monte Carlo simulation of W +jets events(Details were reported elsewhere.⁴).



3. Monte Carlo

We have generated Monte Carlo events based on a leading order theoretical prediction (encoded in the VECBOS generator) and put them through the full D \emptyset detector simulation. We then compared the transverse momentum of W candidates in those Monte Carlo datasets with data normalizing the Monte Carlo sample to the same number of events, and the shapes agree well.

We also compared the number of events predicted by VECBOS (with ISAJET fragmentation) to the number of events observed in our data, and found a good agreement within the statistical errors. We varied the jet minimum E_T cutoff and found the following numbers of events:

E_T^{miss} (jet) (in GeV)	W + 2 jets Data	W + 2 jets VECBOS	W + 3 jets Data	W + 3 jets VECBOS
15	35±6	29±2	5±2	3.5±0.4
20	17±4	17±2	1±1	0.3±0.1
25	8±3	9±1	0	0.05±0.05

4. Top to Electron + Jets

The analysis strategy depends on the integrated luminosity. We have generated 80 GeV Top Monte Carlo events, ran them through the DØ simulation programs, both for the detector (DØGEANT) and for the triggers, and processed them with the same reconstruction program (including offline cuts) as used for the data. The total cross section for Top events at $\sqrt{s} = 1.8$ TeV in p_T collisions was taken from Berends et al.⁵ This estimated cross section is about 30% higher than previous calculations.⁶

We looked for W+3 jets events where the jets were found with the fixed cone algorithm ($R=0.5$), the E_T cut on the jets was 25GeV and their maximum pseudorapidity was 2.5. We observed no events which satisfied these criteria. A preliminary estimate of the uncertainties yields the following percentage errors: 1) Monte Carlo cross section - 30%, 2) Monte Carlo statistics - 8%, 3) Jet energy scale - 20%, 4) Luminosity - 15%, 5) Efficiency - 15%. In total the uncertainty was about 45%. Our Monte Carlo calculation for a Top mass of 80GeV predicted on average 2.6 ± 1.2 events in the integrated luminosity of 1.1 pb^{-1} .

5. Conclusion

DØ has observed $W \rightarrow e\nu$ decays in events with different number of associated jets. The number of events predicted by VECBOS for different jet multiplicities in W events agrees well with the DØ data. A Monte Carlo study of 80GeV Top events predicts about 2.6 ± 1.2 events in 1.1 pb^{-1} whereas no events were observed in the data. This analysis will certainly be improved with time and with the acquisition of significantly more data during the remainder of this collider run. We plan to better understand our detector and the data, to analyze other lepton+jets channels, and to apply sophisticated techniques for signal/background separation.

6. References

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