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CDF

New Particle Searches at CDF

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NEW PARTICLE SEARCHES AT CDF

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FOR THE CDF COLLABORATION

1 Introduction

One of the fundamental roles of a general purpose detector exploring, by means of increasing luminosity, higher and higher mass reach, is to search for new particles and exotic phenomena. This is a continuing effort for the CDF collaboration and I will report on several searches using about 20 pb^{-1} from the 1992/93 run labelled “run 1a” and ~ 50 of the 90 pb^{-1} so far from the current “run 1b.” These are mostly preliminary analyses, typically using a total of 70 pb^{-1} . Our limits on SUSY using missing E_T with jets as well as three leptons are discussed elsewhere;¹ results from the D0 collaboration² are similar.

I will discuss searches for additional vector bosons Z' and W' , second generation scalar leptoquarks, as well as a broad search for objects decaying into jet pairs, including b-tagged jet pairs. I will also describe two events which do not fit in comfortably with either the standard model or a phenomenologically motivated search.

2 Update on the Z' Search

We search for possible neutral heavy vector bosons decaying onto e^+e^- or $\mu^+\mu^-$, updating our previous searches.³ For electron pairs there is some concern that for electron E_T above $\sim 150 \text{ GeV}$ the standard identification cuts may become inefficient. The cuts are loosened to ensure efficiency, and the QCD background rate is then comparable to Drell-Yan above the Z . Muon pairs have less background and a beam position constraint is used in track reconstruction so that the momentum resolution at $200 \text{ GeV}/c$ p_T is $\sim \pm 20\%$. The number of high mass pairs is consistent with expectations. Above $400 \text{ GeV}/c^2$, we expect 0.9 ee and 0.2 $\mu\mu$ candidates and there is one data event, an electron pair at 510. We expect 0.2 events above 500. The (preliminary) combined limit for a “standard” coupling Z' is $m(Z') > 650 \text{ GeV}/c^2$, 95% CL. Updates with more luminosity and particular model coupling limits will come in the future.

3 Update on the W' Search

The CDF limit for run 1a for a “standard” coupling W' is $m(W') > 652 \text{ GeV}/c^2$, 95% CL.⁴ A heavy enough W' might decay preferentially to $W + Z$ rather than to $e + \nu$. Such a possibility can be searched for by looking for $W \rightarrow e\nu$ accompanied by a dijet which could be the decay of a Z . This analysis uses 67 pb^{-1} . The W +dijet mass spectrum is shown in Fig. 1 along with background and signal shapes. A preliminary analysis making no background subtraction and using statistical uncertainties only excludes $205 < m(W') < 400 \text{ GeV}/c^2$, 95% CL.

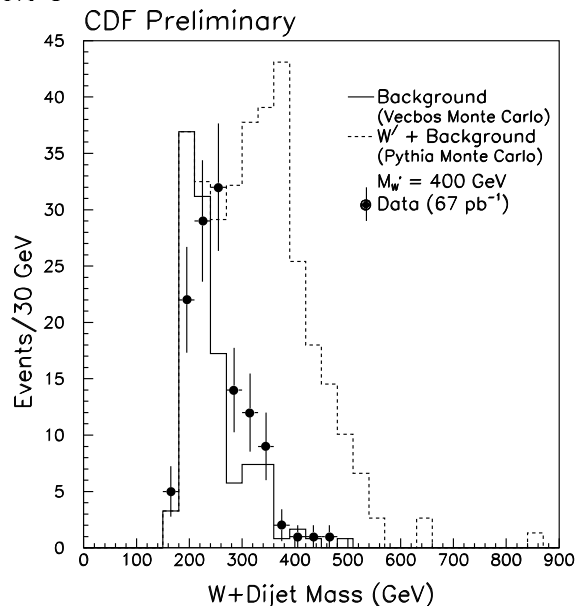


Figure 1: $W +$ dijet mass distribution showing background expectation, the shape expected for a W' at $400 \text{ GeV}/c^2$, and the data.

4 Scalar 2nd Generation Leptoquarks

Leptoquarks are hypothetical color triplet bosons coupling to leptons and quarks. A second generation one would couple to muon number and perhaps second generation quarks. We have a preliminary update of the

Table 1: Preliminary CDF 70 pb^{-1} dijet exclusions.

Object	95% CL Exclusion (GeV/c^2)
axigluon	200-1000
excited quark	200-600
technirho	270-510
W'	380-470
Z'	410-460
E_6 diquark	370-460

search⁵ for events with 2 high p_T muons and 2 high E_T jets using 70 pb^{-1} . We find 4 candidate events with an expected background from Drell-Yan and $Z \rightarrow \tau\tau$ of 4.8 ± 1.3 events. This allows us to exclude $m < 180$ GeV/c^2 , 95% CL. If the branching ratio, β , for LQ to muon plus quark is 50%, this becomes 141 GeV/c^2 .

5 Update of the Dijet Search

The search for particles decaying to dijets⁶ is updated to 70 pb^{-1} . The mass distribution of jet pairs with $|\cos(\Theta^*)| < 0.67$ is fit from 150 to 1100 $GeV E_T$ to a smooth curve plus possible resonances. The excess over QCD at high mass is discussed elsewhere.⁸ Particles which would make a big enough bump are excluded as listed in Table 5. By repeating this after demanding a b tag, one can exclude possible $b\bar{b}$ resonances which could come from topgluons in a topcolor model.⁷

6 Two Interesting Events

We have two events which seem particularly worthy of note. The first is a three lepton event. It has a positron with 182 $GeV E_T$, a muon with 27 $GeV/c p_T$, an electron with 23 $GeV E_T$ ($m(ee) \sim 120 GeV/c^2$), an 83 $GeV E_T$ jet, and 106 GeV of E_T missing. The event is otherwise quite clean. The leptons are too energetic for the SUSY trilepton signature. A plausible if unlikely source of background would be a dilepton top event where one of the bs hadronizes with a semileptonic decay to look like an isolated e or μ .

We have not been able to come up with a plausible background for the event shown in Fig. 2. This event has a 59 $GeV E_T$ electron (sign not determined), a 36 $GeV E_T$ electron ($m(ee) \sim 160 GeV/c^2$) and photon candidates of 38 and 36 $GeV E_T$. Perhaps the photon candidates are well isolated π^0 s but this is no less unlikely. There is 53 $GeV E_T$ missing. One may interpret the event as a pair of objects each decaying to $W + \gamma$. Given the two neutrinos this is consistent, but then there should be many more events where one of the two W s decays to two jets, and we see no such $e\gamma jetjet$ events.

Event: $2 e + 2 \gamma + \cancel{E}_t$

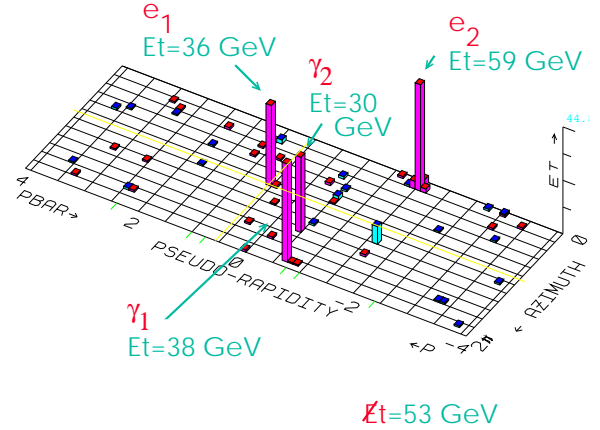


Figure 2: E_T distribution in $\eta - \phi$ for the puzzling $ee\gamma\gamma\nu(s)$ event.

7 Conclusion

We are not finding any of the things we are looking for and the exclusions are growing. Perhaps there is some unexpected new thing in our data, but odd events are a relatively constant phenomenon.

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