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THE DIPHOTON MISSING E_T DISTRIBUTION AT CDF

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We present a preliminary systematic study of the missing E_T ($\not\!\!E_T$) spectrum in diphoton events for a CDF data sample of 85 pb^{-1}. The event selection cuts used are looser, but based on, the cuts used for the CDF diphoton cross section measurement. The event with the largest missing E_T is the $ee\gamma\gamma\not\!\!E_T$ candidate event. The distribution shows no other significant deviations from the background estimate. This measurement lays the groundwork for searches for new phenomenon involving diphotons and missing E_T, as is predicted in some models which attempt to explain the CDF $ee\gamma\gamma\not\!\!E_T$ candidate event.

On April 28, 1995 an $ee\gamma\gamma\not\!\!E_T$ candidate event was recorded at the CDF Detector. This event is shown in Figure 1. Since that time there have been a large number of theoretical papers[1–15] which explore possible new physics explanations for this event (SUSY, E6, extra generations, axinos, etc). Many of these papers postulate that in addition to this event there should be anomalous production of events which contain two photons + $\not\!\!E_T$. In an effort to address this hypothesis, we present a preliminary systematic study of the missing E_T spectrum in diphoton events.

The data were taken at the Fermilab Tevatron using the CDF detector during the Run 1b data taking period[a]. We select events with two central, isolated photons with $E_T > 12$ GeV. The photon identification cuts are based on those used for the CDF diphoton cross section measurement[16], but are tailored for a search.

The missing E_T is corrected for jet and underlying event energy mismeasurements and uses a method which is similar to that used in the CDF top quark mass analysis[17]. The method helps avoid measuring significant missing E_T when there is no 'true' missing E_T by correcting for the fact that we measure photon E_T well but typically undermeasure hadronic jet E_T and other unclustered energy by 40%.

[a] The luminosity for this dataset is 85 pb^{-1}.

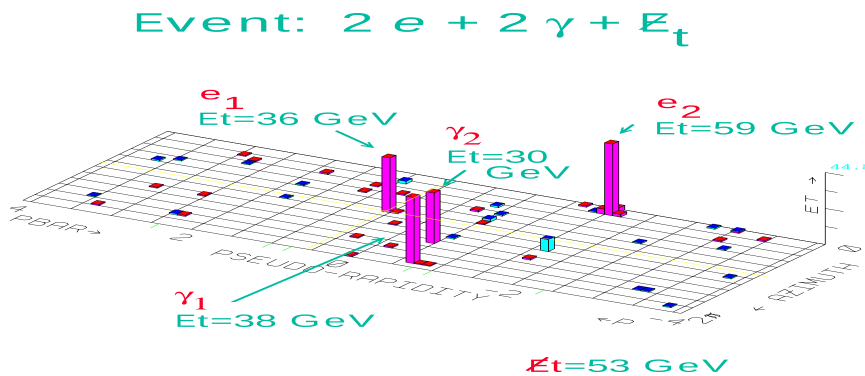

Figure 1: The $ee\gamma\gamma\not{E}_{\rm T}$ candidate event from CDF.

In order to search for anomalous production we compare the shape of the missing $\rm E_T$ spectrum in diphoton events to e^+e^- events since the detector response for the electromagnetic clusters should be similar. The dominant source of these events is Drell-Yan and $Z^0 \rightarrow e^+e^-$ production. These two sources have event topologies which are similar to diphoton events and do not have intrinsic $\not{E}_{\rm T}$. However, there are a number of small cross section sources of e^+e^- events which can have large intrinsic $\not{E}_{\rm T}$ and would change the shape of the tail of the distribution. For example, WW, WZ and $t\bar{t}$ production can yield e^+e^- pairs with large $\not{E}_{\rm T}$. We use the same algorithm for calculating $\not{E}_{\rm T}$ and normalize the background to the diphoton total event rate.

Figure 2 shows the data (points) along with the background shape from e^+e^- events (solid line). The diphoton event with the largest $\not{E}_{\rm T}$ is the $ee\gamma\gamma\not{E}_{\rm T}$ event. There are no other significant deviations from the background estimate except at the highest $\not{E}_{\rm T}$ where WW, WZ and $t\bar{t}$ production contribute events to the background shape, and may well account for the events above 30 GeV in the background distribution.

As mentioned previously, there have been a number of theoretical papers which predict anomalous $\gamma\gamma\not{E}_{\rm T} + X$ production. We have investigated our sensitivity to one such SUSY theory with light Gravitinos[1]. In this model the LSP is assumed to be a light Gravitino ($\tilde{G}$) and the parameters are such that gaugino-gaugino production dominates. We take the lightest chargino[b] to have $\rm M_{C_1}$ = 75 GeV/c^2 and simulate inclusive $\rm N_iN_j$, $\rm C_iC_j$ and $\rm N_iC_j$ production using the full CDF detector simulation. In most events there is the $\gamma\gamma\not{E}_{\rm T} + X$

[b] In this notation $\rm C_1$ is the lightest chargino and $\rm N_1$ is the lightest neutralino.

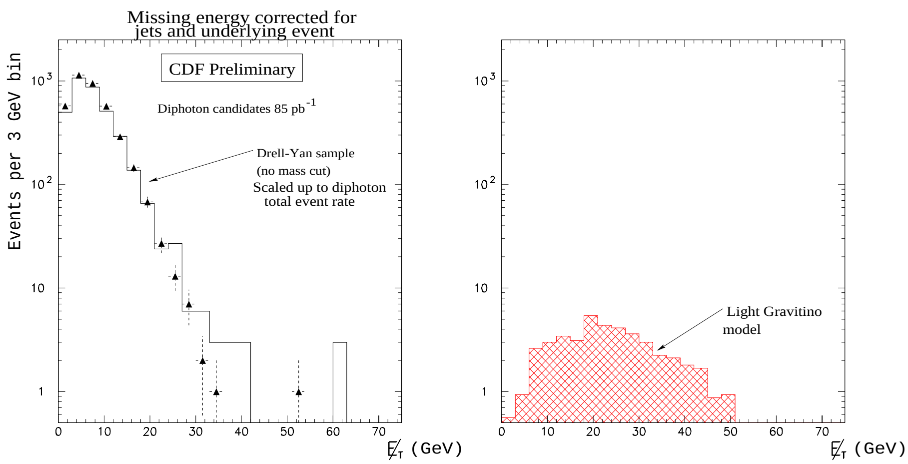

Figure 2: Left: The missing E_T ($\not{E}_T$) distribution for diphoton events. The background shape is taken from e^+e^- events and contains small amounts of WW, WZ and $t\bar{t}$ events which produce events with large $\not{E}_T$. Right: $\not{E}_T$ distribution for a SUSY scenario with light Gravitinos. Note that the simulation is not yet fully corrected for trigger and photon identification efficiencies.

signature from decays such as $C_1 \rightarrow N_1 + X$, $N_1 \rightarrow \gamma \tilde{G}$. The results[c] are shown in Figure 2. From the number of predicted events with $\not{E}_T$ above 30 GeV it appears that we have sensitivity to this model and others like it.

We have presented a preliminary systematic study of the missing E_T spectrum in diphoton events. Other than the $ee\gamma\gamma\not{E}_T$ candidate event the distribution shows no significant deviations from the background estimate. This measurement lays the groundwork for searches for new phenomenon involving diphotons and missing E_T, as is predicted in some models which attempt to explain the $ee\gamma\gamma\not{E}_T$ event.

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[c] Note that these results are not yet fully corrected for trigger and photon identification efficiencies

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