Search for Anomalous Production of $\gamma\gamma + \not{E}_T$ Events in 2 fb^{-1} of Data.

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Abstract

We present a model-independent search for anomalous production of $\gamma\gamma + \not{E}_T$ events in 2 fb^{-1} of data collected by CDF II detector. The observed number of events is consistent with the sum of a predicted number of fake and Standard Model events.

1 Short Analysis Description

The $\gamma\gamma + \not\!\!E_T$ signature is predicted in many well-motivated models of new physics beyond the Standard Model. Examples include gauge-mediated SUSY [1], fermiophobic Higgs [2, 3], 4^{th} generation fermions [4], and the E_6 model [5]. Rather than trying to optimize for these or other models, the CDF Collaboration takes a model-independent approach. The analysis is performed with 2 fb^{-1} of data. Events are required to have two central photons ($|\eta|<1.1$) with $E_T>13$ GeV. Both photons are required to be in time with a $p\bar{p}$ collision to reduce a contamination from non-collision sources. The dominant backgrounds are regular di-photon and QCD jet events with fake $\not\!\!E_T$ due to energy mismeasurement in the calorimeter, and electroweak (EWK) processes with real $\not\!\!E_T$. In this search, the CDF Collaboration applies a novel approach to discriminate events with unobserved particles producing the $\gamma\gamma+\not\!\!E_T$ signature. Events are selected based on a significance of the measured $\not\!\!E_T$, unlike the majority of similar analyses where a fixed cut (usually with a large value) on $\not\!\!E_T$ is applied. The $\not\!\!E_T$-significance is estimated on an event-by-event basis according to the measured resolution for jet and soft unclustered (due to the underlying event and multiple interactions) energy, and helps to efficiently separate events with fake and true $\not\!\!E_T$. Figure 1 shows the observed $\not\!\!E_T$-significance distribution in $\gamma\gamma$ events, and Fig. 2 illustrates how a cut on significance>5 helps to select EWK events with $\not\!\!E_T$ as low as 20 GeV, which otherwise would be buried under the huge di-photon and QCD jet background. This plot demonstrates the major advantage of the $\not\!\!E_T$-significance method: it allows sensitivity to new physics processes even with moderate values of $\not\!\!E_T$ ($\not\!\!E_T \approx$20-40 GeV). Table 1 shows the observed and predicted numbers of $\gamma\gamma + \not\!\!E_T$ events for three values of the $\not\!\!E_T$-significance cut. The data agree with the predicted background for all values of the significance cut.

Table 1: *Observed and expected number of $\gamma\gamma + \not\!\!E_T$ events for three values of the $\not\!\!E_T$-significance cut. Systematic and MC statistical uncertainties of the background are added in quadrature.*

	$\not\!\!E_T$-sig>3	$\not\!\!E_T$-sig>4	$\not\!\!E_T$-sig>5
Non-collision	0.90±0.32	0.85±0.30	0.80±0.27
QCD (fake $\not\!\!E_T$)	52.1±11.5	15.4±3.8	6.2±2.7
EWK (real $\not\!\!E_T$)	53.6±8.9	47.3±8.0	41.6±7.0
Total background	106.6±14.5	63.6±8.9	48.6±7.5
Data	120	52	34

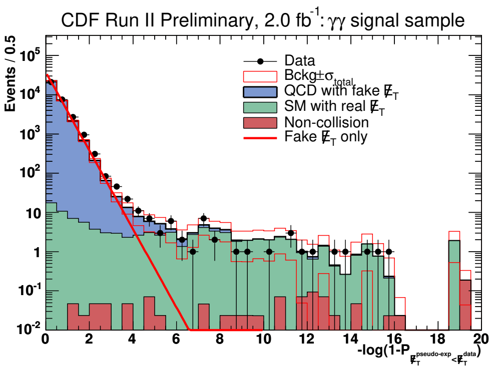

Figure 1: *The $\not\!\!E_T$-significance distribution in $\gamma\gamma$ events.*

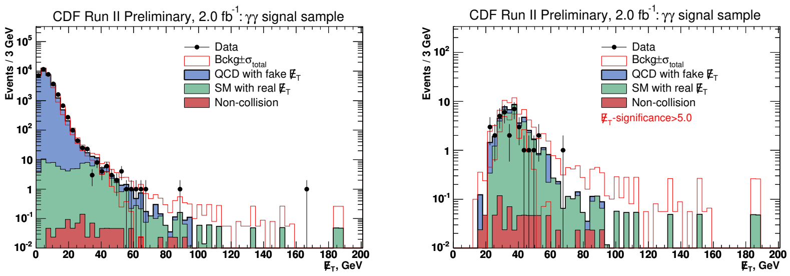

Figure 2: *The observed $\not\!\!E_T$ distribution in all (left) $\gamma\gamma$ events and events with $\not\!\!E_T$-significance>5 (right).*

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