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ANALYSIS OF DIPHOTON EVENTS AT CDF

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The Collider Detector at Fermilab Collaboration has analyzed events with two photons in the central detector. The cross section is measured and compared to theoretical models. The diphoton mass spectrum is searched for anomalous narrow peaks and a search for gauge–mediated SUSY is performed with events with two photons and missing E_t.

Keywords: CDF; photon; QCD; cross section; search; GMSB; SUSY; graviton.

1. Introduction

As of late Summer 2004, CDF has collected approximately 500 pb^{-1} of $p\bar{p}$ collisions and has completed three preliminary analyses of the diphoton data. Diphoton studies are based on triggers which require two clusters with $E_t > 18$ GeV and no isolation, or two clusters with $E_t > 12$ GeV with calorimeter isolation. Only events with both photons in the central ($\eta < 1$) are considered at this time. Photon identification requirements include less than 2 GeV of calorimeter E_t and 2 GeV of track P_t in the $\eta - \phi$ cone of 0.4, and a shower shape consistent with a single, isolated cluster in the shower maximum detector. We find approximately 30% of the events are true diphoton events, increasing at higher E_t. In the remainder, one or both of the clusters are π^0's or other jet fragments.

2. Diphoton Cross Section

To measure the diphoton cross section, we require the photons have E_t >13 GeV and 14 GeV in 207pb^{-1} of data. We use tighter identification cuts, for example, isolation E_t <1 GeV. We use two techniques to measure the background, both with moderate discrimination power leading to increased statistical uncertainties. The first, which works best at lower E_t, examines the shower shapes to estimate single and multiple photon clusters. The second method uses the central preradiator detector to count how often the shower starts early, which is more likely for multiple–photon showers.

After subtraction, the result is compared to three predictions: Pythia leading order, scaled by a factor of 2; RESBOS[1], which sums soft gluons in the initial state;

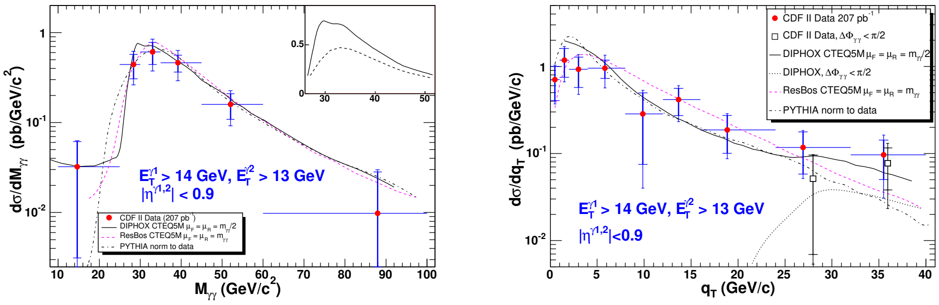


Fig. 1. The diphoton cross section as a function of diphoton mass (left) and P_t of the diphoton system (right). Results are preliminary.

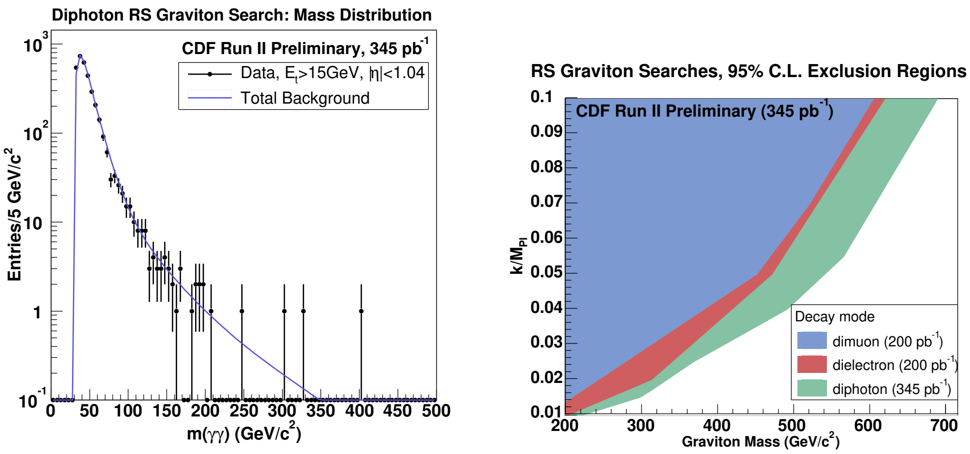


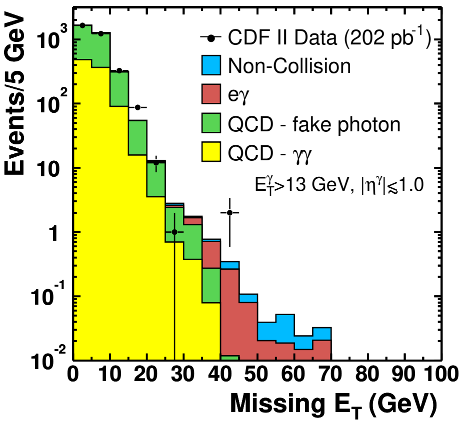
Fig. 2. The diphoton mass spectrum (left) and the limits on the Randall–Sundrum Gravitons in the plane of Graviton mass *vs* the model's warp factor (right).

and the next–to–leading–order DIPHOX[2]. Figure 1 shows the comparison of the diphoton mass and the P_t of the diphoton system. RESBOS predicts the low-P_t region more accurately, but DIPHOX predicts other features.

3. Search for Narrow Diphoton Mass Peaks

In 345 pb^{-1} of data, we form the diphoton mass distribution, shown in Figure 2. For the background, we use absolutely–normalized DIPHOX for the true diphoton events, and a sample of π^0–dominated dijets for the shape of the fake photons, normalized the low–mass region.

The spectrum agrees well, and we set limits on narrow, high–mass diphoton peaks by counting events in a mass window. We set limits on the Randall–Sundrum



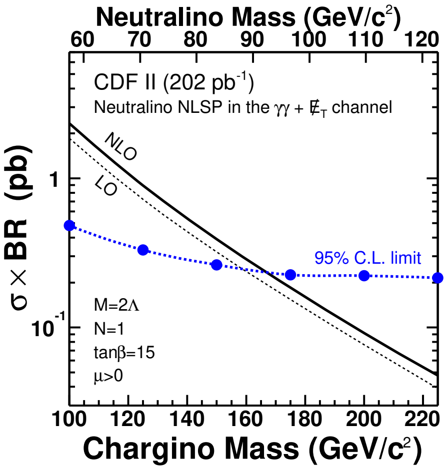


Fig. 3. The missing E_t spectrum in diphoton events (left) and the cross section limit on the GMSB model (right).

model of Graviton production[3], with a typical total acceptance of 20%, as shown in Figure 2.

4. Search for GMSB

Using 202 pb^{-1} of data, we examine the missing E_t ($\not\!\!E_T$) as shown in Figure 3. The $\not\!\!E_T$ distribution of both the true diphoton events and fake diphoton events are expected to be similar, so the prediction for both are taken from the $\not\!\!E_T$ distribution of dijets. Sources such as $W\gamma$ production, where the electron track is not reconstructed, are predicted from the number of observed $e\gamma$ events times the probability to miss the track (1%). Cosmic rays and beam–induced muons can produce showers which pass photon cuts and spurious $\not\!\!E_T$ at the same time. This background is estimated from events with no collision vertex, which are dominated by cosmic rays.

The data is consistent with the predictions and we set limits on the Snowmass gauge–mediated model line[4]. In this model, all SUSY production decays to two neutralinos which decay to a Gravitino and a photon producing $\gamma\gamma\not\!\!E_T + X$ events. With a typical total acceptance of 8%, we find a mass limit of 167 GeV for the first chargino.

References

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