Diphoton Missing $E_T$ Distribution at CDF

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Outline:

Looking at "Diphoton" events at CDF

- Motivation
  
  The $e e \gamma \gamma E_T$ Event
  
  Recent Theoretical Papers

- The Diphoton Dataset and Event Selection

- Missing $E_T$ Evaluation
  
  Detector Response to Electromagnetic Events

- The Missing $E_T$ Distribution

- Some Comments on one (set of) SUSY Model(s)

- Conclusions
Motivation:

On April 28, 1995 an $ee\gamma\gamma E_T$

candidate event was recorded
Event: \(2 \, e + 2 \, \gamma + E_t\)
Motivation Cont...

Since then there have been a large number of theoretical papers which refer to this event...


M. Kawasaki et al., *Gravitino Warm Dark Matter Motivated by the CDF ee\(\gamma\gamma\) Event* hep-ph/9607273, July 1996


J. Lopez and D. Nanopoloulos *A supergravity explanation of the CDF ee\(\gamma\gamma\) Event* hep-ph/9607220, July 1996

G. Bhattacharyya and R. Mohapatra *A Non-supersymmetric Interpretation of the CDP e^+ e^- \(\gamma\gamma\) event* hep-ph/9606408, June 1996

Many predict events with final state of

\[ \gamma\gamma E_T + X \]
The Dibron Dataset and Event Selection:

We search events with two photons for anomalous production of events with large $E_T$

Specifically, we look at events with two photons with the following properties:

- $E_T > 12$ GeV
- Central ($|\eta| < 1.0$)
- Isolated

Analysis based on the CDF dibronon cross section measurements, but tailored for a search

This data was taken at the Fermilab Tevatron at CDF during the Run 1b data taking period

The Luminosity for this dataset is 85 pb$^{-1}$
**Missing \( E_T \) Evaluation**

Systematic problems can lead to significant measured missing \( E_T \) when there is no true missing energy.

- We measure photon \( E_T \) well
- We undermeasure hadronic Jet \( E_T \)
  
  Corrections are at the 40% level
- The unclustered energy is (on average) undermeasured

We evaluate the Missing \( E_T \) in a manner similar to that used in the Top mass analysis. Specifically:

- Begin with the raw Missing \( E_T \)
- Correct for Jet mismeasurement using standard CDF jet corrections
- Overall correction for the unclustered energy
Detector Response to Electromagnetic Events

- We want to estimate the detector response to electromagnetic events.
- We compare the shape of the Missing $E_T$ spectrum to $e^+e^-$ events.
  
  Drell-Yan has a similar event topology.
- Use the same algorithm as for Diphoton events.

We normalize to the diphoton total event rate.
$E_T$ Mismeasurement

- Photon $E_T$
- Photon $E_T$
- Measured Jet $E_T$
- True Jet $E_T$

Raw Measured $E_T$
Missing energy corrected for jets only

CDF Preliminary

Diphoton candidates 85 pb⁻¹

Drell-Yan sample
(no mass cut)
Scaled up to diphoton event rate

Events per 3 GeV bin

jet corrected $E_T$ (GeV)
Theoretical Predictions: Light Gravitino Model


In Light Gravitino ($\tilde{G}$) Models $\tilde{G} = LSP$.

$\rightarrow \tilde{\chi} \rightarrow N_1 + X$ and

$N_1 \rightarrow \gamma\tilde{G}$

So,

$\rightarrow$ Always have $\gamma\gamma E_T + X$
Inclusive $N_1 N_2$ $C_1 C_2$, $N_1 C_j$ Production

e.g., $C_1 \rightarrow N_1 + X$, $N_1 \rightarrow \gamma \tilde{G}$

$|\eta| < 1$
$P_T > 12$ GeV
$E_T > 30$ GeV

Variation of parameters
$\mu, \tan\beta, M_1 = .5 M_2$, $\tilde{Q}$ mass
Conclusions:

- We have presented a preliminary systematic study of the missing $E_T$ spectrum in diphoton events.
- There are no significant deviations in the data.
- This measurement lays the groundwork for searches for new phenomenon involving diphotons and missing energy, as is expected in some SUSY models.