Probing Supersymmetry with Photons

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for the DØ Collaboration

Introduction
Search for $\gamma\gamma\not{E}_T$ events
Search for $\gamma\not{E}_T$+≥2-Jet events
Summary

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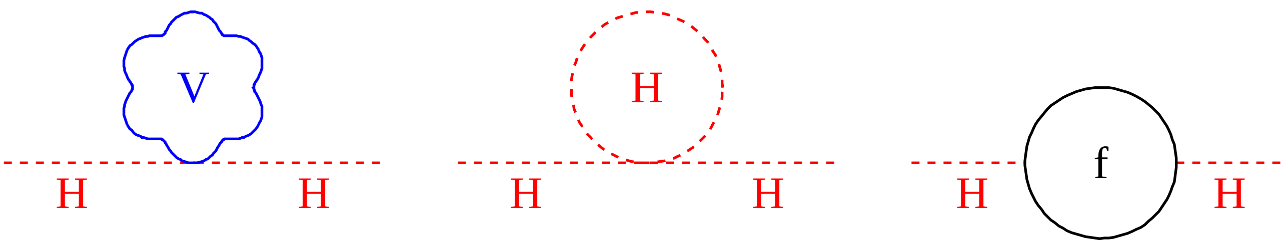
Motivations for Supersymmetry

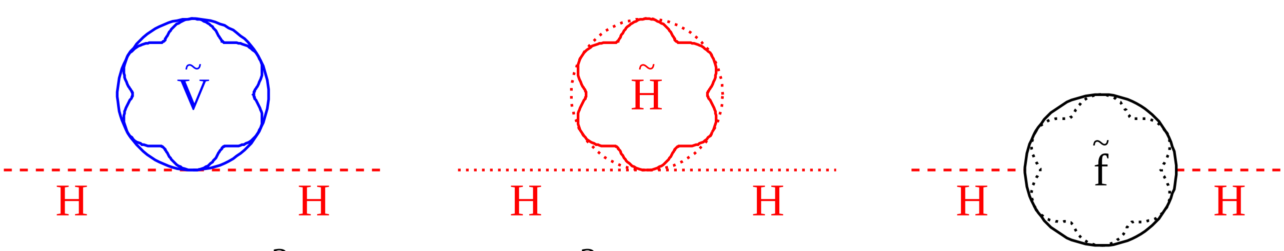
Why supersymmetry?
Or any theory beyond the Standard Model?

There are, however, theoretical problems with
the Standard Model associated with the disparities
in the known mass scales in physics

The Higgs boson receives radiative
corrections which are quadratically divergent



Since the fermion and boson loops have opposite signs,
the leading quadratic divergences will cancel if
there are equal numbers of bosons and fermions with
identical couplings



$$\delta m_H^2 \approx -\left(\frac{g_F^2}{4\pi^2}\right)(\Lambda^2+m_F^2)+\left(\frac{g_B^2}{4\pi^2}\right)(\Lambda^2+m_B^2)\approx O\left(\frac{\alpha}{\pi}\right)|m_B^2-m_F^2|$$

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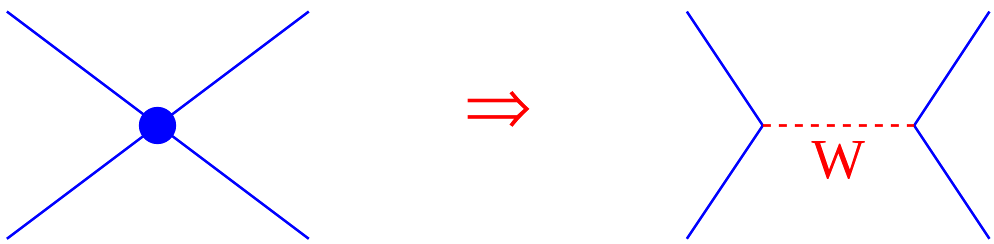
Motivations for Supersymmetry

Historically, introducing new particles served us well

In 1928, Dirac proposed that each particle
had to have a partner - antiparticle

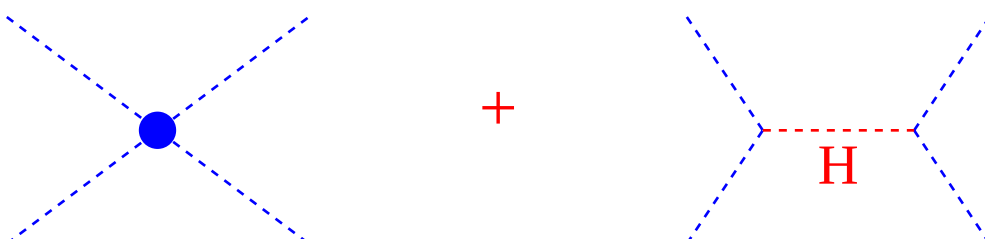
Charm quark was postulated to solve the
$K^0 \to \mu^+ \mu^-$ problem (GIM mechanism)
and was discovered in 1974

W boson was introduced to make $\sigma(\nu_e e \to \nu_e e)$ finite
and was discovered in 1983



$$\sigma \Rightarrow \frac{G_F^2 \, s}{\pi} \qquad\qquad \sigma \Rightarrow \frac{G_F^2 \, M_W^2}{\pi}$$

We need the Higgs boson to make $\sigma(W_L^+ W_L^- \to W_L^+ W_L^-)$ finite
though it remains to be discovered



Supersymmetry Models

Supersymmetry predicts a supersymmetric
partner (sparticle) for every Standard Model particle

Weak-scale supersymmetry predicts
the radiative breaking of the electroweak symmetry

Minimal Supersymmetric Standard Model (MSSM)
is the simplest supersymmetric model
(1) add an extra Higgs doublet of opposite hypercharge
(2) supersymmetrization of the gauge theory

Standard Model Particles

Gauge/Higgs Bosons: γ, Z^0, $W^\pm$, h^0, H^0, A^0, $H^\pm$, g
Leptons/Quarks: $(\nu,e)_L$, e_R, $(u,d)_L$, u_R, d_R, ...

Supersymmetric Particles

Gauginos/Higgsinos: $\tilde{\chi}^0_1$, $\tilde{\chi}^0_2$, $\tilde{\chi}^0_3$, $\tilde{\chi}^0_4$, $\tilde{\chi}^\pm_1$, $\tilde{\chi}^\pm_2$, $\tilde{g}$
Sleptons/Squarks: $(\tilde{\nu},\tilde{e})_L$, $\tilde{e}_R$, $(\tilde{u},\tilde{d})_L$, $\tilde{u}_R$, $\tilde{d}_R$, ...

Lots of free parameters
⇒ theorists´ dream, experimenters´ nightmare...

Double the number of particles ⇒
half of the particles remain to be discovered...

Supersymmetry Models

Within the MSSM, the gaugino-higgsino sector
is described by only four parameters

M_1 the U(1) gaugino mass parameter
M_2 the SU(2) gaugino mass parameter
μ higgsino mass parameter
$\tan\beta$ ratio of VEV of the higgs doublet

(Gaugino mass unification $M_1 = \frac{5}{3} M_2 \tan^2\theta_W$)

Most supersymmetric models assume that R-parity
(R=+1 for the SM particles and R=-1 for their partners)
is conserved

(1) supersymmetric particles are pair produced
(2) heavy sparticles decay to lighter sparticles
(3) the LSP is stable (no available decay mode)

$\Rightarrow$ missing transverse energy ($\not{E}_T$)

Supersymmetry cannot be an exact symmetry
It is assumed to be broken in a hidden sector

A messenger sector transmits the SUSY breaking
to the visible sector (SM particles and their superpartners)

The messenger sector interactions are assumed to be either
of gravitational strength (gravity inspired models)
or SM gauge interactions (gauge mediated models)

Supersymmetry Models

In gravity inspired models,
the supersymmetry breaking scale is generally of

$$\Lambda_{SUSY} \sim 10^9 \text{ TeV}$$

Resulting in a massive gravitino ($\tilde{G}$)
$\Rightarrow$ no role in low energy phenomenology
$\Rightarrow$ LSP=the lightest SM superpartner (often $\tilde{\chi}_1^0$)

Have been the focus of experimental searches
the standard signatures are leptons, jets (w/o leptons) and $\not{E}_T$

In gauge mediated models,
the supersymmetry breaking scale can be as low as

$$\Lambda_{SUSY} \sim 100 \text{ TeV}$$

Resulting in an exceedingly light gravitino
$\Rightarrow$ gravitino is naturally the LSP
$\Rightarrow$ the lightest SM superpartner is the NLSP
$\Rightarrow$ NLSP is unstable and decays to $\tilde{G}$

Phenomenology depends on NLSP and
most models assume NLSP=$\tilde{\chi}_1^0$ or $\tilde{\tau}$

$$\tilde{\chi}_1^0 \to \gamma \tilde{G}, \quad \tilde{\tau} \to \tau \tilde{G}$$

Not well explored experimentally until recently

Experimental Status of Supersymmetry

There are no confirmed data that disagree
with the Standard Model predictions

Searches for supersymmetry have all been negative

However, the apparent unification
of the three gauge coupling constants is suggestive

It is unlikely that
we can ever exclude supersymmetry...

Photon as a Probe for Supersymmetry

A CDF event has generated considerable
theoretical and experimental interests in using
photons as probe for supersymmetry

In Gauge Mediated Models with NLSP=$\tilde{\chi}_1^0$

$$\tilde{\chi}_1^0 \to \gamma \tilde{G}$$

occurs with almost 100% branching ratio if
$\tilde{\chi}_1^0$ has a non-zero photino component

Any supersymmetric particle will produce
a photon and a $\tilde{G}$ in its decay chain

However, the $\tilde{\chi}_1^0$ decay width

$$\Gamma \propto m^{-2}(\tilde{G})$$

$\tilde{\chi}_1^0$ can have sizable decay distance

Pair production of supersymmetric particles
will result in $\gamma\gamma\not{E}_T$+X events
if both $\tilde{\chi}_1^0$ decay inside the detector

$$p\bar{p} \to \tilde{\chi}^+ \tilde{\chi}^- \to W^+ W^- \tilde{\chi}_1^0 \tilde{\chi}_1^0$$

$$p\bar{p} \to \tilde{e}\tilde{e} \to ee \tilde{\chi}_1^0 \tilde{\chi}_1^0$$

were proposed as possible explanations of the event

Ellis et al., PRB 394 (1997), Ambrosanio et al., PRD 54, 5395 (1996), ...

Photon as a Probe for Supersymmetry

Within the framework of MSSM with the LSP=$\tilde{\chi}_1^0$,
a class of models with dominant
$\tilde{e}\rightarrow e+\tilde{\chi}_2^0$ and $\tilde{\chi}_2^0\rightarrow\tilde{\chi}_1^0+\gamma$
decays was also proposed as a plausible explanation of the event
$p\bar{p}\rightarrow\tilde{e}\tilde{e}\rightarrow ee\tilde{\chi}_2^0\tilde{\chi}_2^0\rightarrow ee\gamma\gamma\tilde{\chi}_1^0\tilde{\chi}_1^0$
Kane et al., Phys. Rev. D55, 1372 (1997)

In these models, $M_1 \sim M_2$, $\tan\beta \sim 1$ and $\mu < M_2$
$\tilde{\chi}_1^0$ is mostly higgsino and $\tilde{\chi}_2^0$ is mostly gaugino
No gaugino mass unification

The event kinematics and rate suggest that
$m(\tilde{\chi}_2^0)-m(\tilde{\chi}_1^0)>20$ GeV/c^2
$Br(\tilde{\chi}_2^0\rightarrow\tilde{\chi}_1^0+\gamma)\approx 100\%$

$\gamma\not{E}_T$+jets events are expected from
$p\bar{p}\rightarrow\tilde{q}/\tilde{g}\rightarrow\tilde{\chi}_2^0+X$ processes

$\gamma\gamma\not{E}_T$ events are expected from
$p\bar{p}\rightarrow\tilde{e}\tilde{e}$, $\tilde{\nu}\tilde{\nu}$, $\tilde{\chi}_2^0\tilde{\chi}_2^0+X$ processes

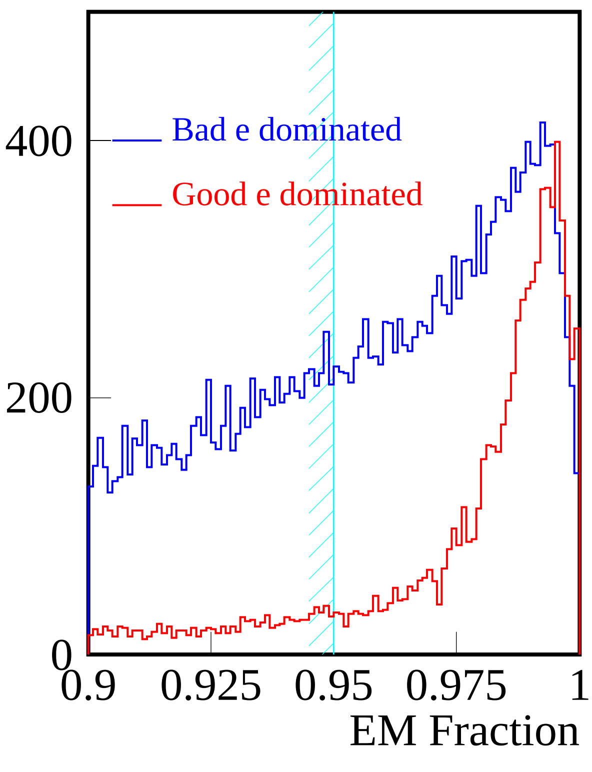
Photon Identification

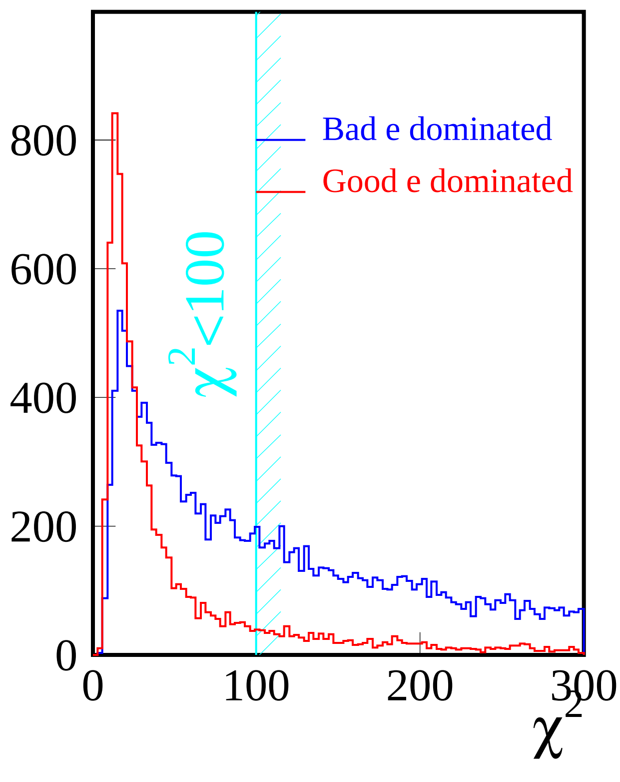
Isolated photons are identified through a two-step process

1) identification of isolated EM clusters
2) rejection of electrons

Identification of EM clusters

1) Electromagnetic energy fraction > 0.95
2) Shower profile consistent with a EM shower
3) Isolation = $(E_{cone}(0.4)-E_{cone}(0.2))/E_{\gamma} < 0.1$





For photons with E_T>20 GeV, ε~90%

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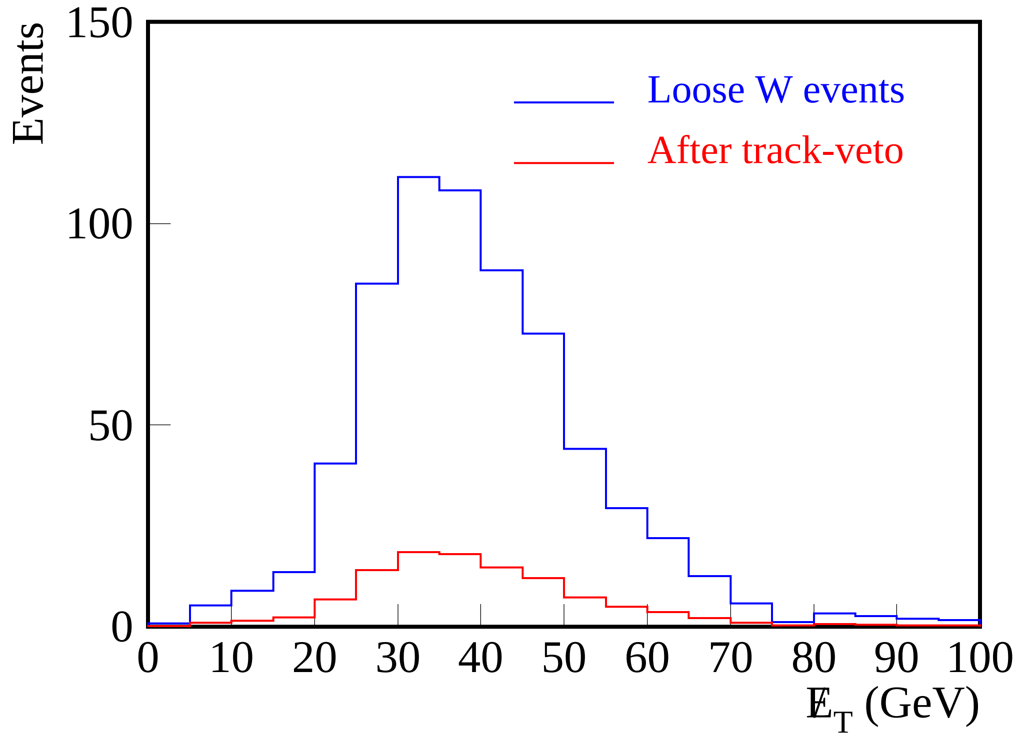
Photon Identification

Electron Rejection

Events with large $\not{E}_T$ are dominated
by W productions with $W \to e\nu$

Electron is rejected by the presence of
a reconstructed track or a large number of hits

Still, there will be one electron misidentified
as a photon for every 220 identified electrons



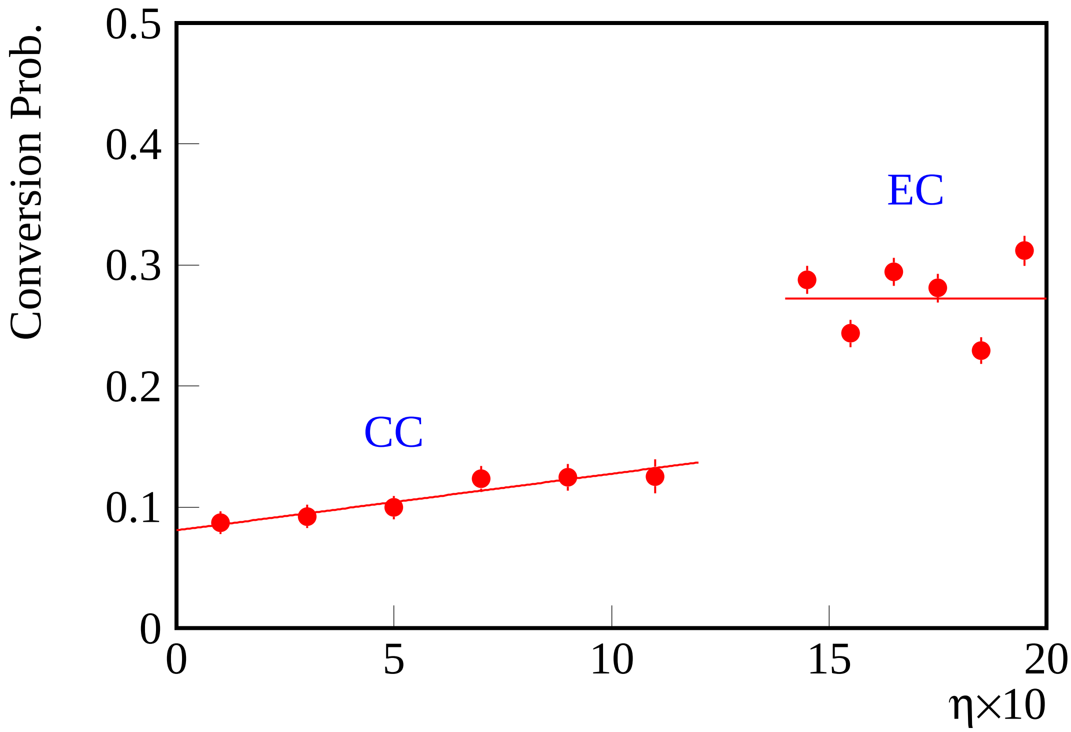
About 30% of photons is also lost
due to random overlaps

Photon Identification

Conversions

Many photons are lost due to
conversion in the materials upstream

The conversion probability is about
10% in $|\eta|<1.1$ (CC region) and about 30% in $1.5<|\eta|<2.0$ (EC region)
determined using single photon Monte Carlo



Most of photons from high p_T processes
are in the central region

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Trigger and Luminosity

Trigger

(1) One E.M. cluster with E_T>15 GeV
(2) A second object with E_T>10 GeV
(3) $\not\!\!E_T$>14 (10) GeV

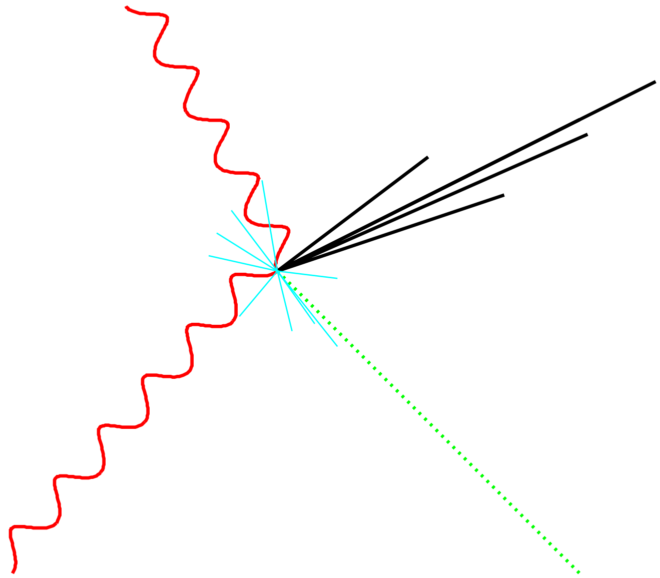
The trigger is >95% efficient
for events of interest in these analyses

Luminosity

The data used in this analysis were taken
during the 1992-1996 Tevatron Run

The integrated luminosity for this analysis is
~100 pb^{-1}

Search for $\gamma\gamma\not{E}_T$ Events



Two high E_T photons
Large missing transverse energy
with/without leptons/jets

There is almost no Standard Model
background at parton-level

But there are important instrumental backgrounds

(1) multijet, direct photon events

(2) $W+\gamma$, $Z\rightarrow\tau\tau\rightarrow ee$, $t\bar{t}\rightarrow ee$+jets

Search for $\gamma\gamma \not{E}_T$ Events

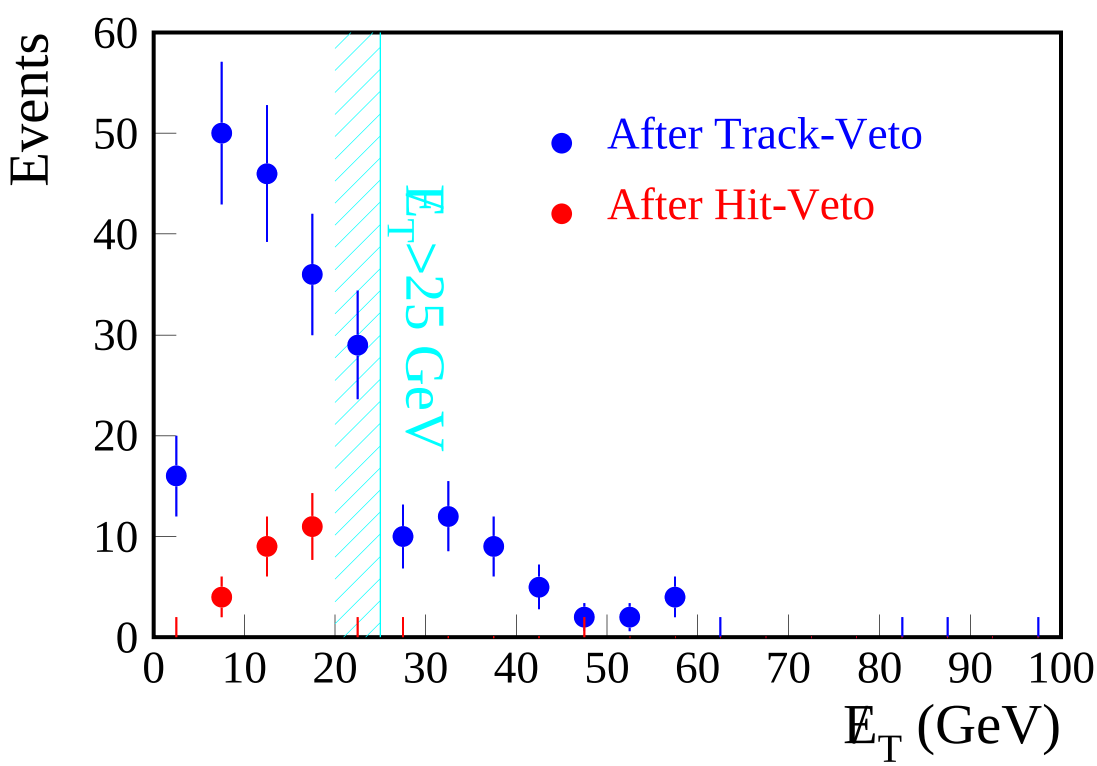
Event Selection

(1) $E_T^{\gamma 1}>20$ GeV $|\eta|<1.1$ or $1.5<|\eta|<2.0$

(2) $E_T^{\gamma 2}>12$ GeV $|\eta|<1.1$ or $1.5<|\eta|<2.0$

(3) $\not{E}_T>25$ GeV

No requirements on jets or other objects were made



Two events survived

from a data sample of $\int Ldt = 106.5\pm5.6\ pb^{-1}$

Search for $\gamma\gamma\not{E}_T$ Events

QCD Background

Multijet and direct photon events with
misidentified photons and/or mismeasured $\not{E}_T$
will fake $\gamma\gamma\not{E}_T$ events

This background was estimated
using events with two EM-like clusters

By normalizing the observed $\not{E}_T$ distributions
a background of 2.1±0.9 events was obtained

W-Like Background

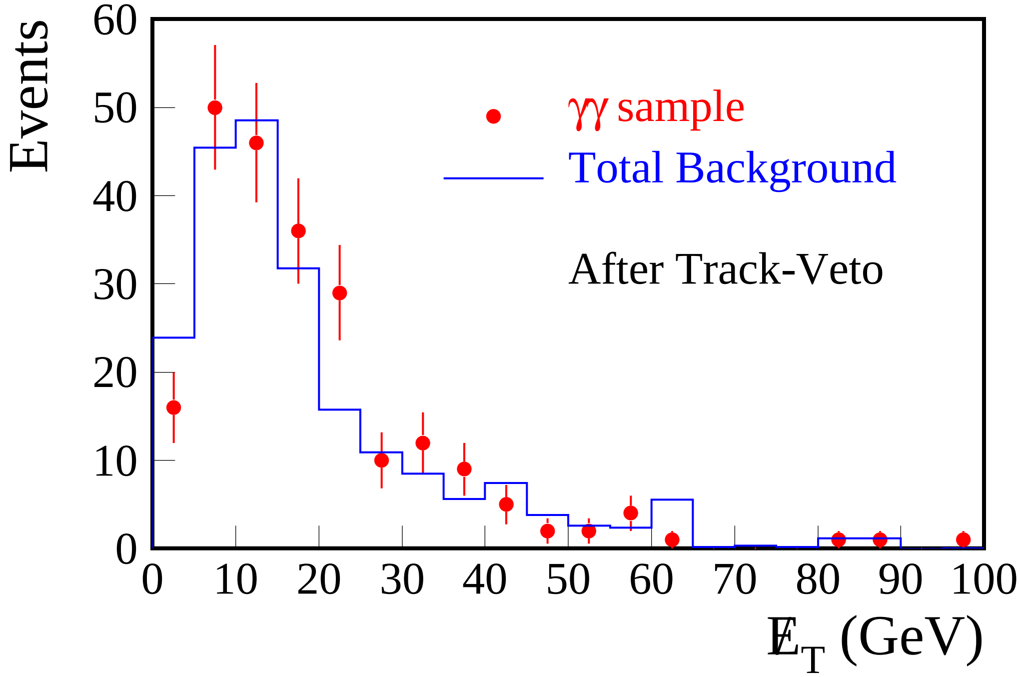
Events with genuine $\not{E}_T$ such as those from
$W+\gamma$, $Z\rightarrow\tau\tau\rightarrow ee$, $t\bar{t}\rightarrow ee$+jets would fake $\gamma\gamma\not{E}_T$
events if the electrons were misidentified as photons

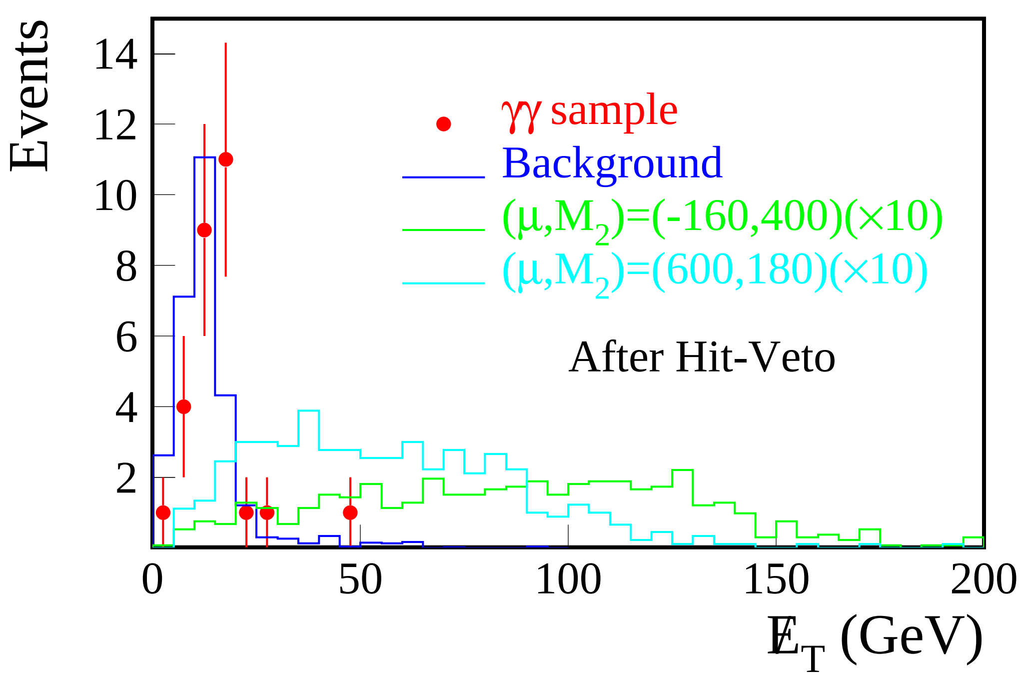
We estimate their contribution using a sample
of e+γ events passing the kinematic requirements

Applying the electron rejection factor from the photon ID
a background of 0.2±0.1 events was obtained

Total number of background events 2.3±0.9

Search for $\gamma\gamma\not{E}_T$ Events





Search for $\gamma\gamma\not{E}_T$ Events

$\tilde{\chi}_i\tilde{\chi}_j$ Pair Production

We interpret our null results
in terms of chargino and neutralino pair production
$p\bar{p}\rightarrow\tilde{\chi}_i\tilde{\chi}_j\rightarrow\tilde{\chi}_1^0\tilde{\chi}_1^0+X\rightarrow\gamma\gamma\tilde{G}\tilde{G}+X$
within the framework of MSSM with LSP=$\tilde{G}$

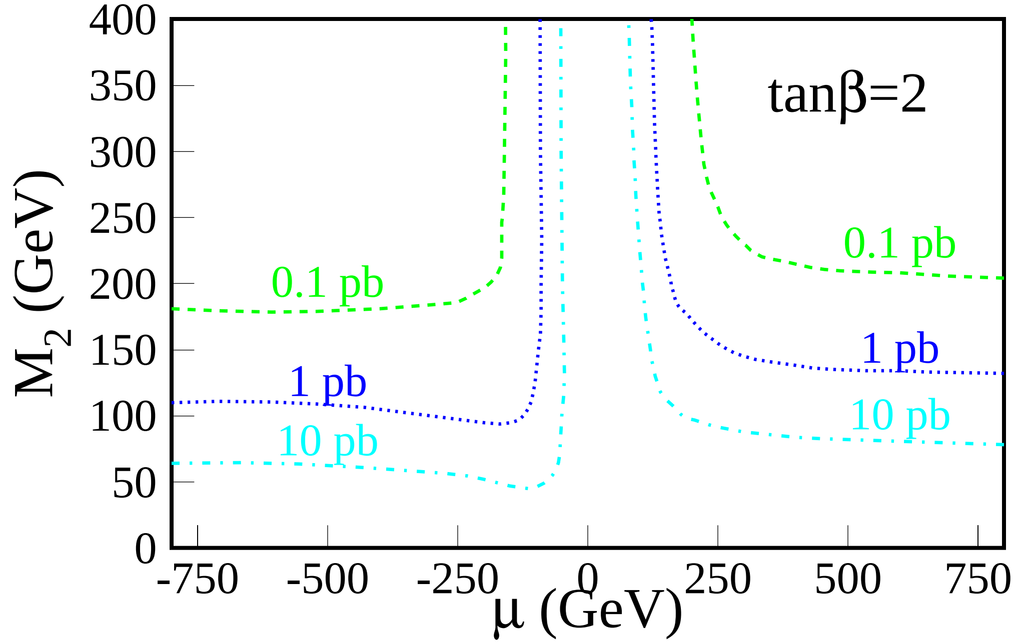
We explore the (μ,M_2) parameter space within the MSSM
assuming gaugino mass unification at the GUT scale
$$M_1=\frac{5}{3}M_2\tan^2\theta_W$$
and keeping $\tan\beta$ fixed.

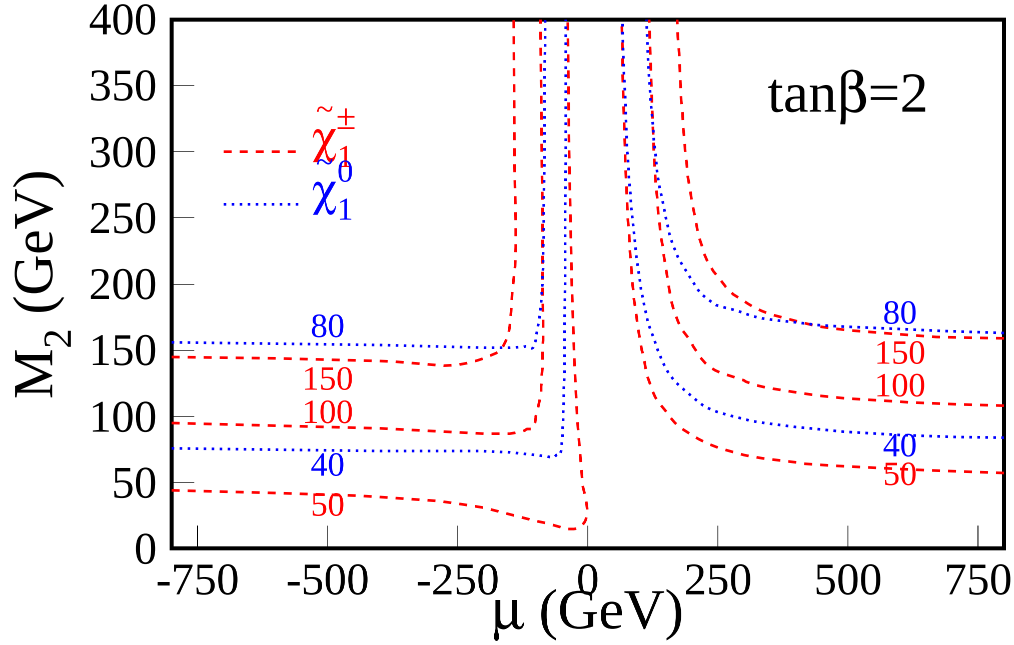
For the most part of the parameter space
the pair production is dominated by
$p\bar{p}\rightarrow\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm},\ \tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 + X$

The chargino/neutralino production and decays
are modeled using Spythia Monte Carlo program

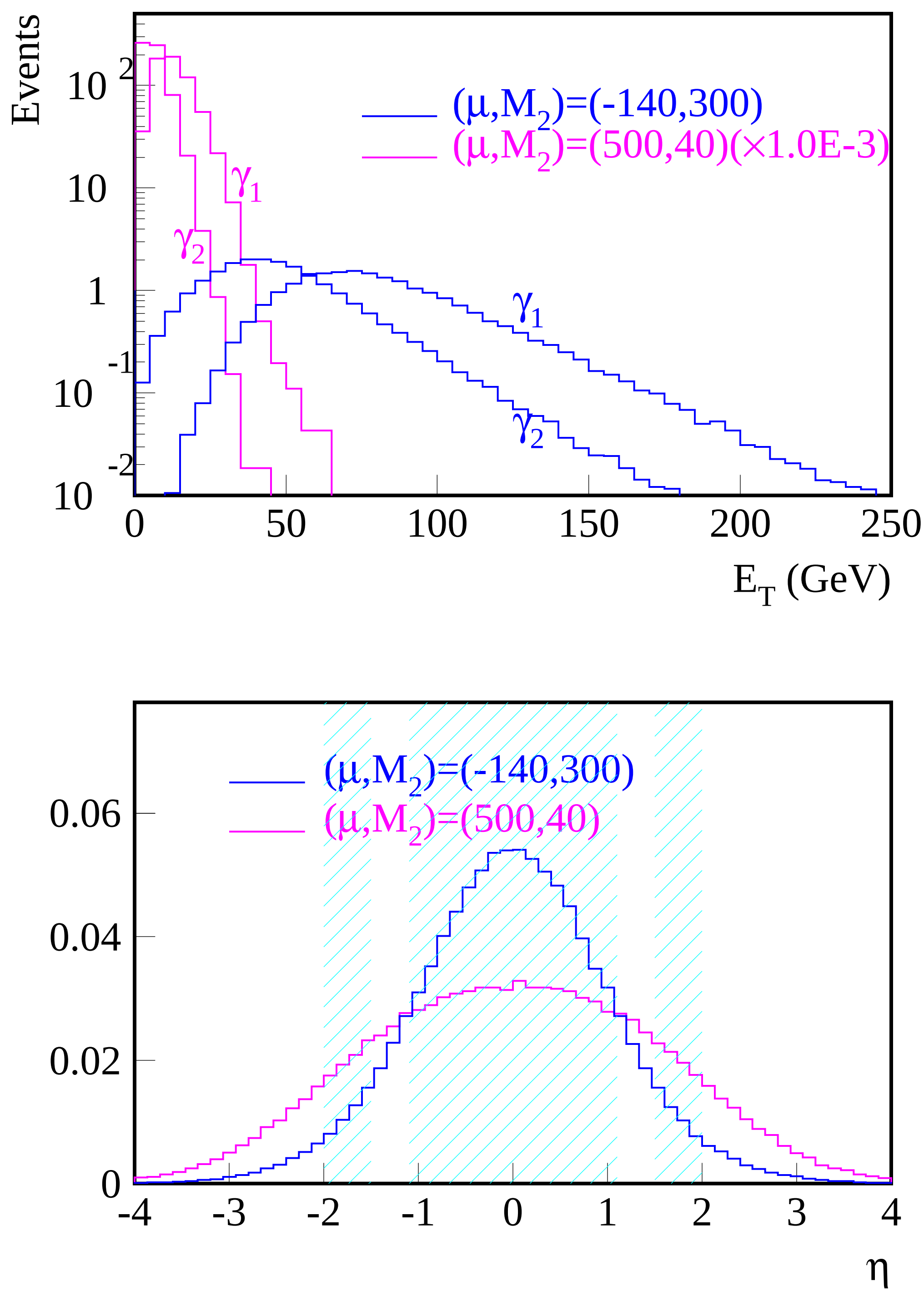
The efficiency for a typical point of interest
in the parameter space is about 25%

Search for $\gamma\gamma\not{E}_T$ Events





Search for $\gamma\gamma \not{E}_T$ Events



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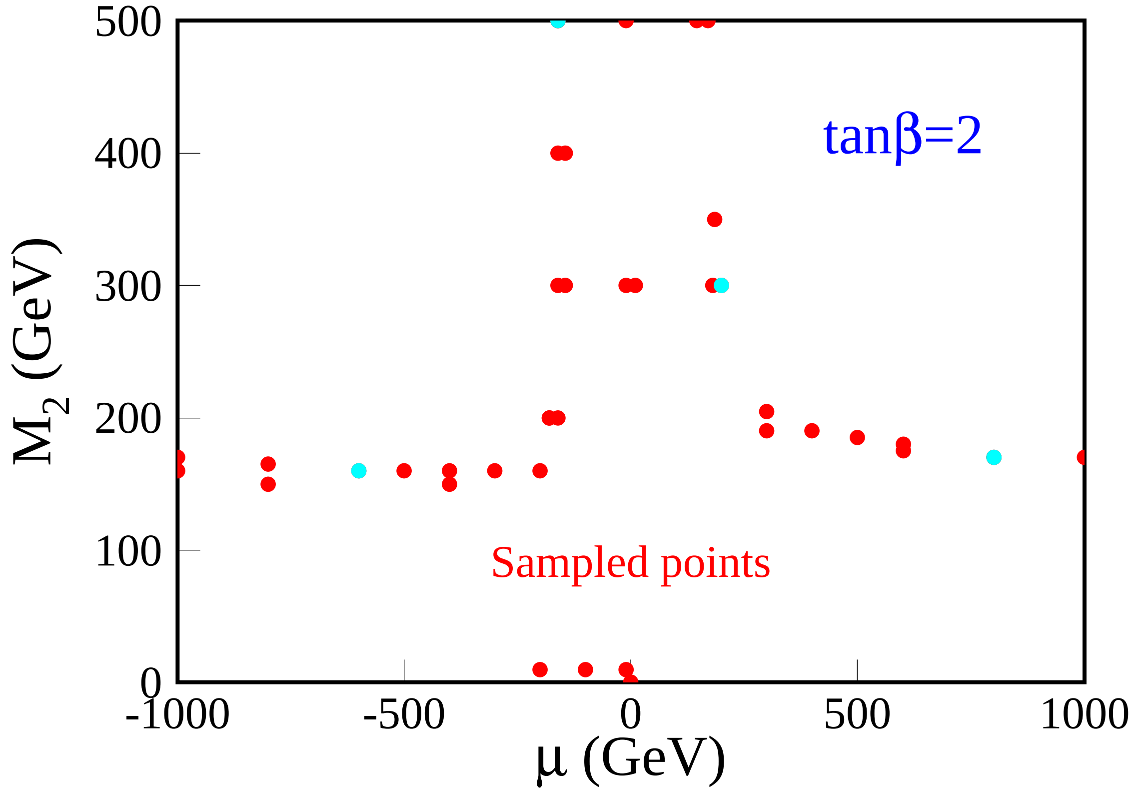
Search for $\gamma\gamma\not{E}_T$ Events

Signal Efficiencies

Pair production of charginos and neutralinos
is modeled using Spythia Monte Carlo program

μ (GeV)	M_2 (GeV)	$m(\tilde{\chi}_1^0)$ (GeV/c^2)	$m(\tilde{\chi}_1^\pm)$ (GeV/c^2)	ε_K(%)	ε (%)
-160	500	156	167	66.0	33.4
-600	160	83	166	58.0	18.4
200	300	118	160	66.8	27.9
800	170	83	162	58.7	25.4



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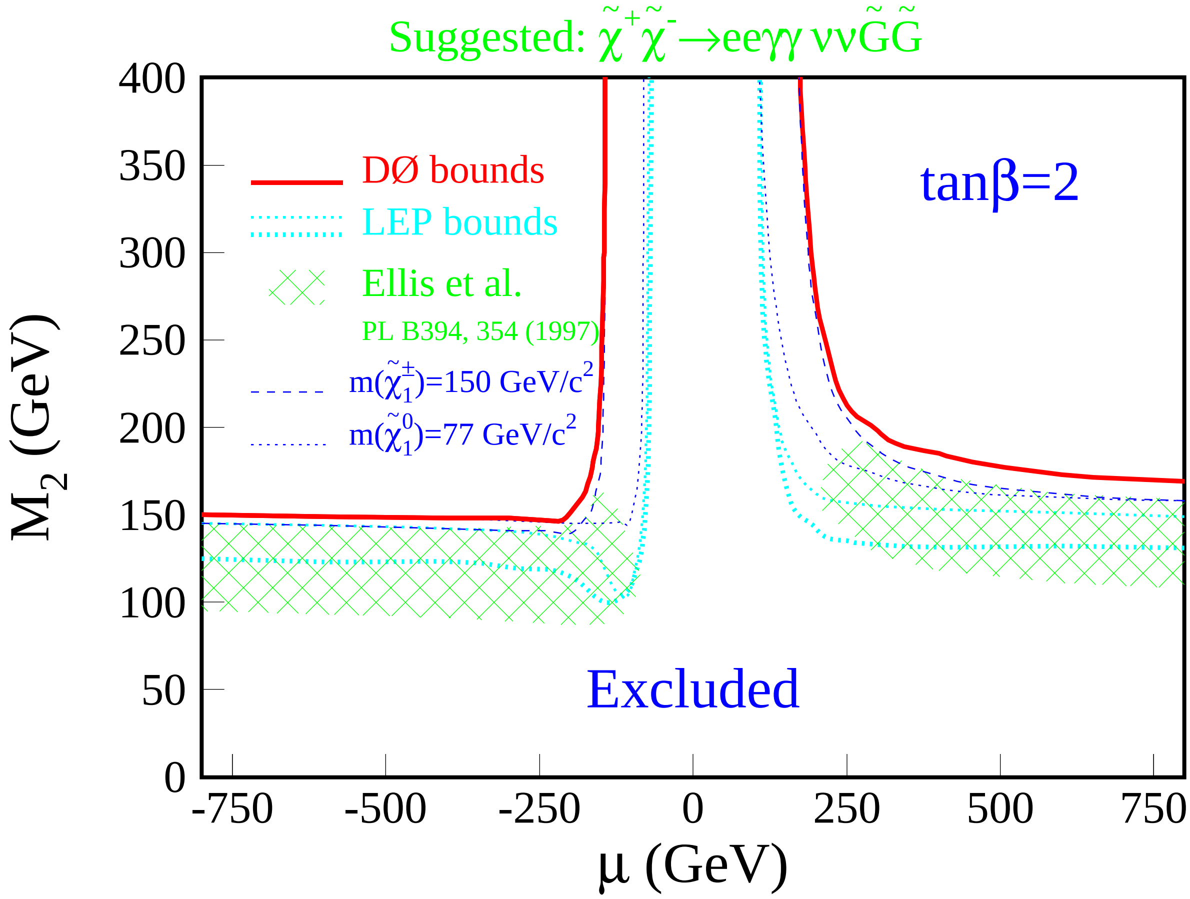
Search for $\gamma\gamma \not{E}_T$ Events

Bounds in (μ, M_2) Plane

Based on 2 events observed and 2.3±0.9 events expected,
we set 95% C.L. upper limit on the cross section
The limit is typically ~200 fb for the region of interest



We also set 95% C.L. lower mass limits
$m(\tilde{\chi}_1^{\pm}) > 150$ GeV/c^2
$m(\tilde{\chi}_1^{0}) > 77$ GeV/c^2

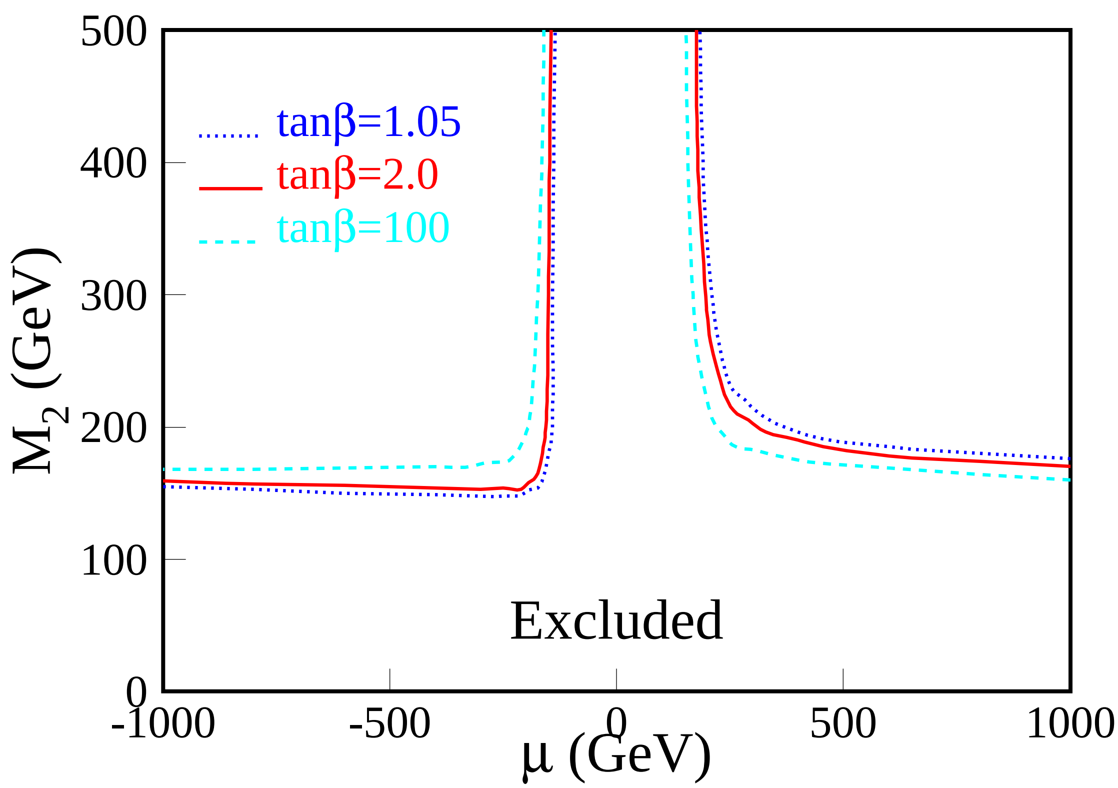
Search for $\gamma\gamma \not\!\!E_T$ Events

$\tan\beta$ Dependence

The bounds depend on the value of
$\tan\beta$ slightly, due to the $\tan\beta$ dependence
of the expected cross section

As $\tan\beta$ is increased, the limits become
stronger in the $\mu<0$ half-plane
and weaker in the other half-plane

NLSP will be $\tilde{\tau}$ in most models for large $\tan\beta$ values



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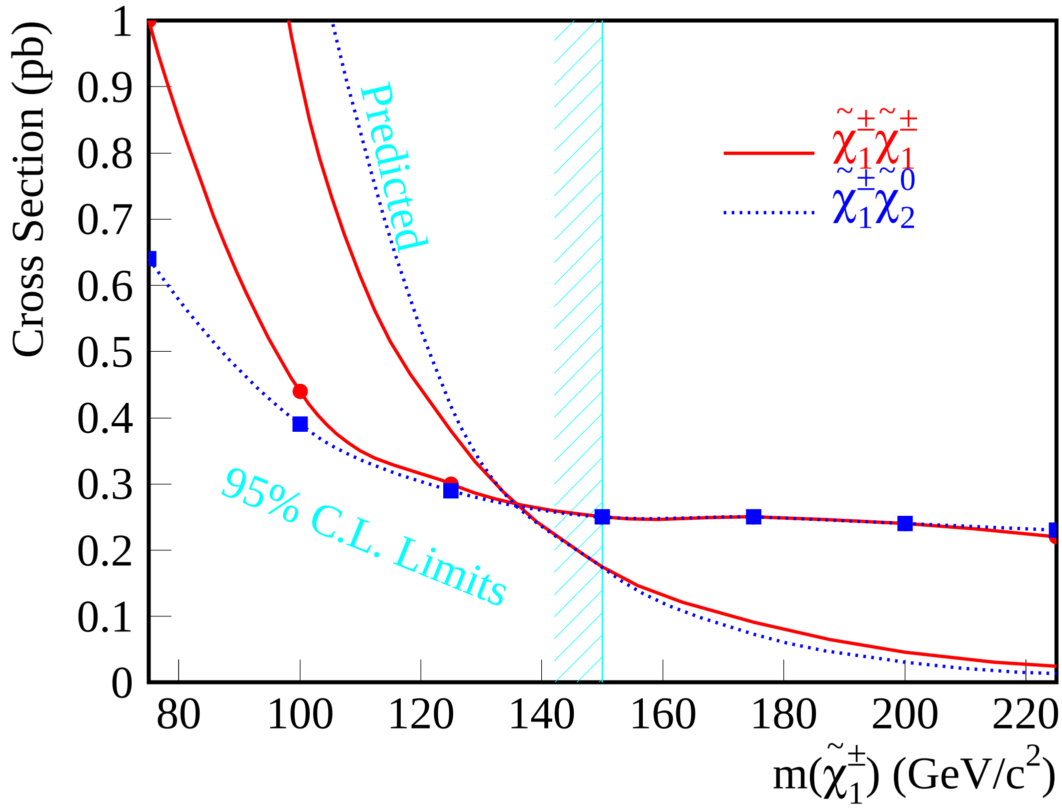
Search for $\gamma\gamma \not{E}_T$ Events

Limits for $\tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$, $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ Productions

$p\bar{p} \rightarrow \tilde{\chi}_1^\pm \tilde{\chi}_1^\pm$, $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ dominates
pair production of charginos and neutralinos

For a large part of the parameter space
$m(\tilde{\chi}_1^\pm) \approx m(\tilde{\chi}_2^0) \approx 2m(\tilde{\chi}_1^0)$

For heavy masses
the upper cross section limit is ~200 fb



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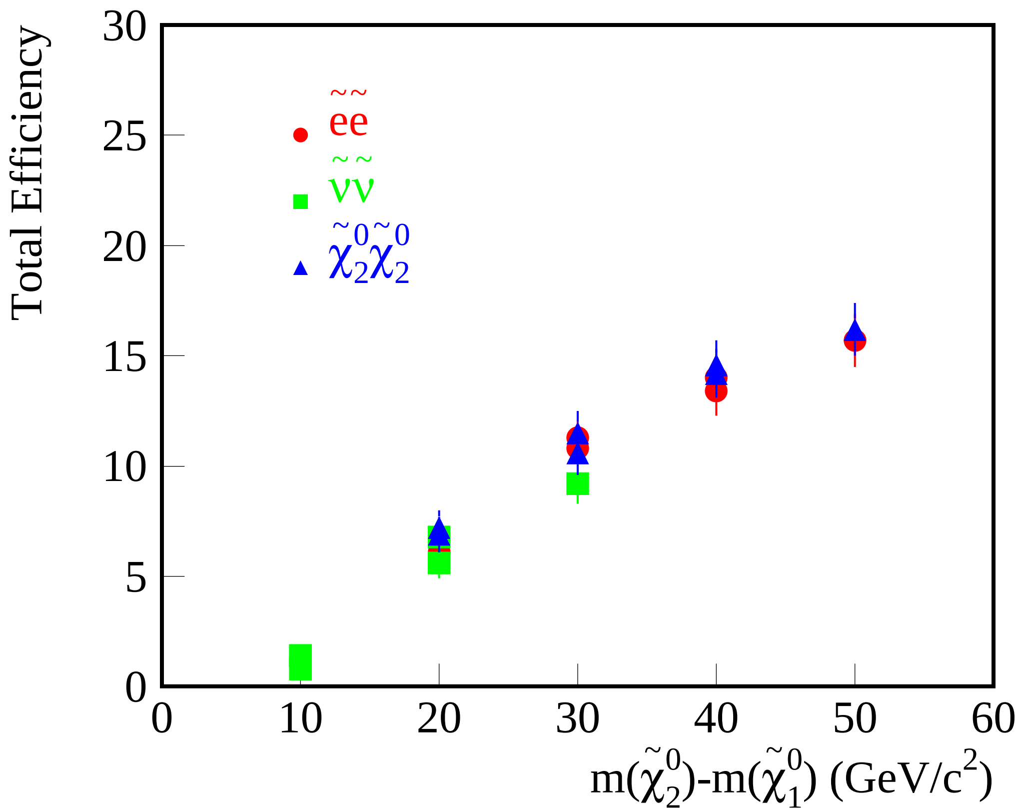
Search for $\gamma\gamma \not{E}_T$ Events

$\tilde{e}\tilde{e}$, $\tilde{\nu}\tilde{\nu}$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$ Production

In the models of Kane et al.,
the $\tilde{e}\tilde{e}$, $\tilde{\nu}\tilde{\nu}$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$ production can also result $\gamma\gamma\not{E}_T$ events
with $\tilde{e}\to e\tilde{\chi}_2^0$, $\tilde{\nu}\to\nu\tilde{\chi}_2^0$ and $\tilde{\chi}_2^0\to\tilde{\chi}_1^0+\gamma$

The event topology is largely determined by
the mass difference between $\tilde{\chi}_2^0$ and $\tilde{\chi}_1^0$

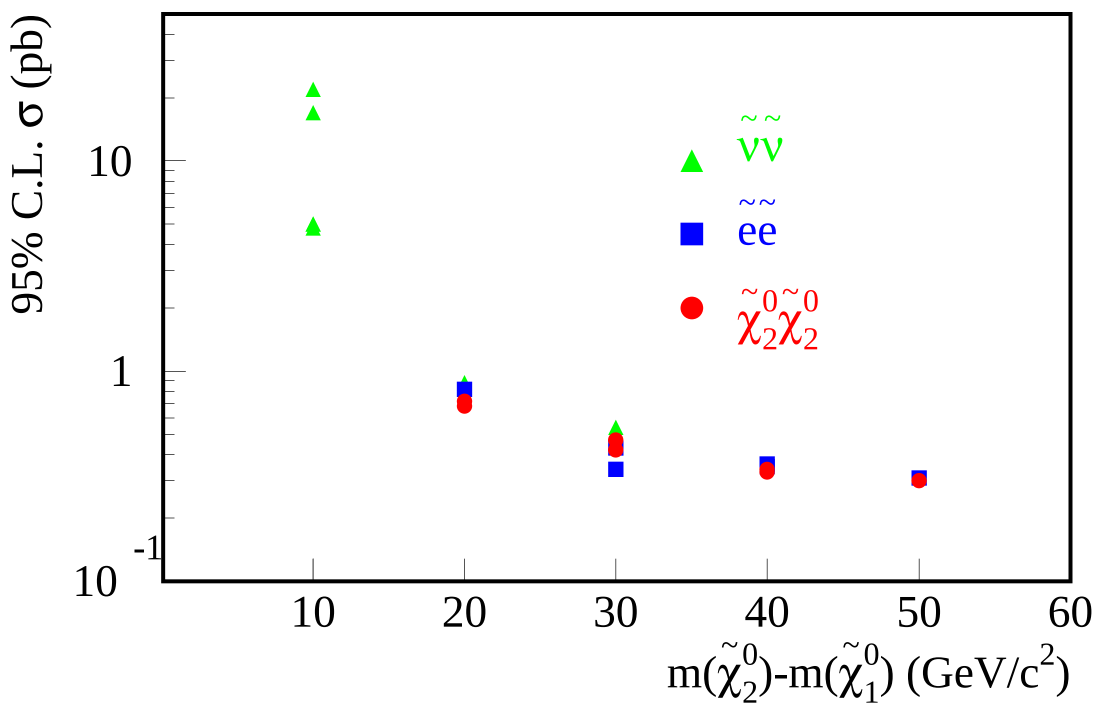
For a given $m(\tilde{\chi}_2^0)$-$m(\tilde{\chi}_1^0)$
the efficiency is almost independent of the processes



Search for $\gamma\gamma \not{E}_T$ Events

Limits on $\tilde{e}\tilde{e}$, $\tilde{\nu}\tilde{\nu}$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$ Production

With two observed $\gamma\gamma \not{E}_T$ events and
2.3±0.9 events expected from backgrounds, we set 95% C.L.
upper cross section limits on $\tilde{e}\tilde{e}$, $\tilde{\nu}\tilde{\nu}$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$ production

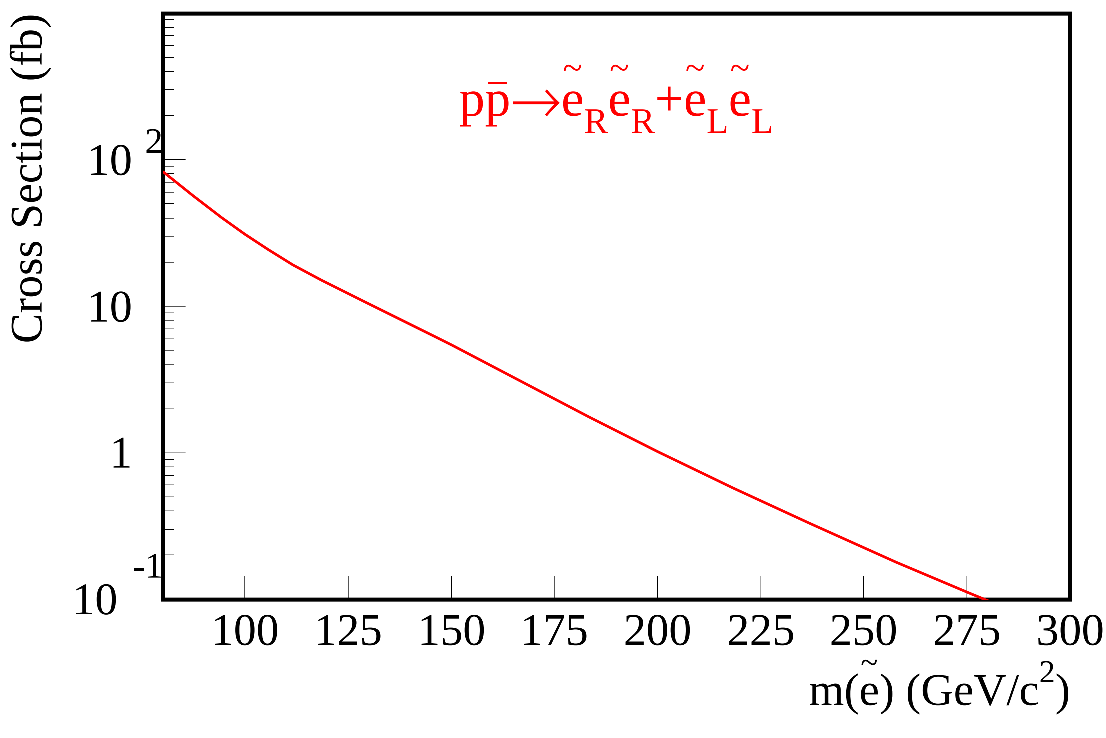


For $m(\tilde{\chi}_2^0)-m(\tilde{\chi}_1^0) > 30$ GeV/c^2,
the 95% C.L. upper cross section limit is ~ 400 fb
almost independent of the processes

Search for $\gamma\gamma \not{E}_T$ Events

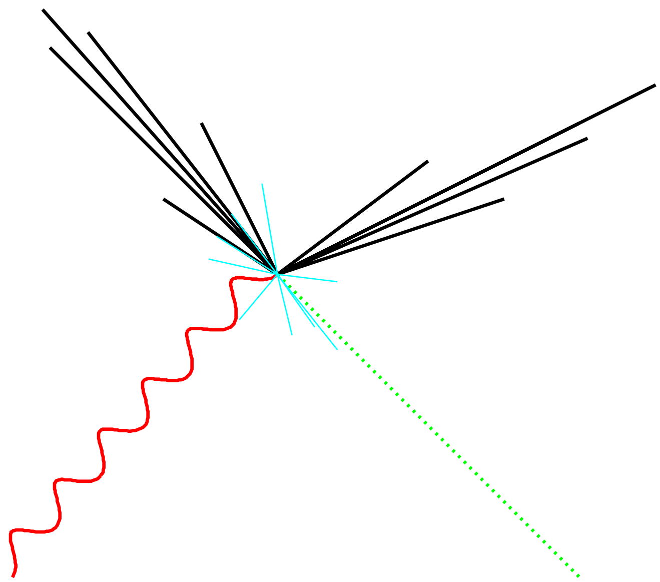
Theoretical Cross Sections

However, the theoretical cross sections for
$p\bar{p} \to \tilde{e}\tilde{e},\ \tilde{\nu}\tilde{\nu},\ \tilde{\chi}_2^0\tilde{\chi}_2^0 \to \gamma\gamma \not{E}_T + X$
production are small even with the assumptions
$Br(\tilde{e},\tilde{\nu} \to e,\nu + \tilde{\chi}_2^0) = 100\%$ and $Br(\tilde{\chi}_2^0 \to \tilde{\chi}_1^0 + \gamma) = 100\%$



The experimental upper cross section limits are above the theoretical cross sections for the mass region of interest.

Search for $\gamma \not{E}_T$+≥2-Jets Events



One high E_T photon, two or more jets
Large missing transverse energy

There is almost no Standard Model
backgrounds at parton-level

But there are important instrumental backgrounds
(1) multijet, direct photon events
(2) e+jets (W+jets, $t\bar{t}$,...) and ν+jets events

Events with less than two jets are not considered
due to the large backgrounds from QCD and W→eν events

Search for $\gamma \not{E}_T + \geq 2$-Jets Events

Selection of Base Sample

(1) $E_T^\gamma > 20$ GeV, $|\eta| < 1.1$ or $1.5 < |\eta| < 2.0$

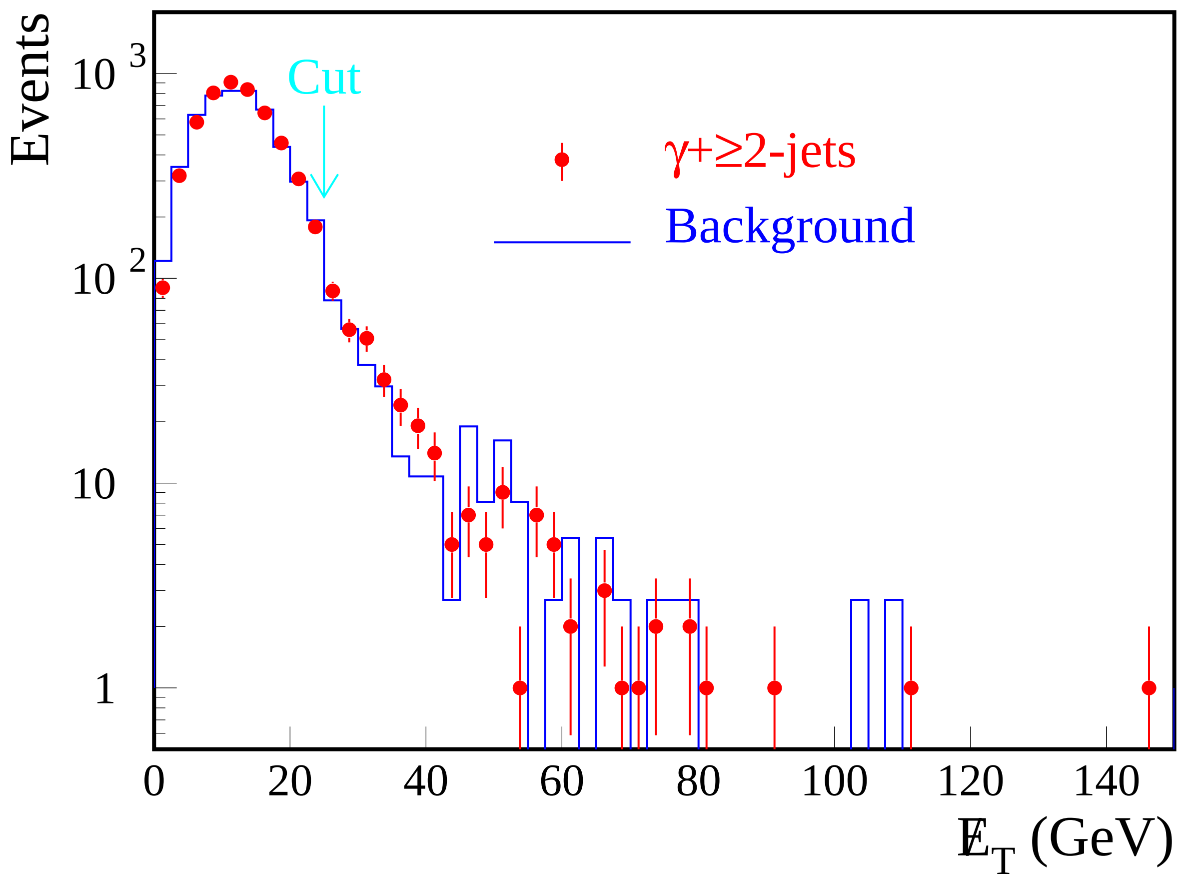
(2) Two or more jets with $E_T^j > 20$ GeV, $|\eta| < 2.0$

(3) $\not{E}_T > 25$ GeV

A total of 378 events are selected

(74 events with ≥3-jets and 10 events with ≥4-jets)

from a data sample of $\int Ldt = 99.4 \pm 5.4\ pb^{-1}$



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Search for $\gamma\not{E}_T$+≥2-Jets Events

Multijet Backgrounds

Multijet (with misidentified photon)
and direct photon events with mismeasured $\not{E}_T$
will fake $\gamma\not{E}_T$+≥2-jets events

$\not{E}_T$ mismeasurement can be modeled using
multijet events with photon-like clusters

The estimated multijet background is
370±36 events

e/ν+jets Backgrounds

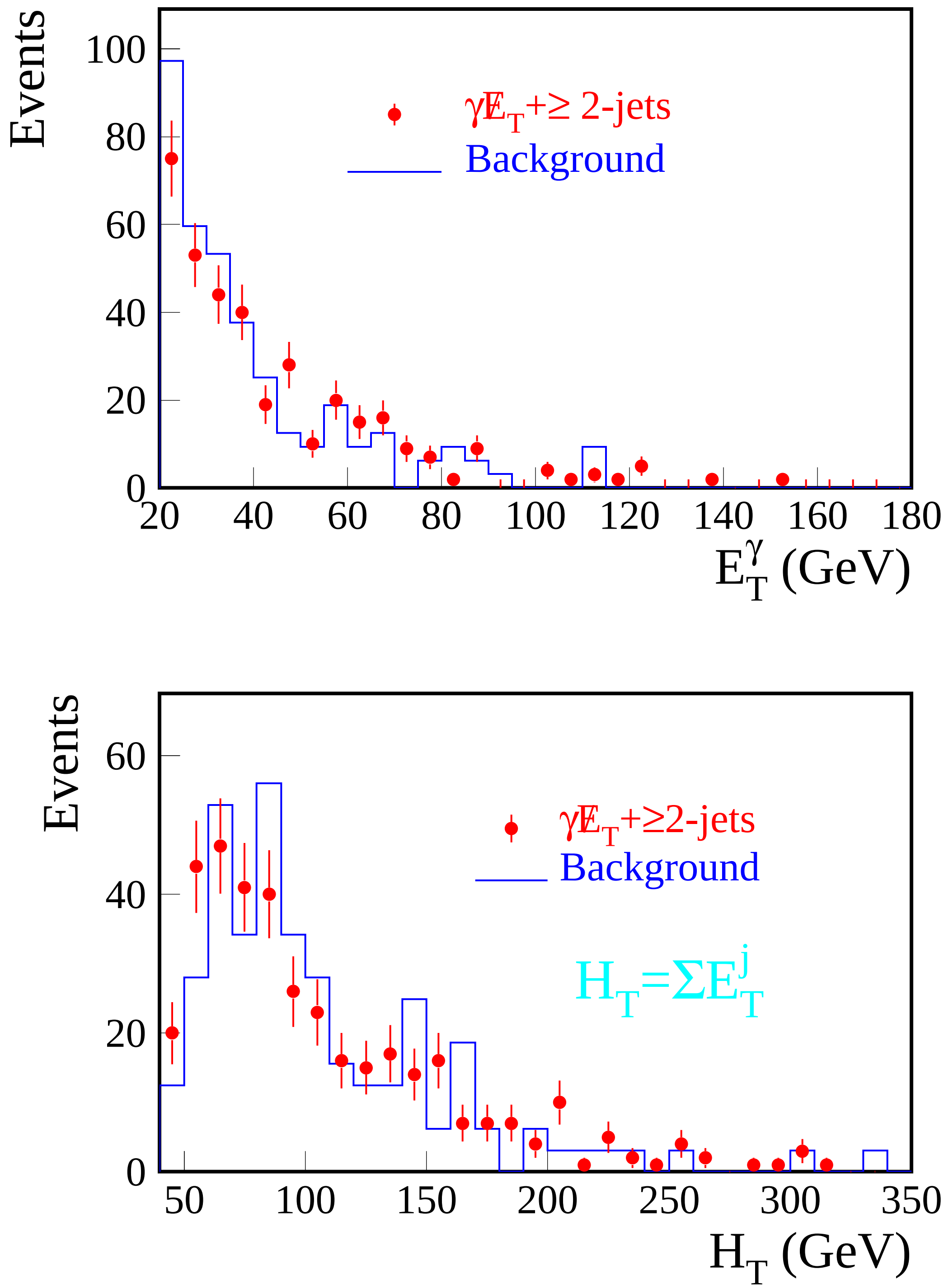
Events with genuine $\not{E}_T$ such as those from
W(→eν)+jets and Z(→νν)+jets would fake $\gamma\not{E}_T$+≥2-jets
events if the electrons or jets were misidentified as photons

We estimate their contributions using the fake
P(e→γ) and P(jet→γ) probabilities

The estimated e/ν+jets background is 6±1 events

Total background 376±36

Search for $\gamma \not{E}_T + \geq 2$-Jets Events



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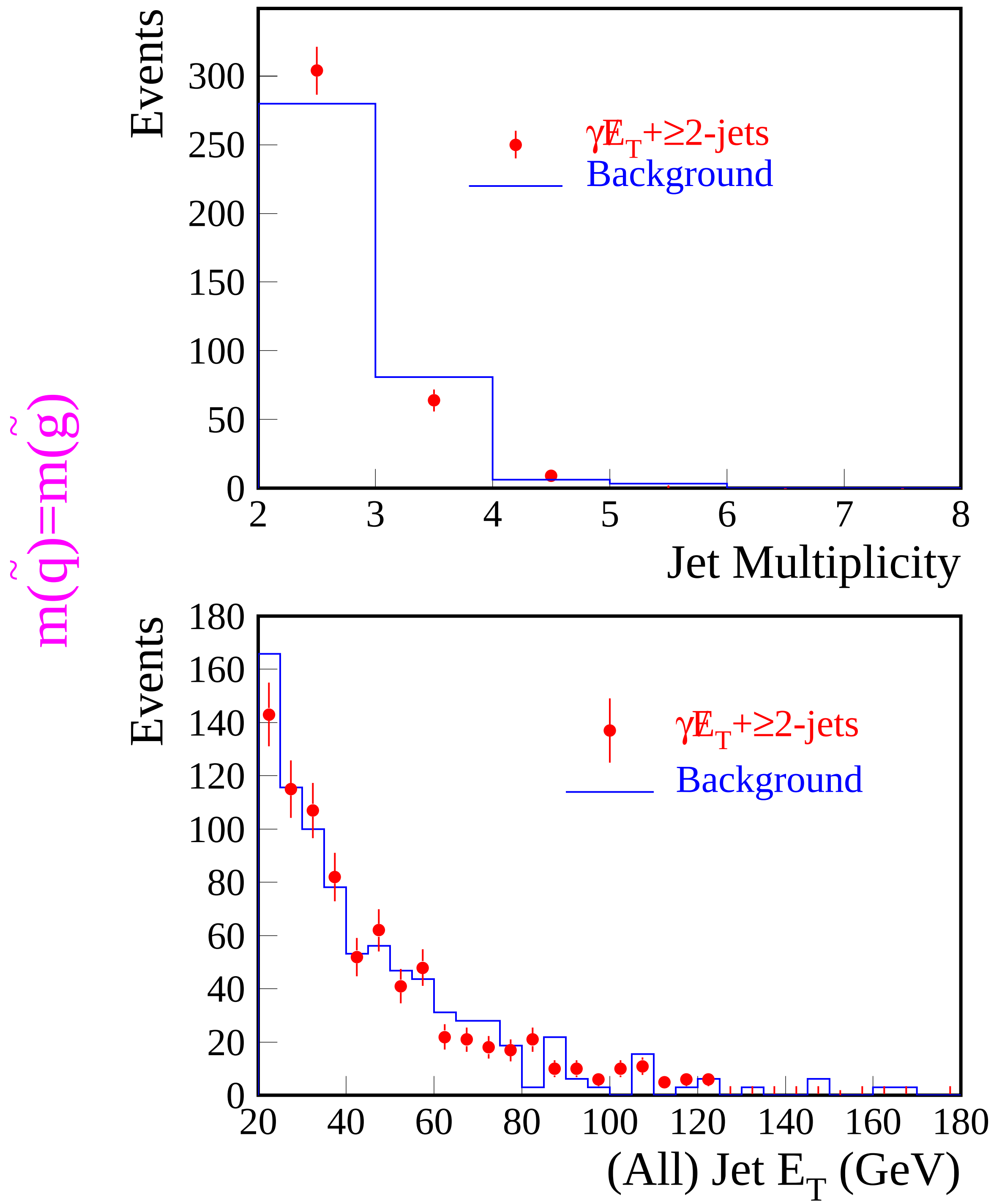
Search for $\gamma \not{E}_T + \geq 2$-Jets Events



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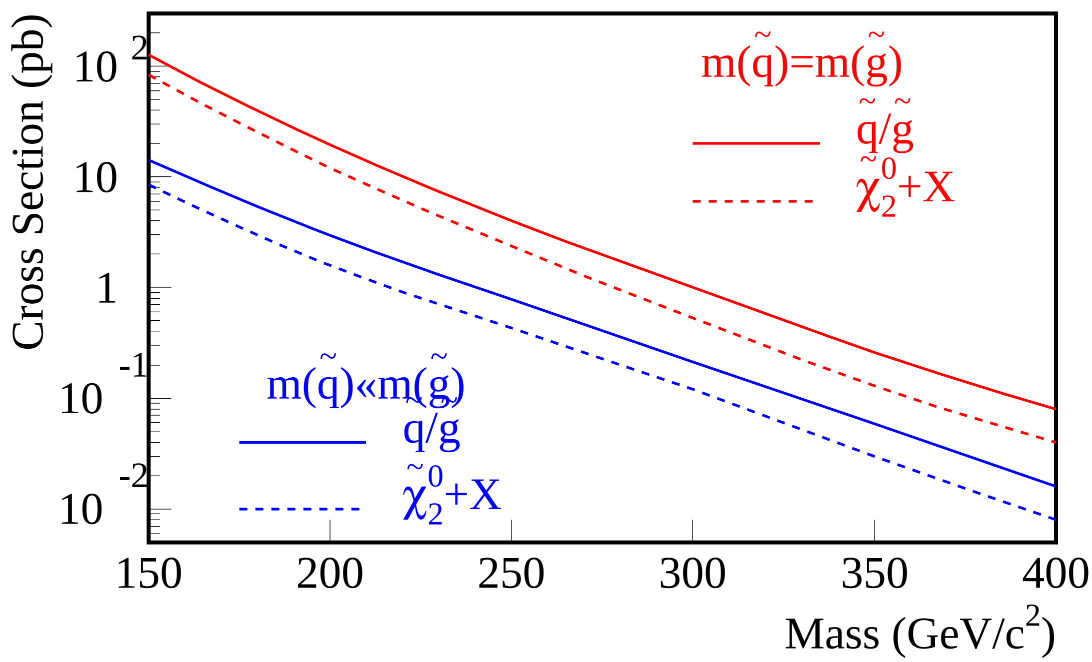
Search for $\gamma \not{E}_T + \geq 2$-Jets Events

Squark/Gluino Production

We interpret our results in terms of
squarks/gluinos production within the models of Kane et al.

The production of $p\bar{p} \rightarrow (\tilde{q}, \tilde{g}, \tilde{\chi}_2^0) \rightarrow \tilde{\chi}_2^0 + X$
are modeled using Spythia program



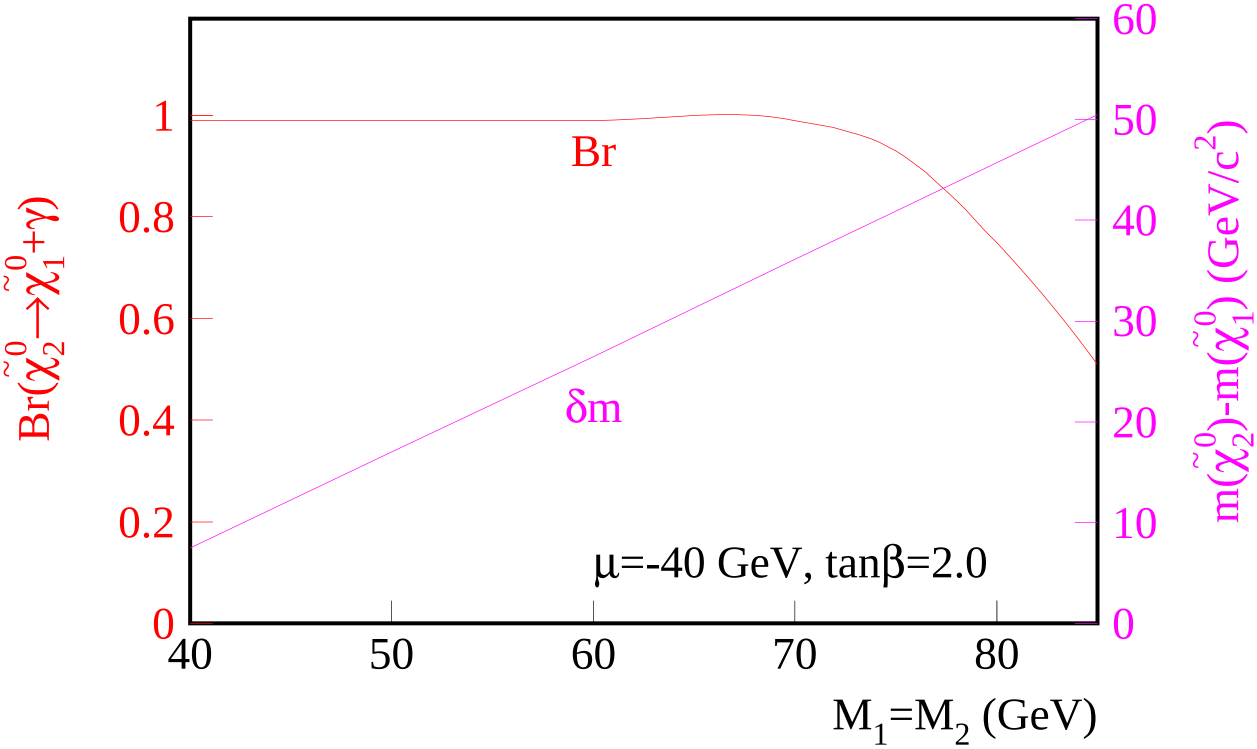
$Br(\tilde{q}/\tilde{g} \rightarrow \tilde{\chi}_2^0 + X)$ depends on
the MSSM parameters: M_1, M_2, μ, and $\tan\beta$ and scalar masses

About 60% of the events containing $\tilde{\chi}_2^0$

Search for $\gamma \not\!\!E_T + \geq 2$-Jets Events

$\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 + \gamma$ Decay

The $\tilde{\chi}_2^0$ decay is governed by
the four MSSM parameters: M_1, M_2, μ, and $\tan\beta$



The mass difference between $\tilde{\chi}_2^0$ and $\tilde{\chi}_1^0$
affects photon E_T and $\not\!\!E_T$

The branching ratio of $\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 + \gamma$ decay
directly affects the $\gamma \not\!\!E_T + \geq 2$-Jets event rate

Search for $\gamma \not{E}_T + \geq 2$-Jets Events

Signal Simulation

We simulate $p\bar{p} \rightarrow \tilde{q}\tilde{q}, \tilde{q}\tilde{g}, \tilde{g}\tilde{g}, \tilde{q}\tilde{\chi}, \tilde{g}\tilde{\chi}$ production
using the Spythia program

1) M_1=M_2=60 GeV, μ=-40 GeV, and tanβ=2.0
2) heavy scalar leptons
3) no stop production

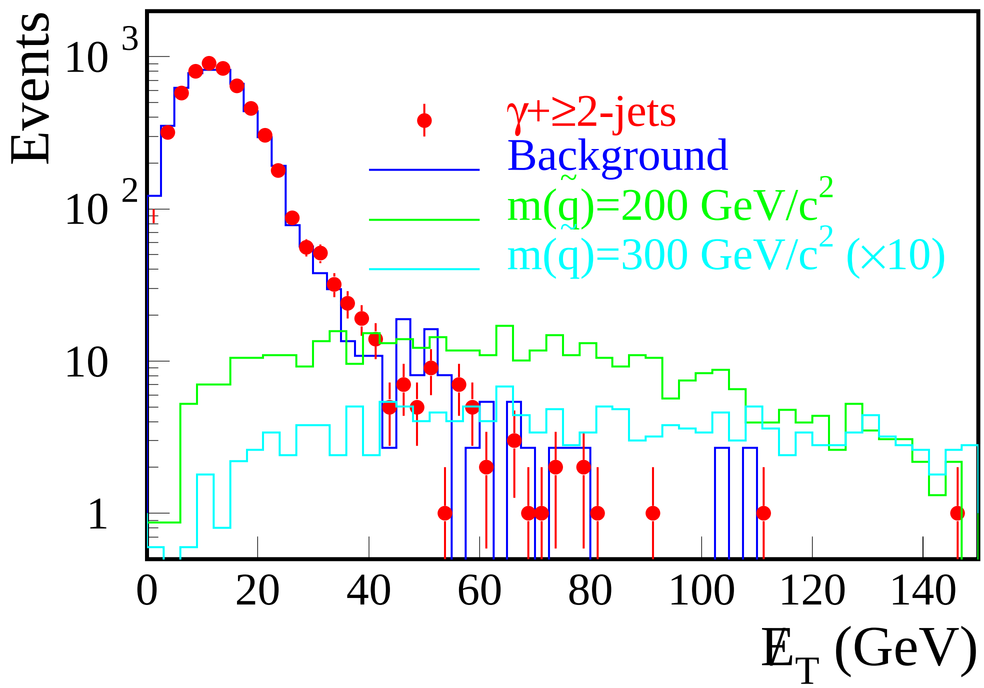
for three different squark/gluino mass scenarios

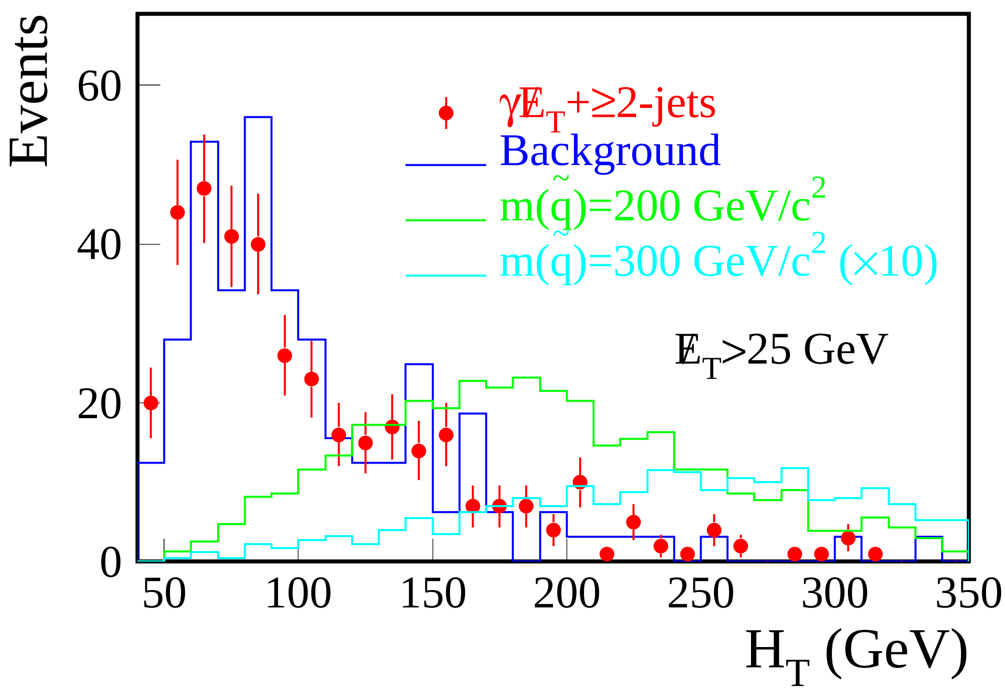
1) $m(\tilde{q})=m(\tilde{g})$
2) $m(\tilde{q}) \gg m(\tilde{g})$
3) $m(\tilde{q}) \ll m(\tilde{g})$

For the case $m(\tilde{q})=m(\tilde{g})$, the expected numbers of events are
351 for $m(\tilde{q})$=200 GeV/c^2 and 19 for $m(\tilde{q})$=300 GeV/c^2
in the base sample

Search for $\gamma \not{E}_T + \geq 2$-Jets Events

$m(\tilde{q}) = m(\tilde{g})$





Search for $\gamma \not\!\!E_T$+≥2-Jets Events

Selection Optimization

The base sample is dominated by multijet backgrounds
Events from supersymmetry are expected to
have very different $\not\!\!E_T$ and H_T distributions

To increase sensitivity to supersymmetry, we optimize
the event selection in $\not\!\!E_T$-H_T plane

$\not\!\!E_T$ and H_T cuts are varied to maximize the ratio
ε/σ_b for $m(\tilde{q})=m(\tilde{g})=300$ GeV/c^2

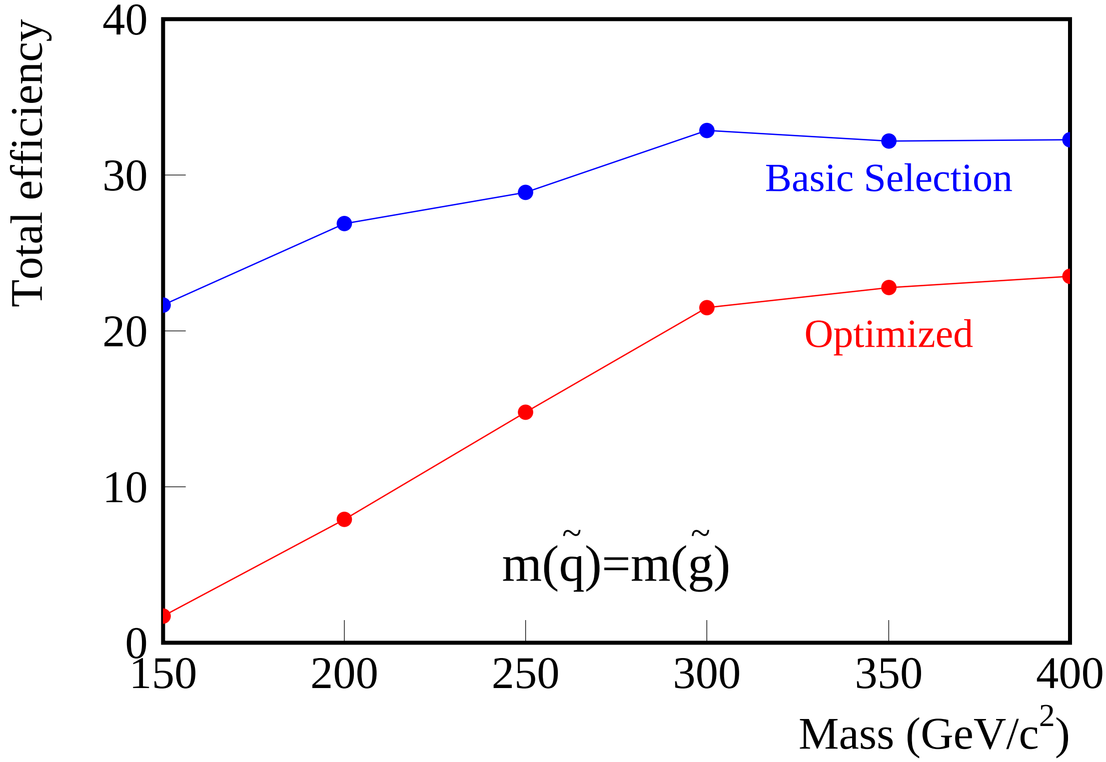
The optimized cuts are
$\not\!\!E_T$>45 GeV and H_T>220 GeV

For the optimized cuts, we observe
5 data events while 8±6 background events are expected

No excess of events

Search for $\gamma \not\!\!E_T$+≥2-Jets Events

Selection Efficiency



The efficiencies change by about 4% by varying
the MSSM parameters (M_1, M_2, μ and $\tan\beta$) with the constraints
$m(\tilde{\chi}_2^0) - m(\tilde{\chi}_1^0) > 20$ GeV/c^2
$Br(\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 + \gamma) = 100\%$

For $m(\tilde{q}) = m(\tilde{g}) = 300$ GeV/c^2,
11.3 events are expected for the optimized cuts

Search for $\gamma \not{E}_T + \geq 2$-Jets Events

Interpretations

Without excess of events, we set 95% C.L. lower mass limit

$m(\tilde{q}) > 311$ GeV/c^2 for $m(\tilde{q}) = m(\tilde{g})$

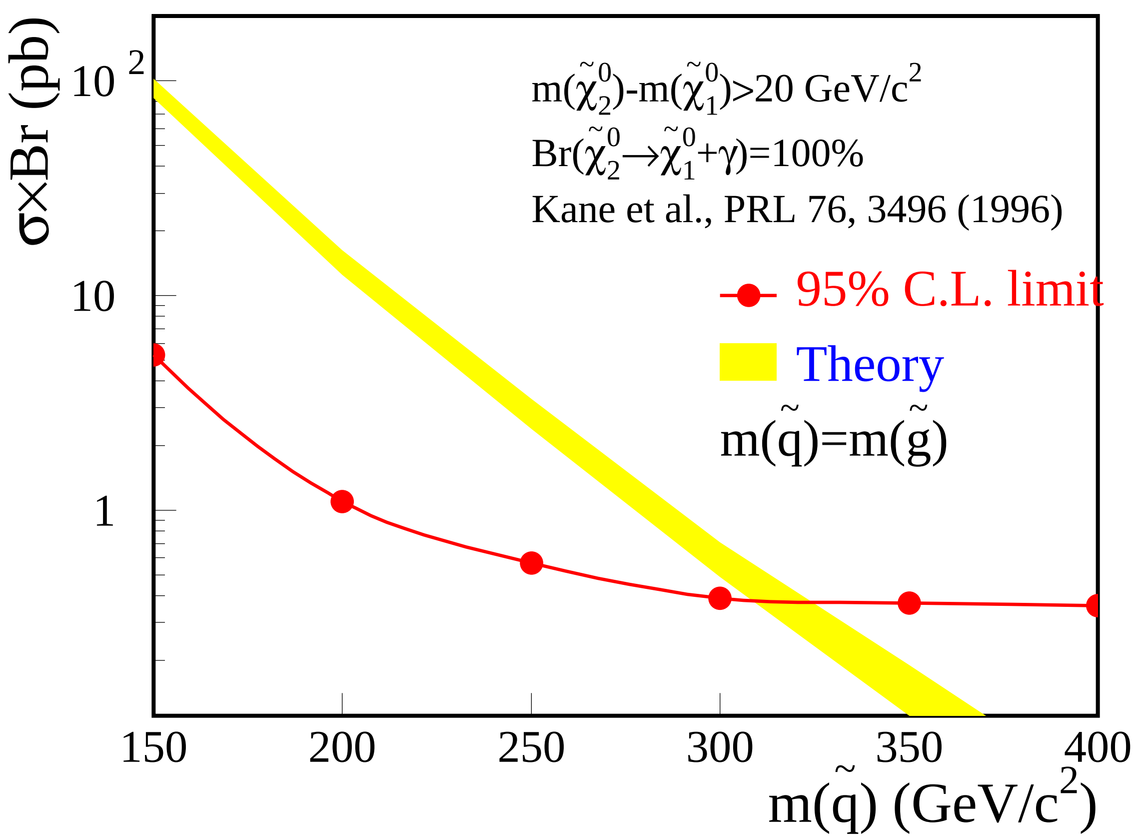
$m(\tilde{g}) > 233$ GeV/c^2 for $m(\tilde{q}) \gg m(\tilde{g})$

$m(\tilde{q}) > 219$ GeV/c^2 for $m(\tilde{q}) \ll m(\tilde{g})$

with the constraints

$m(\tilde{\chi}_2^0) - m(\tilde{\chi}_1^0) > 20$ GeV/c^2

$Br(\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 + \gamma) = 100\%$

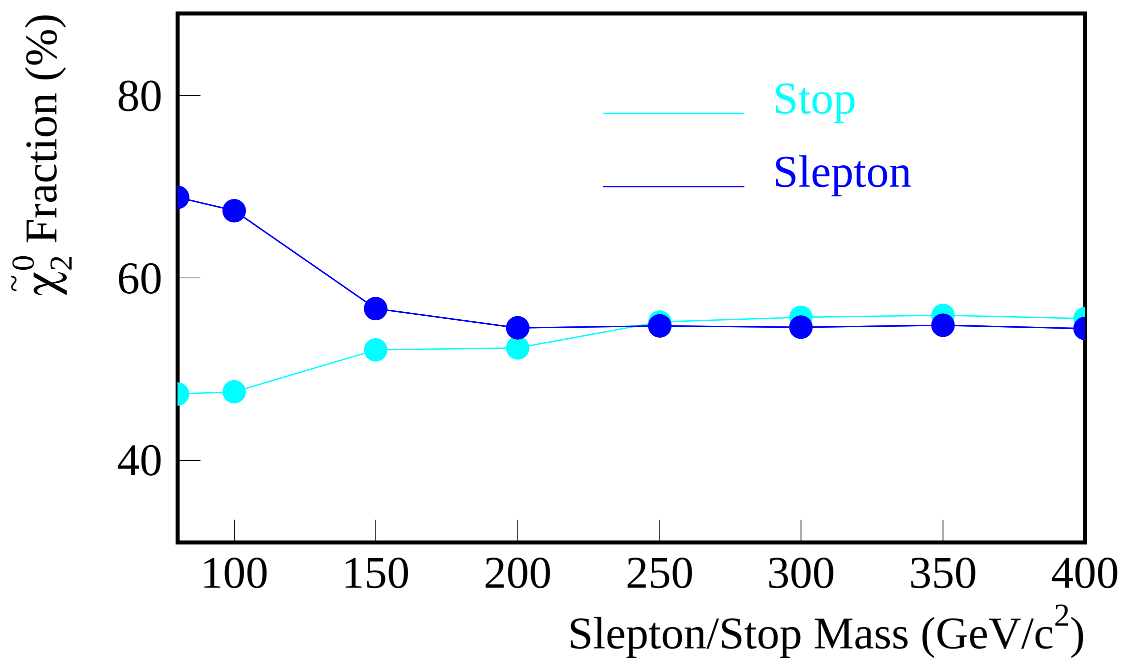


Search for $\gamma\not{E}_T$+≥2-Jets Events

Interpretations

The fraction of events containing $\tilde{\chi}_2^0$ depends on slepton and stop masses

The mass limit changes by about 10 GeV/c^2 if slepton and stop masses are lowered to 80 GeV/c^2



These results constrain (but do not exclude) the models of Kane et al.

Summary

We have searched for supersymmetry
in $\gamma\gamma \not{E}_T$ and $\gamma \not{E}_T + \geq 2$-Jet final states
No excess of events was found

Within the MSSM with a light $\tilde{G}$,
we set 95% C.L. lower mass limits
$m(\tilde{\chi}_1^{\pm}) > 150$ GeV/c^2 and $m(\tilde{\chi}_1^0) > 77$ GeV/c^2

These limits exclude the region of
parameter space suggested
for the chargino interpretation of the CDF event

In the models of Kane et al.,
we obtain a 95% C.L. lower mass limit of
311 GeV/c^2 for $\tilde{q}/\tilde{g}$ assuming $m(\tilde{q}) = m(\tilde{g})$

No sign of supersymmetry
If we cannot exclude it, can we discover it?