Supersymmetry

Searches & Discoveries

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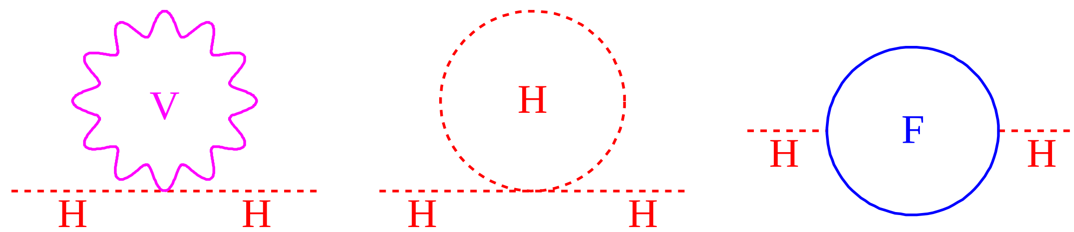
Supersymmetry theory
Experimental signatures
Examples of Run I searches
New possibilities in Run II
Final Remarks

UTEV, Fermilab
November 18, 1999

Theoretical Problems

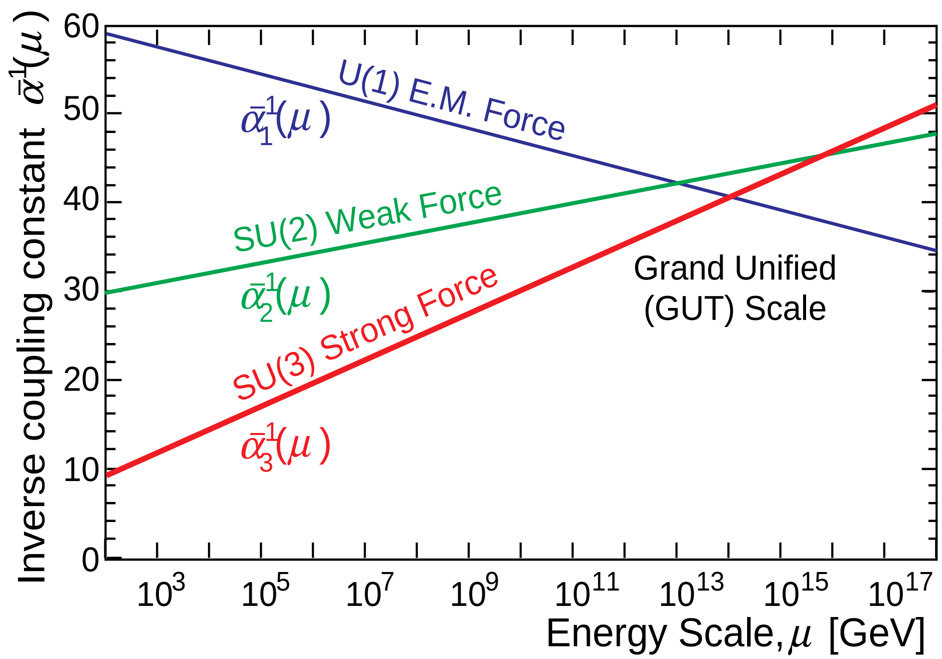
As much as we love the Standard Model, it is unlikely to be a complete theory

Higgs boson mass receives radiative corrections which are quadratically divergent



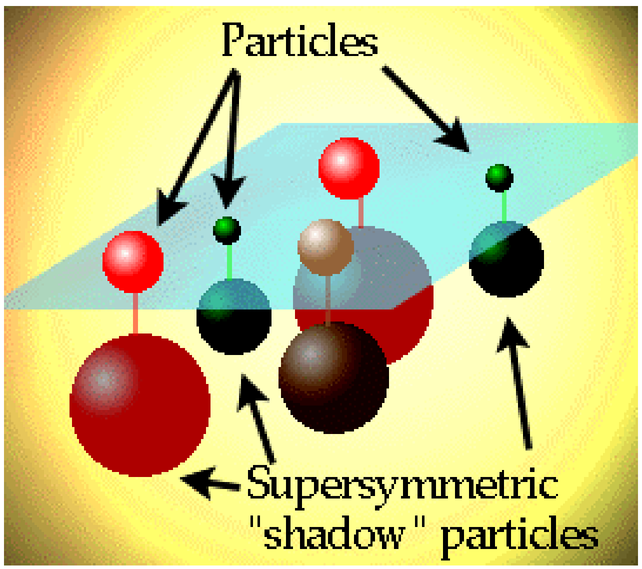
Standard Model does not incorporate gravity

Strong, electromagnetic and weak interactions do not unify at high energies without new physics

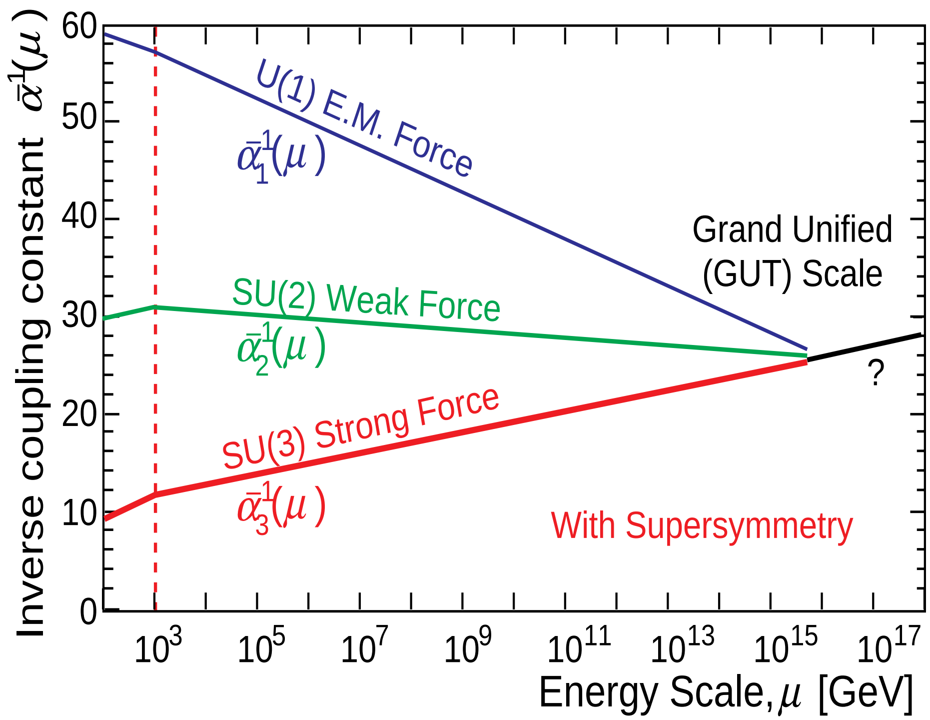


What is the Supersymmetry?

For every *He*
there is a *She*



It is a theory
popular theoretically but
unobserved experimentally



Provides a solution to Higgs mass problem

Offers a path to the incorporation of gravity

Unifies strong, electromagnetic and weak forces at high energies

Predicts the radiative breaking of EW symmetry

Supersymmetric Models

The simplest supersymmetric model
is the minimal supersymmetric standard model (MSSM)

(1) An extra Higgs doublet of opposite hypercharge
(2) Supersymmetrizing the gauge field

Standard Model Particles

$W^{\pm} H^{\pm}$ γ Z h H A u d e ν ......

$\Downarrow$ $\Downarrow$ $\Downarrow$

$\tilde{\chi}_2^{\pm}$ $\tilde{\chi}_1^{\pm}$ $\tilde{\chi}_4^0$ $\tilde{\chi}_3^0$ $\tilde{\chi}_2^0$ $\tilde{\chi}_1^0$ $\tilde{u}_L$ $\tilde{d}_L$ $\tilde{e}_L$ $\tilde{\nu}_L$ / $\tilde{u}_R$ $\tilde{d}_R$ $\tilde{e}_R$ $\tilde{\nu}_R$ $\tilde{\cdots}$

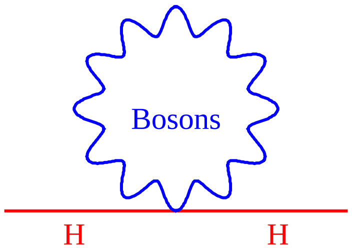
Supersymmetric Particles

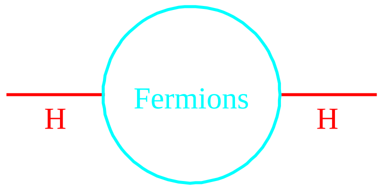
For every spin degree of freedom in SM,
there is a supersymmetric spin degree of freedom

Lots of new particles $\Rightarrow$ lots of opportunity

Higgs Mass Solution

Standard Model





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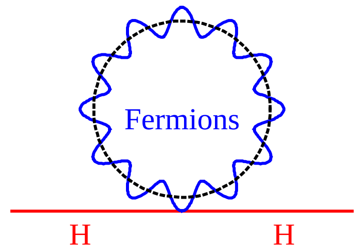
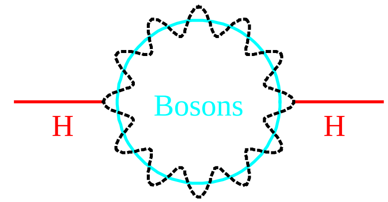
Supersymmetry





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With supersymmetry
fermion and boson loops have opposite signs
there are equal numbers of bosons and fermions

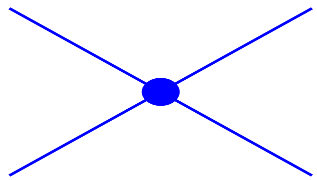
$$\delta m_H^2 = -\left(\frac{g_F^2}{4\pi}\right)\left(\Lambda^2 + m_F^2\right) + \left(\frac{g_B^2}{4\pi}\right)\left(\Lambda^2 + m_B^2\right) \approx O\left(\frac{\alpha}{\pi}\right)|m_B^2 - m_F^2|$$

The divergence cancels for identical couplings

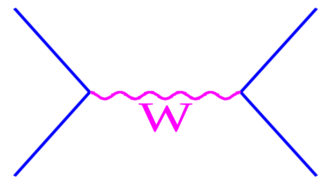
Supersymmetry mass scale $\lesssim$ 1 TeV
if $\delta m_H^2 \lesssim m_H^2$

Historical Guidance

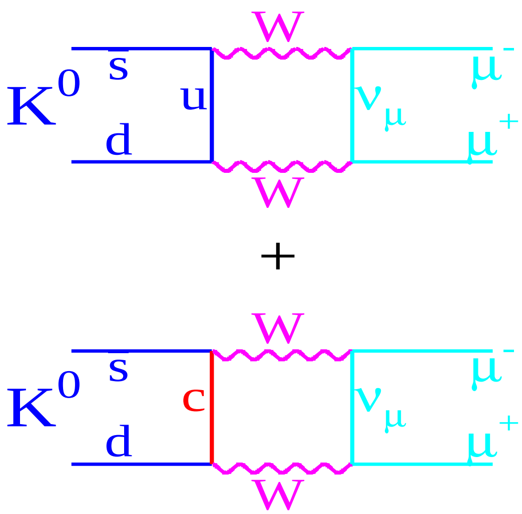
W boson was introduced to make $\sigma(e\nu_e \to e\nu_e)$ finite

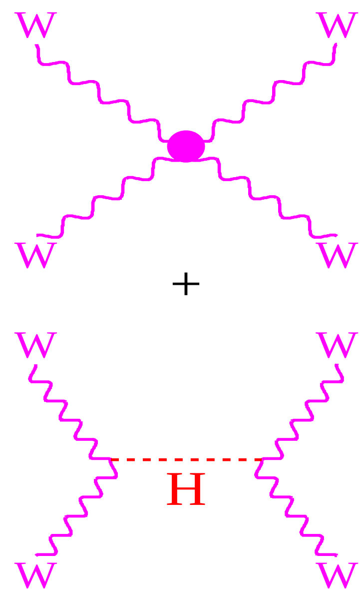


$\Rightarrow$



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



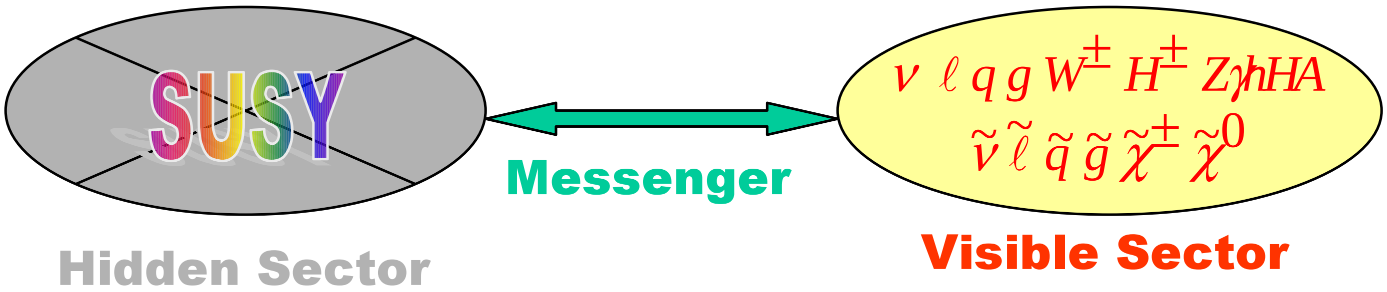


To solve $K^0 \to \mu\mu$ decay problem, the charm quark was postulated

To make $\sigma\left(W_L^+ W_L^- \to W_L^+ W_L^-\right)$ finite, we introduced the Higgs boson

Supersymmetry Breaking

Supersymmetry must be broken



The symmetry is assumed to be broken in a hidden sector, a messenger sector mediates the breaking to the visible sector

Different mediation leads to different classes of models

- **Gravity inspired models**
  - The messenger interaction is of gravitational strength
- **Gauge mediated models**
  - SM gauge interactions play the role of messenger force

R-Parity & LSP

Supersymmetry phenomenology depends on

(1) Whether R-parity is conserved
(2) What is the lightest supersymmetric particle (LSP)

If R-parity is conserved:

(1) Supersymmetric particles are pair produced
(2) Heavy sparticles decay to lighter sparticles
(3) LSP is stable (no available decay mode)

Cosmological consideration suggests that the LSP is neutral in electric and color charges

LSP candidates are:
Neutralino, scalar neutrino, gravitino, ...

R-parity conservation generally leads to missing E_T signature

Minimal SuperGravity Model

Supersymmetry breaking scale is general of ~ 10^9 TeV

- ⇒ A massive gravitino
- ⇒ The lightest SM superpartner is the LSP

mSUGRA assumes scalar and gaugino mass unification at GUT scale

Has four continuous and one discrete free parameters at GUT scale

m_0	common scalar mass parameter
$m_{1/2}$	common gaugino mass parameter
A_0	common trilinear coupling
$\tan\beta$	ratio of V.E.V. of the Higgs doublets
Sign(μ)	sign of higgsino mass parameter

mSUGRA predicts radiative breaking of the electroweak gauge symmetry

Minimal Gauge Mediation Model

Susy breaking scale can be as low as ~ 100 TeV

$\Rightarrow$ **An exceedingly light gravitino**

$\Rightarrow$ **Gravitino is naturally the LSP**

The phenomenology depends on the next lightest supersymmetric particle (NLSP)

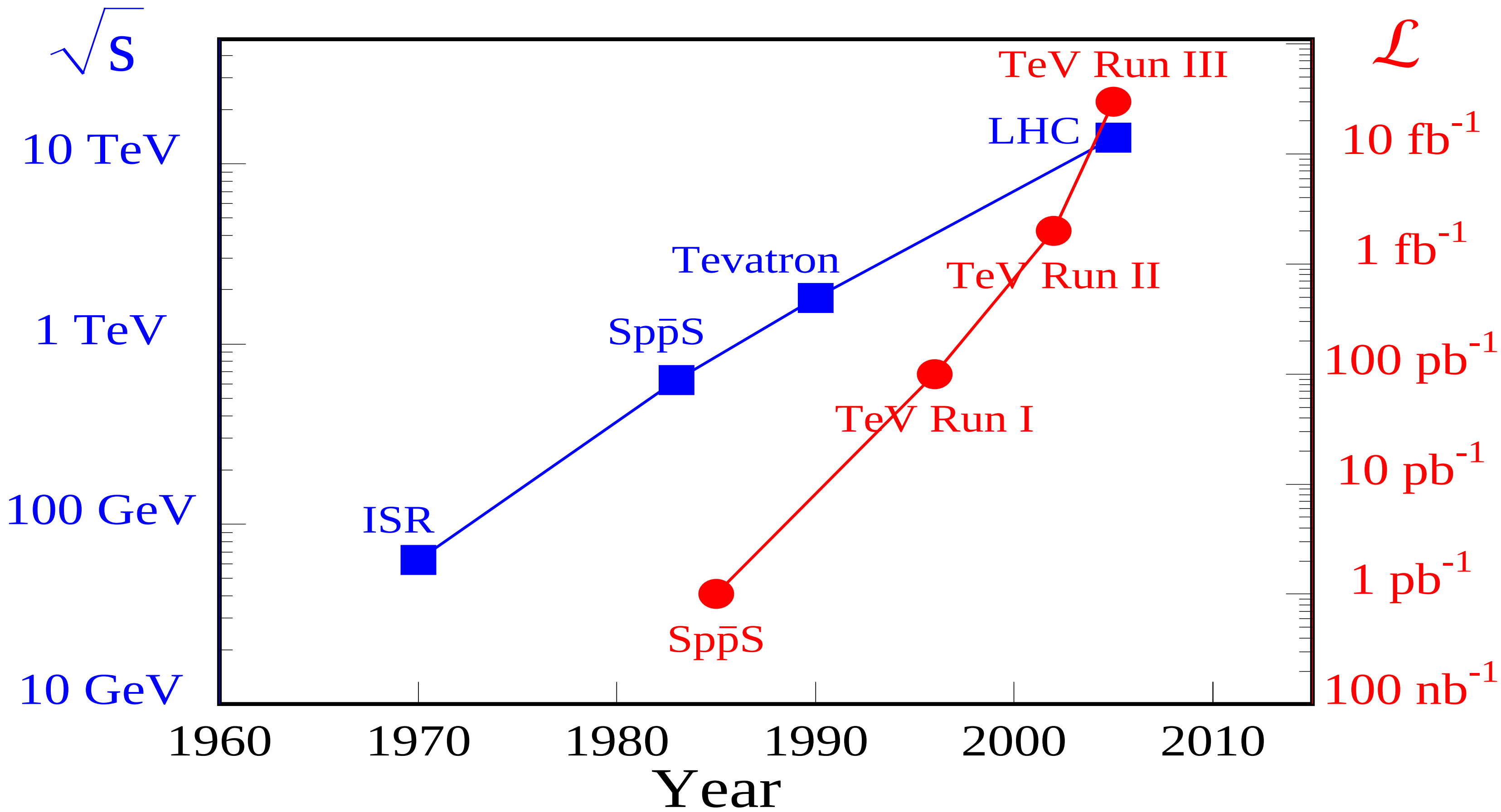
$$\tilde{\chi}_1^0 \rightarrow (\gamma,\ h,\ Z) + \tilde{G} \qquad \tilde{\tau} \rightarrow \tau + \tilde{G}$$

Leading to anomalous production of events with photon/tau and large missing E_T

Minimal Gauge Mediation Model (MGM)

Λ	**supersymmetry breaking scale**
M_m	**messenger sector scale**
N	**number of messengers**
tanβ	**ratio of V.E.V. of the Higgs doublets**
Sign(μ**)**	**sign of the higgsino mass parameter**

Hadron Collider Chronicle



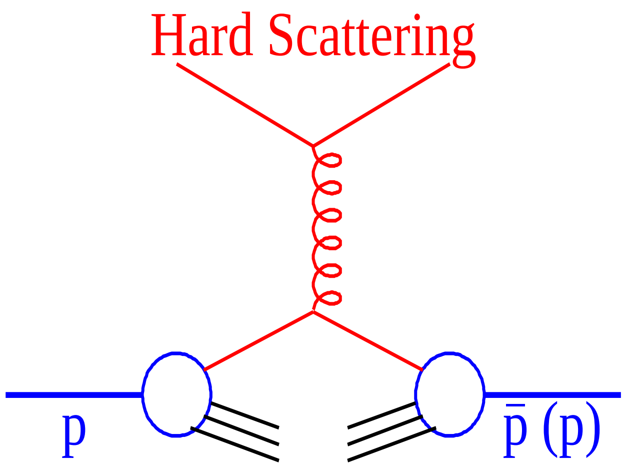
1970: ISR at CERN pp high p_T physics (missed J/ψ)

1982: Sp$\bar{p}$S at CERN $p\bar{p}$ W / Z discoveries

1990: Tevatron at Fermilab $p\bar{p}$ top discovery, ...

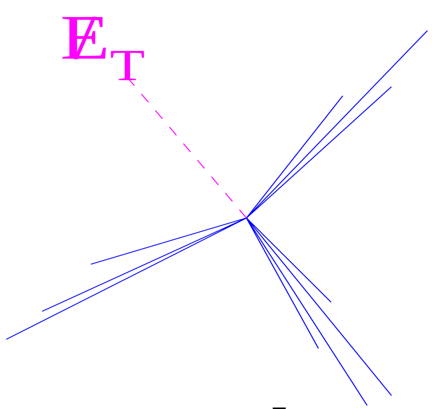
2005: LHC at CERN pp ???

Hadron Collision Kinematics



For the purpose of hard scattering, a proton (anti-proton) is a broad-band, unselected beam of quarks, anti-quarks and gluons.

Total energy is unknown
Total longitudinal momentum is unknown
Total transverse momentum is zero



R-ϕ plane

(Transverse Plane)

The total transverse energy of invisible particles can be inferred from visible particles

$$\sum_{\text{inv}} \vec{E}_T + \sum_{\text{vis}} \vec{E}_T = 0$$

$$\vec{\not{E}}_T \equiv \sum_{\text{inv}} \vec{E}_T = -\sum_{\text{vis}} \vec{E}_T$$

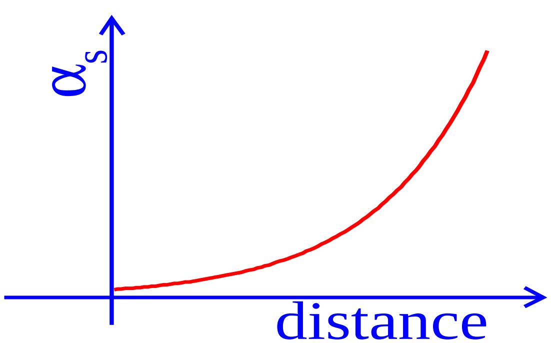
From Collision to Detection

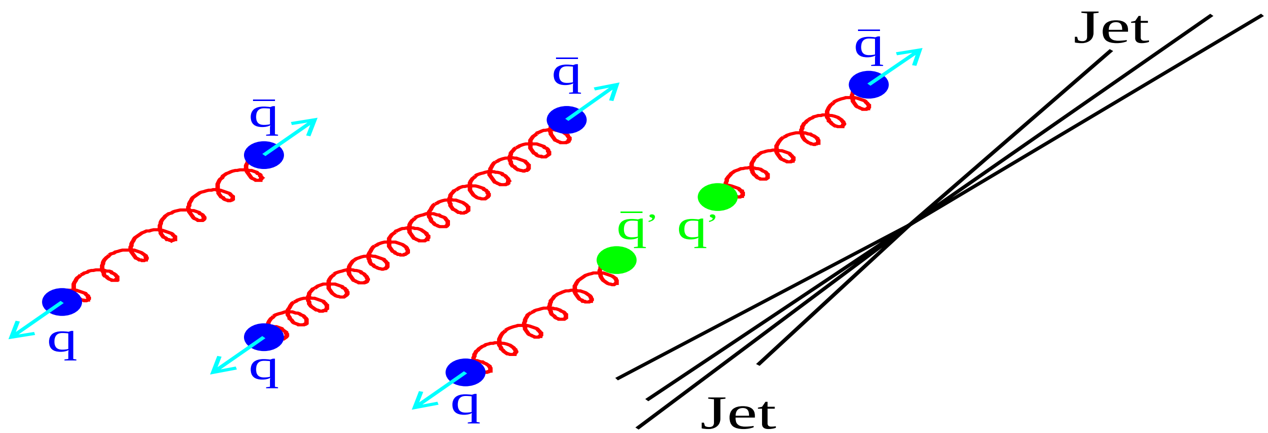
Heavy quarks/leptons decay via weak interaction to their lighter counterparts whenever kinematically allowed

2/3	u	c	t
−1/3	d	s	b
0	ν_e	ν_μ	ν_τ
−1	e	μ	τ

$t \to bW$	$c\tau \sim 1\,\mathrm{fm}$	(prompt)
$b \to cW^*$	$c\tau \sim 470\,\mu\mathrm{m}$	(delayed)
$\tau \to \nu_\tau W^*$	$c\tau \sim 90\,\mu\mathrm{m}$	(delayed)
$\mu \to \nu_\mu W^*$	$c\tau \sim 650\,\mathrm{m}$	(stable)

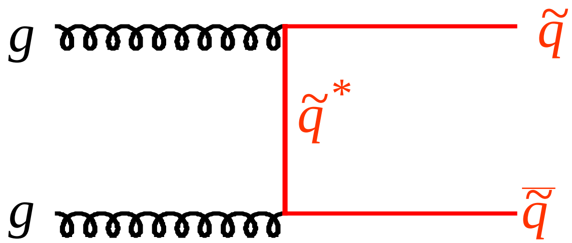
An energetic quark or gluon appears in a detector as a jet of colorless hadrons

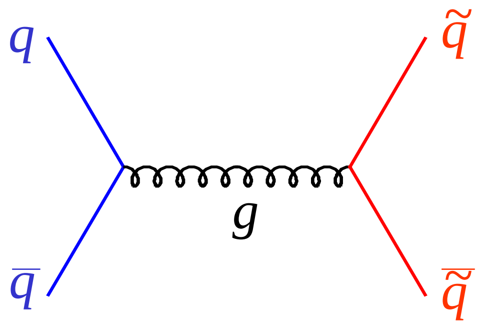


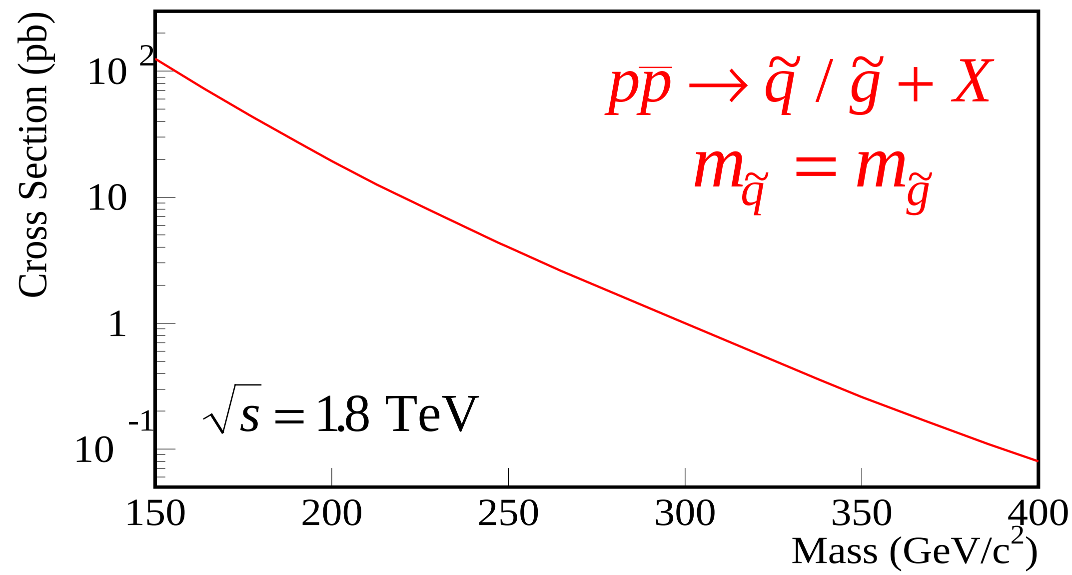


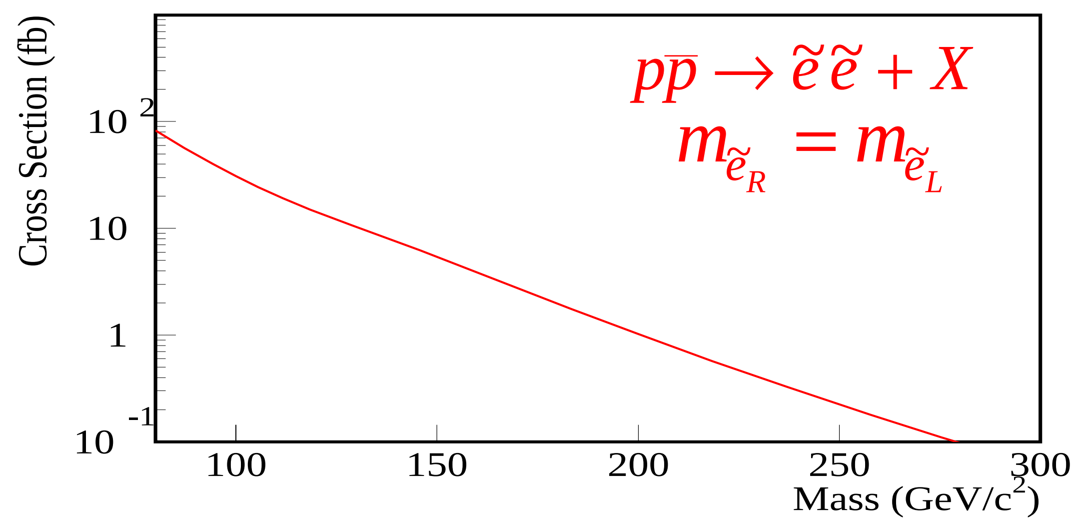
Occur at an energy scale Λ_{QCD}~150 MeV

Signal Cross Sections









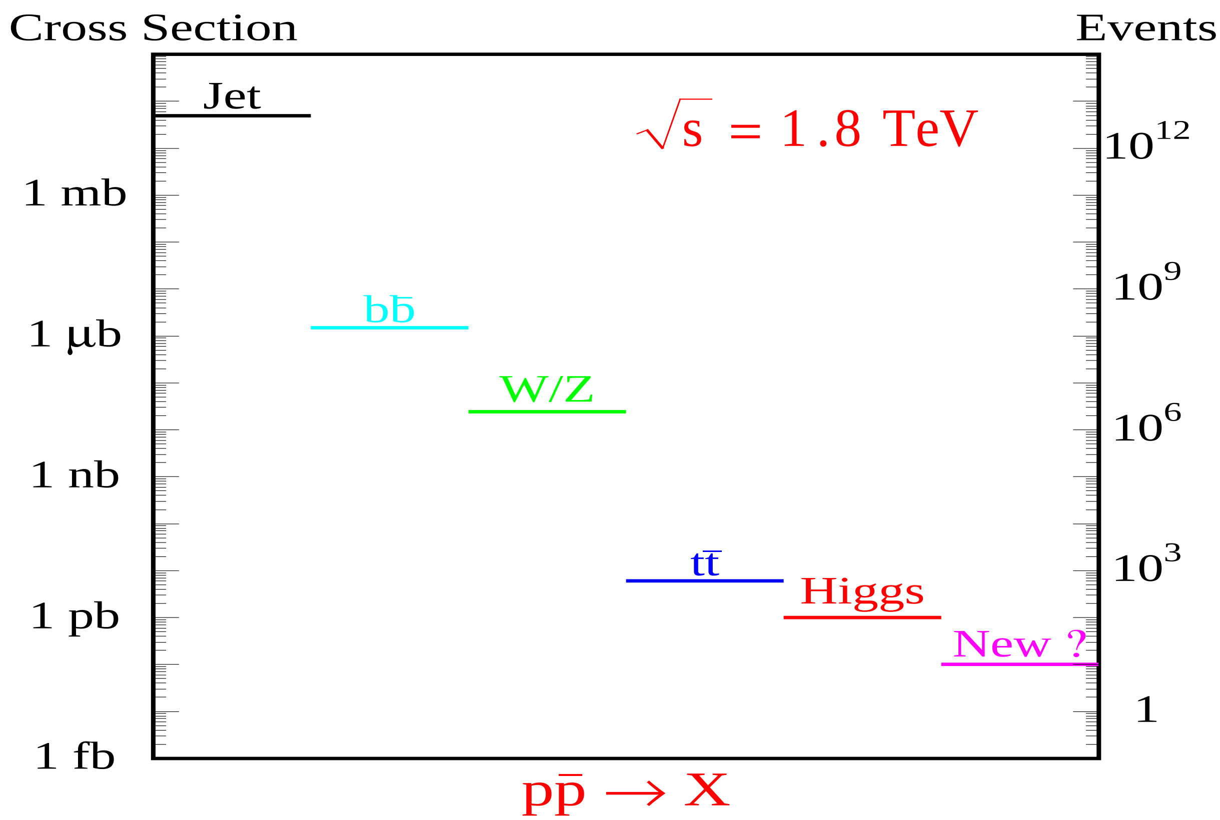
Production has less dependence on susy parameters than decays

Squarks and gluinos dominant the production at Tevatron if accessible kinematically

Cross sections for scalar leptons are small

Background Cross Sections

The cross section for new physics is small compared with dominant Standard Model processes

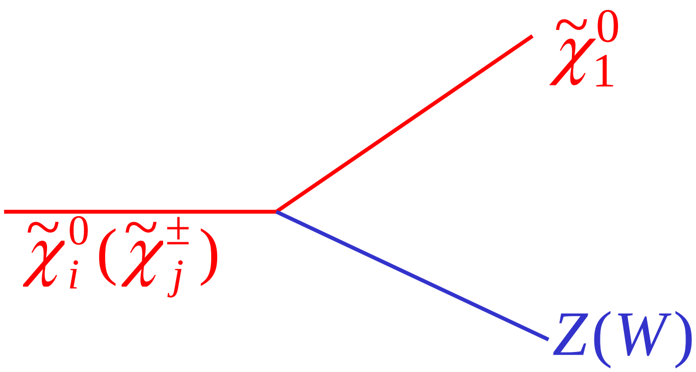


Leptons (e, μ) and missing E_T are the keys

- **missing E_T resolution**
- **lepton identification efficiency**
- **lepton fake rate**

mSUGRA Signatures

For most of the parameter space, the lightest neutralino is the LSP



$$pp̄ \to \tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to WZ + \not\!\!E_T \Rightarrow \ell^{1,2,3} + \not\!\!E_T + X$$
$$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm} \to WW + \not\!\!E_T \Rightarrow \ell^{1,2} + \not\!\!E_T + X$$

$$\tilde{\chi}_i^0 \to Z\,\tilde{\chi}_1^0$$
$$\tilde{\chi}_j^{\pm} \to W\,\tilde{\chi}_1^0$$
$$\tilde{q} \to q\,\tilde{\chi}_1^0$$
$$\tilde{g} \to q\,\tilde{q}$$

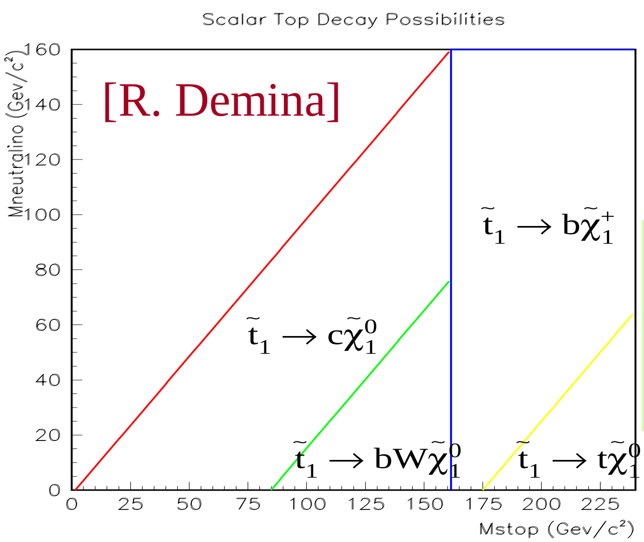
$$p\bar{p} \to \tilde{q}\tilde{q} \to X + \tilde{\chi}_1^0\tilde{\chi}_1^0 \Rightarrow jets + \not\!\!E_T$$
$$+\,\tilde{\chi}_1^{\pm}\tilde{\chi}_1^0 \Rightarrow jets + \not\!\!E_T + \ell$$
$$+\,\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \Rightarrow jets + \not\!\!E_T + \ell^{\pm}\ell^{\mp}$$
$$+\,\tilde{\chi}_2^0\tilde{\chi}_1^0 \Rightarrow jets + \not\!\!E_T + \ell^{\pm}\ell^{\mp}$$
$$+\,\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \Rightarrow jets + \not\!\!E_T + \ell\ell\ell$$
$$+\ \ldots\ldots$$
$$p\bar{p} \to \tilde{g}\tilde{g} \to X + \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm} \Rightarrow jets + \not\!\!E_T + \ell^{\pm}\ell^{\pm}$$

Signatures:

$$p\bar{p} \to SUSY \Rightarrow \not\!\!E_T + \ell^n + j^m$$

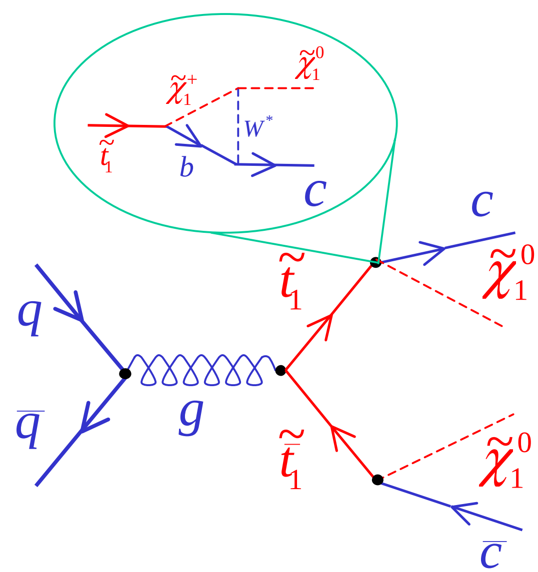
Stop and Sbottom Signatures

In many supersymmetry models, stop (and sbottom) can be significantly lighter than other squarks

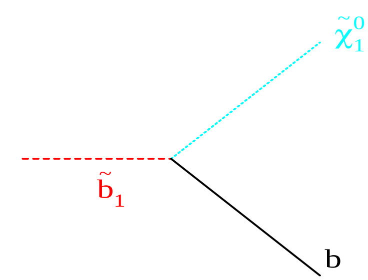


$$\tilde{t}_1 \to \tilde{\chi}_1^{\pm} + b \to \tilde{\chi}_1^0 + Wb$$
$$\tilde{t}_1 \to \tilde{\chi}_1^0 + c$$

Signatures:
1) **excess of SM top events**
2) **two acoplanar c-jets + missing E_T**



Assuming $Br(\tilde{b}_1 \to b\tilde{\chi}_1^0) = 100\%$
pair production of $\tilde{b}_1$ will yield
two acoplanar b - jets



Signatures:
two acoplanar b-jets + missing E_T

(Also expected from WH, ZH)

MGM Signatures

Signatures depend on the next-lightest supersymmetric particle (NLSP)

$$\tilde{\chi}_1^0 \to \gamma\tilde{G},\ \ Z\tilde{G},\ \ h\tilde{G}$$
$$\tilde{\ell} \to \ell G$$

$$p\bar{p} \to SUSY \Rightarrow 2\,NLSP + \ell^n + j^m$$
$$\Rightarrow (\not{E}_T + \ell^n + j^m) + \gamma\gamma$$

Depending on their lifetimes, NLSPs can decay at the production vertex, inside and outside detector

$\Downarrow$

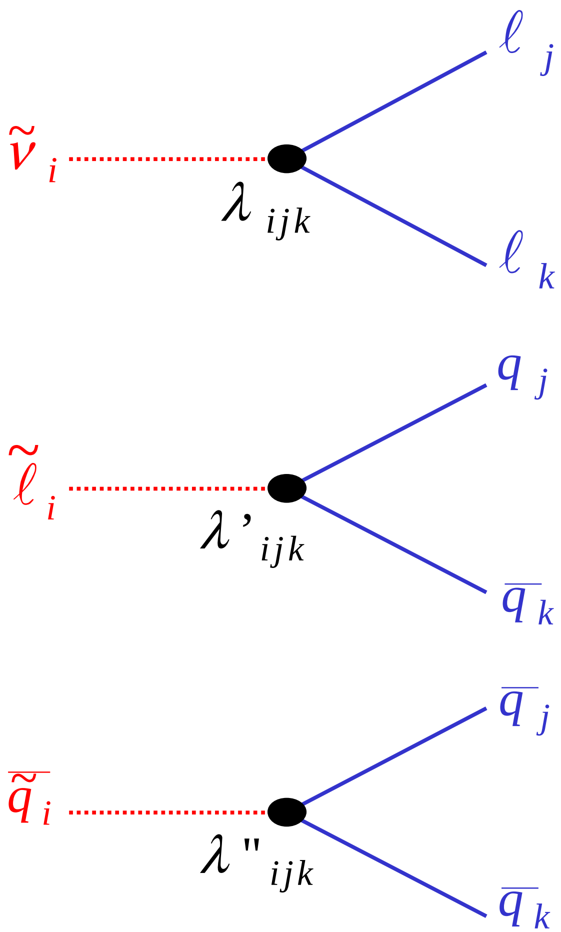
displaced photons
hot cells
slow moving particles
kinked tracks

Signatures:

$$\gamma\gamma\not{E}_T,\ \ \ell\ell\not{E}_T,\ \ \gamma b\bar{b}\,\not{E}_T,\ \ldots$$

R-parity Violating Scenario

In addition to the SM interactions, following interactions are allowed



Resulting lepton and baryon number violations as well as the R-parity violation

B - violating λ''_{ijk} couplings will lead to multijet events without $\not{E}_T$

The L - violating λ_{ijk} and λ'_{ijk} couplings will give rise to multilepton events

$$\tilde{\chi}_1^0 \to \nu\tilde{\nu}^* \Rightarrow \nu\ell\ell \ \ (\lambda_{ijk})$$
$$\tilde{\chi}_1^0 \to \ell\tilde{\ell}^* \Rightarrow \ell qq \ \ (\lambda'_{ijk})$$

Frequent assumptions:

1) R-parity violating LSP decay
2) couplings are not too week or too strong
3) terms with similar event topology dominate

Signatures:

$$p\bar{p} \to SUSY \Rightarrow \ell^n + j^m (+\not{E}_T)$$

Summary of Signatures

Experimental signatures can be grouped into three broad categories

Leptonic Signatures

- Single-lepton
- Di-lepton
  - opposite-sign
  - like-sign
  - Heavy charged particles
- Tri- & multi-lepton
  - chargino-neutralino
  - R-parity violating
- τ events

Photonic Signatures

- Single photon
- Diphoton

Jet Signatures

- b-quark jets
- c-quark jets
- jets

Supersymmetry can result almost any final state

Search for Supersymmetry

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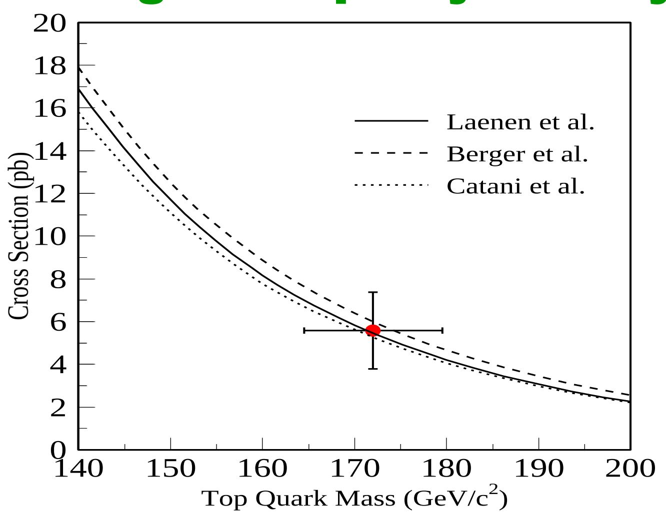
Search for New Physics

Search for Charged Higgs

Supersymmetry cannot exist without charged higgs bosons

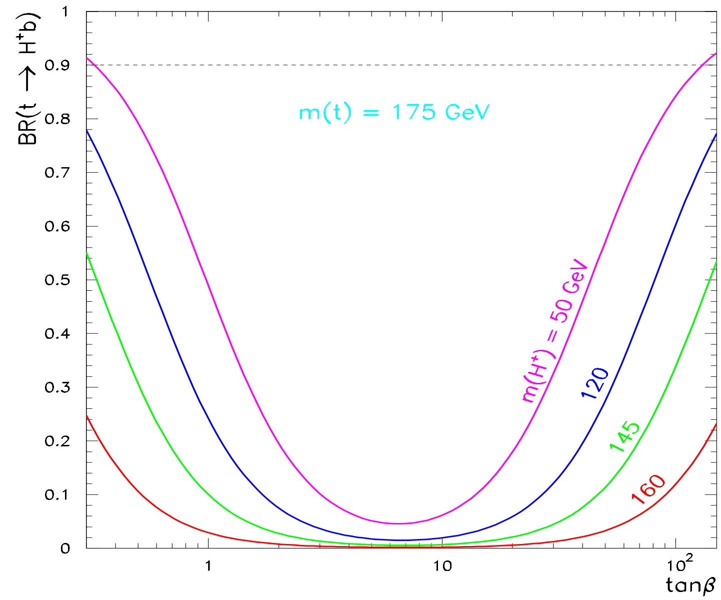
Without knowing it, you might be searching for supersymmetry

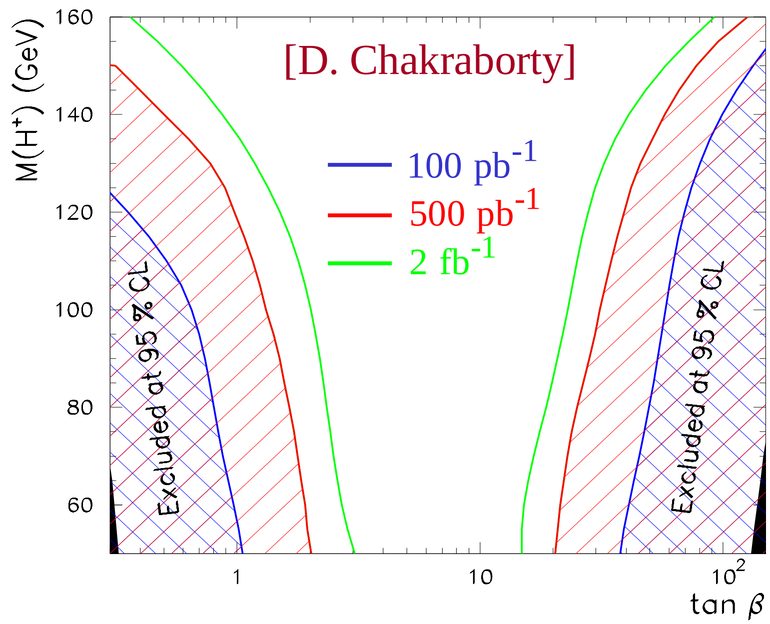


If $H^{\pm}$ are light, they can be produced in top quark decays $t \to Hb$

Therefore $t \to Hb$ **will compete with the standard model** $t \to Wb$ **decay**

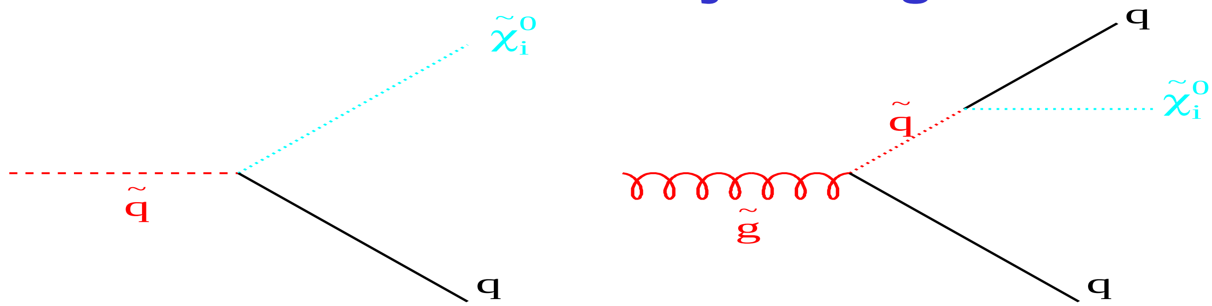
$$H^+ \to c\bar{s}, \tau\nu, Wb\bar{b}$$





Jets+$\not{E}_T$ Final State

Squarks and gluinos can be copiously produced at Tevatron if they are light



The signature for $p\bar{p} \to \tilde{q}\tilde{q}, \tilde{q}\tilde{g}, \tilde{g}\tilde{g} + X$ production is therefore Jets+ $\not{E}_T$

DØ (80 pb^{-1}) searched for events with jets and missing E_T

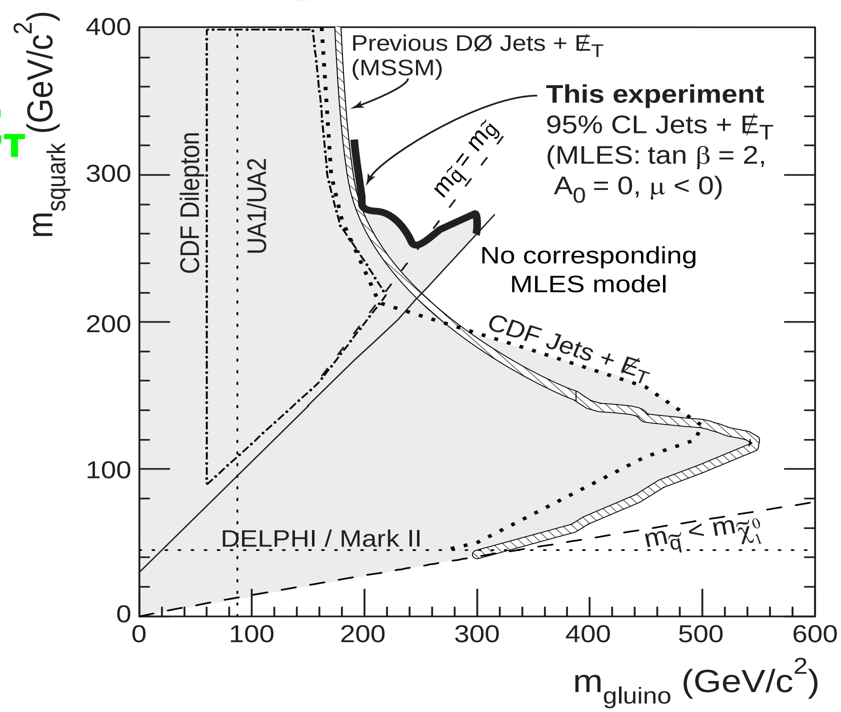
Advantage:

Large cross section

Disadvantage:

Huge QCD background

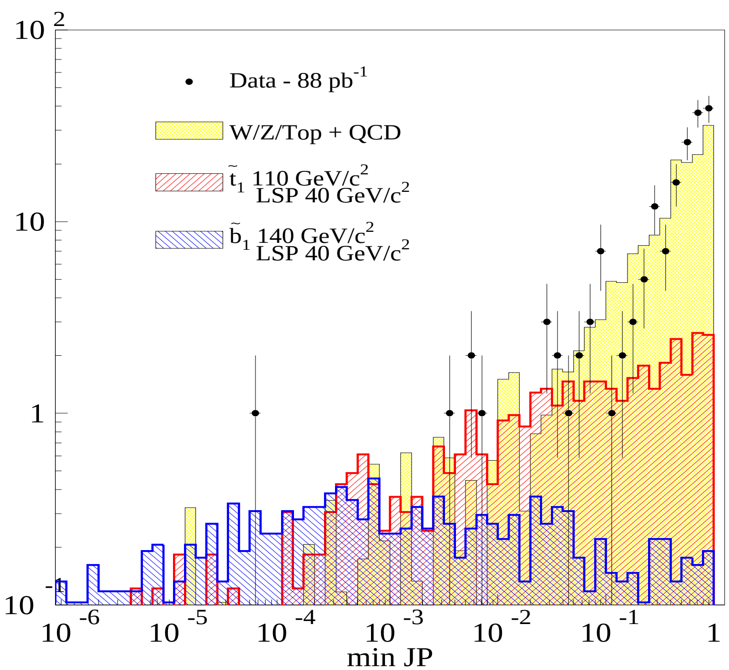
(Also expected from LQ)

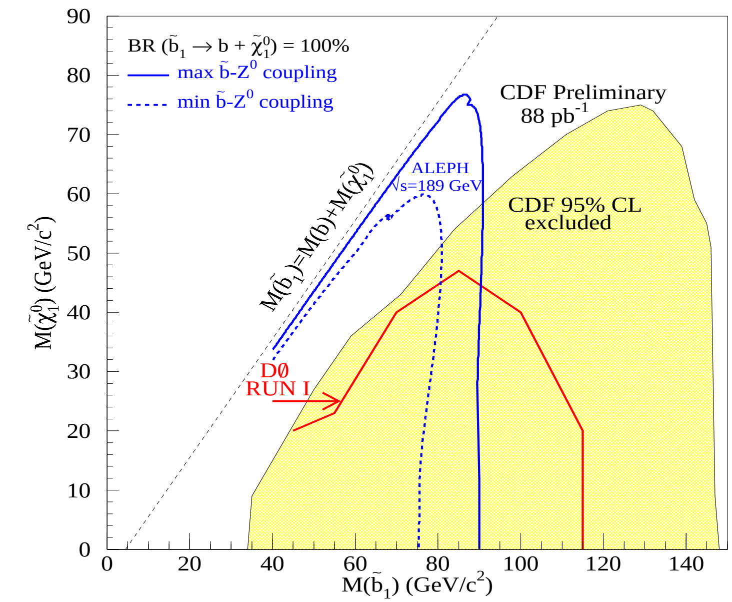


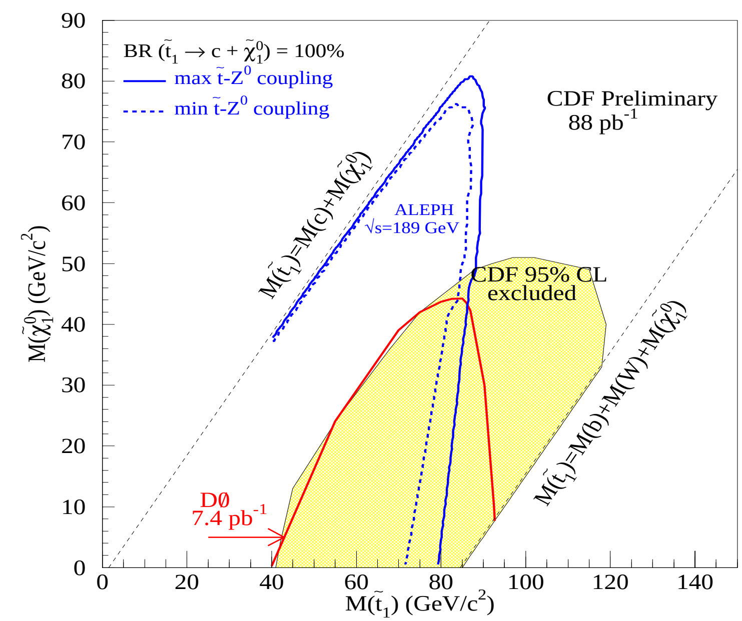
Jets (b,c)+$\not{E}_T$ Final States

CDF searched for events with heavy-quark jets and large missing E_T

b- and c-quark jets are tagged using the vertex information

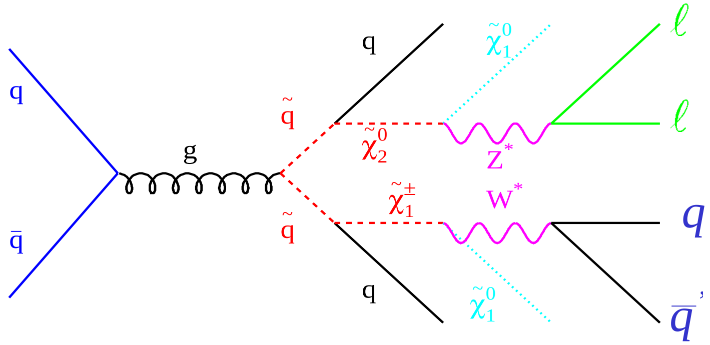






Dilepton Final State

Squarks and gluinos can also result in dilepton final states



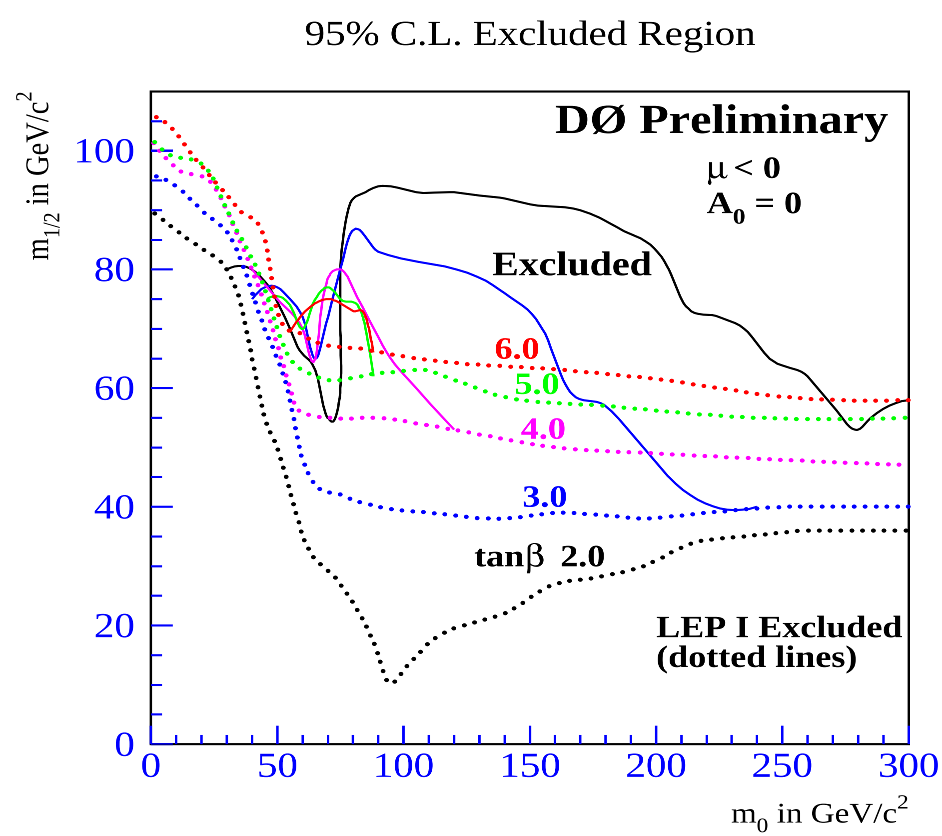
Signature:
dilepton events with
two jets and large missing E_T

$$p\bar{p} \rightarrow SUSY \Rightarrow \ell\ell jj + \not{E}_T$$

Advantage:
- Relative small background

Disadvantage:
- Small production rate
- Low efficiency

DØ: ε~0.5%



Like-Sign Dileptons

CDF searched for
$\ell^{\pm}\ell^{\mp}jj$ **events**

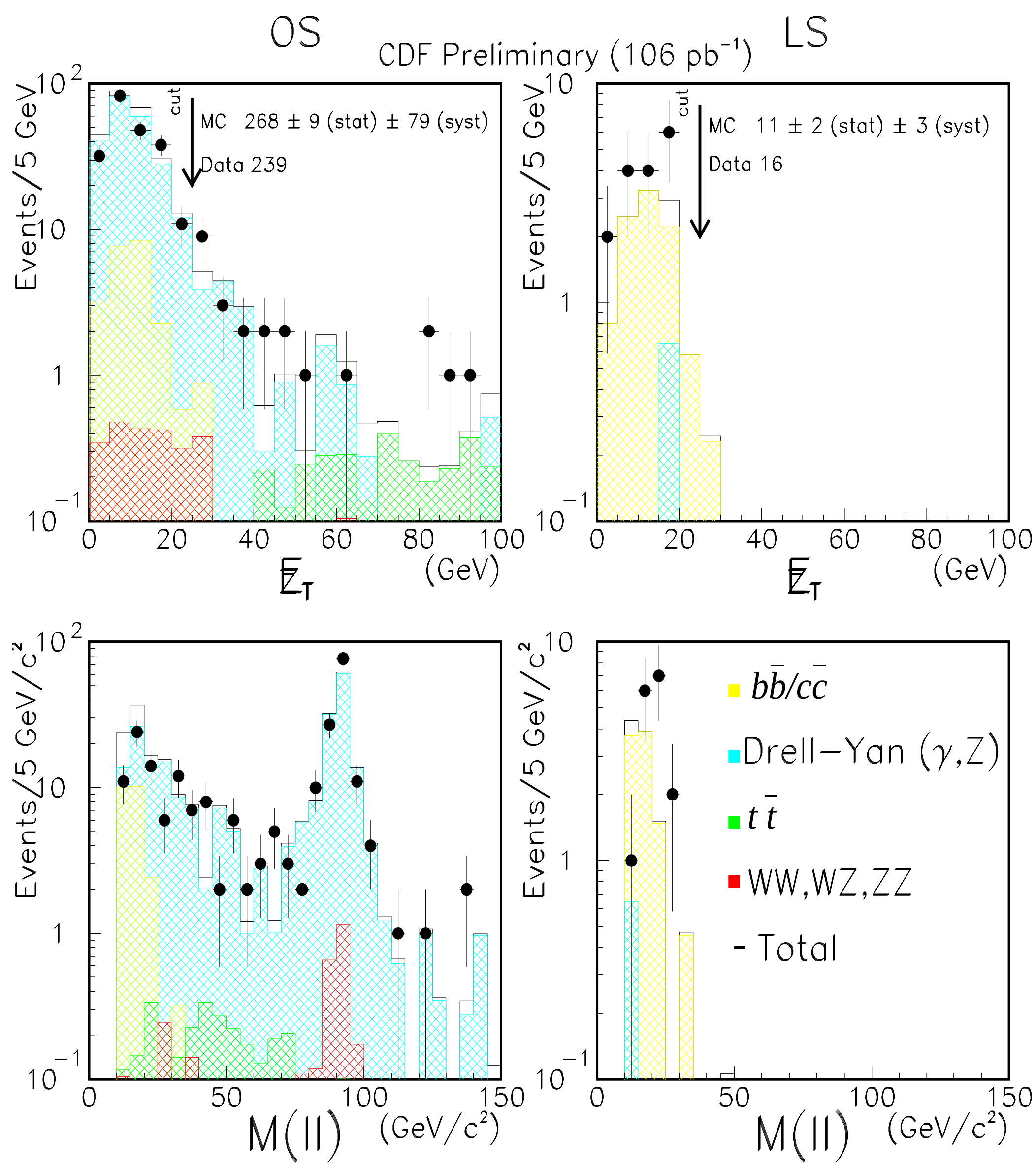
Expected from:

$$\tilde{g}\tilde{g} \to (\bar{c}\tilde{c})(\bar{c}\tilde{c})$$
$$\Rightarrow \bar{c}\bar{c}(\ell^{+}d)(\ell^{+}d)$$
$$\tilde{q}\tilde{\bar{q}} \to (\bar{q}\tilde{\chi}_1^0)(q\tilde{\chi}_1^0)$$
$$\Rightarrow q\bar{q}(q\bar{q}'\ell^{\pm})(q\bar{q}'\ell^{\pm})$$

……

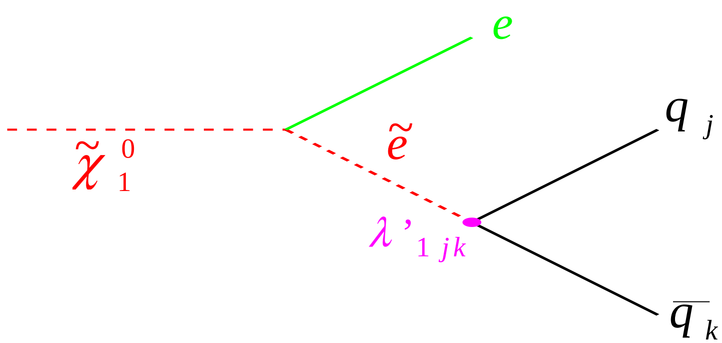
Very small background

No events observed with 0.6±0.3 expected background events



Dilepton+Jets Final State

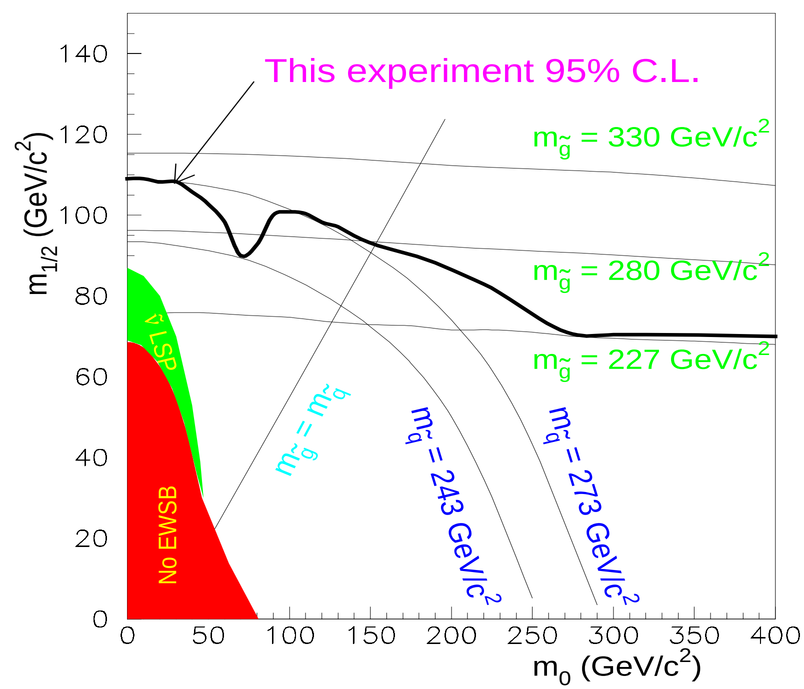
D0 Studied the case that all $R\!\!\!/_p$ couplings are small except λ'_{1jk} within the framework of mSUGRA



Signature:
two electrons with four jets and no missing E_T

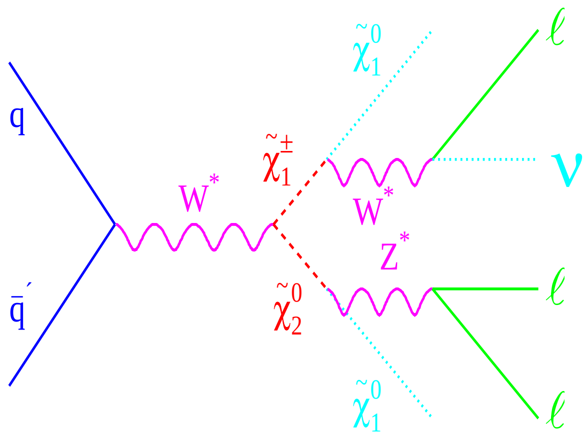
$$p\bar{p} \rightarrow SUSY \Rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow eejjjj$$

Backgrounds:
- **Misidentification**
- **Drell-Yan process**



Two events observed with 1.8±0.4 events expected

Trilepton Final State



Production of $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ will lead to trilepton events with $\not{E}_T$

One of the cleanest signatures of supersymmetry

Both CDF (106 pb^{-1}) and DØ (~90 pb^{-1}) searched for eee, eeμ, eμμ, μμμ **events in Run I**
PRL 80, 5275 (1998), PRL 80, 1591 (1998)

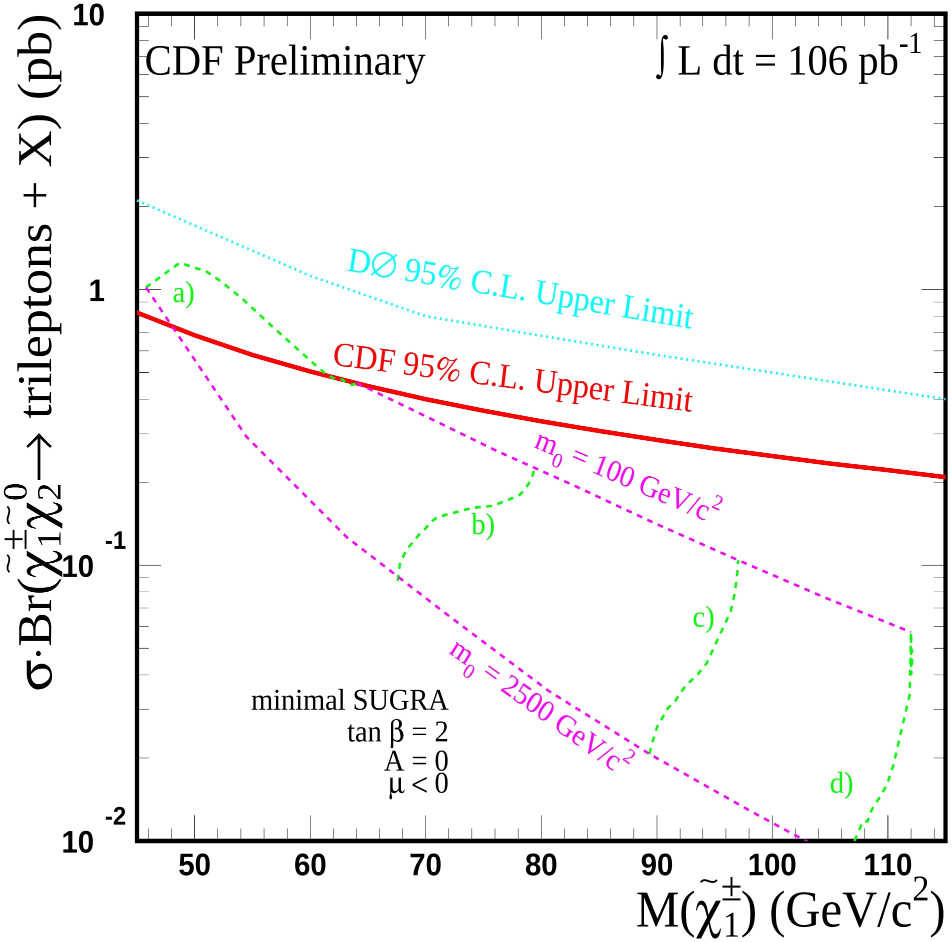
Main backgrounds are WZ, top quark, misidentification

No events were observed in either experiment
The expected # of background events is 1.2±0.2 for CDF and 1.3±0.4 for DØ

Charginos and Neutralinos

The null results were interpreted within the framework of MSSM models which give

$$m_{\tilde{\chi}_1^\pm} \approx m_{\tilde{\chi}_2^0} \approx 2m_{\tilde{\chi}_1^0}$$



The typical efficiency is 3-12% for CDF and 2-6% for DØ when chargino mass is varied from 50 to 100 GeV

Advantage:

Small background

Disadvantage:

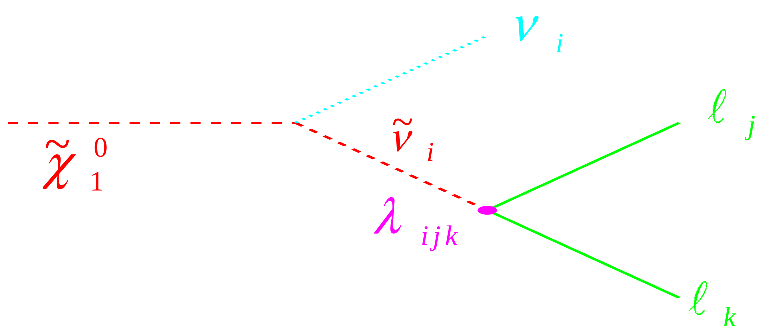
Small cross section

Low efficiency

Similar to dilepton in top quark search and discovery

Four Lepton Final State

CDF studied the case with a dominant λ'_{121} in the mSUGRA framework



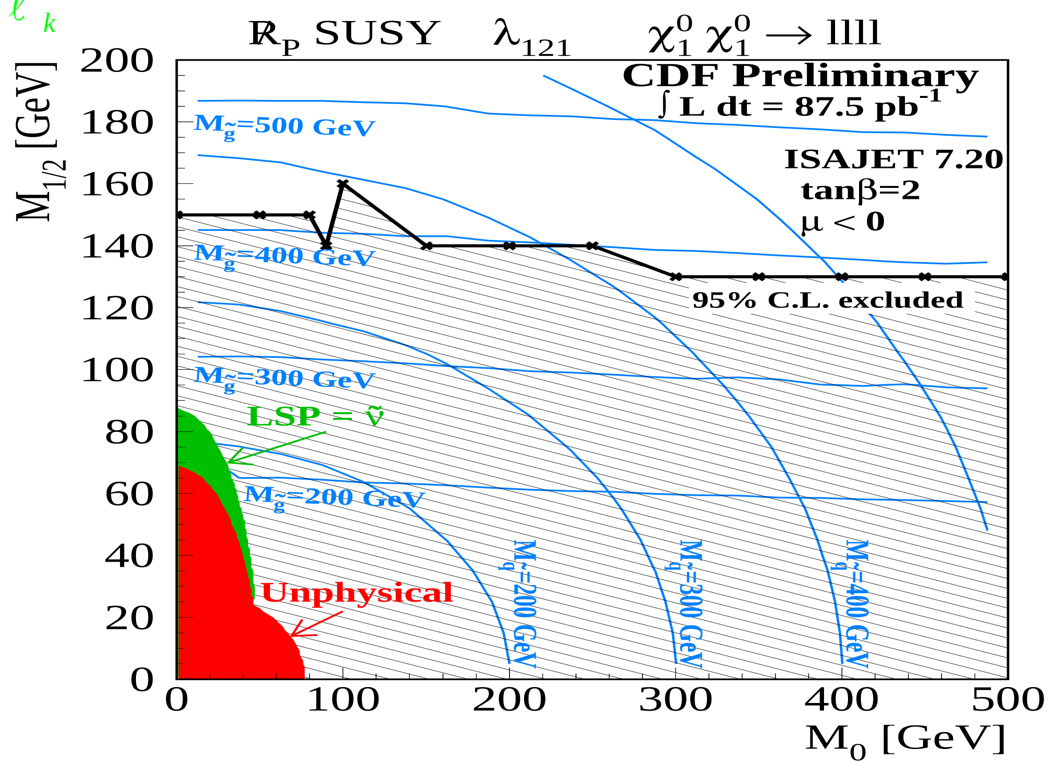
$$p\bar{p} \rightarrow SUSY \Rightarrow \tilde{\chi}^0_1\tilde{\chi}^0_1 \rightarrow \ell\ell\ell\ell + X$$

Signature:
Events with four leptons

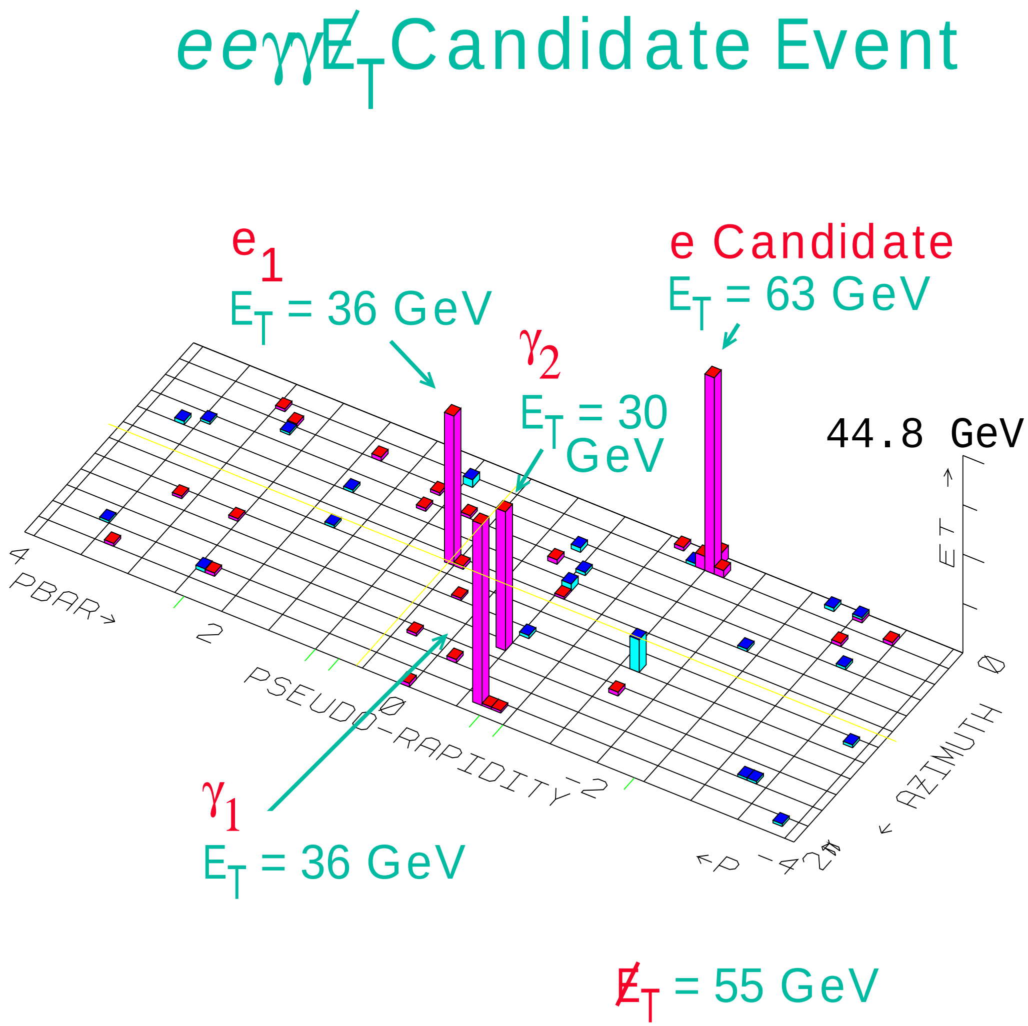
Advantage:
Very clean signature

Disadvantage:
Low efficiency

One event observed compared with 1.3±0.4 events expected



CDF $ee\gamma\gamma\not{E}_T$ Event



Much publicity has accompanied the CDF event

It is unusual because isolated leptons, photons, and especially large missing E_T are rare in the Standard Model

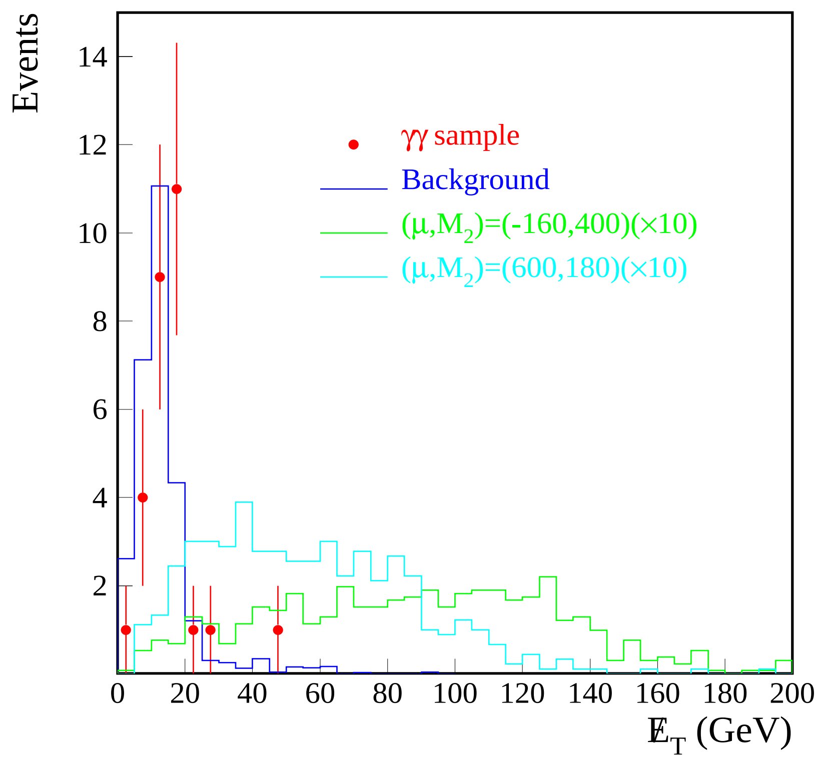
The probability for the event to be resulted from known process is small.

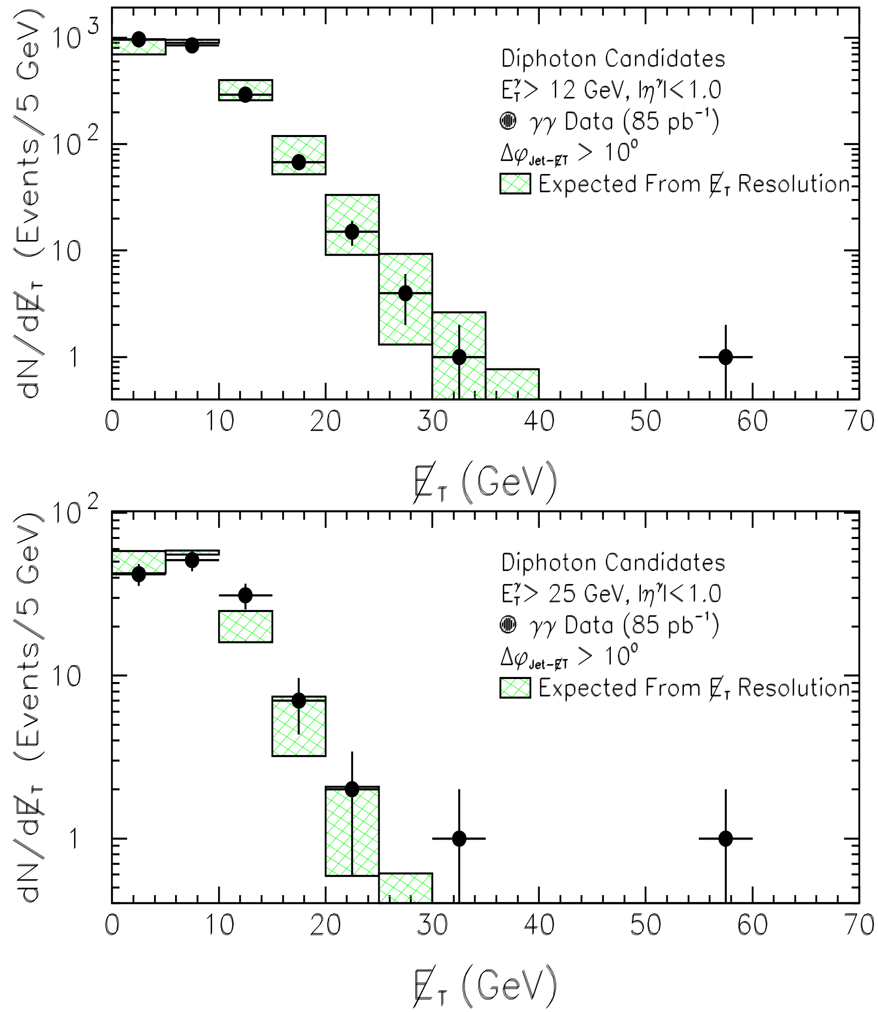
PRL 81, 1791 (1998)

$\gamma\gamma\not{E}_T$ Final State

Both CDF and DØ searched for $\gamma\not{E}_T$ events and no significant excess was found

CDF: PRD 59, 092002 (1999)
DØ: PRL 80, 442 (1998)





$\gamma \not{E}_T$+Jets Final State

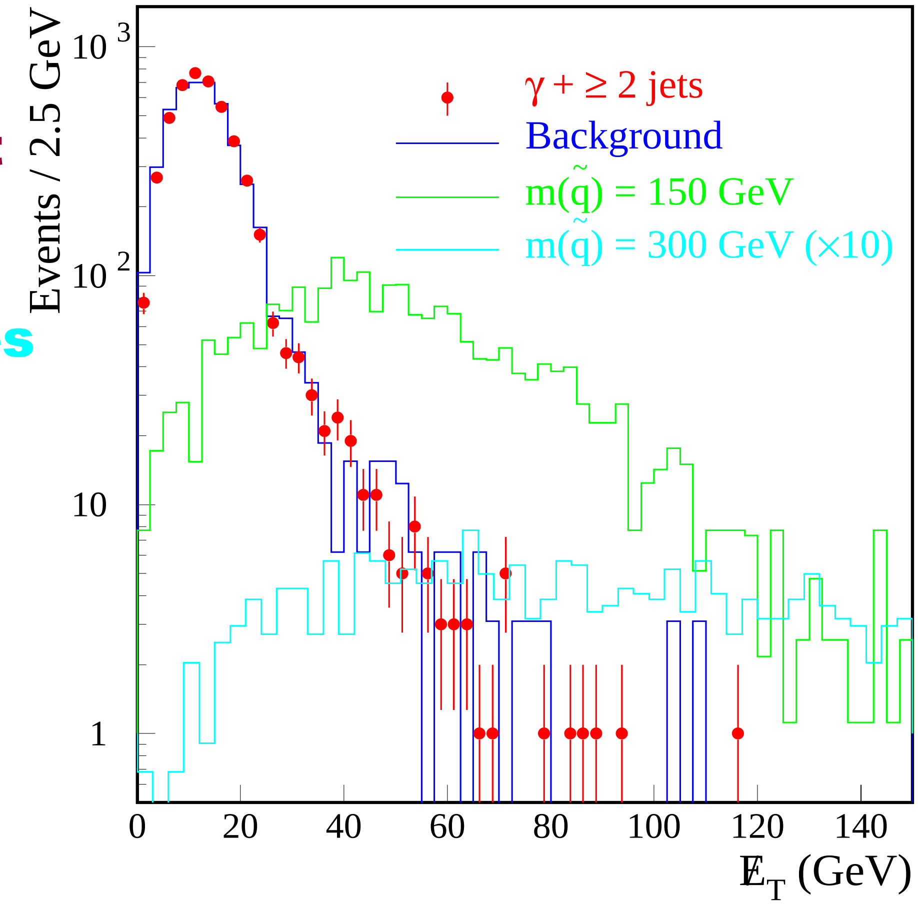
DØ (99 pb^{-1}) also searched for single-photon events with two or more jets and large missing E_T

Phys. Rev. Letters 82, 29 (1999)

Major background from missing E_T mismeasurement

The missing E_T distributions of signal and control samples agree very well

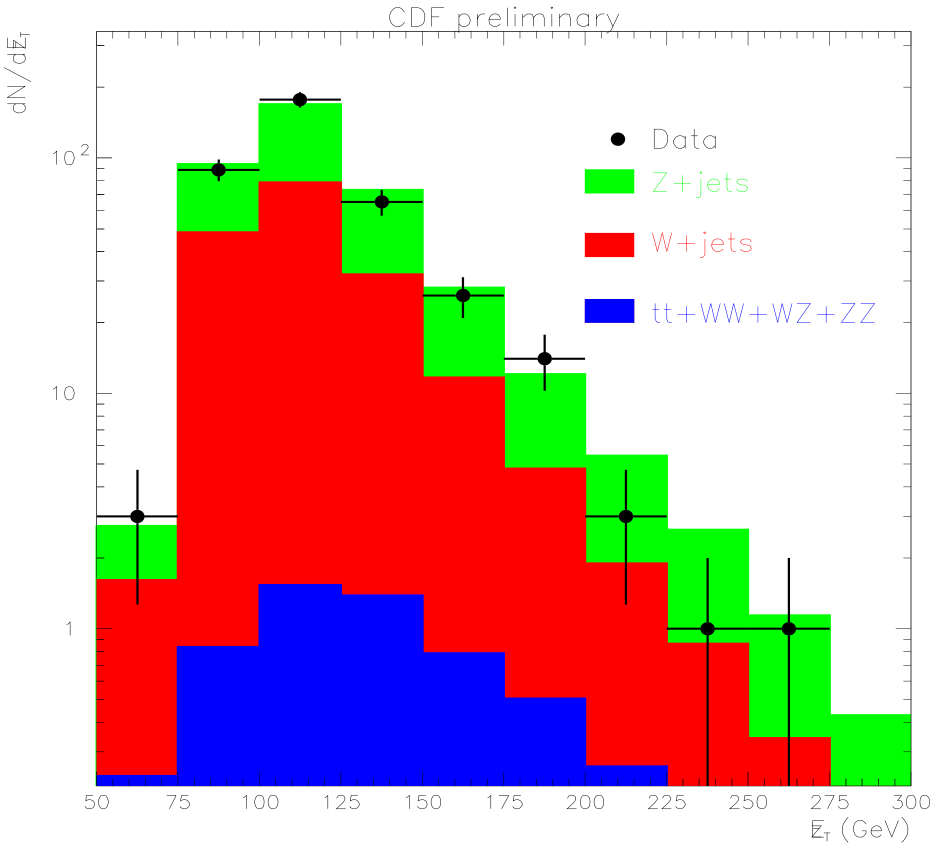
For missing E_T>25 GeV, 318 events selected with 320±20 events expected



Monojet Final State

If the gravitino is light and all other super-partners are heavy, it could be the only super-partner produced at Tevatron

$$q\bar{q} \rightarrow \tilde{G}\tilde{G}g \quad qg \rightarrow \tilde{G}\tilde{G}q \quad gg \rightarrow \tilde{G}\tilde{G}g$$



Signature:
high E_T monojet events

Large background from W/Z and top quark production

Five events observed while 10±3 events are expected

Since $\sigma \propto m_{\tilde{G}}^{-2}$

$$m_{\tilde{G}} > 1.2 \times 10^{-5}\ eV$$

$$\sqrt{F} > 221\ GeV$$

Long-lived Neutralino

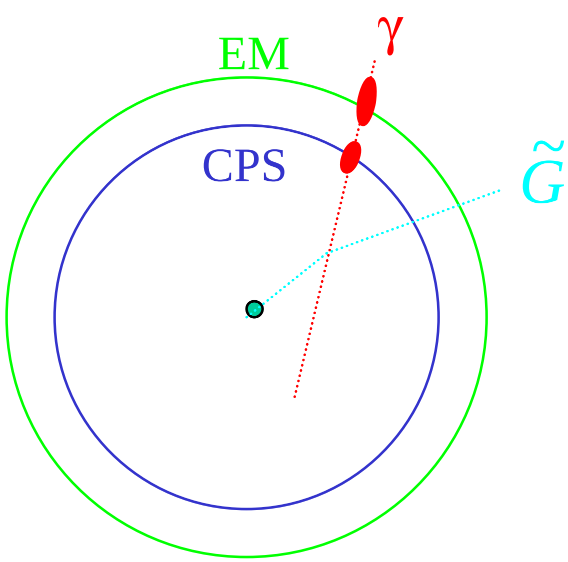
$\tilde{\chi}_1^0 \rightarrow \gamma \tilde{G}$

0.1mm 1mm 1cm 10cm 1m 10m $\gamma c \tau$

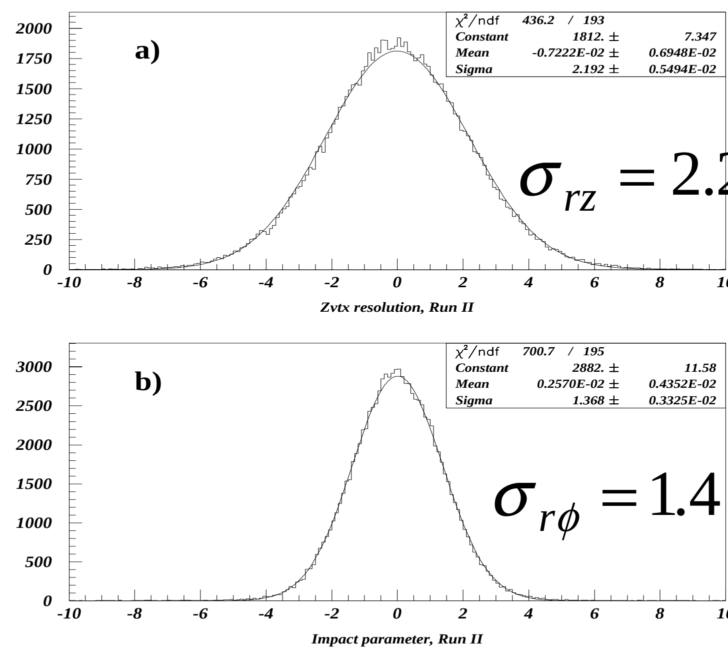
Photons as we know

Impact parameter

Hot cell



Central Region



$\sigma_{rz} = 2.2$ cm

$\sigma_{r\phi} = 1.4$ cm

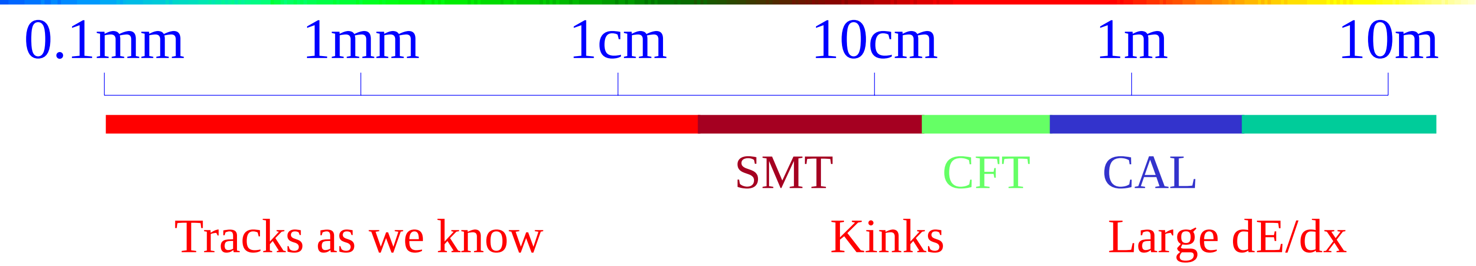
Similar resolutions in forward region

$\sigma_{r\phi} = 1.2$ cm $\sigma_{rz} = 2.8$ cm

[D. Cutts & G. Landsberg hep-ph/9904396]

Long-lived Slepton

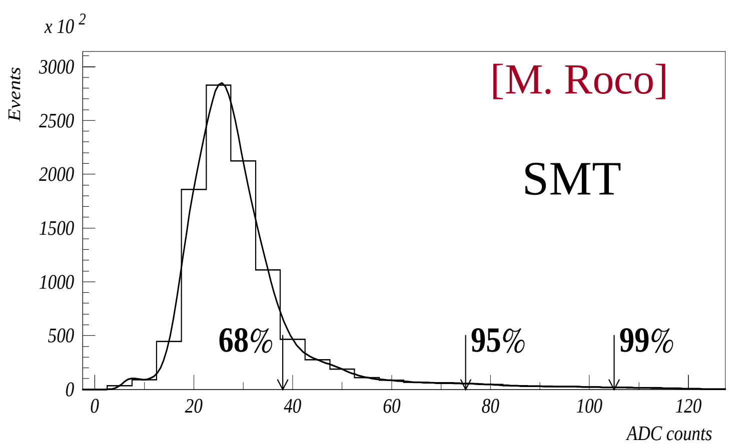
$\tilde{\ell} \to \ell \tilde{G}$

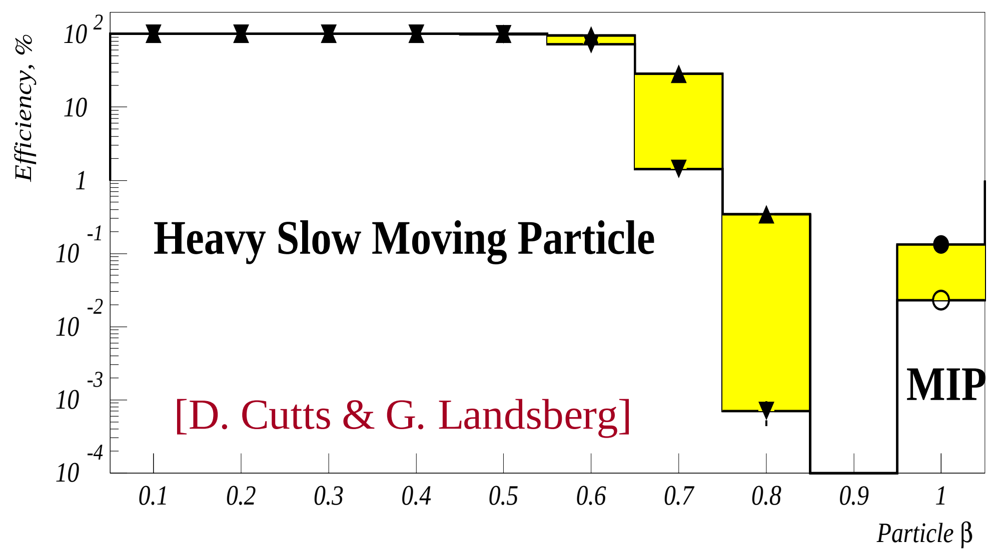


Tools for massive stable charged particles (MSP)

dE/dx information from

1) Silicon
2) Fiber tracker
3) Preshowers
4) Calorimeter

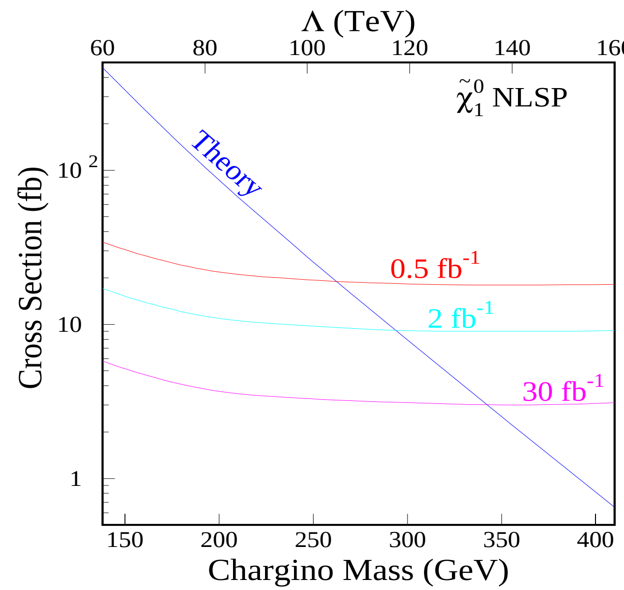




An efficiency of 68% for MSP and
a rejection factor of 10 for MIP are assumed

MGM with a Neutralino NLSP

$$p\bar{p} \rightarrow \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0} \rightarrow \tilde{\chi}_1^{0}\tilde{\chi}_1^{0} + X$$
$$\Rightarrow \gamma\gamma \not{E}_T + X \text{ (prompt } \tilde{\chi}_1^0 \rightarrow \gamma\tilde{G})$$
$$\Rightarrow \gamma jj \not{E}_T + X \text{ (delayed } \tilde{\chi}_1^0 \rightarrow \gamma\tilde{G})$$

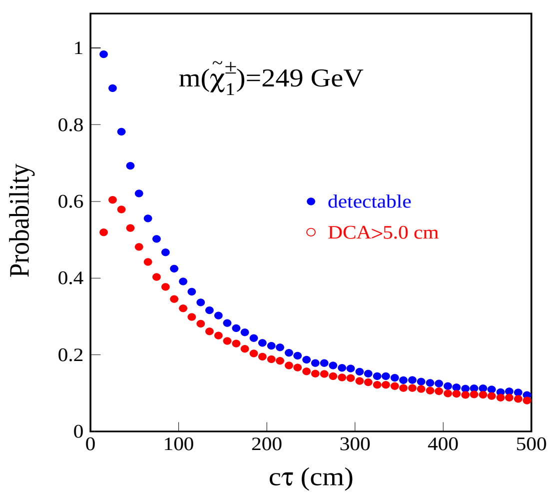


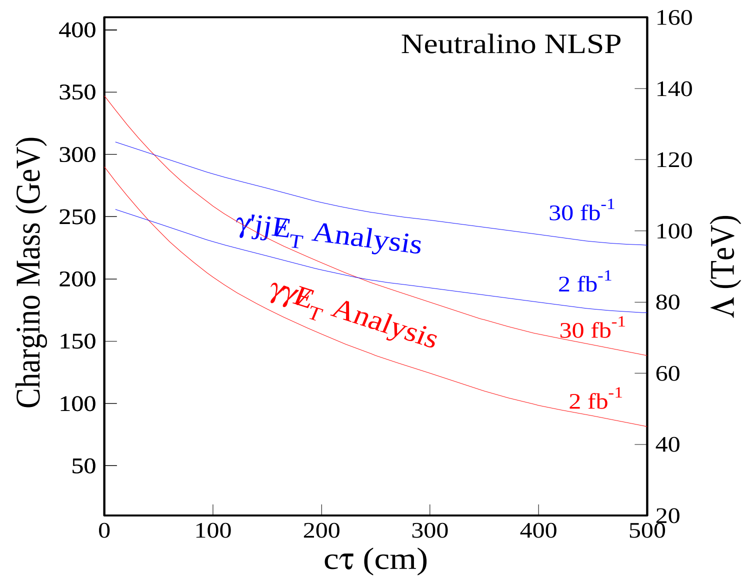
$\gamma\gamma\not{E}_T + X$

- Cuts: ≥2γ, E_T>20 GeV, $\not{E}_T$>50 GeV
- Backgrounds
  - 0.4 fb (QCD)
  - 0.2 fb (Fakes)
- Efficiency: 15–30%
- 5σ reach: $M_{\tilde{\chi}_1^{\pm}} < 290$ GeV

$\gamma jj\not{E}_T + X$

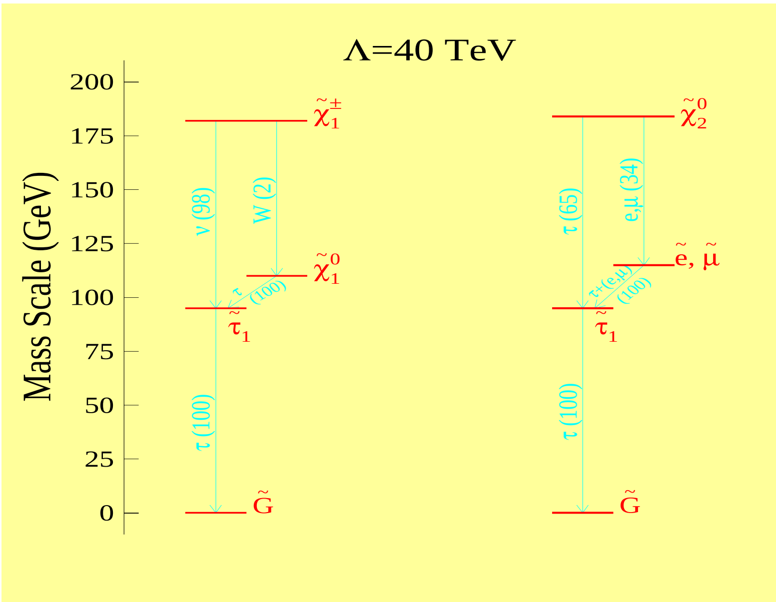
- Cuts: ≥1γ', E_T>20 GeV, $\not{E}_T$>50 GeV
- Backgrounds: 0.6 fb
- Efficiencies: varies





[JQ: hep-ph/9903548]

MGM with a Stau NLSP



Prompt $\tilde{\tau}_1 \to \tau \tilde{G}$

$\ell\ell\ell j \not{E}_T$

Cuts: $p_T^\ell > 15{,}5{,}5$ GeV, $E_T^j > 20$ GeV, $\not{E}_T > 20$ GeV

$\ell^\pm \ell^\pm jj \not{E}_T$

Cuts: $p_T^\ell > 15$ GeV, $E_T^j > 20$ GeV, $\not{E}_T > 25$ GeV

Background: 0.7 fb

Efficiency: 0.5–3.5%

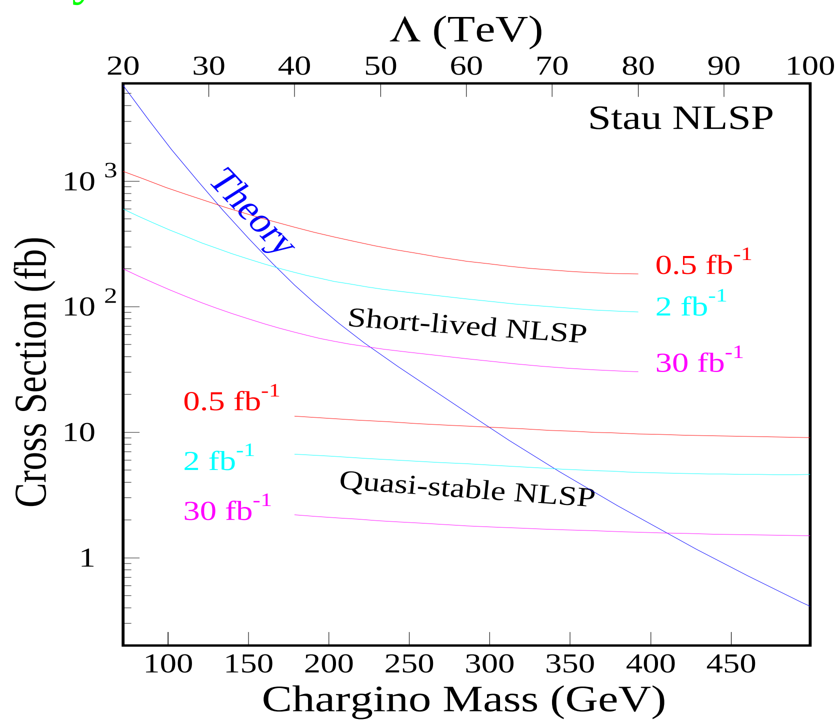
Quasi-stable $\tilde{\tau}_1$

$\ell\ell + dE/dx$

Cuts: $p_T^\ell > 50$ GeV, $M_{\ell\ell} > 150$ GeV, dE/dx

Background: 0.5 fb

Efficiency: 35–55%



[JQ: hep-ph/9903548]

Slepton and Higgsino NLSPs

$\tilde{\ell} \to \ell \tilde{G}$

Prompt: $\ell\ell\ell j \not{E}_T + X$

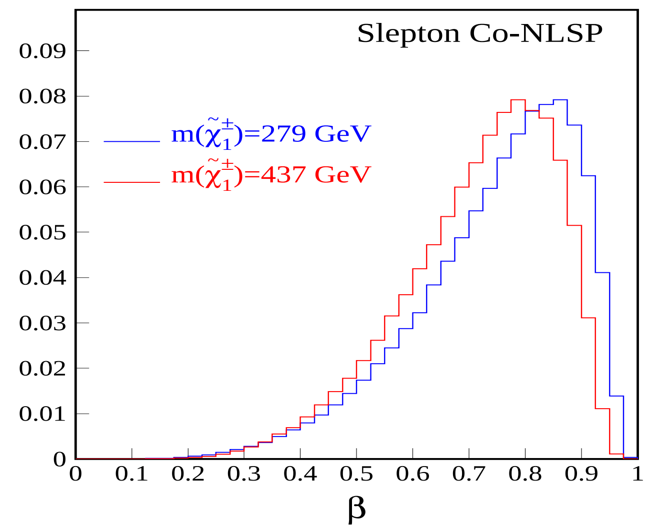
Efficiency: 1-15%

5σ reach: $M_{\tilde{\chi}_1^\pm} < 250$ GeV

Quasi-stable: $\ell\ell + dE/dx$

Efficiency: 30-50%

5σ reach: $M_{\tilde{\chi}_1^\pm} < 330$ GeV



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

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

Prompt decay

$\Rightarrow \gamma bj \not{E}_T + X$ events

$\geq 1\gamma$ with $E_T > 20$ GeV

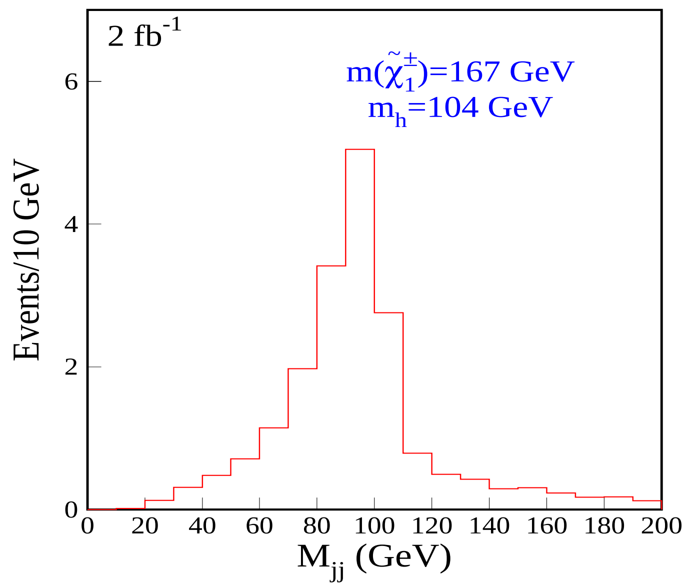
≥ 2j with $E_T > 20$ GeV

≥ 1 tagged b-jet

$\not{E}_T > 50$ GeV

Backgrounds: 0.4 fb

using $P(j \to b) = 10^{-3}$



Physics We Do

1) **Measurement of standard model parameters**
   Quark/lepton masses, coupling constants,
   CKM matrix elements

2) **Measurement of things with no reliable calculations**
   Cross sections of high order QCD processes,
   branching ratios of rare decays, ...

3) **Test of standard model**
   W/Z physics, top quark, B physics, ν physics, ...

4) **Searches for new phenomena**
   Supersymmetry, leptoquarks, technicolors, ...

Why are we doing these?

Search for New Physics!

Search Strategies

Any search has to answer two questions:

(1) Do data agree with expectation?
(2) What is the implication on theory?

Despite its beauty, world may not be supersymmetric
Even it is, all but one models are wrong

As experimentalists, we need to

(1) Focus on data, on event topology
(2) Have great interest in tails of distributions
(3) Pay special attention to rare events

Models are theorist's lifeline for papers
We make our living on data!

Summary

No evidence for (against) supersymmetry

It is unlikely that we can ever exclude supersymmetry

We can make discoveries through supersymmetry searches

with God's help

R-parity Violation

$$p\bar{p} \rightarrow SUSY \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 + X$$
$$\Rightarrow (\ell \tilde{\ell})(\ell \tilde{\ell}) + X \Rightarrow (\ell q \bar{q}')(\ell q \bar{q}') + X$$

Using mSUGRA framework as a measure of sensitivity
$\tan\beta = 2$, $A_0 = 0$, $\mu < 0$

$$p\bar{p} \Rightarrow \ell\ell + \geq 4\,\text{jets} \quad (\ell = e, \mu)$$

Sensitive to couplings λ'_{1jk} and λ'_{2jk}

λ'_{1jk}

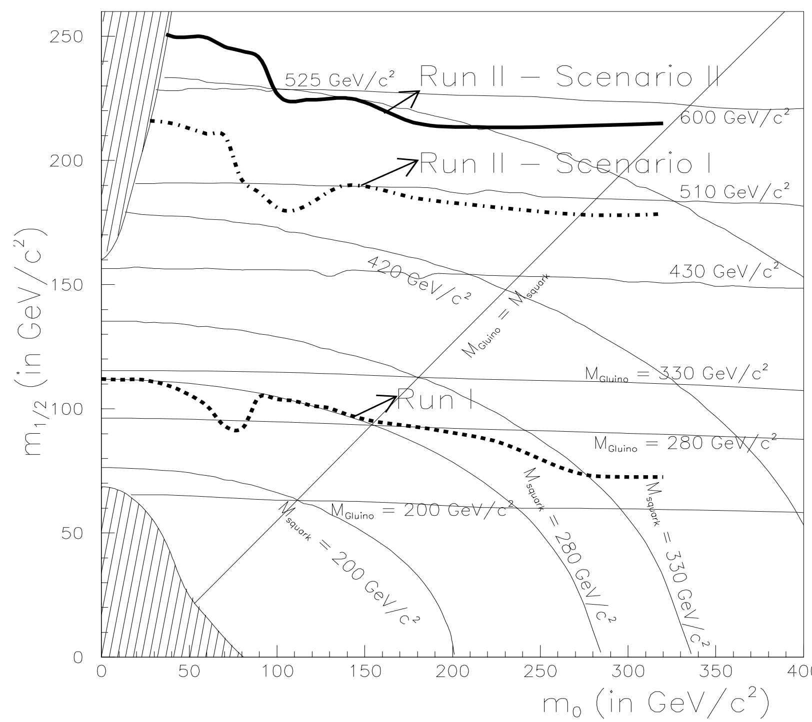
Extrapolating from Run I *eejjjj* analysis:

Selection:

- $\geq 2\ell$ with $E_T > 15{,}10$ GeV
- $\geq$ 4jets with $E_T > 15$ GeV
- $Z \rightarrow \ell\ell$ veto

Backgrounds:

- DY + 4 jets
- $t\bar{t} \rightarrow \ell\ell$ + jets
- Fakes



[N. Parua et al.: hep-ph/9904397]