Disclaimer

This note has not been internally reviewed by the DØ Collaboration. Results or plots contained in this note were only intended for internal documentation by the authors of the note and they are not approved as scientific results by either the authors or the DØ Collaboration. All approved scientific results of the DØ Collaboration have been published as internally reviewed Conference Notes or in peer reviewed journals.

DØ note
2151

Review of SUSY Searches at DØ

Chang Kee Jung
SUNY at Stony Brook

June 2, 1994
DØ col. Meeting
Fermilab

◎ Outline

- SUSY
- MSSM
- SUGRA inspired MSSM
- List of SUSY searches at DØ
- Squark / Gluino searches
- Chargino / Neutralino searches
- Top squark searches
- Conclusions and Future Outlook

⑩ Supersymmetry

⇒ provides connection between bosons & fermions

→ predicts "Superpartner" for each Known partick

⇒ a spacetime symmetry: indep. of all internal sym.

→ Superpartners have same internal Q.#'s

- same couplings
- calculable cross-sections
- calculable decay rates

⇒ introduces new multiplicative Q.#. "R-parity"

+1 for "normal" Known particles

−1 for "SUSY" particles

if R-parity is assumed to be conserved,
the Lightest Supersymmetric Particle (LSP)
is absolutely stable.

What Supersymmetry accomplishes (in theory)...

⇒ solves quadratic divergence problem "so-called fine tuning problem" with the elementary scalar mass arising from radiative loop corrections in the SM. (Fermion loops are now canceled by boson loops.)

⇒ provides dark matter candidate (the LSP) for R-parity conserving models

⇒ provides SUSY GUT Models (e.g. SUSY SU(5)) that are consistant w/ the experimental proton lifetime limit.

⇒ unifies the U(1), SU(2), SU(3) couplings at $\sim 10^{16}$ GeV for SUSY SU(5) SUGRA model consistant w/ the LEP measurements of the running of coupling constants

⇒ SUSY is still the most attractive extensions of the SM

3 The Minimal Supersymmetric Standard Model (MSSM)

⇒ Supersymmetric extension of SM w/ fewest new particl

⇒ Adds second Higgs doublet

Standard Model States		SUSY Partners	
Particle name	Symbol	Sparticle name	Symbol
quark	q	squark	$\tilde{q}_L$, $\tilde{q}_R$
lepton	l	slepton	$\tilde{l}_L$, $\tilde{l}_R$
neutrino	ν	sneutrino	$\tilde{\nu}$
gluon	g	gluino	$\tilde{g}$
charged Higgs	$H^{\pm}$		$[\chi_i^{\pm}]$
charged weak boson	$W^{\pm}$	chargino	$\tilde{W}_i$ i=1,2
light Higgs	h		
heavy Higgs	H		$[\chi_i^{\circ}]$
pseudoscalar Higgs	A	neutralino	$\tilde{Z}_i$ i=1,2,3,4
neutral weak boson	Z°		
photon	γ		

⇒ R-parity conservation

→ LSP escape collider detector → $\not{E}_T$

→ $\tilde{\nu}$ or $\tilde{\chi}_1$ most likely LSP candidates

ⓐ The Supergravity (SUGRA) inspired MSSM

⇒ MSSM, w/o further assumptions, has too many arbitrary parameters

→ makes phenomenological analyses intractable

⇒ The SUGRA inspired models provide guidence for mass relations and mixings among sparticles

→ e.g.) • degenerate squark masses are natural in the absence of large Yukawa couplings

• if $m_{\tilde{q}} \tilde{=} m_{\tilde{q}}$, then $m_{\tilde{l}} < m_{\tilde{q}}$.

⇒ In fact, if the following four parameters are chosen at GUT scale, all sparticle masses and mixings and couplings are calculable.

- m_0 : common scalar mass
- $m_{1/2}$: common gaugino mass
- A : trilinear term
- $\tan\beta$: ratio of VEV's of the two Higgs doublets
- $\mathrm{sign}(\mu)$: the higgsino mass mixing parameter

$\Rightarrow$ Since it is rather difficult to work w/ GUT scale masses, in practice the following parameters are commonly used as input parameters

$m_{\tilde{q}_{L,R}}$ (m_0) $\rightarrow$ scalar fermion masses

$m_{\tilde{g}}$ $(m_{1/2})$ $\rightarrow$ gaugino masses

$\tan\beta$

A $\rightarrow$ top squark mixing

m_A or m_{H^+} $\rightarrow$ Higgs masses

μ

$m_{\tilde{l}_L}$, $m_{\tilde{l}_R}$, $m_{\tilde{\nu}_L}$

these are <u>ISASUSY</u> generator (by H. Baer et al.) input parameters.

$\rightarrow$ ISASUSY is now part of the standard ISAJET V 7.09

⇒ Currently, the input parameter set in ISAJET has too many indep. parameters. Thus, certain choices of parameter values will create internally inconsistant mass relations among sparticles in the framework of SUGRA-MSSM. This problem is intended to be fixed in the next ISAJET version 8.0.

⇒ In DØ, for all SUSY search analyses, we search for SUSY particles in the framework of the SUGRA inspired MSSM w/ some further assumptions for each analysis.

◎ List of SUSY searches at DØ

Search for

- $\tilde{g}/\tilde{q} \longrightarrow$ jets + $\not{E}_T$ — Paterno* (Run 1A, Jung); Goforth* (Run 1A, Wahl); Lyon* (Run 1B, Hadley)
- $\tilde{g}/\tilde{q} \longrightarrow$ leptons + $\not{E}_T$ — Genik* (Run 1B (?), Linnemann); Hapopian
  $\longrightarrow$ like sign leptons + $\not{E}_T$ — Gallas, De
- $\tilde{W}/\tilde{Z} \longrightarrow$ trileptons + $\not{E}_T$ — Sosebee* (Run 1A, A. White); Sawyer; Gass*, Wirjawan* (Run 1B, J. White)
- $\tilde{t}_1$ (top-squark) $\rightarrow c\tilde{Z}_1$ (two jets + $\not{E}_T$) — Claes, Jung, Yamapisawa
- $\tilde{t}_1 \longrightarrow b\tilde{W}_1$ (two leptons + jets + $\not{E}_T$) — Boehnlein, Blessing

(* thesis students)

◎ $\tilde{q}/\tilde{g} \longrightarrow$ jets + $\not{E}_x$ analyses

⇒ important assumptions

- all squarks (excluding top squark) are mass degenerate
- $m_{\tilde{q}} \approx m_{\tilde{l}}$

⇒ choice of MSSM parameter values

- $\tan\beta = 2.0$
- $\mu = -250$ GeV
- $m_{H^+} = 500$ GeV

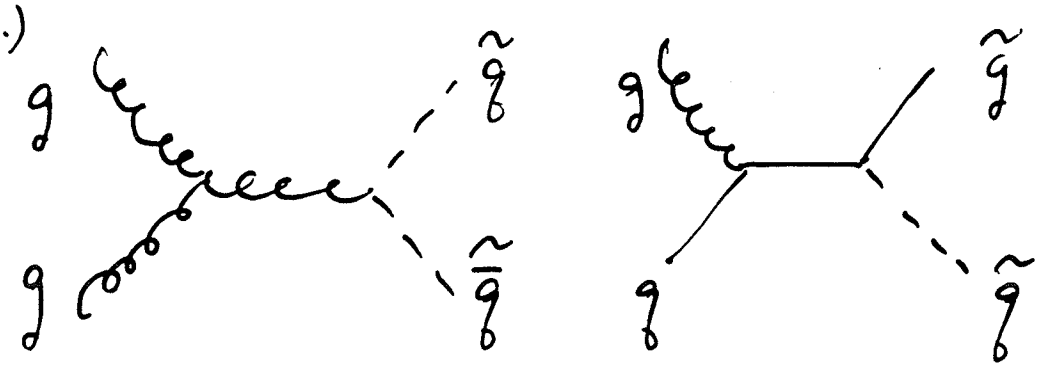
} strictly speaking these are not indep. variables in SUGRA MSSM framework

- Vary $m_{\tilde{q}}, m_{\tilde{g}}$

@ Production of Squarks & Gluinos

- Couple like q and g ; strong production

e.g.)



- Cross section falls rapidly with mass

$m_{\tilde{g}} = m_{\tilde{q}} = 100$ GeV

$\rightarrow \sigma \cong 1.3$ nb

$= 200$ GeV

$\rightarrow \sigma \cong 13$ pb

(calculation from ISASUSY
Baer & Tata)

3) Decays of Squarks and Gluinos

- All decay chains end w/ 1 stable LSP ($= \tilde{Z}_1$)
- Decays are often through cascades of $\tilde{W}_i$, $\tilde{Z}_i$ down to $\tilde{Z}_1$
- Values of 5 input parameters uniquely determine branching fractions
- Cascades can produce ~~$\hat{q}$~~, multiple quarks gluons, leptons in addition to $\tilde{Z}_1$.

e.g.) two possible modes

$\tilde{g} \longrightarrow q\bar{q}\tilde{q}$ (for $\tilde{g}$ heavier than $\tilde{q}$)

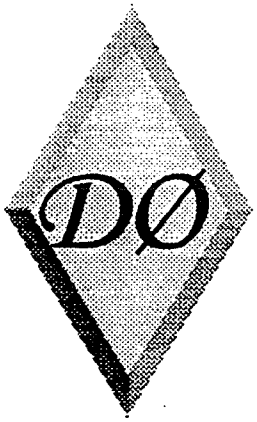
$\quad\quad \hookrightarrow q\tilde{Z}_2$

$\quad\quad\quad \hookrightarrow q\bar{q}\tilde{Z}_1$

$\tilde{g} \longrightarrow q\bar{q}\tilde{Z}_2$ (for $m_{\tilde{g}} < m_{\tilde{q}}$)

$\quad\quad \hookrightarrow l\bar{l}\tilde{Z}_1$

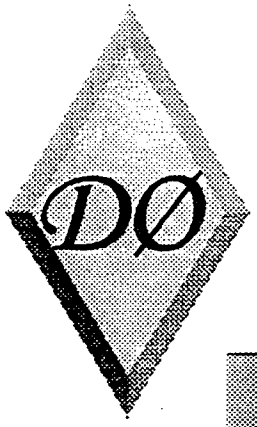
Paterno



General Search Strategy

- Experimental Signature:
  - LSP does not interact —produces ME_T
  - Multiple jets (3 or more)
  - No leptons
- Major Backgrounds:
  - Missing E_T from W and Z + jets
    - $W \rightarrow e\nu, \mu\nu, \tau\nu$
    - $Z \rightarrow \nu\nu, \mu\mu, \tau\tau$
    - Reject leptons to remove these
  - Missing E_T from mismeasured QCD multijets
    - Demand large Missing E_T
    - Reject jet-Missing E_T correlation

Paterno

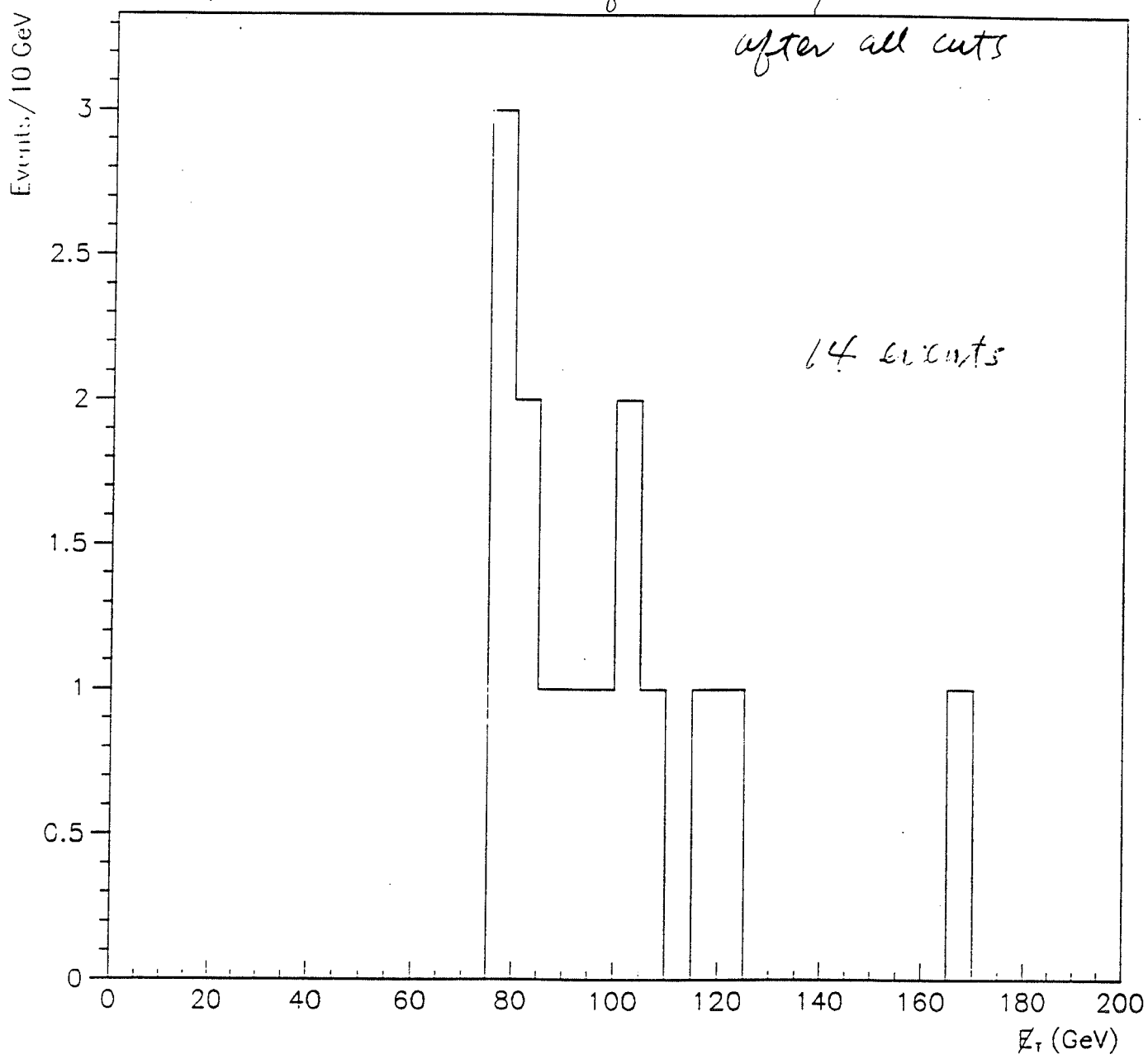


Analysis Results

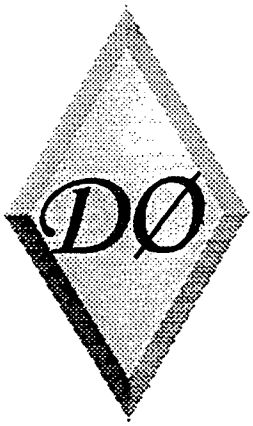
Cut	# of events passing
trigger/offline filter	9625
single interaction	3730
$ME_T > 75$ GeV	107
3 jets $E_T > 25$ GeV	47
leading jet not in ICR	45
reject jet- ME_T correlation	30
reject electrons & muons	25
reject noise jets	17
scan: 1 cosmic muon, 2 vertex errors	14

Paterno

$\not{E}_T$ distribution of the SUSY candidate events after all cuts



Paterno

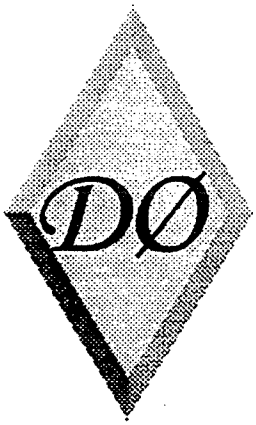


Backgrounds

- W/Z + jets:
  - analyzed with VECBOS/ISAJET generator, GEANT-based detector simulation
  - total of 18.1±1.9 [+7.6/-7.1] events expected
  - Dominant backgrounds
    - $W \rightarrow \mu\nu$ (5.5 events)
    - $Z \rightarrow \nu\nu$ (5.0 events)
    - $W \rightarrow \tau\nu$ (4.3 events)
    - $W \rightarrow e\nu$ (2.5 events)
    - all others (0.8 events)

    } + 2, 3 jets
- QCD with "fake" ME_T
  - analyzed from low E_T jet triggers
  - total of 0.42±0.37 events
- Combined total of 18.5 ±1.9[+7.6/-7.1] events expected
- Number of events in data (14) consistent with SM - no excess seen

Paterno



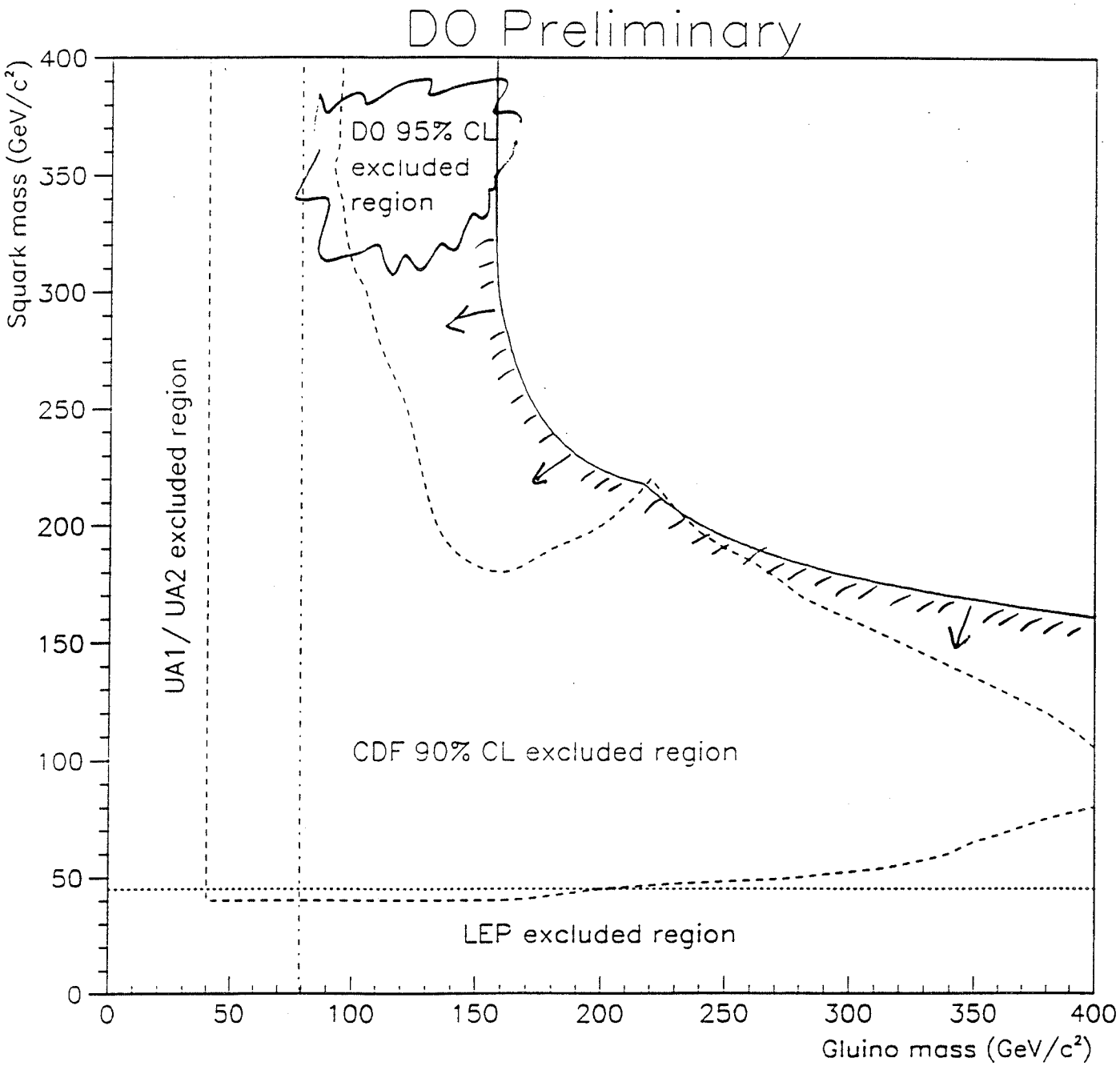
Preliminary Mass Limits

- Leading order cross section from Baer, *et al.*
- Varied scale for α_s and factorization from $4\hat{s}$ to $\hat{s}/4$; variation in mass limit ~10 GeV
- SUSY-GUTs generally have either
  - squark mass $\gg$ gluino mass *or*
  - squark mass $\approx$ gluino mass
- For heavy squarks, we find

  $m_{gluino} > 157$ GeV @ 95% CL
- For equal masses, we find

  $m > 218$ GeV @ 95% CL

Paterno


DO Preliminary
Squark mass (GeV/c²)
Gluino mass (GeV/c²)
D0 95% CL
excluded
region
UA1/ UA2 excluded region
CDF 90% CL excluded region
LEP excluded region
0
50
100
150
200
250
300
350
400

Go forth

◎ $\tilde{q}/\bar{\tilde{q}} \longrightarrow$ hadrons + $\not{E}_T$

Data Sample

Triggers: Jet_Miss, Jet_3_Miss, Missing_Et

SSY Stream Reco 11 (all triggers)	24,847	
Remove Bad Runs, require triggers	8,666	
Multiple Interaction Tool ≤ 2	3,348	
Energy Corrections:	None	Cafix
Clean Jets: ET $\geq$ 20 GeV, $\lvert\eta\rvert \leq 3.5$		
Hot Cell Fraction > 10%	3,077	3,022
# Cells E > 1 GeV $\neq$ 1 or 2	2,897	2,677
Coarse Hadronic Fraction < 40%	2,773	2,530
ICD Fraction < 50%	1,772	1,571
5% < EM Fraction < 90%	1,767	1,561
Clean missing E_T		
All Jets:		
$\pi/32 < \lvert \phi_{\text{missing ET}} - \phi_{\text{jet i}} \rvert < 31/32\ \pi$	1,262	1,019
$\Psi = [\ (\pi-\Delta\phi_{jet1})^2 + \Delta\phi_{jet2}^{\ 2}\ )^{1/2} > 0.5$	901	735
missing E_T > 45 GeV *	125	193
4 or 5 jets *	8	32

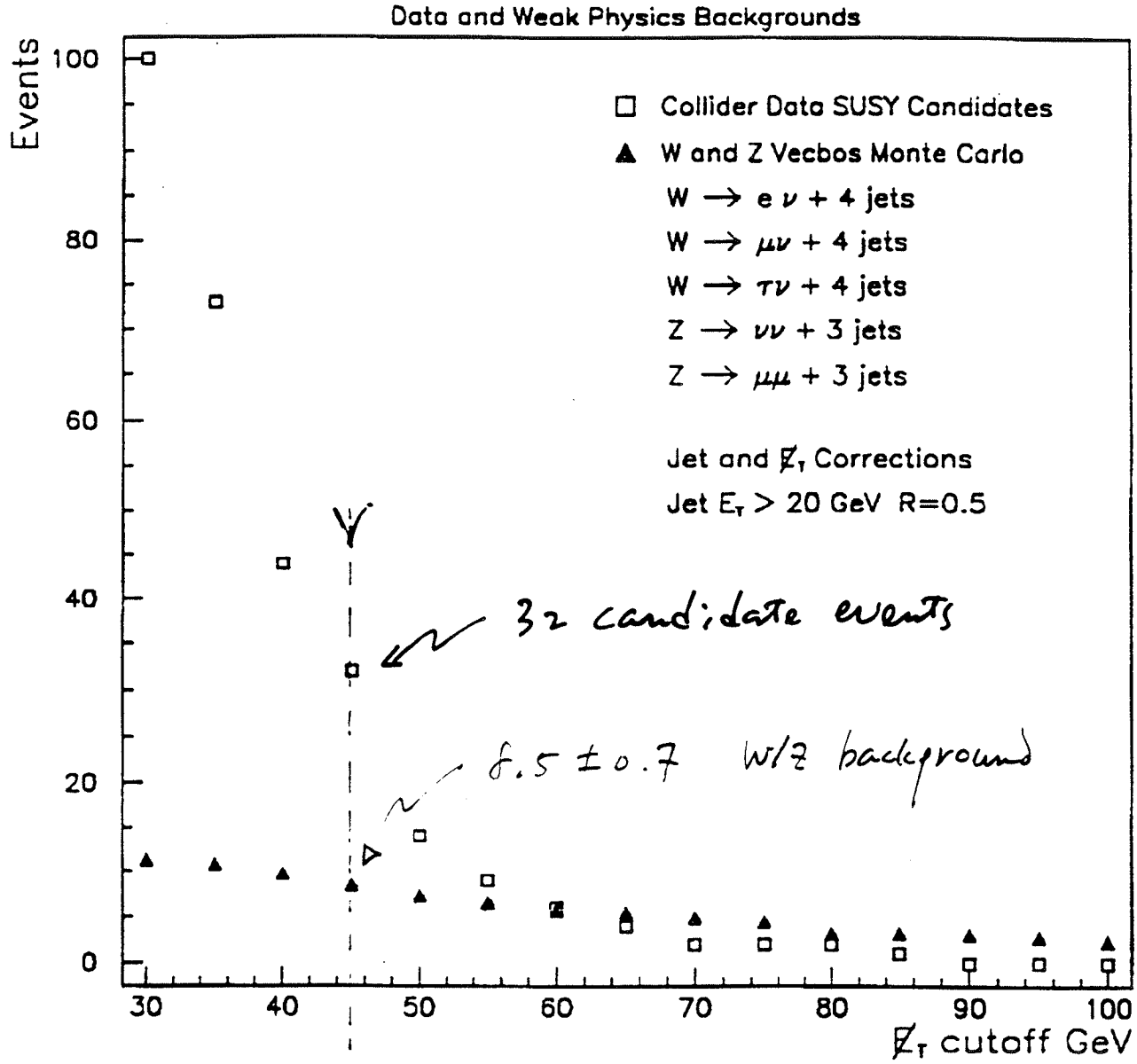
These events have not all been PICKed!

* Paterno cuts

$\not{E}_T > 75$ GeV

3 or more jets

Go forth



$\not{E}_T$ > 45 GeV

4 or 5 jets

Go forth

QCD Background Estimate

- QCD Group's Ntuples (Freedy Nang)
- QCD Jet_Min Trigger
  - Runs 51423 - 65981
  - Integrated L = 8.7 nb^{-1}
  - 254,337 events
  - Reco 10.x
  - Jet Energy Corrected
  - Missing Et corrected with jet energy corrections
- Same cuts applied to sample as with data, except:
  - cone size R=0.7
  - Number of cells in jet not available
  - Mitool » number of CD vertices found
- After all cuts (except missing Et) **222 events** left
  These events have not all been PICKed!
- Integrate missing Et distribution, fit to exponential
  missing Et - cutoff $\in$ [5,30]
  $N_{QCD} = e^{p1 + p2 * x}$ x = missing Et - cutoff
  p1 = 5.91 ± 0.65 p2 = -0.176 ± 0.047 GeV^{-1}
- Missing Et > 45 GeV

Expect 192 QCD events in SUSY Data Sample!

Expect 1 QCD event for Missing Et cut of 75 GeV

ⓐ $\tilde{g}/\tilde{q} \longrightarrow$ leptons + $\not{E}_T$ analyses

$\Rightarrow$ Consider a case; $m_{\tilde{g}} \gtrsim m_{\tilde{q}}$, then

$m_{\tilde{l}}$ can be significantly lighter than $m_{\tilde{q}}$

$\rightarrow$ more leptons in the final state

$\Rightarrow$ trigger study has begun recently w/ full DØ GEANT / RECO MC events

$\rightarrow$ no immediate trigger concerns

$\Rightarrow$ Two lepton event signature will have usual $t\bar{t}$ backgrounds

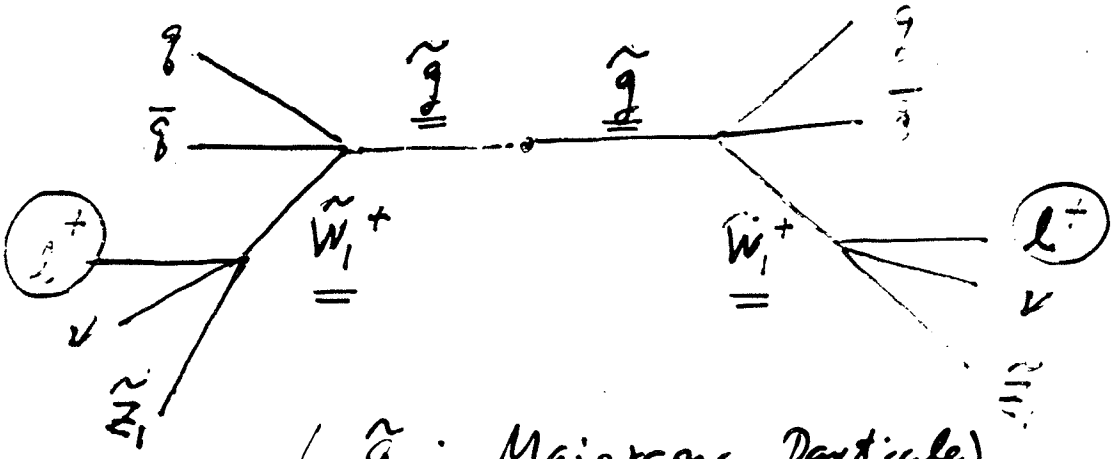
$\Rightarrow$ Three lepton final state is possible through cascade decays involving:

$\tilde{W}_2 \longrightarrow l\nu\tilde{Z}_1$, $\tilde{Z}_2 \longrightarrow ll\tilde{Z}_1$

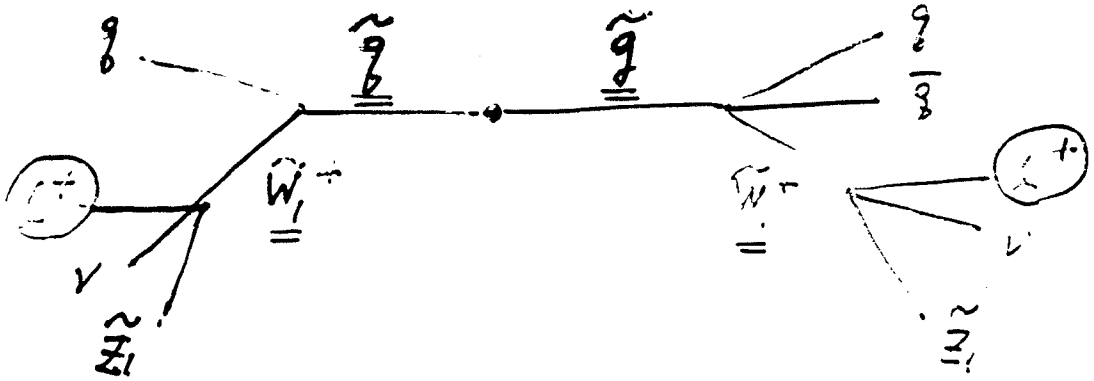
$\rightarrow$ small background

$\rightarrow$ possible analysis at DØ

⇒ Also, same sign isolated dilepton final state is possible



($\tilde{g}$: Majorana particle)



→ backgrounds very tiny

→ But, requires good measurement of sign of lept

→ at DØ, under investigation

→ most likely, it will require > 100 pb^{-1} of Data

◎ $\tilde{W}_1 / \tilde{Z}_2 \longrightarrow$ trilepton + $\not{E}_T$ analysis

$\Rightarrow$ important assumptions

- all squarks are mass degenerate
- $m_{\tilde{\ell}} < m_{\tilde{q}}$

$\Rightarrow$ choice of MSSM parameter values

- $\tan\beta = 2 \sim 10$
- $\mu = -500 \sim 500$
- $m_{\tilde{q}} = 500$ GeV
- $m_{\tilde{\ell}} = 200$ GeV
- Very $m_{\tilde{q}}$
- $m_{H^+} = 500$ GeV

S. Sabes

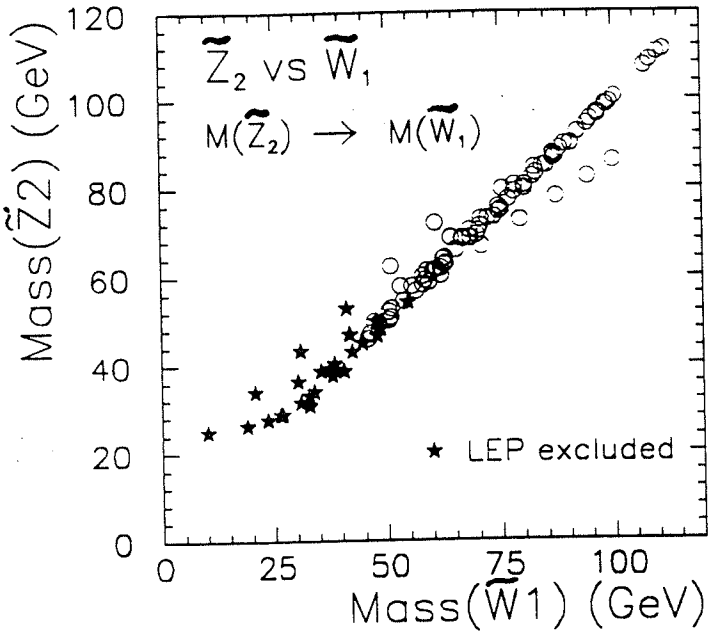
(SUGRA) MSSM Mass Correlations

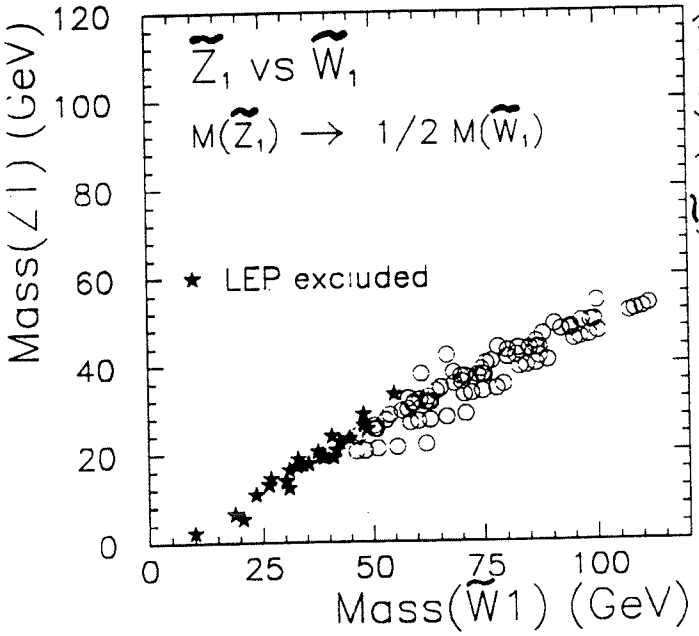
MSSM Correlations
(ISASUSY – Baer, et al)

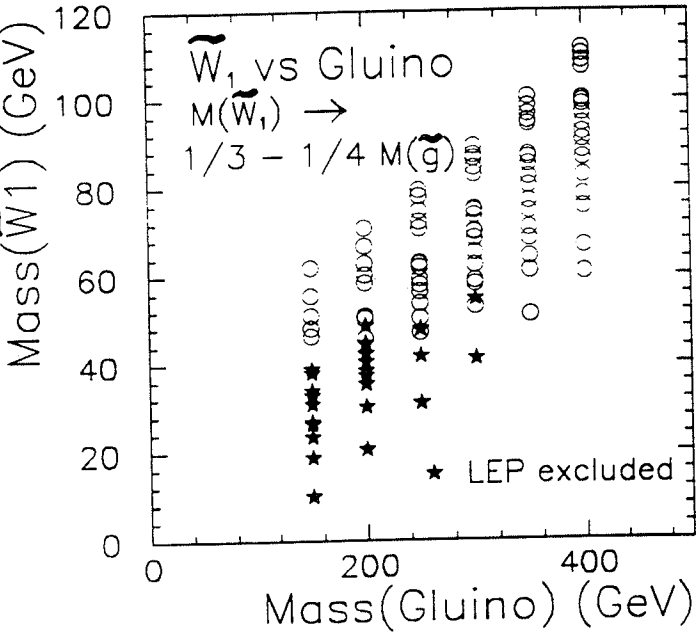
μ −500 → 500
tanβ 2, 10
$M\tilde{a}$ = 500, $M\tilde{}$ = 200 GeV

Current limits (LEP)

$M(\tilde{W}_1) > 45$ GeV





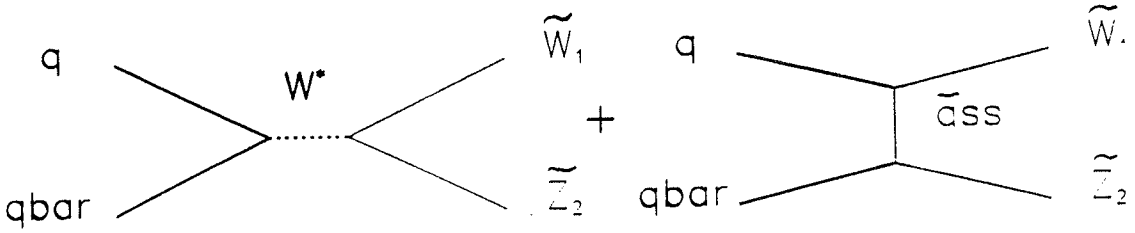


LSP: $m_{\tilde{z}_1} \sim \frac{1}{6} m_{\tilde{g}}$

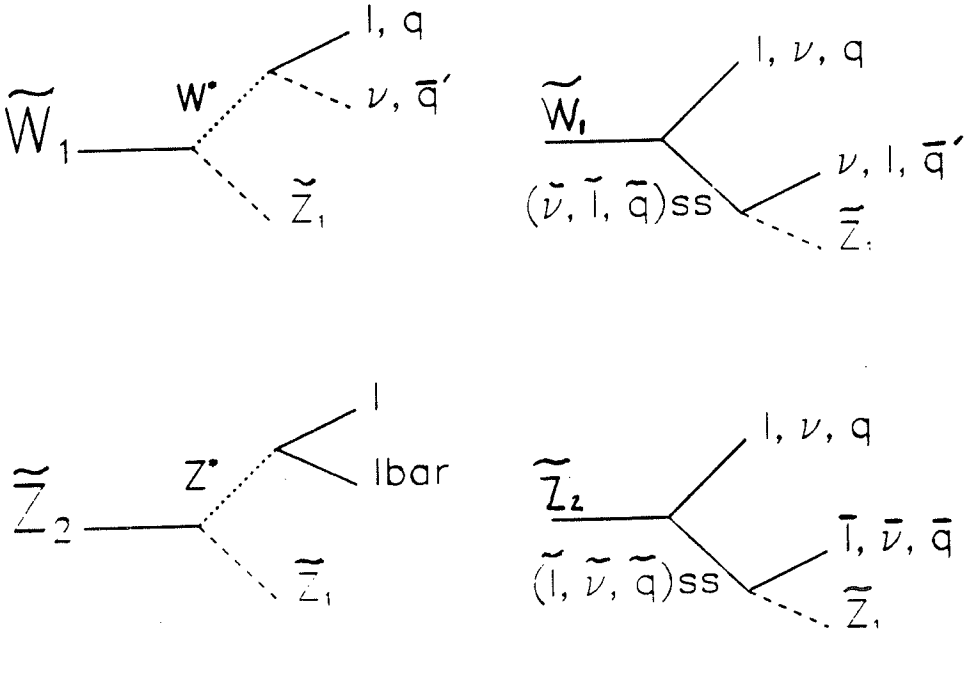
Sosebee

$\tilde{W}_1 \tilde{Z}_2$ Signal

Production – p pbar collisions

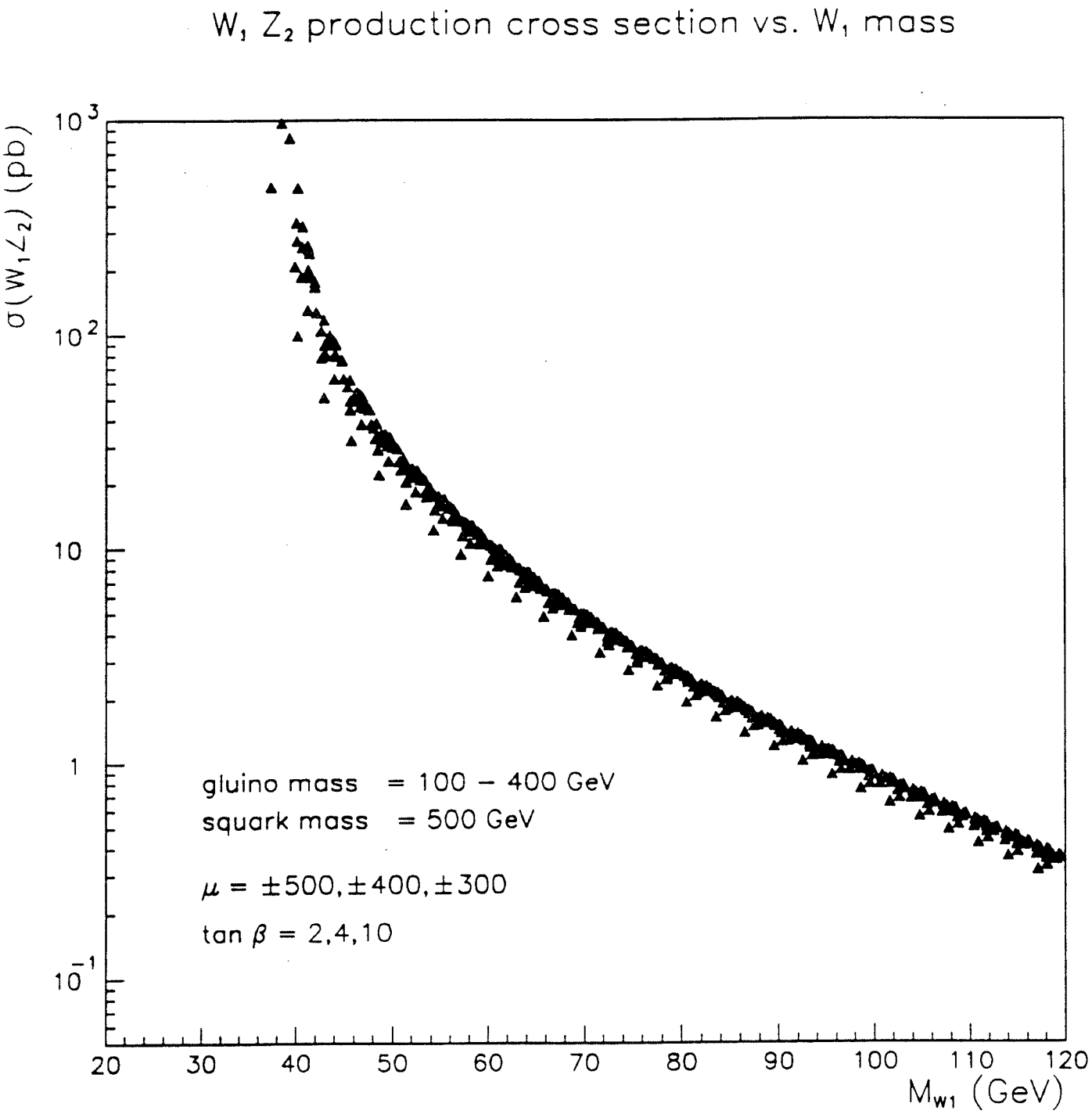


Decays (dominant)

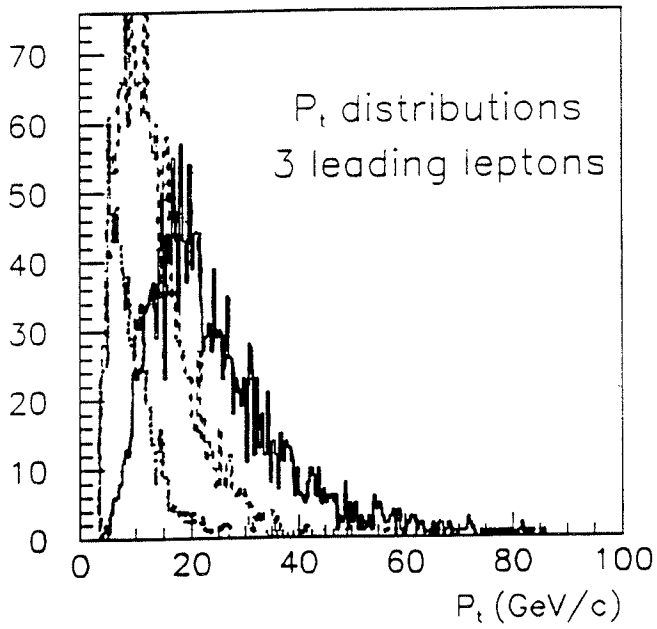


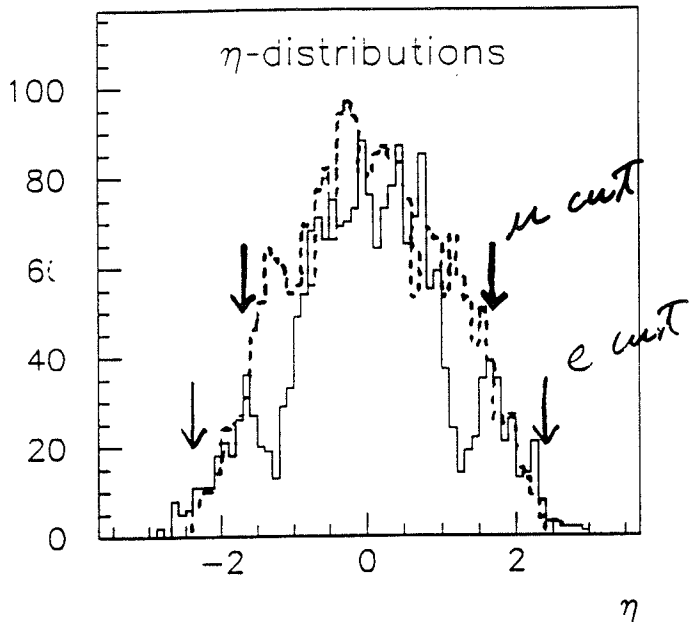
★★ BF $\longrightarrow$ 3 l strongly depends on Masses of Sleptons, Sneutrinos, and Squarks

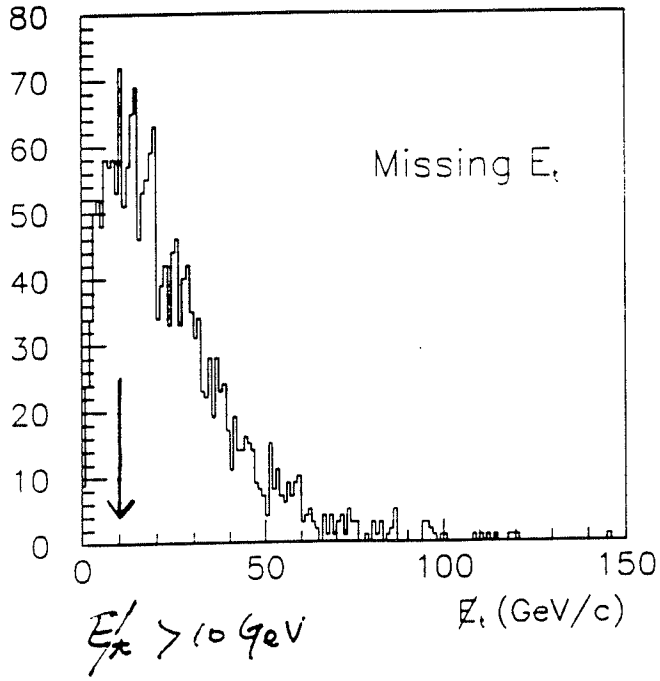
Sosebee


$W_1 Z_2$ production cross section vs. W_1 mass
$\sigma(W_1 Z_2)$ (pb)
10^3
10^2
10
1
10^{-1}
gluino mass = 100 – 400 GeV
squark mass = 500 GeV
$\mu = \pm 500, \pm 400, \pm 300$
$\tan\beta = 2, 4, 10$
20
30
40
50
60
70
80
90
100
110
120
M_{W1} (GeV)

Sosebee







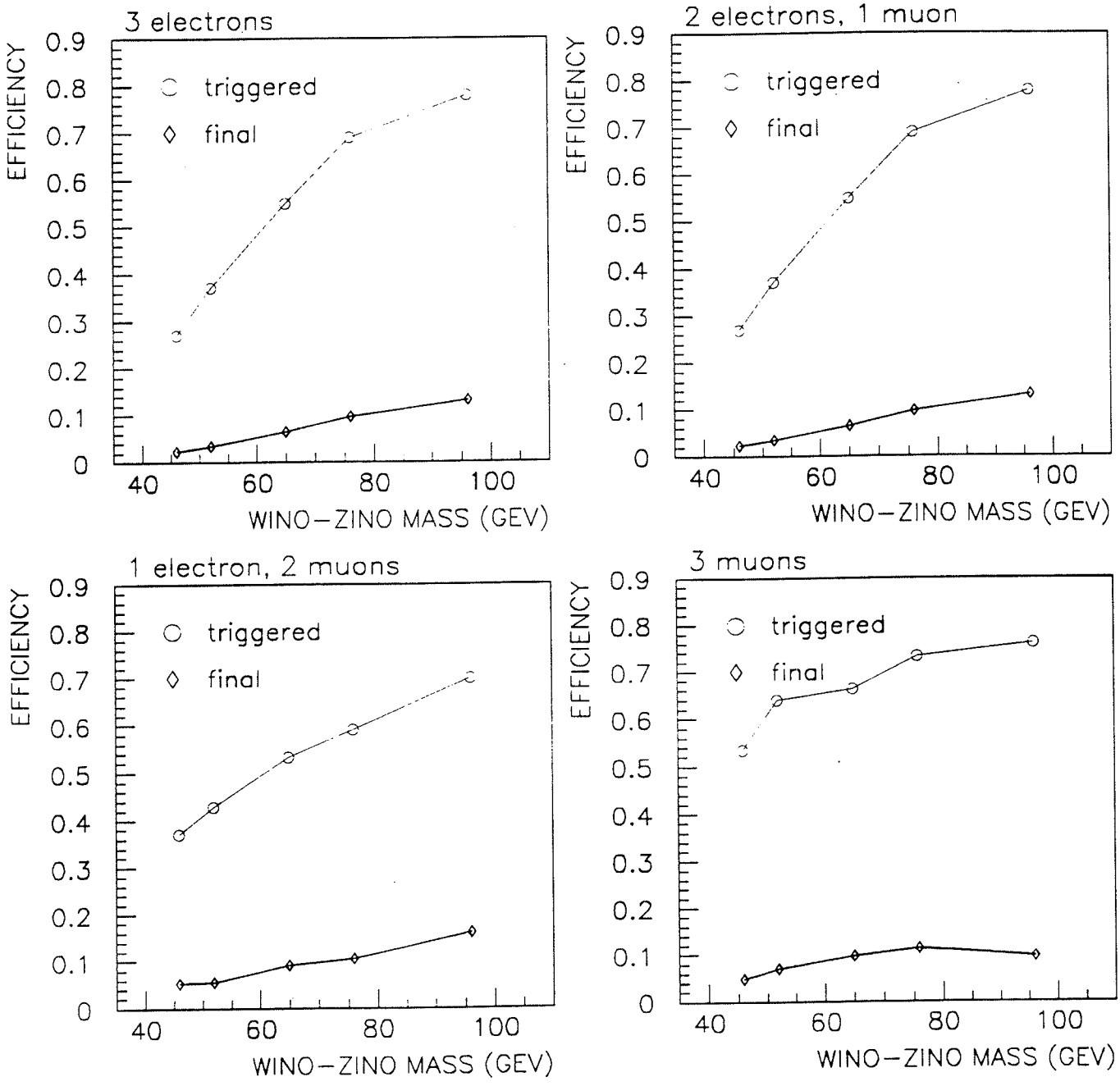
W_1/Z_2 kinematics

mass(W_1) = 65 GeV

(ISASUSY Monte Carlo generator)

Sosebee

Efficiencies



Sosebee

$\tilde{W}_1/\tilde{Z}_2 \longrightarrow \mu\mu\mu$ channel

- **DATA**

  Subset from collider run Ia

  $\int \mathcal{L}dt = 5.0 \pm 0.6$ pb^{-1}

- **TRIGGERS**

  1 muon - $p_t > 15$ GeV/c, $|\eta| < 1.7$

  2 muons - $p_t > 3$ GeV/c, $|\eta| < 1.7$

- **OFFLINE CUTS**

  3 muons - $p_t > 5$ GeV/c, $|\eta| < 1.7$

  ΔR from a muon to any jet, electron, or photon > 0.4

  mass of $\mu\mu$ pairs > 5 GeV (eliminate J/Ψ background)

- **RESULT**

  7 events pass cuts

  these events scanned - all rejected

  no events remain

  preliminary background estimate < 0.2 events

Sosebe

$\tilde{W}_1/\tilde{Z}_2 \longrightarrow eee$ channel

- **DATA**

  ALL physics stream

  $\int \mathcal{L}dt = 14.8 \pm 1.8$ pb^{-1}

- **TRIGGERS**

  1 EM object - $p_t > 20$ GeV/c

  2 EM objcts - $p_t > 10$ GeV/c

- **OFFLINE CUTS**

  3 electrons - $p_t > 7$ GeV/c, $|\eta| < 2.4$

  missing $E_t > 10$ GeV/c

- **RESULT**

  no events remain

  preliminary background estimate < 1.1 events

Sosebee

$\tilde{W}_1/\tilde{Z}_2 \longrightarrow e\mu\mu$ channel

- **DATA**

  EXPRESS stream - top $e\mu$ selection

  $\int \mathcal{L}dt = 15.2 \pm 1.8$ pb^{-1}

- **TRIGGERS**

  1 EM object - $p_t > 7$ GeV/c, and

  1 muon - $p_t > 5$ GeV/c, $|\eta| < 2.4$

  1 muon - $p_t > 15$ GeV/c, $|\eta| < 1.7$ and

  2 muons - $p_t > 10$ GeV/c, $|\eta| < 1.7$

  1 EM object - $p_t > 20$ GeV/c, missing $E_t > 20$ GeV/c

- **OFFLINE CUTS**

  1 electron - $p_t > 10$ GeV/c, $|\eta| < 2.4$

  1 muon - $p_t > 10$ GeV/c, $|\eta| < 1.7$

  second muon - $p_t > 5$ GeV/c, $|\eta| < 1.7$

  mass of $\mu\mu$ pairs > 5 GeV (eliminate J/Ψ background)

  ΔR from a muon to any jet, electron, or photon > 0.4

- **RESULT**

  no events remain

  preliminary background estimate < 0.5 events

Sosebee

$\tilde{W}_1/\tilde{Z}_2 \longrightarrow ee\mu$ channel

- **DATA**

  EXPRESS stream - top $e\mu$ selection

  $\int \mathcal{L}dt = 15.2 \pm 1.8$ pb^{-1}

- **TRIGGERS**

  1 EM object - $p_t > 7$ GeV/c, and

  1 muon - $p_t > 5$ GeV/c, $|\eta| < 2.4$

  2 EM objects - $p_t > 20$ GeV/c

  1 EM object - $p_t > 20$ GeV/c, missing $E_t > 20$ GeV/c

- **OFFLINE CUTS**

  1 electron - $p_t > 10$ GeV/c, $|\eta| < 2.4$

  second electron - $p_t > 5$ GeV/c, $|\eta| < 1.7$

  1 muon - $p_t > 10$ GeV/c, $|\eta| < 1.7$

  ΔR from a muon to any jet, electron, or photon > 0.4

- **RESULT**

  one event remains

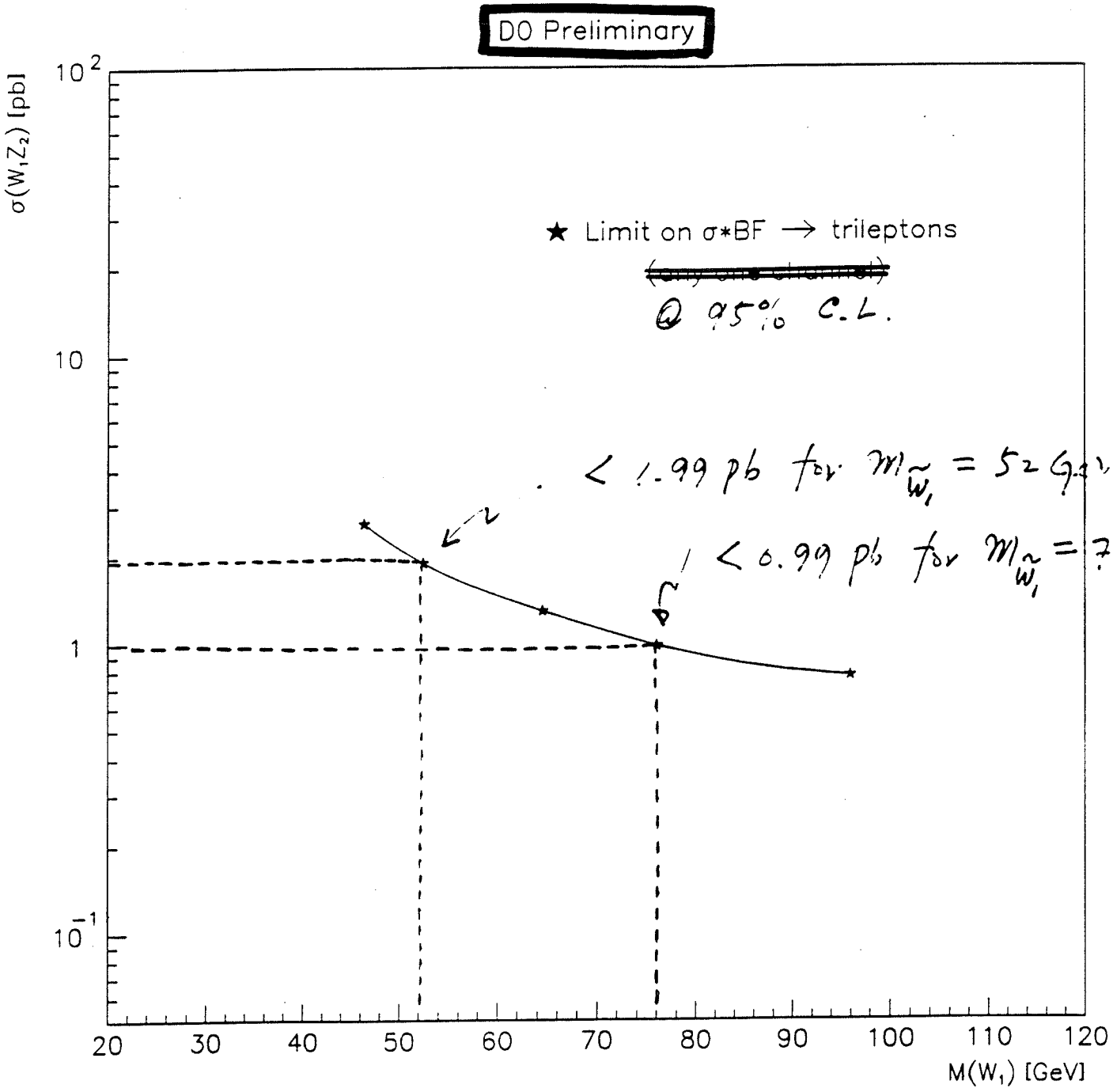
  preliminary background estimate < 0.5 events

PRELIMINARY BACKGROUND ESTIMATES

Background Process	Cross-Section [pb]	Fraction Passing Kinematic Cuts	eee Backgrounds (w/ MisID)	$ee\mu$ Backgrounds (w/ MisID)	$e\mu\mu$ Backgrounds (w/ MisID)	$\mu\mu\mu$ Backgrounds (w/ MisID)
QCD 3 Jets	5.77E+8	0.0359	0.182	0.024	0.003	$< 10^{-3}$
Drell-Yan + b Jets (QMW = 5 - 80 GeV)	25.26	0.031	0.080	0.077	0.066	0.040
Drell-Yan + Jet	148.6	0.409	0.089	0.023	0.073	0.012
$Z^0 \to e\bar{e}$ + jet	3.44	1.0	0.003	0.001	–	–
$Z^0 \to \mu\bar{\mu}$ + jet	3.44	1.0	–	–	0.009	$< 10^{-3}$
$Z^0 \to \tau\bar{\tau}$ + jet	3.38	0.89	$< 10^{-3}$	$< 10^{-3}$	$< 10^{-3}$	$< 10^{-3}$
Drell-Yan (incl. Z^0) $\to e\bar{e}\gamma$ or $\to \mu\bar{\mu}\gamma$	7.0	1.0	0.252	–	0.208	–
Drell-Yan (incl. Z^0) $\to \tau\bar{\tau}\gamma$	7.0	0.89	0.146	0.140	0.120	–
$W^{\pm}$ + 2 jets	100.0	1.0	$< 10^{-3}$	$< 10^{-3}$	$< 10^{-3}$	$< 10^{-3}$
$W^{\pm}Z^0 \to 3l$	0.0265	0.60	0.047	0.045	0.039	0.023
$b\bar{b}$ and 1 or more additional b jets	1.58E+5	2.57E-3	0.153	0.015	0.013	0.076
$b\bar{b}$ and $\geq$ 1 c jet	1.85E+6	1.10E-3	0.153	0.015	0.013	0.076
Total :			1.105	0.340	0.544	0.227

Table 1: A summary of Monte Carlo cross section calculations from ISAJET, for various input parameter sets and events configuration requirements, for possible sources of background to the $\tilde{W}_1/\tilde{Z}_2 \to 3l$ search. Number of background events is based on 15 pb^{-1} of data. Misidentification factors are included All events are required to pass minimum kinematic cuts, and are corrected for reconstruction, trigger, and selection efficiencies.

Susabee



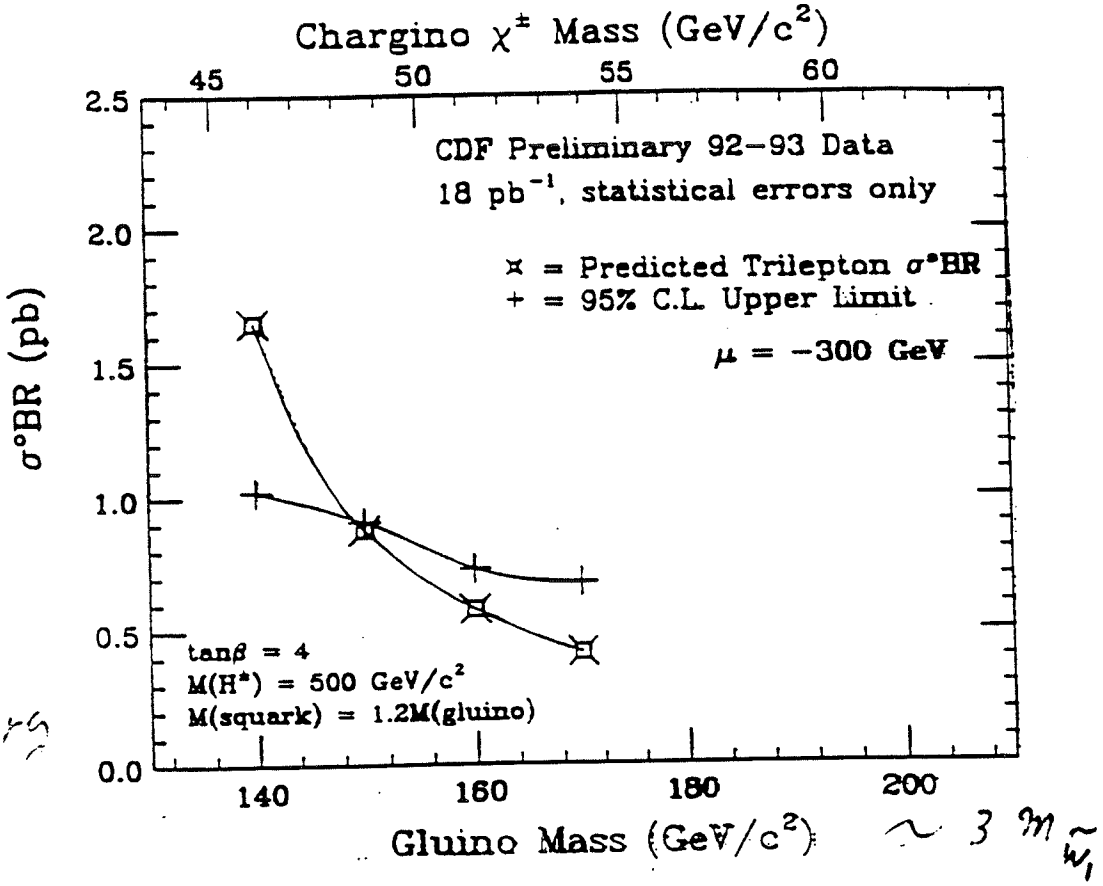
$\tilde{W}_1/\tilde{Z}_2$ search

CDF

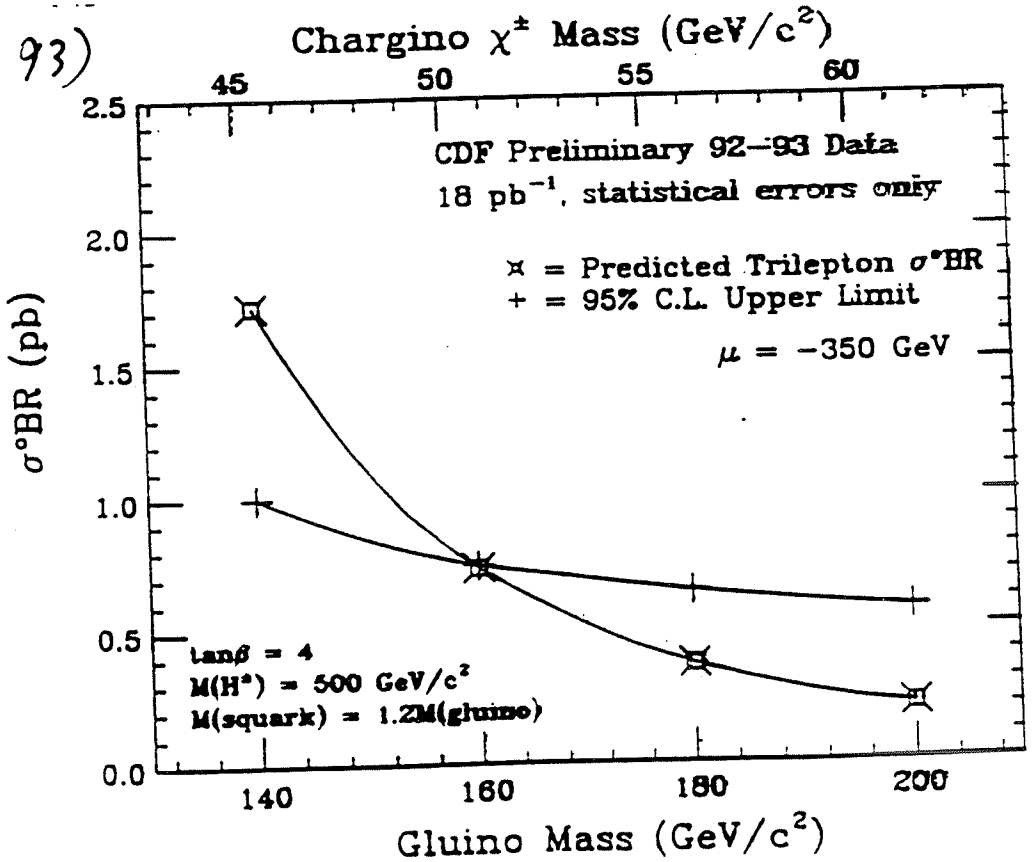
Preliminary

Results

(Tsukuba, 93)



$\sim 3\, m_{\tilde{w}_1}$



⑥ top-squark Search Analyses

- $\tilde{t}_1 \longrightarrow b\,\tilde{W}_1$

  $\hookrightarrow l\bar{\nu}\,\tilde{Z}_1$

  two leptons + jets + $\not{E}_T$

  $\Rightarrow$ dominant decay if $m_{\tilde{t}_1} > m_{\tilde{W}_1} + m_b$

  $\Rightarrow$ reasonable cross-section

  $\Rightarrow$ backgrounds : $t\bar{t}$, backgrounds to $t\bar{t}$, W pair

  $\Rightarrow$ analysis has just started (ISAJET, Tripper)

- $\tilde{t}_1 \longrightarrow c\,\tilde{Z}_1$

  two acolinear jets + $\not{E}_T$

  $\Rightarrow$ dominant if $m_{\tilde{t}_1} < m_{\tilde{W}_1} + m_b$

  and $m_{\tilde{t}_1} < m_W + m_{\tilde{Z}_1} + m_b$

  $\Rightarrow$ on-going analysis

3 Why top squark search ?

– old SUSY working model argued that the degeneracy among squarks was only SLIGHTLY broken.

⇒ The squarks were treated as

"effectively degenerate"

But acknowledging that Top is heavy (only the 1st 2 generations can be treated as ~ degenerate), Yukawa interactions (substantial only for top) drive $\tilde{t}_L$, $\tilde{t}_R$ weak eigenstates considerably lower than All others. (SUGRA) Additionally, $\tilde{t}_L$, $\tilde{t}_R$ mixing split these mass eigenstates even Further, with one

$$m_{\tilde{t}_1} < m_{\tilde{t}_2}$$

⇒ Search maybe possible at TeVatron

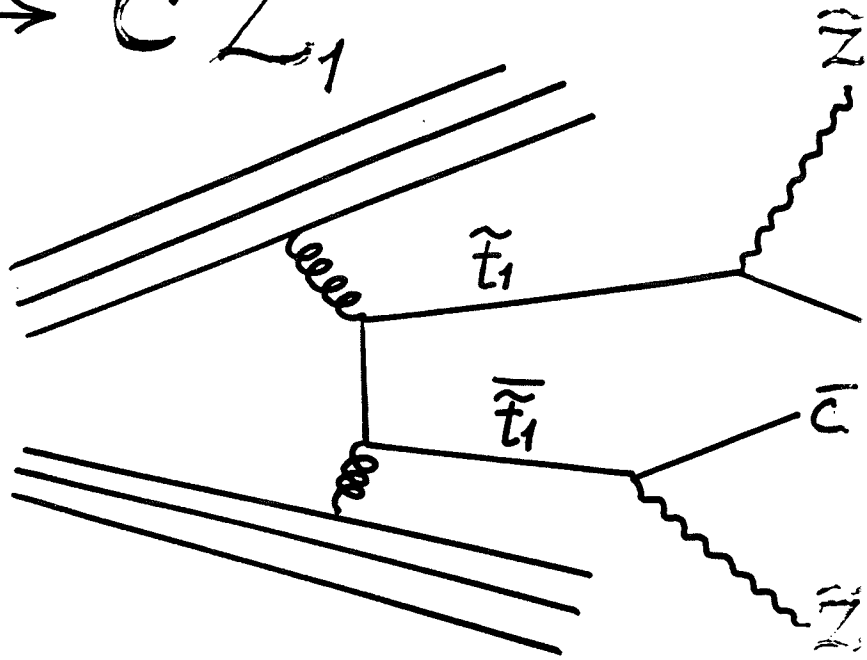
low mass $\tilde{t} < 150$ GeV

SEARCH FOR LIGHT STOP SQUARK

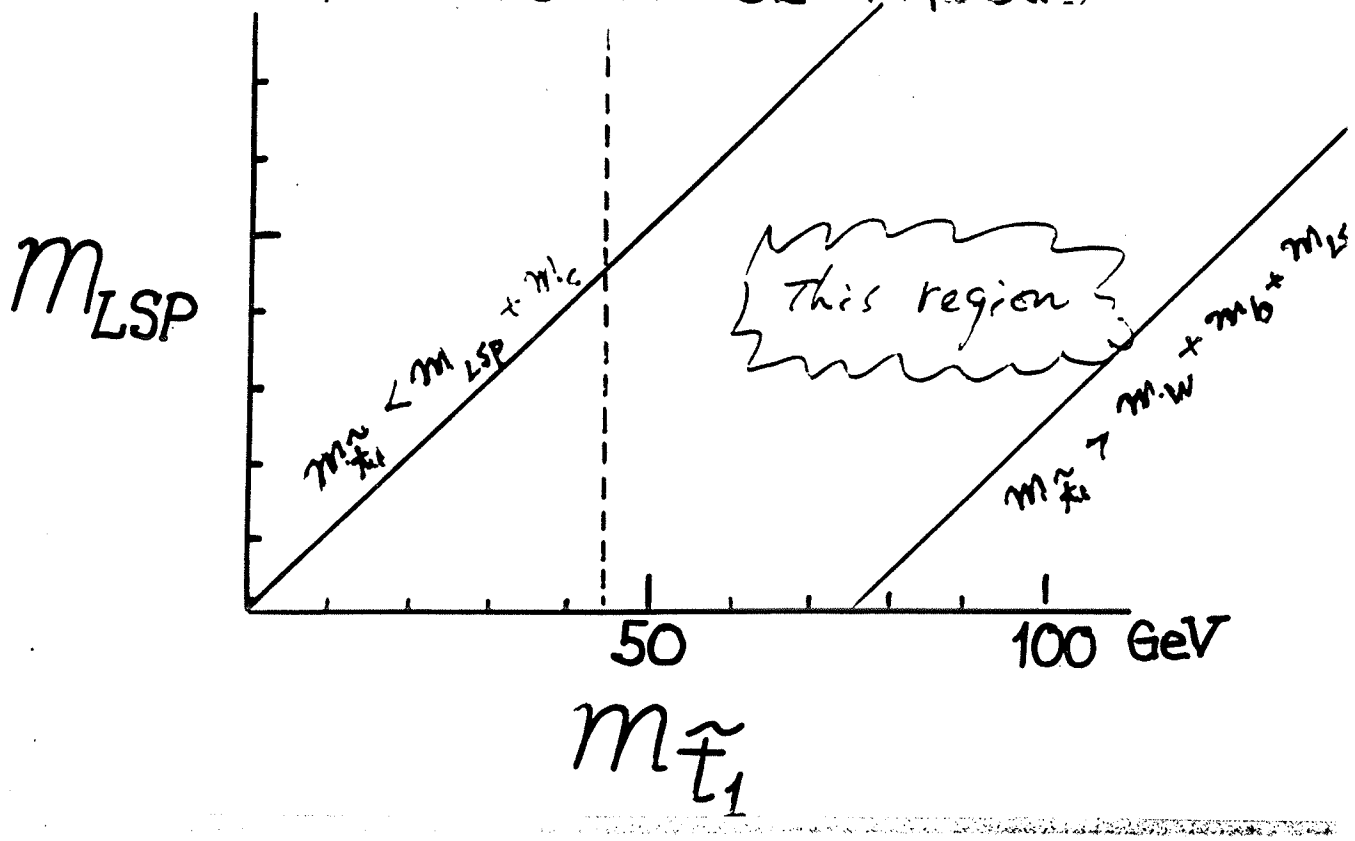
thru the direct S-top pair production channel where:

$$\tilde{t}_1 \rightarrow c\,\tilde{Z}_1$$

signal would be 2 acollinear jets plus $\not{E}_T$



PARAMETER SPACE TO BE PROBED:



Class

$\tilde{t}_1 \bar{\tilde{t}}_1$ pair production cross-section

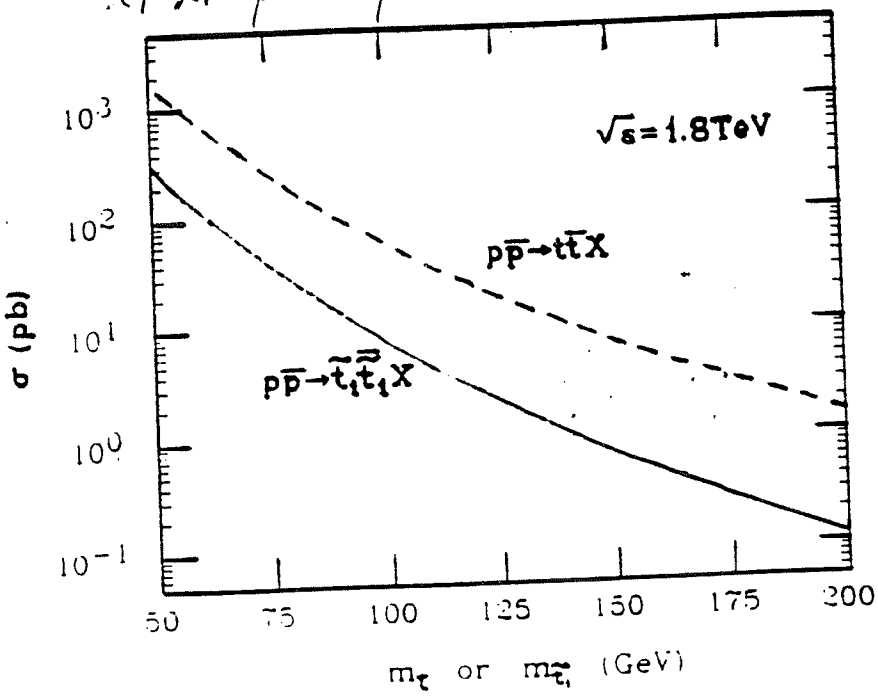


FIG. 2. We have shown the cross sections for the production of top-quark and top-squark pairs at the Tevatron. In our computation we have used the Duke-Owen structure functions (set 1) with Λ_5=0.14 GeV for five flavors, and have taken $Q^2=\hat{s}$.

MAJOR BACKGROUNDS TO CONSIDER

- Standard Model heavy flavor production
- Direct Z plus 2-jet production
  - $\to \nu\nu$
  - $\to \mu\mu$ (where one or both not identified)
  - $\to \tau\tau$
- W plus 1-jet
  - $\to \tau\nu$
    - $\to$ hadron jet
- W plus 2-jets
  - $\to \mu\nu$ (where μ unobserved)
  - $\to \tau\nu$
    - $\to \mu\nu$
    - $\to$ hadrons

Claes

OPTIMIZED CUTS

(assuming any passed candidates in the data represent background)

Maximum Signal/$\sqrt{\text{background}}$

35-GeV < $\not\!\!E_t$

50-GeV < jet1, E_t 35-GeV < jet2, E_t

muon_frac < 0.30 ele_frac < 0.05

$\Delta\phi(j_1, j_2) < 2.99$

$\Delta\phi(j_1, \not\!\!E_t) < 2.64$

SIGNAL EVENTS EXPECTED IN 13.6/pb: 55

CANDIDATES IN RUN Ia DATA : 53

Maximum Signal/Background

35-GeV < $\not\!\!E_t$

95-GeV < jet1, E_t 15-GeV < jet2, E_t

muon_frac < 0.00 ele_frac < 0.05

$\Delta\phi(j_1, j_2) < 2.99$

$\Delta\phi(j_1, \not\!\!E_t) < 2.64$

SIGNAL EVENTS EXPECTED IN 13.6/pb: 5

CANDIDATES IN RUN Ia DATA : 1

⑥ Summary and Future Outlook

⇒ at DØ, many on-going SUSY search analyses

→ Our results are very competative

- $\tilde{q}/\tilde{g} \rightarrow$ jets + $\not{E}_T$

  → Paterno Analysis, matured for a publication
  - presented at the SUSY 94 workshop (May 94) and received much attension from theorists
  - draft for a PRL publication being prepared by Jung and Paterno
  - a few more improvements will be made

  (more high mass signal points, $\not{E}_T$ cut optimization Luminosity correction etc.)

  → Gotfort analysis, being matured
  - having difficulties in estimating QCD background
  - need to work on systematic errors, etc. ..

- $\tilde{q}/\tilde{g} \longrightarrow$ leptons + $\not{E}_t$

  → serious data analysis attempts just begun

  ⇒ same-sign lepton has little background but small cross-section ⇒ Run 2 analysis

  ⇒ tripperring is no problem

- $\tilde{W}/\tilde{Z} \longrightarrow$ trileptons + $\not{E}_t$

  → a preliminary result obtained

  → cuts are not settled, yet.

  → need to understand the low energy responce of the Calorimeter better (testbeam?)

    → low E electron ϵ, fake rates

  → recently, the results were presented at the APS and SUSY 94 meetings

  → plan to have the 1st draft for paper at the end of this summer

  → better SUSY parameterization can be made.

- top – squark search
  - → recent hot topic in the SUSY world
  - → $\tilde{t}_1 \to \tilde{W}_1 b$ analysis, just begun
  - → $\tilde{t}_1 \to \tilde{Z}_1 c$ analysis being matured
    - so far, looks promising
    - Most of the background MC events available
    - Optimizing cuts, exploring new cuts
    - new special filter : JET_2_MISS
    - need to relieve Claes from Level 2 (Don't bother him!)
    - aim for a presentation at Spring [redacted] 95 conferences