The Search for Chargino-Neutralino Production at CDF

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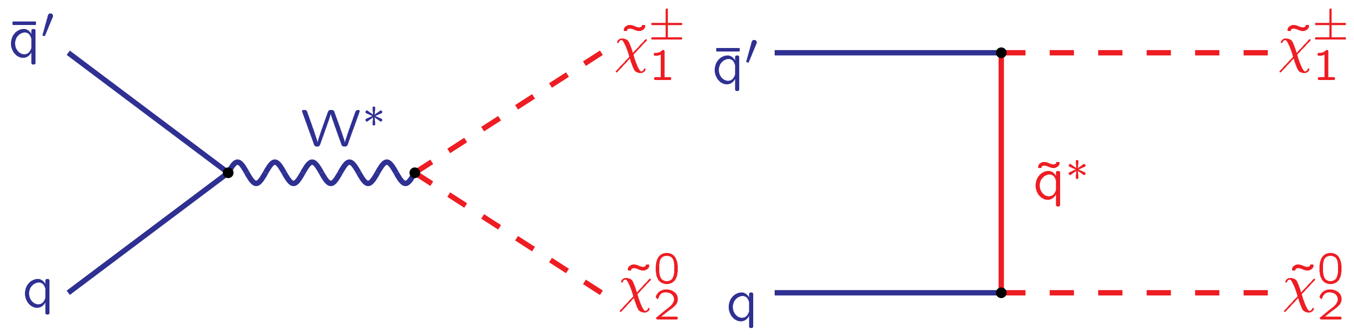
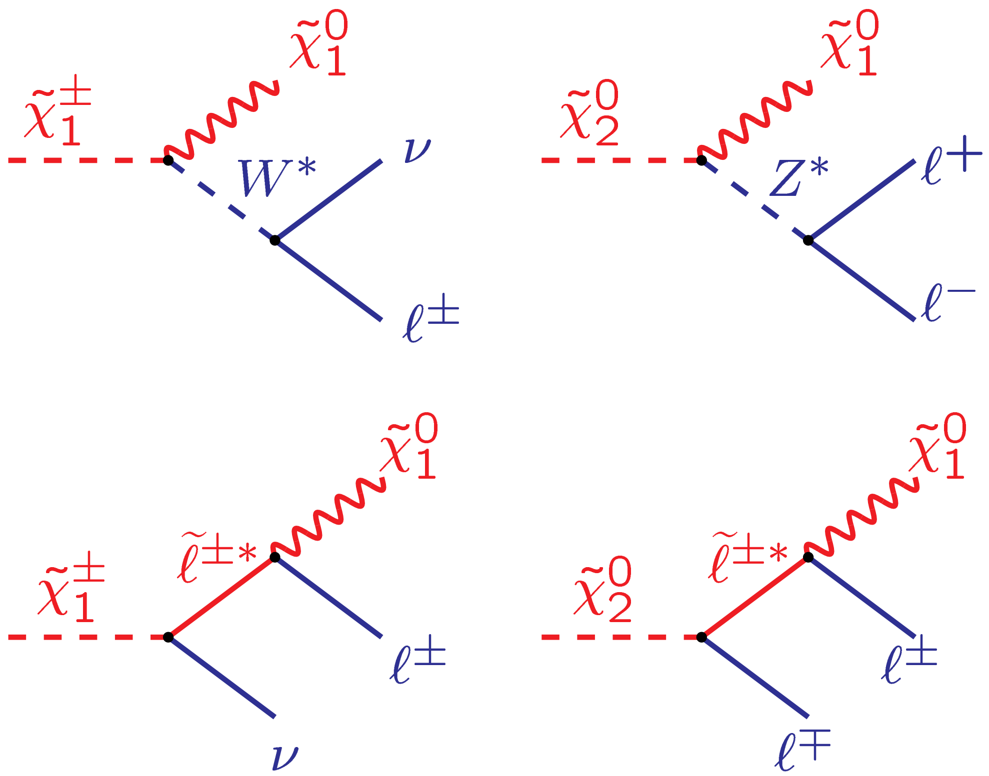
Outline

- CDF Detector
- SUSY
- Chargino-Neutralino Signature at Tevatron
- Trilepton Search
- Like-Sign Dilepton Analysis
- Combined Analyses
- Expected Sensitivity
- Conclusions/Work in Progress

$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ Production

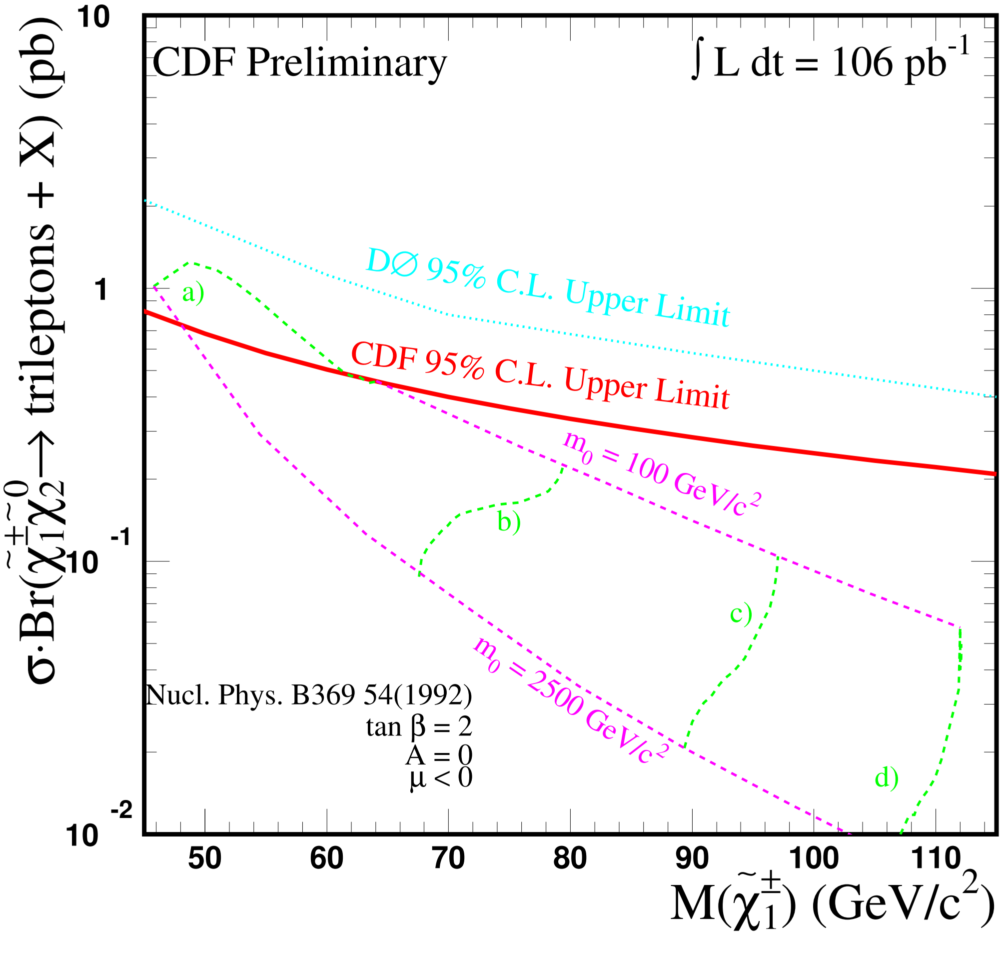


$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ Decay



Trilepton Analysis

• Trilepton analysis previously published, Phys. Rev. Lett. 80 (June, 1998)



• Problem: losing one or more lepton in detector major source of inefficiency in trilepton signature

R Parity

R = -1 for SUSY particles
+1 for SM particles

Generally, we assume R parity is conserved

Consequences of R parity conservation:

- SUSY particles produced in pairs

- Lightest SUSY particle does not decay, interacts weakly, usually assumed to be neutral: $\tilde{\chi}_1^0$

$\rightarrow$ Characteristic signature of SUSY:

Large Missing Energy, Mass from undetected lightest neutralinos ($\tilde{\chi}_1^0$s)

mSUGRA parameters

- signμ SUSY-conserving Higgs mass parameter
- $M_{1/2}$ gaugino mass
- $\tan\beta$ ratio of v.e.v.'s of Higgs doublets
- m_0 universal scalar mass
- A trilinear coupling constant

  μ, $M_{1/2}$, $\tan\beta$ determine masses and cross-sections
  m_0 effects decay branching ratio, cross-section

Like-Sign Dilepton Analysis

Solution: look for 2 out of 3 leptons

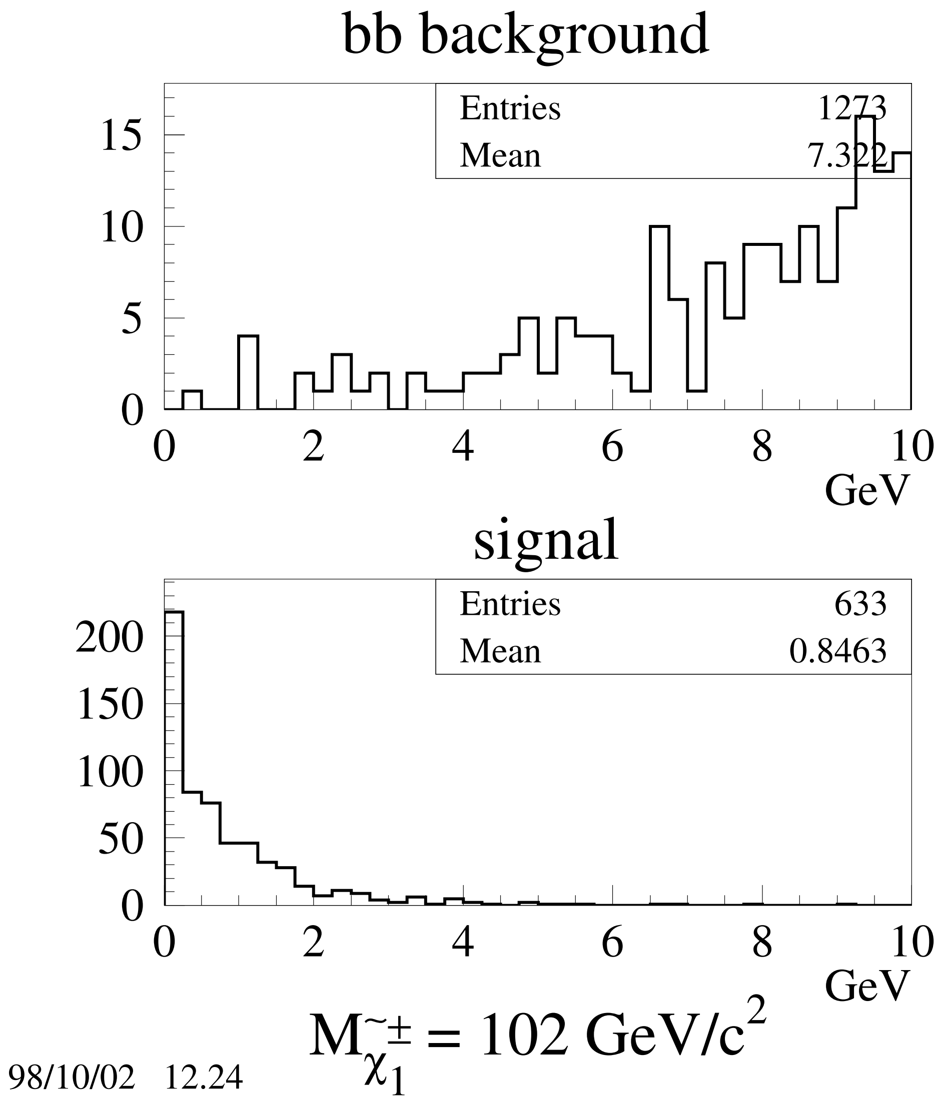
- Problem: adds new background over trilepton analysis

Solution: require like-sign pair of isolated leptons, one from $\tilde{\chi}_1^+$, one from $\tilde{\chi}_2^0$

Process	Same-sign	Isolation	P_T^{min}
WW	$\surd$		
$t\bar{t}$	$\surd$	$\surd$	
Drell-Yan (γ^*/Z)	$\surd$		$\surd$
WZ, ZZ	$\surd$		
$b\bar{b}, c\bar{c}$	$\surd$	$\surd$	$\surd$
W + jets	$\frac{1}{2}$	$\surd$	$\surd$

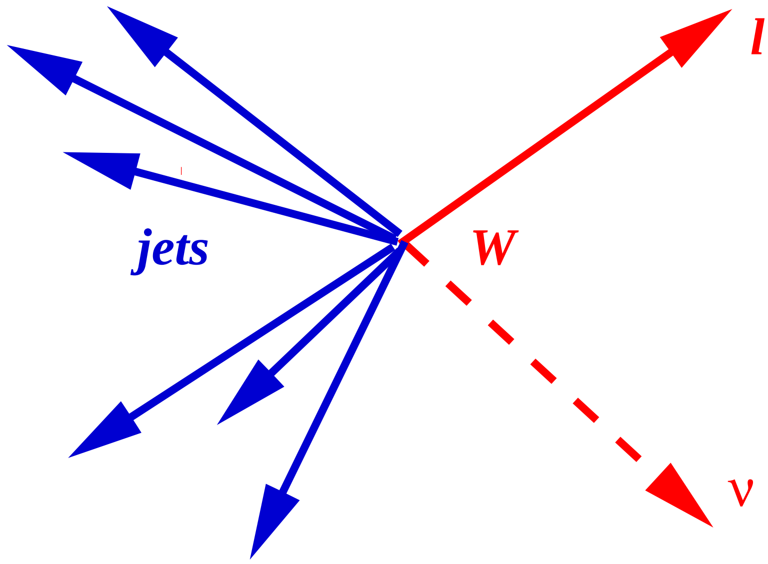
Isolation

$\rightarrow$ Isolation removes events ($t\bar{t}, b\bar{b}, c\bar{c}$) where at least one lepton has an energy > 2 GeV in cone of 0.4 radians around the lepton



W + jets background

– potentially largest background



• Step 1: determine distribution of isolated tracks as function of P_T in W+jets using Z→ e^+e^-
• Step 2: use minimum bias data to determine fake rate = 1.5 % per isolated track
• Step 3: use fake rate, isolated track distribution to calculate expected background

result → we expect 0.3 events from W+jets in 100 pb^{-1}

Expected Background

Process	Lum (pb^{-1})	N_{bkg} (100 pb^{-1})
WZ	16,684	0.11 ± 0.02
ZZ	13,992	0.01 ± 0.01
WW	6,870	$0^{+0.02}_{-0}$
$t\bar{t}$	5,558	$0^{+0.02}_{-0}$
Drell-Yan (γ^*/Z)	1,728	$0.11^{+0.10}_{-0.06}$
$b\bar{b}, c\bar{c}$	3,122	$0.03^{+0.04}_{-0.02}$
W + jets	(data)	0.30
total		0.56

Total expected background $\rightarrow$

0.56 events in 100 pb^{-1}

Signal Efficiency

– our SUGRA parameters yield:

→ $M_{\tilde{\chi}_1^+} \sim M_{\tilde{\chi}_2^0} \sim 2M_{\tilde{\chi}_1^0}$: 80-130 GeV,

→ 3-body $\tilde{\chi}_1^+, \tilde{\chi}_2^0$ decays

– efficiency =

$$\frac{\text{number of events selected}}{\text{number of } \tilde{\chi}_1^+\tilde{\chi}_2^0 \to \ell\ell\ell \text{ events generated}}$$

Combining Dilepton and Trilepton Analyses

Signal–

OR of trilepton and dilepton selections

Background–

little overlap

→ sum: trileptons 1.2

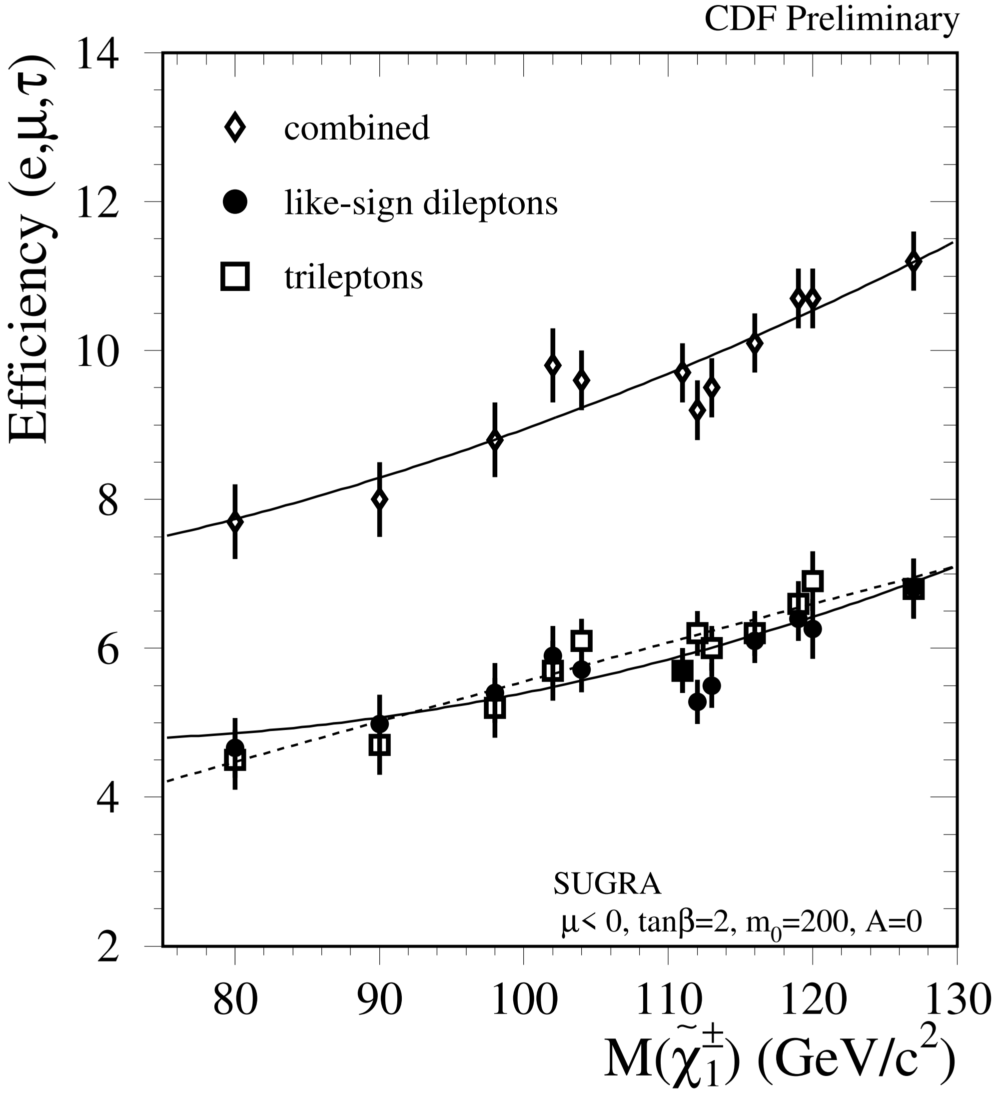
LS-dileptons <u>0.6</u>

1.8

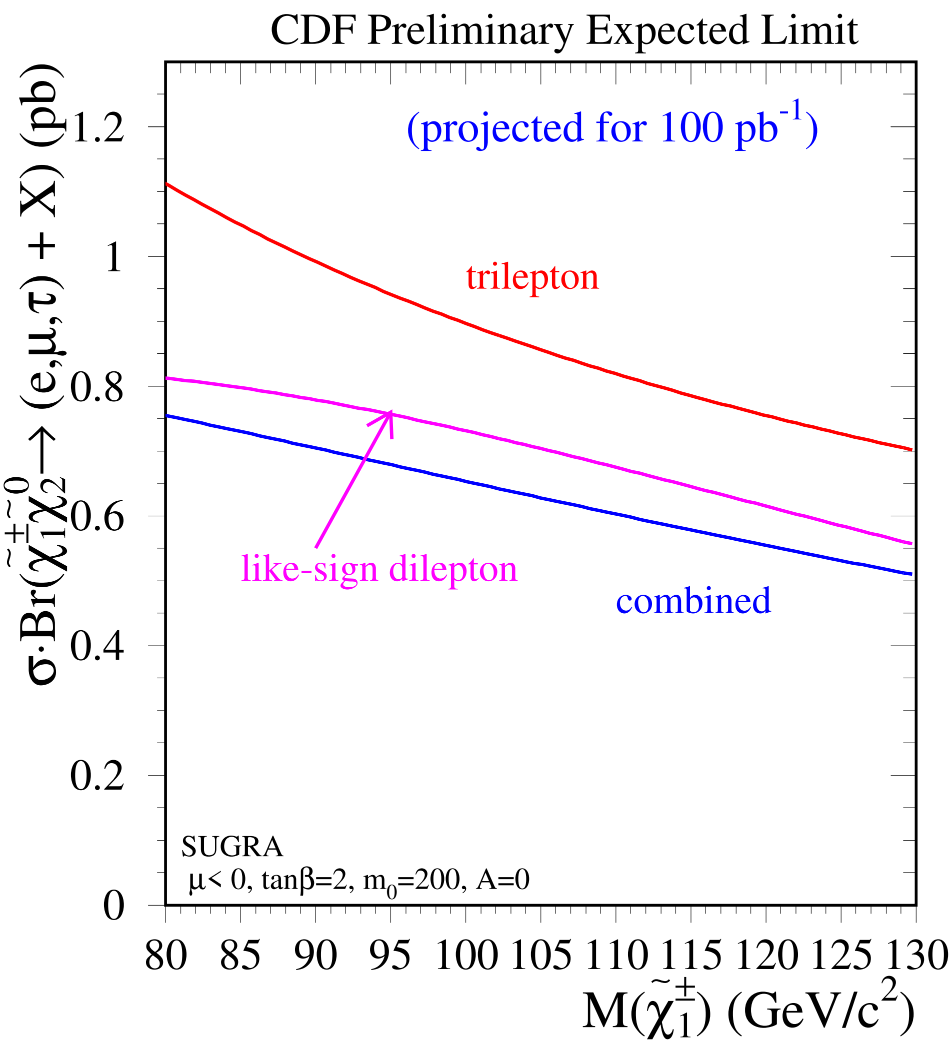
events expected

in 100 pb^{-1}

Signal Efficiency



Expected Exclusion Limits (95% C.L.) From Monte Carlo Studies



Conclusions

Like-sign Dilepton Analysis can significantly increase the sensitivity of the existing Trilepton Analysis

- possibility of discovery...
- or improved 95% C.L. exclusion limit

Work in Progress

- feasibility for Fermilab Run II
- new isolation studies
- new cuts on other kinematic variables
- potential acceptance for other new phenomena