

## Disclaimer

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# **Search for Supersymmetry with the D0 Detector**

**At the Fermilab Tevatron  $\sqrt{s} = 1.8$  TeV**

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*APS April 1993*

# *Supersymmetry*

**Interrelates: bosons  $\longleftrightarrow$  fermions**

**Couplings same as Standard Model**

**gluon Spin 1  $\longrightarrow$  gluino spin 1/2  $\tilde{g}$**

**Assume Minimal SUSY Model (MSSM):**

- Lightest superpartner (LSP) is colorless, electrically neutral**
- R-parity is conserved, pair production of SUSY particles**
- $\tilde{Z}_1$  is the LSP, deposits no energy in the detector, missing  $E_T$**

**Consider cascade decays only!**

**Strong Production of  $\tilde{g}$ ,  $\tilde{q}$**

$$p \bar{p} \longrightarrow \tilde{g} \tilde{g} \text{ or } \tilde{q} \tilde{g} \text{ or } \tilde{q} \tilde{q}$$

$$\begin{array}{l} \tilde{g} \longrightarrow \tilde{Z}_2 q \bar{q} \\ \quad \quad \quad \searrow \\ \quad \quad \quad \tilde{W}_1 q' \bar{q} \\ \quad \quad \quad \quad \quad \searrow \\ \quad \quad \quad \quad \quad \tilde{Z}_1 q \bar{q} \end{array}$$

**Signal: Multi-jets and missing  $E_T$**

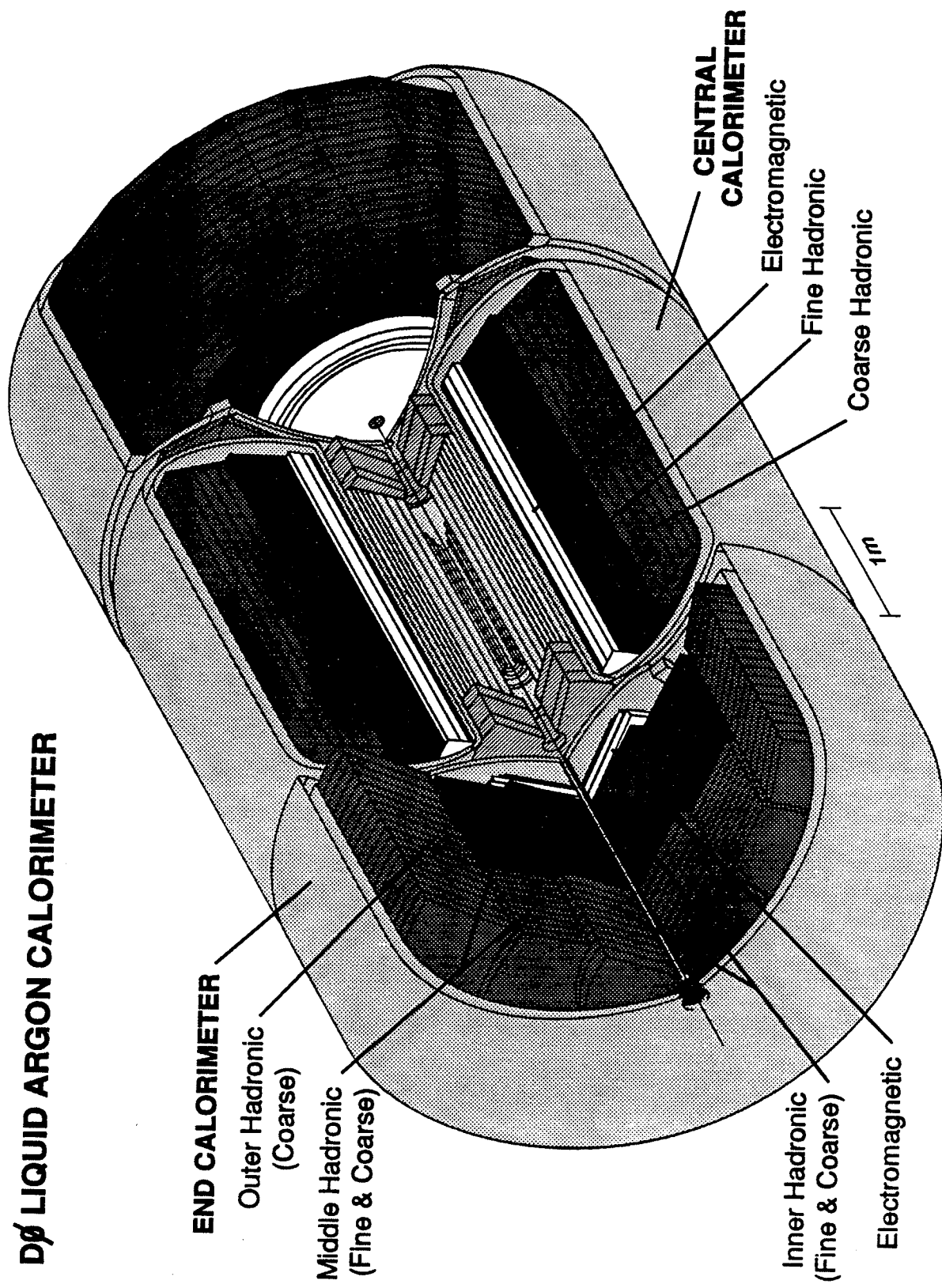
# *SUSY Monte Carlo*

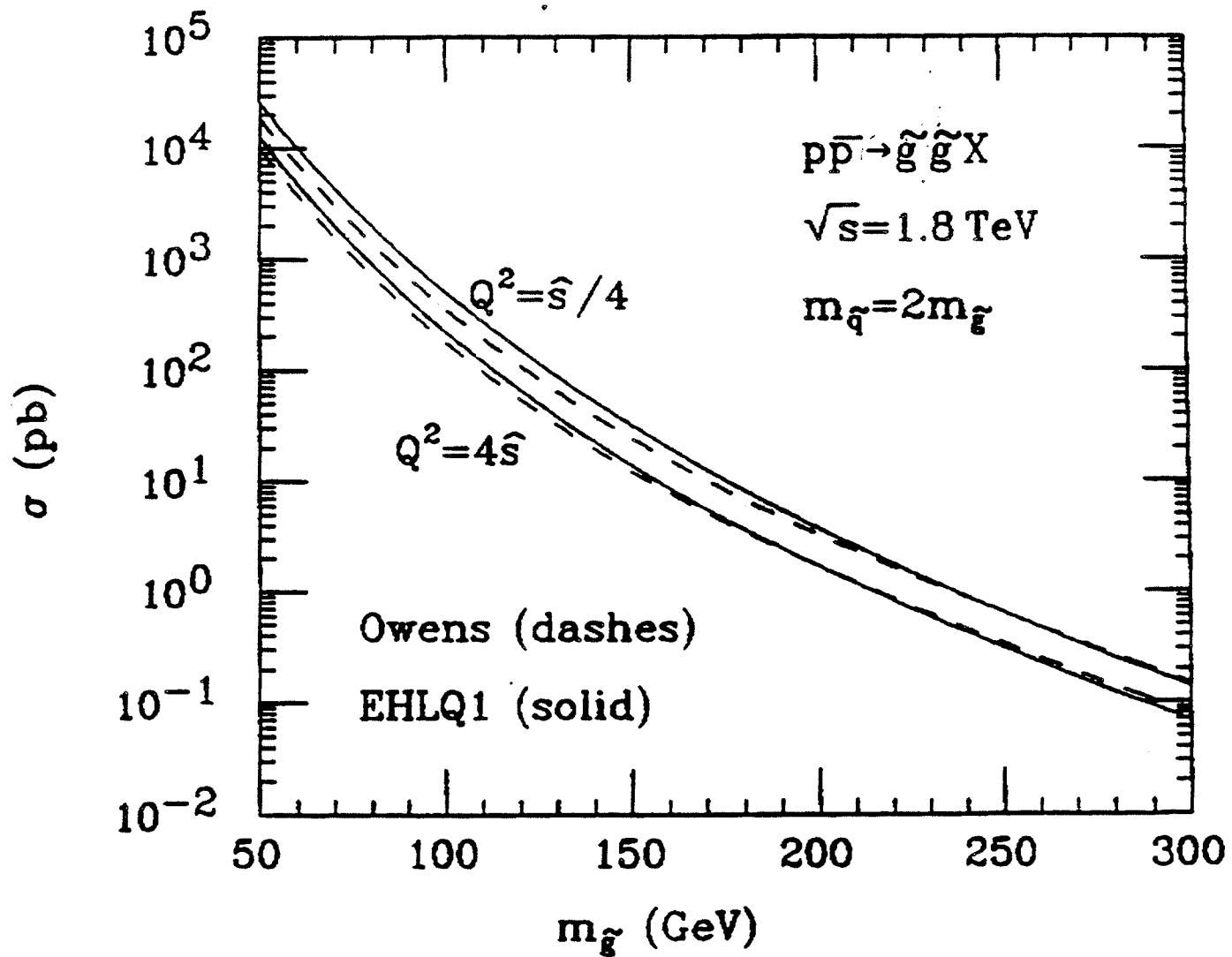
- $\tilde{g}$  and  $\tilde{q}$  events generated with ISASUSY monte carlo ( H. Baer and X. Tata )
- detailed detector and trigger simulator
- various choices of gluino and squark masses from 100 to 500 GeV, 1000 events each
- $\tan(\beta)=2.0$

$$m_{H^+} = 500 \text{ GeV}$$

$$\mu = -250 \text{ GeV}$$

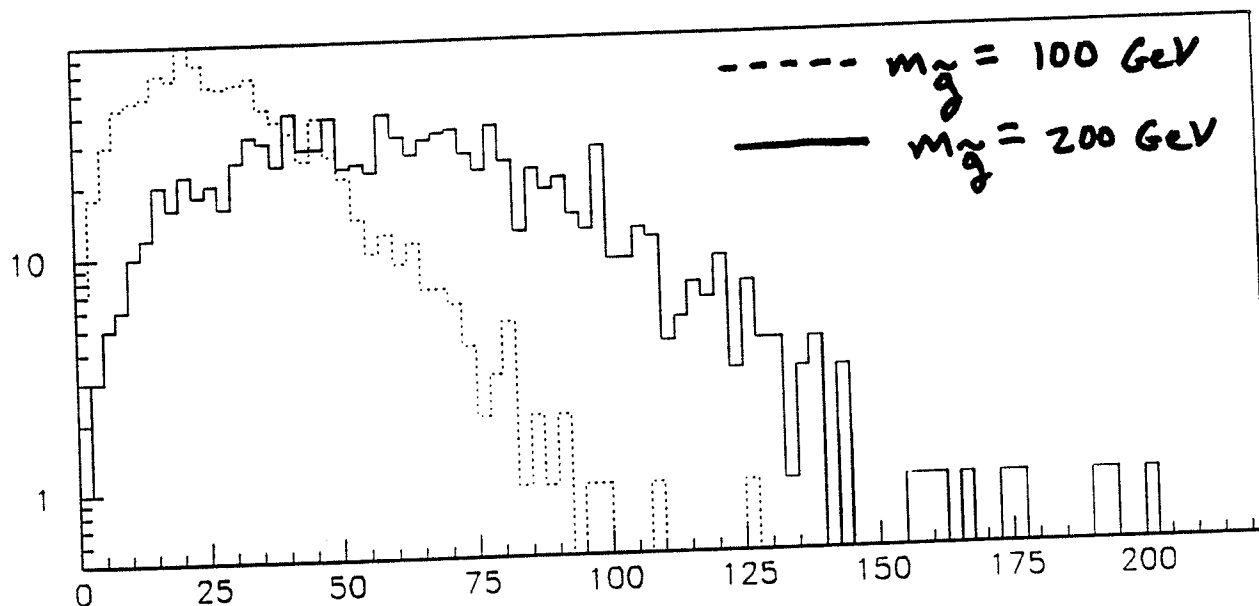
# DØ LIQUID ARGON CALORIMETER



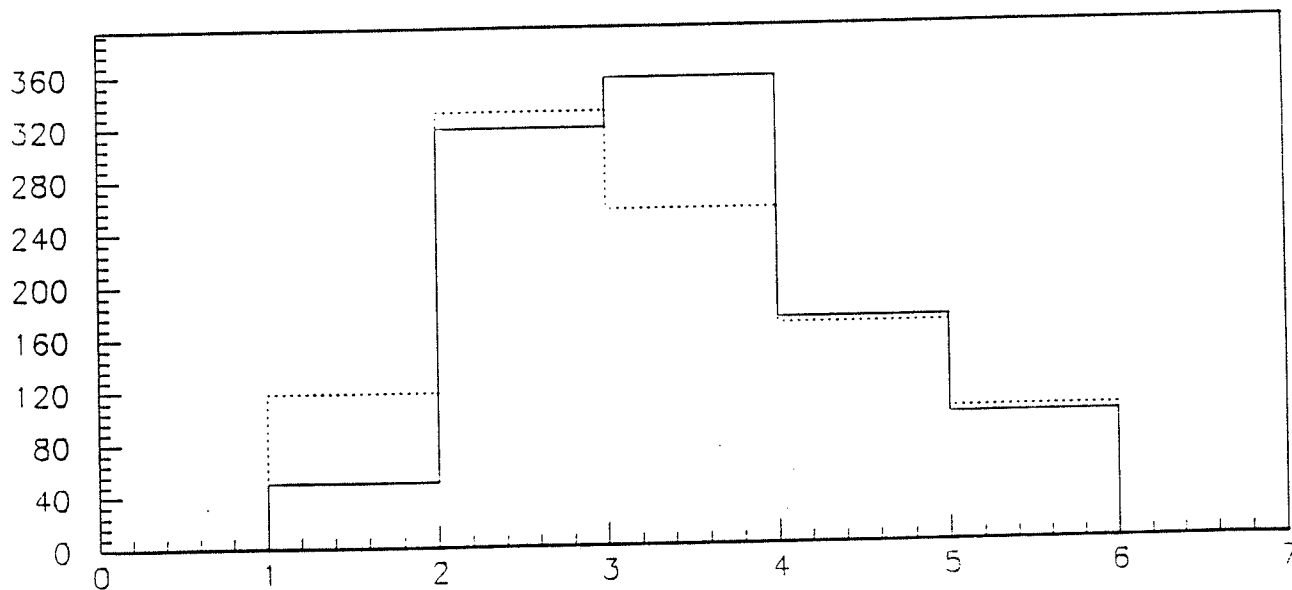


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## SUSY Monte Carlo



Missing  $E_T$  GeV



Number of Jets

$m_{\tilde{g}} = 150$  GeV

$E_T > 20$  GeV  $|\eta| < 3.5$

# *Data Analysis*

**Data Sample: 140 nb<sup>-1</sup> luminosity**

**Online triggers for SUSY analysis:**

- **Jet + missing E<sub>T</sub> trigger**

**Hardware: missing E<sub>T</sub> > 20 GeV  
trigger tower E<sub>T</sub> > 7 GeV**

**Software: missing E<sub>T</sub> > 25 GeV  
jet E<sub>T</sub> > 20 GeV (R=0.3)**

- **missing ET trigger**

**Hardware: missing E<sub>T</sub> > 35 GeV  
trigger tower E<sub>T</sub> > 3 GeV**

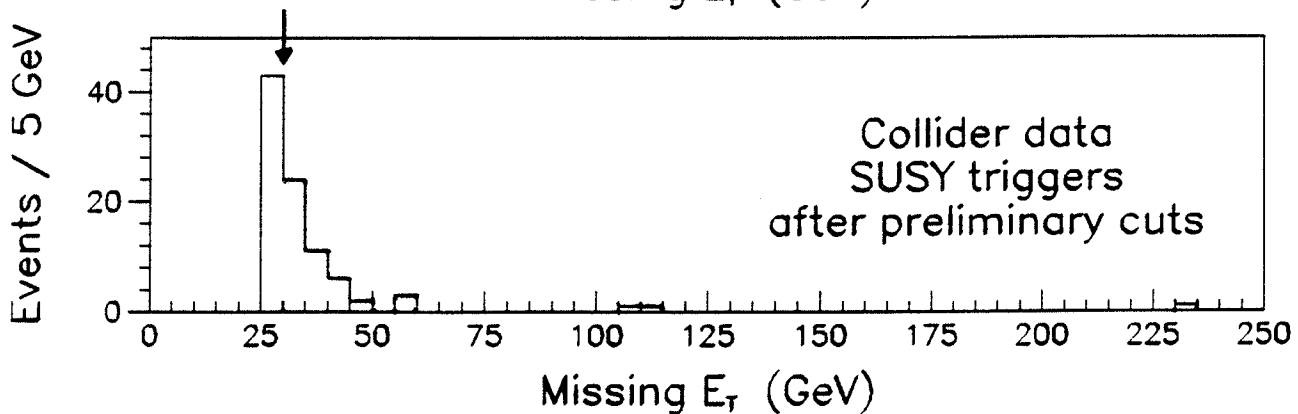
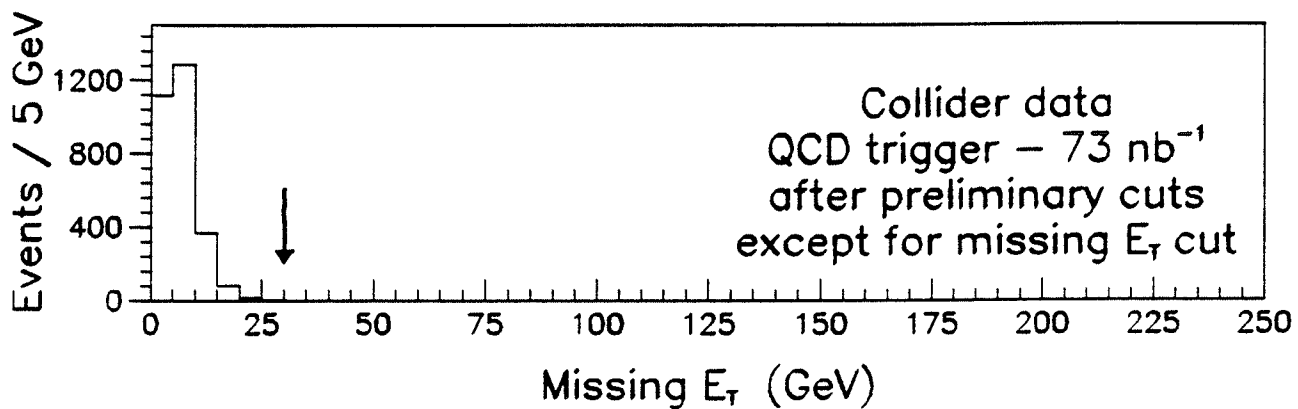
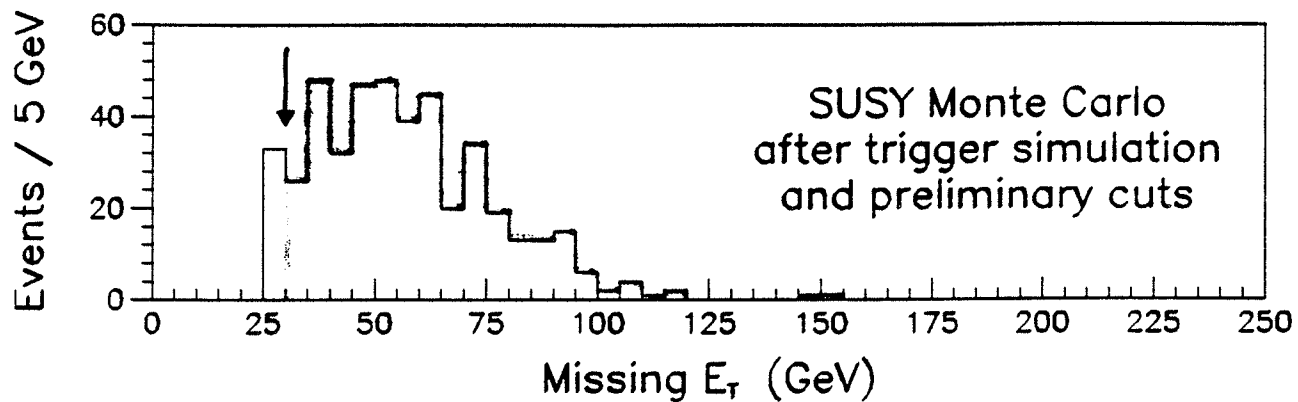
**Software: missing E<sub>T</sub> > 40 GeV**

**Offline preselection:**

**missing E<sub>T</sub> > 25 GeV  
jet E<sub>T</sub> > 20 GeV (R=0.5)  
clean event with unambiguous E<sub>T</sub>**

***92 events survived***

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## Signal Selection

- **missing  $E_T > 30$  GeV**  
**3 hadronic jets**       **$R=0.5$**   
                                  **$E_T > 20$  GeV**  
                                  **$|\eta| < 3.5$**
- **QCD Rejection**  
**mismeasured jets: tend to have**  
 **$\phi_{\text{missing } E_T}$  opposite to the leading**  
**jet, near  $\phi$  of the second jet**

$$\delta\phi_1 \equiv \phi_{\text{jet1}} - \phi_{\text{missing } E_T}$$

$$\delta\phi_2 \equiv \phi_{\text{jet2}} - \phi_{\text{missing } E_T}$$

$$(\pi - \delta\phi_1)^2 + (\delta\phi_1)^2 > .25$$

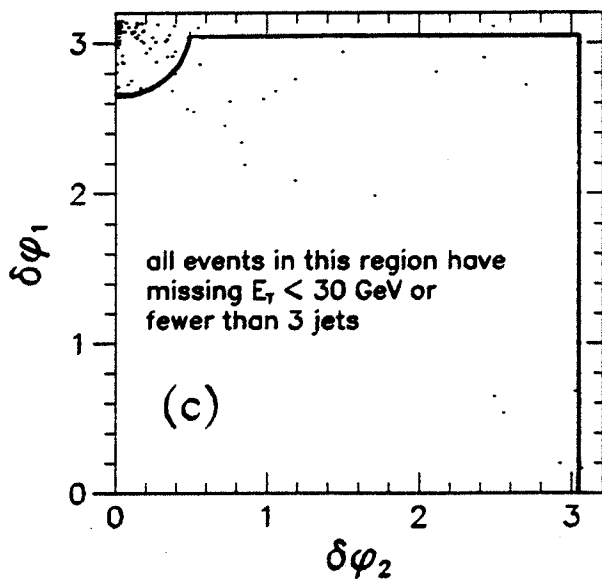
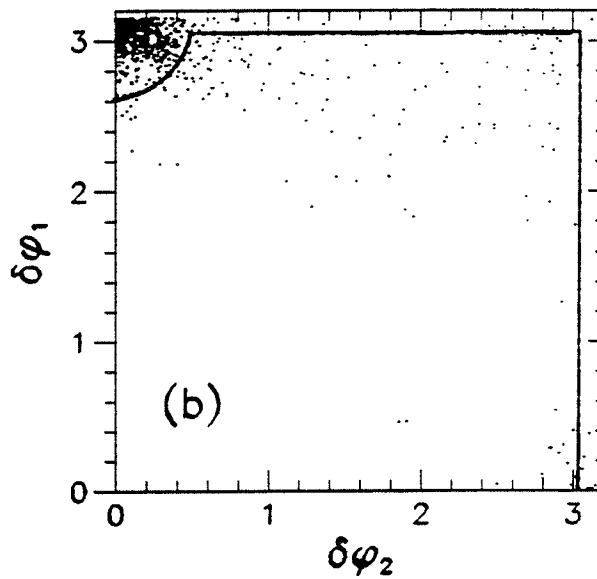
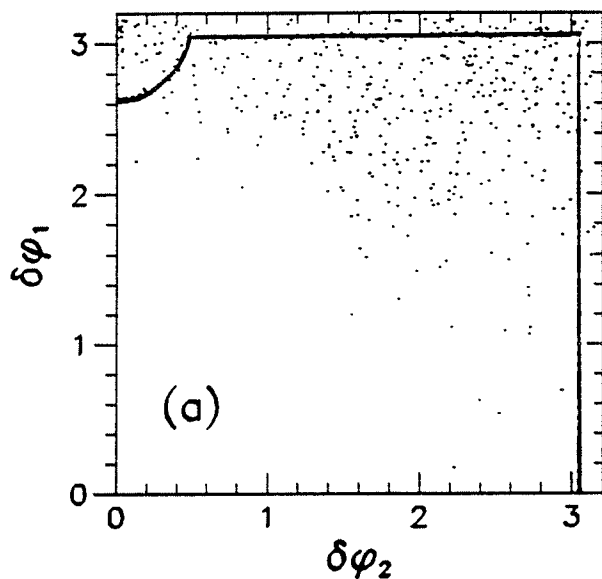
**1 event**

- **Remove large jet fluctuations**

$$\pi - \delta\phi_{1,2,3} > 0.1$$

**No events Survive**

# DØ Preliminary



(a) SUSY Monte Carlo  
after trigger simulation  
and preselection cuts

(b) QCD Monte Carlo  
after preselection cuts

(c) Collider data  
SUSY triggers  
after preselection cuts

# *Physics Backgrounds*

- **W + jets**      where  $W \longrightarrow l \nu$
- **Z + jets**      where  $Z \longrightarrow \nu \nu$
- **QCD heavy quark production**
- **QCD jet production with missing  $E_T$  from a mismeasured jet**

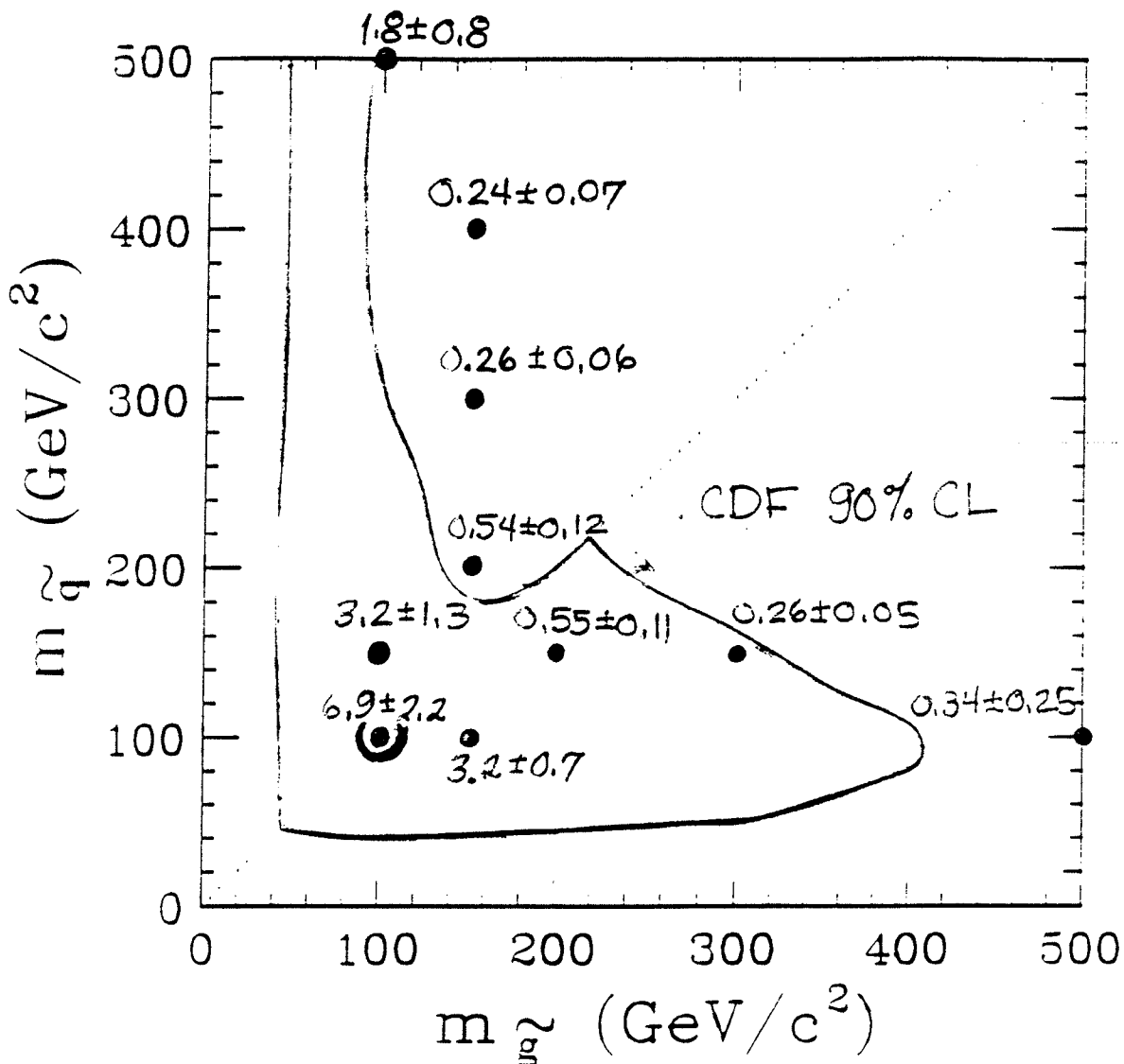
*Expect no events*

## **Error Estimation:**

- **theoretical : structure function 30%**
- **integrated luminosity:**  
15% systematic and 3% statistical
- **jet energy scale comparison:**  
10% systematic
- **missing  $E_T$  scale comparison:**  
15% systematic

CDF limit from FNAL Preprint FERMILAB  
PUB-92/221-E  
 cascade decay limit contour  
 for  $4.3 \text{ pb}^{-1}$  integrated luminosity

$D\bar{D}$  expected number of events  
 from  $0.14 \text{ pb}^{-1}$  integrated luminosity



# *Conclusion*

- **At 95% confidence level, with 140 nb<sup>-1</sup> integrated luminosity, rule out**

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

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

$$\tan(\beta)=2.0$$

$$m_{H^+} = 500 \text{ GeV}$$

$$\mu = -250 \text{ GeV}$$

- **Working hard to improve limit!**