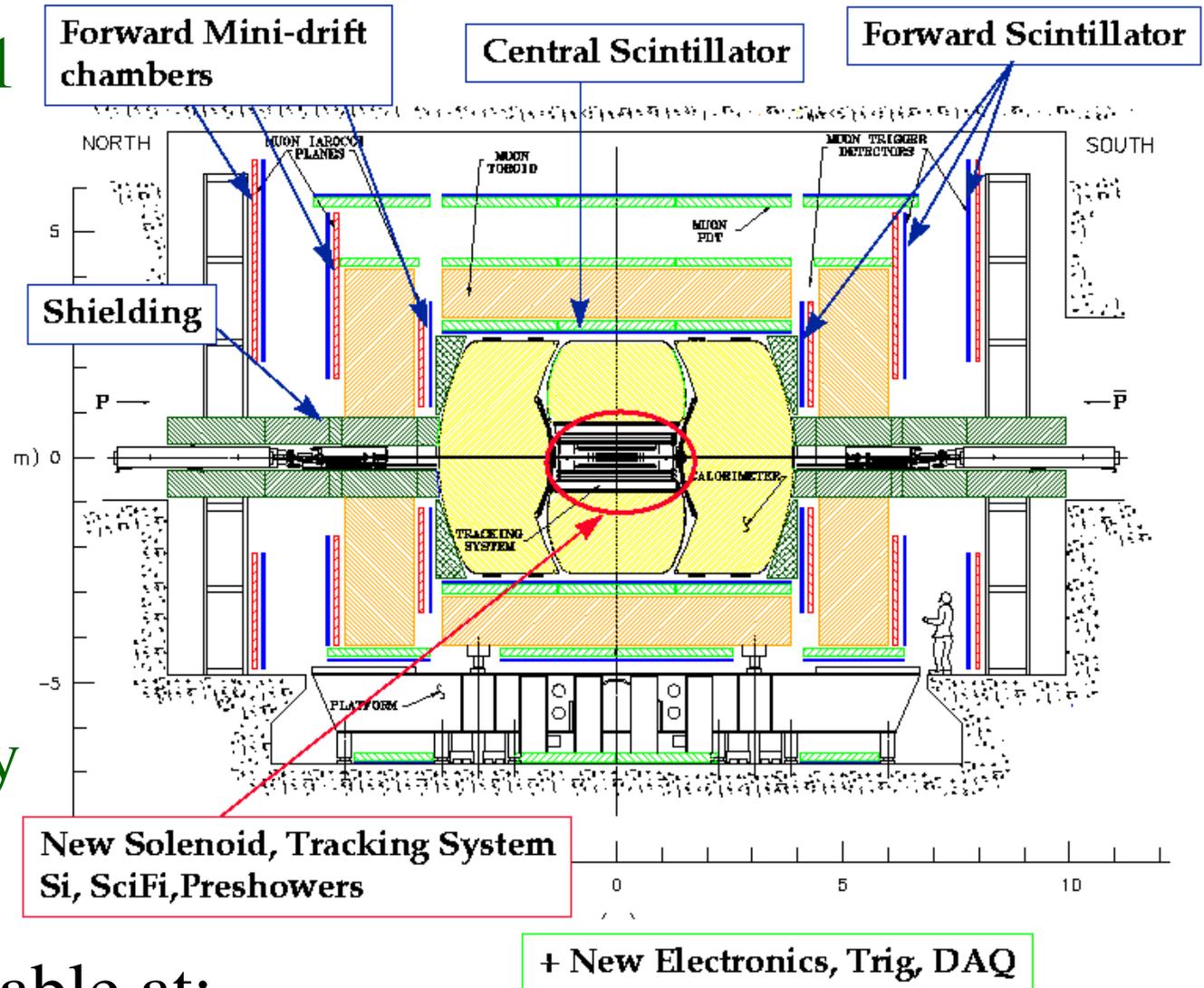


# Searches for New Phenomena at DØ

Adam Yurkewicz  
Stony Brook

# DØ Experiment

- Run II began 2001
- $p\bar{p}$  collisions at 1.96 TeV
- Integrated luminosity for results shown today 85-263  $\text{pb}^{-1}$
- $\sim 500 \text{pb}^{-1}$  of data now on tape – stay tuned!



All DØ results available at:

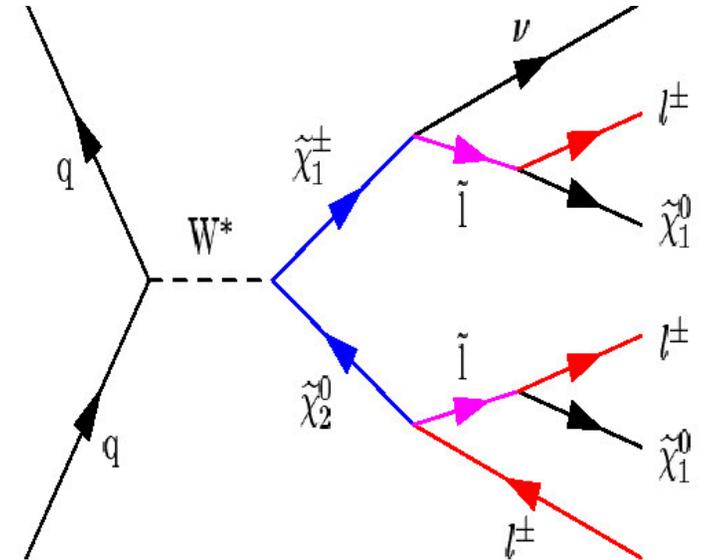
<http://www-d0.fnal.gov/Run2Physics/WWW/results.htm>

# Topics Covered

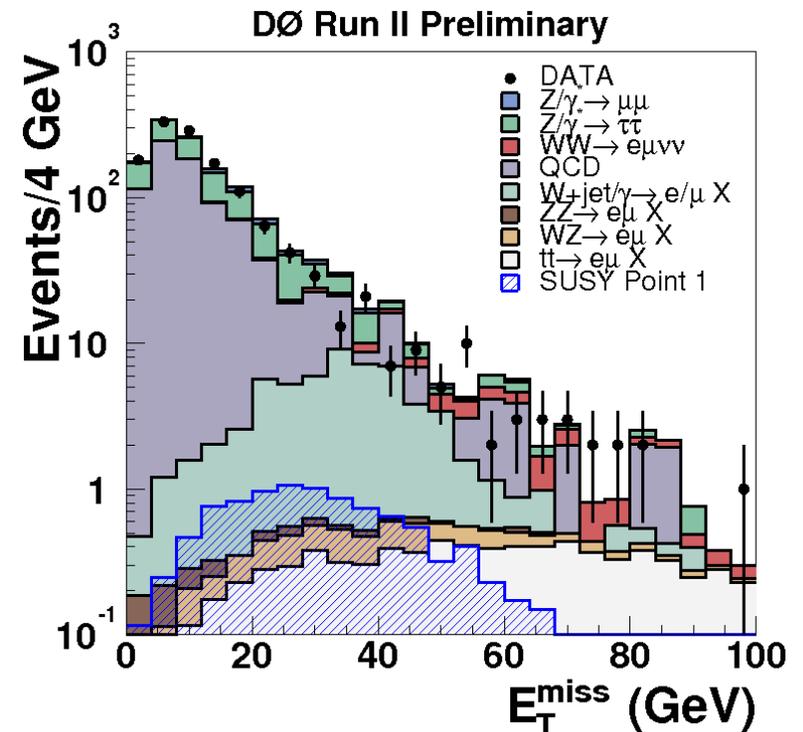
- Supersymmetry
  - mSUGRA
  - R-parity violating
  - Gauge-mediated
- Large Extra Dimensions
  - Dilepton final states
  - Jets plus missing transverse energy (MET)
- $Z'$  in dileptons
- Leptoquarks
- No time for many others!

# mSUGRA Supersymmetry: Trileptons

- mSUGRA free parameters:
  - $m_0, m_{1/2}, \tan\beta, A_0, \text{sign } \mu$
- Chargino / neutralino production leads to trilepton final states with large amount of MET from the LSP



- Clean signature with low background but low expected cross section
- 4 final states used:
  - $eel, \mu\mu l, e\mu l, \text{like-sign } \mu\mu$
- Combine all final states for best sensitivity



# mSUGRA: Trileptons

- Combine results from 4 channels:  $e\bar{e}l$ ,  $\mu\mu l$ ,  $e\mu l$ , LS  $\mu\mu$ 
  - MET, anti-Z, anti-jet cuts
- Final states with taus coming soon!
- Important at high  $\tan\beta$

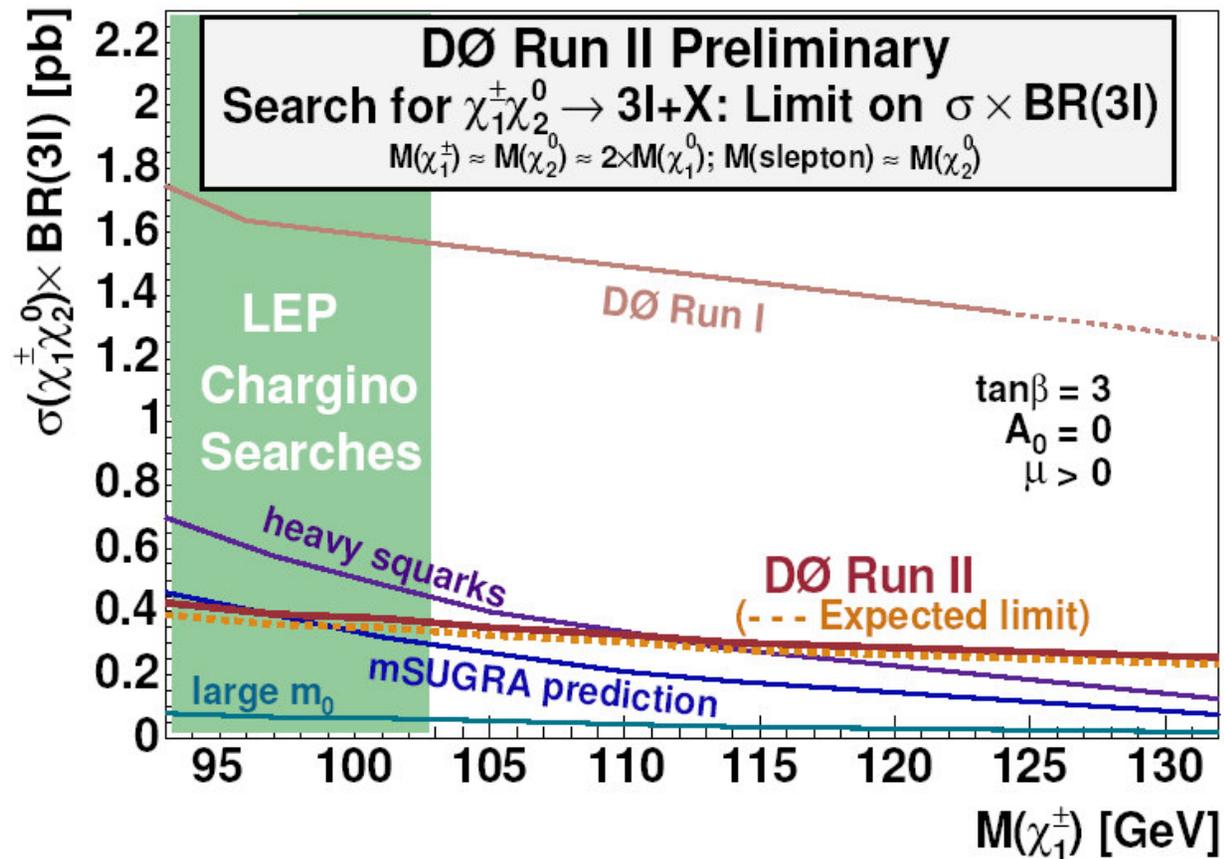
- $N_{\text{expected}} = 2.9 \pm 0.8$

- $N_{\text{observed}} = 3$

- Cross section limit as a function of  $m_{\text{chargino}}$  for

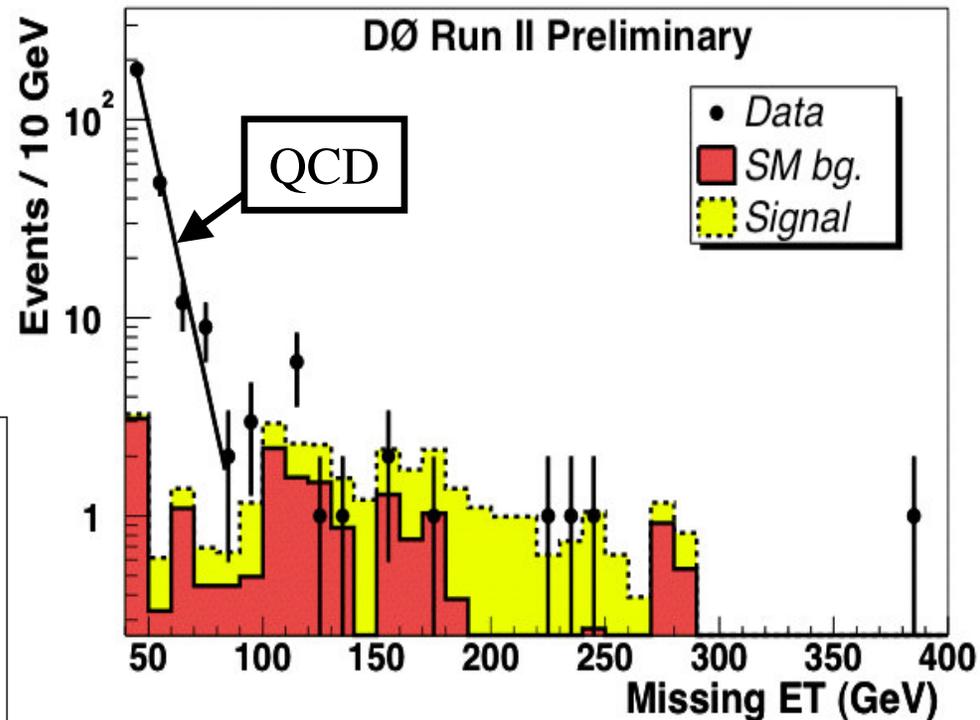
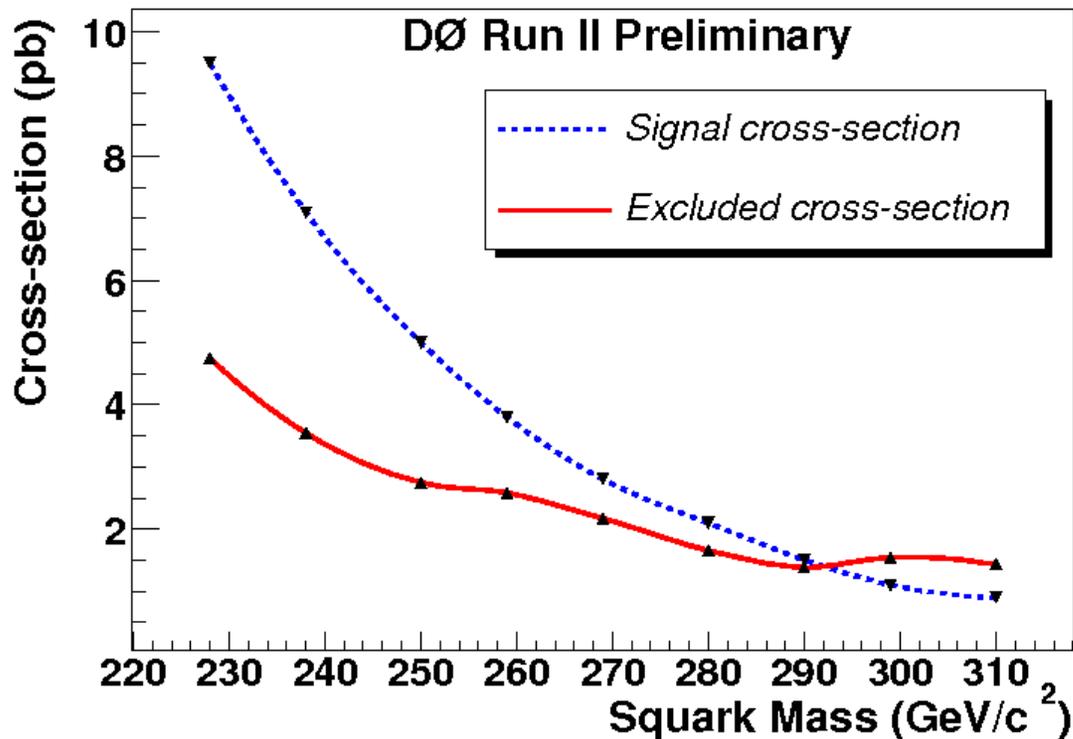
$$m_{\text{chargino}} \approx m_{\text{slepton}}$$

- Data on tape will allow probing beyond LEP limits



# mSUGRA: Jets + Missing $E_T$

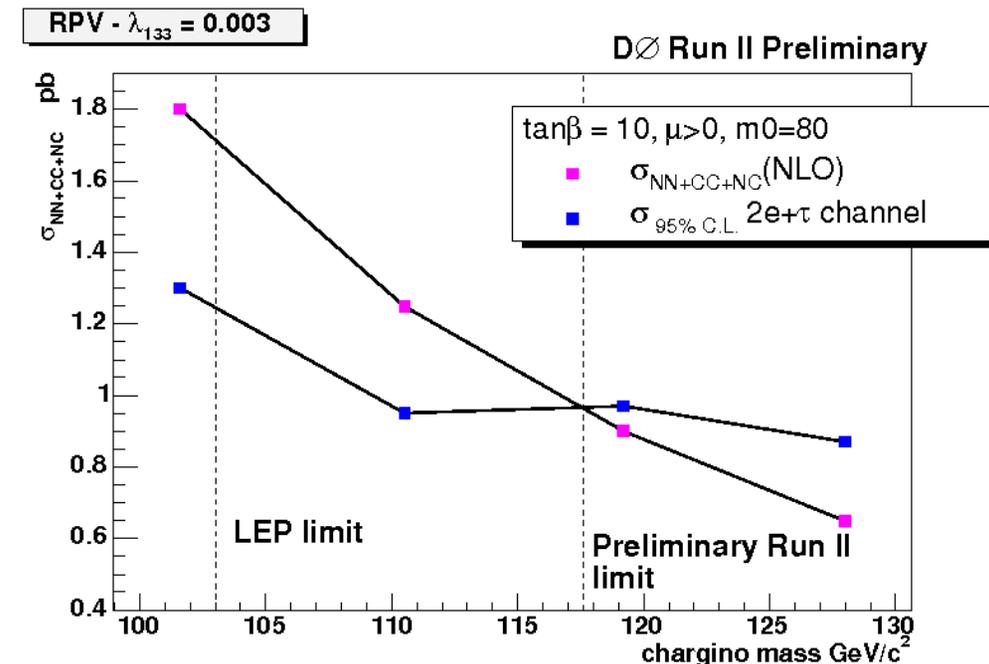
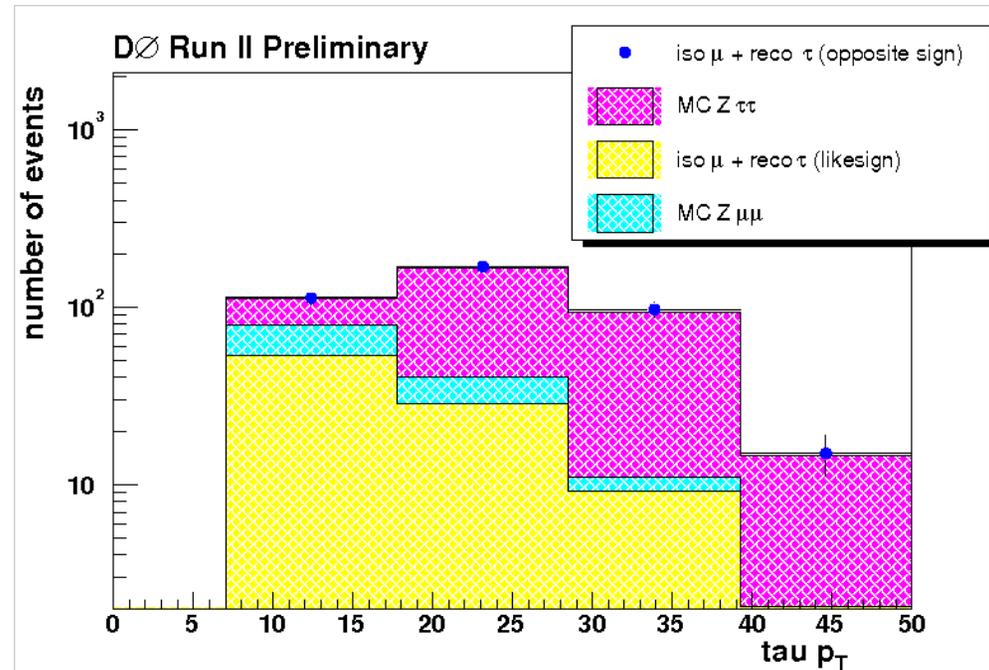
- Search for squark / gluino decays
  - At least two high  $p_T$  jets
  - Sum of jet  $p_T > 275$  GeV
  - MET  $> 175$  GeV
  - Analysis uses  $85 \text{ pb}^{-1}$



- $N_{\text{expected}} = 2.7 + 2.3/-1.5$
- $N_{\text{observed}} = 4$

# R-Parity Violating SUSY

- DØ has several RPV SUSY analyses in progress
  - Recent result in  $e\tau$  final state ( $\lambda_{133}$  RPV coupling)
- Builds on DØ  $Z \rightarrow \tau\tau$  results
- Limit on gaugino production cross section as a function of chargino mass
  - $m_0 = 80$ ,  $\tan\beta = 10$ ,  $A_0 = 0$ ,  $\text{sign } \mu > 0$
- $N_{\text{expected}} = 1.04 + 1.42/-1.04$
- $N_{\text{observed}} = 0$

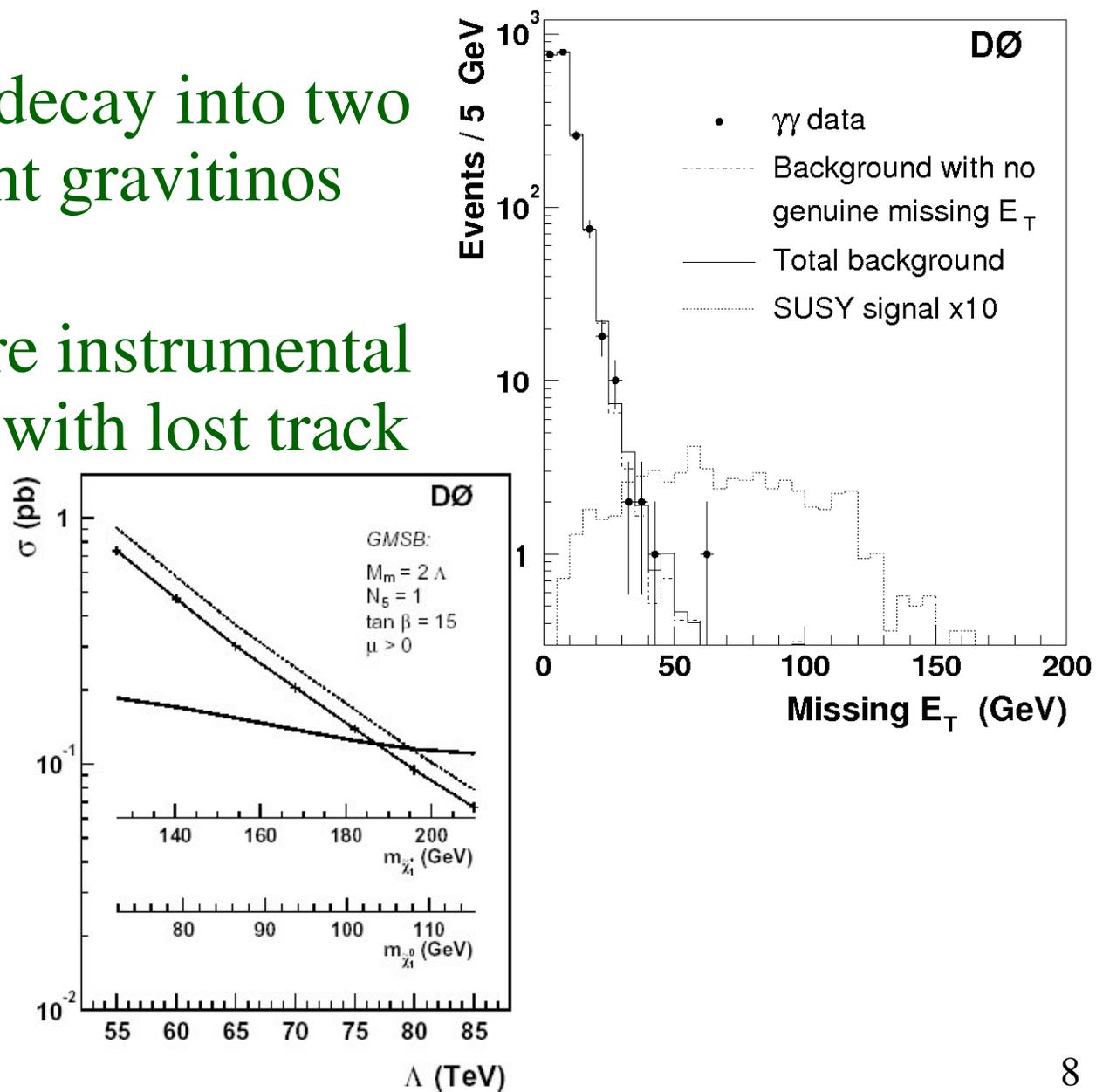


# SUSY with Gauge-Mediated Breaking

- Neutralinos (NLSP) decay into two photons and very light gravitinos (MET)
- Main backgrounds are instrumental from QCD and  $W+\gamma$  with lost track

• Recently published  
in **PRL 94, 041801**

•  $m_{\text{neutralino}} > 108 \text{ GeV}$   
–World's Best  
Limit!



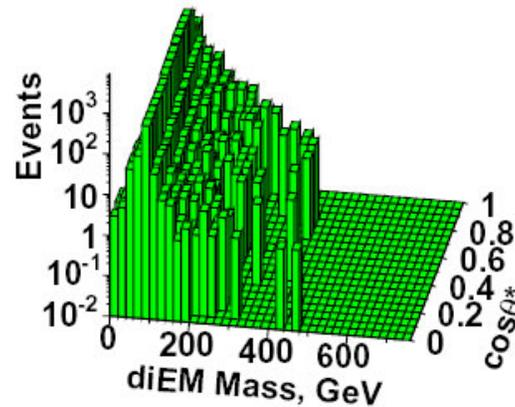
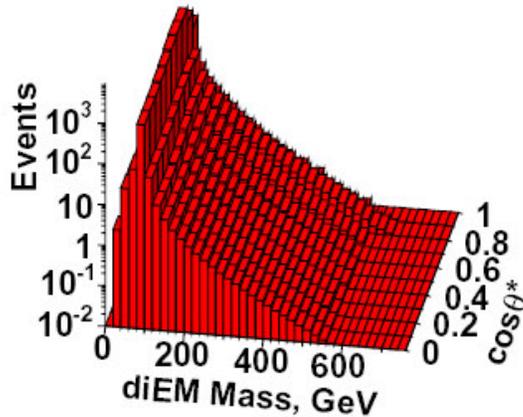
# Large Extra Dimensions

- Theories proposing the existence of LED can be studied at the TeVatron
- Graviton propagates in extra dimensions while other SM fields do not
  - Virtual graviton exchange modifies SM cross sections – look for deviations in invariant mass and angular distributions in di-EM final states
  - Graviton recoils against a quark or gluon, escaping into the bulk. Signal is monojet + MET from graviton

# LED in Di-EM Final State

- Separate signal / background with 2-dimensional mass-cos  $\theta^*$  fit

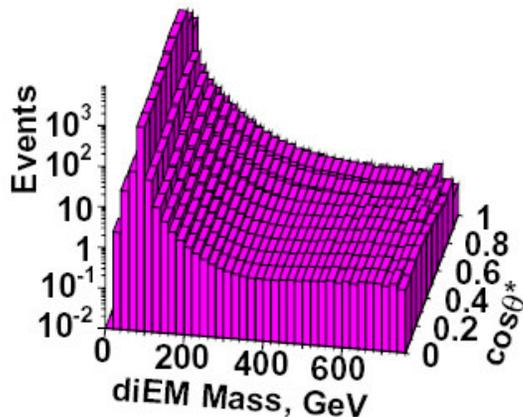
SM Prediction **DØ Run II Preliminary** Data



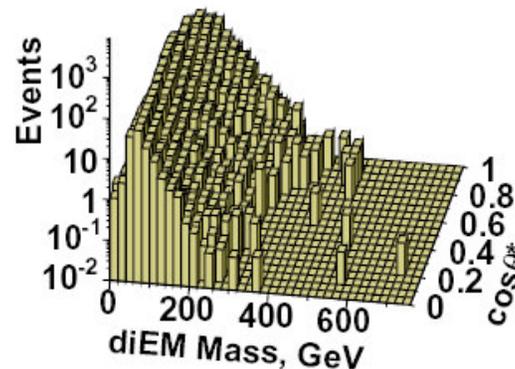
• Limit of  $M_S > 1.43$  TeV in the GRW formalism from combination with Run I data

• World's Best Limit!

ED Signal

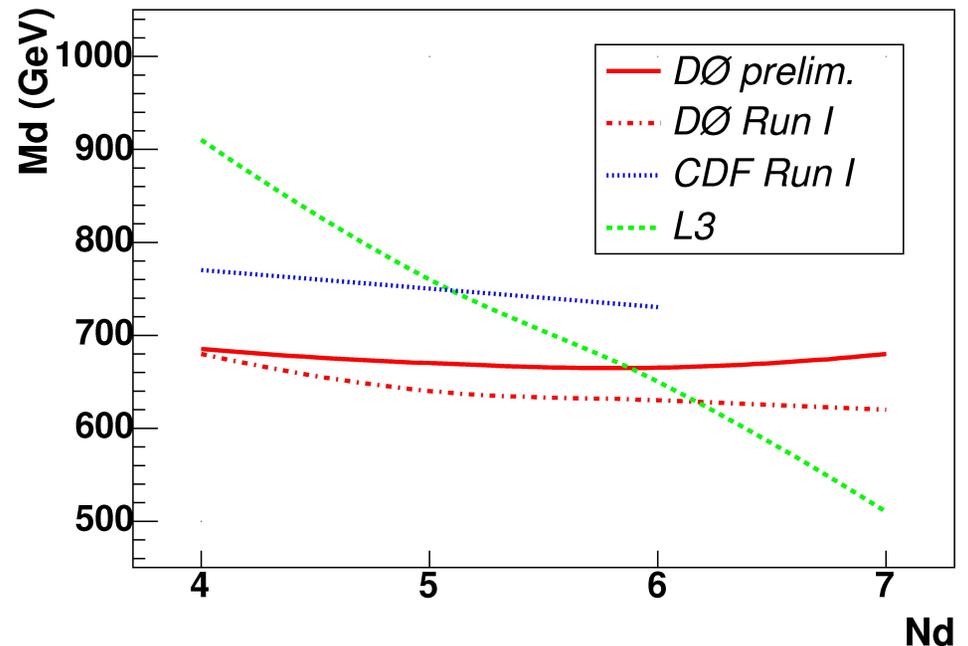
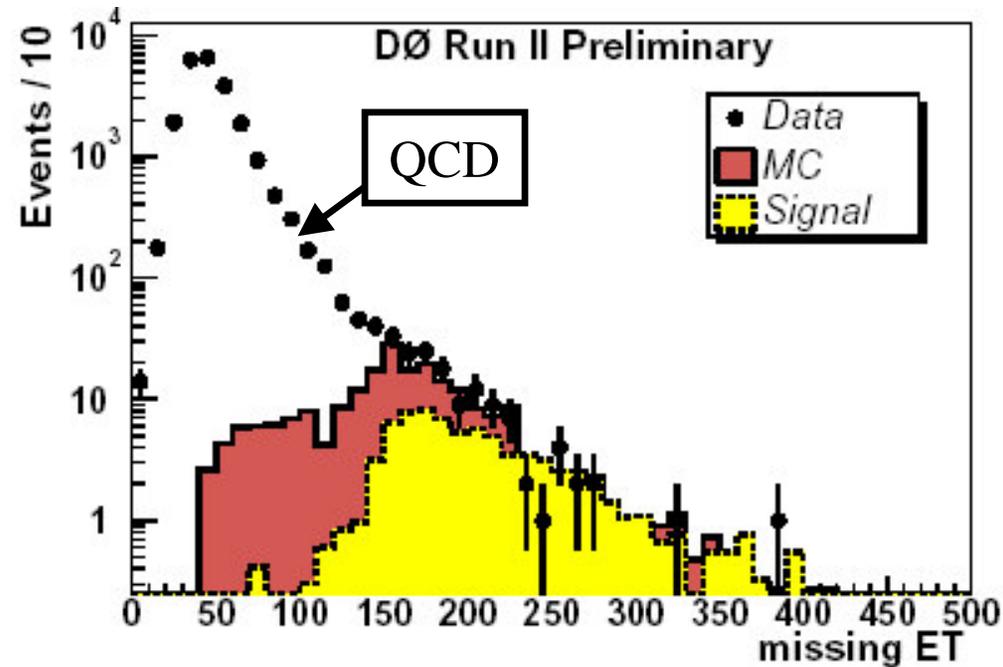


QCD Background



# LED in Jets + MET Final State

- One jet with  $p_T > 150$  GeV
- MET  $> 150$  GeV
  - Very little QCD background remains
- Main background left is from  $Z \rightarrow \nu\nu + \text{jets}$
- $N_{\text{expected}} = 100 + 51/-32$ 
  - Large uncertainty from jet energy scale
- $N_{\text{observed}} = 63$
- Search in  $85 \text{ pb}^{-1}$ 
  - Update coming soon



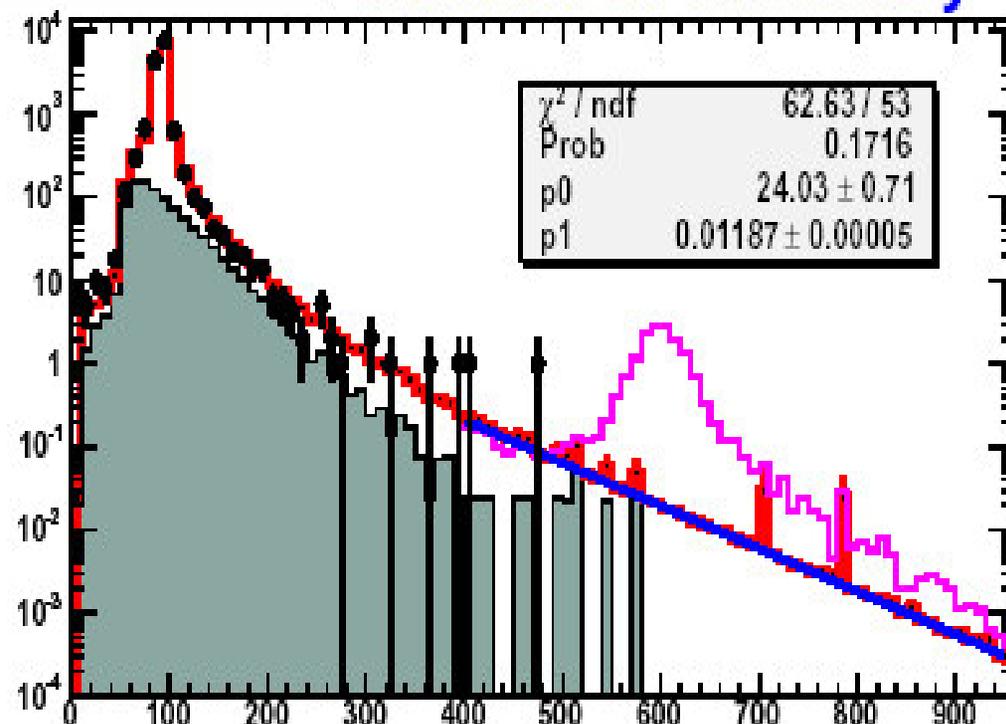
# Z' in Dielectron Final State

- DØ can look for new neutral gauge bosons (Z')
- Analysis optimized by setting counting window separately for each resonance position

- Limit of 780 GeV set on Z' mass with SM-like couplings
- World's best limit!

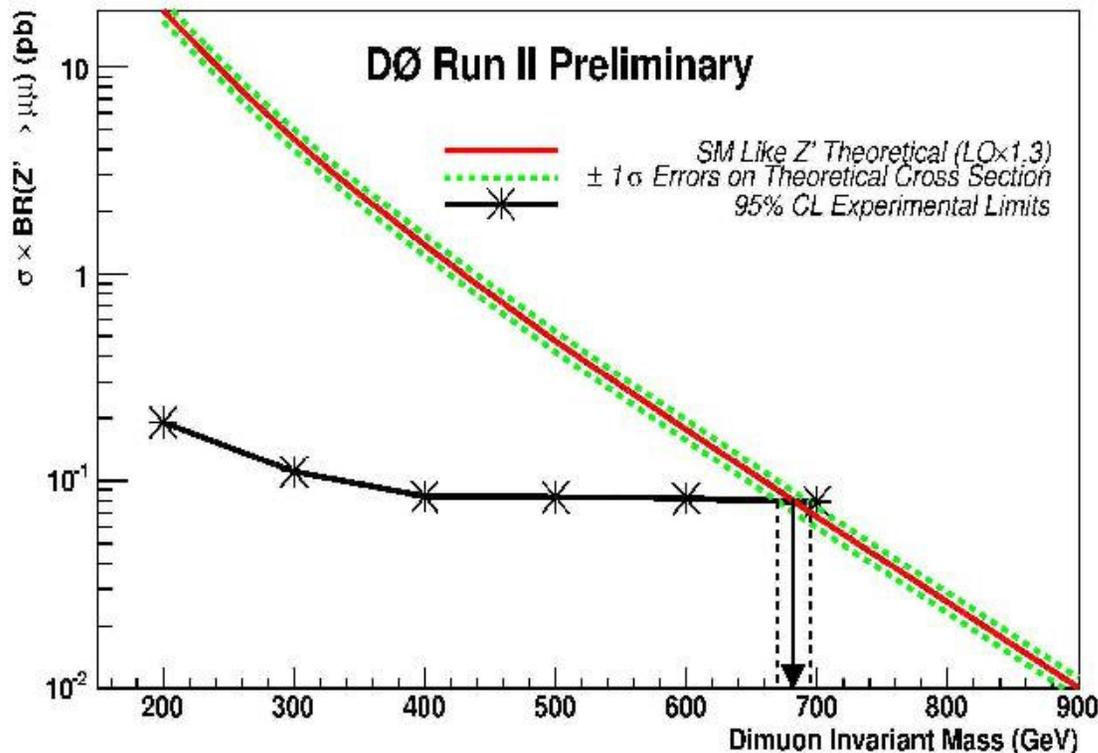
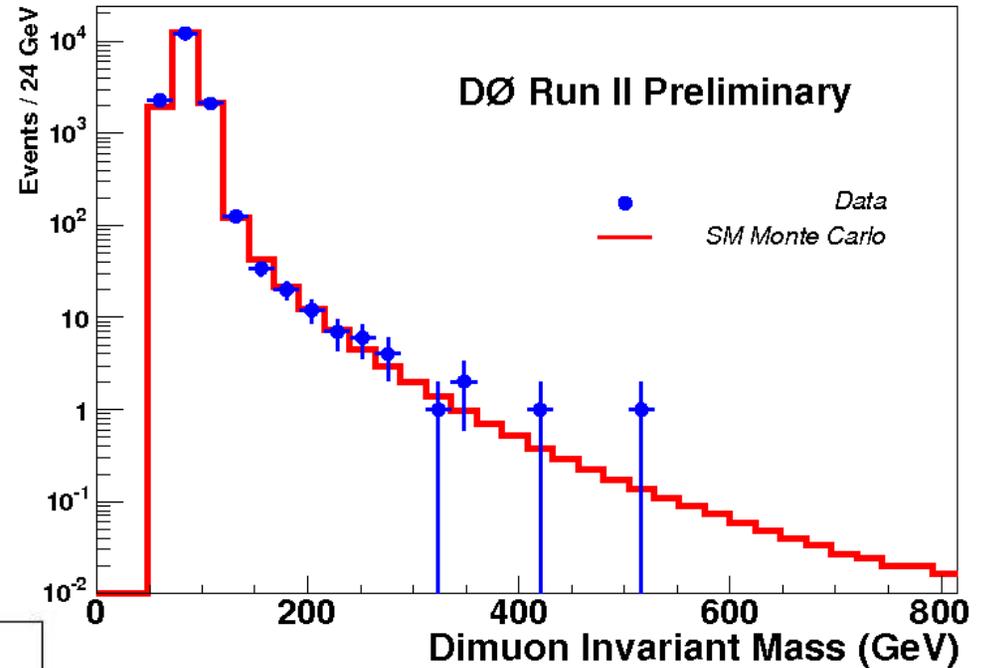
diEM Mass Spectrum

DØ Run II Preliminary



# Z' in Dimuons

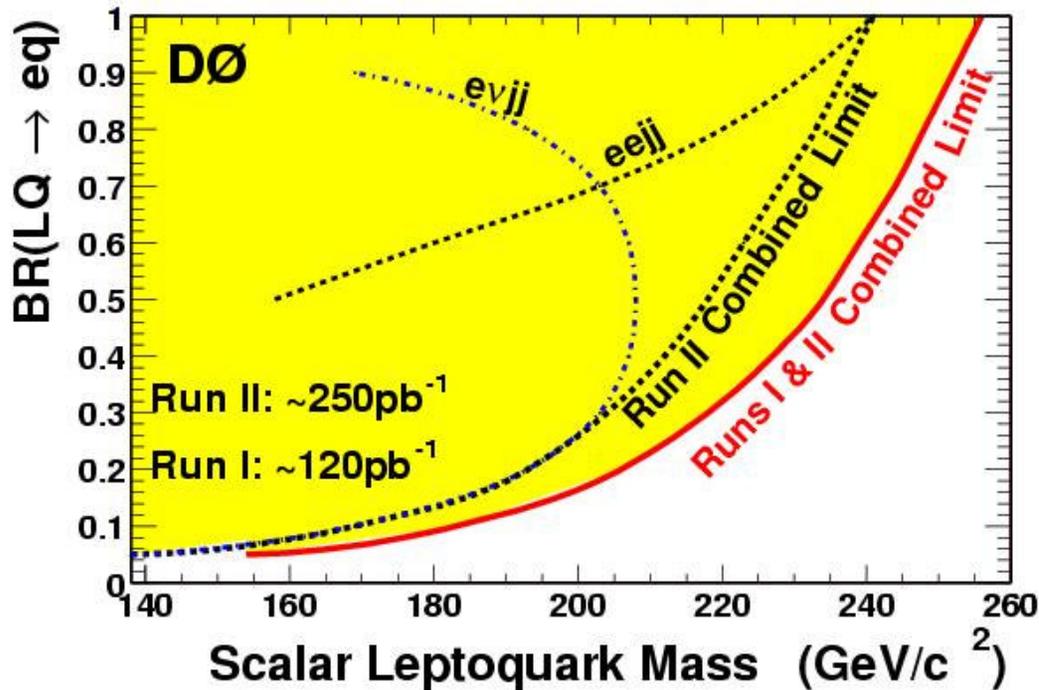
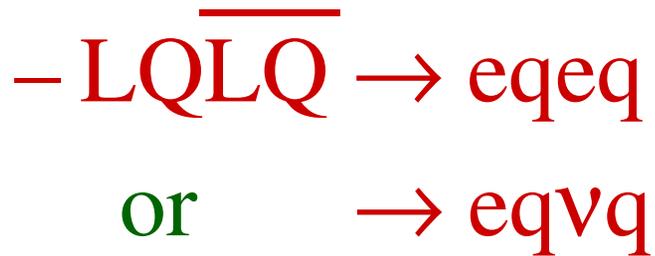
- Analysis also done in dimuon channel
  - Clean signal but worse resolution than Dielectron channel



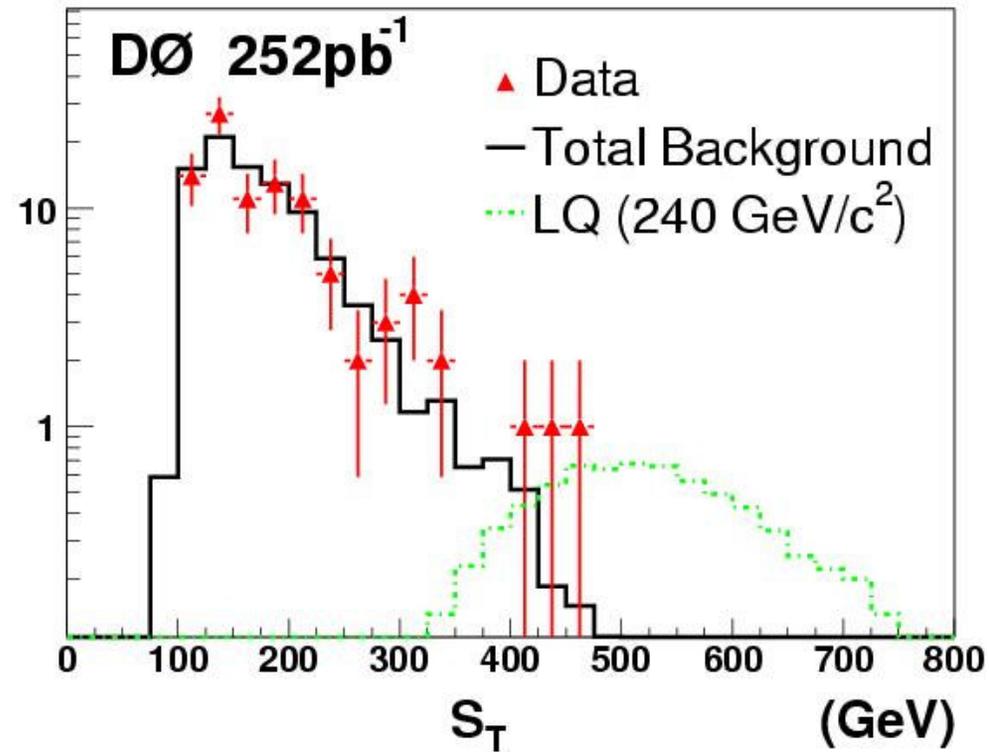
- Limit of 680 GeV set on Z' mass with SM-like couplings

# Scalar Leptoquarks

- First generation leptoquark search



Number of events/25 GeV



- Limits from combination with Run I data

# Conclusions

- Run II at DØ has already yielded many new results
  - Several publications on the way
- Could not show everything here!
  - <http://www-d0.fnal.gov/Run2Physics/WWW/results.htm>

