



NORTHERN ILLINOIS  
UNIVERSITY

# Electroweak and QCD Results from DØ

Michael Eads  
Northern Illinois University

*for the DØ Collaboration*

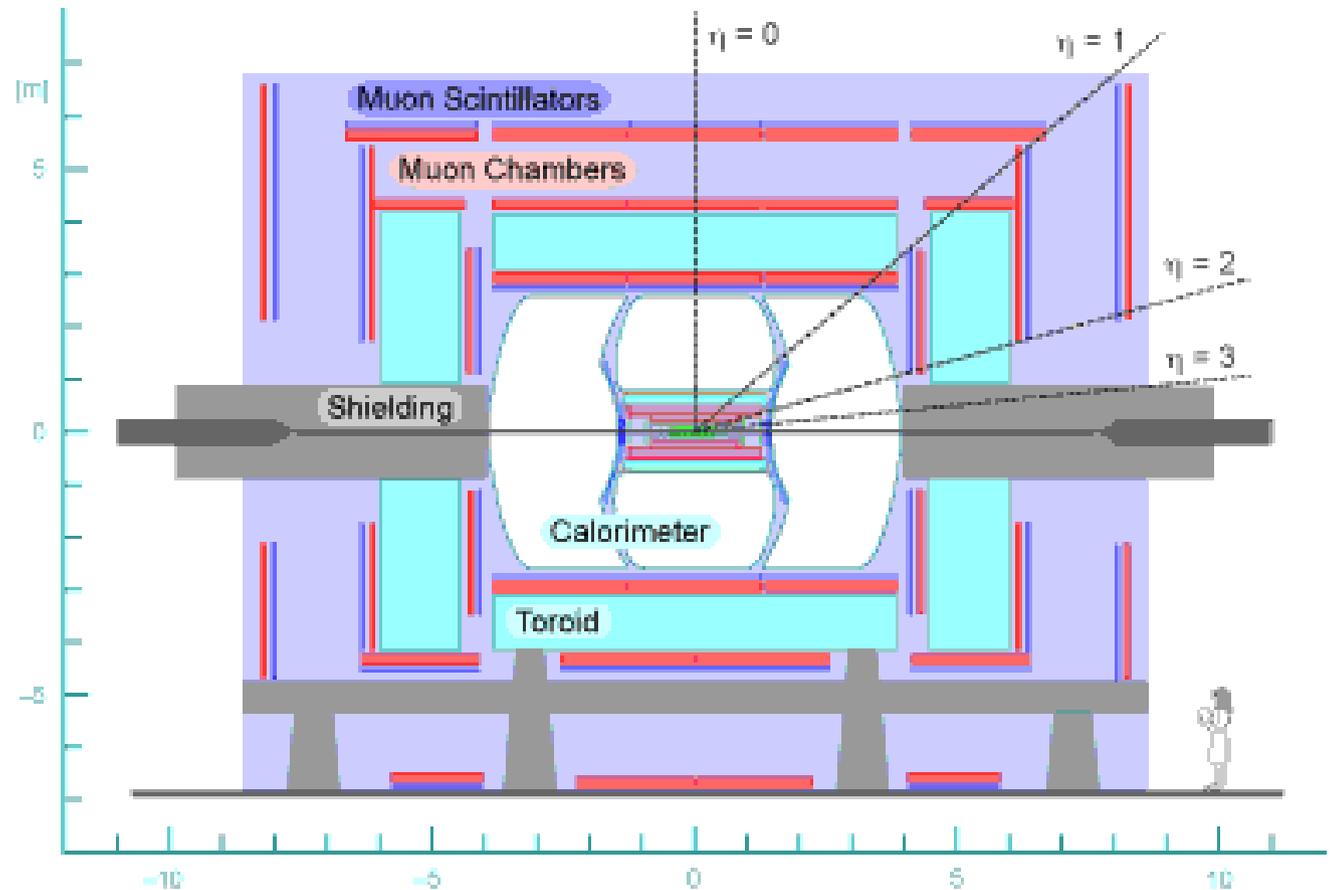


# Outline

- ◆ I will give a *brief* overview of some of the latest results from DØ:
  - ◆ QCD results
    - ◆ Dijet angular decorrelations
    - ◆ Inclusive jet cross section
    - ◆ Dijet cross section
  - ◆ Electroweak results
    - ◆  $Z \rightarrow \tau\tau$  cross section times branching fraction
    - ◆ Diboson cross sections
    - ◆ Limits on anomalous couplings
- ◆ Unfortunately, there isn't enough time for details on the different analyses

# The DØ Detector

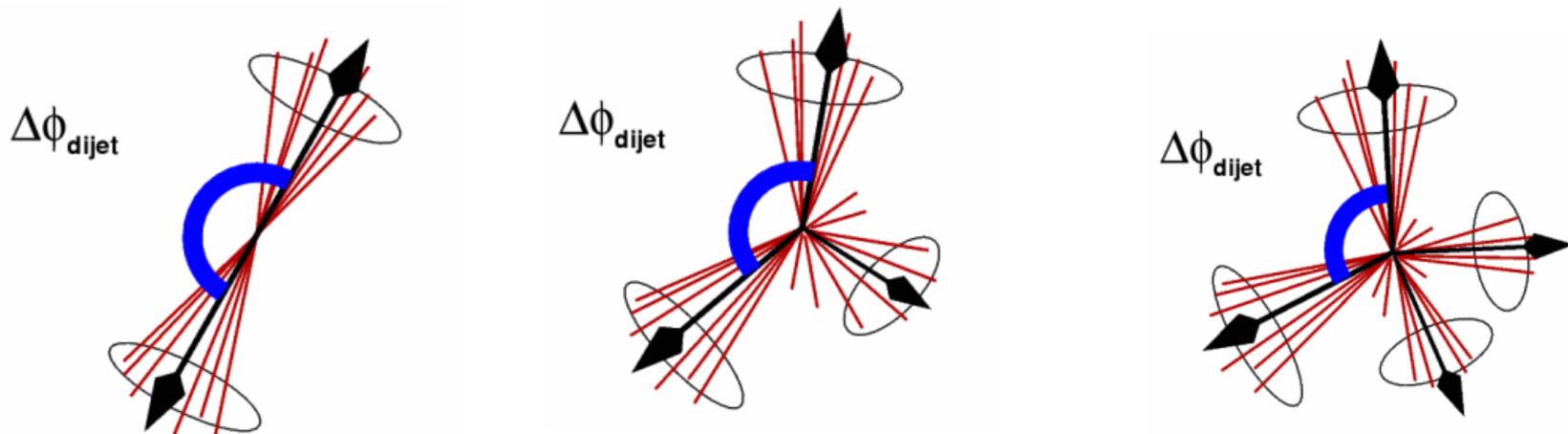
- ◆ Over 600 physicists in 86 institutions from 19 countries
- ◆ Run II has been in progress since 2001
- ◆ Current results have similar to double the luminosity of Run I (at a larger  $\sqrt{s}$ )





# Dijet Angular Decorrelations

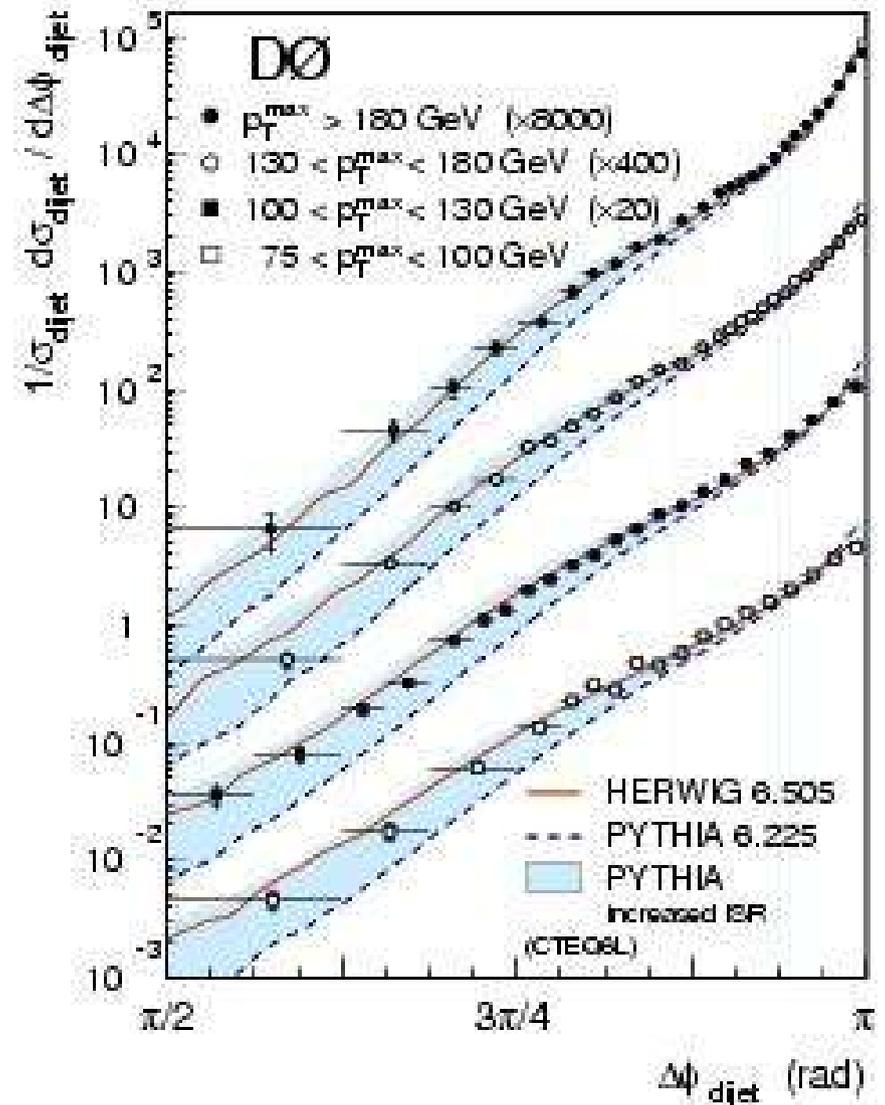
- ◆ At LO, jets are produced back-to-back in azimuth ( $\Delta\phi = \pi$ ,  $\phi$  is azimuthal angle)
- ◆ Additional radiation causes  $\Delta\phi < \pi$ 
  - ◆ The harder the initial radiation, the smaller  $\Delta\phi$  becomes





# Dijet Angular Decorrelations

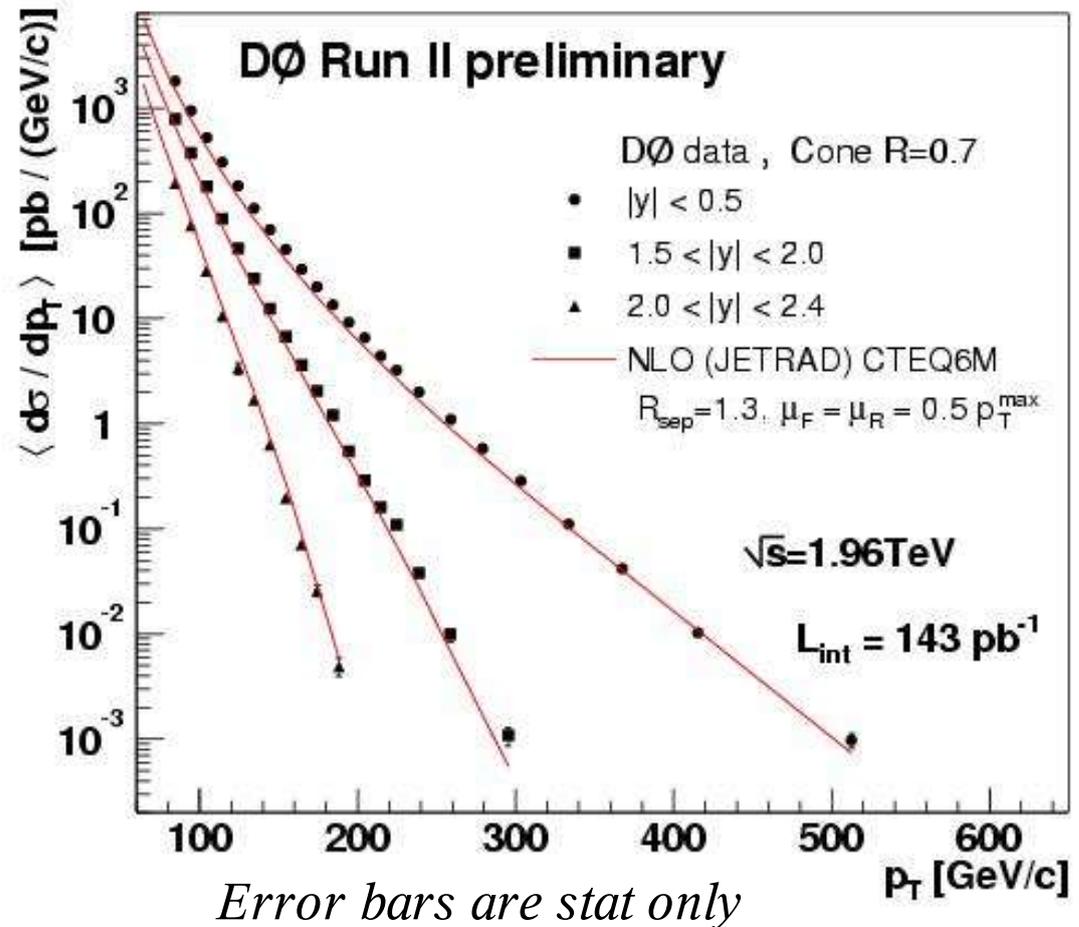
- Angular correlations are sensitive to radiative effects, but don't suffer from energy scale systematics
- The angular correlation has been studied in four transverse momentum regions in 150 pb<sup>-1</sup> of data
- This can be used to tune parton-shower models





# Inclusive Jet Cross Section

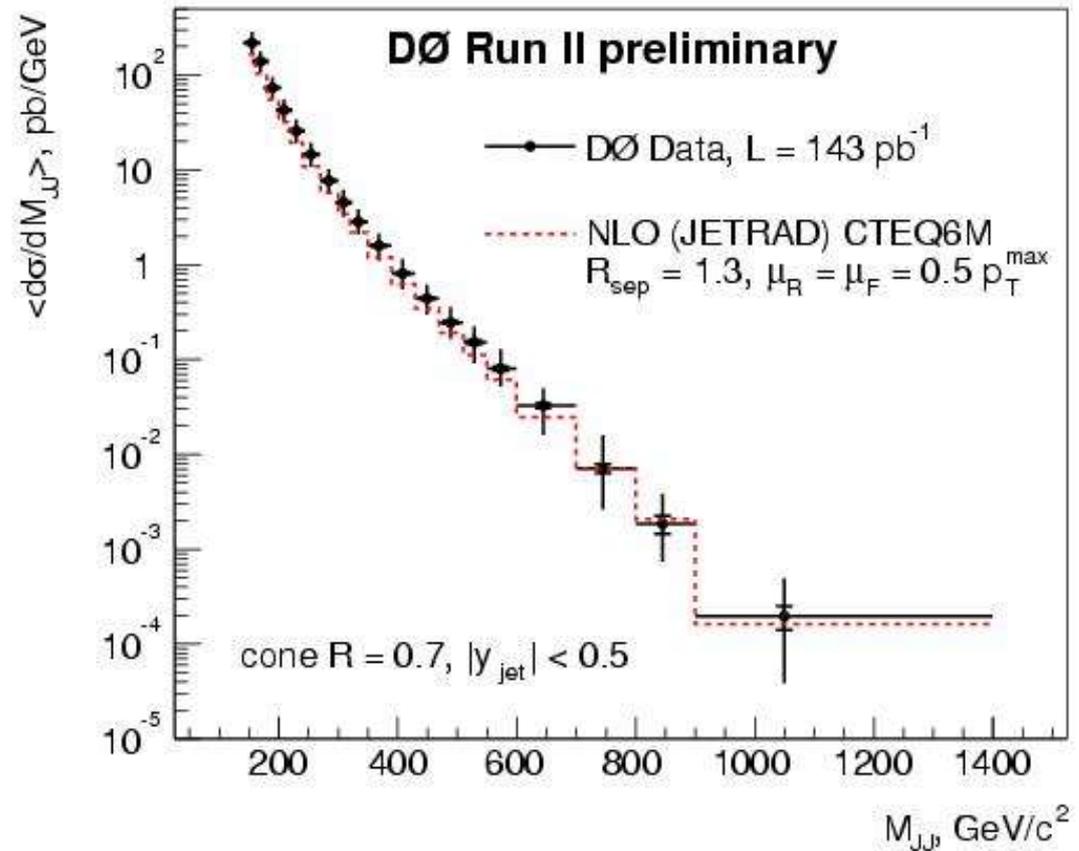
- ◆ Jet cross sections are sensitive to pQCD calculations, the strong coupling constant, and PDFs
- ◆ Events are triggered on (calorimeter) jet triggers and jets reconstructed with the Run II cone algorithm





# Dijet Cross Section

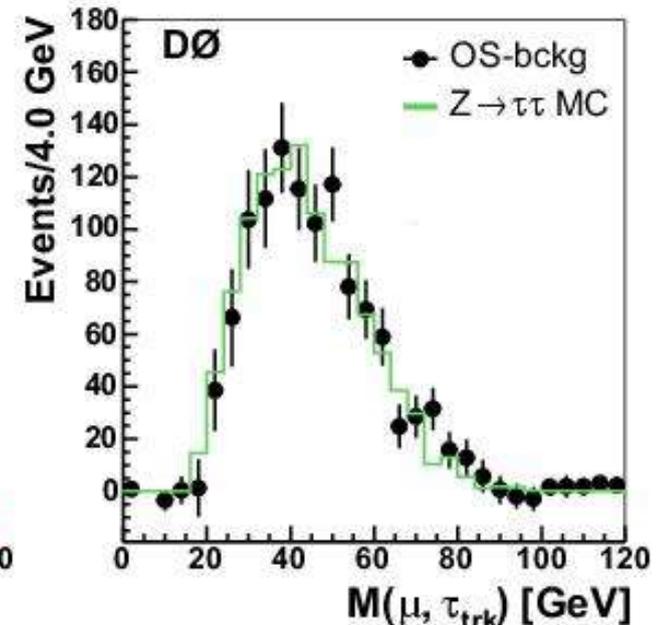
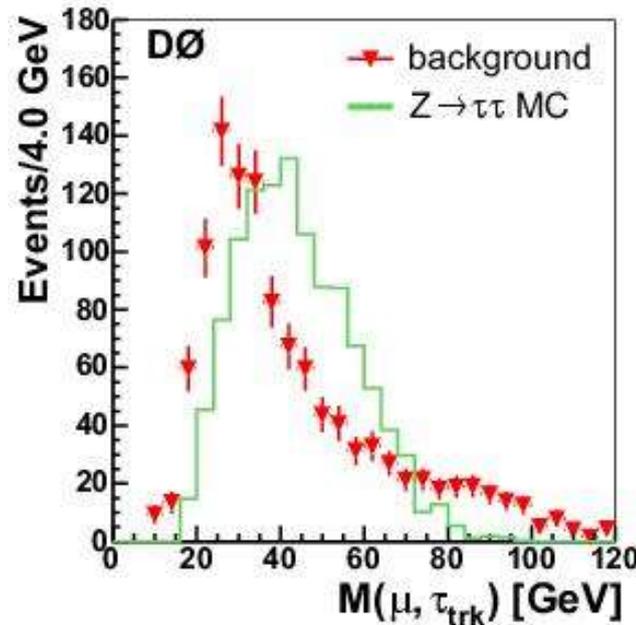
- ◆ An excess at large dijet invariant mass could be a sign of new physics
- ◆ The highest  $p_T$  event:
  - ◆  $p_{T1} = 616$  GeV
  - ◆  $p_{T2} = 557$  GeV
  - ◆  $M_{jj} = 1206$  GeV
- ◆ Results are consistent with SM expectations





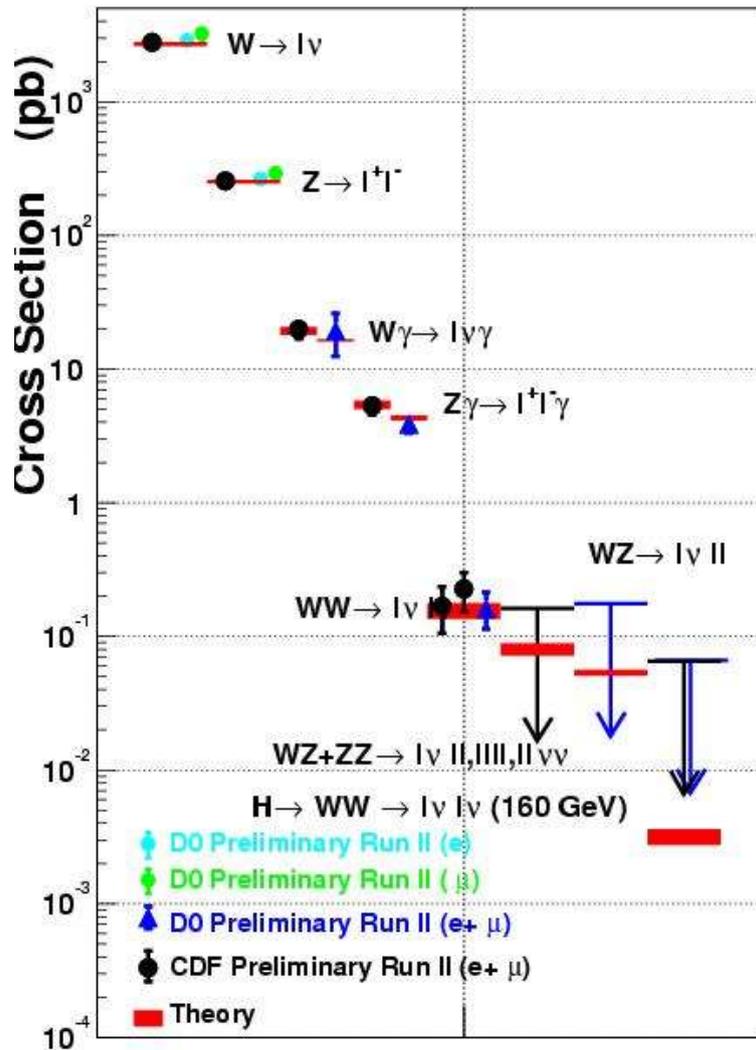
# Z $\rightarrow$ $\tau\tau$ Cross Section

- ◆ Tests lepton universality
  - ◆ An indirect probe of new physics that may decay to taus
    - ◆ For example, SUSY at large  $\tan \beta$
  - ◆ Require one tau to decay to muon
- ◆ 2008 candidate events (with 55% background) in  $226 \text{ pb}^{-1}$
  - ◆  $\sigma \cdot \text{Br}(Z \rightarrow \tau\tau) = 237 \pm 15_{\text{stat}} \pm 18_{\text{sys}} \pm 15_{\text{lum}} \text{ pb}$ 
    - ◆ Agrees with SM ( $242 \pm 9 \text{ pb}$ )

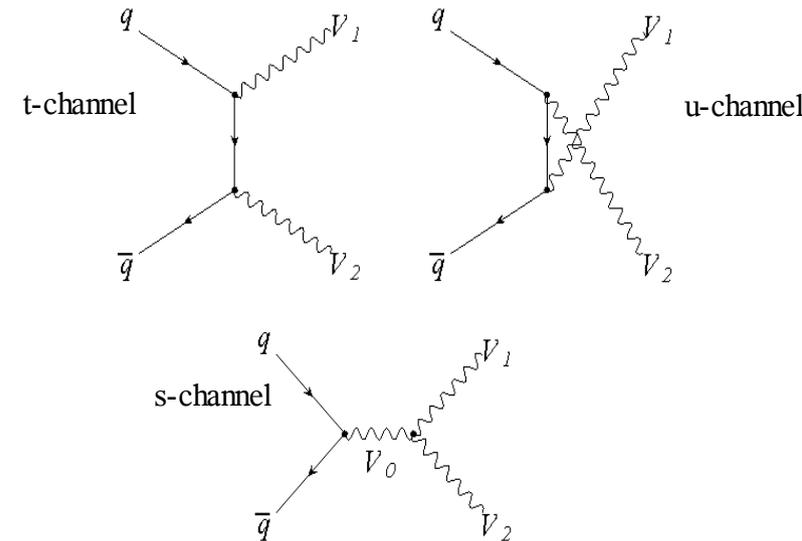




# Dibosons at DØ



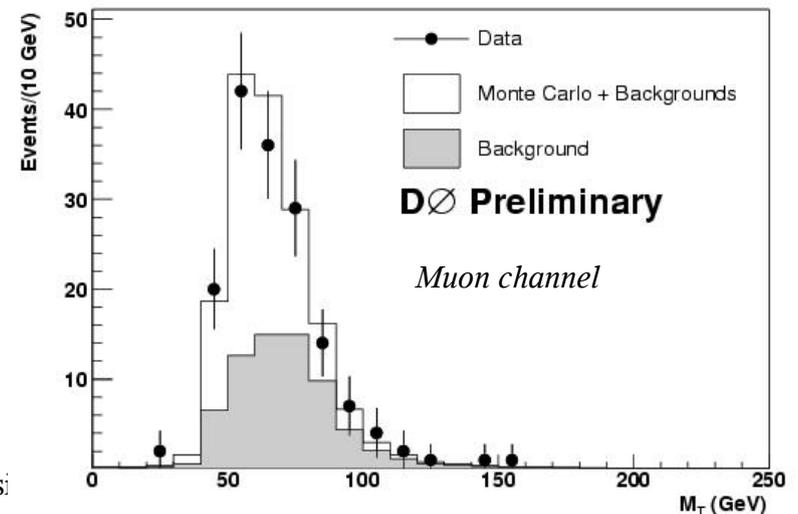
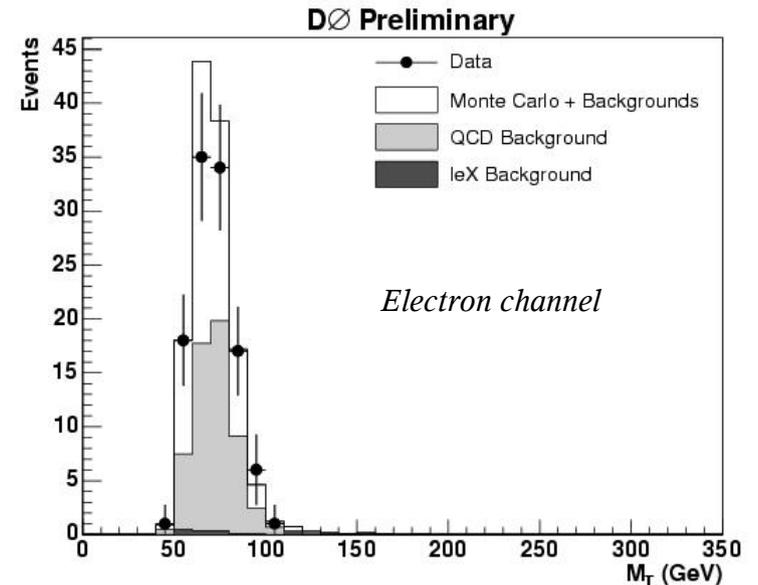
- ◆ Gauge boson pairs can be produced through t/u-channel or through s-channel triple gauge boson vertex
- ◆ Strength of coupling predicted by SM
- ◆ Important in Higgs and new physics searches





# $W\gamma + X$

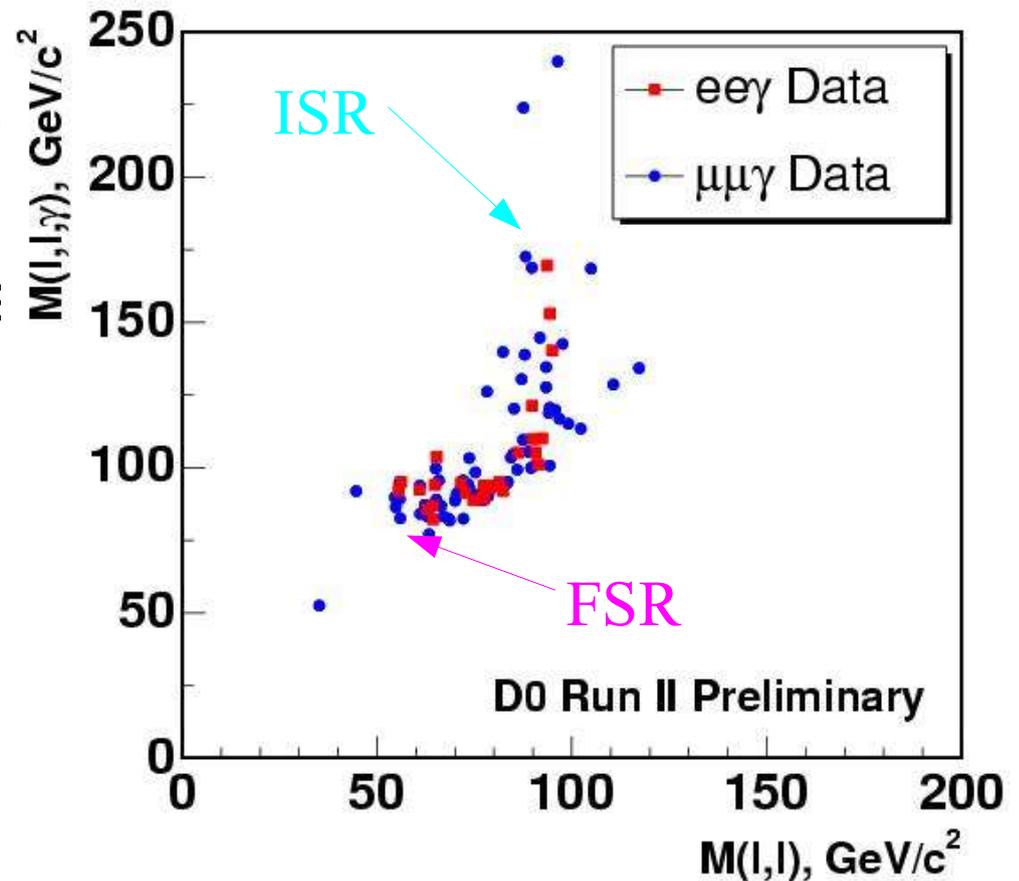
- ◆ Events are selected with a lepton (e or  $\mu$ ), a photon and missing energy
- ◆ Electron channel:
  - ◆  $162 \text{ pb}^{-1}$ , 112 data events  
( $51.2 \pm 11.5$  sig,  $60.8 \pm 4.5$  bgd)
- ◆ Muon channel:
  - ◆  $134 \text{ pb}^{-1}$ , 161 data events  
( $89.7 \pm 13.7$  sig,  $71.3 \pm 5.2$  bgd)
- ◆ Cross section for  $W(\gamma)X \rightarrow l\nu X$  measured to be  
 $14.8 \pm 1.6_{\text{stat}} \pm 1.0_{\text{sys}} \pm 1.0_{\text{lum}} \text{ pb}$ ,
  - ◆ SM prediction is  $16.0 \pm 0.4 \text{ pb}$





$$Z\gamma + X$$

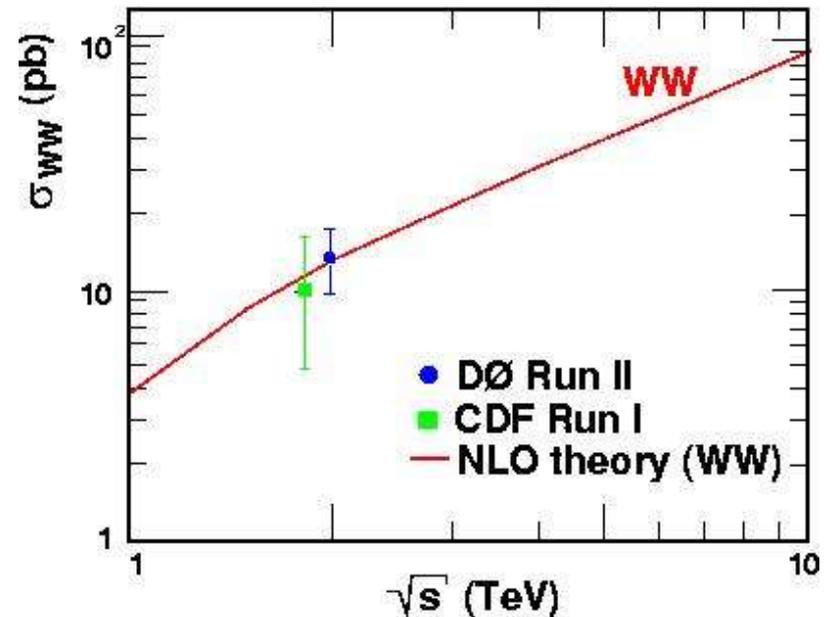
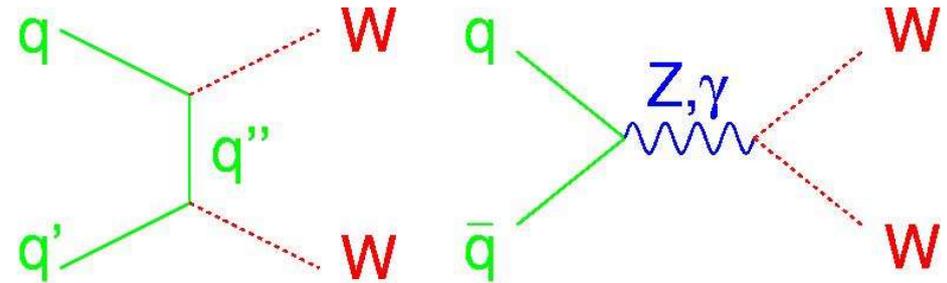
- ◆ Channels:
  - ◆  $ee\gamma$  –  $177\text{pb}^{-1}$  (33 data events,  $4.7 \pm 0.7$  bgd)
  - ◆  $\mu\mu\gamma$  –  $144\text{pb}^{-1}$  (68 data events,  $10.1 \pm 1.3$  bgd)
- ◆ Combined  $\sigma \cdot \text{Br}$  is  $3.90 \pm 0.51_{\text{stat+sys}} \pm 0.25_{\text{lum}} \text{pb}$
- ◆ SM predicts  $4.3 \text{pb}$





# WW

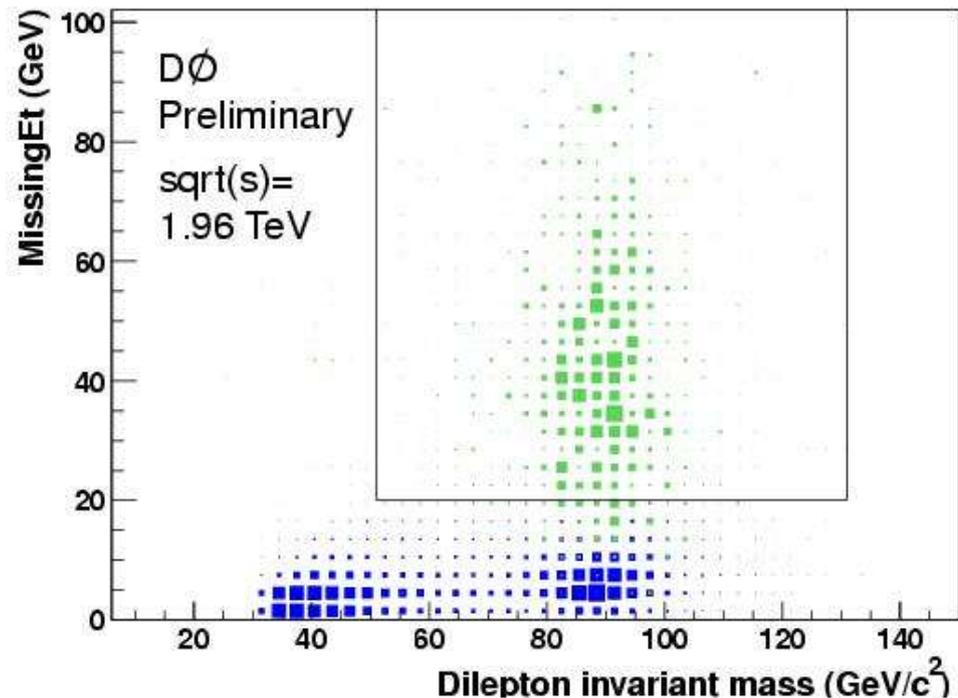
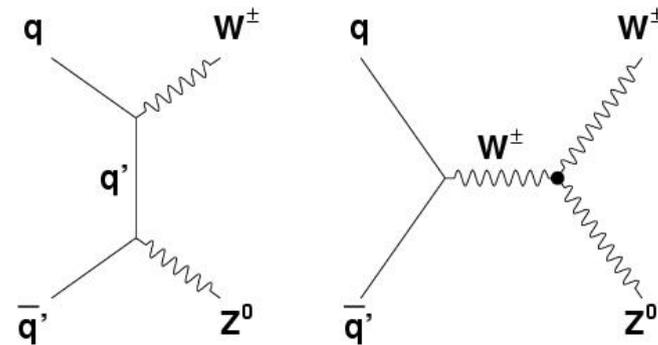
- ◆ Select events with two oppositely charged leptons (e or  $\mu$ ) and missing energy
  - ◆  $252 \text{ pb}^{-1}$  to  $224 \text{ pb}^{-1}$
- ◆ 25 events observed, with background of  $8.1 \pm 0.6_{\text{stat}} \pm 0.6_{\text{sys}} \pm 0.5_{\text{lum}}$ 
  - ◆  $5.2\sigma$  excess!





# WZ

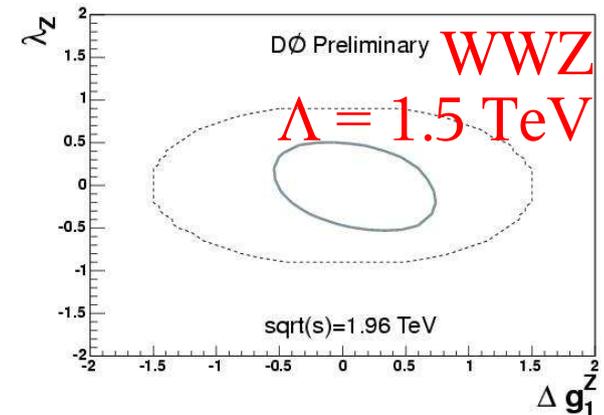
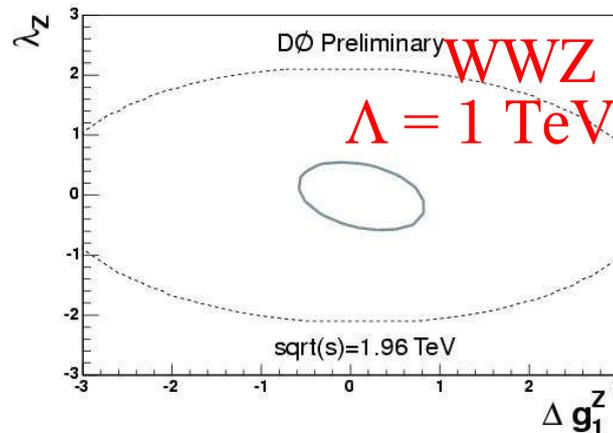
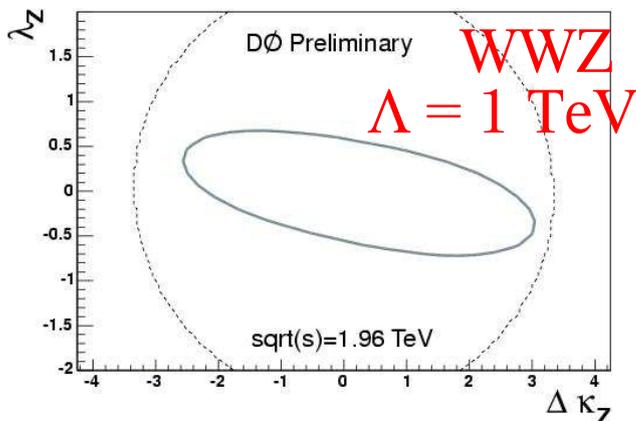
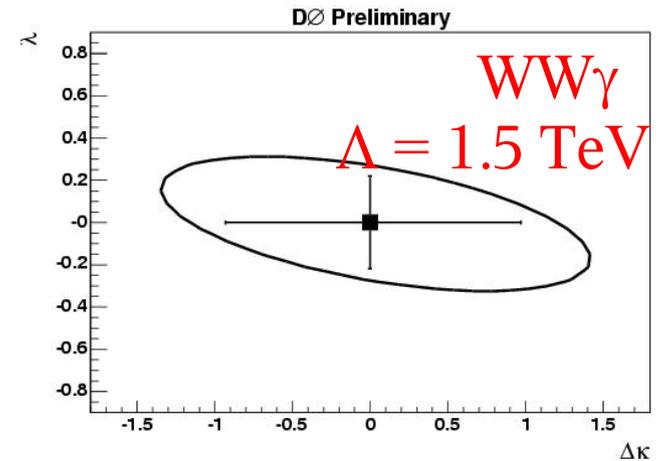
- ◆ Select events with 3 leptons (e or  $\mu$ , 2 of same flavor and opposite sign) and missing energy
- ◆ Data samples are from 285 pb<sup>-1</sup> to 320 pb<sup>-1</sup>
- ◆ 3 events in data, with  $2.04 \pm 0.13$  expected signal and  $0.71 \pm 0.08$  background
- ◆ 95% CL upper limit on cross section set at 13.3 pb





# Anomalous Couplings

- ◆ Anomalous  $WW\gamma$  or  $WWZ$  couplings can be written in terms of an effective Lagrangian
- ◆ 95% CL limits are set on the parameters in these effective Lagrangians
  - ◆ Predicted to be zero in SM



# Summary

- ◆ Many exciting new results from DØ are available in QCD, electroweak, and other physics areas
  - ◆ See <http://www-d0.fnal.gov/Run2Physics/WWW/results.htm>
- ◆ Much more data is now available (over 500 pb<sup>-1</sup> on tape), so look for more results coming out soon
- ◆ My thanks to everyone at DØ who made these results possible, and also to the conference organizers!



Michael Eads  
Northern Illinois University

# Backup Slides

# $\tau$ Identification

- ◆ Type 1
  - ◆ Single track, no EM subcluster ( $\pi$ -like)
- ◆ Type 2
  - ◆ Single track, EM subcluster ( $\rho$ -like)
- ◆ Type 3
  - ◆ More than 1 track
- ◆ No effort made to separate hadrons and electrons
- ◆ Neural network used to identify taus
  - ◆ Based on narrow width, low track multiplicity, low tau mass, and isolation
- ◆ In final sample, 13% type 1, 58% type 2, 29% type 3