

# DZERO Status & Physics

**Jerry Blazey**



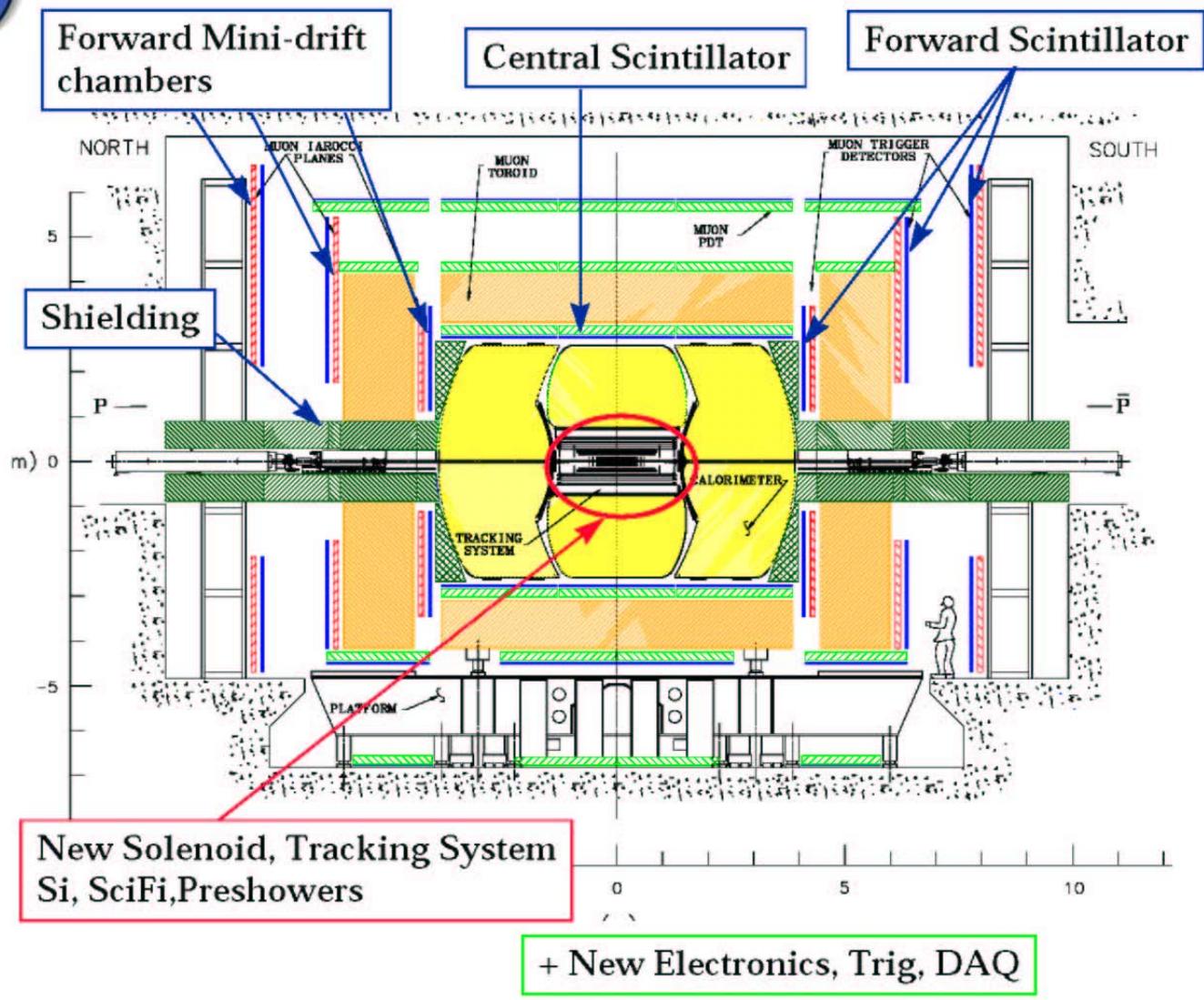
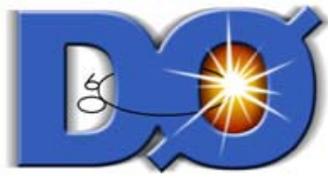
**NORTHERN ILLINOIS  
UNIVERSITY**



# Overview

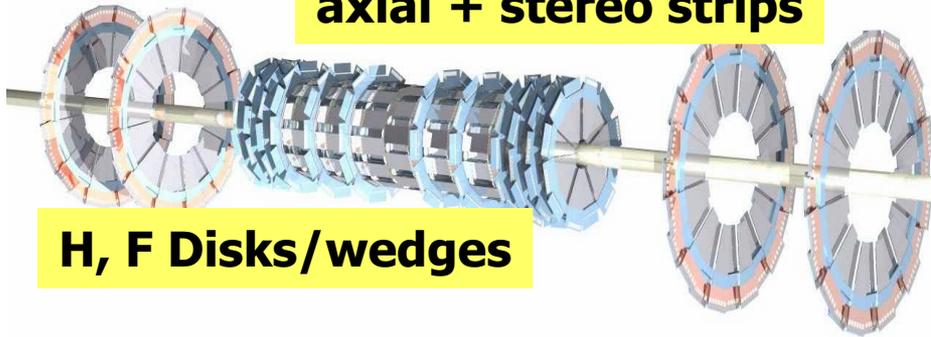
- **Detector fully installed**
  - Now integrating forward proton detector
  - Making increasing use of tracking triggers
  - Silicon track trigger installed this summer
- **Operating stably and efficiently**
- **Event reconstruction <3 days**
- **Broad physics presentations for spring conferences and beyond**





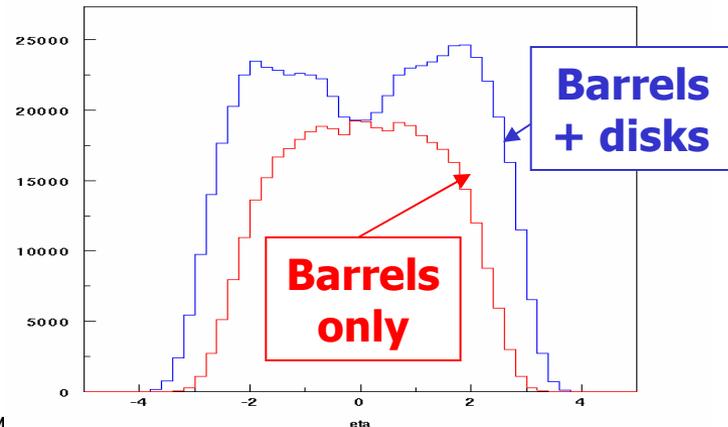
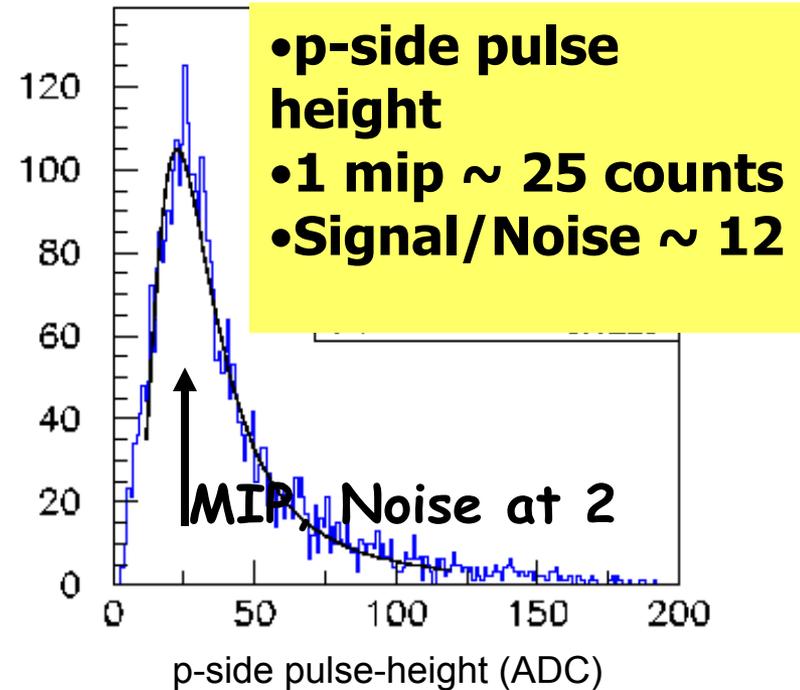
# Silicon Microstrip Tracker

4 barrel layers  
axial + stereo strips



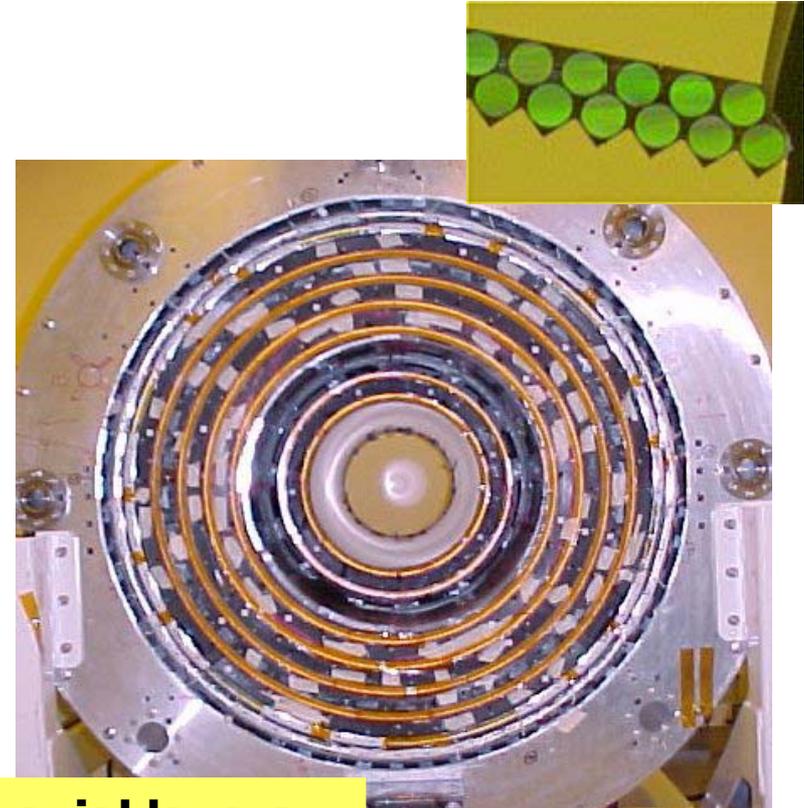
H, F Disks/wedges

- S/Noise: > 10 all devices
- Active Channels: 91% of 1M
- Cluster Efficiency: > 97%
- No fiducial loss

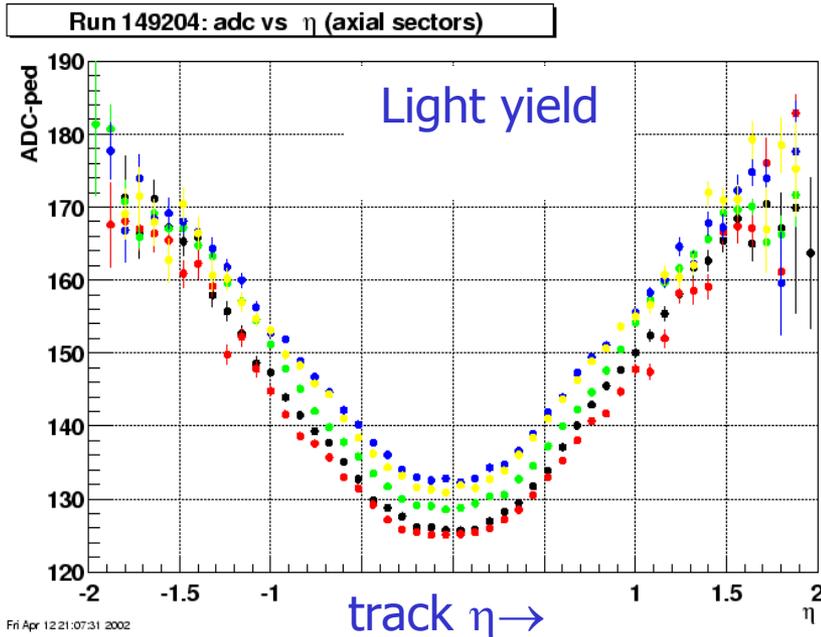


# Scintillating Fiber Tracker

- Active Channels: 99% of 80k
- Light yield excellent
- Hit efficiency > 98%

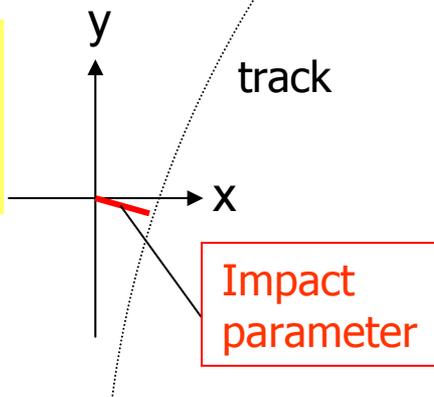


**8 axial layers**  
**8 stereo layers**

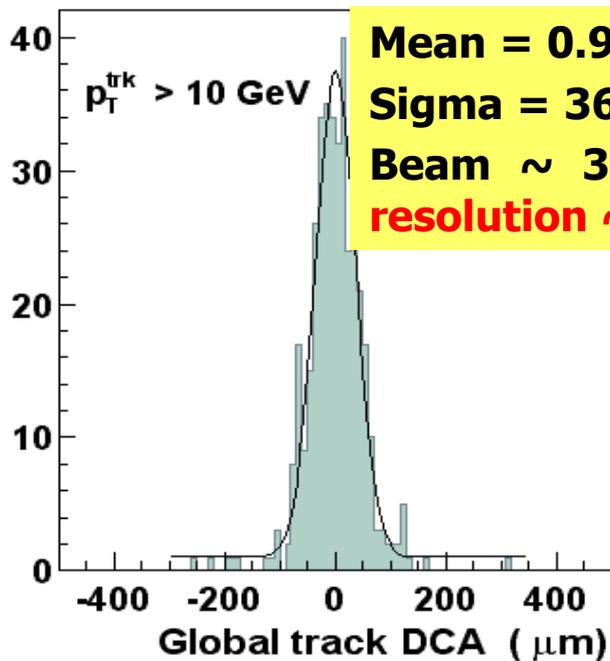
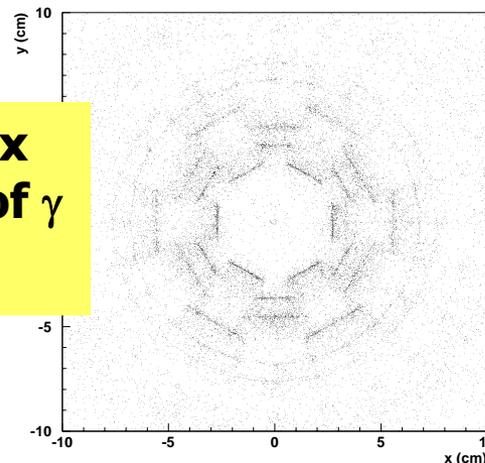


# Tracking Performance

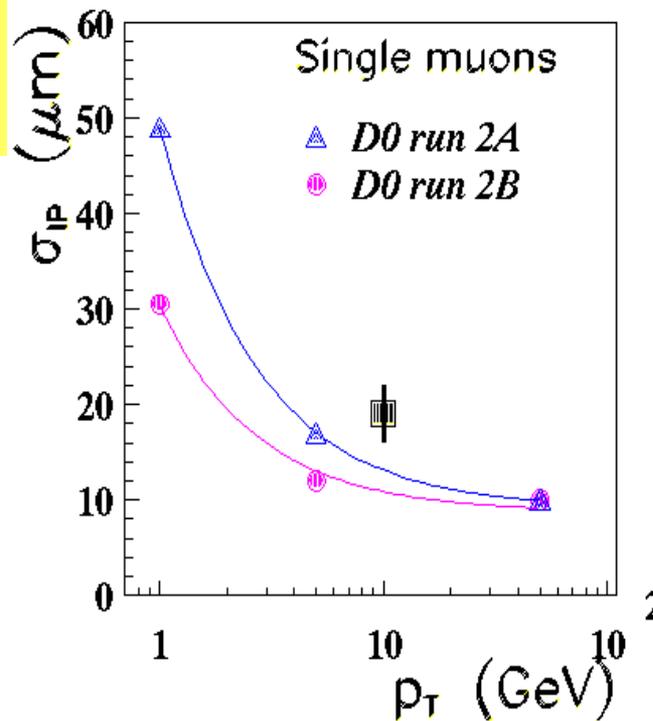
**Impact  
Parameter  
Resolution**



**X-Y vertex  
location of  $\gamma$   
to  $e^+ e^-$**

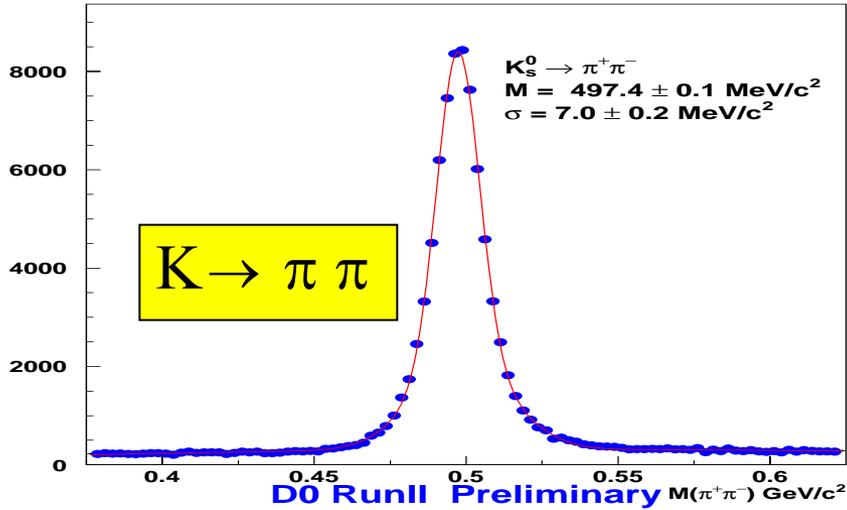


**Mean =  $0.9 \pm 2.2 \mu\text{m}$**   
**Sigma =  $36.3 \pm 1.8 \mu\text{m}$**   
**Beam  $\sim 30 \mu\text{m} \rightarrow$  IP  
resolution  $\sim 20 \mu\text{m}$**

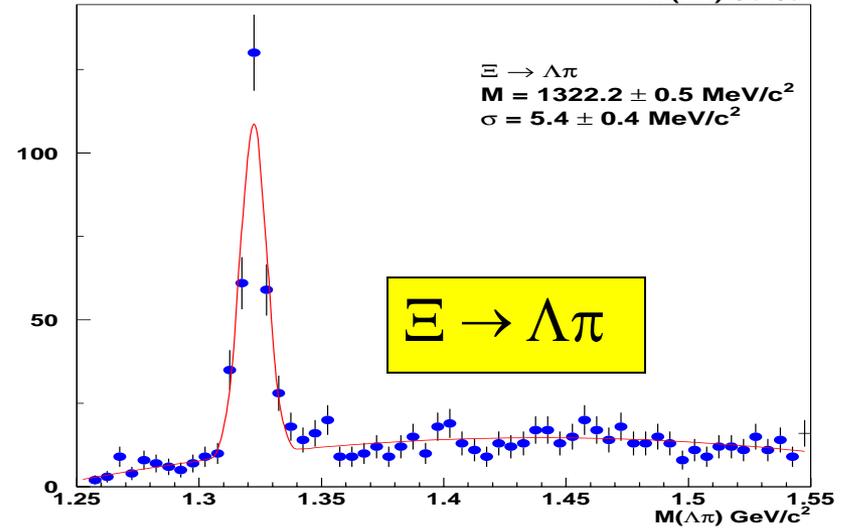
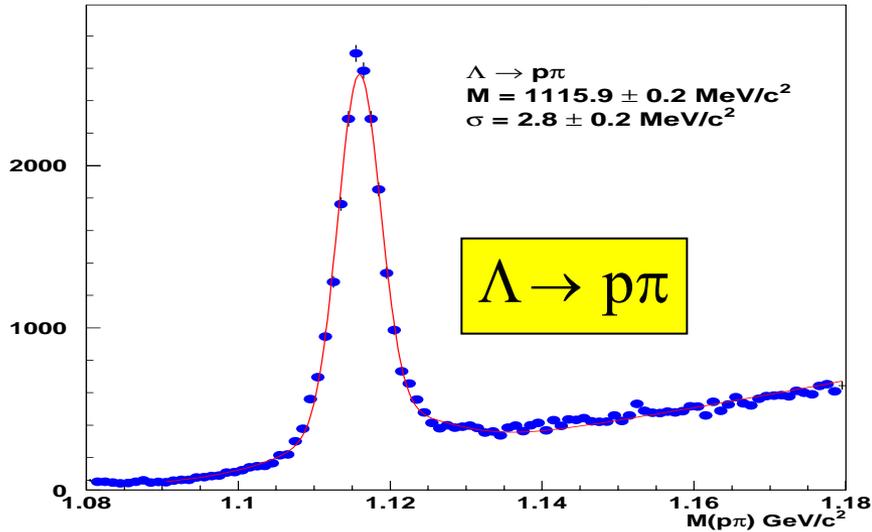
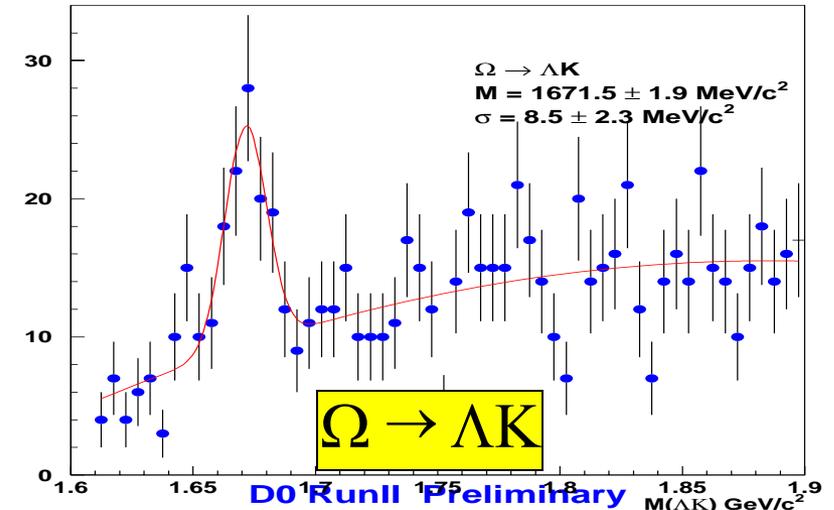


# Resonances

D0 RunII Preliminary

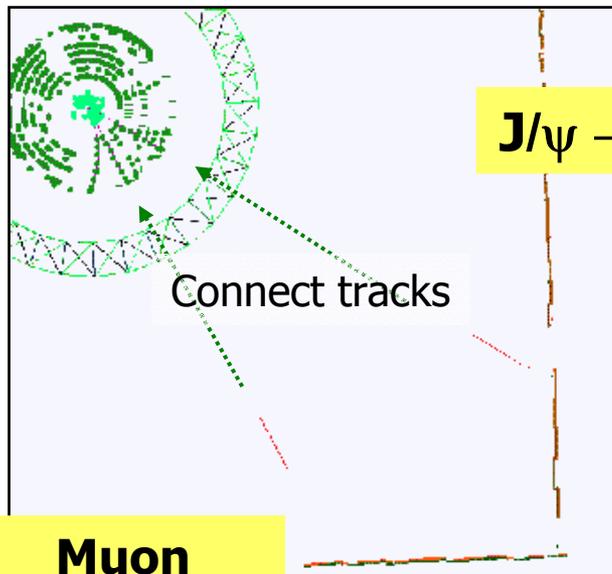
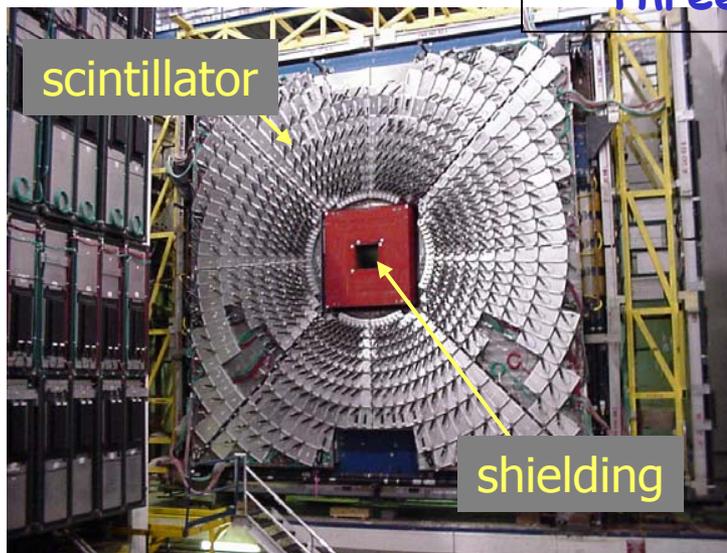


D0 RunII Preliminary

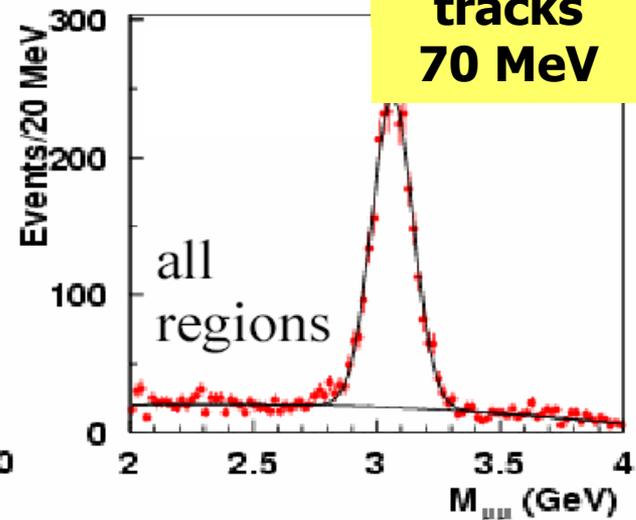
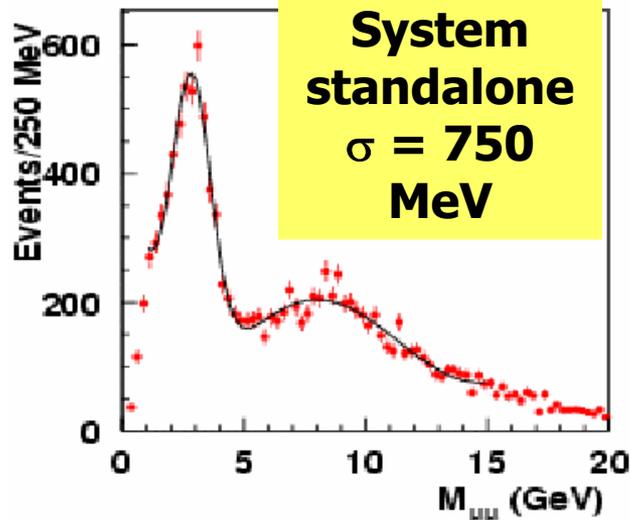


# Muon System

- Three layers of triggering scintillator planes.
- Three layers of precise tracking drift tubes.



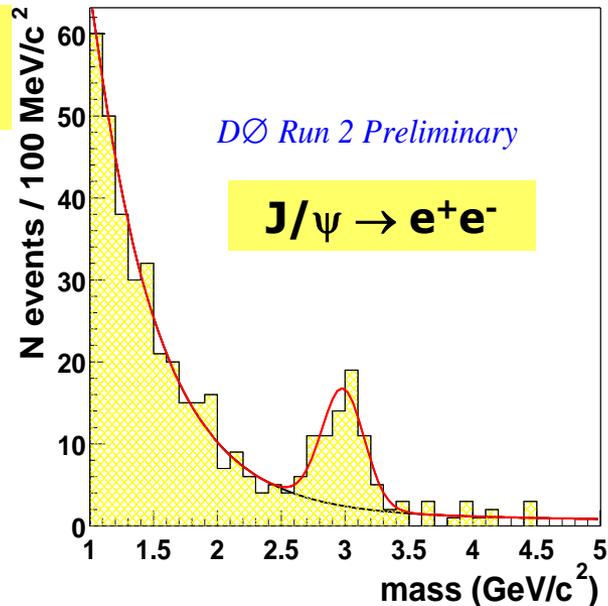
- Active Scintillator Channels: 99.9%
- Active Tracking Channels 99.5%



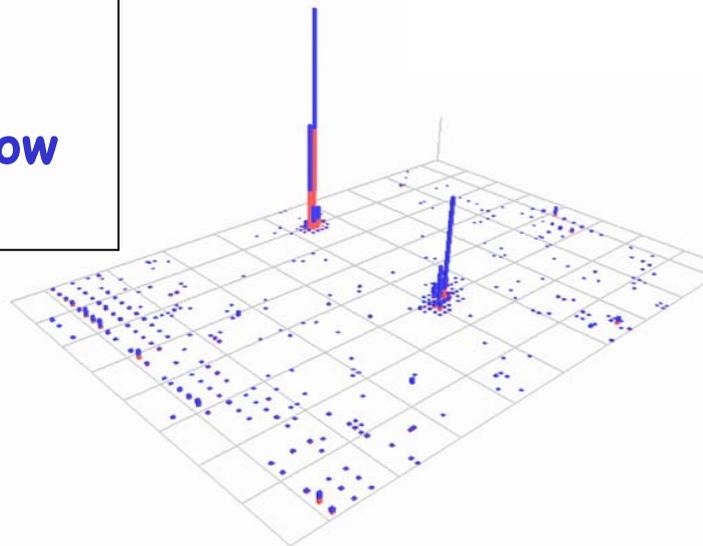
# Calorimeter



Liquid argon calorimeter with uranium absorber



- Active Channels: 99.9% of 50K
- Working well at low and high energies

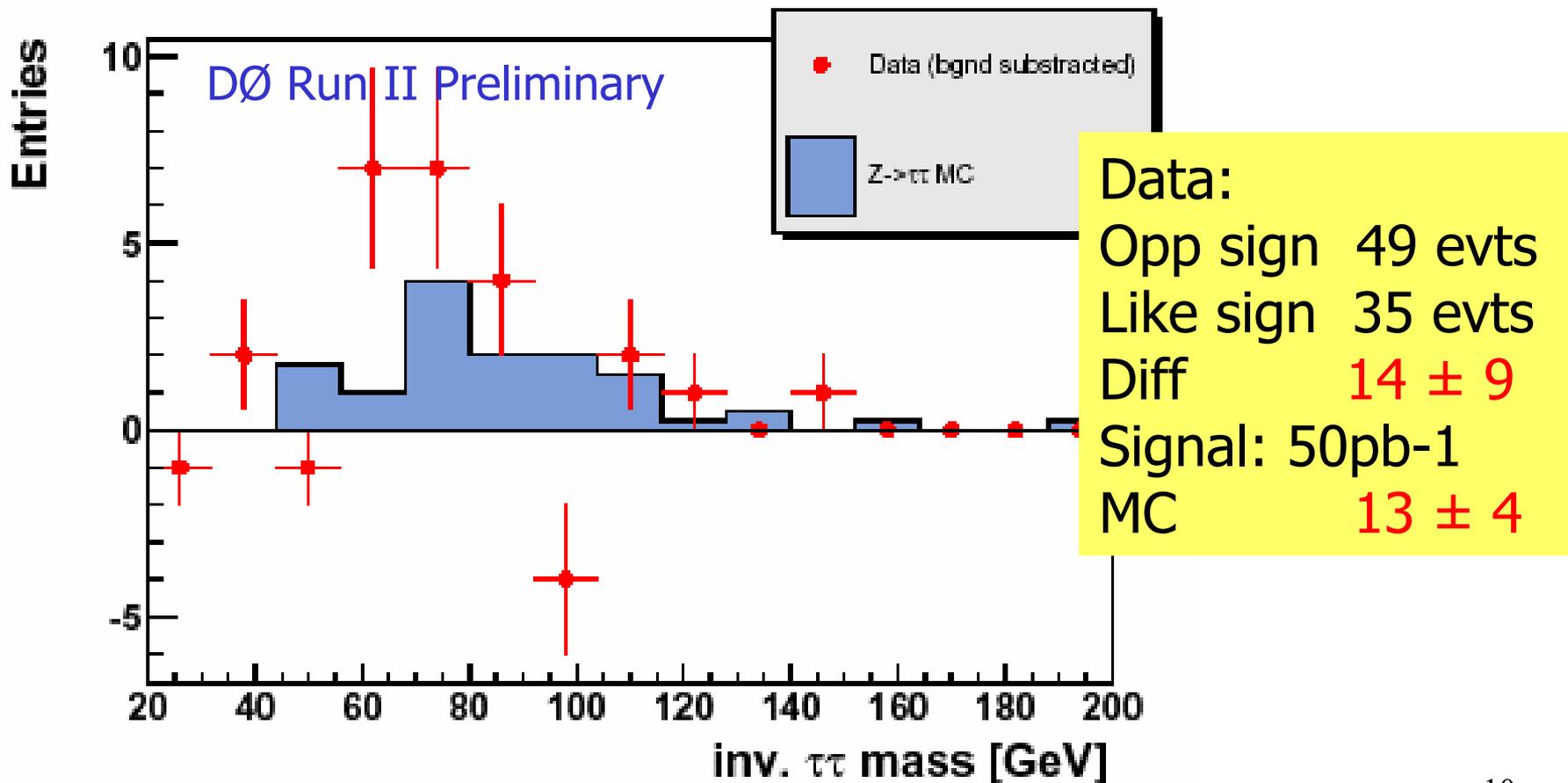


**High Mass DiJet Event**  
**E<sub>T</sub> : 432, 396 GeV**  
**Dijet Mass: 838 GeV**  
**X ~ 0.5**



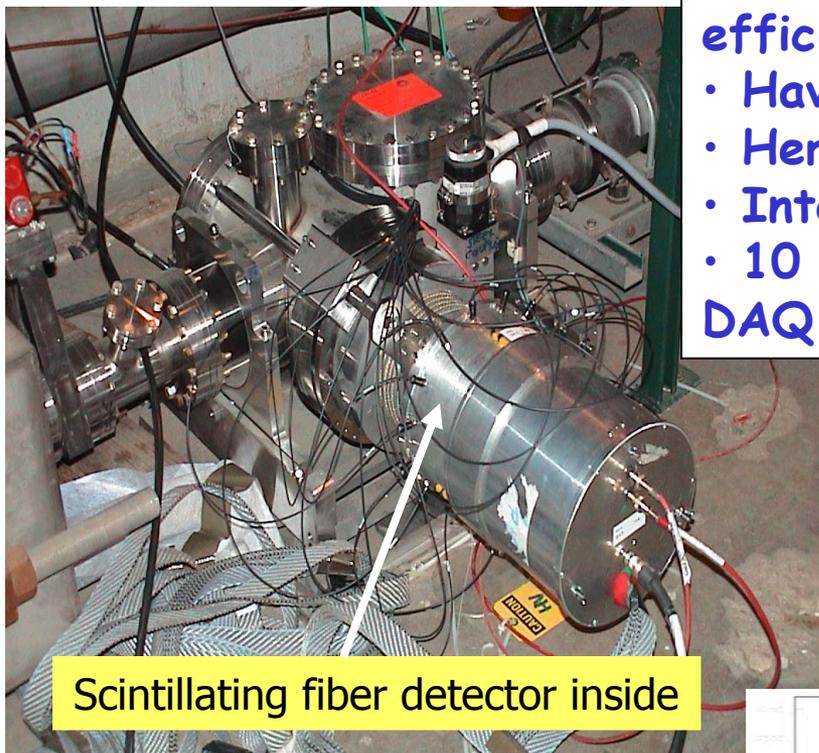
# A new capability for DØ: $Z \rightarrow \tau^+ \tau^-$

- First  $\tau$  leptonic electron decay
- Second  $\tau$  decay hadronic one prong decay
- Comparison of opposite to like sign  $\rightarrow$  excess



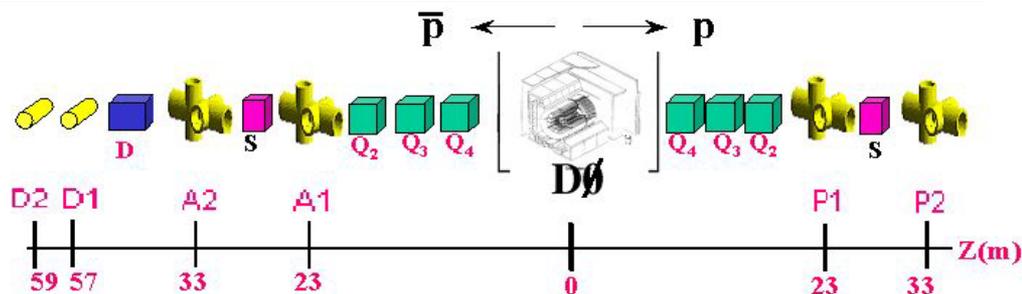
# Forward Proton

## Detector

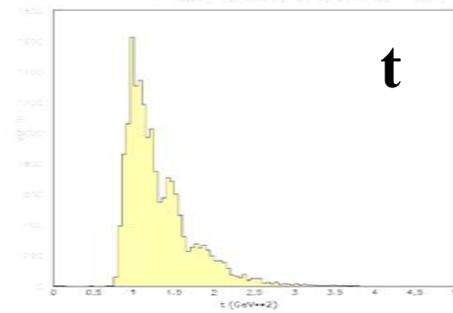
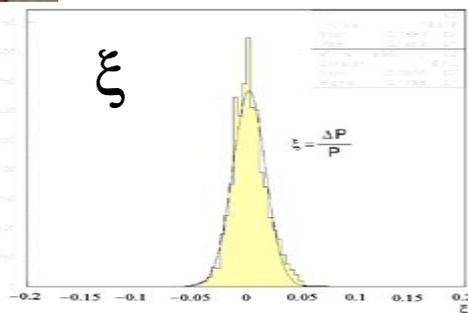


Scintillating fiber detector inside

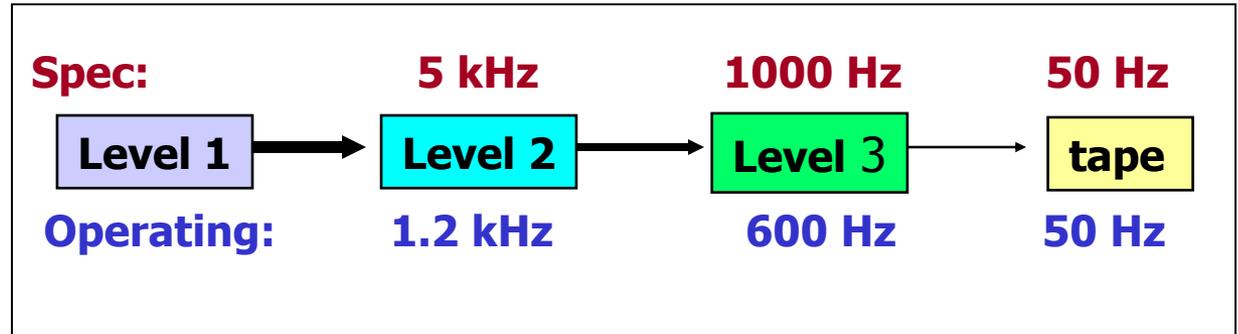
- Routinely and reliably insert pots
- Detectors perform as designed (good efficiency, resolution)
- Have observed diffractive and elastic events
- Heretofore standalone
- Integrating into trigger & daq
- 10 (of 18) pots now being integrated into DAQ.



Elastic scattering data



# Trigger/ DAQ



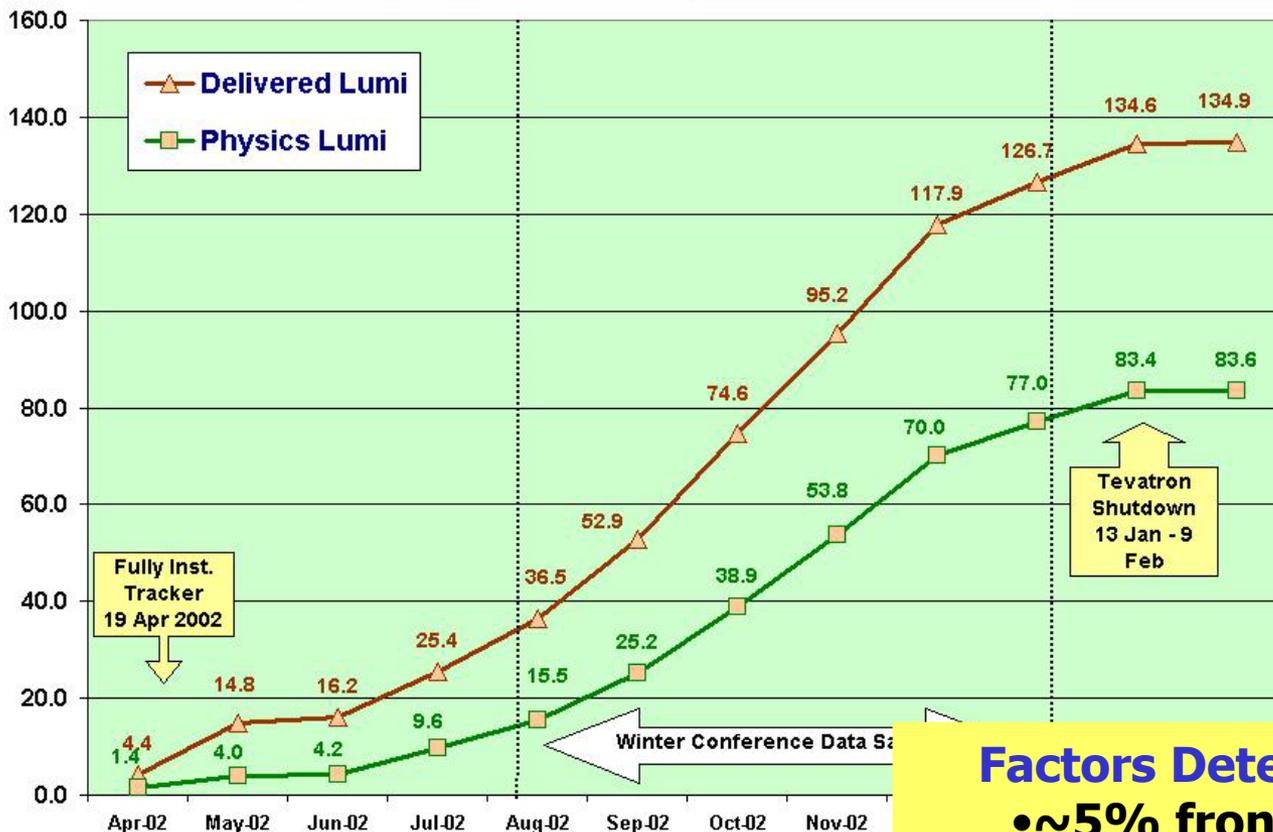
- Runs comfortably up to  $4E31 \text{ cm}^{-2}\text{s}^{-1}$  & will keep pace with luminosity growth as tracking triggers completed, CPUs added.
- L1 >100 independent trigger bits
  - Operating with Cal & Muon
  - CTT & PS integration underway
- L2
  - Operating with CAL, Muon, Global
  - CTT, STT integration underway
  - Input rate expansion spring w/ processor replacements
- L3 Extensive suite of filters available
- DAQ
  - Working to reduce Front End Busies.
  - All commodities solution easily meets 1 kHz L2 accept specification.



# Luminosity and Efficiency

## D0 Integrated Luminosity

19 April 2002 - 11 March 2003



## D0 Monthly Data Taking Efficiency

19 April 2002 - 29 February 2003



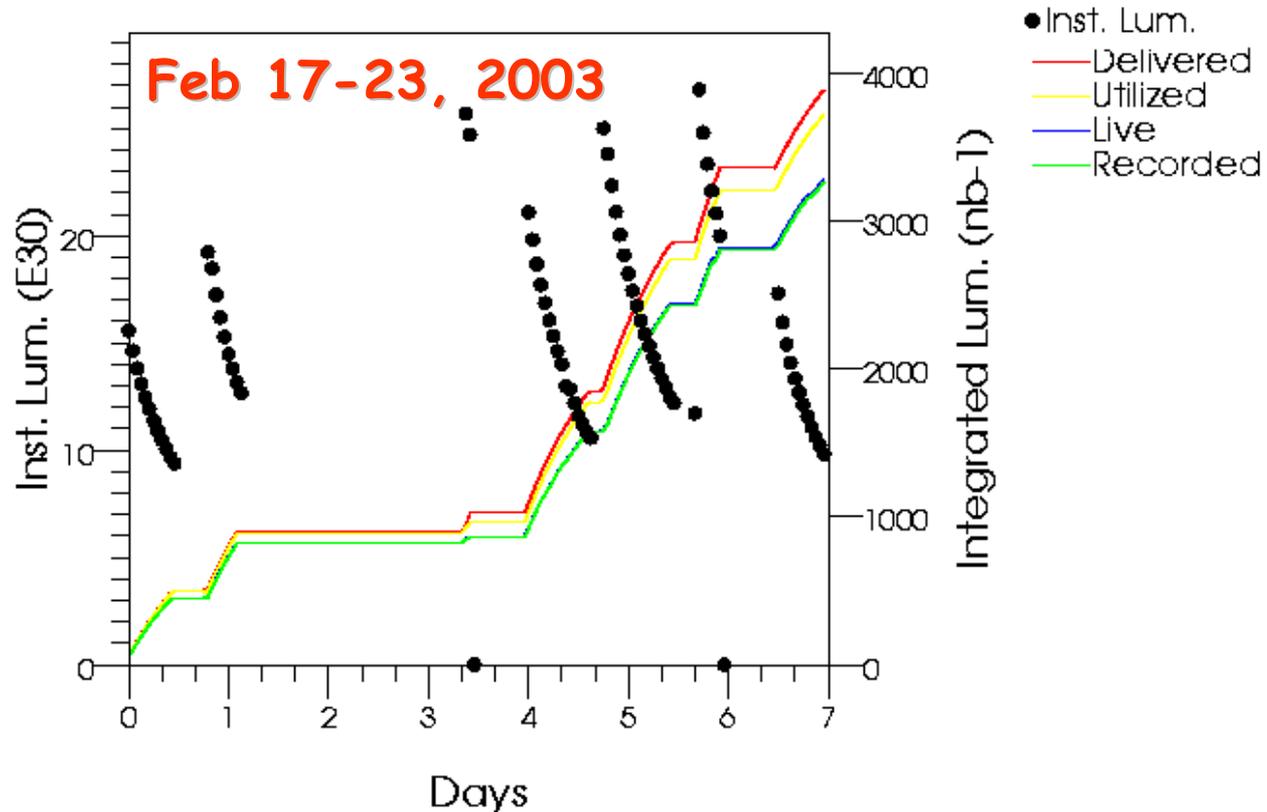
2 Jul-02 Aug-02 Sep-02 Oct-02 Nov-02 Dec-02 Jan-03 Feb-03

## Factors Determining Inefficiency:

- ~5% front-end busy
- ~5% are losses due to store & run transitions
- ~5% "incidentals"



# Latest Performance



**Expectations:**  
**Typical Run Efficiency: 90%**  
**Typical Week Efficiency: 85%**





# Representative Physics Analyses

- QCD: Dijet Mass
- B: Exclusive States, Lifetimes
- EW: Z to  $\mu\mu$ , Z' to ee
- Top: Cross Section, Run I mass
- Higgs Studies
- New Phenomena Searches

## Poster Sessions:

Standard Model Physics at Run II,  
Joshua Kalk

Search for New Physics at Run II,  
Ulla Blumenschein

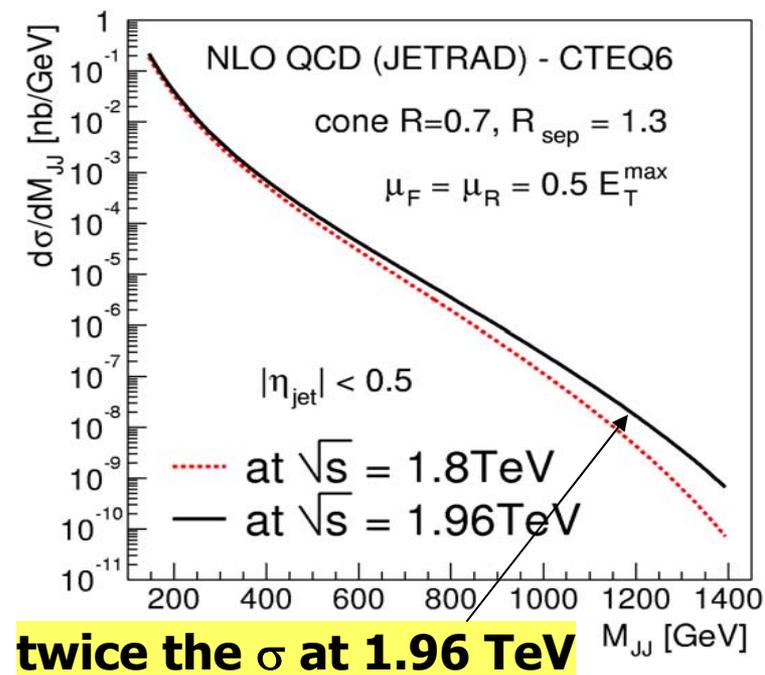
## Upcoming talks:

LaThuile: 5 , Moriond  
EW: 3, Moriond QCD: 1  
+ 4 shared, DPF: 15,  
APS: 35

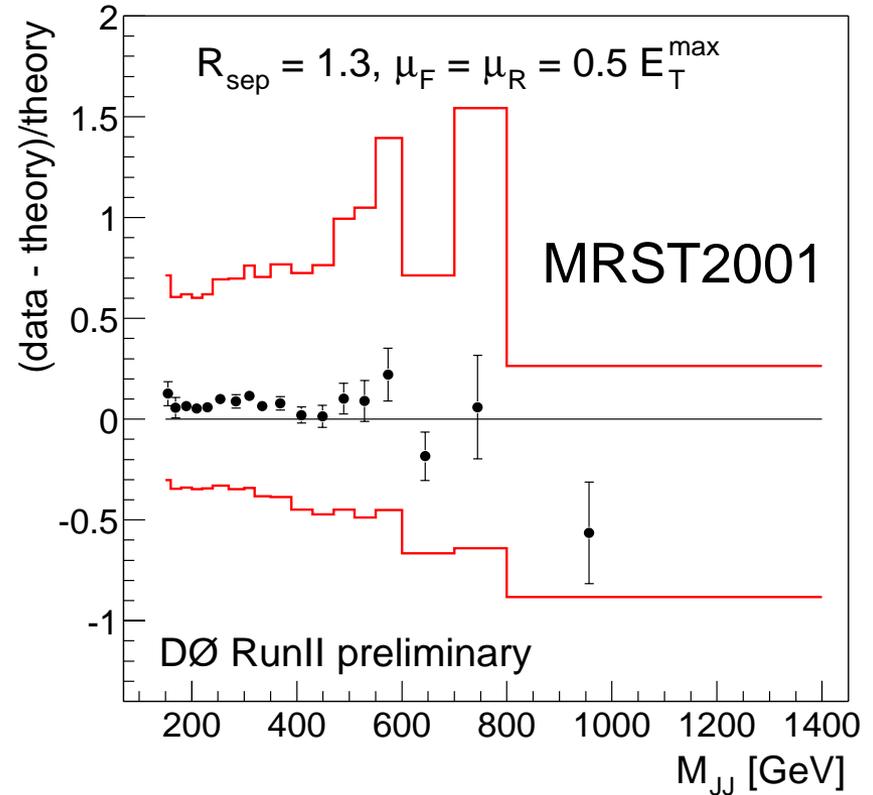
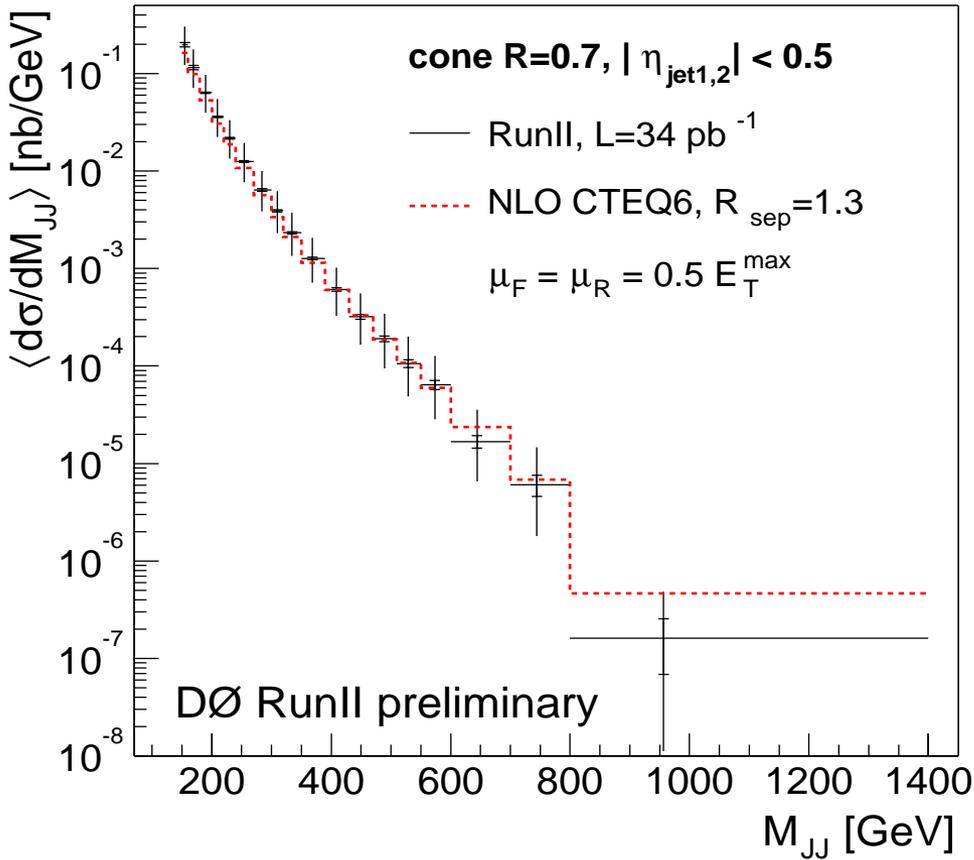


# QCD: Dijet Mass Cross Section

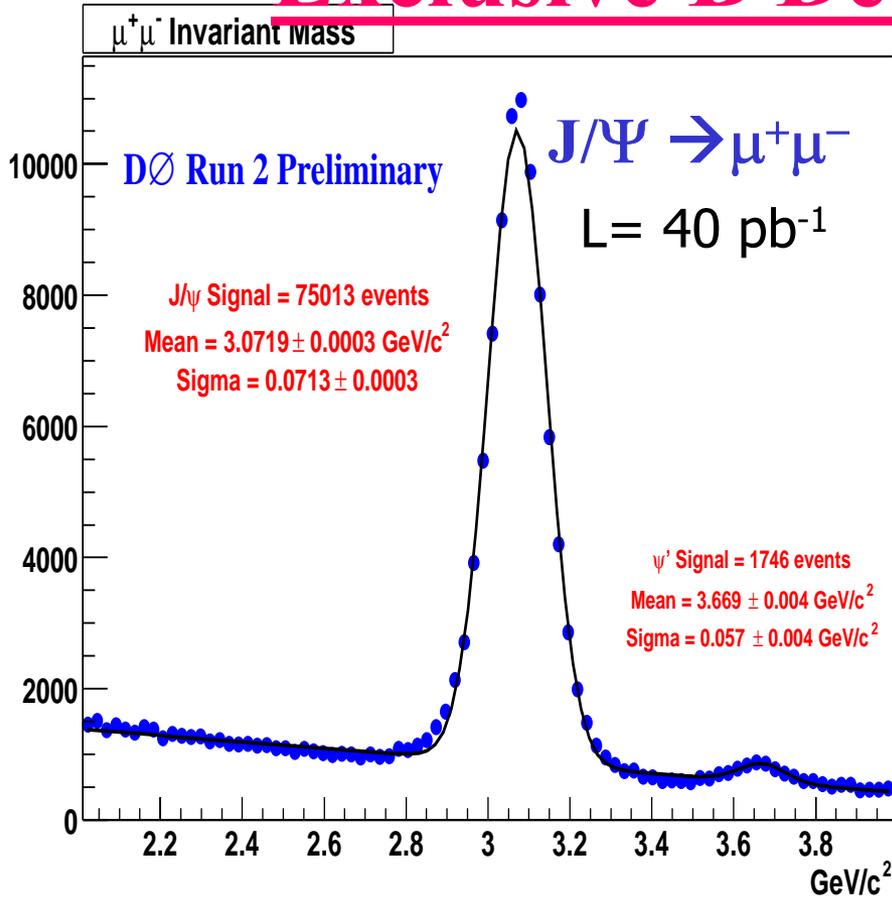
- Probe of
  - QCD
  - hunting for resonances
  - proton structure at large  $x$
  - quark compositeness
- Data sample:
  - $34 \text{ pb}^{-1}$
  - $\Delta R = 0.7$  cone jets
  - $|\eta_{\text{jet}}| < 0.5$



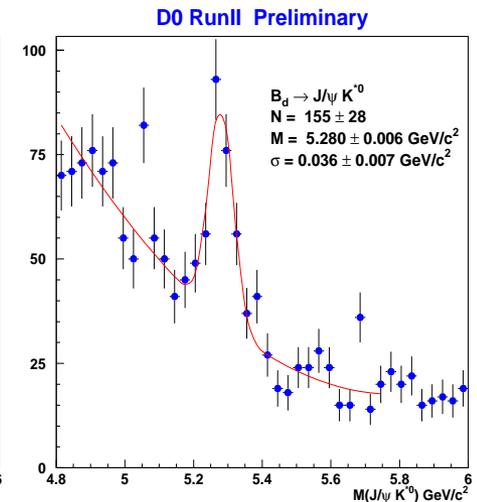
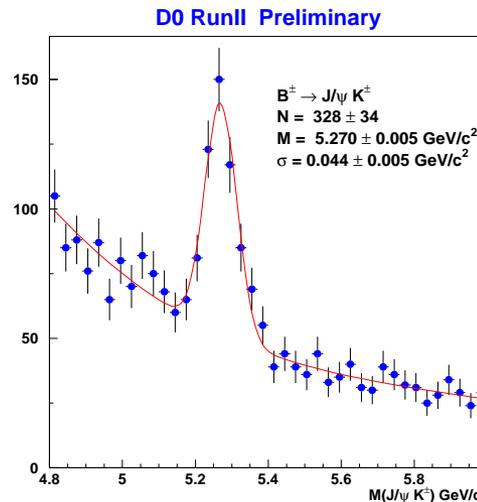
# Dijet mass spectrum



# Exclusive B Decays and Lifetimes

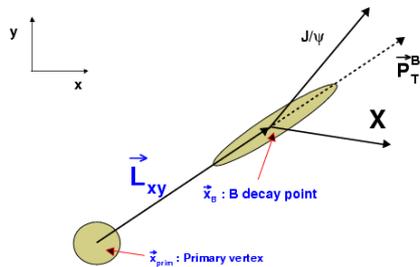


Combine  $J/\Psi$  with track or  
 combine  $J/\Psi$  with  $K^*$  and  
 then require decay length  
 significance > 3.0

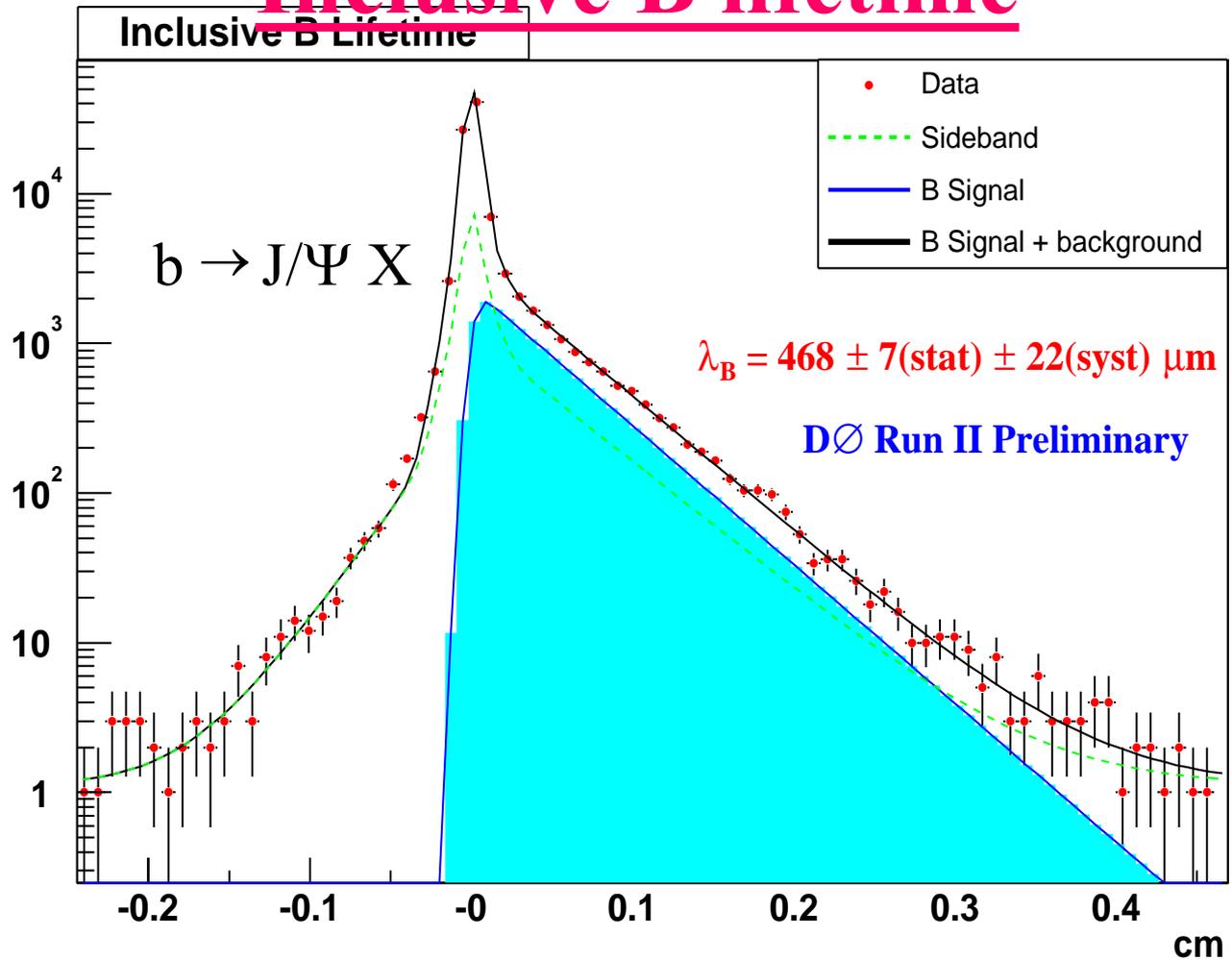


$B^+ \rightarrow J/\Psi K^+$

$B_d \rightarrow J/\Psi K^0$



# Inclusive B lifetime



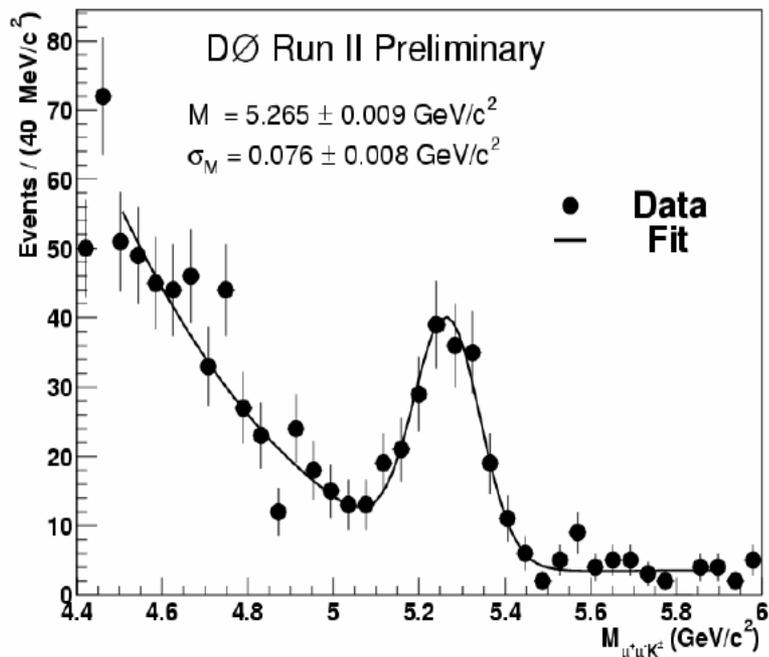
$\langle \tau \rangle = 1.561 \pm 0.024 \text{ (stat)} \pm 0.074 \text{ (sys)} \text{ ps}$

$\langle \tau \rangle = 1.564 \pm 0.014 \text{ ps (PDG)}$



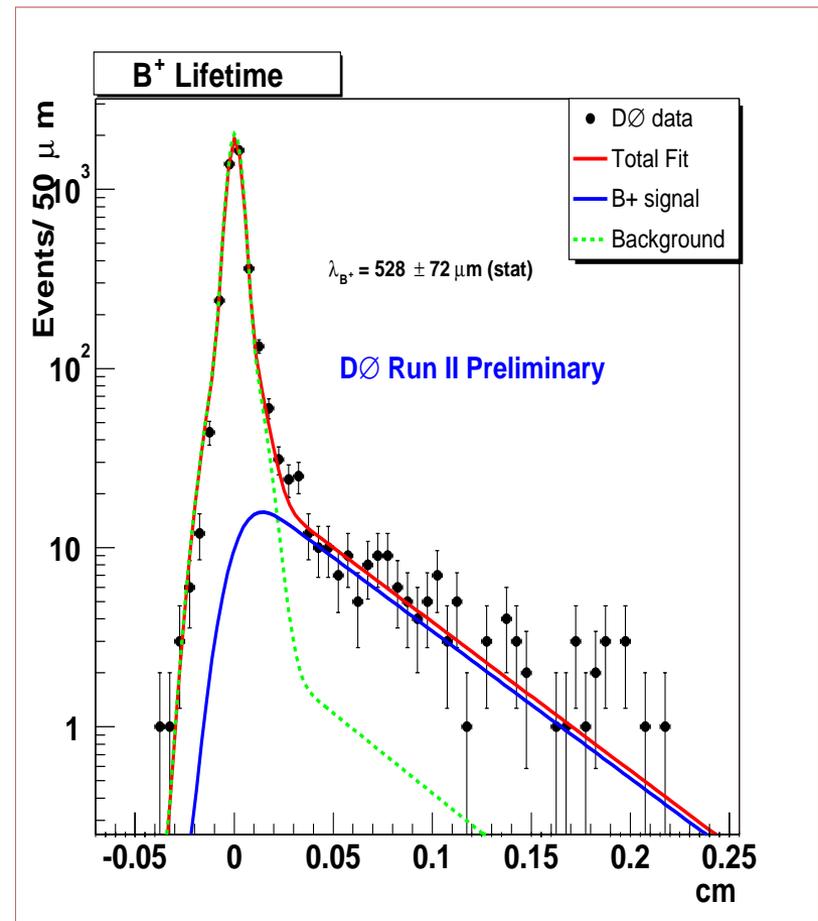
# Charged B & Lifetime

$B^{+-} \rightarrow J/\Psi K^{+-}$



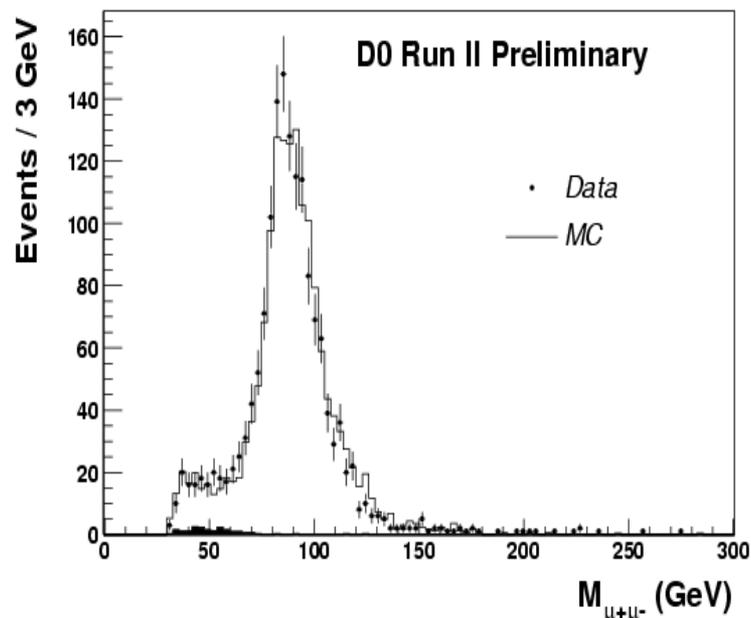
$\langle \tau \rangle = 1.76 \pm 0.24 \text{ ps (stat)}$

$\langle \tau \rangle = 1.674 \pm 0.018 \text{ ps (PDG)}$



# Electroweak: $Z \rightarrow \mu\mu$

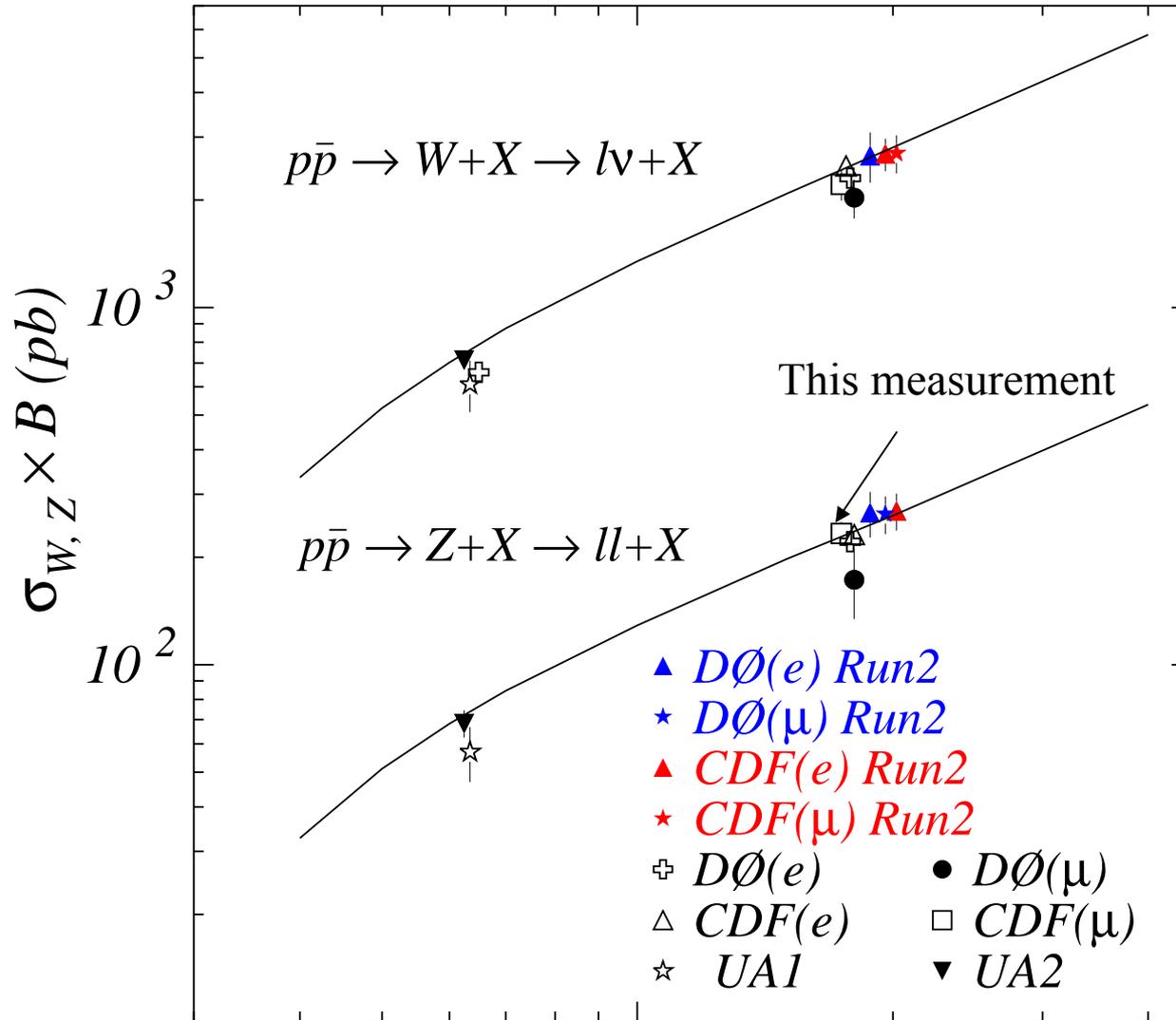
- Data sample:  $32 \text{ pb}^{-1}$
- Selection
  - $|\eta^\mu| < 1.8$
  - pair of oppositely charged muon
    - $P_T > 15 \text{ GeV}$
    - $\sqrt{\Delta\eta^2 + \Delta\phi^2} > 2.0$
    - Isolation
    - timing cut removes cosmics
- 1585 events pass cuts



$$\sigma * \text{Br} = 263.8 \pm 6.6 \text{ (stat)} \pm 17.3 \text{ (sys)} \pm 26.4 \text{ (lum)} \text{ pb}$$



# *DØ and CDF Run2 Preliminary*



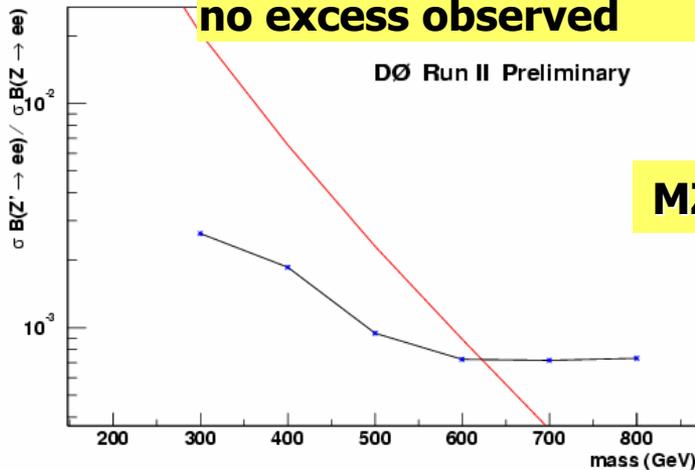
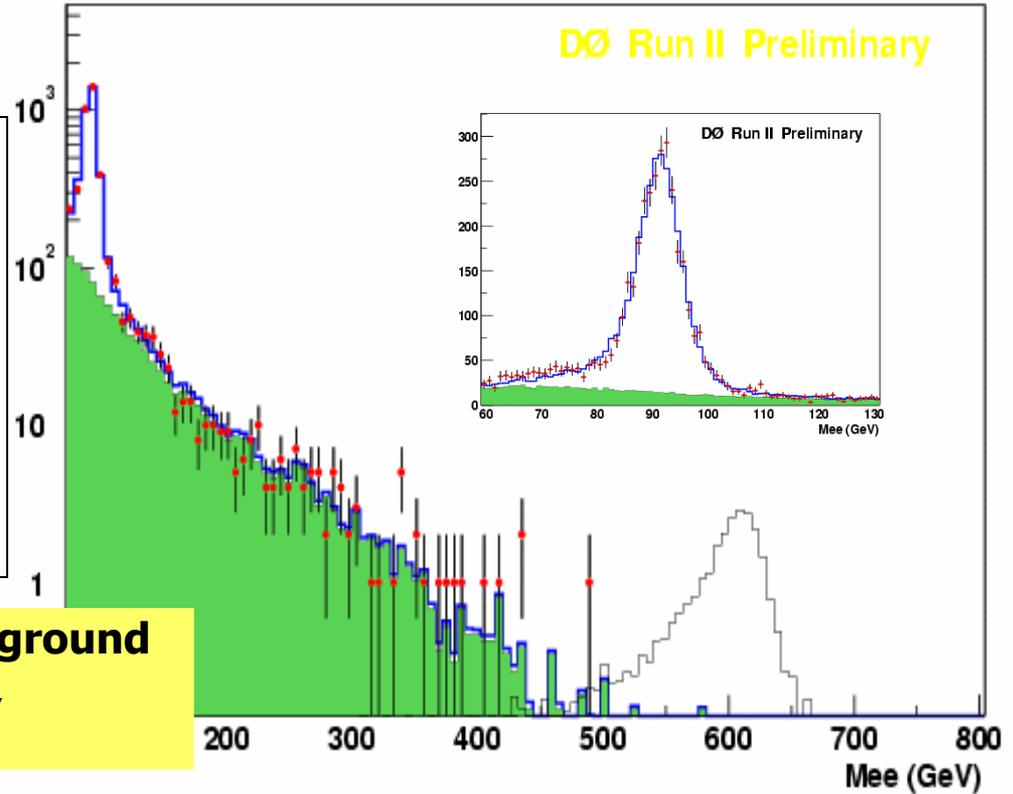
$1$   
Center of Mass Energy (TeV)

DOE Review March 18-20, 2008



# Z' → ee Search

- Expected in left-right symmetric models
- Data sample
  - 50 pb<sup>-1</sup>
  - single electron
  - $|\eta| < 2.5$
  - $E_T > 25$  GeV



**MZ' > 620 GeV @ 95% c.l.**



# Run I Top Mass Measurement in the Lepton+Jets Channels

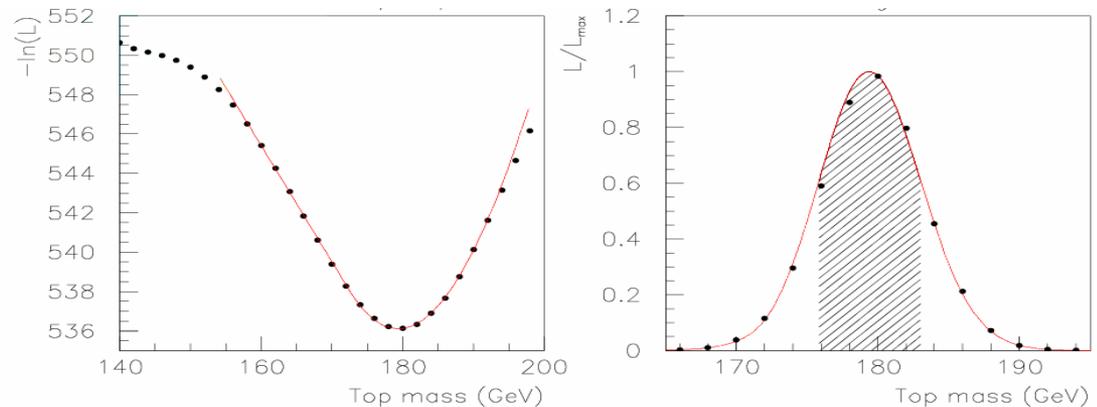
- Likelihood method using most available information
- Uses DØ Run I statistics (125 pb<sup>-1</sup>) & selection → 91 events
- Additional cuts for this analysis:

4 Jets exclusively: 71 events

P<sub>b</sub>: 22 events (pure samp

$$m_{top} = 179.9 \pm 3.6 \text{ (stat) GeV}/c^2$$

*(5.6 GeV from 1998 PRD)*



Improvement  
equivalent to a 2.4  
increase in statistics

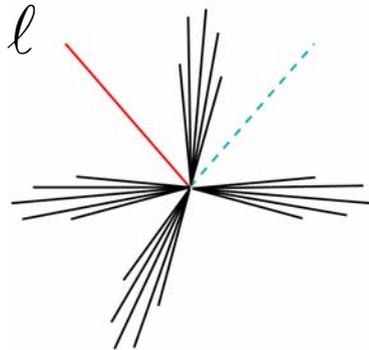
Details to be presented at an  
upcoming Wine and Cheese  
seminar



# Top

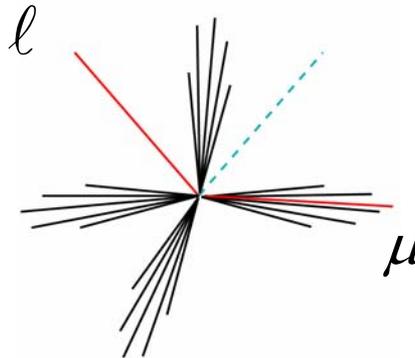
- First cross section measurement at 1.96 TeV
- Cross section predictions between 6.7 - 7.5 pb (30% higher than Run I)
- Six analysis channels ( $t\bar{t} \rightarrow W^-W^+bb$ )

Lepton+jets  
(topological)



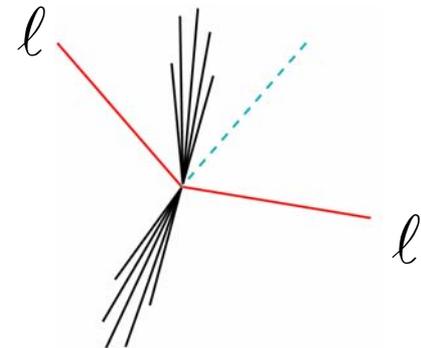
e+jets,  $\mu$ +jets  
Br = 14.7%

Lepton+jets  
(soft muon tag)



e+jets/ $\mu$ ,  $\mu$ +jets/ $\mu$   
Br = 14.7%

Dileptons



e $\mu$  and  $\mu\mu$   
Br = 2.5 and 1.2%



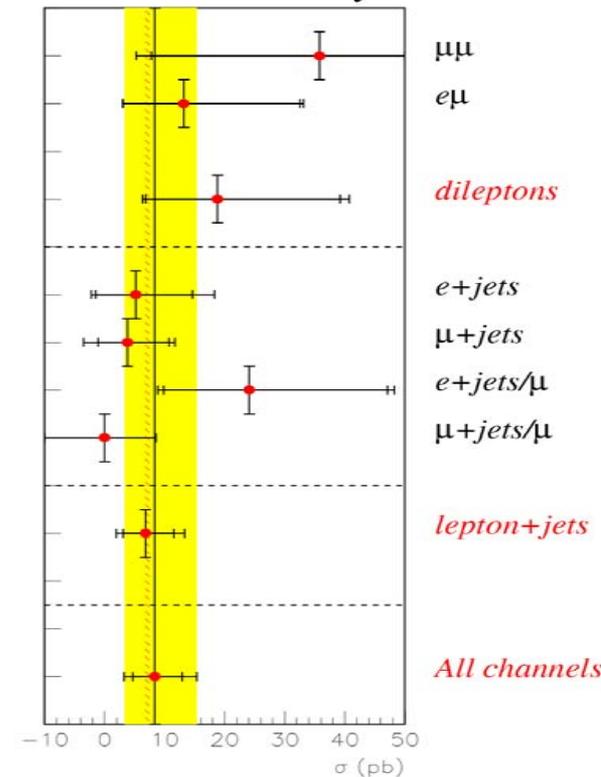
# Results

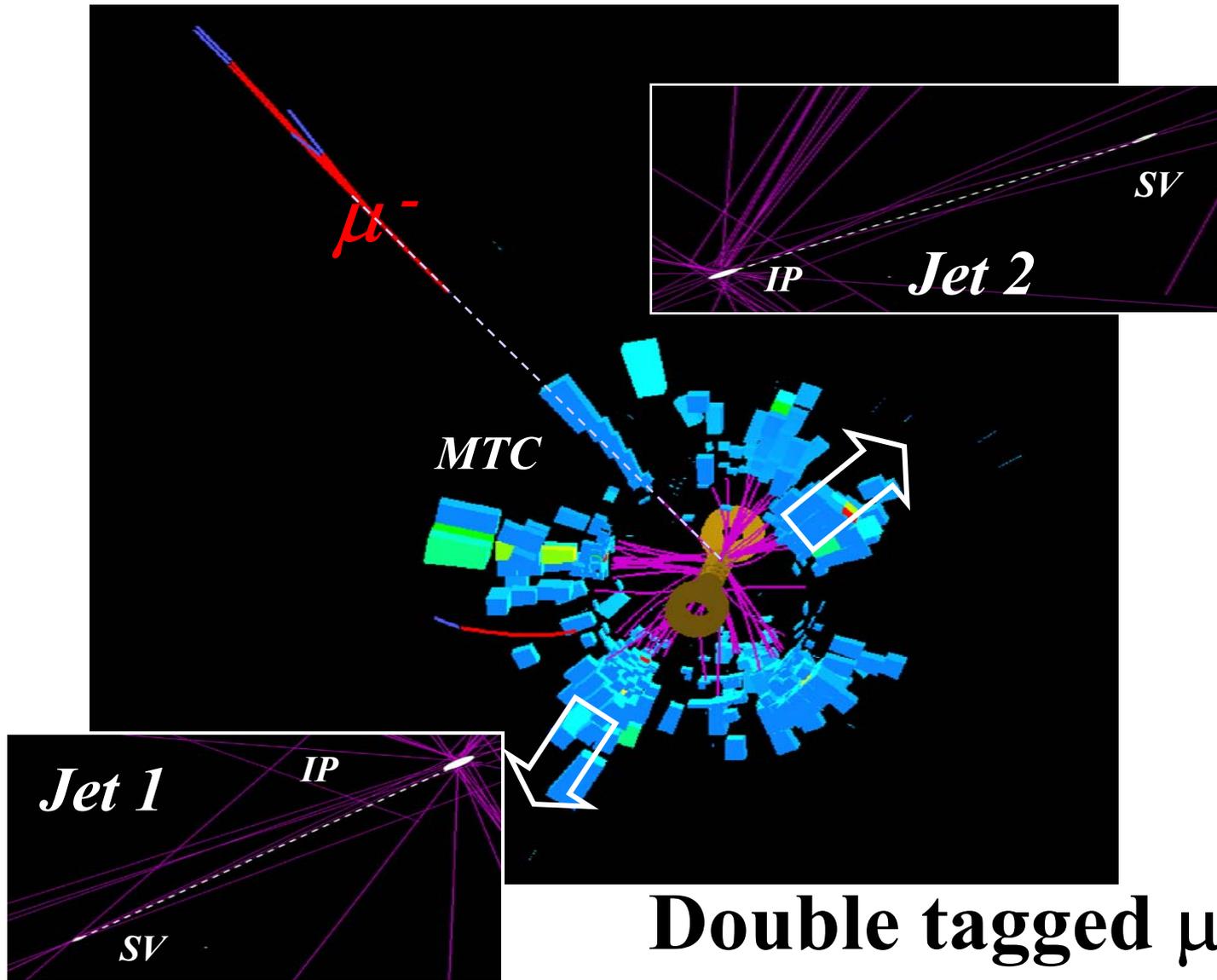
- **Jets:** 0.5 cone Improved Legacy Algorithm with JES corrections
- **Electrons:** Central only, Selected based on simple cone, shower shape, EM fraction, Match with track ( $\phi$ ,  $\eta$  and  $E/p$ )
- **Muons:** Tracks in muon system, Tracks in central tracker
- **Missing Et:** From calorimeter with JES corrections and muon correction

Channel	Lum( $\text{pb}^{-1}$ )	Expected Background	Expected Signal	Obs.
<b>e+jet</b>	<b>50</b>	<b>2.7+/-0.6</b>	<b>1.8</b>	<b>4</b>
<b><math>\mu</math>+jet</b>	<b>40</b>	<b>2.7+/-1.1</b>	<b>2.4</b>	<b>4</b>
<b>e+jet/<math>\mu</math></b>	<b>50</b>	<b>0.2+/-0.1</b>	<b>0.5</b>	<b>2</b>
<b><math>\mu</math>+jet/<math>\mu</math></b>	<b>40</b>	<b>0.6+/-0.3</b>	<b>0.4</b>	<b>0</b>
<b><math>\mu\mu</math></b>	<b>43</b>	<b>0.60+/-0.30</b>	<b>0.30+/-0.04</b>	<b>2</b>
<b><math>e\mu</math></b>	<b>33</b>	<b>0.07+/-0.01</b>	<b>0.50+/-0.01</b>	<b>1</b>

$$\sigma = 8.4^{+4.5}_{-3.7} \text{ (stat)} \quad ^{+5.3}_{-3.5} \text{ (syst)} \pm 0.8 \text{ (lumi) pb}$$

*DØ Preliminary*





# Double tagged $\mu$ +jets Candidate Event



# Higgs Activities

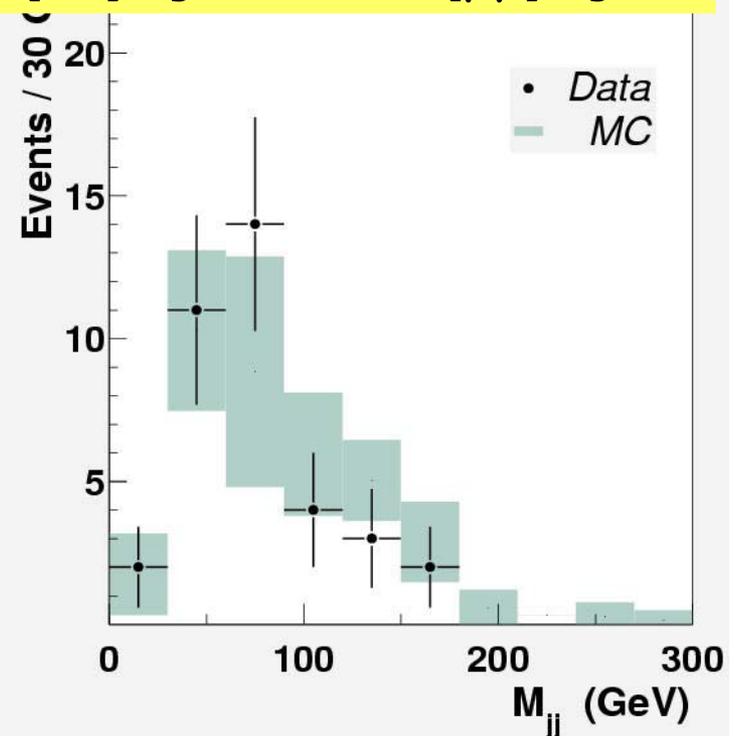
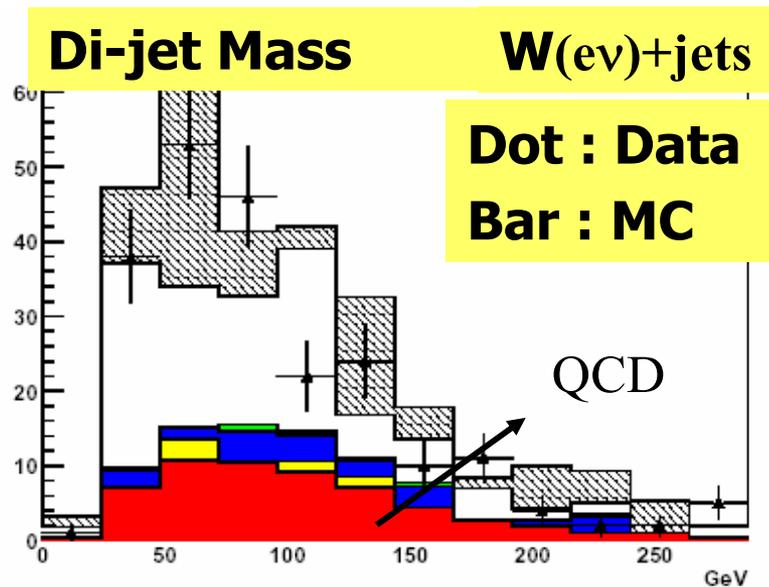
- In collaboration with CDF, undertaken a joint Higgs Sensitivity Study.
  - CDF will study HW, D0 HZ channels.
  - Preliminary discussions by June.
- Concentrating on study of the background from  $W/Z(\rightarrow\text{lepton}) + \text{jets}$  production
  - First step towards  $W/Z(\rightarrow\text{leptons}) + H(\rightarrow\text{bb})$  measurement
  - The  $W/Z + \text{b-jets}$  distributions related to  $W/Z + \text{jets}$  distributions
- $H \rightarrow WW^*$  ( $\rightarrow ee\nu\nu, e\mu\nu\nu$ ) decays (observed number of events consistent with expected number of background)



# Some Data/Background Comparisons

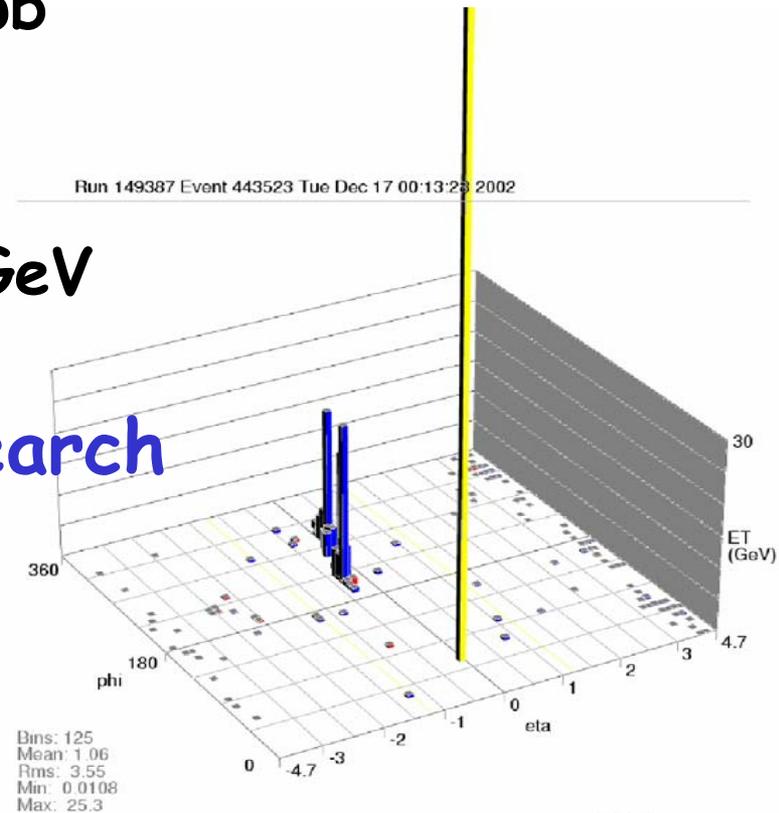
- Selection  $35\text{pb}^{-1}$
- Pythia/Data Good Agreement

## Di-jet Mass Combined Z(ee)+jets and Z( $\mu\mu$ )+jets



# New, New Phenomena Results

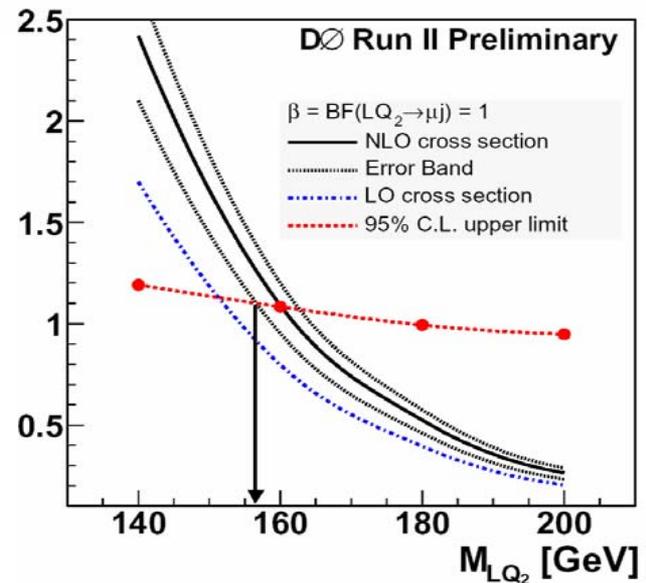
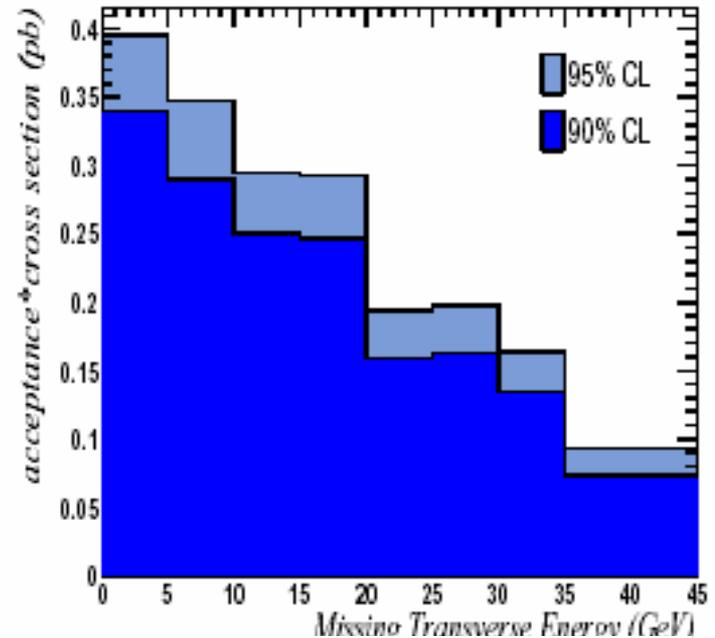
- **mSUGRA Chargino/Neutralino Search**
  - Tri-lepton mode
  - excludes  $\sigma \times \text{BR} = 3.5\text{-}2.2 \text{ pb}$
- **GMSB SUSY LSP Search**
  - $2\gamma + mE_T$
  - 95% CLimit  $m(\text{LSP}) = 66 \text{ GeV}$
  - close to Run I
- **SUGRA neutralino LSP Search**
  - Jets +  $mE_T$
  - Sets model-ind cross section limit as a function of  $mE_T$ ,



$mE_T: 105$   
 $\phi_{T: 61.1 \text{ deg}}$

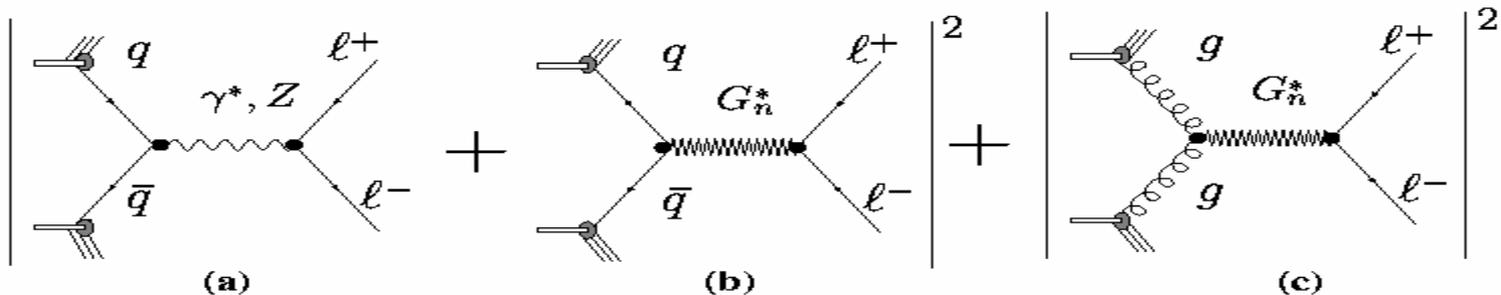


- Limits on New Physics in an  $e\text{-}\mu$  Search
  - Sets limit on cross section as a function of  $mE_T$
- Search for 2nd Gen LQ
  - $2\ \mu + 2\ \text{jets}$
  - $MLQ > 157\ \text{GeV}$



# Large Extra Dimensions Search

- Model framework: string theory w/ SM restricted to D3-brane, gravity propagating in extra dim's. Virtual graviton diagrams contributing to dilepton and diboson production.



- $50\text{pb}^{-1}$   $ee$  and  $\gamma\gamma$  channels and  $30\text{pb}^{-1}$   $\mu\mu$  channel
- Combined dodel dependent 95% CL lower limit on Planck scale

$M_s$  in TeV

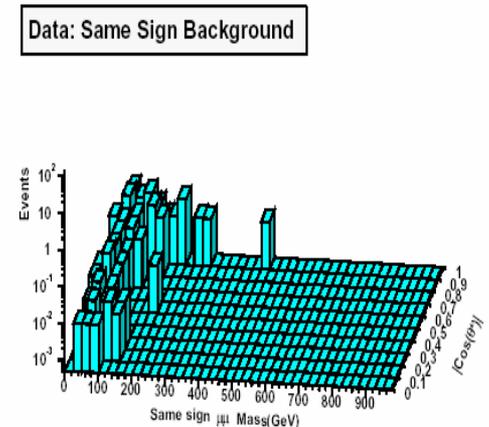
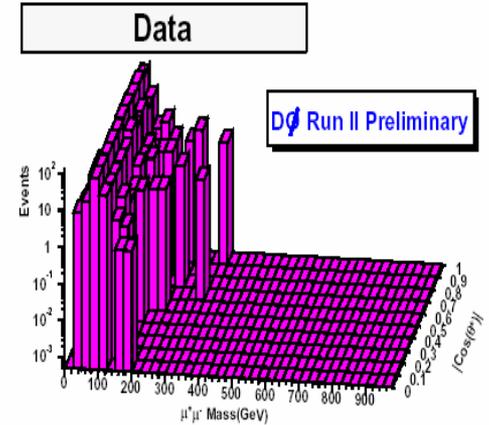
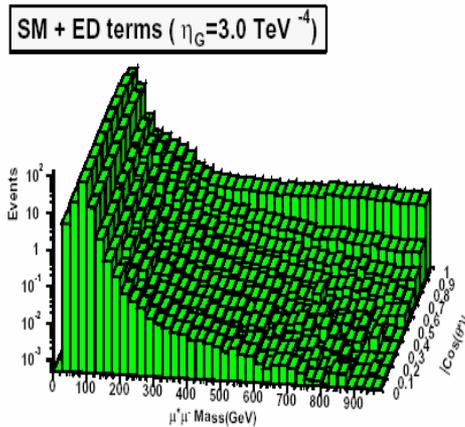
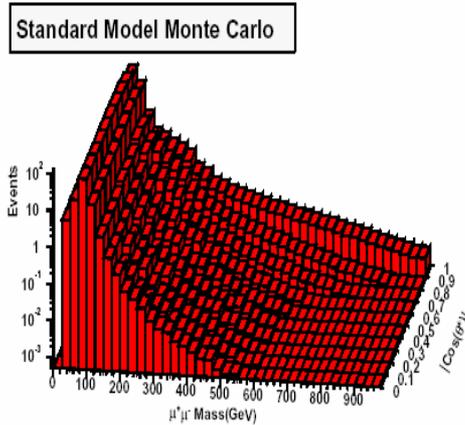
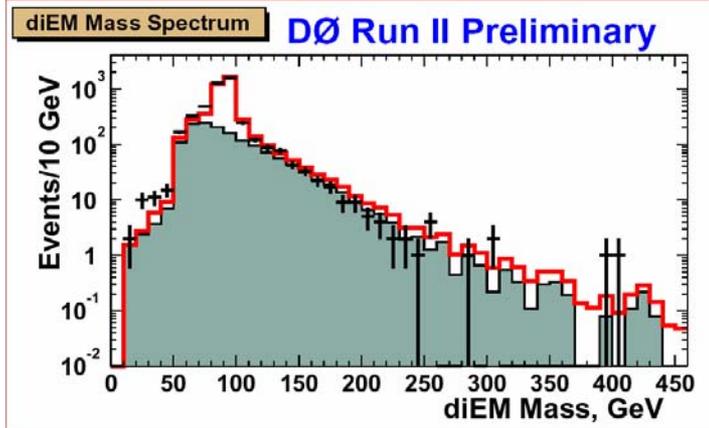
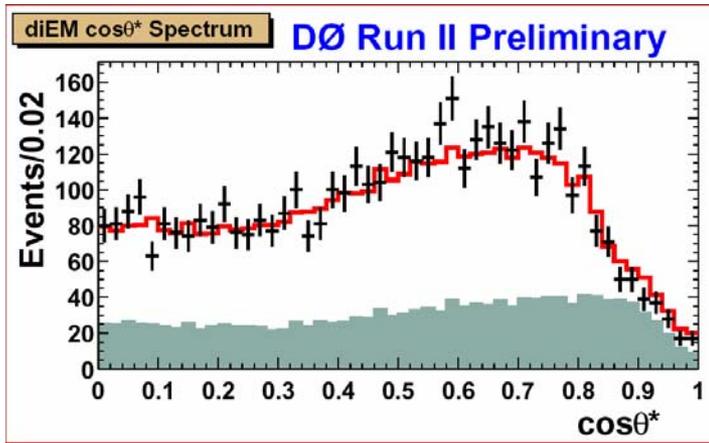
	GRW	HLZ for n:		Hewett
		2	7	$\lambda = +1$
diEM	1.12	1.16	0.89	1.00
diMU	0.79	0.68	0.63	0.71



# Signal/Theory

ee Channel

$\mu\mu$  a New Channel!

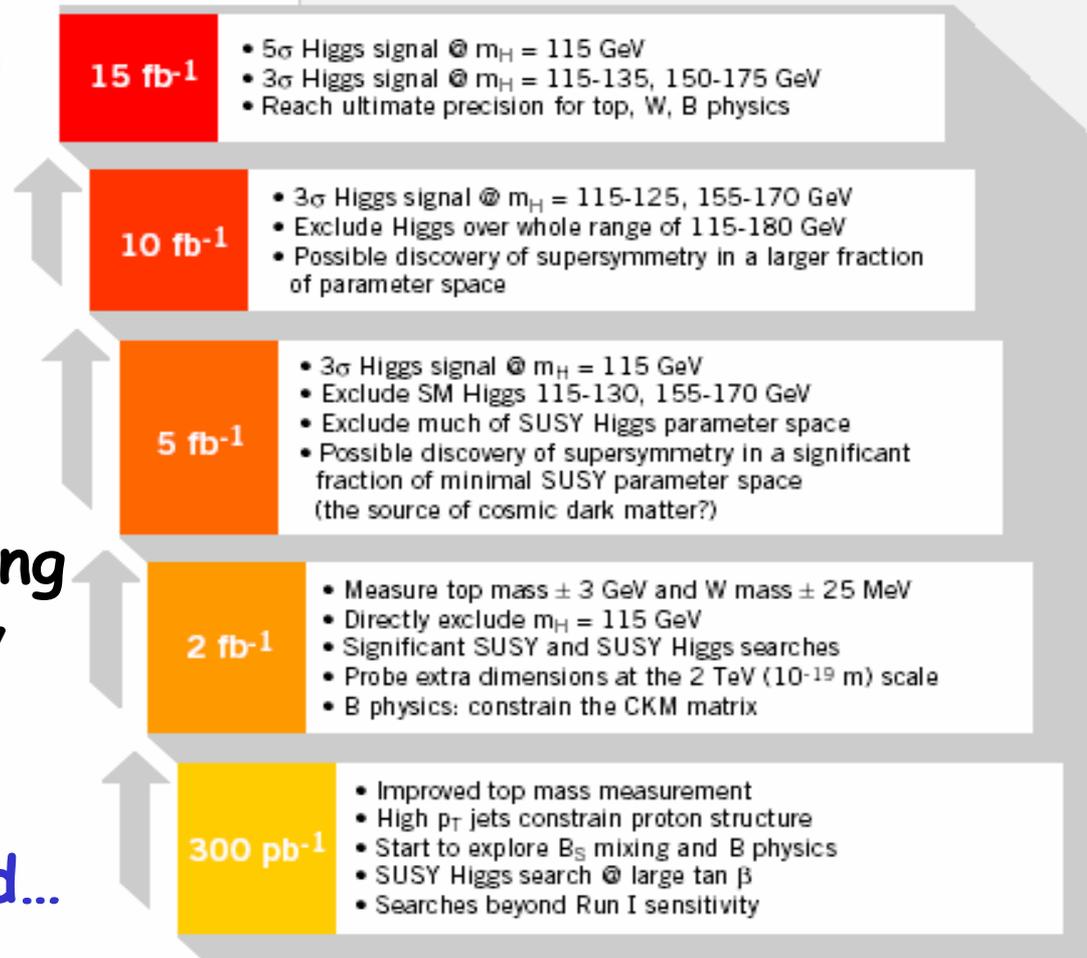


Fit to 2-D distributions to extract SM, interference, and direct gravity terms; use topologies w/ at least 1 EM obj in central calorimeter



# Run II Physics Program

- Detector operating well.
- Producing lots of interesting physics
  - QCD, B, W&Z, Top,
  - Limits approaching Run I sensitivity
- Looking forward to new physics this summer and beyond...



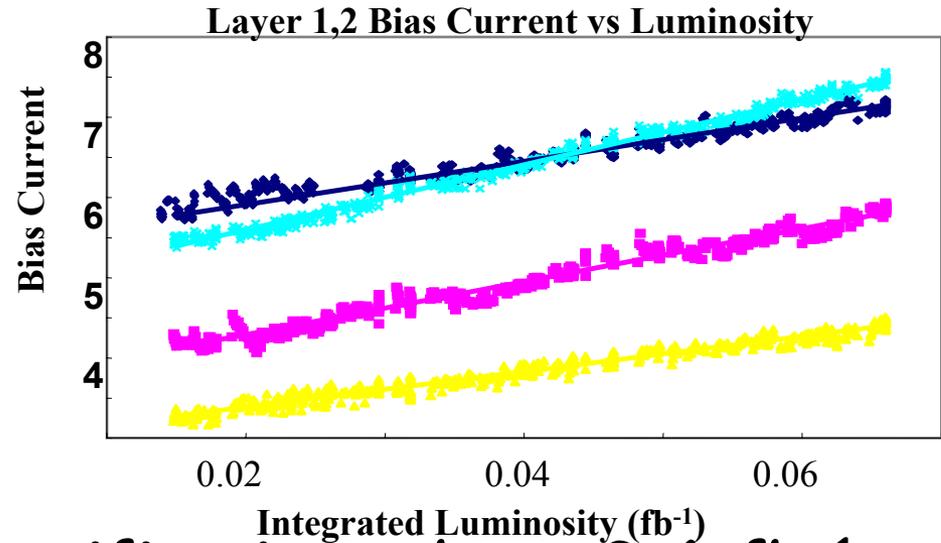
*Each gain in luminosity yields a significant increase in reach and lays the foundation for the next steps*



# Silicon Status

## • Radiation

- Increase of bias current measured and consistent with expectations
- Infers depletion voltage exceeds specifications above  $3.6 \text{ fb}^{-1}$
- 100% loss inner layer by  $4.9 \text{ fb}^{-1}$
- 50% Uncertainty



## • Active Ladders/Wedges

<u>Device</u>	<u>Oct 01</u>	<u>Feb03</u>	<u>Mar 03</u>
Ladders:	93.4%	93.1%	88.4%
F-wedges:	92.7	91.5	91.3
H-wedges:	86.0	86.0	85.4

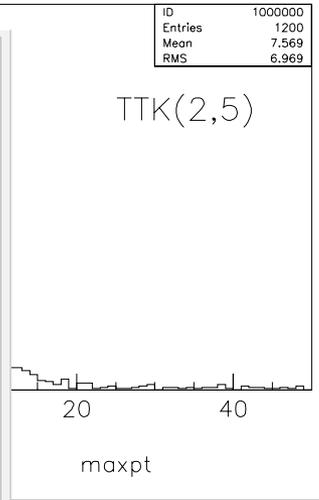
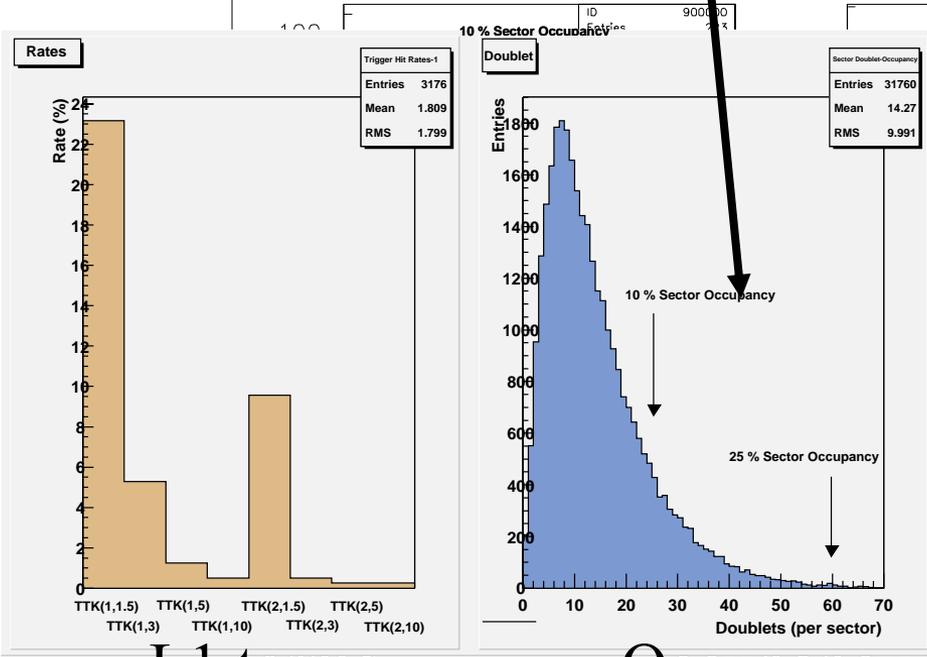
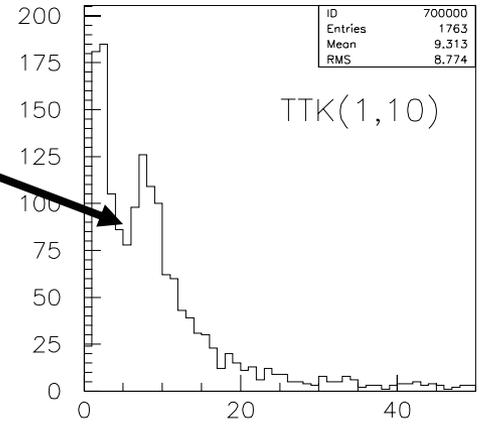
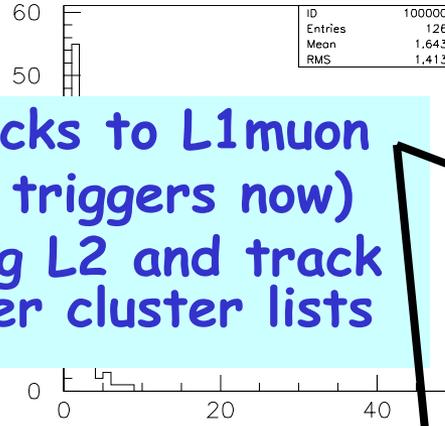
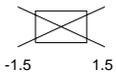
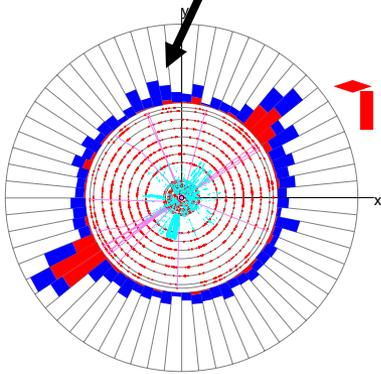


# L1CTT

- Providing tracks to L1muon
- L1 terms (in triggers now)
- Commissioning L2 and track and preshower cluster lists

Run 165897 Event 14247346 Wed Oct 16 12:54:30 2002

ET scale: 12 GeV



L1 terms

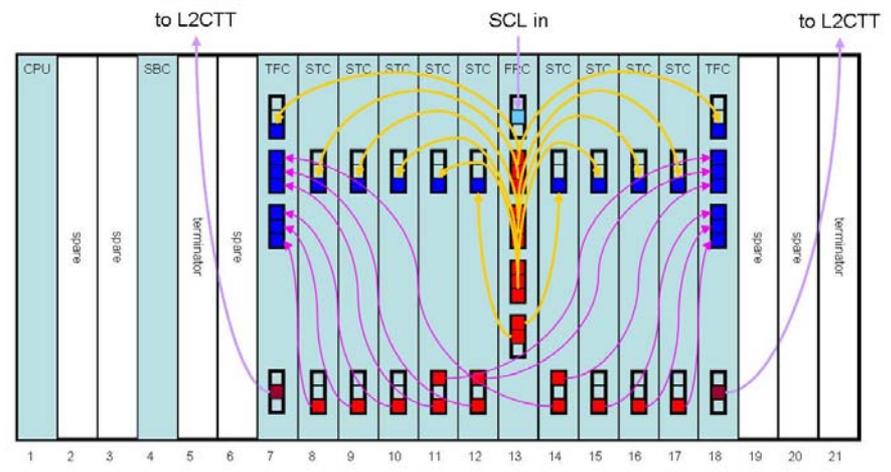
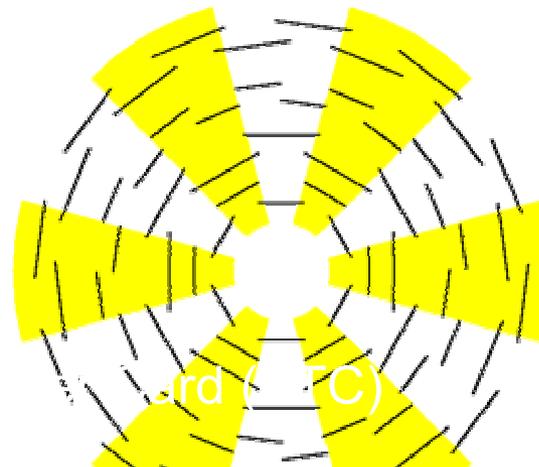
Occupancy

DOE Review March 18-20, 2003



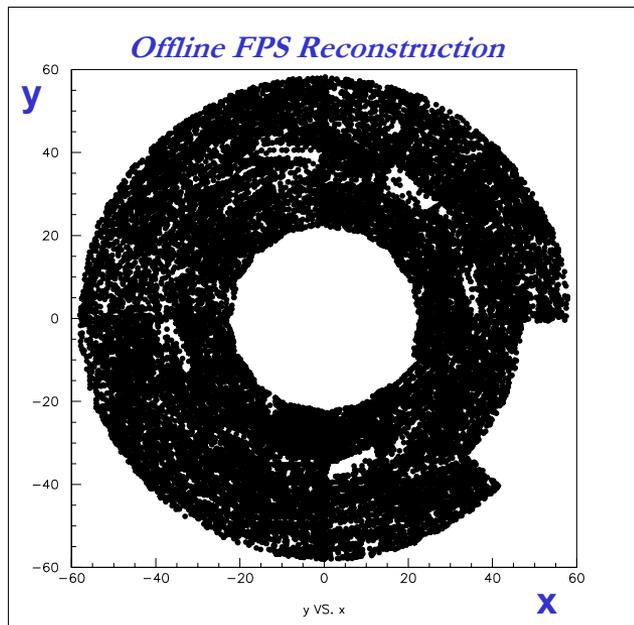
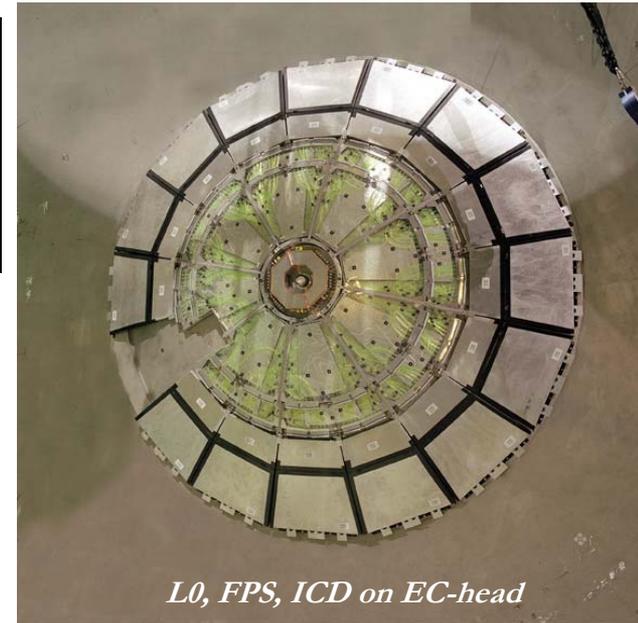
# STT

- 30° azimuthal units, 6 crates
- Common Motherboard w/ PCI communication
- Huge progress last calendar year, from prototypes to complete production
- Commissioning 1<sup>st</sup> sector at DØ
  - Firmware debugging
  - Interface with DØ systems
- Operational Spring 2003



# Forward Preshower Detector

- Extensive forward coverage:  $1.5 \leq |\eta| \leq 2.5$
- u,v Stereo Layers with  $2X_0$  Lead Absorber
- 14,988 channels: 99% active.



- System instrumented June 2002
- Offline reconstruction using matched u, v clusters and energy correlation requirement

