Recent DØ results in B, QCD Electroweak, Top and Higgs Physics

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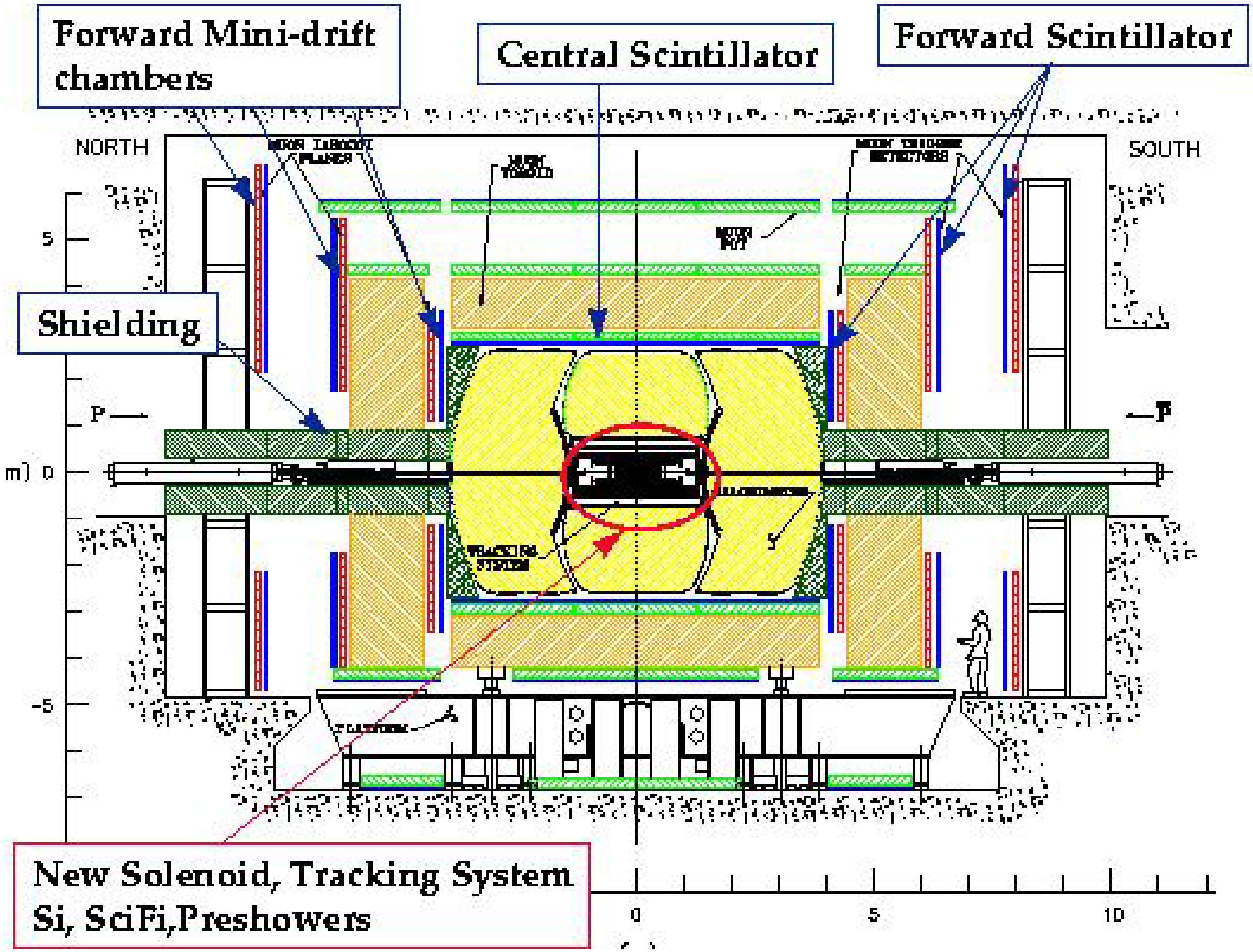
For the DØ Collaboration

Wine and Cheese seminar

March 14, 2003

DØ Detector


Forward Mini-drift chambers
Central Scintillator
Forward Scintillator
NORTH
SOUTH
Shielding
5
-5
0
5
10
New Solenoid, Tracking System
Si, SciFi,Preshowers

Status of the DØ detectors

- Silicon detector
  - Running smoothly: ~91% of channels are in readout
  - A few noisy HDIs are causing infrequent HV trips
  - Working on optimizing monitoring and L1 accept data speed transfer
- Fiber tracker and preshowers
  - More then 99% of channels are operating well
  - Concentrating on commissioning the new tracking trigger
- Calorimeter
  - Number of channels in operation is 99.9%
  - Precision readout is working stably and reliably
  - Concentrating on commissioning Level 1 calorimeter trigger in the eta region between 2.4 and 3.3
  - Triggering on jets and electrons in physics runs
- Muon system
  - Total number of dead channels is < 0.5% for tracking detectors and ~0.1% for trigger detectors
  - Detectors are operating stably
  - Triggering on muons (single, di-muon, muon+jets, etc.) during physics data taking

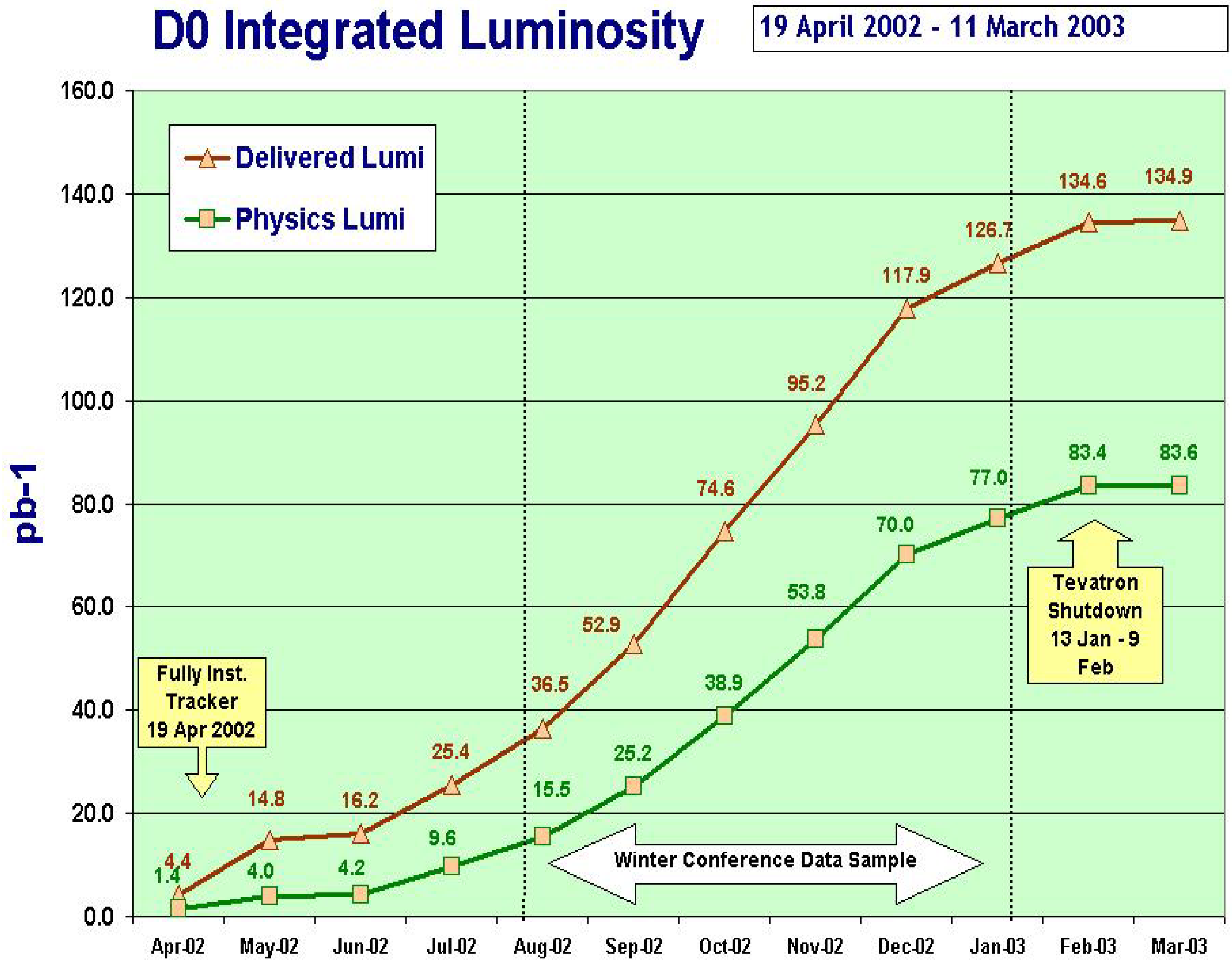
Current trigger rates

L1 rate 1KHz

L2 rate 0.6 KHz

L3 rate 50 Hz

February data taking ε:
~90% per run
~85% overall

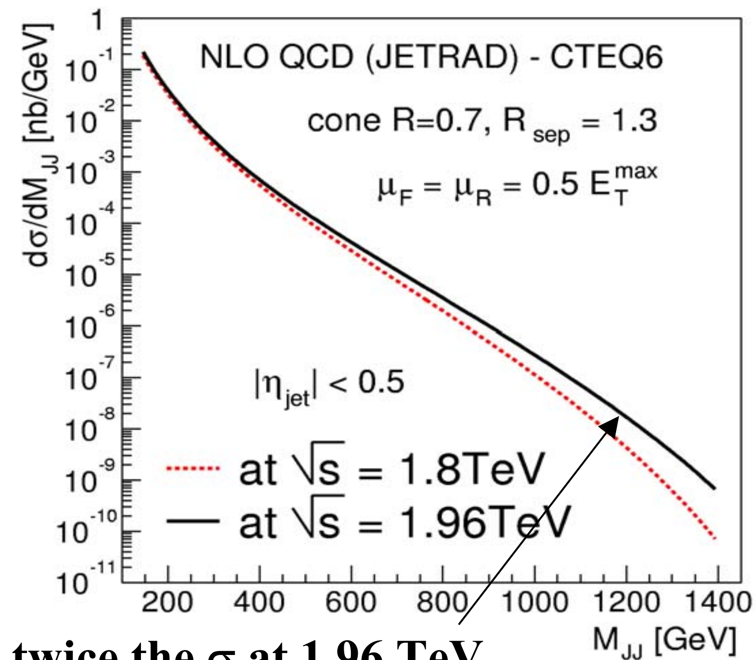


Many new results from DØ

- QCD
- B
- Electroweak
- Higgs
- Top
- New Phenomena (Last week's wine and cheese seminar by S. Protopopescu)

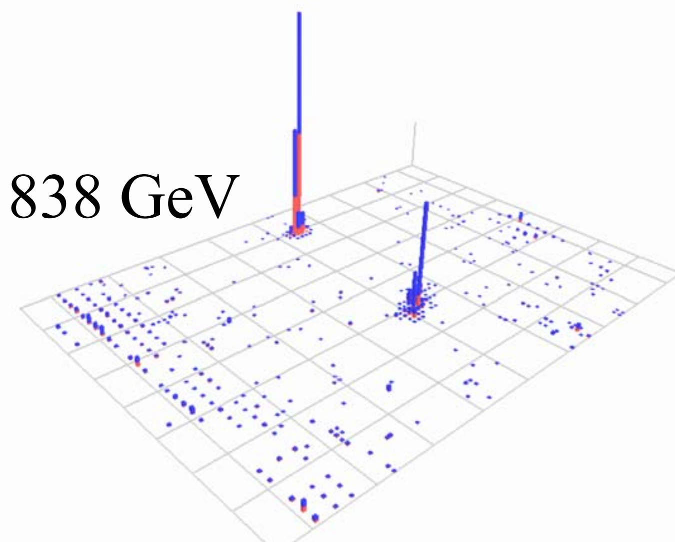
Dijet Mass Cross Section

- **probe of**
  - QCD
  - Proton structure at large x
  - hunting for resonances
  - *quark compositeness*
- ***data sample:***
  - ***34.1 pb^{-1}***
  - $\not{E}_T / P_{Tj1} < 0.7$
  - *primary vertex:* $|z_{vtx}| < 50$ *cm,* $N_{trks} > 4$
- ***selection & sample definitions***
  - $\Delta R = 0.7$ *cone jets*
  - $|\eta_{jet}| < 0.5$
  - $N_{jet} > 1$
  - *calculate invariant mass of leading two jets*



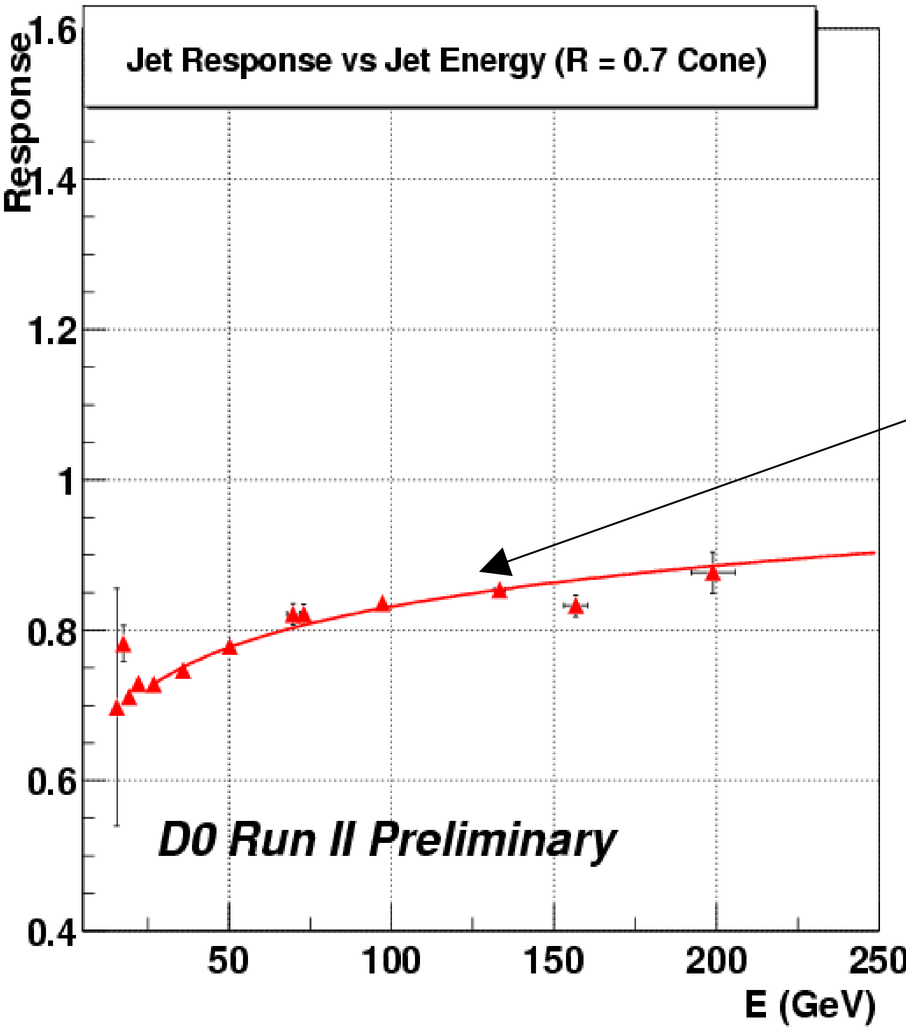
twice the σ at 1.96 TeV

$M_{jj} = 838$ GeV



Jet Energy Scale

$$E_{corr} = (E_{uncorr} - O) / R*S$$



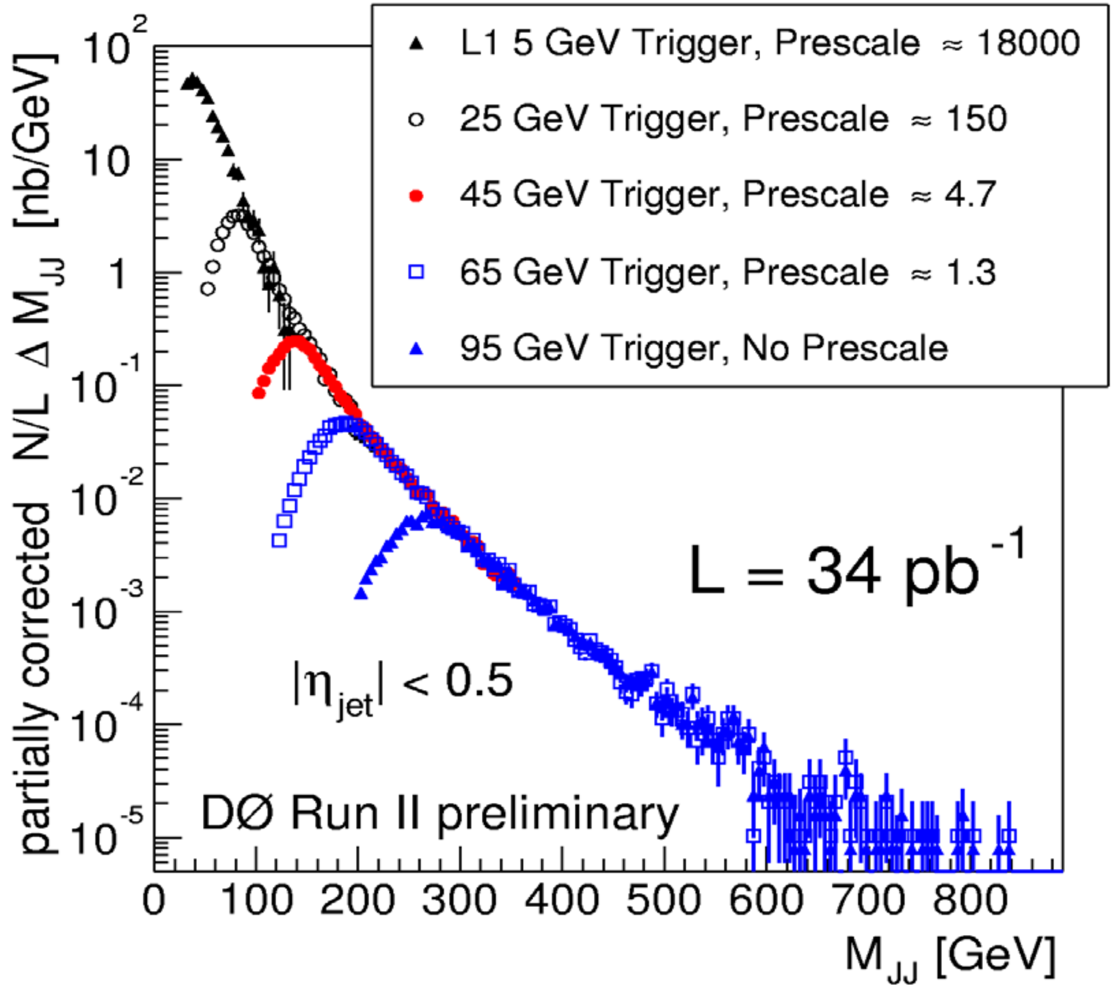
methods currently used

- O: underlying event, noise
  - **minimum bias events**
- R: non-linearities, dead material
  - **direct photon candidate events**
  - **statistics up to 200 GeV energy**
- S: particle showers
  - **jet transverse shapes in data**

errors

- large statistical errors
- substantial systematic errors
  - **increase with energy due to extrapolation**
- for central jets : error ~ 9%

Raw dijet mass spectrum

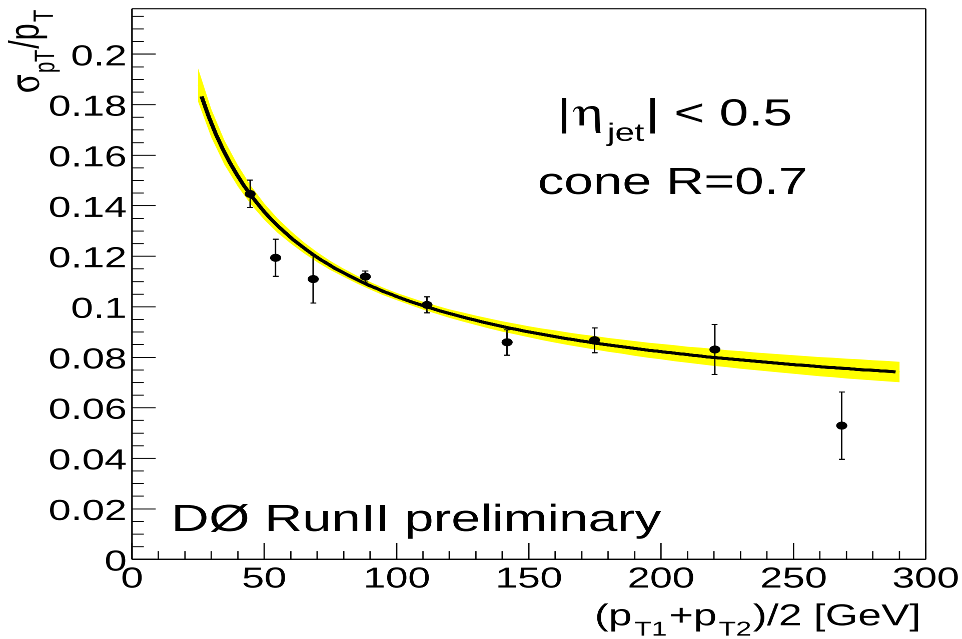


Jet energy scale corrected

Unsmearing correction

- Measure P_T resolution using P_T imbalance in dijets

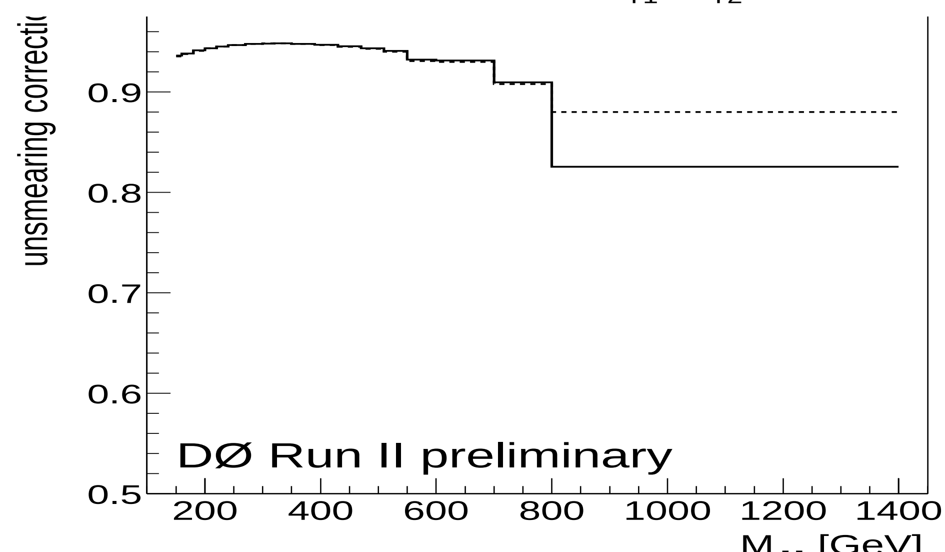
$$\mathcal{A} = \frac{p_T^{jet1} - p_T^{jet2}}{p_T^{jet1} + p_T^{jet2}} \qquad \frac{\sigma_{P_T}}{P_T} = \sqrt{2}\,\sigma_{\mathcal{A}}$$



- Derive dijet mass resolution using jet P_T resolution
- Use ansatz function to unsmear data

$$f = N\, M_{jj}^{-\alpha} \left(1 - \frac{M_{jj}}{\sqrt{s}}\right)^{-\beta}$$

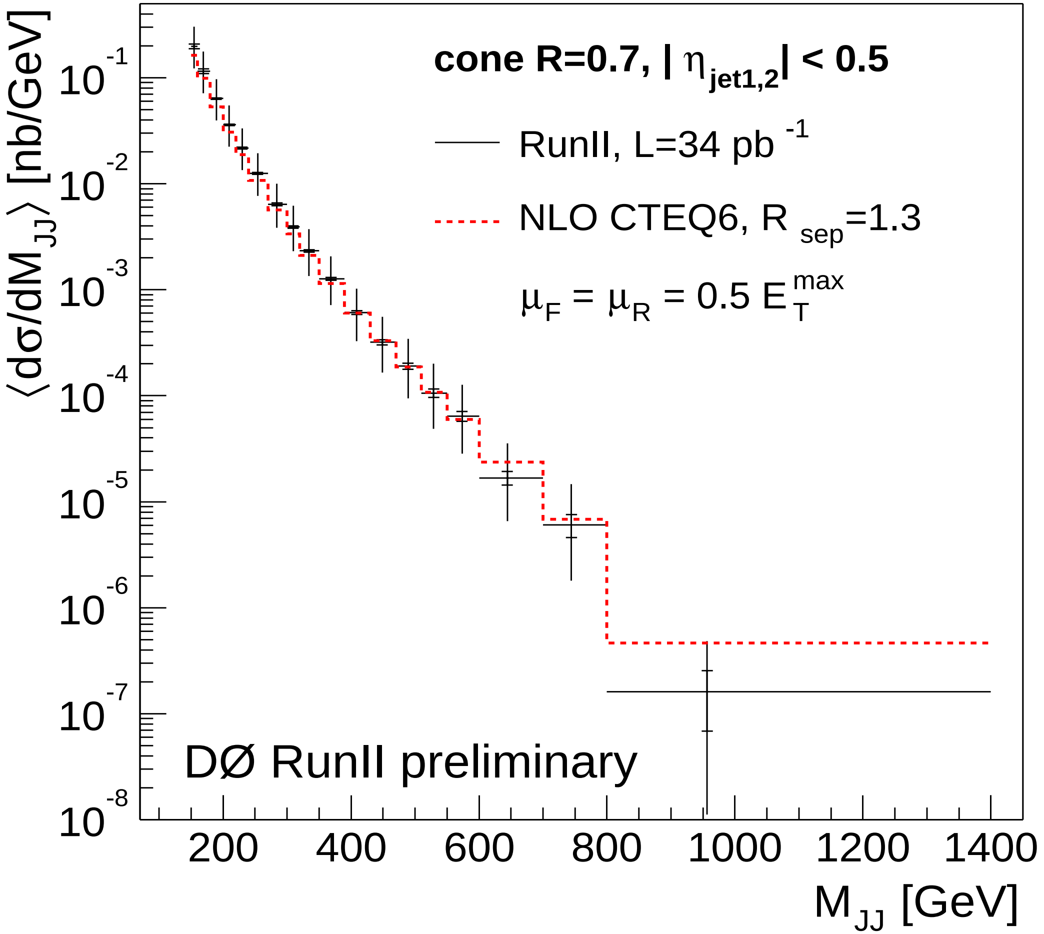
- Correction is small



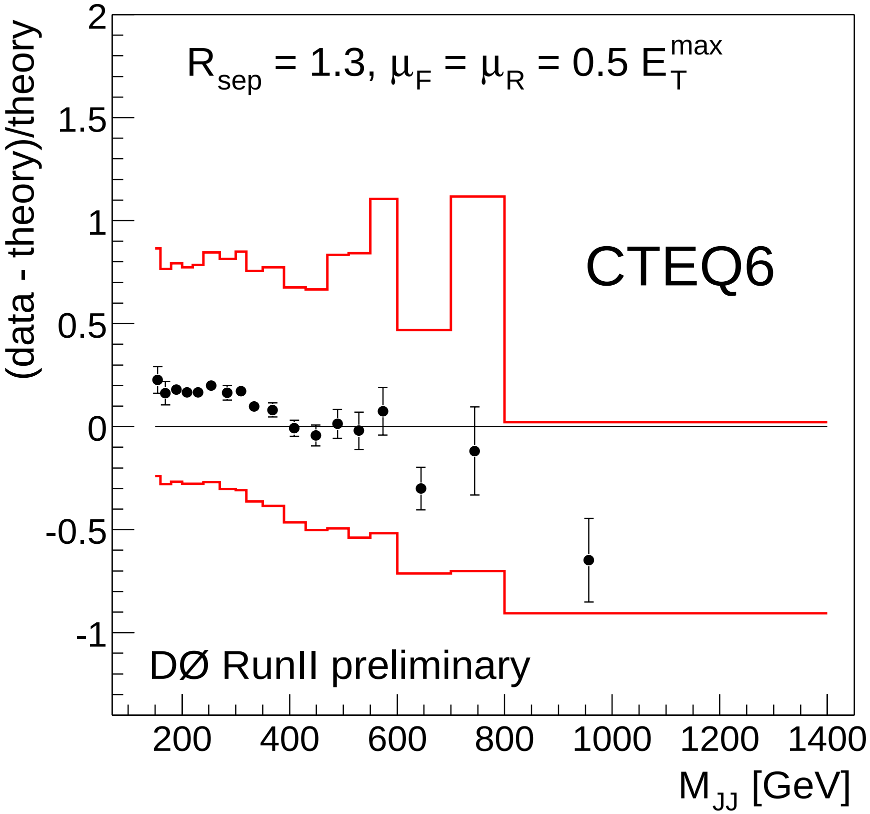
Dijet mass spectrum

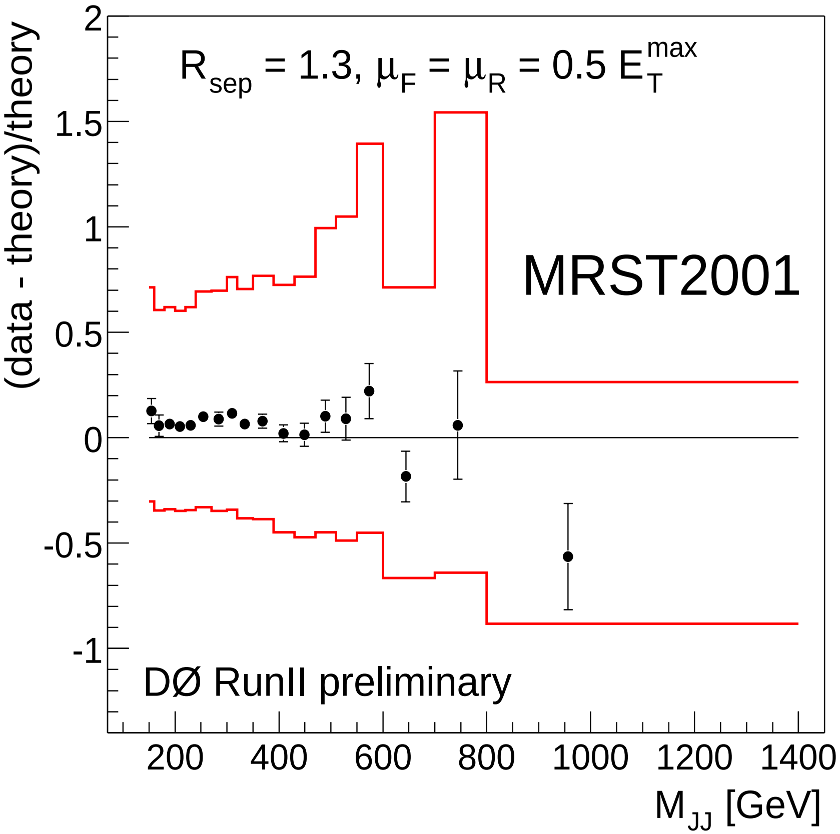
$$\frac{d\sigma}{dMjj} = \frac{N_{evt}}{L\varepsilon} C_{UNSMEAR} \frac{1}{\Delta Mjj}$$

10% luminosity error not shown



(Data-Theory)/Theory





10% luminosity
error not shown

Dominant error is energy scale

B physics

- Cross sections
- Lifetimes
- Flavor tagging
- Prove we understand detector before moving on to other interesting physics
- Bs mixing, Sin(2β), b baryons,…
- Mixing measurements
  - Reconstruct B
  - Determine proper time
  - Flavor tag

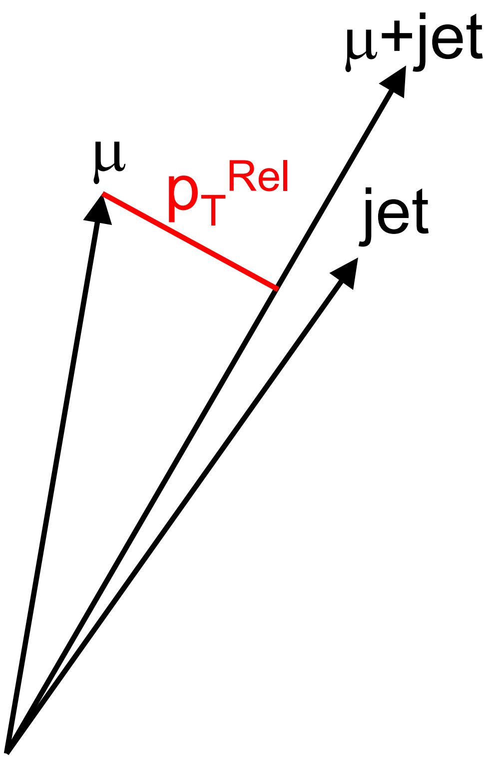
B jet cross section

- Measured in Run I: 2-3 times higher than predictions

Strategy:

Measure μ+jet cross-section

Extract b-content using P_T^{Rel}



Data selection & kinematic cuts

- $p_T^{\mu} > 6$ GeV/c, $|\eta^{\mu}| < 0.8$

(Muon P_T measured in muon system only)

- $|\eta^{jet}| < 0.6$
- $E_T^{corr} > 20$ GeV
- 0.5 cone jet
- $\delta R(jet,\mu) < 0.7$

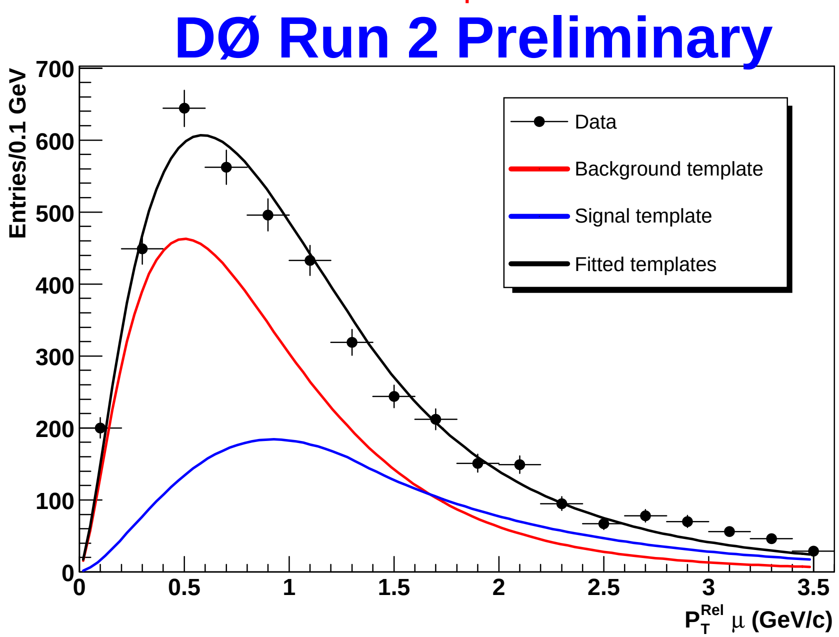
Data:

02/28/02-05/10/02 :

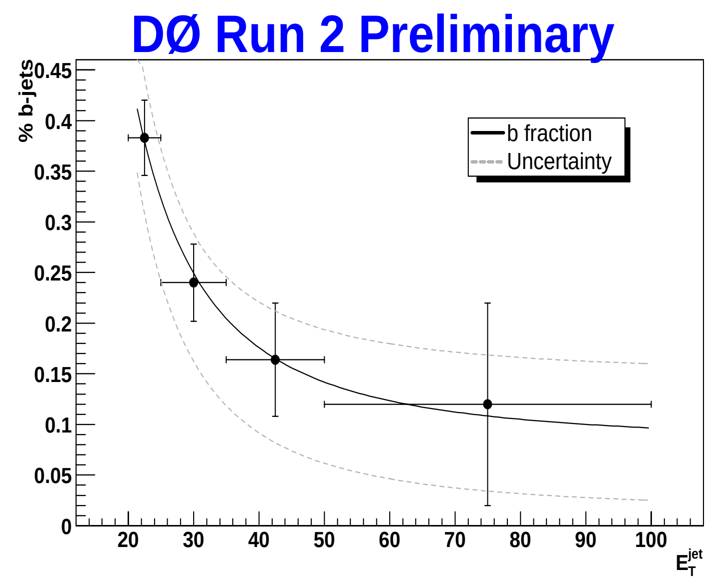
(3.4 pb^{-1})

Obtain B jet cross section from μ+jets cross section: Fit P_T^{rel} templates to data in jet E_T bins

P_T^{rel} for jets with
20 GeV < E_T < 25 GeV



B fraction as a function of Jet E_T



(cannot distinguish c→μX and decays in flight so only fit b, non-b)

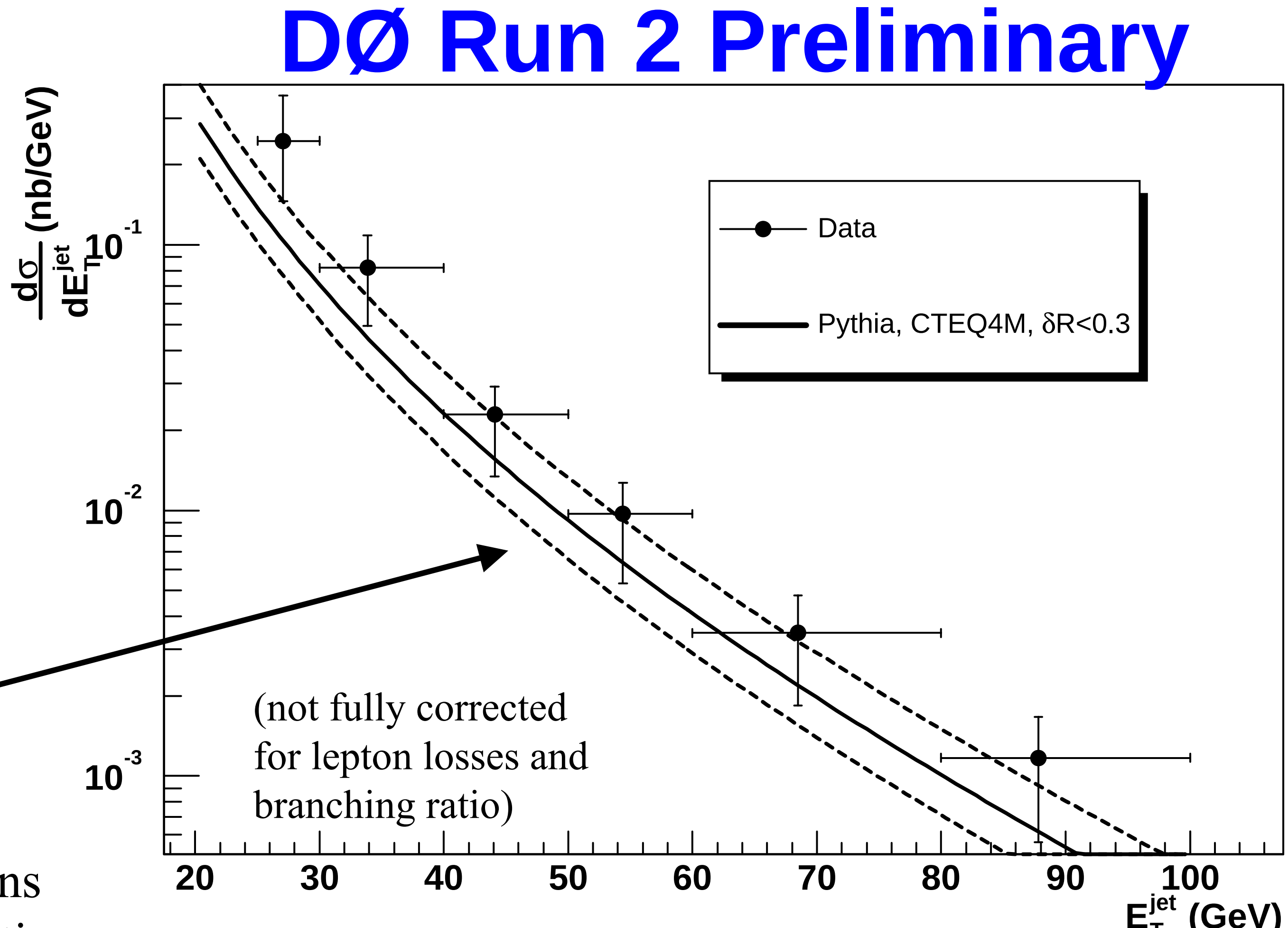
b jet cross section

Data unsmeared using ansatz function

Dominant error is due to jet energy scale

Uncertainty due to
- b quark mass
- renormalization/ factorization scale
- pdf's
- fragmentation functions

Based on NLO calculations and applied to Pythia

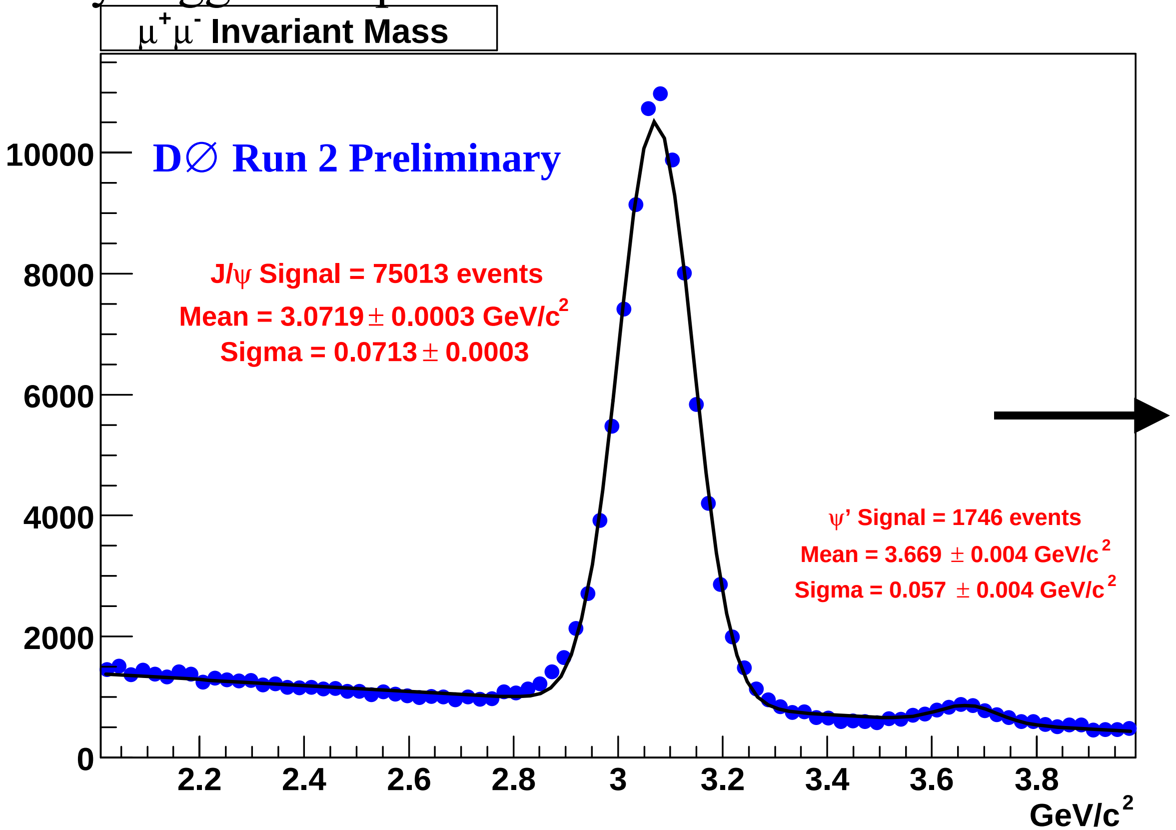


Consistent with Run I result

Lifetimes and exclusive B decays

- For now focusing on $J/\Psi \rightarrow \mu^+ \mu^-$ sample
- Useful for calibration
- Easy trigger and provides lots of B's

L~ 40 pb^{-1}

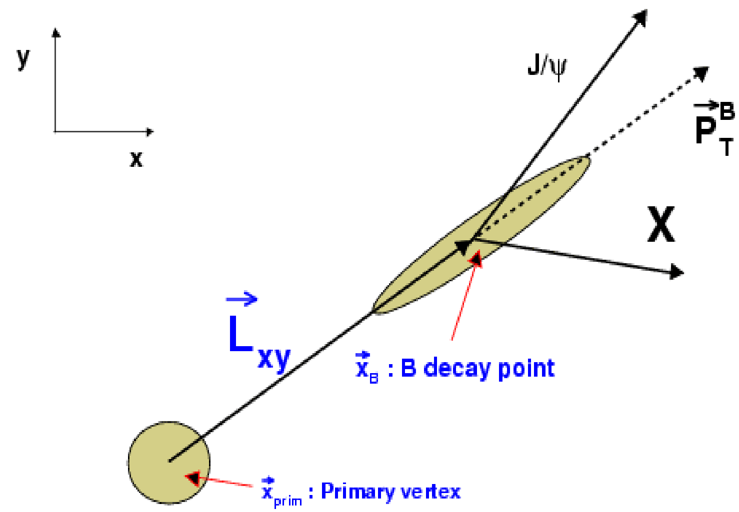


75,000*0.17

~13,000 b's

Average B Hadron Lifetime

J/ψ Sources
- **$(c\bar{c})$ states (prompt)**
- **B → J/ψ X**



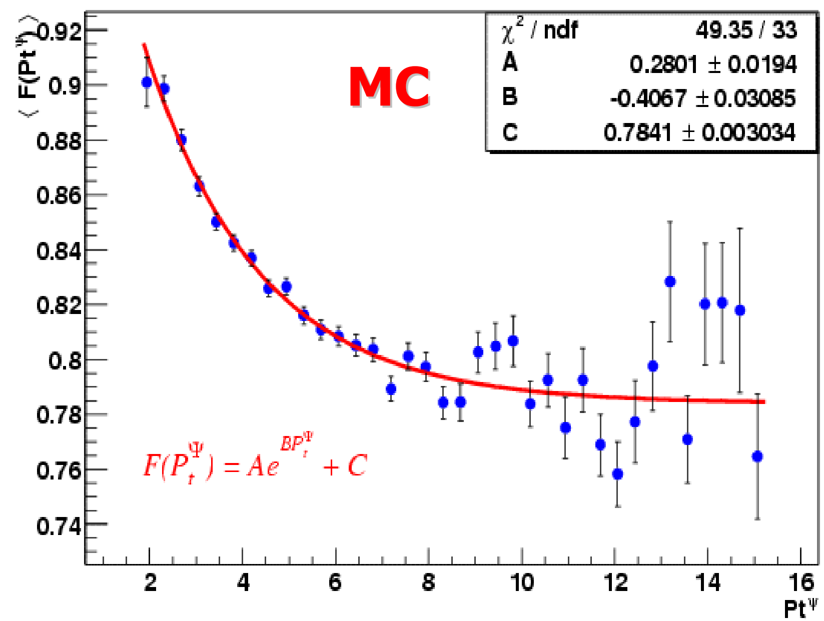
Difference

		decay
Prompt	~	**PV**
J/ψ(B)	~	**SV**

λ_B through λ_ψ

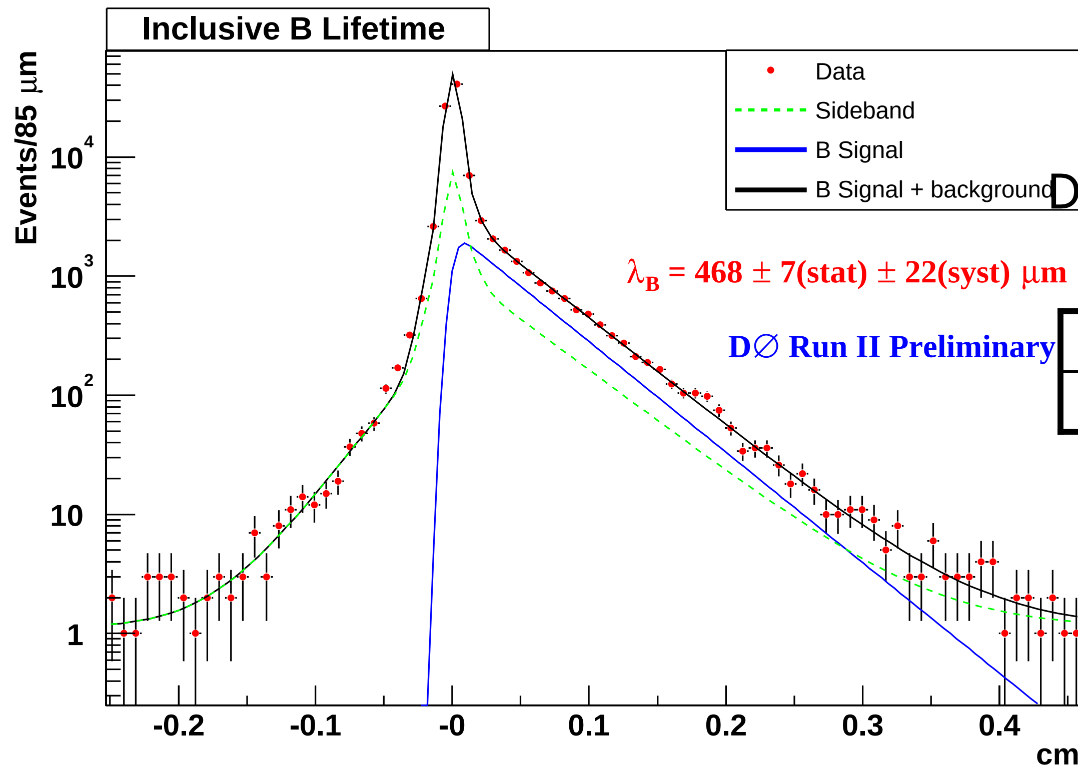
$$\lambda_B = L_{xy}\frac{M^{\Psi}}{P_T^{\Psi}\left\langle F(P_T^{\Psi})\right\rangle}$$

$$\left\langle F(P_T^{\Psi})\right\rangle = \frac{M_{\Psi}}{M_B}\frac{P_T^B}{P_T^{\Psi}}$$



Inclusive B lifetime

λ_b distribution



Dominant Sys Errors

Source	Error (μm)
Correction factor	15.9
Fitting Bias	14.0

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

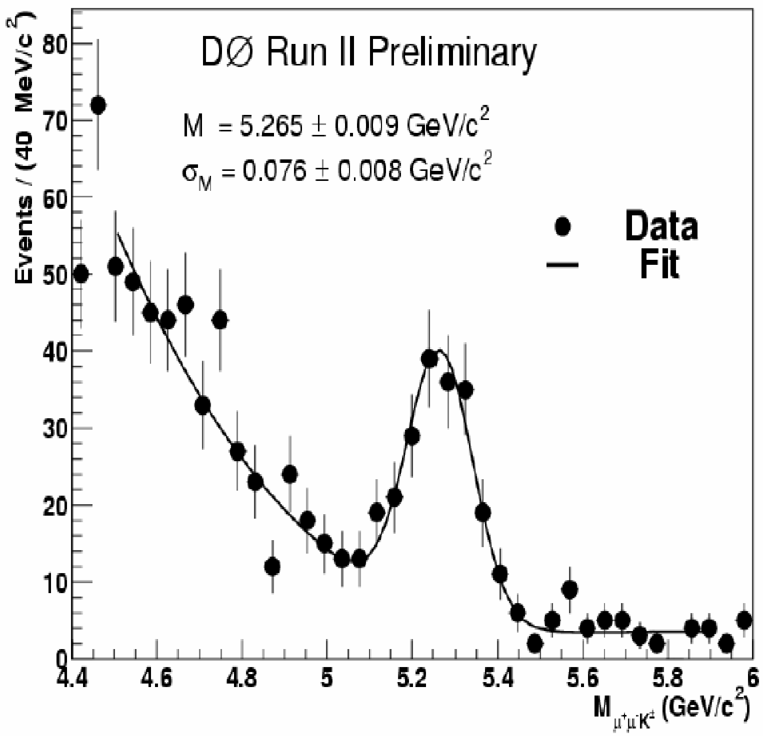
$\langle \tau \rangle = 1.564 \pm 0.014 \text{ ps}$ (PDG)

B fraction 17.3 ± 0.5 %

Fraction of outliers = 1×10^{-3}

Charged B

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



Cuts (J/ψ):

1. Muons with opp. charge
2. $p_T(\mu) > 2.0$ GeV
3. SMT hits ≥ 1
4. χ^2 on J/ψ vertex < 10
5. 2.8 < J/ψ mass < 3.3

Cuts (Charged B):

1. χ^2 for K < 10
2. Total χ^2 < 20
3. Kaon hits ≥ 3
4. $p_T(K) > 2.0$ GeV
5. Collinearity>0.9
6. B decay length > 0.3mm

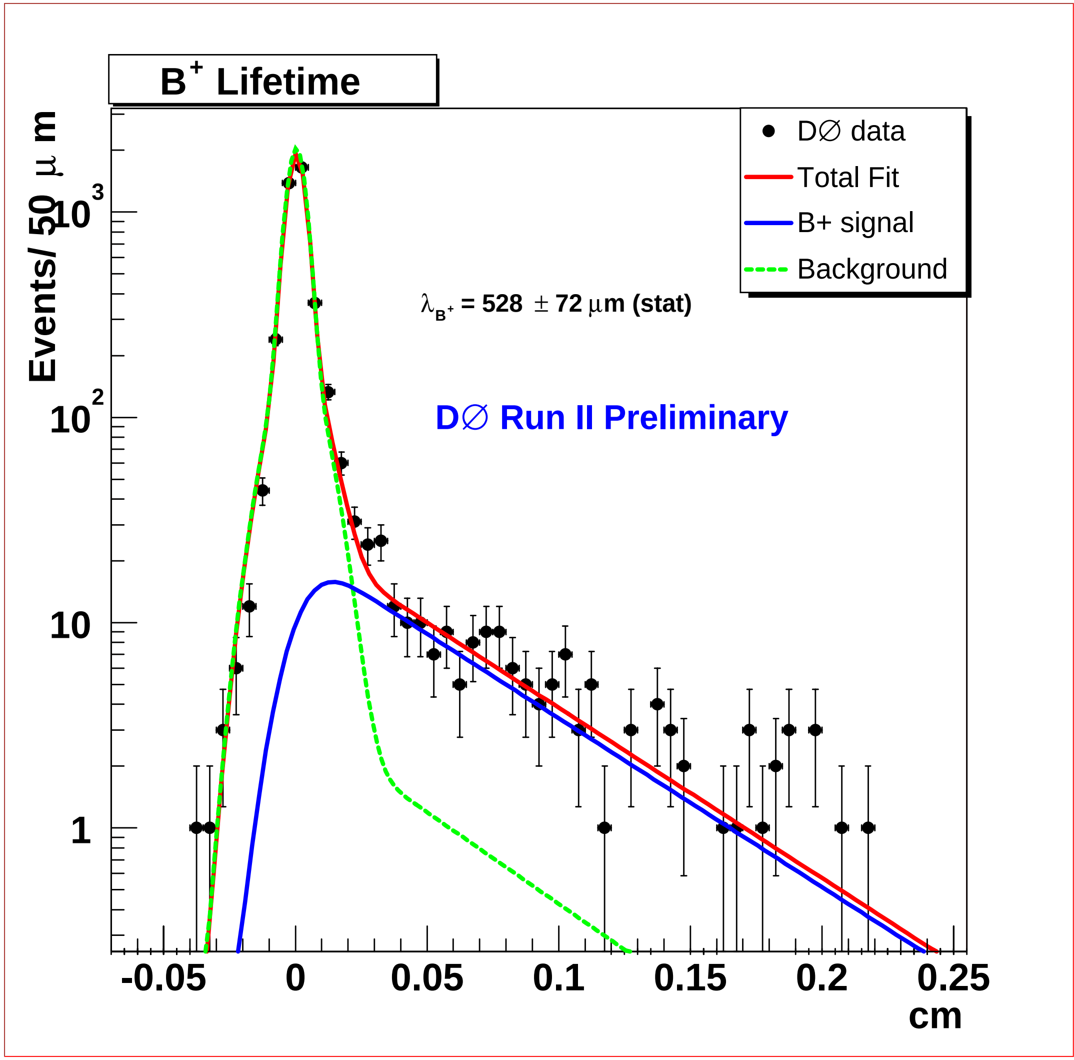
Charged B lifetime

Fully reconstructed B so no need for a correction factor

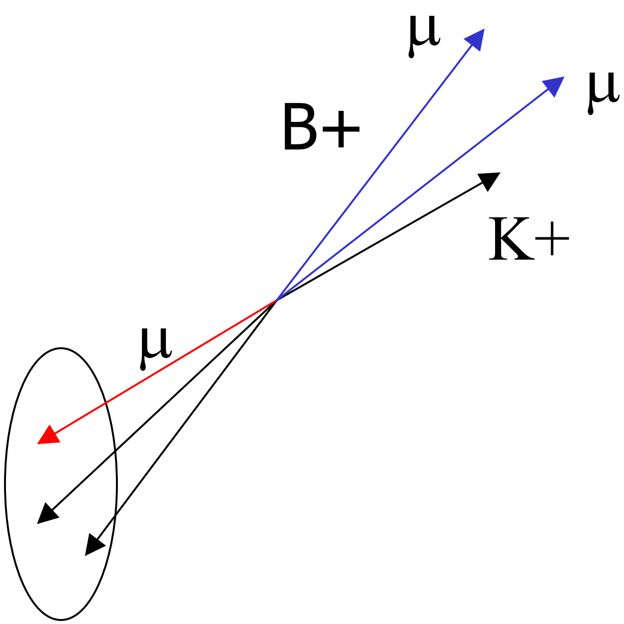
$$\lambda = L_{xy}\frac{M(B)}{P_T(B)}$$

<τ>=1.76±0.24 ps (stat)

<τ>=1.674±0.018 ps (PDG)



Use charged B sample to measure flavor tagging performance



Muon tagging
Muon $\Delta R > 2.0$ from B^+
Muon P_T > 1.9 GeV/c
Muon charge ⇒ B-tag

Jet Charge tagging
- Remove B^+ daughters
- Only use tracks with impact parameter < 0.2 within a phi cone 1.14 opposite to direction of B

$$Q = \frac{\sum pT_i * q_i}{\sum pT_i}$$

- Only events with |Q|>0.2 are used as tags

Use Jet charge or Lepton charge to Determine b flavor

Tagging power : εD^2

Significance of a mixing measurement proportional to εD^2

ε: efficiency for a tag = $\frac{N_{correct} + N_{wrong}}{N_{corrrect} + N_{wrong} + N_{notag}}$

D: Dilution= $\frac{N_{correct} - N_{wrong}}{N_{correct} + N_{wrong}}$

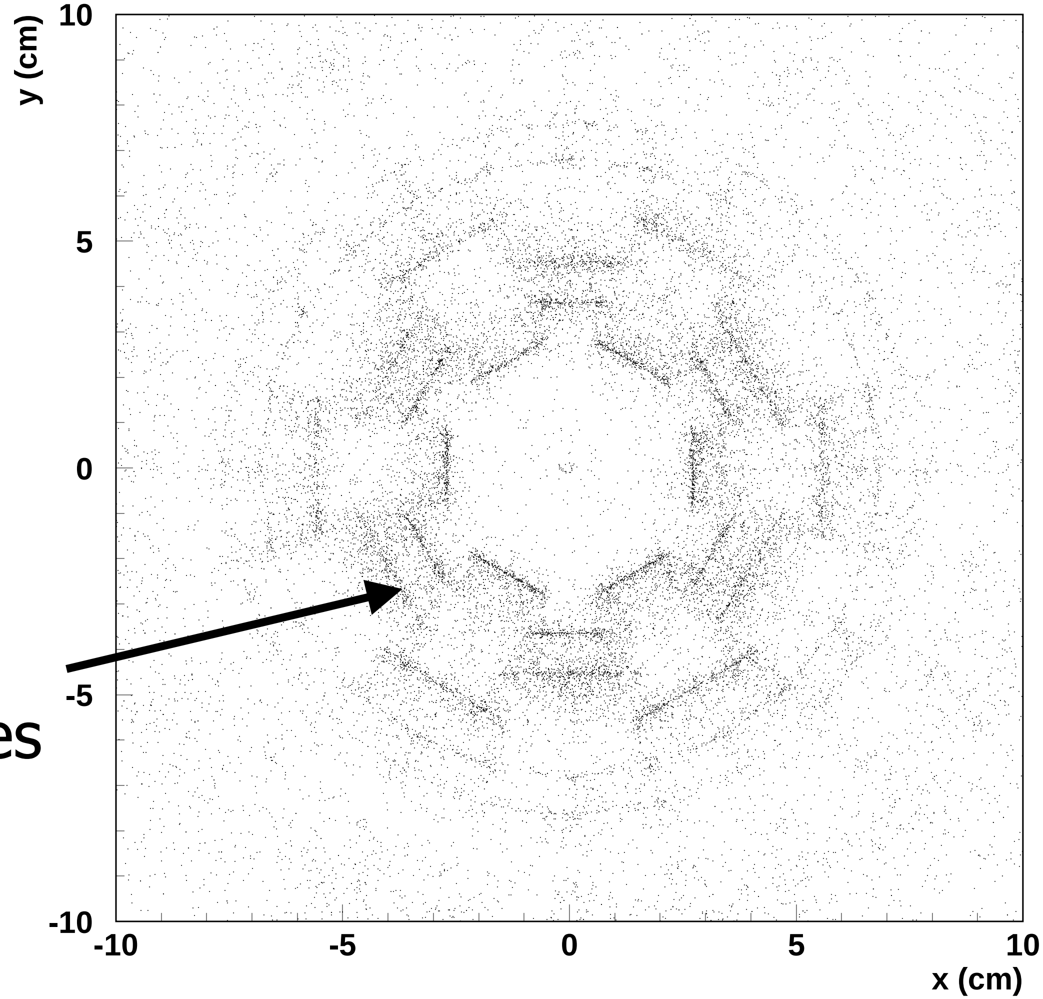
	Jet tag	Muon tag
Signal region	$\varepsilon = 63.0 \pm 3.6\%$	$\varepsilon = 8.3 \pm 1.9\%$
	$D=15.8 \pm 8.3\ \%$	$D=44.4 \pm 21.1\%$
Sidebands	$\varepsilon = 65.8 \pm 2.4\%$	$\varepsilon = 8.5 \pm 1.6\ \%$
	$D=2.4 \pm 4.1\%$	$D=-3.7 \pm 19.2\%$
εD^2 for signal	$2.4 \pm 1.7\%$	$3.3 \pm 1.8\ \%$

Photon conversions

Since low P_T tracks are very important for B physics, tracking algorithm has been improved

Improved performance for low P_T tracks and tracks with large impact parameter(Ks,Λ)

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

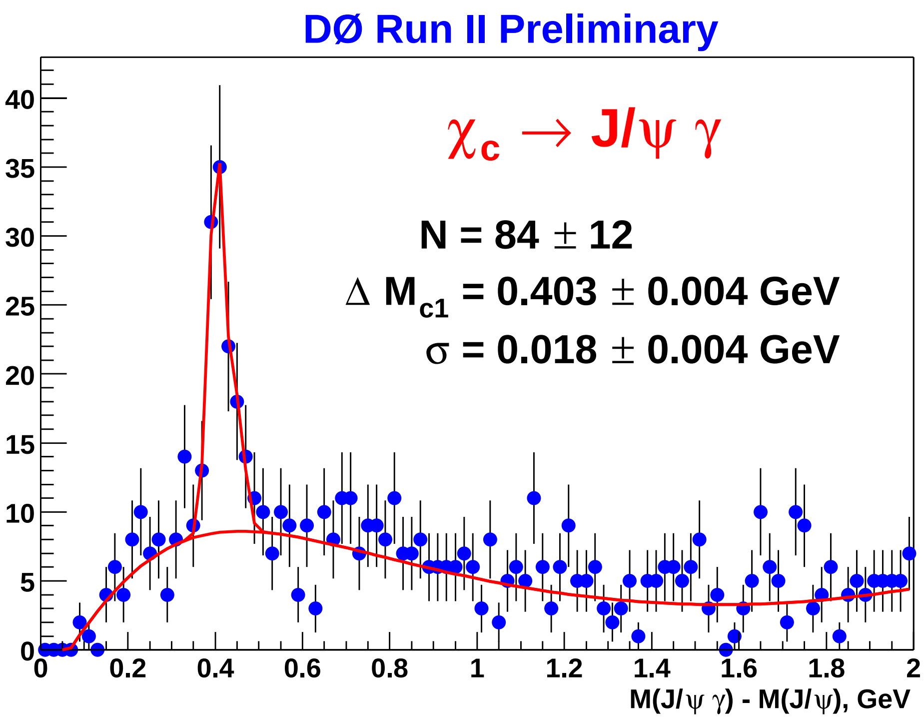


Silicon modules

$\chi_C \rightarrow J/\psi\ \gamma$

According to CDF Run I measurement: fraction of J/Ψ from χ_c

$27.4 \pm 1.6 \pm 5.2\ \%$



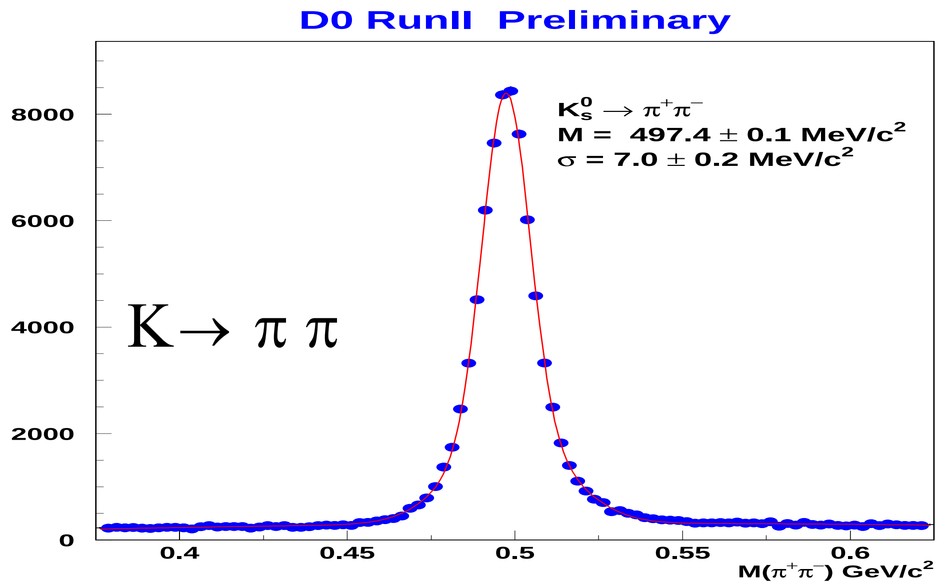
Expect ~ 80 events

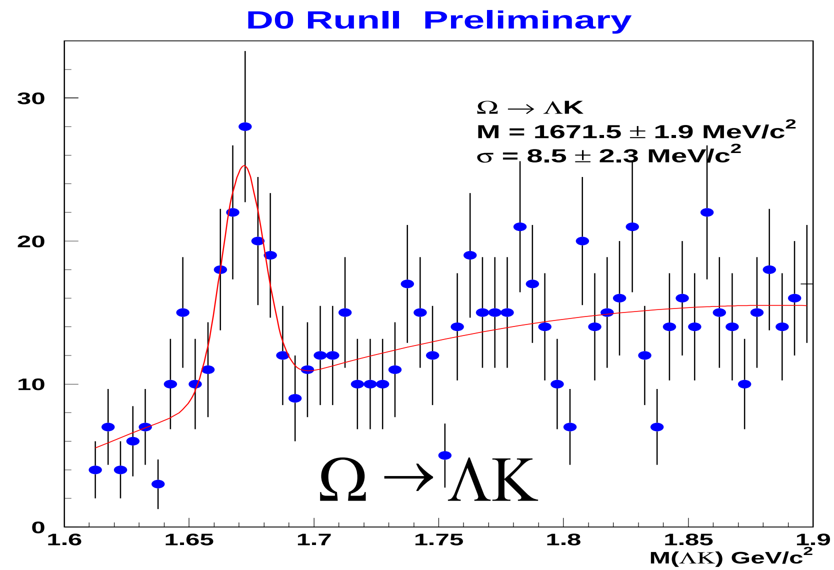
Cuts:

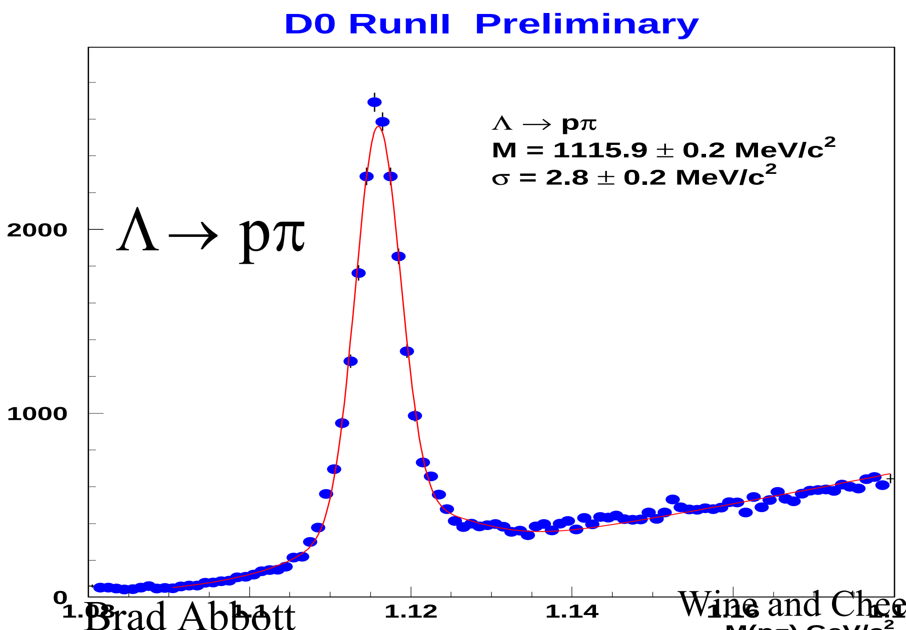
1. Track $p_T > 2.0$ GeV on tracks from J/Ψ
2. $p_{T\gamma} > 1.0$ GeV

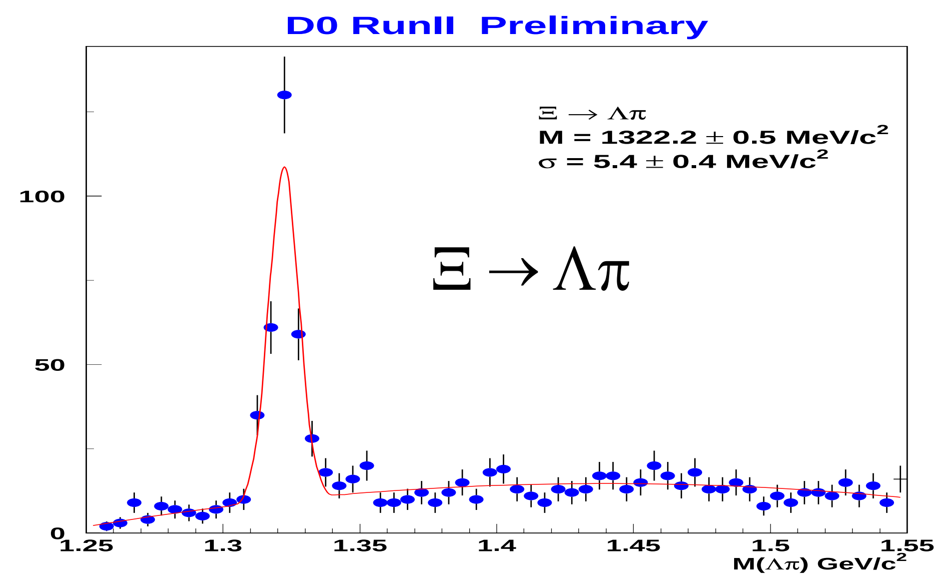
Fit with fixed $M\chi_{c1}$-$M\chi_{c2}$ = 46 MeV but float relative contributions

Results with new tracking algorithm



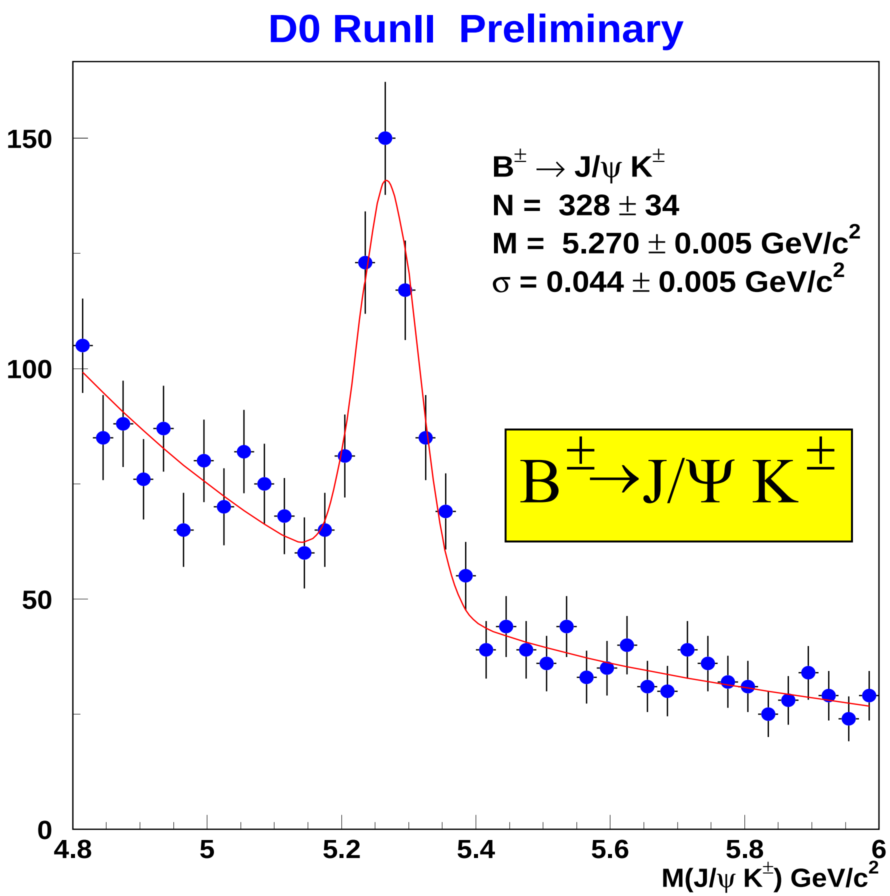


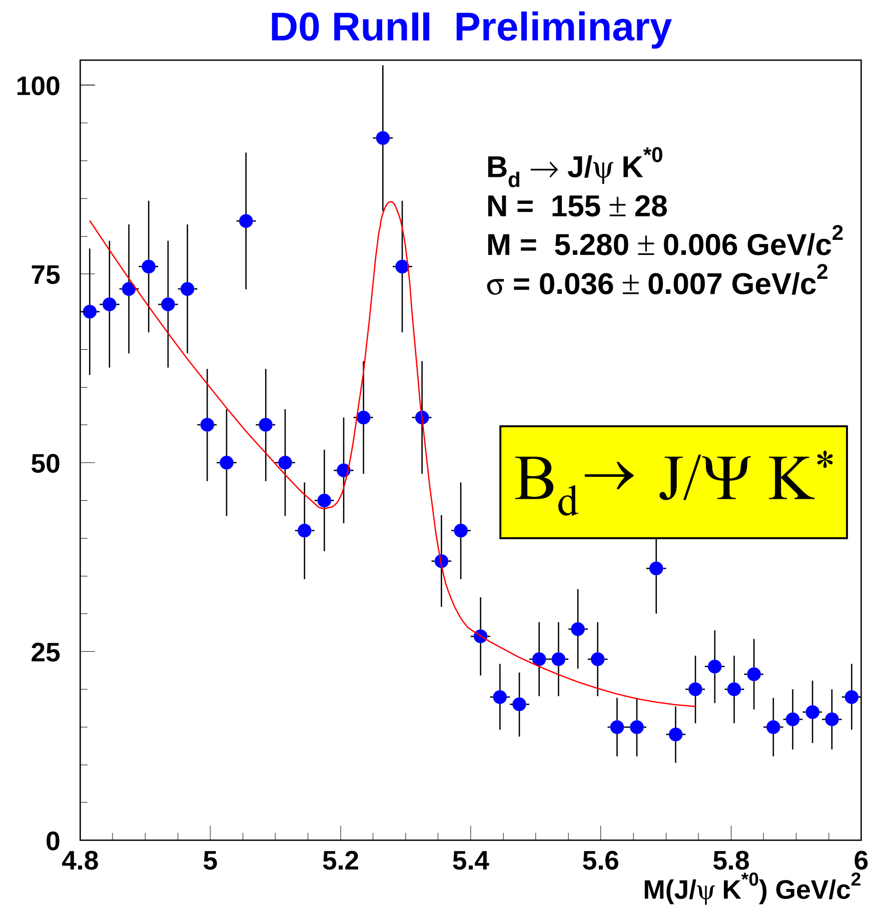




Exclusive B decays

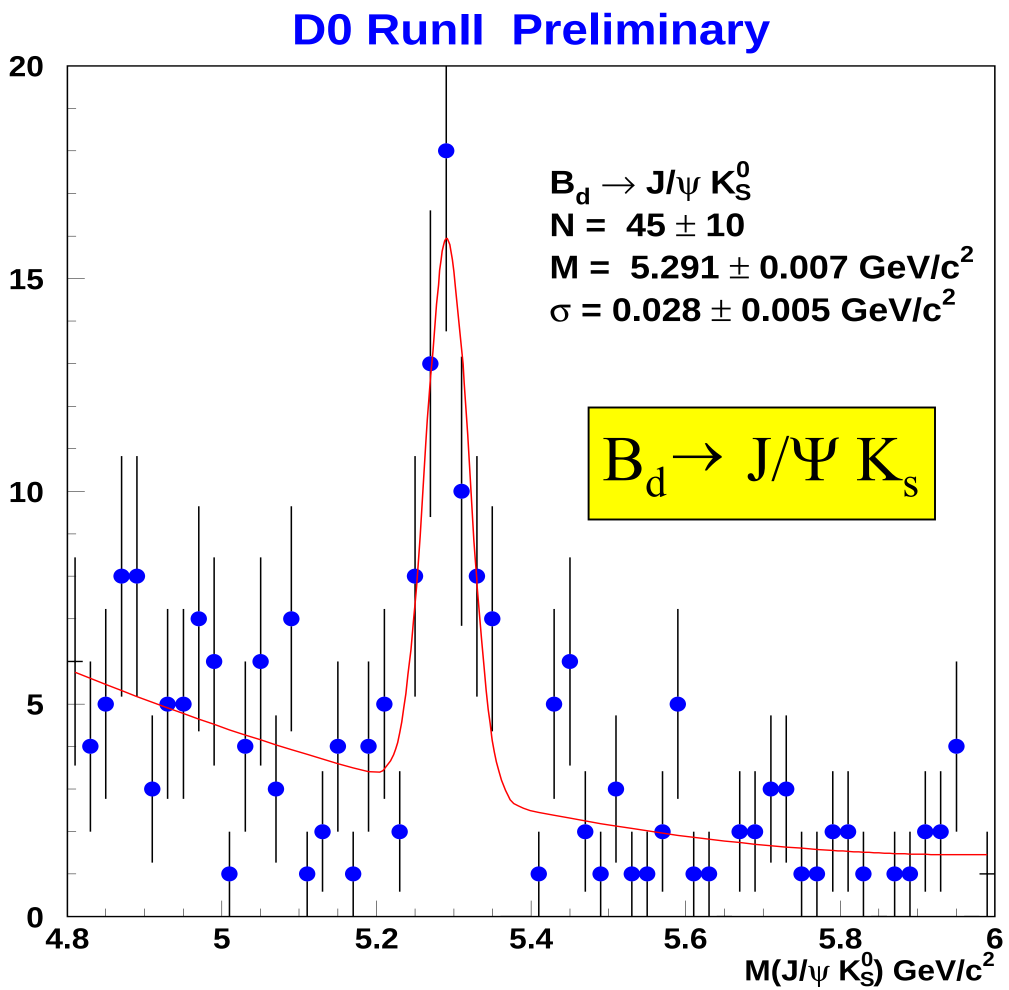
Combine J/Ψ with track or combine J/Ψ with K* and then require decay length significance>3.0





Towards Sin(2β)

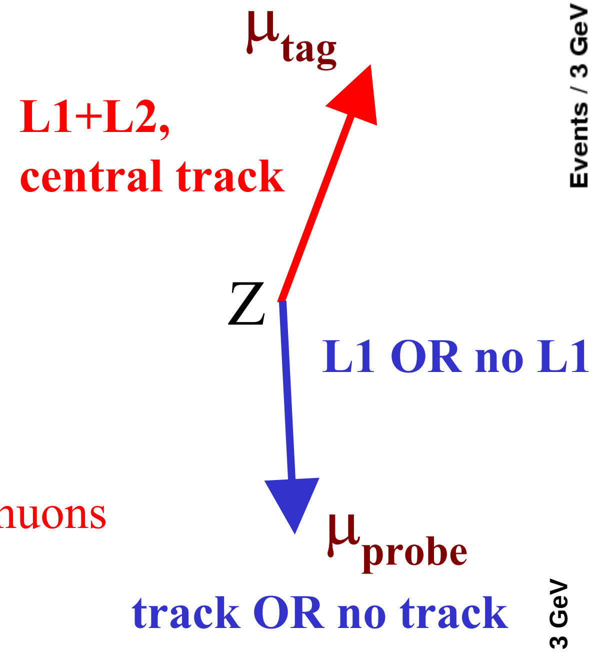
Combine J/Ψ with K_s and require decay length significance >3.0



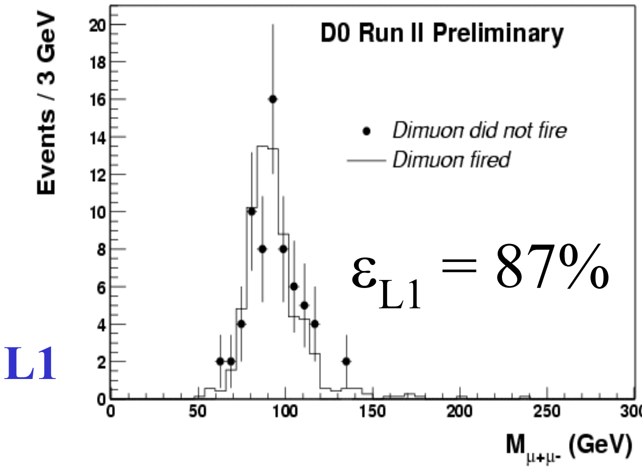
Electroweak

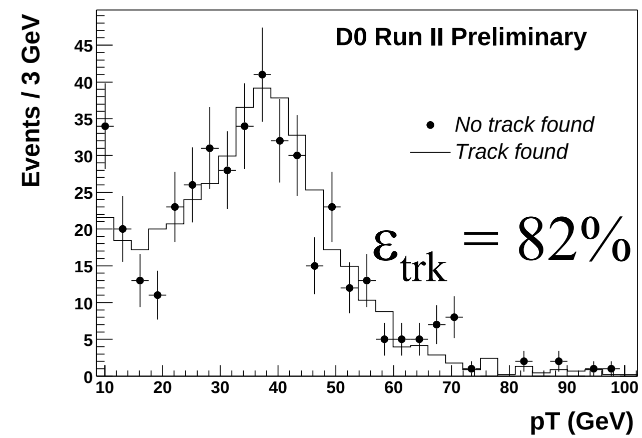
- Search for Z' in Dielectron Decays
  (Presented at last week's Wine and Cheese seminar)
- Measurement of the $Z \rightarrow \mu\,\mu$ Cross Section at $\sqrt{s} = 1.96$ TeV

$\sigma * BR(Z \rightarrow \mu\mu)$

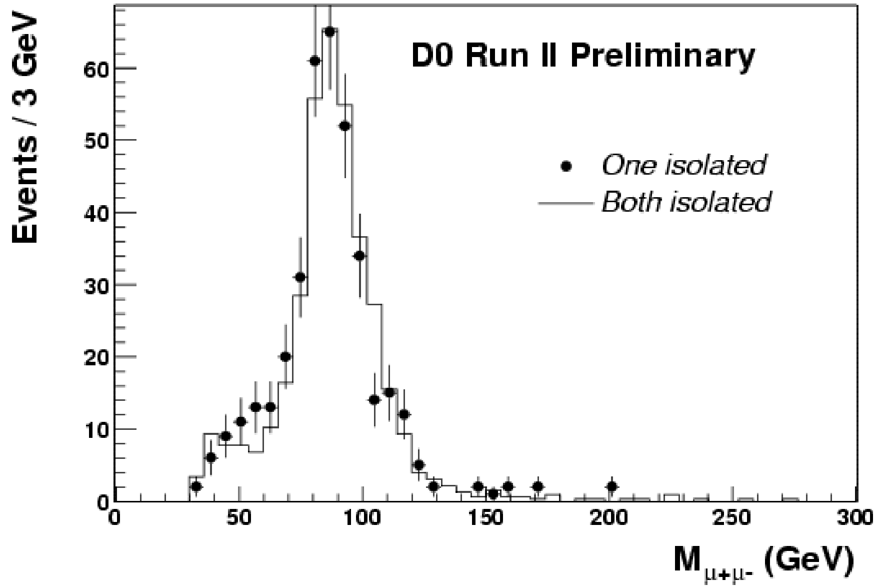


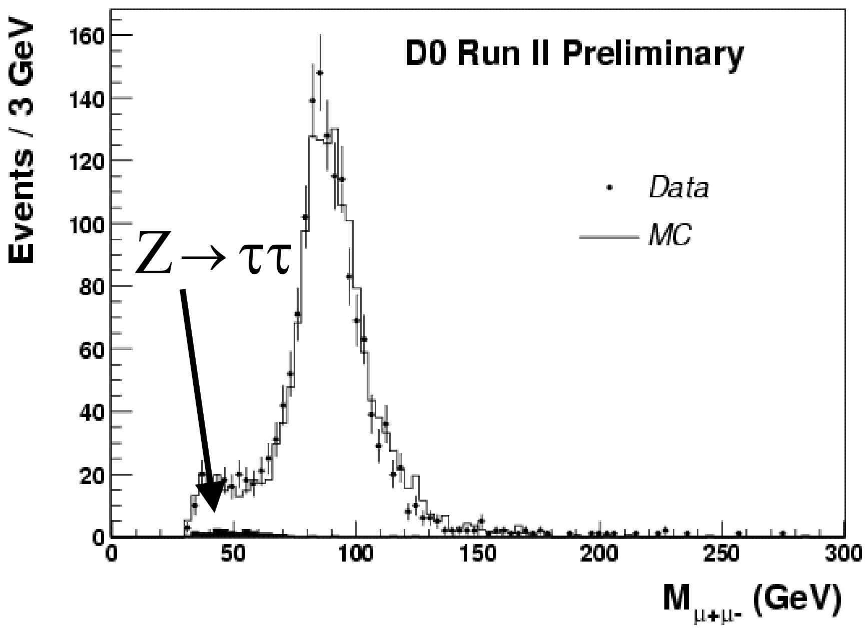
- **data sample: 31.8 pb^{-1}**
- **selection**
  - $|\eta^{\mu}| < 1.8$
  - pair of oppositely charged muons
    - **$P_T > 15$ GeV**
    - $\sqrt{\Delta\eta^2 + \Delta\phi^2} > 2.0$
    - **require one be isolated in calorimeter AND tracker**
    - **timing cut to remove cosmics**
  - di-muon trigger
    - **efficiency calculated from data**
- **1585 events pass cuts**





Dimuon Backgrounds





- **cosmics negligible**
- **heavy flavor ($b\bar{b}$)**
  - compare dimuon events
    - **two isolated muons**
    - **one isolated muon**
  - two samples agree well
    - **< 1% non-isolated muons**
    - **1% +/- 1% BG**
- **$Z \rightarrow \tau\tau \rightarrow \mu\mu$**
- **Drell-Yan**
  - Pythia plus fast detector simulation
    - **Z and Z/γ***
    - **muon resolution tuned to data**
    - **correction factor = $N_Z/N_{Z,\gamma}$**

Measured σ*BR($Z \to \mu\mu$)

- **calculation of efficiency**

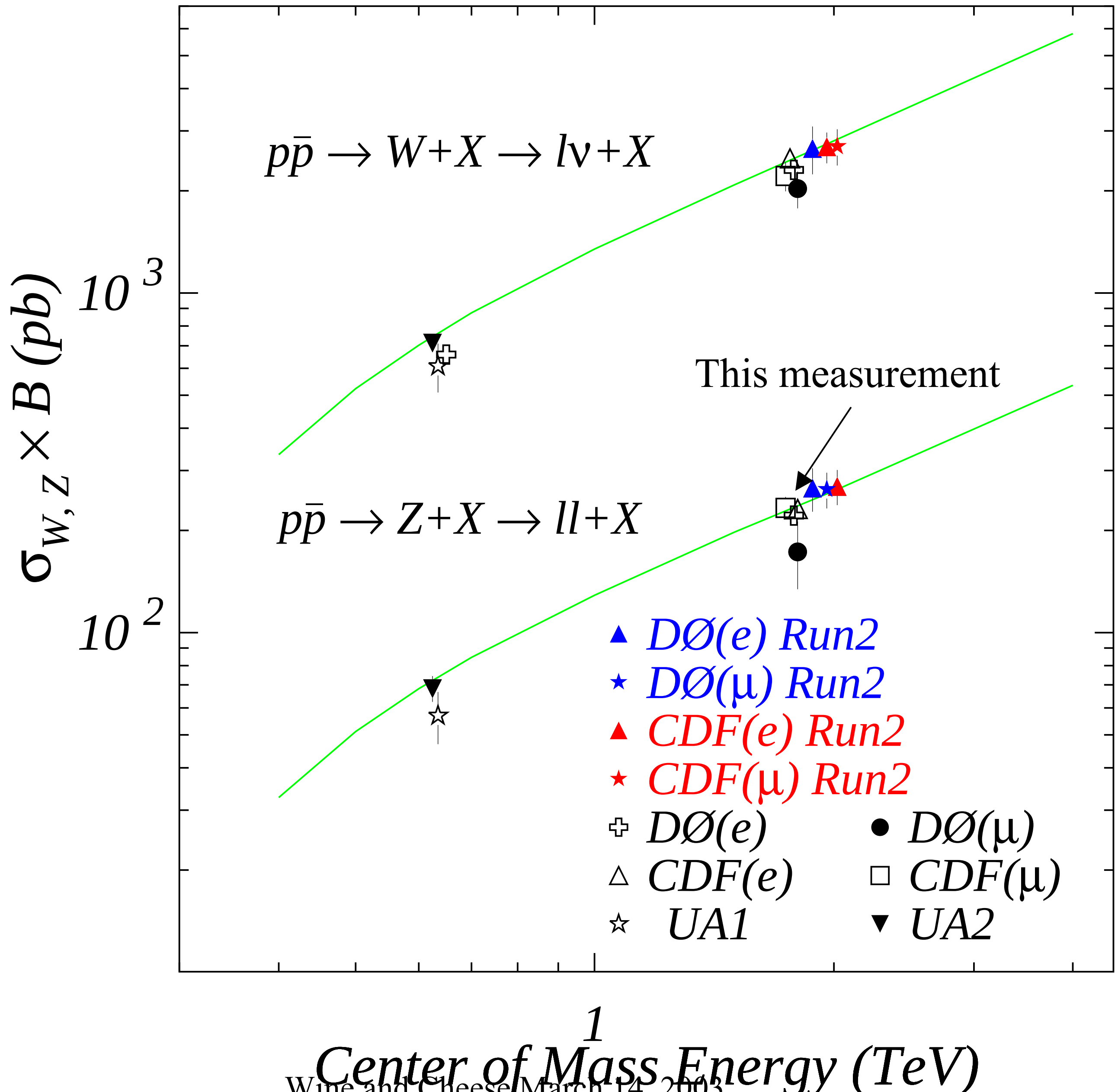
$$\varepsilon_z = \varepsilon_{mc} \times \varepsilon_{L1}^2 \times \varepsilon_{loose}^2 \times \varepsilon_{track}^2 \times \varepsilon_{fz} \times (2\varepsilon_{L2}-\varepsilon_{L2}^2) \times \varepsilon_{opposite\_q} \times \varepsilon_{isol} \times \varepsilon_{cosmic}$$

	effic.	error
– Monte Carlo (acceptance)	**0.403**	**0.012**
– Level 1 muon	**0.912**	**0.017**
– loose muon identification	**0.909**	**0.01**
– track efficiency	**0.822**	**0.014**

σ*Br = 263.8 ± 6.6 (stat) ± 17.3 (sys) ± 26.4 (lum) pb

First measurement at $\sqrt{s} = 1.96$ TeV

DØ and CDF Run2 Preliminary



Higgs

- Study of the W/Z(→lepton) + jets production
  - First step towards W/Z (→leptons) +H (→ $b\bar{b}$) measurement
  - The W/Z + b-jets distributions related to W/Z+ jets distributions
  - Try to understand major background source from W/Z + di-jets
- Search for $H \to WW^{(*)}$ ($\to ee\nu\nu/\mu\mu\nu\nu/e\mu\nu\nu$) decays

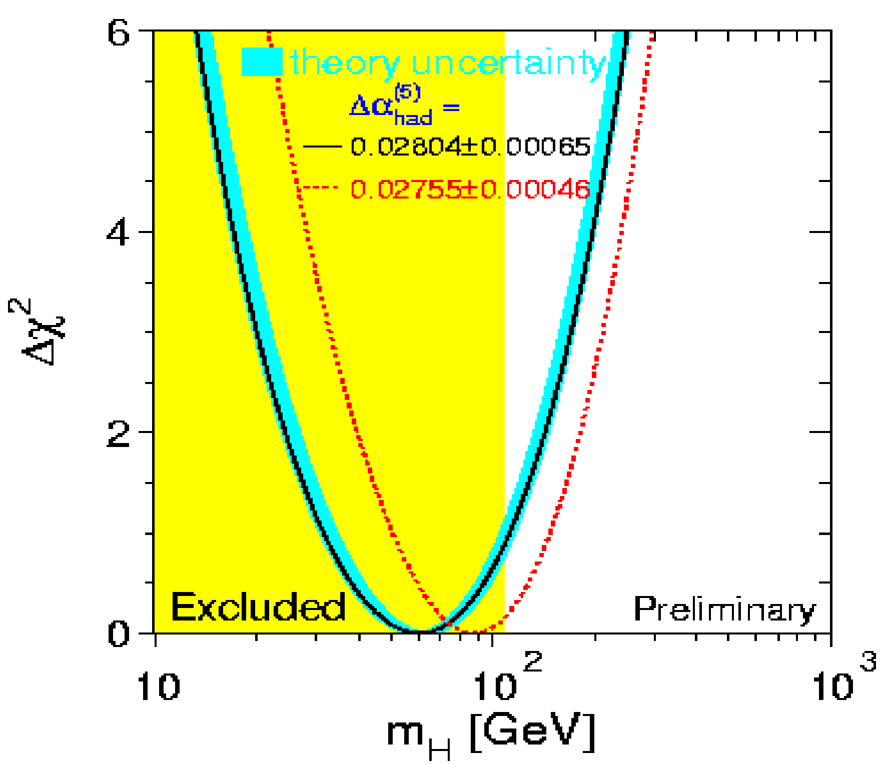
Others

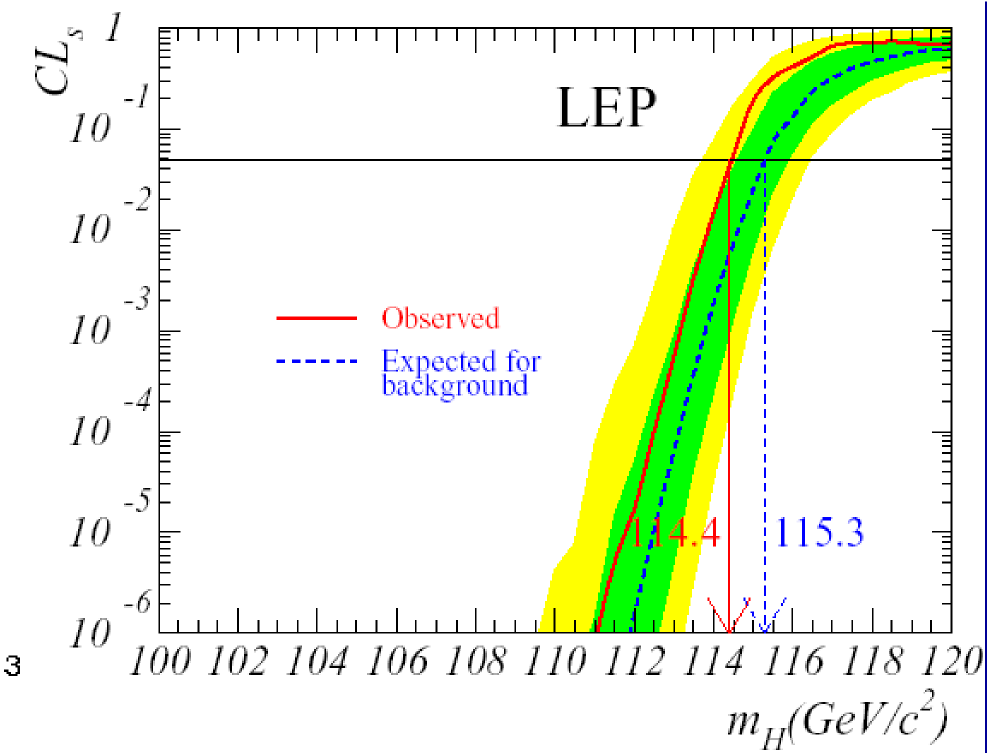
- Search for $H \to \gamma\gamma$ decays
- $WH(\to l^{\pm}\nu + b\bar{b})$
- $ZH(\to l^{+}l^{-}$ or $\nu\nu + b\bar{b})$
- ϕbb ($\to$ 4 b jets) (ϕ = h,H,A ; SUSY Higgs)

Higgs Mass Limits

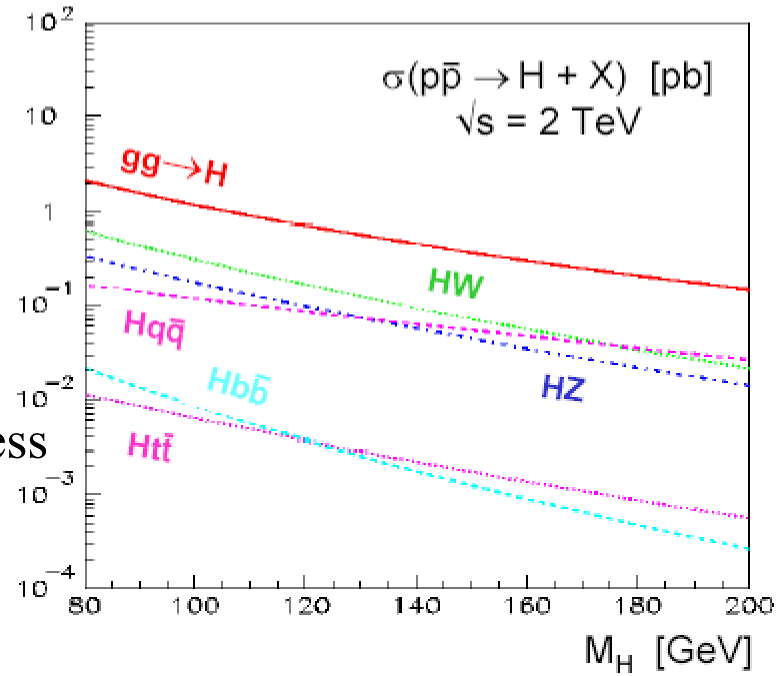
Indirect limit from global SM fit
M_H< 195 GeV at 95% CL

Direct SM Higgs search of LEP
M_H>114.4 GeV at 95% CL

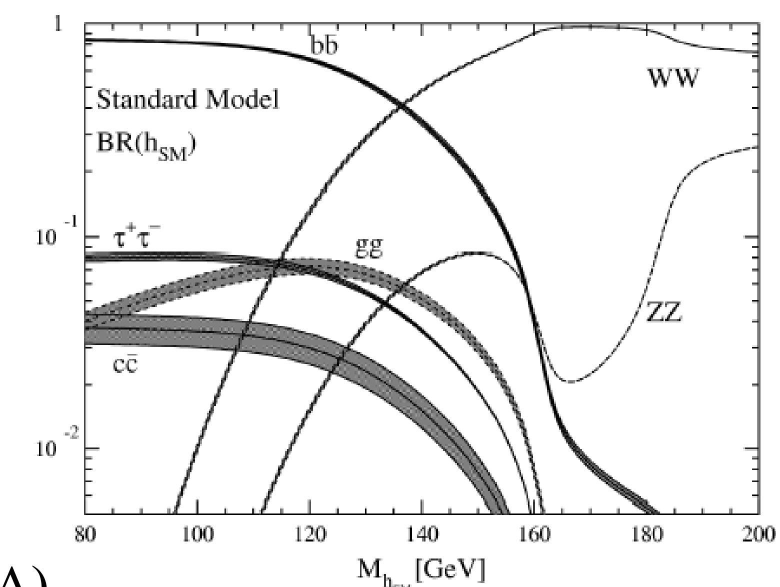




- $gg \rightarrow H$ … $\sigma(gg \rightarrow H) \sim 1$pb
  - For masses below ~140GeV,
  - ✗ Background hides $H \rightarrow b\bar{b}$ signals
  - For higher masses; $m_H >$ ~120GeV,
  - ○ Combination with $H \rightarrow WW^{(*)}$ decay process can be useful



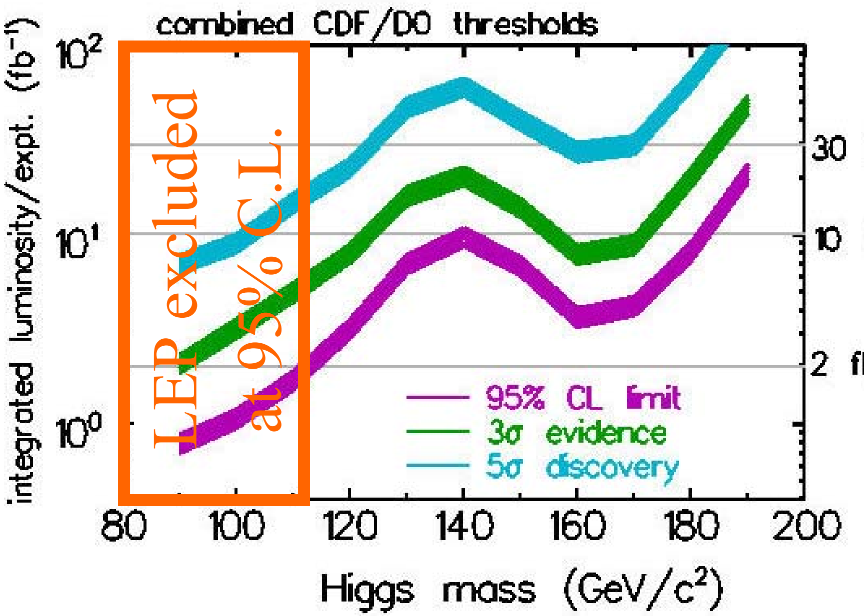
- HW, HZ … $\sigma(HW/HZ) \sim 0.1$pb
  - ○ Leptonic decays of W/Z help background rejection



- Hqq … $\sigma(Hqq) \sim 0.1$ pb
  - ✗ Backgrounds too large
- Hbb … $\sigma(Hbb) \sim 5$fb
  - ○ SM extensions may enhance ϕbb (ϕ =h,H,A)

Tevatron Higgs Working Group Study

- **The Higgs discovery potential for the RunII Tevatron has been evaluated.**
  - hep-ph/0010338
- **A joint effort of theorists and both experimental groups, CDF and DØ.**
- **Simulation performed using a parameterized fast detector simulation.**
- **Main conclusion :**
  - **Discovery at 3-5 σ can be made,**
    - **Combine all channels.**
    - **Combine the data from both experiments, CDF and DØ**
  - **Must improve understanding of signal and background cross sections, kinematics and detector performance.**
    - **b-tagging, resolution of M_{bb}**
  - **Advanced analysis techniques are vital**



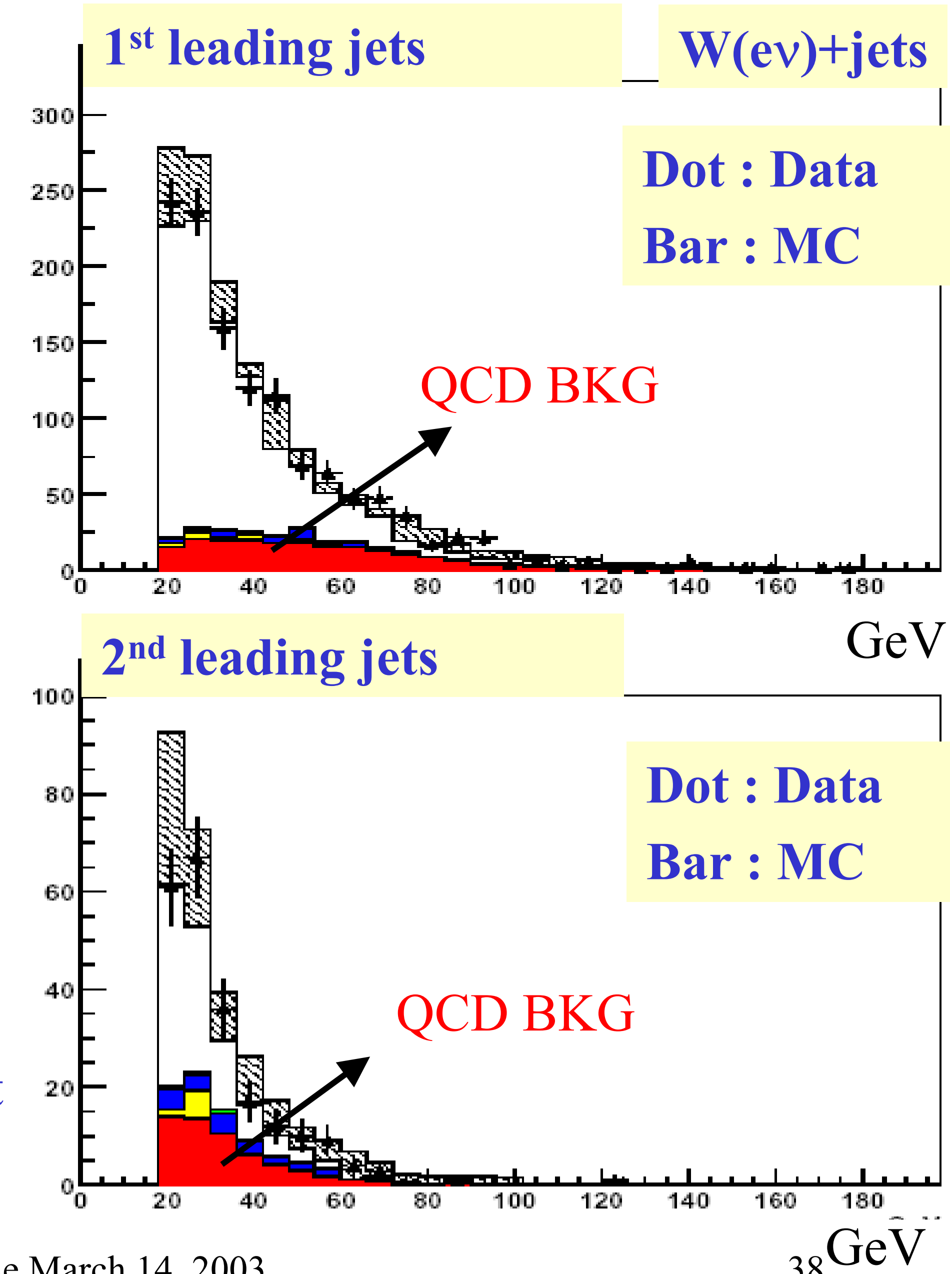
- **Results of studies with full simulations for selected signal process are consistent with SHWG expectations.**

W/Z + jets production

- First step towards W/Z ($\rightarrow$leptons) +H ($\rightarrow b\bar{b}$) measurement.
- W/Z + b-jets distributions related to W/Z + jets distributions well.
- Try to understand major background source from W/Z + di-jets.
- Analysis utilized ~35 pb^{-1}
- Data samples triggered by lepton
  - No bias for jets distribution.
- Basic Selection:
  - Isolated lepton with large missing E_T (for W)
  - 2 high p_T leptons and m_{ll} consistent with m_z
  - Look at high p_T jets

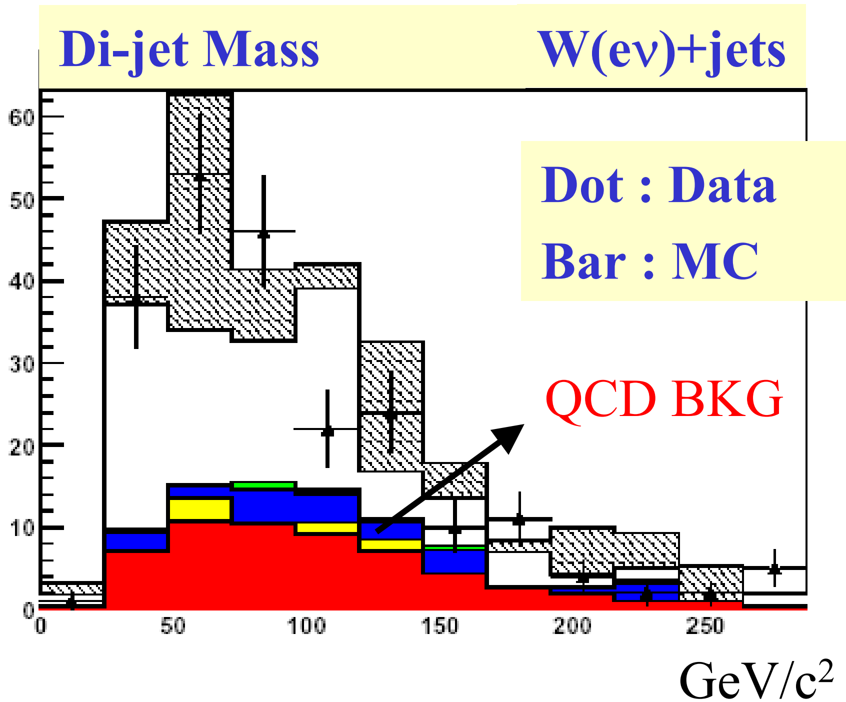
W+jets production

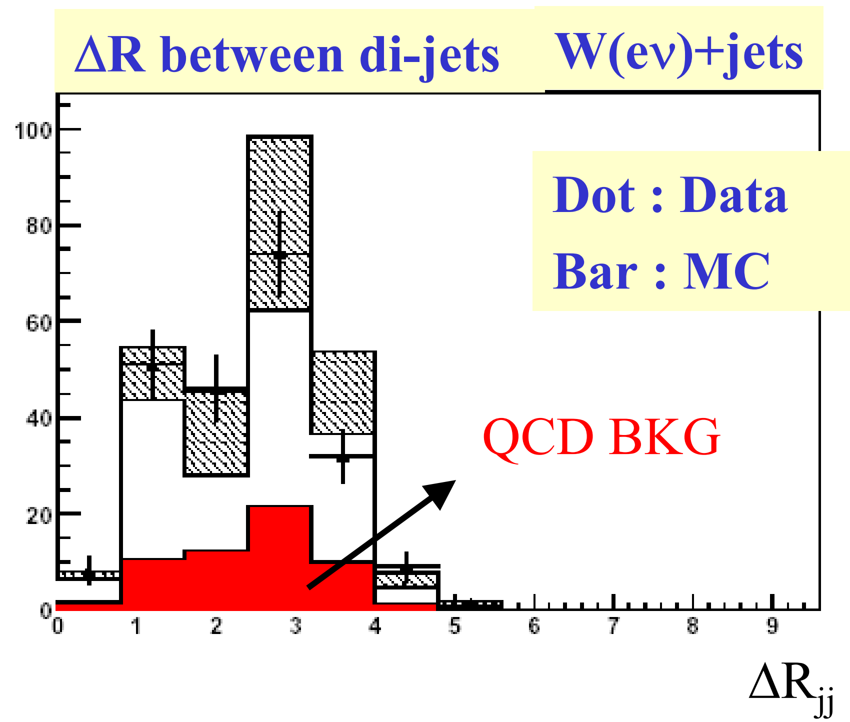
- Selection
  - **W(eν)**
    - **Isolated e : p_T > 20 GeV**
    - **$|\eta| < 0.8$**
    - **Missing E_T > 25 GeV**
  - **W(μν)**
    - **Isolated μ : p_T > 25 GeV**
    - **$|\eta| < 1.5$**
    - **missing E_T> 20 GeV**
  - **Jets**
    - **p_T > 20 GeV**
    - **$|\eta| < 2.5$**
- Compare PYTHIA with DATA
- Normalized by area
- Error includes stat. error and dominant sys. error from JES



W+jets production (2)

- Reconstructed di-jet mass and $\Delta R(= \sqrt{\Delta\phi^2 + \Delta\eta^2})$ between di-jet
  - MC represents jet distributions well
  - First step towards study of $Z(\rightarrow \text{leptons})H(\rightarrow b\bar{b})$ decay process



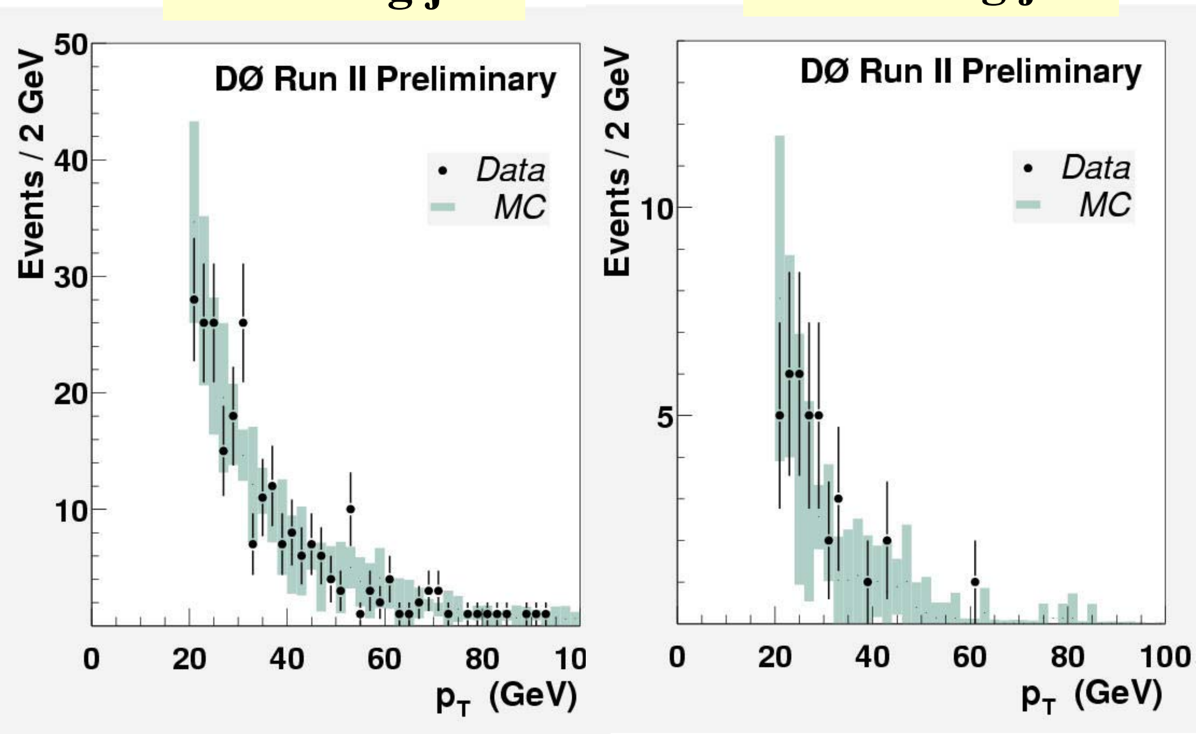


Z+jets production

- Selections
  - 2 electrons from Z(ee)
    - $p_T > 20$ GeV
    - $|\eta| < 2.3$
  - 2 muons from Z(μμ)
    - $p_T > 15$ GeV
    - $|\eta| < 2$
  - Jets
    - $p_T > 20$ GeV
    - $|\eta| < 2.5$
- Compared PYTHIA with DATA
- Normalized by area
- Error includes stat. error and dominant sys. error from JES

1st leading jets

2nd leading jets

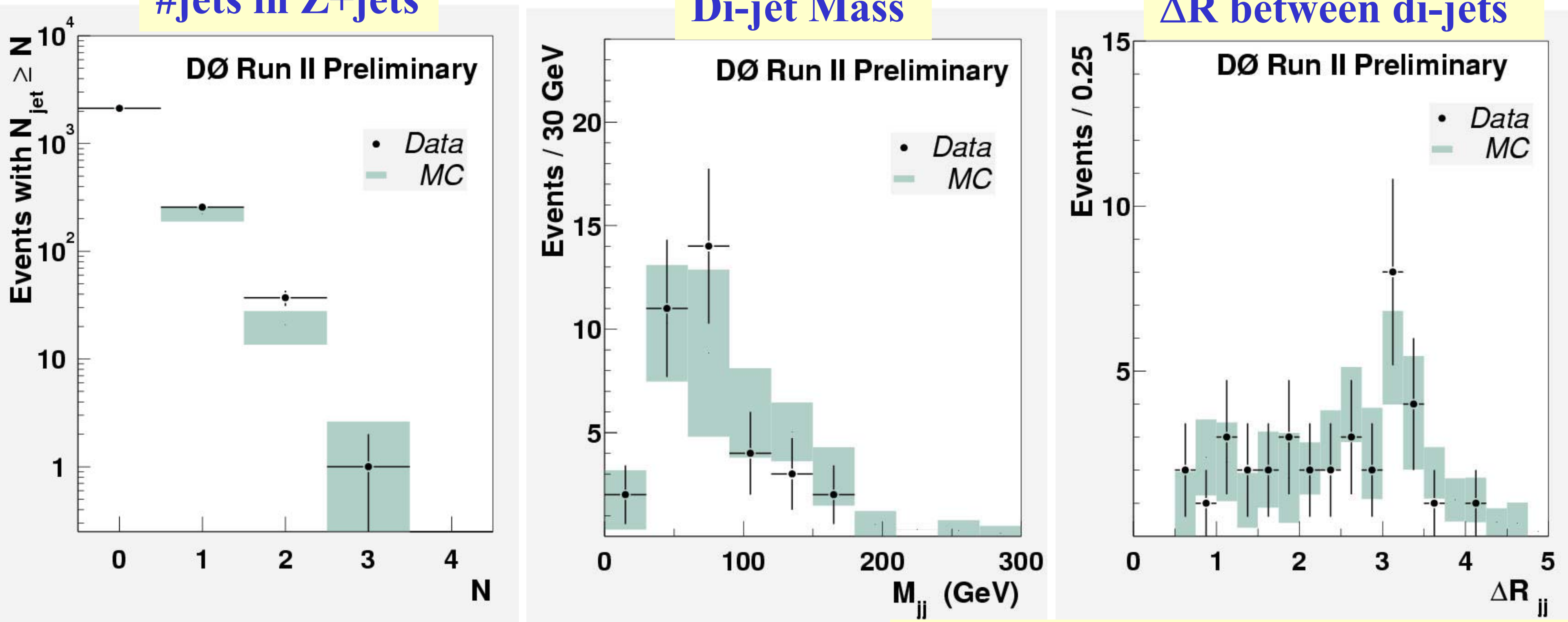


Combined Z(ee)+jets and Z(μμ)+jets

Z+jets production (2)

- Number of jets in Z + jets production
- Reconstructed di-jet mass and $\Delta R (= \sqrt{\Delta\phi^2 + \Delta\eta^2})$ between di-jet
  - MC represents jet distributions well
  - First step towards study of Z(→leptons)H(→ $b\bar{b}$) decay process

#jets in Z+jets **Di-jet Mass** **ΔR between di-jets**

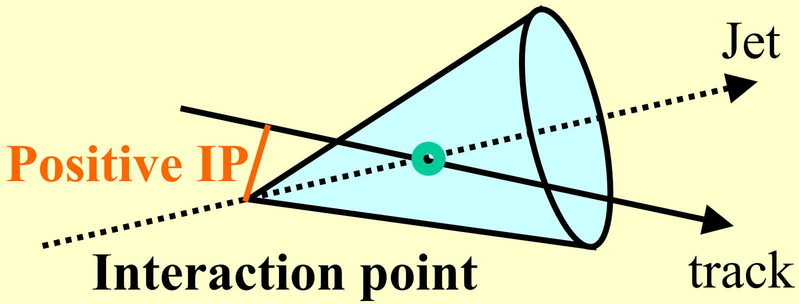


Combined Z(ee)+jets and Z(μμ)+jets

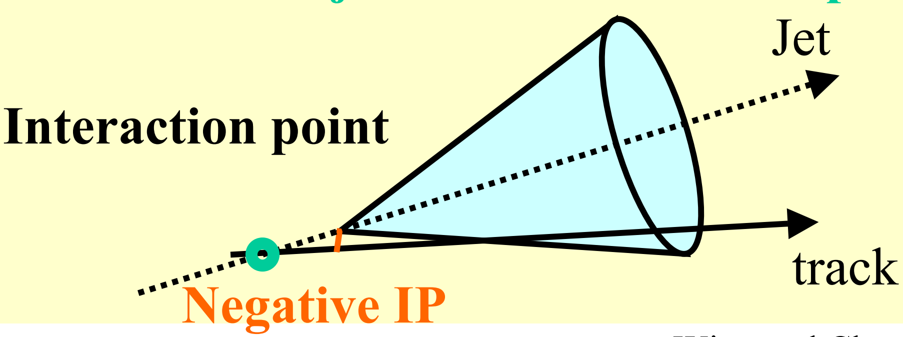
b-tagging

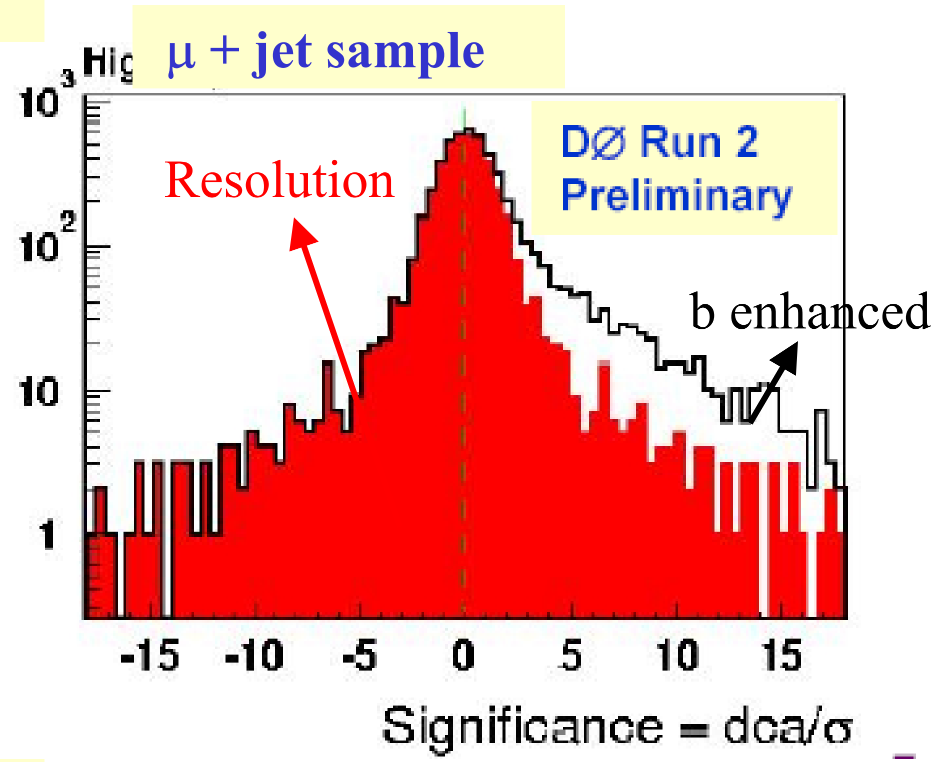
- Next step towards study of W/Z + H(→$b\bar{b}$) production is b-jet reconstruction
- b tagging is performed using secondary vertex reconstruction
- Lepton from semileptonic decay of b is very useful

• Impact Parameter > 0
→ track cross jet axis after closest point



• Impact Parameter < 0
→ track cross jet axis before closest point





$H \rightarrow WW^{(*)} \rightarrow l^+l^-\nu\bar{\nu}$

- Lot of interesting physics in WW production
  - SM Higgs at high mass region
  - 4th fermion family enhances SM Higgs cross section (factor ~8.5 for m_H=100 - 200GeV)
  - Fermiophobic/Topcolor Higgs (Br(H $\rightarrow$WW)>98% for m_H > 100GeV)
  - Non Higgs-related … Tri-linear couplings, New Phenomena
- Look at ee/eμ/μμ plus missing E_T events
- Cannot directly reconstruct mass
  - Transverse mass computed by the m_{ll} and missing E_T
- Opening angle between leptons ($\Delta\Phi_{ll}$) is useful discriminating variable
  - Two leptons tend to move in parallel ($\rightarrow$ $\Delta\Phi_{ll}$ is small) , due to spin correlation of Higgs boson decay products.
  - Leptons from Z/γ^* , multijets are emitted back to back, large $\Delta\Phi_{ll}$
- Backgrounds include Z/γ^*, WW, tt, W/Z+jets, QCD

Results of $H \rightarrow WW^{(*)} \rightarrow e^+e^-\nu\nu$

$L=44.5\ pb^{-1}$
Selection optimized
$m_H = 120$ GeV

	Expected background	DATA
Lepton ID, p_T>20 GeV/c	$2748 \pm 42 \pm 245$	2753
$m_{ee} < m_H/2$	$264 \pm 18.6 \pm 4.3$	262
$\not{E}_T > 20$ GeV/c^2	$12.3 \pm 2.5 \pm 0.7$	11
Transverse mass	$3.6 \pm 1.4 \pm 0.2$	1
$\Delta\Phi_{ee} < 2.0$	$0.7 \pm 1.4 \pm 0.1$	0

$\varepsilon_{sig} = \sim 8\%$

Results of $H \rightarrow WW^{(*)} \rightarrow e\mu\nu\nu$

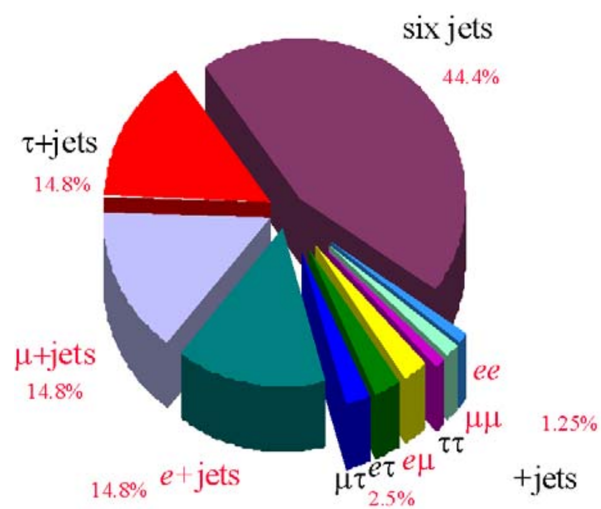
$L=34\ pb^{-1}$
Selection optimized
$m_H = 160$ GeV

	Expected background	DATA
Lepton ID, p_T>20 GeV/c	$22 \pm 2.1 \pm 2.2$	22
$\not{E}_T > 20$ GeV/c^2	$3.1 \pm 1.7 \pm 0.1$	4
Anti W	$1.4 \pm 1.5 \pm 0.1$	2
$\Delta\Phi_{e\mu} < 2.0$	$0.9 \pm 1.5 \pm 0.1$	1

$\varepsilon_{sig} = \sim 12\%$

Top

- Improved measurement of the top mass with Run I data
- First measurement of $t\bar{t}$ cross section at $\sqrt{s}$ = 1.96 TeV
- Cross section at Run II ~ 30% higher than at Run I.
  - Predictions between 6.7 – 7.5 pb
- 6 Analysis channels
  - μμ
  - eμ
  - e + jets
  - μ + jets
  - e + jets (soft muon tag)
  - μ + jets (soft muon tag)



Status of the Top Mass Measurement in the Lepton+Jets Channels at Run I

Likelihood method using most available information

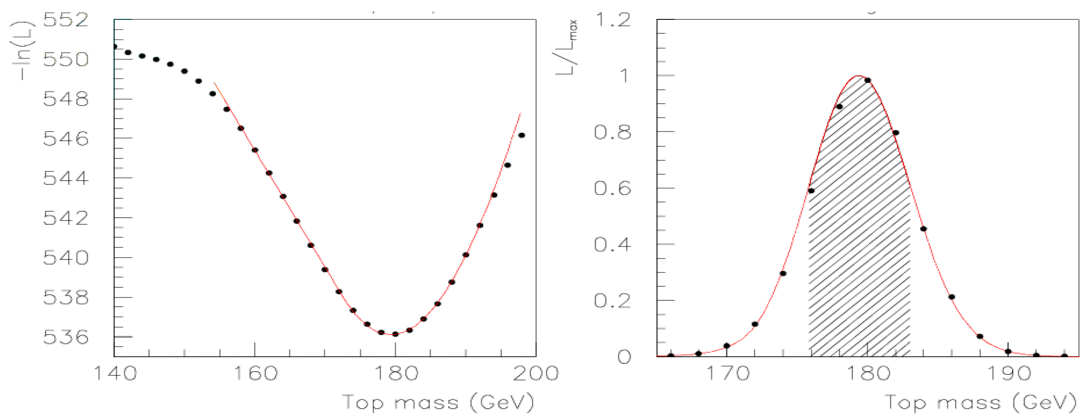
Uses DØ Run I statistics (125 pb^{-1}) & selection → 91 events

Additional cuts for this analysis:

4 Jets exclusively: 71 events

P_b: 22 events (pure sample)

$$-\ln L(\alpha) = -\sum_{i=1}^{N}\left\{\ln\left[c_1 P_{t\bar{t}}(x_i;\alpha) + c_2 P_{bkg}(x_i)\right]\right\} + N\int A(x)\left[c_1 P_{t\bar{t}}(x;\alpha) + c_2 P_{bkg}(x)\right]dx$$



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

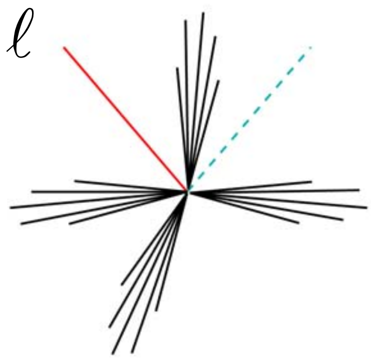
(5.6 GeV from PRD 58 052001,1998)

Large improvement on the statistical uncertainty (~2.4× stats)

Details to be presented at an upcoming Wine and Cheese seminar

Analysis Channels

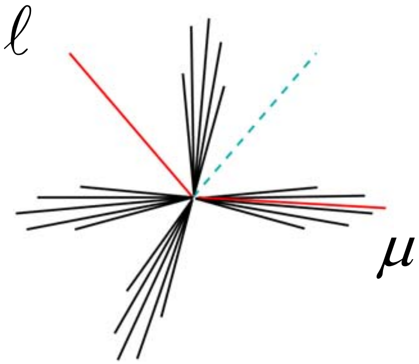
Lepton+jets
(topological)



e+jets, μ+jets

Efficient
Not very pure

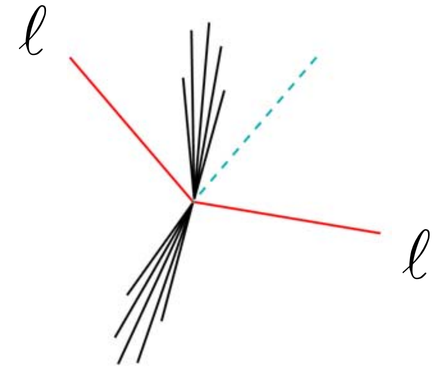
Lepton+jets
(soft muon tag)



e+jets/μ, μ+jets/μ

Pure
Not very efficient

dileptons



eμ and μμ

Pure and efficient
Low branching

Data Sample

Data mid-August to mid-January Luminosity 30-50 pb^{-1}

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 (ϕ, η and E/p)

Muons:

- Tracks in muon system
- Tracks in central tracker
- Minimum ionization in calorimeter (Used only to measure ε)

Missing ET

- From calorimeter with JES corrections and muon correction

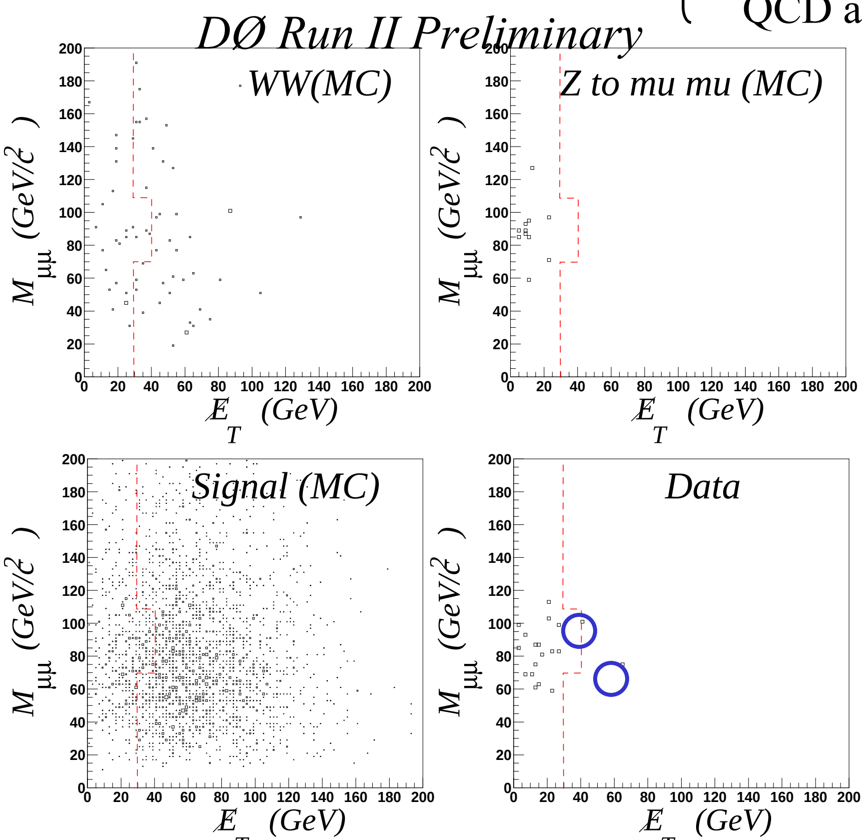
Dimuon Channel

Selection: 2 isolated muons, MET($M_{\mu\mu}$), H_T and 2 or more jets

Backgrounds:

Estimated from data { $Z \to \mu\mu$, $DY \to \mu\mu$, QCD and W+jets }

from MC { $Z \to \tau\tau$, $WW \to \mu\mu$ }



$L = 42.6\ pb^{-1}$

$Z \to \mu\mu$	0.20±0.11
$DY \to \mu\mu$	0.20±0.20
Fakes	0.18±0.18
$Z \to \tau\tau$	0.02±0.02
WW	0.00±0.00
Background	0.60±0.30
Signal*	0.3±0.04
Data	2

* *For* $\sigma = 7pb$

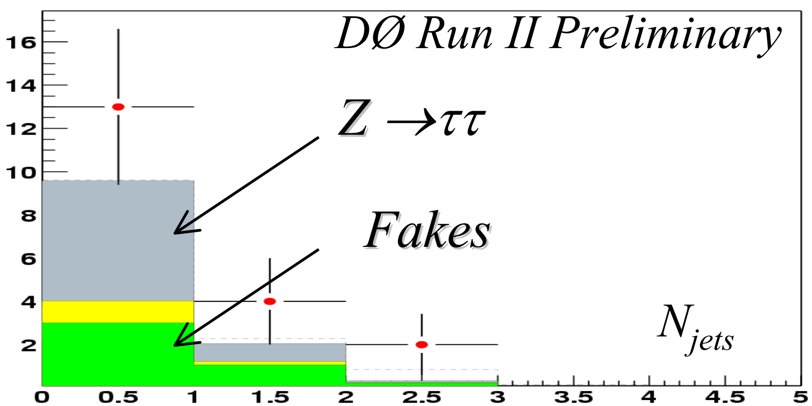
$e\mu$ Channel

Selection criteria: *1 electron, 1 isolated muon, MET, MET_{CAL}, H_T (e) and 2 or more Jets*

Backgrounds:

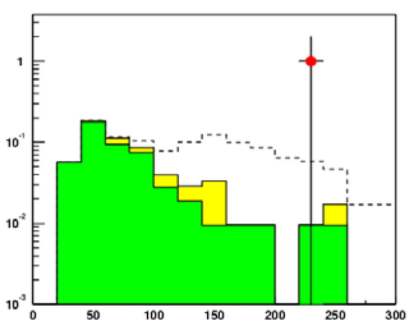
QCD and W+jets
Estimated from data
(Fakes)

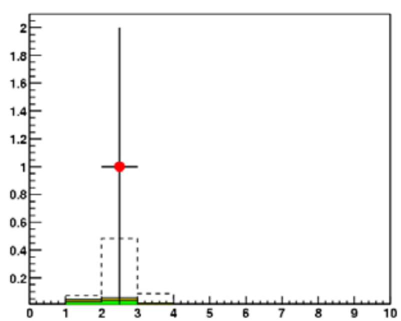
from MC: $Z \rightarrow \tau\tau$, $WW \rightarrow e\mu$



33.0 pb^-1

Fakes	0.05±0.01
$Z \rightarrow \tau\tau$	0.02±0.01
WW	0.00±0.00
Bkg	0.07±0.01
Signal*	0.5±0.01
Data	1





Br: $H_T(e)$ (GeV) N_{jets}

* *For σ = 7pb*

Lepton-plus-Jets Analyses

- Luminosities: e+jets *49.5 pb^{-1}* and μ+jets *40.0 pb^{-1}*
- Backgrounds: QCD multi-jets and W multi-jets
- Method:
  - *- Preselect a sample enriched in W events*
  - *- Evaluate QCD multi-jet (as a function of N_{jets})*
  - *- Estimate W+4jets assuming Berends scaling*
  - *- Apply topological selection*
- Preselection: *1 EM object or muon, MET, soft muon veto*
- QCD background evaluation (matrix method):

Separate W+tt and QCD with loose (L) and tight (T) lepton characteristics. Efficiencies (L→T) for signal ε_{W+tt} and background ε_{QCD} are measured independently:

"Matrix method"
- *e+jets: Track match to the EM object*
- *μ+jets: Muon isolation*

⇒

$$N_L = \tilde{N}_{W+t\bar{t}} + \tilde{N}_{QCD}$$

$$N_T = \varepsilon_{W+t\bar{t}} \tilde{N}_{W+t\bar{t}} + \varepsilon_{QCD} \tilde{N}_{QCD}$$

$$\begin{cases} \tilde{N}_{W+tt} = \varepsilon_{W+tt} \dfrac{N_T - \varepsilon_{QCD} N_L}{\varepsilon_{W+tt} - \varepsilon_{QCD}} \\ \tilde{N}_{QCD} = \varepsilon_{QCD} \dfrac{\varepsilon_{QCD} N_L - N_T}{\varepsilon_{W+tt} - \varepsilon_{QCD}} \end{cases}$$

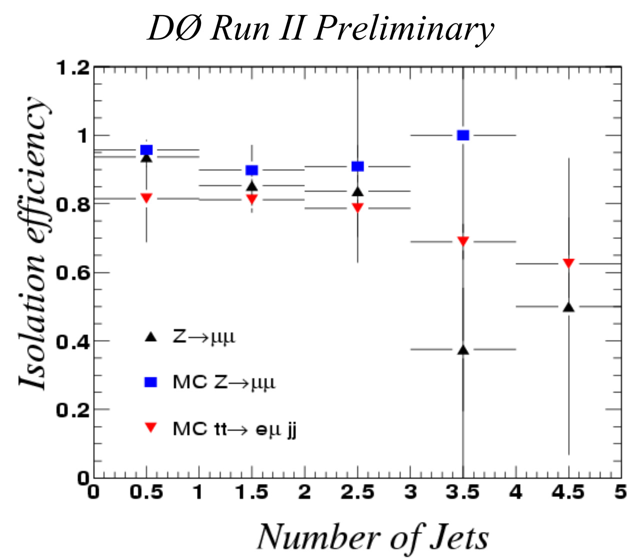
- Signal probabilities:

obtained from benchmark signal samples of $Z \rightarrow ee$ or $\mu\mu$

Non trivial dependence of ε_{W+tt} w.r.t. N_{jets} (especially in the μ+jets case)…

$\Rightarrow$ *Correction taken from MC*

ε_{W+tt} *vs* N_{jets}



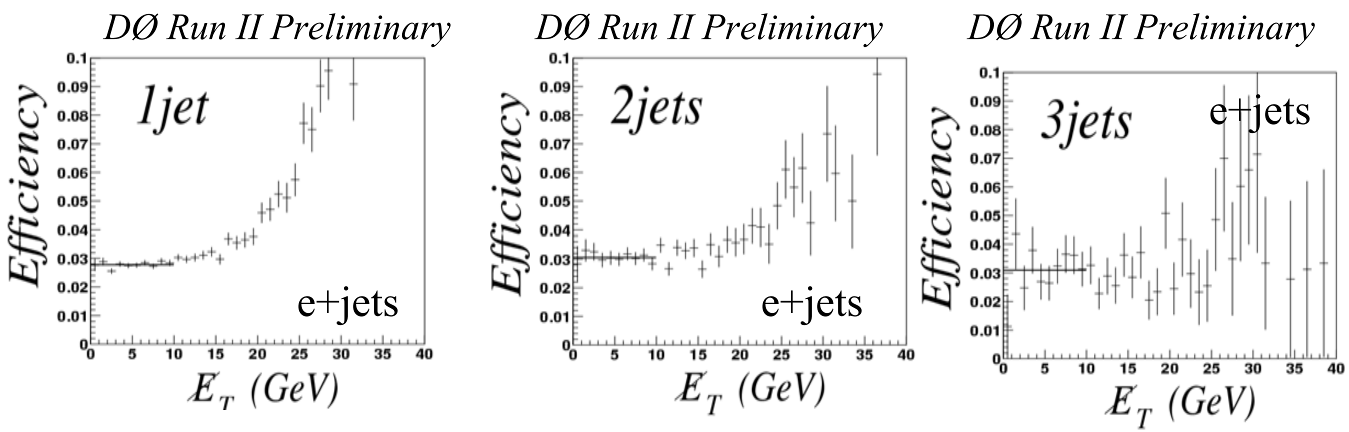
- Background nature:

μ+jets	*QCD Background essentially due to Heavy Flavor semi-leptonic decays*
e+jets	*QCD Background due to leading π^0 or compton QCD events and Fake track or γ conversion*

- Background Probabilities:

… are obtained from benchmark QCD samples with low MET

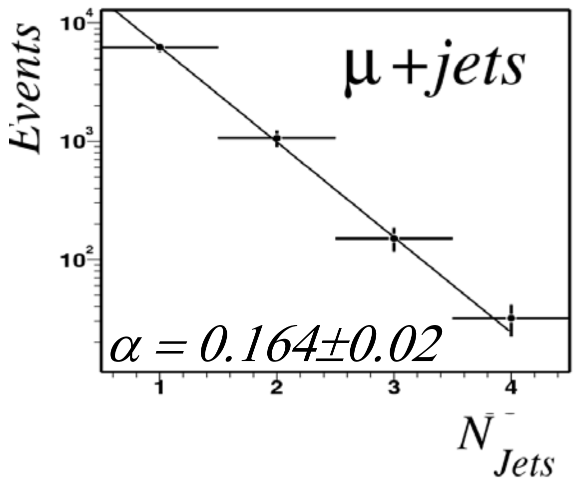
Dependence of the ε_{QCD} w.r.t. MET and N_{jet} …



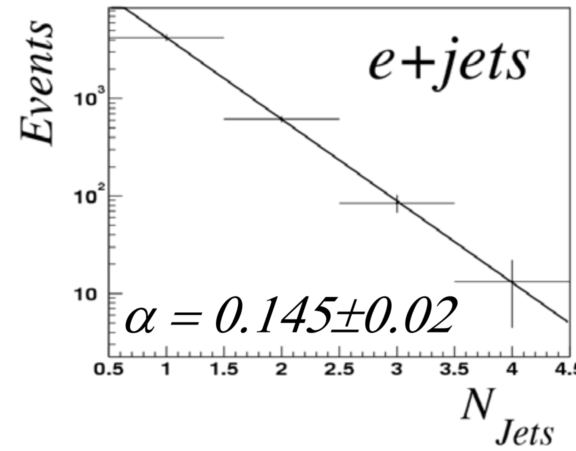
Berends scaling:

$$\alpha \equiv \frac{\sigma(W+(n+1)_{jets})}{\sigma(W+n_{jets})}$$

DØ Run II Preliminary



DØ Run II Preliminary



Estimation of the W background for $N_{jets} \geq 4$:

$$\tilde{N}_W^4 = \begin{cases} 24.2 \\ 11.9 \end{cases} \quad \tilde{N}_{QCD}^4 = \begin{cases} 11.9 \\ 12.5 \end{cases} \quad N_{obs}^4 = \begin{cases} 38 \ (\mu\text{+jets}) \\ 22 \ (e\text{+jets}) \end{cases}$$

Apply topological cuts: *Aplanarity and HT*

Analysis	N_W	N_{QCD}	Bkg. Tot.	Signal*	N_{obs}
e+jets	1.3±0.5	1.4±0.4	2.7±0.6	1.8	4
μ+jets	2.1±0.9	0.6±0.4	2.7±1.1	2.4	4

* *For σ = 7pb*

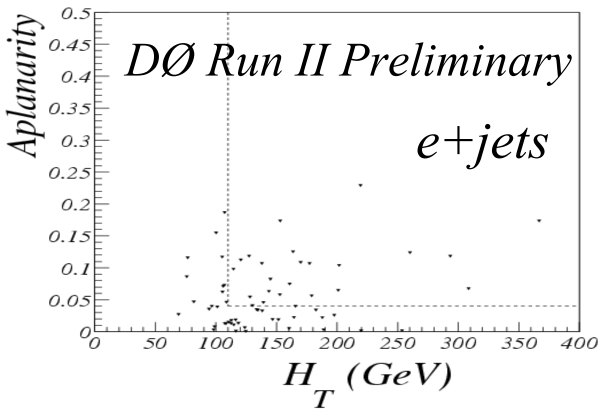
Soft Muon Tag Analyses

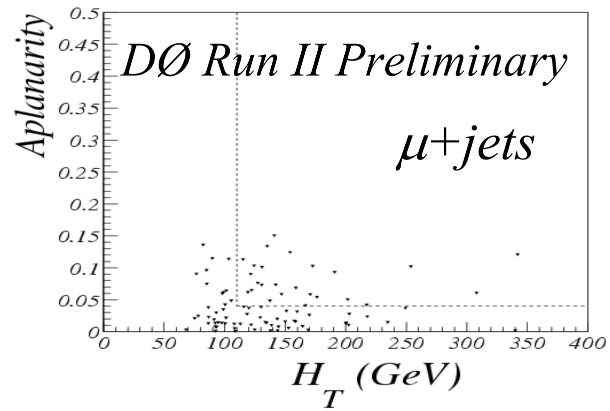
Selection before Soft Muon Tag

- *Use the same preselection as l+jets*
- *Require at least 3 jets*
- *Apply mild topological cuts*

(Loose/Tight sample)

$$\Rightarrow \begin{cases} 75/23 \quad (\mu\text{+jets}) \\ 459/27 \quad (e\text{+jets}) \end{cases}$$





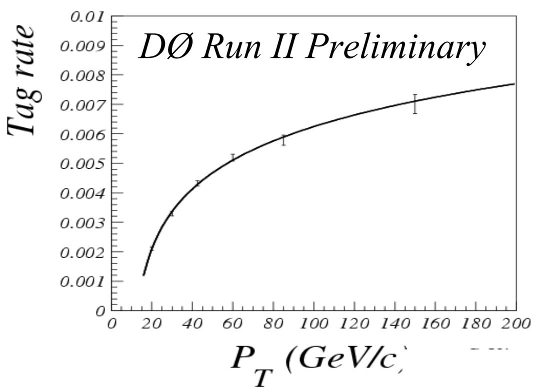
When SMT applied

$$\begin{cases} 1/0 \quad (\mu\text{+jets}) \\ 9/2 \quad (e\text{+jets}) \end{cases}$$

$$\tilde{N}^{SMT}_{QCD} = \begin{cases} 0.2 \pm 0.2 \ (\mu) \\ 0.2 \pm 0.1 \ (e) \end{cases}$$

W bkg. from Tag rate functions:

QCD background. from matrix method

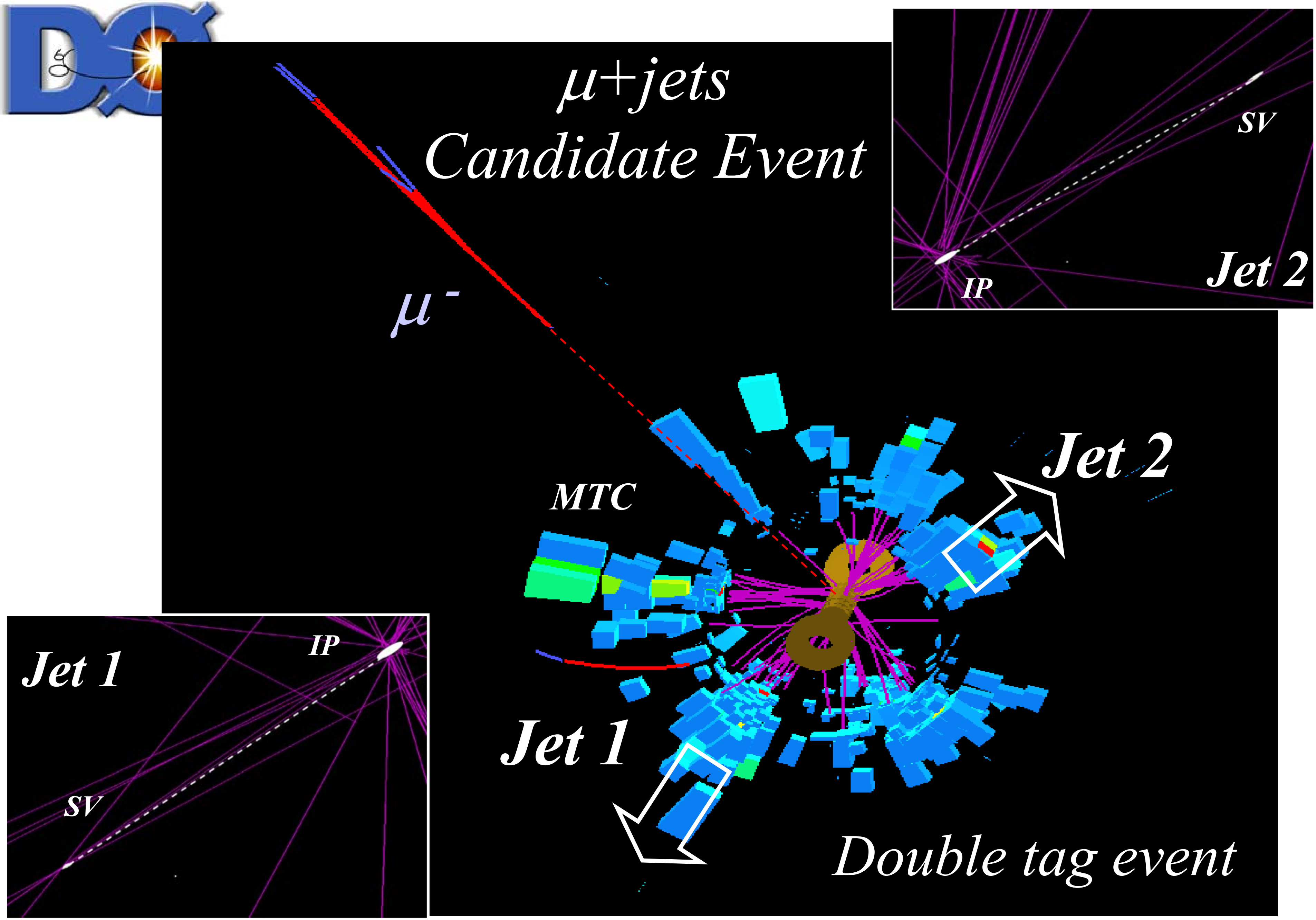


$$\tilde{N}^{SMT}_{W} = \begin{cases} 0.4 \pm 0.1 \ (\mu) \\ 0.0 \pm 0.1 \ (e) \end{cases}$$

Analysis	Bkg. Tot.	Sig.*	N_{obs}
e+jets	0.2±0.1	0.5	2
μ+jets	0.6±0.3	0.4	0

* *For σ = 7pb*

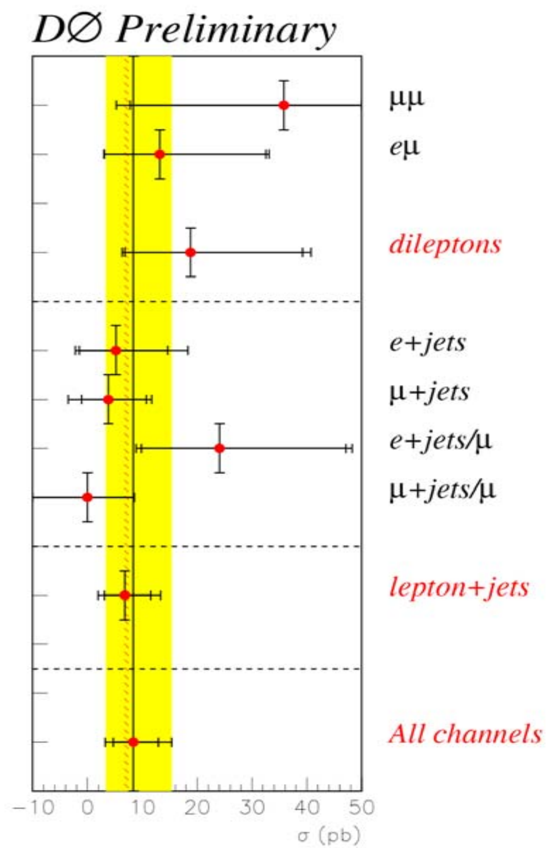
μ+jets Candidate Event



Double tag event

Cross Section Measurement

- Combining the observation of all channels an excess of 3σ is observed



Combined cross section:

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

Conclusions

- Many new analyses are producing interesting physics results
- DØ is already showing exciting measurements/ more to come soon
- Tevatron program is rich and promising-We are enthusiastic about the physics through the end of the decade