Recent Results on B Physics at DØ

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Dzero Collaboration

Les Rencontres de Physique De La Valle D'Aoste

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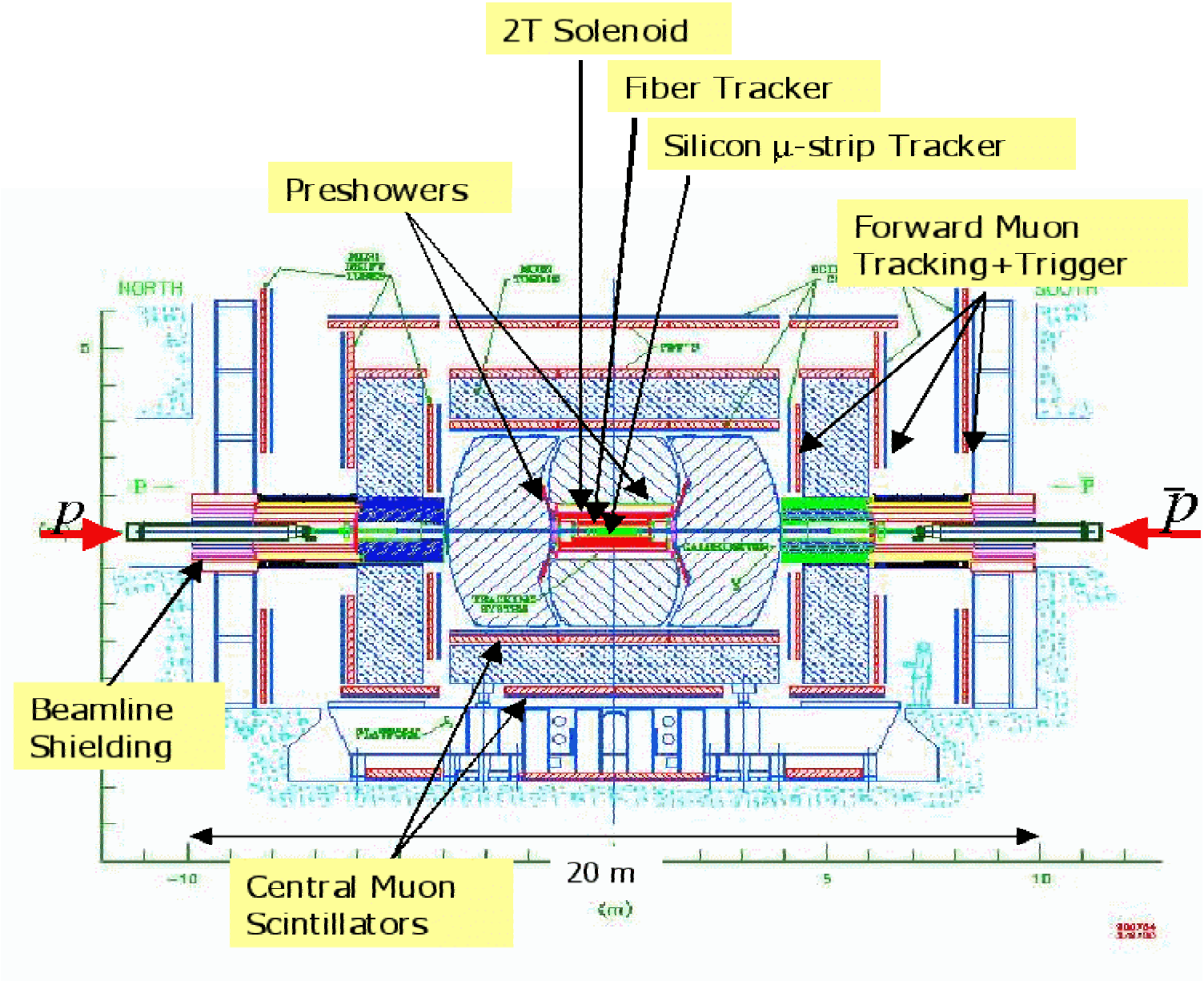
DØ B Physics Program

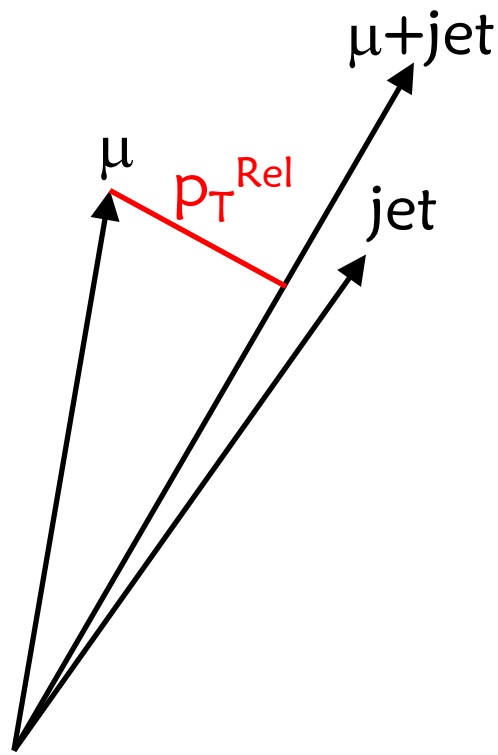
- B^0_s mixing: $B_s \rightarrow D_s$ l X, $B_s \rightarrow D_s(n\pi)$
- B Lifetimes
  - Average B lifetime: b $\rightarrow J/\psi X$
  - Λ_b lifetime: $\Lambda_b \rightarrow J/\psi \Lambda^0$
  - B^0_s lifetime and width: $B^0_s \rightarrow J/\psi\phi$
- CP violation in B^0_d & B^0_s
- Rare decays, cross sections
- Ingredients for a Time-dependent B Physics program
  - Reconstruct final states
  - Reconstruct proper time distribution
  - Tag the flavor of the b at production

The Run II DØ Detector



B jet Cross Section

Measured in Run1: 2-3 times higher than predictions



•Strategy:

Measure μ+jet cross-section
Extract b-content using P_T^{Rel}

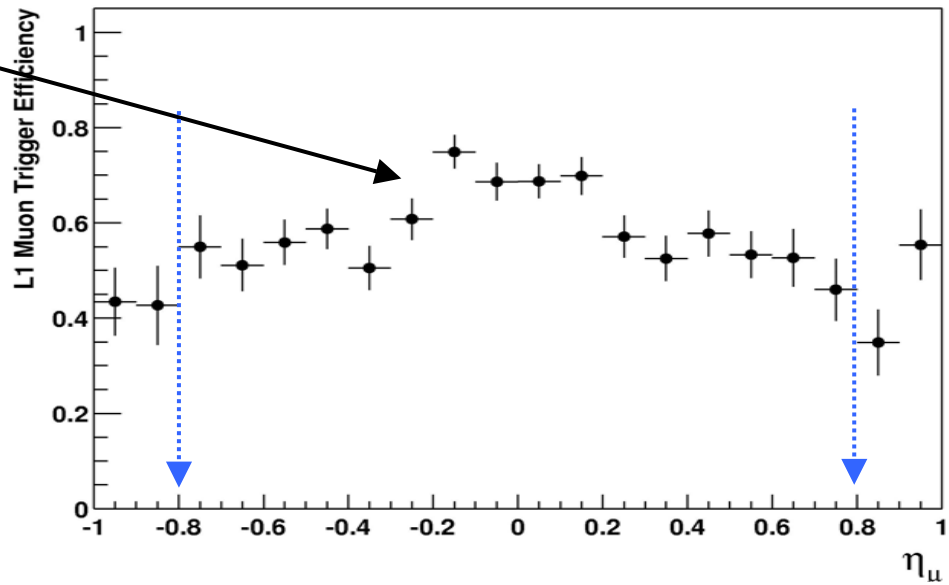
Data selection & kinematic cuts

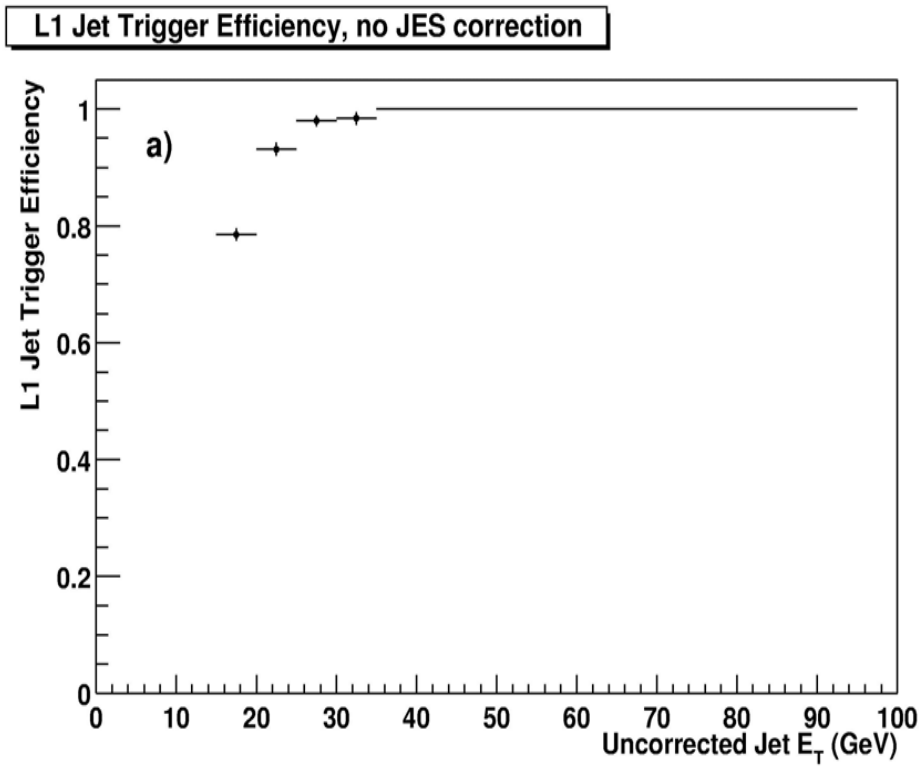
p_T^{μ} >6 GeV/c, $|\eta^{\mu}|$ <0.8 (Muon P_T measured in muon system only)
$|\eta^{jet}| < 0.6$, $E_t^{corr} > 20$ GeV
0.5 cone
$\delta R(jet,\mu) < 0.7$

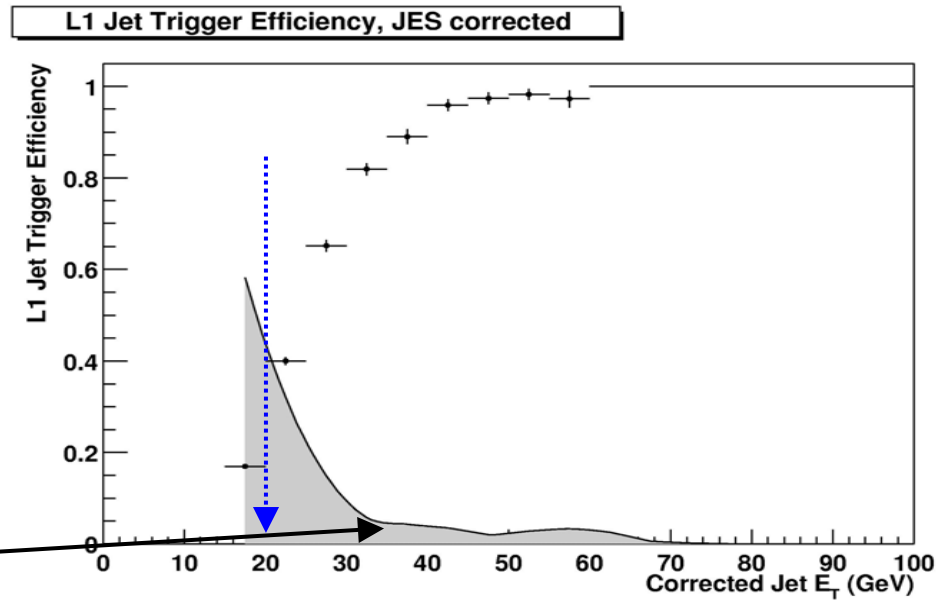
Muon + jet cross section

Lower in Jet E_T so need muon and jet trigger efficiencies

ε_{muon} =55-70%







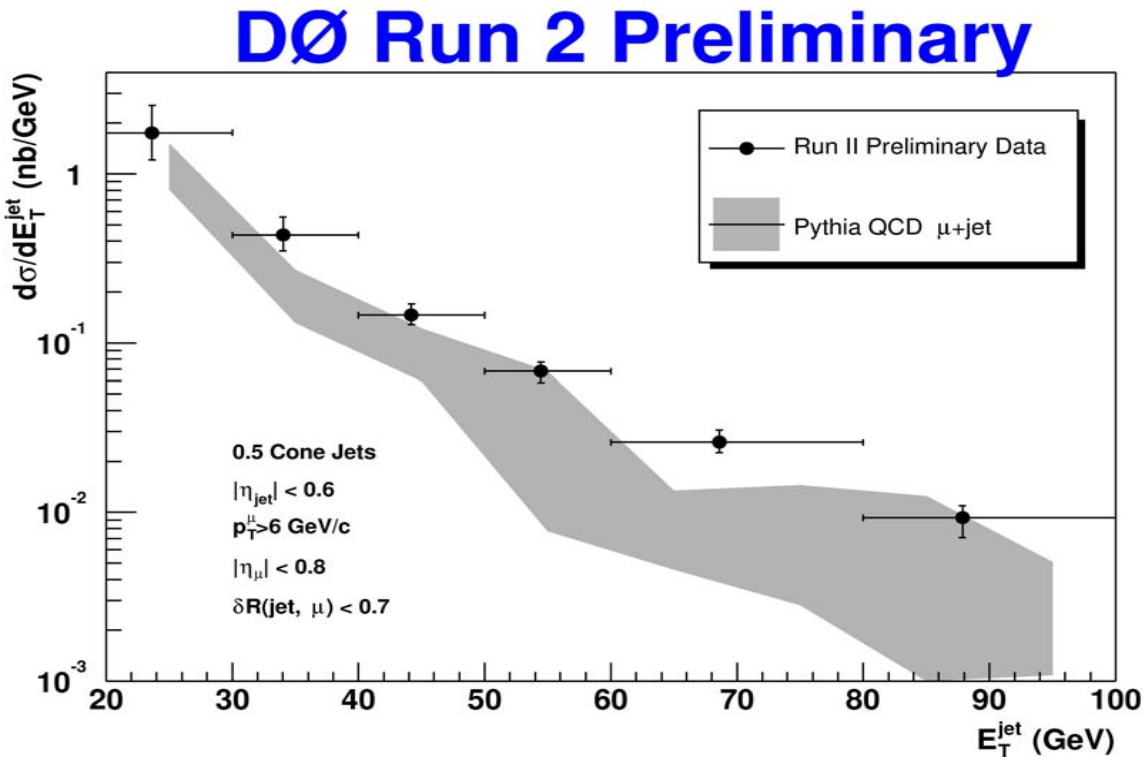
Error on Jet Energy scale

μ + jet cross section

Jet reco. Eff. 100% E > 20 GeV
μ reco. Eff. 43.7±0.8(stat)±2.2(sys)%

Jet resolution: dijet p_T imbalance
μ momentum resolution: from central tracks

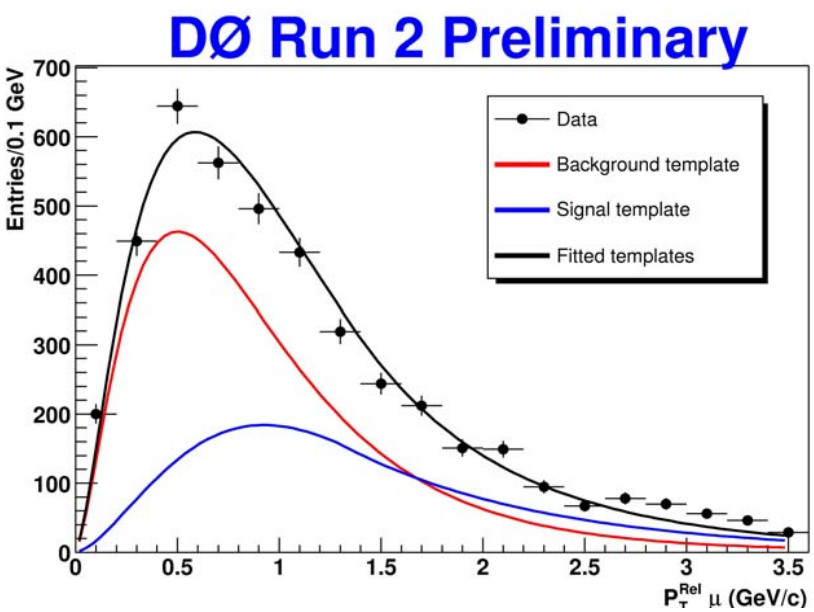
Jet quality cuts applied



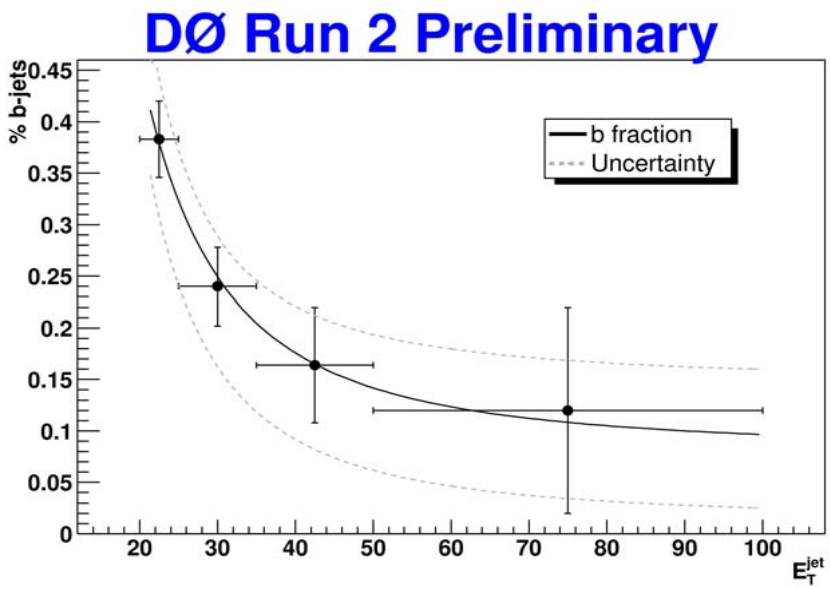
Data: 02/27/02 – 05/10/02
~ 3.4 pb^{-1}

B jet cross section

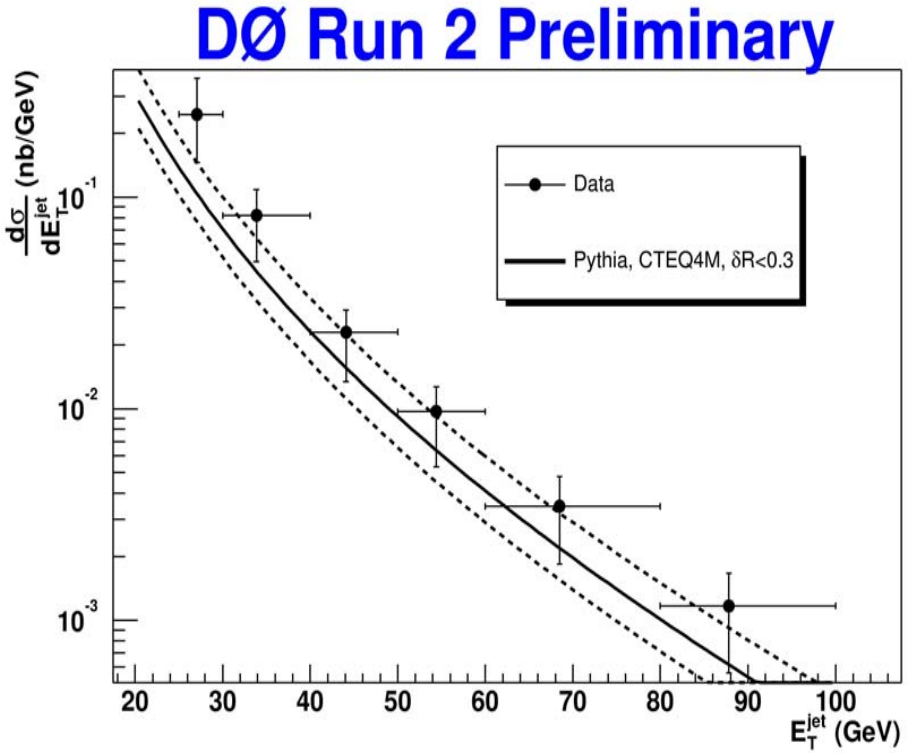
Fit p_T^{rel} templates to data in jet E_T bins



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



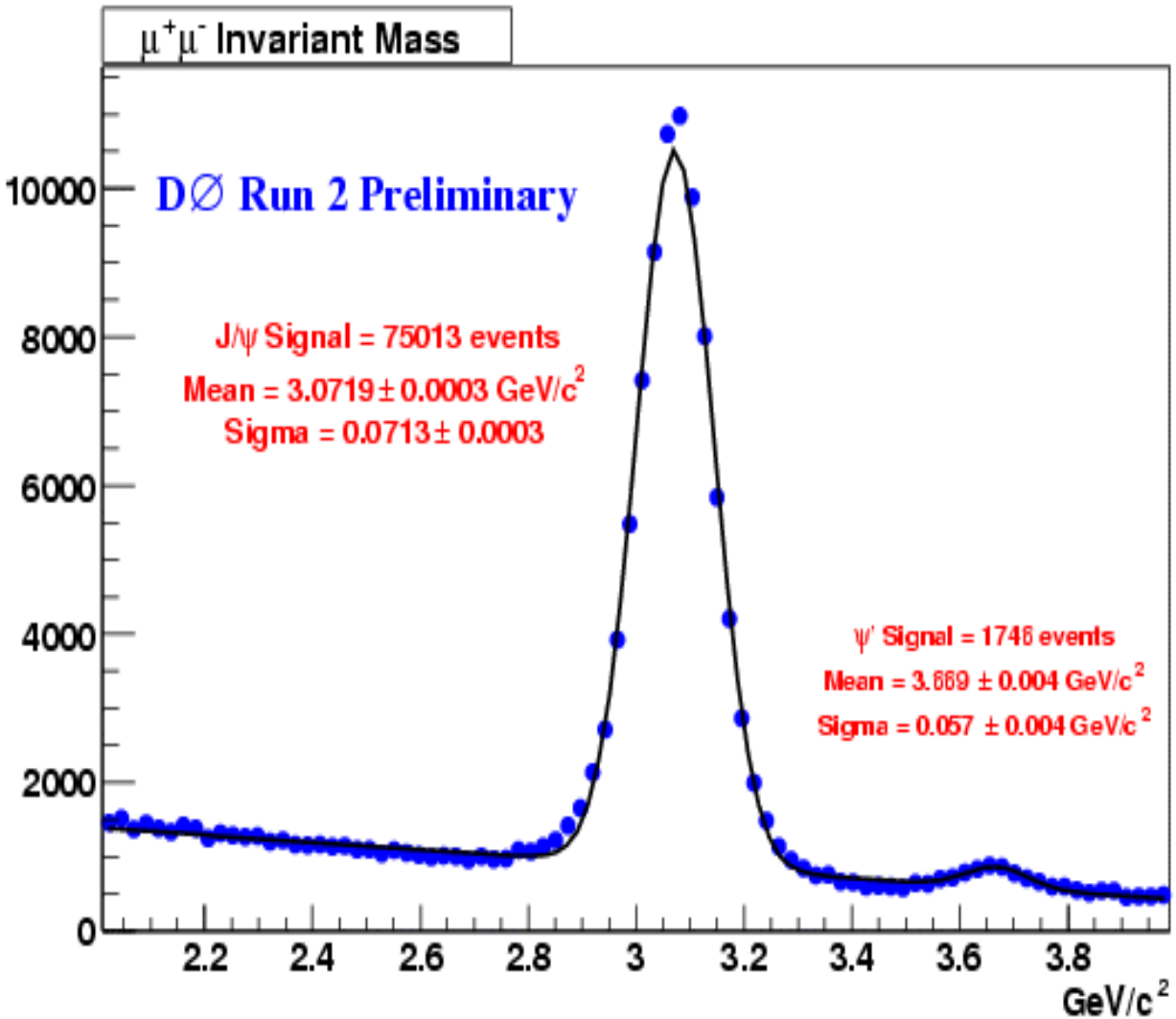
B fraction as a functionof Jet E_T



Data unsmeared using ansatz function

Dominant error is due to jet energy scale

The J/ψ



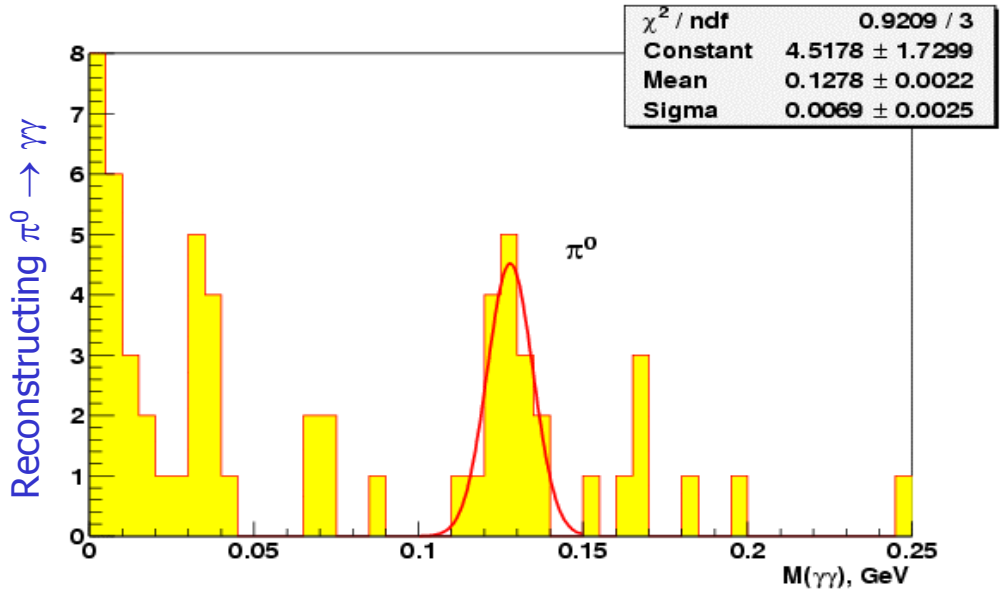
μ p_T > 1.5 GeV &

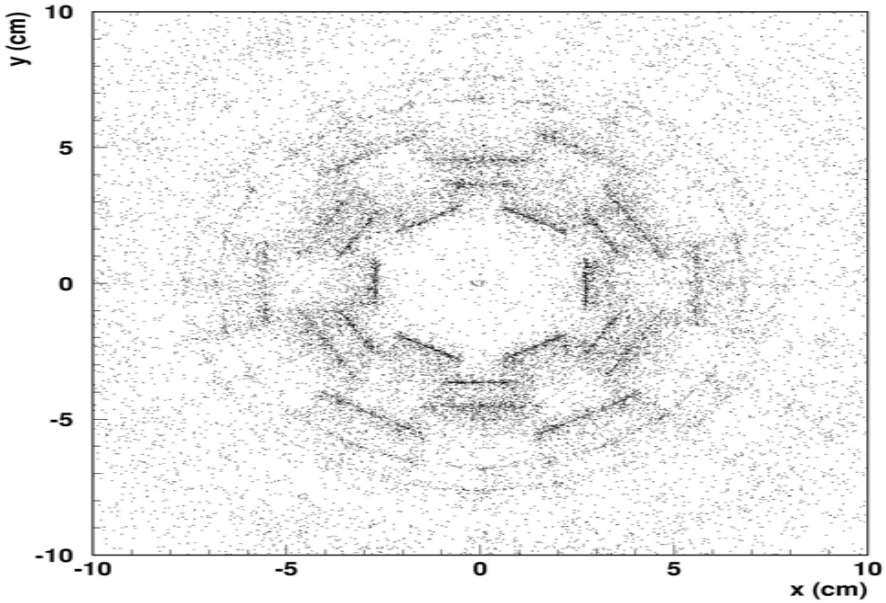
J/ψ p_T > 3.0 GeV

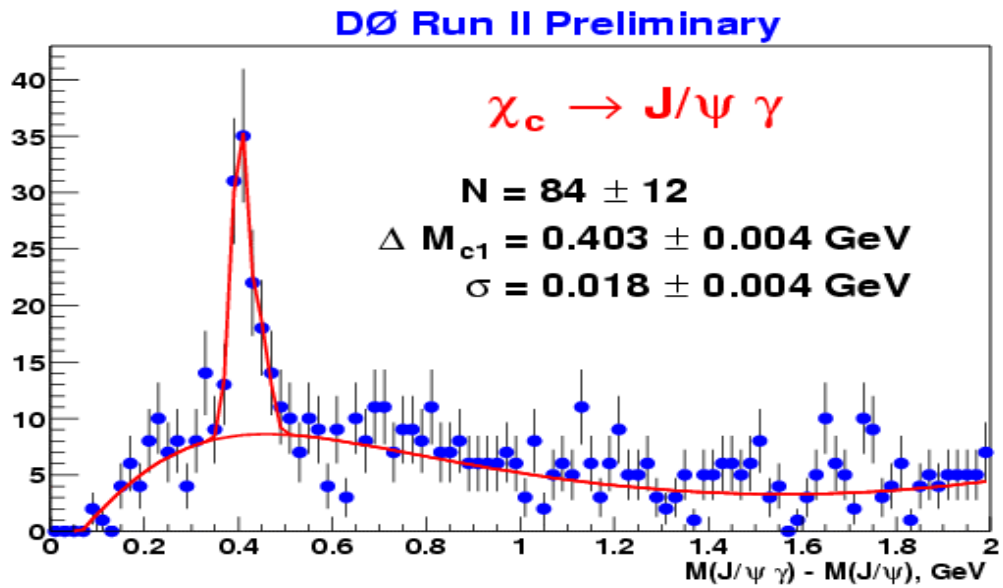
SMT hits>3 & CFT hits>4

J/ψ's: 75,013

The J/ψ

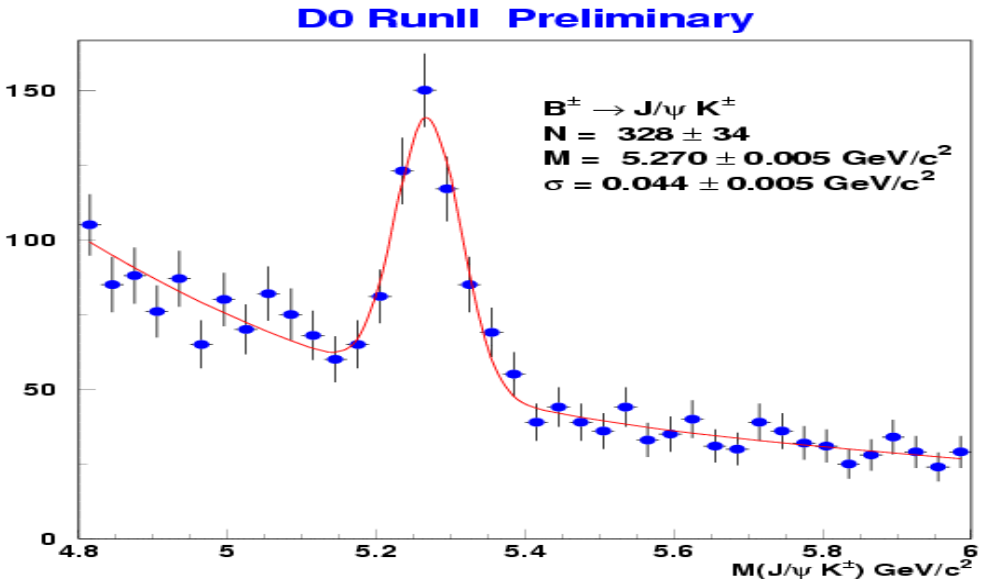


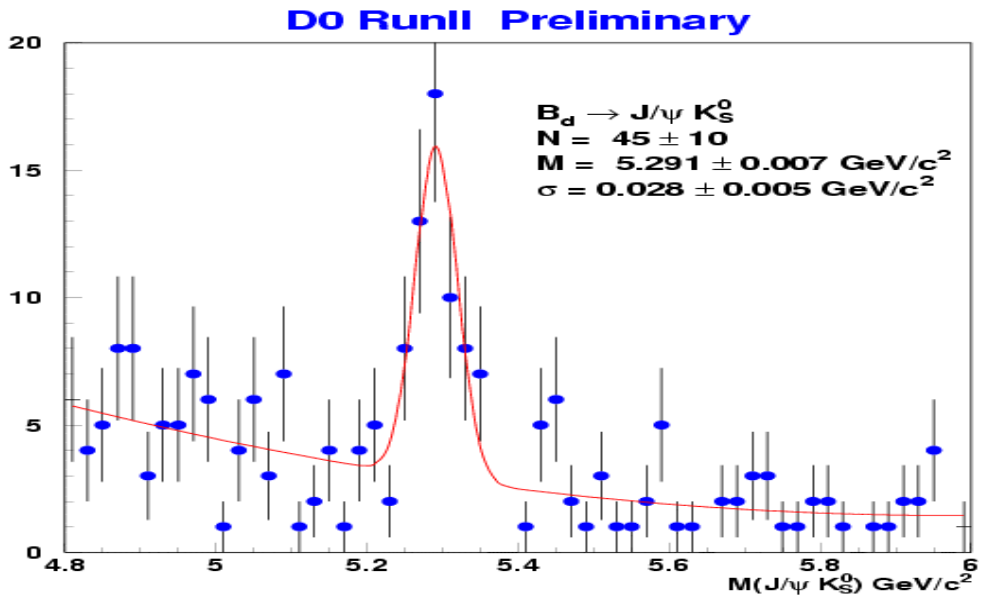


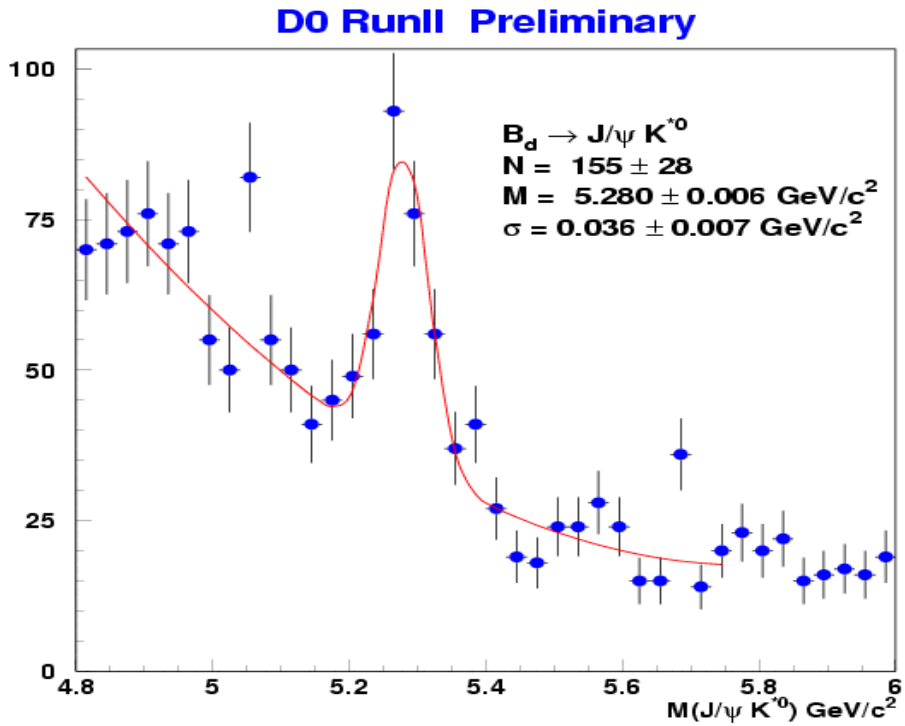


- $\gamma \to e^+e^-$ conversion
- J/ψ tracks $p_T > 2$ GeV
- γ tracks $p_T > 1$ GeV
- J/ψ mass window 2.8 – 3.3 GeV
- J/ψ and γ vertex constrained

Exclusive B decays





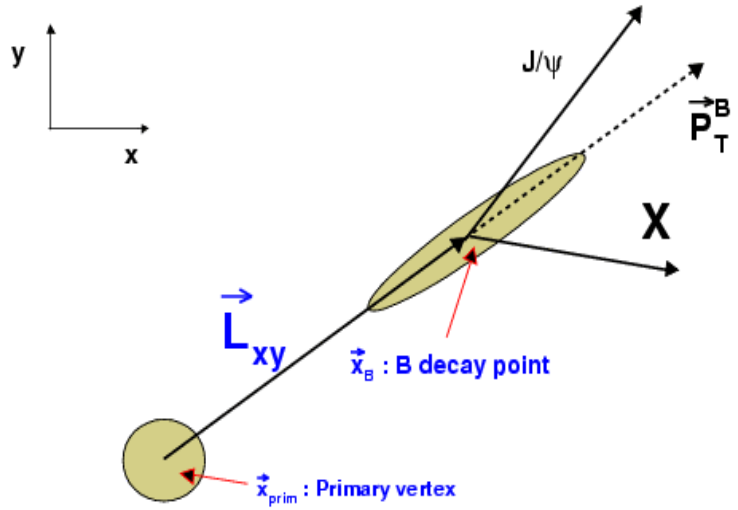


Average B Hadron Lifetime

J/ψ Sources
- $(c\bar{c})$ states (prompt)
- $B \rightarrow J/\psi$

Difference

		decay
Prompt	~	PV
J/ψ(B)	~	SV



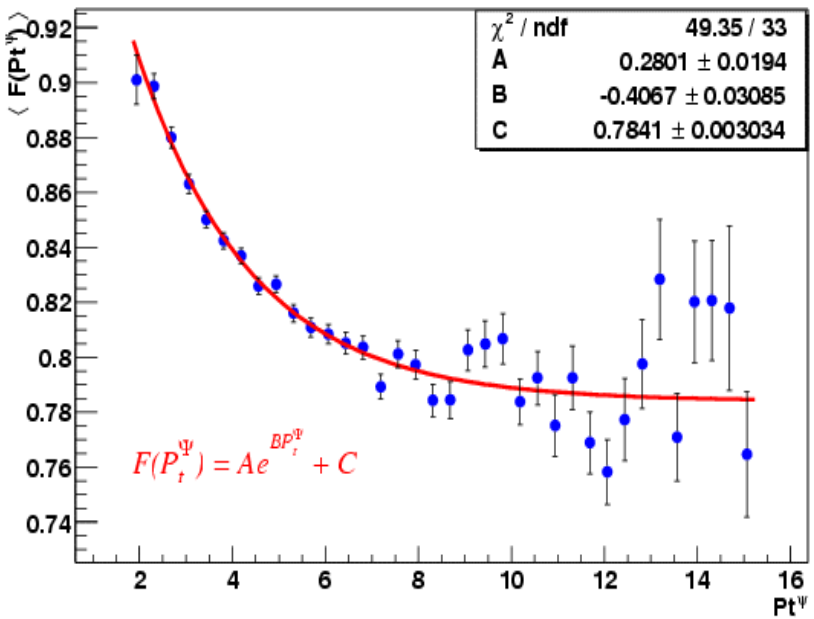
Transverse Decay Length Plot

λ_B through λ_ψ

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

MC

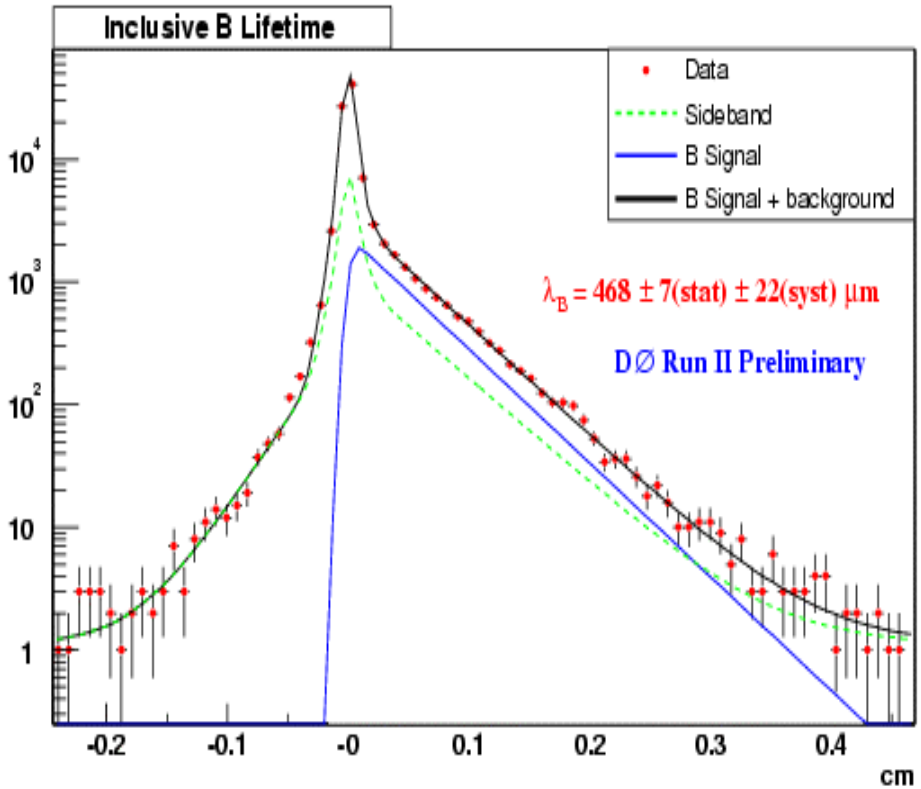
$$\left\langle F(P_T^\Psi)\right\rangle = \frac{M_\Psi}{M_B}\frac{P_T^B}{P_T^\Psi}$$



Average B Hadron Lifetime

Transverse Decay Length Plot Contributions

- **Zero lifetime component:**
  - Prompt J/ψ signal
  - Combinatorial Background
  - Both modeled as double Gaussians
  - Parameters from J/ψ sidebands
  - Background fraction from fit to J/ψ peak
- **Long lived component:**
  - $B \rightarrow J/\psi$ signal
  - Semileptonic Background
  - Both modeled as exponentials convoluted with gaussians
  - Background parameters and normalization determined from J/ψ sideband
  - Signal parameters floated



$\lambda_B = 468 \pm 7(stat) \pm 22(syst)$ μm

B fraction: 17.3±0.5%

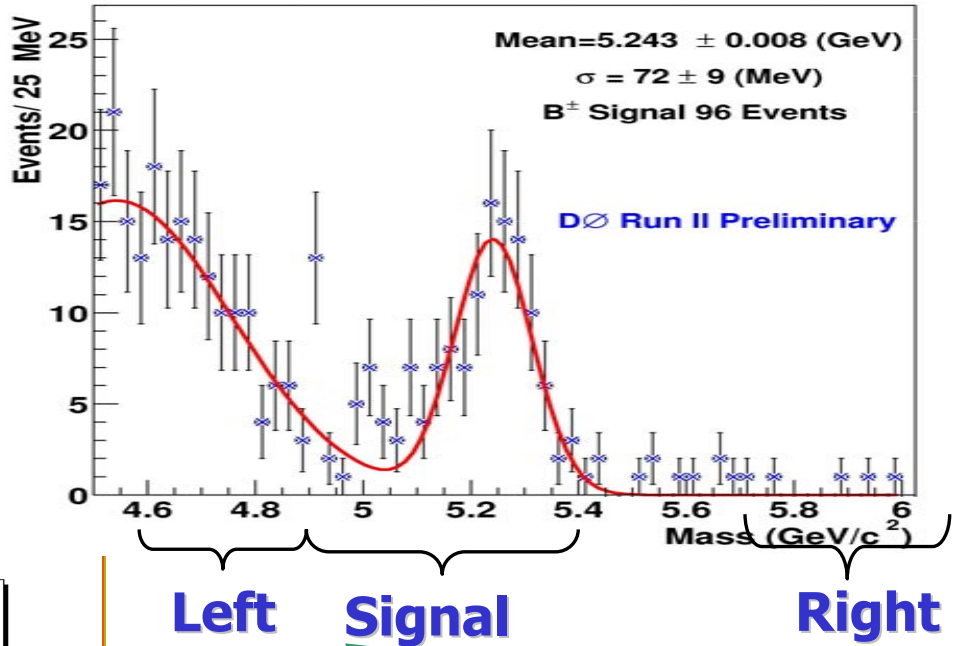
Prompt fraction: 82.7±0.6%

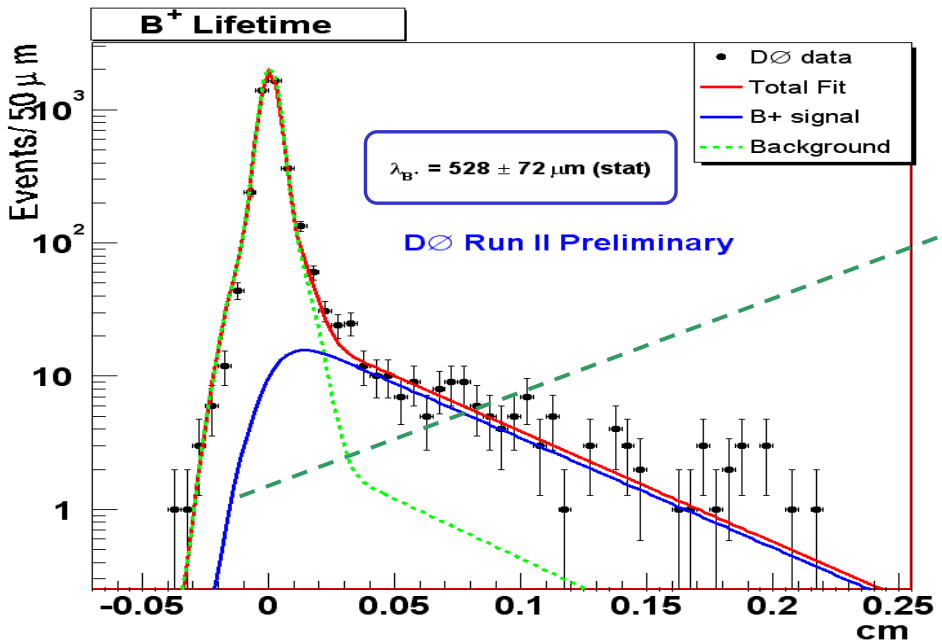
$(\tau) = 1.561 \pm 0.024(stat) \pm 0.074(syst)$ ps

Charged B Lifetime

$$\lambda_B = L_{xy}\frac{M^B}{P_T^B}$$

- R: $G_1 \oplus G_2$
- L: Right $\oplus$ E*G ($B \rightarrow J/\psi\ K^{0*}$)
- P: Right $\oplus$ E_1*G_1 $\oplus$ E_2*G_2





Flavor tagging

Jet Charge Tagging

Jet charge tagger:

- Remove daughter tracks from the reconstructed B
- Remove tracks 2D impact parameter greater than 0.2cm
- Remove tracks with |vtx_z – pvtxz| > 2. Cm, suppress minimum bias events
- Use tracks left to calculate the jet charge Q by weighing on track pT
- Events with |Q|>0.2 are counted as tagged, while the others are dropped

Soft Muon Tag

Muon tagger:

- must have ΔR > 2.0 separation from reconstructed B
- must have p_T > 1.9 GeV/c
- ***b* flavor tagging:** charge of highest-p_T muon in event gives (opposite-side) *B*-tag

$$\text{Efficiency } \varepsilon = \frac{N_{\text{correct}} + N_{\text{wrong}}}{N_{\text{correct}} + N_{\text{wrong}} + N_{\text{no tag}}}$$

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

$$\text{Tagging power} : \varepsilon \times D^2$$

B Flavor Tagging

DØ Run-II Preliminary

Soft muons

# of events	218
# of events with correct tag	13
# of events with wrong tag	5
Raw efficiency (%)	8.3±1.9
Raw dilution (%)	44.4±21.1
Estimated # of signal events	12.8
Estimated # of bgd events	5.2
Estimated efficiency of signal events (%)	8.2±2.2
Estimated dilution of signal events (%)	63.9±30.1
Estimated $\varepsilon \times D^2$ of signal events (%)	3.3±1.8

Average jet charge

# of events	181
# of events with correct tag	66
# of events with wrong tag	48
Raw efficiency (%)	63.0±3.6
Raw dilution (%)	15.8±8.3
Estimated # of signal events	114
Purity	63.0
Estimated efficiency of signal events (%)	55.1±4.1
Estimated dilution of signal events (%)	21.0±10.6
Estimated $\varepsilon \times D^2$ of signal events (%)	2.4±1.7

- Errors only statistical
- Errors in fractions of signal, bgd events in mass window (from fit) are ignored

Conclusions

- **Latest Run IIa D0 B Physics results**
  - **B-jet cross section**
  - **B exclusive decays (B+, B0d in two different channels)**
  - **Average B Lifetime**
  - **Preliminary Charged B lifetime measurement**
  - **Understanding Flavor Tagging**

- **Improvements in the short term future:**
  - **Track trigger and Silicon Trigger**

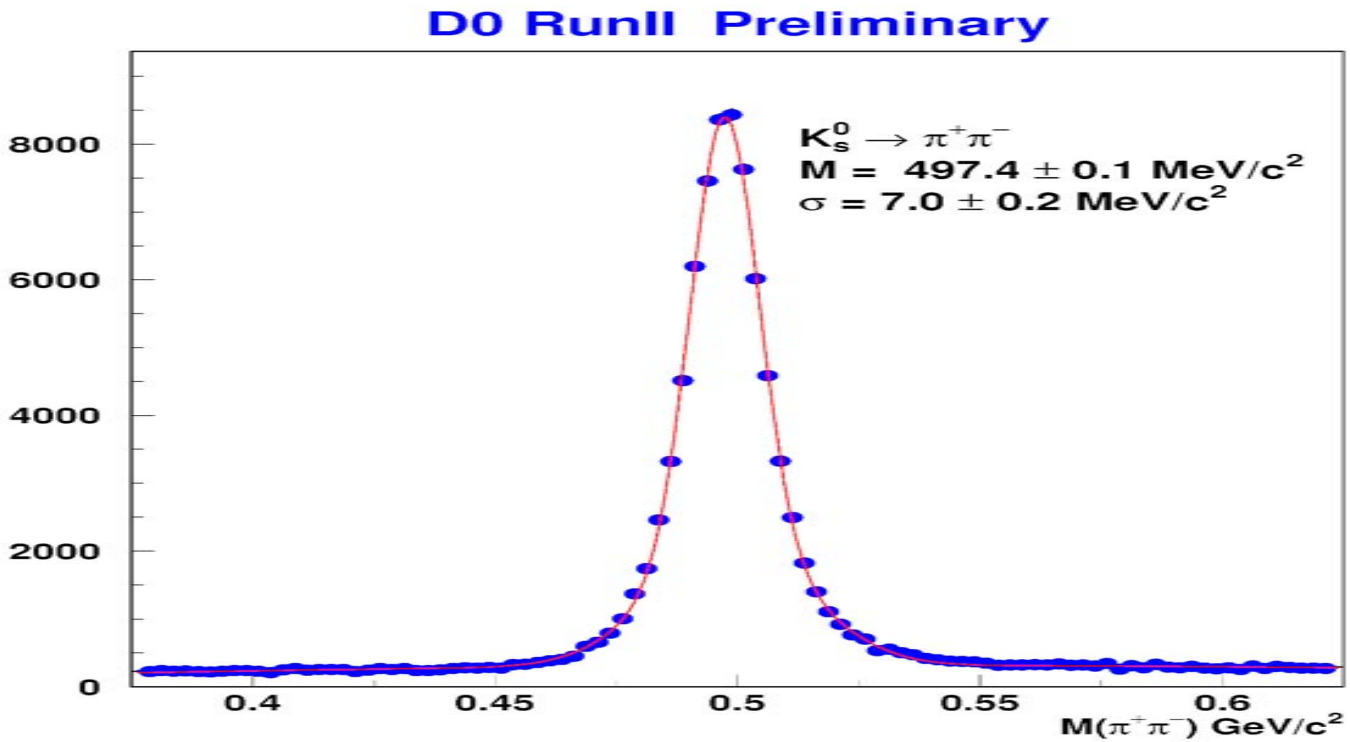
Just the beginning of an exciting DØ B Physics program …

Average B Hadron Lifetime

Systematic Uncertainties

Source	Uncertainty (μm)
Boost Correction	±15.9
Background Shape	± 3.0
Flight Length dependence	± 1.1
Back. Normalization	± 0.68
Alignment bias	± 4.1
Fitting Bias	±13
Total	±22 μm

V0 Finding


D0 RunII Preliminary
$K^0_s \rightarrow \pi^+\pi^-$
M = 497.4 ± 0.1 MeV/c²
σ = 7.0 ± 0.2 MeV/c²
8000
6000
4000
2000
0
0.4
0.45
0.5
0.55
0.6
M(π⁺π⁻) GeV/c²

Flavor tagging