Recent B Physics Results at DØ

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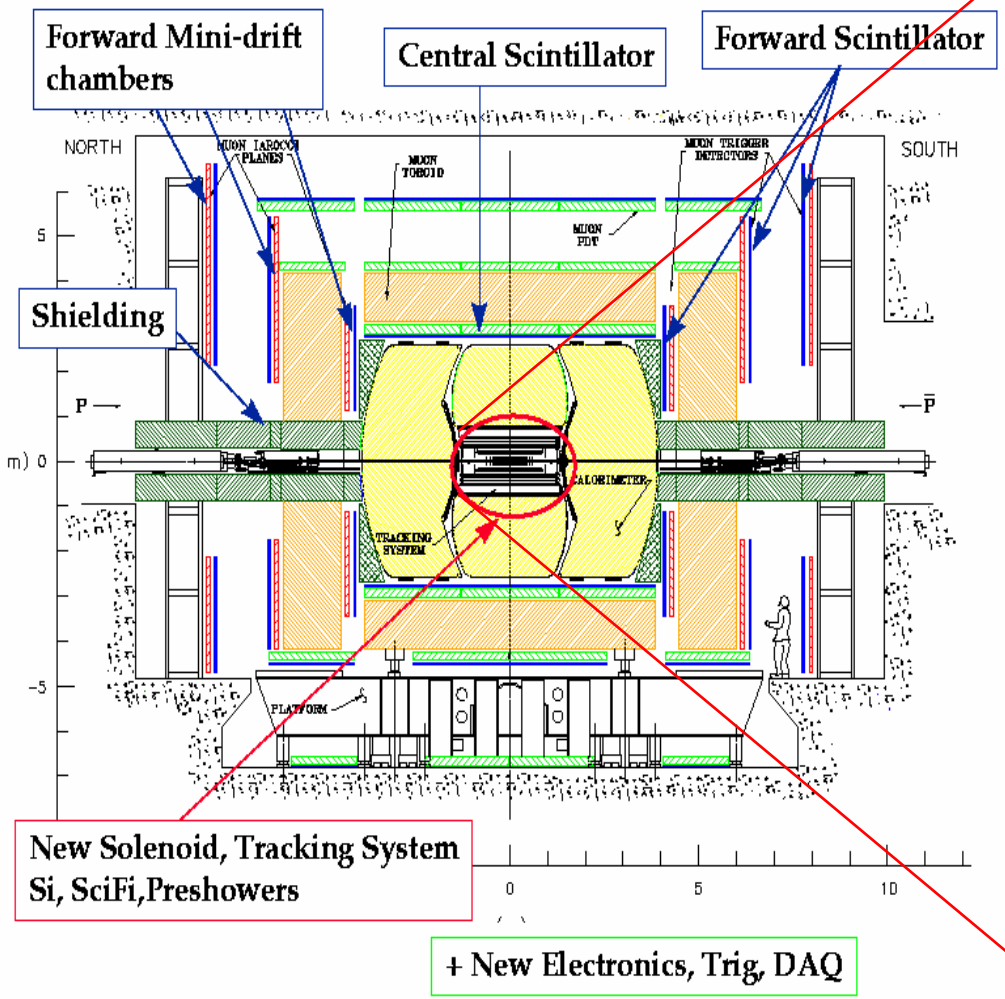
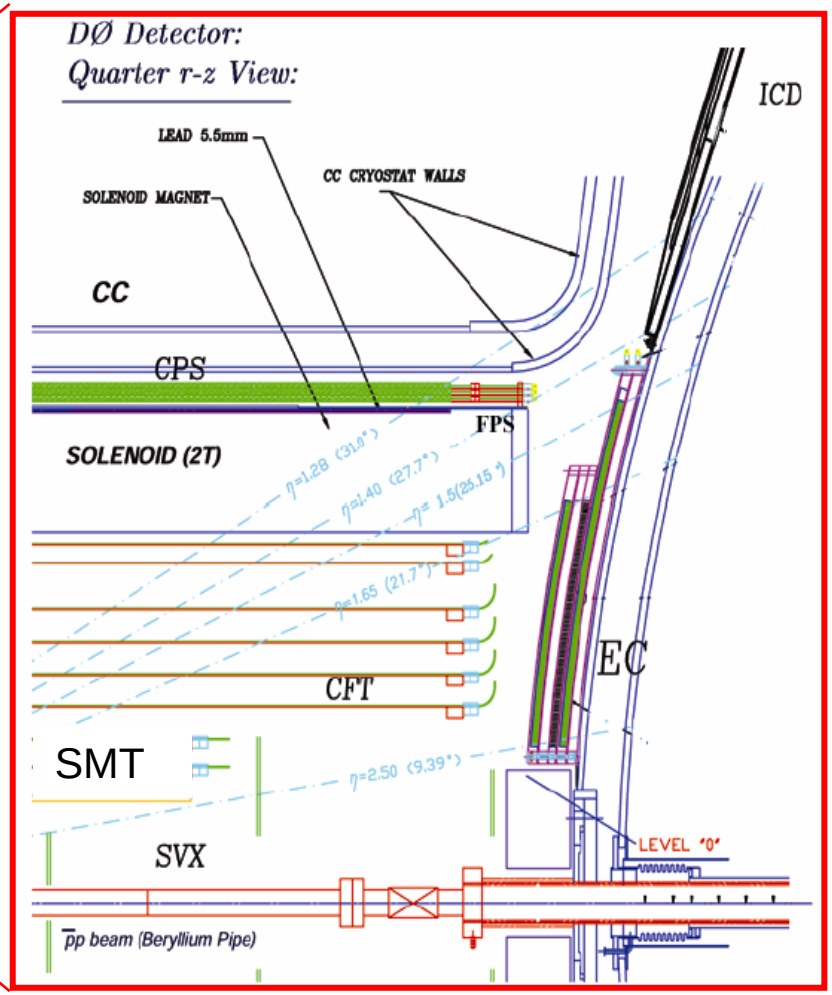
- Florida State University

- 18 February 2004

- **X(3872)**
- **B Lifetime and Mixing**
- **$B_s \rightarrow \mu^+\mu^-$ Search**

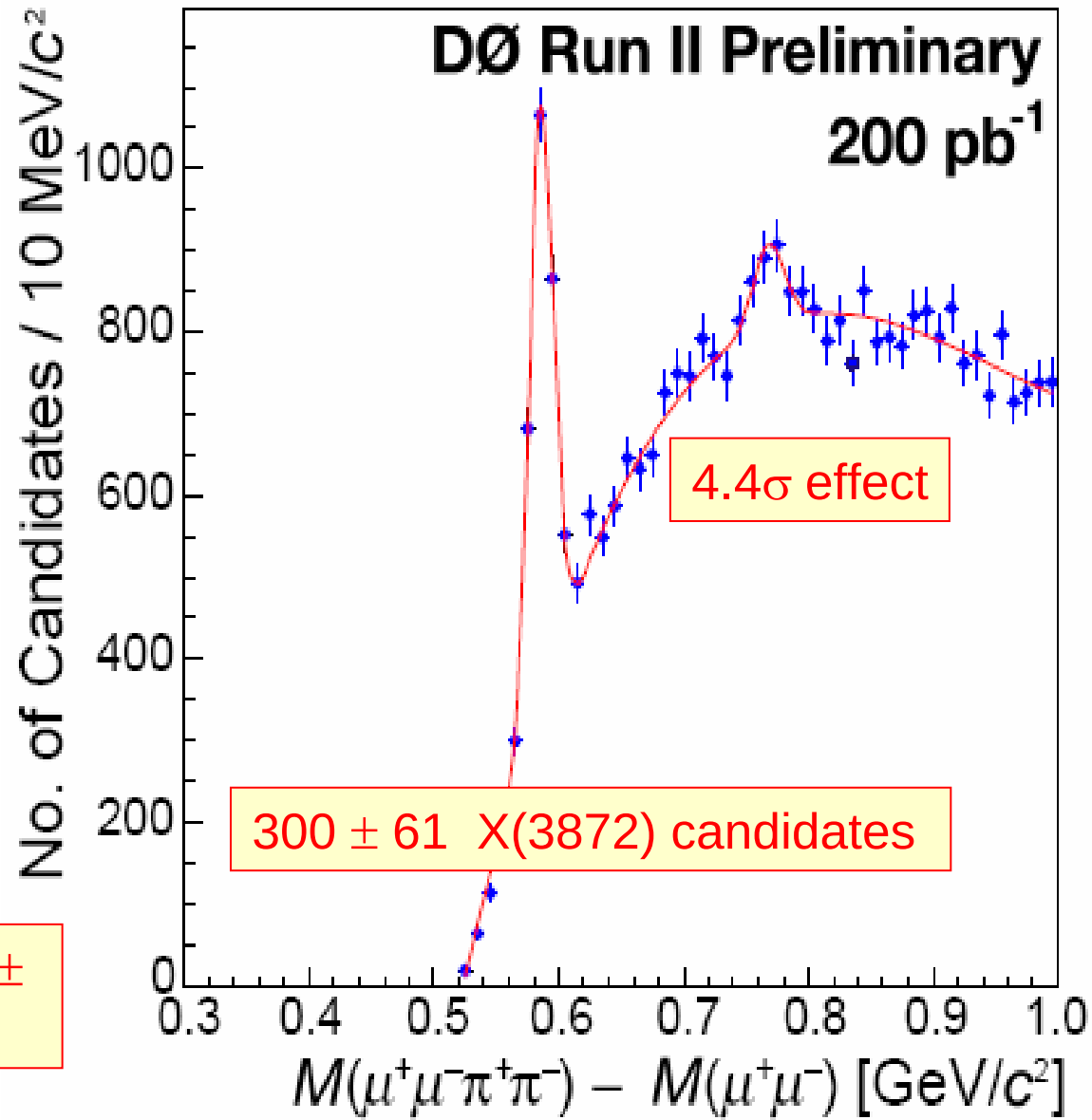
The DØ Run 2 Detector





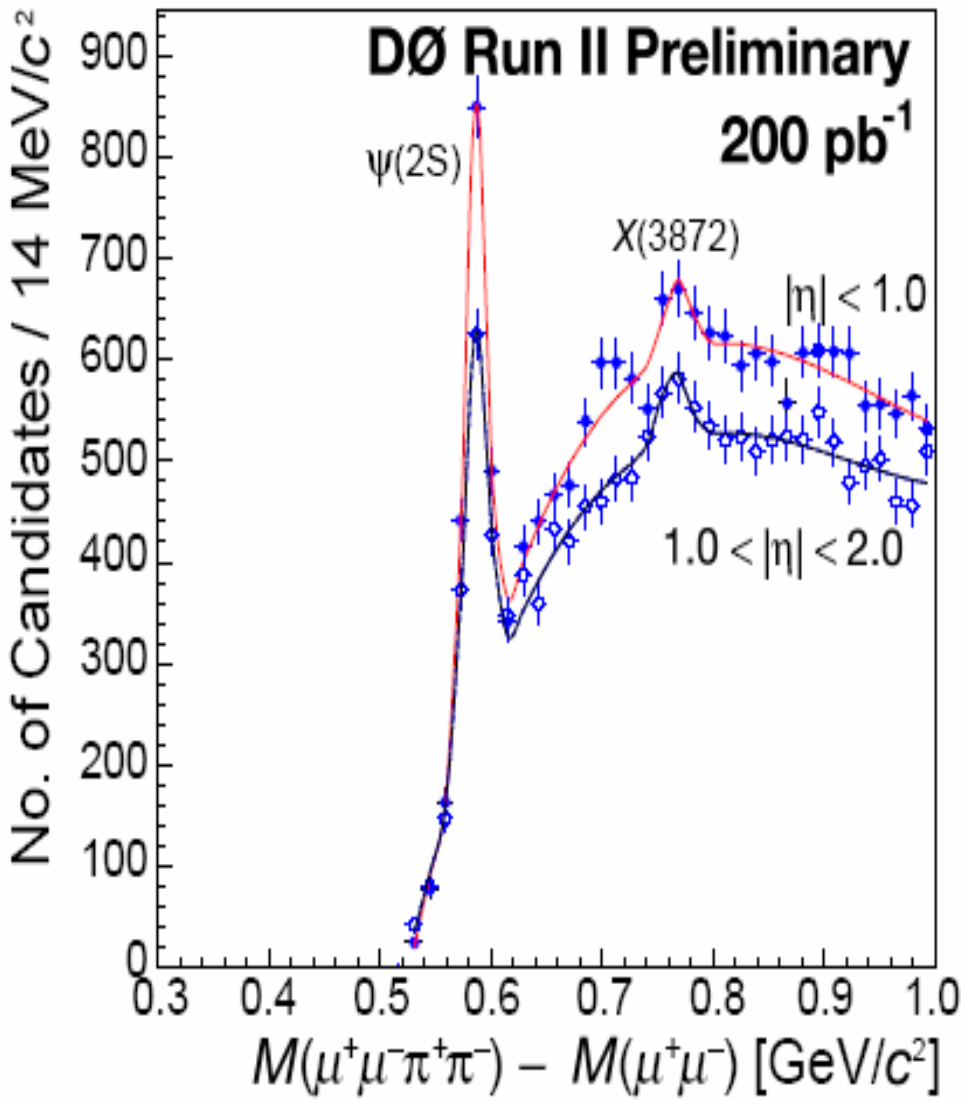
X(3872) at D0

- Using 200 pb^{-1} of DATA collected April 2002 – September 2003, we look for X(3872) → $J/\psi\ \pi^+\pi^-$
  - Silicon hit > 1
  - num tracks < 100
  - pT(J/ψ) > 4 GeV/c
  - 2.8 < M($\mu^+\mu^-$) < 3.4 GeV/c^2
  - pT(π) > 0.4 GeV/c
  - π's within same cone as J/ψ
  - M($\pi^+\pi^-$) > 0.52 GeV/c^2
  - M($\mu^+\mu^-\ \pi^+\pi^-$) -M($\mu^+\mu^-$) < 1.0 GeV/c^2
  - χ^2 ($\mu^+\mu^-\ \pi^+\pi^-$ - vertex) < 16
  - $|z_{vertex}|$ < 35 cm



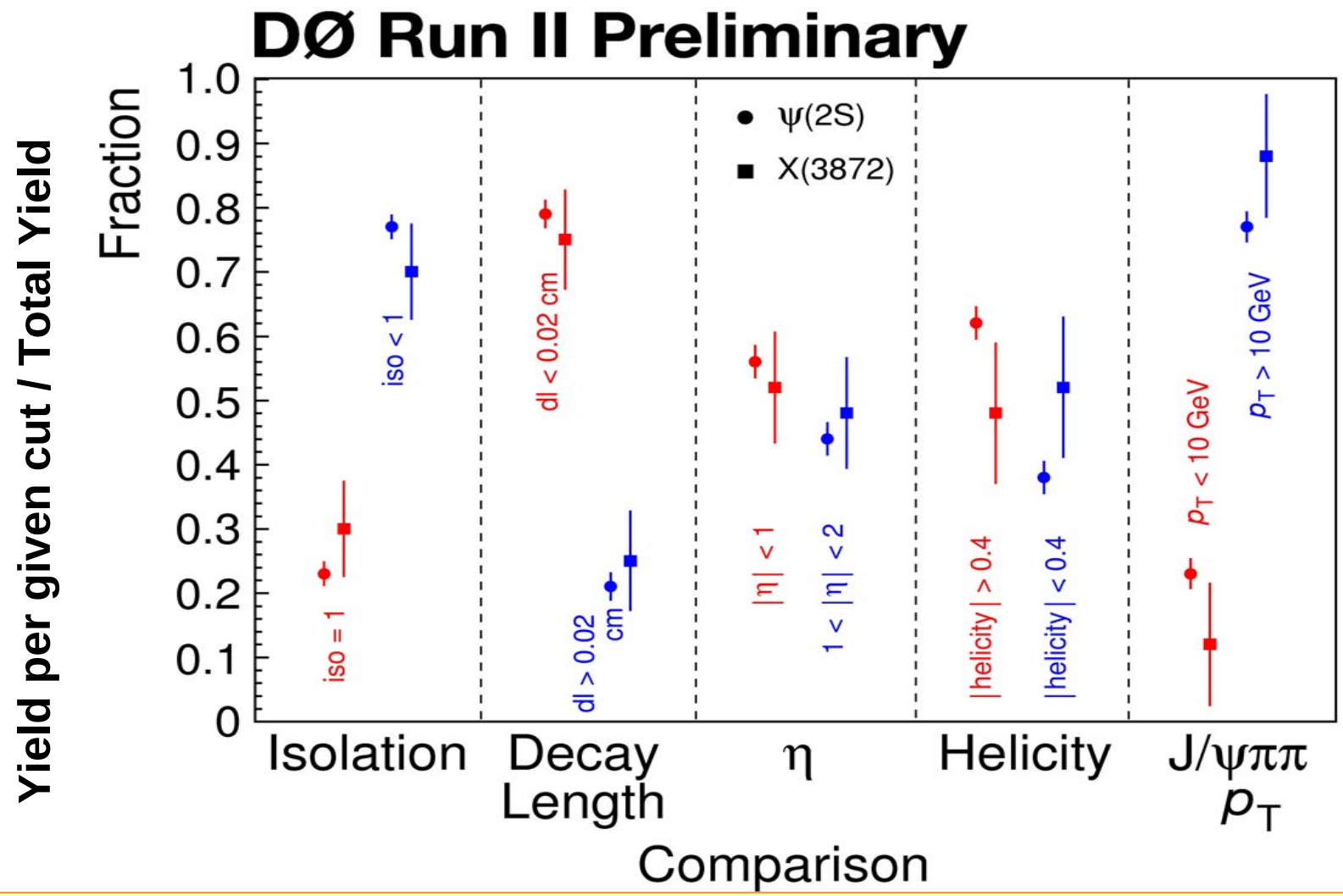
$\Delta M = 0.7684 \pm 0.0035$ (stat) $\pm$ 0.0039 (sys) GeV/ c^2

Properties of X(3872)



- **Are the production characteristics similar to the ψ(2S)?**
- **To compare, the data was binned for several different variables: decay-length, isolation, η (pseudo-rapidity), pT, and helicity of ($\pi^+\pi^-$)**

X(3872) and ψ(2S) comparison



Within the current statistical uncertainties, the production of X(3872) has similar behavior as the ψ(2S), but an exotic meson could also behave similarly.

Is X(3872) charmonia?

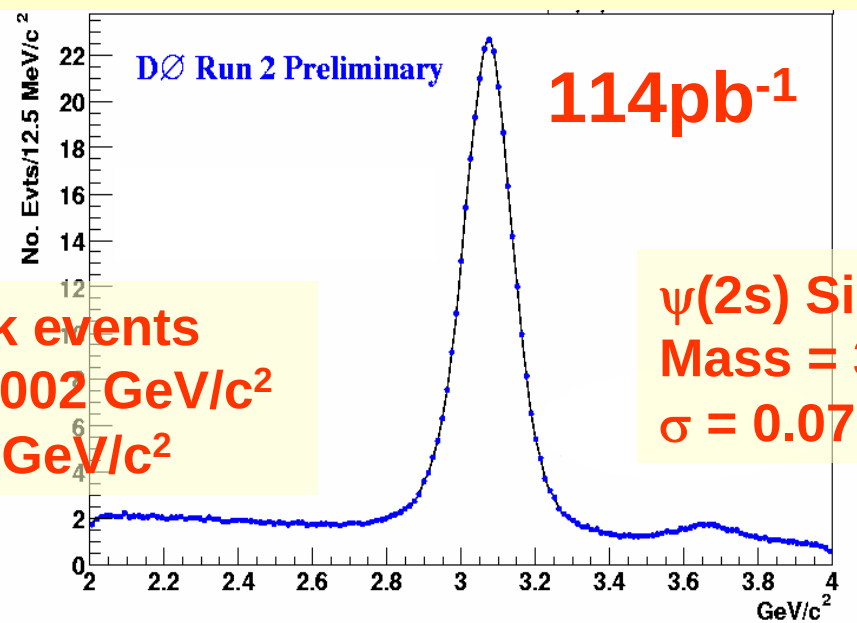
- If the charged analog $X^+ \rightarrow J/\psi \pi^+ \pi^0$ was observed, then $c\bar{c}$ hypothesis could be ruled out
- While observing radiative decays $X \rightarrow \gamma \chi_{c1}$ would favor $c\bar{c}$ hypothesis
- Both of these would require DØ to identify low energy π^0 and γ (work in progress)

Measuring Lifetime using $B \to J/\psi\ X$, $J/\psi \to \mu^+\mu^-$

Use $J/\psi \to \mu^+\mu^-$ for tagging, vertex constraint, p_T determination:

- √ Clean signal
- √ Large statistics
- √ Good vertex resolution
- √ Good momenta resolution

- × Large prompt J/ψ contamination
- × Need Pt correction factor from MC

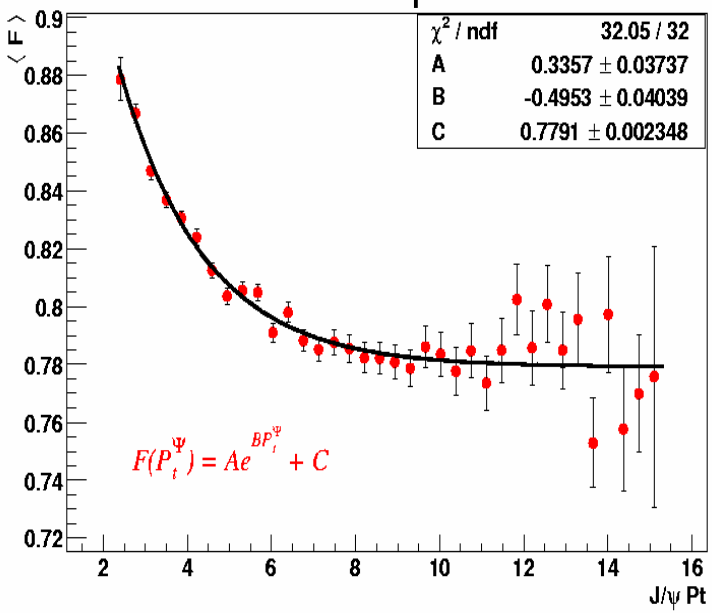


J/ψ Signal = 290.3k events
Mass = 3.0718±0.0002 GeV/c²
σ = 0.0741±0.0002 GeV/c²

$\psi(2s)$ Signal = 8.22K events
Mass = 3.668 ± 0.002 GeV/c²
σ = 0.071 ± 0.002 GeV/c²

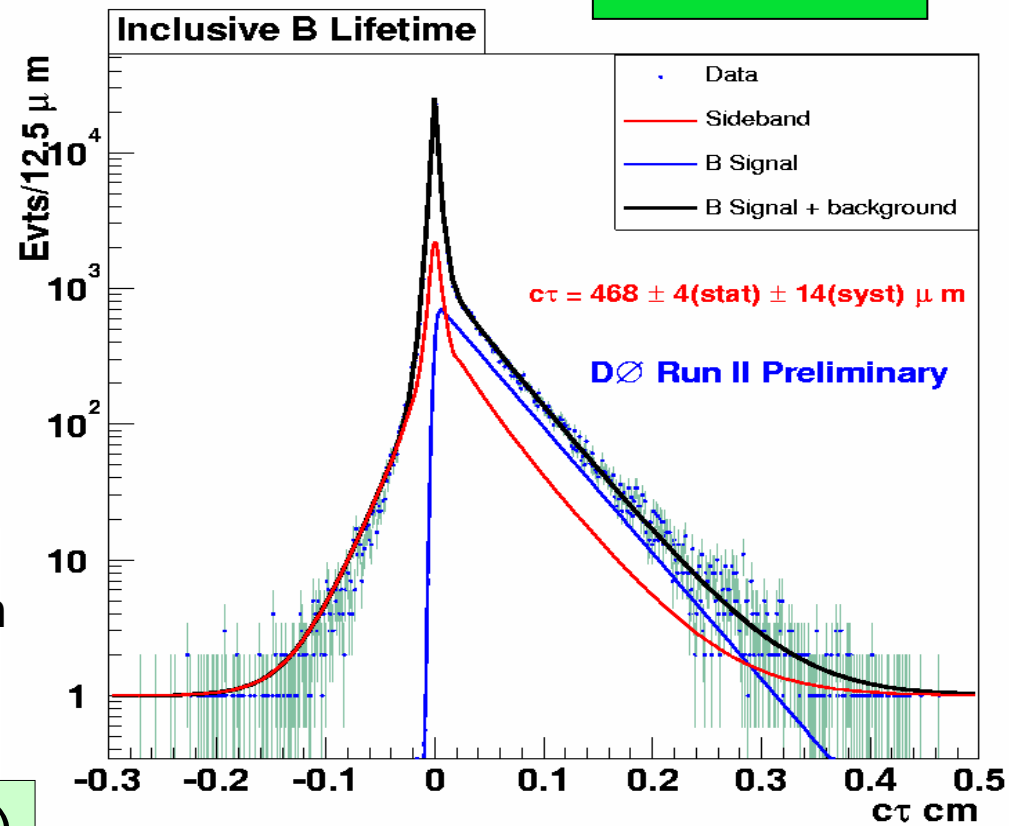
B Lifetime from Inclusive B→J/ψ+X

B→ J/ψ X



∫Ldt≈114 pb^{-1}

$$\lambda = \frac{L_{xy} M_{\Psi}}{P_{T\Psi} F(P_T)}$$



F: correction factor to use the pT(J/ ψ) to estimate the momentum of the B to find proper time. Obtained from Monte Carlo

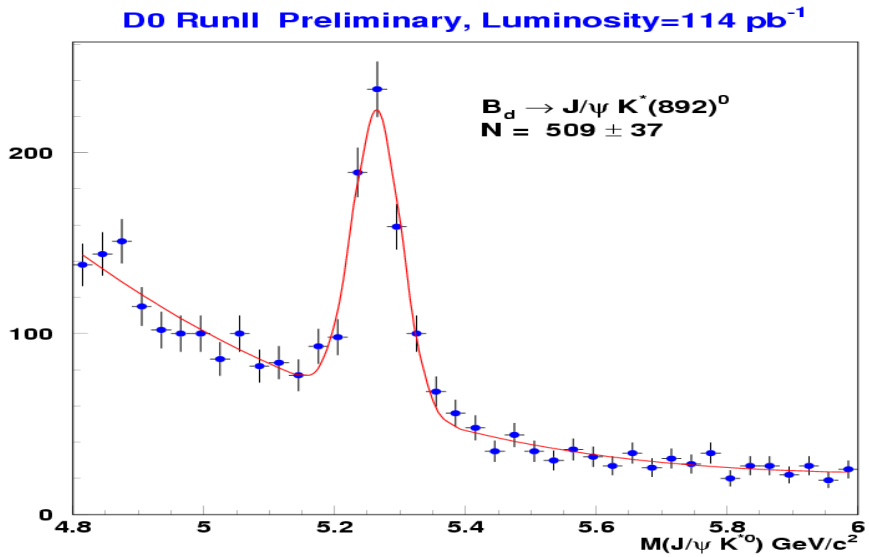
$\langle\tau\rangle = 1.564 \pm 0.014$ ps (PDG)

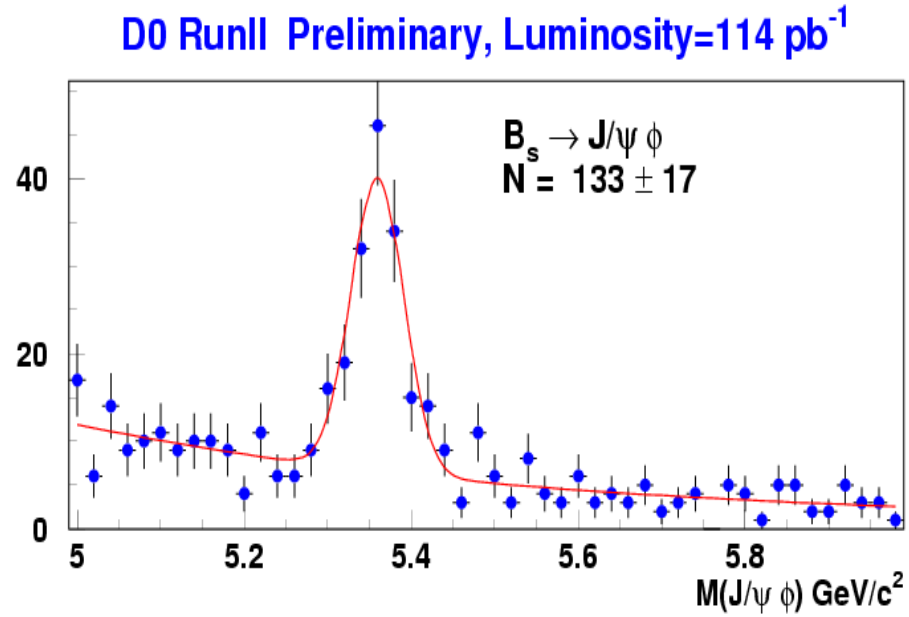
$\langle\tau\rangle = 1.562 \pm 0.013 \pm 0.045$ ps

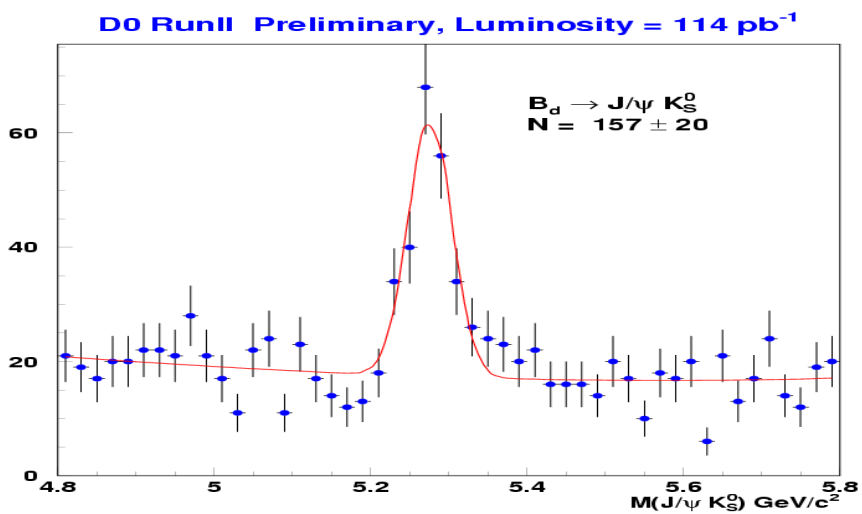
J/ψ from B's = 18%

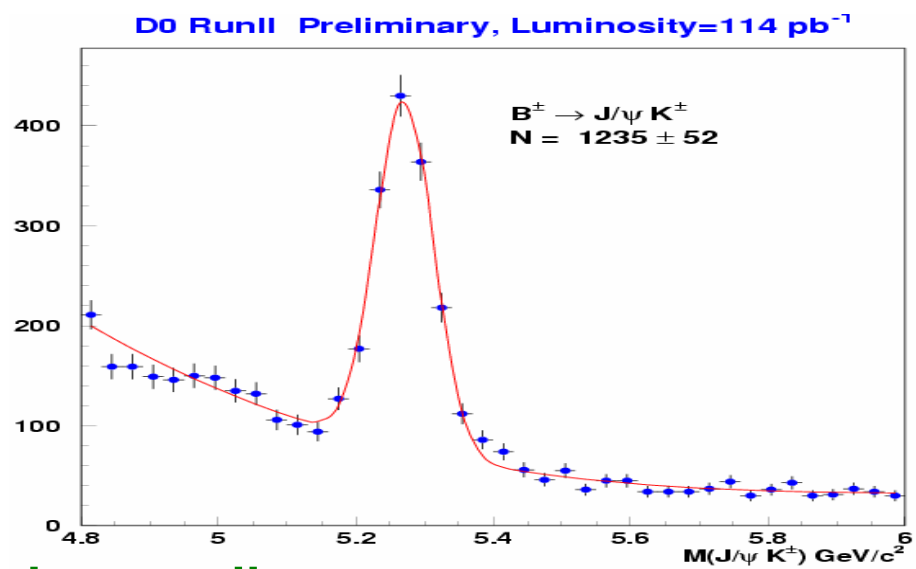
Correction factor leads to the major systematic error

$B_{d,s}$ Masses ($J/\psi + K^{0*}, \phi, K^0_s$)



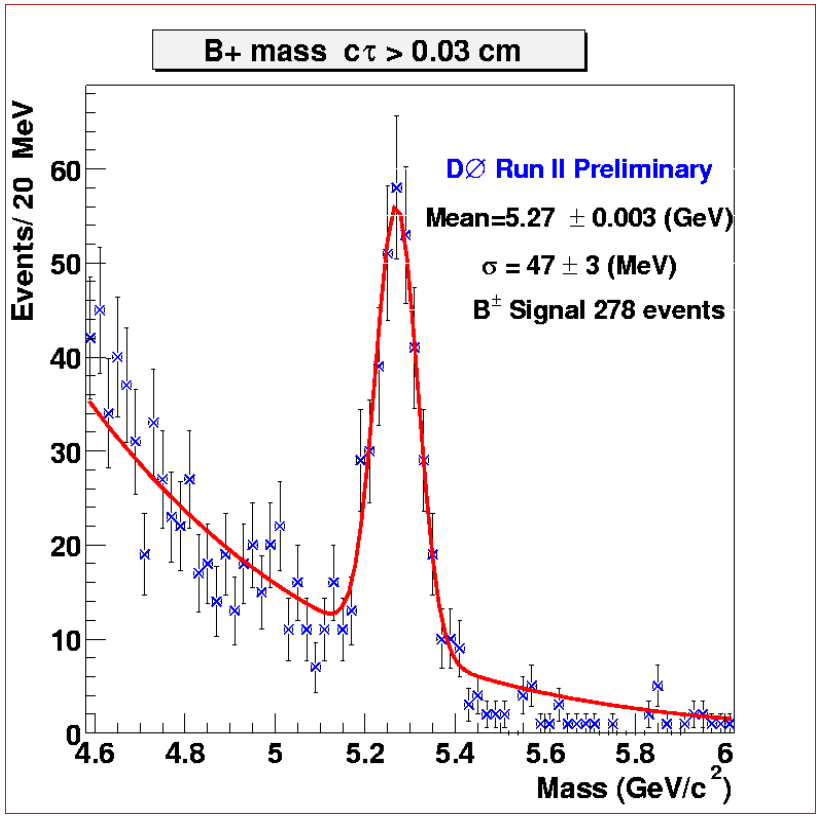




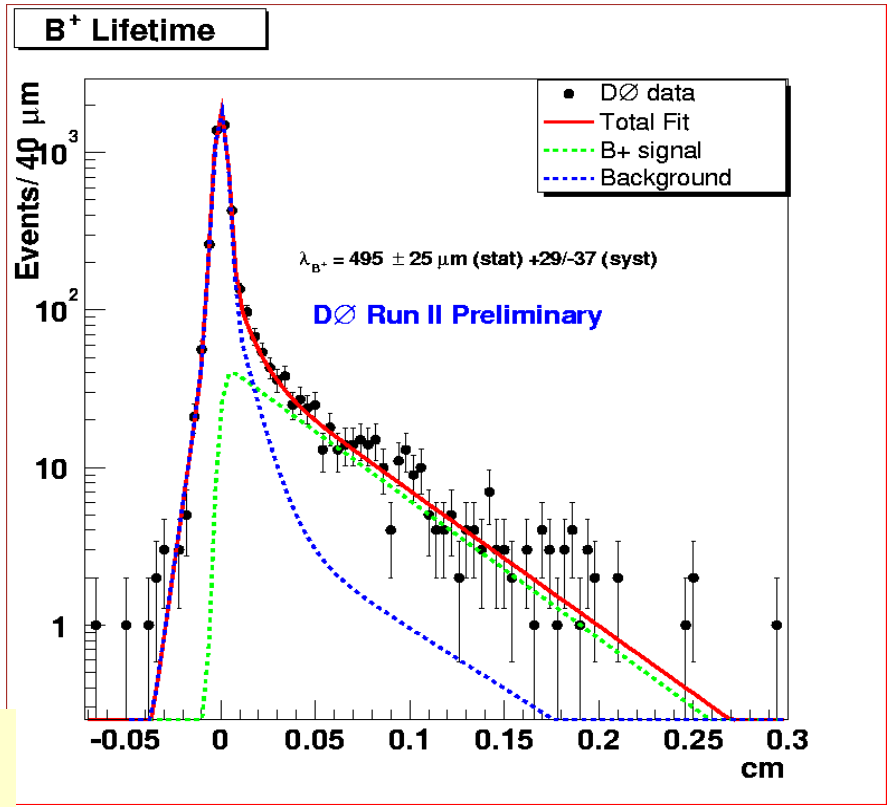


For CP and Lifetime studies

$B^{\pm}$ Lifetime from $B^{\pm} \rightarrow J/\psi K^{\pm}$



$\int Ldt \approx 114\ pb^{-1}$

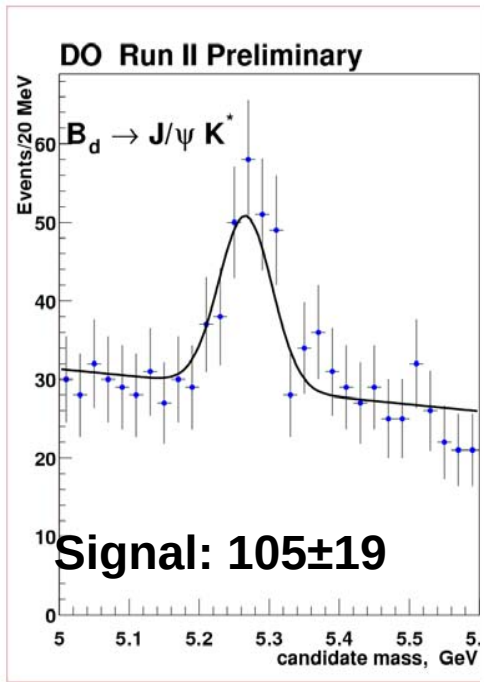


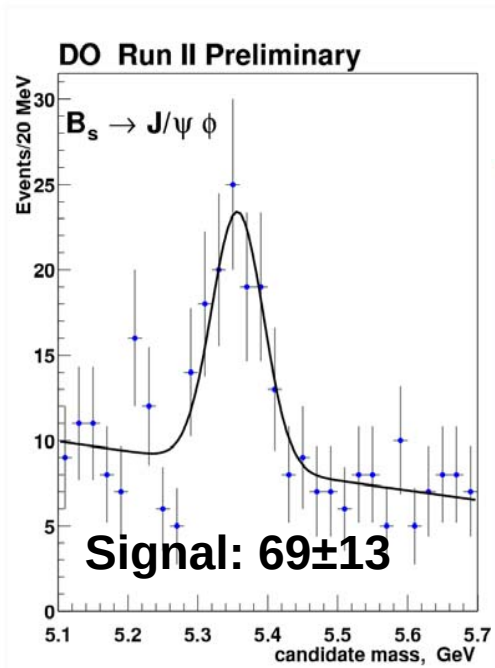
Fully reconstructed→No Correction Factor!

$\langle \tau_{B\pm} \rangle = 1.65 \pm 0.083(stat) \pm 0.123(syst)$ ps

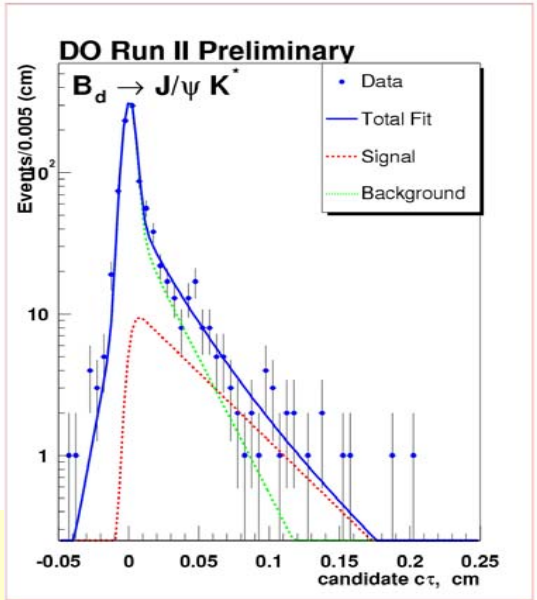
$\langle \tau_{B\pm} \rangle = 1.671 \pm 0.018$ ps (PDG)

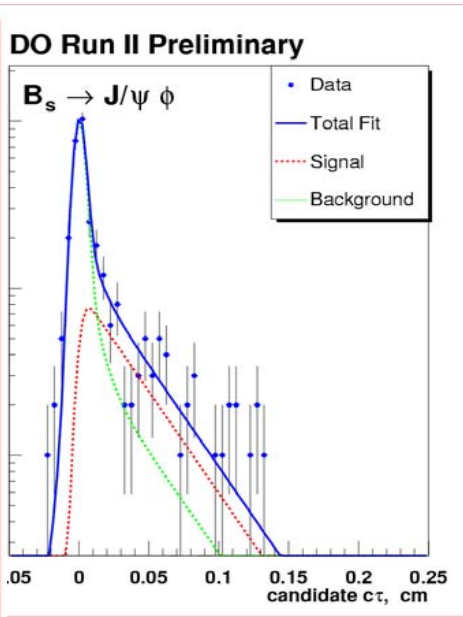
$B_{d,s}$ Lifetimes from $B \rightarrow J/\psi + K^{0*}, \phi$





Similar kinematics→Some systematic errors can be cancelled in ratio!





$\int Ldt \approx 114\ pb^{-1}$

$\tau_{Bd} = 1.51^{+0.19}_{-0.17}$ (stat) ± 0.20(syst) ps

$\tau_{Bs} = 1.19^{+0.19}_{-0.16}$ (stat) ± 0.14(syst) ps

$\tau_{Bs}/\tau_{Bd} = 0.79 \pm 0.14$

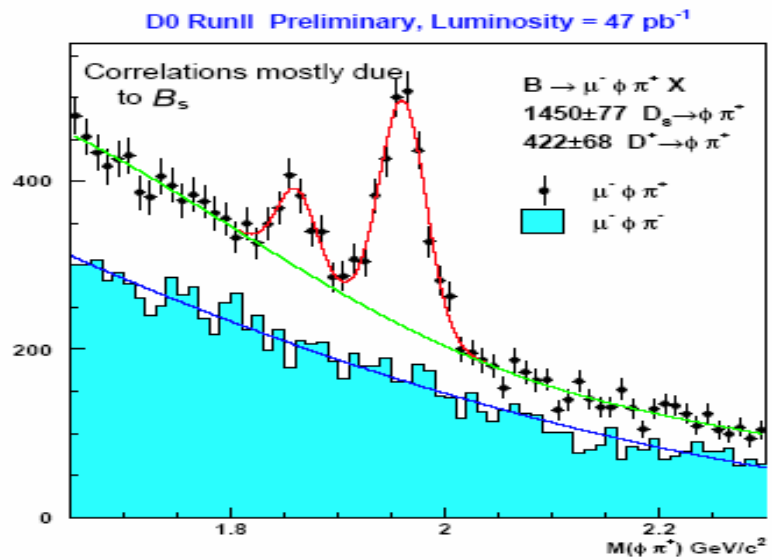
PDG: $\tau_{Bd} = 1.537 \pm 0.015$ ps

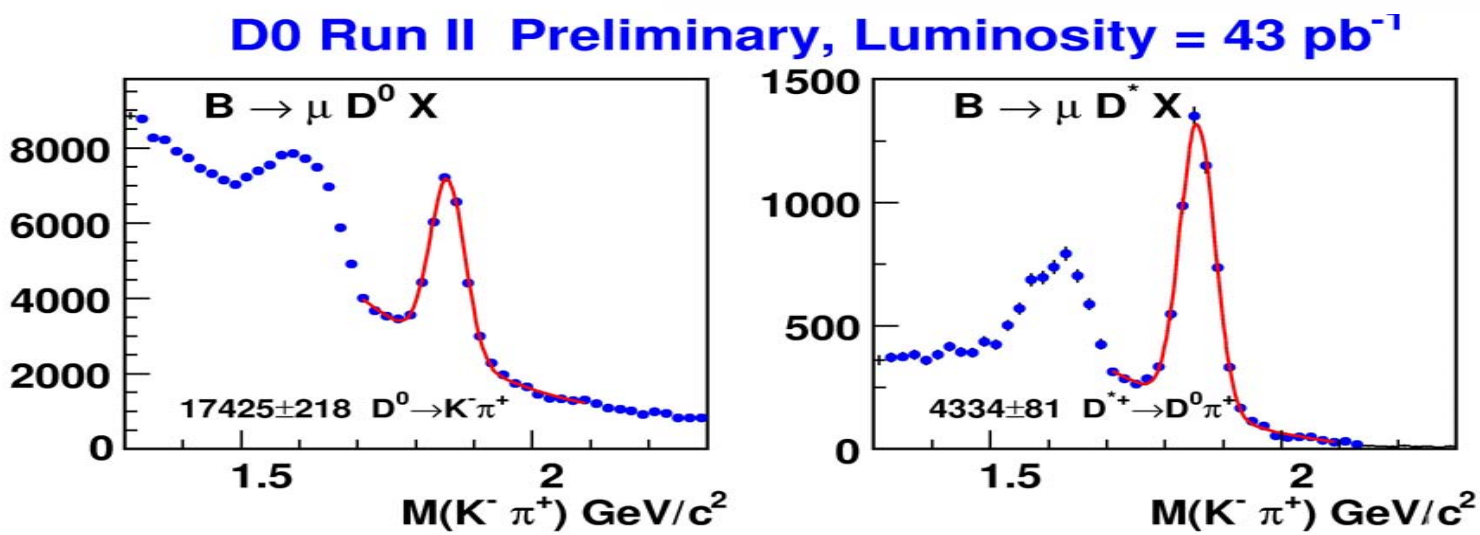
PDG: $\tau_{Bs} = 1.461 \pm 0.057$ ps

PDG: $\tau_{Bs}/\tau_{Bd} = 0.95 \pm 0.038$

Large B Semileptonic Sample

- **Muon:**
  - **Pt > 2 GeV/c**
- **Charged tracks:**
  - **pT > 0.7-1 GeV/c**
- **Secondary Vertex**
  - **$L_{xy} / \sigma_L > 4$**
  - **$\cos(\theta(L,P_D))>0.95$**

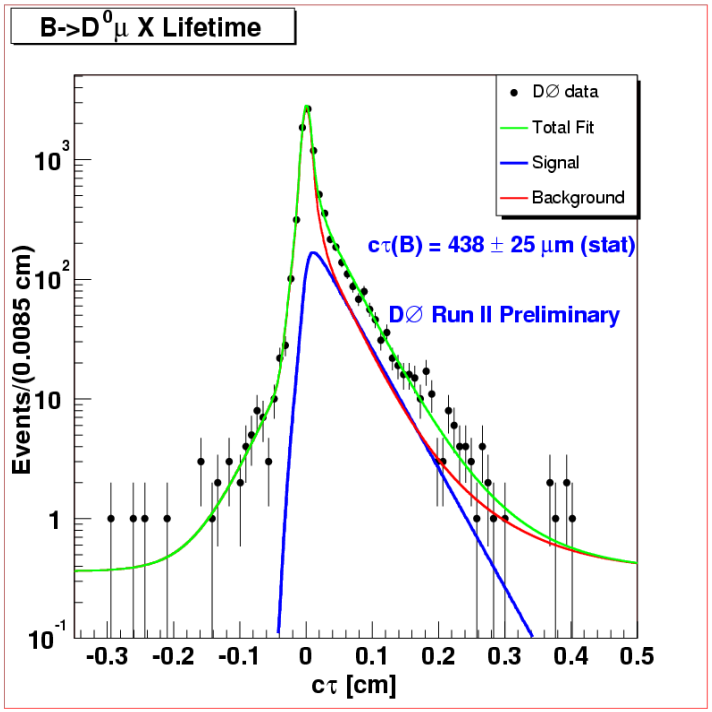




B Lifetime from Semileptonic Decays $B \rightarrow D^0 \mu X$

$\int Ldt \approx 12\ pb^{-1}$

We are able to measure Lifetime



$$c\tau = L_{xy} M_b K / Pt_{(D+\mu)}$$

$$K = Pt_{(D+\mu)} / Pt_B \quad \text{(from MC)}$$

$$\tau_B = 1.460 \pm 0.083\ (\text{stat})\ \text{ps}$$

$$\tau_B = 1.564 \pm 0.014\ \text{ps (PDG)}$$

We will use this for mixing studies

Mixing: Flavor tagging

- In order to study B_s mixing we will need
  - final state reconstruction
  - ability to measure B decay lengths
  - the ability to tag the flavor of the B at production and decay.

- We can use **flavor-specific decays** to get the flavor of the B at decay. To get the **flavor of the B at production** we use three methods:
  - Soft-lepton tags
  - Jet Charge tag
  - Same Side tagging

- We can test these tools using our B^+ data sample

Flavour Tagging results

DØ RunII Preliminary

Method **Based on** **B+ Signal**	Efficiency ε	Dilution D	Tagging Power $\varepsilon D^2 (\%)$
Soft Muon	**5%**	**57%**	1.6 ± 1.1
Jet Charge	**47%**	**27%**	3.3 ± 1.7
Same Side	**79%**	**26%**	5.5 ± 2.0

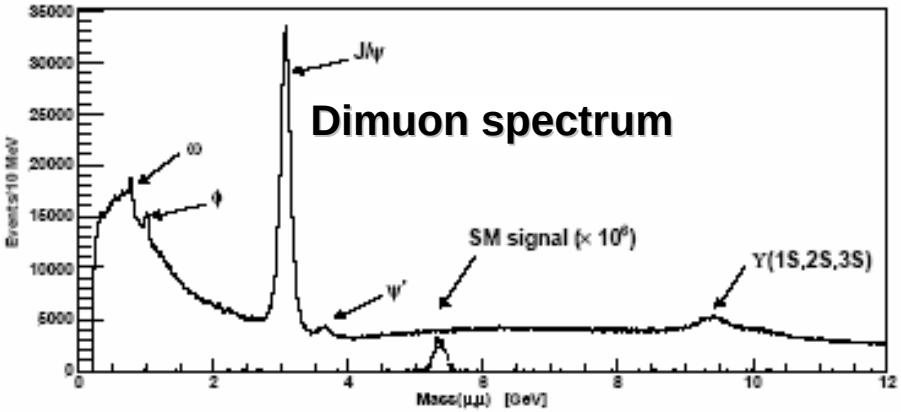
$$D = \frac{N_R - N_W}{N_R + N_W}$$

$$\varepsilon = \frac{N_R + N_W}{N_R + N_W + N_{notag}}$$

Muon DATA, we will also use electrons

Performance with B^0/B_s is under study

Search for $B_s \rightarrow \mu^+\mu^-$

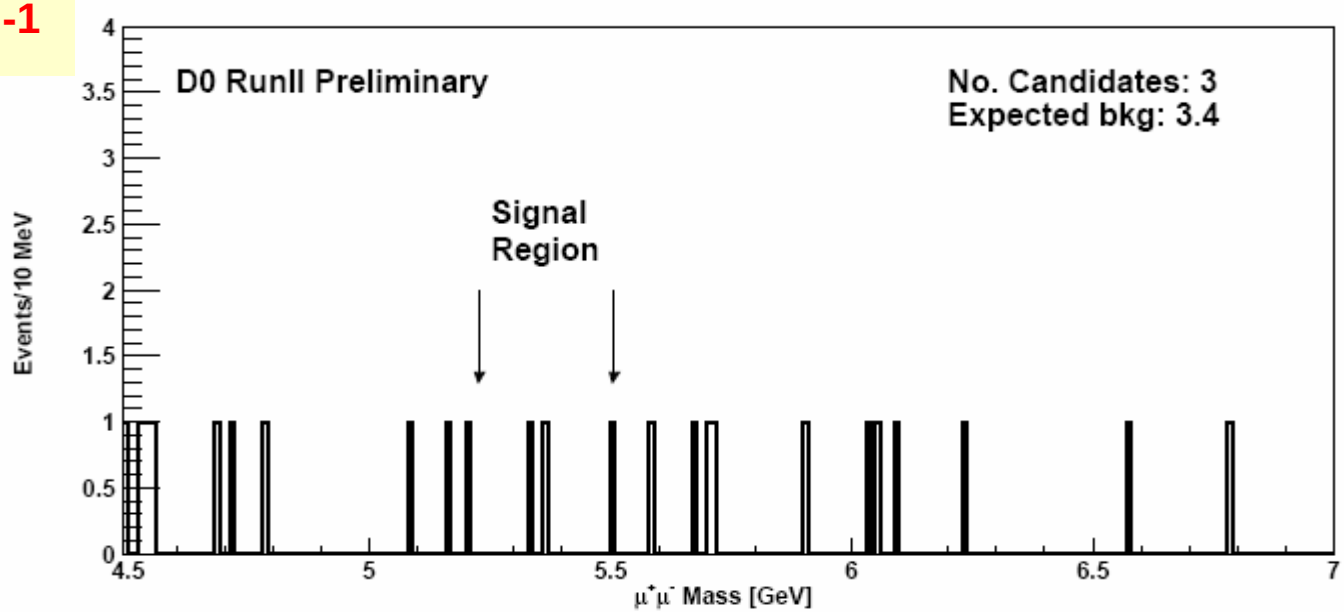


SM: $Br(B_s \rightarrow \mu^+\mu^-) = 3.7 \times 10^{-9}$

Some SUSY tan(β) models can enhance the signal.

$\int Ldt \approx 100\ pb^{-1}$

No Excess Seen.



$Br(B_s \rightarrow \mu^+\mu^-) < 1.6 \times 10^{-6}$ at 90% CL

Summary

- DØ has observed the X(3872) particle in 200 pb^{-1} data
- We have reprocessed ≈ 200 pb^{-1} of data to better improve our analyses.
- D0 will be able to study B_s mixing
- Tevatron is performing well.
  - D0 recorded 9.4 pb^{-1} last week.
- Lots of data.
- Many more interesting results coming very soon!