B Reconstruction
&
Spectroscopy
at DØ

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Kansas State U.
October 15th, 2003
(presented by Vivek Jain)

B Spectroscopy at the Tevatron

Positive aspects:

- All b hadrons are produced (B0 B+ Bs Bc Λ_b)
- Huge cross section - $(p\bar{p} \to b\bar{b}) \approx 150\,\mu b$

Negative aspects:

- Almost overwhelming QCD background
  - Reliable reconstruction necessary
  - Efficient triggers needed
- Soft Pt spectrum $\rightarrow$ lower boost compared to LEP

Accelerator performance

	Run Ib	Run IIa	Run IIb
# bunches	6X6	36X36	140X133
$\sqrt{s}$ (TeV)	1.8	1.96	1.96
$L\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}$	1.6E31	8E31	2-5E32
Bunch x-ing (ns)	3500	396	132(?)
Int./x-ing	2.8	2.4	2-5

Currently $L_{inst} \approx 3-4\mathrm{E}31\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}$

- Have $\int L \approx 215\ \mathrm{pb}^{-1}$

Track Reconstruction

D0 Run II Detector - Tracking

Silicon Tracker

- Four layer barrels (double/single sided)
- Interspersed double sided disks
- 840,00 channels

Fiber Tracker

- Eight layers sci-fi ribbon doublets (z-u-v, or z
- 77,800 835um fibers w/ VLPC readout

Central Preshower

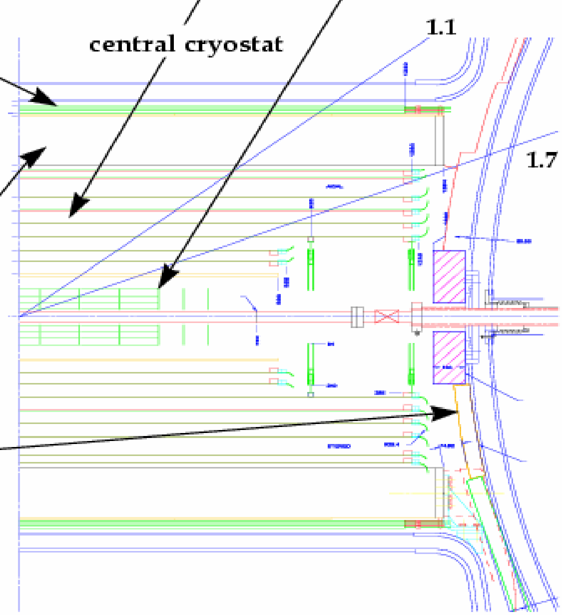
- Scintillator strips, WLS fiber readout
- 7,680 channels
- VLPC readout

Solenoid

- 2T superconducting

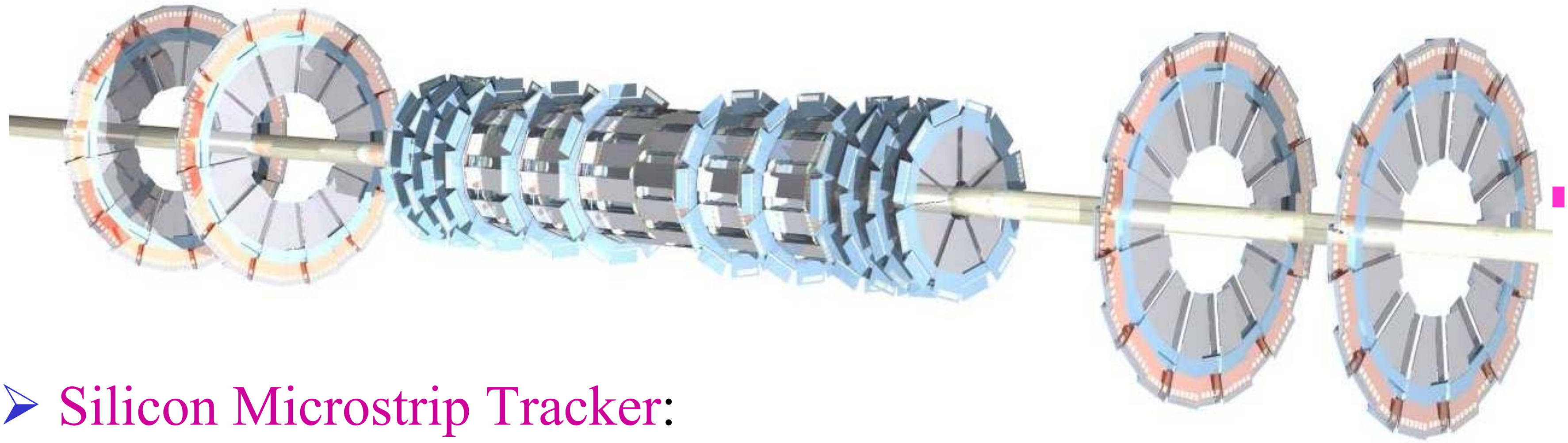
Forward Preshower

- Scintillator strips, stereo, WLS readout
- 14,968 channels
- VLPC readout



Tracker radius 20-50 cm

Pre-showers used for electron-ID



- Silicon Microstrip Tracker:
- 6 Barrels: 4-layers, Single/Double sided,
  2/90 deg. stereo, $|z|<0.6$ cm, Radius: 2.7-10 cm
- 12 Central F disks: D-Sided, $\pm$ 15 deg stereo
- 4 Forward H disks: S-sided, $\pm$ 7.5 deg stereo,
  $|z| = \pm$ 1.1/1.2 m, Radius: 9.5-20 cm
- Tracking to $\eta \approx 3$ ($\theta \approx 6^\circ$)

793K channels
>95% active

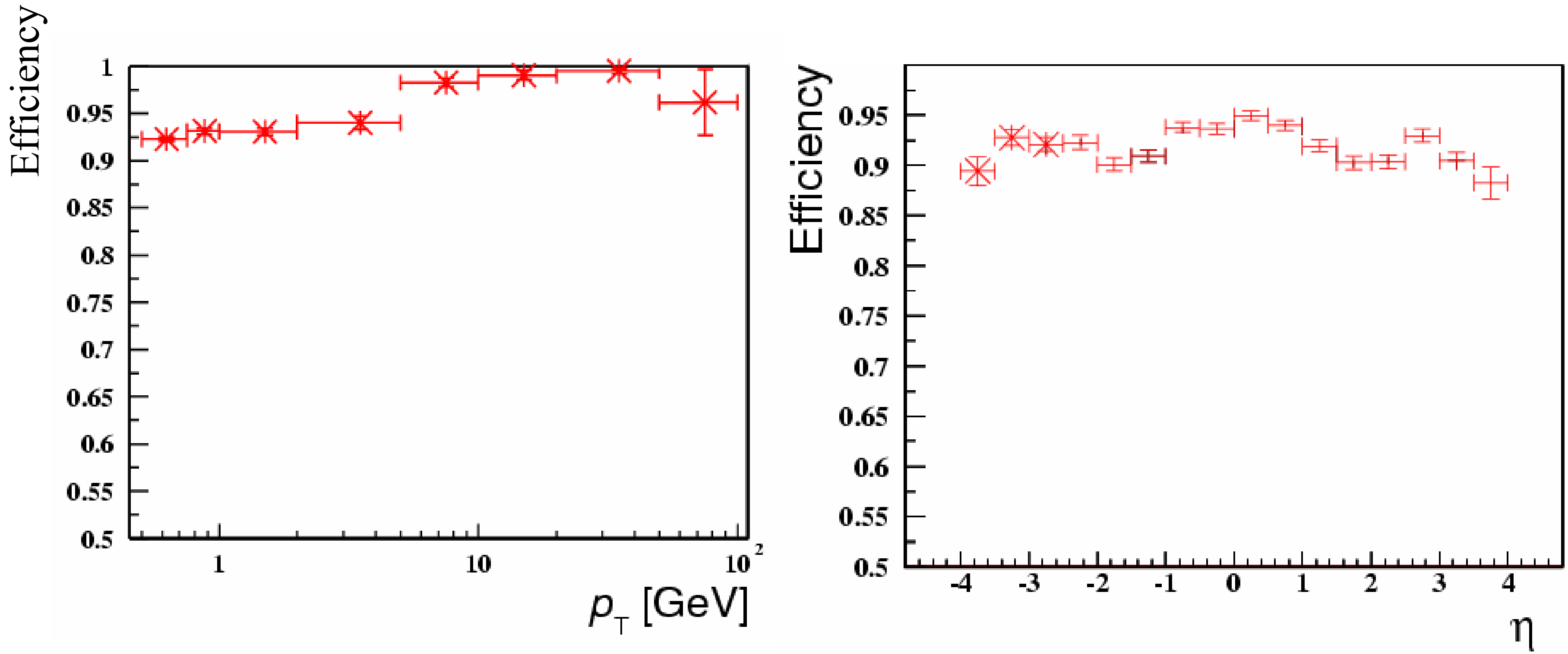
Rad. hard to
1 MRad

Hit resolution is 10 μ
Signal/Noise > 10

Excellent Tracking acceptance:

SMT+CFT for |η|<2

SMT only for |η|>2



These are MC estimates – checking in data

Muon ID

- Central and Forward regions, $\eta \approx 2\ (\theta \approx 15^{\circ})$

- Three layers: one inside Toroid, two outside

- Muon system can be used standalone to get pT information
- Fast enough to be in L1 trigger

- Overall Efficiency plateaus at about 85-90% (measd. in data)

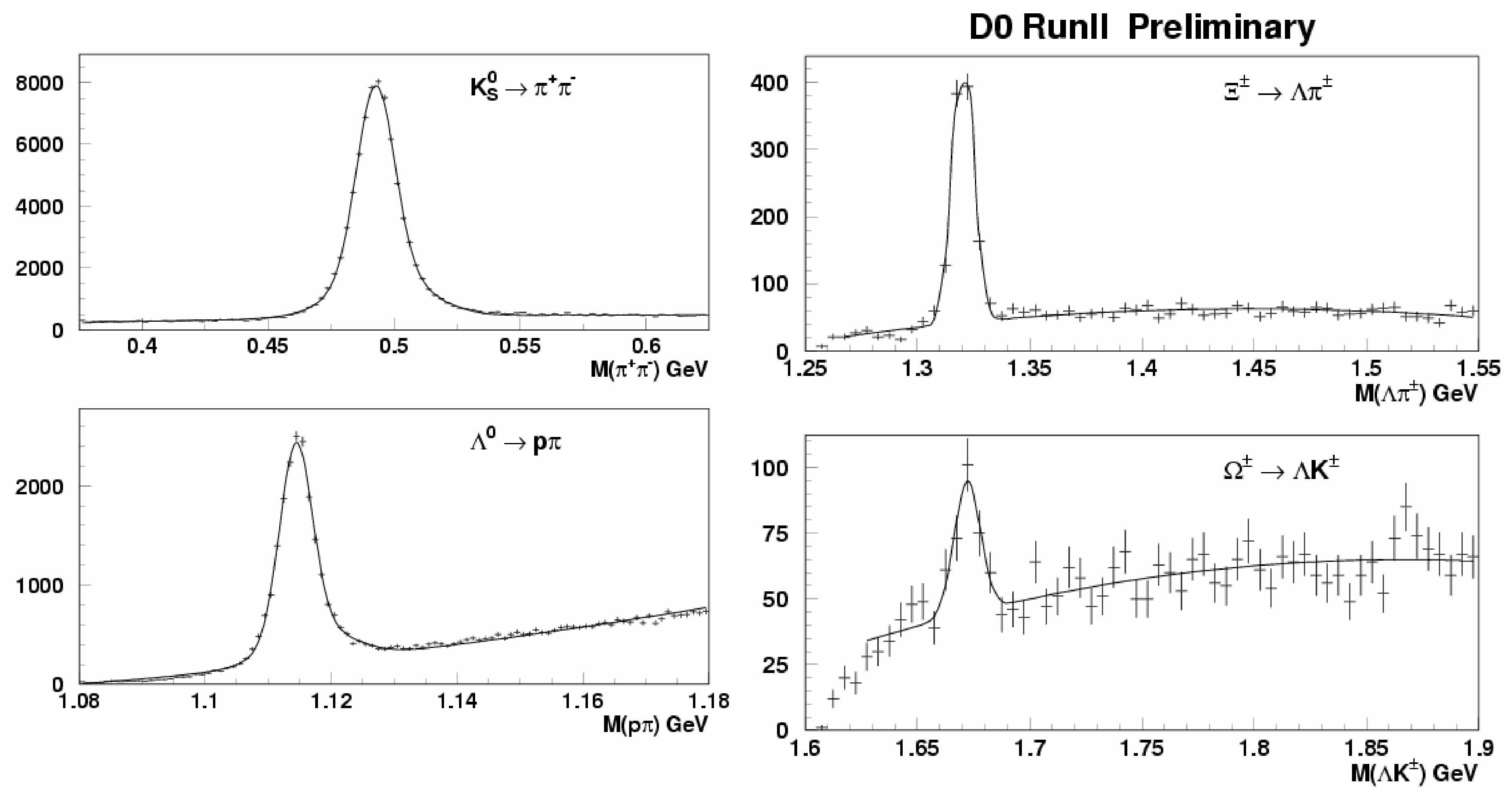
Triggers

- Data were taken with
  - Dimuon trigger
  - Single Muon trigger (matched to L1 track)

- Muon pT>2-4 (function of η)

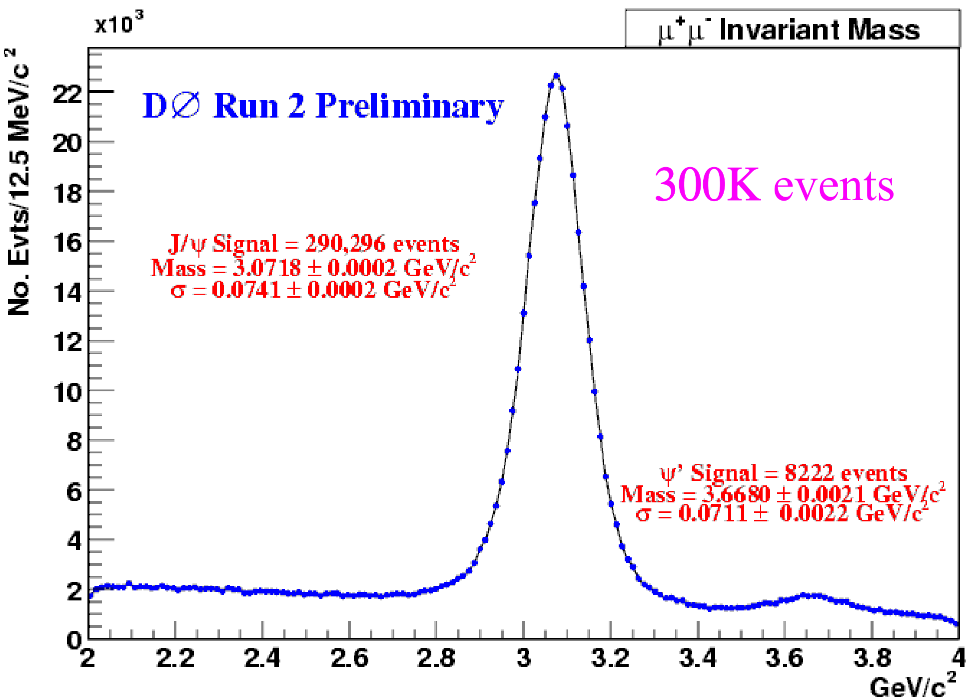
- Dimuon trigger is unprescaled
- Single Muon trigger is (at times) prescaled

Basic Particles

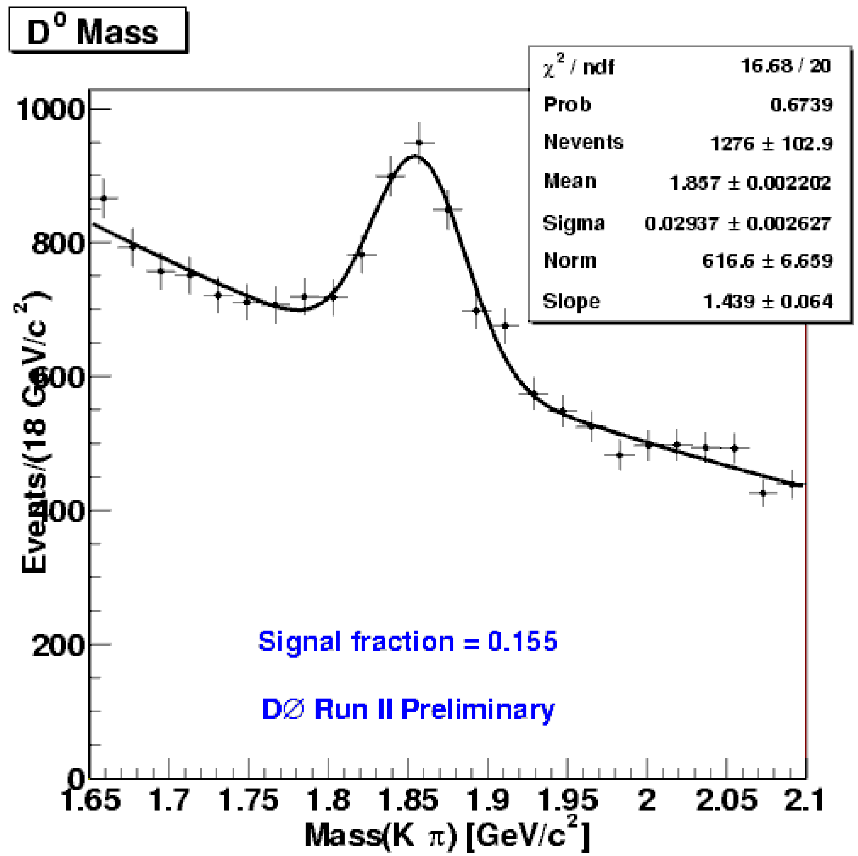


Basic Particles (contd.)

also used for incl. B lifetime

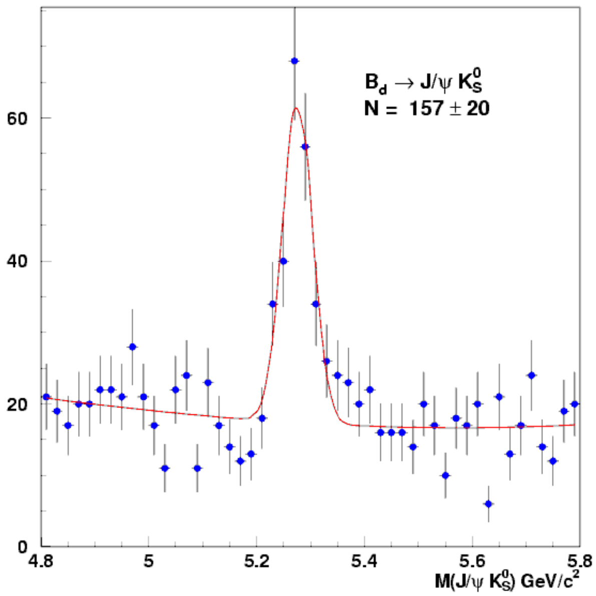


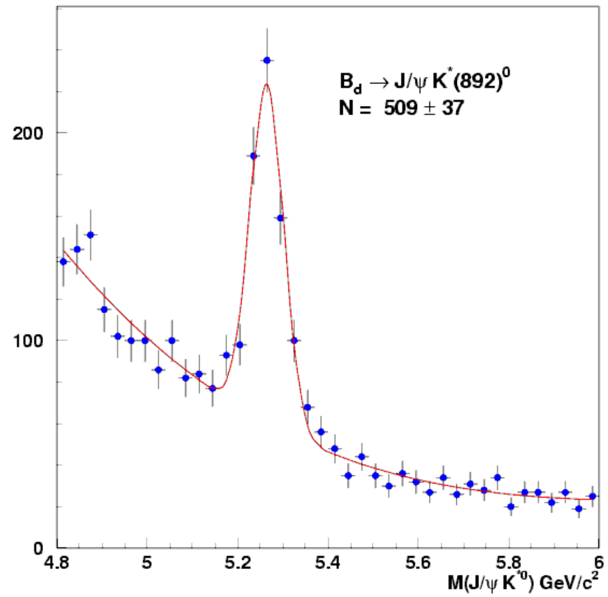
Trigger on soft dimuons

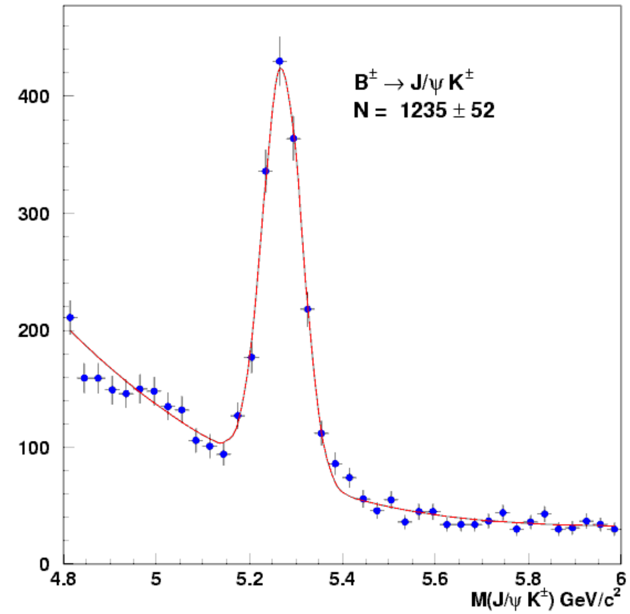


Single Muon trigger

Benchmark B decays

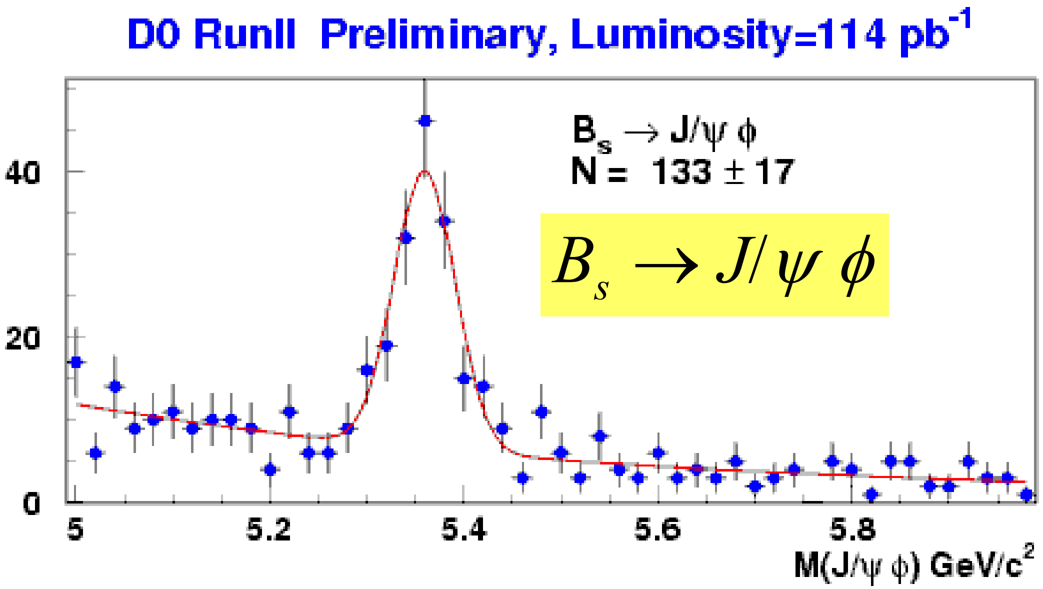


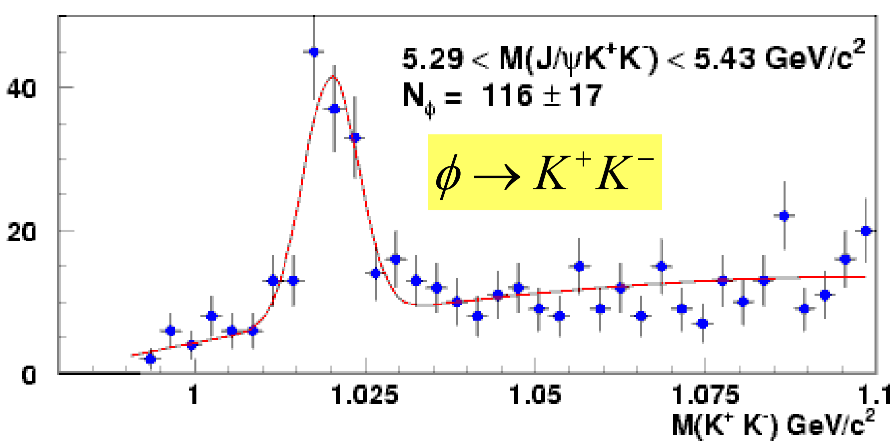


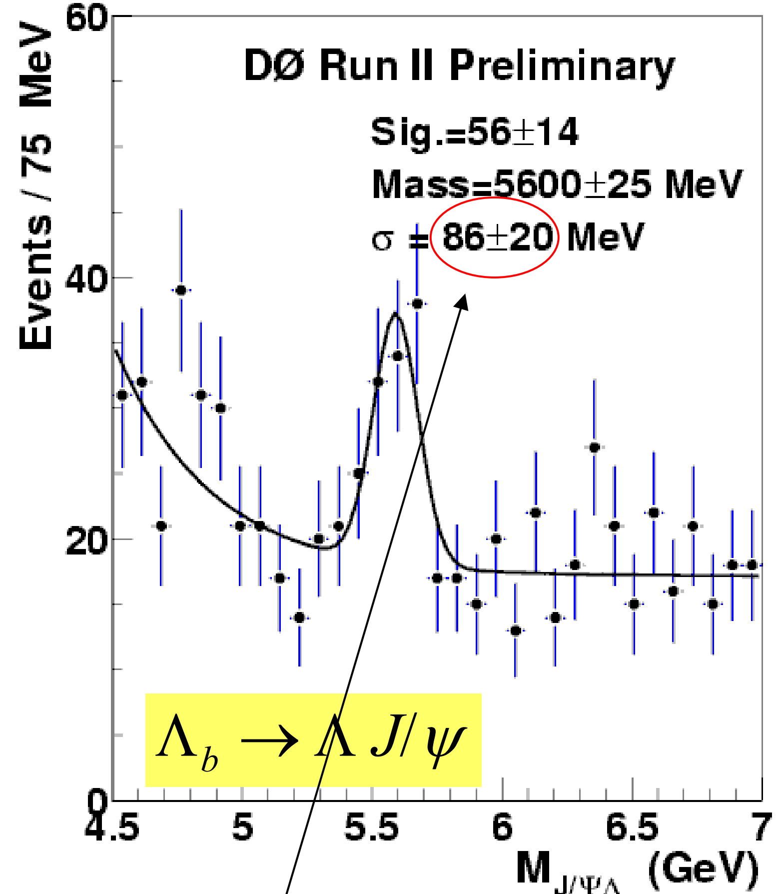


$B^0 \to J/\psi\, K_S^0$	$B^0 \to J/\psi\, K^{*0}$	$B^+ \to J/\psi\, K^+$
157 events	509 events	1235 events
	$L \approx 114\, pb^{-1}$	Flavour tag studies

B_s and Λ_b







Need to fix our mass scale and

Event Estimates for 500 pb^{-1}

All modes use,

$J/\psi \to \mu^+\mu^-$

- $B^+ \to J/\psi K^+$ ≈ 5000
- $B_s \to J/\psi\ \phi$ ≈ 500
- $\Lambda_b \to \Lambda\ J/\psi$ $\approx 250 - 500$

Also study other B-baryons

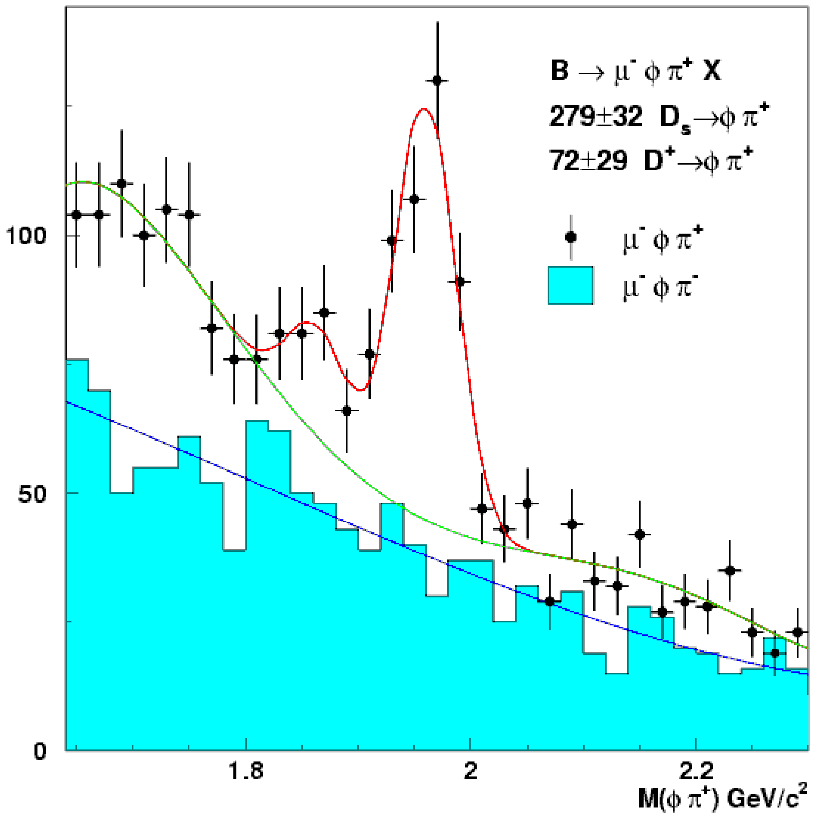
- $B_c \to J/\psi \mu \upsilon$ $\approx 150 - 500$
- $B_c \to J/\psi \pi$ $\approx 40 - 100$

Range is from CDF RunI yield, Ratio of Bc/B+ prod. (0.13 ± 0.042) and our B+ yield

Extrapolated from B+ had/SL br. fractions

Bs Semileptonic samples

$$B_S \to D_S^- \mu^+ \nu + X$$



- Impact Parameter cuts on charm meson daughters
- Pt of π/K > (0.7-1.0) GeV

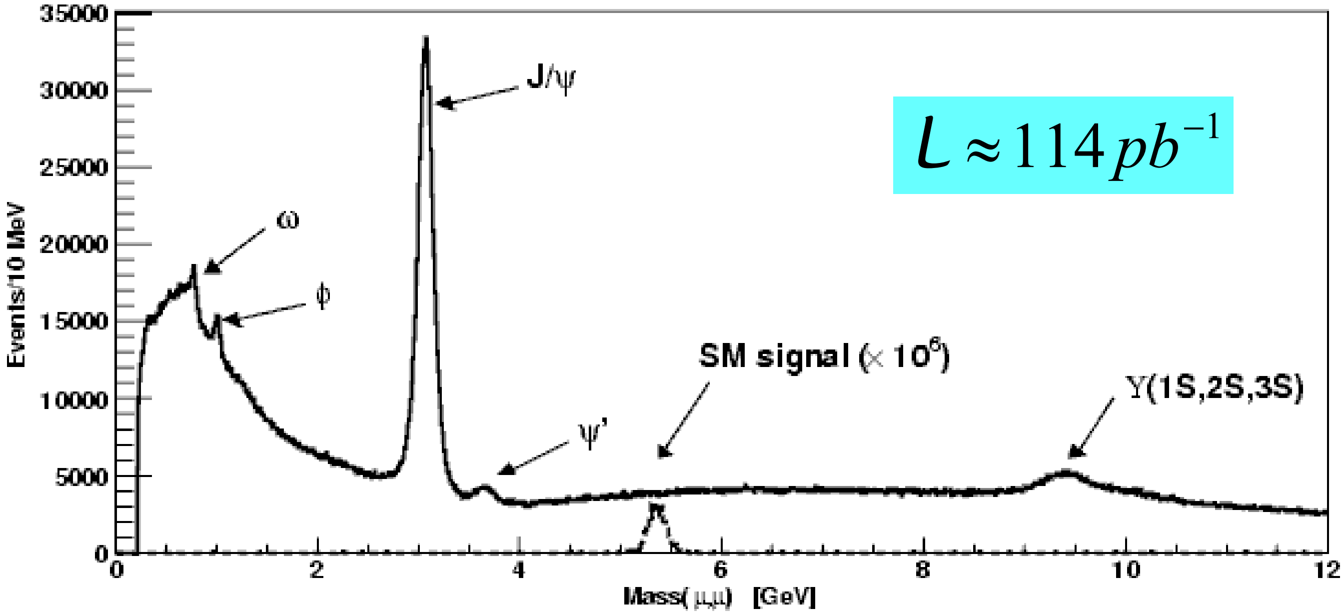
$$\text{Yield} \approx (30 - 40)\ \text{events}/\text{pb}^{-1}$$

Use for Mixing studies

$B_s \to \mu^+\mu^-$

- Rare B decays allow us (among other things) to search for new physics
- Need to consider processes where Standard model contribution is small
- Good example: $b \to s\,\gamma$ or $B_s \to \mu\mu$

- SM prediction $BR(B_s \to \mu\mu) = 3.7 \pm 1.2\ 10^{-9}$
- MSSM [large tan(β)] models can enhance rate by 2-3 orders of magnitude



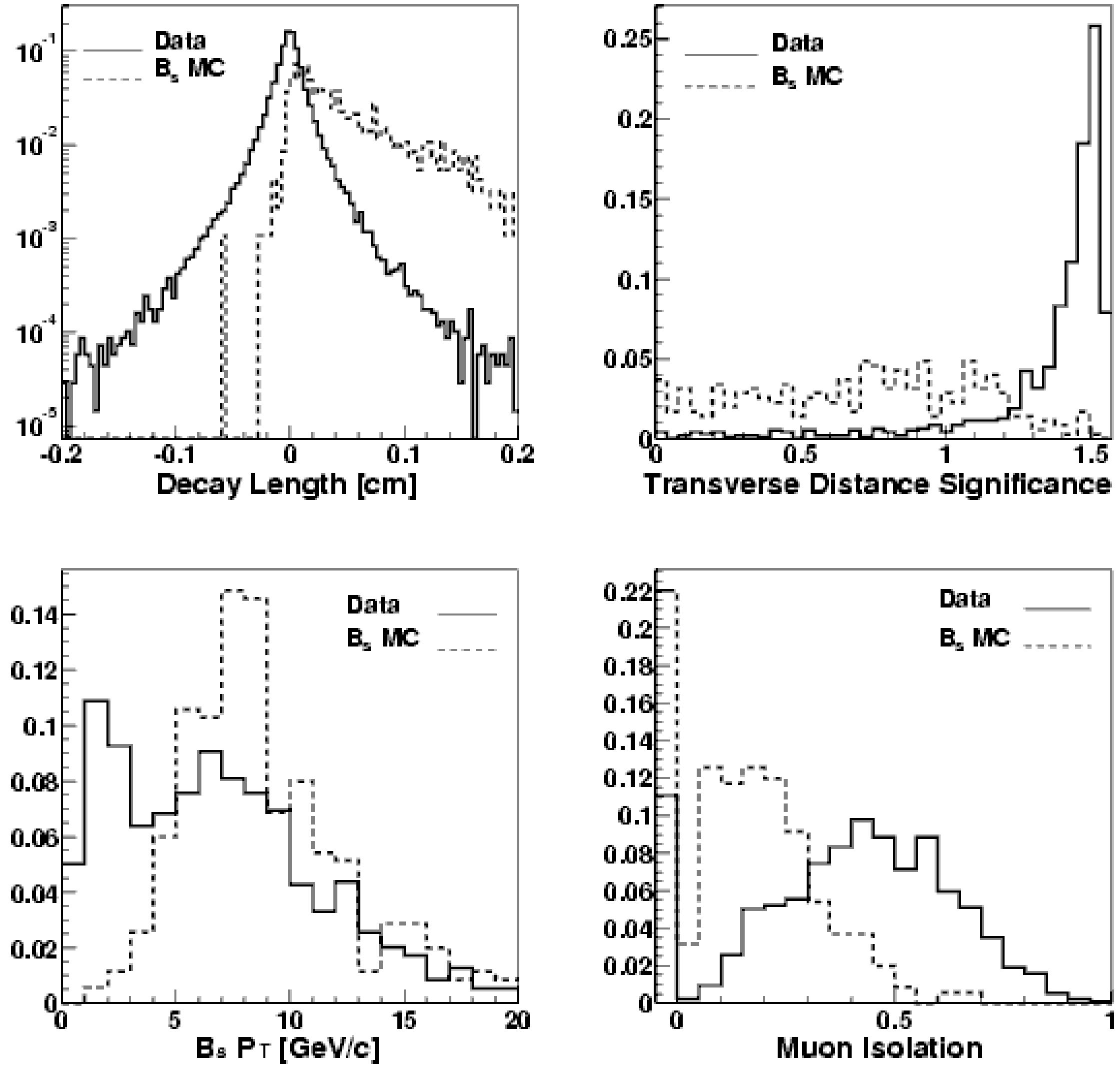
Lot of background

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

Background rejection via

- Decay length
- P_t
- Muon Isolation

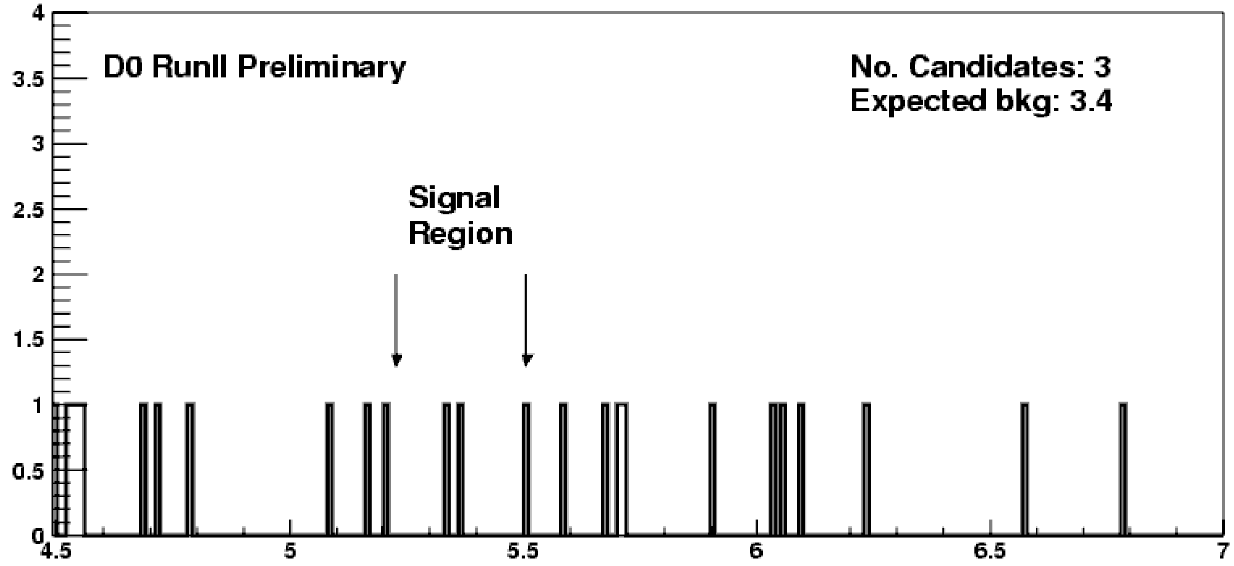
- At the moment, used "square" cuts. Looking into Neural Net/Likelihood approach Eff could increase by 20-30%



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

- No candidate excess in signal window
- Observed 3
- Expected 3.4 BG

  (Feldman-Cousins)



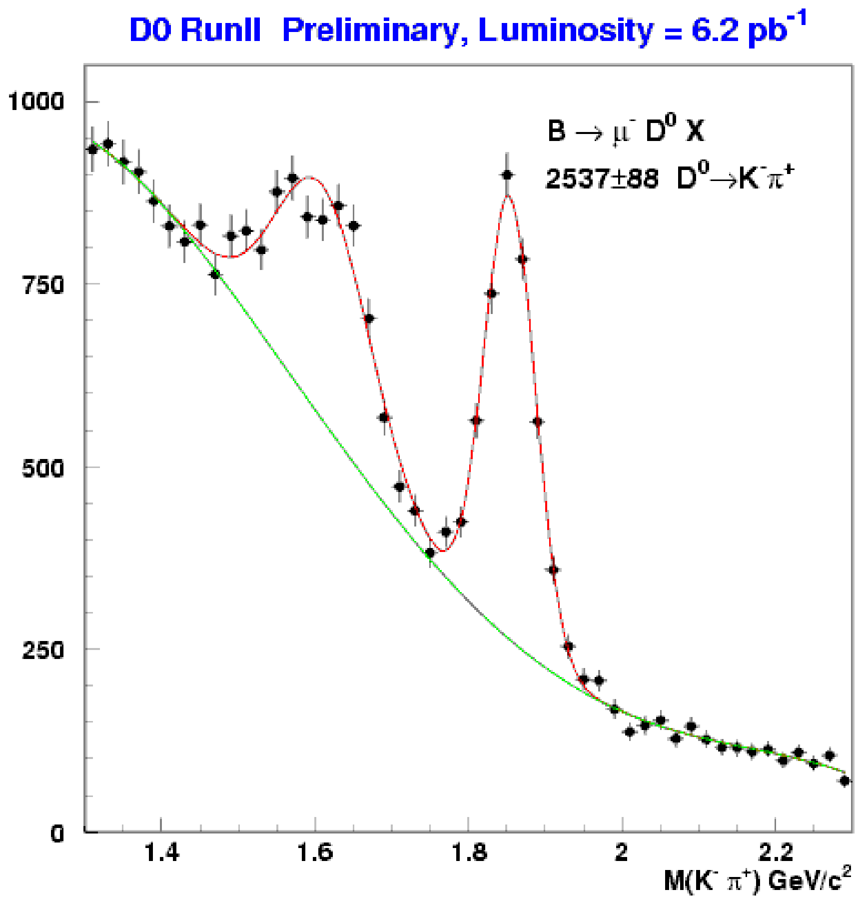
Normalize to B+/Bs

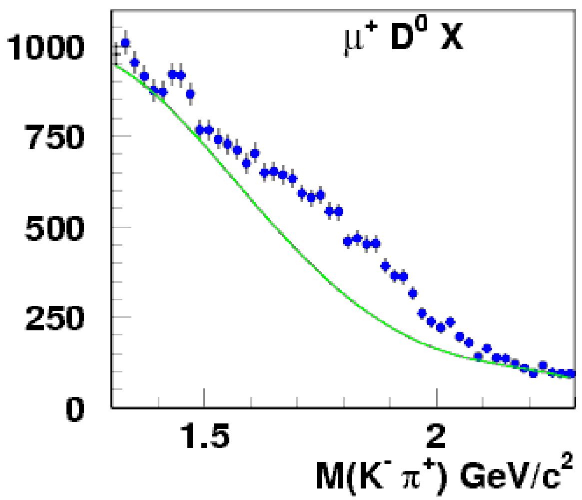
J/ψ final states

BR($Bs \rightarrow \mu+\mu-$) < 1.6 10^{-6}
@ (90% CL)

Single Muon Samples

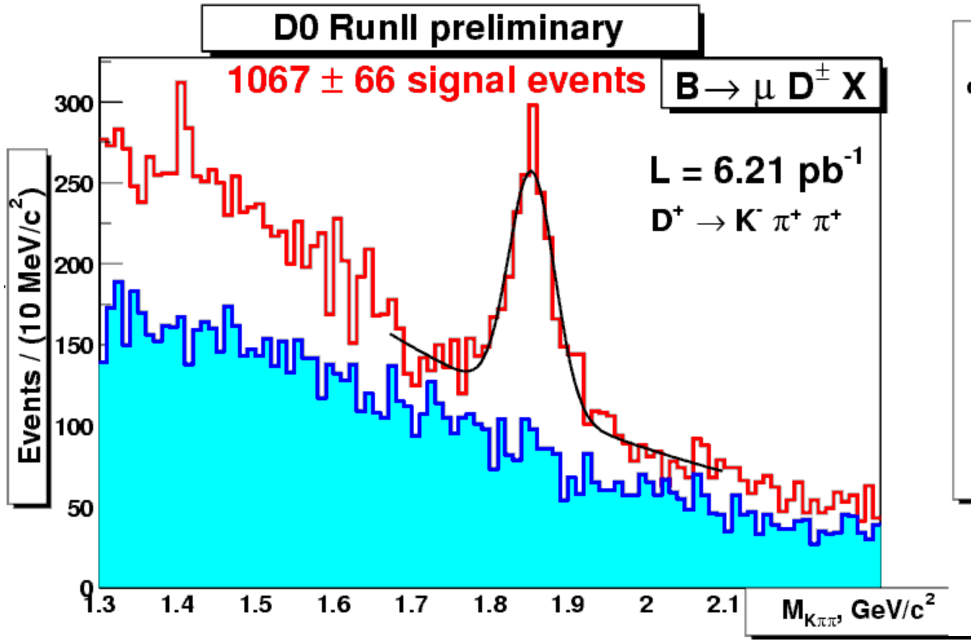
$$B \to \overline{D}^0 \mu^+ \nu X$$

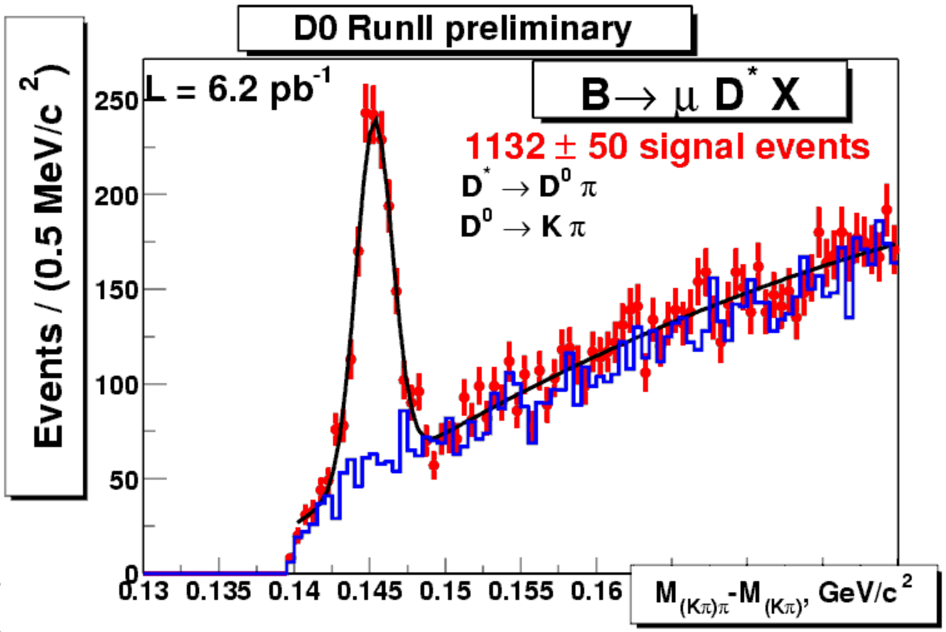




small opposite-sign background

Single Muon Samples

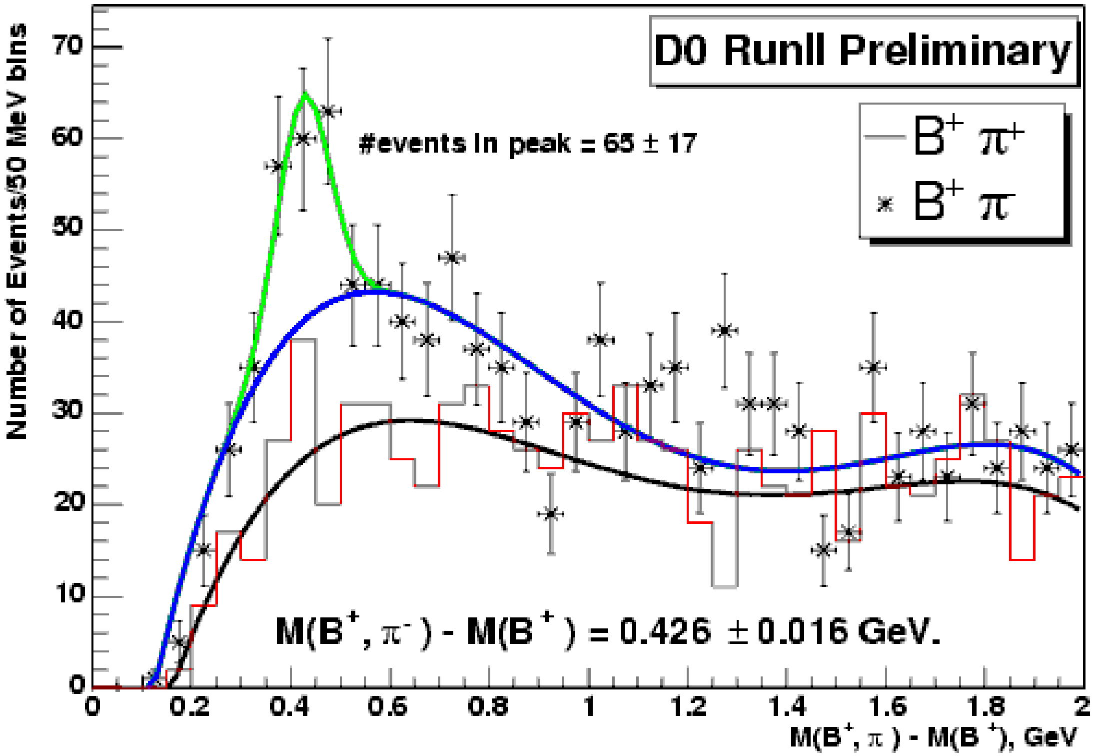




- Much tighter cuts, e.g., IP of K/π > 7 or pT > 2

- No explicit pT cuts on K/π tracks
- Imp. Parameter cuts

B**0



$$B^{**0} \rightarrow B^+ \pi^-$$

- 4 different unresolved B** states expected (within 150 MeV)
- N=65 ± 17
- *Mass* = 5.71±0.016 *GeV*

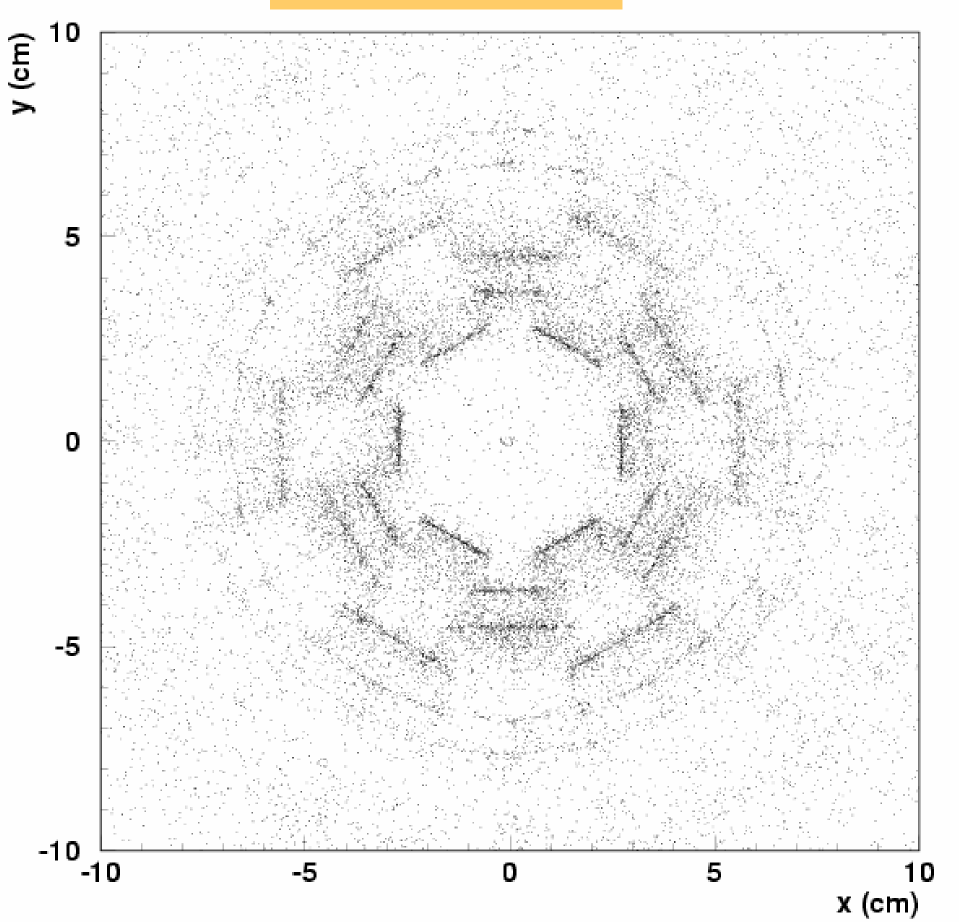
Compare to PDG: *M*= 5.698±0.008 *GeV*

Chi_c Reconstruction

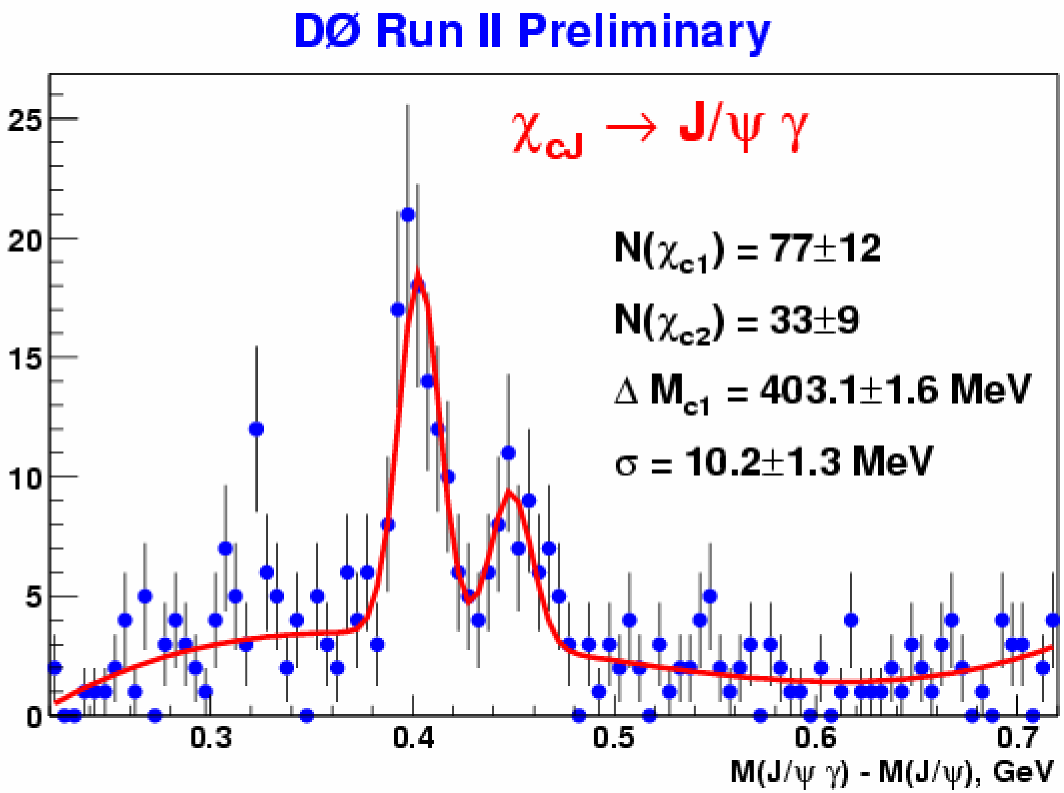
- In Run I, large production rate for direct J/Psi (1-2 orders of magnitude larger than model expectations, e.g., Colour Singlet)
- Expectation was that most of the direct charmonium would be χ_C (CDF measured the fraction of J/Psi from χ_C to be $\approx$ **27%**)

- Use $\chi_C \rightarrow J/\psi + \gamma$ mode, where $\gamma \rightarrow e^+e^-$ good resolution

$$\gamma \to e^{+}e^{-}$$



- X-ray of the detector!
- Also use to tune material in MC (we are now seeing capacitors on SMT hybrid!)
- pT(γ) > 1.0 GeV



- Need to understand efficiency before we can make a statement about relative production ratio of the two states

Conclusions & Outlook

- Making good progress in understanding detector, e.g., mass scale…
- Lots of fully reconstructed B hadrons
- Look for B-baryons, B_c …
- Exciting results down the road