B *PHYSICS IN* CDF II

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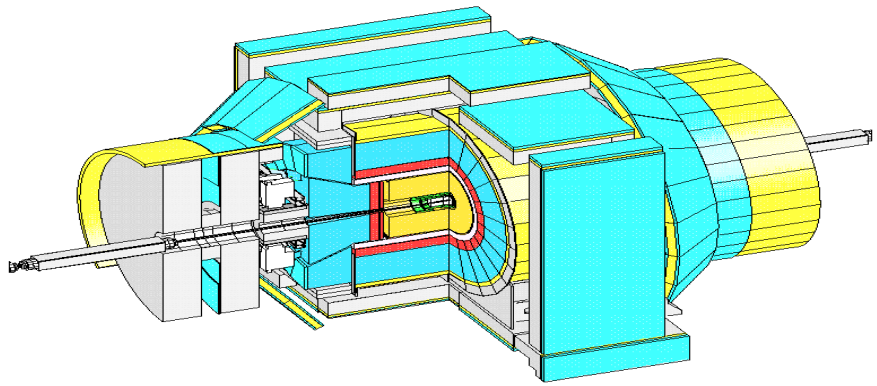
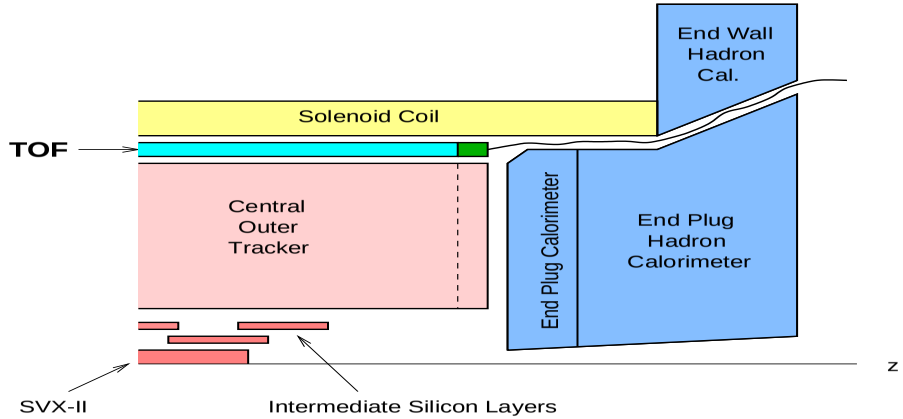
(for the CDF II collaboration)

Fermi National Accelerator Laboratory

DPF 2002, Williamsburg, VA May 23rd-28th, 2002

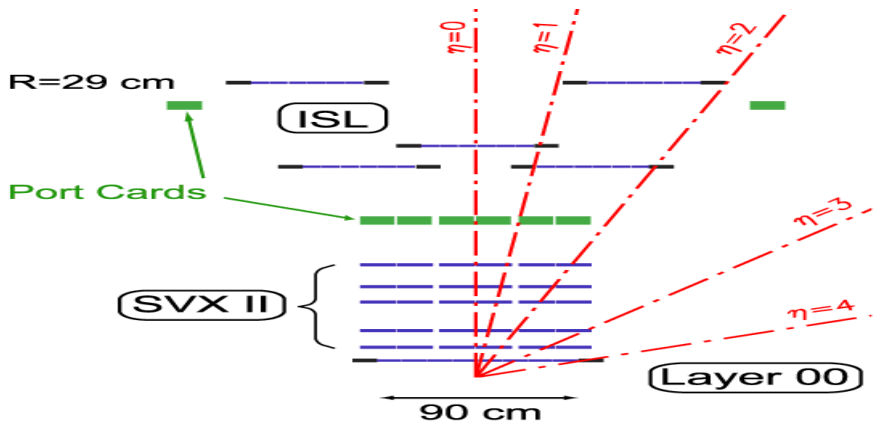
The CDF Run II Detector

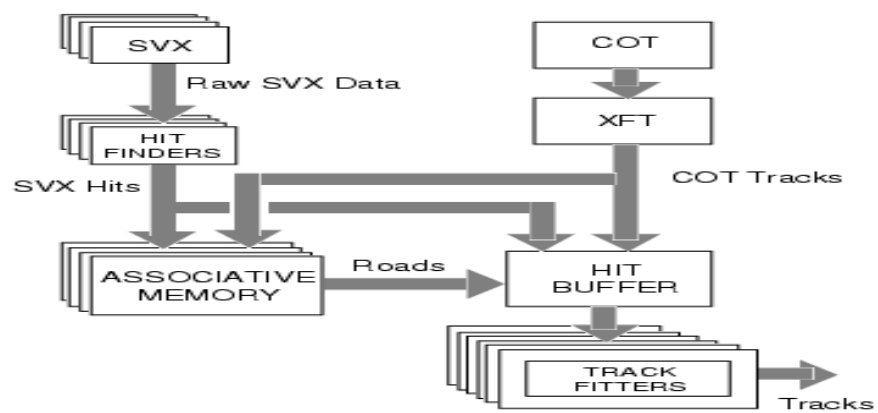




B-physics friendly

TOF for particle ID

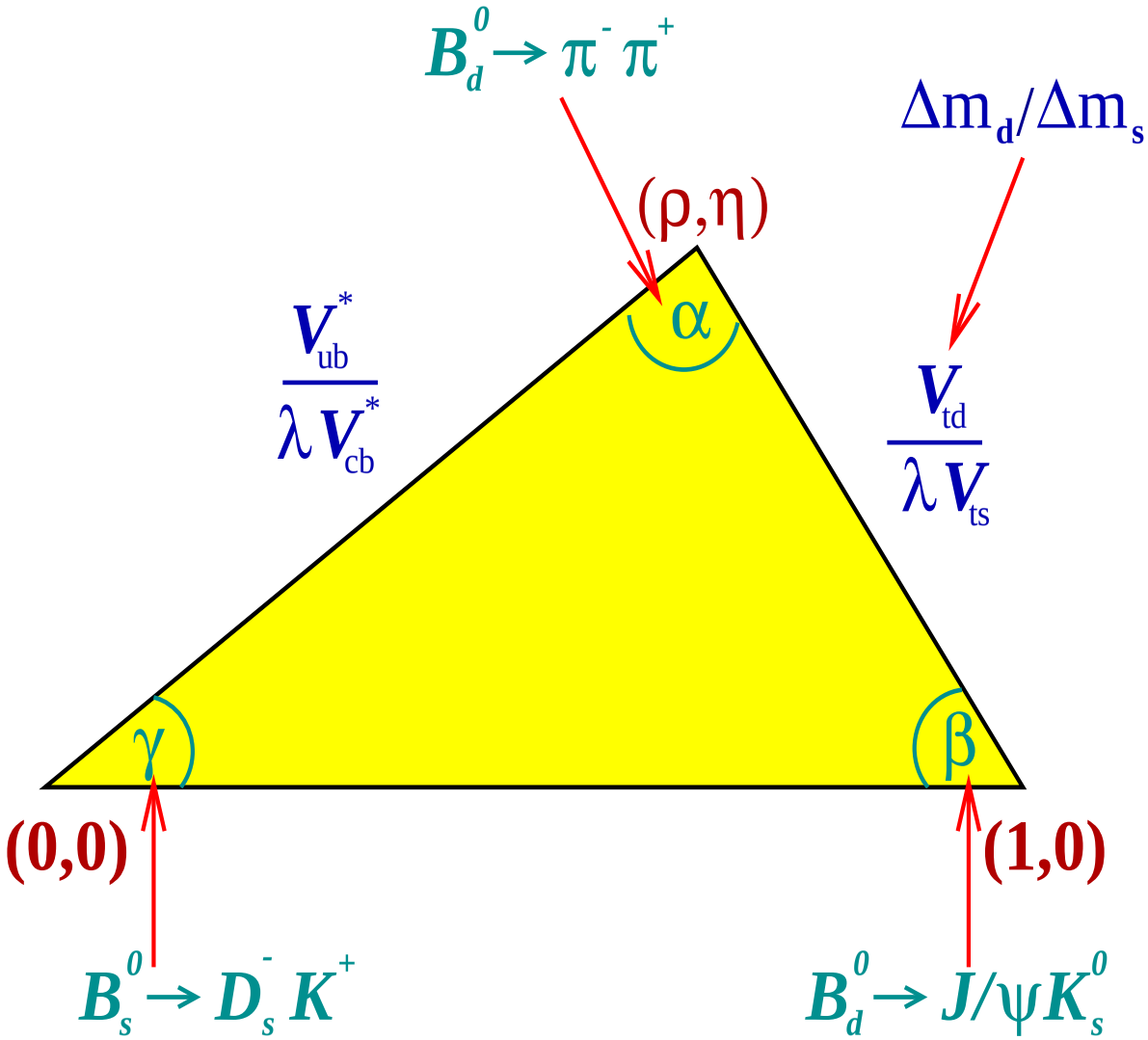


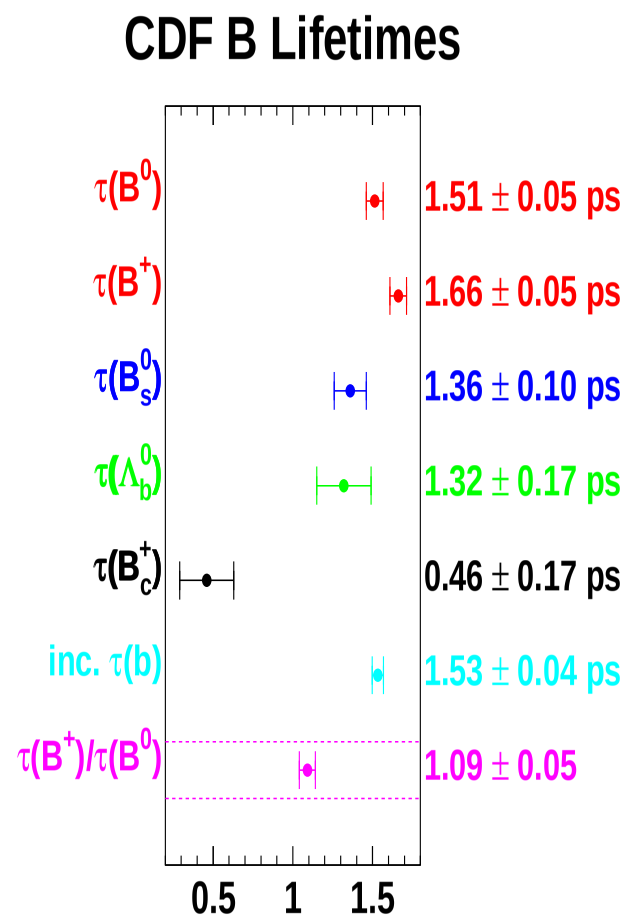


8 Layers of Silicon up to
$|\eta| = 2,\ \sigma(d_0) \sim 20\mu m$

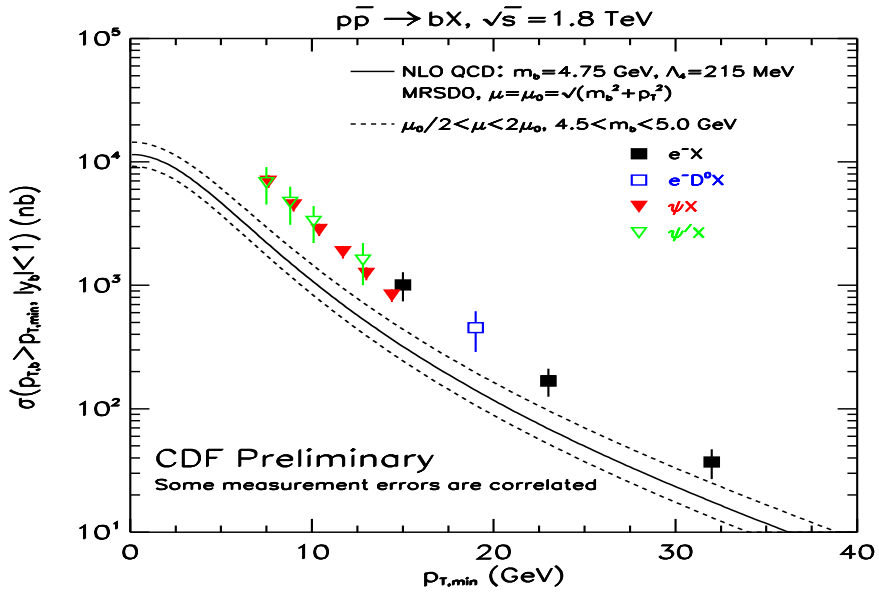
Track Triggers for B hadronic modes

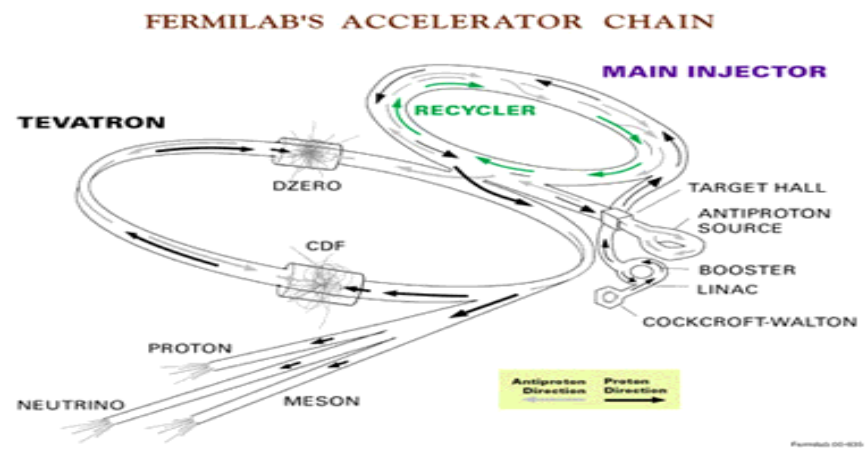
Studying the α, β, γ of B Physics





B's at the the other B Factory

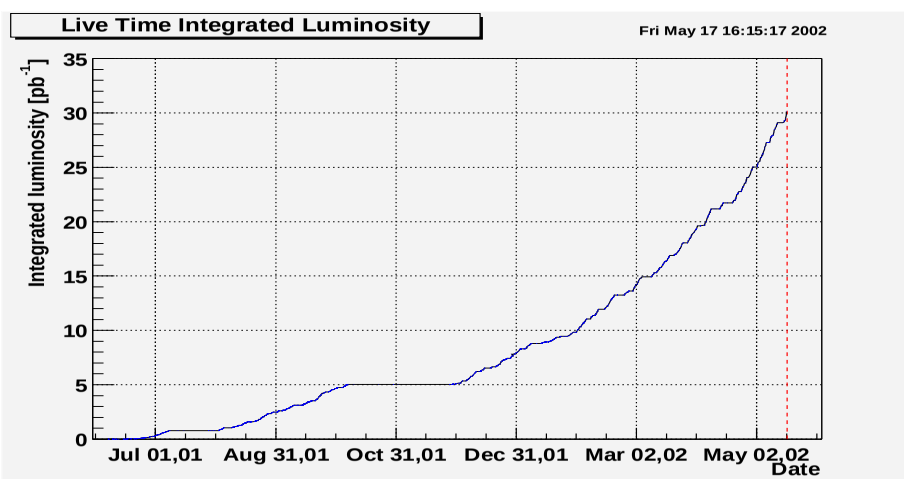


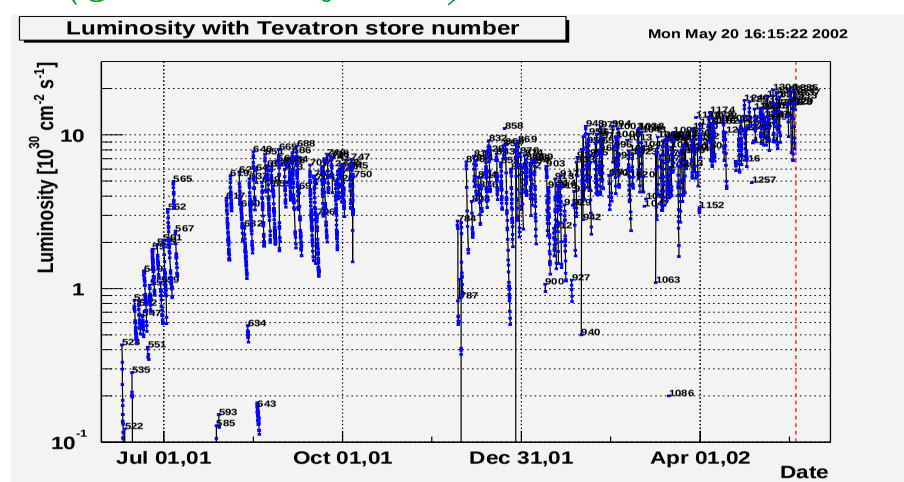


$\times 118$ pb^{-1}

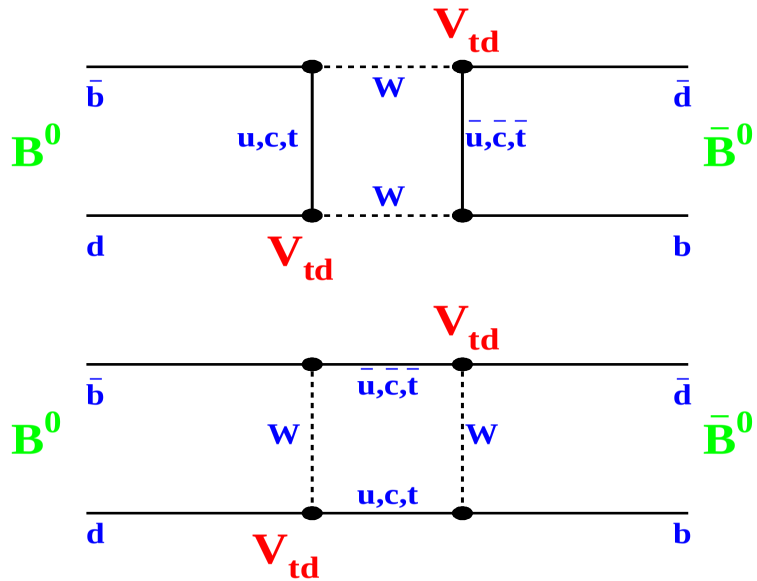
$\sim 5 \times 10^9$ $b\bar{b}$ pairs (Run I)

So far in Run II.. (goal = $2fb^{-1}$)





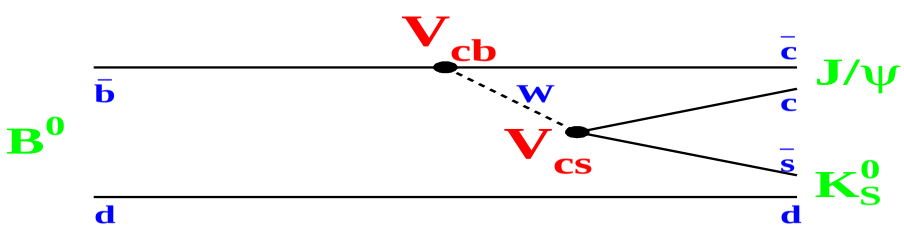
B_d mixing and measuring $\sin 2\beta$

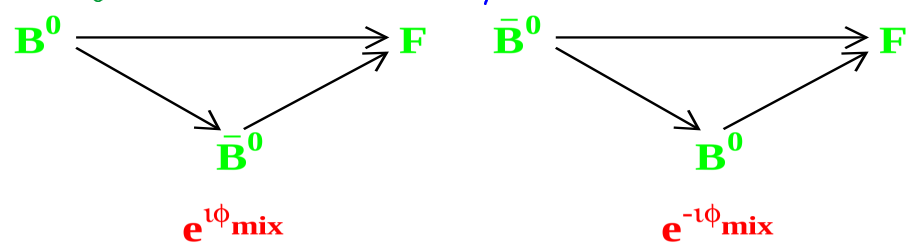


$$B(\bar{B}) \to l^{\pm}X,\ D^{*\mp}l^{\pm}\nu,\ l^{\pm} + jet$$

$$A(t) = \frac{\text{Unmixed}(t) - \text{Mixed}(t)}{\text{Unmixed}(t) - \text{Mixed}(t)} = \cos(\underbrace{\Delta m_d}_{M_{heavy} - M_{light}} t)$$

If $B\bar{B}$ mix AND decay to the same final state $\Rightarrow \not{C}P$

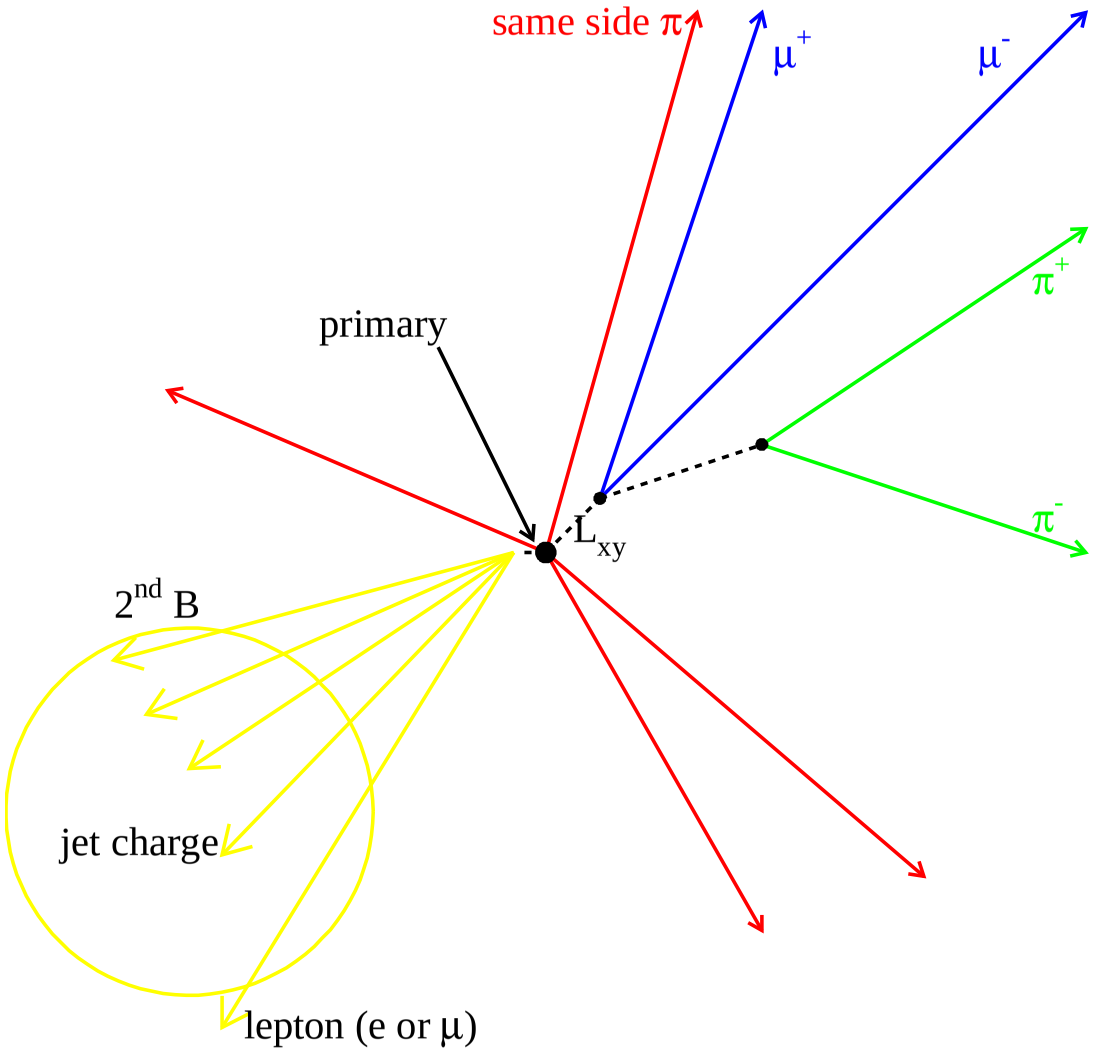




$$A_{CP} = \frac{N(\bar{B} \to f) - N(B \to f)}{N(\bar{B} \to f) + N(B \to f)} = \sin(2\beta)\sin(\Delta m_d t)$$

Flavor Tagging

Tag B flavor at production:.



RUN II $\sin 2\beta$

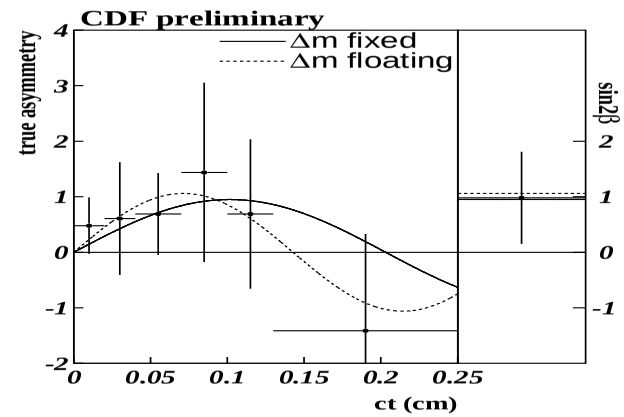
$$D_{ilution} = \frac{N_{Right\ tags} - N_{wrong\ tags}}{N_{Right\ tags} + N_{wrong\ tags}}$$

$$A_{cp}^{observed} = D A_{cp}^{true}$$

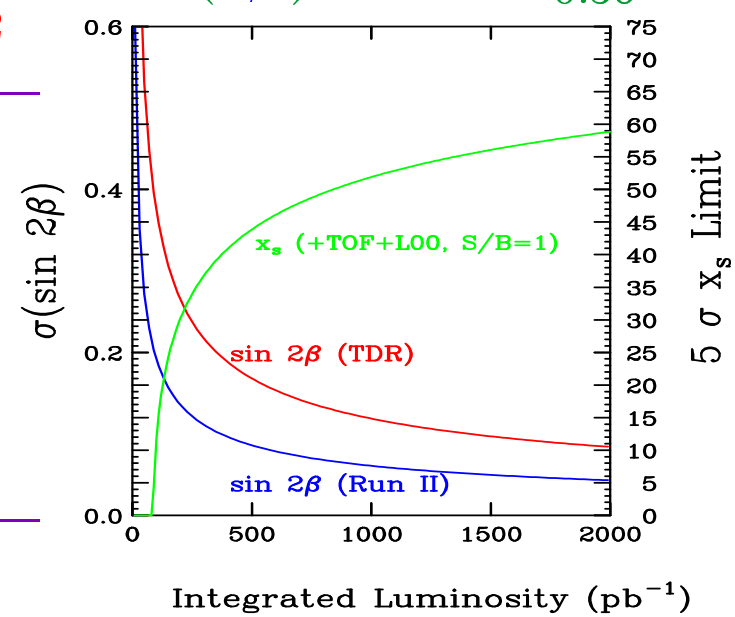
$$\sigma(\sin 2\beta) \sim 1/\sqrt{\underbrace{\epsilon}_{tag\ efficiency} D^2 N_{tot}}$$

Tag	RUN I ϵD^2	RUN II ϵD^2
JetQ	3.0%	3.0%
SLT	1.7%	1.7%
SST(π,K)	(1.4%,1.0%)	(1.9%,4.2%)
OS(K)	-	2.4%
Total (B_d)	6.1%	9.0%

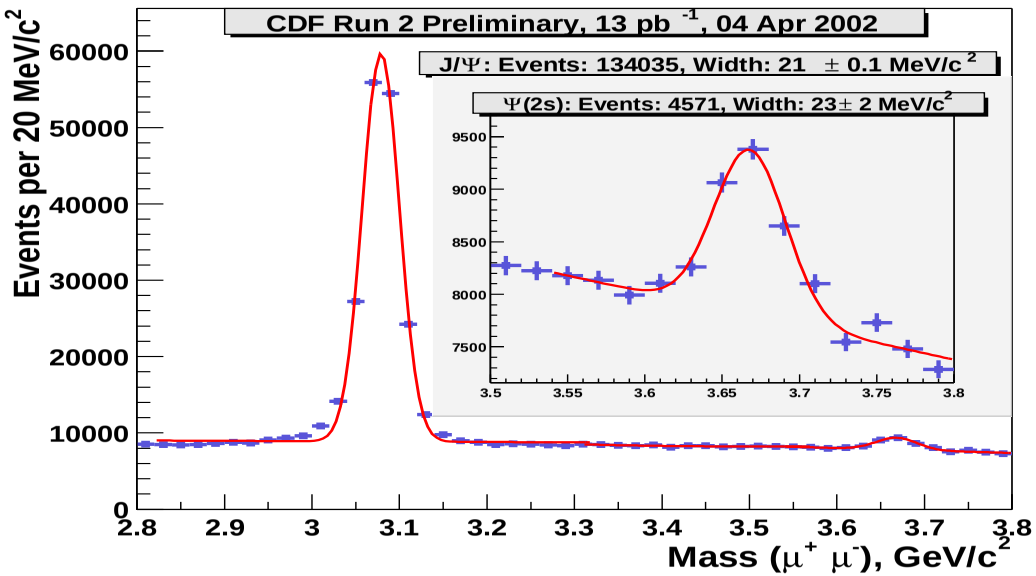
RUN I

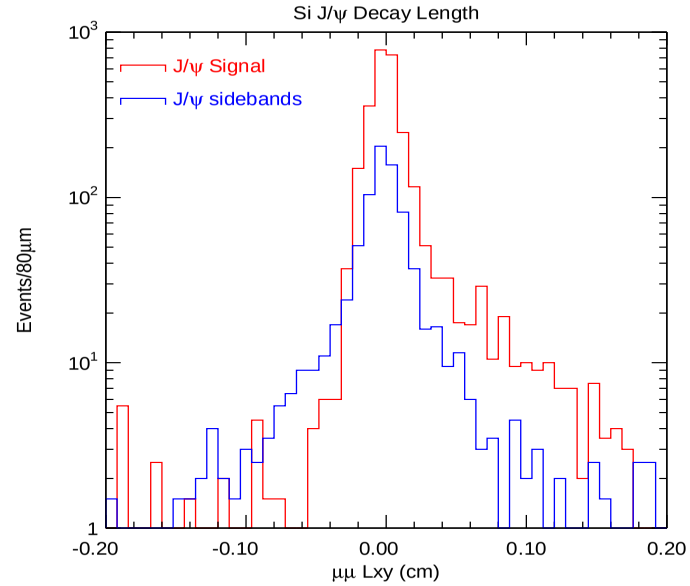


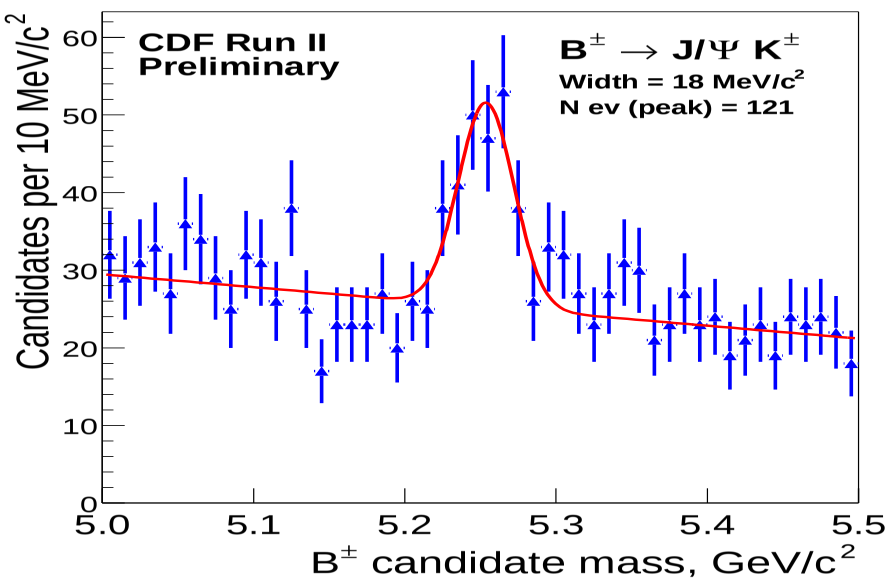
$$\sin(2\beta) = 0.91^{+0.37}_{-0.36}$$

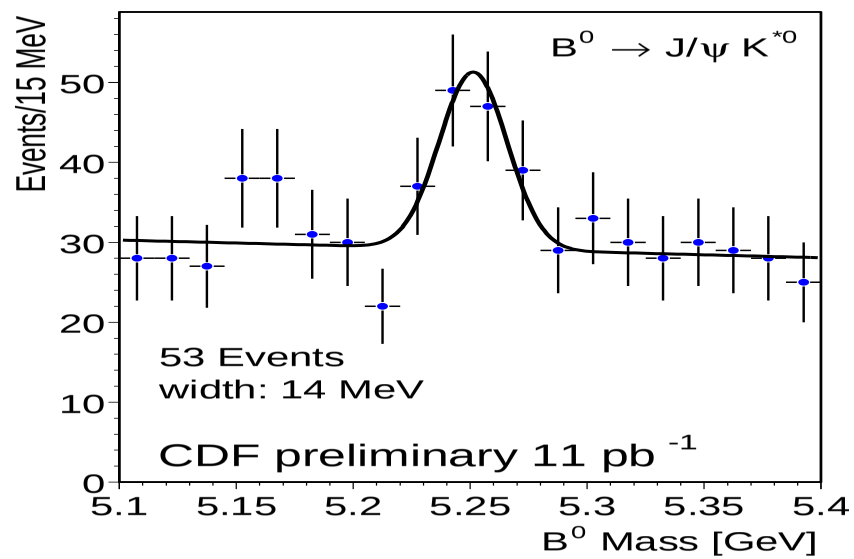


$B \to J/\psi X$ Run II

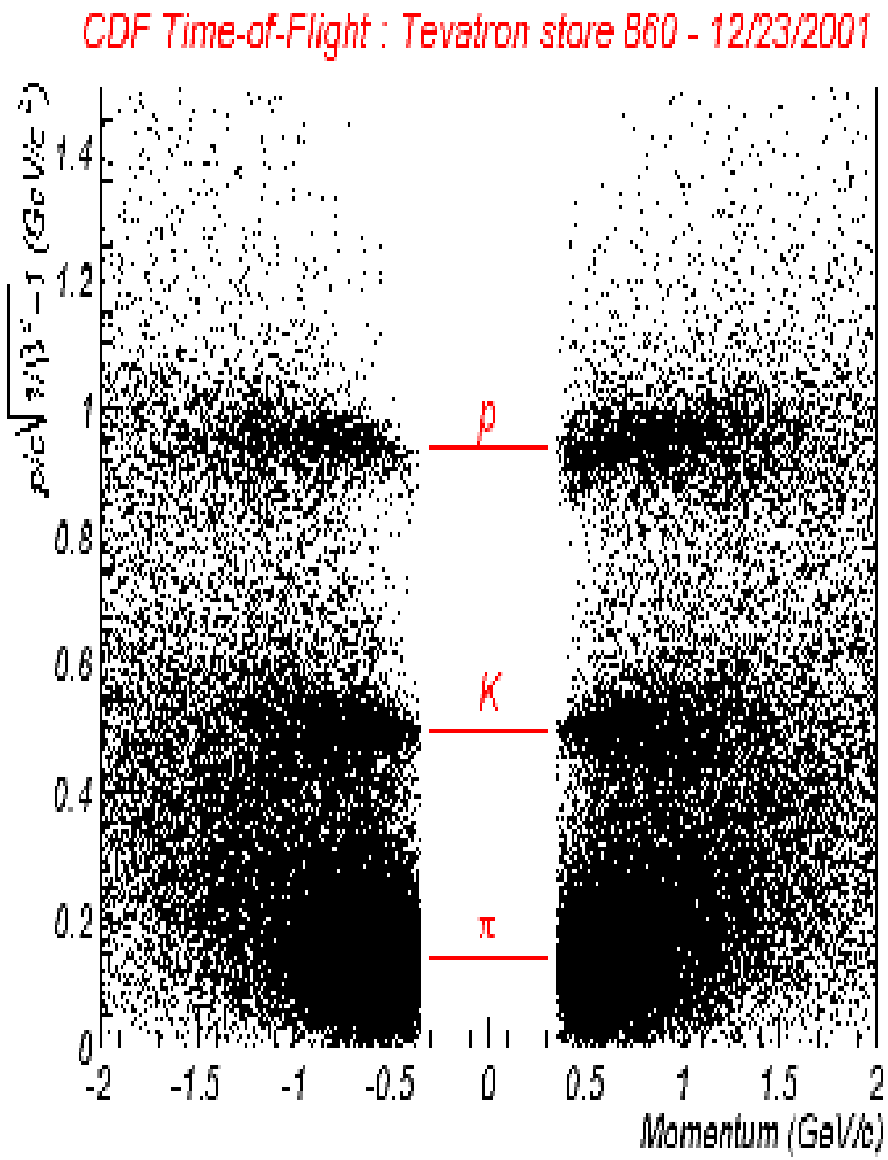


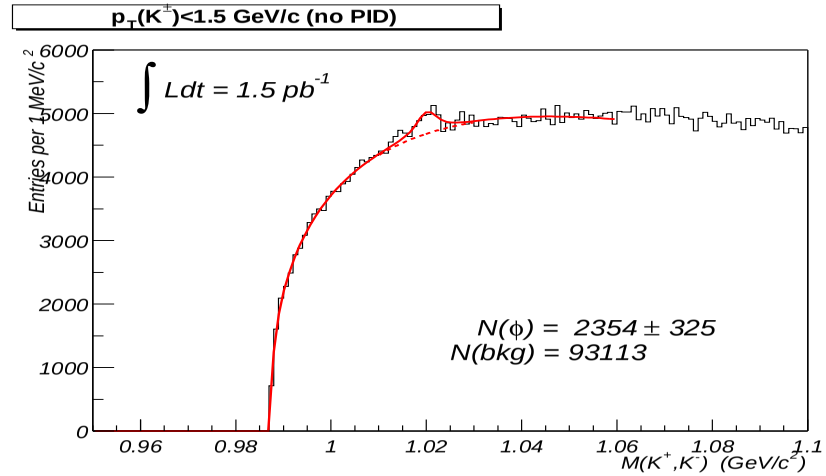




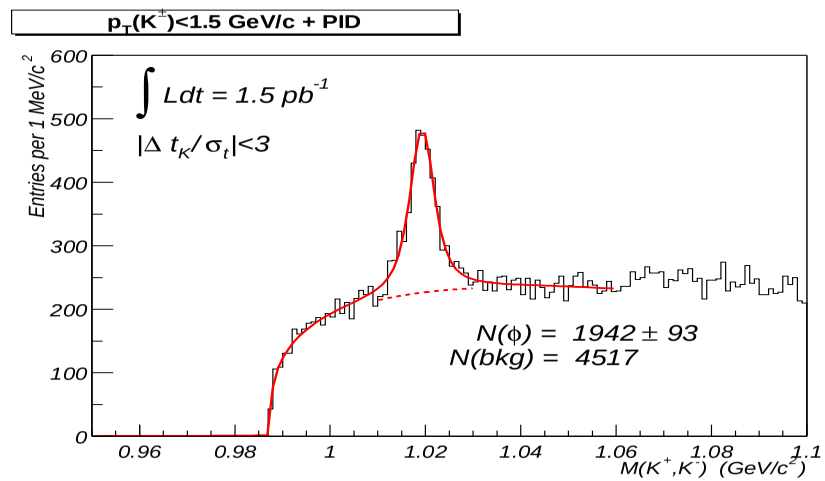


Particle ID: TOF performance



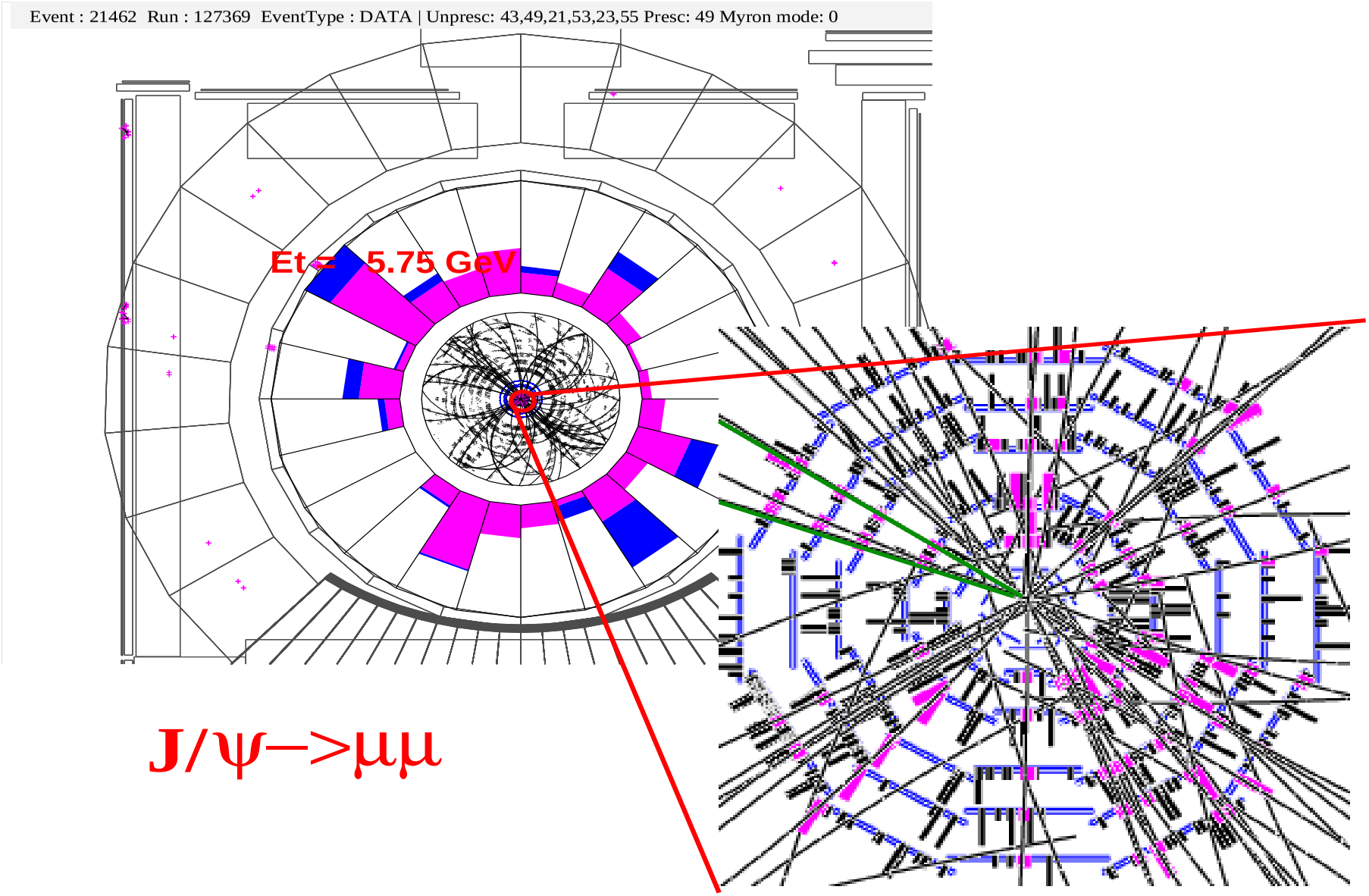


$Raw\ \phi \rightarrow K^+K^-$



$\phi \rightarrow K^+K^- + \mathrm{TOF}$

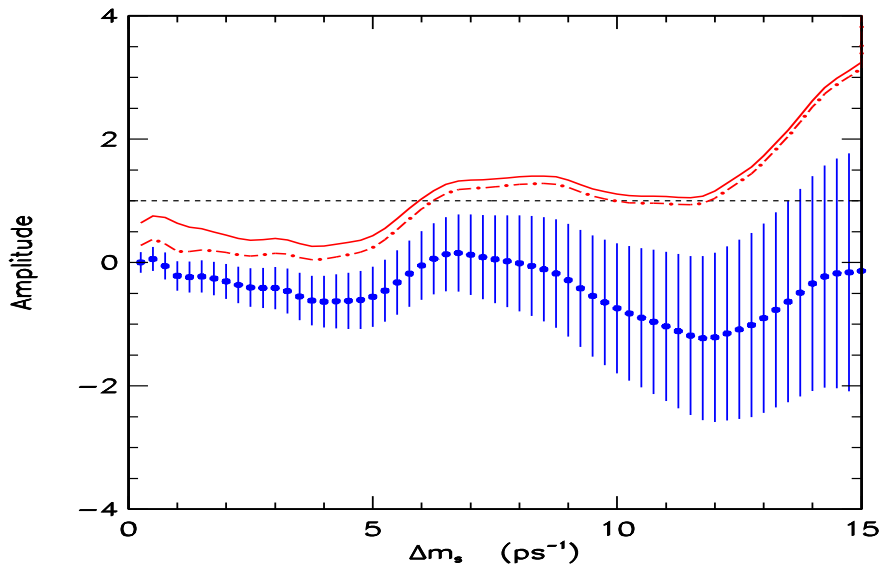
SVXII Events



J/ψ–>μμ

B_s mixing ($\Delta m_s >> \Delta m_d$)

$$P^{B_s^0}_{SS(OS)} = 1/2\tau \exp(-t/\tau) \times [1 \mp \mathcal{A}(\Delta m_s)\cos(\Delta m_s t)]$$



Run I limit :

$\Delta(m_s) > 5.8\text{ps}^{-1}$@ 95% CL.

From $B_s \to \phi\, l\ \underbrace{X\nu}_{direction?}$

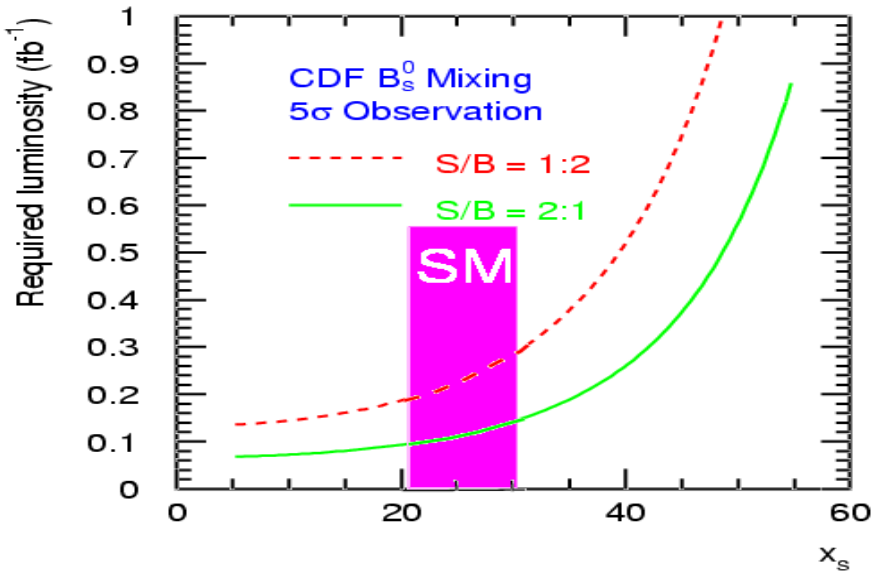
Run II

Hadronic trigger

And L00 + TOF

$B_s \to D_s^{(*)+}\pi^-$ and

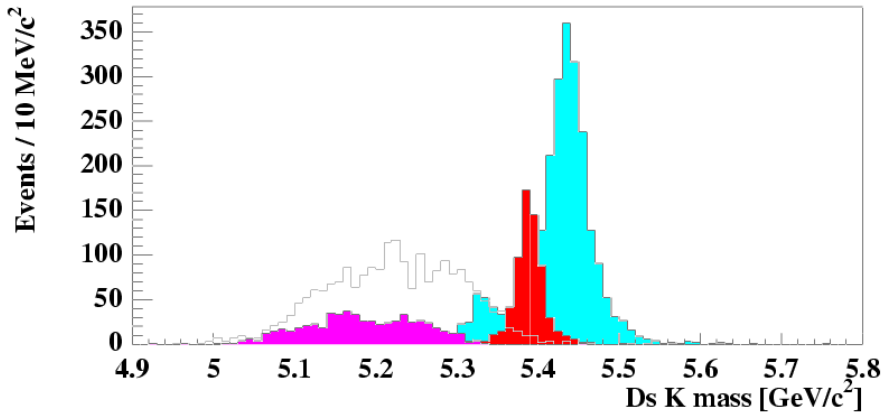
$B_s \to D_s^{(*)+}3\pi$



$X_s = \Delta m_s/\tau(B_s)$

Measuring $\sin\gamma$

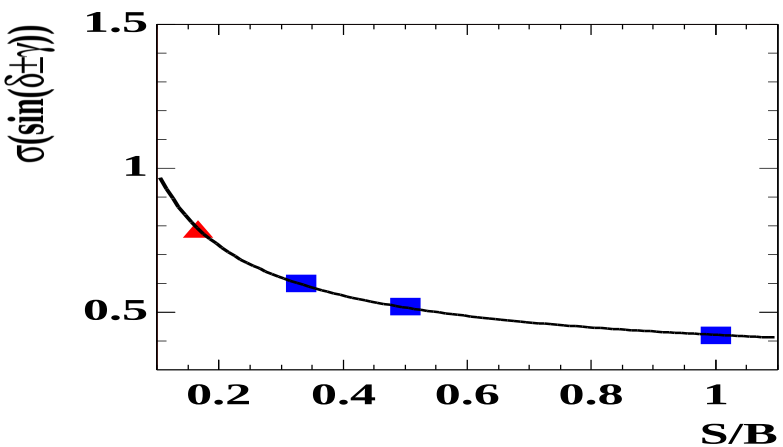
$$\Gamma_{B_s^0 \to D_s^\mp K^\pm}(t) = Ae^{-t}[1 \pm R\cos x_s t \pm \sqrt{1-R^2}\sin(x_s t)\sin(\delta+\gamma)]$$

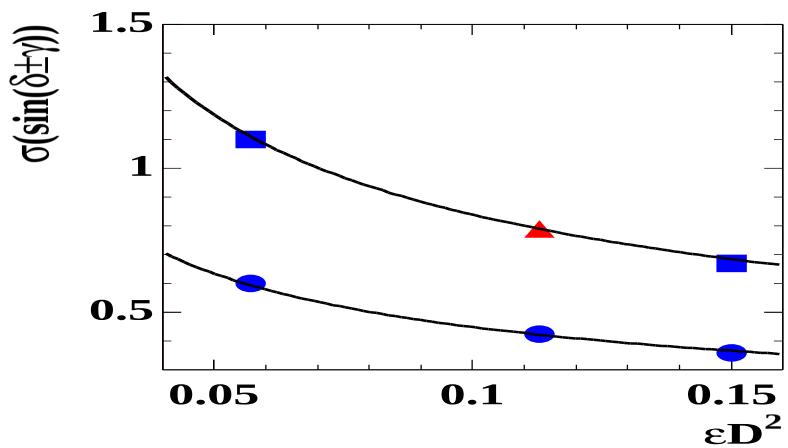


$B_s^0 \to D_s^\mp K^\pm$ expected yield

and backgrounds:

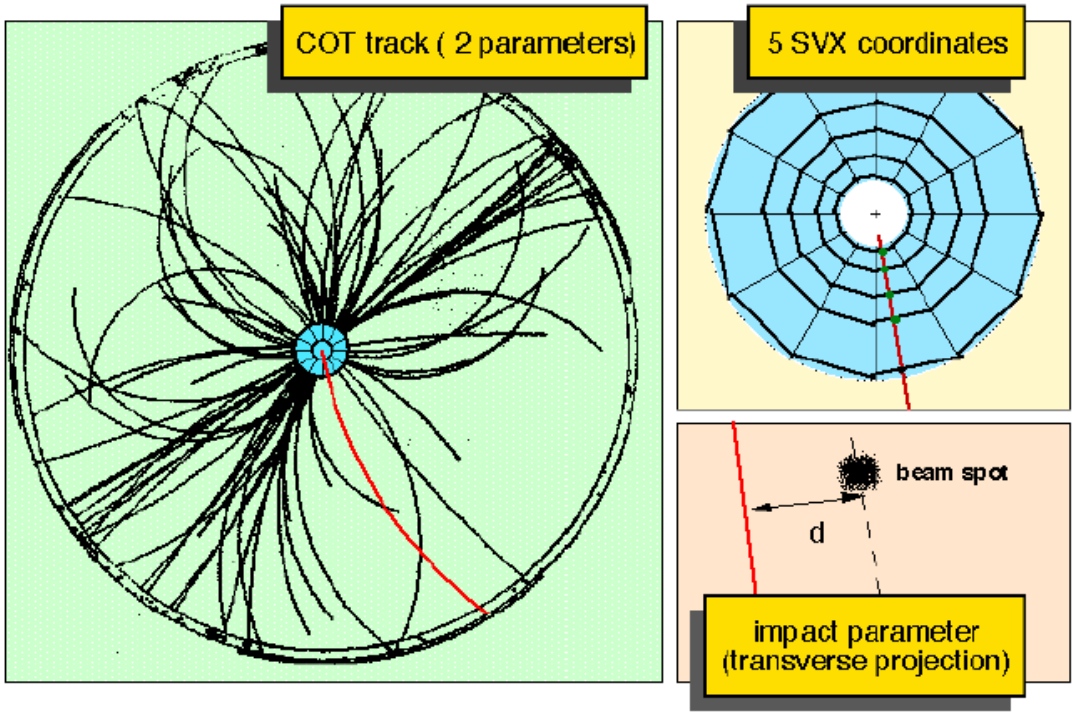
$D_s\pi$ $D_s^* K$ $D_s^*\pi$

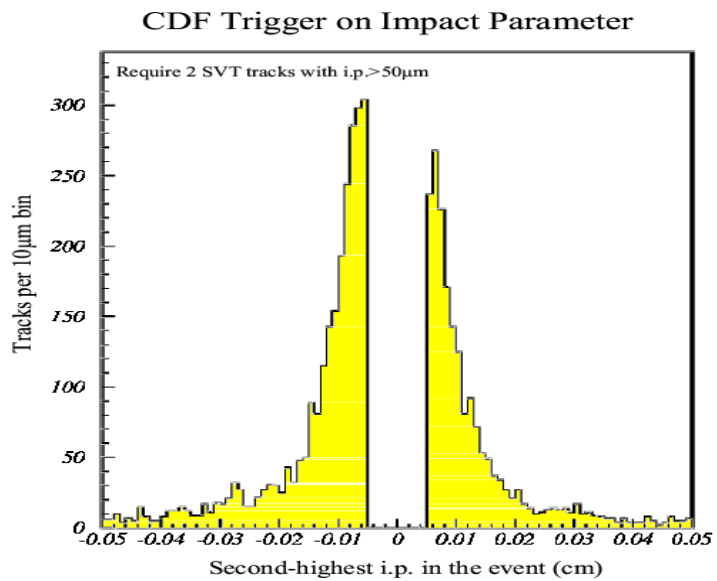




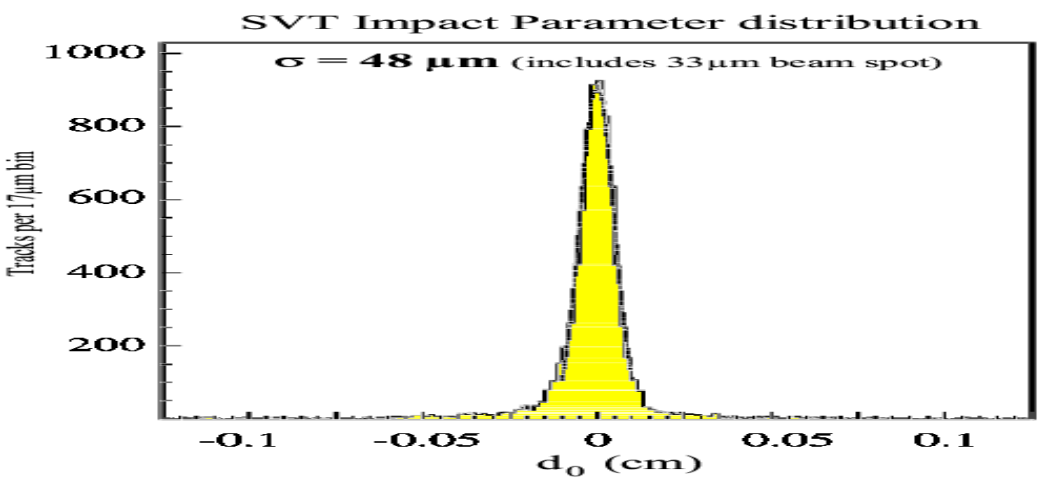
Expected error on $\sin(\delta+\gamma)$

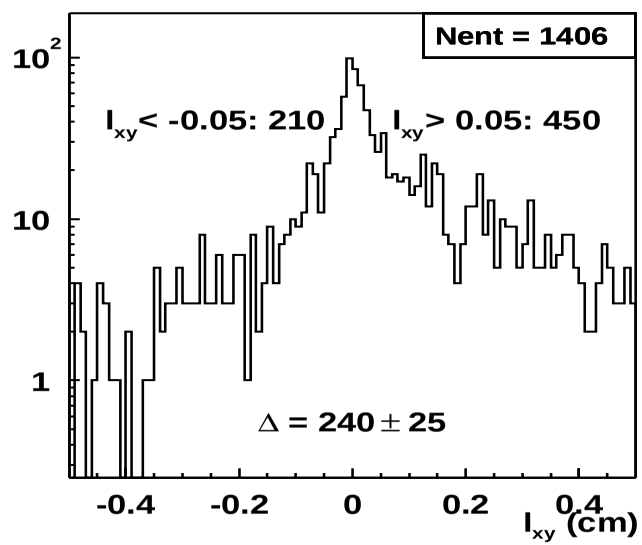
Secondary Vertex Trigger



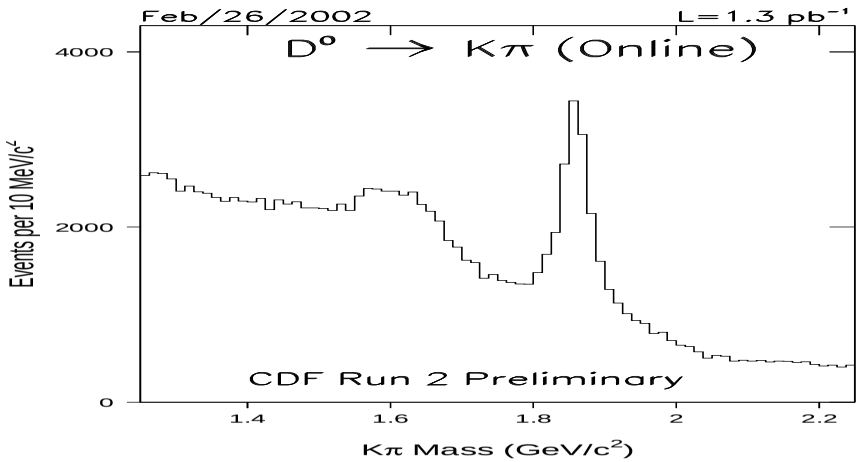


$150\mu m \leq d_0 \leq 1mm \quad 2° \leq \Delta\phi \leq 90°$

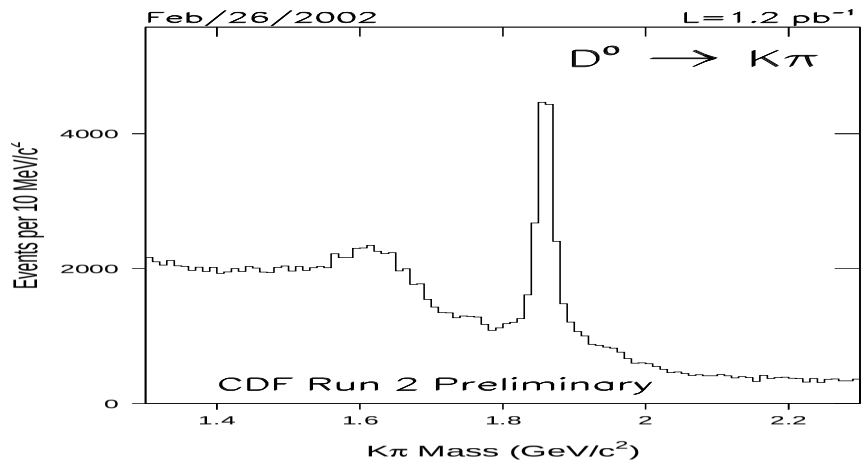




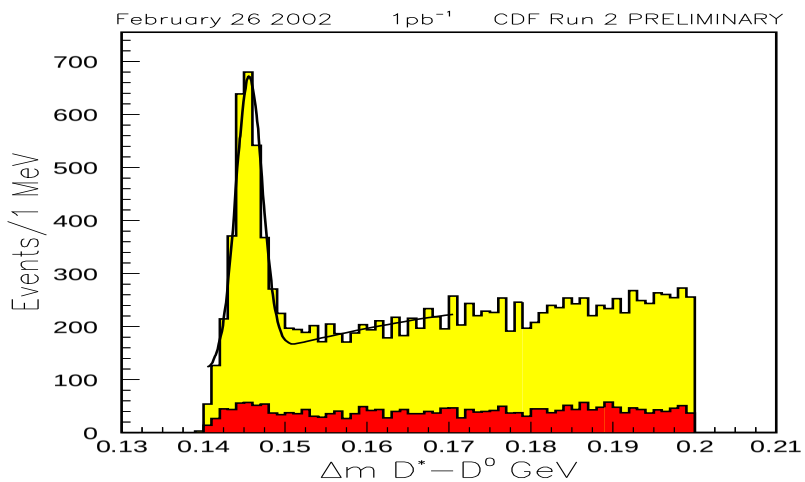
Charm in Run II



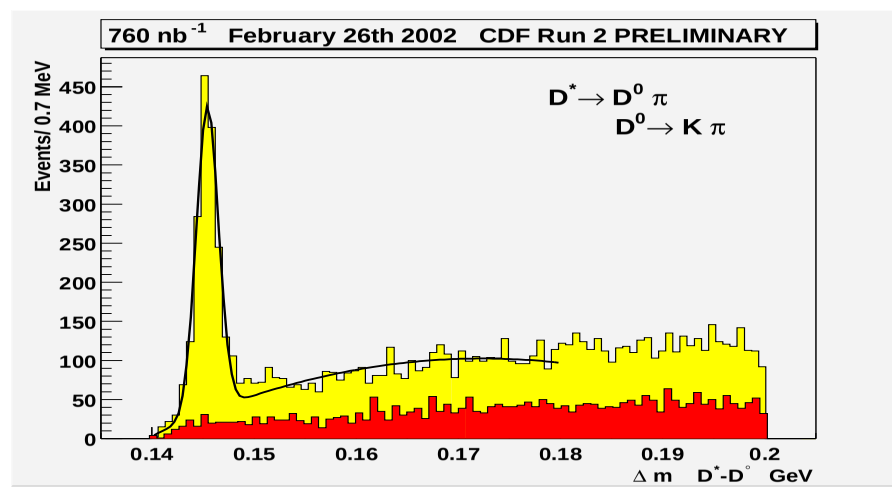
SVT + trigger info



Offline reconstruction



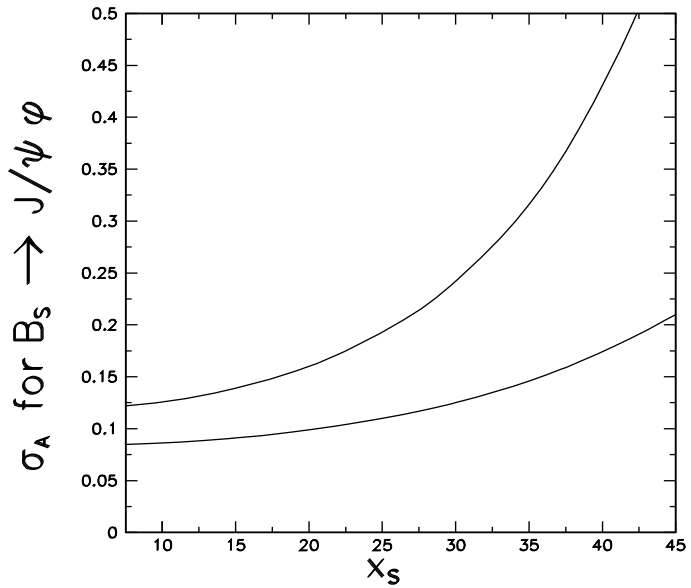
SVT + trigger info

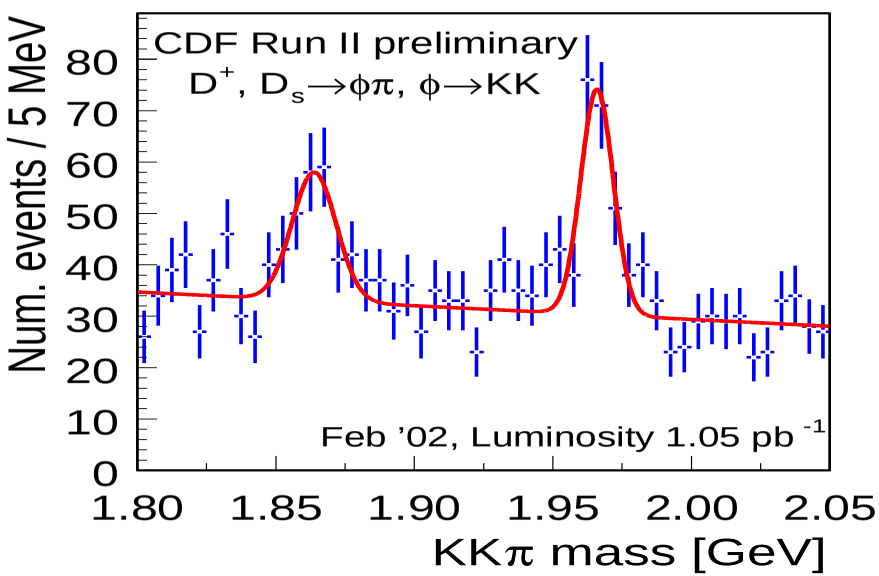


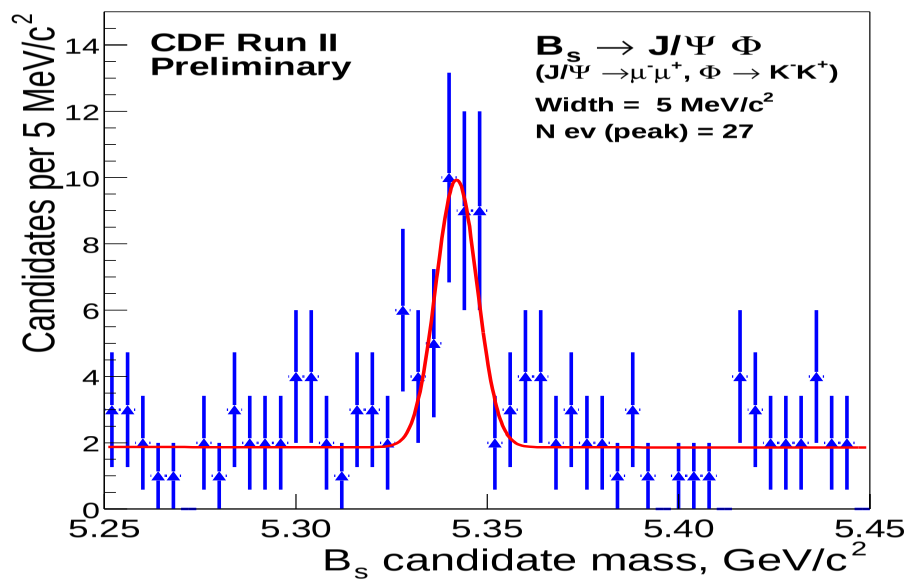
Offline reconstruction

A_{cp} in $B_s \to J/\psi\phi$ and $B_s \to D_s^+ D_s^-$

Measures weak phase of V_{ts} which is very small in SM. Evidence for anomalous ¢P phases if asymmetry is observed. $B_s \to D_s^- \pi^+$ is $\sim (50:50)$ CP even and odd, $B_s \to J/\psi\phi$ is mixed, $B_s \to D_s^+ D_s^-$ is CP even.

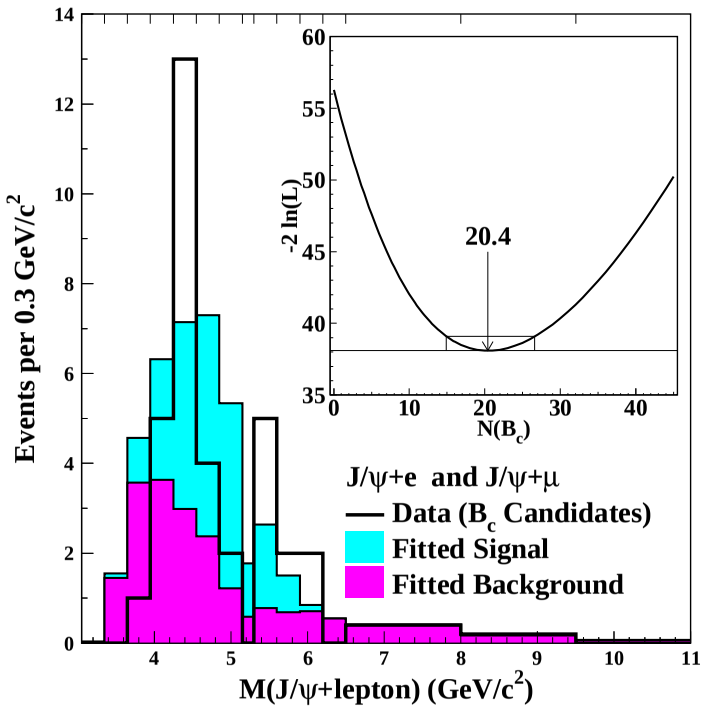






B_c and B Baryons

$B_c^- \to J/\psi l^- X,\ J/\psi \to l^+ l-$



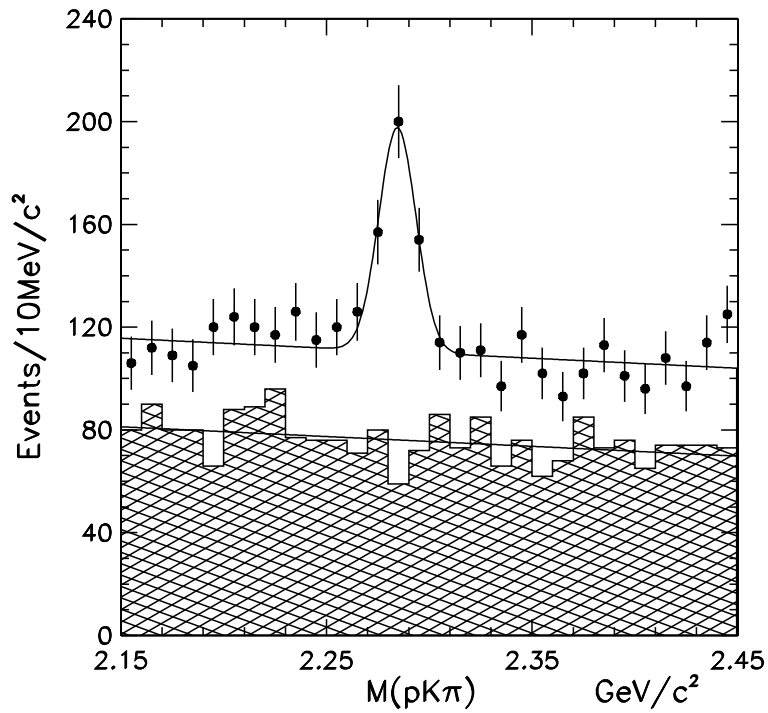
RUN I: $20^{+6.2}_{-5.5}$ events,

$M_{B_c} = 6.40 \pm 0.39 \pm 0.13$,

$\tau_{B_c^-} = 0.46^{+0.18}_{-0.16} \pm 0.03$ ps

RUN II: $B_c^- \to J/\psi n(\pi)$

$\Lambda_b^0 \to \Lambda_c^+ l^- X,\ \Lambda_c^+ \to pK\pi$



RUN I: 197 ± 25 events

$\tau_{\Lambda_b^0 \to \Lambda_c^+ l X} = 1.32 \pm 0.15 \pm 0.07$ ps

$\tau_{\Lambda_b^0 \to J/\psi \Lambda} = 1.22 \pm 0.36 \pm 0.033$ ps

RUN II: Much more $\Lambda_b^0 \to J/\psi \Lambda$

Of course there is also $\sin 2\alpha$:

New 2-track trigger $\Rightarrow B_d^0 \to \pi^+\pi^-$. Expected yield is $\mathcal{O}(1000)$ events but beware of Penguin "pollution"

And more to do with b-baryons:

- Search for Ξ_b, Ω_b
- Measurement of direct $\not{C}$P in $\Lambda_b \to p^+\pi^-(K^-)$

Lets not forget charm(onium)

- $J/\psi, \Upsilon$ production cross-section measurements
- Production polarization

RUN II IS WELL UNDER WAY!!

New and improved triggers ! Dimuon trigger yield is $> 2\times$ Run I. Track triggers and SVT promise a rich b yield.

New and improved particle ID! TOF system is online and already yielding results. Calibrations being finalized.

First B and c signals reconstructed

$D^0 \to \pi\pi, K\pi, KK$,$D^+ \to K\pi\pi$, $D^* \to D^0\pi$, $D_s \to \phi\pi$, $B_d^+ \to J/\psi K^+$, $B_d^0 \to J/\psi K^*$, $B_s^0 \to J/\psi\phi$

FIRST B MEASUREMENTS FROM RUN II EXPECTED BY FALL '02