

Charm at CDF

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Topics to be covered:

- 1) Inclusive $\varphi(2s)$ production
- 2) First evidence for D^0 mixing at Tevatron
- 3) $D^0 \rightarrow \mu\mu$ limits

Inclusive $\phi(2s)$ production.

- Detect the $\phi(2s)$ in its $\mu^+\mu^-$ decay mode
- Integrated luminosity 1.1 fb^{-1}
- Use CDF Central Outer Tracker and Central Muon detector. Muons are match between COT and muon detector signals.
- $M(\mu^+\mu^-)$ in range $3.5 - 3.8 \text{ GeV}/c^2$.
- $y(\mu^+\mu^-)$ in range ± 0.6
- $p_T(\mu^+\mu^-)$ in range $2.0 - 30.0 \text{ GeV}/c$

Extract $\varphi(2s)$ signal from background by means of unbinned maximum likelihood fit using parametrised functions for the background and the signal ("Crystal Ball Function").

There is also for both signal and background:

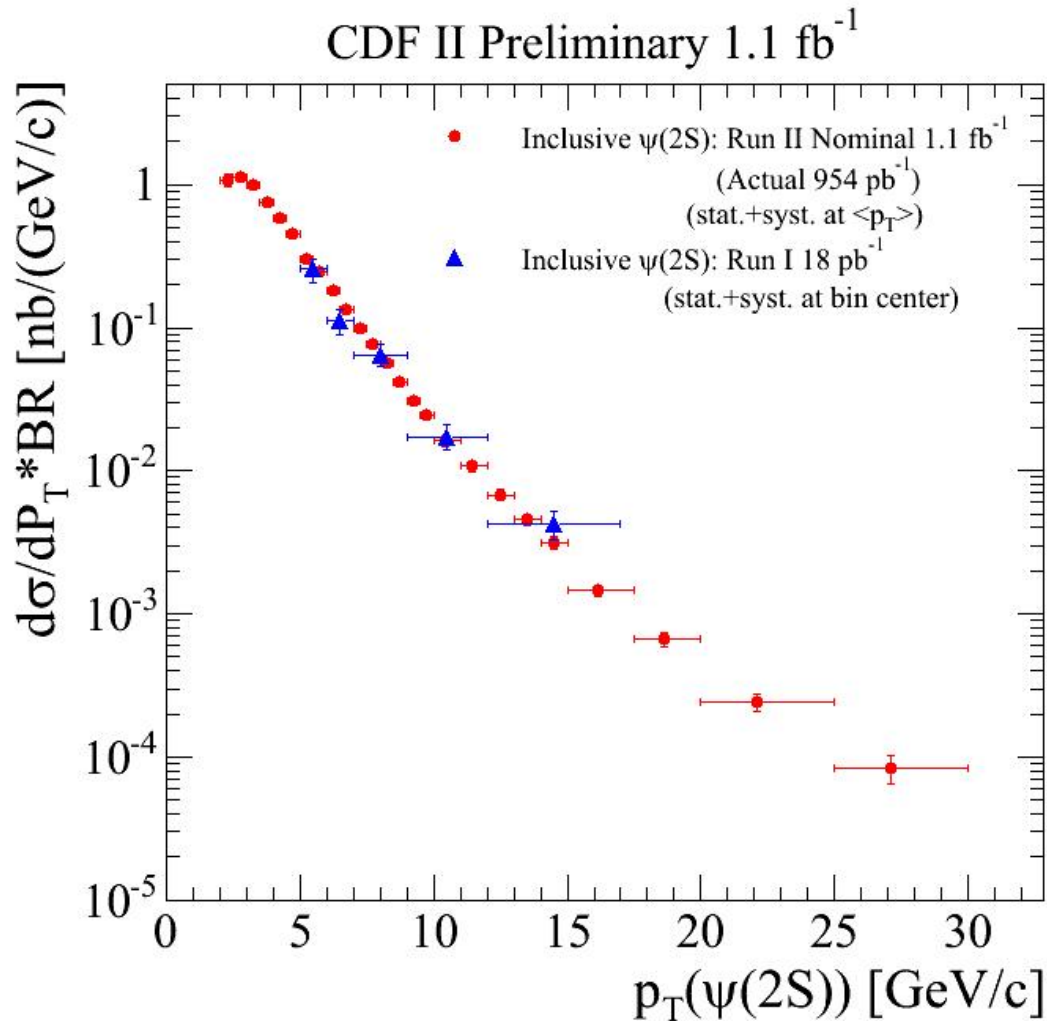
- a prompt component and
- a longlived component (from B decays)

Model prompt component as Gaussian in distance from beamline.

Model decayed component as Gaussian convoluted with exponential decay.

Silicon Vertex Tracker used. Correct for acceptance and efficiencies.

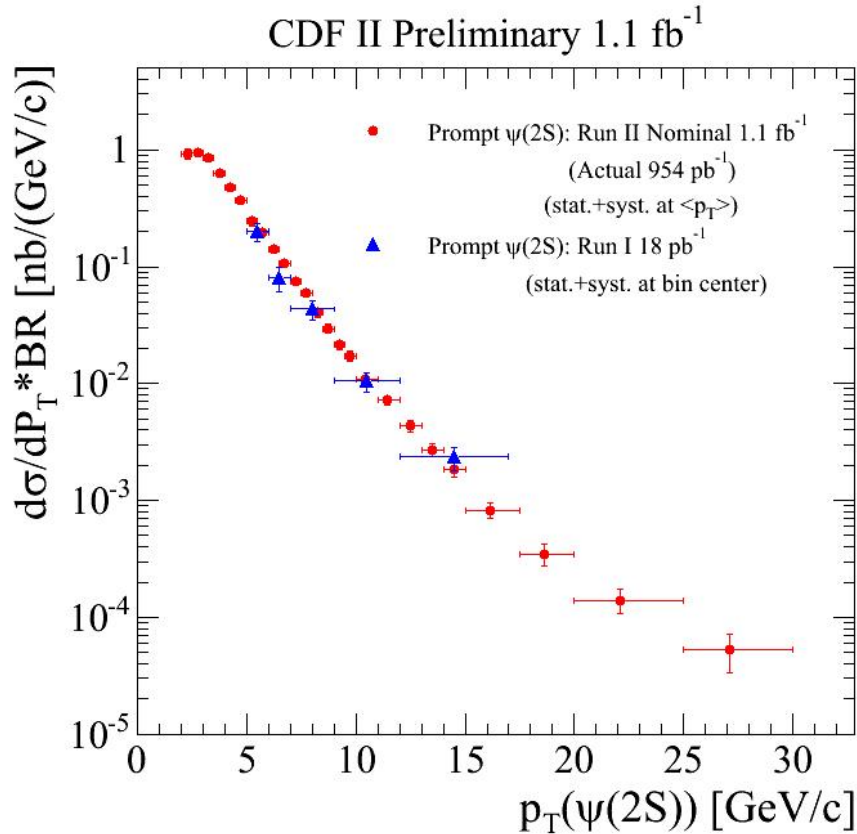
Results



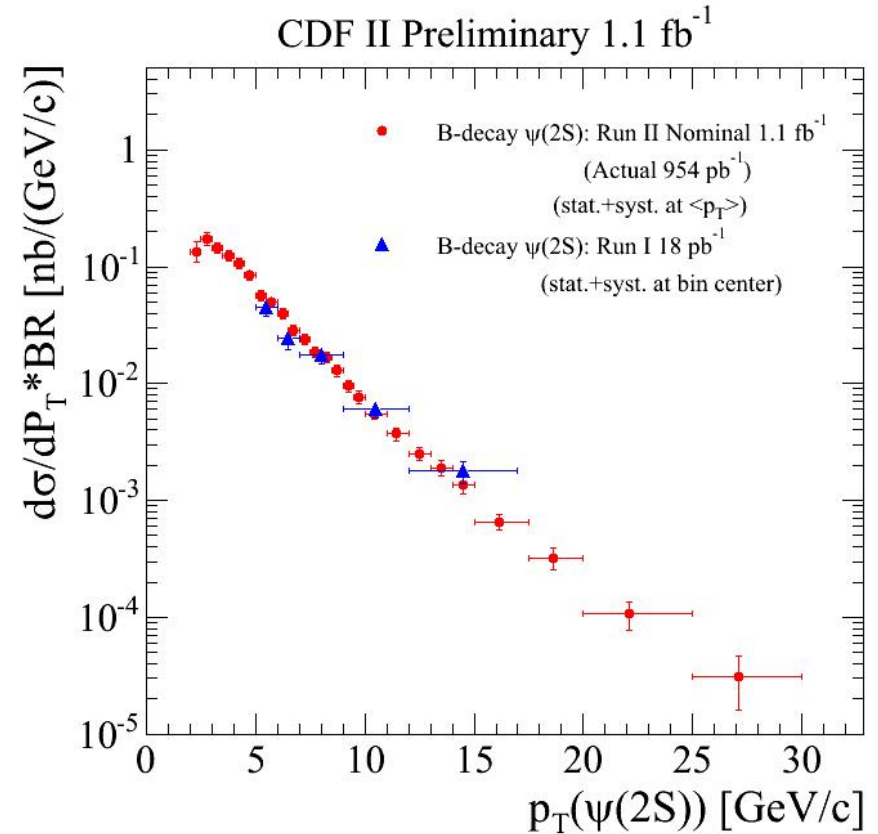
Inclusive cross sections compared with CDF Run I results.

Integrated cross section
= **3.141**
 ± 0.038 (stat)
 $\pm 0.225/0.218$ (sys) nb.

Prompt component

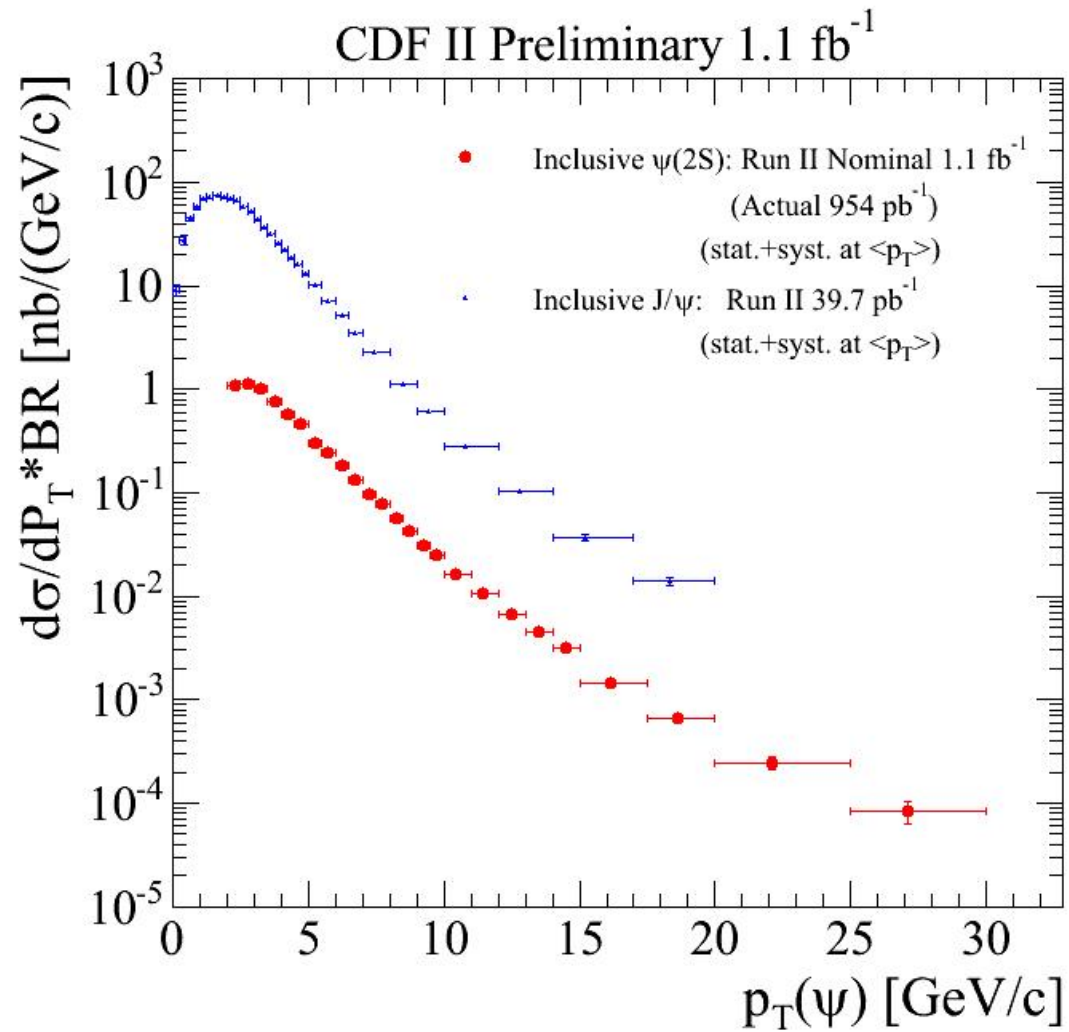


B-decay component



Consistency with Run I again.

Comparison between J/ψ and $\psi(2s)$



First evidence for D^0 mixing at Tevatron.

BELLE found evidence that the lifetime for D^0 decay into CP eigenstates (K^+K^- , $\pi^+\pi^-$) differed from CP mixed states ($K^-\pi^+$ + c.c.)

BaBar found difference in decay time between $D^0 \rightarrow K^-\pi^+$ and $D^0 \rightarrow K^+\pi^-$. (Not seen by BELLE).

CDF have now found evidence for the latter in hadronic collisions.

Aim:

Define $R(t) = \text{ratio of } K^+n^- / K^+n^-$

Then under reasonable assumptions,

$$R(t) = R_D + \sqrt{R_D} y' t + \frac{1}{4}(x'^2 + y'^2)t^2$$

where x' and y' are linear combinations of x , y

and $x = \Delta m/\Gamma$ and $y = \Delta\Gamma/2\Gamma$.

Measure R_D , x' , y' . Mixing is found if x' or y' are non-zero.

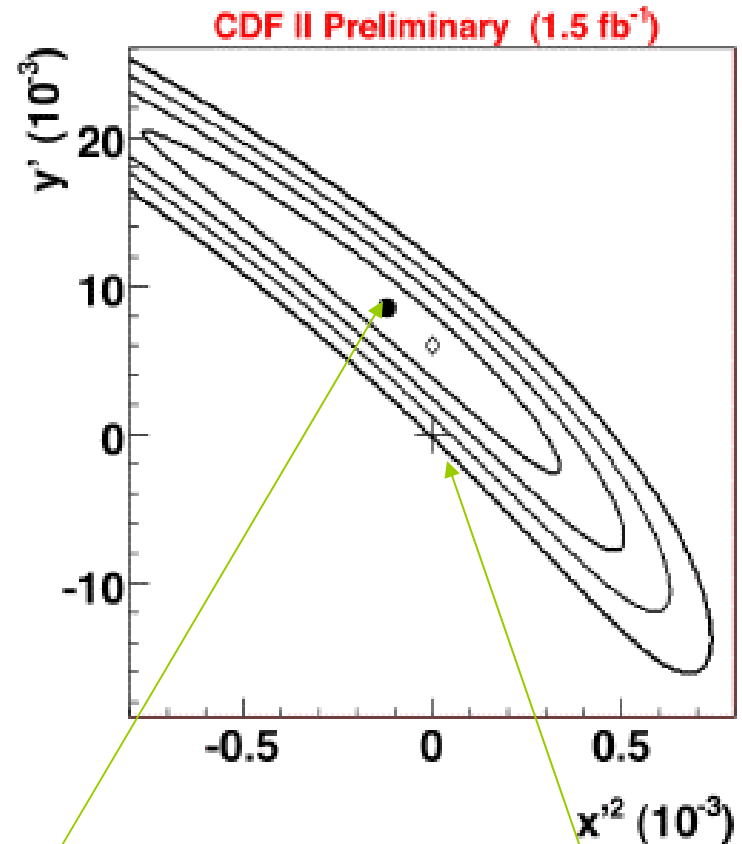
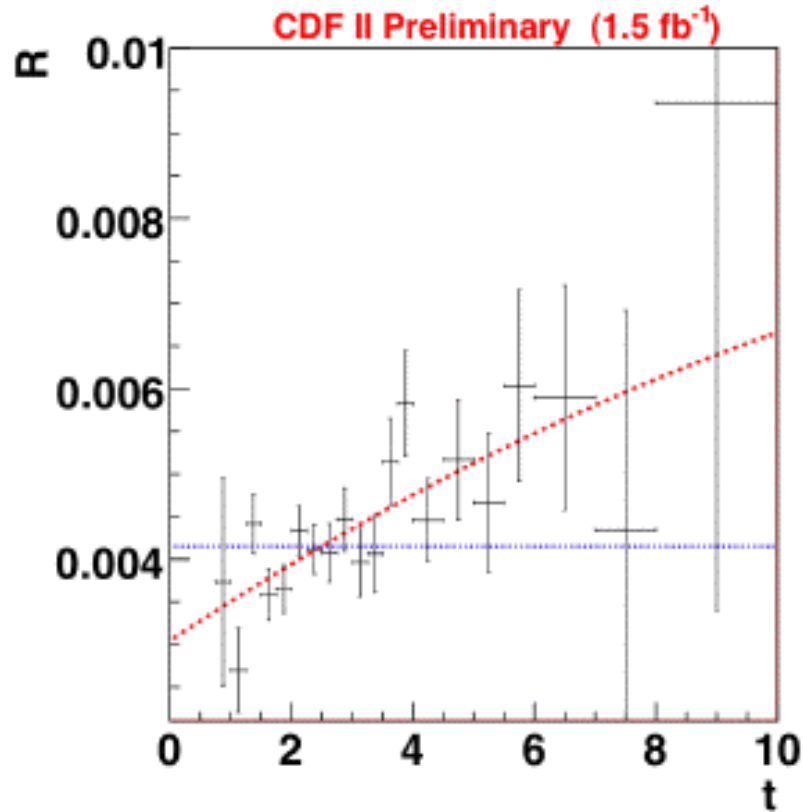
CDF Method

Using integrated luminosity of 1.5 fb^{-1} ,

Tag $D^{*+} \rightarrow \pi^+ D^0$ and seek $D^0 \rightarrow K^- \pi^+$
(and c.c.)

Study proper time variation of the D^0
decays.

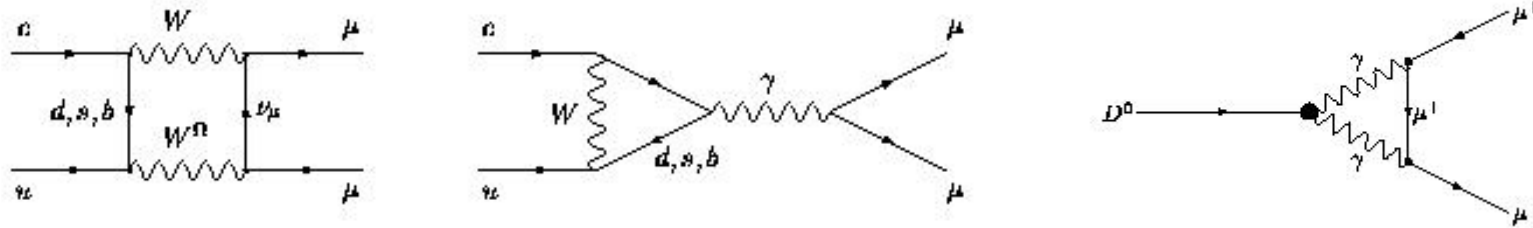
Results



- (1) Some evidence that R increases with t
 - (2) Most likely (x', y') point is different from zero.
- 3.8 σ effect – evidence for mixing.**

Search for rare decay $D^0 \rightarrow \mu^+ \mu^-$.

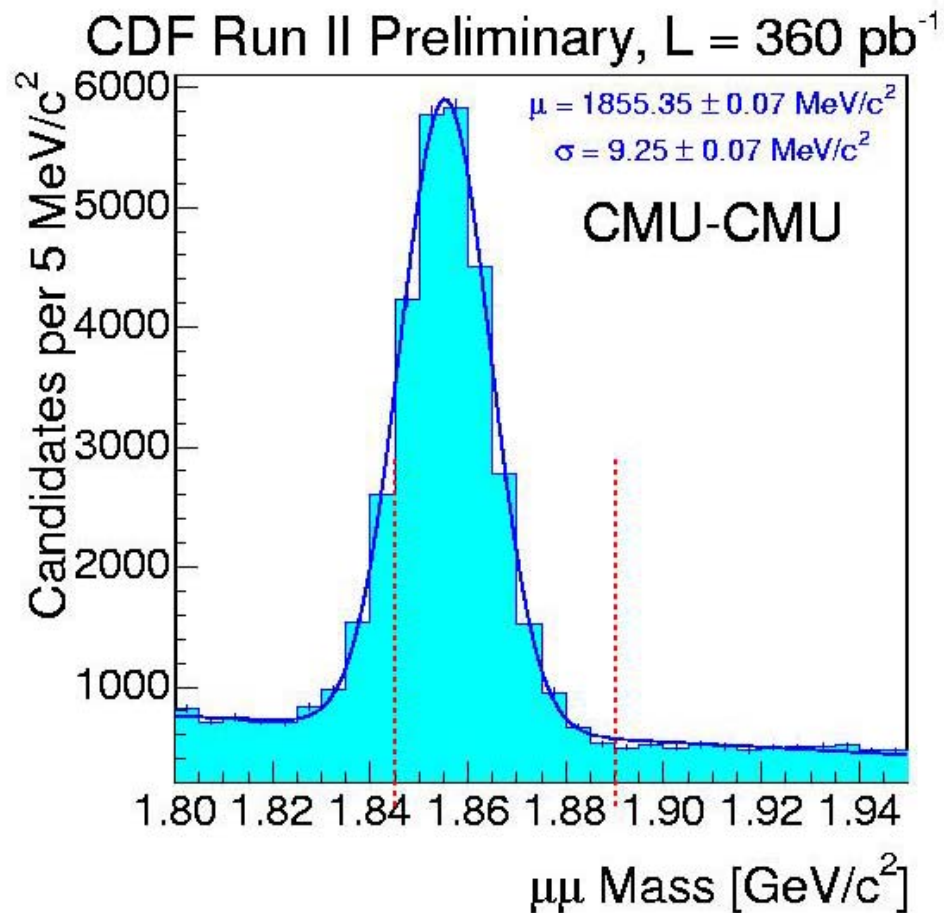
Second CDF analysis. Uses 360 pb^{-1} data



There are rare SM processes that give this decay, but at level of 4×10^{-13}

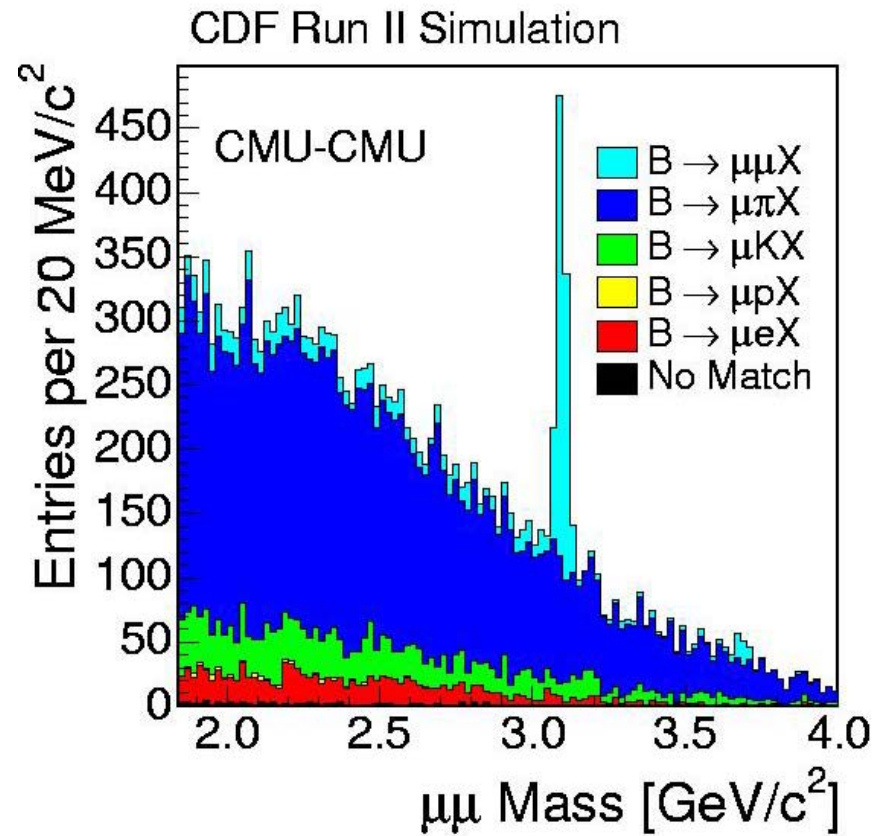
R-parity violating SUSY could give these decays up to level 3.5×10^{-6}

CDF have recently improved their limits



Peak obtained if pions are simply called muons.

Largest source
of background
is muon pairs from
B decays.



Results

Detector	CMU-CMU	CMU-CMX	CMX-CMX
Expected Bgd	4.9 ± 1.3	2.7 ± 1.0	1.0 ± 0.5
Observed Evt	3	0	1

No excess of events in the search window.
Using a Bayesian approach we derive the following upper limits on the branching fraction:

5.3×10^{-7} at 95% CL

4.3×10^{-7} at 90% CL

World's best! Translates into a limit on the R parity violating couplings.

Summary

Inclusive $\phi(2s)$ production measured

First evidence for D^0 mixing at Tevatron

$D^0 \rightarrow \mu\mu$ limits improved

