Update of Run 1 B Results at CDF

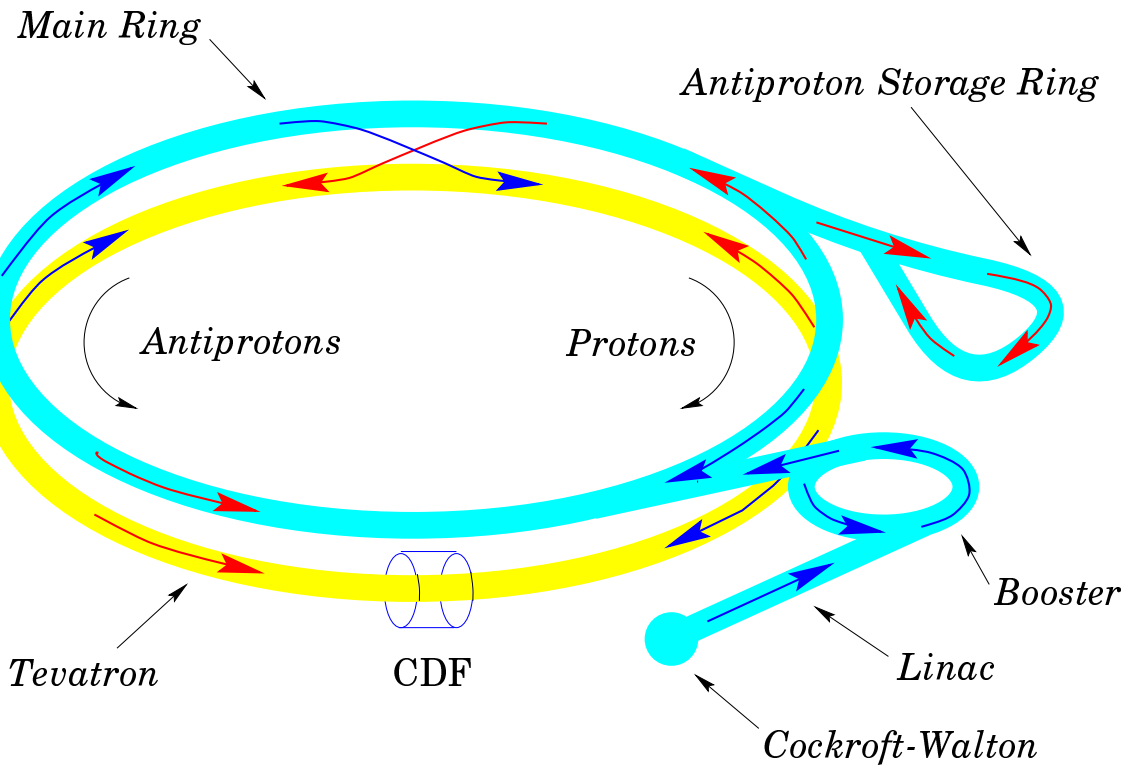
J. Tseng
Massachusetts Institute of Technology
for the CDF Collaboration

Les Rencontres de Physique
de la Vallée d'Aoste
LaThuile, Italy
7 March 2002

- ▷ Introduction
- ▷ Λ_b lifetime
- ▷ Bottom production
- ▷ Looking forward

Fermilab Tevatron and CDF

$p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV



Run "0"	1988-89	4.5 pb^{-1}
Run 1a	1992-93	20 pb^{-1}
Run 1b	1994-96	90 pb^{-1}
Run 2a	2001-	2000 pb^{-1}
Run 2b		15000 pb^{-1}

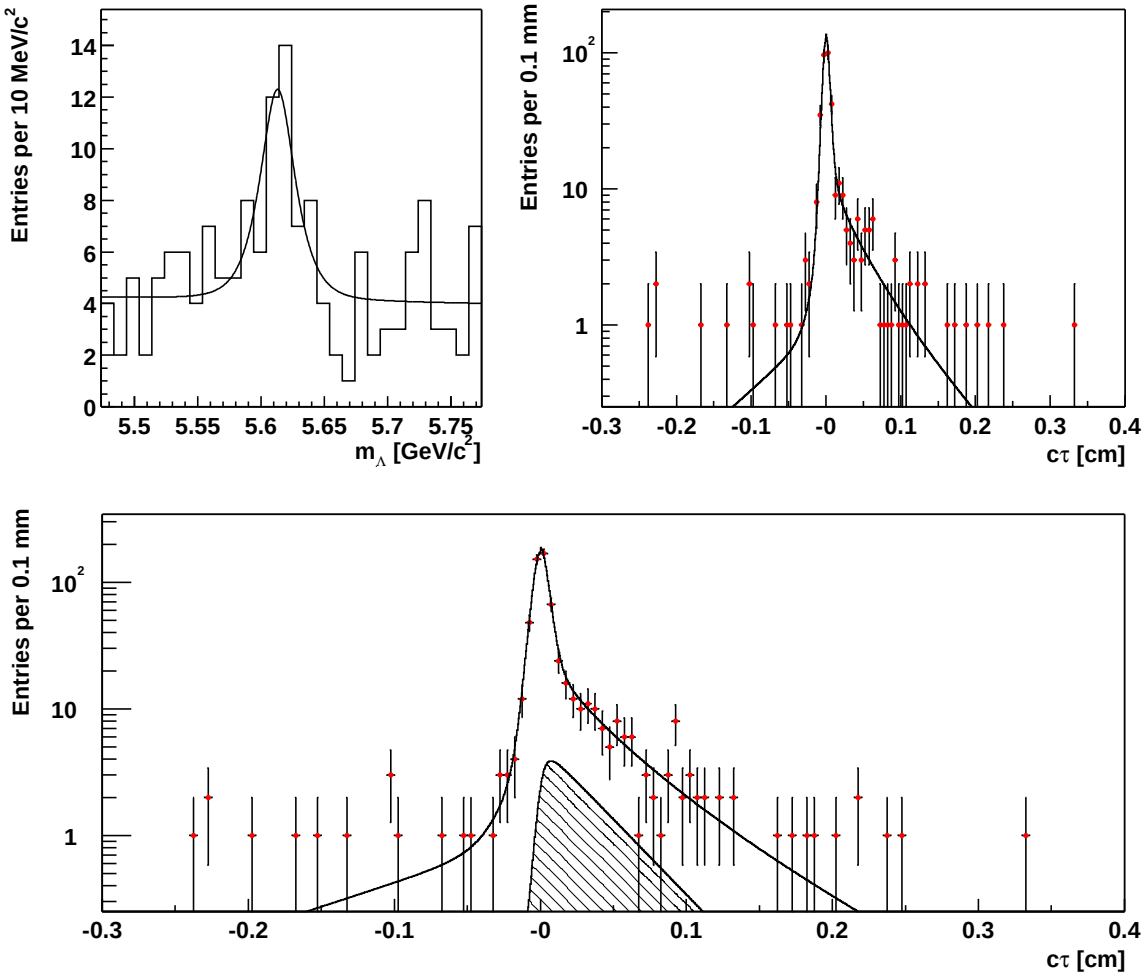
Finishing Run 1 Studies

Main Run 1 business as Run 2 begins:
finalize, publish results

- ▷ First exclusive $\Lambda_b \to J/\psi\Lambda^0$ lifetime
- ▷ B^+ production
- ▷ σ_b ratio at $\sqrt{s} = 630$ and 1800 GeV
- ▷ B^{**} production *PR* **D64**, 072002 (2001)
  $f(B^{**})/f(B_{u,d}) = 0.28 \pm 0.06 \pm 0.03$
- ▷ $\chi_{c1,2}$ production *PRL* **86**, 3963 (2001)
  $\sigma_{\chi_{c2}}/\sigma_{\chi_{c1}} = 0.96 \pm 0.27 \pm 0.11$
- ▷ Υ production and polarization:
  $\alpha = -0.12 \pm 0.22$ for $8 < p_T < 20$ GeV/c
- ▷ $\sin 2\beta$ with $B^0 \to \psi K^0_S$:
  $\sin 2\beta = 0.91^{+0.37}_{-0.36}$ (previous $^{+0.41}_{-0.44}$)

$\Lambda_b \to J/\psi\Lambda^0$ Exclusive Lifetime

- $\Lambda_b \to J/\psi\Lambda^0$
  - $J/\psi \to \mu^+\mu^-$
  - $\Lambda^0 \to p\pi^-$



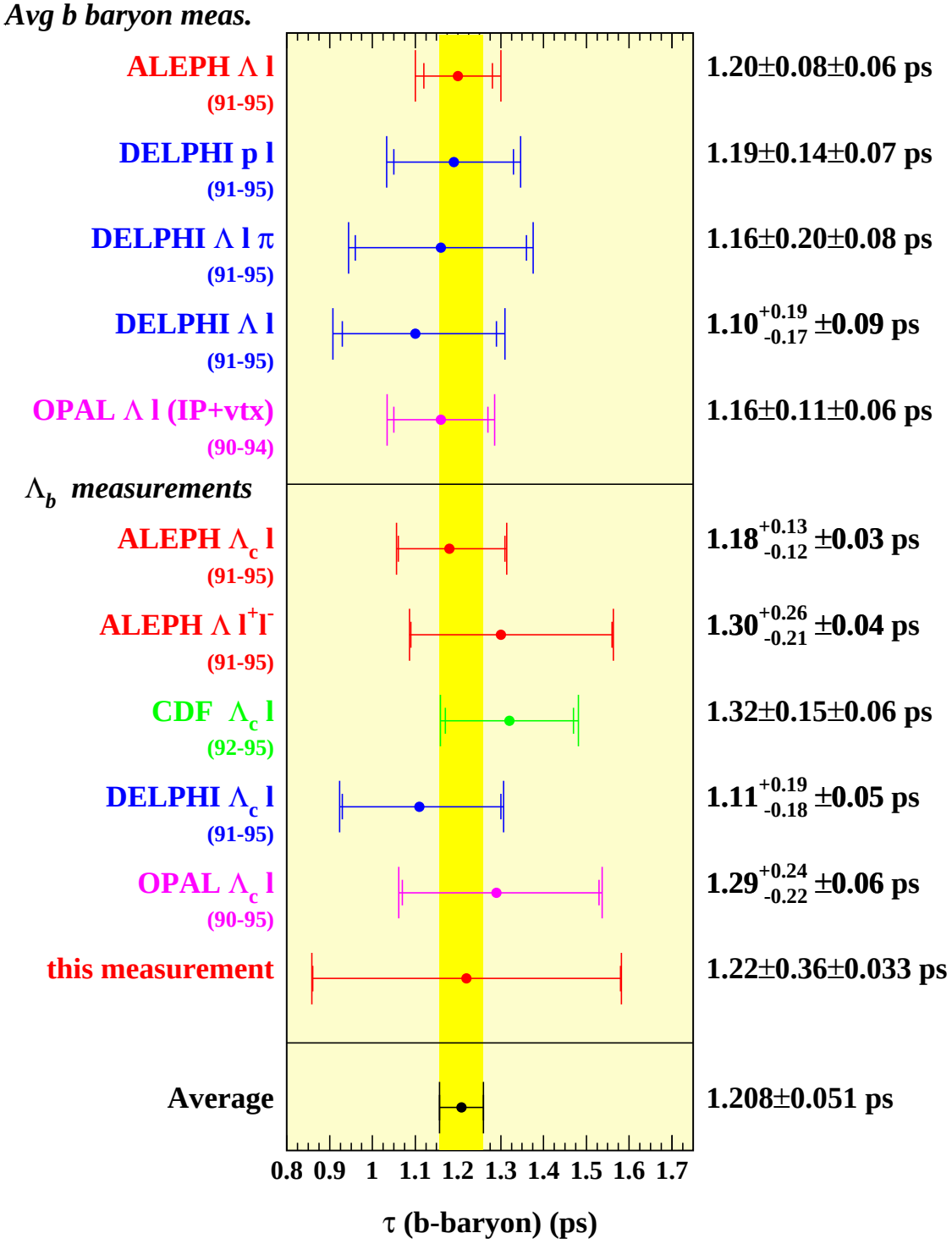
▷ 38 ± 11 candidates

$\Rightarrow \tau_{\Lambda_b} = 1.22 \pm 0.36 \pm 0.033$ ps

first exclusive Λ_b lifetime measurement

$\Lambda_b \to J/\psi\Lambda^0$ Exclusive Lifetime (II)

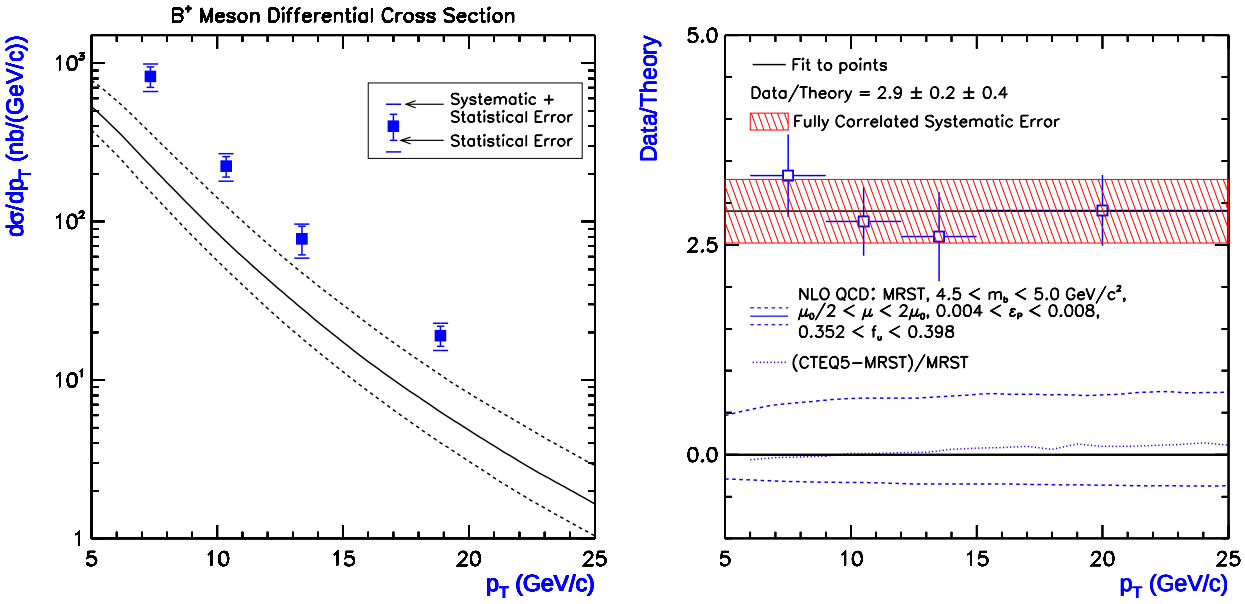
Comparison with world measurements



$B^+ \to J/\psi K^+$ Production

▷ 387 ± 32 events

▷ differential cross section:



▷ Largest systematic uncertainties:

- integrated luminosity
- $\mathcal{B}(B^+ \to J/\psi K^+)$

▷ Comparison to NLO prediction:

- p_T shape consistent

$\Rightarrow$ average data/theory $2.9 \pm 0.2 \pm 0.4$

b Cross Section Ratio

$$\frac{\sigma_b(\sqrt{s} = 630 \text{ GeV})}{\sigma_b(\sqrt{s} = 1800 \text{ GeV})}$$

▷ $p_T > 10.75$ GeV/c and $|y| < 1$

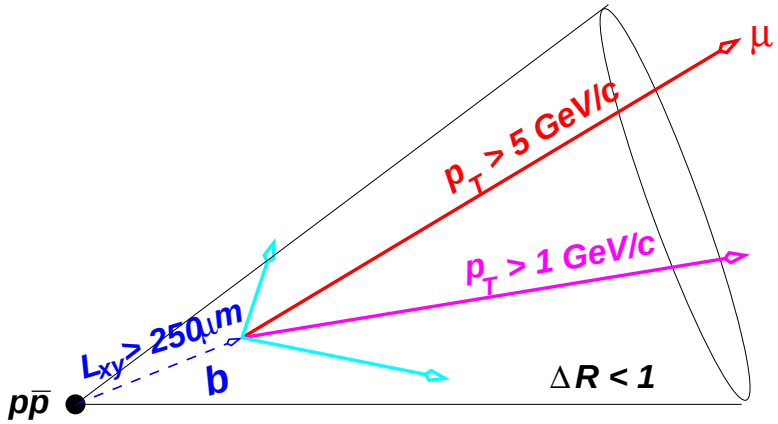
▷ ratio predicted with $10 - 15\%$ uncertainty

▷ comparison with previous UA1 results

Method

▷ 9 days data at $\sqrt{s} = 630$ GeV

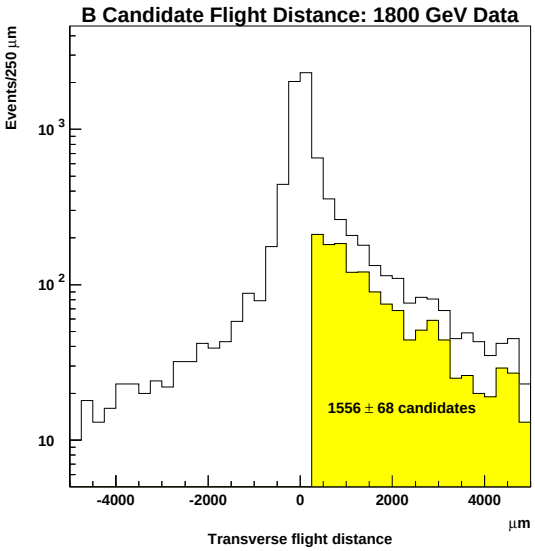
▷ before/after data at $\sqrt{s} = 1800$ GeV

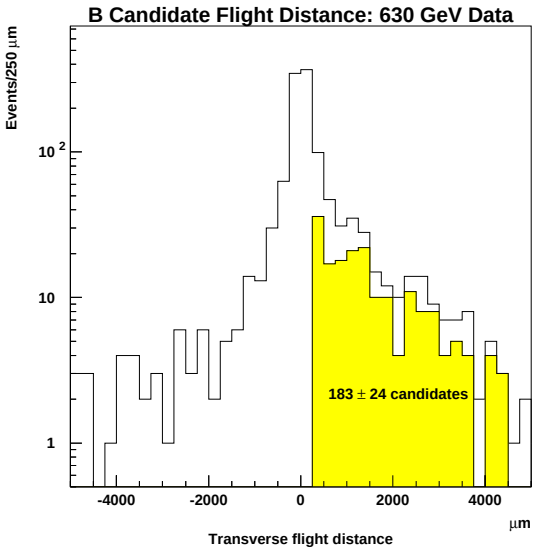


▷ count $L_{xy} > 250$ μm events

▷ subtract $L_{xy} < -250$ μm events (fake combinations)

b Cross Section Ratio (II)



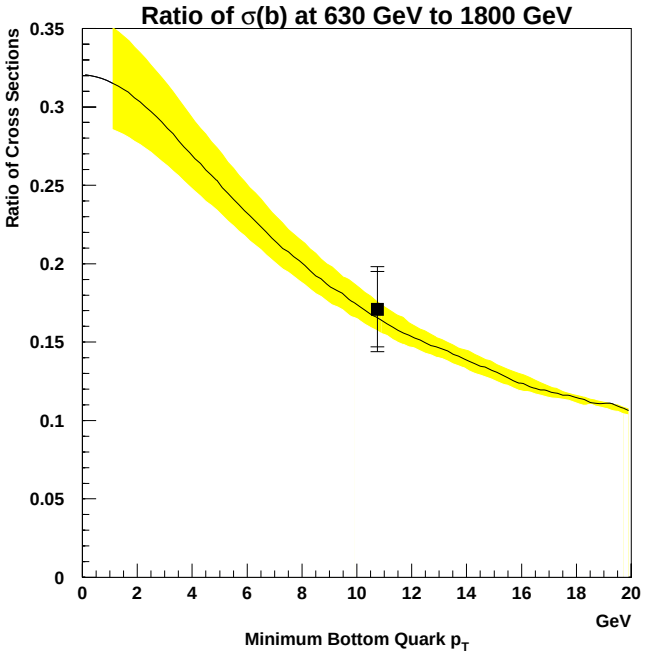


$$\frac{\sigma_b^{630}}{\sigma_b^{1800}} = \frac{N_b^{630}}{N_b^{1800}} \left(\frac{A^{1800}}{A^{630}}\right)_{MC} \frac{\mathcal{L}^{1800}}{\mathcal{L}^{630}}$$
$$= 0.171 \pm 0.024 \pm 0.012$$

Largest systematic:
$\mathcal{L}^{1800}/\mathcal{L}^{630}$

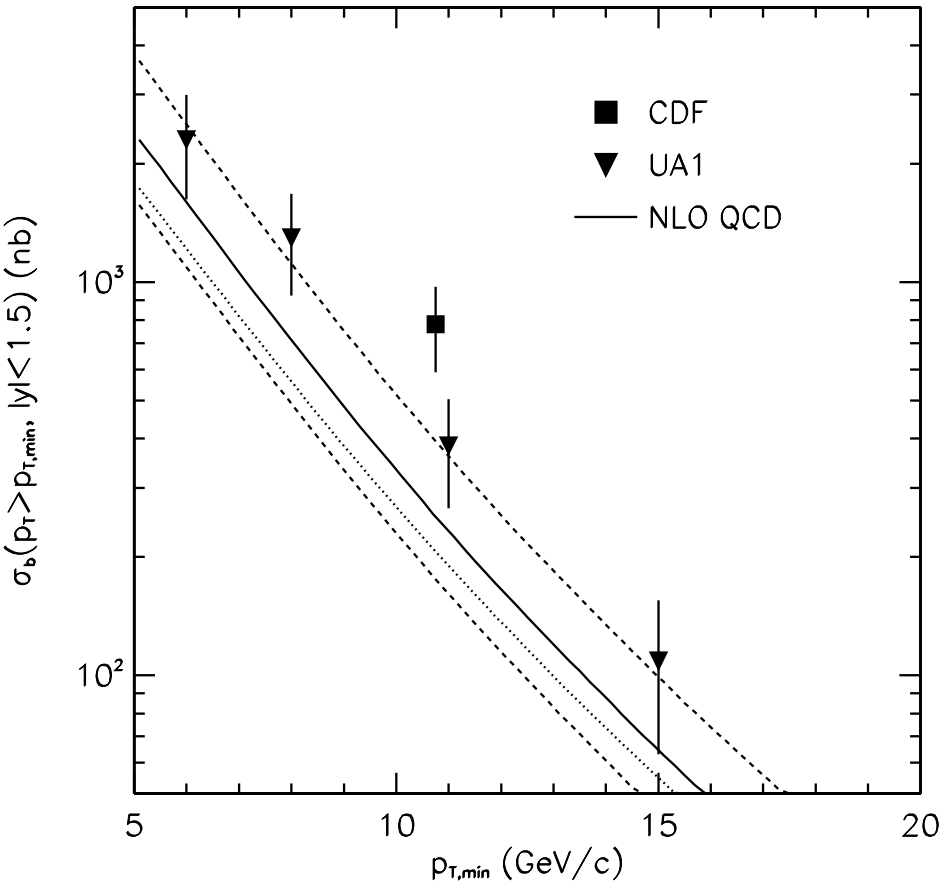
▷ compare NLO →

⇒ theory ratio agrees well with experiment



b Cross Section Ratio (III)

▷ absolute $\sigma_b(\sqrt{s} = 630$ GeV):

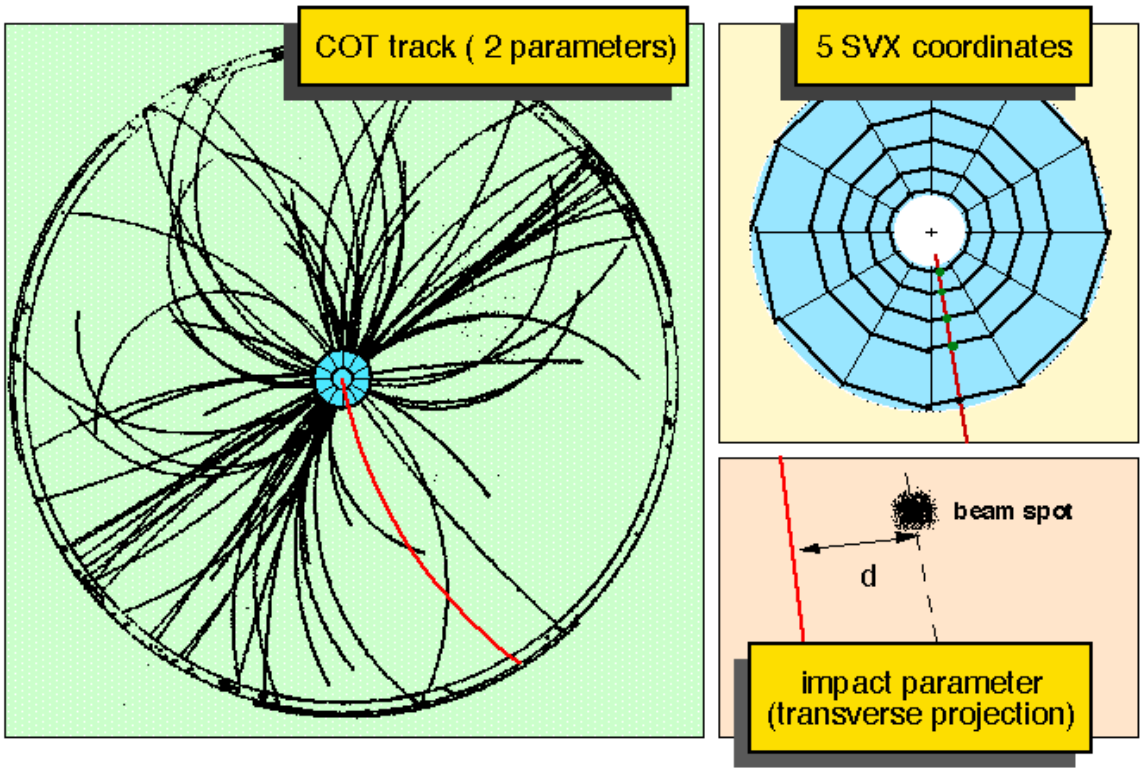


- best σ_b measurement at 630 GeV
- theory σ_b^{630} lower than experiment

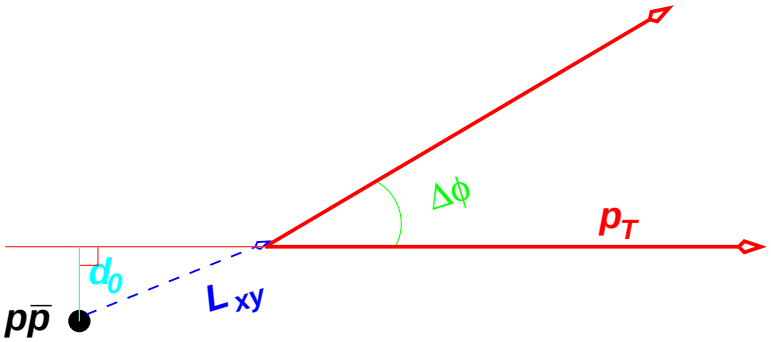
▷ compare UA1: disagree $< 95\%$ C.L.

- theory curves lower: updated PDF's
- UA1 numbers not adjusted

Silicon Vertex Trigger



▷ large d_0: generic feature of b decay



⇒ many more exclusive hadronic modes at CDF

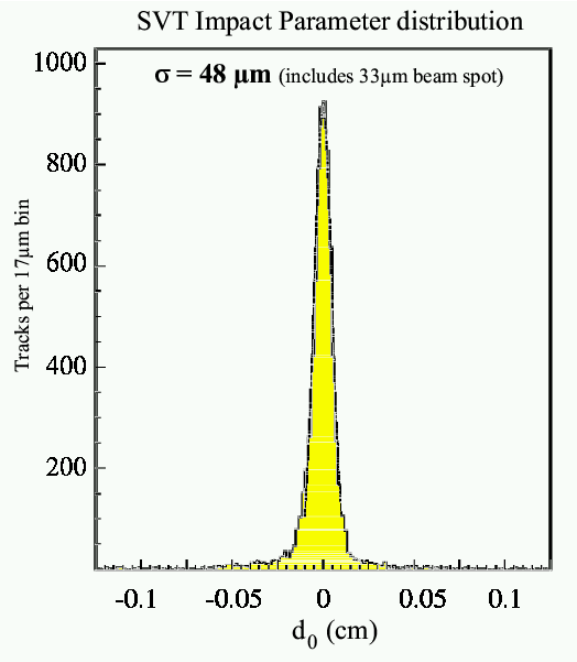
$\mathcal{O}(10,000)\times$ improvement over Run 1

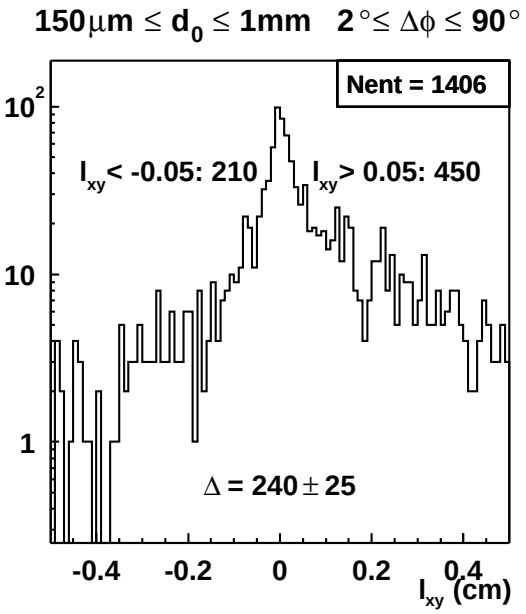
SVT Performance

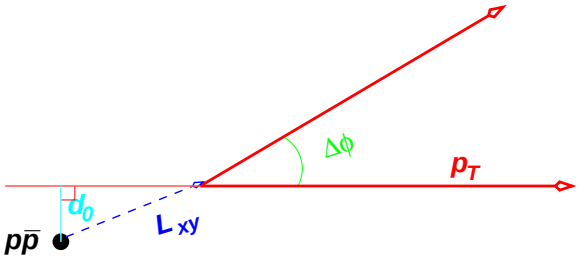
Online d_0 distribution

contributions:

- SVT d_0 resolution
- beam width
- beam tilt
- alignment







Heavy flavor evident

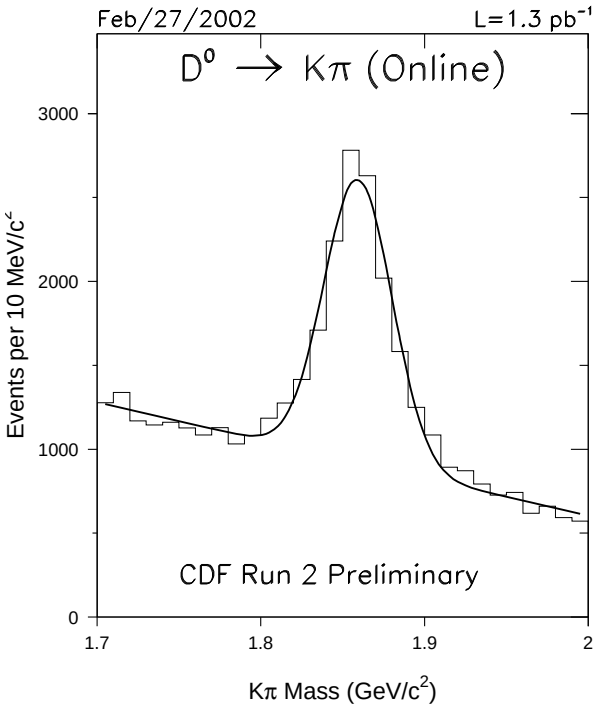
▷ small sample

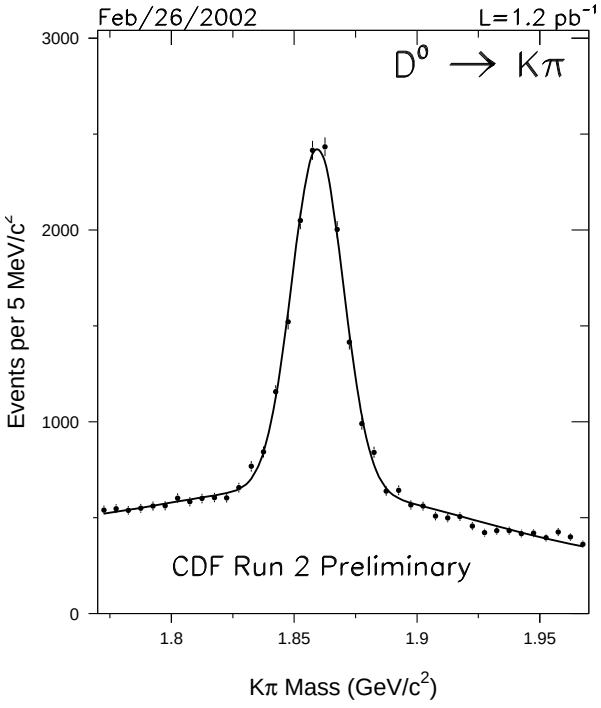
▷ online information

Charm in SVT

trigger
info only

offline
reconstruction





▷ two-body decays easily visible in trigger

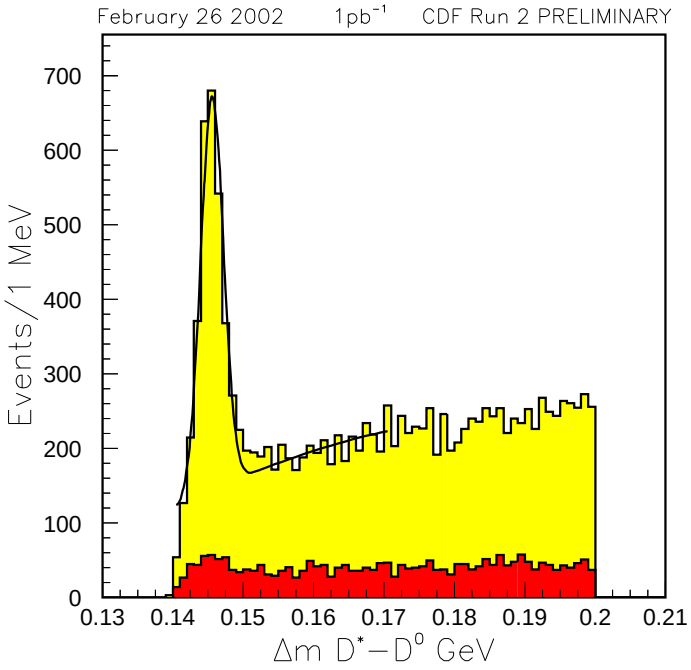
⇒ specific triggers for, *e.g.*,

- $D^0 \rightarrow K\pi$
- $B^0 \rightarrow \pi\pi$

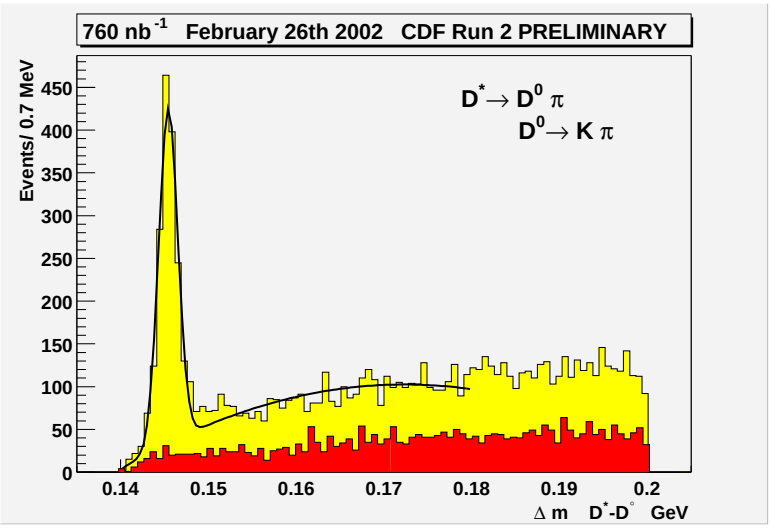
Charm in SVT (II)

▷ $D^{*+} \to D^0\pi^+, D^0 \to K\pi$

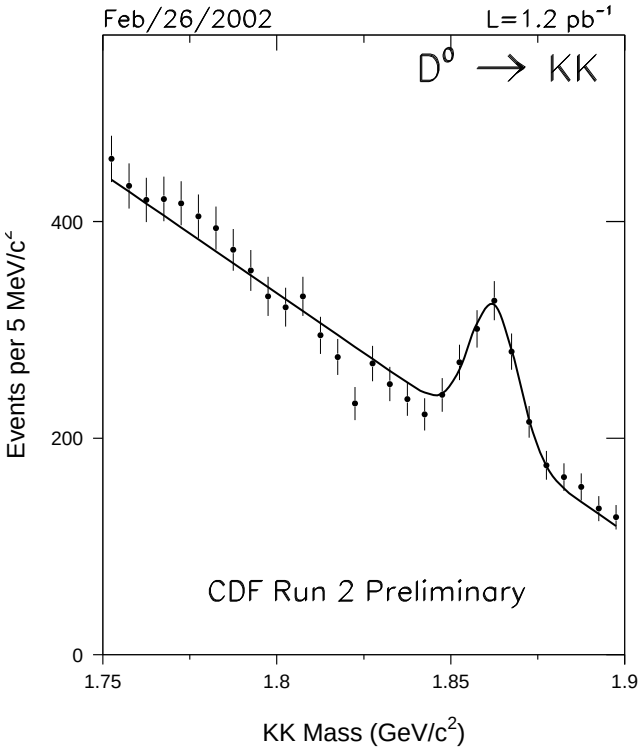
▷ trigger information only:



▷ offline reconstruction:

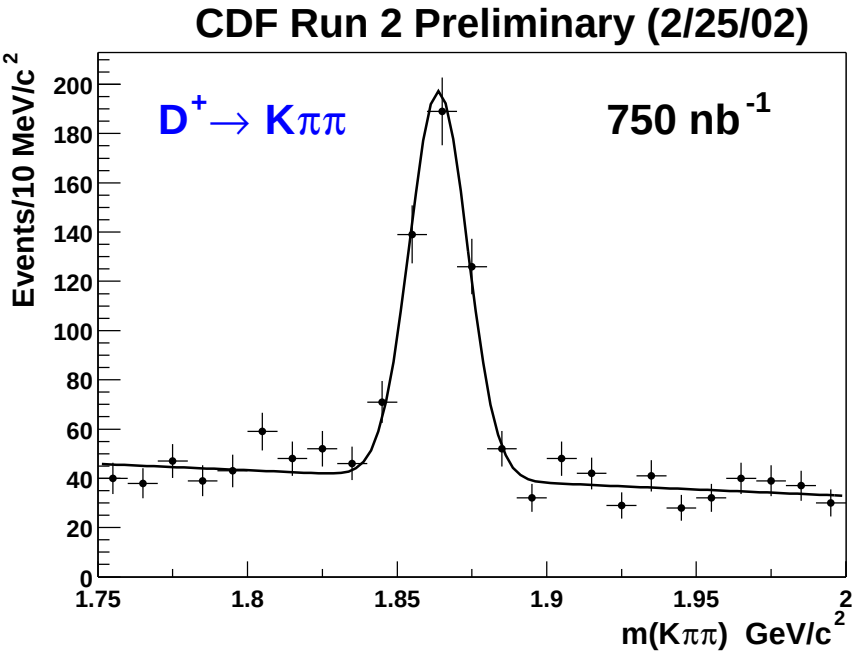


Charm in SVT (III)



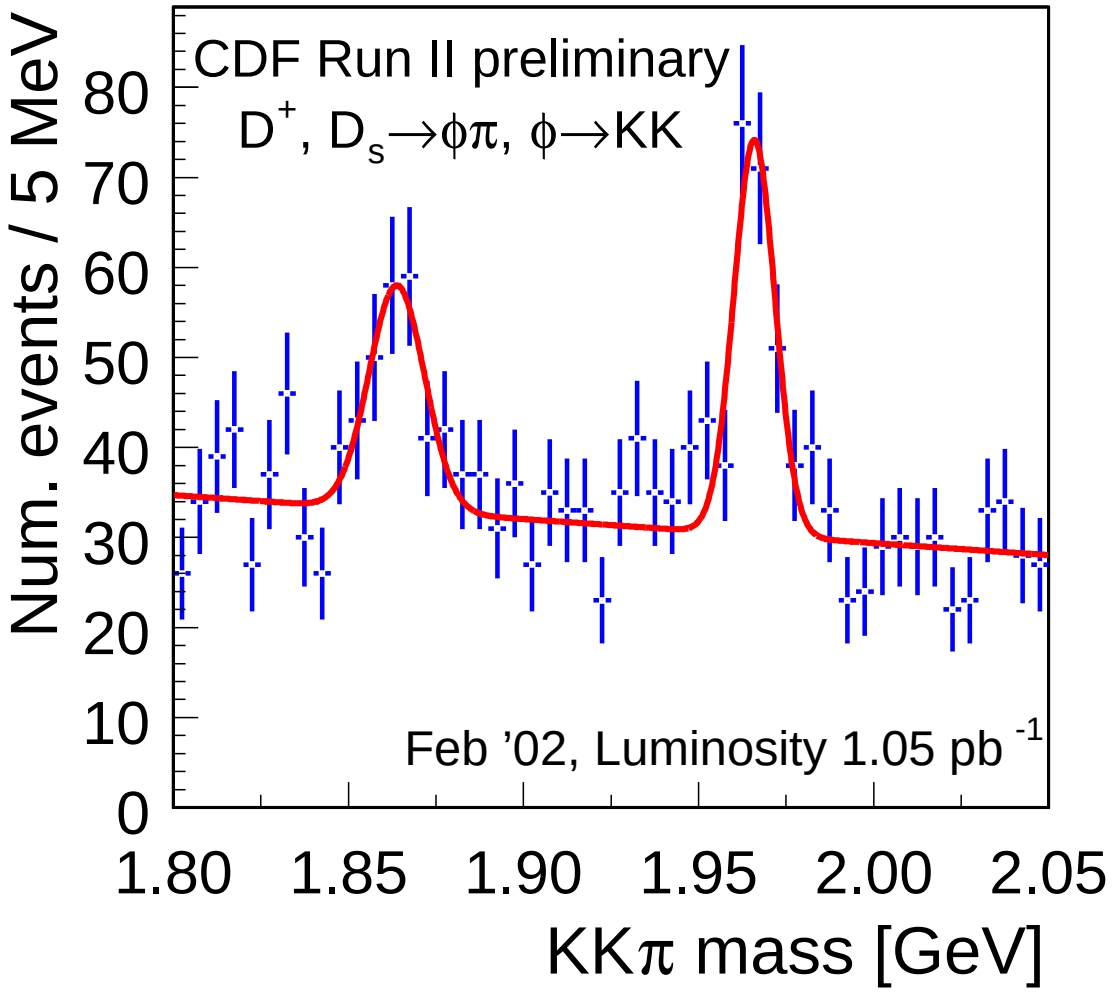
$\leftarrow D^0 \rightarrow K^+K^-$

▷ large direct charm component



$\Rightarrow$ CDF is a bottom+charm factory

Charm in SVT (IV)



$\Rightarrow$ first steps to B_s mixing!

Conclusion

▷ Run 1 results finalized (a few left)

▷ first exclusive Λ_b lifetime:
$\tau_{\Lambda_b} = 1.22 \pm 0.36 \pm 0.033$ ps

▷ theory cross sections under experiment:

- B^+: theory 1/3 of experiment
- $\sigma_b(\sqrt{s} = 630 \text{ GeV})/\sigma_b(\sqrt{s} = 1800 \text{ GeV})$: theory consistent with experiment

▷ Run 2 has already begun

- ◦ SVT trigger promises rich b yield
- first steps to B_s mixing, CKM measurements
- ◦ also large direct charm component

⇒ new leverage on production studies: more B's, D's, excited states

→ more on Run 2: Simona Rolli's talk