Beautiful B Physics at the Tevatron

IOP HEPP half day meeting

Results From the Tevatron

Imperial College London, 21 September 2005

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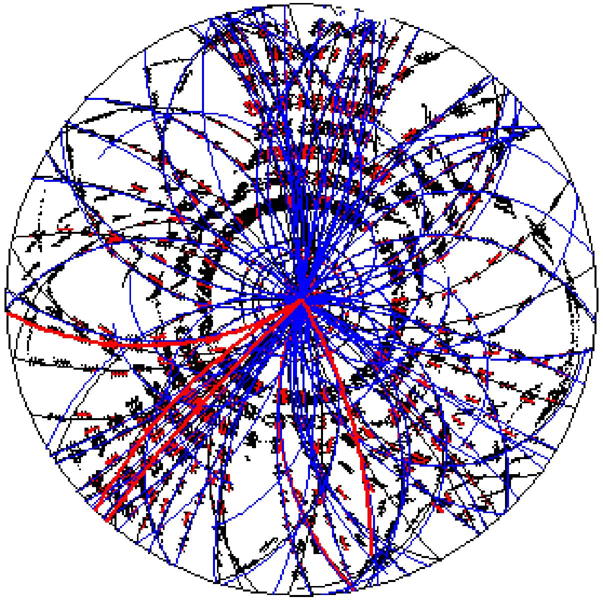
Representing the
DØ and CDF collaborations

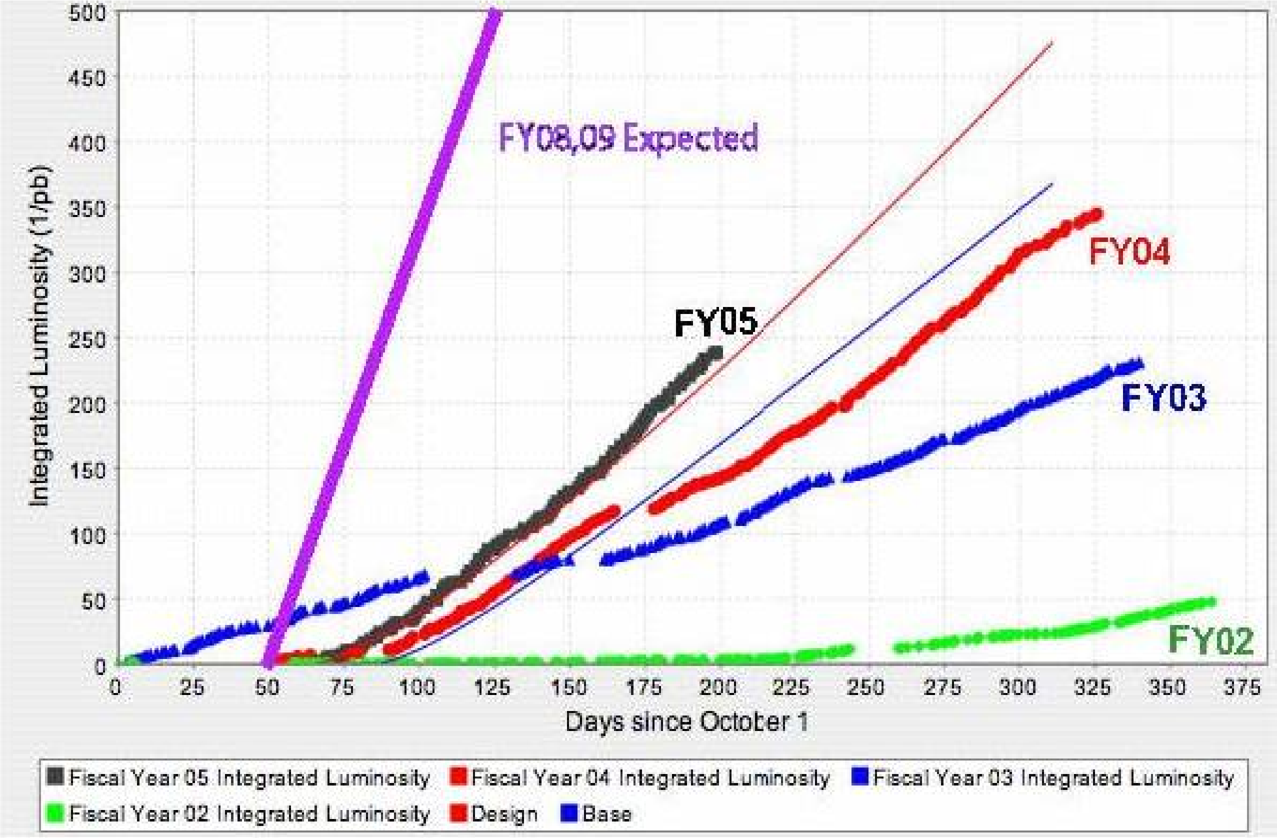
B Physics at Hadron Colliders

- Pros
  - Large production cross section – 300 Hz of reconstructable B's
  - All b species produced
    - $B^{\pm}$, B^0, B_s, B_c, Λ_b, Ξ_b
  - We get to look for the Higgs at the same time
- Cons
  - Large combinatorics and messy events
  - We only write about 50 Hz of data total, which we have to share with other physics
  - Inelastic cross section is a factor of 10^3 larger with roughly the same pT spectrum – difficult to trigger on B's
  - Many decays of interest have BR's of the order 10^{-6} – hard to separate from "regular" B decays at the trigger level
  - Difficult to detect low pT photons and pi0's from B decays



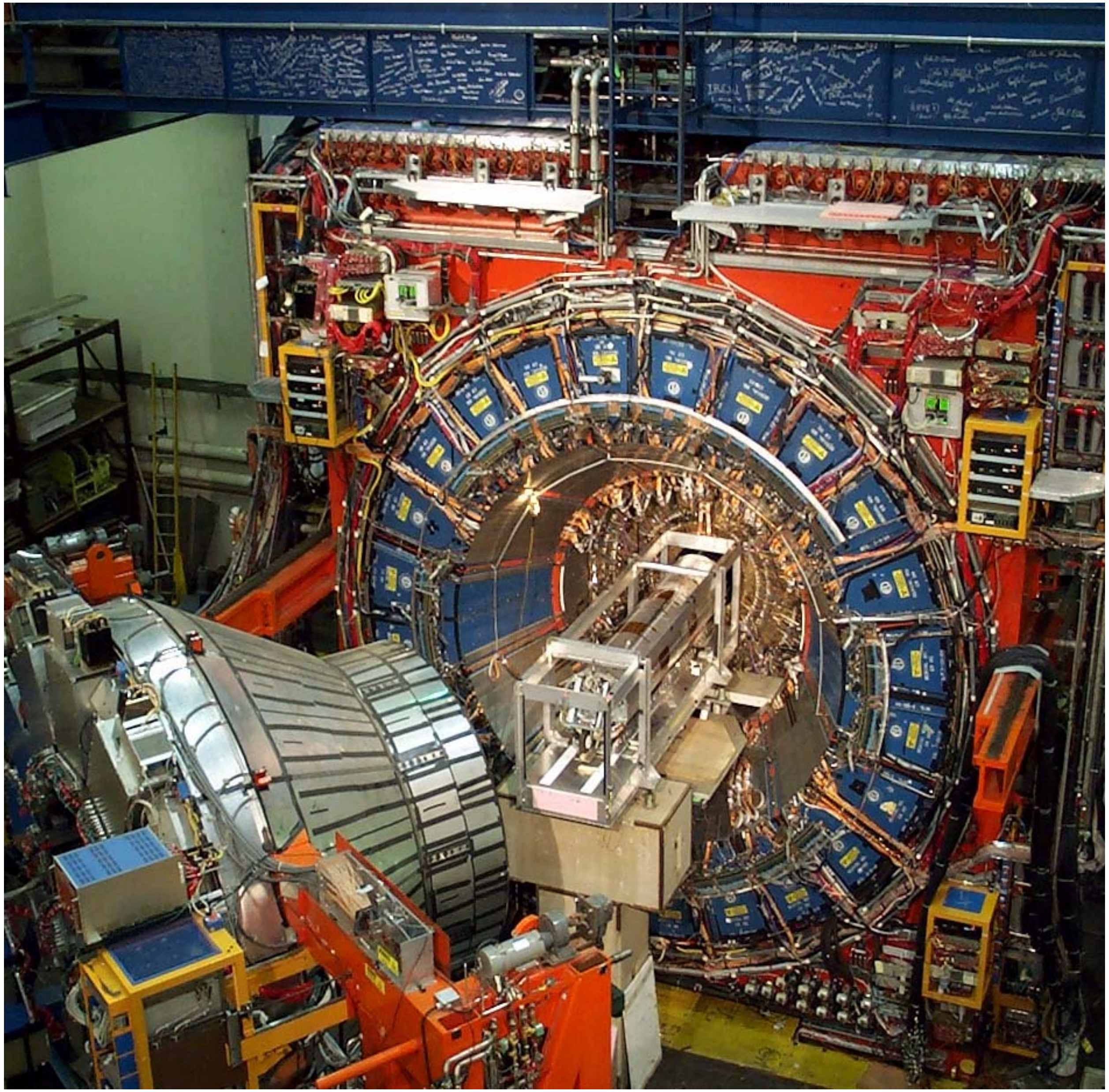
Tevatron Luminosity

- Over 1 fb^{-1} of collisions have been delivered to the experiments so far in Run II
  - Todays results based on ~ 0.5 fb^{-1}
  - UK institutions contribute to every analysis shown



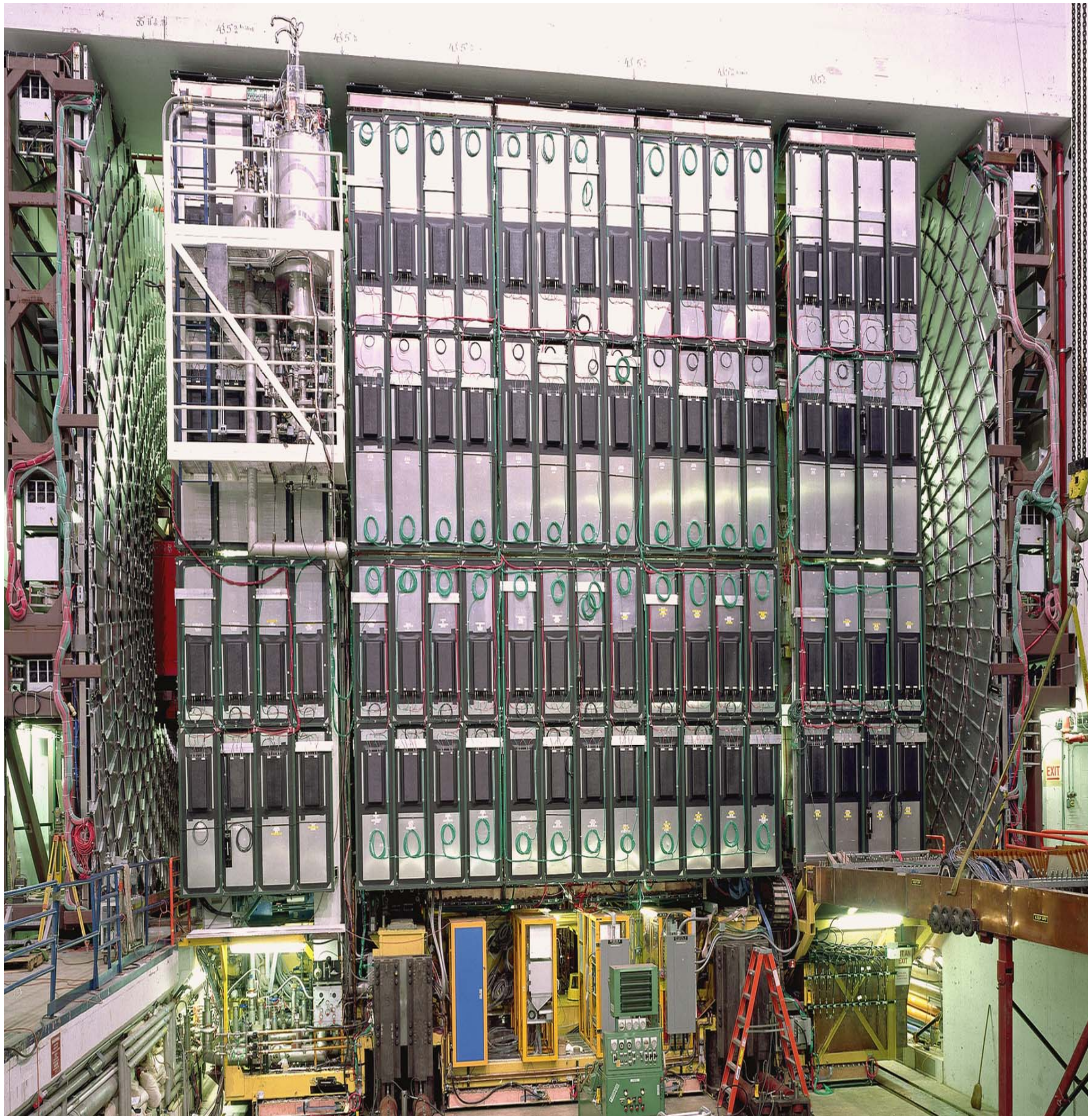
The CDF Run II Detector

- New silicon vertex detector
  - inner layer at 1.35 cm
- New central tracker
  - Excellent mass resolution
- Extended μ coverage
- TOF and dE/dx particle ID
- Second level impact parameter trigger
  - Allows all hadronic B decay triggers



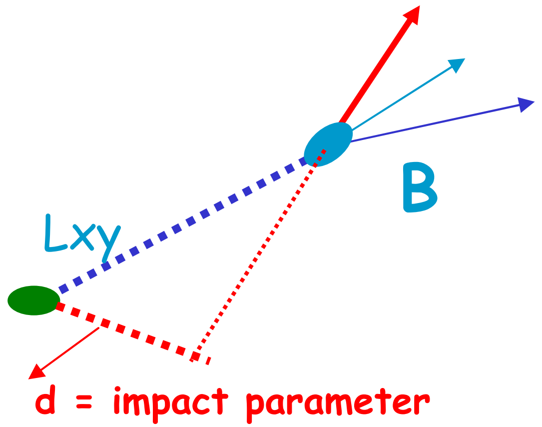
The DØ Run II Detector

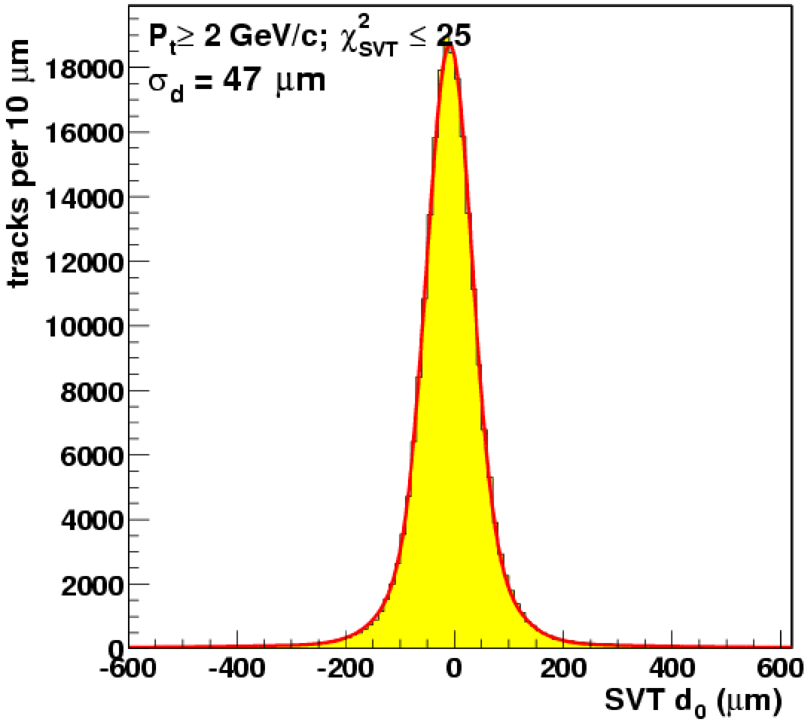
- Silicon vertex detector
  - $|\eta| < 3.0$
- Central fiber tracker and pre-shower detectors
  - $|\eta| < 1.5$
- 2 T solenoid magnet
- New low pT central muon trigger scintillators
- New forward μ system
  - Excellent muon purity and coverage: $|\eta| < 2.0$
- Second level silicon track trigger being commissioned, B tagging at 3rd level now



CDF Silicon Vertex Trigger (SVT)

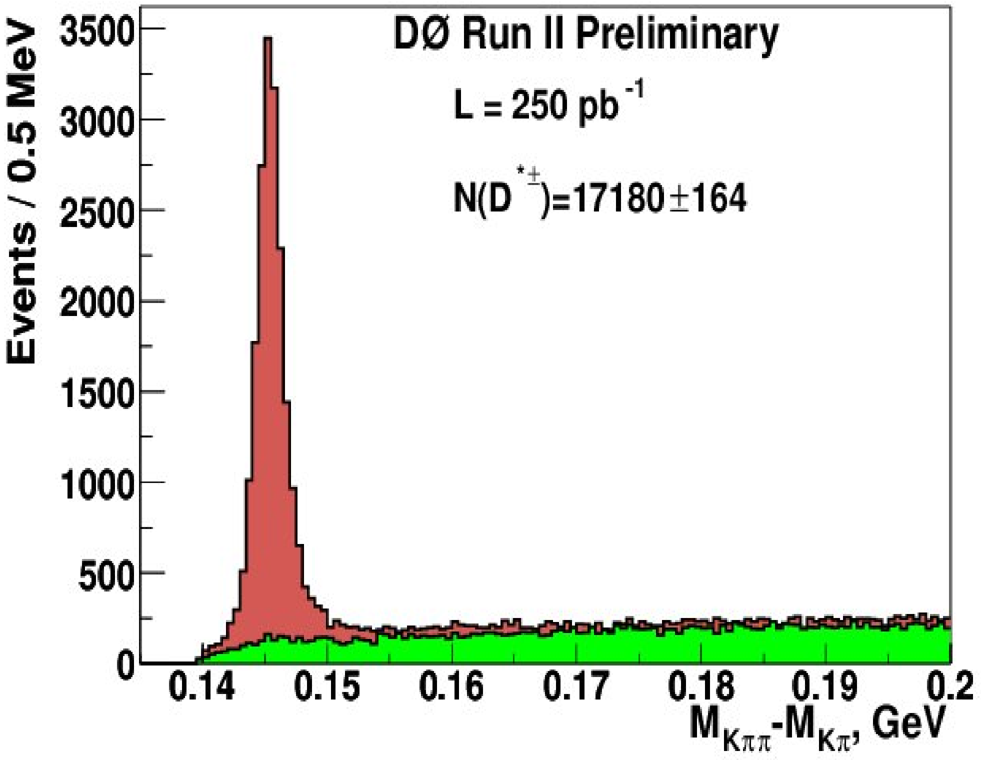
- CDF Level 2 Silicon Vertex Trigger
  - Good IP resolution
  - Trigger on displaced tracks
  - beamspot reconstruction
    - update every ~ 30 seconds
  - IP resolution: ~ 50 μm
    - 35 μm beam size + 35 μm
  - Buffered vertex detector information allows for hadronic track trigger





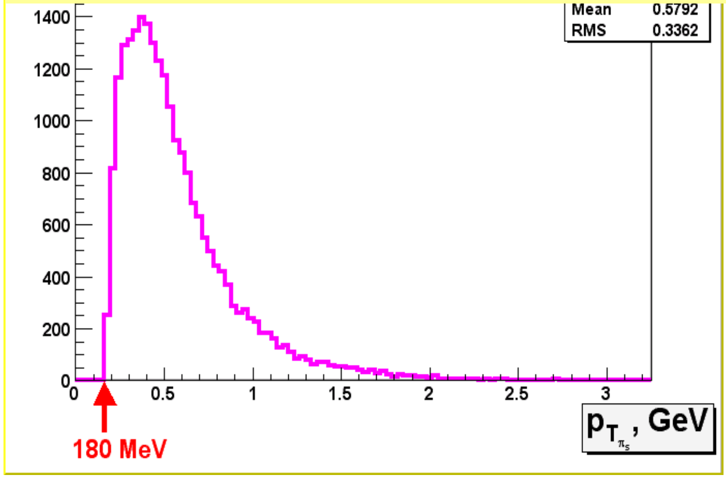
DØ Extended Tracking Coverage

Data from semileptonic decays
($B \to \mu D^* X$)

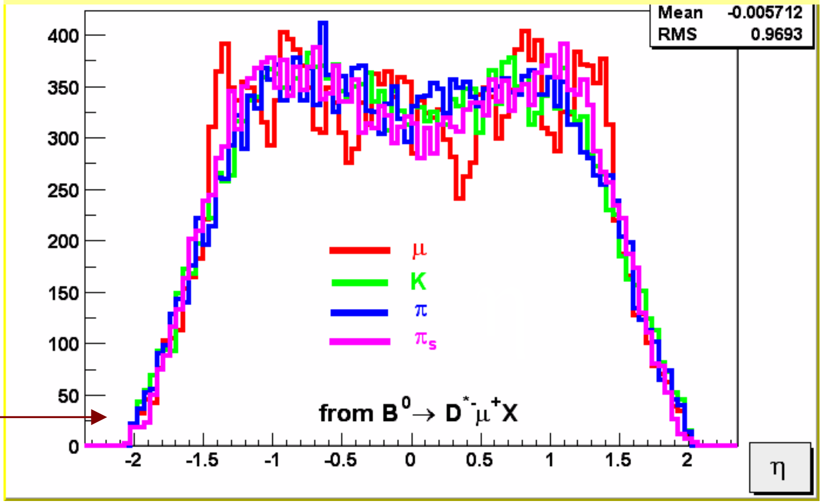


Tracking extended out to $|\eta| < 3.0$ for vertex finding and tagging

p_T of soft pion from $D^* \to D^0\pi$



η of all B signal particles

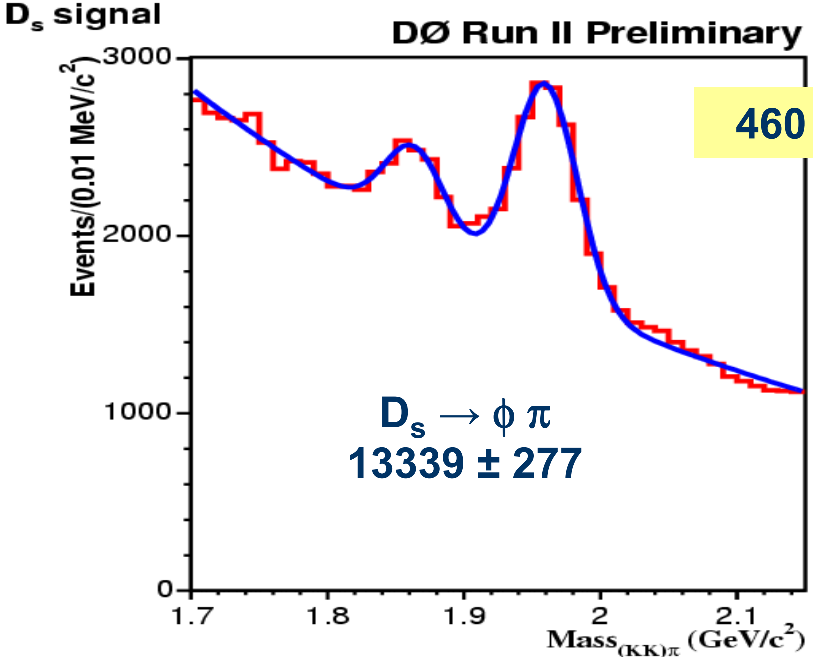


B triggers at the Tevatron

- Dimuons – J/ψ modes
  - pT > 1.5 - 3.0 GeV
  - CDF central, DØ out to $|\eta| < 2.0$
- Single muons – semileptonic decays, tagging triggers
  - DØ: very pure central track matched muons with pT > 4 GeV
    - require additional tracks at medium lums
    - require impact parameters, phi mass, at high lums
  - CDF: pT > 4 GeV/c, 120 μm < d0(Trk) < 1mm, pT(Trk) > 2 GeV/c
- CDF two displaced vertex tracks - hadronic samples
  - pT(Trk) >2 GeV/c, 120 μm < d0(Trk) < 1mm, ΣpT > 5.5 GeV/c

DØ B Samples

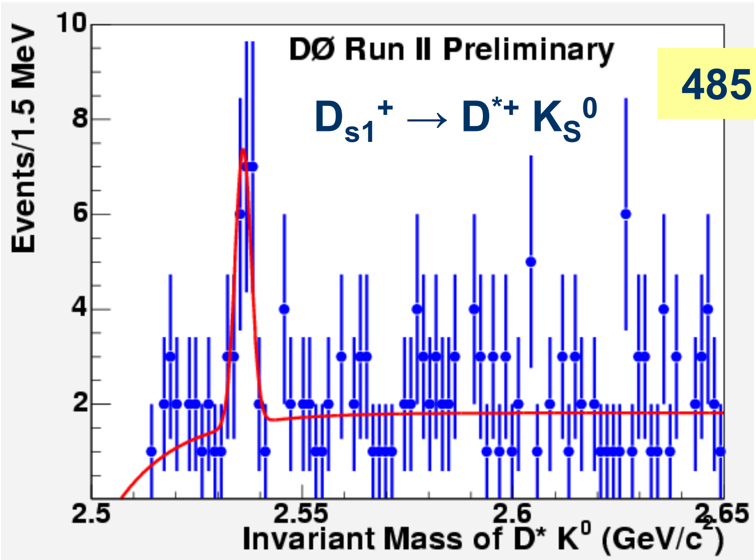
Mode	evts / 100pb^{-1}
$J/\psi \rightarrow \mu^+ \mu^-$	1.14 M
$B^+ \rightarrow J/\psi K^+$	1700
$B_d \rightarrow J/\psi K^{*0}$	740
$B_d \rightarrow J/\psi K^0_S$	40
$B_s \rightarrow J/\psi \phi$	100
$\Lambda_b \rightarrow J/\psi \Lambda$	25
$B_c \rightarrow J/\psi \mu X$	65
$X(3872) \rightarrow J/\psi \pi^+ \pi^-$	230
$B \rightarrow D^{**} \mu \nu$	210
$B^{**} \rightarrow B \pi$	150
$B_s \rightarrow D_{s1} \mu X$	4
$B^+ \rightarrow D^0 \mu^+ X$	46.2 K
$B_d \rightarrow D^{*-} \mu^+ X$	10 K
$B_s \rightarrow D_s(\phi\pi) \mu X$	2900
$B_s \rightarrow D_s(K^*K) \mu X$	2500



$D_s \rightarrow \phi \pi$

13339 ± 277

460 pb^{-1}

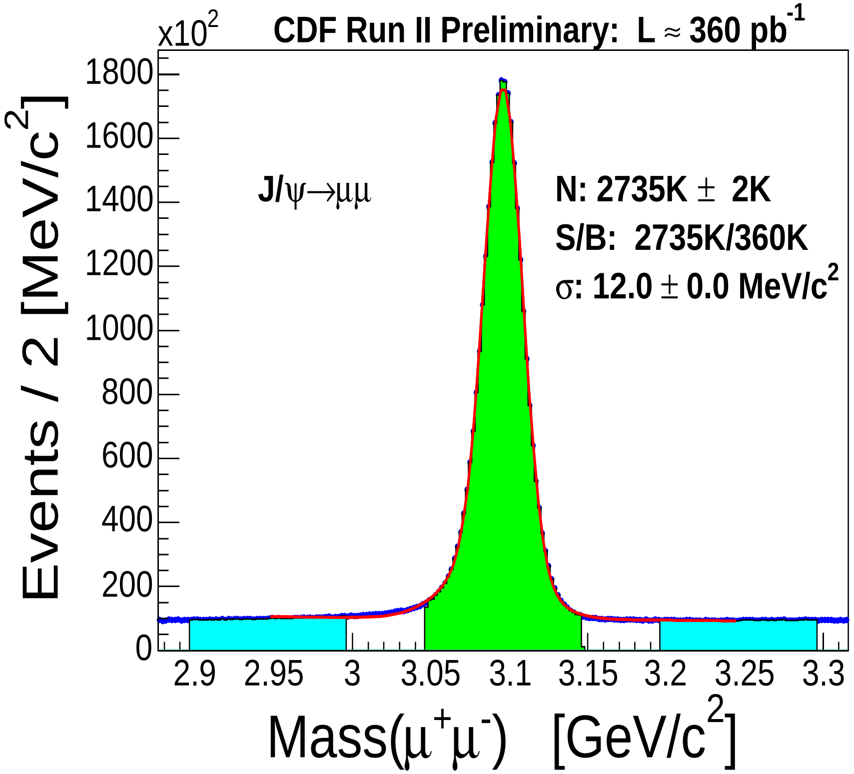


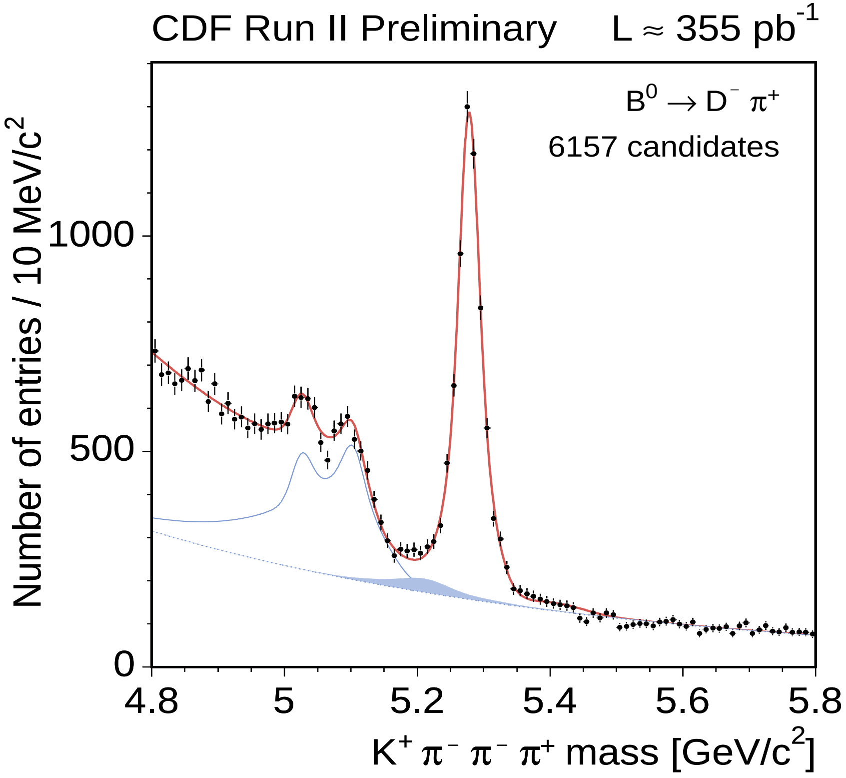
$D_{s1}^+ \rightarrow D^{*+} K_S^0$

485 pb^{-1}

CDF B Signals

- $J/\psi \to \mu\mu$
  - 2.7M candidates in 360 pb^{-1}
  - ~15%: B decay
- $B^0 \to D^- \pi^+$
  - 6k candidates in 360 pb^{-1}
  - Two IP track trigger sample





Lifetime Measurements

- Hadron collider experiments are now making precision measurements of B_s, Λ_b, B_c , B^0, B^- lifetimes
- Tests of HQET, OPE, NLO QCD
- Input to other measurements
- Measure/predict ratios to minimize systematic uncertainties

Theory predictions

	$\frac{\tau(B^+)}{\tau(B_d)}$	$\frac{\tau(B_s)}{\tau(B_d)}$	$\frac{\tau(\Lambda_b)}{\tau(B_d)}$
LO	**1.01(3)**	**1.00(1)**	**0.93(4)**
NLO	**1.06(3)**	**1.00(1)**	**0.90(5)**
NLO+ $O(1/m_b^4)$	**1.06(2)**	**1.00(1)**	**0.88(5)**

reduced disagreement with data

DØ Semileptonic B_s

- $B_s \to D_s \mu \nu X$
- Large data sample from muon triggers ~400 pb^{-1}
- Resolutions and K factors from data semileptonic modes of B^0, B^-

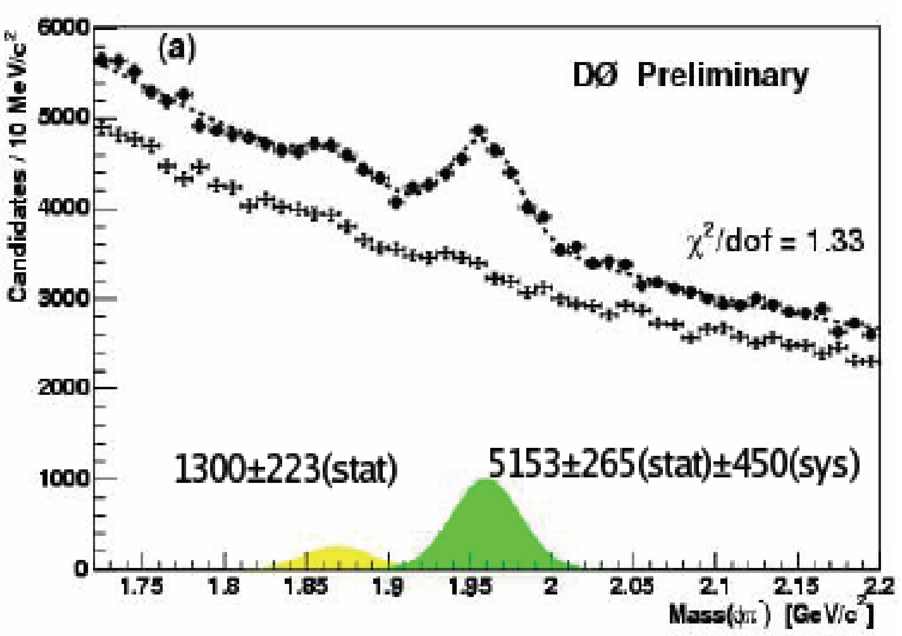
Sample Composition

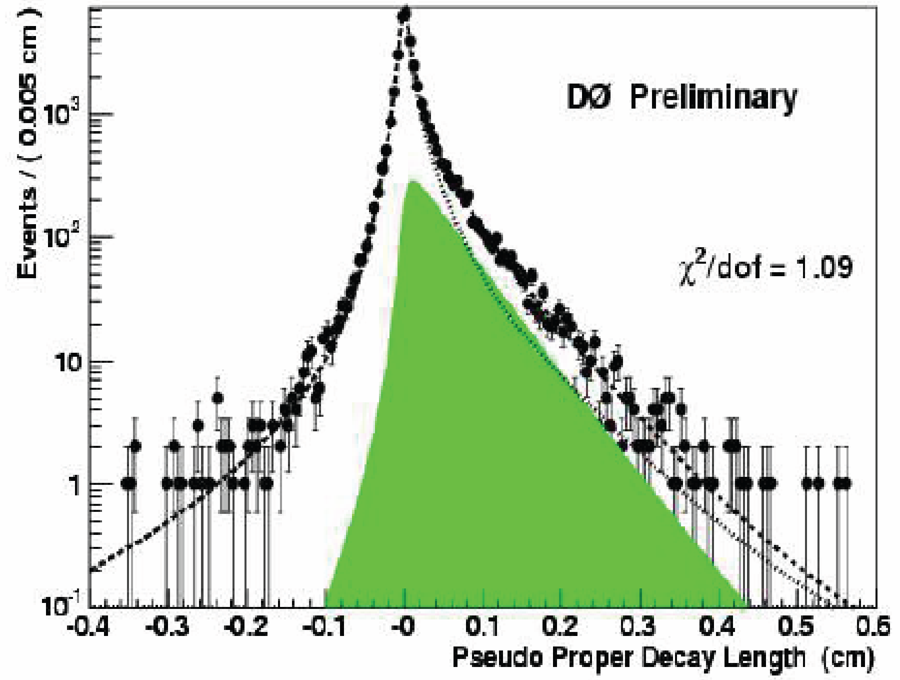
25.4%	$B_s^0 \to D_s^- \mu^+ \nu X$
67.7%	$B_s^0 \to D_s^{*-} \mu^+ \nu X$
2.4%	$B_s^0 \to D_{s0}^{*-} \mu^+ \nu X$
4.5%	$B_s^0 \to D_{s1}^{'-} \mu^+ \nu X$
Total Br: 7.9 %	

- Include charm backgrounds in the fit (wide tails)

$$\boxed{\tau(B_s) = 1.420 \pm 0.043 \pm 0.057}$$

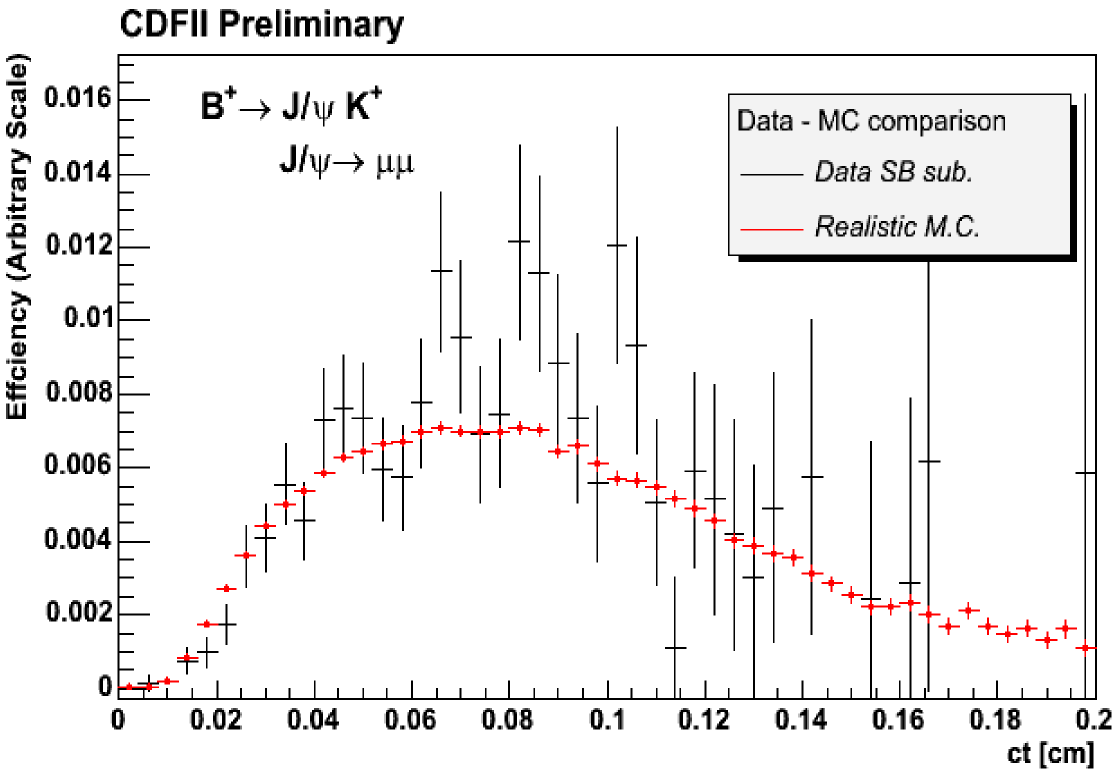
World Best Measurement !



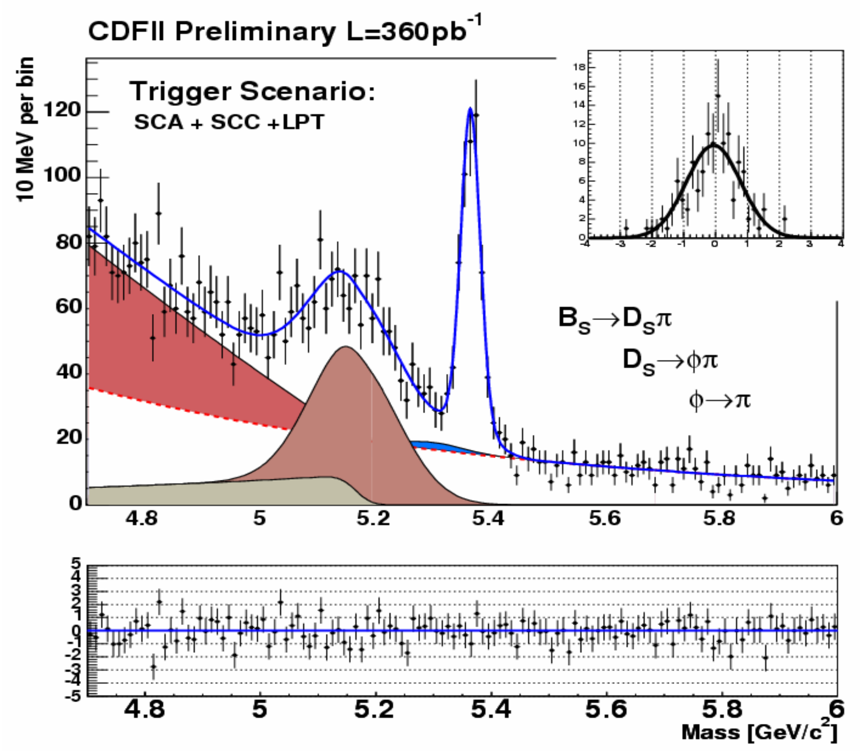


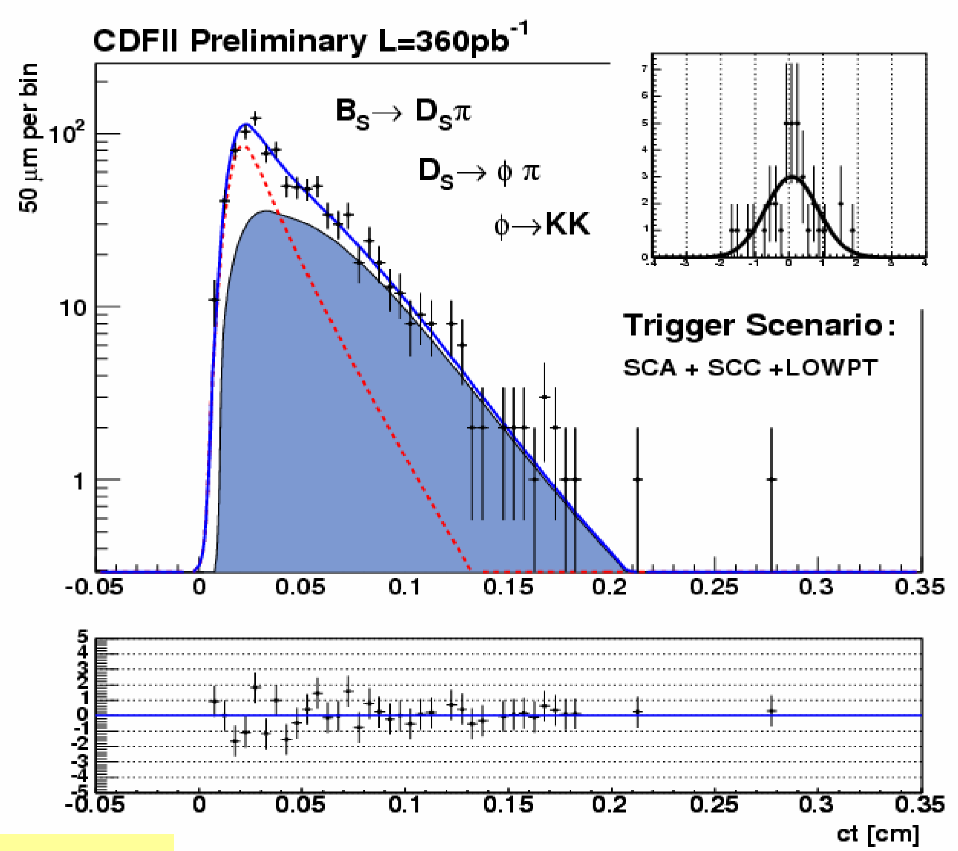
CDF Hadronic modes

- First lifetime results to use events triggered by Silicon Vertex Trigger
  - Trigger IP cuts bias lifetime distributions but provides large all hadronic decay samples – no K factors needed
  - Correct for trigger bias using Monte Carlo – verified with B^+
  - Systematic uncertainties ~ 4-5 μm



CDF Lifetimes in Hadronic Mode





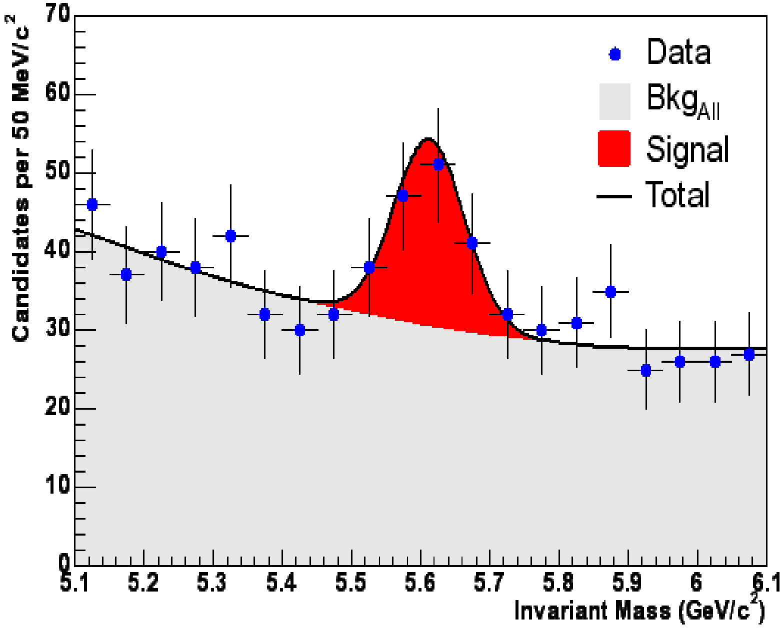
$\tau(B^+)$ = **1.661±0.027±0.013 ps**

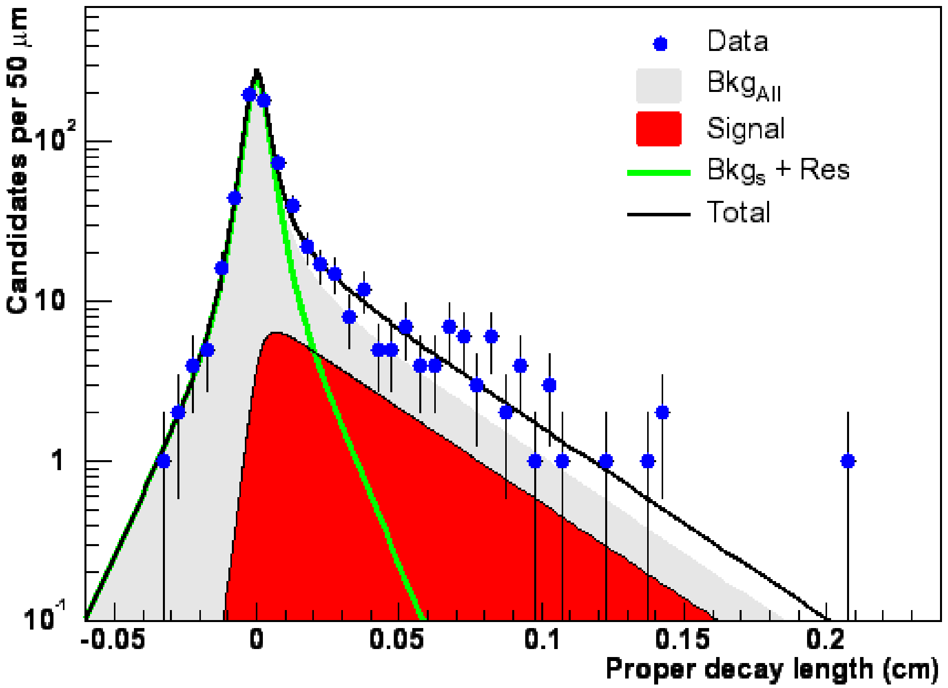
$\tau(B^0)$ = **1.511±0.023±0.013 ps**

$\tau(B_s)$ = **1.598±0.097±0.017 ps**

DØ Λ_b lifetime

$$\Lambda_b \to J/\psi + \Lambda$$



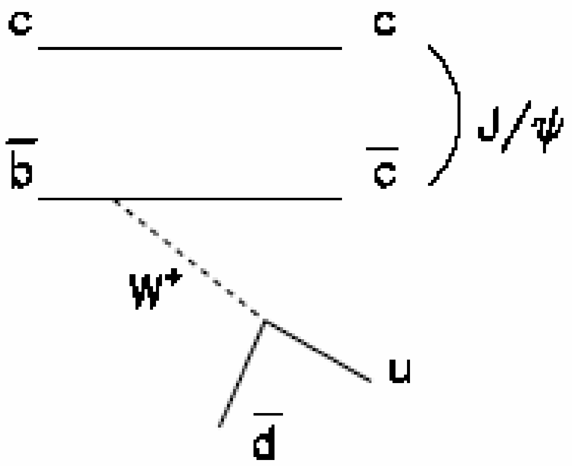


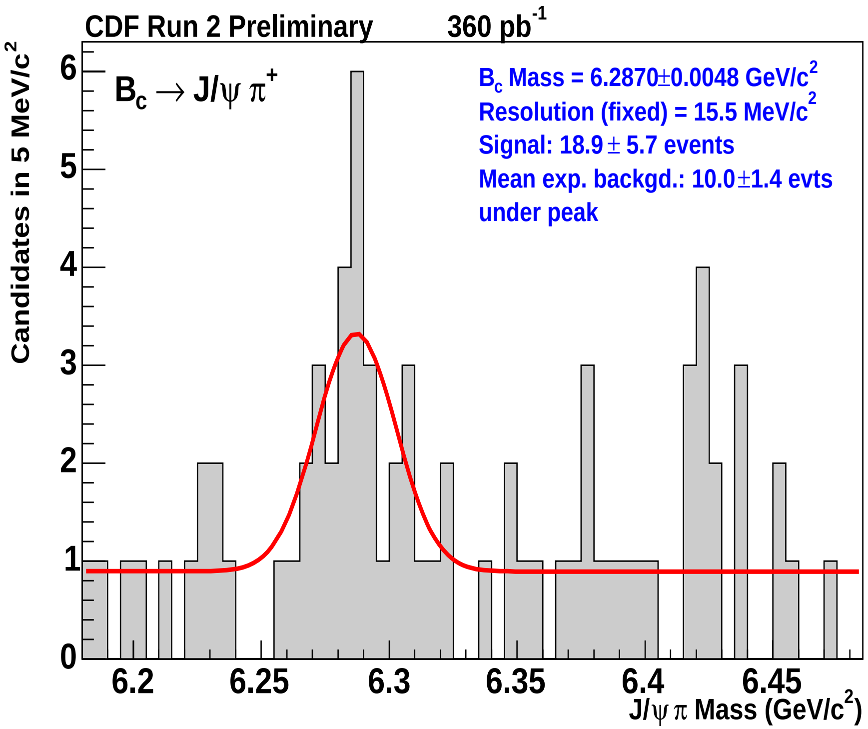
- 2D mass – decay length fits: 61 ± 12 signal events

$$\tau(\Lambda_b)/\tau(B^0) = 0.87 \pm 0.17 \pm 0.03$$

Consistent with new theory

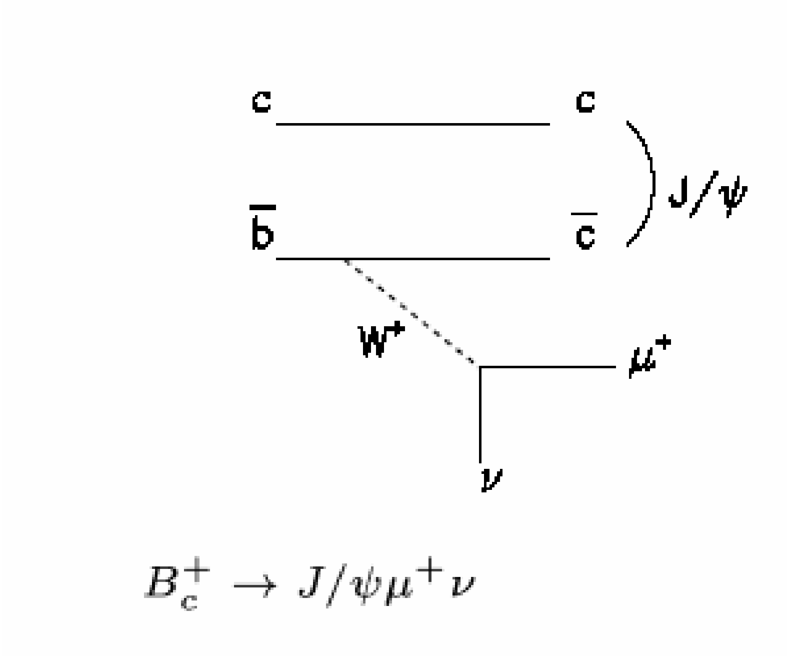
CDF B_c mass



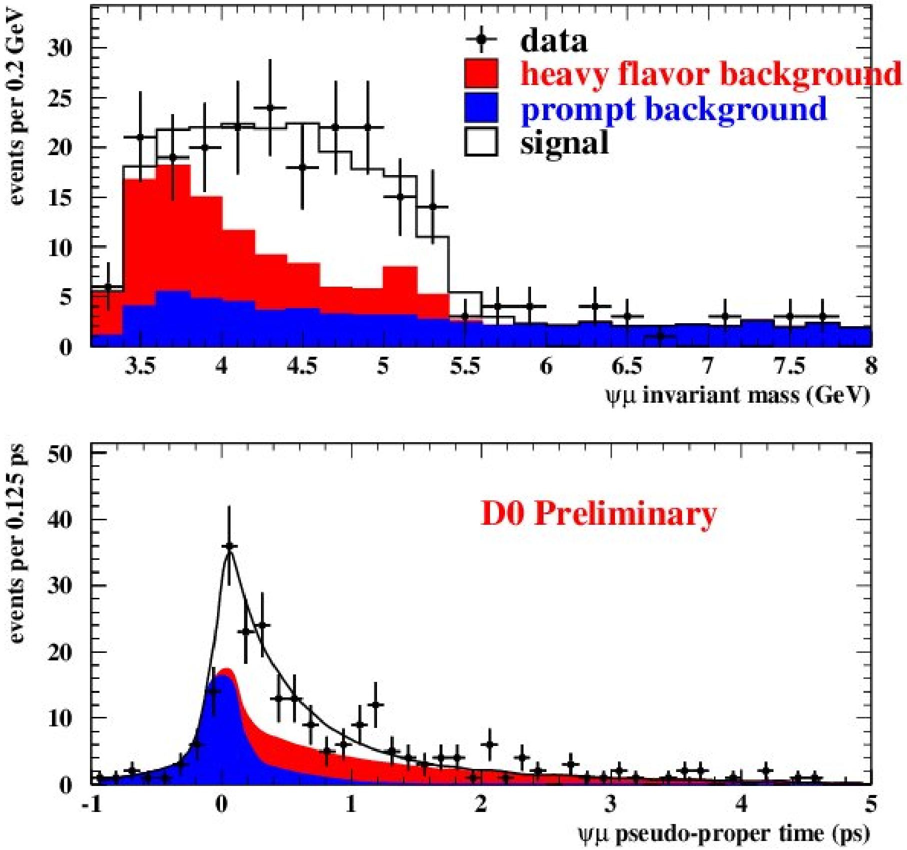


- "Evidence" of Hadronic $B_c \to J/\psi\pi$
  - Significance: 3.5 σ
  - $M(B_c) = 6287.0 \pm 4.8 \pm 1.1$ MeV
    - Good agreement with recent Lattice prediction of 6304±12+18 MeV
      - FHPQCD, Fermilab Lattice, UKQCD
      - PRL 94 2005

DØ B_c mass and lifetime



$B_c^+ \to J/\psi \mu^+ \nu$



$N(B_c) = 95 \pm 12 \pm 11$

$M(B_c) = 5.95 \pm 0.14 \pm 0.34\ \mathrm{GeV}/c^2$

$\tau(B_c) = 0.45 \pm 0.12 \pm 0.12$ ps

Theory vs. Data

2005 HFAG world average lifetimes vs. theoretical predictions

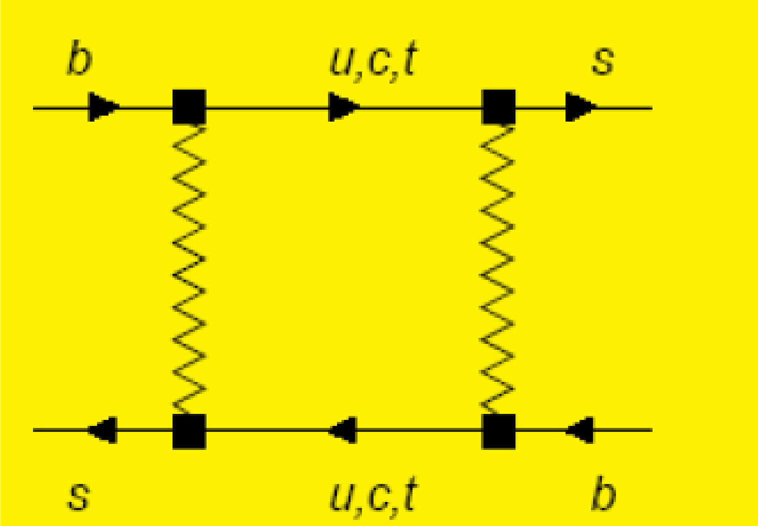
	$\frac{\tau(B^+)}{\tau(B_d)}$	$\frac{\tau(B_s)}{\tau(B_d)}$	$\frac{\tau(\Lambda_b)}{\tau(B_d)}$	$\tau(B_c)$
Measured	**1.076(8)**	**0.92(3)**	**0.81(5)**	**0.45(12) ps**
Theory	**1.06(2)**	**1.00(1)**	**0.88(5)**	**0.36(?) ps**

Precision on Bs and Lb measurements will continue to increase – may show discrepancy with theory.
B_c prediction needs to be revisited.

The B_s System

$$i\frac{d}{dt}\begin{pmatrix} |B_s(t)\rangle \\ |\overline{B}_s(t)\rangle \end{pmatrix} = \left(M - i\frac{\Gamma}{2}\right)\begin{pmatrix} |B_s(t)\rangle \\ |\overline{B}_s(t)\rangle \end{pmatrix}$$

- M_{12} stems from the real part of the box diagram, dominated by top
- G_{12} stems from the imaginary part, dominated by charm
- Heavy and light Bs eigenstates are expected to have different widths



$$B_L = p|B_s\rangle + q|\overline{B}_s\rangle \approx cp\ odd$$

$$B_H = p|B_s\rangle - q|\overline{B}_s\rangle \approx cp\ even, \quad p^2 + q^2 = 1$$

$\Delta\Gamma_s$ from $B_s \to J/\psi\phi$

- Relation of matrix elements to decay and oscillation parameters:

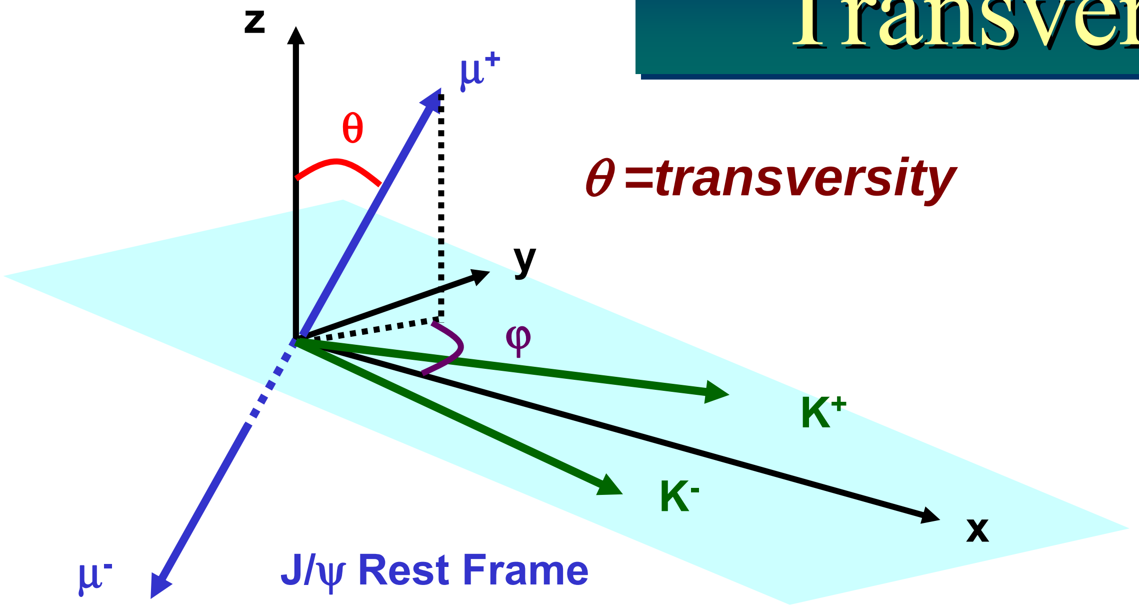
$$\Delta m = M_H - M_L \approx 2|M_{12}|$$

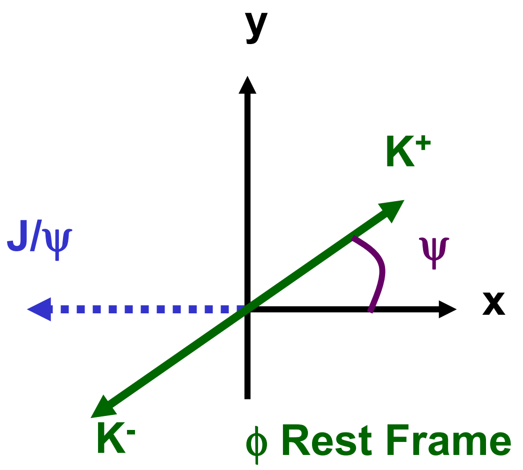
$$\Delta\Gamma = \Gamma_L - \Gamma_H \approx 2|\Gamma_{12}|\cos\phi$$

$$\phi = \arg\left(-\frac{M_{12}}{\Gamma_{12}}\right)$$

- In the Standard Model:
  - The CP violating phase, ϕ is expected to be small
  - Mass eigenstates are ~ CP eigenstates with definite lifetimes
- The $J/\psi\ \phi$ final state is a mixture of CP states
  - L=0, 2; CP even; $(A_0, A_\parallel)$
  - L=1; CP odd; $(A_\perp)$
- Assuming no CP violation in the **B_s** system, measure two **B_s** lifetimes, τ_L and τ_H, (or $\Delta\Gamma/\Gamma$ and τ) by simultaneously fitting time evolution and angular distribution in untagged $B_s \to J/\psi\ \phi$ decays
- CDF result last summer: $\Delta\Gamma/\Gamma = 0.65^{+0.25}_{-0.33} \pm 0.01$

Transversity Analysis





$$\frac{d^3\Gamma \to J/\psi(\to l^+l^-)\,\phi(\to K^+K^-)}{d\cos\theta\, d\phi\, d\cos\psi\, dt} \propto \frac{9}{16\pi}\Big[\, 2|A_0(0)|^2 e^{-\Gamma_L t}\cos^2\psi(1 - \sin^2\theta\cos^2\phi)$$

$$+ \sin^2\psi \left\{|A_{||}(0)|^2 e^{-\Gamma_L t}(1 - \sin^2\theta\sin^2\phi) + |A_\perp(0)|^2 e^{-\Gamma_H t}\sin^2\theta\right\}$$

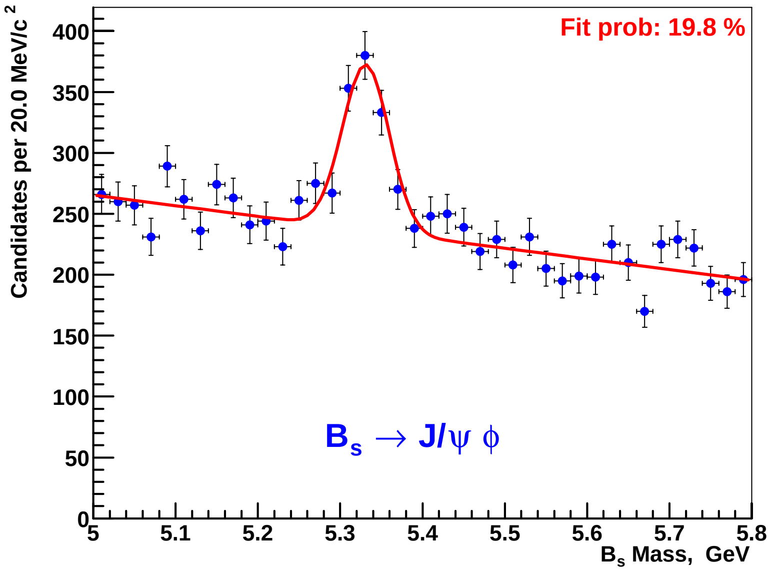
$$+ \frac{1}{\sqrt{2}}\sin 2\psi\left\{|A_0(0)||A_\perp(0)|\cos(\delta_2 - \delta_1)e^{-\Gamma_L t}\sin^2\theta\sin^2 2\phi\right\}$$

$$+ \left\{\frac{1}{\sqrt{2}}|A_0(0)||A_\perp(0)|\cos\delta_2\sin 2\psi\sin 2\theta\cos\phi\right\}\frac{1}{2}\left(e^{-\Gamma_H t} - e^{-\Gamma_L t}\right)\delta\phi$$

$$- \left\{\frac{1}{\sqrt{2}}|A_{||}(0)||A_\perp(0)|\cos\delta_1\sin^2\psi\sin 2\theta\sin\phi\right\}\frac{1}{2}\left(e^{-\Gamma_H t} - e^{-\Gamma_L t}\right)\delta\phi\,\Big]\, H(\cos\psi)\, F(\phi)\, G(\cos\theta)$$

DØ $\Delta\Gamma_s$ from $B_s \to J/\psi\phi$

- CDF result fit to θ,ϕ,ψ angles giving A_0, $A_\parallel$, $A_\perp$, phase, $R_\perp = |A_\perp(0)|^2$
- New DØ result integrates over the angles ϕ,ψ using MC efficiency
- Fit technique similar to lifetime fit, but adds angle dependence
- Provides values for τ, $\Delta\Gamma$, and $R_\perp$ - no amplitudes or phase



$$\frac{d\Gamma(t)}{d\cos\theta} \propto \left(|A_0(t)|^2 + |A_\parallel(t)|^2\right)\frac{3}{8}\left(1+\cos^2\theta\right) + |A_\perp(t)^2|\frac{3}{4}\sin^2\theta$$

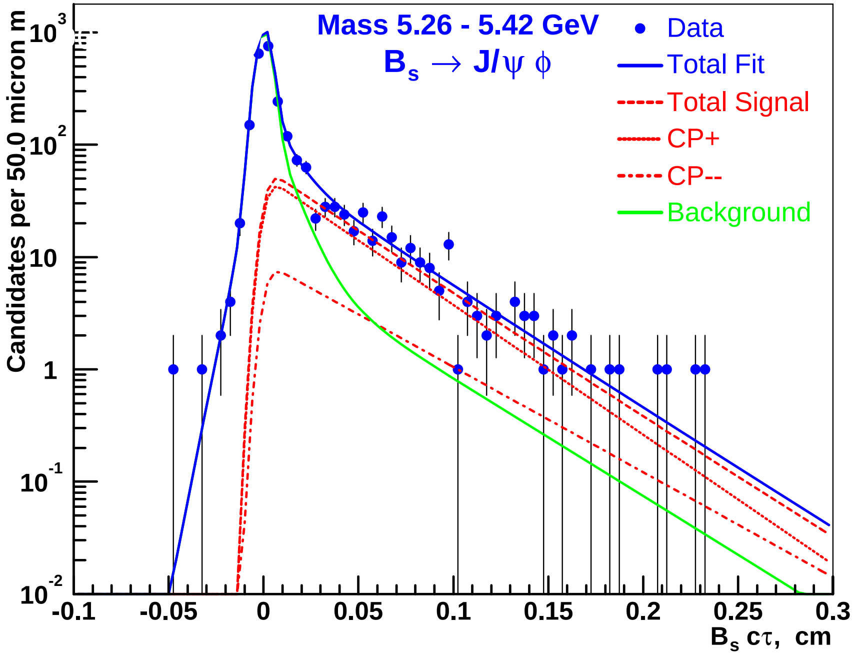
DØ $\Delta\Gamma_s$ Results

- Fit Results:

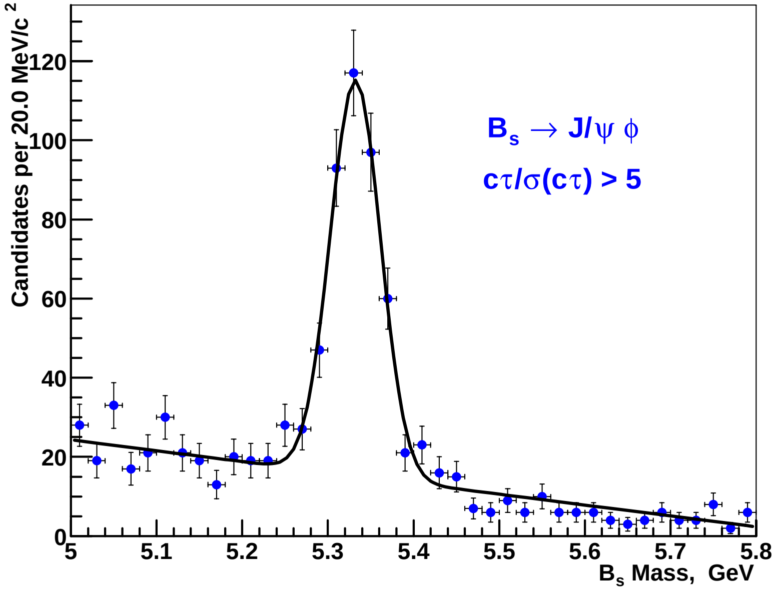
$$\overline{\tau}(B_s^0) = 1.39^{+0.13}_{-0.14} \pm 0.08\, ps$$

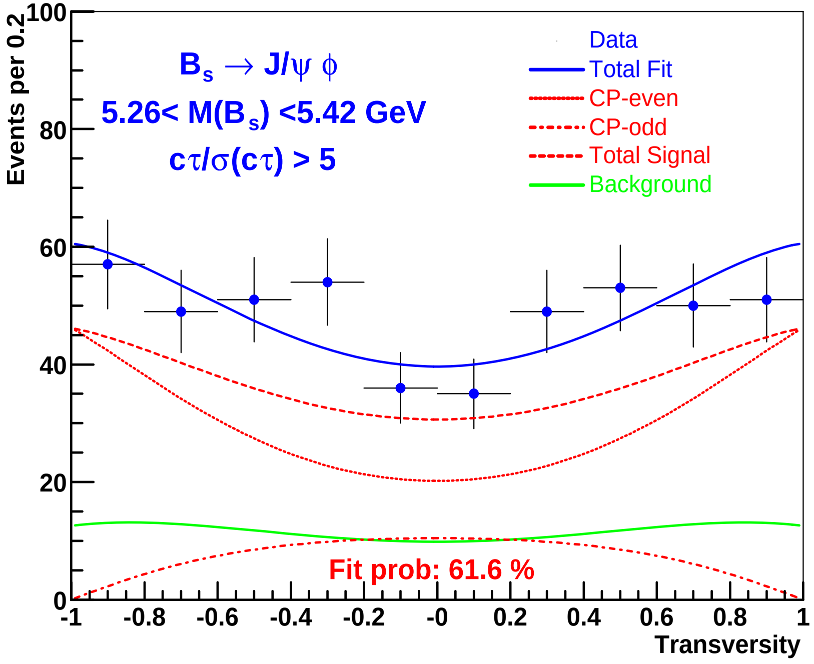
$$\frac{\Delta\Gamma}{\overline{\Gamma}} = 0.21^{+0.27}_{-0.40} \pm 0.20$$

$$R_\perp = 0.17 \pm 0.10 \pm 0.02$$



DØ Preliminary





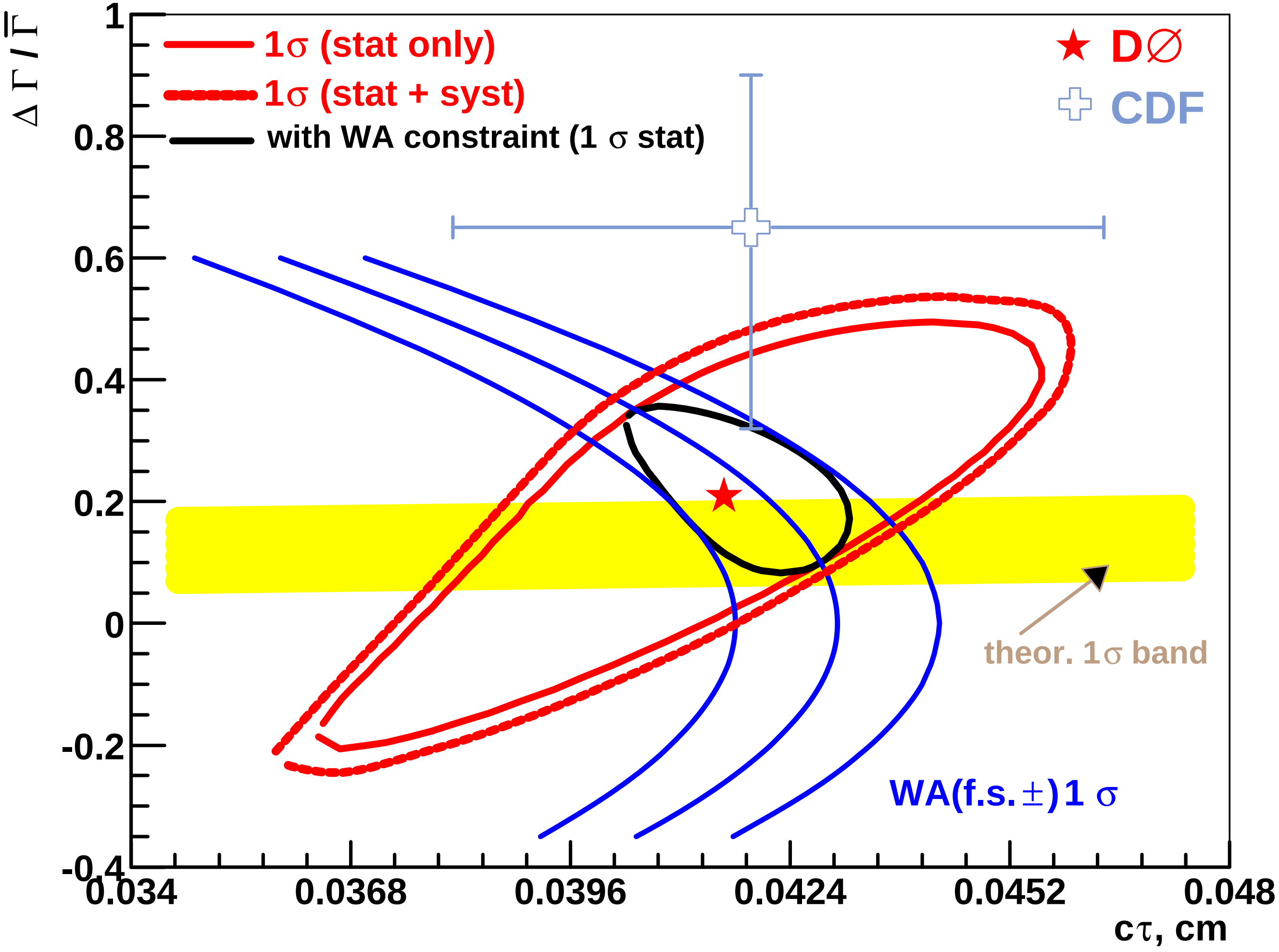
Additional Constraints

- Include τ_{fs} constraint from semleptonic measurements:

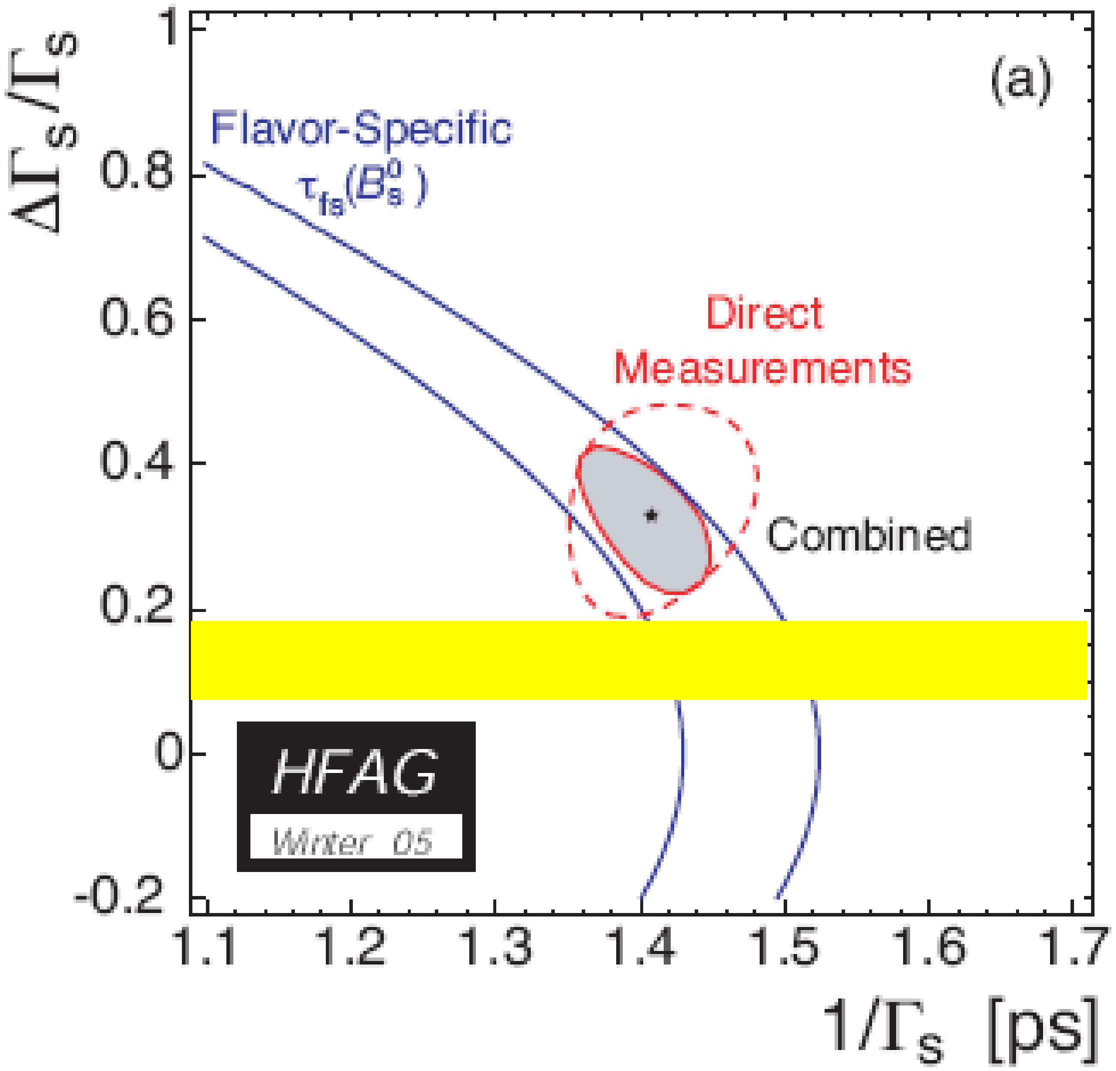
$$\Gamma_{fs} = \bar{\Gamma}\left(\frac{1-\left(\Delta\Gamma/2\bar{\Gamma}\right)^2}{1+\left(\Delta\Gamma/2\bar{\Gamma}\right)^2}\right)$$

$$\overline{\tau_{fs}} = 1.43 \pm 0.05 ps$$

$$\Rightarrow \frac{\Delta\Gamma}{\Gamma} = 0.23^{+0.16}_{-0.17}$$

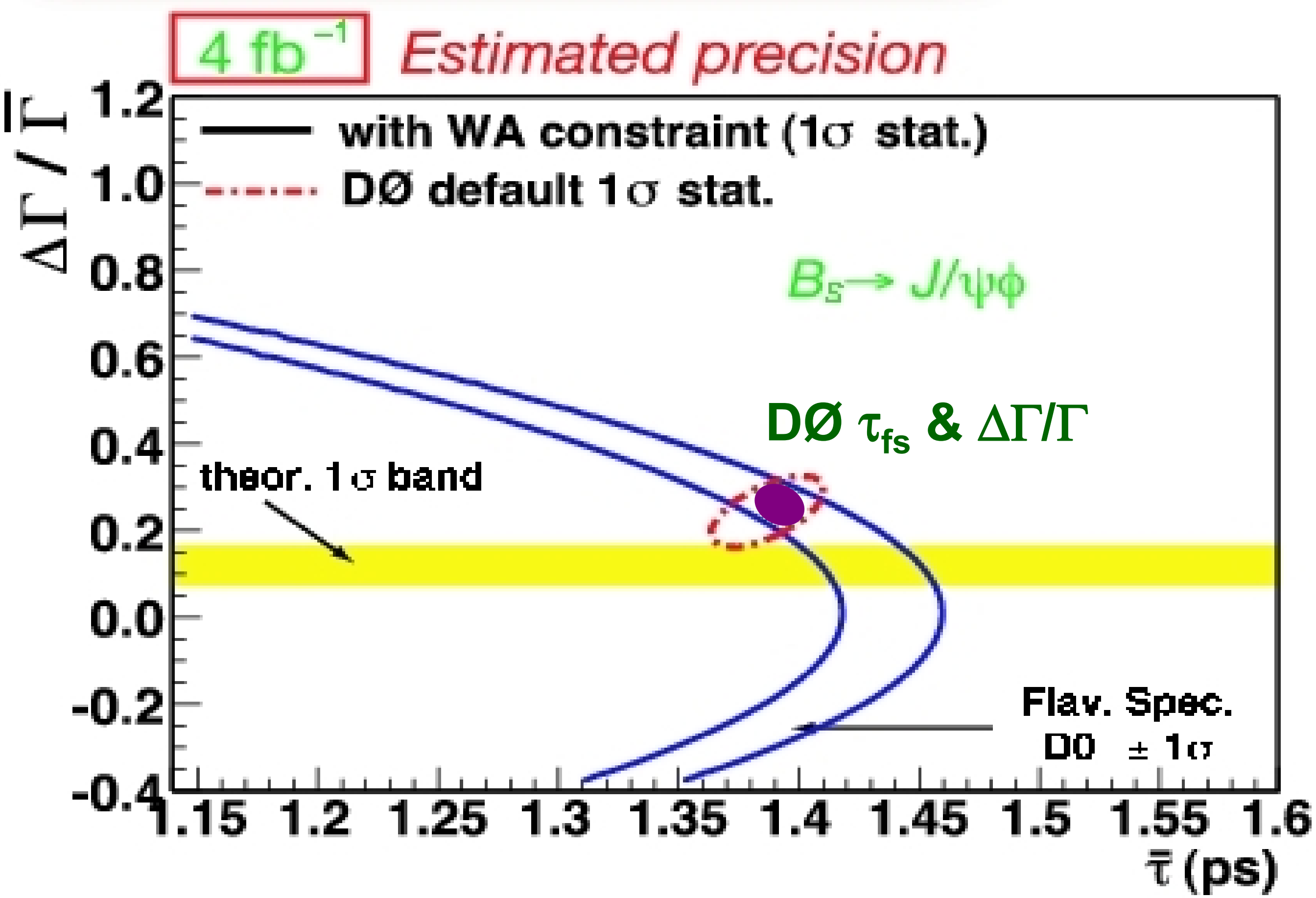


$(\Delta\Gamma/\Gamma)_s$ Combined Results

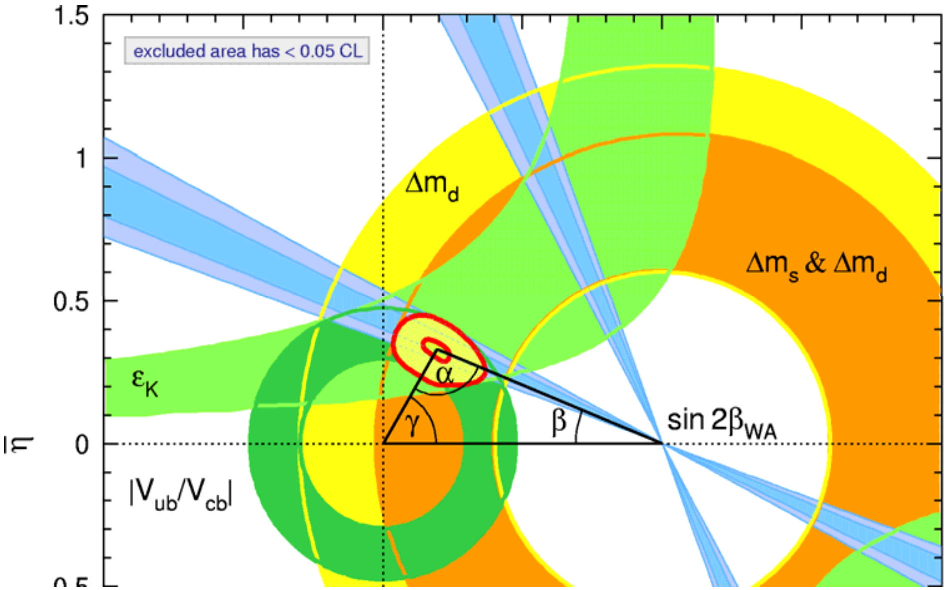


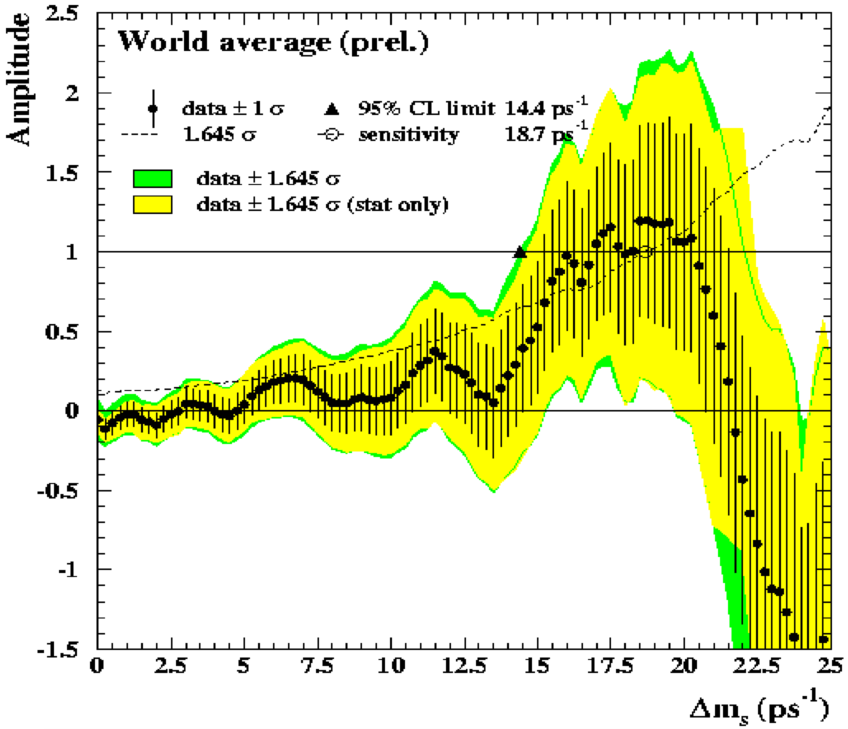
$(\Delta\Gamma/\Gamma)_s$ Future

- D projection, CDF has similar sensitivity
- Both experiments plan tagged CPV analysis

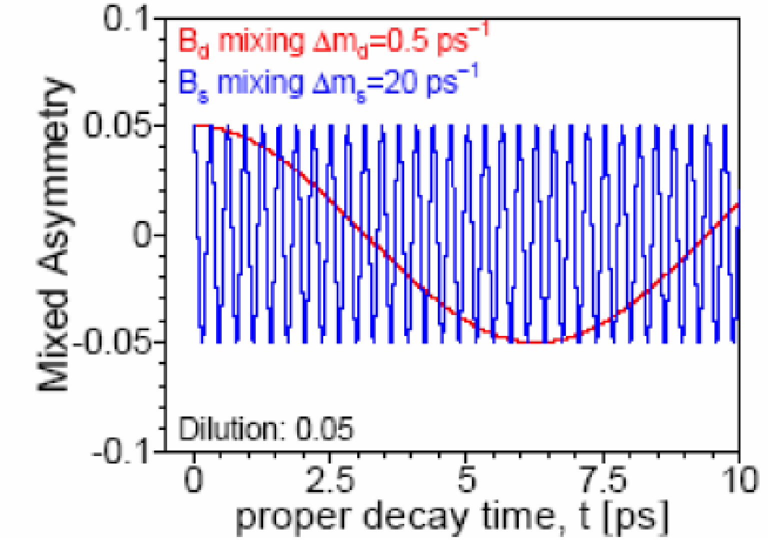


B_s mixing



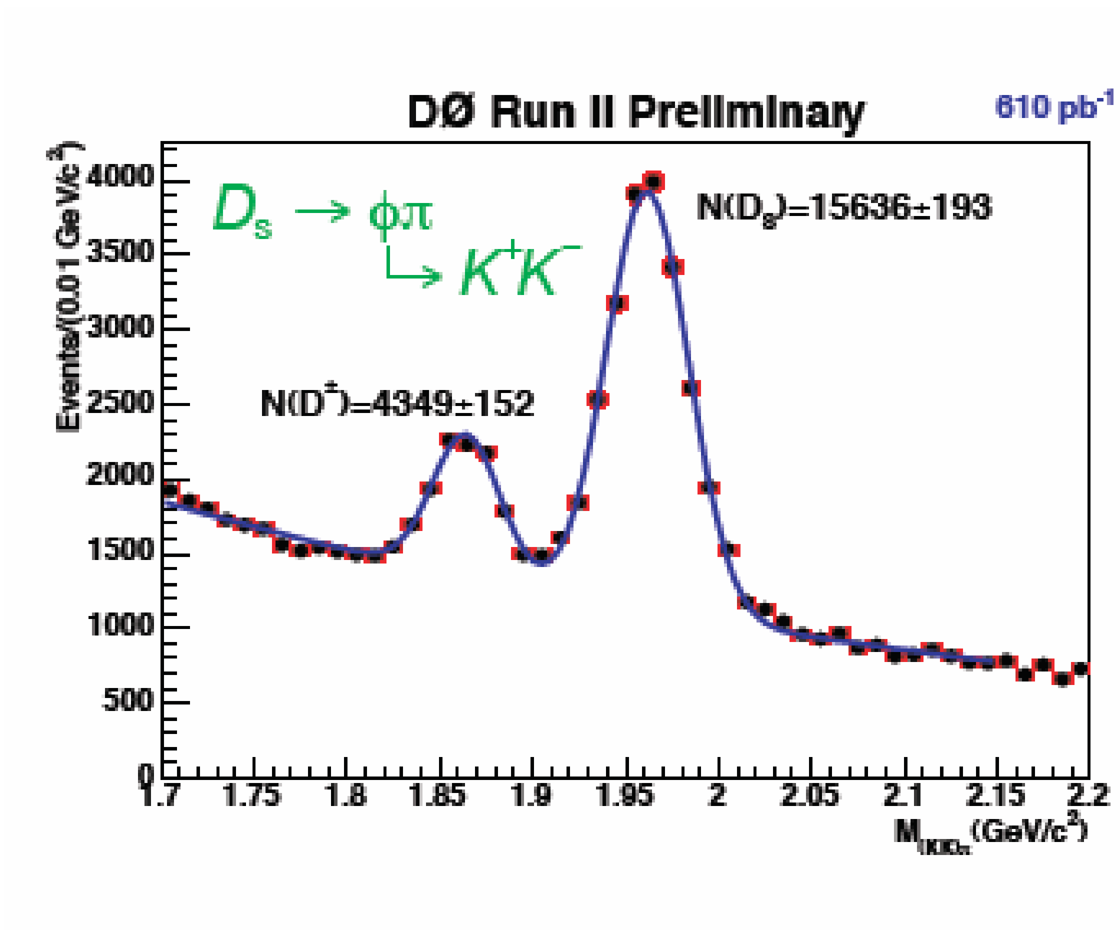


- Measures least known side of unitary triangle
- Can not be done at B factories
- Difficult measurement – requires:
  - High yield, good S/B
  - Oscillations are rapid, so we need excellent lifetime resolution
  - Flavor tagging



DØ Bs Mixing

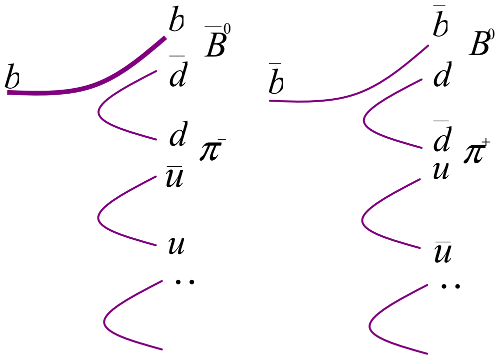
- Use Semileptonic Decay mode:
  $B_s \to D_s \mu \nu$, $D_s \to \phi \pi$, $\phi \to K^+ K^-$



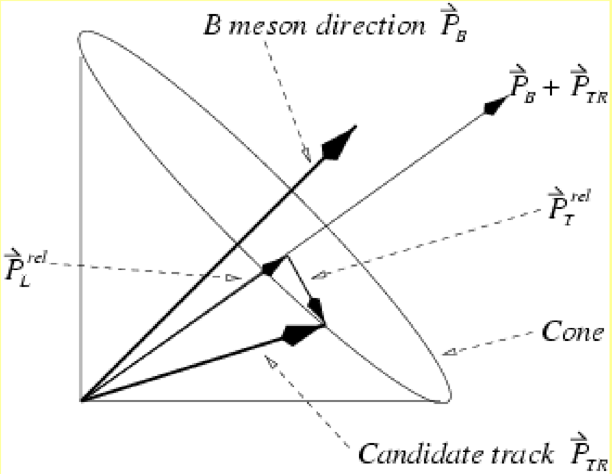
Flavor tagging

Opposite side lepton

Q of the highest pT muon or electron in the event separated in ϕ from the signal B by 2.2 rads.

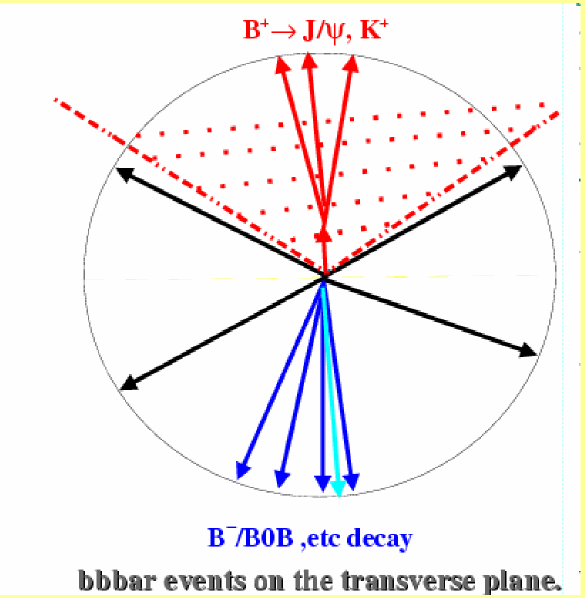


Same side track charge



Q of the highest pT (or lowest pTrel) track in a cone (dR < 0.7) around the B

Opposite jet charge



$$\text{Jet Q} = \frac{\Sigma p_T^i . q^i}{\Sigma p_T^i}$$

Require |Q| > 0.2

DØ Flavor Tagging Variable

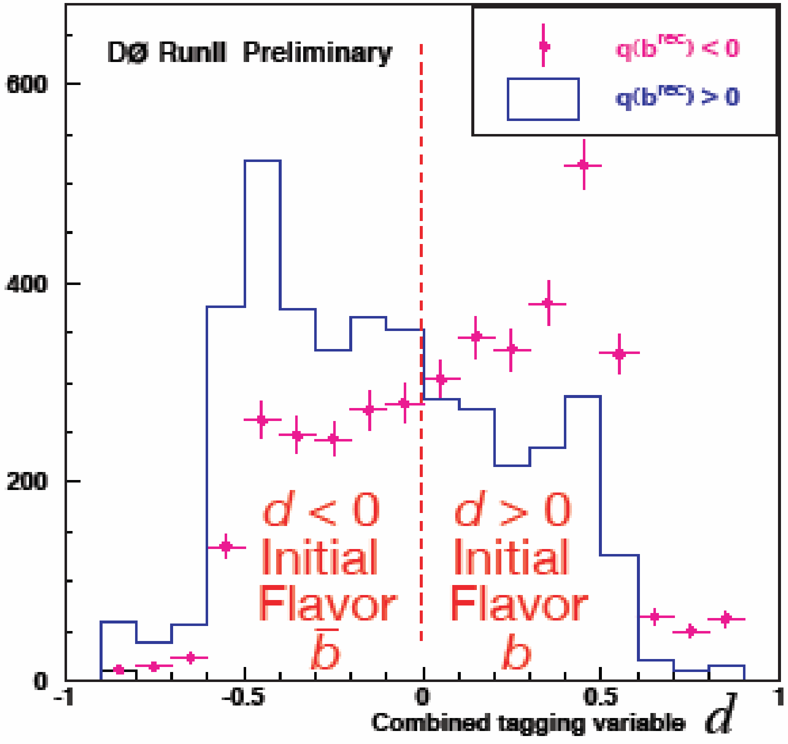
- Each flavor discriminating variable x_i as used described previously, likelihood ratio:

$$y = \prod_i^n y_i \; ; \quad y_i = \frac{PDF_i^{\bar{b}}(x_i)}{PDF_i^{b}(x_i)}$$

From *data*, $B_d^0 \rightarrow D^{*-} \mu^+ \nu$ wrong-sign subtracted, at short lifetimes *(non-oscillated)*

- Form single flavor-tag variable

$$d = \frac{1-y}{1+y}$$



more pure ← → more pure

Measure Tagging using B_d and B^+

- Make B_d^0 oscillation measurement with same opposite-side tagger as for B_s^0, use as inputs

  (since signal and opposite-side B species uncorrelated. Same-side tagging does depend of specific species fragmentation, will need MC to get dilutions, more uncertainty.)

- Take $|d| > 0.3$, amplitude gives dilution, $\mathcal{D}$, frequency gives Δm_d

- $\Delta m_d = 0.501 \pm 0.030 \pm 0.016$ ps

  (WA $0.509 \pm 0.004\ \mathrm{ps}^{-1}$)

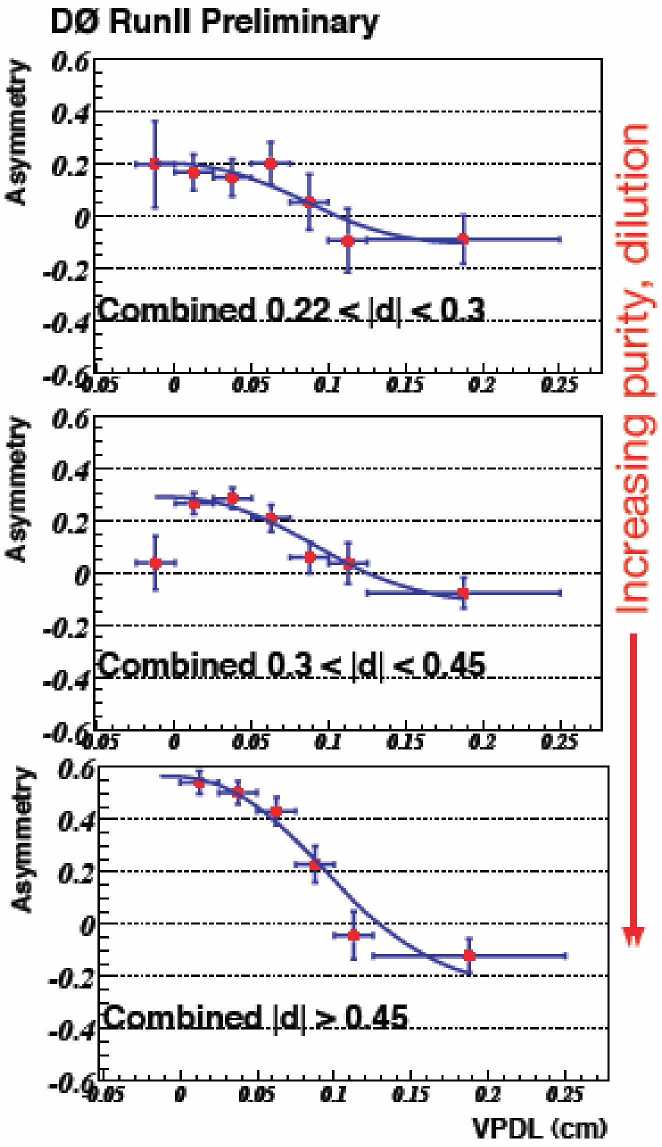
- Dilutions
  - $\mathcal{D}(B_d^0) = 0.414 \pm 0.023 \pm 0.017$
  - $\mathcal{D}(B^+) = 0.368 \pm 0.016 \pm 0.008$

  syst.

  - $\mathcal{D}_{\text{comb.}} = 0.368 \pm 0.016 \pm 0.008$

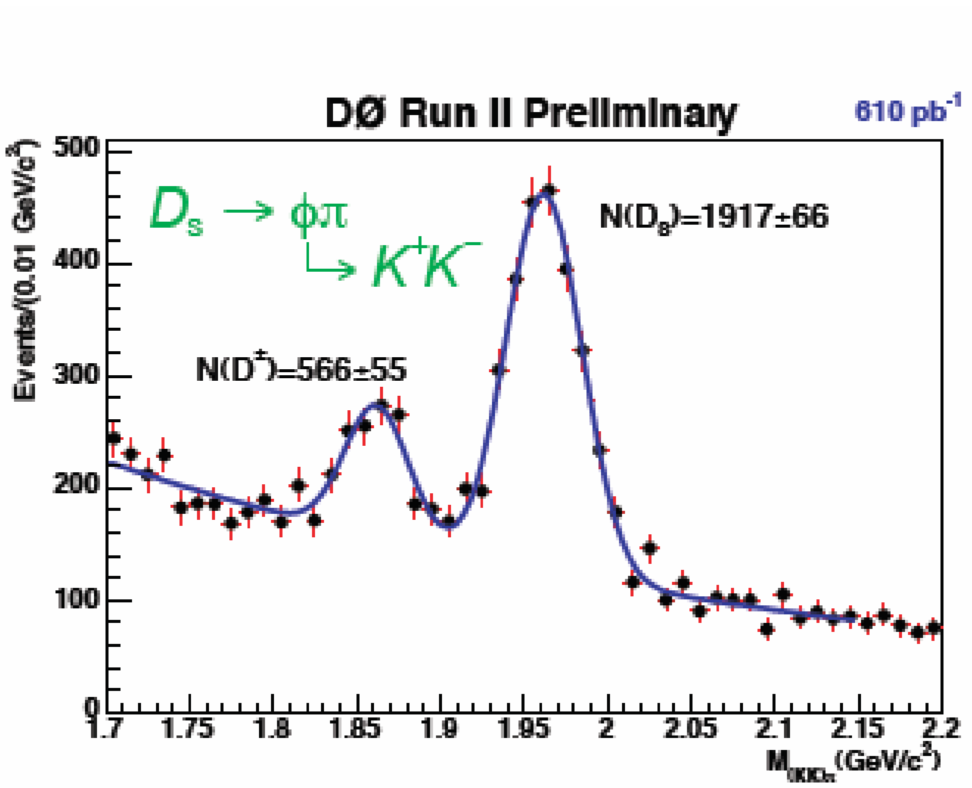
    $\varepsilon\mathcal{D}^2 = (1.94 \pm 0.14 \pm 0.09)\%$

  - MC shows that dilutions for B_s^0 and B_d^0 agree
  - Dilution for B_d^0 agrees in data and MC

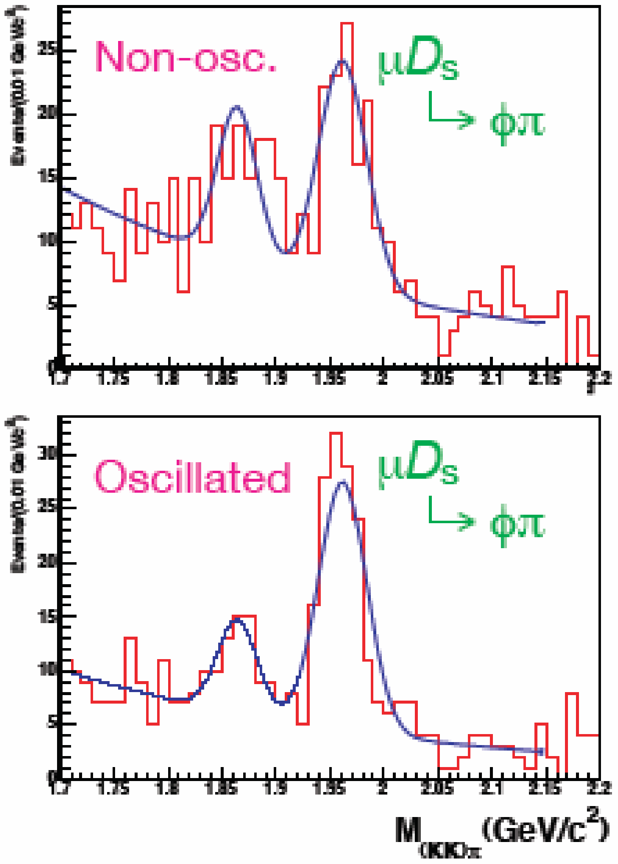


Measured Assymetry

- Fit flavor tagged signal in bins of proper decay length

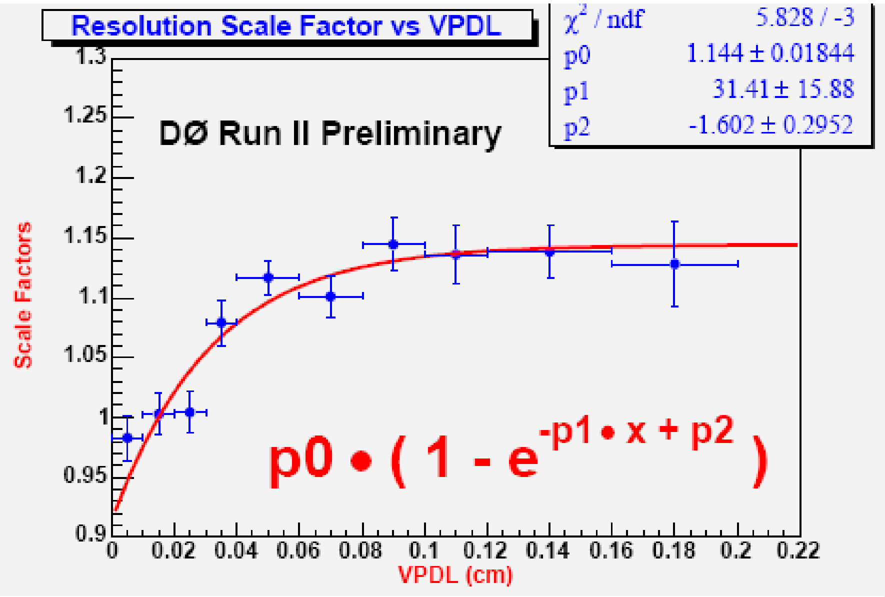


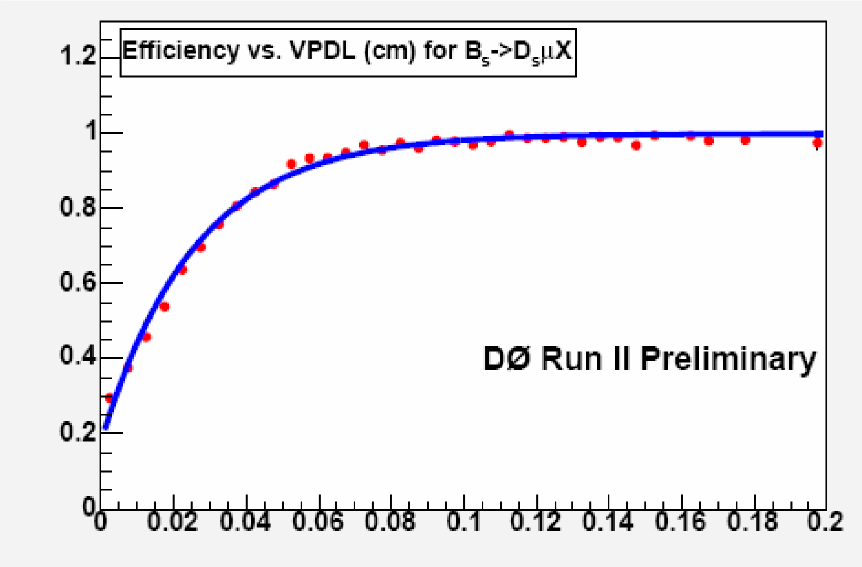
0.06 < *VPDL* < 0.08 cm



Corrected Asymmetry

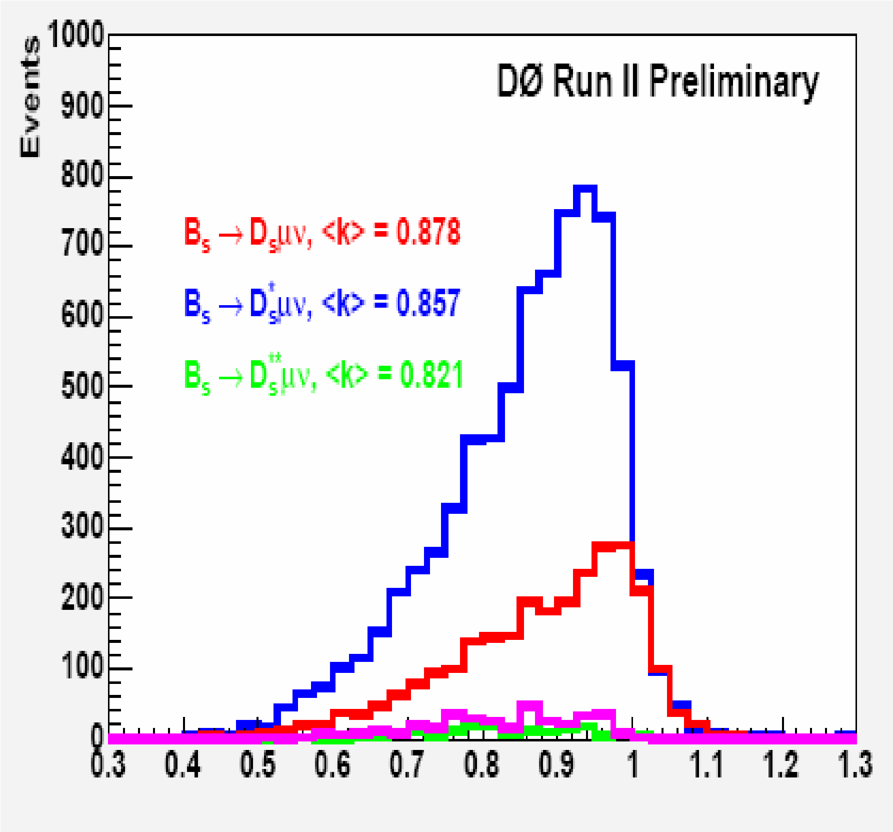
- Measured asymmetry must be corrected for
  - Decay length resolution (tuned MC to look like data)
  - Reconstruction efficiency vs. decay length
  - Sample composition





Sample Composition and K factors

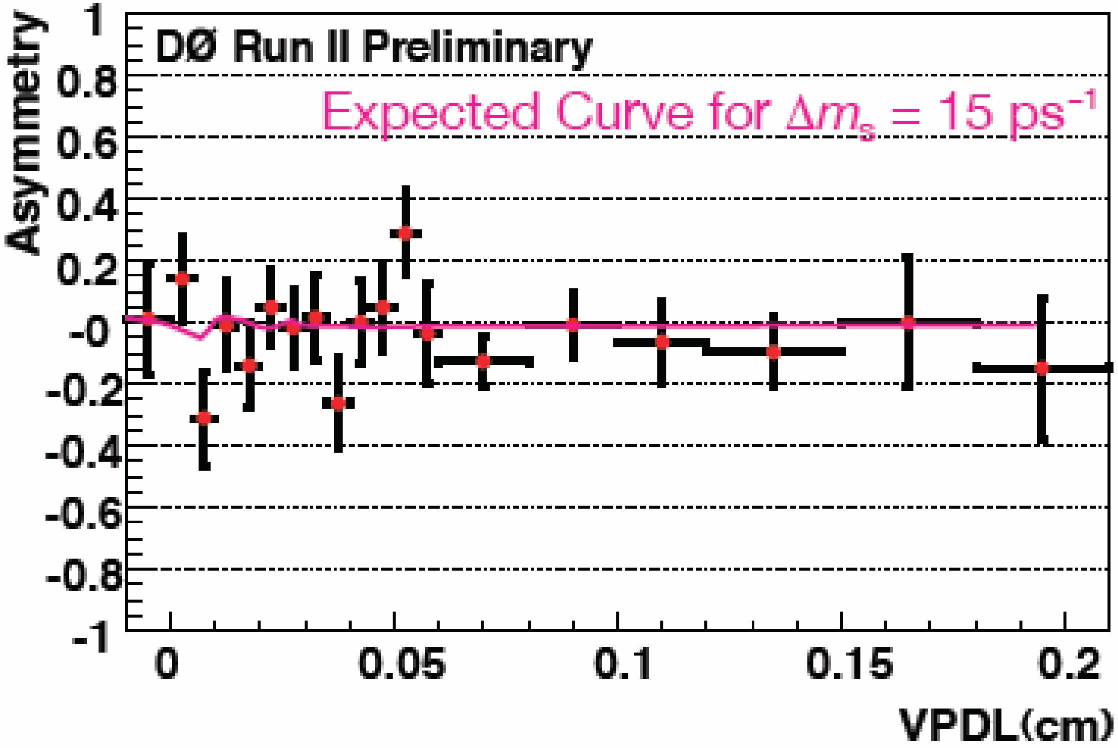
Decay	Sample composition
$B_s \rightarrow D_s \mu \nu$	20.6%
$B_s \rightarrow D^*_s \mu \nu$	57.2%
$B_s \rightarrow D^*_{0s} \mu \nu$	1.4%
$B_s \rightarrow D^*_{1s} \mu \nu$	2.9%
$B_s \rightarrow D_s D_s X$	11.3%
$B^0 \rightarrow D_s D X$	3.2%
$B^- \rightarrow D_s D X$	3.4%



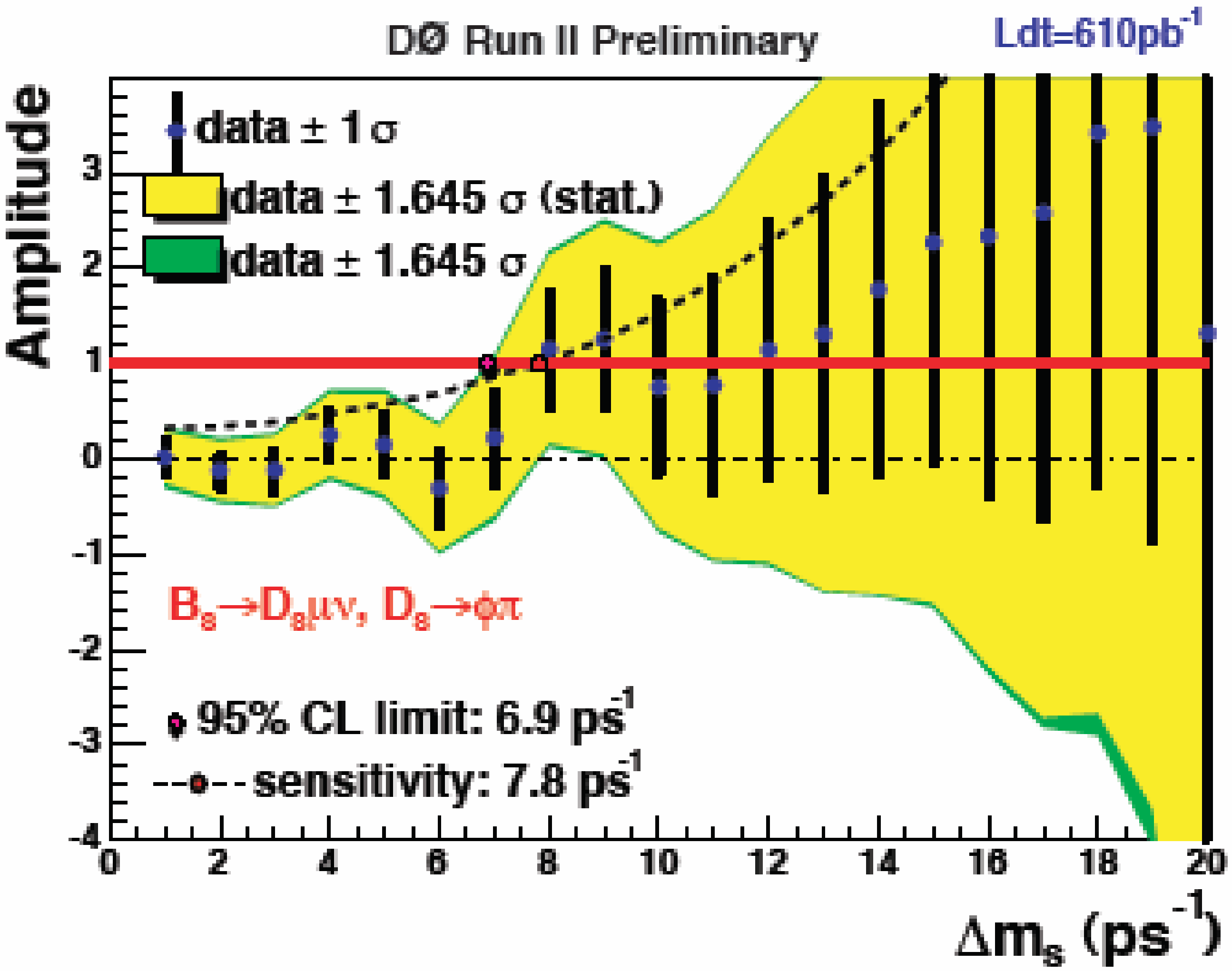
Bs mixing limit – Amplitude fit method

$$n_s^{osc,non\text{-}osc}(x) = \frac{K}{c\tau}\cdot 0.5\cdot(1\mp(2\eta-1)\cdot\ \mathcal{A}\cos(\Delta m_s\cdot Kx/c))$$

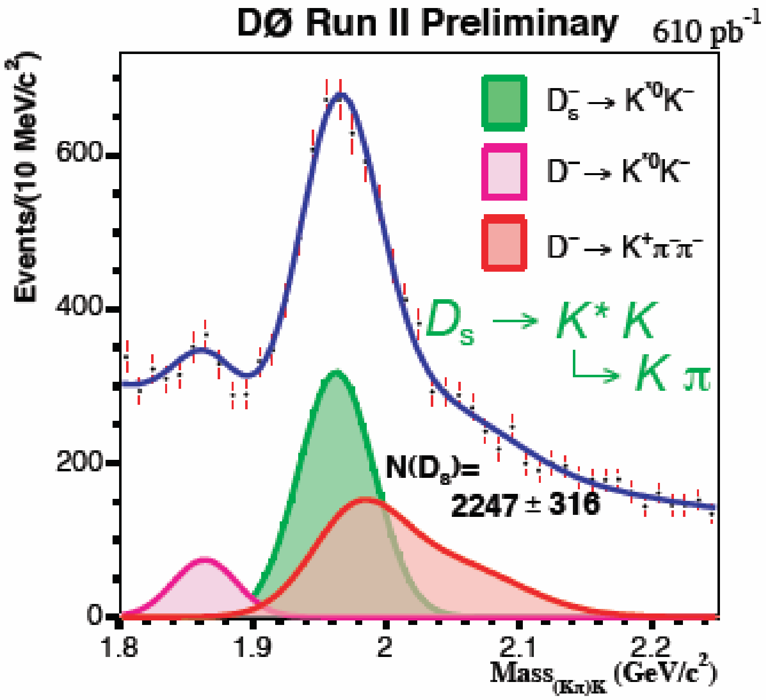
- If mixing signal with Δm_s , amplitude $\mathcal{A}=1$ otherwise $\mathcal{A}=0$
- Scan Δm_s, for each value, minimize χ^2 between expected and measured asymmetry vs. VPDL and find $\mathcal{A}\pm\Delta\mathcal{A}$

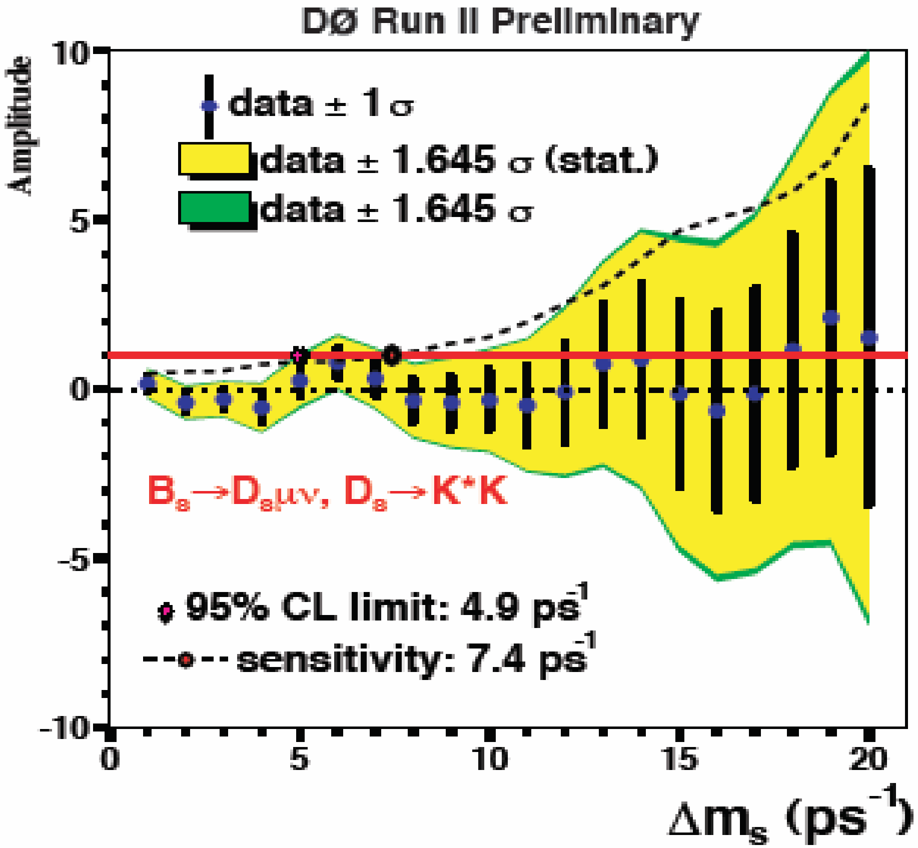


Bs mixing Limit

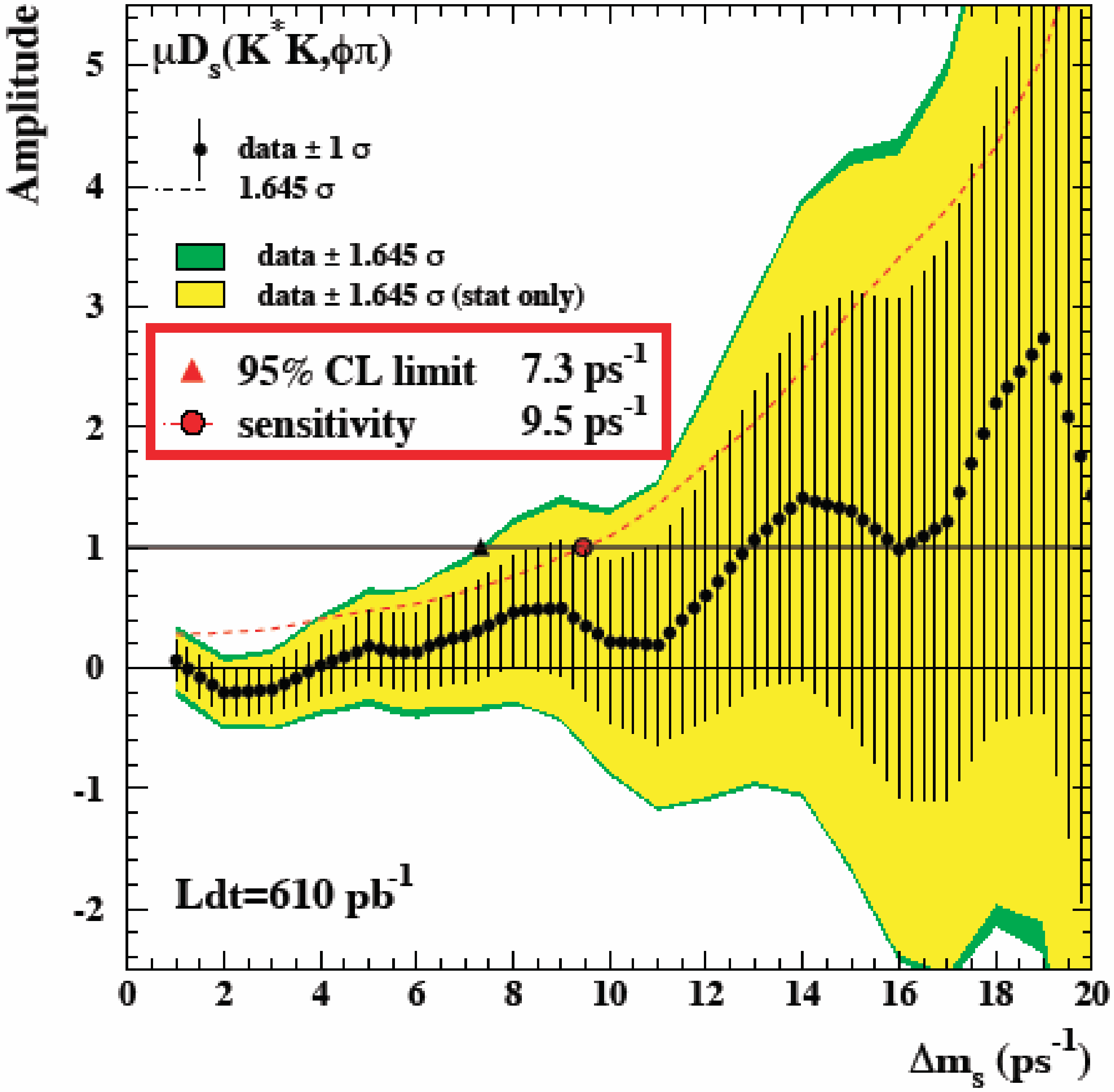


Adding K*K Decay Mode





DØ combined Bs mixing limit

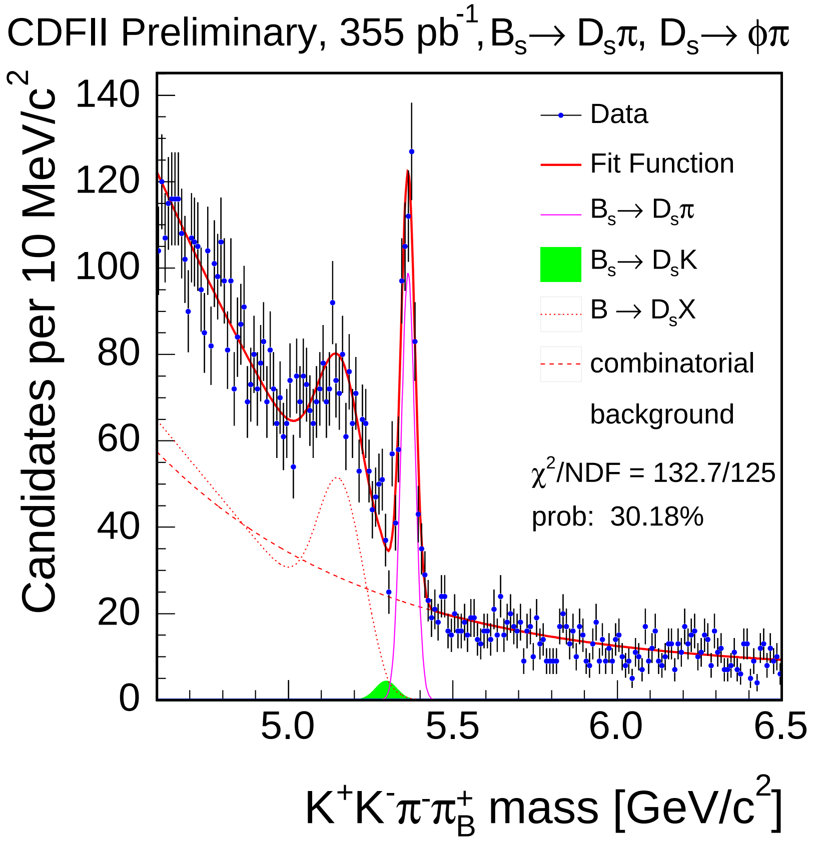


DØ Prelim

(610 pb^{-1})

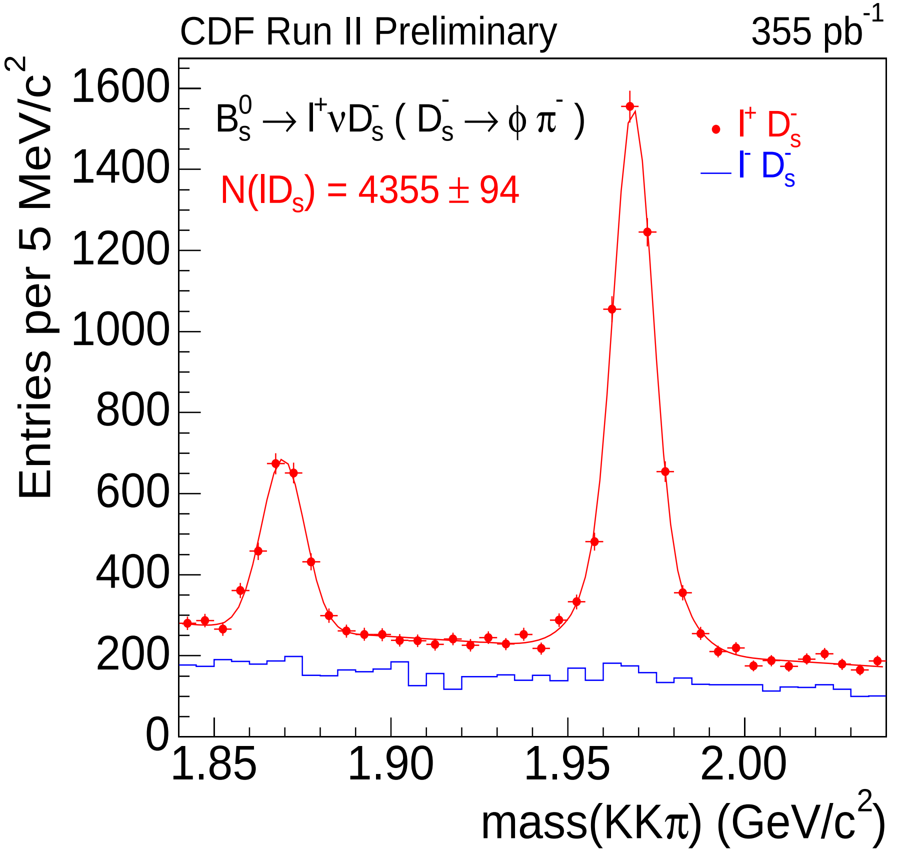
CDF Bs Signal Reconstruction

Hadronic channel



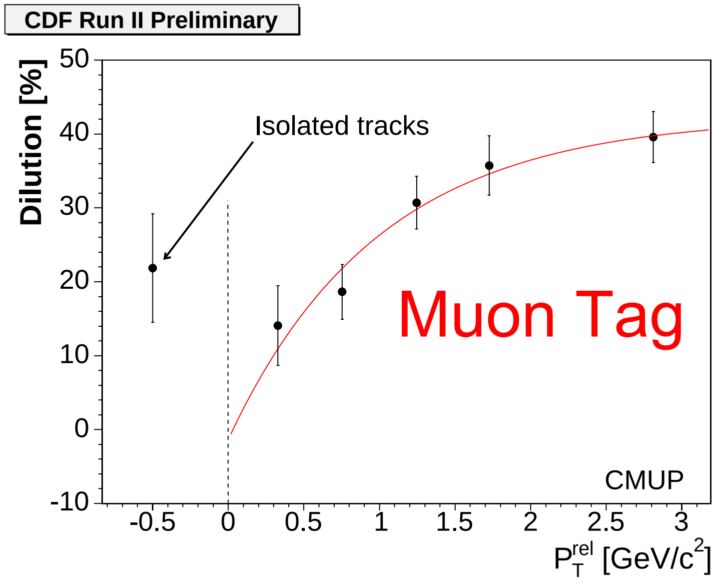
526±33 events

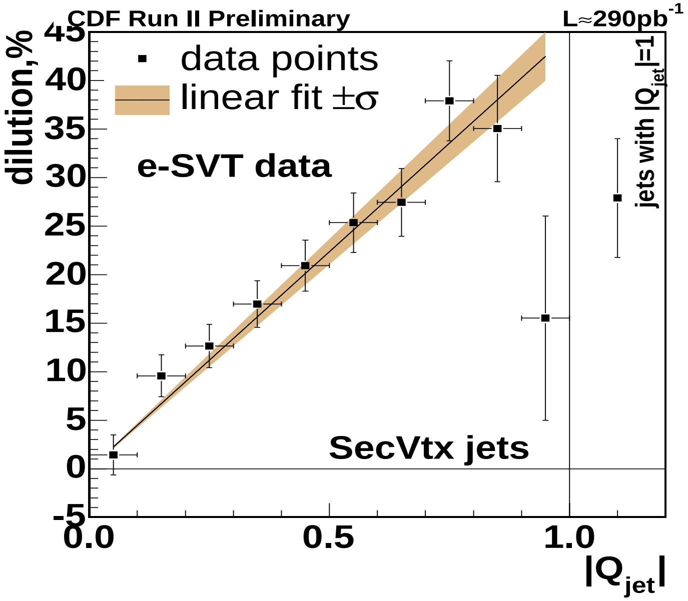
Semileptonic channel



CDF Flavor Tagging

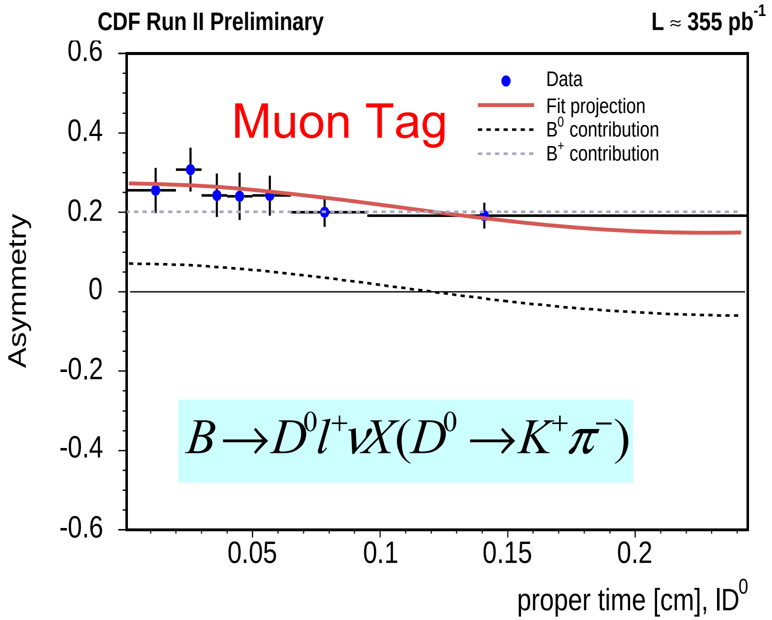
Tag type	εD^2 (%)
Muon	(0.70±0.04)%
Electron	(0.37±0.03)%
2ndary vtx	(0.36±0.02)%
Displaced track	(0.36±0.03)%
Highest p jet	(0.15±0.01)%
Total	~1.6%

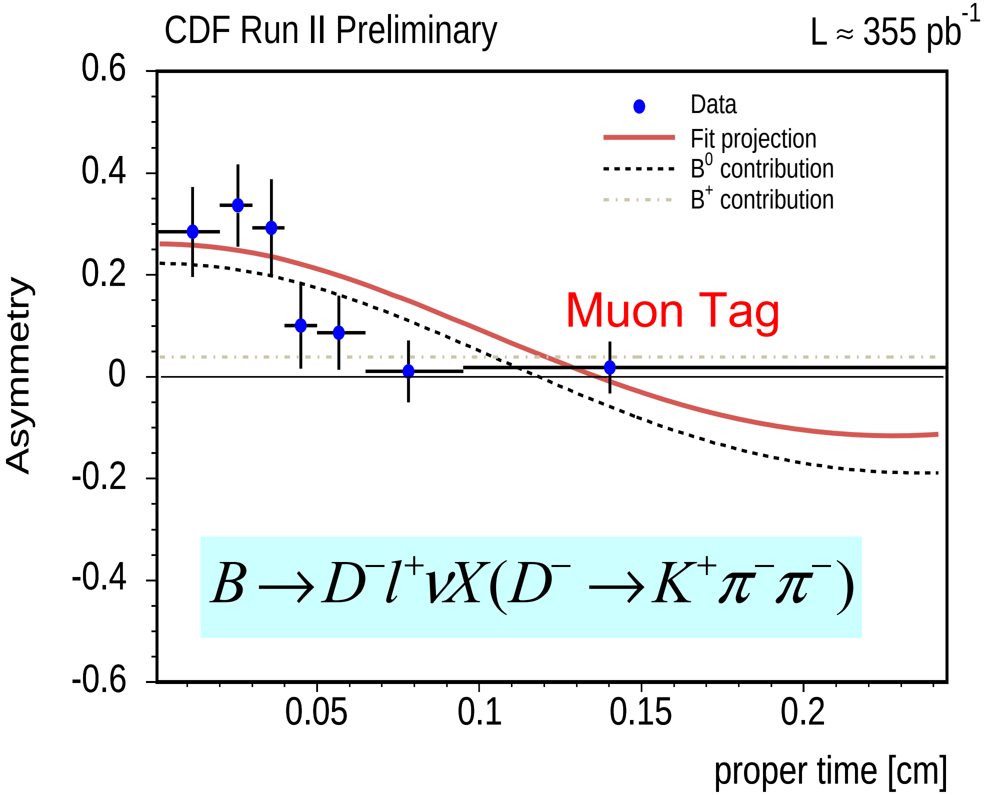




CDF B^0_d Mixing (Semileptonic)

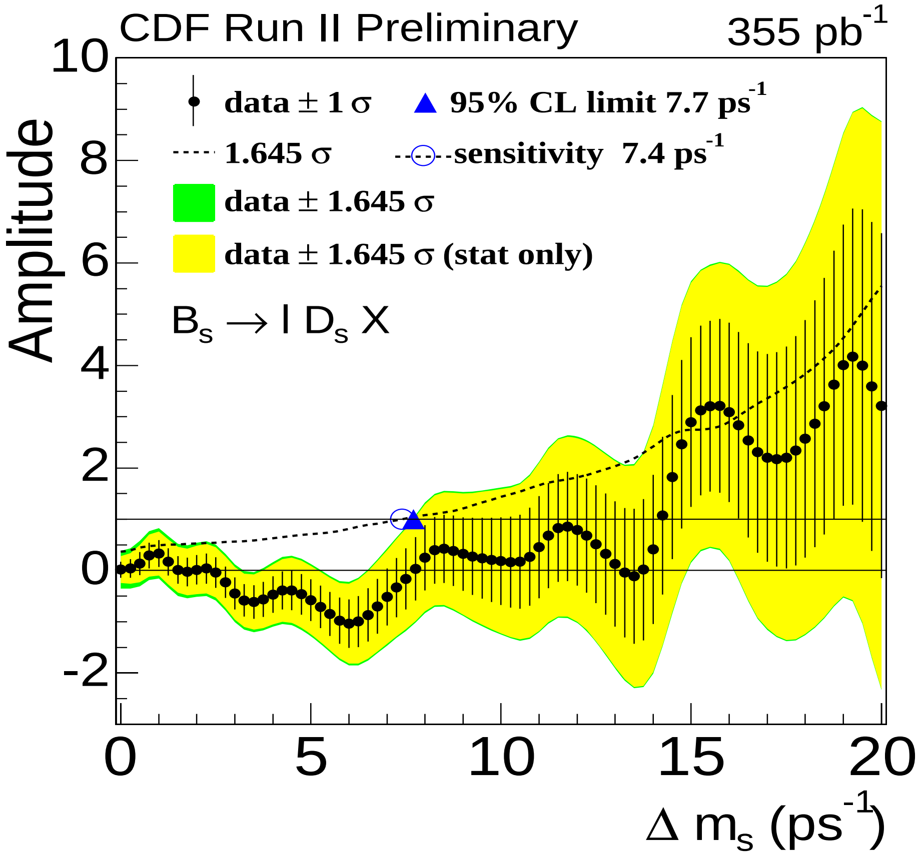
- Validation of the flavor tag using B^0 and B^+ sample
  - $\Delta m_d = 0.498 \pm 0.028 \pm 0.015)\ \mathrm{ps}^{-1}$

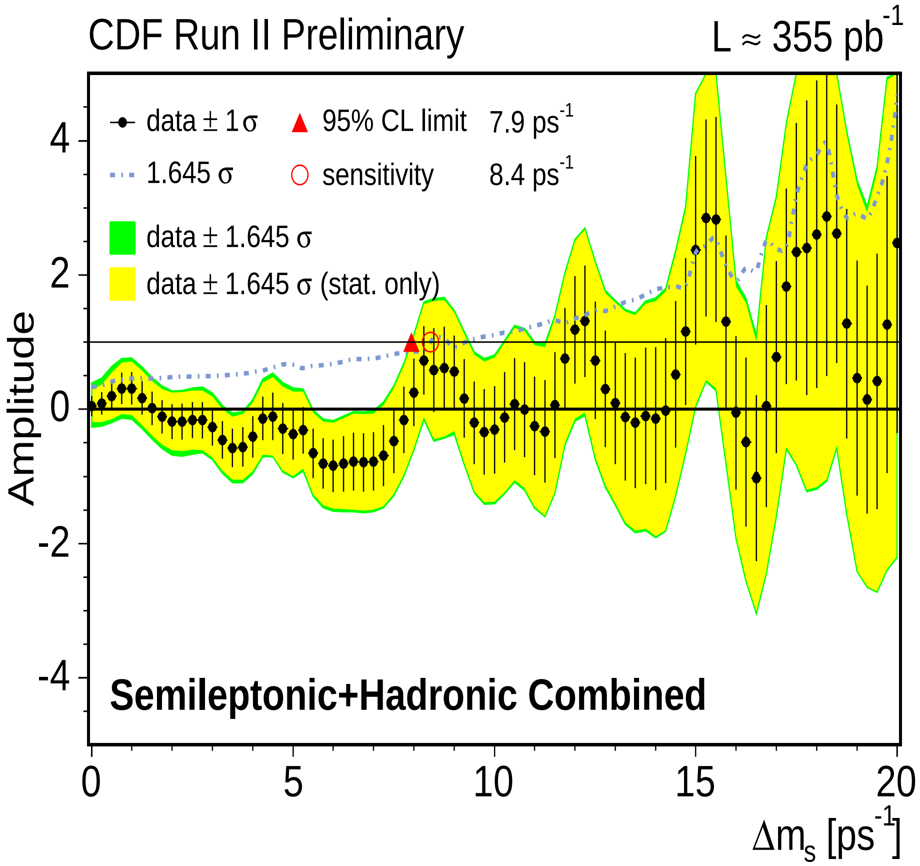




CDF B_s Mixing Result

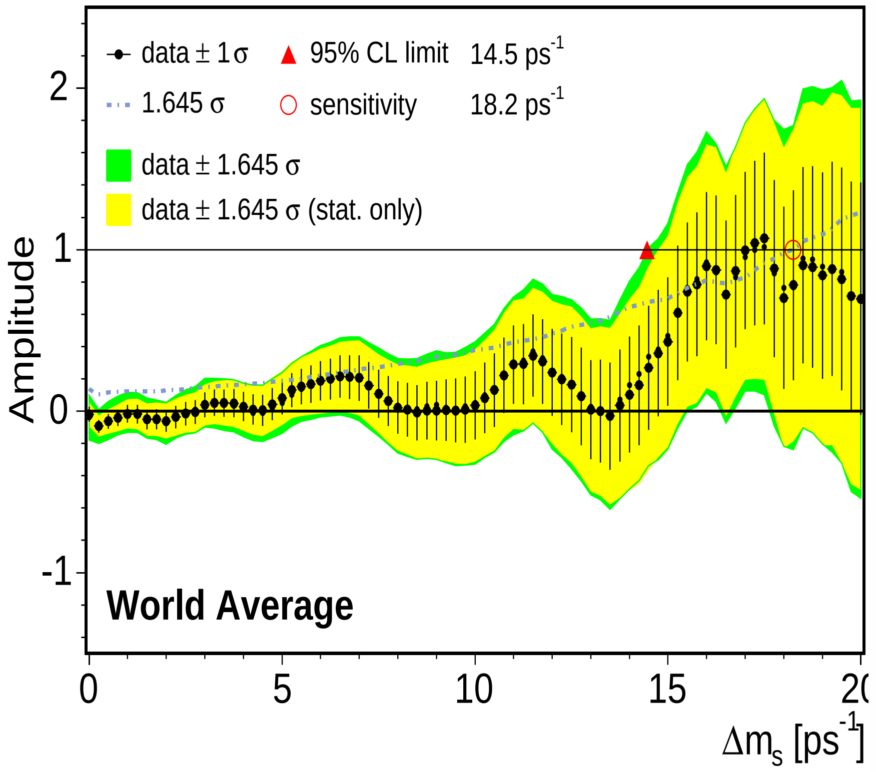
- Semileptonic Channel
  - Sensitivity = 7.4 ps^{-1}
  - Limit: 7.7 ps^{-1}
- Semileptonic + Hadronic
  - Sensitivity: 7.4 → 8.4 ps^{-1}
  - Limit: 7.7 → 7.9 ps^{-1}

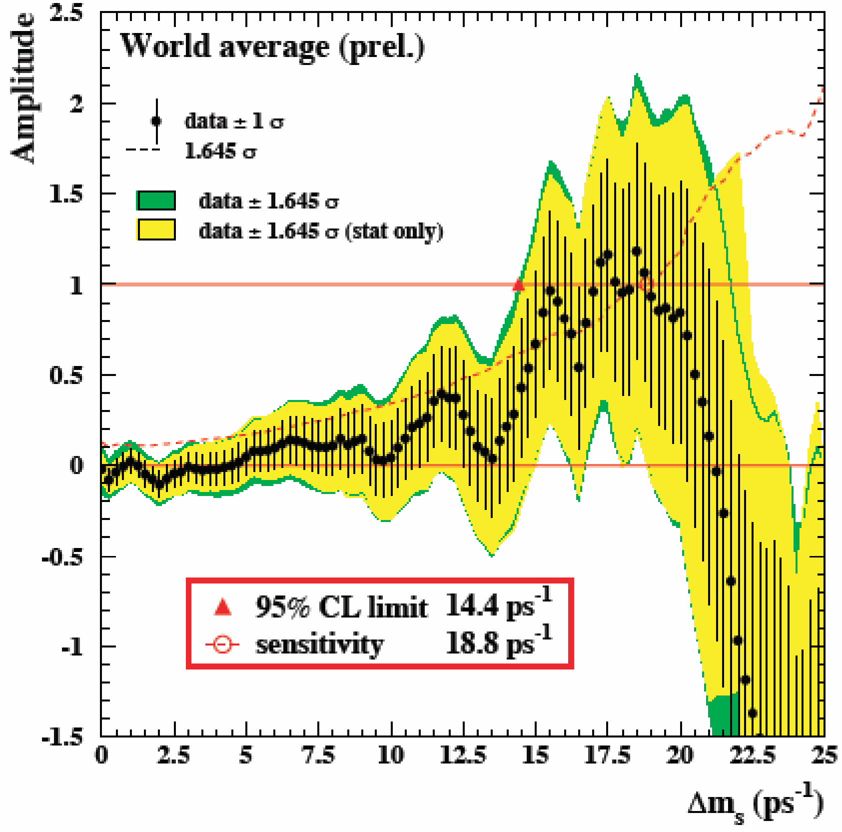




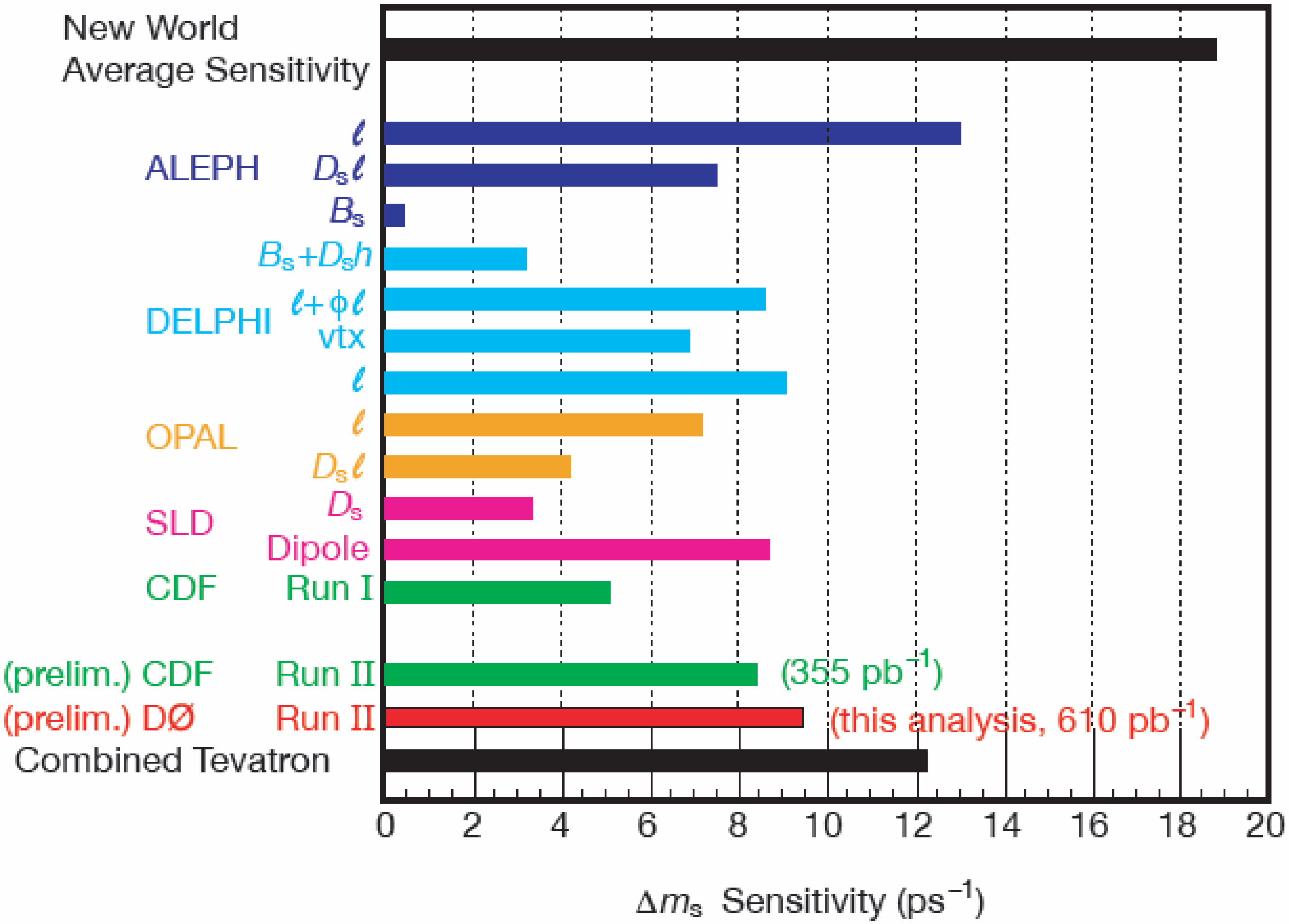
Tevatron+World Combined Result

- World Average
  - LEP, SLD, CDF run I
  - Sensitivity: 18.2 ps^{-1}
  - Limit: 14.5 ps^{-1}
- World Average + TeV Run II
  - Sensitivity: 18.8 ps^{-1}
  - Limit 14.4 ps^{-1}



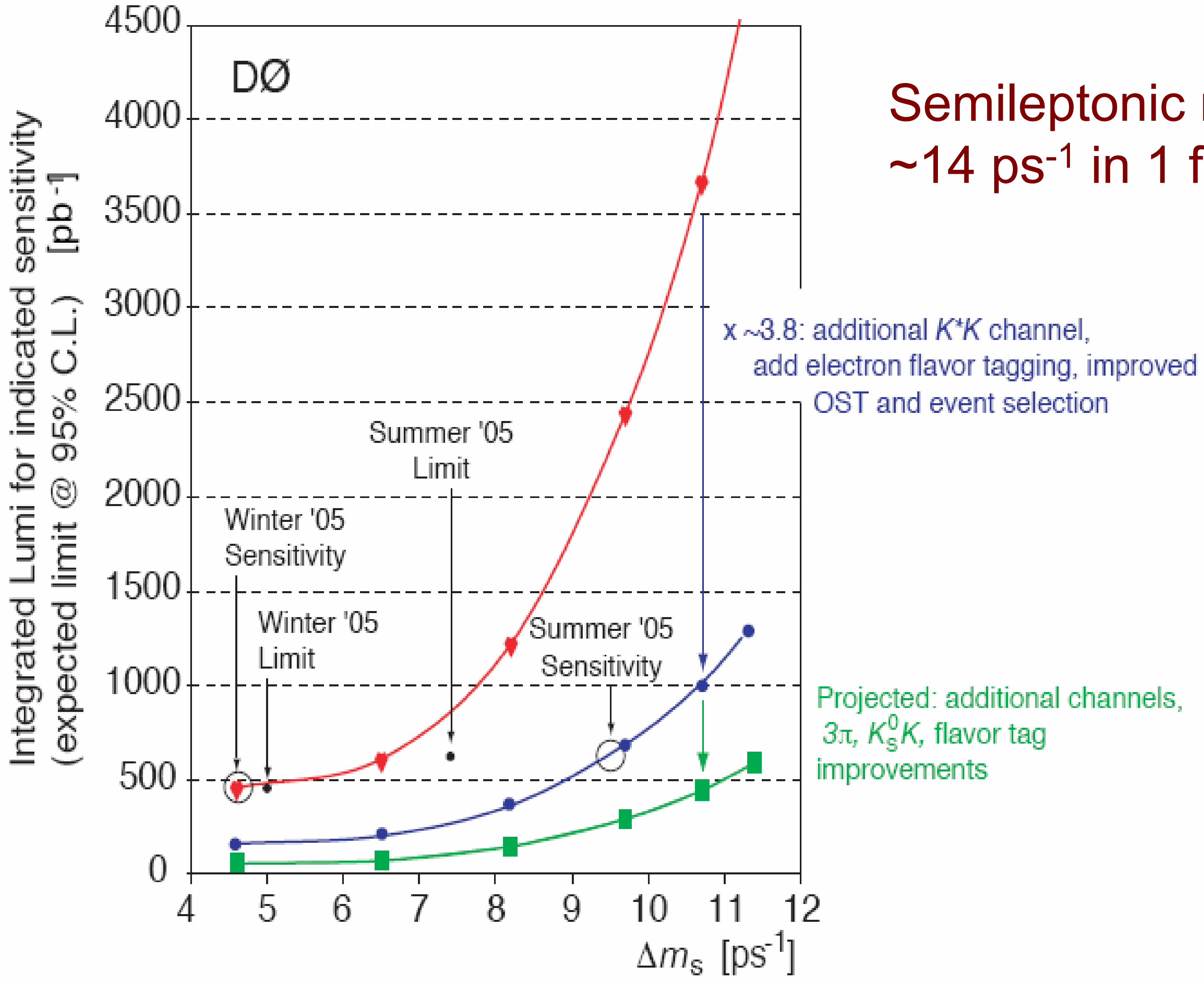


Bs Mixing Sensitivities



Not too bad for our first try, but we can do much better….

Near term DØ B_s Mixing Reach

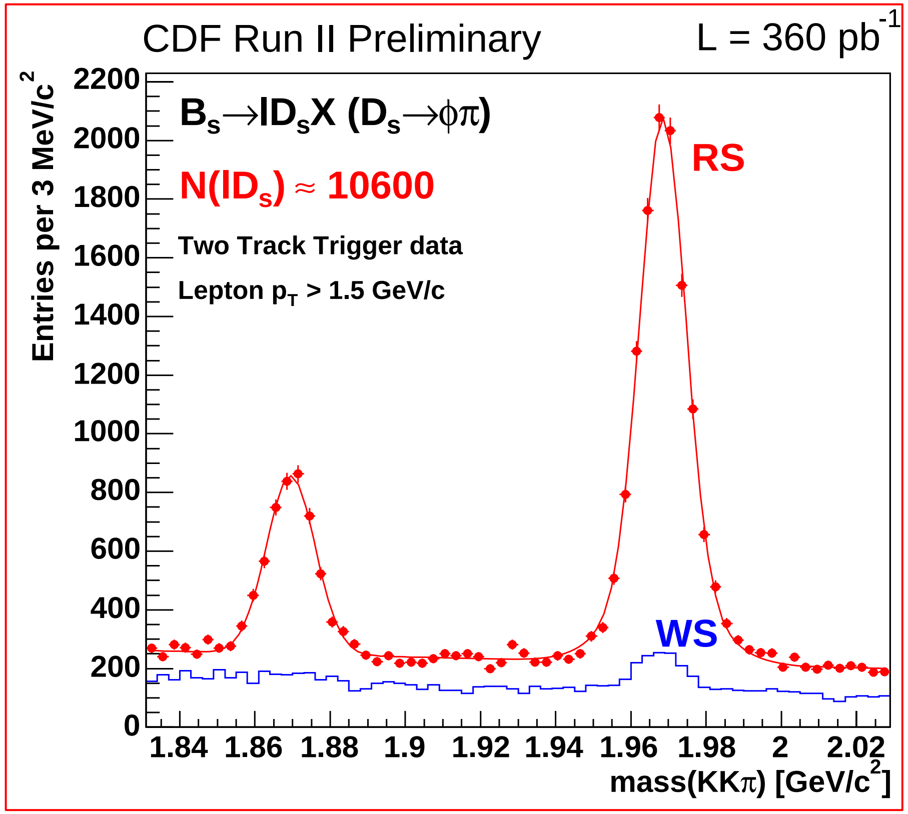


Semileptonic reach ~14 ps^{-1} in 1 fb^{-1}

CDF Near Term Δm_s Reach Improvements

- Add new tagging algorithms
  - same side Kaon
- Add more channels
  - K*K, 3π
- Add signals from other triggers
  - 4GeV-lepton + 1 displaced track trigger adds 3x data
- Improve decay time resolution with event by event primary vertex reconstruction

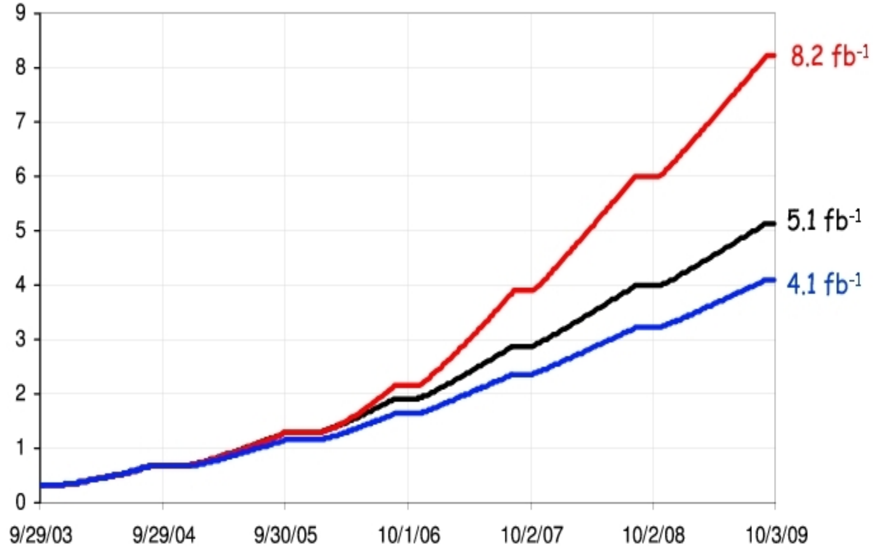
2 displaced track trigger



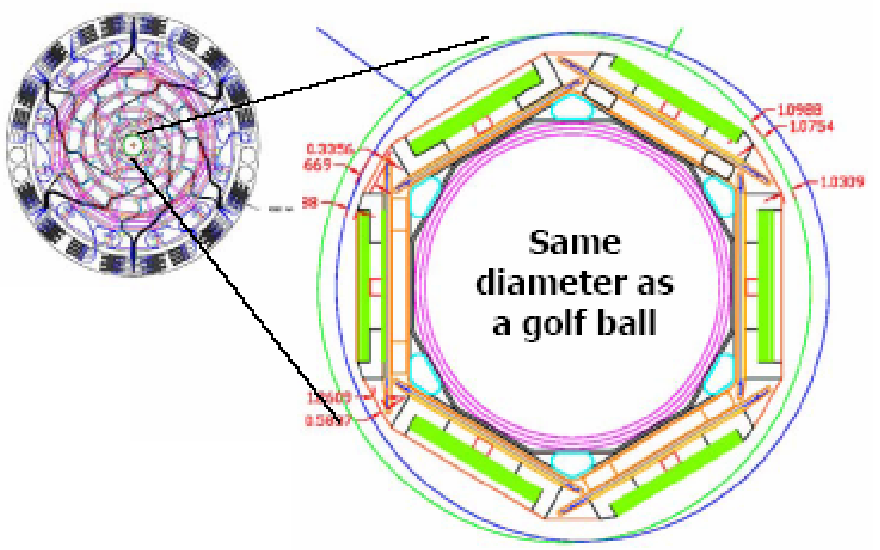
expect combined hadronic and semileptonic sensitivity ~ 15ps^{-1} in 1 fb^{-1}

DØ Upgrades for High Luminosity

- Trigger Bandwidth Upgrade
  - current limit for B-Physics triggers is rate to tape
  - Proposal to add 50 Hz of dedicated B physics bandwidth



- Silicon Layer-0
  - add new, rad hard Layer-0 at R = 1.7 cm inside present detector around beam pipe
  - Impact Parameter resolution: 55→35 μm at 1 GeV
  - Installed this spring



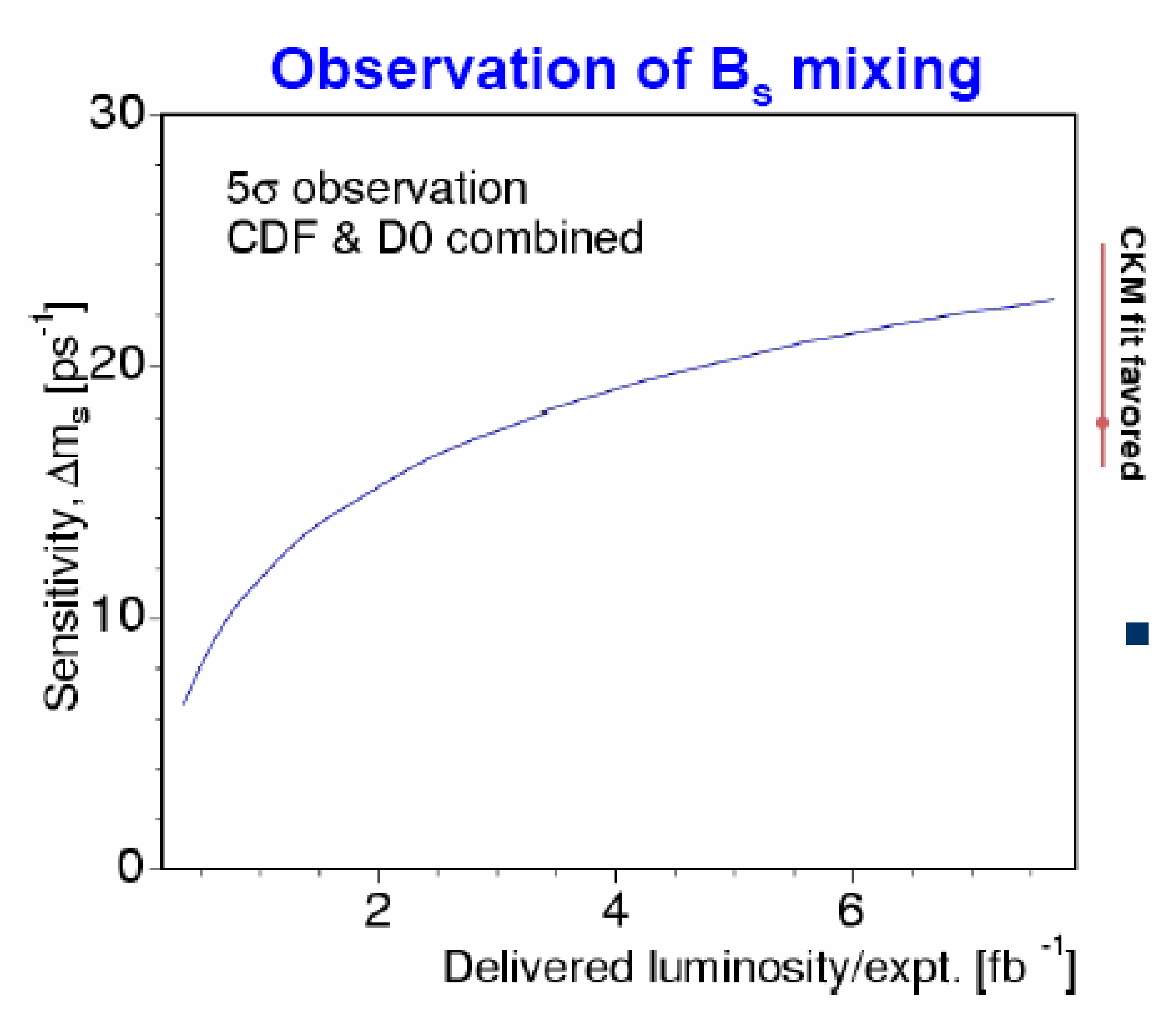
Same diameter as a golf ball

DØ B_s Mixing with Hadronic Modes

- Difficult trigger, small BR's
  - trigger on single muon from other B in event
  - ~ 10x less events, but we are starting to see hadronic signals
  - single muon triggers saturate extra rate to tape at low lums
  - specialized B_s triggers now running unprescaled at all lums
  - DAQ upgrade proposed to write even more inclusive muon data to tape
- Excellent tagging power

  $\varepsilon D^2 \sim$ 40 - 70 %, self tagging trigger!
- Excellent proper time resolution with new silicon layer
  - $\sigma(\tau) \sim$ 50 - 75 fs
- CDF has added similar trigger for high lums

Long Term B_s Mixing Reach

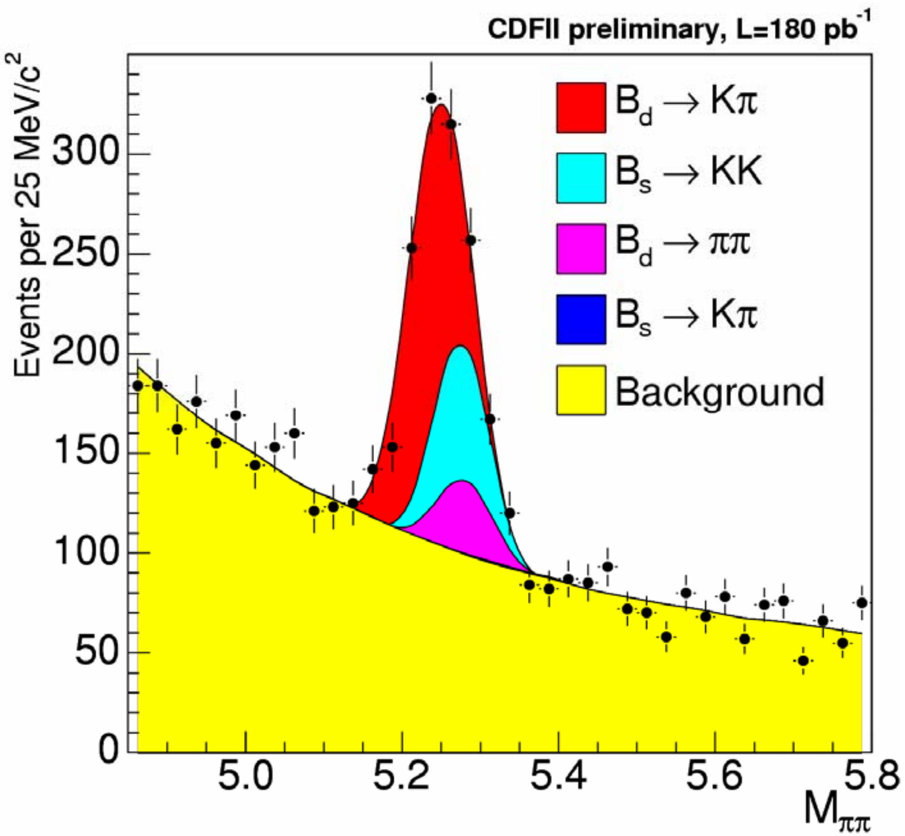


- B factories and Tevatron will continue to shrink the SM allowed region

- Combined Tevatron can Fully cover SM range by the end of Run II

CP violation at the Tevatron

parameter	fraction	yield
$B^0 \to \pi^+\pi^-$	$(13 \pm 3)\%$	121 ± 27
$B^0 \to K^+\pi^-$	$(60 \pm 3)\%$	542 ± 30
$B_s^0 \to K^-\pi^+$	$(0 \pm 3)\%$	-
$B_s^0 \to K^+K^-$	$(26 \pm 3)\%$	236 ± 32



What we measure:

$$A_{CP}(B^0 \to K^+\pi^-)$$

$$\frac{f_s \cdot BR(B_s^0 \to K^+K^-)}{f_d \cdot BR(B^0 \to K^+\pi^-)}$$

$$\frac{f_d \cdot BR(B^0 \to \pi^+\pi^-)}{f_s \cdot BR(B_s^0 \to K^+K^-)}$$

$$\frac{BR(B^0 \to \pi^+\pi^-)}{BR(B^0 \to K^+\pi^-)}$$

~900 evts/180 pb^{-1} in initial CDF data, taken with still non optimized detector/trigger.

Now much better: ~2700 / 360 pb^{-1}

Conclusions

- The Tevatron continues to perform very well, and is a great place to do B physics
  - $1 fb^{-1}$ of data has been delivered, on track for 4-8 fb^{-1} of data by 2009

- Both CDF and DØ have made significant B lifetime measurements
  - B^+, B^0 are competitive, Λ_b , B_s are the best in the world
  - $(\Delta\Gamma/\Gamma)_s$ measured and is not exactly at SM value (but is within errors)
    - More data will confirm SM or point to new physics

- Both Experiments are poised to attack Bs mixing
  - First Δm_s limits and sensitivity have been presented
  - Look for significant contributions to the world knowledge by next summer
  - We have an excellent chance to either measure Bs mixing, or exclude its SM model predicted values by the end of Run II

- The Tevatron has a rich B physics program beyond what I've shown here; including production properties, searches for new physics in rare decays, CP violation, and other CKM measurements…