

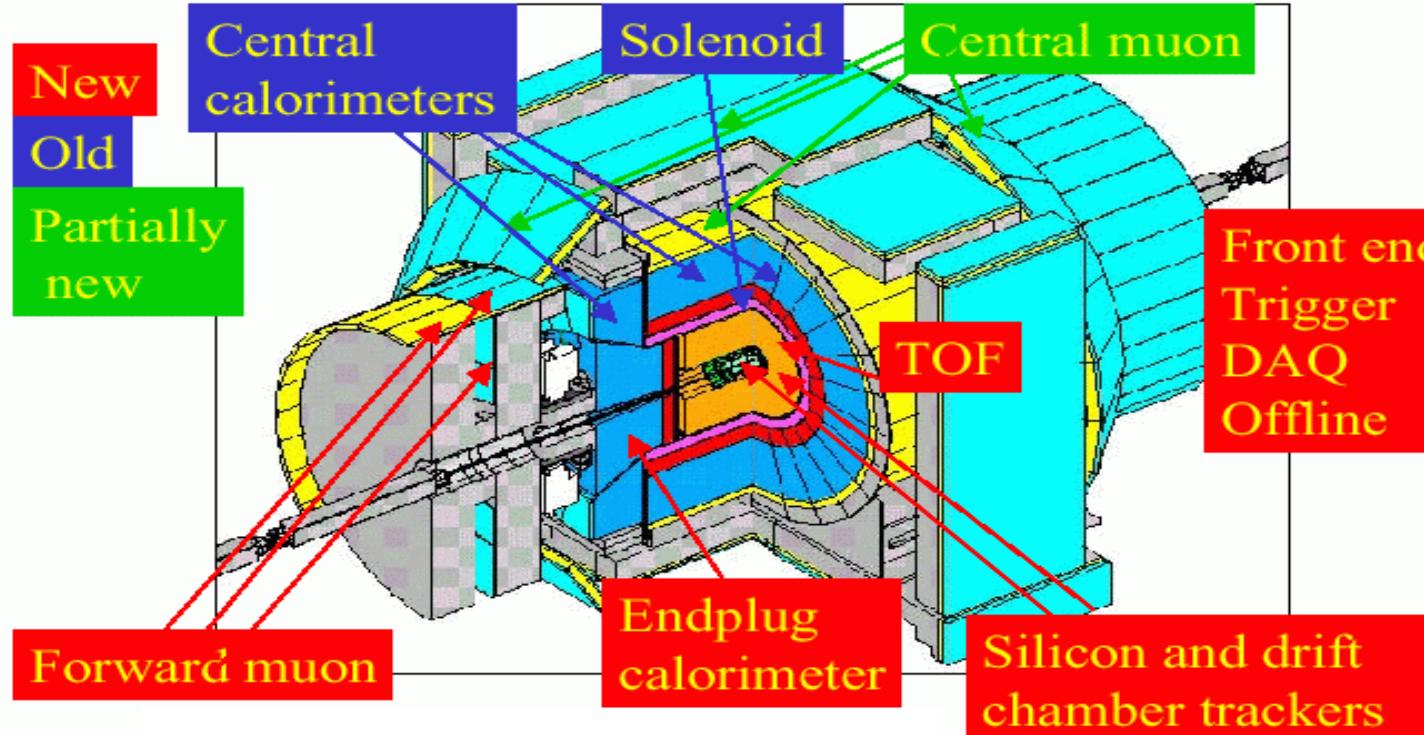


B Lifetimes at CDF RunII

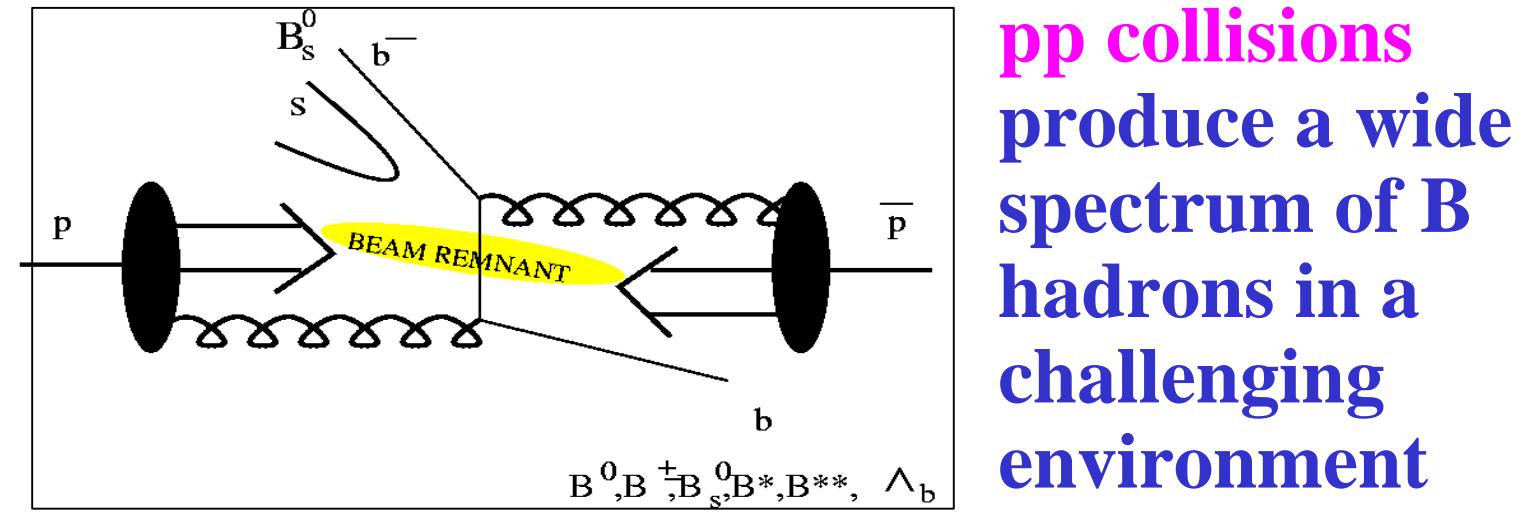
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The CDF Run II Detector:



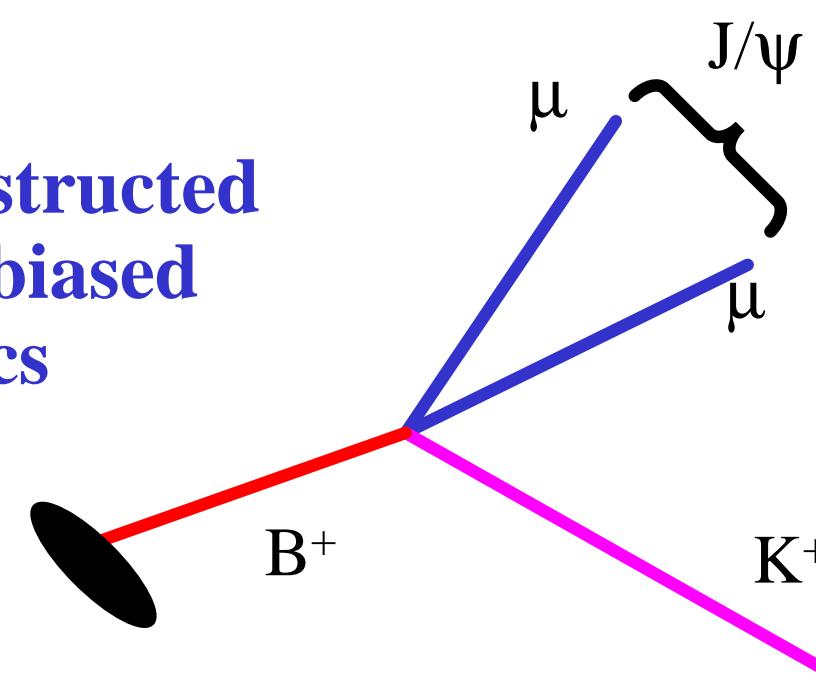
The detector is fully commissioned and working well



Lifetime Measurements:

Exclusive:

- J/ ψ trigger
- clean
- fully reconstructed
- lifetime unbiased
- low statistics



Semileptonic:

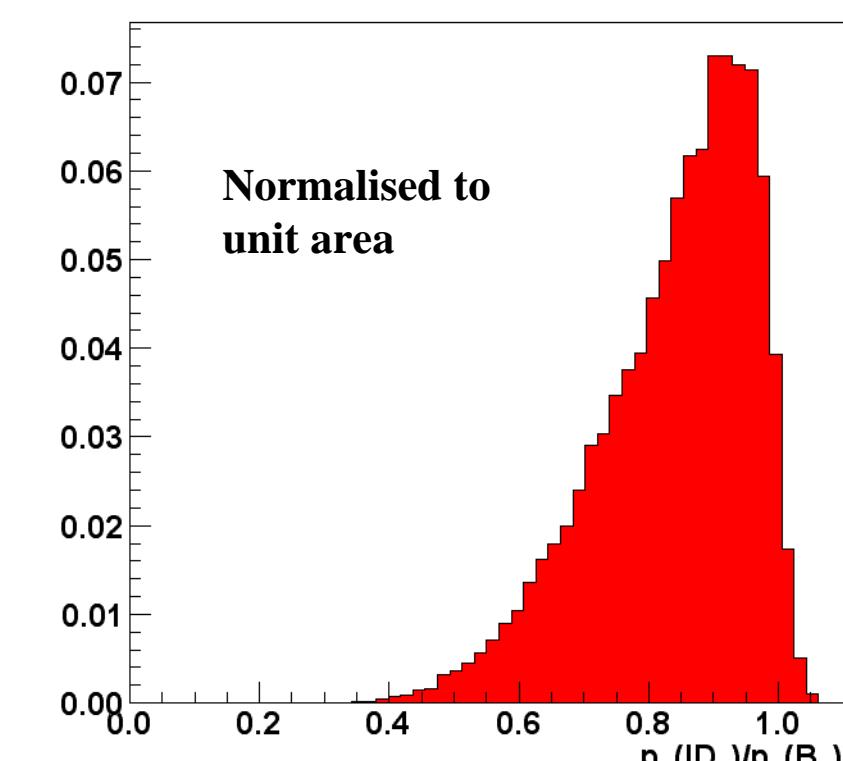
lepton+displaced track trigger

- clean
- partially reconstructed
 - need MC to unfold ct
- lifetime biased
- good statistics

$$ct = \frac{L_{xy} m(B)}{p_T(B)}$$

- B decay not fully reconstructed

- ® extract the bg factor from Monte Carlo:



- extract lifetime from decay length:

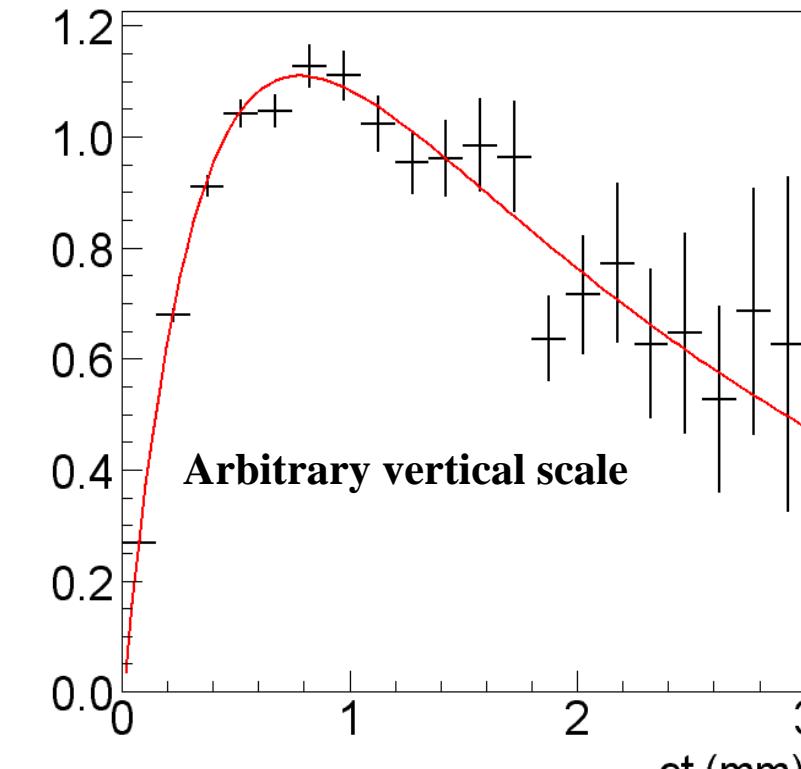
$$ct = \frac{L_{xy} m(B_s^0)}{p_t(B_s^0)} = \frac{L_{xy} m(B_s^0)}{p_t(lD_s^\pm)} K; K = \frac{p_t(lD_s^\pm)}{p_t(B_s^0)}$$

•but:

lifetime bias from the displaced vertex trigger:

2 GeV track with $120 \text{ mm} < d_0 < 1 \text{ mm}$

→Emulate trigger with Monte Carlo and model the lifetime bias which is factored into the fit function.



$s(bb) \ll s(pp)$ B events are selected with specialised triggers:

Di-Muon (J/ ψ) (conventional) $p_T(m) > 1.5 \text{ GeV}/c$

J/ ψ modes at low $p_T(\text{J}/\psi) > 0 \text{ GeV}/c$
Measure x-section
J/ ψ Yield = 2x Run I

I+displaced track $p_T(e/m) > 4 \text{ GeV}/c$
 $p_T(\text{trk}) > 2 \text{ GeV}/c$
 $120 \text{ mm} < d_0(\text{trk}) < 1 \text{ mm}$

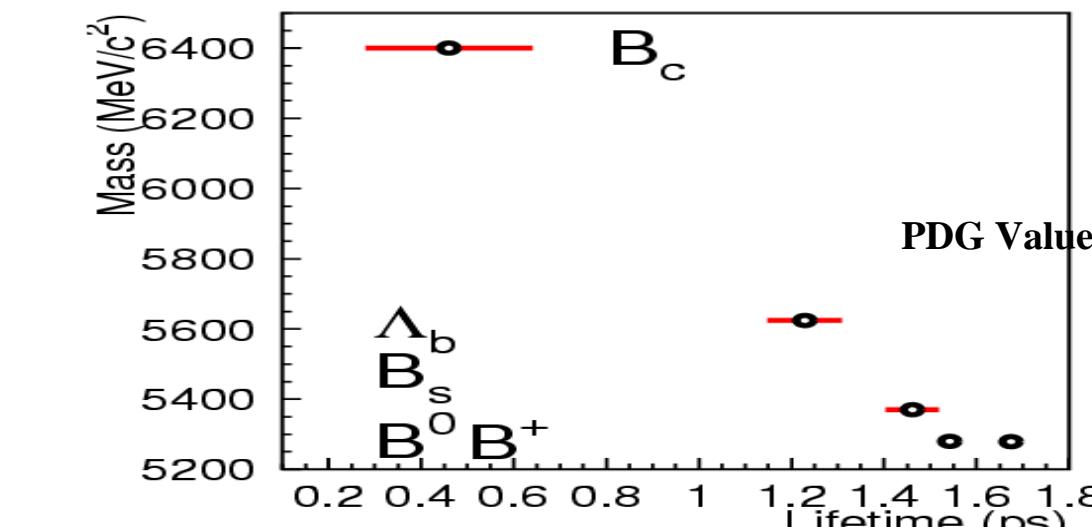
Semileptonic modes
Lifetimes, flavour tagging
B Yields 3x Run I

Two displaced tracks $p_T(\text{trk}) > 2 \text{ GeV}/c$
 $120 \text{ mm} < d_0(\text{trk}) < 1 \text{ mm}$

Hadronic modes
Charm Physics, B_s^0 mixing

Individual data samples of about 140 pb^{-1} accumulated

According to the spectator model all B mesons would have the same lifetime... but that is not the whole story!



The HQE predicts by how much the lifetimes differ.

Aim 1: Measure lifetimes accurately to inform theories

Aim 2: Prove the detector and triggers are working

Aim 3: Measure DG_s/G_s

$B_s^0 \otimes \ln D_s$ is an admixture of CP even and CP odd states

$$\frac{1}{2} e^{-rt} \left[\left(1 + \left| \frac{p}{q} \right|^2 \right) \cosh \left(\frac{\Delta \Gamma}{2} t \right) + \left(1 - \left| \frac{p}{q} \right|^2 \right) \cos (\Delta mt) \right] \approx \frac{1}{2} e^{-rt}$$

Pair it with fully CP even or CP odd state (or use polarisation analysis) and measure DG_s/G_s

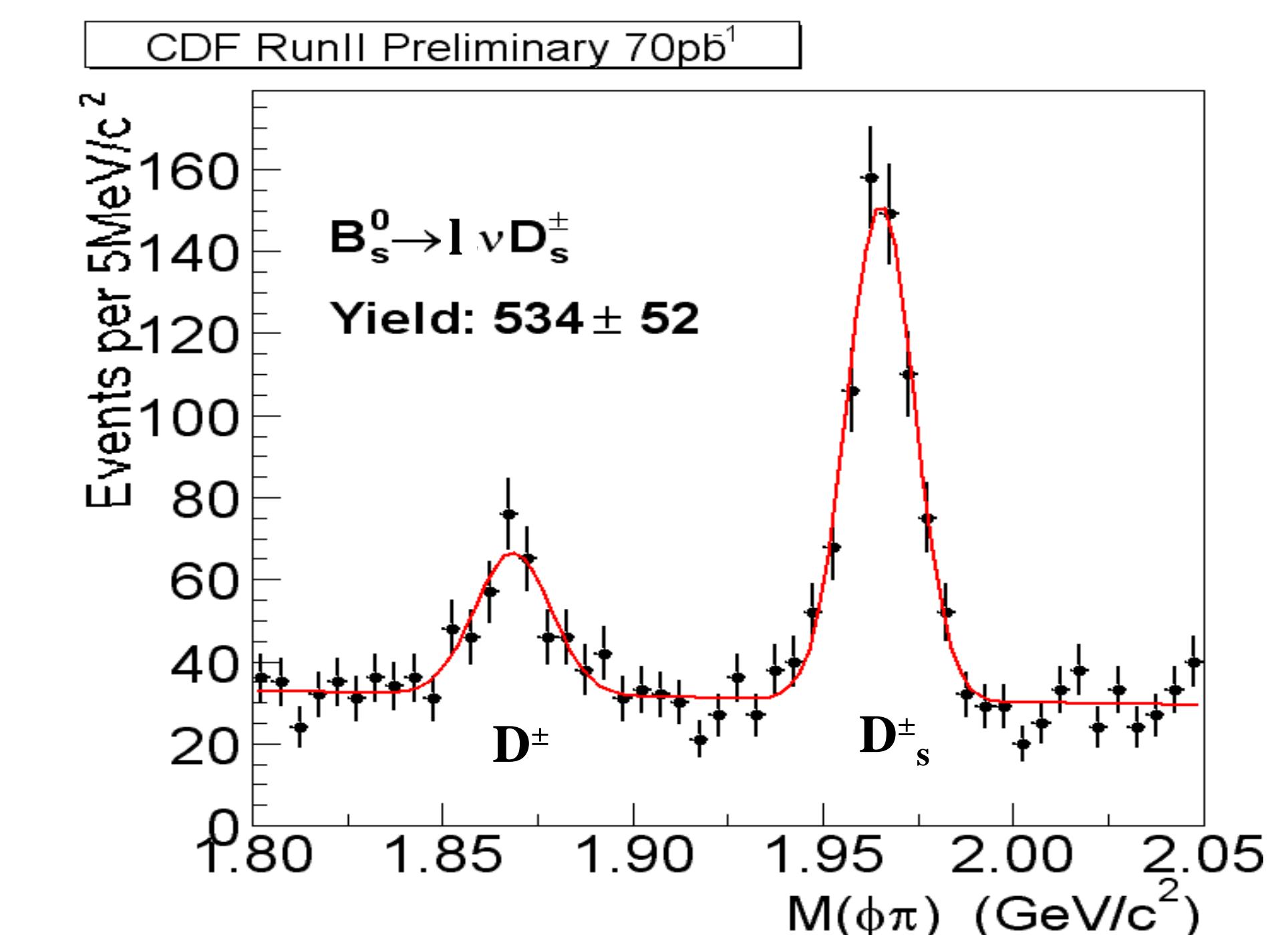
Exclusive Lifetime Measurements

Lepton+ displaced track trigger implemented successfully for the first time!

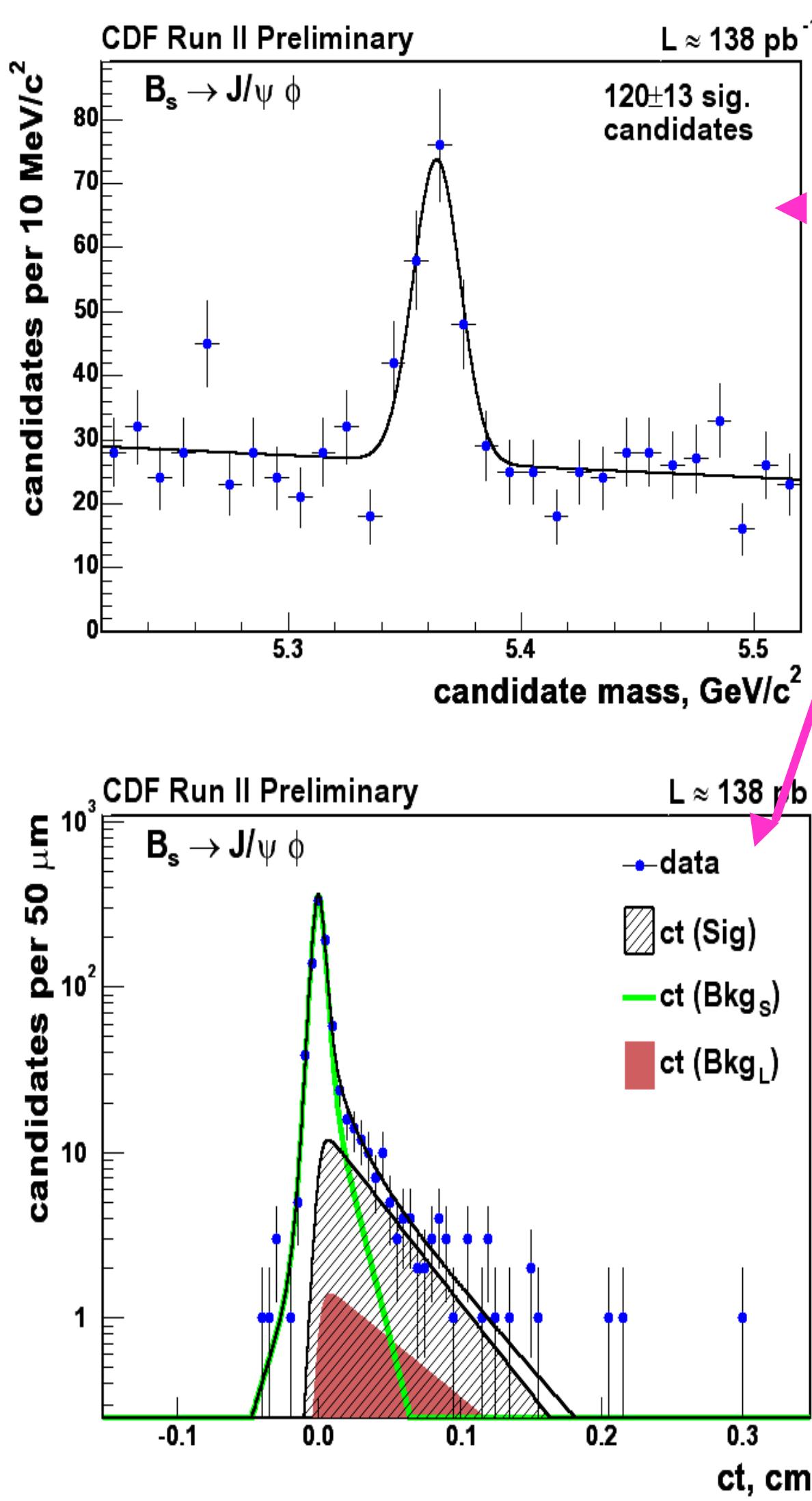
® samples rich in B hadron semileptonic decays

Follow the standard methodology:

- reconstruct the D decay near to lepton



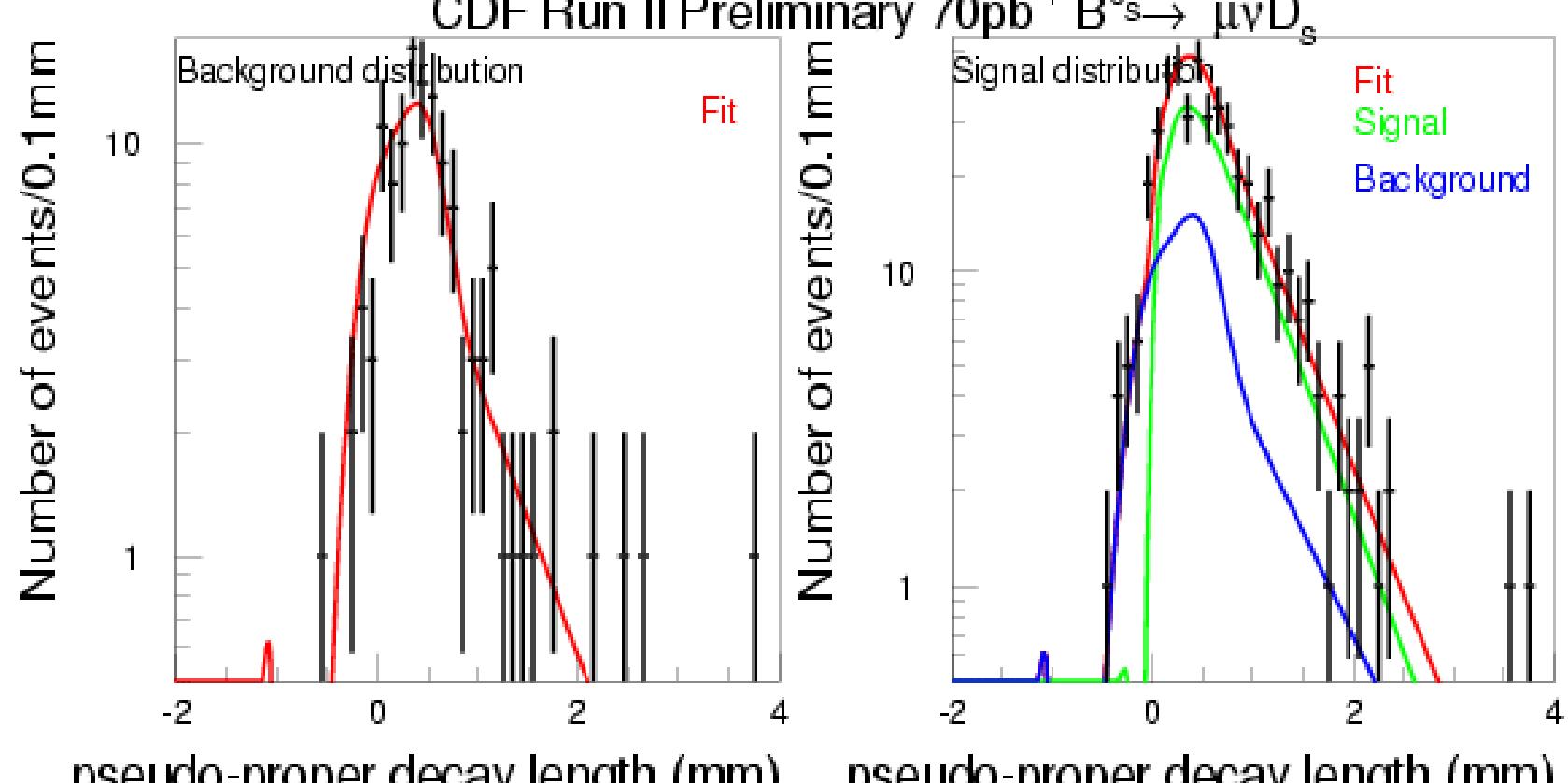
Exclusive Lifetime Measurements



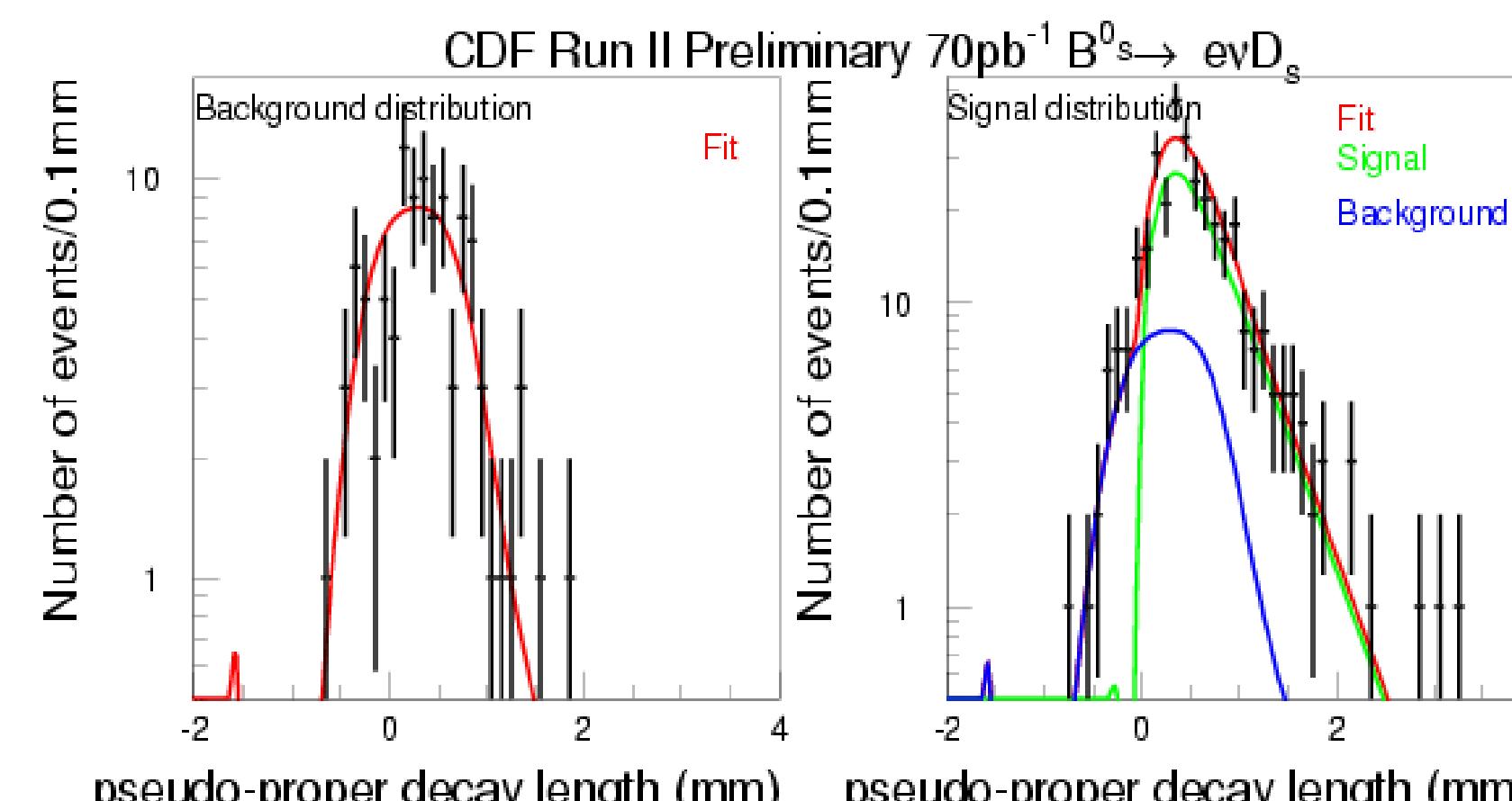
CDF Run II Preliminary	
B^+	$1.63 \pm 0.05 \pm 0.04 \text{ ps}$
B_d^0	$1.51 \pm 0.06 \pm 0.02 \text{ ps}$
B_s^0	$1.33 \pm 0.14 \pm 0.02 \text{ ps}$
L_b	$1.25 \pm 0.26 \pm 0.10 \text{ ps}$

Fit to Data

Muons:



Electrons:



Lifetime statistical error projections

B^+	$\pm 0.04 \text{ ps}$
B_d^0	$\pm 0.06 \text{ ps}$
B_s^0	$\pm 0.07 \text{ ps}$
L_b	$\pm 0.09 \text{ ps}$