Questions for CDF on TOF from PAC

In response to our presentation to the PAC on 15 January 1999, we received the following questions:

1. Given that Layer 00 by itself without TOF gives $\geq 5\sigma$ significance for B_s^0 mixing up to $x_s \leq 50$, what are the strongest justifications for adding a $1.3 M TOF system to CDF?

2. What fraction of $K^{\pm}$ from B or B_s^0 decay (that are within the TOF acceptance) can be separated from $\pi^{\pm}$ (You can choose a definition of separation, *e.g.*, 2σ)?

The CDF Collaboration
Joseph Kroll
16 January 1999

Response to Question 1

The most important application of TOF is B flavor tagging

TOF doubles the flavor tagging effectiveness
$\epsilon D^2 = 5.7\% \Longrightarrow 11.3\%$ for $B_s^0 \to D_s^- \pi^+$
$\epsilon D^2 = 4.9\% \Longrightarrow 9.7\%$ for $B_s^0 \to J/\psi\, \phi$

Equivalent to doubling the statistics for measurements that require B flavor tagging

Increase independent of presence of Layer 00 (improvement from TOF "multiplies" improvement from Layer 00)

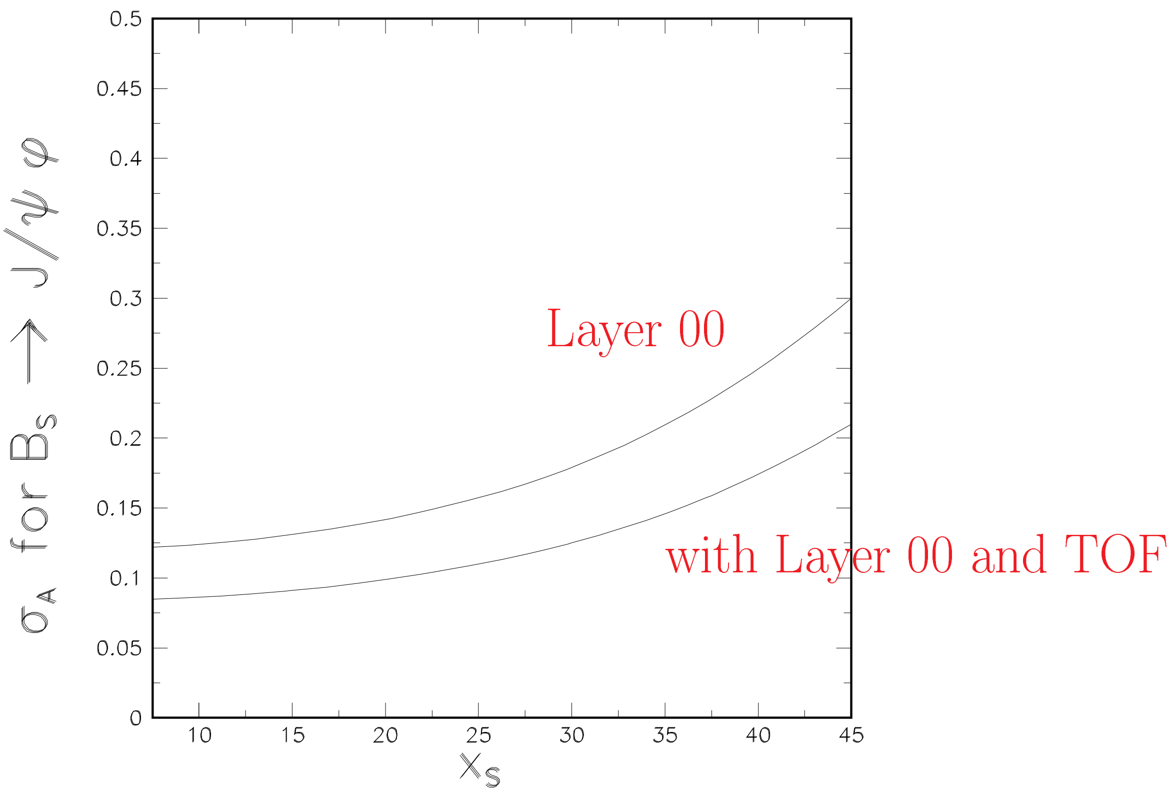
Examples:

- B_s^0-$\bar{B}_s^0$ flavor oscillations
- $B_s^0 \to J/\psi\, \phi$
- $B_s^0 \to D_s^\pm K^\mp$

Also improves flavor tagging for B^0
$\boldsymbol{\epsilon D^2 = 6.1\% \Longrightarrow 9.0\%}$

CP Violation in $B_s^0/\bar{B}_s^0 \to J/\psi\phi$

- Small in the Standard Model
  Significant asymmetry unambiguous sign of new physics
- Expected signal: 6000 $B_s^0/\bar{B}_s^0 \to J/\psi\phi$
- Requires measurement of x_s
- Expected combined ϵD^2 for this sample: $\epsilon D^2 = 9.7\%$

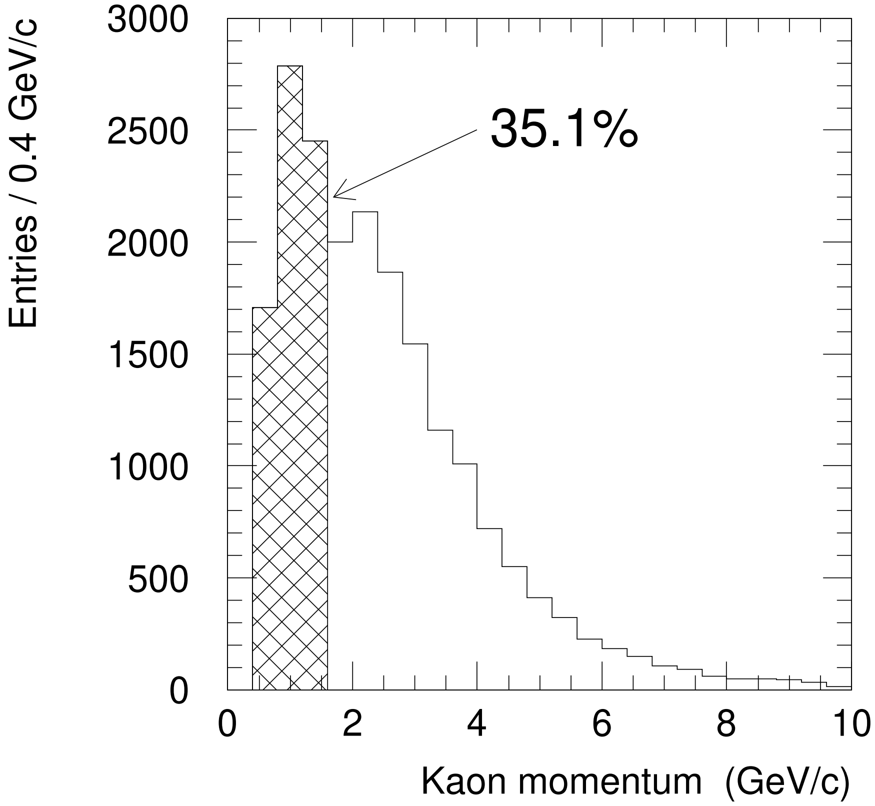


Response to Question 2

$B_s^0 \to D_s^- \pi^+, D_s^- \to \phi\pi^-$

Apply Run II hadronic B trigger

Momentum of K from ϕ



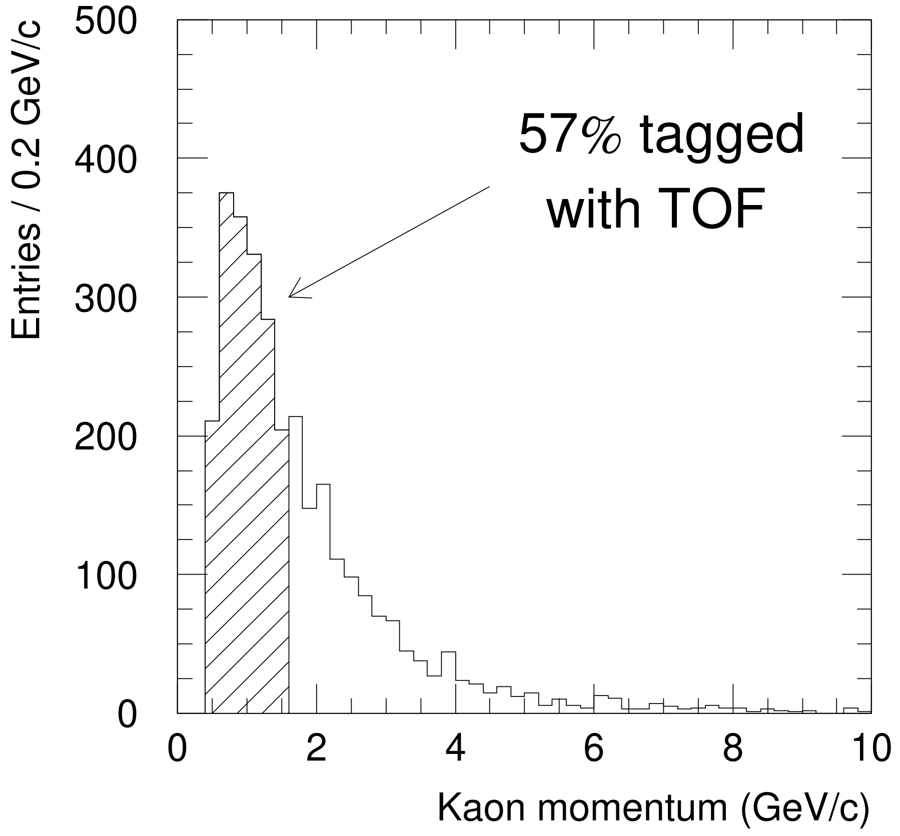
35.1% have $p_K < 1.6$ GeV/c
K/π separation better than 2σ

Question 2 (continued)

K Momentum spectrum for "opposite-side" *B*

Generic *B* decay

But no Run II trigger requirement
(probably still representative)



57% have $p_K < 1.6$ GeV$/c$
K/π separation better than 2σ

Will TOF Help with Signal-to-Noise?

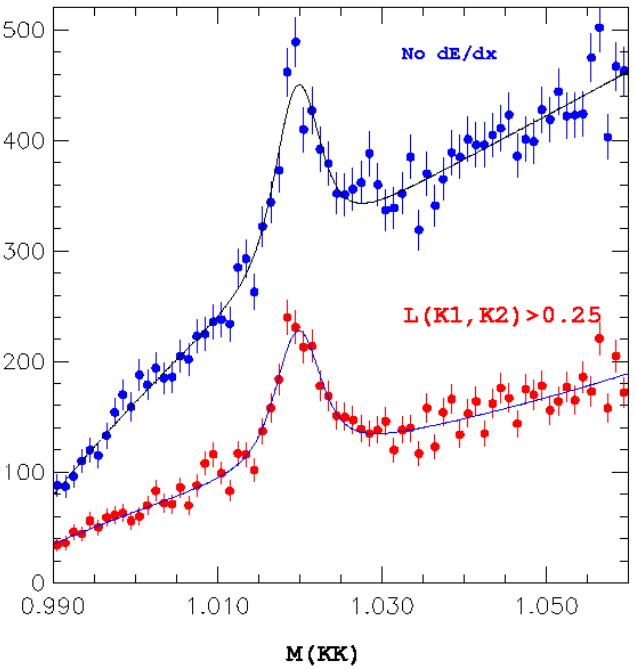
Run I dE/dx can give indication

Used in limit on Δm_s ($\Delta m_s > 5.8$ at 95% C.L.)

(F. Abe *et al.*, *A Search for* $B_s^0-\bar{B}_s^0$ *Oscillations Using the Semileptonic Decay* $B_s^0 \rightarrow \phi \ell^+ X \nu$, FERMILAB–PUB–98/401–E, submitted to Phys. Rev. Lett.)

Partially reconstruct B_s^0: $B_s^0 \rightarrow \ell^+ \nu_\ell \phi X$

dE/dx used to reduce background in ϕ



Additional Applications

Many other potential PHYSICS applications
Examples:

- kaon identification in $D_s^{\pm} K^{\mp}$, $J/\psi K^{*0}$, $\mu^+ \mu^- K^{(*)0}$ etc.
- proton identification (used in $\Lambda_c \to p K^- \pi^+$)
- search for long-lived heavy charged particles ($\tilde{\tau}$)
- monopole trigger

As well as other practical uses:

- cosmic ray trigger and rejection
- luminosity monitor

Important physics studies for
Run III dedicated B experiment

Physics applications we have not thought of (yet)