

Possibilities for Measuring Δm_s Using Semileptonic Decay $B_s \rightarrow \phi l X \nu$ in Dilepton Trigger Data

S. Behari, P. Maksimovic, J. R. Mumford, J. Pursley
Johns Hopkins University
2nd B Mixing Workshop

12 July, 2004

Introduction

Best limit on B_s mixing in CDF Run I came from a sample of B_s semileptonic decays collected using Run I dilepton triggers.

Ting Miao CDF Note #4485.

- Analysis used partially reconstructed decay of $B_s \rightarrow \phi l X \nu$ and an opposite side soft lepton relative to the ϕl pair as a flavor tag.
- Found 1068 ± 70 candidates with a B_s purity of 61%.
- Obtained a lower limit of $\Delta m_s > 5.8 ps^{-1}$

How well would this method work in Run II data?

Features of the Analysis

Fully reconstructed B_s hadronic decay events provide the best precision in the measurement of Δm_s . However, poor small hadronic branching ratios make it difficult to obtain a large enough sample size.

- Semileptonics

- Large branching ratios \rightarrow large sample size.
- Less accurate because decays are partially reconstructed.

- Inclusive Search

- More modes \rightarrow larger sample size.
- Actual decay products are not fully specified; Large Background

- $B_s \rightarrow \phi l X \nu$ in Dilepton Data

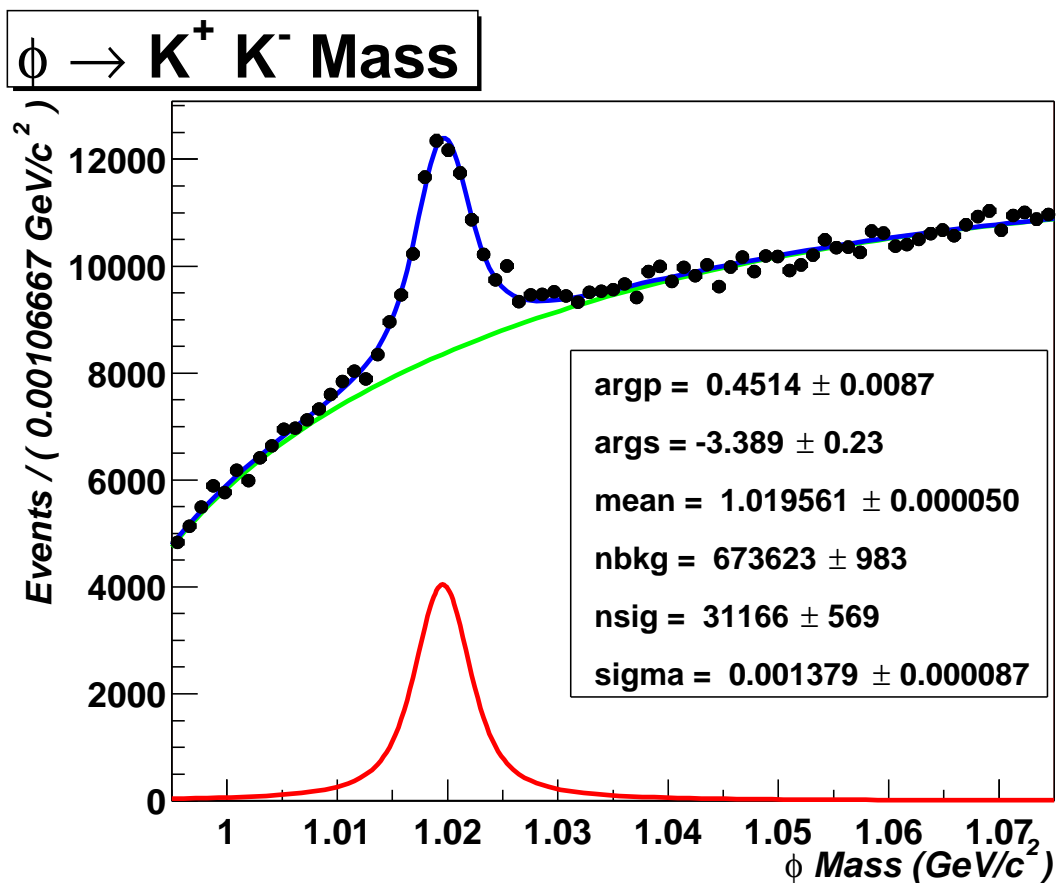
- The mode is self-tagged
- The dimuon sample is not prescaled

Our Sample of $B_s \rightarrow \phi\mu X\nu$ w/ opposite side μ

Use 5.3.1 version of [UniversalFinder](#) (available in [Sin2BetaMods](#) package) to strip a sample from 5.1.1f dimuon data ([xrar0c](#)).

| Particle | Run I | This Analysis |
|--------------|--|--|
| μ | $p_T > 2 \text{ GeV}$ | $p_T > 1.3 \text{ GeV}$ |
| K | $p_T > 1 \text{ GeV}$ $\Delta R(K, l) < 1$ $dE/dx: L(K_1, K_2) > 0.25$ | $p_T > 1.3 \text{ GeV}$ not yet implemented not yet implemented |
| ϕ | $p_T > 2.7 \text{ GeV}$ | $p_T > 2.7 \text{ GeV}$ |
| $\phi\mu$ | $2.0 < m_{\phi l} < 5.0$ $p_T(\phi l) > 5.0 \text{ GeV}$ $p_T^{rel} > 1.0 \text{ GeV}$ | $2.0 < m_{\phi l} < 5.0$ $p_T(\phi l) > 5.0 \text{ GeV}$ not yet implemented |
| ϕh | $\Delta R(h, \phi l) < 1$ $1.0 < m_{\phi h} < 2.0$ $\text{Prob}(\chi^2) > 0.01$ | not yet implemented not yet implemented not yet implemented |
| $\phi h \mu$ | $m_{\phi h \mu} < 6 \text{ GeV}$ $\text{Prob}(\chi^2) > 0.01$ | not yet implemented not yet implemented |
| $\mu\mu$ | $\Delta R(l_{tag}, l) > 2$ | $\Delta\phi(l_{tag}, \phi l) > 1.8$ |

Our ϕ Yield



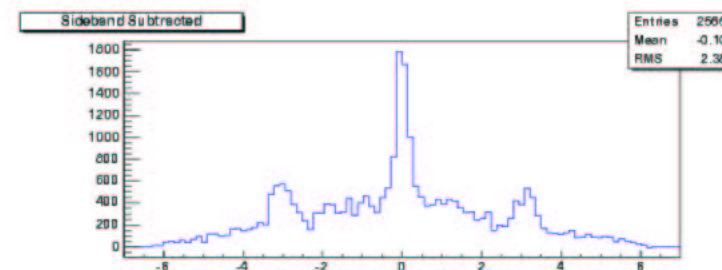
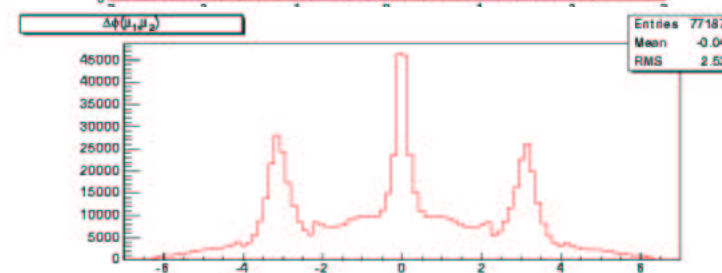
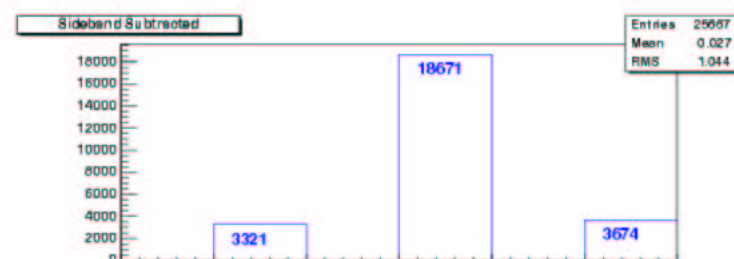
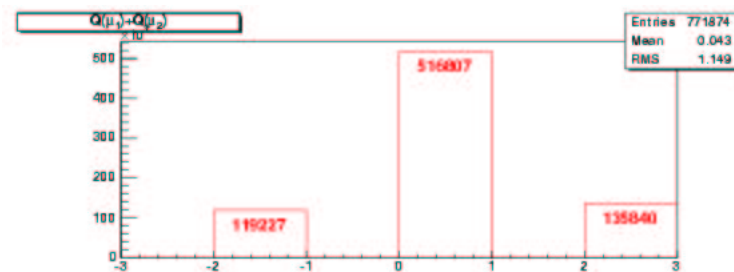
Signal Region: 1.014-1.026 GeV

Low Sideband: 0.999-1.011 GeV

High Sideband: 1.029-1.041 GeV

Yield: 26850 ϕ from B_s , B^0 , and B^+ .

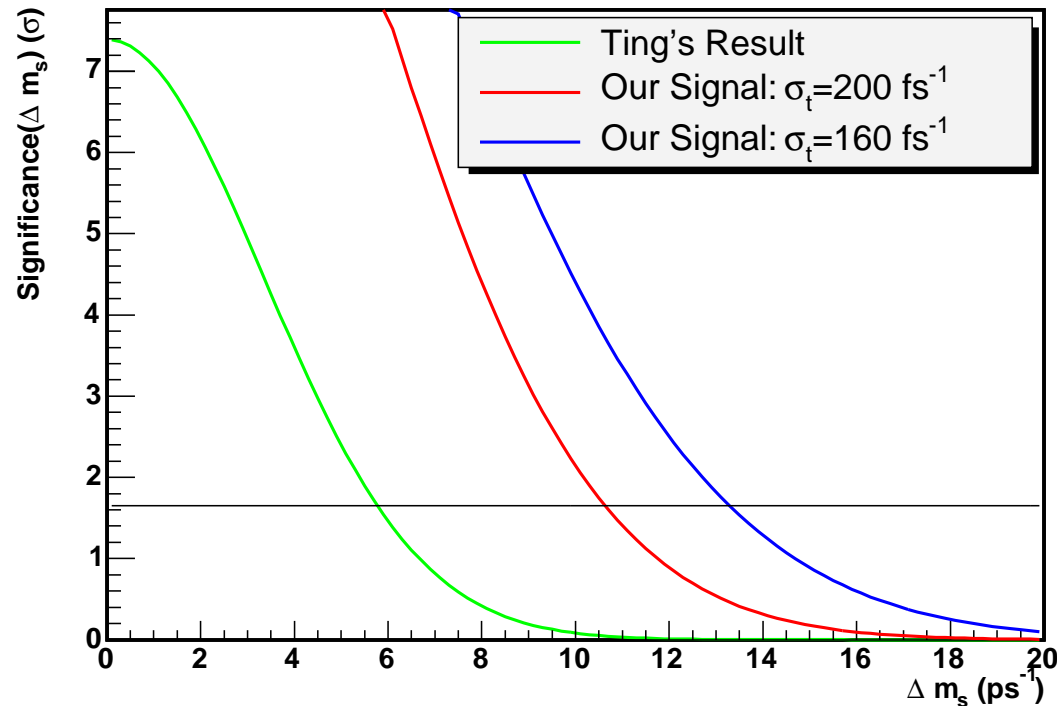
S/B : $\sim 25\%$



Possible Δm_s Sensitivity

| | Ting | Us | Notes |
|------------|-----------------------|----------------------------|---|
| ϵ | 1 | 1 | Thanks to the dimuon trigger. |
| D | 0.52 | 0.52 | Taken from Ting's Run I note (4485) |
| σ_t | 300 fs^{-1} | $160, 200 \text{ fs}^{-1}$ | Assumed an error for Ting's analysis. Our values were taken from Nuno's note (6811). |
| S | 1068 | 16379 | estimated with $f_{B_s} = 0.61$ from Ting's Note |
| B | 1753 | 117872 | Obtained from the S/B in our ϕ mass peak. |

Projected Δm_s Sensitivity



Significance(Δm_s)

$$= \sqrt{\frac{S\epsilon D^2}{2}} \cdot e^{-\frac{1}{2}(\Delta m_s \sigma_t)^2} \cdot \sqrt{\frac{S}{S+B}}$$

Sensitivity to $\Delta m_s < \sim 10 \text{ ps}^{-1}$

To Do List and Conclusions

The preliminary numbers indicate that the Run I technique may also be promising for us in Run II.

there is still much to do...

- Determine the missing parameters in our sensitivity estimate:
 ϵ , D , σ_t
- Improve our S/B. Big gains expected in dE/dx for example
- Use 5.3.3 with L00 and Primary Vertex
- Implement hadron track adding for D_s vertex.
- Sample composition study. The Run II sample composition will very likely be much different from Run I
- Generic semileptonic MC for K factor estimation.
- Use Ting's existing Run I fitter for Δm_s fit.