

Reporting on the Lifetime of the B_s meson decay to K^+K^-

Mauro Donega*

Universite de Geneve, Switzerland

E-mail: mauro.donega@cern.ch

We use data collected by the displaced track trigger of the CDF Run II detector at TeVatron to measure the B mesons lifetime in the hadronic decays: $B_u \rightarrow D^0\pi$, $B_d \rightarrow D^\mp\pi^\pm$, $B_d \rightarrow D^\mp 3\pi$, $B_s \rightarrow D_s^\mp\pi^\pm$, $B_s \rightarrow D_s^\mp 3\pi$. Recent developments in the measurement of the lifetime of the charmless $B_s \rightarrow k^+k^-$ mode will be presented.

International Europhysics Conference on High Energy Physics

July 21st - 27th 2005

Lisboa, Portugal

*Speaker.

1. Introduction

The TeVatron produces the full spectrum of b-hadrons, giving the opportunity to CDF to collect events kinematically inaccessible at the B-factories as the decays of the B_s meson. High energy experiments typically trigger on B decays using the leptons in the final states. CDF add to this the capability to trigger on fully hadronic modes. The hadronic trigger, selecting events with high impact parameters of the decays products, sculpts the proper decay distribution. To measure the lifetimes of the B hadrons it is then necessary to properly correct for the effect of the trigger. In the following the technique used to measure the lifetimes and the first CDF results are reported.

2. Trigger on hadronic modes

The fast CDF silicon read out allows to have silicon hits information already at the second level of the trigger. The SVT (Silicon Vertex Tracker) [1] is a device capable of estimating on line the impact parameters of B decay products with a resolution comparable to the offline one and trigger the events that have at least two tracks with impact parameter in the range between $100\mu\text{m}$ and 1 mm. Because of the long b lifetime, the effect of this selection is to increase the purity of the b-sample at the price of sculpting its proper decay length distribution, hence reducing its statistical power in a lifetime measurement. The lifetime information has thus to be deconvolved from the smearing effects coming from the resolution on the impact parameter cut, from the efficiency of the trigger and from the effect of the analysis cuts. The study of this effects is modeled with an efficiency as a function of the proper decay length that is extracted from MonteCarlo. This efficiency function is defined as the ratio between the proper decay length distribution of the events that pass the trigger and the “un-sculpted” one, described with an exponential convoluted with a resolution model that depends on the event by event error (σ_{ct}). The applicability and robustness of this method have been verified in several ways. The most relevant ones aim at verifying that the MonteCarlo is correctly representing the data and that the efficiency curves do not depend on the specific lifetime of the MonteCarlo used to extract them.

The first test has been performed on a sample of $B^\pm \rightarrow J/\psi k^\pm$. These decays are triggered using the muons on the final states coming from the decay of the J/ψ , and so this sample is not biased by the SVT. It is now possible to compare the efficiency functions build with at the numerator respectively the proper decay distribution of the MonteCarlo events, or the distribution coming from the unbiased $B^\pm \rightarrow J/\psi k^\pm$ where the SVT criteria are applied offline. The results show a good agreement between the two.

For the second test different MonteCarlo samples of $B^\pm \rightarrow D^0 \pi^\pm$ have been produced modifying the generated lifetime of the decay. For each of the samples an efficiency curve has been extracted, and then the different efficiency curves have been applied on data, showing no dependence of the fitted lifetimes with respect to the distribution used to extract the efficiency curve.

3. Charmed modes

The method presented above may be included in an unbinned likelihood fit, combining the mass information and the proper decay length of the decay. The mass distribution of the $B^0 \rightarrow$

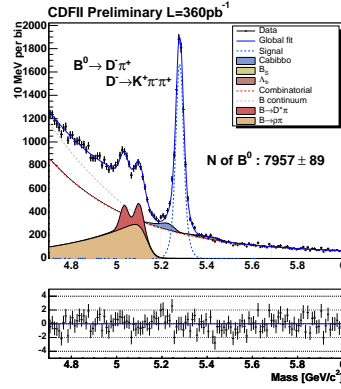


Figure 1: Wide Mass Region Fits: A Mass fit on a wide mass region is performed before to run the combined fit, in order to fix the mass shape of the combinatorial background and estimate the contamination coming from partially reconstructed background. These fits show the projection results for the $B^0 \rightarrow D^\pm \pi^\mp$ decay mode

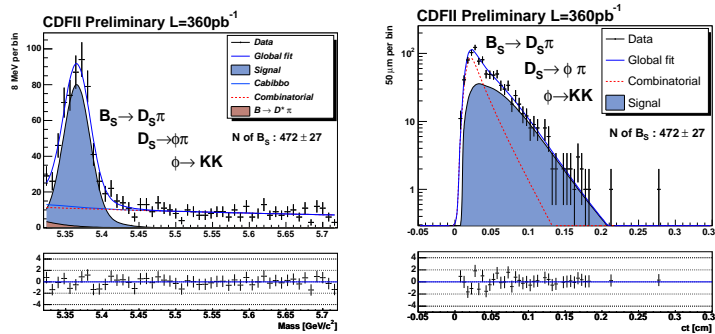


Figure 2: Projection plots for the combined Mass-Lifetime fit on $B_s \rightarrow D_s^- \pi^+$ decay mode. The partially reconstructed contribution is less than 1% and then can be neglected.

$D^\pm \pi^\mp$ is shown in figure (1). This presents a typical structure where the B peak is visible. On the lower mass side of the peak the structures of the partially reconstructed decays appears, while the combinatorial background appears on the higher mass side. The procedure used is to perform a mass fit, estimate the amount of contamination of the partially reconstructed B decays underneath the B peak and then perform a combined fit in mass and proper decay length in a reduced mass range that excludes the misreconstructed decays region. The preliminary results for the charmed modes analysed on the first 360pb^{-1} of CDF data are collected in the following table. Figure (2) show the mass and lifetime fit projections for the $B_s \rightarrow D_s \pi (D_s \rightarrow \phi \pi)$. The statistical error is still dominant while the systematics are within few microns.

B meson	lifetime (ps)	lifetime (μm)
B_u	$1.66 \pm 0.03(\text{stat}) \pm 0.01(\text{syst})$	$438 \pm 8 (\text{stat}) \pm 4 (\text{syst})$
B_d	$1.51 \pm 0.02(\text{stat}) \pm 0.01(\text{syst})$	$453 \pm 7 (\text{stat}) \pm 4 (\text{syst})$
B_s	$1.60 \pm 0.10(\text{stat}) \pm 0.02(\text{syst})$	$479 \pm 29 (\text{stat}) \pm 5 (\text{syst})$

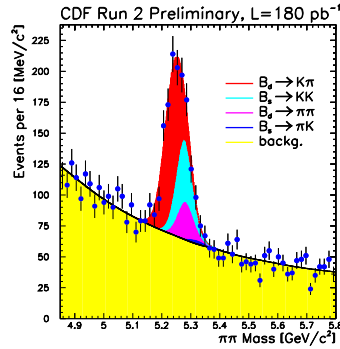


Figure 3: $M_{\pi\pi}$ distribution of the $B \rightarrow h^+h^-$ candidates selected applying the optimized analysis cuts and assigning the pion mass to both decay tracks. The result of the fit of the fractions is overlaid.

4. Charmless modes

The same method is currently in the process of being applied also to the hadronic charmless B decays. CDF is able to collect the decays of the B meson in two hadrons. Figure (3) shows the mass spectrum (obtained on 180pb^{-1}) of the B sample obtained assigning the mass of the pion to the two tracks of the event. The pronounced peak at about $5.25 \text{ GeV}/c^2$ is the sum of four main decay channels: $B_d \rightarrow \pi^+\pi^-$, $B_d \rightarrow K^+\pi^-$, $B_s \rightarrow K^+K^-$, $B_s \rightarrow K^-\pi^+$ (and charge conjugated). These modes are statistically separated including both kinematics and particle identification information in an unbinned maximum likelihood fit. The details of the method have been presented elsewhere at this conference [2]. This sample allows the extraction of the lifetime of the B_d modes and the $B_s \rightarrow K^+K^-$ (the $B_s \rightarrow K^-\pi^+$ is still not significant in 180pb^{-1}). The $B_s \rightarrow K^+K^-$ mode is predicted not to be an eigenstate of CP, but still be dominated by the CP even component (about 95%). Combining the lifetime value that will be measured in this mode and combining it with the lifetime of a flavour specific decay (for instance the $B_s \rightarrow D_s\pi$ showed above) it is possible to measure the $\Delta\Gamma_s$ without using the angular analysis of the vector vector B decays (as $B_s \rightarrow J/\psi\phi$ or $B_s \rightarrow \phi\phi$).

5. Conclusion

The demonstrated capability of CDF to trigger on fully hadronic B decays has been used for the first time to measure the lifetimes. A MonteCarlo based method to correct for the trigger bias has been developed. The results of the lifetime measurements on charmed B decay modes have been presented. The analysis of the lifetime in charmless B decays is presently ongoing and new results are expected soon.

References

- [1] W. Ashmanskas *et al.*, Nucl. Instrum. Meth A **518**, 532 (2004).
- [2] D. Tonelli, these conference proceedings