PROCEEDINGS OF SCIENCE

Measurement of the B_s^0 lifetime in the CP-odd decay channel $B_s^0 \to J/\psi f_0(980)$ in the D0 experiment

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(On behalft of the D0 Collaboration)

The lifetime measurement of the B_s^0 meson in the CP-odd decay channel $B_s^0 \to J/\psi\ f_0(980)$ is reported. Data equivalent to 10.4 fb^{-1}, collected with the D0 detector in the Run II of the Tevatron is used. The lifetime of the CP-odd component of the B_s^0 meson is measured, obtaining a result of $\tau(B_s^0) = 1.70 \pm 0.14$ (stat) ± 0.05 (syst) ps.

38th International Conference on High Energy Physics
3-10 August 2016
Chicago, USA

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PoS(ICHEP2016)1218

1. Introduction

The B_s^0 and $\bar{B}_s^0$ mesons are produced as flavor eigenstates, but the particles propagate as mass eigenstates. In the absence of CP-violation in mixing, the mass eigenstates are also CP eigenstates.

The $B_s^0 \to J/\psi f_0(980)$ decay channel corresponds to a nearly pure CP-odd eigenstate decay. A measurement of the B_s^0 lifetime in this channel gives access to the lifetime of the heavy mass eigenstate.

We report the lifetime of the B_s^0 meson measured in the decay channel $B_s^0 \to J/\psi f_0(980)$.

2. Data Selection

The data were collected with the D0 detector during Run II of the Tevatron collider at a center-of-mass energy of 1.96 TeV. The D0 detector is described here [1].

The reconstruction begins by reconstructing $J/\psi \to \mu^+\mu^-$, followed by searching for $f_0(980) \to \pi^+\pi^-$ candidates. The B_s^0 candidates are reconstructed by performing a constrained fit to a common vertex for the charged tracks.

3. Analysis and Results

The lifetime measurement is based on the transverse decay length method: The proper transverse decay length, λ, for the B_s^0 candidate is given by:

$$\lambda = L_{xy}\frac{cM_B}{p_T}, \tag{3.1}$$

where M_B is the average mass value of the B_s^0 meson.

A simultaneous unbinned maximum likelihood fit to the mass and proper decay length distributions is performed to measure the lifetime. The components of the model are:

- **Signal**: mass modeled with a Gaussian.
- **Cross-feed background** (mis-reconstructed B decays): mass modeled with a wide Gaussian.
- B^+ **background** ($B^+ \to J/\psi K^+$ with accidental track): mass distribution taken from data.
- **Combinatorial background**: mass modeled with an exponential.

Proper decay lengths are modeled with an exponential convoluted with a Gaussian resolution in all cases. The distribution of the decay length uncertainty is described by a phenomenological model for all the components, using an exponential convoluted with a Gaussian.

The fit yields $c\tau(B_s^0) = 504 \pm 42$ μm and the numbers of signal decays to be 494 ± 85.

We test the modeling and fitting method used to estimate the lifetime using data generated in pseudoexperiments. We correct for a small -4.4 μm fit bias which arises due to imperfect separation of signal and background.

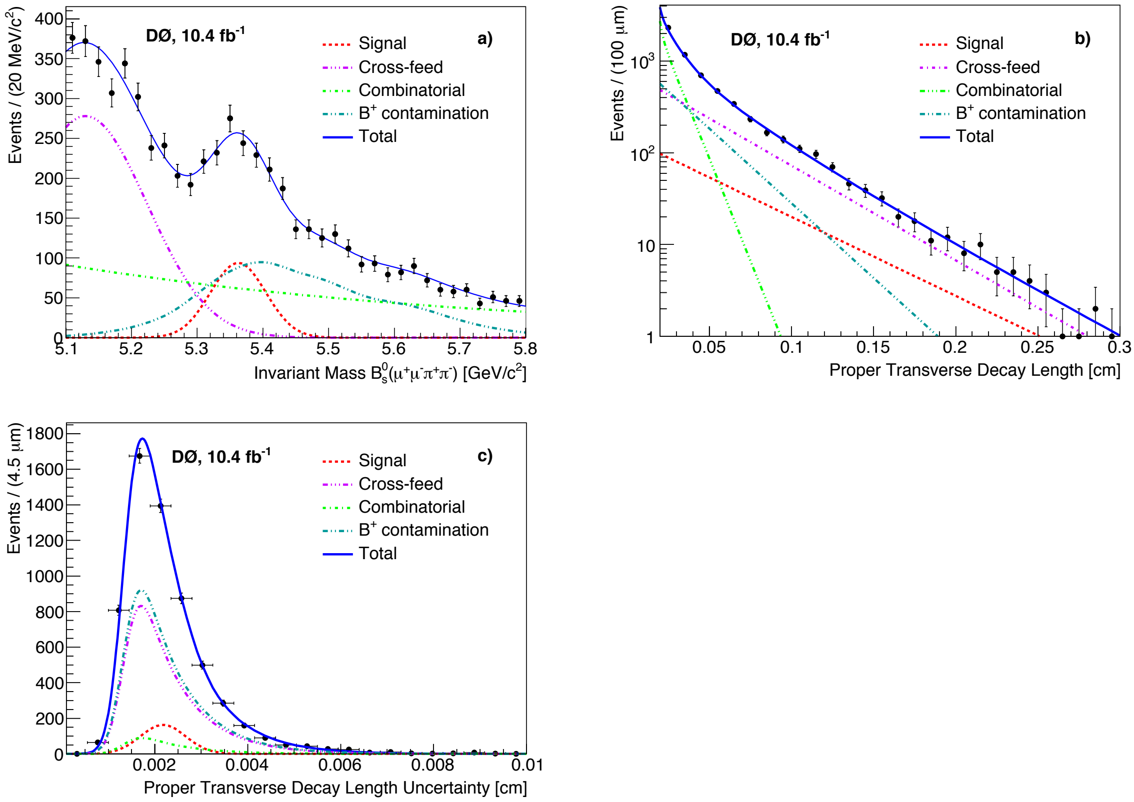

Figure 1: Distributions of (a) invariant mass, (b) proper transverse decay length, and (c) proper transverse decay length uncertainty for B_s^0 candidates.

4. Systematic Uncertainties

Source	Variation (μm)
Alignment	5.4
$\pi^+\pi^-$ invariant mass window	8.0
Fit bias	4.4
Distribution models	12.5
Total (sum in cuadrature)	16.4

5. Conclusions

In summary, the lifetime of the B_s^0 is measured [2] to be:

$$c\tau(B_s^0) = 508 \pm 42\ (\text{stat}) \pm 16\ (\text{syst})\ \mu\text{m}, \tag{5.1}$$

from which we determine:

$$\tau(B_s^0) = 1.70 \pm 0.14\ (\text{stat}) \pm 0.05\ (\text{syst})\ \text{ps}, \tag{5.2}$$

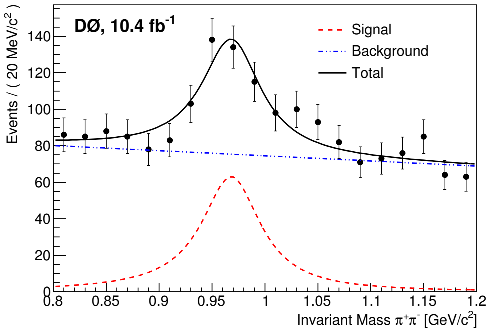

Figure 2: $M(\pi^+\pi^-)$ distribution for events with $M(\mu^+\mu^-\pi^+\pi^-)$ within $\pm 1\sigma$ of the B_s^0 mass.

in the decay channel $B_s^0 \to J/\psi\pi^+\pi^-$ with $880 \le M_{\pi^+\pi^-} \le 1080$ MeV/c^2.

CDF [3] and LHCb [4] have measured this lifetime, reporting $\tau(B_s^0) = (1.70 \pm 0.12 \pm 0.03)$ ps and $\tau(B_s^0) = (1.70 \pm 0.04 \pm 0.026)$ ps respectively.

Our result is in good agreement with previous measurements and provides an independent confirmation of the longer lifetime for the CP-odd eigenstate of the $B_s^0/\bar{B}_s^0$ system.

6. Acknowledgements

The D0 Collaboration thanks the staffs at Fermilab and collaborating institutions, and acknowledges support of the many international funding agencies which made these experimental programs possible. The speaker wants to aknowledge the financial support of CONACYT (FOINS-296-2016) and the Mexican HEP Network (Red FAE) to attend the conference.

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