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Measurements of *CP* Asymmetries in the Decay $B \to \phi K$

The *BABAR* Collaboration

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Abstract

We present a preliminary measurement of the time-dependent *CP* asymmetry for the neutral *B*-meson decay $B^0 \to \phi K^0$. We use a sample of approximately 227 million *B*-meson pairs recorded at the $\Upsilon(4S)$ resonance with the *BABAR* detector at the PEP-II *B*-meson Factory at SLAC. We reconstruct the *CP* eigenstates ϕK^0_S and ϕK^0_L where $\phi \to K^+K^-$, $K^0_S \to \pi^+\pi^-$, and K^0_L is observed via its hadronic interactions. The other *B* meson in the event is tagged as either a B^0 or $\overline{B}^0$ from its decay products. The values of the *CP*-violation parameters derived from the combined ϕK^0 dataset are $S_{\phi K} = +0.50 \pm 0.25\,(\mathrm{stat})^{+0.07}_{-0.04}(\mathrm{syst})$ and $C_{\phi K} = 0.00 \pm 0.23\,(\mathrm{stat}) \pm 0.05\,(\mathrm{syst})$. In addition, we measure the *CP*-violating charge asymmetry $\mathcal{A}_{\mathcal{CP}}(B^+ \to \phi K^+) = 0.054 \pm 0.056\,(\mathrm{stat}) \pm 0.012\,(\mathrm{syst})$. All results are preliminary.

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1 INTRODUCTION

Decays of B mesons into charmless hadronic final states with a ϕ meson are dominated by $b \to s\bar{s}s$ gluonic penguin amplitudes, possibly with smaller contributions from electroweak penguins, while other Standard Model (SM) amplitudes are strongly suppressed [1]. In the SM, *CP* violation arises from a single complex phase in the Cabibbo–Kobayashi–Maskawa (CKM) quark-mixing matrix [2]. Neglecting CKM-suppressed contributions, the time-dependent *CP*-violating asymmetries in the decays $B^0 \to \phi K^0$ and $B^0 \to J/\psi K^0$ are proportional to the same parameter $\sin 2\beta$ [3], where the latter decay is dominated by tree diagrams. Since many scenarios of physics beyond the SM introduce additional diagrams with heavy particles in the penguin loops and new *CP*-violating phases, comparison of *CP*-violating observables with SM expectations is a sensitive probe for new physics. Measurements of sin2β in B decays to charmonium such as $B^0 \to J/\psi K^0_S$ have been reported by the *BABAR* [4] and Belle [5] collaborations, and the world average for sin2β is 0.731 ± 0.056 [6]. In the decay $B^0 \to \phi K^0_S$ the Belle collaboration measures sin$2\beta = -0.96 \pm 0.50^{+0.09}_{-0.11}$ [7], while the *BABAR* collaboration (with a sample of approximately 114 million $B\bar{B}$ pairs) measures sin$2\beta = 0.47 \pm 0.34(\text{stat})^{+0.08}_{-0.06}(\text{syst})$ [8] in the decays $B^0 \to \phi K^0_S$ and $B^0 \to \phi K^0_L$.

In the SM, neglecting CKM-suppressed contributions, the direct *CP* violation in $B^+ \to \phi K^+$ [9], detected as an asymmetry $\mathcal{A}_{\mathcal{CP}} = (\Gamma_{\phi K^-} - \Gamma_{\phi K^+})/(\Gamma_{\phi K^-} + \Gamma_{\phi K^+})$ in the decay rates $\Gamma_{\phi K^{\pm}} = \Gamma(B^{\pm} \to \phi K^{\pm})$, is expected to be zero; in the presence of large new-physics contributions to the $b \to s\bar{s}s$ transition, it could be of order 1 [10]. The *BABAR* collaboration measures (with a sample of approximately 89 million $B\overline{B}$ pairs) $\mathcal{A}_{\mathcal{CP}}(B^{\pm} \to \phi K^{\pm}) = 0.04 \pm 0.09 \pm 0.01$ [11].

In this paper we report preliminary measurements of the time-dependent *CP* asymmetry in the decay $B^0 \to \phi K^0$ and the charge asymmetry in the decay $B^+ \to \phi K^+$ based on a sample of approximately 227 million $B\bar{B}$ pairs collected at the $\Upsilon(4S)$ resonance with the *BABAR* detector [12] at the PEP-II asymmetric-energy e^+e^- storage ring [13] located at the Stanford Linear Accelerator Center.

2 THE BABAR DETECTOR

The *BABAR* detector is described elsewhere [12]. The primary components used in the analysis are a charged-particle tracking system consisting of a five-layer silicon vertex tracker (SVT) and a 40-layer drift chamber (DCH) surrounded by a 1.5-T solenoidal magnet with an instrumented flux return (IFR), an electromagnetic calorimeter (EMC) comprised of 6580 CsI(Tl) crystals, and a detector of internally reflected Cherenkov light (DIRC) providing excellent charged K and π identification [14] in the momentum range relevant for this analysis.

3 ANALYSIS METHOD

From a $B^0\overline{B}{}^0$ meson pair we fully reconstruct one meson, B_{CP}, in the final state ϕK^0, and partially reconstruct the recoil B meson, B_{tag}. We examine B_{tag} for evidence that it decayed either as B^0 or $\overline{B}{}^0$ (flavor tag). The asymmetric beam configuration in the laboratory frame provides a nominal boost of $\beta\gamma = 0.56$ to the $\Upsilon(4S)$, which allows the determination of the proper decay-time difference $\Delta t = t_{CP} - t_{\text{tag}}$ using the vertex separation of the two neutral B mesons along the beam (z) axis. The decay rate $\mathrm{f}_+(\mathrm{f}_-)$ when the tagging meson is a $B^0(\overline{B}{}^0)$ is given by

$$\mathrm{f}_{\pm}(\,\Delta t) \;=\; \frac{\mathrm{e}^{-|\Delta t|/\tau_{B^0}}}{4\tau_{B^0}}\,[\,1 \mp \eta_f\, S_{\phi K} \sin{(\Delta m_d \Delta t)} \mp C_{\phi K} \cos{(\Delta m_d \Delta t)}]\,, \tag{1}$$

where τ_{B^0} is the neutral B meson mean lifetime, Δm_d is the B^0–$\overline{B}^0$ oscillation frequency, and the CP eigenvalue is $\eta_f = -1$ $(+1)$ for ϕK^0_S (ϕK^0_L). The time-dependent CP-violating asymmetry is defined as $A_{CP} \equiv (\mathrm{f}_+ - \mathrm{f}_-)/(\mathrm{f}_+ + \mathrm{f}_-)$. In the SM, decays that proceed purely via the $b \to s\bar{s}s$ penguin transitions have CP parameters $S_{\phi K} = \sin 2\beta$ and $C_{\phi K} = 0$, where $\beta \equiv \arg\left[-V_{cd}V^*_{cb}/V_{td}V^*_{tb}\right]$. Here V_{ik} is the CKM matrix element for quarks i and k.

4 EVENT RECONSTRUCTION

The B_{CP} candidate is reconstructed in the decay mode ϕK^0 with $\phi \to K^+K^-$; the K^0 is either a K^0_L or a K^0_S decaying into $\pi^+\pi^-$. We combine pairs of oppositely charged tracks extrapolated to a common vertex to form ϕ and K^0_S candidates. For the charged tracks from the ϕ decay we require at least 12 measured drift-chamber coordinates and a minimal transverse momentum of 0.1 GeV/c. The tracks must also originate from within 1.5 cm of the nominal beam spot in the plane transverse to the beam axis and ±10 cm along the z-axis. Tracks with momentum less than 0.7 GeV/c that are used to reconstruct the ϕ meson are distinguished from pions and protons via a requirement on the likelihood that combines $\mathrm{d}E/\mathrm{d}x$ information from the SVT and the DCH. For tracks with higher momentum, $\mathrm{d}E/\mathrm{d}x$ in the DCH and the Cherenkov angle and the number of photons as measured by the DIRC are used in the likelihood. The two-kaon invariant mass must be within 15 MeV/c^2 of the known ϕ mass [6].

For tracks corresponding to K^0_S and B_{tag} daughters our requirements are less restrictive. A $K^0_S \to \pi^+\pi^-$ candidate is accepted if its two-pion invariant mass is within 15 MeV/c^2 of the known K^0 mass [6], its reconstructed decay vertex is separated from the ϕ decay vertex by at least 3 standard deviations, and the projected angle between the line connecting the ϕ and K^0_S decay vertices and the K^0_S momentum direction, in the plane perpendicular to the beam axis, is less than 45 mrad.

We identify a K^0_L candidate like in our $B^0 \to J/\psi K^0_L$ analysis [15] either as a cluster of energy deposited in the electromagnetic calorimeter or as a cluster of hits in two or more layers of the instrumented flux return that cannot be associated with any charged track in the event. The K^0_L energy is not well measured. Therefore, we determine the K^0_L laboratory momentum from its flight direction as measured from the EMC or IFR cluster, and the constraint that the invariant ϕK^0_L mass agrees with the known B^0 mass. In those cases where the K^0_L is detected in both the IFR and EMC we use the angular information from the EMC, because it has higher precision. In order to reduce background from π^0 decays, we reject an EMC K^0_L candidate cluster if it forms an invariant mass between 100 and 150 MeV/c^2 with any other cluster in the event under the $\gamma\gamma$ hypothesis, or if it has energy greater than 1 GeV and contains two shower maxima consistent with two photons from a π^0 decay. The remaining background of K^0_L candidates due to photons and overlapping showers is further reduced with the use of a neural network constructed from cluster shape variables, trained on Monte Carlo (MC) simulated $B^0 \to \phi K^0_L$ and measured radiative Bhabha events, and tested on measured $e^+e^- \to \phi(\to K^0_S K^0_L)\gamma$ and $B^0 \to J/\psi K^0_L$ events.

5 EVENT VARIABLES

The results are extracted from an extended unbinned maximum likelihood fit for which we parameterize the distributions of several kinematic and topological variables for signal and background events in terms of probability density functions (PDFs) [16]. The selection keeps loose requirements in those variables to include ranges dominated by background, too. The background B candidates come primarily from random combinations of tracks produced in events of the type $e^+e^- \to q\bar{q}$, where $q = u, d, s, c$ (continuum). Background from other B decay final states with and without charm is estimated with MC simulations. Opposite-*CP* contributions from the $K^+K^-K^0$ final state (K^+K^- S-wave) are estimated with data using a moment analysis method [17] to be less than 6.6% at a 95% confidence level and are treated as a systematic error. The shapes of event variable distributions are obtained from signal and background MC samples and high statistics data control samples. In many cases parameters describing these distributions are varied in the likelihood fit.

Each B_{CP} candidate is characterized by the energy difference $\Delta E = E^*_B - \frac{1}{2}\sqrt{s}$ and, except for $B^0 \to \phi K^0_L$, the beam-energy–substituted mass $m_{\rm ES} = \sqrt{(\frac{1}{2}s + \vec{p}_0 \cdot \vec{p}_B)^2/E^2_0 - p^2_B}$ [12]. The subscripts 0 and B refer to the initial $\Upsilon(4S)$ and the B_{CP} candidate, respectively, and the asterisk denotes the $\Upsilon(4S)$ rest frame. For signal events, ΔE is expected to peak at zero and $m_{\rm ES}$ at the known B mass. We require $\Delta E < 0.08$ GeV for $B^0 \to \phi K^0_L$, and $|\Delta E| < 0.1$ GeV and $m_{\rm ES} > 5.21\,{\rm GeV}/c^2$ for $B^0 \to \phi K^0_S$. The ϕ-meson signal in the KK invariant mass, m_{KK}, is described with a relativistic P-wave Breit-Wigner function with parameters obtained from data. In the fit we also use the helicity angle θ_H, which is defined as the angle between the directions of the K^+ and the parent B_{CP} in the K^+K^- rest frame. The $\cos\theta_H$ distribution for pseudoscalar-vector B decay modes is $\cos^2\theta_H$, and for the combinatorial background it is nearly uniform.

In continuum events, particles appear mostly in two jets. This topology can be characterized with several variables computed in the $\Upsilon(4S)$ frame. One such quantity is the angle θ_T between the thrust axis of the B_{CP} candidate and the thrust axis formed from the other charged and neutral particles in the event. We also use the angle θ_B between the B_{CP} momentum and the beam axis, and the sum of the momenta p_i of the other charged and neutral particles in the event weighted by the Legendre polynomials $L_0(\theta_i)$ and $L_2(\theta_i)$ where θ_i is the angle between the momentum of particle i and the thrust axis of the B_{CP} candidate. For $B^0 \to \phi K^0_S$ candidates, we combine these variables into a Fisher discriminant $\mathcal{F}$ [18]. In this mode, background from other B decays is negligible, as demonstrated in MC simulation studies.

More stringent criteria must be applied to suppress backgrounds in the case of $B^0 \to \phi K^0_L$ candidates, and we require $|\cos\theta_T| < 0.8$ and $|\cos\theta_B| < 0.85$. We define the missing momentum $\vec{p}_{miss}$, calculated in the laboratory frame from the sum of beam momenta and all tracks and EMC clusters, excluding the K^0_L candidate. We require the polar angle θ_{miss} of the missing momentum with respect to the beam direction to be greater than 0.3 rad. The cosine of the angle between $\vec{p}_{miss}$ and the K^0_L direction, θ_K, must satisfy $\cos\theta_K > 0.6$. In the plane transverse to the beam direction, the difference between the missing momentum projected along the K^0_L direction and the calculated K^0_L momentum must be greater than -0.75 GeV/c. In the Fisher discriminant we replace $|\cos\theta_B|$ by the cosine of the angle between the missing momentum and the K^+ from the ϕ decay. The dominant *CP* contamination is the mode $B \to \phi K^{*0}$, where the K^{*0} decays to $K^0_L\pi^0$. In the likelihood fit we explicitly parameterize backgrounds from both charm and charmless B decays, differently for neutral and charged B mesons, as derived from MC simulations.

All the other tracks and clusters that are not associated with the reconstructed $B^0 \to \phi K^0$ decay are used to form the $B_{\rm tag}$, and its flavor is determined with a multivariate tagging algorithm [19]. The tagging efficiency ϵ_i and mistag probability w_i in six hierarchical and mutually exclusive categories are measured from fully reconstructed B^0 decays into the $D^{(*)-}X^+$ ($X^+ = \pi^+, \rho^+, a^+_1$) and $J/\psi K^{*0}$ ($K^{*0} \to K^+\pi^-$) flavor eigenstates ($B_{\rm flav}$ sample). The analyzing power $\sum_{i=1}^{6}\epsilon_i(1 - 2w_i)^2$ is $(30.5 \pm 0.4)\%$.

A detailed description of the Δt reconstruction algorithm is given in Ref. [15]. The B_{CP} vertex resolution is determined by the ϕ vertex. The average Δz resolution is $190\,\mu$m and is dominated by the tagging vertex in the event. Thus, we can characterize the resolution with the much larger $B_{\rm flav}$ sample, which we fit simultaneously with the CP samples. The amplitudes for the B_{CP} asymmetries and for the $B_{\rm flav}$ flavor oscillations are reduced by the same factor due to wrong-flavor tags. Both distributions are convoluted with a common Δt resolution function. Backgrounds are accounted for by adding terms to the likelihood, incorporated with different assumptions about their Δt evolution and resolution function [15].

6 MAXIMUM LIKELIHOOD FIT

Since we measure the correlations among the observables to be small in the data samples entering the fit (the largest one is 13% between m_{ES} and ΔE for the signal, all others are below 7%), we take the probability density function $\mathcal{P}^j_{i,c}$ for each event j to be a product of the PDFs for the separate observables. For each event hypothesis i (signal, backgrounds) and tagging category c, for the ϕK^0_S mode we define $\mathcal{P}^j_{i,c} = \mathcal{P}_i(m_{ES}) \cdot \mathcal{P}_i(\Delta E) \cdot \mathcal{P}_i(\mathcal{F}) \cdot \mathcal{P}_i(m_{KK}) \cdot \mathcal{P}_i(\cos\theta_H) \cdot \mathcal{P}_i(\Delta t; \sigma_{\Delta t}, c)$, for the ϕK^0_L mode $\mathcal{P}^j_{i,c} = \mathcal{P}_i(\Delta E) \cdot \mathcal{P}_i(\mathcal{F}) \cdot \mathcal{P}_i(m_{KK}) \cdot \mathcal{P}_i(\cos\theta_H) \cdot \mathcal{P}_i(\Delta t; \sigma_{\Delta t}, c)$, and for the flavor sample $\mathcal{P}^j_{i,c} = \mathcal{P}_i(m_{ES}) \cdot \mathcal{P}_i(\Delta t; \sigma_{\Delta t}, c)$. The $\sigma_{\Delta t}$ is the error on Δt for a given event. The likelihood function for each decay is then

$$\mathcal{L} = \prod_c \exp\left(-\sum_i N_{i,c}\right) \prod_j^{N_c} \left[\sum_i N_{i,c}\, \mathcal{P}^j_{i,c}\right], \tag{2}$$

where $N_{i,c}$ is the yield of events of hypothesis i determined by the fit in category c, and N_c is the number of category c events in the sample. The total sample consists of 135,315 $B_{\rm flav}$, 4300 ϕK^0_S and 8238 ϕK^0_L candidates. The reconstruction efficiency for the ϕK^0_S mode is about 40% and and for the ϕK^0_L mode about 20%. From the fit we find 114 ± 12 ϕK^0_S and 98 ± 18 ϕK^0_L signal events. The signal yields in both the ϕK^0 channels agree well with our determination of the branching fraction for $B^0 \to \phi K^0$ [11]. Figure 1 shows the $m_{\rm ES}$ (ΔE) distribution for ϕK^0_S (ϕK^0_L) events together with the result from the fit after applying a requirement on the ratio of signal likelihood to the signal-plus-background likelihood (computed without the variable plotted) to reduce the background.

We determine the CP parameters $S_{\phi K}$ and $C_{\phi K}$ along with 83 other unconstrained parameters: event yields in signal and background (18 parameters), distributions of kinematic and topological variables for signal and background (12), the signal efficiency per tagging category (6), the average mistag fraction and the difference between B^0 and $\overline{B}^0$ mistags for each tagging category in the signal (12), and the signal Δt resolution (17). The Δt parameters for the charmless B background are the same as for the ϕK^0 signal. For the B decays into charm final states we parameterize the Δt resolution (3) and the mistag fractions (12). Their parameters are shared with the $B_{\rm flav}$ sample. The Δt resolution for the continuum background (3) is kept unconstrained in the ϕK^0 datasets. We fix τ_{B^0} and Δm_d to the world averages [6]. The determination of the mistag fractions and Δt-resolution parameters is dominated by the large $B_{\rm flav}$ sample. The fit was tested with both a parameterized simulation of a large number of data-sized experiments and a full detector simulation. The likelihood of our data fit agrees with the likelihoods from fits to the simulated data. The fit was also verified with our $J/\psi K^0_S$ and $J/\psi K^0_L$ data samples.

As a cross check the analysis was also performed using different selection criteria which we describe in turn. The invariant K^+K^- mass is required to be within 10 MeV/c^2 of the known mass

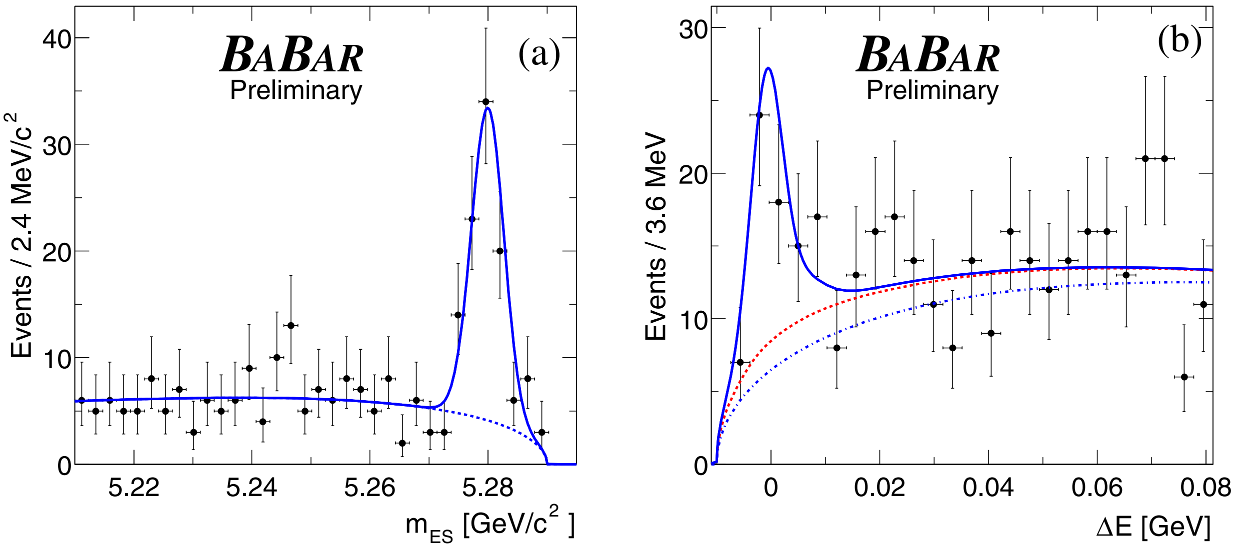

Figure 1: Distribution of the event variable (a) m_{ES} for the ϕK_S^0 final state and (b) ΔE for the ϕK_L^0 final state after reconstruction and a requirement on the ratio of signal likelihood to the signal-plus-background likelihood, calculated without the plotted variable. The signal efficiency for the selection and likelihood requirements is 32% for (a) and 9% for (b). The solid line represents the fit result for the total event yield and the dotted line for the total background. The dash-dotted (lower) line in (b) represents the continuum background only.

of the ϕ meson and is not used in the likelihood fit. The K_S^0 flight requirements are tightened. The same four-category multivariate tagging algorithm as was used for the earlier published analysis [4] is used. Instead of the Fisher discriminant a multivariate algorithm [20] for continuum background suppression is used, which in the ϕK_S^0 final state combines the same four variables. In the case of ϕK_L^0 the ingredients are L_0, L_2, p_{miss}, $\cos\theta_B$, and $\cos\theta_T$. The algorithm is trained in the same way as the Fisher discriminant and tested on data control samples. The central values of $S_{\phi K}$ and $C_{\phi K}$ for both the cross-check analysis and the primary analysis were hidden until the analyses were complete. We measure values for $S_{\phi K}$ and $C_{\phi K}$ in very close agreement for the ϕK_S^0 and the ϕK_L^0 sample, separately, and for the combined samples.

In the measurement of the CP-violating charge asymmetry in the decay $B^+ \to \phi K^+$ the selection of the ϕ meson candidate is identical. For the K^+ candidate from the B^+ decay the track requirements are the same as for the ϕ daughters but we apply a more restrictive kaon identification criterion. We use the same set of event variables as for the ϕK_S^0 channel. The likelihood is the same as in Eq. 2 with c corresponding to the two charge categories in signal and continuum background. The total sample consists of 6654 ϕK^+ candidates and from the fit we find 400 ± 23 signal candidates. Figure 2 shows the distribution of m_{ES} and m_{KK} with the result of the likelihood fit superimposed. We do not observe a significant asymmetry in Monte Carlo or in the continuum background data.

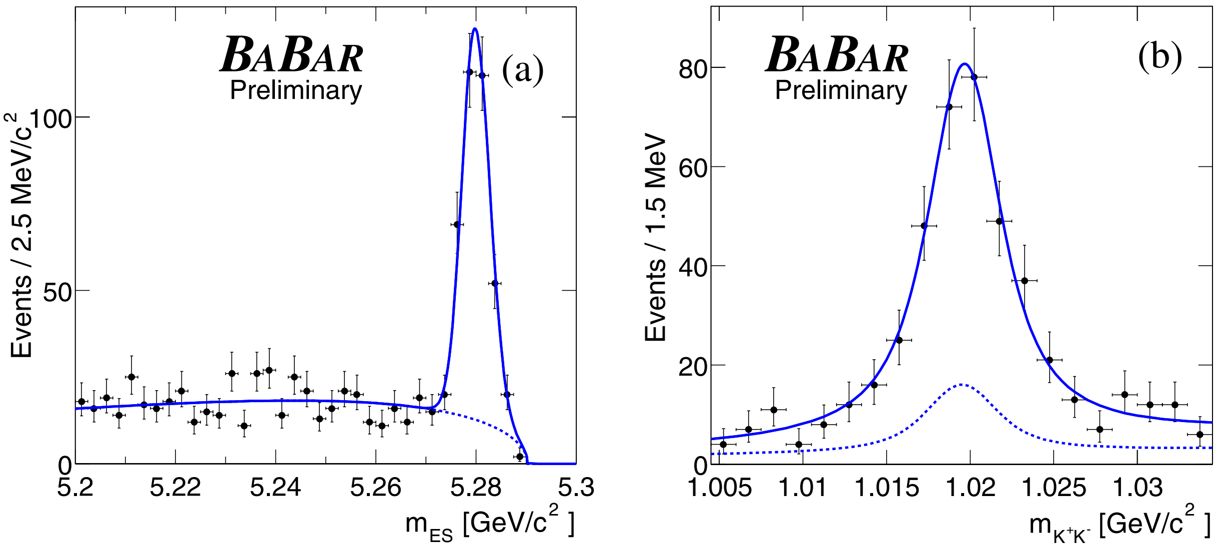

Figure 2: Distribution of the event variable (a) m_{ES} and (b) m_{KK} in the ϕK^+ final state after reconstruction and a requirement on the likelihood calculated without the plotted variable. The efficiency for the selection and likelihood requirements is 37% for (a) and 40% for (b). The solid line represents the fit result for the total event yield and the dotted line for the background.

7 SYSTEMATIC STUDIES

We consider systematic uncertainties in the *CP* coefficients $S_{\phi K}$ and $C_{\phi K}$ due to contributions from B^0 final states with opposite *CP* ($+0.06$ for $S_{\phi K}$, ± 0.02 for $C_{\phi K}$), the parameterization of PDFs for the event yield in signal and background (± 0.01, ± 0.01), *CP* asymmetry of the background (± 0.02, ± 0.01), the assumed parameterization of the Δt resolution function (± 0.02, ± 0.01), a possible difference in the efficiency for B^0 and $\overline{B}^0$ (± 0.01, ± 0.02), the fixed values for Δm_d and τ_B (± 0.00, ± 0.01), the beam-spot position (± 0.01, ± 0.01), and uncertainties in the SVT alignment (± 0.01, ± 0.01). The bias in the coefficients due to the fit procedure is included as uncertainty (± 0.01, ± 0.01) without making corrections to the final results. We estimate errors due to the effect of doubly CKM-suppressed decays [21] to be (± 0.01, ± 0.03). We add these contributions in quadrature to obtain the total systematic uncertainty.

For the measurement of the charge asymmetry $\mathcal{A}_{\mathcal{CP}}$ we estimate the uncertainty due to charge asymmetries in tracking and particle identification to be 0.011. We also consider the systematic error due to uncertainties in the parameterization of the signal Fisher PDF (0.005) and B background content (0.002). We add these contributions in quadrature to obtain the total systematic uncertainty.

8 RESULTS

The simultaneous fit to the ϕK^0 and flavor decay modes yields the preliminary result

$$\begin{aligned} S_{\phi K} &= +0.50 \pm 0.25\,(\mathrm{stat})^{+0.07}_{-0.04}(\mathrm{syst}), \\ C_{\phi K} &= 0.00 \pm 0.23\,(\mathrm{stat}) \pm 0.05\,(\mathrm{syst}). \end{aligned}$$

The preliminary results in the channel $B^0 \to \phi K^0_S$ alone are $S_{\phi K} = 0.29 \pm 0.31$ and $C_{\phi K} = -0.07 \pm 0.27$, and in the channel $B^0 \to \phi K^0_L$, $S_{\phi K} = 1.05 \pm 0.51$ and $C_{\phi K} = 0.31 \pm 0.49$, with statistical errors only. Figure 3 shows the Δt distributions of the B^0- and the $\overline{B}^0$-tagged subsets together with the raw asymmetry, for ϕK^0_S and ϕK^0_L events separately, with the result of the combined time-dependent *CP*-asymmetry fit superimposed.

The preliminary value of the charge asymmetry in $B^+ \to \phi K^+$ is

$$\mathcal{A}_{\mathcal{CP}} = 0.054 \pm 0.056\,(\mathrm{stat}) \pm 0.012\,(\mathrm{syst}).$$

9 CONCLUSION

In the decay $B^0 \to \phi K^0$ we measure preliminary values for $S_{\phi K}$ and $C_{\phi K}$ in the time-dependent *CP* asymmetry that are in close agreement with our previously published values [8]. Our value of $S_{\phi K}$ agrees within one standard deviation with the value of $\sin 2\beta$ in the $B^0 \to (\bar{c}c)K^0$ decays [19]. We do not observe a significant charge asymmetry in the mode $B^+ \to \phi K^+$.

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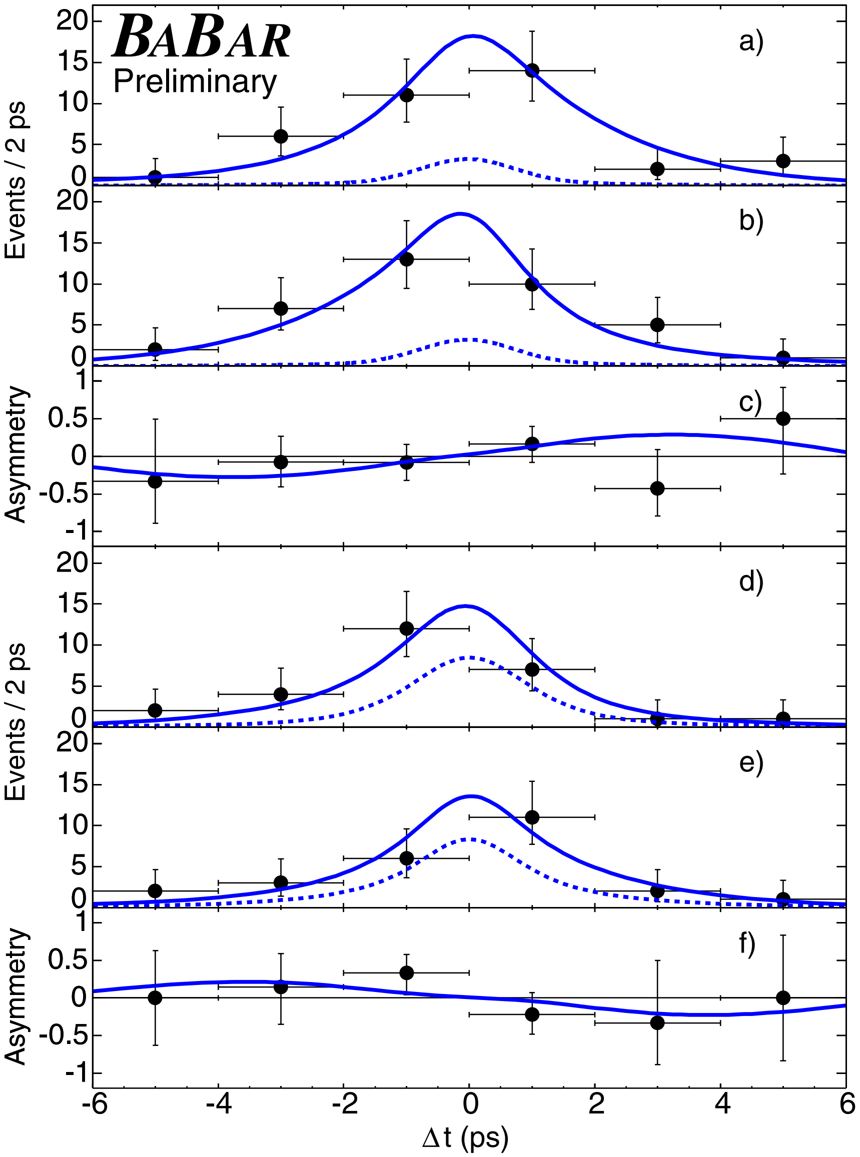

Figure 3: Plots a) and b) show the Δt distributions of B^0- and $\overline{B}^0$-tagged ϕK^0_S candidates. The solid lines refer to the fit for all events; the dashed lines correspond to the background. Plot c) shows the asymmetry. Plots d), e), and f) are the corresponding plots for ϕK^0_L candidates. For each final state, a requirement is applied on the event likelihood to suppress background.

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