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Measurement of the branching fraction ratios and *CP* asymmetries in $B^- \to D^0_{CP} K^-$ decays

The *BABAR* Collaboration

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Abstract

We present a preliminary study of $B^- \to D^0_{(CP)}\pi^-$ and $B^- \to D^0_{(CP)}K^-$ decays, with the $D^0_{(CP)}$ reconstructed in the CP-odd eigenstates $K_s\pi^0$, $K_s\omega$, in the CP-even eigenstates K^+K^-, $\pi^+\pi^-$, and in the (non-CP) flavor eigenstate $K^\mp\pi^\pm$. Using a sample of about 382 million $\Upsilon(4S)$ decays into $B\overline{B}$ pairs, collected with the *BABAR* detector operating at the PEP-II asymmetric-energy B Factory at SLAC, we measure the ratios of the branching fractions

$$R_{CP\pm} \equiv \frac{\mathcal{B}(B^- \to D^0_{CP\pm}K^-) + \mathcal{B}(B^+ \to D^0_{CP\pm}K^+)}{[\mathcal{B}(B^- \to D^0K^-) + \mathcal{B}(B^+ \to D^0K^+)]/2}$$

and the direct CP asymmetry

$$A_{CP\pm} \equiv \frac{\mathcal{B}(B^- \to D^0_{CP\pm}K^-) - \mathcal{B}(B^+ \to D^0_{CP\pm}K^+)}{\mathcal{B}(B^- \to D^0_{CP\pm}K^-) + \mathcal{B}(B^+ \to D^0_{CP\pm}K^+)}.$$

The results are:

$$\begin{aligned} R_{CP-} &= 0.81 \pm 0.10(\text{stat}) \pm 0.05(\text{syst}) \\ R_{CP+} &= 1.07 \pm 0.10(\text{stat}) \pm 0.04(\text{syst}) \\ A_{CP-} &= -0.19 \pm 0.12(\text{stat}) \pm 0.02(\text{syst}) \\ A_{CP+} &= 0.35 \pm 0.09(\text{stat}) \pm 0.05(\text{syst}) \end{aligned}$$

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1 INTRODUCTION

A measurement of the processes $B^- \to D^0 K^-$ [1] and $B \to D^0_{CP\pm} K$, where $D^0_{CP\pm}$ indicates the *CP*-even or *CP*-odd states $1/\sqrt{2}(D^0 \pm \bar{D}^0)$, has been attracting the attention of theorists for the last fifteen years [2]. These decay rates are fundamental ingredients in some of the proposed methods to extract the γ angle of the CKM matrix in a theoretically clean way. To this end, one needs to measure the two direct *CP* asymmetries

$$A_{CP\pm} \equiv \frac{\mathcal{B}(B^- \to D^0_{CP\pm} K^-) - \mathcal{B}(B^+ \to D^0_{CP\pm} K^+)}{\mathcal{B}(B^- \to D^0_{CP\pm} K^-) + \mathcal{B}(B^+ \to D^0_{CP\pm} K^+)} , \tag{1}$$

and the two ratios of charge-averaged branching fractions in D^0 decays to *CP* eigenstates

$$R_{CP\pm} \equiv \frac{\mathcal{B}(B^- \to D^0_{CP\pm} K^-) + \mathcal{B}(B^+ \to D^0_{CP\pm} K^+)}{\left[\mathcal{B}(B^- \to D^0 K^-) + \mathcal{B}(B^+ \to \overline{D}^0 K^+)\right]/2}. \tag{2}$$

In fact, γ is constrained by the following set of equations in the three unknowns γ, δ, r:

$$R_{CP\pm} = 1 + r^2 \pm 2r\cos\delta\cos\gamma \tag{3}$$

$$A_{CP\pm} = \frac{\pm 2r\sin\delta\sin\gamma}{1 + r^2 \pm 2r\cos\delta\cos\gamma}, \tag{4}$$

where $r \equiv \left|A(B^- \to \overline{D}^0 K^-)/A(B^- \to D^0 K^-)\right| \approx \mathcal{O}(0.1)$ is the magnitude of the ratio of the amplitudes for $B^- \to \overline{D}^0 K^-$ and $B^- \to D^0 K^-$ and δ the difference between their strong phases. The asymmetries $A_{CP\pm}$, in addition to being ingredients for the extraction of γ, are of special relevance because they would indicate, if significantly different from zero, direct *CP* violation in charged B decays. To measure $R_{CP\pm}$ and $A_{CP\pm}$ we reconstruct $B \to D^0_{CP\pm} K$ and $B \to D^0_{CP\pm}\pi$ decays with the $D^0_{CP\pm}$ decaying to two *CP*-odd and two *CP*-even eigenstates, and $B^- \to D^0 K^-$ and $B^- \to D^0 \pi^-$ decays with D^0 decaying to one non-*CP* state. Previous measurements of these quantities were performed by *BABAR* [3] and Belle [4]. We update the result by *BABAR* from 211 fb^{-1} to 348 fb^{-1} of data. Compared to the previous analysis, the current study does not include the decay mode $D^0 \to K^0_S \phi$, since it is going to be explored by the Dalitz analysis method using $B^- \to D K^-$, $D \to K^0_S K^+ K^-$ decays. Dropping $D^0 \to K^0_S \phi$ allows to combine the results of both measurements in the future. We also express the *CP*-sensitive observables in terms of three Dalitz related independent quantities:

$$x_\pm = \frac{R_{CP+}(1 \mp A_{CP+}) - R_{CP-}(1 \mp A_{CP-})}{4} , \tag{5}$$

$$r^2 = x^2_\pm + y^2_\pm = \frac{R_{CP+} + R_{CP-} - 2}{2} , \tag{6}$$

where the Cartesian coordinates $x_\pm = r\cos(\delta \pm \gamma)$ and $y_\pm = r\sin(\delta \pm \gamma)$ are the same *CP* parameters as were measured by the *BABAR* Collaboration using $B^- \to D K^-, D \to K^0_S \pi^- \pi^+$ decays [5]. We reduce the systematic uncertainties from D^0 branching fractions and reconstruction efficiencies of different D^0 modes by measuring the double branching fraction ratios

$$R_\pm = \frac{R^{K/\pi}_{CP\pm}}{R^{K/\pi}} \tag{7}$$

rather than the quantities $R_{CP\pm}$. Here,

$$R^{K/\pi}_{CP\pm} \equiv \frac{\mathcal{B}(B^- \to D^0_{CP\pm} K^-) + \mathcal{B}(B^+ \to D^0_{CP\pm} K^+)}{\mathcal{B}(B^- \to D^0_{CP\pm} \pi^-) + \mathcal{B}(B^+ \to D^0_{CP\pm} \pi^+)} \ , \tag{8}$$

and

$$R^{K/\pi} \equiv \frac{\mathcal{B}(B^- \to D^0 K^-) + \mathcal{B}(B^+ \to \overline{D}^0 K^+)}{\mathcal{B}(B^- \to D^0 \pi^-) + \mathcal{B}(B^+ \to \overline{D}^0 \pi^+)}. \tag{9}$$

$R_\pm$ and $R_{CP\pm}$ are equivalent discarding a term of the order of ≈ 0.01, which will be accounted for by assigning a systematic uncertainty when quoting the result in terms of $R_{CP\pm}$. [7]

2 THE *BaBar* DETECTOR AND DATASET

This measurement uses $348\,\mathrm{fb}^{-1}$ of data taken at the $\Upsilon(4S)$ resonance by the *BABAR* detector with the PEP-II asymmetric B factory. The *BABAR* detector is described in detail elsewhere [6]. Tracking of charged particles is provided by a five-layer silicon vertex tracker (SVT) and a 40-layer drift chamber (DCH). A ring-imaging Cherenkov detector (DIRC) provides improved particle identification (PID). An electromagnetic calorimeter (EMC), comprised of CsI crystals, is used to identify electrons and photons. These systems are mounted inside a 1.5 T solenoidal magnetic field. The instrumented flux return of the magnet allows discrimination of muons from other particles. We use a GEANT4-based Monte Carlo (MC) simulation [7] to model the response of the detector, taking into account the varying accelerator and detector conditions.

3 EVENT SELECTION

We reconstruct $B^- \to D^0 h^-$ decays where the prompt track h^- is a kaon or a pion. Candidates for D^0 are reconstructed in the *CP*-even eigenstates $\pi^-\pi^+$ and K^-K^+, in the *CP*-odd eigenstates $K^0_S\pi^0$, $K^0_S\omega$ and in the non-*CP* flavor eigenstate $K^-\pi^+$. K^0_S and ω candidates are selected in the $\pi^+\pi^-$ and $\pi^+\pi^-\pi^0$ channels, respectively.

PID information from the DCH and, when available, from the DIRC must be consistent with the kaon hypothesis for the K meson candidate in all D^0 modes and with the pion hypothesis for the $\pi^\pm$ meson candidates in the $D^0 \to \pi^-\pi^+$ mode. For the prompt track to be identified as a pion or a kaon, we require at least five Cherenkov photons to be detected to ensure a good measurement of the Cherenkov angle. We reject a candidate track if its Cherenkov angle is not within 4σ of the expected value for either a kaon or pion mass hypothesis. We also reject candidate tracks that are identified as electrons by the DCH and the EMC or as muons by the DCH and the muon system.

Photon candidates are clusters in the EMC that are not matched to any charged track, have a raw energy greater than 30 MeV and lateral shower shape consistent with the expected pattern of energy deposit from an electromagnetic shower. Photon pairs with invariant mass within the range 115–150 MeV/c^2 ($\sim 3\sigma$) and total energy greater than 200 MeV are considered π^0 candidates. To improve the momentum resolution, the π^0 candidates are kinematically fit with their mass constrained to the nominal π^0 mass [8].

Neutral kaons are reconstructed from pairs of oppositely charged tracks with invariant mass within 10 MeV/c^2 from the nominal K^0_S mass [8]. We also require the ratio between the flight

[7] The double branching fraction ratios, in the approximation $A(B^+ \to D^0_{\mathrm{CP}\pm}\pi^+) \approx A(B^- \to D^0_{\mathrm{CP}\pm}\pi^-) \approx \frac{1}{\sqrt{2}} A(B^- \to D^0\pi^-)$, are equivalent to $R_{CP\pm}$, discarding a term $r_B|V_{us}V_{cd}/V_{ud}V_{cs}| \approx 0.01$.

distance in the plane transverse to the beam direction and its expected uncertainty to be greater than 2.

The invariant mass of a D^0 candidate must agree within 2.5σ of its mass resolution to the nominal D^0 mass [8]. The D^0 mass resolution is about 7.5 MeV/c^2 in the $K\pi$, K^+K^- and $\pi^+\pi^-$ modes, and about 21 MeV/c^2 and 9 MeV/c^2 in the $K^0_S\pi^0$ and $K^0_S\omega$ modes, respectively. Selected D^0 candidates are fit with a constraint to the nominal D^0 mass.

We reconstruct B meson candidates by combining a D^0 candidate with a charged track h^-. For the $K^-\pi^+$ mode, the charge of the track h^- must match the one of the kaon from the D^0 decay. We select B meson candidates by using two kinematically independent variables: the beam-energy-substituted mass

$$m_{\rm ES} = \sqrt{(E_i^{*2}/2 + \mathbf{p}_i \cdot \mathbf{p}_B)^2/E_i^2 - p_B^2}$$

and the energy difference

$$\Delta E = E_B^* - E_i^*/2,$$

where the subscripts i and B refer to the initial e^+e^- system and the B candidate, respectively, and the asterisk denotes the beams center-of-mass (CM) frame. The $m_{\rm ES}$ distributions for $B^- \to D^0h^-$ signal events are Gaussian distributions centered at the B mass with a width of 2.6 MeV/c^2, which does not depend on the decay mode or on the nature of the prompt track. In contrast, the ΔE distributions depend on the mass assigned to the prompt track. We evaluate ΔE with the kaon mass hypothesis so that the distributions are centered near zero for $B^- \to D^0K^-$ events and shifted on average by approximately 50 MeV/c to the positive direction for $B^- \to D^0\pi^-$ events. The ΔE resolution depends on the momentum resolutions of the D^0 meson and the prompt track h^-, and is typically 16 MeV for all the D^0 decay modes. All B candidates are required to have $m_{\rm ES}$ within 2.5σ of the mean value and ΔE in the range $-0.15 < \Delta E < 0.20$ GeV.

To reduce background from continuum production of light quarks, we construct a Fisher discriminant based on the following four quantities: (i) The Legendre polynomials, a set of momentum-weighted sums of the tracks and neutrals not associated with the reconstructed candidate, i.e. coming from the rest of the event (ROE):

$$L_j \;=\; \sum_i^{\rm ROE} p_i^* \;\times\; |cos(\theta_i^*)|^j, \tag{10}$$

where θ_i^* is the CM angle between $\mathbf{p}_i^*$ and the thrust axis $\hat{T}^B$ of the B candidate. We have considered only the L_0, L_2 pair, since previous studies have shown that adding other L_j to the set of discriminating variables does not improve the sensitivity. In particular we use the ratio L_2/L_0; (ii) $R_2^{\rm ROE}$, the ratio of the Fox-Wolfram moments $H_2^{\rm ROE}/H_0^{\rm ROE}$, computed using tracks and photons in the ROE. $H_l^{\rm ROE}$ is defined as [9]:

$$H_l^{\rm ROE} \equiv \sum_{i,j}^{\rm ROE} \frac{|\mathbf{p}_i^*||\mathbf{p}^*{}_j|}{E_{\rm vis}^{*2}} P_l(\cos\theta_{ij}^*), \tag{11}$$

where P_l is a Legendre polynomial, θ_{ij} is the opening angle between $\mathbf{p}_i^*$ and $\mathbf{p}_j^*$, and $E_{\rm vis}^*$ is the total visible energy of the event. (iii) $|\cos(\mathbf{p}_B^*, z)|$ is the cosine of the angle of the B candidate momentum with respect to the beam (z) axis. (iv) $|\cos(\hat{T}^B, z)|$ is the cosine of the angle of the B candidate thrust axis with respect to the z axis. A cut on the value of the Fisher discriminant rejects more than 75% of the continuum background while retaining about 85% of the signal in all modes.

Another source of background is related to $B\overline{B}$ events. Its main contributions come from the processes $B \to D^* h$ ($h = \pi, K$) and $B^- \to D^0 \rho^-$ mis-reconstructed as $B^- \to D^0 h^-$candidates. For $D^0 \to K^- K^+$, $D^0 \to \pi^- \pi^+$, $D^0 \to K^0_S \pi^0$ and $D^0 \to K^0_S \omega$ decays, there are peaking backgrounds caused by B mesons decaying into the same final state particles. The peaking backgrounds have ΔE and $m_{\rm ES}$ distributions similar to the signal. Their yields are estimated from the D^0 invariant mass sideband data and are taken into acount in the fit.

When reconstructing B candidates, it is possible that more than one combination satisfies the selection criteria in the same event. In order to select only one candidate per event, we define a criterion that allows to identify the combination with the largest probability to be a true signal $B^- \to D^0 h^-$ decay. The D^0 invariant mass and the energy-substituted mass are chosen as discriminating quantities in all the channels. When D^0 decays into the *CP*-odd channels we also include the invariant masses of the ω and π^0 candidates. These variables are combined in a χ^2 function whose minimization defines the best candidate choice. In the end, the fraction of rejected background candidates in the selected samples is 2% in the $K\pi$, less than 1% for KK and $\pi^+\pi^-$ modes, while it is about 5% in the $K^0_S \pi^0$ mode and 8% in the $K^0_S \omega$.

The total reconstruction efficiencies, based on simulated signal events, are about 35%($K^-\pi^+$), 32%($K^- K^+$), 33%($\pi^-\pi^+$), 20%($K^0_S \pi^0$) and 8%($K^0_S \omega$).

4 FIT PROCEDURE

We determine the signal and background yields for each D^0 decay mode from a two-dimensional extended unbinned maximum-likelihood fit to the selected data events determines the signal and background yields. The input variables to the fit are ΔE and a particle identification probability for the prompt track based on the Cherenkov angle θ_C, the momentum p and the polar angle θ of the track. The extended likelihood function $\mathcal{L}$ for the selected sample is given by the product of the probabilities for each individual candidate and a Poisson factor:

$$\mathcal{L} = \frac{e^{-N'} (N')^N}{N!} \prod_{i=1}^{N} \mathcal{P}_i. \tag{12}$$

The probability $\mathcal{P}_i$ for a candidate in the event i is the sum of the signal and background terms:

$$\begin{aligned} \mathcal{P}_i(\Delta E, \theta_C) \; = \; & \frac{N_{D^0\pi}}{N'} \, \mathcal{P}_i^{D^0\pi} + \frac{N_{D^0K}}{N'} \, \mathcal{P}_i^{D^0 \; K} + \\ & \frac{N_{q\bar{q}(\pi)}}{N'} \, \mathcal{P}_i^{q\bar{q}(\pi)} + \frac{N_{q\bar{q}(K)}}{N'} \, \mathcal{P}_i^{q\bar{q}(K)} + \\ & \frac{N_{B\bar{B}(\pi)}}{N'} \, \mathcal{P}_i^{B\bar{B}(\pi)} + \frac{N_{B\bar{B}(K)}}{N'} \, \mathcal{P}_i^{B\bar{B}(K)} + \\ & \frac{N_{X_1 X_2 K}}{N'} \, \mathcal{P}_i^{X_1 X_2 K}. \end{aligned} \tag{13}$$

where $N' = N_{D^0\pi} + N_{D^0K} + N_{q\bar{q}(\pi)} + N_{q\bar{q}(K)} + N_{B\bar{B}(\pi)} + N_{B\bar{B}(K)} + N_{X_1 X_2 K}$. Each addendum on the right-hand side of equation (13) is the product of two different terms. The ratio N_J/N' ($J = D^0\pi, D^0K, ...$) represents the probability to choose a candidate of type J after the selection criteria are applied; the term $\mathcal{P}_i^J$ is the probability to measure the particular set of physical quantities $\{\Delta E, \theta_C\}_i$ in the i^{th} event, once the candidate of type J has been selected:

$$\mathcal{P}_i^J = \mathcal{P}_{\Delta E,i}^J \, \mathcal{P}_{\theta_C,i}^J. \tag{14}$$

The ΔE distribution for $B^- \to D^0 K^-$ signal is parameterized with a double Gaussian function. The mean and width of the narrow Gaussian are denoted in the following with $\mu(D^0 K)$ and $\sigma(D^0 K)$. The $B^- \to D^0 \pi^-$ ΔE probability density function (PDF) would be the same as the $B^- \to D^0 K^-$ one, if the prompt track had been assigned the pion mass. Since ΔE is computed by assigning the kaon mass, it is shifted by a quantity

$$\Delta E_{\mathrm{shift}}(\gamma, |\vec{p}|) = \gamma \left(\sqrt{m_K^2 + |\vec{p}|^2} - \sqrt{m_\pi^2 + |\vec{p}|^2} \right)$$

which depends on the momentum $\vec{p}$ of the prompt track in the lab frame. γ is the Lorentz parameter characterizing the boost of the center of mass frame relative to the lab frame. Therefore we parameterize the $B^- \to D^0 \pi^-$ ΔE shape with a double Gaussian whose mean is computed, event-by-event, as $\mu(D^0\pi) = \mu(D^0 K) + \Delta E_{\mathrm{shift}}(\gamma, |\vec{p}|)$, and whose width is the same as for the $B^- \to D^0 K^-$ signal component. The fraction of the wide component of the signal shape, its offset from the narrow component and the ratio between its width and the width of the narrow component are fixed using the mode-dependent numbers obtained from the MC simulation. The ΔE distributions for the continuum background are parameterized with a first order polynomial. The ΔE distribution for the $B\overline{B}$ background is empirically parametrized with a "Crystal-Ball" lineshape [10]: a Gaussian with an exponential tail at higher ΔE values. The parameters of the background shapes are determined from MC simulated events and are fixed in the fit.

The particle identification PDF is obtained from MC simulation. Its parametrization is performed by means of a double Gaussian distribution as a function of θ_C^{pull}, which is the difference between the measured Cherenkov angle and its expected value for a given mass hypothesis, divided by the expected error.

We independently fit five samples corresponding to each of the five D^0 decay modes under study. The fit simultaneously evaluates separate likelihood functions for B^+ and B^- categories. In the fit the free parameters are $D^0 K$ and $D^0 \pi$ signal yield asymmetries, total number of signal events in $D^0\pi$ ($N_{D^0\pi}$), ratio $R_{K/\pi} = N_{D^0 K}/N_{D^0\pi}$, eight background yields: $N_{q\overline{q}(\pi)}$, $N_{q\overline{q}(K)}$, $N_{B\overline{B}(\pi)}$, $N_{B\overline{B}(K)}$ (one for each charge, i.e. $4 \times 2 = 8$), and two parameters of the ΔE signal shape (shared between positive and negative samples). The number of peaking background events $N_{X_1 X_2 K}$ is fixed to the values obtained from the study using D^0 mass sidebands. We assume no charge asymmetry in the peaking background (a small systematic error due to this assumption is considered later).

5 PHYSICS RESULTS AND SYSTEMATIC STUDIES

The results of the fit are summarized in Table 1. Figure 1 shows the distributions of ΔE and θ_C for the $K^-\pi^+$, *CP*-even and *CP*-odd modes. The projections of the likelihood fits are overlaid on the plots. On Figure 2 we show the ΔE projections produced with a kaon identification requirement applied to the prompt track. Hence the $B^- \to D^0 K^-$ signals become prominently visible on the plots, while $B^- \to D^0 \pi^-$ contributions significantly decrease.

The double ratios $R_{CP\pm}$ are computed by calculating a weighted mean of the ratios $R_{K/\pi}$ for *CP*-even and *CP*-odd modes and dividing it by $R_{K/\pi}$ for the non-*CP* mode. Correction factors

Table 1: $B^- \to D^0 K^-$ and $B^- \to D^0 \pi^-$ signal event yields obtained from the fit to the data. All values are preliminary.

D^0 mode	$N(B \to D^0\pi)$	$N(B \to D^0 K)$	$N(B^+ \to D^0 K^+)$	$N(B^- \to \overline{D}^0 K^-)$
$K^-\pi^+$	24965 ± 169	1859 ± 52	951 ± 36	909 ± 35
K^-K^+	2412 ± 54	189 ± 20	61 ± 11	128 ± 16
$\pi^-\pi^+$	876 ± 38	73 ± 15	24 ± 9	49 ± 12
$K^0_S\pi^0$	2967 ± 69	184 ± 25	107 ± 19	77 ± 16
$K^0_S\omega$	1023 ± 44	59 ± 14	36 ± 12	23 ± 9

(ranging from 1.006 to 1.027 depending on the D^0 mode) that account for small differences in the efficiency between the $B^- \to D^0 K^-$ and $B^- \to D^0 \pi^-$ selections are taken into account. An additional factor is applied to the results in the $D^0 \to K^0_S\omega$ mode to correct for a dilution due to the S-wave non-resonant contribution. These corrections were estimated using a fit to the ω helicity angle in the selected data events and found to be 1.10 ± 0.11 for $A^{K^0_S\omega}_{CP-}$ and 0.98 ± 0.02 for $R^{K^0_S\omega}_{CP-}$. The uncertainties in the correction factors are included in the systematic errors (± 0.006 and ± 0.008 for R_{CP-} and A_{CP-}, respectively). The results for each mode separately and combined by CP-even and CP-odd categories are listed in Table 2.

Table 2: Measured double branching fraction ratios $R_{CP\pm}$ and CP asymmetries $A_{CP\pm}$ for different D^0 decay modes. In the combined results, the first error is statistical, the second is systematic. For individual modes, only statistical errors are shown. All values are preliminary.

D^0 decay mode	R_{CP}	A_{CP}
K^-K^+	1.05 ± 0.11	0.36 ± 0.10
$\pi^-\pi^+$	1.13 ± 0.22	0.33 ± 0.20
CP-even combined	$1.07 \pm 0.10 \pm 0.04$	$0.35 \pm 0.09 \pm 0.05$
$K^0_S\pi^0$	0.84 ± 0.11	-0.16 ± 0.13
$K^0_S\omega$	0.75 ± 0.18	-0.24 ± 0.26
CP-odd combined	$0.81 \pm 0.10 \pm 0.05$	$-0.19 \pm 0.12 \pm 0.02$

Systematic uncertainties in the double ratios $R_{CP\pm}$ and in the CP asymmetries $A_{CP\pm}$ arise primarily from uncertainties in signal yields due to the estimate of the peaking backgrounds (± 0.03 for R_{CP+} and ± 0.05 for R_{CP-}) and from the imperfect knowledge of the PDF shapes. The parameters of the PDFs that are fixed in the nominal fit are varied by $\pm 1\sigma$ and the observed difference in the parameters $R_{K/\pi}$, signal yield asymmetries and N_{D^0K} is taken as a systematic uncertainty (± 0.003 for A_{CP+}, ± 0.002 for A_{CP-}, ± 0.010 for R_{CP+} and ± 0.007 for R_{CP-}). Possible CP asymmetries up to 20% in the peaking backgrounds are also taken into account (± 0.04 for A_{CP+}). An estimate of the intrinsic detector charge bias due to acceptance, tracking, and particle identification efficiency has been obtained from the weighted average of the measured asymmetries in the processes $B^- \to D^0[\to K^-\pi^+]h^-$ and $B^- \to D^0_{CP\pm}\pi^-$, where CP violation is expected to be negligible. This asymmetry estimate (± 0.02) has been added in quadrature to the total systematic uncertainties on the *CP* asymmetries $A_{CP\pm}$ (this is a correlated part of the systematics for A_{CP+} and A_{CP-}). The accuracy in the equivalence between $R_{\pm}$ and $R_{CP\pm}$ is evaluated to be ± 0.03 for R_{CP+} and ± 0.02 for R_{CP-} (these uncertainties are correlated).

6 SUMMARY

In conclusion, we reconstruct $B^- \to D^0 K^-$ decays with D^0 mesons decaying to non-*CP* $K^{\mp}\pi^{\pm}$, *CP*-even K^+K^- and $\pi^+\pi^-$ and *CP*-odd $K_S^0\pi^0$ and $K_S^0\omega$ eigenstates. We have measured the *CP* asymmetries $A_{CP+} = 0.35 \pm 0.09(\text{stat}) \pm 0.05(\text{syst})$ and $A_{CP-} = -0.19 \pm 0.12(\text{stat}) \pm 0.02(\text{syst})$. Our result for A_{CP+} is 3.4σ away from 0. This constitutes the first evidence for direct *CP* violation in $B^- \to D^0 K^-$ decays. The double ratios of branching fractions are measured to be $R_{CP+} = 1.07 \pm 0.10(\text{stat}) \pm 0.04(\text{syst})$ and $R_{CP-} = 0.81 \pm 0.10(\text{stat}) \pm 0.05(\text{syst})$.

The corresponding values of $x_{\pm}$ and r_B^2 are extracted using equations 5 and 6, separately propagating correlated and uncorrelated errors on $A_{CP\pm}$ and $R_{CP\pm}$. We obtain $x_+ = -0.065 \pm 0.047(\text{stat}) \pm 0.020(\text{syst})$, $x_- = 0.199 \pm 0.052(\text{stat}) \pm 0.020(\text{syst})$, $r_B^2 = -0.060 \pm 0.070(\text{stat}) \pm 0.039(\text{syst})$.

The results obtained in this analysis are statistically in agreement with the previous measurements as demonstrated in Table 3. All results presented in this document are preliminary.

Table 3: Comparison of the preliminary results of this analysis to the previous measurements by *BABAR* [3] and Belle [4]. The decay mode $D^0 \to K_S^0\phi$, used in the previous analyses, is not included in the present measurement.

Parameter	Present analysis	*BABAR* (2006) [3]	Belle (2006) [4]
R_{CP-}	$0.81 \pm 0.10 \pm 0.05$	$0.86 \pm 0.10 \pm 0.05$	$1.17 \pm 0.14 \pm 0.14$
R_{CP+}	$1.07 \pm 0.10 \pm 0.04$	$0.90 \pm 0.12 \pm 0.04$	$1.13 \pm 0.16 \pm 0.08$
A_{CP-}	$-0.19 \pm 0.12 \pm 0.02$	$-0.06 \pm 0.13 \pm 0.04$	$-0.12 \pm 0.14 \pm 0.05$
A_{CP+}	$0.35 \pm 0.09 \pm 0.05$	$0.35 \pm 0.13 \pm 0.04$	$0.06 \pm 0.14 \pm 0.05$

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[1] Charge conjugation is implied here and throughout the text unless explicitly stated otherwise.

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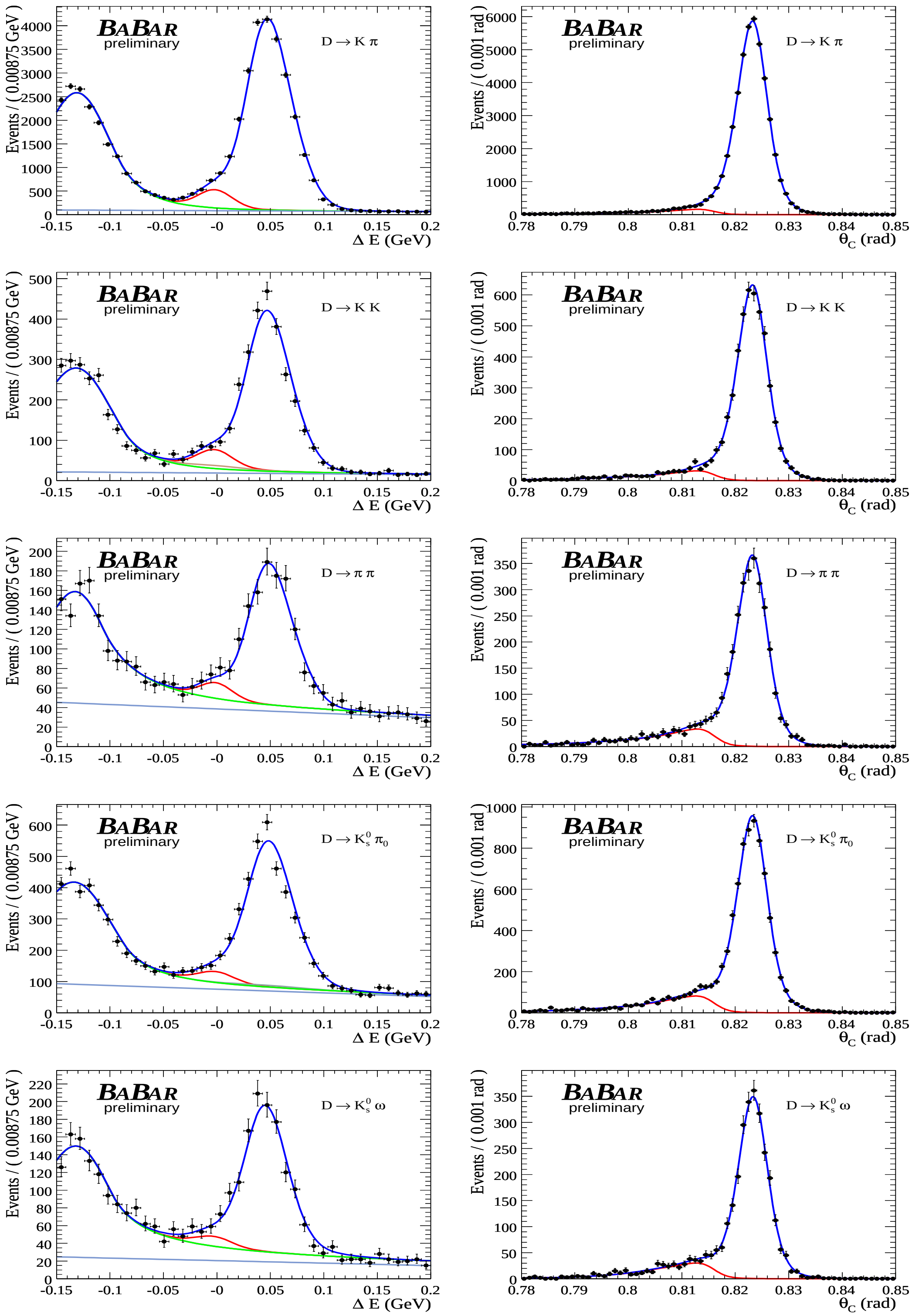

Figure 1: ΔE (left) and θ_C (right) distributions of selected $B^- \to D^0 h^-$ events. The blue line represents the projection of the likelihood in the plotted variable. The red line represents the $B^- \to D^0 K^-$ component. In the left hand plots, the green and light blue lines indicate $B\bar{B}$ and continuum backgrounds, respectively. The brown line refers to the peaking background (when present).

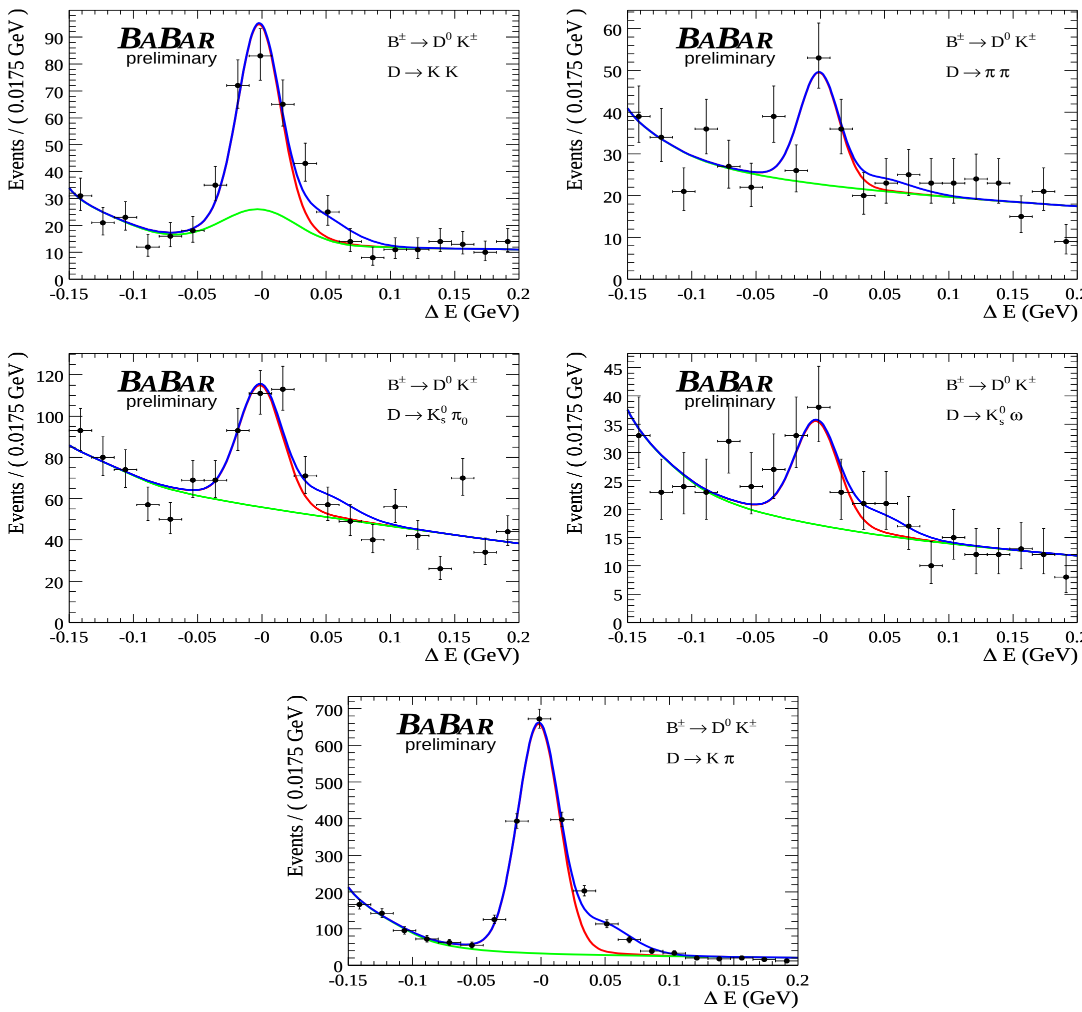

Figure 2: ΔE distributions of $B^- \to D^0 K^-$ signal enhanced $B^- \to D^0 h^-$ events. The blue line represents the projection of the likelihood, the red line indicates the $B^- \to D^0 K^-$ component, the green line shows the total background contribution. The remaining $B^- \to D^0 \pi^-$ signal is visible as a small shoulder on the right hand side of the $B^- \to D^0 K^-$ signal peak.