CLEO CONF 95-18
EPS0179

A Measurement of $\mathcal{B}(D^0 \to K^-\pi^+\pi^0)/\mathcal{B}(D^0 \to K^-\pi^+)$

L. Gibbons,[1] S.D. Johnson,[1] Y. Kwon,[1] S. Roberts,[1] E.H. Thorndike,[1] T.E. Coan,[2] J. Dominick,[2] V. Fadeyev,[2] I. Korolkov,[2] M. Lambrecht,[2] S. Sanghera,[2] V. Shelkov,[2] T. Skwarnicki,[2] R. Stroynowski,[2] I. Volobouev,[2] G. Wei,[2] M. Artuso,[3] M. Gao,[3] M. Goldberg,[3] D. He,[3] N. Horwitz,[3] S. Kopp,[3] G.C. Moneti,[3] R. Mountain,[3] F. Muheim,[3] Y. Mukhin,[3] S. Playfer,[3] S. Stone,[3] X. Xing,[3] J. Bartelt,[4] S.E. Csorna,[4] V. Jain,[4] S. Marka,[4] D. Gibaut,[5] K. Kinoshita,[5] P. Pomianowski,[5] B. Barish,[6] M. Chadha,[6] S. Chan,[6] D.F. Cowen,[6] G. Eigen,[6] J.S. Miller,[6] C. O'Grady,[6] J. Urheim,[6] A.J. Weinstein,[6] F. Würthwein,[6] D.M. Asner,[7] M. Athanas,[7] D.W. Bliss,[7] W.S. Brower,[7] G. Masek,[7] H.P. Paar,[7] J. Gronberg,[8] C.M. Korte,[8] R. Kutschke,[8] S. Menary,[8] R.J. Morrison,[8] S. Nakanishi,[8] H.N. Nelson,[8] T.K. Nelson,[8] C. Qiao,[8] J.D. Richman,[8] D. Roberts,[8] A. Ryd,[8] H. Tajima,[8] M.S. Witherell,[8] R. Balest,[9] K. Cho,[9] W.T. Ford,[9] M. Lohner,[9] H. Park,[9] P. Rankin,[9] J.G. Smith,[9] J.P. Alexander,[10] C. Bebek,[10] B.E. Berger,[10] K. Berkelman,[10] K. Bloom,[10] T.E. Browder,[10*] D.G. Cassel,[10] H.A. Cho,[10] D.M. Coffman,[10] D.S. Crowcroft,[10] M. Dickson,[10] P.S. Drell,[10] D.J. Dumas,[10] R. Ehrlich,[10] R. Elia,[10] P. Gaidarev,[10] M. Garcia-Sciveres,[10] B. Gittelman,[10] S.W. Gray,[10] D.L. Hartill,[10] B.K. Heltsley,[10] S. Henderson,[10] C.D. Jones,[10] S.L. Jones,[10] J. Kandaswamy,[10] N. Katayama,[10] P.C. Kim,[10] D.L. Kreinick,[10] T. Lee,[10] Y. Liu,[10] G.S. Ludwig,[10] J. Masui,[10] J. Mevissen,[10] N.B. Mistry,[10] C.R. Ng,[10] E. Nordberg,[10] J.R. Patterson,[10] D. Peterson,[10] D. Riley,[10] A. Soffer,[10] P. Avery,[11] A. Freyberger,[11] K. Lingel,[11] C. Prescott,[11] J. Rodriguez,[11] S. Yang,[11] J. Yelton,[11] G. Brandenburg,[12] D. Cinabro,[12] T. Liu,[12] M. Saulnier,[12] R. Wilson,[12] H. Yamamoto,[12] T. Bergfeld,[13] B.I. Eisenstein,[13] J. Ernst,[13] G.E. Gladding,[13] G.D. Gollin,[13] M. Palmer,[13] M. Selen,[13] J.J. Thaler,[13] K.W. Edwards,[14] K.W. McLean,[14] M. Ogg,[14] A. Bellerive,[15] D.I. Britton,[15] E.R.F. Hyatt,[15] R. Janicek,[15] D.B. MacFarlane,[15] P.M. Patel,[15] B. Spaan,[15] A.J. Sadoff,[16] R. Ammar,[17] P. Baringer,[17] A. Bean,[17] D. Besson,[17] D. Coppage,[17] N. Copty,[17] R. Davis,[17] N. Hancock,[17] S. Kotov,[17] I. Kravchenko,[17] N. Kwak,[17] Y. Kubota,[18] M. Lattery,[18] M. Momayezi,[18] J.K. Nelson,[18] S. Patton,[18] R. Poling,[18] V. Savinov,[18] S. Schrenk,[18] R. Wang,[18] M.S. Alam,[19] I.J. Kim,[19] Z. Ling,[19] A.H. Mahmood,[19] J.J. O'Neill,[19] H. Severini,[19] C.R. Sun,[19] F. Wappler,[19]

G. Crawford,[20] R. Fulton,[20] D. Fujino,[20] K.K. Gan,[20] K. Honscheid,[20] H. Kagan,[20] R. Kass,[20] J. Lee,[20] M. Sung,[20] C. White,[20] A. Wolf,[20] M.M. Zoeller,[20] X. Fu,[21] B. Nemati,[21] W.R. Ross,[21] P. Skubic,[21] M. Wood,[21] M. Bishai,[22] J. Fast,[22] E. Gerndt,[22] J.W. Hinson,[22] T. Miao,[22] D.H. Miller,[22] M. Modesitt,[22] E.I. Shibata,[22] I.P.J. Shipsey,[22] and P.N. Wang[22]

(CLEO Collaboration)

[1]University of Rochester, Rochester, New York 14627

[2]Southern Methodist University, Dallas, Texas 75275

[3]Syracuse University, Syracuse, New York 13244

[4]Vanderbilt University, Nashville, Tennessee 37235

[5]Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061

[6]California Institute of Technology, Pasadena, California 91125

[7]University of California, San Diego, La Jolla, California 92093

[8]University of California, Santa Barbara, California 93106

[9]University of Colorado, Boulder, Colorado 80309-0390

[10]Cornell University, Ithaca, New York 14853

[11]University of Florida, Gainesville, Florida 32611

[12]Harvard University, Cambridge, Massachusetts 02138

[13]University of Illinois, Champaign-Urbana, Illinois, 61801

[14]Carleton University, Ottawa, Ontario K1S 5B6 and the Institute of Particle Physics, Canada

[15]McGill University, Montréal, Québec H3A 2T8 and the Institute of Particle Physics, Canada

[16]Ithaca College, Ithaca, New York 14850

[17]University of Kansas, Lawrence, Kansas 66045

[18]University of Minnesota, Minneapolis, Minnesota 55455

[19]State University of New York at Albany, Albany, New York 12222

[20]Ohio State University, Columbus, Ohio, 43210

[21]University of Oklahoma, Norman, Oklahoma 73019

[22]Purdue University, West Lafayette, Indiana 47907

Abstract

Using the large data set accumulated with the CLEO II detector at the Cornell Electron Storage Ring, we make a preliminary measurement of $\mathcal{B}(D^0 \to K^-\pi^+\pi^0)/\mathcal{B}(D^0 \to K^-\pi^+) = 3.78 \pm 0.071 \pm 0.26$, the most precise determination of this ratio to date.

When CLEO studied the decays of the B meson to charmed final states, the measured B branching ratios were consistantly higher when the D^0 was reconstructed in the $K^-\pi^+\pi^0$ decay channel [1], motivating this work. Previous measurements of the ratio of branching fractions $\mathcal{B}(D^0 \to K^-\pi^+\pi^0)/\mathcal{B}(D^0 \to K^-\pi^+)$ are shown in Table 1. The most recent measurement was done by ARGUS in 1992 with 931 events. Since CLEO has already made a precision measurement of the absolute branching fraction for $D^0 \to K^-\pi^+$ [2], a relative measurement of these two mode is made here.

ARGUS	1992	$3.04 \pm 0.16 \pm 0.34$
NA14	1991	$4.0 \pm 0.9 \pm 1.0$
CLEO 1.5	1991	$2.8 \pm 0.14 \pm 0.52$
E691	1984	4.2 ± 1.4
PDG Ave.	3.07 ± 0.29	
PDG Fit	3.43 ± 0.24	

Table 1. Previous measurements of $\mathcal{B}(D^0 \to K^-\pi^+\pi^0)/\mathcal{B}(D^0 \to K^-\pi^+)$

We use a sample of $3.1 fb^{-1}$ integrated luminosity accumulated with the CLEO II detector at the Cornell Electron Storage Ring (CESR), running at center of mass energies at or just below the $\Upsilon(4S)$ resonance. The details of the CLEO II detector are described elsewhere [3].

The D^0 mesons in this analysis are required to come from a decaying $D^{*+} \to D^0\pi^+$ [4]. Reconstructing this decay chain provides additional kinematic information which allows us to reduce the combinatoric background significantly.

To reconstruct the $D^0 \to K^-\pi^+$, we combine all pairs of oppositely charged tracks. We assign the track which has the same charge as the "slow" π from the $D^{*+} \to D^0\pi^+$ decay to be the pion. This assignment is consistent with the Cabibbo favored decay, and no other particle identification is used. When reconstructing $D^0 \to K^-\pi^+\pi^0$, we include two showers for the π^0. We require both showers to be in the good region of our detector ($|\cos\theta| < 0.71$, where θ is the angle between the beam direction and the direction of the shower from the interaction point), have energy above 100 MeV and not be matched to a track. The invariant mass of the two photons is required to be between 115 MeV/c^2 and 155 MeV/c^2. To improve the measurements of the π^0 4-vector, the photons are kinematically fit to give the known π^0 mass.

We reconstruct the D^* by combining slow pion canidates, having momentum between between 225 MeV/c and 425 MeV/c, with all D^0 candidates. We require the measured mass difference between the D^{*+} and D^0 to be between 143.5 MeV/c^2 and 147.4 MeV/c^2

($\approx 2.5\sigma$) as shown in figure 1. Additionally, we look at the scaled momentum of the D^*, X_{D^*}, defined as the momentum of the D^* over the maximum allowed momentum in the event $\sqrt{E_{beam}^2 - M_{D^*}^2}$. We require $X_{D^*} > 0.6$ to restrict our analysis to continuum $e^+e^- \to c\bar{c}$ reactions and to reduce combinatoric background. We also look at a sideband in the mass difference , between 151.4 and 154.9 MeV/c^2, and perform a sideband subtraction from the signal area.

After the D^{*+} is reconstructed, we fit the D^0 mass peak with the sum of two Gausians whose left and right σs are allowed to differ. We constrain the mean and ratio of the left and right σs to be identical for both Gaussians. The background is fit between 1.7 and 2.0 GeV/c^2 with a straight line. After making the sideband subtraction the fitted yields were 13789 $\pm$ 189 events for $D^0 \to K^-\pi^+\pi^0$ and 8852 $\pm$ 115 events for $D^0 \to K^-\pi^+$, as shown in figures 2 and 3. We generated a large sample of $D^0 \to K^-\pi^+$ and $D^0 \to K^-\pi^+\pi^0$ decays with our Monte Carlo, and use these events to find efficiencies of 18.5% and 7.6% respectively. The $D^0 \to K^-\pi^+\pi^0$ Monte Carlo included the resonant substructure of the three body decay using the published amplitudes from E691 [5].

Using the yields found from data and the above efficiencies, we find the ratio of branching fractions to be 3.78 ± 0.071 where the error shown is only statistical.

Possible systematic errors from several sources were investigated. We vary the cuts used and observe a 3.5% change in the ratio. Changing the resonant substructure used in the $D^0 \to K^-\pi^+\pi^0$ Monte Carlo, and studying the efficiency of the π^0's, we obtain a preliminary estimate of 5.9% uncertainty in the efficiency ratio. We study the systematics of extracting the yields by changing the fitting functions, changing the location of the mass difference sidebands and by fitting the mass difference $M(D^{*+})$-$M(D^0)$ instead of $M(D^0)$. We observe a 1.0% variation in the ratio of branching fractions. Summing these numbers in quadrature, we arrive at a preliminary 7% systematic uncertainty.

We obtain a preliminary measurement of the ratio of branching fractions

$$\mathcal{B}(D^0 \to K^-\pi^+\pi^0)/\mathcal{B}(D^0 \to K^-\pi^+) = 3.78 \pm 0.071 \pm 0.26.$$

This measurement, with over 8,000 events in each signal, is the most precise determination of the ratio to date.

ACKNOWLEDGEMENTS

We gratefully acknowledge the effort of the CESR staff in providing us with excellent luminosity and running conditions. This work was supported by the National Science Foundation, the U.S. Department of Energy, the Heisenberg Foundation, the Alexander von Humboldt Stiftung, the Natural Sciences and Engineering Research Council of Canada, and the A.P. Sloan Foundation.

REFERENCES

[1] (CLEO COLLABORATION) Alam *et.al.*, Phys. Rev. D **50**, 43 (1994).

[2] (CLEO COLLABORATION) Akerib *et.al.*, Phys. Rev. Lett. **71**, 3070 (1993).

[3] (CLEO COLLABORATION) Y. Kubota *et.al.* Nucl. Instrum. Methods Phys. Res. Sect. A **320**, 66 (1992).

[4] The charge conjugation is implied throughout .

[5] (E691 COLLABORATION) Anjos *et.al.*, Phys. Rev. D **48**, 56 (1993).

FIGURES

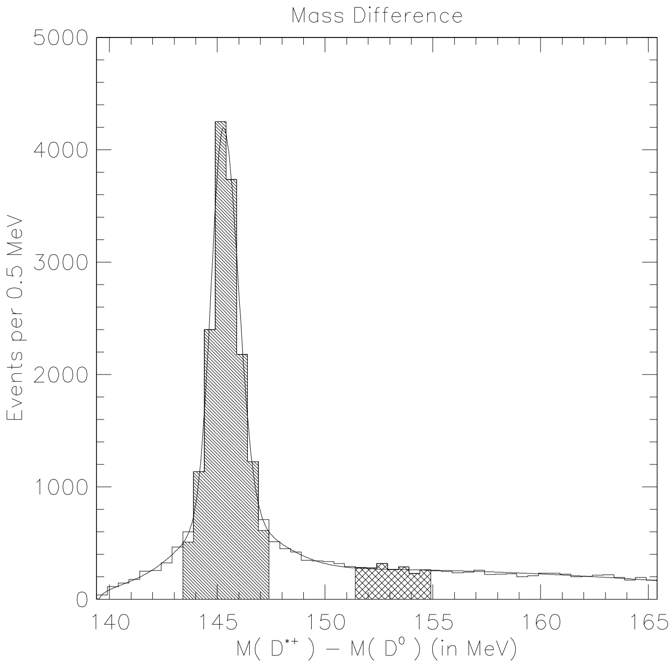

FIG. 1.

Mass difference between $M(D^{*+})$ and $M(D^0)$. The hatched region is the signal region and the cross hatched region is the sideband region

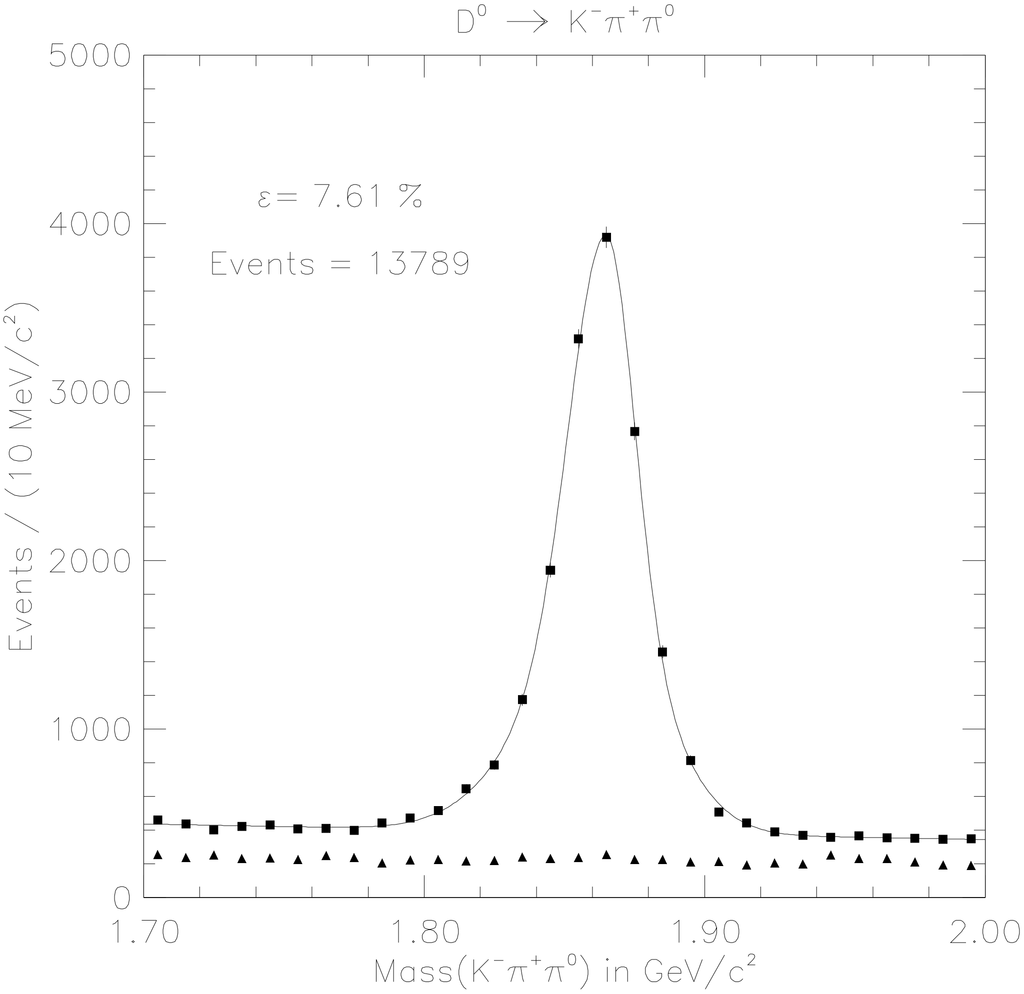

FIG. 2.

Signal region in the data for $D^0 \rightarrow K^-\pi^+\pi^0$. The fitted points are the signal region, and the triangles are from the mass difference sideband.

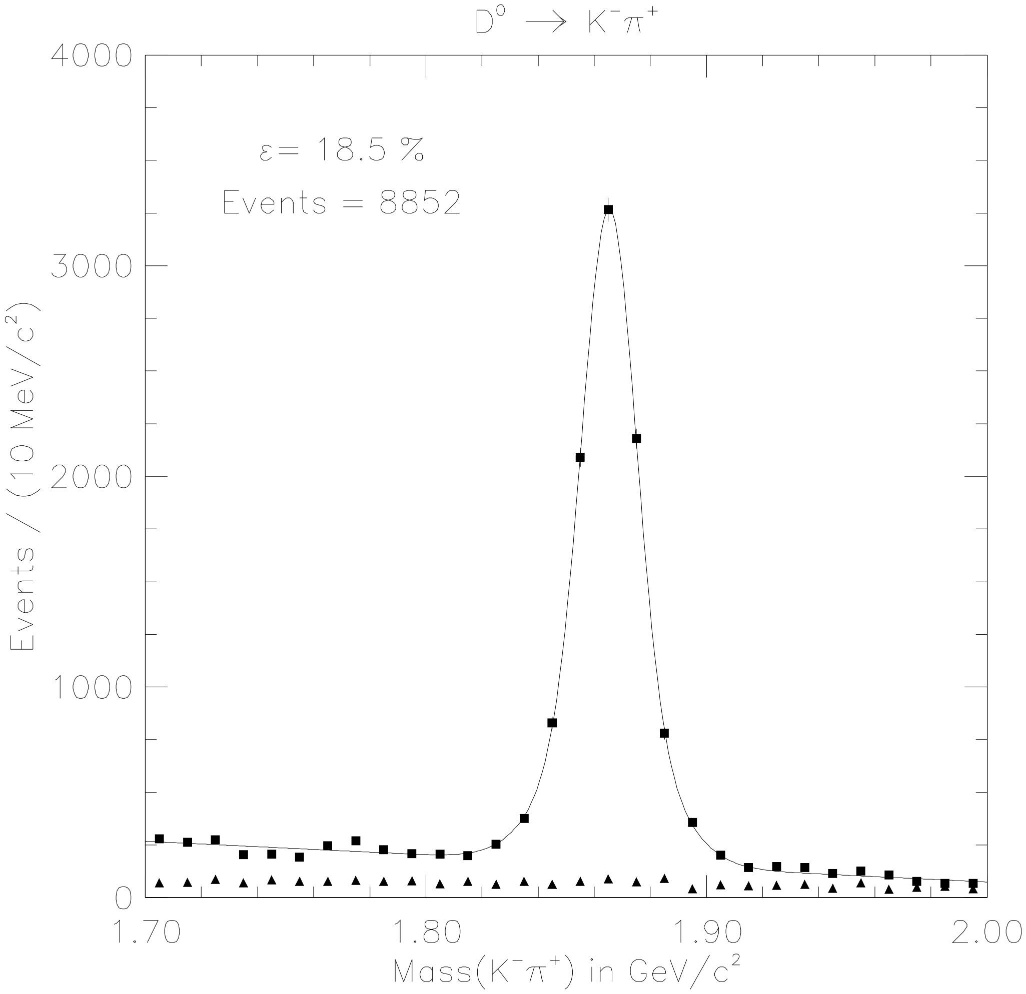

FIG. 3.

Signal region in the data for $D^0 \to K^-\pi^+$ The fitted points are the signal region, and the triangles are from the mass difference sideband.