Fermi National Accelerator Laboratory

FERMILAB-Pub-92/21-E

A Measurement of the B-Meson and b-Quark Cross Sections at $\sqrt{s}$=1.8 TeV Using the Exclusive Decay $B^{\pm} \rightarrow J/\psi K^{\pm}$

The CDF Collaboration

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

January 1992

Submitted to *Physical Review Letters*.

Operated by Universities Research Association Inc. under Contract No. DE-AC02-76CHO3000 with the United States Department of Energy

Disclaimer

FERMILAB-PUB-92/21-E
CDF/PUB/HEAVYFLAVOR/CDFR/1536

A Measurement of the B-Meson and b-Quark Cross Sections at $\sqrt{s} = 1.8$ TeV Using the Exclusive Decay $B^{\pm} \rightarrow J/\psi K^{\pm}$

F. Abe,[9] D. Amidei,[4] G. Apollinari,[16] M. Atac,[4] P. Auchincloss,[15] A. R. Baden,[6] N. Bacchetta,[11] M. W. Bailey,[14] A. Bamberger,[4,a] P. de Barbaro,[15] B. A. Barnett,[8] A. Barbaro-Galtieri,[10] V. E. Barnes,[14] T. Baumann,[6] F. Bedeschi,[13] S. Behrends,[2] S. Belforte,[13] G. Bellettini,[13] J. Bellinger,[21] D. Benjamin,[20] J. Bensinger,[2] A. Beretvas,[4] J. P. Berge,[4] S. Bertolucci,[5] S. Bhadra,[7] M. Binkley,[4] D. Bisello,[11] R. Blair,[1] C. Blocker,[2] A. Bodek,[15] V. Bolognesi,[13] A. W. Booth,[4] C. Boswell,[8] G. Brandenburg,[6] D. Brown,[6] E. Buckley-Geer,[17] H. S. Budd,[15] G. Busetto,[11] A. Byon-Wagner,[4] K. L. Byrum,[21] C. Campagnari,[3] M. Campbell,[3] A. Caner,[4] R. Carey,[6] W. Carithers,[10] D. Carlsmith,[21] J. T. Carroll,[4] R. Cashmore,[4,a] A. Castro,[11] F. Cervelli,[13] K. Chadwick,[4] G. Chiarelli,[5] W. Chinowsky,[10] S. Cihangir,[4] A. G. Clark,[4] M. Cobal,[13] D. Connor,[12] M. Contreras,[3] J. Cooper,[4] M. Cordelli,[5] D. Crane,[4] M. Curatolo,[5] C. Day,[4] F. DeJongh,[4] S. Dell'Agnello,[13] M. Dell'Orso,[13] L. Demortier,[2] B. Denby,[4] P. F. Derwent,[3] T. Devlin,[17] D. DiBitonto,[18] M. Dickson,[15] R. B. Drucker,[10] K. Einsweiler,[10] J. E. Elias,[4] R. Ely,[10] S. Eno,[3] S. Errede,[7] B. Esposito,[5] A. Etchegoyen,[4,a] B. Flaugher,[4] G. W. Foster,[4] M. Franklin,[6] J. Freeman,[4] H. Frisch,[3] T. Fuess,[4] Y. Fukui,[9] A. F. Garfinkel,[14] A. Gauthier,[7] S. Geer,[4] D. W. Gerdes,[3] P. Giannetti,[13] N. Giokaris,[16] P. Giromini,[5] L. Gladney,[12] M. Gold,[10] K. Goulianos,[16] H. Grassmann,[11] G. Grieco,[13] C. Grosso-Pilcher,[3] C. Haber,[10] S. R. Hahn,[4] R. Handler,[21] K. Hara,[19] B. Harral,[12] R. M. Harris,[4]

Submitted to Physical Review Letters, January 24, 1992

J. Hauser,[4] C. Hawk,[17] T. Hessing,[18] R. Hollebeek,[12] L. Holloway,[7] P. Hu,[17] B. Hubbard,[10] B. T. Huffman,[14] R. Hughes,[12] P. Hurst,[5] J. Huth,[4] J. Hylen,[4] M. Incagli,[13] T. Ino,[19] H. Iso,[19] H. Jensen,[4] C. P. Jessop,[6] R. P. Johnson,[4] U. Joshi,[4] R. W. Kadel,[10] T. Kamon,[18] S. Kanda,[19] D. A. Kardelis,[7] I. Karliner,[7] E. Kearns,[6] L. Keeble,[18] R. Kephart,[4] P. Kesten,[2] R. M. Keup,[7] H. Keutelian,[4] D. Kim,[4] S. Kim,[19] L. Kirsch,[2] K. Kondo,[19] J. Konigsberg,[6] E. Kovacs,[4] S. E. Kuhlmann,[1] E. Kuns,[17] A. T. Laasanen,[14] J. I. Lamoureux,[21] S. Leone,[13] J. Lewis,[4] W. Li,[1] P. Limon,[4] T. M. Liss,[7] N. Lockyer,[12] M. Loreti,[11] E. H. Low,[12] C. B. Luchini,[7] P. Lukens,[4] P. Maas,[21] K. Maeshima,[4] M. Mangano,[13] J. P. Marriner,[4] M. Mariotti,[13] R. Markeloff,[21] L. A. Markosky,[21] R. Mattingly,[2] P. McIntyre,[18] A. Menzione,[13] T. Meyer,[18] S. Mikamo,[9] M. Miller,[3] T. Mimashi,[19] S. Miscetti,[5] M. Mishina,[9] S. Miyashita,[19] Y. Morita,[19] S. Moulding,[2] J. Mueller,[17] A. Mukherjee,[4] L. F. Nakae,[2] I. Nakano,[19] C. Nelson,[4] C. Newman-Holmes,[4] J. S. T. Ng,[6] M. Ninomiya,[19] L. Nodulman,[1] S. Ogawa,[19] R. Paoletti,[13] V. Papadimitriou,[4] A. Para,[4] E. Pare,[6] S. Park,[4] J. Patrick,[4] G. Pauletta,[13] L. Pescara,[11] T. J. Phillips,[6] F. Ptohos,[6] R. Plunkett,[4] L. Pondrom,[21] J. Proudfoot,[1] G. Punzi,[13] D. Quarrie,[4] K. Ragan,[12] G. Redlinger,[3] J. Rhoades,[21] M. Roach,[20] F. Rimondi,[4,a] L. Ristori,[13] T. Rodrigo,[4] T. Rohaly,[12] A. Roodman,[3] W. K. Sakumoto,[15] A. Sansoni,[5] R. D. Sard,[7] A. Savoy-Navarro,[4] V. Scarpine,[7] P. Schlabach,[6] E. E. Schmidt,[4] O. Schneider,[10] M. H. Schub,[14] R. Schwitters,[6] A. Scribano,[13] S. Segler,[4] Y. Seiya,[19] M. Shapiro,[10] N. M. Shaw,[14] M. Sheaff,[21] M. Shochet,[3] J. Siegrist,[10] P. Sinervo,[12] J. Skarha,[8] K. Sliwa,[20] D. A. Smith,[13] F. D. Snider,[8] L. Song, [12] M. Spahn,[10] P. Sphicas,[4] R. St. Denis,[6] A. Stefanini,[13] G. Sullivan,[3] R. L. Swartz, Jr.,[7] M. Takano,[19] F. Tartarelli,[13] K. Takikawa,[19] S. Tarem,[2] D. Theriot,[4] M. Timko,[18]

P. Tipton,[4] S. Tkaczyk,[4] A. Tollestrup,[4] J. Tonnison,[14] W. Trischuk,[6] N. Turini,[13] Y. Tsay,[3] F. Ukegawa,[19] D. Underwood,[1] S. Vejcik, III,[8] R. Vidal,[4] R. G. Wagner,[1] R. L. Wagner,[4] N. Wainer,[4] J. Walsh,[12] T. Watts,[17] R. Webb,[18] C. Wendt,[21] H. Wenzel,[13] W. C. Wester, III,[10] T. Westhusing,[13] S. N. White,[16] A. B. Wicklund,[1] H. H. Williams,[12] B. L. Winer,[15] J. Wyss, [11] A. Yagil,[4] K. Yasuoka,[19] G. P. Yeh,[4] J. Yoh,[4] M. Yokoyama,[19] J. C. Yun,[4] A. Zanetti,[13] F. Zetti,[13] S. Zucchelli [4,a]

The CDF Collaboration

[1] *Argonne National Laboratory, Argonne, Illinois 60439*

[2] *Brandeis University, Waltham, Massachusetts 02254*

[3] *University of Chicago, Chicago, Illinois 60637*

[4] *Fermi National Accelerator Laboratory, Batavia, Illinois 60510*

[5] *Laboratori Nazionali di Frascati, Istituto Nazionale di Fisica Nucleare, Frascati, Italy*

[6] *Harvard University, Cambridge, Massachusetts 02138*

[7] *University of Illinois, Urbana, Illinois 61801*

[8] *The Johns Hopkins University, Baltimore, Maryland 21218*

[9] *National Laboratory for High Energy Physics (KEK), Japan*

[10] *Lawrence Berkeley Laboratory, Berkeley, California 94720*

[11] *Universita di Padova, Instituto Nazionale di Fisica Nucleare, Sezione di Padova, I-35131 Padova, Italy*

[12] *University of Pennsylvania, Philadelphia, Pennsylvania 19104*

[13] *Istituto Nazionale di Fisica Nucleare, University and Scuola Normale Superiore of Pisa, I-56100 Pisa, Italy*

[14] *Purdue University, West Lafayette, Indiana 47907*

[15] *University of Rochester, Rochester, New York 14627*

[16] *Rockefeller University, New York, New York 10021*

(17) *Rutgers University, Piscataway, New Jersey 08854*

(18) *Texas A&M University, College Station, Texas 77843*

(19) *University of Tsukuba, Tsukuba, Ibaraki 305, Japan*

(20) *Tufts University, Medford, Massachusetts 02155*

(21) *University of Wisconsin, Madison, Wisconsin 53706*

Abstract

This letter reports the full reconstruction of B mesons through the decay chain $B^{\pm} \rightarrow J/\psi K^{\pm}$, $J/\psi \rightarrow \mu^{+}\mu^{-}$, using data obtained at the Collider Detector at Fermilab in $\bar{p}p$ collisions at $\sqrt{s} = 1.8$ TeV. This exclusive sample, the first observed at a hadron collider, is then used to measure the B-meson cross section, from which we extract the b-quark cross section. We obtain $\sigma = 2.8 \pm 0.9(stat) \pm 1.1(syst)$ μb for B^{-} mesons with $P_T > 9.0$ GeV/c and rapidity $|y| < 1.0$. We obtain $\sigma = 6.1 \pm 1.9(stat) \pm 2.4(syst)$ μb, for b quarks with transverse momentum $P_T > 11.5$ GeV/c and rapidity $|y| < 1.0$.

PACS numbers: 13.25.+m, 13.85.Ni, 14.40.Jz, 14.80.Dq

This letter reports the first full reconstruction of B mesons at a hadron collider, through the decay chain $B^{\pm} \rightarrow J/\psi + K^{\pm}$, $J/\psi \rightarrow \mu^{+}\mu^{-}$. Although the branching ratio for this process is small, the J/ψ decay into dimuons provides an easily implemented trigger at low momentum. The technique employs the fact that the J/ψ signal is cleanly identified in a hadron collider; in addition, the J/ψ sample has been shown previously by UA1 at CERN [1] to be a sample enriched in B mesons. This observation confirms the expectation of a large B-meson cross section at $\sqrt{s} = 1.8$ TeV in $p\bar{p}$ collisions.

The B mesons observed at the Tevatron are a result of the production and fragmentation of b quarks formed in $p\bar{p}$ collisions. The b quark is considered heavy enough that its production cross section can be calculated as a perturbation series in the QCD running coupling constant α_s. A calculation of the total and differential cross section for b-quark production exists [2], which includes the $O(\alpha_S^3)$ radiative corrections. This calculation is sensitive to a number of parameters, including the b-quark mass, Λ_{QCD}, the gluon structure functions, and the contribution of higher-order terms. In this Letter we present a measurement of the b-quark and B-meson cross sections using a data sample with an integrated luminosity of (2.6 ± 0.2) pb^{-1} accumulated with the Collider Detector at Fermilab (CDF).

CDF has been described in detail elsewhere [3, 4]. The events used in this analysis were collected using a multi-level trigger system [5, 6, 7, 8]. The first level required the presence of two charged tracks in the muon chambers. The second level required both muon chamber tracks to match charged tracks in the central tracking chamber (CTC). In addition, the two muon candidates can be no closer than approximately 0.26 radians.

We assume that the efficiencies of the two muons are uncorrelated, given their geometrical separation. The trigger efficiency of a muon candidate is the product of the level-one and level-two trigger efficiencies; the trigger efficiency of a muon pair is then the product of the trigger efficiencies of the two muon candidates. The level-one and level-two efficiencies have been studied using muon candidates in data taken with non-muon triggers. The level-one trigger efficiency was determined to be an increasing function of the muon P_T, with an efficiency of $(44 \pm 4)\%$ at $P_T = 2.0$ GeV/c , rising to $(92 \pm 4)\%$ for $P_T > 6.0$ GeV/c . The level-two trigger efficiency rises sharply from $(10 \pm 5)\%$ at $P_T = 2.0$ GeV/c to $(99 \pm 1)\%$ for $P_T > 3.0$ GeV/c .

Transverse momenta are calculated from track curvature in the 1.4116 T axial magnetic field. There is an uncertainty in the magnetic field of $\pm 0.05\%$. Constraining the tracks of a multi-body decay to come from a common-vertex (called a vertex constraint) yields a momentum resolution of $\delta P_T/P_T = \sqrt{(0.0014 P_T)^2 + (0.0066)^2}$. (Note that the momentum resolution for tracks originating from the beam can be further improved by constraining the common-vertex to be coincident with the beam position. The long lifetime of the B meson implies that its decay vertex will be significantly displaced from the beam position, therefore, a common-vertex constraint is favored over a beam-vertex constraint.) The mass scale was checked by studying the following decays: $J/\psi \to \mu^+\mu^-$, $\psi(2S) \to \mu^+\mu^-$, $\Upsilon(1S) \to \mu^+\mu^-$, and $\Upsilon(2S) \to \mu^+\mu^-$. After corrections for dE/dX losses, we obtain values of mass of $3.099 \pm 0.001, 3.690 \pm 0.005, 9.470 \pm 0.015$, and 10.002 ± 0.024 GeV/c^2 , respectively, which are in reasonable agreement with the world-average values. Based on these measurements we estimate a mass-scale error of $\sim 0.1\%$ due to systematic momentum-scale uncertainties.

The process of reconstructing $B^{\pm}$ mesons begins with the reconstruction of the daughter J/ψ . The J/ψ is identified by requiring two oppositely-charged muon candidates, with each muon having $P_T > 3.0$ GeV/c . We form the differences between the muon chamber track and the extrapolated CTC track in the transverse and longitudinal directions, weight the differences by multiple scattering and measurement errors, and require they be less than 3.0 standard deviations from zero. These muon matching cuts remove approximately 50% of the $\mu^+\mu^-$ background. The $\mu^+\mu^-$ mass distribution is shown in Figure 1. J/ψ candidates are defined as $\mu^+\mu^-$ mass pairs within $\pm 3.0\sigma$ of the mean, where σ is the observed width of 0.022 GeV/c^2 . We observe 1029 ± 37 reconstructed J/ψ mesons above a background of 128 $\mu^+\mu^-$ pairs.

Since CDF has no charged kaon identification, candidate kaons are defined as any track with $P_T > 2.0$ GeV/c . The $\mu^+\mu^-K^\pm$ system is required to have $P_T > 9.0$ GeV/c ; this removes that part of the phase space in which the efficiency is changing rapidly. The invariant mass of the $\mu^+\mu^-K^\pm$ system is formed by simultaneously vertex constraining the three tracks and mass constraining the $\mu^+\mu^-$ pair to the world average J/ψ mass 3.09693 GeV/c^2 [9]. The $\mu^+\mu^-K^\pm$ mass distribution is shown in Figure 2. A clear signal is present in the mass range 5.25 to 5.33 GeV/c^2 .

The number of events is determined by fitting the $\mu^+\mu^-K^\pm$ mass distribution to a Gaussian signal distribution plus linear background using a binned maximum likelihood technique. We fix σ to 0.012 GeV/c^2 , the value we obtain in a Monte Carlo study. The fit results in a mean of $5.294 \pm 0.006(fit) \pm 0.005(scale)$ GeV/c^2 with 14.1 ± 4.3 signal events. The mean is within two standard deviations of the world average $B^\pm$ mass of 5.2791 ± 0.0019 GeV/c^2 [10, 11]. We have investigated the effects of fixing the mean and floating the σ of the Gaussian, and we assign a systematic error of 20% due to the fitting procedure.

We determine our detection efficiency using a Monte Carlo which incorporates the following:

(1) We assume the shape of the b-quark P_T and rapidity spectrum provided by the $O(\alpha_S^3)$ calculation [2]. We then generate b quarks with $P_T > 7.0$ GeV/c and rapidity $|y| < 1.0$. We assign a systematic error of 10% in both the $B^\pm$-meson and b-quark cross sections due to variations in the shape of the b-quark P_T spectrum.

(2) We model energy sharing between the quark and meson with the Peterson parameterization [12], which is governed by the ϵ_P parameter. Results from several experiments indicate $\epsilon_P = 0.006 \pm 0.002$ [13]. The variations in ϵ_P lead to a 7% variation in the acceptance.

(3) In the decay $B^{\pm} \rightarrow J/\psi + K^{\pm}$, the J/ψ and $K^{\pm}$ are produced in a $\ell = 1$ state and the J/ψ is transversely polarized in the rest frame of the decaying B meson. This results in a $\sin^2\theta$ angular distribution for the decay muons with respect to the J/ψ direction in the rest frame of the B meson.

(4) Parameterizations of both the level-one and level-two trigger efficiencies as functions of muon P_T were used in the simulation. We assign a systematic uncertainty of 12% due to variations in the trigger parameterizations for muons with $P_T > 3.0$ GeV/c .

(5) We measured the CTC position resolution and wire efficiency for both muons from the J/ψ decay, and then imposed these effects in our simulation. The azimuthal position resolution varied from about 350 microns in the inner CTC layers to about 200 microns in the outer layers. The probability that a CTC wire measurement would be used in the final fit varied from about 50% in the inner layers to about 93% in the outer layers. The simulation predicts a width 0.012 GeV/c^2 for the B meson.

(6) We measured the CTC track reconstruction efficiency by embedding simulated tracks in real data J/ψ events. We see a tracking efficiency of $(97 \pm 2)\%$ for each muon. The broader pseudorapidity (η) spectrum of the kaons results in a slightly lower efficiency of $(94 \pm 2)\%$. The overall tracking efficiency is then $(89 \pm 4)\%$. Based on this study, we assign a systematic error of 5% due to the track reconstruction algorithm.

(7) The simulation predicts 7% of the kaons with $P_T > 2.0$ GeV/c decay before exiting the CTC. Approximately half of these are successfully reconstructed as B-meson decays. We assign a 4% systematic due to kaon decays inside the CTC.

(8) The simulation models the muon chamber geometry, the single wire resolution,

and the single wire efficiency. The muon fiducial volume covers 85% of the solid angle in the region $|\eta| < 0.65$. For muons inside the fiducial volume with $P_T > 3.0$ GeV/c , the simulation predicts an efficiency of $(98 \pm 1)\%$ for muon reconstruction.

(9) We measure the efficiency of the muon matching cuts using both a cosmic-ray muon sample and a Monte Carlo muon sample. We find that $(97 \pm 2)\%$ of real muons pass these cuts. In addition, we investigated the possibility that the wrong CTC track was matched to the muon chamber track. We assign a systematic error of 8% in associating extrapolated CTC tracks with muon tracks.

The Monte Carlo model predicts the reconstruction efficiency for $B^{\pm} \rightarrow J/\psi + K^{\pm}$, $J/\psi \rightarrow \mu^+\mu^-$ is $(1.87 \pm 0.37)\%$, where the error represents the sum in quadrature of all the systematic effects listed in steps (1) through (9).

In our results we quote the cross section for $p\bar{p} \rightarrow B^- X$ only; note that the cross section for $p\bar{p} \rightarrow B^{\pm} X$ is twice as large. The measurement is determined by the following formula:

$$\sigma(\bar{p}p \rightarrow B^- X; P_T > 9.0\ GeV/c, |y| < 1.0)$$

$$= \frac{(N/2)}{\epsilon \cdot \mathcal{L} \cdot Br(B^- \rightarrow J/\psi + K^-) \cdot Br(J/\psi \rightarrow \mu^+\mu^-)}$$

where N is the number of events we observe in the data, $\mathcal{L}$ is the integrated luminosity, and ϵ is the detection efficiency for reconstructing B^- mesons. The combined branching ratio $Br(B^- \rightarrow J/\psi + K^-) \cdot Br(J/\psi \rightarrow \mu^+\mu^-)$ is $(5.2 \pm 1.4) \times 10^{-5}$ [10, 11]. Since our observed sample includes contributions from both B^+ and B^- mesons, we divide N by 2.

The result for the cross section is:

$$\sigma(\bar{p}p \rightarrow B^- X; P_T > 9.0\ GeV/c, |y| < 1.0) = 2.8 \pm 0.9(stat) \pm 1.1(syst)\ \mu\text{b}$$

The first error is statistical and the second combines in quadrature the systematics due to the mass-fitting procedure, the efficiency calculation, the luminosity measurement, and the branching ratio uncertainties. The P_T cut on the kaon has been varied over the range 1.5 to 3.5 GeV/c , and after correcting the efficiency for the different cut values, we observe that our result is not a strong function of this cut.

A b quark can fragment into B^-, $\bar{B}^0$, $\bar{B}^0_s$ mesons, or a variety of b flavored baryons. To extract the b-quark cross section, we make the standard assumption [14] that B^-, $\bar{B}^0$, $\bar{B}^0_s$, and b baryons are produced in the ratio 0.375 : 0.375 : 0.15 : 0.10. Since the b quark is not observed directly, we quote the cross section for b quarks with $P_T > P_T^{min}$ where P_T^{min} is defined as that b-quark P_T such that 90% of our final sample of reconstructed $B^\pm$ mesons come from b quarks with $P_T > P_T^{min}$. Using the Monte Carlo model described above, we find that $P_T^{min} = 11.5$ GeV/c , and that the efficiency for the decay chain $b \to B^- \to J/\psi K^-$, $J/\psi \to \mu^+\mu^-$ is $(2.27 \pm 0.45)\%$.

Our result for the cross section is:

$$\sigma(\bar{p}p \to bX; P_T > 11.5\ GeV, |y| < 1.0) = 6.1 \pm 1.9 \pm 2.4\ \mu\text{b}$$

where the errors are broken down as for the meson calculation. The order $O(\alpha_S^3)$ prediction for the b-quark cross section for $P_T > 11.5$ GeV/c and $|y| < 1.0$ is $1.1^{+0.5}_{-0.4}$ μb. The errors quoted on the theoretical prediction are intended to show how sensitive the result is to reasonable variations of the parameters that enter into the calculation. Our measurement is approximately 1.6 standard deviations above the theoretical calculation.

In summary, we have presented the first full reconstruction of $B^\pm$ mesons in a hadron collider environment. We have used this sample to measure the B-meson and b-quark production cross sections.

This work would not have been possible without the skill and hard work of the Fermilab staff. We thank the staffs of our institutions for their many contributions to the construction of the detector. This work was supported by the U.S. Department of Energy, the National Science Foundation, the Istituto Nazionale di Fisica Nucleare, the Ministry of Science, Culture, and Education of Japan, the A. P. Sloan Foundation, and the Max Planck Gesellschaft.

References

[1] UA1 Collaboration, C. Albajar *et al.*, Phys. Lett. B **256** 121 (1991).

[2] P. Nason, S. Dawson, and R. K. Ellis, Nucl. Phys. B **303** 607 (1988); Nucl. Phys. B **327** 49 (1989); Nucl. Phys. B **335** 260 (1990).

[3] F. Abe *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **271**, 387 (1988).

[4] G. Ascoli *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **268**, 33 (1988).

[5] E. Barsotti *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **269**, 82 (1988).

[6] D. Amidei *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **269**, 51 (1988).

[7] G. Ascoli *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **269**, 63 (1988).

[8] G. W. Foster *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **269**, 93 (1988).

[9] Particle Data Group, J.J. Hernández *et al.*, Phys. Lett. B **239**, 1 (1990).

[10] ARGUS Collaboration, H. Albrecht *et al.*, Z. Phys. C **48** 543 (1990).

[11] CLEO Collaboration, D. Bortoletto *et al.*, Phys. Rev. D **45** 21 (1992).

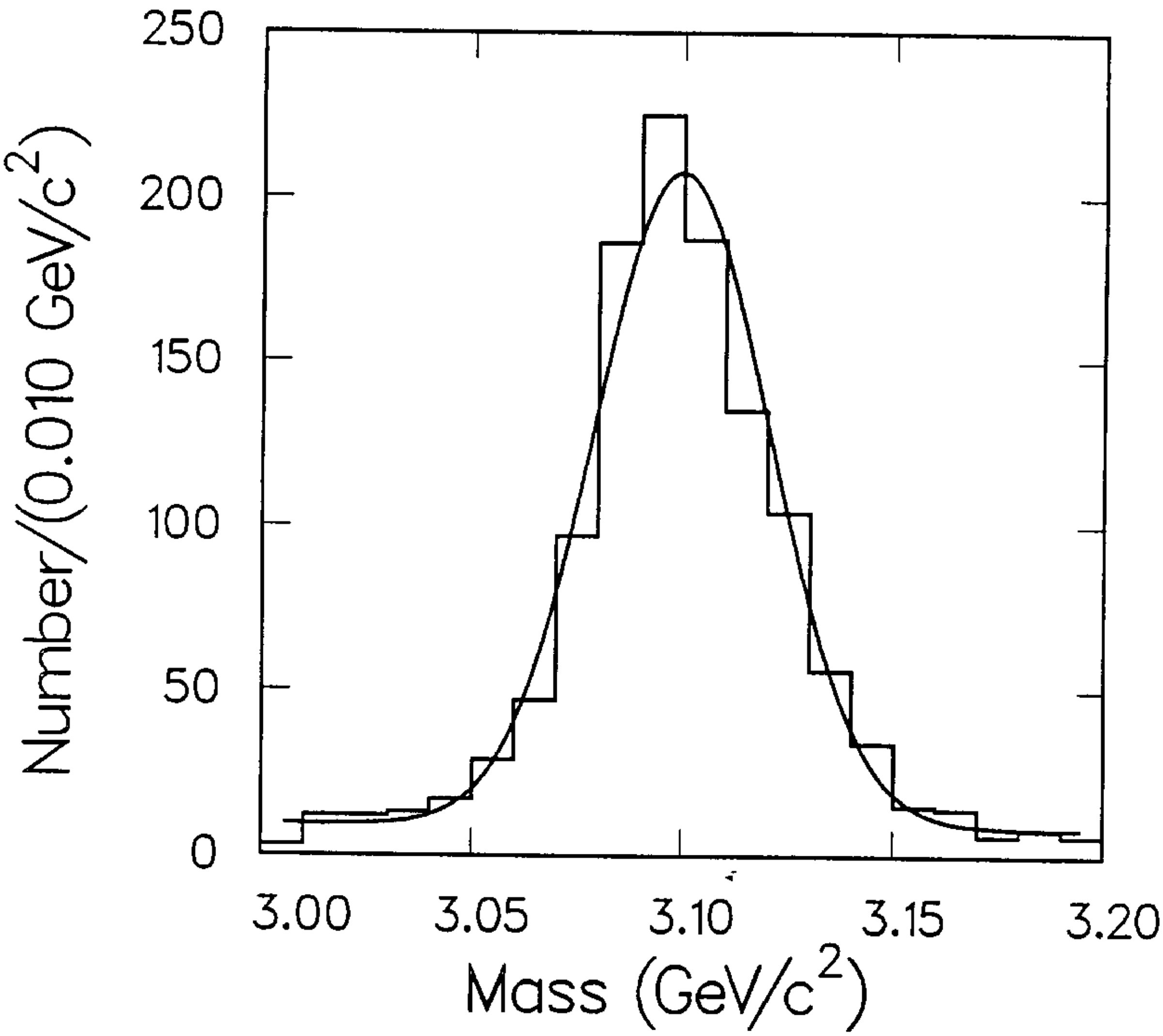
[12] C. Peterson *et al.*, Phys. Rev. D **27** 105 (1983).

[13] J. Chrin, Z. Phys. C **36** 163 (1987).

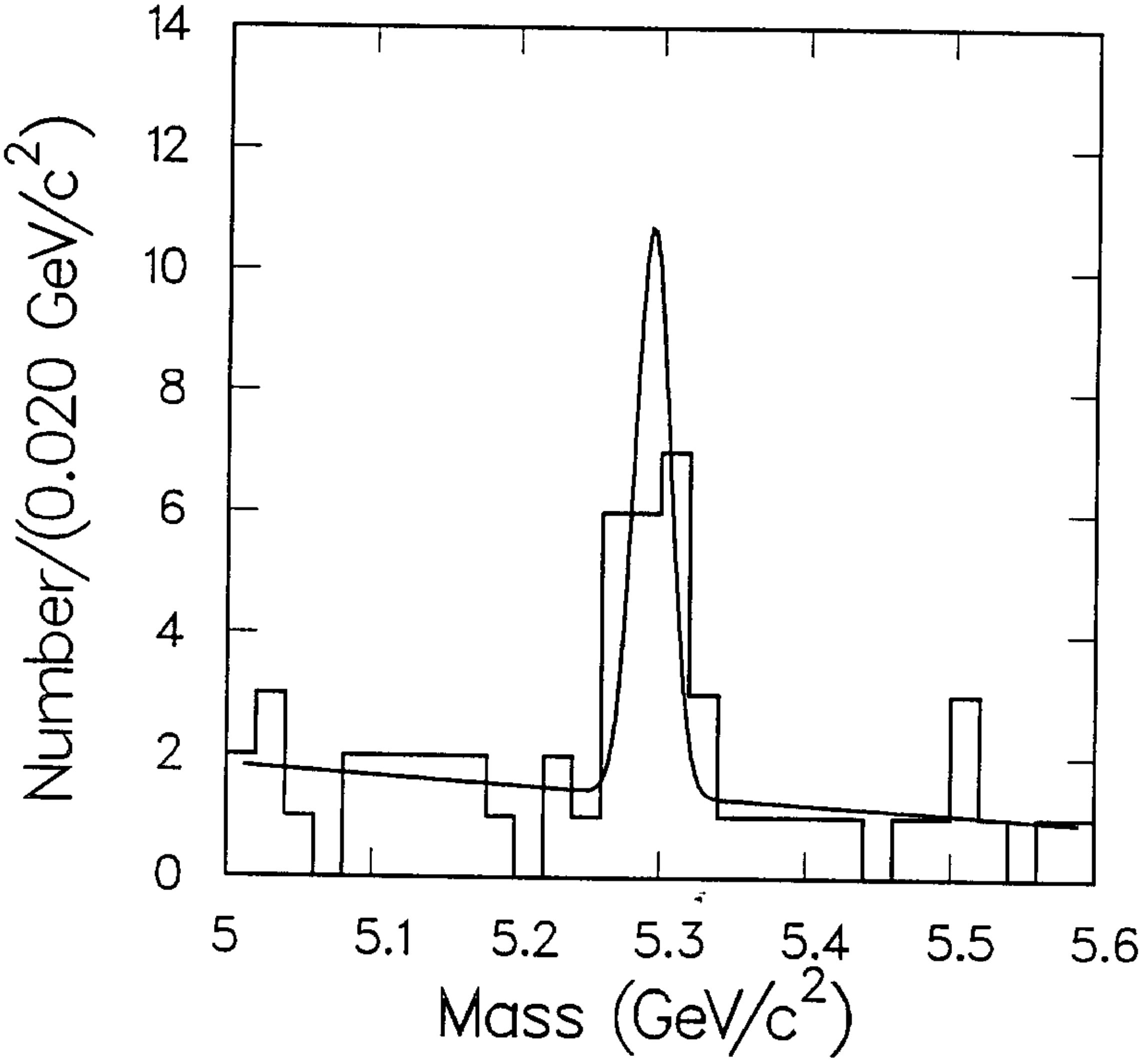
[14] L3 Collaboration, B. Adeva, *et al.*, Phys. Lett. B **252**, 703 (1990); ALEPH Collaboration, D. Decamp, *et al.*, Phys. Lett. B **258**, 236 (1991); F. Abe, *et al.*, Phys. Rev. Lett. **67** 3351 (1991).

Figure 1: $\mu^+\mu^-$ mass distribution after all cuts. The histogram is the data and the solid curve is a fit to a Gaussian signal plus linear background.

Figure 2: $\mu^+\mu^- K^\pm$ mass distribution after all cuts. The histogram is the data and the solid curve is a fit to a Gaussian signal (with the width fixed to 0.012 GeV/c^2) plus linear background.



250
200
150
100
50
0
Number/(0.010 GeV/c^2)
3.00
3.05
3.10
3.15
3.20
Mass (GeV/c^2)


Number/(0.020 GeV/c^2)
Mass (GeV/c^2)
0
2
4
6
8
10
12
14
5
5.1
5.2
5.3
5.4
5.5
5.6