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HRS RESULTS ON D AND F PRODUCTION AT PEP

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I briefly summarize here the results presented for the HRS collaboration[1] on D and F production measured at PEP. Fragmentation functions and total cross-sections for D^0, D^+, D^{*+} and F^+ are reported as well as a measurement of the charmed quark electroweak asymmetry using the inclusive D^0 and D^+ signals in addition to three observed modes of the $D^{*+} \to D^0$ transition.

The HRS (High Resolution Spectrometer) is a general purpose e^+e^- detector designed with emphasis very much on measurement of the charged particle momenta. With an average $\sigma_p/p \simeq 2 \times 10^{-3} \cdot p$ (GeV/c), D^0 and D^+ mesons are observed inclusively without requirement of the D^{*+}, as shown in Figs. 1(a) and (b) for 106 pb^{-1} integrated luminosity. No particle identification is used in the current analysis. Signals of 144±18 and 123±23 events are observed with $z_D(\equiv 2 \cdot E_D/\sqrt{s}) \geq 0.5$ for $D^0 \to K^-\pi^+$ and $D^+ \to K^-\pi^+\pi^+$, respectively, with decay angle cuts in each case to reduce background. The D^{*+} is also observed, using the standard $D^{*+} \to D^0\pi^+$ transition, and this is shown in Figs. 2(a)-(c) for the three different modes $D^0 \to K^-\pi^+, K^-\pi^+\pi^+\pi^-$ and $K^-\pi^+\pi^0$ with $z_D^* \geq 0.4$, 0.6 and 0.6, respectively. A decay angle cut similar to that used for the inclusive D's was applied for $0.2 < z_D^* < 0.4$ to yield the clear low-z D^{*+} signal shown in Fig. 2(d). Relatively low background levels are obtained in

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all cases. We use the $D^0 \rightarrow K^-\pi^+$ mode to measure the D^* fragmentation function which is plotted in Fig. 3 along with the fragmentation function measured from the inclusive D^0. The results are in good agreement with each other and with D^+ results not shown. Together, the data can be characterized by a Peterson form[2] with ϵ = 0.35 ± 0.06 but are in fact more consistent with the predictions of the Webber[3] Monte Carlo which are plotted in Fig. 3. Comparable agreement with the Lund Monte Carlo[4] requires substantial adjustment of the heavy quark fragmentation parameters from those commonly used but is also possible.

The D^{*+} data observed over the full range in z correspond to a total cross section of $R(D^*+\bar{D}^*)$ = 2.7 ± 0.9, assuming $\sigma(D^{*+})=\sigma(D^{*0})$ from isospin. Using any of the fragmentation forms mentioned above we extrapolate the D^0 and D^+ results to obtain $R(D^0+\bar{D}^0)$ = 1.8 ± 0.5 and $R(D^++D^-)$ = 1.2 ± 0.4, including the extrapolation uncertainty. Errors here are dominated by uncertainties in the measured D branching ratios which we can expect to be substantially improved by future Mark III measurements.[5] The sum of the D^0 and D^+ measurements $R(D+\bar{D})$ is 3.0 ± 0.6 and can be compared to the D^* measurements to obtain directly the D/D^* ratio. Doing this for the range z>0.5 where all signals are observed, we obtain $D/D^* = 1.0^{+0.3}_{-0.2}$ which is consistent with most or all D's coming in fact from D^* production.

Adding the 3 different $D^{*+} - D^0$ modes observed, we obtain the D^{*+} angular distribution shown in Fig. 4. Fitting this data to the expected distribution with electroweak interference in charmed quark production gives an asymmetry parameter A= −0.15 ± 0.09. In addition, we combine the D^0 and D^+ inclusive spectra divided into forward and backward hemispheres to obtain a separate asymmetry measurement of A = -0.08 ± 0.12 for D production. Finally, both measurements are combined to obtain our current best value of A = -0.12 ± 0.08 for the electroweak asymmetry of charmed quark production. This compares to an expectation for PEP of A = -0.09.

The production of F^+ is observed using the $\phi\pi$ mode of the F, after first satisfying ourselves that our inclusive $\phi \to K^+K^-$ signal and ϕ fragmentation cross sections are in very good agreement with ϕ results from TPC[6] and DELCO[7] over the full range in z, (not shown here). The $\phi\pi$ mass spectrum, again with no particle identification, is plotted in Fig. 5 and shows a clear signal of 104 ± 18 events at $m(F)=1.975 \pm 0.004$ GeV/c^2 and with a width consistent with apparatus resolution. Control bands and a variety of other techniques and reflection searches have been used to exclude a spurious origin for this $\approx 5\sigma$ signal. The observed mass is consistent with F results from CLEO,[8] TASSO[9] and ARGUS.[10] The fragmentation function which we observe, however, plotted in Fig. 6, is found to be very different from what is measured for the D's and from what is expected from dominant direct charm production. The signal level we measure at high z (>0.4) is consistent with the signal levels from the other experiments but the bulk of our observed signal in fact comes from lower z values, not covered by the other experiments. The <u>shape</u> of this low z component resembles that expected for F mesons arising from secondary charm from primary b quarks. However, for a branching fraction $B(F^+ \to \phi\pi^+) \lesssim 0.10$ estimated from the amount of signal observed for $z>0.4$ and the known number of produced charm quarks, our measurement implies a value of $R(F^+ + F^-)$ at low z which would represent a very large fraction of the expected b-quark production. Thus the observed cross section and fragmentation distribution are very puzzling under an F interpretation of this effect. Our measurements of the various angular distributions in $F^{+}\rightarrow\phi\pi^{+}$ are also not in good agreement with the expected spin properties of the F, although with less statistical significance. We consider the F results reported here to be preliminary and expect to increase the data sample by 60% in the near future. At that time we will present our final analysis.

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References

1. M. Derrick, E. Fernandez, R. Fries, L.Hyman, P. Kooijman, J.S. Loos, B. Musgrave. L.E. Price. J. Schlereth, K. Sugano, J.M. Weiss, D.E. Wood, S. Ahlen, G. Baranko, P. Baringer, D. Blockus, B. Brabson, M. Daigo, G.E. Forden, S.W. Gray, J.-P. Guilluad, C. Jung, H. Neal, H. Ogren, D.R. Rust, M. Valdata-Nappi, C. Akerlof, J. Chapman, D. Errede, N. Harnew, P. Kesten, S. Kooijman, D.I. Meyer, D. Nitz, D. Rubin, A.A. Seidl, R. Thun, T. Trinko, M. Willutzky, I. Beltrami, R. DeBonte, K.K. Gan, D. Koltick, F.J. Loeffler, U. Mallik, R.L. McIlwain, D.H. Miller, C.R. Ng, P.P. Ong, L.K. Rangan, E.I. Shibata, R. Stevens, R. J. Wilson, B. Cork, L. Keller and J. Va'vra, Argonne National Laboratory, Indiana University, University of Michigan, Purdue University, Lawrence Berkeley Laboratory and Stanford Linear Accelerator Center.
2. C. Peterson et al., Phys. Rev. D27, 105 (1983).
3. B. Webber, private communication.
4. B.Andersson, G.Gustafson and T.Sjoestrand, Phys. Reports. 97 33 (1983).
5. see R. Schindler, elsewhere in these proceedings.
6. H. Airhara et al., Phys. Rev. Lett. 52, 2201 (1984).
7. W. Hofmann, Raporteur's Talk, presented at the Vanderbilt Conf., (1984).
8. A. Chen et al., Phys. Rev. Lett. 51, 634 (1983).
9. M.Althoff et al., DESY 83-119 (1983).
10. Elsewhere in these proceedings and C. Darden, ARGUS Coll., presented at Vanderbilt Conference (1984).

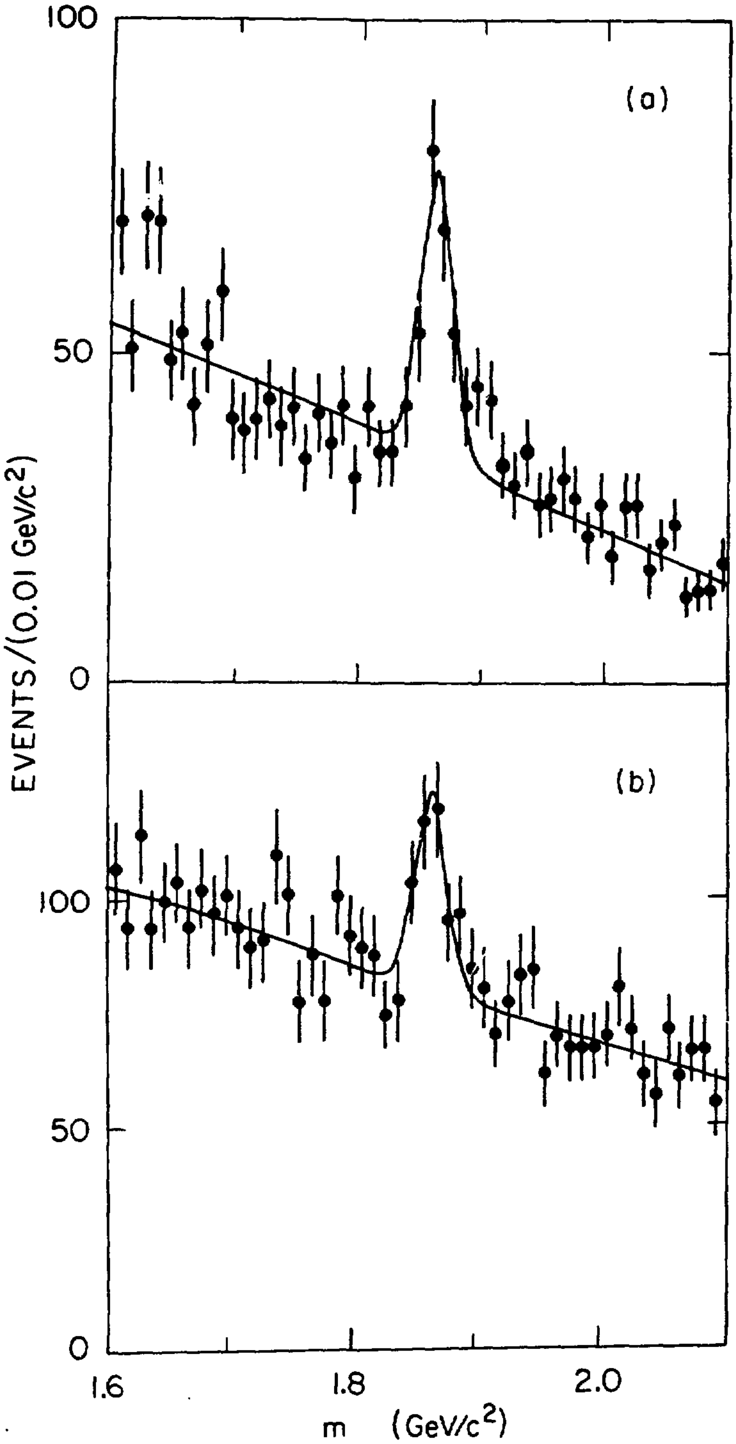

Figure 1(a). Invariant $K\pi$ mass distribution for $z_D \geq 0.5$ and $|\cos\theta^*| < 0.7$, (helicity angle).

Figure 1(b). Invariant $K\pi\pi$ mass distribution for $z_D \geq 0.5$. and $|\cos\theta^*| > 0.3$, (normal to decay plane in helicity frame).

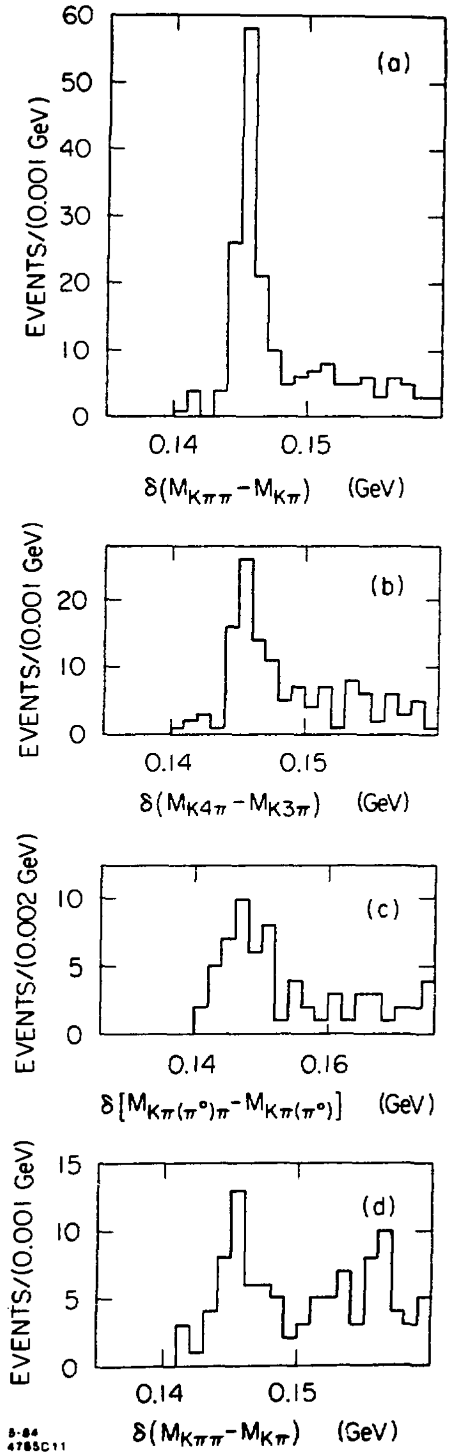

Figure 2. Mass difference $\delta \equiv m(D^{*+})-m(D^{0})$ for (a) $D^{0}\to K^{-}\pi^{+}$ and $z \geq 0.4$, (b) $D^{0}\to K^{-}\pi^{+}\pi^{+}\pi^{-}$ and $z \geq 0.6$, (c) $D^{0}\to K^{-}\pi^{+}\pi^{0}$ and $z \geq 0.6$ and (d) $D^{0}\to K^{-}\pi^{+}$ with $0.2 \leq z \leq 0.4$ and $|\cos\theta^{*}| \leq 0.8$.

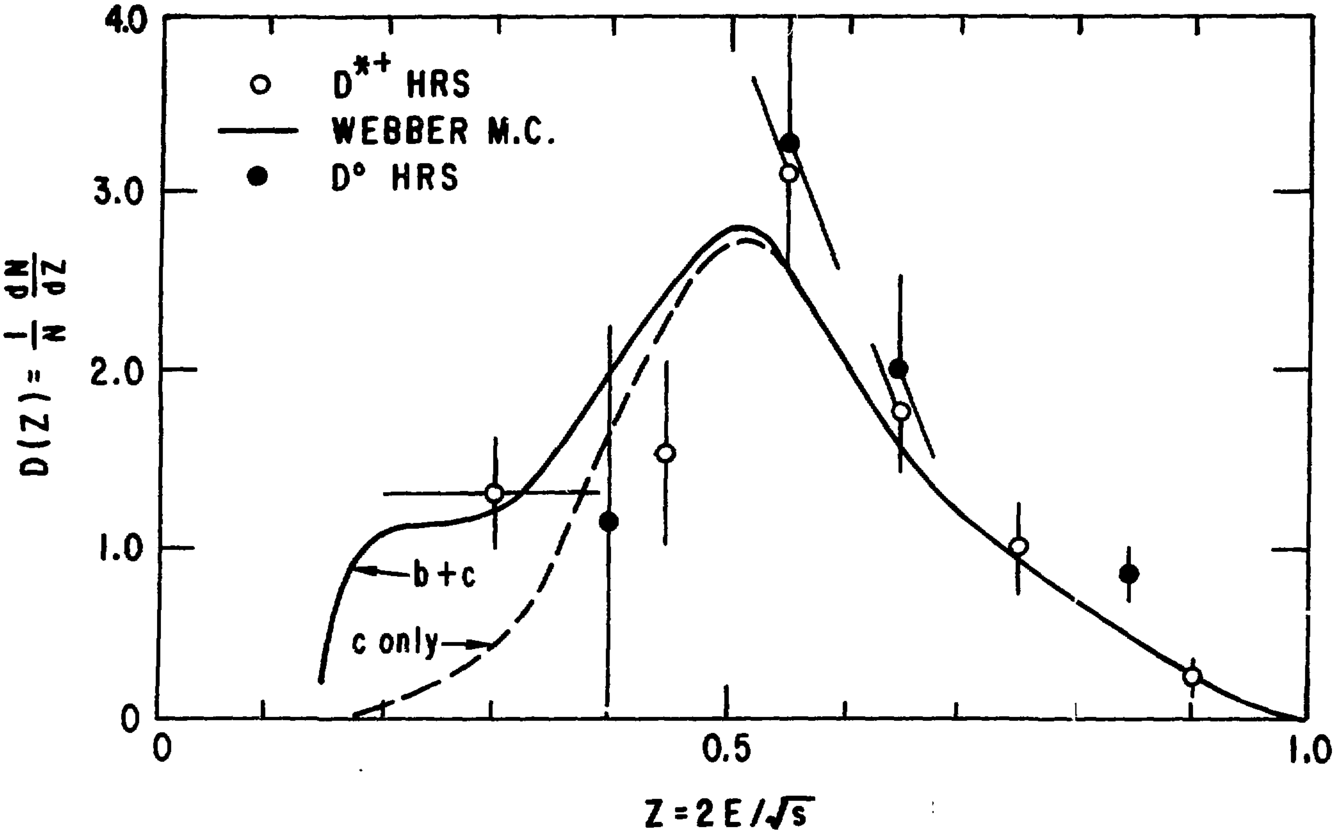

Figure 3. Fragmentation function obtained from D° and D*.

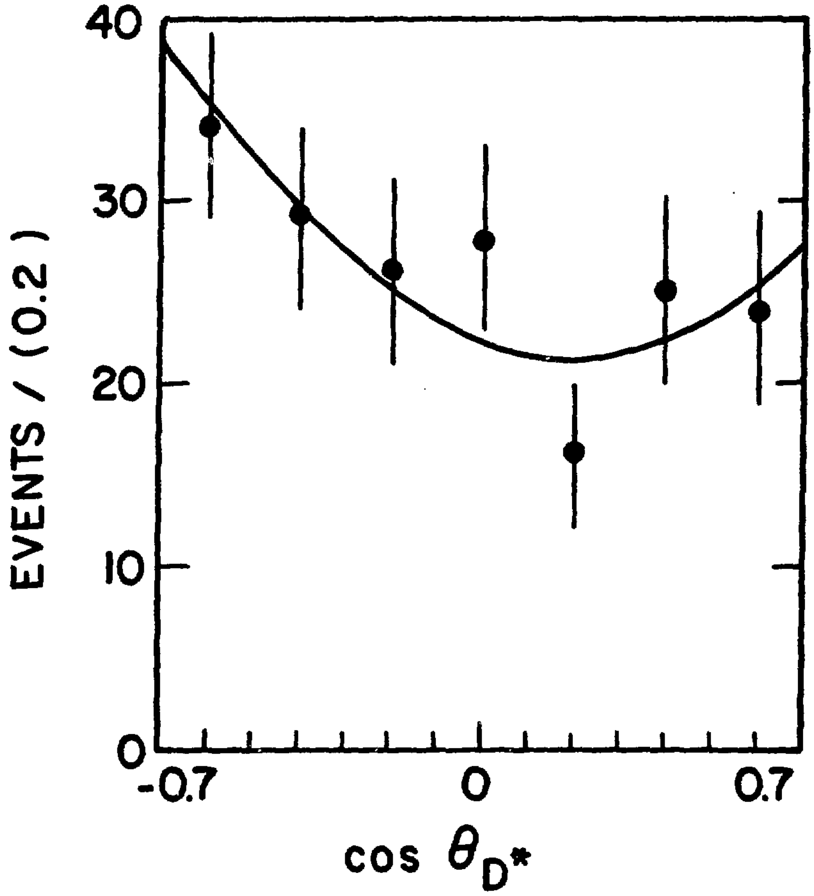

Figure 4. D^{*+} angular distribution.

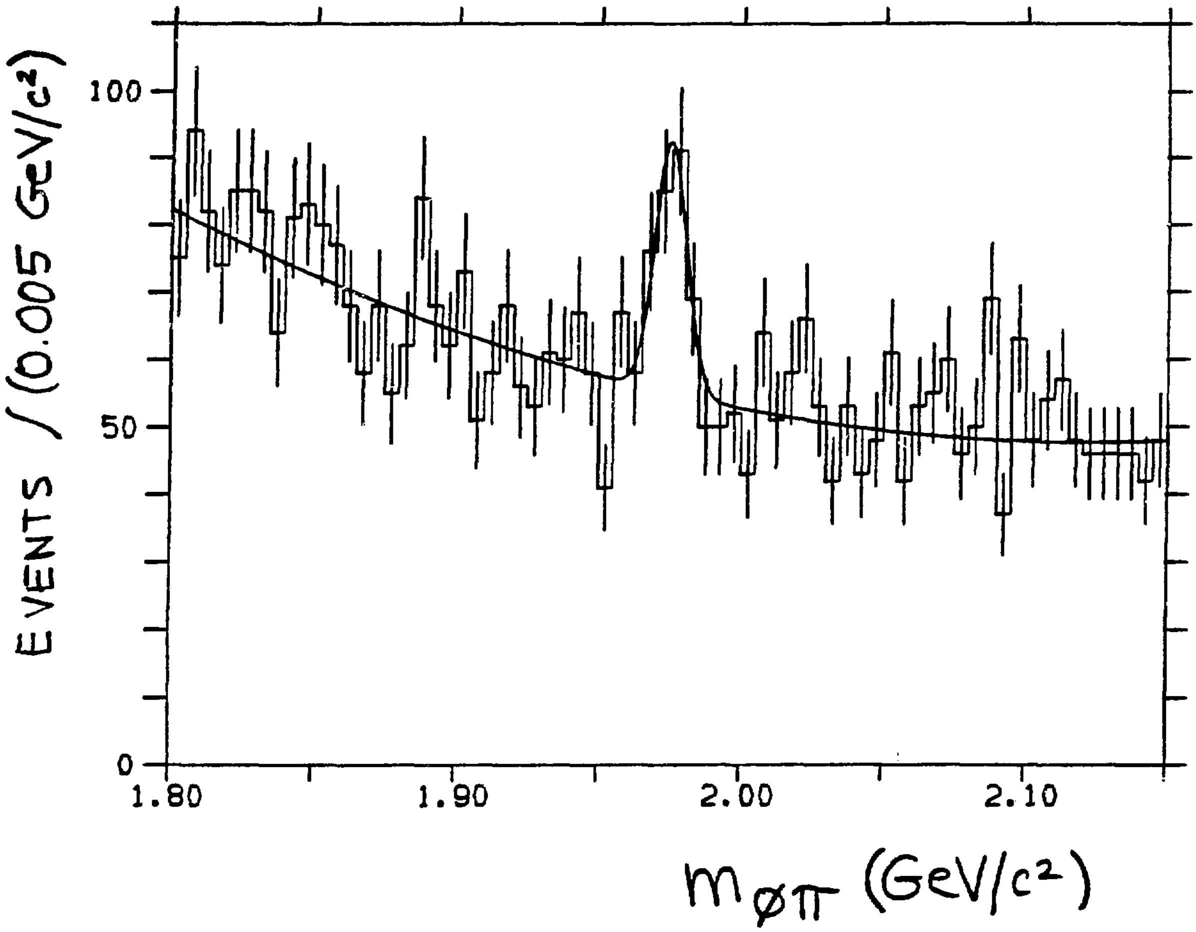

Figure 5. The $\phi\pi$ invariant mass spectrum for events where $z(\phi) \geq 0.1$ and $z(\phi\pi) \geq 0.2$. The fitted curve is a Gaussian with $m=1975$ MeV/c^2 and $\Gamma = 13$ MeV/c^2.

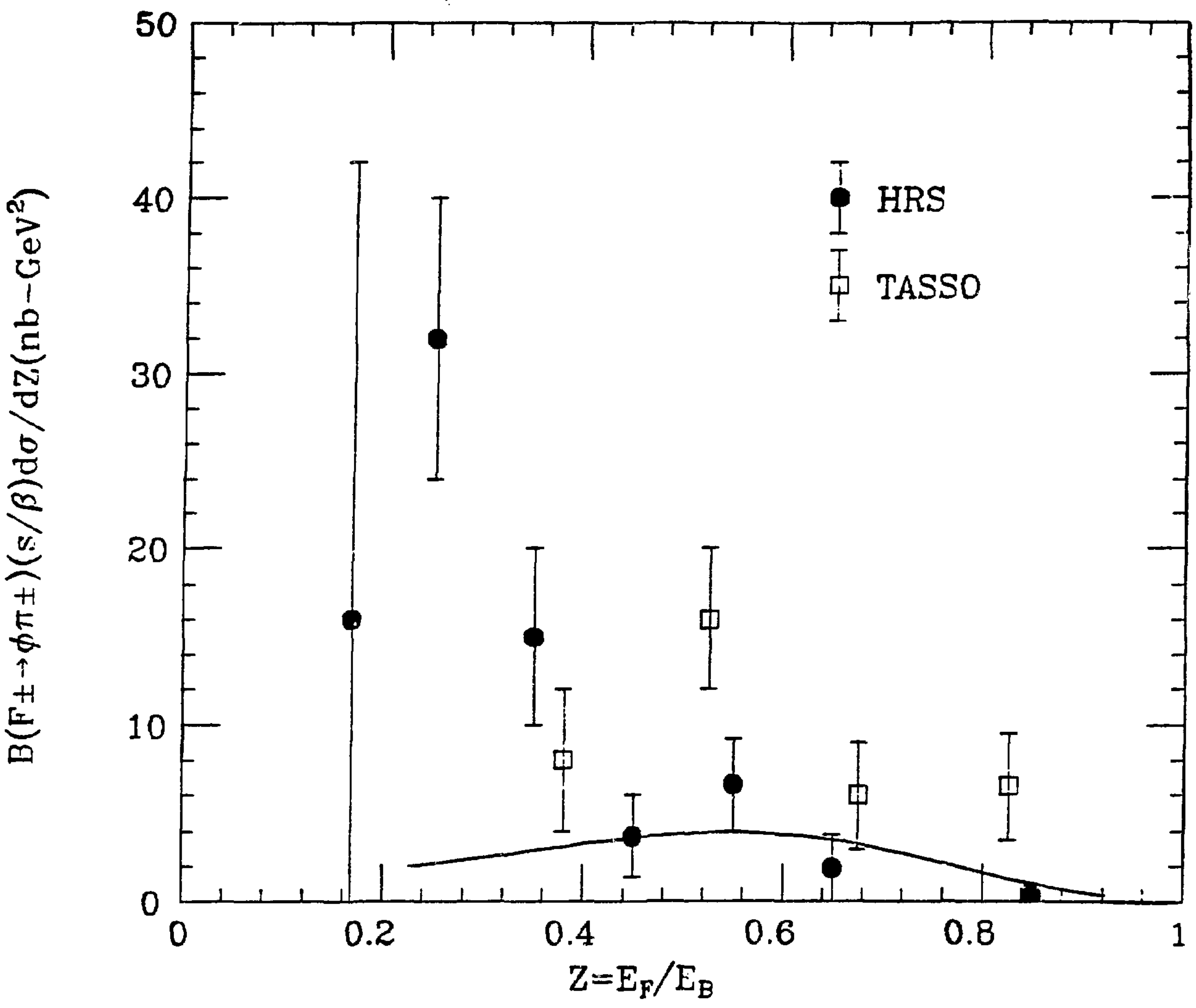

Figure 6. The F fragmentation function as measured by the HRS and TASSO collaborations. The solid curve is the Peterson form $\epsilon = 0.35$ and area as estimated from the CLEO data.