INCLUSIVE D AND D* PRODUCTION IN e^+e^- ANNIHILATIONS AT 29 GEV*

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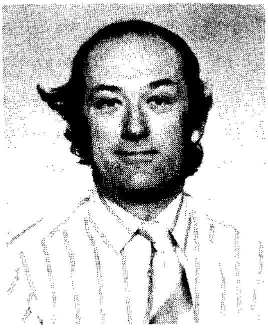

ABSTRACT

Results are presented from a preliminary analysis of an 120 pb^{-1} data sample of e^+e^- annihilations at 29 GeV from the High Resolution Spectrometer (HRS) at PEP. The excellent mass resolution of the HRS allows the study of D^* production and decay with very low background and the analysis of inclusive D^o and D^+ production. The electroweak asymmetry for D^* production is $-.15 \pm .09$ and the ratio $\sigma(D^o)/(D^*) = .6 \pm .2$ indicates a dominance of direct D^* production. The fragmentation function is presented over the range of z (= $2E_{D^*}/E_{CM}$) from .2 to 1.0.

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Charm fragmentation has been measured in e^+e^- annihilations at high energy in several experiments by measuring the charged D^* decay.[1,2,3,4] We have also presented results using D^o decay directly.[5] In this paper we will present results on a preliminary analysis of an 120 pb^{-1} data sample taken at PEP using the High Resolution Spectrometer (HRS) at a centre of mass energy of 29 GeV.[6] We have isolated samples of charmed meson production without using particle identification in the decay modes of the $D^{*+} \rightarrow D^o\pi^+$ ($D^o \rightarrow K^-\pi^+$, $K^-\pi^+\pi^+\pi^-$, $K^-\pi^+\pi^o$) and the inclusive channels $D^o \rightarrow K^-\pi^+$ and $D^+ \rightarrow K^- \pi^+\pi^+$. In all cases the change conjugate decays have also been used.

The detector, shown in Figure 1 has been described in detail elsewhere,[7,8] and is a high resolution, general purpose solenoidal detector, placed inside a superconducting magnet with a field of 1.62 Tesla. The tracking is mainly done by a 15 layer central drift chamber, the innermost and the outermost layers being situated at radii of .21 m and 1.03 m respectively. Two layers of drift tubes provide additional coordinate measurements at a radius of 1.89 m for tracks contained in the central two-thirds of the solid angle. For the 1983 data taking, 11 high pressure Cerenkov tori were installed between the inner drift chamber and the outer drift tubes to distinguish between pions and kaons. The measured momentum resolution for high momentum tracks at large angles is $\sigma_p/p = 1.0 \times 10^{-3}$ p (p in GeV/c). At 5 GeV/c, the corresponding numbers are 0.4×10^{-3} and 0.6×10^{-3}, without and with the Cerenkov counters respectively.[9] The drift chamber system is surrounded by barrel and endcap electromagnetic calorimeters comprised of lead-scintillator sandwiches. The barrel shower counter scintillators also provide time-of-flight information to separate pions from kaons up to a momentum of 1 GeV/c. The positions of the showering particles in the shower counters are measured by a set of proportional tubes.

One photon annihilation events were triggered by two or more 'tracks' found by the trigger processor in the central drift chambers or by > 4.8 GeV of energy deposited in the barrel and endcap calorimeters.

Reconstructed individual tracks from each event were fitted to a primary vertex at the intersection point. The analysis was performed with successfully fitted tracks only to avoid contributions from obvious secondary vertices, e.g. K^o's and to improve mass resolution. To reduce beam gas and two photon backgrounds a minimum multiplicity of 5 was required and that the sum of the charged track momenta be $\geq$ 7.25 GeV/c. All events passing these cuts were used in the subsequent analysis assigning both kaon and pion mass assignments to each track.

D^{*+} production was then isolated by utilizing our excellent mass resolution for all charged particle decays of the D^o which is ~ 13 MeV, and exploiting the low Q value of the decay $D^{*+} \rightarrow D^o \pi^+$ which results in a resolution of ~ 1 MeV for the quantity $\Delta = M(D^o\pi^+) - M(D^o)$. Figure 2 shows for the three different decay modes of the D^o the resulting peaks in the Δ distributions at ~ 145 MeV which indicate D^* production. The Z selection indicated for the different decay modes is made to reduce background to an acceptable level. The peak for the $D^o \rightarrow K^-\pi^+\pi^o$ is broader since we do not observe the π^o and a wide mass cut taken to select the satellite peak in $M(K\pi)$ near 1.65 GeV.

We have also observed the D^o inclusively in the region Z > .5. In order to reduce the background under the peak we have selected only those combinations with $|\cos\theta_\pi| < .7$ where θ_π is the angle of the pion with respect to the $K\pi$ line of flight in the $K\pi$ rest system. This angle is isotropic for genuine D^o decays but is sharply peaked for the background because of the two jet like nature of the events. The $K\pi$ mass spectrum is shown in Figure 3 with these kinematic cuts. A clear peak is seen with M = 1861 ± 2 MeV and σ = 13 ± 2 MeV. A similar peak on a substantial background can be seen in Figure 4 for the $D^+ \rightarrow K\pi\pi$ decay.

Preliminary cross-sections have been determined using branching fractions and an acceptance which was obtained from events generated with the LUND Monte Carlo program.[10] Figure 5 shows the fragmentation function $D(Z) = \frac{1}{\sigma}\frac{d\sigma}{dz}$ for the $D^{*+} \rightarrow K\pi\pi$ and D^o events. Fitting the data to the parameterization of Ref.[11] yields an ε of .25 ± .09.

Assuming $\sigma(D^{*+}) = \sigma(D^{*o})$ from isospin arguments, the measured total D^* cross-section, corrected for acceptance, is $\sigma(D^* + \overline{D^*}) = 0.22 \pm 0.08$ nb. In units of the point cross-section, and using a radiative correction factor of 0.93, this yields an R value of $R\,(D^* + \overline{D^*}) = 2.0 \pm 0.7$. This is to be compared to the expected inclusive R value for all charm production using $\alpha_s = .17$ of 3.53 including 0.7 units of R expected for the b decay into charm.

We have also determined the ratio $\sigma(D^o)/\sigma(D^*)$ to be .6 ± .2. This ratio which is less dependent on systemmatic errors and does not depend on the magnitude of the $D^o \rightarrow K\pi$ branching ratio is a measure of the amount of D^o which is produced directly and not due to subsequent D^* decays. Our value can be compared to .7 ± .2 which is expected if all D^o decays are from D^*. We have also used all three decay modes of the D^* to measure the production asymmetry due to electroweak interference and find a value of -.15 ± .09.

Since the D^* carries a large fraction of the available momentum it is expected that it is a primary fragment of the charm quark and we can therefore compare our value to that expected for $e^+e^- \rightarrow c\bar{c}$ of -.09.

In conclusion we have observed charmed D and D^* production and measured the fragmentation function in the range $z = 0.2 \rightarrow 1.0$. Our data is consistent with the predicted electroweak asymmetry and we find that direct D^* production is dominant.

The analysis presented here is the result of the dedicated efforts of the whole HRS collaboration which has made the experiment possible. I would like to thank my colleagues and also the technical staffs of PEP and the collaborating institutions.

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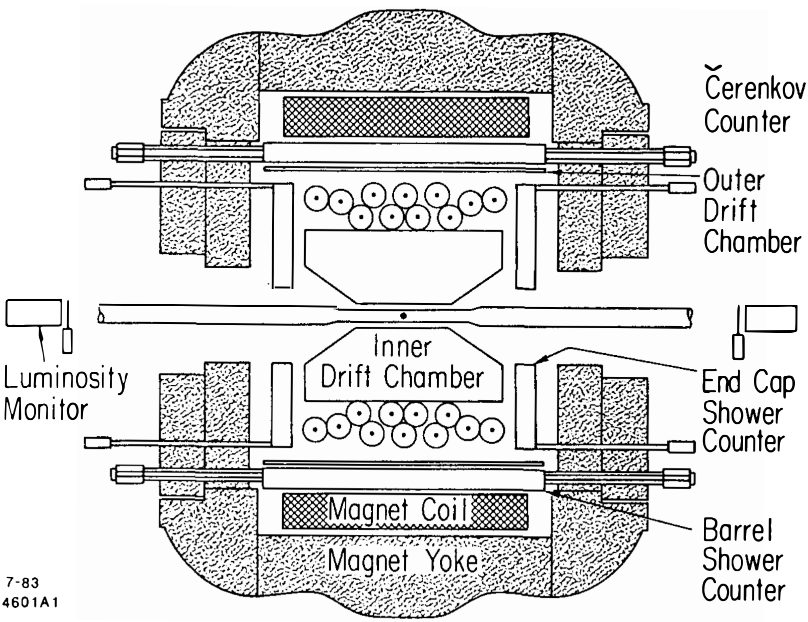

Figure 1 The High Resolution Spectrometer

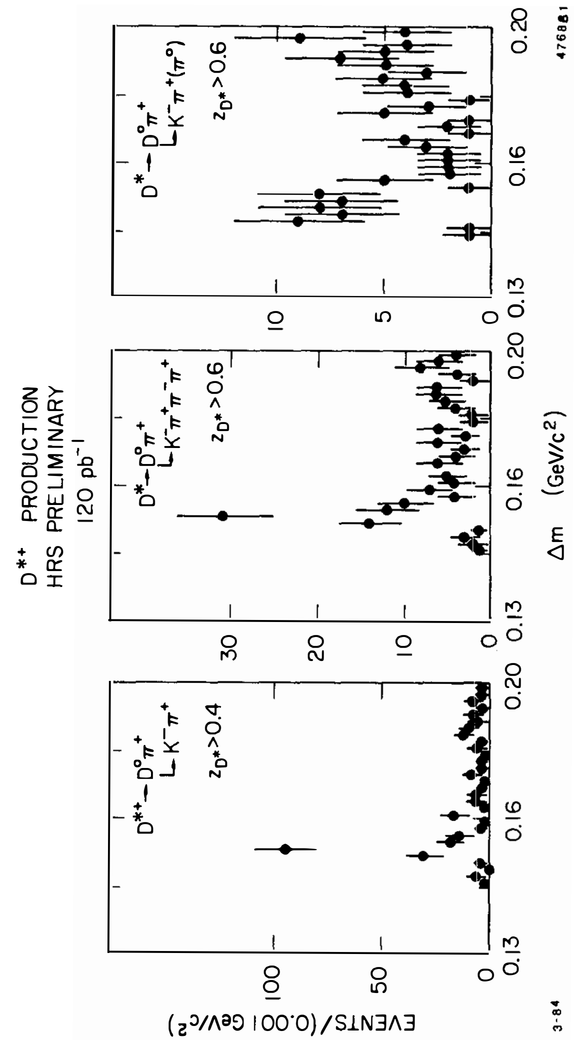

Figure 2 The Quantity $\Delta = M(D^o\pi^+) - M(D^o)$ For The Three Decay Modes Used For The D^* Analysis

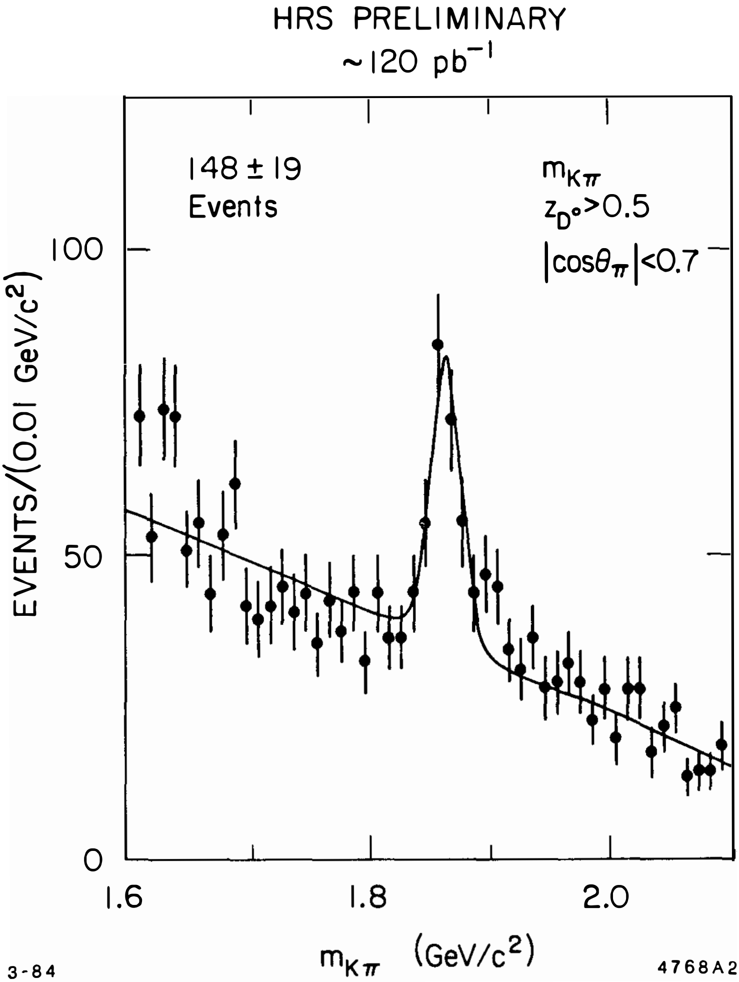

Figure 3 Inclusive Kπ Mass Spectrum

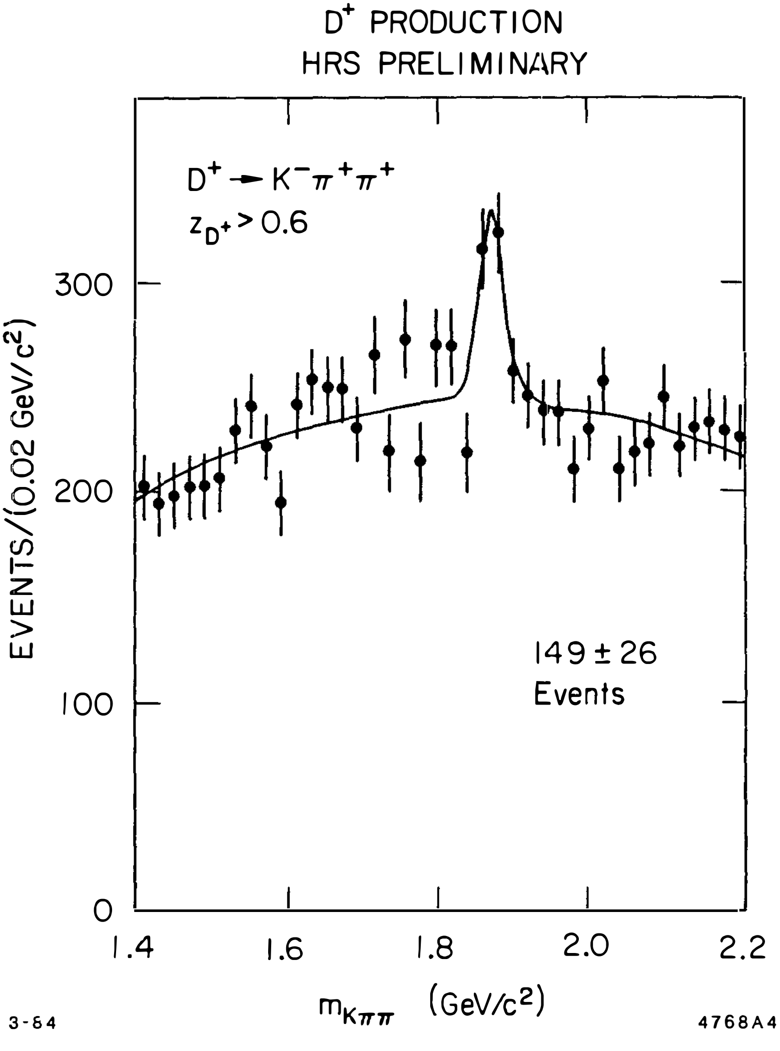

Figure 4 Inclusive $K^-\pi^+\pi^+$ Mass Spectrum

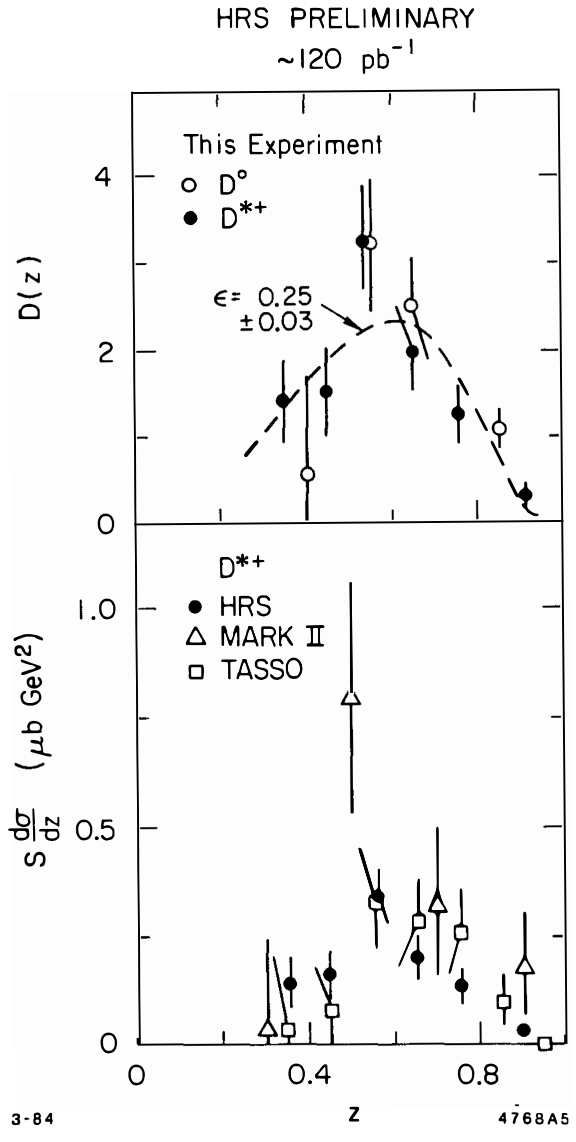

Figure 5 Fragmentation function of the D^o and D^* Mesons