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JET PRODUCTION AND QUARK FRAGMENTATION RESULTS FROM PEP

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INTRODUCTION

Results on jet production and quark fragmentation are presented from the five detectors at the PEP e^+e^- storage ring at the Stanford Linear Accelerator Center: DELCO (Caltech–SLAC–Stanford), HRS (Argonne–Indiana–LBL–Michigan–Purdue–SLAC), MAC (Colorado–Frascati–Houston–Northeastern–SLAC–Stanford–Utah–Wisconsin), MARK II (SLAC–LBL–Harvard), and TPC (LBL–Johns Hopkins–UCLA–UC Riverside–Yale). All data were taken at a center-of-mass energy ($E_{c.m.}$) of 29 GeV. The topics which will be discussed are particle identification, charge and multiplicity correlations, energy correlation asymmetry, D^* and D production and fragmentation, and heavy quark fragmentation results from inclusive lepton studies. PEP ran very well this year with 150 pb^{-1} delivered during the past running period. It will take the experiments some time to fully analyze this data.

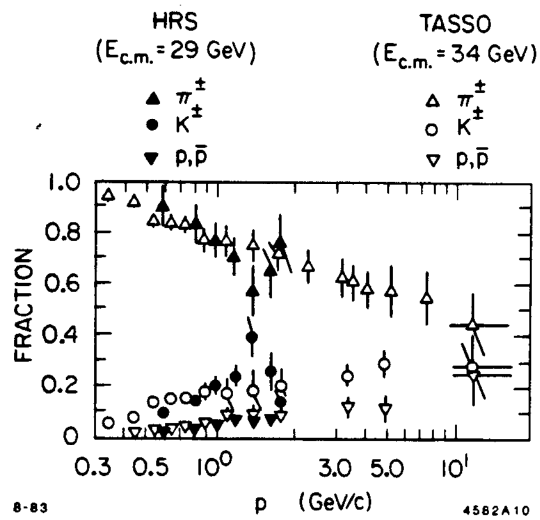

Fig. 1. Preliminary (19.6 pb^{-1}) charged hadron fractions from HRS.

PARTICLE IDENTIFICATION

HRS, TPC and DELCO have made preliminary measurements of inclusive charged π, K and p fractions as a function of particle momentum. Their data are shown in Figs. 1, 3 and 4, respectively. A plot of dE/dx versus particle momentum for the TPC is shown in Fig. 2; they obtain an rms resolution of 3.65%. All the data are compared with TASSO[1] data at $E_{c.m.}$ = 34 GeV; the data are basically in agreement and show an approach towards equality at the highest momenta.

TPC has made preliminary measurements of the inclusive π^0 cross section $(s/\beta)\, d\sigma/dx$, where $s = E^2_{c.m.}$ and $x = 2E_{\pi^0}/E_{c.m.}$, shown in Fig. 5. The results agree with previous measurements. They have also isolated a K^{0*} signal and a ϕ signal.

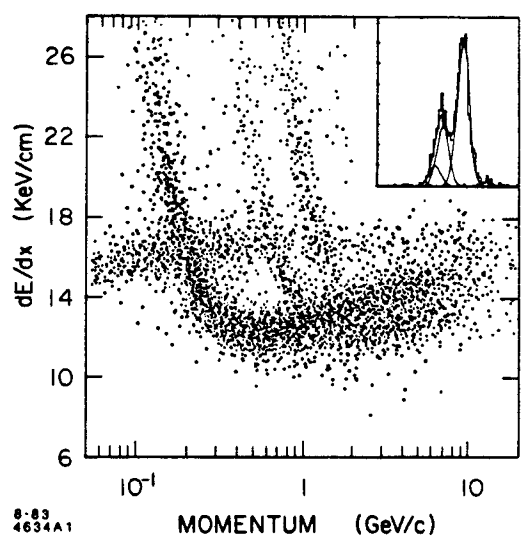

Fig. 2. Preliminary dE/dx versus momentum distribution from TPC.

CHARGE AND MULTIPLICITY CORRELATIONS

The TPC group finds no evidence for correlations in multiplicity between the two jets in an event, other than those introduced by event selection and acceptance, as shown in Fig. 6. Figure 7 shows the TPC measurement of negative jet charge product versus rapidity gap; they find a short-range correlation

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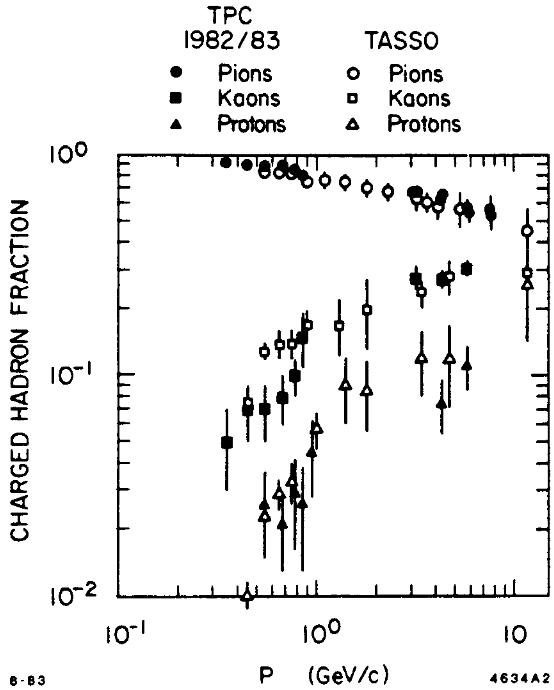

Fig. 3. Preliminary (13 pb^{-1}) charged hadron fractions from TPC.

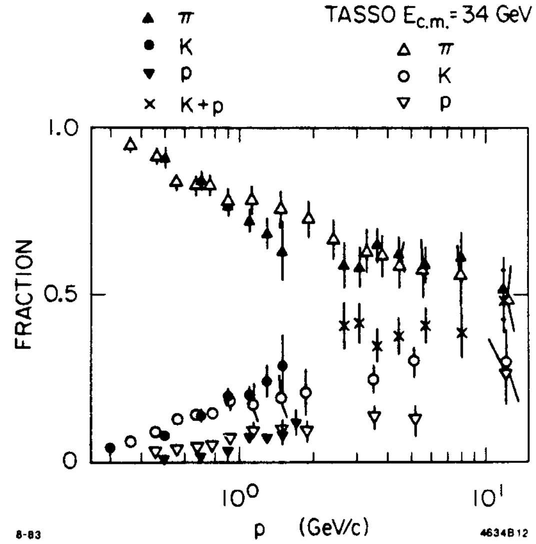

Fig. 4. Preliminary (21.4 pb^{-1}) charged hadron fractions from DELCO.

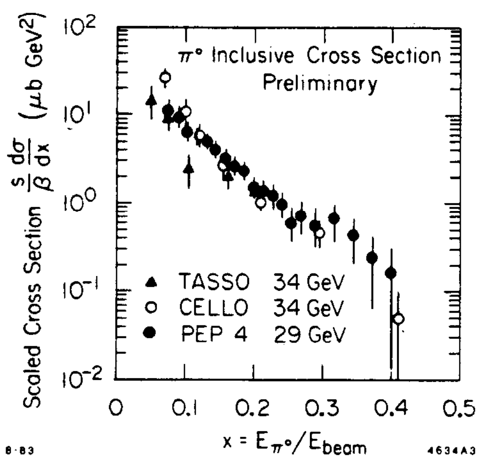

Fig. 5. Preliminary π^0 inclusive x distribution from TPC.

at small rapidity gap and evidence for a long-range correlation at large rapidity gap. The data all agree with the predictions of the Lund model.

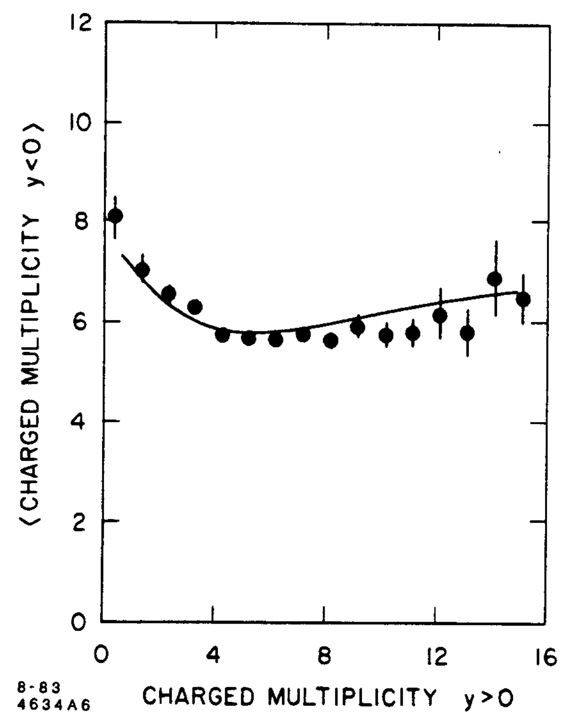

Fig. 6. Preliminary mean charged multiplicity for y < 0 versus charged multiplicity for y > 0 from TPC. The solid curve is the Lund model prediction.

ENERGY-ENERGY CORRELATIONS

The corrected energy-energy correlation asymmetry[2] measurement made by the MAC collaboration is shown in Fig. 8. They compare their data to a Monte Carlo version of the Lund model (LUND82) which has some terms to second order in α_s, the strong coupling constant, but no second order virtual corrections. For independent parton fragmentation (ICJ) they find $\alpha_s = 0.13$ is consistent with the data, whereas for color string fragmentation (STR) $\alpha_s = 0.24$ is indicated and $\alpha_s = 0.13$ is inconsistent. Other groups have found similar effects, although the MARK J group finds agreement in the values of α_s for the two fragmentation schemes.[2] The second order virtual terms are important, and more work is needed on the model dependence.

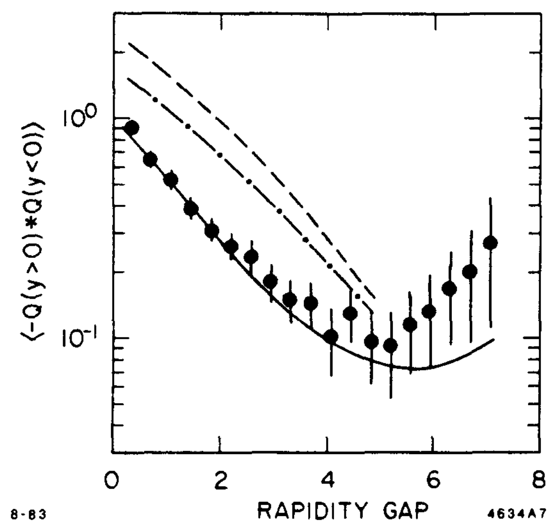

Fig. 7. Preliminary mean product of jet charges versus rapidity gap from TPC. The solid curve is the prediction of the Lund model. The dashed and dot–dashed curves are the predictions of the Lund model with randomized charges and randomized charges of the primary particles, respectively.

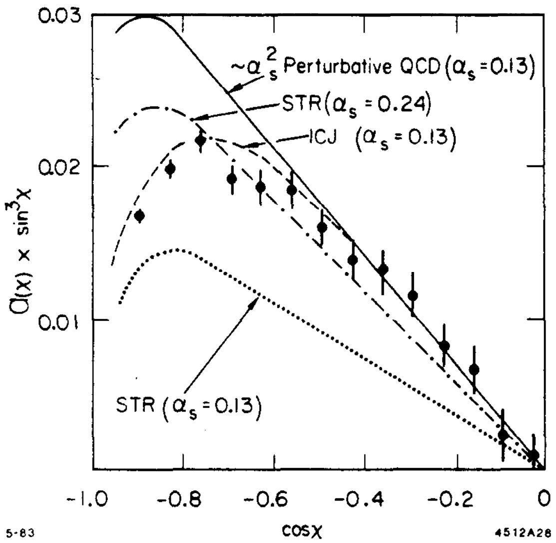

Fig. 8. Preliminary (49 pb^{-1}) energy–energy correlation asymmetry measurement from MAC. An additional ± 15% systematic error should be added to the statistical errors.

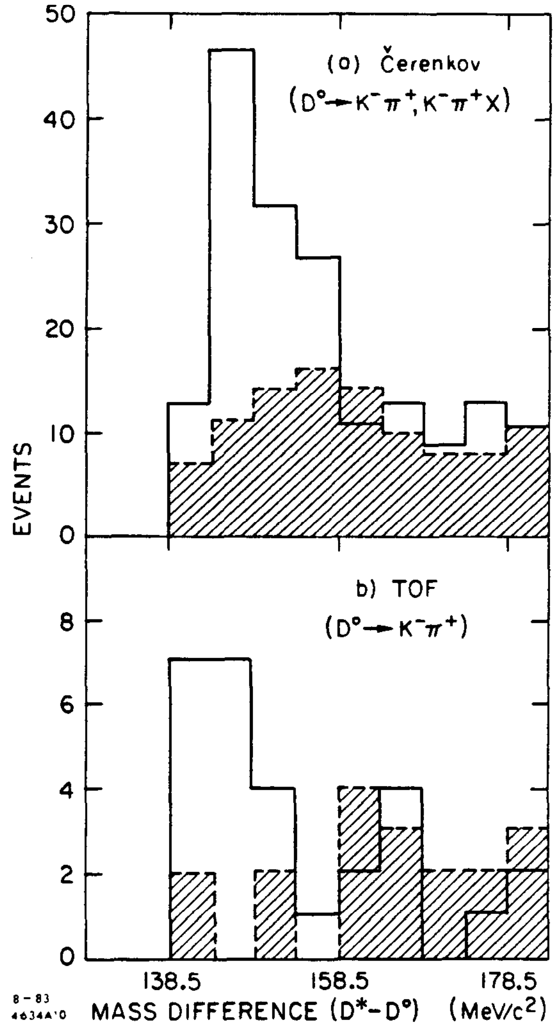

Fig. 9. $D^0 \pi^+ - D^0$ mass difference from DELCO.

D^* AND D PRODUCTION AND FRAGMENTATION

The HRS and DELCO collaborations have new measurements of charm production cross sections and fragmentation functions. $D^{*\pm}$'s were selected by cuts on the D^*-D^0 mass difference. DELCO data, based on 90 pb^{-1} integrated luminosity, are shown in Fig. 9. The HRS analysis is based on 19.6 pb^{-1}; they also report more preliminary results based on an 80 pb^{-1} sample. HRS data are shown in Fig. 10. DELCO finds $\sigma(D^{*+} + D^{*-}) = 0.17 \pm 0.02 \pm 0.05$ nb, based on an average over three D^0 decay modes. (For this talk the first error given is statistical and the second systematic.) HRS measures $\sigma(D^{*+} + D^{*-}) = 0.10 \pm 0.04$ nb for the 19.6 pb^{-1} sample and 0.11 ± 0.04 nb for the 80 pb^{-1} sample. MARK II[3] found 0.25 ± 0.13 nb. These cross sections can be compared to the total cross section for b and c quark production, $2\sigma_{c\bar{c}} + 2\sigma_{b\bar{b}} = 0.39$ nb, which includes radiative and QCD effects.

The inclusive D^* z-distribution ($z = 2E_{D^*}/E_{c.m.}$) $(s/\beta)\,d\sigma/dz$ has been measured by DELCO and HRS and is shown in Fig. 11. Both collaborations have seen a D^* signal for $0.2 < z < 0.4$, whereas MARK II[3] saw no obvious signal for $z < 0.4$. The mean z-values found are 0.56 ± 0.02 from HRS (19.6 pb^{-1}) and $0.57 \pm 0.02 \pm 0.05$ from DELCO; MARK II[3] found 0.59 ± 0.06 for $z_{D^*} > 0.2$. The z-distribution has been fitted to the form[4]

$$D_Q(z) = \frac{A}{z\left[1 - \frac{1}{z} - \frac{\epsilon_Q}{1-z}\right]^2} \quad . \qquad (1)$$

HRS finds $\epsilon_c = 0.36 \pm 0.12$ from the 19.6 pb^{-1} sample and $\epsilon_c = 0.29 \pm 0.10$ from the 80 pb^{-1} sample. DELCO finds that the shape of the z-distribution is not sensitive to ϵ_c.

HRS has measured D^0 and D^+ production directly, that is, without requiring a D^*. Their invariant mass distributions are shown in Fig. 12. For the 19.6 pb^{-1} sample they obtain $D^0/D^* = 1.7 \pm 0.7$ for $z_{D^*} > 0.4$; this ratio would be expected to be 0.7 if all D^0's came from D^*'s. They also find $D^0/D^+ = 2.3 \pm 1.2$ for $z_D > 0.5$. Their measurements favor some amount of direct D production.

HEAVY QUARK FRAGMENTATION RESULTS FROM INCLUSIVE LEPTONS

Prompt leptons can be used as a powerful probe of heavy quark fragmentation; they can also be used to tag events containing heavy quarks.

The MARK II group has studied electrons and muons in a data sample corresponding to 35 pb^{-1} integrated luminosity. The electron analysis has been published,[5] but an improved analysis is reported here. The electrons are identified in lead-liquid-argon calorimeters covering 64% of the solid angle. Muons are identified using an iron-proportional-tube system covering 45% of the solid angle. After corrections for efficiencies and backgrounds, the data is binned in momentum (p) and transverse momentum relative to the thrust direction (p_T) and fitted by a maximum likelihood method to contributions from charm and bottom semileptonic decays. The contributions are simulated using a Monte Carlo calculation including Ali, *et al.*, QCD effects, Feynman-Field hadronization, and heavy quark fragmentation functions as represented in Eq. (1); $\epsilon_c = 0.25$ was assumed. The results of the fits are given in Table I.

The MAC collaboration[6] has performed a similar analysis based on prompt muons in a data sample corresponding to 54 pb^{-1} integrated luminosity. Muons are detected in drift chambers

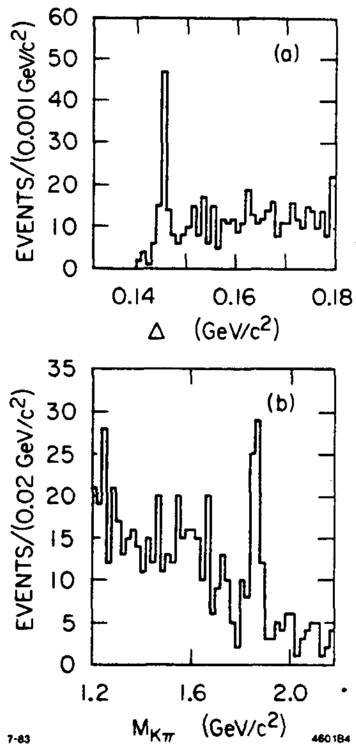

Fig. 10. Preliminary (80 pb^{-1}) HRS data showing (a) $\Delta = D^0\pi^+ - D^0$ mass difference for $1.81 \le M(K^\pm\pi^\mp) < 1.92$ GeV/c^2 and (b) $K^\pm\pi^\mp$ invariant mass for $143 < \Delta < 148$ MeV/c^2.

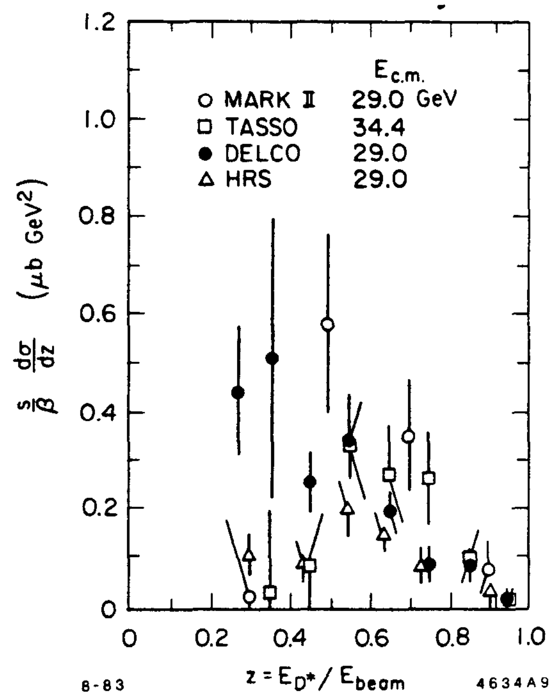

Fig. 11. Corrected inclusive distribution $(s/\beta)\,d\sigma/dz$ for D^*'s from various experiments.

covering 77% of the solid angle outside the calorimeters. Their results are listed in Table I.

Both collaborations find a hard bottom fragmentation function. A b-enriched region can be defined by requiring that the lepton have large p_T. For $p > 2$ GeV/c and $p_T > 1$ GeV/c MARK II finds 20% background from misidentified hadrons, 16% contribution from semileptonic decays of charmed hadrons, and 64% contribution from bottom decays. Such a sample can be used for further studies of bottom hadrons.

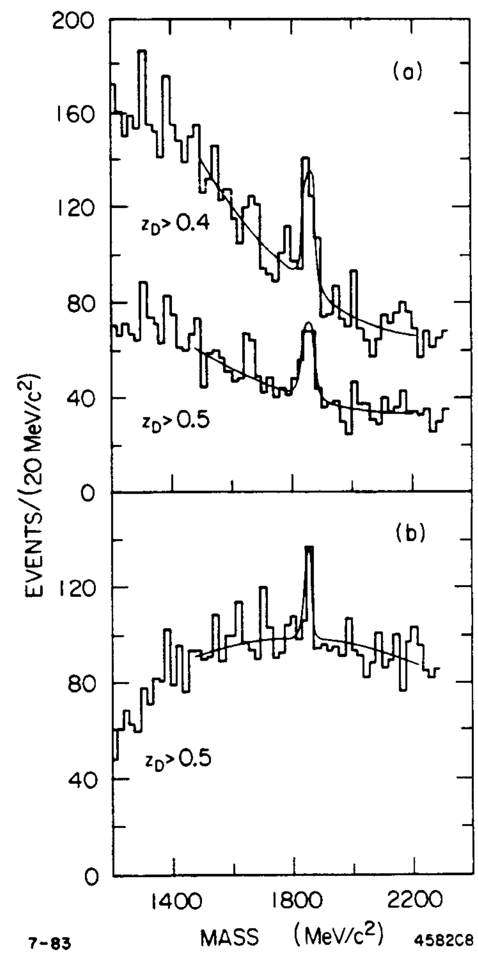

Fig. 12. Preliminary HRS data showing (a) $K^{\pm}\pi^{\mp}$ invariant mass distribution for $z_D \geq 0.4$ and $z_D \geq 0.5$, and (b) $K^{\mp}\pi^{\pm}\pi^{\pm}$ invariant mass distribution for $z_D \geq 0.5$. The curves shown are the fits used to extract the cross sections.

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TABLE I. FITS TO PROMPT LEPTON SIGNALS

	MARK II e's	MARK II μ's	MAC μ's
$B(b \to \ell X)$	$(13.5 \pm 2.6 \pm 2.0)\%$	$(12.6 \pm 5.2 \pm 3.0)\%$	$(15.5^{+5.4}_{-2.9})\%$
$B(c \to \ell X)$	$(6.6 \pm 1.4 \pm 2.8)\%$	$(8.3 \pm 1.3 \pm 1.8)\%$	$(7.6^{+9.7}_{-2.7})\%$
ϵ_b	$0.015^{+0.022+0.023}_{-0.011-0.011}$	$0.042^{+0.218+0.120}_{-0.041-0.035}$	$0.008^{+0.037}_{-0.008}$
$\langle z_b \rangle$	$0.79 \pm 0.06 \pm 0.06$	$0.73 \pm 0.15 \pm 0.10$	0.8 ± 0.1