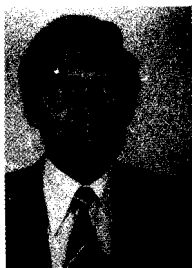


JET LIKE PROPERTIES OF MULTIPARTICLE SYSTEMS PRODUCED
IN K^+p INTERACTIONS AT 70 GeV/c.

Brussels-CERN-Genova-Mons-Nijmegen-Serpukhov Collaboration

F. GRARD

Faculté des Sciences, Université de l'Etat, Mons, Belgique



Abstract :

Using a sample of non-diffractive events from K^+p interactions at 70 GeV/c in BEBC, extensive comparisons are made between the hadronic low p_T data and results from hard jet production in e^+e^- annihilations and in deep inelastic ν -N interactions at comparable hadronic energies. Many similarities are found between low- p_T jets in this experiment and jets observed in leptonic interactions. Our data are very well reproduced by the Field and Feynman quark fragmentation parametrisation but equally well by a simple longitudinal phase space model, suggesting that these similarities do not prove or disprove the universal character of the jet fragmentation.

In recent years, hadron production in e^+e^- annihilations and in deep inelastic lepton-nucleon interactions as well as in high transverse momentum hadron-hadron collisions have been successfully interpreted in terms of quark-parton models.

In low p_T hadron-hadron collisions, the bulk of particles are produced in forward-backward jets, aligned along the incident beam direction. Striking similarities have been observed between these jets and those found in the above so-called hard processes. They would suggest that the quark-parton picture could be extended to hadron-hadron collisions at low p_T .

Using data from an exposure of BEBC filled with hydrogen to a RF separated K^+ beam having a nominal momentum of 70 GeV/c¹⁾, corresponding to a c.m. energy of 11.5 GeV, we have made extensive comparisons between the hadronic low p_T data and data from hard-jet production in e^+e^- and neutrino induced reactions at comparable available energies²⁾.

The analysis is based on a partial sample of 9561 complete well measured events having at least four charged outgoing tracks. All charged particles were assumed to be pions, unless identified as protons by ionization. Neutral particles were identified by kinematical fitting. All measured particles were included in the analysis.

In order to compare our results to leptonic data, the influence of the diffractive component in hadronic interactions has been reduced by removing from the sample the events having at least one leading particle with $|X| > 0.8$. This cut affects 18.3 % of the events, mainly with 4 and 6 prongs.

The data have also been compared to the predictions of two models : a Field and Feynman model (FF) and a simple uncorrelated longitudinal phase space model (LPS). The parameters in these models were adjusted in such a way that the generated events reproduce the multiplicity and P_T distributions observed in our experiment.

In the FF simulation, two back to back quark jets have been generated by allowing only one valence quark from each of the colliding particles to fragment into hadrons. The σ_q parameter which accounts for the quark intrinsic p_T distribution has been extended from its original value of 250 MeV/c to

300 MeV/c³). The FF Monte Carlo reproduces quite well the measured charged particle multiplicity.

In the LPS model, n-particle exclusive reactions were generated according to the matrix element

$$|M|^2 = \prod_{i=1}^n e^{-B(y_i)m_{Ti}}$$

where m_{Ti} is the transverse mass of particle (i) calculated with respect to the beam direction. $B(y_i)$ are rapidity dependent parameters taken from the experimental inclusive single particle distributions. The various exclusive channels containing π^+ , p, n, K^0 and π^0 particles were properly weighted using the measured average charged and neutral multiplicities.

All generated events were analysed in the same way as the experimental data.

The data have been analysed in terms of the sphericity, thrust and sphericity variables⁴⁾. In principle, the sphericity, thrust and sphericity axes should coincide. In practice, they do not and the average angle between these axes is a measure of the precision with which either of them can be determined experimentally. This average angle is about 10°. It is interesting to note that the average angle between the jet axes and the beam direction has also about the same value. Also of interest is the fact that the above models account quite well for this observed spread in the direction of the jet axes.

In Fig. 1, the normalized sphericity, thrust and sphericity distributions are represented and compared to e^+e^- and ν -N data, as well as with the FF and LPS predictions. In Fig. 2, the average values $\langle S \rangle$, $\langle T \rangle$, $\langle S' \rangle$ are compared with leptonic data plotted over a wide range of energy. There is very good agreement between the various sets of data.

The average multiplicity for non diffractive events with $n_c \geq 4$ is 7.07 ± 0.03 , a value which agrees quite well with leptonic results at the same hadronic energy²⁾. In Fig. 3, the multiplicity distribution in a KNO plot is compared to e^+e^- results. We observe a good agreement with these data when the diffractive component is removed, whereas the corresponding distribution for the complete sample exhibits a quite different

shape (full line).

Fig.4 shows the normalized p_T^2 distribution relative to the sphericity axis. It agrees well with the e^+e^- data for $p_T^2 < 0.5$. At higher p_T^2 , the TASSO data are slightly above our data. This effect is most probably due to the higher energy used for the comparison.

The normalized rapidity distribution of the charged particles, in the overall c.m. system, evaluated with respect to the thrust axis, is shown in Fig. 5. To avoid the asymmetry due to the backward identified protons, we use only particles produced forward in the total c.m. The TASSO results at $\sqrt{s} = 13$ GeV are represented also for comparison. Both distributions are compatible with each other and have a clear plateau practically at the same height at y close to 0. The insert shows that the K^+p data are in agreement with the linear dependence of the height of the plateau on $\ln E_{cm}$ found in e^+e^- .

The average p_T and p_L as well as the average p_L evaluated by considering only secondary particles with $X > 0.1$ to suppress the non scaling part of the single particle distribution are represented on Fig. 6 together with PLUTO data plotted as a function of $\sqrt{s}$. Both sets of data are here also in very good agreement.

In conclusion, we find good agreement between the collective properties of low p_T "jets" in non diffractive K^+p interactions and of jets in leptonic induced reactions at the same available energy. In particular, the average charged particle multiplicity and p_T^2 distributions are very similar.

Furthermore, both Monte-Carlo models (LPS and FF) describe the data equally well and yield very similar predictions. This is not unexpected since the input to the models is essentially the same, namely the average charged particle multiplicity and transverse momentum distribution. We conclude that these two features alone account for many of the similarities observed.

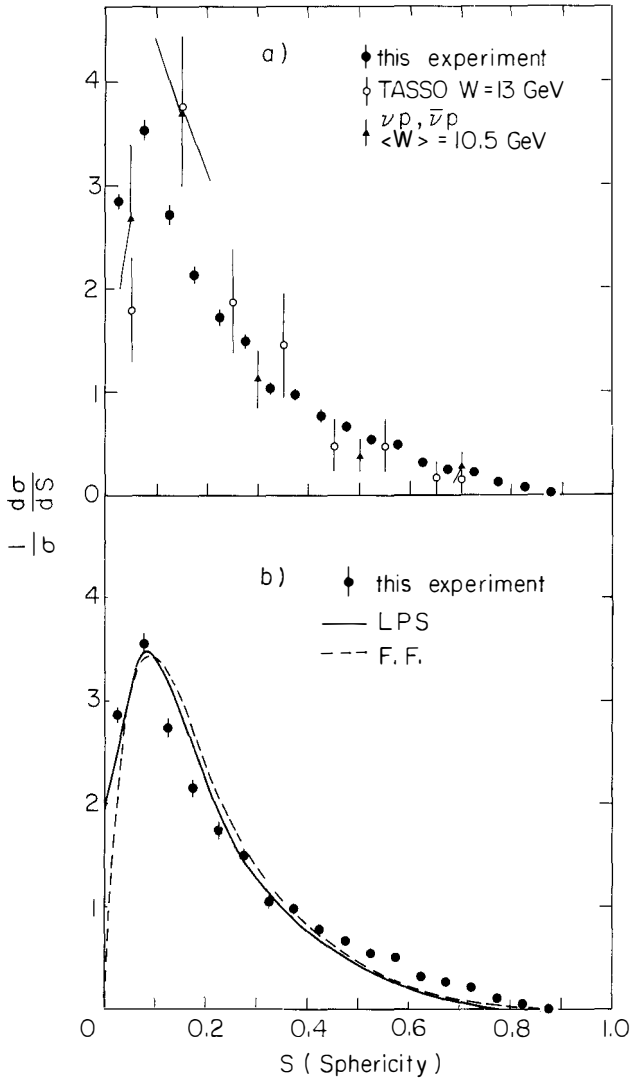


Fig. 1A

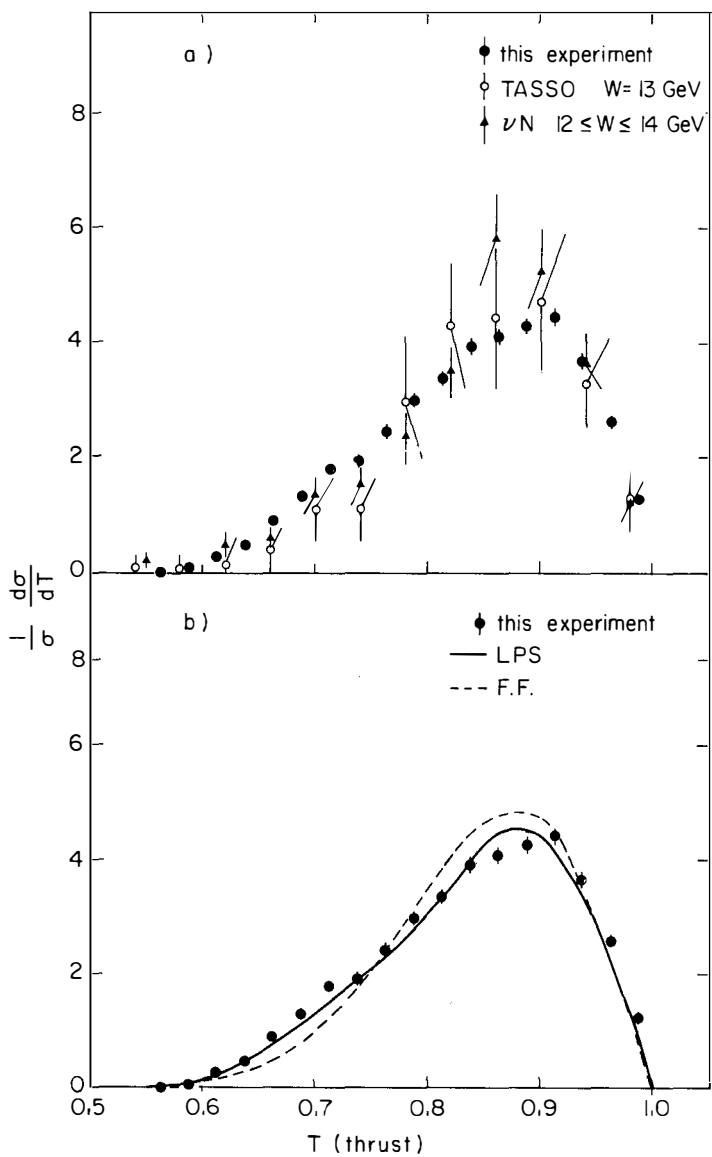


Fig. 1B

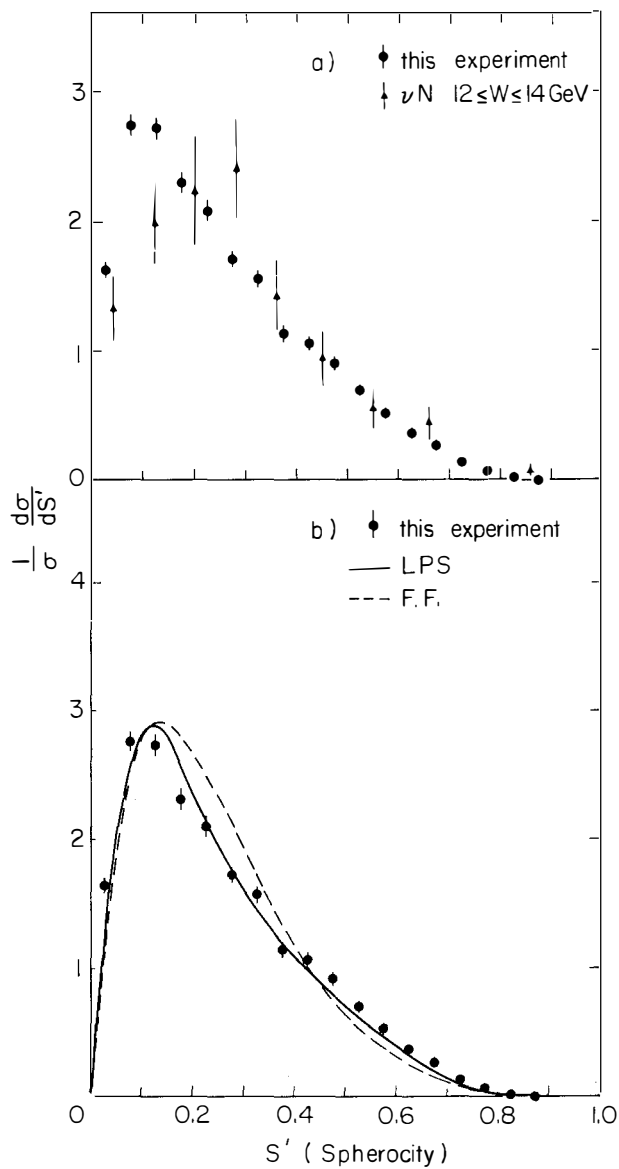


Fig. 1C

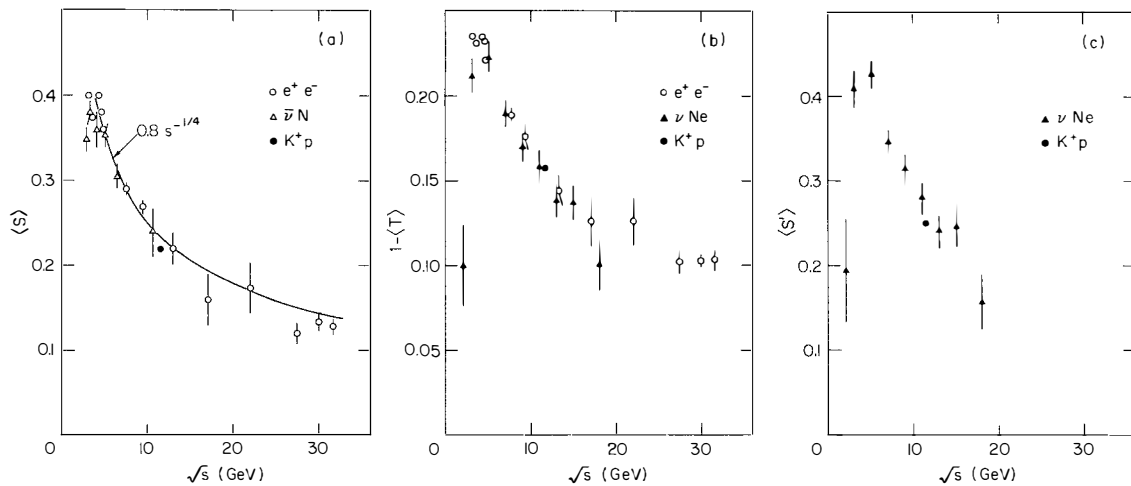
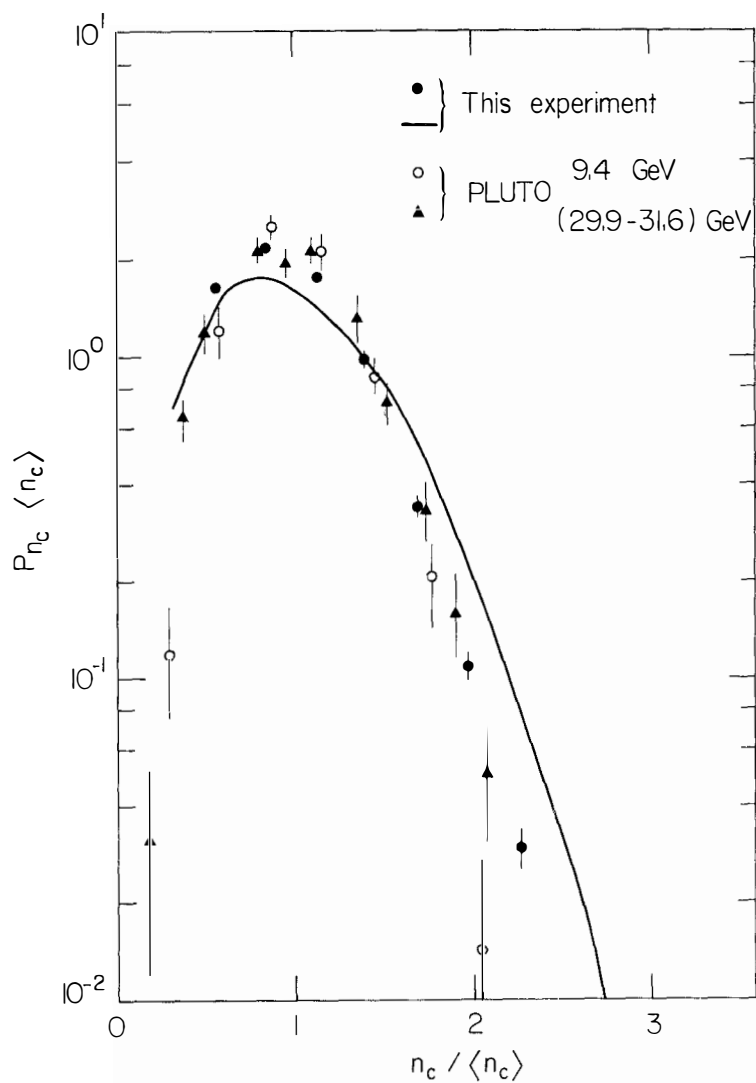


FIG. 2



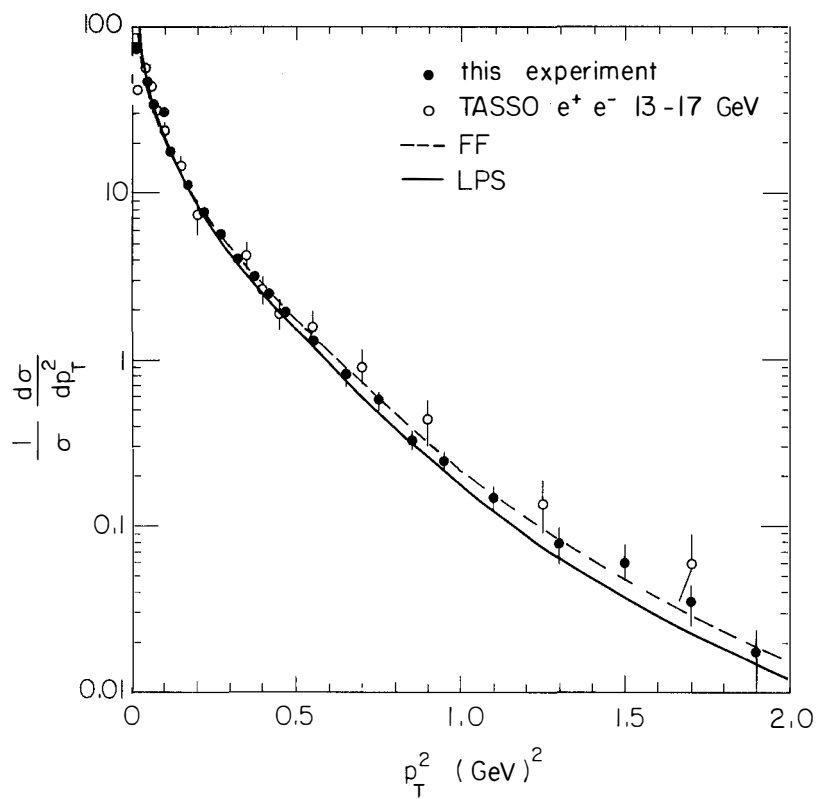


Fig. 4

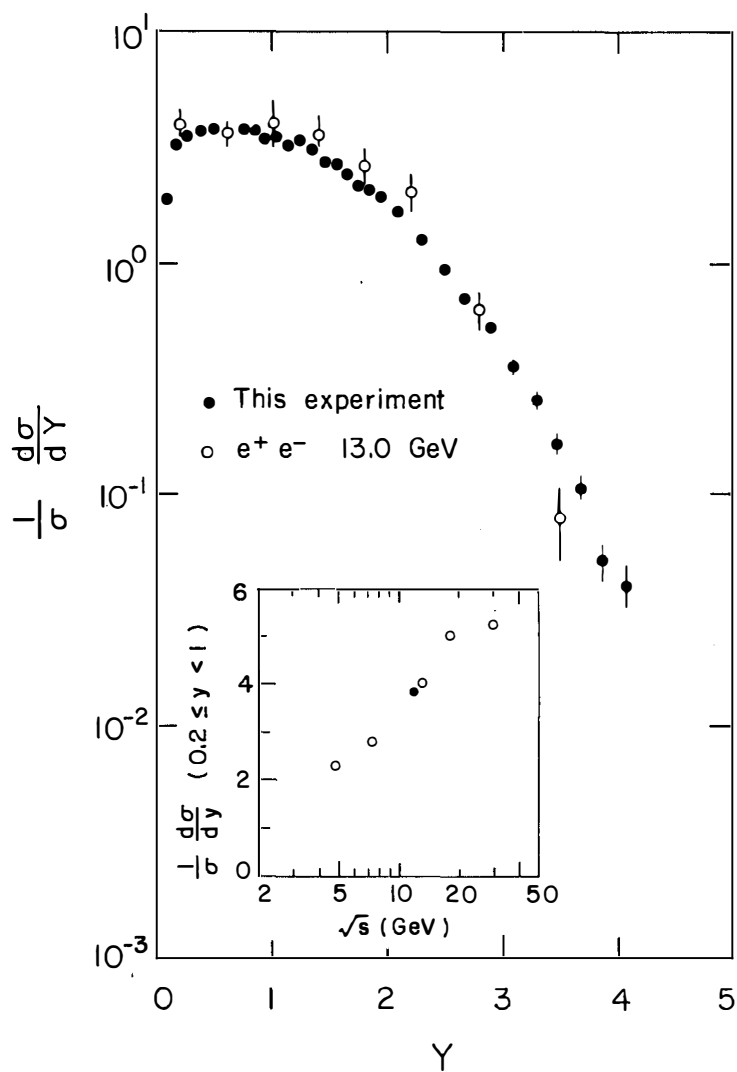


Fig. 5

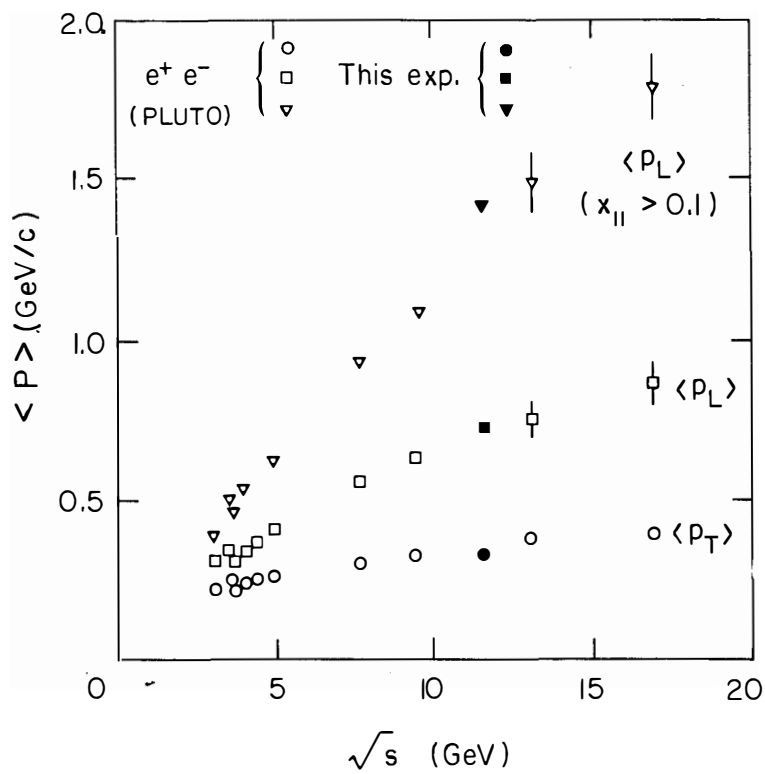


Fig. 6