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M. Basile et al. : THE TRANSVERSE-MOMENTUM DISTRIBUTIONS
OF PARTICLES PRODUCED IN pp REACTIONS AND COMPARI-
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The Transverse-Momentum Distributions of Particles Produced in pp Reactions and Comparison with e^+e^- .

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Summary. - Following our previous work, the comparison of the properties of multihadron systems, produced in high-energy pp reactions, with hadron jets produced in e^+e^- annihilation, is further extended through the study of the inclusive distributions in the «reduced» variable $p_T/\langle p_T \rangle$.

A good agreement with e^+e^- data is found.

Introduction. - We have recently reported ⁽¹⁻⁷⁾ the results of a new method for studying the multiparticle production properties in pp reactions and comparing them with e^+e^-

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annihilation. The basic point was to remove the leading-particle effect. This analysis has shown that multiparticle systems produced in pp reactions have remarkable similarities with multiparticle systems produced in e^+e^- annihilation.

In this paper the comparison with e^+e^- is further extended to the study of the inclusive transverse-momentum distributions. Recently ⁽⁸⁾ the inclusive p_T distributions in e^+e^- hadronic final states have been measured in terms of the « reduced » variable $p_T/\langle p_T \rangle$, where p_T is the transverse momentum of the particle produced, and $\langle p_T \rangle$ is the average transverse momentum of all charged particles produced, defined as follows:

$$\langle p_T \rangle = \frac{1}{N} \sum_{i=1}^N (p_T)_i$$

with N being the total number of particles. The experimental study ⁽⁸⁾ of multiparticle systems produced in e^+e^- annihilation has shown that the distributions in the « reduced » variable $p_T/\langle p_T \rangle$ at different e^+e^- c.m. energies ($\sqrt{s} = 9.4$ GeV and $\sqrt{s} = 30$ GeV) are the same.

The occurrence of this scaling was recently shown to be a consequence of QCD ⁽⁹⁾. This means that the particle distribution in this « reduced » variable $p_T/\langle p_T \rangle$ is a basic property of the hadronization processes.

The purpose of the present paper is to study these distributions when multiparticle systems are produced in pp reactions.

Experimental apparatus and data analysis. — The experiment was performed at the CERN Intersecting Storage Rings (ISR) with pp total c.m. energy, $\sqrt{s} = 62$ GeV. A description of the apparatus and data collection has already been given elsewhere ^(1-7,10). The set-up consisted mainly of a large-volume magnetic field, coupled to a powerful system of multiwire proportional chambers (MWPCs). This set-up was used in the simplest possible mode, *i.e.* with a « minimum bias » trigger ⁽¹⁻⁷⁾.

As in our previous papers ⁽¹⁻⁷⁾, where a more detailed description of the method can be found, events with a leading proton detected in the apparatus are selected out of a sample of « minimum bias » events. The systems of particles produced in the same hemisphere as that of the leading proton are studied for different intervals of the hadronic energy $E_{\text{had}} = \frac{1}{2}\sqrt{s} - E_{\text{leading}}$ (where $E_{\text{leading}} \equiv$ energy of the leading proton).

The transverse momentum p_T of the particles produced is evaluated with respect to the direction of the missing momentum $\mathbf{p}_{\text{miss}} = \mathbf{p}_{\text{beam}} - \mathbf{p}_{\text{leading}}$ (where $\mathbf{p}_{\text{leading}} \equiv$ momentum of the leading proton). In order to be considered for the analysis, the particles of a given event had to satisfy the very simple conditions: i) to fit the event vertex to within ± 5 cm; ii) to have a momentum resolution $\delta p/p < 30\%$. Corrections for the acceptance of the apparatus have been applied using Monte Carlo simulation.

Results. — The results are presented in fig. 1 for two energy bands ($8 \text{ GeV} \leq 2E_{\text{had}} \leq 16 \text{ GeV}$ and $24 \text{ GeV} \leq 2E_{\text{had}} \leq 32 \text{ GeV}$).

The analysis is based on 1255 events for the range $8 \text{ GeV} \leq 2E_{\text{had}} \leq 16 \text{ GeV}$, and on 2705 events for the range $24 \text{ GeV} \leq 2E_{\text{had}} \leq 32 \text{ GeV}$.

⁽⁸⁾ CH. BERGER *et al.* (PLUTO COLLABORATION): preprint DESY 80/111 (1980).

⁽⁹⁾ G. PANCHERI-SRIVASTAVA and Y. SRIVASTAVA: *Phys. Rev. D*, **21**, 95 (1980).

⁽¹⁰⁾ R. BOUCLIER, R. C. A. BROWN, E. CHESI, L. DUMPS, H. G. FISCHER, P. G. INNOCENTI, G. MAURIN, A. MINTEN, L. NAUMANN, F. PIUZ and O. ULLALAND: *Nucl. Instrum. Methods*, **125**, 19 (1975).

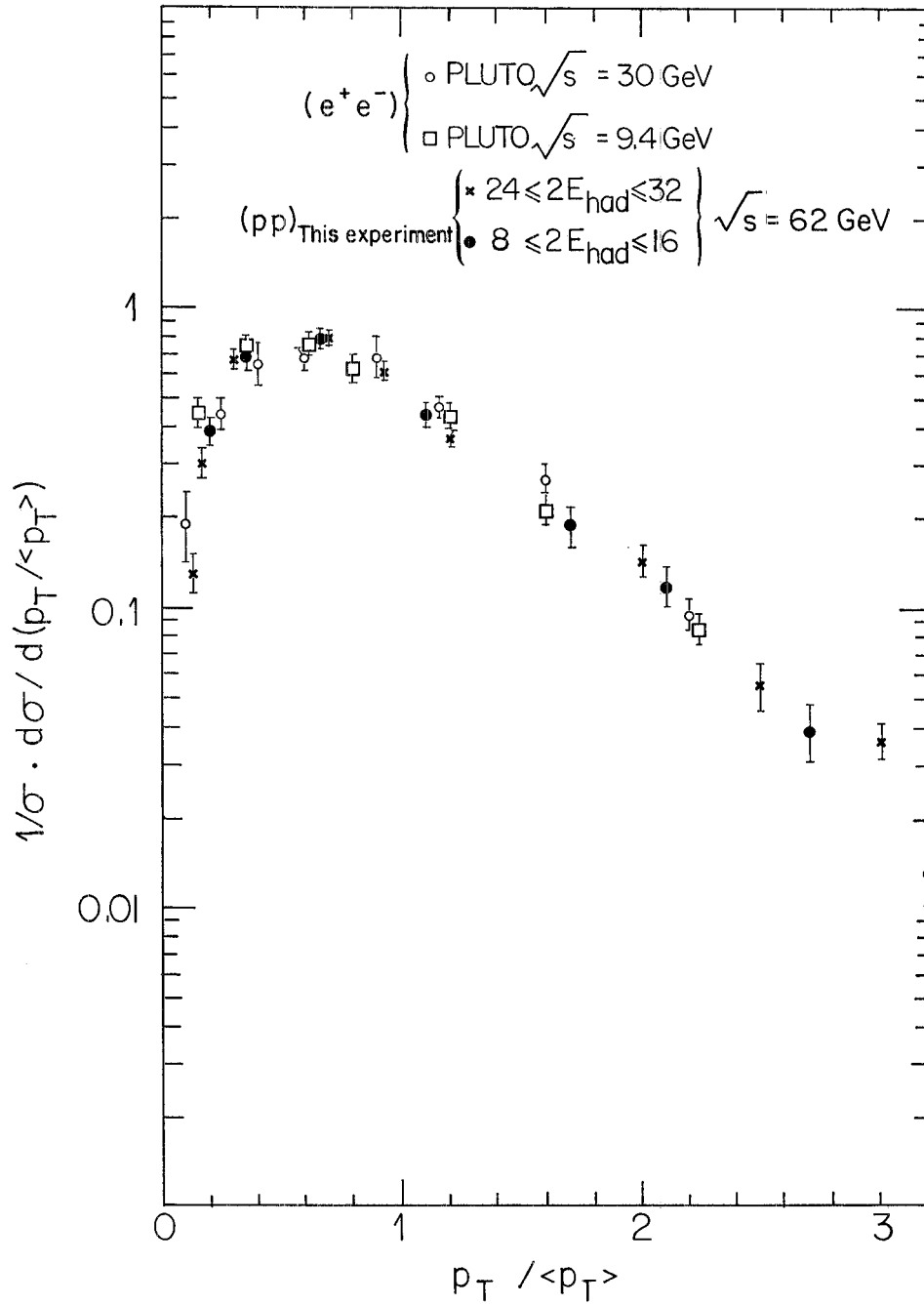


Fig. 1. - Renormalized $(1/\sigma)$, differential cross-section *vs.* the 'reduced' variable $p_T/\langle p_T \rangle$. These distributions allow a comparison of the multiparticle systems produced in e^+e^- annihilation and in pp interactions in terms of the 'reduced' transverse-momentum properties.

In fig. 1 the e^+e^- data are reported for comparison. The corresponding e^+e^- energies are $\sqrt{s} = 9.4$ GeV and $\sqrt{s} = 30$ GeV, respectively. The agreement with e^+e^- data is remarkable.

Conclusions. - The comparison between properties of multiparticle systems produced in high-energy pp reactions, and e^+e^- annihilations, has been extended to the inclusive $p_T/\langle p_T \rangle$ distributions. The conclusion is that, also in this transverse-momentum property, the multiparticle hadronic systems produced in pp interactions show a remarkable agreement with e^+e^- annihilation.

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