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PROPOSAL TO STUDY $\bar{p}d$ INTERACTIONS AT 200 GeV/c WITH THE 30" HYBRID BUBBLE CHAMBER

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12 pgs.

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1. INTRODUCTION

We are proposing to study $\bar{p}d$ interactions at 200 GeV/c. There are two essential motivations for which we are asking this experiment :

– The $\bar{p}d$ data at 200 GeV/c will allow us to continue the systematic $\bar{p}d$ study we are making at Strasbourg as a function of the incident momentum. Furthermore the use of a deuteron target for studying interactions on neutrons introduces many additional complications which we are used to handle, [see for instance our works, ref. (1) and (2)]. Therefore it seems to us essential that quantities as for instance topological cross section and multiplicity distributions should be determined by the same experimental methods and then be compared with our available data.

– With the proposed experiment we will be able to make a detailed comparison between the pp, pn, $\bar{p}p$ and $\bar{p}n$ data at 200 GeV/c. At lower energy clear differences appear between $\bar{p}p$ and $\bar{p}n$ multiplicity distributions (see for instance Figs. 1 and 2) and also between pp and pn data. Our point at 200 GeV/c will certainly help to understand these differences or at least to see if they persist at high energy. On the other hand the Strasbourg group is also involved in the study of pn interactions at 200 GeV/c. We can thus make a detailed com- between $\bar{p}n$ and pn interactions handled by the same methods, minimising thus the complications introduced by the use of a complex target.

The specific physics points which we want to study have already been discussed several times in our previous proposals. The main subjects of interest can be summarized as follow :

- Topological cross sections and statistical moments
- Comparison of the leading particle effect in $\bar{p}N$ and pN interactions at 200 GeV/c
- Diffraction dissociation processes
- Correlation features
- Multiparticle production phenomena
- Charge structure of the events
- Single particle distributions and inclusive reactions.

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In the following we will describe with some more details the physics aspects just mentioned. Our main objective consists, however, in the study of these phenomena as a function of the c.m. incident momentum. In addition as we are carrying out a pd experiment at 200 GeV/c, a meaningfull comparison of $\bar{p}$d and pd data can be made.

II. PHYSICS INTERESTS

1 - Topological cross sections and statistical moments

It is primarily in determination of thoses quantities that the systematic errors will be of great importance. Our recent results in the 5.55 – 14.6 GeV/c region[1] (see also Fig.1) and also at 200 GeV/c [pd interactions[2]] have shown that systematic errors are rather difficult to estimate. In the framework of the impulse approximation, however, these errors are expected to be nearly independent on the incident momentum. Therefore it seems to us essential that statistical moments and multiplicity distributions should be determined by the same experimental methods. Using our previous data (4.5 – 15 GeV/c) we will be able to carry out a meaningfull study of the incident momentum dependence of the $\bar{p}$n multiplicity distributions.

Among other things we will also see :

- If the dispersion D and the average <n> of the charged multiplicity distributions are related through a linear rule as for pp[3] and $\bar{p}$p[1] interactions

- If the data still obey the early KNO scaling as shown by the $\bar{p}$n interactions in the 5.55 – 14.6 GeV/c region

- If, as for lower incident momenta, the average <n> for $\bar{p}$n is smaller than for $\bar{p}$p in contrast to the dispersion D which is greater for $\bar{p}$p than for $\bar{p}$p[1].

2 - Comparaison of the leading particle effect in $\bar{p}$N and pN interactions at 200 GeV/c

With the present experiment we will have pp, pn, $\bar{p}$p and $\bar{p}$n interactions at the same incident momentum. We will then be able to compare the leading effect in $\bar{p}$N and pN interactions, using for instance the rapidity or even the Feynman x variables.

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3 - Diffraction dissociation processes

The present experiment will of course allow us to study the diffraction dissociation of the neutron. This is, however, of a minor interest as many other experiments has been made by using other types of hadron beam particles and a neutron target. Nevertheless a comparison of these results with our data will be made. In addition we will also be able to obtain information about the diffraction dissociation of the beam.

4 - Correlation features

We intend to study the two and many particle correlation between the charged outgoing particles. A comparison with our pn data at 200 GeV/c will allow us to see the importance of the S - channel quantum numbers. Moreover we will study the two particle correlation in the transverse plane along the lines proposed by us some time ago[4,5].

We will also study the correlation between the charged outgoing particles and the γ, V^o, Λ and π^o observed in the final state. Because of the small size of the chamber this will be made by examinating the average number of these neutral particles associated to the charged, leading thus to information about the multiparticle production mechanism[6].

5 - Multiparticle production phenomena

At high energy the multiparticle production contribute to an important part of the inelastic cross section. Except for the multiplicity distribution already discussed above we will also study these production phenomena using, among other things, multivariable techniques as proposed some years ago[7]. In the same manner as made for lower $\bar{p}p$ incident momenta[8] we will search for multivariable distributions sensitive to the production mechanism. To do this we need to know at least the momenta of the charged tracks. The 30" hybrid system will allow us to proceed with such an analysis using in particular the four constraint events.

5 - Charge structure of the events

In a similar way to our previous works[9] we would like to study the manner that charges of the emitted particles are distributed in the c.m. system. In particular we will investigate the charge transfer fluctuation across a

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boundary at any fixed rapidity $[D^2(y)]$. Our $\bar{p}N$ data at ~ 5.5 GeV/c[9] (see Fig.3) and the pN data at 200 GeV/c[5] (Fig.4) present some striking similarity. Indeed in both cases $D^2(y)$ is proportional to the charge particle density distribution dn/dy, although the shapes of these distributions are different. New $\bar{p}n$ data at 200 GeV/c may help to understand better these effects.

III. NUMBER OF PICTURES AND EVENTS

We estimate the $\bar{p}n$ topological cross sections at 200 GeV/c from our pn data at 195 GeV/c[2], assuming that the ratio $\sigma_n(\bar{p}n)/\sigma_n(pn)$ has the same n-dependence as $\sigma_n(\bar{p}p)/\sigma_n(pp)$[10]. With 150,000 pictures and 2 $\bar{p}$ per picture we will obtain a reasonable number of events in the fiducial volume (see Table I) for carrying out the outlined study program.

The Strasbourg group made during these last two years a great effort for handling 30" bubble chamber film. Together with CERN and other European groups we contributed in developing a new software (working under the Hydra system) which will be available to all the scientific community. In fact, the new chain of program has been adapted using the events pd, π^+d (200 GeV/c) measured at Strasbourg with sligthly modified conventional measuring machines. The setting errors for these devices has been decreased by using a television camera coupled to the optics of the apparatus in order to magnify the film image and display it on a TV screen. By using our apparatus and the new chain of program we obtain a very good momentum resolution for the tracks entering into the downstream spectrometer (see Fig. 5).

In conclusion, it would be rather unfortunate that the important effort (software and handware) made by our group for handling 30" data could not be devoted to the $\bar{p}d$ physics which is the main topic studied in Strasbourg. We consider the $\bar{p}d$ proposal at 200 GeV/c (150,000 photographs) as our first priority experiment.

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TABLE I - Estimated number of $\bar{p}n$ events at 200 GeV/c

Topology n	Estimated cross section (mb)	Number of events
$1^{inelast.}$	1.5	750
3	4.0	2000
5	6.7	3400
7	6.9	3500
9	5.6	2800
11	4.2	2100
13	2.8	1400
15	1.6	800
17	0.8	400
19	0.4	200
21	0.18	90
$\sigma_{inel.}$	34.7	17400
$\sigma_{el.}$	7.0	3500
$\sigma_{tot.}$	41.7	20900

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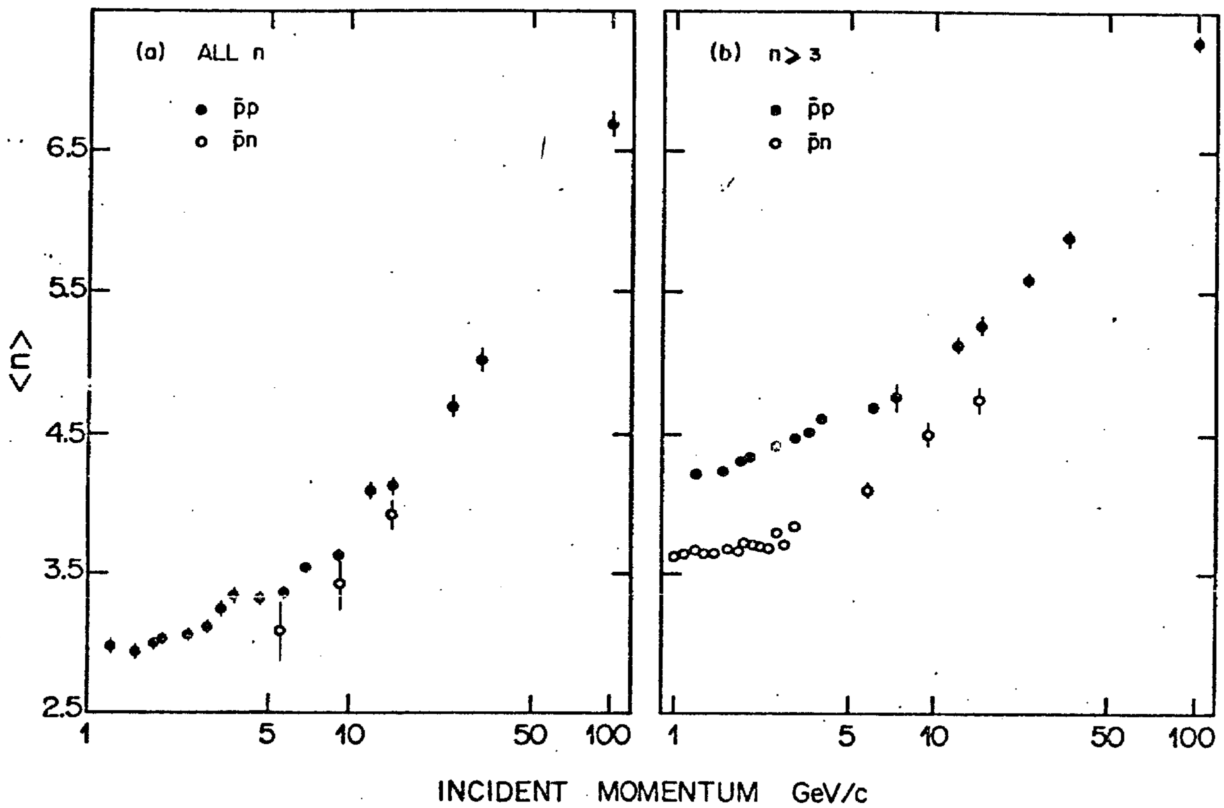

Figure 1

(a) Comparison between the average multiplicity for $\bar{p}p$ and $\bar{p}n$ interactions

(b) Same distributions as in (a) but obtained from multiplicity distributions when the number of charged particles is $n \geq 3$.

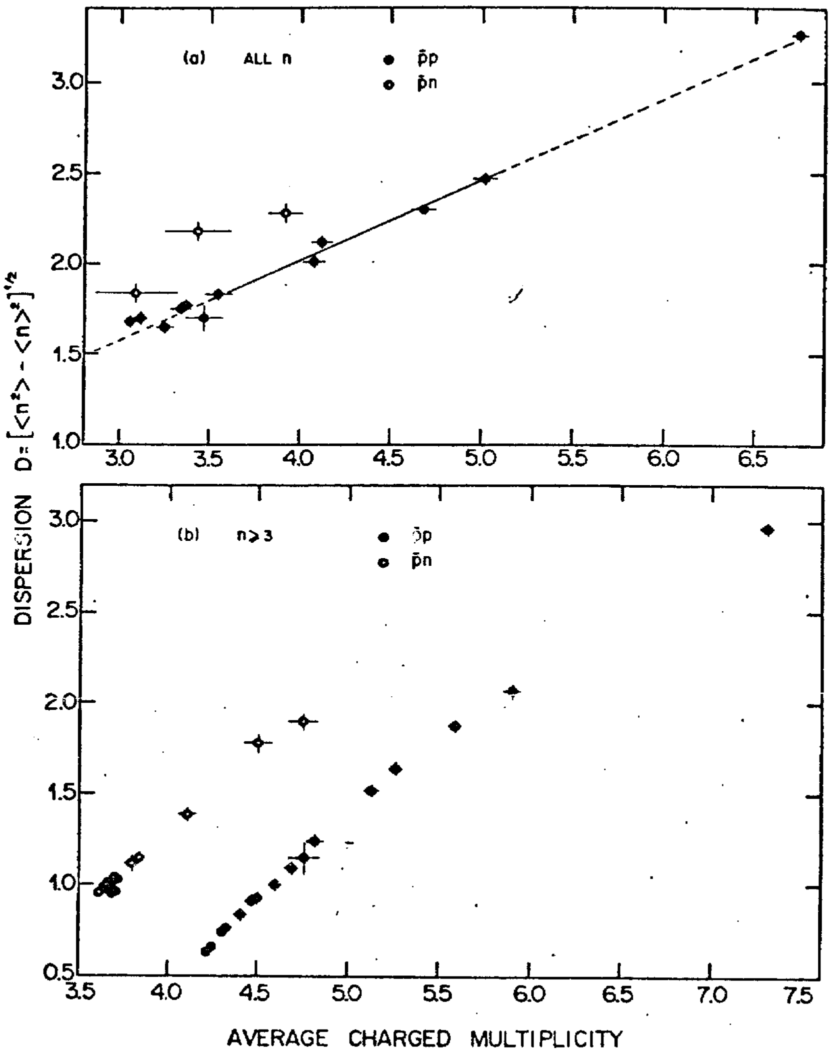

Figure 2

(a) The dispersion D of the charged multiplicity versus its average $\langle n \rangle$ for $\bar{p}p$ and $\bar{p}n$ interactions. The full line represents a linear fit to the data in the $3.5 < \langle n \rangle < 5.5$ region. By including the 100 GeV/c point one obtains $D = [0.44 \pm 0.02]\langle n \rangle + [0.27 \pm 0.05]$.

(b) The same distributions as above but obtained from multiplicities with $n \geq 3$.

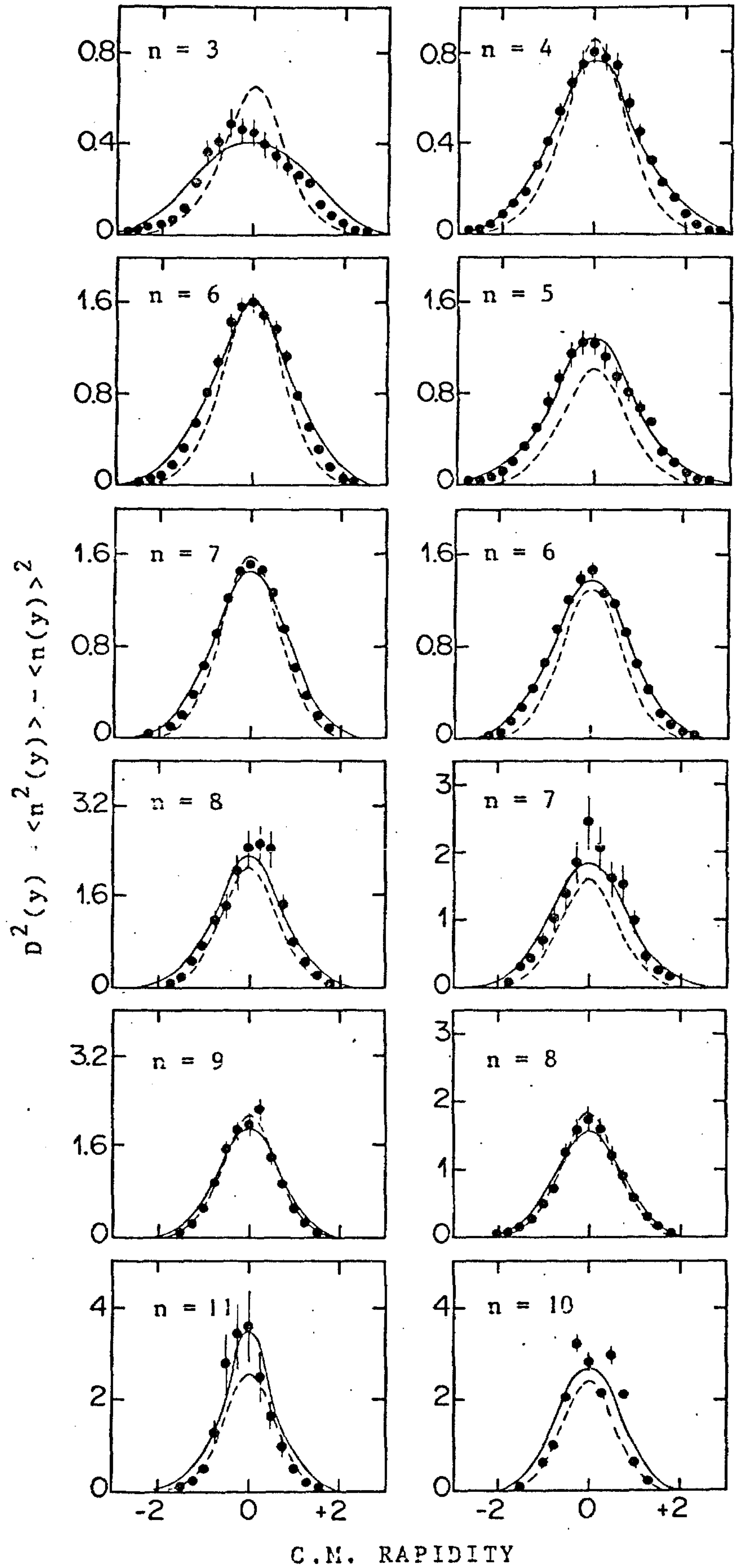

Figure 3 - The charge transfer fluctuation across boundary at any fixed rapidity y. The full curves represent the charged particle density distributions while the dashed curves are the phase space distributions.

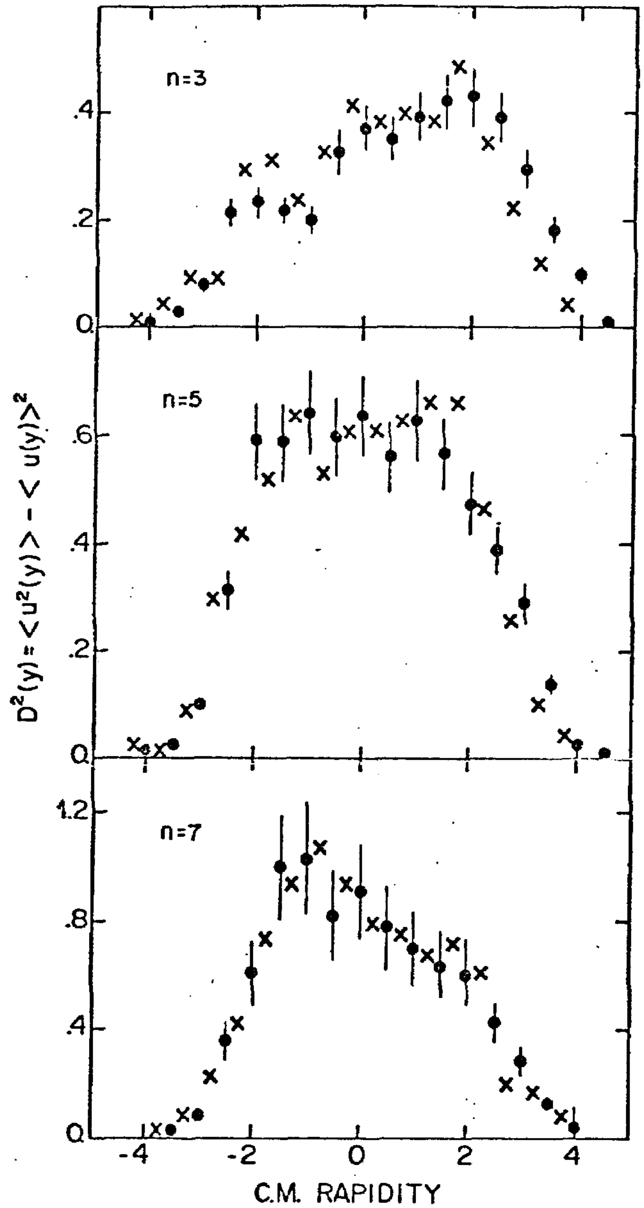

Figure 4

The charge transfer fluctuation across a boundary at any fixed rapidity y. The crosses represent the charged particle density distributions.

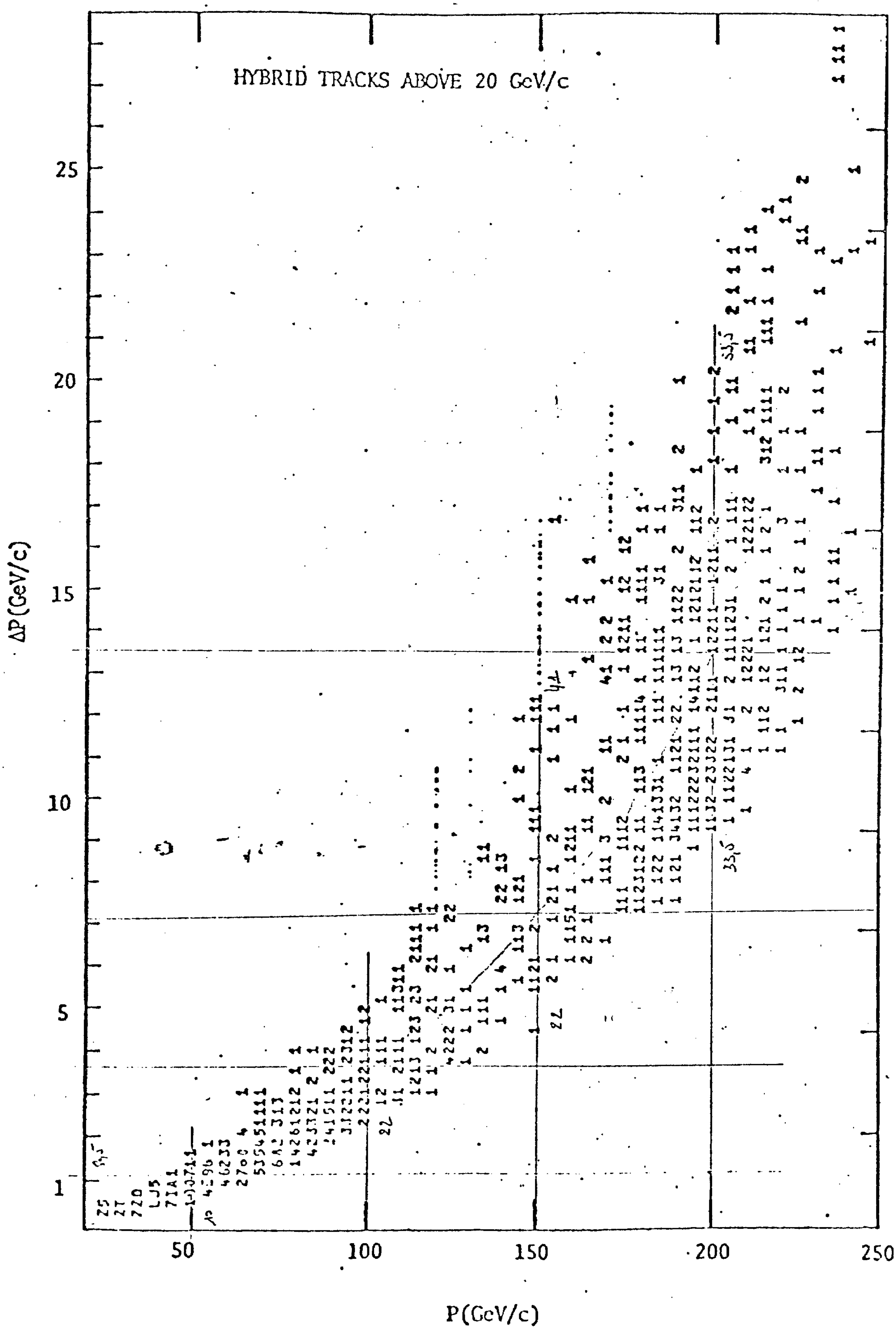
HYBRID TRACKS ABOVE 20 GeV/c
ΔP (GeV/c)
1
5
10
15
20
25
50
100
150
200
250
P(GeV/c)

Figure 5