# LOW $P_T$ HADRON-NUCLEUS INTERACTIONS

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Introduction. We are discussing the possibility of describing hadron-nucleus (hA) interactions in terms of a number of independent collisions of the projectile inside the target nucleus. This multiple rescattering may occur on a particle or quark-parton level. To investigate the characteristics of hA interactions as a function of $\bar{\nu}$ we are taking advantage of the correlation between the average number $\bar{\nu}$ of collisions of the projectile inside the nucleus and the number Ng of fast protons ejected from the struck nucleus. We shall use the relation $\bar{\nu}$ vs Ng obtained in [1] (see Fig. 1). For a given target nucleus this allows us to select interactions occuring at different impact parameters.

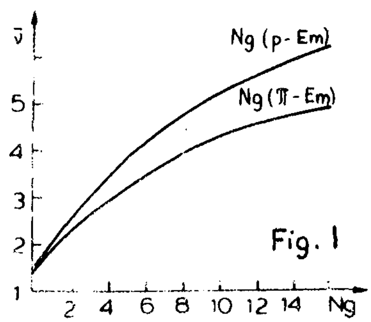


Fig. 1

Experimental material. Our data consist of more than eight thousand interactions of negative pions and protons with emulsion nuclei (see Table 1).

Table 1.

| $\pi^-$ - Emulsion | | p-Emulsion | |
|---|---|---|---|
| $E_0$ (GeV) | # of events | $E_0$ (GeV) | # of events |
| 60 | 789 | 67 | 1183 |
| 200 | 973 | 200 | 2595 |
| 300 | 2115 | 400 | 853 |

For a given energy the events were binned in five Ng-groups which correspond to the different $\bar{\nu}$ . Details are given in Table 2.

Table 2.

| Ng - interval | 0 | 1 | 2-3 | 4-8 | 9-15 |
|---|---|---|---|---|---|
| $\overline{Ng}$ ($\pi^-$Em) | 0 | 1 | 2.40 | 5.40 | 10.6 |
| $\bar{\nu}$ ($\pi^-$ Em) | 1.39 | 1.82 | 2.42 | 3.30 | 4.40 |
| $\overline{Ng}$ (p-Em) | 0 | 1 | 2.40 | 5.52 | 10.9 |
| $\bar{\nu}$ (p-Em) | 1.44 | 1.97 | 2.71 | 3.98 | 5.40 |

Thus for fixed target, by choosing events characterized by a given number of fast protons Ng, we have the possibility to investigate the characteristics of hA interactions in significantly greater interval of $\bar{\nu}$ than that, achieved by varying the atomic number of target nucleus. In the latter method by changing targets from hydrogen to uranium we get following $\bar{\nu}$ variation range: $1 \leq \bar{\nu} \lesssim 4$ and $1 \leq \bar{\nu} \lesssim 3$ for proton and pion induced reactions respectively.

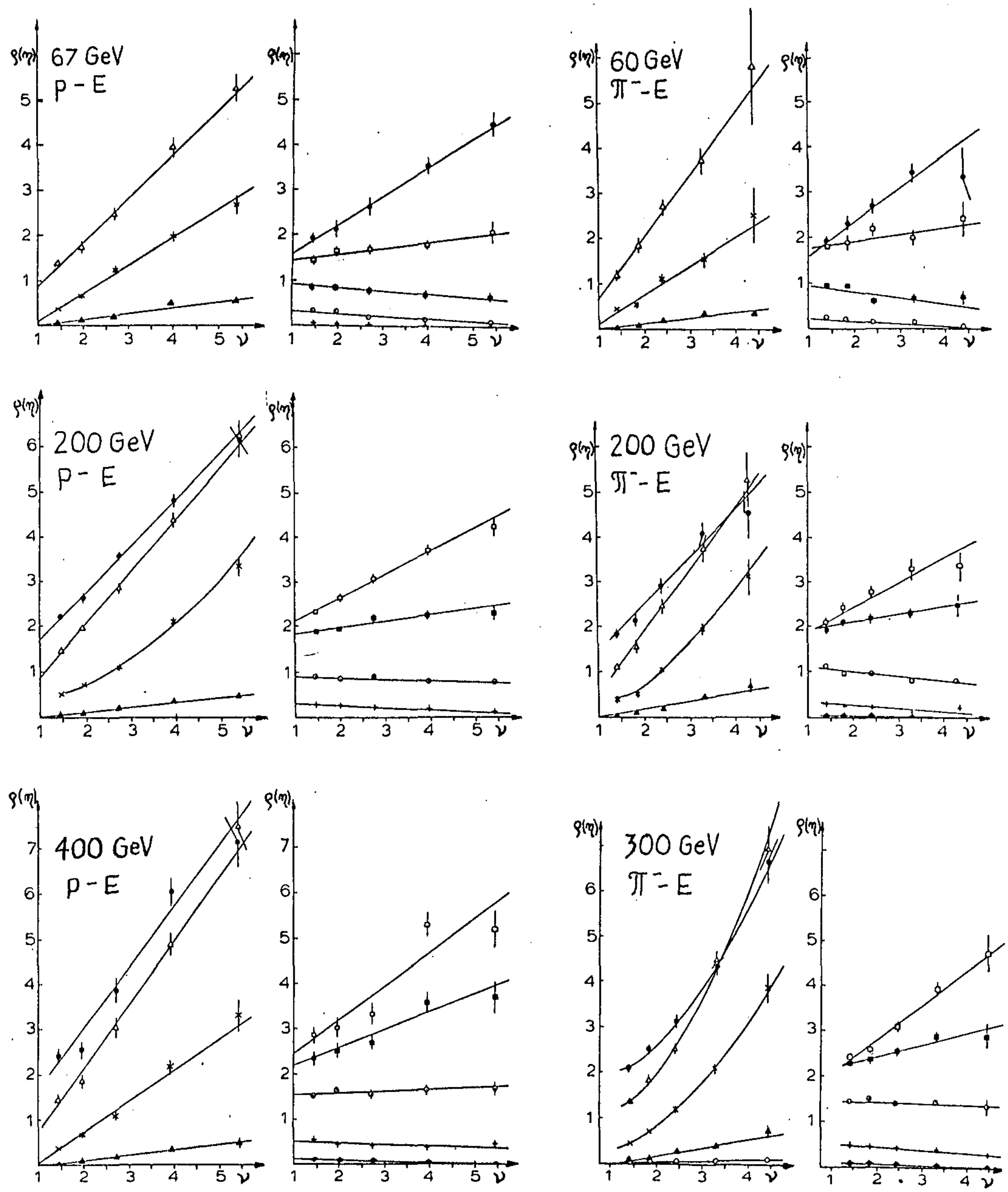
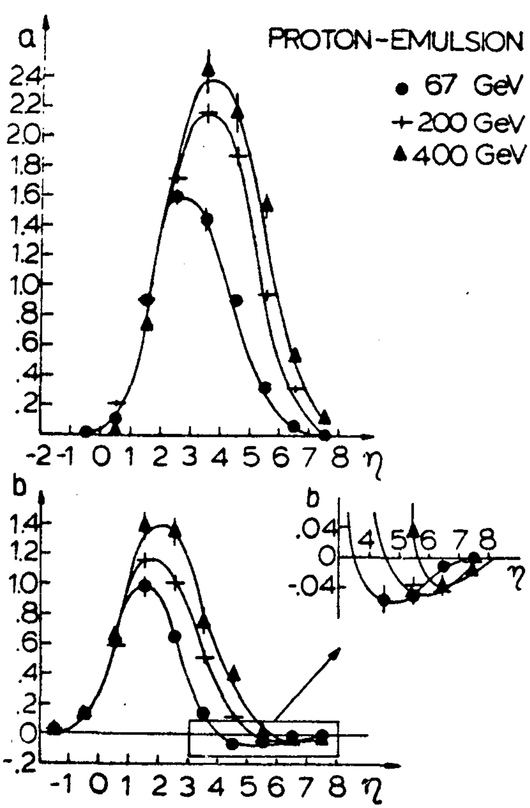



**Fig. 2. Particle densities $\rho(\eta)$ vs Ng for different $\eta$ - bins:** ◆ $8<\eta\leq7$, + $7<\eta\leq6$, ⊙ $6<\eta\leq5$, ■ $5<\eta\leq4$, □ $4<\eta\leq3$, ● $3<\eta\leq2$, Δ $2<\eta\leq1$, × $1<\eta\leq0$, ▲ $0<\eta\leq-1$, ○ $-1<\eta\leq-2$.

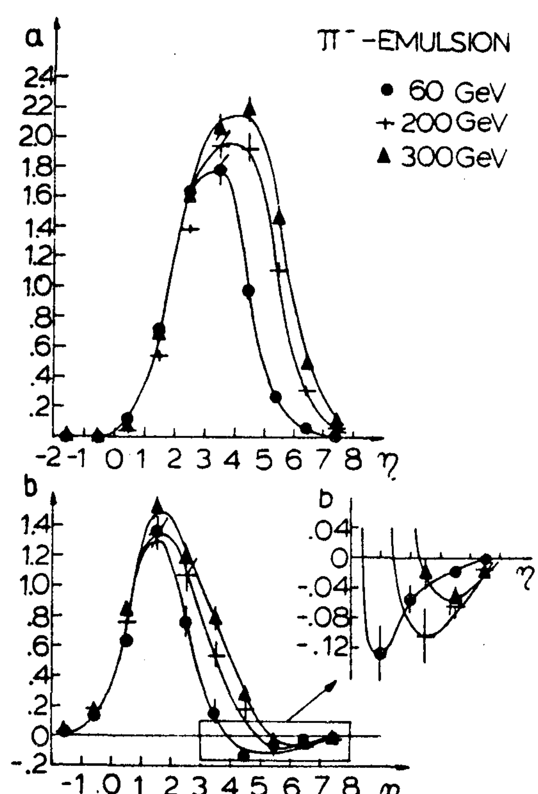
Results. In Fig. 2 the shover particle densities $\varrho(\eta) = 1/N_{ev}\, dn_s/d\eta$ in ten pseudorapidity intervals of unit width as a function of $\bar{\nu}$ are presented. The $\varrho(\eta)$ vs. $\bar{\nu}$ dependence can be parametrized by the linear relation:

$$\varrho(\eta) = a(\eta) + b(\eta)(\bar{\nu}-1) \qquad (1)$$

It should be stressed that for data analysed here the linear parametrization gives always satisfactory $\chi^2$ values in projectile fragmentation region and forward central region ($\eta \gtrsim 2.5$). Some intervals in target fragmentation region and backward central region are only approximately described by linear parametrization (see Fig.2). Better parametrization is obtained when the quadratic term equal $c(\eta)(\nu-1)^2$ in eq.(1) is added. The $a(\eta)$ and $b(\eta)$ coefficients for pion and proton interactions in emulsion are depicted in Figs.3a, b and Figs. 4a,b. For sake of clarity the errors are indicated in central and projectile fragmentation region only. The solid curves are to guide the eye. Using the obtained dependences of a and b on $\eta$ one can construct, according to(1), the inclusive pseudorapidity distribution of shower particles for any value of $\bar{\nu}$.




Figs. 3a,b




Figs. 4a,b

Discussion and Conclusions. The dependence of particle densities $\varrho(\eta)$ as a function of $\bar{\nu}$ is not universal in the whole pseudorapidity range. For the highest pseudorapidity values the $\varrho(\eta)$ decreases with the increasing number of $\bar{\nu}$. In the forward region ($\eta \gtrsim 2.5$) there is no evidence of intranuclear cascade because the ratio $b(\eta)/a(\eta)$ in this region is always less than unity. In backward region ($\eta \lesssim 2.5$) the increase of multiplicity is much faster than the multiplicity in elementary collision multiplied by $\bar{\nu}$. This should be interpreted as an evidence for the existence of cascade effect inside the target nucleus. This cascading is caused by interactions of pions produced in target fragmentation region. From the above, one can argue that in order to discriminate between different superposition models the experimental results in the forward region should be compared with the theoretical predictions. The agreement in the backward region can be obtained by excluding or including cascading of slow pions in the model. Having this in mind the attempt was made in [2] to describe the experimental results obtained in this work for forward region by the additive quark model (AQM). It was tested whether the particle production, in $\pi^-$- emulsion interactions can be described by the following relation resulting from AQM:

$$\varrho(\eta, Ng) = F_W(\eta)\bar{w}(Ng) + F_S(\eta)(2-\bar{w}(Ng)) \qquad (2)$$

where $F_W$ and $F_S$ are the fragmentation functions of wounded and spectator quark respectively and $\bar{w}(Ng)$ for a sample of events characterized by a given Ng is an average number of wounded quarks. To obtain $\bar{w}(Ng)$ the relation between $\bar{\nu}$ and Ng was used [1] and Glauber calculations were performed. It was found at $\eta$ antylab $\simeq -3.0$, the values of $F_W$ and $F_S$ obtained from experimental data are equal. Thus, as follows from (2), the particle production at this $\eta$ value should not depend on $\bar{w}(Ng)$ and $\varrho(\eta) = 2F_S$. Our $\pi^-$-emulsion data are in good agreement with this prediction for all primary energies considered.

References: [1] E.Stenlund and I.Otterlund, Nucl. Phys. B198 (1982) 407.
[2] R.Hołyński, M.Jeżabek and K.Woźniak, to be published.