# FORWARD PARTICLE PRODUCTION IN INELASTIC $^{22}$Ne INTERACTIONS IN EMULSION AT 4.1 A GeV/c.

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## 1. Introduction

The collisions of high energy nuclei are likely to be the subject of intense experimental investigation in the near future. In this paper we present the results on multiple meson production in forward cone in inelastic interactions of $^{22}$Ne nuclei in emulsion at a primary momentum 4.1 GeV/c per nucleon. The detailed characteristics of particle production and the fragmentation processes in collisions of $^{22}$Ne nuclei in emulsion will be described in [1].

## 2. Experimental procedure

Stacks of BR-2 photographic emulsions were exposed to a 4.1 A GeV/c neon beam at the synchrophasotron of Joint Institute of Nuclear Research in Dubna. The intensity of the exposure was $10^4$ particles/cm$^2$. In along the track scanning 10,000 neon interactions were found in emulsion. The detailed measurements (emission angles of all charged secondaries as well as charges of projectile fragments) for about 4000 inelastic interactions have been completed. The present paper is devoted to the study of fast ($\beta \geq 0.7$) particle production in the forward hemisphere. We define a forward hemisphere in the center of mass of proton-proton collision at the same primary momentum: $\Theta_{forward} \leq 90^{\circ}_{cms,pp}$. We restrict ourselves to the analysis of forward particle production since in this hemisphere we can define experimentally the number of produced mesons. In a backward hemisphere it is not possible to separate produced mesons (both fast and slow) from a proton fragments of target nucleus. The presented investigation was carried out on a sample of 2031 inelastic interactions. For each event the following multiplicities were determined:

$N_F$ - number of multicharged projectile fragments ($Z \geq 2$);

$N_p$ - number of protons released from $^{22}$Ne, can be evaluated from the charge balance between primary charge and sum of charges of heavier fragments: $N_p = 10 - \sum_{i=1}^{N_F} Z_{F,i}$;

$N_{sf}$ - number of all relativistic ($\beta \geq 0.7$) singly charged tracks emitted in forward hemisphere;

$N_{mf} = N_{sf} - N_p$ , number of produced mesons in forward cone;
$N_{sp}$ - number of spectator protons (see explanation below) ;
$N_{part} = N_p - N_{sp}$, number of protons participating in the collision.

Not all nucleons released from incident nucleus $\left(\frac{A}{Z} \cdot N_p\right)$ participate in the collision. Part of them remains spectators. Spectator protons ( $N_{sp}$) were identified by momentum measurements and from the angular distribution of singly charged secondary particles [2]. Thus, we can obtain the number of protons participating in the collision*.

The data presented in this paper are averaged over all emulsion components and over different impact parameters and are investigated in dependence of the number of participating nucleons from projectile nucleus only.

3. Results

The data on inclusive forward multiplicities are summarized in the Table. The errors quoted in the Table and in Figures include statistical uncertainties only.

| Multiplicity | Average |
|---|---|
| $N_F$, $Z \geq 3$ | .42±.01 |
| $N_F$, $Z = 2$ | .84±.02 |
| $N_p$ | 5.63±.08 |
| $N_{sp}$ | 1.89±.03 |
| $N_{part}$ | 3.74±.08 |
| $N_{mf}$ | 3.76±.08 |

In Figure 1 we present the inclusive distribution of produced mesons. Distribution is peaked at small multiplicities due to the low primary energy per nucleon with a very long tail of large multiplicities, which contribute to a large value of the dispersion. The ratio:

$$\bar{N}_{mf}/D = 1.06 \pm .03.$$

Different superpositions models [3] predict for this ratio a value close to 1 for inclusive nucleus-nucleus data (data averaged over all impact parameters and over all wounded nucleons ). The measured value is consistent with these predictions.

It is interesting to study the characteristics of forward particle production in dependence of the number of participating protons from incident nucleus. In Fig.2 we show the distributions of $N_{mf}$ for interactions with different values

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*) Among participating nucleons there are wounded nucleons which interact inelastically in the target and produce secondaries as well as nucleons which undergo the elastic scatterings on wounded nucleons and other secondaries. It is not possible to separate experimentally wounded nucleons from those originated in second generation processes. It is natural to assume that participating nucleons are related to the wounded ones.

of $N_{part}$. With increasing $N_{part}$ (more central collisions) the distributions shift towards the larger multiplicities and change the shape. The dependence of the moments of these distributions on $N_{part}$ are shown in Figs.3a,b. One can observe that both average multiplicity and dispersion increase with increasing $N_{part}$. If we assume a simple superposition of independent elementary processes, we expect that the ratio $\bar{N}_{mf}/D^2$ will be independent of $N_{part}$. Qualitatively such an independence is observed for $N_{part} \geqslant 2$ and is illustrated in Figure 4.

We have separated from the released protons of $^{22}$Ne projectile the spectator ones. Spectator protons are not affected by the collision and we do not expect the strong dependence of the average number of produced mesons on the number of spectator protons unless the $N_{sp}$ is not correlated with the number of participating protons. A strong correlation between $N_{sp}$ and $N_{part}$ occurs only for events with a total desintegration of primary nucleus into singly charged fragments : $N_{part} = 10 - N_{sp}$. In other cases the spectator part of the incident nucleus may evaporate as protons as well as alpha particles and heavier fragments. The observed very weak dependence of $\bar{N}_{mf}$ on $N_{sp}$ is shown in Figure 5.

## 4. Conclusions

The presented data on the multiplicities of mesons produced in forward cone and on the dependence of the production process on the number of participating nucleons from primary nucleus can be qualitatively explained by the hypothesis that a simple superposition of elementary collisions describes the interaction between nuclei. However it should be mentioned that some other characteristics of nucleus-nucleus collisions (collective behaviour, cascade processes in the target fragmentation region etc.) can not be described by such a simple model [1,4] .

## References

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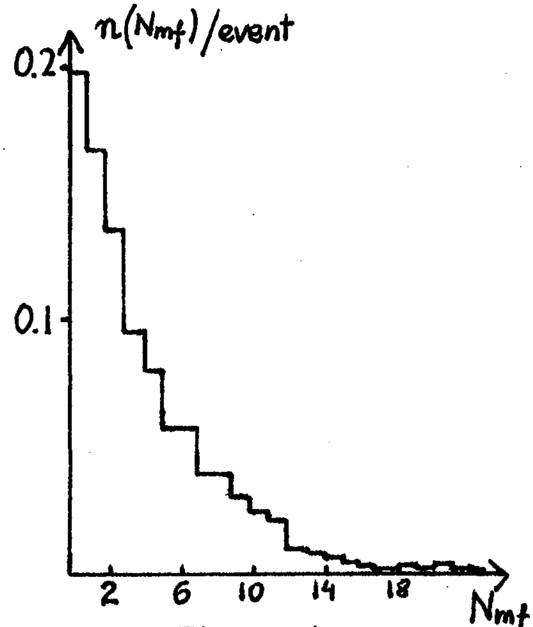


Figure 1.

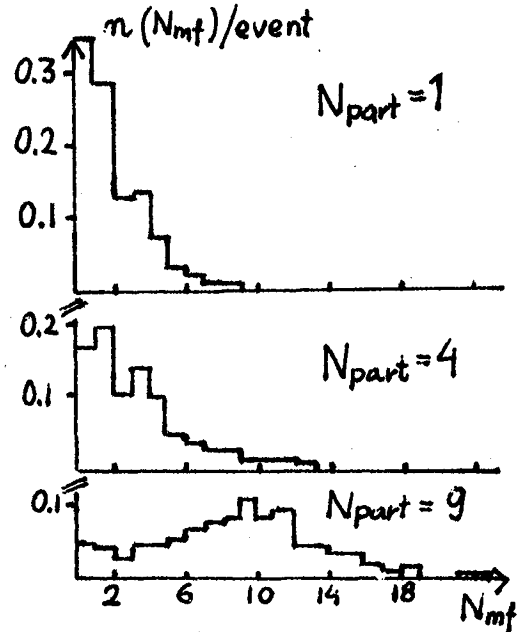


Figure 2.

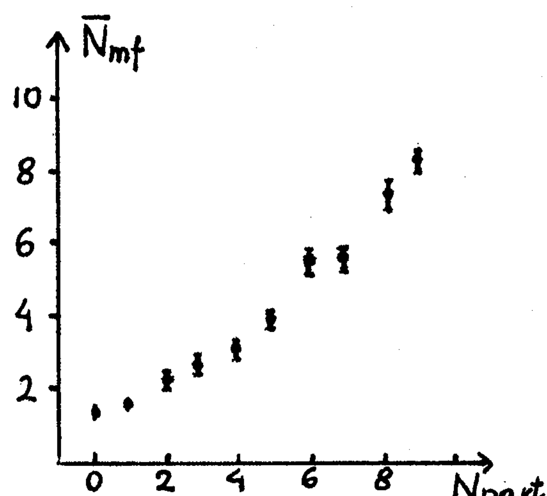


Figure 3a.

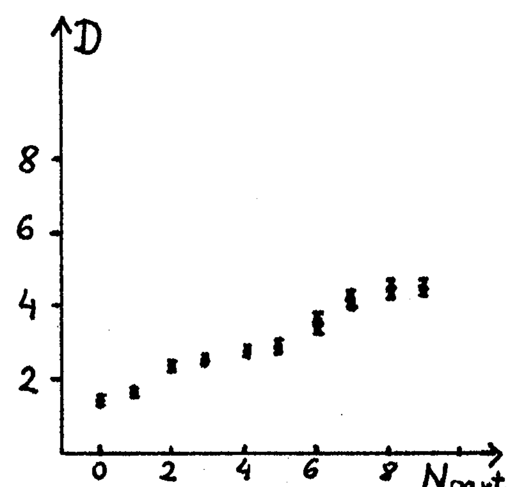


Figure 3b.

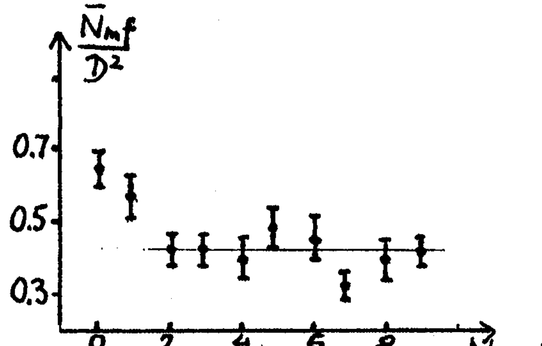


Figure 4.

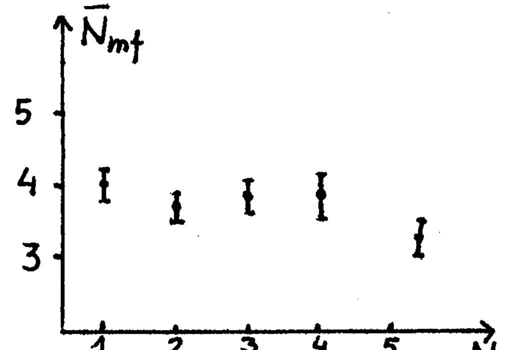


Figure 5.