EXPERIMENTAL SETUP FOR STUDYING PION-INDUCED η PRODUCTION

V. S. Bekrenev, E. A. Filimonov, S. P. Kruglov, I. V. Lopatin, A. B. Starostin

Investigation of pion-induced η production on nucleons and nuclei is very important for understanding η-nucleon and η-nucleus interactions. Interest to this problem has grown tremendously in recent years but there exists very little experimental information about these processes.

Experimental program of PNPI for investigation of pion-induced η production is based on developing large calorimeters made of $CsI(Na)$ crystals. Two such calorimeters will be used as main parts of a neutral meson spectrometer — a new device aimed at precise determining the energy of η-meson (or π^0-meson) and the angle of its emission through measuring energies of two gammas from the $\eta \to 2\gamma$ ($\pi^0 \to 2\gamma$) decay and their opening angle. On the other hand, such calorimeter can be used for measuring the energy of charged particles which are produced in another modes of η decay or accompany η production.

The main element of the calorimeter is a scintillation counter consisting of a $CsI(Na)$ crystal (its dimensions are 6 cm×6 cm×30 cm) coupled to a photomultiplier tube. The most important characteristics of counters — such as an energy resolution, a light output, a transmission of the light through a crystal — were investigated by means of radioactive source tests. For example, the standard energy resolution with ^{137}Cs source was about 18%, the nonuniformity of the output amplitude along the crystal did not exceed 5%.

For studying properties of a calorimeter as a whole we have built and tested its prototype — an array of 16 counters having configuration 4×4 (see Fig.1). For proper operation of the array, gains of individual counters should be chosen in such a manner that pulse heights corresponding to the same energy deposition were equal for all counters. To do that, we used the energy line (approximately 40 MeV) due to cosmic muons traversing all four crystals of one vertical column. Periodical measuring of this line can be used later on for monitoring gains of individual counters during an experiment.

The array of 16 counters was also investigated using beams of a pion channel of the PNPI synchrocyclotron in the momentum range 100 to 250 MeV/c. Separation of pion, muon and electron components of the beam was made by means of time-of-flight technique on the base of 12.5 m. For each kind of particles incident on the array pulse height spectra were measured from both the counter which the beam struck (the arrow 1 in Fig.1) and the neighbouring counters. In the software, it was possible to sum signals from several counters or from all counters of the array. The energy resolution $\Delta E/E$ was calculated as the ratio of the FWHM for corresponding peak in the pulse height spectrum to the position of this peak, both values were measured in CDC channels. While determining the energy resolution for electrons, we used only those events when an incident particle struck on one of four central counters (darked in Fig.1). Since for such events the counter which the beam struck was surrounded with eight neighbouring counters (shaded in Fig.1), summing of signals from nine counters allows to determine practically the total energy of the shower. It means that fluctuations due to a transverse leakage do not influence essentially the energy resolution.

As an example, Fig.2 displays the pulse height spectrum measured in the experiment using the beam of positive particles with a momentum of 200 MeV/c. Pion, muon and

positron components (π, μ, e) were obtained for the central counter. The right peak (Σe) is the result of summing signals from the nine counters for the case of incident positrons. The shaded left peak is due to cosmic muons traversing the array.

In Fig.3 the position of corresponding peak in the spectrum and the energy resolution are plotted against the energy of positrons. Results for the central counter are presented by circles, those obtained by summing signals from nine counters — by triangles. Shown by a square is the position of the peak attributed to cosmic muons, the energy deposition in one crystal is approximately 40 MeV.

The results of measurements are in agreement with our calculations using the Monte Carlo code GEANT3 [1]. Obtained values of the energy resolution are consistent with characteristics of similar setups [2] developed in another laboratories for studying π^0 and η production.

In the course of investigations using the beam, apart from experiments in usual geometry (axes of crystals were along the beam direction) some measurements were performed for the case when axes of crystals were normal to the beam — the arrow 2 in Fig.1. Pulse height spectra obtained in these measurements were applied for checking the gain of each counter.

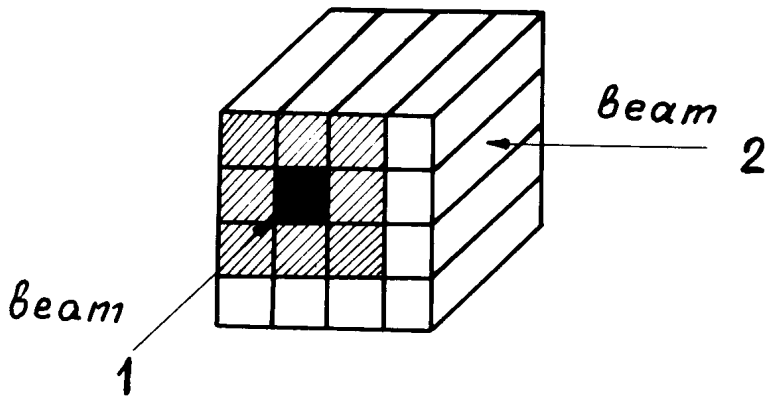

Fig.1. Disposition of array of 16 counters relative to the beam direction

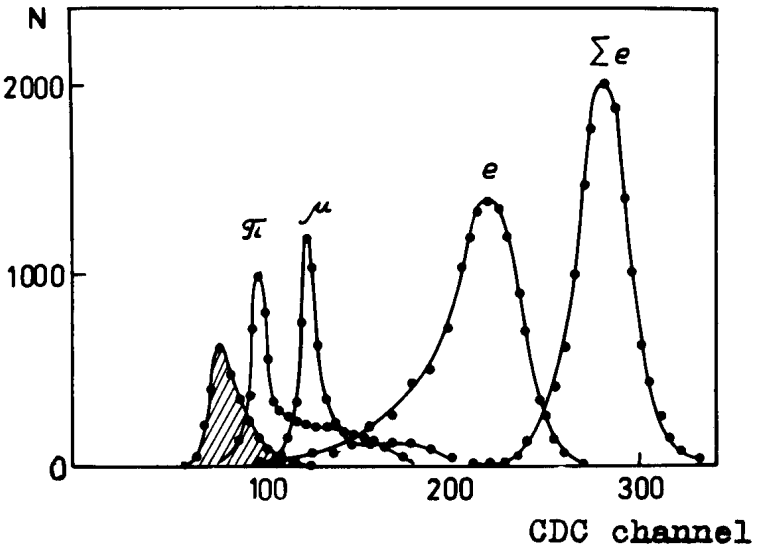

Fig.2. Pulse height spectrum measured in experiment using beam of positive particles with a momentum of 200 MeV/c

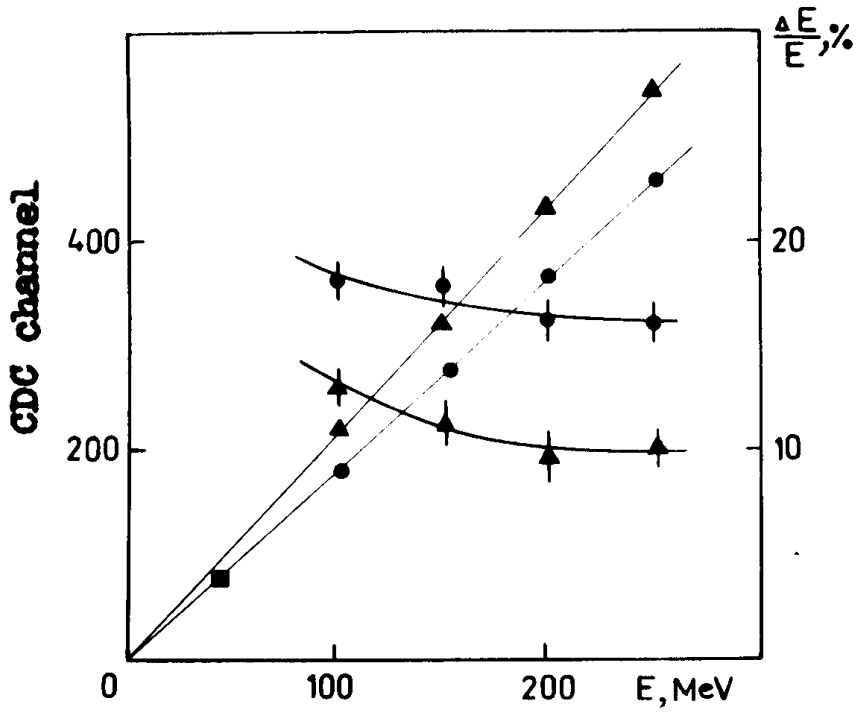

Fig.3. Position of positron peak in the pulse height spectrum (straight lines) and energy resolution (curves) plotted against energy of positrons

REFERENCES

1. *Brun R. et al.* GEANT3, CERN/DD/84-1, 1987.
2. *Blucher E. et al.* // Nucl.Instr.Methods, 1986. V.A249. P.201.