FURTHER DEVELOPMENT OF THE APPARATUS FOR MEASUREMENTS OF THE PARTICLE TRACKS IN PHOTOEMULSIONS BY THE TELEVISION METHOD

by

G.E.Belovitsky, A.E.Voronkov, G.B.Zhdanov,
L.N.Kolesnikova, V.S.Marenkov, L.V.Sukhov,
M.F.Solovjeva, M.I.Tretjakova, M.M.Chernjavsky.

I. The apparatus for an automatic following the particle tracks worked out in P.N.Lebedev Physical Institute (Moscow) allows, in principle, to carry out any studies of the track structure in transverse and longitudinal directions.

As one of the new applications of that method we proposed the problem of measurements of neutron spectra by the spectrum of the corresponding recoil protons. To solve that problem a special device was worked out which allows to record the coordinates $(X^I, Y^I, Z^I, X^{II}, Y^{II}, Z^{II})$ of the beginning and end of all proton tracks passing in a given interval of angles. The whole subsequent procedure of deriving the neutron spectrum is carried out by the electronic computer on a rather simple programme.

In order to increase the rate of measurements of neutron spectra it was found to be useful to work in the semi-automatic regime, instead of the automatic one, of following the tracks - it provided the rate approximately 5 - 6 times as greater than the visual observation. As a result, one operator is able to measure 150 tracks of the recoil protons with a general length $\sim$ 10 cm during 6 hours.

II. The principal block of the apparatus for measurement of scattering and ionization was also modified.

1. Up to now transverse deflections of the track were measured only by one (left) edge of each grain that resulted in "noises" depending on the grain diameter spread. In the new variant the information which is transformed into the amplitude of "detuning" signal is obtained symmetrically from both edges of the grains - from left and right fronts of the corresponding electric pulses. Thus, now the difference of the machine logics from that of visual measurements is connected mainly with a shorter length of the operating zone (40μ).

2. The teletype which recorded previously digitised scattering data on a paper tape is displaced now for the perforator which plots on a card only first differences of Y-coordinates. The whole subsequent numerical treatment, including introduction of corrections for spurious scattering by the value of $\rho = \bar{D}_3/\bar{D}_2$ may be carried out by the electronic computer on a rather simple programme.

The recorder drawing a clear picture of the track scattering on a paper tape is a doubling element of the scattering output.

3. Instead of the differential spectrum of gaps by lengths we take directly the integral spectrum which allows to determine a mean slope of the spectrum (on a semi-logarithmic diagram) and the corresponding ionization parameter g with a considerably greater accuracy than it was before.

III. After the aforesaid modification we carried out a new study of operating characteristics of the apparatus.

Fig. 1 represents distributions of second differences of Y-coordinates on several tracks of a proton beam with the momentum of 19.6 GeV/c in the Ilford-C5 emulsion measured one time automatically and another time visually on various cells. It can be seen that the demand $(\bar{D}_2^2)_{coul} > 2\sigma$ (σ - dispersion for the total noise) is fulfilled in the first case at the momenta of 1000 MeV/c on the cell of 400μ and 5 GeV/c on the cell of 1600μ, for the visual measurement of 1.5 and 7.0 GeV/c, respectively.

Fig. 2b,c shows relative fluctuations of the measured values of two parameters suitable for the ionization measurements: blob number N_b and slope of the gap spectrum by lengths g. For comparison, Fig. 2a represents also the results of visual measurements of the parameter N_b. One may see that the effect of the apparatus noises is small on the blob counting as compared with the statistical fluctuations. It increases however on using the average of two parameters as the ionization value. Although the analysis has shown existence of the well-expressed correlation between them, the negative effect of the apparatus noises in the case of relativistic tracks is larger than the gain in information attained on measurement of the gap spectrum. Probably, this is connected with the fact that the noise effect interrupting accumulation of the information on the gap length becomes sufficiently large.

IV. We made an attempt to apply our automatic apparatus to the measurement of tracks in the emulsion exposed in the magnetic field*. Unfortunately, in this case the exceeding of the useful signal over the background noises was such that the apparatus is at the very limit of its potentialities and cannot provide reliable data. And the contrast, i.e. the relative amplitude of the useful signal decreased by 10 times as compared with usual emulsions NIKFI or Ilford in which, thus, at least 10-fold margin of sensitivity takes place.

In conclusion, the authors wish to thank I.V.Shtranikh and I.Ya.Barit for their interest in the work, fruitful discussion of several difficulties and assistance in carrying out the work.

---

* The emulsions were kindly given to us by Dr. E. Dahl-Jensen.

VIII-42

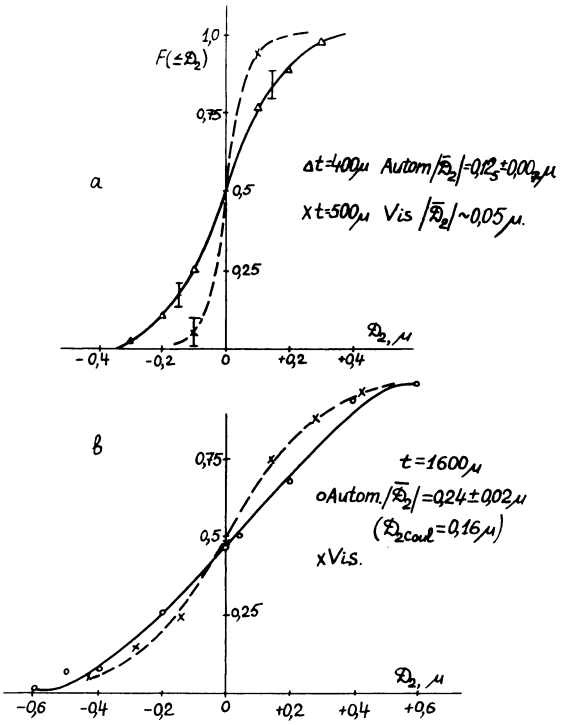

Fig. 1

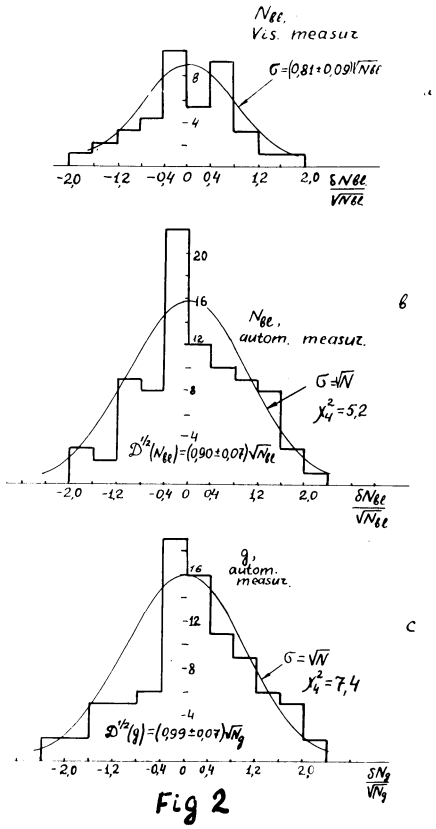

Fig 2