HADRONS REGISTRATION IN EMULSION CHAMBER WITH CARBON BLOCK

A. Tomaszewski and Z. Włodarczyk
Institute of Physics, University of Lodz, Lodz, Poland and
Institute of Physics, Pedagogical University
Kielce 25-509, Lesna 16, Poland

NEC in X-ray emulsion chambers with carbon block, which are usually used in the "Pamir" experiment, was Monte-Carlo simulated. Going over from optical density to ΣE_γ is discussed. Role NEC in the interpretation of energy spectra is analysed.

1. Introduction. As a result of the nuclear-electromagnetic cascade (NEC) in C-layer and Pb-layer of haderonic block, we get a spot on X-ray film of emulsion chamber and then we get several optical densities of the spot corresponding to several radii of a photometer diaphragm. General methodical problem of the hadronic block measurements is how to obtain a value of energy of the hadron - E_0 (or energy of electromagnetic component of a cascade initiated by the hadron-ΣE_γ) from the data of the optical densities D.

2. Simulation Assumptions. Spots of the individual NEC were simulated. We took into account a chamber consisting of 6 cm Pb gamma block (0.35 λ, 10.5 c.u.) and hadronic block having 65 cm C-generator (0.95 λ, 2.7 c.u.) and 4 cm Pb-layer (0.23 λ 7.0 c.u.). The calculation were divided into following parts:
a. For purely proton spectrum with integral slope γ=2, NEC in the chamber was Monte - Carlo simulated, useing scaling model
b. For each particles of electromagnetic component at energy $E_\gamma > 0.05$ TeV the mean cascade function for electron density $\rho(E_\gamma, r, t)$ at depths t was used. Target diagramme was constructed on the area 300x300 μm^2 with cells 12x12 μm^2 each.
c. The electron density diagramme was transformed to the flux of light diagramme, assumed the characteristic curve $D(r) = 4.0\{1-\exp[-3.25\ \rho(r)]\}$ of X-ray film. At a position of diaphragm for X-ray film at depth 4 cm of Pb-layer was obtained.

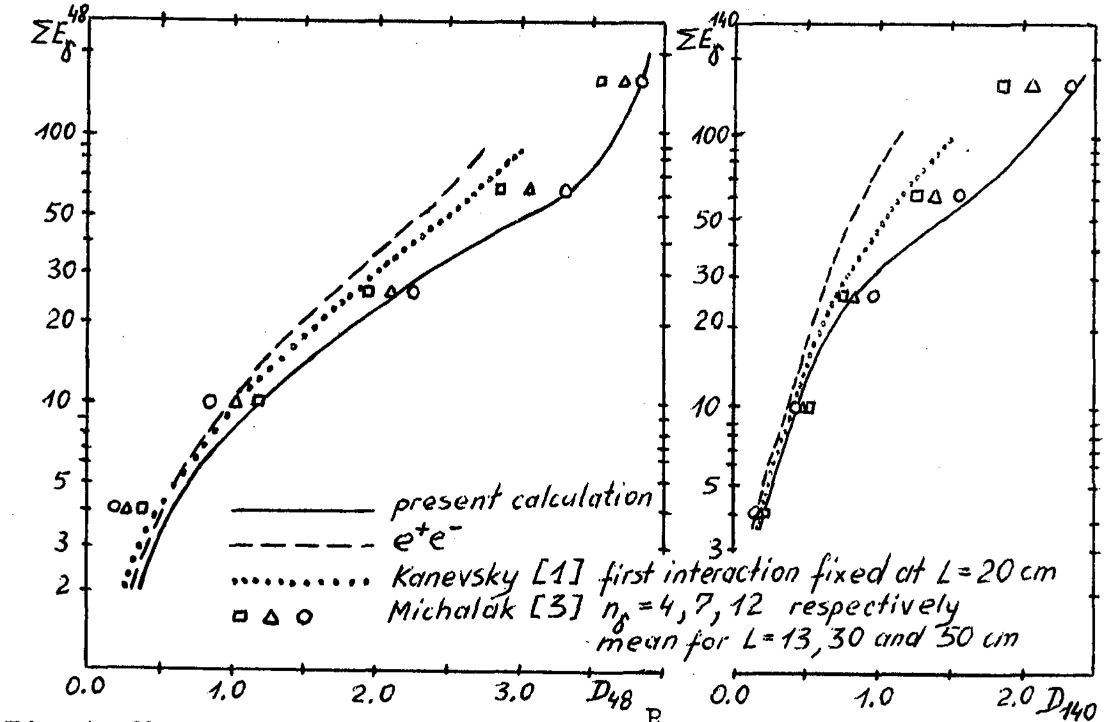

Fig.1. Mean cascade curves $D_R - \Sigma E_\gamma^R$ for NEC at 4 cm Pb.

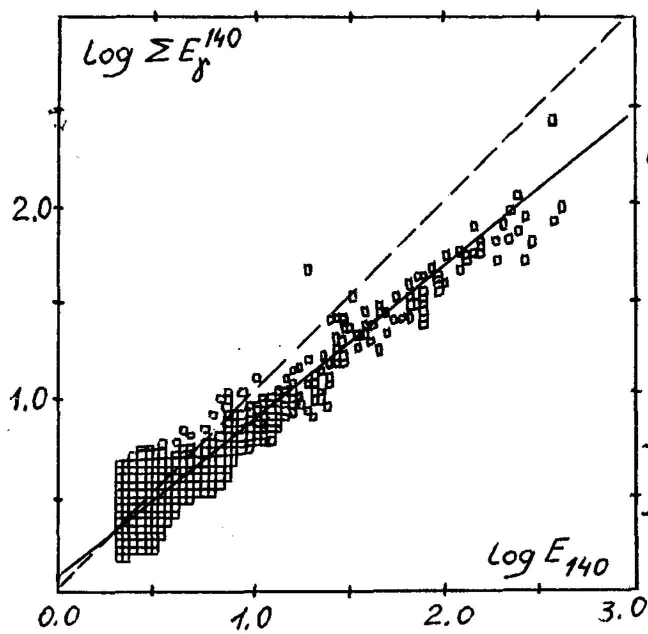

Fig.2. Scatter plot of ΣE_γ versus E for R=140 µm and Δt=0. Dasched line is the dependence for the case Δt = -2.0 c.u.

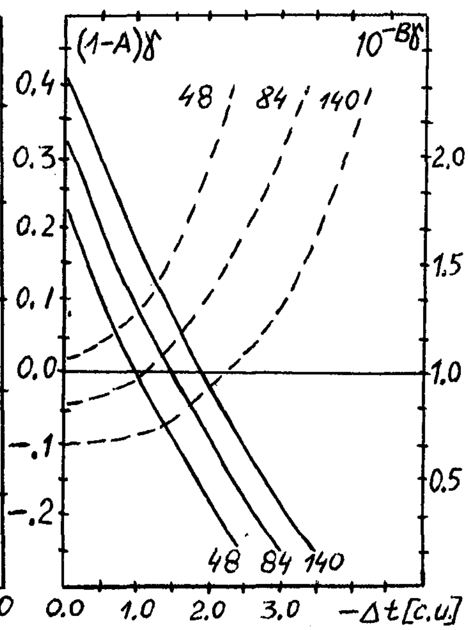

Fig.3. Dependence of $(1-A)\gamma$ and $10^{-B\gamma}$ on the Δt (solid and dashed curves, respectively).

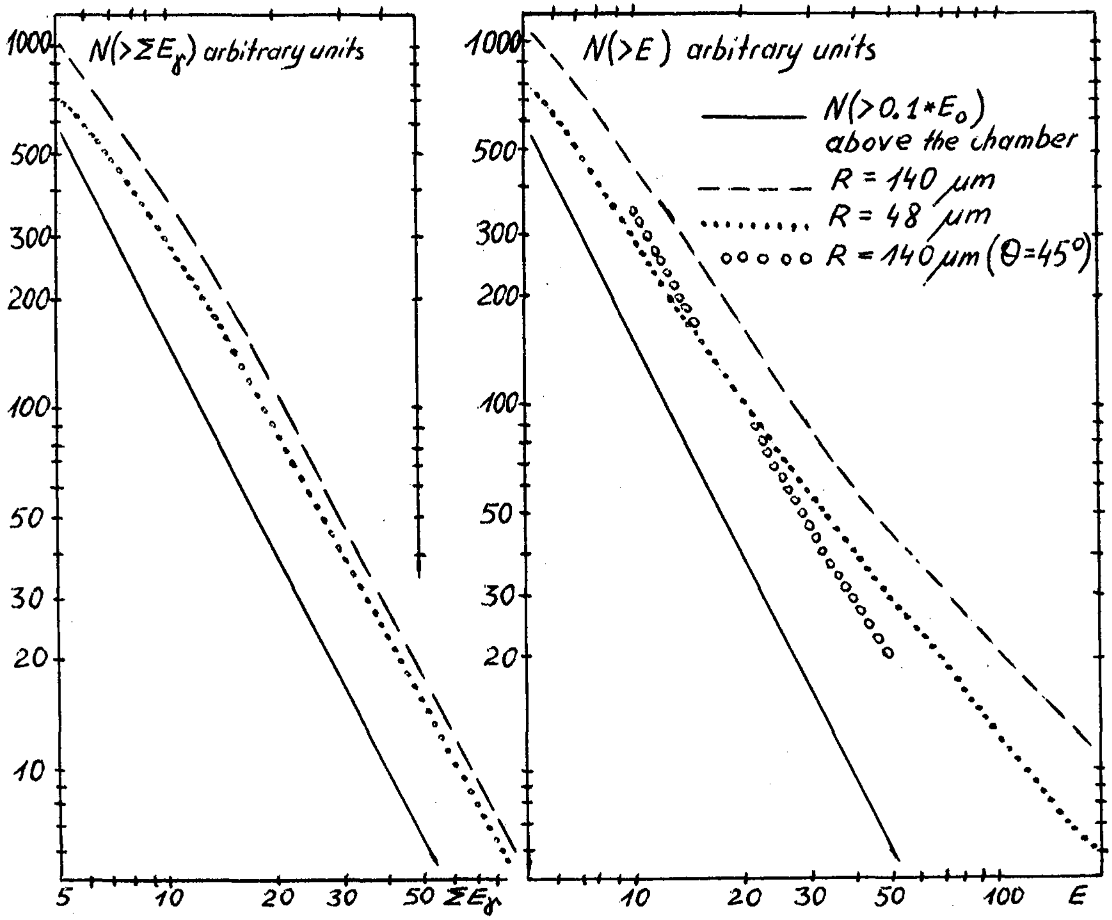

Fig.4. Integral spectra of ΣE_γ and E.

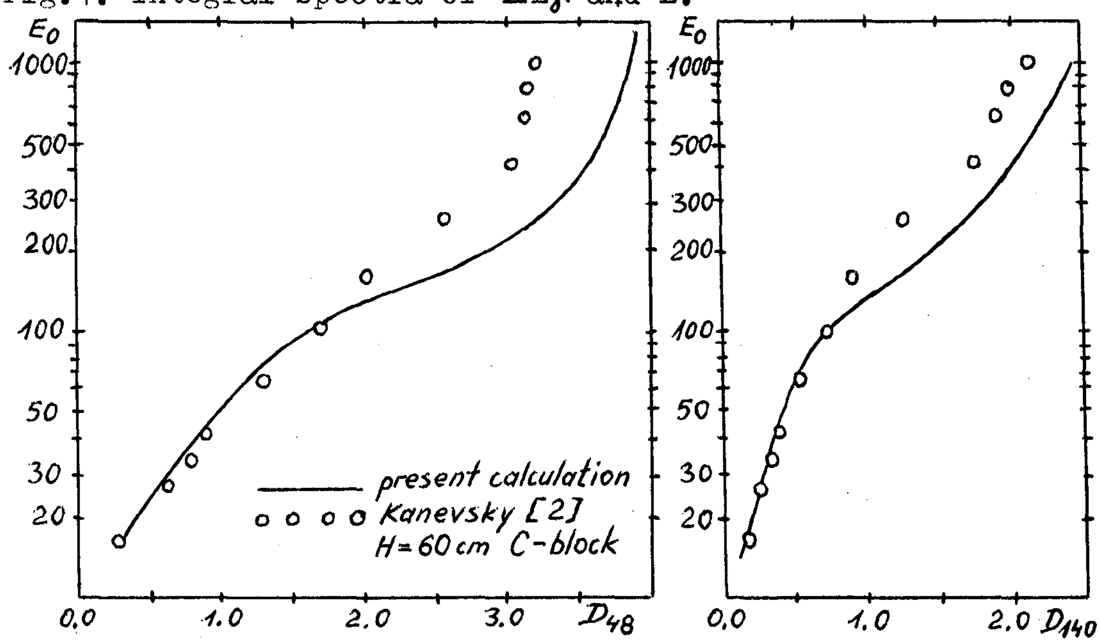

Fig.5. Mean cascade curves D_R-E_O for NEC recorded at 4 cm Pb.

3. Results and Discussion. Mean cascade curves for D_R as a function of the energy $\sum E_\gamma^R$ (for radii of photometer diaphragm R=48 and 140 μm) are ploted in Figure 1. The difference between the densities given by NEC in chamber and the ones corresponding to electron cascade is significant at energies above 30 TeV. The present calculation shows the much stronger difference than the one pointed out by [1] (the difference in the C-block thick is negligible at high energy, see Fig.5)

In Figure 2 we presented scatter plot of $\sum E_\gamma$ and of energy E obtained useing the "average transition curves" for e^+e^- (recorded by diaphragm with R=140 μm). The energy $\sum E_\gamma$ depend on E as $\sum E_\gamma = 10^B E^A$. Then the observed spectrum $N(>E) = C\ 10^{-B\gamma} E^{(1-A)\gamma} E^{-\gamma}$ should be flatten by power index of $(1-A)\gamma$ than the injection spectrum on $\sum E_\gamma$: $N(>\sum E_\gamma) = C(\sum E_\gamma)^{-\gamma}$. The quantities $(1-A)\gamma$ and $10^{-B\gamma}$ are presented in Figure 3 (at $\Delta t=0$). Figure 4 shows the integral spectra of $\sum E_\gamma$ and E

Roughly , it is possible to estimate the energy spectra took into account the thick of carbon layer Δt penetrated by NEC. Nevertheless this manner is dangerous, because deepen in NEC development the difference is not so significant (see Figure 4 , curve for θ= 45 deg : t = 4.0/cos(45) Pb).

Mean cascade curves for optical density as a function of hadron energy E_0 are ploted in Figure 5. The difference between present calculation and Kanevski [2] data are caused by the difference in transition $\sum E_\gamma \rightarrow D$ mentioned above.

4. Conclusion. Useing $D(\sum E_\gamma)$ corresponding to e^+e^- cascade or these calculated by [1,2] provide to flattenens of the observed hadron spectrum and decreases of attenuation m.f.p. (calculated from zenith angle distribution) at $\sum E_\gamma > 30$ TeV.

References

[1] Kanevsky B.L., in: Electron-Photon Cascade at High Energy Cosmic Rays, Moscow (1980), in Russian
[2] Kanevsky B.L., et al., 17 th ICRC, 5, 335, Paris (1981) and Moscow State University Report-in Russian
[3] Michalak W., Acta University of Lodz, 60, 137, Lodz (1977)