Experimental Results on Neutron Production by Muons at 4300 m w.e.

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Summary. - An experiment on neutron production by cosmic-ray muons has been carried out at the depth of 4300 m w.e. The target is a 35 cm layer of Pb and the neutron detector with twenty-eight BF$_3$ counters has an average efficiency of $2 \cdot 10^{-3}$. The results on the muon interaction cross-section $\sigma$ and on the mean multiplicity at production $\bar{m}$ are compared with other data at lower energies (magnetic spectrographs and underrock) and with the expectation from the conventional nuclear and electromagnetic processes of muons of mean energy $(250 \pm 300)$ GeV.

1. - Introduction.

The investigation of neutron production by cosmic-ray muons gives information on the muon interaction cross-section which is particularly valuable in that energy range $E_{\mu} > 10$ GeV not yet reached by the accelerators. This research can be made in two different ways, involving different techniques and problems:

a) Sea-level experiments, using magnetic spectrographs to select the muon energy range ($^{(1)}$). The advantage is given by the "quasi-monochromatic"

energy of the muons; the problems are the usual ones of the big magnetic spectrographs (the dimensions limit the maximum attainable energy, the shielding of the high c.r. flux, etc.).

b) Under-rock experiments, where the rock burden provides a good natural shielding, but the muons have an energy spectrum characteristic of each depth range (49).

As our purpose is the exploration of the highest energy range, we have followed the second way, and already two years ago carried out some preliminary measurements at the intermediate depths 60 and 110 m w.e. (5). The results of this first run can now be used as a normalization for our new experiment carried out in the Mont Blanc Station at a depth of 4300 m w.e.

2. - Experimental apparatus.

The neutron detector is made up by a tank (100 × 100 × 40) cm filled with paraffin, in which twenty-eight BF₃ proportional counters are embedded. The counters are divided in two sets (12 + 16) geometrically located along two planes parallel to the top face of the tank, at different depths within the moderator.

The BF₃ counters, 5 cm diameter, have an active length of 40 cm and are filled with ¹⁰B- enriched (96%) gas at a pressure of 70 cm Hg.

Each counter is rigidly connected with a circuitry which performs the following operations: high input impedance amplification, bipolar pulse shaping (pulses about 2 µs long), amplitude selection and, finally, shaping (~100 ns) and low output impedance amplification.

The lead target has dimensions (80 × 100 × 35) cm² (producing a thickness Δx = 392 g cm⁻²) and is separated from the neutron detector by 24 cm of air.

A 2 m² scintillator system placed above the detector selects vertical muons.

The arrival of the triggering neutron opens a 2 ms gate in which the pulses go from the neutron detector to the multiplicity recorder. The registration of the neutron event (i.e. its multiplicity r) and that of the producing muons is photographic on a Tektronix 555 oscilloscope.

(8) L. Bergamasco: Nuovo Cimento, 66 B, 120 (1970); in Table II of this reference there is a misprint: the numbers relative to 108 m w.e. are 8.3 and 8.7 instead of 3.3 and 3.7.