Measurements on the Cosmic Radiation Intensity in the Mont Blanc Tunnel.

C. Castagnoli, A. De Marco, A. Longhetto and P. Penengo

Istituto di Fisica Generale dell'Università - Torino

(ricevuto il 20 Maggio 1964)

Summary. — Measurements on the muonic vertical intensity at different depths under rock (140; 290; 1325; 4100±100 m.w.e.) have been performed in the Mont Blanc tunnel. The experimental equipment is described. Our results are compared with the results obtained by other authors. Taking into account the values $Z^2/A$ of the various types of rock there is a good agreement among all these measurements. The comparison of experimental points with the muonic spectrum at s.l. suggests to use the Weizsäcker-Williams instead of Kessler-Kessler virtual photonic spectrum in the calculation of the energy losses due to nuclear interactions.

1. — Introduction.

The interest in the intensity-depth measurements of cosmic radiation far underground is connected with three main problems: 1) To extend the knowledge of the muonic component spectrum at very high energies. 2) To obtain information on primary spectra and on production processes at energies not attainable today by accelerators. 3) To know more accurately the energy loss processes of ultrarelativistic muons, especially the pair production and nuclear interactions.

The underground measurements of the muon intensity were started many years ago but the information at depths greater than 1500 m.w.e. is still quite
scanty. Only in the last year an important experiment has been performed by the Bombay group at the Kolar Gold Fields in South India (1).

This scarcity of information is due not only to the difficulty to find an accessible place covered by a sufficient thickness of rock but also to use suitable detectors.

In fact the ratio signal/background is very low due to the high attenuation of the cosmic radiation and to the local radioactivity of the rocks. For example Geiger counters have been found (2) unsuitable for measurements at high depth because they do not discriminate between the different heights of the pulses from rock radioactivity and cosmic rays.

In this type of experiments there are two main sources of error. The first is statistical and due to the very high \( \mu \) attenuation with depth, which requires a long measuring time. The second (which we believe to be more important than the former) arises from the difficulty in converting the rock thickness into equivalent metres of \( H_2O \) because the density of the covering material is not always well known.

For these reasons it is important (3) to have independent measurements at equivalent depths. We have performed one of these measurements inside the Mont Blanc tunnel (1381 m a.s.l.).

2. - Experimental equipment.

Our experimental device has the following main features: 1) the large sensitive surface required by the low value expected for vertical intensity \( I(0, h) \), 2) an acceptable ratio signal/background to allow measurements at very high depth \( h \), 3) good angular definition. This condition, which is in contradiction with point 1), is however very important.

In fact, in order to calculate \( I(0, h) \) (cm\(^{-2}\)s\(^{-1}\)sr\(^{-1}\)) from the counting rate it is necessary to know the angular distribution of the muonic component to evaluate the telescopic geometric factor. As this distribution is not directly known for depths \( h \geq 850 \) m w.e., only the use of telescopes with small solid angle can obviate such a difficulty.

We satisfied condition 1) using 4 plastic scintillators each one of size \((70 \times 70 \times 13)\) cm\(^3\) and the condition 3) by proper arrangement of the counter-telescope. We use 2 telescopes each one mounting two counters at the distance of 2.5 m. In order to satisfy condition 2):


(2) C. Barton: *Phil. Mag.*, 6, 1271 (1961).