ISTITUTO NAZIONALE DI FISICA NUCLEARE
Laboratori Nazionali di Frascati

LNF-86/73

G. Battistoni, P. Campana, V. Chiarella, A. Ciocio, E. Iarocci,
G.P. Murtas, G. Nicoletti, L. Satta, L. Trasatti ,.........., G. Bologna,
C. Castagnoli, B. D'Ettore Piazzoli, P. Galeotti, G. Mannocchi,
P. Picchi, O. Saavedra, D.C. Cundy and M.J. Price:

CONTAINED EVENTS IN THE MONT-BLANC NUCLEON STABILITY EXPERIMENT

Estratto da:
Nuovo Cimento 9C, 182 (1986)

Servizio Documentazione
dei Laboratori Nazionali di Frascati
Cas. Postale 13 - Frascati (Roma)

IL NUOVO CIMENTO VOL. 9 C, N. 2 Marzo-Aprile 1986

Contained Events in the Mont-Blanc Nucleon Stability Experiment.

G. BATTISTONI, P. CAMPANA, V. CHIARELLA, A. CIOCIO, E. IAROCCI
G. P. MURTAS, G. NICOLETTI, L. SATTA and L. TRASATTI

Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati

E. BELLOTTI, E. FIORINI, C. LIGUORI, P. NEGRI, A. PULLIA
S. RAGAZZI, M. ROLLIER and L. ZANOTTI

Dipartimento di Fisica dell'Università - Milano
Istituto Nazionale di Fisica Nucleare - Sezione di Milano

G. BOLOGNA, C. CASTAGNOLI, B. D'ETTORRE PIAZZOLI, P. GALEOTTI
G. MANNOCCHI, P. PICCHI and O. SAAVEDRA

Istituto di Cosmo-geofisica del C.N.R. - Torino
Istituto di Fisica Generale - Torino

D. C. CUNDY and M. J. PRICE

C.E.R.N., European Organization for Nuclear Research - Geneva

(ricevuto il 12 Agosto 1985)

Summary. — The Mont-Blanc nucleon stability experiment is reviewed and some of the more recently observed contained events are described.

The Mont-Blanc nucleon stability experiment (NUSEX) is located in garage 17 almost exactly half-way along the road tunnel linking France and Italy. The rock above the laboratory has a minimum depth of 4800 m.w.e. The detector takes the form of a cube with 3.5 m side consisting of 136 1 cm thick iron sheets interleaved with limited streamer tubes. The apparatus thus serves both as source of nucleons and as detector of an eventual decay.

The active mass of the detector is approximately 150 tons. The outer layers of tubes are used to veto against incoming particles and thus the effective mass for nucleon decay is of the order of 130 tons, however, this figure clearly will depend on the topology of the particular decay mode. The planes of limited streamer tubes consist of 320 parallel wires each 3.5 metres long. The tubes containing the individual wires have a resistive coating and the electrical transparency of this coating allows the signal produced during the limited streamer discharge to be picked up on strips placed parallel and perpendicular to the wires.

Signals from discriminators attached to each of the strips are fed to parallel-in-serial-out shift registers. In addition all signals from one plane are combined together to produce a « fast OR » signal. The « fast OR's » from all the planes are treated electronically to produce a trigger signal. In view of the rate of radioactivity in the iron (on the average about 1 Hz per wire but rising significantly near the sides of the apparatus due to the radioactivity in the rock) certain minimum configurations of simultaneous hits in the planes have to be satisfied in order to reduce the rate of data-taking to a reasonable level. At present, we accept as triggers those events with hits in at least three contigous planes together with hits in at least two contiguous planes.

Early results and a fuller description of the apparatus have been reported previously ([1,2]). The characteristics of the detector have been established in experiments at the CERN PS ([3]), where a 1 m^3 test module was exposed to unfocused neutrino beams and to π^+ and electron beams. From these tests it was established that, for example, 500 MeV pions could be identified correctly in 55 % of cases whilst in 40 % of cases there is a π-μ ambiguity and in 5 % of cases a π-e confusion. The direction of μ^+ can be inferred in 35 % of cases since the apparatus is equipped with means of recording the time that a particular plane was hit. The direction of the μ is obtained from the characteristic delayed μ-e decay. In the case of μ^- there is a 90 % probability of nuclear capture. In certain cases the direction of stopping particles can be inferred from the increase of multiple scattering as they slow down. The energy of electrons is obtained from shower measurement; from the CERN PS experiments it was shown that a resolution of $0.2/\sqrt{(E(\text{GeV}))}$ is obtainable. The energy of muons is estimated from their range. In the case of a 500 MeV muon perpendicular to the iron plates the sampling error and the error on the mo-

([1]) G. BATTISTONI *et al.*: *Phys. Lett. B*, **118**, 461 (1982).
([2]) G. BATTISTONI *et al.*: *Phys. Lett. B*, **133**, 454 (1983).
([3]) G. BATTISTONI, E. BELLOTTI, G. BOLOGNA, P. CAMPANA, C. CASTAGNOLI, V. CHIARELLA, D. C. CUNDY, B. D'ETTORRE PIAZZOLI, E. FIORINI, E. IAROCCI, G. MANNOCCHI, G. P. MURTAS, P. NEGRI, G. NICOLETTI, L. PERIALE, P. PICCHI, M. PRICE, A. PULLIA, S. RAGAZZI, M. ROLLIER, O. SAAVEDRA, L. TRASATTI and L. ZANOTTI: *Nucl. Instrum. Methods*, **219**, 300 (1984).

mentum due to straggling are comparable at about 3 %. A large proportion of pions interact with nothing visible so that in this case we can at best estimate a lower limit on the initial energy of the particle.

At mid April 1985 the total live time of the apparatus was 22 350 hours which corresponds to $2.3 \cdot 10^{32}$ nucleon years. During this time 31 fully contained events had been observed. If all these events are taken to be neutrino events and if the cut E(visible) > 250 MeV is applied, 30 events remain of which 22 events are considered as being due to ν_μ, 7 events due to ν_e and one ambiguous event. The neutrino interaction rate is 149 ± 27 events kton^{-1} y^{-1}. In the recent period from 22 March until 13 April 1985 four fully contained events were obtained in the apparatus. One of these events is a two-prong event with an opening angle of 136°. A possible interpretation is $\nu_\mu \to \pi\mu$, however the nucleon decay $n \to \pi\mu$ is an alternative hypothesis. The total visible energy is (850 ± 180) MeV and the momentum imbalance is 350 MeV/c. In the neutron decay hypothesis this momentum imbalance would be interpreted as being due to Fermi motion. From the CERN neutrino test we would expect a neutrino event background of 0.6 ± 0.15 events. From Monte Carlo simulations it has been found that approximately one-third of pions are absorbed in the nucleus, one third interact and one third scatter through less than 120°. The estimated nucleon lifetime for this particular channel is calculated to be $0.3 \cdot 10^{31}$ years at the 90 % confidence level.

● RIASSUNTO

Si esamina l'esperimento di stabilità del nucleone del Monte Bianco e si descrivono gli eventi contenuti osservati piú recentemente.

События в эксперименте по стабильности нуклона под Мон-Бланом.

Резюме (*). — Заново анализируется эксперимент по стабильности нуклона под Мод-Бланом. Обсуждаются недавно наблюдавшиеся сопутствующие события.

(*) *Переведено редакцией.*