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# P. Spillantini: TEST OF LIMITED STREAMER TUBES NEAR URANIUM PLATES.

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# P. Spillantini : TEST OF LIMITED STREAMER TUBES NEAR URANIUM PLATES.

Limited streamer tubes are currently used in experiments (see e.g. ref. (1)) and are planned as detection elements in electromagnetic and hadronic calorimeters in several experiments proposed for LEP.

Concerning the hadronic calorimeters it was extensively demonstrated that the use of a suitable amount of uranium in the absorbing material gives a number of neutrons coming from the uranium fission, which compensate efficiently the fluctuation of the electromagnetic component in the hadronic shower : the main source of uncertainty in the energy determination is indeed depressed and the resolution improves considerably(2, 3). Therefore it is interesting to know if limited streamer tubes could be used as sampling detectors in uranium compensated hadron calorimeters.

A very simple preliminary test was performed to give a first answer to this question : a uranium plate (1.7 mm thick, exagonal in shape with 17.5 cm side(4)), was faced to a limited streamer tube module (composed of 32 tubes, $9 \times 9$ mm$^2$ cross section each(5)) covering a total area ($32.2 \times 50$ cm$^2$) wider than the uranium plate area. The tubes were filled by the "standard" high quenching gas mixture (3/4 isobutane + 1/4 argon) suitable for the relatively large diameter (100 $\mu$m) sense wire mounted in the tubes.

The H.V. plateau shown in Fig. 1 was obtained registering without the help of any external gate the number of pulses induced on a pad faced to the module and covering its whole area. It shows that we can work cleanly in sin-

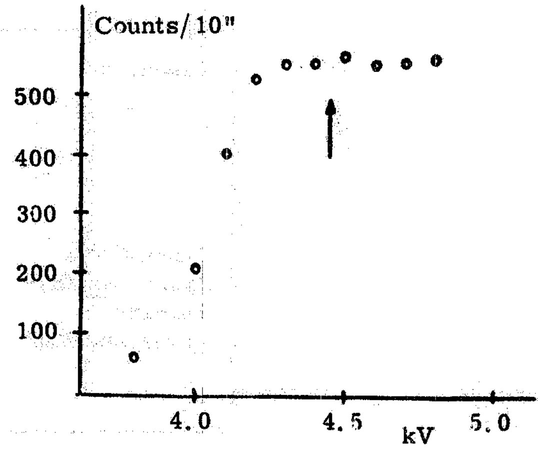

FIG. 1

gle at a fixed H.V. (it was chosen 4.45 kV).

The test consisted simply in recording the counting rate from the pad faced to the tube module with and without the uranium plate faced to the other side of the module. Different absorbers were placed between the module and the uranium.

A pulse formation time of 0.7 $\mu$sec was chosen, as a suitable compromise to avoid efficiency losse without affecting appreciably the counting rates up to some $10^5$/sec. In fact, with the uranium faced to the module without any absorber in between the efficiency was measured to be 86.6 %, exactly that given considering only the geometrical losses due to the walls of the tubes and of the gas box.

The results, plotted versus the radiation length thickneee of the absorber, show an exponential trend with superimposed a copious but very short range ($\lesssim$ 0.05 r.l.) component (see Fig. 2).

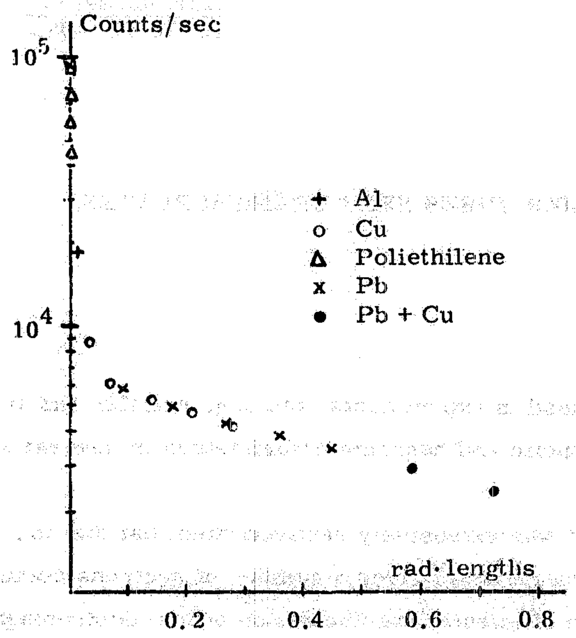

FIG. 2

In Table I the same rates are reported for $m^2$ and for one 3 m long tube, 6x6 $mm^2$ in cross section$^{(6)}$. Based on this table, assuming a formation time of 0.4 $\mu$sec and considering that the detector, when used in a uranium calorimeter, receives radiation from both its sides, we can evaluate the noise per tube and per tower reported in Table II.

TABLE I

| | | |
|---|---|---|
| Counts/$m^2$ | $1.25 \times 10^6$/sec | U faced to the module |
| | $0.24 \times 10^6$/sec | U shielded by 1 mm Al |
| | $0.11 \times 10^6$/sec | U shielded by 0.5 mm Cu |
| | $0.07 \times 10^6$/sec | U shielded by 1 mm Cu |
| | $0.07 \times 10^6$/sec | U shielded by 0.5 mm Pb |
| | $0.06 \times 10^6$/sec | U shielded by 1 mm Pb |
| Counts/tube (tube 3 m long 6 x 6 $mm^2$ cross section) | $22 \times 10^3$/sec | U faced to the tube |
| | $4.3 \times 10^3$/sec | U shielded by 1 mm Al |
| | $2.0 \times 10^3$/sec | U shielded by 0.5 mm Cu |
| | $1.3 \times 10^3$/sec | U shielded by 1 mm Cu |
| | $1.2 \times 10^3$/sec | U shielded by 0.5 mm Pb |
| | $1.1 \times 10^3$/sec | U shielded by 1 mm Pb |

TABLE II

| | | | |
|---|---|---|---|
| Extra-streamer/event/tube (tube 3 m long $6 \times 6$ mm$^2$ cross section) | 0.0088 | U | faced to both sides of the tube |
| | 0.0017 | U | as above but shielded by 1 mm Al |
| | 0.0008 | U | as above but shielded by 0.5 mm Cu |
| | 0.0005 | U | as above but shielded by 1 mm Cu |
| | 0.0005 | U | as above but shielded by 0.5 mm Pb |
| | 0.0004 | U | as above but shielded by 1 mm Pb |
| Extra-streamer/event/tower (tower : 40 sampling with $10 \times 10$ cm$^2$ pads) | 0.20 | U | faced to both side of each sampling plane |
| | 0.038 | U | as above but shielded by 1 mm Al |
| | 0.018 | U | as above but shielded by 0.5 mm Cu |
| | 0.011 | U | as above but shielded by 1 mm Cu |
| | 0.011 | U | as above but shielded by 0.5 mm Pb |
| | 0.010 | U | as above but shielded by 1 mm Pb |

These figures are very incouranging. However it must be noted that the "build-up" effect due to the highly penetrating component coming from all the other uranium plates of the calorimeter must be considered: it depends very much from the total uranium thickness, its ratio to that of the shielding material (Cu or other), the geometrical arrangement, etc. As a first guess an increasing of a factor $\lesssim 2$ could be considered(7), but a more accurate evaluation and perhaps an experimental test should be necessary for each experimental situation to know how noisy the hadron calorimeter will be.

The author wishes to thank the "Nucleon Stability Experiment"group for the collaboration in particular Mr. G. Nicoletti for the continuous assistance given during the test. He is very grateful also to C.W.Fabjan for providing the uranium plates.

## REFERENCES AND NOTES.

(1) - C. Bacci et al., Phys. Letters 86B, 234 (1979); J. E. Augustin et al., Phys. Scripta 23, 623 (1981); M. Jonker et al., Phys. Scripta 23, 677 (1981); Proposal for a Nucleon Stability Experiment, Frascati-Milano-Torino (1979), unpublished; G. Battistoni et al., contribution to the "European Conference on Elementary Particle Physics", Lisbon, July 1981, to be published on the Proceedings; G. Battistoni et al., contribution to the "International Conference on Instrumentation for Colliding Beam Physics, Stanford, February 1982, to be published on the Proceedings; M. Baldo-Ceolin et al., "Workshop on Grand Unification Theories", Venezia, March 1982.

(2) - C. W. Fabjan et al., Nuclear Instr. and Meth. 141, 61 (1977).

(3) - O. Botner et al., IEEE Trans. on Nuclear Sci. NS-28, 510 (1981).

(4) - It is one of the uranium plates (depleted in its $U^{235}$ content) used by C. W. Fabjan for his previous test some years ago(2), and that he kindly rent for this test, together with a second uranium plate. This second one was used only to control if the "mass effect" obtained facing both the plates to the same side of the tube module agrees with the results of Fig. 2 (it does).

(5) - This module is a short length sample of the modules used for the "Nucleon Stability Experiment" under the "Mont Blanc", kindly borrowed by this group.

(6) - These are the cross section and the maximum length of the tubes forseen for the "magnetic cave" experiment proposed for LEP (letter of intent LEP/I 3).

(7) - The effective attenuation length of the penetrating component corresponds to 0.79 radiation lengths (see Fig. 2). Hence the penetrating component is reduced by a factor two in 0.54 radiation length, i.e. in a thickness nearly equivalent to that of our test uranium plate. Hence the "mass effect" of a uranium absorber infinitely thick can increase the total noise for a (maximum) factor

$$\lim_{n \to \infty} \sum_{j=0}^{n} \left(\frac{1}{2^j}\right) = 2.$$