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# A CUBE LATTICE MULTIWIRE DETECTOR.

ABSTRACT.

A multiwire detector consisting of an array of cubic sensitive cells operated in the limited streamer mode is presented. It should exhibit improved electromagnetic shower detection properties, due to soft electron absorption caused by its geometry.

The high sensitivity to soft electrons of multiwire detectors is responsible for their poor response when used as the sensitive elements of electromagnetic calorimeters[1]. The use of tube layers improves the response since sense wires are separated by a material thickness which prevents the spread of soft radiation over different sense wire regions. We have introduced a method[2] for bidimensional readout on tube layers. It is based on the use of resistive cathodes: due to their transparency to pulsed fields, particle position along the wire is measured by detecting induced pulses on external pick-up electrodes, such as strips at an angle with respect to the tubes. However, from the point of view of soft particle confinement the wire and strip readouts are not symmetric, since soft electrons can travel along a tube element and cause undesired strip hits.

We propose a device which is again based on strip readout outside resistive cathodes, but with strip detection properties fully equivalent to those of the wires. It may be thought of as a resistive tube layer transformed into a cube lattice by insulating diaphragms inserted across the tubes, orthogonally to the wires. Such diaphragms will absorb soft electrons travelling along the original tube elements. The thickness of the diaphragms (1 mm PVC) is equivalent to the mean range of a 800 keV electron.

We have built and tested a resistive cube lattice consisting of an 8 x 8 array of sensitive cells ($18x18x18\ mm^3$). The construction procedure is the following: eight PVC plastic square tubes (1.3 mm wall thickness) are glued together in one layer (Fig. 1a); the layer is cut othogonally to the tubes into eight 8-cell elements (Fig. 1b); after being coated with a resistive varnish ($\sim$1 M$\Omega$/square) the 8-cell elements are glued together on a PVC foil reproducing the original tube layer, but interleaved with PVC spacers closing one half of the tube cross section (Fig. 1c); 100 $\mu$m sense wires are inserted, in order to operate in the limited streamer mode similarly to the corresponding tubes[3] (Fig. 1d); PVC spacers are again introduced to complete the diaphragms across the tubes (Fig. 1e). The original resistive tube structure is reproduced, with sense wires inside, but cut across by PVC diaphragms to realize a cube lattice structure (Fig. 1f). A cube element has four resistive faces (the cathode) and two insulating faces which are crossed in the middle by the wire. Gas can flow through 1 mm holes on the diaphragms.

We have operated the cube lattice in the limited streamer mode, and such operation turned out to be improved with respect to the tubes. In fact the subdivision in independent cells inhibits secondary limited streamer generation along the wire (afterpulses)[3],

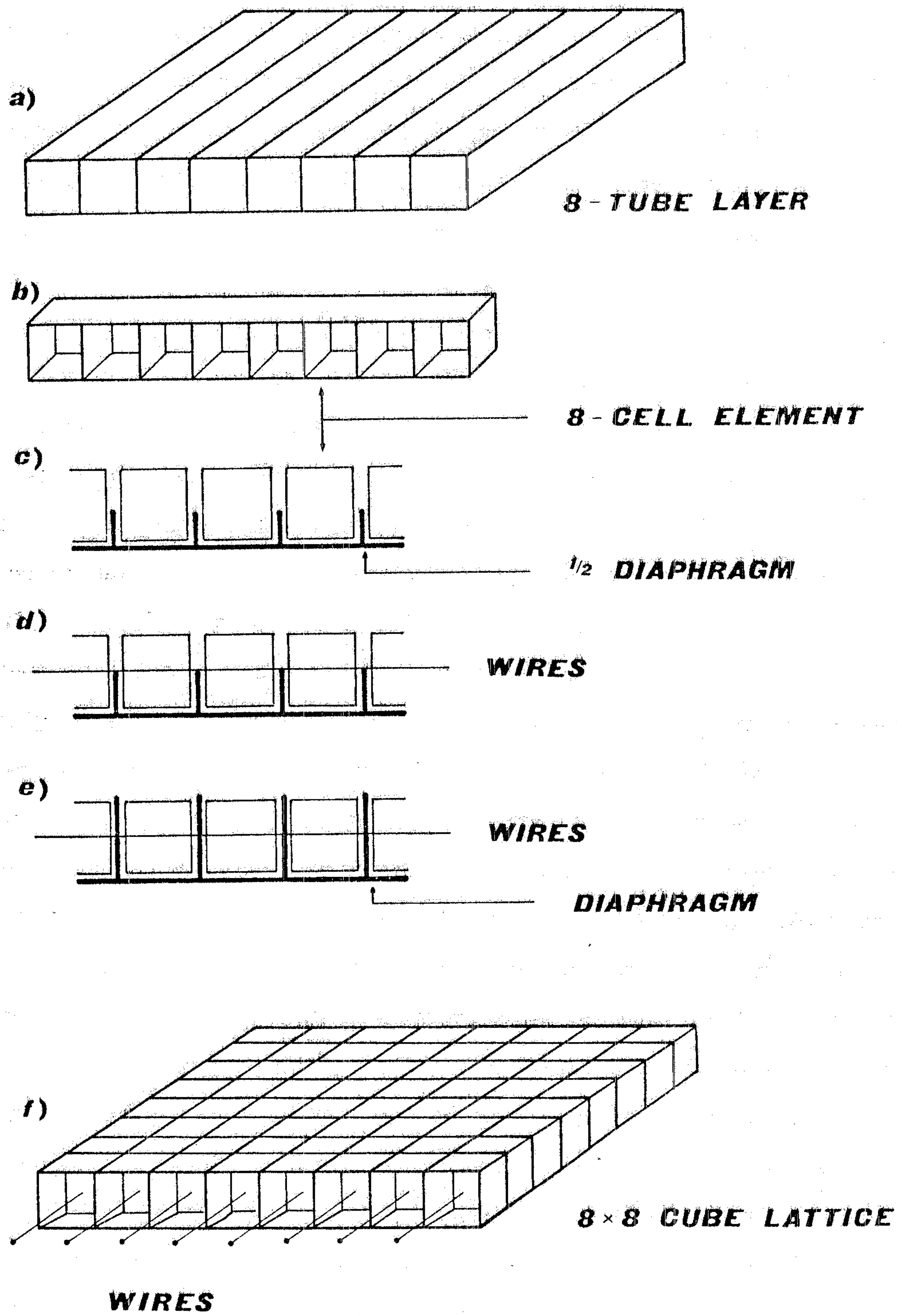


FIG. 1 - Construction procedure for the cube lattice prototype.

so that a wider high voltage range is available for stable operation. In Fig. 2 the typical singles rate curve as a function of the high voltage is shown for the cube lattice, as obtained by a $Sr^{90}$ source.

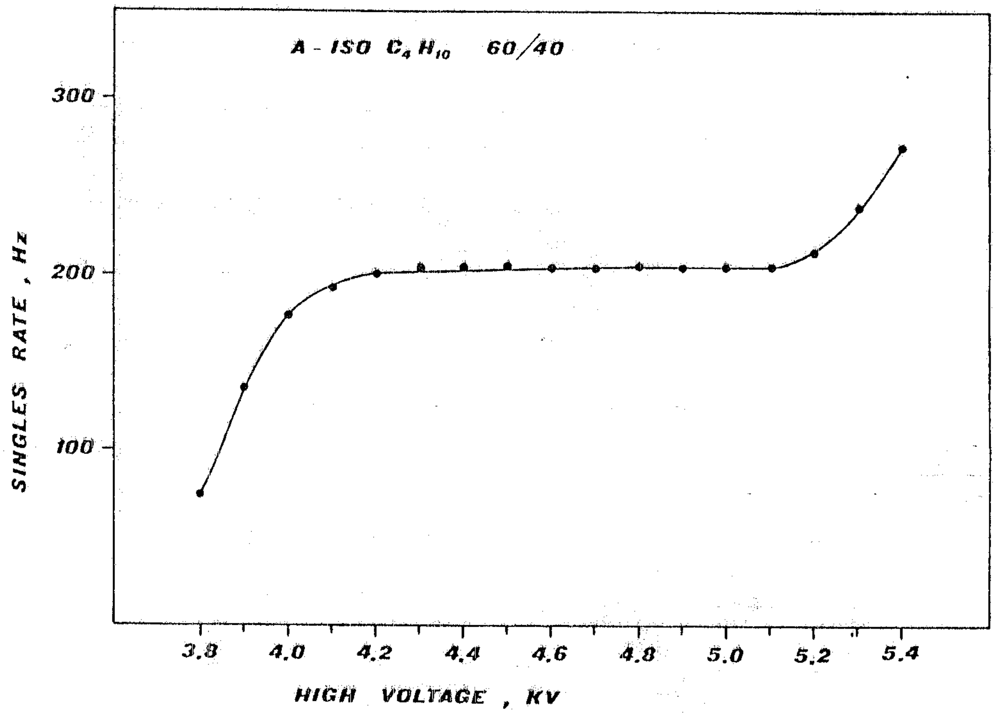


FIG. 2 - Singles rate vs high voltage, irradiating a single cube element by a $Sr^{90}$ source; gas mixture: argon-isobutane (60/40); wire pulse threshold: 30 mV/50 $\Omega$.

The gas mixture is the optimal one for square tubes of the same cross section: argon-isobutane, 60/40. A flat counting rate region extends over about 1000 V. The wire pulses generated at two different supply voltages are shown in Figs. 3a, b: at the higher voltage the pulse height is increased, but both time lengthening and afterpulse generation are inhibited by the diaphragms.

Detection efficiency has been measured with cosmic rays, selected by two 10 x 10 $cm^2$ scintillation counters, 10 cm apart. The sensitive area on the wire plane is 80% of the total detector area (separation walls included). The efficiency plateau level is 78%.

We have detected induced pulses by 18 mm wide strips, with the cube lattice spacing, and facing it on one side. The strips were atta-

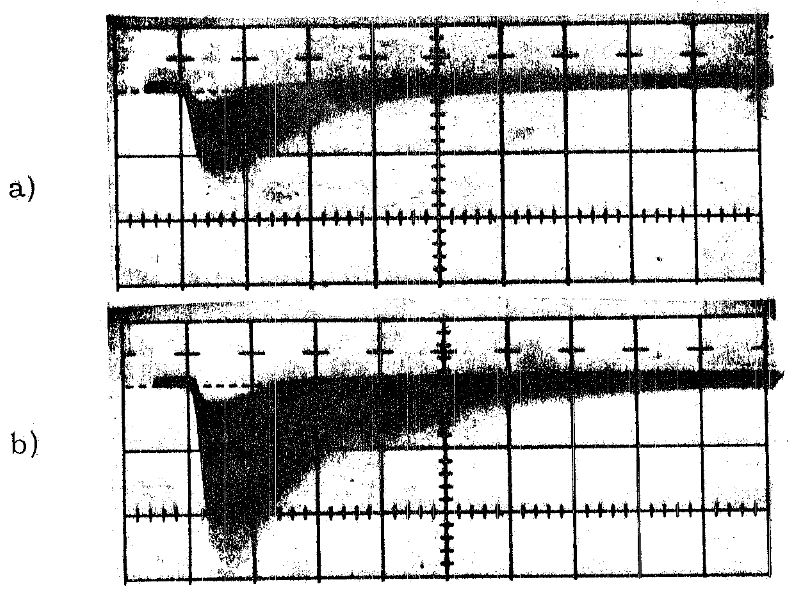

FIG. 3 - Wire pulses on a 50 Ω load, at 4.4 KV (a) and 4.9 KV (b), in the same conditions as in Fig. 2 (100 ns/div, 100 mV/div).

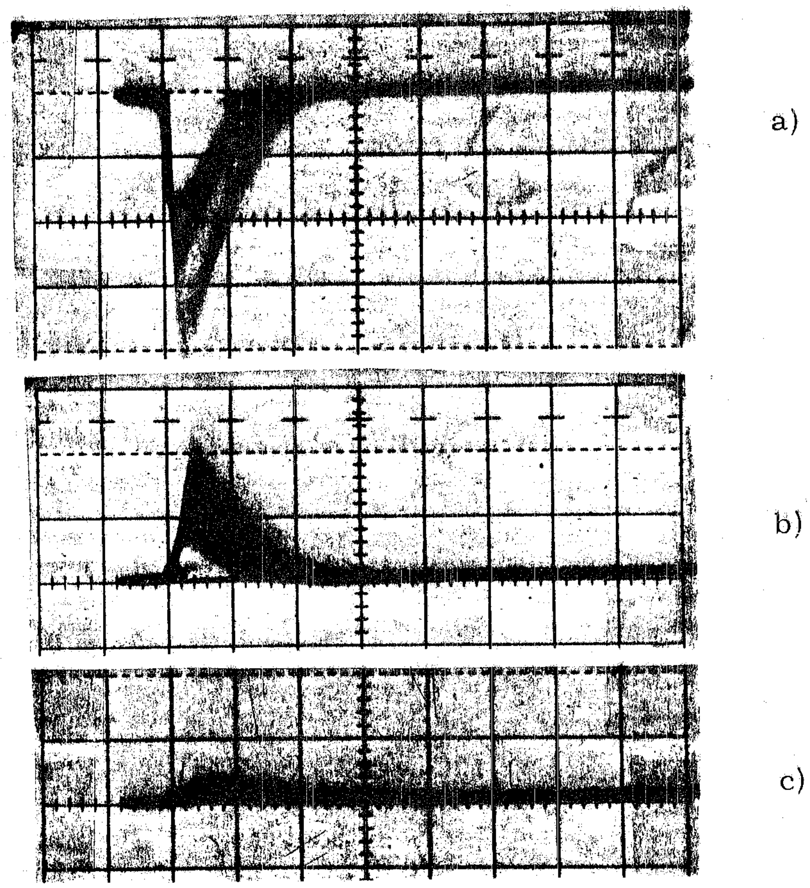

FIG. 4 - Pulse shapes on a 50 Ω load when a single cube element is irradiated by a $Sr^{90}$ source : a) wire pulses, b) the correspon ding pulses on the central strip, c) the corresponding pulses on the neighbouring strip (100 ns/div, 20 mV/div).

ched on a PVC foil with an aluminium sheet on the back as ground electrode.

Fig. 4 shows wire pulses (a) together with the corresponding strip pulses (b), for strips either orthogonal or parallel to the wires (no difference is in practice detectable) ; the small pulse induction on the neighbouring strip is shown in Fig. 4c (a $Sr^{90}$ source was irradiating one cube element only).

As far as the construction of large detectors is concerned, it must be observed that the amount of work needed to realize an n x n cube layer is of the order of magnitude of that needed for an n-tube layer. The construction procedure we followed for the prototype could be substantially maintained. Two extruded or molded plastic structures would be the basic modular units to be assembled: a molded multicell element (Fig. 1b), and an extruded comb profile (Fig. 1c). The use of resistive plastics(3) would simplify construction.

In conclusion the cube lattice device beyond the basic feature of soft radiation confinement, maintains and improves the operation properties of limited streamer tubes, which are high reliability (thick sense wires, large wire signals, wide high voltage operation range) and relatively simple and cheap construction due to the use of plastic materials and their widely used mass production technologies, such as extrusion and molding.

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(1) - H.G. Fisher, CERN/EF/78-2 (1978).

(2) - G. Battistoni et al., Nuclear Instr. and Meth. 152, 423 (1978).

(3) - G. Battistoni et al., Frascati preprint LNF-70/60 (1970), submitted to Nuclear Instr. and Meth.