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PRELIMINARY IMAGES FROM A PROTOTYPE LIQUID XENON γ-CAMERA

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PRELIMINARY IMAGES FROM A PROTOTYPE LIQUID XENON γ-CAMERA

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A new approach to gamma imaging in vivo based on electron multiplication in liquid xenon that offers an improved image was described earlier [1]. A prototype liquid xenon multiwire proportional chamber has now been constructed and preliminary results obtained. A more detailed description is given in Ref. [2]. The sensitive volume is 7 cm × 7 cm in area and 1.5 cm thick, and contains an array of 24 anode wires and 24 cathode strips shown in Fig. 1.

Two types of wires were used: 3.5 μm and 5 μm diam. Most of the studies were made with the 5-μm wire because of its greater strength. The anode wires were spaced 2.8 mm apart and stretched over 7 mm distance, but supported at the center by 0.020-in. quartz fibers. The cathode consisted of conductive strips spaced 2.8 mm apart to provide the orthogonal coordinate.

The readout consists of two, almost identical, charge division networks. The charge at the cathode is induced over several strips. The readout automatically finds the center of gravity of this induced charge.

The chamber is placed in the thin-windowed Dewar containing freon-11, and cooled by means of liquid nitrogen.

The chamber was radiated by means of a ^{203}Hg point source collimated to 2 mm at the chamber.

In the multiwire detector chamber it was found that due to geometry the voltage required to obtain the same gain is higher than in the cylindrical geometry by a factor of 2.2 for both 3.5-μm and 5-μm wires. In order to operate at a amplification factor of 10, a voltage of 6 kV was required in the 5-μm wire case and 5 kV in the 3.5-μm wire

case. From the single wire chamber data given in ref. 3 we note that that a gain of 70 should be reached at 7 kV. We could not reach this level with the 5μ wire due to breakage at 6.5 kV, even though the wires were supported at the center by a quartz fiber. The problem of wire instability at high electrostatic forces has been treated elsewhere. [2]

The energy resolution was found to be 19% FWHM, similar to the single-wire data. The resolution was not degraded with the increase in again. The gas was specially purified [4] before condensing. The chamber was maintained in a liquid state for a 24-h period. By the method of electronegative ion pumping described in Ref. [1], the liquid can be made reliably clean to a level such that the electron attachment is $< 1\%$ per mm of drift. For a chamber of a few centimeters thickness, this implies that the purity level does not effect the energy resolution.

In order to investigate the chamber's spatial response, the point source was imaged and then re-imaged after the source was moved 5 mm in both coordinates (Fig. 2). We note that for the reasons discussed earlier the wires (running in the horizontal direction) produced two points when the source was not aligned exactly on one wire. The resolution is estimated to be 4 mm FWHM.

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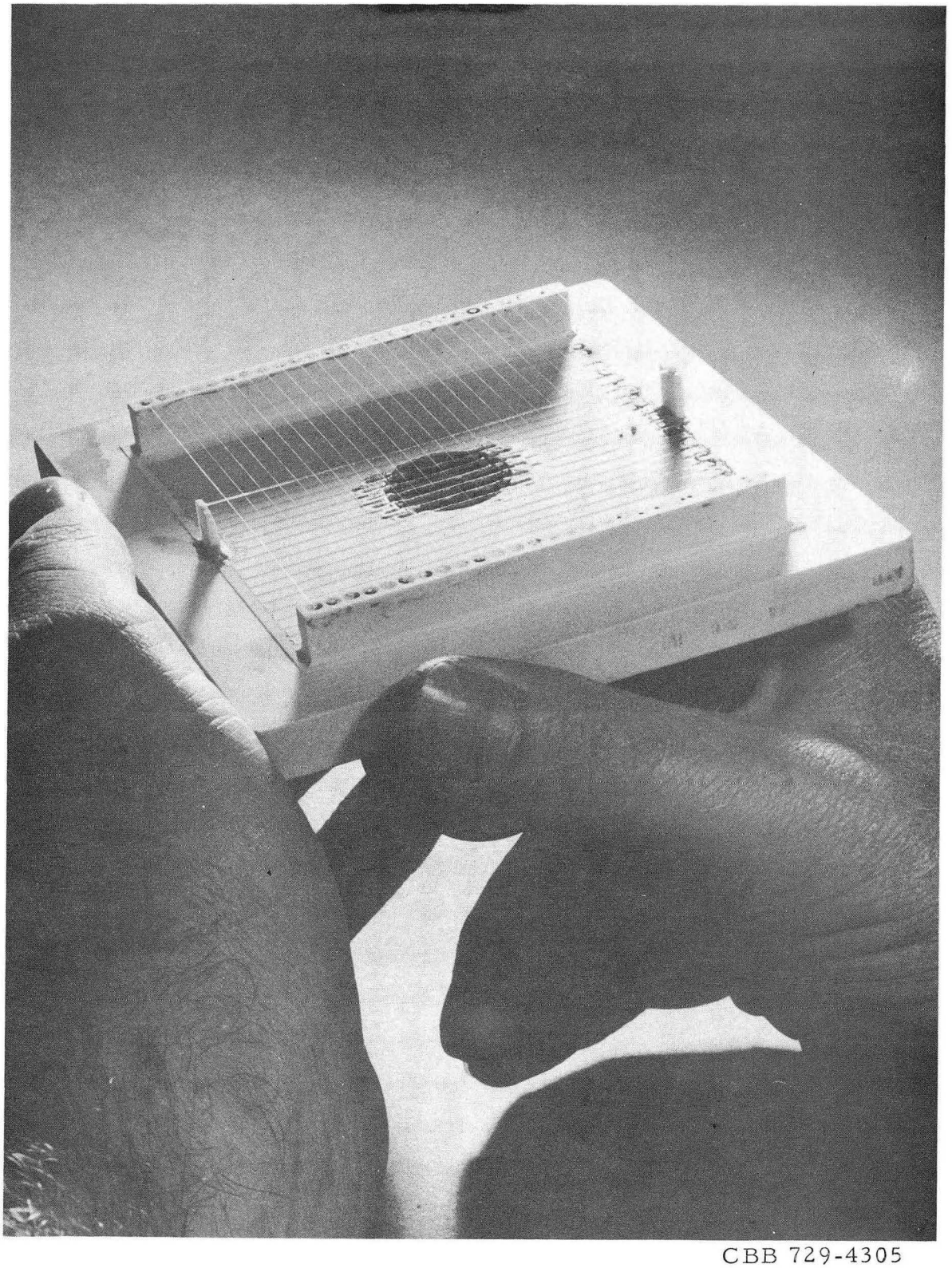

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Figure 1

Anode-cathode assembly of the liquid-xenon detector. Anode wire (5 μ diam.) and cathode strips are spaced 2.8 mm apart. Wires are centrally supported by passing between two quartz fibers.

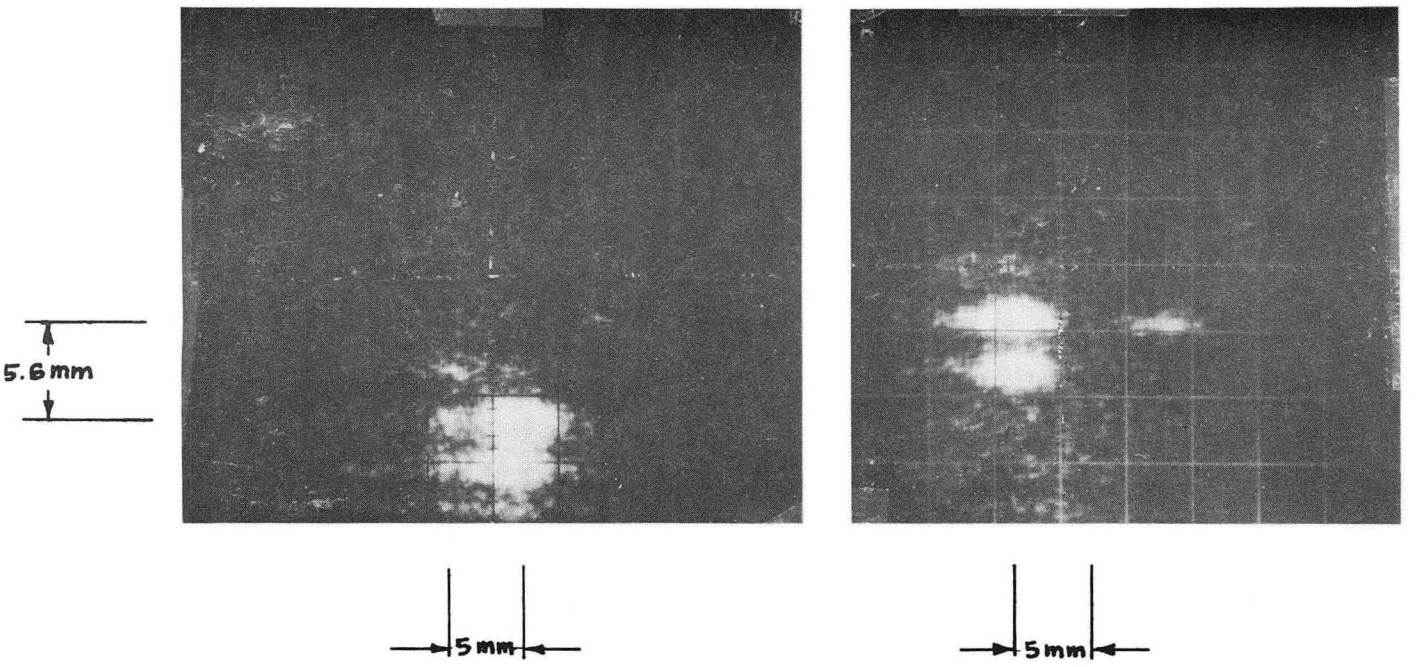

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Figure 2

Image of a 279-keV source collimated to 2 mm at the chamber. It was first imaged at one position, then moved 5 mm in both coordinates and re-imaged. The wires (running in the horizontal direction) produce two points when the source is not aligned exactly on one wire. We estimate the resolution to be 4 mm FWHM.

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