Title
NEUTRON RADIOGRAPHY WITH A MULTIWIRE PROPORTIONAL CHAMBER?PERFORMANCE AND PROJECTIONS

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NEUTRON RADIOGRAPHY WITH A MULTIWIRE PROPORTIONAL CHAMBER--PERFORMANCE AND PROJECTIONS*

Summary

A multiwire proportional chamber with delay-line readout can be employed for electronic neutron-radiographic imaging in a sensitive, highly selective, moderate-resolution system where low-intensity thresholds and high information yield per unit neutron dose are important considerations. Each detected event may be stored in an array for later manipulations such as background subtraction, image enhancement, or statistical interpretation.

The basic system is equivalent to an $N \times N$ array of 1- to 2-mm^2 neutron-sensitive proportional chambers. Independent of chamber size, signal detection and position location require only a single integrated detector and three amplifiers. One amplifier provides a prompt signal indicating an ionizing event anywhere in the chamber, and the other two each receive signals from delay lines which are capacitively coupled to each wire of one of two orthogonal grids that serve as cathode or anode planes of the proportional chamber. The two analog timing signals are then processed for display or storage. Neutron sensitivity is achieved by coating the inside surfaces of the chamber windows with neutron-to-charged-particle converting material. The method used for calculating the efficiency and resolution characteristics of such a converting surface together with a more detailed description of the electronic system is given elsewhere.[1]

The performance of a small natural-boron-lined, prototype chamber, 3×4-cm sensitive area, has been tested for thermal-neutron imaging. With 2-mm wire spacing and a single neutron converting surface we have achieved 0.5% detection efficiency and 2-mm 10-90% resolution of a Cd knife edge or a Lucite step.

An example of image quality and information content is shown in Fig. 1. Each neutron detected is imaged as an analog dot on an oscilloscope face. The prototype chamber has also been used to obtain quantitative measurements of

Lucite-step thicknesses. As with any electronic counter the precision of such measurements is limited only by counting statistics and background.

Extrapolating the measured efficiency of this chamber to one with two optimum-thickness converting surfaces of either ^{10}B for slow neutrons or CH_2 for fast neutrons, we may predict the following efficiency characteristics:

Neutron spectrum	Efficiency (%)	Approximate neutron dose at chamber for a 1 n-mm^{-2} image (n-cm^{-2})	(mrem)
Thermal	7	1.4×10^3	1.5×10^{-3}
1 eV	1.2	8.0×10^3	8.0×10^{-3}
Fission	0.2	5.0×10^4	1.7
14 MeV	0.6	1.6×10^4	1.1

A 25- × 25-cm, two-surface ^{10}B chamber with 1-mm wire spacing is under construction. The converter-covered chamber windows are easily interchangeable and will permit testing of a fast-neutron converter also.

Figure Caption

Fig. 1. Electronic images of 5/8-in. stencil letters cut in a 20-mil Cd sheet. Images (b), (c), and (d) were all taken with the same oscilloscope intensity setting. Image (a) was taken at a lower scope intensity. The horizontal-lines are images of the anode wires and are characteristic of such multiwire chambers. (Refs. 1 and 2).

Footnote and References

* Work done under the auspices of the U. S. Atomic Energy Commission

1. K. VALENTINE, S. KAPLAN, L. KAUFMAN, and V. PEREZ-MENDEZ, "The Adaptation of Multiwire Proportional Counters with Delay-Line Readouts for Neutron Radiographic Imaging," UCRL-20840 (1971); IEEE Transactions on Nuclear Science (to be published).

2. R. GROVE, K. LEE, V. PEREZ-MENDEZ, and J. SPERINDE, "Electromagnetic Delay-Line Readout for Proportional Wire Chambers," Nucl. Instr. Methods 89, 257 (1970).

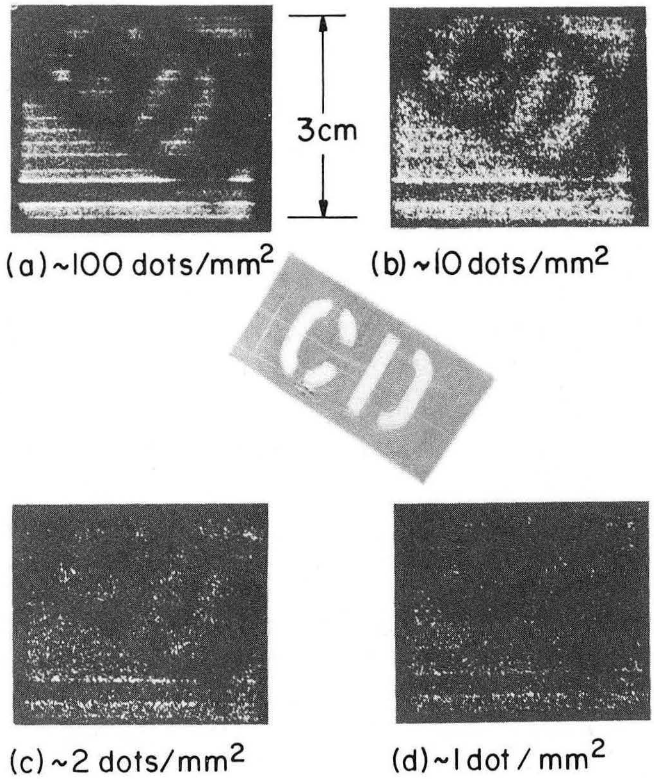

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Fig. 1

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