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Alaharw Jam
April, 1996

LA REPORT 123

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Series C

August 15, 1944

This document contains 12 pages

SPHERICAL PROPORTIONAL COUNTER

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ABSTRACT

A spherical proportional counter is described which records recoils and shows no asymmetry in detecting a neutron beam incident from different directions. The central electrode consists of two circular loops of fine wire.



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SPHERICAL PROPORTIONAL COUNTER

The investigation of large-angle scattering with disks requires a detector which has a sensitivity nearly independent of the direction of the incident neutron. This condition was met in the case of the ionization chamber previously used (LA-51), but the need for information at low neutron energies suggested the use of a proportional counter. The usual cylindrical proportional counter is definitely asymmetrical. One which we used showed a 25 percent difference between axial and radial neutron incidence to the counter.


The pressure in the ionization chamber described in LA-51 was reduced in the hope that the potential difference per mean free path at the surface of the $1/4$ " sphere would be made large enough to give gas amplification. It was found that the voltage needed to give gas amplification exceeded that for which the insulators of the chamber were designed. The $1/4$ " sphere was removed from its $1/8$ " electrode rod and in its stead was placed a single loop of .003" W wire $1/4$ " in diameter (see Fig. I). With this type of electrode construction gas amplification was obtained. Subsequent testing showed that two such loops at right angles to each other gave better results.

Preliminary testing was done with alpha particles from Po and U. The alphas were sent into the chamber through a thin Al window or placed directly in the chamber. In either case no plateau was observed even though there was equal energy loss for all alphas passing through the chamber.

Since it was possible to operate the chamber as a proportional counter it was decided to test its symmetry. The counter was filled with CH_4 to a pressure of 20 cm Hg and run at 1550 volts. No difference was found in its action when a beam of 2.5 Mev neutrons was parallel or at right angles to the counter electrode rod (see Fig. II).

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In order to increase the efficiency of the counter it was filled with Cg Hg to 25 cm Hg, run at a voltage of 2160, and tested in building W at various energies (Fig. III). Because of the stopping power introduced in the filling, the counter would not be satisfactory for 150 Kev neutrons as the γ ray background was about 100 Kev high. The stopping power was reduced by filling the counter with Cu to 14 cm Hg and it was again tested in building W (Figs. IV and V).

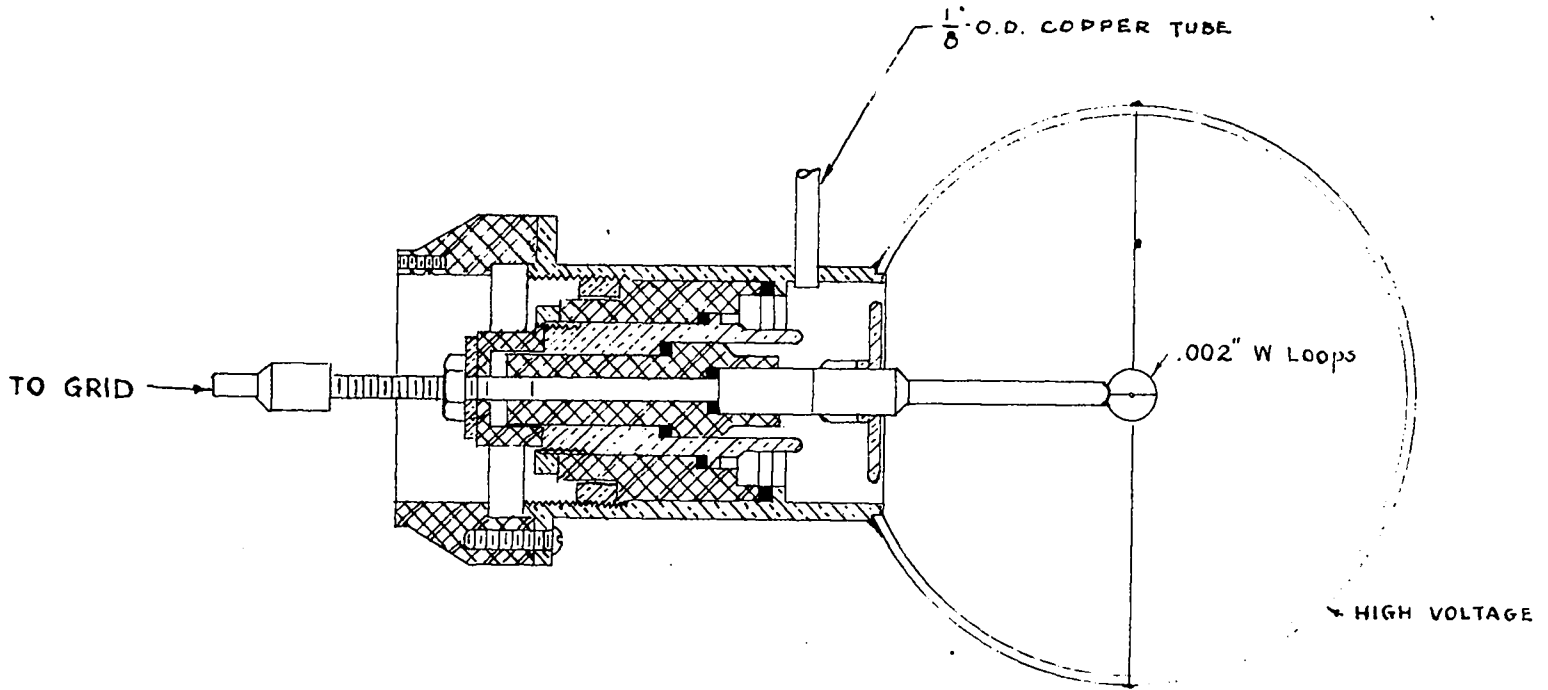
Finally the counter was filled with 25 cm of tank hydrogen run at 2096 volts and retested. Fig. VI is a cut-off curve using 100 Kev neutrons at 115° to the proton beam. The tail is believed to be due in part to high energy neutrons being scattered back from the target box¹⁾.

Fig. VIII shows the symmetry of the counters. The dots indicate data taken so that the center electrode is in line with the target tube, whereas the dashes indicate data taken with the electrode at 90° to the target tube, i.e., a 90° rotation of the detector in the plane of its axis. There was no evidence of any asymmetry. This chamber with this filling was used in the measurements given in LA-109.

1) Because of this long tail it was somewhat difficult to assign definite neutron energies to the biases.



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SPHERICAL PROPORTIONAL COUNTER

Scale - Full Size

FIG. I

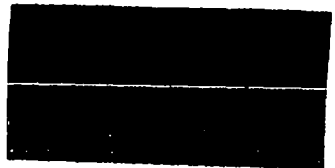




FIG. II

2-1/4" 003" W LOOPS
COUNTER FILLED WITH 20cm CH₄
TESTING SYMMETRY

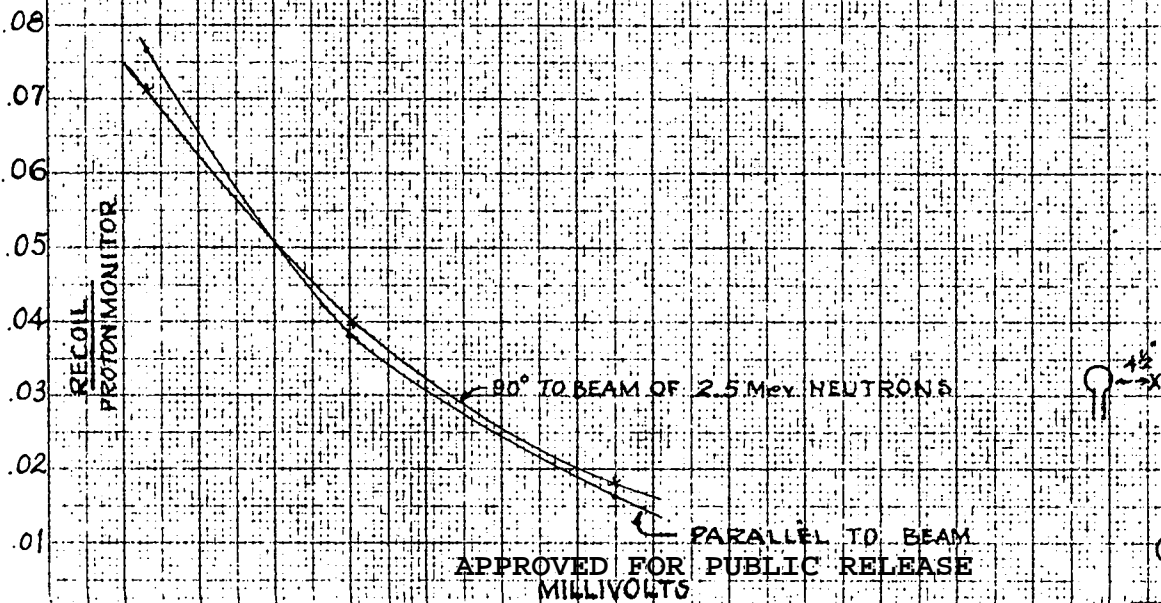
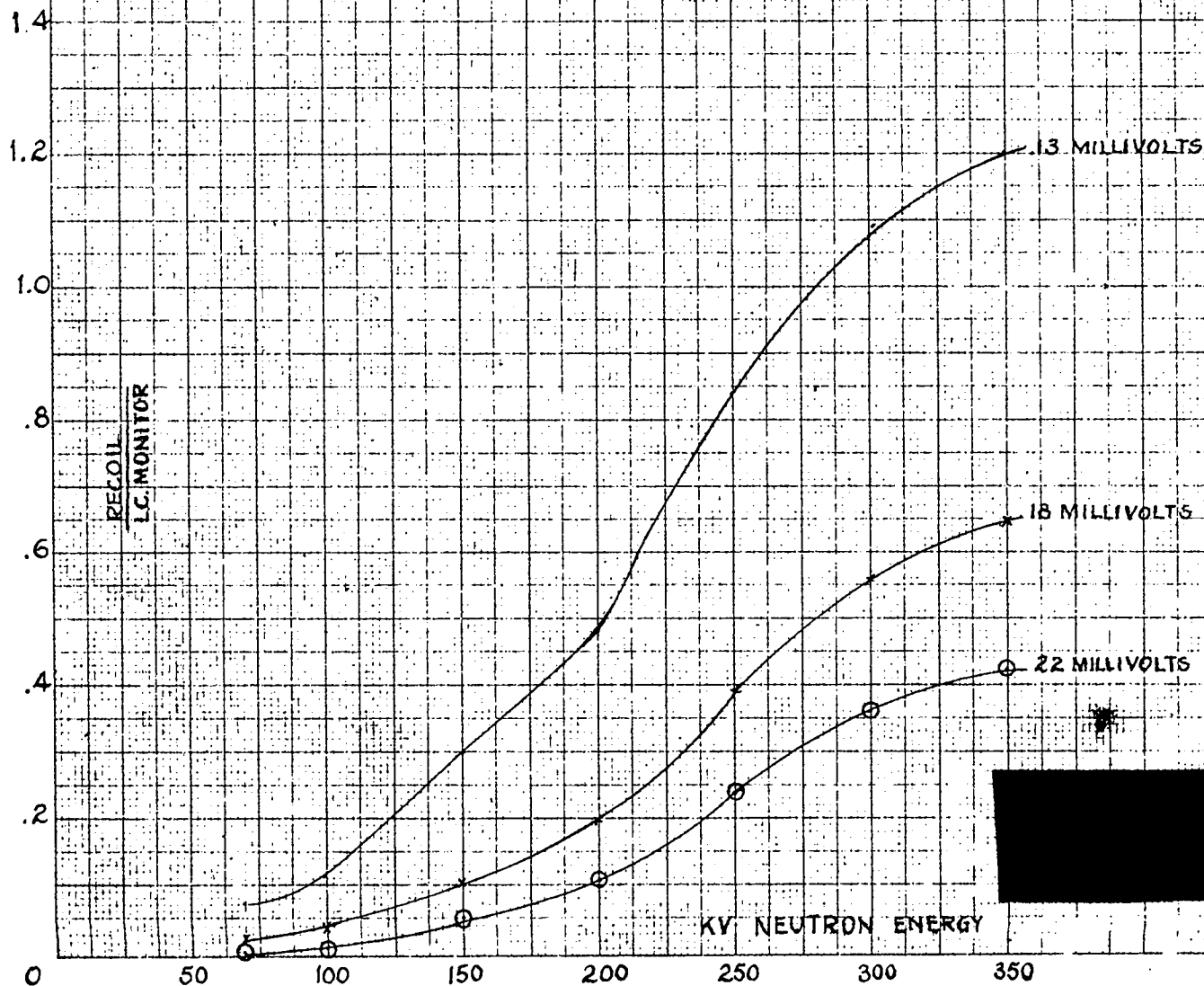


FIG. III

DATA TAKEN AT 115° IN BACKWARD DIRECTION
IN W. 2-1/4" .003" W LOOPS
COUNTER FILLED WITH 25cm C₃H₈ AT 2700
VOLTS 10" FROM LI TARGET MONITOR 20"
AWAY ON OTHER SIDE



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Millimeter, 2 mm, line 4 second, cm, line 4 heavy
1/4" x 1/4" x 1/4"

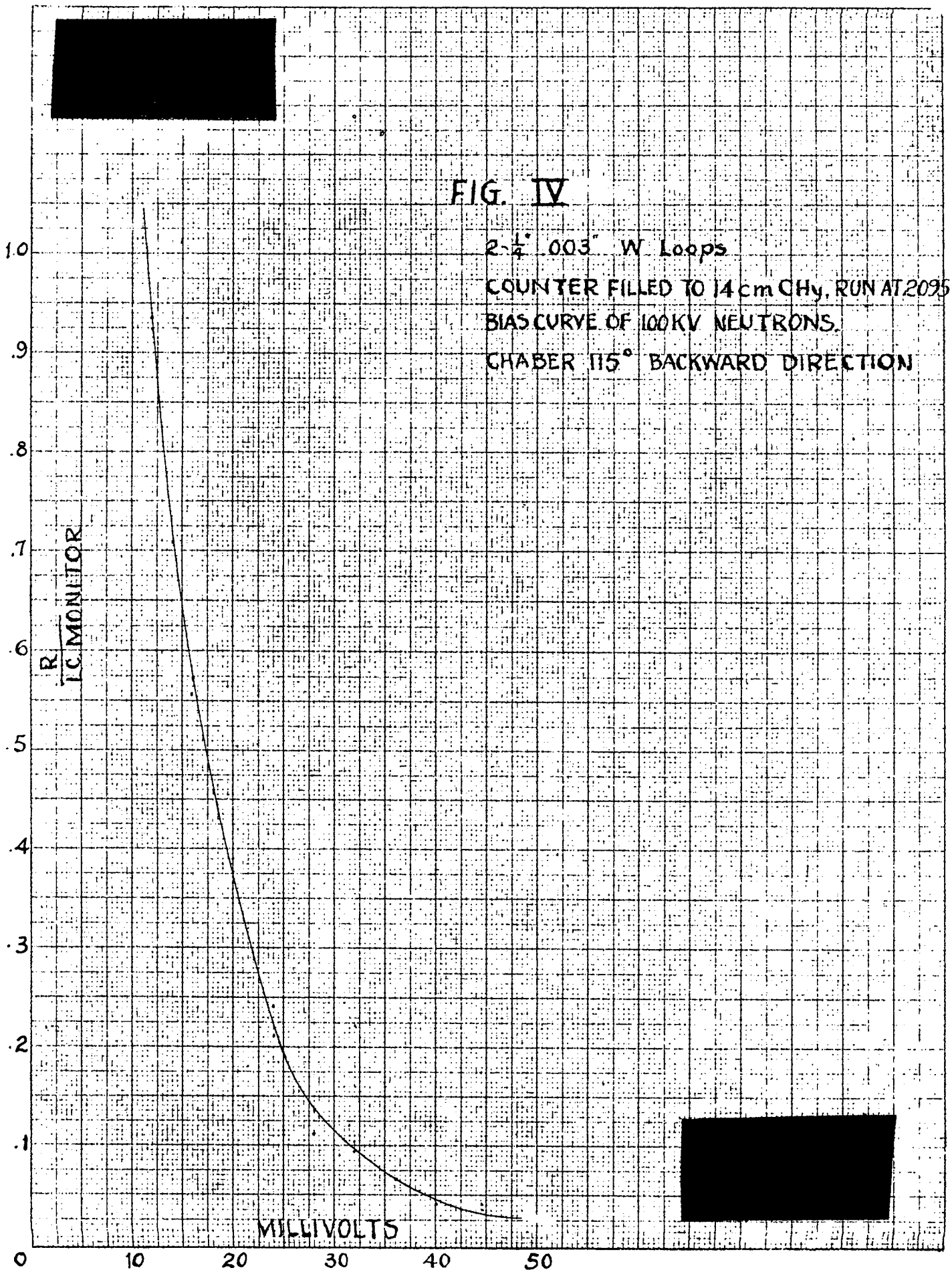
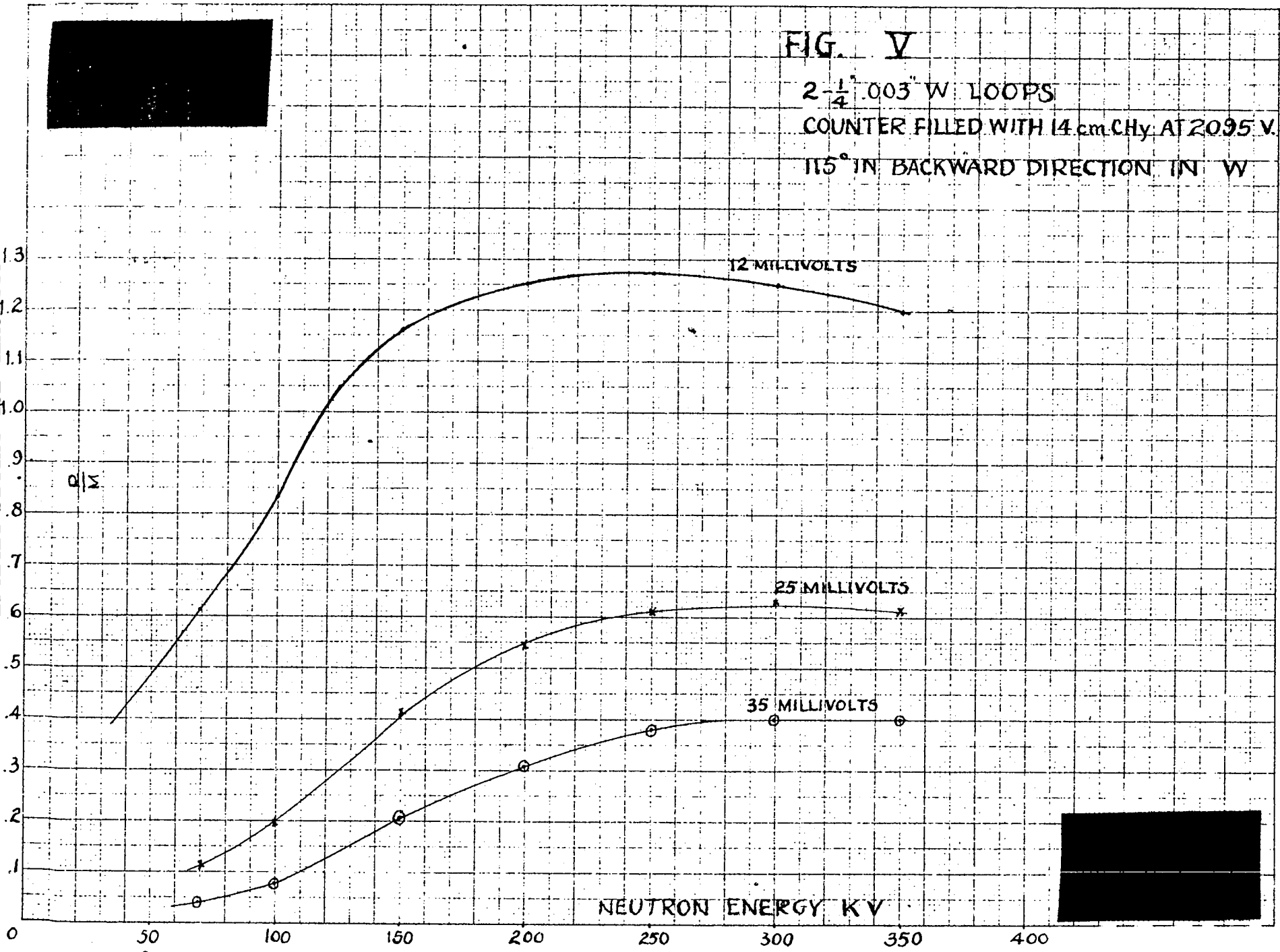


FIG. V

2- $\frac{1}{4}$ " 003" W LOOPS
COUNTER FILLED WITH 14 cm CHy AT 2095 V.
115° IN BACKWARD DIRECTION IN W

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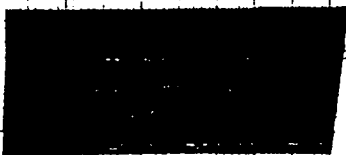
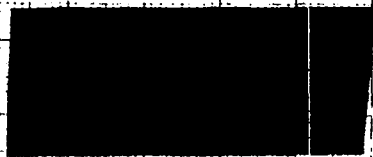
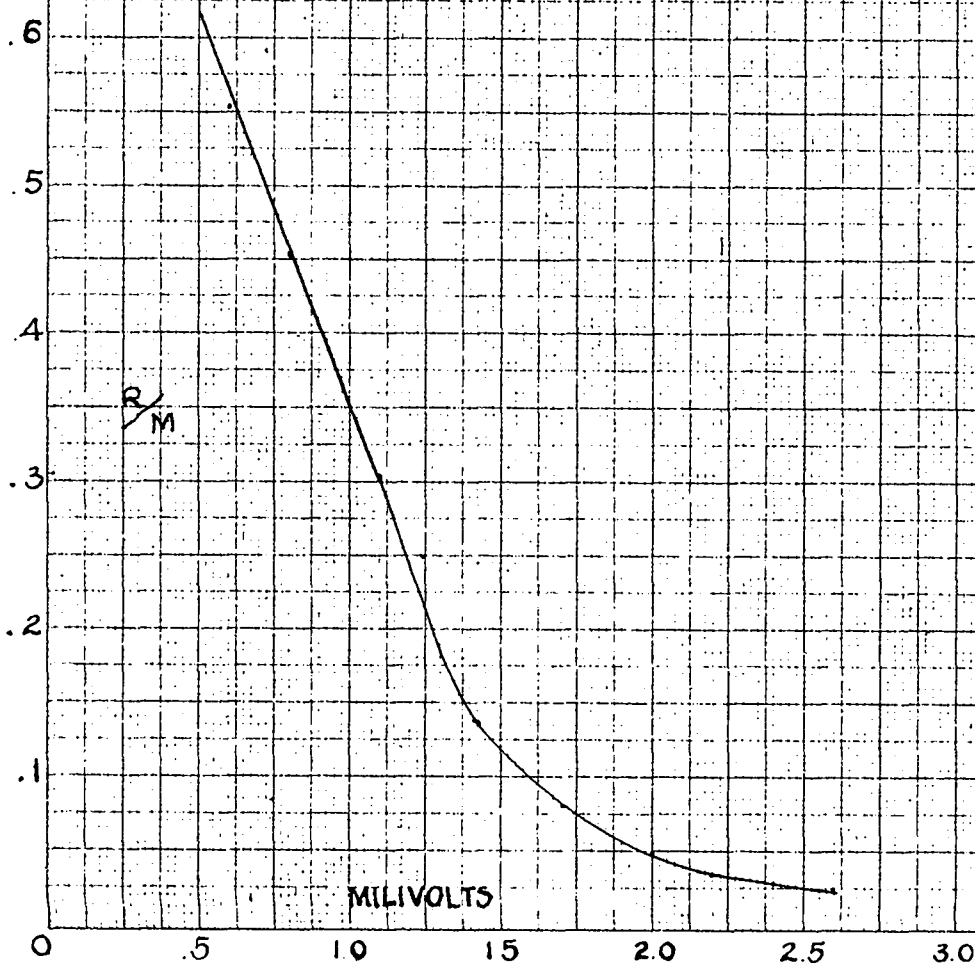


FIG. VI

BIAS CURVE WITH 100KV NEUTRONS
AT 115° POSITION, 25cm H₂, 2095 VOLTS
003" DOUBLE W LOOP.

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FIG. VII

BIAS CURVE WITH 100 KV NEUTRONS AT 0°
25cm H₂, 2095 VOLTS, .003" DOUBLE LOOP

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9
8
7
6
5
4
3
2
1
0

MS

MILIVOLTS



0 .5 1.0 1.5 2.0 2.5 3.0

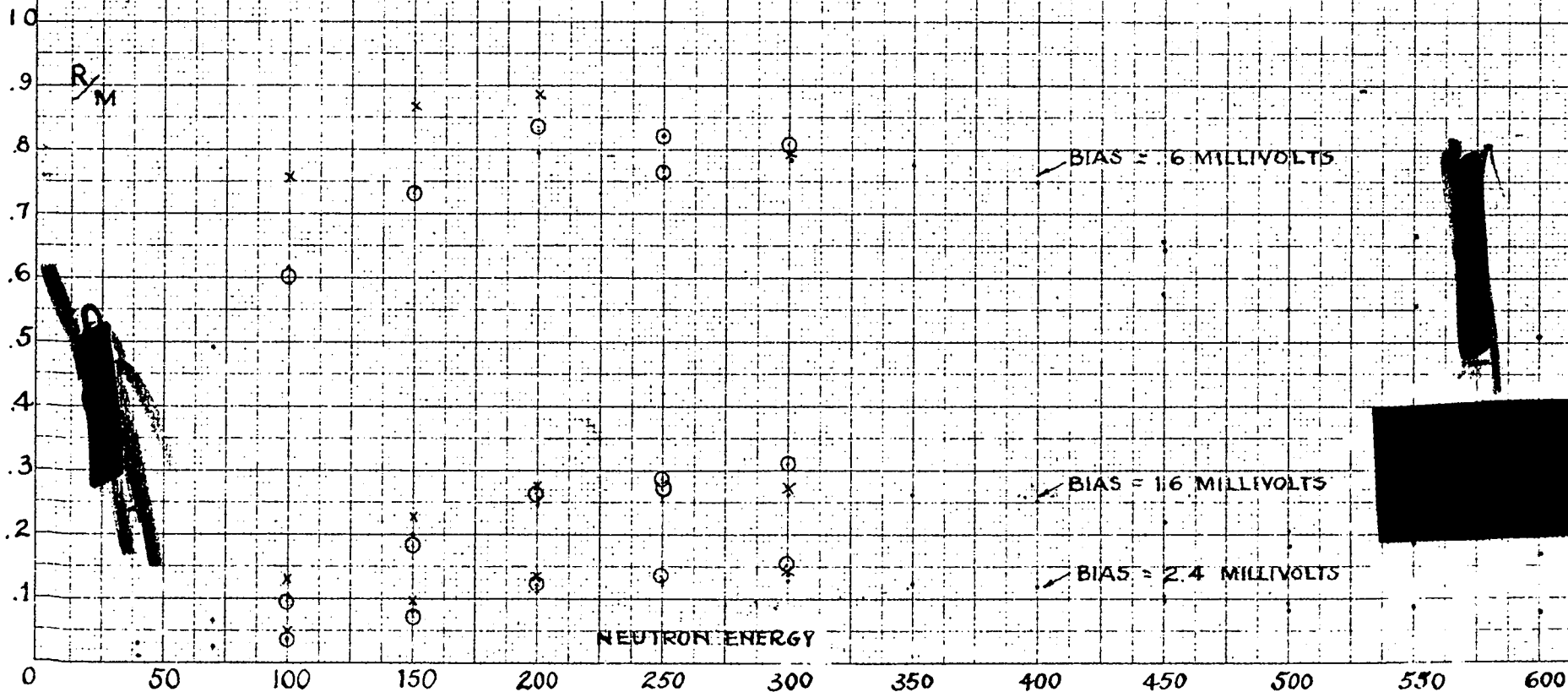
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FIG. VIII

SENSITIVITY CURVE, 25 cm H₂, 2095 VOLTS
10^{3/4}" FROM TARGET MONITOR ~18" AWAY
CHAMBER HEAD ON: DOUBLE .003" W LOOPS

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- ORIGINAL DATA: HEAD ON TO TARGET AT 115°
- DATA TAKE SIDE ON TO TARGET AT 115°
- x ORIGINAL DATA WITH 1/16" BRASS PLATE OVER TARGET BOX FACE



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