Title
Research Progress Meeting of June 10, 1948

Author
Wakerling, R.K.

Publication Date
1948-06-10

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

BERKELEY, CALIFORNIA

DISCLAIMER

UNIVERSITY OF CALIFORNIA
RADIATION LABORATORY

Cover Sheet
Do not remove

INDEX NO. UCRL-132
This document contains 7 pages
and 7 plates of figures.
This is copy 78 of 83. Series A

DECLASSIFIED

Issued to: Info Div.

~~RESTRICTED~~

Classification

Each person who received this document must sign the cover sheet in the space below.

Route to	Noted by	Date	Route to	Noted by	Date
	Wilson	7/15/48			
CHEMISTRY DIVISION					
~~F. Weigt~~					
Jim McHugh					

UCRL 132
Physics General

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

RESEARCH PROGRESS MEETING

June 10, 1948

R. K. Wakerling

Berkeley, California

STANDARD DISTRIBUTION: Series A UCRL 132

	Copy Numbers
Argonne National Laboratory	1-8
Armed Forces Special Weapons Project	9
Atomic Energy Commission, Washington	10-11
Battelle Memorial Institute	12
Brookhaven National Laboratories	13-20
Carbide & Carbon Chemicals Corporation (K-25 Area)	21-24
Carbide & Carbon Chemicals Corporation (Y-12 Area)	25-28
Columbia University (Dunning)	29
General Electric Company	30-33
Hanford Directed Operations	34-38
Iowa State College	39
Los Alamos	40-42
Monsanto Chemical Company, Dayton	43-44
National Bureau of Standards	45-46
Naval Radiological Defense Laboratory	47
NEPA	48
New York Directed Operations	49-50
Oak Ridge National Laboratory	51-58
Patent Advisor, Washington	59
Technical Information Division, ORDO	60-74
UCLA Medical Research Laboratory (Warren)	75
University of California Radiation Laboratory	
Information Division	76-78
Chemistry Dept., Bldg 4	79
Patent Dept., Bldg 29	80
University of Rochester	81-82
Chicago Office of Directed Operations	83

TOTAL 83 Copies.

INFORMATION DIVISION
RADIATION LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

RESEARCH PROGRESS MEETING

June 10, 1948

R.K. Wakerling

184-inch Cyclotron. J. Vale

A study is being made of the arc source of the 184-inch cyclotron. An experimental arrangement has been set up for determining the quantity of ions produced in the source, since the size of the beam may not be a true measure of the number of ions produced by the arc. The ions have been collected on a plate located 1-1/2" from the arc and pivotted so as to allow it to be rotated out of the way of the beam. A potential is placed on this plate, and the current to it observed visually on an oscilloscope. Voltages up to -2.5 kv have been used on the collector.

In Figure 1 the arc current as a function of collector voltage is shown. The curve was not carried beyond -2.5 kv due to electrical limits in the collector and its circuit.

A number of runs were made to determine the effect on the arc current of varying the gas flow to the arc, the arc voltage and filament current. Figures 2, 3 and 4 exhibit the general character of the results of these measurements. The largest arc current recorded was 5 ma.

Experiments were also done to determine the effect of the size and shape of the arc cone on the size of the ion beam. It was found that a longer cone produced less beam, and that without any cone at all one could get as much beam as ordinarily but that a larger gas flow was necessary. The results obtained thus far are only qualitative, and plans are under way to re-design the apparatus in order to achieve more accurate measurements. The collector will be mounted on the "jiffy probe" and measurements will be made of the size of the beam at various radii less than 20", a region in which the beam current has never before been measured. Plans are also under way for experiments with an aim to increasing the number of ions drawn out of the arc source by means of some preliminary accelerating arrangement.

Slow Neutrons in the Shielding of the 184-inch Cyclotron. W. Benson.

Slow neutron flux densities have been measured by the activation of indium foils placed at particular locations and at various depths in the concrete shielding surrounding the 184-inch cyclotron. Two exposures were made at each location, one with plain indium foils and the other with indium foils wrapped in cadmium. The second measurement was designed to record only those neutrons with an energy in excess of 0.2 electron volts. By subtracting the results of the two measurements the activity produced by the slow neutrons could be determined.

Anderson and Fermi have done similar work and have calibrated thick indium foils and prepared distribution curves with respect to distance. They gave an empirical formula for flux density as a function of foil count with foils .005" thick, 26 sq. cm. in area and 2.42 gms. in weight. They state that the neutron flux is 0.14 A_S neutrons/cm^2/sec., where A_S represents the saturation activity.

In the experiments here the foils are calibrated in a water tank with a known radium-beryllium source. It was determined that the neutrons flux is 0.1 $(A_o - A_o\,(Cd))$ neutrons/cm^2/sec. with reasonable accuracy. Several counts were made on each foil.

The foils were exposed in the 6-inch cable holes in the shielding near the concrete igloo (see Figure 5). Each run was made in two steps. In the first step a run was made in the hole through the first five feet of concrete which was filled with one foot wooden blocks separated by the cadmium foils, while the hole in the second concrete block was filled with its customary plug. In the second step the situations in the two blocks were reversed. The same pair of runs were also made with the indium foils covered with cadmium, making four runs in all for each of the holes. In this work a standard radiation rate of 4 r per hour was assumed, and all data were normalized to this value.

Figure 6 shows the neutron flux distribution as a function of distance in the ten feet of shielding. It is seen that the value falls through a range of 5×10^4 in passing from inside to a point one foot from the outer surface. From this point to the outside the values rise again by a factor of between 5 and 10, presumably because of the neutron atmosphere outside the walls arising from air scattered neutrons which leak through the two-foot shielding roof. Under the strongest beam conditions the slow neutron flux in the air outside the wall is less than 100 neutrons /sq. cm./ second. The fast neutron flux is measured to be much below tolerance. It is felt that with the additional two feet of concrete on the roof the flux in air outside the walls will be reduced by a factor of 10.

In conjunction with this experiment, the half value thickness of concrete was measured to be 8-1/4" while the deadening ratio varied from 3-1/2 to 1 to approximately 6 to 1.

Fission of Thorium with Alpha Particles. A. Newton.

Since the same compound nucleus is formed in the fission of thorium with alpha particles as is formed in the fission of uranium 235 with neutrons, it was thought to be of interest to study the fission of thorium with alphas and to compare the resulting distribution of fission products with that found in the fission of uranium with slow and fast neutrons. Any difference between the various results where the same compound nucleus is formed must be due to differences in energy content and possible differences in distribution of nucleons in the compound nucleus at the time of fission.

The thorium used in the bombardment was of special purity. After bombardment for 3,020 microampere hours in the 60-inch cyclotron a radioautograph of the disc target was made to determine the active area, which was then removed by milling thin layers by a process in which the millings could be quantitatively collected. Eleven layers varying in thickness from 1 to 3 mils were removed from the target so that the fission product distribution and excitation curve for fission could be determined.

The technique used in determining the fission yields was the standard chemical technique as used on the Plutonium Project. Decay curves were taken to characterize all activity, and absorption curves were taken where possible.

Since neither the absolute fission yield of the fission products produced in the fission of thorium with alpha particles nor the fission cross section are known, the product of the fission yield and cross section has been calculated by the equation

$$\sigma_f \times \mathrm{F.Y.} = \frac{(\text{atoms F.P.})(\text{Target Area})}{(\text{atoms}_{\mathrm{Th}})(\mu\mathrm{ah})(1.13\times10^{16})},$$

where the term μah refers to the length of the effective bombardment at the time of comparison, and the factor 1.13×10^{16} converts μah to number of alpha particles striking the target.

The values of the yields of the various fission products investigated with an average alpha energy of 37.5 Mev are plotted in Figure 7 with the curve obtained from the slow neutron fission of uranium 235 for comparison. Despite the spread of the points it is at once apparent that the spectrum is quite different in the middle region of the distribution. Instead of a factor of 600 in yield between the peaks and the minimum as is the case in the slow neutron fission of uranium 235, there is only a factor of about 2 in the depth of the dip in the fission of thorium with 37.5 Mev alpha particles. A summation of the values of the product of the fission cross section and the fission yield over the entire curve on the assumption of a total fission yield of 200 percent gives a value for the cross section of thorium with the alpha particles of 37.5 Mev of 0.58 ± 0.1 barns.

The layers separated in the milling of the thorium discs used in the bombardment were analyzed separately for Ba, Sr, Sn, Ce, Ru and Cd. Hence it was possible to obtain a rough excitation curve for the fission of thorium by alpha particles. In Figure 8 is plotted on logarithmic scale the measured yields expressed as the product σ_f x fission yield for the isotopes studied in each of the various layers of thorium, together with the specific beta activity of that layer. A slight deuteron contamination of the alpha beam, or fast neutron fission, or a combination of these two effects is offered as the explanation for the fact that fission continues to occur well beyond the range of the impinging alpha particles in thorium, which is about 340 mg/cm. sq.

In Figures 9 and 10 the gross beta activity and the quantity σ_f x F.Y. found for barium have been plotted against the thickness of thorium and an excitation curve drawn. The threshold for the alpha reaction is found to be approximately 24 Mev and the cross section for fission at 39 Mev is about 0.7 barns if the cross section for fission is 0.6 barns at 37.5 Mev.

The conversion of thorium thickness to energy has been made on the basis of the curve shown in Figure 11 which was obtained by integrating the curve of rate of energy loss versus energy for thorium.

A possible explanation of the thorium fission was mentioned briefly in light of work done by Goeckermann and Perlman on the fission of bismuth with 400 Mev alpha particles.

Information Division
MR

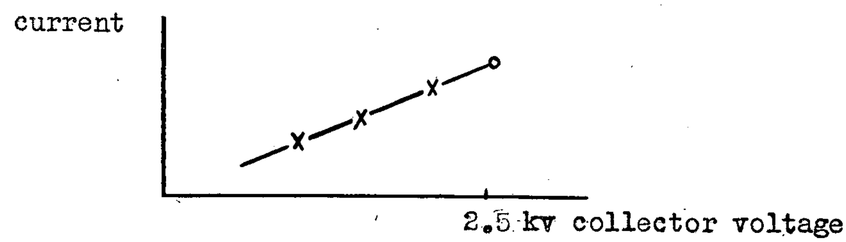


Figure 1

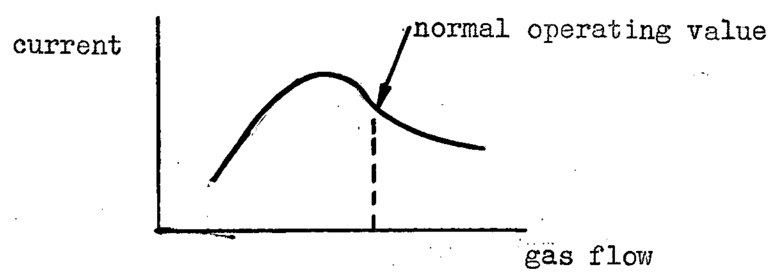


Figure 2

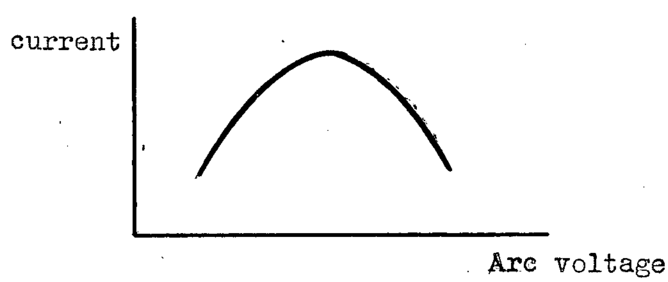


Figure 3

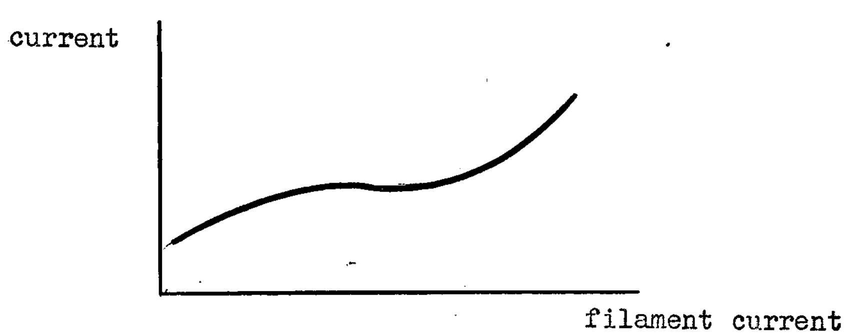


Figure 4

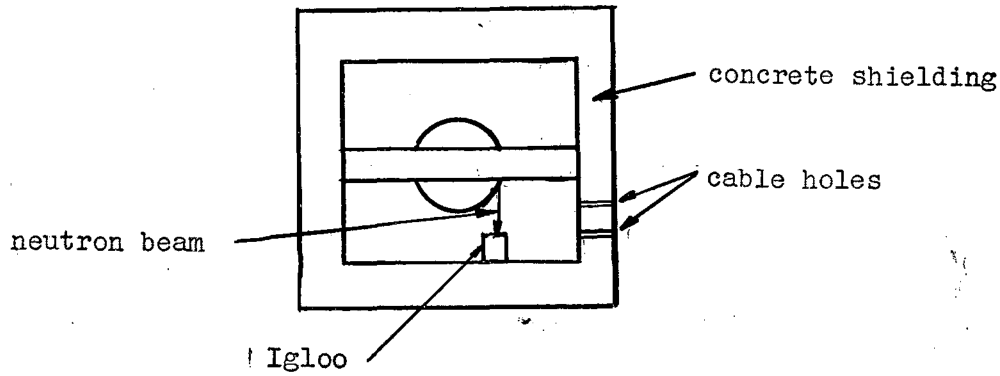
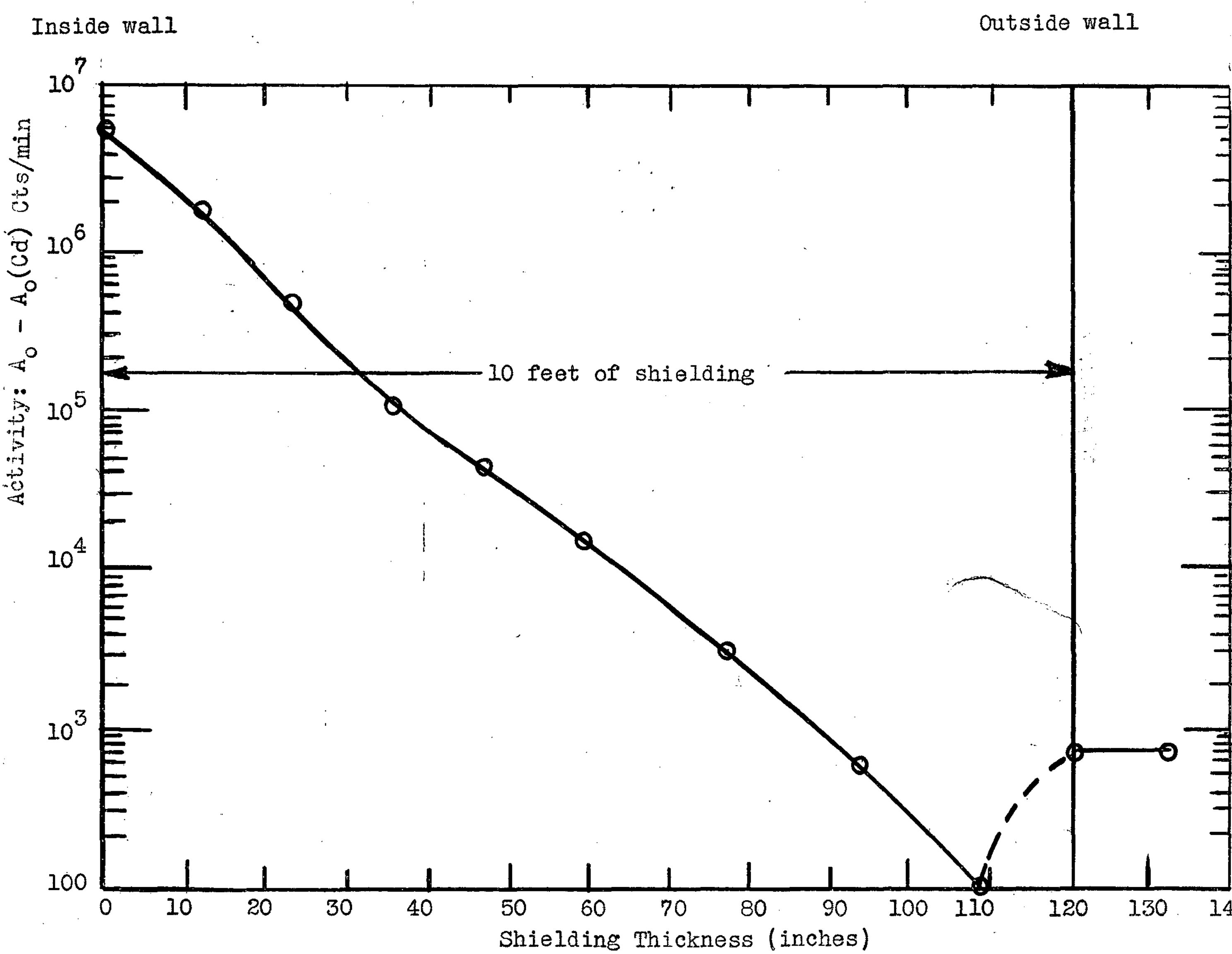


Figure 5



Slow Neutron Flux Distribution

Figure 6

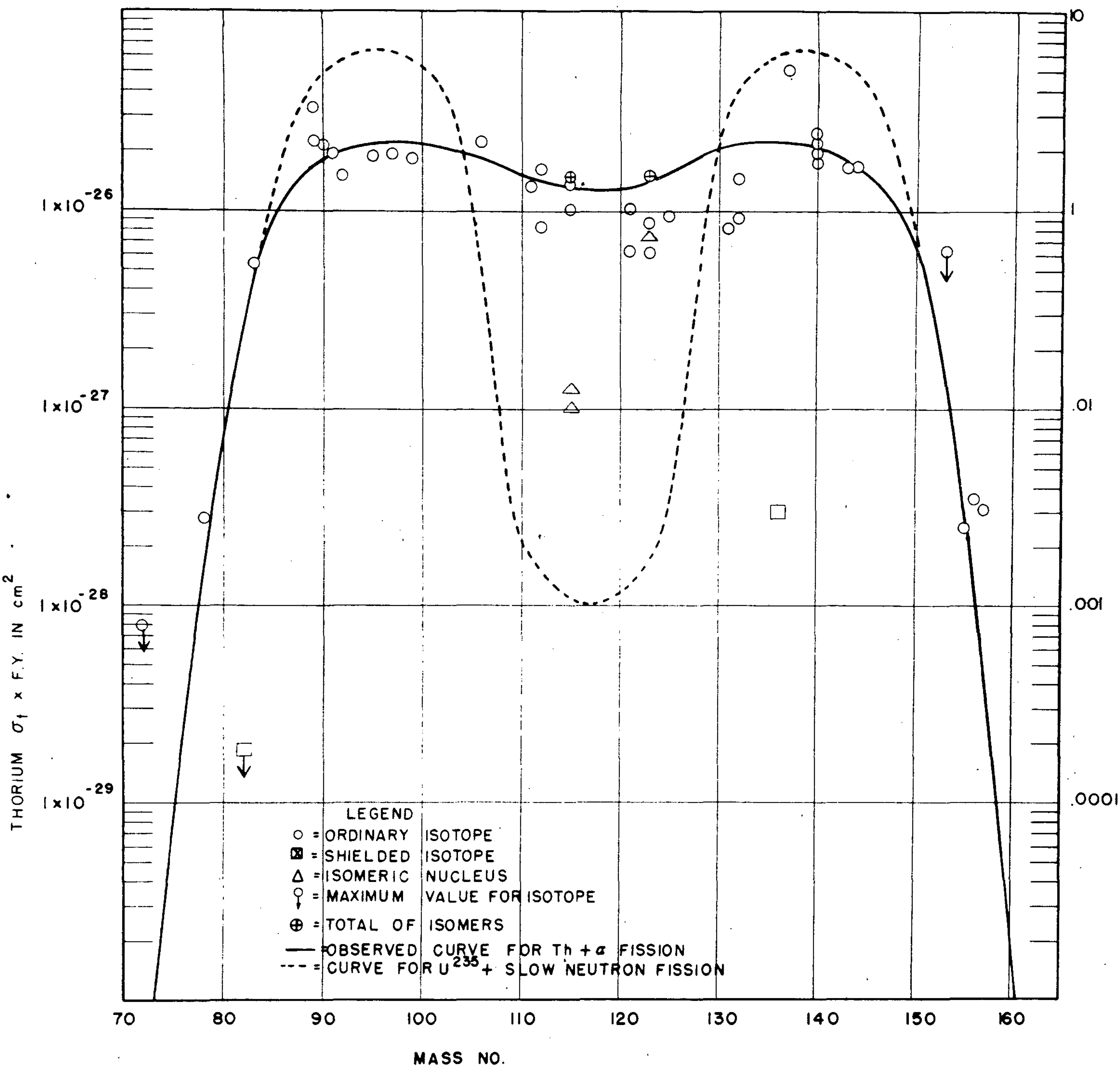


FIG. 7

FISSION YIELD SPECTRUM OF THORIUM FOR FISSION WITH 38 MEV. HELIUM IONS COMPARED TO THAT OF U^{235} FOR FISSION WITH SLOW NEUTRONS

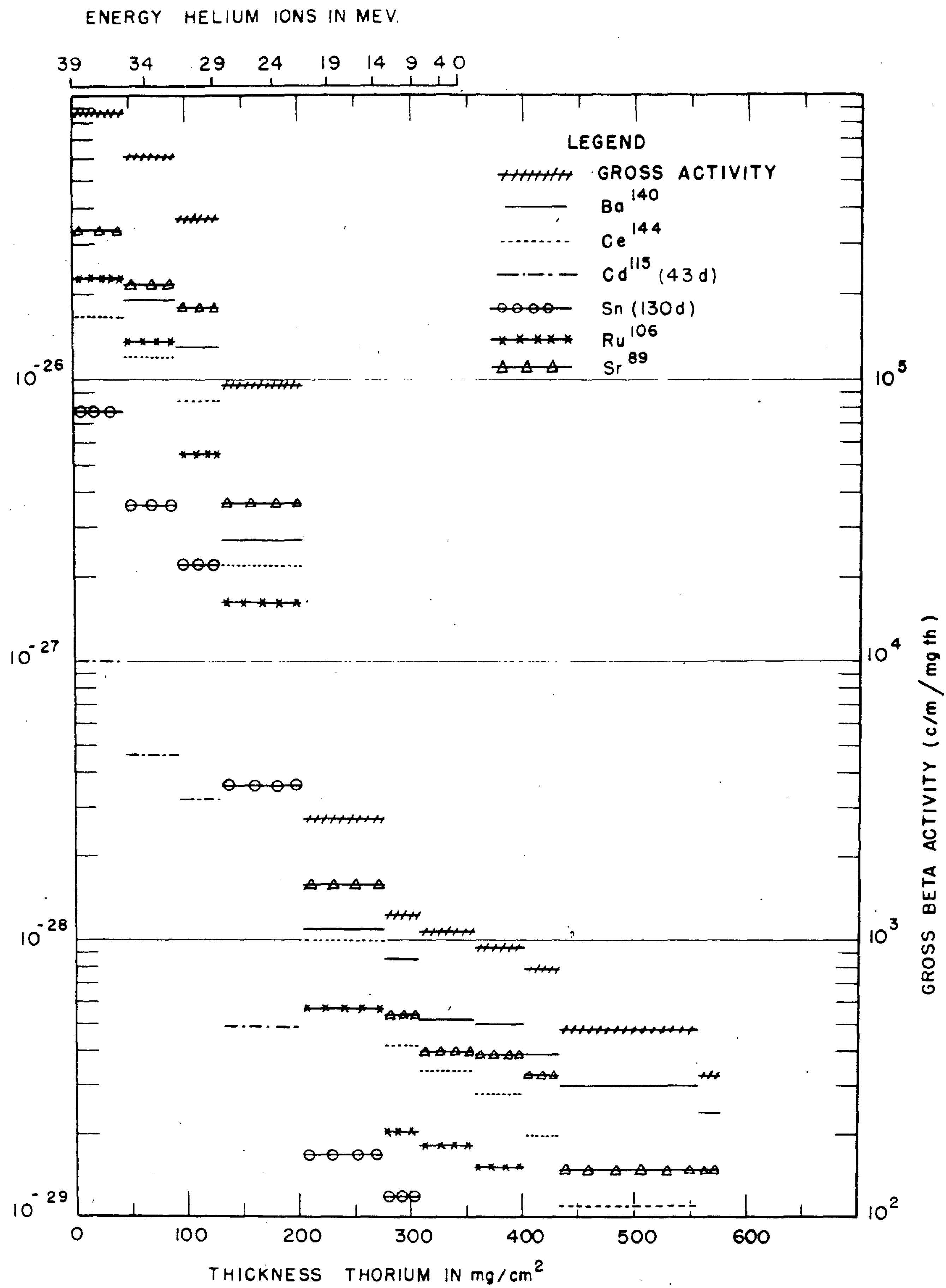


FIG. 8

YIELD OF SOME FISSION PRODUCTS FROM THORIUM + HELIUM IONS

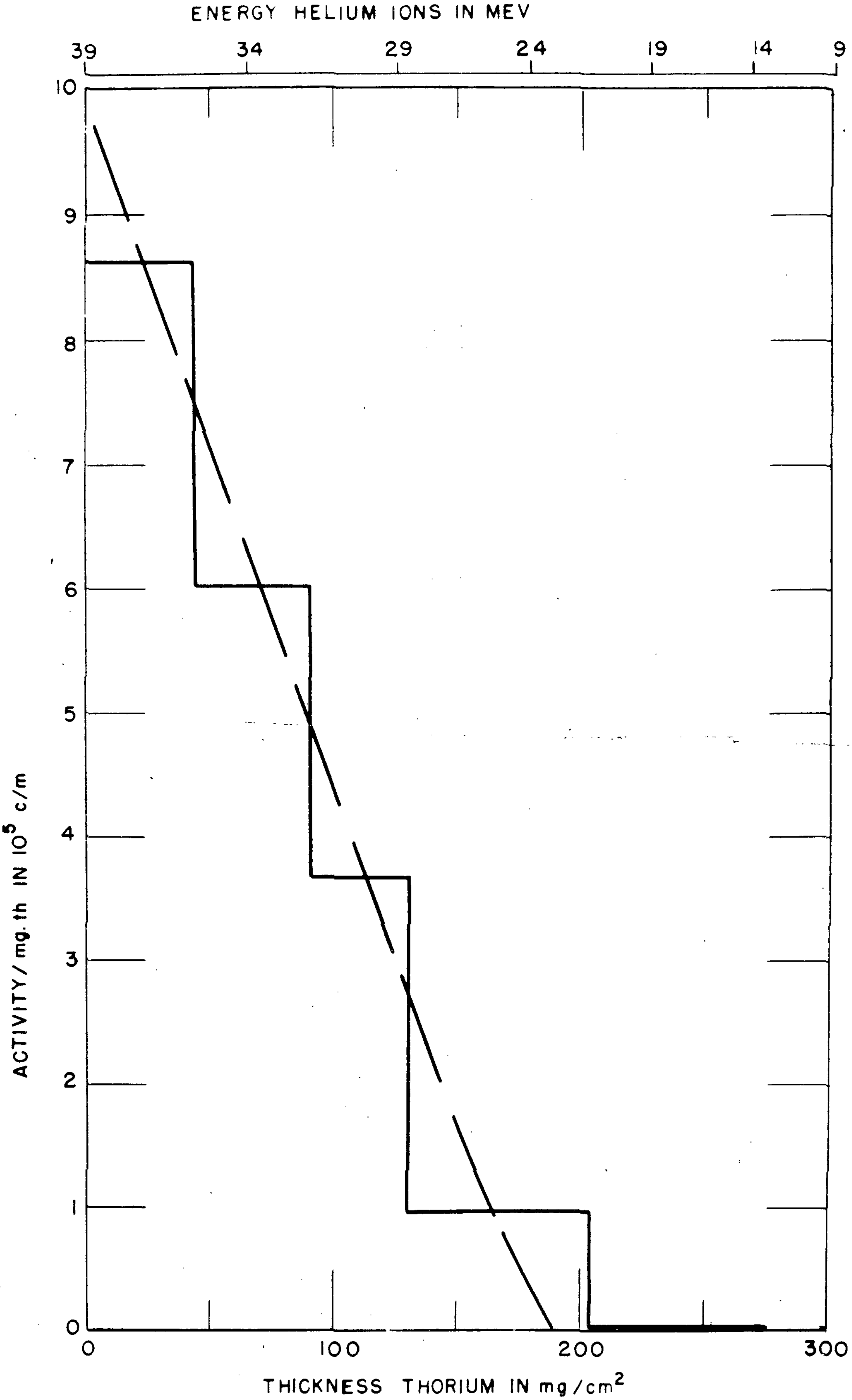


FIG 9

EXCITATION CURVE OF GROSS BETA ACTIVITY IN THORIUM TARGET

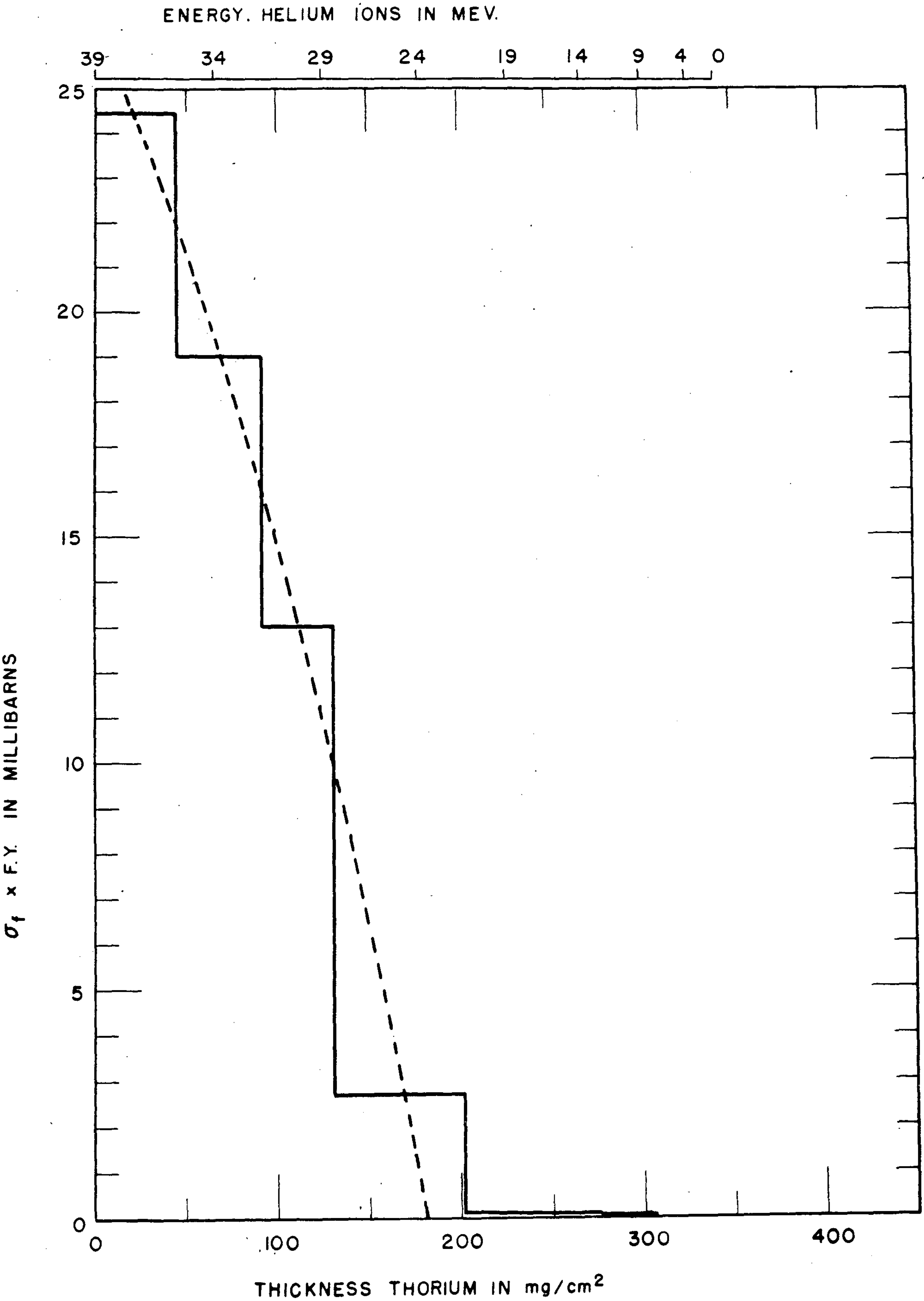


FIG. 10

EXCITATION CURVE OF BARIUM ACTIVITY IN THORIUM TARGET

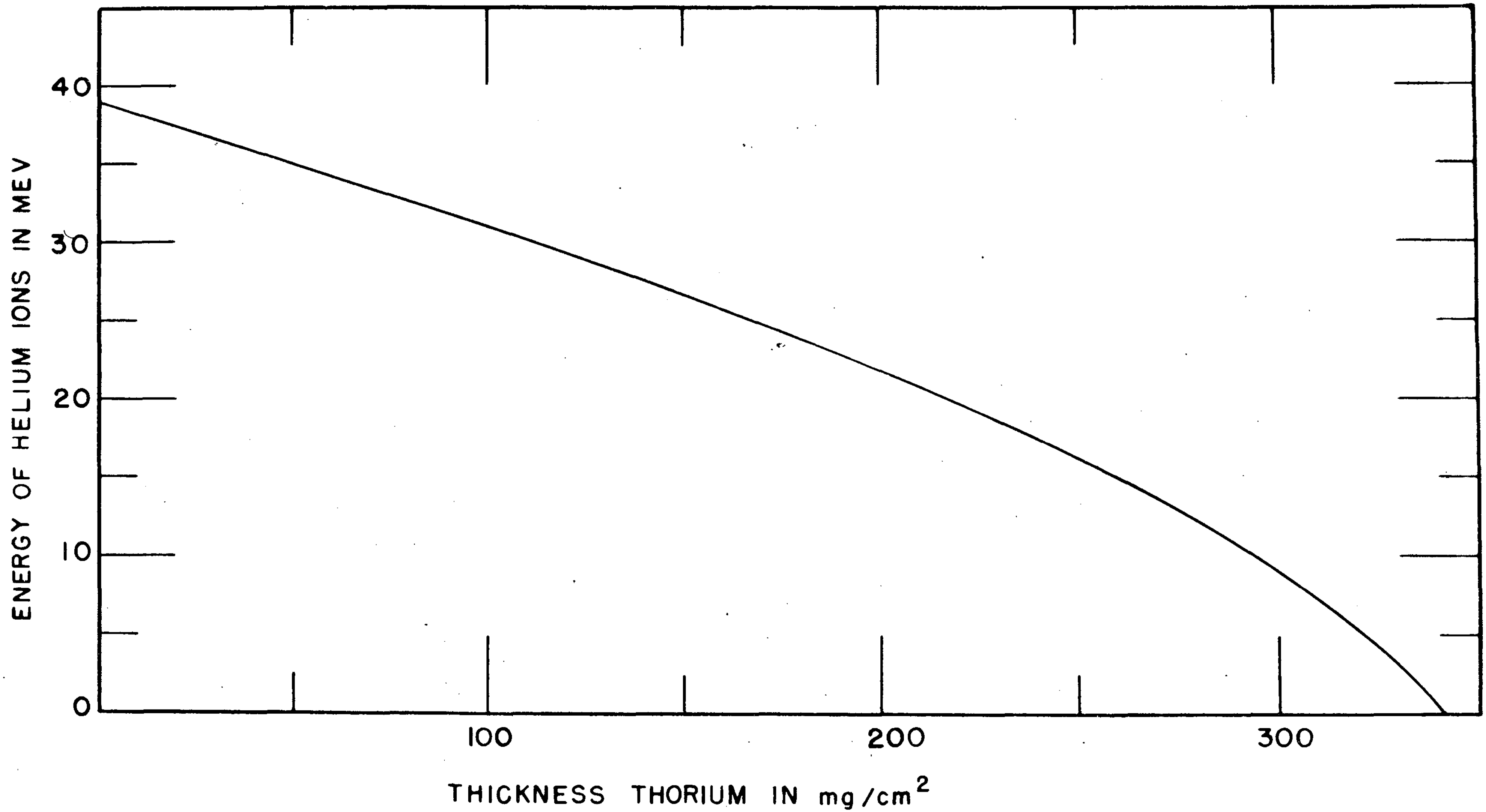


FIG. 11

ENERGY LOSS OF 39 MEV HELIUM IONS IN THORIUM