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TOTAL CROSS SECTIONS OF U, H AND C FROM 35 TO 500 KEV.

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ABSTRACT

The total cross sections of U, H, and C have been measured at four energies; 35, 95, 265 and 490 Kev. The results for H are in very good agreement with Richman's theoretical curve. The U and C results agree well with the Chicago γ - n data.

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TOTAL CROSS SECTIONS OF U, H AND C FROM 35 TO 500 KEV.

The total cross sections of normal uranium, of hydrogen and of carbon have been measured at neutron energies of 490, 265, 95 and 35 Kev. The experimental arrangement is shown in Fig. 1. Neutrons radiating at 0° to the direction of the incident proton beam, from a spot 3/32" in diameter, were scattered by uranium, graphite and polythene (CH_2) discs 3/4" in diameter suspended at 4" from the target. The detector was a hydrogen-filled proportional counter of approximately 1/2" cross section placed with its active volume at approximately 4" beyond the scatterers.

The monochromatic quality of the neutrons from the short electrostatic generator in W was ensured by control of the proton beam to $\pm$ 2 Kev and by the evaporation of a lithium target so thin that the maximum fractional spread in neutron energy was less than 10 percent except at the 35-Kev point. Neutrons for the 35-Kev point were made by the "tickling threshold" technique, i.e. setting the proton energy just at the sharp threshold of the neutron-producing reaction. Although the neutron energies for this point spread between 20 and 40 Kev, the mean value was taken to be 35 $\pm$ 5 Kev because of the changing sensitivity with energy of the biased recoil detector in this region.

The scattering discs were supported by a single .008" piano wire, and all parts of the counter and preamplifier lay within their shadow. A polythene shadow cone was inserted in order to measure room scattering and counter background. Background was never greater than 3 percent, and in data taken with higher counter biases was about 1 percent. It is probable that the room background was even less, since the transmission of the shadow cone was of the order of 1 percent.

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The densities of the scatterers were computed from their dimensions and agreed with the expected values. Polythene is considered to be pure CH_2 to within less than .1 percent.

The geometry was such that the maximum angle of scattering into the detector was approximately 10°. The conversion of 10° data to "perfect geometry", in which no neutrons are scattered into the detector, is only about 1 percent for carbon, but 4 percent for hydrogen and an estimated 6 percent for uranium. With the scatterer midway between source and detector, the fractional correction to the scattering cross section is four times the fractional solid angle subtended by the scatterer at the (small) detector for the isotropic case and 16 times the solid angle in hydrogen-like scattering. The same corrections apply to total cross section in H and C, for which $\sigma_a \ll \sigma_s$, if judged by the known thermal values and the 1/v behavior of σ_a. While there is no detailed data on the angular distribution of uranium scattering in this small angular interval and at these energies, the correction has been estimated to be roughly 6 percent from the large differences in the 500-Kev region between the 10° and 30° cross sections.

In addition a correction for multiple scattering should be made. For non-isotropic scattering and where there is a sharp dependence of energy on angle, the problem becomes quite complicated. By keeping transmissions in the range $.55 \leq T \leq .85$ this correction was minimized, since its maximum value is of the order (1-T) times the geometric correction made in the preceding paragraph. No multiple scattering correction has been made here.

The observed and corrected data are given in Table 1. The uranium cross section is plotted in Fig. 2 along with the recent Chicago data [1] taken with γ-n sources. The carbon cross section is plotted along with the Chicago [1] and the

1) D. Sachs in CP-2638

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Minnesota[2] data, the British[3] data, and the theoretical curve matched to these at higher energies and to the Chicago epithermal value. The agreement with the work with γ-n sources is good except perhaps for the lanthanum-beryllium source, which from the present carbon and uranium data might be assigned an energy of around 400 Kev rather than 600 Kev.

Richman has recalculated the theoretical hydrogen curve to the present best epithermal value, 20.3 barns. The agreement with the theoretical curve is very good.

TABLE I

E_n Kev	$\sigma_t(H)$ Data	$\sigma_t(H)$ Corrected	$\sigma_t(C)$ Data	$\sigma_t(C)$ Corrected	$\sigma_t(U)$ Data	$\sigma_t(U)$ Corrected
490	6.19 ± .15	6.4 ± .2	3.24 ± .07	3.3 ± .1	8.77 ± .19	9.3 ± .5
265	8.87 ± .15	9.2 ± .2	3.82 ± .05	3.9 ± .1	10.00 ± .15	10.6 ± .6
95	13.04 ± .26	13.6 ± .4	4.62 ± .09	4.7 ± .2	12.47 ± .25	13.2 ± .7
35	16.15 ± .25	16.8 ± .4	4.60 ± .14	4.7 ± .2	13.60 ± .30	14.4 ± .8

2) J. H. Williams, et al., CF-507, CF-599
3) E. Bretscher, et al., BM-62

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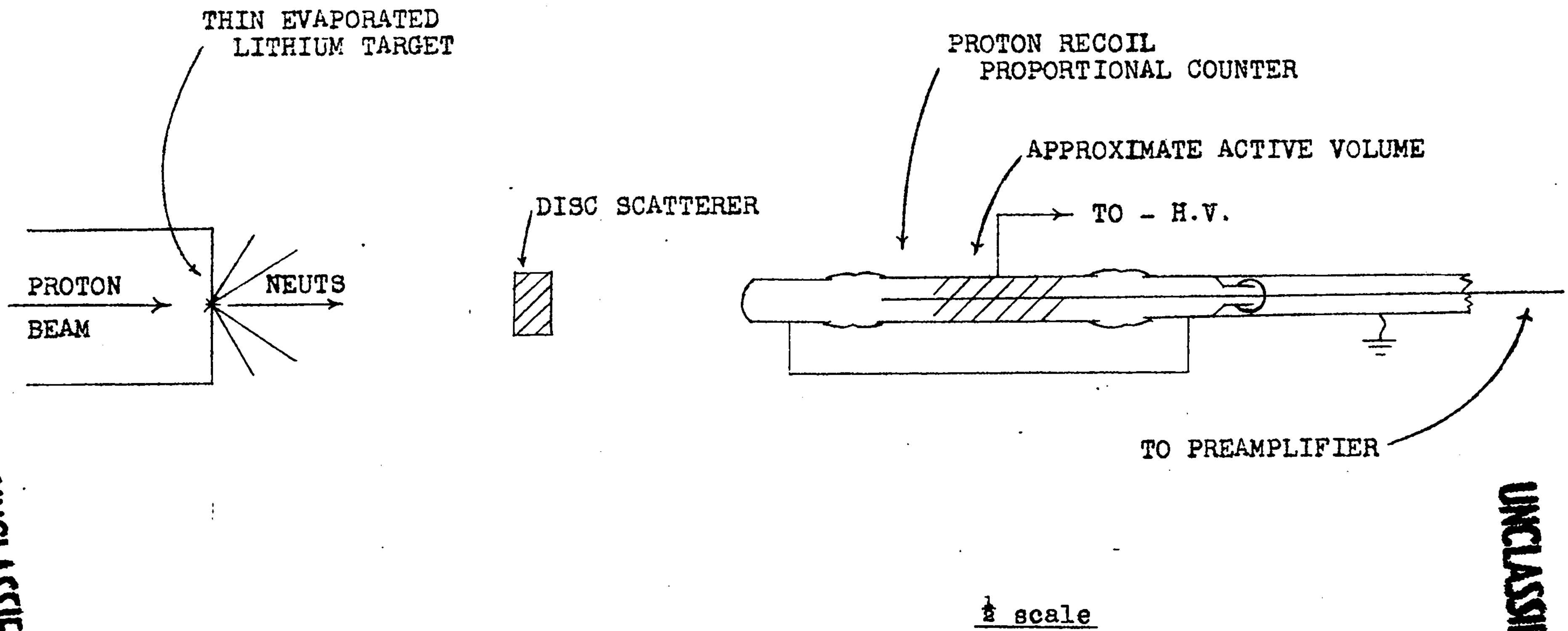

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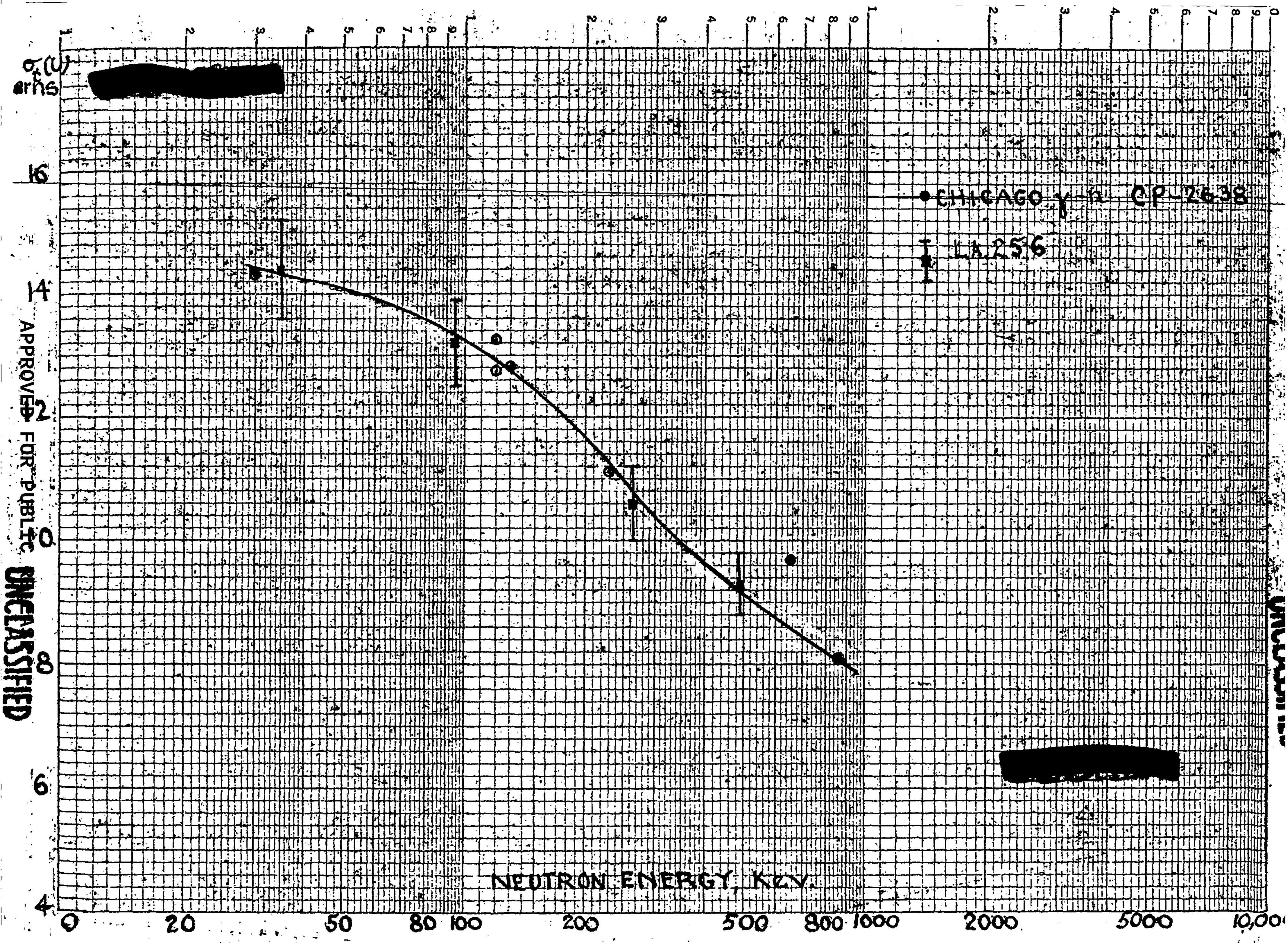
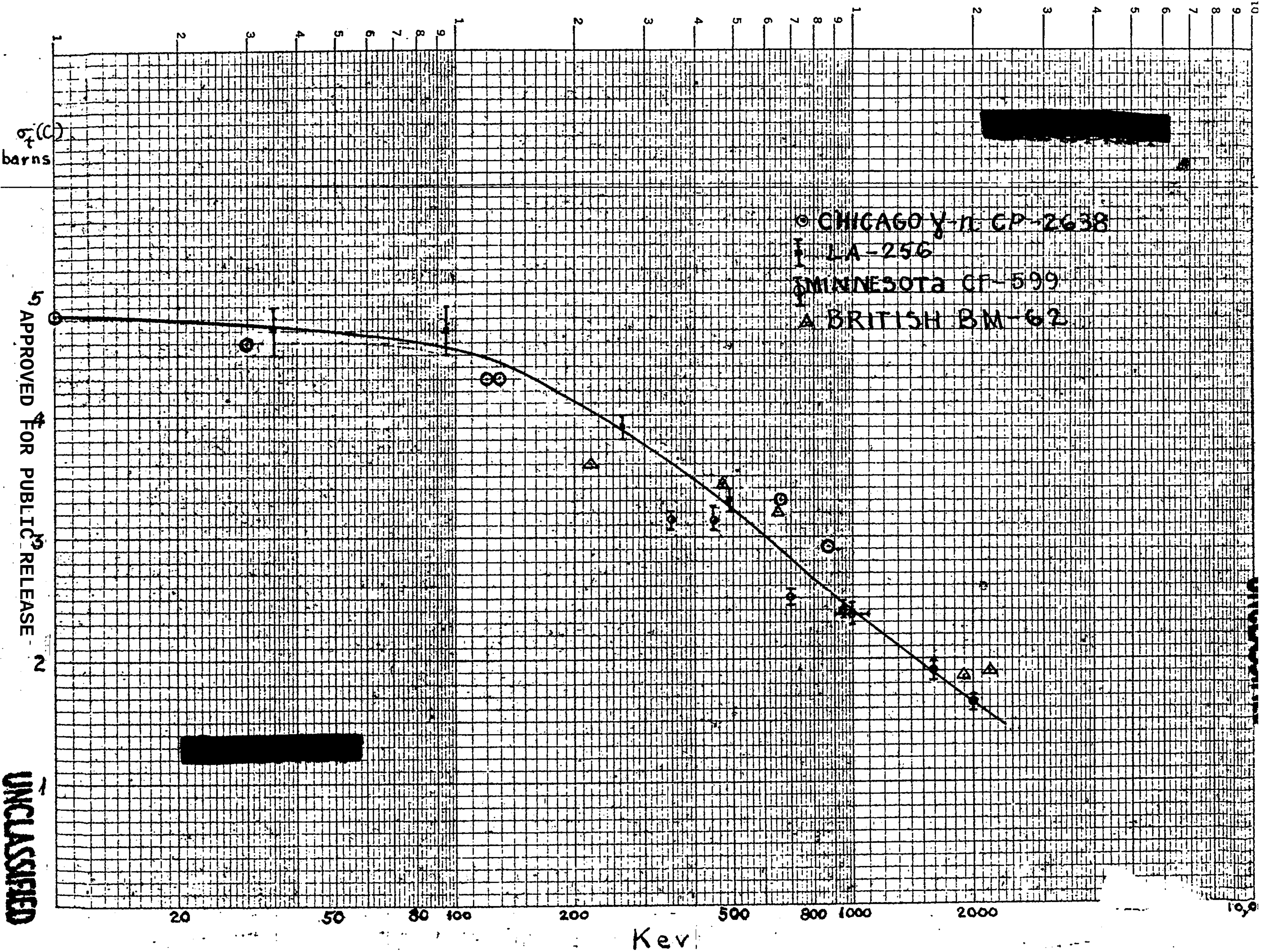
FIG. 1



σt(U) barns
[redacted]
16
14
12
10
8
6
4
CHICAGO γ-n CP-2638
LA256
[redacted]
NEUTRON ENERGY KeV
0
20
50
80 100
200
500
800 1000
2000
5000
10,000



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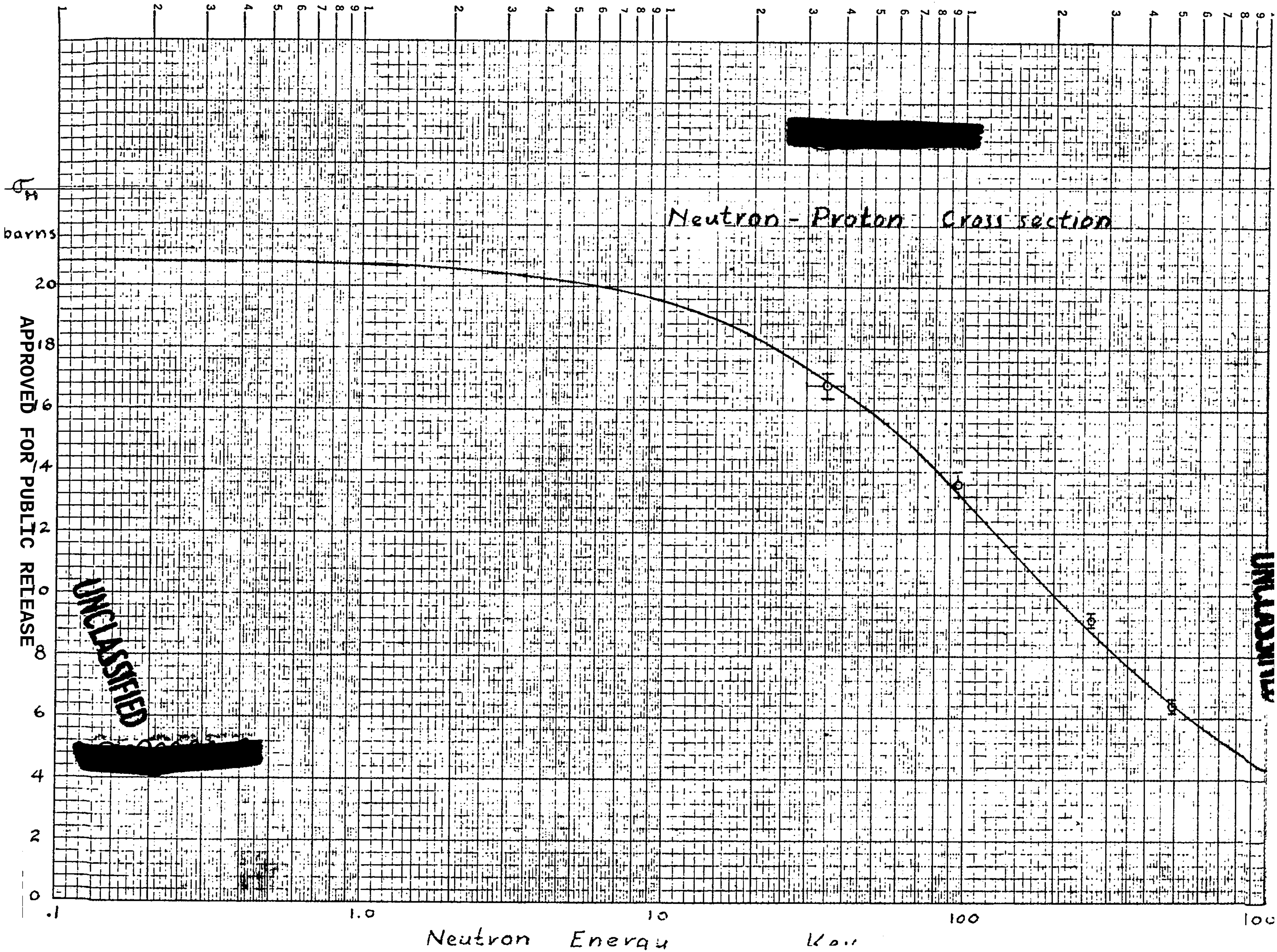

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