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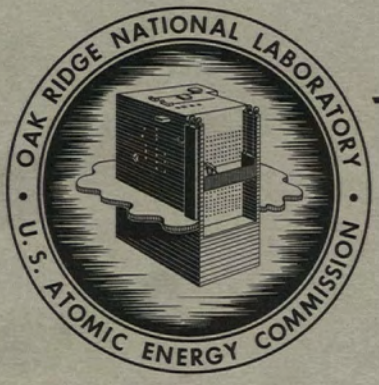
CROSS SECTIONS FOR ATOMIC DISPLACEMENTS IN SOLIDS BY FAST ELECTRONS

O. S. Oen



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SOLID STATE DIVISION

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O. S. Oen

MAY 1965

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Oak Ridge, Tennessee
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CROSS SECTIONS FOR ATOMIC DISPLACEMENTS IN SOLIDS BY FAST ELECTRONS

O. S. Oen

ABSTRACT

The Mott series has been used to calculate the number of displacements produced by elastic collisions between fast electrons and atomic nuclei. Displacement cross sections of 18 different elements spanning the atomic table were calculated for electron energies ranging from threshold to 10 MeV. Both the primary and the cascade using the Kinchin and Pease model were calculated using sharp displacement thresholds ranging from 15 to 50 eV in steps of either 5 or 10 eV. The results are compared with those using the less accurate McKinley-Feshbach formula commonly used in radiation damage studies. In addition, tables giving the differential cross section in steps of $7\frac{1}{2}^{\circ}$ for both the Mott series and the McKinley-Feshbach formula are included.

INTRODUCTION

Electrons in the energy range of one MeV have been frequently used to irradiate solids in the study of radiation damage. Electrons of this energy possess sufficient momentum to displace atoms from their normal lattice positions directly through near head-on collisions. To calculate the probability of such a displacement it is necessary to know the scattering cross section between an electron and an atom. The scattering of a nonrelativistic electron by the Coulomb field of a point nucleus was first treated by Rutherford, and the relativistic extension was done by Mott[1] using the Dirac theory of the electron. Since the electrons used

[1] N. F. Mott, Proc. Roy. Soc. (London) A124, 426 (1929); A135, 429 (1932); N. F. Mott and H. S. W. Massey, The Theory of Atomic Collisions (Oxford University Press, New York, 1949), 2nd ed., chap. IV.

in radiation damage are in the relativistic velocity range, it is necessary to use Mott's theory. Mott has expressed the scattering between a point nucleus and an electron as an infinite series of Legendre expansions. Since that series solution is cumbersome to evaluate, several authors have approximated it to get simpler, more tractable expressions. The so-called McKinley-Feshbach version of the Mott equation has been most frequently used to calculate atomic displacement cross sections for radiation damage research. Seitz and Koehler[2] have pointed out that the McKinley-Feshbach formula should be sufficiently accurate for light elements ($Z \lesssim 29$), but that for heavy elements it becomes necessary to use the more accurate Mott series formulation. In view of the very limited number of calculations that have been done using the Mott series, it has seemed desirable to compute atomic displacement cross sections using this series for a variety of elements and electron energies. This has been done for 18 different elements spanning the atomic table. The Mott series has been used to evaluate each case.

METHOD OF CALCULATION

Our method of calculating the atomic displacement cross sections by fast electrons follows closely that of Seitz and Koehler.[2] The calculational procedures are outlined in the paragraphs below. The calculations were performed with the aid of a 1604 CDC computer located at Oak Ridge National Laboratory.

The energy transferred to a heavy nucleus by an electron scattered through an angle Θ is given by

---

[2] F. Seitz and J. S. Koehler, p. 305 in Solid State Physics, vol. 2, ed. by F. Seitz and D. Turnbull (Academic Press, New York, 1956).

$$T = T_m \sin^2 \theta/2 \tag{1}$$

where T_m, the maximum transferred energy which occurs for a head-on collision, is

$$T_m(\text{eV}) = \frac{2147.66\ E(E + 1.0220)}{A} . \tag{2}$$

Here A is the atomic weight and E is the kinetic energy of the electron expressed in MeV. The rest mass energy of the electron is taken as 0.511 MeV.

The conventional sharp displacement threshold model has been used. It assumes that an atom can be displaced only if it receives an energy equal or greater than some threshold energy, E_d. Upon receiving such an energy, the probability that the atom is displaced is taken as unity. Furthermore, the primary displaced atom can, if sufficiently energetic, produce additional displaced atoms. We have used the Kinchin and Pease[3] cascade model which gives the average number of displacements, ν, produced by a primary knock-on of energy T as

$$\begin{aligned} \nu(T) &= T/2E_d && T \geq 2E_d \\ &= 1 && E_d \leq T \leq 2E_d \end{aligned} \tag{3}$$

The total cross section (primary plus secondaries) for producing atomic displacements by an electron of energy E can be written as

$$\sigma_{tot}(E) = \int_{E_d}^{T_m} \nu(T) \frac{d\sigma}{dT}\, dT \tag{4}$$

---

[3] G. H. Kinchin and R. S. Pease, Repts. Progr. Phys. 18, 1 (1955).

while the cross section for producing primary displacements only is

$$\sigma_p(E) = \int_{E_d}^{T_m} \frac{d\sigma}{dT}\, dT. \tag{5}$$

In Eqs. (4) and (5) the quantity $d\sigma/dT$ is the differential scattering cross section for transferring an energy T to an atom by an electron of energy E. The above integrals can be done analytically for the McKinley-Feshbach version of $d\sigma/dT$, but numerical methods become necessary when using the Mott series. Rewriting Eq. (4) more explicitly using the results of Eq. (3) gives

$$\sigma_{tot}(E) = \frac{0.06515\, Z^2(E + 0.511)^2}{E^2(E + 1.022)^2} \left\{ \int_{E_d/T_m}^{1} \frac{dx}{x^2} M(x,E) \right\} \text{ (barns) } E_d \leq T_m \leq 2E_d \tag{4a}$$

$$= \frac{0.06515\, Z^2(E + 0.511)^2}{E^2(E + 1.022)^2} \left\{ \int_{E_d/T_m}^{2E_d/T_m} \frac{dx}{x^2} M(x,E) \right.$$

$$\left. + \int_{2E_d/T_m}^{1} \frac{T}{2E_d} \frac{dx}{x^2} M(x,E) \right\} \quad \text{(barns)} \quad T_m > 2E_d \tag{4b}$$

where $x = T/T_m$, Z the atomic number and M(x,E) the ratio of the Mott to the Rutherford cross section. The ratio M(x,E) was calculated using the method of Doggett and Spencer[4] and the integrals evaluated by 16 point

[4] J. A. Doggett and L. V. Spencer, Phys. Rev. 103, 1597 (1956).

Gauss-Legendre quadrature techniques. The integrand in the second integral of Eq. (4b) was transformed by the substitution $x = e^{-y}$ before evaluating the integral. The transformed integrand which varied less over the domain of integration proved easier to evaluate. The primary displacement cross section given by Eq. (5), when written out more explicitly, becomes identical to Eq. (4a) except that now there is no restriction on the magnitude of T_m provided it is larger than E_d. The substitution, $x = 1/y$, facilitated the evaluation of the integral for the primary cross sections.

The differential Rutherford scattering cross section is calculated from the expression

$$\frac{d\sigma_R(\Theta)}{d\Omega} = 0.020738\left[\frac{E + 0.511}{E(E + 1.022)}\right]^2 \frac{Z^2}{(1 - \cos\Theta)^2} \text{ (barns per steradian).} \quad (6)$$

ACCURACY AND OTHER CALCULATIONS

The Mott series was evaluated using the computer code of Doggett and Spencer[4] taking 36 terms in the Legendre sums. For those cases of overlap our results, as expected, are in excellent agreement with theirs and therefore their comments on the accuracy of the method apply here also. They have made several comparisons with other previous calculations and find good agreement. They have stated that "overall accuracy of different portions of the tabulations can be expected to differ; however, we estimate that except for the largest angles at high energies it should be 0.5 percent or better."

The tables of the differential cross section have, for convenience and accuracy in reproducing, been printed as output by the computer

and therefore some of the values contain more than the three or four figures which are significant.

All of the integrations were performed using 16 point Gauss-Legendre quadrature techniques. The integration routine was checked by numerically integrating the McKinley-Feshbach version of the Mott series and comparing that with what one gets when it is done analytically. Excellent agreement was found.

Our calculated displacement cross sections for gold agree well with those of Khandelwal and Merzbacher.[5] For the light elements they agree well with what one calculates using the McKinley-Feshbach formula. We believe that the overall accuracy of the calculations should be good to within a few percent. Furthermore, we feel that the displacement model rather than the calculational accuracy is the limiting factor in the displacement cross sections.

DISCUSSION OF FIGURES AND TABLES

A. Integral Displacement Cross Sections

a) The first 18 figures show both the primary and the total displacement cross sections as a function of electron energy using several displacement threshold energies for 18 different elements spanning the atomic table. The Mott series is used for the electron-nuclear differential scattering and it was computed by the procedure already described.

b) Figures 19-21 show a comparison of the Mott and McKinley-Feshbach displacement cross sections. Figure 19 shows this comparison for

---

[5] G. S. Khandelwal and E. Merzbacher, Phys. Rev. 130, 1822 (1963).

gold for both the primary and total displacement cross sections. The primary displacement cross section of the Mott and the McKinley-Feshbach is shown as a ratio in Fig. 20. In Fig. 21 the maximum of this ratio is plotted against the atomic number.

B. Differential Scattering Cross Sections

For some purposes it is desirable to calculate displacement cross sections using a more refined, but specialized, displacement model than that of Kinchin and Pease. This occurs, for instance, when one is studying atomic displacements as a function of crystal orientation. For purposes such as these it would seem convenient to have available tables giving the Mott differential scattering.

a) Tables 1-9 give the ratio of the Mott to the Rutherford scattering as a function of scattering angle for several electron energies. Tables 9-18 give the ratio of the Mott to the McKinley-Feshbach. Table 19 gives the differential Rutherford scattering cross section in barns per steradian with the Z^2 factor omitted.

b) For convenience, some of the results of the above tables are compared and plotted in Figs. 1-3.

C. Subsidiary Results

The maximum energy transferred to an atom, T_m, by an electron in a head-on elastic collision (Eq. 2) is plotted as a function of electron energy for several different elements in Fig. 25.

The author is indebted to J. J. Coyne of the National Bureau of Standards for making available the computer code of J. A. Doggett and L. V. Spencer. Members of the Solid State Division have been most helpful and special thanks are due to J. H. Barrett, D. K. Holmes, M. T. Robinson, and M. S. Wechsler.

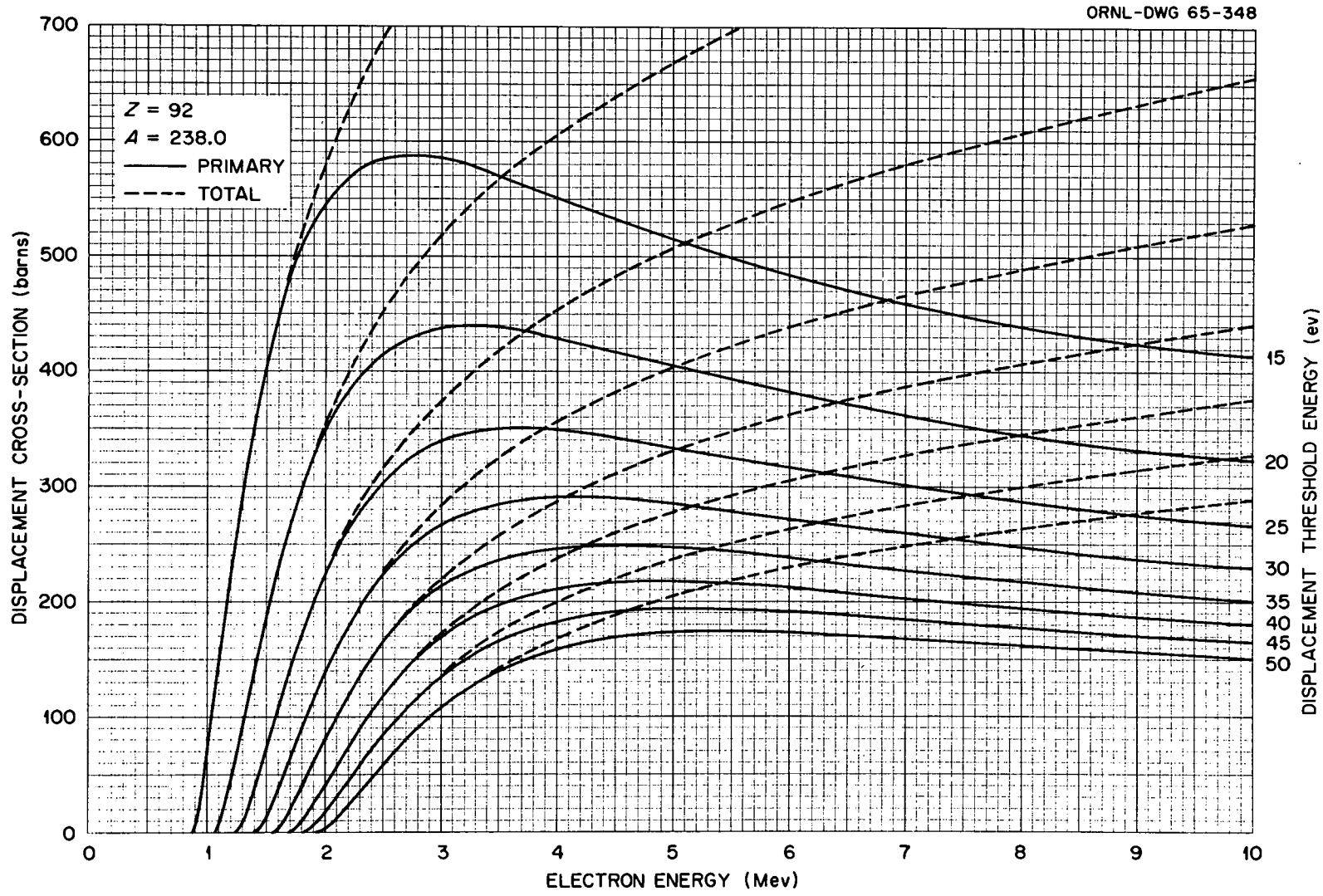

ORNL-DWG 65-348
Z = 92
A = 238.0
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
45
50

Figure 1

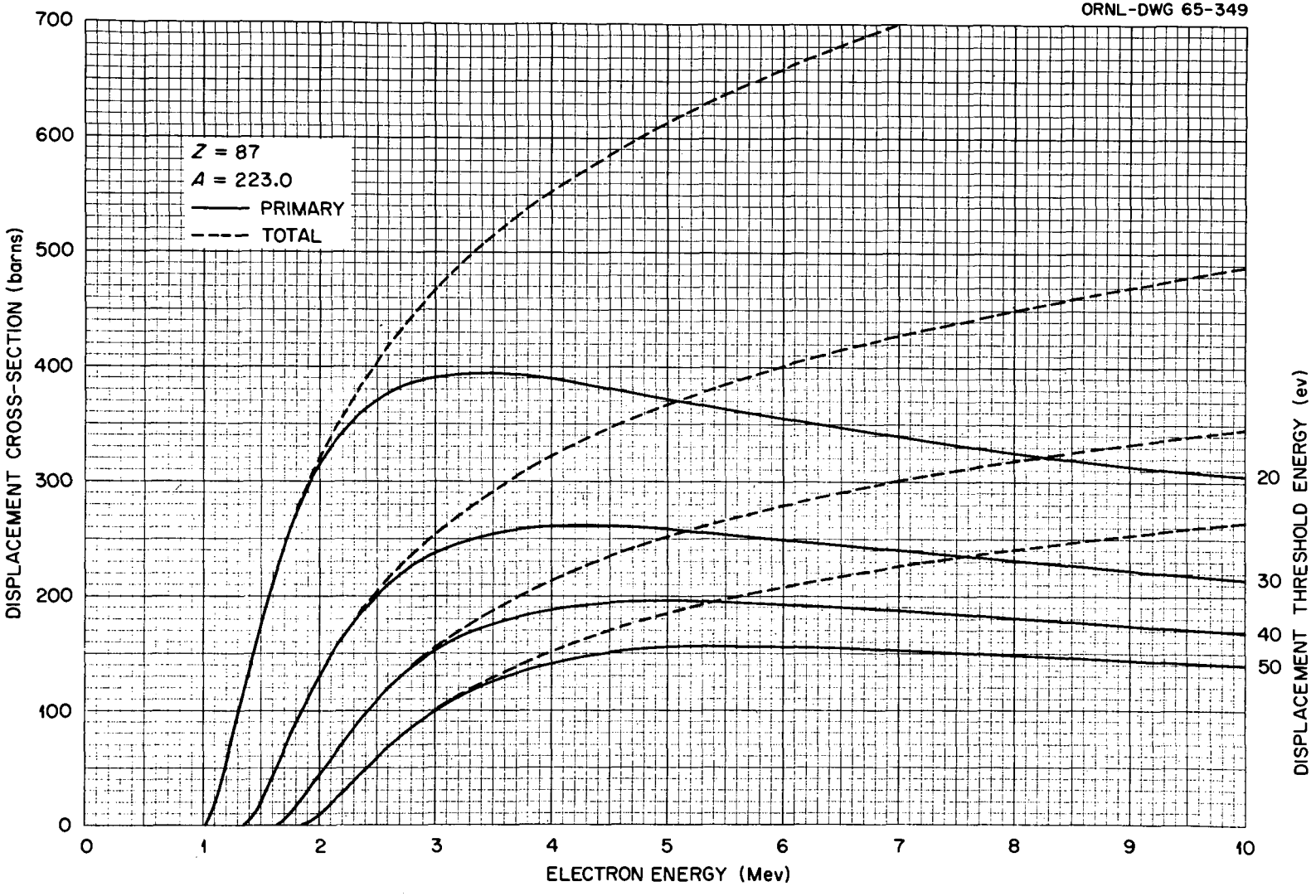

ORNL-DWG 65-349
Z = 87
A = 223.0
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
0
100
200
300
400
500
600
700
1
2
3
4
5
6
7
8
9
10
20
30
40
50

Figure 2

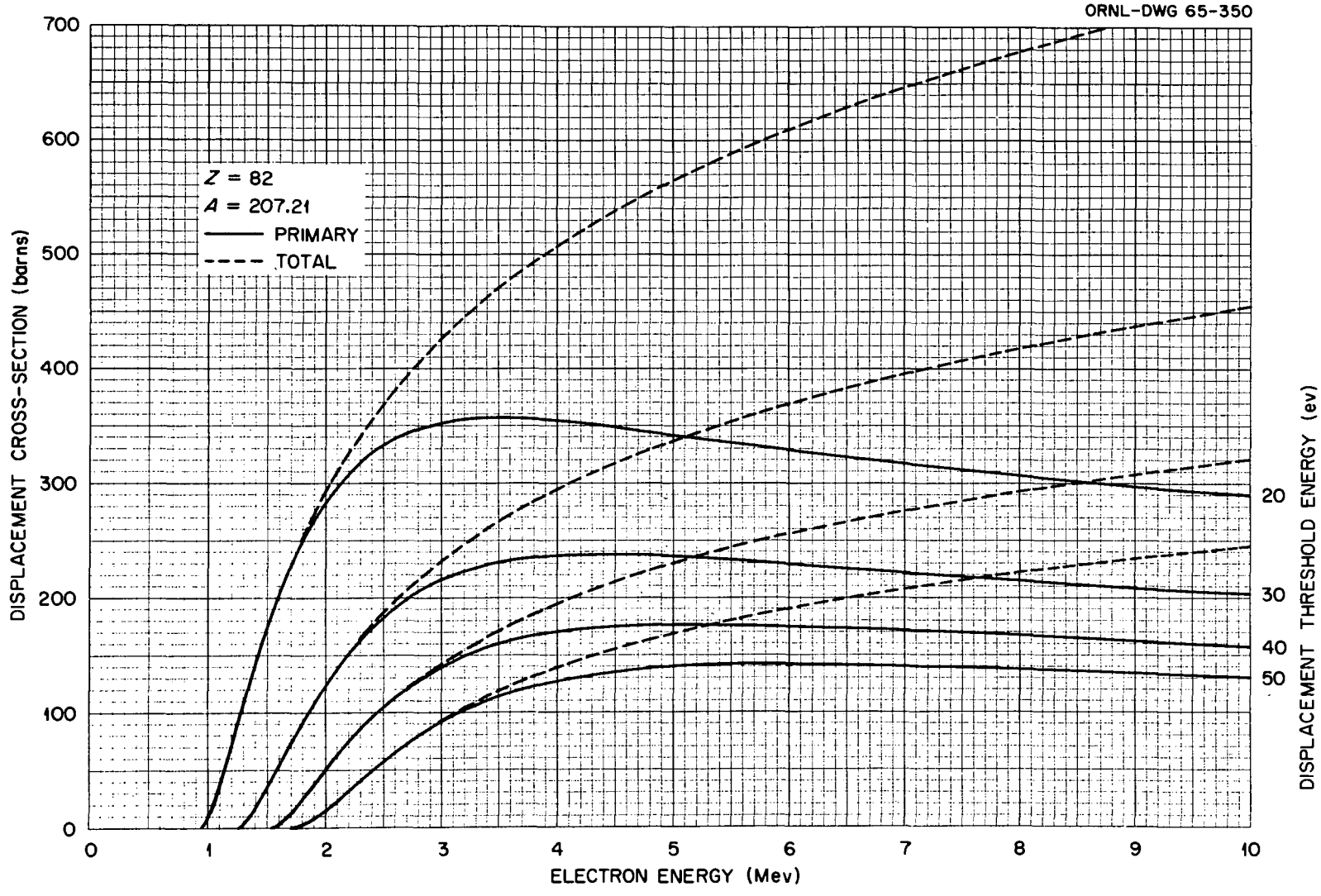

ORNL-DWG 65-350
Z = 82
A = 207.21
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
20
30
40
50

Figure 3

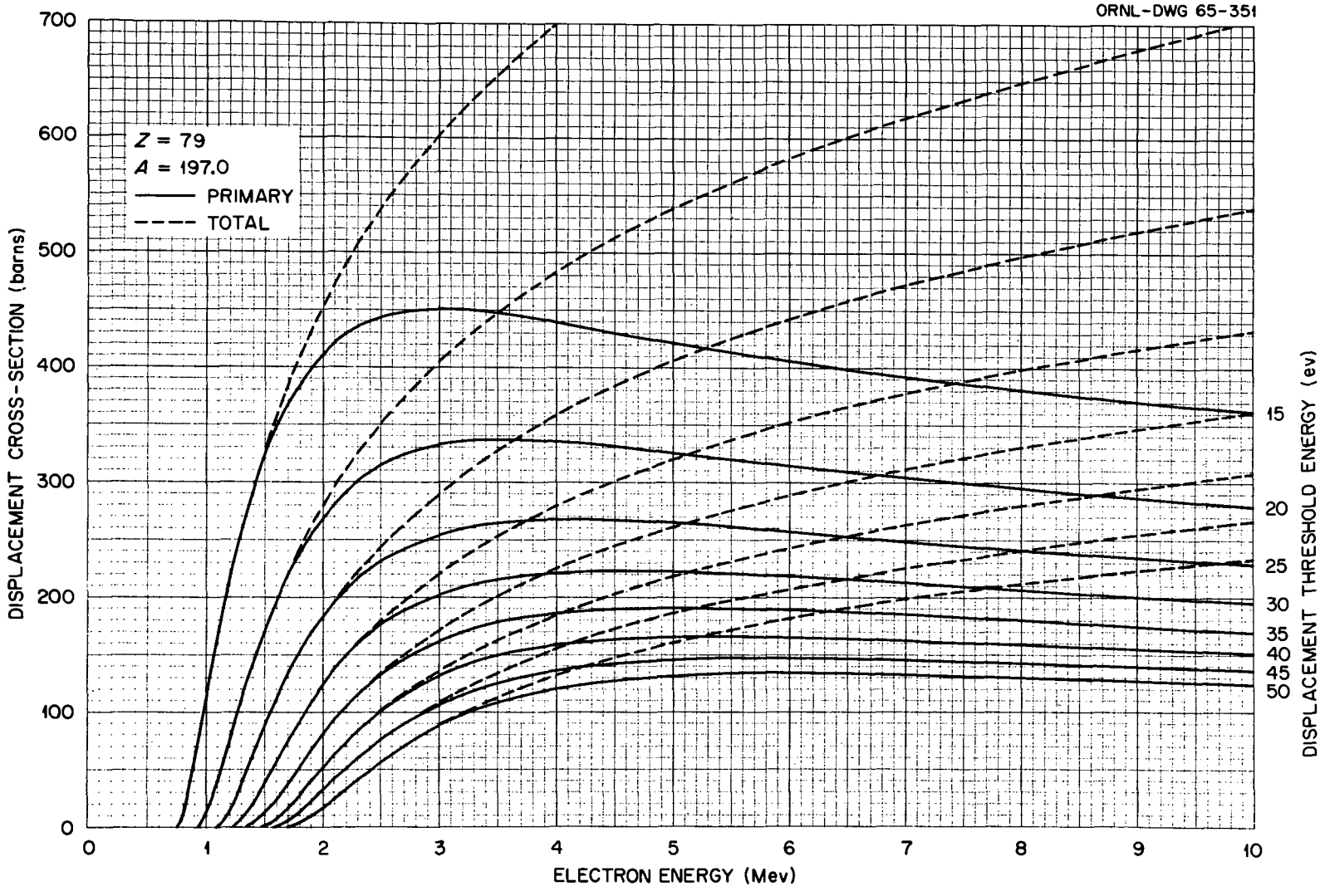

ORNL-DWG 65-351
Z = 79
A = 197.0
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
45
50

Figure 4

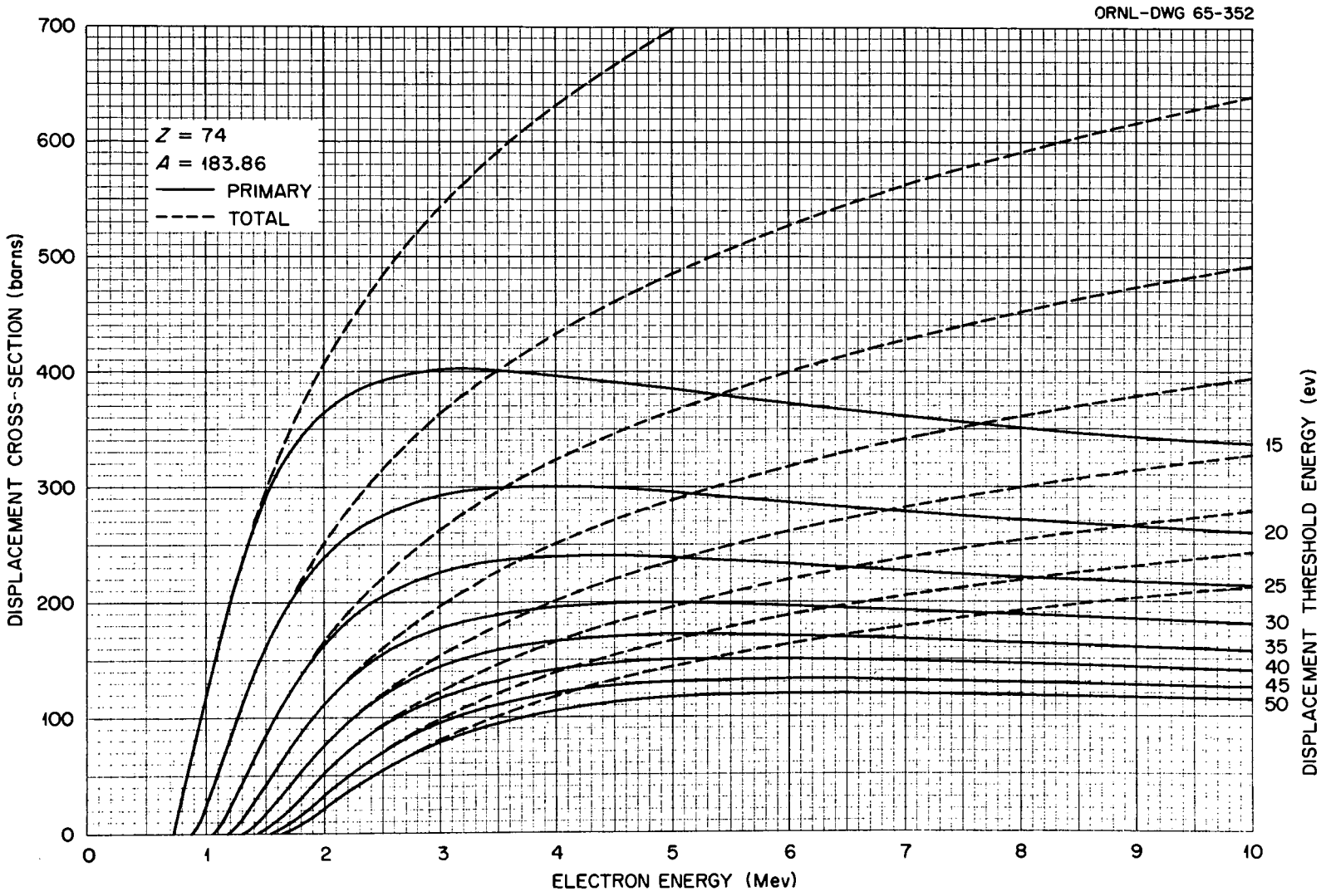

ORNL-DWG 65-352
Z = 74
A = 183.86
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
45
50
0
100
200
300
400
500
600
700
0
1
2
3
4
5
6
7
8
9
10

Figure 5

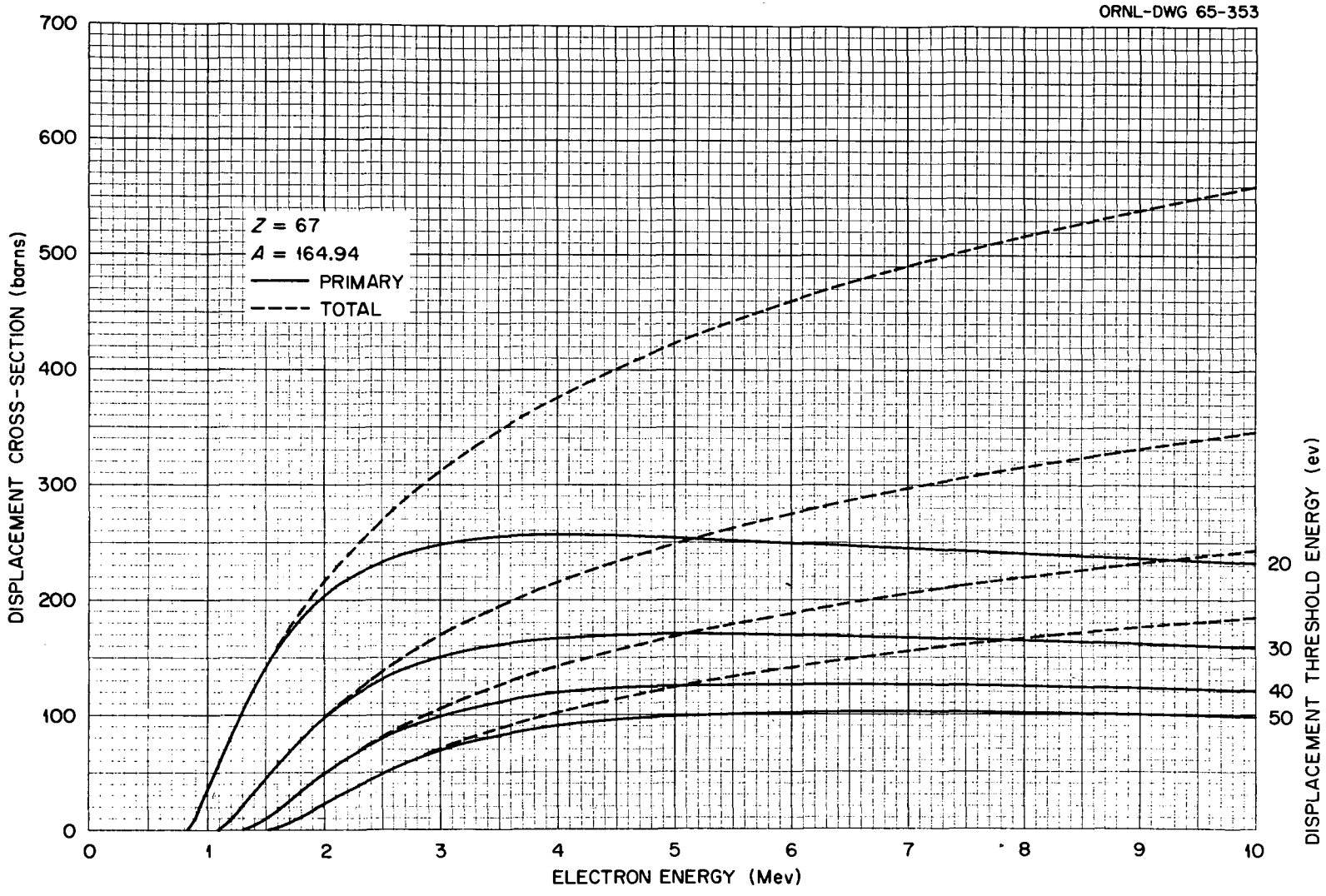

ORNL-DWG 65-353
Z = 67
A = 164.94
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
20
30
40
50
0
100
200
300
400
500
600
700
1
2
3
4
5
6
7
8
9
10

Figure 6

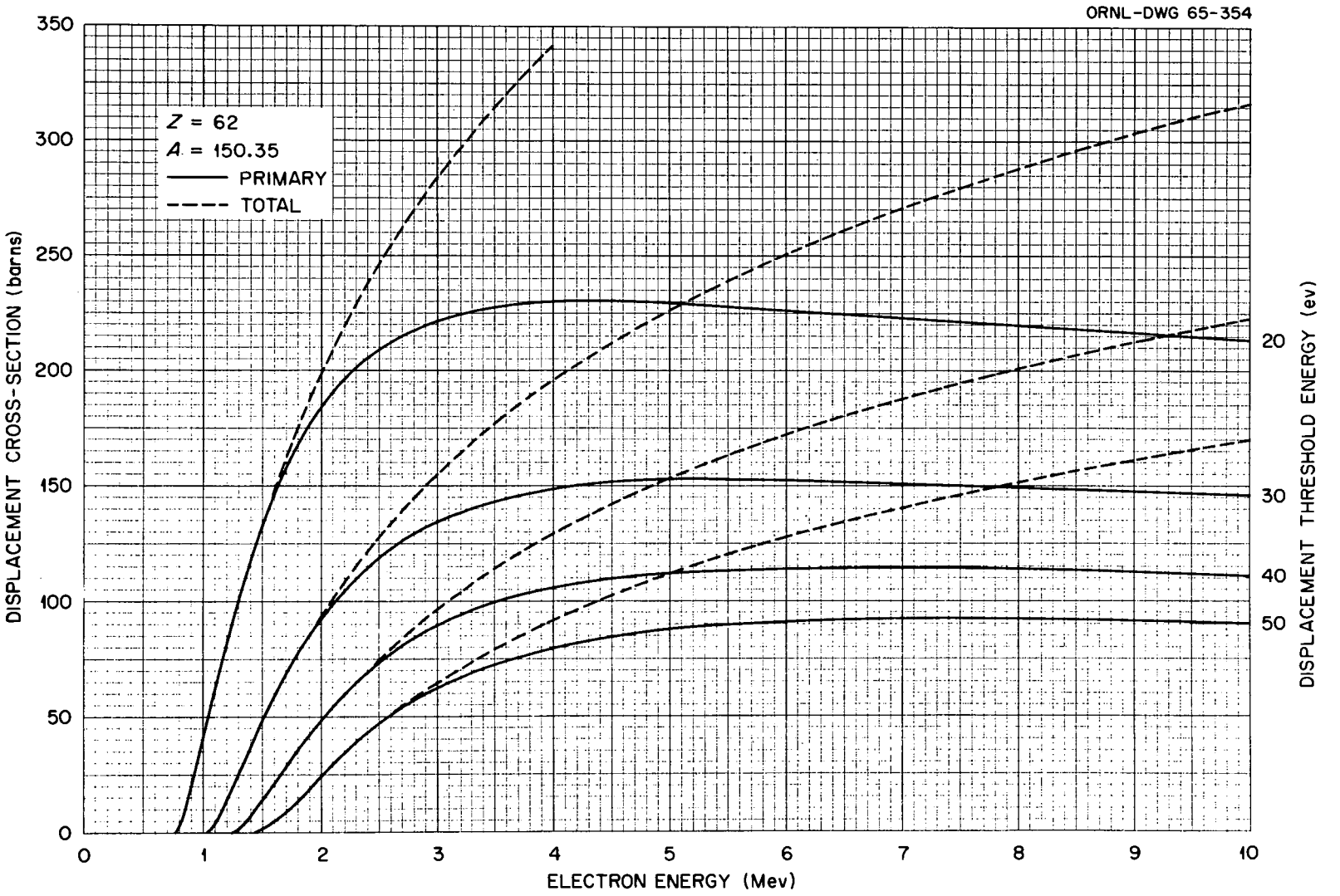

ORNL-DWG 65-354
Z = 62
A = 150.35
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
DISPLACEMENT THRESHOLD ENERGY (ev)
ELECTRON ENERGY (Mev)
0
50
100
150
200
250
300
350
1
2
3
4
5
6
7
8
9
10
20
30
40
50

Figure 7

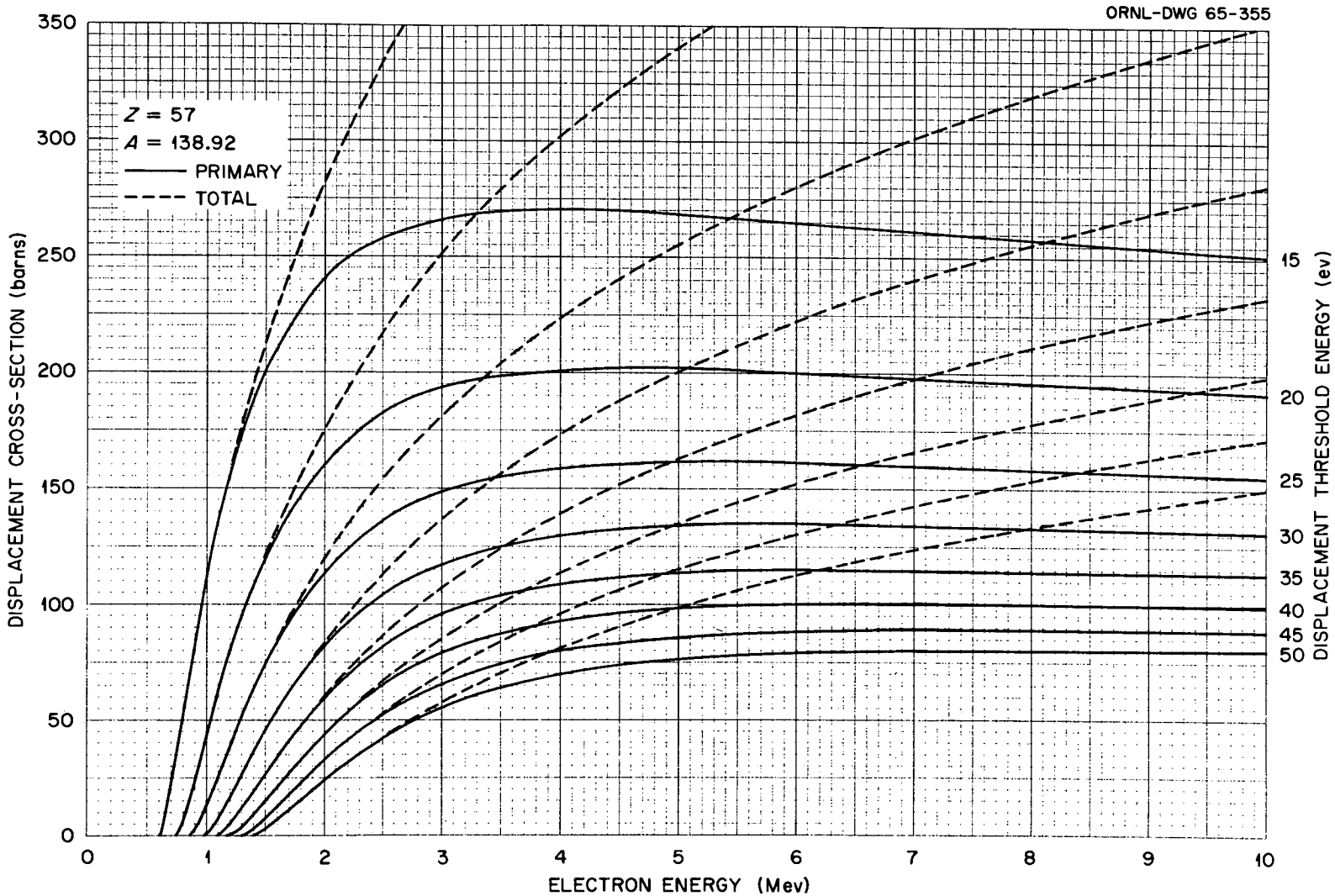

ORNL-DWG 65-355
Z = 57
A = 138.92
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350
0
1
2
3
4
5
6
7
8
9
10

Figure 8

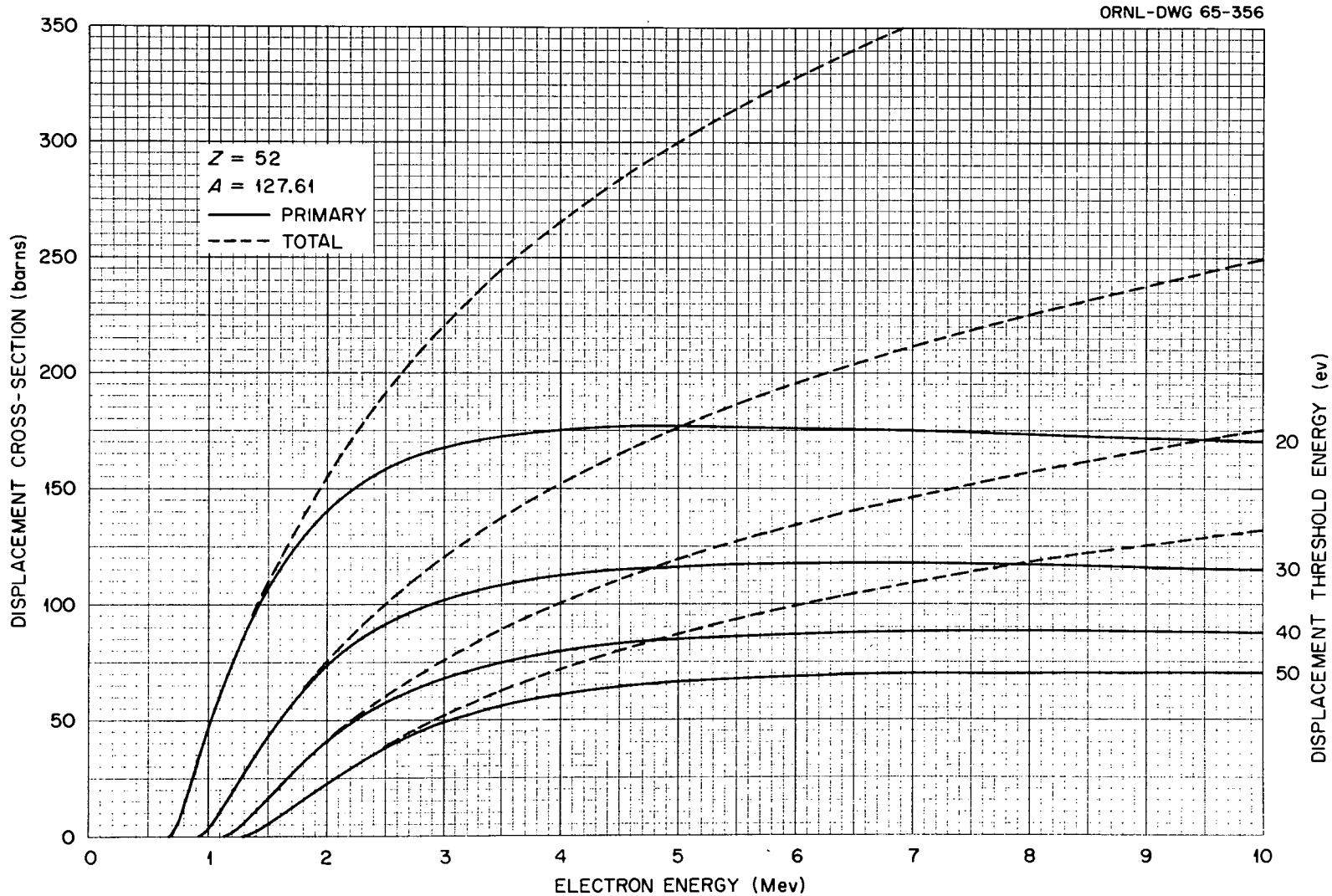

ORNL-DWG 65-356
Z = 52
A = 127.61
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
DISPLACEMENT THRESHOLD ENERGY (ev)
ELECTRON ENERGY (Mev)
0
50
100
150
200
250
300
350
1
2
3
4
5
6
7
8
9
10
20
30
40
50

Figure 9

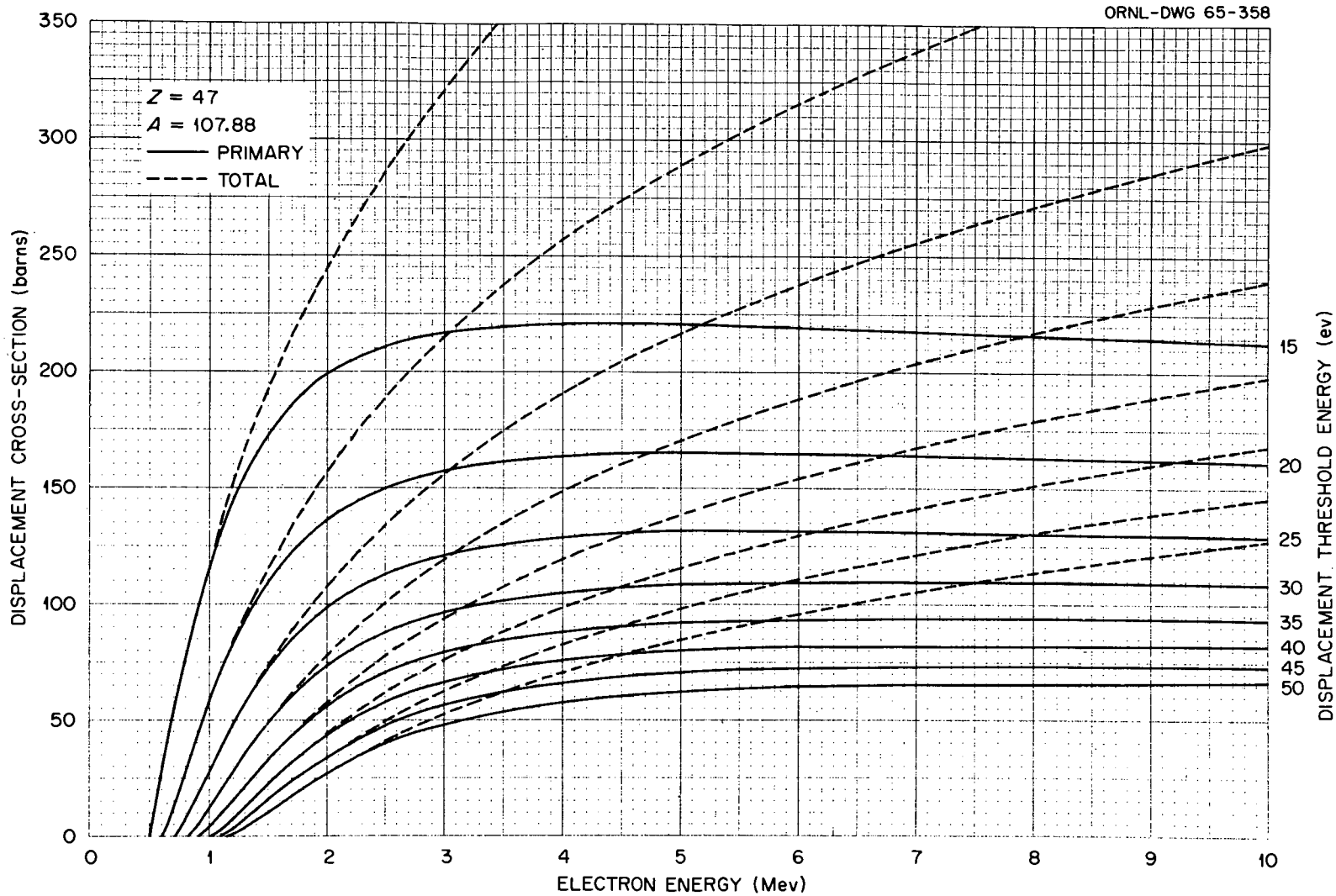
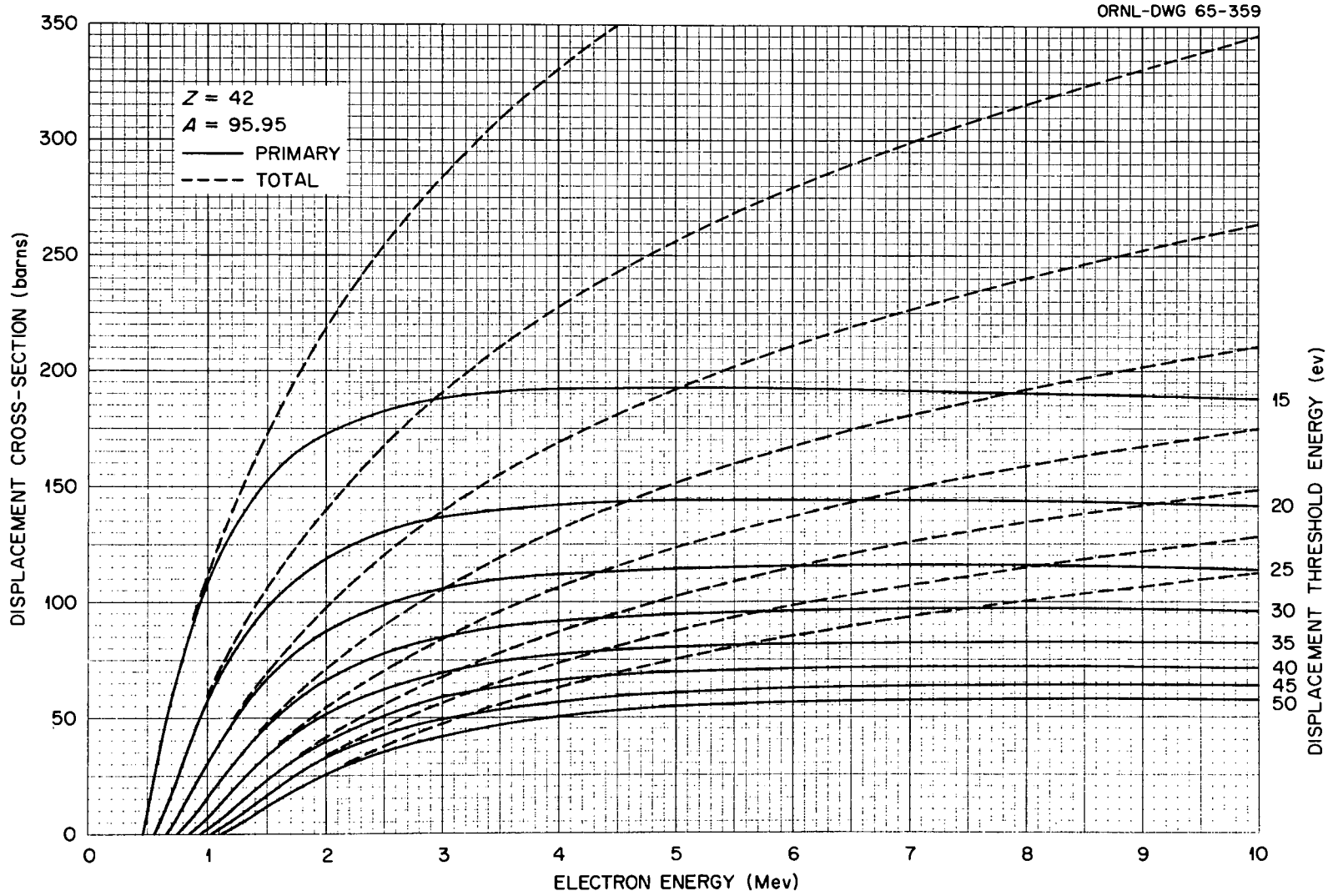

ORNL-DWG 65-358
Z = 47
A = 107.88
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350
0
1
2
3
4
5
6
7
8
9
10

Figure 10


ORNL-DWG 65-359
Z = 42
A = 95.95
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350
0
1
2
3
4
5
6
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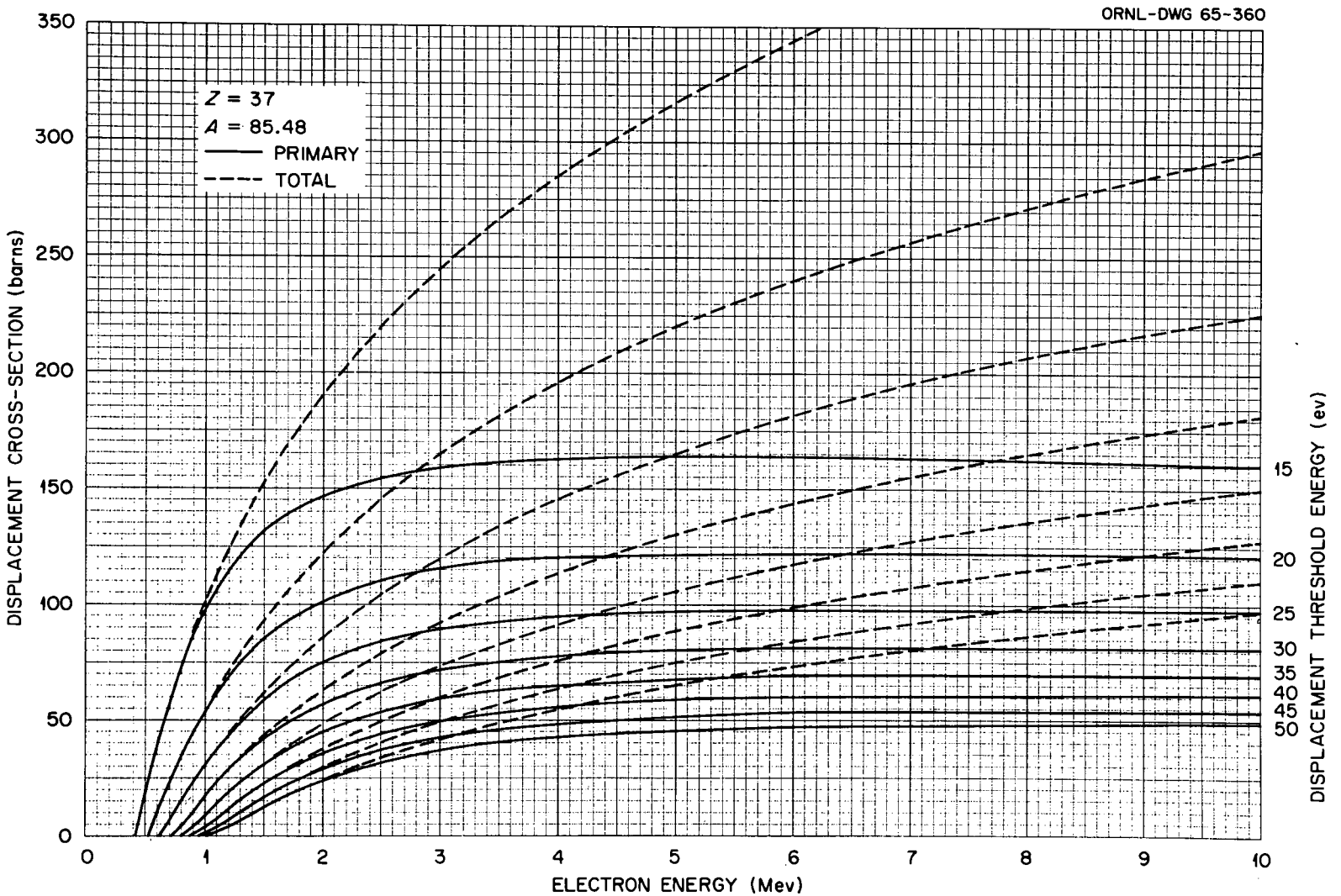
8
9
10

Figure 11


ORNL-DWG 65-360
Z = 37
A = 85.48
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
0
50
100
150
200
250
300
350
1
2
3
4
5
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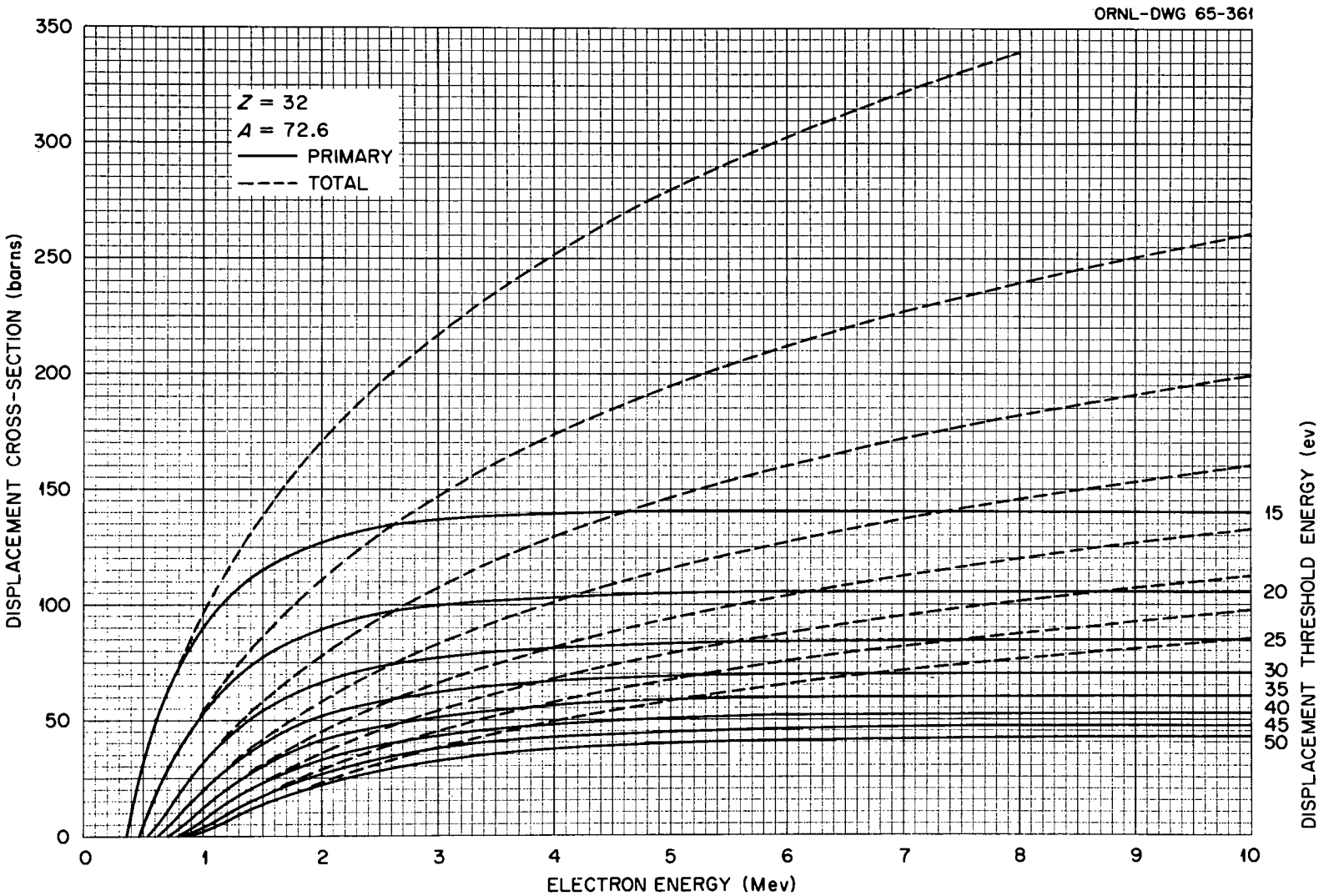
20
25
30
35
40
45
50

Figure 12


ORNL-DWG 65-361
Z = 32
A = 72.6
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
0
50
100
150
200
250
300
350
1
2
3
4
5
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25
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45
50

Figure 13

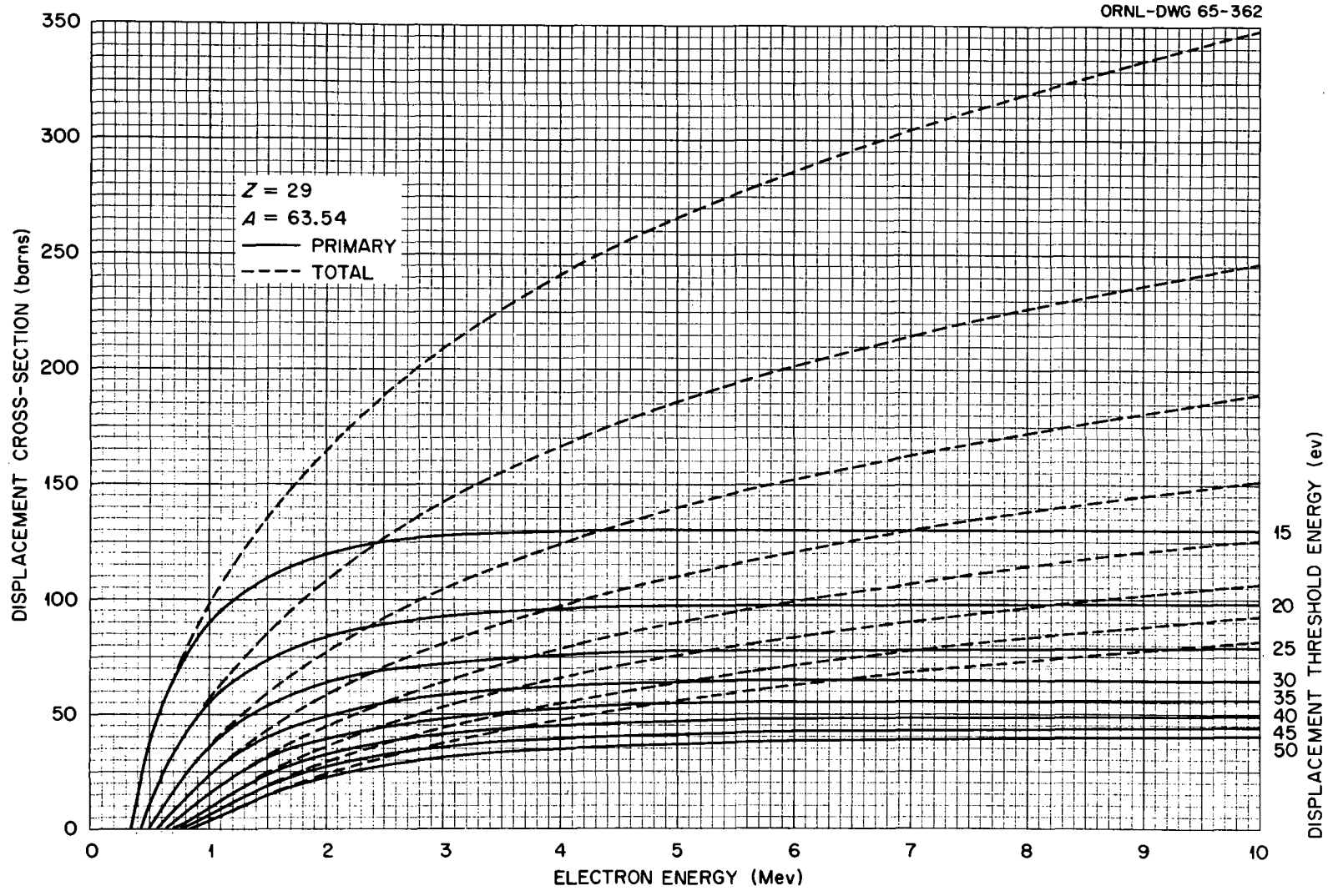
ORNL-DWG 65-362
DISPLACEMENT CROSS-SECTION (barns)
350
300
250
200
150
100
50
0
Z = 29
A = 63.54
PRIMARY
TOTAL
0
1
2
3
4
5
6
7
8
9
10
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
45
50

Figure 14

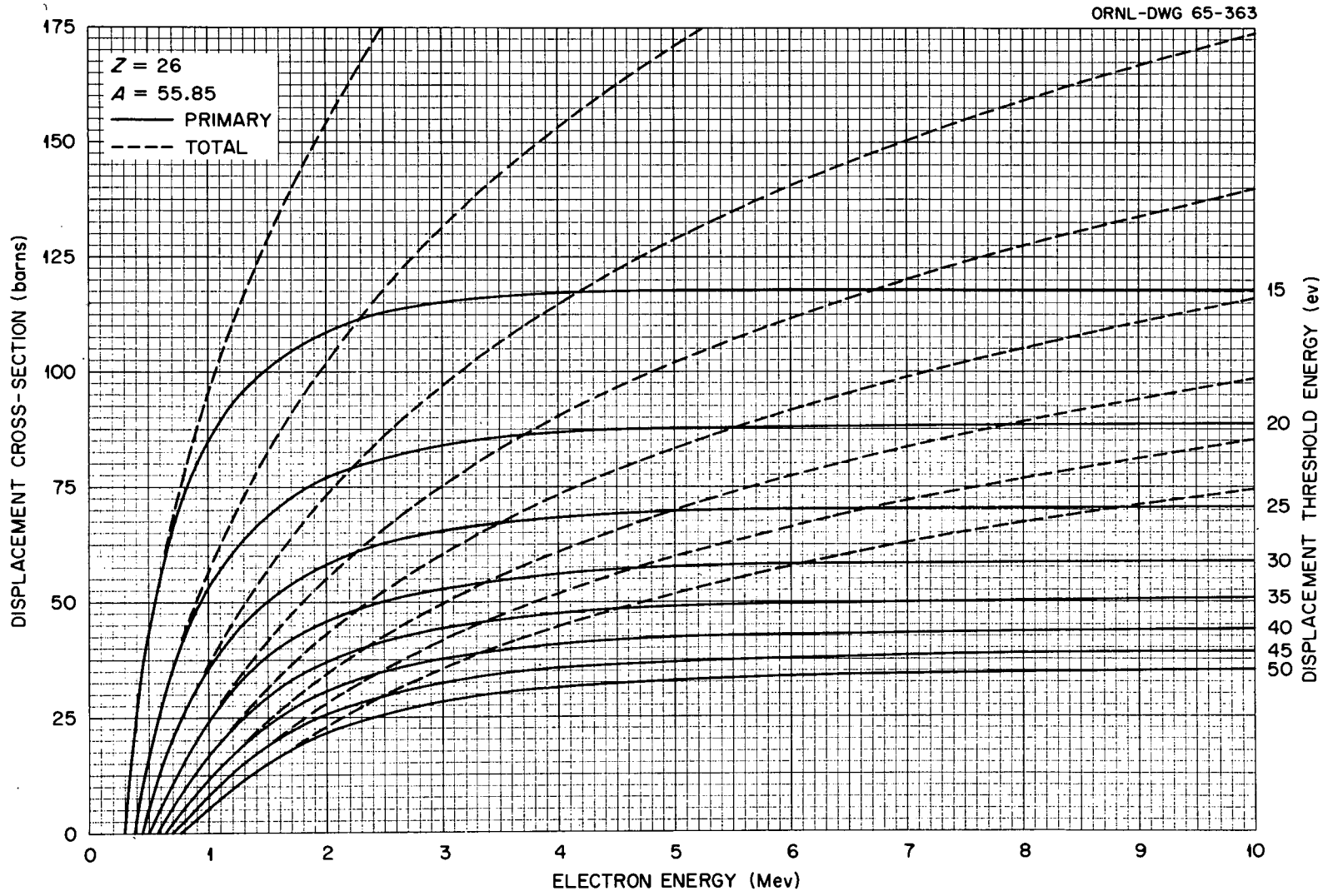
ORNL-DWG 65-363
Z = 26
A = 55.85
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
0
25
50
75
100
125
150
175
1
2
3
4
5
6
7
8
9
10
15
20
25
30
35
40
45
50

Figure 15

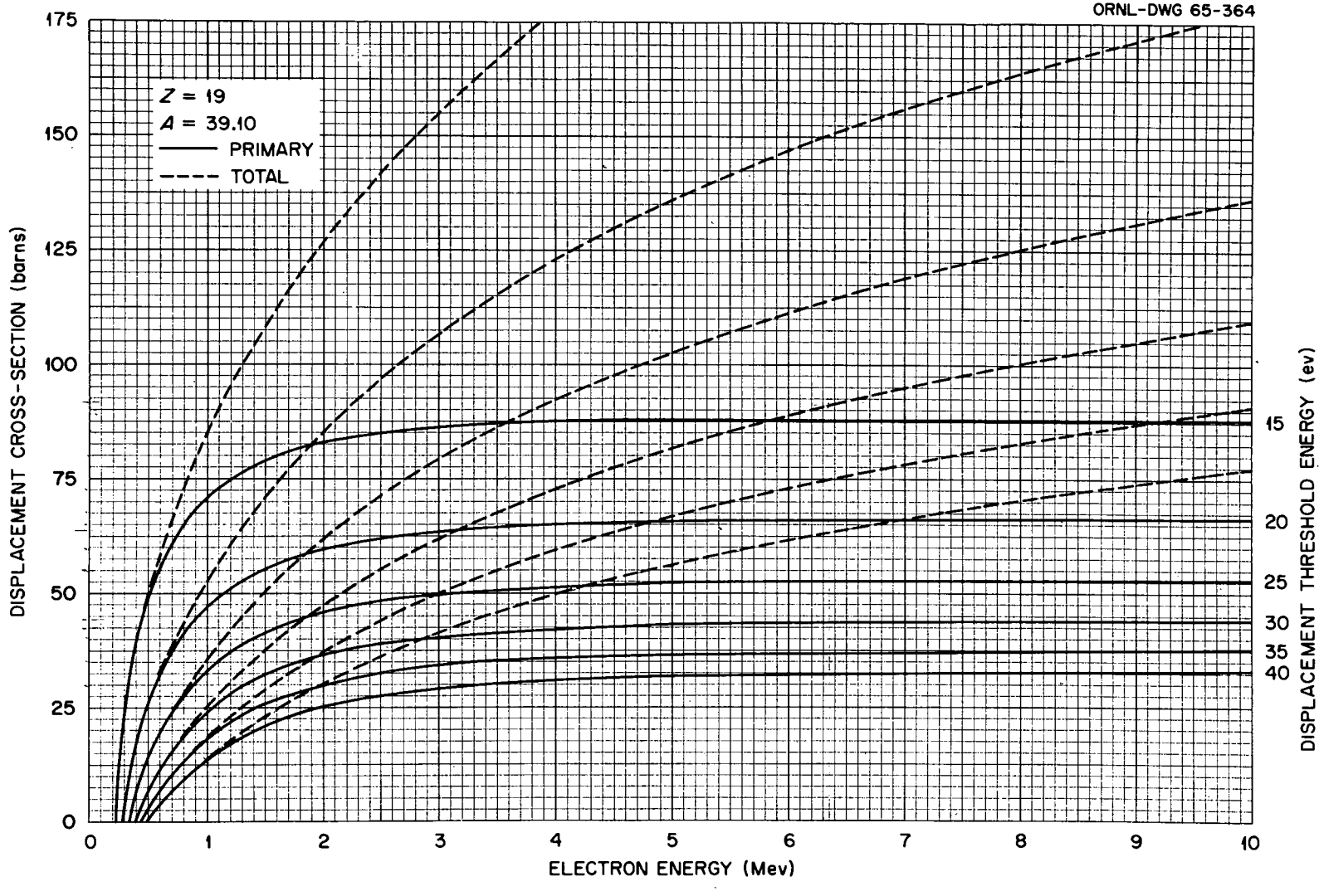
ORNL-DWG 65-364
Z = 19
A = 39.10
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
0
25
50
75
100
125
150
175
0
1
2
3
4
5
6
7
8
9
10
15
20
25
30
35
40

Figure 16

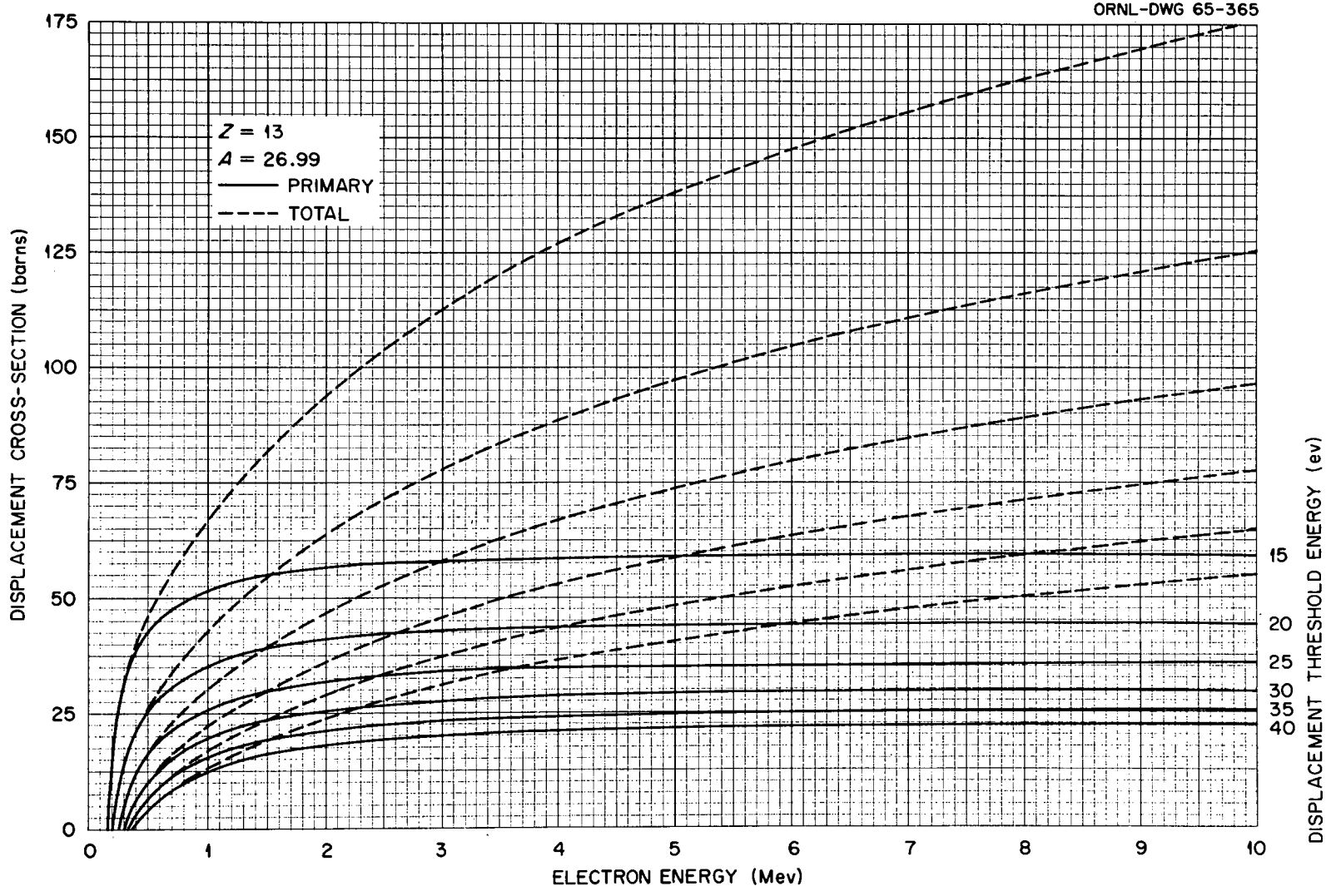
ORNL-DWG 65-365
Z = 13
A = 26.99
PRIMARY
TOTAL
DISPLACEMENT CROSS-SECTION (barns)
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30
35
40
0
25
50
75
100
125
150
175
0
1
2
3
4
5
6
7
8
9
10

Figure 17

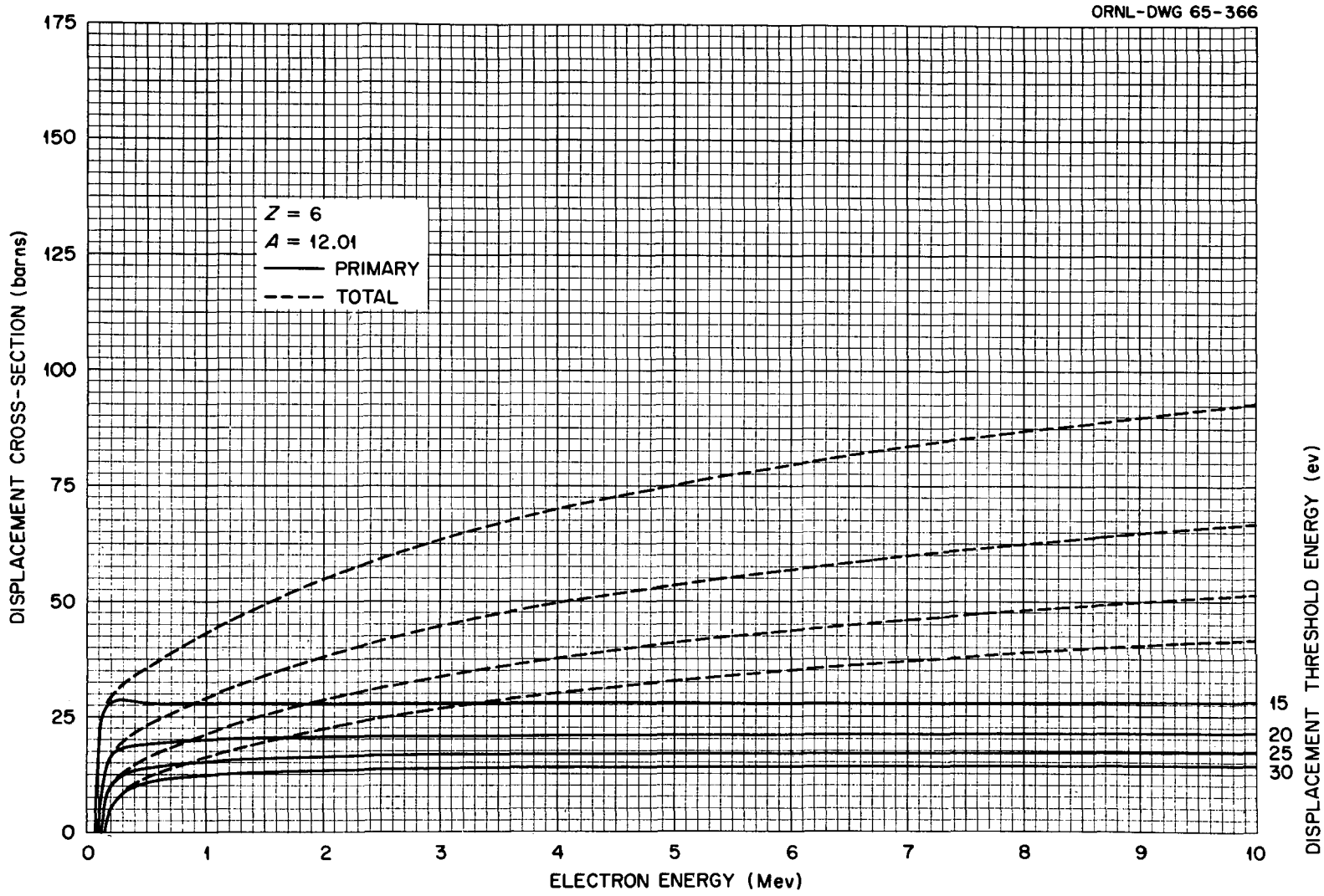
ORNL-DWG 65-366
DISPLACEMENT CROSS-SECTION (barns)
175
150
125
100
75
50
25
0
Z = 6
A = 12.01
PRIMARY
TOTAL
0
1
2
3
4
5
6
7
8
9
10
ELECTRON ENERGY (Mev)
DISPLACEMENT THRESHOLD ENERGY (ev)
15
20
25
30

Figure 18

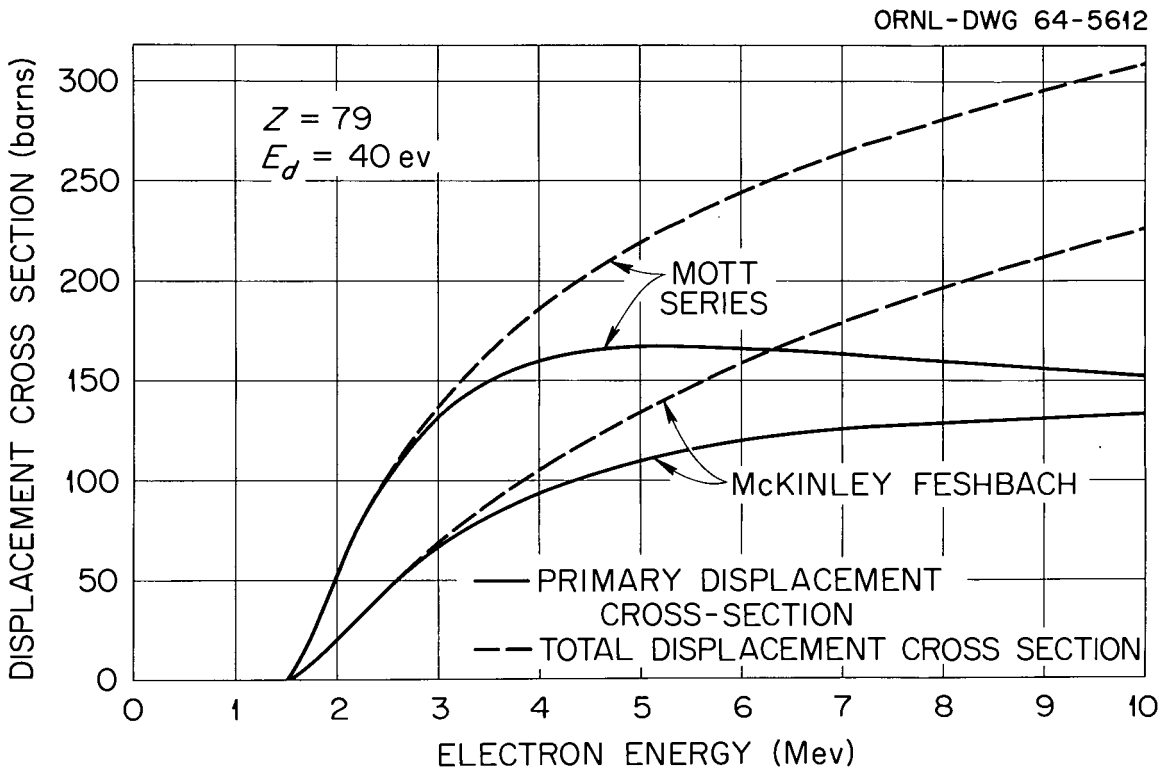

Figure 19 Comparison of the Displacement Cross Sections Computed from the Mott Series and the McKinley-Feshbach Formula for Gold vs Electron Energy.

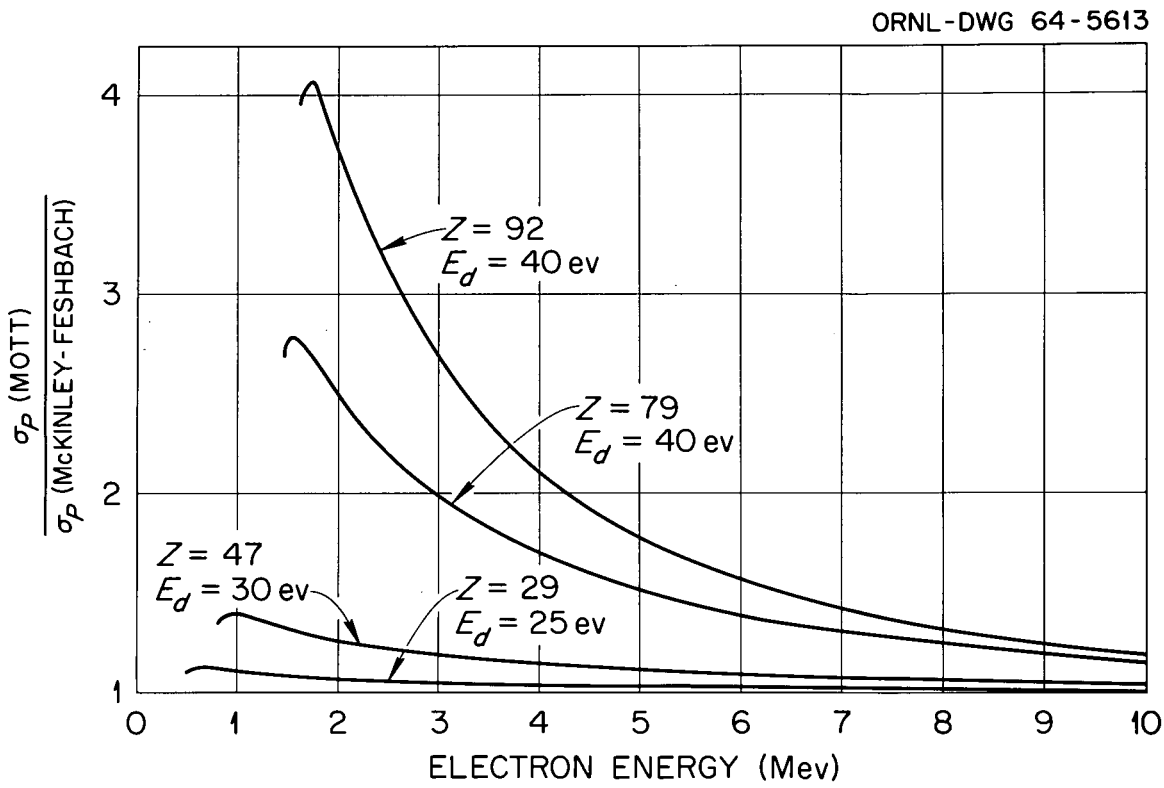

Figure 20 Ratio of the Primary Displacement Cross Section Computed from the Mott Series to that of the McKinley-Feshbach Formula for Uranium, Gold, Silver, and Copper vs Electron Energy.

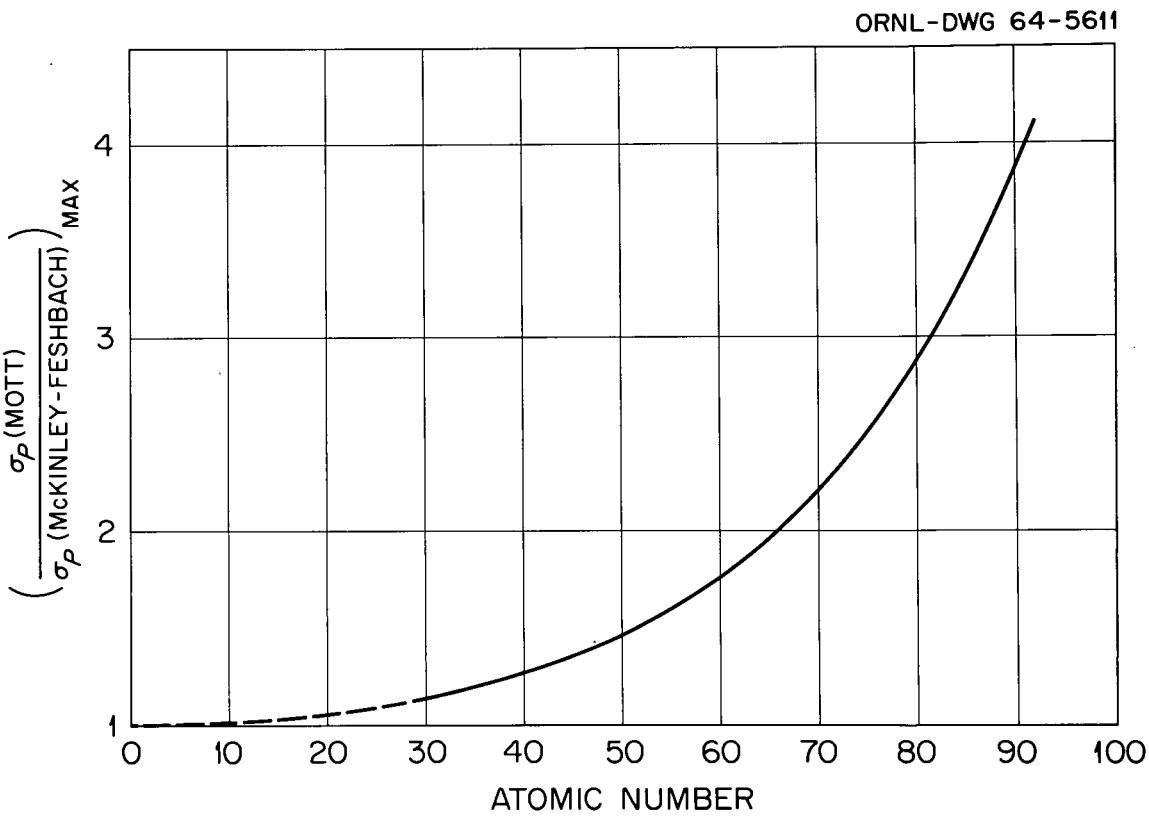

Figure 21 A Plot of the Maximum in the Ratio of the Primary Displacement Computed by the Mott Series to that of the McKinley-Feshbach Formula.

Table 1

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 92			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0467	1.0466	1.0460	1.0445	1.0408	1.0344
15.0	1.0949	1.0947	1.0930	1.0886	1.0774	1.0571
22.5	1.1856	1.1851	1.1820	1.1735	1.1517	1.1093
30.0	1.3212	1.3205	1.3158	1.3029	1.2694	1.2023
37.5	1.4995	1.4985	1.4924	1.4754	1.4308	1.3394
45.0	1.7043	1.7031	1.6956	1.6750	1.6206	1.5075
52.5	1.9169	1.9155	1.9071	1.8837	1.8219	1.6917
60.0	2.1202	2.1187	2.1098	2.0850	2.0189	1.8783
67.5	2.2938	2.2923	2.2834	2.2587	2.1925	2.0494
75.0	2.4189	2.4176	2.4094	2.3867	2.3252	2.1895
82.5	2.4844	2.4833	2.4767	2.4580	2.4065	2.2890
90.0	2.4823	2.4816	2.4772	2.4646	2.4287	2.3406
97.5	2.4069	2.4067	2.4053	2.4012	2.3866	2.3395
105.0	2.2607	2.2611	2.2636	2.2698	2.2819	2.2868
112.5	2.0527	2.0538	2.0607	2.0790	2.1221	2.1878
120.0	1.7935	1.7955	1.8072	1.8388	1.9163	2.0498
127.5	1.4978	1.5007	1.5176	1.5633	1.6773	1.8831
135.0	1.1859	1.1896	1.2116	1.2716	1.4222	1.7010
142.5	.8778	.8823	.9093	.9828	1.1684	1.5167
150.0	.5915	.5968	.6283	.7141	.9315	1.3434
157.5	.3462	.3521	.3874	.4836	.7280	1.1937
165.0	.1600	.1663	.2044	.3084	.5729	1.0787
172.5	.0433	.0500	.0898	.1986	.4756	1.0063
180.0	.0024	.0091	.0497	.1602	.4417	.9814

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 87			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0486	1.0485	1.0479	1.0461	1.0419	1.0342
15.0	1.1083	1.1080	1.1063	1.1016	1.0897	1.0669
22.5	1.2093	1.2088	1.2058	1.1975	1.1760	1.1330
30.0	1.3461	1.3454	1.3411	1.3292	1.2981	1.2343
37.5	1.5118	1.5109	1.5055	1.4905	1.4510	1.3686
45.0	1.6908	1.6898	1.6835	1.6660	1.6196	1.5218
52.5	1.8663	1.8652	1.8583	1.8392	1.7884	1.6800
60.0	2.0242	2.0231	2.0161	1.9966	1.9444	1.8315
67.5	2.1490	2.1479	2.1413	2.1228	2.0727	1.9625
75.0	2.2271	2.2262	2.2204	2.2044	2.1605	2.0612
82.5	2.2514	2.2507	2.2465	2.2346	2.2011	2.1214
90.0	2.2176	2.2172	2.2152	2.2091	2.1905	2.1393
97.5	2.1232	2.1233	2.1240	2.1254	2.1261	2.1123
105.0	1.9721	1.9727	1.9767	1.9872	2.0109	2.0427
112.5	1.7733	1.7746	1.7823	1.8029	1.8530	1.9367
120.0	1.5364	1.5383	1.5501	1.5818	1.6605	1.8010
127.5	1.2738	1.2764	1.2924	1.3357	1.4443	1.6443
135.0	1.0023	1.0057	1.0258	1.0806	1.2189	1.4782
142.5	.7383	.7423	.7664	.8320	.9984	1.3138
150.0	.4955	.5001	.5277	.6831	.7949	1.1612
157.5	.2890	.2941	.3248	.4884	.6214	1.0305
165.0	.1334	.1388	.1717	.2615	.4904	.9312
172.5	.0363	.0420	.0762	.1698	.4085	.8691
180.0	.0021	.0078	.0426	.1375	.3799	.8476

Table 2

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 82			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0513	1.0511	1.0505	1.0486	1.0439	1.0352
15.0	1.1200	1.1197	1.1180	1.1133	1.1012	1.0774
22.5	1.2258	1.2253	1.2225	1.2147	1.1943	1.1528
30.0	1.3578	1.3572	1.3533	1.3427	1.3147	1.2564
37.5	1.5070	1.5062	1.5016	1.4887	1.4546	1.3824
45.0	1.6592	1.6583	1.6531	1.6387	1.6001	1.5177
52.5	1.8001	1.7992	1.7937	1.7785	1.7378	1.6497
60.0	1.9185	1.9176	1.9123	1.8974	1.8572	1.7690
67.5	2.0028	2.0020	1.9973	1.9839	1.9473	1.8652
75.0	2.0436	2.0430	2.0393	2.0286	1.9990	1.9296
82.5	2.0368	2.0365	2.0342	2.0276	2.0084	1.9589
90.0	1.9807	1.9807	1.9804	1.9792	1.9738	1.9512
97.5	1.8750	1.8753	1.8775	1.8830	1.8947	1.9058
105.0	1.7241	1.7249	1.7299	1.7432	1.7750	1.8256
112.5	1.5366	1.5380	1.5461	1.5680	1.6221	1.7170
120.0	1.3211	1.3230	1.3345	1.3657	1.4437	1.5861
127.5	1.0881	1.0906	1.1055	1.1462	1.2487	1.4403
135.0	.8514	.8544	.8728	.9228	1.0494	1.2894
142.5	.6242	.6278	.6494	.7081	.8574	1.1429
150.0	.4174	.4214	.4458	.5124	.6821	1.0084
157.5	.2428	.2472	.2740	.3471	.5337	.8942
165.0	.1118	.1166	.1451	.2231	.4223	.8082
172.5	.0305	.0354	.0650	.1460	.3531	.7546
180.0	.0018	.0068	.0368	.1189	.3288	.7360

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 79			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0530	1.0529	1.0522	1.0503	1.0455	1.0363
15.0	1.1257	1.1255	1.1238	1.1192	1.1073	1.0834
22.5	1.2321	1.2316	1.2290	1.2216	1.2022	1.1623
30.0	1.3592	1.3586	1.3550	1.3452	1.3193	1.2648
37.5	1.4974	1.4967	1.4925	1.4809	1.4500	1.3842
45.0	1.6337	1.6330	1.6284	1.6156	1.5815	1.5079
52.5	1.7554	1.7547	1.7499	1.7368	1.7016	1.6247
60.0	1.8528	1.8521	1.8476	1.8352	1.8014	1.7264
67.5	1.9166	1.9159	1.9121	1.9013	1.8718	1.8042
75.0	1.9391	1.9386	1.9358	1.9279	1.9054	1.8513
82.5	1.9176	1.9174	1.9160	1.9121	1.8998	1.8653
90.0	1.8517	1.8518	1.8523	1.8535	1.8544	1.8456
97.5	1.7418	1.7423	1.7451	1.7525	1.7693	1.7919
105.0	1.5927	1.5936	1.5990	1.6135	1.6487	1.7078
112.5	1.4125	1.4139	1.4222	1.4445	1.5000	1.5992
120.0	1.2092	1.2111	1.2224	1.2530	1.3299	1.4720
127.5	.9923	.9947	1.0090	1.0481	1.1469	1.3328
135.0	.7740	.7769	.7942	.8416	.9617	1.1906
142.5	.5660	.5694	.5895	.6446	.7848	1.0538
150.0	.3777	.3814	.4041	.4660	.6241	.9290
157.5	.2193	.2234	.2482	.3158	.4887	.8236
165.0	.1009	.1053	.1316	.2035	.3875	.7445
172.5	.0275	.0320	.0593	.1338	.3246	.6954
180.0	.0016	.0062	.0338	.1093	.3026	.6784

Table 3

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 74			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0558	1.0557	1.0550	1.0531	1.0481	1.0385
15.0	1.1328	1.1326	1.1310	1.1267	1.1154	1.0923
22.5	1.2369	1.2365	1.2341	1.2275	1.2101	1.1736
30.0	1.3533	1.3528	1.3497	1.3413	1.3189	1.2714
37.5	1.4724	1.4718	1.4684	1.4587	1.4330	1.3777
45.0	1.5834	1.5828	1.5791	1.5690	1.5416	1.4820
52.5	1.6760	1.6754	1.6719	1.6619	1.6348	1.5748
60.0	1.7429	1.7424	1.7392	1.7302	1.7056	1.6500
67.5	1.7776	1.7771	1.7747	1.7676	1.7479	1.7013
75.0	1.7752	1.7750	1.7735	1.7693	1.7568	1.7240
82.5	1.7348	1.7347	1.7347	1.7343	1.7315	1.7175
90.0	1.6570	1.6573	1.6590	1.6632	1.6724	1.6821
97.5	1.5437	1.5443	1.5480	1.5577	1.5811	1.6187
105.0	1.3995	1.4005	1.4064	1.4223	1.4616	1.5308
112.5	1.2317	1.2331	1.2414	1.2640	1.3205	1.4241
120.0	1.0474	1.0492	1.0601	1.0896	1.1641	1.3038
127.5	.8546	.8568	.8702	.9068	.9994	1.1754
135.0	.6634	.6660	.6819	.7252	.8354	1.0468
142.5	.4831	.4861	.5043	.5539	.6805	.9247
150.0	.3213	.3247	.3449	.4001	.5411	.8145
157.5	.1862	.1898	.2117	.2715	.4245	.7220
165.0	.0855	.0894	.1125	.1757	.3377	.6531
172.5	.0233	.0273	.0512	.1165	.2840	.6104
180.0	.0014	.0055	.0296	.0957	.2651	.5956

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 67			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0587	1.0586	1.0580	1.0561	1.0514	1.0418
15.0	1.1371	1.1368	1.1355	1.1317	1.1217	1.1009
22.5	1.2327	1.2323	1.2304	1.2250	1.2106	1.1800
30.0	1.3310	1.3306	1.3282	1.3217	1.3042	1.2664
37.5	1.4235	1.4231	1.4205	1.4134	1.3943	1.3525
45.0	1.5024	1.5019	1.4994	1.4923	1.4731	1.4306
52.5	1.5604	1.5601	1.5578	1.5513	1.5337	1.4937
60.0	1.5930	1.5927	1.5909	1.5858	1.5716	1.5379
67.5	1.5965	1.5964	1.5953	1.5923	1.5833	1.5597
75.0	1.5690	1.5690	1.5690	1.5687	1.5668	1.5568
82.5	1.5109	1.5111	1.5123	1.5155	1.5224	1.5297
90.0	1.4239	1.4243	1.4270	1.4343	1.4517	1.4798
97.5	1.3106	1.3114	1.3158	1.3277	1.3570	1.4088
105.0	1.1756	1.1766	1.1829	1.1998	1.2423	1.3201
112.5	1.0248	1.0262	1.0344	1.0567	1.1130	1.2185
120.0	.8642	.8659	.8761	.9039	.9745	1.1085
127.5	.7001	.7021	.7143	.7476	.8323	.9947
135.0	.5401	.5424	.5566	.5951	.6934	.8829
142.5	.3912	.3939	.4097	.4531	.5639	.7786
150.0	.2592	.2621	.2795	.3270	.4488	.6855
157.5	.1498	.1529	.1716	.2226	.3533	.6081
165.0	.0686	.0719	.0915	.1451	.2826	.5508
172.5	.0186	.0220	.0421	.0974	.2389	.5155
180.0	.0012	.0046	.0250	.0807	.2237	.5032

Table 4

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 62			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0597	1.0596	1.0590	1.0573	1.0529	1.0438
15.0	1.1360	1.1358	1.1346	1.1312	1.1224	1.1038
22.5	1.2230	1.2228	1.2211	1.2165	1.2043	1.1781
30.0	1.3075	1.3072	1.3052	1.2999	1.2855	1.2544
37.5	1.3820	1.3816	1.3796	1.3741	1.3590	1.3260
45.0	1.4407	1.4403	1.4385	1.4332	1.4189	1.3867
52.5	1.4783	1.4780	1.4765	1.4721	1.4600	1.4317
60.0	1.4915	1.4913	1.4903	1.4875	1.4791	1.4579
67.5	1.4784	1.4784	1.4782	1.4773	1.4743	1.4633
75.0	1.4383	1.4385	1.4392	1.4410	1.4447	1.4470
82.5	1.3722	1.3725	1.3744	1.3794	1.3914	1.4098
90.0	1.2822	1.2828	1.2860	1.2948	1.3162	1.3535
97.5	1.1713	1.1721	1.1768	1.1897	1.2218	1.2801
105.0	1.0435	1.0446	1.0509	1.0682	1.1118	1.1929
112.5	.9041	.9055	.9135	.9354	.9910	1.0960
120.0	.7583	.7599	.7697	.7963	.8641	.9935
127.5	.6115	.6134	.6249	.6562	.7359	.8892
135.0	.4699	.4721	.4852	.5209	.6119	.7881
142.5	.3393	.3417	.3562	.3959	.4974	.6945
150.0	.2242	.2268	.2426	.2858	.3964	.6118
157.5	.1294	.1322	.1490	.1951	.3131	.5434
165.0	.0592	.0621	.0797	.1279	.2515	.4929
172.5	.0160	.0190	.0371	.0866	.2136	.4618
180.0	.0011	.0041	.0224	.0724	.2005	.4511

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 57			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0596	1.0595	1.0590	1.0574	1.0534	1.0450
15.0	1.1317	1.1315	1.1305	1.1276	1.1200	1.1037
22.5	1.2089	1.2087	1.2073	1.2035	1.1933	1.1714
30.0	1.2794	1.2792	1.2776	1.2734	1.2619	1.2369
37.5	1.3372	1.3370	1.3355	1.3312	1.3198	1.2943
45.0	1.3782	1.3780	1.3766	1.3730	1.3628	1.3395
52.5	1.3985	1.3984	1.3974	1.3948	1.3872	1.3687
60.0	1.3961	1.3960	1.3957	1.3946	1.3909	1.3800
67.5	1.3702	1.3702	1.3706	1.3715	1.3732	1.3724
75.0	1.3209	1.3211	1.3224	1.3259	1.3340	1.3459
82.5	1.2496	1.2500	1.2524	1.2588	1.2746	1.3015
90.0	1.1587	1.1593	1.1630	1.1728	1.1972	1.2413
97.5	1.0512	1.0520	1.0570	1.0705	1.1044	1.1674
105.0	.9308	.9319	.9383	.9557	.9997	1.0827
112.5	.8020	.8033	.8112	.8327	.8871	.9909
120.0	.6694	.6709	.6803	.7058	.7708	.8956
127.5	.5376	.5394	.5502	.5797	.6549	.8001
135.0	.4117	.4137	.4259	.4591	.5440	.7085
142.5	.2962	.2985	.3119	.3485	.4423	.6244
150.0	.1953	.1977	.2122	.2518	.3532	.5506
157.5	.1126	.1151	.1305	.1725	.2801	.4899
165.0	.0514	.0541	.0701	.1139	.2261	.4452
172.5	.0138	.0166	.0330	.0779	.1929	.4177
180.0	.0010	.0037	.0203	.0655	.1815	.4083

Table 5

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 52			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0582	1.0581	1.0577	1.0563	1.0527	1.0452
15.0	1.1246	1.1244	1.1236	1.1211	1.1147	1.1009
22.5	1.1912	1.1910	1.1899	1.1869	1.1786	1.1607
30.0	1.2482	1.2480	1.2468	1.2436	1.2347	1.2150
37.5	1.2909	1.2907	1.2896	1.2865	1.2782	1.2593
45.0	1.3164	1.3163	1.3154	1.3131	1.3064	1.2906
52.5	1.3223	1.3223	1.3219	1.3206	1.3168	1.3064
60.0	1.3074	1.3074	1.3076	1.3079	1.3082	1.3055
67.5	1.2716	1.2717	1.2726	1.2750	1.2804	1.2870
75.0	1.2158	1.2161	1.2178	1.2226	1.2342	1.2536
82.5	1.1415	1.1420	1.1447	1.1523	1.1710	1.2045
90.0	1.0512	1.0518	1.0557	1.0663	1.0930	1.1421
97.5	.9477	.9485	.9537	.9676	1.0028	1.0689
105.0	.8345	.8356	.8420	.8594	.9036	.9874
112.5	.7154	.7167	.7244	.7454	.7988	.9009
120.0	.5945	.5960	.6050	.6295	.6921	.8124
127.5	.4757	.4774	.4876	.5156	.5870	.7250
135.0	.3631	.3650	.3764	.4076	.4873	.6418
142.5	.2605	.2626	.2751	.3092	.3965	.5660
150.0	.1714	.1736	.1870	.2236	.3174	.4999
157.5	.0987	.1010	.1152	.1538	.2529	.4459
165.0	.0450	.0475	.0621	.1023	.2053	.4061
172.5	.0121	.0146	.0296	.0707	.1761	.3817
180.0	.0009	.0034	.0186	.0600	.1661	.3733

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 47			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0556	1.0555	1.0551	1.0540	1.0509	1.0443
15.0	1.1150	1.1149	1.1142	1.1122	1.1069	1.0954
22.5	1.1709	1.1707	1.1699	1.1674	1.1609	1.1466
30.0	1.2151	1.2149	1.2141	1.2116	1.2049	1.1901
37.5	1.2442	1.2441	1.2433	1.2413	1.2356	1.2224
45.0	1.2565	1.2564	1.2560	1.2547	1.2510	1.2416
52.5	1.2505	1.2505	1.2505	1.2504	1.2498	1.2461
60.0	1.2256	1.2257	1.2263	1.2278	1.2312	1.2354
67.5	1.1824	1.1826	1.1839	1.1874	1.1958	1.2098
75.0	1.1221	1.1224	1.1246	1.1304	1.1447	1.1702
82.5	1.0464	1.0469	1.0500	1.0584	1.0793	1.1179
90.0	.9576	.9583	.9624	.9736	1.0019	1.0548
97.5	.8585	.8594	.8646	.8788	.9149	.9831
105.0	.7522	.7532	.7596	.7770	.8211	.9053
112.5	.6420	.6432	.6508	.6713	.7236	.8240
120.0	.5313	.5328	.5414	.5651	.6255	.7419
127.5	.4237	.4253	.4351	.4618	.5299	.6616
135.0	.3225	.3243	.3351	.3646	.4399	.5860
142.5	.2308	.2327	.2445	.2765	.3584	.5174
150.0	.1515	.1536	.1661	.2003	.2878	.4580
157.5	.0872	.0894	.1025	.1385	.2305	.4097
165.0	.0397	.0420	.0556	.0929	.1882	.3741
172.5	.0106	.0130	.0269	.0649	.1624	.3523
180.0	.0008	.0032	.0172	.0555	.1536	.3449

Table 6

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 42			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0518	1.0518	1.0514	1.0504	1.0478	1.0423
15.0	1.1035	1.1034	1.1028	1.1012	1.0969	1.0876
22.5	1.1486	1.1485	1.1479	1.1460	1.1410	1.1300
30.0	1.1810	1.1809	1.1803	1.1786	1.1738	1.1632
37.5	1.1981	1.1980	1.1976	1.1964	1.1930	1.1846
45.0	1.1991	1.1991	1.1990	1.1987	1.1975	1.1934
52.5	1.1834	1.1834	1.1838	1.1847	1.1867	1.1886
60.0	1.1507	1.1508	1.1518	1.1543	1.1603	1.1701
67.5	1.1020	1.1023	1.1039	1.1083	1.1192	1.1386
75.0	1.0388	1.0392	1.0417	1.0483	1.0648	1.0951
82.5	.9628	.9634	.9667	.9757	.9985	1.0410
90.0	.8762	.8769	.8812	.8929	.9224	.9782
97.5	.7816	.7825	.7878	.8022	.8389	.9086
105.0	.6817	.6828	.6891	.7064	.7504	.8346
112.5	.5795	.5807	.5881	.6083	.6596	.7583
120.0	.4779	.4793	.4877	.5107	.5692	.6821
127.5	.3799	.3815	.3909	.4165	.4819	.6084
135.0	.2884	.2901	.3004	.3285	.4003	.5394
142.5	.2059	.2078	.2189	.2492	.3268	.4772
150.0	.1350	.1370	.1488	.1810	.2634	.4235
157.5	.0776	.0796	.0920	.1258	.2121	.3801
165.0	.0353	.0374	.0502	.0851	.1744	.3481
172.5	.0095	.0116	.0246	.0602	.1513	.3286
180.0	.0008	.0030	.0161	.0519	.1435	.3219

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 37			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0470	1.0470	1.0467	1.0459	1.0437	1.0392
15.0	1.0904	1.0904	1.0899	1.0887	1.0853	1.0780
22.5	1.1253	1.1252	1.1247	1.1233	1.1197	1.1115
30.0	1.1468	1.1467	1.1463	1.1452	1.1422	1.1351
37.5	1.1534	1.1534	1.1532	1.1528	1.1513	1.1470
45.0	1.1450	1.1450	1.1452	1.1457	1.1466	1.1469
52.5	1.1212	1.1213	1.1220	1.1237	1.1279	1.1345
60.0	1.0825	1.0827	1.0839	1.0872	1.0955	1.1099
67.5	1.0299	1.0302	1.0321	1.0373	1.0503	1.0739
75.0	.9650	.9655	.9681	.9754	.9938	1.0279
82.5	.8895	.8901	.8936	.9032	.9274	.9731
90.0	.8054	.8061	.8106	.8226	.8532	.9112
97.5	.7152	.7161	.7215	.7361	.7732	.8442
105.0	.6213	.6224	.6287	.6459	.6897	.7739
112.5	.5262	.5274	.5347	.5545	.6051	.7023
120.0	.4326	.4340	.4422	.4645	.5216	.6316
127.5	.3430	.3445	.3536	.3783	.4415	.5638
135.0	.2597	.2614	.2713	.2983	.3672	.5006
142.5	.1851	.1869	.1975	.2264	.3005	.4439
150.0	.1212	.1230	.1342	.1649	.2433	.3953
157.5	.0696	.0715	.0832	.1153	.1971	.3560
165.0	.0317	.0337	.0457	.0788	.1632	.3272
172.5	.0085	.0105	.0228	.0565	.1425	.3096
180.0	.0007	.0028	.0152	.0490	.1355	.3036

Table 7

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 32			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0413	1.0413	1.0410	1.0404	1.0387	1.0350
15.0	1.0763	1.0762	1.0759	1.0749	1.0724	1.0669
22.5	1.1013	1.1013	1.1010	1.1000	1.0975	1.0919
30.0	1.1131	1.1130	1.1129	1.1123	1.1107	1.1067
37.5	1.1106	1.1106	1.1107	1.1109	1.1110	1.1103
45.0	1.0942	1.0943	1.0947	1.0959	1.0986	1.1028
52.5	1.0641	1.0642	1.0651	1.0676	1.0736	1.0842
60.0	1.0207	1.0209	1.0224	1.0265	1.0365	1.0548
67.5	.9654	.9657	.9679	.9737	.9884	1.0157
75.0	.8997	.9001	.9030	.9109	.9308	.9682
82.5	.8252	.8258	.8295	.8396	.8650	.9134
90.0	.7439	.7446	.7491	.7615	.7929	.8529
97.5	.6579	.6588	.6642	.6790	.7165	.7885
105.0	.5695	.5705	.5768	.5940	.6378	.7218
112.5	.4808	.4820	.4891	.5087	.5586	.6548
120.0	.3941	.3954	.4035	.4254	.4812	.5890
127.5	.3117	.3132	.3220	.3461	.4076	.5264
135.0	.2356	.2372	.2467	.2728	.3395	.4684
142.5	.1676	.1693	.1795	.2074	.2786	.4166
150.0	.1095	.1113	.1221	.1515	.2267	.3723
157.5	.0629	.0647	.0759	.1066	.1848	.3366
165.0	.0286	.0305	.0421	.0736	.1542	.3105
172.5	.0077	.0096	.0214	.0534	.1354	.2945
180.0	.0007	.0027	.0145	.0467	.1292	.2891

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 29			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0375	1.0375	1.0373	1.0367	1.0353	1.0321
15.0	1.0674	1.0674	1.0671	1.0663	1.0643	1.0597
22.5	1.0869	1.0869	1.0867	1.0860	1.0841	1.0799
30.0	1.0933	1.0933	1.0932	1.0930	1.0922	1.0898
37.5	1.0860	1.0861	1.0863	1.0867	1.0878	1.0890
45.0	1.0655	1.0656	1.0662	1.0677	1.0714	1.0776
52.5	1.0321	1.0323	1.0334	1.0362	1.0432	1.0559
60.0	.9865	.9868	.9884	.9928	1.0039	1.0243
67.5	.9300	.9304	.9327	.9389	.9545	.9838
75.0	.8642	.8647	.8677	.8758	.8965	.9356
82.5	.7905	.7911	.7949	.8052	.8313	.8811
90.0	.7108	.7116	.7162	.7288	.7606	.8216
97.5	.6273	.6282	.6337	.6485	.6863	.7588
105.0	.5419	.5430	.5493	.5664	.6102	.6943
112.5	.4567	.4579	.4650	.4845	.5341	.6298
120.0	.3738	.3751	.3831	.4048	.4601	.5668
127.5	.2953	.2967	.3054	.3292	.3898	.5070
135.0	.2229	.2245	.2339	.2595	.3251	.4518
142.5	.1584	.1601	.1701	.1975	.2674	.4026
150.0	.1035	.1052	.1158	.1446	.2182	.3607
157.5	.0594	.0612	.0721	.1021	.1786	.3269
165.0	.0270	.0289	.0402	.0710	.1496	.3022
172.5	.0073	.0092	.0206	.0520	.1320	.2871
180.0	.0007	.0026	.0141	.0456	.1261	.2821

Table 8

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 24			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0308	1.0307	1.0306	1.0302	1.0291	1.0267
15.0	1.0524	1.0523	1.0522	1.0517	1.0503	1.0472
22.5	1.0632	1.0631	1.0630	1.0627	1.0618	1.0596
30.0	1.0614	1.0614	1.0615	1.0617	1.0621	1.0623
37.5	1.0470	1.0471	1.0475	1.0485	1.0509	1.0549
45.0	1.0206	1.0207	1.0215	1.0236	1.0287	1.0380
52.5	.9827	.9829	.9842	.9876	.9961	1.0119
60.0	.9342	.9345	.9363	.9413	.9538	.9773
67.5	.8763	.8767	.8792	.8859	.9029	.9351
75.0	.8106	.8111	.8143	.8229	.8448	.8866
82.5	.7384	.7391	.7430	.7537	.7809	.8328
90.0	.6616	.6623	.6671	.6799	.7125	.7751
97.5	.5819	.5828	.5883	.6033	.6415	.7150
105.0	.5012	.5022	.5085	.5257	.5696	.6540
112.5	.4213	.4224	.4295	.4489	.4982	.5933
120.0	.3440	.3453	.3531	.3746	.4292	.5346
127.5	.2712	.2726	.2811	.3045	.3640	.4791
135.0	.2044	.2059	.2151	.2402	.3043	.4282
142.5	.1450	.1467	.1564	.1831	.2512	.3829
150.0	.0946	.0963	.1066	.1346	.2061	.3444
157.5	.0542	.0560	.0667	.0957	.1699	.3135
165.0	.0247	.0265	.0374	.0672	.1434	.2909
172.5	.0067	.0085	.0196	.0499	.1273	.2772
180.0	.0007	.0025	.0137	.0441	.1219	.2726

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 19			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0236	1.0236	1.0235	1.0232	1.0224	1.0208
15.0	1.0372	1.0372	1.0371	1.0368	1.0360	1.0343
22.5	1.0400	1.0400	1.0400	1.0400	1.0400	1.0396
30.0	1.0311	1.0311	1.0314	1.0320	1.0334	1.0358
37.5	1.0106	1.0107	1.0112	1.0127	1.0163	1.0229
45.0	.9793	.9795	.9804	.9830	.9895	1.0014
52.5	.9379	.9381	.9396	.9435	.9534	.9720
60.0	.8872	.8876	.8896	.8951	.9089	.9351
67.5	.8286	.8290	.8317	.8389	.8571	.8919
75.0	.7633	.7639	.7672	.7763	.7993	.8434
82.5	.6928	.6935	.6976	.7086	.7367	.7907
90.0	.6187	.6195	.6243	.6374	.6708	.7349
97.5	.5425	.5435	.5490	.5642	.6030	.6775
105.0	.4661	.4671	.4735	.4907	.5348	.6196
112.5	.3908	.3920	.3991	.4184	.4676	.5626
120.0	.3185	.3198	.3276	.3488	.4030	.5076
127.5	.2506	.2520	.2605	.2835	.3424	.4560
135.0	.1886	.1901	.1992	.2239	.2869	.4088
142.5	.1337	.1353	.1449	.1710	.2378	.3670
150.0	.0872	.0888	.0989	.1263	.1962	.3315
157.5	.0499	.0517	.0621	.0904	.1629	.3031
165.0	.0227	.0245	.0352	.0643	.1386	.2824
172.5	.0062	.0080	.0188	.0483	.1238	.2698
180.0	.0006	.0025	.0133	.0430	.1188	.2655

Table 9

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 13			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0147	1.0147	1.0147	1.0145	1.0141	1.0132
15.0	1.0192	1.0192	1.0192	1.0192	1.0191	1.0188
22.5	1.0134	1.0135	1.0136	1.0140	1.0149	1.0165
30.0	.9971	.9971	.9975	.9986	1.0012	1.0060
37.5	.9705	.9706	.9713	.9733	.9782	.9875
45.0	.9345	.9346	.9358	.9389	.9468	.9617
52.5	.8898	.8901	.8917	.8962	.9075	.9292
60.0	.8373	.8377	.8399	.8459	.8613	.8905
67.5	.7783	.7788	.7816	.7893	.8090	.8467
75.0	.7139	.7145	.7180	.7276	.7519	.7987
82.5	.6455	.6462	.6504	.6619	.6912	.7474
90.0	.5744	.5753	.5802	.5937	.6279	.6940
97.5	.5022	.5031	.5088	.5243	.5636	.6396
105.0	.4302	.4313	.4377	.4551	.4995	.5853
112.5	.3599	.3611	.3682	.3875	.4369	.5321
120.0	.2927	.2940	.3017	.3229	.3769	.4813
127.5	.2299	.2313	.2397	.2625	.3209	.4337
135.0	.1727	.1742	.1832	.2076	.2699	.3904
142.5	.1223	.1239	.1333	.1591	.2249	.3522
150.0	.0797	.0813	.0912	.1181	.1869	.3198
157.5	.0456	.0473	.0575	.0854	.1565	.2940
165.0	.0208	.0225	.0330	.0615	.1343	.2751
172.5	.0057	.0074	.0180	.0470	.1208	.2637
180.0	.0006	.0024	.0130	.0421	.1163	.2599

RATIO OF MOTT TO RUTHERFORD SCATTERING

ENERGY(MEV)	20	10	4	2	1	.5
ANGLE(DEGREES)			ATOMIC NUMBER = 6			
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7.5	1.0043	1.0043	1.0043	1.0043	1.0043	1.0043
15.0	.9991	.9991	.9992	.9995	1.0001	1.0013
22.5	.9846	.9846	.9849	.9857	.9876	.9913
30.0	.9609	.9610	.9616	.9631	.9670	.9743
37.5	.9286	.9287	.9296	.9322	.9385	.9507
45.0	.8883	.8885	.8899	.8936	.9030	.9211
52.5	.8408	.8412	.8430	.8481	.8611	.8860
60.0	.7871	.7875	.7900	.7966	.8135	.8461
67.5	.7281	.7287	.7317	.7400	.7613	.8021
75.0	.6651	.6657	.6694	.6795	.7053	.7550
82.5	.5990	.5998	.6042	.6161	.6467	.7057
90.0	.5313	.5321	.5372	.5511	.5865	.6549
97.5	.4630	.4640	.4698	.4856	.5259	.6038
105.0	.3956	.3967	.4031	.4208	.4660	.5532
112.5	.3301	.3313	.3385	.3580	.4078	.5041
120.0	.2679	.2692	.2770	.2983	.3525	.4573
127.5	.2101	.2115	.2198	.2427	.3010	.4138
135.0	.1576	.1591	.1680	.1923	.2544	.3744
142.5	.1115	.1130	.1224	.1480	.2134	.3397
150.0	.0725	.0742	.0839	.1106	.1787	.3104
157.5	.0415	.0432	.0533	.0808	.1511	.2871
165.0	.0189	.0206	.0310	.0591	.1310	.2701
172.5	.0052	.0070	.0174	.0460	.1188	.2598
180.0	.0006	.0024	.0129	.0416	.1148	.2563

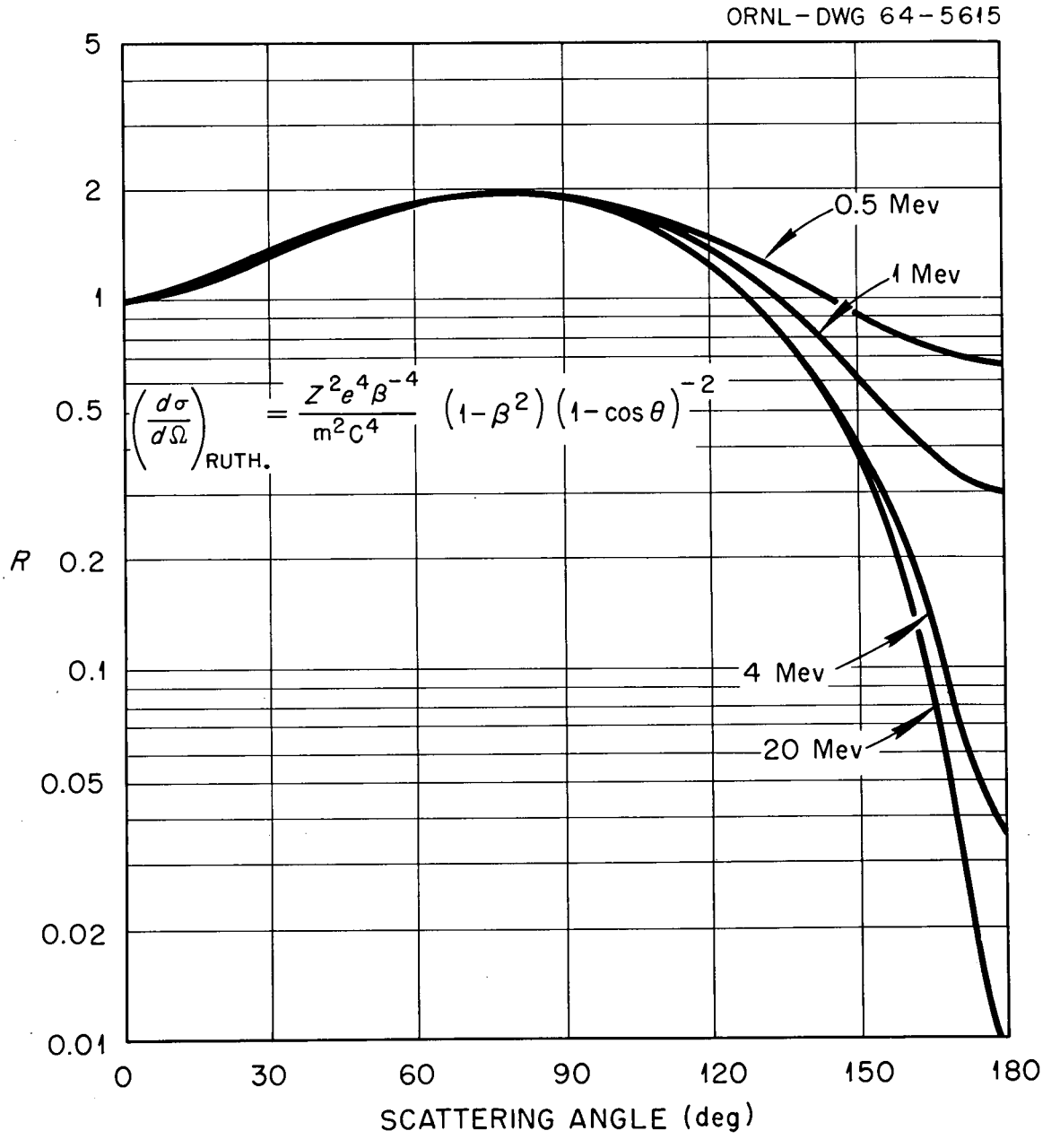

Figure 22 The Ratio of the Mott to Rutherford Scattering for Gold vs Electron Scattering Angle for Several Electron Energies.

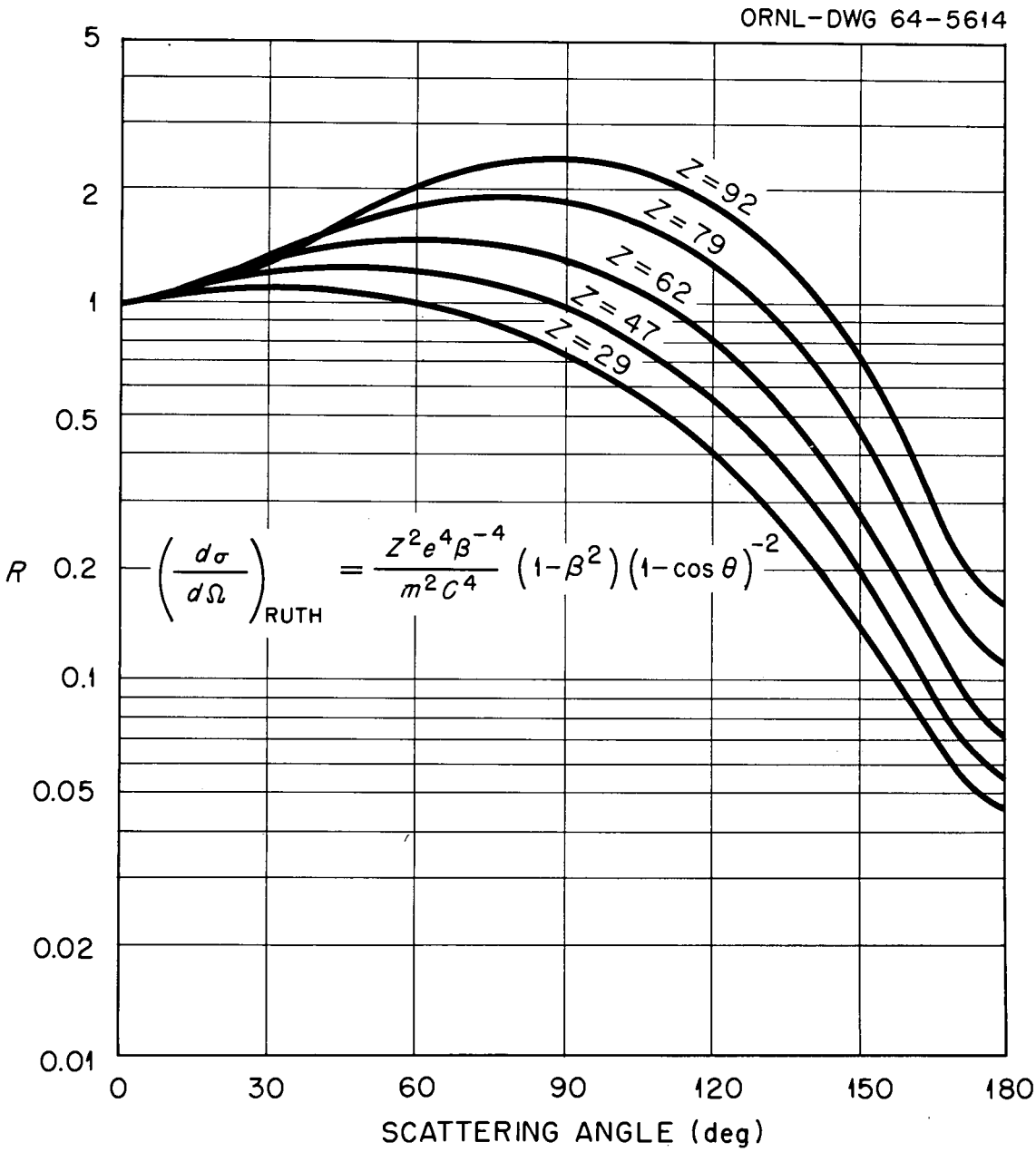

Figure 23 The Ratio of the Mott to Rutherford Scattering vs Electron Scattering Angle for Z = 92, 79, 62, 47, and 29 for 2 MeV Electrons.

Table 10

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 92

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.931	.931	.931	.931	.931	.934
15.0	.896	.896	.895	.894	.890	.885
22.5	.917	.917	.915	.911	.901	.882
30.0	.988	.987	.985	.978	.961	.925
37.5	1.105	1.105	1.101	1.092	1.067	1.015
45.0	1.261	1.260	1.255	1.243	1.210	1.141
52.5	1.447	1.446	1.441	1.425	1.384	1.298
60.0	1.660	1.659	1.652	1.633	1.584	1.480
67.5	1.892	1.891	1.883	1.860	1.802	1.680
75.0	2.137	2.135	2.126	2.100	2.031	1.891
82.5	2.391	2.389	2.378	2.347	2.268	2.109
90.0	2.649	2.647	2.634	2.599	2.508	2.330
97.5	2.905	2.902	2.887	2.847	2.744	2.546
105.0	3.154	3.151	3.134	3.087	2.971	2.756
112.5	3.395	3.392	3.371	3.317	3.187	2.955
120.0	3.622	3.618	3.594	3.531	3.385	3.140
127.5	3.829	3.824	3.796	3.723	3.559	3.307
135.0	4.016	4.010	3.975	3.888	3.707	3.454
142.5	4.183	4.175	4.130	4.024	3.823	3.578
150.0	4.318	4.307	4.247	4.113	3.897	3.678
157.5	4.416	4.399	4.309	4.140	3.925	3.752
165.0	4.502	4.467	4.311	4.098	3.916	3.804
172.5	4.608	4.488	4.172	3.978	3.885	3.833
180.0	3.871	3.871	3.870	3.868	3.862	3.841

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 87

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.938	.938	.938	.938	.938	.938
15.0	.916	.916	.916	.914	.910	.902
22.5	.948	.948	.947	.943	.933	.912
30.0	1.023	1.023	1.021	1.014	.998	.964
37.5	1.135	1.135	1.132	1.123	1.101	1.054
45.0	1.276	1.276	1.272	1.261	1.233	1.173
52.5	1.440	1.439	1.434	1.421	1.387	1.314
60.0	1.621	1.620	1.615	1.599	1.558	1.472
67.5	1.815	1.814	1.807	1.789	1.742	1.642
75.0	2.016	2.015	2.007	1.986	1.931	1.818
82.5	2.221	2.220	2.211	2.187	2.123	1.996
90.0	2.428	2.426	2.416	2.388	2.316	2.174
97.5	2.630	2.628	2.616	2.584	2.502	2.346
105.0	2.828	2.823	2.809	2.772	2.680	2.511
112.5	3.013	3.010	2.994	2.951	2.847	2.666
120.0	3.188	3.185	3.166	3.116	3.000	2.808
127.5	3.347	3.343	3.320	3.261	3.131	2.935
135.0	3.490	3.485	3.456	3.386	3.241	3.044
142.5	3.617	3.611	3.574	3.487	3.325	3.136
150.0	3.720	3.710	3.660	3.550	3.376	3.208
157.5	3.791	3.777	3.701	3.560	3.387	3.259
165.0	3.859	3.829	3.696	3.518	3.373	3.293
172.5	3.961	3.855	3.581	3.417	3.344	3.313
180.0	3.320	3.320	3.320	3.321	3.321	3.318

Table 11

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 82

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.947	.947	.946	.946	.945	.945
15.0	.936	.936	.935	.934	.929	.920
22.5	.975	.975	.973	.970	.960	.940
30.0	1.050	1.049	1.047	1.042	1.027	.990
37.5	1.153	1.153	1.150	1.143	1.124	1.083
45.0	1.279	1.278	1.275	1.266	1.242	1.191
52.5	1.419	1.419	1.415	1.404	1.376	1.315
60.0	1.572	1.572	1.567	1.554	1.521	1.451
67.5	1.733	1.732	1.727	1.712	1.674	1.593
75.0	1.897	1.896	1.890	1.873	1.825	1.738
82.5	2.062	2.061	2.054	2.034	1.984	1.882
90.0	2.227	2.225	2.217	2.194	2.137	2.025
97.5	2.386	2.384	2.375	2.349	2.284	2.161
105.0	2.539	2.537	2.526	2.496	2.423	2.290
112.5	2.684	2.682	2.669	2.634	2.552	2.409
120.0	2.820	2.817	2.801	2.761	2.668	2.518
127.5	2.941	2.938	2.919	2.871	2.767	2.613
135.0	3.050	3.046	3.022	2.965	2.848	2.694
142.5	3.147	3.142	3.111	3.039	2.909	2.761
150.0	3.225	3.217	3.174	3.083	2.941	2.811
157.5	3.277	3.265	3.200	3.083	2.942	2.844
165.0	3.330	3.304	3.190	3.041	2.923	2.867
172.5	3.420	3.327	3.090	2.953	2.896	2.879
180.0	2.867	2.868	2.868	2.870	2.875	2.881

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 79

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.952	.952	.952	.951	.950	.949
15.0	.947	.947	.946	.945	.940	.930
22.5	.989	.988	.987	.984	.974	.955
30.0	1.061	1.061	1.059	1.054	1.041	1.012
37.5	1.159	1.159	1.156	1.150	1.133	1.095
45.0	1.275	1.274	1.272	1.264	1.242	1.197
52.5	1.403	1.402	1.399	1.390	1.364	1.310
60.0	1.540	1.540	1.536	1.525	1.495	1.433
67.5	1.683	1.682	1.678	1.665	1.631	1.561
75.0	1.828	1.827	1.821	1.807	1.768	1.689
82.5	1.972	1.971	1.965	1.948	1.904	1.816
90.0	2.115	2.114	2.107	2.087	2.037	1.940
97.5	2.253	2.252	2.244	2.221	2.164	2.058
105.0	2.385	2.383	2.373	2.347	2.283	2.168
112.5	2.510	2.508	2.496	2.466	2.394	2.271
120.0	2.625	2.623	2.609	2.574	2.492	2.363
127.5	2.729	2.726	2.709	2.667	2.576	2.442
135.0	2.821	2.818	2.797	2.746	2.642	2.510
142.5	2.904	2.899	2.872	2.808	2.692	2.564
150.0	2.970	2.963	2.924	2.842	2.716	2.604
157.5	3.013	3.002	2.943	2.837	2.712	2.629
165.0	3.058	3.035	2.930	2.796	2.692	2.646
172.5	3.139	3.053	2.838	2.715	2.665	2.654
180.0	2.636	2.636	2.637	2.640	2.645	2.655

Table 12

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 74

ENERGY(MEV) ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.960	.960	.960	.960	.958	.956
15.0	.964	.964	.963	.961	.956	.947
22.5	1.007	1.007	1.006	1.003	.994	.977
30.0	1.075	1.075	1.074	1.069	1.058	1.033
37.5	1.162	1.162	1.160	1.155	1.140	1.109
45.0	1.262	1.262	1.260	1.253	1.236	1.198
52.5	1.371	1.370	1.367	1.360	1.339	1.296
60.0	1.484	1.484	1.481	1.472	1.448	1.398
67.5	1.601	1.600	1.597	1.586	1.559	1.503
75.0	1.717	1.717	1.712	1.701	1.670	1.607
82.5	1.833	1.832	1.827	1.813	1.778	1.709
90.0	1.946	1.945	1.939	1.923	1.884	1.807
97.5	2.054	2.053	2.046	2.028	1.983	1.899
105.0	2.156	2.155	2.147	2.126	2.075	1.984
112.5	2.253	2.251	2.242	2.217	2.160	2.063
120.0	2.342	2.340	2.329	2.300	2.234	2.132
127.5	2.421	2.419	2.405	2.370	2.296	2.191
135.0	2.491	2.488	2.471	2.428	2.344	2.239
142.5	2.554	2.550	2.527	2.473	2.378	2.278
150.0	2.604	2.598	2.565	2.496	2.392	2.304
157.5	2.636	2.626	2.576	2.486	2.383	2.319
165.0	2.670	2.650	2.560	2.446	2.361	2.328
172.5	2.732	2.659	2.476	2.375	2.336	2.332
180.0	2.308	2.308	2.309	2.311	2.318	2.331

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 67

ENERGY(MEV) ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.972	.972	.971	.971	.969	.967
15.0	.983	.982	.982	.980	.976	.968
22.5	1.025	1.024	1.024	1.021	1.014	1.000
30.0	1.084	1.084	1.083	1.080	1.071	1.051
37.5	1.156	1.155	1.154	1.150	1.139	1.116
45.0	1.235	1.235	1.233	1.228	1.216	1.188
52.5	1.319	1.318	1.316	1.311	1.296	1.264
60.0	1.405	1.404	1.402	1.395	1.379	1.343
67.5	1.491	1.491	1.488	1.481	1.461	1.421
75.0	1.576	1.576	1.573	1.564	1.542	1.497
82.5	1.659	1.659	1.655	1.645	1.620	1.570
90.0	1.740	1.739	1.735	1.723	1.695	1.640
97.5	1.816	1.815	1.810	1.797	1.764	1.705
105.0	1.888	1.887	1.881	1.865	1.828	1.763
112.5	1.955	1.953	1.946	1.928	1.885	1.816
120.0	2.016	2.014	2.006	1.984	1.935	1.862
127.5	2.070	2.068	2.058	2.031	1.975	1.899
135.0	2.118	2.116	2.102	2.069	2.005	1.929
142.5	2.161	2.158	2.139	2.097	2.024	1.951
150.0	2.194	2.189	2.163	2.108	2.028	1.964
157.5	2.216	2.208	2.167	2.095	2.015	1.969
165.0	2.238	2.221	2.148	2.058	1.994	1.972
172.5	2.275	2.216	2.075	1.998	1.971	1.971
180.0	1.946	1.946	1.947	1.949	1.956	1.970

Table 13

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 62

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.979	.979	.979	.978	.977	.974
15.0	.993	.993	.992	.991	.987	.980
22.5	1.032	1.032	1.031	1.029	1.024	1.012
30.0	1.084	1.084	1.083	1.081	1.074	1.058
37.5	1.145	1.145	1.144	1.141	1.132	1.114
45.0	1.211	1.211	1.210	1.206	1.196	1.174
52.5	1.280	1.280	1.278	1.274	1.262	1.237
60.0	1.349	1.349	1.347	1.342	1.329	1.301
67.5	1.418	1.418	1.416	1.410	1.395	1.364
75.0	1.486	1.485	1.483	1.476	1.459	1.424
82.5	1.551	1.550	1.548	1.540	1.520	1.481
90.0	1.614	1.613	1.610	1.600	1.578	1.535
97.5	1.673	1.672	1.668	1.657	1.631	1.584
105.0	1.728	1.727	1.722	1.710	1.680	1.629
112.5	1.779	1.778	1.772	1.757	1.723	1.668
120.0	1.826	1.824	1.817	1.799	1.760	1.701
127.5	1.867	1.865	1.857	1.835	1.789	1.728
135.0	1.903	1.901	1.890	1.862	1.810	1.748
142.5	1.935	1.932	1.917	1.882	1.821	1.763
150.0	1.960	1.956	1.934	1.887	1.821	1.770
157.5	1.977	1.970	1.935	1.874	1.807	1.771
165.0	1.992	1.978	1.915	1.840	1.786	1.769
172.5	2.015	1.965	1.848	1.787	1.765	1.768
180.0	1.744	1.744	1.745	1.747	1.753	1.766

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 57

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.985	.985	.985	.984	.983	.981
15.0	1.000	1.000	1.000	.999	.996	.990
22.5	1.036	1.036	1.035	1.034	1.029	1.020
30.0	1.081	1.081	1.080	1.078	1.072	1.060
37.5	1.132	1.131	1.131	1.128	1.122	1.107
45.0	1.186	1.186	1.185	1.182	1.174	1.157
52.5	1.241	1.241	1.240	1.236	1.227	1.209
60.0	1.297	1.296	1.295	1.291	1.281	1.259
67.5	1.351	1.351	1.349	1.345	1.333	1.309
75.0	1.404	1.404	1.402	1.396	1.383	1.356
82.5	1.455	1.454	1.452	1.446	1.430	1.400
90.0	1.503	1.503	1.500	1.493	1.475	1.441
97.5	1.548	1.548	1.545	1.536	1.515	1.478
105.0	1.591	1.590	1.586	1.576	1.552	1.512
112.5	1.629	1.629	1.624	1.612	1.584	1.540
120.0	1.665	1.664	1.658	1.643	1.611	1.564
127.5	1.696	1.695	1.687	1.669	1.632	1.583
135.0	1.723	1.722	1.712	1.689	1.646	1.596
142.5	1.747	1.745	1.732	1.702	1.652	1.605
150.0	1.766	1.763	1.743	1.704	1.649	1.608
157.5	1.779	1.773	1.743	1.691	1.635	1.606
165.0	1.789	1.777	1.723	1.660	1.616	1.603
172.5	1.800	1.759	1.663	1.614	1.597	1.600
180.0	1.579	1.580	1.580	1.582	1.587	1.598

Table 14

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 52

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.990	.990	.990	.990	.989	.986
15.0	1.006	1.006	1.005	1.004	1.002	.997
22.5	1.037	1.037	1.036	1.035	1.032	1.024
30.0	1.074	1.074	1.074	1.072	1.068	1.059
37.5	1.116	1.116	1.115	1.113	1.108	1.097
45.0	1.160	1.159	1.159	1.156	1.151	1.138
52.5	1.204	1.204	1.203	1.200	1.193	1.179
60.0	1.247	1.247	1.246	1.243	1.235	1.219
67.5	1.290	1.290	1.288	1.285	1.276	1.257
75.0	1.331	1.331	1.329	1.325	1.314	1.294
82.5	1.370	1.370	1.368	1.363	1.351	1.327
90.0	1.407	1.406	1.404	1.399	1.384	1.358
97.5	1.441	1.441	1.438	1.431	1.415	1.386
105.0	1.473	1.473	1.470	1.461	1.442	1.410
112.5	1.503	1.502	1.498	1.488	1.466	1.431
120.0	1.529	1.528	1.524	1.511	1.485	1.448
127.5	1.553	1.552	1.546	1.530	1.500	1.461
135.0	1.573	1.572	1.564	1.545	1.509	1.469
142.5	1.591	1.589	1.578	1.553	1.512	1.474
150.0	1.605	1.602	1.586	1.553	1.507	1.474
157.5	1.614	1.609	1.584	1.540	1.494	1.471
165.0	1.621	1.611	1.565	1.513	1.477	1.467
172.5	1.623	1.589	1.512	1.473	1.460	1.463
180.0	1.446	1.446	1.447	1.448	1.452	1.461

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 47

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.994	.994	.994	.994	.993	.991
15.0	1.009	1.009	1.009	1.008	1.006	1.002
22.5	1.035	1.035	1.035	1.034	1.031	1.026
30.0	1.066	1.066	1.066	1.064	1.061	1.055
37.5	1.099	1.099	1.099	1.097	1.094	1.086
45.0	1.134	1.134	1.133	1.132	1.127	1.118
52.5	1.168	1.168	1.168	1.166	1.160	1.150
60.0	1.202	1.202	1.201	1.199	1.193	1.181
67.5	1.235	1.235	1.234	1.231	1.224	1.210
75.0	1.266	1.266	1.265	1.261	1.253	1.238
82.5	1.296	1.296	1.294	1.290	1.281	1.263
90.0	1.324	1.323	1.322	1.317	1.306	1.286
97.5	1.350	1.349	1.347	1.342	1.329	1.306
105.0	1.374	1.373	1.371	1.364	1.349	1.324
112.5	1.395	1.395	1.392	1.384	1.366	1.338
120.0	1.415	1.414	1.411	1.401	1.379	1.350
127.5	1.433	1.432	1.427	1.414	1.389	1.358
135.0	1.448	1.447	1.440	1.424	1.395	1.363
142.5	1.461	1.459	1.450	1.429	1.395	1.365
150.0	1.471	1.468	1.455	1.427	1.390	1.363
157.5	1.478	1.474	1.452	1.416	1.379	1.360
165.0	1.483	1.473	1.436	1.392	1.363	1.355
172.5	1.478	1.461	1.389	1.359	1.349	1.352
180.0	1.338	1.338	1.339	1.340	1.343	1.350

Table 15

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 42

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.997	.997	.997	.997	.996	.995
15.0	1.010	1.010	1.010	1.010	1.008	1.006
22.5	1.032	1.032	1.032	1.031	1.029	1.025
30.0	1.057	1.057	1.056	1.055	1.053	1.048
37.5	1.083	1.083	1.082	1.081	1.078	1.073
45.0	1.109	1.109	1.109	1.107	1.104	1.098
52.5	1.136	1.136	1.135	1.134	1.130	1.122
60.0	1.161	1.161	1.161	1.159	1.154	1.145
67.5	1.186	1.186	1.185	1.183	1.178	1.167
75.0	1.209	1.209	1.208	1.206	1.200	1.188
82.5	1.232	1.231	1.230	1.227	1.220	1.206
90.0	1.252	1.252	1.251	1.247	1.238	1.223
97.5	1.271	1.271	1.270	1.265	1.255	1.238
105.0	1.289	1.289	1.287	1.281	1.269	1.250
112.5	1.305	1.305	1.302	1.296	1.281	1.260
120.0	1.320	1.319	1.316	1.308	1.291	1.268
127.5	1.332	1.332	1.328	1.317	1.297	1.273
135.0	1.343	1.342	1.337	1.324	1.301	1.275
142.5	1.353	1.351	1.344	1.327	1.300	1.275
150.0	1.360	1.358	1.347	1.324	1.294	1.273
157.5	1.366	1.362	1.344	1.315	1.284	1.269
165.0	1.368	1.361	1.330	1.295	1.272	1.265
172.5	1.360	1.338	1.290	1.267	1.260	1.262
180.0	1.251	1.251	1.252	1.253	1.255	1.260

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 37

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	.999	.999	.999	.999	.999	.998
15.0	1.010	1.010	1.010	1.010	1.009	1.007
22.5	1.027	1.027	1.027	1.027	1.026	1.023
30.0	1.047	1.047	1.046	1.046	1.044	1.041
37.5	1.066	1.066	1.066	1.065	1.063	1.059
45.0	1.086	1.086	1.086	1.085	1.083	1.078
52.5	1.106	1.106	1.106	1.105	1.102	1.096
60.0	1.125	1.125	1.124	1.123	1.120	1.113
67.5	1.143	1.143	1.142	1.141	1.137	1.129
75.0	1.160	1.160	1.160	1.158	1.153	1.144
82.5	1.177	1.176	1.176	1.173	1.168	1.157
90.0	1.191	1.191	1.190	1.187	1.181	1.169
97.5	1.205	1.205	1.204	1.201	1.193	1.179
105.0	1.218	1.218	1.216	1.212	1.203	1.188
112.5	1.230	1.229	1.227	1.222	1.211	1.195
120.0	1.240	1.240	1.237	1.231	1.217	1.200
127.5	1.249	1.249	1.245	1.237	1.222	1.202
135.0	1.257	1.256	1.252	1.242	1.223	1.203
142.5	1.264	1.262	1.256	1.243	1.221	1.202
150.0	1.269	1.267	1.258	1.240	1.216	1.200
157.5	1.273	1.270	1.256	1.232	1.208	1.196
165.0	1.274	1.268	1.243	1.216	1.198	1.193
172.5	1.265	1.247	1.211	1.194	1.188	1.190
180.0	1.182	1.182	1.182	1.183	1.185	1.188

Table 16

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 32

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	1.001	1.001	1.001	1.001	1.000	1.000
15.0	1.009	1.009	1.009	1.009	1.009	1.007
22.5	1.022	1.022	1.022	1.022	1.021	1.019
30.0	1.037	1.037	1.036	1.036	1.035	1.033
37.5	1.051	1.051	1.051	1.050	1.049	1.046
45.0	1.066	1.065	1.065	1.065	1.063	1.060
52.5	1.080	1.080	1.079	1.079	1.077	1.073
60.0	1.093	1.093	1.093	1.092	1.090	1.085
67.5	1.106	1.106	1.106	1.105	1.102	1.096
75.0	1.119	1.118	1.118	1.116	1.113	1.107
82.5	1.130	1.130	1.129	1.127	1.123	1.116
90.0	1.140	1.140	1.140	1.137	1.132	1.124
97.5	1.150	1.150	1.149	1.147	1.141	1.131
105.0	1.159	1.159	1.158	1.155	1.147	1.136
112.5	1.167	1.167	1.165	1.162	1.153	1.141
120.0	1.174	1.174	1.172	1.167	1.157	1.144
127.5	1.181	1.180	1.178	1.172	1.160	1.145
135.0	1.186	1.186	1.182	1.174	1.160	1.145
142.5	1.191	1.190	1.185	1.175	1.158	1.144
150.0	1.194	1.193	1.186	1.172	1.154	1.141
157.5	1.198	1.195	1.184	1.166	1.147	1.138
165.0	1.198	1.193	1.174	1.153	1.139	1.135
172.5	1.188	1.175	1.148	1.136	1.132	1.133
180.0	1.128	1.128	1.128	1.128	1.129	1.132

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 29

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	1.001	1.001	1.001	1.001	1.001	1.000
15.0	1.009	1.009	1.008	1.008	1.008	1.007
22.5	1.019	1.019	1.019	1.019	1.018	1.017
30.0	1.031	1.031	1.031	1.030	1.030	1.028
37.5	1.043	1.042	1.042	1.042	1.041	1.039
45.0	1.054	1.054	1.054	1.054	1.052	1.050
52.5	1.066	1.066	1.065	1.065	1.063	1.060
60.0	1.077	1.077	1.076	1.076	1.074	1.070
67.5	1.087	1.087	1.087	1.086	1.083	1.079
75.0	1.097	1.097	1.096	1.095	1.092	1.087
82.5	1.106	1.106	1.105	1.104	1.100	1.094
90.0	1.114	1.114	1.113	1.112	1.108	1.101
97.5	1.122	1.122	1.121	1.119	1.114	1.106
105.0	1.129	1.129	1.128	1.125	1.119	1.110
112.5	1.135	1.135	1.134	1.131	1.124	1.113
120.0	1.141	1.141	1.139	1.135	1.127	1.115
127.5	1.146	1.146	1.144	1.138	1.128	1.116
135.0	1.151	1.150	1.147	1.140	1.128	1.116
142.5	1.154	1.153	1.149	1.140	1.127	1.115
150.0	1.157	1.156	1.150	1.138	1.123	1.112
157.5	1.160	1.158	1.148	1.132	1.117	1.110
165.0	1.159	1.155	1.139	1.121	1.110	1.107
172.5	1.150	1.139	1.117	1.108	1.104	1.105
180.0	1.101	1.101	1.101	1.101	1.102	1.104

Table 17

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 24

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	1.001	1.001	1.001	1.001	1.001	1.001
15.0	1.007	1.007	1.007	1.007	1.006	1.006
22.5	1.014	1.014	1.014	1.014	1.014	1.013
30.0	1.022	1.022	1.022	1.022	1.021	1.020
37.5	1.030	1.030	1.030	1.029	1.029	1.028
45.0	1.038	1.038	1.037	1.037	1.036	1.035
52.5	1.045	1.045	1.045	1.045	1.044	1.042
60.0	1.052	1.052	1.052	1.052	1.050	1.048
67.5	1.059	1.059	1.059	1.058	1.057	1.054
75.0	1.066	1.066	1.065	1.064	1.062	1.059
82.5	1.072	1.072	1.071	1.070	1.068	1.064
90.0	1.077	1.077	1.076	1.075	1.072	1.068
97.5	1.082	1.082	1.081	1.080	1.076	1.071
105.0	1.087	1.087	1.086	1.084	1.080	1.073
112.5	1.091	1.091	1.090	1.087	1.082	1.075
120.0	1.094	1.094	1.093	1.090	1.084	1.076
127.5	1.098	1.098	1.096	1.092	1.085	1.077
135.0	1.101	1.100	1.098	1.093	1.085	1.076
142.5	1.103	1.102	1.099	1.093	1.083	1.075
150.0	1.105	1.104	1.099	1.091	1.080	1.073
157.5	1.107	1.105	1.098	1.087	1.076	1.071
165.0	1.106	1.103	1.091	1.079	1.071	1.069
172.5	1.098	1.090	1.076	1.069	1.067	1.067
180.0	1.065	1.065	1.065	1.065	1.066	1.067

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 19

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	1.001	1.001	1.001	1.001	1.001	1.001
15.0	1.005	1.005	1.005	1.005	1.004	1.004
22.5	1.009	1.009	1.009	1.009	1.009	1.009
30.0	1.014	1.014	1.014	1.014	1.014	1.013
37.5	1.019	1.019	1.019	1.019	1.018	1.018
45.0	1.024	1.024	1.024	1.024	1.023	1.022
52.5	1.028	1.028	1.028	1.028	1.027	1.026
60.0	1.033	1.033	1.033	1.032	1.032	1.030
67.5	1.037	1.037	1.037	1.036	1.035	1.033
75.0	1.041	1.041	1.041	1.040	1.039	1.037
82.5	1.044	1.044	1.044	1.043	1.042	1.039
90.0	1.048	1.048	1.047	1.047	1.045	1.042
97.5	1.051	1.051	1.050	1.049	1.047	1.043
105.0	1.054	1.053	1.053	1.052	1.049	1.045
112.5	1.056	1.056	1.055	1.054	1.050	1.046
120.0	1.058	1.058	1.057	1.055	1.051	1.046
127.5	1.060	1.060	1.059	1.056	1.052	1.046
135.0	1.062	1.062	1.060	1.057	1.051	1.046
142.5	1.063	1.063	1.061	1.057	1.050	1.045
150.0	1.064	1.064	1.061	1.055	1.048	1.043
157.5	1.065	1.064	1.060	1.052	1.046	1.042
165.0	1.065	1.063	1.055	1.047	1.042	1.041
172.5	1.058	1.053	1.045	1.041	1.040	1.040
180.0	1.039	1.039	1.039	1.039	1.039	1.039

Table 18

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 13

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	1.001	1.001	1.001	1.001	1.001	1.001
15.0	1.002	1.002	1.002	1.002	1.002	1.002
22.5	1.005	1.005	1.005	1.005	1.005	1.004
30.0	1.007	1.007	1.007	1.007	1.007	1.007
37.5	1.009	1.009	1.009	1.009	1.009	1.009
45.0	1.011	1.011	1.011	1.011	1.011	1.010
52.5	1.013	1.013	1.013	1.013	1.013	1.012
60.0	1.015	1.015	1.015	1.015	1.015	1.014
67.5	1.017	1.017	1.017	1.017	1.016	1.016
75.0	1.019	1.019	1.019	1.019	1.018	1.017
82.5	1.021	1.021	1.020	1.020	1.019	1.018
90.0	1.022	1.022	1.022	1.022	1.021	1.019
97.5	1.023	1.023	1.023	1.023	1.022	1.020
105.0	1.025	1.025	1.024	1.024	1.022	1.020
112.5	1.026	1.026	1.025	1.025	1.023	1.021
120.0	1.027	1.027	1.026	1.025	1.023	1.021
127.5	1.028	1.028	1.027	1.026	1.023	1.021
135.0	1.028	1.028	1.028	1.026	1.023	1.020
142.5	1.029	1.029	1.028	1.026	1.023	1.020
150.0	1.029	1.029	1.028	1.025	1.022	1.019
157.5	1.030	1.030	1.027	1.024	1.020	1.019
165.0	1.030	1.029	1.025	1.021	1.019	1.018
172.5	1.025	1.023	1.019	1.018	1.017	1.017
180.0	1.017	1.017	1.017	1.017	1.017	1.017

RATIO OF MOTT TO MCKINLEY-FESHBACH SCATTERING
ATOMIC NUMBER = 6

ENERGY(MEV) / ANGLE(DEGREES)	20	10	4	2	1	.5
0	1.000	1.000	1.000	1.000	1.000	1.000
7.5	1.000	1.000	1.000	1.000	1.000	1.000
15.0	1.001	1.001	1.001	1.001	1.001	1.001
22.5	1.001	1.001	1.001	1.001	1.001	1.001
30.0	1.002	1.002	1.002	1.002	1.001	1.001
37.5	1.002	1.002	1.002	1.002	1.002	1.002
45.0	1.002	1.002	1.002	1.002	1.002	1.002
52.5	1.003	1.003	1.003	1.003	1.003	1.003
60.0	1.003	1.003	1.003	1.003	1.003	1.003
67.5	1.004	1.004	1.004	1.004	1.003	1.003
75.0	1.004	1.004	1.004	1.004	1.004	1.004
82.5	1.004	1.004	1.004	1.004	1.004	1.004
90.0	1.005	1.005	1.005	1.005	1.004	1.004
97.5	1.005	1.005	1.005	1.005	1.005	1.004
105.0	1.005	1.005	1.005	1.005	1.005	1.004
112.5	1.005	1.005	1.005	1.005	1.005	1.004
120.0	1.006	1.006	1.006	1.005	1.005	1.004
127.5	1.006	1.006	1.006	1.005	1.005	1.004
135.0	1.006	1.006	1.006	1.005	1.005	1.004
142.5	1.006	1.006	1.006	1.005	1.005	1.004
150.0	1.006	1.006	1.006	1.005	1.004	1.004
157.5	1.006	1.006	1.006	1.005	1.004	1.004
165.0	1.006	1.006	1.005	1.004	1.004	1.004
172.5	1.004	1.004	1.004	1.003	1.003	1.003
180.0	1.003	1.003	1.003	1.003	1.003	1.003

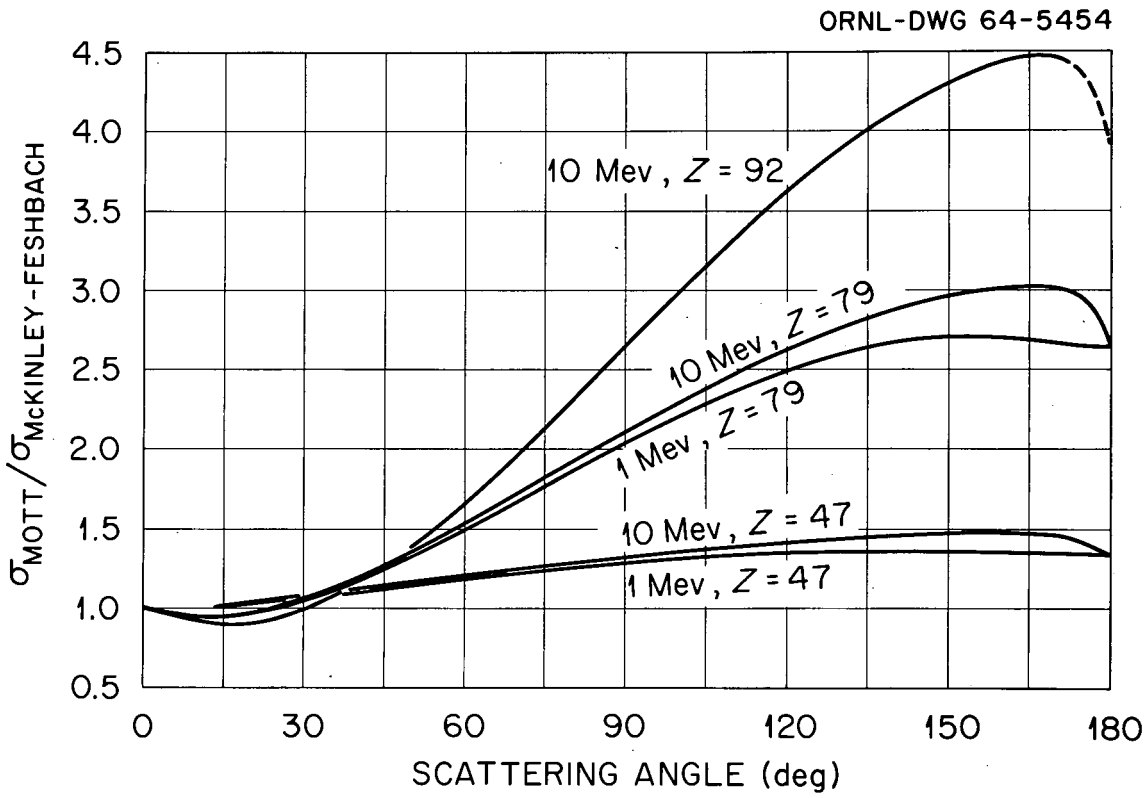

Figure 24 The Ratio of the Mott to the McKinley-Feshbach Scattering vs Electron Scattering Angle for Uranium, Gold, and Silver.

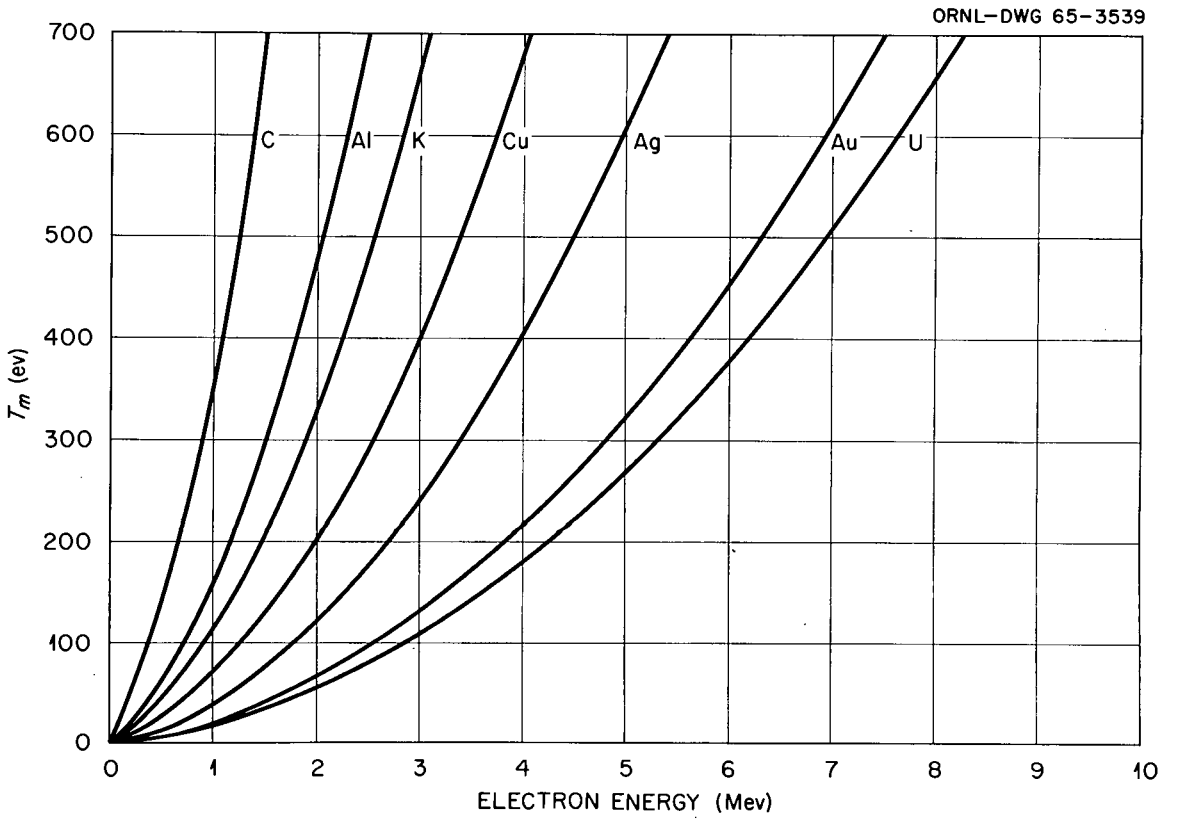

Figure 25 The Maximum Energy Transferred to an Atomic Nucleus by an Electron in a Head-on Elastic Collision vs Electron Energy for Several Elements.

Table 19 The Differential Rutherford Scattering Per Steradian with the Z^2 Factor Omitted vs Electron Scattering Angle.

DIFF. RUTHERFORD SCAT. (IN BARNS PER STERADIAN, WITHOUT Z SQUARED FACTOR

ENERGY(MEV) ANGLE(DEGREES)	20	10	4	2	1	.5
7.5	.674330	2.576760	14.288245	48.904761	158.224326	500.080162
15.0	.042508	.162434	.900704	3.082866	9.974168	31.524127
22.5	.008518	.032548	.180480	.617735	1.998593	6.316709
30.0	.002750	.010507	.058262	.199416	.645182	2.039148
37.5	.001156	.004416	.024489	.083820	.271188	.857111
45.0	.000575	.002198	.012190	.041724	.134992	.426653
52.5	.000322	.001232	.006832	.023384	.075656	.239117
60.0	.000197	.000754	.004183	.014317	.046322	.146404
67.5	.000130	.000495	.002744	.009393	.030389	.096046
75.0	.000090	.000343	.001904	.006516	.021080	.066626
82.5	.000065	.000249	.001383	.004735	.015318	.048415
90.0	.000049	.000189	.001046	.003579	.011581	.036601
97.5	.000039	.000148	.000818	.002801	.009061	.028637
105.0	.000031	.000119	.000660	.002259	.007308	.023098
112.5	.000026	.000099	.000547	.001872	.006057	.019145
120.0	.000022	.000084	.000465	.001591	.005147	.016267
127.5	.000019	.000073	.000404	.001383	.004474	.014142
135.0	.000017	.000065	.000359	.001228	.003974	.012560
142.5	.000015	.000059	.000325	.001113	.003601	.011381
150.0	.000014	.000054	.000300	.001028	.003326	.010511
157.5	.000013	.000051	.000283	.000967	.003129	.009889
165.0	.000013	.000049	.000271	.000926	.002996	.009470
172.5	.000012	.000048	.000264	.000903	.002920	.009229
180.0	.000012	.000047	.000261	.000895	.002895	.009150

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