NISTIR 7163

Experimentally Measured Total X-Ray Attenuation Coefficients Extracted from Previously Unprocessed Documents Held by the NIST Photon and Charged Particle Data Center. II.

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September 2004

U.S. DEPARTMENT OF COMMERCE
Donald L. Evans, Secretary

TECHNOLOGY ADMINISTRATION
Phillip J. Bond, Under Secretary for Technology

NATIONAL INSTITUTE OF STANDARDS
AND TECHNOLOGY
Arden L. Bement, Jr., Director

I. Introduction:

Since 1950 the National Institute of Standards and Technology (NIST; formerly National Bureau of Standards) has maintained a data base of measured and theoretical x-ray attenuation and cross section data in a hard-copy file of original source documents in the form of reprints, reports, and personal communications. This data base extends over 11 decades of photon energies, from 10 eV (extreme ultraviolet or XUV region) to 100 GeV (cosmic-ray energy region). The purpose of this data base, now residing in the NIST Photon and Charged Particle Data Center (PCPDC), is to provide photon (XUV, x-ray, gamma-ray, and bremsstrahlung) interaction data required in a variety of medical, industrial, defense, and basic-science applications. This NIST/PCPDC data base, unique in the global scientific community, has been used from time to time as the basis for the tabulation of photon cross sections and attenuation coefficients [1-15] and related quantities such as the photon energy-transfer and energy-absorption coefficients [5-7, 9, 11, 16-18].

In collaboration with H. Gerstenberg, E. Saloman and a series of summer student assistants, the data extracted from the accumulated NIST/PCPDC-held documents (1907-1986) were keyboarded into machine-readable form in 1986 [19-24]. In a further report, NISTIR 5893 (1996) [25], to which this report is a sequel, the data from additional documents (1981-1995) were extracted and put in machine-readable and standardized form. The present report is a further supplement and update to the data base, incorporating data from further previously unprocessed documents (1978-2004) accumulated in the PCPDC collection and listed and annotated (photon energy ranges, elements measured, and uncertainty estimates) in Section V.

II. Procedures:

In the above hard-copy file of original source documents, the measurements were made in a great variety of contexts and scientific disciplines, for different purposes. These purposes range from medical x-ray therapy and diagnostic applications to x-ray crystallography and aircraft radiometric fuel gauge development, and include many other extremely diverse human endeavors requiring, in common, reliable values of this x-ray interaction data. Hence the measured results in these source documents were given by the authors in units peculiar to the particular scientific discipline in which the measurements were taken.

For example, in much of the x-ray crystallography and x-ray fluorescence (XRF) analytical literature, and also in much of the atomic physics basic research literature, the photon energies are not given, but rather the photon wavelengths, in units of angstroms (Å) or nanometers (nm). The photon interaction probabilities (cross sections) are also given in a variety of different forms, such as linear attenuation coefficients (e.g., cm^{-1}), mass attenuation (or absorption) coefficients (e.g., cm^2/g or m^2/kg), cross sections (e.g., barns per atom [b/atom], or Mb per atom, or Mb per molecule for binary gases, etc.). In previous

photon energies 9.6 MeV to 162 MeV, in addition to many-point measurements also for Cu, Sn and Ta in that same source reference [78Gi01]. In this current report, the extreme case for density and number of data points for a single element are the 502 cross section measurements in W (Z=74) from 1.453 keV to 2.353 keV by Levine et al. [003Le01], followed closely by the 501 measurements in Si (Z=14) from 1.800 keV to 2.300 keV by Owens et al. [002Ow02].

Table 1 is summarized in Table 2, showing for each element the number of papers which contained data for that element, and the total number of data points extracted from these papers. From the 23 papers examined, for all elements, a grand total of 3357 data points were extracted.

Authors' estimates of uncertainty, if provided, are noted in the square brackets at the end of each annotated reference in the document listing in Section V. These uncertainties vary greatly, from a lower bound of $\pm 0.1\%$ in Roy et al. [97Ro01] to an upper bound of $\pm 300\%$ in Tikkanen and Huovelin [96Ti01]. In general, a more meaningful "envelope of uncertainty" is obtained by noting differences between independent measurements for the same element and energies under different experimental conditions.

IV. Text References:

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5. Berger, R.T. (McGinnies), The X- or Gamma-Ray Energy Absorption or Transfer Coefficient: Tabulations and Discussion, Radiat. Res. **15**, 1-29 (1961).

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Coefficients, Rad. Res. **136**, 147-170 (1993).

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19. Gerstenberg, H.M., and Hubbell, J.H., Comparison of Experimental with Theoretical Photon Attenuation Cross Sections Between 10 eV and 100 GeV (p. 1007-1009), Nuclear Data for Science and Technology, K.H. Bockhoff, ed., ECSC, EEC, EAEC, Brussels and Luxembourg (1983).

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22. Saloman, E.B., and Hubbell, J.H., Critical Analysis of Soft X-Ray Cross Section Data, (Presented at the Third International Symposium on Radiation Physics, Ferrara, Italy, Sept. 30-Oct. 4, 1985), Nucl. Instr. Meth. A 255, 38-42 (1987).

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001An01 Angelone, M., Bubba, T. and Esposito, A., Appl. Radiat. Isot. **55**, 505-511 (2001)
Measurement of the Mass Attenuation Coefficient for Elemental Materials in the Range $6 \leq Z \leq 82$ Using X-Rays from 13 up to 50 keV
(13.37 kev to 50.65 keV: C, Al, Ti, V, Mn, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, Rh, Pd, Ag, Cd, In, Ta, Pt, Au, Pb) [±2.5% to 8.0%]

001Ba01 Baltazar-Rodrigues, J. and Cusatis, C., Nucl. Instr. Meth. B **179**, 325-333 (2001)
Determination of X-Ray Photoelectric Absorption of Ge and Si Avoiding Solid-State Effects
(8.048 keV to 24.945 keV: Si, Ge) [±0.1% to 0.3%]

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Measurement of the X-Ray Mass Attenuation Coefficient of Copper Using 8.85-20 keV Synchrotron Radiation
(8.8709 keV to 20.0268 keV: Cu) [0.271% to 0.332%]

002Ma01 Mallikarjuna, M.L., Gowda, S.B.A., Krishnaveni, S., Gowda, R. and Umesh, T.K., Nucl. Sci. & Eng. **140**, 96-102 (2002)
Studies on Photon Interaction around the K-Edge of Some Elements
(5.895 keV to 84.3 keV: Cu, Zr, Ag, Sn) [±3% to 4%]

002Ma02 Mallikarjuna, M/L., Gowda, S.B.A., Gowda, R. and Umesh, T.K., Radiat. Phys. Chem. **65**, 217-223 (2002)
Studies on Photon Interaction around the K-Edge of some Rare-Earth Elements
(6.4 keV to 84.3 keV: O, La, Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er) [±3% to 4%]

002Ow01 Owens, A., Fraser, G.W. and Gurman, S.J., Radiat. Phys. Chem. **65**, 109-121 (2002)
Near K-Edge Linear Attenuation Coefficients for Si, SiO_2 and Si_3N_4
Note: Measurement results are presented for both crystalline ("Si-c") and amorphous ("Si-a"). For presentation in this report the crystalline-sample "Si-c" results were selected.
(1.800 keV to 2.300 keV: Si) [± % not given]

002Su01 Suzuki, I.H. and Saito, N., J. Electron Spectrosc. **123**, 239-245 (2002)
Photoabsorption Cross Section of Kr in the Sub-keV Energy region
(100 eV to 1300 eV: Kr) [±1%]

002Ta01 Tamura, M., Akimoto, T., Aoki, Y., Ikeda, J., Sato, K., Fujita, F., Homma, A., Sawamura, T. and Narita, M., Nucl. Instr. Meth. A **484**, 642-649 (2002)
Measurement of Mass Attenuation Coefficients around the K absorption Edge by Parametric X-Rays
(17.22 keV to 20.56 keV: Nb, Zr, Mo) [±1% to 15%]

Table 1. Experimental Cross Section Data Extracted from Documents.

Z = 5, B eV, barns per atom pairs 5 pts ref = 003Te01
5.110+05 1.415+00 6.620+05 1.303+00 1.170+06 9.864−01 1.280+06 7.460−01
1.330+06 6.203−01

Z = 6, C eV, barns per atom pairs 65 pts ref = 96Ti01
2.834+02 4.168+04 2.836+02 4.837+04 2.838+02 6.904+04 2.840+02 1.395+05
2.842+02 3.212+05 2.844+02 6.027+05 2.846+02 8.851+05 2.848+02 1.078+06
2.850+02 1.075+06 2.852+02 8.326+05 2.854+02 6.128+05 2.856+02 4.578+05
2.858+02 4.205+05 2.860+02 4.746+05 2.862+02 5.068+05 2.864+02 4.324+05
2.866+02 3.413+05 2.868+02 3.423+05 2.870+02 4.930+05 2.875+02 9.477+05
2.880+02 6.307+05 2.885+02 6.232+05 2.890+02 7.147+05 2.895+02 7.486+05
2.900+02 7.750+05 2.905+02 8.196+05 2.910+02 9.467+05 2.915+02 1.089+06
2.920+02 1.187+06 2.925+02 1.227+06 2.930+02 1.267+06 2.935+02 1.341+06
2.940+02 1.416+06 2.945+02 1.482+06 2.950+02 1.545+06 2.955+02 1.585+06
2.960+02 1.579+06 2.965+02 1.535+06 2.970+02 1.478+06 2.975+02 1.430+06
2.980+02 1.404+06 2.985+02 1.402+06 2.990+02 1.414+06 2.995+02 1.427+06
3.000+02 1.434+06 3.050+02 1.387+06 3.100+02 9.697+05 3.150+02 8.225+05
3.200+02 7.726+05 3.250+02 7.608+05 3.300+02 7.314+05 3.350+02 6.828+05
3.400+02 6.467+05 3.450+02 6.177+05 3.500+02 5.978+05 3.550+02 5.866+05
3.600+02 5.811+05 3.650+02 5.746+05 3.700+02 5.629+05 3.750+02 5.463+05
3.800+02 5.299+05 3.850+02 5.153+05 3.900+02 5.008+05 3.950+02 4.860+05
4.000+02 4.774+05

Z = 6, C eV, barns per atom pairs 1 pt ref = 004Ec01
8.041+03 9.973+01

Z = 6, C eV, barns per atom pairs 8 pts ref = 001An01
1.337+04 2.200+01 1.744+04 1.150+01 2.210+04 7.200+00 2.499+04 6.100+00
3.206+04 5.000+00 3.665+04 4.200+00 4.423+04 4.030+00 5.065+04 3.900+00

Z = 7, N eV, barns per atom pairs 77 pts ref = 96Ti01
4.020+02 3.328+05 4.025+02 3.117+05 4.030+02 4.431+05 4.035+02 7.422+05
4.040+02 8.120+05 4.045+02 7.656+05 4.050+02 8.918+05 4.055+02 1.146+06
4.060+02 1.402+06 4.065+02 1.597+06 4.070+02 1.674+06 4.075+02 1.681+06
4.080+02 1.738+06 4.085+02 1.783+06 4.090+02 1.688+06 4.095+02 1.495+06
4.100+02 1.331+06 4.105+02 1.251+06 4.110+02 1.261+06 4.115+02 1.302+06
4.120+02 1.333+06 4.125+02 1.316+06 4.130+02 1.264+06 4.135+02 1.186+06
4.140+02 1.087+06 4.145+02 9.882+05 4.150+02 9.030+05 4.155+02 8.399+05
4.160+02 7.987+05 4.165+02 7.835+05 4.170+02 7.685+05 4.175+02 7.663+05

Z = 8, O eV, barns per atom pairs 13 pts ref = 002Ma02

6.400+03 6.036+02 8.041+03 3.303+02 1.053+04 1.355+02 1.440+04 5.424+01
2.414+04 1.504+01 3.080+04 9.630+00 3.500+04 8.010+00 5.201+04 5.560+00
6.430+04 4.890+00 7.083+04 4.670+00 7.287+04 4.630+00 8.100+04 4.430+00
8.430+04 4,380+00

Z = 10, Ne eV, barns per atom pairs 103 pts ref = 003Su01

4.490+01 7.730+06 4.990+01 7.920+06 5.490+01 7.530+06 5.990+01 6.810+06
6.990+01 6.120+06 7.980+01 5.200+06 8.600+01 4.910+06 9.000+01 4.560+96
9.500+01 4.230+06 1.000+02 3.940+06 1.050+02 3.650+06 1.100+02 3.380+06
1.150+02 3.140+06 1.200+02 2.920+06 1.250+02 2.710+06 1.300+02 2.510+06
1.350+02 2.330+06 1.400+02 2.180+06 1.450+02 2.040+06 1.500+02 1.910+06
1.550+02 1.780+06 1.600+02 1.660+06 1.650+02 1.550+06 1.700+02 1.450+06
1.750+02 1.350+06 1.800+02 1.270+06 1.900+02 1.130+06 2.000+02 1.000+06
2.100+02 9.030+05 2.200+02 8.160+05 2.300+02 7.310+05 2.400+02 6.500+05
2.500+02 5.840+05 2.600+02 5.300+05 2.700+02 4.840+05 2.800+02 4.420+05
2.900+02 4.010+05 3.000+02 3.700+05 3.100+02 3.400+05 3.200+02 3.120+05
3.300+02 2.870+05 3.400+02 2.670+05 3.500+02 2.490+05 3.600+02 2.340+05
3.700+02 2.180+05 3.800+02 2.040+05 3.900+02 1.910+05 4.000+02 1.790+05
4.200+02 1.570+05 4.400+02 1.390+05 4.600+02 1.230+05 4.800+02 1.100+05
5.000+02 9.800+04 5.200+02 8.870+04 5.400+02 8.010+04 5.600+02 7.250+04
5.800+02 6.600+04 6.000+02 6.070+04 6.200+02 5.610+04 6.400+02 5.160+04
6.500+02 4.950+04 6.600+02 4.740+04 6.800+02 4.340+04 7.000+02 3.980+04
7.200+02 3.650+04 7.400+02 3.410+04 7.500+02 3.310+04 7.600+02 3.230+04
7.800+02 3.040+04 8.000+02 2.850+04 8.200+02 2.670+04 8.400+02 2.560+04
8.479+02 2.330+04 8.588+02 2.280+04 8.700+02 3.760+05 8.750+02 3.670+05
8.800+02 3.550+05 8.850+02 3.450+05 8.900+02 3.370+05 8.925+02 3.330+05
8.950+02 3.300+05 8.975+02 3.290+05 9.000+02 3.290+05 9.025+02 3.300+05
9.050+02 3.310+05 9.075+02 3.310+05 9.100+02 3.290+05 9.150+02 3.260+05
9.200+02 3.220+05 9.300+02 3.130+05 9.400+02 3.050+05 9.500+02 2.970+05
9.600+02 2.890+05 9.800+02 2.710+05 1.000+03 2.560+05 1.050+03 2.260+05
1.100+03 2.020+05 1.150+03 1.820+05 1.200+03 1.600+05 1.240+03 1.460+05
1.265+03 1.360+05 1.290+03 1.270+05 1.316+03 1.260+05

Z = 13, Al eV, barns per atom pairs 291 pts ref = 96Ti01

6.000+01 1.022+06 6.100+01 5.173+05 6.200+01 5.719+05 6.300+01 6.193+05
6.400+01 6.550+05 6.500+01 6.345+05 6.600+01 5.223+05 6.700+01 5.229+05
6.800+01 5.420+05 6.900+01 5.309+05 7.000+01 5.358+05 7.100+01 5.585+05
7.150+01 5.610+05 7.160+01 5.608+05 7.170+01 5.598+05 7.180+01 5.617+05
7.190+01 5.612+05 7.200+01 5.614+05 7.210+01 5.630+05 7.220+01 5.653+05
7.230+01 5.689+05 7.240+01 5.758+05 7.250+01 5.923+05 7.260+01 6.828+05
7.270+01 1.287+06 7.280+01 1.763+06 7.290+01 1.720+06 7.300+01 1.682+06
7.310+01 1.878+06 7.320+01 2.136+06 7.330+01 2.125+06 7.340+01 2.087+06
7.350+01 2.061+06 7.360+01 2.042+06 7.370+01 2.031+06 7.380+01 2.029+06

2.810+02 1.330+06 2.812+02 1.328+06 2.814+02 1.328+06 2.816+02 1.326+06
2.818+02 1.325+06 2.820+02 1.327+06 2.822+02 1.327+06 2.824+02 1.328+06
2.826+02 1.330+06 2.828+02 1.333+06 2.830+02 1.338+06 2.832+02 1.350+06
1.554+03 1.905+04 1.555+03 2.424+04 1.556+03 3.662+04 1.557+03 6.007+04
1.558+03 8.841+04 1.559+03 1.243+05 1.560+03 1.604+05 1.561+03 1.904+05
1.562+03 2.110+05 1.563+03 2.246+05 1.564+03 2.339+05 1.565+03 2.383+05
1.566+03 2.367+05 1.567+03 2.341+05 1.568+03 2.333+05 1.569+03 2.312+05
1.570+03 2.320+05 1.571+03 2.300+05 1.572+03 2.261+05 1.573+03 2.202+05
1.574+03 2.107+05 1.575+03 2.046+05 1.576+03 1.980+05 1.577+03 1.933+05
1.578+03 1.829+05 1.579+03 1.780+05 1.580+03 1.707+05 1.581+03 1.657+05
1.582+03 1.600+05 1.583+03 1.549+05 1.584+03 1.512+05 1.585+03 1.467+05
1.586+03 1.449+05 1.587+03 1.470+05 1.588+03 1.527+05 1.589+03 1.558+05
1.590+03 1.662+05 1.591+03 1.739+05 1.592+03 1.803+05 1.593+03 1.840+05
1.594+03 1.866+05 1.595+03 1.889+05 1.596+03 1.876+05 1.597+03 1.852+05
1.598+03 1.843+05 1.599+03 1.827+05 1.600+03 1.803+05 1.610+03 1.701+05
1.620+03 1.474+05 1.630+03 1.609+05 1.640+03 1.636+05 1.650+03 1.608+05
1.660+03 1.482+05 1.670+03 1.479+05 1.680+03 1.494+05 1.690+03 1.509+05
1.700+03 1.504+05 1.710+03 1.436+05 1.720+03 1.391+05 1.730+03 1.367+05
1.740+03 1.349+05 1.750+03 1.347+05 1.760+03 1.316+05 1.770+03 1.284+05
1.780+03 1.267+05 1.790+03 1.248+05 1.800+03 1.232+05

Z = 13, Al eV, barns per atom pairs 31 pts ref = 004Le01
4.000+03 1.631+04 4.200+03 1.417+04 4.400+03 1.243+04 4.600+03 1.106+04
4.800+03 9.810+03 5.000+03 8.728+03 5.200+03 7.728+03 5.400+03 6.879+03
5.600+03 6.358+03 5.800+03 5.646+03 6.000+03 5.148+03 6.200+03 4.747+03
6.400+03 4.276+03 6.600+03 3.924+03 6.800+03 3.596+03 7.000+03 3.341+03
7.200+03 3.030+03 7.400+03 2.710+03 7.600+03 2.583+03 7.800+03 3.347+03
8.000+03 2.204+03 8.200+03 2.017+03 8.400+03 1.935+03 8.600+03 1.807+03
8.800+03 1.677+03 9.000+03 1.582+03 9.100+03 1.491+03 9.300+03 1.391+03
9.500+03 1.299+03 9.700+03 1.231+03 9.900+03 1.166+03

Z = 13, Al eV, barns per atom pairs 2 pts ref = 97Ke01
6.400+03 4.310+03 8.041+03 2.263+03

Z = 13, Al eV, barns per atom pairs 10 pts ref = 001An01
1.337+04 4.400+02 1.497+04 3.180+02 1.744+04 2.300+02 1.963+04 1.540+02
2.210+04 1.120+02 2.499+04 7.800+01 3.206+04 4.100+01 3.665+04 3.000+01
4.423+04 2.070+01 5.065+04 1.630+01

Z = 14, Si eV, barns per atom pairs 501 pts ref = 002Ow01
1.800+03 1.414+04 1.801+03 1.410+04 1.802+03 1.405+04 1.803+03 1.401+04
1.804+03 1.397+04 1.805+03 1.393+04 1.806+03 1.389+04 1.807+03 1.385+04
1.808+03 1.381+04 1.809+03 1.380+04 1.810+03 1.378+04 1.811+03 1.377+04
1.812+03 1.376+04 1.813+03 1.374+04 1.814+03 1.371+04 1.815+03 1.369+04

1.992+03 1.196+05 1.993+03 1.195+05 1.994+03 1.194+05 1.995+03 1.193+05
1.996+03 1.191+05 1.997+03 1.190+05 1.998+03 1.188+05 1.999+03 1.187+05
2.000+03 1.186+05 2.001+03 1.185+05 2.002+03 1.184+05 2.003+03 1.183+05
2.004+03 1.184+05 2.005+03 1.184+05 2.006+03 1.184+05 2.007+03 1.184+05
2.008+03 1.185+05 2.009+03 1.187+05 2.010+03 1.184+05 2.011+03 1.191+05
2.012+03 1.193+05 2.013+03 1.194+05 2.014+03 1.195+05 2.015+03 1.195+05
2.016+03 1.196+05 2.017+03 1.196+05 2.018+03 1.197+05 2.019+03 1.197+05
2.020+03 1.197+05 2.021+03 1.197+05 2.022+03 1.197+05 2.023+03 1.198+05
2.024+03 1.197+05 2.025+03 1.197+05 2.026+03 1.197+05 2.027+03 1.197+05
2.028+03 1.197+05 2.029+03 1.194+05 2.030+03 1.190+05 2.031+03 1.187+05
2.032+03 1.184+05 2.033+03 1.181+05 2.034+03 1.182+05 2.035+03 1.183+05
2.036+03 1.184+05 2.037+03 1.186+05 2.038+03 1.187+05 2.039+03 1.185+05
2.040+03 1.184+05 2.041+03 1.183+05 2.042+03 1.182+05 2.043+03 1.181+05
2.044+03 1.177+05 2.045+03 1.173+05 2.046+03 1.170+05 2.047+03 1.166+05
2.048+03 1.163+05 2.049+03 1.160+05 2.050+03 1.157+05 2.051+03 1.153+05
2.052+03 1.150+05 2.053+03 1.148+05 2.054+03 1.146+05 2.055+03 1.145+05
2.056+03 1.144+05 2.057+03 1.143+05 2.058+03 1.142+05 2.059+03 1.142+05
2.060+03 1.142+05 2.061+03 1.141+05 2.062+03 1.141+05 2.063+03 1.141+05
2.064+03 1.138+05 2.065+03 1.136+05 2.066+03 1.133+05 2.067+03 1.131+05
2.068+03 1.129+05 2.069+03 1.127+05 2.070+03 1.124+05 2.071+03 1.122+05
2.072+03 1.120+05 2.073+03 1.118+05 2.074+03 1.115+05 2.075+03 1.113+05
2.076+03 1.111+05 2.077+03 1.109+05 2.078+03 1.107+05 2.079+03 1.105+05
2.080+03 1.103+05 2.081+03 1.101+05 2.082+03 1.099+05 2.083+03 1.097+05
2.084+03 1.096+05 2.085+03 1.095+05 2.086+03 1.094+05 2.087+03 1.093+05
2.088+03 1.092+05 2.089+03 1.092+05 2.090+03 1.091+05 2.091+03 1.090+05
2.092+03 1.089+05 2.093+03 1.088+05 2.094+03 1.088+05 2.095+03 1.087+05
2.096+03 1.080+05 2.097+03 1.085+05 2.098+03 1.089+05 2.099+03 1.083+05
2.100+03 1.081+05 2.101+03 1.080+05 2.102+03 1.079+05 2.103+03 1.078+05
2.104+03 1.078+05 2.105+03 1.079+05 2.106+03 1.079+05 2.107+03 1.079+05
2.108+03 1.079+05 2.109+03 1.079+05 2.110+03 1.079+05 2.111+03 1.079+05
2.112+03 1.079+05 2.113+03 1.079+05 2.114+03 1.079+05 2.115+03 1.079+05
2.116+03 1.079+05 2.117+03 1.078+05 2.118+03 1.078+05 2.119+03 1.078+05
2.120+03 1.078+05 2.121+03 1.077+05 2.122+03 1.077+05 2.123+03 1.077+05
2.124+03 1.076+05 2.125+03 1.076+05 2.126+03 1.075+05 2.127+03 1.075+05
2.128+03 1.075+05 2.129+03 1.073+05 2.130+03 1.072+05 2.131+03 1.070+05
2.132+03 1.069+05 2.133+03 1.067+05 2.134+03 1.064+05 2.135+03 1.062+05
2.136+03 1.059+05 2.137+03 1.056+05 2.138+03 1.054+05 2.139+03 1.052+05
2.140+03 1.050+05 2.141+03 1.048+05 2.142+03 1.046+05 2.143+03 1.044+05
2.144+03 1.042+05 2.145+03 1.041+05 2.146+03 1.039+05 2.147+03 1.037+05
2.148+03 1.036+05 2.149+03 1.035+05 2.150+03 1.134+05 2.151+03 1.032+05
2.152+03 1.031+05 2.153+03 1.029+05 2.154+03 1.028+05 2.155+03 1.027+05
2.156+03 1.027+05 2.157+03 1.026+05 2.158+03 1.025+05 2.159+03 1.024+05
2.160+03 1.022+05 2.161+03 1.021+05 2.162+03 1.020+05 2.163+03 1.019+05
2.164+03 1.018+05 2.165+03 1.017+05 2.166+03 1.016+05 2.167+03 1.015+05

8.113+03 2.872+03 8.214+03 2.765+03 8.314+03 2.669+03 8.414+03 2.576+03
8.514+03 2.488+03 8.614+03 2.404+03 8.714+03 2.324+03 8.815+03 2.247+03
8.915+03 2.174+03 9.016+03 2.107+03 9.116+03 2.038+03 9.216+03 1.975+03
9.316+03 1.916+03 9.416+03 1.853+03 9.516+03 1.795+03 9.616+03 1.740+03
9.716+03 1.692+03 9.816+03 1.639+03 9.917+03 1.591+03 1.002+04 1.544+03
1.002+04 1.542+03 1.002+04 1.543+03 1.012+04 1.498+03 1.022+04 1.454+03
1.032+04 1.413+03 1.042+04 1.373+03 1.052+04 1.335+03 1.062+04 1.302+04
1.072+04 1.267+03 1.082+04 1.228+03 1.092+04 1.198+03 1.102+04 1.165+03
1.112+04 1.134+03 1.122+04 1.104+03 1.132+04 1.073+03 1.142+04 1.046+03
1.152+04 1.024+03 1.162+04 9.964+02 1.172+04 9.728+02 1.182+04 9.449+02
1.192+04 9.245+02 1.202+04 9.018+02 1.202+04 9.018+02 1.217+04 8.682+02
1.232+04 8.359+02 1.247+04 8.064+02 1.262+04 7.774+02 1.277+04 7.505+02
1.292+04 7.239+02 1.307+04 7.004+02 1.322+04 6.778+02 1.337+04 6.555+02
1.352+04 6.324+02 1.367+04 6.127+02 1.382+04 5.949+02 1.397+04 5.743+02
1.412+04 5.589+02 1.427+04 5.387+02 1.442+04 5.234+02 1.457+04 5.085+02
1.472+04 4.917+02 1.487+04 4.744+02 1.488+04 4.782+02 1.502+04 4.649+02
1.523+04 4.455+02 1.543+04 4.288+02 1.563+04 4.131+02 1.583+04 3.974+02
1.603+04 3.831+02 1.623+04 3.694+02 1.623+04 3.690+02 1.642+04 3.566+02
1.663+04 3.446+02 1.683+04 3.319+02 1.703+04 3.202+02 1.723+04 3.093+02
1.743+04 2.987+02 1.763+04 2.879+02 1.763+04 2.875+02 1.783+04 2.786+02
1.803+04 2.688+02 1.823+04 2.604+02 1.843+04 2.531+02 1.863+04 2.448+02
1.863+04 2.439+02 1.883+04 2.369+02 1.903+04 2.303+02 1.923+04 2.226+02
1.942+04 2.159+02 1.962+04 2.097+02 1.982+04 2.031+02 2.003+04 1.972+02

Z = 14, Si eV, barns per atom pairs 6 pts ref = 001Ba01
8.048+03 2.922+03 8.906+03 2.172+03 1.748+04 2.933+02 1.961+04 2.093+02
2.216+04 1.467+02 2.495+04 1.045+04

Z = 16, S eV, barns per atom pairs 2 pts ref = 97Ke01
6.400+03 9.263+03 8.041+03 5.042+03

Z = 20, Ca eV, barns per atom pairs 2 pts ref = 97Ke01
6.400+03 2.103+04 8.041+03 1.121+04

Z = 20, Ca eV, barns per atom pairs 5 pts ref = 003Te01
5.110+05 5.831+00 6.620+05 5.242+00 1.170+06 3.909+00 1.280+06 3.758+00
1.330+06 3.650+00

Z = 22, Ti eV, barns per atom pairs 4 pts ref = 001An01
1.744+04 1.900+03 2.210+04 9.000+02 3.206+04 3.310+02 4.423+04 1.320+02

Z = 23, V eV, barns per atom pairs 2 pts ref = 97Ke01
6.400+03 3.715+04 8.041+03 2.152+04

Z = 29, Cu eV, barns per atom pairs 14 pts ref = 002Ma01
5.895+03 1.262+04 6.400+03 1.007+04 8.041+03 5.389+03 1.053+04 1.989+04
1.440+04 8.480+03 2.414+04 2.077+03 3.080+04 1.070+03 3.500+04 7.550+02
5.201+04 2.560+02 6.430+04 1.440+02 7.083+04 1.110+02 7.287+04 1.020+02
8.100+04 7.700+01 8.430+04 6.900+01

Z = 29, Cu eV, barns per atom pairs 2 pts ref = 97Ke01
6.400+03 1.015+04 8.041+03 5.487+03

Z = 29, Cu eV, barns per atom pairs 84 pts ref = 001Ch01
8.871+03 4.009+03 8.972+03 4.154+03 8.982+03 1.844+04 9.003+03 3.179+04
9.013+03 3.157+04 9.023+03 2.962+04 9.033+03 3.329+04 9.043+03 3.016+04
9.053+03 3.050+04 9.063+03 3.117+04 9.073+03 3.254+04 9.083+03 3.284+04
9.093+03 3.071+04 9.103+03 2.930+04 9.113+03 3.009+04 9.123+03 3.096+04
9.133+03 3.225+04 9.183+03 3.064+04 9.233+03 2.994+04 9.283+03 2.867+04
9.333+03 2.857+04 9.384+03 2.823+04 9.434+03 2.759+04 9.634+03 2.585+04
9,835+03 2.427+04 9.836+03 2.437+04 1.004+04 2.297+04 1.044+04 2.068+04
1.064+04 1.964+04 1.084+04 1.866+04 1.104+04 1.775+04 1.125+04 1.692+04
1.145+04 1.612+04 1.165+04 1.540+04 1.185+04 1.470+04 1.205+04 1.406+04
1.245+04 1.287+04 1.266+04 1.233+04 1.286+04 1.180+04 1.306+04 1.133+04
1.326+04 1.086+04 1.346+04 1.044+04 1.366+04 1.002+04 1.386+04 9.639+03
1.407+04 9.277+03 1.427+04 8.931+03 1.447+04 8.592+03 1.467+04 8.289+03
1.487+04 7.977+03 1.507+04 7.705+03 1.527+04 7.424+03 1.547+04 7.181+03
1.548+04 7.171+03 1.558+04 7.045+03 1.568+04 6.931+03 1.568+04 6.933+03
1.568+04 6.934+03 1.588+04 6.691+03 1.608+04 6.475+03 1.628+04 6.254+03
1.648+04 6.053+03 1.669+04 5.848+03 1.689+04 5.670+03 1.709+04 5.483+03
1.729+04 5.317+03 1.750+04 4.876+03 1.770+04 5.001+03 1.770+04 5.002+03
1.770+04 4.995+03 1.790+04 4.841+03 1.810+04 4,698+03 1.830+04 4.554+03
1.850+04 4.423+03 1.871+04 4.297+03 1.871+04 4.297+03 1.871+04 4.293+03
1.891+04 4.167+03 1.910+04 4.049+03 1.930+04 3.938+03 1.949+04 3.830+03
1.968+04 3.733+03 1.986+04 3.643+03 2.003+04 3.562+03 2.003+04 3.561+03

Z = 29, Cu eV, barns per atom pairs 6 pts ref = 001An01
2.210+04 2.570+03 2.499+04 1.830+03 3.206+04 9.200+02 3.665+04 7.100+02
4.423+04 3.730+02 5.065+04 2.500+02

Z = 29, Cu eV, barns per atom pairs 47 pts ref = 78Gi01
9.620+06 3.269+00 9.870+06 3.282+00 1.013+07 3.289+00 1.037+07 3.291+00
1.061+07 3.297+00 1.086+07 3.305+00 1.112+07 3.315+00 1.134+07 3.322+00
1.150+07 3.326+00 1.417+07 3.446+00 1.440+07 3.458+00 1.464+07 3.454+00
1.486+07 3.453+00 1.514+07 3.495+00 1.537+07 3.498+00 1.560+07 3.530+00
1.587+07 3.537+00 1.610+07 3.553+00 1.635+07 3.570+00 1.664+07 3.587+00
1.687+07 3.605+00 1.711+07 3.611+00 1.736+07 3.611+00 1.761+07 3.634+00
1.788+07 3.622+00 1.814+07 3.618+00 1.839+07 3.643+00 1.864+07 3.659+00

Z = 40, Zr eV, barns per atom pairs 12 pts ref = 002Ta01
1.722+04 2.448+03 1.748+04 2.081+03 1.767+04 1.913+03 1.780+04 1.447+03
1.786+04 1.527+03 1.799+04 1.643+03 1.806+04 1.846+03 1.818+04 2.243+03
1.825+04 3.946+03 1.838+04 1.247+04 1.876+04 1.260+04 1.934+04 1.272+04

Z = 41, Nb eV, barns per atom pairs 10 pts ref = 001An01
1.337+04 5.500+03 1.497+04 4.200+03 1.744+04 2.650+03 1.963+04 1.130+04
2.210+04 9.400+03 2.499+04 6.810+03 3.206+04 3.400+03 3.665+04 2.390+03
4.423+04 1.420+03 5.065+04 9.800+02

Z = 41, Nb eV, barns per atom pairs 9 pts ref = 002Ta01
1.857+04 2.055+03 1.870+04 1.884+03 1.876+04 2.093+03 1.883+04 2.329+03
1.896+04 6.117+03 1.902+04 1.247+04 1.928+04 1.569+04 1.966+04 1.208+04
2.011+04 1.202+04

Z = 41, Nb eV, barns per atom pairs 2 pts ref = 97Ro01
4.300+04 1.549+03 5.950+04 7.337+02

Z = 42, Mo eV, barns per atom pairs 2 pts ref = 97Ke01
6.400+03 4.591+04 8.041+03 2.524+04

Z = 42, Mo eV, barns per atom pairs 3 pts ref = 001An01
1.337+04 6.200+03 1.497+04 3.900+03 1.744+04 2.930+03

Z = 42, Mo eV, barns per atom pairs 8 pts ref = 002Ta01
1.966+04 1.333+03 1.985+04 1.550+03 1.998+04 1.585+03 2.005+04 3.298+03
2.011+04 5.297+03 2.018+04 9.415+03 2.030+04 1.184+04 2.056+04 1,255+04

Z = 42, Mo eV, barns per atom pairs 1 pt ref = 97Ro01
5.950+04 6.872+02

Z = 42, Mo eV, barns per atom pairs 5 pts ref = 003Te01
5.110+05 1.403+01 6.620+05 1.168+01 1.170+06 8.850+00 1.280+06 8.122+00
1.330+06 8.001+00

Z = 45, Rh eV, barns per atom pairs 9 pts ref = 001An01
1.337+04 9.100+03 1.497+04 6.900+03 1.744+04 4.000+03 1.963+04 2.890+03
2.210+04 2.100+03 3.206+04 4.750+03 3.665+04 3.300+03 4.423+04 2.020+03
5.065+04 1.470+03

Z = 45, Rh eV, barns per atom pairs 5 pts ref = 003Te01
5.110+05 1.501+01 6.620+05 1.260+01 1.170+06 9.255+00 1.280+06 8.645+00
1.330+06 8.488+00

Z = 50, Sn eV, barns per atom pairs 128 pts ref = 78Gi01

9.620+06 7.641+00 9.870+06 7.686+00 1.013+07 7.740+00 1.037+07 7.776+00
1.061+07 7.822+00 1.087+07 7.870+00 1.112+07 7.902+00 1.136+07 7.973+00
1.158+07 8.028+00 1.186+07 8.060+00 1.210+07 8.091+00 1.234+07 8.168+00
1.261+07 8.210+00 1.286+07 8.279+00 1.311+07 8.325+00 1.336+07 8.402+00
1.361+07 8.438+00 1.387+07 8.486+00 1.411+07 8.555+00 1.439+07 8.617+00
1.464+07 8.662+00 1.487+07 8.757+00 1.512+07 8.785+00 1.537+07 8.800+00
1.560+07 8.860+00 1.585+07 8.913+00 1.611+07 8.896+00 1.635+07 8.928+00
1.664+07 8.974+00 1.688+07 9.013+00 1.710+07 9.043+00 1.735+07 9.078+00
1.761+07 9.078+00 1.790+07 9.098+00 1.814+07 9.091+00 1.839+07 9.144+00
1.864+07 9.156+00 1.888+07 9.179+00 1.912+07 9.229+00 1.936+07 9.219+00
1.962+07 9.248+00 1.988+07 9.275+00 2.015+07 9.290+00 2.037+07 9.361+00
2.057+07 9.398+00 2.086+07 9.392+00 2.114+07 9.421+00 2.136+07 5.418+00
2.157+07 9.484+00 2.180+07 9.506+00 2.207+07 9.508+00 2.236+07 9.537+00
2.264+07 9.600+07 2.279+07 9.595+00 2.308+07 9.654+00 2.337+07 9.625+00
2.365+07 9.668+00 2.383+07 9.700+00 2.405+07 9.704+00 2.433+07 9.736+00
2.464+07 9.787+00 2.490+07 9.842+00 2.515+07 9.876+00 2.528+07 9.825+00
2.556+07 9.880+00 2.583+07 9.882+00 2.612+07 9.965+00 2.630+07 9.978+00
2.656+07 9.982+00 2.683+07 1.003+01 2.710+07 1.000+01 2.737+07 1.004+01
2.757+07 1.006+01 2.783+07 1.013+01 2.811+07 1.013+01 2.839+07 1.014+01
2.856+07 1.012+01 2.884+07 1.017+01 2.913+07 1.018+01 2.942+07 1.024+01
2.958+07 1.033+01 2.985+07 1.031+01 3.015+07 1.033+01 3.045+07 1.028+01
3.068+07 1.037+01 3.085+07 1.036+01 3.112+07 1.032+01 3.139+07 1.039+01
3.161+07 1.035+01 3.186+07 1.046+01 3.211+07 1.042+01 3.238+07 1.052+01
3.262+07 1.046+01 3.278+07 1.061+01 3.308+07 1.050+01 3.339+07 1.056+01
3.360+07 1.060+01 3.377+07 1.056+01 3.410+07 1.064+01 3.443+07 1.059+01
3.466+07 1.067+01 3.479+07 1.064+01 3.512+07 1.060+01 3.545+07 1.067+01
3.573+07 1.068+01 3.582+07 1.072+01 3.615+07 1.081+01 3.647+07 1.092+01
3.679+07 1.084+01 4.790+07 1.150+01 4.840+07 1.165+01 4.889+07 1.160+01
4.939+07 1.160+01 4.987+07 1.165+01 5.037+07 1.163+01 5.087+07 1.168+01
5.136+07 1.161+01 5.185+07 1.173+01 5.238+07 1.168+01 5.286+07 1.173+01
5.340+07 1.175+01 5.388+07 1.175+01 1.004+08 1.335+01 1.013+08 1.343+01
1.025+08 1.347+01 1.035+08 1.351+01 1.046+08 1.335+01 1.056+08 1.350+01

Z = 54, Xe eV, barns per atom pairs 110 pts ref = 003Su01

8.600+01 1.960+07 9.000+01 2.420+07 9.500+01 2.760+07 1.000+02 2.870+07
1.050+02 2.710+07 1.100+02 2.380+07 1.200+02 1.500+07 1.300+02 7.830+06
1.350+02 5.360+06 1.400+02 3.570+06 1.410+02 3.400+06 1.414+02 3.600+06
1.417+02 3.970+06 1.424+02 3.370+06 1.433+02 2.830+06 1.439+02 3.150+06
1.443+02 2.880+06 1.450+02 2.850+06 1.460+02 2.630+06 1.470+02 2.540+06
1.500+02 2.180+06 1.600+02 1.360+06 1.700+02 9.890+05 1.800+02 8.790+05
1.900+02 9.010+05 2.000+02 9.730+05 2.099+02 1.100+06 2.110+02 1.150+06
2.157+02 1.200+06 2.200+02 1.220+06 2.300+02 1.310+06 2.400+02 1.390+06
2.500+02 1.470+06 2.600+02 1.530+06 2.700+02 1.570+06 2.800+02 1.590+06

Z = 60, Nd eV, barns per atom pairs 12 pts ref = 002Ma02
8.041+03 9.657+04 1.053+04 4.757+04 1.440+04 2.092+04 2.414+04 5.260+03
3.080+04 2.740+03 3.500+04 1.960+03 5.201+04 3.560+03 6.430+04 2.050+03
7.083+04 1.600+03 7.287+04 1.480+03 8.100+04 1.120+03 8.430+04 1.000+03

Z = 62, Sm eV, barns per atom pairs 11 pts ref = 002Ma02
1.053+04 5.391+04 1.440+04 2.374+04 2.414+04 6.010+03 3.080+04 3.160+03
3.500+04 2.220+03 5.201+04 3.990+03 6.430+04 2.250+03 7.083+04 1.800+03
7.287+04 1.660+03 8.100+04 1.260+03 8.430+04 1.130+03

Z = 63, Eu eV, barns per atom pairs 1 pt ref = 99Ka01
5.954+04 2.872+03

Z = 64, Gd eV, barns per atom pairs 11 pts ref = 002Ma02
1.053+04 6.059+04 1.440+04 2.690+04 2.414+04 6.920+03 3.080+04 3.600+03
3.500+04 2.550+03 5.201+04 4.550+03 6.430+04 2.570+03 7.083+04 2.000+03
7.287+04 1.860+03 8.100+04 1.400+03 8.430+04 1.260+03

Z = 64, Gd eV, barns per atom pairs 1 pt ref = 97Ro01
5.950+04 3.462+03

Z = 64, Gd eV, barns per atom pairs 1 pt ref = 99Ka01
5.954+04 3.050+03

Z = 64, Gd eV, barns per atom pairs 1 pt ref = 96Er01
5.960+04 3.071+03

Z = 65, Tb eV, barns per atom pairs 1 pt ref = 99Ka01
5.954+04 3.178+03

Z = 65, Tb eV, barns per atom pairs 1 pt ref = 96Er01
5.960+04 3.086+03

Z = 66, Dy eV, barns per atom pairs 11 pts ref = 002Ma02
1.053+04 6.831+04 1.440+04 3.000+04 2.414+04 7.720+03 3.080+04 4.060+03
3.500+04 2.900+03 5.201+04 1.040+03 6.430+04 2.840+03 7.083+04 2.220+03
7.287+04 2.100+03 8.100+04 1.570+03 8.430+04 1.410+03

Z = 66, Dy eV, barns per atom pairs 1 pt ref = 97Ro01
4.300+04 1.497+03

Z = 66, Dy eV, barns per atom pairs 1 pt ref = 99Ka01
5.954+04 3.396+03

1.791+03 7.174+05 1.793+03 7.197+05 1.796+03 7.241+05 1.798+03 7.311+05
1.801+03 7.388+05 1.803+03 7.686+05 1.806+03 7.887+05 1.808+03 8.041+05
1.811+03 8.210+05 1.813+03 8.342+05 1.816+03 8.579+05 1.818+03 8.777+05
1.821+03 9.061+05 1.823+03 9.307+05 1.826+03 9.647+05 1.828+03 9.816+05
1.831+03 9.927+05 1.833+03 9.943+05 1.836+03 9.949+05 1.838+03 1.003+06
1.840+03 9.966+05 1.843+03 9.980+05 1.846+03 9.935+05 1.848+03 9.961+05
1.851+03 1.005+06 1.853+03 1.002+06 1.856+03 1.015+06 1.858+03 1.014+06
1.861+03 1.017+06 1.863+03 1.021+06 1.866+03 1.019+06 1.868+03 1.032+06
1.871+03 1.032+06 1.873+03 1.039+06 1.876+03 1.039+06 1.878+03 1.038+06
1.881+03 1.044+06 1.883+03 1.040+06 1.886+03 1.042+06 1.888+03 1.036+06
1.891+03 1.037+06 1.893+03 1.031+06 1.896+03 1.033+06 1.898+03 1.041+06
1.901+03 1.033+06 1.903+03 1.031+06 1.906+03 1.034+06 1.908+03 1.020+06
1.911+03 1.026+06 1.913+03 1.020+06 1.916+03 1.017+06 1.918+03 1.025+06
1.921+03 1.023+06 1.923+03 1.026+06 1.926+03 1.024+06 1.928+03 1.024+06
1.931+03 1.021+06 1.933+03 1.023+06 1.936+03 1.022+06 1.938+03 1.020+06
1.941+03 1.023+06 1.943+03 1.018+06 1.946+03 1.013+06 1.948+03 1.016+06
1.951+03 1.007+06 1.953+03 9.938+05 1.956+03 1.005+06 1.958+03 1.001+06
1.961+03 9.986+05 1.963+03 9.948+05 1.966+03 9.953+05 1.968+03 9.879+05
1.971+03 9.940+05 1.973+03 9.846+05 1.976+03 9.793+05 1.978+03 9.891+05
1.981+03 9.870+05 1.983+03 9.835+05 1.986+03 9.876+05 1.988+03 9.813+05
1.991+03 9.843+05 1.993+03 9.772+05 1.996+03 9.821+05 1.998+03 9.790+05
2.001+03 9.841+05 2.003+03 9.750+05 2.006+03 9.675+05 2.008+03 9.637+05
2.011+03 9.666+05 2.013+03 9.658+05 2.016+03 9.551+05 2.018+03 9.593+05
2.021+03 9.578+05 2.023+03 9.548+05 2.026+03 9.521+05 2.028+03 9.508+05
2.031+03 9.461+05 2.033+03 9.449+05 2.036+03 9.381+05 2.038+03 9.378+05
2.041+03 9.378+05 2.043+03 9.337+05 2.046+03 9.325+05 2.048+03 9.369+05
2.051+03 9.315+05 2.053+03 9.291+05 2.056+03 9.236+05 2.058+03 9.241+05
2.061+03 9.128+05 2.063+03 9.157+05 2.066+03 9.141+05 2.068+03 9.153+05
2.071+03 9.154+05 2.073+03 9.039+05 2.076+03 9.080+05 2.078+03 9.042+05
2.081+03 9.022+05 2.083+03 9.024+05 2.086+03 8.938+05 2.088+03 9.002+05
2.091+03 8.943+05 2.093+03 8.916+05 2.096+03 8.895+05 2.098+03 8.913+05
2.101+03 8.861+05 2.103+03 8.872+05 2.106+03 8.835+05 2.108+03 8.793+05
2.111+03 8.843+05 2.113+03 8.791+05 2.116+03 8.776+05 2.118+03 8.730+05
2.121+03 8.753+05 2.123+03 8.767+05 2.126+03 8.675+05 2.128+03 8.683+05
2.131+03 8.669+05 2.133+03 8.666+05 2.136+03 8.692+05 2.138+03 8.595+05
2.141+03 8.611+05 2.143+03 8.592+05 2.146+03 8.578+05 2.148+03 8.630+05
2.151+03 8.466+05 2.153+03 8.541+05 2.156+03 8.521+05 2.158+03 8.502+05
2.161+03 8.503+05 2.163+03 8.460+05 2.166+03 8.510+05 2.168+03 8.482+05
2.171+03 8.440+05 2.173+03 8.459+05 2.176+03 8.480+05 2.178+03 8.541+05
2.181+03 8.616+05 2.183+03 8.695+05 2.186+03 9.035+05 2.188+03 9.405+05
2.191+03 9.999+05 2.193+03 1.030+06 2.196+03 1.026+06 2.198+03 1.002+06
2.201+03 9.755+05 2.203+03 9.604+05 2.206+03 9.485+05 2.208+03 9.422+05
2.211+03 9.347+05 2.213+03 9.252+05 2.216+03 9.274+05 2.218+03 9.181+05
2.221+03 9.164+05 2.223+03 9.156+05 2.226+03 9.057+05 2.228+03 9.062+05

7.483+07 2.482+01 7.525+07 2.501+01 7.555+07 2.496+01 7.652+07 2.504+01
7.747+07 2.519+01 7.850+07 2.513+01 7.949+07 2.519+01 8.028+07 2.528+01
8.109+07 2.520+01 9.356+07 2.597+01 9.456+07 2.617+07 9.555+07 2.603+01
9.654+07 2.613+01 9.753+07 2.619+01 9.851+07 2.631+01 9.952+07 2.615+01
1.005+08 2.622+01 1.015+08 2.624+01 1.025+08 2.618+01 1.034+08 2.635+01
1.045+08 2.627+01 1.055+08 2.636+01 1.065+08 2.630+01 1.075+08 2.675+01
1.085+08 2.643+01 1.131+08 2.677+01 1.142+08 2.665+01 1.153+08 2.719+01
1.164+08 2.705+01 1.174+08 2.715+01 1.185+08 2.706+01 1.196+08 2.712+01
1.206+08 2.724+01 1.213+08 2.725+01 1.222+08 2.726+01 1.234+08 2.729+01
1.245+08 2.727+01 1.256+08 2.740+01 1.261+08 2.742+01 1.283+08 2.754+01
1.301+08 2.708+01 1.426+08 2.765+01 1.440+08 2.779+01 1.460+08 2.778+01
1.480+08 2.797+01 1.499+08 2.806+01 1.520+08 2.808+01 1.541+08 2.798+01
1.560+08 2.815+01 1.579+08 2.818+01 1.598+08 2.816+01 1.618+08 2.830+01

Z = 74, W eV, barns per atom pairs 502 pts ref = 003Le01
1.453+03 5.889+05 1.463+03 5.810+05 1.473+03 5.753+05 1.483+03 5.611+05
1.493+03 5.539+05 1.503+03 5.503+05 1.513+03 5.361+05 1.523+03 5.310+05
1.533+03 5.213+05 1.543+03 5.084+05 1.553+03 4.994+05 1.563+03 5.022+05
1.573+03 4.810+05 1.583+03 4.892+05 1.593+03 4.740+05 1.603+03 4.681+05
1.613+03 4.605+05 1.623+03 4.507+05 1.633+03 4.478+05 1.643+03 4.331+05
1.653+03 4.483+05 1.663+03 4.234+05 1.673+03 4.189+05 1.683+03 4.059+05
1.693+03 4.008+05 1.703+03 3.981+05 1.713+03 3.930+05 1.723+03 3.816+05
1.733+03 3.745+05 1.743+03 3.657+05 1.753+03 3.660+05 1.756+03 3.394+05
1.761+03 3.510+05 1.766+03 3.467+05 1.771+03 3.373+05 1.776+03 3.369+05
1.781+03 3.431+05 1.786+03 3.431+05 1.791+03 3.326+05 1.796+03 3.314+05
1.801+03 3.420+05 1.803+03 3.709+05 1.804+03 3.652+05 1.805+03 3.671+05
1.806+03 3.644+05 1.807+03 3.601+05 1.808+03 3.682+05 1.809+03 3.659+05
1.810+03 3.682+05 1.811+03 3.771+05 1.812+03 3.615+05 1.813+03 3.728+05
1.814+03 3.689+05 1.815+03 3.789+05 1.816+03 3.815+05 1.817+03 3.843+05
1.818+03 3.973+05 1.819+03 4.103+05 1.820+03 4.270+05 1.821+03 4.363+05
1.822+03 4.371+05 1.823+03 4.668+05 1.824+03 4.716+05 1.825+03 4.789+05
1.826+03 4.859+05 1.827+03 4.937+05 1.828+03 5.088+05 1.829+03 5.192+05
1.830+03 5.212+05 1.831+03 5.381+05 1.832+03 5.435+05 1.833+03 5.554+05
1.834+03 5.719+05 1.835+03 5.846+05 1.836+03 5.911+05 1.837+03 5.984+05
1.838+03 6.058+05 1.839+03 6.200+05 1.840+03 6.280+05 1.841+03 6.344+05
1.842+03 6.746+05 1.843+03 6.967+05 1.844+03 7.198+05 1.845+03 7.423+05
1.846+03 7.428+05 1.847+03 7.468+05 1.848+03 7.551+05 1.849+03 7.462+05
1.850+03 7.466+05 1.851+03 7.466+05 1.852+03 7.432+05 1.853+03 7.445+05
1.854+03 7.586+05 1.855+03 7.747+05 1.856+03 7.862+05 1.857+03 7.887+05
1.858+03 8.004+05 1.859+03 8.066+05 1.860+03 8.027+05 1.861+03 8.097+05
1.862+03 8.024+05 1.863+03 7.957+05 1.864+03 8.053+05 1.865+03 7.880+05
1.866+03 7.903+05 1.867+03 7.867+05 1.868+03 7.915+05 1.869+03 7.742+05
1.870+03 7.852+05 1.871+03 7.891+05 1.872+03 7.877+05 1.873+03 8.009+05
1.874+03 8.030+05 1.875+03 7.966+05 1.876+03 8.050+05 1.877+03 8.013+05

2.046+03 1.103+06 2.046+03 1.091+06 2.047+03 1.090+06 2.048+03 1.100+06
2.049+03 1.089+06 2.050+03 1.092+06 2.051+03 1.092+06 2.051+03 1.085+06
2.052+03 1.094+06 2.053+03 1.084+06 2.054+03 1.085+06 2.055+03 1.078+06
2.056+03 1.079+06 2.056+03 1.070+06 2.057+03 1.080+06 2.058+03 1.079+06
2.059+03 1.078+06 2.060+03 1.071+06 2.061+03 1.069+06 2.061+03 1.072+06
2.062+03 1.063+06 2.063+03 1.060+06 2.064+03 1.061+06 2.065+03 1.062+06
2.066+03 1.062+06 2.066+03 1.060+06 2.067+03 1.053+06 2.068+03 1.051+06
2.069+03 1.044+06 2.070+03 1.042+06 2.071+03 1.045+06 2.071+03 1.043+06
2.072+03 1.043+06 2.073+03 1.046+06 2.074+03 1.047+06 2.075+03 1.060+06
2.076+03 1.030+06 2.076+03 1.058+06 2.077+03 1.057+06 2.078+03 1.053+06
2.079+03 1.068+06 2.080+03 1.072+06 2.081+03 1.056+06 2.081+03 1.080+06
2.082+03 1.084+06 2.083+03 1.082+06 2.084+03 1.081+06 2.085+03 1.083+06
2.086+03 1.067+06 2.086+03 1.076+06 2.087+03 1.082+06 2.088+03 1.079+06
2.089+03 1.079+06 2.090+03 1.079+06 2.091+03 1.077+06 2.091+03 1.080+06
2.092+03 1.070+06 2.093+03 1.072+06 2.094+03 1.064+06 2.095+03 1.068+06
2.096+03 1.070+06 2.096+03 1.069+06 2.097+03 1.067+06 2.098+03 1.069+96
2.099+03 1.076+06 2.100+03 1.066+06 2.101+03 1.066+06 2.101+03 1.076+06
2.102+03 1.063+06 2.103+03 1.070+06 2.104+03 1.064+06 2.105+03 1.053+06
2.106+03 1.059+06 2.106+03 1.060+06 2.107+03 1.062+06 2.108+03 1.045+06
2.109+03 1.039+06 2.110+03 1.039+06 2.111+03 1.050+06 2.111+03 1.039+06
2.112+03 1.030+06 2.113+03 1.040+06 2.114+03 1.032+06 2.115+03 1.020+06
2.116+03 1.037+06 2.116+03 1.026+06 2.117+03 1.029+06 2.118+03 1.032+06
2.119+03 1.023+06 2.120+03 1.017+06 2.121+03 1.030+06 2.121+03 1.017+06
2.122+03 1.018+06 2.123+03 1.020+06 2.124+03 1.016+06 2.125+03 1.005+06
2.126+03 1.024+06 2.126+03 1.012+06 2.127+03 1.011+06 2.128+03 1.012+06
2.129+03 1.011+06 2.130+03 1.008+06 2.131+03 1.020+06 2.131+03 1.006+06
2.132+03 1.004+06 2.133+03 1.002+06 2.134+03 9.975+05 2.135+03 1.002+06
2.136+03 1.006+06 2.136+03 9.951+05 2.137+03 1.003+06 2.138+03 9.990+05
2.139+03 9.826+05 2.140+03 9.837+05 2.141+03 1.009+06 2.141+03 9.894+05
2.142+03 9.911+05 2.143+03 1.000+06 2.144+03 9.878+05 2.145+03 9.968+05
2.146+03 1.003+06 2.146+03 9.831+05 2.147+03 9.913+05 2.148+03 9.991+05
2.149+03 9.887+05 2.150+03 9.936+05 2.151+03 1.003+06 2.151+03 9.866+05
2.152+03 9.924+05 2.153+03 1.003+06 2.156+03 1.010+06 2.158+03 1.006+06
2.161+03 1.013+06 2.163+03 1.014+06 2.166+03 1.008+06 2.168+03 1.012+06
2.171+03 1.004+06 2.173+03 1.001+06 2.176+03 1.005+06 2.178+03 1.007+06
2.181+03 9.964+05 2.183+03 9.892+05 2.186+03 9.787+05 2.188+03 9.785+05
2.191+03 9.759+05 2.193+03 9.710+05 2.196+03 9.609+05 2.198+03 9.582+05
2.201+03 9.708+05 2.203+03 9.585+05 2.206+03 9.602+05 2.208+03 9.521+05
2.211+03 9.574+05 2.213+03 9.512+05 2.216+03 9.614+05 2.218+03 9.568+05
2.221+03 9.580+05 2.223+03 9.487+05 2.226+03 9.402+05 2.228+03 9.509+05
2.231+03 9.498+05 2.233+03 9.387+05 2.236+03 9.488+05 2.238+03 9.441+05
2.241+03 9.417+05 2.243+03 9.439+05 2.246+03 9.459+05 2.248+03 9.389+05
2.251+03 9.322+05 2.253+03 9.429+05 2.256+03 9.349+05 2.258+05 9.367+05
2.261+03 9.378+05 2.263+03 9.394+05 2.266+03 9.408+05 2.268+03 9.484+05

2.364+07 2.257+01 2.390+07 2.269+01 2.413+07 2.274+01 2.438+07 2.282+01
2.463+07 2.295+01 2.485+07 2.294+01 2.513+07 2.301+01 2.536+07 2.310+01
2.562+07 2.316+01 2.580+07 2.322+01 2.608+07 2.335+01 2.631+07 2.347+01
2.657+07 2.340+01 2.682+07 2.342+01 2.708+07 2.360+01 2.735+07 2.366+01
2.759+07 2.374+01 2.786+07 2.369+01 2.810+07 2.380+01 2.837+07 2.390+01
2.861+07 2.402+01 2.888+07 2.406+01 2.910+07 2.403+01 2.937+07 2.419+01
2.961+07 2.424+01 2.989+07 2.425+01 3.080+07 2.448+01 3.126+07 2.458+01
3.177+07 2.472+01 3.227+01 2.483+01 3.277+07 2.491+01 3.324+07 2.504+01
3.374+07 2.519+01 3.426+07 2.518+01 3.478+07 2.535+01 3.528+07 2.538+01
3.577+07 2.547+01 3.627+07 2.570+01 3.672+01 2.573+01 3.721+07 2.577+01
3.772+07 2.588+01 3.823+07 2.592+01 3.873+07 2.606+01 3.923+07 2.617+01
3.975+07 2.623+01 4.021+07 2.630+01 4.070+07 2.639+01 4.119+07 2.657+01
4.176+07 2.659+01 4.223+07 2.661+01 4.276+07 2.681+01 4.326+07 2.682+01
4.378+07 2.699+01 4.424+07 2.691+01 4.482+07 2.704+01 4.533+07 2.716+01
4.584+07 2.724+01 4.636+07 2.721+01 4.683+07 2.740+01 4.730+07 2.742+01
4.781+07 2.744+01 4.829+07 2.756+01 4.877+07 2.761+01 4.933+07 2.774+01
4.981+07 2.764+01 5.033+07 2.776+01 5.081+07 2.799+01 5.136+07 2.809+01
5.183+07 2.810+01 5.235+07 2.807+01 5.282+07 2.825+01 5.338+07 2.827+01
5.386+07 2.843+01 5.440+07 2.845+01 5.485+07 2.847+01 5.526+07 2.865+01
5.574+07 2.857+01 5.616+07 2.854+01 5.665+07 2.870+01 5.706+07 2.869+01
5.757+07 2.873+01 5.813+07 2.869+01 5.865+07 2.900+01 5.923+07 2.896+01
5.970+07 2.903+01 6.026+07 2.901+01 6.067+07 2.923+01 6.121+07 2.922+01
6.171+07 2.919+01 6.227+07 2.932+01 6.279+07 2.935+01 6.328+07 2.940+01
6.381+07 2.955+01 6.427+07 2.949+01 6.467+07 2.969+01 6.523+07 2.946+01
6.573+07 2.967+01 6.620+07 2.964+01 6.674+07 2.979+01 6.726+07 2.974+01
6.779+07 2.999+01 6.818+07 2.981+01 6.876+07 3.011+01 6.930+07 3.011+01
6.980+07 2.993+01 7.020+07 3.003+01 7.079+07 2.999+01 7.127+07 3.015+01
7.174+07 3.013+01 7.215+07 3.036+01 7.279+07 3.040+01 7.335+07 3.031+01
7.374+07 3.049+01 7.422+07 3.049+01 7.479+07 3.050+01 7.551+07 3.042+01
7.663+07 3.051+01 7.765+07 3.081+01 7.854+07 3.064+01 7.949+07 3.084+01
8.050+07 3.098+01 8.154+07 3.082+01 8.257+07 3.108+01 8.353+07 3.111+01
8.451+07 3.117+01 8.556+07 3.137+01 8.656+07 3.135+01 8.749+07 3.124+01
8.848+07 3.145+01 8.947+07 3.148+01 9.051+07 3.151+01 9.150+07 3.163+01
9.245+07 3.177+01 9.348+07 3.188+01 9.454+07 3.178+01 9.551+07 3.181+01
9.649+07 3.187+01 9.751+07 3.198+01 9.842+07 3.203+01 9.940+07 3.206+01
1.004+08 3.215+01 1.014+08 3.227+01 1.024+08 3.233+01 1.035+08 3.229+01
1.044+08 3.245+01 1.055+08 3.254+01 1.065+08 3.269+01 1.075+08 3.248+01
1.086+08 3.260+01 1.097+08 3.255+01 1.107+08 3.287+01 1.117+08 3.280+01
1.128+08 3.293+01 1.136+08 3.299+01 1.145+08 3.294+01 1.155+08 3.302+01
1.163+08 3.287+01 1.174+08 3.305+01 1.183+08 3.300+01 1.192+08 3.310+01
1.204+08 3.316+01 1.215+08 3.318+01 1.225+08 3.351+01 1.234+08 3.324+01
1.246+08 3.338+01 1.260+08 3.333+01 1.280+08 3.347+01 1.302+08 3.360+01
1.319+08 3.362+01 1.340+08 3.384+01 1.361+08 3.372+01 1.379+08 3.385+01
1.399+08 3.397+01 1.421+08 3.404+01 1.441+08 3.415+01 1.458+08 3.422+01

57 La	1	13
58 Ce	2	13
59 Pr	2	13
60 Nd	2	13
62 Sm	1	11
63 Eu	1	1
64 Gd	4	14
65 Tb	2	2
66 Dy	4	14
67 Ho	2	12
68 Er	4	14
70 Yb	1	2
73 Ta	5	426
74 W	2	507
78 Pt	1	2
79 Au	3	7
82 Pb	2	244
92 U	2	3

48 Elements Total Data Points Extracted: 3357