Electronic Stopping Power of Proton in Elements

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ABSTRACT

The problem of the energy loss of protons penetrating into material has been attacked in the present work. Stopping power due to the interaction of protons with the electrons of the medium is discussed basicly not going beyond linear response theories. The corresponding physical models, their limitations and possible improvements are briefly summarized. Beside the classical models a more recent model is presented, which allows the consideration of impact parameter dependent electronic energy losses. Experimental data have been compiled and compared to those obtained by theories resulting in tables of low energy (below the Fermi energy) stopping cross sections for elements ranging from lithium to uranium as a function of energy.

Electronic Stopping Power of Proton in Elements

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Introduction

The penetration of particles in solids is an area of science, whose importance has been growing throughout the last some decades. Electronic device fabrication, ion beam techniques, methods of surface analysis, extraterrestial investigations of electronics imply the fundamental and universal theoretical description of related physical phenomena. Problems arising are usually classified according to the complexity of the applied physical model as

- point charge penetrating into a solid described by an electron gas
- point charge penetrating into a solid described by an electron gas, including polarization of the medium,
- charge of finite volume penetrating into a solid described by an electron gas,
- charge of finite volume penetrating into a solid described by an electron gas, including polarization of the medium and changes in the charge state of the projectile,
- charge of finite volume penetrating into a solid described by an electron gas and atomic cores, including polarization of the medium, changes in the charge state of the projectile and screened Coulomb scattering,
- those above including relativistic effects due to projectile velocity and/or inner shell electron velocity.

The model applied for the electron gas itself can be as simple as a homogeneous electron gas, or a jellium model, or can be sophisticated, as a solid state electron gas.

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In other words, the physical reasons of the electronic damping are the following processes, kinetic energy transfer from projectile electron to target electron, excitation or ionization of the target atom (promotion of localized, bound electrons), excitation of conduction (unlocalized) electrons, excitation, ionization or electron capture of the projectile.

In this compilation electronic stopping powers of protons penetrating in solid media as a function of the projectile energy are compared. Beside empirical stopping powers, also the results of linear response theory are presented. The electronic stopping cross section is defined as

$$S \stackrel{\text{def}}{=} \frac{1}{M}\frac{dE}{dr} \tag{1}$$

where M is the atomic density of the target, E the instantaneous energy of the moving particle, dE/dr the electronic stopping power, which latter is a force like quantity that acts against the motion of the projectile in the medium due to the target electron-projectile ion interaction. All the way through this presentation 'stopping' will be used as an abbreviated synonym for either 'stopping cross section' or 'stopping power'. This slackness is widely spread in the literature. Mathematical correctness is maintained by distinguishing between physical units of dE/dr (eV/Å) and S (10^{-15} eV cm^2/atom).

In the framework of dielectric theory dE/dr is related to the integral of the imaginary part of the reciprocal longitudinal dielectric function over energy. In the primary energy regime below the Fermi energy of the target electrons, the slowly moving, fully stripped and frozen point charge can be well approached by a static impurity picture, and therefore linear response theory may give an adequate description of the interaction of the moving projectile and the electron system of the target. In this report energies below 1 keV and over 25 keV will not be discussed. Below 1 keV the energy loss and slowing down of an ion in a solid is dominated by elastic scattering effects. Above 25 keV, the static impurity picture and therefore the static dielectric description looses its validity. No relativistic corrections and no finite-temperature effects are considered. Exclusively proton will be considered as a projectile. Generalization of the results to heavier projectiles may be achieved via either the effective charge theory, or the statistical electronic stopping model. The present discussion does not go beyond linear response theory in details although, e.g., recent results of density functional calculations will be studied as a basis for comparison. This restriction is due to several reasons beyond volume limitations, and these will be discussed to some

extent. Completeness, in this sense, has not even been aimed. Results of two models elaborated by the author and his coworkers and of some further theories predicting a velocity proportional electronic stopping will be compared in reasonable details. Neither elastic (nuclear) nor inelastic (electronic) energy straggling is included in this study in spite of their role in attracting the attention of physicists in the field. This is owing to the fact that the calculation of energy straggling within the linear response theory lies on the same fundaments as that of the energy loss. Some references from this aspect are [1,2]. The target range covers the periodic table, although some of the data may be accepted with reservations only (see the Remarks to the Tables).

A natural continuation of a study on stopping powers would be a description of ranges of particles into matter [3-6]. This is here also not presented simply due to volume limitations.

Projectiles of higher atomic numbers (the statistical theory [7]) will not be discussed, since the results obtained for protons can be extended – with limitations – to heavier particles on the basis of the so called effective charge theory [8].

This is also the reason for not speaking about the oscillatory model [9,10].

In context here, another modern topic to be included would be the charge state of ions at a solid surface or in a solid [11], which subject would also lead us too far, e.g., to antiproton stopping (e.g., [12]).

Recent studies involve the effect of finite temperatures [13], the contribution of the surface to the stopping [14], the vicinity effect for molecular impinging beams [15].

Wave packet theory for stopping shell by shell can be read in [16], while the boson formalism was also applied for proton motion in an interactive electron gas [17]. Non-linear screening plays another important but here neglected role in stopping calculations, e.g., [18].

Theory

In order to get a comprehensive view over the field the reader is referred to [4].

Fermi and Teller are considered as pioneers of the field of stopping theory [19]. Their model applied for the electronic stopping of heavy intruders (negative mesons) at the high electron density limit, which implies strong screening and therefore the exclusion of bound states.

1) As the first consistent theory of the electronic stopping within the dielectric formalism (referred to as a random phase approximation – RPA) Lindhard et al. described the slowing down of a point charge in a polarizable medium [20]. The strong temptation of solving the problem within linear response theory relies on the fact, that once the dielectric function of the medium is known, the induced potential (or screening) can be deduced. Basic assumptions in their work (after [3]) were

- free electron gas,
- $T = 0$ K temperature,
- fixed, uniform, positive background charges,
- constant initial density of the electron gas,
- penetration causes a small perturbation, only,
- non-relativistic velocities.

Starting from the Poisson equation, the change of the kinetic energy (W) per unit time can be written in the form

$$\frac{1}{v}\frac{dW}{dt} = e\frac{\vec{v}}{v}\vec{E}(\vec{r},t) \tag{2}$$

with $\vec{r} = \vec{v}t$ distance, $\vec{v}$ instantaneous velocity, $\vec{E}$ time and space dependent electric field, e electron charge. Using the above assumptions and Fourier transforming the equation, we get

$$\frac{1}{v}\frac{dW}{dt} = \frac{e^2}{2\pi^2 v}\int dk \frac{\omega}{k^2} Im\frac{1}{\varepsilon(\omega,k)} \tag{3}$$

where $\omega = \vec{k}\vec{v}$, $\vec{k}$ the wave vector, ε the dielectric function. Making some further assumptions the final result for the stopping power [21] (which was not published in great details) can be expressed as

$$S_{LS} = 80\pi e^2 a_0 f(Z)\frac{v}{v_0} \tag{4a}$$

or in terms of energy

$$S_{LS} = 12.12 f(Z)\sqrt{E} \tag{4b}$$

with

$$f(Z) = \frac{Z}{(1+Z^{2/3})^{3/2}}$$

(for proton intruders here) in 10^{-15} eVcm^2/atom, if E is substituted in eV. a_0 the first Bohr radius ($\hbar^2/(m_e e^2)$) with m_e electron mass, v_0 the first Bohr velocity ($e^2/\hbar$) and Z the atomic number of the target.

2) Formulas fitted to experimental data usually follow the rule

$$S_{expt} = A_{expt} E^{b_{expt}} \tag{5}$$

where A_{expt} and b_{expt} are the fitted parameters. Examples will be taken in the forthcoming chapter. $b_{expt} = 0.5$ has been experimentally justified in [22].

3) Oen and Robinson [23] assumed the following approximate form for the stopping power

$$S_{OR} = S_{LS}(\frac{C}{a})^2 \int_0^{p_{max}} p * e^{-\frac{Cr_0}{a}} dp \tag{6a}$$

where C is the factor of the first exponential term in the screened Coulomb interaction potential, a the screening length (a_0 or other), p_{max} the maximal impact parameter (determined by the atomic density of the matter), r_0 the apsis of the trajectory. In the limiting case, where $E \to \infty$, $r_0 \to p$ and so

$$S_{OR} = S_{LS}[1 - (\frac{C}{a} p_{max} + 1) * e^{\frac{C p_{max}}{a}}] \tag{6b}$$

where the second term in the brackets is usually a small correction only.

4) The Andersen and Ziegler tables [5] as against those mentioned so far do not give a velocity dependent electronic stopping above 10 keV. The power of energy has been obtained by fitting curves to experimental data available in the whole energy range. For the interval between 1 and 10 keV the authors suggest

$$S_{AZ} = A_1 \sqrt{E} \tag{7a}$$

while for higher energies

$$S_{AZ} = \frac{S_L S_H}{S_L + S_H} \tag{7b}$$

with

$$S_L = A_2 E^{0.45}$$

and

$$S_H = \frac{A_3}{E} * \ln(1 + \frac{A_4}{E} + A_5 E)$$

The A_1 through A_5 coefficients are listed in their tables.

5) The model of Biersack et al. [24] has not been extended to all elements. The authors also suggested to divide the stopping into low and high energy parts

$$S_{BE} = \frac{S_L S_H}{S_L + S_H} \tag{8}$$

with

$$S_L = \frac{\sqrt{E}}{C}$$

and

$$S_H = \frac{B}{E} * \ln(1 + AE + \frac{5}{AE})$$

The parameters A, B and C are listed in their report.

6) The model of Montenegro et al. [25] does also not obviously result in a velocity proportional electronic stopping, because they included an exponential term in their fitting procedure. For such low energies in question

$$S_{MS} = S_{LS} * e^{-6.331*10^{-3}\sqrt{E}} \tag{9}$$

is resulted.

7) The basis for the so called impact parameter dependent stopping model [26] is the linear response theory. A simple model of the atom as proposed by Gertner et al. [27] has been used. In their work the atom consists of a core and two concentric spherical shells. The outer shell represents a free electron gas of constant density (c_0), while the inner shell is characterized by such a solid state electron gas, that the density is continuous at the boundary (c_i density correction). Out of the atomic volume the electron density is zero. The following coupled equations determine c_0, c_i and the radius of the inner sphere (R)

$$\frac{4}{3}\pi(R_x^3 - R^3)c_0 = N_{eff} \tag{10a}$$

$$4\pi \int_0^R r^2 n_A(r)dr + \frac{4}{3}\pi R^3 c_i = Z - N_{eff} \tag{10b}$$

and

$$c_0 = c_i + n_A(R) \tag{10c}$$

where R_x is the muffin-tin radius of the atom (the radius of the outermost shell), N_{eff} the effective number of electrons participating in the volume plasmon excitation and $n_A(r)$ is the free atom electron density. The modified electron density has the form

$$n(r) = \begin{cases} n_A(r) + c_i & \text{if } r \leq R \\ c_0 & \text{if } R \leq r \leq R_x \\ 0 & \text{if } r > R_x \end{cases} \tag{11}$$

We shall come back to the question of the determination of the input parameters (relying on N_{eff}) in the following chapter. The free-atom electron density has been taken over from the model of Green et al. [28]. This is an independent particle approximation with a radial electron density

$$4\pi r^2 n_A(r) = \frac{N}{d}\xi \frac{H * e^{\xi}}{(HT+1)^2}(-1 + \frac{2H * e^{\xi}}{HT+1}) \tag{12}$$

with $T = e^{\xi} - 1$, $\xi = r/d$ and $H = 1.05dN^{0.4}$. N stands for the number of bound electrons in the given atom, d is adjustable parameter. The absolute value of the radial electric field is then obtained as

$$E(r) = \begin{cases} 0 & \text{if } r > R_x \\ \frac{N_{eff}}{r^2} - \frac{4}{3}\pi c_0(r - \frac{R^3}{r^2}) & \text{if } R \leq r \leq R_x \\ \frac{Z}{r^2} - \frac{4}{3}\pi c_i r + \frac{N}{r^2}[\frac{\xi H e^{\xi}}{(HT+1)^2} + \frac{1}{HT+1} - 1] & \text{if } r \leq R \end{cases} \tag{13}$$

The potential the proton feels at a distance r from the target nucleus is then

$$V(r) = -\int_{R_x}^{r} E(r')dr' \tag{14a}$$

The analytical potential of the free atom is then

$$V(r) = \frac{Z}{r}(1 - \frac{N}{Z}\frac{HT}{HT+1}) \tag{14b}$$

while the screened potential corresponding to the Gertner atom model is

$$V(r) = \begin{cases} \frac{Z}{r}(1 - r/R)(1 - \frac{N}{Z}\frac{HT}{HT+1}) = \\ -\frac{4\pi c_0 R_x^3}{3R}(1 - 1.5R/R_x + 0.5R^3/R_x^3) & \text{if } r \leq R \\ \frac{4\pi c_0 R_x^3}{3R}(1 - 1.5r/R_x + 0.5r^3/R_x^3) & \text{if } R \leq r \leq R_x \\ 0 & \text{if } r > R_x \end{cases} \tag{14c}$$

Being aware of the central symmetrical interaction potential between proton and screened target nucleus and keeping in mind that the kinetic energy of the proton is much bigger, than the electronic energy loss, we can determine the curved trajectory the proton travels along. On the basis of classical two-body elastic scattering theory, supposing an instantaneous velocity of $\vec{v}(\vec{r})$ at point $\vec{r}$ we obtain the trajectory equation as

$$\vec{v}(\vec{r})d\vec{r} = v_0[1 - \frac{V(r)}{E_0} - (\frac{p}{r})^2]^{-\frac{1}{2}}dr \tag{15}$$

where v_0 and E_0 are the initial velocity and energy of the proton, resp. and p the impact parameter. Regarding our previously mentioned belief in linear response theory, we assume that the proton slowing down (damping) is due to a friction like, i.e., a velocity proportional force. If this is the case, the infinitesimal energy loss along an infinitesimal pathlength is

$$dE = -KC(\vec{r})\vec{v}(\vec{r})d\vec{r} \tag{16}$$

where $K = (4m_e^2e^4)/(3\hbar^3\pi)$ (with m_e electron mass) is a constant, and $C(\vec{r})$ must be a proportionality factor characteristic of the target matter. The determination of C can be based on either theory (e.g., on the basis of the dielectric theory, see below) or on experiments (see later). For the atom model, we use the local density approximation (LDA, first applied to stopping calculations in [29]) to find a relationship between the so called density parameter and the spherically symmetrical electron density. The basic

feature of LDA is that independent plasma volume elements build up the solid, and the response of these volumes are averaged according to their distribution function. Further assumptions involved are

- the electron density changes slowly with distance,
- the energy levels and transition strengths are those of a free electron gas.

In this approximation

$$\kappa^2(r) = [3\pi^5 n(\vec{r})]^{-\frac{1}{3}} \tag{17}$$

A form of $C(\kappa^2)$ going beyond the Lindhard result (by considering an interacting electron gas) has been proposed [30] on the basis of Hubbard's model for the dielectric function of a degenerate electron gas (after [31])

$$\varepsilon = 1 + \frac{Q}{1 - QG} \tag{18}$$

where Q is the complex Lindhard polarizability and G the complex local field correction describing dynamic exchange and short-range correlation effects due to the Coulomb interaction of the electrons (analysed in [32]). Both quantities depend on frequency and wave number. In general

$$Im\frac{1}{\varepsilon} = \frac{-Q"[1 + \frac{G"}{Q"}(Q'^2 + Q"^2)]}{[1 - Q'(G' - 1) + Q"G"]^2 + [G"Q' + Q"(G" - 1)]^2} \tag{19}$$

holds, where $Q = Q' + iQ"$ and similarly $G = G' + iG"$. Consequently, the expression for C is

$$C(\kappa^2) = \frac{6}{\pi}\int_0^1 C(\kappa^2, z) z dz \tag{20a}$$

$$C(\kappa^2, z) = \int_0^\infty dx \frac{x^3 f_2[1 + \frac{G"}{Q"}(Q'^2 + Q"^2)]}{[x^2 - \kappa^2 f_1(G' - 1) + \kappa^2 f_2 G"]^2 + [\kappa^2 f_1 G" + \kappa^2 f_2(G' - 1)]^2} \tag{20b}$$

with the following notation $x = k/2k_F$, k_F the Fermi wave number.

$$f_1 = 0.5 + \frac{0.125}{x}\{[1-(x-u)^2] * \ln\left|\frac{x-u+1}{x-u-1}\right| + [1-(x+u)^2] * \ln\left|\frac{x+u+1}{x+u-1}\right|\} \quad (20c)$$

and

$$f_2 = \begin{cases} 0.5\pi u & \text{if } x+u<1 \\ \frac{0.125\pi}{x}[1-(x-u)^2] & \text{if } |x-u|<1<x+u \\ 0 & \text{if } |x-u|>1 \end{cases} \quad (20d)$$

where $u = 0.2\pi\kappa^2 z\sqrt{E}$. The complex polarizability can be expressed in terms of f_1 and f_2

$$Q = \frac{\kappa^2}{x^2}(f_1 + if_2) \quad (21)$$

The following formula has been proposed as a dynamic local field correction for the complete energy range [33] (applied later in [34])

$$G = \frac{1}{1+y^2}\{y^2 I(x) + G(x) + iy[G(x) - I(x)]\} \quad (22a)$$

with $y = 1.73ux/\sqrt{\kappa^2}$ and

$$I(x) = -\frac{3}{16}[\frac{32}{63\eta^2} - \frac{608}{945} - \frac{142\eta^2}{315} - \frac{2\eta^4}{315} + \frac{\eta^4}{35}(2 - \frac{\eta^2}{18}) * \ln\left|1 - \frac{4}{\eta^2}\right| +$$

$$(-\frac{32}{63\eta^2} + \frac{24}{35} - \frac{2\eta^2}{5} + \frac{\eta^4}{6})\frac{1}{\eta} * \ln\left|\frac{\eta+2}{\eta-2}\right|] \quad (22b)$$

with $\eta = 2x$. A static local field correction has been chosen according to the expected boundary conditions

$$G(x) = \begin{cases} x^2 & \text{if } x \leq 1 \\ x^2/3 - 4x/3 + 2 & \text{if } 1 \leq x \leq 2 \\ 2/3 & \text{if } x \geq 2 \end{cases} \tag{22c}$$

Restricting our discussion to low energies and applying different approximations, we can have the expressions for C from earlier theories as limits. E.g., in the small k limit (small $x = k/2k_F$) and using a first order expansion of f_1 ($f_1 = 1$) [35]

$$C(\kappa^2) = 0.5[\ln(1 + \frac{1}{\kappa^2}) - \frac{1}{1+\kappa^2}] \tag{23a}$$

which is a modification of the Fermi-Teller result [19] of

$$C(\kappa^2) \propto \ln\frac{1}{\kappa^2} \tag{23b}$$

Expanding f_1 to a second order ($f_1 = 1 - \kappa^2/3$), the result is

$$C(\kappa^2) = 4.5\frac{1}{(3-\kappa^2)^2}[\ln(\frac{2\kappa^2+3}{3\kappa^2}) - \frac{3-\kappa^2}{3+2\kappa^2}] \tag{24}$$

If we take the complete f_1 function, we can come up with the result obtained by Lindhard and Winther [20]. Rewriting and simplifying Eq.20a by taking only static local field correction and neglecting second and higher order terms in Eq.19, we get the following result for an interacting electron gas

$$C(\kappa^2) = \int_0^1 \frac{x^3\{1 + \kappa^2 f_1(x)[1.5 - G(x)/x^2]\}}{\{x^2 - \kappa^2 f_1(x)[G(x) - 1]\}^2} dx \tag{25}$$

with

$$f_1(x) = 0.5 + \frac{1-x^2}{4x} * \ln\left|\frac{x+1}{x-1}\right|$$

where $G(x)$ is the static local field correction function. It may be worth mentioning at this point that the different expansions of f_1 lead us to well known interaction potentials. The first order expansion corresponds to a Yukawa type potential, the second order expansion to what Lindhard and Winther have proposed [20], the expansion in the high-k limit to what Bonch-Bruevich and Glasko suggested [36].

It must be added to this short review that the derivation of a proper local field correction requires many-body techniques [32,37], and goes beyond the present topic. Strictly speaking G depends on the target material, i.e., on r_s [38]. Both exchange and correlation must be considered for the derivation of the local field correction in order to make the very sensitive function smooth at $k = 2k_F$, as it should be on physical considerations (discussed in [39]).

Another possibility is also given to find $C(\kappa^2)$. In the frame of the Landau theory of Fermi liquids [40] (idea after [41]), we can get

$$C(\kappa^2) = \frac{1 + F_1^s/3}{2(1 + F_0^s)^2}[\ln(1 + \frac{1}{\kappa_x^2}) - \frac{1}{1 + \kappa_x^2}] \tag{26}$$

where the modified density parameter is

$$\kappa_x^2 = \frac{\kappa^2}{(1 + F_0^s)(1 + F_1^s/3)}$$

The coefficients F_0^s and F_1^s can be determined from the effective mass to mass ratio

$$m_e^*/m_e = 1 + F_1^s/3$$

and from the compressibility ratio

$$\chi^0/\chi = \frac{1 + F_0^s}{1 + F_1^s/3}$$

where χ^0 and χ are the compressibilities of the free and the correlated electron gas, resp.

A further possibility relies in the application of the scattering theory [42], where

$$dE/dx = nv_F v m_e \sigma_{tr} \tag{27a}$$

with n density of the electron gas, and σ_{tr} transport cross section. Then, again

$$dE/dx = -\frac{4e^4 m_e^2}{3\pi\hbar^3} C(\kappa^2) v \tag{27b}$$

and

$$C(\kappa^2) = \frac{1}{\pi\kappa^2} \sum_{l=0}^{\infty} (l+1) \sin^2[\delta_l(E_F) - \delta_{l+1}(E_F)] \tag{28}$$

where δ_l's are the phase shifts of the outgoing wave scattered on a screened proton (see details in [43]). We shall come back to the choice of the potential later. In a first Born approximation ($v << v_F$, and so $\kappa^2 << 1$ or equivalently $r_s << 1$), applying a Yukawa type potential with a screening factor $2\sqrt{\kappa^2}/\pi$, the result for $C(\kappa^2)$ is identical to Eq.23a. The main point in scattering theory is not only how accurately one can calculate the phase shifts, but how consistently a potential can be determined. Using a model potential beyond the Thomas-Fermi model, e.g., a Hartree-Fock approximation fulfilling the compressibility rules, unexpected electronic losses are resulted for high r_s values, and especially around $r_s = 6$ ($\kappa^2 = 1$), which is the stability limit of the jellium electron gas in this approximation. Some points of scattering theory will be discussed later in this point.

Integrating Eq.14 along the trajectory we can obtain an energy loss function, that depends on impact parameter and initial energy

$$\epsilon(p, E_0) = -2K \int_{r_0}^{R_x} C(r) \vec{v}(\vec{r}) d\vec{r} \tag{29}$$

where r_0 is the apsis of the trajectory. These functions have been shown to increase with increasing primary energy and have a local maximum as a function of impact parameter as expected from experiments [44] and theory [10,45]. By integrating over all impact parameters we obtain the stopping power as

$$S = 2\pi \int_0^{R_x} p * \epsilon(p, E_0) dp \tag{30}$$

It has been checked by the Moruzzi-Janak-Williams atomic electron density model [46], whether the obtained stopping powers are sensitive on the applied solid state electron density or not [28]. The averaging over radius and impact parameter seems to be sufficient to smear out small density fluctuations. From this standpoint it looks like less sophisticated atomic electron densities would also give comparable results.

8) In the so called volume averaged electronic loss model [28] the procedure is similar to that described before. The basic difference is, that we do not assume a curved, but a straight line trajectory of the proton in the field of the target atom, i.e., we exchange the order of integration over r (Eq.18) and p (Eq.19). Then the integral is simplified to

$$S = -4\pi K v_c \int_0^{R_x} r^2 C(r) dr \tag{31}$$

where v_c is a constant velocity.

Leaving earlier theories alone, the most recent theory for the description of electronic stopping is based on a binary encounter approximation (BEA) [47]. The electronic stopping in this approach is proportional to the transport cross section at a mean, relative velocity of the colliding particles (electrons and the heavy atom). For a spherically symmetrical scattering potential, the transport cross section can be expressed in terms of phase shifts at the Fermi level. The parameter of a one-parameter potential can be selfconsistently calculated by using the Friedel sum rule [48] at the static limit. Typical model potentials are the Yukawa and the Hulthen types. For non-linear screening effects [18,49], one needs a first principles theory, that provides full selfconsistency. Such is the density functional theory (DF) [50]. Linear response theory [20,51] deals with a frozen point charge as an intruder. Density functional theory regards the projectile with a bound electron. The principal question is still the charge state of the projectile. Can a proton in an experimental situation bind an electron? Can this bound state be populated? For a first approximation, we can take the binding energy for real metals in the order of 10^{-2} – 10^{-3} eV [52]. The probability that a "H-atom" remains in ground state supposing the validity of the "sudden" picture, if the proton moves with a speed of v is [53]

$$(1 + .25\frac{m_p v^2}{E_b})^{-4} << 1 \tag{32}$$

if E_b is the binding energy, m_p the mass of the proton. The development of a bound state is therefore questionable (as discussed in [54]). Density functional theory uses the Friedel sum rule at the Fermi energy, although there is a finite probability for electrons possessing an energy exceeding the Fermi energy in an interacting, degenerate electron gas, where the self-energy and the vertex corrections partially cancel according to Wick's theorem (see details in [55]). For velocities close to the Fermi velocity, DF has no more existence theorem for velocity-dependent (dynamic) processes. (We implicitly always use the steady-state 'outgoing scattering wave' approximation.) At these energies we are left alone with linear response theory of an homogeneous electron gas. If we accept that a hydrogen atom moves always as a bare nucleus in a solid, then a reason for using the effective charge theory [8] can be elaborated.

Since some of the measurements have been carried out on compound targets we should mention Bragg's rule [56], that applies perfectly for higher energies and fails in the lower regime. It states

$$S(x_m y_n) = mS_x + nS_y \tag{33a}$$

which is a simple superposition rule for a compound of $m/(m+n)$ atomic fraction of component x and $n/(m+n)$ of kind y. An alloy may be well described by the individual stopping powers of the constitutents, but molecules of such composition will probably exert very different electronic damping forces due to molecular binding effects. A more sophisticated formula for the summation has also been proposed [57] without curing the disadvantage of Eq.33a, namely its linearity

$$S(x_m y_n) = \frac{1}{w_{x_m y_n}}(mw_x S_x + nw_y S_y) \tag{33b}$$

This is more like a weighted average, where w's are molecular and atomic weights.

Experiments

A class of electronic stopping measurements is based on calorimetric principles, such as those available in the Andersen-Ziegler tables [5]. Some of the experiments were transmission through foils. In the low energy region these are basicly [2,58-63]. Channeling transmission helps to prevent effects due to nuclear collisions. Low energy transmission through metal foils have been done only once [64]. Scattering along surface channels with helium ions has also been executed [65]. Indirect data can be deduced from secondary kinetic electron emission studies [66], since under certain circumstances the yield is known to be proportional to the electronic stopping. Some measurements have been carried out by means of RBS [67].

Focusing on channeling experiments, we should mention some technical problems occuring in the measurements or later, in the evaluation of the raw data. Sources of discrepancies are the original surface roughness, surface contamination, target texture inhomogeneities, inhomogeneous mass distribution, uneven foil thickness, sputter thinning, inaccuracies in the thickness determination [68]. A problem with the evaluation arises, when comparing results to those of theory. An ideal case for the measurement would be $x << \lambda$ and in correlation to this $(E_0 - E_1)/E_0 << 1$, where λ is the mean free path of the projectile, x the target thickness, E_0 the initial, E_1 the most probable outcoming energy. If these assumptions hold, then $dE/dx \approx \Delta E/\Delta x = (E_0 - E_1)/x$. Theory predicts $dE/dx = KC\sqrt{\overline{E}}$. If we now compare our experimental and theoretical results in order to find C, we must define $\overline{E}$ appropriately. If the experimental situation is close to perfect, the mean energy can be either E_0 or E_1. If this is not the case, the following definitions have been used in the literature [69,70,64,71,72], resp.

$$\overline{E} = .5[E_0 + E(x)] \tag{34a}$$

$$\overline{E} = \frac{3}{5}\frac{E_0^{5/2} - E(x)^{5/2}}{E_0^{3/2} - E(x)^{3/2}} \tag{34b}$$

$$\overline{E} = .25[\sqrt{E_0} + \sqrt{E(x)}]^2 \tag{34c}$$

$$\overline{E} = .125[E_0 + E(x)] \tag{34d}$$

$$\overline{E} = \{\frac{(1-b)[E(x)-E_0]}{E(x)^{1-b} - E_0^{1-b}}\}^{1/b} \tag{34e}$$

with b the power of energy (Eq.5). Some of these definitions are fitted, and do not result in correct asymptotical behaviour.

Most of the early single stopping power values have been included in the tables of Andersen and Ziegler [5], and in the reviews of Brandt [73,74]. The following tables compile some additional experimental data completed with some calculated predictions (again energy in keV and stopping power in 10^{-15} eV cm^2/atom).

matter	proton energy (eV)	stopping power	reference
Cu	4,000	6.22	[75] (calc.)
Ge	20,000	24.67	[75] (calc.)
Se	20,000	27.58	[75] (calc.)
Ag	16,000	20.0	[76]
Ag	20,000	22.89	[75] (calc.)
Pd	20,000	19.99	[75] (calc.)
Sb	20,000	33.03	[75] (calc.)
Au	10,000	16.41	[75] (calc.)
Au	18,500	21.5	[76]
Bi	10,000	36.03	[75] (calc.)

Complete functional fits have been done in some cases on the basis of measured results for low energies (below the Fermi velocity). Since these studies always wanted to clear up deviations from the Lindhard formula, they presupposed an expression like Eq.5 even for compound targets. The following table shows such fits including lower limits of the incident energy (E_0). The upper limit always exceeds 25 keV.

matter	A_{expt}	b_{expt}	limitation (eV)	reference
Be	6.76	0.44	E_0 >8,000	[58]
C	3.3	0.4	E_0 >10,000	[61]
C	3.193	0.45	E_0 >4,000	[60]
Al	9.23	0.43	E_0 >8,000	[58]
Al	4.8	0.4	E_0 >12,000	[61]
Cu	13.4	0.39	E_0 >8,000	[58]
Ag	19.1	0.41	E_0 >8,000	[58]
Au	21.4	0.38	E_0 >8,000	[58]
Au	6.065	0.45	E_0 >20,000	[59]
Au	6.71	0.5	E_0 >10,000	[57]
Au	1.7	0.87	E_0 >12,000	[62]
Sc_2O_3*	3.11	0.5	E_0 >10,000	[57]
Er_2O_3*	3.06	0.5	E_0 >10,000	[57]
Al_2O_3	4.3	0.45	E_0 >6,000	[60]

where in the cases marked by $*$, dE/dr values have been published. Conclusively, the constant A_{expt} is different from the others listed (it has an inherent dependence on the target material, Eq.1). If we apply Bragg's rule (Eq.33) for the partial stopping powers of Al and O as obtained from Theory 7 (Eq.30), we arrive to

$$dE/dr = 0.163\sqrt{E_0}$$

In the range of 6 keV to 25 keV, the agreement with the measured function [60] is between 24 % (for 6 keV) and 37 % (for 25 keV). Concerning Sc_2O_3, we get

$$dE/dr = 0.079\sqrt{E_0}$$

which gives a discrepancy of 20 % from the measured function [57]. For Er_2O_3, we must borrow a stopping power value for Er from the Andersen-Ziegler tables [5] (between 10 keV and 25 keV), and get a 30 % disagreement with the reference [57].

A direct verification of theoretical stopping powers can be achieved by taking the most probable outcoming energies of projectiles into account. This is, i.e., a way out of the problematical definition of the mean energy (Eq.33), which leads to contradictions in the energy scaling of theoretical and experimental stopping (discussed in [34]). For the comparison with transmission experiments, where the optimal conditions hold, namely thin foil and channeling direction, a model may apply, where the projectile moves along a straight line through the target foil represented by an electron gas only. Energy degradation in penetration depth can then evaluated by either direct integration of an equation, like Eq.27b, or by solving the newtonian equation of motion of the projectile in a medium, that excerts a velocity proportional frictional force on it (studied in [77]). In this latter case,

$$m\ddot{x} = -\gamma\dot{x} \tag{35}$$

with γ coefficient of friction, that is proportional to the coefficient of the stopping power (for Theory 1, $\gamma = 80\pi e^2 a_0 f(Z)M/v_0$, Eq.1 and 4a). The advantage of this latter method is that not only energy degradation, but the dynamic description of the motion becomes possible. For the case of proton bombardment through gold foils, such a simple model (including sometimes a rather complicated determination of the coefficient of the stopping) gives the following results for the velocity degradation [77]

$$v(x) = v_0 - K * \sum_{i=1}^{\infty} \frac{x^i}{i!} \tag{36}$$

where $v(x)$ and v_0 are instantaneous and initial speed of the projectile, resp., and K is equal to γ for proton. Eq.(35) contains the assumptions of a linear trajectory and only electronic stopping. The following table compiles ratios of the instantaneous to the initial energy as measured and approached with Eq.(36). For the multicomponental targets a superpositio of the stopping powers has been supposed. The agreement for single crystal targets is good, nevertheless, for polycrystalline and amorphous materials it becomes poorer with increasing thickness and decreasing initial energy. This is partly due to the nuclear loss contributions, that play a significant role, if the projectile speed goes below a limit in the target. The other reason is the linear path assumption, which causes a sampling from shorter travelled pathlengths, than in reality.

E_0	target	foil thickness (x)	$E(x)/E_0$ expt. (ref.)	calc.
6	Au, single crystal [100]	620	0.44 [64,70]	0.41
18	Au, single crystal [100]	1200	0.32 [64,70]	0.36
4	Au, polycrystal	590	0.31 [64,70]	0.34
6	Au, polycrystal	590	0.33 [64,70]	0.43
8	Au, polycrystal	590	0.37 [64,70]	0.50
11	Au, polycrystal	590	0.49 [64,70]	0.56
12	Au, polycrystal	590	0.45 [64,70]	0.58
15	Au, polycrystal	590	0.48 [64,70]	0.61
17	Au, polycrystal	590	0.57 [64,70]	0.64
10	Au, polycrystal	150	0.83 [64,70]	0.87
10	Au, polycrystal	300	0.67 [64,70]	0.74
20	Au, polycrystal	150	0.88 [64,70]	0.91
20	Au, polycrystal	300	0.76 [64,70]	0.81
20	Au, polycrystal	500	0.63 [65,71]	0.70
5.8	Al_2O_3, amorphous	205	0.72 [60]	0.79
11.1	Al_2O_3, amorphous	205	0.80 [60]	0.85
16.2	Al_2O_3, amorphous	205	0.85 [60]	0.87
17.5	Al_2O_3, amorphous	205	0.86 [60]	0.87
21.4	Al_2O_3, amorphous	205	0.87 [60]	0.89
6.0	Al_2O_3, amorphous	278	0.67 [60]	0.73
11.5	Al_2O_3, amorphous	278	0.74 [60]	0.80
16.8	Al_2O_3, amorphous	278	0.79 [60]	0.83
17.5	Al_2O_3, amorphous	278	0.80 [60]	0.83
22.0	Al_2O_3, amorphous	278	0.82 [60]	0.85
12.0	Al_2O_3, amorphous	383	0.67 [60]	0.73
17.4	Al_2O_3, amorphous	383	0.72 [60]	0.78
17.5	Al_2O_3, amorphous	383	0.73 [60]	0.78
22.7	Al_2O_3, amorphous	383	0.76 [60]	0.80
17.5	Al_2O_3, amorphous	536	0.63 [60]	0.70
23.9	Al_2O_3, amorphous	536	0.67 [60]	0.74
18.4	Al_2O_3, amorphous	536	0.63 [60]	0.70
20	Er_2O_3, amorphous	230	0.83 [57]	0.89

If the newtonian equation of motion is completed by the nuclear energy loss contribution (in either a linearized way, which results in closed formulas, or full description implying numerical evaluation), the energy ratios sink below the experimental values rather, than exceeding them [77]. This is a clear indication against linear path models, which include a nuclear energy loss from a quasi-continuous medium of nuclei. These two above models may still be assigned as single collision models, not because of the linear trajectory (without collisions), but because of the evaluation of the coefficient of friction (Theory 7).

The way beyond the single collision approximation may be simulation: Monte Carlo simulations of the binary collision of atomic particles [78], or molecular dynamic simulations [79]. The coefficient of friction, that has been discussed in the previous section applies as an input parameter for the single collisions and/or for the penetration of the particles between elastic collisisons with nuclei. Monte Carlo studies show that the coefficient of friction on protons in non-crystalline matter exceeds the predictions of linear theory by about 50 % [49,77].

Remarks to the Tables

The following tables are compilations of electronic stopping power (more precisely electronic stopping cross section) data of slow protons in different materials. Basicly, the before mentioned theoretical values (Theory 1-4 and 6-8) are compared completed with data from Theory 5, wherever fitting parameters were available. The data do not contain any single experimental value for different reasons. First, the Andersen and Ziegler tables [5] contain most of the data available at the time of publication. From that time on very few more recent data have been published. These could be seen in the tables of the previous section. Second, there are elements which have never been subjects of such investigations for their unfavourable thermodynamical or mechanical, or both features. Andersen and Ziegler [5] fitted curves to insufficient experimental data points completed by theoretical results after linear response theory [51]. Third, the evaluation of the measured data as well as the method of the experiment determine the stopping value. This fact is due to circumstances that occur in experiments, but cannot be quantitatively described yet. A recent study shows that the stopping values can easily be 50 % higher if the experiment is done on amorphous targets rather than single crystalline ones [49,77]. The physical unit of the data presented here is always 10^{-15} eV cm^2/atom, while energies are listed in keV in the tables. The heading of the tables is divided into two parts, one containing Target Data, such data, that are necessary for the correct interpretation of the tables, but of common knowledge. The other part concerns Model Data, such intermediate values, which are calculated for Theories 7 and 8, and of principial importance there. All these data are given in physical units. Obviously enough, problems arise, when trying to find, e.g., mass densities for such materials, which are either volatile at room temperature, or have many different forms depending on the method (and result) of the production technology. An example can be gallium, that is fluid at room temperature, therefore its solid state mass density is hard to find out. (We keep in mind that the calculations have been done assuming 0 K. Solid – vapour differences have been studied in [80].) Another example is carbon, which has a mass density range from 1.3 g/cm^3 (carbon/carbon fiber composites) to 2.5 g/cm^3 (pyrolitic graphite). The mass density influences the muffin-tin radius of the solid state atom in Theory 7 and 8, thus changes the upper limit of the integrations. This effect may be reflected in the results in comparison with data of other models, which do not use the density. We must return to our point of N_{eff}, the number of electrons participating in the volume plasmon excitation. This number is usually derived

from optically measured volume plasmon frequencies ($\hbar\omega_p$) [81,82]. Such experiments also lack for a number of materials presented here. (In these cases, we used Fermi velocity values of theories [74,83].) Even in the cases, where measurements have been carried out, the discrepancy between data can be significant (e.g., 40 % for carbon). Of course N_{eff} enters the calculation of Theory 7 and 8, changes the one-electron radius of the target, therefore the radius of the inner shell, the free atom electron density, the density correction, and the stopping.

To be more concrete Theory 7 and 8 will likely fail, wherever the Gertner model [27] results in an internal radius of an atom equal to the external radius (Li, B, C, N, Ne, Na, Ar, K, Fe, Co, Br, Kr, Rb, Rh, In, I, Xe, Cs, Ba, La, Ce, Pr, Nd, Sm, Gd, Tb, Re, Os, Hg, Tl). However, the stopping cross section may still be accepted in some cases, where the calculated internal potential at the radius of the atom is already close to the constant (external) value (B, C, N, Fe, Co, Rh, In, Ce, Pr, Nd, Sm, Gd, Tb, Re, Os).

Some elements (H, He, Tc, Pm, Dy, Ho, Er, Tm, Yb, Lu, Hf, At, Rn, Fr and elements heavier than U) have not been considered due to the lack of one or more parameters for the calculation in Theory 7 and 8.

These models are not expected to apply for either alkaline or alkaline-earth elements neither for semi-metals (Be, O, F, Mg, P, S, Cl, Ca, Se, Sr, Y, Te, Eu, Pb, Bi, Po, Ra, Th).

The following relations have been used for the description of the parameters

$$\kappa_{max}^2 = \frac{e^2}{\pi\hbar v_F} \tag{35a}$$

$$c_o = \frac{v_F^3}{3\pi^2} \tag{35b}$$

$$\hbar\omega_p = \frac{r_s^{3/2}}{47.1} \tag{35c}$$

and

$$r_s = (\frac{3}{4\pi c_0})^{1/3} \qquad (35d)$$

where, r_s is the one-electron radius, κ^2_{max} the density parameter of the homogeneous, non-interacting electron gas, c_0 the density of the free electron gas and v_F the Fermi velocity.

In the high electron density limit ($r_s << 1$) all theoretical results are expected to align, since the Coulomb potential of the proton is indeed a small perturbation compared to the high kinetic energy of the free electrons. For metallic electron densities ($1.5 < r_s < 2.5$) linear response theory completed with a dynamic local field correction gives similar results as DF, and these data are well above those obtained in RPA. For $r_s >> 3$ the results differ to a great extent, and the electron gas is thought to undergo a phase transition to the Wigner crystal phase [84].

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Tables

Electronic Stopping Power (Cross Section) of Proton in Elements

Matter Range: from Li to U (with exclusions)

Energy Range: from 1 to 25 keV

Theoretical Models (in order of appearence in the tables):

impact parameter dependent linear response (Theory 7)

volume averaged linear response (Theory 8)

Lindhard-Scharff (Theory 1)

Andersen-Ziegler (Theory 4)

Oen-Robinson (Theory 3)

Montenegro et al. (Theory 6)

Biersack et al. (Theory 5)

ELECTRONIC STOPPING POWER OF PROTONS IN Li

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:			*Model Data:*		
Atomic Number:	3.		Radius of Atom:	1.737	[Å]
Atomic Mass:	7.016	[amu]	Internal Radius of Atom:	1.737	[Å]
Density:	0.530	[g/cm^3]	Homogeneous Electron Gas Density:	0.049	[Å^{-3}]
Measured Plasma Frequency:	8.	[eV]	Density Correction:	0.045	[Å^{-3}]
One-Electron Radius:	1.696	[Å]	Fitting Parameter:	0.563	
χ^2 of Free Electron Gas:	0.532				

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.882	6.930	8.498	9.819	10.982	12.033	12.999	13.899
volume averaged	4.944	6.992	8.563	9.888	11.055	12.110	13.080	13.984
Lindhard-Scharff	2.157	3.051	3.737	4.315	4.824	5.284	5.708	6.102
Andersen-Ziegler	1.411	1.995	2.444	2.822	3.155	3.456	3.733	3.991
Oen-Robinson	2.127	3.008	3.684	4.254	4.757	5.211	5.628	6.017
Montenegro	1.575	2.325	2.933	3.462	3.937	4.371	4.770	5.140
Biersack	2.131	3.008	3.675	4.230	4.710	5.134	5.515	5.859

energy	9	10	11	12	13	14	15	16
impact p. dependent	14.743	15.542	16.302	17.028	17.725	18.396	19.041	19.667
volume averaged	14.832	15.634	16.397	17.126	17.826	18.498	19.148	19.776
Lindhard-Scharff	6.472	6.822	7.155	7.473	7.778	8.072	8.355	8.629
Andersen-Ziegler	4.233	4.462	4.648	4.824	4.991	5.150	5.300	5.444
Oen-Robinson	6.382	6.727	7.055	7.369	7.670	7.959	8.239	8.509
Montenegro	5.485	5.807	6.108	6.391	6.657	6.907	7.143	7.364
Biersack	6.172	6.458	6.719	6.958	7.178	7.379	7.564	7.733

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	20.273	20.861	21.433	21.991	22.533	23.064	23.582	24.091	24.588
volume averaged	20.384	20.975	21.550	22.110	22.656	23.189	23.710	24.220	24.720
Lindhard-Scharff	8.895	9.153	9.403	9.648	9.886	10.119	10.346	10.569	10.787
Andersen-Ziegler	5.581	5.713	5.838	5.959	6.074	6.186	6.292	6.395	6.494
Oen-Robinson	8.771	9.025	9.272	9.513	9.748	9.978	10.202	10.421	10.636
Montenegro	7.573	7.770	7.955	8.130	8.295	8.450	8.597	8.735	8.866
Biersack	7.889	8.032	8.163	8.283	8.394	8.495	8.588	8.674	8.752

ELECTRONIC STOPPING POWER OF PROTONS IN Be

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	4.	
Atomic Mass:	9.012	[amu]
Density:	1.802	[g/cm^3]
Measured Plasma Frequency:	20.	[eV]
One-Electron Radius:	0.941	[Å]
χ^2 of Free Electron Gas:	0.295	

Model Data:

Radius of Atom:	1.256	[Å]
Internal Radius of Atom:	0.906	[Å]
Homogeneous Electron Gas Density:	0.288	[Å^{-3}]
Density Correction:	0.142	[Å^{-3}]
Fitting Parameter:	0.858	

energy	1	2	3	4	5	6	7	8
impact p. dependent	2.222	3.167	3.888	4.497	5.031	5.514	5.958	6.371
volume averaged	2.268	3.208	3.929	4.537	5.072	5.556	6.002	6.416
Lindhard-Scharff	2.355	3.330	4.078	4.709	5.265	5.767	6.230	6.660
Andersen-Ziegler	2.248	3.179	3.894	4.496	5.027	5.506	5.948	6.358
Oen-Robinson	2.322	3.283	4.021	4.643	5.192	5.687	6.143	6.567
Montenegro	2.410	3.490	4.330	5.035	5.648	6.189	6.674	7.111

energy	9	10	11	12	13	14	15	16
impact p. dependent	6.760	7.127	7.475	7.808	8.128	8.437	8.732	9.020
volume averaged	6.805	7.173	7.523	7.858	8.179	8.487	8.785	9.074
Lindhard-Scharff	7.064	7.446	7.809	8.156	8.489	8.810	9.119	9.418
Andersen-Ziegler	6.744	7.109	7.385	7.641	7.878	8.098	8.303	8.493
Oen-Robinson	6.965	7.342	7.700	8.043	8.371	8.687	8.992	9.287
Montenegro	7.508	7.871	8.203	8.508	8.789	9.048	9.288	9.510

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	9.298	9.568	9.831	10.087	10.336	10.579	10.817	11.050	11.279
volume averaged	9.353	9.624	9.888	10.144	10.395	10.640	10.879	11.113	11.342
Lindhard-Scharff	9.708	9.990	10.263	10.530	10.790	11.044	11.292	11.535	11.773
Andersen-Ziegler	8.670	8.835	8.988	9.130	9.261	9.383	9.496	9.600	9.696
Oen-Robinson	9.573	9.850	10.120	10.383	10.640	10.890	11.135	11.374	11.609
Montenegro	9.716	9.908	10.086	10.251	10.405	10.549	10.683	10.808	10.924

ELECTRONIC STOPPING POWER OF PROTONS IN B

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:			*Model Data:*		
Atomic Number:	5.		Radius of Atom:	1.229	[Å]
Atomic Mass:	11.009	[amu]	Internal Radius of Atom:	1.229	[Å]
Density:	2.350	[g/cm^3]	Homogeneous Electron Gas Density:	0.265	[Å^{-3}]
Measured Plasma Frequency:	19.	[eV]	Density Correction:	0.206	[Å^{-3}]
One-Electron Radius:	0.967	[Å]	Fitting Parameter:	0.979	
χ^2 of Free Electron Gas:	0.303				

energy	1	2	3	4	5	6	7	8
impact p. dependent	2.120	3.026	3.719	4.300	4.813	5.276	5.701	6.097
volume averaged	2.172	3.071	3.762	4.343	4.856	5.320	5.746	6.143
Lindhard-Scharff	2.500	3.536	4.331	5.001	5.591	6.125	6.615	7.072
Andersen-Ziegler	2.474	3.499	4.285	4.948	5.532	6.060	6.546	6.998
Oen-Robinson	2.466	3.487	4.270	4.931	5.513	6.039	6.523	6.974
Montenegro	2.588	3.720	4.597	5.331	5.967	6.530	7.035	7.490
Biersack	2.474	3.495	4.275	4.926	5.495	6.002	6.462	6.883

energy	9	10	11	12	13	14	15	16
impact p. dependent	6.468	6.819	7.154	7.473	7.779	8.073	8.358	8.632
volume averaged	6.515	6.868	7.203	7.523	7.830	8.126	8.411	8.687
Lindhard-Scharff	7.501	7.907	8.293	8.662	9.015	9.356	9.684	10.002
Andersen-Ziegler	7.422	7.823	8.147	8.451	8.738	9.009	9.265	9.509
Oen-Robinson	7.397	7.797	8.177	8.541	8.890	9.225	9.549	9.862
Montenegro	7.904	8.282	8.629	8.948	9.242	9.514	9.766	9.999
Biersack	7.271	7.631	7.965	8.276	8.567	8.839	9.093	9.330

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	8.899	9.158	9.409	9.654	9.892	10.125	10.353	10.576	10.795
volume averaged	8.954	9.214	9.466	9.712	9.952	10.186	10.415	10.639	10.859
Lindhard-Scharff	10.309	10.608	10.899	11.182	11.458	11.728	11.991	12.249	12.502
Andersen-Ziegler	9.741	9.961	10.171	10.372	10.563	10.745	10.920	11.086	11.245
Oen-Robinson	10.166	10.460	10.747	11.026	11.298	11.564	11.824	12.079	12.328
Montenegro	10.216	10.418	10.605	10.780	10.942	11.094	11.236	11.368	11.491
Biersack	9.553	9.761	9.956	10.138	10.308	10.467	10.616	10.754	10.883

ELECTRONIC STOPPING POWER OF PROTONS IN C

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	6.	
Atomic Mass:	12.000	[amu]
Density:	2.266	[g/cm^3]
Measured Plasma Frequency:	18.	[eV]
One-Electron Radius:	1.014	[Å]
χ^2 of Free Electron Gas:	0.318	

Model Data:

Radius of Atom:	1.280	[Å]
Internal Radius of Atom:	1.280	[Å]
Homogeneous Electron Gas Density:	0.230	[Å^{-3}]
Density Correction:	0.171	[Å^{-3}]
Fitting Parameter:	0.880	

energy	1	2	3	4	5	6	7	8
impact p. dependent	2.376	3.394	4.171	4.825	5.400	5.920	6.397	6.841
volume averaged	2.437	3.447	4.222	4.875	5.450	5.970	6.449	6.894
Lindhard-Scharff	2.614	3.697	4.527	5.228	5.845	6.403	6.916	7.393
Andersen-Ziegler	2.631	3.721	4.557	5.262	5.883	6.445	6.961	7.442
Oen-Robinson	2.577	3.645	4.464	5.155	5.763	6.313	6.819	7.290
Montenegro	2.771	3.994	4.944	5.742	6.436	7.052	7.604	8.104
Biersack	2.583	3.650	4.465	5.147	5.743	6.277	6.761	7.207

energy	9	10	11	12	13	14	15	16
impact p. dependent	7.258	7.653	8.028	8.386	8.730	9.061	9.380	9.688
volume averaged	7.312	7.708	8.084	8.443	8.788	9.120	9.440	9.749
Lindhard-Scharff	7.842	8.266	8.669	9.055	9.425	9.780	10.124	10.456
Andersen-Ziegler	7.893	8.320	8.664	8.989	9.296	9.587	9.863	10.125
Oen-Robinson	7.732	8.151	8.548	8.929	9.293	9.644	9.982	10.310
Montenegro	8.559	8.975	9.357	9.709	10.034	10.335	10.614	10.872
Biersack	7.618	8.001	8.359	8.693	9.007	9.302	9.580	9.841

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	9.987	10.277	10.559	10.834	11.102	11.364	11.619	11.870	12.115
volume averaged	10.049	10.341	10.624	10.900	11.169	11.432	11.689	11.940	12.187
Lindhard-Scharff	10.777	11.090	11.394	11.690	11.978	12.260	12.536	12.805	13.069
Andersen-Ziegler	10.374	10.612	10.839	11.056	11.264	11.462	11.651	11.833	12.007
Oen-Robinson	10.627	10.935	11.235	11.527	11.811	12.089	12.361	12.627	12.887
Montenegro	11.112	11.336	11.544	11.738	11.918	12.087	12.245	12.392	12.529
Biersack	10.087	10.318	10.536	10.742	10.935	11.117	11.288	11.449	11.600

ELECTRONIC STOPPING POWER OF PROTONS IN N

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	7.	
Atomic Mass:	14.003	[amu]
Density:	0.810	[g/cm^3]
Measured Plasma Frequency:	19.	[eV]
One-Electron Radius:	0.959	[Å]
χ^2 of Free Electron Gas:	0.301	

Model Data:

Radius of Atom:	1.898	[Å]
Internal Radius of Atom:	1.898	[Å]
Homogeneous Electron Gas Density:	0.272	[Å^{-3}]
Density Correction:	0.263	[Å^{-3}]
Fitting Parameter:	0.776	

energy	1	2	3	4	5	6	7	8
impact p. dependent	2.376	3.394	4.171	4.825	5.400	5.920	6.397	6.841
volume averaged	2.437	3.447	4.222	4.875	5.450	5.970	6.449	6.894
Lindhard-Scharff	2.614	3.697	4.527	5.228	5.845	6.403	6.916	7.393
Andersen-Ziegler	2.954	4.178	5.116	5.908	6.605	7.236	7.816	8.355
Oen-Robinson	2.668	3.773	4.621	5.336	5.965	6.535	7.058	7.546
Montenegro	2.771	3.994	4.944	5.742	6.436	7.052	7.604	8.104

energy	9	10	11	12	13	14	15	16
impact p. dependent	7.258	7.653	8.028	8.386	8.730	9.061	9.380	9.688
volume averaged	7.312	7.708	8.084	8.443	8.788	9.120	9.440	9.749
Lindhard-Scharff	7.842	8.266	8.669	9.055	9.425	9.780	10.124	10.456
Andersen-Ziegler	8.862	9.341	9.734	10.103	10.453	10.785	11.100	11.401
Oen-Robinson	8.003	8.436	8.848	9.241	9.619	9.982	10.332	10.671
Montenegro	8.559	8.975	9.357	9.709	10.034	10.335	10.614	10.872

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	9.987	10.277	10.559	10.834	11.102	11.364	11.619	11.870	12.115
volume averaged	10.049	10.341	10.624	10.900	11.169	11.432	11.689	11.940	12.187
Lindhard-Scharff	10.777	11.090	11.394	11.690	11.978	12.260	12.536	12.805	13.069
Andersen-Ziegler	11.689	11.964	12.227	12.479	12.721	12.954	13.177	13.392	13.598
Oen-Robinson	11.000	11.318	11.629	11.931	12.225	12.513	12.794	13.069	13.339
Montenegro	11.112	11.336	11.544	11.738	11.918	12.087	12.245	12.392	12.529

ELECTRONIC STOPPING POWER OF PROTONS IN O

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	8.	
Atomic Mass:	15.995	[amu]
Density:	1.143	[g/cm^3]
Measured Plasma Frequency:	16.	[eV]
One-Electron Radius:	1.080	[Å]
χ^2 of Free Electron Gas:	0.339	

Model Data:

Radius of Atom:	1.769	[Å]
Internal Radius of Atom:	0.637	[Å]
Homogeneous Electron Gas Density:	0.190	[Å^{-3}]
Density Correction:	-0.745	[Å^{-3}]
Fitting Parameter:	0.708	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.742	8.196	10.070	11.646	13.034	14.286	15.440	16.511
volume averaged	5.880	8.316	10.185	11.760	13.148	14.403	15.557	16.631
Lindhard-Scharff	2.781	3.934	4.818	5.563	6.219	6.813	7.359	7.867
Andersen-Ziegler	2.652	3.750	4.593	5.304	5.930	6.496	7.017	7.501
Oen-Robinson	2.743	3.879	4.750	5.485	6.133	6.718	7.256	7.757
Montenegro	2.817	4.076	5.062	5.897	6.628	7.280	7.868	8.404

energy	9	10	11	12	13	14	15	16
impact p. dependent	17.517	18.468	19.376	20.238	21.068	21.865	22.634	23.378
volume averaged	17.640	18.595	19.502	20.369	21.201	22.001	22.774	23.520
Lindhard-Scharff	8.344	8.796	9.225	9.635	10.029	10.407	10.772	11.126
Andersen-Ziegler	7.956	8.386	8.741	9.076	9.395	9.697	9.986	10.262
Oen-Robinson	8.228	8.673	9.096	9.501	9.889	10.262	10.622	10.971
Montenegro	8.895	9.346	9.763	10.148	10.506	10.838	11.148	11.436

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	24.100	24.798	25.480	26.144	26.790	27.422	28.039	28.642	29.236
volume averaged	24.244	24.947	25.631	26.297	26.946	27.580	28.200	28.807	29.401
Lindhard-Scharff	11.468	11.801	12.124	12.439	12.746	13.046	13.339	13.626	13.907
Andersen-Ziegler	10.526	10.780	11.023	11.257	11.482	11.699	11.908	12.110	12.305
Oen-Robinson	11.308	11.636	11.955	12.265	12.568	12.864	13.153	13.436	13.713
Montenegro	11.706	11.957	12.192	12.412	12.618	12.811	12.992	13.162	13.321

ELECTRONIC STOPPING POWER OF PROTONS IN F

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	9.	
Atomic Mass:	18.998	[amu]
Density:	1.111	[g/cm^3]
Measured Plasma Frequency:	11.	[eV]
One-Electron Radius:	1.359	[Å]
χ^2 of Free Electron Gas:	0.426	

Model Data:

Radius of Atom:	1.892	[Å]
Internal Radius of Atom:	1.013	[Å]
Homogeneous Electron Gas Density:	0.095	[Å^{-3}]
Density Correction:	-0.087	[Å^{-3}]
Fitting Parameter:	0.575	

energy	1	2	3	4	5	6	7	8
impact p. dependent	6.598	9.395	11.535	13.335	14.919	16.350	17.665	18.891
volume averaged	6.723	9.508	11.645	13.447	15.034	16.469	17.788	19.016
Lindhard-Scharff	2.846	4.024	4.929	5.691	6.363	6.970	7.529	8.049
Andersen-Ziegler	2.085	2.949	3.611	4.170	4.662	5.107	5.516	5.897
Oen-Robinson	2.806	3.968	4.860	5.612	6.274	6.873	7.424	7.937
Montenegro	2.242	3.263	4.071	4.763	5.374	5.924	6.425	6.886

energy	9	10	11	12	13	14	15	16
impact p. dependent	20.040	21.128	22.163	23.151	24.098	25.008	25.888	26.740
volume averaged	20.170	21.261	22.299	23.290	24.241	25.156	26.039	26.893
Lindhard-Scharff	8.537	8.999	9.438	9.858	10.260	10.647	11.021	11.383
Andersen-Ziegler	6.255	6.593	6.875	7.143	7.397	7.640	7.872	8.094
Oen-Robinson	8.418	8.873	9.306	9.720	10.117	10.499	10.868	11.224
Montenegro	7.311	7.705	8.072	8.414	8.734	9.035	9.316	9.581

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	27.566	28.364	29.143	29.900	30.639	31.362	32.068	32.760	33.436
volume averaged	27.721	28.525	29.306	30.068	30.810	31.535	32.244	32.937	33.617
Lindhard-Scharff	11.733	12.073	12.404	12.726	13.040	13.347	13.647	13.941	14.228
Andersen-Ziegler	8.308	8.513	8.711	8.902	9.087	9.266	9.439	9.607	9.769
Oen-Robinson	11.569	11.905	12.231	12.549	12.859	13.161	13.457	13.746	14.030
Montenegro	9.829	10.064	10.285	10.493	10.690	10.876	11.051	11.217	11.374

ELECTRONIC STOPPING POWER OF PROTONS IN Ne

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	10.	
Atomic Mass:	19.992	[amu]
Density:	1.202	[g/cm^3]
Measured Plasma Frequency:	4.	[eV]
One-Electron Radius:	2.965	[Å]
χ^2 of Free Electron Gas:	0.930	

Model Data:

Radius of Atom:	1.874	[Å]
Internal Radius of Atom:	1.874	[Å]
Homogeneous Electron Gas Density:	0.009	[Å^{-3}]
Density Correction:	0.006	[Å^{-3}]
Fitting Parameter:	0.500	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.678	8.089	9.932	11.484	12.851	14.084	15.219	16.274
volume averaged	5.791	8.190	10.031	11.583	12.950	14.186	15.322	16.380
Lindhard-Scharff	2.901	4.102	5.024	5.802	6.487	7.106	7.675	8.205
Andersen-Ziegler	1.951	2.759	3.379	3.902	4.363	4.779	5.162	5.518
Oen-Robinson	2.860	4.045	4.954	5.721	6.396	7.007	7.568	8.091
Montenegro	2.109	3.075	3.845	4.505	5.092	5.622	6.106	6.553
Biersack	2.873	4.061	4.970	5.733	6.403	7.005	7.555	8.062

energy	9	10	11	12	13	14	15	16
impact p. dependent	17.265	18.201	19.095	19.944	20.761	21.547	22.305	23.037
volume averaged	17.374	18.314	19.208	20.062	20.881	21.669	22.430	23.165
Lindhard-Scharff	8.703	9.173	9.621	10.049	10.459	10.854	11.235	11.603
Andersen-Ziegler	5.853	6.170	6.434	6.686	6.925	7.154	7.372	7.582
Oen-Robinson	8.581	9.045	9.487	9.909	10.313	10.703	11.078	11.442
Montenegro	6.967	7.352	7.712	8.049	8.365	8.662	8.942	9.206
Biersack	8.535	8.979	9.396	9.790	10.164	10.519	10.857	11.179

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	23.749	24.440	25.110	25.761	26.399	27.023	27.631	28.228	28.811
volume averaged	23.878	24.570	25.244	25.900	26.539	27.164	27.774	28.371	28.957
Lindhard-Scharff	11.961	12.307	12.645	12.973	13.293	13.606	13.912	14.211	14.504
Andersen-Ziegler	7.783	7.978	8.165	8.346	8.521	8.691	8.855	9.015	9.169
Oen-Robinson	11.794	12.136	12.468	12.792	13.108	13.417	13.718	14.013	14.302
Montenegro	9.455	9.690	9.913	10.123	10.323	10.511	10.690	10.860	11.021
Biersack	11.486	11.779	12.059	12.327	12.584	12.829	13.064	13.289	13.504

ELECTRONIC STOPPING POWER OF PROTONS IN Na

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	11.	
Atomic Mass:	22.990	[amu]
Density:	0.970	[g/cm^3]
Measured Plasma Frequency:	5.	[eV]
One-Electron Radius:	2.239	[Å]
χ^2 of Free Electron Gas:	0.702	

Model Data:

Radius of Atom:	2.109	[Å]
Internal Radius of Atom:	2.109	[Å]
Homogeneous Electron Gas Density:	0.021	[Å^{-3}]
Density Correction:	0.019	[Å^{-3}]
Fitting Parameter:	0.561	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.271	11.763	14.432	16.683	18.664	20.453	22.097	23.629
volume averaged	8.407	11.890	14.562	16.814	18.799	20.593	22.243	23.779
Lindhard-Scharff	2.949	4.171	5.108	5.898	6.594	7.224	7.802	8.341
Andersen-Ziegler	2.542	3.595	4.403	5.084	5.684	6.227	6.725	7.190
Oen-Robinson	2.908	4.112	5.037	5.816	6.502	7.123	7.694	8.225
Montenegro	2.716	3.943	4.912	5.739	6.470	7.126	7.724	8.272

energy	9	10	11	12	13	14	15	16
impact p. dependent	25.067	26.426	27.719	28.954	30.136	31.277	32.377	33.439
volume averaged	25.222	26.586	27.884	29.123	30.313	31.457	32.561	33.629
Lindhard-Scharff	8.847	9.326	9.781	10.216	10.633	11.034	11.421	11.796
Andersen-Ziegler	7.626	8.039	8.383	8.708	9.018	9.312	9.594	9.864
Oen-Robinson	8.724	9.196	9.644	10.073	10.485	10.880	11.262	11.632
Montenegro	8.778	9.247	9.683	10.090	10.470	10.826	11.160	11.473

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	34.472	35.472	36.448	37.397	38.320	39.222	40.105	40.969	41.814
volume averaged	34.664	35.669	36.646	37.598	38.527	39.433	40.320	41.187	42.036
Lindhard-Scharff	12.159	12.512	12.854	13.188	13.514	13.832	14.143	14.447	14.745
Andersen-Ziegler	10.124	10.373	10.613	10.845	11.069	11.285	11.494	11.697	11.893
Oen-Robinson	11.990	12.337	12.675	13.005	13.326	13.639	13.946	14.246	14.540
Montenegro	11.767	12.045	12.306	12.552	12.784	13.003	13.210	13.405	13.590

ELECTRONIC STOPPING POWER OF PROTONS IN Mg

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	12.	
Atomic Mass:	23.985	[amu]
Density:	1.737	[g/cm^3]
Measured Plasma Frequency:	11.	[eV]
One-Electron Radius:	1.426	[Å]
χ^2 of Free Electron Gas:	0.447	

Model Data:

Radius of Atom:	1.761	[Å]
Internal Radius of Atom:	1.479	[Å]
Homogeneous Electron Gas Density:	0.083	[Å^{-3}]
Density Correction:	0.046	[Å^{-3}]
Fitting Parameter:	0.621	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.505	7.846	9.636	11.142	12.470	13.667	14.768	15.792
volume averaged	5.622	7.951	9.738	11.245	12.572	13.772	14.875	15.903
Lindhard-Scharff	2.991	4.231	5.181	5.983	6.689	7.327	7.915	8.461
Andersen-Ziegler	3.792	5.363	6.568	7.584	8.479	9.288	10.033	10.725
Oen-Robinson	2.950	4.172	5.109	5.899	6.596	7.225	7.804	8.343
Montenegro	3.984	5.742	7.113	8.269	9.279	10.179	10.989	11.726

energy	9	10	11	12	13	14	15	16
impact p. dependent	16.754	17.664	18.530	19.356	20.147	20.911	21.644	22.356
volume averaged	16.867	17.780	18.647	19.477	20.272	21.037	21.775	22.490
Lindhard-Scharff	8.974	9.460	9.921	10.363	10.786	11.193	11.586	11.966
Andersen-Ziegler	11.376	11.991	12.496	12.973	13.425	13.855	14.264	14.655
Oen-Robinson	8.849	9.328	9.783	10.218	10.635	11.037	11.424	11.799
Montenegro	12.399	13.018	13.589	14.116	14.605	15.059	15.481	15.875

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	23.047	23.717	24.369	25.004	25.621	26.226	26.816	27.393	27.959
volume averaged	23.182	23.854	24.507	25.144	25.765	26.371	26.964	27.544	28.112
Lindhard-Scharff	12.334	12.692	13.039	13.378	13.708	14.031	14.346	14.655	14.957
Andersen-Ziegler	15.028	15.386	15.729	16.058	16.374	16.679	16.971	17.253	17.524
Oen-Robinson	12.162	12.515	12.858	13.192	13.517	13.836	14.146	14.451	14.749
Montenegro	16.241	16.584	16.903	17.202	17.482	17.744	17.989	18.218	18.433

ELECTRONIC STOPPING POWER OF PROTONS IN Al

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	13.	
Atomic Mass:	26.982	[amu]
Density:	2.698	[g/cm^3]
Measured Plasma Frequency:	15.	[eV]
One-Electron Radius:	1.121	[Å]
χ^2 of Free Electron Gas:	0.351	

Model Data:

Radius of Atom:	1.582	[Å]
Internal Radius of Atom:	1.262	[Å]
Homogeneous Electron Gas Density:	0.170	[Å^{-3}]
Density Correction:	0.069	[Å^{-3}]
Fitting Parameter:	0.729	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.289	6.131	7.537	8.720	9.760	10.699	11.564	12.366
volume averaged	4.406	6.231	7.632	8.813	9.853	10.793	11.658	12.463
Lindhard-Scharff	3.029	4.284	5.247	6.058	6.773	7.420	8.014	8.568
Andersen-Ziegler	4.154	5.875	7.195	8.308	9.289	10.175	10.990	11.749
Oen-Robinson	2.987	4.224	5.174	5.974	6.679	7.317	7.903	8.448
Montenegro	4.351	6.263	7.750	9.003	10.095	11.066	11.939	12.732
Biersack	2.994	4.232	5.180	5.977	6.677	7.307	7.884	8.418

energy	9	10	11	12	13	14	15	16
impact p. dependent	13.120	13.835	14.511	15.161	15.782	16.379	16.957	17.514
volume averaged	13.219	13.934	14.614	15.264	15.887	16.487	17.066	17.625
Lindhard-Scharff	9.088	9.579	10.047	10.493	10.922	11.334	11.732	12.117
Andersen-Ziegler	12.462	13.136	13.669	14.169	14.637	15.078	15.493	15.884
Oen-Robinson	8.961	9.446	9.907	10.347	10.770	11.176	11.568	11.948
Montenegro	13.457	14.121	14.733	15.299	15.822	16.307	16.759	17.178
Biersack	8.916	9.384	9.826	10.245	10.643	11.023	11.385	11.732

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	18.056	18.581	19.090	19.588	20.072	20.545	21.008	21.461	21.904
volume averaged	18.168	18.694	19.207	19.706	20.192	20.667	21.132	21.586	22.032
Lindhard-Scharff	12.490	12.852	13.204	13.547	13.881	14.208	14.527	14.840	15.146
Andersen-Ziegler	16.253	16.601	16.930	17.241	17.535	17.812	18.074	18.321	18.554
Oen-Robinson	12.316	12.673	13.020	13.358	13.688	14.010	14.325	14.633	14.935
Montenegro	17.569	17.934	18.275	18.593	18.890	19.167	19.427	19.670	19.898
Biersack	12.065	12.384	12.690	12.985	13.268	13.541	13.804	14.056	14.300

ELECTRONIC STOPPING POWER OF PROTONS IN Si

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	14.	
Atomic Mass:	27.977	[amu]
Density:	2.321	[g/cm^3]
Measured Plasma Frequency:	17.	[eV]
One-Electron Radius:	1.041	[Å]
χ^2 of Free Electron Gas:	0.326	

Model Data:

Radius of Atom:	1.683	[Å]
Internal Radius of Atom:	0.987	[Å]
Homogeneous Electron Gas Density:	0.212	[Å^{-3}]
Density Correction:	-0.092	[Å^{-3}]
Fitting Parameter:	0.817	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.134	7.345	9.031	10.450	11.698	12.824	13.859	14.823
volume averaged	5.283	7.471	9.150	10.566	11.813	12.940	13.977	14.942
Lindhard-Scharff	3.063	4.332	5.305	6.126	6.849	7.503	8.104	8.664
Andersen-Ziegler	4.150	5.869	7.188	8.300	9.280	10.165	10.980	11.738
Oen-Robinson	3.020	4.271	5.231	6.041	6.754	7.398	7.991	8.543
Montenegro	4.337	6.243	7.728	8.981	10.077	11.053	11.934	12.736

energy	9	10	11	12	13	14	15	16
impact p. dependent	15.729	16.583	17.397	18.174	18.920	19.635	20.328	20.997
volume averaged	15.849	16.706	17.521	18.301	19.048	19.767	20.461	21.132
Lindhard-Scharff	9.189	9.686	10.159	10.611	11.044	11.461	11.863	12.252
Andersen-Ziegler	12.450	13.123	13.668	14.188	14.680	15.147	15.591	16.014
Oen-Robinson	9.061	9.551	10.017	10.463	10.890	11.301	11.698	12.081
Montenegro	13.471	14.147	14.771	15.349	15.885	16.384	16.849	17.283

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	21.645	22.275	22.887	23.483	24.064	24.632	25.187	25.729	26.261
volume averaged	21.782	22.413	23.028	23.626	24.209	24.779	25.336	25.881	26.415
Lindhard-Scharff	12.629	12.995	13.352	13.698	14.037	14.367	14.690	15.006	15.315
Andersen-Ziegler	16.418	16.804	17.174	17.528	17.868	18.193	18.506	18.807	19.096
Oen-Robinson	12.453	12.814	13.165	13.507	13.841	14.167	14.485	14.797	15.102
Montenegro	17.689	18.068	18.422	18.754	19.066	19.358	19.632	19.888	20.130

ELECTRONIC STOPPING POWER OF PROTONS IN P

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	15.	
Atomic Mass:	30.994	[amu]
Density:	1.822	[g/cm^3]
Measured Plasma Frequency:	17.	[eV]
One-Electron Radius:	1.043	[Å]
χ^2 of Free Electron Gas:	0.327	

Model Data:

Radius of Atom:	1.888	[Å]
Internal Radius of Atom:	0.746	[Å]
Homogeneous Electron Gas Density:	0.211	[Å^{-3}]
Density Correction:	-0.670	[Å^{-3}]
Fitting Parameter:	0.868	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.070	10.120	12.448	14.404	16.126	17.679	19.105	20.435
volume averaged	7.284	10.301	12.616	14.568	16.287	17.842	19.272	20.602
Lindhard-Scharff	3.094	4.375	5.358	6.187	6.918	7.578	8.185	8.750
Andersen-Ziegler	3.232	4.571	5.598	6.464	7.227	7.917	8.551	9.141
Oen-Robinson	3.051	4.314	5.284	6.101	6.821	7.472	8.071	8.628
Montenegro	3.339	4.796	5.934	6.901	7.751	8.515	9.210	9.848

energy	9	10	11	12	13	14	15	16
impact p. dependent	21.681	22.863	23.985	25.054	26.082	27.072	28.024	28.946
volume averaged	21.852	23.034	24.158	25.232	26.263	27.254	28.211	29.136
Lindhard-Scharff	9.281	9.783	10.260	10.717	11.154	11.575	11.982	12.375
Andersen-Ziegler	9.696	10.220	10.658	11.072	11.466	11.841	12.200	12.544
Oen-Robinson	9.152	9.647	10.117	10.567	10.999	11.414	11.815	12.202
Montenegro	10.438	10.985	11.495	11.971	12.418	12.836	13.230	13.601

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	29.840	30.709	31.553	32.374	33.177	33.959	34.724	35.472	36.205
volume averaged	30.033	30.903	31.750	32.575	33.379	34.165	34.933	35.684	36.420
Lindhard-Scharff	12.755	13.125	13.485	13.835	14.177	14.510	14.837	15.156	15.468
Andersen-Ziegler	12.874	13.191	13.497	13.792	14.077	14.353	14.619	14.877	15.127
Oen-Robinson	12.578	12.942	13.297	13.642	13.979	14.308	14.630	14.944	15.253
Montenegro	13.951	14.281	14.593	14.887	15.166	15.430	15.680	15.917	16.141

ELECTRONIC STOPPING POWER OF PROTONS IN S

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	16.	
Atomic Mass:	31.970	[amu]
Density:	2.069	[g/cm^3]
Measured Plasma Frequency:	15.	[eV]
One-Electron Radius:	1.128	[Å]
χ^2 of Free Electron Gas:	0.354	

Model Data:

Radius of Atom:	1.829	[Å]
Internal Radius of Atom:	1.077	[Å]
Homogeneous Electron Gas Density:	0.167	[Å^{-3}]
Density Correction:	-0.073	[Å^{-3}]
Fitting Parameter:	0.885	

energy	1	2	3	4	5	6	7	8
impact p. dependent	6.392	9.139	11.237	12.998	14.550	15.950	17.239	18.438
volume averaged	6.570	9.291	11.379	13.140	14.691	16.093	17.382	18.582
Lindhard-Scharff	3.121	4.414	5.406	6.243	6.980	7.646	8.259	8.829
Andersen-Ziegler	3.447	4.875	5.970	6.894	7.708	8.443	9.120	9.750
Oen-Robinson	3.078	4.353	5.331	6.156	6.882	7.539	8.143	8.706
Montenegro	3.565	5.122	6.339	7.371	8.279	9.095	9.837	10.517

energy	9	10	11	12	13	14	15	16
impact p. dependent	19.563	20.627	21.637	22.603	23.529	24.422	25.281	26.114
volume averaged	19.710	20.776	21.790	22.759	23.688	24.582	25.445	26.279
Lindhard-Scharff	9.364	9.871	10.353	10.813	11.254	11.679	12.089	12.486
Andersen-Ziegler	10.341	10.900	11.367	11.808	12.227	12.626	13.008	13.373
Oen-Robinson	9.234	9.733	10.208	10.662	11.098	11.517	11.921	12.312
Montenegro	11.146	11.729	12.272	12.779	13.254	13.700	14.119	14.513

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	26.920	27.702	28.463	29.205	29.928	30.634	31.323	31.998	32.659
volume averaged	27.088	27.874	28.637	29.381	30.107	30.815	31.508	32.186	32.849
Lindhard-Scharff	12.870	13.243	13.606	13.959	14.304	14.641	14.970	15.292	15.607
Andersen-Ziegler	13.724	14.061	14.386	14.699	15.001	15.293	15.576	15.849	16.113
Oen-Robinson	12.691	13.059	13.416	13.765	14.105	14.437	14.761	15.079	15.390
Montenegro	14.884	15.234	15.565	15.878	16.173	16.453	16.718	16.969	17.206

ELECTRONIC STOPPING POWER OF PROTONS IN Cl

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	17.	
Atomic Mass:	34.969	[amu]
Density:	1.896	[g/cm^3]
Measured Plasma Frequency:	11.	[eV]
One-Electron Radius:	1.432	[Å]
χ^2 of Free Electron Gas:	0.449	

Model Data:

Radius of Atom:	1.940	[Å]
Internal Radius of Atom:	1.664	[Å]
Homogeneous Electron Gas Density:	0.082	[Å^{-3}]
Density Correction:	0.043	[Å^{-3}]
Fitting Parameter:	0.881	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.308	10.429	12.814	14.820	16.584	18.180	19.647	21.009
volume averaged	7.483	10.582	12.961	14.966	16.732	18.329	19.798	21.165
Lindhard-Scharff	3.147	4.450	5.450	6.294	7.037	7.708	8.326	8.901
Andersen-Ziegler	5.047	7.138	8.742	10.094	11.285	12.363	13.353	14.275
Oen-Robinson	3.103	4.388	5.375	6.206	6.938	7.601	8.210	8.777
Montenegro	5.197	7.443	9.184	10.648	11.925	13.062	14.087	15.020

energy	9	10	11	12	13	14	15	16
impact p. dependent	22.290	23.502	24.652	25.754	26.809	27.825	28.802	29.750
volume averaged	22.449	23.663	24.818	25.922	26.980	27.999	28.981	29.932
Lindhard-Scharff	9.441	9.951	10.437	10.901	11.346	11.774	12.188	12.587
Andersen-Ziegler	15.141	15.960	16.636	17.272	17.875	18.448	18.993	19.514
Oen-Robinson	9.309	9.812	10.291	10.749	11.188	11.610	12.018	12.412
Montenegro	15.873	16.659	17.385	18.057	18.681	19.262	19.803	20.308

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	30.667	31.559	32.426	33.269	34.092	34.898	35.683	36.453	37.206
volume averaged	30.853	31.747	32.617	33.465	34.291	35.098	35.887	36.659	37.415
Lindhard-Scharff	12.975	13.351	13.717	14.073	14.421	14.760	15.092	15.416	15.734
Andersen-Ziegler	20.012	20.489	20.946	21.385	21.807	22.213	22.603	22.979	23.342
Oen-Robinson	12.794	13.165	13.526	13.877	14.220	14.554	14.881	15.201	15.515
Montenegro	20.781	21.222	21.636	22.024	22.388	22.729	23.049	23.350	23.632

ELECTRONIC STOPPING POWER OF PROTONS IN Ar

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	18.	
Atomic Mass:	39.980	[amu]
Density:	1.650	[g/cm^3]
Measured Plasma Frequency:	4.	[eV]
One-Electron Radius:	2.548	[Å]
χ^2 of Free Electron Gas:	0.799	

Model Data:

Radius of Atom:	2.125	[Å]
Internal Radius of Atom:	2.125	[Å]
Homogeneous Electron Gas Density:	0.014	[Å^{-3}]
Density Correction:	0.004	[Å^{-3}]
Fitting Parameter:	0.862	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.569	12.234	15.034	17.388	19.462	21.334	23.054	24.657
volume averaged	8.780	12.417	15.207	17.560	19.633	21.507	23.230	24.834
Lindhard-Scharff	3.170	4.483	5.491	6.340	7.089	7.765	8.387	8.967
Andersen-Ziegler	5.731	8.105	9.926	11.462	12.815	14.038	15.163	16.210
Oen-Robinson	3.126	4.421	5.414	6.252	6.990	7.657	8.271	8.842
Montenegro	5.894	8.432	10.394	12.038	13.468	14.738	15.879	16.914
Biersack	3.134	4.432	5.425	6.262	6.997	7.659	8.266	8.829

energy	9	10	11	12	13	14	15	16
impact p. dependent	26.160	27.583	28.934	30.224	31.462	32.654	33.802	34.915
volume averaged	26.340	27.765	29.120	30.415	31.657	32.852	34.005	35.120
Lindhard-Scharff	9.510	10.025	10.514	10.982	11.430	11.862	12.278	12.681
Andersen-Ziegler	17.193	18.123	18.883	19.598	20.273	20.914	21.522	22.102
Oen-Robinson	9.378	9.885	10.368	10.829	11.271	11.696	12.107	12.504
Montenegro	17.858	18.725	19.523	20.260	20.943	21.577	22.166	22.714
Biersack	9.356	9.852	10.321	10.767	11.192	11.599	11.988	12.363

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	35.992	37.037	38.056	39.043	40.011	40.961	41.877	42.778	43.660
volume averaged	36.201	37.250	38.271	39.265	40.235	41.182	42.107	43.013	43.900
Lindhard-Scharff	13.071	13.450	13.818	14.177	14.528	14.869	15.204	15.531	15.851
Andersen-Ziegler	22.655	23.182	23.687	24.169	24.631	25.074	25.498	25.905	26.295
Oen-Robinson	12.889	13.262	13.626	13.980	14.325	14.662	14.992	15.314	15.630
Montenegro	23.225	23.702	24.147	24.564	24.953	25.317	25.658	25.978	26.277
Biersack	12.722	13.069	13.404	13.726	14.038	14.340	14.632	14.915	15.189

ELECTRONIC STOPPING POWER OF PROTONS IN K

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	19.	
Atomic Mass:	38.960	[amu]
Density:	0.863	[g/cm^3]
Measured Plasma Frequency:	4.	[eV]
One-Electron Radius:	2.771	[Å]
χ^2 of Free Electron Gas:	0.869	

Model Data:

Radius of Atom:	2.614	[Å]
Internal Radius of Atom:	2.614	[Å]
Homogeneous Electron Gas Density:	0.011	[Å^{-3}]
Density Correction:	0.007	[Å^{-3}]
Fitting Parameter:	1.006	

energy	1	2	3	4	5	6	7	8
impact p. dependent	14.937	21.266	26.107	30.179	33.764	37.007	39.987	42.757
volume averaged	15.217	21.520	26.356	30.433	34.025	37.273	40.259	43.039
Lindhard-Scharff	3.192	4.514	5.528	6.383	7.137	7.818	8.444	9.027
Andersen-Ziegler	5.151	7.285	8.922	10.302	11.518	12.617	13.628	14.569
Oen-Robinson	3.147	4.451	5.451	6.294	7.037	7.709	8.327	8.902
Montenegro	5.317	7.623	9.413	10.921	12.238	13.413	14.473	15.439

energy	9	10	11	12	13	14	15	16
impact p. dependent	45.362	47.822	50.162	52.399	54.547	56.610	58.597	60.527
volume averaged	45.650	48.119	50.468	52.712	54.864	56.935	58.934	60.867
Lindhard-Scharff	9.575	10.093	10.586	11.056	11.508	11.942	12.361	12.767
Andersen-Ziegler	15.453	16.289	16.978	17.626	18.240	18.823	19.377	19.907
Oen-Robinson	9.442	9.952	10.438	10.902	11.347	11.776	12.189	12.589
Montenegro	16.325	17.141	17.895	18.595	19.246	19.852	20.418	20.947

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	62.398	64.204	65.959	67.673	69.350	70.986	72.580	74.142	75.679
volume averaged	62.740	64.559	66.328	68.051	69.731	71.372	72.976	74.546	76.083
Lindhard-Scharff	13.160	13.541	13.912	14.274	14.626	14.970	15.307	15.636	15.958
Andersen-Ziegler	20.412	20.896	21.360	21.805	22.232	22.642	23.037	23.416	23.781
Oen-Robinson	12.976	13.352	13.718	14.075	14.422	14.762	15.093	15.418	15.736
Montenegro	21.442	21.906	22.341	22.750	23.133	23.494	23.833	24.151	24.451

ELECTRONIC STOPPING POWER OF PROTONS IN Ca

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	20.	
Atomic Mass:	39.960	[amu]
Density:	1.540	[g/cm^3]
Measured Plasma Frequency:	9.	[eV]
One-Electron Radius:	1.617	[Å]
χ^2 of Free Electron Gas:	0.507	

Model Data:

Radius of Atom:	2.174	[Å]
Internal Radius of Atom:	2.071	[Å]
Homogeneous Electron Gas Density:	0.057	[Å^{-3}]
Density Correction:	0.038	[Å^{-3}]
Fitting Parameter:	1.154	

energy	1	2	3	4	5	6	7	8
impact p. dependent	9.931	14.165	17.403	20.126	22.524	24.687	26.678	28.529
volume averaged	10.161	14.369	17.599	20.321	22.720	24.889	26.883	28.739
Lindhard-Scharff	3.212	4.542	5.563	6.423	7.181	7.867	8.497	9.084
Andersen-Ziegler	5.521	7.808	9.563	11.042	12.345	13.524	14.607	15.616
Oen-Robinson	3.167	4.479	5.485	6.334	7.081	7.757	8.379	8.957
Montenegro	5.699	8.169	10.084	11.696	13.103	14.356	15.486	16.515

energy	9	10	11	12	13	14	15	16
impact p. dependent	30.269	31.913	33.477	34.970	36.401	37.779	39.108	40.395
volume averaged	30.482	32.131	33.699	35.198	36.635	38.018	39.352	40.643
Lindhard-Scharff	9.635	10.156	10.652	11.125	11.580	12.017	12.438	12.846
Andersen-Ziegler	16.563	17.459	18.194	18.888	19.545	20.169	20.763	21.330
Oen-Robinson	9.501	10.014	10.503	10.970	11.418	11.849	12.265	12.667
Montenegro	17.457	18.323	19.124	19.866	20.556	21.198	21.796	22.355

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	41.642	42.853	44.029	45.176	46.293	47.386	48.452	49.498	50.517
volume averaged	41.894	43.108	44.289	45.440	46.562	47.658	48.729	49.777	50.803
Lindhard-Scharff	13.242	13.626	13.999	14.363	14.717	15.064	15.402	15.734	16.058
Andersen-Ziegler	21.871	22.389	22.885	23.360	23.817	24.256	24.677	25.082	25.472
Oen-Robinson	13.057	13.436	13.804	14.163	14.512	14.854	15.188	15.514	15.834
Montenegro	22.878	23.367	23.825	24.255	24.659	25.038	25.393	25.728	26.042

ELECTRONIC STOPPING POWER OF PROTONS IN Sc

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	21.	
Atomic Mass:	44.956	[amu]
Density:	2.997	[g/cm^3]
Measured Plasma Frequency:	13.	[eV]
One-Electron Radius:	1.241	[Å]
χ^2 of Free Electron Gas:	0.389	

Model Data:

Radius of Atom:	1.811	[Å]
Internal Radius of Atom:	1.716	[Å]
Homogeneous Electron Gas Density:	0.125	[Å^{-3}]
Density Correction:	0.081	[Å^{-3}]
Fitting Parameter:	1.116	

energy	1	2	3	4	5	6	7	8
impact p. dependent	6.298	9.013	11.085	12.829	14.362	15.747	17.017	18.201
volume averaged	6.489	9.177	11.240	12.979	14.511	15.895	17.169	18.354
Lindhard-Scharff	3.230	4.568	5.595	6.460	7.223	7.912	8.546	9.136
Andersen-Ziegler	5.201	7.355	9.008	10.402	11.630	12.740	13.761	14.711
Oen-Robinson	3.185	4.504	5.517	6.370	7.122	7.802	8.427	9.009
Montenegro	5.376	7.712	9.527	11.058	12.396	13.590	14.669	15.653

energy	9	10	11	12	13	14	15	16
impact p. dependent	19.313	20.364	21.365	22.318	23.235	24.114	24.964	25.784
volume averaged	19.468	20.521	21.523	22.480	23.397	24.281	25.133	25.957
Lindhard-Scharff	9.690	10.215	10.713	11.189	11.646	12.086	12.510	12.920
Andersen-Ziegler	15.603	16.447	17.143	17.800	18.423	19.015	19.579	20.117
Oen-Robinson	9.555	10.072	10.564	11.033	11.484	11.918	12.336	12.740
Montenegro	16.556	17.388	18.158	18.873	19.539	20.160	20.740	21.283

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	26.581	27.354	28.106	28.841	29.553	30.250	30.934	31.599	32.253
volume averaged	26.756	27.532	28.286	29.021	29.738	30.437	31.122	31.791	32.446
Lindhard-Scharff	13.318	13.704	14.080	14.446	14.802	15.151	15.491	15.824	16.151
Andersen-Ziegler	20.632	21.126	21.599	22.054	22.491	22.912	23.316	23.706	24.082
Oen-Robinson	13.132	13.513	13.883	14.244	14.596	14.939	15.275	15.604	15.925
Montenegro	21.791	22.268	22.716	23.137	23.533	23.905	24.256	24.586	24.897

ELECTRONIC STOPPING POWER OF PROTONS IN Ti

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	22.	
Atomic Mass:	47.950	[amu]
Density:	4.519	[g/cm^3]
Measured Plasma Frequency:	18.	[eV]
One-Electron Radius:	1.020	[Å]
χ^2 of Free Electron Gas:	0.320	

Model Data:

Radius of Atom:	1.613	[Å]
Internal Radius of Atom:	1.412	[Å]
Homogeneous Electron Gas Density:	0.226	[Å^{-3}]
Density Correction:	0.123	[Å^{-3}]
Fitting Parameter:	1.060	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.720	6.774	8.340	9.655	10.813	11.859	12.820	13.711
volume averaged	4.893	6.919	8.475	9.786	10.941	11.985	12.945	13.839
Lindhard-Scharff	3.247	4.592	5.625	6.495	7.261	7.954	8.592	9.185
Andersen-Ziegler	4.862	6.876	8.421	9.724	10.872	11.909	12.864	13.752
Oen-Robinson	3.202	4.528	5.546	6.404	7.160	7.844	8.472	9.057
Montenegro	5.038	7.236	8.950	10.399	11.669	12.805	13.835	14.776
Biersack	3.215	4.546	5.566	6.424	7.179	7.860	8.485	9.064

energy	9	10	11	12	13	14	15	16
impact p. dependent	14.550	15.345	16.100	16.819	17.508	18.172	18.815	19.433
volume averaged	14.678	15.472	16.228	16.949	17.641	18.307	18.950	19.571
Lindhard-Scharff	9.742	10.269	10.770	11.249	11.709	12.151	12.577	12.989
Andersen-Ziegler	14.586	15.375	16.029	16.647	17.232	17.789	18.320	18.828
Oen-Robinson	9.606	10.126	10.620	11.092	11.545	11.981	12.402	12.808
Montenegro	15.641	16.441	17.184	17.875	18.520	19.123	19.687	20.217
Biersack	9.607	10.118	10.602	11.063	11.503	11.924	12.329	12.718

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	20.034	20.617	21.186	21.738	22.275	22.802	23.317	23.818	24.312
volume averaged	20.174	20.758	21.327	21.881	22.422	22.949	23.465	23.970	24.464
Lindhard-Scharff	13.389	13.777	14.155	14.523	14.881	15.232	15.574	15.909	16.237
Andersen-Ziegler	19.315	19.781	20.229	20.660	21.075	21.474	21.860	22.231	22.590
Oen-Robinson	13.203	13.585	13.958	14.320	14.674	15.019	15.357	15.687	16.011
Montenegro	20.714	21.182	21.622	22.037	22.428	22.797	23.145	23.474	23.784
Biersack	13.092	13.454	13.803	14.141	14.469	14.786	15.094	15.392	15.682

ELECTRONIC STOPPING POWER OF PROTONS IN V

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	23.	
Atomic Mass:	50.940	[amu]
Density:	6.101	[g/cm^3]
Measured Plasma Frequency:	22.	[eV]
One-Electron Radius:	0.888	[Å]
χ^2 of Free Electron Gas:	0.278	

Model Data:

Radius of Atom:	1.490	[Å]
Internal Radius of Atom:	1.215	[Å]
Homogeneous Electron Gas Density:	0.342	[Å^{-3}]
Density Correction:	0.149	[Å^{-3}]
Fitting Parameter:	0.996	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.864	5.560	6.851	7.935	8.889	9.751	10.542	11.279
volume averaged	4.027	5.695	6.975	8.055	9.005	9.865	10.655	11.391
Lindhard-Scharff	3.264	4.615	5.653	6.527	7.297	7.994	8.634	9.231
Andersen-Ziegler	4.480	6.336	7.760	8.960	10.018	10.974	11.853	12.671
Oen-Robinson	3.218	4.551	5.574	6.436	7.196	7.882	8.514	9.102
Montenegro	4.658	6.702	8.302	9.659	10.853	11.924	12.899	13.792

energy	9	10	11	12	13	14	15	16
impact p. dependent	11.970	12.622	13.242	13.837	14.405	14.952	15.479	15.990
volume averaged	12.082	12.735	13.357	13.951	14.521	15.069	15.598	16.109
Lindhard-Scharff	9.791	10.320	10.824	11.305	11.767	12.211	12.640	13.054
Andersen-Ziegler	13.440	14.167	14.771	15.345	15.890	16.409	16.906	17.381
Oen-Robinson	9.654	10.176	10.673	11.148	11.603	12.041	12.463	12.872
Montenegro	14.616	15.380	16.092	16.755	17.377	17.959	18.507	19.022

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	16.485	16.963	17.432	17.886	18.330	18.763	19.186	19.601	20.006
volume averaged	16.605	17.086	17.554	18.010	18.455	18.890	19.314	19.730	20.136
Lindhard-Scharff	13.456	13.846	14.225	14.595	14.955	15.307	15.651	15.988	16.318
Andersen-Ziegler	17.838	18.277	18.699	19.107	19.500	19.880	20.248	20.604	20.948
Oen-Robinson	13.268	13.653	14.027	14.391	14.747	15.094	15.433	15.765	16.090
Montenegro	19.507	19.964	20.396	20.804	21.189	21.554	21.899	22.227	22.536

ELECTRONIC STOPPING POWER OF PROTONS IN Cr

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	24.	
Atomic Mass:	51.940	[amu]
Density:	7.192	[g/cm^3]
Measured Plasma Frequency:	24.	[eV]
One-Electron Radius:	0.819	[Å]
χ^2 of Free Electron Gas:	0.257	

Model Data:

Radius of Atom:	1.419	[Å]
Internal Radius of Atom:	1.065	[Å]
Homogeneous Electron Gas Density:	0.436	[Å^{-3}]
Density Correction:	0.107	[Å^{-3}]
Fitting Parameter:	0.837	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.415	4.920	6.067	7.029	7.876	8.640	9.342	9.995
volume averaged	3.571	5.050	6.184	7.141	7.984	8.746	9.447	10.099
Lindhard-Scharff	3.279	4.637	5.679	6.557	7.331	8.031	8.674	9.273
Andersen-Ziegler	3.983	5.633	6.899	7.966	8.906	9.756	10.538	11.266
Oen-Robinson	3.233	4.572	5.600	6.466	7.229	7.919	8.554	9.144
Montenegro	4.156	5.990	7.431	8.658	9.742	10.718	11.608	12.427

energy	9	10	11	12	13	14	15	16
impact p. dependent	10.607	11.187	11.739	12.263	12.768	13.253	13.720	14.174
volume averaged	10.712	11.291	11.842	12.369	12.874	13.360	13.829	14.282
Lindhard-Scharff	9.836	10.368	10.874	11.358	11.821	12.268	12.698	13.115
Andersen-Ziegler	11.949	12.595	13.135	13.649	14.137	14.603	15.049	15.476
Oen-Robinson	9.699	10.223	10.722	11.199	11.657	12.097	12.521	12.932
Montenegro	13.185	13.891	14.550	15.166	15.746	16.290	16.804	17.288

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	14.613	15.039	15.453	15.856	16.249	16.633	17.008	17.374	17.735
volume averaged	14.722	15.149	15.564	15.968	16.363	16.748	17.124	17.492	17.853
Lindhard-Scharff	13.518	13.910	14.291	14.662	15.025	15.378	15.724	16.062	16.393
Andersen-Ziegler	15.887	16.283	16.665	17.034	17.391	17.736	18.071	18.396	18.711
Oen-Robinson	13.330	13.716	14.092	14.458	14.815	15.164	15.505	15.838	16.165
Montenegro	17.746	18.179	18.589	18.978	19.346	19.696	20.029	20.344	20.644

ELECTRONIC STOPPING POWER OF PROTONS IN Mn

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	25.	
Atomic Mass:	54.940	[amu]
Density:	7.434	[g/cm^3]
Measured Plasma Frequency:	21.	[eV]
One-Electron Radius:	0.904	[Å]
χ^2 of Free Electron Gas:	0.283	

Model Data:

Radius of Atom:	1.430	[Å]
Internal Radius of Atom:	1.342	[Å]
Homogeneous Electron Gas Density:	0.324	[Å^{-3}]
Density Correction:	0.195	[Å^{-3}]
Fitting Parameter:	0.866	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.478	5.008	6.174	7.154	8.015	8.793	9.506	10.170
volume averaged	3.633	5.138	6.293	7.266	8.124	8.899	9.612	10.276
Lindhard-Scharff	3.293	4.657	5.703	6.586	7.363	8.066	8.712	9.314
Andersen-Ziegler	3.469	4.906	6.008	6.938	7.757	8.497	9.178	9.812
Oen-Robinson	3.247	4.592	5.624	6.494	7.260	7.953	8.591	9.184
Montenegro	3.637	5.255	6.532	7.624	8.593	9.469	10.271	11.012

energy	9	10	11	12	13	14	15	16
impact p. dependent	10.793	11.383	11.943	12.478	12.991	13.485	13.961	14.420
volume averaged	10.899	11.489	12.049	12.585	13.099	13.594	14.071	14.532
Lindhard-Scharff	9.879	10.413	10.921	11.407	11.873	12.321	12.753	13.171
Andersen-Ziegler	10.407	10.970	11.442	11.891	12.318	12.726	13.117	13.492
Oen-Robinson	9.741	10.268	10.769	11.248	11.707	12.149	12.575	12.988
Montenegro	11.701	12.345	12.947	13.514	14.048	14.552	15.029	15.480

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	14.868	15.301	15.722	16.133	16.533	16.924	17.306	17.680	18.045
volume averaged	14.979	15.414	15.836	16.247	16.649	17.040	17.423	17.798	18.165
Lindhard-Scharff	13.577	13.970	14.353	14.726	15.090	15.445	15.792	16.132	16.464
Andersen-Ziegler	13.852	14.200	14.536	14.861	15.175	15.480	15.775	16.062	16.341
Oen-Robinson	13.388	13.776	14.153	14.521	14.879	15.230	15.572	15.907	16.235
Montenegro	15.908	16.315	16.701	17.068	17.418	17.751	18.068	18.371	18.660

ELECTRONIC STOPPING POWER OF PROTONS IN Fe

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	26.	
Atomic Mass:	55.940	[amu]
Density:	7.866	[g/cm^3]
Measured Plasma Frequency:	16.	[eV]
One-Electron Radius:	1.094	[Å]
χ^2 of Free Electron Gas:	0.343	

Model Data:

Radius of Atom:	1.412	[Å]
Internal Radius of Atom:	1.412	[Å]
Homogeneous Electron Gas Density:	0.183	[Å^{-3}]
Density Correction:	0.081	[Å^{-3}]
Fitting Parameter:	0.807	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.235	4.673	5.767	6.686	7.494	8.222	8.892	9.514
volume averaged	3.401	4.810	5.891	6.803	7.606	8.332	8.999	9.620
Lindhard-Scharff	3.306	4.676	5.727	6.612	7.393	8.099	8.747	9.351
Andersen-Ziegler	3.519	4.977	6.095	7.038	7.869	8.620	9.310	9.953
Oen-Robinson	3.260	4.611	5.647	6.520	7.290	7.986	8.626	9.221
Montenegro	3.692	5.335	6.633	7.743	8.728	9.619	10.435	11.189

energy	9	10	11	12	13	14	15	16
impact p. dependent	10.099	10.650	11.176	11.676	12.158	12.619	13.067	13.497
volume averaged	10.204	10.756	11.281	11.783	12.264	12.727	13.173	13.605
Lindhard-Scharff	9.919	10.455	10.966	11.453	11.921	12.371	12.805	13.225
Andersen-Ziegler	10.557	11.128	11.607	12.062	12.495	12.909	13.305	13.686
Oen-Robinson	9.780	10.310	10.813	11.294	11.755	12.198	12.627	13.041
Montenegro	11.890	12.545	13.158	13.735	14.279	14.793	15.278	15.738

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	13.915	14.321	14.715	15.100	15.475	15.842	16.200	16.549	16.892
volume averaged	14.024	14.431	14.826	15.211	15.587	15.954	16.312	16.663	17.007
Lindhard-Scharff	13.632	14.027	14.412	14.786	15.151	15.508	15.856	16.197	16.531
Andersen-Ziegler	14.052	14.405	14.745	15.075	15.394	15.703	16.002	16.293	16.576
Oen-Robinson	13.442	13.832	14.211	14.580	14.940	15.291	15.635	15.971	16.301
Montenegro	16.175	16.589	16.983	17.357	17.714	18.054	18.378	18.687	18.981

ELECTRONIC STOPPING POWER OF PROTONS IN Co

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	27.	
Atomic Mass:	58.930	[amu]
Density:	8.796	[g/cm^3]
Measured Plasma Frequency:	18.	[eV]
One-Electron Radius:	1.009	[Å]
χ^2 of Free Electron Gas:	0.316	

Model Data:

Radius of Atom:	1.384	[Å]
Internal Radius of Atom:	1.384	[Å]
Homogeneous Electron Gas Density:	0.233	[Å^{-3}]
Density Correction:	0.125	[Å^{-3}]
Fitting Parameter:	0.751	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.120	4.504	5.558	6.443	7.221	7.923	8.568	9.168
volume averaged	3.278	4.635	5.677	6.556	7.329	8.029	8.672	9.271
Lindhard-Scharff	3.319	4.694	5.748	6.638	7.421	8.130	8.781	9.387
Andersen-Ziegler	3.140	4.441	5.439	6.280	7.021	7.691	8.308	8.881
Oen-Robinson	3.273	4.628	5.668	6.545	7.318	8.016	8.659	9.256
Montenegro	3.308	4.790	5.964	6.973	7.871	8.685	9.434	10.127

energy	9	10	11	12	13	14	15	16
impact p. dependent	9.731	10.264	10.770	11.252	11.716	12.160	12.591	13.006
volume averaged	9.833	10.365	10.871	11.354	11.818	12.264	12.695	13.111
Lindhard-Scharff	9.957	10.495	11.007	11.497	11.966	12.418	12.854	13.276
Andersen-Ziegler	9.420	9.930	10.361	10.768	11.156	11.527	11.882	12.224
Oen-Robinson	9.818	10.349	10.854	11.337	11.800	12.245	12.675	13.090
Montenegro	10.774	11.380	11.949	12.486	12.994	13.474	13.930	14.363

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	13.410	13.801	14.181	14.551	14.913	15.265	15.609	15.947	16.277
volume averaged	13.515	13.906	14.287	14.659	15.021	15.374	15.720	16.058	16.389
Lindhard-Scharff	13.684	14.081	14.467	14.843	15.209	15.567	15.917	16.259	16.594
Andersen-Ziegler	12.553	12.870	13.176	13.472	13.760	14.038	14.309	14.571	14.827
Oen-Robinson	13.493	13.885	14.265	14.636	14.997	15.350	15.695	16.033	16.363
Montenegro	14.774	15.166	15.540	15.896	16.236	16.561	16.871	17.168	17.452

ELECTRONIC STOPPING POWER OF PROTONS IN Ni

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	28.	
Atomic Mass:	57.940	[amu]
Density:	8.896	[g/cm^3]
Measured Plasma Frequency:	26.	[eV]
One-Electron Radius:	0.780	[Å]
χ^2 of Free Electron Gas:	0.245	

Model Data:

Radius of Atom:	1.371	[Å]
Internal Radius of Atom:	1.012	[Å]
Homogeneous Electron Gas Density:	0.505	[Å^{-3}]
Density Correction:	0.071	[Å^{-3}]
Fitting Parameter:	0.700	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.137	4.527	5.585	6.474	7.254	7.960	8.607	9.210
volume averaged	3.292	4.656	5.703	6.585	7.362	8.065	8.711	9.312
Lindhard-Scharff	3.331	4.711	5.769	6.662	7.448	8.159	8.813	9.421
Andersen-Ziegler	3.553	5.025	6.154	7.106	7.945	8.703	9.400	10.049
Oen-Robinson	3.284	4.645	5.689	6.569	7.344	8.045	8.690	9.290
Montenegro	3.729	5.389	6.700	7.822	8.818	9.718	10.543	11.306

energy	9	10	11	12	13	14	15	16
impact p. dependent	9.775	10.309	10.818	11.303	11.768	12.216	12.648	13.065
volume averaged	9.877	10.412	10.920	11.405	11.871	12.319	12.752	13.170
Lindhard-Scharff	9.993	10.533	11.047	11.538	12.010	12.463	12.900	13.323
Andersen-Ziegler	10.659	11.236	11.717	12.175	12.610	13.026	13.423	13.804
Oen-Robinson	9.853	10.386	10.893	11.378	11.842	12.289	12.720	13.138
Montenegro	12.015	12.677	13.298	13.882	14.433	14.953	15.445	15.911

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	13.470	13.861	14.244	14.616	14.978	15.333	15.680	16.018	16.350
volume averaged	13.575	13.969	14.351	14.724	15.088	15.443	15.790	16.130	16.462
Lindhard-Scharff	13.733	14.132	14.519	14.896	15.264	15.623	15.974	16.318	16.654
Andersen-Ziegler	14.170	14.523	14.863	15.191	15.508	15.815	16.113	16.401	16.681
Oen-Robinson	13.542	13.935	14.316	14.688	15.051	15.405	15.752	16.090	16.422
Montenegro	16.353	16.773	17.173	17.553	17.915	18.260	18.589	18.903	19.203

ELECTRONIC STOPPING POWER OF PROTONS IN Cu

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	29.	
Atomic Mass:	62.930	[amu]
Density:	8.949	[g/cm^3]
Measured Plasma Frequency:	20.	[eV]
One-Electron Radius:	0.951	[Å]
χ^2 of Free Electron Gas:	0.298	

Model Data:

Radius of Atom:	1.407	[Å]
Internal Radius of Atom:	1.287	[Å]
Homogeneous Electron Gas Density:	0.278	[Å^{-3}]
Density Correction:	0.147	[Å^{-3}]
Fitting Parameter:	0.606	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.297	4.746	5.850	6.778	7.594	8.331	9.008	9.638
volume averaged	3.443	4.869	5.963	6.886	7.699	8.433	9.109	9.738
Lindhard-Scharff	3.342	4.727	5.789	6.684	7.473	8.187	8.843	9.453
Andersen-Ziegler	3.696	5.227	6.402	7.392	8.265	9.053	9.779	10.454
Oen-Robinson	3.296	4.661	5.708	6.591	7.369	8.073	8.719	9.321
Montenegro	3.874	5.595	6.952	8.113	9.141	10.070	10.921	11.706
Biersack	3.311	4.682	5.733	6.618	7.396	8.099	8.744	9.343

energy	9	10	11	12	13	14	15	16
impact p. dependent	10.227	10.786	11.318	11.825	12.312	12.779	13.230	13.667
volume averaged	10.329	10.887	11.419	11.927	12.414	12.882	13.334	13.772
Lindhard-Scharff	10.027	10.569	11.085	11.578	12.050	12.505	12.944	13.369
Andersen-Ziegler	11.088	11.688	12.184	12.655	13.101	13.526	13.931	14.318
Oen-Robinson	9.887	10.422	10.930	11.416	11.882	12.331	12.764	13.182
Montenegro	12.436	13.116	13.754	14.354	14.918	15.451	15.954	16.431
Biersack	9.904	10.433	10.936	11.414	11.871	12.310	12.731	13.137

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	14.090	14.500	14.901	15.290	15.669	16.037	16.401	16.755	17.101
volume averaged	14.195	14.607	15.007	15.397	15.777	16.149	16.512	16.867	17.215
Lindhard-Scharff	13.780	14.180	14.568	14.947	15.316	15.676	16.029	16.373	16.711
Andersen-Ziegler	14.690	15.046	15.388	15.718	16.035	16.341	16.636	16.920	17.195
Oen-Robinson	13.588	13.982	14.365	14.738	15.102	15.458	15.805	16.145	16.478
Montenegro	16.883	17.313	17.720	18.108	18.477	18.829	19.164	19.483	19.788
Biersack	13.529	13.908	14.275	14.630	14.975	15.310	15.636	15.953	16.262

ELECTRONIC STOPPING POWER OF PROTONS IN Zn

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	30.	
Atomic Mass:	63.930	[amu]
Density:	7.105	[g/cm^3]
Measured Plasma Frequency:	17.	[eV]
One-Electron Radius:	1.041	[Å]
χ^2 of Free Electron Gas:	0.326	

Model Data:

Radius of Atom:	1.527	[Å]
Internal Radius of Atom:	1.322	[Å]
Homogeneous Electron Gas Density:	0.212	[Å^{-3}]
Density Correction:	0.094	[Å^{-3}]
Fitting Parameter:	0.612	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.059	5.830	7.181	8.317	9.317	10.218	11.047	11.818
volume averaged	4.219	5.967	7.307	8.438	9.434	10.334	11.162	11.933
Lindhard-Scharff	3.353	4.742	5.807	6.706	7.497	8.213	8.871	9.484
Andersen-Ziegler	4.210	5.954	7.292	8.420	9.414	10.312	11.139	11.908
Oen-Robinson	3.306	4.676	5.727	6.612	7.393	8.099	8.747	9.351
Montenegro	4.389	6.325	7.847	9.143	10.289	11.322	12.265	13.133

energy	9	10	11	12	13	14	15	16
impact p. dependent	12.540	13.226	13.875	14.499	15.093	15.667	16.219	16.754
volume averaged	12.657	13.342	13.993	14.615	15.212	15.786	16.340	16.876
Lindhard-Scharff	10.059	10.603	11.120	11.615	12.089	12.546	12.986	13.412
Andersen-Ziegler	12.630	13.313	13.882	14.421	14.932	15.420	15.886	16.331
Oen-Robinson	9.919	10.455	10.965	11.453	11.921	12.371	12.805	13.225
Montenegro	13.938	14.687	15.388	16.045	16.662	17.244	17.793	18.312

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	17.271	17.775	18.264	18.741	19.205	19.658	20.103	20.536	20.961
volume averaged	17.395	17.900	18.390	18.868	19.334	19.789	20.234	20.669	21.095
Lindhard-Scharff	13.825	14.225	14.615	14.995	15.365	15.727	16.080	16.426	16.765
Andersen-Ziegler	16.759	17.170	17.565	17.946	18.314	18.668	19.011	19.342	19.662
Oen-Robinson	13.632	14.027	14.411	14.786	15.151	15.507	15.856	16.197	16.531
Montenegro	18.802	19.267	19.708	20.127	20.525	20.903	21.262	21.605	21.931

ELECTRONIC STOPPING POWER OF PROTONS IN Ga

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	31.	
Atomic Mass:	68.930	[amu]
Density:	5.909	[g/cm^3]
Measured Plasma Frequency:	14.	[eV]
One-Electron Radius:	1.194	[Å]
χ^2 of Free Electron Gas:	0.375	

Model Data:

Radius of Atom:	1.665	[Å]
Internal Radius of Atom:	1.472	[Å]
Homogeneous Electron Gas Density:	0.141	[Å^{-3}]
Density Correction:	0.070	[Å^{-3}]
Fitting Parameter:	0.631	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.042	7.229	8.898	10.302	11.536	12.653	13.675	14.629
volume averaged	5.219	7.381	9.040	10.438	11.671	12.784	13.809	14.762
Lindhard-Scharff	3.363	4.756	5.825	6.726	7.520	8.238	8.898	9.512
Andersen-Ziegler	5.041	7.129	8.731	10.082	11.272	12.348	13.337	14.258
Oen-Robinson	3.316	4.690	5.744	6.633	7.415	8.123	8.774	9.380
Montenegro	5.229	7.516	9.301	10.814	12.143	13.334	14.415	15.406

energy	9	10	11	12	13	14	15	16
impact p. dependent	15.524	16.372	17.175	17.943	18.679	19.387	20.071	20.733
volume averaged	15.658	16.505	17.310	18.080	18.818	19.529	20.214	20.877
Lindhard-Scharff	10.090	10.635	11.154	11.650	12.126	12.584	13.026	13.453
Andersen-Ziegler	15.123	15.941	16.616	17.255	17.861	18.436	18.985	19.509
Oen-Robinson	9.949	10.487	10.999	11.488	11.957	12.408	12.844	13.265
Montenegro	16.319	17.166	17.953	18.687	19.375	20.019	20.624	21.193

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	21.373	21.995	22.600	23.190	23.763	24.326	24.875	25.411	25.937
volume averaged	21.519	22.143	22.750	23.341	23.918	24.480	25.031	25.569	26.096
Lindhard-Scharff	13.867	14.269	14.660	15.041	15.412	15.775	16.129	16.476	16.816
Andersen-Ziegler	20.010	20.490	20.951	21.393	21.818	22.227	22.620	22.999	23.364
Oen-Robinson	13.673	14.070	14.455	14.831	15.197	15.555	15.904	16.246	16.581
Montenegro	21.729	22.235	22.712	23.164	23.590	23.994	24.377	24.740	25.084

ELECTRONIC STOPPING POWER OF PROTONS IN Ge

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	32.	
Atomic Mass:	73.920	[amu]
Density:	5.338	[g/cm^3]
Measured Plasma Frequency:	16.	[eV]
One-Electron Radius:	1.067	[Å]
χ^2 of Free Electron Gas:	0.335	

Model Data:

Radius of Atom:	1.763	[Å]
Internal Radius of Atom:	1.144	[Å]
Homogeneous Electron Gas Density:	0.197	[Å^{-3}]
Density Correction:	-0.069	[Å^{-3}]
Fitting Parameter:	0.649	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.933	8.509	10.476	12.128	13.581	14.893	16.102	17.223
volume averaged	6.145	8.690	10.643	12.289	13.740	15.051	16.257	17.380
Lindhard-Scharff	3.373	4.770	5.842	6.746	7.542	8.262	8.924	9.540
Andersen-Ziegler	5.554	7.855	9.620	11.108	12.419	13.604	14.695	15.709
Oen-Robinson	3.326	4.704	5.761	6.652	7.437	8.147	8.800	9.407
Montenegro	5.759	8.275	10.236	11.896	13.352	14.655	15.837	16.919
Biersack	3.333	4.713	5.771	6.662	7.446	8.154	8.804	9.407

energy	9	10	11	12	13	14	15	16
impact p. dependent	18.276	19.271	20.219	21.124	21.990	22.827	23.631	24.410
volume averaged	18.434	19.431	20.379	21.286	22.155	22.991	23.798	24.578
Lindhard-Scharff	10.119	10.666	11.187	11.684	12.161	12.620	13.063	13.492
Andersen-Ziegler	16.662	17.563	18.295	18.984	19.634	20.248	20.830	21.383
Oen-Robinson	9.978	10.517	11.031	11.521	11.992	12.444	12.881	13.304
Montenegro	17.915	18.836	19.692	20.489	21.235	21.932	22.587	23.202
Biersack	9.973	10.507	11.014	11.496	11.958	12.400	12.826	13.237

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	25.163	25.895	26.608	27.301	27.977	28.638	29.283	29.916	30.534
volume averaged	25.335	26.069	26.784	27.479	28.158	28.821	29.468	30.102	30.723
Lindhard-Scharff	13.907	14.310	14.702	15.084	15.457	15.820	16.176	16.524	16.865
Andersen-Ziegler	21.909	22.409	22.885	23.338	23.771	24.183	24.576	24.951	25.308
Oen-Robinson	13.713	14.111	14.497	14.874	15.241	15.600	15.950	16.294	16.630
Montenegro	23.780	24.325	24.839	25.324	25.782	26.215	26.625	27.013	27.380
Biersack	13.633	14.016	14.387	14.748	15.097	15.437	15.768	16.090	16.403

ELECTRONIC STOPPING POWER OF PROTONS IN As

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	33.	
Atomic Mass:	74.920	[amu]
Density:	5.719	[g/cm^3]
Measured Plasma Frequency:	20.	[eV]
One-Electron Radius:	0.930	[Å]
χ^2 of Free Electron Gas:	0.292	

Model Data:

Radius of Atom:	1.731	[Å]
Internal Radius of Atom:	0.933	[Å]
Homogeneous Electron Gas Density:	0.298	[Å^{-3}]
Density Correction:	-0.372	[Å^{-3}]
Fitting Parameter:	0.663	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.772	8.300	10.226	11.845	13.270	14.555	15.735	16.834
volume averaged	6.010	8.500	10.410	12.021	13.439	14.722	15.902	17.000
Lindhard-Scharff	3.382	4.783	5.858	6.764	7.563	8.285	8.948	9.566
Andersen-Ziegler	5.323	7.528	9.220	10.646	11.903	13.039	14.083	15.056
Oen-Robinson	3.335	4.716	5.777	6.670	7.457	8.169	8.824	9.433
Montenegro	5.482	7.860	9.710	11.275	12.647	13.875	14.989	16.009

energy	9	10	11	12	13	14	15	16
impact p. dependent	17.864	18.838	19.766	20.650	21.501	22.316	23.103	23.866
volume averaged	18.031	19.006	19.934	20.820	21.670	22.488	23.278	24.041
Lindhard-Scharff	10.147	10.695	11.218	11.716	12.195	12.655	13.099	13.529
Andersen-Ziegler	15.969	16.833	17.552	18.230	18.873	19.485	20.070	20.629
Oen-Robinson	10.005	10.546	11.061	11.553	12.025	12.479	12.917	13.340
Montenegro	16.949	17.819	18.628	19.383	20.089	20.750	21.371	21.955

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	24.604	25.321	26.019	26.697	27.355	28.004	28.634	29.253	29.859
volume averaged	24.781	25.499	26.198	26.879	27.543	28.191	28.824	29.444	30.051
Lindhard-Scharff	13.945	14.349	14.743	15.126	15.499	15.864	16.221	16.569	16.911
Andersen-Ziegler	21.164	21.678	22.172	22.647	23.104	23.545	23.970	24.380	24.776
Oen-Robinson	13.751	14.149	14.537	14.915	15.283	15.643	15.994	16.338	16.675
Montenegro	22.505	23.024	23.514	23.976	24.414	24.828	25.221	25.593	25.945

ELECTRONIC STOPPING POWER OF PROTONS IN Se

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	34.	
Atomic Mass:	79.920	[amu]
Density:	4.786	[g/cm^3]
Measured Plasma Frequency:	19.	[eV]
One-Electron Radius:	0.972	[Å]
χ^2 of Free Electron Gas:	0.305	

Model Data:

Radius of Atom:	1.877	[Å]
Internal Radius of Atom:	0.880	[Å]
Homogeneous Electron Gas Density:	0.261	[Å^{-3}]
Density Correction:	-0.608	[Å^{-3}]
Fitting Parameter:	0.675	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.168	10.301	12.690	14.697	16.460	18.054	19.517	20.879
volume averaged	7.453	10.540	12.909	14.906	16.665	18.256	19.719	21.080
Lindhard-Scharff	3.391	4.796	5.874	6.782	7.583	8.306	8.972	9.591
Andersen-Ziegler	5.874	8.307	10.174	11.748	13.135	14.388	15.541	16.614
Oen-Robinson	3.344	4.729	5.792	6.688	7.477	8.191	8.847	9.458
Montenegro	6.049	8.668	10.704	12.423	13.928	15.274	16.493	17.606

energy	9	10	11	12	13	14	15	16
impact p. dependent	22.156	23.367	24.514	25.612	26.664	27.677	28.653	29.600
volume averaged	22.359	23.568	24.719	25.818	26.872	27.887	28.865	29.812
Lindhard-Scharff	10.173	10.724	11.247	11.747	12.227	12.688	13.134	13.564
Andersen-Ziegler	17.622	18.575	19.353	20.085	20.777	21.432	22.055	22.646
Oen-Robinson	10.031	10.574	11.090	11.583	12.056	12.511	12.951	13.375
Montenegro	18.631	19.578	20.458	21.277	22.041	22.757	23.428	24.058

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	30.514	31.403	32.263	33.110	33.928	34.727	35.513	36.280	37.026
volume averaged	30.730	31.620	32.487	33.331	34.154	34.958	35.743	36.512	37.265
Lindhard-Scharff	13.982	14.387	14.781	15.165	15.540	15.906	16.263	16.613	16.955
Andersen-Ziegler	23.209	23.746	24.258	24.746	25.213	25.659	26.085	26.492	26.881
Oen-Robinson	13.787	14.187	14.575	14.954	15.323	15.684	16.036	16.381	16.719
Montenegro	24.651	25.208	25.734	26.231	26.699	27.142	27.561	27.958	28.333

ELECTRONIC STOPPING POWER OF PROTONS IN Br

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	35.	
Atomic Mass:	78.920	[amu]
Density:	3.400	[g/cm^3]
Measured Plasma Frequency:	6.	[eV]
One-Electron Radius:	2.040	[Å]
χ^2 of Free Electron Gas:	0.640	

Model Data:

Radius of Atom:	2.094	[Å]
Internal Radius of Atom:	2.094	[Å]
Homogeneous Electron Gas Density:	0.028	[Å^{-3}]
Density Correction:	0.018	[Å^{-3}]
Fitting Parameter:	0.684	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.721	12.465	15.326	17.733	19.849	21.763	23.522	25.157
volume averaged	8.965	12.678	15.528	17.930	20.046	21.960	23.719	25.357
Lindhard-Scharff	3.400	4.808	5.888	6.799	7.602	8.327	8.994	9.615
Andersen-Ziegler	5.611	7.935	9.719	11.222	12.547	13.744	14.845	15.870
Oen-Robinson	3.352	4.741	5.806	6.704	7.496	8.211	8.869	9.481
Montenegro	5.792	8.312	10.277	11.941	13.402	14.712	15.902	16.992

energy	9	10	11	12	13	14	15	16
impact p. dependent	26.692	28.144	29.527	30.844	32.108	33.327	34.501	35.636
volume averaged	26.895	28.350	29.733	31.055	32.324	33.544	34.721	35.860
Lindhard-Scharff	10.199	10.750	11.275	11.776	12.257	12.720	13.166	13.598
Andersen-Ziegler	16.833	17.744	18.503	19.220	19.900	20.548	21.167	21.759
Oen-Robinson	10.057	10.601	11.118	11.612	12.086	12.543	12.983	13.409
Montenegro	17.998	18.931	19.798	20.608	21.366	22.078	22.746	23.375

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	36.737	37.806	38.843	39.855	40.841	41.805	42.743	43.667	44.569
volume averaged	36.963	38.035	39.077	40.092	41.082	42.049	42.994	43.919	44.825
Lindhard-Scharff	14.017	14.423	14.818	15.203	15.579	15.945	16.304	16.654	16.998
Andersen-Ziegler	22.327	22.872	23.396	23.901	24.388	24.857	25.310	25.748	26.171
Oen-Robinson	13.821	14.222	14.612	14.991	15.362	15.723	16.077	16.422	16.761
Montenegro	23.969	24.528	25.057	25.557	26.031	26.479	26.904	27.307	27.689

ELECTRONIC STOPPING POWER OF PROTONS IN Kr

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	36.	
Atomic Mass:	83.920	[amu]
Density:	2.602	[g/cm^3]
Measured Plasma Frequency:	4.	[eV]
One-Electron Radius:	2.683	[Å]
χ^2 of Free Electron Gas:	0.841	

Model Data:

Radius of Atom:	2.337	[Å]
Internal Radius of Atom:	2.337	[Å]
Homogeneous Electron Gas Density:	0.012	[Å^{-3}]
Density Correction:	0.007	[Å^{-3}]
Fitting Parameter:	0.689	

energy	1	2	3	4	5	6	7	8
impact p. dependent	11.220	16.014	19.677	22.760	25.473	27.925	30.177	32.274
volume averaged	11.495	16.256	19.909	22.989	25.703	28.156	30.412	32.512
Lindhard-Scharff	3.408	4.819	5.902	6.815	7.620	8.347	9.016	9.638
Andersen-Ziegler	6.411	9.067	11.104	12.822	14.335	15.704	16.962	18.133
Oen-Robinson	3.360	4.752	5.820	6.720	7.514	8.231	8.890	9.504
Montenegro	6.602	9.460	11.679	13.549	15.185	16.645	17.966	19.172
Biersack	3.367	4.761	5.830	6.730	7.522	8.238	8.895	9.505

energy	9	10	11	12	13	14	15	16
impact p. dependent	34.243	36.101	37.873	39.561	41.187	42.745	44.251	45.706
volume averaged	34.484	36.349	38.123	39.818	41.444	43.009	44.518	45.978
Lindhard-Scharff	10.223	10.776	11.302	11.805	12.287	12.750	13.198	13.631
Andersen-Ziegler	19.233	20.273	21.132	21.942	22.710	23.439	24.134	24.797
Oen-Robinson	10.081	10.626	11.145	11.640	12.115	12.573	13.014	13.441
Montenegro	20.280	21.302	22.251	23.133	23.955	24.724	25.444	26.119
Biersack	10.077	10.617	11.130	11.619	12.086	12.535	12.967	13.383

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	47.115	48.489	49.822	51.114	52.378	53.611	54.822	56.000	57.156
volume averaged	47.393	48.767	50.104	51.405	52.675	53.914	55.126	56.312	57.473
Lindhard-Scharff	14.050	14.458	14.854	15.240	15.616	15.984	16.343	16.694	17.038
Andersen-Ziegler	25.430	26.037	26.619	27.177	27.712	28.227	28.722	29.198	29.656
Oen-Robinson	13.854	14.256	14.647	15.027	15.398	15.761	16.115	16.462	16.801
Montenegro	26.753	27.350	27.911	28.441	28.940	29.411	29.856	30.277	30.675
Biersack	13.785	14.174	14.551	14.917	15.273	15.619	15.955	16.283	16.603

ELECTRONIC STOPPING POWER OF PROTONS IN Rb

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	37.	
Atomic Mass:	84.910	[amu]
Density:	1.529	[g/cm^3]
Measured Plasma Frequency:	4.	[eV]
One-Electron Radius:	2.881	[Å]
χ^2 of Free Electron Gas:	0.903	

Model Data:

Radius of Atom:	2.801	[Å]
Internal Radius of Atom:	2.801	[Å]
Homogeneous Electron Gas Density:	0.010	[Å^{-3}]
Density Correction:	0.008	[Å^{-3}]
Fitting Parameter:	0.744	

energy	1	2	3	4	5	6	7	8
impact p. dependent	18.108	25.772	31.633	36.571	40.914	44.841	48.453	51.813
volume averaged	18.440	26.078	31.939	36.880	41.234	45.169	48.788	52.157
Lindhard-Scharff	3.415	4.830	5.916	6.831	7.637	8.366	9.037	9.660
Andersen-Ziegler	5.694	8.053	9.862	11.388	12.732	13.947	15.065	16.105
Oen-Robinson	3.368	4.763	5.833	6.736	7.531	8.250	8.911	9.526
Montenegro	5.886	8.452	10.454	12.151	13.643	14.981	16.197	17.312

energy	9	10	11	12	13	14	15	16
impact p. dependent	54.964	57.947	60.784	63.491	66.096	68.595	71.011	73.347
volume averaged	55.321	58.313	61.159	63.879	66.487	68.997	71.419	73.761
Lindhard-Scharff	10.246	10.801	11.328	11.832	12.315	12.780	13.228	13.662
Andersen-Ziegler	17.082	18.006	18.775	19.501	20.190	20.847	21.473	22.073
Oen-Robinson	10.104	10.650	11.170	11.667	12.143	12.601	13.044	13.472
Montenegro	18.341	19.296	20.185	21.015	21.793	22.523	23.209	23.855

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	75.608	77.799	79.936	82.016	84.041	86.022	87.955	89.850	91.707
volume averaged	76.031	78.235	80.379	82.467	84.504	86.492	88.436	90.338	92.201
Lindhard-Scharff	14.082	14.491	14.888	15.275	15.652	16.020	16.380	16.732	17.077
Andersen-Ziegler	22.647	23.198	23.729	24.239	24.730	25.204	25.661	26.102	26.528
Oen-Robinson	13.886	14.289	14.680	15.062	15.434	15.797	16.152	16.499	16.839
Montenegro	24.465	25.041	25.585	26.100	26.588	27.050	27.488	27.904	28.299

ELECTRONIC STOPPING POWER OF PROTONS IN Sr

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	38.	
Atomic Mass:	87.910	[amu]
Density:	2.600	[g/cm^3]
Measured Plasma Frequency:	8.	[eV]
One-Electron Radius:	1.754	[Å]
χ^2 of Free Electron Gas:	0.550	

Model Data:

Radius of Atom:	2.374	[Å]
Internal Radius of Atom:	1.886	[Å]
Homogeneous Electron Gas Density:	0.044	[Å^{-3}]
Density Correction:	0.015	[Å^{-3}]
Fitting Parameter:	0.798	

energy	1	2	3	4	5	6	7	8
impact p. dependent	12.487	17.817	21.892	25.319	28.341	31.065	33.573	35.901
volume averaged	12.788	18.085	22.150	25.577	28.596	31.325	33.835	36.171
Lindhard-Scharff	3.423	4.841	5.929	6.846	7.654	8.384	9.056	9.682
Andersen-Ziegler	6.339	8.965	10.979	12.678	14.174	15.527	16.771	17.929
Oen-Robinson	3.375	4.773	5.846	6.750	7.547	8.268	8.930	9.547
Montenegro	6.480	9.265	11.425	13.248	14.843	16.270	17.564	18.746

energy	9	10	11	12	13	14	15	16
impact p. dependent	38.095	40.163	42.132	44.010	45.816	47.548	49.220	50.841
volume averaged	38.365	40.440	42.414	44.300	46.109	47.849	49.529	51.153
Lindhard-Scharff	10.269	10.824	11.353	11.857	12.342	12.808	13.257	13.692
Andersen-Ziegler	19.017	20.046	20.899	21.706	22.472	23.202	23.898	24.563
Oen-Robinson	10.126	10.673	11.194	11.692	12.170	12.629	13.072	13.501
Montenegro	19.836	20.844	21.780	22.654	23.470	24.235	24.953	25.627

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	52.411	53.937	55.416	56.861	58.267	59.640	60.984	62.298	63.586
volume averaged	52.728	54.256	55.743	57.191	58.603	59.982	61.331	62.650	63.941
Lindhard-Scharff	14.113	14.522	14.920	15.308	15.686	16.055	16.416	16.769	17.115
Andersen-Ziegler	25.201	25.813	26.401	26.966	27.511	28.036	28.543	29.031	29.503
Oen-Robinson	13.916	14.320	14.712	15.095	15.467	15.831	16.187	16.535	16.876
Montenegro	26.263	26.862	27.428	27.962	28.467	28.945	29.397	29.826	30.233

ELECTRONIC STOPPING POWER OF PROTONS IN Y

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	39.	
Atomic Mass:	89.910	[amu]
Density:	4.490	[g/cm^3]
Measured Plasma Frequency:	12.	[eV]
One-Electron Radius:	1.303	[Å]
χ^2 of Free Electron Gas:	0.409	

Model Data:

Radius of Atom:	1.994	[Å]
Internal Radius of Atom:	1.618	[Å]
Homogeneous Electron Gas Density:	0.108	[Å^{-3}]
Density Correction:	0.036	[Å^{-3}]
Fitting Parameter:	0.855	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.195	11.739	14.444	16.720	18.721	20.528	22.190	23.736
volume averaged	8.466	11.972	14.663	16.931	18.930	20.736	22.398	23.944
Lindhard-Scharff	3.430	4.851	5.941	6.860	7.670	8.402	9.075	9.702
Andersen-Ziegler	6.407	9.061	11.097	12.814	14.326	15.694	16.951	18.122
Oen-Robinson	3.382	4.783	5.858	6.765	7.563	8.285	8.949	9.567
Montenegro	6.552	9.370	11.555	13.397	15.011	16.453	17.760	18.955

energy	9	10	11	12	13	14	15	16
impact p. dependent	25.185	26.557	27.861	29.107	30.303	31.453	32.562	33.631
volume averaged	25.397	26.771	28.077	29.326	30.523	31.675	32.787	33.862
Lindhard-Scharff	10.290	10.847	11.376	11.882	12.368	12.834	13.285	13.721
Andersen-Ziegler	19.221	20.261	21.125	21.942	22.718	23.457	24.162	24.837
Oen-Robinson	10.147	10.696	11.218	11.717	12.195	12.655	13.100	13.529
Montenegro	20.054	21.072	22.018	22.899	23.722	24.494	25.218	25.898

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	34.672	35.681	36.664	37.618	38.550	39.461	40.349	41.218	42.072
volume averaged	34.905	35.916	36.901	37.859	38.794	39.707	40.600	41.473	42.328
Lindhard-Scharff	14.143	14.553	14.952	15.340	15.719	16.089	16.450	16.804	17.151
Andersen-Ziegler	25.484	26.105	26.702	27.277	27.831	28.365	28.880	29.378	29.859
Oen-Robinson	13.946	14.350	14.743	15.126	15.500	15.864	16.221	16.570	16.912
Montenegro	26.539	27.142	27.712	28.250	28.759	29.240	29.696	30.127	30.537

ELECTRONIC STOPPING POWER OF PROTONS IN Zr

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	40.	
Atomic Mass:	89.900	[amu]
Density:	6.470	[g/cm^3]
Measured Plasma Frequency:	18.	[eV]
One-Electron Radius:	0.993	[Å]
χ^2 of Free Electron Gas:	0.311	

Model Data:

Radius of Atom:	1.765	[Å]
Internal Radius of Atom:	1.243	[Å]
Homogeneous Electron Gas Density:	0.245	[Å^{-3}]
Density Correction:	0.000	[Å^{-3}]
Fitting Parameter:	0.866	

energy	1	2	3	4	5	6	7	8
impact p. dependent	6.112	8.792	10.835	12.550	14.061	15.423	16.674	17.840
volume averaged	6.371	9.011	11.036	12.743	14.247	15.607	16.857	18.021
Lindhard-Scharff	3.437	4.861	5.953	6.874	7.685	8.419	9.094	9.721
Andersen-Ziegler	6.734	9.523	11.664	13.468	15.058	16.495	17.816	19.047
Oen-Robinson	3.389	4.793	5.870	6.778	7.578	8.302	8.967	9.586
Montenegro	6.884	9.839	12.127	14.052	15.734	17.235	18.592	19.830

energy	9	10	11	12	13	14	15	16
impact p. dependent	18.932	19.968	20.948	21.888	22.787	23.654	24.488	25.297
volume averaged	19.114	20.148	21.132	22.071	22.972	23.840	24.676	25.486
Lindhard-Scharff	10.311	10.869	11.399	11.906	12.392	12.860	13.312	13.748
Andersen-Ziegler	20.202	21.295	22.202	23.062	23.877	24.654	25.395	26.105
Oen-Robinson	10.167	10.717	11.240	11.740	12.220	12.681	13.126	13.556
Montenegro	20.968	22.019	22.993	23.899	24.745	25.536	26.276	26.971

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	26.078	26.839	27.578	28.297	28.998	29.684	30.353	31.007	31.650
volume averaged	26.270	27.032	27.772	28.494	29.197	29.885	30.556	31.213	31.857
Lindhard-Scharff	14.171	14.582	14.982	15.371	15.750	16.121	16.483	16.838	17.185
Andersen-Ziegler	26.785	27.438	28.066	28.671	29.253	29.815	30.358	30.882	31.388
Oen-Robinson	13.974	14.379	14.773	15.157	15.531	15.896	16.254	16.603	16.946
Montenegro	27.624	28.239	28.818	29.364	29.879	30.366	30.826	31.261	31.673

ELECTRONIC STOPPING POWER OF PROTONS IN Nb

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	41.	
Atomic Mass:	92.910	[amu]
Density:	8.602	[g/cm^3]
Measured Plasma Frequency:	19.	[eV]
One-Electron Radius:	0.986	[Å]
χ^2 of Free Electron Gas:	0.309	

Model Data:

Radius of Atom:	1.623	[Å]
Internal Radius of Atom:	1.418	[Å]
Homogeneous Electron Gas Density:	0.250	[Å^{-3}]
Density Correction:	0.114	[Å^{-3}]
Fitting Parameter:	0.831	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.908	7.069	8.718	10.104	11.321	12.420	13.429	14.369
volume averaged	5.135	7.262	8.894	10.270	11.482	12.578	13.586	14.524
Lindhard-Scharff	3.444	4.870	5.965	6.887	7.700	8.435	9.111	9.740
Andersen-Ziegler	6.902	9.761	11.955	13.804	15.433	16.906	18.261	19.522
Oen-Robinson	3.396	4.802	5.881	6.791	7.593	8.318	8.984	9.604
Montenegro	7.057	10.086	12.430	14.401	16.122	17.657	19.043	20.308
Biersack	3.401	4.809	5.889	6.799	7.600	8.323	8.987	9.605

energy	9	10	11	12	13	14	15	16
impact p. dependent	15.250	16.084	16.876	17.631	18.357	19.056	19.728	20.379
volume averaged	15.405	16.238	17.031	17.788	18.515	19.213	19.888	20.540
Lindhard-Scharff	10.331	10.890	11.421	11.929	12.416	12.885	13.337	13.775
Andersen-Ziegler	20.706	21.826	22.755	23.636	24.473	25.270	26.031	26.759
Oen-Robinson	10.187	10.738	11.262	11.763	12.243	12.705	13.151	13.583
Montenegro	21.469	22.540	23.533	24.457	25.317	26.122	26.875	27.581
Biersack	10.183	10.730	11.249	11.744	12.217	12.672	13.109	13.531

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	21.011	21.623	22.217	22.801	23.366	23.918	24.457	24.986	25.503
volume averaged	21.172	21.786	22.383	22.964	23.532	24.085	24.627	25.156	25.675
Lindhard-Scharff	14.199	14.610	15.011	15.401	15.781	16.152	16.515	16.870	17.218
Andersen-Ziegler	27.458	28.129	28.774	29.395	29.994	30.572	31.130	31.669	32.190
Oen-Robinson	14.001	14.407	14.801	15.186	15.561	15.927	16.285	16.635	16.978
Montenegro	28.245	28.869	29.456	30.010	30.532	31.025	31.491	31.932	32.349
Biersack	13.939	14.334	14.718	15.089	15.451	15.803	16.146	16.480	16.806

ELECTRONIC STOPPING POWER OF PROTONS IN Mo

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	42.	
Atomic Mass:	95.500	[amu]
Density:	10.206	[g/cm^3]
Measured Plasma Frequency:	25.	[eV]
One-Electron Radius:	0.809	[Å]
χ^2 of Free Electron Gas:	0.254	

Model Data:

Radius of Atom:	1.547	[Å]
Internal Radius of Atom:	1.063	[Å]
Homogeneous Electron Gas Density:	0.453	[Å^{-3}]
Density Correction:	-0.027	[Å^{-3}]
Fitting Parameter:	0.825	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.395	6.352	7.842	9.093	10.193	11.185	12.097	12.945
volume averaged	4.631	6.549	8.021	9.262	10.355	11.343	12.252	13.098
Lindhard-Scharff	3.450	4.879	5.976	6.900	7.715	8.451	9.128	9.758
Andersen-Ziegler	6.425	9.086	11.128	12.850	14.367	15.738	16.999	18.173
Oen-Robinson	3.402	4.811	5.892	6.804	7.607	8.333	9.001	9.622
Montenegro	6.583	9.420	11.623	13.482	15.111	16.568	17.889	19.097

energy	9	10	11	12	13	14	15	16
impact p. dependent	13.740	14.493	15.207	15.890	16.544	17.174	17.784	18.370
volume averaged	13.893	14.644	15.359	16.042	16.697	17.327	17.935	18.524
Lindhard-Scharff	10.350	10.910	11.443	11.951	12.439	12.909	13.362	13.800
Andersen-Ziegler	19.275	20.318	21.186	22.009	22.791	23.537	24.250	24.932
Oen-Robinson	10.206	10.758	11.283	11.785	12.266	12.729	13.176	13.608
Montenegro	20.210	21.240	22.198	23.091	23.926	24.708	25.443	26.134

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	18.939	19.492	20.028	20.553	21.064	21.561	22.049	22.524	22.991
volume averaged	19.094	19.647	20.186	20.710	21.222	21.721	22.209	22.687	23.155
Lindhard-Scharff	14.225	14.637	15.038	15.429	15.810	16.182	16.546	16.902	17.250
Andersen-Ziegler	25.587	26.217	26.823	27.408	27.972	28.517	29.044	29.553	30.047
Oen-Robinson	14.027	14.433	14.829	15.214	15.590	15.957	16.315	16.666	17.010
Montenegro	26.785	27.398	27.978	28.526	29.044	29.534	29.999	30.439	30.857

ELECTRONIC STOPPING POWER OF PROTONS IN Ru

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	44.	
Atomic Mass:	101.900	[amu]
Density:	12.177	[g/cm^3]
Measured Plasma Frequency:	21.	[eV]
One-Electron Radius:	0.902	[Å]
χ^2 of Free Electron Gas:	0.283	

Model Data:

Radius of Atom:	1.491	[Å]
Internal Radius of Atom:	1.411	[Å]
Homogeneous Electron Gas Density:	0.326	[Å^{-3}]
Density Correction:	0.184	[Å^{-3}]
Fitting Parameter:	0.803	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.967	5.731	7.076	8.205	9.198	10.094	10.917	11.683
volume averaged	4.180	5.912	7.240	8.360	9.347	10.239	11.060	11.823
Lindhard-Scharff	3.462	4.896	5.997	6.924	7.742	8.481	9.160	9.793
Andersen-Ziegler	6.108	8.638	10.579	12.216	13.658	14.961	16.160	17.276
Oen-Robinson	3.414	4.828	5.913	6.828	7.634	8.362	9.032	9.656
Montenegro	6.267	8.973	11.077	12.855	14.414	15.811	17.078	18.238

energy	9	10	11	12	13	14	15	16
impact p. dependent	12.401	13.079	13.724	14.342	14.932	15.502	16.051	16.580
volume averaged	12.540	13.219	13.864	14.480	15.072	15.641	16.190	16.721
Lindhard-Scharff	10.387	10.948	11.483	11.993	12.483	12.954	13.409	13.849
Andersen-Ziegler	18.324	19.315	20.147	20.932	21.679	22.392	23.073	23.727
Oen-Robinson	10.242	10.796	11.323	11.826	12.309	12.774	13.222	13.656
Montenegro	19.308	20.300	21.223	22.084	22.890	23.647	24.357	25.027

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	17.092	17.592	18.077	18.549	19.011	19.459	19.900	20.329	20.752
volume averaged	17.235	17.735	18.221	18.694	19.156	19.607	20.047	20.478	20.901
Lindhard-Scharff	14.275	14.689	15.091	15.483	15.866	16.239	16.604	16.961	17.311
Andersen-Ziegler	24.354	24.958	25.540	26.102	26.645	27.170	27.678	28.170	28.647
Oen-Robinson	14.076	14.484	14.881	15.268	15.645	16.013	16.373	16.725	17.070
Montenegro	25.658	26.254	26.817	27.350	27.854	28.333	28.786	29.217	29.625

ELECTRONIC STOPPING POWER OF PROTONS IN Rh

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	45.	
Atomic Mass:	102.900	[amu]
Density:	12.399	[g/cm^3]
Measured Plasma Frequency:	20.	[eV]
One-Electron Radius:	0.932	[Å]
χ^2 of Free Electron Gas:	0.292	

Model Data:

Radius of Atom:	1.487	[Å]
Internal Radius of Atom:	1.487	[Å]
Homogeneous Electron Gas Density:	0.296	[Å^{-3}]
Density Correction:	0.185	[Å^{-3}]
Fitting Parameter:	0.788	

energy	1	2	3	4	5	6	7	8
impact p. dependent	3.937	5.690	7.025	8.146	9.132	10.022	10.839	11.599
volume averaged	4.151	5.870	7.189	8.302	9.281	10.167	10.982	11.740
Lindhard-Scharff	3.468	4.904	6.007	6.936	7.755	8.495	9.175	9.809
Andersen-Ziegler	5.924	8.378	10.261	11.848	13.246	14.511	15.673	16.756
Oen-Robinson	3.420	4.836	5.923	6.839	7.646	8.376	9.047	9.672
Montenegro	6.085	8.718	10.769	12.504	14.028	15.394	16.636	17.775

energy	9	10	11	12	13	14	15	16
impact p. dependent	12.313	12.986	13.627	14.239	14.826	15.393	15.936	16.462
volume averaged	12.452	13.126	13.766	14.379	14.966	15.531	16.076	16.603
Lindhard-Scharff	10.404	10.967	11.502	12.013	12.504	12.976	13.431	13.872
Andersen-Ziegler	17.772	18.733	19.539	20.303	21.029	21.721	22.384	23.020
Oen-Robinson	10.259	10.814	11.341	11.846	12.329	12.795	13.244	13.678
Montenegro	18.826	19.801	20.710	21.559	22.355	23.103	23.806	24.469

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	16.972	17.468	17.950	18.418	18.876	19.323	19.759	20.187	20.604
volume averaged	17.114	17.610	18.093	18.563	19.021	19.469	19.906	20.334	20.754
Lindhard-Scharff	14.299	14.713	15.116	15.509	15.892	16.266	16.632	16.989	17.340
Andersen-Ziegler	23.630	24.219	24.786	25.333	25.862	26.374	26.870	27.351	27.817
Oen-Robinson	14.099	14.508	14.906	15.293	15.671	16.039	16.400	16.752	17.098
Montenegro	25.095	25.687	26.247	26.777	27.280	27.757	28.210	28.640	29.049

ELECTRONIC STOPPING POWER OF PROTONS IN Pd

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	46.	
Atomic Mass:	105.900	[amu]
Density:	11.955	[g/cm^3]
Measured Plasma Frequency:	25.	[eV]
One-Electron Radius:	0.798	[Å]
χ^2 of Free Electron Gas:	0.250	

Model Data:

Radius of Atom:	1.519	[Å]
Internal Radius of Atom:	1.056	[Å]
Homogeneous Electron Gas Density:	0.472	[Å^{-3}]
Density Correction:	-0.038	[Å^{-3}]
Fitting Parameter:	0.737	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.193	6.064	7.488	8.685	9.737	10.685	11.555	12.366
volume averaged	4.426	6.259	7.666	8.852	9.896	10.841	11.710	12.518
Lindhard-Scharff	3.473	4.912	6.016	6.947	7.767	8.508	9.190	9.824
Andersen-Ziegler	5.238	7.408	9.072	10.476	11.713	12.830	13.858	14.815
Oen-Robinson	3.425	4.844	5.932	6.850	7.659	8.390	9.062	9.688
Montenegro	5.394	7.740	9.574	11.132	12.505	13.741	14.868	15.905

energy	9	10	11	12	13	14	15	16
impact p. dependent	13.128	13.847	14.530	15.183	15.808	16.409	16.992	17.553
volume averaged	13.277	13.996	14.679	15.331	15.957	16.560	17.141	17.703
Lindhard-Scharff	10.420	10.984	11.520	12.032	12.524	12.997	13.453	13.894
Andersen-Ziegler	15.714	16.564	17.279	17.956	18.601	19.216	19.805	20.371
Oen-Robinson	10.275	10.831	11.360	11.865	12.349	12.815	13.265	13.700
Montenegro	16.866	17.761	18.598	19.382	20.120	20.815	21.471	22.092

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	18.095	18.625	19.139	19.640	20.128	20.604	21.069	21.525	21.971
volume averaged	18.248	18.777	19.292	19.793	20.282	20.759	21.225	21.682	22.129
Lindhard-Scharff	14.322	14.737	15.141	15.534	15.917	16.292	16.658	17.016	17.367
Andersen-Ziegler	20.915	21.439	21.945	22.433	22.906	23.364	23.809	24.240	24.658
Oen-Robinson	14.122	14.531	14.929	15.317	15.696	16.065	16.426	16.779	17.125
Montenegro	22.680	23.237	23.766	24.268	24.746	25.201	25.634	26.047	26.441

ELECTRONIC STOPPING POWER OF PROTONS IN Ag

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	47.	
Atomic Mass:	106.900	[amu]
Density:	10.473	[g/cm^3]
Measured Plasma Frequency:	25.	[eV]
One-Electron Radius:	0.809	[Å]
χ^2 of Free Electron Gas:	0.254	

Model Data:

Radius of Atom:	1.593	[Å]
Internal Radius of Atom:	1.005	[Å]
Homogeneous Electron Gas Density:	0.453	[Å^{-3}]
Density Correction:	-0.186	[Å^{-3}]
Fitting Parameter:	0.754	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.759	6.880	8.495	9.851	11.042	12.118	13.105	14.025
volume averaged	5.018	7.096	8.691	10.035	11.220	12.291	13.276	14.192
Lindhard-Scharff	3.479	4.920	6.026	6.958	7.779	8.521	9.204	9.840
Andersen-Ziegler	5.623	7.952	9.739	11.246	12.573	13.773	14.877	15.904
Oen-Robinson	3.430	4.851	5.942	6.861	7.670	8.403	9.076	9.702
Montenegro	5.784	8.294	10.250	11.908	13.367	14.676	15.867	16.961
Biersack	3.436	4.859	5.950	6.870	7.679	8.410	9.082	9.706

energy	9	10	11	12	13	14	15	16
impact p. dependent	14.886	15.701	16.475	17.216	17.925	18.606	19.268	19.903
volume averaged	15.053	15.867	16.642	17.382	18.091	18.774	19.433	20.071
Lindhard-Scharff	10.437	11.001	11.538	12.051	12.543	13.017	13.473	13.915
Andersen-Ziegler	16.869	17.781	18.539	19.254	19.931	20.576	21.191	21.779
Oen-Robinson	10.291	10.848	11.377	11.883	12.368	12.835	13.286	13.721
Montenegro	17.973	18.912	19.788	20.608	21.377	22.101	22.782	23.425
Biersack	10.291	10.844	11.370	11.871	12.350	12.811	13.254	13.682

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	20.519	21.118	21.700	22.268	22.820	23.362	23.888	24.404	24.909
volume averaged	20.688	21.288	21.872	22.440	22.994	23.535	24.064	24.581	25.088
Lindhard-Scharff	14.344	14.759	15.164	15.558	15.942	16.317	16.684	17.043	17.394
Andersen-Ziegler	22.342	22.882	23.401	23.900	24.380	24.842	25.288	25.718	26.132
Oen-Robinson	14.144	14.554	14.953	15.341	15.720	16.090	16.451	16.805	17.152
Montenegro	24.033	24.609	25.154	25.671	26.161	26.627	27.070	27.492	27.893
Biersack	14.096	14.497	14.886	15.263	15.631	15.989	16.337	16.678	17.010

ELECTRONIC STOPPING POWER OF PROTONS IN Cd

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	48.	
Atomic Mass:	113.900	[amu]
Density:	8.580	[g/cm^3]
Measured Plasma Frequency:	15.	[eV]
One-Electron Radius:	1.126	[Å]
χ^2 of Free Electron Gas:	0.353	

Model Data:

Radius of Atom:	1.738	[Å]
Internal Radius of Atom:	1.579	[Å]
Homogeneous Electron Gas Density:	0.168	[Å^{-3}]
Density Correction:	0.084	[Å^{-3}]
Fitting Parameter:	0.775	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.841	8.402	10.355	11.996	13.440	14.743	15.940	17.054
volume averaged	6.093	8.616	10.553	12.185	13.623	14.924	16.120	17.233
Lindhard-Scharff	3.484	4.927	6.035	6.968	7.791	8.534	9.218	9.854
Andersen-Ziegler	5.814	8.222	10.070	11.628	13.000	14.241	15.382	16.444
Oen-Robinson	3.435	4.858	5.950	6.871	7.682	8.415	9.089	9.717
Montenegro	5.983	8.579	10.604	12.319	13.828	15.182	16.414	17.544

energy	9	10	11	12	13	14	15	16
impact p. dependent	18.098	19.088	20.029	20.925	21.786	22.614	23.410	24.186
volume averaged	18.278	19.267	20.207	21.105	21.967	22.796	23.597	24.370
Lindhard-Scharff	10.452	11.017	11.555	12.069	12.562	13.036	13.494	13.936
Andersen-Ziegler	17.442	18.385	19.174	19.921	20.632	21.310	21.958	22.580
Oen-Robinson	10.306	10.864	11.394	11.901	12.387	12.854	13.306	13.742
Montenegro	18.590	19.560	20.465	21.312	22.107	22.853	23.557	24.221

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	24.935	25.659	26.367	27.056	27.726	28.382	29.023	29.648	30.262
volume averaged	25.120	25.849	26.557	27.247	27.920	28.577	29.219	29.848	30.463
Lindhard-Scharff	14.365	14.781	15.187	15.581	15.966	16.342	16.709	17.068	17.420
Andersen-Ziegler	23.177	23.751	24.304	24.838	25.353	25.852	26.334	26.801	27.254
Oen-Robinson	14.165	14.575	14.975	15.364	15.743	16.114	16.476	16.830	17.177
Montenegro	24.848	25.441	26.003	26.536	27.042	27.522	27.979	28.413	28.827

ELECTRONIC STOPPING POWER OF PROTONS IN In

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	49.	
Atomic Mass:	114.900	[amu]
Density:	7.313	[g/cm^3]
Measured Plasma Frequency:	11.	[eV]
One-Electron Radius:	1.369	[Å]
χ^2 of Free Electron Gas:	0.429	

Model Data:

Radius of Atom:	1.839	[Å]
Internal Radius of Atom:	1.839	[Å]
Homogeneous Electron Gas Density:	0.093	[Å^{-3}]
Density Correction:	0.053	[Å^{-3}]
Fitting Parameter:	0.810	

energy	1	2	3	4	5	6	7	8
impact p. dependent	6.647	9.556	11.775	13.640	15.282	16.763	18.123	19.390
volume averaged	6.925	9.793	11.994	13.849	15.484	16.962	18.321	19.585
Lindhard-Scharff	3.489	4.934	6.043	6.978	7.802	8.546	9.231	9.869
Andersen-Ziegler	6.230	8.811	10.791	12.460	13.931	15.260	16.483	17.621
Oen-Robinson	3.440	4.865	5.959	6.881	7.693	8.427	-9.103	9.731
Montenegro	6.404	9.176	11.332	13.154	14.753	16.185	17.484	18.674

energy	9	10	11	12	13	14	15	16
impact p. dependent	20.576	21.699	22.770	23.788	24.768	25.707	26.617	27.492
volume averaged	20.774	21.897	22.966	23.987	24.967	25.909	26.819	27.698
Lindhard-Scharff	10.467	11.033	11.572	12.086	12.580	13.055	13.513	13.956
Andersen-Ziegler	18.690	19.701	20.544	21.345	22.105	22.831	23.525	24.189
Oen-Robinson	10.321	10.880	11.411	11.918	12.405	12.873	13.325	13.762
Montenegro	19.771	20.787	21.733	22.616	23.443	24.218	24.947	25.634

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	28.343	29.169	29.974	30.754	31.518	32.261	32.990	33.703	34.401
volume averaged	28.551	29.378	30.183	30.967	31.732	32.479	33.209	33.923	34.623
Lindhard-Scharff	14.386	14.803	15.208	15.604	15.989	16.365	16.733	17.093	17.445
Andersen-Ziegler	24.828	25.442	26.033	26.604	27.154	27.687	28.202	28.701	29.184
Oen-Robinson	14.185	14.596	14.996	15.386	15.766	16.137	16.500	16.855	17.202
Montenegro	26.281	26.892	27.470	28.017	28.535	29.026	29.491	29.934	30.354

ELECTRONIC STOPPING POWER OF PROTONS IN Sn

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	50.	
Atomic Mass:	119.900	[amu]
Density:	7.282	[g/cm^3]
Measured Plasma Frequency:	14.	[eV]
One-Electron Radius:	1.178	[Å]
χ^2 of Free Electron Gas:	0.369	

Model Data:

Radius of Atom:	1.868	[Å]
Internal Radius of Atom:	1.607	[Å]
Homogeneous Electron Gas Density:	0.147	[Å^{-3}]
Density Correction:	0.061	[Å^{-3}]
Fitting Parameter:	0.841	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.047	10.127	12.475	14.449	16.186	17.753	19.191	20.534
volume averaged	7.332	10.369	12.700	14.664	16.395	17.960	19.399	20.739
Lindhard-Scharff	3.494	4.941	6.052	6.988	7.813	8.558	9.244	9.882
Andersen-Ziegler	6.410	9.065	11.102	12.820	14.333	15.701	16.959	18.130
Oen-Robinson	3.445	4.872	5.967	6.890	7.704	8.439	9.115	9.745
Montenegro	6.574	9.408	11.606	13.460	15.082	16.532	17.844	19.044

energy	9	10	11	12	13	14	15	16
impact p. dependent	21.791	22.981	24.110	25.190	26.228	27.219	28.183	29.113
volume averaged	21.997	23.187	24.318	25.400	26.437	27.435	28.398	29.329
Lindhard-Scharff	10.482	11.049	11.588	12.103	12.598	13.073	13.532	13.976
Andersen-Ziegler	19.230	20.270	21.138	21.962	22.745	23.491	24.205	24.889
Oen-Robinson	10.336	10.895	11.427	11.935	12.422	12.891	13.343	13.781
Montenegro	20.148	21.169	22.117	23.000	23.826	24.599	25.325	26.007

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	30.013	30.888	31.738	32.566	33.371	34.161	34.933	35.688	36.427
volume averaged	30.232	31.108	31.960	32.791	33.601	34.391	35.164	35.920	36.661
Lindhard-Scharff	14.406	14.823	15.230	15.625	16.011	16.388	16.756	17.117	17.470
Andersen-Ziegler	25.546	26.178	26.786	27.374	27.941	28.489	29.019	29.532	30.029
Oen-Robinson	14.205	14.617	15.017	15.408	15.788	16.160	16.523	16.878	17.226
Montenegro	26.649	27.254	27.826	28.366	28.876	29.360	29.818	30.252	30.664

ELECTRONIC STOPPING POWER OF PROTONS IN Sb

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	51.	
Atomic Mass:	120.900	[amu]
Density:	6.617	[g/cm^3]
Measured Plasma Frequency:	16.	[eV]
One-Electron Radius:	1.088	[Å]
χ^2 of Free Electron Gas:	0.341	

Model Data:

Radius of Atom:	1.934	[Å]
Internal Radius of Atom:	1.351	[Å]
Homogeneous Electron Gas Density:	0.186	[Å^{-3}]
Density Correction:	-0.013	[Å^{-3}]
Fitting Parameter:	0.870	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.785	11.188	13.786	15.967	17.886	19.620	21.211	22.692
volume averaged	8.103	11.460	14.036	16.207	18.120	19.849	21.440	22.920
Lindhard-Scharff	3.499	4.948	6.060	6.997	7.823	8.570	9.257	9.896
Andersen-Ziegler	7.500	10.607	12.990	15.000	16.771	18.371	19.843	21.213
Oen-Robinson	3.450	4.879	5.975	6.900	7.714	8.450	9.128	9.758
Montenegro	7.681	10.979	13.527	15.667	17.533	19.193	20.691	22.054

energy	9	10	11	12	13	14	15	16
impact p. dependent	24.082	25.397	26.647	27.840	28.986	30.086	31.146	32.175
volume averaged	24.310	25.625	26.876	28.071	29.218	30.320	31.385	32.414
Lindhard-Scharff	10.496	11.064	11.604	12.120	12.615	13.091	13.550	13.995
Andersen-Ziegler	22.500	23.717	24.721	25.671	26.571	27.426	28.242	29.020
Oen-Robinson	10.350	10.909	11.442	11.951	12.439	12.908	13.361	13.800
Montenegro	23.304	24.455	25.520	26.510	27.430	28.290	29.093	29.846

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	33.169	34.134	35.076	35.990	36.882	37.754	38.604	39.440	40.257
volume averaged	33.412	34.380	35.322	36.240	37.135	38.009	38.863	39.699	40.517
Lindhard-Scharff	14.425	14.844	15.250	15.646	16.033	16.410	16.779	17.140	17.493
Andersen-Ziegler	29.765	30.479	31.164	31.822	32.455	33.063	33.649	34.213	34.756
Oen-Robinson	14.224	14.637	15.038	15.428	15.809	16.181	16.545	16.901	17.249
Montenegro	30.553	31.216	31.841	32.428	32.983	33.505	33.999	34.465	34.906

ELECTRONIC STOPPING POWER OF PROTONS IN Te

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	52.	
Atomic Mass:	130.000	[amu]
Density:	6.224	[g/cm^3]
Measured Plasma Frequency:	18.	[eV]
One-Electron Radius:	1.009	[Å]
χ^2 of Free Electron Gas:	0.316	

Model Data:

Radius of Atom:	2.022	[Å]
Internal Radius of Atom:	1.084	[Å]
Homogeneous Electron Gas Density:	0.233	[Å^{-3}]
Density Correction:	-0.283	[Å^{-3}]
Fitting Parameter:	0.896	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.884	12.788	15.761	18.261	20.458	22.443	24.262	25.960
volume averaged	9.273	13.113	16.061	18.545	20.734	22.713	24.533	26.227
Lindhard-Scharff	3.503	4.954	6.068	7.006	7.833	8.581	9.269	9.909
Andersen-Ziegler	6.979	9.870	12.088	13.958	15.606	17.095	18.465	19.740
Oen-Robinson	3.454	4.885	5.983	6.909	7.724	8.462	9.139	9.771
Montenegro	7.162	10.251	12.646	14.665	16.432	18.009	19.437	20.741

energy	9	10	11	12	13	14	15	16
impact p. dependent	27.551	29.054	30.485	31.848	33.156	34.420	35.637	36.812
volume averaged	27.818	29.322	30.754	32.121	33.433	34.695	35.913	37.090
Lindhard-Scharff	10.510	11.078	11.619	12.136	12.631	13.108	13.568	14.013
Andersen-Ziegler	20.937	22.070	23.016	23.911	24.763	25.574	26.350	27.093
Oen-Robinson	10.363	10.924	11.457	11.966	12.455	12.925	13.379	13.818
Montenegro	21.941	23.050	24.079	25.037	25.932	26.770	27.556	28.294

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	37.949	39.055	40.131	41.183	42.203	43.198	44.173	45.125	46.061
volume averaged	38.232	39.340	40.418	41.468	42.492	43.492	44.470	45.426	46.363
Lindhard-Scharff	14.444	14.863	15.270	15.667	16.054	16.432	16.801	17.162	17.516
Andersen-Ziegler	27.807	28.493	29.154	29.791	30.406	31.000	31.575	32.131	32.670
Oen-Robinson	14.243	14.656	15.057	15.449	15.830	16.203	16.567	16.923	17.272
Montenegro	28.989	29.644	30.261	30.844	31.396	31.917	32.411	32.878	33.322

ELECTRONIC STOPPING POWER OF PROTONS IN I

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	53.	
Atomic Mass:	126.900	[amu]
Density:	4.937	[g/cm^3]
Measured Plasma Frequency:	7.	[eV]
One-Electron Radius:	1.830	[Å]
χ^2 of Free Electron Gas:	0.574	

Model Data:

Radius of Atom:	2.167	[Å]
Internal Radius of Atom:	2.167	[Å]
Homogeneous Electron Gas Density:	0.039	[Å^{-3}]
Density Correction:	0.018	[Å^{-3}]
Fitting Parameter:	0.919	

energy	1	2	3	4	5	6	7	8
impact p. dependent	9.954	14.277	17.576	20.349	22.789	24.992	27.016	28.900
volume averaged	10.312	14.583	17.860	20.623	23.057	25.258	27.282	29.166
Lindhard-Scharff	3.508	4.961	6.075	7.015	7.843	8.592	9.280	9.921
Andersen-Ziegler	7.725	10.925	13.380	15.450	17.274	18.922	20.438	21.850
Oen-Robinson	3.459	4.891	5.991	6.918	7.734	8.472	9.151	9.783
Montenegro	7.920	11.331	13.975	16.202	18.148	19.886	21.458	22.893

energy	9	10	11	12	13	14	15	16
impact p. dependent	30.669	32.341	33.931	35.446	36.903	38.306	39.655	40.963
volume averaged	30.935	32.608	34.200	35.720	37.179	38.582	39.937	41.246
Lindhard-Scharff	10.523	11.092	11.634	12.151	12.647	13.125	13.585	14.031
Andersen-Ziegler	23.175	24.429	25.473	26.462	27.402	28.297	29.153	29.972
Oen-Robinson	10.376	10.938	11.471	11.982	12.471	12.942	13.396	13.835
Montenegro	24.212	25.430	26.561	27.613	28.595	29.513	30.374	31.183

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	42.226	43.454	44.654	45.818	46.953	48.062	49.149	50.208	51.245
volume averaged	42.516	43.748	44.947	46.115	47.254	48.366	49.453	50.516	51.558
Lindhard-Scharff	14.463	14.882	15.290	15.687	16.074	16.452	16.822	17.184	17.538
Andersen-Ziegler	30.758	31.514	32.241	32.941	33.617	34.270	34.900	35.510	36.100
Oen-Robinson	14.261	14.674	15.076	15.468	15.850	16.223	16.588	16.945	17.294
Montenegro	31.943	32.659	33.334	33.970	34.572	35.141	35.679	36.188	36.670

ELECTRONIC STOPPING POWER OF PROTONS IN Xe

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	54.	
Atomic Mass:	129.500	[amu]
Density:	3.059	[g/cm^3]
Measured Plasma Frequency:	5.	[eV]
One-Electron Radius:	2.342	[Å]
χ^2 of Free Electron Gas:	0.734	

Model Data:

Radius of Atom:	2.559	[Å]
Internal Radius of Atom:	2.559	[Å]
Homogeneous Electron Gas Density:	0.019	[Å^{-3}]
Density Correction:	0.010	[Å^{-3}]
Fitting Parameter:	0.940	

energy	1	2	3	4	5	6	7	8
impact p. dependent	15.072	21.536	26.478	30.635	34.290	37.594	40.629	43.456
volume averaged	15.485	21.900	26.821	30.971	34.626	37.931	40.970	43.799
Lindhard-Scharff	3.512	4.967	6.083	7.024	7.853	8.603	9.292	9.933
Andersen-Ziegler	8.231	11.640	14.257	16.462	18.405	20.162	21.777	23.281
Oen-Robinson	3.463	4.897	5.998	6.926	7.744	8.483	9.162	9.795
Montenegro	8.414	12.021	14.810	17.153	19.196	21.017	22.660	24.157
Biersack	3.472	4.910	6.013	6.942	7.760	8.499	9.178	9.809

energy	9	10	11	12	13	14	15	16
impact p. dependent	46.106	48.619	50.998	53.277	55.463	57.563	59.597	61.557
volume averaged	46.456	48.969	51.359	53.643	55.833	57.941	59.974	61.941
Lindhard-Scharff	10.536	11.106	11.648	12.166	12.663	13.141	13.602	14.048
Andersen-Ziegler	24.693	26.029	27.140	28.192	29.192	30.144	31.053	31.924
Oen-Robinson	10.389	10.951	11.486	11.996	12.486	12.958	13.412	13.852
Montenegro	25.531	26.798	27.971	29.061	30.076	31.025	31.912	32.745
Biersack	10.401	10.961	11.492	11.999	12 484	12.951	13.400	13.834

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	63.462	65.300	67.098	68.846	70.544	72.203	73.833	75.421	76.982
volume averaged	63.848	65.699	67.499	69.252	70.963	72.633	74.265	75.862	77.427
Lindhard-Scharff	14.480	14.900	15.308	15.706	16.094	16.473	16.843	17.205	17.560
Andersen-Ziegler	32.759	33.562	34.334	35.077	35.794	36.486	37.155	37.801	38.426
Oen-Robinson	14.278	14.692	15.095	15.487	15.870	16.243	16.608	16.965	17.315
Montenegro	33.526	34.260	34.952	35.603	36.218	36.798	37.346	37.864	38.354
Biersack	14.253	14.660	15.054	15.438	15.811	16.174	16.529	16.874	17.212

ELECTRONIC STOPPING POWER OF PROTONS IN Cs

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	55.	
Atomic Mass:	134.000	[amu]
Density:	1.899	[g/cm^3]
Measured Plasma Frequency:	3.	[eV]
One-Electron Radius:	3.111	[Å]
χ^2 of Free Electron Gas:	0.975	

Model Data:

Radius of Atom:	3.034	[Å]
Internal Radius of Atom:	3.034	[Å]
Homogeneous Electron Gas Density:	0.008	[Å^{-3}]
Density Correction:	0.005	[Å^{-3}]
Fitting Parameter:	1.022	

energy	1	2	3	4	5	6	7	8
impact p. dependent	22.934	32.694	40.157	46.437	51.969	56.961	61.559	65.828
volume averaged	23.439	33.147	40.597	46.877	52.410	57.413	62.013	66.295
Lindhard-Scharff	3.516	4.973	6.090	7.032	7.862	8.613	9.303	9.945
Andersen-Ziegler	7.287	10.305	12.621	14.574	16.294	17.849	19.280	20.611
Oen-Robinson	3.467	4.903	6.005	6.934	7.753	8.493	9.173	9.807
Montenegro	7.463	10.675	13.168	15.269	17.109	18.754	20.244	21.606

energy	9	10	11	12	13	14	15	16
impact p. dependent	69.837	73.633	77.246	80.692	83.993	87.179	90.241	93.208
volume averaged	70.316	74.120	77.737	81.194	84.509	87.699	90.778	93.755
Lindhard-Scharff	10.549	11.119	11.662	12.180	12.678	13.156	13.618	14.065
Andersen-Ziegler	21.861	23.044	24.032	24.968	25.857	26.705	27.515	28.292
Oen-Robinson	10.402	10.964	11.499	12.011	12.501	12.973	13.428	13.869
Montenegro	22.860	24.021	25.099	26.104	27.044	27.924	28.750	29.528

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	96.080	98.872	101.588	104.226	106.805	109.325	111.795	114.204	116.568
volume averaged	96.640	99.442	102.167	104.821	107.409	109.937	112.408	114.825	117.193
Lindhard-Scharff	14.498	14.918	15.327	15.725	16.113	16.492	16.863	17.226	17.581
Andersen-Ziegler	29.038	29.755	30.445	31.111	31.754	32.376	32.977	33.559	34.122
Oen-Robinson	14.296	14.710	15.113	15.506	15.889	16.263	16.628	16.986	17.336
Montenegro	30.260	30.950	31.602	32.218	32.801	33.353	33.876	34.372	34.842

ELECTRONIC STOPPING POWER OF PROTONS IN Ba

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	56.	
Atomic Mass:	138.000	[amu]
Density:	3.522	[g/cm^3]
Measured Plasma Frequency:	7.	[eV]
One-Electron Radius:	1.977	[Å]
χ^2 of Free Electron Gas:	0.620	

Model Data:

Radius of Atom:	2.494	[Å]
Internal Radius of Atom:	2.494	[Å]
Homogeneous Electron Gas Density:	0.031	[Å^{-3}]
Density Correction:	0.018	[Å^{-3}]
Fitting Parameter:	1.108	

energy	1	2	3	4	5	6	7	8
impact p. dependent	14.513	20.764	25.540	29.554	33.090	36.280	39.215	41.941
volume averaged	14.953	21.147	25.899	29.906	33.436	36.627	39.562	42.293
Lindhard-Scharff	3.520	4.978	6.097	7.041	7.872	8.623	9.314	9.957
Andersen-Ziegler	7.899	11.171	13.681	15.798	17.663	19.349	20.899	22.342
Oen-Robinson	3.471	4.909	6.012	6.942	7.762	8.503	9.184	9.818
Montenegro	8.084	11.556	14.244	16.505	18.480	20.241	21.833	23.285

energy	9	10	11	12	13	14	15	16
impact p. dependent	44.504	46.927	49.228	51.430	53.537	55.566	57.527	59.423
volume averaged	44.859	47.286	49.593	51.799	53.914	55.949	57.913	59.812
Lindhard-Scharff	10.561	11.132	11.675	12.195	12.692	13.172	13.634	14.081
Andersen-Ziegler	23.697	24.979	26.049	27.061	28.023	28.940	29.816	30.655
Oen-Robinson	10.414	10.977	11.513	12.025	12.516	12.988	13.444	13.885
Montenegro	24.619	25.850	26.992	28.054	29.044	29.970	30.838	31.652

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	61.260	63.040	64.771	66.458	68.106	69.710	71.282	72.816	74.324
volume averaged	61.653	63.440	65.179	66.872	68.523	70.136	71.712	73.254	74.765
Lindhard-Scharff	14.514	14.935	15.344	15.743	16.132	16.512	16.883	17.246	17.601
Andersen-Ziegler	31.460	32.235	32.980	33.698	34.392	35.061	35.709	36.335	36.941
Oen-Robinson	14.312	14.727	15.131	15.524	15.907	16.281	16.647	17.005	17.356
Montenegro	32.418	33.138	33.817	34.457	35.062	35.633	36.174	36.686	37.170

ELECTRONIC STOPPING POWER OF PROTONS IN La

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	57.	
Atomic Mass:	139.000	[amu]
Density:	6.174	[g/cm^3]
Measured Plasma Frequency:	10.	[eV]
One-Electron Radius:	1.459	[Å]
χ^2 of Free Electron Gas:	0.458	

Model Data:

Radius of Atom:	2.073	[Å]
Internal Radius of Atom:	2.073	[Å]
Homogeneous Electron Gas Density:	0.077	[Å^{-3}]
Density Correction:	0.042	[Å^{-3}]
Fitting Parameter:	1.150	

energy	1	2	3	4	5	6	7	8
impact p. dependent	9.185	13.211	16.280	18.859	21.128	23.177	25.055	26.803
volume averaged	9.574	13.539	16.582	19.147	21.407	23.451	25.330	27.078
Lindhard-Scharff	3.524	4.984	6.104	7.048	7.880	8.633	9.324	9.968
Andersen-Ziegler	8.041	11.372	13.927	16.082	17.980	19.696	21.274	22.743
Oen-Robinson	3.475	4.915	6.019	6.950	7.771	8.512	9.194	9.829
Montenegro	8.230	11.764	14.498	16.798	18.805	20.594	22.210	23.683

energy	9	10	11	12	13	14	15	16
impact p. dependent	28.448	30.000	31.477	32.888	34.240	35.539	36.796	38.008
volume averaged	28.721	30.275	31.752	33.164	34.518	35.821	37.079	38.295
Lindhard-Scharff	10.573	11.145	11.689	12.208	12.707	13.186	13.649	14.097
Andersen-Ziegler	24.123	25.428	26.516	27.547	28.526	29.459	30.351	31.205
Oen-Robinson	10.425	10.989	11.526	12.038	12.530	13.003	13.459	13.900
Montenegro	25.036	26.284	27.441	28.516	29.519	30.456	31.333	32.156

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	39.185	40.327	41.438	42.516	43.572	44.605	45.607	46.594	47.556
volume averaged	39.473	40.618	41.731	42.815	43.872	44.905	45.914	46.901	47.868
Lindhard-Scharff	14.531	14.952	15.362	15.761	16.150	16.530	16.902	17.265	17.621
Andersen-Ziegler	32.025	32.813	33.572	34.304	35.009	35.691	36.350	36.987	37.604
Oen-Robinson	14.328	14.744	15.148	15.541	15.925	16.300	16.666	17.024	17.376
Montenegro	32.929	33.657	34.342	34.989	35.599	36.175	36.720	37.235	37.723

ELECTRONIC STOPPING POWER OF PROTONS IN Ce

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	58.	
Atomic Mass:	140.000	[amu]
Density:	6.672	[g/cm^3]
Measured Plasma Frequency:	11.	[eV]
One-Electron Radius:	1.397	[Å]
χ^2 of Free Electron Gas:	0.438	

Model Data:

Radius of Atom:	2.025	[Å]
Internal Radius of Atom:	2.025	[Å]
Homogeneous Electron Gas Density:	0.088	[Å^{-3}]
Density Correction:	0.050	[Å^{-3}]
Fitting Parameter:	1.081	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.689	12.498	15.402	17.843	19.990	21.929	23.707	25.365
volume averaged	9.060	12.813	15.692	18.120	20.258	22.192	23.970	25.625
Lindhard-Scharff	3.528	4.989	6.111	7.056	7.889	8.642	9.334	9.979
Andersen-Ziegler	7.489	10.591	12.971	14.978	16.746	18.344	19.814	21.182
Oen-Robinson	3.479	4.920	6.026	6.958	7.779	8.522	9.204	9.840
Montenegro	7.674	10.979	13.541	15.701	17.590	19.278	20.805	22.201

energy	9	10	11	12	13	14	15	16
impact p. dependent	26.921	28.387	29.786	31.119	32.400	33.629	34.820	35.967
volume averaged	27.180	28.650	30.048	31.384	32.666	33.899	35.089	36.239
Lindhard-Scharff	10.584	11.157	11.701	12.222	12.721	13.201	13.664	14.112
Andersen-Ziegler	22.467	23.682	24.697	25.659	26.573	27.445	28.279	29.078
Oen-Robinson	10.437	11.001	11.538	12.051	12.543	13.017	13.474	13.916
Montenegro	23.485	24.672	25.775	26.802	27.761	28.659	29.502	30.294

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	37.079	38.159	39.212	40.232	41.230	42.208	43.160	44.095	45.003
volume averaged	37.355	38.438	39.491	40.517	41.517	42.494	43.449	44.384	45.299
Lindhard-Scharff	14.547	14.968	15.379	15.778	16.168	16.548	16.920	17.284	17.640
Andersen-Ziegler	29.846	30.584	31.295	31.981	32.643	33.283	33.903	34.502	35.083
Oen-Robinson	14.344	14.760	15.164	15.558	15.942	16.318	16.684	17.043	17.395
Montenegro	31.040	31.743	32.406	33.033	33.626	34.186	34.718	35.221	35.699

ELECTRONIC STOPPING POWER OF PROTONS IN Pr

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	59.	
Atomic Mass:	141.000	[amu]
Density:	6.774	[g/cm^3]
Measured Plasma Frequency:	11.	[eV]
One-Electron Radius:	1.424	[Å]
χ^2 of Free Electron Gas:	0.447	

Model Data:

Radius of Atom:	2.020	[Å]
Internal Radius of Atom:	2.020	[Å]
Homogeneous Electron Gas Density:	0.083	[Å^{-3}]
Density Correction:	0.048	[Å^{-3}]
Fitting Parameter:	0.970	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.608	12.373	15.242	17.658	19.780	21.695	23.457	25.095
volume averaged	8.962	12.675	15.523	17.925	20.040	21.953	23.712	25.349
Lindhard-Scharff	3.532	4.995	6.117	7.064	7.897	8.651	9.344	9.990
Andersen-Ziegler	7.291	10.311	12.628	14.582	16.303	17.859	19.290	20.622
Oen-Robinson	3.483	4.925	6.032	6.965	7.787	8.531	9.214	9.850
Montenegro	7.478	10.703	13.208	15.321	17.172	18.827	20.327	21.699

energy	9	10	11	12	13	14	15	16
impact p. dependent	26.634	28.087	29.469	30.788	32.052	33.271	34.447	35.585
volume averaged	26.887	28.341	29.725	31.047	32.314	33.534	34.711	35.849
Lindhard-Scharff	10.596	11.169	11.714	12.235	12.734	13.215	13.679	14.127
Andersen-Ziegler	21.873	23.056	24.045	24.982	25.874	26.724	27.537	28.317
Oen-Robinson	10.448	11.013	11.551	12.064	12.557	13.031	13.488	13.930
Montenegro	22.963	24.133	25.220	26.234	27.182	28.071	28.906	29.691

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	36.685	37.753	38.793	39.810	40.794	41.756	42.699	43.619	44.522
volume averaged	36.953	38.024	39.066	40.081	41.071	42.037	42.982	43.906	44.812
Lindhard-Scharff	14.562	14.984	15.395	15.795	16.185	16.566	16.938	17.302	17.659
Andersen-Ziegler	29.066	29.786	30.481	31.151	31.798	32.423	33.029	33.615	34.184
Oen-Robinson	14.359	14.775	15.180	15.575	15.959	16.335	16.702	17.061	17.413
Montenegro	30.431	31.129	31.789	32.412	33.003	33.562	34.092	34.595	35.073

ELECTRONIC STOPPING POWER OF PROTONS IN Nd

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	60.	
Atomic Mass:	142.000	[amu]
Density:	7.002	[g/cm^3]
Measured Plasma Frequency:	10.	[eV]
One-Electron Radius:	1.505	[Å]
χ^2 of Free Electron Gas:	0.472	

Model Data:

Radius of Atom:	2.002	[Å]
Internal Radius of Atom:	2.002	[Å]
Homogeneous Electron Gas Density:	0.070	[Å^{-3}]
Density Correction:	0.035	[Å^{-3}]
Fitting Parameter:	0.938	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.314	11.960	14.739	17.076	19.131	20.986	22.688	24.274
volume averaged	8.671	12.263	15.019	17.342	19.389	21.240	22.942	24.526
Lindhard-Scharff	3.535	5.000	6.124	7.071	7.906	8.660	9.354	10.000
Andersen-Ziegler	7.098	10.038	12.294	14.196	15.872	17.386	18.780	20.076
Oen-Robinson	3.486	4.930	6.038	6.972	7.795	8.539	9.224	9.861
Montenegro	7.283	10.427	12.870	14.932	16.739	18.355	19.821	21.162

energy	9	10	11	12	13	14	15	16
impact p. dependent	25.763	27.170	28.505	29.784	31.012	32.186	33.326	34.426
volume averaged	26.013	27.421	28.759	30.038	31.264	32.444	33.583	34.685
Lindhard-Scharff	10.606	11.180	11.726	12.247	12.747	13.229	13.693	14.142
Andersen-Ziegler	21.294	22.446	23.410	24.324	25.193	26.022	26.815	27.575
Oen-Robinson	10.459	11.024	11.562	12.077	12.570	13.044	13.502	13.945
Montenegro	22.398	23.543	24.607	25.601	26.530	27.401	28.220	28.990

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	35.489	36.526	37.529	38.510	39.464	40.398	41.308	42.199	43.074
volume averaged	35.752	36.789	37.797	38.779	39.736	40.671	41.585	42.480	43.356
Lindhard-Scharff	14.577	15.000	15.411	15.811	16.202	16.583	16.956	17.320	17.677
Andersen-Ziegler	28.306	29.009	29.687	30.341	30.973	31.584	32.176	32.750	33.306
Oen-Robinson	14.374	14.791	15.196	15.591	15.976	16.352	16.719	17.079	17.431
Montenegro	29.716	30.402	31.050	31.663	32.244	32.794	33.316	33.811	34.282

ELECTRONIC STOPPING POWER OF PROTONS IN Sm

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	62.	
Atomic Mass:	152.000	[amu]
Density:	7.555	[g/cm^3]
Measured Plasma Frequency:	11.	[eV]
One-Electron Radius:	1.418	[Å]
χ^2 of Free Electron Gas:	0.445	

Model Data:

Radius of Atom:	1.997	[Å]
Internal Radius of Atom:	1.997	[Å]
Homogeneous Electron Gas Density:	0.084	[Å^{-3}]
Density Correction:	0.051	[Å^{-3}]
Fitting Parameter:	0.873	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.366	12.022	14.810	17.152	19.215	21.076	22.788	24.379
volume averaged	8.706	12.312	15.080	17.412	19.468	21.326	23.034	24.625
Lindhard-Scharff	3.543	5.010	6.136	7.085	7.921	8.677	9.373	10.020
Andersen-Ziegler	6.728	9.515	11.653	13.456	15.044	16.480	17.801	19.030
Oen-Robinson	3.493	4.940	6.050	6.986	7.811	8.556	9.242	9.880
Montenegro	6.878	9.841	12.144	14.093	15.805	17.340	18.736	20.018

energy	9	10	11	12	13	14	15	16
impact p. dependent	25.871	27.285	28.625	29.908	31.139	32.321	33.465	34.567
volume averaged	26.119	27.531	28.875	30.159	31.391	32.575	33.719	34.825
Lindhard-Scharff	10.628	11.202	11.749	12.272	12.773	13.255	13.720	14.170
Andersen-Ziegler	20.184	21.276	22.190	23.058	23.884	24.672	25.426	26.149
Oen-Robinson	10.479	11.046	11.585	12.101	12.595	13.070	13.529	13.973
Montenegro	21.202	22.301	23.327	24.287	25.187	26.034	26.832	27.585

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	35.636	36.674	37.684	38.667	39.625	40.563	41.477	42.373	43.250
volume averaged	35.896	36.937	37.949	38.935	39.897	40.836	41.753	42.651	43.531
Lindhard-Scharff	14.606	15.030	15.442	15.843	16.234	16.616	16.989	17.355	17.713
Andersen-Ziegler	26.845	27.514	28.160	28.784	29.387	29.970	30.535	31.083	31.615
Oen-Robinson	14.403	14.820	15.226	15.622	16.008	16.384	16.753	17.113	17.466
Montenegro	28.297	28.970	29.609	30.215	30.790	31.337	31.857	32.352	32.823

ELECTRONIC STOPPING POWER OF PROTONS IN Eu

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	63.	
Atomic Mass:	153.000	[amu]
Density:	5.258	[g/cm^3]
Measured Plasma Frequency:	8.	[eV]
One-Electron Radius:	1.716	[Å]
χ^2 of Free Electron Gas:	0.538	

Model Data:

Radius of Atom:	2.258	[Å]
Internal Radius of Atom:	2.243	[Å]
Homogeneous Electron Gas Density:	0.047	[Å^{-3}]
Density Correction:	0.031	[Å^{-3}]
Fitting Parameter:	0.842	

energy	1	2	3	4	5	6	7	8
impact p. dependent	11.344	16.241	19.980	23.128	25.892	28.397	30.693	32.834
volume averaged	11.710	16.560	20.282	23.420	26.184	28.683	30.981	33.121
Lindhard-Scharff	3.546	5.015	6.142	7.092	7.929	8.686	9.382	10.029
Andersen-Ziegler	6.551	9.265	11.347	13.102	14.648	16.047	17.332	18.529
Oen-Robinson	3.496	4.945	6.056	6.993	7.818	8.565	9.251	9.890
Montenegro	6.704	9.597	11.850	13.758	15.437	16.945	18.318	19.580
Biersack	3.509	4.962	6.076	7.015	7.842	8.589	9.276	9.914

energy	9	10	11	12	13	14	15	16
impact p. dependent	34.836	36.734	38.540	40.265	41.916	43.506	45.035	46.522
volume averaged	35.130	37.030	38.837	40.564	42.221	43.814	45.352	46.840
Lindhard-Scharff	10.638	11.213	11.760	12.283	12.785	13.268	13.733	14.184
Andersen-Ziegler	19.653	20.716	21.609	22.455	23.260	24.028	24.764	25.469
Oen-Robinson	10.489	11.057	11.597	12.112	12.607	13.083	13.542	13.986
Montenegro	20.747	21.833	22.846	23.796	24.688	25.528	26.321	27.069
Biersack	10.513	11.079	11.617	12.130	12.622	13.094	13.549	13.989

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	47.961	49.356	50.715	52.037	53.324	54.586	55.813	57.022	58.200
volume averaged	48.281	49.681	51.042	52.368	53.661	54.924	56.159	57.367	58.549
Lindhard-Scharff	14.620	15.044	15.456	15.858	16.249	16.632	17.006	17.371	17.730
Andersen-Ziegler	26.148	26.801	27.431	28.040	28.629	29.199	29.751	30.287	30.807
Oen-Robinson	14.416	14.834	15.241	15.637	16.023	16.400	16.769	17.129	17.482
Montenegro	27.778	28.450	29.087	29.692	30.267	30.814	31.335	31.832	32.305
Biersack	14.414	14.826	15.226	15.616	15.994	16.363	16.724	17.075	17.419

ELECTRONIC STOPPING POWER OF PROTONS IN Gd

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	64.	
Atomic Mass:	157.900	[amu]
Density:	7.902	[g/cm^3]
Measured Plasma Frequency:	10.	[eV]
One-Electron Radius:	1.443	[Å]
χ^2 of Free Electron Gas:	0.452	

Model Data:

Radius of Atom:	1.992	[Å]
Internal Radius of Atom:	1.992	[Å]
Homogeneous Electron Gas Density:	0.080	[Å^{-3}]
Density Correction:	0.046	[Å^{-3}]
Fitting Parameter:	0.862	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.291	11.918	14.685	17.011	19.058	20.905	22.603	24.180
volume averaged	8.637	12.214	14.959	17.273	19.312	21.155	22.850	24.428
Lindhard-Scharff	3.549	5.019	6.147	7.098	7.936	8.694	9.390	10.039
Andersen-Ziegler	6.739	9.530	11.672	13.478	15.069	16.507	17.830	19.061
Oen-Robinson	3.500	4.949	6.062	6.999	7.826	8.573	9.259	9.899
Montenegro	6.895	9.867	12.178	14.133	15.851	17.392	18.793	20.079

energy	9	10	11	12	13	14	15	16
impact p. dependent	25.663	27.062	28.397	29.667	30.886	32.060	33.192	34.288
volume averaged	25.910	27.312	28.645	29.918	31.140	32.315	33.450	34.547
Lindhard-Scharff	10.648	11.224	11.771	12.295	12.797	13.280	13.746	14.197
Andersen-Ziegler	20.217	21.311	22.229	23.099	23.926	24.716	25.473	26.198
Oen-Robinson	10.499	11.067	11.607	12.123	12.619	13.095	13.554	13.999
Montenegro	21.267	22.370	23.399	24.362	25.265	26.114	26.915	27.670

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	35.351	36.381	37.384	38.358	39.310	40.239	41.146	42.033	42.901
volume averaged	35.610	36.642	37.646	38.624	39.578	40.510	41.420	42.311	43.183
Lindhard-Scharff	14.634	15.058	15.471	15.873	16.265	16.647	17.021	17.388	17.746
Andersen-Ziegler	26.896	27.567	28.215	28.841	29.446	30.032	30.600	31.150	31.685
Oen-Robinson	14.430	14.848	15.255	15.651	16.038	16.415	16.784	17.145	17.499
Montenegro	28.384	29.060	29.701	30.309	30.886	31.434	31.956	32.452	32.925

ELECTRONIC STOPPING POWER OF PROTONS IN Tb

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	65.	
Atomic Mass:	159.900	[amu]
Density:	8.277	[g/cm^3]
Measured Plasma Frequency:	10.	[eV]
One-Electron Radius:	1.491	[Å]
χ^2 of Free Electron Gas:	0.468	

Model Data:

Radius of Atom:	1.970	[Å]
Internal Radius of Atom:	1.970	[Å]
Homogeneous Electron Gas Density:	0.072	[Å^{-3}]
Density Correction:	0.038	[Å^{-3}]
Fitting Parameter:	0.830	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.987	11.487	14.157	16.401	18.374	20.157	21.792	23.318
volume averaged	8.329	11.780	14.427	16.659	18.625	20.403	22.038	23.559
Lindhard-Scharff	3.552	5.024	6.153	7.105	7.944	8.702	9.399	10.048
Andersen-Ziegler	6.212	8.785	10.759	12.424	13.890	15.216	16.435	17.570
Oen-Robinson	3.503	4.954	6.067	7.006	7.833	8.580	9.268	9.908
Montenegro	6.366	9.119	11.267	13.089	14.694	16.138	17.454	18.666

energy	9	10	11	12	13	14	15	16
impact p. dependent	24.746	26.097	27.382	28.611	29.784	30.918	32.010	33.063
volume averaged	24.988	26.340	27.626	28.854	30.032	31.166	32.260	33.318
Lindhard-Scharff	10.657	11.234	11.782	12.306	12.809	13.292	13.759	14.210
Andersen-Ziegler	18.636	19.644	20.493	21.296	22.061	22.791	23.490	24.162
Oen-Robinson	10.509	11.077	11.618	12.134	12.630	13.107	13.567	14.012
Montenegro	19.788	20.833	21.810	22.726	23.588	24.401	25.168	25.895

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	34.088	35.084	36.048	36.991	37.909	38.804	39.682	40.539	41.380
volume averaged	34.343	35.339	36.307	37.250	38.170	39.068	39.946	40.806	41.647
Lindhard-Scharff	14.647	15.072	15.485	15.887	16.279	16.662	17.037	17.403	17.762
Andersen-Ziegler	24.807	25.429	26.030	26.610	27.171	27.715	28.242	28.753	29.250
Oen-Robinson	14.443	14.862	15.269	15.666	16.052	16.430	16.799	17.161	17.515
Montenegro	26.583	27.236	27.856	28.445	29.007	29.541	30.051	30.537	31.001

ELECTRONIC STOPPING POWER OF PROTONS IN Ta

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	73.	
Atomic Mass:	181.000	[amu]
Density:	16.601	[g/cm^3]
Measured Plasma Frequency:	21.	[eV]
One-Electron Radius:	0.904	[Å]
χ^2 of Free Electron Gas:	0.283	

Model Data:

Radius of Atom:	1.628	[Å]
Internal Radius of Atom:	1.274	[Å]
Homogeneous Electron Gas Density:	0.324	[Å^{-3}]
Density Correction:	0.047	[Å^{-3}]
Fitting Parameter:	0.676	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.046	7.296	9.011	10.452	11.719	12.863	13.913	14.889
volume averaged	5.331	7.540	9.234	10.663	11.921	13.059	14.106	15.080
Lindhard-Scharff	3.576	5.057	6.193	7.151	7.995	8.759	9.460	10.114
Andersen-Ziegler	4.738	6.701	8.206	9.476	10.594	11.606	12.536	13.401
Oen-Robinson	3.526	4.986	6.107	7.052	7.884	8.637	9.328	9.973
Montenegro	4.892	7.036	8.723	10.166	11.448	12.610	13.678	14.668
Biersack	3.533	4.997	6.119	7.065	7.898	8.651	9.342	9.986

energy	9	10	11	12	13	14	15	16
impact p. dependent	15.805	16.672	17.495	18.284	19.036	19.761	20.462	21.139
volume averaged	15.994	16.860	17.682	18.469	19.223	19.948	20.649	21.326
Lindhard-Scharff	10.727	11.307	11.859	12.387	12.892	13.379	13.849	14.303
Andersen-Ziegler	14.214	14.983	15.631	16.248	16.835	17.397	17.935	18.453
Oen-Robinson	10.578	11.150	11.694	12.214	12.713	13.192	13.656	14.103
Montenegro	15.592	16.459	17.275	18.046	18.777	19.470	20.129	20.757
Biersack	10.590	11.160	11.702	12.220	12.715	13.192	13.651	14.095

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	21.794	22.431	23.049	23.652	24.240	24.814	25.374	25.923	26.462
volume averaged	21.982	22.619	23.239	23.843	24.432	25.007	25.569	26.119	26.657
Lindhard-Scharff	14.743	15.170	15.586	15.991	16.386	16.771	17.148	17.517	17.878
Andersen-Ziegler	18.952	19.433	19.898	20.348	20.785	21.208	21.619	22.020	22.409
Oen-Robinson	14.537	14.959	15.369	15.768	16.157	16.538	16.909	17.273	17.629
Montenegro	21.356	21.928	22.475	22.999	23.500	23.981	24.442	24.885	25.310
Biersack	14.524	14.940	15.345	15.738	16.121	16.494	16.858	17.214	17.561

ELECTRONIC STOPPING POWER OF PROTONS IN W

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	74.	
Atomic Mass:	184.000	[amu]
Density:	19.292	[g/cm^3]
Measured Plasma Frequency:	24.	[eV]
One-Electron Radius:	0.819	[Å]
χ^2 of Free Electron Gas:	0.257	

Model Data:

Radius of Atom:	1.557	[Å]
Internal Radius of Atom:	1.179	[Å]
Homogeneous Electron Gas Density:	0.436	[Å^{-3}]
Density Correction:	0.031	[Å^{-3}]
Fitting Parameter:	0.679	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.526	6.561	8.110	9.413	10.555	11.588	12.536	13.418
volume averaged	4.809	6.801	8.329	9.618	10.753	11.780	12.723	13.602
Lindhard-Scharff	3.578	5.060	6.198	7.157	8.001	8.765	9.467	10.121
Andersen-Ziegler	4.574	6.469	7.922	9.148	10.228	11.204	12.102	12.937
Oen-Robinson	3.528	4.990	6.111	7.057	7.890	8.643	9.335	9.980
Montenegro	4.728	6.803	8.439	9.839	11.084	12.214	13.253	14.218

energy	9	10	11	12	13	14	15	16
impact p. dependent	14.246	15.028	15.771	16.481	17.160	17.815	18.448	19.058
volume averaged	14.427	15.207	15.950	16.659	17.339	17.994	18.625	19.236
Lindhard-Scharff	10.735	11.316	11.868	12.396	12.902	13.389	13.859	14.313
Andersen-Ziegler	13.722	14.464	15.091	15.686	16.254	16.796	17.317	17.817
Oen-Robinson	10.585	11.158	11.702	12.223	12.722	13.202	13.666	14.114
Montenegro	15.119	15.965	16.762	17.516	18.231	18.910	19.556	20.172

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	19.650	20.224	20.783	21.325	21.855	22.375	22.881	23.376	23.860
volume averaged	19.828	20.403	20.962	21.507	22.038	22.556	23.063	23.559	24.045
Lindhard-Scharff	14.754	15.181	15.597	16.003	16.398	16.784	17.161	17.530	17.892
Andersen-Ziegler	18.299	18.764	19.214	19.649	20.071	20.481	20.879	21.266	21.643
Oen-Robinson	14.548	14.970	15.380	15.780	16.169	16.550	16.922	17.286	17.642
Montenegro	20.760	21.322	21.860	22.375	22.869	23.343	23.798	24.235	24.655

ELECTRONIC STOPPING POWER OF PROTONS IN Re

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	75.	
Atomic Mass:	187.000	[amu]
Density:	21.040	[g/cm^3]
Measured Plasma Frequency:	19.	[eV]
One-Electron Radius:	0.970	[Å]
χ^2 of Free Electron Gas:	0.304	

Model Data:

Radius of Atom:	1.521	[Å]
Internal Radius of Atom:	1.521	[Å]
Homogeneous Electron Gas Density:	0.262	[Å^{-3}]
Density Correction:	0.148	[Å^{-3}]
Fitting Parameter:	0.680	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.215	6.111	7.557	8.769	9.836	10.798	11.682	12.506
volume averaged	4.483	6.340	7.765	8.966	10.024	10.981	11.861	12.680
Lindhard-Scharff	3.581	5.064	6.202	7.162	8.007	8.771	9.474	10.128
Andersen-Ziegler	5.200	7.354	9.007	10.400	11.628	12.737	13.758	14.708
Oen-Robinson	3.531	4.994	6.116	7.062	7.895	8.649	9.342	9.987
Montenegro	5.361	7.701	9.537	11.104	12.490	13.743	14.891	15.952

energy	9	10	11	12	13	14	15	16
impact p. dependent	13.277	14.006	14.698	15.360	15.995	16.604	17.194	17.764
volume averaged	13.449	14.177	14.869	15.530	16.164	16.774	17.363	17.932
Lindhard-Scharff	10.743	11.324	11.876	12.405	12.911	13.398	13.869	14.323
Andersen-Ziegler	15.600	16.444	17.159	17.835	18.479	19.095	19.685	20.252
Oen-Robinson	10.593	11.166	11.711	12.232	12.731	13.212	13.675	14.124
Montenegro	16.940	17.863	18.731	19.548	20.319	21.050	21.743	22.401

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	18.315	18.851	19.371	19.878	20.372	20.857	21.329	21.788	22.241
volume averaged	18.484	19.020	19.541	20.049	20.544	21.027	21.500	21.962	22.415
Lindhard-Scharff	14.764	15.192	15.609	16.014	16.410	16.796	17.173	17.543	17.904
Andersen-Ziegler	20.799	21.326	21.835	22.328	22.806	23.269	23.719	24.156	24.582
Oen-Robinson	14.559	14.981	15.391	15.791	16.181	16.562	16.934	17.298	17.655
Montenegro	23.027	23.623	24.192	24.735	25.254	25.750	26.225	26.680	27.115

ELECTRONIC STOPPING POWER OF PROTONS IN Os

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	76.	
Atomic Mass:	192.000	[amu]
Density:	22.562	[g/cm^3]
Measured Plasma Frequency:	20.	[eV]
One-Electron Radius:	0.945	[Å]
χ^2 of Free Electron Gas:	0.296	

Model Data:

Radius of Atom:	1.499	[Å]
Internal Radius of Atom:	1.499	[Å]
Homogeneous Electron Gas Density:	0.284	[Å^{-3}]
Density Correction:	0.159	[Å^{-3}]
Fitting Parameter:	0.680	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.067	5.901	7.298	8.472	9.504	10.433	11.289	12.083
volume averaged	4.334	6.129	7.506	8.667	9.690	10.615	11.466	12.257
Lindhard-Scharff	3.583	5.068	6.207	7.167	8.013	8.777	9.481	10.135
Andersen-Ziegler	5.070	7.170	8.781	10.140	11.337	12.419	13.414	14.340
Oen-Robinson	3.533	4.997	6.120	7.067	7.901	8.655	9.349	9.994
Montenegro	5.231	7.518	9.313	10.846	12.204	13.433	14.559	15.600

energy	9	10	11	12	13	14	15	16
impact p. dependent	12.831	13.534	14.204	14.844	15.458	16.048	16.618	17.168
volume averaged	13.001	13.704	14.373	15.012	15.625	16.215	16.784	17.334
Lindhard-Scharff	10.750	11.332	11.885	12.413	12.920	13.408	13.878	14.334
Andersen-Ziegler	15.210	16.033	16.730	17.389	18.018	18.618	19.194	19.748
Oen-Robinson	10.600	11.174	11.719	12.240	12.740	13.221	13.685	14.134
Montenegro	16.570	17.478	18.331	19.135	19.895	20.615	21.298	21.948

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	17.701	18.219	18.723	19.214	19.693	20.158	20.614	21.061	21.498
volume averaged	17.868	18.386	18.890	19.380	19.859	20.326	20.783	21.230	21.668
Lindhard-Scharff	14.775	15.203	15.620	16.025	16.421	16.808	17.185	17.555	17.917
Andersen-Ziegler	20.281	20.795	21.292	21.774	22.240	22.693	23.132	23.560	23.975
Oen-Robinson	14.569	14.991	15.402	15.802	16.192	16.573	16.946	17.310	17.667
Montenegro	22.566	23.155	23.717	24.255	24.768	25.259	25.730	26.181	26.613

ELECTRONIC STOPPING POWER OF PROTONS IN Ir

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	77.	
Atomic Mass:	193.000	[amu]
Density:	22.506	[g/cm^3]
Measured Plasma Frequency:	20.	[eV]
One-Electron Radius:	0.926	[Å]
χ^2 of Free Electron Gas:	0.290	

Model Data:

Radius of Atom:	1.503	[Å]
Internal Radius of Atom:	1.501	[Å]
Homogeneous Electron Gas Density:	0.302	[Å^{-3}]
Density Correction:	0.177	[Å^{-3}]
Fitting Parameter:	0.679	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.116	5.970	7.382	8.569	9.612	10.554	11.417	12.220
volume averaged	4.382	6.197	7.590	8.764	9.799	10.734	11.594	12.395
Lindhard-Scharff	3.586	5.071	6.211	7.172	8.018	8.784	9.487	10.142
Andersen-Ziegler	4.945	6.993	8.565	9.890	11.057	12.113	13.083	13.987
Oen-Robinson	3.536	5.000	6.124	7.072	7.906	8.661	9.355	10.001
Montenegro	5.106	7.340	9.095	10.595	11.924	13.128	14.231	15.253

energy	9	10	11	12	13	14	15	16
impact p. dependent	12.975	13.689	14.366	15.013	15.633	16.229	16.803	17.361
volume averaged	13.147	13.858	14.534	15.181	15.800	16.397	16.972	17.529
Lindhard-Scharff	10.758	11.339	11.893	12.422	12.929	13.417	13.888	14.343
Andersen-Ziegler	14.835	15.637	16.318	16.961	17.575	18.161	18.723	19.263
Oen-Robinson	10.608	11.181	11.727	12.249	12.749	13.230	13.694	14.143
Montenegro	16.205	17.096	17.934	18.724	19.471	20.179	20.852	21.491

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	17.900	18.425	18.933	19.428	19.914	20.383	20.847	21.297	21.740
volume averaged	18.068	18.592	19.102	19.598	20.082	20.555	21.017	21.469	21.911
Lindhard-Scharff	14.785	15.213	15.630	16.036	16.432	16.819	17.197	17.567	17.929
Andersen-Ziegler	19.784	20.286	20.772	21.242	21.697	22.140	22.569	22.987	23.393
Oen-Robinson	14.579	15.001	15.412	15.813	16.203	16.585	16.957	17.322	17.679
Montenegro	22.100	22.681	23.236	23.766	24.272	24.758	25.222	25.668	26.096

ELECTRONIC STOPPING POWER OF PROTONS IN Pt

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	78.	
Atomic Mass:	195.000	[amu]
Density:	21.438	[g/cm^3]
Measured Plasma Frequency:	24.	[eV]
One-Electron Radius:	0.819	[Å]
χ^2 of Free Electron Gas:	0.257	

Model Data:

Radius of Atom:	1.533	[Å]
Internal Radius of Atom:	1.207	[Å]
Homogeneous Electron Gas Density:	0.436	[Å^{-3}]
Density Correction:	0.069	[Å^{-3}]
Fitting Parameter:	0.661	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.345	6.301	7.791	9.043	10.144	11.136	12.048	12.896
volume averaged	4.624	6.539	8.008	9.247	10.339	11.325	12.233	13.077
Lindhard-Scharff	3.588	5.075	6.215	7.177	8.024	8.789	9.494	10.149
Andersen-Ziegler	4.476	6.330	7.753	8.952	10.009	10.964	11.842	12.660
Oen-Robinson	3.538	5.004	6.128	7.076	7.912	8.667	9.361	10.008
Montenegro	4.633	6.669	8.274	9.649	10.872	11.982	13.002	13.950

energy	9	10	11	12	13	14	15	16
impact p. dependent	13.691	14.442	15.158	15.840	16.496	17.124	17.733	18.319
volume averaged	13.871	14.621	15.335	16.017	16.671	17.300	17.907	18.494
Lindhard-Scharff	10.765	11.347	11.901	12.430	12.938	13.426	13.897	14.353
Andersen-Ziegler	13.428	14.154	14.771	15.354	15.910	16.442	16.952	17.442
Oen-Robinson	10.615	11.189	11.735	12.257	12.757	13.239	13.704	14.153
Montenegro	14.835	15.666	16.449	17.190	17.892	18.559	19.194	19.799

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	18.888	19.441	19.977	20.501	21.010	21.510	21.996	22.471	22.937
volume averaged	19.064	19.616	20.154	20.677	21.188	21.687	22.174	22.651	23.118
Lindhard-Scharff	14.795	15.224	15.641	16.047	16.443	16.830	17.209	17.579	17.941
Andersen-Ziegler	17.914	18.370	18.811	19.238	19.653	20.055	20.445	20.825	21.195
Oen-Robinson	14.589	15.012	15.423	15.824	16.214	16.596	16.969	17.334	17.691
Montenegro	20.377	20.929	21.458	21.964	22.449	22.915	23.362	23.791	24.204

ELECTRONIC STOPPING POWER OF PROTONS IN Au

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	79.	
Atomic Mass:	197.000	[amu]
Density:	19.311	[g/cm^3]
Measured Plasma Frequency:	26.	[eV]
One-Electron Radius:	0.787	[Å]
χ^2 of Free Electron Gas:	0.247	

Model Data:

Radius of Atom:	1.592	[Å]
Internal Radius of Atom:	1.067	[Å]
Homogeneous Electron Gas Density:	0.491	[Å^{-3}]
Density Correction:	-0.162	[Å^{-3}]
Fitting Parameter:	0.657	

energy	1	2	3	4	5	6	7	8
impact p. dependent	4.827	7.001	8.658	10.048	11.271	12.373	13.387	14.328
volume averaged	5.136	7.264	8.896	10.272	11.485	12.581	13.589	14.527
Lindhard-Scharff	3.591	5.078	6.219	7.181	8.029	8.795	9.500	10.156
Andersen-Ziegler	4.856	6.867	8.411	9.712	10.858	11.895	12.848	13.735
Oen-Robinson	3.541	5.007	6.132	7.081	7.917	8.673	9.367	10.014
Montenegro	5.023	7.227	8.961	10.446	11.763	12.958	14.055	15.071
Biersack	3.546	5.015	6.141	7.090	7.926	8.682	9.376	10.022

energy	9	10	11	12	13	14	15	16
impact p. dependent	15.211	16.046	16.842	17.599	18.326	19.026	19.702	20.352
volume averaged	15.409	16.242	17.035	17.792	18.519	19.218	19.892	20.545
Lindhard-Scharff	10.772	11.355	11.909	12.438	12.946	13.435	13.906	14.363
Andersen-Ziegler	14.568	15.356	16.021	16.654	17.257	17.834	18.387	18.919
Oen-Robinson	10.622	11.196	11.743	12.265	12.766	13.248	13.713	14.162
Montenegro	16.020	16.909	17.746	18.537	19.285	19.995	20.670	21.313
Biersack	10.628	11.201	11.745	12.265	12.763	13.241	13.703	14.148

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	20.983	21.598	22.194	22.775	23.342	23.897	24.435	24.965	25.483
volume averaged	21.177	21.791	22.388	22.970	23.537	24.091	24.632	25.162	25.681
Lindhard-Scharff	14.805	15.234	15.651	16.058	16.454	16.842	17.220	17.590	17.953
Andersen-Ziegler	19.432	19.926	20.405	20.868	21.318	21.754	22.178	22.591	22.992
Oen-Robinson	14.598	15.021	15.433	15.834	16.225	16.607	16.980	17.345	17.703
Montenegro	21.926	22.511	23.070	23.605	24.117	24.607	25.078	25.530	25.963
Biersack	14.580	14.998	15.404	15.800	16.184	16.560	16.926	17.284	17.634

ELECTRONIC STOPPING POWER OF PROTONS IN Hg

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	80.	
Atomic Mass:	202.000	[amu]
Density:	13.553	[g/cm^3]
Measured Plasma Frequency:	12.	[eV]
One-Electron Radius:	1.289	[Å]
χ^2 of Free Electron Gas:	0.404	

Model Data:

Radius of Atom:	1.807	[Å]
Internal Radius of Atom:	1.807	[Å]
Homogeneous Electron Gas Density:	0.112	[Å^{-3}]
Density Correction:	0.069	[Å^{-3}]
Fitting Parameter:	0.671	

energy	1	2	3	4	5	6	7	8
impact p. dependent	6.493	9.352	11.534	13.367	14.980	16.435	17.773	19.019
volume averaged	6.800	9.617	11.778	13.600	15.206	16.657	17.992	19.234
Lindhard-Scharff	3.593	5.081	6.223	7.186	8.034	8.801	9.506	10.162
Andersen-Ziegler	4.308	6.092	7.462	8.616	9.633	10.552	11.398	12.185
Oen-Robinson	3.543	5.010	6.136	7.086	7.922	8.678	9.374	10.021
Montenegro	4.468	6.438	7.994	9.330	10.519	11.601	12.597	13.523

energy	9	10	11	12	13	14	15	16
impact p. dependent	20.185	21.289	22.337	23.342	24.303	25.228	26.117	26.983
volume averaged	20.401	21.504	22.554	23.557	24.519	25.444	26.337	27.201
Lindhard-Scharff	10.779	11.362	11.916	12.446	12.955	13.444	13.915	14.372
Andersen-Ziegler	12.924	13.623	14.213	14.775	15.311	15.823	16.315	16.787
Oen-Robinson	10.629	11.204	11.750	12.273	12.774	13.256	13.721	14.171
Montenegro	14.389	15.204	15.973	16.701	17.392	18.049	18.676	19.274

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	27.816	28.629	29.419	30.184	30.936	31.664	32.381	33.083	33.769
volume averaged	28.038	28.851	29.642	30.412	31.163	31.896	32.613	33.314	34.001
Lindhard-Scharff	14.814	15.244	15.661	16.068	16.465	16.852	17.231	17.602	17.965
Andersen-Ziegler	17.243	17.683	18.108	18.520	18.920	19.309	19.686	20.053	20.411
Oen-Robinson	14.608	15.031	15.443	15.844	16.235	16.618	16.991	17.356	17.714
Montenegro	19.846	20.393	20.917	21.420	21.903	22.366	22.812	23.240	23.653

ELECTRONIC STOPPING POWER OF PROTONS IN Tl

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	81.	
Atomic Mass:	205.000	[amu]
Density:	11.882	[g/cm^3]
Measured Plasma Frequency:	10.	[eV]
One-Electron Radius:	1.527	[Å]
χ^2 of Free Electron Gas:	0.479	

Model Data:

Radius of Atom:	1.897	[Å]
Internal Radius of Atom:	1.897	[Å]
Homogeneous Electron Gas Density:	0.067	[Å^{-3}]
Density Correction:	0.033	[Å^{-3}]
Fitting Parameter:	0.690	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.205	10.376	12.795	14.829	16.617	18.230	19.714	21.093
volume averaged	7.541	10.664	13.061	15.082	16.862	18.471	19.951	21.328
Lindhard-Scharff	3.595	5.084	6.227	7.190	8.039	8.806	9.512	10.169
Andersen-Ziegler	4.723	6.679	8.180	9.446	10.561	11.569	12.496	13.359
Oen-Robinson	3.545	5.014	6.140	7.090	7.927	8.684	9.379	10.027
Montenegro	4.885	7.030	8.719	10.166	11.451	12.617	13.688	14.682

energy	9	10	11	12	13	14	15	16
impact p. dependent	22.388	23.613	24.776	25.888	26.955	27.982	28.970	29.925
volume averaged	22.622	23.846	25.010	26.122	27.189	28.215	29.205	30.163
Lindhard-Scharff	10.786	11.369	11.924	12.454	12.963	13.452	13.924	14.381
Andersen-Ziegler	14.169	14.935	15.585	16.200	16.787	17.349	17.887	18.405
Oen-Robinson	10.635	11.211	11.758	12.281	12.782	13.265	13.730	14.180
Montenegro	15.610	16.481	17.302	18.077	18.812	19.509	20.173	20.805

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	30.851	31.751	32.626	33.479	34.313	35.125	35.917	36.690	37.453
volume averaged	31.091	31.993	32.869	33.723	34.556	35.369	36.164	36.942	37.704
Lindhard-Scharff	14.823	15.253	15.671	16.078	16.475	16.863	17.242	17.613	17.976
Andersen-Ziegler	18.904	19.385	19.851	20.303	20.740	21.165	21.578	21.980	22.372
Oen-Robinson	14.617	15.041	15.453	15.854	16.246	16.628	17.002	17.367	17.726
Montenegro	21.408	21.985	22.536	23.064	23.569	24.054	24.520	24.967	25.396

ELECTRONIC STOPPING POWER OF PROTONS IN Pb

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	82.	
Atomic Mass:	208.000	[amu]
Density:	11.322	[g/cm^3]
Measured Plasma Frequency:	14.	[eV]
One-Electron Radius:	1.194	[Å]
χ^2 of Free Electron Gas:	0.375	

Model Data:

Radius of Atom:	1.937	[Å]
Internal Radius of Atom:	1.565	[Å]
Homogeneous Electron Gas Density:	0.141	[Å^{-3}]
Density Correction:	0.031	[Å^{-3}]
Fitting Parameter:	0.708	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.811	11.239	13.853	16.053	17.986	19.732	21.334	22.828
volume averaged	8.158	11.537	14.130	16.316	18.242	19.983	21.584	23.074
Lindhard-Scharff	3.597	5.088	6.231	7.195	8.044	8.812	9.518	10.175
Andersen-Ziegler	5.319	7.522	9.213	10.638	11.894	13.029	14.073	15.044
Oen-Robinson	3.547	5.017	6.144	7.095	7.932	8.689	9.385	10.033
Montenegro	5.450	7.814	9.665	11.242	12.638	13.900	15.056	16.126

energy	9	10	11	12	13	14	15	16
impact p. dependent	24.227	25.551	26.809	28.010	29.166	30.274	31.343	32.380
volume averaged	24.474	25.798	27.057	28.260	29.414	30.525	31.596	32.632
Lindhard-Scharff	10.792	11.376	11.931	12.462	12.971	13.460	13.933	14.390
Andersen-Ziegler	15.957	16.820	17.550	18.242	18.902	19.534	20.139	20.721
Oen-Robinson	10.642	11.218	11.765	12.288	12.790	13.273	13.739	14.189
Montenegro	17.121	18.053	18.929	19.755	20.535	21.275	21.977	22.644

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	33.378	34.352	35.300	36.222	37.123	37.999	38.854	39.697	40.514
volume averaged	33.636	34.612	35.560	36.484	37.385	38.265	39.124	39.966	40.790
Lindhard-Scharff	14.833	15.263	15.681	16.088	16.486	16.874	17.253	17.624	17.987
Andersen-Ziegler	21.282	21.823	22.347	22.854	23.345	23.822	24.286	24.737	25.176
Oen-Robinson	14.626	15.050	15.462	15.864	16.256	16.638	17.012	17.378	17.737
Montenegro	23.279	23.885	24.464	25.016	25.545	26.051	26.535	27.000	27.446

ELECTRONIC STOPPING POWER OF PROTONS IN Bi

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	83.	
Atomic Mass:	209.000	[amu]
Density:	9.811	[g/cm^3]
Measured Plasma Frequency:	15.	[eV]
One-Electron Radius:	1.147	[Å]
χ^2 of Free Electron Gas:	0.360	

Model Data:

Radius of Atom:	2.035	[Å]
Internal Radius of Atom:	1.404	[Å]
Homogeneous Electron Gas Density:	0.159	[Å^{-3}]
Density Correction:	-0.040	[Å^{-3}]
Fitting Parameter:	0.726	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.944	12.865	15.855	18.372	20.580	22.578	24.412	26.117
volume averaged	9.332	13.198	16.164	18.664	20.867	22.859	24.691	26.395
Lindhard-Scharff	3.600	5.091	6.235	7.199	8.049	8.817	9.524	10.181
Andersen-Ziegler	5.956	8.423	10.316	11.912	13.318	14.589	15.758	16.846
Oen-Robinson	3.549	5.020	6.148	7.099	7.937	8.694	9.391	10.039
Montenegro	6.096	8.732	10.789	12.537	14.079	15.468	16.738	17.908

energy	9	10	11	12	13	14	15	16
impact p. dependent	27.716	29.233	30.673	32.047	33.367	34.635	35.860	37.041
volume averaged	27.996	29.511	30.951	32.328	33.648	34.918	36.143	37.329
Lindhard-Scharff	10.799	11.383	11.939	12.470	12.979	13.469	13.941	14.399
Andersen-Ziegler	17.868	18.835	19.653	20.428	21.167	21.873	22.551	23.202
Oen-Robinson	10.648	11.224	11.772	12.296	12.798	13.281	13.747	14.198
Montenegro	18.993	20.007	20.956	21.848	22.689	23.483	24.235	24.948

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	38.185	39.301	40.385	41.439	42.468	43.470	44.450	45.412	46.350
volume averaged	38.477	39.593	40.678	41.735	42.765	43.772	44.755	45.718	46.661
Lindhard-Scharff	14.842	15.272	15.690	16.098	16.496	16.884	17.263	17.635	17.998
Andersen-Ziegler	23.829	24.434	25.020	25.586	26.136	26.669	27.187	27.691	28.182
Oen-Robinson	14.635	15.059	15.472	15.874	16.266	16.648	17.023	17.389	17.747
Montenegro	25.624	26.268	26.881	27.464	28.021	28.553	29.061	29.546	30.011

ELECTRONIC STOPPING POWER OF PROTONS IN Po

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	84.	
Atomic Mass:	210.000	[amu]
Density:	9.251	[g/cm^3]
Measured Plasma Frequency:	13.	[eV]
One-Electron Radius:	1.257	[Å]
χ^2 of Free Electron Gas:	0.394	

Model Data:

Radius of Atom:	2.079	[Å]
Internal Radius of Atom:	1.581	[Å]
Homogeneous Electron Gas Density:	0.121	[Å^{-3}]
Density Correction:	0.008	[Å^{-3}]
Fitting Parameter:	0.744	

energy	1	2	3	4	5	6	7	8
impact p. dependent	9.379	13.474	16.603	19.232	21.543	23.632	25.552	27.336
volume averaged	9.764	13.808	16.912	19.528	21.833	23.917	25.833	27.616
Lindhard-Scharff	3.602	5.094	6.238	7.204	8.054	8.823	9.529	10.187
Andersen-Ziegler	6.158	8.709	10.666	12.316	13.770	15.084	16.293	17.417
Oen-Robinson	3.552	5.023	6.152	7.103	7.942	8.700	9.397	10.045
Montenegro	6.303	9.026	11.151	12.955	14.545	15.977	17.284	18.488

energy	9	10	11	12	13	14	15	16
impact p. dependent	29.010	30.595	32.104	33.537	34.920	36.245	37.526	38.760
volume averaged	29.292	30.876	32.383	33.823	35.204	36.533	37.815	39.056
Lindhard-Scharff	10.805	11.390	11.946	12.477	12.986	13.477	13.950	14.407
Andersen-Ziegler	18.474	19.473	20.317	21.118	21.881	22.610	23.309	23.981
Oen-Robinson	10.655	11.231	11.779	12.303	12.805	13.289	13.755	14.206
Montenegro	19.604	20.645	21.619	22.534	23.396	24.210	24.979	25.708

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	39.962	41.128	42.258	43.361	44.436	45.488	46.512	47.516	48.502
volume averaged	40.258	41.425	42.560	43.665	44.744	45.797	46.826	47.833	48.819
Lindhard-Scharff	14.851	15.281	15.700	16.108	16.505	16.894	17.274	17.645	18.009
Andersen-Ziegler	24.628	25.253	25.856	26.440	27.007	27.556	28.089	28.608	29.113
Oen-Robinson	14.644	15.068	15.481	15.883	16.275	16.658	17.033	17.399	17.758
Montenegro	26.400	27.057	27.683	28.278	28.846	29.387	29.904	30.398	30.871

ELECTRONIC STOPPING POWER OF PROTONS IN Ra

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	88.	
Atomic Mass:	226.000	[amu]
Density:	5.022	[g/cm^3]
Measured Plasma Frequency:	7.	[eV]
One-Electron Radius:	1.969	[Å]
χ^2 of Free Electron Gas:	0.617	

Model Data:

Radius of Atom:	2.612	[Å]
Internal Radius of Atom:	2.379	[Å]
Homogeneous Electron Gas Density:	0.031	[Å^{-3}]
Density Correction:	0.017	[Å^{-3}]
Fitting Parameter:	0.859	

energy	1	2	3	4	5	6	7	8
impact p. dependent	16.492	23.576	28.994	33.547	37.558	41.179	44.510	47.606
volume averaged	16.973	24.003	29.398	33.945	37.952	41.574	44.906	48.006
Lindhard-Scharff	3.610	5.105	6.253	7.220	8.072	8.843	9.551	10.211
Andersen-Ziegler	7.506	10.615	13.001	15.012	16.784	18.386	19.859	21.230
Oen-Robinson	3.560	5.034	6.165	7.119	7.960	8.719	9.418	10.068
Montenegro	7.658	10.946	13.497	15.652	17.542	19.235	20.772	22.181

energy	9	10	11	12	13	14	15	16
impact p. dependent	50.513	53.261	55.877	58.374	60.771	63.075	65.298	67.451
volume averaged	50.918	53.672	56.292	58.795	61.196	63.506	65.735	67.891
Lindhard-Scharff	10.830	11.416	11.973	12.505	13.016	13.507	13.981	14.440
Andersen-Ziegler	22.518	23.736	24.761	25.735	26.662	27.548	28.397	29.213
Oen-Robinson	10.679	11.257	11.806	12.331	12.835	13.319	13.786	14.239
Montenegro	23.482	24.689	25.814	26.865	27.851	28.778	29.650	30.474

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	69.534	71.558	73.523	75.437	77.306	79.130	80.914	82.657	84.369
volume averaged	69.980	72.009	73.982	75.904	77.779	79.609	81.398	83.149	84.863
Lindhard-Scharff	14.884	15.316	15.735	16.144	16.543	16.932	17.313	17.685	18.050
Andersen-Ziegler	29.998	30.755	31.486	32.193	32.878	33.542	34.187	34.813	35.422
Oen-Robinson	14.677	15.102	15.516	15.919	16.312	16.696	17.071	17.439	17.798
Montenegro	31.252	31.988	32.685	33.347	33.975	34.572	35.139	35.680	36.194

ELECTRONIC STOPPING POWER OF PROTONS IN Th

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	90.	
Atomic Mass:	232.000	[amu]
Density:	11.658	[g/cm^3]
Measured Plasma Frequency:	13.	[eV]
One-Electron Radius:	1.250	[Å]
χ^2 of Free Electron Gas:	0.392	

Model Data:

Radius of Atom:	1.990	[Å]
Internal Radius of Atom:	1.953	[Å]
Homogeneous Electron Gas Density:	0.123	[Å^{-3}]
Density Correction:	0.072	[Å^{-3}]
Fitting Parameter:	0.927	

energy	1	2	3	4	5	6	7	8
impact p. dependent	8.548	12.319	15.197	17.613	19.741	21.659	23.421	25.060
volume averaged	8.963	12.675	15.524	17.925	20.041	21.954	23.713	25.350
Lindhard-Scharff	3.614	5.111	6.259	7.228	8.081	8.852	9.561	10.222
Andersen-Ziegler	7.710	10.904	13.354	15.420	17.240	18.886	20.399	21.807
Oen-Robinson	3.563	5.040	6.172	7.127	7.968	8.729	9.428	10.079
Montenegro	7.868	11.245	13.864	16.074	18.011	19.745	21.318	22.759

energy	9	10	11	12	13	14	15	16
impact p. dependent	26.602	28.056	29.439	30.760	32.028	33.244	34.419	35.558
volume averaged	26.888	28.342	29.725	31.047	32.315	33.535	34.712	35.850
Lindhard-Scharff	10.842	11.428	11.986	12.519	13.030	13.522	13.996	14.455
Andersen-Ziegler	23.130	24.381	25.438	26.438	27.390	28.300	29.172	30.019
Oen-Robinson	10.690	11.269	11.819	12.344	12.848	13.333	13.801	14.254
Montenegro	24.087	25.319	26.466	27.538	28.542	29.485	30.372	31.209

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	36.661	37.729	38.770	39.784	40.768	41.734	42.674	43.600	44.501
volume averaged	36.954	38.025	39.067	40.082	41.072	42.038	42.983	43.907	44.813
Lindhard-Scharff	14.900	15.332	15.752	16.162	16.561	16.950	17.331	17.704	18.069
Andersen-Ziegler	30.816	31.593	32.344	33.071	33.774	34.456	35.118	35.761	36.386
Oen-Robinson	14.693	15.119	15.533	15.936	16.330	16.714	17.090	17.457	17.817
Montenegro	31.998	32.745	33.452	34.123	34.759	35.363	35.937	36.483	37.002

ELECTRONIC STOPPING POWER OF PROTONS IN Pa

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	91.	
Atomic Mass:	231.000	[amu]
Density:	15.400	[g/cm^3]
Measured Plasma Frequency:	49.	[eV]
One-Electron Radius:	0.518	[Å]
χ^2 of Free Electron Gas:	0.162	

Model Data:

Radius of Atom:	1.811	[Å]
Internal Radius of Atom:	0.289	[Å]
Homogeneous Electron Gas Density:	1.724	[Å^{-3}]
Density Correction:	-88.712	[Å^{-3}]
Fitting Parameter:	0.887	

energy	1	2	3	4	5	6	7	8
impact p. dependent	7.276	10.927	13.687	15.993	18.011	19.829	21.498	23.043
volume averaged	8.351	11.810	14.464	16.702	18.673	20.456	22.095	23.620
Lindhard-Scharff	3.616	5.113	6.263	7.231	8.085	8.857	9.566	10.227
Andersen-Ziegler	7.407	10.475	12.829	14.814	16.563	18.143	19.597	20.950
Oen-Robinson	3.565	5.042	6.175	7.131	7.972	8.733	9.433	10.084
Montenegro	7.562	10.811	13.332	15.461	17.328	19.000	20.518	21.909

energy	9	10	11	12	13	14	15	16
impact p. dependent	24.495	25.864	27.161	28.406	29.595	30.740	31.846	32.910
volume averaged	25.053	26.408	27.697	28.929	30.110	31.247	32.343	33.404
Lindhard-Scharff	10.847	11.434	11.992	12.525	13.037	13.529	14.004	14.463
Andersen-Ziegler	22.221	23.423	24.437	25.398	26.314	27.189	28.028	28.834
Oen-Robinson	10.696	11.275	11.825	12.351	12.855	13.340	13.808	14.261
Montenegro	23.193	24.384	25.494	26.531	27.503	28.417	29.278	30.089

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	33.942	34.943	35.915	36.867	37.788	38.693	39.571	40.437	41.283
volume averaged	34.432	35.430	36.401	37.347	38.269	39.170	40.050	40.911	41.755
Lindhard-Scharff	14.908	15.340	15.761	16.170	16.569	16.959	17.340	17.713	18.079
Andersen-Ziegler	29.609	30.357	31.080	31.779	32.457	33.114	33.751	34.371	34.974
Oen-Robinson	14.700	15.126	15.541	15.945	16.338	16.723	17.099	17.467	17.827
Montenegro	30.856	31.581	32.269	32.920	33.539	34.127	34.686	35.218	35.725

ELECTRONIC STOPPING POWER OF PROTONS IN U

(energies in keV, stopping powers in 10^{-15} eVcm^2/atom)

Target Data:

Atomic Number:	92.	
Atomic Mass:	238.040	[amu]
Density:	19.043	[g/cm^3]
Measured Plasma Frequency:	18.	[eV]
One-Electron Radius:	0.988	[Å]
χ^2 of Free Electron Gas:	0.310	

Model Data:

Radius of Atom:	1.704	[Å]
Internal Radius of Atom:	1.688	[Å]
Homogeneous Electron Gas Density:	0.248	[Å^{-3}]
Density Correction:	0.146	[Å^{-3}]
Fitting Parameter:	0.880	

energy	1	2	3	4	5	6	7	8
impact p. dependent	5.792	8.395	10.378	12.042	13.507	14.828	16.040	17.169
volume averaged	6.154	8.703	10.659	12.308	13.761	15.074	16.282	17.406
Lindhard-Scharff	3.618	5.116	6.266	7.235	8.089	8.861	9.571	10.232
Andersen-Ziegler	7.290	10.310	12.627	14.580	16.301	17.857	19.288	20.619
Oen-Robinson	3.567	5.045	6.179	7.134	7.976	8.738	9.438	10.089
Montenegro	7.447	10.651	13.139	15.243	17.089	18.744	20.248	21.628
Biersack	3.584	5.069	6.207	7.167	8.012	8.776	9.478	10.131

energy	9	10	11	12	13	14	15	16
impact p. dependent	18.227	19.227	20.179	21.088	21.960	22.796	23.604	24.388
volume averaged	18.462	19.461	20.411	21.318	22.189	23.027	23.835	24.616
Lindhard-Scharff	10.853	11.440	11.998	12.532	13.043	13.536	14.011	14.470
Andersen-Ziegler	21.870	23.053	24.052	24.999	25.900	26.762	27.588	28.382
Oen-Robinson	10.701	11.280	11.831	12.357	12.862	13.347	13.816	14.269
Montenegro	22.902	24.085	25.188	26.221	27.189	28.100	28.958	29.768
Biersack	10.744	11.323	11.874	12.400	12.904	13.388	13.855	14.306

energy	17	18	19	20	21	22	23	24	25
impact p. dependent	25.141	25.875	26.592	27.290	27.969	28.631	29.277	29.913	30.532
volume averaged	25.374	26.110	26.825	27.522	28.202	28.865	29.514	30.149	30.771
Lindhard-Scharff	14.916	15.348	15.769	16.178	16.578	16.968	17.349	17.722	18.088
Andersen-Ziegler	29.146	29.883	30.595	31.284	31.951	32.599	33.227	33.838	34.432
Oen-Robinson	14.708	15.134	15.549	15.953	16.347	16.731	17.108	17.475	17.836
Montenegro	30.534	31.259	31.947	32.599	33.219	33.809	34.370	34.904	35.413
Biersack	14.743	15.167	15.578	15.979	16.369	16.749	17.121	17.484	17.839