

MUON STOPPING POWER AND RANGE TABLES 10 MeV–100 TeV

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The mean stopping power for high-energy muons in matter can be described by $\langle -dE/dx \rangle = a(E) + b(E)E$, where $a(E)$ is the electronic stopping power and $b(E)$ is the energy-scaled contribution from radiative processes—bremsstrahlung, pair production, and photonuclear interactions. $a(E)$ and $b(E)$ are both slowly varying functions of the muon energy E where radiative effects are important. Tables of these stopping power contributions and continuous-slowning-down-approximation ranges (which neglect multiple scattering and range straggling) are given for a selection of elements, compounds, mixtures, and biological materials for incident kinetic energies in the range of 10 MeV to 100 TeV. Tables of the contributions to $b(E)$ are given for the same materials.

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1. INTRODUCTION

The mean stopping power for high-energy muons (or other heavy charged particles¹) in a material can be described by [1]

$$\langle -dE/dx \rangle = a(E) + b(E)E, \quad (1)$$

where E is the total energy, $a(E)$ is the electronic stopping power, and $b(E)$ is due to radiative processes—bremsstrahlung, pair production, and photonuclear interactions:

$$b \equiv b_{\text{brems}} + b_{\text{pair}} + b_{\text{nucl}}. \quad (2)$$

The notation is convenient because $a(E)$ and $b(E)$ are slowly varying functions of E at the high energies where radiative contributions are important. $b(E)E$ is less than 1% of $a(E)$ for $E \lesssim 100$ GeV for most materials.

The continuous-slowing-down-approximation (CSDA) range is obtained from the integral

$$R(E) = \int_{E_0}^E [a(E') + b(E')E']^{-1} dE', \quad (3)$$

where E_0 is sufficiently small that the result is insensitive to its exact value. At very high energies, where a and b are (essentially) constant,

$$R(E) \approx (1/b) \ln(1 + E/E_{\mu c}), \quad (4)$$

where $E_{\mu c} = a/b$ is the muon critical energy. The muon critical energy can be defined more precisely as the energy at which electronic losses and radiative losses are equal, in analogy to one of the ways of defining the critical energy for electrons. It is obtained by finding $E_{\mu c}$ such that

$$a(E_{\mu c}) = E_{\mu c} b(E_{\mu c}). \quad (5)$$

The CSDA range is of limited usefulness, particularly at higher energies, because of the effect of fluctuations. (Fluctu-

ations in radiative losses are discussed briefly in Section 4.6.) For example, the cosmic ray muon intensity falls very rapidly with energy, so that the flux observed deep underground is quite different from that to be expected from Eq. (3). We nonetheless calculate the CSDA range given by Eq. (3) as an indicator of actual muon range.

The important and well-studied subjects of stopping power fluctuations and range straggling in electronic energy loss [2, 3] are not treated, even though they are much more serious for muons than for heavier particles: The fractional range straggling ($\sqrt{\text{variance}(\text{range})}/\text{range}$) scales as $\sqrt{1/M}$ for particles with the same velocity, and hence is three times larger for a 100-MeV muon than for a 900-MeV proton. In copper the fractional straggling varies from 4% at 10 MeV, through a minimum of 2.8% at 300 MeV, then rises through 5.7% at 10 GeV. Above ~ 100 GeV straggling due to fluctuations in bremsstrahlung losses begins to dominate.

Multiple scattering is also neglected, but with more justification. One measure of multiple scattering is provided by the “detour factor” [3], the ratio of the average penetration depth to the average path length for a stopping particle. The detour factor is 0.98 in the worst case (uranium at our lowest energy). This ratio increases rapidly toward unity as the energy is increased or if the atomic weight of the absorber is decreased.

Tables of muon energy loss from a 1985 CERN internal report by Lohmann et al. [4] have become the de facto world standard. This careful work serves as the benchmark for the present effort. Later theoretical work enables us to improve the calculations for low- Z elements ($2 \leq Z \leq 10$) and to make minor improvements elsewhere.

It is our intention to make this report sufficiently self-contained that the interested user can replicate our calculations, even though this results in our giving often-tedious detail. The necessary constants for electronic loss calculations and tables of $b(E)$ for elements, for the mean radiative loss calculations, are also available as ASCII files at <http://pdg.lbl.gov/AtomicNuclearProperties>. These tables are more extensive than the subset of data actually presented in this paper.

There is one serious dilemma: We believe that the density-effect corrections via the careful parameterizations of Sternheimer et al. [5] are more dependable than those calculated via their general algorithm [6]. But, as will be discussed in Section 3.2, better values for mean excitation energies are now available for a variety of materials. The changes are sometimes as great as 10%. Over much of our energy region of interest (for $\beta\gamma \gtrsim 1000$), however, the density effect has “replaced” the mean excitation energy by the plasma energy, so that improvements in the mean excitation energy have no

¹ The radiative loss formulae given in this paper apply only to spin-1/2 pointlike heavy particles, where “heavy” means “much more massive than an electron.” Insofar as we know, the solution for spin-0 particles has never been published.

TABLE 1
Definitions of Most of the Variables Used in This Report

Symbol	Definition	Units or value
α	Fine structure constant $e^2/4\pi\epsilon_0\hbar c$	1/137.035 999 76(50)
M	Incident particle mass	MeV/c ²
M_μ	Muon mass	105.658 356 8(52) MeV/c ²
E	Incident particle energy γMc^2	MeV
T	Kinetic energy $(\gamma - 1)Mc^2$	MeV
p	Momentum $\gamma\beta Mc$	MeV/c
$m_e c^2$	Electron mass $\times c^2$	0.510 998 902(21) MeV
r_e	Classical electron radius $e^2/4\pi\epsilon_0 m_e c^2$	2.817 940 285(31) fm
N_A	Avogadro's number	6.022 141 99(47) $\times 10^{23}$ mol ⁻¹
ze	Charge of incident particle	
Z	Atomic number of medium	
A	Atomic mass of medium (Occasionally: atomic mass number)	g mol ⁻¹ dimensionless
K/A	$4\pi N_A r_e^2 m_e c^2 / A$	0.307 075 MeV g ⁻¹ cm ² for $A = 1$ g mol ⁻¹
I	Mean excitation energy	eV (<i>Nota bene!</i>)
δ	Density effect correction to electronic energy loss	
$\hbar\omega_p$	Plasma energy $\sqrt{4\pi N_e r_e^3} m_e c^2 / \alpha$	28.816 $\sqrt{\rho(Z/A)}$ eV for ρ in g cm ⁻³
N_e	Electron density	
w_j	Fraction by weight of the j th element in a compound or mixture ($\sum w_i = 1$)	
n_j	number of the j th kind of atoms in a compound or mixture	
$E_{\mu c}$	Muon critical energy	GeV
ν	Fractional energy transfer in an incident particle interaction	
ε	νE , the energy transfer in a single interaction	

Note. The electronic charge e and the kinematic variables $\beta = v/c$ and $\gamma = 1/\sqrt{1-\beta^2}$ have their usual definitions. Constants are from *CODATA Recommended Values of the Fundamental Physical Constants: 1998* [7]. Parenthetical numbers after the values give the one-standard deviation uncertainties in the last digits. In Section 4 the convention $c = 1$ is used.

effect on the stopping power. We therefore continue to use sometimes-obsolete excitation energy values. How this affects our results will be discussed in Section 3.2. On the other hand, corrections to the densities used by Sternheimer et al. [5] are easily accommodated if the changes are small; this is done in several cases.

We present tables of stopping power and mean range for muons from kinetic energy $T = 10$ MeV to 100 TeV for most elements and a variety compounds and mixtures. Tables of $b(E)$ are given for the same materials. In the case of elemental gases, tables are also given for the liquid state.

The symbols and constants used in this report are explained in Table 1.

2. OVERVIEW

The behavior of stopping power ($=(-dE/dx)$) in copper over 12 decades of muon kinetic energy is shown by the solid curves in Fig. 1. Data below the breaks in the curves are from ICRU 49 [3], while data above the breaks are from our present calculations. Approximate boundaries between regions described by different theories or phenomenologies

are indicated by the shaded vertical bands. While our main interest is at higher energies, some understanding of the behavior at lower energies is useful, in particular for starting range integrals.

For $\beta < \alpha$, below the first gray band in Fig. 1, the muon velocity is small compared with that of the valence electrons in the absorber. Following the work of Fermi and Teller [9], Lindhard and collaborators have constructed a successful semi-phenomenological model to describe ionizing energy losses in this regime, approximating the electronic structure of solids by a Fermi electron gas distribution [10]. The stopping power is found to be proportional to the projectile velocity. This region is marked by the dashed curve with the dotted extension in Fig. 1. However, below $\beta \approx 0.001$ – 0.01 nonionizing energy losses via nuclear recoil become increasingly significant [3], finally dominating energy loss at very low energies.

Above $\beta \approx 0.05$ or 0.1 (the second gray band in Fig. 1) one may make the opposite approximation, neglecting electronic motion within atoms. There is no satisfactory theory for the intermediate region, $\alpha < \beta < 0.1$ (but see [11]). There is, however, a rich experimental literature, which

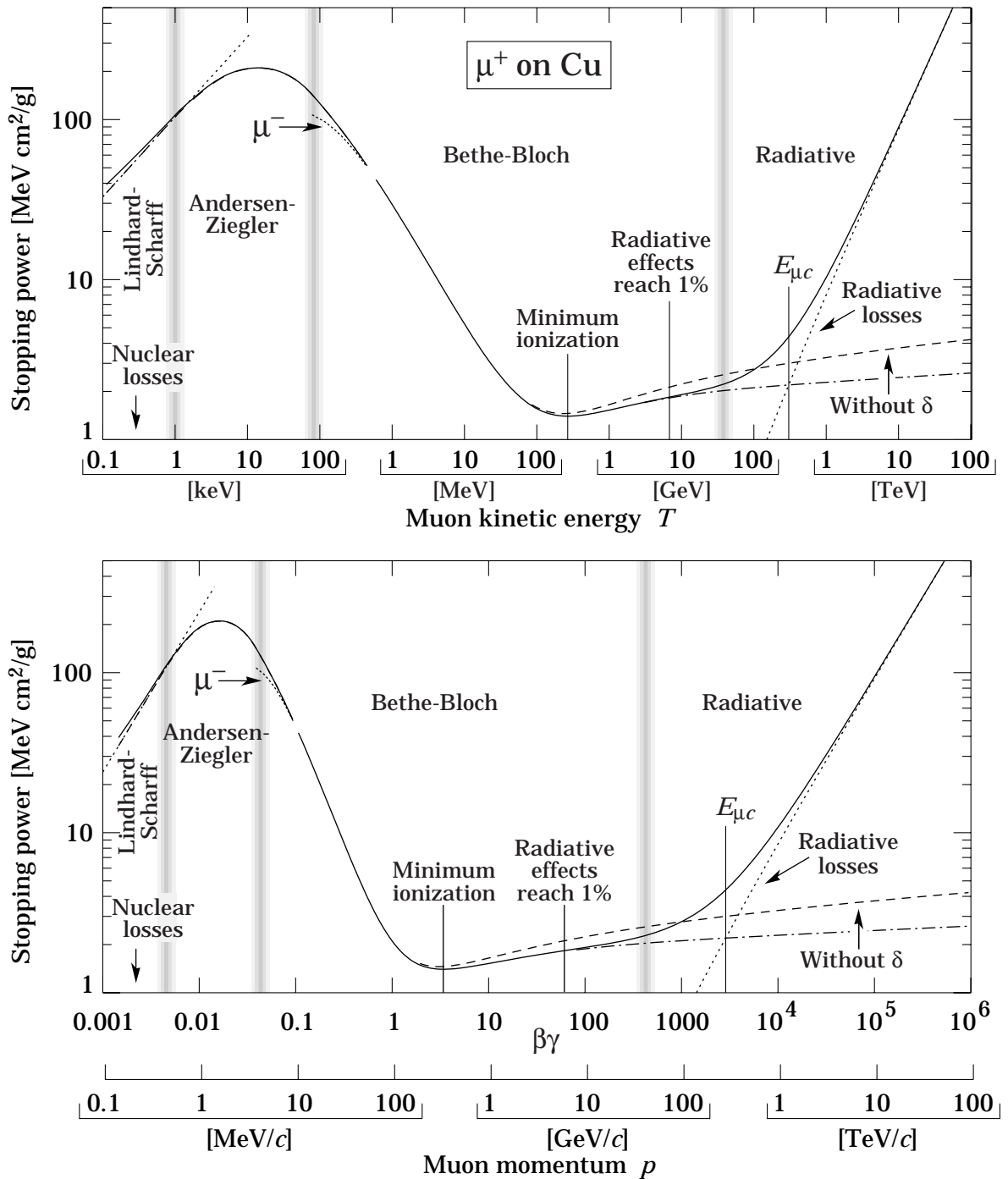


FIG. 1. Stopping power ($= -dE/dx$) for positive muons in copper as a function of kinetic energy T (top figure, 12 orders of magnitude range) and as a function of momentum $p = M\beta c\gamma$ (bottom figure, nine orders of magnitude). Solid curves indicate the total stopping power. Data below the break at $T \approx 0.5$ MeV are scaled by the appropriate mass ratios from the π^- and p tables in ICRU 49 [3], and data at higher energies are from the present calculations. Vertical bands indicate boundaries between different theoretical approximations or dominant physical processes. The short dotted lines labeled “ μ^- ” illustrate the “Barkas effect” [8]. “Nuclear losses” indicates non-ionizing nuclear recoil energy losses, which are negligible here.

Andersen and Ziegler have used to construct phenomenological fits bridging the regions in which there is adequate theoretical understanding [12]. This is the interval between the gray bands shown in Fig. 1.

Electronic (ionization + excitation) losses in the high-velocity region are well described by Bethe’s theory based on a first-order Born approximation [13], to which are added a number of corrections for the low-energy region and to

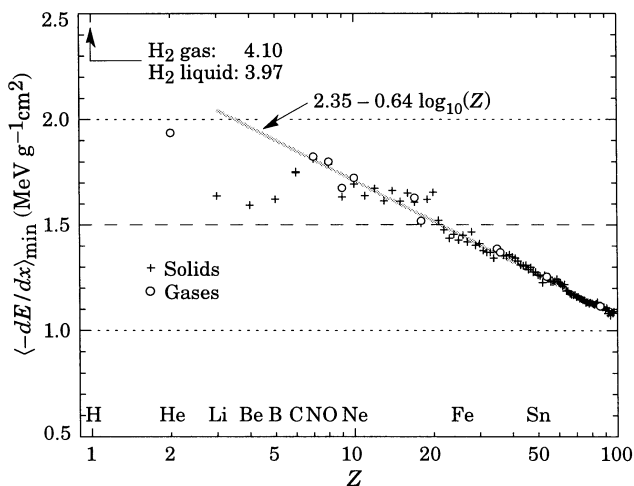


FIG. 2. Minimum ionization as a function of Z . The straight line is fitted for $Z \geq 6$.

account for the polarization of the medium at high energies. The curve falls to a broad minimum whose position for solid absorbers decreases from $\beta\gamma = 3.5$ to 3.0 as Z goes from 7 to 100. The mean electronic loss at the minimum value as a function of Z is shown in Fig. 2. The rise in Fig. 1 with further increases of the projectile energy (labeled “without δ ” in Fig. 1) is less marked when the polarization effects are taken into account (dash-dotted curve).

Electronic losses at very high energies are somewhat modified by bremsstrahlung from the atomic electrons [14] (see Section 3.5) and other effects, such as form factor corrections [15]. These are of decreased importance because radiative energy losses begin to be significant above a few hundreds of GeV for even intermediate- Z absorbers. For example, radiative losses in copper dominate above $E_{\mu c} = 315$ GeV. The radiative contribution, and hence the entire energy loss rate, increases nearly linearly with energy above 1 TeV or so.

3. ELECTRONIC ENERGY LOSSES OF HIGH-ENERGY HEAVY PARTICLES

The physics formulae needed to describe the average electronic energy losses of a high-energy ($\beta \gg \alpha Z$), massive (\neq electron) charged particle as it passes through matter have been reviewed elsewhere [3, 16–24]. ICRU 49 is particularly useful, although it is limited to protons and alpha particles (except for a short π^- table) and to proton energies less than 10 GeV, corresponding to $E < 1.1$ GeV for muons. In this energy region nuclear recoil contributes negligibly to energy loss, and radiative losses, which typically become important above tens of GeV, can be added as an independent contribution.

For the moment, we leave open the possibilities that the charge is ze and that the particle might be something other than a muon. We briefly review the subject here in order to emphasize high-energy behavior.

3.1. Major Contributions

The electronic stopping power² is calculated by summing the contributions of all possible inelastic scatterings. These are normally from lower to higher (bound or unbound) electronic energy states, so the particle loses a small amount of energy in each scattering. The kinetic energy of the scattered electron is Q .

In his derivation of the stopping power, Bethe [25] introduced the concept of “generalized oscillator strength” which is closely related to the inelastic-scattering form-factor [20]. The following summarizes the detailed discussions by Rossi [17], Fano [19], and Bichsel [24].

1. Low- Q region: Here the reciprocal of the 3-momentum transfer (roughly an impact parameter) is large compared with atomic dimensions. The scattered electrons have kinetic energies up to some cutoff Q_1 , typically 0.01–0.1 eV [17]. For this region, Bethe approximated the generalized oscillator strength by the dipole oscillator strength $f(\varepsilon)$, which is the generalized oscillator strength $f(\varepsilon, q)$ for zero momentum transfer q (ε is the energy loss in a single collision). $f(\varepsilon)$ is closely related to the optical absorption coefficient. He derived the following contribution to S :

$$S_{\text{low}} = \frac{K}{2} z^2 \frac{Z}{A} \frac{1}{\beta^2} \left[\ln \frac{Q_1}{I^2/2m_e\beta^2c^2} + \ln \gamma^2 - \beta^2 \right]. \quad (6)$$

Here $\ln I = \int f(\varepsilon) \ln \varepsilon d\varepsilon$. The denominator $I^2/2m_e\beta^2c^2$ in the first (logarithmic) term is the effective lower cutoff on the integral over dQ/Q . This term comes from “longitudinal excitations” (the ordinary Coulomb potential), and the next two terms from transverse excitations.

The low- Q region is associated with large impact parameters and hence with long distances. Polarization of the medium can seriously reduce this contribution, particularly at high energies where the transverse extension of the incident particle’s electric field becomes substantial. The correction is usually made by subtracting a density-effect term δ , inside the square brackets of Eq. (6). This important correction is discussed in Sect. 3.4.

2. Intermediate- and high- Q regions: In an intermediate region atomic excitation energies are not necessarily small

² Various called S , $a(E)$, or the electronic part of the total mean energy loss rate $\langle -dE/dx \rangle$.

compared with Q , but transverse excitations can be neglected. At higher energies Q can be equated to the energy given to the electron, neglecting its binding energy. When the integration of the energy-weighted cross sections is carried out from Q_1 to some upper limit Q_{upper} , one obtains

$$S_{\text{high}} = \frac{K}{2} z^2 \frac{Z}{A} \frac{1}{\beta^2} \left[\ln \frac{Q_{\text{upper}}}{Q_1} - \beta^2 \frac{Q_{\text{upper}}}{Q_{\text{max}}} \right]. \quad (7)$$

Here Q_{max} is the kinematic maximum possible electron recoil kinetic energy, given by

$$Q_{\text{max}} = \frac{2m_e c^2 \beta^2 \gamma^2}{1 + 2\gamma m_e/M + (m_e/M)^2}. \quad (8)$$

Q_{upper} is normally equal to Q_{max} (as will be the case after the conclusion of this section) and cannot exceed Q_{max} . The more general form given in Eq. (7) is useful in considering restricted energy loss, which is of relevance in considering the energy actually deposited in a thin absorber. At high energies (such that $Q_{\text{upper}}/Q_{\text{max}} \ll 1$) the first term in the square brackets dominates. If Q_{upper} is restricted to some maximum value, e.g., 0.5 MeV, then S_{high} is essentially constant for $Q_{\text{max}} > Q_{\text{upper}}$. If $Q_{\text{upper}} = Q_{\text{max}}$ the high- Q region stopping power rises with energy as $\ln Q_{\text{max}}$. In other words, the increase of S_{high} with energy is associated with the production of high-energy recoil electrons, or δ -rays. A very small projectile mass dependence of the electronic stopping power is introduced by Q_{max} , which otherwise depends only on projectile velocity.

In Fano's discussion the low-energy approximation $Q_{\text{max}} \approx 2m_e c^2 \beta^2 \gamma^2 = 2m_e p^2/M^2$ is implicit. Accordingly, Eq. (7) is more closely related to Rossi's form (see his Eqs. 2.3.6 and 2.5.4). This low-energy approximation is made in many papers of the Bevatron era, but is in error by a factor of 2 for a muon with $T = 10.8$ GeV. Note that $Q_{\text{max}} \rightarrow E$ at very high energies.

3.2. Mean Excitation Energy

"The determination of the mean excitation energy is the principal non-trivial task in the evaluation of the Bethe stopping-power formula" [26]. Recommended values have varied substantially with time. Estimates based on experimental stopping-power measurements for protons, deuterons, and alpha particles and on oscillator-strength distributions and dielectric-response functions were given in ICRU 37 [27]. These were retained in ICRU 49 [3], where a useful comparison with other results is given, and they are used in the EGS4 [28] electron/photon transport code. These values (scaled by $1/Z$) are shown in Fig. 3. The error estimates are

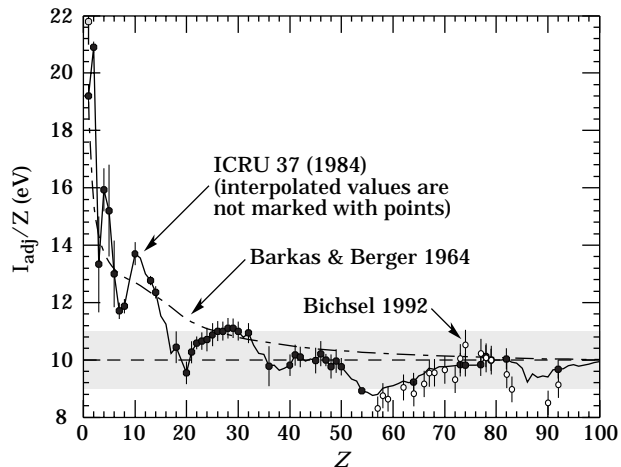


FIG. 3. Mean excitation energies (divided by Z) as adopted in ICRU 37 [27] (filled points). Those based on experimental measurements are shown by symbols with error flags; the interpolated values are simply joined. The grey point is for liquid H_2 ; the black point at 19.2 is for H_2 gas. The open circles show more modern determinations by Bichsel [29]. The dotted curve is from the approximate formula of Barkas [30].

from Table 2 in [26]. As can be seen, $I/Z \simeq 10 \pm 1$ eV for elements heavier than sulphur.

The figure also shows Bichsel's more recent determination of I for selected heavy elements [29]. He estimates uncertainties from 1.5% to 5%; the 5% errors are shown. The change from the ICRU 37 values is less than 7% in all of the 19 cases except for samarium (7.5%), tungsten (7.5%), bismuth (9.3%), and thorium (9.5%). In addition, the mean excitation energy for liquid water has been more recently determined to be 79.7 ± 0.5 eV [31], significantly higher than the ICRU 37 value, 75.0 eV. This reference also gives mean excitation energies for a variety of biological materials of interest here. In addition, Leung has described further corrections to stopping power theory due to relativistic effects of the target electrons [32]. Such effects could increase the stopping power by as much as 2% for high- Z targets. Bichsel has observed that this would be equivalent to lowering the mean excitation energy values for high- Z materials by as much as 10%.

We are strongly motivated to use the ICRU 37 mean excitation energies because of the availability of density-effect parameters based on these values [5]; yet in many cases the more recent values are superior and should be used. To investigate the consequences of errors or changes in the mean excitation energies, we ran a version of our code in which I was increased by 10% and no other changes were made. In the $T_\mu = 10$ –100 MeV region, the stopping power increased by somewhat over 1% for carbon and iron. For lead it decreased by 2.6%–1.4% over this energy range. Since we did not modify the density-effect parameters, in particular \bar{C} (see

(Eq. 12)), there was a residual $\approx 0.4\%$ at high energies. The density-effect correction essentially replaces I by the plasma frequency $\hbar\omega_p$ for $p/M \gtrsim 1000$, so the stopping power is completely insensitive to I for $T \gtrsim 100$ GeV, or for the lower half of our stopping power tables. The range integral always has contributions from lower-energy parts, but these also become increasingly insignificant as the energy increases. We therefore feel justified in using the older data, for which dependable density-effect parameters are available.

3.3. Low-Energy Corrections

The distant-collision contribution to the stopping power given by Eq. (6) was obtained by Bethe [25] with the approximation that the velocities of atomic electrons are small compared with that of the projectile. More precisely, Bethe's approximation was to replace the generalized oscillator strength by the dipole oscillator strength $f(\varepsilon)$ in obtaining this result. This leads to correction terms [16] which are different for each atomic shell. The "shell correction" for the j th shell is represented by $-2C_j/Z$, so that an additional term $-C/Z = -\sum C_j/Z$ appears in the square brackets of Eq. (6). Other ways to calculate the shell correction are discussed in [3]. Unfortunately, the algorithms are not easy for the non-expert to implement.

The shell correction is not important at the energies of interest in this report. For example, the stopping power correction is 0.3% for a 10 MeV muon in iron and 3% in uranium. It falls rapidly with increasing energy. But even at intermediate energies it plays a role in "starting" the range integral. To investigate its importance, and to compare our results with the proton stopping power and range-energy tables in ICRU 49 [3], we have used the simple but long-obsolete analytic approximation for the shell correction introduced by Barkas [30].³ The accuracy of our results is addressed in Section 3.7.

In early Bevatron experiments Barkas et al. [8] found that negative pions had a somewhat greater range than positive pions with the same (small) initial energy. This was at-

tributed to a departure from first-order Born theory [33] and is normally included by adding a term $zL_1(\beta)$ to the stopping-power formula. The effect has been measured for a number of negative/positive particle pairs, most recently for antiprotons/protons at the CERN LEAR facility [34]. It is illustrated by the μ^- stopping-power segment shown in Fig. 1.

Bethe's stopping power theory is based on a first-order Born approximation. To obtain Bloch's result, a term $z^2L_2(\beta)$ is added if results accurate at low energies are desired.

These corrections are discussed in detail in ICRU 49 and are mentioned here for completeness. They are not significant at the energies of concern in this report.

3.4. Density Effect

As the particle energy increases its electric field flattens and extends, so that the distant-collision part of dE/dx (Eq. (6)) increases as $\ln \beta\gamma$. However, real media become polarized, limiting this extension and effectively truncating part of this logarithmic rise. This "density effect" has been extensively treated over the years; see [5, 6, 28] and references therein. The approach is to subtract a density-effect correction, δ , from the distant-collision contribution, resulting in the $\delta/2$ term in Eq. (15). At very high energies,

$$\delta/2 \rightarrow \ln(\hbar\omega_p/I) + \ln \beta\gamma - 1/2, \quad (10)$$

where $\hbar\omega_p$ is the plasma energy defined in Table 1. As can be seen from Eq. (15), the effect of Eq. (10) is to replace I with $\hbar\omega_p$ and to eliminate the explicit $\beta^2\gamma^2$ dependence in the first (log) term in the square brackets. The remaining rise of the electronic stopping power comes from Q_{\max} , given by Eq. (8). The effect of the density correction is shown in Fig. 1.

At some low energy (related to x_0 below) the density effect is insignificant, and above some high energy (see x_1 below) it is well described by the asymptotic form given in Eq. (10). Conductors require special treatment at the low-energy end. Sternheimer has proposed the parameterization [35]

$$\delta = \begin{cases} 2(\ln 10)x - \bar{C} & \text{if } x \geq x_1; \\ 2(\ln 10)x - \bar{C} \\ \quad + a(x_1 - x)^k & \text{if } x_0 \leq x < x_1; \\ 0 & \text{if } x < x_0 \text{ (nonconductors);} \\ \delta_0 10^{2(x-x_0)} & \text{if } x < x_0 \text{ (conductors),} \end{cases} \quad (11)$$

where $x = \log_{10}(p/M) = \log_{10} \beta\gamma$. \bar{C} is obtained by equating the high-energy case of Eq. (11) with the limit of Eq. (10),

³ Explicitly,

$$C = (0.422377\eta^{-2} + 0.0304043\eta^{-4} - 0.00038106\eta^{-6}) \times 10^{-6} I^2 + (3.858019\eta^{-2} - 0.1667989\eta^{-4} + 0.00157955\eta^{-6}) \times 10^{-9} I^3, \quad (9)$$

where $\eta = \beta\gamma$ and I is in eV. This form is reasonably good only for $\eta > 0.13$ ($T = 7.9$ MeV for a proton, 0.89 MeV for a muon).

so that

$$\bar{C} = 2 \ln(I/\hbar\omega_p) + 1. \quad (12)$$

The other parameters (a , k , x_0 , x_1 , and δ_0) are adjusted to give a best fit to the results of detailed numerical calculations for a logarithmically spaced grid of energy values. Note that \bar{C} is the negative of the C used in earlier publications. A variety of different parameter sets is available. In some cases these result from a different fitting procedure having been used with the same model, and although the parameters look different, the resulting δ is not sensibly different. For elements, the PEGS4 data [28] use the values from [36].

In a series of papers by Sternheimer, Seltzer, and Berger, the density-effect parameter tables are extended to nearly 300 elements, compounds, and mixtures. The chemical composition of the materials is given in [26].⁴ The agreement with more detailed calculations or results obtained with other parameter sets is usually at the 0.5% level [37]; however, see Table IV in [38]. We use the tables given in [5] for most of the present calculations.⁵

The densities used in these tables are occasionally in error, or, in the case of some polymers with variable density, out of the usual range. In this and other cases we use Eq. (A.8) [6] to adjust the parameters; these are marked by footnotes to the tables in Section 5.

There remains the problem of obtaining the density-effect parameters if they have not been tabulated for the material of interest. This issue is of particular importance here in the case of cryogenic liquids such as N_2 , but is also of interest when dealing with a compound or mixture not tabulated by Sternheimer et al. [5]. The algorithm proposed by Sternheimer and Peierls [6] is discussed in Appendix A.

⁴ Slightly incorrect compositions (and therefore density-effect parameters) are given for lanthanum oxysulfide (corrected in a footnote in [37]), cellulose acetate, cellulose nitrate, polypropylene, and perhaps other materials. These will be corrected, and an approximately equal number of new materials added, in a forthcoming publication [39].

⁵ Given the power of modern computers, experts now calculate the density effect from first principles rather than use these formulae [39]. One problem along the way is knowing the mean excitation energy, which can be different for condensed and gas states of the same substance and even depends upon density. In our case radiative effects dominate over most of the relevant energy range, and no great error is engendered by employing the user-friendly parameterized forms.

To some degree, both the adjustment of the parameters for a different density and the Sternheimer–Peierls algorithm can be checked by using those cases in the tables where parameters are given for different densities of the same material. When the “compact carbon” parameters are adjusted to the two other tabulated carbon densities, the difference in stopping power and range with those obtained directly is less than 0.2%. Calculation of parameters for a cryogenic liquid using the Sternheimer–Peierls algorithm can be checked for hydrogen and water. This method was used to calculate parameters for liquid hydrogen at bubble chamber density (0.060 g/cm^3), using the excitation energy for the liquid; at worst, at minimum ionization, $(-dE/dx)$ was low by 2.5%, while the range was high by 1.1%. Deviations were smaller elsewhere. When the algorithm was used to calculate parameters for water using the excitation energy for steam, the result was 1% higher at minimum ionization than that obtained directly with the water parameters. Only a slight improvement was obtained by using the excitation energy given for water.

Hydrogen is always a worst case. Sternheimer et al. [5] tabulate parameters for both hydrogen gas and liquid hydrogen under bubble chamber conditions, so we have made calculations in both directions via the Sternheimer–Peierls algorithm and by scaling densities via Eq. (A.8). We conclude that the stopping power results in this report obtained with parameters scaled to different densities are accurate to within the overall 0.5% agreement level estimated by Seltzer and Berger [37], and that the parameters calculated for cryogenic liquids (except hydrogen) using the Sternheimer–Peierls algorithm could produce stopping power errors of slightly over 1% at minimum ionization, and less elsewhere.

3.5. Other High-Energy Corrections

Bremsstrahlung from atomic electrons in the case of incident muons was considered in a 1997 paper by Kelner et al. [14]. There are four lowest order diagrams: Photon emission by the muon before and after photon exchange with the electron, and emission by the electron before and after photon exchange. The former diagrams result in losses nearly proportional to E and are described by Eq. (19). The latter are properly part of electronic losses, and produce an additional term in the stopping power. To leading powers in logarithms, this loss is given by

$$\Delta \left| \frac{dE}{dx} \right| = \frac{K}{4\pi} \frac{Z}{A} \alpha \left[\ln \frac{2E}{M_\mu c^2} - \frac{1}{3} \ln \frac{2Q_{\max}}{m_e c^2} \right] \ln^2 \frac{2Q_{\max}}{m_e c^2}. \quad (13)$$

As Kelner et al. observe, this addition is important at high energies, amounting to 2% of the electronic loss at 100 GeV and 4% at 1 TeV. It is included in our calculations.

An additional spin-correction term, $(1/4)(Q_{\max}/E)^2$, is included in the square brackets of Eq. (7) if the incident particle is a muon (point-like and spin 1/2) [17]. Its contribution to the stopping power asymptotically approaches 0.038 (Z/A) MeV g^{-1} cm^2 , reaching 90% of that value at 200 GeV in most materials. In iron its fractional contribution reaches a maximum of 0.75% at 670 GeV. Although this contribution is well within uncertainties in the total stopping power, its inclusion avoids a systematic bias.

At energies above a few hundred GeV, the maximum 4-momentum transfer to the electron can exceed 1 GeV/c, so that, in the case of incident pions, protons, and other hadrons, cross sections are modified by the extended charge distributions of the projectiles. One might expect this “soft” cutoff to Q_{\max} to reduce the electronic stopping power. This problem has been investigated by Jackson [15], who concluded that corrections to dE/dx become important only at energies where radiative losses dominate. At lower energies the stopping power is almost unchanged, since its average, dominated by losses due to many soft collisions, is insensitive to the rare hard collisions. For muons the spin correction replaces this form-factor correction.

Jackson and McCarthy [40] have pointed out that the Barkas correction calculated by Fermi (but see their reference [20]) persists at high energies; hence, a term should be added to the close-collision part of Eq. (15):

$$K z^3 \frac{Z \pi \alpha}{A 2 \beta}. \tag{14}$$

This correction, which is ± 0.00176 MeV g^{-1} cm^2 for $z = \pm 1$, $Z/A = 1/2$ and $\beta = 1$, produces range differences of a few parts per thousand between positive and negative muons near minimum ionization. At higher energies sign-indifferent radiative effects dominate. We neglect this correction.

3.6. Bethe–Bloch Equation

We summarize this discussion with the Bethe–Bloch equation for muons in the form used in this paper:

$$\left\langle -\frac{dE}{dx} \right\rangle_{\text{electronic}} = K \frac{Z}{A} \frac{1}{\beta^2} \left[\frac{1}{2} \ln \frac{2m_e c^2 \beta^2 \gamma^2 Q_{\max}}{I^2} - \beta^2 - \frac{\delta}{2} + \frac{1}{8} \frac{Q_{\max}^2}{(\gamma M c^2)^2} \right] + \Delta \left| \frac{dE}{dx} \right|. \tag{15}$$

The final term, for bremsstrahlung from atomic electrons, is given by Eq. (13).

Except for the very small projectile mass dependence introduced by Q_{\max} , this expression depends only on the projectile velocity. This means that a value of the stopping power for a particle with mass M_1 and kinetic energy T_1 is the same as the stopping power for a particle with mass M_2 at $T_2 = (M_2/M_1)T_1$. Similarly, R/M is a function of T/M (or E/M , or p/M).

3.7. Comparison with Other Ionizing Energy Loss Calculations

Comparisons with the ICRU 49 proton tables have been made by running our code with the proton mass. A summary of the stopping power comparisons is given in Table 2 and of the CSDA range comparisons in Table 3. In general the agreement is regarded as adequate, but is worse at high atomic number and low energy. The simple shell correction given by Eq. (9) has been used, and under these conditions somewhat overcorrects.

ICRU 49 concludes that the “differences between tabulated and experimental stopping powers are mostly smaller than 1% and hardly ever greater than 2%,” and in the case of compounds and mixtures “the uncertainties are approximately three times as large as in the case of elements” [3].

Our muon tables start at $T = 10$ MeV, corresponding to a proton energy of about 100 MeV, so that only 100 MeV and

TABLE 2
Comparison of Stopping-Power Calculations for Protons (in MeV g^{-1} cm^2) with those of ICRU 49 [3] and Bichsel 1992 [29]

	10 MeV	100 MeV	1 GeV	10 GeV
Hydrogen gas ($Z = 1$)				
This calculation	101.7	15.29	4.496	4.539
ICRU 49	101.9	15.30	4.497	4.539
Graphite ($Z = 6$, $\rho = 1.7$ g/cm³)				
This calculation	40.72	6.514	1.942	1.883
ICRU 49	40.84	6.520	1.946	1.881
Iron ($Z = 26$)				
This calculation	28.54	5.045	1.575	1.603
ICRU 49	28.56	5.043	1.574	1.601
Tin ($Z = 50$)				
This calculation	22.26	4.177	1.351	1.426
ICRU 49	22.02	4.165	1.349	1.423
Lead ($Z = 82$)				
This calculation	17.52	3.532	1.189	1.291
ICRU 49	17.79	3.552	1.186	1.288
Bichsel 1992	17.79	3.592		
Uranium ($Z = 92$)				
This calculation	16.68	3.388	1.144	1.243
ICRU 49	16.90	3.411	1.140	1.242
Bichsel 1992	16.86	3.450		
Liquid water				
This calculation	45.94	7.290	2.210	2.132
ICRU 49	45.67	7.289	2.211	2.126

TABLE 3
Comparison of CSDA Range Calculations for Protons
(in g cm⁻²) with Those of ICRU 49

	10 MeV	100 MeV	1 GeV	10 GeV
Hydrogen gas				
This calculation	0.0534	3.636	158.7	2254.
ICRU 49	0.0535	3.633	158.7	2254.
Graphite ($Z = 6$, $\rho = 1.7$ g/cm ³)				
This calculation	0.1361	8.634	367.4	5333.
ICRU 49	0.1377	8.627	367.0	5337.
Iron ($Z = 26$)				
This calculation	0.2013	11.36	459.2	6383.
ICRU 49	0.2064	11.37	459.6	6389.
Tin ($Z = 50$)				
This calculation	0.2623	13.90	540.9	7272.
ICRU 49	0.2764	13.95	541.9	7291.
Lead				
This calculation	0.3315	16.79	620.7	8120.
ICRU 49	0.3528	16.52	621.7	8143.
Uranium				
This calculation	0.3462	17.56	645.2	8432.
ICRU 49	0.3718	17.24	646.8	8456.
Liquid water				
This calculation	0.1201	7.710	325.4	4703.
ICRU 49	0.1230	7.718	325.4	4700.

above is relevant in the proton comparisons. For uranium the stopping power at 100 MeV is low by 0.8% and the range high by 1.9%. Without the shell correction the stopping power for this case is high by 1.7% and the range low by 2.5%. We make the shell correction only for elements. We conclude that in a worst-case scenario, PuCl₄ (which we do not tabulate) at 10 MeV, our results could be in error by nearly 3%. For lower- Z materials the agreement is consistent with ICRU 49. In any case the agreement improves rapidly with increasing energy.

Lohmann et al. [4] list muon electronic losses separately for hydrogen, iron, and uranium. Since they do not consider the contributions of bremsstrahlung from atomic electrons (Eq. (13)), we have made comparisons with this correction “turned off.” Under these conditions, our results disagree by at most 2 in the fourth decimal place, presumably from different rounding of the density-effect parameters.

4. RADIATIVE LOSSES

The radiative contribution to muon stopping power is conveniently written as $b(E)E$ [1], where $b(E)$ is a slowly varying function of energy which is asymptotically constant. As indicated earlier, it is usually written as a sum of contributions from bremsstrahlung, direct pair production, and photonuclear interactions:

$$b \equiv b_{\text{brems}} + b_{\text{pair}} + b_{\text{nucl}}. \quad (2)$$

Here we describe the calculation of these contributions. Note that the convention $c = 1$ is used in all the formulae in this section.

In this section we specialize to $M = M_\mu$, although the results apply to any massive spin-1/2 pointlike particle. To a very rough approximation, the bremsstrahlung contribution scales as $1/M^2$, and the pair-production part as $1/M$. The results below probably apply fairly well to charged pion radiative energy losses, although to the best of our knowledge radiative losses by spin-0 particles have not been treated.

4.1. Bremsstrahlung

The cross section for electron bremsstrahlung was obtained by Bethe and Heitler [41]. In the case of muons, it is necessary to take into account nuclear screening, which was first done consistently by Petrukhin and Shestakov [42]. A simple approximation for medium and heavy nuclei ($Z > 10$) was derived. Lohmann et al. [4] also used this approximation, but for $Z < 10$ they set the nuclear screening correction equal to zero. As a result, their bremsstrahlung contribution for low- Z nuclei is overestimated by about 10%.

The CCFR collaboration [43] revised the Petrukhin and Shestakov [42] results, pointing out that [42] overestimates the nuclear screening correction by about 10%. Kelner et al. [44] later observed that the CCFR conclusion probably resulted from an incorrect treatment of the Bethe–Heitler formula. Their new calculations were in good agreement with the old ones by Petrukhin and Shestakov for medium and heavy nuclei, but in addition they proposed an approximation for light nuclei. An independent analysis was performed by the Bugaev group (see, e.g., Ref. 45). The results of Petrukhin and Shestakov and the Bugaev group for bremsstrahlung on screened nuclei agree to within a few percent.

All of the results mentioned above were derived in the Born approximation. It was recently shown [45] that the non-Born corrections in the region of low and high momentum transfers have the same order of magnitude but opposite signs. As a consequence, they nearly compensate each other.

The differential cross section for muon bremsstrahlung from a (screened) nucleus as given in [44] is used for the present paper:

$$\left. \frac{d\sigma}{d\nu} \right|_{\text{brems,nucl}} = \alpha \left(2Z \frac{m_e}{M_\mu} r_e \right)^2 \left(\frac{4}{3} - \frac{4}{3}\nu + \nu^2 \right) \frac{\Phi(\delta)}{\nu}. \quad (16)$$

Here ν is the fraction of the muon’s energy transferred to the

photon, and

$$\Phi(\delta) = \ln\left(\frac{BM_\mu Z^{-1/3}/m_e}{1 + \delta\sqrt{e}BZ^{-1/3}/m_e}\right) - \Delta_n(\delta), \quad (17)$$

where $D_n = 1.54A^{0.27}$, $B = 182.7$ ($B = 202.4$ for hydrogen), $e = 2.7181\dots$, $\delta = M_\mu^2\nu/2E(1 - \nu)$, and the nuclear screening correction Δ_n is given by

$$\Delta_n = \ln\left(\frac{D_n}{1 + \delta(D_n\sqrt{e} - 2)/M_\mu}\right). \quad (18)$$

The Thomas–Fermi potential for atomic electrons is assumed. A more precise calculation of the radiation logarithm using the Hartree–Fock model is described in [46], and the results agree with the Thomas–Fermi results within about 1% at high energies (total screening); the agreement is better at low energies. Since there is not yet a Hartree–Fock result for screening in the case of bremsstrahlung from atomic electrons, we prefer to use the form factors based on the Thomas–Fermi potential throughout.

To account for bremsstrahlung losses on atomic electrons, Z^2 in Eq. (16) is usually replaced with $Z(Z + 1)$ (e.g., see [4]). A much better approximation for the contribution from electrons, taking into account electronic binding and recoil, is given by [14]:

$$\left.\frac{d\sigma}{d\nu}\right|_{\text{brems,elec}} = \alpha Z \left(2\frac{m_e}{M_\mu}r_e\right)^2 \left(\frac{4}{3} - \frac{4}{3}\nu + \nu^2\right) \frac{\Phi_{in}(\delta)}{\nu}. \quad (19)$$

In this case

$$\Phi_{in}(\delta) = \ln\left(\frac{M_\mu/\delta}{M_\mu\delta/m_e^2 + \sqrt{e}}\right) - \ln\left(1 + \frac{m_e}{\delta BZ^{-2/3}\sqrt{e}}\right), \quad (20)$$

where $B = 1429$ for all elements but hydrogen, where $B = 446$, and $\delta = M_\mu^2\nu/2E(1 - \nu)$, as above.

The cross section for bremsstrahlung as a function of fractional energy transfer ν is shown in Fig. 4. Although pair production dominates the radiative contributions to the stopping power, bremsstrahlung dominates at high ν .

The average energy loss $\langle -dE/dx \rangle$ due to bremsstrahlung is calculated by integrating the sum of these cross sections, as in Eq. (21) below.

4.2. Direct e^+e^- Pair Production

The cross section for direct e^+e^- pair production in a Coulomb field was first calculated by Racah [47]. Atomic screening was later taken into account by Kelner and Kotov [48]. With their approach, the average energy loss is obtained through a three-fold numerical integration. With the simple parameterization of the screening functions proposed by Kokoulin and Petrukhin [49], one obtains a double differential cross section for e^+e^- production. This formula is widely used in muon transport calculations (for example, see [4]). Based on this work, a (rather complicated) analytic form for the energy spectrum of pairs created in screened muon-nucleus collisions was derived by Nikishov [50]. The explicit formula is given in Appendix B. The average energy loss for pair production is calculated by numerical integration:

$$b_{\text{pair,nucl}} = -\left.\frac{1}{E}\frac{dE}{dx}\right|_{\text{pair,nucl}} = \frac{N_A}{A} \int_0^1 \nu \frac{d\sigma}{d\nu} d\nu. \quad (21)$$

The same expression as for the nucleus is usually used to calculate the pair production contribution from atomic electrons, with Z^2 replaced with Z (e.g., [4]). A more precise approach has recently been developed by Kelner [51], who proposed a simple parameterization of the energy loss based on a rigorous QED calculation. This formula for the electronic contribution to pair production energy loss by muons is valid to within 5% of the more laborious numerical result for $E > 5$ GeV, and is used for the present calculations:

$$\begin{aligned} b_{\text{pair,elec}} &= -\left.\frac{1}{E}\frac{dE}{dx}\right|_{\text{pair,elec}} \\ &= \frac{Z}{A} \left(0.073 \ln\left(\frac{2E/M_\mu}{1 + gZ^{2/3}E/M_\mu}\right) - 0.31\right) \\ &\quad \times 10^{-6} \text{ cm}^2/\text{g}. \end{aligned} \quad (22)$$

Here $g = 4.4 \times 10^{-5}$ for hydrogen and $g = 1.95 \times 10^{-5}$ for other materials.

The cross section for direct pair production as a function of fractional energy transfer ν is shown in Fig. 4.

4.3. Photonuclear Interactions

Several approaches have been developed to calculate the muon photonuclear cross section. The most widely used is

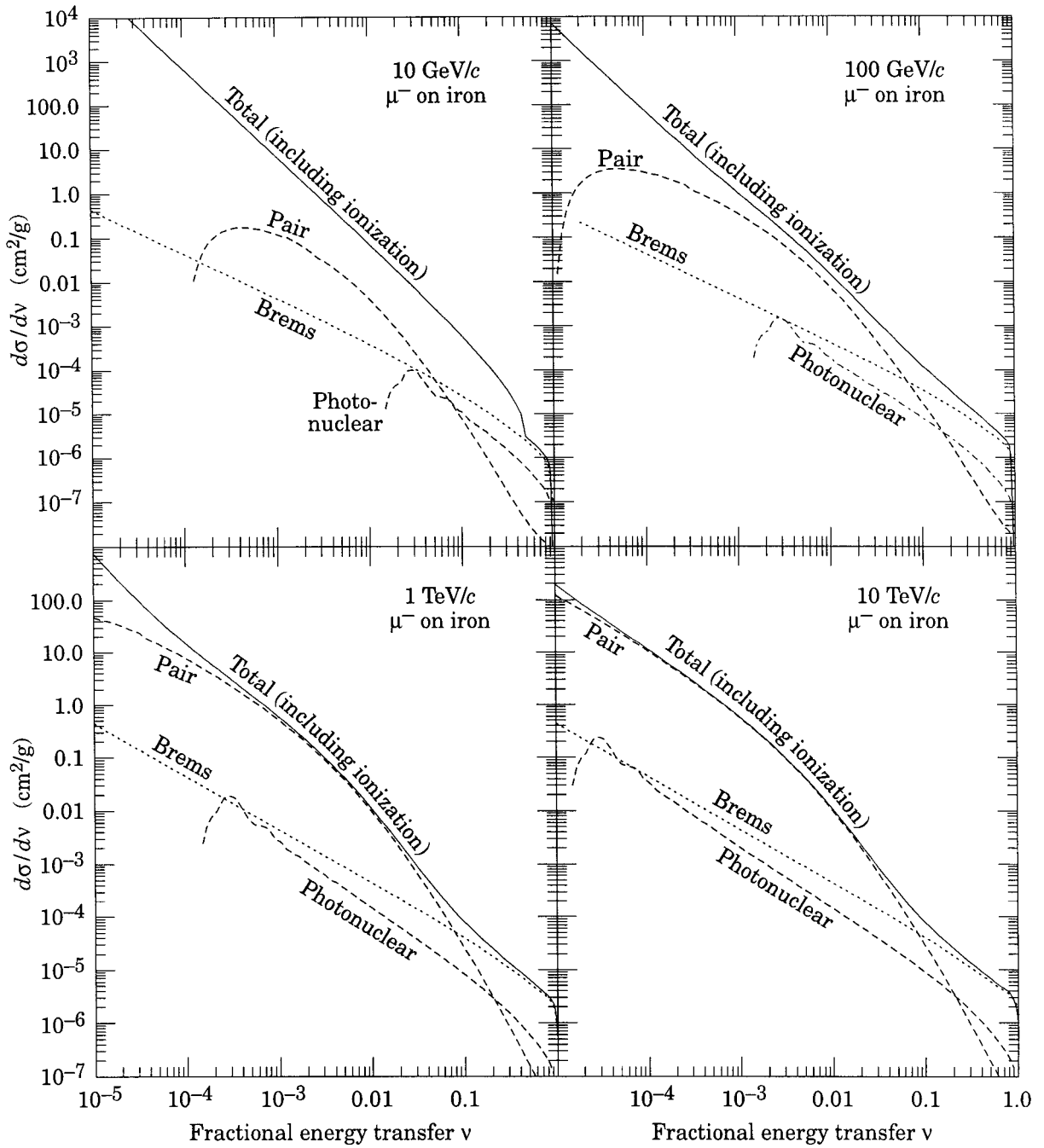


FIG. 4. Differential cross section for total and radiative processes as a function of the fractional energy transfer for muons on iron.

that of Bezrukov and Bugaev [52]:

$$\begin{aligned}
 \left. \frac{d\sigma}{dv} \right|_{\text{nucl}} &= \frac{\alpha}{2\pi} A\sigma_{\gamma N}(\varepsilon)\nu \left\{ 0.75 G(x) \right. \\
 &\times \left[\kappa \ln\left(1 + \frac{m_1^2}{t}\right) - \frac{\kappa m_1^2}{m_1^2 + t} - \frac{2M_\mu^2}{t} \right] \\
 &+ 0.25 \left[\kappa \ln\left(1 + \frac{m_2^2}{t}\right) - \frac{2M_\mu^2}{t} \right] \\
 &+ \frac{M_\mu^2}{2t} \left[0.75 G(x) \frac{m_1^2}{m_1^2 + t} \right. \\
 &\left. \left. + 0.25 \frac{m_2^2}{t} \ln\left(1 + \frac{t}{m_2^2}\right) \right] \right\}. \tag{23}
 \end{aligned}$$

Here ε is the energy loss of the muon and $\sigma_{\gamma N}(\varepsilon)$ is the photoabsorption cross section defined below. Other values are given by

$$\nu = \frac{\varepsilon}{E}, \quad t = \frac{M_\mu^2 \nu^2}{1 - \nu}, \quad \kappa = 1 - \frac{2}{\nu} + \frac{2}{\nu^2}, \quad \text{and}$$

$$G(x) = \frac{3}{x^3} \left(\frac{x^2}{2} - 1 + e^{-x}(1 + x) \right), \quad (24)$$

$x = 0.00282 A^{1/3} \sigma_{\gamma N}(\varepsilon)$, $m_1^2 = 0.54 \text{ GeV}^2$, and $m_2^2 = 1.8 \text{ GeV}^2$. This cross section gives results consistent with other calculations to within 30% [4]. Recent measurements of photonuclear interactions of muons in rock performed by the MACRO collaboration [53] agree quite well with Monte Carlo simulations based on the Bezrukov and Bugaev cross section.

The total cross section $\sigma_{\gamma N}(\varepsilon)$ for the photon–nucleon interaction appears as a normalization parameter in [52], which proposes a simple parameterization

$$\sigma_{\gamma N}(\varepsilon) \text{ (in } \mu\text{b)} = 114.3 + 1.647 \ln^2(0.0213\varepsilon). \quad (25)$$

This approximation is good enough only for muon energy loss $\varepsilon > 5 \text{ GeV}$. For smaller ε , we use the experimental data given by Armstrong et al. [54]. The energy loss contribution is calculated by numerical integration of the differential cross section given by Eq. (23). The use here of a more precise photo-absorption cross section for $\varepsilon < 5 \text{ GeV}$ than was used in the original model [52] does not change the photonuclear part of $\langle -dE/dx \rangle$ appreciably.

The cross section for photonuclear interactions as a function of fractional energy transfer ν is shown in Fig. 4.

4.4. Comparison with Other Works on Muon Radiative Losses

Selected b values from our present calculations and according to Lohmann et al. [4] are listed in Table 4 and plotted in Fig. 5 as a function of muon energy. Since Lohmann et al. did not give the decomposition of the stopping powers except for H, Fe, and U, values of b_{tot} for the materials given in the right half of the figure were obtained by assuming our values of the ionizing losses (without the bremsstrahlung correction given by Eq. (13), which was omitted in [4]). This is justified because for the fiducial cases H, Fe, and U our results agree with their values to within rounding errors in the fourth place.

For $Z > 10$ the results are nearly identical. For smaller atomic number, and at low energies, two effects are responsible for the differences:

1. In the nuclear part of bremsstrahlung, nuclear screening has only a weak energy dependence and produces about a

TABLE 4
Comparison of b_{tot} Calculations with Previous Work

Total energy =	10 GeV	100 GeV	1 TeV	10 TeV	100 TeV
Hydrogen					
This calculation	0.941	1.345	1.773	2.079	2.284
Lohmann et al.	1.081	1.463	1.814	2.046	—
Carbon					
This calculation	1.278	1.972	2.548	2.859	3.030
^a Lohmann et al.	1.3	2.14	2.679	2.958	—
Iron					
This calculation	3.290	5.701	7.392	8.110	8.371
Lohmann et al.	3.312	5.795	7.444	8.128	—
Uranium					
This calculation	8.234	14.614	18.747	20.308	20.760
Lohmann et al.	8.046	14.790	18.870	20.360	—
Water					
This calculation	1.439	2.279	2.959	3.313	3.497
^a Lohmann et al.	1.5	2.49	3.125	3.459	—
Standard rock					
This calculation	1.840	3.028	3.934	4.365	4.563
^a Lohmann et al.	1.8	3.10	3.960	4.361	—
Gaisser & Stanev	1.91	3.12	4.01	4.40	—
Oxygen					
This calculation	1.502	2.397	3.108	3.468	3.650
^a Lohmann et al.	1.6	2.62	3.290	3.620	—

Note. Comparison with work of Lohmann et al. [4] and, in the case of standard rock, with Gaisser and Stanev [55]. b_{tot} is listed in units of $10^{-6} \text{ g}^{-1} \text{ cm}^2$.

^a Obtained from the Lohmann et al. energy loss tables assuming our values for electronic losses (without the bremsstrahlung correction given by Eq. (13)). The subtraction loses significance at 10 GeV, where the radiative contribution is small.

4% reduction for hydrogen and a 10% reduction for carbon. This is apparent in our lower values of b_{tot} for carbon and water as compared with Lohmann et al.

2. The cross sections for bremsstrahlung and pair production from atomic electrons decrease at low energies because of electron recoil. In our calculations Lohmann et al.’s $Z(Z + 1)$ factor is replaced by $Z(Z + 0)$ in the low-energy limit, so that for hydrogen our contributions to these processes for 1–10 GeV are smaller by nearly a factor of 2. Similarly, in the low-energy limit our bremsstrahlung and pair production contributions for carbon are 6/7 of Lohmann et al.’s values.

The CERN RD 34 collaboration has measured the energy loss spectrum of 150 GeV muons in iron [56]. The energy deposition was measured in prototype hadron calorimeter modules for the ATLAS detector. The most probable electronic loss was subtracted, as was background from photonuclear interactions (which in this case is only about 7% of the total cross section). The remaining sensitivity was to energy loss by pair production (dominant at the smallest energy transfers, $0.01 < \nu < 0.03$), knock-on electrons

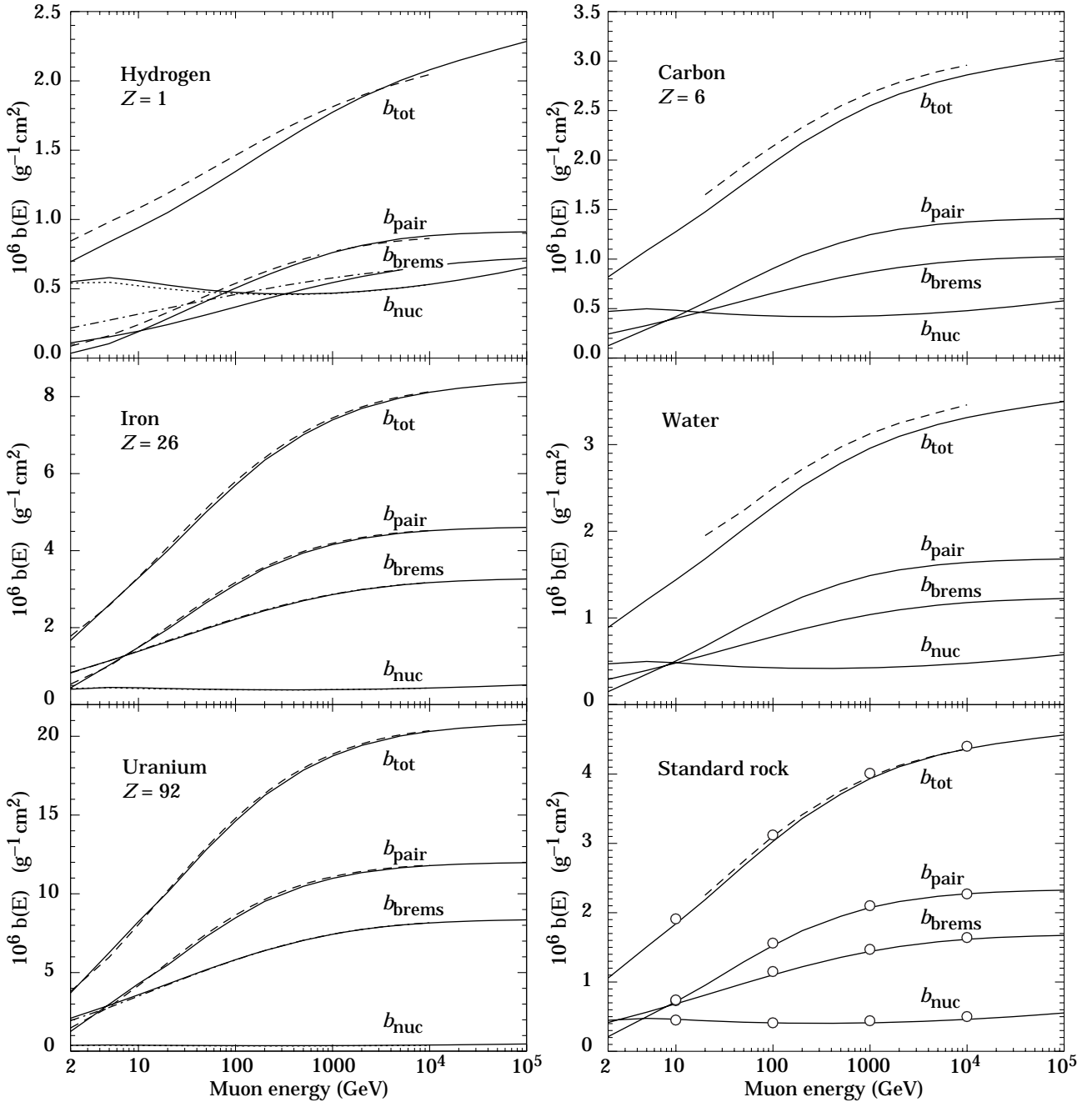


FIG. 5. b -values for a sampling of materials. Solid lines represent our results, while the dashed/dotted lines are from Lohmann et al. [4]. The circles for standard rock are from Gaisser and Stanev [55].

(δ rays, included in the high-energy tail of the electronic loss and dominating for $0.03 < \nu < 0.12$), and bremsstrahlung (dominant for $\nu > 0.12$). The RD 34 experimental results shown in Fig. 6 are expressed as the fractional deviation from the present calculations, where the Kelner et al. [14] model (basically that of Petrukhin and Shestakov) is used to obtain the bremsstrahlung component important at large ν . The fractional deviations from our results are also shown for the CCFR collaboration's revision of the Petrukhin and

Shestakov cross section [43] and Rozental's formula [57]. The present calculation describes the data reasonably well, while the others are evidently less successful.

4.5. Muon Critical Energy

Equation (5) defines the muon critical energy $E_{\mu c}$ as the energy for which electronic and radiative losses are equal. $E_{\mu c}$ for the chemical elements is shown in Fig. 7. The equality

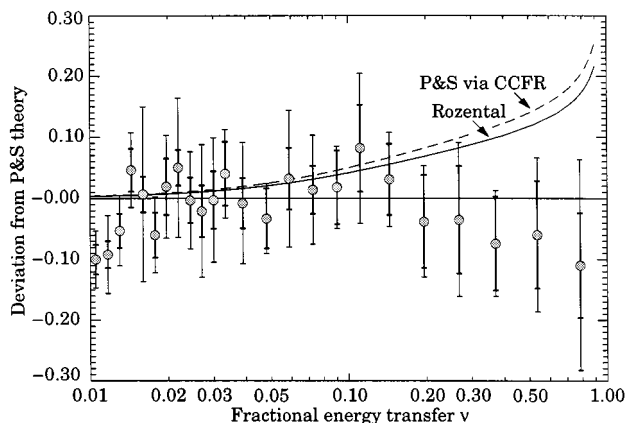


FIG. 6. RD 34 measurements of energy losses by 150 GeV muons in iron [56], shown as fractional deviations from the present calculation, including bremsstrahlung via Kelner et al. [14]. Heavy error bars indicate statistical errors only, while the light bars include systematic errors combined in quadrature. Deviations of alternate models from our calculations are shown by the solid line (Rozenal’s formula [57]) and the dashed line (the CCFR collaboration’s revision of the Petrukhin and Shestakov cross section [43]).

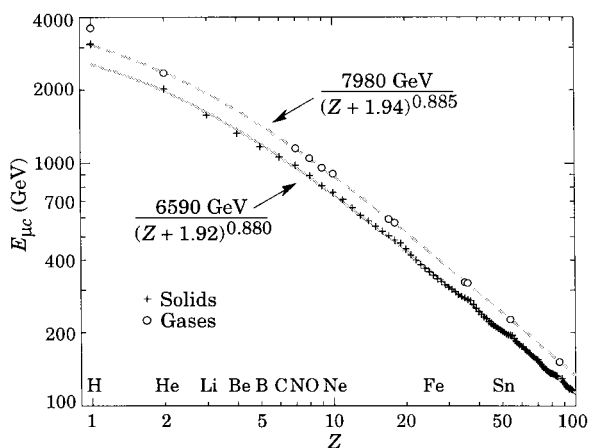


FIG. 7. Muon critical energy for the chemical elements. As discussed in the text, the fitted functions shown in the figure cannot be exact and are for guidance only.

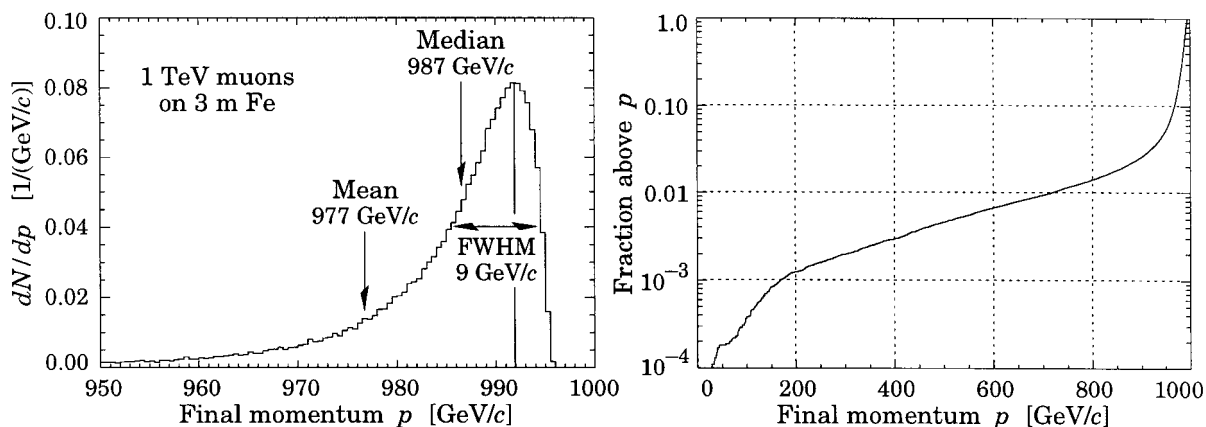


FIG. 8. The momentum distribution of 1 TeV/c muons after traversing 3 m of iron, as obtained with the MARS14 Monte Carlo code [59]. The comparative rarity of very low final momenta follows from the approach of the cross sections to zero as $\nu \rightarrow 0$.

of electronic and radiative losses comes at a higher energy for gases than for solids and liquids because of the smaller density-effect correction for gases. Empirical functions have been fitted to these data for gases and for solids/liquids, in both cases excluding hydrogen from the fits. Since $E_{\mu c}$ depends upon ionization potentials and density-effect parameters as well as Z , the fits cannot be exact. Potassium, rubidium, and cesium are 3.6%, 3.2%, and 3.4% high, respectively, while beryllium is 3.8% low. Most of the other solids and liquids fall within 2.5% of the fitted function. Among gases the worst fit is for neon (1.9% high).

4.6. Fluctuations in Radiative Energy Loss

The radiative cross sections at several energies are shown in Fig. 4. The bremsstrahlung cross section varies roughly as $1/\nu$ over most of the range (where ν is the fraction of the muon’s energy transferred in a collision), while for pair production the distribution varies as ν^{-3} to ν^{-2} (see also [58]). “Hard” losses are therefore more probable in bremsstrahlung, and in fact energy losses due to pair production may very nearly be treated as continuous. The photonuclear cross section has almost the same shape as the bremsstrahlung cross section at high ν , but it is about an order of magnitude lower.

An example illustrating the fluctuations is shown in Fig. 8. The distribution of final muon momenta was obtained by following 10^5 1 TeV/c muons through 3 m (2360 g/cm^2) of iron, using the MARS14 Monte Carlo code [59]. Our result is in nearly exact agreement with results obtained earlier with TRAMU [58]. The most probable loss is 8 GeV, or $3.4 \text{ MeV g}^{-1} \text{ cm}^2$. Our tables list a stopping power in iron as $9.82 \text{ MeV g}^{-1} \text{ cm}^2$ for a 1 TeV muon, so that the mean loss should be 23 GeV, for a final energy (\approx momentum $\times c$) of 977 GeV, far below the peak. This is also the mean calculated from the simulated output.

TABLE 5
Index of Tables for Selected Chemical Elements

Element	Symbol	Z	A	State	ρ [g/cm ³]	$\langle -dE/dx \rangle_{\min}$ [MeV cm ² /g]	$E_{\mu c}$ [GeV]	$\langle -dE/dx \rangle$ and range	b	Notes
Hydrogen gas	H	1	1.00794	D	8.375×10^{-5}	4.103	3611.	I-1	VI-1	
Liquid hydrogen	H	1	1.00794	L	7.080×10^{-2}	4.034	3102.	I-2	VI-1	1
Helium gas	He	2	4.002602	G	1.663×10^{-4}	1.937	2351.	I-3	VI-2	
Liquid helium	He	2	4.002602	L	0.125	1.936	2020.	I-4	VI-2	2
Lithium	Li	3	6.941	S	0.534	1.639	1578.	I-5	VI-3	
Beryllium	Be	4	9.012182	S	1.848	1.595	1328.	I-6	VI-4	
Boron	B	5	10.811	S	2.370	1.623	1169.	I-7	VI-5	
Carbon (compact)	C	6	12.0107	S	2.265	1.745	1056.	I-8	VI-6	
Carbon (graphite)	C	6	12.0107	S	1.700	1.753	1065.	I-9	VI-6	
Nitrogen gas	N	7	14.00674	D	1.165×10^{-3}	1.825	1153.	I-10	VI-7	
Liquid nitrogen	N	7	14.00674	L	0.807	1.813	982.	I-11	VI-7	2
Oxygen gas	O	8	15.9994	D	1.332×10^{-3}	1.801	1050.	I-12	VI-8	
Liquid oxygen	O	8	15.9994	L	1.141	1.788	890.	I-13	VI-8	2
Fluorine gas	F	9	18.9984032	D	1.580×10^{-3}	1.676	959.	I-14	VI-9	
Liquid fluorine	F	9	18.9984032	L	1.507	1.634	810.	I-15	VI-9	2
Neon gas	Ne	10	20.1797	G	8.385×10^{-4}	1.724	906.	I-16	VI-10	
Liquid neon	Ne	10	20.1797	L	1.204	1.695	759.	I-17	VI-10	2
Sodium	Na	11	22.989770	S	0.971	1.639	711.	I-18	VI-11	
Magnesium	Mg	12	24.3050	S	1.740	1.674	658.	I-19	VI-12	
Aluminum	Al	13	26.981538	S	2.699	1.615	612.	I-20	VI-13	
Silicon	Si	14	28.0855	S	2.329	1.664	581.	I-21	VI-14	1
Phosphorus	P	15	30.973761	S	2.200	1.613	551.	I-22	VI-15	
Sulfur	S	16	32.066	S	2.000	1.652	526.	I-23	VI-16	
Chlorine gas	Cl	17	35.4527	D	2.995×10^{-3}	1.630	591.	I-24	VI-17	
Liquid chlorine	Cl	17	35.4527	L	1.574	1.608	504.	I-25	VI-17	2
Argon gas	Ar	18	39.948	G	1.662×10^{-3}	1.519	571.	I-26	VI-18	
Liquid argon	Ar	18	39.948	L	1.396	1.508	483.	I-27	VI-18	2
Potassium	K	19	39.0983	S	0.862	1.623	470.	I-28	VI-19	
Calcium	Ca	20	40.078	S	1.550	1.655	445.	I-29	VI-20	
Scandium	Sc	21	44.955910	S	2.989	1.522	420.	I-30	VI-21	
Titanium	Ti	22	47.867	S	4.540	1.477	401.	I-31	VI-22	
Vanadium	V	23	50.9415	S	6.110	1.436	383.	I-32	VI-23	
Chromium	Cr	24	51.9961	S	7.180	1.456	369.	I-33	VI-24	
Manganese	Mn	25	54.938049	S	7.440	1.428	357.	I-34	VI-25	
Iron	Fe	26	55.845	S	7.874	1.451	345.	I-35	VI-26	
Cobalt	Co	27	58.933200	S	8.900	1.419	334.	I-36	VI-27	
Nickel	Ni	28	58.6934	S	8.902	1.468	324.	I-37	VI-28	
Copper	Cu	29	63.546	S	8.960	1.403	315.	I-38	VI-29	
Zinc	Zn	30	65.39	S	7.133	1.411	308.	I-39	VI-30	
Gallium	Ga	31	69.723	S	5.904	1.379	302.	I-40	VI-31	
Germanium	Ge	32	72.61	S	5.323	1.370	295.	I-41	VI-32	
Arsenic	As	33	74.92160	S	5.730	1.370	287.	I-42	VI-33	
Selenium	Se	34	78.96	S	4.500	1.343	282.	I-43	VI-34	
Bromine	Br	35	79.904	L	3.103	1.385	278.	I-44	VI-35	2
Krypton gas	Kr	36	83.80	G	3.478×10^{-3}	1.357	321.	I-45	VI-36	

Note. Physical states are indicated by “G” for gas, “D” for diatomic gas, “L” for liquid, and “S” for solid. Gases are evaluated at one atmosphere and 20°C. The corresponding cryogenic liquids are evaluated at their boiling points at one atmosphere, and carbon is evaluated at several typical densities. Atomic weights are given to their experimental significance. The densities here and the density effect parameters in Table I are as given by Sternheimer, Berger, and Seltzer [5], except for the cases where a number is shown in the “Notes” column to indicate the following: (1) Density effect parameters adjusted to this density using Eq. (A.8). (2) Density effect parameters calculated via the Sternheimer–Peierls algorithm discussed in Appendix A.

TABLE 5—Continued

Element	Symbol	Z	A	State	ρ [g/cm ³]	$(-dE/dx)_{\min}$ [MeV cm ² /g]	$E_{\mu c}$ [GeV]	$(-dE/dx)$ and range	b	Notes
Liquid krypton	Kr	36	83.80	L	2.418	1.357	274.	I-46	VI-36	2
Rubidium	Rb	37	85.4678	S	1.532	1.356	271.	I-47	VI-37	
Strontium	Sr	38	87.62	S	2.540	1.353	262.	I-48	VI-38	
Zirconium	Zr	40	91.224	S	6.506	1.349	244.	I-49	VI-39	
Niobium	Nb	41	92.90638	S	8.570	1.343	237.	I-50	VI-40	
Molybdenum	Mo	42	95.94	S	10.220	1.330	232.	I-51	VI-41	
Palladium	Pd	46	106.42	S	12.020	1.289	214.	I-52	VI-42	
Silver	Ag	47	107.8682	S	10.500	1.299	211.	I-53	VI-43	
Cadmium	Cd	48	112.411	S	8.650	1.277	208.	I-54	VI-44	
Indium	In	49	114.818	S	7.310	1.278	206.	I-55	VI-45	
Tin	Sn	50	118.710	S	7.310	1.263	202.	I-56	VI-46	
Antimony	Sb	51	121.760	S	6.691	1.259	200.	I-57	VI-47	
Iodine	I	53	126.90447	S	4.930	1.263	195.	I-58	VI-48	
Xenon gas	Xe	54	131.29	G	5.485×10^{-3}	1.255	226.	I-59	VI-49	
Liquid xenon	Xe	54	131.29	L	2.953	1.255	195.	I-60	VI-49	2
Cesium	Cs	55	132.90545	S	1.873	1.254	195.	I-61	VI-50	
Barium	Ba	56	137.327	S	3.500	1.231	189.	I-62	VI-51	
Cerium	Ce	58	140.116	S	6.657	1.234	180.	I-63	VI-52	
Dysprosium	Dy	66	162.50	S	8.550	1.175	161.	I-64	VI-53	
Tantalum	Ta	73	180.9479	S	16.654	1.149	145.	I-65	VI-54	
Tungsten	W	74	183.84	S	19.300	1.145	143.	I-66	VI-55	
Platinum	Pt	78	195.078	S	21.450	1.128	137.	I-67	VI-56	
Gold	Au	79	196.96655	S	19.320	1.134	136.	I-68	VI-57	
Mercury	Hg	80	200.59	L	13.546	1.130	136.	I-69	VI-58	
Lead	Pb	82	207.2	S	11.350	1.122	134.	I-70	VI-59	
Bismuth	Bi	83	208.98038	S	9.747	1.128	133.	I-71	VI-60	
Thorium	Th	90	232.0381	S	11.720	1.098	124.	I-72	VI-61	
Uranium	U	92	238.0289	S	18.950	1.081	120.	I-73	VI-62	
Plutonium	Pu	94	244.064197	S	19.840	1.071	117.	I-74	VI-63	

The full width at half maximum is 9 GeV/c, or 0.9%. The median is 987 GeV/c. 10% of the muons lost more than 3.2% of their energy and 2.6% lost more than 10% of their energy. Three out of the 10^5 candidates stopped in the iron, presumably because of very inelastic photonuclear interactions.

The classic case of the propagation of very high-energy muons in “standard rock” is discussed in [60] and references therein. Of special interest is Fig. 3 of that paper, showing the survival probabilities as a function of depth for muons from 1 to 10^6 TeV. The effects of the “radiative tail” are enormous; at 10^6 TeV only about 15% of the muons reach the CSDA range. At 10 TeV about half of them do, giving some indication of the usefulness of our CSDA ranges.

Treatment of radiative loss fluctuations in local energy deposit, range, or direction is beyond the scope of this paper. It is usually handled by Monte Carlo methods [58, 60, 61], although moment expansions are sometimes used when likelihoods need to be assigned to individual events. Electronic-loss straggling of high energy muons is described using a modified Vavilov distribution in [62].

5. TABULATED DATA

The contents of the main tables are shown in Tables 5–9. In this section we discuss the rationale in the selection of the elements, simple compounds, polymers, mixtures, and biological materials for which tables of muon range-energy loss and radiative loss parameters are provided.

All “common” elements were selected. This included all elements with $Z \leq 38$ (strontium), most elements through $Z = 58$ (cerium), and the more common heavy elements through $Z = 94$ (plutonium). Dysprosium ($Z = 66$) was included to avoid a large gap in Z between cerium and tantalum ($Z = 73$). The list is given in Table 5.

Cryogenic liquid forms of most of the elemental room-temperature gases (radon is the exception) are fairly common in laboratories, and hence were included as well. Because of differences in the density-effect corrections, ionization energy loss differs between liquid and gaseous forms. Radiative losses are not affected by density, but the muon critical energy, where the electronic and radiative losses are the same, can

TABLE 6
Index of Tables for Selected Simple Compounds

Compound or mixture	(Z/A)	State	ρ [g/cm ³]	$(-dE/dx)_{\min}$ [MeV cm ² /g]	$E_{\mu c}$ [GeV]	$(-dE/dx)$ and range	<i>b</i>	Notes
Acetone (CH ₃ CHCH ₃)	0.55097	L	0.790	2.003	1160.	II-1	VII-1	
Acetylene (C ₂ H ₂)	0.53768	G	1.097 × 10 ⁻³	2.025	1400.	II-2	VII-2	
Aluminum oxide (Al ₂ O ₃)	0.49038	S	3.970	1.647	705.	II-3	VII-3	
Barium fluoride (BaF ₂)	0.42207	S	4.890	1.303	227.	II-4	VII-4	
Beryllium oxide (BeO)	0.47979	S	3.010	1.665	975.	II-5	VII-5	
Bismuth germanate (BGO, Bi ₄ (GeO ₄) ₃)	0.42065	S	7.130	1.251	176.	II-6	VII-6	
Butane (C ₄ H ₁₀)	0.59497	G	2.493 × 10 ⁻³	2.278	1557.	II-7	VII-7	
Calcium carbonate (CaCO ₃)	0.49955	S	2.800	1.686	630.	II-8	VII-8	
Calcium fluoride (CaF ₂)	0.49670	S	3.180	1.655	564.	II-9	VII-9	
Calcium oxide (CaO)	0.49929	S	3.300	1.650	506.	II-10	VII-10	
Carbon dioxide (CO ₂)	0.49989	G	1.842 × 10 ⁻³	1.819	1094.	II-11	VII-11	
Solid carbon dioxide (dry ice)	0.49989	S	1.563	1.787	927.	II-12	VII-11	2
Cesium iodide (CsI)	0.41569	S	4.510	1.243	193.	II-13	VII-12	
Diethyl ether ((CH ₃ CH ₂) ₂ O)	0.56663	L	0.714	2.072	1220.	II-14	VII-13	
Ethane (C ₂ H ₆)	0.59861	G	1.253 × 10 ⁻³	2.304	1603.	II-15	VII-14	
Ethanol (C ₂ H ₅ OH)	0.56437	L	0.789	2.054	1178.	II-16	VII-15	
Lithium fluoride (LiF)	0.46262	S	2.635	1.614	903.	II-17	VII-16	
Lithium iodide (LiI)	0.41939	S	3.494	1.272	207.	II-18	VII-17	
Methane (CH ₄)	0.62334	G	6.672 × 10 ⁻⁴	2.417	1715.	II-19	VII-18	
Octane (C ₈ H ₁₈)	0.57778	L	0.703	2.123	1312.	II-20	VII-19	
Paraffin (CH ₃ (CH ₂) _{n≈23} CH ₃)	0.57275	S	0.930	2.088	1287.	II-21	VII-20	
Plutonium dioxide (PuO ₂)	0.40583	S	11.460	1.158	136.	II-22	VII-21	
Liquid propane (C ₃ H ₈)	0.58962	L	0.493	2.191	1360.	II-23	VII-22	1
Silicon dioxide (fused quartz, SiO ₂)	0.49930	S	2.200	1.699	708.	II-24	VII-23	1
Sodium iodide (NaI)	0.42697	S	3.667	1.305	223.	II-25	VII-24	
Toluene (C ₆ H ₅ CH ₃)	0.54265	L	0.867	1.972	1203.	II-26	VII-25	
Trichloroethylene (C ₂ HCl ₃)	0.48710	L	1.460	1.656	568.	II-27	VII-26	
Water (liquid) (H ₂ O)	0.55509	L	1.000	1.992	1032.	II-28	VII-27	
Water (vapor) (H ₂ O)	0.55509	G	7.562 × 10 ⁻⁴	2.052	1231.	II-29	VII-27	

Note. Physical states are indicated by “G” for gas, “D” for diatomic gas, “L” for liquid, and “S” for solid. Gases are evaluated at one atmosphere and 20°C. The densities here and the density effect parameters in Table II are as given by Sternheimer et al. [5], except for the cases where a number is shown in the “Notes” column to indicate the following: (1) Density effect parameters adjusted to this density using Eq. (A.8). Ref. 5 lists 2.32 g/cm³ for SiO₂, which may be the density of cristobalite. The density of crystalline quartz is about 2.65 g/cm³, and the density of fused quartz is typically 2.20 g/cm³. (2) Density effect parameters calculated via the Sternheimer-Peierls algorithm discussed in Appendix A.

be quite different. We have excluded gaseous bromine (boiling point 58.8°C), although it is tabulated by Sternheimer et al. [5]. For carbon, two forms with different densities appear. In all, 74 range/energy-loss tables are given for 63 elements.

We should not overemphasize these differences: Related materials have similar stopping-power properties when these are listed in MeV cm²/g (as we do) rather than in MeV/cm. Liquid and gaseous xenon are not dissimilar in spite of a density ratio of 540. Plutonium is more than twice as dense as bismuth, but their stopping powers differ by only 5% at minimum ionization. The stopping powers of hydrocarbons are quite similar, as are those of many polymers and biological materials.

Atomic weights are given to the available significance. This varies with element, since the isotopic composition of samples from different sources varies. In general the atomic weights of elements with only one isotope are known to great precision [63].

The same “commonness” criterion was applied to the selection of the simple compounds listed in Table 6, with some qualifications: We limited ourselves to the compounds listed by Sternheimer et al. [5], which meant that certain common compounds such as NaCl were not available. Common inorganic scintillators (BaF₂, BGO, CsI, LiF, LiI, NaI) are present. Materials such as trichloroethylene are included because of their role in important physics experiments. The list contains perhaps more hydrocarbons than necessary, in

TABLE 7
Index of Tables for Selected High Polymers

Compound or mixture	$\langle Z/A \rangle$	ρ [g/cm ³]	$\langle -dE/dx \rangle_{\min}$ [MeV cm ² /g]	$E_{\mu c}$ [GeV]	$\langle -dE/dx \rangle$ and range	b	Notes
Bakelite [C ₄₃ H ₃₈ O ₇] _n	0.52792	1.250	1.889	1110.	III-1	VIII-1	
Nylon (type 6, 6/6) [C ₁₂ H ₂₂ O ₂ N ₂] _n	0.54790	1.180	1.973	1156.	III-2	VIII-2	1
Polycarbonate [OC ₆ H ₄ C(CH ₃) ₂ C ₆ H ₄ OCO] _n	0.52697	1.200	1.886	1104.	III-3	VIII-3	
Polyethylene [C ₂ H ₄] _n	0.57034	0.890	2.079	1282.	III-4	VIII-4	1
Polymethylmethacrylate (acrylic)	0.53937	1.190	1.929	1107.	III-5	VIII-5	
Polystyrene [C ₆ H ₅ CHCH ₂] _n	0.53768	1.060	1.936	1183.	III-6	VIII-6	
Polytetrafluoroethylene (Teflon) [C ₂ F ₄] _n	0.47992	2.200	1.671	853.	III-7	VIII-7	
Polyvinylchloride (PVC) [CH ₂ CHCl] _n	0.51201	1.300	1.779	696.	III-8	VIII-8	
Polyvinyltoluene [2-CH ₃ C ₆ H ₄ CHCH ₂] _n	0.54141	1.032	1.956	1194.	III-9	VIII-9	

Note. The densities here and the density effect parameters in Table III are as given by Sternheimer et al. [5]; actual densities of polymers will vary. The number 1 in the Notes column indicates that the density-effect parameters have been adjusted to the density shown, using Eq. (A.8). Composition not explained may be found in Seltzer and Berger [26] or in the file `properties.dat` at <http://pdg.lbl.gov/AtomicNuclearProperties>. (1) Density-effect parameters adjusted to this density using Eq. (A.8).

TABLE 8
Index of Tables for Selected Mixtures

Compound or mixture	$\langle Z/A \rangle$	State	ρ [g/cm ³]	$\langle -dE/dx \rangle_{\min}$ [MeV cm ² /g]	$E_{\mu c}$ [GeV]	$\langle -dE/dx \rangle$ and range	b
Air (dry, 1 atm)	0.49919	G	1.205×10^{-3}	1.815	1114.	IV-1	IX-1
Concrete	0.50274	S	2.300	1.711	700.	IV-2	IX-2
Lead glass	0.42101	S	6.220	1.255	175.	IV-3	IX-3
Photographic emulsion	0.43663	S	6.470	1.313	235.	IV-4	IX-4
Plate glass	0.49731	S	2.400	1.684	670.	IV-5	IX-5
Standard rock	0.50000	S	2.650	1.688	693.	IV-6	IX-6

Note. Physical states are indicated by “G” for gas and “S” for solid. Gases are evaluated at one atmosphere and 20°C. Densities are those given by Sternheimer et al. [5]. Composition may be found in Seltzer and Berger [26] or in the file `properties.dat` at <http://pdg.lbl.gov/AtomicNuclearProperties>.

TABLE 9
Index of Tables for Selected Biological Materials

Biological material or phantom	$\langle Z/A \rangle$	State	ρ [g/cm ³]	$\langle -dE/dx \rangle_{\min}$ [MeV cm ² /g]	$E_{\mu c}$ [GeV]	$\langle -dE/dx \rangle$ and range	b
A-150 tissue-equivalent plastic	0.54903	S	1.127	1.978	1158.	V-1	X-1
Adipose tissue (ICRP)	0.55947	S	0.920	2.029	1183.	V-2	X-2
Blood (ICRP)	0.54995	L	1.060	1.971	1032.	V-3	X-3
Cortical bone (ICRP)	0.52130	S	1.850	1.803	748.	V-4	X-4
C-552 air-equivalent plastic	0.49969	S	1.760	1.760	953.	V-5	X-5
Eye lens (ICRP)	0.54977	S	1.100	1.971	1057.	V-6	X-6
MS20 tissue substitute	0.53886	S	1.000	1.934	1056.	V-7	X-7
Skeletal muscle (ICRP)	0.54938	S	1.040	1.970	1032.	V-8	X-8
Soft tissue (ICRP)	0.55121	S	1.000	1.982	1063.	V-9	X-9

Note. Physical states are indicated by “L” for liquid and “S” for solid. Densities are those given by Sternheimer et al. [5]. Composition may be found in Seltzer and Berger [26] or in the file `properties.dat` at <http://pdg.lbl.gov/AtomicNuclearProperties>.

part to show the change of stopping-power behavior as the H/C ratio changes (note the difference between acetylene and ethane). Liquid water and steam are both listed. Dry ice was included with some difficulty.

Polymers are listed in Table 7. Their energy loss behavior is quite similar except in the case of Teflon, which contains no hydrogen. “Thin film” polymers (Mylar, Kapton) were omitted. Polymers used for plastic scintillators (acrylic, polystyrene, polyvinyltoluene) are included. In some cases the name, like acrylic or polycarbonate, describes a family of polymers. The chemistry given is typical, and no great variation is to be expected except perhaps for “Bakelite,” which is not very well characterized. Where space permits, the formula is given in such a way as to convey as much structural information as possible.

Mixtures of interest are given in Table 8. Muon energy loss in air is of great current interest, given atmospheric neutrino observations. Photographic emulsion is of more historic interest. Except for dry air (and, by definition, standard rock) none of the materials is particularly well characterized. The somewhat arbitrary concrete recipe is taken from *The Reactor Handbook* [64] and may be found, along with the other compositions, in [26].

For at least two generations, the depth of underground muon experiments has been reduced to depth in “standard rock.” This is by definition the overburden of the Cayuga Rock Salt Mine near Ithaca, New York, where K. Greisen and collaborators made seminal observations of muons at substantial depths [1]. Reference [1] says only “Most of the ground consists of shales of various types, with average density 2.65 g/cm² and average atomic number 11.” Menon and Murthy later extended the definition: $\langle Z^2/A \rangle = 5.5$, $\langle Z/A \rangle = 0.5$, and $\rho = 2.65$ g/cm² [65]. It was thus not quite-sodium. Lohmann et al. [4] further assumed the mean excitation energy and density effect parameters were those of calcium carbonate, with no adjustments for the slight density difference. We use their definition for this most important material.

Sternheimer et al. [5] list 14 biological materials and “phantoms,” mixtures which have nearly identical responses to radiation as the biological materials they replace. Omitted materials can be approximated by those on the list: Brain (ICRP), lung (ICRP), skin (ICRP), testes (ICRP), soft tissue (ICRU 4-component), and striated muscle (ICRU) are quite similar to soft tissue (ICRP), as are several included materials such as eye lens (ICRP) and skeletal muscle (ICRP). Compact bone (ICRU) is similar to cortical bone (ICRP).

APPENDIX A: STOPPING POWER AND DENSITY-EFFECT PARAMETERS FOR COMPOUNDS AND MIXTURES

For most of the materials for which tables are given in this report, the relevant effective excitation energy and density-effect parameters have already been tabulated and should be used. This section concerns how to deal with an untabulated compound or mixture.

It is usual to think of a compound or mixture as made up of thin layers of the pure elements (or, better, constituent compounds for which tabulated data are available) in the right proportion (Bragg additivity [66]). Let n_j be the number of the j th kind of atom in a compound (it need not be an integer for a mixture), and w_j its weight fraction

$$w_j = n_j A_j / \sum_k n_k A_k. \quad (\text{A.1})$$

Then

$$\left\langle \frac{dE}{dx} \right\rangle = \sum_j w_j \left. \frac{dE}{dx} \right|_j. \quad (\text{A.2})$$

When the Bethe–Bloch equation is inserted and the radiative terms added, the Z -dependent terms can be sorted out to find that the mixture or compound is equivalent to a single material with

$$\begin{aligned} \left\langle \frac{Z}{A} \right\rangle &= \sum_j w_j \frac{Z_j}{A_j} = \sum_j n_j Z_j / \sum_j n_j A_j \\ \ln \langle I \rangle &= \sum_j w_j (Z_j/A_j) \ln I_j / \sum_j w_j (Z_j/A_j) \\ &= \sum_j n_j Z_j \ln I_j / \sum_j n_j Z_j \\ \langle b(E) \rangle &= \sum_j w_j b_j(E). \end{aligned} \quad (\text{A.3})$$

There are pitfalls in actually using Eq. (A.3) to calculate $\langle I \rangle$. Since the electrons in a compound are more tightly bound than in the constituent elements, the effective I_j are in general higher than those of the constituent elements. Exceptions are provided by diatomic gases and by metals in metallic alloys or compounds. Berger and Seltzer discuss ways to extend the Bragg additivity rule in lieu of a detailed calculation [26]:

(a) For a select list of materials (carbon and some common gases), they propose alternate mean excitation energies in their Table 5.1 (or Table 6 in [26]).

(b) For other elements, the excitation energies are multiplied by 1.13 before calculation of the mean (the “13% rule”). Although it is not said, it would seem sensible to apply this rule in the case of a tightly bound material such as CsI and not to apply it in the case of a metallic compound like Nb₃Sn.

(c) Both are superseded by experimental numbers when available, as in the case of SiO₂.

Bragg additivity has little meaning in calculating the density-effect correction. If the material of interest is not available in the tables of [5], then the algorithm given by Sternheimer and Peierls [6] should be used. Their recipe is given more succinctly in the EGS4 manual [28], and the following algorithm is adopted from that version for the parameterization of Section 3.4.

- (a) I is obtained as described above.
 (b) k is always taken as 3.00.
 (c) $\bar{C} = 2 \ln(I/\hbar\omega_p) + 1$, with the plasma energy $\hbar\omega_p$ obtained using the expression from Table 1.
 (d) For solids and liquids,

$$x_1 = \begin{cases} 2.0 & \text{if } I < 100 \text{ eV, and} \\ & x_0 = \begin{cases} 0.2 & \text{if } \bar{C} < 3.681 \\ 0.326\bar{C} - 1.0 & \text{otherwise} \end{cases} \\ 3.0 & \text{if } I \geq 100 \text{ eV, and} \\ & x_0 = \begin{cases} 0.2 & \text{if } \bar{C} < 5.215 \\ 0.326\bar{C} - 1.5 & \text{otherwise.} \end{cases} \end{cases} \quad (\text{A.4})$$

- (e) In the case of gases,

$$x_0 = \begin{cases} 1.6 \text{ and } x_1 = 4.0 & \text{if } \bar{C} < 10.0 \\ 1.7 \text{ and } x_1 = 4.0 & \text{if } 10.0 \leq \bar{C} < 10.5 \\ 1.8 \text{ and } x_1 = 4.0 & \text{if } 10.5 \leq \bar{C} < 11.0 \\ 1.9 \text{ and } x_1 = 4.0 & \text{if } 11.0 \leq \bar{C} < 11.5 \\ 2.0 \text{ and } x_1 = 4.0 & \text{if } 11.5 \leq \bar{C} < 12.25 \\ 2.0 \text{ and } x_1 = 5.0 & \text{if } 12.25 \leq \bar{C} < 13.804 \\ 0.326\bar{C} - 1.5 & \\ \text{and } x_1 = 5.0 & \text{if } \bar{C} \geq 13.804. \end{cases} \quad (\text{A.5})$$

- (f)

$$a = \frac{\bar{C} - 2(\ln 10)x_0}{(x_1 - x_0)^3}. \quad (\text{A.6})$$

We have used this algorithm to calculate the density-effect coefficients for cryogenic liquids, which are not tabulated by Sternheimer et al. [5]. In this case, I for the gas was used.

One problem remains: Given the density-effect parameters, either from the literature [5] or from the algorithm given above, how does one modify them for the same material at a different density? This problem occurs for gases at different pressures, or for solid and liquids at different densities than those tabulated. In an early paper [6], Sternheimer noted that under quite general conditions

$$\delta_r(p) = \delta(p\sqrt{r}), \quad (\text{A.7})$$

where $r = \rho/\rho_0$, the ratio of desired to tabulated densities, and the subscript r indicates the quantity evaluated at the desired density. This implies [6] that

$$\begin{aligned} \bar{C}_r &= \bar{C} - \ln r, \\ x_{0r} &= x_0 - \frac{1}{2} \log_{10} r, \\ x_{1r} &= x_1 - \frac{1}{2} \log_{10} r. \end{aligned} \quad (\text{A.8})$$

It is easily shown by matching different regions in Eq. (11) that the parameters a and k are unchanged by the transformation.

This method was used to correct the parameters for several materials for which we prefer different densities, for example the density of fused silica. Liquid hydrogen is tabulated for the “bubble chamber density,” from which we scaled the parameters to the density of liquid hydrogen at its boiling point at a pressure of one atmosphere.

Both algorithms were checked by calculating $\langle -dE/dx \rangle$ several ways, taking advantage of the fact that [5] lists both gaseous and liquid helium, three densities of carbon, and both steam and liquid water. The comparisons are discussed at the end of Section 3.4.

APPENDIX B: DIRECT PAIR PRODUCTION FROM SCREENED NUCLEI

Nikishov’s analytic form for the cross section is given by [50]

$$\begin{aligned} \frac{d\sigma}{dv} \Big|_{\text{pair,nucl}} &= \frac{(2\alpha r_e Z)^2 (1-v)}{\pi v} \left[(f_1 + \theta f_3) \ln \left(\frac{2\varepsilon}{m_e} \right) \right. \\ &\quad \left. + \phi_2 + \theta \phi_4 + I \right], \end{aligned} \quad (\text{B.1})$$

where $\varepsilon = \nu E$ is the energy transferred to the e^+e^- pair, and $\theta = m_e^2/M^2$. The functions in the square brackets are given by

$$f_1 + \theta f_3 = \frac{44}{45z} - \frac{16}{45} - \frac{4}{9}\theta - \left(\frac{7}{9} + \frac{8}{45}z + \frac{7}{18}z\theta\right) \ln z + \left[\frac{16}{45}z + \frac{38}{45} - \frac{44}{45z} + \frac{4}{3(z+4)} + \left(\frac{7}{9}z - \frac{2}{9} + \frac{8}{3(z+4)}\right)\theta\right] B(z) \ln \frac{z_2}{z_1}, \quad (\text{B.2})$$

$$\phi_2 + \theta\phi_4 = \left(\frac{7}{36} + \frac{2}{45}z + \frac{7}{72}z\theta\right) \left(\ln^2 \frac{z_2}{z_1} + \pi^2 + 2 \ln^2 z\right) + \left(\frac{7}{18} + \frac{3}{20}z + \frac{7}{36}z\theta\right) \ln z + \frac{653}{270} - \frac{28}{9z} + \frac{2}{3}\theta + \left[-\frac{3}{10}z - \frac{92}{45} + \frac{52}{45z} - \left(\frac{2}{9} - \frac{7}{18}z\right)\theta\right] \times B(z) \ln \frac{z_2}{z_1} + B(z) \left[-\frac{8}{45}z - \frac{19}{45} - \frac{8}{45z} - \left(\frac{2}{9} + \frac{7}{18}z\right)\theta\right] \left[\text{Li}_2(y) + 2 \text{Li}_2\left(\frac{1}{z_2}\right) + \frac{3}{2} \ln^2 \frac{z_2}{z_1}\right] + \left(\frac{8}{z} + z\theta\right) \frac{B(z)}{3(z+4)} \times \left[6 \text{Li}_2\left(\frac{1}{z_2}\right) - \text{Li}_2(y) + \frac{1}{2} \ln^2 \frac{z_2}{z_1}\right], \quad (\text{B.3})$$

where

$$z = \frac{\nu^2}{\theta(1-\nu)}, \quad z_{1,2} = B(z) \mp \frac{1}{2},$$

$$B(z) = \sqrt{\frac{1}{4} + \frac{1}{z}}, \quad y = \frac{z_1 + z_2}{z_2^2}.$$

Li_2 is the dilogarithm function (Spence's integral evaluated for $n = 2$) [67], and

$$I = \left(\frac{7}{9} + \frac{8}{45}z + \frac{7}{18}z\theta\right) H - \left[\frac{16}{45}z + \frac{38}{45} + \frac{16}{45z} + \left(\frac{7}{9}z + \frac{4}{9}\right)\theta\right] B(z) J_+ + \left[-\frac{16}{45}z - \frac{14}{9} - \frac{8}{9w} + \frac{2}{45} \frac{z}{w} - \frac{4}{5} \frac{z}{w^2} + \frac{2z}{3(w+4)} - \left(\frac{7}{9}z + \frac{4}{9} \frac{z}{w}\right)\theta\right] B(w) I_+ + \left[\frac{32}{45} \frac{u}{w} - \frac{88}{45z} - \frac{16}{45w} + \frac{8}{5} \frac{z}{w^2} + \frac{8}{9} \frac{u}{w}\theta\right] B(u) \ln \frac{u_2}{u_1}$$

$$+ \left[\frac{68}{45} - \frac{16}{45z} + \frac{8}{3w} - \frac{2}{3} \frac{z}{w} - \frac{8}{9}\theta\right] B(z) \ln \frac{z_2}{z_1} + \frac{104}{45z} - \frac{8}{15w} - \frac{62}{27} - \left(\frac{8}{9w} + \frac{1}{45} \frac{z}{w} + \frac{4}{5} \frac{z}{w^2} + \frac{4}{9} \frac{z}{w}\theta\right) \ln z + \left(1 + \frac{1}{2}z\theta\right) \frac{1}{3w} \left(\ln^2 \frac{u_2}{u_1} - \ln^2 \frac{z_2}{z_1}\right) + \left(\frac{8}{z} + z\theta\right) \times \frac{B(z)}{3(z+4)} - [2J_+^{(2)} + \ln^2 z_2 - \ln^2 z_1], \quad (\text{B.4})$$

where

$$w = s\sqrt{z}, \quad s = \frac{2\sqrt{\gamma\gamma'}Z^{1/3}}{183\sqrt{e}} \approx \frac{\sqrt{\gamma\gamma'}Z^{1/3}}{151},$$

$$u = w + z, \quad \gamma = P_0/M, \quad \gamma' = P'_0/M \quad (\text{B.5})$$

($u_{1,2}$, $B(u)$ and $w_{1,2}$, $B(w)$ are the analogs of $z_{1,2}$, $B(z)$; i.e., $u_{1,2} = B(u) \mp \frac{1}{2}$, etc.),

$$H = \text{Li}_2\left(\frac{z}{u+4}\right) - \text{Li}_2\left(\frac{z+4}{u+4}\right) + \text{Li}_2\left(\frac{z}{z+4}\right) - 2 \text{Li}_2\left(\frac{u}{u+4}\right) + \text{Li}_2\left(\frac{4w}{u(z+4)}\right) + \text{Li}_2\left(\frac{4z}{u(w+4)}\right) - \text{Li}_2\left(\frac{4}{w+4}\right) + \frac{\pi^2}{6} + 2 \ln(z_1) \ln(z_2) - 4 \ln(u_1) \ln(u_2) - \ln^2 z + \ln^2(z+4) - \ln\left(1 + \frac{4}{w}\right) \ln(u+4) - \ln(4w) \ln(z+4) + \ln(16) \ln(u+4) - \ln^2(u+4) + 2 \ln^2 u + \ln(u) \ln\left(\frac{z+4}{4} \frac{w+4}{4w}\right) - \ln(z) \times \ln\left(\frac{z+4}{4} \frac{u}{w}\right), \quad J_+ = J_+^{(1)} + J_+^{(2)}, \quad (\text{B.6})$$

$$J_+^{(1)} = 2 \text{Li}_2\left(\frac{1}{z_2}\right) - \text{Li}_2(y) + \ln(z_1) \ln \frac{z_2}{z_1}, \quad y = \frac{z_1 + z_2}{z_2^2}, \quad (\text{B.7})$$

$$J_+^{(2)} = \text{Li}_2\left(\frac{u_1}{z_1}\right) - \text{Li}_2\left(\frac{u_2}{z_2}\right) + \text{Li}_2\left(\frac{z_1}{z_1 + u_2}\right) - \text{Li}_2\left(\frac{z_2}{z_2 + u_1}\right) + \ln\left(\frac{u_1}{z_1}\right) \ln\left(1 - \frac{u_1}{z_1}\right) - \ln\left(\frac{u_2}{z_2}\right) \times \ln\left(1 - \frac{u_2}{z_2}\right) + \ln\left(\frac{z_2}{z_1}\right) \ln[u(z_1 + u_2)], \quad (\text{B.8})$$

and, finally,

$$\begin{aligned}
 I_+ = & \operatorname{Li}_2\left(\frac{u_1}{w_1}\right) - \operatorname{Li}_2\left(\frac{u_2}{w_2}\right) - 2\operatorname{Li}_2\left(\frac{w_1}{w_2}\right) \\
 & + \operatorname{Li}_2\left(\frac{w_1}{w_1 + u_2}\right) - \operatorname{Li}_2\left(\frac{w_2}{w_2 + u_1}\right) + \frac{\pi^2}{3} \\
 & + \ln\left(\frac{w_2}{w_1}\right) \ln\left(\frac{w_1 + u_2}{w_2} \frac{u}{z}\right) + \ln\left(\frac{u_1}{w_1}\right) \\
 & \times \ln\left(1 - \frac{u_1}{w_1}\right) - \ln\left(\frac{u_2}{w_2}\right) \ln\left(1 - \frac{u_2}{w_2}\right). \quad (\text{B.9})
 \end{aligned}$$

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EXPLANATION OF TABLES⁶**TABLE I. Muon Energy Loss Rate and CSDA Range for Selected Elements**

The contents of Table I and other information are given in Table 5.

The header defines the element and state, and gives the parameters used to calculate the electronic stopping power:

Z Atomic number.

A Atomic weight.

ρ Density. Gas density is evaluated at 20°C.

I Mean excitation energy.

$a-\delta_0$ Sternheimer et al. density effect parameters, as introduced in Sect. 3.4 and Eq. (11).

The body of the table presents ionizing energy loss (Eq. (15)) and the components of radiative loss rate (see Eqs. (1) and (2), as well as CSDA range obtained by integrating the total (Eq. (3)), as a function of the muon's initial kinetic energy T . The spacing of the independent variable is fairly uniform on a logarithmic scale. The corresponding momentum p is also given. The table is interrupted to show the points at which minimum ionization and muon critical energy (Eq. (5)) occur.

A radiative loss field is left blank if the stopping power contribution is less than 0.0001.

TABLE II. Muon Energy Loss Rate and CSDA Range for Simple Compounds

The contents of Table II and other information are given in Table 6. The format is identical with Table I, except that $\langle Z/A \rangle$ (Eq. (A.3)) replaces Z and A .

TABLE III. Muon Energy Loss Rate and CSDA Range for High Polymers

The contents of Table III and other information are given in Table 7. The format is identical with Table II.

TABLE IV. Muon Energy Loss Rate and CSDA Range for Mixtures

The contents of Table IV and other information are given in Table 8. The format is identical with Table II.

TABLE V. Muon Energy Loss Rate and CSDA Range for Biological Materials

The contents of Table V and other information are given in Table 9. The format is identical with Table II.

TABLE VI. b Values for the Elements Listed in Table I

Interpolation in $\log E$ is used to generate the b values shown in Table I and for the ionizing loss calculations. The contents are listed in Table 5.

TABLE VII. b Values for the Simple Compounds Listed in Table II

Table VII has the same format as Table VI except that $\langle Z/A \rangle$ replaces Z and A . The contents are listed in Table 6

TABLE VIII. b Values for the High Polymers Listed in Table III

Table VIII has the same format as Table VII. The contents are listed in Table 7.

⁶ Computer-readable versions of these tables can be found at <http://pdg.lbl.gov/AtomicNuclearProperties>.

EXPLANATION OF TABLES continued

TABLE IX. *b* Values for the Mixtures Listed in Table IV

Table IX has the same format as Table VII. The contents are listed in Table 8.

TABLE X. *b* Values for the Biological Materials Listed in Table V

Table X has the same format as Table VII. The contents are listed in Table 9.

TABLE I-1. Muons in Hydrogen Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
1 (H)	1.00794	8.375×10^{-5}	19.2	0.14092	5.7273	1.8639	3.2718	9.5835	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	12.988				12.988	6.049×10^{-1}
20.0 MeV	6.802×10^1	10.089				10.089	1.135×10^0
30.0 MeV	8.509×10^1	7.783				7.783	2.280×10^0
40.0 MeV	1.003×10^2	6.621				6.621	3.682×10^0
80.0 MeV	1.527×10^2	4.927				4.927	1.091×10^1
100. MeV	1.764×10^2	4.621				4.621	1.512×10^1
140. MeV	2.218×10^2	4.314				4.314	2.412×10^1
200. MeV	2.868×10^2	4.148			0.000	4.148	3.836×10^1
282. MeV	3.733×10^2	4.103			0.000	4.103	<i>Minimum ionization</i>
300. MeV	3.917×10^2	4.104			0.000	4.105	6.266×10^1
400. MeV	4.945×10^2	4.141			0.000	4.141	8.693×10^1
800. MeV	8.995×10^2	4.373			0.000	4.373	1.809×10^2
1.00 GeV	1.101×10^3	4.474			0.001	4.475	2.261×10^2
1.40 GeV	1.502×10^3	4.642	0.000		0.001	4.643	3.138×10^2
2.00 GeV	2.103×10^3	4.832	0.000		0.001	4.833	4.403×10^2
3.00 GeV	3.104×10^3	5.056	0.000	0.000	0.002	5.059	6.422×10^2
4.00 GeV	4.104×10^3	5.218	0.001	0.000	0.002	5.221	8.367×10^2
8.00 GeV	8.105×10^3	5.606	0.001	0.001	0.005	5.614	1.572×10^3
10.0 GeV	1.011×10^4	5.711	0.002	0.002	0.006	5.720	1.925×10^3
14.0 GeV	1.411×10^4	5.841	0.003	0.003	0.008	5.855	2.615×10^3
20.0 GeV	2.011×10^4	5.955	0.005	0.006	0.011	5.976	3.629×10^3
30.0 GeV	3.011×10^4	6.063	0.008	0.010	0.015	6.097	5.284×10^3
40.0 GeV	4.011×10^4	6.132	0.012	0.015	0.020	6.179	6.913×10^3
80.0 GeV	8.011×10^4	6.285	0.028	0.038	0.038	6.389	1.327×10^4
100. GeV	1.001×10^5	6.331	0.037	0.050	0.047	6.466	1.638×10^4
140. GeV	1.401×10^5	6.401	0.055	0.076	0.066	6.598	2.250×10^4
200. GeV	2.001×10^5	6.473	0.085	0.118	0.093	6.770	3.148×10^4
300. GeV	3.001×10^5	6.556	0.137	0.191	0.139	7.023	4.597×10^4
400. GeV	4.001×10^5	6.614	0.191	0.268	0.185	7.258	5.998×10^4
800. GeV	8.001×10^5	6.756	0.423	0.592	0.373	8.144	1.119×10^5
1.00 TeV	1.000×10^6	6.802	0.544	0.761	0.468	8.576	1.359×10^5
1.40 TeV	1.400×10^6	6.873	0.791	1.101	0.663	9.429	1.803×10^5
2.00 TeV	2.000×10^6	6.948	1.175	1.627	0.961	10.711	2.400×10^5
3.00 TeV	3.000×10^6	7.035	1.827	2.504	1.474	12.840	3.252×10^5
3.61 TeV	3.611×10^6	7.075	2.234	3.049	1.792	14.151	<i>Muon critical energy</i>
4.00 TeV	4.000×10^6	7.098	2.496	3.399	1.996	14.989	3.972×10^5
8.00 TeV	8.000×10^6	7.252	5.240	7.012	4.180	23.684	6.078×10^5
10.0 TeV	1.000×10^7	7.302	6.642	8.837	5.308	28.089	6.852×10^5
14.0 TeV	1.400×10^7	7.379	9.452	12.466	7.642	36.940	8.090×10^5
20.0 TeV	2.000×10^7	7.463	13.734	17.952	11.236	50.385	9.476×10^5
30.0 TeV	3.000×10^7	7.559	20.884	27.062	17.498	73.003	1.112×10^6
40.0 TeV	4.000×10^7	7.628	28.113	36.210	23.940	95.890	1.231×10^6
80.0 TeV	8.000×10^7	7.799	57.248	72.833	51.135	189.015	1.523×10^6
100. TeV	1.000×10^8	7.855	71.920	91.170	65.290	236.236	1.617×10^6

TABLE I-2. Muons in Liquid Hydrogen

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
1 (H)	1.00794	7.080×10^{-2}	21.8	0.13483	5.6249	0.4400	1.8856	3.0977	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	12.812				12.812	6.138×10^{-1}
20.0 MeV	6.802×10^1	9.956				9.956	1.151×10^0
30.0 MeV	8.509×10^1	7.684				7.684	2.311×10^0
40.0 MeV	1.003×10^2	6.539				6.539	3.731×10^0
80.0 MeV	1.527×10^2	4.870				4.870	1.105×10^1
100. MeV	1.764×10^2	4.568				4.568	1.530×10^1
140. MeV	2.218×10^2	4.267				4.267	2.441×10^1
200. MeV	2.868×10^2	4.104			0.000	4.104	3.880×10^1
300. MeV	3.917×10^2	4.037			0.000	4.038	6.342×10^1
344. MeV	4.372×10^2	4.034			0.000	4.034	<i>Minimum ionization</i>
400. MeV	4.945×10^2	4.038			0.000	4.038	8.820×10^1
800. MeV	8.995×10^2	4.134			0.000	4.135	1.862×10^2
1.00 GeV	1.101×10^3	4.182			0.001	4.182	2.342×10^2
1.40 GeV	1.502×10^3	4.261	0.000		0.001	4.262	3.289×10^2
2.00 GeV	2.103×10^3	4.352	0.000		0.001	4.353	4.682×10^2
3.00 GeV	3.104×10^3	4.459	0.000	0.000	0.002	4.461	6.949×10^2
4.00 GeV	4.104×10^3	4.536	0.001	0.000	0.002	4.539	9.170×10^2
8.00 GeV	8.105×10^3	4.719	0.001	0.001	0.005	4.726	1.779×10^3
10.0 GeV	1.011×10^4	4.777	0.002	0.002	0.006	4.786	2.199×10^3
14.0 GeV	1.411×10^4	4.861	0.003	0.003	0.008	4.876	3.027×10^3
20.0 GeV	2.011×10^4	4.948	0.005	0.006	0.011	4.969	4.245×10^3
30.0 GeV	3.011×10^4	5.043	0.008	0.010	0.015	5.077	6.234×10^3
40.0 GeV	4.011×10^4	5.108	0.012	0.015	0.020	5.155	8.188×10^3
80.0 GeV	8.011×10^4	5.258	0.028	0.038	0.038	5.362	1.578×10^4
100. GeV	1.001×10^5	5.305	0.037	0.050	0.047	5.439	1.949×10^4
140. GeV	1.401×10^5	5.374	0.055	0.076	0.066	5.572	2.675×10^4
200. GeV	2.001×10^5	5.447	0.085	0.118	0.093	5.743	3.735×10^4
300. GeV	3.001×10^5	5.529	0.137	0.191	0.139	5.996	5.439×10^4
400. GeV	4.001×10^5	5.588	0.191	0.268	0.185	6.232	7.074×10^4
800. GeV	8.001×10^5	5.730	0.423	0.592	0.373	7.117	1.307×10^5
1.00 TeV	1.000×10^6	5.776	0.544	0.761	0.468	7.549	1.580×10^5
1.40 TeV	1.400×10^6	5.846	0.791	1.101	0.663	8.402	2.082×10^5
2.00 TeV	2.000×10^6	5.921	1.175	1.627	0.961	9.684	2.747×10^5
3.00 TeV	3.000×10^6	6.008	1.827	2.504	1.474	11.813	3.680×10^5
3.10 TeV	3.102×10^6	6.016	1.894	2.595	1.527	12.032	<i>Muon critical energy</i>
4.00 TeV	4.000×10^6	6.071	2.496	3.399	1.996	13.962	4.458×10^5
8.00 TeV	8.000×10^6	6.225	5.240	7.012	4.180	22.658	6.686×10^5
10.0 TeV	1.000×10^7	6.276	6.642	8.837	5.308	27.063	7.493×10^5
14.0 TeV	1.400×10^7	6.353	9.452	12.466	7.642	35.913	8.772×10^5
20.0 TeV	2.000×10^7	6.436	13.734	17.952	11.236	49.358	1.019×10^6
30.0 TeV	3.000×10^7	6.532	20.884	27.062	17.498	71.976	1.186×10^6
40.0 TeV	4.000×10^7	6.602	28.113	36.210	23.940	94.863	1.307×10^6
80.0 TeV	8.000×10^7	6.773	57.248	72.833	51.135	187.988	1.601×10^6
100. TeV	1.000×10^8	6.829	71.920	91.170	65.290	235.209	1.696×10^6

TABLE I-3. Muons in Helium Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
2 (He)	4.002602	1.663×10^{-4}	41.8	0.13443	5.8347	2.2017	3.6122	11.1393	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	5.998				5.998	1.317×10^0
20.0 MeV	6.802×10^1	4.673				4.673	2.464×10^0
30.0 MeV	8.509×10^1	3.616				3.616	4.931×10^0
40.0 MeV	1.003×10^2	3.082				3.083	7.946×10^0
80.0 MeV	1.527×10^2	2.305				2.305	2.344×10^1
100. MeV	1.764×10^2	2.165				2.165	3.241×10^1
140. MeV	2.218×10^2	2.026				2.026	5.160×10^1
200. MeV	2.868×10^2	1.954			0.000	1.954	8.187×10^1
267. MeV	3.577×10^2	1.937			0.000	1.937	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.939			0.000	1.939	1.334×10^2
400. MeV	4.945×10^2	1.961			0.000	1.961	1.847×10^2
800. MeV	8.995×10^2	2.081			0.000	2.082	3.826×10^2
1.00 GeV	1.101×10^3	2.133			0.001	2.134	4.774×10^2
1.40 GeV	1.502×10^3	2.218	0.000		0.001	2.219	6.611×10^2
2.00 GeV	2.103×10^3	2.314	0.000		0.001	2.315	9.255×10^2
3.00 GeV	3.104×10^3	2.427	0.000	0.000	0.002	2.429	1.347×10^3
4.00 GeV	4.104×10^3	2.508	0.000	0.000	0.002	2.511	1.751×10^3
8.00 GeV	8.105×10^3	2.705	0.001	0.001	0.004	2.712	3.277×10^3
10.0 GeV	1.011×10^4	2.768	0.002	0.002	0.005	2.776	4.005×10^3
14.0 GeV	1.411×10^4	2.862	0.002	0.003	0.007	2.874	5.420×10^3
20.0 GeV	2.011×10^4	2.954	0.004	0.004	0.010	2.972	7.470×10^3
30.0 GeV	3.011×10^4	3.033	0.006	0.008	0.014	3.062	1.078×10^4
40.0 GeV	4.011×10^4	3.077	0.009	0.012	0.019	3.117	1.401×10^4
80.0 GeV	8.011×10^4	3.163	0.021	0.029	0.036	3.250	2.656×10^4
100. GeV	1.001×10^5	3.188	0.028	0.039	0.045	3.299	3.266×10^4
140. GeV	1.401×10^5	3.223	0.042	0.058	0.062	3.386	4.463×10^4
200. GeV	2.001×10^5	3.260	0.063	0.090	0.088	3.501	6.205×10^4
300. GeV	3.001×10^5	3.302	0.101	0.144	0.132	3.679	8.990×10^4
400. GeV	4.001×10^5	3.331	0.140	0.201	0.175	3.848	1.165×10^5
800. GeV	8.001×10^5	3.403	0.306	0.443	0.354	4.506	2.124×10^5
1.00 TeV	1.000×10^6	3.426	0.392	0.569	0.445	4.832	2.553×10^5
1.40 TeV	1.400×10^6	3.461	0.566	0.821	0.632	5.481	3.329×10^5
2.00 TeV	2.000×10^6	3.499	0.836	1.210	0.916	6.461	4.337×10^5
2.35 TeV	2.352×10^6	3.517	0.993	1.437	1.086	7.034	<i>Muon critical energy</i>
3.00 TeV	3.000×10^6	3.543	1.289	1.861	1.404	8.097	5.717×10^5
4.00 TeV	4.000×10^6	3.575	1.751	2.525	1.902	9.753	6.840×10^5
8.00 TeV	8.000×10^6	3.652	3.634	5.207	3.979	16.472	9.963×10^5
10.0 TeV	1.000×10^7	3.678	4.589	6.563	5.050	19.880	1.107×10^6
14.0 TeV	1.400×10^7	3.717	6.497	9.260	7.260	26.734	1.280×10^6
20.0 TeV	2.000×10^7	3.758	9.390	13.338	10.660	37.147	1.469×10^6
30.0 TeV	3.000×10^7	3.807	14.206	20.113	16.578	54.704	1.690×10^6
40.0 TeV	4.000×10^7	3.842	19.055	26.918	22.660	72.476	1.848×10^6
80.0 TeV	8.000×10^7	3.928	38.527	54.160	48.256	144.871	2.231×10^6
100. TeV	1.000×10^8	3.956	48.300	67.800	61.550	181.606	2.354×10^6

TABLE I-4. Muons in Liquid Helium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
2 (He)	4.002602	0.125	41.8	0.65713	3.0000	0.4729	2.0000	4.5180	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	7.712				7.712	7.221 × 10 ⁻¹
14.0 MeV	5.616 × 10 ¹	6.000				6.000	1.316 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	4.674				4.674	2.463 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	3.616				3.616	4.930 × 10 ⁰
40.0 MeV	1.003 × 10 ²	3.083				3.083	7.944 × 10 ⁰
80.0 MeV	1.527 × 10 ²	2.305				2.305	2.343 × 10 ¹
100. MeV	1.764 × 10 ²	2.165				2.165	3.241 × 10 ¹
140. MeV	2.218 × 10 ²	2.026				2.026	5.160 × 10 ¹
200. MeV	2.868 × 10 ²	1.954			0.000	1.954	8.187 × 10 ¹
277. MeV	3.683 × 10 ²	1.936			0.000	1.936	<i>Minimum ionization</i>
300. MeV	3.917 × 10 ²	1.937			0.000	1.937	1.334 × 10 ²
400. MeV	4.945 × 10 ²	1.952			0.000	1.952	1.849 × 10 ²
800. MeV	8.995 × 10 ²	2.037			0.000	2.037	3.853 × 10 ²
1.00 GeV	1.101 × 10 ³	2.072			0.001	2.072	4.826 × 10 ²
1.40 GeV	1.502 × 10 ³	2.126	0.000		0.001	2.127	6.730 × 10 ²
2.00 GeV	2.103 × 10 ³	2.184	0.000		0.001	2.185	9.511 × 10 ²
3.00 GeV	3.104 × 10 ³	2.247	0.000	0.000	0.002	2.249	1.402 × 10 ³
4.00 GeV	4.104 × 10 ³	2.290	0.000	0.000	0.002	2.293	1.842 × 10 ³
8.00 GeV	8.105 × 10 ³	2.386	0.001	0.001	0.004	2.392	3.545 × 10 ³
10.0 GeV	1.011 × 10 ⁴	2.415	0.002	0.002	0.005	2.423	4.375 × 10 ³
14.0 GeV	1.411 × 10 ⁴	2.458	0.002	0.003	0.007	2.470	6.010 × 10 ³
20.0 GeV	2.011 × 10 ⁴	2.501	0.004	0.004	0.010	2.519	8.414 × 10 ³
30.0 GeV	3.011 × 10 ⁴	2.549	0.006	0.008	0.014	2.578	1.233 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	2.582	0.009	0.012	0.019	2.622	1.618 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	2.657	0.021	0.029	0.036	2.744	3.107 × 10 ⁴
100. GeV	1.001 × 10 ⁵	2.681	0.028	0.039	0.045	2.792	3.829 × 10 ⁴
140. GeV	1.401 × 10 ⁵	2.716	0.042	0.058	0.062	2.878	5.240 × 10 ⁴
200. GeV	2.001 × 10 ⁵	2.752	0.063	0.090	0.088	2.993	7.284 × 10 ⁴
300. GeV	3.001 × 10 ⁵	2.794	0.101	0.144	0.132	3.171	1.053 × 10 ⁵
400. GeV	4.001 × 10 ⁵	2.823	0.140	0.201	0.175	3.340	1.360 × 10 ⁵
800. GeV	8.001 × 10 ⁵	2.895	0.306	0.443	0.354	3.998	2.453 × 10 ⁵
1.00 TeV	1.000 × 10 ⁶	2.918	0.392	0.569	0.445	4.324	2.934 × 10 ⁵
1.40 TeV	1.400 × 10 ⁶	2.953	0.566	0.821	0.632	4.973	3.796 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	2.991	0.836	1.210	0.916	5.953	4.897 × 10 ⁵
2.02 TeV	2.020 × 10 ⁶	2.992	0.844	1.223	0.925	5.985	<i>Muon critical energy</i>
3.00 TeV	3.000 × 10 ⁶	3.035	1.289	1.861	1.404	7.589	6.382 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	3.067	1.751	2.525	1.902	9.245	7.574 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	3.144	3.634	5.207	3.979	15.964	1.083 × 10 ⁶
10.0 TeV	1.000 × 10 ⁷	3.170	4.589	6.563	5.050	19.372	1.196 × 10 ⁶
14.0 TeV	1.400 × 10 ⁷	3.209	6.497	9.260	7.260	26.226	1.373 × 10 ⁶
20.0 TeV	2.000 × 10 ⁷	3.250	9.390	13.338	10.660	36.639	1.566 × 10 ⁶
30.0 TeV	3.000 × 10 ⁷	3.299	14.206	20.113	16.578	54.196	1.789 × 10 ⁶
40.0 TeV	4.000 × 10 ⁷	3.334	19.055	26.918	22.660	71.968	1.949 × 10 ⁶
80.0 TeV	8.000 × 10 ⁷	3.420	38.527	54.160	48.256	144.363	2.334 × 10 ⁶
100. TeV	1.000 × 10 ⁸	3.448	48.300	67.800	61.550	181.099	2.457 × 10 ⁶

TABLE I-5. Muons in Lithium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
3 (Li)	6.941	0.534	40.0	0.95136	2.4993	0.1304	1.6397	3.1221	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	5.209				5.209	1.516×10^0
20.0 MeV	6.802×10^1	4.055				4.055	2.836×10^0
30.0 MeV	8.509×10^1	3.134				3.135	5.681×10^0
40.0 MeV	1.003×10^2	2.669				2.669	9.161×10^0
80.0 MeV	1.527×10^2	1.988				1.988	2.709×10^1
100. MeV	1.764×10^2	1.865				1.865	3.751×10^1
140. MeV	2.218×10^2	1.739				1.739	5.982×10^1
200. MeV	2.868×10^2	1.667				1.667	9.520×10^1
300. MeV	3.917×10^2	1.639			0.000	1.639	1.559×10^2
318. MeV	4.105×10^2	1.639			0.000	1.639	<i>Minimum ionization</i>
400. MeV	4.945×10^2	1.643			0.000	1.644	2.168×10^2
800. MeV	8.995×10^2	1.701			0.000	1.701	4.561×10^2
1.00 GeV	1.101×10^3	1.727			0.000	1.727	5.727×10^2
1.40 GeV	1.502×10^3	1.768	0.000		0.001	1.769	8.014×10^2
2.00 GeV	2.103×10^3	1.813	0.000		0.001	1.814	1.136×10^3
3.00 GeV	3.104×10^3	1.863	0.000	0.000	0.002	1.865	1.679×10^3
4.00 GeV	4.104×10^3	1.897	0.001	0.000	0.002	1.900	2.210×10^3
8.00 GeV	8.105×10^3	1.977	0.001	0.001	0.004	1.984	4.265×10^3
10.0 GeV	1.011×10^4	2.002	0.002	0.002	0.005	2.011	5.266×10^3
14.0 GeV	1.411×10^4	2.039	0.003	0.003	0.007	2.052	7.235×10^3
20.0 GeV	2.011×10^4	2.077	0.005	0.005	0.009	2.096	1.013×10^4
30.0 GeV	3.011×10^4	2.118	0.008	0.009	0.014	2.149	1.483×10^4
40.0 GeV	4.011×10^4	2.146	0.011	0.014	0.018	2.189	1.944×10^4
80.0 GeV	8.011×10^4	2.212	0.025	0.034	0.035	2.305	3.722×10^4
100. GeV	1.001×10^5	2.232	0.032	0.045	0.043	2.353	4.580×10^4
140. GeV	1.401×10^5	2.262	0.048	0.067	0.060	2.438	6.250×10^4
200. GeV	2.001×10^5	2.294	0.073	0.103	0.086	2.556	8.653×10^4
300. GeV	3.001×10^5	2.330	0.115	0.165	0.128	2.739	1.243×10^5
400. GeV	4.001×10^5	2.355	0.160	0.230	0.171	2.916	1.597×10^5
800. GeV	8.001×10^5	2.417	0.346	0.502	0.346	3.611	2.827×10^5
1.00 TeV	1.000×10^6	2.437	0.443	0.643	0.435	3.959	3.355×10^5
1.40 TeV	1.400×10^6	2.468	0.638	0.926	0.617	4.649	4.287×10^5
1.58 TeV	1.578×10^6	2.479	0.727	1.053	0.699	4.958	<i>Muon critical energy</i>
2.00 TeV	2.000×10^6	2.501	0.940	1.360	0.894	5.695	5.451×10^5
3.00 TeV	3.000×10^6	2.539	1.446	2.085	1.371	7.441	6.983×10^5
4.00 TeV	4.000×10^6	2.566	1.962	2.823	1.857	9.208	8.189×10^5
8.00 TeV	8.000×10^6	2.633	4.057	5.799	3.881	16.370	1.141×10^6
10.0 TeV	1.000×10^7	2.655	5.119	7.301	4.924	19.999	1.251×10^6
14.0 TeV	1.400×10^7	2.689	7.239	10.291	7.075	27.293	1.421×10^6
20.0 TeV	2.000×10^7	2.725	10.450	14.806	10.382	38.363	1.606×10^6
30.0 TeV	3.000×10^7	2.767	15.797	22.313	16.131	57.007	1.819×10^6
40.0 TeV	4.000×10^7	2.797	21.178	29.848	22.035	75.858	1.970×10^6
80.0 TeV	8.000×10^7	2.871	42.758	60.016	46.852	152.498	2.335×10^6
100. TeV	1.000×10^8	2.896	53.580	75.120	59.730	191.326	2.452×10^6

TABLE I-6. Muons in Beryllium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
4 (Be)	9.012182	1.848	63.7	0.80392	2.4339	0.0592	1.6922	2.7847	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	6.491				6.491	8.616 × 10 ⁻¹
14.0 MeV	5.616 × 10 ¹	5.058				5.058	1.567 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	3.945				3.945	2.926 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	3.054				3.054	5.848 × 10 ⁰
40.0 MeV	1.003 × 10 ²	2.603				2.603	9.418 × 10 ⁰
80.0 MeV	1.527 × 10 ²	1.940				1.940	2.779 × 10 ¹
100. MeV	1.764 × 10 ²	1.818				1.818	3.847 × 10 ¹
140. MeV	2.218 × 10 ²	1.694				1.694	6.137 × 10 ¹
200. MeV	2.868 × 10 ²	1.622				1.622	9.770 × 10 ¹
300. MeV	3.917 × 10 ²	1.595			0.000	1.595	1.601 × 10 ²
318. MeV	4.105 × 10 ²	1.595			0.000	1.595	<i>Minimum ionization</i>
400. MeV	4.945 × 10 ²	1.600			0.000	1.600	2.227 × 10 ²
800. MeV	8.995 × 10 ²	1.658			0.000	1.659	4.683 × 10 ²
1.00 GeV	1.101 × 10 ³	1.685	0.000		0.000	1.685	5.879 × 10 ²
1.40 GeV	1.502 × 10 ³	1.727	0.000		0.001	1.728	8.221 × 10 ²
2.00 GeV	2.103 × 10 ³	1.774	0.000	0.000	0.001	1.775	1.164 × 10 ³
3.00 GeV	3.104 × 10 ³	1.826	0.001	0.000	0.001	1.828	1.719 × 10 ³
4.00 GeV	4.104 × 10 ³	1.861	0.001	0.001	0.002	1.865	2.260 × 10 ³
8.00 GeV	8.105 × 10 ³	1.944	0.002	0.002	0.004	1.951	4.352 × 10 ³
10.0 GeV	1.011 × 10 ⁴	1.969	0.002	0.002	0.005	1.979	5.369 × 10 ³
14.0 GeV	1.411 × 10 ⁴	2.007	0.004	0.004	0.007	2.022	7.367 × 10 ³
20.0 GeV	2.011 × 10 ⁴	2.046	0.006	0.007	0.009	2.068	1.030 × 10 ⁴
30.0 GeV	3.011 × 10 ⁴	2.089	0.010	0.012	0.014	2.124	1.507 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	2.118	0.014	0.018	0.018	2.167	1.972 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	2.185	0.032	0.043	0.035	2.295	3.763 × 10 ⁴
100. GeV	1.001 × 10 ⁵	2.206	0.042	0.057	0.043	2.348	4.624 × 10 ⁴
140. GeV	1.401 × 10 ⁵	2.237	0.062	0.086	0.060	2.444	6.294 × 10 ⁴
200. GeV	2.001 × 10 ⁵	2.269	0.093	0.132	0.085	2.579	8.683 × 10 ⁴
300. GeV	3.001 × 10 ⁵	2.306	0.147	0.210	0.127	2.791	1.241 × 10 ⁵
400. GeV	4.001 × 10 ⁵	2.332	0.204	0.292	0.169	2.997	1.587 × 10 ⁵
800. GeV	8.001 × 10 ⁵	2.396	0.439	0.635	0.342	3.812	2.767 × 10 ⁵
1.00 TeV	1.000 × 10 ⁶	2.416	0.561	0.813	0.430	4.221	3.265 × 10 ⁵
1.33 TeV	1.328 × 10 ⁶	2.443	0.762	1.103	0.577	4.886	<i>Muon critical energy</i>
1.40 TeV	1.400 × 10 ⁶	2.448	0.807	1.168	0.610	5.034	4.132 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	2.482	1.186	1.713	0.884	6.265	5.198 × 10 ⁵
3.00 TeV	3.000 × 10 ⁶	2.520	1.823	2.622	1.355	8.320	6.579 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	2.548	2.471	3.545	1.834	10.398	7.652 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	2.617	5.099	7.267	3.830	18.814	1.047 × 10 ⁶
10.0 TeV	1.000 × 10 ⁷	2.640	6.430	9.144	4.859	23.073	1.143 × 10 ⁶
14.0 TeV	1.400 × 10 ⁷	2.675	9.086	12.881	6.980	31.621	1.291 × 10 ⁶
20.0 TeV	2.000 × 10 ⁷	2.712	13.106	18.522	10.240	44.580	1.450 × 10 ⁶
30.0 TeV	3.000 × 10 ⁷	2.755	19.801	27.902	15.903	66.361	1.632 × 10 ⁶
40.0 TeV	4.000 × 10 ⁷	2.786	26.536	37.316	21.718	88.356	1.763 × 10 ⁶
80.0 TeV	8.000 × 10 ⁷	2.862	53.530	75.009	46.136	177.537	2.076 × 10 ⁶
100. TeV	1.000 × 10 ⁸	2.888	67.060	93.880	58.800	222.628	2.176 × 10 ⁶

TABLE I-7. Muons in Boron

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
5 (B)	10.811	2.370	76.0	0.56224	2.4512	0.0305	1.9688	2.8477	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	5.155				5.155	1.540×10^0
20.0 MeV	6.802×10^1	4.023				4.023	2.873×10^0
30.0 MeV	8.509×10^1	3.117				3.117	5.736×10^0
40.0 MeV	1.003×10^2	2.657				2.657	9.234×10^0
80.0 MeV	1.527×10^2	1.977				1.977	2.724×10^1
100. MeV	1.764×10^2	1.852				1.852	3.772×10^1
140. MeV	2.218×10^2	1.724				1.724	6.022×10^1
200. MeV	2.868×10^2	1.651				1.651	9.592×10^1
300. MeV	3.917×10^2	1.623			0.000	1.624	1.572×10^2
315. MeV	4.071×10^2	1.623			0.000	1.623	<i>Minimum ionization</i>
400. MeV	4.945×10^2	1.629			0.000	1.629	2.187×10^2
800. MeV	8.995×10^2	1.693	0.000		0.000	1.693	4.596×10^2
1.00 GeV	1.101×10^3	1.721	0.000		0.000	1.722	5.767×10^2
1.40 GeV	1.502×10^3	1.768	0.000		0.001	1.769	8.058×10^2
2.00 GeV	2.103×10^3	1.818	0.000	0.000	0.001	1.820	1.140×10^3
3.00 GeV	3.104×10^3	1.876	0.001	0.000	0.001	1.879	1.680×10^3
4.00 GeV	4.104×10^3	1.915	0.001	0.001	0.002	1.919	2.206×10^3
8.00 GeV	8.105×10^3	2.005	0.002	0.002	0.004	2.013	4.235×10^3
10.0 GeV	1.011×10^4	2.032	0.003	0.003	0.005	2.043	5.221×10^3
14.0 GeV	1.411×10^4	2.071	0.005	0.005	0.007	2.088	7.157×10^3
20.0 GeV	2.011×10^4	2.112	0.007	0.009	0.009	2.137	9.996×10^3
30.0 GeV	3.011×10^4	2.156	0.012	0.015	0.014	2.197	1.461×10^4
40.0 GeV	4.011×10^4	2.186	0.017	0.022	0.018	2.244	1.911×10^4
80.0 GeV	8.011×10^4	2.256	0.040	0.054	0.034	2.385	3.637×10^4
100. GeV	1.001×10^5	2.278	0.052	0.072	0.043	2.444	4.466×10^4
140. GeV	1.401×10^5	2.310	0.077	0.107	0.059	2.553	6.066×10^4
200. GeV	2.001×10^5	2.344	0.116	0.164	0.084	2.708	8.347×10^4
300. GeV	3.001×10^5	2.382	0.183	0.261	0.126	2.952	1.188×10^5
400. GeV	4.001×10^5	2.410	0.253	0.362	0.168	3.193	1.514×10^5
800. GeV	8.001×10^5	2.476	0.544	0.786	0.339	4.145	2.610×10^5
1.00 TeV	1.000×10^6	2.497	0.695	1.005	0.426	4.624	3.067×10^5
1.17 TeV	1.169×10^6	2.513	0.822	1.189	0.502	5.025	<i>Muon critical energy</i>
1.40 TeV	1.400×10^6	2.530	0.998	1.442	0.605	5.575	3.854×10^5
2.00 TeV	2.000×10^6	2.565	1.465	2.112	0.876	7.019	4.811×10^5
3.00 TeV	3.000×10^6	2.606	2.249	3.228	1.342	9.426	6.036×10^5
4.00 TeV	4.000×10^6	2.635	3.046	4.361	1.817	11.860	6.980×10^5
8.00 TeV	8.000×10^6	2.707	6.278	8.927	3.794	21.706	9.437×10^5
10.0 TeV	1.000×10^7	2.730	7.913	11.228	4.813	26.685	1.027×10^6
14.0 TeV	1.400×10^7	2.766	11.175	15.811	6.912	36.664	1.154×10^6
20.0 TeV	2.000×10^7	2.805	16.112	22.726	10.136	51.779	1.291×10^6
30.0 TeV	3.000×10^7	2.850	24.333	34.230	15.736	77.149	1.448×10^6
40.0 TeV	4.000×10^7	2.882	32.599	45.773	21.485	102.740	1.560×10^6
80.0 TeV	8.000×10^7	2.962	65.728	91.985	45.618	206.293	1.830×10^6
100. TeV	1.000×10^8	2.988	82.330	115.120	58.130	258.569	1.916×10^6

TABLE I-8. Muons in Carbon (Compact)

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
6 (C)	12.0107	2.265	78.0	0.26142	2.8697	-0.0178	2.3415	2.8680	0.12
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	7.119				7.119	7.864×10^{-1}		
14.0 MeV	5.616×10^1	5.551				5.551	1.429×10^0		
20.0 MeV	6.802×10^1	4.332				4.332	2.667×10^0		
30.0 MeV	8.509×10^1	3.356				3.356	5.327×10^0		
40.0 MeV	1.003×10^2	2.861				2.861	8.575×10^0		
80.0 MeV	1.527×10^2	2.127				2.127	2.532×10^1		
100. MeV	1.764×10^2	1.992				1.992	3.506×10^1		
140. MeV	2.218×10^2	1.854				1.854	5.598×10^1		
200. MeV	2.868×10^2	1.775				1.775	8.918×10^1		
300. MeV	3.917×10^2	1.745			0.000	1.745	1.462×10^2		
317. MeV	4.096×10^2	1.745			0.000	1.745	<i>Minimum ionization</i>		
400. MeV	4.945×10^2	1.751			0.000	1.751	2.034×10^2		
800. MeV	8.995×10^2	1.819	0.000		0.000	1.820	4.275×10^2		
1.00 GeV	1.101×10^3	1.850	0.000		0.000	1.851	5.365×10^2		
1.40 GeV	1.502×10^3	1.900	0.000		0.001	1.901	7.496×10^2		
2.00 GeV	2.103×10^3	1.955	0.000	0.000	0.001	1.957	1.060×10^3		
3.00 GeV	3.104×10^3	2.018	0.001	0.001	0.001	2.021	1.563×10^3		
4.00 GeV	4.104×10^3	2.062	0.001	0.001	0.002	2.066	2.052×10^3		
8.00 GeV	8.105×10^3	2.161	0.003	0.003	0.004	2.171	3.935×10^3		
10.0 GeV	1.011×10^4	2.191	0.004	0.004	0.005	2.204	4.849×10^3		
14.0 GeV	1.411×10^4	2.234	0.006	0.007	0.007	2.254	6.643×10^3		
20.0 GeV	2.011×10^4	2.278	0.010	0.011	0.009	2.308	9.272×10^3		
30.0 GeV	3.011×10^4	2.326	0.016	0.019	0.013	2.374	1.354×10^4		
40.0 GeV	4.011×10^4	2.359	0.022	0.028	0.018	2.427	1.770×10^4		
80.0 GeV	8.011×10^4	2.434	0.050	0.068	0.034	2.587	3.364×10^4		
100. GeV	1.001×10^5	2.458	0.065	0.089	0.042	2.655	4.127×10^4		
140. GeV	1.401×10^5	2.493	0.097	0.134	0.059	2.783	5.598×10^4		
200. GeV	2.001×10^5	2.529	0.145	0.206	0.084	2.964	7.687×10^4		
300. GeV	3.001×10^5	2.571	0.230	0.327	0.125	3.253	1.091×10^5		
400. GeV	4.001×10^5	2.600	0.317	0.454	0.167	3.538	1.385×10^5		
800. GeV	8.001×10^5	2.672	0.681	0.981	0.338	4.672	2.366×10^5		
1.00 TeV	1.000×10^6	2.695	0.869	1.254	0.424	5.243	2.770×10^5		
1.06 TeV	1.056×10^6	2.701	0.922	1.330	0.449	5.402	<i>Muon critical energy</i>		
1.40 TeV	1.400×10^6	2.730	1.248	1.798	0.602	6.378	3.461×10^5		
2.00 TeV	2.000×10^6	2.768	1.830	2.631	0.871	8.101	4.293×10^5		
3.00 TeV	3.000×10^6	2.812	2.806	4.018	1.335	10.972	5.351×10^5		
4.00 TeV	4.000×10^6	2.844	3.799	5.425	1.807	13.875	6.159×10^5		
8.00 TeV	8.000×10^6	2.921	7.821	11.093	3.773	25.608	8.249×10^5		
10.0 TeV	1.000×10^7	2.947	9.855	13.948	4.785	31.535	8.952×10^5		
14.0 TeV	1.400×10^7	2.986	13.913	19.637	6.871	43.407	1.003×10^6		
20.0 TeV	2.000×10^7	3.027	20.052	28.218	10.076	61.374	1.119×10^6		
30.0 TeV	3.000×10^7	3.076	30.273	42.494	15.640	91.483	1.251×10^6		
40.0 TeV	4.000×10^7	3.111	40.549	56.817	21.350	121.827	1.346×10^6		
80.0 TeV	8.000×10^7	3.197	81.720	114.162	45.316	244.396	1.573×10^6		
100. TeV	1.000×10^8	3.225	102.350	142.870	57.740	306.186	1.646×10^6		

TABLE I-9. Muons in Carbon (Graphite)

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
6 (C)	12.0107	1.700	78.0	0.20762	2.9532	0.0480	2.5387	3.1550	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	7.117				7.117	7.873×10^{-1}		
14.0 MeV	5.616×10^1	5.551				5.551	1.430×10^0		
20.0 MeV	6.802×10^1	4.333				4.333	2.668×10^0		
30.0 MeV	8.509×10^1	3.358				3.358	5.326×10^0		
40.0 MeV	1.003×10^2	2.863				2.863	8.573×10^0		
80.0 MeV	1.527×10^2	2.133				2.133	2.527×10^1		
100. MeV	1.764×10^2	1.998				1.998	3.499×10^1		
140. MeV	2.218×10^2	1.861				1.861	5.583×10^1		
200. MeV	2.868×10^2	1.782				1.783	8.890×10^1		
300. MeV	3.917×10^2	1.754			0.000	1.754	1.456×10^2		
314. MeV	4.065×10^2	1.753			0.000	1.754	<i>Minimum ionization</i>		
400. MeV	4.945×10^2	1.760			0.000	1.760	2.026×10^2		
800. MeV	8.995×10^2	1.830	0.000		0.000	1.831	4.255×10^2		
1.00 GeV	1.101×10^3	1.862	0.000		0.000	1.863	5.337×10^2		
1.40 GeV	1.502×10^3	1.913	0.000		0.001	1.914	7.454×10^2		
2.00 GeV	2.103×10^3	1.970	0.000	0.000	0.001	1.972	1.054×10^3		
3.00 GeV	3.104×10^3	2.034	0.001	0.001	0.001	2.037	1.552×10^3		
4.00 GeV	4.104×10^3	2.079	0.001	0.001	0.002	2.083	2.038×10^3		
8.00 GeV	8.105×10^3	2.180	0.003	0.003	0.004	2.190	3.904×10^3		
10.0 GeV	1.011×10^4	2.211	0.004	0.004	0.005	2.224	4.810×10^3		
14.0 GeV	1.411×10^4	2.255	0.006	0.007	0.007	2.275	6.587×10^3		
20.0 GeV	2.011×10^4	2.300	0.010	0.011	0.009	2.330	9.192×10^3		
30.0 GeV	3.011×10^4	2.348	0.016	0.019	0.013	2.396	1.342×10^4		
40.0 GeV	4.011×10^4	2.381	0.022	0.028	0.018	2.449	1.755×10^4		
80.0 GeV	8.011×10^4	2.456	0.050	0.068	0.034	2.609	3.335×10^4		
100. GeV	1.001×10^5	2.480	0.065	0.089	0.042	2.677	4.091×10^4		
140. GeV	1.401×10^5	2.515	0.097	0.134	0.059	2.805	5.550×10^4		
200. GeV	2.001×10^5	2.551	0.145	0.206	0.084	2.986	7.623×10^4		
300. GeV	3.001×10^5	2.593	0.230	0.327	0.125	3.275	1.082×10^5		
400. GeV	4.001×10^5	2.622	0.317	0.454	0.167	3.560	1.375×10^5		
800. GeV	8.001×10^5	2.694	0.681	0.981	0.338	4.694	2.350×10^5		
1.00 TeV	1.000×10^6	2.717	0.869	1.254	0.424	5.265	2.752×10^5		
1.06 TeV	1.065×10^6	2.724	0.930	1.341	0.453	5.447	<i>Muon critical energy</i>		
1.40 TeV	1.400×10^6	2.752	1.248	1.798	0.602	6.400	3.440×10^5		
2.00 TeV	2.000×10^6	2.790	1.830	2.631	0.871	8.123	4.271×10^5		
3.00 TeV	3.000×10^6	2.834	2.806	4.018	1.335	10.994	5.325×10^5		
4.00 TeV	4.000×10^6	2.866	3.799	5.425	1.807	13.897	6.133×10^5		
8.00 TeV	8.000×10^6	2.943	7.821	11.093	3.773	25.630	8.220×10^5		
10.0 TeV	1.000×10^7	2.969	9.855	13.948	4.785	31.557	8.922×10^5		
14.0 TeV	1.400×10^7	3.008	13.913	19.637	6.871	43.429	9.999×10^5		
20.0 TeV	2.000×10^7	3.049	20.052	28.218	10.076	61.396	1.116×10^6		
30.0 TeV	3.000×10^7	3.098	30.273	42.494	15.640	91.505	1.248×10^6		
40.0 TeV	4.000×10^7	3.133	40.549	56.817	21.350	121.849	1.342×10^6		
80.0 TeV	8.000×10^7	3.219	81.720	114.162	45.316	244.418	1.570×10^6		
100. TeV	1.000×10^8	3.247	102.350	142.870	57.740	306.208	1.643×10^6		

TABLE I-10. Muons in Nitrogen Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
7 (N)	14.00674	1.165×10^{-3}	82.0	0.15349	3.2125	1.7378	4.1323	10.5400	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	7.084				7.084	7.918×10^{-1}		
14.0 MeV	5.616×10^1	5.530				5.530	1.438×10^0		
20.0 MeV	6.802×10^1	4.321				4.321	2.679×10^0		
30.0 MeV	8.509×10^1	3.354				3.354	5.343×10^0		
40.0 MeV	1.003×10^2	2.865				2.865	8.590×10^0		
80.0 MeV	1.527×10^2	2.152				2.152	2.521×10^1		
100. MeV	1.764×10^2	2.025				2.025	3.482×10^1		
140. MeV	2.218×10^2	1.900				1.900	5.530×10^1		
200. MeV	2.868×10^2	1.837				1.837	8.754×10^1		
257. MeV	3.471×10^2	1.825			0.000	1.825	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.829			0.000	1.829	1.423×10^2		
400. MeV	4.945×10^2	1.853			0.000	1.853	1.966×10^2		
800. MeV	8.995×10^2	1.977	0.000		0.000	1.977	4.054×10^2		
1.00 GeV	1.101×10^3	2.029	0.000		0.000	2.030	5.052×10^2		
1.40 GeV	1.502×10^3	2.114	0.000		0.001	2.116	6.980×10^2		
2.00 GeV	2.103×10^3	2.211	0.001	0.000	0.001	2.212	9.750×10^2		
3.00 GeV	3.104×10^3	2.324	0.001	0.001	0.001	2.327	1.415×10^3		
4.00 GeV	4.104×10^3	2.405	0.001	0.001	0.002	2.410	1.837×10^3		
8.00 GeV	8.105×10^3	2.586	0.003	0.003	0.004	2.597	3.426×10^3		
10.0 GeV	1.011×10^4	2.636	0.005	0.005	0.005	2.650	4.188×10^3		
14.0 GeV	1.411×10^4	2.706	0.007	0.008	0.007	2.727	5.675×10^3		
20.0 GeV	2.011×10^4	2.775	0.011	0.012	0.009	2.808	7.841×10^3		
30.0 GeV	3.011×10^4	2.846	0.018	0.022	0.013	2.899	1.134×10^4		
40.0 GeV	4.011×10^4	2.892	0.025	0.032	0.018	2.967	1.475×10^4		
80.0 GeV	8.011×10^4	2.992	0.057	0.077	0.034	3.161	2.778×10^4		
100. GeV	1.001×10^5	3.021	0.074	0.102	0.042	3.240	3.403×10^4		
140. GeV	1.401×10^5	3.063	0.110	0.153	0.059	3.384	4.611×10^4		
200. GeV	2.001×10^5	3.104	0.165	0.234	0.083	3.587	6.332×10^4		
300. GeV	3.001×10^5	3.150	0.261	0.372	0.124	3.907	9.002×10^4		
400. GeV	4.001×10^5	3.181	0.360	0.516	0.166	4.222	1.146×10^5		
800. GeV	8.001×10^5	3.254	0.772	1.113	0.335	5.475	1.976×10^5		
1.00 TeV	1.000×10^6	3.277	0.985	1.422	0.421	6.106	2.322×10^5		
1.15 TeV	1.153×10^6	3.292	1.148	1.656	0.488	6.585	<i>Muon critical energy</i>		
1.40 TeV	1.400×10^6	3.313	1.414	2.037	0.597	7.361	2.918×10^5		
2.00 TeV	2.000×10^6	3.351	2.073	2.978	0.864	9.266	3.643×10^5		
3.00 TeV	3.000×10^6	3.394	3.176	4.546	1.324	12.441	4.571×10^5		
4.00 TeV	4.000×10^6	3.426	4.299	6.135	1.792	15.652	5.286×10^5		
8.00 TeV	8.000×10^6	3.503	8.841	12.536	3.740	28.621	7.148×10^5		
10.0 TeV	1.000×10^7	3.529	11.138	15.760	4.743	35.170	7.778×10^5		
14.0 TeV	1.400×10^7	3.568	15.720	22.184	6.809	48.281	8.745×10^5		
20.0 TeV	2.000×10^7	3.610	22.650	31.872	9.982	68.114	9.786×10^5		
30.0 TeV	3.000×10^7	3.658	34.187	47.994	15.491	101.331	1.098×10^6		
40.0 TeV	4.000×10^7	3.693	45.784	64.168	21.144	134.789	1.184×10^6		
80.0 TeV	8.000×10^7	3.779	92.292	128.917	44.860	269.849	1.389×10^6		
100. TeV	1.000×10^8	3.808	115.610	161.330	57.150	337.898	1.455×10^6		

TABLE I-11. Muons in Liquid Nitrogen

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
7 (N)	14.00674	0.807	82.0	0.53289	3.0000	0.3039	2.0000	3.9996	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	5.531				5.531	1.436×10^0
20.0 MeV	6.802×10^1	4.322				4.322	2.677×10^0
30.0 MeV	8.509×10^1	3.354				3.354	5.341×10^0
40.0 MeV	1.003×10^2	2.865				2.865	8.588×10^0
80.0 MeV	1.527×10^2	2.152				2.152	2.521×10^1
100. MeV	1.764×10^2	2.025				2.025	3.481×10^1
140. MeV	2.218×10^2	1.900				1.900	5.530×10^1
200. MeV	2.868×10^2	1.833				1.833	8.757×10^1
288. MeV	3.788×10^2	1.813			0.000	1.814	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.814			0.000	1.814	1.426×10^2
400. MeV	4.945×10^2	1.826			0.000	1.826	1.975×10^2
800. MeV	8.995×10^2	1.904	0.000		0.000	1.905	4.120×10^2
1.00 GeV	1.101×10^3	1.937	0.000		0.000	1.937	5.161×10^2
1.40 GeV	1.502×10^3	1.989	0.000		0.001	1.990	7.196×10^2
2.00 GeV	2.103×10^3	2.044	0.001	0.000	0.001	2.046	1.017×10^3
3.00 GeV	3.104×10^3	2.106	0.001	0.001	0.001	2.109	1.498×10^3
4.00 GeV	4.104×10^3	2.148	0.001	0.001	0.002	2.152	1.967×10^3
8.00 GeV	8.105×10^3	2.243	0.003	0.003	0.004	2.254	3.778×10^3
10.0 GeV	1.011×10^4	2.272	0.005	0.005	0.005	2.286	4.659×10^3
14.0 GeV	1.411×10^4	2.315	0.007	0.008	0.007	2.336	6.389×10^3
20.0 GeV	2.011×10^4	2.359	0.011	0.012	0.009	2.391	8.926×10^3
30.0 GeV	3.011×10^4	2.406	0.018	0.022	0.013	2.459	1.305×10^4
40.0 GeV	4.011×10^4	2.439	0.025	0.032	0.018	2.514	1.707×10^4
80.0 GeV	8.011×10^4	2.514	0.057	0.077	0.034	2.683	3.244×10^4
100. GeV	1.001×10^5	2.538	0.074	0.102	0.042	2.757	3.979×10^4
140. GeV	1.401×10^5	2.573	0.110	0.153	0.059	2.895	5.395×10^4
200. GeV	2.001×10^5	2.610	0.165	0.234	0.083	3.092	7.400×10^4
300. GeV	3.001×10^5	2.651	0.261	0.372	0.124	3.409	1.048×10^5
400. GeV	4.001×10^5	2.681	0.360	0.516	0.166	3.722	1.328×10^5
800. GeV	8.001×10^5	2.752	0.772	1.113	0.335	4.973	2.255×10^5
982. GeV	9.821×10^5	2.773	0.966	1.394	0.413	5.547	<i>Muon critical energy</i>
1.00 TeV	1.000×10^6	2.775	0.985	1.422	0.421	5.604	2.634×10^5
1.40 TeV	1.400×10^6	2.811	1.414	2.037	0.597	6.859	3.278×10^5
2.00 TeV	2.000×10^6	2.849	2.073	2.978	0.864	8.764	4.050×10^5
3.00 TeV	3.000×10^6	2.893	3.176	4.546	1.324	11.939	5.024×10^5
4.00 TeV	4.000×10^6	2.924	4.299	6.135	1.792	15.150	5.766×10^5
8.00 TeV	8.000×10^6	3.002	8.841	12.536	3.740	28.120	7.674×10^5
10.0 TeV	1.000×10^7	3.027	11.138	15.760	4.743	34.668	8.314×10^5
14.0 TeV	1.400×10^7	3.066	15.720	22.184	6.809	47.779	9.292×10^5
20.0 TeV	2.000×10^7	3.108	22.650	31.872	9.982	67.612	1.034×10^6
30.0 TeV	3.000×10^7	3.156	34.187	47.994	15.491	100.829	1.155×10^6
40.0 TeV	4.000×10^7	3.191	45.784	64.168	21.144	134.287	1.240×10^6
80.0 TeV	8.000×10^7	3.277	92.292	128.917	44.860	269.347	1.447×10^6
100. TeV	1.000×10^8	3.306	115.610	161.330	57.150	337.396	1.513×10^6

TABLE I-12. Muons in Oxygen Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
8 (O)	15.9994	1.332 × 10 ⁻³	95.0	0.11778	3.2913	1.7541	4.3213	10.7004	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	6.951				6.951	8.084 × 10 ⁻¹
14.0 MeV	5.616 × 10 ¹	5.429				5.430	1.466 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	4.246				4.246	2.730 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	3.298				3.298	5.440 × 10 ⁰
40.0 MeV	1.003 × 10 ²	2.818				2.819	8.741 × 10 ⁰
80.0 MeV	1.527 × 10 ²	2.120				2.120	2.562 × 10 ¹
100. MeV	1.764 × 10 ²	1.995				1.995	3.537 × 10 ¹
140. MeV	2.218 × 10 ²	1.873				1.873	5.616 × 10 ¹
200. MeV	2.868 × 10 ²	1.812				1.812	8.885 × 10 ¹
256. MeV	3.462 × 10 ²	1.801			0.000	1.801	<i>Minimum ionization</i>
300. MeV	3.917 × 10 ²	1.805			0.000	1.805	1.443 × 10 ²
400. MeV	4.945 × 10 ²	1.830			0.000	1.831	1.993 × 10 ²
800. MeV	8.995 × 10 ²	1.955	0.000		0.000	1.956	4.106 × 10 ²
1.00 GeV	1.101 × 10 ³	2.007	0.000		0.000	2.008	5.115 × 10 ²
1.40 GeV	1.502 × 10 ³	2.093	0.000	0.000	0.001	2.094	7.063 × 10 ²
2.00 GeV	2.103 × 10 ³	2.189	0.001	0.000	0.001	2.191	9.861 × 10 ²
3.00 GeV	3.104 × 10 ³	2.302	0.001	0.001	0.001	2.306	1.430 × 10 ³
4.00 GeV	4.104 × 10 ³	2.384	0.002	0.001	0.002	2.389	1.856 × 10 ³
8.00 GeV	8.105 × 10 ³	2.567	0.004	0.004	0.004	2.578	3.458 × 10 ³
10.0 GeV	1.011 × 10 ⁴	2.617	0.005	0.005	0.005	2.632	4.225 × 10 ³
14.0 GeV	1.411 × 10 ⁴	2.687	0.008	0.008	0.006	2.710	5.722 × 10 ³
20.0 GeV	2.011 × 10 ⁴	2.757	0.012	0.014	0.009	2.792	7.901 × 10 ³
30.0 GeV	3.011 × 10 ⁴	2.829	0.020	0.024	0.013	2.887	1.142 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	2.876	0.028	0.036	0.017	2.958	1.484 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	2.977	0.064	0.087	0.034	3.163	2.789 × 10 ⁴
100. GeV	1.001 × 10 ⁵	3.007	0.084	0.114	0.042	3.247	3.413 × 10 ⁴
140. GeV	1.401 × 10 ⁵	3.050	0.123	0.172	0.058	3.403	4.616 × 10 ⁴
200. GeV	2.001 × 10 ⁵	3.092	0.185	0.263	0.082	3.623	6.324 × 10 ⁴
300. GeV	3.001 × 10 ⁵	3.139	0.292	0.417	0.123	3.971	8.959 × 10 ⁴
400. GeV	4.001 × 10 ⁵	3.170	0.403	0.577	0.165	4.315	1.137 × 10 ⁵
800. GeV	8.001 × 10 ⁵	3.245	0.863	1.245	0.333	5.685	1.942 × 10 ⁵
1.00 TeV	1.000 × 10 ⁶	3.268	1.101	1.589	0.418	6.377	2.274 × 10 ⁵
1.05 TeV	1.050 × 10 ⁶	3.273	1.160	1.674	0.440	6.547	<i>Muon critical energy</i>
1.40 TeV	1.400 × 10 ⁶	3.304	1.579	2.275	0.593	7.751	2.843 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	3.342	2.313	3.324	0.858	9.838	3.528 × 10 ⁵
3.00 TeV	3.000 × 10 ⁶	3.386	3.544	5.071	1.314	13.316	4.399 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	3.417	4.794	6.842	1.779	16.833	5.065 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	3.495	9.855	13.973	3.711	31.034	6.789 × 10 ⁵
10.0 TeV	1.000 × 10 ⁷	3.520	12.412	17.563	4.706	38.202	7.369 × 10 ⁵
14.0 TeV	1.400 × 10 ⁷	3.559	17.515	24.718	6.755	52.547	8.258 × 10 ⁵
20.0 TeV	2.000 × 10 ⁷	3.601	25.230	35.508	9.902	74.242	9.214 × 10 ⁵
30.0 TeV	3.000 × 10 ⁷	3.650	38.075	53.464	15.361	110.550	1.031 × 10 ⁶
40.0 TeV	4.000 × 10 ⁷	3.685	50.983	71.476	20.963	147.107	1.109 × 10 ⁶
80.0 TeV	8.000 × 10 ⁷	3.771	102.749	143.584	44.451	294.556	1.298 × 10 ⁶
100. TeV	1.000 × 10 ⁸	3.799	128.700	179.680	56.620	368.800	1.358 × 10 ⁶

TABLE I-13. Muons in Liquid Oxygen

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
8 (O)	15.9994	1.141	95.0	0.52231	3.0000	0.2868	2.0000	3.9471	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	6.955				6.955	8.070×10^{-1}
14.0 MeV	5.616×10^1	5.432				5.432	1.465×10^0
20.0 MeV	6.802×10^1	4.247				4.247	2.728×10^0
30.0 MeV	8.509×10^1	3.298				3.299	5.437×10^0
40.0 MeV	1.003×10^2	2.819				2.819	8.738×10^0
80.0 MeV	1.527×10^2	2.120				2.120	2.562×10^1
100. MeV	1.764×10^2	1.995				1.995	3.537×10^1
140. MeV	2.218×10^2	1.873				1.873	5.616×10^1
200. MeV	2.868×10^2	1.807				1.807	8.889×10^1
287. MeV	3.779×10^2	1.788			0.000	1.788	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.788			0.000	1.789	1.447×10^2
400. MeV	4.945×10^2	1.801			0.000	1.801	2.004×10^2
800. MeV	8.995×10^2	1.879	0.000		0.000	1.880	4.177×10^2
1.00 GeV	1.101×10^3	1.912	0.000		0.000	1.912	5.232×10^2
1.40 GeV	1.502×10^3	1.963	0.000	0.000	0.001	1.965	7.294×10^2
2.00 GeV	2.103×10^3	2.019	0.001	0.000	0.001	2.021	1.030×10^3
3.00 GeV	3.104×10^3	2.080	0.001	0.001	0.001	2.084	1.517×10^3
4.00 GeV	4.104×10^3	2.122	0.002	0.001	0.002	2.127	1.992×10^3
8.00 GeV	8.105×10^3	2.218	0.004	0.004	0.004	2.229	3.824×10^3
10.0 GeV	1.011×10^4	2.247	0.005	0.005	0.005	2.262	4.714×10^3
14.0 GeV	1.411×10^4	2.289	0.008	0.008	0.006	2.312	6.462×10^3
20.0 GeV	2.011×10^4	2.333	0.012	0.014	0.009	2.369	9.024×10^3
30.0 GeV	3.011×10^4	2.381	0.020	0.024	0.013	2.439	1.318×10^4
40.0 GeV	4.011×10^4	2.414	0.028	0.036	0.017	2.496	1.723×10^4
80.0 GeV	8.011×10^4	2.489	0.064	0.087	0.034	2.674	3.269×10^4
100. GeV	1.001×10^5	2.513	0.084	0.114	0.042	2.753	4.006×10^4
140. GeV	1.401×10^5	2.548	0.123	0.172	0.058	2.901	5.421×10^4
200. GeV	2.001×10^5	2.584	0.185	0.263	0.082	3.115	7.417×10^4
300. GeV	3.001×10^5	2.626	0.292	0.417	0.123	3.458	1.046×10^5
400. GeV	4.001×10^5	2.655	0.403	0.577	0.165	3.800	1.322×10^5
800. GeV	8.001×10^5	2.727	0.863	1.245	0.333	5.167	2.221×10^5
890. GeV	8.897×10^5	2.738	0.969	1.398	0.371	5.476	<i>Muon critical energy</i>
1.00 TeV	1.000×10^6	2.750	1.101	1.589	0.418	5.858	2.584×10^5
1.40 TeV	1.400×10^6	2.786	1.579	2.275	0.593	7.232	3.198×10^5
2.00 TeV	2.000×10^6	2.824	2.313	3.324	0.858	9.320	3.927×10^5
3.00 TeV	3.000×10^6	2.867	3.544	5.071	1.314	12.797	4.839×10^5
4.00 TeV	4.000×10^6	2.899	4.794	6.842	1.779	16.314	5.530×10^5
8.00 TeV	8.000×10^6	2.977	9.855	13.973	3.711	30.515	7.294×10^5
10.0 TeV	1.000×10^7	3.002	12.412	17.563	4.706	37.683	7.883×10^5
14.0 TeV	1.400×10^7	3.041	17.515	24.718	6.755	52.029	8.783×10^5
20.0 TeV	2.000×10^7	3.083	25.230	35.508	9.902	73.723	9.747×10^5
30.0 TeV	3.000×10^7	3.131	38.075	53.464	15.361	110.032	1.085×10^6
40.0 TeV	4.000×10^7	3.166	50.983	71.476	20.963	146.589	1.163×10^6
80.0 TeV	8.000×10^7	3.253	102.749	143.584	44.451	294.037	1.352×10^6
100. TeV	1.000×10^8	3.281	128.700	179.680	56.620	368.281	1.413×10^6

TABLE I-14. Muons in Fluorine Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
9 (F)	18.9984032	1.580×10^{-3}	115.0	0.11083	3.2962	1.8433	4.4096	10.9653	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	6.415				6.415	8.781×10^{-1}
14.0 MeV	5.616×10^1	5.017				5.017	1.591×10^0
20.0 MeV	6.802×10^1	3.927				3.927	2.958×10^0
30.0 MeV	8.509×10^1	3.054				3.054	5.885×10^0
40.0 MeV	1.003×10^2	2.611				2.611	9.450×10^0
80.0 MeV	1.527×10^2	1.967				1.967	2.765×10^1
100. MeV	1.764×10^2	1.852				1.853	3.816×10^1
140. MeV	2.218×10^2	1.740				1.741	6.054×10^1
200. MeV	2.868×10^2	1.685				1.685	9.570×10^1
252. MeV	3.421×10^2	1.676			0.000	1.676	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.680			0.000	1.681	1.553×10^2
400. MeV	4.945×10^2	1.705			0.000	1.705	2.144×10^2
800. MeV	8.995×10^2	1.824	0.000		0.000	1.825	4.409×10^2
1.00 GeV	1.101×10^3	1.874	0.000		0.000	1.874	5.491×10^2
1.40 GeV	1.502×10^3	1.955	0.000	0.000	0.001	1.956	7.577×10^2
2.00 GeV	2.103×10^3	2.046	0.001	0.000	0.001	2.048	1.057×10^3
3.00 GeV	3.104×10^3	2.154	0.001	0.001	0.001	2.157	1.532×10^3
4.00 GeV	4.104×10^3	2.231	0.002	0.001	0.002	2.236	1.987×10^3
8.00 GeV	8.105×10^3	2.413	0.004	0.004	0.004	2.425	3.695×10^3
10.0 GeV	1.011×10^4	2.461	0.005	0.005	0.005	2.477	4.511×10^3
14.0 GeV	1.411×10^4	2.529	0.008	0.009	0.006	2.553	6.100×10^3
20.0 GeV	2.011×10^4	2.596	0.013	0.015	0.009	2.632	8.413×10^3
30.0 GeV	3.011×10^4	2.665	0.021	0.026	0.013	2.725	1.214×10^4
40.0 GeV	4.011×10^4	2.710	0.030	0.038	0.017	2.795	1.576×10^4
80.0 GeV	8.011×10^4	2.808	0.067	0.091	0.033	3.000	2.955×10^4
100. GeV	1.001×10^5	2.837	0.087	0.120	0.041	3.086	3.612×10^4
140. GeV	1.401×10^5	2.878	0.129	0.180	0.057	3.245	4.875×10^4
200. GeV	2.001×10^5	2.919	0.194	0.276	0.082	3.470	6.663×10^4
300. GeV	3.001×10^5	2.963	0.305	0.437	0.122	3.828	9.405×10^4
400. GeV	4.001×10^5	2.994	0.421	0.605	0.163	4.183	1.190×10^5
800. GeV	8.001×10^5	3.065	0.901	1.302	0.329	5.598	2.014×10^5
959. GeV	9.595×10^5	3.083	1.098	1.589	0.397	6.167	<i>Muon critical energy</i>
1.00 TeV	1.000×10^6	3.088	1.149	1.662	0.414	6.313	2.350×10^5
1.40 TeV	1.400×10^6	3.122	1.648	2.378	0.587	7.734	2.922×10^5
2.00 TeV	2.000×10^6	3.158	2.413	3.473	0.850	9.894	3.606×10^5
3.00 TeV	3.000×10^6	3.199	3.695	5.297	1.301	13.493	4.469×10^5
4.00 TeV	4.000×10^6	3.229	4.998	7.144	1.761	17.133	5.125×10^5
8.00 TeV	8.000×10^6	3.303	10.269	14.583	3.672	31.827	6.811×10^5
10.0 TeV	1.000×10^7	3.327	12.932	18.328	4.656	39.243	7.376×10^5
14.0 TeV	1.400×10^7	3.364	18.245	25.792	6.682	54.082	8.241×10^5
20.0 TeV	2.000×10^7	3.403	26.276	37.046	9.792	76.518	9.169×10^5
30.0 TeV	3.000×10^7	3.449	39.648	55.775	15.187	114.059	1.023×10^6
40.0 TeV	4.000×10^7	3.482	53.085	74.561	20.722	151.850	1.099×10^6
80.0 TeV	8.000×10^7	3.564	106.962	149.771	43.923	304.221	1.282×10^6
100. TeV	1.000×10^8	3.591	133.970	187.420	55.940	380.921	1.340×10^6

TABLE I-15. Muons in Liquid Fluorine

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
9 (F)	18.9984032	1.507	115.0	0.14504	3.0000	0.2000	3.0000	4.1050	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	5.020				5.020	1.588×10^0
20.0 MeV	6.802×10^1	3.929				3.929	2.954×10^0
30.0 MeV	8.509×10^1	3.054				3.054	5.881×10^0
40.0 MeV	1.003×10^2	2.612				2.612	9.445×10^0
80.0 MeV	1.527×10^2	1.967				1.968	2.765×10^1
100. MeV	1.764×10^2	1.850				1.850	3.815×10^1
140. MeV	2.218×10^2	1.726				1.726	6.065×10^1
200. MeV	2.868×10^2	1.657				1.657	9.626×10^1
298. MeV	3.894×10^2	1.634			0.000	1.634	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.634			0.000	1.634	1.572×10^2
400. MeV	4.945×10^2	1.643			0.000	1.643	2.183×10^2
800. MeV	8.995×10^2	1.716	0.000		0.000	1.717	4.565×10^2
1.00 GeV	1.101×10^3	1.748	0.000		0.000	1.749	5.719×10^2
1.40 GeV	1.502×10^3	1.800	0.000	0.000	0.001	1.801	7.971×10^2
2.00 GeV	2.103×10^3	1.857	0.001	0.000	0.001	1.859	1.125×10^3
3.00 GeV	3.104×10^3	1.922	0.001	0.001	0.001	1.926	1.653×10^3
4.00 GeV	4.104×10^3	1.967	0.002	0.001	0.002	1.972	2.165×10^3
8.00 GeV	8.105×10^3	2.070	0.004	0.004	0.004	2.082	4.133×10^3
10.0 GeV	1.011×10^4	2.101	0.005	0.005	0.005	2.117	5.085×10^3
14.0 GeV	1.411×10^4	2.146	0.008	0.009	0.006	2.169	6.951×10^3
20.0 GeV	2.011×10^4	2.190	0.013	0.015	0.009	2.227	9.678×10^3
30.0 GeV	3.011×10^4	2.238	0.021	0.026	0.013	2.298	1.410×10^4
40.0 GeV	4.011×10^4	2.270	0.030	0.038	0.017	2.355	1.839×10^4
80.0 GeV	8.011×10^4	2.342	0.067	0.091	0.033	2.534	3.474×10^4
100. GeV	1.001×10^5	2.364	0.087	0.120	0.041	2.613	4.251×10^4
140. GeV	1.401×10^5	2.397	0.129	0.180	0.057	2.764	5.739×10^4
200. GeV	2.001×10^5	2.432	0.194	0.276	0.082	2.983	7.828×10^4
300. GeV	3.001×10^5	2.471	0.305	0.437	0.122	3.336	1.100×10^5
400. GeV	4.001×10^5	2.499	0.421	0.605	0.163	3.688	1.385×10^5
800. GeV	8.001×10^5	2.567	0.901	1.302	0.329	5.100	2.303×10^5
810. GeV	8.105×10^5	2.568	0.914	1.321	0.334	5.137	<i>Muon critical energy</i>
1.00 TeV	1.000×10^6	2.589	1.149	1.662	0.414	5.815	2.670×10^5
1.40 TeV	1.400×10^6	2.623	1.648	2.378	0.587	7.235	3.286×10^5
2.00 TeV	2.000×10^6	2.659	2.413	3.473	0.850	9.395	4.011×10^5
3.00 TeV	3.000×10^6	2.700	3.695	5.297	1.301	12.994	4.913×10^5
4.00 TeV	4.000×10^6	2.730	4.998	7.144	1.761	16.634	5.591×10^5
8.00 TeV	8.000×10^6	2.804	10.269	14.583	3.672	31.328	7.315×10^5
10.0 TeV	1.000×10^7	2.828	12.932	18.328	4.656	38.744	7.889×10^5
14.0 TeV	1.400×10^7	2.865	18.245	25.792	6.682	53.583	8.763×10^5
20.0 TeV	2.000×10^7	2.904	26.276	37.046	9.792	76.019	9.698×10^5
30.0 TeV	3.000×10^7	2.950	39.648	55.775	15.187	113.560	1.077×10^6
40.0 TeV	4.000×10^7	2.983	53.085	74.561	20.722	151.351	1.153×10^6
80.0 TeV	8.000×10^7	3.065	106.962	149.771	43.923	303.722	1.336×10^6
100. TeV	1.000×10^8	3.092	133.970	187.420	55.940	380.422	1.394×10^6

TABLE I-16. Muons in Neon Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
10 (Ne)	20.1797	8.385 × 10 ⁻⁴	137.0	0.08064	3.5771	2.0735	4.6421	11.9041	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	6.548				6.548	8.626 × 10 ⁻¹
14.0 MeV	5.616 × 10 ¹	5.126				5.126	1.560 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	4.016				4.017	2.897 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	3.126				3.126	5.758 × 10 ⁰
40.0 MeV	1.003 × 10 ²	2.675				2.675	9.238 × 10 ⁰
80.0 MeV	1.527 × 10 ²	2.019				2.019	2.699 × 10 ¹
100. MeV	1.764 × 10 ²	1.902				1.902	3.723 × 10 ¹
140. MeV	2.218 × 10 ²	1.788				1.788	5.902 × 10 ¹
200. MeV	2.868 × 10 ²	1.732				1.732	9.323 × 10 ¹
247. MeV	3.366 × 10 ²	1.724			0.000	1.724	<i>Minimum ionization</i>
300. MeV	3.917 × 10 ²	1.729			0.000	1.730	1.512 × 10 ²
400. MeV	4.945 × 10 ²	1.756			0.000	1.756	2.086 × 10 ²
800. MeV	8.995 × 10 ²	1.881	0.000		0.000	1.882	4.284 × 10 ²
1.00 GeV	1.101 × 10 ³	1.933	0.000		0.000	1.934	5.332 × 10 ²
1.40 GeV	1.502 × 10 ³	2.018	0.000	0.000	0.001	2.019	7.354 × 10 ²
2.00 GeV	2.103 × 10 ³	2.114	0.001	0.000	0.001	2.116	1.025 × 10 ³
3.00 GeV	3.104 × 10 ³	2.226	0.001	0.001	0.001	2.230	1.485 × 10 ³
4.00 GeV	4.104 × 10 ³	2.307	0.002	0.001	0.002	2.312	1.925 × 10 ³
8.00 GeV	8.105 × 10 ³	2.502	0.005	0.005	0.004	2.515	3.575 × 10 ³
10.0 GeV	1.011 × 10 ⁴	2.565	0.006	0.006	0.005	2.582	4.360 × 10 ³
14.0 GeV	1.411 × 10 ⁴	2.652	0.010	0.010	0.006	2.678	5.878 × 10 ³
20.0 GeV	2.011 × 10 ⁴	2.729	0.015	0.017	0.009	2.770	8.079 × 10 ³
30.0 GeV	3.011 × 10 ⁴	2.809	0.024	0.030	0.013	2.876	1.162 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	2.860	0.034	0.043	0.017	2.955	1.505 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	2.970	0.077	0.105	0.033	3.186	2.805 × 10 ⁴
100. GeV	1.001 × 10 ⁵	3.002	0.100	0.138	0.041	3.282	3.424 × 10 ⁴
140. GeV	1.401 × 10 ⁵	3.047	0.148	0.207	0.057	3.459	4.610 × 10 ⁴
200. GeV	2.001 × 10 ⁵	3.092	0.222	0.316	0.081	3.712	6.284 × 10 ⁴
300. GeV	3.001 × 10 ⁵	3.141	0.350	0.501	0.122	4.114	8.841 × 10 ⁴
400. GeV	4.001 × 10 ⁵	3.174	0.482	0.693	0.162	4.511	1.116 × 10 ⁵
800. GeV	8.001 × 10 ⁵	3.250	1.032	1.490	0.328	6.101	1.876 × 10 ⁵
906. GeV	9.065 × 10 ⁵	3.263	1.182	1.708	0.373	6.527	<i>Muon critical energy</i>
1.00 TeV	1.000 × 10 ⁶	3.274	1.316	1.902	0.413	6.904	2.184 × 10 ⁵
1.40 TeV	1.400 × 10 ⁶	3.310	1.886	2.719	0.585	8.500	2.705 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	3.348	2.762	3.970	0.847	10.926	3.326 × 10 ⁵
3.00 TeV	3.000 × 10 ⁶	3.391	4.227	6.052	1.297	14.967	4.105 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	3.423	5.716	8.161	1.754	19.055	4.696 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	3.500	11.738	16.651	3.659	35.548	6.209 × 10 ⁵
10.0 TeV	1.000 × 10 ⁷	3.525	14.780	20.925	4.639	43.869	6.714 × 10 ⁵
14.0 TeV	1.400 × 10 ⁷	3.563	20.849	29.443	6.656	60.512	7.488 × 10 ⁵
20.0 TeV	2.000 × 10 ⁷	3.605	30.022	42.286	9.754	85.667	8.317 × 10 ⁵
30.0 TeV	3.000 × 10 ⁷	3.653	45.295	63.660	15.126	127.734	9.267 × 10 ⁵
40.0 TeV	4.000 × 10 ⁷	3.688	60.640	85.099	20.637	170.063	9.943 × 10 ⁵
80.0 TeV	8.000 × 10 ⁷	3.773	122.163	170.927	43.730	340.594	1.157 × 10 ⁶
100. TeV	1.000 × 10 ⁸	3.801	153.000	213.890	55.690	426.382	1.210 × 10 ⁶

TABLE I-17. Muons in Liquid Neon

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
10 (Ne)	20.1797	1.204	137.0	0.16916	3.0000	0.2000	3.0000	4.6345	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	6.556				6.556	8.598×10^{-1}
14.0 MeV	5.616×10^1	5.130				5.130	1.557×10^0
20.0 MeV	6.802×10^1	4.019				4.019	2.893×10^0
30.0 MeV	8.509×10^1	3.127				3.127	5.753×10^0
40.0 MeV	1.003×10^2	2.676				2.676	9.232×10^0
80.0 MeV	1.527×10^2	2.019				2.019	2.698×10^1
100. MeV	1.764×10^2	1.900				1.900	3.722×10^1
140. MeV	2.218×10^2	1.779				1.779	5.907×10^1
200. MeV	2.868×10^2	1.713				1.713	9.357×10^1
283. MeV	3.738×10^2	1.695			0.000	1.695	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.695			0.000	1.696	1.524×10^2
400. MeV	4.945×10^2	1.709			0.000	1.709	2.112×10^2
800. MeV	8.995×10^2	1.792	0.000		0.000	1.793	4.396×10^2
1.00 GeV	1.101×10^3	1.828	0.000		0.000	1.829	5.500×10^2
1.40 GeV	1.502×10^3	1.885	0.000	0.000	0.001	1.886	7.652×10^2
2.00 GeV	2.103×10^3	1.947	0.001	0.000	0.001	1.950	1.078×10^3
3.00 GeV	3.104×10^3	2.018	0.001	0.001	0.001	2.022	1.581×10^3
4.00 GeV	4.104×10^3	2.066	0.002	0.001	0.002	2.072	2.069×10^3
8.00 GeV	8.105×10^3	2.176	0.005	0.005	0.004	2.190	3.941×10^3
10.0 GeV	1.011×10^4	2.209	0.006	0.006	0.005	2.227	4.846×10^3
14.0 GeV	1.411×10^4	2.257	0.010	0.010	0.006	2.283	6.619×10^3
20.0 GeV	2.011×10^4	2.304	0.015	0.017	0.009	2.345	9.210×10^3
30.0 GeV	3.011×10^4	2.354	0.024	0.030	0.013	2.421	1.340×10^4
40.0 GeV	4.011×10^4	2.388	0.034	0.043	0.017	2.483	1.748×10^4
80.0 GeV	8.011×10^4	2.463	0.077	0.105	0.033	2.679	3.296×10^4
100. GeV	1.001×10^5	2.487	0.100	0.138	0.041	2.767	4.031×10^4
140. GeV	1.401×10^5	2.521	0.148	0.207	0.057	2.934	5.434×10^4
200. GeV	2.001×10^5	2.558	0.222	0.316	0.081	3.178	7.399×10^4
300. GeV	3.001×10^5	2.599	0.350	0.501	0.122	3.572	1.037×10^5
400. GeV	4.001×10^5	2.628	0.482	0.693	0.162	3.966	1.302×10^5
759. GeV	7.594×10^5	2.694	0.975	1.407	0.311	5.388	<i>Muon critical energy</i>
800. GeV	8.001×10^5	2.699	1.032	1.490	0.328	5.550	2.151×10^5
1.00 TeV	1.000×10^6	2.722	1.316	1.902	0.413	6.352	2.487×10^5
1.40 TeV	1.400×10^6	2.757	1.886	2.719	0.585	7.948	3.049×10^5
2.00 TeV	2.000×10^6	2.795	2.762	3.970	0.847	10.373	3.708×10^5
3.00 TeV	3.000×10^6	2.838	4.227	6.052	1.297	14.414	4.523×10^5
4.00 TeV	4.000×10^6	2.870	5.716	8.161	1.754	18.501	5.134×10^5
8.00 TeV	8.000×10^6	2.947	11.738	16.651	3.659	34.995	6.680×10^5
10.0 TeV	1.000×10^7	2.972	14.780	20.925	4.639	43.316	7.193×10^5
14.0 TeV	1.400×10^7	3.010	20.849	29.443	6.656	59.959	7.974×10^5
20.0 TeV	2.000×10^7	3.052	30.022	42.286	9.754	85.114	8.810×10^5
30.0 TeV	3.000×10^7	3.100	45.295	63.660	15.126	127.181	9.765×10^5
40.0 TeV	4.000×10^7	3.135	60.640	85.099	20.637	169.510	1.044×10^6
80.0 TeV	8.000×10^7	3.220	122.163	170.927	43.730	340.041	1.208×10^6
100. TeV	1.000×10^8	3.248	153.000	213.890	55.690	425.829	1.260×10^6

TABLE I-18. Muons in Sodium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
11 (Na)	22.989770	0.971	149.0	0.07772	3.6452	0.2880	3.1962	5.0526	0.08

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	6.245				6.245	9.055 × 10 ⁻¹
14.0 MeV	5.616 × 10 ¹	4.891				4.891	1.637 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	3.833				3.833	3.038 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	2.985				2.985	6.035 × 10 ⁰
40.0 MeV	1.003 × 10 ²	2.554				2.554	9.680 × 10 ⁰
80.0 MeV	1.527 × 10 ²	1.926				1.926	2.828 × 10 ¹
100. MeV	1.764 × 10 ²	1.813				1.813	3.901 × 10 ¹
140. MeV	2.218 × 10 ²	1.704				1.704	6.187 × 10 ¹
200. MeV	2.868 × 10 ²	1.650				1.650	9.777 × 10 ¹
263. MeV	3.527 × 10 ²	1.639			0.000	1.639	<i>Minimum ionization</i>
300. MeV	3.917 × 10 ²	1.641			0.000	1.641	1.587 × 10 ²
400. MeV	4.945 × 10 ²	1.658			0.000	1.659	2.193 × 10 ²
800. MeV	8.995 × 10 ²	1.747	0.000		0.000	1.747	4.541 × 10 ²
1.00 GeV	1.101 × 10 ³	1.783	0.000		0.000	1.784	5.674 × 10 ²
1.40 GeV	1.502 × 10 ³	1.840	0.000	0.000	0.001	1.841	7.879 × 10 ²
2.00 GeV	2.103 × 10 ³	1.901	0.001	0.000	0.001	1.903	1.108 × 10 ³
3.00 GeV	3.104 × 10 ³	1.969	0.001	0.001	0.001	1.973	1.623 × 10 ³
4.00 GeV	4.104 × 10 ³	2.016	0.002	0.002	0.002	2.022	2.124 × 10 ³
8.00 GeV	8.105 × 10 ³	2.122	0.005	0.005	0.004	2.135	4.042 × 10 ³
10.0 GeV	1.011 × 10 ⁴	2.153	0.007	0.007	0.005	2.171	4.971 × 10 ³
14.0 GeV	1.411 × 10 ⁴	2.198	0.010	0.011	0.006	2.226	6.789 × 10 ³
20.0 GeV	2.011 × 10 ⁴	2.244	0.015	0.018	0.009	2.286	9.447 × 10 ³
30.0 GeV	3.011 × 10 ⁴	2.292	0.025	0.031	0.013	2.361	1.375 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	2.324	0.036	0.046	0.017	2.423	1.793 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	2.397	0.081	0.110	0.033	2.621	3.377 × 10 ⁴
100. GeV	1.001 × 10 ⁵	2.419	0.105	0.145	0.041	2.711	4.127 × 10 ⁴
140. GeV	1.401 × 10 ⁵	2.453	0.155	0.217	0.057	2.882	5.558 × 10 ⁴
200. GeV	2.001 × 10 ⁵	2.488	0.233	0.332	0.081	3.134	7.554 × 10 ⁴
300. GeV	3.001 × 10 ⁵	2.528	0.367	0.525	0.121	3.541	1.055 × 10 ⁵
400. GeV	4.001 × 10 ⁵	2.556	0.505	0.727	0.161	3.949	1.323 × 10 ⁵
711. GeV	7.113 × 10 ⁵	2.613	0.951	1.373	0.289	5.226	<i>Muon critical energy</i>
800. GeV	8.001 × 10 ⁵	2.624	1.080	1.562	0.326	5.593	2.170 × 10 ⁵
1.00 TeV	1.000 × 10 ⁶	2.647	1.377	1.993	0.409	6.426	2.503 × 10 ⁵
1.40 TeV	1.400 × 10 ⁶	2.681	1.973	2.848	0.580	8.083	3.057 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	2.717	2.888	4.157	0.840	10.603	3.703 × 10 ⁵
3.00 TeV	3.000 × 10 ⁶	2.759	4.420	6.336	1.286	14.801	4.498 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	2.789	5.976	8.542	1.740	19.048	5.092 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	2.863	12.267	17.423	3.628	36.182	6.591 × 10 ⁵
10.0 TeV	1.000 × 10 ⁷	2.888	15.445	21.893	4.600	44.826	7.086 × 10 ⁵
14.0 TeV	1.400 × 10 ⁷	2.925	21.790	30.802	6.599	62.116	7.841 × 10 ⁵
20.0 TeV	2.000 × 10 ⁷	2.965	31.380	44.234	9.668	88.248	8.648 × 10 ⁵
30.0 TeV	3.000 × 10 ⁷	3.011	47.326	66.590	14.989	131.917	9.568 × 10 ⁵
40.0 TeV	4.000 × 10 ⁷	3.045	63.344	89.013	20.447	175.849	1.022 × 10 ⁶
80.0 TeV	8.000 × 10 ⁷	3.127	127.579	178.777	43.311	352.796	1.180 × 10 ⁶
100. TeV	1.000 × 10 ⁸	3.155	159.780	223.710	55.150	441.795	1.230 × 10 ⁶

TABLE I-19. Muons in Magnesium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
12 (Mg)	24.3050	1.740	156.0	0.08163	3.6166	0.1499	3.0668	4.5297	0.08
T	p	Ionization	Brems	Pair prod	Photonucl	Total	CSDA range		
	[MeV/c]			[MeV cm ² /g]			[g/cm ²]		
10.0 MeV	4.704 × 10 ¹	6.400				6.400	8.840 × 10 ⁻¹		
14.0 MeV	5.616 × 10 ¹	5.013				5.013	1.597 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	3.930				3.930	2.964 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	3.060				3.060	5.888 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	2.618				2.618	9.444 × 10 ⁰		
80.0 MeV	1.527 × 10 ²	1.973				1.973	2.760 × 10 ¹		
100. MeV	1.764 × 10 ²	1.860				1.860	3.806 × 10 ¹		
140. MeV	2.218 × 10 ²	1.748				1.748	6.034 × 10 ¹		
200. MeV	2.868 × 10 ²	1.689				1.689	9.539 × 10 ¹		
274. MeV	3.642 × 10 ²	1.674			0.000	1.674	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.675			0.000	1.675	1.550 × 10 ²		
400. MeV	4.945 × 10 ²	1.690			0.000	1.691	2.144 × 10 ²		
800. MeV	8.995 × 10 ²	1.775	0.000		0.000	1.776	4.452 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.811	0.000		0.000	1.811	5.566 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.867	0.001	0.000	0.001	1.868	7.739 × 10 ²		
2.00 GeV	2.103 × 10 ³	1.927	0.001	0.000	0.001	1.929	1.090 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.995	0.002	0.001	0.001	1.999	1.598 × 10 ³		
4.00 GeV	4.104 × 10 ³	2.042	0.002	0.002	0.002	2.048	2.092 × 10 ³		
8.00 GeV	8.105 × 10 ³	2.147	0.006	0.005	0.004	2.162	3.987 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	2.179	0.007	0.007	0.005	2.199	4.904 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	2.225	0.011	0.012	0.006	2.254	6.699 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	2.270	0.017	0.020	0.009	2.317	9.323 × 10 ³		
30.0 GeV	3.011 × 10 ⁴	2.319	0.028	0.035	0.013	2.395	1.356 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	2.352	0.040	0.051	0.017	2.460	1.768 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	2.427	0.091	0.123	0.033	2.673	3.325 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	2.450	0.117	0.162	0.041	2.770	4.060 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	2.485	0.173	0.242	0.057	2.957	5.457 × 10 ⁴		
200. GeV	2.001 × 10 ⁵	2.521	0.260	0.370	0.080	3.231	7.398 × 10 ⁴		
300. GeV	3.001 × 10 ⁵	2.562	0.409	0.585	0.121	3.676	1.030 × 10 ⁵		
400. GeV	4.001 × 10 ⁵	2.591	0.563	0.809	0.161	4.124	1.286 × 10 ⁵		
658. GeV	6.581 × 10 ⁵	2.641	0.972	1.403	0.266	5.283	<i>Muon critical energy</i>		
800. GeV	8.001 × 10 ⁵	2.662	1.203	1.737	0.325	5.927	2.091 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.685	1.532	2.216	0.408	6.841	2.405 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.719	2.196	3.167	0.578	8.661	2.924 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.757	3.213	4.621	0.837	11.428	3.525 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.800	4.915	7.040	1.282	16.039	4.261 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.831	6.645	9.490	1.734	20.701	4.808 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.908	13.634	19.351	3.615	39.509	6.183 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.933	17.164	24.314	4.583	48.995	6.637 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.972	24.212	34.206	6.575	67.965	7.327 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	3.013	34.864	49.118	9.632	96.628	8.064 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	3.061	52.576	73.940	14.931	144.509	8.905 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	3.095	70.366	98.835	20.365	192.663	9.502 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	3.181	141.708	198.490	43.132	386.512	1.094 × 10 ⁶		
100. TeV	1.000 × 10 ⁸	3.209	177.470	248.370	54.920	483.969	1.140 × 10 ⁶		

TABLE I-20. Muons in Aluminum

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
13 (Al)	26.981538	2.699	166.0	0.08024	3.6345	0.1708	3.0127	4.2395	0.12

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	6.188				6.188	9.151×10^{-1}
14.0 MeV	5.616×10^1	4.849				4.849	1.653×10^0
20.0 MeV	6.802×10^1	3.802				3.802	3.066×10^0
30.0 MeV	8.509×10^1	2.960				2.961	6.088×10^0
40.0 MeV	1.003×10^2	2.533				2.533	9.763×10^0
80.0 MeV	1.527×10^2	1.908				1.908	2.853×10^1
100. MeV	1.764×10^2	1.797				1.798	3.935×10^1
140. MeV	2.218×10^2	1.688				1.688	6.242×10^1
200. MeV	2.868×10^2	1.629				1.630	9.873×10^1
277. MeV	3.683×10^2	1.615			0.000	1.615	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.616			0.000	1.616	1.605×10^2
400. MeV	4.945×10^2	1.630			0.000	1.630	2.222×10^2
800. MeV	8.995×10^2	1.710	0.000		0.000	1.711	4.616×10^2
1.00 GeV	1.101×10^3	1.744	0.000		0.000	1.745	5.773×10^2
1.40 GeV	1.502×10^3	1.797	0.001	0.000	0.001	1.799	8.030×10^2
2.00 GeV	2.103×10^3	1.855	0.001	0.000	0.001	1.858	1.131×10^3
3.00 GeV	3.104×10^3	1.920	0.002	0.001	0.001	1.925	1.659×10^3
4.00 GeV	4.104×10^3	1.965	0.002	0.002	0.002	1.971	2.172×10^3
8.00 GeV	8.105×10^3	2.067	0.006	0.006	0.004	2.082	4.140×10^3
10.0 GeV	1.011×10^4	2.097	0.008	0.008	0.005	2.117	5.092×10^3
14.0 GeV	1.411×10^4	2.141	0.012	0.013	0.006	2.172	6.956×10^3
20.0 GeV	2.011×10^4	2.185	0.018	0.021	0.009	2.233	9.678×10^3
30.0 GeV	3.011×10^4	2.233	0.030	0.037	0.013	2.312	1.408×10^4
40.0 GeV	4.011×10^4	2.265	0.042	0.054	0.017	2.377	1.834×10^4
80.0 GeV	8.011×10^4	2.338	0.095	0.129	0.033	2.594	3.442×10^4
100. GeV	1.001×10^5	2.360	0.123	0.170	0.040	2.694	4.198×10^4
140. GeV	1.401×10^5	2.394	0.181	0.253	0.056	2.885	5.633×10^4
200. GeV	2.001×10^5	2.429	0.272	0.386	0.080	3.167	7.617×10^4
300. GeV	3.001×10^5	2.469	0.427	0.612	0.120	3.628	1.056×10^5
400. GeV	4.001×10^5	2.498	0.588	0.847	0.160	4.093	1.316×10^5
612. GeV	6.117×10^5	2.540	0.939	1.356	0.245	5.080	<i>Muon critical energy</i>
800. GeV	8.001×10^5	2.567	1.257	1.817	0.323	5.964	2.121×10^5
1.00 TeV	1.000×10^6	2.589	1.602	2.317	0.405	6.914	2.432×10^5
1.40 TeV	1.400×10^6	2.623	2.295	3.312	0.575	8.805	2.944×10^5
2.00 TeV	2.000×10^6	2.660	3.357	4.833	0.832	11.682	3.533×10^5
3.00 TeV	3.000×10^6	2.702	5.135	7.362	1.274	16.474	4.251×10^5
4.00 TeV	4.000×10^6	2.732	6.941	9.923	1.723	21.320	4.783×10^5
8.00 TeV	8.000×10^6	2.807	14.238	20.228	3.590	40.865	6.115×10^5
10.0 TeV	1.000×10^7	2.832	17.923	25.414	4.551	50.720	6.554×10^5
14.0 TeV	1.400×10^7	2.869	25.280	35.752	6.528	70.429	7.220×10^5
20.0 TeV	2.000×10^7	2.910	36.398	51.336	9.562	100.206	7.931×10^5
30.0 TeV	3.000×10^7	2.956	54.885	77.275	14.821	149.938	8.741×10^5
40.0 TeV	4.000×10^7	2.990	73.453	103.289	20.213	199.946	9.317×10^5
80.0 TeV	8.000×10^7	3.073	147.903	207.426	42.793	401.196	1.070×10^6
100. TeV	1.000×10^8	3.100	185.220	259.550	54.480	502.351	1.115×10^6

TABLE I-21. Muons in Silicon

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
14 (Si)	28.0855	2.329	173.0	0.14921	3.2546	0.2015	2.8716	4.4355	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	6.363				6.363	8.904×10^{-1}		
14.0 MeV	5.616×10^1	4.987				4.987	1.608×10^0		
20.0 MeV	6.802×10^1	3.912				3.912	2.981×10^0		
30.0 MeV	8.509×10^1	3.047				3.047	5.918×10^0		
40.0 MeV	1.003×10^2	2.608				2.608	9.488×10^0		
80.0 MeV	1.527×10^2	1.965				1.965	2.771×10^1		
100. MeV	1.764×10^2	1.849				1.849	3.824×10^1		
140. MeV	2.218×10^2	1.737				1.737	6.065×10^1		
200. MeV	2.868×10^2	1.678				1.678	9.591×10^1		
273. MeV	3.633×10^2	1.664			0.000	1.664	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.665			0.000	1.666	1.559×10^2		
400. MeV	4.945×10^2	1.681			0.000	1.681	2.157×10^2		
800. MeV	8.995×10^2	1.767	0.000		0.000	1.768	4.475×10^2		
1.00 GeV	1.101×10^3	1.803	0.000		0.000	1.804	5.595×10^2		
1.40 GeV	1.502×10^3	1.860	0.001	0.000	0.001	1.862	7.776×10^2		
2.00 GeV	2.103×10^3	1.922	0.001	0.001	0.001	1.924	1.094×10^3		
3.00 GeV	3.104×10^3	1.991	0.002	0.001	0.001	1.995	1.604×10^3		
4.00 GeV	4.104×10^3	2.038	0.003	0.002	0.002	2.045	2.099×10^3		
8.00 GeV	8.105×10^3	2.145	0.006	0.006	0.004	2.162	3.994×10^3		
10.0 GeV	1.011×10^4	2.177	0.009	0.009	0.005	2.199	4.911×10^3		
14.0 GeV	1.411×10^4	2.224	0.013	0.014	0.006	2.257	6.705×10^3		
20.0 GeV	2.011×10^4	2.270	0.020	0.023	0.009	2.322	9.324×10^3		
30.0 GeV	3.011×10^4	2.319	0.033	0.041	0.013	2.405	1.355×10^4		
40.0 GeV	4.011×10^4	2.352	0.046	0.059	0.017	2.475	1.765×10^4		
80.0 GeV	8.011×10^4	2.427	0.105	0.143	0.033	2.708	3.308×10^4		
100. GeV	1.001×10^5	2.451	0.136	0.188	0.040	2.815	4.032×10^4		
140. GeV	1.401×10^5	2.485	0.200	0.280	0.056	3.022	5.403×10^4		
200. GeV	2.001×10^5	2.522	0.300	0.427	0.080	3.329	7.294×10^4		
300. GeV	3.001×10^5	2.563	0.472	0.677	0.119	3.833	1.009×10^5		
400. GeV	4.001×10^5	2.593	0.651	0.938	0.159	4.341	1.254×10^5		
581. GeV	5.808×10^5	2.631	0.981	1.419	0.232	5.262	<i>Muon critical energy</i>		
800. GeV	8.001×10^5	2.664	1.389	2.008	0.322	6.384	2.009×10^5		
1.00 TeV	1.000×10^6	2.687	1.770	2.558	0.404	7.420	2.300×10^5		
1.40 TeV	1.400×10^6	2.723	2.535	3.654	0.573	9.486	2.775×10^5		
2.00 TeV	2.000×10^6	2.760	3.708	5.332	0.830	12.631	3.322×10^5		
3.00 TeV	3.000×10^6	2.804	5.670	8.121	1.270	17.866	3.985×10^5		
4.00 TeV	4.000×10^6	2.836	7.662	10.944	1.718	23.161	4.475×10^5		
8.00 TeV	8.000×10^6	2.913	15.713	22.305	3.581	44.511	5.699×10^5		
10.0 TeV	1.000×10^7	2.938	19.777	28.021	4.539	55.276	6.102×10^5		
14.0 TeV	1.400×10^7	2.977	27.892	39.417	6.510	76.797	6.713×10^5		
20.0 TeV	2.000×10^7	3.019	40.156	56.594	9.536	109.306	7.365×10^5		
30.0 TeV	3.000×10^7	3.067	60.546	85.187	14.778	163.579	8.108×10^5		
40.0 TeV	4.000×10^7	3.102	81.023	113.863	20.152	218.141	8.635×10^5		
80.0 TeV	8.000×10^7	3.188	163.133	228.648	42.660	437.630	9.904×10^5		
100. TeV	1.000×10^8	3.216	204.290	286.100	54.310	547.917	1.031×10^6		

TABLE I-22. Muons in Phosphorus

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
15 (P)	30.973761	2.200	173.0	0.23610	2.9158	0.1696	2.7815	4.5214	0.14
T	p	Ionization	Brems	Pair prod	Photonucl	Total	CSDA range		
	[MeV/c]			[MeV cm ² /g]			[g/cm ²]		
10.0 MeV	4.704×10^1	6.182				6.182	9.163×10^{-1}		
14.0 MeV	5.616×10^1	4.845				4.845	1.655×10^0		
20.0 MeV	6.802×10^1	3.800				3.800	3.069×10^0		
30.0 MeV	8.509×10^1	2.959				2.959	6.092×10^0		
40.0 MeV	1.003×10^2	2.532				2.532	9.769×10^0		
80.0 MeV	1.527×10^2	1.907				1.907	2.854×10^1		
100. MeV	1.764×10^2	1.795				1.795	3.938×10^1		
140. MeV	2.218×10^2	1.685				1.685	6.249×10^1		
200. MeV	2.868×10^2	1.627				1.627	9.886×10^1		
273. MeV	3.633×10^2	1.613			0.000	1.613	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.614			0.000	1.614	1.607×10^2		
400. MeV	4.945×10^2	1.629			0.000	1.629	2.225×10^2		
800. MeV	8.995×10^2	1.714	0.000		0.000	1.714	4.617×10^2		
1.00 GeV	1.101×10^3	1.749	0.000		0.000	1.750	5.771×10^2		
1.40 GeV	1.502×10^3	1.805	0.001	0.000	0.001	1.807	8.019×10^2		
2.00 GeV	2.103×10^3	1.867	0.001	0.001	0.001	1.869	1.128×10^3		
3.00 GeV	3.104×10^3	1.935	0.002	0.001	0.001	1.940	1.652×10^3		
4.00 GeV	4.104×10^3	1.982	0.003	0.002	0.002	1.989	2.161×10^3		
8.00 GeV	8.105×10^3	2.089	0.007	0.007	0.004	2.106	4.109×10^3		
10.0 GeV	1.011×10^4	2.120	0.009	0.009	0.005	2.143	5.050×10^3		
14.0 GeV	1.411×10^4	2.166	0.013	0.015	0.006	2.200	6.891×10^3		
20.0 GeV	2.011×10^4	2.211	0.021	0.024	0.009	2.265	9.577×10^3		
30.0 GeV	3.011×10^4	2.259	0.034	0.042	0.013	2.348	1.391×10^4		
40.0 GeV	4.011×10^4	2.291	0.048	0.061	0.017	2.417	1.811×10^4		
80.0 GeV	8.011×10^4	2.364	0.108	0.148	0.032	2.653	3.387×10^4		
100. GeV	1.001×10^5	2.387	0.140	0.194	0.040	2.762	4.126×10^4		
140. GeV	1.401×10^5	2.421	0.206	0.290	0.056	2.974	5.521×10^4		
200. GeV	2.001×10^5	2.457	0.310	0.441	0.079	3.287	7.440×10^4		
300. GeV	3.001×10^5	2.497	0.487	0.700	0.119	3.803	1.027×10^5		
400. GeV	4.001×10^5	2.525	0.671	0.969	0.158	4.324	1.273×10^5		
551. GeV	5.510×10^5	2.557	0.955	1.384	0.218	5.115	<i>Muon critical energy</i>		
800. GeV	8.001×10^5	2.595	1.432	2.074	0.320	6.421	2.027×10^5		
1.00 TeV	1.000×10^6	2.617	1.825	2.640	0.402	7.485	2.316×10^5		
1.40 TeV	1.400×10^6	2.651	2.613	3.772	0.570	9.606	2.786×10^5		
2.00 TeV	2.000×10^6	2.688	3.821	5.502	0.824	12.837	3.325×10^5		
3.00 TeV	3.000×10^6	2.731	5.843	8.379	1.262	18.215	3.976×10^5		
4.00 TeV	4.000×10^6	2.761	7.895	11.290	1.707	23.655	4.456×10^5		
8.00 TeV	8.000×10^6	2.836	16.187	23.005	3.557	45.586	5.653×10^5		
10.0 TeV	1.000×10^7	2.861	20.373	28.899	4.508	56.642	6.046×10^5		
14.0 TeV	1.400×10^7	2.899	28.730	40.650	6.465	78.745	6.642×10^5		
20.0 TeV	2.000×10^7	2.939	41.358	58.362	9.468	112.128	7.278×10^5		
30.0 TeV	3.000×10^7	2.986	62.356	87.844	14.672	167.859	8.002×10^5		
40.0 TeV	4.000×10^7	3.020	83.442	117.411	20.007	223.881	8.516×10^5		
80.0 TeV	8.000×10^7	3.104	167.987	235.768	42.342	449.202	9.753×10^5		
100. TeV	1.000×10^8	3.131	210.360	295.010	53.900	562.402	1.015×10^6		

TABLE I-23. Muons in Sulfur
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
16 (S)	32.066	2.000	180.0	0.33992	2.6456	0.1580	2.7159	4.6659	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	6.332				6.332	8.951 × 10 ⁻¹		
14.0 MeV	5.616 × 10 ¹	4.964				4.964	1.616 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	3.894				3.894	2.996 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	3.033				3.033	5.946 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	2.596				2.596	9.533 × 10 ⁰		
80.0 MeV	1.527 × 10 ²	1.955				1.955	2.785 × 10 ¹		
100. MeV	1.764 × 10 ²	1.840				1.840	3.842 × 10 ¹		
140. MeV	2.218 × 10 ²	1.726				1.727	6.096 × 10 ¹		
200. MeV	2.868 × 10 ²	1.667				1.667	9.646 × 10 ¹		
273. MeV	3.633 × 10 ²	1.652			0.000	1.653	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.654			0.000	1.654	1.569 × 10 ²		
400. MeV	4.945 × 10 ²	1.670	0.000		0.000	1.670	2.171 × 10 ²		
800. MeV	8.995 × 10 ²	1.759	0.000		0.000	1.760	4.503 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.796	0.000		0.000	1.797	5.627 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.855	0.001	0.000	0.001	1.857	7.815 × 10 ²		
2.00 GeV	2.103 × 10 ³	1.920	0.001	0.001	0.001	1.922	1.099 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.992	0.002	0.001	0.001	1.997	1.608 × 10 ³		
4.00 GeV	4.104 × 10 ³	2.042	0.003	0.002	0.002	2.049	2.102 × 10 ³		
8.00 GeV	8.105 × 10 ³	2.154	0.007	0.007	0.004	2.172	3.991 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	2.187	0.010	0.010	0.004	2.212	4.904 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	2.235	0.015	0.016	0.006	2.272	6.686 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	2.282	0.023	0.026	0.009	2.341	9.286 × 10 ³		
30.0 GeV	3.011 × 10 ⁴	2.332	0.037	0.046	0.013	2.428	1.348 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	2.366	0.052	0.067	0.017	2.502	1.753 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	2.441	0.118	0.161	0.032	2.754	3.275 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	2.465	0.153	0.212	0.040	2.871	3.986 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	2.499	0.226	0.317	0.056	3.098	5.327 × 10 ⁴		
200. GeV	2.001 × 10 ⁵	2.536	0.339	0.482	0.079	3.436	7.165 × 10 ⁴		
300. GeV	3.001 × 10 ⁵	2.577	0.532	0.764	0.118	3.993	9.863 × 10 ⁴		
400. GeV	4.001 × 10 ⁵	2.607	0.733	1.057	0.158	4.555	1.221 × 10 ⁵		
526. GeV	5.260 × 10 ⁵	2.635	0.991	1.436	0.208	5.270	<i>Muon critical energy</i>		
800. GeV	8.001 × 10 ⁵	2.678	1.564	2.263	0.319	6.824	1.933 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.702	1.992	2.880	0.401	7.975	2.204 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.737	2.852	4.114	0.568	10.271	2.645 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.775	4.170	6.000	0.823	13.768	3.148 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.819	6.375	9.135	1.259	19.588	3.754 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.850	8.613	12.307	1.703	25.474	4.200 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.927	17.655	25.073	3.549	49.205	5.310 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.953	22.219	31.495	4.498	61.165	5.674 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.992	31.331	44.300	6.450	85.073	6.226 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	3.034	45.098	63.598	9.446	121.176	6.814 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	3.082	67.988	95.722	14.635	181.428	7.484 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	3.117	90.974	127.937	19.954	241.983	7.960 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	3.203	183.132	256.894	42.225	485.454	9.104 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	3.231	229.320	321.440	53.750	607.742	9.472 × 10 ⁵		

TABLE I-24. Muons in Chlorine Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
17 (Cl)	35.4527	2.995×10^{-3}	174.0	0.19849	2.9702	1.5555	4.2994	11.1421	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	6.123				6.123	9.253×10^{-1}		
14.0 MeV	5.616×10^1	4.800				4.800	1.671×10^0		
20.0 MeV	6.802×10^1	3.766				3.766	3.098×10^0		
30.0 MeV	8.509×10^1	2.936				2.936	6.147×10^0		
40.0 MeV	1.003×10^2	2.514				2.514	9.851×10^0		
80.0 MeV	1.527×10^2	1.901				1.901	2.872×10^1		
100. MeV	1.764×10^2	1.792				1.792	3.958×10^1		
140. MeV	2.218×10^2	1.687				1.687	6.269×10^1		
200. MeV	2.868×10^2	1.636				1.636	9.893×10^1		
246. MeV	3.356×10^2	1.630			0.000	1.630	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.636			0.000	1.636	1.602×10^2		
400. MeV	4.945×10^2	1.662	0.000		0.000	1.662	2.209×10^2		
800. MeV	8.995×10^2	1.784	0.000		0.000	1.785	4.528×10^2		
1.00 GeV	1.101×10^3	1.835	0.000		0.000	1.836	5.632×10^2		
1.40 GeV	1.502×10^3	1.917	0.001	0.000	0.001	1.919	7.761×10^2		
2.00 GeV	2.103×10^3	2.010	0.001	0.001	0.001	2.013	1.081×10^3		
3.00 GeV	3.104×10^3	2.119	0.002	0.001	0.001	2.124	1.564×10^3		
4.00 GeV	4.104×10^3	2.196	0.003	0.002	0.002	2.204	2.026×10^3		
8.00 GeV	8.105×10^3	2.367	0.007	0.007	0.004	2.385	3.761×10^3		
10.0 GeV	1.011×10^4	2.417	0.010	0.010	0.004	2.442	4.590×10^3		
14.0 GeV	1.411×10^4	2.489	0.015	0.016	0.006	2.527	6.198×10^3		
20.0 GeV	2.011×10^4	2.560	0.023	0.027	0.009	2.619	8.528×10^3		
30.0 GeV	3.011×10^4	2.634	0.038	0.047	0.013	2.731	1.226×10^4		
40.0 GeV	4.011×10^4	2.682	0.053	0.068	0.016	2.820	1.586×10^4		
80.0 GeV	8.011×10^4	2.786	0.120	0.164	0.032	3.103	2.935×10^4		
100. GeV	1.001×10^5	2.817	0.155	0.216	0.040	3.228	3.567×10^4		
140. GeV	1.401×10^5	2.860	0.228	0.323	0.055	3.467	4.762×10^4		
200. GeV	2.001×10^5	2.903	0.343	0.493	0.078	3.818	6.411×10^4		
300. GeV	3.001×10^5	2.950	0.539	0.778	0.118	4.385	8.853×10^4		
400. GeV	4.001×10^5	2.981	0.742	1.074	0.157	4.955	1.100×10^5		
591. GeV	5.907×10^5	3.023	1.139	1.652	0.232	6.046	<i>Muon critical energy</i>		
800. GeV	8.001×10^5	3.054	1.583	2.294	0.317	7.250	1.763×10^5		
1.00 TeV	1.000×10^6	3.077	2.016	2.920	0.398	8.413	2.019×10^5		
1.40 TeV	1.400×10^6	3.112	2.887	4.170	0.565	10.734	2.439×10^5		
2.00 TeV	2.000×10^6	3.148	4.220	6.081	0.817	14.268	2.922×10^5		
3.00 TeV	3.000×10^6	3.190	6.451	9.257	1.251	20.150	3.510×10^5		
4.00 TeV	4.000×10^6	3.221	8.715	12.472	1.692	26.099	3.944×10^5		
8.00 TeV	8.000×10^6	3.295	17.860	25.403	3.524	50.083	5.032×10^5		
10.0 TeV	1.000×10^7	3.319	22.476	31.909	4.466	62.171	5.390×10^5		
14.0 TeV	1.400×10^7	3.357	31.691	44.880	6.403	86.332	5.933×10^5		
20.0 TeV	2.000×10^7	3.397	45.614	64.428	9.376	122.816	6.513×10^5		
30.0 TeV	3.000×10^7	3.444	68.763	96.969	14.525	183.701	7.174×10^5		
40.0 TeV	4.000×10^7	3.477	92.009	129.600	19.802	244.889	7.644×10^5		
80.0 TeV	8.000×10^7	3.560	185.203	260.228	41.886	490.877	8.775×10^5		
100. TeV	1.000×10^8	3.587	231.910	325.610	53.310	614.418	9.139×10^5		

TABLE I-25. Muons in Liquid Chlorine

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
17 (Cl)	35.4527	1.574	174.0	0.18024	3.0000	0.2000	3.0000	4.8776	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	6.131				6.131	9.222 × 10 ⁻¹
14.0 MeV	5.616 × 10 ¹	4.804				4.804	1.667 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	3.768				3.768	3.093 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	2.937				2.937	6.140 × 10 ⁰
40.0 MeV	1.003 × 10 ²	2.515				2.515	9.843 × 10 ⁰
80.0 MeV	1.527 × 10 ²	1.901				1.901	2.871 × 10 ¹
100. MeV	1.764 × 10 ²	1.791				1.792	3.957 × 10 ¹
140. MeV	2.218 × 10 ²	1.681				1.681	6.272 × 10 ¹
200. MeV	2.868 × 10 ²	1.622				1.623	9.919 × 10 ¹
274. MeV	3.642 × 10 ²	1.608			0.000	1.609	<i>Minimum ionization</i>
300. MeV	3.917 × 10 ²	1.609			0.000	1.610	1.612 × 10 ²
400. MeV	4.945 × 10 ²	1.624	0.000		0.000	1.625	2.231 × 10 ²
800. MeV	8.995 × 10 ²	1.709	0.000		0.000	1.710	4.629 × 10 ²
1.00 GeV	1.101 × 10 ³	1.745	0.000		0.000	1.746	5.786 × 10 ²
1.40 GeV	1.502 × 10 ³	1.801	0.001	0.000	0.001	1.803	8.039 × 10 ²
2.00 GeV	2.103 × 10 ³	1.863	0.001	0.001	0.001	1.866	1.131 × 10 ³
3.00 GeV	3.104 × 10 ³	1.932	0.002	0.001	0.001	1.937	1.656 × 10 ³
4.00 GeV	4.104 × 10 ³	1.980	0.003	0.002	0.002	1.987	2.165 × 10 ³
8.00 GeV	8.105 × 10 ³	2.088	0.007	0.007	0.004	2.106	4.114 × 10 ³
10.0 GeV	1.011 × 10 ⁴	2.120	0.010	0.010	0.004	2.144	5.054 × 10 ³
14.0 GeV	1.411 × 10 ⁴	2.166	0.015	0.016	0.006	2.204	6.893 × 10 ³
20.0 GeV	2.011 × 10 ⁴	2.212	0.023	0.027	0.009	2.271	9.574 × 10 ³
30.0 GeV	3.011 × 10 ⁴	2.261	0.038	0.047	0.013	2.358	1.389 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	2.293	0.053	0.068	0.016	2.431	1.807 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	2.366	0.120	0.164	0.032	2.683	3.370 × 10 ⁴
100. GeV	1.001 × 10 ⁵	2.389	0.155	0.216	0.040	2.800	4.100 × 10 ⁴
140. GeV	1.401 × 10 ⁵	2.423	0.228	0.323	0.055	3.030	5.473 × 10 ⁴
200. GeV	2.001 × 10 ⁵	2.458	0.343	0.493	0.078	3.372	7.349 × 10 ⁴
300. GeV	3.001 × 10 ⁵	2.498	0.539	0.778	0.118	3.933	1.009 × 10 ⁵
400. GeV	4.001 × 10 ⁵	2.526	0.742	1.074	0.157	4.500	1.247 × 10 ⁵
504. GeV	5.044 × 10 ⁵	2.549	0.959	1.392	0.198	5.098	<i>Muon critical energy</i>
800. GeV	8.001 × 10 ⁵	2.594	1.583	2.294	0.317	6.790	1.966 × 10 ⁵
1.00 TeV	1.000 × 10 ⁶	2.617	2.016	2.920	0.398	7.952	2.238 × 10 ⁵
1.40 TeV	1.400 × 10 ⁶	2.651	2.887	4.170	0.565	10.273	2.679 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	2.687	4.220	6.081	0.817	13.806	3.181 × 10 ⁵
3.00 TeV	3.000 × 10 ⁶	2.729	6.451	9.257	1.251	19.689	3.785 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	2.759	8.715	12.472	1.692	25.638	4.229 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	2.834	17.860	25.403	3.524	49.622	5.330 × 10 ⁵
10.0 TeV	1.000 × 10 ⁷	2.858	22.476	31.909	4.466	61.710	5.691 × 10 ⁵
14.0 TeV	1.400 × 10 ⁷	2.896	31.691	44.880	6.403	85.871	6.238 × 10 ⁵
20.0 TeV	2.000 × 10 ⁷	2.936	45.614	64.428	9.376	122.354	6.821 × 10 ⁵
30.0 TeV	3.000 × 10 ⁷	2.982	68.763	96.969	14.525	183.240	7.484 × 10 ⁵
40.0 TeV	4.000 × 10 ⁷	3.016	92.009	129.600	19.802	244.427	7.955 × 10 ⁵
80.0 TeV	8.000 × 10 ⁷	3.098	185.203	260.228	41.886	490.416	9.088 × 10 ⁵
100. TeV	1.000 × 10 ⁸	3.126	231.910	325.610	53.310	613.956	9.451 × 10 ⁵

TABLE I-26. Muons in Argon Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
18 (Ar)	39.948	1.662×10^{-3}	188.0	0.19714	2.9618	1.7635	4.4855	11.9480	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	5.687				5.687	9.974×10^{-1}		
14.0 MeV	5.616×10^1	4.461				4.461	1.800×10^0		
20.0 MeV	6.802×10^1	3.502				3.502	3.335×10^0		
30.0 MeV	8.509×10^1	2.731				2.731	6.612×10^0		
40.0 MeV	1.003×10^2	2.340				2.340	1.059×10^1		
80.0 MeV	1.527×10^2	1.771				1.771	3.086×10^1		
100. MeV	1.764×10^2	1.670				1.670	4.252×10^1		
140. MeV	2.218×10^2	1.572				1.572	6.732×10^1		
200. MeV	2.868×10^2	1.525				1.526	1.062×10^2		
242. MeV	3.316×10^2	1.519			0.000	1.520	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.525			0.000	1.526	1.719×10^2		
400. MeV	4.945×10^2	1.551	0.000		0.000	1.551	2.370×10^2		
800. MeV	8.995×10^2	1.666	0.000		0.000	1.667	4.855×10^2		
1.00 GeV	1.101×10^3	1.714	0.000		0.000	1.715	6.037×10^2		
1.40 GeV	1.502×10^3	1.791	0.001	0.000	0.001	1.793	8.317×10^2		
2.00 GeV	2.103×10^3	1.878	0.001	0.001	0.001	1.881	1.158×10^3		
3.00 GeV	3.104×10^3	1.980	0.002	0.001	0.001	1.985	1.675×10^3		
4.00 GeV	4.104×10^3	2.054	0.003	0.002	0.002	2.061	2.168×10^3		
8.00 GeV	8.105×10^3	2.226	0.007	0.007	0.004	2.244	4.018×10^3		
10.0 GeV	1.011×10^4	2.277	0.010	0.010	0.004	2.301	4.897×10^3		
14.0 GeV	1.411×10^4	2.349	0.015	0.016	0.006	2.386	6.603×10^3		
20.0 GeV	2.011×10^4	2.420	0.023	0.027	0.008	2.478	9.068×10^3		
30.0 GeV	3.011×10^4	2.494	0.037	0.046	0.012	2.590	1.301×10^4		
40.0 GeV	4.011×10^4	2.542	0.052	0.068	0.016	2.679	1.681×10^4		
80.0 GeV	8.011×10^4	2.647	0.118	0.162	0.032	2.960	3.098×10^4		
100. GeV	1.001×10^5	2.677	0.153	0.214	0.039	3.084	3.759×10^4		
140. GeV	1.401×10^5	2.721	0.225	0.320	0.055	3.321	5.009×10^4		
200. GeV	2.001×10^5	2.764	0.338	0.488	0.078	3.668	6.727×10^4		
300. GeV	3.001×10^5	2.810	0.532	0.770	0.117	4.229	9.264×10^4		
400. GeV	4.001×10^5	2.842	0.732	1.063	0.156	4.792	1.148×10^5		
571. GeV	5.709×10^5	2.879	1.082	1.574	0.223	5.759	<i>Muon critical energy</i>		
800. GeV	8.001×10^5	2.913	1.561	2.269	0.314	7.058	1.832×10^5		
1.00 TeV	1.000×10^6	2.935	1.989	2.887	0.395	8.207	2.095×10^5		
1.40 TeV	1.400×10^6	2.969	2.847	4.122	0.560	10.498	2.524×10^5		
2.00 TeV	2.000×10^6	3.003	4.161	6.010	0.810	13.986	3.018×10^5		
3.00 TeV	3.000×10^6	3.043	6.360	9.148	1.240	19.792	3.616×10^5		
4.00 TeV	4.000×10^6	3.071	8.592	12.323	1.677	25.664	4.059×10^5		
8.00 TeV	8.000×10^6	3.141	17.605	25.098	3.493	49.338	5.164×10^5		
10.0 TeV	1.000×10^7	3.164	22.154	31.524	4.427	61.270	5.527×10^5		
14.0 TeV	1.400×10^7	3.199	31.236	44.336	6.347	85.119	6.078×10^5		
20.0 TeV	2.000×10^7	3.237	44.956	63.644	9.292	121.130	6.666×10^5		
30.0 TeV	3.000×10^7	3.281	67.769	95.786	14.391	181.227	7.337×10^5		
40.0 TeV	4.000×10^7	3.312	90.675	128.017	19.616	241.621	7.813×10^5		
80.0 TeV	8.000×10^7	3.390	182.502	257.041	41.480	484.414	8.959×10^5		
100. TeV	1.000×10^8	3.416	228.520	321.620	52.790	606.346	9.328×10^5		

TABLE I-27. Muons in Liquid Argon

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
18 (Ar)	39.948	1.396	188.0	0.19559	3.0000	0.2000	3.0000	5.2146	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	5.696				5.696	9.937×10^{-1}		
14.0 MeV	5.616×10^1	4.466				4.466	1.795×10^0		
20.0 MeV	6.802×10^1	3.505				3.505	3.329×10^0		
30.0 MeV	8.509×10^1	2.732				2.732	6.605×10^0		
40.0 MeV	1.003×10^2	2.341				2.341	1.058×10^1		
80.0 MeV	1.527×10^2	1.771				1.771	3.084×10^1		
100. MeV	1.764×10^2	1.670				1.670	4.250×10^1		
140. MeV	2.218×10^2	1.570				1.570	6.732×10^1		
200. MeV	2.868×10^2	1.519				1.519	1.063×10^2		
266. MeV	3.567×10^2	1.508			0.000	1.508	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.509			0.000	1.510	1.725×10^2		
400. MeV	4.945×10^2	1.526	0.000		0.000	1.526	2.384×10^2		
800. MeV	8.995×10^2	1.610	0.000		0.000	1.610	4.934×10^2		
1.00 GeV	1.101×10^3	1.644	0.000		0.000	1.645	6.163×10^2		
1.40 GeV	1.502×10^3	1.699	0.001	0.000	0.001	1.700	8.552×10^2		
2.00 GeV	2.103×10^3	1.758	0.001	0.001	0.001	1.761	1.202×10^3		
3.00 GeV	3.104×10^3	1.825	0.002	0.001	0.001	1.829	1.758×10^3		
4.00 GeV	4.104×10^3	1.870	0.003	0.002	0.002	1.877	2.297×10^3		
8.00 GeV	8.105×10^3	1.973	0.007	0.007	0.004	1.991	4.359×10^3		
10.0 GeV	1.011×10^4	2.003	0.010	0.010	0.004	2.028	5.354×10^3		
14.0 GeV	1.411×10^4	2.047	0.015	0.016	0.006	2.084	7.298×10^3		
20.0 GeV	2.011×10^4	2.091	0.023	0.027	0.008	2.149	1.013×10^4		
30.0 GeV	3.011×10^4	2.137	0.037	0.046	0.012	2.233	1.469×10^4		
40.0 GeV	4.011×10^4	2.167	0.052	0.068	0.016	2.304	1.910×10^4		
80.0 GeV	8.011×10^4	2.236	0.118	0.162	0.032	2.549	3.558×10^4		
100. GeV	1.001×10^5	2.258	0.153	0.214	0.039	2.664	4.325×10^4		
140. GeV	1.401×10^5	2.289	0.225	0.320	0.055	2.889	5.766×10^4		
200. GeV	2.001×10^5	2.322	0.338	0.488	0.078	3.226	7.730×10^4		
300. GeV	3.001×10^5	2.360	0.532	0.770	0.117	3.778	1.059×10^5		
400. GeV	4.001×10^5	2.386	0.732	1.063	0.156	4.337	1.306×10^5		
483. GeV	4.834×10^5	2.404	0.903	1.313	0.188	4.808	<i>Muon critical energy</i>		
800. GeV	8.001×10^5	2.451	1.561	2.269	0.314	6.596	2.049×10^5		
1.00 TeV	1.000×10^6	2.472	1.989	2.887	0.395	7.743	2.328×10^5		
1.40 TeV	1.400×10^6	2.503	2.847	4.122	0.560	10.033	2.781×10^5		
2.00 TeV	2.000×10^6	2.538	4.161	6.010	0.810	13.520	3.295×10^5		
3.00 TeV	3.000×10^6	2.577	6.360	9.148	1.240	19.326	3.910×10^5		
4.00 TeV	4.000×10^6	2.606	8.592	12.323	1.677	25.199	4.362×10^5		
8.00 TeV	8.000×10^6	2.676	17.605	25.098	3.493	48.872	5.482×10^5		
10.0 TeV	1.000×10^7	2.698	22.154	31.524	4.427	60.804	5.848×10^5		
14.0 TeV	1.400×10^7	2.734	31.236	44.336	6.347	84.653	6.403×10^5		
20.0 TeV	2.000×10^7	2.771	44.956	63.644	9.292	120.664	6.994×10^5		
30.0 TeV	3.000×10^7	2.815	67.769	95.786	14.391	180.761	7.666×10^5		
40.0 TeV	4.000×10^7	2.847	90.675	128.017	19.616	241.155	8.144×10^5		
80.0 TeV	8.000×10^7	2.924	182.502	257.041	41.480	483.948	9.292×10^5		
100. TeV	1.000×10^8	2.950	228.520	321.620	52.790	605.880	9.660×10^5		

TABLE I-28. Muons in Potassium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
19 (K)	39.0983	0.862	190.0	0.19827	2.9233	0.3851	3.1724	5.6423	0.10

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	6.123				6.123	9.265×10^{-1}
14.0 MeV	5.616×10^1	4.803				4.803	1.672×10^0
20.0 MeV	6.802×10^1	3.770				3.770	3.098×10^0
30.0 MeV	8.509×10^1	2.939				2.939	6.143×10^0
40.0 MeV	1.003×10^2	2.518				2.518	9.842×10^0
80.0 MeV	1.527×10^2	1.903				1.903	2.868×10^1
100. MeV	1.764×10^2	1.794				1.794	3.954×10^1
140. MeV	2.218×10^2	1.687				1.687	6.264×10^1
200. MeV	2.868×10^2	1.633				1.633	9.892×10^1
260. MeV	3.496×10^2	1.623			0.000	1.623	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.625			0.000	1.625	1.605×10^2
400. MeV	4.945×10^2	1.644	0.000		0.000	1.645	2.217×10^2
800. MeV	8.995×10^2	1.739	0.000		0.000	1.740	4.579×10^2
1.00 GeV	1.101×10^3	1.778	0.001		0.000	1.779	5.716×10^2
1.40 GeV	1.502×10^3	1.839	0.001	0.000	0.001	1.841	7.925×10^2
2.00 GeV	2.103×10^3	1.905	0.001	0.001	0.001	1.909	1.112×10^3
3.00 GeV	3.104×10^3	1.980	0.002	0.002	0.001	1.986	1.625×10^3
4.00 GeV	4.104×10^3	2.032	0.003	0.003	0.002	2.040	2.122×10^3
8.00 GeV	8.105×10^3	2.147	0.008	0.008	0.004	2.168	4.017×10^3
10.0 GeV	1.011×10^4	2.182	0.011	0.011	0.004	2.209	4.931×10^3
14.0 GeV	1.411×10^4	2.231	0.017	0.019	0.006	2.273	6.715×10^3
20.0 GeV	2.011×10^4	2.280	0.026	0.030	0.008	2.345	9.312×10^3
30.0 GeV	3.011×10^4	2.331	0.042	0.053	0.012	2.439	1.349×10^4
40.0 GeV	4.011×10^4	2.366	0.059	0.077	0.016	2.519	1.752×10^4
80.0 GeV	8.011×10^4	2.442	0.134	0.184	0.032	2.793	3.258×10^4
100. GeV	1.001×10^5	2.465	0.174	0.242	0.039	2.921	3.958×10^4
140. GeV	1.401×10^5	2.499	0.256	0.362	0.055	3.173	5.272×10^4
200. GeV	2.001×10^5	2.535	0.384	0.552	0.078	3.550	7.059×10^4
300. GeV	3.001×10^5	2.575	0.604	0.872	0.117	4.168	9.656×10^4
400. GeV	4.001×10^5	2.604	0.831	1.204	0.156	4.794	1.189×10^5
470. GeV	4.705×10^5	2.620	0.994	1.443	0.183	5.240	<i>Muon critical energy</i>
800. GeV	8.001×10^5	2.673	1.771	2.568	0.315	7.328	1.859×10^5
1.00 TeV	1.000×10^6	2.696	2.256	3.267	0.396	8.615	2.111×10^5
1.40 TeV	1.400×10^6	2.730	3.228	4.664	0.561	11.184	2.517×10^5
2.00 TeV	2.000×10^6	2.767	4.719	6.799	0.812	15.098	2.977×10^5
3.00 TeV	3.000×10^6	2.810	7.211	10.348	1.243	21.612	3.528×10^5
4.00 TeV	4.000×10^6	2.840	9.740	13.939	1.680	28.200	3.932×10^5
8.00 TeV	8.000×10^6	2.916	19.954	28.383	3.499	54.752	4.932×10^5
10.0 TeV	1.000×10^7	2.941	25.108	35.649	4.434	68.132	5.259×10^5
14.0 TeV	1.400×10^7	2.978	35.398	50.141	6.356	94.874	5.754×10^5
20.0 TeV	2.000×10^7	3.019	50.942	71.982	9.306	135.250	6.281×10^5
30.0 TeV	3.000×10^7	3.066	76.787	108.322	14.414	202.591	6.881×10^5
40.0 TeV	4.000×10^7	3.100	102.737	144.760	19.650	270.248	7.307×10^5
80.0 TeV	8.000×10^7	3.184	206.767	290.634	41.557	542.143	8.332×10^5
100. TeV	1.000×10^8	3.212	258.900	363.650	52.890	678.652	8.661×10^5

TABLE I-29. Muons in Calcium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
20 (Ca)	40.078	1.550	191.0	0.15643	3.0745	0.3228	3.1191	5.0396	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	6.282				6.282	9.029×10^{-1}
14.0 MeV	5.616×10^1	4.927				4.927	1.629×10^0
20.0 MeV	6.802×10^1	3.867				3.867	3.019×10^0
30.0 MeV	8.509×10^1	3.015				3.015	5.988×10^0
40.0 MeV	1.003×10^2	2.582				2.582	9.595×10^0
80.0 MeV	1.527×10^2	1.950				1.950	2.798×10^1
100. MeV	1.764×10^2	1.837				1.837	3.857×10^1
140. MeV	2.218×10^2	1.725				1.725	6.115×10^1
200. MeV	2.868×10^2	1.668				1.668	9.665×10^1
267. MeV	3.577×10^2	1.655			0.000	1.656	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.657			0.000	1.657	1.570×10^2
400. MeV	4.945×10^2	1.674	0.000		0.000	1.675	2.170×10^2
800. MeV	8.995×10^2	1.766	0.000		0.000	1.767	4.494×10^2
1.00 GeV	1.101×10^3	1.804	0.001		0.000	1.805	5.613×10^2
1.40 GeV	1.502×10^3	1.864	0.001	0.000	0.001	1.866	7.791×10^2
2.00 GeV	2.103×10^3	1.929	0.001	0.001	0.001	1.933	1.095×10^3
3.00 GeV	3.104×10^3	2.003	0.002	0.002	0.001	2.008	1.602×10^3
4.00 GeV	4.104×10^3	2.053	0.004	0.003	0.002	2.062	2.093×10^3
8.00 GeV	8.105×10^3	2.167	0.009	0.009	0.004	2.189	3.969×10^3
10.0 GeV	1.011×10^4	2.201	0.012	0.012	0.004	2.230	4.874×10^3
14.0 GeV	1.411×10^4	2.250	0.018	0.020	0.006	2.294	6.641×10^3
20.0 GeV	2.011×10^4	2.298	0.028	0.033	0.008	2.367	9.214×10^3
30.0 GeV	3.011×10^4	2.350	0.045	0.057	0.012	2.464	1.335×10^4
40.0 GeV	4.011×10^4	2.384	0.064	0.083	0.016	2.547	1.734×10^4
80.0 GeV	8.011×10^4	2.461	0.145	0.198	0.032	2.836	3.220×10^4
100. GeV	1.001×10^5	2.484	0.188	0.261	0.039	2.973	3.908×10^4
140. GeV	1.401×10^5	2.519	0.276	0.390	0.055	3.240	5.197×10^4
200. GeV	2.001×10^5	2.556	0.414	0.595	0.078	3.642	6.942×10^4
300. GeV	3.001×10^5	2.597	0.650	0.938	0.117	4.302	9.466×10^4
400. GeV	4.001×10^5	2.627	0.894	1.295	0.156	4.972	1.163×10^5
445. GeV	4.452×10^5	2.638	1.006	1.458	0.173	5.276	<i>Muon critical energy</i>
800. GeV	8.001×10^5	2.698	1.906	2.761	0.314	7.680	1.805×10^5
1.00 TeV	1.000×10^6	2.721	2.427	3.513	0.395	9.057	2.045×10^5
1.40 TeV	1.400×10^6	2.757	3.473	5.014	0.560	11.804	2.431×10^5
2.00 TeV	2.000×10^6	2.795	5.076	7.308	0.810	15.989	2.866×10^5
3.00 TeV	3.000×10^6	2.838	7.755	11.121	1.240	22.956	3.385×10^5
4.00 TeV	4.000×10^6	2.870	10.474	14.979	1.677	30.001	3.765×10^5
8.00 TeV	8.000×10^6	2.947	21.453	30.496	3.493	58.390	4.704×10^5
10.0 TeV	1.000×10^7	2.973	26.993	38.302	4.426	72.695	5.010×10^5
14.0 TeV	1.400×10^7	3.012	38.053	53.871	6.345	101.282	5.474×10^5
20.0 TeV	2.000×10^7	3.053	54.760	77.334	9.290	144.438	5.968×10^5
30.0 TeV	3.000×10^7	3.102	82.538	116.374	14.388	216.403	6.530×10^5
40.0 TeV	4.000×10^7	3.137	110.428	155.518	19.612	288.695	6.928×10^5
80.0 TeV	8.000×10^7	3.223	222.227	312.224	41.472	579.146	7.887×10^5
100. TeV	1.000×10^8	3.251	278.250	390.660	52.780	724.942	8.195×10^5

TABLE I-30. Muons in Scandium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
21 (Sc)	44.955910	2.989	216.0	0.15754	3.0517	0.1640	3.0593	4.6949	0.10

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	5.769				5.770	9.853×10^{-1}
14.0 MeV	5.616×10^1	4.529				4.529	1.776×10^0
20.0 MeV	6.802×10^1	3.557				3.557	3.287×10^0
30.0 MeV	8.509×10^1	2.775				2.775	6.514×10^0
40.0 MeV	1.003×10^2	2.377				2.377	1.043×10^1
80.0 MeV	1.527×10^2	1.796				1.796	3.039×10^1
100. MeV	1.764×10^2	1.692				1.692	4.190×10^1
140. MeV	2.218×10^2	1.588				1.588	6.641×10^1
200. MeV	2.868×10^2	1.534				1.535	1.050×10^2
267. MeV	3.577×10^2	1.522			0.000	1.522	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.523			0.000	1.524	1.706×10^2
400. MeV	4.945×10^2	1.539	0.000		0.000	1.539	2.359×10^2
800. MeV	8.995×10^2	1.622	0.000		0.000	1.623	4.889×10^2
1.00 GeV	1.101×10^3	1.656	0.001		0.000	1.657	6.108×10^2
1.40 GeV	1.502×10^3	1.711	0.001	0.000	0.001	1.713	8.480×10^2
2.00 GeV	2.103×10^3	1.771	0.001	0.001	0.001	1.774	1.192×10^3
3.00 GeV	3.104×10^3	1.838	0.002	0.002	0.001	1.844	1.744×10^3
4.00 GeV	4.104×10^3	1.884	0.004	0.003	0.002	1.893	2.279×10^3
8.00 GeV	8.105×10^3	1.989	0.009	0.009	0.004	2.010	4.322×10^3
10.0 GeV	1.011×10^4	2.020	0.011	0.012	0.004	2.049	5.308×10^3
14.0 GeV	1.411×10^4	2.065	0.017	0.020	0.006	2.109	7.231×10^3
20.0 GeV	2.011×10^4	2.110	0.027	0.032	0.008	2.178	1.003×10^4
30.0 GeV	3.011×10^4	2.158	0.044	0.056	0.012	2.270	1.452×10^4
40.0 GeV	4.011×10^4	2.189	0.062	0.081	0.016	2.350	1.885×10^4
80.0 GeV	8.011×10^4	2.261	0.141	0.194	0.031	2.629	3.492×10^4
100. GeV	1.001×10^5	2.283	0.183	0.255	0.039	2.761	4.234×10^4
140. GeV	1.401×10^5	2.316	0.269	0.382	0.054	3.021	5.618×10^4
200. GeV	2.001×10^5	2.350	0.403	0.582	0.077	3.413	7.486×10^4
300. GeV	3.001×10^5	2.389	0.634	0.918	0.116	4.057	1.017×10^5
400. GeV	4.001×10^5	2.416	0.872	1.267	0.154	4.710	1.246×10^5
420. GeV	4.203×10^5	2.421	0.921	1.338	0.162	4.843	<i>Muon critical energy</i>
800. GeV	8.001×10^5	2.483	1.859	2.700	0.312	7.355	1.920×10^5
1.00 TeV	1.000×10^6	2.505	2.367	3.435	0.392	8.700	2.170×10^5
1.40 TeV	1.400×10^6	2.538	3.387	4.903	0.555	11.384	2.571×10^5
2.00 TeV	2.000×10^6	2.574	4.950	7.145	0.804	15.473	3.021×10^5
3.00 TeV	3.000×10^6	2.615	7.563	10.872	1.230	22.280	3.557×10^5
4.00 TeV	4.000×10^6	2.644	10.214	14.642	1.663	29.164	3.948×10^5
8.00 TeV	8.000×10^6	2.716	20.918	29.807	3.463	56.904	4.912×10^5
10.0 TeV	1.000×10^7	2.740	26.318	37.434	4.388	70.881	5.226×10^5
14.0 TeV	1.400×10^7	2.777	37.100	52.649	6.290	98.816	5.702×10^5
20.0 TeV	2.000×10^7	2.816	53.386	75.578	9.208	140.989	6.208×10^5
30.0 TeV	3.000×10^7	2.861	80.465	113.728	14.258	211.313	6.784×10^5
40.0 TeV	4.000×10^7	2.894	107.653	151.979	19.433	281.959	7.192×10^5
80.0 TeV	8.000×10^7	2.974	216.637	305.106	41.077	565.795	8.174×10^5
100. TeV	1.000×10^8	3.001	271.250	381.750	52.270	708.271	8.489×10^5

TABLE I-31. Muons in Titanium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
22 (Ti)	47.867	4.540	233.0	0.15662	3.0302	0.0957	3.0386	4.4450	0.12

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	5.608				5.608	1.015 × 10 ⁰
14.0 MeV	5.616 × 10 ¹	4.404				4.404	1.828 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	3.460				3.460	3.382 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	2.699				2.699	6.699 × 10 ⁰
40.0 MeV	1.003 × 10 ²	2.312				2.312	1.073 × 10 ¹
80.0 MeV	1.527 × 10 ²	1.746				1.746	3.126 × 10 ¹
100. MeV	1.764 × 10 ²	1.644				1.644	4.310 × 10 ¹
140. MeV	2.218 × 10 ²	1.543				1.543	6.833 × 10 ¹
200. MeV	2.868 × 10 ²	1.489				1.490	1.081 × 10 ²
274. MeV	3.642 × 10 ²	1.477			0.000	1.477	<i>Minimum ionization</i>
300. MeV	3.917 × 10 ²	1.478			0.000	1.478	1.756 × 10 ²
400. MeV	4.945 × 10 ²	1.493	0.000		0.000	1.493	2.430 × 10 ²
800. MeV	8.995 × 10 ²	1.573	0.000		0.000	1.573	5.038 × 10 ²
1.00 GeV	1.101 × 10 ³	1.606	0.001		0.000	1.607	6.295 × 10 ²
1.40 GeV	1.502 × 10 ³	1.659	0.001	0.000	0.001	1.661	8.741 × 10 ²
2.00 GeV	2.103 × 10 ³	1.717	0.001	0.001	0.001	1.720	1.229 × 10 ³
3.00 GeV	3.104 × 10 ³	1.783	0.002	0.002	0.001	1.788	1.798 × 10 ³
4.00 GeV	4.104 × 10 ³	1.828	0.004	0.003	0.002	1.836	2.349 × 10 ³
8.00 GeV	8.105 × 10 ³	1.930	0.009	0.009	0.004	1.951	4.455 × 10 ³
10.0 GeV	1.011 × 10 ⁴	1.960	0.012	0.012	0.004	1.989	5.470 × 10 ³
14.0 GeV	1.411 × 10 ⁴	2.004	0.018	0.020	0.006	2.049	7.450 × 10 ³
20.0 GeV	2.011 × 10 ⁴	2.048	0.028	0.033	0.008	2.118	1.033 × 10 ⁴
30.0 GeV	3.011 × 10 ⁴	2.095	0.045	0.057	0.012	2.210	1.495 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	2.126	0.064	0.083	0.016	2.290	1.939 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	2.196	0.145	0.199	0.031	2.572	3.584 × 10 ⁴
100. GeV	1.001 × 10 ⁵	2.218	0.188	0.262	0.039	2.707	4.342 × 10 ⁴
140. GeV	1.401 × 10 ⁵	2.250	0.276	0.392	0.054	2.972	5.752 × 10 ⁴
200. GeV	2.001 × 10 ⁵	2.284	0.413	0.597	0.077	3.372	7.646 × 10 ⁴
300. GeV	3.001 × 10 ⁵	2.322	0.649	0.942	0.115	4.029	1.036 × 10 ⁵
400. GeV	4.001 × 10 ⁵	2.349	0.893	1.299	0.154	4.696	1.265 × 10 ⁵
401. GeV	4.006 × 10 ⁵	2.349	0.895	1.301	0.154	4.699	<i>Muon critical energy</i>
800. GeV	8.001 × 10 ⁵	2.415	1.904	2.769	0.311	7.399	1.938 × 10 ⁵
1.00 TeV	1.000 × 10 ⁶	2.436	2.425	3.522	0.390	8.774	2.186 × 10 ⁵
1.40 TeV	1.400 × 10 ⁶	2.469	3.469	5.025	0.553	11.517	2.583 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	2.504	5.069	7.323	0.800	15.697	3.028 × 10 ⁵
3.00 TeV	3.000 × 10 ⁶	2.544	7.744	11.142	1.225	22.655	3.555 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	2.573	10.458	15.004	1.656	29.692	3.940 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	2.644	21.415	30.541	3.446	58.048	4.886 × 10 ⁵
10.0 TeV	1.000 × 10 ⁷	2.668	26.943	38.355	4.367	72.334	5.194 × 10 ⁵
14.0 TeV	1.400 × 10 ⁷	2.704	37.980	53.942	6.259	100.886	5.660 × 10 ⁵
20.0 TeV	2.000 × 10 ⁷	2.742	54.650	77.432	9.162	143.987	6.155 × 10 ⁵
30.0 TeV	3.000 × 10 ⁷	2.787	82.367	116.516	14.185	215.855	6.719 × 10 ⁵
40.0 TeV	4.000 × 10 ⁷	2.819	110.193	155.702	19.332	288.046	7.118 × 10 ⁵
80.0 TeV	8.000 × 10 ⁷	2.898	221.736	312.573	40.858	578.066	8.079 × 10 ⁵
100. TeV	1.000 × 10 ⁸	2.924	277.630	391.090	51.990	723.635	8.388 × 10 ⁵

TABLE I-32. Muons in Vanadium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
23 (V)	50.9415	6.110	245.0	0.15436	3.0163	0.0691	3.0322	4.2659	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	5.463				5.463	1.043×10^0
14.0 MeV	5.616×10^1	4.292				4.292	1.877×10^0
20.0 MeV	6.802×10^1	3.372				3.373	3.472×10^0
30.0 MeV	8.509×10^1	2.631				2.631	6.875×10^0
40.0 MeV	1.003×10^2	2.253				2.254	1.101×10^1
80.0 MeV	1.527×10^2	1.700				1.700	3.208×10^1
100. MeV	1.764×10^2	1.600				1.600	4.424×10^1
140. MeV	2.218×10^2	1.501				1.501	7.016×10^1
200. MeV	2.868×10^2	1.449				1.449	1.110×10^2
273. MeV	3.633×10^2	1.436			0.000	1.437	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.437			0.000	1.438	1.805×10^2
400. MeV	4.945×10^2	1.451	0.000		0.000	1.452	2.497×10^2
800. MeV	8.995×10^2	1.529	0.000		0.000	1.530	5.180×10^2
1.00 GeV	1.101×10^3	1.561	0.001		0.000	1.562	6.474×10^2
1.40 GeV	1.502×10^3	1.613	0.001	0.000	0.001	1.615	8.990×10^2
2.00 GeV	2.103×10^3	1.669	0.001	0.001	0.001	1.673	1.264×10^3
3.00 GeV	3.104×10^3	1.733	0.003	0.002	0.001	1.739	1.849×10^3
4.00 GeV	4.104×10^3	1.777	0.004	0.003	0.002	1.786	2.416×10^3
8.00 GeV	8.105×10^3	1.877	0.009	0.009	0.003	1.899	4.581×10^3
10.0 GeV	1.011×10^4	1.907	0.012	0.013	0.004	1.936	5.623×10^3
14.0 GeV	1.411×10^4	1.950	0.018	0.021	0.006	1.995	7.657×10^3
20.0 GeV	2.011×10^4	1.993	0.028	0.034	0.008	2.064	1.061×10^4
30.0 GeV	3.011×10^4	2.039	0.046	0.058	0.012	2.156	1.535×10^4
40.0 GeV	4.011×10^4	2.069	0.065	0.085	0.016	2.237	1.990×10^4
80.0 GeV	8.011×10^4	2.138	0.148	0.204	0.031	2.522	3.671×10^4
100. GeV	1.001×10^5	2.160	0.192	0.268	0.039	2.659	4.443×10^4
140. GeV	1.401×10^5	2.191	0.282	0.401	0.054	2.929	5.876×10^4
200. GeV	2.001×10^5	2.224	0.423	0.611	0.076	3.335	7.795×10^4
300. GeV	3.001×10^5	2.262	0.664	0.964	0.115	4.005	1.053×10^5
383. GeV	3.832×10^5	2.284	0.871	1.267	0.146	4.570	<i>Muon critical energy</i>
400. GeV	4.001×10^5	2.288	0.913	1.330	0.153	4.685	1.283×10^5
800. GeV	8.001×10^5	2.353	1.947	2.833	0.309	7.442	1.955×10^5
1.00 TeV	1.000×10^6	2.374	2.478	3.603	0.388	8.845	2.201×10^5
1.40 TeV	1.400×10^6	2.406	3.546	5.141	0.550	11.644	2.594×10^5
2.00 TeV	2.000×10^6	2.440	5.181	7.490	0.797	15.909	3.034×10^5
3.00 TeV	3.000×10^6	2.480	7.914	11.395	1.219	23.009	3.554×10^5
4.00 TeV	4.000×10^6	2.508	10.687	15.345	1.648	30.190	3.932×10^5
8.00 TeV	8.000×10^6	2.578	21.882	31.231	3.431	59.123	4.861×10^5
10.0 TeV	1.000×10^7	2.601	27.529	39.221	4.347	73.699	5.164×10^5
14.0 TeV	1.400×10^7	2.637	38.795	55.159	6.230	102.821	5.621×10^5
20.0 TeV	2.000×10^7	2.674	55.806	79.176	9.118	146.775	6.107×10^5
30.0 TeV	3.000×10^7	2.718	84.125	119.137	14.115	220.096	6.660×10^5
40.0 TeV	4.000×10^7	2.750	112.559	159.202	19.235	293.746	7.052×10^5
80.0 TeV	8.000×10^7	2.828	226.515	319.587	40.647	589.577	7.994×10^5
100. TeV	1.000×10^8	2.853	283.610	399.860	51.720	738.044	8.297×10^5

TABLE I-33. Muons in Chromium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
24 (Cr)	51.9961	7.180	257.0	0.15419	2.9896	0.0340	3.0451	4.1781	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	5.542				5.542	1.029×10^0		
14.0 MeV	5.616×10^1	4.354				4.354	1.851×10^0		
20.0 MeV	6.802×10^1	3.422				3.422	3.423×10^0		
30.0 MeV	8.509×10^1	2.670				2.670	6.776×10^0		
40.0 MeV	1.003×10^2	2.287				2.287	1.085×10^1		
80.0 MeV	1.527×10^2	1.725				1.725	3.162×10^1		
100. MeV	1.764×10^2	1.623				1.623	4.360×10^1		
140. MeV	2.218×10^2	1.522				1.522	6.916×10^1		
200. MeV	2.868×10^2	1.469				1.469	1.094×10^2		
273. MeV	3.633×10^2	1.456			0.000	1.456	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.457			0.000	1.457	1.780×10^2		
400. MeV	4.945×10^2	1.471	0.000		0.000	1.472	2.463×10^2		
800. MeV	8.995×10^2	1.550	0.000		0.000	1.551	5.109×10^2		
1.00 GeV	1.101×10^3	1.583	0.001		0.000	1.584	6.385×10^2		
1.40 GeV	1.502×10^3	1.636	0.001	0.000	0.001	1.638	8.866×10^2		
2.00 GeV	2.103×10^3	1.693	0.002	0.001	0.001	1.697	1.246×10^3		
3.00 GeV	3.104×10^3	1.758	0.003	0.002	0.001	1.764	1.823×10^3		
4.00 GeV	4.104×10^3	1.803	0.004	0.003	0.002	1.812	2.382×10^3		
8.00 GeV	8.105×10^3	1.905	0.010	0.010	0.003	1.929	4.514×10^3		
10.0 GeV	1.011×10^4	1.936	0.013	0.014	0.004	1.967	5.541×10^3		
14.0 GeV	1.411×10^4	1.980	0.019	0.022	0.006	2.028	7.542×10^3		
20.0 GeV	2.011×10^4	2.024	0.030	0.036	0.008	2.099	1.045×10^4		
30.0 GeV	3.011×10^4	2.071	0.049	0.062	0.012	2.195	1.510×10^4		
40.0 GeV	4.011×10^4	2.102	0.070	0.091	0.016	2.279	1.957×10^4		
80.0 GeV	8.011×10^4	2.173	0.157	0.217	0.031	2.580	3.604×10^4		
100. GeV	1.001×10^5	2.195	0.204	0.286	0.039	2.723	4.358×10^4		
140. GeV	1.401×10^5	2.227	0.300	0.427	0.054	3.008	5.756×10^4		
200. GeV	2.001×10^5	2.261	0.449	0.650	0.076	3.437	7.620×10^4		
300. GeV	3.001×10^5	2.299	0.706	1.025	0.115	4.145	1.027×10^5		
369. GeV	3.689×10^5	2.319	0.888	1.290	0.141	4.638	<i>Muon critical energy</i>		
400. GeV	4.001×10^5	2.326	0.971	1.413	0.153	4.864	1.249×10^5		
800. GeV	8.001×10^5	2.392	2.069	3.009	0.309	7.781	1.894×10^5		
1.00 TeV	1.000×10^6	2.414	2.634	3.828	0.388	9.264	2.129×10^5		
1.40 TeV	1.400×10^6	2.447	3.768	5.460	0.550	12.226	2.504×10^5		
2.00 TeV	2.000×10^6	2.482	5.506	7.955	0.795	16.739	2.922×10^5		
3.00 TeV	3.000×10^6	2.522	8.409	12.101	1.217	24.250	3.415×10^5		
4.00 TeV	4.000×10^6	2.551	11.355	16.294	1.646	31.847	3.774×10^5		
8.00 TeV	8.000×10^6	2.623	23.245	33.160	3.425	62.454	4.655×10^5		
10.0 TeV	1.000×10^7	2.646	29.243	41.642	4.340	77.872	4.941×10^5		
14.0 TeV	1.400×10^7	2.682	41.207	58.562	6.219	108.672	5.374×10^5		
20.0 TeV	2.000×10^7	2.721	59.272	84.058	9.102	155.154	5.833×10^5		
30.0 TeV	3.000×10^7	2.766	89.347	126.480	14.091	232.685	6.356×10^5		
40.0 TeV	4.000×10^7	2.798	119.546	169.012	19.203	310.559	6.727×10^5		
80.0 TeV	8.000×10^7	2.878	240.561	339.273	40.578	623.289	7.618×10^5		
100. TeV	1.000×10^8	2.904	301.190	424.490	51.630	780.215	7.904×10^5		

TABLE I-34. Muons in Manganese

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
25 (Mn)	54.938049	7.440	272.0	0.14973	2.9796	0.0447	3.1074	4.2702	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	4.257				4.257	1.896×10^0
20.0 MeV	6.802×10^1	3.347				3.347	3.503×10^0
30.0 MeV	8.509×10^1	2.613				2.613	6.931×10^0
40.0 MeV	1.003×10^2	2.239				2.239	1.109×10^1
80.0 MeV	1.527×10^2	1.689				1.689	3.230×10^1
100. MeV	1.764×10^2	1.590				1.590	4.454×10^1
140. MeV	2.218×10^2	1.491				1.492	7.063×10^1
200. MeV	2.868×10^2	1.440				1.440	1.117×10^2
274. MeV	3.642×10^2	1.428			0.000	1.428	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.429			0.000	1.429	1.816×10^2
400. MeV	4.945×10^2	1.443	0.000		0.000	1.443	2.513×10^2
800. MeV	8.995×10^2	1.521	0.000		0.000	1.522	5.210×10^2
1.00 GeV	1.101×10^3	1.554	0.001		0.000	1.555	6.509×10^2
1.40 GeV	1.502×10^3	1.607	0.001	0.000	0.001	1.609	9.036×10^2
2.00 GeV	2.103×10^3	1.664	0.002	0.001	0.001	1.667	1.270×10^3
3.00 GeV	3.104×10^3	1.728	0.003	0.002	0.001	1.735	1.857×10^3
4.00 GeV	4.104×10^3	1.773	0.004	0.003	0.002	1.782	2.425×10^3
8.00 GeV	8.105×10^3	1.875	0.010	0.010	0.003	1.898	4.592×10^3
10.0 GeV	1.011×10^4	1.905	0.013	0.014	0.004	1.937	5.634×10^3
14.0 GeV	1.411×10^4	1.949	0.020	0.023	0.006	1.998	7.666×10^3
20.0 GeV	2.011×10^4	1.993	0.031	0.037	0.008	2.069	1.062×10^4
30.0 GeV	3.011×10^4	2.040	0.050	0.064	0.012	2.166	1.533×10^4
40.0 GeV	4.011×10^4	2.071	0.071	0.093	0.016	2.251	1.986×10^4
80.0 GeV	8.011×10^4	2.141	0.161	0.223	0.031	2.556	3.651×10^4
100. GeV	1.001×10^5	2.162	0.209	0.293	0.038	2.702	4.411×10^4
140. GeV	1.401×10^5	2.194	0.306	0.437	0.054	2.992	5.818×10^4
200. GeV	2.001×10^5	2.228	0.460	0.665	0.076	3.429	7.690×10^4
300. GeV	3.001×10^5	2.265	0.722	1.049	0.114	4.150	1.034×10^5
357. GeV	3.567×10^5	2.281	0.874	1.272	0.136	4.564	<i>Muon critical energy</i>
400. GeV	4.001×10^5	2.292	0.993	1.446	0.152	4.884	1.256×10^5
800. GeV	8.001×10^5	2.357	2.115	3.079	0.307	7.859	1.896×10^5
1.00 TeV	1.000×10^6	2.378	2.693	3.915	0.386	9.373	2.128×10^5
1.40 TeV	1.400×10^6	2.411	3.852	5.585	0.547	12.396	2.498×10^5
2.00 TeV	2.000×10^6	2.445	5.627	8.136	0.792	17.000	2.910×10^5
3.00 TeV	3.000×10^6	2.485	8.593	12.375	1.212	24.666	3.396×10^5
4.00 TeV	4.000×10^6	2.514	11.603	16.662	1.639	32.419	3.748×10^5
8.00 TeV	8.000×10^6	2.584	23.751	33.905	3.410	63.651	4.613×10^5
10.0 TeV	1.000×10^7	2.608	29.878	42.576	4.321	79.383	4.894×10^5
14.0 TeV	1.400×10^7	2.643	42.101	59.873	6.192	110.811	5.318×10^5
20.0 TeV	2.000×10^7	2.681	60.556	85.938	9.062	158.238	5.769×10^5
30.0 TeV	3.000×10^7	2.725	91.279	129.307	14.027	237.339	6.282×10^5
40.0 TeV	4.000×10^7	2.757	122.126	172.787	19.113	316.784	6.645×10^5
80.0 TeV	8.000×10^7	2.836	245.739	346.843	40.383	635.802	7.519×10^5
100. TeV	1.000×10^8	2.861	307.670	433.960	51.380	795.872	7.799×10^5

TABLE I-35. Muons in Iron
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
26 (Fe)	55.845	7.874	286.0	0.14680	2.9632	-0.0012	3.1531	4.2911	0.12

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	4.321				4.321	1.870×10^0
20.0 MeV	6.802×10^1	3.399				3.399	3.453×10^0
30.0 MeV	8.509×10^1	2.654				2.654	6.827×10^0
40.0 MeV	1.003×10^2	2.274				2.274	1.092×10^1
80.0 MeV	1.527×10^2	1.717				1.717	3.180×10^1
100. MeV	1.764×10^2	1.616				1.616	4.384×10^1
140. MeV	2.218×10^2	1.516				1.516	6.951×10^1
200. MeV	2.868×10^2	1.463				1.463	1.099×10^2
274. MeV	3.642×10^2	1.451			0.000	1.451	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.452			0.000	1.453	1.787×10^2
400. MeV	4.945×10^2	1.467	0.000		0.000	1.467	2.473×10^2
800. MeV	8.995×10^2	1.548	0.000		0.000	1.548	5.125×10^2
1.00 GeV	1.101×10^3	1.581	0.001		0.000	1.582	6.402×10^2
1.40 GeV	1.502×10^3	1.635	0.001	0.000	0.001	1.637	8.885×10^2
2.00 GeV	2.103×10^3	1.694	0.002	0.001	0.001	1.697	1.248×10^3
3.00 GeV	3.104×10^3	1.760	0.003	0.002	0.001	1.767	1.825×10^3
4.00 GeV	4.104×10^3	1.806	0.004	0.004	0.002	1.816	2.383×10^3
8.00 GeV	8.105×10^3	1.911	0.010	0.011	0.003	1.936	4.509×10^3
10.0 GeV	1.011×10^4	1.942	0.014	0.015	0.004	1.975	5.531×10^3
14.0 GeV	1.411×10^4	1.987	0.021	0.024	0.006	2.039	7.523×10^3
20.0 GeV	2.011×10^4	2.032	0.033	0.039	0.008	2.113	1.041×10^4
30.0 GeV	3.011×10^4	2.080	0.054	0.068	0.012	2.214	1.503×10^4
40.0 GeV	4.011×10^4	2.112	0.076	0.099	0.016	2.303	1.946×10^4
80.0 GeV	8.011×10^4	2.184	0.171	0.236	0.031	2.623	3.570×10^4
100. GeV	1.001×10^5	2.207	0.221	0.310	0.038	2.777	4.311×10^4
140. GeV	1.401×10^5	2.239	0.325	0.463	0.054	3.082	5.678×10^4
200. GeV	2.001×10^5	2.273	0.488	0.706	0.076	3.543	7.492×10^4
300. GeV	3.001×10^5	2.312	0.766	1.112	0.114	4.304	1.005×10^5
345. GeV	3.451×10^5	2.325	0.894	1.300	0.131	4.651	<i>Muon critical energy</i>
400. GeV	4.001×10^5	2.339	1.053	1.533	0.152	5.079	1.219×10^5
800. GeV	8.001×10^5	2.406	2.244	3.264	0.307	8.221	1.832×10^5
1.00 TeV	1.000×10^6	2.428	2.856	4.150	0.386	9.820	2.054×10^5
1.40 TeV	1.400×10^6	2.461	4.085	5.920	0.547	13.013	2.407×10^5
2.00 TeV	2.000×10^6	2.496	5.967	8.622	0.791	17.877	2.799×10^5
3.00 TeV	3.000×10^6	2.537	9.112	13.114	1.211	25.974	3.261×10^5
4.00 TeV	4.000×10^6	2.566	12.302	17.656	1.637	34.162	3.595×10^5
8.00 TeV	8.000×10^6	2.638	25.178	35.923	3.406	67.147	4.415×10^5
10.0 TeV	1.000×10^7	2.662	31.673	45.109	4.316	83.761	4.681×10^5
14.0 TeV	1.400×10^7	2.698	44.628	63.435	6.184	116.947	5.084×10^5
20.0 TeV	2.000×10^7	2.737	64.188	91.048	9.050	167.024	5.511×10^5
30.0 TeV	3.000×10^7	2.783	96.751	136.994	14.009	250.537	5.996×10^5
40.0 TeV	4.000×10^7	2.815	129.444	183.058	19.089	334.408	6.341×10^5
80.0 TeV	8.000×10^7	2.895	260.455	367.452	40.329	671.133	7.168×10^5
100. TeV	1.000×10^8	2.922	326.090	459.740	51.310	840.063	7.434×10^5

TABLE I-36. Muons in Cobalt

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
27 (Co)	58.933200	8.900	297.0	0.14474	2.9502	-0.0187	3.1790	4.2601	0.12
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	5.372				5.372	1.065 × 10 ⁰		
14.0 MeV	5.616 × 10 ¹	4.226				4.226	1.913 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	3.325				3.325	3.531 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	2.597				2.597	6.980 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	2.225				2.225	1.117 × 10 ¹		
80.0 MeV	1.527 × 10 ²	1.679				1.679	3.250 × 10 ¹		
100. MeV	1.764 × 10 ²	1.580				1.581	4.481 × 10 ¹		
140. MeV	2.218 × 10 ²	1.483				1.483	7.106 × 10 ¹		
200. MeV	2.868 × 10 ²	1.431				1.431	1.124 × 10 ²		
270. MeV	3.602 × 10 ²	1.419			0.000	1.420	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.421			0.000	1.421	1.827 × 10 ²		
400. MeV	4.945 × 10 ²	1.435	0.000		0.000	1.435	2.528 × 10 ²		
800. MeV	8.995 × 10 ²	1.514	0.000		0.000	1.515	5.238 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.547	0.001		0.000	1.548	6.544 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.600	0.001	0.000	0.001	1.602	9.081 × 10 ²		
2.00 GeV	2.103 × 10 ³	1.658	0.002	0.001	0.001	1.662	1.275 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.723	0.003	0.002	0.001	1.730	1.864 × 10 ³		
4.00 GeV	4.104 × 10 ³	1.769	0.004	0.004	0.002	1.779	2.434 × 10 ³		
8.00 GeV	8.105 × 10 ³	1.872	0.011	0.011	0.003	1.897	4.604 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	1.903	0.014	0.015	0.004	1.937	5.647 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	1.947	0.021	0.024	0.006	2.000	7.678 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	1.992	0.033	0.040	0.008	2.074	1.062 × 10 ⁴		
30.0 GeV	3.011 × 10 ⁴	2.039	0.055	0.069	0.012	2.175	1.533 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	2.071	0.077	0.101	0.016	2.265	1.983 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	2.142	0.174	0.241	0.031	2.588	3.632 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	2.164	0.225	0.316	0.038	2.744	4.382 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	2.196	0.331	0.472	0.053	3.053	5.764 × 10 ⁴		
200. GeV	2.001 × 10 ⁵	2.230	0.496	0.719	0.076	3.521	7.592 × 10 ⁴		
300. GeV	3.001 × 10 ⁵	2.268	0.779	1.133	0.114	4.294	1.016 × 10 ⁵		
334. GeV	3.336 × 10 ⁵	2.278	0.876	1.275	0.126	4.556	<i>Muon critical energy</i>		
400. GeV	4.001 × 10 ⁵	2.295	1.072	1.562	0.151	5.080	1.230 × 10 ⁵		
800. GeV	8.001 × 10 ⁵	2.360	2.283	3.324	0.306	8.273	1.841 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.382	2.906	4.226	0.384	9.898	2.062 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.414	4.156	6.027	0.545	13.142	2.412 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.449	6.070	8.778	0.788	18.086	2.799 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.489	9.269	13.350	1.206	26.314	3.255 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.518	12.514	17.973	1.630	34.636	3.585 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.589	25.609	36.565	3.392	68.156	4.393 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.612	32.214	45.914	4.298	85.039	4.656 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.648	45.388	64.565	6.158	118.760	5.052 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	2.686	65.278	92.668	9.010	169.643	5.472 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	2.731	98.391	139.428	13.946	254.497	5.950 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	2.763	131.636	186.307	19.003	339.711	6.289 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	2.842	264.858	373.967	40.143	681.810	7.104 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	2.868	331.600	467.890	51.070	853.429	7.366 × 10 ⁵		

TABLE I-37. Muons in Nickel

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
28 (Ni)	58.6934	8.902	311.0	0.16496	2.8430	-0.0566	3.1851	4.3115	0.10

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	4.369				4.369	1.852×10^0
20.0 MeV	6.802×10^1	3.439				3.439	3.417×10^0
30.0 MeV	8.509×10^1	2.687				2.687	6.751×10^0
40.0 MeV	1.003×10^2	2.302				2.303	1.080×10^1
80.0 MeV	1.527×10^2	1.737				1.737	3.142×10^1
100. MeV	1.764×10^2	1.634				1.634	4.332×10^1
140. MeV	2.218×10^2	1.533				1.533	6.871×10^1
200. MeV	2.868×10^2	1.480				1.480	1.087×10^2
267. MeV	3.577×10^2	1.468			0.000	1.468	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.469			0.000	1.470	1.767×10^2
400. MeV	4.945×10^2	1.484	0.000		0.000	1.485	2.444×10^2
800. MeV	8.995×10^2	1.567	0.000		0.000	1.568	5.064×10^2
1.00 GeV	1.101×10^3	1.602	0.001		0.000	1.603	6.324×10^2
1.40 GeV	1.502×10^3	1.658	0.001	0.000	0.001	1.660	8.774×10^2
2.00 GeV	2.103×10^3	1.718	0.002	0.001	0.001	1.722	1.232×10^3
3.00 GeV	3.104×10^3	1.787	0.003	0.002	0.001	1.794	1.800×10^3
4.00 GeV	4.104×10^3	1.835	0.005	0.004	0.002	1.845	2.349×10^3
8.00 GeV	8.105×10^3	1.943	0.011	0.012	0.003	1.970	4.439×10^3
10.0 GeV	1.011×10^4	1.976	0.015	0.016	0.004	2.012	5.443×10^3
14.0 GeV	1.411×10^4	2.023	0.023	0.026	0.006	2.079	7.398×10^3
20.0 GeV	2.011×10^4	2.070	0.036	0.043	0.008	2.157	1.023×10^4
30.0 GeV	3.011×10^4	2.120	0.059	0.074	0.012	2.265	1.475×10^4
40.0 GeV	4.011×10^4	2.153	0.083	0.109	0.016	2.361	1.907×10^4
80.0 GeV	8.011×10^4	2.227	0.188	0.259	0.031	2.706	3.487×10^4
100. GeV	1.001×10^5	2.250	0.243	0.341	0.038	2.873	4.204×10^4
140. GeV	1.401×10^5	2.284	0.357	0.508	0.053	3.203	5.522×10^4
200. GeV	2.001×10^5	2.319	0.535	0.774	0.076	3.704	7.263×10^4
300. GeV	3.001×10^5	2.358	0.840	1.219	0.114	4.532	9.700×10^4
324. GeV	3.241×10^5	2.366	0.914	1.329	0.123	4.732	<i>Muon critical energy</i>
400. GeV	4.001×10^5	2.386	1.155	1.681	0.151	5.374	1.172×10^5
800. GeV	8.001×10^5	2.455	2.459	3.576	0.306	8.797	1.749×10^5
1.00 TeV	1.000×10^6	2.477	3.130	4.547	0.385	10.539	1.956×10^5
1.40 TeV	1.400×10^6	2.511	4.476	6.484	0.545	14.016	2.284×10^5
2.00 TeV	2.000×10^6	2.547	6.537	9.442	0.788	19.316	2.648×10^5
3.00 TeV	3.000×10^6	2.589	9.982	14.359	1.206	28.137	3.074×10^5
4.00 TeV	4.000×10^6	2.619	13.475	19.330	1.631	37.056	3.383×10^5
8.00 TeV	8.000×10^6	2.693	27.573	39.323	3.393	72.984	4.138×10^5
10.0 TeV	1.000×10^7	2.717	34.683	49.377	4.299	91.077	4.383×10^5
14.0 TeV	1.400×10^7	2.754	48.865	69.433	6.160	127.214	4.752×10^5
20.0 TeV	2.000×10^7	2.794	70.276	99.652	9.014	181.737	5.145×10^5
30.0 TeV	3.000×10^7	2.841	105.920	149.933	13.951	272.646	5.591×10^5
40.0 TeV	4.000×10^7	2.874	141.705	200.342	19.008	363.930	5.908×10^5
80.0 TeV	8.000×10^7	2.956	285.101	402.128	40.151	730.337	6.668×10^5
100. TeV	1.000×10^8	2.983	356.940	503.120	51.080	914.124	6.913×10^5

TABLE I-38. Muons in Copper

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
29 (Cu)	63.546	8.960	322.0	0.14339	2.9044	-0.0254	3.2792	4.4190	0.08
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	5.283				5.283	1.085×10^0		
14.0 MeV	5.616×10^1	4.160				4.160	1.947×10^0		
20.0 MeV	6.802×10^1	3.277				3.277	3.590×10^0		
30.0 MeV	8.509×10^1	2.562				2.562	7.087×10^0		
40.0 MeV	1.003×10^2	2.198				2.198	1.133×10^1		
80.0 MeV	1.527×10^2	1.659				1.659	3.293×10^1		
100. MeV	1.764×10^2	1.561				1.561	4.539×10^1		
140. MeV	2.218×10^2	1.464				1.465	7.197×10^1		
200. MeV	2.868×10^2	1.414				1.414	1.138×10^2		
267. MeV	3.577×10^2	1.403			0.000	1.403	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.404			0.000	1.404	1.850×10^2		
400. MeV	4.945×10^2	1.419	0.000		0.000	1.419	2.558×10^2		
800. MeV	8.995×10^2	1.499	0.000		0.000	1.500	5.298×10^2		
1.00 GeV	1.101×10^3	1.532	0.001		0.000	1.533	6.617×10^2		
1.40 GeV	1.502×10^3	1.585	0.001	0.000	0.001	1.587	9.179×10^2		
2.00 GeV	2.103×10^3	1.643	0.002	0.001	0.001	1.647	1.288×10^3		
3.00 GeV	3.104×10^3	1.709	0.003	0.002	0.001	1.716	1.882×10^3		
4.00 GeV	4.104×10^3	1.755	0.005	0.004	0.002	1.766	2.456×10^3		
8.00 GeV	8.105×10^3	1.860	0.011	0.012	0.003	1.886	4.640×10^3		
10.0 GeV	1.011×10^4	1.891	0.015	0.016	0.004	1.927	5.689×10^3		
14.0 GeV	1.411×10^4	1.936	0.023	0.026	0.006	1.991	7.729×10^3		
20.0 GeV	2.011×10^4	1.981	0.035	0.042	0.008	2.068	1.068×10^4		
30.0 GeV	3.011×10^4	2.029	0.058	0.074	0.012	2.173	1.540×10^4		
40.0 GeV	4.011×10^4	2.061	0.082	0.107	0.016	2.267	1.990×10^4		
80.0 GeV	8.011×10^4	2.133	0.185	0.257	0.031	2.606	3.633×10^4		
100. GeV	1.001×10^5	2.155	0.240	0.337	0.038	2.770	4.377×10^4		
140. GeV	1.401×10^5	2.187	0.352	0.503	0.053	3.095	5.742×10^4		
200. GeV	2.001×10^5	2.221	0.527	0.765	0.075	3.589	7.541×10^4		
300. GeV	3.001×10^5	2.259	0.828	1.205	0.113	4.405	1.005×10^5		
315. GeV	3.148×10^5	2.263	0.873	1.271	0.118	4.527	<i>Muon critical energy</i>		
400. GeV	4.001×10^5	2.285	1.139	1.661	0.151	5.237	1.213×10^5		
800. GeV	8.001×10^5	2.351	2.425	3.533	0.304	8.614	1.803×10^5		
1.00 TeV	1.000×10^6	2.372	3.087	4.492	0.382	10.333	2.015×10^5		
1.40 TeV	1.400×10^6	2.404	4.414	6.405	0.542	13.766	2.349×10^5		
2.00 TeV	2.000×10^6	2.439	6.446	9.327	0.784	18.997	2.719×10^5		
3.00 TeV	3.000×10^6	2.479	9.842	14.182	1.199	27.703	3.152×10^5		
4.00 TeV	4.000×10^6	2.508	13.286	19.092	1.621	36.508	3.466×10^5		
8.00 TeV	8.000×10^6	2.579	27.184	38.835	3.372	71.970	4.231×10^5		
10.0 TeV	1.000×10^7	2.602	34.193	48.762	4.272	89.830	4.480×10^5		
14.0 TeV	1.400×10^7	2.637	48.174	68.567	6.121	125.500	4.855×10^5		
20.0 TeV	2.000×10^7	2.676	69.280	98.408	8.956	179.321	5.253×10^5		
30.0 TeV	3.000×10^7	2.720	104.416	148.058	13.860	269.056	5.705×10^5		
40.0 TeV	4.000×10^7	2.752	139.692	197.833	18.883	359.160	6.025×10^5		
80.0 TeV	8.000×10^7	2.831	281.045	397.085	39.878	720.840	6.796×10^5		
100. TeV	1.000×10^8	2.856	351.860	496.810	50.730	902.257	7.044×10^5		

TABLE I-39. Muons in Zinc
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
30 (Zn)	65.39	7.133	330.0	0.14714	2.8652	0.0049	3.3668	4.6906	0.08
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	5.290				5.290	1.084×10^0		
14.0 MeV	5.616×10^1	4.167				4.167	1.945×10^0		
20.0 MeV	6.802×10^1	3.283				3.283	3.584×10^0		
30.0 MeV	8.509×10^1	2.568				2.568	7.074×10^0		
40.0 MeV	1.003×10^2	2.204				2.204	1.130×10^1		
80.0 MeV	1.527×10^2	1.665				1.665	3.283×10^1		
100. MeV	1.764×10^2	1.568				1.568	4.524×10^1		
140. MeV	2.218×10^2	1.471				1.472	7.169×10^1		
200. MeV	2.868×10^2	1.422				1.422	1.133×10^2		
267. MeV	3.577×10^2	1.411			0.000	1.411	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.413	0.000		0.000	1.413	1.841×10^2		
400. MeV	4.945×10^2	1.428	0.000		0.000	1.429	2.545×10^2		
800. MeV	8.995×10^2	1.510	0.001		0.000	1.511	5.266×10^2		
1.00 GeV	1.101×10^3	1.544	0.001		0.000	1.545	6.574×10^2		
1.40 GeV	1.502×10^3	1.599	0.001	0.000	0.001	1.601	9.115×10^2		
2.00 GeV	2.103×10^3	1.658	0.002	0.001	0.001	1.662	1.279×10^3		
3.00 GeV	3.104×10^3	1.726	0.003	0.002	0.001	1.733	1.867×10^3		
4.00 GeV	4.104×10^3	1.773	0.005	0.004	0.002	1.784	2.436×10^3		
8.00 GeV	8.105×10^3	1.880	0.012	0.012	0.003	1.907	4.596×10^3		
10.0 GeV	1.011×10^4	1.912	0.016	0.017	0.004	1.949	5.633×10^3		
14.0 GeV	1.411×10^4	1.958	0.024	0.027	0.006	2.015	7.650×10^3		
20.0 GeV	2.011×10^4	2.005	0.037	0.044	0.008	2.094	1.057×10^4		
30.0 GeV	3.011×10^4	2.054	0.060	0.076	0.012	2.203	1.522×10^4		
40.0 GeV	4.011×10^4	2.086	0.085	0.112	0.016	2.299	1.966×10^4		
80.0 GeV	8.011×10^4	2.160	0.192	0.266	0.031	2.649	3.584×10^4		
100. GeV	1.001×10^5	2.182	0.248	0.350	0.038	2.819	4.316×10^4		
140. GeV	1.401×10^5	2.214	0.365	0.522	0.053	3.155	5.657×10^4		
200. GeV	2.001×10^5	2.248	0.547	0.794	0.075	3.665	7.420×10^4		
300. GeV	3.001×10^5	2.286	0.859	1.250	0.113	4.509	9.877×10^4		
308. GeV	3.083×10^5	2.289	0.885	1.288	0.116	4.578	<i>Muon critical energy</i>		
400. GeV	4.001×10^5	2.313	1.181	1.723	0.150	5.368	1.191×10^5		
800. GeV	8.001×10^5	2.379	2.515	3.664	0.304	8.862	1.765×10^5		
1.00 TeV	1.000×10^6	2.400	3.201	4.658	0.382	10.641	1.971×10^5		
1.40 TeV	1.400×10^6	2.433	4.577	6.641	0.541	14.192	2.295×10^5		
2.00 TeV	2.000×10^6	2.468	6.683	9.670	0.782	19.604	2.653×10^5		
3.00 TeV	3.000×10^6	2.508	10.204	14.703	1.196	28.612	3.073×10^5		
4.00 TeV	4.000×10^6	2.537	13.773	19.792	1.617	37.721	3.377×10^5		
8.00 TeV	8.000×10^6	2.608	28.179	40.256	3.364	74.408	4.118×10^5		
10.0 TeV	1.000×10^7	2.631	35.443	50.545	4.262	92.882	4.358×10^5		
14.0 TeV	1.400×10^7	2.667	49.934	71.073	6.106	129.781	4.720×10^5		
20.0 TeV	2.000×10^7	2.706	71.808	102.002	8.934	185.451	5.105×10^5		
30.0 TeV	3.000×10^7	2.750	108.223	153.464	13.826	278.264	5.543×10^5		
40.0 TeV	4.000×10^7	2.782	144.781	205.054	18.836	371.454	5.853×10^5		
80.0 TeV	8.000×10^7	2.861	291.272	411.576	39.777	745.487	6.598×10^5		
100. TeV	1.000×10^8	2.887	364.660	514.940	50.600	933.088	6.837×10^5		

TABLE I-40. Muons in Gallium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
31 (Ga)	69.723	5.904	334.0	0.09440	3.1314	0.2267	3.5434	4.9353	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	4.034				4.034	2.010×10^0
20.0 MeV	6.802×10^1	3.179				3.179	3.704×10^0
30.0 MeV	8.509×10^1	2.488				2.488	7.307×10^0
40.0 MeV	1.003×10^2	2.136				2.136	1.167×10^1
80.0 MeV	1.527×10^2	1.620				1.620	3.383×10^1
100. MeV	1.764×10^2	1.528				1.528	4.658×10^1
140. MeV	2.218×10^2	1.436				1.436	7.371×10^1
200. MeV	2.868×10^2	1.388				1.389	1.164×10^2
263. MeV	3.527×10^2	1.379			0.000	1.379	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.381			0.000	1.381	1.888×10^2
400. MeV	4.945×10^2	1.396	0.000		0.000	1.397	2.608×10^2
800. MeV	8.995×10^2	1.477	0.001		0.000	1.478	5.390×10^2
1.00 GeV	1.101×10^3	1.510	0.001		0.000	1.512	6.727×10^2
1.40 GeV	1.502×10^3	1.564	0.001	0.000	0.001	1.566	9.325×10^2
2.00 GeV	2.103×10^3	1.622	0.002	0.001	0.001	1.626	1.308×10^3
3.00 GeV	3.104×10^3	1.687	0.003	0.002	0.001	1.694	1.910×10^3
4.00 GeV	4.104×10^3	1.733	0.005	0.004	0.002	1.744	2.491×10^3
8.00 GeV	8.105×10^3	1.836	0.012	0.012	0.003	1.864	4.702×10^3
10.0 GeV	1.011×10^4	1.867	0.015	0.017	0.004	1.904	5.763×10^3
14.0 GeV	1.411×10^4	1.912	0.024	0.027	0.006	1.969	7.827×10^3
20.0 GeV	2.011×10^4	1.957	0.037	0.044	0.008	2.046	1.081×10^4
30.0 GeV	3.011×10^4	2.005	0.060	0.076	0.012	2.153	1.557×10^4
40.0 GeV	4.011×10^4	2.036	0.085	0.111	0.016	2.249	2.012×10^4
80.0 GeV	8.011×10^4	2.107	0.191	0.266	0.030	2.596	3.664×10^4
100. GeV	1.001×10^5	2.129	0.248	0.349	0.038	2.764	4.411×10^4
140. GeV	1.401×10^5	2.161	0.364	0.521	0.053	3.099	5.777×10^4
200. GeV	2.001×10^5	2.194	0.545	0.793	0.075	3.608	7.570×10^4
300. GeV	3.001×10^5	2.231	0.856	1.248	0.112	4.448	1.006×10^5
302. GeV	3.019×10^5	2.231	0.862	1.257	0.113	4.463	<i>Muon critical energy</i>
400. GeV	4.001×10^5	2.257	1.177	1.720	0.149	5.305	1.212×10^5
800. GeV	8.001×10^5	2.321	2.507	3.657	0.302	8.788	1.792×10^5
1.00 TeV	1.000×10^6	2.341	3.190	4.649	0.380	10.561	1.999×10^5
1.40 TeV	1.400×10^6	2.373	4.562	6.629	0.538	14.102	2.326×10^5
2.00 TeV	2.000×10^6	2.407	6.661	9.650	0.778	19.497	2.686×10^5
3.00 TeV	3.000×10^6	2.446	10.169	14.673	1.190	28.479	3.108×10^5
4.00 TeV	4.000×10^6	2.474	13.727	19.751	1.609	37.561	3.413×10^5
8.00 TeV	8.000×10^6	2.543	28.082	40.169	3.347	74.141	4.157×10^5
10.0 TeV	1.000×10^7	2.565	35.321	50.435	4.240	92.562	4.398×10^5
14.0 TeV	1.400×10^7	2.600	49.760	70.916	6.074	129.351	4.762×10^5
20.0 TeV	2.000×10^7	2.637	71.556	101.774	8.886	184.854	5.148×10^5
30.0 TeV	3.000×10^7	2.680	107.841	153.119	13.750	277.391	5.587×10^5
40.0 TeV	4.000×10^7	2.711	144.268	204.592	18.731	370.303	5.898×10^5
80.0 TeV	8.000×10^7	2.788	290.229	410.643	39.550	743.211	6.645×10^5
100. TeV	1.000×10^8	2.813	363.350	513.770	50.310	930.244	6.885×10^5

TABLE I-41. Muons in Germanium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
32 (Ge)	72.61	5.323	350.0	0.07188	3.3306	0.3376	3.6096	5.1411	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	5.035				5.035	1.141 × 10 ⁰		
14.0 MeV	5.616 × 10 ¹	3.970				3.970	2.044 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	3.131				3.131	3.765 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	2.452				2.452	7.423 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	2.106				2.106	1.185 × 10 ¹		
80.0 MeV	1.527 × 10 ²	1.601				1.601	3.430 × 10 ¹		
100. MeV	1.764 × 10 ²	1.511				1.511	4.720 × 10 ¹		
140. MeV	2.218 × 10 ²	1.423				1.423	7.459 × 10 ¹		
200. MeV	2.868 × 10 ²	1.379				1.379	1.176 × 10 ²		
257. MeV	3.471 × 10 ²	1.370			0.000	1.371	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.373	0.000		0.000	1.373	1.904 × 10 ²		
400. MeV	4.945 × 10 ²	1.389	0.000		0.000	1.390	2.629 × 10 ²		
800. MeV	8.995 × 10 ²	1.472	0.001		0.000	1.472	5.422 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.505	0.001		0.000	1.506	6.765 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.558	0.001	0.000	0.001	1.561	9.371 × 10 ²		
2.00 GeV	2.103 × 10 ³	1.616	0.002	0.001	0.001	1.620	1.314 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.681	0.003	0.002	0.001	1.689	1.918 × 10 ³		
4.00 GeV	4.104 × 10 ³	1.727	0.005	0.004	0.002	1.738	2.501 × 10 ³		
8.00 GeV	8.105 × 10 ³	1.829	0.012	0.012	0.003	1.857	4.720 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	1.860	0.016	0.017	0.004	1.897	5.785 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	1.904	0.024	0.028	0.006	1.962	7.856 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	1.948	0.037	0.045	0.008	2.039	1.085 × 10 ⁴		
30.0 GeV	3.011 × 10 ⁴	1.995	0.061	0.078	0.012	2.147	1.563 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	2.026	0.086	0.114	0.016	2.243	2.019 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	2.097	0.195	0.272	0.030	2.594	3.674 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	2.118	0.253	0.357	0.038	2.766	4.420 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	2.149	0.371	0.532	0.052	3.106	5.785 × 10 ⁴		
200. GeV	2.001 × 10 ⁵	2.182	0.556	0.810	0.075	3.623	7.572 × 10 ⁴		
295. GeV	2.950 × 10 ⁵	2.217	0.857	1.250	0.110	4.435	<i>Muon critical energy</i>		
300. GeV	3.001 × 10 ⁵	2.219	0.873	1.274	0.112	4.479	1.005 × 10 ⁵		
400. GeV	4.001 × 10 ⁵	2.245	1.201	1.756	0.149	5.352	1.209 × 10 ⁵		
800. GeV	8.001 × 10 ⁵	2.308	2.557	3.733	0.301	8.899	1.783 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.328	3.254	4.745	0.378	10.706	1.987 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.359	4.653	6.764	0.536	14.313	2.310 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.393	6.794	9.847	0.776	19.810	2.664 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.432	10.371	14.971	1.187	28.961	3.080 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.459	13.998	20.151	1.604	38.213	3.379 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.528	28.635	40.979	3.336	75.478	4.110 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.550	36.015	51.451	4.226	94.243	4.347 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.585	50.736	72.344	6.054	131.720	4.704 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	2.621	72.958	103.822	8.856	188.258	5.083 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	2.664	109.952	156.198	13.702	282.517	5.514 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	2.695	147.090	208.703	18.665	377.154	5.819 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	2.771	295.896	418.885	39.403	756.957	6.553 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	2.796	370.440	524.080	50.120	947.437	6.789 × 10 ⁵		

TABLE I-42. Muons in Arsenic

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
33 (As)	74.92160	5.730	347.0	0.06633	3.4176	0.1767	3.5702	5.0510	0.08

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.973				3.973	2.042×10^0
20.0 MeV	6.802×10^1	3.133				3.133	3.761×10^0
30.0 MeV	8.509×10^1	2.453				2.453	7.417×10^0
40.0 MeV	1.003×10^2	2.107				2.107	1.184×10^1
80.0 MeV	1.527×10^2	1.600				1.600	3.430×10^1
100. MeV	1.764×10^2	1.510				1.510	4.719×10^1
140. MeV	2.218×10^2	1.422				1.422	7.460×10^1
200. MeV	2.868×10^2	1.378				1.378	1.176×10^2
257. MeV	3.471×10^2	1.370			0.000	1.370	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.373	0.000		0.000	1.373	1.905×10^2
400. MeV	4.945×10^2	1.389	0.000		0.000	1.390	2.629×10^2
800. MeV	8.995×10^2	1.472	0.001		0.000	1.472	5.423×10^2
1.00 GeV	1.101×10^3	1.505	0.001		0.000	1.506	6.765×10^2
1.40 GeV	1.502×10^3	1.558	0.001	0.000	0.001	1.560	9.372×10^2
2.00 GeV	2.103×10^3	1.615	0.002	0.001	0.001	1.619	1.314×10^3
3.00 GeV	3.104×10^3	1.680	0.003	0.003	0.001	1.688	1.918×10^3
4.00 GeV	4.104×10^3	1.725	0.005	0.004	0.002	1.736	2.502×10^3
8.00 GeV	8.105×10^3	1.826	0.012	0.013	0.003	1.855	4.723×10^3
10.0 GeV	1.011×10^4	1.857	0.016	0.018	0.004	1.895	5.789×10^3
14.0 GeV	1.411×10^4	1.900	0.025	0.029	0.006	1.960	7.863×10^3
20.0 GeV	2.011×10^4	1.944	0.038	0.046	0.008	2.037	1.086×10^4
30.0 GeV	3.011×10^4	1.990	0.063	0.080	0.012	2.146	1.564×10^4
40.0 GeV	4.011×10^4	2.021	0.089	0.117	0.016	2.243	2.020×10^4
80.0 GeV	8.011×10^4	2.091	0.200	0.279	0.030	2.602	3.673×10^4
100. GeV	1.001×10^5	2.112	0.260	0.367	0.038	2.777	4.417×10^4
140. GeV	1.401×10^5	2.143	0.381	0.547	0.052	3.125	5.774×10^4
200. GeV	2.001×10^5	2.176	0.572	0.832	0.074	3.655	7.548×10^4
287. GeV	2.872×10^5	2.209	0.855	1.247	0.107	4.418	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.213	0.897	1.310	0.111	4.532	1.000×10^5
400. GeV	4.001×10^5	2.238	1.234	1.805	0.149	5.427	1.202×10^5
800. GeV	8.001×10^5	2.301	2.627	3.836	0.300	9.065	1.766×10^5
1.00 TeV	1.000×10^6	2.322	3.343	4.875	0.378	10.918	1.967×10^5
1.40 TeV	1.400×10^6	2.353	4.779	6.950	0.535	14.618	2.282×10^5
2.00 TeV	2.000×10^6	2.387	6.978	10.117	0.774	20.256	2.630×10^5
3.00 TeV	3.000×10^6	2.425	10.652	15.380	1.184	29.642	3.035×10^5
4.00 TeV	4.000×10^6	2.453	14.378	20.701	1.600	39.133	3.328×10^5
8.00 TeV	8.000×10^6	2.521	29.408	42.095	3.327	77.352	4.041×10^5
10.0 TeV	1.000×10^7	2.544	36.986	52.851	4.215	96.597	4.272×10^5
14.0 TeV	1.400×10^7	2.578	52.103	74.311	6.038	135.031	4.621×10^5
20.0 TeV	2.000×10^7	2.615	74.922	106.642	8.832	193.012	4.991×10^5
30.0 TeV	3.000×10^7	2.658	112.909	160.440	13.665	289.672	5.411×10^5
40.0 TeV	4.000×10^7	2.689	151.042	214.370	18.614	386.716	5.709×10^5
80.0 TeV	8.000×10^7	2.765	303.838	430.243	39.294	776.140	6.424×10^5
100. TeV	1.000×10^8	2.790	380.380	538.280	49.980	971.430	6.654×10^5

TABLE I-43. Muons in Selenium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
34 (Se)	78.96	4.500	348.0	0.06568	3.4317	0.2258	3.6264	5.3210	0.10

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.883				3.883	2.089×10^0
20.0 MeV	6.802×10^1	3.061				3.061	3.849×10^0
30.0 MeV	8.509×10^1	2.397				2.397	7.589×10^0
40.0 MeV	1.003×10^2	2.059				2.059	1.212×10^1
80.0 MeV	1.527×10^2	1.564				1.564	3.509×10^1
100. MeV	1.764×10^2	1.476				1.476	4.829×10^1
140. MeV	2.218×10^2	1.391				1.392	7.632×10^1
200. MeV	2.868×10^2	1.350				1.350	1.202×10^2
252. MeV	3.421×10^2	1.343			0.000	1.343	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.346	0.000		0.000	1.347	1.946×10^2
400. MeV	4.945×10^2	1.364	0.000		0.000	1.364	2.684×10^2
800. MeV	8.995×10^2	1.447	0.001		0.000	1.448	5.528×10^2
1.00 GeV	1.101×10^3	1.480	0.001		0.000	1.481	6.893×10^2
1.40 GeV	1.502×10^3	1.533	0.001	0.000	0.001	1.535	9.543×10^2
2.00 GeV	2.103×10^3	1.590	0.002	0.001	0.001	1.594	1.337×10^3
3.00 GeV	3.104×10^3	1.655	0.003	0.003	0.001	1.662	1.951×10^3
4.00 GeV	4.104×10^3	1.699	0.005	0.004	0.002	1.710	2.543×10^3
8.00 GeV	8.105×10^3	1.800	0.012	0.013	0.003	1.829	4.797×10^3
10.0 GeV	1.011×10^4	1.830	0.016	0.018	0.004	1.868	5.878×10^3
14.0 GeV	1.411×10^4	1.873	0.025	0.029	0.006	1.933	7.982×10^3
20.0 GeV	2.011×10^4	1.916	0.039	0.047	0.008	2.010	1.102×10^4
30.0 GeV	3.011×10^4	1.962	0.063	0.081	0.012	2.118	1.587×10^4
40.0 GeV	4.011×10^4	1.993	0.089	0.118	0.015	2.216	2.048×10^4
80.0 GeV	8.011×10^4	2.061	0.201	0.281	0.030	2.574	3.720×10^4
100. GeV	1.001×10^5	2.082	0.261	0.369	0.037	2.750	4.472×10^4
140. GeV	1.401×10^5	2.113	0.383	0.550	0.052	3.098	5.841×10^4
200. GeV	2.001×10^5	2.145	0.574	0.837	0.074	3.630	7.629×10^4
282. GeV	2.823×10^5	2.175	0.841	1.229	0.104	4.351	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.180	0.901	1.316	0.111	4.509	1.010×10^5
400. GeV	4.001×10^5	2.206	1.239	1.814	0.148	5.407	1.212×10^5
800. GeV	8.001×10^5	2.267	2.636	3.853	0.299	9.057	1.778×10^5
1.00 TeV	1.000×10^6	2.287	3.354	4.898	0.376	10.916	1.979×10^5
1.40 TeV	1.400×10^6	2.318	4.796	6.981	0.533	14.629	2.294×10^5
2.00 TeV	2.000×10^6	2.351	7.002	10.161	0.771	20.286	2.641×10^5
3.00 TeV	3.000×10^6	2.388	10.688	15.447	1.179	29.704	3.046×10^5
4.00 TeV	4.000×10^6	2.416	14.426	20.791	1.593	39.226	3.338×10^5
8.00 TeV	8.000×10^6	2.482	29.504	42.275	3.313	77.576	4.050×10^5
10.0 TeV	1.000×10^7	2.504	37.107	53.076	4.197	96.885	4.280×10^5
14.0 TeV	1.400×10^7	2.538	52.272	74.626	6.011	135.448	4.627×10^5
20.0 TeV	2.000×10^7	2.574	75.162	107.092	8.792	193.621	4.996×10^5
30.0 TeV	3.000×10^7	2.616	113.270	161.113	13.602	290.602	5.415×10^5
40.0 TeV	4.000×10^7	2.646	151.525	215.267	18.528	387.968	5.712×10^5
80.0 TeV	8.000×10^7	2.720	304.806	432.035	39.107	778.669	6.425×10^5
100. TeV	1.000×10^8	2.745	381.590	540.520	49.740	974.596	6.654×10^5

TABLE I-44. Muons in Bromine

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
35 (Br)	79.904	3.103	343.0	0.21683	3.0000	0.3408	3.0000	5.6468	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	5.046				5.047	1.132 × 10 ⁰		
14.0 MeV	5.616 × 10 ¹	3.973				3.973	2.035 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	3.130				3.130	3.755 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	2.450				2.450	7.414 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	2.105				2.105	1.185 × 10 ¹		
80.0 MeV	1.527 × 10 ²	1.602				1.602	3.430 × 10 ¹		
100. MeV	1.764 × 10 ²	1.513				1.513	4.718 × 10 ¹		
140. MeV	2.218 × 10 ²	1.429				1.429	7.450 × 10 ¹		
200. MeV	2.868 × 10 ²	1.390				1.390	1.172 × 10 ²		
243. MeV	3.325 × 10 ²	1.385				1.385	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.390	0.000		0.000	1.390	1.893 × 10 ²		
400. MeV	4.945 × 10 ²	1.410	0.000		0.000	1.410	2.608 × 10 ²		
800. MeV	8.995 × 10 ²	1.499	0.001		0.000	1.500	5.354 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.535	0.001		0.000	1.536	6.671 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.590	0.001	0.000	0.001	1.593	9.226 × 10 ²		
2.00 GeV	2.103 × 10 ³	1.650	0.002	0.001	0.001	1.654	1.292 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.717	0.004	0.003	0.001	1.724	1.883 × 10 ³		
4.00 GeV	4.104 × 10 ³	1.762	0.005	0.004	0.002	1.774	2.454 × 10 ³		
8.00 GeV	8.105 × 10 ³	1.864	0.013	0.014	0.003	1.894	4.628 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	1.894	0.017	0.019	0.004	1.934	5.673 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	1.937	0.026	0.030	0.006	2.000	7.705 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	1.980	0.040	0.049	0.008	2.078	1.065 × 10 ⁴		
30.0 GeV	3.011 × 10 ⁴	2.025	0.066	0.085	0.012	2.188	1.533 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	2.055	0.093	0.123	0.015	2.288	1.980 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	2.122	0.211	0.294	0.030	2.658	3.600 × 10 ⁴		
0 100. GeV	1.001 × 10 ⁵	2.143	0.273	0.386	0.037	2.840	4.328 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	2.173	0.401	0.576	0.052	3.202	5.653 × 10 ⁴		
200. GeV	2.001 × 10 ⁵	2.206	0.601	0.875	0.074	3.756	7.382 × 10 ⁴		
278. GeV	2.783 × 10 ⁵	2.235	0.867	1.266	0.103	4.471	<i>Muon critical energy</i>		
300. GeV	3.001 × 10 ⁵	2.242	0.942	1.377	0.111	4.673	9.765 × 10 ⁴		
400. GeV	4.001 × 10 ⁵	2.268	1.296	1.897	0.148	5.610	1.172 × 10 ⁵		
800. GeV	8.001 × 10 ⁵	2.330	2.758	4.030	0.299	9.418	1.716 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.351	3.510	5.122	0.376	11.359	1.909 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.382	5.018	7.300	0.532	15.233	2.212 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.415	7.325	10.625	0.770	21.137	2.545 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.454	11.181	16.151	1.178	30.964	2.934 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.481	15.090	21.737	1.592	40.901	3.214 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.549	30.860	44.196	3.310	80.916	3.896 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.571	38.811	55.487	4.193	101.064	4.117 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.606	54.670	78.015	6.006	141.298	4.450 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	2.642	78.608	111.954	8.786	201.991	4.804 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	2.685	118.459	168.425	13.592	303.161	5.205 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	2.715	158.463	225.034	18.513	404.726	5.490 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	2.791	318.748	451.638	39.070	812.248	6.173 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	2.816	399.040	565.050	49.690	1016.597	6.393 × 10 ⁵		

TABLE I-45. Muons in Krypton Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
36 (Kr)	83.80	3.478×10^{-3}	352.0	0.07446	3.4051	1.7158	5.0748	12.5115	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	4.909				4.909	1.170×10^0		
14.0 MeV	5.616×10^1	3.870				3.870	2.097×10^0		
20.0 MeV	6.802×10^1	3.053				3.053	3.862×10^0		
30.0 MeV	8.509×10^1	2.392				2.392	7.612×10^0		
40.0 MeV	1.003×10^2	2.055				2.055	1.215×10^1		
80.0 MeV	1.527×10^2	1.565				1.565	3.514×10^1		
100. MeV	1.764×10^2	1.479				1.479	4.831×10^1		
140. MeV	2.218×10^2	1.397				1.397	7.626×10^1		
200. MeV	2.868×10^2	1.360				1.360	1.199×10^2		
232. MeV	3.210×10^2	1.357				1.357	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.366	0.000		0.000	1.366	1.935×10^2		
400. MeV	4.945×10^2	1.392	0.000		0.000	1.392	2.660×10^2		
800. MeV	8.995×10^2	1.504	0.001		0.000	1.505	5.419×10^2		
1.00 GeV	1.101×10^3	1.550	0.001		0.000	1.552	6.727×10^2		
1.40 GeV	1.502×10^3	1.624	0.001	0.000	0.001	1.627	9.242×10^2		
2.00 GeV	2.103×10^3	1.708	0.002	0.001	0.001	1.712	1.283×10^3		
3.00 GeV	3.104×10^3	1.805	0.004	0.003	0.001	1.813	1.850×10^3		
4.00 GeV	4.104×10^3	1.875	0.005	0.005	0.002	1.887	2.390×10^3		
8.00 GeV	8.105×10^3	2.042	0.013	0.014	0.003	2.072	4.401×10^3		
10.0 GeV	1.011×10^4	2.092	0.017	0.019	0.004	2.133	5.352×10^3		
14.0 GeV	1.411×10^4	2.164	0.026	0.030	0.006	2.226	7.186×10^3		
20.0 GeV	2.011×10^4	2.234	0.041	0.049	0.008	2.332	9.816×10^3		
30.0 GeV	3.011×10^4	2.307	0.066	0.085	0.012	2.471	1.398×10^4		
40.0 GeV	4.011×10^4	2.355	0.094	0.124	0.015	2.589	1.793×10^4		
80.0 GeV	8.011×10^4	2.459	0.211	0.296	0.030	2.997	3.225×10^4		
100. GeV	1.001×10^5	2.490	0.274	0.388	0.037	3.190	3.872×10^4		
140. GeV	1.401×10^5	2.533	0.402	0.579	0.052	3.567	5.057×10^4		
200. GeV	2.001×10^5	2.576	0.603	0.880	0.074	4.134	6.618×10^4		
300. GeV	3.001×10^5	2.623	0.946	1.385	0.110	5.065	8.801×10^4		
321. GeV	3.210×10^5	2.630	1.020	1.492	0.118	5.261	<i>Muon critical energy</i>		
400. GeV	4.001×10^5	2.654	1.302	1.907	0.147	6.011	1.061×10^5		
800. GeV	8.001×10^5	2.726	2.769	4.051	0.298	9.845	1.576×10^5		
1.00 TeV	1.000×10^6	2.748	3.524	5.148	0.374	11.795	1.761×10^5		
1.40 TeV	1.400×10^6	2.781	5.038	7.337	0.530	15.687	2.055×10^5		
2.00 TeV	2.000×10^6	2.816	7.355	10.678	0.767	21.616	2.379×10^5		
3.00 TeV	3.000×10^6	2.855	11.225	16.230	1.173	31.485	2.760×10^5		
4.00 TeV	4.000×10^6	2.882	15.150	21.843	1.585	41.461	3.036×10^5		
8.00 TeV	8.000×10^6	2.949	30.981	44.408	3.297	81.636	3.711×10^5		
10.0 TeV	1.000×10^7	2.971	38.962	55.753	4.176	101.863	3.930×10^5		
14.0 TeV	1.400×10^7	3.005	54.882	78.387	5.981	142.256	4.261×10^5		
20.0 TeV	2.000×10^7	3.041	78.910	112.486	8.748	203.186	4.612×10^5		
30.0 TeV	3.000×10^7	3.082	118.912	169.224	13.532	304.752	5.011×10^5		
40.0 TeV	4.000×10^7	3.112	159.067	226.101	18.431	406.712	5.294×10^5		
80.0 TeV	8.000×10^7	3.186	319.956	453.769	38.896	815.808	5.975×10^5		
100. TeV	1.000×10^8	3.211	400.550	567.710	49.470	1020.942	6.194×10^5		

TABLE I-46. Muons in Liquid Krypton

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
36 (Kr)	83.80	2.418	352.0	0.23491	3.0000	0.4454	3.0000	5.9674	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	4.928				4.928	1.160×10^0
14.0 MeV	5.616×10^1	3.881				3.881	2.084×10^0
20.0 MeV	6.802×10^1	3.058				3.058	3.844×10^0
30.0 MeV	8.509×10^1	2.394				2.394	7.590×10^0
40.0 MeV	1.003×10^2	2.057				2.057	1.212×10^1
80.0 MeV	1.527×10^2	1.566				1.566	3.510×10^1
100. MeV	1.764×10^2	1.479				1.480	4.827×10^1
140. MeV	2.218×10^2	1.397				1.397	7.621×10^1
200. MeV	2.868×10^2	1.360				1.361	1.199×10^2
236. MeV	3.250×10^2	1.357				1.357	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.364	0.000		0.000	1.364	1.935×10^2
400. MeV	4.945×10^2	1.386	0.000		0.000	1.386	2.662×10^2
800. MeV	8.995×10^2	1.478	0.001		0.000	1.479	5.452×10^2
1.00 GeV	1.101×10^3	1.514	0.001		0.000	1.515	6.788×10^2
1.40 GeV	1.502×10^3	1.570	0.001	0.000	0.001	1.572	9.377×10^2
2.00 GeV	2.103×10^3	1.630	0.002	0.001	0.001	1.634	1.312×10^3
3.00 GeV	3.104×10^3	1.697	0.004	0.003	0.001	1.705	1.910×10^3
4.00 GeV	4.104×10^3	1.743	0.005	0.005	0.002	1.754	2.487×10^3
8.00 GeV	8.105×10^3	1.844	0.013	0.014	0.003	1.874	4.685×10^3
10.0 GeV	1.011×10^4	1.874	0.017	0.019	0.004	1.915	5.740×10^3
14.0 GeV	1.411×10^4	1.917	0.026	0.030	0.006	1.979	7.794×10^3
20.0 GeV	2.011×10^4	1.959	0.041	0.049	0.008	2.057	1.076×10^4
30.0 GeV	3.011×10^4	2.004	0.066	0.085	0.012	2.167	1.550×10^4
40.0 GeV	4.011×10^4	2.033	0.094	0.124	0.015	2.267	2.001×10^4
80.0 GeV	8.011×10^4	2.099	0.211	0.296	0.030	2.637	3.634×10^4
100. GeV	1.001×10^5	2.119	0.274	0.388	0.037	2.819	4.367×10^4
140. GeV	1.401×10^5	2.149	0.402	0.579	0.052	3.183	5.702×10^4
200. GeV	2.001×10^5	2.181	0.603	0.880	0.074	3.738	7.440×10^4
274. GeV	2.741×10^5	2.209	0.856	1.252	0.101	4.418	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.216	0.946	1.385	0.110	4.659	9.832×10^4
400. GeV	4.001×10^5	2.242	1.302	1.907	0.147	5.599	1.179×10^5
800. GeV	8.001×10^5	2.303	2.769	4.051	0.298	9.422	1.724×10^5
1.00 TeV	1.000×10^6	2.323	3.524	5.148	0.374	11.370	1.917×10^5
1.40 TeV	1.400×10^6	2.354	5.038	7.337	0.530	15.259	2.219×10^5
2.00 TeV	2.000×10^6	2.386	7.355	10.678	0.767	21.187	2.552×10^5
3.00 TeV	3.000×10^6	2.424	11.225	16.230	1.173	31.054	2.939×10^5
4.00 TeV	4.000×10^6	2.451	15.150	21.843	1.585	41.030	3.219×10^5
8.00 TeV	8.000×10^6	2.518	30.981	44.408	3.297	81.205	3.899×10^5
10.0 TeV	1.000×10^7	2.540	38.962	55.753	4.176	101.432	4.118×10^5
14.0 TeV	1.400×10^7	2.573	54.882	78.387	5.981	141.824	4.450×10^5
20.0 TeV	2.000×10^7	2.609	78.910	112.486	8.748	202.754	4.802×10^5
30.0 TeV	3.000×10^7	2.651	118.912	169.224	13.532	304.320	5.202×10^5
40.0 TeV	4.000×10^7	2.681	159.067	226.101	18.431	406.280	5.486×10^5
80.0 TeV	8.000×10^7	2.755	319.956	453.769	38.896	815.377	6.167×10^5
100. TeV	1.000×10^8	2.779	400.550	567.710	49.470	1020.510	6.386×10^5

TABLE I-47. Muons in Rubidium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
37 (Rb)	85.4678	1.532	363.0	0.07261	3.4177	0.5737	3.7995	6.4776	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.880				3.880	2.093×10^0
20.0 MeV	6.802×10^1	3.061				3.061	3.853×10^0
30.0 MeV	8.509×10^1	2.398				2.398	7.593×10^0
40.0 MeV	1.003×10^2	2.061				2.061	1.212×10^1
80.0 MeV	1.527×10^2	1.569				1.569	3.504×10^1
100. MeV	1.764×10^2	1.482				1.483	4.818×10^1
140. MeV	2.218×10^2	1.399				1.399	7.608×10^1
200. MeV	2.868×10^2	1.361				1.361	1.197×10^2
239. MeV	3.285×10^2	1.356				1.356	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.362	0.000		0.000	1.362	1.933×10^2
400. MeV	4.945×10^2	1.385	0.000		0.000	1.385	2.662×10^2
800. MeV	8.995×10^2	1.480	0.001		0.000	1.481	5.449×10^2
1.00 GeV	1.101×10^3	1.517	0.001		0.000	1.519	6.782×10^2
1.40 GeV	1.502×10^3	1.576	0.001	0.000	0.001	1.578	9.363×10^2
2.00 GeV	2.103×10^3	1.639	0.002	0.001	0.001	1.643	1.308×10^3
3.00 GeV	3.104×10^3	1.709	0.004	0.003	0.001	1.717	1.903×10^3
4.00 GeV	4.104×10^3	1.757	0.005	0.005	0.002	1.769	2.476×10^3
8.00 GeV	8.105×10^3	1.865	0.013	0.014	0.003	1.897	4.651×10^3
10.0 GeV	1.011×10^4	1.898	0.018	0.020	0.004	1.939	5.694×10^3
14.0 GeV	1.411×10^4	1.944	0.027	0.031	0.006	2.008	7.719×10^3
20.0 GeV	2.011×10^4	1.990	0.042	0.051	0.008	2.091	1.064×10^4
30.0 GeV	3.011×10^4	2.038	0.069	0.088	0.012	2.207	1.530×10^4
40.0 GeV	4.011×10^4	2.070	0.097	0.128	0.015	2.311	1.972×10^4
80.0 GeV	8.011×10^4	2.141	0.219	0.306	0.030	2.697	3.571×10^4
100. GeV	1.001×10^5	2.163	0.283	0.401	0.037	2.885	4.288×10^4
140. GeV	1.401×10^5	2.194	0.416	0.598	0.052	3.261	5.592×10^4
200. GeV	2.001×10^5	2.227	0.623	0.910	0.074	3.834	7.287×10^4
271. GeV	2.715×10^5	2.254	0.875	1.280	0.100	4.510	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.263	0.978	1.431	0.110	4.784	9.618×10^4
400. GeV	4.001×10^5	2.289	1.345	1.971	0.147	5.753	1.152×10^5
800. GeV	8.001×10^5	2.351	2.862	4.185	0.297	9.697	1.682×10^5
1.00 TeV	1.000×10^6	2.371	3.642	5.319	0.374	11.706	1.870×10^5
1.40 TeV	1.400×10^6	2.402	5.206	7.580	0.529	15.718	2.163×10^5
2.00 TeV	2.000×10^6	2.435	7.599	11.031	0.766	21.832	2.486×10^5
3.00 TeV	3.000×10^6	2.473	11.598	16.767	1.171	32.009	2.862×10^5
4.00 TeV	4.000×10^6	2.500	15.651	22.564	1.583	42.299	3.133×10^5
8.00 TeV	8.000×10^6	2.567	32.004	45.872	3.291	83.735	3.793×10^5
10.0 TeV	1.000×10^7	2.589	40.248	57.589	4.169	104.596	4.006×10^5
14.0 TeV	1.400×10^7	2.623	56.692	80.967	5.971	146.255	4.328×10^5
20.0 TeV	2.000×10^7	2.659	81.512	116.186	8.734	209.092	4.669×10^5
30.0 TeV	3.000×10^7	2.701	122.831	174.789	13.510	313.832	5.057×10^5
40.0 TeV	4.000×10^7	2.731	164.307	233.534	18.400	418.973	5.332×10^5
80.0 TeV	8.000×10^7	2.806	330.487	468.684	38.827	840.805	5.992×10^5
100. TeV	1.000×10^8	2.831	413.730	586.370	49.380	1052.312	6.204×10^5

TABLE I-48. Muons in Strontium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
38 (Sr)	87.62	2.540	366.0	0.07165	3.4435	0.4585	3.6778	5.9867	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.881				3.882	2.092×10^0
20.0 MeV	6.802×10^1	3.062				3.062	3.851×10^0
30.0 MeV	8.509×10^1	2.399				2.399	7.590×10^0
40.0 MeV	1.003×10^2	2.062				2.062	1.211×10^1
80.0 MeV	1.527×10^2	1.569				1.569	3.504×10^1
100. MeV	1.764×10^2	1.482				1.482	4.818×10^1
140. MeV	2.218×10^2	1.398				1.398	7.610×10^1
200. MeV	2.868×10^2	1.358				1.358	1.198×10^2
237. MeV	3.260×10^2	1.353				1.354	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.359	0.000		0.000	1.359	1.936×10^2
400. MeV	4.945×10^2	1.380	0.000		0.000	1.381	2.666×10^2
800. MeV	8.995×10^2	1.471	0.001		0.000	1.472	5.467×10^2
1.00 GeV	1.101×10^3	1.507	0.001		0.000	1.509	6.809×10^2
1.40 GeV	1.502×10^3	1.564	0.001	0.000	0.001	1.566	9.408×10^2
2.00 GeV	2.103×10^3	1.624	0.002	0.001	0.001	1.629	1.316×10^3
3.00 GeV	3.104×10^3	1.692	0.004	0.003	0.001	1.701	1.916×10^3
4.00 GeV	4.104×10^3	1.739	0.006	0.005	0.002	1.751	2.495×10^3
8.00 GeV	8.105×10^3	1.844	0.014	0.014	0.003	1.876	4.693×10^3
10.0 GeV	1.011×10^4	1.875	0.018	0.020	0.004	1.918	5.747×10^3
14.0 GeV	1.411×10^4	1.920	0.028	0.032	0.006	1.986	7.795×10^3
20.0 GeV	2.011×10^4	1.965	0.043	0.052	0.008	2.068	1.075×10^4
30.0 GeV	3.011×10^4	2.012	0.070	0.090	0.012	2.185	1.545×10^4
40.0 GeV	4.011×10^4	2.043	0.099	0.132	0.015	2.290	1.992×10^4
80.0 GeV	8.011×10^4	2.113	0.224	0.314	0.030	2.682	3.603×10^4
100. GeV	1.001×10^5	2.134	0.291	0.412	0.037	2.875	4.323×10^4
140. GeV	1.401×10^5	2.165	0.427	0.615	0.052	3.259	5.629×10^4
200. GeV	2.001×10^5	2.198	0.640	0.934	0.073	3.846	7.323×10^4
262. GeV	2.619×10^5	2.222	0.863	1.262	0.096	4.444	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.234	1.004	1.469	0.110	4.818	9.642×10^4
400. GeV	4.001×10^5	2.259	1.381	2.024	0.147	5.811	1.153×10^5
800. GeV	8.001×10^5	2.321	2.938	4.297	0.297	9.853	1.676×10^5
1.00 TeV	1.000×10^6	2.342	3.738	5.460	0.373	11.913	1.860×10^5
1.40 TeV	1.400×10^6	2.372	5.343	7.781	0.528	16.025	2.149×10^5
2.00 TeV	2.000×10^6	2.405	7.799	11.322	0.764	22.292	2.465×10^5
3.00 TeV	3.000×10^6	2.443	11.902	17.209	1.169	32.725	2.833×10^5
4.00 TeV	4.000×10^6	2.471	16.062	23.158	1.580	43.272	3.098×10^5
8.00 TeV	8.000×10^6	2.538	32.842	47.077	3.284	85.742	3.742×10^5
10.0 TeV	1.000×10^7	2.560	41.301	59.101	4.160	107.123	3.950×10^5
14.0 TeV	1.400×10^7	2.594	58.173	83.091	5.958	149.818	4.265×10^5
20.0 TeV	2.000×10^7	2.630	83.638	119.232	8.714	214.215	4.598×10^5
30.0 TeV	3.000×10^7	2.672	126.032	179.370	13.479	321.553	4.976×10^5
40.0 TeV	4.000×10^7	2.702	168.586	239.653	18.357	429.300	5.245×10^5
80.0 TeV	8.000×10^7	2.777	339.085	480.951	38.739	861.552	5.889×10^5
100. TeV	1.000×10^8	2.802	424.490	601.710	49.270	1078.273	6.096×10^5

TABLE I-49. Muons in Zirconium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
40 (Zr)	91.224	6.506	393.0	0.07177	3.4533	0.2957	3.4890	5.1774	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.877				3.877	2.098×10^0
20.0 MeV	6.802×10^1	3.060				3.060	3.858×10^0
30.0 MeV	8.509×10^1	2.399				2.399	7.598×10^0
40.0 MeV	1.003×10^2	2.061				2.061	1.212×10^1
80.0 MeV	1.527×10^2	1.568				1.568	3.505×10^1
100. MeV	1.764×10^2	1.480				1.480	4.821×10^1
140. MeV	2.218×10^2	1.395				1.395	7.617×10^1
200. MeV	2.868×10^2	1.355				1.355	1.199×10^2
247. MeV	3.366×10^2	1.349				1.349	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.353	0.000		0.000	1.353	1.940×10^2
400. MeV	4.945×10^2	1.371	0.000		0.000	1.372	2.674×10^2
800. MeV	8.995×10^2	1.456	0.001		0.000	1.457	5.500×10^2
1.00 GeV	1.101×10^3	1.490	0.001		0.000	1.491	6.857×10^2
1.40 GeV	1.502×10^3	1.543	0.001	0.000	0.001	1.546	9.489×10^2
2.00 GeV	2.103×10^3	1.601	0.002	0.001	0.001	1.606	1.329×10^3
3.00 GeV	3.104×10^3	1.666	0.004	0.003	0.001	1.675	1.938×10^3
4.00 GeV	4.104×10^3	1.711	0.006	0.005	0.002	1.724	2.526×10^3
8.00 GeV	8.105×10^3	1.812	0.015	0.015	0.003	1.845	4.761×10^3
10.0 GeV	1.011×10^4	1.842	0.019	0.021	0.004	1.887	5.832×10^3
14.0 GeV	1.411×10^4	1.885	0.029	0.034	0.006	1.955	7.914×10^3
20.0 GeV	2.011×10^4	1.928	0.046	0.056	0.008	2.038	1.092×10^4
30.0 GeV	3.011×10^4	1.974	0.075	0.096	0.012	2.157	1.568×10^4
40.0 GeV	4.011×10^4	2.005	0.105	0.140	0.015	2.266	2.021×10^4
80.0 GeV	8.011×10^4	2.074	0.238	0.333	0.030	2.676	3.642×10^4
100. GeV	1.001×10^5	2.095	0.308	0.438	0.037	2.878	4.363×10^4
140. GeV	1.401×10^5	2.126	0.453	0.652	0.052	3.282	5.663×10^4
200. GeV	2.001×10^5	2.158	0.678	0.991	0.073	3.901	7.338×10^4
244. GeV	2.444×10^5	2.176	0.848	1.239	0.089	4.353	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.194	1.065	1.558	0.110	4.928	9.615×10^4
400. GeV	4.001×10^5	2.220	1.464	2.145	0.146	5.976	1.146×10^5
800. GeV	8.001×10^5	2.283	3.113	4.553	0.296	10.247	1.651×10^5
1.00 TeV	1.000×10^6	2.303	3.961	5.785	0.372	12.423	1.828×10^5
1.40 TeV	1.400×10^6	2.334	5.662	8.244	0.527	16.767	2.104×10^5
2.00 TeV	2.000×10^6	2.368	8.264	11.995	0.762	23.389	2.406×10^5
3.00 TeV	3.000×10^6	2.406	12.610	18.229	1.165	34.412	2.756×10^5
4.00 TeV	4.000×10^6	2.434	17.015	24.530	1.575	45.555	3.008×10^5
8.00 TeV	8.000×10^6	2.502	34.786	49.860	3.274	90.422	3.619×10^5
10.0 TeV	1.000×10^7	2.524	43.744	62.593	4.146	113.008	3.817×10^5
14.0 TeV	1.400×10^7	2.558	61.612	87.999	5.938	158.108	4.115×10^5
20.0 TeV	2.000×10^7	2.595	88.578	126.270	8.684	226.128	4.430×10^5
30.0 TeV	3.000×10^7	2.638	133.470	189.952	13.431	339.491	4.789×10^5
40.0 TeV	4.000×10^7	2.668	178.530	253.787	18.291	453.277	5.043×10^5
80.0 TeV	8.000×10^7	2.744	359.067	509.309	38.592	909.713	5.654×10^5
100. TeV	1.000×10^8	2.769	449.500	637.190	49.080	1138.540	5.850×10^5

TABLE I-50. Muons in Niobium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
41 (Nb)	92.90638	8.570	417.0	0.13883	3.0930	0.1785	3.2201	5.0141	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.861				3.861	2.109×10^0
20.0 MeV	6.802×10^1	3.049				3.049	3.877×10^0
30.0 MeV	8.509×10^1	2.390				2.390	7.630×10^0
40.0 MeV	1.003×10^2	2.054				2.054	1.217×10^1
80.0 MeV	1.527×10^2	1.561				1.561	3.519×10^1
100. MeV	1.764×10^2	1.474				1.474	4.841×10^1
140. MeV	2.218×10^2	1.390				1.390	7.647×10^1
200. MeV	2.868×10^2	1.349				1.349	1.204×10^2
253. MeV	3.431×10^2	1.343				1.343	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.346	0.000		0.000	1.347	1.948×10^2
400. MeV	4.945×10^2	1.364	0.000		0.000	1.365	2.686×10^2
800. MeV	8.995×10^2	1.449	0.001		0.000	1.450	5.527×10^2
1.00 GeV	1.101×10^3	1.482	0.001		0.000	1.484	6.890×10^2
1.40 GeV	1.502×10^3	1.536	0.001	0.001	0.001	1.539	9.534×10^2
2.00 GeV	2.103×10^3	1.594	0.002	0.001	0.001	1.599	1.335×10^3
3.00 GeV	3.104×10^3	1.660	0.004	0.003	0.001	1.668	1.947×10^3
4.00 GeV	4.104×10^3	1.704	0.006	0.005	0.002	1.718	2.537×10^3
8.00 GeV	8.105×10^3	1.806	0.015	0.016	0.003	1.840	4.778×10^3
10.0 GeV	1.011×10^4	1.836	0.020	0.022	0.004	1.883	5.852×10^3
14.0 GeV	1.411×10^4	1.880	0.030	0.035	0.006	1.951	7.938×10^3
20.0 GeV	2.011×10^4	1.923	0.047	0.057	0.008	2.036	1.095×10^4
30.0 GeV	3.011×10^4	1.969	0.077	0.099	0.012	2.157	1.571×10^4
40.0 GeV	4.011×10^4	2.000	0.108	0.144	0.015	2.268	2.023×10^4
80.0 GeV	8.011×10^4	2.068	0.245	0.344	0.030	2.688	3.640×10^4
100. GeV	1.001×10^5	2.089	0.317	0.451	0.037	2.895	4.357×10^4
140. GeV	1.401×10^5	2.120	0.466	0.671	0.051	3.310	5.649×10^4
200. GeV	2.001×10^5	2.153	0.699	1.020	0.073	3.946	7.307×10^4
237. GeV	2.375×10^5	2.168	0.846	1.236	0.087	4.337	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.189	1.096	1.604	0.110	5.000	9.554×10^4
400. GeV	4.001×10^5	2.215	1.507	2.209	0.146	6.078	1.137×10^5
800. GeV	8.001×10^5	2.278	3.205	4.688	0.295	10.468	1.632×10^5
1.00 TeV	1.000×10^6	2.299	4.078	5.956	0.371	12.705	1.805×10^5
1.40 TeV	1.400×10^6	2.330	5.828	8.486	0.526	17.171	2.075×10^5
2.00 TeV	2.000×10^6	2.364	8.507	12.346	0.761	23.978	2.370×10^5
3.00 TeV	3.000×10^6	2.403	12.980	18.763	1.163	35.309	2.712×10^5
4.00 TeV	4.000×10^6	2.430	17.514	25.247	1.572	46.764	2.957×10^5
8.00 TeV	8.000×10^6	2.499	35.802	51.314	3.268	92.884	3.552×10^5
10.0 TeV	1.000×10^7	2.521	45.021	64.417	4.140	116.101	3.744×10^5
14.0 TeV	1.400×10^7	2.556	63.409	90.562	5.929	162.456	4.034×10^5
20.0 TeV	2.000×10^7	2.593	91.160	129.946	8.670	232.370	4.341×10^5
30.0 TeV	3.000×10^7	2.635	137.359	195.479	13.410	348.884	4.690×10^5
40.0 TeV	4.000×10^7	2.666	183.730	261.169	18.263	465.829	4.938×10^5
80.0 TeV	8.000×10^7	2.742	369.518	524.115	38.530	934.907	5.532×10^5
100. TeV	1.000×10^8	2.767	462.580	655.710	49.000	1170.059	5.722×10^5

TABLE I-51. Muons in Molybdenum

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
42 (Mo)	95.94	10.220	424.0	0.10525	3.2549	0.2267	3.2784	4.8793	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	4.837				4.837	1.193×10^0		
14.0 MeV	5.616×10^1	3.821				3.821	2.132×10^0		
20.0 MeV	6.802×10^1	3.018				3.018	3.918×10^0		
30.0 MeV	8.509×10^1	2.367				2.367	7.710×10^0		
40.0 MeV	1.003×10^2	2.034				2.034	1.230×10^1		
80.0 MeV	1.527×10^2	1.548				1.548	3.552×10^1		
100. MeV	1.764×10^2	1.461				1.461	4.886×10^1		
140. MeV	2.218×10^2	1.377				1.377	7.718×10^1		
200. MeV	2.868×10^2	1.336				1.336	1.216×10^2		
252. MeV	3.421×10^2	1.330				1.330	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.333	0.000		0.000	1.333	1.967×10^2		
400. MeV	4.945×10^2	1.351	0.000		0.000	1.351	2.712×10^2		
800. MeV	8.995×10^2	1.433	0.001		0.000	1.434	5.583×10^2		
1.00 GeV	1.101×10^3	1.466	0.001		0.000	1.467	6.961×10^2		
1.40 GeV	1.502×10^3	1.518	0.001	0.001	0.001	1.521	9.636×10^2		
2.00 GeV	2.103×10^3	1.575	0.002	0.001	0.001	1.580	1.350×10^3		
3.00 GeV	3.104×10^3	1.639	0.004	0.003	0.001	1.648	1.969×10^3		
4.00 GeV	4.104×10^3	1.683	0.006	0.005	0.002	1.696	2.567×10^3		
8.00 GeV	8.105×10^3	1.782	0.015	0.016	0.003	1.817	4.836×10^3		
10.0 GeV	1.011×10^4	1.812	0.020	0.022	0.004	1.859	5.924×10^3		
14.0 GeV	1.411×10^4	1.855	0.031	0.036	0.006	1.927	8.036×10^3		
20.0 GeV	2.011×10^4	1.897	0.048	0.058	0.008	2.011	1.108×10^4		
30.0 GeV	3.011×10^4	1.942	0.078	0.100	0.011	2.133	1.591×10^4		
40.0 GeV	4.011×10^4	1.973	0.110	0.146	0.015	2.245	2.047×10^4		
80.0 GeV	8.011×10^4	2.040	0.248	0.349	0.030	2.668	3.679×10^4		
100. GeV	1.001×10^5	2.061	0.322	0.457	0.037	2.878	4.400×10^4		
140. GeV	1.401×10^5	2.092	0.472	0.681	0.051	3.298	5.698×10^4		
200. GeV	2.001×10^5	2.124	0.708	1.035	0.073	3.941	7.361×10^4		
232. GeV	2.317×10^5	2.137	0.834	1.219	0.084	4.276	<i>Muon critical energy</i>		
300. GeV	3.001×10^5	2.161	1.111	1.627	0.109	5.009	9.607×10^4		
400. GeV	4.001×10^5	2.186	1.528	2.240	0.146	6.101	1.141×10^5		
800. GeV	8.001×10^5	2.249	3.249	4.754	0.295	10.548	1.634×10^5		
1.00 TeV	1.000×10^6	2.269	4.134	6.040	0.370	12.814	1.806×10^5		
1.40 TeV	1.400×10^6	2.300	5.908	8.605	0.524	17.339	2.073×10^5		
2.00 TeV	2.000×10^6	2.334	8.622	12.519	0.759	24.235	2.365×10^5		
3.00 TeV	3.000×10^6	2.372	13.155	19.025	1.160	35.713	2.703×10^5		
4.00 TeV	4.000×10^6	2.400	17.751	25.599	1.568	47.318	2.945×10^5		
8.00 TeV	8.000×10^6	2.468	36.284	52.027	3.259	94.039	3.533×10^5		
10.0 TeV	1.000×10^7	2.490	45.626	65.311	4.128	117.556	3.723×10^5		
14.0 TeV	1.400×10^7	2.524	64.260	91.817	5.912	164.515	4.010×10^5		
20.0 TeV	2.000×10^7	2.561	92.382	131.746	8.646	235.336	4.313×10^5		
30.0 TeV	3.000×10^7	2.603	139.197	198.185	13.371	353.357	4.657×10^5		
40.0 TeV	4.000×10^7	2.634	186.186	264.781	18.209	471.811	4.901×10^5		
80.0 TeV	8.000×10^7	2.709	374.443	531.358	38.413	946.924	5.488×10^5		
100. TeV	1.000×10^8	2.734	468.740	664.770	48.850	1185.095	5.676×10^5		

TABLE I-52. Muons in Palladium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
46 (Pd)	106.42	12.020	470.0	0.24178	2.7239	0.0563	3.0555	4.9358	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	4.682				4.682	1.236×10^0
14.0 MeV	5.616×10^1	3.702				3.702	2.206×10^0
20.0 MeV	6.802×10^1	2.926				2.926	4.049×10^0
30.0 MeV	8.509×10^1	2.295				2.295	7.959×10^0
40.0 MeV	1.003×10^2	1.972				1.972	1.269×10^1
80.0 MeV	1.527×10^2	1.500				1.501	3.666×10^1
100. MeV	1.764×10^2	1.417				1.417	5.041×10^1
140. MeV	2.218×10^2	1.335				1.335	7.962×10^1
200. MeV	2.868×10^2	1.295				1.295	1.254×10^2
253. MeV	3.431×10^2	1.289				1.289	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.292	0.000		0.000	1.292	2.029×10^2
400. MeV	4.945×10^2	1.309	0.000		0.000	1.310	2.798×10^2
800. MeV	8.995×10^2	1.392	0.001		0.000	1.393	5.756×10^2
1.00 GeV	1.101×10^3	1.425	0.001		0.000	1.427	7.174×10^2
1.40 GeV	1.502×10^3	1.478	0.002	0.001	0.001	1.481	9.924×10^2
2.00 GeV	2.103×10^3	1.535	0.003	0.002	0.001	1.541	1.389×10^3
3.00 GeV	3.104×10^3	1.600	0.005	0.003	0.001	1.610	2.023×10^3
4.00 GeV	4.104×10^3	1.645	0.007	0.006	0.002	1.659	2.635×10^3
8.00 GeV	8.105×10^3	1.746	0.016	0.017	0.003	1.783	4.951×10^3
10.0 GeV	1.011×10^4	1.776	0.022	0.024	0.004	1.826	6.059×10^3
14.0 GeV	1.411×10^4	1.819	0.033	0.039	0.005	1.897	8.207×10^3
20.0 GeV	2.011×10^4	1.862	0.051	0.063	0.008	1.984	1.130×10^4
30.0 GeV	3.011×10^4	1.908	0.084	0.108	0.011	2.111	1.618×10^4
40.0 GeV	4.011×10^4	1.938	0.118	0.158	0.015	2.229	2.079×10^4
80.0 GeV	8.011×10^4	2.005	0.267	0.375	0.029	2.677	3.713×10^4
100. GeV	1.001×10^5	2.026	0.345	0.492	0.037	2.900	4.430×10^4
140. GeV	1.401×10^5	2.056	0.507	0.733	0.051	3.347	5.713×10^4
200. GeV	2.001×10^5	2.087	0.760	1.113	0.072	4.033	7.345×10^4
214. GeV	2.138×10^5	2.093	0.818	1.198	0.077	4.188	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.123	1.192	1.749	0.108	5.173	9.529×10^4
400. GeV	4.001×10^5	2.149	1.639	2.407	0.145	6.340	1.127×10^5
800. GeV	8.001×10^5	2.211	3.484	5.104	0.292	11.092	1.598×10^5
1.00 TeV	1.000×10^6	2.231	4.432	6.483	0.367	13.515	1.762×10^5
1.40 TeV	1.400×10^6	2.261	6.333	9.235	0.520	18.351	2.015×10^5
2.00 TeV	2.000×10^6	2.294	9.242	13.433	0.752	25.723	2.290×10^5
3.00 TeV	3.000×10^6	2.332	14.099	20.411	1.150	37.994	2.608×10^5
4.00 TeV	4.000×10^6	2.359	19.022	27.461	1.554	50.398	2.835×10^5
8.00 TeV	8.000×10^6	2.427	38.875	55.800	3.230	100.333	3.387×10^5
10.0 TeV	1.000×10^7	2.449	48.881	70.044	4.091	125.466	3.565×10^5
14.0 TeV	1.400×10^7	2.482	68.839	98.466	5.858	175.646	3.833×10^5
20.0 TeV	2.000×10^7	2.518	98.956	141.278	8.566	251.320	4.117×10^5
30.0 TeV	3.000×10^7	2.560	149.094	212.517	13.246	377.418	4.440×10^5
40.0 TeV	4.000×10^7	2.591	199.416	283.924	18.037	503.968	4.668×10^5
80.0 TeV	8.000×10^7	2.665	401.021	569.737	38.045	1011.469	5.218×10^5
100. TeV	1.000×10^8	2.690	502.000	712.770	48.380	1265.841	5.394×10^5

TABLE I-53. Muons in Silver

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
47 (Ag)	107.8682	10.500	470.0	0.24585	2.6899	0.0657	3.1074	5.0630	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	4.721				4.721	1.226 × 10 ⁰		
14.0 MeV	5.616 × 10 ¹	3.732				3.733	2.188 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	2.950				2.950	4.015 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	2.314				2.314	7.894 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	1.988				1.988	1.258 × 10 ¹		
80.0 MeV	1.527 × 10 ²	1.513				1.513	3.636 × 10 ¹		
100. MeV	1.764 × 10 ²	1.428				1.428	5.000 × 10 ¹		
140. MeV	2.218 × 10 ²	1.346				1.346	7.898 × 10 ¹		
200. MeV	2.868 × 10 ²	1.305				1.306	1.244 × 10 ²		
253. MeV	3.431 × 10 ²	1.299				1.299	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.303	0.000		0.000	1.303	2.013 × 10 ²		
400. MeV	4.945 × 10 ²	1.321	0.000		0.000	1.321	2.775 × 10 ²		
800. MeV	8.995 × 10 ²	1.404	0.001		0.000	1.405	5.708 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.438	0.001		0.000	1.440	7.113 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.492	0.002	0.001	0.001	1.495	9.837 × 10 ²		
2.00 GeV	2.103 × 10 ³	1.550	0.003	0.002	0.001	1.556	1.377 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.616	0.005	0.004	0.001	1.626	2.005 × 10 ³		
4.00 GeV	4.104 × 10 ³	1.662	0.007	0.006	0.002	1.677	2.610 × 10 ³		
8.00 GeV	8.105 × 10 ³	1.765	0.017	0.018	0.003	1.803	4.901 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	1.796	0.022	0.025	0.004	1.847	5.997 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	1.840	0.034	0.040	0.005	1.920	8.119 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	1.884	0.053	0.064	0.008	2.009	1.117 × 10 ⁴		
30.0 GeV	3.011 × 10 ⁴	1.930	0.086	0.111	0.011	2.140	1.599 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	1.961	0.121	0.162	0.015	2.260	2.054 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	2.029	0.274	0.386	0.029	2.720	3.664 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	2.050	0.355	0.506	0.036	2.949	4.370 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	2.081	0.521	0.753	0.051	3.407	5.631 × 10 ⁴		
200. GeV	2.001 × 10 ⁵	2.113	0.781	1.144	0.072	4.111	7.232 × 10 ⁴		
211. GeV	2.109 × 10 ⁵	2.117	0.828	1.213	0.076	4.236	<i>Muon critical energy</i>		
300. GeV	3.001 × 10 ⁵	2.149	1.226	1.798	0.108	5.282	9.374 × 10 ⁴		
400. GeV	4.001 × 10 ⁵	2.175	1.685	2.474	0.144	6.479	1.108 × 10 ⁵		
800. GeV	8.001 × 10 ⁵	2.237	3.582	5.247	0.292	11.358	1.569 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.257	4.557	6.664	0.367	13.846	1.728 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.288	6.511	9.492	0.519	18.812	1.975 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.321	9.501	13.807	0.751	26.382	2.243 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.359	14.493	20.978	1.149	38.981	2.553 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.387	19.553	28.223	1.553	51.717	2.775 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.454	39.957	57.345	3.227	102.985	3.313 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.477	50.241	71.983	4.086	128.788	3.486 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.511	70.753	101.191	5.851	180.307	3.747 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	2.547	101.706	145.186	8.556	257.997	4.024 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	2.589	153.235	218.391	13.231	387.447	4.338 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	2.620	204.952	291.767	18.017	517.357	4.561 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	2.695	412.144	585.474	37.999	1038.313	5.096 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	2.720	515.920	732.460	48.320	1299.421	5.267 × 10 ⁵		

TABLE I-54. Muons in Cadmium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
48 (Cd)	112.411	8.650	469.0	0.24609	2.6772	0.1281	3.1667	5.2727	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	4.631				4.631	1.249×10^0		
14.0 MeV	5.616×10^1	3.662				3.662	2.230×10^0		
20.0 MeV	6.802×10^1	2.894				2.894	4.093×10^0		
30.0 MeV	8.509×10^1	2.271				2.271	8.045×10^0		
40.0 MeV	1.003×10^2	1.953				1.953	1.282×10^1		
80.0 MeV	1.527×10^2	1.485				1.485	3.703×10^1		
100. MeV	1.764×10^2	1.402				1.403	5.092×10^1		
140. MeV	2.218×10^2	1.322				1.322	8.043×10^1		
200. MeV	2.868×10^2	1.283				1.283	1.267×10^2		
247. MeV	3.366×10^2	1.277				1.277	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.281	0.000		0.000	1.281	2.049×10^2		
400. MeV	4.945×10^2	1.299	0.000		0.000	1.299	2.824×10^2		
800. MeV	8.995×10^2	1.382	0.001		0.000	1.383	5.805×10^2		
1.00 GeV	1.101×10^3	1.415	0.001		0.000	1.417	7.234×10^2		
1.40 GeV	1.502×10^3	1.469	0.002	0.001	0.001	1.472	1.000×10^3		
2.00 GeV	2.103×10^3	1.527	0.003	0.002	0.001	1.532	1.399×10^3		
3.00 GeV	3.104×10^3	1.592	0.005	0.004	0.001	1.602	2.037×10^3		
4.00 GeV	4.104×10^3	1.637	0.007	0.006	0.002	1.652	2.651×10^3		
8.00 GeV	8.105×10^3	1.740	0.017	0.018	0.003	1.778	4.975×10^3		
10.0 GeV	1.011×10^4	1.771	0.022	0.025	0.004	1.822	6.086×10^3		
14.0 GeV	1.411×10^4	1.815	0.034	0.040	0.005	1.894	8.237×10^3		
20.0 GeV	2.011×10^4	1.858	0.052	0.064	0.008	1.983	1.133×10^4		
30.0 GeV	3.011×10^4	1.904	0.086	0.111	0.011	2.113	1.621×10^4		
40.0 GeV	4.011×10^4	1.935	0.121	0.162	0.015	2.234	2.081×10^4		
80.0 GeV	8.011×10^4	2.003	0.274	0.386	0.029	2.692	3.709×10^4		
100. GeV	1.001×10^5	2.023	0.354	0.506	0.036	2.921	4.422×10^4		
140. GeV	1.401×10^5	2.053	0.520	0.753	0.051	3.378	5.695×10^4		
200. GeV	2.001×10^5	2.084	0.780	1.144	0.072	4.081	7.309×10^4		
208. GeV	2.084×10^5	2.088	0.816	1.197	0.075	4.177	<i>Muon critical energy</i>		
300. GeV	3.001×10^5	2.120	1.223	1.797	0.108	5.249	9.465×10^4		
400. GeV	4.001×10^5	2.145	1.682	2.473	0.144	6.445	1.118×10^5		
800. GeV	8.001×10^5	2.206	3.576	5.243	0.291	11.317	1.581×10^5		
1.00 TeV	1.000×10^6	2.226	4.549	6.659	0.365	13.801	1.741×10^5		
1.40 TeV	1.400×10^6	2.256	6.500	9.485	0.518	18.760	1.988×10^5		
2.00 TeV	2.000×10^6	2.289	9.484	13.795	0.749	26.318	2.257×10^5		
3.00 TeV	3.000×10^6	2.326	14.468	20.959	1.145	38.899	2.568×10^5		
4.00 TeV	4.000×10^6	2.353	19.519	28.197	1.547	51.617	2.790×10^5		
8.00 TeV	8.000×10^6	2.419	39.885	57.290	3.215	102.811	3.329×10^5		
10.0 TeV	1.000×10^7	2.441	50.149	71.913	4.072	128.577	3.502×10^5		
14.0 TeV	1.400×10^7	2.474	70.622	101.091	5.830	180.020	3.764×10^5		
20.0 TeV	2.000×10^7	2.510	101.516	145.042	8.524	257.594	4.041×10^5		
30.0 TeV	3.000×10^7	2.552	152.947	218.172	13.180	386.853	4.356×10^5		
40.0 TeV	4.000×10^7	2.581	204.566	291.473	17.947	516.569	4.579×10^5		
80.0 TeV	8.000×10^7	2.655	411.362	584.876	37.850	1036.745	5.115×10^5		
100. TeV	1.000×10^8	2.679	514.940	731.710	48.130	1297.461	5.287×10^5		

TABLE I-55. Muons in Indium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
49 (In)	114.818	7.310	488.0	0.23879	2.7144	0.2406	3.2032	5.5211	0.14
<i>T</i>	<i>p</i> [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	4.596				4.596	1.261×10^0		
14.0 MeV	5.616×10^1	3.637				3.637	2.248×10^0		
20.0 MeV	6.802×10^1	2.877				2.877	4.123×10^0		
30.0 MeV	8.509×10^1	2.260				2.260	8.097×10^0		
40.0 MeV	1.003×10^2	1.944				1.944	1.290×10^1		
80.0 MeV	1.527×10^2	1.482				1.482	3.718×10^1		
100. MeV	1.764×10^2	1.399				1.400	5.110×10^1		
140. MeV	2.218×10^2	1.320				1.321	8.066×10^1		
200. MeV	2.868×10^2	1.283				1.283	1.269×10^2		
246. MeV	3.356×10^2	1.278				1.278	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.282	0.000		0.000	1.282	2.051×10^2		
400. MeV	4.945×10^2	1.301	0.000		0.000	1.301	2.825×10^2		
800. MeV	8.995×10^2	1.386	0.001		0.000	1.387	5.799×10^2		
1.00 GeV	1.101×10^3	1.420	0.001		0.000	1.422	7.223×10^2		
1.40 GeV	1.502×10^3	1.474	0.002	0.001	0.001	1.477	9.980×10^2		
2.00 GeV	2.103×10^3	1.533	0.003	0.002	0.001	1.538	1.396×10^3		
3.00 GeV	3.104×10^3	1.599	0.005	0.004	0.001	1.609	2.030×10^3		
4.00 GeV	4.104×10^3	1.645	0.007	0.006	0.002	1.660	2.642×10^3		
8.00 GeV	8.105×10^3	1.748	0.017	0.018	0.003	1.787	4.955×10^3		
10.0 GeV	1.011×10^4	1.779	0.023	0.025	0.004	1.831	6.060×10^3		
14.0 GeV	1.411×10^4	1.823	0.034	0.041	0.005	1.904	8.200×10^3		
20.0 GeV	2.011×10^4	1.867	0.053	0.066	0.008	1.995	1.128×10^4		
30.0 GeV	3.011×10^4	1.914	0.087	0.113	0.011	2.127	1.613×10^4		
40.0 GeV	4.011×10^4	1.944	0.123	0.165	0.015	2.249	2.070×10^4		
80.0 GeV	8.011×10^4	2.012	0.279	0.393	0.029	2.714	3.686×10^4		
100. GeV	1.001×10^5	2.033	0.361	0.515	0.036	2.947	4.393×10^4		
140. GeV	1.401×10^5	2.063	0.530	0.767	0.051	3.412	5.653×10^4		
200. GeV	2.001×10^5	2.094	0.794	1.165	0.072	4.127	7.251×10^4		
206. GeV	2.059×10^5	2.097	0.820	1.203	0.074	4.195	<i>Muon critical energy</i>		
300. GeV	3.001×10^5	2.130	1.246	1.830	0.108	5.315	9.382×10^4		
400. GeV	4.001×10^5	2.155	1.713	2.519	0.144	6.531	1.108×10^5		
800. GeV	8.001×10^5	2.216	3.641	5.340	0.290	11.488	1.564×10^5		
1.00 TeV	1.000×10^6	2.236	4.632	6.782	0.365	14.015	1.721×10^5		
1.40 TeV	1.400×10^6	2.266	6.618	9.659	0.517	19.061	1.965×10^5		
2.00 TeV	2.000×10^6	2.299	9.657	14.048	0.747	26.752	2.229×10^5		
3.00 TeV	3.000×10^6	2.336	14.730	21.342	1.143	39.553	2.535×10^5		
4.00 TeV	4.000×10^6	2.363	19.872	28.712	1.544	52.493	2.754×10^5		
8.00 TeV	8.000×10^6	2.429	40.605	58.335	3.209	104.579	3.283×10^5		
10.0 TeV	1.000×10^7	2.451	51.054	73.223	4.064	130.793	3.454×10^5		
14.0 TeV	1.400×10^7	2.484	71.896	102.932	5.819	183.131	3.711×10^5		
20.0 TeV	2.000×10^7	2.520	103.344	147.680	8.508	262.053	3.984×10^5		
30.0 TeV	3.000×10^7	2.561	155.700	222.139	13.155	393.556	4.293×10^5		
40.0 TeV	4.000×10^7	2.591	208.246	296.770	17.912	525.521	4.512×10^5		
80.0 TeV	8.000×10^7	2.665	418.754	595.500	37.772	1054.693	5.039×10^5		
100. TeV	1.000×10^8	2.689	524.190	745.000	48.030	1319.910	5.208×10^5		

TABLE I-56. Muons in Tin
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
50 (Sn)	118.710	7.310	488.0	0.18689	2.8576	0.2879	3.2959	5.5340	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	4.538				4.538	1.277×10^0		
14.0 MeV	5.616×10^1	3.591				3.591	2.277×10^0		
20.0 MeV	6.802×10^1	2.840				2.840	4.176×10^0		
30.0 MeV	8.509×10^1	2.231				2.231	8.201×10^0		
40.0 MeV	1.003×10^2	1.920				1.920	1.306×10^1		
80.0 MeV	1.527×10^2	1.464				1.464	3.764×10^1		
100. MeV	1.764×10^2	1.383				1.383	5.173×10^1		
140. MeV	2.218×10^2	1.305				1.305	8.163×10^1		
200. MeV	2.868×10^2	1.268				1.268	1.284×10^2		
246. MeV	3.356×10^2	1.263				1.264	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.268	0.000		0.000	1.268	2.075×10^2		
400. MeV	4.945×10^2	1.286	0.000		0.000	1.287	2.858×10^2		
800. MeV	8.995×10^2	1.371	0.001		0.000	1.372	5.864×10^2		
1.00 GeV	1.101×10^3	1.404	0.001		0.000	1.406	7.304×10^2		
1.40 GeV	1.502×10^3	1.458	0.002	0.001	0.001	1.461	1.009×10^3		
2.00 GeV	2.103×10^3	1.515	0.003	0.002	0.001	1.521	1.411×10^3		
3.00 GeV	3.104×10^3	1.580	0.005	0.004	0.001	1.590	2.053×10^3		
4.00 GeV	4.104×10^3	1.625	0.007	0.006	0.002	1.640	2.672×10^3		
8.00 GeV	8.105×10^3	1.727	0.017	0.018	0.003	1.766	5.013×10^3		
10.0 GeV	1.011×10^4	1.757	0.023	0.026	0.004	1.810	6.132×10^3		
14.0 GeV	1.411×10^4	1.800	0.035	0.041	0.005	1.882	8.298×10^3		
20.0 GeV	2.011×10^4	1.844	0.054	0.066	0.008	1.972	1.141×10^4		
30.0 GeV	3.011×10^4	1.889	0.088	0.114	0.011	2.103	1.632×10^4		
40.0 GeV	4.011×10^4	1.919	0.124	0.166	0.015	2.225	2.094×10^4		
80.0 GeV	8.011×10^4	1.987	0.280	0.395	0.029	2.692	3.725×10^4		
100. GeV	1.001×10^5	2.007	0.363	0.519	0.036	2.926	4.437×10^4		
140. GeV	1.401×10^5	2.037	0.533	0.772	0.050	3.393	5.706×10^4		
200. GeV	2.001×10^5	2.068	0.798	1.172	0.072	4.111	7.311×10^4		
202. GeV	2.025×10^5	2.069	0.809	1.188	0.072	4.139	<i>Muon critical energy</i>		
300. GeV	3.001×10^5	2.103	1.252	1.841	0.107	5.305	9.448×10^4		
400. GeV	4.001×10^5	2.128	1.721	2.533	0.143	6.527	1.114×10^5		
800. GeV	8.001×10^5	2.188	3.659	5.370	0.290	11.508	1.570×10^5		
1.00 TeV	1.000×10^6	2.208	4.655	6.820	0.364	14.047	1.727×10^5		
1.40 TeV	1.400×10^6	2.237	6.651	9.713	0.515	19.118	1.971×10^5		
2.00 TeV	2.000×10^6	2.269	9.704	14.126	0.745	26.846	2.234×10^5		
3.00 TeV	3.000×10^6	2.306	14.802	21.460	1.139	39.709	2.539×10^5		
4.00 TeV	4.000×10^6	2.333	19.969	28.870	1.540	52.712	2.757×10^5		
8.00 TeV	8.000×10^6	2.398	40.801	58.652	3.200	105.052	3.284×10^5		
10.0 TeV	1.000×10^7	2.420	51.300	73.620	4.052	131.393	3.454×10^5		
14.0 TeV	1.400×10^7	2.452	72.241	103.489	5.801	183.985	3.710×10^5		
20.0 TeV	2.000×10^7	2.488	103.840	148.478	8.482	263.289	3.981×10^5		
30.0 TeV	3.000×10^7	2.529	156.444	223.337	13.115	395.425	4.289×10^5		
40.0 TeV	4.000×10^7	2.558	209.238	298.369	17.857	528.024	4.507×10^5		
80.0 TeV	8.000×10^7	2.631	420.738	598.700	37.655	1059.726	5.031×10^5		
100. TeV	1.000×10^8	2.655	526.670	749.000	47.880	1326.206	5.199×10^5		

TABLE I-57. Muons in Antimony

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
51 (Sb)	121.760	6.691	487.0	0.16652	2.9319	0.3189	3.3489	5.6241	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	4.516				4.516	1.283 × 10 ⁰		
14.0 MeV	5.616 × 10 ¹	3.573				3.573	2.288 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	2.826				2.826	4.197 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	2.220				2.220	8.241 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	1.910				1.911	1.313 × 10 ¹		
80.0 MeV	1.527 × 10 ²	1.458				1.458	3.782 × 10 ¹		
100. MeV	1.764 × 10 ²	1.377				1.377	5.197 × 10 ¹		
140. MeV	2.218 × 10 ²	1.300				1.300	8.200 × 10 ¹		
200. MeV	2.868 × 10 ²	1.264				1.264	1.290 × 10 ²		
242. MeV	3.316 × 10 ²	1.259				1.259	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.264	0.000		0.000	1.264	2.083 × 10 ²		
400. MeV	4.945 × 10 ²	1.283	0.000		0.000	1.283	2.868 × 10 ²		
800. MeV	8.995 × 10 ²	1.367	0.001		0.000	1.368	5.883 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.401	0.001		0.000	1.403	7.326 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.454	0.002	0.001	0.001	1.457	1.012 × 10 ³		
2.00 GeV	2.103 × 10 ³	1.512	0.003	0.002	0.001	1.517	1.415 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.577	0.005	0.004	0.001	1.587	2.059 × 10 ³		
4.00 GeV	4.104 × 10 ³	1.621	0.007	0.006	0.002	1.637	2.679 × 10 ³		
8.00 GeV	8.105 × 10 ³	1.722	0.017	0.019	0.003	1.762	5.025 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	1.753	0.023	0.026	0.004	1.806	6.145 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	1.796	0.035	0.041	0.005	1.878	8.315 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	1.839	0.054	0.067	0.008	1.969	1.143 × 10 ⁴		
30.0 GeV	3.011 × 10 ⁴	1.884	0.089	0.116	0.011	2.101	1.635 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	1.915	0.125	0.169	0.015	2.224	2.097 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	1.982	0.284	0.401	0.029	2.696	3.727 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	2.002	0.367	0.525	0.036	2.932	4.438 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	2.032	0.539	0.782	0.050	3.404	5.704 × 10 ⁴		
200. GeV	1.997 × 10 ⁵	2.062	0.806	1.185	0.071	4.126	<i>Muon critical energy</i>		
200. GeV	2.001 × 10 ⁵	2.063	0.808	1.187	0.071	4.130	7.302 × 10 ⁴		
300. GeV	3.001 × 10 ⁵	2.097	1.268	1.865	0.107	5.338	9.427 × 10 ⁴		
400. GeV	4.001 × 10 ⁵	2.122	1.743	2.566	0.143	6.574	1.111 × 10 ⁵		
800. GeV	8.001 × 10 ⁵	2.182	3.704	5.438	0.289	11.614	1.563 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.201	4.712	6.906	0.363	14.183	1.719 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.231	6.732	9.835	0.514	19.314	1.960 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.263	9.822	14.303	0.744	27.133	2.221 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.300	14.982	21.728	1.137	40.148	2.522 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.326	20.211	29.230	1.537	53.305	2.737 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.391	41.295	59.381	3.193	106.261	3.259 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.412	51.920	74.535	4.043	132.912	3.426 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.445	73.113	104.773	5.789	186.121	3.680 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	2.480	105.090	150.318	8.464	266.354	3.948 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	2.521	158.325	226.102	13.085	400.035	4.252 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	2.550	211.753	302.061	17.815	534.181	4.468 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	2.622	425.795	606.114	37.562	1072.094	4.986 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	2.646	533.000	758.280	47.760	1341.687	5.152 × 10 ⁵		

TABLE I-58. Muons in Iodine
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
53 (I)	126.90447	4.930	491.0	0.23766	2.7276	0.0549	3.2596	5.9488	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	4.499				4.499	1.288×10^0		
14.0 MeV	5.616×10^1	3.561				3.561	2.297×10^0		
20.0 MeV	6.802×10^1	2.818				2.818	4.211×10^0		
30.0 MeV	8.509×10^1	2.214				2.215	8.267×10^0		
40.0 MeV	1.003×10^2	1.907				1.907	1.316×10^1		
80.0 MeV	1.527×10^2	1.459				1.459	3.787×10^1		
100. MeV	1.764×10^2	1.380				1.380	5.199×10^1		
140. MeV	2.218×10^2	1.304				1.304	8.194×10^1		
200. MeV	2.868×10^2	1.267				1.268	1.288×10^2		
242. MeV	3.316×10^2	1.263				1.263	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.268	0.000		0.000	1.268	2.078×10^2		
400. MeV	4.945×10^2	1.287	0.000		0.000	1.287	2.862×10^2		
800. MeV	8.995×10^2	1.372	0.001		0.000	1.374	5.866×10^2		
1.00 GeV	1.101×10^3	1.407	0.001		0.000	1.408	7.303×10^2		
1.40 GeV	1.502×10^3	1.461	0.002	0.001	0.001	1.464	1.009×10^3		
2.00 GeV	2.103×10^3	1.519	0.003	0.002	0.001	1.525	1.410×10^3		
3.00 GeV	3.104×10^3	1.585	0.005	0.004	0.001	1.596	2.050×10^3		
4.00 GeV	4.104×10^3	1.631	0.007	0.006	0.002	1.646	2.666×10^3		
8.00 GeV	8.105×10^3	1.734	0.018	0.019	0.003	1.775	4.997×10^3		
10.0 GeV	1.011×10^4	1.764	0.024	0.027	0.004	1.819	6.110×10^3		
14.0 GeV	1.411×10^4	1.808	0.036	0.043	0.005	1.893	8.263×10^3		
20.0 GeV	2.011×10^4	1.852	0.056	0.069	0.008	1.986	1.136×10^4		
30.0 GeV	3.011×10^4	1.898	0.092	0.120	0.011	2.121	1.622×10^4		
40.0 GeV	4.011×10^4	1.928	0.130	0.174	0.015	2.248	2.080×10^4		
80.0 GeV	8.011×10^4	1.996	0.293	0.414	0.029	2.733	3.691×10^4		
100. GeV	1.001×10^5	2.016	0.379	0.543	0.036	2.975	4.392×10^4		
140. GeV	1.401×10^5	2.046	0.557	0.808	0.050	3.462	5.637×10^4		
195. GeV	1.953×10^5	2.074	0.812	1.193	0.070	4.150	<i>Muon critical energy</i>		
200. GeV	2.001×10^5	2.076	0.835	1.227	0.071	4.210	7.207×10^4		
300. GeV	3.001×10^5	2.111	1.309	1.927	0.107	5.455	9.289×10^4		
400. GeV	4.001×10^5	2.136	1.799	2.651	0.142	6.729	1.094×10^5		
800. GeV	8.001×10^5	2.195	3.824	5.617	0.288	11.926	1.535×10^5		
1.00 TeV	1.000×10^6	2.215	4.865	7.133	0.362	14.576	1.686×10^5		
1.40 TeV	1.400×10^6	2.244	6.950	10.158	0.512	19.866	1.920×10^5		
2.00 TeV	2.000×10^6	2.276	10.140	14.771	0.741	27.929	2.174×10^5		
3.00 TeV	3.000×10^6	2.313	15.466	22.438	1.133	41.350	2.466×10^5		
4.00 TeV	4.000×10^6	2.339	20.863	30.183	1.531	54.917	2.676×10^5		
8.00 TeV	8.000×10^6	2.404	42.622	61.312	3.181	109.520	3.181×10^5		
10.0 TeV	1.000×10^7	2.425	53.587	76.957	4.028	136.999	3.344×10^5		
14.0 TeV	1.400×10^7	2.458	75.458	108.176	5.767	191.860	3.590×10^5		
20.0 TeV	2.000×10^7	2.493	108.458	155.198	8.432	274.582	3.850×10^5		
30.0 TeV	3.000×10^7	2.533	163.396	233.438	13.036	412.404	4.145×10^5		
40.0 TeV	4.000×10^7	2.562	218.532	311.858	17.748	550.701	4.354×10^5		
80.0 TeV	8.000×10^7	2.634	439.406	625.741	37.415	1105.197	4.857×10^5		
100. TeV	1.000×10^8	2.658	550.030	782.820	47.570	1383.080	5.018×10^5		

TABLE I-59. Muons in Xenon Gas

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
54 (Xe)	131.29	5.485×10^{-3}	482.0	0.23314	2.7414	1.5630	4.7371	12.7281	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.519				3.519	2.323×10^0
20.0 MeV	6.802×10^1	2.784				2.784	4.260×10^0
30.0 MeV	8.509×10^1	2.187				2.187	8.367×10^0
40.0 MeV	1.003×10^2	1.883				1.883	1.332×10^1
80.0 MeV	1.527×10^2	1.440				1.440	3.836×10^1
100. MeV	1.764×10^2	1.362				1.362	5.267×10^1
140. MeV	2.218×10^2	1.289				1.289	8.300×10^1
200. MeV	2.868×10^2	1.257				1.257	1.303×10^2
226. MeV	3.145×10^2	1.255				1.255	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.265	0.000		0.000	1.265	2.098×10^2
400. MeV	4.945×10^2	1.291	0.000		0.000	1.291	2.880×10^2
800. MeV	8.995×10^2	1.400	0.001		0.000	1.401	5.848×10^2
1.00 GeV	1.101×10^3	1.444	0.001		0.000	1.446	7.253×10^2
1.40 GeV	1.502×10^3	1.515	0.002	0.001	0.001	1.518	9.950×10^2
2.00 GeV	2.103×10^3	1.595	0.003	0.002	0.001	1.601	1.379×10^3
3.00 GeV	3.104×10^3	1.689	0.005	0.004	0.001	1.699	1.985×10^3
4.00 GeV	4.104×10^3	1.756	0.007	0.006	0.002	1.772	2.560×10^3
8.00 GeV	8.105×10^3	1.913	0.018	0.019	0.003	1.954	4.698×10^3
10.0 GeV	1.011×10^4	1.960	0.024	0.027	0.004	2.015	5.705×10^3
14.0 GeV	1.411×10^4	2.028	0.036	0.043	0.005	2.113	7.642×10^3
20.0 GeV	2.011×10^4	2.095	0.056	0.070	0.008	2.229	1.040×10^4
30.0 GeV	3.011×10^4	2.167	0.092	0.120	0.011	2.390	1.473×10^4
40.0 GeV	4.011×10^4	2.214	0.130	0.175	0.015	2.534	1.879×10^4
80.0 GeV	8.011×10^4	2.317	0.293	0.415	0.029	3.055	3.313×10^4
100. GeV	1.001×10^5	2.347	0.380	0.544	0.036	3.308	3.942×10^4
140. GeV	1.401×10^5	2.390	0.557	0.810	0.050	3.809	5.068×10^4
200. GeV	2.001×10^5	2.434	0.836	1.229	0.071	4.571	6.504×10^4
226. GeV	2.263×10^5	2.448	0.958	1.410	0.080	4.897	<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.480	1.310	1.931	0.106	5.829	8.438×10^4
400. GeV	4.001×10^5	2.512	1.801	2.656	0.142	7.112	9.989×10^4
800. GeV	8.001×10^5	2.583	3.829	5.627	0.287	12.327	1.421×10^5
1.00 TeV	1.000×10^6	2.605	4.870	7.146	0.361	14.983	1.568×10^5
1.40 TeV	1.400×10^6	2.637	6.958	10.176	0.511	20.282	1.797×10^5
2.00 TeV	2.000×10^6	2.670	10.151	14.797	0.739	28.358	2.046×10^5
3.00 TeV	3.000×10^6	2.708	15.481	22.476	1.130	41.796	2.335×10^5
4.00 TeV	4.000×10^6	2.734	20.883	30.234	1.526	55.379	2.542×10^5
8.00 TeV	8.000×10^6	2.798	42.663	61.413	3.171	110.047	3.044×10^5
10.0 TeV	1.000×10^7	2.819	53.639	77.083	4.016	137.558	3.207×10^5
14.0 TeV	1.400×10^7	2.851	75.530	108.353	5.749	192.484	3.451×10^5
20.0 TeV	2.000×10^7	2.885	108.560	155.450	8.404	275.301	3.711×10^5
30.0 TeV	3.000×10^7	2.925	163.548	233.816	12.992	413.283	4.005×10^5
40.0 TeV	4.000×10^7	2.954	218.733	312.362	17.689	551.738	4.214×10^5
80.0 TeV	8.000×10^7	3.025	439.800	626.743	37.295	1106.865	4.715×10^5
100. TeV	1.000×10^8	3.048	550.520	784.070	47.420	1385.059	4.877×10^5

TABLE I-60. Muons in Liquid Xenon

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
54 (Xe)	131.29	2.953	482.0	0.26595	3.0000	0.5993	3.0000	6.4396	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.534				3.534	2.302×10^0
20.0 MeV	6.802×10^1	2.791				2.791	4.233×10^0
30.0 MeV	8.509×10^1	2.191				2.191	8.330×10^0
40.0 MeV	1.003×10^2	1.885				1.885	1.328×10^1
80.0 MeV	1.527×10^2	1.440				1.440	3.829×10^1
100. MeV	1.764×10^2	1.362				1.363	5.260×10^1
140. MeV	2.218×10^2	1.289				1.289	8.292×10^1
200. MeV	2.868×10^2	1.257				1.258	1.302×10^2
226. MeV	3.145×10^2	1.255				1.256	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.265	0.000		0.000	1.265	2.097×10^2
400. MeV	4.945×10^2	1.290	0.000		0.000	1.291	2.879×10^2
800. MeV	8.995×10^2	1.387	0.001		0.000	1.388	5.861×10^2
1.00 GeV	1.101×10^3	1.424	0.001		0.000	1.425	7.282×10^2
1.40 GeV	1.502×10^3	1.481	0.002	0.001	0.001	1.484	1.003×10^3
2.00 GeV	2.103×10^3	1.541	0.003	0.002	0.001	1.547	1.398×10^3
3.00 GeV	3.104×10^3	1.608	0.005	0.004	0.001	1.618	2.030×10^3
4.00 GeV	4.104×10^3	1.653	0.007	0.006	0.002	1.669	2.638×10^3
8.00 GeV	8.105×10^3	1.753	0.018	0.019	0.003	1.794	4.940×10^3
10.0 GeV	1.011×10^4	1.782	0.024	0.027	0.004	1.838	6.041×10^3
14.0 GeV	1.411×10^4	1.824	0.036	0.043	0.005	1.909	8.175×10^3
20.0 GeV	2.011×10^4	1.865	0.056	0.070	0.008	1.999	1.124×10^4
30.0 GeV	3.011×10^4	1.908	0.092	0.120	0.011	2.132	1.609×10^4
40.0 GeV	4.011×10^4	1.936	0.130	0.175	0.015	2.257	2.064×10^4
80.0 GeV	8.011×10^4	2.000	0.293	0.415	0.029	2.738	3.670×10^4
100. GeV	1.001×10^5	2.019	0.380	0.544	0.036	2.980	4.370×10^4
140. GeV	1.401×10^5	2.048	0.557	0.810	0.050	3.466	5.614×10^4
195. GeV	1.952×10^5	2.076	0.812	1.194	0.069	4.153	<i>Muon critical energy</i>
200. GeV	2.001×10^5	2.078	0.836	1.229	0.071	4.215	7.182×10^4
300. GeV	3.001×10^5	2.112	1.310	1.931	0.106	5.461	9.262×10^4
400. GeV	4.001×10^5	2.136	1.801	2.656	0.142	6.737	1.091×10^5
800. GeV	8.001×10^5	2.195	3.829	5.627	0.287	11.940	1.531×10^5
1.00 TeV	1.000×10^6	2.214	4.870	7.146	0.361	14.592	1.682×10^5
1.40 TeV	1.400×10^6	2.244	6.958	10.176	0.511	19.889	1.916×10^5
2.00 TeV	2.000×10^6	2.275	10.151	14.797	0.739	27.962	2.170×10^5
3.00 TeV	3.000×10^6	2.311	15.481	22.476	1.130	41.399	2.462×10^5
4.00 TeV	4.000×10^6	2.337	20.883	30.234	1.526	54.982	2.671×10^5
8.00 TeV	8.000×10^6	2.401	42.663	61.413	3.171	109.650	3.176×10^5
10.0 TeV	1.000×10^7	2.422	53.639	77.083	4.016	137.161	3.339×10^5
14.0 TeV	1.400×10^7	2.454	75.530	108.353	5.749	192.087	3.584×10^5
20.0 TeV	2.000×10^7	2.488	108.560	155.450	8.404	274.904	3.844×10^5
30.0 TeV	3.000×10^7	2.528	163.548	233.816	12.992	412.886	4.139×10^5
40.0 TeV	4.000×10^7	2.557	218.733	312.362	17.689	551.341	4.347×10^5
80.0 TeV	8.000×10^7	2.628	439.800	626.743	37.295	1106.468	4.849×10^5
100. TeV	1.000×10^8	2.651	550.520	784.070	47.420	1384.662	5.011×10^5

TABLE I-61. Muons in Cesium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
55 (Cs)	132.90545	1.873	488.0	0.18233	2.8866	0.5473	3.5914	6.9135	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	4.464				4.464	1.297×10^0
14.0 MeV	5.616×10^1	3.532				3.532	2.314×10^0
20.0 MeV	6.802×10^1	2.794				2.794	4.245×10^0
30.0 MeV	8.509×10^1	2.195				2.195	8.335×10^0
40.0 MeV	1.003×10^2	1.890				1.890	1.328×10^1
80.0 MeV	1.527×10^2	1.444				1.444	3.822×10^1
100. MeV	1.764×10^2	1.366				1.366	5.250×10^1
140. MeV	2.218×10^2	1.291				1.291	8.276×10^1
200. MeV	2.868×10^2	1.257				1.257	1.300×10^2
236. MeV	3.250×10^2	1.254				1.254	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.261	0.000		0.000	1.261	2.096×10^2
400. MeV	4.945×10^2	1.284	0.000		0.000	1.285	2.882×10^2
800. MeV	8.995×10^2	1.378	0.001		0.000	1.380	5.881×10^2
1.00 GeV	1.101×10^3	1.415	0.001		0.000	1.417	7.311×10^2
1.40 GeV	1.502×10^3	1.473	0.002	0.001	0.001	1.476	1.007×10^3
2.00 GeV	2.103×10^3	1.535	0.003	0.002	0.001	1.541	1.405×10^3
3.00 GeV	3.104×10^3	1.605	0.005	0.004	0.001	1.616	2.037×10^3
4.00 GeV	4.104×10^3	1.653	0.007	0.007	0.002	1.669	2.646×10^3
8.00 GeV	8.105×10^3	1.762	0.018	0.020	0.003	1.804	4.942×10^3
10.0 GeV	1.011×10^4	1.794	0.024	0.028	0.004	1.850	6.036×10^3
14.0 GeV	1.411×10^4	1.840	0.037	0.044	0.005	1.927	8.153×10^3
20.0 GeV	2.011×10^4	1.886	0.057	0.071	0.008	2.023	1.119×10^4
30.0 GeV	3.011×10^4	1.934	0.094	0.123	0.011	2.163	1.597×10^4
40.0 GeV	4.011×10^4	1.966	0.133	0.179	0.015	2.294	2.045×10^4
80.0 GeV	8.011×10^4	2.036	0.300	0.425	0.029	2.791	3.623×10^4
100. GeV	1.001×10^5	2.057	0.389	0.557	0.036	3.040	4.309×10^4
140. GeV	1.401×10^5	2.088	0.571	0.829	0.050	3.539	5.528×10^4
195. GeV	1.947×10^5	2.117	0.829	1.219	0.069	4.235	<i>Muon critical energy</i>
200. GeV	2.001×10^5	2.119	0.855	1.259	0.071	4.305	7.063×10^4
300. GeV	3.001×10^5	2.154	1.341	1.976	0.106	5.579	9.100×10^4
400. GeV	4.001×10^5	2.178	1.844	2.718	0.142	6.883	1.071×10^5
800. GeV	8.001×10^5	2.237	3.918	5.759	0.287	12.203	1.502×10^5
1.00 TeV	1.000×10^6	2.257	4.984	7.313	0.360	14.915	1.650×10^5
1.40 TeV	1.400×10^6	2.286	7.120	10.413	0.510	20.331	1.879×10^5
2.00 TeV	2.000×10^6	2.317	10.388	15.141	0.738	28.586	2.127×10^5
3.00 TeV	3.000×10^6	2.354	15.843	22.998	1.128	42.325	2.412×10^5
4.00 TeV	4.000×10^6	2.380	21.371	30.936	1.525	56.212	2.617×10^5
8.00 TeV	8.000×10^6	2.444	43.656	62.837	3.168	112.106	3.111×10^5
10.0 TeV	1.000×10^7	2.465	54.886	78.869	4.011	140.233	3.270×10^5
14.0 TeV	1.400×10^7	2.497	77.286	110.862	5.742	196.389	3.510×10^5
20.0 TeV	2.000×10^7	2.532	111.082	159.048	8.396	281.059	3.764×10^5
30.0 TeV	3.000×10^7	2.572	167.344	239.224	12.979	422.120	4.052×10^5
40.0 TeV	4.000×10^7	2.601	223.807	319.582	17.670	563.661	4.257×10^5
80.0 TeV	8.000×10^7	2.672	449.996	641.237	37.249	1131.156	4.748×10^5
100. TeV	1.000×10^8	2.696	563.280	802.210	47.360	1415.547	4.905×10^5

TABLE I-62. Muons in Barium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
56 (Ba)	137.327	3.500	491.0	0.18268	2.8906	0.4190	3.4547	6.3153	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	4.394				4.394	1.318×10^0
14.0 MeV	5.616×10^1	3.476				3.476	2.351×10^0
20.0 MeV	6.802×10^1	2.750				2.750	4.313×10^0
30.0 MeV	8.509×10^1	2.160				2.160	8.470×10^0
40.0 MeV	1.003×10^2	1.859				1.860	1.349×10^1
80.0 MeV	1.527×10^2	1.420				1.420	3.885×10^1
100. MeV	1.764×10^2	1.342				1.342	5.337×10^1
140. MeV	2.218×10^2	1.268				1.268	8.416×10^1
200. MeV	2.868×10^2	1.234				1.234	1.323×10^2
233. MeV	3.220×10^2	1.231				1.231	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.237	0.000		0.000	1.237	2.134×10^2
400. MeV	4.945×10^2	1.258	0.000		0.000	1.259	2.936×10^2
800. MeV	8.995×10^2	1.346	0.001		0.000	1.347	6.003×10^2
1.00 GeV	1.101×10^3	1.381	0.001		0.000	1.383	7.467×10^2
1.40 GeV	1.502×10^3	1.435	0.002	0.001	0.001	1.439	1.030×10^3
2.00 GeV	2.103×10^3	1.494	0.003	0.002	0.001	1.500	1.438×10^3
3.00 GeV	3.104×10^3	1.561	0.005	0.004	0.001	1.571	2.088×10^3
4.00 GeV	4.104×10^3	1.606	0.007	0.007	0.002	1.622	2.714×10^3
8.00 GeV	8.105×10^3	1.709	0.018	0.020	0.003	1.751	5.078×10^3
10.0 GeV	1.011×10^4	1.740	0.024	0.028	0.004	1.796	6.205×10^3
14.0 GeV	1.411×10^4	1.784	0.037	0.044	0.005	1.871	8.386×10^3
20.0 GeV	2.011×10^4	1.827	0.057	0.071	0.008	1.964	1.151×10^4
30.0 GeV	3.011×10^4	1.873	0.094	0.123	0.011	2.102	1.643×10^4
40.0 GeV	4.011×10^4	1.903	0.133	0.179	0.015	2.231	2.105×10^4
80.0 GeV	8.011×10^4	1.970	0.300	0.426	0.029	2.727	3.723×10^4
100. GeV	1.001×10^5	1.990	0.389	0.559	0.036	2.975	4.425×10^4
140. GeV	1.401×10^5	2.020	0.571	0.831	0.050	3.473	5.669×10^4
189. GeV	1.887×10^5	2.045	0.801	1.178	0.067	4.092	<i>Muon critical energy</i>
200. GeV	2.001×10^5	2.050	0.856	1.261	0.071	4.239	7.231×10^4
300. GeV	3.001×10^5	2.084	1.343	1.980	0.106	5.514	9.294×10^4
400. GeV	4.001×10^5	2.108	1.846	2.723	0.141	6.820	1.092×10^5
800. GeV	8.001×10^5	2.166	3.923	5.769	0.286	12.146	1.526×10^5
1.00 TeV	1.000×10^6	2.185	4.989	7.326	0.359	14.861	1.675×10^5
1.40 TeV	1.400×10^6	2.214	7.128	10.431	0.509	20.283	1.904×10^5
2.00 TeV	2.000×10^6	2.245	10.399	15.166	0.736	28.548	2.152×10^5
3.00 TeV	3.000×10^6	2.281	15.859	23.036	1.125	42.303	2.438×10^5
4.00 TeV	4.000×10^6	2.307	21.392	30.986	1.520	56.207	2.643×10^5
8.00 TeV	8.000×10^6	2.370	43.697	62.938	3.158	112.165	3.137×10^5
10.0 TeV	1.000×10^7	2.391	54.937	78.995	3.999	140.323	3.296×10^5
14.0 TeV	1.400×10^7	2.423	77.356	111.037	5.725	196.543	3.536×10^5
20.0 TeV	2.000×10^7	2.457	111.182	159.298	8.370	281.308	3.790×10^5
30.0 TeV	3.000×10^7	2.496	167.494	239.599	12.939	422.529	4.078×10^5
40.0 TeV	4.000×10^7	2.525	224.007	320.082	17.614	564.230	4.282×10^5
80.0 TeV	8.000×10^7	2.595	450.390	642.237	37.132	1132.356	4.772×10^5
100. TeV	1.000×10^8	2.618	563.770	803.460	47.210	1417.060	4.930×10^5

TABLE I-63. Muons in Cerium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
58 (Ce)	140.116	6.657	523.0	0.18885	2.8592	0.2713	3.3432	5.7837	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	4.405				4.405	1.317×10^0		
14.0 MeV	5.616×10^1	3.488				3.488	2.348×10^0		
20.0 MeV	6.802×10^1	2.761				2.761	4.302×10^0		
30.0 MeV	8.509×10^1	2.170				2.170	8.441×10^0		
40.0 MeV	1.003×10^2	1.868				1.868	1.344×10^1		
80.0 MeV	1.527×10^2	1.426				1.426	3.869×10^1		
100. MeV	1.764×10^2	1.347				1.347	5.316×10^1		
140. MeV	2.218×10^2	1.272				1.272	8.386×10^1		
200. MeV	2.868×10^2	1.238				1.238	1.318×10^2		
239. MeV	3.285×10^2	1.234				1.234	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.239	0.000		0.000	1.240	2.127×10^2		
400. MeV	4.945×10^2	1.259	0.000		0.000	1.259	2.928×10^2		
800. MeV	8.995×10^2	1.344	0.001		0.000	1.345	5.997×10^2		
1.00 GeV	1.101×10^3	1.378	0.001		0.000	1.380	7.464×10^2		
1.40 GeV	1.502×10^3	1.431	0.002	0.001	0.001	1.435	1.030×10^3		
2.00 GeV	2.103×10^3	1.489	0.003	0.002	0.001	1.495	1.440×10^3		
3.00 GeV	3.104×10^3	1.554	0.005	0.004	0.001	1.565	2.092×10^3		
4.00 GeV	4.104×10^3	1.599	0.008	0.007	0.002	1.616	2.720×10^3		
8.00 GeV	8.105×10^3	1.700	0.019	0.021	0.003	1.744	5.094×10^3		
10.0 GeV	1.011×10^4	1.731	0.025	0.029	0.004	1.790	6.225×10^3		
14.0 GeV	1.411×10^4	1.774	0.039	0.046	0.005	1.865	8.413×10^3		
20.0 GeV	2.011×10^4	1.817	0.060	0.075	0.008	1.961	1.155×10^4		
30.0 GeV	3.011×10^4	1.862	0.099	0.129	0.011	2.102	1.647×10^4		
40.0 GeV	4.011×10^4	1.893	0.139	0.188	0.015	2.236	2.108×10^4		
80.0 GeV	8.011×10^4	1.959	0.315	0.447	0.029	2.751	3.717×10^4		
100. GeV	1.001×10^5	1.979	0.408	0.586	0.036	3.010	4.412×10^4		
140. GeV	1.401×10^5	2.009	0.599	0.872	0.050	3.531	5.638×10^4		
180. GeV	1.801×10^5	2.030	0.797	1.170	0.064	4.062	<i>Muon critical energy</i>		
200. GeV	2.001×10^5	2.039	0.898	1.323	0.071	4.332	7.170×10^4		
300. GeV	3.001×10^5	2.074	1.409	2.077	0.106	5.666	9.184×10^4		
400. GeV	4.001×10^5	2.098	1.936	2.856	0.141	7.033	1.077×10^5		
800. GeV	8.001×10^5	2.157	4.114	6.049	0.285	12.608	1.496×10^5		
1.00 TeV	1.000×10^6	2.177	5.233	7.681	0.359	15.451	1.639×10^5		
1.40 TeV	1.400×10^6	2.206	7.475	10.936	0.508	21.127	1.859×10^5		
2.00 TeV	2.000×10^6	2.237	10.905	15.899	0.735	29.778	2.097×10^5		
3.00 TeV	3.000×10^6	2.274	16.630	24.148	1.123	44.177	2.372×10^5		
4.00 TeV	4.000×10^6	2.300	22.431	32.481	1.518	58.730	2.567×10^5		
8.00 TeV	8.000×10^6	2.364	45.816	65.968	3.153	117.302	3.040×10^5		
10.0 TeV	1.000×10^7	2.385	57.599	82.797	3.992	146.775	3.192×10^5		
14.0 TeV	1.400×10^7	2.417	81.101	116.379	5.715	205.613	3.421×10^5		
20.0 TeV	2.000×10^7	2.452	116.560	166.956	8.354	294.324	3.664×10^5		
30.0 TeV	3.000×10^7	2.492	175.591	251.115	12.915	442.115	3.939×10^5		
40.0 TeV	4.000×10^7	2.521	234.833	335.464	17.582	590.402	4.134×10^5		
80.0 TeV	8.000×10^7	2.592	472.146	673.083	37.062	1184.886	4.603×10^5		
100. TeV	1.000×10^8	2.616	591.000	842.040	47.120	1482.777	4.753×10^5		

TABLE I-64. Muons in Dysprosium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
66 (Dy)	162.50	8.550	628.0	0.24665	2.5849	0.0822	3.4474	5.9183	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	4.162				4.162	1.404 × 10 ⁰		
14.0 MeV	5.616 × 10 ¹	3.304				3.304	2.492 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	2.621				2.621	4.553 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	2.063				2.063	8.910 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	1.776				1.776	1.417 × 10 ¹		
80.0 MeV	1.527 × 10 ²	1.357				1.357	4.072 × 10 ¹		
100. MeV	1.764 × 10 ²	1.283				1.283	5.591 × 10 ¹		
140. MeV	2.218 × 10 ²	1.212				1.212	8.812 × 10 ¹		
200. MeV	2.868 × 10 ²	1.179				1.179	1.385 × 10 ²		
239. MeV	3.285 × 10 ²	1.175	0.000			1.176	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.180	0.000		0.000	1.181	2.234 × 10 ²		
400. MeV	4.945 × 10 ²	1.199	0.000		0.000	1.200	3.075 × 10 ²		
800. MeV	8.995 × 10 ²	1.283	0.001		0.000	1.284	6.292 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.316	0.001	0.000	0.000	1.318	7.829 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.369	0.002	0.001	0.001	1.373	1.080 × 10 ³		
2.00 GeV	2.103 × 10 ³	1.427	0.003	0.002	0.001	1.433	1.507 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.492	0.006	0.005	0.001	1.504	2.187 × 10 ³		
4.00 GeV	4.104 × 10 ³	1.537	0.009	0.008	0.002	1.555	2.841 × 10 ³		
8.00 GeV	8.105 × 10 ³	1.640	0.021	0.023	0.003	1.688	5.299 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	1.671	0.028	0.032	0.004	1.736	6.467 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	1.715	0.043	0.052	0.005	1.816	8.718 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	1.760	0.067	0.083	0.007	1.918	1.193 × 10 ⁴		
30.0 GeV	3.011 × 10 ⁴	1.806	0.109	0.144	0.011	2.071	1.695 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	1.837	0.154	0.209	0.014	2.216	2.161 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	1.906	0.348	0.496	0.028	2.779	3.769 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	1.926	0.451	0.650	0.035	3.063	4.454 × 10 ⁴		
140. GeV	1.401 × 10 ⁵	1.956	0.662	0.966	0.049	3.634	5.652 × 10 ⁴		
161. GeV	1.610 × 10 ⁵	1.968	0.775	1.137	0.056	3.937	<i>Muon critical energy</i>		
200. GeV	2.001 × 10 ⁵	1.986	0.992	1.465	0.070	4.514	7.132 × 10 ⁴		
300. GeV	3.001 × 10 ⁵	2.020	1.555	2.298	0.105	5.979	9.052 × 10 ⁴		
400. GeV	4.001 × 10 ⁵	2.044	2.137	3.160	0.139	7.482	1.054 × 10 ⁵		
800. GeV	8.001 × 10 ⁵	2.102	4.540	6.687	0.282	13.613	1.445 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.121	5.774	8.489	0.354	16.739	1.577 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.150	8.246	12.083	0.501	22.982	1.781 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.181	12.027	17.563	0.725	32.497	1.999 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.216	18.337	26.669	1.109	48.333	2.250 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.242	24.730	35.866	1.498	64.338	2.429 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.305	50.497	72.825	3.111	128.740	2.860 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.326	63.479	91.396	3.939	161.142	2.998 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.357	89.372	128.457	5.638	225.826	3.207 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	2.391	128.434	184.272	8.240	323.339	3.428 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	2.431	193.462	277.143	12.736	485.774	3.678 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	2.459	258.717	370.220	17.336	648.734	3.856 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	2.529	520.105	742.768	36.531	1301.935	4.283 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	2.552	651.010	929.200	46.440	1629.204	4.420 × 10 ⁵		

TABLE I-65. Muons in Tantalum

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
73 (Ta)	180.9479	16.654	718.0	0.17798	2.7623	0.2117	3.4805	5.5262	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.200				3.200	2.588×10^0
20.0 MeV	6.802×10^1	2.545				2.545	4.712×10^0
30.0 MeV	8.509×10^1	2.008				2.009	9.192×10^0
40.0 MeV	1.003×10^2	1.733				1.733	1.458×10^1
80.0 MeV	1.527×10^2	1.328				1.328	4.174×10^1
100. MeV	1.764×10^2	1.256				1.256	5.726×10^1
140. MeV	2.218×10^2	1.186				1.186	9.018×10^1
200. MeV	2.868×10^2	1.153				1.154	1.416×10^2
243. MeV	3.325×10^2	1.149	0.000			1.150	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.154	0.000		0.000	1.155	2.285×10^2
400. MeV	4.945×10^2	1.172	0.000		0.000	1.173	3.145×10^2
800. MeV	8.995×10^2	1.253	0.001		0.000	1.254	6.438×10^2
1.00 GeV	1.101×10^3	1.285	0.001	0.000	0.000	1.287	8.012×10^2
1.40 GeV	1.502×10^3	1.336	0.002	0.001	0.001	1.340	1.105×10^3
2.00 GeV	2.103×10^3	1.391	0.004	0.002	0.001	1.398	1.543×10^3
3.00 GeV	3.104×10^3	1.454	0.006	0.005	0.001	1.467	2.240×10^3
4.00 GeV	4.104×10^3	1.498	0.009	0.009	0.002	1.518	2.910×10^3
8.00 GeV	8.105×10^3	1.596	0.023	0.026	0.003	1.649	5.429×10^3
10.0 GeV	1.011×10^4	1.626	0.031	0.036	0.004	1.697	6.624×10^3
14.0 GeV	1.411×10^4	1.669	0.047	0.057	0.005	1.778	8.925×10^3
20.0 GeV	2.011×10^4	1.711	0.072	0.091	0.007	1.883	1.220×10^4
30.0 GeV	3.011×10^4	1.756	0.119	0.157	0.011	2.044	1.729×10^4
40.0 GeV	4.011×10^4	1.786	0.168	0.229	0.014	2.198	2.201×10^4
80.0 GeV	8.011×10^4	1.853	0.379	0.542	0.028	2.803	3.808×10^4
100. GeV	1.001×10^5	1.873	0.491	0.710	0.035	3.110	4.485×10^4
140. GeV	1.401×10^5	1.902	0.721	1.055	0.049	3.728	5.659×10^4
145. GeV	1.455×10^5	1.905	0.753	1.102	0.050	3.812	<i>Muon critical energy</i>
200. GeV	2.001×10^5	1.932	1.081	1.599	0.069	4.682	7.093×10^4
300. GeV	3.001×10^5	1.966	1.694	2.508	0.104	6.273	8.933×10^4
400. GeV	4.001×10^5	1.990	2.328	3.447	0.138	7.904	1.035×10^5
800. GeV	8.001×10^5	2.047	4.944	7.290	0.279	14.562	1.402×10^5
1.00 TeV	1.000×10^6	2.066	6.287	9.253	0.351	17.959	1.526×10^5
1.40 TeV	1.400×10^6	2.095	8.978	13.169	0.497	24.739	1.715×10^5
2.00 TeV	2.000×10^6	2.125	13.092	19.136	0.718	35.074	1.918×10^5
3.00 TeV	3.000×10^6	2.161	19.958	29.054	1.098	52.272	2.150×10^5
4.00 TeV	4.000×10^6	2.186	26.913	39.069	1.483	69.654	2.315×10^5
8.00 TeV	8.000×10^6	2.249	54.943	79.312	3.080	139.586	2.713×10^5
10.0 TeV	1.000×10^7	2.269	69.063	99.532	3.899	174.765	2.840×10^5
14.0 TeV	1.400×10^7	2.301	97.226	139.884	5.580	244.992	3.033×10^5
20.0 TeV	2.000×10^7	2.335	139.708	200.650	8.156	350.850	3.236×10^5
30.0 TeV	3.000×10^7	2.374	210.432	301.766	12.604	527.178	3.467×10^5
40.0 TeV	4.000×10^7	2.402	281.398	403.103	17.156	704.061	3.631×10^5
80.0 TeV	8.000×10^7	2.471	565.656	808.713	36.147	1412.990	4.024×10^5
100. TeV	1.000×10^8	2.494	708.010	1011.690	45.950	1768.146	4.150×10^5

TABLE I-66. Muons in Tungsten

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	<i>a</i>	<i>k</i> = <i>m_s</i>	<i>x</i> ₀	<i>x</i> ₁	\bar{C}	δ_0
74 (W)	183.84	19.300	727.0	0.15509	2.8447	0.2167	3.4960	5.4059	0.14

<i>T</i>	<i>p</i> [MeV/ <i>c</i>]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.185				3.186	2.602×10^0
20.0 MeV	6.802×10^1	2.534				2.534	4.735×10^0
30.0 MeV	8.509×10^1	2.000				2.000	9.235×10^0
40.0 MeV	1.003×10^2	1.726				1.726	1.465×10^1
80.0 MeV	1.527×10^2	1.323				1.323	4.191×10^1
100. MeV	1.764×10^2	1.251				1.251	5.749×10^1
140. MeV	2.218×10^2	1.182				1.182	9.053×10^1
200. MeV	2.868×10^2	1.149				1.149	1.422×10^2
242. MeV	3.316×10^2	1.145	0.000			1.145	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.150	0.000		0.000	1.150	2.294×10^2
400. MeV	4.945×10^2	1.168	0.000		0.000	1.168	3.157×10^2
800. MeV	8.995×10^2	1.247	0.001		0.000	1.249	6.465×10^2
1.00 GeV	1.101×10^3	1.279	0.001	0.000	0.000	1.281	8.045×10^2
1.40 GeV	1.502×10^3	1.329	0.002	0.001	0.001	1.333	1.110×10^3
2.00 GeV	2.103×10^3	1.384	0.004	0.002	0.001	1.391	1.550×10^3
3.00 GeV	3.104×10^3	1.446	0.006	0.005	0.001	1.459	2.251×10^3
4.00 GeV	4.104×10^3	1.489	0.009	0.009	0.002	1.509	2.924×10^3
8.00 GeV	8.105×10^3	1.587	0.023	0.026	0.003	1.640	5.457×10^3
10.0 GeV	1.011×10^4	1.616	0.031	0.036	0.004	1.687	6.659×10^3
14.0 GeV	1.411×10^4	1.658	0.047	0.057	0.005	1.768	8.973×10^3
20.0 GeV	2.011×10^4	1.700	0.073	0.092	0.007	1.874	1.227×10^4
30.0 GeV	3.011×10^4	1.745	0.120	0.159	0.011	2.035	1.738×10^4
40.0 GeV	4.011×10^4	1.774	0.169	0.231	0.014	2.190	2.212×10^4
80.0 GeV	8.011×10^4	1.840	0.383	0.548	0.028	2.800	3.823×10^4
100. GeV	1.001×10^5	1.860	0.496	0.717	0.035	3.110	4.500×10^4
140. GeV	1.401×10^5	1.889	0.728	1.066	0.048	3.733	5.673×10^4
143. GeV	1.433×10^5	1.891	0.747	1.094	0.050	3.783	<i>Muon critical energy</i>
200. GeV	2.001×10^5	1.919	1.092	1.616	0.069	4.697	7.104×10^4
300. GeV	3.001×10^5	1.952	1.711	2.534	0.103	6.302	8.937×10^4
400. GeV	4.001×10^5	1.976	2.352	3.483	0.138	7.950	1.035×10^5
800. GeV	8.001×10^5	2.034	4.994	7.366	0.279	14.674	1.400×10^5
1.00 TeV	1.000×10^6	2.052	6.350	9.349	0.350	18.103	1.522×10^5
1.40 TeV	1.400×10^6	2.081	9.068	13.304	0.496	24.951	1.710×10^5
2.00 TeV	2.000×10^6	2.112	13.224	19.332	0.717	35.387	1.911×10^5
3.00 TeV	3.000×10^6	2.147	20.158	29.351	1.096	52.754	2.141×10^5
4.00 TeV	4.000×10^6	2.172	27.183	39.468	1.481	70.306	2.304×10^5
8.00 TeV	8.000×10^6	2.235	55.492	80.119	3.076	140.923	2.698×10^5
10.0 TeV	1.000×10^7	2.255	69.752	100.544	3.894	176.447	2.825×10^5
14.0 TeV	1.400×10^7	2.287	98.195	141.305	5.573	247.361	3.015×10^5
20.0 TeV	2.000×10^7	2.320	141.100	202.688	8.144	354.254	3.217×10^5
30.0 TeV	3.000×10^7	2.359	212.526	304.831	12.585	532.304	3.446×10^5
40.0 TeV	4.000×10^7	2.388	284.197	407.198	17.129	710.913	3.608×10^5
80.0 TeV	8.000×10^7	2.457	571.275	816.908	36.091	1426.733	3.997×10^5
100. TeV	1.000×10^8	2.480	715.040	1021.930	45.880	1785.332	4.122×10^5

TABLE I-67. Muons in Platinum

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
78 (Pt)	195.078	21.450	790.0	0.11128	3.0417	0.1484	3.6212	5.4732	0.12
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704×10^1	3.896				3.896	1.517×10^0		
14.0 MeV	5.616×10^1	3.109				3.109	2.677×10^0		
20.0 MeV	6.802×10^1	2.477				2.477	4.861×10^0		
30.0 MeV	8.509×10^1	1.958				1.958	9.460×10^0		
40.0 MeV	1.003×10^2	1.690				1.690	1.499×10^1		
80.0 MeV	1.527×10^2	1.297				1.297	4.280×10^1		
100. MeV	1.764×10^2	1.228				1.228	5.869×10^1		
140. MeV	2.218×10^2	1.162				1.162	9.231×10^1		
200. MeV	2.868×10^2	1.132				1.132	1.448×10^2		
237. MeV	3.260×10^2	1.128	0.000			1.129	<i>Minimum ionization</i>		
300. MeV	3.917×10^2	1.134	0.000		0.000	1.134	2.333×10^2		
400. MeV	4.945×10^2	1.153	0.000		0.000	1.153	3.207×10^2		
800. MeV	8.995×10^2	1.233	0.001		0.000	1.234	6.555×10^2		
1.00 GeV	1.101×10^3	1.265	0.001	0.000	0.000	1.267	8.154×10^2		
1.40 GeV	1.502×10^3	1.315	0.002	0.001	0.001	1.319	1.124×10^3		
2.00 GeV	2.103×10^3	1.370	0.004	0.002	0.001	1.377	1.569×10^3		
3.00 GeV	3.104×10^3	1.431	0.007	0.005	0.001	1.445	2.277×10^3		
4.00 GeV	4.104×10^3	1.474	0.010	0.009	0.002	1.495	2.957×10^3		
8.00 GeV	8.105×10^3	1.570	0.024	0.027	0.003	1.625	5.513×10^3		
10.0 GeV	1.011×10^4	1.599	0.032	0.038	0.004	1.674	6.725×10^3		
14.0 GeV	1.411×10^4	1.641	0.049	0.060	0.005	1.756	9.057×10^3		
20.0 GeV	2.011×10^4	1.683	0.076	0.097	0.007	1.864	1.237×10^4		
30.0 GeV	3.011×10^4	1.727	0.125	0.166	0.011	2.029	1.751×10^4		
40.0 GeV	4.011×10^4	1.756	0.177	0.242	0.014	2.189	2.225×10^4		
80.0 GeV	8.011×10^4	1.821	0.399	0.572	0.028	2.822	3.830×10^4		
100. GeV	1.001×10^5	1.841	0.517	0.749	0.035	3.143	4.501×10^4		
137. GeV	1.368×10^5	1.868	0.739	1.082	0.047	3.738	<i>Muon critical energy</i>		
140. GeV	1.401×10^5	1.870	0.759	1.113	0.048	3.792	5.659×10^4		
200. GeV	2.001×10^5	1.900	1.138	1.686	0.069	4.794	7.064×10^4		
300. GeV	3.001×10^5	1.933	1.784	2.644	0.103	6.465	8.855×10^4		
400. GeV	4.001×10^5	1.957	2.451	3.633	0.137	8.180	1.023×10^5		
800. GeV	8.001×10^5	2.014	5.204	7.682	0.277	15.179	1.376×10^5		
1.00 TeV	1.000×10^6	2.033	6.618	9.749	0.348	18.749	1.495×10^5		
1.40 TeV	1.400×10^6	2.061	9.449	13.872	0.493	25.878	1.676×10^5		
2.00 TeV	2.000×10^6	2.091	13.779	20.156	0.713	36.741	1.869×10^5		
3.00 TeV	3.000×10^6	2.127	21.002	30.599	1.090	54.820	2.091×10^5		
4.00 TeV	4.000×10^6	2.152	28.319	41.144	1.473	73.090	2.248×10^5		
8.00 TeV	8.000×10^6	2.214	57.805	83.512	3.058	146.591	2.627×10^5		
10.0 TeV	1.000×10^7	2.234	72.658	104.798	3.872	183.564	2.749×10^5		
14.0 TeV	1.400×10^7	2.265	102.282	147.281	5.541	257.371	2.932×10^5		
20.0 TeV	2.000×10^7	2.299	146.966	211.254	8.098	368.619	3.126×10^5		
30.0 TeV	3.000×10^7	2.338	221.354	317.703	12.513	553.910	3.345×10^5		
40.0 TeV	4.000×10^7	2.366	295.996	424.381	17.031	739.775	3.501×10^5		
80.0 TeV	8.000×10^7	2.434	594.964	851.368	35.880	1484.648	3.875×10^5		
100. TeV	1.000×10^8	2.457	744.680	1065.040	45.610	1857.789	3.995×10^5		

TABLE I-68. Muons in Gold
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
79 (Au)	196.96655	19.320	790.0	0.09756	3.1101	0.2021	3.6979	5.5747	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704 × 10 ¹	3.910				3.910	1.511 × 10 ⁰
14.0 MeV	5.616 × 10 ¹	3.120				3.120	2.667 × 10 ⁰
20.0 MeV	6.802 × 10 ¹	2.485				2.485	4.844 × 10 ⁰
30.0 MeV	8.509 × 10 ¹	1.964				1.964	9.427 × 10 ⁰
40.0 MeV	1.003 × 10 ²	1.696				1.696	1.494 × 10 ¹
80.0 MeV	1.527 × 10 ²	1.302				1.302	4.265 × 10 ¹
100. MeV	1.764 × 10 ²	1.232				1.232	5.848 × 10 ¹
140. MeV	2.218 × 10 ²	1.166				1.166	9.199 × 10 ¹
200. MeV	2.868 × 10 ²	1.136				1.137	1.443 × 10 ²
236. MeV	3.250 × 10 ²	1.134	0.000			1.134	<i>Minimum ionization</i>
300. MeV	3.917 × 10 ²	1.139	0.000		0.000	1.140	2.323 × 10 ²
400. MeV	4.945 × 10 ²	1.158	0.000		0.000	1.159	3.194 × 10 ²
800. MeV	8.995 × 10 ²	1.240	0.001		0.000	1.241	6.524 × 10 ²
1.00 GeV	1.101 × 10 ³	1.272	0.001	0.000	0.000	1.274	8.114 × 10 ²
1.40 GeV	1.502 × 10 ³	1.323	0.002	0.001	0.001	1.327	1.119 × 10 ³
2.00 GeV	2.103 × 10 ³	1.378	0.004	0.002	0.001	1.385	1.561 × 10 ³
3.00 GeV	3.104 × 10 ³	1.440	0.007	0.006	0.001	1.454	2.264 × 10 ³
4.00 GeV	4.104 × 10 ³	1.483	0.010	0.009	0.002	1.504	2.940 × 10 ³
8.00 GeV	8.105 × 10 ³	1.580	0.025	0.028	0.003	1.636	5.480 × 10 ³
10.0 GeV	1.011 × 10 ⁴	1.609	0.033	0.038	0.004	1.685	6.685 × 10 ³
14.0 GeV	1.411 × 10 ⁴	1.651	0.050	0.061	0.005	1.768	9.001 × 10 ³
20.0 GeV	2.011 × 10 ⁴	1.693	0.077	0.098	0.007	1.877	1.229 × 10 ⁴
30.0 GeV	3.011 × 10 ⁴	1.737	0.127	0.169	0.011	2.045	1.739 × 10 ⁴
40.0 GeV	4.011 × 10 ⁴	1.767	0.179	0.245	0.014	2.207	2.210 × 10 ⁴
80.0 GeV	8.011 × 10 ⁴	1.833	0.405	0.581	0.028	2.848	3.801 × 10 ⁴
100. GeV	1.001 × 10 ⁵	1.853	0.525	0.760	0.035	3.174	4.466 × 10 ⁴
136. GeV	1.358 × 10 ⁵	1.879	0.744	1.089	0.047	3.760	<i>Muon critical energy</i>
140. GeV	1.401 × 10 ⁵	1.882	0.771	1.129	0.048	3.832	5.612 × 10 ⁴
200. GeV	2.001 × 10 ⁵	1.912	1.155	1.712	0.069	4.848	7.002 × 10 ⁴
300. GeV	3.001 × 10 ⁵	1.946	1.810	2.683	0.103	6.544	8.772 × 10 ⁴
400. GeV	4.001 × 10 ⁵	1.969	2.488	3.687	0.137	8.283	1.013 × 10 ⁵
800. GeV	8.001 × 10 ⁵	2.027	5.282	7.796	0.277	15.383	1.362 × 10 ⁵
1.00 TeV	1.000 × 10 ⁶	2.045	6.716	9.894	0.348	19.005	1.479 × 10 ⁵
1.40 TeV	1.400 × 10 ⁶	2.074	9.590	14.078	0.493	26.237	1.657 × 10 ⁵
2.00 TeV	2.000 × 10 ⁶	2.104	13.983	20.455	0.713	37.257	1.848 × 10 ⁵
3.00 TeV	3.000 × 10 ⁶	2.139	21.314	31.052	1.089	55.596	2.066 × 10 ⁵
4.00 TeV	4.000 × 10 ⁶	2.165	28.739	41.752	1.472	74.129	2.222 × 10 ⁵
8.00 TeV	8.000 × 10 ⁶	2.227	58.660	84.745	3.055	148.689	2.595 × 10 ⁵
10.0 TeV	1.000 × 10 ⁷	2.247	73.732	106.345	3.868	186.194	2.715 × 10 ⁵
14.0 TeV	1.400 × 10 ⁷	2.279	103.793	149.453	5.535	261.062	2.896 × 10 ⁵
20.0 TeV	2.000 × 10 ⁷	2.312	149.136	214.368	8.090	373.908	3.087 × 10 ⁵
30.0 TeV	3.000 × 10 ⁷	2.351	224.621	322.384	12.501	561.860	3.303 × 10 ⁵
40.0 TeV	4.000 × 10 ⁷	2.379	300.363	430.633	17.015	750.392	3.457 × 10 ⁵
80.0 TeV	8.000 × 10 ⁷	2.448	603.732	863.904	35.848	1505.934	3.826 × 10 ⁵
100. TeV	1.000 × 10 ⁸	2.471	755.650	1080.720	45.570	1884.413	3.944 × 10 ⁵

TABLE I-69. Muons in Mercury

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
80 (Hg)	200.59	13.546	800.0	0.11014	3.0519	0.2756	3.7275	5.9605	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.095				3.095	2.690×10^0
20.0 MeV	6.802×10^1	2.467				2.467	4.884×10^0
30.0 MeV	8.509×10^1	1.951				1.951	9.500×10^0
40.0 MeV	1.003×10^2	1.685				1.685	1.505×10^1
80.0 MeV	1.527×10^2	1.295				1.295	4.292×10^1
100. MeV	1.764×10^2	1.226				1.226	5.883×10^1
140. MeV	2.218×10^2	1.161				1.161	9.250×10^1
200. MeV	2.868×10^2	1.133				1.133	1.450×10^2
233. MeV	3.220×10^2	1.130	0.000			1.131	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.137	0.000		0.000	1.137	2.333×10^2
400. MeV	4.945×10^2	1.157	0.000		0.000	1.158	3.204×10^2
800. MeV	8.995×10^2	1.241	0.001		0.000	1.242	6.534×10^2
1.00 GeV	1.101×10^3	1.274	0.001	0.000	0.000	1.276	8.122×10^2
1.40 GeV	1.502×10^3	1.326	0.002	0.001	0.001	1.330	1.119×10^3
2.00 GeV	2.103×10^3	1.382	0.004	0.002	0.001	1.389	1.560×10^3
3.00 GeV	3.104×10^3	1.445	0.007	0.006	0.001	1.459	2.261×10^3
4.00 GeV	4.104×10^3	1.489	0.010	0.009	0.002	1.510	2.934×10^3
8.00 GeV	8.105×10^3	1.588	0.025	0.028	0.003	1.644	5.463×10^3
10.0 GeV	1.011×10^4	1.617	0.033	0.039	0.004	1.693	6.662×10^3
14.0 GeV	1.411×10^4	1.660	0.050	0.061	0.005	1.777	8.966×10^3
20.0 GeV	2.011×10^4	1.702	0.078	0.099	0.007	1.887	1.224×10^4
30.0 GeV	3.011×10^4	1.747	0.128	0.170	0.011	2.056	1.731×10^4
40.0 GeV	4.011×10^4	1.777	0.180	0.247	0.014	2.220	2.199×10^4
80.0 GeV	8.011×10^4	1.844	0.408	0.584	0.028	2.865	3.781×10^4
100. GeV	1.001×10^5	1.864	0.528	0.765	0.035	3.193	4.442×10^4
136. GeV	1.358×10^5	1.890	0.748	1.096	0.047	3.782	<i>Muon critical energy</i>
140. GeV	1.401×10^5	1.893	0.775	1.137	0.048	3.854	5.581×10^4
200. GeV	2.001×10^5	1.923	1.162	1.722	0.068	4.877	6.963×10^4
300. GeV	3.001×10^5	1.957	1.821	2.700	0.103	6.582	8.723×10^4
400. GeV	4.001×10^5	1.980	2.502	3.710	0.137	8.331	1.007×10^5
800. GeV	8.001×10^5	2.037	5.312	7.844	0.277	15.472	1.354×10^5
1.00 TeV	1.000×10^6	2.056	6.755	9.954	0.347	19.114	1.470×10^5
1.40 TeV	1.400×10^6	2.084	9.645	14.163	0.492	26.386	1.648×10^5
2.00 TeV	2.000×10^6	2.114	14.063	20.578	0.712	37.469	1.838×10^5
3.00 TeV	3.000×10^6	2.149	21.436	31.238	1.088	55.913	2.055×10^5
4.00 TeV	4.000×10^6	2.175	28.903	42.003	1.469	74.551	2.209×10^5
8.00 TeV	8.000×10^6	2.236	58.993	85.251	3.050	149.532	2.580×10^5
10.0 TeV	1.000×10^7	2.257	74.149	106.979	3.862	187.249	2.700×10^5
14.0 TeV	1.400×10^7	2.288	104.379	150.344	5.526	262.538	2.879×10^5
20.0 TeV	2.000×10^7	2.321	149.976	215.644	8.076	376.019	3.069×10^5
30.0 TeV	3.000×10^7	2.360	225.885	324.304	12.479	565.030	3.285×10^5
40.0 TeV	4.000×10^7	2.388	302.052	433.197	16.984	754.623	3.437×10^5
80.0 TeV	8.000×10^7	2.457	607.127	869.040	35.784	1514.409	3.804×10^5
100. TeV	1.000×10^8	2.479	759.900	1087.140	45.490	1895.011	3.922×10^5

TABLE I-70. Muons in Lead
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	k = m _s	x ₀	x ₁	\bar{C}	δ_0
82 (Pb)	207.2	11.350	823.0	0.09359	3.1608	0.3776	3.8073	6.2018	0.14
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]		
10.0 MeV	4.704 × 10 ¹	3.823				3.823	1.549 × 10 ⁰		
14.0 MeV	5.616 × 10 ¹	3.054				3.054	2.731 × 10 ⁰		
20.0 MeV	6.802 × 10 ¹	2.436				2.436	4.953 × 10 ⁰		
30.0 MeV	8.509 × 10 ¹	1.928				1.928	9.626 × 10 ⁰		
40.0 MeV	1.003 × 10 ²	1.666				1.666	1.524 × 10 ¹		
80.0 MeV	1.527 × 10 ²	1.283				1.283	4.340 × 10 ¹		
100. MeV	1.764 × 10 ²	1.215				1.215	5.946 × 10 ¹		
140. MeV	2.218 × 10 ²	1.151				1.152	9.341 × 10 ¹		
200. MeV	2.868 × 10 ²	1.124				1.124	1.463 × 10 ²		
226. MeV	3.145 × 10 ²	1.122	0.000			1.123	<i>Minimum ionization</i>		
300. MeV	3.917 × 10 ²	1.130	0.000		0.000	1.131	2.352 × 10 ²		
400. MeV	4.945 × 10 ²	1.151	0.000		0.000	1.152	3.229 × 10 ²		
800. MeV	8.995 × 10 ²	1.237	0.001		0.000	1.238	6.572 × 10 ²		
1.00 GeV	1.101 × 10 ³	1.270	0.001	0.000	0.000	1.272	8.165 × 10 ²		
1.40 GeV	1.502 × 10 ³	1.322	0.002	0.001	0.001	1.326	1.124 × 10 ³		
2.00 GeV	2.103 × 10 ³	1.379	0.004	0.002	0.001	1.386	1.566 × 10 ³		
3.00 GeV	3.104 × 10 ³	1.442	0.007	0.006	0.001	1.456	2.269 × 10 ³		
4.00 GeV	4.104 × 10 ³	1.486	0.010	0.009	0.002	1.508	2.943 × 10 ³		
8.00 GeV	8.105 × 10 ³	1.585	0.025	0.028	0.003	1.642	5.475 × 10 ³		
10.0 GeV	1.011 × 10 ⁴	1.615	0.033	0.039	0.004	1.692	6.675 × 10 ³		
14.0 GeV	1.411 × 10 ⁴	1.657	0.051	0.062	0.005	1.776	8.981 × 10 ³		
20.0 GeV	2.011 × 10 ⁴	1.700	0.079	0.100	0.007	1.887	1.226 × 10 ⁴		
30.0 GeV	3.011 × 10 ⁴	1.744	0.129	0.172	0.011	2.058	1.733 × 10 ⁴		
40.0 GeV	4.011 × 10 ⁴	1.774	0.183	0.251	0.014	2.223	2.200 × 10 ⁴		
80.0 GeV	8.011 × 10 ⁴	1.840	0.414	0.594	0.028	2.877	3.777 × 10 ⁴		
100. GeV	1.001 × 10 ⁵	1.860	0.536	0.777	0.034	3.209	4.435 × 10 ⁴		
134. GeV	1.338 × 10 ⁵	1.885	0.746	1.093	0.046	3.772	<i>Muon critical energy</i>		
140. GeV	1.401 × 10 ⁵	1.889	0.787	1.154	0.048	3.880	5.568 × 10 ⁴		
200. GeV	2.001 × 10 ⁵	1.919	1.179	1.749	0.068	4.917	6.939 × 10 ⁴		
300. GeV	3.001 × 10 ⁵	1.953	1.848	2.742	0.102	6.646	8.683 × 10 ⁴		
400. GeV	4.001 × 10 ⁵	1.976	2.539	3.767	0.136	8.421	1.002 × 10 ⁵		
800. GeV	8.001 × 10 ⁵	2.033	5.391	7.963	0.276	15.664	1.345 × 10 ⁵		
1.00 TeV	1.000 × 10 ⁶	2.051	6.854	10.106	0.346	19.359	1.459 × 10 ⁵		
1.40 TeV	1.400 × 10 ⁶	2.079	9.787	14.378	0.491	26.737	1.635 × 10 ⁵		
2.00 TeV	2.000 × 10 ⁶	2.109	14.269	20.889	0.709	37.979	1.822 × 10 ⁵		
3.00 TeV	3.000 × 10 ⁶	2.144	21.749	31.710	1.084	56.689	2.036 × 10 ⁵		
4.00 TeV	4.000 × 10 ⁶	2.169	29.324	42.635	1.465	75.595	2.188 × 10 ⁵		
8.00 TeV	8.000 × 10 ⁶	2.230	59.850	86.531	3.041	151.655	2.555 × 10 ⁵		
10.0 TeV	1.000 × 10 ⁷	2.251	75.226	108.584	3.850	189.913	2.672 × 10 ⁵		
14.0 TeV	1.400 × 10 ⁷	2.281	105.893	152.597	5.510	266.282	2.849 × 10 ⁵		
20.0 TeV	2.000 × 10 ⁷	2.315	152.148	218.872	8.052	381.389	3.037 × 10 ⁵		
30.0 TeV	3.000 × 10 ⁷	2.353	229.154	329.154	12.440	573.103	3.249 × 10 ⁵		
40.0 TeV	4.000 × 10 ⁷	2.381	306.420	439.672	16.930	765.404	3.399 × 10 ⁵		
80.0 TeV	8.000 × 10 ⁷	2.449	615.890	882.022	35.667	1536.029	3.761 × 10 ⁵		
100. TeV	1.000 × 10 ⁸	2.471	770.860	1103.380	45.340	1922.053	3.877 × 10 ⁵		

TABLE I-71. Muons in Bismuth
See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
83 (Bi)	208.98038	9.747	823.0	0.09410	3.1671	0.4152	3.8248	6.3505	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	3.066				3.066	2.720×10^0
20.0 MeV	6.802×10^1	2.445				2.445	4.933×10^0
30.0 MeV	8.509×10^1	1.935				1.935	9.588×10^0
40.0 MeV	1.003×10^2	1.673				1.673	1.518×10^1
80.0 MeV	1.527×10^2	1.288				1.288	4.323×10^1
100. MeV	1.764×10^2	1.221				1.221	5.922×10^1
140. MeV	2.218×10^2	1.157				1.157	9.302×10^1
200. MeV	2.868×10^2	1.129				1.130	1.457×10^2
223. MeV	3.114×10^2	1.128	0.000			1.128	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.136	0.000		0.000	1.137	2.341×10^2
400. MeV	4.945×10^2	1.158	0.000		0.000	1.159	3.213×10^2
800. MeV	8.995×10^2	1.245	0.001		0.000	1.247	6.535×10^2
1.00 GeV	1.101×10^3	1.279	0.001	0.000	0.000	1.281	8.117×10^2
1.40 GeV	1.502×10^3	1.332	0.002	0.001	0.001	1.336	1.117×10^3
2.00 GeV	2.103×10^3	1.389	0.004	0.002	0.001	1.397	1.556×10^3
3.00 GeV	3.104×10^3	1.453	0.007	0.006	0.001	1.468	2.253×10^3
4.00 GeV	4.104×10^3	1.498	0.010	0.010	0.002	1.520	2.922×10^3
8.00 GeV	8.105×10^3	1.598	0.025	0.029	0.003	1.656	5.433×10^3
10.0 GeV	1.011×10^4	1.628	0.034	0.040	0.004	1.706	6.623×10^3
14.0 GeV	1.411×10^4	1.671	0.052	0.063	0.005	1.792	8.909×10^3
20.0 GeV	2.011×10^4	1.714	0.080	0.102	0.007	1.904	1.216×10^4
30.0 GeV	3.011×10^4	1.759	0.131	0.175	0.011	2.077	1.718×10^4
40.0 GeV	4.011×10^4	1.789	0.186	0.255	0.014	2.245	2.181×10^4
80.0 GeV	8.011×10^4	1.856	0.420	0.603	0.028	2.907	3.743×10^4
100. GeV	1.001×10^5	1.876	0.544	0.789	0.034	3.245	4.394×10^4
133. GeV	1.330×10^5	1.901	0.753	1.103	0.046	3.803	<i>Muon critical energy</i>
140. GeV	1.401×10^5	1.905	0.798	1.172	0.048	3.925	5.513×10^4
200. GeV	2.001×10^5	1.935	1.196	1.775	0.068	4.977	6.869×10^4
300. GeV	3.001×10^5	1.969	1.875	2.783	0.102	6.731	8.591×10^4
400. GeV	4.001×10^5	1.992	2.577	3.823	0.136	8.531	9.908×10^4
800. GeV	8.001×10^5	2.049	5.471	8.081	0.276	15.879	1.329×10^5
1.00 TeV	1.000×10^6	2.068	6.956	10.255	0.346	19.627	1.442×10^5
1.40 TeV	1.400×10^6	2.096	9.932	14.591	0.490	27.111	1.615×10^5
2.00 TeV	2.000×10^6	2.126	14.481	21.198	0.709	38.515	1.800×10^5
3.00 TeV	3.000×10^6	2.161	22.071	32.177	1.083	57.494	2.011×10^5
4.00 TeV	4.000×10^6	2.186	29.758	43.264	1.464	76.673	2.161×10^5
8.00 TeV	8.000×10^6	2.248	60.733	87.804	3.039	153.826	2.522×10^5
10.0 TeV	1.000×10^7	2.268	76.335	110.181	3.847	192.633	2.638×10^5
14.0 TeV	1.400×10^7	2.299	107.453	154.840	5.505	270.099	2.813×10^5
20.0 TeV	2.000×10^7	2.332	154.390	222.088	8.044	386.856	2.997×10^5
30.0 TeV	3.000×10^7	2.370	232.528	333.991	12.430	581.321	3.207×10^5
40.0 TeV	4.000×10^7	2.398	310.928	446.134	16.917	776.379	3.355×10^5
80.0 TeV	8.000×10^7	2.467	624.949	894.971	35.637	1558.026	3.712×10^5
100. TeV	1.000×10^8	2.489	782.200	1119.570	45.300	1949.561	3.826×10^5

TABLE I-72. Muons in Thorium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
90 (Th)	232.0381	11.720	847.0	0.08655	3.2610	0.4202	3.7681	6.2473	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	2.979				2.979	2.801×10^0
20.0 MeV	6.802×10^1	2.376				2.376	5.079×10^0
30.0 MeV	8.509×10^1	1.881				1.881	9.868×10^0
40.0 MeV	1.003×10^2	1.626				1.626	1.562×10^1
80.0 MeV	1.527×10^2	1.253				1.253	4.446×10^1
100. MeV	1.764×10^2	1.187				1.188	6.090×10^1
140. MeV	2.218×10^2	1.126				1.126	9.564×10^1
200. MeV	2.868×10^2	1.099				1.099	1.497×10^2
223. MeV	3.114×10^2	1.098	0.000			1.098	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.107	0.000		0.000	1.107	2.406×10^2
400. MeV	4.945×10^2	1.129	0.000		0.000	1.129	3.300×10^2
800. MeV	8.995×10^2	1.214	0.001		0.000	1.216	6.707×10^2
1.00 GeV	1.101×10^3	1.247	0.002	0.000	0.000	1.249	8.330×10^2
1.40 GeV	1.502×10^3	1.299	0.003	0.001	0.001	1.303	1.146×10^3
2.00 GeV	2.103×10^3	1.354	0.004	0.003	0.001	1.362	1.596×10^3
3.00 GeV	3.104×10^3	1.417	0.007	0.006	0.001	1.432	2.311×10^3
4.00 GeV	4.104×10^3	1.459	0.011	0.010	0.002	1.482	2.997×10^3
8.00 GeV	8.105×10^3	1.556	0.027	0.030	0.003	1.617	5.570×10^3
10.0 GeV	1.011×10^4	1.585	0.035	0.042	0.004	1.667	6.788×10^3
14.0 GeV	1.411×10^4	1.626	0.054	0.067	0.005	1.753	9.126×10^3
20.0 GeV	2.011×10^4	1.667	0.084	0.108	0.007	1.867	1.244×10^4
30.0 GeV	3.011×10^4	1.711	0.138	0.185	0.011	2.045	1.755×10^4
40.0 GeV	4.011×10^4	1.740	0.195	0.269	0.014	2.219	2.224×10^4
80.0 GeV	8.011×10^4	1.804	0.441	0.635	0.027	2.909	3.794×10^4
100. GeV	1.001×10^5	1.823	0.572	0.832	0.034	3.262	4.443×10^4
124. GeV	1.239×10^5	1.841	0.730	1.070	0.042	3.684	<i>Muon critical energy</i>
140. GeV	1.401×10^5	1.851	0.839	1.235	0.047	3.974	5.553×10^4
200. GeV	2.001×10^5	1.881	1.257	1.870	0.067	5.078	6.886×10^4
300. GeV	3.001×10^5	1.913	1.971	2.931	0.101	6.918	8.568×10^4
400. GeV	4.001×10^5	1.936	2.708	4.026	0.135	8.807	9.847×10^4
800. GeV	8.001×10^5	1.992	5.748	8.506	0.273	16.521	1.311×10^5
1.00 TeV	1.000×10^6	2.010	7.309	10.793	0.343	20.456	1.420×10^5
1.40 TeV	1.400×10^6	2.037	10.434	15.353	0.485	28.312	1.585×10^5
2.00 TeV	2.000×10^6	2.067	15.212	22.301	0.702	40.284	1.762×10^5
3.00 TeV	3.000×10^6	2.101	23.182	33.848	1.073	60.206	1.964×10^5
4.00 TeV	4.000×10^6	2.125	31.254	45.507	1.449	80.337	2.107×10^5
8.00 TeV	8.000×10^6	2.185	63.776	92.342	3.009	161.314	2.452×10^5
10.0 TeV	1.000×10^7	2.205	80.156	115.870	3.809	202.042	2.562×10^5
14.0 TeV	1.400×10^7	2.235	112.826	162.828	5.450	283.342	2.729×10^5
20.0 TeV	2.000×10^7	2.268	162.100	233.536	7.964	405.870	2.905×10^5
30.0 TeV	3.000×10^7	2.305	244.128	351.193	12.304	609.934	3.104×10^5
40.0 TeV	4.000×10^7	2.333	326.430	469.099	16.745	814.609	3.246×10^5
80.0 TeV	8.000×10^7	2.399	656.059	941.001	35.269	1634.731	3.585×10^5
100. TeV	1.000×10^8	2.421	821.120	1177.140	44.830	2045.514	3.694×10^5

TABLE I-73. Muons in Uranium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
92 (U)	238.0289	18.950	890.0	0.19677	2.8171	0.2260	3.3721	5.8694	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
14.0 MeV	5.616×10^1	2.933				2.933	2.853×10^0
20.0 MeV	6.802×10^1	2.342				2.342	5.165×10^0
30.0 MeV	8.509×10^1	1.855				1.855	1.002×10^1
40.0 MeV	1.003×10^2	1.604				1.604	1.585×10^1
80.0 MeV	1.527×10^2	1.234				1.234	4.512×10^1
100. MeV	1.764×10^2	1.169				1.169	6.181×10^1
140. MeV	2.218×10^2	1.109				1.109	9.709×10^1
200. MeV	2.868×10^2	1.083				1.083	1.520×10^2
227. MeV	3.154×10^2	1.081	0.000			1.082	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.089	0.000		0.000	1.089	2.443×10^2
400. MeV	4.945×10^2	1.109	0.000		0.000	1.109	3.353×10^2
800. MeV	8.995×10^2	1.191	0.001		0.000	1.192	6.824×10^2
1.00 GeV	1.101×10^3	1.223	0.002	0.000	0.000	1.225	8.478×10^2
1.40 GeV	1.502×10^3	1.273	0.003	0.001	0.001	1.278	1.167×10^3
2.00 GeV	2.103×10^3	1.328	0.004	0.003	0.001	1.336	1.626×10^3
3.00 GeV	3.104×10^3	1.389	0.007	0.006	0.001	1.405	2.355×10^3
4.00 GeV	4.104×10^3	1.431	0.011	0.010	0.002	1.455	3.054×10^3
8.00 GeV	8.105×10^3	1.527	0.027	0.031	0.003	1.589	5.674×10^3
10.0 GeV	1.011×10^4	1.555	0.036	0.043	0.004	1.639	6.913×10^3
14.0 GeV	1.411×10^4	1.596	0.055	0.068	0.005	1.726	9.290×10^3
20.0 GeV	2.011×10^4	1.637	0.086	0.109	0.007	1.840	1.265×10^4
30.0 GeV	3.011×10^4	1.680	0.140	0.188	0.011	2.020	1.784×10^4
40.0 GeV	4.011×10^4	1.708	0.198	0.273	0.014	2.195	2.258×10^4
80.0 GeV	8.011×10^4	1.771	0.449	0.647	0.027	2.895	3.840×10^4
100. GeV	1.001×10^5	1.790	0.581	0.846	0.034	3.253	4.492×10^4
120. GeV	1.201×10^5	1.805	0.716	1.049	0.041	3.612	<i>Muon critical energy</i>
140. GeV	1.401×10^5	1.818	0.853	1.256	0.047	3.976	5.603×10^4
200. GeV	2.001×10^5	1.846	1.278	1.903	0.067	5.096	6.933×10^4
300. GeV	3.001×10^5	1.878	2.004	2.981	0.101	6.966	8.606×10^4
400. GeV	4.001×10^5	1.901	2.753	4.095	0.135	8.886	9.875×10^4
800. GeV	8.001×10^5	1.956	5.844	8.650	0.272	16.724	1.310×10^5
1.00 TeV	1.000×10^6	1.974	7.430	10.975	0.342	20.724	1.418×10^5
1.40 TeV	1.400×10^6	2.002	10.607	15.612	0.484	28.707	1.581×10^5
2.00 TeV	2.000×10^6	2.031	15.463	22.676	0.700	40.873	1.755×10^5
3.00 TeV	3.000×10^6	2.065	23.564	34.417	1.070	61.119	1.954×10^5
4.00 TeV	4.000×10^6	2.089	31.769	46.270	1.446	81.576	2.095×10^5
8.00 TeV	8.000×10^6	2.149	64.824	93.886	3.001	163.862	2.434×10^5
10.0 TeV	1.000×10^7	2.169	81.471	117.806	3.799	205.247	2.543×10^5
14.0 TeV	1.400×10^7	2.199	114.675	165.548	5.436	287.860	2.707×10^5
20.0 TeV	2.000×10^7	2.232	164.754	237.434	7.944	412.366	2.880×10^5
30.0 TeV	3.000×10^7	2.269	248.123	357.051	12.273	619.718	3.077×10^5
40.0 TeV	4.000×10^7	2.296	331.768	476.920	16.702	827.688	3.216×10^5
80.0 TeV	8.000×10^7	2.363	666.782	956.690	35.176	1661.012	3.550×10^5
100. TeV	1.000×10^8	2.385	834.540	1196.770	44.710	2078.406	3.658×10^5

TABLE I-74. Muons in Plutonium

See page 209 for Explanation of Tables

Z	A [g/mol]	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
94 (Pu)	244.064197	19.840	921.0	0.20419	2.7679	0.1557	3.3981	5.8748	0.14

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	3.619				3.619	1.646×10^0
14.0 MeV	5.616×10^1	2.898				2.898	2.892×10^0
20.0 MeV	6.802×10^1	2.316				2.316	5.231×10^0
30.0 MeV	8.509×10^1	1.835				1.835	1.014×10^1
40.0 MeV	1.003×10^2	1.587				1.587	1.604×10^1
80.0 MeV	1.527×10^2	1.220				1.221	4.562×10^1
100. MeV	1.764×10^2	1.158				1.158	6.249×10^1
140. MeV	2.218×10^2	1.098				1.099	9.810×10^1
200. MeV	2.868×10^2	1.073				1.073	1.536×10^2
227. MeV	3.154×10^2	1.071	0.000			1.071	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.078	0.000		0.000	1.078	2.467×10^2
400. MeV	4.945×10^2	1.098	0.000		0.000	1.099	3.386×10^2
800. MeV	8.995×10^2	1.180	0.001		0.000	1.181	6.891×10^2
1.00 GeV	1.101×10^3	1.211	0.002	0.000	0.000	1.214	8.561×10^2
1.40 GeV	1.502×10^3	1.262	0.003	0.001	0.001	1.266	1.178×10^3
2.00 GeV	2.103×10^3	1.316	0.004	0.003	0.001	1.325	1.641×10^3
3.00 GeV	3.104×10^3	1.377	0.008	0.006	0.001	1.393	2.376×10^3
4.00 GeV	4.104×10^3	1.420	0.011	0.011	0.002	1.444	3.081×10^3
8.00 GeV	8.105×10^3	1.515	0.028	0.032	0.003	1.579	5.719×10^3
10.0 GeV	1.011×10^4	1.544	0.037	0.044	0.004	1.630	6.966×10^3
14.0 GeV	1.411×10^4	1.585	0.056	0.070	0.005	1.718	9.355×10^3
20.0 GeV	2.011×10^4	1.626	0.088	0.112	0.007	1.834	1.273×10^4
30.0 GeV	3.011×10^4	1.669	0.144	0.193	0.011	2.018	1.793×10^4
40.0 GeV	4.011×10^4	1.698	0.203	0.281	0.014	2.197	2.268×10^4
80.0 GeV	8.011×10^4	1.761	0.460	0.663	0.027	2.913	3.844×10^4
100. GeV	1.001×10^5	1.780	0.596	0.868	0.034	3.279	4.491×10^4
117. GeV	1.169×10^5	1.793	0.711	1.042	0.040	3.587	<i>Muon critical energy</i>
140. GeV	1.401×10^5	1.807	0.875	1.288	0.047	4.019	5.591×10^4
200. GeV	2.001×10^5	1.836	1.311	1.951	0.067	5.167	6.906×10^4
300. GeV	3.001×10^5	1.868	2.054	3.057	0.101	7.082	8.553×10^4
400. GeV	4.001×10^5	1.891	2.823	4.198	0.135	9.048	9.800×10^4
800. GeV	8.001×10^5	1.946	5.991	8.868	0.272	17.078	1.297×10^5
1.00 TeV	1.000×10^6	1.964	7.617	11.251	0.342	21.175	1.402×10^5
1.40 TeV	1.400×10^6	1.991	10.874	16.004	0.484	29.354	1.561×10^5
2.00 TeV	2.000×10^6	2.020	15.851	23.245	0.699	41.817	1.732×10^5
3.00 TeV	3.000×10^6	2.054	24.155	35.278	1.069	62.558	1.926×10^5
4.00 TeV	4.000×10^6	2.078	32.564	47.426	1.443	83.514	2.064×10^5
8.00 TeV	8.000×10^6	2.138	66.444	96.229	2.996	167.809	2.395×10^5
10.0 TeV	1.000×10^7	2.158	83.506	120.745	3.793	210.204	2.502×10^5
14.0 TeV	1.400×10^7	2.188	117.537	169.675	5.427	294.829	2.661×10^5
20.0 TeV	2.000×10^7	2.220	168.862	243.350	7.930	422.364	2.831×10^5
30.0 TeV	3.000×10^7	2.257	254.390	365.946	12.252	634.847	3.022×10^5
40.0 TeV	4.000×10^7	2.284	340.223	488.800	16.674	847.984	3.158×10^5
80.0 TeV	8.000×10^7	2.351	683.542	980.509	35.120	1701.524	3.485×10^5
100. TeV	1.000×10^8	2.372	855.310	1226.560	44.640	2128.885	3.589×10^5

TABLE II-1. Muons in Acetone (CH₃CHCH₃)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.55097	0.790	64.2	0.11100	3.4047	0.2197	2.6928	3.4341	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.064				8.065	6.932×10^{-1}	
14.0 MeV	5.616×10^1	6.286				6.286	1.261×10^0	
20.0 MeV	6.802×10^1	4.906				4.906	2.354×10^0	
30.0 MeV	8.509×10^1	3.803				3.803	4.702×10^0	
40.0 MeV	1.003×10^2	3.246				3.246	7.566×10^0	
80.0 MeV	1.527×10^2	2.434				2.434	2.225×10^1	
100. MeV	1.764×10^2	2.288				2.288	3.075×10^1	
140. MeV	2.218×10^2	2.130				2.130	4.895×10^1	
200. MeV	2.868×10^2	2.039				2.039	7.785×10^1	
300. MeV	3.917×10^2	2.003			0.000	2.004	1.275×10^2	
318. MeV	4.105×10^2	2.003			0.000	2.003	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.009			0.000	2.009	1.774×10^2	
800. MeV	8.995×10^2	2.083	0.000		0.000	2.083	3.729×10^2	
1.00 GeV	1.101×10^3	2.117	0.000		0.000	2.118	4.681×10^2	
1.40 GeV	1.502×10^3	2.172	0.000		0.001	2.173	6.545×10^2	
2.00 GeV	2.103×10^3	2.233	0.001	0.000	0.001	2.235	9.265×10^2	
3.00 GeV	3.104×10^3	2.303	0.001	0.001	0.001	2.306	1.366×10^3	
4.00 GeV	4.104×10^3	2.351	0.001	0.001	0.002	2.356	1.795×10^3	
8.00 GeV	8.105×10^3	2.462	0.003	0.003	0.004	2.472	3.448×10^3	
10.0 GeV	1.011×10^4	2.495	0.004	0.004	0.005	2.509	4.251×10^3	
14.0 GeV	1.411×10^4	2.544	0.006	0.007	0.007	2.564	5.827×10^3	
20.0 GeV	2.011×10^4	2.593	0.010	0.011	0.009	2.624	8.139×10^3	
30.0 GeV	3.011×10^4	2.646	0.016	0.020	0.014	2.696	1.190×10^4	
40.0 GeV	4.011×10^4	2.683	0.023	0.029	0.018	2.752	1.557×10^4	
80.0 GeV	8.011×10^4	2.766	0.052	0.070	0.035	2.922	2.965×10^4	
100. GeV	1.001×10^5	2.792	0.067	0.092	0.043	2.994	3.641×10^4	
140. GeV	1.401×10^5	2.830	0.100	0.139	0.059	3.128	4.947×10^4	
200. GeV	2.001×10^5	2.871	0.150	0.212	0.084	3.317	6.809×10^4	
300. GeV	3.001×10^5	2.916	0.237	0.338	0.126	3.617	9.695×10^4	
400. GeV	4.001×10^5	2.949	0.327	0.468	0.168	3.913	1.235×10^5	
800. GeV	8.001×10^5	3.028	0.704	1.013	0.340	5.085	2.129×10^5	
1.00 TeV	1.000×10^6	3.053	0.899	1.295	0.427	5.675	2.501×10^5	
1.16 TeV	1.160×10^6	3.070	1.055	1.518	0.498	6.141	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.092	1.292	1.856	0.606	6.846	3.142×10^5	
2.00 TeV	2.000×10^6	3.134	1.895	2.717	0.877	8.624	3.922×10^5	
3.00 TeV	3.000×10^6	3.182	2.907	4.150	1.344	11.584	4.919×10^5	
4.00 TeV	4.000×10^6	3.217	3.938	5.604	1.819	14.578	5.687×10^5	
8.00 TeV	8.000×10^6	3.303	8.112	11.461	3.798	26.675	7.686×10^5	
10.0 TeV	1.000×10^7	3.331	10.225	14.412	4.818	32.785	8.361×10^5	
14.0 TeV	1.400×10^7	3.374	14.441	20.290	6.919	45.024	9.398×10^5	
20.0 TeV	2.000×10^7	3.420	20.821	29.157	10.149	63.547	1.051×10^6	
30.0 TeV	3.000×10^7	3.473	31.445	43.909	15.757	94.584	1.180×10^6	
40.0 TeV	4.000×10^7	3.512	42.128	58.710	21.513	125.863	1.271×10^6	
80.0 TeV	8.000×10^7	3.607	84.965	117.964	45.684	252.220	1.491×10^6	
100. TeV	1.000×10^8	3.638	106.440	147.627	58.218	315.923	1.562×10^6	

TABLE II-2. Muons in Acetylene (C₂H₂)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.53768	1.097×10^{-3}	58.2	0.12167	3.4277	1.6017	4.0074	9.8419	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.968				7.968	7.010×10^{-1}	
14.0 MeV	5.616×10^1	6.208				6.208	1.276×10^0	
20.0 MeV	6.802×10^1	4.843				4.843	2.383×10^0	
30.0 MeV	8.509×10^1	3.753				3.753	4.762×10^0	
40.0 MeV	1.003×10^2	3.202				3.202	7.665×10^0	
80.0 MeV	1.527×10^2	2.399				2.400	2.256×10^1	
100. MeV	1.764×10^2	2.255				2.256	3.118×10^1	
140. MeV	2.218×10^2	2.113				2.114	4.959×10^1	
200. MeV	2.868×10^2	2.040				2.040	7.859×10^1	
263. MeV	3.537×10^2	2.025			0.000	2.025	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	2.028			0.000	2.028	1.279×10^2	
400. MeV	4.945×10^2	2.053			0.000	2.053	1.769×10^2	
800. MeV	8.995×10^2	2.184	0.000		0.000	2.185	3.657×10^2	
1.00 GeV	1.101×10^3	2.240	0.000		0.000	2.241	4.560×10^2	
1.40 GeV	1.502×10^3	2.332	0.000		0.001	2.333	6.308×10^2	
2.00 GeV	2.103×10^3	2.435	0.000	0.000	0.001	2.437	8.822×10^2	
3.00 GeV	3.104×10^3	2.557	0.001	0.001	0.001	2.560	1.282×10^3	
4.00 GeV	4.104×10^3	2.645	0.001	0.001	0.002	2.649	1.666×10^3	
8.00 GeV	8.105×10^3	2.820	0.003	0.003	0.004	2.829	3.120×10^3	
10.0 GeV	1.011×10^4	2.870	0.004	0.004	0.005	2.883	3.820×10^3	
14.0 GeV	1.411×10^4	2.942	0.006	0.006	0.007	2.961	5.188×10^3	
20.0 GeV	2.011×10^4	3.011	0.009	0.010	0.009	3.040	7.186×10^3	
30.0 GeV	3.011×10^4	3.082	0.015	0.018	0.014	3.130	1.042×10^4	
40.0 GeV	4.011×10^4	3.129	0.021	0.027	0.018	3.195	1.359×10^4	
80.0 GeV	8.011×10^4	3.229	0.049	0.065	0.035	3.378	2.574×10^4	
100. GeV	1.001×10^5	3.258	0.063	0.086	0.043	3.451	3.159×10^4	
140. GeV	1.401×10^5	3.300	0.093	0.130	0.059	3.583	4.296×10^4	
200. GeV	2.001×10^5	3.343	0.141	0.199	0.084	3.767	5.929×10^4	
300. GeV	3.001×10^5	3.390	0.222	0.317	0.126	4.055	8.486×10^4	
400. GeV	4.001×10^5	3.422	0.307	0.439	0.168	4.337	1.087×10^5	
800. GeV	8.001×10^5	3.500	0.661	0.951	0.340	5.452	1.908×10^5	
1.00 TeV	1.000×10^6	3.525	0.844	1.216	0.428	6.013	2.257×10^5	
1.40 TeV	1.400×10^6	3.563	1.212	1.744	0.606	7.126	2.867×10^5	
1.40 TeV	1.400×10^6	3.563	1.213	1.744	0.607	7.126	<i>Muon critical energy</i>	
2.00 TeV	2.000×10^6	3.604	1.779	2.553	0.878	8.815	3.623×10^5	
3.00 TeV	3.000×10^6	3.651	2.730	3.900	1.346	11.628	4.608×10^5	
4.00 TeV	4.000×10^6	3.685	3.698	5.268	1.822	14.473	5.377×10^5	
8.00 TeV	8.000×10^6	3.768	7.621	10.777	3.804	25.971	7.412×10^5	
10.0 TeV	1.000×10^7	3.796	9.606	13.552	4.825	31.780	8.108×10^5	
14.0 TeV	1.400×10^7	3.838	13.568	19.082	6.931	43.418	9.180×10^5	
20.0 TeV	2.000×10^7	3.883	19.563	27.423	10.166	61.035	1.034×10^6	
30.0 TeV	3.000×10^7	3.935	29.546	41.300	15.784	90.564	1.168×10^6	
40.0 TeV	4.000×10^7	3.972	39.586	55.222	21.551	120.331	1.263×10^6	
80.0 TeV	8.000×10^7	4.065	79.826	110.962	45.767	240.620	1.494×10^6	
100. TeV	1.000×10^8	4.096	99.994	138.867	58.325	301.282	1.568×10^6	

TABLE II-3. Muons in Aluminum Oxide (Al₂O₃)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49038	3.970	145.2	0.08500	3.5458	0.0402	2.8665	3.5682	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.434				6.434	8.768×10^{-1}	
14.0 MeV	5.616×10^1	5.037				5.037	1.587×10^0	
20.0 MeV	6.802×10^1	3.947				3.947	2.948×10^0	
30.0 MeV	8.509×10^1	3.072				3.072	5.859×10^0	
40.0 MeV	1.003×10^2	2.630				2.630	9.400×10^0	
80.0 MeV	1.527×10^2	1.977				1.977	2.749×10^1	
100. MeV	1.764×10^2	1.857				1.857	3.795×10^1	
140. MeV	2.218×10^2	1.736				1.736	6.033×10^1	
200. MeV	2.868×10^2	1.669				1.669	9.572×10^1	
297. MeV	3.884×10^2	1.647			0.000	1.648	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.647			0.000	1.648	1.562×10^2	
400. MeV	4.945×10^2	1.657			0.000	1.658	2.168×10^2	
800. MeV	8.995×10^2	1.730	0.000		0.000	1.731	4.529×10^2	
1.00 GeV	1.101×10^3	1.762	0.000		0.000	1.763	5.674×10^2	
1.40 GeV	1.502×10^3	1.813	0.000	0.000	0.001	1.815	7.908×10^2	
2.00 GeV	2.103×10^3	1.869	0.001	0.000	0.001	1.871	1.116×10^3	
3.00 GeV	3.104×10^3	1.932	0.001	0.001	0.001	1.936	1.641×10^3	
4.00 GeV	4.104×10^3	1.976	0.002	0.002	0.002	1.982	2.151×10^3	
8.00 GeV	8.105×10^3	2.076	0.005	0.005	0.004	2.090	4.110×10^3	
10.0 GeV	1.011×10^4	2.107	0.006	0.007	0.005	2.125	5.059×10^3	
14.0 GeV	1.411×10^4	2.151	0.010	0.011	0.006	2.178	6.917×10^3	
20.0 GeV	2.011×10^4	2.195	0.015	0.018	0.009	2.237	9.634×10^3	
30.0 GeV	3.011×10^4	2.242	0.025	0.031	0.013	2.312	1.403×10^4	
40.0 GeV	4.011×10^4	2.275	0.036	0.045	0.017	2.373	1.830×10^4	
80.0 GeV	8.011×10^4	2.349	0.080	0.109	0.033	2.572	3.446×10^4	
100. GeV	1.001×10^5	2.372	0.104	0.144	0.041	2.661	4.210×10^4	
140. GeV	1.401×10^5	2.406	0.154	0.215	0.057	2.832	5.667×10^4	
200. GeV	2.001×10^5	2.442	0.231	0.328	0.081	3.082	7.697×10^4	
300. GeV	3.001×10^5	2.483	0.364	0.520	0.121	3.488	1.074×10^5	
400. GeV	4.001×10^5	2.512	0.501	0.720	0.162	3.895	1.346×10^5	
705. GeV	7.050×10^5	2.569	0.934	1.348	0.287	5.138	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.582	1.072	1.548	0.327	5.529	2.203×10^5	
1.00 TeV	1.000×10^6	2.605	1.366	1.975	0.411	6.357	2.540×10^5	
1.40 TeV	1.400×10^6	2.639	1.958	2.823	0.583	8.004	3.100×10^5	
2.00 TeV	2.000×10^6	2.677	2.866	4.123	0.844	10.510	3.752×10^5	
3.00 TeV	3.000×10^6	2.720	4.386	6.284	1.293	14.683	4.554×10^5	
4.00 TeV	4.000×10^6	2.751	5.931	8.473	1.749	18.903	5.153×10^5	
8.00 TeV	8.000×10^6	2.827	12.175	17.283	3.647	35.932	6.662×10^5	
10.0 TeV	1.000×10^7	2.852	15.329	21.718	4.624	44.523	7.161×10^5	
14.0 TeV	1.400×10^7	2.890	21.624	30.558	6.635	61.707	7.921×10^5	
20.0 TeV	2.000×10^7	2.931	31.141	43.885	9.722	87.679	8.733×10^5	
30.0 TeV	3.000×10^7	2.979	46.972	66.066	15.075	131.092	9.660×10^5	
40.0 TeV	4.000×10^7	3.013	62.875	88.313	20.566	174.768	1.032×10^6	
80.0 TeV	8.000×10^7	3.097	126.647	177.373	43.574	350.691	1.190×10^6	
100. TeV	1.000×10^8	3.125	158.613	221.951	55.487	439.178	1.241×10^6	

TABLE II-4. Muons in Barium Fluoride (BaF₂)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$ 0.42207	ρ [g/cm ³] 4.890	I [eV] 375.9	a 0.15991	$k = m_s$ 2.8867	x_0 -0.0098	x_1 3.3871	\bar{C} 5.4122	δ_0 0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.785				4.785	1.198×10^0	
14.0 MeV	5.616×10^1	3.771				3.771	2.149×10^0	
20.0 MeV	6.802×10^1	2.974				2.974	3.960×10^0	
30.0 MeV	8.509×10^1	2.330				2.330	7.810×10^0	
40.0 MeV	1.003×10^2	2.002				2.002	1.247×10^1	
80.0 MeV	1.527×10^2	1.523				1.523	3.607×10^1	
100. MeV	1.764×10^2	1.437				1.437	4.962×10^1	
140. MeV	2.218×10^2	1.352				1.352	7.845×10^1	
200. MeV	2.868×10^2	1.310				1.310	1.237×10^2	
256. MeV	3.462×10^2	1.303			0.000	1.303		<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.305	0.000		0.000	1.306	2.003×10^2	
400. MeV	4.945×10^2	1.322	0.000		0.000	1.323	2.765×10^2	
800. MeV	8.995×10^2	1.403	0.001		0.000	1.404	5.697×10^2	
1.00 GeV	1.101×10^3	1.436	0.001		0.000	1.437	7.105×10^2	
1.40 GeV	1.502×10^3	1.488	0.001	0.001	0.001	1.491	9.835×10^2	
2.00 GeV	2.103×10^3	1.545	0.002	0.001	0.001	1.550	1.378×10^3	
3.00 GeV	3.104×10^3	1.609	0.004	0.003	0.001	1.619	2.008×10^3	
4.00 GeV	4.104×10^3	1.654	0.006	0.006	0.002	1.668	2.616×10^3	
8.00 GeV	8.105×10^3	1.755	0.015	0.016	0.003	1.790	4.922×10^3	
10.0 GeV	1.011×10^4	1.785	0.020	0.023	0.004	1.833	6.026×10^3	
14.0 GeV	1.411×10^4	1.829	0.031	0.037	0.006	1.902	8.167×10^3	
20.0 GeV	2.011×10^4	1.872	0.048	0.059	0.008	1.988	1.125×10^4	
30.0 GeV	3.011×10^4	1.918	0.078	0.102	0.012	2.111	1.613×10^4	
40.0 GeV	4.011×10^4	1.949	0.111	0.149	0.015	2.224	2.074×10^4	
80.0 GeV	8.011×10^4	2.016	0.250	0.354	0.030	2.650	3.719×10^4	
100. GeV	1.001×10^5	2.037	0.324	0.464	0.037	2.862	4.445×10^4	
140. GeV	1.401×10^5	2.067	0.475	0.690	0.051	3.285	5.749×10^4	
200. GeV	2.001×10^5	2.098	0.713	1.047	0.073	3.932	7.417×10^4	
227. GeV	2.270×10^5	2.109	0.820	1.206	0.083	4.219		<i>Muon critical energy</i>
300. GeV	3.001×10^5	2.133	1.118	1.646	0.110	5.007	9.666×10^4	
400. GeV	4.001×10^5	2.158	1.537	2.264	0.146	6.106	1.147×10^5	
800. GeV	8.001×10^5	2.218	3.268	4.801	0.295	10.584	1.639×10^5	
1.00 TeV	1.000×10^6	2.238	4.157	6.098	0.371	12.866	1.810×10^5	
1.40 TeV	1.400×10^6	2.268	5.940	8.686	0.526	17.421	2.076×10^5	
2.00 TeV	2.000×10^6	2.300	8.668	12.632	0.761	24.362	2.366×10^5	
3.00 TeV	3.000×10^6	2.337	13.223	19.192	1.163	35.916	2.702×10^5	
4.00 TeV	4.000×10^6	2.364	17.839	25.819	1.572	47.595	2.944×10^5	
8.00 TeV	8.000×10^6	2.429	36.453	52.458	3.270	94.611	3.528×10^5	
10.0 TeV	1.000×10^7	2.451	45.834	65.847	4.141	118.274	3.717×10^5	
14.0 TeV	1.400×10^7	2.484	64.546	92.563	5.932	165.526	4.001×10^5	
20.0 TeV	2.000×10^7	2.519	92.781	132.804	8.678	236.783	4.303×10^5	
30.0 TeV	3.000×10^7	2.560	139.787	199.760	13.426	355.535	4.645×10^5	
40.0 TeV	4.000×10^7	2.589	186.965	266.872	18.288	474.716	4.888×10^5	
80.0 TeV	8.000×10^7	2.662	375.962	535.510	38.604	952.740	5.471×10^5	
100. TeV	1.000×10^8	2.686	470.624	669.952	49.102	1192.365	5.658×10^5	

TABLE II-5. Muons in Beryllium Oxide (BeO)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.47979	3.010	93.2	0.10755	3.4927	0.0241	2.5846	2.9801	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.691				6.691	8.388×10^{-1}	
14.0 MeV	5.616×10^1	5.225				5.225	1.522×10^0	
20.0 MeV	6.802×10^1	4.085				4.085	2.836×10^0	
30.0 MeV	8.509×10^1	3.172				3.172	5.653×10^0	
40.0 MeV	1.003×10^2	2.711				2.711	9.085×10^0	
80.0 MeV	1.527×10^2	2.025				2.025	2.669×10^1	
100. MeV	1.764×10^2	1.897				1.898	3.692×10^1	
140. MeV	2.218×10^2	1.768				1.768	5.887×10^1	
200. MeV	2.868×10^2	1.693				1.694	9.368×10^1	
300. MeV	3.917×10^2	1.665			0.000	1.666	1.534×10^2	
317. MeV	4.096×10^2	1.665			0.000	1.665	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.671			0.000	1.671	2.134×10^2	
800. MeV	8.995×10^2	1.735	0.000		0.000	1.735	4.483×10^2	
1.00 GeV	1.101×10^3	1.764	0.000		0.000	1.764	5.626×10^2	
1.40 GeV	1.502×10^3	1.811	0.000		0.001	1.812	7.862×10^2	
2.00 GeV	2.103×10^3	1.863	0.001	0.000	0.001	1.864	1.112×10^3	
3.00 GeV	3.104×10^3	1.922	0.001	0.001	0.001	1.925	1.640×10^3	
4.00 GeV	4.104×10^3	1.963	0.001	0.001	0.002	1.967	2.153×10^3	
8.00 GeV	8.105×10^3	2.057	0.003	0.003	0.004	2.067	4.131×10^3	
10.0 GeV	1.011×10^4	2.086	0.004	0.004	0.005	2.099	5.091×10^3	
14.0 GeV	1.411×10^4	2.128	0.006	0.007	0.007	2.148	6.973×10^3	
20.0 GeV	2.011×10^4	2.170	0.010	0.011	0.009	2.201	9.731×10^3	
30.0 GeV	3.011×10^4	2.216	0.016	0.020	0.013	2.266	1.421×10^4	
40.0 GeV	4.011×10^4	2.248	0.023	0.029	0.018	2.318	1.857×10^4	
80.0 GeV	8.011×10^4	2.320	0.053	0.071	0.034	2.478	3.523×10^4	
100. GeV	1.001×10^5	2.343	0.068	0.094	0.042	2.547	4.319×10^4	
140. GeV	1.401×10^5	2.376	0.101	0.141	0.059	2.677	5.850×10^4	
200. GeV	2.001×10^5	2.411	0.152	0.215	0.083	2.862	8.017×10^4	
300. GeV	3.001×10^5	2.451	0.240	0.342	0.125	3.158	1.134×10^5	
400. GeV	4.001×10^5	2.479	0.331	0.474	0.166	3.451	1.437×10^5	
800. GeV	8.001×10^5	2.548	0.710	1.025	0.336	4.620	2.435×10^5	
975. GeV	9.755×10^5	2.568	0.882	1.274	0.412	5.136	<i>Muon critical energy</i>	
1.00 TeV	1.000×10^6	2.570	0.906	1.310	0.422	5.209	2.843×10^5	
1.40 TeV	1.400×10^6	2.604	1.301	1.876	0.599	6.381	3.535×10^5	
2.00 TeV	2.000×10^6	2.641	1.907	2.744	0.867	8.160	4.365×10^5	
3.00 TeV	3.000×10^6	2.683	2.924	4.189	1.329	11.124	5.411×10^5	
4.00 TeV	4.000×10^6	2.713	3.957	5.654	1.799	14.123	6.207×10^5	
8.00 TeV	8.000×10^6	2.788	8.141	11.557	3.754	26.240	8.253×10^5	
10.0 TeV	1.000×10^7	2.812	10.257	14.529	4.761	32.360	8.938×10^5	
14.0 TeV	1.400×10^7	2.849	14.478	20.453	6.836	44.616	9.986×10^5	
20.0 TeV	2.000×10^7	2.890	20.861	29.388	10.024	63.163	1.111×10^6	
30.0 TeV	3.000×10^7	2.936	31.490	44.254	15.557	94.237	1.240×10^6	
40.0 TeV	4.000×10^7	2.970	42.174	59.168	21.235	125.547	1.332×10^6	
80.0 TeV	8.000×10^7	3.053	85.014	118.875	45.058	252.000	1.552×10^6	
100. TeV	1.000×10^8	3.080	106.490	148.765	57.405	315.740	1.623×10^6	

TABLE II-6. Muons in Bismuth Germanate (BGO, Bi₄(GeO₄)₃)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.42065	7.130	534.1	0.09569	3.0781	0.0456	3.7816	5.7409	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.482				4.482	1.290×10^0	
14.0 MeV	5.616×10^1	3.546				3.546	2.303×10^0	
20.0 MeV	6.802×10^1	2.805				2.805	4.226×10^0	
30.0 MeV	8.509×10^1	2.205				2.205	8.300×10^0	
40.0 MeV	1.003×10^2	1.899				1.899	1.322×10^1	
80.0 MeV	1.527×10^2	1.451				1.451	3.804×10^1	
100. MeV	1.764×10^2	1.371				1.371	5.225×10^1	
140. MeV	2.218×10^2	1.293				1.294	8.242×10^1	
200. MeV	2.868×10^2	1.256				1.256	1.297×10^2	
247. MeV	3.366×10^2	1.251	0.000			1.251	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.255	0.000		0.000	1.255	2.095×10^2	
400. MeV	4.945×10^2	1.273	0.000		0.000	1.274	2.886×10^2	
800. MeV	8.995×10^2	1.356	0.001		0.000	1.358	5.925×10^2	
1.00 GeV	1.101×10^3	1.390	0.001		0.000	1.392	7.379×10^2	
1.40 GeV	1.502×10^3	1.443	0.002	0.001	0.001	1.446	1.020×10^3	
2.00 GeV	2.103×10^3	1.501	0.003	0.002	0.001	1.507	1.426×10^3	
3.00 GeV	3.104×10^3	1.566	0.005	0.004	0.001	1.577	2.073×10^3	
4.00 GeV	4.104×10^3	1.611	0.008	0.007	0.002	1.629	2.697×10^3	
8.00 GeV	8.105×10^3	1.714	0.020	0.022	0.003	1.760	5.050×10^3	
10.0 GeV	1.011×10^4	1.745	0.026	0.031	0.004	1.806	6.172×10^3	
14.0 GeV	1.411×10^4	1.790	0.040	0.049	0.006	1.884	8.338×10^3	
20.0 GeV	2.011×10^4	1.834	0.062	0.078	0.008	1.983	1.144×10^4	
30.0 GeV	3.011×10^4	1.881	0.102	0.135	0.011	2.130	1.630×10^4	
40.0 GeV	4.011×10^4	1.912	0.144	0.196	0.015	2.269	2.085×10^4	
80.0 GeV	8.011×10^4	1.982	0.326	0.465	0.029	2.804	3.667×10^4	
100. GeV	1.001×10^5	2.003	0.422	0.610	0.036	3.072	4.349×10^4	
140. GeV	1.401×10^5	2.034	0.620	0.906	0.050	3.611	5.549×10^4	
176. GeV	1.765×10^5	2.055	0.806	1.187	0.063	4.112	<i>Muon critical energy</i>	
200. GeV	2.001×10^5	2.066	0.929	1.373	0.071	4.441	7.045×10^4	
300. GeV	3.001×10^5	2.102	1.456	2.154	0.107	5.821	9.007×10^4	
400. GeV	4.001×10^5	2.127	2.001	2.962	0.143	7.234	1.055×10^5	
800. GeV	8.001×10^5	2.187	4.251	6.267	0.289	12.996	1.462×10^5	
1.00 TeV	1.000×10^6	2.206	5.407	7.956	0.363	15.933	1.600×10^5	
1.40 TeV	1.400×10^6	2.236	7.722	11.324	0.514	21.798	1.814×10^5	
2.00 TeV	2.000×10^6	2.268	11.262	16.459	0.743	30.733	2.045×10^5	
3.00 TeV	3.000×10^6	2.305	17.170	24.992	1.137	45.605	2.310×10^5	
4.00 TeV	4.000×10^6	2.332	23.155	33.610	1.537	60.635	2.500×10^5	
8.00 TeV	8.000×10^6	2.397	47.280	68.239	3.194	121.112	2.958×10^5	
10.0 TeV	1.000×10^7	2.418	59.434	85.639	4.046	151.539	3.105×10^5	
14.0 TeV	1.400×10^7	2.451	83.676	120.363	5.793	212.285	3.327×10^5	
20.0 TeV	2.000×10^7	2.486	120.247	172.656	8.472	303.863	3.562×10^5	
30.0 TeV	3.000×10^7	2.527	181.129	259.673	13.104	456.434	3.829×10^5	
40.0 TeV	4.000×10^7	2.557	242.222	346.882	17.846	609.508	4.018×10^5	
80.0 TeV	8.000×10^7	2.629	486.939	695.933	37.654	1223.157	4.472×10^5	
100. TeV	1.000×10^8	2.653	609.495	870.605	47.887	1530.642	4.618×10^5	

TABLE II-7. Muons in Butane (C₄H₁₀)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.59497	2.493×10^{-3}	48.3	0.10852	3.4884	1.3788	3.7524	8.5633	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	9.023				9.023	6.180×10^{-1}	
14.0 MeV	5.616×10^1	7.024				7.024	1.126×10^0	
20.0 MeV	6.802×10^1	5.475				5.475	2.105×10^0	
30.0 MeV	8.509×10^1	4.239				4.239	4.210×10^0	
40.0 MeV	1.003×10^2	3.615				3.615	6.781×10^0	
80.0 MeV	1.527×10^2	2.705				2.706	1.998×10^1	
100. MeV	1.764×10^2	2.542				2.542	2.763×10^1	
140. MeV	2.218×10^2	2.380				2.381	4.397×10^1	
200. MeV	2.868×10^2	2.296				2.296	6.972×10^1	
266. MeV	3.567×10^2	2.278			0.000	2.278	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	2.281			0.000	2.281	1.135×10^2	
400. MeV	4.945×10^2	2.307			0.000	2.307	1.572×10^2	
800. MeV	8.995×10^2	2.451	0.000		0.000	2.452	3.252×10^2	
1.00 GeV	1.101×10^3	2.513	0.000		0.000	2.514	4.058×10^2	
1.40 GeV	1.502×10^3	2.614	0.000		0.001	2.616	5.616×10^2	
2.00 GeV	2.103×10^3	2.729	0.000	0.000	0.001	2.730	7.859×10^2	
3.00 GeV	3.104×10^3	2.851	0.001	0.000	0.001	2.854	1.143×10^3	
4.00 GeV	4.104×10^3	2.928	0.001	0.001	0.002	2.932	1.489×10^3	
8.00 GeV	8.105×10^3	3.096	0.003	0.003	0.004	3.106	2.809×10^3	
10.0 GeV	1.011×10^4	3.146	0.004	0.004	0.005	3.158	3.447×10^3	
14.0 GeV	1.411×10^4	3.215	0.006	0.006	0.007	3.234	4.698×10^3	
20.0 GeV	2.011×10^4	3.283	0.009	0.010	0.009	3.311	6.530×10^3	
30.0 GeV	3.011×10^4	3.354	0.014	0.017	0.014	3.400	9.508×10^3	
40.0 GeV	4.011×10^4	3.400	0.020	0.026	0.018	3.464	1.242×10^4	
80.0 GeV	8.011×10^4	3.501	0.047	0.063	0.035	3.645	2.366×10^4	
100. GeV	1.001×10^5	3.531	0.061	0.083	0.043	3.718	2.909×10^4	
140. GeV	1.401×10^5	3.575	0.089	0.124	0.060	3.849	3.966×10^4	
200. GeV	2.001×10^5	3.620	0.135	0.190	0.085	4.030	5.489×10^4	
300. GeV	3.001×10^5	3.670	0.213	0.303	0.128	4.314	7.886×10^4	
400. GeV	4.001×10^5	3.705	0.295	0.421	0.170	4.592	1.013×10^5	
800. GeV	8.001×10^5	3.790	0.636	0.914	0.344	5.684	1.795×10^5	
1.00 TeV	1.000×10^6	3.818	0.813	1.169	0.432	6.231	2.131×10^5	
1.40 TeV	1.400×10^6	3.860	1.169	1.677	0.612	7.318	2.722×10^5	
1.56 TeV	1.557×10^6	3.873	1.310	1.879	0.684	7.747	<i>Muon critical energy</i>	
2.00 TeV	2.000×10^6	3.905	1.716	2.457	0.887	8.965	3.462×10^5	
3.00 TeV	3.000×10^6	3.957	2.636	3.755	1.359	11.708	4.435×10^5	
4.00 TeV	4.000×10^6	3.995	3.573	5.073	1.840	14.481	5.202×10^5	
8.00 TeV	8.000×10^6	4.087	7.373	10.385	3.843	25.689	7.249×10^5	
10.0 TeV	1.000×10^7	4.117	9.298	13.062	4.876	31.353	7.952×10^5	
14.0 TeV	1.400×10^7	4.164	13.140	18.393	7.005	42.701	9.041×10^5	
20.0 TeV	2.000×10^7	4.214	18.956	26.438	10.277	59.885	1.022×10^6	
30.0 TeV	3.000×10^7	4.271	28.645	39.818	15.962	88.697	1.159×10^6	
40.0 TeV	4.000×10^7	4.313	38.392	53.244	21.799	117.748	1.256×10^6	
80.0 TeV	8.000×10^7	4.415	77.477	106.995	46.325	235.213	1.492×10^6	
100. TeV	1.000×10^8	4.449	97.073	133.905	59.049	294.477	1.568×10^6	

TABLE II-8. Muons in Calcium Carbonate (CaCO₃)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49955	2.800	136.4	0.08301	3.4120	0.0492	3.0549	3.7738	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.613				6.613	8.525×10^{-1}	
14.0 MeV	5.616×10^1	5.174				5.175	1.543×10^0	
20.0 MeV	6.802×10^1	4.053				4.053	2.868×10^0	
30.0 MeV	8.509×10^1	3.154				3.154	5.704×10^0	
40.0 MeV	1.003×10^2	2.699				2.699	9.153×10^0	
80.0 MeV	1.527×10^2	2.027				2.027	2.678×10^1	
100. MeV	1.764×10^2	1.903				1.903	3.699×10^1	
140. MeV	2.218×10^2	1.778				1.778	5.885×10^1	
200. MeV	2.868×10^2	1.708				1.708	9.341×10^1	
297. MeV	3.884×10^2	1.686			0.000	1.686	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.686			0.000	1.686	1.525×10^2	
400. MeV	4.945×10^2	1.697			0.000	1.697	2.116×10^2	
800. MeV	8.995×10^2	1.773	0.000		0.000	1.773	4.422×10^2	
1.00 GeV	1.101×10^3	1.806	0.000		0.000	1.807	5.539×10^2	
1.40 GeV	1.502×10^3	1.859	0.001	0.000	0.001	1.861	7.719×10^2	
2.00 GeV	2.103×10^3	1.918	0.001	0.000	0.001	1.921	1.089×10^3	
3.00 GeV	3.104×10^3	1.985	0.002	0.001	0.001	1.989	1.600×10^3	
4.00 GeV	4.104×10^3	2.031	0.002	0.002	0.002	2.037	2.097×10^3	
8.00 GeV	8.105×10^3	2.136	0.006	0.006	0.004	2.151	4.001×10^3	
10.0 GeV	1.011×10^4	2.168	0.008	0.008	0.005	2.188	4.923×10^3	
14.0 GeV	1.411×10^4	2.213	0.012	0.013	0.006	2.245	6.726×10^3	
20.0 GeV	2.011×10^4	2.259	0.018	0.021	0.009	2.308	9.361×10^3	
30.0 GeV	3.011×10^4	2.309	0.030	0.037	0.013	2.388	1.362×10^4	
40.0 GeV	4.011×10^4	2.342	0.042	0.054	0.017	2.455	1.775×10^4	
80.0 GeV	8.011×10^4	2.418	0.095	0.129	0.033	2.675	3.333×10^4	
100. GeV	1.001×10^5	2.442	0.123	0.170	0.041	2.776	4.066×10^4	
140. GeV	1.401×10^5	2.476	0.181	0.255	0.057	2.969	5.459×10^4	
200. GeV	2.001×10^5	2.513	0.272	0.389	0.081	3.255	7.388×10^4	
300. GeV	3.001×10^5	2.555	0.428	0.615	0.121	3.718	1.026×10^5	
400. GeV	4.001×10^5	2.584	0.589	0.850	0.161	4.185	1.279×10^5	
630. GeV	6.304×10^5	2.631	0.971	1.404	0.255	5.262	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.656	1.259	1.820	0.326	6.061	2.069×10^5	
1.00 TeV	1.000×10^6	2.679	1.604	2.319	0.410	7.012	2.376×10^5	
1.40 TeV	1.400×10^6	2.714	2.298	3.314	0.581	8.907	2.881×10^5	
2.00 TeV	2.000×10^6	2.752	3.362	4.836	0.841	11.791	3.465×10^5	
3.00 TeV	3.000×10^6	2.796	5.142	7.367	1.287	16.593	4.176×10^5	
4.00 TeV	4.000×10^6	2.827	6.949	9.930	1.742	21.449	4.705×10^5	
8.00 TeV	8.000×10^6	2.905	14.255	20.244	3.631	41.035	6.031×10^5	
10.0 TeV	1.000×10^7	2.930	17.944	25.434	4.603	50.912	6.467×10^5	
14.0 TeV	1.400×10^7	2.969	25.307	35.782	6.605	70.664	7.131×10^5	
20.0 TeV	2.000×10^7	3.011	36.434	51.382	9.678	100.505	7.840×10^5	
30.0 TeV	3.000×10^7	3.060	54.944	77.339	15.005	150.348	8.648×10^5	
40.0 TeV	4.000×10^7	3.095	73.535	103.371	20.468	200.470	9.222×10^5	
80.0 TeV	8.000×10^7	3.181	148.069	207.584	43.362	402.197	1.060×10^6	
100. TeV	1.000×10^8	3.209	185.424	259.748	55.217	503.599	1.105×10^6	

TABLE II-9. Muons in Calcium Fluoride (CaF₂)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49670	3.180	166.0	0.06942	3.5263	0.0676	3.1683	4.0653	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.393				6.394	8.839×10^{-1}	
14.0 MeV	5.616×10^1	5.009				5.009	1.598×10^0	
20.0 MeV	6.802×10^1	3.928				3.928	2.966×10^0	
30.0 MeV	8.509×10^1	3.060				3.060	5.890×10^0	
40.0 MeV	1.003×10^2	2.620				2.620	9.444×10^0	
80.0 MeV	1.527×10^2	1.975				1.975	2.757×10^1	
100. MeV	1.764×10^2	1.857				1.857	3.804×10^1	
140. MeV	2.218×10^2	1.738				1.738	6.041×10^1	
200. MeV	2.868×10^2	1.673				1.674	9.572×10^1	
288. MeV	3.788×10^2	1.655			0.000	1.655	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.655			0.000	1.656	1.560×10^2	
400. MeV	4.945×10^2	1.667			0.000	1.668	2.162×10^2	
800. MeV	8.995×10^2	1.747	0.000		0.000	1.748	4.504×10^2	
1.00 GeV	1.101×10^3	1.781	0.000		0.000	1.782	5.637×10^2	
1.40 GeV	1.502×10^3	1.835	0.001	0.000	0.001	1.837	7.847×10^2	
2.00 GeV	2.103×10^3	1.895	0.001	0.001	0.001	1.897	1.106×10^3	
3.00 GeV	3.104×10^3	1.962	0.002	0.001	0.001	1.966	1.623×10^3	
4.00 GeV	4.104×10^3	2.008	0.003	0.002	0.002	2.015	2.125×10^3	
8.00 GeV	8.105×10^3	2.114	0.007	0.006	0.004	2.131	4.049×10^3	
10.0 GeV	1.011×10^4	2.146	0.009	0.009	0.005	2.168	4.979×10^3	
14.0 GeV	1.411×10^4	2.192	0.013	0.015	0.006	2.226	6.798×10^3	
20.0 GeV	2.011×10^4	2.238	0.020	0.024	0.009	2.291	9.453×10^3	
30.0 GeV	3.011×10^4	2.287	0.034	0.042	0.013	2.376	1.374×10^4	
40.0 GeV	4.011×10^4	2.321	0.047	0.061	0.017	2.446	1.788×10^4	
80.0 GeV	8.011×10^4	2.396	0.107	0.146	0.033	2.683	3.347×10^4	
100. GeV	1.001×10^5	2.420	0.139	0.192	0.040	2.792	4.078×10^4	
140. GeV	1.401×10^5	2.455	0.204	0.288	0.056	3.003	5.459×10^4	
200. GeV	2.001×10^5	2.491	0.307	0.439	0.080	3.317	7.359×10^4	
300. GeV	3.001×10^5	2.532	0.482	0.694	0.119	3.828	1.016×10^5	
400. GeV	4.001×10^5	2.562	0.664	0.959	0.159	4.344	1.261×10^5	
564. GeV	5.640×10^5	2.597	0.969	1.403	0.225	5.194	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.633	1.417	2.051	0.322	6.423	2.014×10^5	
1.00 TeV	1.000×10^6	2.656	1.805	2.612	0.404	7.478	2.302×10^5	
1.40 TeV	1.400×10^6	2.691	2.585	3.731	0.573	9.580	2.774×10^5	
2.00 TeV	2.000×10^6	2.729	3.780	5.442	0.829	12.781	3.314×10^5	
3.00 TeV	3.000×10^6	2.772	5.779	8.287	1.270	18.109	3.969×10^5	
4.00 TeV	4.000×10^6	2.804	7.809	11.166	1.718	23.497	4.452×10^5	
8.00 TeV	8.000×10^6	2.881	16.010	22.752	3.580	45.223	5.658×10^5	
10.0 TeV	1.000×10^7	2.906	20.150	28.581	4.538	56.176	6.054×10^5	
14.0 TeV	1.400×10^7	2.945	28.413	40.206	6.509	78.073	6.655×10^5	
20.0 TeV	2.000×10^7	2.986	40.898	57.727	9.534	111.147	7.296×10^5	
30.0 TeV	3.000×10^7	3.034	61.665	86.883	14.777	166.360	8.027×10^5	
40.0 TeV	4.000×10^7	3.069	82.521	116.120	20.152	221.863	8.546×10^5	
80.0 TeV	8.000×10^7	3.155	166.132	233.165	42.665	445.117	9.794×10^5	
100. TeV	1.000×10^8	3.183	208.035	291.751	54.318	557.288	1.019×10^6	

TABLE II-10. Muons in Calcium Oxide (CaO)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49929	3.300	176.1	0.12128	3.1936	-0.0172	3.0171	4.1209	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.372				6.372	8.876×10^{-1}	
14.0 MeV	5.616×10^1	4.994				4.994	1.604×10^0	
20.0 MeV	6.802×10^1	3.917				3.917	2.976×10^0	
30.0 MeV	8.509×10^1	3.053				3.053	5.907×10^0	
40.0 MeV	1.003×10^2	2.615				2.615	9.469×10^0	
80.0 MeV	1.527×10^2	1.968				1.968	2.765×10^1	
100. MeV	1.764×10^2	1.850				1.850	3.816×10^1	
140. MeV	2.218×10^2	1.732				1.732	6.061×10^1	
200. MeV	2.868×10^2	1.668				1.668	9.604×10^1	
283. MeV	3.738×10^2	1.650			0.000	1.650	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.650			0.000	1.651	1.565×10^2	
400. MeV	4.945×10^2	1.663	0.000		0.000	1.664	2.169×10^2	
800. MeV	8.995×10^2	1.745	0.000		0.000	1.745	4.515×10^2	
1.00 GeV	1.101×10^3	1.779	0.000		0.000	1.780	5.649×10^2	
1.40 GeV	1.502×10^3	1.835	0.001	0.000	0.001	1.837	7.860×10^2	
2.00 GeV	2.103×10^3	1.896	0.001	0.001	0.001	1.898	1.107×10^3	
3.00 GeV	3.104×10^3	1.964	0.002	0.001	0.001	1.969	1.624×10^3	
4.00 GeV	4.104×10^3	2.012	0.003	0.002	0.002	2.019	2.125×10^3	
8.00 GeV	8.105×10^3	2.119	0.007	0.007	0.004	2.138	4.043×10^3	
10.0 GeV	1.011×10^4	2.152	0.010	0.010	0.005	2.177	4.970×10^3	
14.0 GeV	1.411×10^4	2.198	0.015	0.017	0.006	2.236	6.782×10^3	
20.0 GeV	2.011×10^4	2.245	0.023	0.027	0.009	2.305	9.423×10^3	
30.0 GeV	3.011×10^4	2.295	0.038	0.047	0.013	2.393	1.368×10^4	
40.0 GeV	4.011×10^4	2.328	0.054	0.069	0.017	2.469	1.779×10^4	
80.0 GeV	8.011×10^4	2.404	0.122	0.167	0.032	2.725	3.319×10^4	
100. GeV	1.001×10^5	2.428	0.158	0.219	0.040	2.845	4.037×10^4	
140. GeV	1.401×10^5	2.463	0.232	0.328	0.056	3.079	5.388×10^4	
200. GeV	2.001×10^5	2.499	0.348	0.500	0.079	3.427	7.234×10^4	
300. GeV	3.001×10^5	2.541	0.548	0.789	0.119	3.997	9.934×10^4	
400. GeV	4.001×10^5	2.570	0.754	1.090	0.158	4.573	1.227×10^5	
506. GeV	5.060×10^5	2.594	0.978	1.417	0.200	5.189	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.642	1.608	2.328	0.320	6.899	1.935×10^5	
1.00 TeV	1.000×10^6	2.665	2.049	2.964	0.402	8.080	2.202×10^5	
1.40 TeV	1.400×10^6	2.700	2.933	4.232	0.569	10.435	2.637×10^5	
2.00 TeV	2.000×10^6	2.738	4.288	6.171	0.824	14.022	3.131×10^5	
3.00 TeV	3.000×10^6	2.782	6.554	9.395	1.262	19.993	3.726×10^5	
4.00 TeV	4.000×10^6	2.813	8.854	12.657	1.706	26.031	4.163×10^5	
8.00 TeV	8.000×10^6	2.891	18.144	25.782	3.555	50.373	5.248×10^5	
10.0 TeV	1.000×10^7	2.916	22.833	32.385	4.506	62.641	5.603×10^5	
14.0 TeV	1.400×10^7	2.955	32.194	45.554	6.462	87.165	6.142×10^5	
20.0 TeV	2.000×10^7	2.997	46.335	65.401	9.465	124.199	6.716×10^5	
30.0 TeV	3.000×10^7	3.045	69.853	98.426	14.666	185.990	7.370×10^5	
40.0 TeV	4.000×10^7	3.080	93.468	131.541	19.997	248.088	7.834×10^5	
80.0 TeV	8.000×10^7	3.166	188.140	264.111	42.322	497.740	8.950×10^5	
100. TeV	1.000×10^8	3.195	235.584	330.468	53.876	623.122	9.308×10^5	

TABLE II-11. Muons in Carbon Dioxide (CO₂)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49989	1.842×10^{-3}	85.0	0.11768	3.3227	1.6294	4.1825	10.1537	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.056				7.056	7.945×10^{-1}	
14.0 MeV	5.616×10^1	5.508				5.508	1.443×10^0	
20.0 MeV	6.802×10^1	4.304				4.304	2.689×10^0	
30.0 MeV	8.509×10^1	3.341				3.341	5.363×10^0	
40.0 MeV	1.003×10^2	2.854				2.854	8.623×10^0	
80.0 MeV	1.527×10^2	2.145				2.145	2.530×10^1	
100. MeV	1.764×10^2	2.018				2.018	3.494×10^1	
140. MeV	2.218×10^2	1.894				1.894	5.550×10^1	
200. MeV	2.868×10^2	1.831				1.831	8.784×10^1	
257. MeV	3.471×10^2	1.819			0.000	1.820	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.823			0.000	1.823	1.427×10^2	
400. MeV	4.945×10^2	1.848			0.000	1.848	1.972×10^2	
800. MeV	8.995×10^2	1.972	0.000		0.000	1.972	4.066×10^2	
1.00 GeV	1.101×10^3	2.024	0.000		0.000	2.025	5.066×10^2	
1.40 GeV	1.502×10^3	2.109	0.000	0.000	0.001	2.111	6.999×10^2	
2.00 GeV	2.103×10^3	2.206	0.001	0.000	0.001	2.208	9.776×10^2	
3.00 GeV	3.104×10^3	2.319	0.001	0.001	0.001	2.322	1.418×10^3	
4.00 GeV	4.104×10^3	2.401	0.002	0.001	0.002	2.405	1.841×10^3	
8.00 GeV	8.105×10^3	2.567	0.004	0.003	0.004	2.578	3.439×10^3	
10.0 GeV	1.011×10^4	2.615	0.005	0.005	0.005	2.630	4.207×10^3	
14.0 GeV	1.411×10^4	2.683	0.007	0.008	0.007	2.705	5.705×10^3	
20.0 GeV	2.011×10^4	2.749	0.011	0.013	0.009	2.783	7.890×10^3	
30.0 GeV	3.011×10^4	2.818	0.019	0.023	0.013	2.874	1.142×10^4	
40.0 GeV	4.011×10^4	2.863	0.027	0.034	0.017	2.941	1.486×10^4	
80.0 GeV	8.011×10^4	2.960	0.061	0.082	0.034	3.136	2.800×10^4	
100. GeV	1.001×10^5	2.989	0.079	0.108	0.042	3.217	3.430×10^4	
140. GeV	1.401×10^5	3.029	0.116	0.161	0.058	3.365	4.645×10^4	
200. GeV	2.001×10^5	3.071	0.174	0.247	0.083	3.575	6.374×10^4	
300. GeV	3.001×10^5	3.115	0.275	0.392	0.124	3.907	9.048×10^4	
400. GeV	4.001×10^5	3.146	0.379	0.543	0.165	4.235	1.151×10^5	
800. GeV	8.001×10^5	3.219	0.813	1.173	0.334	5.540	1.974×10^5	
1.00 TeV	1.000×10^6	3.243	1.037	1.498	0.420	6.198	2.315×10^5	
1.09 TeV	1.094×10^6	3.252	1.143	1.649	0.461	6.505	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.278	1.489	2.144	0.595	7.507	2.901×10^5	
2.00 TeV	2.000×10^6	3.316	2.181	3.135	0.862	9.495	3.610×10^5	
3.00 TeV	3.000×10^6	3.360	3.342	4.784	1.320	12.807	4.514×10^5	
4.00 TeV	4.000×10^6	3.392	4.523	6.455	1.786	16.156	5.208×10^5	
8.00 TeV	8.000×10^6	3.469	9.300	13.187	3.728	29.684	7.007×10^5	
10.0 TeV	1.000×10^7	3.495	11.714	16.576	4.728	36.513	7.613×10^5	
14.0 TeV	1.400×10^7	3.534	16.532	23.331	6.787	50.184	8.544×10^5	
20.0 TeV	2.000×10^7	3.575	23.817	33.518	9.949	70.861	9.546×10^5	
30.0 TeV	3.000×10^7	3.624	35.946	50.470	15.437	105.477	1.070×10^6	
40.0 TeV	4.000×10^7	3.659	48.136	67.475	21.069	140.339	1.151×10^6	
80.0 TeV	8.000×10^7	3.745	97.010	135.555	44.687	280.997	1.349×10^6	
100. TeV	1.000×10^8	3.773	121.509	169.634	56.926	351.842	1.412×10^6	

TABLE II-12. Muons in Solid Carbon Dioxide (Dry Ice)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$ 0.49989	ρ [g/cm ³] 1.563	I [eV] 85.0	a 0.43387	$k = m_s$ 3.0000	x_0 0.2000	x_1 2.0000	\bar{C} 3.4513	δ_0 0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.057				7.057	7.945×10^{-1}	
14.0 MeV	5.616×10^1	5.508				5.508	1.443×10^0	
20.0 MeV	6.802×10^1	4.304				4.304	2.689×10^0	
30.0 MeV	8.509×10^1	3.341				3.341	5.363×10^0	
40.0 MeV	1.003×10^2	2.854				2.854	8.623×10^0	
80.0 MeV	1.527×10^2	2.145				2.145	2.530×10^1	
100. MeV	1.764×10^2	2.017				2.017	3.494×10^1	
140. MeV	2.218×10^2	1.886				1.886	5.555×10^1	
200. MeV	2.868×10^2	1.812				1.812	8.812×10^1	
300. MeV	3.917×10^2	1.787			0.000	1.787	1.438×10^2	
303. MeV	3.950×10^2	1.787			0.000	1.787	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.795			0.000	1.795	1.997×10^2	
800. MeV	8.995×10^2	1.866	0.000		0.000	1.866	4.182×10^2	
1.00 GeV	1.101×10^3	1.896	0.000		0.000	1.897	5.245×10^2	
1.40 GeV	1.502×10^3	1.946	0.000	0.000	0.001	1.947	7.325×10^2	
2.00 GeV	2.103×10^3	1.999	0.001	0.000	0.001	2.001	1.036×10^3	
3.00 GeV	3.104×10^3	2.060	0.001	0.001	0.001	2.063	1.528×10^3	
4.00 GeV	4.104×10^3	2.101	0.002	0.001	0.002	2.106	2.007×10^3	
8.00 GeV	8.105×10^3	2.196	0.004	0.003	0.004	2.207	3.857×10^3	
10.0 GeV	1.011×10^4	2.225	0.005	0.005	0.005	2.240	4.757×10^3	
14.0 GeV	1.411×10^4	2.268	0.007	0.008	0.007	2.290	6.522×10^3	
20.0 GeV	2.011×10^4	2.312	0.011	0.013	0.009	2.345	9.110×10^3	
30.0 GeV	3.011×10^4	2.359	0.019	0.023	0.013	2.415	1.331×10^4	
40.0 GeV	4.011×10^4	2.392	0.027	0.034	0.017	2.470	1.740×10^4	
80.0 GeV	8.011×10^4	2.468	0.061	0.082	0.034	2.644	3.303×10^4	
100. GeV	1.001×10^5	2.491	0.079	0.108	0.042	2.719	4.049×10^4	
140. GeV	1.401×10^5	2.526	0.116	0.161	0.058	2.862	5.482×10^4	
200. GeV	2.001×10^5	2.563	0.174	0.247	0.083	3.067	7.506×10^4	
300. GeV	3.001×10^5	2.604	0.275	0.392	0.124	3.396	1.060×10^5	
400. GeV	4.001×10^5	2.634	0.379	0.543	0.165	3.722	1.342×10^5	
800. GeV	8.001×10^5	2.705	0.813	1.173	0.334	5.026	2.263×10^5	
927. GeV	9.266×10^5	2.720	0.955	1.378	0.388	5.441	<i>Muon critical energy</i>	
1.00 TeV	1.000×10^6	2.728	1.037	1.498	0.420	5.684	2.637×10^5	
1.40 TeV	1.400×10^6	2.764	1.489	2.144	0.595	6.992	3.270×10^5	
2.00 TeV	2.000×10^6	2.802	2.181	3.135	0.862	8.980	4.026×10^5	
3.00 TeV	3.000×10^6	2.846	3.342	4.784	1.320	12.292	4.974×10^5	
4.00 TeV	4.000×10^6	2.877	4.523	6.455	1.786	15.642	5.694×10^5	
8.00 TeV	8.000×10^6	2.955	9.300	13.187	3.728	29.169	7.537×10^5	
10.0 TeV	1.000×10^7	2.980	11.714	16.576	4.728	35.999	8.153×10^5	
14.0 TeV	1.400×10^7	3.019	16.532	23.331	6.787	49.669	9.095×10^5	
20.0 TeV	2.000×10^7	3.061	23.817	33.518	9.949	70.346	1.011×10^6	
30.0 TeV	3.000×10^7	3.110	35.946	50.470	15.437	104.963	1.126×10^6	
40.0 TeV	4.000×10^7	3.144	48.136	67.475	21.069	139.825	1.208×10^6	
80.0 TeV	8.000×10^7	3.231	97.010	135.555	44.687	280.483	1.407×10^6	
100. TeV	1.000×10^8	3.259	121.509	169.634	56.926	351.328	1.470×10^6	

TABLE II-13. Muons in Cesium Iodide (CsI)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.41569	4.510	553.1	0.25381	2.6657	0.0395	3.3353	6.2807	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.404				4.404	1.313×10^0	
14.0 MeV	5.616×10^1	3.485				3.485	2.344×10^0	
20.0 MeV	6.802×10^1	2.758				2.758	4.301×10^0	
30.0 MeV	8.509×10^1	2.168				2.168	8.445×10^0	
40.0 MeV	1.003×10^2	1.867				1.867	1.345×10^1	
80.0 MeV	1.527×10^2	1.432				1.432	3.865×10^1	
100. MeV	1.764×10^2	1.355				1.355	5.305×10^1	
140. MeV	2.218×10^2	1.281				1.281	8.355×10^1	
200. MeV	2.868×10^2	1.246				1.247	1.312×10^2	
237. MeV	3.260×10^2	1.243				1.243	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.248	0.000		0.000	1.249	2.115×10^2	
400. MeV	4.945×10^2	1.269	0.000		0.000	1.269	2.910×10^2	
800. MeV	8.995×10^2	1.356	0.001		0.000	1.357	5.953×10^2	
1.00 GeV	1.101×10^3	1.391	0.001		0.000	1.393	7.408×10^2	
1.40 GeV	1.502×10^3	1.446	0.002	0.001	0.001	1.449	1.022×10^3	
2.00 GeV	2.103×10^3	1.505	0.003	0.002	0.001	1.511	1.427×10^3	
3.00 GeV	3.104×10^3	1.573	0.005	0.004	0.001	1.583	2.073×10^3	
4.00 GeV	4.104×10^3	1.619	0.007	0.007	0.002	1.635	2.694×10^3	
8.00 GeV	8.105×10^3	1.724	0.018	0.020	0.003	1.765	5.039×10^3	
10.0 GeV	1.011×10^4	1.755	0.024	0.027	0.004	1.811	6.157×10^3	
14.0 GeV	1.411×10^4	1.800	0.037	0.044	0.005	1.886	8.319×10^3	
20.0 GeV	2.011×10^4	1.845	0.057	0.070	0.008	1.980	1.142×10^4	
30.0 GeV	3.011×10^4	1.892	0.093	0.121	0.011	2.118	1.630×10^4	
40.0 GeV	4.011×10^4	1.923	0.131	0.177	0.015	2.247	2.088×10^4	
80.0 GeV	8.011×10^4	1.991	0.297	0.420	0.029	2.738	3.698×10^4	
100. GeV	1.001×10^5	2.012	0.384	0.550	0.036	2.983	4.397×10^4	
140. GeV	1.401×10^5	2.042	0.564	0.819	0.050	3.476	5.639×10^4	
193. GeV	1.928×10^5	2.069	0.810	1.191	0.069	4.140	<i>Muon critical energy</i>	
200. GeV	2.001×10^5	2.073	0.845	1.243	0.071	4.233	7.201×10^4	
300. GeV	3.001×10^5	2.107	1.326	1.952	0.107	5.492	9.270×10^4	
400. GeV	4.001×10^5	2.132	1.822	2.685	0.142	6.782	1.091×10^5	
800. GeV	8.001×10^5	2.191	3.873	5.689	0.287	12.042	1.528×10^5	
1.00 TeV	1.000×10^6	2.210	4.926	7.225	0.361	14.724	1.678×10^5	
1.40 TeV	1.400×10^6	2.240	7.037	10.288	0.511	20.078	1.909×10^5	
2.00 TeV	2.000×10^6	2.271	10.267	14.960	0.739	28.239	2.160×10^5	
3.00 TeV	3.000×10^6	2.308	15.659	22.724	1.131	41.823	2.449×10^5	
4.00 TeV	4.000×10^6	2.334	21.122	30.568	1.528	55.554	2.656×10^5	
8.00 TeV	8.000×10^6	2.399	43.151	62.092	3.174	110.817	3.156×10^5	
10.0 TeV	1.000×10^7	2.420	54.252	77.935	4.019	138.627	3.317×10^5	
14.0 TeV	1.400×10^7	2.452	76.393	109.550	5.754	194.151	3.560×10^5	
20.0 TeV	2.000×10^7	2.487	109.800	157.167	8.414	277.870	3.817×10^5	
30.0 TeV	3.000×10^7	2.527	165.415	236.398	13.007	417.349	4.109×10^5	
40.0 TeV	4.000×10^7	2.556	221.230	315.809	17.708	557.305	4.315×10^5	
80.0 TeV	8.000×10^7	2.628	444.823	633.668	37.330	1118.451	4.812×10^5	
100. TeV	1.000×10^8	2.652	556.808	792.739	47.463	1399.663	4.971×10^5	

TABLE II-14. Muons in Diethyl Ether ((CH₃CH₂)₂O)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.56663	0.714	60.0	0.10550	3.4586	0.2231	2.6745	3.3721	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.365				8.365	6.679×10^{-1}	
14.0 MeV	5.616×10^1	6.518				6.518	1.215×10^0	
20.0 MeV	6.802×10^1	5.085				5.086	2.270×10^0	
30.0 MeV	8.509×10^1	3.941				3.941	4.535×10^0	
40.0 MeV	1.003×10^2	3.363				3.363	7.299×10^0	
80.0 MeV	1.527×10^2	2.521				2.521	2.148×10^1	
100. MeV	1.764×10^2	2.370				2.370	2.968×10^1	
140. MeV	2.218×10^2	2.205				2.205	4.726×10^1	
200. MeV	2.868×10^2	2.110				2.110	7.518×10^1	
300. MeV	3.917×10^2	2.072			0.000	2.073	1.231×10^2	
324. MeV	4.161×10^2	2.072			0.000	2.072	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.077			0.000	2.078	1.714×10^2	
800. MeV	8.995×10^2	2.152	0.000		0.000	2.153	3.606×10^2	
1.00 GeV	1.101×10^3	2.187	0.000		0.000	2.188	4.527×10^2	
1.40 GeV	1.502×10^3	2.243	0.000		0.001	2.244	6.331×10^2	
2.00 GeV	2.103×10^3	2.306	0.000	0.000	0.001	2.307	8.966×10^2	
3.00 GeV	3.104×10^3	2.377	0.001	0.001	0.001	2.379	1.323×10^3	
4.00 GeV	4.104×10^3	2.426	0.001	0.001	0.002	2.430	1.739×10^3	
8.00 GeV	8.105×10^3	2.539	0.003	0.003	0.004	2.549	3.341×10^3	
10.0 GeV	1.011×10^4	2.573	0.004	0.004	0.005	2.586	4.120×10^3	
14.0 GeV	1.411×10^4	2.623	0.006	0.007	0.007	2.643	5.649×10^3	
20.0 GeV	2.011×10^4	2.674	0.009	0.011	0.009	2.703	7.892×10^3	
30.0 GeV	3.011×10^4	2.728	0.016	0.019	0.014	2.776	1.154×10^4	
40.0 GeV	4.011×10^4	2.765	0.022	0.028	0.018	2.833	1.510×10^4	
80.0 GeV	8.011×10^4	2.851	0.050	0.068	0.035	3.004	2.879×10^4	
100. GeV	1.001×10^5	2.877	0.065	0.089	0.043	3.075	3.537×10^4	
140. GeV	1.401×10^5	2.917	0.097	0.134	0.060	3.208	4.810×10^4	
200. GeV	2.001×10^5	2.959	0.146	0.206	0.085	3.395	6.628×10^4	
300. GeV	3.001×10^5	3.006	0.230	0.328	0.127	3.691	9.451×10^4	
400. GeV	4.001×10^5	3.039	0.318	0.455	0.169	3.982	1.206×10^5	
800. GeV	8.001×10^5	3.120	0.685	0.985	0.341	5.132	2.088×10^5	
1.00 TeV	1.000×10^6	3.146	0.875	1.260	0.429	5.710	2.458×10^5	
1.22 TeV	1.220×10^6	3.170	1.084	1.559	0.527	6.341	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.187	1.257	1.806	0.608	6.858	3.096×10^5	
2.00 TeV	2.000×10^6	3.230	1.845	2.644	0.881	8.600	3.876×10^5	
3.00 TeV	3.000×10^6	3.279	2.832	4.039	1.350	11.501	4.878×10^5	
4.00 TeV	4.000×10^6	3.315	3.837	5.455	1.827	14.434	5.653×10^5	
8.00 TeV	8.000×10^6	3.403	7.909	11.159	3.815	26.286	7.677×10^5	
10.0 TeV	1.000×10^7	3.432	9.970	14.033	4.839	32.275	8.362×10^5	
14.0 TeV	1.400×10^7	3.476	14.084	19.758	6.951	44.269	9.416×10^5	
20.0 TeV	2.000×10^7	3.523	20.311	28.396	10.196	62.426	1.055×10^6	
30.0 TeV	3.000×10^7	3.578	30.680	42.764	15.832	92.855	1.186×10^6	
40.0 TeV	4.000×10^7	3.618	41.110	57.179	21.619	123.526	1.279×10^6	
80.0 TeV	8.000×10^7	3.716	82.932	114.893	45.921	247.462	1.503×10^6	
100. TeV	1.000×10^8	3.748	103.900	143.785	58.525	309.958	1.575×10^6	

TABLE II-15. Muons in Ethane (C₂H₆)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.59861	1.253×10^{-3}	45.4	0.09627	3.6095	1.5107	3.8743	9.1043	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	9.147				9.147	6.093×10^{-1}	
14.0 MeV	5.616×10^1	7.119				7.119	1.110×10^0	
20.0 MeV	6.802×10^1	5.547				5.547	2.076×10^0	
30.0 MeV	8.509×10^1	4.294				4.294	4.154×10^0	
40.0 MeV	1.003×10^2	3.661				3.661	6.693×10^0	
80.0 MeV	1.527×10^2	2.739				2.739	1.973×10^1	
100. MeV	1.764×10^2	2.573				2.573	2.728×10^1	
140. MeV	2.218×10^2	2.409				2.409	4.343×10^1	
200. MeV	2.868×10^2	2.323				2.323	6.888×10^1	
267. MeV	3.577×10^2	2.304			0.000	2.304	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	2.307			0.000	2.307	1.122×10^2	
400. MeV	4.945×10^2	2.333			0.000	2.333	1.553×10^2	
800. MeV	8.995×10^2	2.478	0.000		0.000	2.479	3.216×10^2	
1.00 GeV	1.101×10^3	2.540	0.000		0.000	2.541	4.012×10^2	
1.40 GeV	1.502×10^3	2.642	0.000		0.001	2.643	5.555×10^2	
2.00 GeV	2.103×10^3	2.757	0.000	0.000	0.001	2.759	7.774×10^2	
3.00 GeV	3.104×10^3	2.892	0.001	0.000	0.001	2.895	1.131×10^3	
4.00 GeV	4.104×10^3	2.979	0.001	0.001	0.002	2.983	1.470×10^3	
8.00 GeV	8.105×10^3	3.159	0.003	0.003	0.004	3.168	2.766×10^3	
10.0 GeV	1.011×10^4	3.211	0.004	0.004	0.005	3.223	3.392×10^3	
14.0 GeV	1.411×10^4	3.284	0.005	0.006	0.007	3.302	4.617×10^3	
20.0 GeV	2.011×10^4	3.355	0.009	0.010	0.009	3.383	6.411×10^3	
30.0 GeV	3.011×10^4	3.429	0.014	0.017	0.014	3.474	9.325×10^3	
40.0 GeV	4.011×10^4	3.477	0.020	0.025	0.018	3.541	1.217×10^4	
80.0 GeV	8.011×10^4	3.581	0.046	0.062	0.035	3.724	2.317×10^4	
100. GeV	1.001×10^5	3.612	0.060	0.081	0.043	3.797	2.849×10^4	
140. GeV	1.401×10^5	3.657	0.088	0.123	0.060	3.928	3.884×10^4	
200. GeV	2.001×10^5	3.702	0.133	0.188	0.085	4.109	5.377×10^4	
300. GeV	3.001×10^5	3.753	0.211	0.300	0.128	4.392	7.730×10^4	
400. GeV	4.001×10^5	3.788	0.292	0.416	0.171	4.667	9.939×10^4	
800. GeV	8.001×10^5	3.874	0.629	0.903	0.345	5.751	1.764×10^5	
1.00 TeV	1.000×10^6	3.902	0.804	1.155	0.433	6.294	2.097×10^5	
1.40 TeV	1.400×10^6	3.945	1.156	1.658	0.614	7.372	2.683×10^5	
1.60 TeV	1.603×10^6	3.962	1.338	1.917	0.707	7.924	<i>Muon critical energy</i>	
2.00 TeV	2.000×10^6	3.990	1.698	2.429	0.889	9.007	3.419×10^5	
3.00 TeV	3.000×10^6	4.042	2.609	3.713	1.363	11.728	4.389×10^5	
4.00 TeV	4.000×10^6	4.080	3.537	5.017	1.845	14.480	5.155×10^5	
8.00 TeV	8.000×10^6	4.173	7.302	10.272	3.855	25.602	7.206×10^5	
10.0 TeV	1.000×10^7	4.204	9.209	12.920	4.890	31.223	7.912×10^5	
14.0 TeV	1.400×10^7	4.250	13.016	18.195	7.026	42.487	9.006×10^5	
20.0 TeV	2.000×10^7	4.300	18.781	26.153	10.309	59.545	1.019×10^6	
30.0 TeV	3.000×10^7	4.358	28.385	39.391	16.013	88.148	1.157×10^6	
40.0 TeV	4.000×10^7	4.400	38.048	52.673	21.871	116.992	1.255×10^6	
80.0 TeV	8.000×10^7	4.504	76.798	105.850	46.487	233.639	1.492×10^6	
100. TeV	1.000×10^8	4.537	96.230	132.472	59.258	292.499	1.568×10^6	

TABLE II-16. Muons in Ethanol (C₂H₅OH)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.56437	0.789	62.9	0.09878	3.4834	0.2218	2.7052	3.3699	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.282				8.282	6.749×10^{-1}	
14.0 MeV	5.616×10^1	6.455				6.455	1.228×10^0	
20.0 MeV	6.802×10^1	5.037				5.037	2.292×10^0	
30.0 MeV	8.509×10^1	3.905				3.905	4.579×10^0	
40.0 MeV	1.003×10^2	3.332				3.332	7.369×10^0	
80.0 MeV	1.527×10^2	2.499				2.499	2.167×10^1	
100. MeV	1.764×10^2	2.349				2.349	2.995×10^1	
140. MeV	2.218×10^2	2.186				2.186	4.769×10^1	
200. MeV	2.868×10^2	2.092				2.092	7.585×10^1	
300. MeV	3.917×10^2	2.055			0.000	2.055	1.242×10^2	
325. MeV	4.171×10^2	2.054			0.000	2.054	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.060			0.000	2.060	1.729×10^2	
800. MeV	8.995×10^2	2.135	0.000		0.000	2.135	3.637×10^2	
1.00 GeV	1.101×10^3	2.169	0.000		0.000	2.170	4.566×10^2	
1.40 GeV	1.502×10^3	2.225	0.000		0.001	2.226	6.384×10^2	
2.00 GeV	2.103×10^3	2.287	0.001	0.000	0.001	2.289	9.040×10^2	
3.00 GeV	3.104×10^3	2.358	0.001	0.001	0.001	2.361	1.334×10^3	
4.00 GeV	4.104×10^3	2.407	0.001	0.001	0.002	2.412	1.752×10^3	
8.00 GeV	8.105×10^3	2.520	0.003	0.003	0.004	2.530	3.367×10^3	
10.0 GeV	1.011×10^4	2.554	0.004	0.004	0.005	2.568	4.151×10^3	
14.0 GeV	1.411×10^4	2.604	0.006	0.007	0.007	2.624	5.691×10^3	
20.0 GeV	2.011×10^4	2.654	0.010	0.011	0.009	2.685	7.950×10^3	
30.0 GeV	3.011×10^4	2.709	0.016	0.020	0.014	2.758	1.162×10^4	
40.0 GeV	4.011×10^4	2.746	0.023	0.029	0.018	2.816	1.521×10^4	
80.0 GeV	8.011×10^4	2.831	0.052	0.070	0.035	2.988	2.897×10^4	
100. GeV	1.001×10^5	2.857	0.068	0.093	0.043	3.061	3.559×10^4	
140. GeV	1.401×10^5	2.897	0.100	0.140	0.060	3.197	4.837×10^4	
200. GeV	2.001×10^5	2.938	0.151	0.214	0.084	3.388	6.659×10^4	
300. GeV	3.001×10^5	2.985	0.239	0.340	0.126	3.691	9.485×10^4	
400. GeV	4.001×10^5	3.018	0.330	0.472	0.168	3.990	1.209×10^5	
800. GeV	8.001×10^5	3.099	0.710	1.022	0.340	5.172	2.087×10^5	
1.00 TeV	1.000×10^6	3.126	0.907	1.306	0.428	5.766	2.453×10^5	
1.18 TeV	1.178×10^6	3.145	1.082	1.556	0.507	6.290	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.165	1.303	1.872	0.607	6.947	3.084×10^5	
2.00 TeV	2.000×10^6	3.208	1.912	2.740	0.878	8.739	3.853×10^5	
3.00 TeV	3.000×10^6	3.258	2.934	4.185	1.346	11.723	4.838×10^5	
4.00 TeV	4.000×10^6	3.293	3.974	5.651	1.822	14.741	5.597×10^5	
8.00 TeV	8.000×10^6	3.381	8.188	11.557	3.805	26.932	7.575×10^5	
10.0 TeV	1.000×10^7	3.410	10.321	14.533	4.826	33.090	8.244×10^5	
14.0 TeV	1.400×10^7	3.454	14.578	20.460	6.932	45.424	9.272×10^5	
20.0 TeV	2.000×10^7	3.501	21.021	29.402	10.168	64.092	1.038×10^6	
30.0 TeV	3.000×10^7	3.556	31.750	44.278	15.787	95.371	1.165×10^6	
40.0 TeV	4.000×10^7	3.595	42.540	59.203	21.556	126.894	1.256×10^6	
80.0 TeV	8.000×10^7	3.693	85.811	118.955	45.780	254.239	1.474×10^6	
100. TeV	1.000×10^8	3.725	107.507	148.867	58.342	318.441	1.544×10^6	

TABLE II-17. Muons in Lithium Fluoride (LiF)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.46262	2.635	94.0	0.07593	3.7478	0.0171	2.7049	3.1667	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.444				6.444	8.710×10^{-1}	
14.0 MeV	5.616×10^1	5.032				5.032	1.581×10^0	
20.0 MeV	6.802×10^1	3.934				3.934	2.945×10^0	
30.0 MeV	8.509×10^1	3.056				3.056	5.869×10^0	
40.0 MeV	1.003×10^2	2.611				2.611	9.432×10^0	
80.0 MeV	1.527×10^2	1.955				1.955	2.769×10^1	
100. MeV	1.764×10^2	1.834				1.834	3.828×10^1	
140. MeV	2.218×10^2	1.710				1.710	6.098×10^1	
200. MeV	2.868×10^2	1.640				1.640	9.694×10^1	
300. MeV	3.917×10^2	1.614			0.000	1.614	1.586×10^2	
314. MeV	4.065×10^2	1.614			0.000	1.614	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.620			0.000	1.620	2.205×10^2	
800. MeV	8.995×10^2	1.683	0.000		0.000	1.683	4.627×10^2	
1.00 GeV	1.101×10^3	1.711	0.000		0.000	1.712	5.805×10^2	
1.40 GeV	1.502×10^3	1.757	0.000		0.001	1.758	8.109×10^2	
2.00 GeV	2.103×10^3	1.807	0.001	0.000	0.001	1.809	1.147×10^3	
3.00 GeV	3.104×10^3	1.864	0.001	0.001	0.001	1.867	1.691×10^3	
4.00 GeV	4.104×10^3	1.904	0.001	0.001	0.002	1.908	2.220×10^3	
8.00 GeV	8.105×10^3	1.995	0.003	0.003	0.004	2.006	4.258×10^3	
10.0 GeV	1.011×10^4	2.023	0.004	0.005	0.005	2.037	5.248×10^3	
14.0 GeV	1.411×10^4	2.063	0.007	0.007	0.007	2.084	7.188×10^3	
20.0 GeV	2.011×10^4	2.104	0.011	0.012	0.009	2.137	1.003×10^4	
30.0 GeV	3.011×10^4	2.149	0.017	0.021	0.013	2.201	1.464×10^4	
40.0 GeV	4.011×10^4	2.179	0.025	0.031	0.017	2.253	1.913×10^4	
80.0 GeV	8.011×10^4	2.249	0.056	0.076	0.034	2.415	3.625×10^4	
100. GeV	1.001×10^5	2.271	0.073	0.100	0.042	2.486	4.441×10^4	
140. GeV	1.401×10^5	2.303	0.107	0.150	0.058	2.619	6.008×10^4	
200. GeV	2.001×10^5	2.337	0.161	0.229	0.083	2.811	8.219×10^4	
300. GeV	3.001×10^5	2.376	0.254	0.364	0.124	3.118	1.159×10^5	
400. GeV	4.001×10^5	2.403	0.351	0.504	0.165	3.424	1.465×10^5	
800. GeV	8.001×10^5	2.469	0.753	1.088	0.334	4.644	2.465×10^5	
903. GeV	9.035×10^5	2.481	0.859	1.243	0.378	4.962	<i>Muon critical energy</i>	
1.00 TeV	1.000×10^6	2.491	0.960	1.390	0.419	5.260	2.869×10^5	
1.40 TeV	1.400×10^6	2.523	1.378	1.989	0.595	6.485	3.553×10^5	
2.00 TeV	2.000×10^6	2.558	2.019	2.908	0.862	8.347	4.367×10^5	
3.00 TeV	3.000×10^6	2.599	3.093	4.437	1.320	11.450	5.386×10^5	
4.00 TeV	4.000×10^6	2.628	4.186	5.988	1.786	14.589	6.158×10^5	
8.00 TeV	8.000×10^6	2.700	8.607	12.233	3.728	27.268	8.132×10^5	
10.0 TeV	1.000×10^7	2.724	10.841	15.377	4.728	33.670	8.791×10^5	
14.0 TeV	1.400×10^7	2.760	15.300	21.644	6.787	46.490	9.797×10^5	
20.0 TeV	2.000×10^7	2.798	22.041	31.095	9.950	65.885	1.088×10^6	
30.0 TeV	3.000×10^7	2.843	33.266	46.821	15.440	98.370	1.211×10^6	
40.0 TeV	4.000×10^7	2.876	44.547	62.596	21.073	131.092	1.299×10^6	
80.0 TeV	8.000×10^7	2.955	89.782	125.754	44.706	263.198	1.510×10^6	
100. TeV	1.000×10^8	2.982	112.459	157.370	56.954	329.765	1.578×10^6	

TABLE II-18. Muons in Lithium Iodide (LiI)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$ 0.41939	ρ [g/cm ³] 3.494	I [eV] 485.1	a 0.23274	$k = m_s$ 2.7146	x_0 0.0892	x_1 3.3702	\bar{C} 6.2671	δ_0 0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.554				4.554	1.265×10^0	
14.0 MeV	5.616×10^1	3.597				3.597	2.262×10^0	
20.0 MeV	6.802×10^1	2.842				2.842	4.159×10^0	
30.0 MeV	8.509×10^1	2.231				2.231	8.182×10^0	
40.0 MeV	1.003×10^2	1.920				1.920	1.304×10^1	
80.0 MeV	1.527×10^2	1.468				1.469	3.759×10^1	
100. MeV	1.764×10^2	1.389				1.389	5.163×10^1	
140. MeV	2.218×10^2	1.312				1.313	8.138×10^1	
200. MeV	2.868×10^2	1.276				1.277	1.279×10^2	
243. MeV	3.325×10^2	1.272				1.273	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.277	0.000		0.000	1.278	2.064×10^2	
400. MeV	4.945×10^2	1.297	0.000		0.000	1.298	2.841×10^2	
800. MeV	8.995×10^2	1.385	0.001		0.000	1.386	5.819×10^2	
1.00 GeV	1.101×10^3	1.420	0.001		0.000	1.422	7.243×10^2	
1.40 GeV	1.502×10^3	1.476	0.002	0.001	0.001	1.479	9.999×10^2	
2.00 GeV	2.103×10^3	1.536	0.003	0.002	0.001	1.541	1.397×10^3	
3.00 GeV	3.104×10^3	1.603	0.005	0.004	0.001	1.613	2.030×10^3	
4.00 GeV	4.104×10^3	1.650	0.007	0.006	0.002	1.665	2.640×10^3	
8.00 GeV	8.105×10^3	1.755	0.017	0.018	0.003	1.795	4.945×10^3	
10.0 GeV	1.011×10^4	1.787	0.023	0.026	0.004	1.840	6.045×10^3	
14.0 GeV	1.411×10^4	1.832	0.034	0.041	0.006	1.914	8.175×10^3	
20.0 GeV	2.011×10^4	1.877	0.053	0.066	0.008	2.005	1.124×10^4	
30.0 GeV	3.011×10^4	1.925	0.087	0.114	0.011	2.138	1.606×10^4	
40.0 GeV	4.011×10^4	1.956	0.123	0.166	0.015	2.261	2.061×10^4	
80.0 GeV	8.011×10^4	2.025	0.279	0.395	0.029	2.729	3.668×10^4	
100. GeV	1.001×10^5	2.046	0.361	0.517	0.036	2.962	4.371×10^4	
140. GeV	1.401×10^5	2.076	0.530	0.770	0.051	3.428	5.626×10^4	
200. GeV	2.001×10^5	2.107	0.795	1.169	0.072	4.144	7.216×10^4	
207. GeV	2.067×10^5	2.110	0.824	1.211	0.074	4.221	<i>Muon critical energy</i>	
300. GeV	3.001×10^5	2.142	1.247	1.835	0.108	5.333	9.339×10^4	
400. GeV	4.001×10^5	2.167	1.714	2.525	0.144	6.551	1.103×10^5	
800. GeV	8.001×10^5	2.227	3.644	5.352	0.291	11.514	1.558×10^5	
1.00 TeV	1.000×10^6	2.246	4.635	6.796	0.366	14.045	1.715×10^5	
1.40 TeV	1.400×10^6	2.276	6.623	9.679	0.518	19.097	1.958×10^5	
2.00 TeV	2.000×10^6	2.308	9.663	14.075	0.749	26.796	2.222×10^5	
3.00 TeV	3.000×10^6	2.344	14.739	21.382	1.145	39.612	2.527×10^5	
4.00 TeV	4.000×10^6	2.371	19.882	28.764	1.548	52.567	2.746×10^5	
8.00 TeV	8.000×10^6	2.436	40.622	58.433	3.217	104.710	3.274×10^5	
10.0 TeV	1.000×10^7	2.457	51.074	73.345	4.074	130.952	3.445×10^5	
14.0 TeV	1.400×10^7	2.490	71.920	103.100	5.835	183.347	3.702×10^5	
20.0 TeV	2.000×10^7	2.525	103.376	147.918	8.533	262.353	3.974×10^5	
30.0 TeV	3.000×10^7	2.566	155.742	222.490	13.196	393.995	4.283×10^5	
40.0 TeV	4.000×10^7	2.595	208.297	297.233	17.970	526.097	4.502×10^5	
80.0 TeV	8.000×10^7	2.667	418.837	596.404	37.904	1055.813	5.028×10^5	
100. TeV	1.000×10^8	2.691	524.285	746.120	48.201	1321.298	5.197×10^5	

TABLE II-19. Muons in Methane (CH₄)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.62334	6.672×10^{-4}	41.7	0.09253	3.6257	1.6263	3.9716	9.5243	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	9.623				9.623	5.787×10^{-1}	
14.0 MeV	5.616×10^1	7.487				7.487	1.055×10^0	
20.0 MeV	6.802×10^1	5.832				5.832	1.974×10^0	
30.0 MeV	8.509×10^1	4.513				4.513	3.950×10^0	
40.0 MeV	1.003×10^2	3.847				3.847	6.367×10^0	
80.0 MeV	1.527×10^2	2.876				2.876	1.878×10^1	
100. MeV	1.764×10^2	2.702				2.702	2.597×10^1	
140. MeV	2.218×10^2	2.528				2.529	4.135×10^1	
200. MeV	2.868×10^2	2.438				2.438	6.561×10^1	
270. MeV	3.608×10^2	2.417			0.000	2.417	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	2.420			0.000	2.420	1.069×10^2	
400. MeV	4.945×10^2	2.446			0.000	2.447	1.480×10^2	
800. MeV	8.995×10^2	2.597	0.000		0.000	2.597	3.066×10^2	
1.00 GeV	1.101×10^3	2.661	0.000		0.000	2.662	3.827×10^2	
1.40 GeV	1.502×10^3	2.767	0.000		0.001	2.768	5.299×10^2	
2.00 GeV	2.103×10^3	2.887	0.000	0.000	0.001	2.889	7.418×10^2	
3.00 GeV	3.104×10^3	3.028	0.001	0.000	0.002	3.031	1.079×10^3	
4.00 GeV	4.104×10^3	3.130	0.001	0.001	0.002	3.134	1.403×10^3	
8.00 GeV	8.105×10^3	3.328	0.003	0.002	0.004	3.338	2.634×10^3	
10.0 GeV	1.011×10^4	3.385	0.003	0.003	0.005	3.397	3.228×10^3	
14.0 GeV	1.411×10^4	3.464	0.005	0.006	0.007	3.482	4.390×10^3	
20.0 GeV	2.011×10^4	3.540	0.008	0.010	0.010	3.568	6.091×10^3	
30.0 GeV	3.011×10^4	3.619	0.014	0.017	0.014	3.664	8.854×10^3	
40.0 GeV	4.011×10^4	3.671	0.020	0.025	0.018	3.734	1.156×10^4	
80.0 GeV	8.011×10^4	3.782	0.045	0.060	0.035	3.923	2.199×10^4	
100. GeV	1.001×10^5	3.815	0.058	0.080	0.044	3.997	2.704×10^4	
140. GeV	1.401×10^5	3.862	0.086	0.120	0.061	4.129	3.688×10^4	
200. GeV	2.001×10^5	3.911	0.130	0.184	0.086	4.311	5.110×10^4	
300. GeV	3.001×10^5	3.964	0.206	0.293	0.129	4.592	7.356×10^4	
400. GeV	4.001×10^5	4.001	0.285	0.407	0.172	4.865	9.472×10^4	
800. GeV	8.001×10^5	4.091	0.616	0.883	0.346	5.937	1.690×10^5	
1.00 TeV	1.000×10^6	4.120	0.787	1.131	0.435	6.473	2.013×10^5	
1.40 TeV	1.400×10^6	4.164	1.133	1.623	0.617	7.537	2.585×10^5	
1.72 TeV	1.715×10^6	4.191	1.411	2.018	0.762	8.382	<i>Muon critical energy</i>	
2.00 TeV	2.000×10^6	4.211	1.665	2.378	0.894	9.149	3.306×10^5	
3.00 TeV	3.000×10^6	4.266	2.560	3.637	1.370	11.834	4.265×10^5	
4.00 TeV	4.000×10^6	4.305	3.472	4.916	1.855	14.547	5.026×10^5	
8.00 TeV	8.000×10^6	4.402	7.172	10.067	3.875	25.517	7.076×10^5	
10.0 TeV	1.000×10^7	4.434	9.048	12.664	4.916	31.062	7.785×10^5	
14.0 TeV	1.400×10^7	4.482	12.792	17.835	7.065	42.174	8.886×10^5	
20.0 TeV	2.000×10^7	4.535	18.464	25.638	10.368	59.005	1.008×10^6	
30.0 TeV	3.000×10^7	4.595	27.914	38.616	16.107	87.232	1.147×10^6	
40.0 TeV	4.000×10^7	4.639	37.423	51.638	22.001	115.702	1.246×10^6	
80.0 TeV	8.000×10^7	4.746	75.570	103.776	46.779	230.871	1.486×10^6	
100. TeV	1.000×10^8	4.781	94.703	129.877	59.637	288.999	1.564×10^6	

TABLE II-20. Muons in Octane (C₈H₁₈)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.57778	0.703	54.7	0.11387	3.4776	0.1882	2.5664	3.1834	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.629				8.629	6.469×10^{-1}	
14.0 MeV	5.616×10^1	6.721				6.721	1.178×10^0	
20.0 MeV	6.802×10^1	5.242				5.242	2.200×10^0	
30.0 MeV	8.509×10^1	4.060				4.060	4.399×10^0	
40.0 MeV	1.003×10^2	3.464				3.464	7.083×10^0	
80.0 MeV	1.527×10^2	2.595				2.595	2.085×10^1	
100. MeV	1.764×10^2	2.433				2.433	2.883×10^1	
140. MeV	2.218×10^2	2.263				2.264	4.596×10^1	
200. MeV	2.868×10^2	2.165				2.165	7.317×10^1	
300. MeV	3.917×10^2	2.124			0.000	2.125	1.199×10^2	
328. MeV	4.211×10^2	2.123			0.000	2.124	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.129			0.000	2.129	1.670×10^2	
800. MeV	8.995×10^2	2.203	0.000		0.000	2.203	3.518×10^2	
1.00 GeV	1.101×10^3	2.237	0.000		0.000	2.238	4.419×10^2	
1.40 GeV	1.502×10^3	2.293	0.000		0.001	2.295	6.183×10^2	
2.00 GeV	2.103×10^3	2.356	0.000	0.000	0.001	2.357	8.761×10^2	
3.00 GeV	3.104×10^3	2.427	0.001	0.000	0.001	2.430	1.293×10^3	
4.00 GeV	4.104×10^3	2.476	0.001	0.001	0.002	2.480	1.701×10^3	
8.00 GeV	8.105×10^3	2.590	0.003	0.003	0.004	2.599	3.271×10^3	
10.0 GeV	1.011×10^4	2.625	0.004	0.004	0.005	2.637	4.035×10^3	
14.0 GeV	1.411×10^4	2.675	0.006	0.006	0.007	2.693	5.535×10^3	
20.0 GeV	2.011×10^4	2.726	0.009	0.010	0.009	2.754	7.736×10^3	
30.0 GeV	3.011×10^4	2.781	0.014	0.018	0.014	2.827	1.132×10^4	
40.0 GeV	4.011×10^4	2.819	0.020	0.026	0.018	2.884	1.482×10^4	
80.0 GeV	8.011×10^4	2.906	0.047	0.063	0.035	3.051	2.828×10^4	
100. GeV	1.001×10^5	2.934	0.061	0.083	0.043	3.121	3.476×10^4	
140. GeV	1.401×10^5	2.974	0.090	0.125	0.060	3.249	4.732×10^4	
200. GeV	2.001×10^5	3.016	0.136	0.192	0.085	3.429	6.528×10^4	
300. GeV	3.001×10^5	3.064	0.215	0.305	0.127	3.712	9.330×10^4	
400. GeV	4.001×10^5	3.098	0.297	0.424	0.170	3.990	1.193×10^5	
800. GeV	8.001×10^5	3.181	0.640	0.919	0.343	5.084	2.079×10^5	
1.00 TeV	1.000×10^6	3.208	0.817	1.176	0.431	5.633	2.452×10^5	
1.31 TeV	1.312×10^6	3.241	1.096	1.574	0.572	6.482	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.249	1.175	1.687	0.611	6.723	3.101×10^5	
2.00 TeV	2.000×10^6	3.293	1.726	2.471	0.886	8.376	3.900×10^5	
3.00 TeV	3.000×10^6	3.344	2.650	3.777	1.357	11.129	4.932×10^5	
4.00 TeV	4.000×10^6	3.380	3.592	5.103	1.837	13.913	5.734×10^5	
8.00 TeV	8.000×10^6	3.470	7.411	10.445	3.837	25.163	7.842×10^5	
10.0 TeV	1.000×10^7	3.499	9.345	13.136	4.868	30.848	8.559×10^5	
14.0 TeV	1.400×10^7	3.544	13.205	18.498	6.993	42.240	9.663×10^5	
20.0 TeV	2.000×10^7	3.592	19.049	26.588	10.260	59.489	1.085×10^6	
30.0 TeV	3.000×10^7	3.648	28.782	40.043	15.935	88.409	1.222×10^6	
40.0 TeV	4.000×10^7	3.689	38.574	53.544	21.761	117.569	1.320×10^6	
80.0 TeV	8.000×10^7	3.789	77.834	107.598	46.240	235.461	1.556×10^6	
100. TeV	1.000×10^8	3.821	97.517	134.659	58.939	294.937	1.632×10^6	

TABLE II-21. Muons in Paraffin $(\text{CH}_3(\text{CH}_2)_{n \approx 23}\text{CH}_3)$

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.57275	0.930	55.9	0.12087	3.4288	0.1289	2.5084	2.9551	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.531				8.531	6.545×10^{-1}	
14.0 MeV	5.616×10^1	6.645				6.645	1.191×10^0	
20.0 MeV	6.802×10^1	5.183				5.183	2.226×10^0	
30.0 MeV	8.509×10^1	4.015				4.015	4.449×10^0	
40.0 MeV	1.003×10^2	3.426				3.426	7.163×10^0	
80.0 MeV	1.527×10^2	2.561				2.561	2.109×10^1	
100. MeV	1.764×10^2	2.397				2.397	2.918×10^1	
140. MeV	2.218×10^2	2.228				2.228	4.657×10^1	
200. MeV	2.868×10^2	2.130				2.130	7.422×10^1	
300. MeV	3.917×10^2	2.089			0.000	2.089	1.218×10^2	
328. MeV	4.211×10^2	2.088			0.000	2.088	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.092			0.000	2.093	1.696×10^2	
800. MeV	8.995×10^2	2.164	0.000		0.000	2.164	3.577×10^2	
1.00 GeV	1.101×10^3	2.198	0.000		0.000	2.198	4.494×10^2	
1.40 GeV	1.502×10^3	2.253	0.000		0.001	2.254	6.290×10^2	
2.00 GeV	2.103×10^3	2.314	0.000	0.000	0.001	2.315	8.914×10^2	
3.00 GeV	3.104×10^3	2.384	0.001	0.000	0.001	2.386	1.316×10^3	
4.00 GeV	4.104×10^3	2.432	0.001	0.001	0.002	2.436	1.731×10^3	
8.00 GeV	8.105×10^3	2.544	0.003	0.003	0.004	2.554	3.330×10^3	
10.0 GeV	1.011×10^4	2.578	0.004	0.004	0.005	2.591	4.107×10^3	
14.0 GeV	1.411×10^4	2.628	0.006	0.006	0.007	2.647	5.634×10^3	
20.0 GeV	2.011×10^4	2.678	0.009	0.010	0.009	2.707	7.874×10^3	
30.0 GeV	3.011×10^4	2.733	0.015	0.018	0.014	2.779	1.152×10^4	
40.0 GeV	4.011×10^4	2.771	0.021	0.026	0.018	2.836	1.508×10^4	
80.0 GeV	8.011×10^4	2.857	0.047	0.063	0.035	3.003	2.876×10^4	
100. GeV	1.001×10^5	2.884	0.061	0.084	0.043	3.072	3.535×10^4	
140. GeV	1.401×10^5	2.924	0.090	0.126	0.060	3.201	4.810×10^4	
200. GeV	2.001×10^5	2.966	0.136	0.193	0.085	3.381	6.633×10^4	
300. GeV	3.001×10^5	3.014	0.216	0.307	0.127	3.664	9.473×10^4	
400. GeV	4.001×10^5	3.048	0.298	0.426	0.170	3.942	1.210×10^5	
800. GeV	8.001×10^5	3.130	0.642	0.923	0.343	5.038	2.106×10^5	
1.00 TeV	1.000×10^6	3.156	0.821	1.181	0.431	5.589	2.482×10^5	
1.29 TeV	1.288×10^6	3.187	1.078	1.549	0.560	6.374	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.197	1.180	1.694	0.611	6.682	3.136×10^5	
2.00 TeV	2.000×10^6	3.240	1.733	2.481	0.885	8.339	3.938×10^5	
3.00 TeV	3.000×10^6	3.291	2.661	3.793	1.356	11.100	4.975×10^5	
4.00 TeV	4.000×10^6	3.327	3.605	5.124	1.835	13.891	5.778×10^5	
8.00 TeV	8.000×10^6	3.416	7.437	10.486	3.833	25.173	7.887×10^5	
10.0 TeV	1.000×10^7	3.445	9.378	13.188	4.863	30.874	8.603×10^5	
14.0 TeV	1.400×10^7	3.489	13.250	18.571	6.986	42.296	9.706×10^5	
20.0 TeV	2.000×10^7	3.537	19.113	26.692	10.248	59.592	1.090×10^6	
30.0 TeV	3.000×10^7	3.593	28.878	40.201	15.916	88.588	1.226×10^6	
40.0 TeV	4.000×10^7	3.633	38.701	53.755	21.735	117.824	1.324×10^6	
80.0 TeV	8.000×10^7	3.732	78.084	108.020	46.181	236.017	1.559×10^6	
100. TeV	1.000×10^8	3.764	97.828	135.187	58.862	295.641	1.635×10^6	

TABLE II-22. Muons in Plutonium Dioxide (PuO₂)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.40583	11.460	746.5	0.20594	2.6522	-0.2311	3.5554	5.9719	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.064				4.064	1.435×10^0	
14.0 MeV	5.616×10^1	3.227				3.227	2.550×10^0	
20.0 MeV	6.802×10^1	2.564				2.564	4.658×10^0	
30.0 MeV	8.509×10^1	2.024				2.024	9.103×10^0	
40.0 MeV	1.003×10^2	1.746				1.746	1.445×10^1	
80.0 MeV	1.527×10^2	1.337				1.337	4.142×10^1	
100. MeV	1.764×10^2	1.264				1.264	5.684×10^1	
140. MeV	2.218×10^2	1.194				1.194	8.954×10^1	
200. MeV	2.868×10^2	1.161				1.162	1.407×10^2	
237. MeV	3.260×10^2	1.158	0.000			1.158	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.163	0.000		0.000	1.163	2.269×10^2	
400. MeV	4.945×10^2	1.182	0.000		0.000	1.182	3.122×10^2	
800. MeV	8.995×10^2	1.265	0.001		0.000	1.266	6.386×10^2	
1.00 GeV	1.101×10^3	1.298	0.001	0.000	0.000	1.300	7.945×10^2	
1.40 GeV	1.502×10^3	1.350	0.002	0.001	0.001	1.354	1.096×10^3	
2.00 GeV	2.103×10^3	1.407	0.004	0.002	0.001	1.415	1.529×10^3	
3.00 GeV	3.104×10^3	1.472	0.007	0.006	0.001	1.486	2.217×10^3	
4.00 GeV	4.104×10^3	1.517	0.010	0.010	0.002	1.538	2.878×10^3	
8.00 GeV	8.105×10^3	1.619	0.025	0.029	0.003	1.676	5.359×10^3	
10.0 GeV	1.011×10^4	1.650	0.033	0.039	0.004	1.727	6.534×10^3	
14.0 GeV	1.411×10^4	1.694	0.051	0.063	0.005	1.814	8.792×10^3	
20.0 GeV	2.011×10^4	1.738	0.079	0.101	0.007	1.926	1.200×10^4	
30.0 GeV	3.011×10^4	1.785	0.129	0.173	0.011	2.100	1.697×10^4	
40.0 GeV	4.011×10^4	1.816	0.183	0.252	0.014	2.266	2.155×10^4	
80.0 GeV	8.011×10^4	1.885	0.413	0.595	0.028	2.923	3.705×10^4	
100. GeV	1.001×10^5	1.906	0.535	0.779	0.035	3.257	4.353×10^4	
136. GeV	1.366×10^5	1.933	0.764	1.123	0.047	3.868	<i>Muon critical energy</i>	
140. GeV	1.401×10^5	1.936	0.786	1.157	0.049	3.928	5.470×10^4	
200. GeV	2.001×10^5	1.966	1.178	1.752	0.069	4.967	6.826×10^4	
300. GeV	3.001×10^5	2.000	1.846	2.745	0.104	6.697	8.555×10^4	
400. GeV	4.001×10^5	2.024	2.537	3.771	0.138	8.472	9.880×10^4	
800. GeV	8.001×10^5	2.082	5.386	7.968	0.279	15.717	1.329×10^5	
1.00 TeV	1.000×10^6	2.101	6.848	10.110	0.351	19.412	1.444×10^5	
1.40 TeV	1.400×10^6	2.130	9.776	14.383	0.496	26.788	1.619×10^5	
2.00 TeV	2.000×10^6	2.161	14.253	20.893	0.718	38.027	1.806×10^5	
3.00 TeV	3.000×10^6	2.197	21.722	31.712	1.098	56.730	2.020×10^5	
4.00 TeV	4.000×10^6	2.222	29.286	42.635	1.483	75.628	2.172×10^5	
8.00 TeV	8.000×10^6	2.285	59.763	86.518	3.081	151.649	2.538×10^5	
10.0 TeV	1.000×10^7	2.306	75.113	108.564	3.901	189.885	2.656×10^5	
14.0 TeV	1.400×10^7	2.337	105.729	152.562	5.584	266.214	2.833×10^5	
20.0 TeV	2.000×10^7	2.371	151.906	218.813	8.163	381.255	3.020×10^5	
30.0 TeV	3.000×10^7	2.411	228.852	329.056	12.619	572.941	3.233×10^5	
40.0 TeV	4.000×10^7	2.439	306.077	439.533	17.180	765.231	3.383×10^5	
80.0 TeV	8.000×10^7	2.509	614.977	881.706	36.221	1535.415	3.745×10^5	
100. TeV	1.000×10^8	2.532	769.530	1102.971	46.054	1921.089	3.861×10^5	

TABLE II-23. Muons in Liquid Propane (C₃H₈)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.58962	0.493	52.0	0.10329	3.5620	0.2564	2.6271	3.4162	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.861				8.861	6.297×10^{-1}	
14.0 MeV	5.616×10^1	6.900				6.900	1.147×10^0	
20.0 MeV	6.802×10^1	5.380				5.380	2.143×10^0	
30.0 MeV	8.509×10^1	4.167				4.167	4.285×10^0	
40.0 MeV	1.003×10^2	3.554				3.554	6.900×10^0	
80.0 MeV	1.527×10^2	2.661				2.661	2.032×10^1	
100. MeV	1.764×10^2	2.501				2.501	2.810×10^1	
140. MeV	2.218×10^2	2.333				2.333	4.472×10^1	
200. MeV	2.868×10^2	2.232				2.232	7.112×10^1	
300. MeV	3.917×10^2	2.192			0.000	2.192	1.165×10^2	
325. MeV	4.171×10^2	2.191			0.000	2.191	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.197			0.000	2.197	1.621×10^2	
800. MeV	8.995×10^2	2.274	0.000		0.000	2.274	3.411×10^2	
1.00 GeV	1.101×10^3	2.310	0.000		0.000	2.310	4.283×10^2	
1.40 GeV	1.502×10^3	2.368	0.000		0.001	2.369	5.992×10^2	
2.00 GeV	2.103×10^3	2.432	0.000	0.000	0.001	2.434	8.489×10^2	
3.00 GeV	3.104×10^3	2.505	0.001	0.000	0.001	2.508	1.253×10^3	
4.00 GeV	4.104×10^3	2.556	0.001	0.001	0.002	2.560	1.648×10^3	
8.00 GeV	8.105×10^3	2.673	0.003	0.003	0.004	2.682	3.170×10^3	
10.0 GeV	1.011×10^4	2.708	0.004	0.004	0.005	2.721	3.910×10^3	
14.0 GeV	1.411×10^4	2.760	0.006	0.006	0.007	2.778	5.364×10^3	
20.0 GeV	2.011×10^4	2.812	0.009	0.010	0.009	2.840	7.498×10^3	
30.0 GeV	3.011×10^4	2.869	0.014	0.017	0.014	2.914	1.097×10^4	
40.0 GeV	4.011×10^4	2.907	0.020	0.026	0.018	2.971	1.437×10^4	
80.0 GeV	8.011×10^4	2.996	0.046	0.062	0.035	3.140	2.744×10^4	
100. GeV	1.001×10^5	3.024	0.060	0.082	0.043	3.210	3.374×10^4	
140. GeV	1.401×10^5	3.065	0.089	0.124	0.060	3.338	4.596×10^4	
200. GeV	2.001×10^5	3.108	0.134	0.190	0.085	3.518	6.346×10^4	
300. GeV	3.001×10^5	3.157	0.213	0.302	0.128	3.800	9.079×10^4	
400. GeV	4.001×10^5	3.192	0.294	0.420	0.170	4.076	1.162×10^5	
800. GeV	8.001×10^5	3.277	0.634	0.910	0.344	5.164	2.032×10^5	
1.00 TeV	1.000×10^6	3.304	0.810	1.164	0.432	5.710	2.400×10^5	
1.36 TeV	1.360×10^6	3.342	1.128	1.619	0.595	6.685	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.346	1.164	1.670	0.613	6.794	3.041×10^5	
2.00 TeV	2.000×10^6	3.391	1.710	2.447	0.888	8.436	3.832×10^5	
3.00 TeV	3.000×10^6	3.442	2.627	3.741	1.361	11.171	4.859×10^5	
4.00 TeV	4.000×10^6	3.479	3.561	5.054	1.842	13.937	5.659×10^5	
8.00 TeV	8.000×10^6	3.571	7.349	10.347	3.847	25.114	7.768×10^5	
10.0 TeV	1.000×10^7	3.601	9.267	13.013	4.881	30.763	8.486×10^5	
14.0 TeV	1.400×10^7	3.647	13.097	18.325	7.012	42.082	9.594×10^5	
20.0 TeV	2.000×10^7	3.696	18.897	26.341	10.288	59.222	1.079×10^6	
30.0 TeV	3.000×10^7	3.753	28.556	39.672	15.979	87.962	1.217×10^6	
40.0 TeV	4.000×10^7	3.795	38.275	53.049	21.824	116.943	1.315×10^6	
80.0 TeV	8.000×10^7	3.896	77.245	106.605	46.380	234.127	1.552×10^6	
100. TeV	1.000×10^8	3.930	96.786	133.416	59.121	293.253	1.628×10^6	

TABLE II-24. Muons in Silicon Dioxide (Fused Quartz, SiO₂)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$ 0.49930	ρ [g/cm ³] 2.200	I [eV] 139.2	a 0.08408	$k = m_s$ 3.5064	x_0 0.1500	x_1 3.0140	\bar{C} 4.0560	δ_0 0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.591					6.591	8.554×10^{-1}
14.0 MeV	5.616×10^1	5.158					5.158	1.549×10^0
20.0 MeV	6.802×10^1	4.041					4.041	2.878×10^0
30.0 MeV	8.509×10^1	3.145					3.145	5.722×10^0
40.0 MeV	1.003×10^2	2.691					2.691	9.181×10^0
80.0 MeV	1.527×10^2	2.030					2.030	2.683×10^1
100. MeV	1.764×10^2	1.908					1.908	3.702×10^1
140. MeV	2.218×10^2	1.786					1.786	5.879×10^1
200. MeV	2.868×10^2	1.719					1.719	9.316×10^1
288. MeV	3.788×10^2	1.699				0.000	1.699	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.699				0.000	1.699	1.518×10^2
400. MeV	4.945×10^2	1.711				0.000	1.711	2.105×10^2
800. MeV	8.995×10^2	1.789	0.000			0.000	1.790	4.391×10^2
1.00 GeV	1.101×10^3	1.823	0.000			0.000	1.824	5.497×10^2
1.40 GeV	1.502×10^3	1.877	0.001	0.000		0.001	1.879	7.657×10^2
2.00 GeV	2.103×10^3	1.936	0.001	0.000		0.001	1.939	1.080×10^3
3.00 GeV	3.104×10^3	2.003	0.001	0.001		0.001	2.007	1.586×10^3
4.00 GeV	4.104×10^3	2.049	0.002	0.002		0.002	2.055	2.078×10^3
8.00 GeV	8.105×10^3	2.154	0.005	0.005		0.004	2.168	3.967×10^3
10.0 GeV	1.011×10^4	2.186	0.007	0.007		0.005	2.204	4.881×10^3
14.0 GeV	1.411×10^4	2.232	0.010	0.011		0.006	2.260	6.673×10^3
20.0 GeV	2.011×10^4	2.277	0.016	0.018		0.009	2.321	9.291×10^3
30.0 GeV	3.011×10^4	2.326	0.026	0.032		0.013	2.398	1.353×10^4
40.0 GeV	4.011×10^4	2.360	0.037	0.047		0.017	2.461	1.764×10^4
80.0 GeV	8.011×10^4	2.435	0.083	0.113		0.033	2.665	3.324×10^4
100. GeV	1.001×10^5	2.459	0.108	0.149		0.041	2.757	4.061×10^4
140. GeV	1.401×10^5	2.494	0.159	0.222		0.057	2.933	5.467×10^4
200. GeV	2.001×10^5	2.530	0.239	0.339		0.081	3.190	7.428×10^4
300. GeV	3.001×10^5	2.572	0.376	0.538		0.122	3.609	1.037×10^5
400. GeV	4.001×10^5	2.601	0.519	0.746		0.162	4.028	1.300×10^5
708. GeV	7.076×10^5	2.660	0.970	1.401		0.289	5.320	<i>Muon critical energy</i>
800. GeV	8.001×10^5	2.673	1.109	1.602		0.328	5.711	2.129×10^5
1.00 TeV	1.000×10^6	2.696	1.413	2.042		0.412	6.563	2.456×10^5
1.40 TeV	1.400×10^6	2.731	2.026	2.920		0.584	8.261	2.998×10^5
2.00 TeV	2.000×10^6	2.769	2.965	4.263		0.845	10.842	3.630×10^5
3.00 TeV	3.000×10^6	2.813	4.537	6.497		1.294	15.142	4.407×10^5
4.00 TeV	4.000×10^6	2.845	6.135	8.759		1.750	19.490	4.988×10^5
8.00 TeV	8.000×10^6	2.922	12.593	17.867		3.650	37.033	6.452×10^5
10.0 TeV	1.000×10^7	2.947	15.855	22.451		4.628	45.882	6.936×10^5
14.0 TeV	1.400×10^7	2.986	22.366	31.589		6.641	63.582	7.674×10^5
20.0 TeV	2.000×10^7	3.028	32.207	45.364		9.731	90.331	8.462×10^5
30.0 TeV	3.000×10^7	3.077	48.579	68.292		15.089	135.037	9.361×10^5
40.0 TeV	4.000×10^7	3.112	65.025	91.289		20.584	180.010	1.000×10^6
80.0 TeV	8.000×10^7	3.198	130.975	183.346		43.614	361.133	1.154×10^6
100. TeV	1.000×10^8	3.226	164.033	229.424		55.540	452.224	1.203×10^6

TABLE II-25. Muons in Sodium Iodide (NaI)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.42697	3.667	452.0	0.12516	3.0398	0.1203	3.5920	6.0572	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.697				4.697	1.224×10^0	
14.0 MeV	5.616×10^1	3.707				3.707	2.192×10^0	
20.0 MeV	6.802×10^1	2.927				2.927	4.033×10^0	
30.0 MeV	8.509×10^1	2.296				2.296	7.942×10^0	
40.0 MeV	1.003×10^2	1.975				1.975	1.267×10^1	
80.0 MeV	1.527×10^2	1.508				1.508	3.655×10^1	
100. MeV	1.764×10^2	1.426				1.427	5.022×10^1	
140. MeV	2.218×10^2	1.347				1.348	7.920×10^1	
200. MeV	2.868×10^2	1.310				1.310	1.245×10^2	
243. MeV	3.325×10^2	1.305				1.305	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.310	0.000		0.000	1.310	2.010×10^2	
400. MeV	4.945×10^2	1.329	0.000		0.000	1.330	2.768×10^2	
800. MeV	8.995×10^2	1.417	0.001		0.000	1.418	5.678×10^2	
1.00 GeV	1.101×10^3	1.452	0.001		0.000	1.453	7.070×10^2	
1.40 GeV	1.502×10^3	1.507	0.002	0.001	0.001	1.510	9.768×10^2	
2.00 GeV	2.103×10^3	1.567	0.003	0.001	0.001	1.572	1.366×10^3	
3.00 GeV	3.104×10^3	1.634	0.004	0.003	0.001	1.643	1.987×10^3	
4.00 GeV	4.104×10^3	1.681	0.006	0.006	0.002	1.695	2.586×10^3	
8.00 GeV	8.105×10^3	1.786	0.016	0.017	0.003	1.822	4.853×10^3	
10.0 GeV	1.011×10^4	1.817	0.021	0.024	0.004	1.867	5.937×10^3	
14.0 GeV	1.411×10^4	1.862	0.032	0.038	0.006	1.939	8.038×10^3	
20.0 GeV	2.011×10^4	1.907	0.050	0.062	0.008	2.027	1.106×10^4	
30.0 GeV	3.011×10^4	1.955	0.082	0.106	0.011	2.155	1.584×10^4	
40.0 GeV	4.011×10^4	1.986	0.115	0.155	0.015	2.272	2.036×10^4	
80.0 GeV	8.011×10^4	2.056	0.260	0.368	0.030	2.715	3.643×10^4	
100. GeV	1.001×10^5	2.078	0.337	0.482	0.037	2.935	4.352×10^4	
140. GeV	1.401×10^5	2.108	0.495	0.718	0.051	3.373	5.622×10^4	
200. GeV	2.001×10^5	2.140	0.742	1.090	0.073	4.046	7.245×10^4	
223. GeV	2.232×10^5	2.150	0.838	1.231	0.081	4.301	<i>Muon critical energy</i>	
300. GeV	3.001×10^5	2.176	1.164	1.712	0.109	5.162	9.429×10^4	
400. GeV	4.001×10^5	2.201	1.601	2.356	0.145	6.304	1.118×10^5	
800. GeV	8.001×10^5	2.262	3.404	4.995	0.294	10.956	1.594×10^5	
1.00 TeV	1.000×10^6	2.282	4.330	6.345	0.369	13.327	1.759×10^5	
1.40 TeV	1.400×10^6	2.312	6.187	9.037	0.523	18.060	2.016×10^5	
2.00 TeV	2.000×10^6	2.345	9.028	13.143	0.756	25.273	2.295×10^5	
3.00 TeV	3.000×10^6	2.382	13.772	19.968	1.157	37.280	2.619×10^5	
4.00 TeV	4.000×10^6	2.409	18.579	26.864	1.563	49.417	2.852×10^5	
8.00 TeV	8.000×10^6	2.475	37.966	54.581	3.250	98.273	3.414×10^5	
10.0 TeV	1.000×10^7	2.497	47.737	68.512	4.116	122.863	3.596×10^5	
14.0 TeV	1.400×10^7	2.530	67.227	96.309	5.895	171.962	3.870×10^5	
20.0 TeV	2.000×10^7	2.566	96.636	138.179	8.622	246.005	4.160×10^5	
30.0 TeV	3.000×10^7	2.608	145.594	207.848	13.335	369.386	4.490×10^5	
40.0 TeV	4.000×10^7	2.638	194.730	277.679	18.162	493.210	4.723×10^5	
80.0 TeV	8.000×10^7	2.711	391.580	557.189	38.319	989.800	5.284×10^5	
100. TeV	1.000×10^8	2.735	490.176	697.068	48.733	1238.713	5.465×10^5	

TABLE II-26. Muons in Toluene (C₆H₅CH₃)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.54265	0.867	62.5	0.13284	3.3558	0.1722	2.5728	3.3026	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.970				7.970	7.013×10^{-1}	
14.0 MeV	5.616×10^1	6.212				6.212	1.276×10^0	
20.0 MeV	6.802×10^1	4.847				4.847	2.382×10^0	
30.0 MeV	8.509×10^1	3.757				3.757	4.758×10^0	
40.0 MeV	1.003×10^2	3.206				3.206	7.658×10^0	
80.0 MeV	1.527×10^2	2.404				2.404	2.253×10^1	
100. MeV	1.764×10^2	2.253				2.254	3.114×10^1	
140. MeV	2.218×10^2	2.098				2.098	4.962×10^1	
200. MeV	2.868×10^2	2.008				2.008	7.897×10^1	
300. MeV	3.917×10^2	1.973			0.000	1.973	1.294×10^2	
318. MeV	4.105×10^2	1.972			0.000	1.972	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.978			0.000	1.978	1.800×10^2	
800. MeV	8.995×10^2	2.050	0.000		0.000	2.051	3.787×10^2	
1.00 GeV	1.101×10^3	2.083	0.000		0.000	2.084	4.754×10^2	
1.40 GeV	1.502×10^3	2.137	0.000		0.001	2.138	6.648×10^2	
2.00 GeV	2.103×10^3	2.197	0.000	0.000	0.001	2.199	9.413×10^2	
3.00 GeV	3.104×10^3	2.265	0.001	0.001	0.001	2.268	1.389×10^3	
4.00 GeV	4.104×10^3	2.312	0.001	0.001	0.002	2.316	1.825×10^3	
8.00 GeV	8.105×10^3	2.420	0.003	0.003	0.004	2.429	3.506×10^3	
10.0 GeV	1.011×10^4	2.452	0.004	0.004	0.005	2.465	4.323×10^3	
14.0 GeV	1.411×10^4	2.500	0.006	0.006	0.007	2.519	5.928×10^3	
20.0 GeV	2.011×10^4	2.548	0.009	0.010	0.009	2.577	8.281×10^3	
30.0 GeV	3.011×10^4	2.600	0.015	0.018	0.014	2.647	1.211×10^4	
40.0 GeV	4.011×10^4	2.636	0.021	0.027	0.018	2.702	1.585×10^4	
80.0 GeV	8.011×10^4	2.717	0.048	0.065	0.035	2.866	3.020×10^4	
100. GeV	1.001×10^5	2.743	0.063	0.086	0.043	2.935	3.709×10^4	
140. GeV	1.401×10^5	2.781	0.093	0.129	0.060	3.063	5.043×10^4	
200. GeV	2.001×10^5	2.821	0.140	0.198	0.084	3.243	6.946×10^4	
300. GeV	3.001×10^5	2.866	0.221	0.315	0.127	3.529	9.900×10^4	
400. GeV	4.001×10^5	2.898	0.306	0.437	0.169	3.810	1.263×10^5	
800. GeV	8.001×10^5	2.975	0.658	0.947	0.341	4.922	2.184×10^5	
1.00 TeV	1.000×10^6	3.001	0.840	1.211	0.428	5.481	2.569×10^5	
1.20 TeV	1.203×10^6	3.022	1.026	1.477	0.519	6.044	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.039	1.208	1.737	0.607	6.591	3.233×10^5	
2.00 TeV	2.000×10^6	3.080	1.773	2.543	0.879	8.275	4.044×10^5	
3.00 TeV	3.000×10^6	3.128	2.720	3.885	1.348	11.081	5.085×10^5	
4.00 TeV	4.000×10^6	3.162	3.685	5.247	1.824	13.919	5.889×10^5	
8.00 TeV	8.000×10^6	3.246	7.595	10.736	3.808	25.386	7.986×10^5	
10.0 TeV	1.000×10^7	3.274	9.574	13.501	4.831	31.180	8.696×10^5	
14.0 TeV	1.400×10^7	3.316	13.523	19.009	6.938	42.787	9.787×10^5	
20.0 TeV	2.000×10^7	3.362	19.499	27.320	10.178	60.358	1.096×10^6	
30.0 TeV	3.000×10^7	3.414	29.451	41.144	15.802	89.812	1.231×10^6	
40.0 TeV	4.000×10^7	3.452	39.461	55.014	21.577	119.504	1.327×10^6	
80.0 TeV	8.000×10^7	3.546	79.579	110.545	45.826	239.496	1.559×10^6	
100. TeV	1.000×10^8	3.577	99.687	138.346	58.401	300.010	1.634×10^6	

TABLE II-27. Muons in Trichloroethylene (C₂HCl₃)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.48710	1.460	148.1	0.18272	3.0137	0.1803	2.9140	4.6148	0.00

T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]
10.0 MeV	4.704×10^1	6.374				6.374	8.852×10^{-1}
14.0 MeV	5.616×10^1	4.990				4.990	1.602×10^0
20.0 MeV	6.802×10^1	3.910				3.910	2.976×10^0
30.0 MeV	8.509×10^1	3.044				3.044	5.914×10^0
40.0 MeV	1.003×10^2	2.606				2.606	9.487×10^0
80.0 MeV	1.527×10^2	1.967				1.967	2.771×10^1
100. MeV	1.764×10^2	1.851				1.851	3.821×10^1
140. MeV	2.218×10^2	1.735				1.735	6.064×10^1
200. MeV	2.868×10^2	1.672				1.672	9.599×10^1
280. MeV	3.708×10^2	1.656			0.000	1.656	<i>Minimum ionization</i>
300. MeV	3.917×10^2	1.656			0.000	1.656	1.562×10^2
400. MeV	4.945×10^2	1.670			0.000	1.670	2.164×10^2
800. MeV	8.995×10^2	1.753	0.000		0.000	1.754	4.500×10^2
1.00 GeV	1.101×10^3	1.788	0.000		0.000	1.789	5.629×10^2
1.40 GeV	1.502×10^3	1.844	0.001	0.000	0.001	1.846	7.829×10^2
2.00 GeV	2.103×10^3	1.905	0.001	0.001	0.001	1.908	1.102×10^3
3.00 GeV	3.104×10^3	1.974	0.002	0.001	0.001	1.979	1.616×10^3
4.00 GeV	4.104×10^3	2.022	0.003	0.002	0.002	2.028	2.115×10^3
8.00 GeV	8.105×10^3	2.129	0.007	0.006	0.004	2.146	4.026×10^3
10.0 GeV	1.011×10^4	2.161	0.009	0.009	0.005	2.183	4.949×10^3
14.0 GeV	1.411×10^4	2.207	0.013	0.015	0.006	2.241	6.757×10^3
20.0 GeV	2.011×10^4	2.253	0.020	0.024	0.009	2.306	9.394×10^3
30.0 GeV	3.011×10^4	2.302	0.033	0.041	0.013	2.389	1.365×10^4
40.0 GeV	4.011×10^4	2.334	0.047	0.061	0.017	2.459	1.777×10^4
80.0 GeV	8.011×10^4	2.408	0.107	0.145	0.032	2.693	3.329×10^4
100. GeV	1.001×10^5	2.431	0.138	0.191	0.040	2.801	4.057×10^4
140. GeV	1.401×10^5	2.465	0.203	0.286	0.056	3.011	5.434×10^4
200. GeV	2.001×10^5	2.501	0.305	0.437	0.080	3.323	7.330×10^4
300. GeV	3.001×10^5	2.542	0.479	0.691	0.119	3.832	1.013×10^5
400. GeV	4.001×10^5	2.570	0.660	0.955	0.159	4.344	1.258×10^5
568. GeV	5.681×10^5	2.605	0.971	1.408	0.226	5.211	<i>Muon critical energy</i>
800. GeV	8.001×10^5	2.640	1.409	2.041	0.321	6.412	2.011×10^5
1.00 TeV	1.000×10^6	2.663	1.795	2.599	0.404	7.461	2.300×10^5
1.40 TeV	1.400×10^6	2.697	2.571	3.713	0.572	9.554	2.773×10^5
2.00 TeV	2.000×10^6	2.734	3.760	5.416	0.828	12.739	3.315×10^5
3.00 TeV	3.000×10^6	2.777	5.749	8.248	1.268	18.042	3.972×10^5
4.00 TeV	4.000×10^6	2.808	7.768	11.114	1.715	23.405	4.457×10^5
8.00 TeV	8.000×10^6	2.883	15.928	22.646	3.574	45.032	5.668×10^5
10.0 TeV	1.000×10^7	2.908	20.047	28.448	4.531	55.935	6.065×10^5
14.0 TeV	1.400×10^7	2.946	28.270	40.016	6.498	77.731	6.670×10^5
20.0 TeV	2.000×10^7	2.987	40.696	57.451	9.518	110.653	7.313×10^5
30.0 TeV	3.000×10^7	3.034	61.359	86.473	14.751	165.618	8.047×10^5
40.0 TeV	4.000×10^7	3.068	82.110	115.577	20.117	220.872	8.568×10^5
80.0 TeV	8.000×10^7	3.152	165.302	232.085	42.584	443.123	9.822×10^5
100. TeV	1.000×10^8	3.180	206.995	290.401	54.212	554.788	1.022×10^6

TABLE II-28. Muons in Water (liquid) (H₂O)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$ 0.55509	ρ [g/cm ³] 1.000	I [eV] 75.0	a 0.09116	$k = m_s$ 3.4773	x_0 0.2400	x_1 2.8004	\bar{C} 3.5017	δ_0 0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.965				7.965	7.030×10^{-1}	
14.0 MeV	5.616×10^1	6.213				6.213	1.278×10^0	
20.0 MeV	6.802×10^1	4.852				4.852	2.383×10^0	
30.0 MeV	8.509×10^1	3.764				3.764	4.756×10^0	
40.0 MeV	1.003×10^2	3.214				3.214	7.649×10^0	
80.0 MeV	1.527×10^2	2.413				2.413	2.247×10^1	
100. MeV	1.764×10^2	2.270				2.270	3.104×10^1	
140. MeV	2.218×10^2	2.116				2.116	4.937×10^1	
200. MeV	2.868×10^2	2.026				2.026	7.845×10^1	
300. MeV	3.917×10^2	1.992			0.000	1.992	1.284×10^2	
318. MeV	4.105×10^2	1.992			0.000	1.992	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.998			0.000	1.999	1.785×10^2	
800. MeV	8.995×10^2	2.074	0.000		0.000	2.075	3.750×10^2	
1.00 GeV	1.101×10^3	2.109	0.000		0.000	2.109	4.706×10^2	
1.40 GeV	1.502×10^3	2.165	0.000		0.001	2.166	6.576×10^2	
2.00 GeV	2.103×10^3	2.227	0.001	0.000	0.001	2.229	9.305×10^2	
3.00 GeV	3.104×10^3	2.297	0.001	0.001	0.001	2.300	1.372×10^3	
4.00 GeV	4.104×10^3	2.346	0.001	0.001	0.002	2.351	1.801×10^3	
8.00 GeV	8.105×10^3	2.458	0.004	0.003	0.004	2.470	3.456×10^3	
10.0 GeV	1.011×10^4	2.492	0.005	0.005	0.005	2.507	4.260×10^3	
14.0 GeV	1.411×10^4	2.542	0.007	0.008	0.007	2.564	5.837×10^3	
20.0 GeV	2.011×10^4	2.592	0.011	0.013	0.009	2.625	8.148×10^3	
30.0 GeV	3.011×10^4	2.645	0.019	0.023	0.013	2.701	1.190×10^4	
40.0 GeV	4.011×10^4	2.682	0.027	0.034	0.018	2.760	1.556×10^4	
80.0 GeV	8.011×10^4	2.766	0.060	0.081	0.034	2.942	2.958×10^4	
100. GeV	1.001×10^5	2.792	0.078	0.107	0.042	3.020	3.629×10^4	
140. GeV	1.401×10^5	2.831	0.116	0.161	0.059	3.166	4.922×10^4	
200. GeV	2.001×10^5	2.871	0.174	0.246	0.084	3.376	6.756×10^4	
300. GeV	3.001×10^5	2.917	0.275	0.391	0.125	3.709	9.581×10^4	
400. GeV	4.001×10^5	2.950	0.379	0.543	0.167	4.039	1.216×10^5	
800. GeV	8.001×10^5	3.030	0.814	1.172	0.337	5.352	2.074×10^5	
1.00 TeV	1.000×10^6	3.055	1.038	1.497	0.423	6.014	2.426×10^5	
1.03 TeV	1.032×10^6	3.059	1.074	1.548	0.437	6.118	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.095	1.491	2.143	0.601	7.330	3.028×10^5	
2.00 TeV	2.000×10^6	3.137	2.186	3.134	0.870	9.327	3.752×10^5	
3.00 TeV	3.000×10^6	3.186	3.352	4.784	1.332	12.654	4.669×10^5	
4.00 TeV	4.000×10^6	3.221	4.537	6.457	1.803	16.018	5.370×10^5	
8.00 TeV	8.000×10^6	3.307	9.338	13.194	3.763	29.603	7.179×10^5	
10.0 TeV	1.000×10^7	3.335	11.766	16.587	4.773	36.462	7.787×10^5	
14.0 TeV	1.400×10^7	3.378	16.613	23.347	6.854	50.192	8.718×10^5	
20.0 TeV	2.000×10^7	3.425	23.944	33.544	10.051	70.964	9.719×10^5	
30.0 TeV	3.000×10^7	3.479	36.151	50.510	15.600	105.740	1.087×10^6	
40.0 TeV	4.000×10^7	3.517	48.424	67.530	21.296	140.768	1.168×10^6	
80.0 TeV	8.000×10^7	3.613	97.657	135.668	45.199	282.138	1.365×10^6	
100. TeV	1.000×10^8	3.645	122.347	169.776	57.590	353.358	1.428×10^6	

TABLE II-29. Muons in Water (vapor) (H₂O)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.55509	7.562×10^{-4}	71.6	0.08101	3.5901	1.7952	4.3437	10.5962	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.012				8.013	6.985×10^{-1}	
14.0 MeV	5.616×10^1	6.249				6.249	1.270×10^0	
20.0 MeV	6.802×10^1	4.879				4.879	2.369×10^0	
30.0 MeV	8.509×10^1	3.784				3.784	4.729×10^0	
40.0 MeV	1.003×10^2	3.231				3.231	7.607×10^0	
80.0 MeV	1.527×10^2	2.425				2.425	2.235×10^1	
100. MeV	1.764×10^2	2.281				2.281	3.088×10^1	
140. MeV	2.218×10^2	2.139				2.139	4.908×10^1	
200. MeV	2.868×10^2	2.066				2.066	7.773×10^1	
260. MeV	3.496×10^2	2.052			0.000	2.052	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	2.056			0.000	2.056	1.264×10^2	
400. MeV	4.945×10^2	2.082			0.000	2.083	1.747×10^2	
800. MeV	8.995×10^2	2.219	0.000		0.000	2.220	3.606×10^2	
1.00 GeV	1.101×10^3	2.277	0.000		0.000	2.278	4.496×10^2	
1.40 GeV	1.502×10^3	2.372	0.000		0.001	2.373	6.215×10^2	
2.00 GeV	2.103×10^3	2.479	0.001	0.000	0.001	2.480	8.685×10^2	
3.00 GeV	3.104×10^3	2.604	0.001	0.001	0.001	2.608	1.261×10^3	
4.00 GeV	4.104×10^3	2.695	0.001	0.001	0.002	2.700	1.638×10^3	
8.00 GeV	8.105×10^3	2.902	0.004	0.003	0.004	2.913	3.055×10^3	
10.0 GeV	1.011×10^4	2.958	0.005	0.005	0.005	2.972	3.735×10^3	
14.0 GeV	1.411×10^4	3.036	0.007	0.008	0.007	3.058	5.060×10^3	
20.0 GeV	2.011×10^4	3.112	0.011	0.013	0.009	3.146	6.993×10^3	
30.0 GeV	3.011×10^4	3.190	0.019	0.023	0.013	3.246	1.012×10^4	
40.0 GeV	4.011×10^4	3.241	0.027	0.034	0.018	3.319	1.316×10^4	
80.0 GeV	8.011×10^4	3.351	0.060	0.081	0.034	3.527	2.483×10^4	
100. GeV	1.001×10^5	3.383	0.078	0.107	0.042	3.611	3.043×10^4	
140. GeV	1.401×10^5	3.429	0.116	0.161	0.059	3.765	4.128×10^4	
200. GeV	2.001×10^5	3.475	0.174	0.246	0.084	3.979	5.677×10^4	
300. GeV	3.001×10^5	3.525	0.275	0.391	0.125	4.317	8.089×10^4	
400. GeV	4.001×10^5	3.560	0.379	0.543	0.167	4.649	1.032×10^5	
800. GeV	8.001×10^5	3.642	0.814	1.172	0.337	5.964	1.790×10^5	
1.00 TeV	1.000×10^6	3.668	1.038	1.497	0.423	6.627	2.108×10^5	
1.23 TeV	1.231×10^6	3.692	1.298	1.868	0.525	7.384	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.707	1.491	2.143	0.601	7.942	2.658×10^5	
2.00 TeV	2.000×10^6	3.749	2.186	3.134	0.870	9.940	3.332×10^5	
3.00 TeV	3.000×10^6	3.798	3.352	4.784	1.332	13.266	4.200×10^5	
4.00 TeV	4.000×10^6	3.833	4.537	6.457	1.803	16.630	4.872×10^5	
8.00 TeV	8.000×10^6	3.919	9.338	13.194	3.763	30.215	6.631×10^5	
10.0 TeV	1.000×10^7	3.948	11.766	16.587	4.773	37.074	7.228×10^5	
14.0 TeV	1.400×10^7	3.991	16.613	23.347	6.854	50.805	8.146×10^5	
20.0 TeV	2.000×10^7	4.037	23.944	33.544	10.051	71.576	9.136×10^5	
30.0 TeV	3.000×10^7	4.091	36.151	50.510	15.600	106.353	1.028×10^6	
40.0 TeV	4.000×10^7	4.130	48.424	67.530	21.296	141.380	1.109×10^6	
80.0 TeV	8.000×10^7	4.226	97.657	135.668	45.199	282.750	1.305×10^6	
100. TeV	1.000×10^8	4.257	122.347	169.776	57.590	353.971	1.368×10^6	

TABLE III-1. Muons in Bakelite [C₄₃H₃₈O₇]_n

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.52792	1.250	72.4	0.12713	3.3470	0.1471	2.6055	3.2582	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.609				7.609	7.356×10^{-1}	
14.0 MeV	5.616×10^1	5.935				5.935	1.337×10^0	
20.0 MeV	6.802×10^1	4.634				4.634	2.494×10^0	
30.0 MeV	8.509×10^1	3.594				3.595	4.979×10^0	
40.0 MeV	1.003×10^2	3.069				3.069	8.009×10^0	
80.0 MeV	1.527×10^2	2.302				2.302	2.353×10^1	
100. MeV	1.764×10^2	2.156				2.156	3.253×10^1	
140. MeV	2.218×10^2	2.008				2.008	5.185×10^1	
200. MeV	2.868×10^2	1.922				1.922	8.251×10^1	
300. MeV	3.917×10^2	1.889			0.000	1.889	1.351×10^2	
318. MeV	4.105×10^2	1.889			0.000	1.889	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.895			0.000	1.895	1.880×10^2	
800. MeV	8.995×10^2	1.966	0.000		0.000	1.966	3.953×10^2	
1.00 GeV	1.101×10^3	1.998	0.000		0.000	1.999	4.962×10^2	
1.40 GeV	1.502×10^3	2.051	0.000		0.001	2.052	6.936×10^2	
2.00 GeV	2.103×10^3	2.109	0.001	0.000	0.001	2.111	9.817×10^2	
3.00 GeV	3.104×10^3	2.175	0.001	0.001	0.001	2.178	1.448×10^3	
4.00 GeV	4.104×10^3	2.221	0.001	0.001	0.002	2.225	1.902×10^3	
8.00 GeV	8.105×10^3	2.326	0.003	0.003	0.004	2.336	3.651×10^3	
10.0 GeV	1.011×10^4	2.358	0.004	0.004	0.005	2.371	4.500×10^3	
14.0 GeV	1.411×10^4	2.404	0.006	0.007	0.007	2.424	6.168×10^3	
20.0 GeV	2.011×10^4	2.451	0.010	0.011	0.009	2.481	8.612×10^3	
30.0 GeV	3.011×10^4	2.502	0.016	0.019	0.014	2.551	1.258×10^4	
40.0 GeV	4.011×10^4	2.537	0.023	0.028	0.018	2.606	1.646×10^4	
80.0 GeV	8.011×10^4	2.616	0.051	0.069	0.034	2.771	3.132×10^4	
100. GeV	1.001×10^5	2.641	0.067	0.091	0.043	2.842	3.845×10^4	
140. GeV	1.401×10^5	2.678	0.099	0.137	0.059	2.973	5.220×10^4	
200. GeV	2.001×10^5	2.717	0.149	0.210	0.084	3.160	7.177×10^4	
300. GeV	3.001×10^5	2.761	0.235	0.334	0.126	3.456	1.020×10^5	
400. GeV	4.001×10^5	2.792	0.324	0.464	0.168	3.747	1.298×10^5	
800. GeV	8.001×10^5	2.867	0.697	1.003	0.339	4.906	2.228×10^5	
1.00 TeV	1.000×10^6	2.892	0.889	1.282	0.426	5.489	2.613×10^5	
1.11 TeV	1.110×10^6	2.903	0.995	1.434	0.474	5.807	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	2.929	1.277	1.838	0.604	6.648	3.274×10^5	
2.00 TeV	2.000×10^6	2.969	1.874	2.689	0.874	8.407	4.075×10^5	
3.00 TeV	3.000×10^6	3.016	2.874	4.108	1.340	11.337	5.096×10^5	
4.00 TeV	4.000×10^6	3.049	3.891	5.546	1.813	14.300	5.880×10^5	
8.00 TeV	8.000×10^6	3.131	8.014	11.342	3.786	26.273	7.913×10^5	
10.0 TeV	1.000×10^7	3.158	10.100	14.262	4.802	32.321	8.598×10^5	
14.0 TeV	1.400×10^7	3.199	14.262	20.078	6.896	44.435	9.650×10^5	
20.0 TeV	2.000×10^7	3.243	20.559	28.853	10.113	62.768	1.078×10^6	
30.0 TeV	3.000×10^7	3.294	31.044	43.450	15.700	93.489	1.208×10^6	
40.0 TeV	4.000×10^7	3.331	41.587	58.096	21.434	124.448	1.300×10^6	
80.0 TeV	8.000×10^7	3.422	83.847	116.730	45.505	249.505	1.523×10^6	
100. TeV	1.000×10^8	3.452	105.028	146.083	57.986	312.549	1.594×10^6	

TABLE III-2. Muons in Nylon (type 6, 6/6) $[\text{NH}(\text{CH}_2)_6\text{NHCO}(\text{CH}_2)_4\text{CO}]_n$
 See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.54790	1.180	63.9	0.11818	3.3826	0.1261	2.5759	3.0289	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.024				8.024	6.967×10^{-1}	
14.0 MeV	5.616×10^1	6.255				6.255	1.267×10^0	
20.0 MeV	6.802×10^1	4.881				4.881	2.366×10^0	
30.0 MeV	8.509×10^1	3.784				3.784	4.725×10^0	
40.0 MeV	1.003×10^2	3.229				3.230	7.605×10^0	
80.0 MeV	1.527×10^2	2.416				2.417	2.237×10^1	
100. MeV	1.764×10^2	2.262				2.262	3.095×10^1	
140. MeV	2.218×10^2	2.103				2.103	4.937×10^1	
200. MeV	2.868×10^2	2.011				2.011	7.866×10^1	
300. MeV	3.917×10^2	1.974			0.000	1.974	1.290×10^2	
328. MeV	4.201×10^2	1.973			0.000	1.973	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.978			0.000	1.978	1.796×10^2	
800. MeV	8.995×10^2	2.048	0.000		0.000	2.049	3.784×10^2	
1.00 GeV	1.101×10^3	2.081	0.000		0.000	2.082	4.752×10^2	
1.40 GeV	1.502×10^3	2.135	0.000		0.001	2.136	6.648×10^2	
2.00 GeV	2.103×10^3	2.194	0.000	0.000	0.001	2.196	9.417×10^2	
3.00 GeV	3.104×10^3	2.261	0.001	0.001	0.001	2.264	1.390×10^3	
4.00 GeV	4.104×10^3	2.308	0.001	0.001	0.002	2.313	1.826×10^3	
8.00 GeV	8.105×10^3	2.417	0.003	0.003	0.004	2.427	3.510×10^3	
10.0 GeV	1.011×10^4	2.449	0.004	0.004	0.005	2.463	4.328×10^3	
14.0 GeV	1.411×10^4	2.497	0.006	0.007	0.007	2.517	5.934×10^3	
20.0 GeV	2.011×10^4	2.546	0.010	0.011	0.009	2.576	8.288×10^3	
30.0 GeV	3.011×10^4	2.598	0.016	0.019	0.014	2.647	1.212×10^4	
40.0 GeV	4.011×10^4	2.634	0.022	0.028	0.018	2.703	1.585×10^4	
80.0 GeV	8.011×10^4	2.717	0.051	0.069	0.035	2.871	3.019×10^4	
100. GeV	1.001×10^5	2.743	0.066	0.091	0.043	2.943	3.706×10^4	
140. GeV	1.401×10^5	2.781	0.098	0.136	0.059	3.075	5.036×10^4	
200. GeV	2.001×10^5	2.821	0.148	0.209	0.084	3.262	6.930×10^4	
300. GeV	3.001×10^5	2.867	0.233	0.332	0.126	3.558	9.863×10^4	
400. GeV	4.001×10^5	2.899	0.322	0.461	0.168	3.850	1.256×10^5	
800. GeV	8.001×10^5	2.977	0.693	0.997	0.340	5.007	2.165×10^5	
1.00 TeV	1.000×10^6	3.003	0.884	1.274	0.427	5.589	2.543×10^5	
1.16 TeV	1.157×10^6	3.020	1.034	1.489	0.497	6.040	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.042	1.270	1.826	0.606	6.745	3.193×10^5	
2.00 TeV	2.000×10^6	3.083	1.864	2.673	0.877	8.499	3.984×10^5	
3.00 TeV	3.000×10^6	3.131	2.860	4.084	1.345	11.420	4.996×10^5	
4.00 TeV	4.000×10^6	3.166	3.874	5.515	1.820	14.375	5.775×10^5	
8.00 TeV	8.000×10^6	3.251	7.982	11.279	3.800	26.312	7.801×10^5	
10.0 TeV	1.000×10^7	3.279	10.061	14.183	4.820	32.342	8.486×10^5	
14.0 TeV	1.400×10^7	3.322	14.209	19.968	6.922	44.421	9.537×10^5	
20.0 TeV	2.000×10^7	3.368	20.487	28.695	10.153	62.703	1.067×10^6	
30.0 TeV	3.000×10^7	3.421	30.941	43.214	15.764	93.340	1.197×10^6	
40.0 TeV	4.000×10^7	3.459	41.454	57.781	21.524	124.217	1.289×10^6	
80.0 TeV	8.000×10^7	3.553	83.604	116.099	45.708	248.965	1.512×10^6	
100. TeV	1.000×10^8	3.585	104.736	145.294	58.248	311.863	1.584×10^6	

TABLE III-3. Muons in Polycarbonate $[\text{OC}_6\text{H}_4\text{C}(\text{CH}_3)_2\text{C}_6\text{H}_4\text{OCO}]_n$
 See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.52697	1.200	73.1	0.12860	3.3288	0.1606	2.6225	3.3201	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.586				7.586	7.379×10^{-1}	
14.0 MeV	5.616×10^1	5.917				5.917	1.341×10^0	
20.0 MeV	6.802×10^1	4.620				4.621	2.502×10^0	
30.0 MeV	8.509×10^1	3.584				3.584	4.994×10^0	
40.0 MeV	1.003×10^2	3.060				3.060	8.033×10^0	
80.0 MeV	1.527×10^2	2.297				2.297	2.360×10^1	
100. MeV	1.764×10^2	2.152				2.152	3.262×10^1	
140. MeV	2.218×10^2	2.004				2.004	5.197×10^1	
200. MeV	2.868×10^2	1.919				1.919	8.269×10^1	
300. MeV	3.917×10^2	1.886			0.000	1.887	1.354×10^2	
318. MeV	4.105×10^2	1.886			0.000	1.886	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.892			0.000	1.892	1.884×10^2	
800. MeV	8.995×10^2	1.963	0.000		0.000	1.964	3.959×10^2	
1.00 GeV	1.101×10^3	1.996	0.000		0.000	1.997	4.969×10^2	
1.40 GeV	1.502×10^3	2.049	0.000		0.001	2.050	6.945×10^2	
2.00 GeV	2.103×10^3	2.107	0.001	0.000	0.001	2.109	9.828×10^2	
3.00 GeV	3.104×10^3	2.174	0.001	0.001	0.001	2.177	1.449×10^3	
4.00 GeV	4.104×10^3	2.220	0.001	0.001	0.002	2.224	1.903×10^3	
8.00 GeV	8.105×10^3	2.325	0.003	0.003	0.004	2.335	3.653×10^3	
10.0 GeV	1.011×10^4	2.357	0.004	0.004	0.005	2.370	4.503×10^3	
14.0 GeV	1.411×10^4	2.403	0.006	0.007	0.007	2.423	6.171×10^3	
20.0 GeV	2.011×10^4	2.450	0.010	0.011	0.009	2.481	8.617×10^3	
30.0 GeV	3.011×10^4	2.501	0.016	0.020	0.014	2.550	1.259×10^4	
40.0 GeV	4.011×10^4	2.535	0.023	0.029	0.018	2.605	1.647×10^4	
80.0 GeV	8.011×10^4	2.615	0.052	0.070	0.034	2.771	3.133×10^4	
100. GeV	1.001×10^5	2.640	0.067	0.092	0.043	2.842	3.846×10^4	
140. GeV	1.401×10^5	2.677	0.099	0.138	0.059	2.973	5.221×10^4	
200. GeV	2.001×10^5	2.715	0.150	0.212	0.084	3.161	7.178×10^4	
300. GeV	3.001×10^5	2.759	0.236	0.336	0.126	3.458	1.020×10^5	
400. GeV	4.001×10^5	2.790	0.326	0.467	0.168	3.751	1.298×10^5	
800. GeV	8.001×10^5	2.865	0.701	1.009	0.339	4.915	2.226×10^5	
1.00 TeV	1.000×10^6	2.890	0.895	1.290	0.425	5.501	2.611×10^5	
1.10 TeV	1.104×10^6	2.901	0.995	1.434	0.471	5.802	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	2.927	1.285	1.849	0.603	6.665	3.271×10^5	
2.00 TeV	2.000×10^6	2.967	1.885	2.706	0.874	8.432	4.069×10^5	
3.00 TeV	3.000×10^6	3.014	2.891	4.132	1.339	11.376	5.087×10^5	
4.00 TeV	4.000×10^6	3.047	3.915	5.580	1.812	14.354	5.868×10^5	
8.00 TeV	8.000×10^6	3.129	8.062	11.410	3.784	26.384	7.893×10^5	
10.0 TeV	1.000×10^7	3.155	10.159	14.347	4.799	32.461	8.575×10^5	
14.0 TeV	1.400×10^7	3.197	14.345	20.198	6.892	44.632	9.622×10^5	
20.0 TeV	2.000×10^7	3.241	20.679	29.024	10.108	63.052	1.075×10^6	
30.0 TeV	3.000×10^7	3.292	31.225	43.709	15.690	93.916	1.204×10^6	
40.0 TeV	4.000×10^7	3.329	41.828	58.441	21.421	125.019	1.296×10^6	
80.0 TeV	8.000×10^7	3.419	84.332	117.422	45.476	250.650	1.517×10^6	
100. TeV	1.000×10^8	3.449	105.635	146.949	57.948	313.982	1.589×10^6	

TABLE III-4. Muons in Polyethylene [C₂H₄]_n

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.57034	0.890	57.4	0.12108	3.4292	0.1489	2.5296	3.0563	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.467				8.467	6.596×10^{-1}	
14.0 MeV	5.616×10^1	6.596				6.596	1.201×10^0	
20.0 MeV	6.802×10^1	5.145				5.145	2.242×10^0	
30.0 MeV	8.509×10^1	3.987				3.987	4.481×10^0	
40.0 MeV	1.003×10^2	3.401				3.401	7.215×10^0	
80.0 MeV	1.527×10^2	2.547				2.547	2.124×10^1	
100. MeV	1.764×10^2	2.384				2.384	2.937×10^1	
140. MeV	2.218×10^2	2.217				2.217	4.685×10^1	
200. MeV	2.868×10^2	2.120				2.120	7.464×10^1	
300. MeV	3.917×10^2	2.080			0.000	2.081	1.224×10^2	
328. MeV	4.211×10^2	2.079			0.000	2.079	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.084			0.000	2.084	1.705×10^2	
800. MeV	8.995×10^2	2.157	0.000		0.000	2.157	3.592×10^2	
1.00 GeV	1.101×10^3	2.190	0.000		0.000	2.191	4.512×10^2	
1.40 GeV	1.502×10^3	2.246	0.000		0.001	2.247	6.313×10^2	
2.00 GeV	2.103×10^3	2.307	0.000	0.000	0.001	2.309	8.946×10^2	
3.00 GeV	3.104×10^3	2.377	0.001	0.000	0.001	2.380	1.321×10^3	
4.00 GeV	4.104×10^3	2.425	0.001	0.001	0.002	2.430	1.736×10^3	
8.00 GeV	8.105×10^3	2.537	0.003	0.003	0.004	2.547	3.340×10^3	
10.0 GeV	1.011×10^4	2.571	0.004	0.004	0.005	2.584	4.119×10^3	
14.0 GeV	1.411×10^4	2.621	0.006	0.006	0.007	2.640	5.650×10^3	
20.0 GeV	2.011×10^4	2.671	0.009	0.010	0.009	2.700	7.896×10^3	
30.0 GeV	3.011×10^4	2.726	0.015	0.018	0.014	2.772	1.155×10^4	
40.0 GeV	4.011×10^4	2.763	0.021	0.026	0.018	2.828	1.512×10^4	
80.0 GeV	8.011×10^4	2.849	0.047	0.063	0.035	2.995	2.884×10^4	
100. GeV	1.001×10^5	2.876	0.061	0.084	0.043	3.065	3.544×10^4	
140. GeV	1.401×10^5	2.916	0.091	0.126	0.060	3.193	4.822×10^4	
200. GeV	2.001×10^5	2.958	0.137	0.193	0.085	3.373	6.650×10^4	
300. GeV	3.001×10^5	3.005	0.216	0.307	0.127	3.657	9.496×10^4	
400. GeV	4.001×10^5	3.039	0.299	0.427	0.170	3.935	1.213×10^5	
800. GeV	8.001×10^5	3.121	0.644	0.925	0.343	5.033	2.110×10^5	
1.00 TeV	1.000×10^6	3.147	0.822	1.184	0.430	5.584	2.487×10^5	
1.28 TeV	1.282×10^6	3.177	1.075	1.545	0.557	6.354	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.188	1.182	1.697	0.611	6.678	3.141×10^5	
2.00 TeV	2.000×10^6	3.231	1.736	2.486	0.884	8.338	3.944×10^5	
3.00 TeV	3.000×10^6	3.281	2.665	3.800	1.355	11.102	4.980×10^5	
4.00 TeV	4.000×10^6	3.317	3.612	5.133	1.834	13.897	5.783×10^5	
8.00 TeV	8.000×10^6	3.405	7.450	10.506	3.831	25.193	7.891×10^5	
10.0 TeV	1.000×10^7	3.434	9.393	13.213	4.860	30.902	8.607×10^5	
14.0 TeV	1.400×10^7	3.479	13.272	18.606	6.982	42.339	9.708×10^5	
20.0 TeV	2.000×10^7	3.527	19.144	26.743	10.243	59.656	1.090×10^6	
30.0 TeV	3.000×10^7	3.582	28.924	40.276	15.907	88.689	1.226×10^6	
40.0 TeV	4.000×10^7	3.622	38.762	53.856	21.722	117.962	1.324×10^6	
80.0 TeV	8.000×10^7	3.720	78.203	108.223	46.153	236.299	1.559×10^6	
100. TeV	1.000×10^8	3.753	97.977	135.440	58.825	295.995	1.634×10^6	

TABLE III-5. Muons in Polymethylmethacrylate $[\text{CH}_2\text{C}(\text{CH}_3)(\text{COOCH}_3)]_n$

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.53937	1.190	74.0	0.11433	3.3836	0.1824	2.6681	3.3297	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.753				7.753	7.221×10^{-1}	
14.0 MeV	5.616×10^1	6.047				6.047	1.313×10^0	
20.0 MeV	6.802×10^1	4.722				4.722	2.448×10^0	
30.0 MeV	8.509×10^1	3.663				3.663	4.886×10^0	
40.0 MeV	1.003×10^2	3.128				3.128	7.860×10^0	
80.0 MeV	1.527×10^2	2.348				2.348	2.309×10^1	
100. MeV	1.764×10^2	2.203				2.203	3.190×10^1	
140. MeV	2.218×10^2	2.051				2.051	5.081×10^1	
200. MeV	2.868×10^2	1.963				1.964	8.083×10^1	
300. MeV	3.917×10^2	1.930			0.000	1.930	1.324×10^2	
318. MeV	4.105×10^2	1.929			0.000	1.930	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.936			0.000	1.936	1.841×10^2	
800. MeV	8.995×10^2	2.008	0.000		0.000	2.009	3.870×10^2	
1.00 GeV	1.101×10^3	2.042	0.000		0.000	2.042	4.857×10^2	
1.40 GeV	1.502×10^3	2.096	0.000		0.001	2.097	6.789×10^2	
2.00 GeV	2.103×10^3	2.155	0.001	0.000	0.001	2.157	9.608×10^2	
3.00 GeV	3.104×10^3	2.223	0.001	0.001	0.001	2.226	1.417×10^3	
4.00 GeV	4.104×10^3	2.270	0.001	0.001	0.002	2.275	1.861×10^3	
8.00 GeV	8.105×10^3	2.378	0.003	0.003	0.004	2.388	3.572×10^3	
10.0 GeV	1.011×10^4	2.411	0.004	0.004	0.005	2.424	4.403×10^3	
14.0 GeV	1.411×10^4	2.459	0.006	0.007	0.007	2.479	6.033×10^3	
20.0 GeV	2.011×10^4	2.507	0.010	0.011	0.009	2.537	8.424×10^3	
30.0 GeV	3.011×10^4	2.559	0.016	0.020	0.014	2.609	1.231×10^4	
40.0 GeV	4.011×10^4	2.594	0.023	0.029	0.018	2.665	1.610×10^4	
80.0 GeV	8.011×10^4	2.675	0.053	0.071	0.034	2.834	3.063×10^4	
100. GeV	1.001×10^5	2.701	0.069	0.094	0.043	2.907	3.760×10^4	
140. GeV	1.401×10^5	2.738	0.102	0.142	0.059	3.041	5.105×10^4	
200. GeV	2.001×10^5	2.778	0.153	0.217	0.084	3.232	7.018×10^4	
300. GeV	3.001×10^5	2.823	0.242	0.345	0.126	3.536	9.974×10^4	
400. GeV	4.001×10^5	2.855	0.334	0.478	0.168	3.835	1.269×10^5	
800. GeV	8.001×10^5	2.932	0.718	1.034	0.339	5.023	2.177×10^5	
1.00 TeV	1.000×10^6	2.957	0.917	1.322	0.426	5.621	2.554×10^5	
1.11 TeV	1.107×10^6	2.968	1.022	1.473	0.473	5.937	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	2.995	1.317	1.894	0.604	6.810	3.199×10^5	
2.00 TeV	2.000×10^6	3.036	1.932	2.771	0.874	8.614	3.981×10^5	
3.00 TeV	3.000×10^6	3.083	2.963	4.232	1.340	11.619	4.977×10^5	
4.00 TeV	4.000×10^6	3.117	4.012	5.714	1.813	14.658	5.742×10^5	
8.00 TeV	8.000×10^6	3.201	8.263	11.685	3.786	26.935	7.725×10^5	
10.0 TeV	1.000×10^7	3.229	10.413	14.692	4.802	33.136	8.394×10^5	
14.0 TeV	1.400×10^7	3.270	14.705	20.683	6.896	45.555	9.419×10^5	
20.0 TeV	2.000×10^7	3.316	21.198	29.721	10.114	64.349	1.052×10^6	
30.0 TeV	3.000×10^7	3.368	32.010	44.757	15.700	95.837	1.179×10^6	
40.0 TeV	4.000×10^7	3.406	42.882	59.843	21.435	127.566	1.269×10^6	
80.0 TeV	8.000×10^7	3.499	86.470	120.237	45.508	255.715	1.486×10^6	
100. TeV	1.000×10^8	3.529	108.321	150.471	57.990	320.312	1.556×10^6	

TABLE III-6. Muons in Polystyrene [C₆H₅CHCH₂]_n

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.53768	1.060	68.7	0.16454	3.2224	0.1647	2.5031	3.2999	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.802				7.802	7.170×10^{-1}	
14.0 MeV	5.616×10^1	6.084				6.084	1.304×10^0	
20.0 MeV	6.802×10^1	4.749				4.749	2.433×10^0	
30.0 MeV	8.509×10^1	3.683				3.683	4.857×10^0	
40.0 MeV	1.003×10^2	3.144				3.144	7.815×10^0	
80.0 MeV	1.527×10^2	2.359				2.359	2.297×10^1	
100. MeV	1.764×10^2	2.210				2.211	3.175×10^1	
140. MeV	2.218×10^2	2.058				2.058	5.060×10^1	
200. MeV	2.868×10^2	1.970				1.971	8.050×10^1	
300. MeV	3.917×10^2	1.937			0.000	1.937	1.318×10^2	
318. MeV	4.105×10^2	1.936			0.000	1.936	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.942			0.000	1.943	1.834×10^2	
800. MeV	8.995×10^2	2.015	0.000		0.000	2.015	3.857×10^2	
1.00 GeV	1.101×10^3	2.048	0.000		0.000	2.049	4.841×10^2	
1.40 GeV	1.502×10^3	2.102	0.000		0.001	2.103	6.767×10^2	
2.00 GeV	2.103×10^3	2.161	0.000	0.000	0.001	2.163	9.578×10^2	
3.00 GeV	3.104×10^3	2.228	0.001	0.001	0.001	2.231	1.413×10^3	
4.00 GeV	4.104×10^3	2.275	0.001	0.001	0.002	2.279	1.856×10^3	
8.00 GeV	8.105×10^3	2.382	0.003	0.003	0.004	2.391	3.564×10^3	
10.0 GeV	1.011×10^4	2.414	0.004	0.004	0.005	2.427	4.394×10^3	
14.0 GeV	1.411×10^4	2.461	0.006	0.006	0.007	2.480	6.023×10^3	
20.0 GeV	2.011×10^4	2.509	0.009	0.010	0.009	2.538	8.413×10^3	
30.0 GeV	3.011×10^4	2.560	0.015	0.018	0.014	2.608	1.230×10^4	
40.0 GeV	4.011×10^4	2.596	0.021	0.027	0.018	2.662	1.609×10^4	
80.0 GeV	8.011×10^4	2.677	0.049	0.065	0.035	2.826	3.065×10^4	
100. GeV	1.001×10^5	2.702	0.063	0.086	0.043	2.895	3.764×10^4	
140. GeV	1.401×10^5	2.740	0.093	0.130	0.059	3.022	5.116×10^4	
200. GeV	2.001×10^5	2.779	0.141	0.199	0.084	3.203	7.044×10^4	
300. GeV	3.001×10^5	2.824	0.222	0.317	0.126	3.489	1.003×10^5	
400. GeV	4.001×10^5	2.855	0.307	0.439	0.168	3.770	1.279×10^5	
800. GeV	8.001×10^5	2.932	0.661	0.951	0.340	4.885	2.208×10^5	
1.00 TeV	1.000×10^6	2.957	0.844	1.216	0.428	5.445	2.596×10^5	
1.18 TeV	1.183×10^6	2.976	1.011	1.456	0.509	5.953	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	2.995	1.212	1.744	0.606	6.558	3.264×10^5	
2.00 TeV	2.000×10^6	3.036	1.779	2.553	0.878	8.247	4.079×10^5	
3.00 TeV	3.000×10^6	3.083	2.730	3.900	1.346	11.060	5.122×10^5	
4.00 TeV	4.000×10^6	3.117	3.698	5.268	1.822	13.906	5.927×10^5	
8.00 TeV	8.000×10^6	3.201	7.621	10.777	3.804	25.403	8.024×10^5	
10.0 TeV	1.000×10^7	3.228	9.606	13.552	4.825	31.213	8.733×10^5	
14.0 TeV	1.400×10^7	3.270	13.568	19.082	6.931	42.850	9.823×10^5	
20.0 TeV	2.000×10^7	3.315	19.563	27.423	10.166	60.467	1.100×10^6	
30.0 TeV	3.000×10^7	3.367	29.546	41.300	15.784	89.997	1.234×10^6	
40.0 TeV	4.000×10^7	3.405	39.586	55.222	21.551	119.764	1.330×10^6	
80.0 TeV	8.000×10^7	3.498	79.826	110.962	45.767	240.053	1.562×10^6	
100. TeV	1.000×10^8	3.528	99.994	138.867	58.325	300.715	1.636×10^6	

TABLE III-7. Muons in Polytetrafluoroethylene (Teflon, $[C_2F_4]_n$)

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.47992	2.200	99.1	0.10606	3.4046	0.1648	2.7404	3.4161	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.638				6.638	8.460×10^{-1}	
14.0 MeV	5.616×10^1	5.185				5.185	1.535×10^0	
20.0 MeV	6.802×10^1	4.055				4.055	2.858×10^0	
30.0 MeV	8.509×10^1	3.150				3.150	5.696×10^0	
40.0 MeV	1.003×10^2	2.692				2.692	9.152×10^0	
80.0 MeV	1.527×10^2	2.026				2.026	2.682×10^1	
100. MeV	1.764×10^2	1.900				1.900	3.704×10^1	
140. MeV	2.218×10^2	1.771				1.771	5.895×10^1	
200. MeV	2.868×10^2	1.698				1.698	9.368×10^1	
300. MeV	3.917×10^2	1.671			0.000	1.672	1.532×10^2	
308. MeV	4.000×10^2	1.671			0.000	1.672	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.678			0.000	1.679	2.130×10^2	
800. MeV	8.995×10^2	1.745	0.000		0.000	1.746	4.467×10^2	
1.00 GeV	1.101×10^3	1.776	0.000		0.000	1.776	5.602×10^2	
1.40 GeV	1.502×10^3	1.824	0.000	0.000	0.001	1.826	7.822×10^2	
2.00 GeV	2.103×10^3	1.878	0.001	0.000	0.001	1.880	1.106×10^3	
3.00 GeV	3.104×10^3	1.939	0.001	0.001	0.001	1.942	1.628×10^3	
4.00 GeV	4.104×10^3	1.982	0.002	0.001	0.002	1.986	2.137×10^3	
8.00 GeV	8.105×10^3	2.078	0.004	0.004	0.004	2.090	4.094×10^3	
10.0 GeV	1.011×10^4	2.108	0.005	0.005	0.005	2.123	5.044×10^3	
14.0 GeV	1.411×10^4	2.150	0.008	0.008	0.006	2.173	6.905×10^3	
20.0 GeV	2.011×10^4	2.193	0.012	0.014	0.009	2.228	9.629×10^3	
30.0 GeV	3.011×10^4	2.240	0.020	0.024	0.013	2.297	1.405×10^4	
40.0 GeV	4.011×10^4	2.271	0.028	0.035	0.017	2.352	1.835×10^4	
80.0 GeV	8.011×10^4	2.344	0.063	0.086	0.034	2.526	3.473×10^4	
100. GeV	1.001×10^5	2.366	0.082	0.113	0.042	2.603	4.253×10^4	
140. GeV	1.401×10^5	2.400	0.121	0.169	0.058	2.748	5.748×10^4	
200. GeV	2.001×10^5	2.435	0.182	0.259	0.082	2.958	7.851×10^4	
300. GeV	3.001×10^5	2.475	0.287	0.410	0.123	3.296	1.105×10^5	
400. GeV	4.001×10^5	2.503	0.396	0.568	0.164	3.632	1.394×10^5	
800. GeV	8.001×10^5	2.572	0.848	1.225	0.331	4.977	2.331×10^5	
853. GeV	8.533×10^5	2.578	0.910	1.315	0.354	5.157	<i>Muon critical energy</i>	
1.00 TeV	1.000×10^6	2.594	1.082	1.564	0.416	5.657	2.708×10^5	
1.40 TeV	1.400×10^6	2.628	1.552	2.238	0.590	7.009	3.342×10^5	
2.00 TeV	2.000×10^6	2.665	2.273	3.271	0.855	9.064	4.093×10^5	
3.00 TeV	3.000×10^6	2.707	3.482	4.990	1.310	12.488	5.029×10^5	
4.00 TeV	4.000×10^6	2.737	4.710	6.731	1.772	15.951	5.736×10^5	
8.00 TeV	8.000×10^6	2.812	9.681	13.745	3.696	29.934	7.538×10^5	
10.0 TeV	1.000×10^7	2.836	12.193	17.276	4.687	36.992	8.138×10^5	
14.0 TeV	1.400×10^7	2.873	17.204	24.313	6.727	51.119	9.054×10^5	
20.0 TeV	2.000×10^7	2.914	24.781	34.926	9.860	72.481	1.003×10^6	
30.0 TeV	3.000×10^7	2.960	37.396	52.585	15.296	108.237	1.116×10^6	
40.0 TeV	4.000×10^7	2.994	50.074	70.299	20.873	144.240	1.195×10^6	
80.0 TeV	8.000×10^7	3.076	100.900	141.218	44.257	289.452	1.387×10^6	
100. TeV	1.000×10^8	3.104	126.375	176.720	56.372	362.572	1.449×10^6	

TABLE III-8. Muons in Polyvinylchloride (PVC) [CH₂CHCl]_n

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.51201	1.300	108.2	0.12438	3.2104	0.1559	2.9415	4.0532	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.998				6.998	8.032×10^{-1}	
14.0 MeV	5.616×10^1	5.469				5.469	1.457×10^0	
20.0 MeV	6.802×10^1	4.279				4.279	2.711×10^0	
30.0 MeV	8.509×10^1	3.326				3.326	5.399×10^0	
40.0 MeV	1.003×10^2	2.843				2.843	8.672×10^0	
80.0 MeV	1.527×10^2	2.140				2.140	2.540×10^1	
100. MeV	1.764×10^2	2.009				2.009	3.507×10^1	
140. MeV	2.218×10^2	1.877				1.877	5.576×10^1	
200. MeV	2.868×10^2	1.803				1.803	8.850×10^1	
298. MeV	3.894×10^2	1.779			0.000	1.780	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.779			0.000	1.780	1.445×10^2	
400. MeV	4.945×10^2	1.790			0.000	1.790	2.005×10^2	
800. MeV	8.995×10^2	1.869	0.000		0.000	1.870	4.192×10^2	
1.00 GeV	1.101×10^3	1.904	0.000		0.000	1.905	5.251×10^2	
1.40 GeV	1.502×10^3	1.960	0.001	0.000	0.001	1.961	7.319×10^2	
2.00 GeV	2.103×10^3	2.021	0.001	0.000	0.001	2.023	1.033×10^3	
3.00 GeV	3.104×10^3	2.090	0.002	0.001	0.001	2.094	1.518×10^3	
4.00 GeV	4.104×10^3	2.138	0.002	0.002	0.002	2.144	1.990×10^3	
8.00 GeV	8.105×10^3	2.247	0.005	0.005	0.004	2.262	3.800×10^3	
10.0 GeV	1.011×10^4	2.280	0.007	0.007	0.005	2.299	4.677×10^3	
14.0 GeV	1.411×10^4	2.327	0.011	0.012	0.006	2.357	6.394×10^3	
20.0 GeV	2.011×10^4	2.374	0.017	0.020	0.009	2.420	8.905×10^3	
30.0 GeV	3.011×10^4	2.425	0.028	0.034	0.013	2.500	1.297×10^4	
40.0 GeV	4.011×10^4	2.459	0.039	0.050	0.017	2.566	1.691×10^4	
80.0 GeV	8.011×10^4	2.537	0.089	0.121	0.033	2.780	3.187×10^4	
100. GeV	1.001×10^5	2.561	0.115	0.159	0.041	2.877	3.894×10^4	
140. GeV	1.401×10^5	2.597	0.169	0.238	0.057	3.062	5.241×10^4	
200. GeV	2.001×10^5	2.634	0.254	0.364	0.081	3.334	7.118×10^4	
300. GeV	3.001×10^5	2.677	0.401	0.576	0.122	3.776	9.935×10^4	
400. GeV	4.001×10^5	2.707	0.552	0.797	0.162	4.218	1.244×10^5	
696. GeV	6.960×10^5	2.765	1.014	1.467	0.284	5.531	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.780	1.180	1.707	0.328	5.996	2.035×10^5	
1.00 TeV	1.000×10^6	2.804	1.504	2.176	0.412	6.896	2.346×10^5	
1.40 TeV	1.400×10^6	2.840	2.155	3.110	0.584	8.689	2.862×10^5	
2.00 TeV	2.000×10^6	2.879	3.154	4.539	0.845	11.418	3.463×10^5	
3.00 TeV	3.000×10^6	2.924	4.826	6.917	1.294	15.962	4.200×10^5	
4.00 TeV	4.000×10^6	2.956	6.525	9.324	1.751	20.556	4.751×10^5	
8.00 TeV	8.000×10^6	3.036	13.391	19.013	3.651	39.091	6.138×10^5	
10.0 TeV	1.000×10^7	3.062	16.859	23.889	4.629	48.440	6.597×10^5	
14.0 TeV	1.400×10^7	3.102	23.782	33.609	6.643	67.137	7.296×10^5	
20.0 TeV	2.000×10^7	3.145	34.247	48.262	9.735	95.389	8.042×10^5	
30.0 TeV	3.000×10^7	3.194	51.653	72.649	15.097	142.594	8.894×10^5	
40.0 TeV	4.000×10^7	3.230	69.138	97.107	20.597	190.073	9.499×10^5	
80.0 TeV	8.000×10^7	3.318	139.238	195.020	43.652	381.229	1.096×10^6	
100. TeV	1.000×10^8	3.347	174.372	244.030	55.592	477.342	1.142×10^6	

TABLE III-9. Muons in Polyvinyltoluene [2-CH₃C₆H₄CHCH₂]_n

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.54141	1.032	64.7	0.16101	3.2393	0.1464	2.4855	3.1997	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.917				7.917	7.062×10^{-1}	
14.0 MeV	5.616×10^1	6.171				6.171	1.285×10^0	
20.0 MeV	6.802×10^1	4.816				4.816	2.398×10^0	
30.0 MeV	8.509×10^1	3.734				3.734	4.789×10^0	
40.0 MeV	1.003×10^2	3.187				3.187	7.707×10^0	
80.0 MeV	1.527×10^2	2.388				2.388	2.266×10^1	
100. MeV	1.764×10^2	2.237				2.237	3.134×10^1	
140. MeV	2.218×10^2	2.082				2.082	4.997×10^1	
200. MeV	2.868×10^2	1.992				1.992	7.955×10^1	
300. MeV	3.917×10^2	1.957			0.000	1.957	1.303×10^2	
325. MeV	4.171×10^2	1.956			0.000	1.956	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.962			0.000	1.962	1.814×10^2	
800. MeV	8.995×10^2	2.033	0.000		0.000	2.034	3.817×10^2	
1.00 GeV	1.101×10^3	2.066	0.000		0.000	2.067	4.793×10^2	
1.40 GeV	1.502×10^3	2.120	0.000		0.001	2.121	6.702×10^2	
2.00 GeV	2.103×10^3	2.179	0.000	0.000	0.001	2.181	9.489×10^2	
3.00 GeV	3.104×10^3	2.246	0.001	0.001	0.001	2.249	1.400×10^3	
4.00 GeV	4.104×10^3	2.293	0.001	0.001	0.002	2.297	1.840×10^3	
8.00 GeV	8.105×10^3	2.400	0.003	0.003	0.004	2.410	3.534×10^3	
10.0 GeV	1.011×10^4	2.433	0.004	0.004	0.005	2.445	4.358×10^3	
14.0 GeV	1.411×10^4	2.480	0.006	0.006	0.007	2.499	5.975×10^3	
20.0 GeV	2.011×10^4	2.528	0.009	0.010	0.009	2.557	8.347×10^3	
30.0 GeV	3.011×10^4	2.580	0.015	0.018	0.014	2.627	1.220×10^4	
40.0 GeV	4.011×10^4	2.615	0.021	0.027	0.018	2.681	1.597×10^4	
80.0 GeV	8.011×10^4	2.697	0.048	0.065	0.035	2.845	3.043×10^4	
100. GeV	1.001×10^5	2.722	0.063	0.086	0.043	2.914	3.737×10^4	
140. GeV	1.401×10^5	2.760	0.093	0.129	0.060	3.042	5.080×10^4	
200. GeV	2.001×10^5	2.800	0.140	0.198	0.084	3.223	6.995×10^4	
300. GeV	3.001×10^5	2.845	0.222	0.315	0.126	3.509	9.967×10^4	
400. GeV	4.001×10^5	2.877	0.306	0.438	0.169	3.790	1.271×10^5	
800. GeV	8.001×10^5	2.954	0.659	0.948	0.341	4.902	2.196×10^5	
1.00 TeV	1.000×10^6	2.980	0.841	1.213	0.428	5.461	2.583×10^5	
1.19 TeV	1.194×10^6	3.000	1.019	1.466	0.515	6.000	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.018	1.209	1.738	0.607	6.572	3.249×10^5	
2.00 TeV	2.000×10^6	3.059	1.774	2.545	0.879	8.258	4.062×10^5	
3.00 TeV	3.000×10^6	3.106	2.723	3.889	1.347	11.066	5.105×10^5	
4.00 TeV	4.000×10^6	3.141	3.688	5.252	1.823	13.905	5.910×10^5	
8.00 TeV	8.000×10^6	3.225	7.602	10.746	3.807	25.380	8.008×10^5	
10.0 TeV	1.000×10^7	3.252	9.582	13.514	4.829	31.177	8.718×10^5	
14.0 TeV	1.400×10^7	3.294	13.534	19.027	6.936	42.792	9.809×10^5	
20.0 TeV	2.000×10^7	3.340	19.515	27.345	10.175	60.375	1.098×10^6	
30.0 TeV	3.000×10^7	3.392	29.475	41.183	15.798	89.848	1.233×10^6	
40.0 TeV	4.000×10^7	3.430	39.492	55.066	21.570	119.558	1.329×10^6	
80.0 TeV	8.000×10^7	3.523	79.640	110.649	45.811	239.624	1.561×10^6	
100. TeV	1.000×10^8	3.554	99.763	138.476	58.382	300.175	1.636×10^6	

TABLE IV-1. Muons in Air (dry, 1 atm)

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49919	1.205×10^{-3}	85.7	0.10914	3.3994	1.7418	4.2759	10.5961	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.039				7.039	7.966×10^{-1}	
14.0 MeV	5.616×10^1	5.494				5.494	1.447×10^0	
20.0 MeV	6.802×10^1	4.294				4.294	2.696×10^0	
30.0 MeV	8.509×10^1	3.333				3.333	5.376×10^0	
40.0 MeV	1.003×10^2	2.847				2.847	8.643×10^0	
80.0 MeV	1.527×10^2	2.140				2.140	2.536×10^1	
100. MeV	1.764×10^2	2.013				2.014	3.502×10^1	
140. MeV	2.218×10^2	1.889				1.889	5.563×10^1	
200. MeV	2.868×10^2	1.827				1.827	8.804×10^1	
257. MeV	3.471×10^2	1.815			0.000	1.816	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.819			0.000	1.819	1.430×10^2	
400. MeV	4.945×10^2	1.844			0.000	1.844	1.977×10^2	
800. MeV	8.995×10^2	1.968	0.000		0.000	1.968	4.075×10^2	
1.00 GeV	1.101×10^3	2.020	0.000		0.000	2.021	5.077×10^2	
1.40 GeV	1.502×10^3	2.105	0.000		0.001	2.106	7.014×10^2	
2.00 GeV	2.103×10^3	2.201	0.001	0.000	0.001	2.203	9.796×10^2	
3.00 GeV	3.104×10^3	2.314	0.001	0.001	0.001	2.318	1.421×10^3	
4.00 GeV	4.104×10^3	2.396	0.001	0.001	0.002	2.401	1.845×10^3	
8.00 GeV	8.105×10^3	2.577	0.004	0.003	0.004	2.588	3.440×10^3	
10.0 GeV	1.011×10^4	2.627	0.005	0.005	0.005	2.642	4.204×10^3	
14.0 GeV	1.411×10^4	2.698	0.007	0.008	0.007	2.720	5.695×10^3	
20.0 GeV	2.011×10^4	2.767	0.011	0.013	0.009	2.801	7.867×10^3	
30.0 GeV	3.011×10^4	2.838	0.019	0.023	0.013	2.893	1.138×10^4	
40.0 GeV	4.011×10^4	2.885	0.026	0.033	0.017	2.962	1.479×10^4	
80.0 GeV	8.011×10^4	2.984	0.060	0.081	0.034	3.159	2.784×10^4	
100. GeV	1.001×10^5	3.014	0.078	0.106	0.042	3.240	3.409×10^4	
140. GeV	1.401×10^5	3.055	0.114	0.159	0.058	3.388	4.616×10^4	
200. GeV	2.001×10^5	3.097	0.172	0.244	0.083	3.596	6.334×10^4	
300. GeV	3.001×10^5	3.143	0.272	0.387	0.124	3.926	8.994×10^4	
400. GeV	4.001×10^5	3.174	0.375	0.537	0.165	4.251	1.144×10^5	
800. GeV	8.001×10^5	3.247	0.803	1.159	0.334	5.544	1.966×10^5	
1.00 TeV	1.000×10^6	3.271	1.025	1.480	0.420	6.196	2.307×10^5	
1.11 TeV	1.114×10^6	3.282	1.151	1.661	0.470	6.565	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.306	1.471	2.119	0.595	7.491	2.893×10^5	
2.00 TeV	2.000×10^6	3.344	2.155	3.097	0.862	9.459	3.604×10^5	
3.00 TeV	3.000×10^6	3.388	3.302	4.727	1.321	12.738	4.512×10^5	
4.00 TeV	4.000×10^6	3.420	4.469	6.378	1.787	16.054	5.210×10^5	
8.00 TeV	8.000×10^6	3.497	9.189	13.030	3.730	29.446	7.023×10^5	
10.0 TeV	1.000×10^7	3.522	11.574	16.380	4.730	36.207	7.634×10^5	
14.0 TeV	1.400×10^7	3.561	16.335	23.055	6.790	49.742	8.573×10^5	
20.0 TeV	2.000×10^7	3.603	23.534	33.122	9.955	70.214	9.584×10^5	
30.0 TeV	3.000×10^7	3.652	35.519	49.874	15.447	104.491	1.074×10^6	
40.0 TeV	4.000×10^7	3.686	47.564	66.680	21.083	139.013	1.157×10^6	
80.0 TeV	8.000×10^7	3.773	95.872	133.958	44.722	278.325	1.357×10^6	
100. TeV	1.000×10^8	3.801	120.091	167.637	56.971	348.500	1.421×10^6	

TABLE IV-2. Muons in Concrete

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.50274	2.300	135.2	0.07515	3.5467	0.1301	3.0466	3.9464	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.663				6.663	8.459×10^{-1}	
14.0 MeV	5.616×10^1	5.214				5.214	1.532×10^0	
20.0 MeV	6.802×10^1	4.084				4.084	2.847×10^0	
30.0 MeV	8.509×10^1	3.178				3.178	5.661×10^0	
40.0 MeV	1.003×10^2	2.719				2.719	9.085×10^0	
80.0 MeV	1.527×10^2	2.049				2.049	2.656×10^1	
100. MeV	1.764×10^2	1.925				1.925	3.665×10^1	
140. MeV	2.218×10^2	1.801				1.801	5.823×10^1	
200. MeV	2.868×10^2	1.732				1.732	9.233×10^1	
293. MeV	3.844×10^2	1.711			0.000	1.711	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.711			0.000	1.711	1.506×10^2	
400. MeV	4.945×10^2	1.722			0.000	1.722	2.089×10^2	
800. MeV	8.995×10^2	1.800	0.000		0.000	1.801	4.360×10^2	
1.00 GeV	1.101×10^3	1.834	0.000		0.000	1.834	5.460×10^2	
1.40 GeV	1.502×10^3	1.888	0.001	0.000	0.001	1.889	7.607×10^2	
2.00 GeV	2.103×10^3	1.947	0.001	0.000	0.001	1.949	1.073×10^3	
3.00 GeV	3.104×10^3	2.014	0.001	0.001	0.001	2.018	1.577×10^3	
4.00 GeV	4.104×10^3	2.060	0.002	0.002	0.002	2.066	2.066×10^3	
8.00 GeV	8.105×10^3	2.165	0.005	0.005	0.004	2.179	3.945×10^3	
10.0 GeV	1.011×10^4	2.197	0.007	0.007	0.005	2.216	4.855×10^3	
14.0 GeV	1.411×10^4	2.243	0.010	0.011	0.006	2.271	6.637×10^3	
20.0 GeV	2.011×10^4	2.289	0.016	0.019	0.009	2.333	9.242×10^3	
30.0 GeV	3.011×10^4	2.338	0.027	0.033	0.013	2.411	1.345×10^4	
40.0 GeV	4.011×10^4	2.372	0.038	0.048	0.017	2.475	1.755×10^4	
80.0 GeV	8.011×10^4	2.448	0.085	0.115	0.033	2.682	3.305×10^4	
100. GeV	1.001×10^5	2.472	0.110	0.152	0.041	2.775	4.038×10^4	
140. GeV	1.401×10^5	2.507	0.162	0.227	0.057	2.954	5.434×10^4	
200. GeV	2.001×10^5	2.544	0.244	0.346	0.081	3.216	7.380×10^4	
300. GeV	3.001×10^5	2.586	0.384	0.549	0.122	3.641	1.030×10^5	
400. GeV	4.001×10^5	2.615	0.529	0.760	0.162	4.067	1.290×10^5	
700. GeV	6.997×10^5	2.673	0.977	1.411	0.286	5.347	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.687	1.130	1.633	0.328	5.778	2.111×10^5	
1.00 TeV	1.000×10^6	2.711	1.441	2.082	0.412	6.645	2.433×10^5	
1.40 TeV	1.400×10^6	2.746	2.065	2.976	0.583	8.371	2.969×10^5	
2.00 TeV	2.000×10^6	2.784	3.022	4.345	0.845	10.996	3.592×10^5	
3.00 TeV	3.000×10^6	2.828	4.624	6.622	1.294	15.368	4.358×10^5	
4.00 TeV	4.000×10^6	2.860	6.252	8.927	1.750	19.790	4.930×10^5	
8.00 TeV	8.000×10^6	2.938	12.832	18.208	3.650	37.628	6.372×10^5	
10.0 TeV	1.000×10^7	2.964	16.155	22.879	4.627	46.625	6.848×10^5	
14.0 TeV	1.400×10^7	3.003	22.789	32.190	6.640	64.621	7.574×10^5	
20.0 TeV	2.000×10^7	3.045	32.815	46.227	9.730	91.817	8.349×10^5	
30.0 TeV	3.000×10^7	3.094	49.496	69.588	15.087	137.266	9.234×10^5	
40.0 TeV	4.000×10^7	3.129	66.253	93.019	20.582	182.984	9.863×10^5	
80.0 TeV	8.000×10^7	3.216	133.445	186.817	43.612	367.090	1.138×10^6	
100. TeV	1.000×10^8	3.244	167.127	233.767	55.538	459.676	1.186×10^6	

TABLE IV-3. Muons in Lead Glass

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.42101	6.220	526.4	0.09544	3.0740	0.0614	3.8146	5.8476	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.504				4.504	1.282×10^0	
14.0 MeV	5.616×10^1	3.561				3.561	2.290×10^0	
20.0 MeV	6.802×10^1	2.816				2.816	4.205×10^0	
30.0 MeV	8.509×10^1	2.213				2.213	8.264×10^0	
40.0 MeV	1.003×10^2	1.905				1.905	1.316×10^1	
80.0 MeV	1.527×10^2	1.456				1.456	3.791×10^1	
100. MeV	1.764×10^2	1.376				1.376	5.207×10^1	
140. MeV	2.218×10^2	1.298				1.298	8.214×10^1	
200. MeV	2.868×10^2	1.260				1.261	1.292×10^2	
247. MeV	3.366×10^2	1.255	0.000			1.256	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.259	0.000		0.000	1.260	2.088×10^2	
400. MeV	4.945×10^2	1.278	0.000		0.000	1.278	2.876×10^2	
800. MeV	8.995×10^2	1.362	0.001		0.000	1.363	5.902×10^2	
1.00 GeV	1.101×10^3	1.395	0.001	0.000	0.000	1.397	7.351×10^2	
1.40 GeV	1.502×10^3	1.449	0.002	0.001	0.001	1.452	1.016×10^3	
2.00 GeV	2.103×10^3	1.507	0.003	0.002	0.001	1.513	1.420×10^3	
3.00 GeV	3.104×10^3	1.573	0.006	0.005	0.001	1.585	2.065×10^3	
4.00 GeV	4.104×10^3	1.618	0.008	0.008	0.002	1.636	2.685×10^3	
8.00 GeV	8.105×10^3	1.722	0.020	0.022	0.003	1.768	5.027×10^3	
10.0 GeV	1.011×10^4	1.753	0.027	0.031	0.004	1.816	6.143×10^3	
14.0 GeV	1.411×10^4	1.798	0.041	0.050	0.006	1.895	8.298×10^3	
20.0 GeV	2.011×10^4	1.843	0.063	0.080	0.008	1.995	1.138×10^4	
30.0 GeV	3.011×10^4	1.890	0.104	0.137	0.011	2.144	1.621×10^4	
40.0 GeV	4.011×10^4	1.922	0.146	0.200	0.015	2.284	2.073×10^4	
80.0 GeV	8.011×10^4	1.992	0.331	0.474	0.029	2.828	3.643×10^4	
100. GeV	1.001×10^5	2.014	0.429	0.621	0.036	3.101	4.319×10^4	
140. GeV	1.401×10^5	2.045	0.630	0.922	0.050	3.648	5.507×10^4	
175. GeV	1.746×10^5	2.064	0.809	1.193	0.062	4.130	<i>Muon critical energy</i>	
200. GeV	2.001×10^5	2.077	0.944	1.398	0.071	4.492	6.987×10^4	
300. GeV	3.001×10^5	2.112	1.481	2.193	0.107	5.894	8.926×10^4	
400. GeV	4.001×10^5	2.137	2.035	3.014	0.143	7.331	1.044×10^5	
800. GeV	8.001×10^5	2.197	4.323	6.378	0.289	13.188	1.446×10^5	
1.00 TeV	1.000×10^6	2.217	5.498	8.096	0.363	16.175	1.583×10^5	
1.40 TeV	1.400×10^6	2.247	7.852	11.522	0.514	22.136	1.793×10^5	
2.00 TeV	2.000×10^6	2.279	11.451	16.745	0.743	31.219	2.020×10^5	
3.00 TeV	3.000×10^6	2.316	17.457	25.425	1.137	46.336	2.282×10^5	
4.00 TeV	4.000×10^6	2.342	23.542	34.191	1.536	61.614	2.468×10^5	
8.00 TeV	8.000×10^6	2.408	48.067	69.414	3.194	123.085	2.919×10^5	
10.0 TeV	1.000×10^7	2.429	60.423	87.113	4.045	154.011	3.064×10^5	
14.0 TeV	1.400×10^7	2.462	85.066	122.431	5.793	215.754	3.282×10^5	
20.0 TeV	2.000×10^7	2.497	122.241	175.619	8.472	308.832	3.513×10^5	
30.0 TeV	3.000×10^7	2.538	184.128	264.125	13.104	463.896	3.776×10^5	
40.0 TeV	4.000×10^7	2.567	246.230	352.824	17.845	619.468	3.962×10^5	
80.0 TeV	8.000×10^7	2.640	494.978	707.849	37.658	1243.127	4.408×10^5	
100. TeV	1.000×10^8	2.664	619.549	885.512	47.896	1555.624	4.552×10^5	

TABLE IV-4. Muons in Photographic Emulsion

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.43663	6.470	487.1	0.24593	2.6814	0.0353	3.2117	5.6166	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	4.741				4.741	1.214×10^0	
14.0 MeV	5.616×10^1	3.744				3.744	2.173×10^0	
20.0 MeV	6.802×10^1	2.958				2.958	3.995×10^0	
30.0 MeV	8.509×10^1	2.322				2.322	7.862×10^0	
40.0 MeV	1.003×10^2	1.998				1.998	1.253×10^1	
80.0 MeV	1.527×10^2	1.525				1.525	3.614×10^1	
100. MeV	1.764×10^2	1.441				1.441	4.966×10^1	
140. MeV	2.218×10^2	1.359				1.359	7.838×10^1	
200. MeV	2.868×10^2	1.319				1.319	1.234×10^2	
247. MeV	3.366×10^2	1.313				1.313	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.317	0.000		0.000	1.318	1.994×10^2	
400. MeV	4.945×10^2	1.336	0.000		0.000	1.337	2.748×10^2	
800. MeV	8.995×10^2	1.423	0.001		0.000	1.424	5.644×10^2	
1.00 GeV	1.101×10^3	1.458	0.001		0.000	1.459	7.031×10^2	
1.40 GeV	1.502×10^3	1.513	0.001	0.001	0.001	1.516	9.718×10^2	
2.00 GeV	2.103×10^3	1.573	0.002	0.001	0.001	1.578	1.359×10^3	
3.00 GeV	3.104×10^3	1.641	0.004	0.003	0.001	1.650	1.978×10^3	
4.00 GeV	4.104×10^3	1.688	0.006	0.005	0.002	1.701	2.574×10^3	
8.00 GeV	8.105×10^3	1.794	0.015	0.016	0.003	1.829	4.833×10^3	
10.0 GeV	1.011×10^4	1.826	0.020	0.022	0.004	1.872	5.913×10^3	
14.0 GeV	1.411×10^4	1.871	0.031	0.036	0.006	1.944	8.009×10^3	
20.0 GeV	2.011×10^4	1.916	0.047	0.058	0.008	2.030	1.103×10^4	
30.0 GeV	3.011×10^4	1.964	0.078	0.100	0.012	2.154	1.581×10^4	
40.0 GeV	4.011×10^4	1.996	0.109	0.146	0.015	2.267	2.033×10^4	
80.0 GeV	8.011×10^4	2.066	0.247	0.347	0.030	2.690	3.649×10^4	
100. GeV	1.001×10^5	2.087	0.320	0.455	0.037	2.900	4.365×10^4	
140. GeV	1.401×10^5	2.117	0.470	0.678	0.051	3.318	5.654×10^4	
200. GeV	2.001×10^5	2.149	0.705	1.031	0.073	3.959	7.308×10^4	
235. GeV	2.352×10^5	2.164	0.844	1.235	0.086	4.329	<i>Muon critical energy</i>	
300. GeV	3.001×10^5	2.186	1.106	1.620	0.109	5.023	9.546×10^4	
400. GeV	4.001×10^5	2.211	1.521	2.231	0.146	6.110	1.135×10^5	
800. GeV	8.001×10^5	2.274	3.234	4.733	0.295	10.537	1.628×10^5	
1.00 TeV	1.000×10^6	2.294	4.115	6.013	0.370	12.794	1.800×10^5	
1.40 TeV	1.400×10^6	2.325	5.881	8.568	0.525	17.300	2.068×10^5	
2.00 TeV	2.000×10^6	2.358	8.583	12.465	0.759	24.166	2.360×10^5	
3.00 TeV	3.000×10^6	2.397	13.096	18.941	1.161	35.596	2.699×10^5	
4.00 TeV	4.000×10^6	2.424	17.670	25.487	1.569	47.151	2.942×10^5	
8.00 TeV	8.000×10^6	2.492	36.119	51.798	3.262	93.672	3.532×10^5	
10.0 TeV	1.000×10^7	2.514	45.419	65.024	4.131	117.089	3.723×10^5	
14.0 TeV	1.400×10^7	2.548	63.968	91.413	5.916	163.847	4.011×10^5	
20.0 TeV	2.000×10^7	2.585	91.961	131.166	8.653	234.365	4.315×10^5	
30.0 TeV	3.000×10^7	2.627	138.562	197.311	13.383	351.885	4.661×10^5	
40.0 TeV	4.000×10^7	2.658	185.338	263.613	18.226	469.835	4.906×10^5	
80.0 TeV	8.000×10^7	2.733	372.739	529.010	38.450	942.933	5.495×10^5	
100. TeV	1.000×10^8	2.758	466.607	661.832	48.897	1180.094	5.684×10^5	

TABLE IV-5. Muons in Plate Glass

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49731	2.400	145.4	0.07678	3.5381	0.1237	3.0649	4.0602	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.524				6.524	8.647×10^{-1}	
14.0 MeV	5.616×10^1	5.107				5.107	1.565×10^0	
20.0 MeV	6.802×10^1	4.002				4.002	2.907×10^0	
30.0 MeV	8.509×10^1	3.115				3.115	5.778×10^0	
40.0 MeV	1.003×10^2	2.666				2.666	9.270×10^0	
80.0 MeV	1.527×10^2	2.011				2.011	2.708×10^1	
100. MeV	1.764×10^2	1.890				1.890	3.737×10^1	
140. MeV	2.218×10^2	1.769				1.769	5.934×10^1	
200. MeV	2.868×10^2	1.703				1.703	9.404×10^1	
288. MeV	3.788×10^2	1.684			0.000	1.684	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.684			0.000	1.684	1.532×10^2	
400. MeV	4.945×10^2	1.695			0.000	1.696	2.125×10^2	
800. MeV	8.995×10^2	1.774	0.000		0.000	1.775	4.430×10^2	
1.00 GeV	1.101×10^3	1.808	0.000		0.000	1.809	5.546×10^2	
1.40 GeV	1.502×10^3	1.862	0.001	0.000	0.001	1.863	7.723×10^2	
2.00 GeV	2.103×10^3	1.921	0.001	0.000	0.001	1.923	1.089×10^3	
3.00 GeV	3.104×10^3	1.988	0.002	0.001	0.001	1.992	1.599×10^3	
4.00 GeV	4.104×10^3	2.034	0.002	0.002	0.002	2.040	2.095×10^3	
8.00 GeV	8.105×10^3	2.139	0.005	0.005	0.004	2.153	3.997×10^3	
10.0 GeV	1.011×10^4	2.170	0.007	0.007	0.005	2.189	4.918×10^3	
14.0 GeV	1.411×10^4	2.216	0.011	0.012	0.006	2.245	6.721×10^3	
20.0 GeV	2.011×10^4	2.262	0.017	0.020	0.009	2.307	9.356×10^3	
30.0 GeV	3.011×10^4	2.311	0.028	0.034	0.013	2.385	1.361×10^4	
40.0 GeV	4.011×10^4	2.344	0.039	0.050	0.017	2.450	1.775×10^4	
80.0 GeV	8.011×10^4	2.419	0.088	0.120	0.033	2.661	3.339×10^4	
100. GeV	1.001×10^5	2.443	0.114	0.158	0.041	2.756	4.077×10^4	
140. GeV	1.401×10^5	2.477	0.168	0.236	0.057	2.939	5.482×10^4	
200. GeV	2.001×10^5	2.514	0.253	0.360	0.081	3.208	7.435×10^4	
300. GeV	3.001×10^5	2.555	0.398	0.571	0.121	3.646	1.036×10^5	
400. GeV	4.001×10^5	2.585	0.549	0.790	0.161	4.085	1.295×10^5	
670. GeV	6.703×10^5	2.637	0.967	1.398	0.272	5.275	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.656	1.173	1.695	0.326	5.850	2.109×10^5	
1.00 TeV	1.000×10^6	2.679	1.495	2.160	0.410	6.744	2.427×10^5	
1.40 TeV	1.400×10^6	2.714	2.142	3.088	0.581	8.526	2.953×10^5	
2.00 TeV	2.000×10^6	2.752	3.134	4.507	0.842	11.236	3.565×10^5	
3.00 TeV	3.000×10^6	2.795	4.795	6.868	1.289	15.748	4.313×10^5	
4.00 TeV	4.000×10^6	2.827	6.482	9.259	1.744	20.312	4.871×10^5	
8.00 TeV	8.000×10^6	2.904	13.302	18.881	3.636	38.723	6.273×10^5	
10.0 TeV	1.000×10^7	2.929	16.746	23.724	4.610	48.009	6.736×10^5	
14.0 TeV	1.400×10^7	2.968	23.621	33.377	6.614	66.581	7.441×10^5	
20.0 TeV	2.000×10^7	3.010	34.012	47.930	9.691	94.643	8.193×10^5	
30.0 TeV	3.000×10^7	3.058	51.296	72.150	15.025	141.530	9.051×10^5	
40.0 TeV	4.000×10^7	3.093	68.658	96.442	20.495	188.689	9.661×10^5	
80.0 TeV	8.000×10^7	3.179	138.275	193.686	43.419	378.558	1.113×10^6	
100. TeV	1.000×10^8	3.207	173.170	242.360	55.289	474.026	1.160×10^6	

TABLE IV-6. Muons in Standard Rock

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.50000	2.650	136.4	0.08301	3.4120	0.0492	3.0549	3.7738	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	6.619				6.619	8.516×10^{-1}	
14.0 MeV	5.616×10^1	5.179				5.179	1.542×10^0	
20.0 MeV	6.802×10^1	4.057				4.057	2.866×10^0	
30.0 MeV	8.509×10^1	3.157				3.157	5.698×10^0	
40.0 MeV	1.003×10^2	2.701				2.701	9.145×10^0	
80.0 MeV	1.527×10^2	2.028				2.029	2.676×10^1	
100. MeV	1.764×10^2	1.904				1.904	3.696×10^1	
140. MeV	2.218×10^2	1.779				1.779	5.879×10^1	
200. MeV	2.868×10^2	1.710				1.710	9.332×10^1	
297. MeV	3.884×10^2	1.688			0.000	1.688	<i>Minimum ionization</i>	
300. MeV	3.917×10^2	1.688			0.000	1.688	1.524×10^2	
400. MeV	4.945×10^2	1.698			0.000	1.698	2.115×10^2	
800. MeV	8.995×10^2	1.774	0.000		0.000	1.775	4.418×10^2	
1.00 GeV	1.101×10^3	1.808	0.000		0.000	1.808	5.534×10^2	
1.40 GeV	1.502×10^3	1.861	0.001	0.000	0.001	1.862	7.712×10^2	
2.00 GeV	2.103×10^3	1.920	0.001	0.000	0.001	1.922	1.088×10^3	
3.00 GeV	3.104×10^3	1.986	0.001	0.001	0.001	1.990	1.599×10^3	
4.00 GeV	4.104×10^3	2.033	0.002	0.002	0.002	2.038	2.095×10^3	
8.00 GeV	8.105×10^3	2.138	0.005	0.005	0.004	2.152	3.998×10^3	
10.0 GeV	1.011×10^4	2.170	0.007	0.007	0.005	2.188	4.920×10^3	
14.0 GeV	1.411×10^4	2.215	0.010	0.011	0.006	2.244	6.724×10^3	
20.0 GeV	2.011×10^4	2.262	0.016	0.019	0.009	2.306	9.360×10^3	
30.0 GeV	3.011×10^4	2.311	0.027	0.033	0.013	2.383	1.362×10^4	
40.0 GeV	4.011×10^4	2.344	0.038	0.048	0.017	2.447	1.776×10^4	
80.0 GeV	8.011×10^4	2.420	0.085	0.115	0.033	2.654	3.343×10^4	
100. GeV	1.001×10^5	2.444	0.110	0.152	0.041	2.747	4.084×10^4	
140. GeV	1.401×10^5	2.479	0.162	0.227	0.057	2.925	5.495×10^4	
200. GeV	2.001×10^5	2.515	0.244	0.347	0.081	3.187	7.459×10^4	
300. GeV	3.001×10^5	2.557	0.384	0.549	0.121	3.611	1.040×10^5	
400. GeV	4.001×10^5	2.586	0.529	0.759	0.162	4.037	1.302×10^5	
693. GeV	6.928×10^5	2.643	0.967	1.394	0.282	5.286	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.658	1.131	1.632	0.327	5.748	2.129×10^5	
1.00 TeV	1.000×10^6	2.681	1.441	2.082	0.410	6.615	2.453×10^5	
1.40 TeV	1.400×10^6	2.717	2.065	2.976	0.582	8.340	2.990×10^5	
2.00 TeV	2.000×10^6	2.755	3.023	4.344	0.842	10.964	3.616×10^5	
3.00 TeV	3.000×10^6	2.798	4.625	6.621	1.290	15.335	4.384×10^5	
4.00 TeV	4.000×10^6	2.830	6.253	8.926	1.745	19.755	4.957×10^5	
8.00 TeV	8.000×10^6	2.908	12.836	18.207	3.639	37.590	6.400×10^5	
10.0 TeV	1.000×10^7	2.933	16.161	22.878	4.613	46.586	6.877×10^5	
14.0 TeV	1.400×10^7	2.972	22.799	32.188	6.619	64.579	7.603×10^5	
20.0 TeV	2.000×10^7	3.014	32.834	46.224	9.698	91.770	8.379×10^5	
30.0 TeV	3.000×10^7	3.062	49.519	69.586	15.037	137.204	9.264×10^5	
40.0 TeV	4.000×10^7	3.097	66.279	93.017	20.513	182.906	9.894×10^5	
80.0 TeV	8.000×10^7	3.184	133.489	186.823	43.458	366.954	1.141×10^6	
100. TeV	1.000×10^8	3.212	167.180	233.780	55.340	459.512	1.189×10^6	

TABLE V-1. Muons in A-150 Tissue-Equivalent Plastic

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.54903	1.127	65.1	0.10783	3.4442	0.1329	2.6234	3.1100	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.022				8.022	6.970×10^{-1}	
14.0 MeV	5.616×10^1	6.253				6.253	1.268×10^0	
20.0 MeV	6.802×10^1	4.881				4.881	2.366×10^0	
30.0 MeV	8.509×10^1	3.784				3.784	4.726×10^0	
40.0 MeV	1.003×10^2	3.230				3.230	7.606×10^0	
80.0 MeV	1.527×10^2	2.418				2.418	2.237×10^1	
100. MeV	1.764×10^2	2.264				2.264	3.094×10^1	
140. MeV	2.218×10^2	2.106				2.106	4.934×10^1	
200. MeV	2.868×10^2	2.015				2.015	7.858×10^1	
300. MeV	3.917×10^2	1.978			0.000	1.979	1.288×10^2	
324. MeV	4.161×10^2	1.978			0.000	1.978	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.983			0.000	1.983	1.793×10^2	
800. MeV	8.995×10^2	2.054	0.000		0.000	2.055	3.776×10^2	
1.00 GeV	1.101×10^3	2.087	0.000		0.000	2.088	4.741×10^2	
1.40 GeV	1.502×10^3	2.141	0.000		0.001	2.142	6.631×10^2	
2.00 GeV	2.103×10^3	2.201	0.000	0.000	0.001	2.203	9.391×10^2	
3.00 GeV	3.104×10^3	2.269	0.001	0.001	0.001	2.272	1.386×10^3	
4.00 GeV	4.104×10^3	2.316	0.001	0.001	0.002	2.320	1.821×10^3	
8.00 GeV	8.105×10^3	2.425	0.003	0.003	0.004	2.435	3.499×10^3	
10.0 GeV	1.011×10^4	2.458	0.004	0.004	0.005	2.471	4.314×10^3	
14.0 GeV	1.411×10^4	2.506	0.006	0.007	0.007	2.526	5.914×10^3	
20.0 GeV	2.011×10^4	2.555	0.010	0.011	0.009	2.585	8.261×10^3	
30.0 GeV	3.011×10^4	2.607	0.016	0.019	0.014	2.656	1.207×10^4	
40.0 GeV	4.011×10^4	2.643	0.022	0.028	0.018	2.712	1.580×10^4	
80.0 GeV	8.011×10^4	2.726	0.051	0.069	0.035	2.881	3.008×10^4	
100. GeV	1.001×10^5	2.752	0.066	0.091	0.043	2.952	3.694×10^4	
140. GeV	1.401×10^5	2.791	0.098	0.136	0.059	3.085	5.019×10^4	
200. GeV	2.001×10^5	2.831	0.148	0.209	0.084	3.272	6.907×10^4	
300. GeV	3.001×10^5	2.876	0.234	0.333	0.126	3.569	9.831×10^4	
400. GeV	4.001×10^5	2.909	0.323	0.462	0.168	3.861	1.252×10^5	
800. GeV	8.001×10^5	2.987	0.694	0.999	0.340	5.020	2.158×10^5	
1.00 TeV	1.000×10^6	3.013	0.886	1.276	0.427	5.603	2.535×10^5	
1.16 TeV	1.159×10^6	3.030	1.038	1.494	0.498	6.060	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.052	1.273	1.830	0.606	6.760	3.184×10^5	
2.00 TeV	2.000×10^6	3.093	1.867	2.678	0.878	8.517	3.973×10^5	
3.00 TeV	3.000×10^6	3.142	2.865	4.091	1.346	11.443	4.983×10^5	
4.00 TeV	4.000×10^6	3.176	3.880	5.524	1.821	14.402	5.760×10^5	
8.00 TeV	8.000×10^6	3.261	7.995	11.298	3.803	26.357	7.783×10^5	
10.0 TeV	1.000×10^7	3.289	10.077	14.207	4.824	32.397	8.467×10^5	
14.0 TeV	1.400×10^7	3.332	14.232	20.002	6.928	44.494	9.516×10^5	
20.0 TeV	2.000×10^7	3.378	20.520	28.744	10.162	62.804	1.065×10^6	
30.0 TeV	3.000×10^7	3.431	30.991	43.286	15.777	93.486	1.194×10^6	
40.0 TeV	4.000×10^7	3.470	41.521	57.877	21.542	124.410	1.287×10^6	
80.0 TeV	8.000×10^7	3.564	83.733	116.291	45.750	249.339	1.509×10^6	
100. TeV	1.000×10^8	3.596	104.894	145.534	58.303	312.327	1.581×10^6	

TABLE V-2. Muons in Adipose Tissue (ICRP)

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.55947	0.920	63.2	0.10278	3.4817	0.1827	2.6530	3.2367	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	8.205				8.205	6.812×10^{-1}	
14.0 MeV	5.616×10^1	6.395				6.395	1.239×10^0	
20.0 MeV	6.802×10^1	4.991				4.991	2.314×10^0	
30.0 MeV	8.509×10^1	3.869				3.869	4.621×10^0	
40.0 MeV	1.003×10^2	3.302				3.302	7.438×10^0	
80.0 MeV	1.527×10^2	2.476				2.476	2.188×10^1	
100. MeV	1.764×10^2	2.322				2.322	3.024×10^1	
140. MeV	2.218×10^2	2.160				2.160	4.818×10^1	
200. MeV	2.868×10^2	2.067				2.067	7.669×10^1	
300. MeV	3.917×10^2	2.030			0.000	2.030	1.257×10^2	
324. MeV	4.161×10^2	2.029			0.000	2.029	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	2.035			0.000	2.035	1.749×10^2	
800. MeV	8.995×10^2	2.108	0.000		0.000	2.108	3.681×10^2	
1.00 GeV	1.101×10^3	2.142	0.000		0.000	2.142	4.622×10^2	
1.40 GeV	1.502×10^3	2.197	0.000		0.001	2.198	6.464×10^2	
2.00 GeV	2.103×10^3	2.258	0.000	0.000	0.001	2.260	9.155×10^2	
3.00 GeV	3.104×10^3	2.327	0.001	0.001	0.001	2.330	1.351×10^3	
4.00 GeV	4.104×10^3	2.376	0.001	0.001	0.002	2.380	1.775×10^3	
8.00 GeV	8.105×10^3	2.487	0.003	0.003	0.004	2.497	3.411×10^3	
10.0 GeV	1.011×10^4	2.520	0.004	0.004	0.005	2.534	4.206×10^3	
14.0 GeV	1.411×10^4	2.570	0.006	0.007	0.007	2.589	5.767×10^3	
20.0 GeV	2.011×10^4	2.619	0.010	0.011	0.009	2.649	8.056×10^3	
30.0 GeV	3.011×10^4	2.673	0.016	0.019	0.014	2.722	1.178×10^4	
40.0 GeV	4.011×10^4	2.710	0.022	0.028	0.018	2.779	1.541×10^4	
80.0 GeV	8.011×10^4	2.794	0.051	0.069	0.035	2.949	2.936×10^4	
100. GeV	1.001×10^5	2.820	0.067	0.091	0.043	3.021	3.606×10^4	
140. GeV	1.401×10^5	2.860	0.098	0.137	0.060	3.154	4.902×10^4	
200. GeV	2.001×10^5	2.901	0.148	0.209	0.084	3.343	6.749×10^4	
300. GeV	3.001×10^5	2.947	0.234	0.333	0.126	3.641	9.613×10^4	
400. GeV	4.001×10^5	2.980	0.323	0.462	0.169	3.934	1.225×10^5	
800. GeV	8.001×10^5	3.060	0.696	1.001	0.341	5.097	2.116×10^5	
1.00 TeV	1.000×10^6	3.086	0.888	1.279	0.428	5.682	2.488×10^5	
1.18 TeV	1.183×10^6	3.106	1.065	1.532	0.510	6.212	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.126	1.276	1.834	0.607	6.843	3.128×10^5	
2.00 TeV	2.000×10^6	3.168	1.873	2.684	0.879	8.604	3.909×10^5	
3.00 TeV	3.000×10^6	3.217	2.873	4.100	1.347	11.538	4.909×10^5	
4.00 TeV	4.000×10^6	3.253	3.892	5.537	1.823	14.505	5.681×10^5	
8.00 TeV	8.000×10^6	3.339	8.021	11.325	3.806	26.492	7.691×10^5	
10.0 TeV	1.000×10^7	3.368	10.110	14.241	4.828	32.548	8.371×10^5	
14.0 TeV	1.400×10^7	3.411	14.280	20.050	6.934	44.677	9.416×10^5	
20.0 TeV	2.000×10^7	3.458	20.591	28.814	10.172	63.036	1.054×10^6	
30.0 TeV	3.000×10^7	3.513	31.101	43.393	15.793	93.800	1.183×10^6	
40.0 TeV	4.000×10^7	3.552	41.671	58.020	21.564	124.807	1.276×10^6	
80.0 TeV	8.000×10^7	3.648	84.052	116.580	45.798	250.079	1.498×10^6	
100. TeV	1.000×10^8	3.680	105.300	145.896	58.365	313.241	1.569×10^6	

TABLE V-3. Muons in Blood (ICRP)

See page 209 for Explanation of Tables

(Z/A) 0.54995	ρ [g/cm ³] 1.060	I [eV] 75.2	a 0.08492	$k = m_s$ 3.5406	x_0 0.2239	x_1 2.8017	\bar{C} 3.4581	δ_0 0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.888				7.888	7.098×10^{-1}	
14.0 MeV	5.616×10^1	6.153				6.153	1.290×10^0	
20.0 MeV	6.802×10^1	4.806				4.806	2.406×10^0	
30.0 MeV	8.509×10^1	3.728				3.728	4.802×10^0	
40.0 MeV	1.003×10^2	3.184				3.184	7.723×10^0	
80.0 MeV	1.527×10^2	2.390				2.390	2.269×10^1	
100. MeV	1.764×10^2	2.248				2.248	3.134×10^1	
140. MeV	2.218×10^2	2.094				2.094	4.986×10^1	
200. MeV	2.868×10^2	2.005				2.006	7.925×10^1	
300. MeV	3.917×10^2	1.972			0.000	1.972	1.297×10^2	
318. MeV	4.105×10^2	1.971			0.000	1.971	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.978			0.000	1.978	1.804×10^2	
800. MeV	8.995×10^2	2.053	0.000		0.000	2.053	3.789×10^2	
1.00 GeV	1.101×10^3	2.087	0.000		0.000	2.087	4.755×10^2	
1.40 GeV	1.502×10^3	2.142	0.000		0.001	2.143	6.645×10^2	
2.00 GeV	2.103×10^3	2.203	0.001	0.000	0.001	2.205	9.402×10^2	
3.00 GeV	3.104×10^3	2.273	0.001	0.001	0.001	2.276	1.386×10^3	
4.00 GeV	4.104×10^3	2.321	0.001	0.001	0.002	2.326	1.821×10^3	
8.00 GeV	8.105×10^3	2.432	0.004	0.003	0.004	2.443	3.493×10^3	
10.0 GeV	1.011×10^4	2.466	0.005	0.005	0.005	2.480	4.306×10^3	
14.0 GeV	1.411×10^4	2.514	0.007	0.008	0.007	2.536	5.900×10^3	
20.0 GeV	2.011×10^4	2.564	0.011	0.013	0.009	2.597	8.236×10^3	
30.0 GeV	3.011×10^4	2.617	0.018	0.023	0.013	2.671	1.203×10^4	
40.0 GeV	4.011×10^4	2.653	0.026	0.033	0.018	2.730	1.573×10^4	
80.0 GeV	8.011×10^4	2.736	0.060	0.080	0.034	2.910	2.990×10^4	
100. GeV	1.001×10^5	2.762	0.077	0.106	0.042	2.988	3.668×10^4	
140. GeV	1.401×10^5	2.800	0.114	0.159	0.059	3.132	4.975×10^4	
200. GeV	2.001×10^5	2.841	0.172	0.243	0.084	3.340	6.830×10^4	
300. GeV	3.001×10^5	2.886	0.271	0.387	0.125	3.669	9.685×10^4	
400. GeV	4.001×10^5	2.919	0.374	0.536	0.167	3.996	1.230×10^5	
800. GeV	8.001×10^5	2.997	0.803	1.157	0.337	5.295	2.096×10^5	
1.00 TeV	1.000×10^6	3.023	1.025	1.478	0.424	5.950	2.452×10^5	
1.03 TeV	1.032×10^6	3.027	1.061	1.528	0.438	6.053	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.062	1.472	2.116	0.601	7.251	3.060×10^5	
2.00 TeV	2.000×10^6	3.104	2.158	3.095	0.870	9.227	3.792×10^5	
3.00 TeV	3.000×10^6	3.152	3.309	4.724	1.333	12.518	4.720×10^5	
4.00 TeV	4.000×10^6	3.187	4.479	6.376	1.803	15.846	5.428×10^5	
8.00 TeV	8.000×10^6	3.272	9.219	13.030	3.764	29.286	7.257×10^5	
10.0 TeV	1.000×10^7	3.300	11.616	16.381	4.774	36.072	7.871×10^5	
14.0 TeV	1.400×10^7	3.343	16.401	23.058	6.856	49.657	8.812×10^5	
20.0 TeV	2.000×10^7	3.389	23.638	33.129	10.053	70.209	9.824×10^5	
30.0 TeV	3.000×10^7	3.442	35.689	49.885	15.604	104.620	1.098×10^6	
40.0 TeV	4.000×10^7	3.481	47.805	66.695	21.301	139.281	1.181×10^6	
80.0 TeV	8.000×10^7	3.575	96.402	133.991	45.210	279.178	1.380×10^6	
100. TeV	1.000×10^8	3.607	120.770	167.679	57.604	349.660	1.444×10^6	

TABLE V-4. Muons in Cortical Bone (ICRP)

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.52130	1.850	106.4	0.06198	3.5919	0.1161	3.0919	3.6488	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.141				7.141	7.870×10^{-1}	
14.0 MeV	5.616×10^1	5.580				5.580	1.427×10^0	
20.0 MeV	6.802×10^1	4.366				4.366	2.657×10^0	
30.0 MeV	8.509×10^1	3.393				3.393	5.291×10^0	
40.0 MeV	1.003×10^2	2.900				2.900	8.500×10^0	
80.0 MeV	1.527×10^2	2.179				2.179	2.490×10^1	
100. MeV	1.764×10^2	2.044				2.044	3.441×10^1	
140. MeV	2.218×10^2	1.907				1.907	5.476×10^1	
200. MeV	2.868×10^2	1.830				1.830	8.701×10^1	
300. MeV	3.917×10^2	1.803			0.000	1.803	1.422×10^2	
303. MeV	3.950×10^2	1.803			0.000	1.803	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.812			0.000	1.812	1.976×10^2	
800. MeV	8.995×10^2	1.888	0.000		0.000	1.889	4.138×10^2	
1.00 GeV	1.101×10^3	1.922	0.000		0.000	1.923	5.187×10^2	
1.40 GeV	1.502×10^3	1.976	0.000	0.000	0.001	1.978	7.237×10^2	
2.00 GeV	2.103×10^3	2.036	0.001	0.000	0.001	2.039	1.022×10^3	
3.00 GeV	3.104×10^3	2.105	0.001	0.001	0.001	2.108	1.504×10^3	
4.00 GeV	4.104×10^3	2.152	0.002	0.002	0.002	2.158	1.973×10^3	
8.00 GeV	8.105×10^3	2.260	0.005	0.005	0.004	2.274	3.773×10^3	
10.0 GeV	1.011×10^4	2.293	0.007	0.007	0.005	2.311	4.645×10^3	
14.0 GeV	1.411×10^4	2.340	0.010	0.011	0.006	2.368	6.353×10^3	
20.0 GeV	2.011×10^4	2.388	0.016	0.018	0.009	2.431	8.852×10^3	
30.0 GeV	3.011×10^4	2.439	0.026	0.032	0.013	2.510	1.290×10^4	
40.0 GeV	4.011×10^4	2.474	0.036	0.046	0.017	2.574	1.683×10^4	
80.0 GeV	8.011×10^4	2.553	0.082	0.111	0.033	2.780	3.176×10^4	
100. GeV	1.001×10^5	2.578	0.106	0.147	0.041	2.873	3.883×10^4	
140. GeV	1.401×10^5	2.614	0.157	0.220	0.058	3.049	5.235×10^4	
200. GeV	2.001×10^5	2.652	0.236	0.336	0.082	3.306	7.124×10^4	
300. GeV	3.001×10^5	2.696	0.371	0.532	0.123	3.721	9.973×10^4	
400. GeV	4.001×10^5	2.726	0.511	0.736	0.163	4.137	1.252×10^5	
748. GeV	7.481×10^5	2.794	1.017	1.469	0.308	5.588	<i>Muon critical energy</i>	
800. GeV	8.001×10^5	2.801	1.094	1.580	0.330	5.806	2.064×10^5	
1.00 TeV	1.000×10^6	2.825	1.394	2.015	0.415	6.650	2.386×10^5	
1.40 TeV	1.400×10^6	2.862	1.999	2.881	0.588	8.330	2.923×10^5	
2.00 TeV	2.000×10^6	2.902	2.926	4.206	0.851	10.886	3.551×10^5	
3.00 TeV	3.000×10^6	2.947	4.479	6.411	1.304	15.142	4.327×10^5	
4.00 TeV	4.000×10^6	2.980	6.056	8.644	1.765	19.446	4.908×10^5	
8.00 TeV	8.000×10^6	3.061	12.435	17.634	3.680	36.811	6.378×10^5	
10.0 TeV	1.000×10^7	3.088	15.657	22.159	4.667	45.571	6.866×10^5	
14.0 TeV	1.400×10^7	3.128	22.089	31.179	6.698	63.095	7.609×10^5	
20.0 TeV	2.000×10^7	3.172	31.812	44.779	9.817	89.580	8.403×10^5	
30.0 TeV	3.000×10^7	3.223	47.990	67.408	15.228	133.848	9.310×10^5	
40.0 TeV	4.000×10^7	3.259	64.243	90.104	20.778	178.385	9.955×10^5	
80.0 TeV	8.000×10^7	3.349	129.413	180.964	44.052	357.778	1.151×10^6	
100. TeV	1.000×10^8	3.378	162.080	226.444	56.108	448.012	1.201×10^6	

TABLE V-5. Muons in C-552 Air-Equivalent Plastic

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.49969	1.760	86.8	0.10492	3.4344	0.1510	2.7083	3.3338	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.034				7.034	7.972×10^{-1}	
14.0 MeV	5.616×10^1	5.491				5.491	1.448×10^0	
20.0 MeV	6.802×10^1	4.291				4.291	2.698×10^0	
30.0 MeV	8.509×10^1	3.332				3.332	5.380×10^0	
40.0 MeV	1.003×10^2	2.846				2.846	8.648×10^0	
80.0 MeV	1.527×10^2	2.138				2.138	2.537×10^1	
100. MeV	1.764×10^2	2.004				2.004	3.506×10^1	
140. MeV	2.218×10^2	1.867				1.867	5.584×10^1	
200. MeV	2.868×10^2	1.789				1.789	8.879×10^1	
300. MeV	3.917×10^2	1.760			0.000	1.760	1.453×10^2	
313. MeV	4.055×10^2	1.760			0.000	1.760	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.766			0.000	1.767	2.021×10^2	
800. MeV	8.995×10^2	1.835	0.000		0.000	1.835	4.243×10^2	
1.00 GeV	1.101×10^3	1.866	0.000		0.000	1.867	5.323×10^2	
1.40 GeV	1.502×10^3	1.916	0.000		0.001	1.917	7.436×10^2	
2.00 GeV	2.103×10^3	1.972	0.001	0.000	0.001	1.974	1.052×10^3	
3.00 GeV	3.104×10^3	2.035	0.001	0.001	0.001	2.038	1.550×10^3	
4.00 GeV	4.104×10^3	2.079	0.001	0.001	0.002	2.083	2.035×10^3	
8.00 GeV	8.105×10^3	2.179	0.003	0.003	0.004	2.190	3.902×10^3	
10.0 GeV	1.011×10^4	2.209	0.005	0.005	0.005	2.223	4.808×10^3	
14.0 GeV	1.411×10^4	2.253	0.007	0.008	0.007	2.275	6.586×10^3	
20.0 GeV	2.011×10^4	2.298	0.011	0.013	0.009	2.331	9.190×10^3	
30.0 GeV	3.011×10^4	2.346	0.018	0.022	0.013	2.400	1.341×10^4	
40.0 GeV	4.011×10^4	2.379	0.026	0.032	0.017	2.454	1.753×10^4	
80.0 GeV	8.011×10^4	2.454	0.058	0.078	0.034	2.625	3.327×10^4	
100. GeV	1.001×10^5	2.478	0.075	0.103	0.042	2.699	4.078×10^4	
140. GeV	1.401×10^5	2.513	0.111	0.155	0.058	2.837	5.523×10^4	
200. GeV	2.001×10^5	2.549	0.167	0.237	0.083	3.037	7.566×10^4	
300. GeV	3.001×10^5	2.591	0.264	0.377	0.124	3.356	1.070×10^5	
400. GeV	4.001×10^5	2.620	0.364	0.522	0.165	3.672	1.354×10^5	
800. GeV	8.001×10^5	2.692	0.781	1.126	0.334	4.933	2.291×10^5	
953. GeV	9.532×10^5	2.710	0.945	1.365	0.400	5.421	<i>Muon critical energy</i>	
1.00 TeV	1.000×10^6	2.715	0.996	1.439	0.420	5.570	2.672×10^5	
1.40 TeV	1.400×10^6	2.751	1.429	2.060	0.596	6.836	3.319×10^5	
2.00 TeV	2.000×10^6	2.788	2.095	3.012	0.863	8.759	4.093×10^5	
3.00 TeV	3.000×10^6	2.832	3.210	4.596	1.323	11.962	5.066×10^5	
4.00 TeV	4.000×10^6	2.864	4.345	6.203	1.790	15.202	5.806×10^5	
8.00 TeV	8.000×10^6	2.941	8.937	12.673	3.735	28.286	7.706×10^5	
10.0 TeV	1.000×10^7	2.967	11.258	15.932	4.737	34.894	8.341×10^5	
14.0 TeV	1.400×10^7	3.006	15.890	22.425	6.800	48.121	9.313×10^5	
20.0 TeV	2.000×10^7	3.048	22.895	32.217	9.970	68.130	1.036×10^6	
30.0 TeV	3.000×10^7	3.096	34.558	48.511	15.470	101.636	1.155×10^6	
40.0 TeV	4.000×10^7	3.131	46.282	64.856	21.115	135.384	1.240×10^6	
80.0 TeV	8.000×10^7	3.217	93.278	130.296	44.797	271.588	1.445×10^6	
100. TeV	1.000×10^8	3.246	116.833	163.055	57.070	340.204	1.510×10^6	

TABLE V-6. Muons in Eye Lens (ICRP)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.54977	1.100	73.3	0.09690	3.4550	0.2070	2.7446	3.3720	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.912				7.912	7.075×10^{-1}	
14.0 MeV	5.616×10^1	6.171				6.171	1.286×10^0	
20.0 MeV	6.802×10^1	4.819				4.819	2.399×10^0	
30.0 MeV	8.509×10^1	3.738				3.738	4.788×10^0	
40.0 MeV	1.003×10^2	3.192				3.192	7.702×10^0	
80.0 MeV	1.527×10^2	2.396				2.396	2.263×10^1	
100. MeV	1.764×10^2	2.251				2.251	3.126×10^1	
140. MeV	2.218×10^2	2.095				2.096	4.977×10^1	
200. MeV	2.868×10^2	2.006				2.006	7.915×10^1	
300. MeV	3.917×10^2	1.971			0.000	1.971	1.296×10^2	
318. MeV	4.105×10^2	1.971			0.000	1.971	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.977			0.000	1.977	1.803×10^2	
800. MeV	8.995×10^2	2.051	0.000		0.000	2.051	3.790×10^2	
1.00 GeV	1.101×10^3	2.085	0.000		0.000	2.085	4.756×10^2	
1.40 GeV	1.502×10^3	2.140	0.000		0.001	2.141	6.648×10^2	
2.00 GeV	2.103×10^3	2.201	0.001	0.000	0.001	2.203	9.409×10^2	
3.00 GeV	3.104×10^3	2.270	0.001	0.001	0.001	2.273	1.387×10^3	
4.00 GeV	4.104×10^3	2.318	0.001	0.001	0.002	2.323	1.822×10^3	
8.00 GeV	8.105×10^3	2.429	0.003	0.003	0.004	2.439	3.498×10^3	
10.0 GeV	1.011×10^4	2.462	0.005	0.005	0.005	2.476	4.311×10^3	
14.0 GeV	1.411×10^4	2.511	0.007	0.008	0.007	2.532	5.908×10^3	
20.0 GeV	2.011×10^4	2.560	0.011	0.012	0.009	2.593	8.248×10^3	
30.0 GeV	3.011×10^4	2.613	0.018	0.022	0.014	2.666	1.205×10^4	
40.0 GeV	4.011×10^4	2.649	0.025	0.032	0.018	2.724	1.576×10^4	
80.0 GeV	8.011×10^4	2.732	0.058	0.078	0.034	2.902	2.996×10^4	
100. GeV	1.001×10^5	2.758	0.075	0.103	0.042	2.978	3.676×10^4	
140. GeV	1.401×10^5	2.796	0.111	0.154	0.059	3.120	4.988×10^4	
200. GeV	2.001×10^5	2.837	0.167	0.236	0.084	3.323	6.851×10^4	
300. GeV	3.001×10^5	2.882	0.263	0.375	0.125	3.645	9.722×10^4	
400. GeV	4.001×10^5	2.915	0.363	0.519	0.167	3.964	1.235×10^5	
800. GeV	8.001×10^5	2.993	0.779	1.122	0.338	5.232	2.111×10^5	
1.00 TeV	1.000×10^6	3.019	0.994	1.433	0.424	5.871	2.471×10^5	
1.06 TeV	1.057×10^6	3.025	1.055	1.521	0.449	6.051	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.058	1.428	2.053	0.602	7.141	3.088×10^5	
2.00 TeV	2.000×10^6	3.100	2.094	3.003	0.871	9.068	3.832×10^5	
3.00 TeV	3.000×10^6	3.148	3.211	4.584	1.335	12.278	4.777×10^5	
4.00 TeV	4.000×10^6	3.183	4.347	6.188	1.807	15.525	5.499×10^5	
8.00 TeV	8.000×10^6	3.268	8.949	12.647	3.771	28.635	7.368×10^5	
10.0 TeV	1.000×10^7	3.296	11.276	15.900	4.783	35.256	7.996×10^5	
14.0 TeV	1.400×10^7	3.339	15.921	22.382	6.868	48.511	8.960×10^5	
20.0 TeV	2.000×10^7	3.385	22.948	32.159	10.072	68.565	9.995×10^5	
30.0 TeV	3.000×10^7	3.438	34.650	48.427	15.634	102.149	1.118×10^6	
40.0 TeV	4.000×10^7	3.477	46.415	64.746	21.343	135.981	1.203×10^6	
80.0 TeV	8.000×10^7	3.571	93.601	130.080	45.304	272.557	1.407×10^6	
100. TeV	1.000×10^8	3.603	117.262	162.786	57.726	341.376	1.472×10^6	

TABLE V-7. Muons in mS20 Tissue Substitute

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.53886	1.000	75.1	0.08294	3.6061	0.1997	2.8033	3.5341	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.730				7.731	7.243×10^{-1}	
14.0 MeV	5.616×10^1	6.030				6.030	1.316×10^0	
20.0 MeV	6.802×10^1	4.709				4.710	2.455×10^0	
30.0 MeV	8.509×10^1	3.654				3.654	4.900×10^0	
40.0 MeV	1.003×10^2	3.120				3.120	7.881×10^0	
80.0 MeV	1.527×10^2	2.342				2.342	2.315×10^1	
100. MeV	1.764×10^2	2.200				2.201	3.198×10^1	
140. MeV	2.218×10^2	2.051				2.052	5.089×10^1	
200. MeV	2.868×10^2	1.966				1.966	8.088×10^1	
300. MeV	3.917×10^2	1.935			0.000	1.935	1.323×10^2	
313. MeV	4.055×10^2	1.934			0.000	1.935	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.942			0.000	1.942	1.839×10^2	
800. MeV	8.995×10^2	2.016	0.000		0.000	2.017	3.861×10^2	
1.00 GeV	1.101×10^3	2.050	0.000		0.000	2.051	4.844×10^2	
1.40 GeV	1.502×10^3	2.105	0.000		0.001	2.106	6.767×10^2	
2.00 GeV	2.103×10^3	2.165	0.001	0.000	0.001	2.167	9.574×10^2	
3.00 GeV	3.104×10^3	2.234	0.001	0.001	0.001	2.237	1.411×10^3	
4.00 GeV	4.104×10^3	2.281	0.001	0.001	0.002	2.285	1.853×10^3	
8.00 GeV	8.105×10^3	2.389	0.003	0.003	0.004	2.400	3.556×10^3	
10.0 GeV	1.011×10^4	2.422	0.005	0.004	0.005	2.436	4.383×10^3	
14.0 GeV	1.411×10^4	2.470	0.007	0.007	0.007	2.491	6.005×10^3	
20.0 GeV	2.011×10^4	2.518	0.011	0.012	0.009	2.551	8.384×10^3	
30.0 GeV	3.011×10^4	2.570	0.018	0.021	0.014	2.623	1.225×10^4	
40.0 GeV	4.011×10^4	2.606	0.025	0.031	0.018	2.680	1.602×10^4	
80.0 GeV	8.011×10^4	2.687	0.057	0.076	0.034	2.855	3.045×10^4	
100. GeV	1.001×10^5	2.713	0.074	0.101	0.042	2.929	3.737×10^4	
140. GeV	1.401×10^5	2.750	0.108	0.151	0.059	3.069	5.070×10^4	
200. GeV	2.001×10^5	2.790	0.163	0.231	0.084	3.268	6.964×10^4	
300. GeV	3.001×10^5	2.835	0.258	0.368	0.125	3.586	9.884×10^4	
400. GeV	4.001×10^5	2.866	0.356	0.510	0.167	3.899	1.256×10^5	
800. GeV	8.001×10^5	2.943	0.764	1.101	0.338	5.146	2.146×10^5	
1.00 TeV	1.000×10^6	2.968	0.975	1.407	0.424	5.775	2.512×10^5	
1.06 TeV	1.056×10^6	2.975	1.034	1.491	0.449	5.950	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.007	1.400	2.015	0.602	7.024	3.140×10^5	
2.00 TeV	2.000×10^6	3.048	2.054	2.947	0.872	8.920	3.896×10^5	
3.00 TeV	3.000×10^6	3.095	3.149	4.499	1.336	12.078	4.856×10^5	
4.00 TeV	4.000×10^6	3.129	4.263	6.073	1.807	15.272	5.591×10^5	
8.00 TeV	8.000×10^6	3.212	8.775	12.413	3.773	28.173	7.490×10^5	
10.0 TeV	1.000×10^7	3.240	11.057	15.606	4.785	34.689	8.129×10^5	
14.0 TeV	1.400×10^7	3.282	15.612	21.968	6.872	47.734	9.108×10^5	
20.0 TeV	2.000×10^7	3.327	22.503	31.564	10.078	67.472	1.016×10^6	
30.0 TeV	3.000×10^7	3.379	33.975	47.530	15.643	100.527	1.137×10^6	
40.0 TeV	4.000×10^7	3.417	45.508	63.547	21.355	133.827	1.223×10^6	
80.0 TeV	8.000×10^7	3.510	91.750	127.671	45.332	268.263	1.430×10^6	
100. TeV	1.000×10^8	3.540	114.930	159.771	57.762	336.005	1.496×10^6	

TABLE V-8. Muons in Skeletal Muscle (ICRP)

See page 209 for Explanation of Tables

(Z/A)	ρ [g/cm ³]	I [eV]	a	$k = m_s$	x_0	x_1	\bar{C}	δ_0
0.54938	1.040	75.3	0.08636	3.5330	0.2282	2.7999	3.4809	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.879				7.879	7.107×10^{-1}	
14.0 MeV	5.616×10^1	6.146				6.146	1.292×10^0	
20.0 MeV	6.802×10^1	4.800				4.800	2.409×10^0	
30.0 MeV	8.509×10^1	3.724				3.724	4.808×10^0	
40.0 MeV	1.003×10^2	3.180				3.180	7.733×10^0	
80.0 MeV	1.527×10^2	2.387				2.387	2.271×10^1	
100. MeV	1.764×10^2	2.246				2.246	3.137×10^1	
140. MeV	2.218×10^2	2.092				2.092	4.991×10^1	
200. MeV	2.868×10^2	2.004				2.004	7.933×10^1	
300. MeV	3.917×10^2	1.970			0.000	1.971	1.298×10^2	
318. MeV	4.105×10^2	1.970			0.000	1.970	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.977			0.000	1.977	1.805×10^2	
800. MeV	8.995×10^2	2.052	0.000		0.000	2.052	3.792×10^2	
1.00 GeV	1.101×10^3	2.086	0.000		0.000	2.086	4.758×10^2	
1.40 GeV	1.502×10^3	2.141	0.000		0.001	2.142	6.649×10^2	
2.00 GeV	2.103×10^3	2.202	0.001	0.000	0.001	2.204	9.407×10^2	
3.00 GeV	3.104×10^3	2.272	0.001	0.001	0.001	2.275	1.387×10^3	
4.00 GeV	4.104×10^3	2.320	0.001	0.001	0.002	2.325	1.821×10^3	
8.00 GeV	8.105×10^3	2.431	0.004	0.003	0.004	2.442	3.495×10^3	
10.0 GeV	1.011×10^4	2.465	0.005	0.005	0.005	2.479	4.308×10^3	
14.0 GeV	1.411×10^4	2.513	0.007	0.008	0.007	2.535	5.902×10^3	
20.0 GeV	2.011×10^4	2.563	0.011	0.013	0.009	2.596	8.239×10^3	
30.0 GeV	3.011×10^4	2.616	0.018	0.023	0.013	2.670	1.203×10^4	
40.0 GeV	4.011×10^4	2.652	0.026	0.033	0.018	2.729	1.574×10^4	
80.0 GeV	8.011×10^4	2.735	0.060	0.080	0.034	2.909	2.991×10^4	
100. GeV	1.001×10^5	2.761	0.077	0.106	0.042	2.986	3.669×10^4	
140. GeV	1.401×10^5	2.799	0.114	0.159	0.059	3.131	4.977×10^4	
200. GeV	2.001×10^5	2.839	0.172	0.243	0.084	3.338	6.832×10^4	
300. GeV	3.001×10^5	2.885	0.271	0.386	0.125	3.668	9.689×10^4	
400. GeV	4.001×10^5	2.917	0.374	0.535	0.167	3.994	1.230×10^5	
800. GeV	8.001×10^5	2.996	0.803	1.156	0.337	5.293	2.097×10^5	
1.00 TeV	1.000×10^6	3.021	1.025	1.477	0.424	5.947	2.453×10^5	
1.03 TeV	1.032×10^6	3.025	1.060	1.528	0.438	6.051	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.060	1.471	2.115	0.601	7.248	3.062×10^5	
2.00 TeV	2.000×10^6	3.102	2.157	3.094	0.870	9.223	3.794×10^5	
3.00 TeV	3.000×10^6	3.150	3.307	4.722	1.333	12.512	4.722×10^5	
4.00 TeV	4.000×10^6	3.185	4.477	6.373	1.803	15.839	5.431×10^5	
8.00 TeV	8.000×10^6	3.270	9.214	13.024	3.764	29.273	7.260×10^5	
10.0 TeV	1.000×10^7	3.298	11.610	16.373	4.774	36.056	7.875×10^5	
14.0 TeV	1.400×10^7	3.341	16.392	23.047	6.855	49.635	8.816×10^5	
20.0 TeV	2.000×10^7	3.387	23.625	33.112	10.053	70.178	9.828×10^5	
30.0 TeV	3.000×10^7	3.440	35.670	49.860	15.603	104.574	1.099×10^6	
40.0 TeV	4.000×10^7	3.479	47.779	66.662	21.300	139.219	1.181×10^6	
80.0 TeV	8.000×10^7	3.573	96.349	133.925	45.207	279.054	1.380×10^6	
100. TeV	1.000×10^8	3.605	120.703	167.596	57.600	349.504	1.444×10^6	

TABLE V-9. Muons in Soft Tissue (ICRP)

See page 209 for Explanation of Tables

$\langle Z/A \rangle$	ρ [g/cm ³]	I [eV]	a	$k = m_e$	x_0	x_1	\bar{C}	δ_0
0.55121	1.000	72.3	0.08926	3.5110	0.2211	2.7799	3.4354	0.00
T	p [MeV/c]	Ionization	Brems	Pair prod [MeV cm ² /g]	Photonucl	Total	CSDA range [g/cm ²]	
10.0 MeV	4.704×10^1	7.947				7.947	7.043×10^{-1}	
14.0 MeV	5.616×10^1	6.198				6.198	1.280×10^0	
20.0 MeV	6.802×10^1	4.839				4.839	2.389×10^0	
30.0 MeV	8.509×10^1	3.754				3.754	4.768×10^0	
40.0 MeV	1.003×10^2	3.205				3.205	7.670×10^0	
80.0 MeV	1.527×10^2	2.406				2.406	2.254×10^1	
100. MeV	1.764×10^2	2.262				2.262	3.113×10^1	
140. MeV	2.218×10^2	2.106				2.107	4.954×10^1	
200. MeV	2.868×10^2	2.017				2.017	7.877×10^1	
300. MeV	3.917×10^2	1.982			0.000	1.983	1.289×10^2	
318. MeV	4.105×10^2	1.982			0.000	1.982	<i>Minimum ionization</i>	
400. MeV	4.945×10^2	1.988			0.000	1.989	1.793×10^2	
800. MeV	8.995×10^2	2.063	0.000		0.000	2.063	3.769×10^2	
1.00 GeV	1.101×10^3	2.097	0.000		0.000	2.098	4.730×10^2	
1.40 GeV	1.502×10^3	2.152	0.000		0.001	2.153	6.611×10^2	
2.00 GeV	2.103×10^3	2.213	0.001	0.000	0.001	2.215	9.356×10^2	
3.00 GeV	3.104×10^3	2.283	0.001	0.001	0.001	2.286	1.379×10^3	
4.00 GeV	4.104×10^3	2.332	0.001	0.001	0.002	2.336	1.812×10^3	
8.00 GeV	8.105×10^3	2.442	0.003	0.003	0.004	2.453	3.478×10^3	
10.0 GeV	1.011×10^4	2.476	0.005	0.005	0.005	2.490	4.287×10^3	
14.0 GeV	1.411×10^4	2.525	0.007	0.008	0.007	2.546	5.874×10^3	
20.0 GeV	2.011×10^4	2.574	0.011	0.012	0.009	2.607	8.202×10^3	
30.0 GeV	3.011×10^4	2.627	0.018	0.022	0.014	2.681	1.198×10^4	
40.0 GeV	4.011×10^4	2.664	0.025	0.032	0.018	2.739	1.567×10^4	
80.0 GeV	8.011×10^4	2.747	0.058	0.078	0.034	2.917	2.980×10^4	
100. GeV	1.001×10^5	2.773	0.075	0.102	0.042	2.993	3.657×10^4	
140. GeV	1.401×10^5	2.811	0.110	0.154	0.059	3.135	4.962×10^4	
200. GeV	2.001×10^5	2.852	0.166	0.235	0.084	3.337	6.817×10^4	
300. GeV	3.001×10^5	2.898	0.262	0.374	0.125	3.660	9.676×10^4	
400. GeV	4.001×10^5	2.930	0.362	0.518	0.167	3.978	1.230×10^5	
800. GeV	8.001×10^5	3.009	0.778	1.120	0.338	5.245	2.102×10^5	
1.00 TeV	1.000×10^6	3.035	0.993	1.431	0.424	5.884	2.462×10^5	
1.06 TeV	1.063×10^6	3.042	1.061	1.528	0.452	6.084	<i>Muon critical energy</i>	
1.40 TeV	1.400×10^6	3.074	1.426	2.050	0.602	7.152	3.078×10^5	
2.00 TeV	2.000×10^6	3.116	2.091	2.999	0.872	9.077	3.821×10^5	
3.00 TeV	3.000×10^6	3.164	3.206	4.578	1.336	12.284	4.765×10^5	
4.00 TeV	4.000×10^6	3.199	4.341	6.179	1.808	15.527	5.487×10^5	
8.00 TeV	8.000×10^6	3.284	8.937	12.629	3.774	28.625	7.356×10^5	
10.0 TeV	1.000×10^7	3.312	11.262	15.878	4.786	35.239	7.985×10^5	
14.0 TeV	1.400×10^7	3.355	15.901	22.351	6.873	48.481	8.949×10^5	
20.0 TeV	2.000×10^7	3.401	22.920	32.114	10.080	68.516	9.985×10^5	
30.0 TeV	3.000×10^7	3.455	34.608	48.359	15.646	102.068	1.117×10^6	
40.0 TeV	4.000×10^7	3.493	46.360	64.656	21.360	135.869	1.202×10^6	
80.0 TeV	8.000×10^7	3.588	93.491	129.898	45.342	272.319	1.406×10^6	
100. TeV	1.000×10^8	3.620	117.123	162.558	57.775	341.076	1.471×10^6	

TABLE VI-1. $b(E) \times 10^6$ [cm^2g^{-1}] for
Hydrogen, $Z = 1$, $A = 1.00794$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.1091	0.0349	0.5501	0.6940
5.	0.1526	0.1043	0.5796	0.8366
10.	0.1935	0.1903	0.5568	0.9405
20.	0.2407	0.2829	0.5255	1.0491
50.	0.3114	0.4120	0.4908	1.2142
100.	0.3678	0.5039	0.4736	1.3453
200.	0.4246	0.5912	0.4640	1.4798
500.	0.4951	0.6944	0.4622	1.6517
1000.	0.5441	0.7614	0.4676	1.7732
2000.	0.5876	0.8134	0.4804	1.8814
5000.	0.6356	0.8614	0.5051	2.0020
10000.	0.6642	0.8837	0.5308	2.0788
20000.	0.6867	0.8976	0.5618	2.1461
50000.	0.7080	0.9077	0.6103	2.2260
100000.	0.7192	0.9117	0.6529	2.2838

TABLE VI-2. $b(E) \times 10^6$ [cm^2g^{-1}] for
Helium, $Z = 2$, $A = 4.002602$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.0931	0.0351	0.5095	0.6377
5.	0.1279	0.0941	0.5334	0.7553
10.	0.1587	0.1555	0.5141	0.8283
20.	0.1928	0.2229	0.4878	0.9035
50.	0.2417	0.3191	0.4597	1.0206
100.	0.2797	0.3860	0.4462	1.1118
200.	0.3171	0.4486	0.4392	1.2049
500.	0.3621	0.5212	0.4377	1.3210
1000.	0.3922	0.5685	0.4453	1.4059
2000.	0.4178	0.6050	0.4578	1.4806
5000.	0.4443	0.6396	0.4812	1.5651
10000.	0.4589	0.6563	0.5050	1.6202
20000.	0.4695	0.6669	0.5330	1.6694
50000.	0.4786	0.6749	0.5773	1.7307
100000.	0.4830	0.6780	0.6155	1.7765

TABLE VI-3. $b(E) \times 10^6$ [cm^2g^{-1}] for
Lithium, $Z = 3$, $A = 6.941$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.1128	0.0456	0.4906	0.6490
5.	0.1540	0.1173	0.5148	0.7861
10.	0.1895	0.1861	0.4975	0.8731
20.	0.2279	0.2620	0.4733	0.9632
50.	0.2819	0.3673	0.4474	1.0966
100.	0.3237	0.4463	0.4349	1.2049
200.	0.3635	0.5153	0.4287	1.3075
500.	0.4115	0.5935	0.4276	1.4325
1000.	0.4431	0.6432	0.4350	1.5213
2000.	0.4698	0.6801	0.4471	1.5971
5000.	0.4971	0.7140	0.4697	1.6807
10000.	0.5119	0.7301	0.4924	1.7345
20000.	0.5225	0.7403	0.5191	1.7819
50000.	0.5317	0.7481	0.5611	1.8409
100000.	0.5358	0.7512	0.5973	1.8843

TABLE VI-4. $b(E) \times 10^6$ [cm^2g^{-1}] for
Beryllium, $Z = 4$, $A = 9.012182$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.1491	0.0624	0.4811	0.6926
5.	0.2028	0.1573	0.5063	0.8663
10.	0.2482	0.2441	0.4900	0.9823
20.	0.2968	0.3396	0.4668	1.1032
50.	0.3642	0.4729	0.4418	1.2789
100.	0.4158	0.5725	0.4297	1.4180
200.	0.4646	0.6582	0.4237	1.5465
500.	0.5230	0.7536	0.4227	1.6993
1000.	0.5612	0.8133	0.4300	1.8045
2000.	0.5932	0.8567	0.4418	1.8917
5000.	0.6256	0.8958	0.4638	1.9852
10000.	0.6430	0.9144	0.4859	2.0433
20000.	0.6553	0.9261	0.5120	2.0934
50000.	0.6660	0.9351	0.5529	2.1539
100000.	0.6706	0.9388	0.5880	2.1974

TABLE VI-5. $b(E) \times 10^6$ [cm^2g^{-1}] for
Boron, $Z = 5$, $A = 10.811$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.1897	0.0813	0.4744	0.7453
5.	0.2574	0.2023	0.5003	0.9600
10.	0.3141	0.3095	0.4848	1.1085
20.	0.3742	0.4272	0.4623	1.2637
50.	0.4568	0.5921	0.4378	1.4868
100.	0.5196	0.7149	0.4260	1.6606
200.	0.5787	0.8193	0.4201	1.8182
500.	0.6490	0.9340	0.4192	2.0022
1000.	0.6946	1.0052	0.4263	2.1261
2000.	0.7327	1.0560	0.4379	2.2266
5000.	0.7709	1.1014	0.4595	2.3317
10000.	0.7913	1.1228	0.4813	2.3954
20000.	0.8056	1.1363	0.5068	2.4488
50000.	0.8180	1.1469	0.5469	2.5118
100000.	0.8233	1.1512	0.5813	2.5559

TABLE VI-6. $b(E) \times 10^6$ [cm^2g^{-1}] for
Carbon, $Z = 6$, $A = 12.0107$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2422	0.1054	0.4703	0.8180
5.	0.3282	0.2600	0.4971	1.0853
10.	0.3994	0.3939	0.4822	1.2755
20.	0.4746	0.5405	0.4600	1.4752
50.	0.5772	0.7463	0.4359	1.7595
100.	0.6548	0.8927	0.4241	1.9716
200.	0.7269	1.0280	0.4182	2.1732
500.	0.8133	1.1682	0.4172	2.3987
1000.	0.8689	1.2544	0.4242	2.5475
2000.	0.9150	1.3153	0.4357	2.6660
5000.	0.9610	1.3693	0.4570	2.7873
10000.	0.9855	1.3948	0.4785	2.8588
20000.	1.0026	1.4109	0.5038	2.9172
50000.	1.0173	1.4235	0.5434	2.9842
100000.	1.0235	1.4287	0.5774	3.0297

TABLE VI-7. $b(E) \times 10^6$ [cm^2g^{-1}] for Nitrogen, $Z = 7$, $A = 14.00674$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2778	0.1230	0.4645	0.8653
5.	0.3764	0.3016	0.4917	1.1697
10.	0.4576	0.4537	0.4773	1.3886
20.	0.5430	0.6196	0.4557	1.6184
50.	0.6589	0.8531	0.4322	1.9442
100.	0.7448	1.0185	0.4207	2.1839
200.	0.8269	1.1708	0.4149	2.4126
500.	0.9234	1.3269	0.4140	2.6643
1000.	0.9852	1.4224	0.4209	2.8284
2000.	1.0363	1.4892	0.4322	2.9576
5000.	1.0870	1.5482	0.4531	3.0883
10000.	1.1138	1.5760	0.4743	3.1642
20000.	1.1325	1.5936	0.4991	3.2253
50000.	1.1485	1.6076	0.5381	3.2942
100000.	1.1561	1.6133	0.5715	3.3409

TABLE VI-10. $b(E) \times 10^6$ [cm^2g^{-1}] for Neon, $Z = 10$, $A = 20.1797$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.3782	0.1742	0.4506	1.0030
5.	0.5127	0.4225	0.4783	1.4135
10.	0.6226	0.6271	0.4653	1.7150
20.	0.7373	0.8480	0.4450	2.0303
50.	0.8912	1.1604	0.4228	2.4743
100.	1.0041	1.3794	0.4119	2.7955
200.	1.1115	1.5798	0.4065	3.0977
500.	1.2367	1.7802	0.4058	3.4227
1000.	1.3158	1.9015	0.4125	3.6297
2000.	1.3808	1.9849	0.4233	3.7890
5000.	1.4446	2.0580	0.4435	3.9462
10000.	1.4780	2.0925	0.4639	4.0344
20000.	1.5011	2.1143	0.4877	4.1031
50000.	1.5208	2.1317	0.5250	4.1775
100000.	1.5300	2.1389	0.5569	4.2258

TABLE VI-8. $b(E) \times 10^6$ [cm^2g^{-1}] for Oxygen, $Z = 8$, $A = 15.9994$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.3130	0.1406	0.4595	0.9132
5.	0.4241	0.3433	0.4869	1.2543
10.	0.5153	0.5136	0.4730	1.5019
20.	0.6109	0.6987	0.4519	1.7615
50.	0.7400	0.9597	0.4288	2.1285
100.	0.8353	1.1439	0.4176	2.3967
200.	0.9263	1.3130	0.4119	2.6512
500.	1.0329	1.4848	0.4111	2.9287
1000.	1.1007	1.5894	0.4179	3.1080
2000.	1.1567	1.6621	0.4290	3.2479
5000.	1.2121	1.7261	0.4497	3.3879
10000.	1.2412	1.7563	0.4706	3.4681
20000.	1.2615	1.7754	0.4951	3.5319
50000.	1.2788	1.7906	0.5334	3.6027
100000.	1.2870	1.7968	0.5662	3.6501

TABLE VI-11. $b(E) \times 10^6$ [cm^2g^{-1}] for Sodium, $Z = 11$, $A = 22.989770$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.3964	0.1850	0.4457	1.0271
5.	0.5379	0.4478	0.4732	1.4589
10.	0.6534	0.6627	0.4606	1.7767
20.	0.7736	0.8939	0.4408	2.1084
50.	0.9347	1.2213	0.4191	2.5750
100.	1.0527	1.4503	0.4085	2.9115
200.	1.1646	1.6593	0.4032	3.2271
500.	1.2948	1.8672	0.4026	3.5647
1000.	1.3769	1.9926	0.4093	3.7787
2000.	1.4442	2.0786	0.4200	3.9428
5000.	1.5101	2.1538	0.4399	4.1038
10000.	1.5445	2.1893	0.4600	4.1937
20000.	1.5690	2.2117	0.4834	4.2641
50000.	1.5883	2.2297	0.5201	4.3382
100000.	1.5978	2.2371	0.5515	4.3864

TABLE VI-9. $b(E) \times 10^6$ [cm^2g^{-1}] for Fluorine, $Z = 9$, $A = 18.9984032$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.3278	0.1499	0.4530	0.9308
5.	0.4446	0.3646	0.4802	1.2894
10.	0.5403	0.5431	0.4669	1.5503
20.	0.6403	0.7365	0.4465	1.8233
50.	0.7750	1.0095	0.4240	2.2086
100.	0.8742	1.2015	0.4131	2.4889
200.	0.9686	1.3775	0.4077	2.7538
500.	1.0790	1.5548	0.4070	3.0408
1000.	1.1489	1.6624	0.4138	3.2251
2000.	1.2066	1.7367	0.4248	3.3681
5000.	1.2634	1.8020	0.4451	3.5105
10000.	1.2932	1.8328	0.4656	3.5916
20000.	1.3138	1.8523	0.4896	3.6557
50000.	1.3314	1.8678	0.5272	3.7264
100000.	1.3397	1.8742	0.5594	3.7733

TABLE VI-12. $b(E) \times 10^6$ [cm^2g^{-1}] for Magnesium, $Z = 12$, $A = 24.3050$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4433	0.2082	0.4434	1.0949
5.	0.6014	0.5029	0.4713	1.5756
10.	0.7303	0.7425	0.4590	1.9318
20.	0.8642	0.9994	0.4394	2.3029
50.	1.0432	1.3635	0.4178	2.8245
100.	1.1741	1.6176	0.4072	3.1990
200.	1.2981	1.8491	0.4020	3.5492
500.	1.4420	2.0783	0.4014	3.9216
1000.	1.5324	2.2161	0.4079	4.1565
2000.	1.6065	2.3103	0.4186	4.3354
5000.	1.6788	2.3926	0.4384	4.5098
10000.	1.7164	2.4314	0.4583	4.6061
20000.	1.7432	2.4559	0.4816	4.6808
50000.	1.7643	2.4757	0.5180	4.7581
100000.	1.7747	2.4837	0.5492	4.8076

TABLE VI-13. $b(E) \times 10^6$ [cm^2g^{-1}] for
Aluminum, $Z = 13$, $A = 26.981538$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4638	0.2202	0.4395	1.1235
5.	0.6297	0.5310	0.4672	1.6279
10.	0.7649	0.7823	0.4552	2.0024
20.	0.9052	1.0508	0.4360	2.3920
50.	1.0924	1.4319	0.4148	2.9391
100.	1.2291	1.6973	0.4045	3.3308
200.	1.3583	1.9297	0.3993	3.6873
500.	1.5075	2.1765	0.3988	4.0828
1000.	1.6020	2.3171	0.4053	4.3244
2000.	1.6787	2.4165	0.4159	4.5111
5000.	1.7535	2.5014	0.4355	4.6904
10000.	1.7923	2.5414	0.4551	4.7889
20000.	1.8199	2.5668	0.4781	4.8648
50000.	1.8416	2.5872	0.5141	4.9429
100000.	1.8522	2.5955	0.5448	4.9926

TABLE VI-14. $b(E) \times 10^6$ [cm^2g^{-1}] for
Silicon, $Z = 14$, $A = 28.0855$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5143	0.2453	0.4378	1.1974
5.	0.6982	0.5907	0.4659	1.7548
10.	0.8479	0.8688	0.4541	2.1707
20.	1.0030	1.1648	0.4350	2.6028
50.	1.2096	1.5855	0.4139	3.2090
100.	1.3602	1.8778	0.4036	3.6416
200.	1.5023	2.1333	0.3985	4.0341
500.	1.6662	2.4115	0.3979	4.4757
1000.	1.7698	2.5576	0.4044	4.7318
2000.	1.8538	2.6661	0.4149	4.9347
5000.	1.9354	2.7585	0.4343	5.1283
10000.	1.9777	2.8021	0.4539	5.2338
20000.	2.0078	2.8297	0.4768	5.3143
50000.	2.0313	2.8520	0.5125	5.3958
100000.	2.0429	2.8610	0.5431	5.4470

TABLE VI-15. $b(E) \times 10^6$ [cm^2g^{-1}] for
Phosphorus, $Z = 15$, $A = 30.973761$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5301	0.2554	0.4341	1.2196
5.	0.7204	0.6141	0.4620	1.7965
10.	0.8751	0.9019	0.4505	2.2275
20.	1.0353	1.2072	0.4317	2.6742
50.	1.2485	1.6415	0.4110	3.3010
100.	1.4037	1.9428	0.4009	3.7473
200.	1.5500	2.2055	0.3959	4.1513
500.	1.7185	2.4910	0.3954	4.6048
1000.	1.8247	2.6404	0.4018	4.8669
2000.	1.9107	2.7511	0.4122	5.0741
5000.	1.9942	2.8455	0.4315	5.2712
10000.	2.0373	2.8899	0.4508	5.3781
20000.	2.0679	2.9181	0.4734	5.4595
50000.	2.0919	2.9408	0.5088	5.5415
100000.	2.1036	2.9501	0.5390	5.5927

TABLE VI-16. $b(E) \times 10^6$ [cm^2g^{-1}] for
Sulfur, $Z = 16$, $A = 32.066$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5803	0.2807	0.4327	1.2937
5.	0.7886	0.6743	0.4609	1.9237
10.	0.9578	0.9889	0.4495	2.3962
20.	1.1328	1.3216	0.4309	2.8852
50.	1.3654	1.7953	0.4102	3.5709
100.	1.5344	2.1233	0.4001	4.0579
200.	1.6927	2.4089	0.3951	4.4967
500.	1.8767	2.7186	0.3946	4.9899
1000.	1.9919	2.8801	0.4010	5.2731
2000.	2.0851	2.9998	0.4113	5.4962
5000.	2.1753	3.1016	0.4305	5.7074
10000.	2.2219	3.1495	0.4498	5.8212
20000.	2.2549	3.1799	0.4723	5.9070
50000.	2.2806	3.2044	0.5074	5.9925
100000.	2.2932	3.2144	0.5375	6.0451

TABLE VI-17. $b(E) \times 10^6$ [cm^2g^{-1}] for
Chlorine, $Z = 17$, $A = 35.4527$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5866	0.2866	0.4289	1.3021
5.	0.7980	0.6878	0.4568	1.9425
10.	0.9697	1.0074	0.4456	2.4228
20.	1.1473	1.3445	0.4274	2.9191
50.	1.3830	1.8248	0.4071	3.6149
100.	1.5542	2.1569	0.3972	4.1083
200.	1.7143	2.4633	0.3924	4.5699
500.	1.9001	2.7578	0.3920	5.0499
1000.	2.0163	2.9203	0.3983	5.3350
2000.	2.1101	3.0406	0.4086	5.5592
5000.	2.2008	3.1428	0.4275	5.7712
10000.	2.2476	3.1909	0.4466	5.8850
20000.	2.2807	3.2214	0.4688	5.9708
50000.	2.3065	3.2460	0.5035	6.0560
100000.	2.3191	3.2561	0.5331	6.1083

TABLE VI-18. $b(E) \times 10^6$ [cm^2g^{-1}] for
Argon, $Z = 18$, $A = 39.948$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5769	0.2851	0.4243	1.2864
5.	0.7858	0.6837	0.4518	1.9214
10.	0.9557	1.0004	0.4410	2.3971
20.	1.1312	1.3333	0.4231	2.8876
50.	1.3641	1.8082	0.4033	3.5756
100.	1.5331	2.1360	0.3937	4.0628
200.	1.6910	2.4381	0.3890	4.5182
500.	1.8741	2.7277	0.3887	4.9906
1000.	1.9885	2.8872	0.3950	5.2707
2000.	2.0806	3.0051	0.4052	5.4909
5000.	2.1696	3.1052	0.4239	5.6988
10000.	2.2154	3.1524	0.4427	5.8104
20000.	2.2478	3.1822	0.4646	5.8945
50000.	2.2730	3.2063	0.4987	5.9780
100000.	2.2852	3.2162	0.5279	6.0294

TABLE VI-19. $b(E) \times 10^6$ [cm²g⁻¹] for
Potassium, $Z = 19$, $A = 39.0983$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.6576	0.3246	0.4250	1.4072
5.	0.8951	0.7777	0.4531	2.1258
10.	1.0879	1.1368	0.4423	2.6671
20.	1.2869	1.5132	0.4243	3.2245
50.	1.5507	2.0506	0.4044	4.0057
100.	1.7419	2.4210	0.3947	4.5576
200.	1.9203	2.7620	0.3899	5.0721
500.	2.1269	3.0881	0.3895	5.6044
1000.	2.2557	3.2673	0.3957	5.9188
2000.	2.3594	3.3997	0.4059	6.1650
5000.	2.4594	3.5120	0.4246	6.3960
10000.	2.5108	3.5649	0.4434	6.5190
20000.	2.5471	3.5991	0.4653	6.6115
50000.	2.5753	3.6254	0.4996	6.7003
100000.	2.5890	3.6365	0.5289	6.7543

TABLE VI-20. $b(E) \times 10^6$ [cm²g⁻¹] for
Calcium, $Z = 20$, $A = 40.078$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.7088	0.3508	0.4240	1.4837
5.	0.9648	0.8401	0.4523	2.2572
10.	1.1726	1.2270	0.4416	2.8412
20.	1.3869	1.6313	0.4237	3.4419
50.	1.6705	2.2091	0.4038	4.2835
100.	1.8759	2.6067	0.3941	4.8768
200.	2.0675	2.9723	0.3893	5.4291
500.	2.2889	3.3213	0.3889	5.9991
1000.	2.4269	3.5128	0.3951	6.3348
2000.	2.5378	3.6540	0.4052	6.5970
5000.	2.6445	3.7738	0.4239	6.8423
10000.	2.6993	3.8302	0.4426	6.9721
20000.	2.7380	3.8667	0.4645	7.0692
50000.	2.7680	3.8948	0.4986	7.1614
100000.	2.7825	3.9066	0.5278	7.2169

TABLE VI-21. $b(E) \times 10^6$ [cm²g⁻¹] for
Scandium, $Z = 21$, $A = 44.95910$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.6890	0.3448	0.4197	1.4535
5.	0.9391	0.8252	0.4475	2.2118
10.	1.1423	1.2044	0.4370	2.7837
20.	1.3518	1.5994	0.4195	3.3707
50.	1.6291	2.1644	0.4001	4.1936
100.	1.8297	2.5528	0.3906	4.7731
200.	2.0167	2.9094	0.3860	5.3121
500.	2.2327	3.2491	0.3857	5.8675
1000.	2.3671	3.4353	0.3919	6.1943
2000.	2.4749	3.5725	0.4019	6.4493
5000.	2.5787	3.6888	0.4203	6.6878
10000.	2.6318	3.7434	0.4388	6.8141
20000.	2.6693	3.7789	0.4604	6.9086
50000.	2.6984	3.8061	0.4940	6.9985
100000.	2.7125	3.8175	0.5227	7.0527

TABLE VI-22. $b(E) \times 10^6$ [cm²g⁻¹] for
Titanium, $Z = 22$, $A = 47.867$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.7051	0.3552	0.4173	1.4776
5.	0.9618	0.8496	0.4449	2.2563
10.	1.1703	1.2390	0.4346	2.8439
20.	1.3852	1.6436	0.4173	3.4461
50.	1.6694	2.2228	0.3981	4.2904
100.	1.8750	2.6204	0.3888	4.8842
200.	2.0664	2.9852	0.3842	5.4358
500.	2.2872	3.3320	0.3840	6.0032
1000.	2.4245	3.5218	0.3902	6.3364
2000.	2.5346	3.6614	0.4001	6.5961
5000.	2.6403	3.7799	0.4184	6.8385
10000.	2.6943	3.8355	0.4367	6.9665
20000.	2.7325	3.8716	0.4581	7.0621
50000.	2.7620	3.8993	0.4914	7.1527
100000.	2.7763	3.9109	0.5199	7.2071

TABLE VI-23. $b(E) \times 10^6$ [cm²g⁻¹] for
Vanadium, $Z = 23$, $A = 50.9415$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.7202	0.3651	0.4149	1.5002
5.	0.9830	0.8726	0.4234	2.2790
10.	1.1965	1.2718	0.4323	2.9006
20.	1.4164	1.6812	0.4152	3.5129
50.	1.7073	2.2780	0.3962	4.3815
100.	1.9174	2.6843	0.3870	4.9887
200.	2.1130	3.0567	0.3825	5.5522
500.	2.3384	3.4101	0.3823	6.1308
1000.	2.4784	3.6032	0.3884	6.4700
2000.	2.5905	3.7452	0.3983	6.7340
5000.	2.6980	3.8656	0.4165	6.9801
10000.	2.7529	3.9221	0.4347	7.1097
20000.	2.7903	3.9588	0.4559	7.2049
50000.	2.8216	3.9869	0.4889	7.2975
100000.	2.8361	3.9986	0.5172	7.3519

TABLE VI-24. $b(E) \times 10^6$ [cm²g⁻¹] for
Chromium, $Z = 24$, $A = 51.9961$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.7665	0.3894	0.4141	1.5700
5.	1.0462	0.9304	0.4417	2.4184
10.	1.2733	1.3553	0.4317	3.0603
20.	1.5069	1.7897	0.4147	3.7113
50.	1.8163	2.4237	0.3957	4.6357
100.	2.0395	2.8548	0.3865	5.2807
200.	2.2470	3.2495	0.3820	5.8785
500.	2.4860	3.6234	0.3818	6.4912
1000.	2.6342	3.8275	0.3879	6.8496
2000.	2.7528	3.9775	0.3977	7.1280
5000.	2.8663	4.1045	0.4158	7.3867
10000.	2.9243	4.1642	0.4340	7.5224
20000.	2.9636	4.2029	0.4551	7.6216
50000.	2.9967	4.2325	0.4881	7.7172
100000.	3.0119	4.2449	0.5163	7.7731

TABLE VI-25. $b(E) \times 10^6$ [cm^2g^{-1}] for
Manganese, $Z = 25$, $A = 54.938049$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.7828	0.3999	0.4120	1.5947
5.	1.0691	0.9551	0.4205	2.4448
10.	1.3016	1.3905	0.4296	3.1217
20.	1.5407	1.8345	0.4128	3.7880
50.	1.8572	2.4830	0.3940	4.7342
100.	2.0854	2.9244	0.3849	5.3947
200.	2.2974	3.3264	0.3805	6.0042
500.	2.5414	3.7075	0.3803	6.6291
1000.	2.6925	3.9152	0.3863	6.9941
2000.	2.8133	4.0678	0.3961	7.2773
5000.	2.9289	4.1970	0.4141	7.5400
10000.	2.9878	4.2576	0.4321	7.6775
20000.	3.0278	4.2969	0.4531	7.7778
50000.	3.0613	4.3270	0.4858	7.8742
100000.	3.0767	4.3396	0.5138	7.9301

TABLE VI-26. $b(E) \times 10^6$ [cm^2g^{-1}] for
Iron, $Z = 26$, $A = 55.845$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.8313	0.4255	0.4113	1.6681
5.	1.1354	1.0159	0.4390	2.5903
10.	1.3823	1.4781	0.4292	3.2895
20.	1.6360	1.9483	0.4124	3.9967
50.	1.9716	2.6358	0.3936	5.0010
100.	2.2134	3.1031	0.3845	5.7010
200.	2.4379	3.5283	0.3801	6.3464
500.	2.6960	3.9309	0.3799	7.0069
1000.	2.8558	4.1501	0.3859	7.3918
2000.	2.9833	4.3110	0.3957	7.6900
5000.	3.1052	4.4471	0.4136	7.9660
10000.	3.1673	4.5109	0.4316	8.1099
20000.	3.2094	4.5524	0.4525	8.2143
50000.	3.2447	4.5842	0.4852	8.3140
100000.	3.2609	4.5974	0.5131	8.3714

TABLE VI-27. $b(E) \times 10^6$ [cm^2g^{-1}] for
Cobalt, $Z = 27$, $A = 58.933200$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.8449	0.4349	0.4093	1.6891
5.	1.1548	1.0377	0.4179	2.6104
10.	1.4063	1.5093	0.4271	3.3426
20.	1.6648	1.9876	0.4105	4.0629
50.	2.0065	2.6876	0.3919	5.0861
100.	2.2526	3.1630	0.3829	5.7986
200.	2.4810	3.5952	0.3785	6.4547
500.	2.7434	4.0038	0.3784	7.1255
1000.	2.9056	4.2260	0.3844	7.5159
2000.	3.0350	4.3889	0.3941	7.8180
5000.	3.1585	4.5268	0.4119	8.0972
10000.	3.2214	4.5914	0.4298	8.2425
20000.	3.2639	4.6334	0.4505	8.3479
50000.	3.2996	4.6655	0.4830	8.4481
100000.	3.3160	4.6789	0.5107	8.5055

TABLE VI-28. $b(E) \times 10^6$ [cm^2g^{-1}] for
Nickel, $Z = 28$, $A = 58.6934$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.9121	0.4694	0.4093	1.7909
5.	1.2463	1.1199	0.4372	2.8034
10.	1.5174	1.6280	0.4275	3.5730
20.	1.7960	2.1422	0.4109	4.3491
50.	2.1639	2.8953	0.3923	5.4514
100.	2.4286	3.4063	0.3832	6.2181
200.	2.6741	3.8703	0.3788	6.9232
500.	2.9559	4.3085	0.3786	7.6430
1000.	3.1300	4.5465	0.3846	8.0611
2000.	3.2687	4.7210	0.3942	8.3840
5000.	3.4010	4.8685	0.4121	8.6816
10000.	3.4683	4.9377	0.4299	8.8359
20000.	3.5138	4.9826	0.4507	8.9471
50000.	3.5519	5.0169	0.4831	9.0520
100000.	3.5694	5.0312	0.5108	9.1115

TABLE VI-29. $b(E) \times 10^6$ [cm^2g^{-1}] for
Copper, $Z = 29$, $A = 63.546$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.8971	0.4653	0.4064	1.7687
5.	1.2270	1.1096	0.4152	2.7518
10.	1.4948	1.6124	0.4243	3.5315
20.	1.7699	2.1200	0.4079	4.2979
50.	2.1333	2.8640	0.3896	5.3869
100.	2.3947	3.3683	0.3807	6.1438
200.	2.6370	3.8259	0.3764	6.8394
500.	2.9149	4.2575	0.3763	7.5487
1000.	3.0865	4.4917	0.3823	7.9604
2000.	3.2231	4.6633	0.3919	8.2782
5000.	3.3532	4.8083	0.4095	8.5710
10000.	3.4193	4.8762	0.4272	8.7227
20000.	3.4640	4.9204	0.4478	8.8321
50000.	3.5014	4.9540	0.4799	8.9353
100000.	3.5186	4.9681	0.5073	8.9939

TABLE VI-30. $b(E) \times 10^6$ [cm^2g^{-1}] for
Zinc, $Z = 30$, $A = 65.39$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.9303	0.4840	0.4053	1.8196
5.	1.2728	1.1539	0.4141	2.8408
10.	1.5508	1.6761	0.4233	3.6502
20.	1.8363	2.2020	0.4070	4.4453
50.	2.2133	2.9735	0.3888	5.5755
100.	2.4843	3.4959	0.3799	6.3601
200.	2.7354	3.9696	0.3756	7.0806
500.	3.0231	4.4158	0.3755	7.8144
1000.	3.2005	4.6577	0.3815	8.2397
2000.	3.3417	4.8348	0.3910	8.5676
5000.	3.4761	4.9845	0.4086	8.8692
10000.	3.5443	5.0545	0.4262	9.0251
20000.	3.5904	5.1001	0.4467	9.1372
50000.	3.6289	5.1348	0.4787	9.2425
100000.	3.6466	5.1494	0.5060	9.3020

TABLE VI-31. $b(E) \times 10^6$ [cm²g⁻¹] for Gallium, $Z = 31$, $A = 69.723$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.9255	0.4846	0.4029	1.8129
5.	1.2672	1.1549	0.4301	2.8522
10.	1.5447	1.6770	0.4208	3.6424
20.	1.8297	2.2015	0.4047	4.4358
50.	2.2059	2.9715	0.3866	5.5641
100.	2.4763	3.4925	0.3779	6.3468
200.	2.7267	3.9645	0.3737	7.0650
500.	3.0135	4.4086	0.3736	7.7957
1000.	3.1902	4.6492	0.3796	8.2189
2000.	3.3307	4.8252	0.3891	8.5450
5000.	3.4643	4.9739	0.4065	8.8447
10000.	3.5321	5.0435	0.4240	8.9995
20000.	3.5778	5.0887	0.4443	9.1108
50000.	3.6160	5.1232	0.4760	9.2152
100000.	3.6335	5.1377	0.5031	9.2743

TABLE VI-34. $b(E) \times 10^6$ [cm²g⁻¹] for Selenium, $Z = 34$, $A = 78.96$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.9706	0.5147	0.3982	1.8834
5.	1.3309	1.2258	0.4251	2.9818
10.	1.6237	1.7782	0.4059	3.8077
20.	1.9243	2.3293	0.3944	4.6481
50.	2.3208	3.1405	0.3826	5.8439
100.	2.6055	3.6878	0.3741	6.6674
200.	2.8687	4.1826	0.3701	7.4214
500.	3.1695	4.6467	0.3700	8.1862
1000.	3.3544	4.8975	0.3759	8.6278
2000.	3.5012	5.0807	0.3853	8.9671
5000.	3.6403	5.2353	0.4025	9.2781
10000.	3.7107	5.3076	0.4197	9.4380
20000.	3.7581	5.3546	0.4396	9.5524
50000.	3.7978	5.3904	0.4708	9.6590
100000.	3.8159	5.4052	0.4974	9.7185

TABLE VI-32. $b(E) \times 10^6$ [cm²g⁻¹] for Germanium, $Z = 32$, $A = 72.61$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.9433	0.4959	0.4013	1.8405
5.	1.2921	1.1817	0.4285	2.9023
10.	1.5755	1.7152	0.4192	3.7100
20.	1.8665	2.2500	0.4032	4.5198
50.	2.2505	3.0359	0.3853	5.6717
100.	2.5264	3.5671	0.3767	6.4701
200.	2.7817	4.0479	0.3725	7.2022
500.	3.0740	4.4999	0.3725	7.9463
1000.	3.2539	4.7445	0.3784	8.3767
2000.	3.3968	4.9234	0.3878	8.7081
5000.	3.5326	5.0745	0.4052	9.0123
10000.	3.6015	5.1451	0.4226	9.1692
20000.	3.6479	5.1911	0.4428	9.2817
50000.	3.6867	5.2261	0.4743	9.3871
100000.	3.7044	5.2408	0.5012	9.4464

TABLE VI-35. $b(E) \times 10^6$ [cm²g⁻¹] for Bromine, $Z = 35$, $A = 79.904$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.0163	0.5396	0.3977	1.9537
5.	1.3937	1.2848	0.4248	3.1033
10.	1.7002	1.8634	0.4054	3.9689
20.	2.0149	2.4392	0.4000	4.8542
50.	2.4297	3.2875	0.3824	6.0996
100.	2.7274	3.8594	0.3739	6.9607
200.	3.0025	4.3761	0.3698	7.7484
500.	3.3167	4.8602	0.3698	8.5466
1000.	3.5097	5.1216	0.3756	9.0069
2000.	3.6627	5.3125	0.3850	9.3602
5000.	3.8078	5.4735	0.4021	9.6834
10000.	3.8811	5.5487	0.4193	9.8491
20000.	3.9304	5.5977	0.4393	9.9674
50000.	3.9716	5.6349	0.4704	10.0770
100000.	3.9904	5.6505	0.4969	10.1379

TABLE VI-33. $b(E) \times 10^6$ [cm²g⁻¹] for Arsenic, $Z = 33$, $A = 74.92160$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.9687	0.5110	0.4001	1.8798
5.	1.3275	1.2172	0.4273	2.9720
10.	1.6188	1.7664	0.4076	3.7928
20.	1.9181	2.3154	0.4022	4.6357
50.	2.3128	3.1229	0.3844	5.8200
100.	2.5962	3.6682	0.3758	6.6402
200.	2.8584	4.1615	0.3716	7.3916
500.	3.1583	4.6247	0.3716	8.1545
1000.	3.3427	4.8752	0.3775	8.5954
2000.	3.4892	5.0583	0.3869	8.9344
5000.	3.6283	5.2129	0.4042	9.2453
10000.	3.6986	5.2851	0.4215	9.4052
20000.	3.7461	5.3321	0.4416	9.5198
50000.	3.7857	5.3680	0.4730	9.6267
100000.	3.8038	5.3828	0.4998	9.6865

TABLE VI-36. $b(E) \times 10^6$ [cm²g⁻¹] for Krypton, $Z = 36$, $A = 83.80$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.0190	0.5437	0.3959	1.9586
5.	1.3982	1.2943	0.4228	3.1152
10.	1.7063	1.8766	0.4038	3.9867
20.	2.0227	2.4549	0.3924	4.8701
50.	2.4396	3.3075	0.3808	6.1278
100.	2.7387	3.8818	0.3724	6.9929
200.	3.0151	4.4003	0.3683	7.7837
500.	3.3305	4.8857	0.3683	8.5845
1000.	3.5241	5.1476	0.3742	9.0458
2000.	3.6775	5.3388	0.3835	9.3997
5000.	3.8228	5.5000	0.4005	9.7233
10000.	3.8962	5.5753	0.4176	9.8890
20000.	3.9455	5.6243	0.4374	10.0072
50000.	3.9867	5.6616	0.4683	10.1166
100000.	4.0055	5.6771	0.4947	10.1773

TABLE VI-37. $b(E) \times 10^6$ [cm²g⁻¹] for Rubidium, $Z = 37$, $A = 85.4678$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.0531	0.5631	0.3952	2.0113
5.	1.4453	1.3402	0.4220	3.2075
10.	1.7639	1.9427	0.4030	4.1096
20.	2.0911	2.5398	0.3918	5.0226
50.	2.5220	3.4206	0.3802	6.3228
100.	2.8310	4.0136	0.3718	7.2164
200.	3.1164	4.5485	0.3678	8.0327
500.	3.4419	5.0489	0.3678	8.8585
1000.	3.6416	5.3186	0.3736	9.3338
2000.	3.7997	5.5155	0.3829	9.6980
5000.	3.9493	5.6814	0.3999	10.0306
10000.	4.0248	5.7589	0.4169	10.2006
20000.	4.0756	5.8093	0.4367	10.3215
50000.	4.1180	5.8477	0.4675	10.4331
100000.	4.1373	5.8637	0.4938	10.4948

TABLE VI-38. $b(E) \times 10^6$ [cm²g⁻¹] for Strontium, $Z = 38$, $A = 87.62$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.0807	0.5794	0.3942	2.0543
5.	1.4836	1.3787	0.4211	3.2834
10.	1.8109	1.9980	0.4022	4.2111
20.	2.1470	2.6104	0.3910	5.1483
50.	2.5894	3.5146	0.3794	6.4835
100.	2.9066	4.1228	0.3711	7.4006
200.	3.1994	4.6712	0.3671	8.2377
500.	3.5332	5.1837	0.3670	9.0839
1000.	3.7378	5.4598	0.3729	9.5705
2000.	3.8997	5.6612	0.3821	9.9430
5000.	4.0529	5.8309	0.3991	10.2828
10000.	4.1301	5.9101	0.4160	10.4561
20000.	4.1819	5.9616	0.4357	10.5793
50000.	4.2252	6.0009	0.4664	10.6925
100000.	4.2449	6.0171	0.4927	10.7547

TABLE VI-39. $b(E) \times 10^6$ [cm²g⁻¹] for Zirconium, $Z = 40$, $A = 91.224$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.1453	0.6166	0.3927	2.1546
5.	1.5729	1.4668	0.4195	3.4593
10.	1.9203	2.1248	0.4007	4.4457
20.	2.2768	2.7728	0.3896	5.4392
50.	2.7460	3.7308	0.3782	6.8550
100.	3.0821	4.3744	0.3699	7.8264
200.	3.3920	4.9539	0.3659	8.7118
500.	3.7450	5.4945	0.3659	9.6054
1000.	3.9611	5.7854	0.3717	10.1182
2000.	4.1319	5.9975	0.3809	10.5102
5000.	4.2931	6.1760	0.3978	10.8669
10000.	4.3744	6.2593	0.4146	11.0482
20000.	4.4289	6.3135	0.4342	11.1766
50000.	4.4743	6.3547	0.4647	11.2937
100000.	4.4950	6.3719	0.4908	11.3577

TABLE VI-40. $b(E) \times 10^6$ [cm²g⁻¹] for Niobium, $Z = 41$, $A = 92.90638$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.1792	0.6361	0.3920	2.2072
5.	1.6197	1.5129	0.4189	3.5514
10.	1.9775	2.1910	0.4000	4.5686
20.	2.3448	2.8576	0.3890	5.5914
50.	2.8279	3.8438	0.3777	7.0493
100.	3.1739	4.5058	0.3694	8.0490
200.	3.4928	5.1015	0.3654	8.9597
500.	3.8558	5.6569	0.3654	9.8781
1000.	4.0779	5.9555	0.3712	10.4046
2000.	4.2533	6.1731	0.3803	10.8067
5000.	4.4188	6.3563	0.3971	11.1723
10000.	4.5021	6.4417	0.4140	11.3578
20000.	4.5580	6.4973	0.4335	11.4888
50000.	4.6046	6.5395	0.4640	11.6081
100000.	4.6258	6.5571	0.4900	11.6729

TABLE VI-41. $b(E) \times 10^6$ [cm²g⁻¹] for Molybdenum, $Z = 42$, $A = 95.94$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.1943	0.6464	0.3908	2.2315
5.	1.6411	1.5372	0.4176	3.5958
10.	2.0042	2.2258	0.3989	4.6288
20.	2.3768	2.9012	0.3879	5.6659
50.	2.8668	3.9013	0.3766	7.1447
100.	3.2176	4.5721	0.3684	8.1582
200.	3.5409	5.1755	0.3645	9.0809
500.	3.9086	5.7376	0.3644	10.0107
1000.	4.1335	6.0397	0.3702	10.5434
2000.	4.3110	6.2596	0.3793	10.9500
5000.	4.4784	6.4448	0.3961	11.3193
10000.	4.5626	6.5311	0.4128	11.5065
20000.	4.6191	6.5873	0.4323	11.6386
50000.	4.6661	6.6299	0.4626	11.7586
100000.	4.6874	6.6477	0.4885	11.8236

TABLE VI-42. $b(E) \times 10^6$ [cm²g⁻¹] for Palladium, $Z = 46$, $A = 106.42$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.2780	0.6991	0.3869	2.3640
5.	1.7583	1.6617	0.4135	3.8335
10.	2.1488	2.4044	0.3953	4.9485
20.	2.5494	3.1274	0.3845	6.0613
50.	3.0759	4.2007	0.3733	7.6499
100.	3.4524	4.9189	0.3652	8.7366
200.	3.7989	5.5634	0.3614	9.7237
500.	4.1922	6.1622	0.3614	10.7158
1000.	4.4322	6.4833	0.3671	11.2825
2000.	4.6211	6.7167	0.3761	11.7140
5000.	4.7989	6.9130	0.3926	12.1046
10000.	4.8881	7.0044	0.4091	12.3017
20000.	4.9478	7.0639	0.4283	12.4401
50000.	4.9975	7.1091	0.4582	12.5648
100000.	5.0200	7.1277	0.4838	12.6315

TABLE VI-43. $b(E) \times 10^6$ [cm²g⁻¹] for
Silver, $Z = 47$, $A = 107.8682$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3140	0.7199	0.3864	2.4203
5.	1.8081	1.7109	0.4130	3.9320
10.	2.2098	2.4752	0.3947	5.0797
20.	2.6219	3.2178	0.3840	6.2237
50.	3.1632	4.3211	0.3729	7.8571
100.	3.5502	5.0588	0.3648	8.9739
200.	3.9062	5.7205	0.3610	9.9877
500.	4.3102	6.3349	0.3610	11.0061
1000.	4.5565	6.6641	0.3667	11.5873
2000.	4.7504	6.9035	0.3757	12.0296
5000.	4.9327	7.1047	0.3922	12.4296
10000.	5.0241	7.1983	0.4086	12.6311
20000.	5.0853	7.2593	0.4278	12.7724
50000.	5.1362	7.3054	0.4577	12.8993
100000.	5.1592	7.3246	0.4832	12.9669

TABLE VI-44. $b(E) \times 10^6$ [cm²g⁻¹] for
Cadmium, $Z = 48$, $A = 112.411$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3098	0.7206	0.3849	2.4153
5.	1.8033	1.7124	0.4113	3.9270
10.	2.2047	2.4770	0.3934	5.0750
20.	2.6165	3.2185	0.3826	6.2176
50.	3.1574	4.3208	0.3715	7.8497
100.	3.5441	5.0576	0.3635	8.9651
200.	3.8997	5.7180	0.3597	9.9774
500.	4.3030	6.3308	0.3597	10.9935
1000.	4.5488	6.6591	0.3654	11.5732
2000.	4.7421	6.8976	0.3744	12.0141
5000.	4.9239	7.0981	0.3908	12.4127
10000.	5.0149	7.1913	0.4072	12.6134
20000.	5.0758	7.2521	0.4262	12.7541
50000.	5.1265	7.2980	0.4559	12.8804
100000.	5.1494	7.3171	0.4813	12.9478

TABLE VI-45. $b(E) \times 10^6$ [cm²g⁻¹] for
Indium, $Z = 49$, $A = 114.818$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3332	0.7351	0.3841	2.4524
5.	1.8360	1.7467	0.4104	3.9931
10.	2.2449	2.5262	0.3926	5.1638
20.	2.6645	3.2809	0.3819	6.3273
50.	3.2155	4.4034	0.3708	7.9898
100.	3.6093	5.1533	0.3629	9.1254
200.	3.9713	5.8251	0.3591	10.1555
500.	4.3817	6.4482	0.3591	11.1890
1000.	4.6317	6.7817	0.3648	11.7782
2000.	4.8283	7.0240	0.3737	12.2260
5000.	5.0130	7.2276	0.3901	12.6306
10000.	5.1054	7.3223	0.4064	12.8341
20000.	5.1672	7.3840	0.4254	12.9766
50000.	5.2187	7.4306	0.4550	13.1043
100000.	5.2419	7.4500	0.4803	13.1721

TABLE VI-46. $b(E) \times 10^6$ [cm²g⁻¹] for
Tin, $Z = 50$, $A = 118.710$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3384	0.7405	0.3830	2.4619
5.	1.8439	1.7592	0.4091	4.0122
10.	2.2552	2.5440	0.3915	5.1907
20.	2.6772	3.3024	0.3808	6.3603
50.	3.2314	4.4312	0.3697	8.0323
100.	3.6273	5.1848	0.3618	9.1739
200.	3.9913	5.8597	0.3580	10.2089
500.	4.4036	6.4852	0.3581	11.2469
1000.	4.6547	6.8198	0.3637	11.8383
2000.	4.8520	7.0629	0.3726	12.2876
5000.	5.0373	7.2671	0.3889	12.6933
10000.	5.1300	7.3620	0.4052	12.8972
20000.	5.1920	7.4239	0.4241	13.0400
50000.	5.2435	7.4706	0.4536	13.1677
100000.	5.2667	7.4900	0.4788	13.2355

TABLE VI-47. $b(E) \times 10^6$ [cm²g⁻¹] for
Antimony, $Z = 51$, $A = 121.760$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3539	0.7510	0.3821	2.4870
5.	1.8659	1.7841	0.4081	4.0580
10.	2.2825	2.5796	0.3999	5.2620
20.	2.7099	3.3470	0.3799	6.4369
50.	3.2712	4.4901	0.3688	8.1301
100.	3.6722	5.2527	0.3610	9.2859
200.	4.0405	5.9354	0.3573	10.3332
500.	4.4578	6.5677	0.3573	11.3828
1000.	4.7117	6.9059	0.3629	11.9806
2000.	4.9112	7.1514	0.3718	12.4344
5000.	5.0984	7.3576	0.3881	12.8441
10000.	5.1920	7.4535	0.4043	13.0497
20000.	5.2545	7.5159	0.4232	13.1936
50000.	5.3065	7.5630	0.4525	13.3221
100000.	5.3300	7.5828	0.4776	13.3903

TABLE VI-48. $b(E) \times 10^6$ [cm²g⁻¹] for
Iodine, $Z = 53$, $A = 126.90447$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3967	0.7781	0.3805	2.5554
5.	1.9259	1.8481	0.4065	4.1804
10.	2.3565	2.6716	0.3983	5.4264
20.	2.7984	3.4632	0.3785	6.6400
50.	3.3783	4.6437	0.3675	8.3895
100.	3.7925	5.4305	0.3597	9.5826
200.	4.1727	6.1341	0.3560	10.6628
500.	4.6031	6.7851	0.3561	11.7443
1000.	4.8647	7.1330	0.3617	12.3594
2000.	5.0701	7.3854	0.3705	12.8260
5000.	5.2625	7.5973	0.3867	13.2465
10000.	5.3587	7.6957	0.4028	13.4572
20000.	5.4229	7.7599	0.4216	13.6044
50000.	5.4763	7.8082	0.4508	13.7353
100000.	5.5003	7.8282	0.4757	13.8042

TABLE VI-49. $b(E) \times 10^6$ [cm²g⁻¹] for Xenon, $Z = 54$, $A = 131.29$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3965	0.7807	0.3793	2.5565
5.	1.9264	1.8541	0.4051	4.1857
10.	2.3579	2.6800	0.3970	5.4348
20.	2.8006	3.4724	0.3774	6.6504
50.	3.3817	4.6550	0.3663	8.4030
100.	3.7965	5.4428	0.3586	9.5979
200.	4.1773	6.1470	0.3549	10.6793
500.	4.6081	6.7982	0.3551	11.7614
1000.	4.8700	7.1460	0.3606	12.3766
2000.	5.0753	7.3983	0.3694	12.8431
5000.	5.2677	7.6100	0.3855	13.2633
10000.	5.3639	7.7083	0.4016	13.4738
20000.	5.4280	7.7725	0.4202	13.6207
50000.	5.4813	7.8208	0.4493	13.7513
100000.	5.5052	7.8407	0.4742	13.8201

TABLE VI-52. $b(E) \times 10^6$ [cm²g⁻¹] for Cerium, $Z = 58$, $A = 140.116$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.4992	0.8440	0.3769	2.7201
5.	2.0698	2.0037	0.4026	4.4761
10.	2.5344	2.8949	0.3946	5.8239
20.	3.0111	3.7444	0.3751	7.1306
50.	3.6362	5.0153	0.3643	9.0158
100.	4.0822	5.8601	0.3566	10.2989
200.	4.4911	6.6140	0.3530	11.4581
500.	4.9529	7.3099	0.3531	12.6159
1000.	5.2331	7.6809	0.3586	13.2726
2000.	5.4525	7.9497	0.3674	13.7695
5000.	5.6576	8.1751	0.3833	14.2160
10000.	5.7599	8.2797	0.3992	14.4388
20000.	5.8280	8.3478	0.4177	14.5935
50000.	5.8846	8.3991	0.4466	14.7303
100000.	5.9100	8.4204	0.4712	14.8016

TABLE VI-50. $b(E) \times 10^6$ [cm²g⁻¹] for Cesium, $Z = 55$, $A = 132.90545$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.4293	0.8001	0.3788	2.6083
5.	1.9720	1.9000	0.4046	4.2766
10.	2.4137	2.7460	0.3965	5.5563
20.	2.8670	3.5564	0.3769	6.8004
50.	3.4618	4.7666	0.3660	8.5944
100.	3.8864	5.5723	0.3583	9.8169
200.	4.2760	6.2922	0.3546	10.9228
500.	4.7166	6.9576	0.3547	12.0289
1000.	4.9842	7.3128	0.3603	12.6573
2000.	5.1940	7.5704	0.3690	13.1335
5000.	5.3905	7.7866	0.3851	13.5622
10000.	5.4886	7.8869	0.4011	13.7767
20000.	5.5541	7.9524	0.4198	13.9262
50000.	5.6084	8.0015	0.4488	14.0587
100000.	5.6328	8.0221	0.4736	14.1285

TABLE VI-53. $b(E) \times 10^6$ [cm²g⁻¹] for Dysprosium, $Z = 66$, $A = 162.50$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.6481	0.9424	0.3715	2.9620
5.	2.2796	2.2360	0.3968	4.9124
10.	2.7944	3.2282	0.3890	6.4116
20.	3.3225	4.1624	0.3701	7.8550
50.	4.0145	5.5664	0.3594	9.9402
100.	4.5074	6.4963	0.3520	11.3556
200.	4.9584	7.3236	0.3484	12.6304
500.	5.4664	8.0845	0.3486	13.8995
1000.	5.7736	8.4890	0.3540	14.6166
2000.	6.0134	8.7814	0.3626	15.1574
5000.	6.2369	9.0262	0.3783	15.6414
10000.	6.3479	9.1396	0.3939	15.8813
20000.	6.4217	9.2136	0.4120	16.0472
50000.	6.4828	9.2690	0.4403	16.1920
100000.	6.5101	9.2920	0.4644	16.2665

TABLE VI-51. $b(E) \times 10^6$ [cm²g⁻¹] for Barium, $Z = 56$, $A = 137.327$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.4291	0.8027	0.3776	2.6094
5.	1.9725	1.9060	0.4033	4.2818
10.	2.4151	2.7543	0.3953	5.5647
20.	2.8692	3.5656	0.3758	6.8107
50.	3.4651	4.7779	0.3648	8.6078
100.	3.8904	5.5845	0.3572	9.8321
200.	4.2806	6.3050	0.3536	10.9391
500.	4.7216	6.9706	0.3537	12.0459
1000.	4.9894	7.3258	0.3592	12.6744
2000.	5.1993	7.5832	0.3680	13.1505
5000.	5.3957	7.7992	0.3840	13.5789
10000.	5.4937	7.8995	0.3999	13.7931
20000.	5.5591	7.9649	0.4185	13.9424
50000.	5.6134	8.0140	0.4474	14.0747
100000.	5.6377	8.0346	0.4721	14.1444

TABLE VI-54. $b(E) \times 10^6$ [cm²g⁻¹] for Tantalum, $Z = 73$, $A = 180.9479$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.7901	1.0353	0.3677	3.1931
5.	2.4795	2.4556	0.3927	5.3278
10.	3.0418	3.5436	0.3850	6.9704
20.	3.6187	4.5576	0.3664	8.5427
50.	4.3739	6.0873	0.3559	10.8172
100.	4.9113	7.0978	0.3486	12.3577
200.	5.4023	7.9944	0.3451	13.7418
500.	5.9541	8.8170	0.3453	15.1164
1000.	6.2869	9.2532	0.3507	15.8908
2000.	6.5461	9.5681	0.3591	16.4733
5000.	6.7869	9.8315	0.3746	16.9930
10000.	6.9063	9.9532	0.3899	17.2494
20000.	6.9854	10.0325	0.4078	17.4258
50000.	7.0509	10.0921	0.4357	17.5787
100000.	7.0801	10.1169	0.4595	17.6564

TABLE VI-55. $b(E) \times 10^6$ [cm²g⁻¹] for
Tungsten, $Z = 74$, $A = 183.84$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.8074	1.0471	0.3671	3.2216
5.	2.5040	2.4834	0.3920	5.3794
10.	3.0722	3.5835	0.3844	7.0401
20.	3.6552	4.6073	0.3659	8.6283
50.	4.4183	6.1527	0.3553	10.9264
100.	4.9613	7.1731	0.3481	12.4825
200.	5.4572	8.0783	0.3446	13.8801
500.	6.0144	8.9084	0.3448	15.2676
1000.	6.3504	9.3485	0.3502	16.0491
2000.	6.6119	9.6661	0.3586	16.6366
5000.	6.8549	9.9317	0.3740	17.1606
10000.	6.9752	10.0544	0.3894	17.4190
20000.	7.0550	10.1344	0.4072	17.5967
50000.	7.1210	10.1946	0.4350	17.7507
100000.	7.1504	10.2193	0.4588	17.8285

TABLE VI-56. $b(E) \times 10^6$ [cm²g⁻¹] for
Platinum, $Z = 78$, $A = 195.078$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.8806	1.0964	0.3650	3.3420
5.	2.6074	2.5999	0.3898	5.5970
10.	3.2005	3.7506	0.3822	7.3333
20.	3.8091	4.8158	0.3638	8.9887
50.	4.6055	6.4270	0.3534	11.3859
100.	5.1717	7.4893	0.3462	13.0072
200.	5.6886	8.4303	0.3428	14.4617
500.	6.2685	9.2923	0.3430	15.9038
1000.	6.6177	9.7488	0.3483	16.7148
2000.	6.8893	10.0778	0.3567	17.3238
5000.	7.1411	10.3529	0.3720	17.8660
10000.	7.2658	10.4798	0.3872	18.1328
20000.	7.3483	10.5627	0.4049	18.3159
50000.	7.4165	10.6246	0.4325	18.4736
100000.	7.4468	10.6504	0.4561	18.5533

TABLE VI-57. $b(E) \times 10^6$ [cm²g⁻¹] for
Gold, $Z = 79$, $A = 196.96655$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.9085	1.1138	0.3647	3.3869
5.	2.6463	2.6410	0.3894	5.6767
10.	3.2485	3.8098	0.3818	7.4401
20.	3.8663	4.8902	0.3635	9.1200
50.	4.6747	6.5252	0.3531	11.5531
100.	5.2494	7.6030	0.3459	13.1983
200.	5.7739	8.5573	0.3425	14.6736
500.	6.3622	9.4311	0.3427	16.1360
1000.	6.7164	9.8938	0.3480	16.9581
2000.	6.9917	10.2273	0.3564	17.5753
5000.	7.2469	10.5059	0.3716	18.1245
10000.	7.3732	10.6345	0.3868	18.3945
20000.	7.4568	10.7184	0.4045	18.5797
50000.	7.5259	10.7811	0.4321	18.7391
100000.	7.5565	10.8072	0.4557	18.8194

TABLE VI-58. $b(E) \times 10^6$ [cm²g⁻¹] for
Mercury, $Z = 80$, $A = 200.59$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.9183	1.1216	0.3640	3.4039
5.	2.6605	2.6595	0.3887	5.7088
10.	3.2665	3.8363	0.3811	7.4839
20.	3.8882	4.9226	0.3629	9.1737
50.	4.7016	6.5675	0.3525	11.6216
100.	5.2798	7.6513	0.3453	13.2764
200.	5.8073	8.6108	0.3419	14.7600
500.	6.3990	9.4891	0.3421	16.2302
1000.	6.7550	9.9540	0.3474	17.0564
2000.	7.0317	10.2889	0.3558	17.6764
5000.	7.2881	10.5688	0.3710	18.2279
10000.	7.4149	10.6979	0.3862	18.4990
20000.	7.4988	10.7822	0.4038	18.6849
50000.	7.5682	10.8453	0.4313	18.8448
100000.	7.5990	10.8714	0.4549	18.9252

TABLE VI-59. $b(E) \times 10^6$ [cm²g⁻¹] for
Lead, $Z = 82$, $A = 207.2$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.9445	1.1409	0.3629	3.4483
5.	2.6981	2.7050	0.3874	5.7905
10.	3.3134	3.9014	0.3799	7.5948
20.	3.9449	5.0030	0.3665	9.3144
50.	4.7709	6.6728	0.3514	11.7951
100.	5.3579	7.7722	0.3443	13.4743
200.	5.8933	8.7449	0.3409	14.9791
500.	6.4934	9.6347	0.3411	16.4693
1000.	6.8543	10.1055	0.3464	17.3062
2000.	7.1346	10.4446	0.3547	17.9339
5000.	7.3943	10.7278	0.3699	18.4919
10000.	7.5226	10.8584	0.3850	18.7659
20000.	7.6074	10.9436	0.4026	18.9536
50000.	7.6776	11.0073	0.4299	19.1149
100000.	7.7086	11.0338	0.4534	19.1959

TABLE VI-60. $b(E) \times 10^6$ [cm²g⁻¹] for
Bismuth, $Z = 83$, $A = 208.98038$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.9733	1.1589	0.3626	3.4947
5.	2.7383	2.7475	0.3871	5.8730
10.	3.3630	3.9626	0.3796	7.7052
20.	4.0040	5.0799	0.3662	9.4501
50.	4.8425	6.7743	0.3511	11.9679
100.	5.4382	7.8895	0.3440	13.6717
200.	5.9815	8.8760	0.3407	15.1981
500.	6.5902	9.7781	0.3409	16.7092
1000.	6.9562	10.2552	0.3461	17.5576
2000.	7.2404	10.5988	0.3544	18.1936
5000.	7.5035	10.8858	0.3696	18.7589
10000.	7.6335	11.0181	0.3847	19.0363
20000.	7.7195	11.1044	0.4022	19.2261
50000.	7.7905	11.1691	0.4296	19.3892
100000.	7.8220	11.1957	0.4530	19.4707

TABLE VI-61. $b(E) \times 10^6$ [cm²g⁻¹] for Thorium, $Z = 90$, $A = 232.0381$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	2.0665	1.2272	0.3589	3.6526
5.	2.8718	2.9088	0.3831	6.1636
10.	3.5299	4.1938	0.3757	8.0994
20.	4.2054	5.3652	0.3624	9.9330
50.	5.0886	7.1476	0.3476	12.5838
100.	5.7156	8.3181	0.3406	14.3743
200.	6.2867	9.3514	0.3374	15.9755
500.	6.9255	10.2946	0.3376	17.5577
1000.	7.3088	10.7925	0.3428	18.4441
2000.	7.6059	11.1506	0.3510	19.1075
5000.	7.8803	11.4494	0.3660	19.6957
10000.	8.0156	11.5870	0.3809	19.9834
20000.	8.1050	11.6768	0.3982	20.1799
50000.	8.1787	11.7438	0.4252	20.3476
100000.	8.2112	11.7714	0.4483	20.4310

TABLE VI-62. $b(E) \times 10^6$ [cm²g⁻¹] for Uranium, $Z = 92$, $A = 238.0289$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	2.0992	1.2500	0.3581	3.7073
5.	2.9183	2.9628	0.3821	6.2632
10.	3.5878	4.2713	0.3747	8.2339
20.	4.2750	5.4612	0.3615	10.0977
50.	5.1734	7.2736	0.3468	12.7937
100.	5.8110	8.4630	0.3398	14.6138
200.	6.3916	9.5125	0.3366	16.2406
500.	7.0408	10.4699	0.3368	17.8475
1000.	7.4300	10.9751	0.3420	18.7471
2000.	7.7316	11.3382	0.3502	19.4200
5000.	8.0100	11.6412	0.3651	20.0163
10000.	8.1471	11.7806	0.3799	20.3077
20000.	8.2377	11.8717	0.3972	20.5066
50000.	8.3124	11.9395	0.4241	20.6760
100000.	8.3454	11.9677	0.4471	20.7602

TABLE VI-63. $b(E) \times 10^6$ [cm²g⁻¹] for Plutonium, $Z = 94$, $A = 244.064197$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	2.1516	1.2836	0.3575	3.7927
5.	2.9918	3.0420	0.3815	6.4153
10.	3.6785	4.3853	0.3741	8.4380
20.	4.3834	5.6038	0.3610	10.3482
50.	5.3047	7.4615	0.3462	13.1125
100.	5.9585	8.6800	0.3393	14.9778
200.	6.5535	9.7544	0.3361	16.6440
500.	7.2186	10.7342	0.3363	18.2891
1000.	7.6171	11.2510	0.3415	19.2096
2000.	7.9256	11.6223	0.3496	19.8976
5000.	8.2104	11.9320	0.3645	20.5069
10000.	8.3506	12.0745	0.3793	20.8044
20000.	8.4431	12.1675	0.3965	21.0071
50000.	8.5257	12.2369	0.4234	21.1860
100000.	8.5531	12.2656	0.4464	21.2651

TABLE VII-1. $b(E) \times 10^6$ [cm²g⁻¹] for Acetone (CH₃CHCH₃), $\langle Z/A \rangle = 0.55097$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2478	0.1078	0.4756	0.8313
5.	0.3363	0.2667	0.5029	1.1060
10.	0.4099	0.4057	0.4874	1.3030
20.	0.4878	0.5573	0.4646	1.5097
50.	0.5944	0.7703	0.4397	1.8044
100.	0.6746	0.9214	0.4275	2.0235
200.	0.7504	1.0610	0.4212	2.2327
500.	0.8407	1.2061	0.4202	2.4669
1000.	0.8989	1.2954	0.4270	2.6213
2000.	0.9475	1.3586	0.4385	2.7446
5000.	0.9963	1.4147	0.4600	2.8710
10000.	1.0225	1.4412	0.4818	2.9454
20000.	1.0410	1.4579	0.5074	3.0062
50000.	1.0571	1.4709	0.5476	3.0756
100000.	1.0644	1.4763	0.5822	3.1229

TABLE VII-2. $b(E) \times 10^6$ [cm²g⁻¹] for Acetylene (C₂H₂), $\langle Z/A \rangle = 0.53768$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2319	0.0999	0.4765	0.8084
5.	0.3146	0.2479	0.5035	1.0660
10.	0.3835	0.3781	0.4880	1.2496
20.	0.4565	0.5206	0.4651	1.4422
50.	0.5566	0.7204	0.4402	1.7173
100.	0.6326	0.8626	0.4279	1.9231
200.	0.7035	0.9942	0.4217	2.1195
500.	0.7887	1.1315	0.4207	2.3409
1000.	0.8438	1.2162	0.4276	2.4876
2000.	0.8897	1.2764	0.4392	2.6053
5000.	0.9358	1.3300	0.4607	2.7265
10000.	0.9606	1.3552	0.4825	2.7984
20000.	0.9781	1.3712	0.5083	2.8575
50000.	0.9934	1.3836	0.5486	2.9255
100000.	0.9999	1.3887	0.5832	2.9720

TABLE VII-3. $b(E) \times 10^6$ [cm²g⁻¹] for Aluminum Oxide (Al₂O₃), $\langle Z/A \rangle = 0.49038$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.3928	0.1827	0.4489	1.0245
5.	0.5329	0.4426	0.4765	1.4520
10.	0.6474	0.6558	0.4636	1.7668
20.	0.7667	0.8850	0.4435	2.0952
50.	0.9265	1.2096	0.4214	2.5575
100.	1.0437	1.4368	0.4107	2.8911
200.	1.1549	1.6394	0.4052	3.1996
500.	1.2841	1.8509	0.4046	3.5395
1000.	1.3660	1.9745	0.4112	3.7518
2000.	1.4330	2.0614	0.4221	3.9164
5000.	1.4986	2.1364	0.4422	4.0772
10000.	1.5329	2.1718	0.4624	4.1671
20000.	1.5570	2.1942	0.4861	4.2373
50000.	1.5767	2.2122	0.5232	4.3120
100000.	1.5861	2.2195	0.5549	4.3606

TABLE VII-4. $b(E) \times 10^6$ [cm^2g^{-1}] for Barium Fluoride (BaF_2), $\langle Z/A \rangle = 0.42207$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.1904	0.6612	0.3939	2.2456
5.	1.6414	1.5719	0.4200	3.6333
10.	2.0088	2.2751	0.4108	4.6947
20.	2.3862	2.9525	0.3911	5.7298
50.	2.8821	3.9612	0.3776	7.2210
100.	3.2367	4.6346	0.3693	8.2407
200.	3.5628	5.2371	0.3653	9.1652
500.	3.9322	5.7969	0.3653	10.0943
1000.	4.1571	6.0984	0.3710	10.6265
2000.	4.3340	6.3161	0.3803	11.0305
5000.	4.5001	6.4995	0.3972	11.3969
10000.	4.5834	6.5847	0.4141	11.5822
20000.	4.6391	6.6402	0.4339	11.7131
50000.	4.6854	6.6820	0.4647	11.8320
100000.	4.7062	6.6995	0.4910	11.8968

TABLE VII-7. $b(E) \times 10^6$ [cm^2g^{-1}] for Butane (C_4H_{10}), $\langle Z/A \rangle = 0.59497$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2191	0.0932	0.4841	0.7965
5.	0.2977	0.2330	0.5114	1.0422
10.	0.3637	0.3586	0.4951	1.2174
20.	0.4340	0.4958	0.4714	1.4013
50.	0.5311	0.6883	0.4454	1.6649
100.	0.6050	0.8253	0.4327	1.8630
200.	0.6745	0.9523	0.4261	2.0530
500.	0.7581	1.0860	0.4250	2.2692
1000.	0.8126	1.1689	0.4317	2.4132
2000.	0.8582	1.2283	0.4435	2.5299
5000.	0.9046	1.2812	0.4653	2.6511
10000.	0.9298	1.3062	0.4876	2.7235
20000.	0.9478	1.3219	0.5139	2.7835
50000.	0.9637	1.3341	0.5550	2.8527
100000.	0.9707	1.3390	0.5905	2.9004

TABLE VII-5. $b(E) \times 10^6$ [cm^2g^{-1}] for Beryllium Oxide (BeO), $\langle Z/A \rangle = 0.47979$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2539	0.1124	0.4673	0.8337
5.	0.3444	0.2763	0.4939	1.1145
10.	0.4191	0.4165	0.4791	1.3147
20.	0.4977	0.5693	0.4573	1.5243
50.	0.6046	0.7843	0.4335	1.8224
100.	0.6841	0.9380	0.4220	2.0441
200.	0.7599	1.0771	0.4162	2.2532
500.	0.8492	1.2213	0.4153	2.4857
1000.	0.9063	1.3098	0.4223	2.6383
2000.	0.9537	1.3719	0.4336	2.7592
5000.	1.0008	1.4269	0.4548	2.8825
10000.	1.0257	1.4529	0.4761	2.9547
20000.	1.0431	1.4694	0.5012	3.0136
50000.	1.0580	1.4823	0.5404	3.0807
100000.	1.0649	1.4876	0.5741	3.1267

TABLE VII-8. $b(E) \times 10^6$ [cm^2g^{-1}] for Calcium Carbonate (CaCO_3), $\langle Z/A \rangle = 0.49955$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4630	0.2205	0.4466	1.1302
5.	0.6291	0.5322	0.4743	1.6356
10.	0.7646	0.7849	0.4615	2.0110
20.	0.9053	1.0532	0.4416	2.4000
50.	1.0931	1.4344	0.4196	2.9472
100.	1.2303	1.6995	0.4090	3.3388
200.	1.3594	1.9433	0.4036	3.7062
500.	1.5095	2.1822	0.4029	4.0946
1000.	1.6040	2.3194	0.4095	4.3329
2000.	1.6807	2.4181	0.4203	4.5192
5000.	1.7556	2.5033	0.4402	4.6991
10000.	1.7944	2.5434	0.4603	4.7981
20000.	1.8217	2.5691	0.4839	4.8746
50000.	1.8438	2.5892	0.5207	4.9535
100000.	1.8542	2.5975	0.5522	5.0040

TABLE VII-6. $b(E) \times 10^6$ [cm^2g^{-1}] for Bismuth Germanate, $\langle Z/A \rangle = 0.42065$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.5373	0.8860	0.3843	2.8076
5.	2.1288	2.1032	0.4097	4.6418
10.	2.6116	3.0381	0.4009	6.0507
20.	3.1074	3.9099	0.3859	7.4032
50.	3.7571	5.2246	0.3691	9.3507
100.	4.2197	6.0942	0.3611	10.6749
200.	4.6430	6.8663	0.3572	11.8665
500.	5.1190	7.5772	0.3572	13.0533
1000.	5.4065	7.9562	0.3628	13.7255
2000.	5.6308	8.2292	0.3717	14.2318
5000.	5.8396	8.4581	0.3882	14.6859
10000.	5.9434	8.5639	0.4046	14.9119
20000.	6.0124	8.6328	0.4236	15.0687
50000.	6.0695	8.6847	0.4534	15.2075
100000.	6.0949	8.7060	0.4789	15.2799

TABLE VII-9. $b(E) \times 10^6$ [cm^2g^{-1}] for Calcium Fluoride CaF_2 , $\langle Z/A \rangle = 0.49670$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5234	0.2530	0.4381	1.2146
5.	0.7116	0.6087	0.4659	1.7862
10.	0.8649	0.8942	0.4539	2.2130
20.	1.0236	1.1958	0.4348	2.6542
50.	1.2347	1.6253	0.4136	3.2737
100.	1.3884	1.9228	0.4033	3.7147
200.	1.5327	2.1962	0.3983	4.1271
500.	1.7001	2.4616	0.3977	4.5594
1000.	1.8049	2.6123	0.4042	4.8214
2000.	1.8900	2.7209	0.4147	5.0256
5000.	1.9724	2.8142	0.4342	5.2208
10000.	2.0150	2.8581	0.4538	5.3269
20000.	2.0449	2.8864	0.4767	5.4080
50000.	2.0689	2.9083	0.5125	5.4897
100000.	2.0803	2.9175	0.5432	5.5410

TABLE VII-10. $b(E) \times 10^6$ [cm^2g^{-1}] for
Calcium Oxide (CaO), $\langle Z/A \rangle = 0.49929$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5959	0.2908	0.4341	1.3209
5.	0.8105	0.6984	0.4622	1.9711
10.	0.9851	1.0235	0.4506	2.4591
20.	1.1655	1.3652	0.4317	2.9625
50.	1.4050	1.8526	0.4109	3.6687
100.	1.5790	2.1894	0.4008	4.1692
200.	1.7419	2.4989	0.3957	4.6366
500.	1.9306	2.7973	0.3952	5.1231
1000.	2.0485	2.9641	0.4016	5.4142
2000.	2.1438	3.0857	0.4120	5.6415
5000.	2.2358	3.1896	0.4313	5.8568
10000.	2.2833	3.2385	0.4506	5.9724
20000.	2.3168	3.2701	0.4732	6.0600
50000.	2.3431	3.2945	0.5085	6.1461
100000.	2.3558	3.3047	0.5388	6.1993

TABLE VII-11. $b(E) \times 10^6$ [cm^2g^{-1}] for
Carbon Dioxide (CO₂), $\langle Z/A \rangle = 0.49989$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2937	0.1310	0.4624	0.8872
5.	0.3979	0.3206	0.4897	1.2082
10.	0.4837	0.4809	0.4755	1.4401
20.	0.5737	0.6555	0.4541	1.6834
50.	0.6956	0.9015	0.4307	2.0278
100.	0.7860	1.0753	0.4194	2.2807
200.	0.8719	1.2352	0.4136	2.5207
500.	0.9730	1.3984	0.4128	2.7841
1000.	1.0374	1.4980	0.4196	2.9550
2000.	1.0907	1.5675	0.4308	3.0891
5000.	1.1436	1.6287	0.4517	3.2240
10000.	1.1714	1.6576	0.4728	3.3018
20000.	1.1908	1.6759	0.4975	3.3641
50000.	1.2074	1.6904	0.5361	3.4339
100000.	1.2151	1.6963	0.5693	3.4808

TABLE VII-12. $b(E) \times 10^6$ [cm^2g^{-1}] for
Cesium Iodide (CsI), $\langle Z/A \rangle = 0.41569$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.4134	0.7894	0.3796	2.5825
5.	1.9495	1.8746	0.4055	4.2296
10.	2.3858	2.7097	0.3974	5.4929
20.	2.8335	3.5109	0.3777	6.7221
50.	3.4210	4.7066	0.3667	8.4943
100.	3.8405	5.5030	0.3590	9.7025
200.	4.2255	6.2150	0.3553	10.7958
500.	4.6612	6.8733	0.3554	11.8899
1000.	4.9258	7.2250	0.3610	12.5118
2000.	5.1335	7.4800	0.3697	12.9833
5000.	5.3280	7.6941	0.3859	13.4080
10000.	5.4251	7.7935	0.4019	13.6206
20000.	5.4900	7.8584	0.4207	13.7690
50000.	5.5439	7.9071	0.4498	13.9007
100000.	5.5681	7.9274	0.4746	13.9701

TABLE VII-13. $b(E) \times 10^6$ [cm^2g^{-1}] for
Diethyl Ether ((CH₃CH₂)₂O), $\langle Z/A \rangle = 0.56663$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2394	0.1034	0.4788	0.8217
5.	0.3250	0.2568	0.5061	1.0880
10.	0.3964	0.3921	0.4904	1.2788
20.	0.4722	0.5396	0.4672	1.4791
50.	0.5762	0.7469	0.4418	1.7650
100.	0.6547	0.8941	0.4294	1.9782
200.	0.7288	1.0301	0.4231	2.1821
500.	0.8174	1.1721	0.4220	2.4115
1000.	0.8748	1.2597	0.4287	2.5632
2000.	0.9227	1.3219	0.4403	2.6849
5000.	0.9710	1.3773	0.4620	2.8102
10000.	0.9970	1.4033	0.4839	2.8843
20000.	1.0155	1.4198	0.5098	2.9450
50000.	1.0317	1.4326	0.5503	3.0146
100000.	1.0390	1.4379	0.5852	3.0622

TABLE VII-14. $b(E) \times 10^6$ [cm^2g^{-1}] for
Ethane (C₂H₆), $\langle Z/A \rangle = 0.59861$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2154	0.0912	0.4863	0.7931
5.	0.2929	0.2287	0.5137	1.0353
10.	0.3580	0.3530	0.4972	1.2081
20.	0.4276	0.4887	0.4732	1.3895
50.	0.5237	0.6791	0.4469	1.6498
100.	0.5971	0.8145	0.4341	1.8456
200.	0.6661	0.9402	0.4274	2.0337
500.	0.7493	1.0729	0.4263	2.2485
1000.	0.8036	1.1553	0.4329	2.3918
2000.	0.8492	1.2144	0.4447	2.5082
5000.	0.8956	1.2672	0.4667	2.6294
10000.	0.9209	1.2920	0.4890	2.7019
20000.	0.9391	1.3077	0.5155	2.7621
50000.	0.9551	1.3198	0.5569	2.8317
100000.	0.9623	1.3247	0.5926	2.8797

TABLE VII-15. $b(E) \times 10^6$ [cm^2g^{-1}] for
Ethanol (C₂H₅OH), $\langle Z/A \rangle = 0.56437$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2493	0.1084	0.4770	0.8348
5.	0.3385	0.2685	0.5044	1.1113
10.	0.4126	0.4087	0.4888	1.3102
20.	0.4912	0.5616	0.4658	1.5187
50.	0.5988	0.7765	0.4406	1.8161
100.	0.6798	0.9289	0.4283	2.0370
200.	0.7565	1.0696	0.4220	2.2482
500.	0.8478	1.2160	0.4210	2.4847
1000.	0.9068	1.3060	0.4277	2.6405
2000.	0.9560	1.3699	0.4392	2.7651
5000.	1.0055	1.4265	0.4608	2.8928
10000.	1.0321	1.4533	0.4826	2.9680
20000.	1.0510	1.4701	0.5084	3.0295
50000.	1.0675	1.4833	0.5487	3.0995
100000.	1.0751	1.4887	0.5834	3.1473

TABLE VII-16. $b(E) \times 10^6$ [cm^2g^{-1}] for Lithium Fluoride (LiF), $\langle Z/A \rangle = 0.46262$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2703	0.1220	0.4631	0.8554
5.	0.3668	0.2984	0.4895	1.1547
10.	0.4464	0.4476	0.4751	1.3691
20.	0.5299	0.6095	0.4537	1.5932
50.	0.6431	0.8377	0.4303	1.9110
100.	0.7269	0.9994	0.4189	2.1453
200.	0.8067	1.1468	0.4133	2.3668
500.	0.9004	1.2976	0.4125	2.6104
1000.	0.9600	1.3897	0.4195	2.7692
2000.	1.0094	1.4540	0.4308	2.8942
5000.	1.0583	1.5109	0.4517	3.0209
10000.	1.0841	1.5377	0.4728	3.0947
20000.	1.1021	1.5547	0.4975	3.1543
50000.	1.1174	1.5682	0.5363	3.2219
100000.	1.1246	1.5737	0.5695	3.2678

TABLE VII-17. $b(E) \times 10^6$ [cm^2g^{-1}] for Lithium Iodide (LiI), $\langle Z/A \rangle = 0.41939$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.3301	0.7401	0.3862	2.4565
5.	1.8340	1.7583	0.4121	4.0044
10.	2.2441	2.5427	0.4034	5.1903
20.	2.6651	3.2972	0.3834	6.3456
50.	3.2177	4.4219	0.3716	8.0113
100.	3.6126	5.1720	0.3636	9.1481
200.	3.9752	5.8427	0.3598	10.1777
500.	4.3857	6.4640	0.3598	11.2095
1000.	4.6354	6.7965	0.3655	11.7974
2000.	4.8315	7.0377	0.3745	12.2437
5000.	5.0154	7.2403	0.3910	12.6467
10000.	5.1074	7.3345	0.4074	12.8493
20000.	5.1688	7.3959	0.4267	12.9913
50000.	5.2199	7.4421	0.4565	13.1185
100000.	5.2429	7.4612	0.4820	13.1861

TABLE VII-18. $b(E) \times 10^6$ [cm^2g^{-1}] for Methane (CH_4), $\langle Z/A \rangle = 0.62334$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2088	0.0877	0.4904	0.7868
5.	0.2841	0.2209	0.5178	1.0228
10.	0.3477	0.3427	0.5009	1.1913
20.	0.4158	0.4758	0.4765	1.3681
50.	0.5104	0.6623	0.4497	1.6225
100.	0.5827	0.7950	0.4365	1.8142
200.	0.6509	0.9182	0.4297	1.9989
500.	0.7333	1.0491	0.4285	2.2110
1000.	0.7873	1.1305	0.4351	2.3529
2000.	0.8327	1.1892	0.4469	2.4688
5000.	0.8792	1.2417	0.4691	2.5899
10000.	0.9048	1.2664	0.4916	2.6628
20000.	0.9232	1.2819	0.5184	2.7234
50000.	0.9396	1.2939	0.5602	2.7937
100000.	0.9470	1.2988	0.5964	2.8423

TABLE VII-19. $b(E) \times 10^6$ [cm^2g^{-1}] for Octane (C_8H_{18}), $\langle Z/A \rangle = 0.57778$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2211	0.0942	0.4830	0.7983
5.	0.3003	0.2353	0.5102	1.0458
10.	0.3667	0.3616	0.4940	1.2223
20.	0.4375	0.4996	0.4704	1.4075
50.	0.5350	0.6932	0.4446	1.6729
100.	0.6092	0.8310	0.4320	1.8721
200.	0.6789	0.9586	0.4255	2.0631
500.	0.7628	1.0930	0.4243	2.2801
1000.	0.8173	1.1761	0.4311	2.4245
2000.	0.8630	1.2356	0.4428	2.5414
5000.	0.9093	1.2886	0.4646	2.6626
10000.	0.9345	1.3136	0.4868	2.7349
20000.	0.9524	1.3294	0.5130	2.7947
50000.	0.9682	1.3416	0.5540	2.8638
100000.	0.9752	1.3466	0.5894	2.9112

TABLE VII-20. $b(E) \times 10^6$ [cm^2g^{-1}] for Paraffin ($\text{CH}_3(\text{CH}_2)_{n \approx 23}\text{CH}_3$), $\langle Z/A \rangle = 0.57275$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2224	0.0949	0.4822	0.7996
5.	0.3021	0.2369	0.5094	1.0483
10.	0.3688	0.3636	0.4933	1.2257
20.	0.4398	0.5022	0.4697	1.4119
50.	0.5377	0.6966	0.4441	1.6785
100.	0.6122	0.8349	0.4315	1.8785
200.	0.6820	0.9631	0.4250	2.0702
500.	0.7660	1.0978	0.4239	2.2877
1000.	0.8206	1.1811	0.4306	2.4324
2000.	0.8663	1.2407	0.4423	2.5494
5000.	0.9126	1.2938	0.4641	2.6706
10000.	0.9378	1.3188	0.4863	2.7429
20000.	0.9557	1.3346	0.5124	2.8026
50000.	0.9713	1.3468	0.5533	2.8715
100000.	0.9783	1.3519	0.5886	2.9189

TABLE VII-21. $b(E) \times 10^6$ [cm^2g^{-1}] for Plutonium Dioxide (PuO_2), $\langle Z/A \rangle = 0.40583$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.9345	1.1487	0.3695	3.4528
5.	2.6887	2.7234	0.3939	5.8060
10.	3.3051	3.9282	0.3858	7.6192
20.	3.9380	5.0247	0.3717	9.3345
50.	4.7658	6.6939	0.3560	11.8158
100.	5.3537	7.7903	0.3485	13.4925
200.	5.8892	8.7579	0.3450	14.9921
500.	6.4883	9.6423	0.3451	16.4757
1000.	6.8478	10.1104	0.3505	17.3087
2000.	7.1265	10.4464	0.3590	17.9320
5000.	7.3842	10.7271	0.3746	18.4859
10000.	7.5113	10.8564	0.3901	18.7578
20000.	7.5953	10.9407	0.4081	18.9441
50000.	7.6702	11.0037	0.4364	19.1102
100000.	7.6953	11.0297	0.4605	19.1856

TABLE VII-22. $b(E) \times 10^6$ [cm^2g^{-1}] for
Propane (C_3H_8), $\langle Z/A \rangle = 0.58962$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2179	0.0925	0.4849	0.7953
5.	0.2961	0.2315	0.5122	1.0398
10.	0.3618	0.3567	0.4958	1.2142
20.	0.4318	0.4934	0.4720	1.3973
50.	0.5286	0.6852	0.4459	1.6598
100.	0.6023	0.8216	0.4332	1.8571
200.	0.6716	0.9481	0.4266	2.0464
500.	0.7551	1.0816	0.4254	2.2621
1000.	0.8095	1.1643	0.4321	2.4059
2000.	0.8551	1.2235	0.4439	2.5225
5000.	0.9015	1.2764	0.4658	2.6437
10000.	0.9267	1.3013	0.4881	2.7162
20000.	0.9448	1.3170	0.5144	2.7762
50000.	0.9607	1.3292	0.5556	2.8456
100000.	0.9679	1.3342	0.5912	2.8933

TABLE VII-23. $b(E) \times 10^6$ [cm^2g^{-1}] for
Silicon Dioxide (SiO_2), $\langle Z/A \rangle = 0.49930$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4071	0.1895	0.4494	1.0460
5.	0.5522	0.4589	0.4771	1.4883
10.	0.6708	0.6796	0.4642	1.8145
20.	0.7942	0.9166	0.4440	2.1548
50.	0.9595	1.2522	0.4218	2.6336
100.	1.0807	1.4870	0.4111	2.9786
200.	1.1955	1.6964	0.4056	3.2976
500.	1.3289	1.9180	0.4049	3.6518
1000.	1.4135	2.0420	0.4116	3.8670
2000.	1.4825	2.1314	0.4224	4.0364
5000.	1.5502	2.2087	0.4425	4.2014
10000.	1.5855	2.2451	0.4628	4.2934
20000.	1.6103	2.2682	0.4865	4.3651
50000.	1.6305	2.2867	0.5236	4.4409
100000.	1.6403	2.2942	0.5554	4.4900

TABLE VII-24. $b(E) \times 10^6$ [cm^2g^{-1}] for
Sodium Iodide (NaI), $\langle Z/A \rangle = 0.42697$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.2433	0.6871	0.3905	2.3210
5.	1.7130	1.6333	0.4167	3.7630
10.	2.0953	2.3635	0.4079	4.8666
20.	2.4879	3.0691	0.3881	5.9450
50.	3.0035	4.1188	0.3754	7.4977
100.	3.3723	4.8200	0.3672	8.5594
200.	3.7113	5.4478	0.3632	9.5224
500.	4.0957	6.0308	0.3632	10.4898
1000.	4.3298	6.3446	0.3690	11.0434
2000.	4.5140	6.5715	0.3781	11.4636
5000.	4.6870	6.7624	0.3949	11.8443
10000.	4.7737	6.8512	0.4116	12.0364
20000.	4.8318	6.9090	0.4311	12.1718
50000.	4.8800	6.9526	0.4614	12.2940
100000.	4.9018	6.9707	0.4873	12.3598

TABLE VII-25. $b(E) \times 10^6$ [cm^2g^{-1}] for
Toluene ($\text{C}_6\text{H}_5\text{CH}_3$), $\langle Z/A \rangle = 0.54265$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2306	0.0992	0.4773	0.8071
5.	0.3128	0.2464	0.5043	1.0635
10.	0.3814	0.3761	0.4887	1.2462
20.	0.4541	0.5180	0.4657	1.4379
50.	0.5539	0.7170	0.4407	1.7118
100.	0.6297	0.8587	0.4284	1.9168
200.	0.7004	0.9898	0.4222	2.1125
500.	0.7855	1.1267	0.4211	2.3333
1000.	0.8405	1.2113	0.4280	2.4797
2000.	0.8863	1.2714	0.4396	2.5973
5000.	0.9325	1.3249	0.4612	2.7186
10000.	0.9574	1.3501	0.4831	2.7905
20000.	0.9750	1.3660	0.5089	2.8497
50000.	0.9902	1.3784	0.5493	2.9179
100000.	0.9969	1.3835	0.5840	2.9644

TABLE VII-26. $b(E) \times 10^6$ [cm^2g^{-1}] for
Trichloroethylene (C_2HCl_3), $\langle Z/A \rangle = 0.48710$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.5200	0.2515	0.4374	1.2089
5.	0.7072	0.6051	0.4651	1.7773
10.	0.8595	0.8890	0.4531	2.2017
20.	1.0174	1.1894	0.4341	2.6408
50.	1.2275	1.6168	0.4130	3.2573
100.	1.3807	1.9131	0.4027	3.6965
200.	1.5239	2.1865	0.3977	4.1080
500.	1.6906	2.4513	0.3971	4.5391
1000.	1.7952	2.5992	0.4036	4.7980
2000.	1.8799	2.7081	0.4141	5.0020
5000.	1.9621	2.8010	0.4335	5.1967
10000.	2.0047	2.8448	0.4531	5.3025
20000.	2.0348	2.8726	0.4759	5.3832
50000.	2.0585	2.8949	0.5116	5.4650
100000.	2.0700	2.9040	0.5421	5.5161

TABLE VII-27. $b(E) \times 10^6$ [cm^2g^{-1}] for
Water (H_2O), $\langle Z/A \rangle = 0.55509$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2902	0.1288	0.4696	0.8887
5.	0.3937	0.3166	0.4973	1.2076
10.	0.4793	0.4774	0.4824	1.4391
20.	0.5695	0.6522	0.4601	1.6818
50.	0.6920	0.8984	0.4357	2.0262
100.	0.7830	1.0723	0.4239	2.2791
200.	0.8702	1.2322	0.4177	2.5201
500.	0.9727	1.3964	0.4168	2.7858
1000.	1.0384	1.4968	0.4235	2.9586
2000.	1.0930	1.5671	0.4348	3.0950
5000.	1.1476	1.6293	0.4559	3.2328
10000.	1.1766	1.6587	0.4773	3.3126
20000.	1.1972	1.6772	0.5026	3.3768
50000.	1.2149	1.6918	0.5420	3.4487
100000.	1.2235	1.6978	0.5759	3.4972

TABLE VIII-1. $b(E) \times 10^6$ [cm²g⁻¹] for Bakelite [C₄₃H₃₈O₇]_n, $\langle Z/A \rangle = 0.52792$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2464	0.1073	0.4731	0.8269
5.	0.3342	0.2650	0.5001	1.0994
10.	0.4070	0.4023	0.4849	1.2943
20.	0.4841	0.5523	0.4624	1.4988
50.	0.5893	0.7629	0.4379	1.7902
100.	0.6686	0.9126	0.4259	2.0070
200.	0.7430	1.0508	0.4198	2.2137
500.	0.8319	1.1942	0.4188	2.4448
1000.	0.8892	1.2824	0.4256	2.5972
2000.	0.9368	1.3447	0.4371	2.7187
5000.	0.9845	1.4001	0.4585	2.8431
10000.	1.0100	1.4262	0.4802	2.9163
20000.	1.0279	1.4426	0.5057	2.9762
50000.	1.0435	1.4555	0.5456	3.0445
100000.	1.0503	1.4608	0.5799	3.0911

TABLE VIII-2. $b(E) \times 10^6$ [cm²g⁻¹] for Nylon (type 6, 6/6), $\langle Z/A \rangle = 0.54790$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2436	0.1056	0.4759	0.8252
5.	0.3305	0.2617	0.5031	1.0953
10.	0.4028	0.3983	0.4876	1.2887
20.	0.4794	0.5474	0.4647	1.4917
50.	0.5843	0.7569	0.4398	1.7811
100.	0.6633	0.9057	0.4276	1.9966
200.	0.7379	1.0432	0.4214	2.2025
500.	0.8268	1.1862	0.4204	2.4333
1000.	0.8842	1.2743	0.4272	2.5857
2000.	0.9321	1.3367	0.4387	2.7075
5000.	0.9802	1.3921	0.4602	2.8325
10000.	1.0061	1.4183	0.4820	2.9063
20000.	1.0243	1.4348	0.5077	2.9667
50000.	1.0402	1.4477	0.5479	3.0357
100000.	1.0474	1.4529	0.5825	3.0829

TABLE VIII-3. $b(E) \times 10^6$ [cm²g⁻¹] for Polycarbonate, $\langle Z/A \rangle = 0.52697$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2482	0.1081	0.4727	0.8291
5.	0.3366	0.2671	0.4998	1.1034
10.	0.4099	0.4052	0.4846	1.2996
20.	0.4873	0.5561	0.4621	1.5056
50.	0.5932	0.7680	0.4376	1.7989
100.	0.6729	0.9185	0.4256	2.0171
200.	0.7478	1.0576	0.4196	2.2249
500.	0.8371	1.2017	0.4185	2.4573
1000.	0.8946	1.2903	0.4254	2.6103
2000.	0.9425	1.3529	0.4369	2.7323
5000.	0.9903	1.4085	0.4583	2.8571
10000.	1.0159	1.4347	0.4799	2.9305
20000.	1.0339	1.4512	0.5054	2.9904
50000.	1.0495	1.4642	0.5452	3.0589
100000.	1.0564	1.4695	0.5795	3.1054

TABLE VIII-4. $b(E) \times 10^6$ [cm²g⁻¹] for Polyethylene [C₂H₄]_n, $\langle Z/A \rangle = 0.57034$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2231	0.0953	0.4818	0.8002
5.	0.3030	0.2376	0.5090	1.0496
10.	0.3698	0.3646	0.4929	1.2274
20.	0.4410	0.5035	0.4694	1.4140
50.	0.5390	0.6983	0.4438	1.6811
100.	0.6136	0.8368	0.4312	1.8816
200.	0.6835	0.9652	0.4248	2.0736
500.	0.7676	1.1001	0.4237	2.2913
1000.	0.8222	1.1836	0.4304	2.4362
2000.	0.8679	1.2432	0.4421	2.5532
5000.	0.9142	1.2963	0.4639	2.6744
10000.	0.9393	1.3213	0.4860	2.7467
20000.	0.9572	1.3371	0.5121	2.8064
50000.	0.9729	1.3494	0.5530	2.8752
100000.	0.9798	1.3544	0.5883	2.9225

TABLE VIII-5. $b(E) \times 10^6$ [cm²g⁻¹] for Polymethylmethacrylate, $\langle Z/A \rangle = 0.53937$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2541	0.1110	0.4733	0.8384
5.	0.3447	0.2741	0.5005	1.1193
10.	0.4199	0.4158	0.4853	1.3209
20.	0.4993	0.5703	0.4627	1.5324
50.	0.6078	0.7876	0.4381	1.8335
100.	0.6894	0.9417	0.4260	2.0570
200.	0.7663	1.0839	0.4199	2.2701
500.	0.8579	1.2312	0.4189	2.5079
1000.	0.9168	1.3218	0.4257	2.6643
2000.	0.9659	1.3857	0.4372	2.7888
5000.	1.0150	1.4424	0.4585	2.9160
10000.	1.0413	1.4692	0.4802	2.9907
20000.	1.0599	1.4861	0.5057	3.0516
50000.	1.0760	1.4993	0.5456	3.1208
100000.	1.0832	1.5047	0.5799	3.1679

TABLE VIII-6. $b(E) \times 10^6$ [cm²g⁻¹] for Polystyrene [C₆H₅CHCH₂]_n, $\langle Z/A \rangle = 0.53768$

See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2319	0.0999	0.4765	0.8084
5.	0.3146	0.2479	0.5035	1.0660
10.	0.3835	0.3781	0.4880	1.2496
20.	0.4565	0.5206	0.4651	1.4422
50.	0.5566	0.7204	0.4402	1.7173
100.	0.6326	0.8626	0.4279	1.9231
200.	0.7035	0.9942	0.4217	2.1195
500.	0.7887	1.1315	0.4207	2.3409
1000.	0.8438	1.2162	0.4276	2.4876
2000.	0.8897	1.2764	0.4392	2.6053
5000.	0.9358	1.3300	0.4607	2.7265
10000.	0.9606	1.3552	0.4825	2.7984
20000.	0.9781	1.3712	0.5083	2.8575
50000.	0.9934	1.3836	0.5486	2.9255
100000.	0.9999	1.3887	0.5832	2.9720

TABLE VIII-7. $b(E) \times 10^6$ [cm²g⁻¹] for
Polytetrafluoroethylene, $\langle Z/A \rangle = 0.47992$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.3072	0.1392	0.4572	0.9037
5.	0.4166	0.3395	0.4843	1.2404
10.	0.5065	0.5073	0.4706	1.4843
20.	0.6005	0.6894	0.4497	1.7397
50.	0.7275	0.9463	0.4269	2.1007
100.	0.8215	1.1273	0.4157	2.3647
200.	0.9105	1.2936	0.4102	2.6143
500.	1.0152	1.4619	0.4094	2.8866
1000.	1.0816	1.5644	0.4163	3.0624
2000.	1.1366	1.6355	0.4274	3.1995
5000.	1.1908	1.6981	0.4480	3.3368
10000.	1.2193	1.7276	0.4687	3.4156
20000.	1.2391	1.7463	0.4930	3.4783
50000.	1.2560	1.7611	0.5311	3.5481
100000.	1.2638	1.7672	0.5637	3.5947

TABLE IX-1. $b(E) \times 10^6$ [cm²g⁻¹] for
Air (dry, 1 atm), $\langle Z/A \rangle = 0.49919$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2898	0.1292	0.4628	0.8818
5.	0.3927	0.3162	0.4901	1.1989
10.	0.4774	0.4746	0.4758	1.4278
20.	0.5663	0.6471	0.4544	1.6678
50.	0.6867	0.8900	0.4310	2.0078
100.	0.7759	1.0619	0.4196	2.2573
200.	0.8610	1.2200	0.4139	2.4949
500.	0.9610	1.3814	0.4130	2.7554
1000.	1.0248	1.4799	0.4199	2.9245
2000.	1.0776	1.5487	0.4311	3.0573
5000.	1.1299	1.6094	0.4519	3.1912
10000.	1.1574	1.6380	0.4730	3.2685
20000.	1.1767	1.6561	0.4977	3.3306
50000.	1.1931	1.6705	0.5365	3.4001
100000.	1.2009	1.6764	0.5697	3.4470

TABLE VIII-8. $b(E) \times 10^6$ [cm²g⁻¹] for
Polyvinylchloride (PVC), $\langle Z/A \rangle = 0.51201$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4311	0.2048	0.4507	1.0866
5.	0.5862	0.4951	0.4782	1.5595
10.	0.7129	0.7321	0.4650	1.9101
20.	0.8449	0.9841	0.4447	2.2737
50.	1.0214	1.3419	0.4222	2.7856
100.	1.1511	1.5910	0.4112	3.1534
200.	1.2724	1.8211	0.4058	3.4992
500.	1.4144	2.0470	0.4051	3.8665
1000.	1.5041	2.1755	0.4116	4.0913
2000.	1.5771	2.2697	0.4225	4.2692
5000.	1.6485	2.3508	0.4426	4.4420
10000.	1.6859	2.3889	0.4629	4.5377
20000.	1.7123	2.4131	0.4868	4.6121
50000.	1.7336	2.4324	0.5240	4.6900
100000.	1.7437	2.4403	0.5559	4.7400

TABLE IX-2. $b(E) \times 10^6$ [cm²g⁻¹] for
Concrete, $\langle Z/A \rangle = 0.50274$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4146	0.1940	0.4495	1.0581
5.	0.5627	0.4695	0.4772	1.5094
10.	0.6837	0.6949	0.4643	1.8428
20.	0.8096	0.9362	0.4441	2.1899
50.	0.9782	1.2785	0.4218	2.6786
100.	1.1017	1.5176	0.4110	3.0303
200.	1.2187	1.7323	0.4056	3.3566
500.	1.3546	1.9555	0.4049	3.7150
1000.	1.4406	2.0817	0.4115	3.9339
2000.	1.5109	2.1725	0.4223	4.1057
5000.	1.5796	2.2509	0.4424	4.2730
10000.	1.6155	2.2879	0.4627	4.3661
20000.	1.6408	2.3113	0.4865	4.4385
50000.	1.6613	2.3300	0.5236	4.5149
100000.	1.6713	2.3377	0.5554	4.5644

TABLE VIII-9. $b(E) \times 10^6$ [cm²g⁻¹] for
Polyvinyltoluene, $\langle Z/A \rangle = 0.54141$
See page 209 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2309	0.0994	0.4771	0.8075
5.	0.3133	0.2468	0.5041	1.0642
10.	0.3819	0.3766	0.4885	1.2470
20.	0.4547	0.5186	0.4656	1.4390
50.	0.5546	0.7179	0.4406	1.7131
100.	0.6304	0.8597	0.4283	1.9184
200.	0.7012	0.9909	0.4221	2.1143
500.	0.7863	1.1279	0.4210	2.3352
1000.	0.8413	1.2125	0.4279	2.4817
2000.	0.8872	1.2726	0.4395	2.5993
5000.	0.9333	1.3261	0.4611	2.7205
10000.	0.9582	1.3514	0.4829	2.7925
20000.	0.9757	1.3673	0.5087	2.8517
50000.	0.9910	1.3797	0.5491	2.9198
100000.	0.9976	1.3848	0.5838	2.9663

TABLE IX-3. $b(E) \times 10^6$ [cm²g⁻¹] for
Lead Glass, $\langle Z/A \rangle = 0.42101$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.5610	0.9039	0.3846	2.8495
5.	2.1629	2.1456	0.4099	4.7184
10.	2.6544	3.0989	0.4010	6.1544
20.	3.1593	3.9849	0.3859	7.5301
50.	3.8207	5.3222	0.3690	9.5118
100.	4.2915	6.2060	0.3610	10.8584
200.	4.7221	6.9887	0.3571	12.0679
500.	5.2059	7.7112	0.3571	13.2742
1000.	5.4978	8.0956	0.3627	13.9561
2000.	5.7254	8.3724	0.3716	14.4694
5000.	5.9372	8.6042	0.3881	14.9294
10000.	6.0423	8.7113	0.4045	15.1579
20000.	6.1121	8.7810	0.4236	15.3166
50000.	6.1698	8.8334	0.4534	15.4566
100000.	6.1955	8.8551	0.4790	15.5297

TABLE IX-4. $b(E) \times 10^6$ [cm^2g^{-1}] for
Photographic Emulsion, $\langle Z/A \rangle = 0.43663$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	1.1884	0.6438	0.3912	2.2234
5.	1.6332	1.5312	0.4180	3.5824
10.	1.9948	2.2171	0.3992	4.6111
20.	2.3658	2.8894	0.3907	5.6459
50.	2.8537	3.8851	0.3769	7.1156
100.	3.2031	4.5528	0.3686	8.1246
200.	3.5249	5.1533	0.3647	9.0430
500.	3.8910	5.7128	0.3647	9.9685
1000.	4.1148	6.0134	0.3704	10.4987
2000.	4.2915	6.2323	0.3796	10.9034
5000.	4.4581	6.4165	0.3964	11.2710
10000.	4.5419	6.5024	0.4131	11.4574
20000.	4.5980	6.5583	0.4326	11.5890
50000.	4.6448	6.6006	0.4630	11.7086
100000.	4.6661	6.6183	0.4890	11.7733

TABLE IX-5. $b(E) \times 10^6$ [cm^2g^{-1}] for
Plate Glass, $\langle Z/A \rangle = 0.49731$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4312	0.2027	0.4471	1.0810
5.	0.5853	0.4899	0.4748	1.5500
10.	0.7110	0.7240	0.4621	1.8971
20.	0.8417	0.9744	0.4421	2.2582
50.	1.0166	1.3295	0.4202	2.7662
100.	1.1445	1.5773	0.4095	3.1312
200.	1.2655	1.8004	0.4041	3.4700
500.	1.4059	2.0304	0.4035	3.8398
1000.	1.4947	2.1603	0.4101	4.0651
2000.	1.5671	2.2537	0.4208	4.2417
5000.	1.6378	2.3343	0.4408	4.4130
10000.	1.6746	2.3724	0.4610	4.5080
20000.	1.7006	2.3965	0.4845	4.5816
50000.	1.7216	2.4157	0.5214	4.6586
100000.	1.7317	2.4236	0.5529	4.7082

TABLE IX-6. $b(E) \times 10^6$ [cm^2g^{-1}] for
Standard Rock, $\langle Z/A \rangle = 0.50000$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.4159	0.1933	0.4473	1.0565
5.	0.5639	0.4679	0.4751	1.5070
10.	0.6847	0.6925	0.4625	1.8397
20.	0.8104	0.9341	0.4425	2.1871
50.	0.9788	1.2762	0.4206	2.6756
100.	1.1021	1.5155	0.4098	3.0275
200.	1.2191	1.7340	0.4045	3.3575
500.	1.3552	1.9512	0.4038	3.7102
1000.	1.4409	2.0823	0.4104	3.9336
2000.	1.5113	2.1721	0.4212	4.1046
5000.	1.5801	2.2507	0.4412	4.2720
10000.	1.6161	2.2878	0.4613	4.3652
20000.	1.6417	2.3112	0.4849	4.4378
50000.	1.6619	2.3300	0.5218	4.5137
100000.	1.6718	2.3378	0.5534	4.5630

TABLE X-1. $b(E) \times 10^6$ [cm^2g^{-1}] for
A-150 Tissue-Equivalent Plastic, $\langle Z/A \rangle = 0.54903$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2437	0.1060	0.4765	0.8263
5.	0.3308	0.2625	0.5036	1.0970
10.	0.4033	0.3995	0.4881	1.2909
20.	0.4801	0.5489	0.4652	1.4942
50.	0.5852	0.7588	0.4402	1.7842
100.	0.6646	0.9077	0.4279	2.0002
200.	0.7391	1.0455	0.4217	2.2063
500.	0.8282	1.1886	0.4206	2.4374
1000.	0.8857	1.2765	0.4274	2.5896
2000.	0.9336	1.3390	0.4390	2.7116
5000.	0.9818	1.3945	0.4605	2.8368
10000.	1.0077	1.4207	0.4824	2.9107
20000.	1.0260	1.4372	0.5081	2.9712
50000.	1.0419	1.4501	0.5484	3.0403
100000.	1.0489	1.4553	0.5830	3.0874

TABLE X-2. $b(E) \times 10^6$ [cm^2g^{-1}] for
Adipose Tissue (ICRP), $\langle Z/A \rangle = 0.55947$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2440	0.1058	0.4772	0.8270
5.	0.3312	0.2623	0.5044	1.0979
10.	0.4038	0.3996	0.4888	1.2921
20.	0.4807	0.5493	0.4658	1.4959
50.	0.5861	0.7598	0.4407	1.7867
100.	0.6656	0.9091	0.4284	2.0031
200.	0.7406	1.0471	0.4221	2.2099
500.	0.8302	1.1908	0.4211	2.4420
1000.	0.8880	1.2793	0.4278	2.5951
2000.	0.9363	1.3421	0.4394	2.7178
5000.	0.9849	1.3978	0.4609	2.8436
10000.	1.0110	1.4241	0.4828	2.9180
20000.	1.0296	1.4407	0.5086	2.9788
50000.	1.0457	1.4537	0.5489	3.0483
100000.	1.0530	1.4590	0.5837	3.0957

TABLE X-3. $b(E) \times 10^6$ [cm^2g^{-1}] for
Blood (ICRP), $\langle Z/A \rangle = 0.54995$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2864	0.1270	0.4697	0.8832
5.	0.3886	0.3123	0.4973	1.1982
10.	0.4731	0.4711	0.4824	1.4265
20.	0.5621	0.6437	0.4601	1.6659
50.	0.6831	0.8868	0.4357	2.0056
100.	0.7731	1.0585	0.4239	2.2553
200.	0.8590	1.2165	0.4178	2.4933
500.	0.9603	1.3787	0.4168	2.7558
1000.	1.0252	1.4779	0.4235	2.9266
2000.	1.0791	1.5476	0.4348	3.0615
5000.	1.1330	1.6091	0.4560	3.1980
10000.	1.1616	1.6381	0.4774	3.2772
20000.	1.1819	1.6564	0.5027	3.3409
50000.	1.1994	1.6709	0.5421	3.4123
100000.	1.2077	1.6768	0.5760	3.4606

TABLE X-4. $b(E) \times 10^6$ [cm²g⁻¹] for Cortical Bone (ICRP), $\langle Z/A \rangle = 0.52130$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.3987	0.1866	0.4553	1.0407
5.	0.5417	0.4524	0.4830	1.4771
10.	0.6587	0.6712	0.4694	1.7993
20.	0.7807	0.9048	0.4486	2.1341
50.	0.9444	1.2361	0.4257	2.6062
100.	1.0646	1.4675	0.4145	2.9466
200.	1.1781	1.6787	0.4089	3.2657
500.	1.3106	1.8918	0.4081	3.6105
1000.	1.3945	2.0148	0.4147	3.8240
2000.	1.4631	2.1031	0.4257	3.9920
5000.	1.5305	2.1798	0.4461	4.1564
10000.	1.5657	2.2159	0.4667	4.2483
20000.	1.5906	2.2389	0.4909	4.3203
50000.	1.6111	2.2570	0.5287	4.3967
100000.	1.6208	2.2644	0.5611	4.4464

TABLE X-7. $b(E) \times 10^6$ [cm²g⁻¹] for MS20 Tissue Substitute, $\langle Z/A \rangle = 0.53886$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2717	0.1201	0.4711	0.8630
5.	0.3687	0.2957	0.4984	1.1628
10.	0.4489	0.4467	0.4834	1.3791
20.	0.5336	0.6110	0.4610	1.6057
50.	0.6489	0.8422	0.4366	1.9277
100.	0.7352	1.0058	0.4246	2.1656
200.	0.8166	1.1565	0.4186	2.3917
500.	0.9132	1.3116	0.4176	2.6424
1000.	0.9753	1.4066	0.4243	2.8062
2000.	1.0268	1.4735	0.4358	2.9360
5000.	1.0783	1.5327	0.4570	3.0679
10000.	1.1057	1.5606	0.4785	3.1448
20000.	1.1252	1.5782	0.5039	3.2072
50000.	1.1417	1.5920	0.5435	3.2773
100000.	1.1493	1.5977	0.5776	3.3247

TABLE X-5. $b(E) \times 10^6$ [cm²g⁻¹] for C-552 Air-equivalent Plastic, $\langle Z/A \rangle = 0.49969$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2801	0.1251	0.4640	0.8694
5.	0.3799	0.3065	0.4911	1.1775
10.	0.4622	0.4607	0.4768	1.3997
20.	0.5486	0.6285	0.4552	1.6324
50.	0.6659	0.8648	0.4316	1.9624
100.	0.7534	1.0318	0.4201	2.2054
200.	0.8359	1.1855	0.4143	2.4357
500.	0.9334	1.3427	0.4135	2.6896
1000.	0.9958	1.4387	0.4203	2.8548
2000.	1.0474	1.5059	0.4316	2.9849
5000.	1.0987	1.5652	0.4525	3.1164
10000.	1.1258	1.5932	0.4737	3.1926
20000.	1.1447	1.6109	0.4985	3.2540
50000.	1.1610	1.6248	0.5373	3.3231
100000.	1.1683	1.6305	0.5707	3.3696

TABLE X-8. $b(E) \times 10^6$ [cm²g⁻¹] for Skeletal Muscle (ICRP), $\langle Z/A \rangle = 0.54938$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2863	0.1270	0.4697	0.8830
5.	0.3885	0.3122	0.4972	1.1978
10.	0.4729	0.4709	0.4823	1.4261
20.	0.5619	0.6434	0.4601	1.6653
50.	0.6828	0.8863	0.4357	2.0048
100.	0.7727	1.0579	0.4239	2.2544
200.	0.8586	1.2159	0.4177	2.4922
500.	0.9598	1.3781	0.4168	2.7546
1000.	1.0247	1.4772	0.4235	2.9254
2000.	1.0785	1.5468	0.4348	3.0602
5000.	1.1324	1.6083	0.4560	3.1966
10000.	1.1610	1.6373	0.4774	3.2757
20000.	1.1813	1.6556	0.5026	3.3394
50000.	1.1987	1.6701	0.5421	3.4108
100000.	1.2070	1.6760	0.5760	3.4591

TABLE X-6. $b(E) \times 10^6$ [cm²g⁻¹] for Eye Lens (ICRP), $\langle Z/A \rangle = 0.54977$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2772	0.1224	0.4709	0.8704
5.	0.3760	0.3012	0.4983	1.1756
10.	0.4578	0.4551	0.4833	1.3963
20.	0.5441	0.6226	0.4610	1.6277
50.	0.6616	0.8583	0.4365	1.9564
100.	0.7491	1.0250	0.4246	2.1986
200.	0.8326	1.1786	0.4185	2.4296
500.	0.9311	1.3366	0.4175	2.6852
1000.	0.9944	1.4334	0.4242	2.8520
2000.	1.0470	1.5015	0.4356	2.9841
5000.	1.0996	1.5617	0.4568	3.1180
10000.	1.1276	1.5900	0.4783	3.1960
20000.	1.1474	1.6080	0.5036	3.2589
50000.	1.1645	1.6221	0.5432	3.3298
100000.	1.1726	1.6279	0.5773	3.3778

TABLE X-9. $b(E) \times 10^6$ [cm²g⁻¹] for Soft Tissue (ICRP), $\langle Z/A \rangle = 0.55121$
See page 210 for Explanation of Tables

E [GeV]	b_{brems}	b_{pair}	b_{nucl}	b_{tot}
2.	0.2765	0.1221	0.4714	0.8700
5.	0.3752	0.3006	0.4988	1.1746
10.	0.4569	0.4544	0.4838	1.3950
20.	0.5430	0.6215	0.4614	1.6260
50.	0.6604	0.8570	0.4369	1.9542
100.	0.7479	1.0234	0.4249	2.1961
200.	0.8312	1.1767	0.4187	2.4267
500.	0.9297	1.3346	0.4178	2.6821
1000.	0.9929	1.4312	0.4245	2.8487
2000.	1.0455	1.4993	0.4359	2.9807
5000.	1.0981	1.5594	0.4571	3.1146
10000.	1.1262	1.5878	0.4786	3.1926
20000.	1.1460	1.6057	0.5040	3.2556
50000.	1.1632	1.6198	0.5437	3.3266
100000.	1.1712	1.6256	0.5777	3.3746