

## Muons in skin (ICRP)

|          | $\langle Z/A \rangle$ | $\rho$ [g/cm <sup>3</sup> ] | $I$ [eV] | $a$                      | $k = m_s$ | $x_0$   | $x_1$                              | $\bar{C}$                   | $\delta_0$ |
|----------|-----------------------|-----------------------------|----------|--------------------------|-----------|---------|------------------------------------|-----------------------------|------------|
|          | 0.54932               | 1.100                       | 72.7     | 0.09459                  | 3.4643    | 0.2019  | 2.7526                             | 3.3546                      | 0.00       |
| $T$      | $p$<br>[MeV/c]        | Ionization                  | Brems    | Pair prod                | Photonucl | Total   | CSDA range<br>[g/cm <sup>2</sup> ] |                             |            |
|          |                       |                             |          | [MeV cm <sup>2</sup> /g] |           |         |                                    |                             |            |
| 10.0 MeV | $4.704 \times 10^1$   | 7.914                       |          |                          |           | 7.914   |                                    | $6.982 \times 10^{-1}$      |            |
| 14.0 MeV | $5.616 \times 10^1$   | 6.172                       |          |                          |           | 6.172   |                                    | $1.277 \times 10^0$         |            |
| 20.0 MeV | $6.802 \times 10^1$   | 4.820                       |          |                          |           | 4.820   |                                    | $2.389 \times 10^0$         |            |
| 30.0 MeV | $8.509 \times 10^1$   | 3.738                       |          |                          |           | 3.739   |                                    | $4.778 \times 10^0$         |            |
| 40.0 MeV | $1.003 \times 10^2$   | 3.192                       |          |                          |           | 3.192   |                                    | $7.692 \times 10^0$         |            |
| 80.0 MeV | $1.527 \times 10^2$   | 2.396                       |          |                          |           | 2.396   |                                    | $2.262 \times 10^1$         |            |
| 100. MeV | $1.764 \times 10^2$   | 2.250                       |          |                          |           | 2.250   |                                    | $3.125 \times 10^1$         |            |
| 140. MeV | $2.218 \times 10^2$   | 2.095                       |          |                          |           | 2.095   |                                    | $4.976 \times 10^1$         |            |
| 200. MeV | $2.868 \times 10^2$   | 2.005                       |          |                          |           | 2.005   |                                    | $7.916 \times 10^1$         |            |
| 300. MeV | $3.917 \times 10^2$   | 1.970                       |          |                          | 0.000     | 1.970   |                                    | $1.296 \times 10^2$         |            |
| 318. MeV | $4.105 \times 10^2$   | 1.969                       |          |                          | 0.000     | 1.970   |                                    | <i>Minimum ionization</i>   |            |
| 400. MeV | $4.945 \times 10^2$   | 1.976                       |          |                          | 0.000     | 1.976   |                                    | $1.803 \times 10^2$         |            |
| 800. MeV | $8.995 \times 10^2$   | 2.049                       | 0.000    |                          | 0.000     | 2.050   |                                    | $3.792 \times 10^2$         |            |
| 1.00 GeV | $1.101 \times 10^3$   | 2.083                       | 0.000    |                          | 0.000     | 2.084   |                                    | $4.759 \times 10^2$         |            |
| 1.40 GeV | $1.502 \times 10^3$   | 2.138                       | 0.000    |                          | 0.001     | 2.139   |                                    | $6.653 \times 10^2$         |            |
| 2.00 GeV | $2.103 \times 10^3$   | 2.199                       | 0.001    | 0.000                    | 0.001     | 2.201   |                                    | $9.416 \times 10^2$         |            |
| 3.00 GeV | $3.104 \times 10^3$   | 2.268                       | 0.001    | 0.001                    | 0.001     | 2.271   |                                    | $1.388 \times 10^3$         |            |
| 4.00 GeV | $4.104 \times 10^3$   | 2.316                       | 0.001    | 0.001                    | 0.002     | 2.321   |                                    | $1.824 \times 10^3$         |            |
| 8.00 GeV | $8.105 \times 10^3$   | 2.426                       | 0.003    | 0.003                    | 0.004     | 2.437   |                                    | $3.500 \times 10^3$         |            |
| 10.0 GeV | $1.011 \times 10^4$   | 2.460                       | 0.005    | 0.005                    | 0.005     | 2.474   |                                    | $4.315 \times 10^3$         |            |
| 14.0 GeV | $1.411 \times 10^4$   | 2.509                       | 0.007    | 0.008                    | 0.007     | 2.530   |                                    | $5.913 \times 10^3$         |            |
| 20.0 GeV | $2.011 \times 10^4$   | 2.558                       | 0.011    | 0.012                    | 0.009     | 2.590   |                                    | $8.255 \times 10^3$         |            |
| 30.0 GeV | $3.011 \times 10^4$   | 2.611                       | 0.018    | 0.022                    | 0.014     | 2.664   |                                    | $1.206 \times 10^4$         |            |
| 40.0 GeV | $4.011 \times 10^4$   | 2.647                       | 0.025    | 0.032                    | 0.018     | 2.722   |                                    | $1.577 \times 10^4$         |            |
| 80.0 GeV | $8.011 \times 10^4$   | 2.730                       | 0.058    | 0.077                    | 0.034     | 2.899   |                                    | $2.999 \times 10^4$         |            |
| 100. GeV | $1.001 \times 10^5$   | 2.756                       | 0.075    | 0.102                    | 0.042     | 2.975   |                                    | $3.679 \times 10^4$         |            |
| 140. GeV | $1.401 \times 10^5$   | 2.794                       | 0.110    | 0.153                    | 0.059     | 3.117   |                                    | $4.992 \times 10^4$         |            |
| 200. GeV | $2.001 \times 10^5$   | 2.834                       | 0.166    | 0.235                    | 0.084     | 3.319   |                                    | $6.857 \times 10^4$         |            |
| 300. GeV | $3.001 \times 10^5$   | 2.880                       | 0.262    | 0.373                    | 0.125     | 3.641   |                                    | $9.732 \times 10^4$         |            |
| 400. GeV | $4.001 \times 10^5$   | 2.912                       | 0.362    | 0.518                    | 0.167     | 3.959   |                                    | $1.237 \times 10^5$         |            |
| 800. GeV | $8.001 \times 10^5$   | 2.991                       | 0.777    | 1.118                    | 0.338     | 5.224   |                                    | $2.113 \times 10^5$         |            |
| 1.00 TeV | $1.000 \times 10^6$   | 3.016                       | 0.992    | 1.429                    | 0.424     | 5.862   |                                    | $2.474 \times 10^5$         |            |
| 1.06 TeV | $1.059 \times 10^6$   | 3.023                       | 1.054    | 1.518                    | 0.450     | 6.046   |                                    | <i>Muon critical energy</i> |            |
| 1.40 TeV | $1.400 \times 10^6$   | 3.055                       | 1.424    | 2.046                    | 0.602     | 7.128   |                                    | $3.092 \times 10^5$         |            |
| 2.00 TeV | $2.000 \times 10^6$   | 3.097                       | 2.089    | 2.993                    | 0.871     | 9.051   |                                    | $3.838 \times 10^5$         |            |
| 3.00 TeV | $3.000 \times 10^6$   | 3.145                       | 3.203    | 4.570                    | 1.335     | 12.253  |                                    | $4.784 \times 10^5$         |            |
| 4.00 TeV | $4.000 \times 10^6$   | 3.180                       | 4.336    | 6.168                    | 1.807     | 15.492  |                                    | $5.508 \times 10^5$         |            |
| 8.00 TeV | $8.000 \times 10^6$   | 3.265                       | 8.926    | 12.607                   | 3.773     | 28.571  |                                    | $7.381 \times 10^5$         |            |
| 10.0 TeV | $1.000 \times 10^7$   | 3.293                       | 11.248   | 15.850                   | 4.785     | 35.176  |                                    | $8.011 \times 10^5$         |            |
| 14.0 TeV | $1.400 \times 10^7$   | 3.336                       | 15.881   | 22.312                   | 6.871     | 48.400  |                                    | $8.976 \times 10^5$         |            |
| 20.0 TeV | $2.000 \times 10^7$   | 3.382                       | 22.891   | 32.058                   | 10.077    | 68.408  |                                    | $1.001 \times 10^6$         |            |
| 30.0 TeV | $3.000 \times 10^7$   | 3.435                       | 34.564   | 48.274                   | 15.641    | 101.915 |                                    | $1.120 \times 10^6$         |            |
| 40.0 TeV | $4.000 \times 10^7$   | 3.474                       | 46.300   | 64.543                   | 21.353    | 135.670 |                                    | $1.205 \times 10^6$         |            |
| 80.0 TeV | $8.000 \times 10^7$   | 3.568                       | 93.370   | 129.672                  | 45.326    | 271.936 |                                    | $1.409 \times 10^6$         |            |
| 100. TeV | $1.000 \times 10^8$   | 3.600                       | 116.972  | 162.275                  | 57.754    | 340.600 |                                    | $1.475 \times 10^6$         |            |