## Muons in hafnium (Hf)

| Z | $A$ [g/mol] | $\rho$ [g/cm$^3$] | $I$ [eV] | $a$ | $k = m_s$ | $x_0$ | $x_1$ | $\overline{C}$ | $\delta_0$ |
|---|---|---|---|---|---|---|---|---|---|
| 72 (Hf) | 178.49 (2) | 13.310 | 705.0 | 0.22918 | 2.6155 | 0.1965 | 3.4337 | 5.7139 | 0.14 |

| $T$ | $p$ [MeV/$c$] | Ionization | Brems | Pair prod | Photonucl | Total | CSDA range [g/cm$^2$] |
|---|---|---|---|---|---|---|---|
| | | [MeV cm$^2$/g] | | | | | |
| 10.0 MeV | $4.704 \times 10^1$ | 4.035 | | | | 4.035 | $1.432 \times 10^0$ |
| 14.0 MeV | $5.616 \times 10^1$ | 3.212 | | | | 3.212 | $2.553 \times 10^0$ |
| 20.0 MeV | $6.802 \times 10^1$ | 2.553 | | | | 2.553 | $4.670 \times 10^0$ |
| 30.0 MeV | $8.509 \times 10^1$ | 2.014 | | | | 2.014 | $9.137 \times 10^0$ |
| 40.0 MeV | $1.003 \times 10^2$ | 1.737 | | | | 1.737 | $1.452 \times 10^1$ |
| 80.0 MeV | $1.527 \times 10^2$ | 1.330 | | | | 1.331 | $4.161 \times 10^1$ |
| 100. MeV | $1.764 \times 10^2$ | 1.258 | | | | 1.258 | $5.711 \times 10^1$ |
| 140. MeV | $2.218 \times 10^2$ | 1.188 | | | | 1.188 | $8.997 \times 10^1$ |
| 200. MeV | $2.868 \times 10^2$ | 1.155 | | | | 1.156 | $1.413 \times 10^2$ |
| 243. MeV | $3.325 \times 10^2$ | 1.152 | 0.000 | | | 1.152 | *Minimum ionization* |
| 300. MeV | $3.917 \times 10^2$ | 1.156 | 0.000 | | 0.000 | 1.157 | $2.280 \times 10^2$ |
| 400. MeV | $4.945 \times 10^2$ | 1.175 | 0.000 | | 0.000 | 1.176 | $3.138 \times 10^2$ |
| 800. MeV | $8.995 \times 10^2$ | 1.256 | 0.001 | | 0.000 | 1.258 | $6.423 \times 10^2$ |
| 1.00 GeV | $1.101 \times 10^3$ | 1.289 | 0.001 | | 0.000 | 1.291 | $7.992 \times 10^2$ |
| 1.40 GeV | $1.502 \times 10^3$ | 1.341 | 0.002 | | 0.001 | 1.344 | $1.103 \times 10^3$ |
| 2.00 GeV | $2.103 \times 10^3$ | 1.397 | 0.004 | 0.001 | 0.001 | 1.403 | $1.539 \times 10^3$ |
| 3.00 GeV | $3.104 \times 10^3$ | 1.461 | 0.006 | 0.003 | 0.001 | 1.472 | $2.234 \times 10^3$ |
| 4.00 GeV | $4.104 \times 10^3$ | 1.505 | 0.009 | 0.006 | 0.002 | 1.522 | $2.901 \times 10^3$ |
| 8.00 GeV | $8.105 \times 10^3$ | 1.606 | 0.023 | 0.021 | 0.003 | 1.653 | $5.413 \times 10^3$ |
| 10.0 GeV | $1.011 \times 10^4$ | 1.636 | 0.030 | 0.029 | 0.004 | 1.700 | $6.606 \times 10^3$ |
| 14.0 GeV | $1.411 \times 10^4$ | 1.679 | 0.046 | 0.048 | 0.005 | 1.779 | $8.904 \times 10^3$ |
| 20.0 GeV | $2.011 \times 10^4$ | 1.723 | 0.072 | 0.078 | 0.007 | 1.881 | $1.218 \times 10^4$ |
| 30.0 GeV | $3.011 \times 10^4$ | 1.769 | 0.117 | 0.137 | 0.011 | 2.035 | $1.729 \times 10^4$ |
| 40.0 GeV | $4.011 \times 10^4$ | 1.799 | 0.166 | 0.202 | 0.014 | 2.182 | $2.204 \times 10^4$ |
| 80.0 GeV | $8.011 \times 10^4$ | 1.866 | 0.374 | 0.487 | 0.028 | 2.756 | $3.831 \times 10^4$ |
| 100. GeV | $1.001 \times 10^5$ | 1.886 | 0.485 | 0.640 | 0.035 | 3.048 | $4.521 \times 10^4$ |
| 140. GeV | $1.401 \times 10^5$ | 1.916 | 0.712 | 0.956 | 0.049 | 3.634 | $5.721 \times 10^4$ |
| 154. GeV | $1.546 \times 10^5$ | 1.924 | 0.796 | 1.075 | 0.054 | 3.850 | *Muon critical energy* |
| 200. GeV | $2.001 \times 10^5$ | 1.946 | 1.067 | 1.457 | 0.069 | 4.540 | $7.196 \times 10^4$ |
| 300. GeV | $3.001 \times 10^5$ | 1.980 | 1.672 | 2.294 | 0.104 | 6.051 | $9.099 \times 10^4$ |
| 400. GeV | $4.001 \times 10^5$ | 2.003 | 2.298 | 3.160 | 0.138 | 7.602 | $1.057 \times 10^5$ |
| 800. GeV | $8.001 \times 10^5$ | 2.061 | 4.881 | 6.713 | 0.279 | 13.936 | $1.440 \times 10^5$ |
| 1.00 TeV | $1.000 \times 10^6$ | 2.080 | 6.207 | 8.529 | 0.351 | 17.169 | $1.569 \times 10^5$ |
| 1.40 TeV | $1.400 \times 10^6$ | 2.108 | 8.864 | 12.153 | 0.497 | 23.624 | $1.767 \times 10^5$ |
| 2.00 TeV | $2.000 \times 10^6$ | 2.139 | 12.927 | 17.681 | 0.719 | 33.468 | $1.980 \times 10^5$ |
| 3.00 TeV | $3.000 \times 10^6$ | 2.174 | 19.707 | 26.868 | 1.099 | 49.850 | $2.223 \times 10^5$ |
| 4.00 TeV | $4.000 \times 10^6$ | 2.200 | 26.574 | 36.150 | 1.485 | 66.411 | $2.396 \times 10^5$ |
| 8.00 TeV | $8.000 \times 10^6$ | 2.262 | 54.253 | 73.461 | 3.084 | 133.062 | $2.813 \times 10^5$ |
| 10.0 TeV | $1.000 \times 10^7$ | 2.283 | 68.197 | 92.214 | 3.904 | 166.600 | $2.947 \times 10^5$ |
| 14.0 TeV | $1.400 \times 10^7$ | 2.314 | 96.008 | 129.633 | 5.587 | 233.544 | $3.149 \times 10^5$ |
| 20.0 TeV | $2.000 \times 10^7$ | 2.348 | 137.960 | 185.998 | 8.166 | 334.474 | $3.363 \times 10^5$ |
| 30.0 TeV | $3.000 \times 10^7$ | 2.387 | 207.800 | 279.776 | 12.621 | 502.586 | $3.605 \times 10^5$ |
| 40.0 TeV | $4.000 \times 10^7$ | 2.415 | 277.881 | 373.772 | 17.179 | 671.249 | $3.776 \times 10^5$ |
| 80.0 TeV | $8.000 \times 10^7$ | 2.485 | 558.592 | 750.012 | 36.195 | 1347.285 | $4.189 \times 10^5$ |
| 100. TeV | $1.000 \times 10^8$ | 2.508 | 699.170 | 938.300 | 46.010 | 1685.990 | $4.321 \times 10^5$ |