

## Muons in aluminum oxide (sapphire, Al<sub>2</sub>O<sub>3</sub>)

$\langle Z/A \rangle$	$\rho$ [g/cm <sup>3</sup> ]	$I$ [eV]	$a$	$k = m_s$	$x_0$	$x_1$	$\bar{C}$	$\delta_0$
0.49038	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 <sup>2</sup> /g]	Photonucl	Total	CSDA range [g/cm <sup>2</sup> ]	
10.0 MeV	$4.704 \times 10^1$	6.435				6.435	$8.647 \times 10^{-1}$	
14.0 MeV	$5.616 \times 10^1$	5.037				5.037	$1.575 \times 10^0$	
20.0 MeV	$6.802 \times 10^1$	3.947				3.947	$2.935 \times 10^0$	
30.0 MeV	$8.509 \times 10^1$	3.073				3.073	$5.847 \times 10^0$	
40.0 MeV	$1.003 \times 10^2$	2.630				2.630	$9.387 \times 10^0$	
80.0 MeV	$1.527 \times 10^2$	1.977				1.977	$2.747 \times 10^1$	
100. MeV	$1.764 \times 10^2$	1.857				1.857	$3.794 \times 10^1$	
140. MeV	$2.218 \times 10^2$	1.736				1.736	$6.032 \times 10^1$	
200. MeV	$2.868 \times 10^2$	1.669				1.669	$9.570 \times 10^1$	
297. MeV	$3.884 \times 10^2$	1.647			0.000	1.648	<i>Minimum ionization</i>	
300. MeV	$3.917 \times 10^2$	1.647			0.000	1.648	$1.562 \times 10^2$	
400. MeV	$4.945 \times 10^2$	1.657			0.000	1.658	$2.167 \times 10^2$	
800. MeV	$8.995 \times 10^2$	1.730	0.000		0.000	1.731	$4.529 \times 10^2$	
1.00 GeV	$1.101 \times 10^3$	1.762	0.000		0.000	1.763	$5.673 \times 10^2$	
1.40 GeV	$1.502 \times 10^3$	1.813	0.000	0.000	0.001	1.815	$7.908 \times 10^2$	
2.00 GeV	$2.103 \times 10^3$	1.869	0.001	0.000	0.001	1.871	$1.116 \times 10^3$	
3.00 GeV	$3.104 \times 10^3$	1.932	0.001	0.001	0.001	1.936	$1.641 \times 10^3$	
4.00 GeV	$4.104 \times 10^3$	1.976	0.002	0.002	0.002	1.982	$2.151 \times 10^3$	
8.00 GeV	$8.105 \times 10^3$	2.076	0.005	0.005	0.004	2.090	$4.110 \times 10^3$	
10.0 GeV	$1.011 \times 10^4$	2.107	0.006	0.007	0.005	2.125	$5.059 \times 10^3$	
14.0 GeV	$1.411 \times 10^4$	2.151	0.010	0.011	0.006	2.178	$6.917 \times 10^3$	
20.0 GeV	$2.011 \times 10^4$	2.195	0.015	0.018	0.009	2.237	$9.634 \times 10^3$	
30.0 GeV	$3.011 \times 10^4$	2.242	0.025	0.031	0.013	2.312	$1.403 \times 10^4$	
40.0 GeV	$4.011 \times 10^4$	2.275	0.036	0.045	0.017	2.373	$1.830 \times 10^4$	
80.0 GeV	$8.011 \times 10^4$	2.349	0.080	0.109	0.033	2.572	$3.446 \times 10^4$	
100. GeV	$1.001 \times 10^5$	2.372	0.104	0.143	0.041	2.661	$4.211 \times 10^4$	
140. GeV	$1.401 \times 10^5$	2.406	0.154	0.214	0.057	2.832	$5.667 \times 10^4$	
200. GeV	$2.001 \times 10^5$	2.442	0.231	0.327	0.081	3.082	$7.698 \times 10^4$	
300. GeV	$3.001 \times 10^5$	2.483	0.364	0.519	0.121	3.487	$1.075 \times 10^5$	
400. GeV	$4.001 \times 10^5$	2.512	0.501	0.718	0.162	3.893	$1.346 \times 10^5$	
705. GeV	$7.056 \times 10^5$	2.569	0.935	1.347	0.288	5.139	<i>Muon critical energy</i>	
800. GeV	$8.001 \times 10^5$	2.582	1.072	1.545	0.327	5.526	$2.204 \times 10^5$	
1.00 TeV	$1.000 \times 10^6$	2.605	1.366	1.971	0.411	6.354	$2.541 \times 10^5$	
1.40 TeV	$1.400 \times 10^6$	2.639	1.958	2.819	0.583	8.000	$3.101 \times 10^5$	
2.00 TeV	$2.000 \times 10^6$	2.677	2.866	4.116	0.844	10.503	$3.754 \times 10^5$	
3.00 TeV	$3.000 \times 10^6$	2.720	4.386	6.274	1.293	14.673	$4.556 \times 10^5$	
4.00 TeV	$4.000 \times 10^6$	2.751	5.931	8.459	1.749	18.890	$5.155 \times 10^5$	
8.00 TeV	$8.000 \times 10^6$	2.827	12.175	17.256	3.647	35.906	$6.666 \times 10^5$	
10.0 TeV	$1.000 \times 10^7$	2.852	15.329	21.685	4.624	44.489	$7.165 \times 10^5$	
14.0 TeV	$1.400 \times 10^7$	2.890	21.624	30.510	6.635	61.660	$7.926 \times 10^5$	
20.0 TeV	$2.000 \times 10^7$	2.931	31.141	43.817	9.722	87.611	$8.738 \times 10^5$	
30.0 TeV	$3.000 \times 10^7$	2.979	46.972	65.963	15.075	130.989	$9.665 \times 10^5$	
40.0 TeV	$4.000 \times 10^7$	3.013	62.875	88.176	20.566	174.631	$1.032 \times 10^6$	
80.0 TeV	$8.000 \times 10^7$	3.097	126.647	177.102	43.574	350.421	$1.191 \times 10^6$	
100. TeV	$1.000 \times 10^8$	3.125	158.613	221.615	55.487	438.841	$1.242 \times 10^6$	