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A TABLE OF PARAMETERS FOR HEAVY ION TRACKS IN NUCLEAR EMULSIONS

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Abstract.

Relations between a number of track parameters useful in nuclear emulsion analyses have been computed. The table includes the following quantities: Residual range, velocity, kinetic energy per nucleon, effective charge, energy loss of heavy ions, maximum energy and practical range for secondary electrons. The calculations have been performed for isotopes of interest in cosmic ray work with charges in the interval $2 \leq Z \leq 28$ and for residual ranges $R \leq 30$ cm.

In an appendix we give the velocity, the γ-factor and the momentum of a nucleon as a function of kinetic energy.

Introduction.

This paper presents computed track parameters for isotopes in the charge interval $2 \leq Z \leq 28$, which are of interest in cosmic ray studies using nuclear emulsions. The residual range of a stopping particle in the emulsion is a very easily measured quantity. We have therefore used this range as the first entry in the track parameter table. In the second column of the table we give the corresponding particle velocity. The velocity provides a link with the rest of the given track quantities. All the entries in a row are interdependent and the table will give the value of each of these parameters if any one is known. The calculations are based on theoretical and empirical relations, which can be found in other works, whose references are given below.

Appendix I gives a number of constants relating to a nuclear emulsion of standard composition. In Appendix II there are listed a few quantities independent of the properties of the emulsion, which are generally useful in calculations on relativistic ions.

Formulae description.

a) Residual range and velocity.

The residual range, R, of a heavy ion with charge Z and mass M for a certain velocity, β, can be found by the general expression given by Heckman et al. (1):

$$R = \frac{M}{Z^2} \left[\lambda(\beta) + B_Z(\beta) \right]$$

where $\lambda(\beta)$ is the range given by Barkas (2) and Barkas and Berger (3) of an ideal proton of velocity β in a standard

emulsion.

The function $B_Z(\beta)$ corrects for the extension in range of an ion, owing to charge pick-up at low velocities. It can be written

$$B_Z(\beta) = \begin{cases} 1.525 \cdot 10^{-3} \cdot \beta \cdot Z^{5/3} \text{ (cm) if } \beta \leq \frac{2Z}{137} \\ 2.233 \cdot 10^{-5} \cdot Z^{8/3} \text{ (cm) if } \beta \geq \frac{2Z}{137} \end{cases}$$

according to Barkas and Berger (3).

b) Kinetic energy.

The kinetic energy per nucleon, T, for an ion of mass M and mass number A with a velocity β is given by

$$T = (\gamma - 1) \cdot \frac{M}{A} \cdot c^2$$

where $\gamma = (1 - \beta^2)^{-1/2}$.

In the calculations we use the approximation $\frac{M}{A} \simeq m_p$ = = proton mass.

c) Effective charge.

The effective charge, Z_{eff}, of an ion of atomic number Z and with a velocity β can be expressed:

$$Z_{eff} = Z \cdot \left[1 - \exp (- 125 \cdot \beta \cdot Z^{-2/3}) \right] .$$

This formula is given by Barkas (2).

d) Rate of loss of energy.

The Bethe-Bloch formula for the rate of loss of energy for an ion with effective charge, Z_{eff}, and velocity β is written

$$J = - \frac{dT}{dx} = \frac{2\pi n Z^2_{eff} r_o^2 mc^2}{\beta^2} \left[\ln \left(\frac{2mc^2 \beta^2 \gamma^2 w_{max}}{I^2} \right) - 2\beta^2 - 2C(\beta) \right]$$

where n = the electron density in the stopping medium,

m = the mass of an electron,

c = the velocity of light,

r_o = $e^2/(mc^2)$,

e = the charge of an electron,

I = the mean ionization potential of the atoms of the stopping medium,

w_{max} = the maximum energy transfer from the incident particle to the atomic electrons,

$C(\beta)$ = a correction term which accounts for the density effect at high velocities and for the shell correction at low velocities.

This formula has been used for energies above 40 MeV/nucleon. The correction term, $C(\beta)$, for a standard emulsion is given by Barkas (4,2).

Below 40 MeV/nucleon the rate of energy loss for heavy ions has been estimated from the empirical energy-loss curve for protons, given by Barkas (2).

This calculation has been performed using the relation

$$J = Z^2_{eff} \cdot J_{proton} \quad .$$

e) Maximum energy transfer to secondary electrons (delta-rays)

The maximum energy transfer from a particle with mass M and velocity β to a free electron is

$$w_{max} = \frac{2\, m\, c^2\, \beta^2\, \gamma^2}{1 + 2(\frac{m}{M})\gamma + (\frac{m}{M})^2} \quad , \text{ see Barkas (2).}$$

In order to estimate the kinetic energy available for a delta-ray in the emulsion, to compile the table, w_{max} is reduced by the average electron binding energy.

f) Ranges of secondary electrons in emulsion.

The values of the ranges in the table have been calculated from a practical range-energy relation for monoenergetic electrons given by Weber (5):

$$r = A \cdot w \left[1 - \frac{B}{1 + C \cdot w} \right]$$

where r = the practical range and w = the kinetic energy of the electron. The constants A, B and C depend on the target material. They have recently been determined by Kobetich and Katz (6):

$$A = (8.1 \cdot Z_T^{-0.38} + 1.8)/\rho \qquad \mu m \cdot keV^{-1}$$

$$B = 0.21 \cdot Z_T^{-0.055} + 0.78$$

$$C = (1.1 \cdot Z_T^{0.29} + 0.21) \cdot 10^{-3} \qquad keV^{-1}$$

where Z_T = the effective atomic number of the target material and ρ = the density of the target material (g/cm^3). This gives an electron range, r, equivalent to a characteristic thickness at which the probability for electron transmission is equal to 0.05 (Ref. 6).

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HELIUM CHARGE= 2 MASSNUMBER= 3

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.057	1.5	1.98	1480	3.0	0.2
50	0.074	2.6	1.99	1058	5.3	0.3
75	0.085	3.4	2.00	899	7.0	0.5
100	0.093	4.1	2.00	789	8.6	0.6
200	0.115	6.2	2.00	593	13.3	1.2
300	0.129	7.9	2.00	498	17.1	1.7
400	0.141	9.5	2.00	437	20.4	2.2
500	0.150	10.7	2.00	399	23.2	2.7
600	0.158	12.0	2.00	367	25.9	3.2
700	0.166	13.1	2.00	342	28.5	3.8
800	0.172	14.3	2.00	322	31.0	4.3
900	0.178	15.2	2.00	306	33.0	4.8
1000	0.183	16.2	2.00	292	35.2	5.3
1500	0.206	20.5	2.00	243	44.9	7.8
2000	0.223	24.3	2.00	212	53.3	10.3
3000	0.250	30.7	2.00	178	67.6	15.3
4000	0.270	36.1	2.00	157	79.8	20.0
5000	0.287	41.2	2.00	142	91.4	25.0
6000	0.301	45.6	2.00	131	101.5	29.6
7000	0.314	49.9	2.00	123	111.1	34.4
8000	0.324	53.7	2.00	116	119.9	38.8
9000	0.334	57.3	2.00	111	128.4	43.3
10000	0.344	61.0	2.00	106	136.7	47.9
15000	0.383	77.3	2.00	89	175.0	70.7
20000	0.411	90.8	2.00	79	207.1	91.6
25000	0.434	103.2	2.00	72	236.9	112.4
30000	0.454	114.6	2.00	67	264.5	132.5
35000	0.471	125.3	2.00	63	290.7	152.2
40000	0.487	135.9	2.00	59	317.1	172.7
45000	0.500	145.4	2.00	57	340.9	191.6
50000	0.512	154.4	2.00	55	363.5	209.9
60000	0.534	171.7	2.00	51	407.7	246.7
70000	0.553	188.1	2.00	48	450.3	282.9
80000	0.570	203.7	2.00	46	491.5	318.7
90000	0.585	218.5	2.00	44	530.8	353.5
100000	0.598	232.7	2.00	42	569.3	388.0
150000	0.651	297.5	2.00	37	750.3	554.6
200000	0.688	355.2	2.00	33	919.4	715.0
300000	0.741	458.2	2.00	30	1241.1	1027.0

HELIUM CHARGE= 2 MASSNUMBER= 4

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.051	1.2	1.96	1666	2.4	0.1
50	0.067	2.1	1.99	1215	4.3	0.3
75	0.077	2.8	2.00	1000	5.8	0.4
100	0.085	3.4	2.00	899	7.0	0.5
200	0.105	5.3	2.00	663	11.2	0.9
300	0.119	6.7	2.00	562	14.3	1.3
400	0.129	7.9	2.00	498	17.1	1.7
500	0.139	9.1	2.00	450	19.7	2.1
600	0.146	10.1	2.00	416	21.9	2.5
700	0.152	11.0	2.00	390	23.8	2.8
800	0.158	12.0	2.00	367	25.9	3.2
900	0.164	12.8	2.00	348	27.8	3.6
1000	0.169	13.7	2.00	331	29.8	4.0
1500	0.190	17.3	2.00	277	37.7	5.9
2000	0.206	20.5	2.00	243	44.9	7.8
3000	0.231	26.1	2.00	201	57.3	11.6
4000	0.250	30.7	2.00	178	67.6	15.3
5000	0.265	34.8	2.00	162	76.9	18.8
6000	0.279	38.7	2.00	149	85.6	22.5
7000	0.291	42.4	2.00	139	94.1	26.2
8000	0.301	45.6	2.00	131	101.5	29.6
9000	0.311	48.8	2.00	125	108.7	33.2
10000	0.319	51.7	2.00	119	115.5	36.5
15000	0.355	65.4	2.00	100	147.1	53.8
20000	0.383	77.3	2.00	89	175.1	70.7
25000	0.404	87.5	2.00	81	199.2	86.3
30000	0.423	97.2	2.00	75	222.3	102.1
35000	0.439	106.3	2.00	70	244.2	117.6
40000	0.454	114.6	2.00	67	264.5	132.5
45000	0.467	122.8	2.00	64	284.7	147.7
50000	0.479	130.6	2.00	61	303.8	162.4
60000	0.500	145.4	2.00	57	340.9	191.7
70000	0.519	159.0	2.00	53	375.4	219.7
80000	0.534	171.7	2.00	51	407.7	246.7
90000	0.549	184.4	2.00	49	440.7	274.7
100000	0.562	196.2	2.00	47	471.7	301.5
150000	0.614	250.4	2.00	40	617.9	432.0
200000	0.651	297.5	2.00	37	750.4	554.7
300000	0.704	382.9	2.00	32	1003.7	796.1

LITHIUM CHARGE= 3 MASSNUMBER= 6

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.058	1.6	2.91	3133	3.1	0.2
50	0.076	2.7	2.97	2255	5.6	0.4
75	0.087	3.6	2.98	1923	7.5	0.5
100	0.096	4.3	2.99	1700	9.1	0.7
200	0.119	6.7	3.00	1267	14.2	1.3
300	0.134	8.5	3.00	1069	18.3	1.9
400	0.146	10.1	3.00	937	21.8	2.5
500	0.155	11.5	3.00	853	24.8	3.0
600	0.164	12.8	3.00	784	27.8	3.6
700	0.172	14.1	3.00	728	30.7	4.2
800	0.178	15.2	3.00	690	33.0	4.7
900	0.184	16.2	3.00	655	35.4	5.3
1000	0.189	17.3	3.00	624	37.7	5.9
1500	0.213	22.1	3.00	516	48.3	8.8
2000	0.231	26.1	3.00	452	57.3	11.6
3000	0.258	32.8	3.00	380	72.4	17.1
4000	0.279	38.7	3.00	335	85.6	22.5
5000	0.296	44.0	3.00	304	97.8	27.9
6000	0.311	48.8	3.00	281	108.7	33.2
7000	0.323	53.2	3.00	263	118.8	38.2
8000	0.334	57.3	3.00	249	128.4	43.3
9000	0.345	61.4	3.00	236	137.8	48.5
10000	0.355	65.4	3.00	226	147.1	53.8
15000	0.394	82.6	3.00	190	187.4	78.6
20000	0.423	97.2	3.00	169	222.3	102.1
25000	0.447	110.6	3.00	154	254.9	125.4
30000	0.467	122.8	3.00	143	284.8	147.7
35000	0.485	134.6	3.00	134	314.0	170.3
40000	0.500	145.4	3.00	128	341.0	191.7
45000	0.514	155.5	3.00	122	366.4	212.3
50000	0.527	165.4	3.00	117	391.8	233.3
60000	0.549	184.4	3.00	109	440.8	274.8
70000	0.568	201.9	3.00	103	486.9	314.7
80000	0.585	218.5	3.00	98	531.0	353.6
90000	0.600	234.5	3.00	94	574.4	392.5
100000	0.614	250.4	3.00	91	618.0	432.1
150000	0.666	319.5	3.00	79	814.1	614.7
200000	0.704	382.9	3.00	73	1003.9	796.2
300000	0.756	495.8	3.00	65	1364.9	1148.8

LITHIUM CHARGE= 3 MASSNUMBER= 7

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.054	1.4	2.89	3338	2.7	0.2
50	0.072	2.4	2.96	2435	5.0	0.3
75	0.083	3.2	2.98	2053	6.7	0.5
100	0.091	3.9	2.99	1805	8.3	0.6
200	0.115	6.1	3.00	1354	13.0	1.1
300	0.128	7.7	3.00	1138	16.6	1.6
400	0.139	9.3	3.00	1002	19.9	2.2
500	0.148	10.5	3.00	912	22.7	2.6
600	0.156	11.7	3.00	842	25.3	3.1
700	0.164	12.8	3.00	784	27.8	3.6
800	0.171	14.0	3.00	735	30.3	4.2
900	0.176	14.9	3.00	700	32.3	4.6
1000	0.181	15.8	3.00	669	34.4	5.1
1500	0.204	20.1	3.00	555	43.9	7.5
2000	0.221	23.8	3.00	486	52.1	10.0
3000	0.247	30.1	3.00	406	66.2	14.7
4000	0.267	35.3	3.00	359	78.1	19.3
5000	0.284	40.3	3.00	325	89.3	24.1
6000	0.298	44.7	3.00	300	99.4	28.7
7000	0.311	48.8	3.00	281	108.7	33.2
8000	0.321	52.6	3.00	266	117.4	37.5
9000	0.331	56.2	3.00	253	125.7	41.9
10000	0.341	59.7	3.00	241	133.8	46.3
15000	0.379	75.8	3.00	202	171.4	68.5
20000	0.407	88.9	3.00	180	202.6	88.6
25000	0.430	101.0	3.00	164	231.6	108.6
30000	0.450	112.3	3.00	152	259.0	128.4
35000	0.467	122.8	3.00	143	284.8	147.7
40000	0.482	132.9	3.00	136	309.6	166.9
45000	0.496	142.3	3.00	129	333.3	185.5
50000	0.508	151.4	3.00	124	356.0	203.8
60000	0.530	168.1	3.00	116	398.6	239.0
70000	0.549	184.4	3.00	109	440.8	274.8
80000	0.566	199.7	3.00	104	480.8	309.4
90000	0.580	213.6	3.00	100	518.0	342.1
100000	0.594	227.6	3.00	96	555.5	375.6
150000	0.646	290.4	3.00	84	730.0	535.6
200000	0.684	347.2	3.00	76	895.9	692.5
300000	0.736	447.7	3.00	68	1207.6	994.2

BERYLLIUM CHARGE= 4 MASSNUMBER= 7

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.067	2.1	3.86	4579	4.3	0.3
50	0.086	3.5	3.94	3406	7.3	0.5
75	0.099	4.6	3.97	2854	9.9	0.8
100	0.109	5.6	3.98	2528	11.9	1.0
200	0.134	8.5	3.99	1892	18.4	1.9
300	0.151	10.8	4.00	1581	23.4	2.8
400	0.164	12.9	4.00	1386	27.9	3.6
500	0.175	14.7	4.00	1254	32.0	4.5
600	0.184	16.4	4.00	1158	35.6	5.4
700	0.193	18.0	4.00	1076	39.2	6.3
800	0.200	19.4	4.00	1013	42.4	7.1
900	0.207	20.8	4.00	961	45.6	8.0
1000	0.214	22.2	4.00	913	48.7	8.9
1500	0.239	28.0	4.00	761	61.7	13.1
2000	0.259	33.1	4.00	671	73.0	17.3
3000	0.289	41.9	4.00	561	93.0	25.7
4000	0.312	49.2	4.00	496	109.7	33.6
5000	0.330	55.8	4.00	452	124.8	41.4
6000	0.347	62.0	4.00	417	139.1	49.2
7000	0.361	67.8	4.00	391	152.6	57.0
8000	0.374	73.4	4.00	368	165.7	64.9
9000	0.385	78.6	4.00	350	178.0	72.6
10000	0.395	83.3	4.00	336	189.1	79.7
15000	0.437	105.0	4.00	284	241.2	115.5
20000	0.469	123.9	4.00	253	287.3	149.6
25000	0.495	141.3	4.00	231	330.7	183.5
30000	0.516	157.0	4.00	216	370.2	215.5
35000	0.534	171.7	4.00	203	407.8	246.7
40000	0.551	186.0	4.00	193	445.1	278.5
45000	0.566	199.6	4.00	185	480.8	309.4
50000	0.579	212.0	4.00	178	513.7	338.3
60000	0.602	236.9	4.00	167	580.9	398.4
70000	0.622	260.0	4.00	158	644.4	456.3
80000	0.639	281.7	4.00	151	705.5	512.7
90000	0.655	303.0	4.00	145	766.3	569.6
100000	0.668	322.7	4.00	141	823.4	623.5
150000	0.721	415.8	4.00	124	1106.0	895.2
200000	0.758	501.0	4.00	115	1382.1	1165.7
300000	0.809	657.0	4.00	104	1931.7	1711.8

BERYLLIUM CHARGE= 4 MASSNUMBER= 9

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.060	1.7	3.80	5135	3.3	0.2
50	0.080	3.0	3.92	3735	6.2	0.4
75	0.091	3.9	3.96	3167	8.3	0.6
100	0.100	4.8	3.97	2809	10.1	0.8
200	0.124	7.3	3.99	2101	15.7	1.5
300	0.141	9.4	4.00	1756	20.3	2.2
400	0.152	11.1	4.00	1555	23.9	2.9
500	0.163	12.7	4.00	1405	27.5	3.5
600	0.172	14.2	4.00	1289	30.9	4.3
700	0.179	15.5	4.00	1209	33.6	4.9
800	0.186	16.7	4.00	1138	36.4	5.6
900	0.193	18.0	4.00	1076	39.2	6.3
1000	0.199	19.1	4.00	1026	41.7	6.9
1500	0.225	24.3	4.00	849	53.2	10.3
2000	0.242	28.6	4.00	750	63.0	13.6
3000	0.270	36.1	4.00	628	79.8	20.0
4000	0.292	42.7	4.00	552	94.9	26.6
5000	0.309	48.4	4.00	502	107.9	32.7
6000	0.324	53.6	4.00	465	119.9	38.8
7000	0.338	58.5	4.00	436	131.2	44.8
8000	0.350	63.3	4.00	411	142.3	51.1
9000	0.361	67.8	4.00	391	152.6	57.0
10000	0.371	72.1	4.00	373	162.7	63.1
15000	0.411	90.8	4.00	315	207.1	91.6
20000	0.441	107.2	4.00	280	246.6	119.4
25000	0.466	122.0	4.00	256	282.8	146.2
30000	0.487	135.9	4.00	237	317.2	172.8
35000	0.505	148.6	4.00	224	348.9	198.1
40000	0.520	160.6	4.00	212	379.3	223.0
45000	0.534	171.7	4.00	203	407.8	246.8
50000	0.547	183.0	4.00	195	437.1	271.6
60000	0.570	203.7	4.00	183	491.6	318.9
70000	0.589	223.2	4.00	173	543.7	365.0
80000	0.607	242.4	4.00	165	595.8	411.9
90000	0.622	260.0	4.00	158	644.4	456.3
100000	0.635	276.8	4.00	153	691.6	499.9
150000	0.688	355.2	4.00	134	919.7	715.3
200000	0.726	425.9	4.00	123	1137.8	926.2
300000	0.778	554.6	4.00	111	1564.8	1346.4

BERYLLIUM CHARGE= 4 MASSNUMBER= 10

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.057	1.5	3.76	5366	3.0	0.2
50	0.076	2.7	3.91	3902	5.6	0.4
75	0.088	3.6	3.95	3329	7.6	0.5
100	0.097	4.4	3.97	2946	9.3	0.7
200	0.120	6.9	3.99	2195	14.7	1.4
300	0.136	8.8	4.00	1847	19.0	2.0
400	0.148	10.4	4.00	1628	22.5	2.6
500	0.158	11.9	4.00	1473	25.7	3.2
600	0.167	13.3	4.00	1355	28.9	3.8
700	0.174	14.6	4.00	1264	31.7	4.4
800	0.181	15.7	4.00	1194	34.2	5.0
900	0.187	16.8	4.00	1132	36.7	5.6
1000	0.193	18.0	4.00	1076	39.2	6.3
1500	0.217	22.8	4.00	893	50.0	9.3
2000	0.235	27.0	4.00	784	59.3	12.3
3000	0.262	34.0	4.00	658	75.1	18.1
4000	0.284	40.2	4.00	579	89.1	24.0
5000	0.301	45.6	4.00	526	101.4	29.6
6000	0.316	50.6	4.00	486	112.9	35.2
7000	0.329	55.2	4.00	455	123.4	40.7
8000	0.340	59.5	4.00	430	133.4	46.1
9000	0.351	63.8	4.00	408	143.4	51.7
10000	0.361	67.8	4.00	391	152.6	57.0
15000	0.400	85.5	4.00	329	194.5	83.3
20000	0.430	100.8	4.00	292	231.0	108.2
25000	0.454	114.6	4.00	267	264.6	132.5
30000	0.474	127.4	4.00	248	296.0	156.3
35000	0.492	139.7	4.00	233	326.7	180.3
40000	0.508	151.0	4.00	221	355.1	203.1
45000	0.522	161.7	4.00	212	382.2	225.3
50000	0.534	171.7	4.00	203	407.8	246.8
60000	0.557	191.2	4.00	190	458.5	290.0
70000	0.576	209.5	4.00	179	507.0	332.4
80000	0.593	227.0	4.00	171	553.9	374.1
90000	0.609	244.2	4.00	164	600.8	416.5
100000	0.622	260.0	4.00	158	644.4	456.3
150000	0.675	332.8	4.00	138	853.2	651.8
200000	0.712	398.4	4.00	127	1051.7	842.4
300000	0.764	516.6	4.00	114	1434.9	1217.8

BORON CHARGE= 5 MASSNUMBER= 10

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.067	2.1	4.71	6863	4.3	0.3
50	0.087	3.6	4.88	5134	7.5	0.5
75	0.101	4.8	4.93	4303	10.2	0.8
100	0.111	5.8	4.96	3809	12.3	1.1
200	0.137	9.0	4.99	2838	19.3	2.1
300	0.154	11.4	4.99	2381	24.6	3.0
400	0.168	13.6	5.00	2081	29.5	4.0
500	0.179	15.5	5.00	1889	33.6	4.9
600	0.189	17.2	5.00	1738	37.5	5.8
700	0.198	18.9	5.00	1618	41.2	6.8
800	0.205	20.5	5.00	1522	44.7	7.7
900	0.213	22.0	5.00	1437	48.1	8.7
1000	0.219	23.3	5.00	1371	51.1	9.6
1500	0.245	29.5	5.00	1145	64.9	14.3
2000	0.265	34.7	5.00	1011	76.8	18.8
3000	0.296	44.0	5.00	844	97.8	27.9
4000	0.319	51.7	5.00	747	115.4	36.5
5000	0.338	58.7	5.00	679	131.5	45.0
6000	0.355	65.4	5.00	627	147.1	53.8
7000	0.369	71.4	5.00	587	161.1	62.1
8000	0.383	77.3	5.00	554	175.0	70.7
9000	0.394	82.5	5.00	528	187.4	78.6
10000	0.404	87.5	5.00	506	199.1	86.3
15000	0.447	110.6	5.00	428	254.9	125.4
20000	0.479	130.5	5.00	381	303.8	162.4
25000	0.505	148.9	5.00	349	349.9	198.9
30000	0.527	165.4	5.00	326	391.8	233.3
35000	0.545	181.2	5.00	307	432.4	267.6
40000	0.562	196.2	5.00	292	471.7	301.5
45000	0.577	210.0	5.00	280	508.4	333.7
50000	0.590	223.8	5.00	270	545.3	366.4
60000	0.614	250.4	5.00	252	618.0	432.1
70000	0.633	273.9	5.00	240	683.5	492.4
80000	0.651	297.5	5.00	229	750.5	554.8
90000	0.666	319.5	5.00	221	814.2	614.8
100000	0.680	341.4	5.00	214	878.5	675.9
150000	0.733	440.0	5.00	190	1183.0	970.2
200000	0.769	530.8	5.00	176	1483.1	1265.4
300000	0.819	697.7	5.00	160	2084.5	1864.6

BORON CHARGE= 5 MASSNUMBER= 11

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.064	2.0	4.68	7123	3.9	0.2
50	0.084	3.3	4.86	5357	7.0	0.5
75	0.097	4.5	4.92	4494	9.5	0.7
100	0.107	5.4	4.95	3970	11.6	1.0
200	0.135	8.4	4.98	2973	18.1	1.9
300	0.150	10.7	4.99	2483	23.2	2.7
400	0.163	12.8	5.00	2178	27.7	3.6
500	0.175	14.6	5.00	1967	31.8	4.5
600	0.184	16.3	5.00	1817	35.4	5.3
700	0.192	17.9	5.00	1689	39.0	6.2
800	0.200	19.3	5.00	1590	42.2	7.0
900	0.207	20.7	5.00	1507	45.3	7.9
1000	0.213	22.1	5.00	1431	48.4	8.8
1500	0.239	27.9	5.00	1193	61.4	13.0
2000	0.256	33.0	5.00	1052	72.7	17.2
3000	0.289	41.7	5.00	879	92.6	25.5
4000	0.311	49.0	5.00	777	109.3	33.4
5000	0.330	55.6	5.00	707	124.4	41.2
6000	0.346	61.7	5.00	654	138.6	48.9
7000	0.360	67.5	5.00	612	152.1	56.7
8000	0.373	73.1	5.00	577	165.1	64.5
9000	0.385	78.3	5.00	548	177.4	72.2
10000	0.395	83.0	5.00	526	188.4	79.3
15000	0.437	104.6	5.00	445	240.3	114.8
20000	0.468	123.5	5.00	396	286.3	148.9
25000	0.494	140.9	5.00	362	329.6	182.6
30000	0.515	156.4	5.00	338	368.8	214.3
35000	0.534	171.1	5.00	319	406.3	245.5
40000	0.550	185.5	5.00	303	443.7	277.2
45000	0.565	198.9	5.00	290	479.0	307.8
50000	0.578	211.3	5.00	279	511.8	336.6
60000	0.601	236.0	5.00	261	578.5	396.3
70000	0.621	259.1	5.00	247	642.0	454.1
80000	0.639	280.9	5.00	237	703.0	510.5
90000	0.654	302.0	5.00	227	763.3	566.8
100000	0.667	321.5	5.00	220	820.0	620.3
150000	0.720	414.3	5.00	195	1101.3	890.6
200000	0.758	499.1	5.00	180	1376.1	1159.8
300000	0.808	654.2	5.00	163	1921.3	1701.4

CARBON CHARGE= 6 MASSNUMBER= 12

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.069	2.3	5.57	9071	4.6	0.3
50	0.091	3.9	5.81	6846	8.2	0.6
75	0.105	5.3	5.89	5752	11.2	0.9
100	0.116	6.4	5.93	5148	13.6	1.2
200	0.144	9.9	5.97	3783	21.4	2.4
300	0.162	12.6	5.99	3161	27.3	3.5
400	0.177	15.0	5.99	2773	32.7	4.7
500	0.189	17.1	6.00	2508	37.4	5.8
600	0.199	19.1	6.00	2304	41.8	6.9
700	0.208	21.0	6.00	2148	45.9	8.1
800	0.216	22.7	6.00	2016	49.8	9.2
900	0.224	24.3	6.00	1906	53.4	10.4
1000	0.231	26.0	6.00	1814	57.1	11.6
1500	0.258	32.7	6.00	1522	72.3	17.0
2000	0.278	38.6	6.00	1343	85.4	22.4
3000	0.310	48.7	6.00	1125	108.6	33.1
4000	0.334	57.3	6.00	996	128.2	43.3
5000	0.355	65.4	6.00	903	147.0	53.8
6000	0.372	72.6	6.00	835	163.9	63.8
7000	0.387	79.5	6.00	781	180.2	74.0
8000	0.400	85.5	6.00	741	194.4	83.2
9000	0.412	91.4	6.00	706	208.6	92.7
10000	0.423	97.1	6.00	676	222.2	102.1
15000	0.467	122.8	6.00	573	284.7	147.7
20000	0.500	145.4	6.00	511	340.9	191.7
25000	0.527	165.4	6.00	469	391.7	233.3
30000	0.549	184.4	6.00	437	440.7	274.7
35000	0.568	201.9	6.00	413	486.9	314.7
40000	0.585	218.5	6.00	394	530.9	353.6
45000	0.600	234.5	6.00	377	574.4	392.5
50000	0.614	250.4	6.00	363	618.0	432.1
60000	0.637	279.1	6.00	342	698.1	505.9
70000	0.657	306.9	6.00	325	777.6	580.2
80000	0.675	332.8	6.00	311	853.2	651.8
90000	0.690	358.0	6.00	300	928.2	723.4
100000	0.704	382.9	6.00	291	1003.9	796.3
150000	0.756	495.8	6.00	260	1365.1	1148.9
200000	0.792	597.9	6.00	242	1716.9	1497.5
300000	0.840	791.5	6.00	223	2450.8	2232.2

CARBON CHARGE= 6 MASSNUMBER= 13

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.067	2.1	5.53	9360	4.3	0.3
50	0.088	3.7	5.79	7102	7.7	0.6
75	0.103	5.0	5.88	5942	10.6	0.9
100	0.113	6.0	5.92	5295	12.9	1.1
200	0.141	9.4	5.97	3910	20.3	2.2
300	0.159	12.0	5.99	3275	26.0	3.3
400	0.173	14.4	5.99	2869	31.2	4.3
500	0.184	16.3	5.99	2604	35.6	5.4
600	0.194	18.3	6.00	2390	39.8	6.4
700	0.203	20.0	6.00	2225	43.7	7.5
800	0.211	21.7	6.00	2091	47.5	8.6
900	0.218	23.2	6.00	1980	50.9	9.6
1000	0.225	24.7	6.00	1885	54.2	10.6
1500	0.252	31.3	6.00	1576	69.0	15.8
2000	0.272	36.8	6.00	1392	81.4	20.7
3000	0.304	46.5	6.00	1165	103.5	30.6
4000	0.328	54.8	6.00	1030	122.5	40.2
5000	0.347	62.3	6.00	936	139.8	49.7
6000	0.364	69.2	6.00	865	156.0	59.0
7000	0.380	76.0	6.00	808	171.8	68.7
8000	0.392	81.8	6.00	765	185.7	77.5
9000	0.404	87.3	6.00	729	198.7	86.1
10000	0.415	92.8	6.00	698	211.8	94.9
15000	0.458	117.3	6.00	591	271.1	137.4
20000	0.491	138.8	6.00	527	324.4	178.5
25000	0.517	157.9	6.00	483	372.6	217.4
30000	0.539	175.5	6.00	451	417.7	255.1
35000	0.558	192.3	6.00	426	461.5	292.7
40000	0.575	208.1	6.00	405	503.4	329.2
45000	0.590	223.4	6.00	389	544.2	365.4
50000	0.603	238.4	6.00	374	584.9	402.0
60000	0.626	265.5	6.00	351	659.8	470.4
70000	0.646	291.3	6.00	334	732.8	538.2
80000	0.664	316.7	6.00	319	805.9	607.0
90000	0.680	340.7	6.00	308	876.7	674.2
100000	0.693	363.9	6.00	298	946.2	740.7
150000	0.746	470.1	6.00	265	1280.3	1065.6
200000	0.782	568.3	6.00	247	1612.7	1393.9
300000	0.831	747.2	6.00	226	2275.3	2055.9

NITROGEN CHARGE= 7 MASSNUMBER= 14

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.072	2.4	6.59	11406	4.9	0.3
50	0.094	4.2	6.72	8768	8.8	0.7
75	0.109	5.6	6.83	7399	12.0	1.0
100	0.120	6.9	6.88	6546	14.7	1.4
200	0.150	10.7	6.96	4841	23.1	2.7
300	0.170	13.8	6.98	4005	30.0	4.1
400	0.184	16.3	6.99	3536	35.6	5.4
500	0.197	18.7	6.99	3185	40.9	6.7
600	0.208	20.9	6.99	2929	45.7	8.0
700	0.217	22.9	7.00	2723	50.2	9.4
800	0.226	24.8	7.00	2557	54.4	10.7
900	0.233	26.6	7.00	2425	58.5	12.0
1000	0.240	28.2	7.00	2318	62.1	13.3
1500	0.268	35.6	7.00	1942	78.8	19.6
2000	0.291	42.3	7.00	1705	93.9	26.1
3000	0.323	53.1	7.00	1436	118.6	38.1
4000	0.348	62.7	7.00	1268	140.7	50.2
5000	0.369	71.3	7.00	1152	160.9	62.0
6000	0.387	79.5	7.00	1064	180.1	73.9
7000	0.402	86.5	7.00	1000	196.7	84.7
8000	0.416	93.4	7.00	946	213.2	95.8
9000	0.428	99.8	7.00	902	228.7	106.6
10000	0.439	106.2	7.00	863	244.1	117.6
15000	0.485	134.6	7.00	732	313.9	170.2
20000	0.518	159.0	7.00	655	375.3	219.7
25000	0.545	181.1	7.00	602	432.4	267.6
30000	0.568	201.9	7.00	562	486.8	314.7
35000	0.587	221.1	7.00	532	538.2	360.1
40000	0.605	240.1	7.00	507	589.5	406.2
45000	0.620	257.5	7.00	487	637.7	450.1
50000	0.633	273.9	7.00	470	683.5	492.4
60000	0.657	306.9	7.00	442	777.6	580.2
70000	0.677	337.1	7.00	421	865.9	663.9
80000	0.695	366.6	7.00	404	954.3	748.5
90000	0.710	394.6	7.00	390	1040.2	831.3
100000	0.724	421.4	7.00	379	1123.8	912.5
150000	0.776	548.5	7.00	340	1543.8	1325.6
200000	0.811	666.4	7.00	318	1967.0	1747.0
300000	0.857	880.4	7.00	296	2817.5	2601.3

NITROGEN CHARGE= 7 MASSNUMBER= 15

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.070	2.3	6.35	11759	4.6	0.3
50	0.092	4.0	6.70	8971	8.4	0.6
75	0.106	5.4	6.82	7612	11.4	0.9
100	0.117	6.5	6.87	6768	14.0	1.3
200	0.147	10.3	6.95	4982	22.2	2.5
300	0.166	13.2	6.98	4144	28.6	3.8
400	0.181	15.7	6.99	3647	34.1	5.0
500	0.193	18.0	6.99	3284	39.3	6.3
600	0.204	20.1	6.99	3020	43.9	7.5
700	0.213	22.1	7.00	2807	48.3	8.8
800	0.221	23.8	7.00	2637	52.2	10.0
900	0.229	25.6	7.00	2499	56.2	11.2
1000	0.236	27.2	7.00	2389	59.7	12.4
1500	0.263	34.3	7.00	2002	75.7	18.4
2000	0.285	40.6	7.00	1760	89.9	24.4
3000	0.317	51.1	7.00	1478	114.0	35.8
4000	0.342	60.2	7.00	1307	134.9	46.9
5000	0.363	68.5	7.00	1187	154.3	58.0
6000	0.381	76.4	7.00	1095	172.9	69.3
7000	0.395	83.2	7.00	1028	189.0	79.6
8000	0.409	89.7	7.00	974	204.4	89.9
9000	0.421	96.1	7.00	927	219.6	100.3
10000	0.432	101.9	7.00	888	233.8	110.2
15000	0.476	128.9	7.00	754	299.8	159.2
20000	0.510	152.6	7.00	673	359.2	206.5
25000	0.537	173.7	7.00	618	413.1	251.2
30000	0.559	193.7	7.00	577	465.1	295.8
35000	0.579	212.1	7.00	546	513.8	338.4
40000	0.596	229.8	7.00	520	561.6	381.0
45000	0.611	247.3	7.00	498	609.3	424.2
50000	0.624	262.9	7.00	481	652.7	463.9
60000	0.648	293.4	7.00	453	738.9	543.9
70000	0.668	322.7	7.00	431	823.6	623.7
80000	0.686	350.7	7.00	413	906.3	702.4
90000	0.701	378.0	7.00	398	989.1	782.0
100000	0.715	403.3	7.00	386	1067.2	857.4
150000	0.767	523.7	7.00	346	1458.8	1241.5
200000	0.802	633.8	7.00	323	1846.8	1626.9
300000	0.849	836.8	7.00	299	2635.2	2417.7

OXYGEN CHARGE= 8 MASSNUMBER= 16

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.073	2.5	7.19	13889	5.2	0.3
50	0.097	4.5	7.62	10805	9.4	0.7
75	0.112	6.0	7.76	9177	12.7	1.1
100	0.124	7.3	7.83	8116	15.6	1.5
200	0.155	11.4	7.94	5981	24.7	3.0
300	0.176	14.8	7.97	4958	32.2	4.6
400	0.191	17.6	7.98	4348	38.5	6.1
500	0.204	20.2	7.99	3919	44.2	7.6
600	0.216	22.6	7.99	3598	49.4	9.1
700	0.225	24.7	7.99	3346	54.2	10.6
800	0.234	26.8	7.99	3152	58.8	12.1
900	0.241	28.6	8.00	2996	62.9	13.6
1000	0.249	30.5	8.00	2858	67.1	15.1
1500	0.278	38.5	8.00	2392	85.2	22.3
2000	0.300	45.4	8.00	2108	101.1	29.5
3000	0.334	57.2	8.00	1773	128.1	43.2
4000	0.361	67.6	8.00	1564	152.3	56.9
5000	0.383	77.2	8.00	1419	174.8	70.6
6000	0.400	85.4	8.00	1317	194.3	83.1
7000	0.416	93.4	8.00	1236	213.2	95.8
8000	0.429	100.7	8.00	1171	230.8	108.0
9000	0.442	107.9	8.00	1114	248.4	120.6
10000	0.454	114.5	8.00	1069	264.4	132.4
15000	0.500	145.3	8.00	908	340.8	191.6
20000	0.534	171.6	8.00	814	407.7	246.6
25000	0.562	196.1	8.00	748	471.6	301.4
30000	0.585	218.4	8.00	700	530.9	353.5
35000	0.605	240.0	8.00	662	589.5	406.2
40000	0.622	259.9	8.00	632	644.4	456.2
45000	0.637	279.1	8.00	608	698.0	505.8
50000	0.651	297.5	8.00	587	750.4	554.7
60000	0.675	332.8	8.00	554	853.1	651.7
70000	0.695	366.6	8.00	528	954.3	748.5
80000	0.712	398.3	8.00	507	1051.6	842.4
90000	0.728	429.4	8.00	491	1149.2	937.3
100000	0.741	458.2	8.00	477	1241.5	1027.4
150000	0.792	597.8	8.00	431	1716.9	1497.5
200000	0.826	728.1	8.00	405	2201.1	1981.4
300000	0.871	969.5	8.00	378	3202.7	2990.0

FLUORINE CHARGE= 9 MASSNUMBER= 19

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.073	2.5	7.91	16928	5.1	0.3
50	0.098	4.5	8.46	13244	9.5	0.7
75	0.113	6.1	8.66	11310	13.0	1.1
100	0.125	7.4	8.75	10053	15.8	1.5
200	0.157	11.7	8.90	7381	25.4	3.1
300	0.178	15.2	8.95	6124	33.1	4.8
400	0.194	18.2	8.97	5357	39.7	6.4
500	0.208	20.9	8.98	4854	45.7	8.0
600	0.219	23.3	8.98	4430	51.1	9.6
700	0.229	25.6	8.99	4120	56.2	11.3
800	0.238	27.6	8.99	3888	60.8	12.8
900	0.245	29.6	8.99	3692	65.2	14.4
1000	0.253	31.5	8.99	3518	69.6	16.0
1500	0.283	39.9	9.00	2944	88.4	23.7
2000	0.305	47.1	9.00	2598	104.8	31.2
3000	0.340	59.3	9.00	2184	132.9	45.8
4000	0.366	70.1	9.00	1927	158.2	60.3
5000	0.389	80.1	9.00	1748	181.6	74.8
6000	0.406	88.5	9.00	1625	201.6	88.0
7000	0.422	96.8	9.00	1524	221.4	101.4
8000	0.436	104.5	9.00	1443	240.1	114.7
9000	0.449	111.9	9.00	1375	258.0	127.6
10000	0.461	119.1	9.00	1316	275.6	140.8
15000	0.508	150.8	9.00	1121	354.7	202.8
20000	0.542	178.2	9.00	1005	424.8	261.1
25000	0.570	203.5	9.00	925	491.2	318.5
30000	0.593	226.8	9.00	866	553.4	373.7
35000	0.613	249.5	9.00	819	615.5	429.9
40000	0.630	269.4	9.00	784	670.8	480.6
45000	0.645	289.3	9.00	754	727.1	532.9
50000	0.659	309.8	9.00	727	785.9	588.1
60000	0.683	346.0	9.00	687	892.5	689.2
70000	0.703	381.6	9.00	655	999.9	792.4
80000	0.720	414.3	9.00	631	1101.6	890.9
90000	0.735	446.2	9.00	611	1202.9	989.6
100000	0.749	478.8	9.00	593	1308.9	1093.6
150000	0.800	624.3	9.00	537	1812.0	1592.2
200000	0.834	760.7	9.00	506	2328.7	2109.5
300000	0.877	1015.9	9.00	475	3411.0	3200.4

NEON CHARGE= 10 MASSNUMBER= 20

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.076	2.7	8.71	19375	5.6	0.4
50	0.102	4.9	9.56	15220	10.4	0.8
75	0.118	6.6	9.58	13037	14.1	1.3
100	0.130	8.1	9.70	11609	17.3	1.7
200	0.164	12.8	9.88	8499	27.8	3.6
300	0.186	16.6	9.93	7060	36.2	5.5
400	0.203	19.9	9.96	6156	43.5	7.4
500	0.217	22.9	9.97	5546	50.1	9.3
600	0.229	25.6	9.98	5086	56.1	11.2
700	0.239	27.9	9.98	4753	61.4	13.0
800	0.248	30.2	9.99	4481	66.6	14.9
900	0.256	32.4	9.99	4249	71.6	16.8
1000	0.264	34.4	9.99	4067	76.0	18.5
1500	0.295	43.7	10.00	3391	97.1	27.6
2000	0.318	51.5	10.00	2998	114.8	36.2
3000	0.355	65.2	10.00	2512	146.6	53.5
4000	0.382	77.1	10.00	2218	174.6	70.4
5000	0.404	87.3	10.00	2026	198.7	86.1
6000	0.423	97.0	10.00	1878	221.9	101.8
7000	0.439	106.1	10.00	1762	243.9	117.4
8000	0.453	114.4	10.00	1671	264.2	132.2
9000	0.467	122.7	10.00	1592	284.4	147.5
10000	0.479	130.4	10.00	1527	303.5	162.1
15000	0.526	165.3	10.00	1303	391.5	233.1
20000	0.562	196.1	10.00	1169	471.5	301.3
25000	0.590	223.7	10.00	1078	545.1	366.2
30000	0.614	250.3	10.00	1009	617.8	431.9
35000	0.633	273.9	10.00	960	683.3	492.2
40000	0.651	297.4	10.00	917	750.3	554.6
45000	0.666	319.4	10.00	883	814.0	614.6
50000	0.680	341.3	10.00	854	878.4	675.8
60000	0.704	382.8	10.00	808	1003.8	796.1
70000	0.724	421.3	10.00	773	1123.7	912.4
80000	0.741	456.1	10.00	745	1241.4	1027.4
90000	0.756	495.8	10.00	722	1365.0	1148.8
100000	0.769	530.8	10.00	703	1483.0	1265.3
150000	0.819	697.7	10.00	641	2084.5	1864.6
200000	0.851	848.8	10.00	608	2685.3	2468.1
300000	0.893	1145.3	10.00	575	4017.6	3814.0

NEON CHARGE= 10 MASSNUMBER= 21

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.074	2.6	8.65	19675	5.3	0.3
50	0.100	4.7	9.32	15537	10.0	0.8
75	0.116	6.4	9.56	13374	13.6	1.2
100	0.128	7.8	9.68	11823	16.7	1.7
200	0.161	12.4	9.87	8703	26.9	3.4
300	0.183	16.1	9.93	7218	35.1	5.2
400	0.200	19.3	9.95	6304	42.2	7.0
500	0.214	22.2	9.97	5668	48.7	8.9
600	0.225	24.8	9.98	5205	54.4	10.7
700	0.236	27.2	9.98	4860	59.7	12.4
800	0.245	29.4	9.99	4583	64.6	14.2
900	0.253	31.5	9.99	4341	69.5	16.0
1000	0.260	33.5	9.99	4152	73.9	17.7
1500	0.291	42.5	10.00	3461	94.5	26.4
2000	0.314	50.1	10.00	3058	111.8	34.7
3000	0.350	63.3	10.00	2569	142.1	51.0
4000	0.378	75.0	10.00	2263	169.7	67.4
5000	0.399	85.0	10.00	2067	193.2	82.4
6000	0.418	94.4	10.00	1915	215.7	97.5
7000	0.434	103.1	10.00	1799	236.5	112.1
8000	0.448	111.4	10.00	1703	256.8	126.8
9000	0.462	119.5	10.00	1622	276.5	141.5
10000	0.473	126.6	10.00	1558	294.1	154.8
15000	0.521	160.8	10.00	1326	380.1	223.6
20000	0.555	190.1	10.00	1192	455.7	287.6
25000	0.584	217.3	10.00	1097	527.8	350.8
30000	0.607	242.9	10.00	1027	597.4	413.3
35000	0.627	265.9	10.00	976	660.9	471.5
40000	0.644	288.1	10.00	933	723.7	529.7
45000	0.660	310.8	10.00	896	788.8	590.8
50000	0.674	331.1	10.00	867	848.2	647.1
60000	0.698	371.4	10.00	819	969.0	762.6
70000	0.717	408.3	10.00	784	1082.8	872.7
80000	0.734	444.2	10.00	755	1196.5	983.4
90000	0.750	480.6	10.00	731	1314.6	1099.3
100000	0.763	513.9	10.00	711	1425.9	1208.9
150000	0.814	675.1	10.00	647	1999.5	1779.5
200000	0.846	820.6	10.00	613	2569.2	2351.2
300000	0.889	1106.5	10.00	578	3831.5	3625.6

NEON CHARGE= 10 MASSNUMBER= 22

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.073	2.5	8.58	20119	5.1	0.3
50	0.098	4.6	9.29	15826	9.6	0.8
75	0.114	6.2	9.54	13586	13.2	1.2
100	0.126	7.5	9.66	12037	16.2	1.6
200	0.159	12.0	9.86	8884	26.0	3.3
300	0.180	15.6	9.92	7376	34.0	5.0
400	0.197	18.8	9.95	6444	40.9	6.7
500	0.211	21.6	9.97	5800	47.2	8.5
600	0.222	24.1	9.97	5310	52.8	10.2
700	0.233	26.5	9.98	4954	58.2	11.9
800	0.241	28.6	9.98	4678	62.8	13.5
900	0.250	30.7	9.99	4437	67.5	15.2
1000	0.257	32.6	9.99	4232	72.0	16.9
1500	0.288	41.4	10.00	3534	91.8	25.2
2000	0.310	48.8	10.00	3122	108.7	33.1
3000	0.345	61.5	10.00	2623	138.0	48.6
4000	0.373	72.9	10.00	2313	164.6	64.2
5000	0.395	82.8	10.00	2106	188.0	79.0
6000	0.413	91.8	10.00	1954	209.5	93.3
7000	0.429	100.3	10.00	1834	229.8	107.3
8000	0.443	108.5	10.00	1735	249.7	121.6
9000	0.456	116.0	10.00	1655	268.0	135.1
10000	0.468	123.3	10.00	1586	286.0	148.7
15000	0.515	156.3	10.00	1352	368.5	214.1
20000	0.550	185.4	10.00	1210	443.4	277.1
25000	0.578	211.2	10.00	1116	511.6	336.4
30000	0.601	235.9	10.00	1045	578.3	396.1
35000	0.621	259.0	10.00	990	641.8	453.9
40000	0.638	280.8	10.00	946	702.9	510.3
45000	0.654	301.9	10.00	910	763.1	566.6
50000	0.667	321.4	10.00	881	819.9	620.2
60000	0.691	360.2	10.00	832	935.1	730.1
70000	0.711	396.9	10.00	794	1047.3	838.2
80000	0.729	432.0	10.00	764	1157.5	945.4
90000	0.744	465.1	10.00	741	1264.1	1049.6
100000	0.758	499.1	10.00	720	1376.0	1159.7
150000	0.808	654.1	10.00	653	1921.3	1701.3
200000	0.841	796.4	10.00	618	2470.8	2252.3
300000	0.884	1066.1	10.00	581	3641.7	3433.6

SODIUM CHARGE= 11 MASSNUMBER= 23

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.075	2.7	9.96	22668	5.5	0.4
50	0.102	4.9	10.17	17938	10.5	0.8
75	0.119	6.7	10.45	15397	14.2	1.3
100	0.131	8.2	10.60	13737	17.6	1.8
200	0.165	15.0	10.83	10086	28.2	3.7
300	0.187	16.9	10.90	.372	36.9	5.7
400	0.205	20.4	10.94	7308	44.5	7.7
500	0.219	23.4	10.96	6568	51.3	9.7
600	0.232	26.2	10.97	6025	57.6	11.7
700	0.242	28.6	10.98	5642	63.0	13.6
800	0.251	31.1	10.98	5311	68.4	15.6
900	0.259	33.3	10.98	5045	73.4	17.5
1000	0.267	35.3	10.99	4820	78.0	19.3
1500	0.299	44.9	10.99	4022	99.7	28.8
2000	0.322	52.9	11.00	3554	118.1	37.9
3000	0.359	66.9	11.00	2979	150.7	55.9
4000	0.387	79.3	11.00	2629	179.8	73.7
5000	0.409	89.9	11.00	2401	204.8	90.1
6000	0.428	99.8	11.00	2228	228.6	106.5
7000	0.445	109.3	11.00	2088	251.6	123.0
8000	0.459	118.0	11.00	1979	273.0	138.8
9000	0.472	126.1	11.00	1890	292.9	154.0
10000	0.485	134.6	11.00	1808	313.9	170.2
15000	0.532	170.2	11.00	1547	404.0	243.5
20000	0.566	202.0	11.00	1388	487.2	315.0
25000	0.596	230.6	11.00	1281	563.8	383.0
30000	0.620	257.8	11.00	1201	638.3	450.7
35000	0.640	282.7	11.00	1141	708.3	515.4
40000	0.658	307.2	11.00	1091	778.5	581.1
45000	0.673	329.9	11.00	1051	844.7	643.7
50000	0.686	352.0	11.00	1018	910.4	706.3
60000	0.711	395.1	11.00	963	1041.5	832.6
70000	0.730	435.2	11.00	922	1167.7	955.3
80000	0.746	474.4	11.00	889	1294.4	1079.3
90000	0.763	512.0	11.00	862	1419.5	1202.5
100000	0.776	549.2	11.00	839	1546.4	1328.1
150000	0.825	721.3	11.00	768	2175.1	1955.4
200000	0.857	881.8	11.00	730	2823.4	2607.3
300000	0.898	1190.8	11.00	692	4239.8	4038.9

MAGNESIUM CHARGE= 12 MASSNUMBER= 24

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.078	2.9	10.12	25483	5.9	0.4
50	0.105	5.3	11.03	20163	11.2	0.9
75	0.123	7.1	11.36	17259	15.3	1.5
100	0.136	8.8	11.53	15417	18.9	2.0
200	0.171	14.1	11.80	11306	30.5	4.2
300	0.194	18.2	11.88	9397	39.8	6.4
400	0.213	22.0	11.92	8182	48.1	8.7
500	0.227	25.2	11.95	7369	55.3	11.0
600	0.239	28.1	11.96	6792	61.8	13.2
700	0.250	30.9	11.97	6341	68.0	15.4
800	0.260	33.4	11.98	5980	73.7	17.6
900	0.268	35.7	11.98	5677	79.0	19.7
1000	0.276	38.0	11.98	5411	84.2	21.9
1500	0.309	48.3	11.99	4526	107.6	32.6
2000	0.333	56.9	12.00	4002	127.4	42.8
3000	0.371	72.2	12.00	3351	163.1	63.3
4000	0.400	85.2	12.00	2969	193.8	82.8
5000	0.422	96.9	12.00	2707	221.7	101.6
6000	0.442	107.7	12.00	2510	247.9	120.3
7000	0.459	117.8	12.00	2358	272.5	138.4
8000	0.474	127.1	12.00	2237	295.3	155.8
9000	0.486	136.6	12.00	2130	319.0	174.2
10000	0.500	145.2	12.00	2044	340.4	191.3
15000	0.549	184.2	12.00	1750	440.3	274.3
20000	0.585	218.3	12.00	1576	530.5	353.2
25000	0.614	250.3	12.00	1454	617.6	431.7
30000	0.637	279.0	12.00	1368	697.7	505.6
35000	0.657	306.8	12.00	1299	777.3	579.9
40000	0.675	332.7	12.00	1246	852.9	651.5
45000	0.690	357.9	12.00	1201	927.9	723.1
50000	0.704	382.8	12.00	1163	1003.6	796.0
60000	0.728	429.3	12.00	1104	1149.0	937.0
70000	0.747	475.7	12.00	1058	1292.0	1077.0
80000	0.764	516.5	12.00	1022	1434.7	1217.6
90000	0.779	559.4	12.00	992	1581.7	1363.2
100000	0.792	597.8	12.00	969	1716.7	1497.3
150000	0.840	791.4	12.00	891	2450.7	2232.1
200000	0.871	969.4	12.00	851	3202.6	2989.9
300000	0.909	1312.0	12.00	813	4856.1	4663.4

MAGNESIUM CHARGE= 12 MASSNUMBER= 25

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.076	2.7	10.04	25769	5.6	0.4
50	0.104	5.1	10.99	20460	10.8	0.9
75	0.121	6.9	11.33	17565	14.9	1.4
100	0.134	8.5	11.51	15711	18.4	1.9
200	0.169	13.7	11.79	11539	29.6	4.0
300	0.192	17.8	11.88	9582	38.7	6.1
400	0.210	21.4	11.92	8363	46.8	8.3
500	0.224	24.6	11.94	7509	53.9	10.5
600	0.237	27.4	11.96	6920	60.3	12.6
700	0.247	30.1	11.97	6457	66.3	14.8
800	0.257	32.6	11.97	6081	72.0	16.9
900	0.265	34.9	11.98	5785	77.0	18.9
1000	0.273	37.1	11.98	5516	82.1	21.0
1500	0.306	47.1	11.99	4608	104.9	31.3
2000	0.330	55.6	12.00	4071	124.4	41.2
3000	0.367	70.5	12.00	3413	158.9	60.8
4000	0.396	83.3	12.00	3019	189.2	79.8
5000	0.418	94.7	12.00	2751	216.5	98.1
6000	0.438	105.2	12.00	2553	241.7	115.8
7000	0.454	114.9	12.00	2400	265.2	133.0
8000	0.469	124.2	12.00	2274	288.0	150.2
9000	0.483	133.3	12.00	2166	310.7	167.7
10000	0.495	141.8	12.00	2077	331.8	184.4
15000	0.544	179.6	12.00	1779	428.3	264.1
20000	0.579	212.9	12.00	1600	516.0	340.4
25000	0.608	244.0	12.00	1475	600.4	416.1
30000	0.631	271.5	12.00	1388	676.8	486.2
35000	0.652	299.0	12.00	1317	754.8	558.8
40000	0.669	324.2	12.00	1263	827.8	627.7
45000	0.685	348.8	12.00	1217	900.7	697.1
50000	0.699	373.2	12.00	1177	974.3	767.7
60000	0.722	417.8	12.00	1117	1112.6	901.5
70000	0.742	460.5	12.00	1071	1249.1	1034.9
80000	0.759	503.3	12.00	1033	1390.3	1173.7
90000	0.774	543.7	12.00	1003	1527.2	1309.1
100000	0.787	582.2	12.00	978	1661.7	1442.6
150000	0.835	767.9	12.00	898	2357.1	2138.0
200000	0.866	941.1	12.00	856	3077.9	2864.0
300000	0.905	1271.5	12.00	816	4646.6	4451.0

MAGNESIUM CHARGE= 12 MASSNUMBER= 26

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.074	2.6	9.97	26057	5.4	0.4
50	0.102	5.0	10.95	20783	10.5	0.8
75	0.119	6.7	11.30	17873	14.4	1.3
100	0.132	8.3	11.49	15972	17.8	1.8
200	0.166	13.3	11.77	11759	28.8	3.8
300	0.189	17.3	11.87	9771	37.7	5.9
400	0.207	20.8	11.91	8526	45.6	8.0
500	0.222	24.0	11.94	7638	52.5	10.1
600	0.234	26.8	11.95	7038	58.9	12.2
700	0.245	29.4	11.96	6577	64.7	14.2
800	0.254	31.9	11.97	6179	70.4	16.3
900	0.263	34.1	11.98	5883	75.3	18.2
1000	0.270	36.2	11.98	5613	80.2	20.2
1500	0.302	46.1	11.99	4688	102.5	30.1
2000	0.326	54.4	12.00	4140	121.6	39.7
3000	0.363	68.9	12.00	3472	155.2	58.6
4000	0.392	81.6	12.00	3066	185.1	77.1
5000	0.414	92.5	12.00	2798	211.2	94.4
6000	0.433	102.7	12.00	2596	235.8	111.6
7000	0.450	112.4	12.00	2437	259.2	128.5
8000	0.465	121.6	12.00	2306	281.8	145.4
9000	0.478	130.1	12.00	2202	302.6	161.4
10000	0.491	138.6	12.00	2109	323.9	178.1
15000	0.539	175.3	12.00	1806	417.3	254.8
20000	0.574	208.0	12.00	1623	503.0	328.9
25000	0.603	238.2	12.00	1496	584.5	401.6
30000	0.626	265.3	12.00	1406	659.4	470.1
35000	0.646	291.2	12.00	1336	732.4	537.9
40000	0.664	316.6	12.00	1278	805.6	606.7
45000	0.680	340.6	12.00	1231	876.4	673.9
50000	0.693	363.8	12.00	1192	945.9	740.4
60000	0.717	407.5	12.00	1130	1080.2	870.1
70000	0.737	449.0	12.00	1082	1212.0	998.6
80000	0.754	490.7	12.00	1043	1348.3	1132.4
90000	0.769	529.7	12.00	1013	1479.2	1261.6
100000	0.782	568.2	12.00	987	1612.5	1393.7
150000	0.831	747.1	12.00	905	2275.1	2055.7
200000	0.862	915.6	12.00	861	2967.5	2752.6
300000	0.902	1235.6	12.00	819	4463.8	4265.8

ALUMINUM CHARGE= 13 MASSNUMBER= 26

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.078	2.9	10.79	28736	6.0	0.4
50	0.107	5.4	11.84	22846	11.5	1.0
75	0.125	7.4	12.22	19619	15.8	1.5
100	0.139	9.1	12.43	17403	19.7	2.1
200	0.174	14.6	12.75	12853	31.7	4.4
300	0.198	18.9	12.85	10671	41.3	6.8
400	0.217	22.8	12.90	9296	50.0	9.3
500	0.232	26.3	12.93	8355	57.8	11.8
600	0.244	29.3	12.95	7719	64.5	14.1
700	0.256	32.2	12.96	7184	71.1	16.6
800	0.265	34.8	12.97	6794	76.8	18.8
900	0.274	37.3	12.97	6440	82.5	21.2
1000	0.282	39.8	12.98	6138	88.2	23.6
1500	0.315	50.5	12.99	5136	112.5	35.1
2000	0.340	59.5	12.99	4540	133.4	46.1
3000	0.379	75.8	13.00	3795	171.5	68.5
4000	0.407	89.1	13.00	3374	203.0	88.9
5000	0.431	101.3	13.00	3077	232.3	109.1
6000	0.451	112.7	13.00	2855	259.9	129.1
7000	0.468	123.3	13.00	2682	285.8	148.5
8000	0.483	133.5	13.00	2539	311.1	168.1
9000	0.497	143.0	13.00	2424	334.9	186.8
10000	0.509	152.0	13.00	2327	357.6	205.2
15000	0.558	192.8	13.00	1996	462.9	293.8
20000	0.595	228.9	13.00	1798	559.1	378.8
25000	0.624	262.0	13.00	1662	650.2	461.6
30000	0.647	292.3	13.00	1565	735.6	540.8
35000	0.667	321.5	13.00	1488	820.2	620.5
40000	0.685	349.4	13.00	1427	902.6	698.9
45000	0.701	376.7	13.00	1375	985.1	778.1
50000	0.714	402.0	13.00	1334	1062.9	853.3
60000	0.737	450.7	13.00	1268	1217.3	1003.8
70000	0.758	499.3	13.00	1216	1376.9	1160.5
80000	0.774	544.8	13.00	1176	1531.1	1313.0
90000	0.789	588.0	13.00	1144	1682.2	1463.0
100000	0.802	631.4	13.00	1117	1838.0	1618.2
150000	0.848	833.7	13.00	1032	2622.8	2405.3
200000	0.879	1027.9	13.00	989	3465.8	3255.8
300000	0.916	1400.3	13.00	946	5326.4	5140.3

ALUMINUM CHARGE= 13 MASSNUMBER= 27

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.077	2.8	10.70	28970	5.7	0.4
50	0.105	5.2	11.80	23119	11.1	0.9
75	0.123	7.2	12.19	19832	15.4	1.5
100	0.137	8.9	12.41	17723	19.1	2.0
200	0.172	14.3	12.74	13048	31.0	4.3
300	0.196	18.5	12.84	10868	40.3	6.5
400	0.214	22.3	12.90	9458	48.9	9.0
500	0.229	25.7	12.93	8501	56.4	11.3
600	0.242	28.6	12.94	7850	63.0	13.6
700	0.253	31.5	12.96	7313	69.4	15.9
800	0.262	34.0	12.97	6904	75.2	18.1
900	0.271	36.5	12.97	6551	80.6	20.4
1000	0.279	38.9	12.98	6246	86.1	22.7
1500	0.312	49.4	12.99	5220	110.1	33.8
2000	0.337	58.2	12.99	4617	130.4	44.4
3000	0.376	74.1	13.00	3860	167.5	66.0
4000	0.404	87.2	13.00	3428	198.4	85.9
5000	0.427	99.1	13.00	3125	227.1	105.4
6000	0.447	110.4	13.00	2896	254.4	125.0
7000	0.464	120.9	13.00	2719	279.9	144.0
8000	0.479	130.4	13.00	2581	303.4	162.0
9000	0.493	139.9	13.00	2460	327.2	180.7
10000	0.505	148.8	13.00	2360	349.6	198.6
15000	0.554	188.4	13.00	2025	451.4	283.9
20000	0.590	223.8	13.00	1822	545.3	366.4
25000	0.619	256.4	13.00	1683	634.5	447.2
30000	0.642	285.7	13.00	1584	716.9	523.4
35000	0.663	314.5	13.00	1505	799.7	601.1
40000	0.680	341.5	13.00	1443	879.1	676.4
45000	0.696	367.9	13.00	1391	958.4	752.4
50000	0.709	393.0	13.00	1348	1035.2	826.5
60000	0.733	440.3	13.00	1281	1184.0	971.2
70000	0.753	487.2	13.00	1228	1336.6	1120.9
80000	0.770	531.2	13.00	1187	1484.5	1266.9
90000	0.784	574.2	13.00	1154	1633.2	1414.3
100000	0.797	615.0	13.00	1127	1778.5	1558.8
150000	0.844	812.9	13.00	1039	2537.7	2319.5
200000	0.875	1000.6	13.00	993	3342.0	3130.7
300000	0.913	1356.4	13.00	951	5090.5	4901.0

SILICON CHARGE= 14 MASSNUMBER= 28

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.079	2.9	11.42	32080	6.0	0.4
50	0.108	5.5	12.63	25612	11.7	1.0
75	0.126	7.6	13.08	21945	16.2	1.6
100	0.141	9.4	13.32	19490	20.3	2.2
200	0.177	15.1	13.69	14438	32.8	4.7
300	0.201	19.6	13.82	11995	42.9	7.2
400	0.220	23.7	13.88	10435	51.9	9.9
500	0.236	27.2	13.91	9419	59.9	12.5
600	0.249	30.5	13.93	8675	67.1	15.1
700	0.260	33.4	13.95	8102	73.8	17.6
800	0.270	36.2	13.96	7632	80.0	20.1
900	0.279	38.9	13.97	7237	86.1	22.7
1000	0.288	41.5	13.97	6889	92.1	25.3
1500	0.321	52.5	13.99	5782	117.1	37.4
2000	0.347	62.1	13.99	5101	139.4	49.4
3000	0.386	79.0	14.00	4271	179.0	73.2
4000	0.415	93.0	14.00	3795	212.2	95.1
5000	0.439	105.8	14.00	3460	243.2	116.9
6000	0.459	117.7	14.00	3212	272.1	138.1
7000	0.476	128.6	14.00	3021	298.9	158.6
8000	0.492	139.4	14.00	2860	325.8	179.6
9000	0.506	149.3	14.00	2730	350.9	199.7
10000	0.518	158.7	14.00	2623	374.6	219.1
15000	0.568	201.7	14.00	2251	486.3	314.2
20000	0.605	239.8	14.00	2028	588.9	405.7
25000	0.633	273.7	14.00	1881	682.9	491.8
30000	0.657	306.7	14.00	1769	777.0	579.7
35000	0.677	336.9	14.00	1685	865.4	663.4
40000	0.695	366.4	14.00	1616	953.8	748.0
45000	0.710	394.5	14.00	1561	1039.8	830.9
50000	0.724	421.2	14.00	1515	1123.3	912.0
60000	0.747	473.6	14.00	1441	1291.8	1076.8
70000	0.767	523.5	14.00	1384	1458.4	1241.0
80000	0.784	572.0	14.00	1340	1625.8	1406.9
90000	0.798	617.7	14.00	1305	1788.4	1568.7
100000	0.811	666.3	14.00	1273	1966.7	1746.7
150000	0.857	880.3	14.00	1182	2817.1	2600.9
200000	0.886	1088.9	14.00	1135	3748.5	3541.6
300000	0.921	1474.0	14.00	1091	5732.9	5552.6

PHOSPHORUS CHARGE= 15 MASSNUMBER= 31

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.077	2.8	11.93	35671	5.8	0.4
50	0.108	5.5	13.36	28797	11.6	1.0
75	0.126	7.6	13.88	24725	16.3	1.6
100	0.141	9.5	14.17	21976	20.4	2.2
200	0.178	15.2	14.61	16319	33.1	4.8
300	0.203	19.9	14.77	13544	43.5	7.4
400	0.222	23.9	14.84	11811	52.5	10.1
500	0.237	27.6	14.89	10672	60.7	12.8
600	0.251	30.9	14.91	9824	68.2	15.5
700	0.262	33.9	14.93	9175	74.9	18.1
800	0.272	36.8	14.94	8642	81.3	20.6
900	0.282	39.5	14.95	8188	87.6	23.3
1000	0.290	42.3	14.96	7792	93.8	26.1
1500	0.324	53.4	14.98	6543	119.4	38.5
2000	0.350	63.3	14.99	5766	142.3	51.1
3000	0.390	80.5	15.00	4832	182.7	75.6
4000	0.419	94.9	15.00	4291	216.9	98.4
5000	0.443	108.0	15.00	3914	248.6	120.8
6000	0.463	120.3	15.00	3630	278.7	143.1
7000	0.480	131.4	15.00	3417	305.9	164.0
8000	0.496	142.2	15.00	3238	333.0	185.3
9000	0.510	152.3	15.00	3094	358.3	205.8
10000	0.522	162.0	15.00	2970	383.1	226.1
15000	0.572	205.8	15.00	2552	497.1	323.7
20000	0.609	245.1	15.00	2299	603.3	418.7
25000	0.636	280.3	15.00	2131	701.5	509.1
30000	0.662	313.4	15.00	2008	796.4	598.0
35000	0.682	344.4	15.00	1913	887.7	684.6
40000	0.700	374.9	15.00	1835	979.6	772.8
45000	0.715	403.1	15.00	1774	1066.5	856.8
50000	0.729	431.4	15.00	1721	1155.5	943.4
60000	0.752	485.2	15.00	1638	1330.2	1114.5
70000	0.771	536.3	15.00	1575	1501.8	1283.9
80000	0.788	585.2	15.00	1526	1672.0	1452.8
90000	0.802	633.6	15.00	1485	1846.0	1626.1
100000	0.815	682.1	15.00	1451	2026.0	1806.0
150000	0.861	905.0	15.00	1349	2921.9	2706.6
200000	0.890	1118.7	15.00	1298	3889.5	3684.4
300000	0.924	1515.0	15.00	1250	5964.6	5787.7

SULFUR CHARGE= 16 MASSNUMBER= 32

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.079	2.9	12.61	38998	6.1	0.4
50	0.110	5.7	14.17	31383	12.2	1.0
75	0.129	8.0	14.75	27059	17.1	1.7
100	0.144	9.9	15.07	23992	21.4	2.4
200	0.183	16.1	15.56	17779	34.9	5.2
300	0.208	21.0	15.73	14767	46.0	8.1
400	0.228	25.3	15.82	12887	55.5	11.0
500	0.243	29.0	15.87	11667	63.9	13.9
600	0.257	32.6	15.90	10723	71.9	16.9
700	0.268	35.7	15.92	10019	79.0	19.7
800	0.279	38.8	15.93	9427	86.0	22.6
900	0.289	41.9	15.95	8917	92.9	25.7
1000	0.297	44.5	15.95	8524	98.9	28.4
1500	0.332	56.4	15.98	7148	126.2	42.1
2000	0.359	66.9	15.99	6296	150.7	55.9
3000	0.399	84.8	15.99	5293	192.9	82.2
4000	0.428	100.1	16.00	4699	229.5	107.1
5000	0.453	114.0	16.00	4287	263.2	131.5
6000	0.473	126.8	16.00	3983	294.6	155.2
7000	0.492	139.2	16.00	3738	325.4	179.3
8000	0.507	150.6	16.00	3547	354.0	202.2
9000	0.521	161.2	16.00	3390	381.1	224.4
10000	0.534	171.2	16.00	3260	406.7	245.8
15000	0.584	218.1	16.00	2803	529.9	352.7
20000	0.622	259.6	16.00	2531	643.6	455.5
25000	0.651	297.2	16.00	2349	749.5	553.9
30000	0.674	332.5	16.00	2216	852.4	651.0
35000	0.695	366.3	16.00	2112	953.5	747.7
40000	0.712	398.1	16.00	2030	1051.0	841.7
45000	0.727	429.2	16.00	1963	1148.5	936.5
50000	0.741	457.9	16.00	1908	1240.8	1026.8
60000	0.764	516.4	16.00	1818	1434.2	1217.1
70000	0.784	572.0	16.00	1750	1625.5	1406.6
80000	0.800	624.4	16.00	1698	1812.7	1592.9
90000	0.814	678.5	16.00	1654	2012.2	1792.2
100000	0.826	727.9	16.00	1620	2200.5	1980.8
150000	0.871	969.3	16.00	1514	3202.1	2989.4
200000	0.899	1203.8	16.00	1461	4304.7	4104.7
300000	0.931	1635.9	16.00	1415	6670.3	6503.9

CHLORINE CHARGE= 17 MASSNUMBER= 35

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.077	2.8	13.05	42681	5.8	0.4
50	0.109	5.7	14.65	34781	12.0	1.0
75	0.129	7.9	15.52	30032	17.0	1.7
100	0.144	9.9	15.89	26650	21.5	2.4
200	0.183	16.2	16.47	19790	35.2	5.3
300	0.209	21.3	16.68	16433	46.5	8.3
400	0.229	25.6	16.78	14343	56.3	11.3
500	0.245	29.4	16.83	13017	64.7	14.2
600	0.258	33.0	16.87	11980	72.7	17.2
700	0.270	36.2	16.90	11178	80.0	20.1
800	0.281	39.4	16.92	10515	87.2	23.2
900	0.291	42.4	16.93	9948	94.2	26.3
1000	0.299	45.1	16.94	9511	100.3	29.1
1500	0.334	57.2	16.97	7972	128.2	43.2
2000	0.361	68.0	16.98	7021	153.2	57.4
3000	0.402	86.2	16.99	5904	196.2	84.3
4000	0.432	101.9	17.00	5238	233.7	110.1
5000	0.456	116.1	17.00	4779	268.3	135.3
6000	0.477	129.2	17.00	4440	300.4	159.7
7000	0.495	141.7	17.00	4170	331.6	184.2
8000	0.511	153.0	17.00	3960	360.3	207.4
9000	0.525	164.0	17.00	3784	388.3	230.4
10000	0.537	174.4	17.00	3637	414.8	252.7
15000	0.588	222.2	17.00	3129	540.9	362.5
20000	0.625	264.2	17.00	2829	656.3	467.2
25000	0.655	303.3	17.00	2624	767.2	570.5
30000	0.679	339.1	17.00	2476	872.0	669.7
35000	0.699	373.8	17.00	2361	976.1	769.5
40000	0.716	407.8	17.00	2272	1074.8	864.9
45000	0.731	437.3	17.00	2197	1174.5	961.9
50000	0.745	467.8	17.00	2135	1272.9	1058.3
60000	0.768	527.3	17.00	2036	1471.2	1253.7
70000	0.787	583.4	17.00	1962	1665.7	1446.5
80000	0.804	638.6	17.00	1903	1864.5	1644.6
90000	0.818	693.0	17.00	1855	2067.1	1847.2
100000	0.830	743.8	17.00	1818	2262.5	2043.0
150000	0.874	992.4	17.00	1701	3305.2	3093.5
200000	0.902	1230.2	17.00	1645	4436.5	4238.2
300000	0.933	1675.5	17.00	1595	6908.7	6745.9

ARGON CHARGE= 18 MASSNUMBER= 36

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.078	2.9	13.68	46145	6.0	0.4
50	0.112	5.9	15.64	37563	12.5	1.1
75	0.132	8.3	16.37	32479	17.8	1.8
100	0.147	10.3	16.77	28805	22.3	2.6
200	0.188	16.9	17.41	21323	36.9	5.7
300	0.214	22.3	17.64	17681	48.9	9.0
400	0.234	26.8	17.75	15502	59.0	12.2
500	0.250	30.8	17.81	14046	68.0	15.4
600	0.264	34.4	17.85	12972	76.1	18.5
700	0.276	37.9	17.88	12073	84.0	21.8
800	0.287	41.3	17.90	11346	91.7	25.1
900	0.297	44.4	17.92	10772	98.6	28.3
1000	0.306	47.2	17.93	10287	105.2	31.4
1500	0.342	60.1	17.96	8615	134.8	46.8
2000	0.369	71.4	17.98	7587	161.2	62.2
3000	0.410	90.5	17.99	6390	206.4	91.2
4000	0.441	107.2	17.99	5666	246.5	119.3
5000	0.466	122.1	18.00	5172	283.1	146.4
6000	0.487	136.2	18.00	4802	317.8	173.3
7000	0.505	149.0	18.00	4520	350.0	199.0
8000	0.521	161.1	18.00	4293	380.6	224.1
9000	0.535	172.3	18.00	4109	409.5	248.2
10000	0.548	183.8	18.00	3944	439.2	273.4
15000	0.600	234.0	18.00	3401	573.0	391.3
20000	0.637	278.6	18.00	3079	696.8	504.7
25000	0.666	319.1	18.00	2864	813.1	613.8
30000	0.690	357.6	18.00	2704	927.1	722.4
35000	0.710	394.3	18.00	2581	1039.2	830.4
40000	0.727	429.1	18.00	2484	1148.1	936.2
45000	0.742	461.7	18.00	2407	1252.8	1038.6
50000	0.756	495.5	18.00	2338	1364.1	1147.9
60000	0.779	559.2	18.00	2233	1580.9	1362.4
70000	0.798	617.5	18.00	2157	1787.8	1568.1
80000	0.814	678.4	18.00	2093	2011.9	1791.9
90000	0.828	734.0	18.00	2046	2224.4	2004.8
100000	0.840	791.2	18.00	2005	2450.1	2231.5
150000	0.883	1057.5	18.00	1886	3601.8	3393.3
200000	0.909	1311.8	18.00	1830	4855.3	4662.6
300000	0.939	1800.4	18.00	1782	7685.0	7534.2

ARGON CHARGE= 18 MASSNUMBER= 38

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.076	2.7	13.47	46556	5.6	0.4
50	0.109	5.6	15.51	38263	11.9	1.0
75	0.129	7.9	16.28	33093	17.0	1.7
100	0.145	10.0	16.71	29389	21.5	2.4
200	0.184	16.3	17.37	21865	35.6	5.4
300	0.211	21.5	17.61	18148	47.1	8.4
400	0.231	26.0	17.73	15842	57.1	11.6
500	0.246	29.8	17.80	14389	65.6	14.5
600	0.260	33.3	17.84	13279	73.6	17.5
700	0.272	36.6	17.87	12389	81.0	20.5
800	0.283	39.9	17.90	11641	88.5	23.7
900	0.293	43.0	17.91	11025	95.5	26.8
1000	0.301	45.7	17.93	10537	101.7	29.8
1500	0.337	58.1	17.96	8826	130.3	44.3
2000	0.364	69.1	17.98	7773	155.8	58.9
3000	0.405	87.7	17.99	6537	199.6	86.6
4000	0.435	103.8	17.99	5797	238.2	113.3
5000	0.460	118.4	18.00	5286	273.8	139.4
6000	0.481	131.6	18.00	4913	306.6	164.5
7000	0.499	144.3	18.00	4618	338.1	189.4
8000	0.514	155.8	18.00	4388	367.2	213.0
9000	0.529	167.0	18.00	4193	395.8	236.7
10000	0.541	177.7	18.00	4029	423.4	260.0
15000	0.592	226.3	18.00	3469	552.2	372.6
20000	0.629	269.0	18.00	3140	669.7	479.6
25000	0.659	309.4	18.00	2911	784.8	587.0
30000	0.683	345.7	18.00	2750	891.5	688.3
35000	0.703	381.2	18.00	2622	998.9	791.4
40000	0.720	414.0	18.00	2524	1100.6	889.9
45000	0.735	445.9	18.00	2443	1201.9	988.7
50000	0.749	478.5	18.00	2372	1307.8	1092.5
60000	0.772	538.6	18.00	2264	1509.8	1291.9
70000	0.791	595.5	18.00	2184	1708.7	1489.3
80000	0.808	654.0	18.00	2117	1921.1	1701.1
90000	0.822	708.0	18.00	2067	2124.0	1904.1
100000	0.834	760.5	18.00	2026	2327.8	2108.6
150000	0.877	1015.7	18.00	1899	3410.1	3199.5
200000	0.904	1258.8	18.00	1839	4581.9	4385.5
300000	0.936	1719.0	18.00	1785	7175.2	7016.5

ARGON CHARGE= 18 MASSNUMBER= 40

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.073	2.5	13.26	47243	5.2	0.3
50	0.106	5.3	15.40	38903	11.4	0.9
75	0.126	7.6	16.20	33627	16.3	1.6
100	0.142	9.6	16.64	29937	20.7	2.3
200	0.181	15.8	17.33	22360	34.3	5.1
300	0.207	20.8	17.58	18602	45.5	8.0
400	0.227	25.1	17.71	16244	55.1	10.9
500	0.242	28.8	17.78	14731	63.5	13.8
600	0.256	32.4	17.83	13557	71.4	16.7
700	0.268	35.5	17.86	12686	78.4	19.5
800	0.278	38.6	17.89	11925	85.5	22.4
900	0.289	41.7	17.91	11278	92.5	25.5
1000	0.297	44.4	17.92	10772	98.6	28.3
1500	0.332	56.4	17.96	9025	126.3	42.2
2000	0.359	67.1	17.97	7945	151.0	56.1
3000	0.399	85.2	17.99	6676	193.6	82.7
4000	0.429	100.6	17.99	5925	230.6	107.9
5000	0.454	114.6	18.00	5405	264.6	132.6
6000	0.474	127.5	18.00	5020	296.4	156.6
7000	0.493	140.0	18.00	4712	327.5	180.9
8000	0.509	151.4	18.00	4472	356.1	203.9
9000	0.523	162.2	18.00	4274	383.5	226.5
10000	0.535	172.3	18.00	4109	409.5	248.2
15000	0.586	219.6	18.00	3532	534.2	356.5
20000	0.623	261.3	18.00	3192	648.2	459.8
25000	0.652	299.6	18.00	2961	756.5	560.4
30000	0.676	335.0	18.00	2793	859.7	658.0
35000	0.697	369.3	18.00	2662	962.5	756.4
40000	0.714	401.0	18.00	2561	1059.9	850.4
45000	0.729	432.4	18.00	2476	1158.6	946.4
50000	0.742	461.7	18.00	2407	1252.8	1038.6
60000	0.766	520.5	18.00	2294	1448.2	1231.0
70000	0.785	576.3	18.00	2209	1640.7	1421.7
80000	0.801	629.8	18.00	2143	1832.3	1612.5
90000	0.816	684.0	18.00	2088	2033.1	1813.1
100000	0.828	734.0	18.00	2046	2224.4	2004.8
150000	0.872	976.1	18.00	1913	3241.3	3029.0
200000	0.900	1213.9	18.00	1847	4355.1	4155.7
300000	0.932	1651.0	18.00	1789	6761.0	6596.0

POTASSIUM CHARGE= 19 MASSNUMBER= 39

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.077	2.8	14.07	49903	5.7	0.4
50	0.111	5.8	16.28	41061	12.4	1.1
75	0.132	8.2	17.12	35630	17.7	1.8
100	0.147	10.3	17.57	31633	22.3	2.6
200	0.188	17.1	18.30	23446	37.2	5.8
300	0.215	22.5	18.57	19460	49.3	9.1
400	0.235	27.1	18.69	17072	59.6	12.4
500	0.252	31.2	18.77	15460	68.8	15.7
600	0.265	34.8	18.82	14290	77.0	18.9
700	0.277	38.3	18.85	13320	84.9	22.2
800	0.289	41.8	18.88	12507	92.8	25.6
900	0.299	44.9	18.90	11885	99.7	28.8
1000	0.308	47.8	18.91	11341	106.5	32.1
1500	0.344	60.9	18.95	9494	136.7	47.9
2000	0.372	72.5	18.97	8356	163.7	63.7
3000	0.413	91.9	18.99	7041	209.6	93.4
4000	0.444	108.9	18.99	6243	250.6	122.2
5000	0.469	123.9	18.99	5707	287.3	149.6
6000	0.490	138.2	19.00	5295	323.0	177.4
7000	0.508	151.3	19.00	4984	355.8	203.7
8000	0.524	163.5	19.00	4736	387.0	229.3
9000	0.538	175.1	19.00	4531	416.7	254.3
10000	0.552	186.6	19.00	4351	446.7	279.9
15000	0.603	238.2	19.00	3751	584.4	401.6
20000	0.640	283.2	19.00	3401	709.7	516.6
25000	0.669	324.7	19.00	3162	829.4	629.2
30000	0.694	364.1	19.00	2986	946.9	741.3
35000	0.714	400.9	19.00	2854	1059.7	850.2
40000	0.731	436.3	19.00	2748	1171.2	958.7
45000	0.746	470.6	19.00	2661	1282.0	1067.2
50000	0.760	504.4	19.00	2587	1394.0	1177.4
60000	0.783	569.0	19.00	2472	1615.0	1396.2
70000	0.801	629.7	19.00	2388	1832.0	1612.2
80000	0.818	691.3	19.00	2319	2060.4	1840.4
90000	0.831	748.2	19.00	2267	2279.8	2060.4
100000	0.843	805.2	19.00	2224	2506.7	2288.4
150000	0.886	1081.4	19.00	2093	3713.1	3505.8
200000	0.911	1340.7	19.00	2034	5007.5	4816.8
300000	0.941	1843.6	19.00	1983	7961.7	7815.2

CALCIUM CHARGE= 20 MASSNUMBER= 40

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.078	2.8	14.65	53416	5.9	0.4
50	0.113	6.0	17.04	44111	12.8	1.1
75	0.134	8.6	17.94	38150	18.4	1.9
100	0.150	10.7	18.43	33881	23.1	2.7
200	0.192	17.8	19.23	25057	38.9	6.2
300	0.219	23.4	19.52	20798	51.4	9.7
400	0.240	28.2	19.66	18288	62.1	13.3
500	0.257	32.6	19.74	16557	71.8	16.8
600	0.271	36.3	19.80	15298	80.4	20.3
700	0.283	40.1	19.84	14261	88.8	23.9
800	0.294	43.5	19.86	13431	96.7	27.4
900	0.304	46.7	19.89	12757	104.0	30.8
1000	0.314	49.9	19.90	12161	111.2	34.4
1500	0.351	63.7	19.95	10170	143.1	51.5
2000	0.380	75.9	19.97	8949	171.8	68.7
3000	0.421	96.0	19.98	7557	219.6	100.2
4000	0.452	113.6	19.99	6714	262.0	130.6
5000	0.477	129.5	19.99	6132	301.3	160.4
6000	0.499	144.5	20.00	5694	338.7	189.9
7000	0.517	158.1	20.00	5364	373.1	217.8
8000	0.533	170.8	20.00	5100	405.8	245.0
9000	0.548	183.5	20.00	4872	438.7	273.0
10000	0.561	195.4	20.00	4683	469.8	299.8
15000	0.613	249.7	20.00	4043	616.2	430.5
20000	0.650	296.9	20.00	3673	748.7	553.1
25000	0.680	340.8	20.00	3419	877.1	674.5
30000	0.704	382.4	20.00	3232	1002.5	794.8
35000	0.724	420.9	20.00	3093	1122.3	911.0
40000	0.740	457.7	20.00	2982	1240.1	1026.1
45000	0.756	495.4	20.00	2887	1363.7	1147.5
50000	0.769	530.4	20.00	2811	1481.8	1264.1
60000	0.792	597.4	20.00	2693	1715.6	1496.2
70000	0.811	666.1	20.00	2599	1965.8	1745.8
80000	0.826	727.7	20.00	2532	2199.8	1980.1
90000	0.840	791.1	20.00	2475	2449.8	2231.1
100000	0.851	848.5	20.00	2433	2684.0	2466.8
150000	0.893	1145.0	20.00	2299	4016.3	3812.7
200000	0.918	1423.9	20.00	2234	5455.3	5270.9
300000	0.947	1982.0	20.00	2193	8877.9	8745.9

CALCIUM CHARGE= 20 MASSNUMBER= 44

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.073	2.5	14.20	54606	5.1	0.3
50	0.108	5.5	16.77	45449	11.6	1.0
75	0.129	7.9	17.75	39459	16.9	1.7
100	0.145	10.0	18.29	35104	21.6	2.4
200	0.186	16.6	19.15	26193	36.2	5.5
30	0.213	22.1	19.46	21722	48.3	8.8
400	0.233	26.6	19.62	19058	58.5	12.0
500	0.250	30.6	19.71	17284	67.5	15.2
600	0.263	34.3	19.77	15966	75.7	18.4
700	0.275	37.7	19.81	14893	83.5	21.5
800	0.287	41.1	19.85	14012	91.1	24.9
900	0.296	44.1	19.87	13301	98.0	28.0
1000	0.305	47.0	19.89	12700	104.7	31.2
1500	0.342	60.0	19.94	10622	134.6	46.7
2000	0.370	71.5	19.96	9349	161.3	62.2
3000	0.411	90.7	19.98	7869	206.9	91.5
4000	0.442	107.5	19.99	6976	247.3	119.9
5000	0.467	122.6	19.99	6368	284.1	147.2
6000	0.488	136.7	19.99	5910	319.2	174.4
7000	0.506	149.7	20.00	5562	351.7	200.4
8000	0.522	161.8	20.00	5284	382.4	225.6
9000	0.536	173.1	20.00	5057	411.6	250.0
10000	0.549	184.7	20.00	4852	441.7	275.6
15000	0.601	235.3	20.00	4185	576.6	394.6
20000	0.638	280.3	20.00	3789	701.6	509.1
25000	0.667	320.9	20.00	3525	818.5	618.8
30000	0.691	359.8	20.00	3328	933.7	728.7
35000	0.711	396.5	20.00	3178	1046.1	837.0
40000	0.729	431.6	20.00	3059	1156.4	944.2
45000	0.743	464.7	20.00	2964	1262.7	1048.3
50000	0.757	498.7	20.00	2880	1374.7	1158.4
60000	0.781	562.8	20.00	2750	1593.4	1374.7
70000	0.799	621.7	20.00	2657	1803.0	1583.3
80000	0.815	682.8	20.00	2579	2028.6	1808.6
90000	0.829	739.1	20.00	2521	2244.1	2024.6
100000	0.841	796.1	20.00	2472	2469.7	2251.2
150000	0.884	1065.8	20.00	2325	3640.3	3432.2
200000	0.910	1321.9	20.00	2257	4908.0	4716.0
300000	0.940	1815.4	20.00	2199	7780.7	7631.4

SCANDIUM CHARGE= 21 MASSNUMBER= 45

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.074	2.6	14.75	57878	5.3	0.3
50	0.109	5.6	17.50	48458	12.0	1.0
75	0.131	8.2	18.56	42165	17.5	1.8
100	0.147	10.3	19.13	37519	22.3	2.6
200	0.190	17.3	20.07	27883	37.7	5.9
300	0.217	22.9	20.41	23166	50.2	9.4
400	0.238	27.7	20.58	20344	60.9	12.8
500	0.255	32.0	20.68	18397	70.5	16.4
600	0.268	35.7	20.74	17030	78.9	19.7
700	0.281	39.3	20.79	15889	87.2	23.1
800	0.292	42.8	20.83	14947	95.1	26.7
900	0.302	45.9	20.85	14217	102.1	29.9
1000	0.311	49.0	20.87	13565	109.1	33.4
1500	0.348	62.6	20.93	11339	140.7	50.1
2000	0.377	74.8	20.96	9965	169.1	67.0
3000	0.418	94.8	20.98	8406	216.6	98.1
4000	0.450	112.1	20.99	7465	258.6	128.1
5000	0.475	127.8	20.99	6821	297.0	157.1
6000	0.497	142.6	20.99	6332	334.0	186.1
7000	0.515	156.0	21.00	5966	367.7	213.4
8000	0.531	168.7	21.00	5668	400.3	240.5
9000	0.545	181.1	21.00	5416	432.4	267.6
10000	0.558	192.8	21.00	5208	462.8	293.7
15000	0.611	246.5	21.00	4491	607.3	422.3
20000	0.647	292.7	21.00	4080	736.9	542.1
25000	0.677	336.5	21.00	3793	864.2	662.2
30000	0.701	377.5	21.00	3585	987.5	780.4
35000	0.721	415.3	21.00	3430	1104.7	893.9
40000	0.738	451.8	21.00	3306	1220.8	1007.2
45000	0.754	488.8	21.00	3200	1342.1	1126.2
50000	0.767	523.2	21.00	3116	1457.2	1239.9
60000	0.789	589.6	21.00	2983	1687.9	1468.6
70000	0.809	656.7	21.00	2878	1930.9	1711.0
80000	0.824	717.8	21.00	2802	2161.7	1942.0
90000	0.838	779.2	21.00	2740	2402.0	2183.1
100000	0.849	836.3	21.00	2692	2633.7	2416.2
150000	0.891	1128.4	21.00	2540	3936.2	3731.5
200000	0.916	1404.7	21.00	2467	5351.0	5165.1
300000	0.945	1942.6	21.00	2419	8612.6	8476.4

TITANIUM CHARGE= 22 MASSNUMBER= 46

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.074	2.6	15.28	61216	5.4	0.4
50	0.111	5.8	18.23	51462	12.4	1.1
75	0.133	8.4	19.36	44865	18.1	1.9
100	0.150	10.7	19.97	39908	23 0	2.7
200	0.193	18.0	20.98	29577	39.3	6.3
300	0.221	23.8	21.35	24554	52.2	10.0
400	0.242	28.7	21.53	21659	63.2	13.7
500	0.259	33.2	21.64	19627	73.2	17.4
600	0.273	37.1	21.72	18115	82.1	21.0
700	0.286	41.0	21.77	16882	90.9	24.8
800	0.297	44.5	21.81	15927	98.8	28.4
900	0.307	47.7	21.84	15132	106.3	32.0
1000	0.317	50.9	21.86	14452	113.5	35.5
1500	0.355	65.3	21.92	12062	146.8	53.6
2000	0.384	77.8	21.95	10625	176.1	71.4
3000	0.425	98.5	21.97	8974	225.5	104.3
4000	0.457	116.8	21.98	7963	269.9	136.5
5000	0.483	133.4	21.99	7267	311.0	168.0
6000	0.505	148.7	21.99	6758	349.2	198.3
7000	0.523	162.7	21.99	6369	384.8	227.5
8000	0.539	175.8	22.00	6057	418.7	255.9
9000	0.554	188.6	22.00	5793	451.9	284.3
10000	0.568	201.3	22.00	5564	485.2	313.2
15000	0.620	257.1	22.00	4812	636.4	449.0
20000	0.657	306.6	22.00	4369	776.6	579.3
25000	0.686	351.4	22.00	4074	908.6	704.6
30000	0.710	394.5	22.00	3854	1039.9	831.0
35000	0.730	434.7	22.00	3689	1166.2	953.8
40000	0.747	473.8	22.00	3557	1292.6	1077.6
45000	0.762	511.5	22.00	3449	1417.8	1200.9
50000	0.776	548.7	22.00	3359	1544.7	1326.4
60000	0.798	618.2	22.00	3221	1790.2	1570.5
70000	0.817	688.5	22.00	3113	2050.1	1830.2
80000	0.832	753.4	22.00	3034	2300.1	2080.8
90000	0.845	817.1	22.00	2971	2554.9	2336.9
100000	0.857	881.3	22.00	2919	2821.5	2605.4
150000	0.898	1190.3	22.00	2766	4237.9	4037.0
200000	0.921	1475.9	22.00	2695	5744.0	5563.8
300000	0.950	2063.6	22.00	2652	9438.9	9315.9

TITANIUM CHARGE= 22 MASSNUMBER= 48

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.072	2.5	15.04	62149	5.0	0.3
50	0.108	5.6	18.08	52245	11.8	1.0
75	0.131	8.1	19.25	45541	17.4	1.8
100	0.147	10.3	19.89	40571	22.3	2.6
200	0.190	17.4	20.93	30186	38.0	6.0
300	0.218	23.1	21.32	25087	50.7	9.5
400	0.239	28.0	21.51	22040	61.5	13.1
500	0.256	32.3	21.63	19961	71.3	16.7
600	0.270	36.1	21.70	18457	79.9	20.1
700	0.283	39.9	21.76	17219	88.4	23.7
800	0.294	43.4	21.80	16216	95.3	27.2
900	0.304	46.5	21.83	15421	103.5	30.6
1000	0.313	49.6	21.85	14715	110.6	34.1
1500	0.350	63.5	21.92	12303	142.7	51.3
2000	0.380	75.9	21.95	10816	171.6	68.6
3000	0.421	96.1	21.97	9128	219.8	100.4
4000	0.452	113.8	21.98	8108	262.6	131.1
5000	0.478	129.9	21.99	7402	302.2	161.1
6000	0.500	144.9	21.99	6874	339.8	190.8
7000	0.518	158.7	21.99	6474	374.5	219.0
8000	0.534	171.4	22.00	6156	407.3	246.3
9000	0.549	184.3	22.00	5879	440.5	274.6
10000	0.562	196.2	22.00	5652	471.8	301.6
15000	0.614	250.8	22.00	4880	619.1	433.1
20000	0.651	298.4	22.00	4432	753.0	557.1
25000	0.681	342.4	22.00	4127	881.7	678.9
30000	0.705	384.3	22.00	3902	1008.2	800.4
35000	0.725	423.1	22.00	3734	1129.2	917.7
40000	0.741	460.1	22.00	3601	1247.8	1033.6
45000	0.757	497.9	22.00	3486	1372.3	1156.0
50000	0.770	533.1	22.00	3395	1491.2	1273.4
60000	0.793	600.6	22.00	3253	1726.9	1507.4
70000	0.812	669.5	22.00	3140	1978.6	1758.6
80000	0.827	731.7	22.00	3059	2215.4	1995.8
90000	0.841	795.1	22.00	2991	2465.8	2247.2
100000	0.852	853.5	22.00	2940	2704.8	2487.8
150000	0.894	1152.0	22.00	2779	4050.0	3846.8
200000	0.918	1431.9	22.00	2702	5499.3	5315.6
300000	0.948	1998.7	22.00	2653	8992.0	8861.9

VANADIUM CHARGE= 23 MASSNUMBER= 51

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.071	2.4	15.32	66361	4.8	0.3
50	0.108	5.5	18.64	56080	11.6	1.0
75	0.130	8.1	19.93	48985	17.3	1.7
100	0.147	10.3	20.63	43692	22.3	2.6
200	0.191	17.6	21.80	32541	38.3	6.0
300	0.219	23.4	22.22	27050	51.2	9.7
400	0.240	28.3	22.44	23803	62.2	13.3
500	0.257	32.7	22.57	21571	72.1	17.0
600	0.271	36.6	22.65	19933	80.9	20.5
700	0.284	40.4	22.72	18585	89.6	24.2
800	0.296	43.9	22.76	17518	97.6	27.8
900	0.306	47.1	22.80	16655	104.9	31.3
1000	0.315	50.3	22.82	15897	112.2	34.9
1500	0.353	64.4	22.90	13293	144.8	52.5
2000	0.382	76.9	22.94	11698	174.0	70.1
3000	0.424	97.5	22.97	9874	223.1	102.6
4000	0.455	115.5	22.98	8766	266.9	134.2
5000	0.481	132.0	22.99	7998	307.6	165.3
6000	0.503	147.2	22.99	7433	345.6	195.4
7000	0.521	161.2	22.99	7001	381.1	224.5
8000	0.537	174.2	22.99	6659	414.4	252.3
9000	0.552	187.1	23.00	6364	447.9	280.9
10000	0.566	199.6	23.00	6113	480.6	309.3
15000	0.618	254.8	23.00	5285	630.2	443.3
20000	0.655	303.7	23.00	4798	768.5	571.7
25000	0.684	348.2	23.00	4473	899.1	695.5
30000	0.708	391.2	23.00	4229	1029.6	821.0
35000	0.728	431.0	23.00	4048	1154.4	942.3
40000	0.745	469.0	23.00	3904	1276.8	1062.1
45000	0.761	506.8	23.00	3784	1402.1	1185.4
50000	0.774	543.3	23.00	3685	1525.9	1307.8
60000	0.796	612.1	23.00	3532	1768.0	1548.4
70000	0.815	681.9	23.00	3413	2025.1	1805.1
80000	0.830	746.0	23.00	3325	2271.0	2051.6
90000	0.844	809.4	23.00	3255	2523.8	2305.6
100000	0.855	871.6	23.00	3198	2780.7	2564.2
150000	0.896	1177.0	23.00	3028	4172.0	3970.3
200000	0.920	1460.6	23.00	2948	5658.3	5476.9
300000	0.949	2042.3	23.00	2899	9291.1	9165.8

CHROMIUM CHARGE= 24 MASSNUMBER= 50

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.073	2.5	16.04	68951	5.2	0.3
50	0.111	5.9	19.48	58537	12.5	1.1
75	0.135	8.6	20.82	51090	18.5	1.9
100	0.152	11.0	21.54	45449	23.7	2.8
200	0.197	18.7	22.75	33773	40.8	6.7
300	0.226	24.9	23.19	28058	54.6	10.7
400	0.247	30.1	23.42	24742	66.2	14.7
500	0.264	34.6	23.55	22475	76.5	18.7
600	0.279	38.9	23.64	20711	86.2	22.7
700	0.293	43.0	23.70	19313	95.4	26.8
800	0.304	46.6	23.75	18246	103.6	30.7
900	0.314	50.1	23.79	17317	111.7	34.6
1000	0.323	53.3	23.81	16566	119.1	38.4
1500	0.362	68.3	23.90	13859	153.8	57.8
2000	0.392	81.5	23.93	12202	185.0	77.0
3000	0.435	103.5	23.96	10298	237.7	112.9
4000	0.467	122.9	23.98	9145	284.9	147.8
5000	0.493	140.5	23.99	8350	328.6	181.8
6000	0.515	156.3	23.99	7780	368.4	214.0
7000	0.534	171.1	23.99	7333	406.5	245.7
8000	0.551	185.7	23.99	6962	444.2	277.7
9000	0.565	199.4	24.00	6659	480.1	308.8
10000	0.578	211.9	24.00	6416	513.4	338.0
15000	0.631	270.6	24.00	5563	674.3	483.8
20000	0.669	323.3	24.00	5056	825.5	625.5
25000	0.698	372.5	24.00	4713	972.2	765.7
30000	0.722	417.1	24.00	4472	1110.4	899.4
35000	0.741	459.8	24.00	4286	1246.9	1032.8
40000	0.759	502.7	24.00	4133	1388.3	1171.8
45000	0.774	543.0	24.00	4013	1525.1	1307.0
50000	0.787	581.7	24.00	3914	1659.7	1440.6
60000	0.810	660.3	24.00	3753	1944.3	1724.3
70000	0.827	731.4	24.00	3641	2214.3	1994.6
80000	0.842	802.7	24.00	3551	2496.6	2278.2
90000	0.855	871.3	24.00	3483	2779.1	2562.7
100000	0.866	940.5	24.00	3426	3075.7	2861.8
150000	0.905	1271.0	24.00	3265	4644.3	4448.7
200000	0.928	1586.7	24.00	3189	6379.2	6208.4
300000	0.955	2218.8	24.00	3155	10548.8	10443.7

CHROMIUM CHARGE= 24 MASSNUMBER= 52

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.071	2.4	15.80	69778	4.9	0.3
50	0.109	5.6	19.33	59278	11.9	1.0
75	0.132	8.3	20.71	51852	17.8	1.8
100	0.149	10.6	21.45	46215	22.9	2.7
200	0.194	18.2	22.70	34355	39.7	6.4
300	0.223	24.2	23.16	28525	53.1	10.3
400	0.244	29.3	23.39	25195	64.5	14.1
500	0.261	33.8	23.53	22851	74.7	18.0
600	0.276	37.9	23.62	21063	84.0	21.8
700	0.290	42.0	23.69	19634	93.2	25.8
800	0.300	45.5	23.74	18559	101.1	29.5
900	0.311	48.9	23.77	17623	108.9	33.3
1000	0.320	52.0	23.80	16849	116.2	36.9
1500	0.358	66.7	23.89	14094	150.2	55.6
2000	0.388	79.7	23.93	12398	180.7	74.3
3000	0.430	101.1	23.96	10473	231.8	108.7
4000	0.463	120.3	23.98	9276	278.7	143.1
5000	0.489	137.3	23.98	8479	320.7	175.6
6000	0.510	152.7	23.99	7897	359.5	206.7
7000	0.529	167.3	23.99	7442	396.5	237.3
8000	0.546	181.2	23.99	7069	432.7	267.8
9000	0.560	194.5	23.99	6762	467.4	297.7
10000	0.573	207.0	24.00	6507	500.4	326.6
15000	0.626	264.5	24.00	5634	657.2	468.0
20000	0.664	315.8	24.00	5118	803.5	604.7
25000	0.693	363.0	24.00	4772	943.6	738.2
30000	0.717	406.8	24.00	4523	1078.1	868.1
35000	0.736	448.4	24.00	4332	1209.9	996.6
40000	0.754	490.1	24.00	4175	1346.2	1130.3
45000	0.769	529.0	24.00	4052	1477.1	1259.5
50000	0.782	567.7	24.00	3948	1610.6	1391.8
60000	0.804	641.0	24.00	3788	1873.3	1653.4
70000	0.823	712.4	24.00	3668	2141.0	1921.2
80000	0.838	781.7	24.00	3576	2412.0	2193.2
90000	0.851	846.4	24.00	3506	2675.2	2458.0
100000	0.862	915.1	24.00	3446	2965.5	2750.6
150000	0.902	1235.1	24.00	3276	4461.6	4263.6
200000	0.925	1535.5	24.00	3197	6082.2	5907.0
300000	0.953	2146.8	24.00	3155	10027.4	9913.9

MANGANESE CHARGE= 25 MASSNUMBER= 53

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.072	2.4	16.26	73273	5.0	0.3
50	0.110	5.7	20.01	62473	12.2	1.1
75	0.134	8.5	21.48	54702	18.4	1.9
100	0.151	10.9	22.26	48703	23.6	2.8
200	0.197	18.8	23.60	36227	41.0	6.7
300	0.226	25.0	24.09	30116	54.9	10.8
400	0.248	30.3	24.34	26573	66.7	14.9
500	0.266	34.9	24.48	24139	77.2	19.0
600	0.281	39.3	24.59	22244	87.1	23.1
700	0.294	43.4	24.66	20754	96.4	27.3
800	0.305	47.0	24.71	19603	104.7	31.2
900	0.316	50.6	24.75	18617	112.8	35.2
1000	0.325	53.9	24.78	17799	120.4	39.1
1500	0.364	69.0	24.88	14907	155.5	58.7
2000	0.394	82.4	24.92	13132	187.0	78.3
3000	0.437	104.8	24.96	11071	240.8	115.2
4000	0.469	124.2	24.97	9843	288.3	150.4
5000	0.496	142.2	24.98	8983	333.0	185.3
6000	0.518	158.4	24.99	8365	373.9	218.5
7000	0.536	173.4	24.99	7890	412.2	250.5
8000	0.553	187.9	24.99	7497	449.9	282.6
9000	0.568	201.9	24.99	7169	486.8	314.7
10000	0.581	214.8	24.99	6904	521.1	344.9
15000	0.634	274.7	25.00	5986	685.7	494.4
20000	0.672	328.1	25.00	5445	839.5	638.8
25000	0.701	377.8	25.00	5079	988.4	781.3
30000	0.725	423.5	25.00	4819	1130.5	919.0
35000	0.745	467.1	25.00	4620	1270.7	1056.1
40000	0.762	510.1	25.00	4459	1412.9	1196.1
45000	0.777	551.8	25.00	4328	1555.3	1337.0
50000	0.789	590.4	25.00	4225	1690.6	1471.3
60000	0.812	670.3	25.00	4053	1981.7	1761.7
70000	0.830	743.2	25.00	3933	2260.1	2040.7
80000	0.845	814.9	25.00	3839	2545.9	2327.8
90000	0.858	887.1	25.00	3764	2845.9	2630.0
100000	0.869	956.7	25.00	3705	3146.5	2933.3
150000	0.907	1294.0	25.00	3535	4762.7	4568.7
200000	0.930	1614.9	25.00	3456	6545.8	6377.6
300000	0.956	2265.6	25.00	3423	10894.8	10795.3

MANGANESE CHARGE= 25 MASSNUMBER= 54

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.071	2.4	16.14	73670	4.8	0.3
50	0.109	5.6	19.93	62878	12.0	1.0
75	0.133	8.4	21.41	55085	18.0	1.9
100	0.150	10.8	22.22	49098	23.2	2.7
200	0.196	18.5	23.57	36534	40.4	6.6
300	0.225	24.7	24.07	30364	54.2	10.6
400	0.247	29.9	24.32	26786	65.9	14.6
500	0.264	34.5	24.47	24335	76.3	18.6
600	0.279	38.8	24.58	22430	86.0	22.6
700	0.292	42.9	24.65	20917	95.3	26.7
800	0.304	46.5	24.70	19764	103.5	30.6
900	0.314	50.0	24.75	18758	111.6	34.6
1000	0.323	53.2	24.78	17947	119.0	38.3
1500	0.362	68.2	24.87	15028	153.7	57.7
2000	0.392	81.5	24.92	13231	184.9	77.0
3000	0.435	103.6	24.96	11163	237.9	113.1
4000	0.467	123.0	24.97	9912	285.2	148.0
5000	0.494	140.7	24.98	9049	329.1	182.3
6000	0.515	156.5	24.99	8430	369.2	214.6
7000	0.534	171.4	24.99	7946	407.3	246.3
8000	0.551	186.0	24.99	7544	445.1	278.5
9000	0.566	199.8	24.99	7215	481.3	309.8
10000	0.579	212.3	24.99	6952	514.6	339.1
15000	0.631	271.3	25.00	6027	676.3	485.7
20000	0.669	324.2	25.00	5479	828.0	627.9
25000	0.699	373.4	25.00	5107	975.2	768.5
30000	0.722	418.3	25.00	4846	1114.1	903.0
35000	0.742	461.2	25.00	4645	1251.3	1037.1
40000	0.760	504.1	25.00	4480	1392.9	1176.3
45000	0.774	544.7	25.00	4349	1530.8	1312.6
50000	0.787	583.3	25.00	4243	1665.6	1446.4
60000	0.810	662.4	25.00	4068	1952.2	1732.2
70000	0.828	733.7	25.00	3947	2223.2	2003.6
80000	0.843	805.1	25.00	3851	2506.0	2287.7
90000	0.856	874.3	25.00	3776	2791.9	2575.6
100000	0.867	943.6	25.00	3715	3089.3	2875.5
150000	0.906	1275.5	25.00	3541	4667.1	4471.8
200000	0.929	1593.1	25.00	3460	6416.8	6246.6
300000	0.955	2227.9	25.00	3423	10615.5	10511.5

MANGANESE CHARGE= 25 MASSNUMBER= 55

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.070	2.3	16.02	74069	4.7	0.3
50	0.108	5.5	19.85	63241	11.7	1.0
75	0.132	8.2	21.35	55437	17.7	1.8
100	0.149	10.6	22.17	49466	22.9	2.7
200	0.195	18.3	23.55	36824	39.9	6.4
300	0.224	24.4	24.05	30599	53.5	10.4
400	0.245	29.6	24.31	27020	65.1	14.3
500	0.263	34.1	24.46	24522	75.4	18.2
600	0.277	38.3	24.57	22608	84.9	22.2
700	0.291	42.4	24.64	21076	94.2	26.3
800	0.302	46.0	24.70	19922	102.3	30.0
900	0.313	49.5	24.74	18913	110.3	33.9
1000	0.322	52.7	24.77	18090	117.6	37.6
1500	0.360	67.5	24.87	15146	152.0	56.6
2000	0.390	80.7	24.92	13327	183.0	75.8
3000	0.433	102.4	24.96	11252	235.0	111.1
4000	0.465	121.8	24.97	9979	282.2	145.8
5000	0.492	139.2	24.98	9114	325.4	179.3
6000	0.513	154.8	24.99	8493	364.6	210.9
7000	0.532	169.6	24.99	8001	402.6	242.4
8000	0.549	184.0	24.99	7596	439.9	274.0
9000	0.564	197.5	24.99	7267	475.3	304.6
10000	0.576	210.0	24.99	6998	508.4	333.6
15000	0.629	268.3	25.00	6065	667.8	477.8
20000	0.667	320.5	25.00	5512	817.1	617.5
25000	0.696	369.2	25.00	5135	962.3	756.1
30000	0.720	413.3	25.00	4872	1098.5	887.9
35000	0.740	455.6	25.00	4669	1233.4	1019.5
40000	0.757	498.3	25.00	4501	1373.4	1157.1
45000	0.772	538.0	25.00	4369	1507.6	1289.7
50000	0.785	576.6	25.00	4260	1641.8	1422.8
60000	0.808	653.3	25.00	4086	1918.4	1698.5
70000	0.826	724.6	25.00	3961	2187.7	1968.0
80000	0.841	795.8	25.00	3862	2468.5	2250.0
90000	0.854	862.3	25.00	3788	2741.4	2524.7
100000	0.865	931.4	25.00	3725	3035.8	2821.5
150000	0.904	1258.1	25.00	3547	4578.0	4381.6
200000	0.927	1568.2	25.00	3463	6271.1	6098.7
300000	0.954	2192.7	25.00	3423	10358.7	10250.5

IRON CHARGE= 26 MASSNUMBER= 54

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.072	2.5	16.71	76776	5.0	0.3
50	0.111	5.9	20.68	65811	12.5	1.1
75	0.136	8.8	22.24	57529	18.9	2.0
100	0.153	11.2	23.07	51279	24.3	2.9
200	0.200	19.4	24.49	38112	42.3	7.1
300	0.230	25.9	25.02	31663	56.8	11.5
400	0.252	31.3	25.28	27977	69.0	15.8
500	0.270	36.1	25.44	25404	79.7	20.0
600	0.285	40.7	25.55	23409	90.2	24.4
700	0.298	44.8	25.63	21892	99.5	28.7
800	0.310	48.6	25.69	20656	108.3	33.0
900	0.320	52.2	25.73	19644	116.5	37.1
1000	0.330	55.7	25.76	18766	124.5	41.3
1500	0.369	71.4	25.87	15709	161.1	62.1
2000	0.399	85.0	25.91	13874	193.2	82.4
3000	0.443	108.5	25.95	11687	249.6	121.5
4000	0.476	128.6	25.97	10397	299.0	158.6
5000	0.503	147.2	25.98	9493	345.5	195.4
6000	0.525	163.9	25.99	8846	387.9	230.1
7000	0.544	179.7	25.99	8340	428.6	264.3
8000	0.561	194.8	25.99	7927	468.1	298.3
9000	0.575	208.8	25.99	7595	505.2	330.8
10000	0.589	222.6	25.99	7308	542.2	363.6
15000	0.641	284.8	26.00	6347	714.2	520.9
20000	0.680	340.6	26.00	5779	876.4	673.9
25000	0.709	392.2	26.00	5398	1032.7	824.1
30000	0.732	439.5	26.00	5128	1181.5	968.7
35000	0.753	486.4	26.00	4915	1334.0	1118.3
40000	0.769	530.4	26.00	4751	1481.9	1264.3
45000	0.784	573.5	26.00	4617	1630.8	1411.9
50000	0.797	614.2	26.00	4509	1775.8	1556.1
60000	0.819	697.6	26.00	4331	2084.4	1864.5
70000	0.837	775.1	26.00	4206	2385.7	2166.8
80000	0.851	849.0	26.00	4112	2686.1	2469.0
90000	0.864	925.7	26.00	4034	3011.3	2796.7
100000	0.875	1000.0	26.00	3974	3339.4	3128.0
150000	0.913	1355.7	26.00	3805	5087.2	4897.7
200000	0.934	1689.1	26.00	3729	6991.7	6830.2
300000	0.960	2401.9	26.00	3705	11930.3	11847.7

IRON CHARGE= 26 MASSNUMBER= 56

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.070	2.3	16.46	77569	4.8	0.3
50	0.109	5.6	20.51	66531	12.0	1.0
75	0.133	8.5	22.11	58370	18.2	1.9
100	0.151	10.9	22.97	52021	23.5	2.8
200	0.197	18.8	24.44	38732	41.1	6.8
300	0.227	25.2	24.98	32217	55.3	11.0
400	0.249	30.5	25.25	28442	67.3	15.1
500	0.267	35.2	25.42	25836	77.9	19.2
600	0.282	39.7	25.53	23807	88.0	23.5
700	0.295	43.8	25.61	22227	97.3	27.7
800	0.307	47.5	25.67	20990	105.8	31.7
900	0.317	51.1	25.72	19947	114.0	35.8
1000	0.327	54.5	25.75	19060	121.7	39.8
1500	0.366	69.8	25.86	15967	157.4	59.9
2000	0.395	83.2	25.91	14086	189.0	79.6
3000	0.439	106.1	25.95	11870	243.8	117.4
4000	0.472	125.7	25.97	10555	292.0	153.2
5000	0.498	144.0	25.98	9632	337.5	189.0
6000	0.520	160.6	25.98	8966	379.4	223.0
7000	0.539	175.7	25.99	8461	418.2	255.5
8000	0.556	190.2	25.99	8045	456.1	287.9
9000	0.571	204.4	25.99	7694	493.6	320.6
10000	0.584	217.8	25.99	7404	529.2	352.1
15000	0.637	278.9	26.00	6420	697.5	505.4
20000	0.675	332.9	26.00	5846	853.6	652.2
25000	0.704	383.3	26.00	5456	1005.2	797.5
30000	0.728	430.1	26.00	5177	1151.6	939.5
35000	0.748	474.7	26.00	4964	1295.6	1080.5
40000	0.765	517.7	26.00	4795	1438.8	1221.6
45000	0.780	561.0	26.00	4653	1587.1	1368.5
50000	0.792	599.3	26.00	4546	1722.4	1503.0
60000	0.815	680.6	26.00	4363	2020.0	1800.1
70000	0.832	755.2	26.00	4235	2306.9	2087.7
80000	0.847	827.6	26.00	4137	2597.9	2380.2
90000	0.860	903.1	26.00	4055	2914.2	2698.9
100000	0.871	973.0	26.00	3994	3218.4	3005.8
150000	0.909	1317.3	26.00	3816	4884.2	4691.8
200000	0.932	1642.6	26.00	3734	6710.7	6544.9
300000	0.958	2315.9	26.00	3703	11271.7	11178.3

COBALT CHARGE= 27 MASSNUMBER= 59

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.069	2.2	16.65	81744	4.6	0.3
50	0.108	5.5	20.99	70603	11.8	1.0
75	0.133	8.4	22.73	62090	18.0	1.9
100	0.151	10.8	23.67	55401	23.4	2.8
200	0.198	18.9	25.27	41287	41.3	6.8
300	0.228	25.4	25.66	34359	55.7	11.1
400	0.250	30.8	26.16	30348	67.8	15.3
500	0.268	35.5	26.34	27566	78.6	19.5
600	0.283	40.1	26.47	25398	88.8	23.9
700	0.297	44.2	26.56	23736	98.2	28.1
800	0.308	48.0	26.63	22407	106.9	32.3
900	0.319	51.6	26.68	21305	115.1	36.4
1000	0.328	55.0	26.72	20350	123.1	40.5
1500	0.368	70.6	26.84	17050	159.3	61.0
2000	0.397	84.1	26.89	15063	191.0	81.0
3000	0.441	107.3	26.94	12687	246.9	119.6
4000	0.474	127.3	26.96	11282	295.9	156.2
5000	0.501	145.9	26.97	10297	342.2	192.7
6000	0.523	162.5	26.98	9591	384.4	227.2
7000	0.542	178.0	26.99	9045	424.3	260.7
8000	0.559	192.9	26.99	8598	463.2	294.1
9000	0.573	207.0	26.99	8232	500.5	326.7
10000	0.587	220.8	26.99	7919	537.2	359.2
15000	0.640	282.6	27.00	6873	708.0	515.1
20000	0.678	337.7	27.00	6259	867.8	665.7
25000	0.707	389.0	27.00	5843	1022.8	814.5
30000	0.731	436.0	27.00	5550	1170.2	957.7
35000	0.751	482.3	27.00	5318	1320.5	1105.0
40000	0.768	525.7	27.00	5141	1465.8	1248.3
45000	0.783	568.8	27.00	4993	1614.4	1395.6
50000	0.795	608.7	27.00	4877	1755.8	1536.2
60000	0.818	691.2	27.00	4684	2060.3	1840.4
70000	0.835	767.7	27.00	4547	2356.2	2137.2
80000	0.850	841.0	27.00	4444	2653.0	2435.6
90000	0.863	917.3	27.00	4359	2975.1	2760.2
100000	0.874	990.0	27.00	4294	3294.3	3082.5
150000	0.911	1341.4	27.00	4107	5011.3	4820.7
200000	0.933	1671.8	27.00	4023	6886.6	6723.5
300000	0.959	2369.7	27.00	3995	11681.9	11595.3

NICKEL CHARGE= 28 MASSNUMBER= 58

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.071	2.4	17.31	84590	4.9	0.3
50	0.111	5.9	21.60	73253	12.5	1.1
75	0.137	8.9	23.61	64180	19.1	2.0
100	0.155	11.4	24.56	57306	24.7	3.0
200	0.203	20.0	26.22	42591	43.6	7.5
300	0.234	26.7	26.82	35521	58.7	12.1
400	0.256	32.5	27.13	31342	71.6	16.8
500	0.274	37.4	27.32	28476	82.9	21.3
600	0.291	42.3	27.46	26217	93.9	26.1
700	0.304	46.5	27.54	24570	103.4	30.6
800	0.316	50.5	27.61	23179	112.7	35.2
900	0.326	54.3	27.66	22042	121.4	39.6
1000	0.336	57.9	27.71	21074	129.6	44.0
1500	0.377	74.7	27.83	17599	168.8	66.8
2000	0.406	88.4	27.89	15620	201.3	87.8
3000	0.451	112.9	27.94	13166	260.5	129.5
4000	0.485	134.6	27.96	11682	313.9	170.2
5000	0.511	153.5	27.97	10704	361.4	208.2
6000	0.533	171.0	27.98	9977	406.2	245.4
7000	0.553	187.7	27.98	9405	449.6	282.3
8000	0.570	203.6	27.99	8944	491.3	318.6
9000	0.585	218.5	27.99	8567	531.2	353.8
10000	0.599	233.0	27.99	8248	570.2	388.8
15000	0.652	298.7	28.00	7173	754.0	558.0
20000	0.689	356.9	28.00	6548	925.1	720.5
25000	0.719	410.7	28.00	6129	1090.3	879.9
30000	0.742	461.2	28.00	5827	1251.4	1037.1
35000	0.762	510.7	28.00	5591	1415.2	1198.3
40000	0.779	558.9	28.00	5404	1579.9	1361.3
45000	0.793	602.2	28.00	5264	1732.8	1513.3
50000	0.807	648.7	28.00	5136	1901.4	1681.5
60000	0.828	734.0	28.00	4950	2224.2	2004.6
70000	0.845	816.2	28.00	4814	2551.4	2333.4
80000	0.860	900.2	28.00	4706	2901.6	2686.2
90000	0.872	978.4	28.00	4628	3242.5	3030.2
100000	0.883	1057.9	28.00	4563	3603.6	3395.1
150000	0.919	1436.8	28.00	4376	5526.7	5343.4
200000	0.940	1801.7	28.00	4311	7693.4	7542.8
300000	0.963	2536.7	28.00	4301	12996.4	12931.4

NICKEL CHARGE= 28 MASSNUMBER= 60

RANGE MICRONS	BETA V/C	ENERGY MEV/NUCL	EFF CHARGE	E-LOSS MEV/CM	EMAX DELTA KEV	RMAX DELTA MICRONS
25	0.069	2.3	17.05	85303	4.6	0.3
50	0.109	5.6	21.62	73984	12.0	1.0
75	0.134	8.6	23.47	65089	18.5	1.9
100	0.153	11.1	24.46	58055	24.0	2.9
200	0.201	19.5	26.15	43271	42.5	7.1
300	0.231	26.2	26.78	35989	57.5	11.7
400	0.254	31.7	27.10	31791	70.0	16.2
500	0.271	36.6	27.29	28913	81.0	20.5
600	0.288	41.4	27.43	26626	91.8	25.2
700	0.301	45.5	27.52	24931	101.2	29.5
800	0.313	49.5	27.60	23514	110.4	34.0
900	0.323	53.2	27.65	22375	118.8	38.2
1000	0.333	56.7	27.69	21384	126.9	42.5
1500	0.373	73.0	27.82	17883	164.9	64.4
2000	0.402	86.6	27.88	15842	197.1	85.0
3000	0.447	110.8	27.93	13340	255.3	125.7
4000	0.481	131.6	27.96	11858	306.5	164.5
5000	0.508	150.7	27.97	10835	354.3	202.4
6000	0.529	167.7	27.98	10106	397.5	238.1
7000	0.549	184.2	27.98	9517	440.4	274.4
8000	0.566	199.7	27.99	9049	481.1	309.7
9000	0.580	213.9	27.99	8677	518.9	342.9
10000	0.594	228.1	27.99	8351	557.0	376.9
15000	0.647	291.9	28.00	7263	734.5	539.8
20000	0.685	349.3	28.00	6618	902.4	698.7
25000	0.714	402.1	28.00	6188	1063.5	853.9
30000	0.738	451.1	28.00	5881	1218.8	1005.2
35000	0.758	500.0	28.00	5638	1379.2	1162.8
40000	0.775	545.7	28.00	5451	1534.3	1316.1
45000	0.789	589.1	28.00	5304	1685.9	1466.7
50000	0.802	632.7	28.00	5178	1843.0	1623.1
60000	0.824	717.3	28.00	4983	2159.7	1940.0
70000	0.842	798.6	28.00	4840	2479.9	2261.5
80000	0.856	876.4	28.00	4734	2800.7	2584.5
90000	0.868	954.5	28.00	4650	3136.8	2923.5
100000	0.879	1031.0	28.00	4583	3479.9	3270.1
150000	0.916	1404.3	28.00	4385	5348.8	5163.0
200000	0.937	1749.7	28.00	4317	7365.5	7209.8
300000	0.961	2475.7	28.00	4299	12509.2	12436.1

APPENDIX I

Constants for a standard emulsion	
Density	3.815 g/cm^3
Effective atomic number	35.8
Effective mass number	81.8
Electron density	$10.45 \cdot 10^{23}$ el./cm^3
Average electron binding energy	331 eV

APPENDIX II.

In this appendix some quantities which are generally useful in calculations on relativistic ions are given. The first column in the table below lists the kinetic energy per nucleon. The energy is linked to the other parameters by common relativistic dynamics.

Momentum

Starting from the relativistic invariant

$$E^2 = p^2c^2 + m_o^2c^4 \qquad \text{MeV}^2$$

the momentum p (MeV/c) of a proton with mass m_p (MeV) is given by

$$p = \frac{1}{c}\,(E^2 - m_p{}^2c^4)^{1/2} \qquad \text{MeV/c}$$

or

$$pc = (E^2 - m_p{}^2c^4)^{1/2} \qquad \text{MeV}.$$

Rigidity

The rigidity P(A,Z) (MV) of a heavy ion with mass number A and charge Z is given by

$$P(A,Z) = \frac{A}{Z} \cdot pc \qquad \text{MV} \quad .$$

The momentum times c can be found in column four.
A and Z for a certain ion can be found in the track parameter tables.

Magnetic curvature.

The magnetic curvature ρ (A,Z) (km) of a heavy ion with

mass number A and charge Z moving in a magnetic field, B, can be calculated from

$$\rho(A,Z) = \frac{3.33564}{B} \cdot P(A,Z) \cdot 10^3 \quad \text{km}$$

where B is the magnetic induction in gammas and P(A,Z) is the rigidity in MV.

(1 gamma = 10^{-5} gauss = 10^{-9} Tesla).

ENERGY	BETA	GAMMA	PC
MEV/NUCL	V/C		MEV
10	0.1448	1.0107	137.3
20	0.2032	1.0213	194.8
30	0.2470	1.0320	239.1
40	0.2830	1.0426	276.9
50	0.3141	1.0533	310.4
60	0.3415	1.0640	340.9
70	0.3661	1.0746	369.1
80	0.3885	1.0853	395.6
90	0.4091	1.0959	420.7
100	0.4282	1.1066	444.6
200	0.5662	1.2132	644.4
300	0.6526	1.3198	808.0
400	0.7131	1.4263	954.2
500	0.7579	1.5329	1090.0
600	0.7925	1.6395	1219.0
700	0.8198	1.7461	1342.9
800	0.8418	1.8527	1463.3
900	0.8599	1.9593	1580.7
1000	0.8750	2.0659	1696.0
1100	0.8878	2.1725	1809.4
1200	0.8986	2.2790	1921.4
1300	0.9079	2.3856	2032.1
1400	0.9160	2.4922	2141.7
1500	0.9230	2.5988	2250.5
1600	0.9292	2.7054	2358.4
1700	0.9346	2.8120	2465.7
1800	0.9395	2.9186	2572.5
1900	0.9438	3.0252	2678.6
2000	0.9476	3.1317	2784.4
2500	0.9620	3.6647	3307.7
3000	0.9712	4.1976	3824.8
3500	0.9774	4.7305	4337.9
4000	0.9818	5.2635	4848.3
4500	0.9850	5.7964	5356.7
5000	0.9874	6.3294	5863.6
6000	0.9908	7.3952	6874.5
7000	0.9930	8.4611	7882.6
8000	0.9945	9.5270	8888.8
9000	0.9955	10.5928	9893.8
10000	0.9963	11.6587	10897.9