

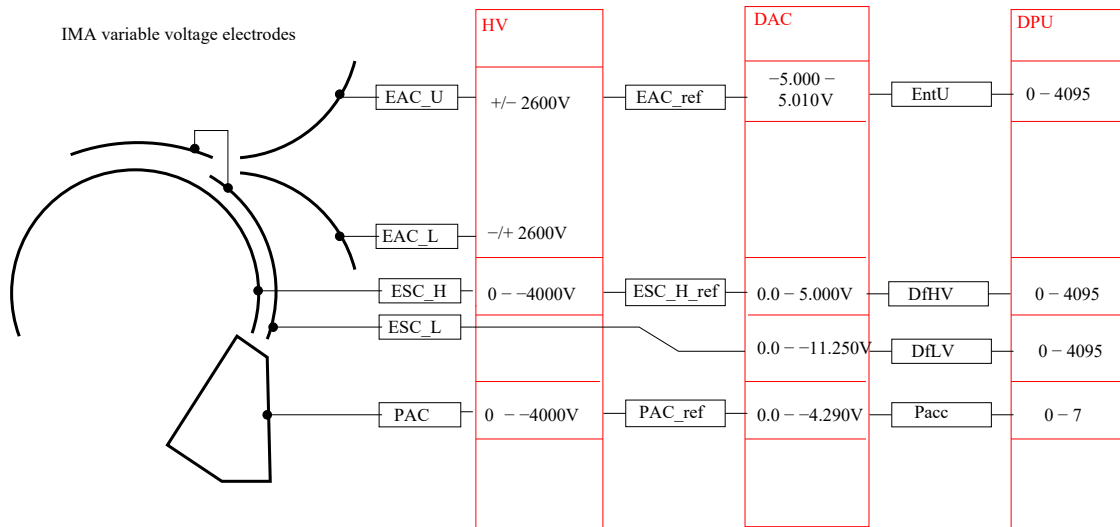
ICA Flight tables

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1 Notation

The general structure of variable voltages and system of notation is shown in figure below (ICA and IMA are equivalent):

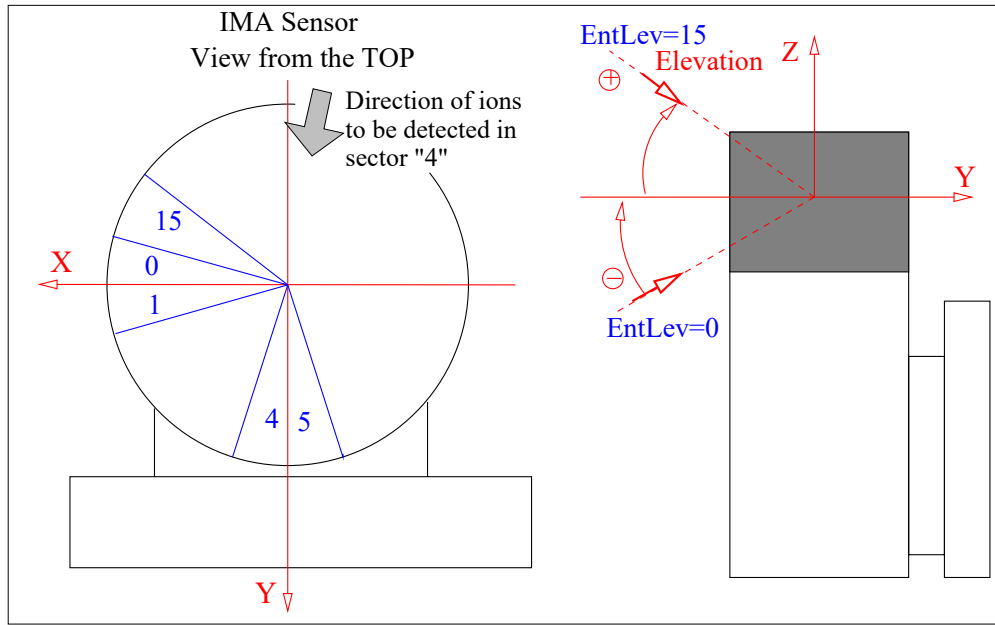


- EAC_U - voltage of the upper electrode of the scanner; EAC_ref, and EntU are reference voltage and digital reference respectively.
- EAC_L is the voltage of low electrode of scanner. It is controlled by the same references.
- ESC_H - voltage of the inner electrode of spherical analyzer (deflector) ESC_H_ref, and DfHV are reference voltage and digital reference respectively.
- ESC_L - low voltage at the outer electrode of the analyzer and top-hat; DfLV is corresponding digital reference.
- DfLV - number of energy step 0 - 95 (index of deflector voltage)
- EntLev - number of elevation angle 0 - 15 (index of voltage of entrance scanner)
- Pacc - digital reference of post-acceleration 0 - 7
- PacLev - number of PAC level 0 - 2
- LookUpN - number of mass row in the mass look-up table
- M0, M1 - low and high number of the mass rings of given mass spot in the mass look-up table (the interval includes these values). Negative 1 means absence of this mass, or overlapping with more significant mass.

2 Coordinate system

The physical location of the azimuthal sectors are shown in the page 2. This figure shows as well the coordinate system used in the present document. In particular the right panel shows the elevation

angles notation. The mass rings in the azimuthal sector is numbered from the center toward periphery. I.e. the very central ring is "0".



3 Inputs

1. Energy range of ICA is $E0 \rightarrow 40000eV/Q$. Here $E0$ is define by calibration from the scanner offset. See below. The range is divided into 96 energy steps uniformly in logarithmic scale. The energy less than $100eV/Q$ is controlled by ESC_L and energy greater than $100eV/Q$ is controlled by ESC_H.

Conversion factor DfHV \rightarrow ESC_H_ref is:

$$ESC_H_ref[mV] = -7.531 - 1.168 \cdot DfHV$$

Conversion factor DfLV \rightarrow ESC_L is

$$ESC_L[mV] = 10.140 - 2.728 \cdot DfLV$$

2. Conversion factor EntU \rightarrow EAC_ref is:

$$EAC_ref[mV] = 9.856 + 2.447 \cdot EntU$$

for $EntU \leq 2047$, and

$$EAC_ref[mV] = -10029.4 + 2.451 \cdot EntU$$

for $EntU > 2047$

3. Post-acceleration levels are chosen as follows:

PACLev	0	1	2
Pacc	0	3	6
RAC_ref[mV]	0.0	1869.0	3740.0

4. Masses resolved by the look-up table are chosen as follows:

LookUpN	0	1	2	3	4	5
Ion	H^+	$> O^+$	O^+	He^+	He^{++}	O^{++}
M/Q	1	32 (for calculations)	16	4	2	8

(Letter of Hans Nilsson from Feb. 5, 2002)

4 Calibration summary

1. In case of $ESC_L = 0.0$ the median ion energy is:

$$E/Q[V] = 52.0 - ESC_H_ref[mV] \cdot 8.536$$

For low energies if $ESC_H_ref = 0.0$:

$$E/Q[V] = E_{INT} + ESC_L[mV] \cdot 10.65 \cdot 10^{-3}$$

Here E_{INT} is the energy per charge calculated according to ESC_H_ref voltage.

2. The electrostatic scanner is characterized as follows:

$$El^\circ = -2.47 - 189.8 \cdot D + 7.31 \cdot D^2 - 289.2 \cdot D^3$$

here

$$D = \frac{EAC_ref[mV] - 15.9}{E/Q[V] - 16.0}$$

According to this formula, the minimum ions energy is 16eV/Q. The finite EAC_ref resolution and low energy limitation lead to impossibility to register particles less than

$$E_0 = 25eV/Q$$

energy. The extreme elevation angles are -39.0° and 41.0° . Dividing this range into 16 levels gives 5.4° angular resolution. FWHM of elevation response is about 5° , thus these two values correspond to each other. EAC HV converter is saturated when $EAC_ref < -2920mv$ and when $EAC_ref > 2950mv$. This corresponds to $EntU = 2900$ and $EntU = 1200$ respectively. See Table notes for more details.

3. Post-acceleration depends on the reference as follows:

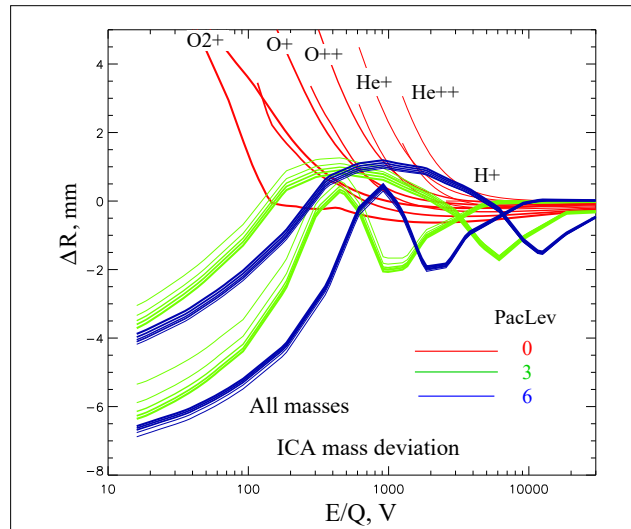
$$PAC[V] = -40.088 + 0.966 \cdot PAC_ref[mV]$$

Location of the mass-spot boundaries (at the FWHM) on the anode rings is described by:

$$M_0 = -6.019 + 2.523 \cdot G - 0.031 \cdot G^2 - \Delta R_{M_0}$$

$$M_1 = -2.902 + 2.780 \cdot G - 0.043 \cdot G^2 - \Delta R_{M_1}$$

Here $G = \frac{10^3}{\sqrt{(E/Q[V] + PAC[V]) \cdot M/Q}}$, M is the mass of the particle. ΔR is defined by diagram below.



5 Tables

Some important notes:

1. Energy steps are enumerated in energy increasing order. DfIL $v = 0$ means minimal energy and DfIL $v = 95$ means maximum energy.
2. Due to the finite EAC_ref step and due to asymmetry of EAC HV source:
 - (a) For low energy levels just a few randomly distributed angles are available. All available angles are grouped in clusters 2, 4, and 8 Elevation steps to allow make a correct averaging. Repeated EAC_ref are marked by "*" to be placed into "unreachable table".
 - (b) For high energy levels some elevations are unreachable. These elevations correspond to EntU greater than 1200 for positive EAC_ref and less than 2900 for negative EAC_ref. Target angles which demands unavailable EntU are replaced in table 2 for nearest available values and are marked by "*". Thus all bins marked "*" should be removed from a processed data stream.
3. For Look-up mass table:
 - (a) $M0 - M1 = "-1 - -1"$ means absence of this mass in the detector range;
 - (b) If low-significant mass (with the greater LookUpN) is overlapped for more than 30% with high-significant mass (with the less LookUpN) the $M0 - M1 = "-1 - -1"$ for the low-significant mass;
 - (c) The lowest M0 is shifted down to 0, and the highest M1 is shifted up to 31 to fill the margin gaps;
 - (d) The M1 of one mass spot and M0 of next mass spot are shifted toward each other to fill the intermediate gap.
4. To simplify the tables installation, each table in the text corresponds to the ASCII file delivered with the present document:
 - Table 1 — ICAEnTableV1.txt
 - Table 2 — ICAEITableV2.txt
 - Table 3 — ICALookUp0V1.txt
 - Table 4 — ICALookUp1V1.txt
 - Table 5 — ICALookUp2V1.txt

Table 1: Energy - DfHV, DfLV

DfIL v	DfLV	DfHV	ESC_L[mV]	ESC_H_ref[mV]	Eion[eV]
0	3489	1	-9507.9	-8.7	25.0
1	3419	1	-9316.9	-8.7	27.0
2	3344	1	-9112.3	-8.7	29.2
3	3263	1	-8891.3	-8.7	31.6
4	3175	1	-8651.3	-8.7	34.1
5	3080	1	-8392.1	-8.7	36.9
6	2978	1	-8113.8	-8.7	39.8
7	2867	1	-7811.0	-8.7	43.1
8	2747	1	-7483.7	-8.7	46.5

Table 1: continued

DfIL v	DfLV	DfHV	ESC_L[mV]	ESC_H_ref[mV]	Eion[eV]
9	2618	1	-7131.8	-8.7	50.3
10	2478	1	-6749.8	-8.7	54.4
11	2327	1	-6337.9	-8.7	58.7
12	2164	1	-5893.3	-8.7	63.5
13	1987	1	-5410.4	-8.7	68.6
14	1797	1	-4892.1	-8.7	74.1
15	1591	1	-4330.1	-8.7	80.1
16	1368	1	-3721.8	-8.7	86.6
17	1127	1	-3064.3	-8.7	93.6
18	867	1	-2355.0	-8.7	101.2
19	586	1	-1588.5	-8.7	109.3
20	282	1	-759.2	-8.7	118.2
21	282	2	-759.2	-9.9	128.1
22	282	3	-759.2	-11.0	138.1
23	282	4	-759.2	-12.2	148.1
24	282	5	-759.2	-13.4	158.0
25	282	7	-759.2	-15.7	178.0
26	282	8	-759.2	-16.9	188.0
27	282	10	-759.2	-19.2	207.9
28	282	11	-759.2	-20.4	217.9
29	282	13	-759.2	-22.7	237.8
30	282	15	-759.2	-25.1	257.7
31	282	17	-759.2	-27.4	277.7
32	282	19	-759.2	-29.7	297.6
33	282	22	-759.2	-33.2	327.5
34	282	24	-759.2	-35.6	347.5
35	282	27	-759.2	-39.1	377.4
36	282	30	-759.2	-42.6	407.3
37	282	34	-759.2	-47.2	447.2
38	282	37	-759.2	-50.7	477.1
39	282	41	-759.2	-55.4	517.0
40	282	45	-759.2	-60.1	556.8
41	282	50	-759.2	-65.9	606.7
42	282	55	-759.2	-71.8	656.5
43	282	60	-759.2	-77.6	706.4
44	282	66	-759.2	-84.6	766.2
45	282	72	-759.2	-91.6	826.0
46	282	78	-759.2	-98.6	885.9
47	282	86	-759.2	-108.0	965.6
48	282	93	-759.2	-116.2	1035.4
49	282	102	-759.2	-126.7	1125.1
50	282	111	-759.2	-137.2	1214.9
51	282	121	-759.2	-148.9	1314.6
52	282	131	-759.2	-160.5	1414.3

Table 1: continued

DfIL v	DfLV	DfHV	ESC_L[mV]	ESC_H_ref[mV]	Eion[eV]
53	282	143	-759.2	-174.6	1533.9
54	282	155	-759.2	-188.6	1653.5
55	282	169	-759.2	-204.9	1793.1
56	282	183	-759.2	-221.3	1932.7
57	282	199	-759.2	-240.0	2092.2
58	282	216	-759.2	-259.8	2261.7
59	282	234	-759.2	-280.8	2441.2
60	282	254	-759.2	-304.2	2640.6
61	282	275	-759.2	-328.7	2850.0
62	282	298	-759.2	-355.6	3079.3
63	282	323	-759.2	-384.8	3328.5
64	282	350	-759.2	-416.3	3597.7
65	282	380	-759.2	-451.4	3896.8
66	282	411	-759.2	-487.6	4205.9
67	282	445	-759.2	-527.3	4544.9
68	282	482	-759.2	-570.5	4913.8
69	282	522	-759.2	-617.2	5312.6
70	282	565	-759.2	-667.5	5741.3
71	282	611	-759.2	-721.2	6199.9
72	282	662	-759.2	-780.7	6708.4
73	282	716	-759.2	-843.8	7246.7
74	282	775	-759.2	-912.7	7835.0
75	282	838	-759.2	-986.3	8463.1
76	282	907	-759.2	-1066.9	9151.0
77	282	981	-759.2	-1153.3	9888.8
78	282	1061	-759.2	-1246.8	10686.4
79	282	1147	-759.2	-1347.2	11543.8
80	282	1241	-759.2	-1457.0	12481.0
81	282	1342	-759.2	-1575.0	13488.0
82	282	1451	-759.2	-1702.3	14574.7
83	282	1569	-759.2	-1840.1	15751.2
84	282	1697	-759.2	-1989.6	17027.4
85	282	1835	-759.2	-2150.8	18403.2
86	282	1984	-759.2	-2324.8	19888.8
87	282	2145	-759.2	-2512.9	21493.9
88	282	2319	-759.2	-2716.1	23228.7
89	282	2507	-759.2	-2935.7	25103.1
90	282	2710	-759.2	-3172.8	27127.0
91	282	2930	-759.2	-3429.8	29320.4
92	282	3167	-759.2	-3706.6	31683.3
93	282	3424	-759.2	-4006.8	34245.6
94	282	3701	-759.2	-4330.3	37007.3
95	282	4001	-759.2	-4680.7	39998.4

Table 2: Energy - Elevation - EntU

DfIL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	EntU El[deg] Remove	3 -30.6 *	3 -30.6 *	3 -30.6 *	3 -30.6 *	3 -30.6 *	3 -30.6 *	3 -30.6 *	3 -30.6 *	2 22.5	2 22.5 *	2 22.5 *	2 22.5 *	2 22.5 *	2 22.5 *	2 22.5 *	2 22.5 *
1	EntU El[deg] Remove	3 -25.2 *	3 -25.2 *	3 -25.2 *	3 -25.2 *	3 -25.2 *	3 -25.2 *	3 -25.2 *	3 -25.2 *	2 17.7	2 17.7 *	2 17.7 *	2 17.7 *	2 17.7 *	2 17.7 *	2 17.7 *	2 17.7 *
2	EntU El[deg] Remove	3 -21.3 *	3 -21.3 *	3 -21.3 *	3 -21.3 *	3 -21.3 *	3 -21.3 *	3 -21.3 *	3 -21.3 *	2 14.3	2 14.3 *	2 14.3 *	2 14.3 *	2 14.3 *	2 14.3 *	2 14.3 *	2 14.3 *
3	EntU El[deg] Remove	3 -18.4 *	3 -18.4 *	3 -18.4 *	3 -18.4 *	3 -18.4 *	3 -18.4 *	3 -18.4 *	3 -18.4 *	2 11.7	2 11.7 *	2 11.7 *	2 11.7 *	2 11.7 *	2 11.7 *	2 11.7 *	2 11.7 *
4	EntU El[deg] Remove	3 -16.1 *	3 -16.1 *	3 -16.1 *	3 -16.1 *	3 -16.1 *	3 -16.1 *	3 -16.1 *	3 -16.1 *	2 9.7	2 9.7 *	2 9.7 *	2 9.7 *	2 9.7 *	2 9.7 *	2 9.7 *	2 9.7 *
5	EntU El[deg] Remove	4 -38.0 *	4 -38.0 *	4 -38.0 *	4 -38.0 *	4 -38.0 *	4 -38.0 *	4 -38.0 *	3 -14.3	2 8.1	2 8.1 *	2 8.1 *	2 8.1 *	1 31.9	1 31.9 *	1 31.9 *	1 31.9 *
6	EntU El[deg] Remove	4 -33.2 *	4 -33.2 *	4 -33.2 *	4 -33.2 *	4 -33.2 *	4 -33.2 *	4 -33.2 *	3 -12.8	2 6.7	2 6.7 *	2 6.7 *	2 6.7 *	1 27.3	1 27.3 *	1 27.3 *	1 27.3 *
7	EntU El[deg] Remove	4 -29.4 *	4 -29.4 *	4 -29.4 *	4 -29.4 *	4 -29.4 *	4 -29.4 *	4 -29.4 *	3 -11.6	2 5.6	2 5.6 *	2 5.6 *	2 5.6 *	1 23.6	1 23.6 *	1 23.6 *	1 23.6 *
8	EntU El[deg] Remove	4 -26.2 *	4 -26.2 *	4 -26.2 *	4 -26.2 *	4 -26.2 *	4 -26.2 *	4 -26.2 *	3 -10.5	2 4.7	2 4.7 *	2 4.7 *	2 4.7 *	1 20.5	1 20.5 *	1 20.5 *	1 20.5 *
9	EntU El[deg] Remove	5 -38.2 *	5 -38.2 *	5 -38.2 *	5 -38.2 *	5 -38.2 *	5 -38.2 *	5 -38.2 *	4 -23.5	2 3.9	2 3.9 *	2 3.9 *	2 3.9 *	0 32.8	0 32.8 *	0 32.8 *	0 32.8 *
10	EntU El[deg] Remove	5 -34.1 *	5 -34.1 *	5 -34.1 *	5 -34.1 *	5 -34.1 *	5 -34.1 *	5 -34.1 *	4 -21.2	2 3.2	2 3.2 *	2 3.2 *	2 3.2 *	0 28.7	0 28.7 *	0 28.7 *	0 28.7 *
11	EntU El[deg] Remove	5 -30.7 *	5 -30.7 *	5 -30.7 *	5 -30.7 *	5 -30.7 *	5 -30.7 *	5 -30.7 *	4 -19.2	2 2.6	2 2.6 *	2 2.6 *	2 2.6 *	0 25.3	0 25.3 *	0 25.3 *	0 25.3 *
12	EntU	6	6	5	5	4	4	3	3	2	2	1	1	0	0	4095	4095

Table 2: continued

DfIL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	El[deg] Remove	-38.5 *	-38.5	-27.7 *	-27.7	-17.5 *	-17.5	-7.7 *	-7.7	2.1	2.1	12.1	12.1	22.4	22.4	33.2	33.2 *
13	EntU El[deg] Remove	6 -34.7 *	6 -34.7	5 -25.2 *	5 -25.2	4 -16.0 *	4 -16.0	3 -7.1 *	3 -7.1	2 1.7	2 1.7	1 10.6	1 10.6	0 19.9	0 19.9	4095 29.4	4095 29.4 *
14	EntU El[deg] Remove	7 -40.4 *	7 -40.4	6 -31.5 *	6 -31.5	5 -22.9 *	5 -22.9	4 -14.7	4 -14.7	2 1.3	2 1.3	1 17.7	1 17.7	0 4095	0 4095	4094 35.3	4094 35.3 *
15	EntU El[deg] Remove	7 -36.6 *	7 -36.6	6 -28.6 *	6 -28.6	5 -21.0 *	5 -21.0	4 -13.6	4 -13.6	2 0.9	2 0.9	1 15.7	1 15.7	0 4095	0 4095	4094 31.4	4094 31.4 *
16	EntU El[deg] Remove	8 -40.6 *	8 -40.6	7 -33.2 *	7 -33.2	6 -26.1 *	6 -26.1	5 -19.3	5 -19.3	2 0.6	2 0.6	1 14.0	1 14.0	0 4094	0 4094	4093 35.7	4093 35.7 *
17	EntU El[deg] Remove	8 -36.9 *	8 -36.9	7 -30.3 *	7 -30.3	6 -23.9 *	6 -23.9	5 -17.7	5 -17.7	2 0.3	2 0.3	1 12.5	1 12.5	0 4094	0 4094	4093 31.9	4093 31.9 *
18	EntU El[deg] Remove	9 -39.7 *	9 -39.7	8 -33.6 *	8 -33.6	7 -27.7 *	7 -27.7	6 -21.9	6 -21.9	2 0.1	2 0.1	1 11.1	1 11.1	0 4094	0 4094	4092 34.9	4092 34.9 *
19	EntU El[deg] Remove	9 -36.2 *	9 -36.2	8 -30.7 *	8 -30.7	7 -25.4 *	7 -25.4	6 -19.1	6 -19.1	1 4.9	1 4.9	0 9.9	0 9.9	0 4093	0 4093	4091 37.1	4091 37.1 *
20	EntU El[deg] Remove	10 -38.2 *	10 -38.2	9 -28.2 *	9 -28.2	8 -23.3 *	8 -23.3	7 -18.6	7 -18.6	2 4.2	2 4.2	1 13.5	1 13.5	0 4093	0 4093	4090 38.7	4090 38.7
21	EntU El[deg] Remove	11 -39.4 *	11 -39.4	10 -30.2 *	10 -30.2	9 -21.4 *	9 -21.4	8 -17.2	8 -17.2	1 3.6	1 3.6	0 16.3	0 16.3	0 4092	0 4092	4089 34.7	4089 34.7
22	EntU El[deg] Remove	12 -40.5 *	12 -40.5	11 -27.8 *	11 -27.8	10 -23.8 *	10 -23.8	9 -18.3	9 -18.3	2 3.1	2 3.1	1 10.8	1 10.8	0 4091	0 4091	4088 40.3	4088 40.3
23	EntU El[deg] Remove	12 -37.3 *	12 -37.3	11 -29.6 *	11 -29.6	10 -22.2 *	10 -22.2	9 -18.5	9 -18.5	2 2.7	2 2.7	1 9.8	1 9.8	0 4090	0 4090	4087 41.0	4087 41.0
24	EntU El[deg]	13 -38.4	13 -38.4	12 -27.6	12 -27.6	11 -24.1	11 -24.1	10 -17.4	10 -17.4	2 2.3	2 2.3	1 8.9	1 8.9	0 4089	0 4089	4086 41.5	4086 41.5

Table 2: continued

DfIL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Remove																
25	EntU	15	13	11	10	8	6	4	2	0	4095	4093	4091	4089	4088	4086	4084
	El[deg]	-40.1	-33.6	-27.4	-24.4	-18.4	-12.6	-6.9	-1.1	4.6	7.5	13.4	19.4	25.7	28.9	35.5	42.4
	Remove																
26	EntU	15	14	12	10	8	6	4	2	0	4094	4092	4090	4089	4087	4085	4084
	El[deg]	-37.7	-34.7	-28.8	-23.1	-17.5	-12.0	-6.6	-1.2	4.2	9.7	15.3	21.0	23.9	30.0	36.2	39.5
	Remove																
27	EntU	17	15	13	11	9	7	4	2	0	4094	4092	4090	4087	4086	4084	4082
	El[deg]	-39.2	-33.8	-28.5	-23.4	-18.4	-13.5	-6.2	-1.3	3.5	8.4	13.4	18.5	26.3	29.1	34.6	40.4
	Remove																
28	EntU	18	16	13	11	9	7	4	2	0	4094	4091	4089	4087	4085	4083	4081
	El[deg]	-39.9	-34.7	-27.2	-22.3	-17.6	-12.9	-6.0	-1.4	3.2	7.9	15.0	19.8	24.8	30.0	35.3	40.8
	Remove																
29	EntU	19	17	15	12	10	7	5	2	0	4093	4091	4088	4086	4083	4081	4079
	El[deg]	-38.6	-33.9	-29.3	-22.7	-18.4	-12.0	-7.8	-1.5	2.7	9.0	13.4	20.0	24.5	31.6	36.5	41.5
	Remove																
30	EntU	21	18	16	13	10	8	5	2	4095	4093	4090	4087	4085	4082	4080	4077
	El[deg]	-39.7	-33.2	-29.1	-23.0	-17.0	-13.1	-7.3	-1.6	4.2	8.1	14.0	20.1	24.3	30.7	35.2	42.1
	Remove																
31	EntU	22	20	17	14	11	8	5	2	4095	4092	4089	4086	4084	4081	4078	4076
	El[deg]	-38.7	-34.7	-28.8	-23.2	-17.7	-12.3	-7.0	-1.6	3.7	9.1	14.6	20.2	24.1	30.0	36.2	40.5
	Remove																
32	EntU	24	21	18	15	12	8	5	2	4095	4092	4088	4085	4082	4079	4077	4074
	El[deg]	-39.6	-34.0	-28.7	-23.4	-18.3	-11.6	-6.6	-1.7	3.2	8.3	15.1	20.3	25.7	31.3	35.1	41.0
	Remove																
33	EntU	26	23	19	16	13	9	6	2	4094	4091	4087	4084	4081	4077	4074	4071
	El[deg]	-39.1	-34.1	-27.6	-22.9	-18.3	-12.2	-7.7	-1.8	4.2	8.7	14.9	19.6	24.5	31.2	36.4	41.8
	Remove																
34	EntU	27	24	21	17	13	9	6	2	4094	4090	4087	4083	4080	4076	4073	4070
	El[deg]	-38.3	-33.6	-29.0	-23.1	-17.3	-11.6	-7.4	-1.8	3.8	9.5	13.8	19.7	24.3	30.6	35.4	40.5
	Remove																
35	EntU	30	26	22	18	14	10	6	2	4094	4090	4086	4082	4078	4074	4070	4067
	El[deg]	-39.5	-33.7	-28.1	-22.7	-17.4	-12.2	-7.0	-1.9	3.3	8.5	13.8	19.2	24.8	30.5	36.5	41.2
	Remove																
36	EntU	32	28	24	20	15	11	6	2	4093	4089	4085	4080	4076	4072	4068	4064
	El[deg]	-39.1	-33.8	-28.6	-23.6	-17.4	-12.6	-6.7	-1.9	4.0	8.9	13.7	20.0	25.2	30.5	36.0	41.7
	Remove																

Table 2: continued

37	DfL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		EntU	35	31	26	21	16	12	7	2	4093	4088	4083	4078	4074	4069	4065	4061
		El[deg]	-39.1	-34.2	-28.4	-22.7	-17.1	-12.8	-7.3	-2.0	3.4	8.9	14.5	20.1	24.8	30.9	35.9	41.1
		Remove																
38		EntU	37	32	28	23	17	12	7	2	4092	4087	4082	4077	4072	4067	4063	4058
		El[deg]	-38.8	-33.1	-28.8	-23.4	-17.2	-12.1	-7.0	-2.0	4.1	9.2	14.4	19.7	25.2	30.8	35.5	41.6
		Remove																
39		EntU	40	35	30	24	19	13	7	2	4092	4086	4081	4075	4070	4065	4060	4055
		El[deg]	-38.8	-33.6	-28.6	-22.7	-17.9	-12.3	-6.7	-2.0	3.5	9.2	14.0	19.8	24.9	30.1	35.4	41.0
		Remove																
40		EntU	43	38	32	26	20	14	8	2	4091	4085	4079	4073	4068	4062	4057	4051
		El[deg]	-38.8	-34.0	-28.4	-22.9	-17.6	-12.4	-7.2	-2.1	4.0	9.2	14.5	20.0	24.6	30.4	35.4	41.6
		Remove																
41		EntU	47	41	35	28	22	15	8	1	4091	4084	4077	4071	4065	4059	4053	4047
		El[deg]	-39.0	-33.8	-28.6	-22.8	-17.9	-12.3	-6.8	-1.3	3.4	9.0	14.7	19.7	24.8	30.1	35.5	41.2
		Remove																
42		EntU	51	44	37	30	23	16	9	1	4090	4083	4076	4069	4062	4055	4049	4043
		El[deg]	-39.2	-33.6	-28.0	-22.7	-17.5	-12.3	-7.2	-1.4	3.7	8.8	14.1	19.4	24.9	30.6	35.7	40.9
		Remove																
43		EntU	54	47	40	33	25	17	9	1	4089	4082	4074	4066	4059	4052	4045	4038
		El[deg]	-38.7	-33.4	-28.3	-23.3	-17.7	-12.3	-6.9	-1.5	3.9	8.7	14.2	19.9	25.0	30.3	35.8	41.5
		Remove																
44		EntU	59	51	43	35	27	18	10	1	4089	4080	4072	4064	4056	4048	4040	4033
		El[deg]	-39.0	-33.5	-28.1	-22.9	-17.8	-12.1	-7.1	-1.6	3.4	9.1	14.2	19.4	24.8	30.3	36.1	41.3
		Remove																
45		EntU	64	55	47	38	29	20	10	1	4088	4079	4070	4061	4052	4044	4036	4028
		El[deg]	-39.4	-33.6	-28.6	-23.1	-17.8	-12.5	-6.8	-1.6	3.5	8.8	14.1	19.6	25.2	30.3	35.6	41.1
		Remove																
46		EntU	68	59	50	40	31	21	11	1	4087	4077	4068	4058	4049	4040	4031	4023
		El[deg]	-39.0	-33.6	-28.4	-22.8	-17.8	-12.4	-7.0	-1.7	3.7	9.1	14.1	19.7	24.9	30.3	35.9	41.0
		Remove																
47		EntU	74	64	54	44	33	23	12	1	4086	4075	4065	4054	4044	4034	4025	4016
		El[deg]	-39.0	-33.5	-28.2	-23.1	-17.5	-12.5	-7.1	-1.8	3.6	9.1	14.2	19.8	25.2	30.6	35.7	41.0
		Remove																
48		EntU	79	69	58	47	36	24	12	1	4085	4074	4062	4051	4040	4030	4020	4010
		El[deg]	-38.9	-33.8	-28.3	-23.0	-17.8	-12.3	-6.8	-1.8	3.7	8.8	14.4	19.7	25.2	30.3	35.5	41.0
		Remove																
49		EntU	86	75	63	51	38	26	13	1	4084	4071	4059	4047	4035	4024	4013	4002

Table 2: continued

DfIL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	El[deg] Remove	-39.0	-33.8	-28.4	-23.1	-17.4	-12.3	-6.9	-1.9	3.6	9.1	14.3	19.6	25.1	30.2	35.6	41.1
50	EntU El[deg] Remove	93 -39.1	81 -33.9	68 -28.4	55 -23.1	41 -17.5	28 -12.4	14 -6.9	0 -1.5	4083 3.5	4069 9.0	4056 14.2	4043 19.6	4030 25.0	4018 30.2	4006 35.6	3994 41.2
51	EntU El[deg] Remove	100 -38.9	87 -33.7	73 -28.2	59 -23.0	45 -17.8	30 -12.3	15 -7.0	0 -1.6	4082 3.4	4067 8.9	4052 14.4	4038 19.7	4024 25.1	4011 30.4	3998 35.7	3986 40.9
52	EntU El[deg] Remove	108 -39.1	94 -33.9	79 -28.5	63 -22.8	48 -17.7	32 -12.3	16 -7.0	0 -1.6	4080 3.7	4064 9.1	4049 14.2	4034 19.5	4019 24.9	4004 30.5	3990 35.9	3977 41.1
53	EntU El[deg] Remove	117 -39.1	101 -33.6	85 -28.3	69 -23.1	52 -17.7	35 -12.4	17 -6.9	0 -1.7	4079 3.5	4061 9.1	4045 14.2	4028 19.6	4012 25.0	3996 30.4	3981 35.8	3967 40.9
54	EntU El[deg] Remove	126 -39.1	109 -33.7	92 -28.4	74 -23.0	56 -17.8	37 -12.3	18 -6.9	0 -1.8	4077 3.6	4059 8.8	4040 14.4	4022 19.8	4005 25.0	3988 30.4	3972 35.7	3956 41.1
55	EntU El[deg] Remove	136 -38.9	118 -33.6	99 -28.2	80 -23.0	60 -17.6	40 -12.3	20 -7.1	0 -1.8	4075 3.7	4055 9.0	4035 14.4	4016 19.6	3997 25.0	3979 30.3	3961 35.7	3944 41.1
56	EntU El[deg] Remove	147 -39.1	127 -33.6	107 -28.4	86 -23.0	65 -17.7	43 -12.3	21 -7.0	4095 -1.6	4073 3.7	4052 8.9	4030 14.4	4009 19.8	3989 25.0	3969 30.5	3950 35.8	3932 41.0
57	EntU El[deg] Remove	159 -39.1	138 -33.8	116 -28.4	93 -23.0	70 -17.7	46 -12.2	23 -7.1	4095 -1.7	4071 3.7	4048 8.9	4025 14.2	4002 19.7	3980 25.0	3958 30.5	3938 35.7	3918 41.1
58	EntU El[deg] Remove	172 -39.1	149 -33.8	125 -28.4	100 -22.9	75 -17.6	50 -12.3	24 -6.9	4095 -1.8	4069 3.6	4044 8.9	4019 14.2	3994 19.7	3970 25.1	3947 30.4	3925 35.7	3903 41.2
59	EntU El[deg] Remove	185 -39.0	160 -33.6	135 -28.4	108 -22.9	81 -17.6	54 -12.4	26 -7.0	4094 -1.6	4067 3.6	4039 9.0	4012 14.4	3986 19.6	3960 25.0	3935 30.4	3911 35.7	3888 41.0
60	EntU El[deg] Remove	200 -39.0	173 -33.6	145 -28.2	117 -23.0	88 -17.7	58 -12.3	28 -7.0	4094 -1.7	4064 3.7	4035 8.9	4005 14.3	3977 19.6	3949 24.9	3921 30.5	3895 35.8	3870 41.2
61	EntU El[deg]	216 -39.0	187 -33.7	157 -28.4	126 -23.0	94 -17.6	62 -12.2	30 -7.0	4094 -1.7	4061 3.7	4029 9.0	3998 14.3	3967 19.6	3937 25.0	3907 30.5	3879 35.8	3852 41.1

Table 2: continued

DfIL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Remove																
62	EntU	233	202	169	136	102	67	32	4093	4059	4024	3990	3956	3923	3892	3861	3832
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.7	-12.3	-6.9	-1.6	3.5	8.9	14.2	19.7	25.1	30.4	35.8	41.1
	Remove																
63	EntU	252	218	183	147	110	73	35	4093	4055	4018	3981	3945	3909	3875	3842	3811
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.4	-7.0	-1.7	3.6	8.9	14.3	19.6	25.1	30.4	35.8	41.0
	Remove																
64	EntU	272	236	198	159	119	78	38	4093	4052	4011	3971	3932	3894	3857	3821	3787
	El[deg]	-39.0	-33.7	-28.4	-23.0	-17.7	-12.3	-7.1	-1.8	3.6	9.0	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
65	EntU	295	255	214	172	128	85	40	4092	4048	4004	3961	3918	3877	3837	3798	3761
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.4	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
66	EntU	318	275	231	185	138	91	43	4092	4044	3996	3950	3904	3859	3816	3774	3734
	El[deg]	-39.0	-33.7	-28.4	-23.0	-17.6	-12.3	-7.0	-1.8	3.6	9.0	14.3	19.6	25.1	30.4	35.8	41.1
	Remove																
67	EntU	344	297	249	200	149	98	47	4091	4039	3988	3938	3888	3840	3793	3748	3705
	El[deg]	-39.1	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.7	9.0	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
68	EntU	372	321	269	216	161	106	50	4090	4035	3979	3925	3871	3819	3768	3719	3673
	El[deg]	-39.1	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	9.0	14.2	19.7	25.0	30.4	35.8	41.1
	Remove																
69	EntU	402	347	291	233	174	115	54	4090	4029	3970	3910	3852	3796	3741	3689	3638
	El[deg]	-39.1	-33.7	-28.3	-23.0	-17.6	-12.4	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.7	41.1
	Remove																
70	EntU	434	375	314	252	188	124	58	4089	4024	3959	3895	3833	3771	3712	3655	3601
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.6	25.1	30.4	35.8	41.1
	Remove																
71	EntU	468	405	339	272	203	133	63	4088	4018	3948	3879	3811	3745	3681	3620	3561
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.1	30.4	35.8	41.1
	Remove																
72	EntU	507	438	367	294	220	144	68	4087	4011	3936	3861	3788	3716	3647	3580	3517
	El[deg]	-39.1	-33.7	-28.3	-23.0	-17.7	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.6	25.1	30.4	35.8	41.1
	Remove																
73	EntU	547	473	396	318	237	156	73	4087	4004	3922	3842	3763	3685	3611	3539	3470
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.4	-7.0	-1.7	3.6	9.0	14.3	19.6	25.1	30.4	35.8	41.1
	Remove																

Table 2: continued

DfL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
74	EntU	592	512	429	343	256	168	79	4086	3996	3908	3821	3735	3652	3571	3493	3419
	El[deg]	-39.1	-33.7	-28.4	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
75	EntU	639	552	463	371	277	181	85	4085	3988	3893	3799	3706	3616	3529	3445	3365
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.7	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	41.0
	Remove																
76	EntU	691	597	500	401	299	196	92	4083	3979	3876	3774	3674	3577	3482	3391	3305
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
77	EntU	747	645	540	433	323	212	99	4082	3970	3858	3748	3640	3535	3432	3334	3241
	El[deg]	-39.1	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
78	EntU	807	697	584	468	349	228	107	4081	3959	3839	3720	3603	3489	3379	3273	3171
	El[deg]	-39.1	-33.7	-28.3	-23.0	-17.7	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
79	EntU	871	753	631	505	377	247	115	4079	3948	3818	3689	3563	3440	3321	3206	3097
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.7	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	41.1
	Remove																
80	EntU	942	814	682	546	407	266	124	4078	3936	3795	3656	3519	3386	3258	3134	3016
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.1	30.4	35.8	41.0
	Remove																
81	EntU	1018	880	737	590	440	288	134	4076	3923	3770	3620	3473	3329	3190	3056	2928
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.7	-12.3	-7.0	-1.7	3.6	9.0	14.3	19.6	25.0	30.4	35.8	41.1
	Remove																
82	EntU	1100	950	796	637	475	311	145	4074	3909	3744	3582	3422	3267	3116	2972	2972
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	30.4	35.8	35.8
	Remove																*
83	EntU	1188	1027	860	688	513	336	156	4072	3893	3715	3540	3368	3200	3037	3037	3037
	El[deg]	-39.0	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	9.0	14.3	19.6	25.0	30.4	30.4	30.4
	Remove															*	*
84	EntU	1110	1110	929	744	555	363	169	4070	3877	3684	3495	3308	3127	2951	2951	2951
	El[deg]	-33.7	-33.7	-28.3	-23.0	-17.7	-12.3	-7.0	-1.7	3.6	9.0	14.3	19.7	25.0	30.4	30.4	30.4
	Remove	*														*	*
85	EntU	1200	1200	1004	804	599	392	182	4068	3859	3651	3446	3244	3048	3048	3048	3048
	El[deg]	-33.7	-33.7	-28.3	-23.0	-17.6	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	25.0	25.0	25.0
	Remove	*													*	*	*
86	EntU	1085	1085	1085	869	648	423	197	4066	3839	3615	3393	3175	2963	2963	2963	2963

Table 2: continued

DfL v	Param	EntLev: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	El[deg] Remove	-28.3 *	-28.3 *	-28.3	-23.0	-17.7	-12.3	-7.0	-1.7	3.6	8.9	14.3	19.7	25.0	25.0 *	25.0 *	25.0 *
87	EntU El[deg] Remove	1173 -28.3 *	1173 -28.3 *	1173 -28.3	939 -23.0	700 -17.7	457 -12.3	213 -7.0	4063 -1.7	3818 3.6	3576 8.9	3336 14.3	3101 19.7	3101 19.7 *	3101 19.7 *	3101 19.7 *	3101 19.7 *
88	EntU El[deg] Remove	1014 -23.0 *	1014 -23.0 *	1014 -23.0 *	1014 -23.0	756 -17.6	494 -12.3	230 -7.0	4060 -1.7	3796 3.6	3533 8.9	3274 14.3	3020 19.7	3020 19.7 *	3020 19.7 *	3020 19.7 *	3020 19.7 *
89	EntU El[deg] Remove	1096 -23.0 *	1096 -23.0 *	1096 -23.0 *	1096 -23.0	817 -17.6	534 -12.3	248 -7.0	4057 -1.7	3771 3.6	3488 8.9	3208 14.3	2933 19.7	2933 19.7 *	2933 19.7 *	2933 19.7 *	2933 19.7 *
90	EntU El[deg] Remove	1184 -23.0 *	1184 -23.0 *	1184 -23.0 *	1184 -23.0	883 -17.7	577 -12.3	268 -7.0	4054 -1.7	3745 3.6	3438 9.0	3136 14.3	3136 14.3 *	3136 14.3 *	3136 14.3 *	3136 14.3 *	3136 14.3 *
91	EntU El[deg] Remove	954 -17.6 *	954 -17.6 *	954 -17.6 *	954 -17.6	954 -17.6	623 -12.3	289 -7.0	4050 -1.7	3716 3.6	3385 8.9	3058 14.3	3058 14.3 *	3058 14.3 *	3058 14.3 *	3058 14.3 *	3058 14.3 *
92	EntU El[deg] Remove	1031 -17.7 *	1031 -17.7 *	1031 -17.7 *	1031 -17.7	1031 -17.7	673 -12.3	312 -7.0	4046 -1.7	3686 3.6	3328 8.9	2974 14.3	2974 14.3 *	2974 14.3 *	2974 14.3 *	2974 14.3 *	2974 14.3 *
93	EntU El[deg] Remove	1114 -17.7 *	1114 -17.7 *	1114 -17.7 *	1114 -17.7	1114 -17.7	727 -12.3	337 -7.0	4042 -1.7	3652 3.6	3265 8.9	3265 8.9 *	3265 8.9 *	3265 8.9 *	3265 8.9 *	3265 8.9 *	3265 8.9 *
94	EntU El[deg] Remove	786 -12.3 *	786 -12.3 *	786 -12.3 *	786 -12.3	786 -12.3	786 -12.3	364 -7.0	4037 -1.7	3616 3.6	3198 8.9	3198 8.9 *	3198 8.9 *	3198 8.9 *	3198 8.9 *	3198 8.9 *	3198 8.9 *
95	EntU El[deg] Remove	849 -12.3 *	849 -12.3 *	849 -12.3 *	849 -12.3	849 -12.3	849 -12.3	394 -7.0	4033 -1.7	3577 3.6	3125 8.9	3125 8.9 *	3125 8.9 *	3125 8.9 *	3125 8.9 *	3125 8.9 *	3125 8.9 *

Table 3: Energy - mass look-up table for PacLev = 0

PacLev	LookUpN Dfil v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
0	0	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1
0	1	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1
0	2	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1
0	3	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1	-1 --1
0	4	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	5	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	6	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	7	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	8	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	9	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	10	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	11	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	12	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	13	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	14	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	15	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	16	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	17	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	18	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	19	-1 --1	0 -31	-1 --1	-1 --1	-1 --1	-1 --1
0	20	-1 --1	0 -26	27 -31	-1 --1	-1 --1	-1 --1
0	21	-1 --1	0 -26	27 -31	-1 --1	-1 --1	-1 --1
0	22	-1 --1	0 -25	26 -31	-1 --1	-1 --1	-1 --1
0	23	-1 --1	0 -25	26 -31	-1 --1	-1 --1	-1 --1
0	24	-1 --1	0 -24	25 -31	-1 --1	-1 --1	-1 --1
0	25	-1 --1	0 -23	24 -31	-1 --1	-1 --1	-1 --1
0	26	-1 --1	0 -23	24 -31	-1 --1	-1 --1	-1 --1
0	27	-1 --1	0 -22	23 -31	-1 --1	-1 --1	-1 --1
0	28	-1 --1	0 -22	23 -31	-1 --1	-1 --1	-1 --1
0	29	-1 --1	0 -21	22 -31	-1 --1	-1 --1	-1 --1
0	30	-1 --1	0 -21	22 -27	-1 --1	-1 --1	28 -31
0	31	-1 --1	0 -20	21 -26	-1 --1	-1 --1	27 -31
0	32	-1 --1	0 -20	21 -26	-1 --1	-1 --1	27 -31
0	33	-1 --1	0 -19	20 -25	-1 --1	-1 --1	26 -31
0	34	-1 --1	0 -19	20 -24	-1 --1	-1 --1	25 -31
0	35	-1 --1	0 -18	19 -24	-1 --1	-1 --1	25 -31
0	36	-1 --1	0 -17	18 -23	-1 --1	-1 --1	24 -31
0	37	-1 --1	0 -17	18 -23	-1 --1	-1 --1	24 -31
0	38	-1 --1	0 -16	17 -22	-1 --1	-1 --1	23 -31
0	39	-1 --1	0 -16	17 -21	-1 --1	-1 --1	22 -31
0	40	-1 --1	0 -15	16 -21	28 -31	-1 --1	22 -27
0	41	-1 --1	0 -14	15 -20	27 -31	-1 --1	21 -26
0	42	-1 --1	0 -14	15 -20	27 -31	-1 --1	21 -26

Table 3: continued

PacLev	LookUpN DfIL v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
0	43	-1 - -1	0 - 13	14 - 19	26 - 31	-1 - -1	20 - 25
0	44	-1 - -1	0 - 13	14 - 18	26 - 31	-1 - -1	19 - 25
0	45	-1 - -1	0 - 12	13 - 18	25 - 31	-1 - -1	19 - 24
0	46	-1 - -1	0 - 12	13 - 17	24 - 31	-1 - -1	18 - 23
0	47	-1 - -1	0 - 11	12 - 16	24 - 31	-1 - -1	17 - 23
0	48	-1 - -1	0 - 11	12 - 16	23 - 31	-1 - -1	17 - 22
0	49	-1 - -1	0 - 10	11 - 15	22 - 28	29 - 31	16 - 21
0	50	-1 - -1	0 - 10	11 - 15	22 - 28	29 - 31	16 - 21
0	51	-1 - -1	0 - 9	10 - 14	21 - 27	28 - 31	15 - 20
0	52	-1 - -1	0 - 9	10 - 14	20 - 26	27 - 31	15 - 19
0	53	-1 - -1	0 - 8	9 - 13	20 - 26	27 - 31	14 - 19
0	54	-1 - -1	0 - 8	9 - 12	19 - 25	26 - 31	13 - 18
0	55	-1 - -1	0 - 8	9 - 12	18 - 24	25 - 31	13 - 17
0	56	-1 - -1	0 - 7	8 - 11	18 - 24	25 - 31	12 - 17
0	57	-1 - -1	0 - 7	8 - 11	17 - 23	24 - 31	12 - 16
0	58	-1 - -1	0 - 6	7 - 10	16 - 22	23 - 31	11 - 15
0	59	-1 - -1	0 - 6	7 - 10	16 - 21	22 - 31	11 - 15
0	60	-1 - -1	0 - 6	7 - 9	15 - 21	22 - 31	10 - 14
0	61	29 - 31	0 - 5	6 - 9	15 - 20	21 - 28	10 - 14
0	62	28 - 31	0 - 5	6 - 8	14 - 19	20 - 27	9 - 13
0	63	27 - 31	0 - 5	6 - 8	13 - 18	19 - 26	9 - 12
0	64	26 - 31	0 - 4	5 - 7	13 - 18	19 - 25	8 - 12
0	65	25 - 31	0 - 4	5 - 7	12 - 17	18 - 24	8 - 11
0	66	24 - 31	0 - 4	5 - 7	12 - 16	17 - 23	8 - 11
0	67	23 - 31	0 - 3	4 - 6	11 - 16	17 - 22	7 - 10
0	68	23 - 31	0 - 5	-1 - -1	11 - 15	16 - 22	6 - 10
0	69	22 - 31	0 - 4	-1 - -1	10 - 14	15 - 21	5 - 9
0	70	21 - 31	0 - 4	-1 - -1	10 - 14	15 - 20	5 - 9
0	71	20 - 31	0 - 4	-1 - -1	9 - 13	14 - 19	5 - 8
0	72	20 - 31	0 - 3	-1 - -1	9 - 12	13 - 19	4 - 8
0	73	19 - 31	0 - 3	-1 - -1	8 - 12	13 - 18	4 - 7
0	74	18 - 31	0 - 3	-1 - -1	8 - 11	12 - 17	4 - 7
0	75	17 - 31	0 - 2	-1 - -1	8 - 11	12 - 16	3 - 7
0	76	17 - 31	0 - 2	-1 - -1	7 - 10	11 - 16	3 - 6
0	77	16 - 31	0 - 2	-1 - -1	7 - 10	11 - 15	3 - 6
0	78	15 - 31	0 - 2	-1 - -1	6 - 9	10 - 14	3 - 5
0	79	15 - 31	0 - 1	-1 - -1	6 - 9	10 - 14	2 - 5
0	80	14 - 31	0 - 1	-1 - -1	6 - 8	9 - 13	2 - 5
0	81	13 - 31	0 - 1	-1 - -1	5 - 8	9 - 12	2 - 4
0	82	13 - 31	0 - 1	-1 - -1	5 - 7	8 - 12	2 - 4
0	83	12 - 31	0 - 1	-1 - -1	5 - 7	8 - 11	2 - 4
0	84	12 - 31	0 - 0	-1 - -1	4 - 7	8 - 11	1 - 3
0	85	11 - 31	0 - 0	-1 - -1	4 - 6	7 - 10	1 - 3

Table 3: continued

PacLev	LookUpN DfIL v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
0	86	11 - 31	0 - 1	-1 - -1	2 - 6	7 - 10	-1 - -1
0	87	10 - 31	0 - 1	-1 - -1	2 - 5	6 - 9	-1 - -1
0	88	10 - 31	0 - 1	-1 - -1	2 - 5	6 - 9	-1 - -1
0	89	9 - 31	0 - 1	-1 - -1	2 - 5	6 - 8	-1 - -1
0	90	9 - 31	0 - 0	-1 - -1	1 - 4	5 - 8	-1 - -1
0	91	8 - 31	0 - 0	-1 - -1	1 - 4	5 - 7	-1 - -1
0	92	8 - 31	-1 - -1	0 - 0	1 - 4	5 - 7	-1 - -1
0	93	7 - 31	-1 - -1	0 - 0	1 - 3	4 - 6	-1 - -1
0	94	6 - 31	-1 - -1	0 - 0	1 - 5	-1 - -1	-1 - -1
0	95	5 - 31	-1 - -1	0 - 0	1 - 4	-1 - -1	-1 - -1

Table 4: Energy - mass look-up table for PacLev = 1

PacLev	LookUpN DfIL v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
1	0	-1 - -1	0 - 14	-1 - -1	23 - 29	30 - 31	15 - 22
1	1	-1 - -1	0 - 14	-1 - -1	23 - 29	30 - 31	15 - 22
1	2	-1 - -1	0 - 14	-1 - -1	23 - 29	30 - 31	15 - 22
1	3	-1 - -1	0 - 14	-1 - -1	23 - 29	30 - 31	15 - 22
1	4	-1 - -1	0 - 14	-1 - -1	23 - 29	30 - 31	15 - 22
1	5	-1 - -1	0 - 14	-1 - -1	23 - 29	30 - 31	15 - 22
1	6	-1 - -1	0 - 14	-1 - -1	23 - 29	30 - 31	15 - 22
1	7	-1 - -1	0 - 14	-1 - -1	22 - 28	29 - 31	15 - 21
1	8	-1 - -1	0 - 14	-1 - -1	22 - 28	29 - 31	15 - 21
1	9	-1 - -1	0 - 13	-1 - -1	22 - 28	29 - 31	14 - 21
1	10	-1 - -1	0 - 13	-1 - -1	22 - 28	29 - 31	14 - 21
1	11	-1 - -1	0 - 13	-1 - -1	22 - 28	29 - 31	14 - 21
1	12	-1 - -1	0 - 13	-1 - -1	22 - 28	29 - 31	14 - 21
1	13	-1 - -1	0 - 13	-1 - -1	22 - 28	29 - 31	14 - 21
1	14	-1 - -1	0 - 13	-1 - -1	21 - 27	28 - 31	14 - 20
1	15	-1 - -1	0 - 13	-1 - -1	21 - 27	28 - 31	14 - 20
1	16	-1 - -1	0 - 12	-1 - -1	21 - 27	28 - 31	13 - 20
1	17	-1 - -1	0 - 12	-1 - -1	21 - 27	28 - 31	13 - 20
1	18	-1 - -1	0 - 12	-1 - -1	21 - 27	28 - 31	13 - 20
1	19	-1 - -1	0 - 12	-1 - -1	20 - 26	27 - 31	13 - 19
1	20	-1 - -1	0 - 12	-1 - -1	20 - 26	27 - 31	13 - 19
1	21	-1 - -1	0 - 11	-1 - -1	20 - 26	27 - 31	12 - 19
1	22	-1 - -1	0 - 11	-1 - -1	20 - 26	27 - 31	12 - 19
1	23	-1 - -1	0 - 11	-1 - -1	20 - 25	26 - 31	12 - 19
1	24	-1 - -1	0 - 11	-1 - -1	19 - 25	26 - 31	12 - 18
1	25	-1 - -1	0 - 10	-1 - -1	19 - 25	26 - 31	11 - 18
1	26	-1 - -1	0 - 10	-1 - -1	19 - 25	26 - 31	11 - 18
1	27	-1 - -1	0 - 10	-1 - -1	18 - 24	25 - 31	11 - 17

Table 4: continued

PacLev	LookUpN Dfil v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
1	28	-1 - -1	0 - 10	-1 - -1	18 - 24	25 - 31	11 - 17
1	29	-1 - -1	0 - 9	-1 - -1	18 - 24	25 - 31	10 - 17
1	30	-1 - -1	0 - 9	-1 - -1	18 - 24	25 - 31	10 - 17
1	31	-1 - -1	0 - 9	-1 - -1	17 - 23	24 - 31	10 - 16
1	32	-1 - -1	0 - 9	-1 - -1	17 - 23	24 - 31	10 - 16
1	33	-1 - -1	0 - 6	7 - 10	17 - 23	24 - 31	11 - 16
1	34	-1 - -1	0 - 6	7 - 10	17 - 23	24 - 31	11 - 16
1	35	-1 - -1	0 - 6	7 - 10	17 - 22	23 - 31	11 - 16
1	36	-1 - -1	0 - 6	7 - 10	16 - 22	23 - 31	11 - 15
1	37	-1 - -1	0 - 6	7 - 10	16 - 22	23 - 31	11 - 15
1	38	-1 - -1	0 - 6	7 - 10	16 - 22	23 - 31	11 - 15
1	39	-1 - -1	0 - 6	7 - 10	16 - 22	23 - 31	11 - 15
1	40	-1 - -1	0 - 8	-1 - -1	16 - 22	23 - 31	9 - 15
1	41	-1 - -1	0 - 8	-1 - -1	16 - 22	23 - 31	9 - 15
1	42	-1 - -1	0 - 8	-1 - -1	16 - 22	23 - 31	9 - 15
1	43	-1 - -1	0 - 8	-1 - -1	16 - 22	23 - 31	9 - 15
1	44	-1 - -1	0 - 8	-1 - -1	16 - 21	22 - 31	9 - 15
1	45	30 - 31	0 - 8	-1 - -1	16 - 21	22 - 29	9 - 15
1	46	30 - 31	0 - 8	-1 - -1	16 - 21	22 - 29	9 - 15
1	47	30 - 31	0 - 8	-1 - -1	16 - 21	22 - 29	9 - 15
1	48	30 - 31	0 - 8	-1 - -1	15 - 21	22 - 29	9 - 14
1	49	29 - 31	0 - 8	-1 - -1	15 - 21	22 - 28	9 - 14
1	50	29 - 31	0 - 8	-1 - -1	15 - 20	21 - 28	9 - 14
1	51	28 - 31	0 - 7	-1 - -1	15 - 20	21 - 27	8 - 14
1	52	28 - 31	0 - 7	-1 - -1	14 - 20	21 - 27	8 - 13
1	53	28 - 31	0 - 7	-1 - -1	14 - 19	20 - 27	8 - 13
1	54	27 - 31	0 - 7	-1 - -1	14 - 19	20 - 26	8 - 13
1	55	27 - 31	0 - 6	-1 - -1	13 - 18	19 - 26	7 - 12
1	56	26 - 31	0 - 6	-1 - -1	13 - 18	19 - 25	7 - 12
1	57	26 - 31	0 - 6	-1 - -1	13 - 18	19 - 25	7 - 12
1	58	25 - 31	0 - 6	-1 - -1	12 - 17	18 - 24	7 - 11
1	59	25 - 31	0 - 6	-1 - -1	12 - 17	18 - 24	7 - 11
1	60	24 - 31	0 - 5	-1 - -1	12 - 16	17 - 23	6 - 11
1	61	24 - 31	0 - 5	-1 - -1	12 - 16	17 - 23	6 - 11
1	62	23 - 31	0 - 5	-1 - -1	11 - 16	17 - 22	6 - 10
1	63	23 - 31	0 - 5	-1 - -1	11 - 15	16 - 22	6 - 10
1	64	22 - 31	0 - 3	4 - 6	11 - 15	16 - 21	7 - 10
1	65	22 - 31	0 - 3	4 - 6	10 - 14	15 - 21	7 - 9
1	66	21 - 31	0 - 3	4 - 5	10 - 14	15 - 20	6 - 9
1	67	21 - 31	0 - 3	4 - 5	10 - 14	15 - 20	6 - 9
1	68	20 - 31	0 - 2	3 - 5	10 - 13	14 - 19	6 - 9
1	69	20 - 31	0 - 2	3 - 5	9 - 13	14 - 19	6 - 8
1	70	19 - 31	0 - 2	3 - 5	9 - 12	13 - 18	6 - 8

Table 4: continued

PacLev	LookUpN DflL v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
1	71	19 - 31	0 - 2	3 - 4	9 - 12	13 - 18	5 - 8
1	72	18 - 31	0 - 2	3 - 4	8 - 11	12 - 17	5 - 7
1	73	17 - 31	0 - 2	3 - 4	8 - 11	12 - 16	5 - 7
1	74	17 - 31	0 - 1	2 - 3	7 - 10	11 - 16	4 - 6
1	75	16 - 31	0 - 1	2 - 3	7 - 10	11 - 15	4 - 6
1	76	16 - 31	0 - 2	-1 - -1	7 - 10	11 - 15	3 - 6
1	77	15 - 31	0 - 2	-1 - -1	6 - 9	10 - 14	3 - 5
1	78	14 - 31	0 - 1	-1 - -1	6 - 9	10 - 13	2 - 5
1	79	14 - 31	0 - 1	-1 - -1	6 - 8	9 - 13	2 - 5
1	80	13 - 31	0 - 1	-1 - -1	5 - 8	9 - 12	2 - 4
1	81	13 - 31	0 - 1	-1 - -1	5 - 7	8 - 12	2 - 4
1	82	12 - 31	0 - 1	-1 - -1	5 - 7	8 - 11	2 - 4
1	83	12 - 31	0 - 0	-1 - -1	4 - 6	7 - 11	1 - 3
1	84	11 - 31	0 - 0	-1 - -1	4 - 6	7 - 10	1 - 3
1	85	11 - 31	0 - 0	-1 - -1	4 - 6	7 - 10	1 - 3
1	86	10 - 31	0 - 0	-1 - -1	4 - 5	6 - 9	1 - 3
1	87	10 - 31	0 - 1	-1 - -1	2 - 5	6 - 9	-1 - -1
1	88	9 - 31	0 - 1	-1 - -1	2 - 5	6 - 8	-1 - -1
1	89	9 - 31	0 - 0	-1 - -1	1 - 4	5 - 8	-1 - -1
1	90	8 - 31	-1 - -1	0 - 1	2 - 4	5 - 7	-1 - -1
1	91	8 - 31	-1 - -1	0 - 1	2 - 4	5 - 7	-1 - -1
1	92	8 - 31	-1 - -1	0 - 0	1 - 3	4 - 7	-1 - -1
1	93	7 - 31	-1 - -1	0 - 0	1 - 3	4 - 6	-1 - -1
1	94	7 - 31	-1 - -1	0 - 0	1 - 3	4 - 6	-1 - -1
1	95	5 - 31	-1 - -1	0 - 0	1 - 4	-1 - -1	-1 - -1

Table 5: Energy - mass look-up table for PacLev = 2

PacLev	LookUpN DflL v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
2	0	-1 - -1	0 - 11	-1 - -1	18 - 23	24 - 31	12 - 17
2	1	-1 - -1	0 - 11	-1 - -1	18 - 23	24 - 31	12 - 17
2	2	31 - 31	0 - 11	-1 - -1	18 - 23	24 - 30	12 - 17
2	3	31 - 31	0 - 11	-1 - -1	18 - 23	24 - 30	12 - 17
2	4	31 - 31	0 - 11	-1 - -1	18 - 23	24 - 30	12 - 17
2	5	31 - 31	0 - 11	-1 - -1	18 - 23	24 - 30	12 - 17
2	6	31 - 31	0 - 10	-1 - -1	18 - 23	24 - 30	11 - 17
2	7	31 - 31	0 - 10	-1 - -1	18 - 22	23 - 30	11 - 17
2	8	31 - 31	0 - 10	-1 - -1	17 - 22	23 - 30	11 - 16
2	9	31 - 31	0 - 10	-1 - -1	17 - 22	23 - 30	11 - 16
2	10	31 - 31	0 - 10	-1 - -1	17 - 22	23 - 30	11 - 16
2	11	30 - 31	0 - 10	-1 - -1	17 - 22	23 - 29	11 - 16
2	12	30 - 31	0 - 10	-1 - -1	17 - 22	23 - 29	11 - 16

Table 5: continued

PacLev	LookUpN Dfil v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
2	13	30 - 31	0 - 10	-1 - -1	17 - 22	23 - 29	11 - 16
2	14	30 - 31	0 - 10	-1 - -1	17 - 22	23 - 29	11 - 16
2	15	30 - 31	0 - 10	-1 - -1	17 - 22	23 - 29	11 - 16
2	16	30 - 31	0 - 10	-1 - -1	17 - 22	23 - 29	11 - 16
2	17	30 - 31	0 - 9	-1 - -1	16 - 21	22 - 29	10 - 15
2	18	30 - 31	0 - 9	-1 - -1	16 - 21	22 - 29	10 - 15
2	19	29 - 31	0 - 9	-1 - -1	16 - 21	22 - 28	10 - 15
2	20	29 - 31	0 - 12	-1 - -1	13 - 21	22 - 28	-1 - -1
2	21	29 - 31	0 - 11	-1 - -1	12 - 21	22 - 28	-1 - -1
2	22	29 - 31	0 - 11	-1 - -1	12 - 21	22 - 28	-1 - -1
2	23	29 - 31	0 - 11	-1 - -1	12 - 21	22 - 28	-1 - -1
2	24	29 - 31	0 - 11	-1 - -1	12 - 20	21 - 28	-1 - -1
2	25	28 - 31	0 - 11	-1 - -1	12 - 20	21 - 27	-1 - -1
2	26	28 - 31	0 - 11	-1 - -1	12 - 20	21 - 27	-1 - -1
2	27	28 - 31	0 - 10	-1 - -1	11 - 20	21 - 27	-1 - -1
2	28	28 - 31	0 - 10	-1 - -1	11 - 20	21 - 27	-1 - -1
2	29	28 - 31	0 - 10	-1 - -1	11 - 19	20 - 27	-1 - -1
2	30	27 - 31	0 - 10	-1 - -1	11 - 19	20 - 26	-1 - -1
2	31	27 - 31	0 - 10	-1 - -1	11 - 19	20 - 26	-1 - -1
2	32	27 - 31	0 - 9	-1 - -1	10 - 19	20 - 26	-1 - -1
2	33	27 - 31	0 - 9	-1 - -1	10 - 18	19 - 26	-1 - -1
2	34	26 - 31	0 - 9	-1 - -1	10 - 18	19 - 25	-1 - -1
2	35	26 - 31	0 - 6	-1 - -1	13 - 18	19 - 25	7 - 12
2	36	26 - 31	0 - 6	-1 - -1	13 - 18	19 - 25	7 - 12
2	37	25 - 31	0 - 6	-1 - -1	13 - 17	18 - 24	7 - 12
2	38	25 - 31	0 - 5	-1 - -1	12 - 17	18 - 24	6 - 11
2	39	25 - 31	0 - 5	-1 - -1	12 - 17	18 - 24	6 - 11
2	40	25 - 31	0 - 5	-1 - -1	12 - 16	17 - 24	6 - 11
2	41	24 - 31	0 - 5	-1 - -1	12 - 16	17 - 23	6 - 11
2	42	24 - 31	0 - 5	-1 - -1	11 - 16	17 - 23	6 - 10
2	43	24 - 31	0 - 4	-1 - -1	11 - 16	17 - 23	5 - 10
2	44	24 - 31	0 - 4	-1 - -1	11 - 16	17 - 23	5 - 10
2	45	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	46	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	47	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	48	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	49	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	50	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	51	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	52	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	53	23 - 31	0 - 4	-1 - -1	11 - 15	16 - 22	5 - 10
2	54	23 - 31	0 - 7	-1 - -1	8 - 15	16 - 22	-1 - -1
2	55	22 - 31	0 - 7	-1 - -1	8 - 15	16 - 21	-1 - -1

Table 5: continued

PacLev	LookUpN Dfil v	0 H^+	1 $> O^+$	2 0^+	3 He^+	4 He^{++}	5 O^{++}
2	56	22 - 31	0 - 7	-1 - -1	8 - 15	16 - 21	-1 - -1
2	57	22 - 31	0 - 6	-1 - -1	7 - 14	15 - 21	-1 - -1
2	58	22 - 31	0 - 6	-1 - -1	7 - 14	15 - 21	-1 - -1
2	59	21 - 31	0 - 6	-1 - -1	7 - 14	15 - 20	-1 - -1
2	60	21 - 31	0 - 6	-1 - -1	7 - 14	15 - 20	-1 - -1
2	61	21 - 31	0 - 6	-1 - -1	7 - 13	14 - 20	-1 - -1
2	62	20 - 31	0 - 4	-1 - -1	9 - 13	14 - 19	5 - 8
2	63	20 - 31	0 - 3	-1 - -1	9 - 13	14 - 19	4 - 8
2	64	19 - 31	0 - 3	-1 - -1	9 - 12	13 - 18	4 - 8
2	65	19 - 31	0 - 3	-1 - -1	9 - 12	13 - 18	4 - 8
2	66	19 - 31	0 - 3	-1 - -1	8 - 12	13 - 18	4 - 7
2	67	18 - 31	0 - 3	-1 - -1	8 - 11	12 - 17	4 - 7
2	68	18 - 31	0 - 3	-1 - -1	8 - 11	12 - 17	4 - 7
2	69	17 - 31	0 - 2	-1 - -1	8 - 11	12 - 16	3 - 7
2	70	17 - 31	0 - 2	-1 - -1	7 - 10	11 - 16	3 - 6
2	71	16 - 31	0 - 2	-1 - -1	7 - 10	11 - 15	3 - 6
2	72	16 - 31	0 - 2	-1 - -1	7 - 10	11 - 15	3 - 6
2	73	16 - 31	0 - 2	-1 - -1	7 - 10	11 - 15	3 - 6
2	74	15 - 31	0 - 2	-1 - -1	7 - 9	10 - 14	3 - 6
2	75	15 - 31	0 - 2	-1 - -1	6 - 9	10 - 14	3 - 5
2	76	15 - 31	0 - 2	-1 - -1	6 - 9	10 - 14	3 - 5
2	77	14 - 31	0 - 1	-1 - -1	6 - 8	9 - 13	2 - 5
2	78	14 - 31	0 - 0	1 - 2	6 - 8	9 - 13	3 - 5
2	79	13 - 31	0 - 0	1 - 2	5 - 8	9 - 12	3 - 4
2	80	13 - 31	0 - 0	1 - 2	5 - 8	9 - 12	3 - 4
2	81	12 - 31	0 - 1	-1 - -1	5 - 7	8 - 11	2 - 4
2	82	12 - 31	0 - 1	-1 - -1	5 - 7	8 - 11	2 - 4
2	83	11 - 31	0 - 0	-1 - -1	4 - 6	7 - 10	1 - 3
2	84	11 - 31	0 - 0	-1 - -1	4 - 6	7 - 10	1 - 3
2	85	10 - 31	0 - 0	-1 - -1	4 - 6	7 - 9	1 - 3
2	86	10 - 31	0 - 0	-1 - -1	4 - 5	6 - 9	1 - 3
2	87	10 - 31	0 - 0	-1 - -1	3 - 5	6 - 9	1 - 2
2	88	9 - 31	0 - 0	-1 - -1	3 - 5	6 - 8	1 - 2
2	89	9 - 31	-1 - -1	0 - 1	2 - 4	5 - 8	-1 - -1
2	90	8 - 31	-1 - -1	0 - 1	2 - 4	5 - 7	-1 - -1
2	91	8 - 31	-1 - -1	0 - 1	2 - 4	5 - 7	-1 - -1
2	92	7 - 31	-1 - -1	0 - 0	1 - 3	4 - 6	-1 - -1
2	93	7 - 31	-1 - -1	0 - 0	1 - 3	4 - 6	-1 - -1
2	94	7 - 31	-1 - -1	0 - 0	1 - 3	4 - 6	-1 - -1
2	95	5 - 31	-1 - -1	0 - 0	1 - 4	-1 - -1	-1 - -1