



VARSKIN 6



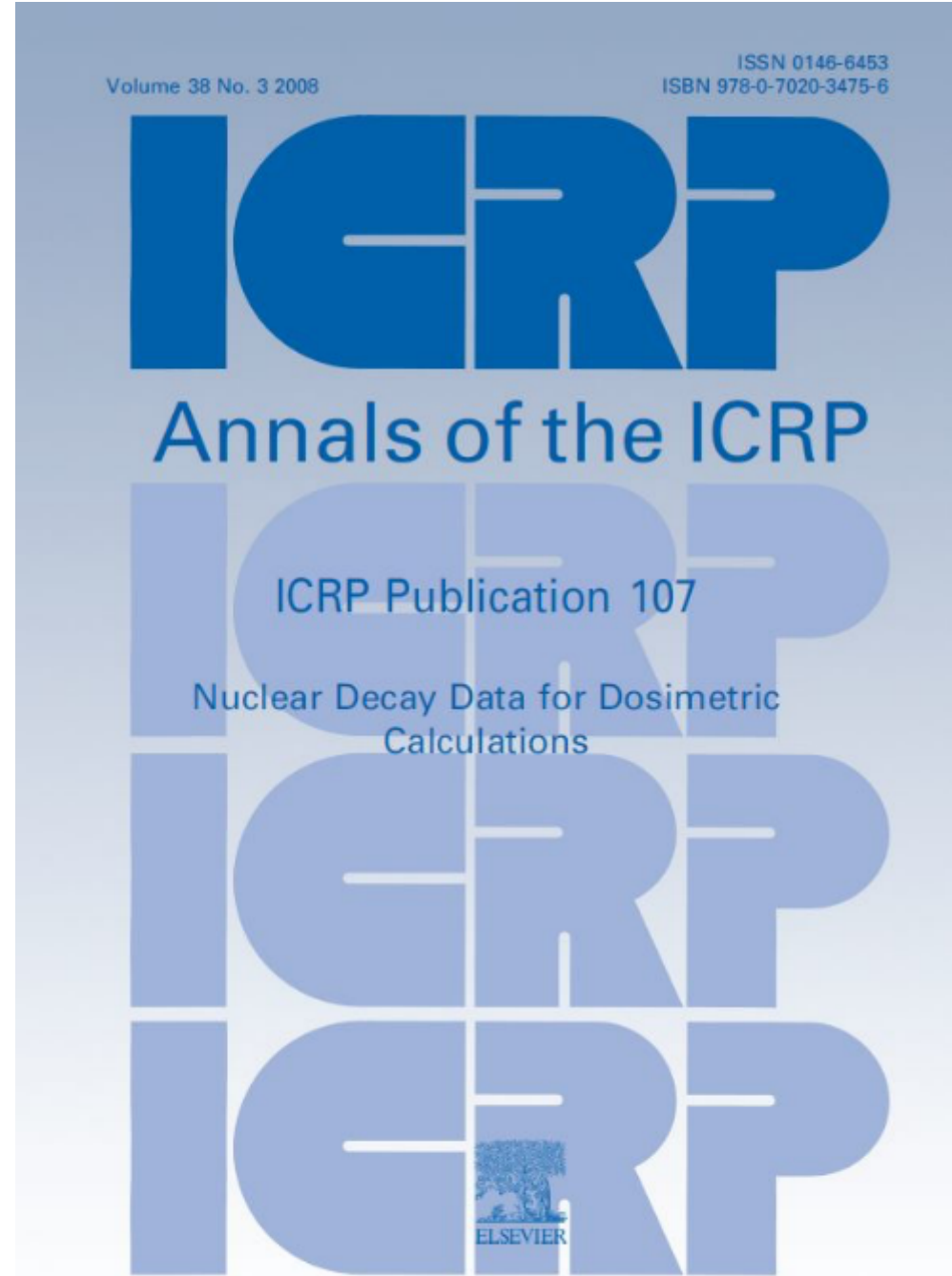
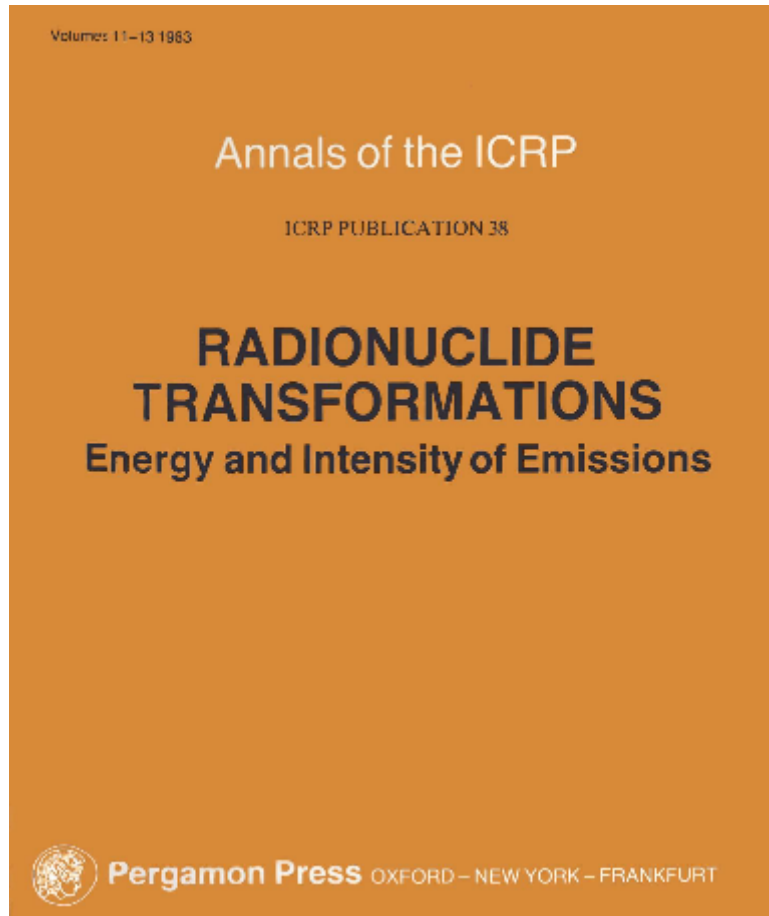
Outline

- ICRP 107 Decay Data
- Progeny Inclusion
- Minor Changes

VARSKIN 6

ICRP 107

Decay Data



ICRP 107

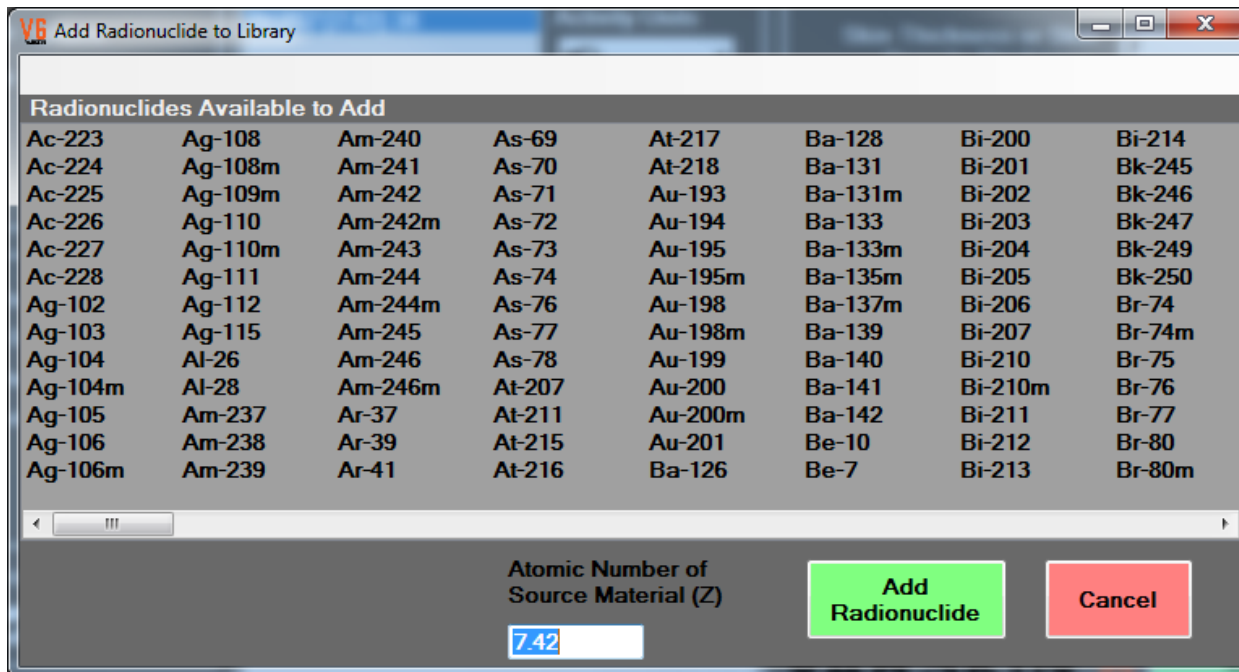
- 1252 radionuclides
- .NDX file
 - entrance into the larger radiation (RAD) and spectral (BET) files. The NDX file
 - contains one record for each nuclide
 - contains progeny info
- .RAD file
 - data on the energy and yield of each radiation emitted in nuclear transformations of the radionuclide
- .BET file
 - contains the beta spectrum for each beta emitter of the ICRP-07 collection

ICRP 38

- 838 radionuclides
- .IDX file
 - entrance into the larger radiation (DAT) and spectral (BET) files. The IDX file
 - contains one record for each nuclide
 - contains limited progeny info
- .DAT file
 - data on the energy and yield of each radiation emitted in nuclear transformations of the radionuclide
- .BET file
 - contains the beta spectrum for each beta emitter of the ICRP-38 collection

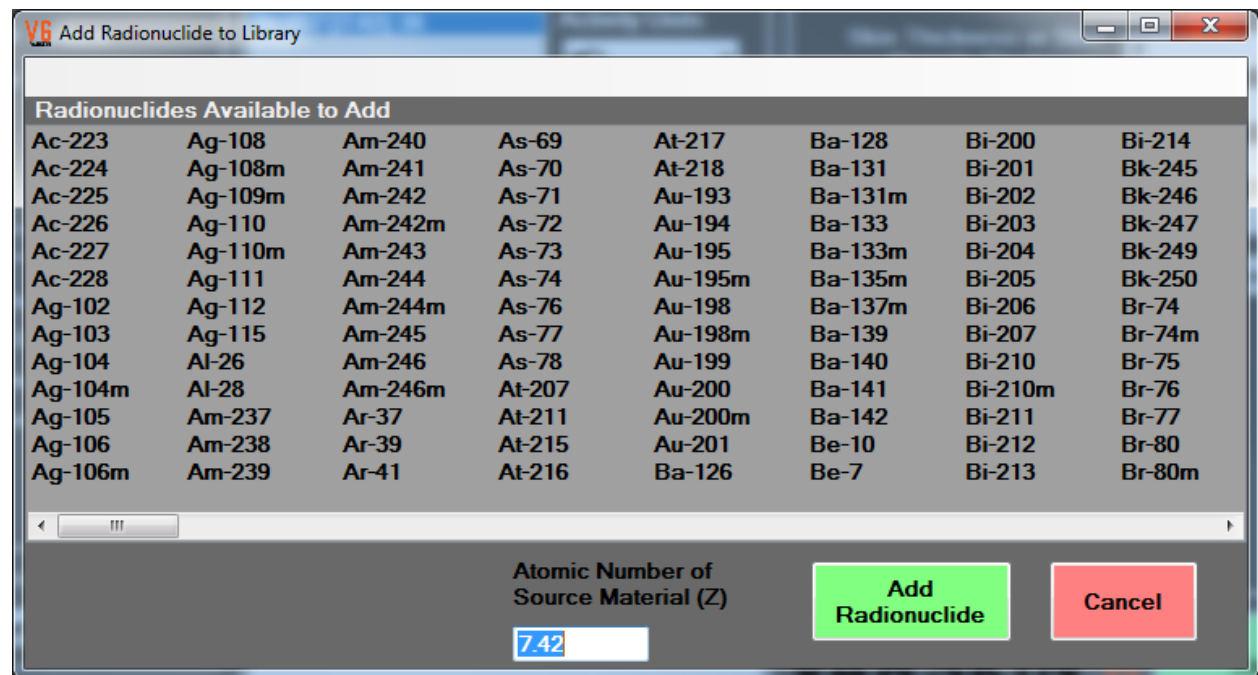
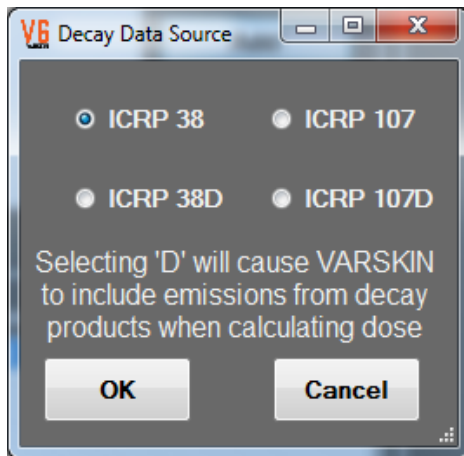
Issues with plug and play method

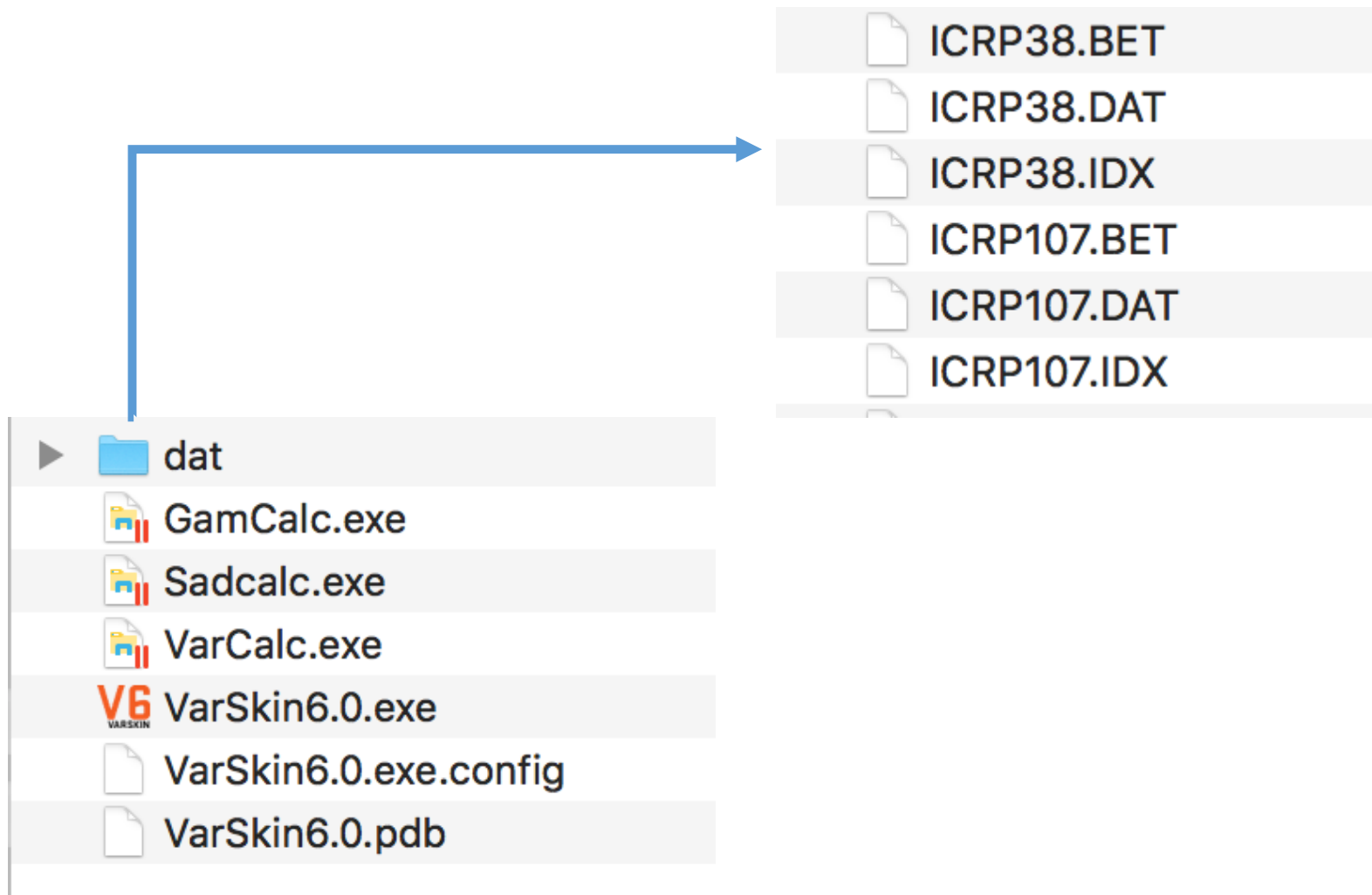
- 107 files formatted differently than 38
 - Creates problem with GUI
- User library will be dependent on user selection



Required changes...

- **Reformatted ICRP-107 files** – minimized GUI changes
 - 750,000+ lines
 - Revised GUI to provide user option
 - Revised GUI to ensure accurate user library





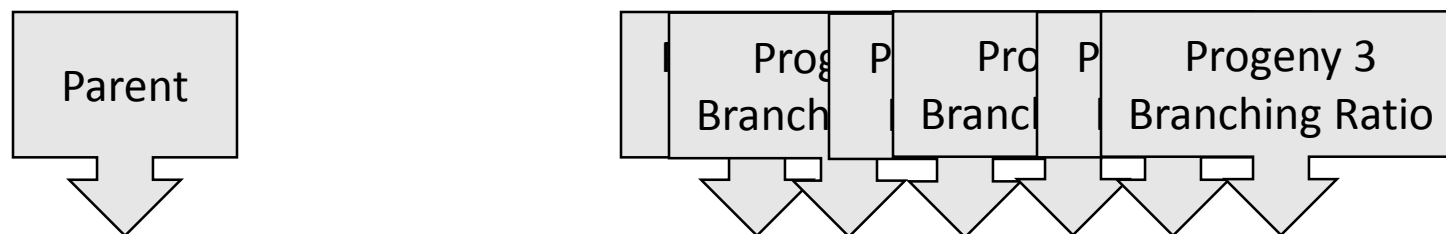
VARSKIN 6

Progeny Inclusion

Prior to VARSKIN 6...

- Decay Progeny were not included
- Examples:
 - Cs-137 dose did not contain Ba-137m 662 KeV gamma
 - Sr-90 dose did not include Y-90 beta and electrons
- Complicated dose calculations for longer decay chains
 - Ra-226
 - DU
 - Th-232
- External application of branching ratios

Decay Progeny: ICRP 38 IDX file



4	Ac-226	29h	A	B-EC	189766	128	57018	112	739	8.2800E-01	550	1.7200E-01	233	6.0000E-05	0.0003	0.2893	0.1300	23-MAR-79
5	Ac-227	21.773y	B-A		190099	232	57132	73	740	9.8620E-01	234	1.3800E-02			0.0680	0.0157	0.0002	20-OCT-77
6	Ac-228	6.13h	B-		192575	1246	57323	119	741	1.0000E 00					0.0	0.4751	0.9708	03-JUN-77
7	Ag-102	12.9m	ECB+		35136	291	19651	125							0.0	0.8189	3.3532	05-MAR-76
8	Ag-103	65.7m	ECB+		35942	769	19986	117	483	1.0000E 00					0.0	0.2593	0.7651	23-MAR-78
9	Ag-104	69.2m	ECB+		37373	530	20337	118							0.0	0.0914	2.6834	29-DEC-78
10	Ag-104m	33.5m	ECB+IT		37032	340	20213	122	10	3.3000E-01					0.0	0.5087	1.1739	09-FEB-76
11	Ag-105	41.0d	ECB+		38959	322	20691	97							0.0	0.0192	0.5254	29-MAR-78
12	Ag-106	23.96m	ECB+		40263	115	21009	118							0.0	0.5078	0.7108	23-MAR-78
13	Ag-106m	8.41d	EC		39830	432	0	0							0.0	0.0132	2.8219	23-MAR-78
14	Ag-108	2.37m	ECB+B-		42554	176	21732	117							0.0	0.6104	0.0178	19-DEC-75
15	Ag-108m	127y	ECIT		42438	115	0	0	15	8.9000E-02					0.0	0.0160	1.6267	09-AUG-77
16	Ag-109m	39.6s	IT		42731	47	0	0							0.0	0.0768	0.0111	01-APR-78
17	Ag-110	24.6s	B-EC		44158	182	22177	123							0.0	1.1815	0.0306	19-JAN-78
18	Ag-110m	249.9d	ITB-		43633	524	22073	102	18	1.3300E-02					0.0	0.0722	2.7505	19-JAN-78
19	Ag-111	7.45d	B-		45184	116	22526	111							0.0	0.3542	0.0263	17-JUN-78
20	Ag-112	3.12h	B-		45518	667	22756	126							0.0	1.3836	0.6571	20-APR-78
21	Ag-115	20.0m	B-		46560	519	23309	124	120	9.3400E-01	121	6.6000E-02			0.0	1.0424	0.7069	20-DEC-77
22	Al-26	7.16E5y	ECB+		122	30	1085	112							0.0	0.4449	2.6756	19-SEP-75
23	Al-28	2.240m	B-		153	23	1199	123							0.0	1.2422	1.7788	06-MAR-77
24	Am-237	73.0m	A	EC	203195	348	0	0	536	9.9970E-01	432	2.5000E-04			0.0015	0.0772	0.3696	23-MAR-78

Decay Progeny: ICRP 107 IDX file

Parent

Progeny 1
Branching Ratio

Progeny 2
Branching Ratio

Progeny 3
Branching Ratio

Parent	Progeny 1 Branching Ratio	Progeny 2 Branching Ratio	Progeny 3 Branching Ratio
Ac-226	29.37h B-ECA	1944 260 67 112 0 0 Th-226 1108 8.3000E-01 Ra-226 822 1.7000E-01 Fr-222 361 6.0000E-05	
Ac-227	21.772y B-A	2205 663 181 73 0 0 Th-227 1109 9.8620E-01 Fr-223 362 1.3800E-02	0 0.0
Ac-228	6.15h B-	2869 1855 256 119 0 0 Th-228 1110 1.0000E+00	0 0.0
Ac-230	122s B-	4725 987 377 123 0 0 Th-230 1112 1.0000E+00	0 0.0
Ac-231	7.5m B-	5713 200 502 118 0 0 Th-231 1113 1.0000E+00	0 0.0
Ac-232	119s B-	5914 301 622 126 0 0 Th-232 1114 1.0000E+00	0 0.0
Ac-233	145s B-	6216 106 750 122 0 0 Th-233 1115 1.0000E+00	0 0.0
Ag-100m	2.24m ECB+	6323 139 874 129 0 0 Pd-100 716 1.0000E+00	0 0.0
Ag-101	11.1m ECB+	6463 563 1005 123 0 0 Pd-101 717 1.0000E+00	0 0.0
Ag-102	12.9m ECB+	7027 223 1130 125 0 0 Pd-102 0 1.0000E+00	0 0.0
Ag-102m	7.7m ECB+IT	7251 230 1257 127 0 0 Ag-102 14 4.9000E-01 Pd-102 0 5.1000E-01	0 0.0
Ag-103	65.7m ECB+	7482 801 1386 117 0 0 Pd-103 718 1.0000E+00	0 0.0
Ag-104	69.2m ECB+	8284 582 1505 118 0 0 Pd-104 0 1.0000E+00	0 0.0
Ag-104m	33.5m ECB+IT	8867 588 1625 122 0 0 Ag-104 17 7.0000E-04 Pd-104 0 9.9930E-01	0 0.0
Ag-105	41.29d EC	9456 465 0 0 0 0 Pd-105 0 1.0000E+00	0 0.0
Ag-105m	7.23m ITECB+	9922 241 1749 98 0 0 Ag-105 19 9.9660E-01 Pd-105 0 3.4000E-03	0 0.0
Ag-106	23.96m ECB+B-	10164 308 1849 118 0 0 Pd-106 0 9.9000E-01 Cd-106 0 1.0000E-02	0 0.0
Ag-106m	8.28d EC	10473 450 0 0 0 0 Pd-106 0 1.0000E+00	0 0.0
Ag-108	2.37m B-ECB+	10924 201 1969 117 0 0 Cd-108 0 9.7150E-01 Pd-108 0 2.8500E-02	0 0.0
Ag-108m	418y ECIT	11126 138 0 0 0 0 Ag-108 23 8.7000E-02 Pd-108 0 9.1300E-01	0 0.0
Ag-109m	39.6s IT	11265 60 0 0 0 0 Ag-109 0 1.0000E+00	0 0.0
Ag-110	24.6s B-EC	11326 214 2088 123 0 0 Cd-110 0 9.9700E-01 Pd-110 0 3.0000E-03	0 0.0
Ag-110m	249.76d B-IT	11541 524 2213 115 0 0 Ag-110 26 1.3600E-02 Cd-110 0 9.8640E-01	0 0.0
Ag-111	7.45d B-	12066 160 2330 111 0 0 Cd-111 0 1.0000E+00	0 0.0
Ag-111m	64.8s ITB-	12227 203 2443 109 0 0 Ag-111 28 9.9300E-01 Cd-111 0 7.0000E-03	0 0.0
Ag-112	3.130h B-	12431 571 2554 126 0 0 Cd-112 0 1.0000E+00	0 0.0
Ag-113	5.37h B-	13003 308 2682 119 0 0 Cd-113 182 9.8261E-01 Cd-113m 183 1.7388E-02	0 0.0
Ag-113m	68.7s ITB-	13312 275 2803 117 0 0 Ag-113 31 6.4000E-01 Cd-113 182 3.6000E-01	0 0.0
Ag-114	4.6s B-	13588 355 2922 129 0 0 Cd-114 0 1.0000E+00	0 0.0
Ag-115	20.0m B-	13944 852 3053 124 0 0 Cd-115 184 9.4210E-01 Cd-115m 185 5.7870E-02	0 0.0

Progeny List Construction

- Parent has up to three branches
- Ac-226
 - Th-226 (8.3000E-01)
 - Ra-226 (1.7000E-01)
 - Fr-222 (6.0000E-05)
- All branches of parent traced to stability
 - Branching Ratio threshold set to 1.00E-02
- Second and third branch of each generation traced one additional generation

Progeny List example...

Ac-226

16

1	Th-226	8.3000E-01
2	Ra-222	1.0000E+00
3	Rn-218	1.0000E+00
4	Po-214	1.0000E+00
5	Pb-210	1.0000E+00
6	Bi-210	1.0000E+00
7	Po-210	1.0000E+00
1	Ra-226	1.7000E-01
2	Rn-222	1.0000E+00
3	Po-218	1.0000E+00
4	Pb-214	9.9980E-01
5	Bi-214	1.0000E+00
6	Po-214	9.9979E-01
7	Pb-210	1.0000E+00
8	Bi-210	1.0000E+00
9	Po-210	1.0000E+00

Ac-224

12

1	Ra-224	9.0900E-01
2	Rn-220	1.0000E+00
3	Po-216	1.0000E+00
4	Pb-212	1.0000E+00
5	Bi-212	1.0000E+00
6	Po-212	6.4060E-01
6	Tl-208	3.5940E-01
1	Fr-220	9.1000E-02
2	At-216	9.9650E-01
3	Bi-212	1.0000E+00
4	Po-212	6.4060E-01
4	Tl-208	3.5940E-01

Ac-225

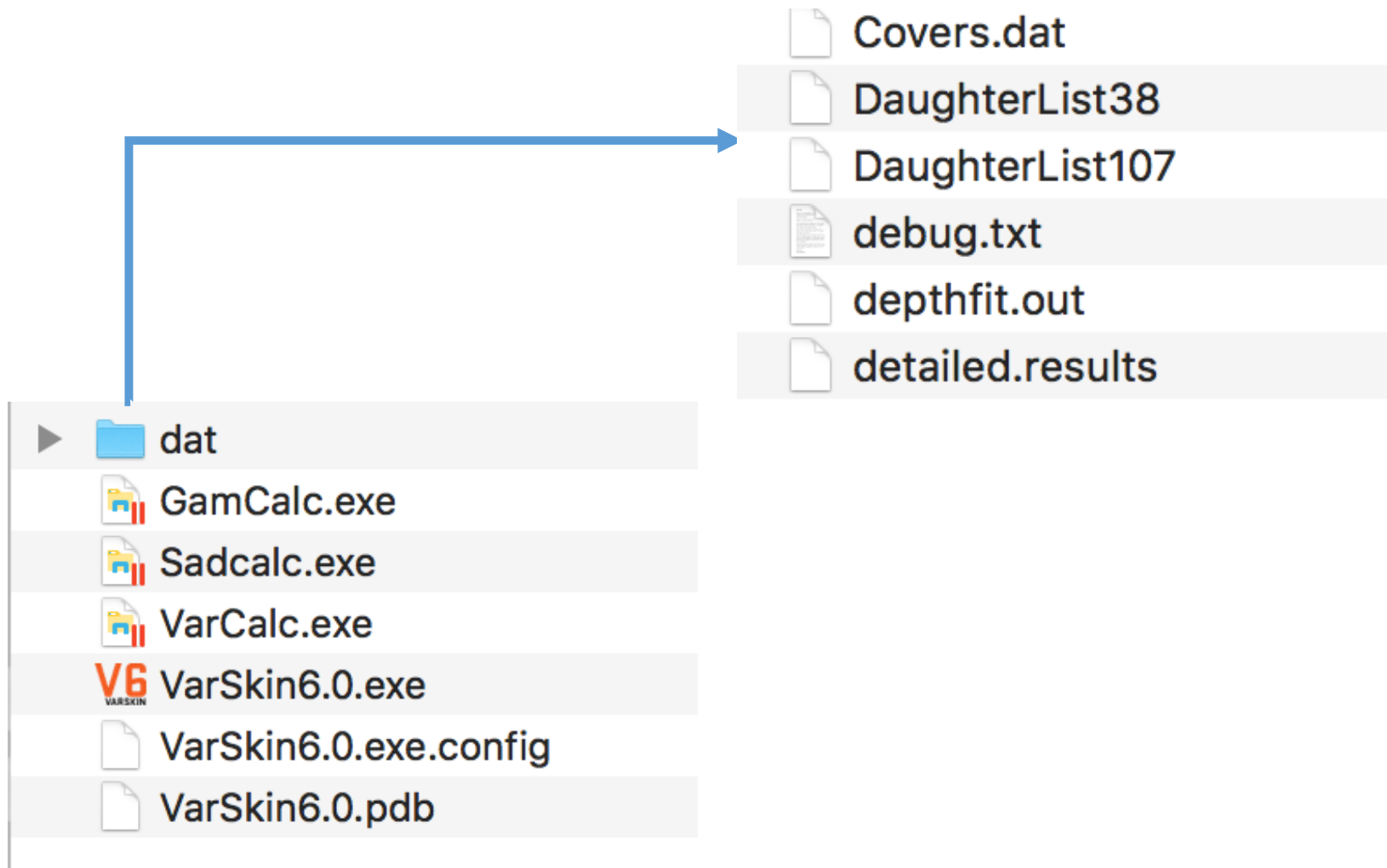
132	Bi-210	5.015d B-A	57257	185	11520	112	0	0	TL-210	758	1.0000E+00	TL-208	1137	1.5200E-03
133	Bi-210m	3.04E+6y A	57341	186	0	0	0	0	TL-206	1137	1.0000E+00		0	0.0
134	Bi-211	2.14m A B-	57528	96	11634	103	0	0	TL-207	1139	9.9724E-01	Po-211	759	2.7600E-03
135	Bi-212	60.55m B-A	57625	320	11739	120	0	0	Po-212	760	6.4060E-01	Tl-208	1140	3.5940E-01
136	Bi-212n	7.0m B-	57946	1	11861	116	0	0	Po-212m	761	1.0000E+00		0	0.0
137	Bi-213	45.59m B-A	57948	269	11979	115	0	0	Po-213	762	9.7910E-01	Tl-209	1141	2.0900E-02
138	Bi-214	19.9m B-A	58218	1822	12096	125	0	0	Po-214	763	9.9979E-01	Tl-210	1142	2.1000E-04
139	Bi-215	7.6m B-	60041	228	12223	118	0	0	Po-215	764	1.0000E+00		0	0.0
140	Bi-216	2.17m B-	60270	100	12343	125	0	0	Po-216	765	1.0000E+00		0	0.0
141	Bk-245	4.94d ECA	60371	324	0	0	0	0	Cm-245	229	9.9880E-01	Am-241	45	1.2000E-03
142	Bk-246	1.80d EC	60696	198	0	0	0	0	Cm-246	230	1.0000E+00		0	0.0

Ac-231

12

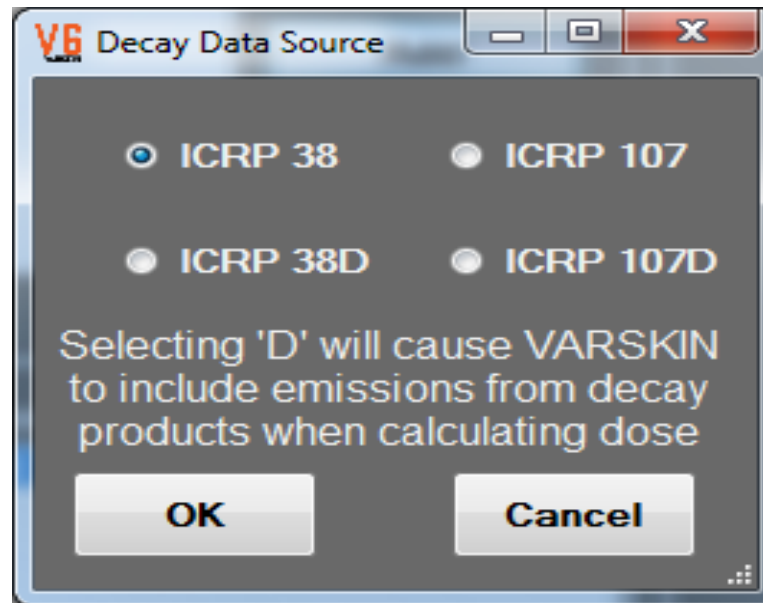
1	Th-231	1.0000E+00
2	Pa-231	1.0000E+00
3	Ac-227	1.0000E+00
4	Th-227	9.8620E-01
4	Fr-223	1.3800E-02
4	Ra-223	1.0000E+00
5	Ra-223	1.0000E+00
6	Rn-219	1.0000E+00
7	Po-215	1.0000E+00
8	Pb-211	1.0000E+00
9	Bi-211	1.0000E+00
10	Tl-207	9.9724E-01

1	Ac-223	2.10m A	1	480	0	0	0	0	Fr-219	358	9.9000E-01	0	0.0	0	0.0		
2	Ac-224	2.78h ECA	482	682	0	0	0	0	Ra-224	820	9.0900E-01	Fr-220	359	9.1000E-02	0	0.0	
3	Ac-225	10.0d A	1165	778	0	0	0	0	Fr-221	360	1.0000E+00	0	0.0	0	0.0		
4	Ac-226	29.37h B-ECA	1944	260	67	112	0	0	Th-226	1108	8.3000E-01	Ra-226	822	1.7000E-01	Fr-222	361	6.0000E-05
5	Ac-227	21.772y B-A	2205	663	181	73	0	0	Th-227	1109	9.8620E-01	Fr-223	362	1.3800E-02	0	0.0	
6	Ac-228	6.15h B-	2869	1855	256	119	0	0	Th-228	1110	1.0000E+00	0	0.0	0	0.0		
7	Ac-230	122s B-	4725	987	377	123	0	0	Th-230	1112	1.0000E+00	0	0.0	0	0.0		
8	Ac-231	7.5m B-	5713	200	502	118	0	0	Th-231	1113	1.0000E+00	0	0.0	0	0.0		
9	Ac-232	119s B-	5914	301	622	126	0	0	Th-232	1114	1.0000E+00	0	0.0	0	0.0		
10	Ac-233	145s B-	6216	106	750	122	0	0	Th-233	1115	1.0000E+00	0	0.0	0	0.0		
358	Fr-220	27.4s A B-	132525	450	33056	113	0	0	At-216	81	9.9650E-01	Ra-220	816	3.5000E-03	0	0	
359	Fr-221	4.9m A	132976	182	0	0	0	0	At-217	82	1.0000E+00	0	0.0	0	0		
360	Fr-222	14.2m B-	133159	566	33171	119	0	0	Ra-222	818	1.0000E+00	0	0.0	0	0		
361	Fr-223	22.00m B-A	133726	1038	33292	112	0	0	Ra-223	819	1.0000E+00	At-219	84	6.0000E-05	0	0	
362	Fr-224	3.33m B-	134765	820	33406	123	0	0	Ra-224	820	1.0000E+00	0	0.0	0	0		
363	Fr-227	2.47m B-	135586	892	33531	120	0	0	Ra-227	823	1.0000E+00	0	0.0	0	0		
364	Ga-64	2.627m ECB+	136479	322	33653	131	0	0	Zn-64	0	1.0000E+00	0	0.0	0	0		
365	Ga-65	15.2m ECB+	136802	406	33786	119	0	0	Zn-65	1239	1.0000E+00	0	0.0	0	0		
366	Ga-66	9.49h ECB+	137209	1035	33907	127	0	0	Zn-66	0	1.0000E+00	0	0.0	0	0		



Required changes...

- **Create the lists for each decay set**
- Revise *sadcalc.exe* to create single scaled absorbed dose distribution data set (SADD) containing parent and all progeny
 - Single average energy and X90 distance
 - Incorporates all betas and electrons (above yield threshold)
 - Creates list of gamma lines to be used in *gamcalc.exe*
- Revise GUI to provide user option for both decay sets



Example #1

- 1 uCi point source
- 10 cm² dose averaging area
- 60 min exposure time
- No air gap
- No cover
- 7 mg/cm²

- Cs-137 [7.42] 38 + Ba-137m [7.42] 38
- Cs-137 [7.42] 107 + Ba-137m [7.42] 107
- Cs-137 [7.42] 107D
- Cs-137 [7.42] 38D

Cs-137/Ba-137m Results

Method	Beta Dose (rad)	Gamma Dose (rad)	Total Dose (rad)
ICRP 38 Parent	4.92E-01	0.00E+00	4.92E-01
ICRP 38 Progeny	5.66E-02	5.34E-03	6.19E-02
ICRP 38 Total	5.48E-02	5.34E-03	5.54E-01

Cs-137/Ba-137m Results

Method	Beta Dose (rad)	Gamma Dose (rad)	Total Dose (rad)
ICRP 38 Parent	4.92E-01	0.00E+00	4.92E-01
ICRP 38 Progeny	5.66E-02	5.34E-03	6.19E-02
ICRP 38 Total	5.48E-02	5.34E-03	5.54E-01
ICRP 38D	5.49E-02	5.05E-03	5.55E-01

Cs-137/Ba-137m Results

Method	Beta Dose (rad)	Gamma Dose (rad)	Total Dose (rad)
ICRP 38 Parent	4.92E-01	0.00E+00	4.92E-01
ICRP 38 Progeny	5.66E-02	5.34E-03	6.19E-02
ICRP 38 Total	5.48E-02	5.34E-03	5.54E-01
ICRP 38D	5.49E-02	5.05E-03	5.55E-01

$$5.05E - 03 / 5.34E - 03 = 9.46E - 01$$

```

1151  Cs-137
1152  1
1153  1      Ba-137m  9.4600E-01

```

Cs-137/Ba-137m Results

Method	Beta Dose (rad)	Gamma Dose (rad)	Total Dose (rad)
ICRP 38 Parent	4.92E-01	0.00E+00	4.92E-01
ICRP 38 Progeny	5.66E-02	5.34E-03	6.19E-02
ICRP 38 Total	5.48E-02	5.34E-03	5.54E-01
ICRP 38D	5.49E-02	5.05E-03	5.55E-01
ICRP 107 Parent	4.93E-01	0.00E+00	4.93E-01
ICRP 107 Progeny	5.73E-02	5.34E-03	6.26E-02
ICRP 107 Total	5.50E-02	5.34E-03	5.55E-01

Cs-137/Ba-137m Results

Method	Beta Dose (rad)	Gamma Dose (rad)	Total Dose (rad)
ICRP 38 Parent	4.92E-01	0.00E+00	4.92E-01
ICRP 38 Progeny	5.66E-02	5.34E-03	6.19E-02
ICRP 38 Total	5.48E-02	5.34E-03	5.54E-01
ICRP 38D	5.49E-02	5.05E-03	5.55E-01
ICRP 107 Parent	4.93E-01	0.00E+00	4.93E-01
ICRP 107 Progeny	5.73E-02	5.34E-03	6.26E-02
ICRP 107 Total	5.50E-02	5.34E-03	5.55E-01
ICRP107D	5.51E-02	5.04E-03	5.56E-01

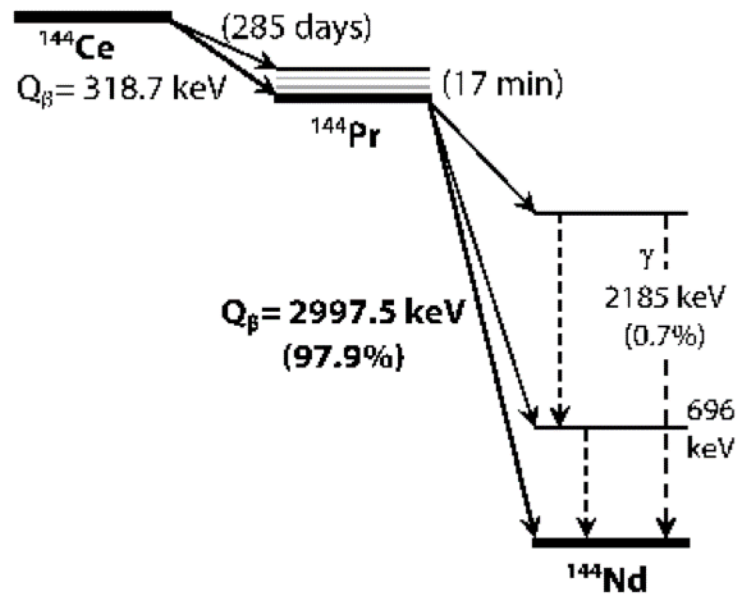
Example #2

- 1 uCi point source
 - 10 cm² dose averaging area
 - 60 min exposure time
 - No air gap
 - No cover
 - 7 mg/cm²
-
- Sr-90 [7.42] 38 + Y-90 [7.42] 38
 - Sr-90 7 [7.42] 107 + Y-90 [7.42] 107
 - Sr-90 [7.42] 107D
 - Sr-90 [7.42] 38D

Sr-90/Y-90 Results

Method	Beta Dose (rad)	Gamma Dose (rad)	Total Dose (rad)
ICRP 38 Parent	5.13E-01	0.00E+00	5.13E-01
ICRP 38 Progeny	5.98E-01	0.00E+00	5.98E-01
ICRP 38 Total	1.11E+00	0.00E+00	1.11E+00
ICRP 38D	1.11E+00	0.00E+00	1.11E+00
ICRP 107 Parent	5.13E-01	0.00E+00	5.13E-01
ICRP 107 Progeny	5.98E-01	0.00E+00	5.98E-01
ICRP 107 Total	1.11E+00	0.00E+00	1.11E+00
ICRP107D	1.11E+00	0.00E+00	1.11E+00

Another example...



ICRP 38 photon emission data for the decay of ^{144}Ce to stable ^{144}Nd .

Nuclide	Branching Ratio	Photon Yield (%)	Photon Energy (MeV)	Nuclide	Photon Yield (%)	Photon Energy (MeV)
^{144}Ce		1.6416	0.0801199	$^{144}\text{Ce(D)}$	1.6416	0.0801199
		10.8	0.13353			
		5.40195	0.0360263			
		2.95756	0.0355502			
		1.06958	0.0407484			
^{144}Pr	0.9822	1.48	0.69649		1.45366	0.69649
$^{144\text{m}}\text{Pr}$	0.0178	15.7456	0.0360263		0.280272	0.0360263
		8.62071	0.0355502		0.153449	0.0355502
		3.11763	0.0407484		0.05549381	0.0407484
		1.25177	0.0417924		0.02228151	0.0417924
		1.60605	0.0406532		0.02858769	0.0406532
		4.53392	0.00503329		0.08070377	0.00503329
		1.63137	0.00548929		0.02903838	0.00548929
					0.02631766	0.69649
^{144}Pr	0.999	1.48	0.69649			

$^{144}\text{Ce(D)}$ represents the combined "nuclide" in VARSKIN having selected the option to include progeny.

ICRP 38 electron emission data for the decay of ^{144}Ce to stable ^{144}Nd .

Nuclide	Half-life (hours)	Electron Yield (%)	Electron Avg Energy (MeV)	Electron X90 (cm)
^{144}Ce	6823.2	1.57344	0.09230879	0.02774469
^{144}Pr	0.288	1.0006	1.2079	0.695699
$^{144\text{m}}\text{Pr}$	0.12	3.37682	0.617	0.004115152
$^{144}\text{Ce(D)}$	6823.2	1.57344	0.654206	0.682593

$^{144}\text{Ce(D)}$ represents the combined "nuclide" in VARSKIN having selected the option to include progeny.

ICRP 107 photon emission data for the decay of ^{144}Ce to stable ^{144}Nd .

Nuclide	Branching Ratio	Photon Yield (%)	Photon Energy (MeV)	Nuclide	Photon Yield (%)	Photon Energy (MeV)
^{144}Ce		1.36407	0.08012	$^{144}\text{Ce(D)}$	1.36407	0.08012
		11.09	0.133515		11.09	0.133515
		4.40559	0.0360557		4.40559	0.0360557
		2.41237	0.0355671		2.41237	0.0355671
^{144}Pr	0.99023	1.342	0.69651		1.32889	0.69651

$^{144}\text{Ce(D)}$ represents the combined “nuclide” in VARSKIN having selected the option to include progeny.

ICRP 107 electron emission data for the decay of ^{144}Ce to stable ^{144}Nd .

Nuclide	Half-life (hours)	Electron Yield (%)	Electron Avg Energy (MeV)	Electron X90 (cm)
^{144}Ce	6837.84	2.34621	0.09170876	0.0285164
^{144}Pr	0.288	1.00107	1.20882	0.696917
$^{144\text{m}}\text{Pr}$	0.12	10.231	0.296957	0.004116936
$^{144}\text{Ce(D)}$	6837.84	2.34621	0.654899	0.682717

$^{144}\text{Ce(D)}$ represents the combined “nuclide” in VARSKIN having selected the option to include progeny.

Final Results

Dose results from VARSKIN with progeny using the ICRP 38 decay database.

Nuclide	Branching Ratio	Electron Dose (mGy/nt)	Photon Dose (mGy/nt)
¹⁴⁴ Ce		2.40x10 ⁻⁹	3.63x10 ⁻¹²
¹⁴⁴ Pr	0.9822	4.58x10 ⁻⁹	7.78x10 ⁻¹³
^{144m} Pr	0.0178	5.55x10 ⁻¹³	1.42x10 ⁻¹¹
¹⁴⁴ Pr*	0.999	4.58x10 ⁻⁹	7.78x10 ⁻¹³
SUM		6.98x10 ⁻⁹	4.66x10 ⁻¹²
¹⁴⁴ Ce(D)		6.85x10 ⁻⁹	4.65x10 ⁻¹²
Discrepancy		-1.9%	-0.2%

¹⁴⁴Ce(D) represents the combined “nuclide” in VARSKIN having selected the option to include progeny.

*this entry represents ¹⁴⁴Pr as the decay product of ^{144m}Pr.

VARSKIN 6

Minor Changes



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Radionuclides Available to Add

Ac-223	Ag-108	Am-240	As-69	At-217	Ba-128	Bi-200	Bi-214
Ac-224	Ag-108m	Am-241	As-70	At-218	Ba-131	Bi-201	Bk-245
Ac-225	Ag-109m	Am-242	As-71	Au-193	Ba-131m	Bi-202	Bk-246
Ac-226	Ag-110	Am-242m	As-72	Au-194	Ba-133	Bi-203	Bk-247
Ac-227	Ag-110m	Am-243	As-73	Au-195	Ba-133m	Bi-204	Bk-249
Ac-228	Ag-111	Am-244	As-74	Au-195m	Ba-135m	Bi-205	Bk-250



Add Radionuclide to Library



Ag-102

Ag-103

Ag-104

Ag-104m

Radionuclides Available to Add

Ag-105	Ac-223	Ag-108	Am-240	As-69	At-217	Ba-128	Bi-200	Bi-214
Ag-106	Ac-224	Ag-108m	Am-241	As-70	At-218	Ba-131	Bi-201	Bk-245
Ag-106m	Ac-225	Ag-109m	Am-242	As-71	Au-193	Ba-131m	Bi-202	Bk-246
	Ac-226	Ag-110	Am-242m	As-72	Au-194	Ba-133	Bi-203	Bk-247
<	Ac-227	Ag-110m	Am-243	As-73	Au-195	Ba-133m	Bi-204	Bk-249
	Ac-228	Ag-111	Am-244	As-74	Au-195m	Ba-135m	Bi-205	Bk-250
Pho	Ag-102	Ag-112	Am-244m	As-76	Au-198	Ba-137m	Bi-206	Br-74
Ene	Ag-103	Ag-115	Am-245	As-77	Au-198m	Ba-139	Bi-207	Br-74m
2	Ag-104	Al-26	Am-246	As-78	Au-199	Ba-140	Bi-210	Br-75
	Ag-104m	Al-28	Am-246m	At-207	Au-200	Ba-141	Bi-210m	Br-76
	Ag-105	Am-237	Ar-37	At-211	Au-200m	Ba-142	Bi-211	Br-77
	Ag-106	Am-238	Ar-39	At-215	Au-201	Be-10	Bi-212	Br-80
	Ag-106m	Am-239	Ar-41	At-216	Ba-126	Be-7	Bi-213	Br-80m

Atomic Number of
Source Material (Z)

7.42

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