Effect of heterogeneous distribution of radionuclides in sediment on dose rate to wildlife

234Th in canadian sediments from Saskatchewan

EMRAS II

DCC comparison between Doses3D and EDEN

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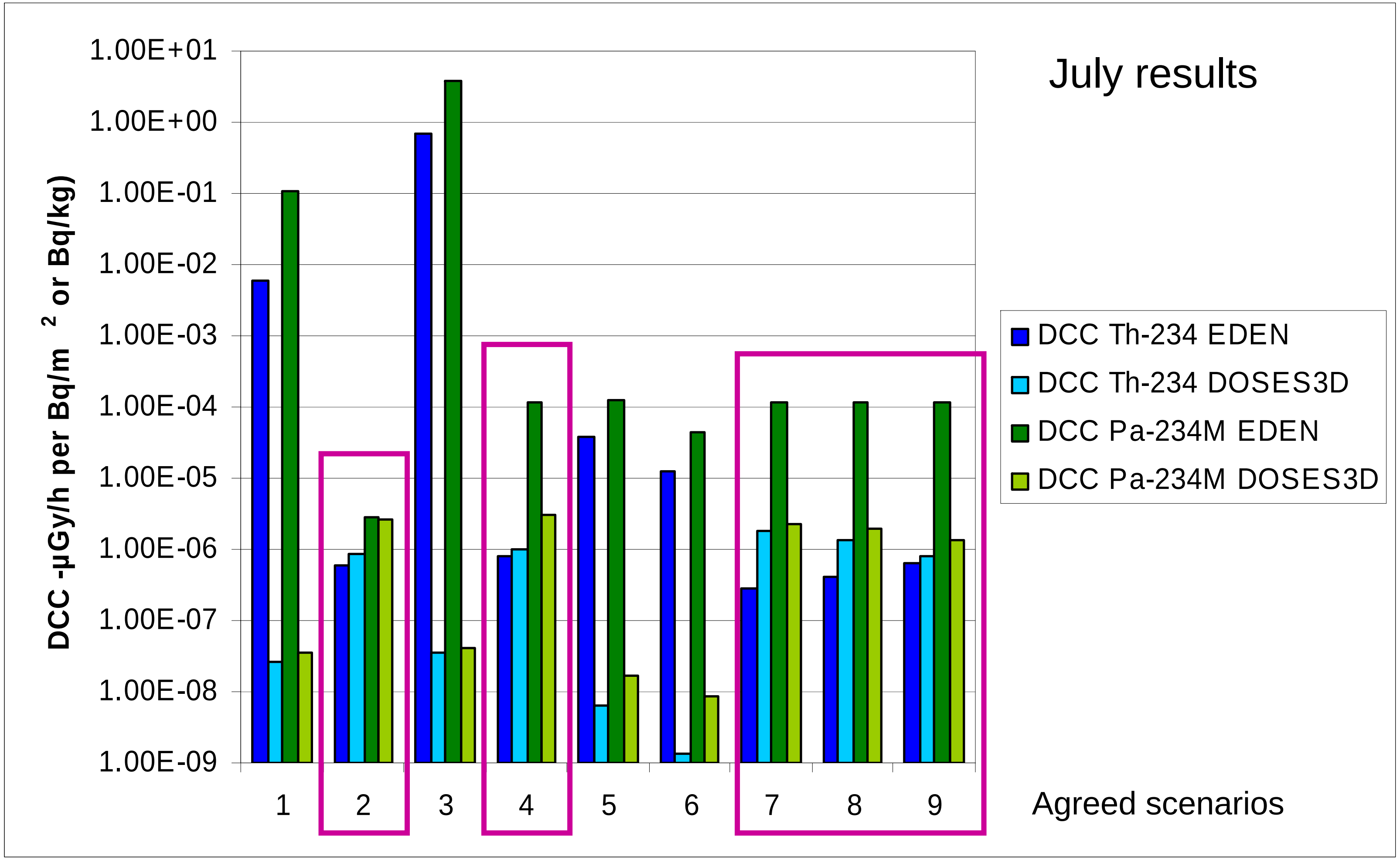
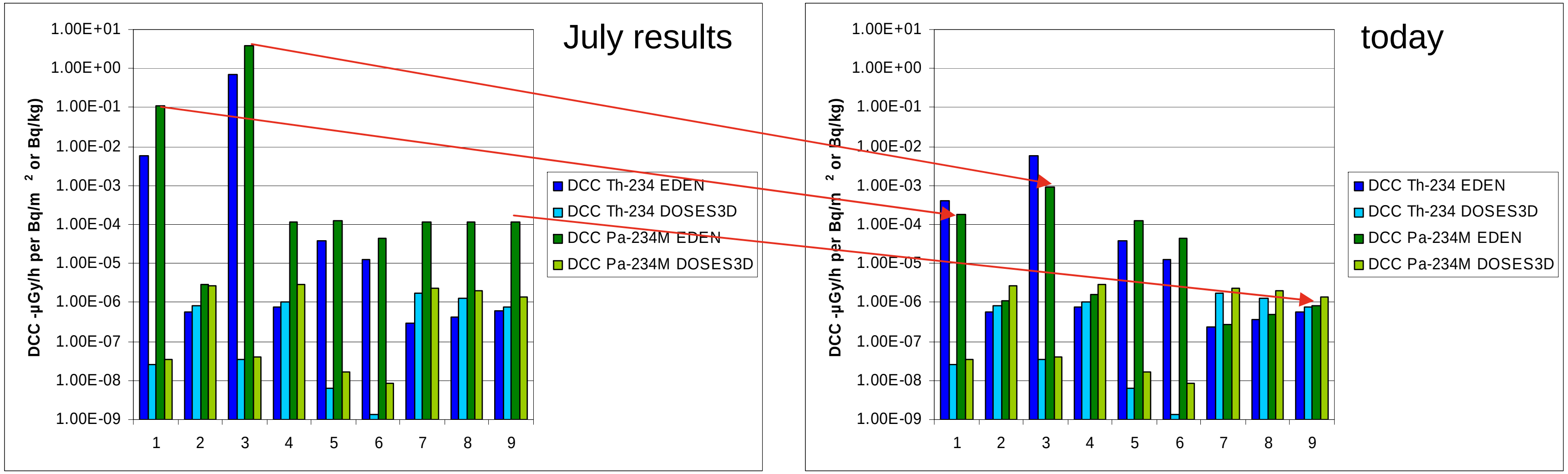
DOSES3D vs EDEN



More or less agreement on volume DCC
-> energies checking ?

DOSES3D vs EDEN

Considering γ radiation only for EDEN results
as done for Doses 3D results



Better agreement, especially for volume/mass DCCs
surface DCCs ???

DOSES3D vs EDEN

Nuclear data comparison (^{234}Th gamma energies)

Doses3D (ICRP38) EDEN (JEFF – NEA/OCDE) Nucleonica

Main energies

Doses3D (ICRP38) MeV	Doses3D (ICRP38) Yield (Bq-s)$^{-1}$	EDEN (JEFF – NEA/OCDE) MeV	EDEN (JEFF – NEA/OCDE) intensity	Nucleonica MeV	Nucleonica Emission Probability, E.P.
		2.00E-02	8.66E-05	2.00E-02	1.15E-04
		2.95E-02	1.51E-05	2.95E-02	1.26E-05
		6.29E-02	2.11E-04	6.29E-02	4.81E-05
6.33E-02	3.81E-02	6.33E-02	4.00E-02	6.33E-02	3.70E-02
7.13E-02	**1.13E-01**	7.40E-02	4.00E-05	7.39E-02	2.59E-05
		8.33E-02	7.03E-04	8.33E-02	7.10E-04
8.82E-02	2.78E-02	8.70E-02	7.03E-05	8.70E-02	6.66E-05
		9.20E-02	9.20E-05		
9.24E-02	2.73E-02	9.24E-02	2.72E-02	9.24E-02	2.62E-02
9.28E-02	2.69E-02	9.28E-02	2.69E-02	9.28E-02	2.59E-02
		1.03E-01	3.52E-05	1.03E-01	5.55E-05
		1.04E-01	7.57E-05	1.08E-01	7.77E-05
		1.13E-01	2.54E-03	1.13E-01	2.44E-03
		1.33E-01	1.51E-05		
		1.85E-01	2.81E-05		

EDEN internal checking

Conversion Mev/(g.s) into Gy/d

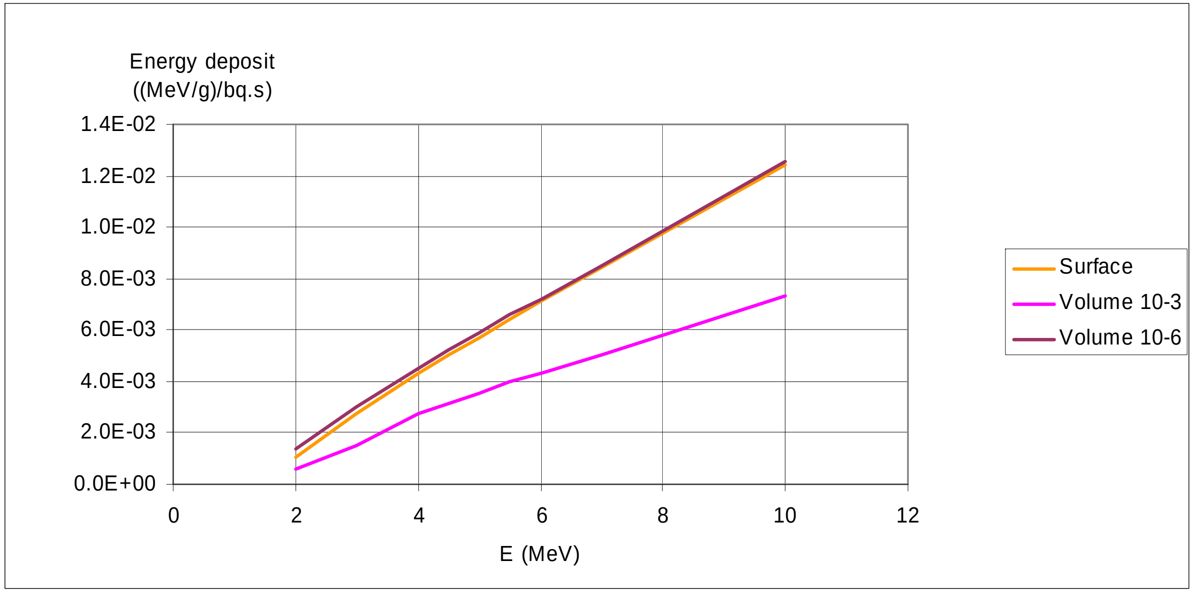
1 MeV = 1.6 10^{-13} J
1 g = 10^{-3} kg
1 j = 86400 s
1 Gy = 1 J.kg^{-1}

$$\frac{MeV}{g.s} = \frac{1.6\ 10^{-13}\ J}{10^{-3}\,kg.\dfrac{1}{86400}\,d} = \frac{1.6\ 10^{-10}\ J}{kg \cdot 1.16\ 10^{-5}\,d} = 1.38\ 10^{-5}\ \frac{Gy}{d}$$

$$\frac{Gy}{d} = 7.23\ 10^{4}\ \frac{MeV}{g.s}$$

EDEN internal consistency

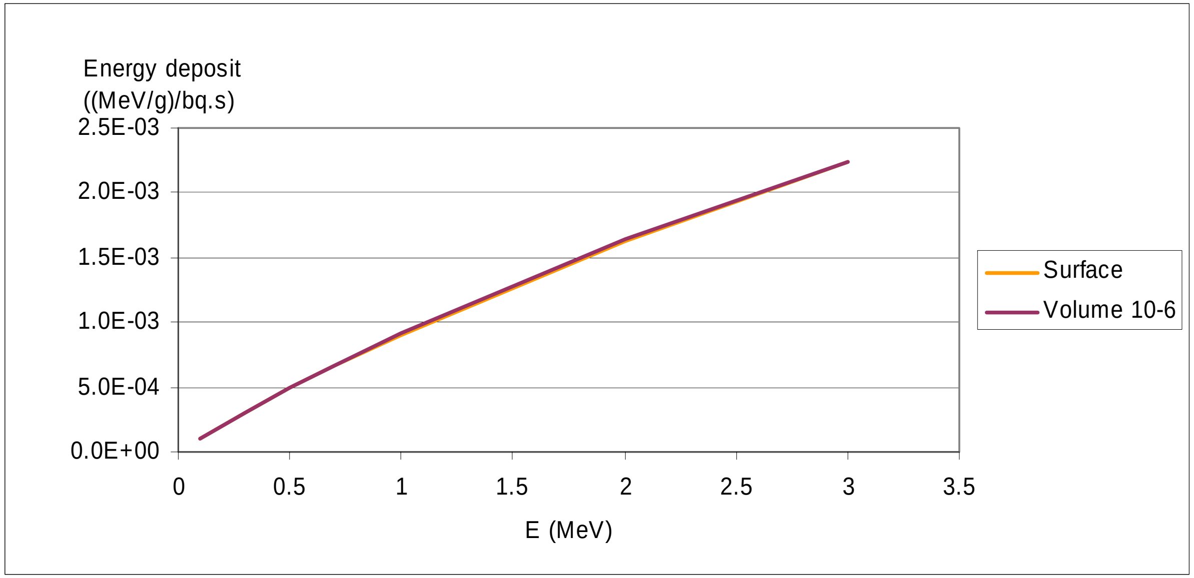
Alpha radiation



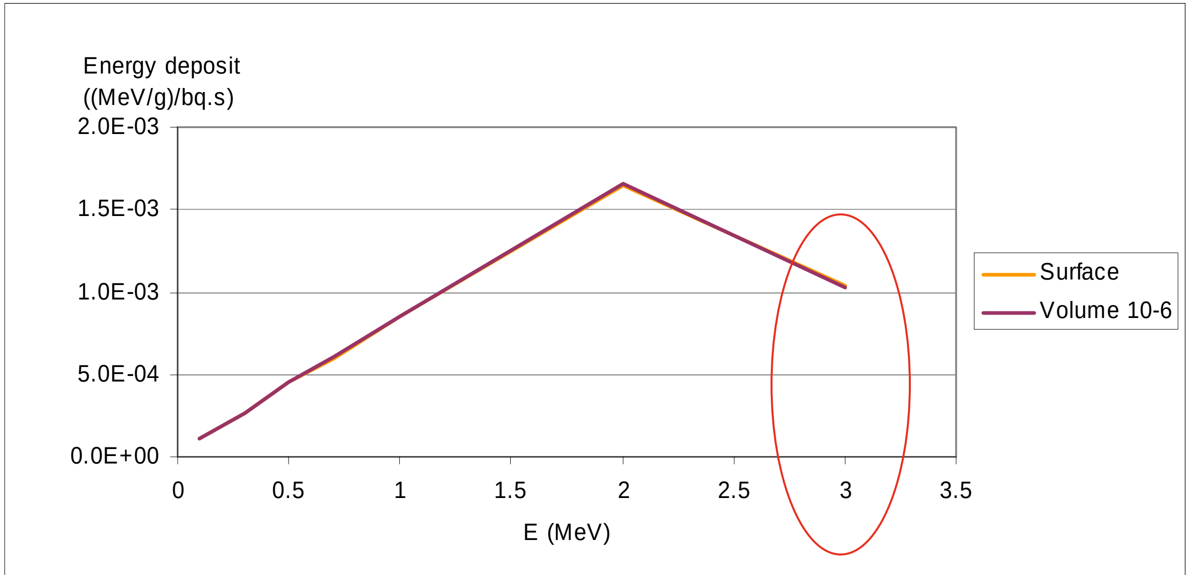
EDEN internal consistency

Beta radiation

Deposit maps

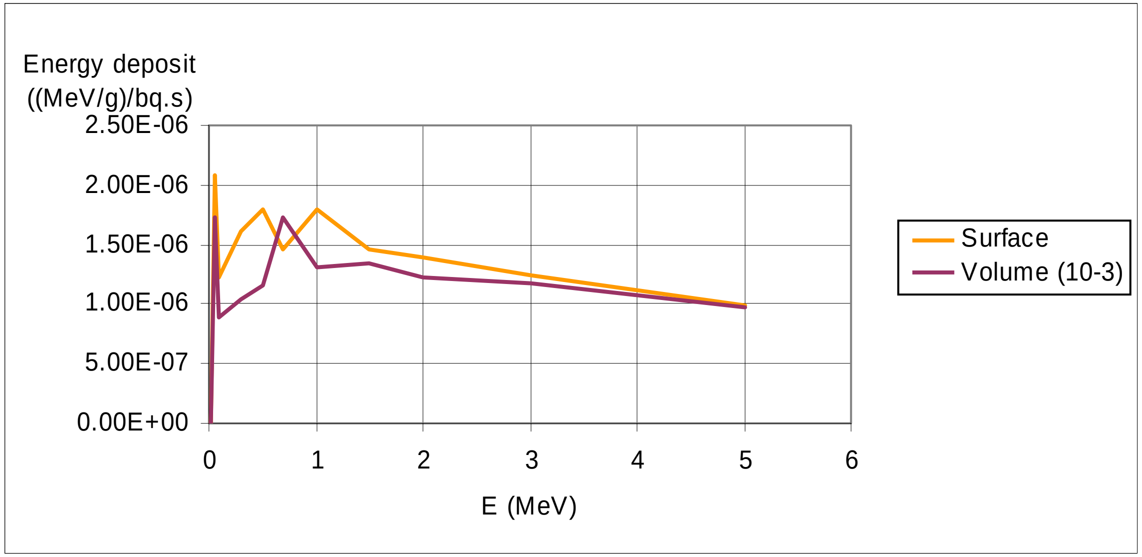


Statisitical approach



EDEN internal consistency

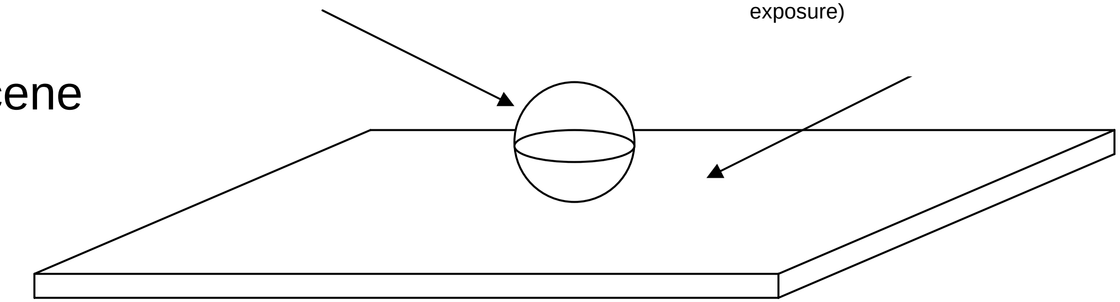
Gamma radiation



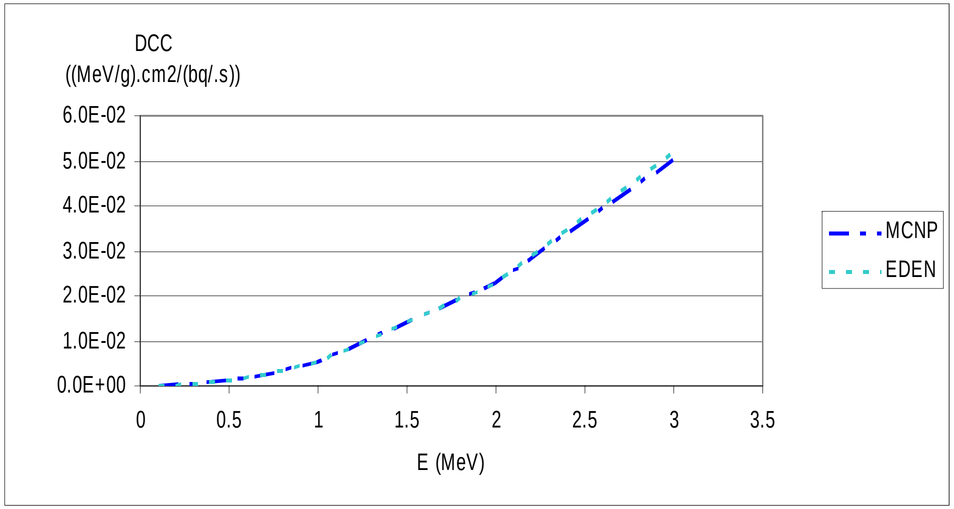
the continuity between volume and surface exposure has been proved in terms of energy deposit

EDEN VS MCNP

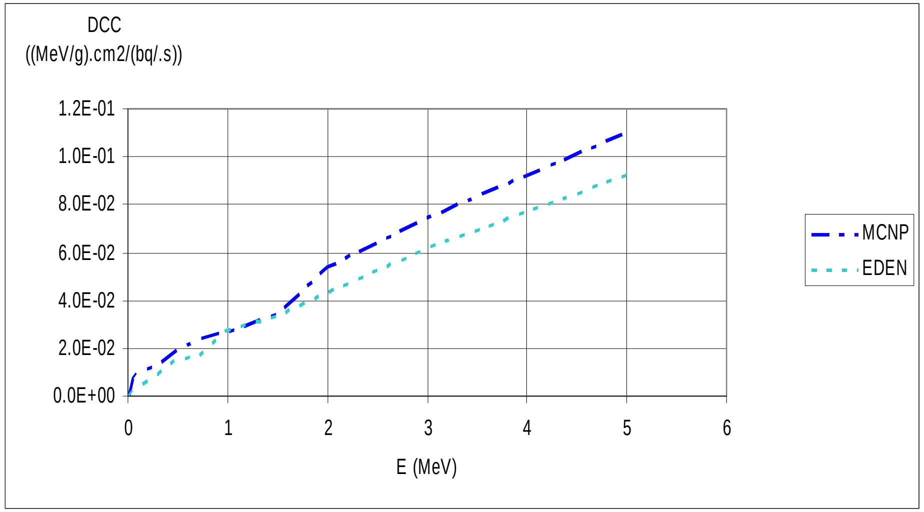
Exposure scene



Beta radiation



Gamma radiation



Work in progress: unit conversion checking (MeV/g).cm²/(Bq/s) into (MeV/g).m²/(Bq/s)

Methodology

- **We have adopted the methodology developed by Valeri Taranenko in connection with FASSET (Deliverable 3 and Taranenko et al., 2004).**
- **Collate information on the principal gamma emission lines and yields of the radionuclide of interest**
- **Collate planar DCC data for the organism of interest**
- **Select the nearest energy, as FASSET reports for a limited range of energies, e.g. Th-234 has a characteristic photon emission at 63.3 keV, in FASSET the nearest DCC of 70 keV was selected**
- **Summing up and then converting to the desired unit (µGy per photon/m2 to µGy s-1 per Bq/m2**

V. Taranenko, G Pr¨ohl and J M G´omez-Ros (2004). Absorbed dose rate conversion coefficients for reference terrestrial biota for external photon and internal exposures. J. Radiol. Prot. **24** (2004) A35–A62

An example: Th-234

MeV	DCC - µGy per photon/m^2 (for MeV)	Yield $(Bq\text{-}s)^{-1}$	µGy s^{-1} per Bq/m^2
6.329E-02	**1.8E-10 (0.07)**	**3.81E-02**	**6,858E-12**
7.128E-02	**1.8E-10 (0.07)**	**1.13E-01**	**2,034E-11**
8.821E-02	**2.4E-10 (0.1)**	**2.78E-02**	**6,672E-12**
9.238E-02	**2.4E-10 (0.1)**	**2.73E-02**	**6,552E-12**
9.28E-02	**2.4E-10 (0.1)**	**2.69E-02**	**6,456E-12**
		TOTAL =	4,6878E-11

Results and comparison

Configuration	Organism	Th-234, DCC (µGy/h per Bq/m^2)	
		FASSET	*Doses3D*
On surface	**Woodlouse**	**1.7E-07**	**7.2E-08**
In depth (5 cm)	**Woodlous**	**5.8E-10**	**6.4E-09**
On surface	**Insect larvae**		**3.6E-08**
In depth (5 cm)	**Insect larvea**		**6.4E-09**