Thyroid Screening of Members of the Public with Portable NaI Detectors after a Radionuclide Release from a Nuclear Power Plant

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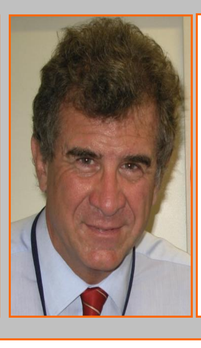
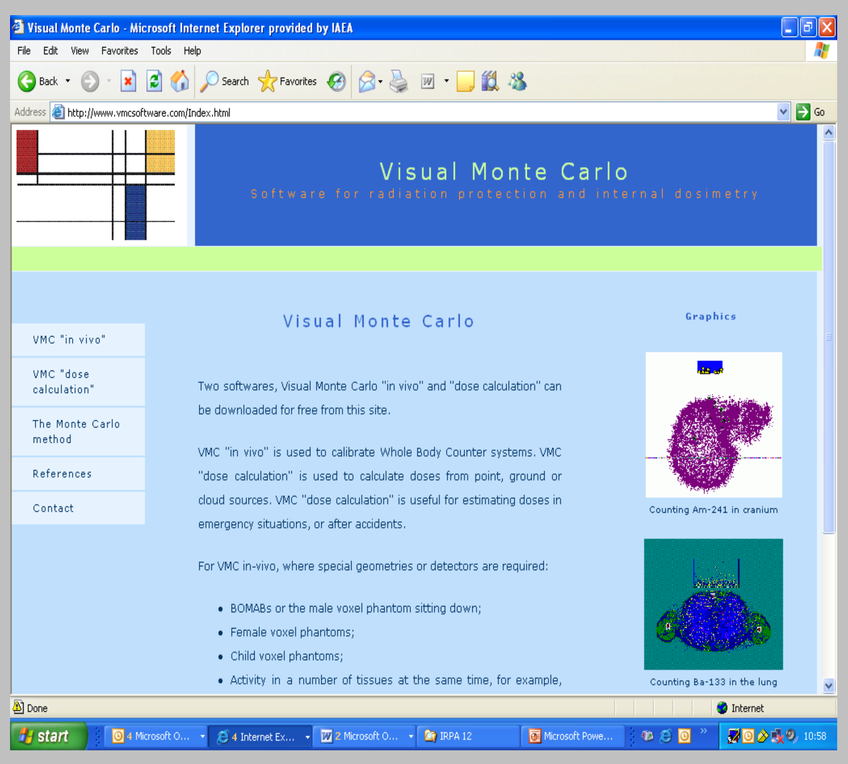




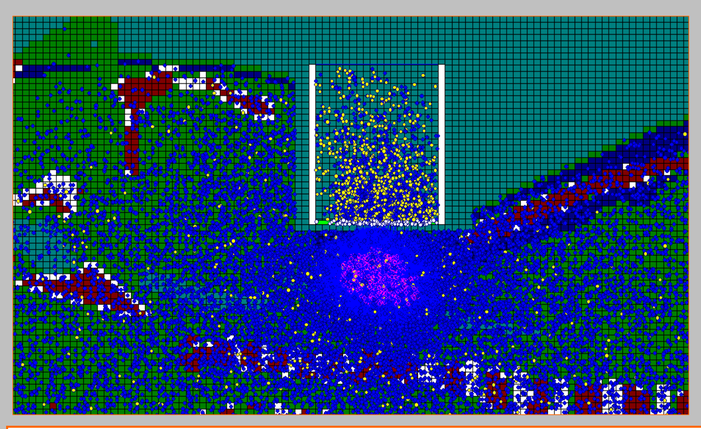
VMC in-vivo free download from vmcsoftware.com – considerable update will be available in July 2012

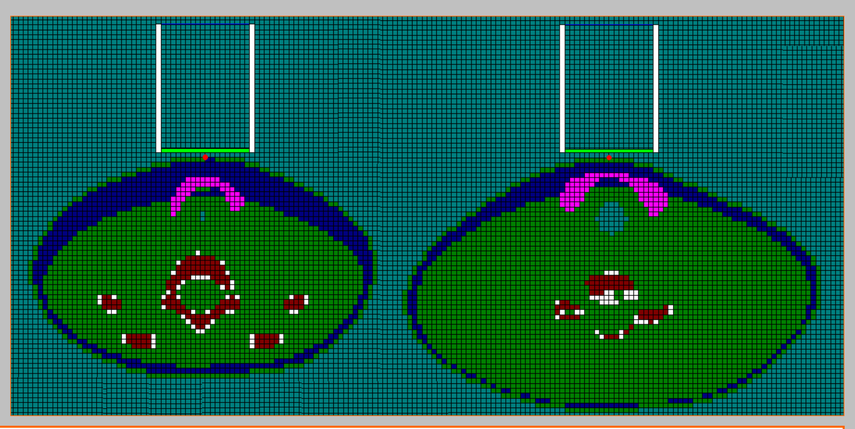
INTRODUCTION

The Monte Carlo program Visual Monte Carlo in-vivo (VMC in-vivo) was used to calculate the counts per second which would be seen on hand-held unshielded NaI detectors when placed over the thyroid of members of the public who have suffered intakes after a serious accident at a Nuclear Power Plant.

MATERIALS AND METHODS

VMC in-vivo simulates a nuclear transformation of the radionuclide in the tissue of interest, transports the photons through the voxel phantoms, and then simulates the detection. VMC is written in Visual Basic version 6 . Four phantoms were used for this study. The voxel phantoms used were the ICRP male reference phantom and the 5, 10 and 15 year old male hybrid phantoms produced by the University of Florida (Many thanks to UF for the phantoms). The left figure below show the simulation of the counting of 131I in the thyroid of a 5 year old with an Identifinder. The figure on the right below shows transverse cuts looking at the same geometry for the 5 and 10 year old phantoms.

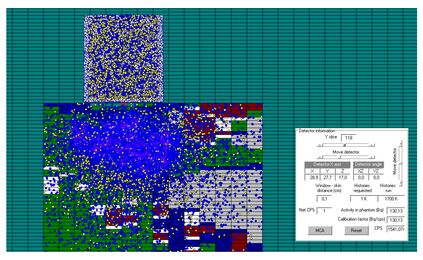




VALIDATION

VMC results for counting 18.2 kBq of ^{133}Ba (^{131}I substitute) in the thyroid of a phantom.

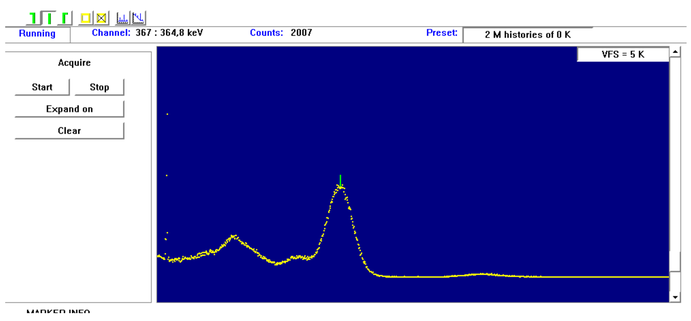
Distance to surface thyroid phantom (cm)	Identifinder measurement (net cps)	VMC calculation (cps)	Ratio of Identifinder cps to VMC cps
0.1	1200	1310	0.92
4.8	410	366	1.1
9.8	170	153	1.1

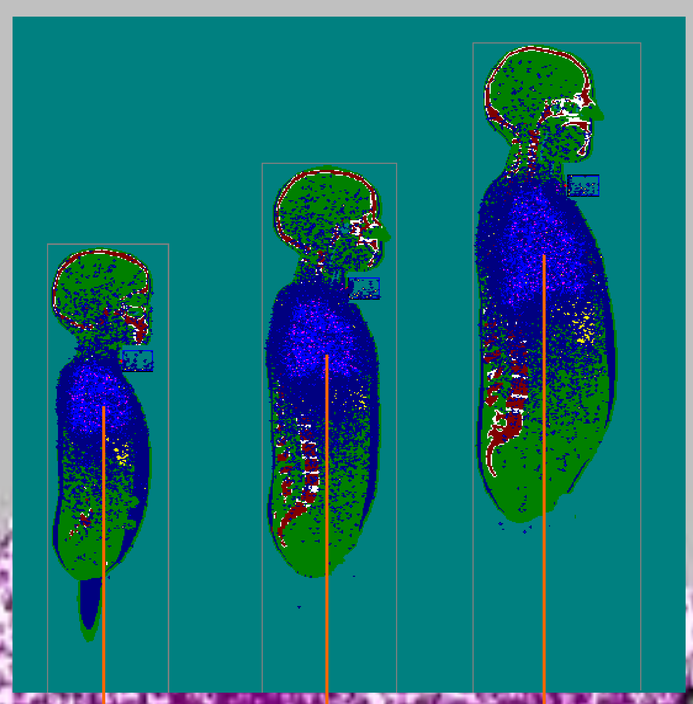


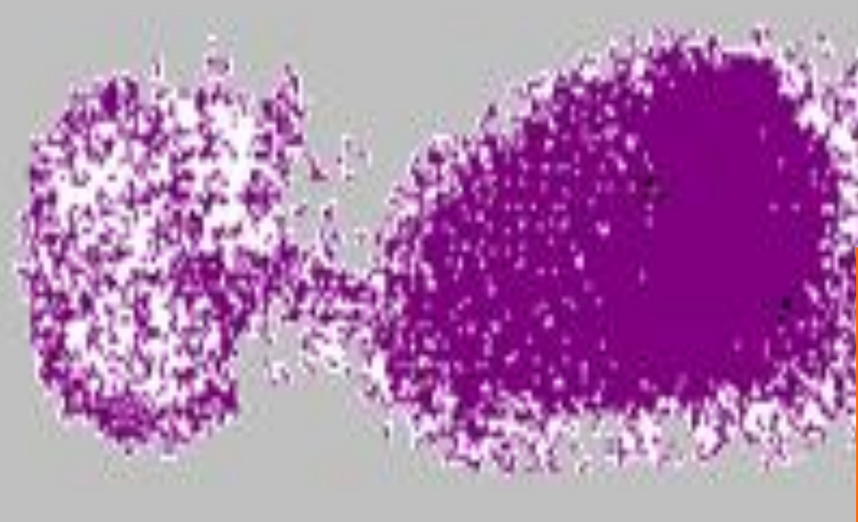
RESULTS

The results of the simulation are as follows:

Calibration factors for radio-iodines in the thyroid counted at the thyroid with an Identifinder (cps/kBq)				
Radionuclide	5 y	10 y	15 y	Adult
I-131	57	56	48	33
I-132	120	119	103	71
I-133	105	102	85	53
I-135	43	43	37	26







MORE RESULTS

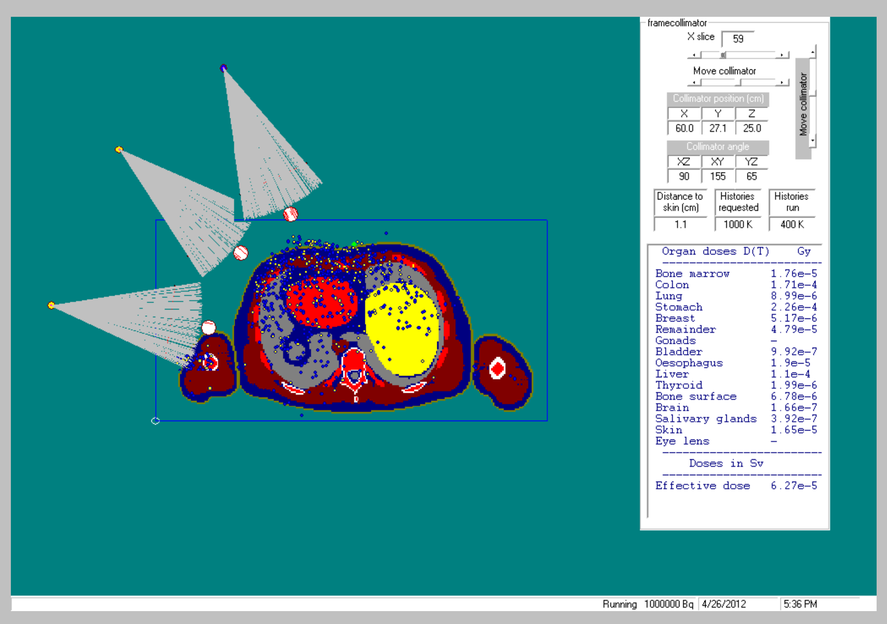
A “Chernobyl” release mixture of radionuclides was assumed, including iodine and caesium radionuclides, and also insoluble radionuclides which are deposited in the lung. The cross-fire from the radionuclides deposited in the lung for the identifinder located at the thyroid was also calculated. The results are given in the following table:

	Released	Inhaled	Tissue or organ	cps at thyroid with identifinder			
	PBq	kBq		5y	10y	15y	adult
I-131	1760	1.76	Thyroid	100	99	84	58
I-133	910	0.91	Thyroid	96	93	77	48
			subtotal	196	192	161	106
Cs-134	47	0.047	Soft tissues				0.08
Cs-136	36	0.036	Soft tissues				0.09
Cs-137	85	0.085	Soft tissues				0.06
			subtotal				0.23
Zr-95	84	0.084	Lung	0.41	0.33	0.31	0.26
Mo-99	100	0.1	Lung	0.77	0.55	0.52	0.43
Ru-103	200	0.2	Lung	1.139	0.87	0.83	0.68
Te-129m	240	0.24	Lung	0.057	0.022	0.017	0.024
Te-132	1150	1.15	Lung	15	11	9	8
Ba-140	240	0.24	Lung	3.1	2.2	2.2	1.8
Ce-141	84	0.084	Lung	0.39	0.27	0.25	0.21
			subtotal	20	15	14	11

OTHER WORK WITH VMC

DOSE CALCULATIONS IN FLUORSCOPY

Dose calculations for CT scans. The simulated X-ray beam with rectangular collimator is rotated around the phantom as it moves up the longitudinal axis.



CONCLUSIONS

1) It is not necessary to use a shielded NaI detector to estimate the iodine activity in the thyroid, even in the presence of considerable lung and whole body contamination.
2) The radioisotopes of cesium distributed over the whole body do not contribute to the cps measured by the identifinder located at the thyroid. Not only is the inhaled activity much lower for the radio-cesium, but also the spread of the radio-cesium over the whole body significantly reduces the calibration factors in cps/kBq.
3) The radionuclides deposited in the lung contribute around 10% of the cps measured by the identifinder located at the thyroid in relation to the direct count of the iodines deposited in the thyroid, for all ages.