Letter to the Editor

Sir,

Whole-body counting (WBC) is a method for measuring and determining the body burden of gamma-emitting radionuclides. The Research Institute for Industrial and Sea Hygiene, Saint-Petersburg, Russia^(1, 2), has designed a human whole-body phantom, IRINA, to be used for calibrations of WBC systems. We have created voxel phantoms of the IRINA phantoms in a lying geometry, in a total of six voxel phantoms, for usages of Monte Carlo (MC) simulations. All the six voxel phantoms are now available through the Nordic Nuclear Safety Research website⁽³⁾ together with a detailed description of the method used to create them⁽⁴⁾.

IRINA consists of a number of polyethylene blocks, called scatterers (density 0.95 g cm^{-3}) and radionuclide sources. The scatterers come in two sizes: $110 \times 165 \times 55 \text{ mm}^3$ and $110 \times 165 \times 25 \text{ mm}^3$. Two vertical channels, aimed for the insertion of the rod-shaped sources, run parallel to each scatterer's height (165 mm). The scatterers can be assembled to represent six different human bodies, who are either laying down, sitting or sitting bending: a 1-y-old with mass of 12 kg, a 6-y-old with mass of 24 kg, a 14-y-old with mass of 50 kg and an adult with mass of 70, 90 and 110 kg, respectively.

Voxel phantoms are commonly created by segmentation of CT or MRI image sets of the real-life phantom, which is a favourable technique for complex geometries such as the human anatomy. This gives a three-dimensional array, whose dimension is determined by millimetre/pixel and slice thickness, where each element defines the position and material composition of a voxel in the *xyz*-space. However, the less-complicated structure of the IRINA phantom made it possible to construct the voxel phantoms without using segmentation of CT or MRI image sets. Instead, the voxel phantoms were created in MATLAB[®], which is a strong computational tool for matrix manipulations. The dimensions of a large scatterer are related by 2:3:1. Each scatterer was divided into six unit cubes, with sides of 55 mm. Each unit cube was further separated into slices of 9×9 voxels, thus measuring $6.1 \times 6.1 \times 55 \text{ mm}^3$. The sizes were chosen so that the voxel in the middle of each unit cube defined the channel in which a rod source could be placed. The smaller scatterers were not separated into unit cubes but treated as single units with slices consisting of 9×4 voxels. Analogous to construction

using building blocks, the six IRINA voxel phantoms were modelled by stacking unit cubes and smaller scatterers. The MATLAB[®] method has three advantages: (1) no need of CT or MRI systems, (2) geometries are not limited by the scan dimensions of a CT or MRI and (3) the voxel size can easily be optimised to the phantom modelled.

To provide a generic IRINA voxel phantom, with respect to MC code, the same file structure as in the ICRP computational phantoms of the Reference Man and Reference Female was used: the voxel phantom contains an array of voxel identification numbers, in ASCII format, with the same orientation in the *xyz*-space as the ICRP phantoms. Each identification number tells whether the voxel is part of a scatterer, air or a channel in which a rod source can be placed. Each channel has its own identification number to enable a wide range of possible voxelised source distributions. Each IRINA voxel phantom comes with a documentation showing the position of each channel.

REFERENCES

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