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Abstract

In routine monitoring whole body counters are able to identify and quantify trace amounts of radionuclides that are taken into the body by gamma spectrometry. The applicable range of these measurements is limited by the energies of the photons emitted by the nuclides. Generally speaking: the lower the energy of the photons, the larger their absorption inside the human body or the more complicated the detection outside the body. Additional technical difficulties make measurements in the energy range below 100keV complicated. Emitting photons of energy 46.5keV lead 210 a progeny of radon lies in this area. In-vivo measurements of Lead -210 can be taken as indication of chronic exposure to radon. In the in-vivo monitoring laboratory (IVM) at Karlsruhe Institute of Technology it is foreseen to conduct measurements of lead 210 to assess doses from exposures to radon.
In this project the in-vivo measurements of Lead-210 were prepared (as well as two PhD theses about this). The detectors that will be used to construct the new whole body counter have been characterized and modeled for Monte-Carlo simulations in great detail. The applicability of the detectors for in-vivo counting has been tested and demonstrated by measurements of persons and phantoms. Based on a CT scan of a calibration phantom (LLNL torso) available at IVM a voxel model was created. Voxel2MCNP, a valuable tool which can be used for the easy handling of complex models and to set up virtual scenarios for the simulation, has been developed during the project. All models developed in this project have been validated for later use by comparison of measurement and simulations. Using the models a generic systematic sensitivity analysis of the parameters, that influence the detection efficiency of whole and partial body counters, has been conducted. Methods that enable an adaption of existing (standardized) models of the human body to a given individual person which is about to be measured have been developed. Using these methods a better agreement of the geometries of calibration and actual measurement and thus an improved determination of the real detection efficiency can be achieved. An innovative method, based on simulations of different models of the human body the optimal configuration of the new whole body counter using four detectors has been determined. Detector mountings providing all of the required degrees of freedom have been constructed. A prototype with two detectors of the new counter was installed and used for tests and last modifications before fixing the final set up. The installation of the new whole/partial body counter in a shielding chamber of IVM is scheduled for summer 2010. Routine measurements with the new installation will be started after calibration measurements in fall. Based on the sensitive measurements of Lead-210, which then will be available, a better estimation of doses resulting from exposures to radon and its progeny will be possible.