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Monte Carlo validation in the diagnostic radiology conditions.

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Radiation transport phenomena have been extensively studied by application of the Monte Carlo technique. This was proven to be by far the most successful technique for the simulation of the stochastic processes involved in radiation detection. During the last decade, various Monte Carlo simulation packages have become commercially available, however constrained by expediency and feasibility. One of these, MCNP, is a general-purpose, generalized geometry, coupled photon/electron/neutron Monte Carlo transport code. The present paper aimed to the validation of Monte Carlo simulation codes already developed by the reporting team, for the study of photon transport, photon absorption and x-ray fluorescence generation phenomena occurring in scintillators employed, in ordinary x-ray medical imaging modalities (general conventional and digital radiography-fluoroscopy and computed tomography).Comparisons are reported between the developed codes, MCNP developed codes and other published data. First, the depth of energy deposition in water was assessed for three monoenergetic x-ray beams (15, 20, 30 keV). A water slab of 10 cm thickness and infinite width was simulated. Exposure was modeled as a narrow beam of photons normally impinging. The energy deposited in slabs of varying depths was tallied. Excellent agreement within ±2% was achieved, except that for 15keV were a more rapid drop with increasing depth was found. Second, the lateral spread of energy deposition was assessed in a 1cm thick slab in the centre of an 8cm thick water phantom, irradiated by a 50keV narrow beam. Again, agreement within ±2% was achieved. Third, a water slab with thickness 5, 10, 15, 20 cm was modeled irradiated by a monoenergetic narrow beam of photons of various energies. The mean number of interactions for each incident photon was determined and compared to published data. Agreement to within ±2% was achieved. Last, the relative scattered x-ray photon fluence as a function of exit angle was determined, using a 4cm thick Plexiglas phantom irradiated by a 27.3keV photon beam. Aggreement between published and modeled data was also found. Further comparisons were performed with published data on Gd2O2S scintillator (coating thickness of 90 mg/cm2 at disk geometry) exposed to a photon source without collimation 10cm above the disk.

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