1.4.27. MONTE CARLO SIMULATING THE ELECTRON EMISSION FROM SURFACES OF OBJECTS BEING UNDER RADIATION

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Mathematical modeling of the interaction processes between ionizing radiation and objects of a complex geometry and inner structure is of great importance in many radiography applications. Electron fluxes appearing as a result of elastic and inelastic scattering of photons in matter of object should be taken into account correctly for adequate analyzing the X-ray images of objects. Developing modern X-ray equipment also requires using of effective and valid methods of electron escape evaluation for optimization and minimization of experimental testing of the equipment. The Monte Carlo method has an advantage over alternative algorithms based on the numerical solution of a kinetic equation which is determined by the ease and the solvability of complex bounded problems in the multicomponent objects. The effectiveness of using the Monte Carlo method is currently determined firstly by developing approaches of decreasing the statistical error of calculation results and secondly by the progress in the multiprocessor computing.

The technique of statistical modeling the transport of electron appearing in matter under radiation is considered in the report. The model of thickened trajectories (MTT) is the central part of the technique. The advantage of the MTT is to save the calculation effectiveness without using the rough distributions of the multiple scattering theory. The electron characteristics distributions for MTT are obtained beforehand using the so called model of individual collisions (MIC). The MTT and the MIC have approximately the same accuracy but the first model is considerably more effective than the second one. The distributions for modeling the electron emission from the surface of an object under gamma radiation are obtained by use of MTT. The electron path in matter is modeled in MTT by making use of the so called “embedded trajectory”. In contrast to the real trajectory when the nodes are the collision points the transition from one embedded trajectory node to another one is the result of the multiple scattering.

The method of modeling the electron production is based on the principle of the maximum of information value of the photon trajectories. Semi-analytical modifications of the Monte Carlo method are made relying on changing the part of random quantities by their probable values. In particular, the fast electron production resulting from the interaction between photon radiation and matter is considered as deterministic process rather than a random event. The statistical weight of the electron is calculated at that with use of built distributions of conditional probabilities. The original algorithm of registration (determination) of the electrons leaving the object surfaces is developed. The algorithm is universal enough to be used in applications. The created technique of modeling the electron emission is realized as parallel code for computing on the modern multiprocessor systems.

Developed technique is demonstrated by computing the fluxes of electrons escaping from surface of aluminum tube irradiated by coin source of X-Ray from the top (fig. 1) and by calculating the electron energy distribution in molybdenum target on the surface of which pencil beam of 100 kev electrons is falling normally (fig. 2).

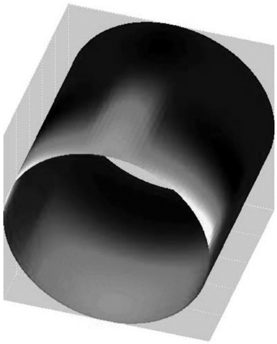

Fig. 1. Electron flux distribution on outside surface of tube

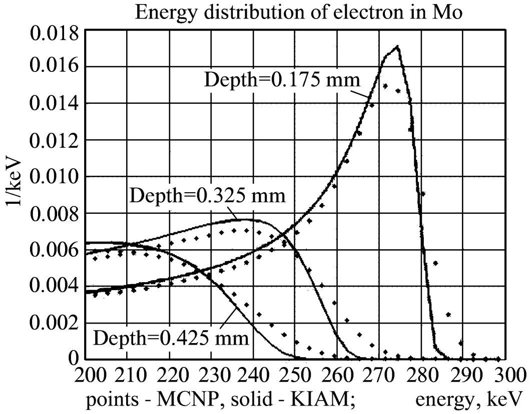

Fig. 2. Energy distribution of electrons in dependence on depth in target

It should be noted that computing with use of developed technique is more as ten times faster than MCNP calculations at the same error level.