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UNCERTAINTY OF THE METHODS OF NUMERICAL DIFFERENTIATION OF DEPTH DOSE DISTRIBUTIONS OF ELECTRON RADIATION

Computer simulation of the absorbed depth-dose distributions in an irradiated products requires the data sets such as the properties of products at radiation processing, and also about the actual parameters of radiation facility. The formal procedure for determining the electrons energy for radiation installations using electron beams is well known [1]. However, the methods for determining the energy are based on the measurement of depth-dose distribution with dosimetric wedge or stack. And therefore, the formal procedures for determining of the electron energy require numerical differentiation of the depth-dose distributions of electron radiation.

Comparison methods of numerical differentiation the electron radiation dose, with use of various types of approximations of measurement results, are given in [2]. In the paper [2] it is shown that the methods of fitting a semi-empirical model of the absorption energy of electrons or polynomial approximation of measurement results allows, with reasonable accuracy calculate the values of first derivative of the dose distribution with respect to depth. It is noted that the considered computational methods are suitable for the assessment of values of second derivatives for the depth-dose distributions.

Evaluation of the accuracy of computational methods processing of measurement results in paper [2] was performed on the basis of numerical experiments data [3] obtained with very low statistical errors. Obviously, when comparing the processing methods of measurement results, it should be taken into account the effect of random errors of processed data in the calculation results.

In this paper, it was performed a comparison methods of numerical differentiation of distributions of electron radiation dose obtained on the base of measurements results with using standard dosimetry wedge and stack [4]. It was estimated the uncertainty of the calculation methods of the first and second derivatives of the depth-dose distribution of electron radiation performed on the basis of a semi-empirical model of electron energy absorption or polynomial approximation of measurement results.

The performed numerical studies have shown that method of parametric fitting of semi-empirical model for the electrons absorption energy to the measurements results is stable relatively the value of the statistical error of measured values. It generalizes the conclusions of the paper [2] relatively the method of parametric fitting the semi-empirical model to the measurement results.

The polynomial approximation methods of measurements results are unstable to the magnitude of the statistical error of measured values, as shown in several numerical examples. This means, that the traditional application of the polynomial approximation of the measurement results can lead to great uncertainty, and to incorrect computational methods. In particular, this conclusion applies to paper [5], which proposes a method for determining the practical range based on electron approximation polynomial of the 4th degree of measurements results for depth-dose distribution of electron radiation.

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