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RECONSTRUCTION OF THE ELECTRON SPECTRUM FROM DEPTH DOSE DISTRIBUTION WITH THE MODIFIED TIKHONOV REGULARIZATION

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Radiation technologies are widely used in various fields of science and medicine. Usually, electron accelerators are utilized as radiation sources. It is necessary to control the energy spectrum of the emitted electrons because it significantly affects the result of exposure to the electron beam. Measuring spectra directly is a difficult and non-trivial task that requires specialized equipment. Thus, it seems to be natural to look for alternative methods of obtaining the energy spectrum of an electron beam.
One of these methods is to reconstruct the beam spectrum from the depth dose distribution. The corresponding inverse problem is usually posed in the form of the Fredholm equation of the first kind. This problem is ill-posed and requires regularization. Usually, Tikhonov regularization a classic zero-order stabilizer is used [1]. However, for beams whose spectra have narrow peaks, this method does not give a satisfactory result. The reconstructed spectrum is excessively smoothed in the region of the peak, and outside the region of the peak, the spectrum is not sufficiently smoothed, and nonphysical oscillations are practically untouched [2]. Increasing the order of the stabilizer does not improve the results, since the peaks also have relatively large derivatives, and, therefore, are subjected to excessive smoothing once again. Thus, the classical regularization method requires modification. The paper proposes a modification of the Tikhonov regularization method, which provides a solution to this problem. The modification consists in introducing nonnegative weight functions into zero and first order stabilizers.
The result of the work was a numerical matrix method for solving a regularized problem. Various types of weighting functions were considered. It was found that the spectra reconstructed with weights having a negative power-law dependence reconstruct spectrum more accurately the position of the spectrum peak and its width.
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