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EVALUATION OF DOSE DISTRIBUTION AROUND IR-192 BRACHITERAPY SOURCE USING PENELOPE CODE

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***Abstract*:** Application of radiation technologies for the treatment of cancer patients requires knowledge about the exact dose which was planned and delivered to the cancerous tissue during the procedure. Usually dose plans are prepared using standard dose planning system however dose plans should be verified using independent dose calculation method and algorithm. Since experimental in vivo dosimetry in brachytherapy is very complicated, modeling results could be used instead of experimentally obtained values.

Monte Carlo based PENELOPE code was used for modeling of dose distributions around Ir-192 brachytherapy source in air and in water. Required simulation accuracy was achieved comparing theoretical calculations and simulation results. Modeling results have been analyzed and are discussed in the present paper.

***Keywords*:** brachytherapy, dosimetry, isodose, Monte Carlo Method.

1. Introduction

In brachytherapy it is important to know precisely dose distribution around radioactive source. Dose optimization is possible analyzing dose modeling results and the results of experimental measurements. Dosimetric methods, though always required, are not always trustworthy. Reliability is essential, when patient health is put under the risk. In therapy dosimeters are allocated in certain positions close to the radiation source, but due to mechanical movement and nature of the source these positions not always coincide with the real dosimeter positions during treatment resulting in significant errors or even loss of data. In such a case application of simulation methods is preferable. GEANT, EGS and PENELOPE are mostly used computer codes for scientific calculations [1].

2. Methods and materials

PENELOPE simulation algorithm is based on a scattering model which combines a set of databases with analytical cross-section area models. These models are designated to different interaction mechanisms and simulate photon transport energies ranging from few by means of the conventional detailed method.[2].

In Monte Carlo simulation the track of a particle is recognized as a random sequence of free flights that end with an interaction event where the particle changes its direction of movement, loses energy and, occasionally,

produces secondary particles [2]. Water is used in order to have dose distributionin in tissue like material Air is used to replicate experiments with films. Radioactive source is placed within the sphere of 15 cm diameter made of water or air. Similar size phantom was mentioned by Francisco Javier Casado [3], where Iridium-192 source is being characterized. For dose measurements in air phantom diameter was equal to 5 meters. When particle escapes the sphere, it is nullified as there are no scattering objects. Brachytherapy source is described as 3 mm diameter sphere made from Ir-192 and surrounded by stainless steel sheat of 0.5 mm diameter which absorbs electrons. At the energy of 370 keV of brachytherapy source Rayleigh scattering, photoelectric effect and Compton effect and are the main interaction processes. Measurement plane is chosen with respect to tumour size and kept near the source. Measurement plane is a square with side of 2 cm. Simulation parameters for materials where selected with respect to simulation presented in Julio F. Almansaa [5] article.

3. Results and discussion

For the first simulation, water was adopted as the medium material in order to obtain dose distributions corresponding to specific human tissues. It is common practice to use water as a phantom material in dosimetry experiments [6].During the modeling 108 primary particle were simulated, simulation speed was 1648 particles per second and simulation took 17 hours of computation. The result is shown in Fig. 1. Isodoses correspond to the certain energies, which are expressed in percentage. Hundred percent boundaries are equivalent to source size. The measurement plane is 2