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Application of monte carlo simulations in medical physics: examples in breast cancer, pancreatic cancer, and ocular melanoma

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Monte Carlo simulations have emerged as a powerful tool in medical physics, allowing for accurate calculations of radiation dose distributions in complex geometries such as the human body. MCNP (Monte Carlo N-Particle) is a widely used code for these types of simulations, capable of modelling various radiation sources and transport mechanisms. In the field of radiation therapy, MCNP can be used to optimize treatment planning by accurately predicting the dose delivered to target volumes and nearby healthy tissue. Specific examples include breast cancer treatment, where the shape and location of the breast tissue can be accurately modelled to deliver precise doses to the tumor while minimizing damage to surrounding healthy tissue. Other examples include pancreatic cancer, where the location and shape of the pancreas and nearby organs at risk can be taken into account for more effective treatment planning, as well as melanoma of the eye, where the shape of the eye and surrounding tissues can be accurately modeled to optimize radiation dose distribution. The use of MCNP in these applications has shown promising results in improving treatment outcomes and reducing side effects.

By using MCNP, we can simulate and optimize radiation therapy treatments, including VMAT (Volumetric Modulated Arc Therapy), for different tumor sites. By integrating MCNP with treatment planning software, we can create treatment plans that are personalized to each patient's unique anatomy and tumor characteristics, leading to more effective and precise radiation therapy treatments.

Recent publications

1. Krstic, D., Nikezic, D., Jeremic, M. Z., Dolicanin, E., Miladinovic, T. B., & Zivkovic, M. (2023) Comparison between MCNP and planning system in brachytherapy of cervical cancer. Appl Radiat Isot, 192, 110614.
2. Yu, Kwan Ngok; Watabe, Hiroshi; Zivkovic, Milena; Krstic, Dragana et al. (2023) DynamicMC: An Open-source GUI Program Coupled with MCNP for Modeling Relative Dynamic Movement of Radioactive Source and ORNL Phantom in a 3- dimensional Radiation Field. Health Physics 124(4): 301-309.
3. Dragana Krstić, Dragoslav Nikezić, Milovan Matović, Suzana Pantović, Marija Ž. Jeremić. (2017) BIOKINETIC AND DOSIMETRY OF 90Y-DOTATOC THERAPY FOR NEUROENDOCRINE TUMOURS. Kragujevac J. Sci. 39: 47-52.

Biography

Krstic studied Physics at the University of Kragujevac, Serbia. She received her PhD degree in 2007 at the same institution. The main subject of research was radiation and medical physics. For dose-determining particles by particle transport codes involved, such as MCNP; owner of the license for the latest MCNP6.2 software. It is also ongoing research in the field of nuclear medicine; recently there was an emphasis on proton boron fusion therapy (PBFT) investigations; Participation in the Voxel Phantom Intercomparison, organized by Eurados 2017. Dragana Krstic has published about 90 papers in journals and most of them were related to the calculation with MCNP. She and D. Nikezic developed input files for MCNP with ORNL and a voxel model of a standard man in a standing position. ORNL phantoms are in the MCNP Medical Physics Geometry Database (D. Krstic and D. Nikezic, U. of Kragujevac, Serbia). Hirsch's index is 12 (according to Scopus) and she obtained about 500 citations.

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