Thermoluminescent dosimetry planning through MNCP

Thuany Nogueira[1], Cristhian Talacimon[1], Lara Teodoro[1], Maria Rigo[1], Priscila Rodrigues[1], Lucas Angelocci[1], Hamona Novaes[1], Carlos Zeituni[1], Maria Rostelato[1]

Email:thuanynogueira@usp.br
[1]Instituto de Pesquisas Energéticas e Nucleares, Universidade de São Paulo (IPEN/USP), Avenida Professor Lineu Prestes, 2242, Cidade Universitária, São Paulo SP, CEP 05508-000, Brazil.

Introduction

Sealed radioactive sources of 125I are tiny seeds that are injected into organs using thin needles through the skin. These sources are being developed and manufactured at IPEN/SP. To use these sources in brachytherapy, it is necessary to perform a dosimetric characterization following the AAPM TG-43 protocol. This protocol provides theoretical and practical guidelines for calculating doses in water or equivalent materials. Experimental measurements were made using thermoluminescent dosimeters (TLDs) to calculate radiation doses. These measurements were corrected and validated by comparison with computer simulations using the Monte Carlo Method. The Monte Carlo Method is a set of algorithms that use random number sampling to obtain reliable numerical results. It is widely used in computational dose calculations and in determining photon distribution in simulated objects. The MCNP (Monte Carlo N-Particle Transport Code) is one of the codes that uses the Monte Carlo Method and has several applications.

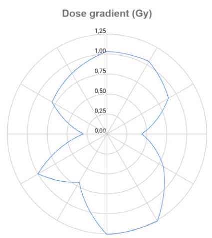
Methods

For the acquisition of the necessary parameters for the TG-43 protocol, solid water phantoms were used together with a plate that has a central space for positioning the 125I source and for radial distribution of the dosimeters. To calculate the measurement of this dose, the MCNP was used to determine the time required for the TLDs to reach 1 Gy, as described in the TG-43. program input, as well as the physical aspects of the source (emission energy, particle type, direction), the materials of all simulated structures and the expected detector response. The correction for energy dependence is given by the dose ratio in the value found in the literature is 1.049.

Results

The use of MCNP for the planning of 125I seed dosimetry shows that the results are promising, as seen in figure 1.

Figure 1: Dose gradient around the iodine seed



Conclusions

The Monte Carlo simulation with MCNP is a powerful tool in dosimetry, achieving the desired dose with the time calculated through the MCNP, in addition to being used to determine the other parameters of the TG-43.

Extensions of PenRed for Computed Tomography Simulation and Brachytherapy Treatments

V. Gimenez-Alventosa[1,2], S. Oliver[3]

Email:gialvi@uv.es
[1]Departament de Física Atòmica, Molecular i Nuclear, 46100 Burjassot, Spain, [2] Instituto de Física Corpuscular, IFIC (UV-CSIC), 46100 Burjassot, Spain. [3]Instituto de Seguridad Industrial, Radiofísica y Medioambiental (ISIRYM), Universitat Politècnica de València, Camí de Vera s/n, 46022, València.

Introduction

PenRed is a highly parallel, efficient, and adaptable code for Monte Carlo simulations, written in C++ language, which incorporates the physics and functionality of PENELOPE. It is distributed as open-source code (https://github.com/PenRed/PenRed). While it is a general-purpose code, its development has focused on medical applications. With this purpose, different specific modules have been implemented to allow for the automatic simulation of computed tomography (CT) devices and brachytherapy treatments.

Methods

For CT simulation, two main modules have been implemented: a particle source that accurately simulates the movement of a CT scanner and a second module that collects photons that reach a user-specified virtual detector, generating a sinogram of the irradiated object.

On the other hand, taking advantage of PenRed's capabilities to process DICOM images, a source for brachytherapy treatment has been implemented. This source retrieves information about the seeds directly from the DICOM RT PLAN and samples the particles considering each position and its temporal weight. Moreover, a module has been implemented to calculate the kerma distribution in a user-defined Cartesian mesh. Additionally, the software generates dose-volume histograms (DVH) for each segmented organ.

Results

With the newly implemented capabilities, sinograms have been obtained for a Catphan-type phantom, and for patients using their DICOM images. Regarding brachytherapy treatments, dose distributions have been obtained for four non-clinical reference cases developed by AAPM/ESTRO/ABG/ABS and clinical cases have been verified using their DICOM plans through DVH analysis and isodose curves.

Conclusions

The obtained results demonstrate the capability of PenRed for use in the field of medical physics, as well as its reliability. Furthermore, these capabilities streamline these types of studies by automating a significant portion of the process, making it seamless and transparent to the user.