Master 2 internship proposal
WP5 LabEx PRIMES

Research group : Health & Environment department, Laboratoire de Physique de Clermont, UMR 6533 UCA-CNRS
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Subject : Validation of the GATE platform for the calculation of the biological dose in hadrontherapy.

Training period : 6 months, usually February to end of July 2022

Overview

One of the current challenges of hadrontherapy is the evaluation of the biological effects due to microscopic energy deposits of ions. The goal of treatment planning systems (TPS) is to optimize beam parameters taking into account their predictions by calculating the biological dose in addition to the physical dose. To estimate the biological dose, biophysical models have been developed such as the mMKM and NanOx models. The input parameters of the models can be estimated with Monte Carlo track structure codes such as Geant4-DNA and LPCHEM codes. These two codes are capable of simulating ionizing radiation down to a few eV as well as the quantification of the species generated during the radiolysis of water between 10^{-12} and 10^{-6} s. Biophysical models, coupled with Monte Carlo codes, allow complex dose calculations at the voxel scale. As part of a thesis work, funded by LabEx PRIMES, the Monte Carlo GATE simulation platform has been improved by creating a biological dose calculation tool (the "BioDose actor"), tested and validated in the water for protons, helium and carbon ions beams.

Purpose of the internship:

The BioDose actor must now be tested and validated on patient CT images for different types of treatments using beams of protons and carbon ions (single Bragg peaks and SOBP). We will work on the medical lines of the Antoine Lacassagne center in Nice, HIMAC in Japan and MedAustron in Austria.

First, the trainee student will use the BioDose actor on heterogeneous voxelized phantoms; different voxel sizes will be tested before working on segmented CT images of patients (different locations). Performance tests will be carried out.

Secondly, the biological doses calculated with GATE will be compared with those obtained from a treatment planning software such as the Raysearch software.

The student will work in a multidisciplinary team and will have all the IT resources necessary to complete his internship. If the sanitary context requires it, we will put in place the best possible conditions so that the student can telework.

Required skills: C ++ programming, Git, Linux, Geant4 / GATE, good practice of English