12 month Post-Doc position for simulation and modeling in radiobiology

PRIMES LabEx

WP5 : Image-based Simulation and Modeling & WP3 : Radiobiology and modeling for innovative radiotherapy

Characterization of biological effects of radiation on 3D cell populations using the Monte Carlo simulation platform GATE based on Geant4 and Geant4-DNA

Supervisor: Lydia Maigne, associate professor, HDR
Pôle Physique pour la Santé et l'Environnement, http://ppse.in2p3.fr
Laboratoire de Physique Corpusculaire UMR6533
Campus Universitaire des Cézeaux
4, avenue Blaise Pascal, TSA 60026, CS 60026
63178 - Aubière Cedex
France

Contact:
Lydia Maigne : maigne@clermont.in2p3.fr

Context :

The implementation of targeted cancer therapies often requires working on 3D cell models (spheroids) able to get closer to the in vivo behavior of cancerous tissue. The study of these cell populations, subjected to different types of ionizing radiation, can provide information on the ability of cancer cells, particularly resistant to radiation, to evolve with agents promoting their radiosensitivity (such as chemotherapy or nanoparticles).

Within the RACE (Radiation Resistance of Cancer cells using Geant4-DNA) project, the department for Health and Environment of LPC of Clermont-Ferrand jointly with INSERM UMR990 laboratory, has been working for over a year to better understand the mechanisms of radiation resistance of certain cell types (such as melanomas and chondrosarcomas) subjected to ionizing radiation. In this framework, we have developed a 3D cell population modeling platform, named as CPOP, coupled with the GATE platform (incorporating in the version 7.0 Geant4-DNA physical processes), in order to assess direct energy deposits by ionizing particles (electrons, photons, protons, ions ...) in realistic cell geometry.

To date, these modeling tools are being compared with biological data imaged using confocal γH2AX microscopy, they should be coupled with predictive algorithms of relative biological effectiveness (RBE) of radiation in order to provide a tool to better inform on the outcomes of some cancer treatments. Different calculation models are being developed to estimate the RBE. We can cite the Local Effect Model (LEM), developed by the GSI biophysics group in Darmstadt, and the microdosimetric kinetic model (MKM) developed by Roland B. Hawkins of Ochsner Hospital in New Orleans, Louisiana. Moreover, other approaches are also

discussed, as the Nanox model from IPNL or other recent approaches using Markov processes to monitor the evolution of cells after radiation and the repair mechanisms in function of time.

Description of the project:

In the department for Health & Environment of LPC Clermont-Ferrand, we wish to implement a coupling between the GATE platform based on Geant4 and Geant4-DNA physical processes and the MKM model to offer a multi-scale platform able to predict the effects of radiotherapy/hadrontherapy treatments on 3D cell populations. This project is part of the forthcoming actions of the WP5 and WP3 for the improvement and validation of the GATE platform and a better understanding of the biological effectiveness of radiation.

Actions to fulfill during the 12-month period:

- A first step will consist into coupling to the last release of GATE, the CPOP platform and the MKM model. An optimization process is required regarding the computing time of simulations on a distributed architecture (using for example the GateLab platform).
- The MKM model uses as input data the value of the energy delivered (ε) to a sensitive volume representing all or part of the cell nucleus. The value of ε to each energy deposition event can be measured by a gas detector called TEPC. In this detector, the measured electronic signal is proportional to ε. This technique allows to obtain the probability distributions for the linear energy y = ε / L in an equivalent spherical volume of a cell nucleus (1 micron). As a second step, the goal will be to validate measurements with the TEPC detector with GATE simulations. A TEPC detector (FAR WEST) is available at LPC; different experiments may be performed with different radiation modalities (low energy photons produced by a X-ray irradiator or proton beams or ion beams) through the National Research Infrastructure for hadrontherapy: France Hadron.

The candidate will join an active multidisciplinary research group composed of physicists, computer scientists and biologists.

This project requires skills in medical physics and computer science. The knowledge of different Monte Carlo algorithms and / or software will be highly appreciated, especially the knowledge of the C ++ language.

Salary: 2000 € /month
Employer: University of Lyon
Location: Laboratoire de Physique Corpusculaire, UMR6533, Clermont-Ferrand
Duration: 12 months, from 1st of January 2016 to 31st of December 2016

For more information:

Laboratoire de Physique Corpusculaire : http://clrwww.in2p3.fr
Department for Health and Environment of LPC: http://ppse.in2p3.fr
OpenGATE collaboration: http://www.opengatecollaboration.org
Geant4-DNA collaboration: http://geant4-dna.org
France Hadron : http://www.univ-bpclermont.fr/article2402.html

To candidate:

Send your CV with your PhD manuscript or last publications together with a cover letter by email to: maigne@clermont.in2p3.fr

If your application is successful, you will be contacted for an interview

Deadline to candidate: 1st of October 2015