Open PhD position:

"Improvement of nuclear physics models and simulation acceleration in the context of hadrontherapy"

Institutes:

The position is located in Lyon (France) in the following laboratories

- Centre de Recherche en Acquisition et Traitement de l'Image pour la Santé (CREATIS)
- Institut de Physique Nucléaire de Lyon (IPNL)

PhD supervisors: Jean Michel Létang (CREATIS) & Étienne Testa (IPNL)

Team members involved:

Denis Dauvergne, Cédric Ray, Étienne Testa (IPNL)

Nicolas Freud, Jean Michel Létang (CREATIS)

Funding:

FP7 European research project ENTERVISION, Marie Curie Initial Training Network

('People' Programme), check eligibility.

Project description:

The position is funded by a FP7-European research training project (ENTERVISION) associated to another FP7-European project (ENVISION) that aims at developing a novel imaging system for the monitoring of hadrontherapy. The work will be performed both in the "CAS-PhaBIO" experimental group of the Nuclear Physics Institute of Lyon (IPNL) and in the radiotherapy group of a medical imaging research center (CREATIS).

This collaboration has been working on hadrontherapy monitoring for more than 4 years. Three modalities are investigated: PET imaging, proton vertex reconstruction imaging and prompt gamma detection. Very promising experimental results have been obtained in prompt gamma detection with either a collimated or a Compton camera: real-time control of the dose deposition during hadrontherapy is no longer a speculative issue.

Besides experimental studies, complementary simulations with the Geant4 toolkit have been carried out (i) to evaluate the nuclear models available in this Monte Carlo code, (ii) to design our experimental setups and (iii) to test various gamma-camera configurations. Comparisons between measured and simulated data on prompt gamma detection have shown that Geant4 nuclear models must be reconsidered. This need has also been pointed out in other Monte Carlo codes (in particular FLUKA and MCNPX) by our ENVISION partners on the production of massive particles.

The first task of PhD project will be the study and the improvement of nuclear models for hadrontherapy which are the main topics of the project workpackage 2 and 3. This task will be carried out in close connection with a post-doc fellow at IPNL, Geant4 developers and other groups involved in this topic among ENVISION and ENTERVISION projects. The PhD student will be also involved in fragmentation experiments (in particular data analysis) that aim at providing detailed fragmentation cross-sections required to constraint nuclear models. A 3-month stay at GSI (Germany) is foreseen as a secondment for the researcher training.

The computation time of Monte Carlo simulations is another crucial issue beyond physics model precision. The second task of the PhD project will be the acceleration of Geant4 simulations for the emission of secondary particles (in the GATE environment). Hybrid techniques that combine Monte Carlo and deterministic approaches, have been developed for several years by researchers from CREATIS to accelerate Monte Carlo simulations of photon interactions with matter. These techniques have to be adapted to ion interactions with matter for the purpose of hadrontherapy imaging.

In the frame of the ENTERVISION initial training network, the student will participate to several courses aiming at providing fruitful exchanges and international recognition among the 15 PhD students and post-docs from the various European partners of the program.

Profile:
- A master in physics is required.
- Expertise in C++ programming is most useful.

Eligibility:
Eligible applicants
- have obtained their diploma granting access to doctoral studies since less than 5 years, and have not yet been awarded a doctoral degree;
- do not have french citizenship (exception if resided for >3 years of the last 4 years in a third state immediately prior to appointment);
- have not resided or carried out their normal activities in France for more than 12 months in the 3 years immediately prior to appointment.
- may be from third states, but applicants from EC and associated countries will be considered in priority.

How to apply:
Please send your application including a motivation letter, a Curriculum Vitae and a record of your scientific publications to
- Jean Michel Létang, e-mail: letang@creatis.insa-lyon.fr
- Étienne Testa, e-mail: e.testa@ipnl.in2p3.fr