Post doctoral / Engineer position in radiation protection (M/F)

"Simulation and assessment of secondary particle dose for very-high energy electron (VHEE) radiotherapy"

The hosting structure

Institut Curie
Institut Curie is a major player in the research and fight against cancer. It consists of a Hospital group and a Research Center of more than 3000 employees with a strong international representativeness. The objective of the Research Center is to develop basic research and to use the knowledge produced to improve the diagnosis, prognosis, and therapeutics of cancers as part of the continuum between basic research and innovation serving the patient. The Orsay Proton therapy Center (CPO) founded in 1991 is part of the radiation oncology department at Institut Curie hospital group, which is one of the European-wide recognition as a Comprehensive Cancer Center of excellence. This position will be associated with a research project at Institut Curie whose goal is to develop new treatment delivery methods for very-high energy electrons (VHEE) treatments, and their application to FLASH radiotherapy, and is an exciting opportunity to join the radiation therapy research activities in Orsay, within the hospital and the research center.

Laboratory
The Laboratory of Translational Imaging in Oncology (LITO) is a research unit (U1288) supported by Inserm (= French NIH) and Institut Curie, the first cancer center in France (https://www.lito-web.fr/). LITO has approximately 30 researchers, including physicists, engineers, physicians, pharmacists, and technologists.

Context

Radiation therapy is currently one of the main techniques used for cancer treatment. More than 50% of patients treated for cancer - about 180,000 per year in France - benefit from it. Over the last thirty years, numerous technical advances have made it possible to considerably improve the conformation of irradiation to the specific characteristics of each tumour and to reduce their side effects. Nevertheless, the tolerance of healthy tissues remains the main limitation of this type of treatment, particularly in the case of particularly radiosensitive patients, such as children, for whom controlling the side effects of radiotherapy remains a major therapeutic challenge. Recently, pioneering work conducted at Institut Curie has shown that ultra-high dose rate irradiation (known as FLASH) has a major effect in sparing healthy tissue - while preserving anti-tumor efficacy (Favaudon et al 2014).

VHEE radiotherapy (very-high energy electrons, in the energy range of 100 to 250 MeV), first proposed in the 2000s, would be particularly accurate and independent of tissue heterogeneities (unlike low energy electrons or protons), and could be applicable in a large number of deep anatomical localizations (Figure 1). It is also potentially much less expensive than other radiotherapy techniques, and would allow accelerated treatment, for example through magnetic scanning of particle beams, with high doses per fraction, thereby improving its effectiveness. It is also possible to take advantage of recent work on FLASH - in which a high dose is administered to the tissues in an extremely short time - allowing the simultaneous reduction in the occurrence and severity of early and late complications affecting normal tissues, while maintaining control of the tumour (Ronga et al 2021).

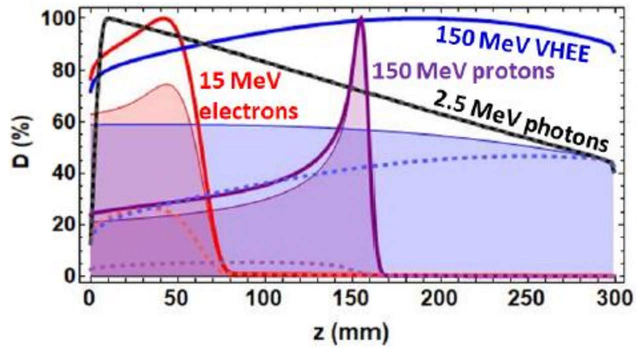

Figure 1: Depth dose distribution in water for several types of radiation (photons, electrons, protons) (A Lagzda 2019).

It is however important for the clinical development of VHEE electron beams to consider the contribution to the equivalent dose received by the patient of neutrons, photons and induced radioactivity at very high energy, and to evaluate the production of neutrons, photons and radioactivity from the radiation protection point of view (patients and workers). The contribution of secondary particles produced by bremsstrahlung and electronuclear interactions must also be analysed, as well as their potential effect on radiation biology as a function of dose-rate or linear energy transfers (LET). As Monte Carlo techniques are the golden standard for radiation transport calculations, the applicant will therefore simulate the irradiation and possible contribution from secondary particles during VHEE treatments, and assess the feasibility of VHEE irradiation within standard radioprotection levels in a conventional bunker. In the assumption of a hospital bunker, a detailed model of the beam interaction areas will be carried out and the generated particles will be transported in complex 3D geometries. Improvements to meet treatment requirements from the point of view of secondary particle contribution to the dose will be assessed. In addition, the possibility of using in vivo imaging and quantification of activity distribution will also be investigated as a means of accessing the dose delivered to patients.

Besides, the secondary particle dose delivered to a patient receiving VHEE therapy would be highly dependent on age and size, as well as tumour morphology and location in addition to the beamline configuration and field parameters such as the energy and angular incidence. Methods to accurately estimate the dose delivered to normal tissues of pediatric or adult patients and computational tools to perform a comprehensive comparison of normal tissue dose and risk across different VHEE beams will be developed. Computational phantom in DICOM format with corresponding age, size and gender, will be used to create realistic whole-body patient. Mean doses to out-of-field organs will then be calculated and compared between different treatment delivery modes (protons, VHEE, scattered or scanned beams). Monte Carlo methods as well as machine/deep learning for rapid estimation of the out-of-field dose will be assessed.

Candidate Profile

The candidate must hold a PhD or Master degree in radiation physics, medical physics or detection physics • Radiation matter interactions / radiation therapy / dosimetry • Preferred expertise and experience in one or more of the following areas: programming skills (MATLAB, Python, C++) – Monte Carlo simulations (ex: Geant4/TOPAS) – Measurements – Treatment planning. You will also be expected to have experience in working as part of a multidisciplinary team.

All our opportunities are open to people with disabilities

Contract information

Type of contract: *Fixed-term contract.*
Starting date: *as soon as possible*
Duration: *24-36 months*
Working time: *full time- number of days*
Remuneration: according to the current grids
Benefits*:* Collective catering, reimbursement of transportation fees up to 70%, supplementary health insurance
Location of the position: *Orsay*
Reference: *not to be completed*

Contact

Please apply by e-mail (CV + application letter + references/support letter) to ludovic.demarzi@curie.fr

Publication date: *not to be completed*
Deadline for application: 30th Dec 2024

Institut Curie is an inclusive, equal opportunity employer
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References

V. Favaudon, L. Caplier, V. Monceau, F. Pouzoulet, M. Sayarath, C. Fouillade, M. F. Poupon, I. Brito, P. Hupe, J. Bourhis, J. Hall, J. J. Fontaine, M. C. Vozenin, Ultrahigh dose-rate FLASH irradiation increases the differential response between normal and tumour tissue in mice, Sci Transl Med 6 (2014) 245ra93.

Ronga, M. G., Cavallone, M., Patriarca, A., Leite, A. M., Loap, P., Favaudon, V., Créhange, G., & De Marzi, L. (2021). Back to the Future: Very High-Energy Electrons (VHEEs) and Their Potential Application in Radiation Therapy. Cancers, 13(19), 4942.

Lagzda, A. VHEE Radiotherapy Studies at CLARA and CLEAR Facilities (The University of Manchester, 2019).