PhD proposal	Development of a virtual patient model to study the DOSImetric optimization of internal vectorized radiotherapy: application to the SALivary glands
Acronym	DOSISAL
Location	IMT Mines Alès, EuroMov Digital Health in Motion (EuroMov DHM)
Scientific responsible	Dr. Baptiste MAGNIER

Research project summary:
Personalizing treatments in Molecular Radiotherapy requires a precise assessment of the irradiation delivered (dosimetry). The aim is to increase the absorbed dose delivered to tumours, while containing any side effects to a tolerable level for the patient.
Given the great diversity of clinical dosimetry protocols implemented, it is necessary to standardize these approaches and assess uncertainties associated with each stage of the clinical dosimetry process, in order to propose optimized treatment plans to the patient.
Our research project aims to capitalize on the multidisciplinary complementarity of the UMR EuroMov Digital Health in Motion and an INSERM team at IRCM (Institut de Recherche en Cancérologie de Montpellier). It will combine the skills of nuclear medicine physicians, medical physicists and specialists in image processing and deep learning to develop *digital twins* from which treatment simulation and optimization can be applied.

Project positioning:
Dosimetric optimization in radiotherapy is a regulatory requirement stemming from European Directive EURATOM 2013/59. In Molecular Radiotherapy (MRT), it is often limited by the complexity associated with determining the irradiation delivered (clinical dosimetry). Commercial solutions are beginning to appear on the market, posing the problem of their validation.
Our project aims to generate procedures to standardize clinical approaches. To this end, we will develop a "virtual patient" (a digital twin) adapted to MRT clinical dosimetry. Deep learning and image processing approaches will be used to extract the features required to define the virtual patient. In this way, Monte Carlo modelling of imaging and dosimetric calculation will enable different scenarios to be simulated, and the most relevant approaches to be extracted (accuracy/fitness trade-off vs. complexity and reproducibility).

Project objectives:
The aim of the project is to develop a virtual patient model for studying dosimetric optimization in internal radiotherapy.
This virtual patient model will be used in the clinical context of iodine 131 (^{131}I) MRT for thyroid pathologies, and treatment of metastasized prostate cancer with lutetium 177 (^{177}Lu) labelled radioligand. What these 2 clinical indications have in common is the possibility of radiation-induced toxicity in the salivary glands.

Using image processing and artificial intelligence approaches, we will use information extracted from clinical data acquired in the nuclear medicine department of the CHU de Nîmes to define the characteristics (geometry, radiovector biodistribution and pharmacokinetics) of a virtual patient suitable for generating scintigraphic images and data for clinical dosimetry. Monte-Carlo modelling (^{131}I and ^{177}Lu) of radiation transport within the virtual patient will enable us to simulate ground truth (3D absorbed dose maps). In addition, Monte Carlo

modelling of images will enable us to provide clinicians with realistic data sets on which to carry out dosimetric studies.
Comparison of the dosimetric results obtained with ground truth will enable us to study the uncertainties associated with clinical dosimetry in MRT.
In this clinical context, the aim is to be able to propose a data acquisition and processing methodology that ensures the accuracy and precision of dosimetric results. In addition, the developments achieved are intended to be reinvested in different clinical contexts requiring MRT dosimetric optimization.
Finally, this project stems from a clinical need and is part of one of the areas of the Regional Innovation Strategy in Occitania: Health, well-being & ageing well.

Profile sought:
Candidates must be motivated, curious and able to take the initiative. On a technical level, mastery and experience of at least one programming language (C++, Python) is required. Basic knowledge of AI / Machine Learning is required to start the project and understand the approaches. Knowledge of image processing is also an important element of the application. Candidates will be required to interact with professionals such as doctors, imaging specialists and others. A good ability to listen and understand the issues involved is therefore a strong point of the application. Ability to write in English is required.
Mastery of UNIX and GPU computing would be a plus.

Thesis location : CERIS laboratory of IMT Mines Alès (30100 ALES)

Application deadline: 09/15/2023

Thesis start date: 10/01/2023

To apply, send cover letter, CV and transcript of grades (M1 + M2) to : Stefan Janaqi, Binbin Xu, Vincent Boudousq, Manuel Bardiès and Baptiste Magnier:
stefan.janaqi@mines-ales.fr
binbin.xu@mines-ales.fr
vincent.boudousq@chu-nimes.fr
manuel.bardies@inserm.fr
baptiste.magnier@mines-ales.fr