PhD fellowship

Gamma imaging system optimization based on MC simulations for targeted radionuclide therapy.

Context

The HORIZON-EURATOM AIDER project(Advanced Imaging DEtector for targeted Radionuclide therapy) is an international collaborative project between partners in France (CREATIS, IP2I, LUMEN and DAMAVAN company), Spain (IFIC and Aspanion cancer patient association), Italy (Politecnico di Milano) and Germany (UZL).

Targeted Radionuclide Therapy (TRT) utilizes unsealed radioactive sources to selectively deliver radiation to tumours. A critical aspect of these treatments is the accurate estimation of the radiation dose delivered to both lesions and organs at risk, enabling individualized treatment planning and verification of therapeutic effectiveness. However, conventional gamma cameras with mechanical collimators face challenges in estimating the 3D distribution of the radionuclides in SPECT, due to the low activity levels and the high energy of the multiple emitted gammas in the radioactive decay [1, 2]. Mechanical collimators inherently involve a trade-off between spatial resolution and sensitivity. Colimator free SPECT cameras, also known as Compton cameras are an alternative to collimated cameras due to their potential efficiency gain while providing high energy resolution and enabling multi-tracer imaging. A Compton camera prototype has been already developed and tested on radiopharmaceuticals by one of the partners [3]. The aim of this project is to optimize current SPECT imaging methods to enhance the personalization and safety of TRT. To achieve this goal, accurate and realistic Monte Carlo simulations are essential.

Objective

The goal of this three-year PhD fellowship is to optimize both current [3] and future imaging Compton camera prototypes and evaluate their performance in clinical TRT applications through accurate and realistic Monte Carlo simulations using the GATE toolkit.

Tasks

- Perform realistic Monte Carlo simulations of the current prototype using GATE [4].
- Optimize the geometry of detectors and system configurations to achieve the best performance in TRT.
- Compare the performance of the camera for different radionuclides.
- Provide accurate physical data for image reconstruction methods [5].
- Compare the performance of the Compton camera with state of the art systems, such as the SPECT available at LUMEN namely Veriton from Spectrum Dynamics and Symbia Intevo Bold from Siemens Healthineers.

Required skills

- **Education**: Master in physics, computer sciences or medical physics.
- **Scientific interests**: physics, computer sciences, medical physics, Monte Carlo simulations.
- **Programming skills**: Python, C++.
- **Languages**: English required, French optional.

Practical information

- **Supervision**: Ane Etxebeste and David Sarrut
- **Location**: Mainly at Centre Léon Bérard, Lyon, France.
- **Period**: 3 years, starting in September 2025.
- **Salary (gross)**: 2200 euros/month (increase to 2300 on January 1, 2026).
- Send CV and a statement of interest to ane.etxebeste@creatis.insa-lyon.fr and david.sarrut@creatis.insa-lyon.fr

References

[1] Gustafsson et al. Feasibility and limitations of quantitative SPECT for 223Ra. *PMB*, 65(8):085012, 2020.

[2] Tulik et al. Quantitative SPECT/CT imaging of Actinium-225 for targeted alpha therapy of glioblastomas. *EJNMMI physics*, 11(1):41, 2024.

[3] Roser et al. Radiopharmaceutical imaging of phantoms and patients with MACACO III Compton camera. *Physica Medica*, 132:104928, 2025.

[4] Etxebeste et al. CCMod: a GATE module for Compton camera imaging simulation. *PMB*, 65(5):055004, 2020.

[5] Lequertier et al. CoReSi: a GPU-based software for Compton camera reconstruction and simulation in collimator-free SPECT. *PMB*, 70(4):045001, 2025.