RESEARCH TOPIC MECM15
Photon-Counting CT in Personalized Radiotherapy: Imaging Protocol Optimization and
Spectral Modeling
MECM Data Science

Research Area
Oncology

Clinical Unit
Radiotherapy and Radiosurgery

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Abstract
Photon-Counting Computed Tomography (PCCT) introduces a novel paradigm in radiotherapy imaging by offering enhanced spatial resolution, superior tissue differentiation, and spectral imaging capabilities compared to conventional energy-integrating detectors. Within the framework of the prospective ANTHEM study which evaluates PCCT's impact on target delineation and dose accuracy in radiotherapy for rare tumors and anatomically complex regions, this PhD project will focus on the technical development and validation of PCCT-based imaging protocols.

The student will play a key role in optimizing acquisition parameters for radiotherapy planning simulations, particularly emphasizing spectral characteristics and their implications for tissue classification, segmentation accuracy, and electron density mapping. A specific focus will be placed on optimizing contouring performance by reducing artifacts and enhancing contrast between tumor and surrounding tissues. Additionally, the project will explore the development and customization of immobilization systems tailored to PCCT imaging workflows in radiotherapy settings.

The project will particularly focus on applications of PCCT in the context of proton therapy, where accurate tissue characterization and spatial alignment are critical. Accordingly, part of the work will be dedicated to evaluating patient immobilization strategies and image-guided radiotherapy (IGRT) protocols during proton therapy delivery. Comparisons between PCCT and conventional CT datasets will be quantitatively assessed through image quality scoring, radiological and dosimetric metrics, and phantom-based validation.

This project aims to generate translational insights that support personalized radiotherapy, including photon and proton therapy, by improving the reliability of organ-at-risk (OAR)

differentiation and enabling precise dose modeling. Preference will be given to candidates with an LM/SNT3 degree (e.g., radiology technologists), as the project aligns closely with RTT professional advancement in medical imaging and technical protocol development.

Approximately 50% of the total time commitment during the PhD will be dedicated to research activities related to this project, including protocol optimization, data analysis, and phantom validation. The remaining time will involve clinical practice and direct interaction with radiotherapy workflows, ensuring a continuous translational feedback loop between research findings and clinical applications.

Main technical approaches

- Imaging protocol development and optimization using PCCT
- Analysis of spectral imaging parameters and tissue differentiation
- Comparative evaluation of PCCT vs standard CT for RT simulation
- Phantom-based validation of electron density maps
- Development of dedicated immobilization systems for PCCT
- Evaluation of IGRT and immobilization protocols in proton therapy settings
- Integration of imaging with treatment planning systems

Scientific references

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Type of contract

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