LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Department of Medical Physics
Faculty of Physics

Prof. Dr. Katia Parodi

Deep-learning based prompt-gamma estimator for range monitoring in proton therapy

1 MSc thesis project available

Proton radiation therapy of cancer allows for a highly conformal dose to the tumor and significant sparing of surrounding healthy tissues. Exactly due to these very steep dose gradients, proton therapy is sensitive to proton range uncertainties that can lead to non-optimal dose coverage of the tumor and/or overdosage of healthy tissues. A promising method for monitoring the therapeutic proton beam inside the patient is by means of secondary prompt gamma detection, which has also recently been applied to human patients. According to this technique, measured prompt-gamma distributions from the patient treatment are compared to calculated prompt-gamma predictions based on the treatment plan, in order to detect deviations from the desired therapeutic dose distributions. The LMU Department of Medical Physics is pioneering both device and algorithmic development pertaining to prompt-gamma range monitoring for proton therapy, including deep learning methods supporting these aspects.

Although therapeutic dose calculation is nowadays a very fast procedure, usually implemented via analytical methods, the prompt-gamma emission is still subject to time consuming Monte Carlo calculations. Despite the development of several analytical approximations that could be used to derive prompt-gamma distributions based on the therapeutic dose, fast and accurate prompt-gamma calculation methods are still an open research topic.

The goal of the proposed MSc thesis is to develop deep learning methods for predicting prompt-gamma distributions from therapeutic dose distributions. Such a fast estimator will use Monte Carlo simulated dose and prompt-gamma simulations on simple geometries and on patient CT data, to train dedicated deep learning algorithms for prompt-gamma distribution prediction.

The ideal candidate has:
- A strong interest in computational aspects
- Experience with some of the listed tools: C/C++, Python or MATLAB, and Linux
- Any familiarity with Monte Carlo transport and interaction codes, preferably Geant4 is highly welcomed
- Basic knowledge of machine learning toolkits (PyTorch, Keras, TensorFlow) is required
- Highly ranked BSc in Physics, preferably in Medical Physics or Biomedical Engineering
- Fluent English knowledge (spoken and written)
- Technical proficiency, scientific creativity, team working skills

The LMU Department of Medical Physics is located in Forschungszentrum Garching, which is well connected with public transportation to the city of Munich. A flexible/hybrid working scheme including home office hours can be arranged. The MSc student will work in a highly motivated and well-established team, within a multidisciplinary and international network, embedded in a stimulating scientific environment with a long tradition of collaboration and excellence in biomedical research, and with outstanding research and clinical infrastructures.

In case of interest, please contact:

Dr. George Dedes
(G.Dedes@physik.uni-muenchen.de)
Department of Medical Physics,
Faculty of Physics,
LMU Munich,
85748 Garching, Germany

Prof. Dr. Katia Parodi
(Katia.Parodi@physik.uni-muenchen.de)
Department of Medical Physics,
Faculty of Physics,
LMU Munich,
85748 Garching, Germany