

Physics of Medical Imaging and Radiotherapy, self-study projects 2025/26

Project code	Project supervisor	Title	Short description
UO01	Uwe Oelfke	Quantifying radiation damage for tumour cells	The group of students will visit CCI in Sutton once (3 hours) to irradiate tumour cells with various doses, we will plate the irradiated cells and will send pictures of the clonogenic assays to the students after one week, students will be asked to count the surviving cell colonies, draw the respective survival curves and fit parameters for a linear quadratic model. This can be compared to data from the literature. The remaining task will be describing the details of the experiment and the methods and analysis and interpretation of their own results.
UO02	Uwe Oelfke	Why MRI guided Radiotherapy with MR-Linacs	We can provide a live stream of an on-line adapted RT treatment at the MR-Linac into a seminar room at ICL. Students should record the clinical workflow and describe the potential advantages and challenges of this new technology for each step of the treatment they observe. This can start from the challenges in dosimetry (electron return effect) and online treatment planning to the problem of extended treatment time and lower patient throughput. In case students would be willing to come to Sutton, we may be able to let them participate in MR-Linac QA – however I cannot confirm this yet.
NHP01	Neva Patel	Radionuclide Therapies in Nuclear Medicine: Principles, Applications, and Clinical Advances	Unsealed radionuclide therapy is a rapidly growing area in the treatment of a variety of cancers. In the UK, between 2007 and 2021 there was an 87% increase in the number of cancer patients treated, and a 231% increase in treatments given. In addition to increased patient and treatment numbers, the number of radiopharmaceuticals available, and the number of cancers treatable are also increasing. Alpha emitting radionuclides, in particular, are a big area of development, with the global market for alpha emitters predicted to increase from \$672.3 million in 2020, to \$5.2 billion by 2027. There are currently dozens of different therapeutic radiopharmaceuticals in development and clinical trials.

JH01	James Hubber	Actinium-225: Targeted Alpha Therapy in cancer treatment.	Unsealed radionuclide therapy is a rapidly growing area in the treatment of a variety of cancers. In the UK, between 2007 and 2021 there was an 87% increase in the number of cancer patients treated, and a 231% increase in treatments given. In addition to increased patient and treatment numbers, the number of radiopharmaceuticals available, and the number of cancers treatable are also increasing. Alpha emitting radionuclides, in particular, are a big area of development, with the global market for alpha emitters predicted to increase from \$672.3 million in 2020, to \$5.2 billion by 2027. There are currently dozens of different therapeutic radiopharmaceuticals in development and clinical trials. One such alpha-emitting therapeutic radionuclide is Ac-225. The students should perform a literature review on the practical considerations of implementing an Ac-225 therapy service in the clinical setting. They should consider the production of Ac-225, physical characteristics of the emitted radiation (shielding, radiation doses to staff etc.), the possible methods of administration, post-therapy radiation protection issues, and post-therapy imaging.
JH02	James Hubber	Artificial Intelligence in Nuclear Medicine	This literature review explores the use of artificial intelligence in nuclear medicine imaging, with emphasis on image reconstruction, analysis, and clinical decision support. Students should summarize and critique recent studies, compare AI-based methods with conventional approaches, and discuss their impact on diagnostic accuracy, workflow, and patient care, while briefly addressing current challenges and future directions.

AS01	Andrew Scott	Measuring motion in MRI	Movement is often considered a source of errors in medical imaging. However, in some circumstances we can use the sensitivity of MRI to movement as a tool that allows us to quantify physiologically important movement. This is particularly relevant in cardiovascular applications of MRI where we can quantify the velocity of blood in the vasculature and the displacement over time of the beating heart. We can also use this sensitivity to detect microscopic movement of self-diffusing water molecules and infer the structure of the sub-voxel sized cellular architecture. In this project, students will investigate the ability of MRI to quantify various types of motion by: • Reviewing the applications of motion encoding techniques applied to the cardiovascular system. • Implementing simulations of the effects of various types of motion on typical motion encoding MRI acquisitions. • Simulating the effects of factors such as voxel size, scanner hardware performance and flow profiles on the MRI signal and motion related parameters extracted from the images.
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RT01	Oliver Steel and Ruth McLauchlan	SRS Margins	Patients undergoing radiotherapy receive bespoke radiation treatment plans according to their anatomy and tumour type/location. These plans are based on a CT scan taken 2-3 weeks before commencement of treatment which is generally given in fractions delivered daily (five days a week) for 1-6 weeks. During treatment, patients can present with anatomical changes which may occur progressively over the course of treatment or rapidly between individual fractions. <i>Adaptive radiotherapy (ART)</i> focusses on ensuring a patient's treatment plan remains suitable for the patient's anatomy at the point of treatment delivery. This project will focus on <i>Offline ART</i> which allows the radiotherapy plan to be updated outside the treatment delivery process. Offline ART is generally used for those patients who have a change in anatomy that appears slowly over several fractions; examples include weight gain/loss, lung collapse/reinflation, etc. Offline ART involves the adaptation of the treatment plan to account for the new anatomy, whilst continuing on the original treatment for a limited timeframe. Offline ART has historically been a subjective decision, based on oncologist clinical judgement regarding the clinical significance of the patient's anatomical change. However, there have been published studies which have sought to create an unambiguous, objective flagging mechanism for patients, and a move to automate this decision-making process. Students should perform a literature review to evaluate the published mechanisms for triggering an offline ART pathway, including the metrics which form the objective decision-making, and any advances made to automate this decision-making process. The final report should include recommendations for successful model(s) and respective anatomical site(s) to aid local clinical implementation. A visit to the clinical Department of Radiation Physics and Radiobiology and Department of Radiotherapy at Imperial College Healthcare NHS Trust will allow students to observe current practices for offline ART, and discuss the issues faced with radiotherapy professionals including radiotherapy physicists.
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CD01	Chris Dunsby	Super-resolution ultrasound imaging using microbubble contrast agents	Microbubble contrast agents are small gas-filled bubbles that are commonly used as contrast agents in clinical US imaging. US imaging systems have the sensitivity to localise individual microbubbles if the concentration of microbubbles is sufficiently low. By localising individual microbubbles as they flow through the vasculature, it is possible to beat the conventional diffraction limit of spatial resolution. This project would review the state-of-the-art of super-resolution ultrasound imaging and the underlying physical principles governing its operation.
CD02	Chris Dunsby	State-of-the-art SPECT imaging systems	This project will involve a review of state-of-the-art commercially available SPECT imaging systems and a comparison of their performance relative to the theoretical limits. This will include consideration of detector technologies, event detection rates, system electronics and image reconstruction algorithms.
JM01	James McGinty	Phase contrast X-ray imaging	Traditional X-ray imaging and computed tomography can suffer from low signal contrast when imaging low atomic number samples, such as biological soft tissues. Phase contrast techniques offer the potential for increased contrast in such samples without the need for additional chemical contrast agents. In this project you will research the experimental approaches and accompanying data processing to generate phase contrast X-ray images, where the techniques are currently applied and discuss the prospects for clinical deployment.
KL01	Ken Long	Simulation of image generation and deconvolution	The raw RF signal generated in an MRI scan is recorded into "k-space" and processed using a two-dimensional Fourier transform to deliver the coordinate-space representation of the image. This process is subtle and is prone to a variety of artefacts. In this project you will develop an object-oriented model of the encoding of the image in k-space and the reconstruction of the image. You will then use your model to investigate a variety of artefacts. The objective of the project is to deepen your understanding and, ideally, to deliver a pedagogical tool that can be used to demonstrate the impact of various instrumental effects on the image.
KL02	Ken Long	Integration of MRI in radiation therapy	This project will review the issues related to the integration of MRI in the radiotherapy, the state-of-the-art in integrated systems and the possible exploitation of MRI techniques to determine the profile of dose delivered.