



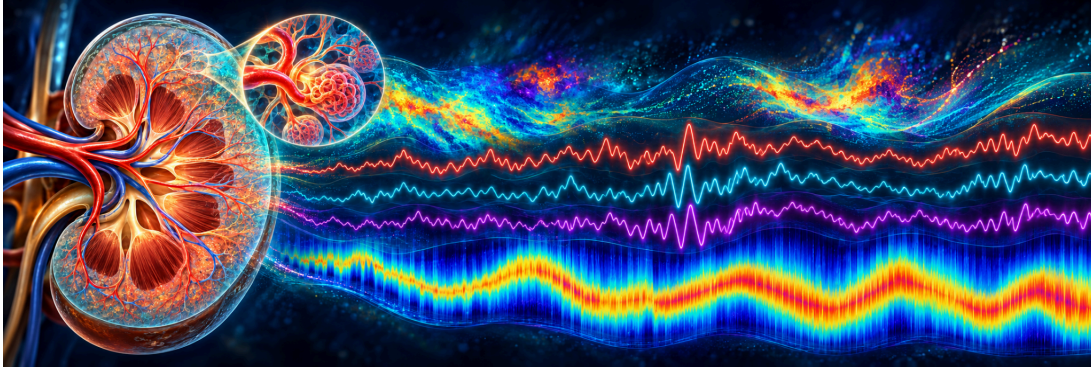
UNIVERSITY OF
COPENHAGEN



Project Catalogue

2026

Advanced Signal Analysis of Renal Blood Flow Dynamics in Hypertension



Background: Kidney autoregulation maintains stable renal blood flow by adjusting vascular diameter. These adjustments generate blood flow oscillations that provide insights into the underlying regulatory mechanisms. Studying these oscillations may help us understand how blood flow regulation is altered in hypertension and how oscillatory activity is synchronized across the renal vasculature.

What you will do: This computational project will investigate kidney blood flow oscillations in an existing experimental dataset. The data have already been collected and contain oscillatory signals suitable for analysis, this particular dataset has not yet been systematically explored.

The student(s) will perform two major tasks: (i) image analysis (involves e.g. image registration, masking); (ii) Time-frequency analysis of blood flow time series extracted from the imaging data. The time-frequency analysis may involve: Autocorrelation, Fourier and wavelet-based analysis; Quantification of oscillation frequency and power; Estimation of instantaneous frequency and its variability. The exact analysis protocol will be determined by the data features, i.e., data-driven analysis. Our existing Python code provides a starting point for major analysis steps, with an opportunity to adapt and expand it as the data require.

What will you gain: Valuable experience in image and time-frequency analysis of biomedical signals, in visualization techniques, and physiological interpretation of experimental data.

Required qualifications/prerequisites: Experience in programming (Python preferred, but not limited to), an interest in quantitative data analysis, and motivation to contribute to a research paper.

Responsible institution/department: Department of Biomedical Sciences, UCPH

Contact information: oleg.zhukov@sund.ku.dk and olga@sund.ku.dk

Allowed no. of students per report: 1–2 students

KU supervisors: Oleg Zhukov, Olga Sosnovtseva

Is the project TUH (Technical University Hospital) affiliated (yes/no): No

Project Title: AI-Based Longitudinal Prediction of Disease Progression in Multiple Sclerosis

Description:

Multiple sclerosis (MS) is an autoimmune inflammatory brain disease with a widespread symptom spectrum and is manifested by focal lesions visible on magnetic resonance imaging (MRI) scans. The extent and location of lesions impact to some degree the type and severity of different symptoms, but despite substantial advances in imaging, clinical monitoring and in recent years AI-based analysis tools, robust delineation of lesions remains a major challenge.

The aim of this master's project is to develop and evaluate artificial intelligence (AI) models that leverage longitudinal information from a large ongoing national study to improve analysis of future datapoints in patients with MS.

Conventional machine learning models are often trained using data from a limited training set, potentially ignoring valuable temporal information. This project will investigate how pre-trained deep learning models can be fine-tuned using historical patient data from previous assessments to enhance accuracy for subsequent outcomes.

The student will work with an existing longitudinal MS dataset containing 4 to 6 timepoints with lesions drawn manually from AI assisted starting points. Different strategies for incorporating temporal information will be explored. Model performance will be evaluated against baseline approaches that use only cross-sectional information trained on historical data.

The project combines state-of-the-art AI methodology with a clinically relevant application and provides hands-on experience in medical image analysis, machine learning, and longitudinal data modeling. The results may contribute to the development of tools that support clinical decision-making and improve understanding of disease progression and treatments in multiple sclerosis.

Required qualifications/prerequisites: Solid Python programming. Basic knowledge of MRI physics or medical image analysis (e.g. an introductory course) is a plus. Interest in neuroscience. Experience with PyTorch or neuroimaging tools such is an advantage but not required.

Responsible institution/department: DTU Health Tech, Section for Magnetic Resonance.

Contact information: Henrik Lundell, hmag@dtu.dk

Allowed no. of students per report: 1-2

DTU supervisor(s): Henrik Lundell (DTU Health Tech), Oula Puonti (DTU Health Tech)

External supervisor(s): Vanessa Wiggermann (DRCMR)

Project Title: NeuroVision

AI-Based Video Analysis and Explainable Clinical Decision Support for Virtual Neurological Consultations

Description: (n.a. if confidential)

Virtual consultations are becoming an increasingly important part of healthcare, offering patients more flexible access to specialised care without the need for hospital visits. However, neurological assessments often rely on subtle observations of facial expressions, movements, coordination and speech, which can be difficult to assess systematically through conventional video consultations.

NeuroVision aims to develop AI-based video analysis and clinical decision-support tools to improve the quality, consistency and clinical usefulness of virtual neurological consultations.

The project initially focuses on people living with Parkinson's disease and patients recovering from stroke. By combining computer vision, machine learning, longitudinal symptom monitoring and Explainable AI (XAI), NeuroVision aims to identify and quantify clinically relevant neurological signs and present this information through an intuitive dashboard supporting clinical decision-making.

The project is an interdisciplinary collaboration between the Technical University of Denmark (DTU), Bispebjerg-Frederiksberg Hospital, Zealand University Hospital and clinical and patient partners.

Potential targets for students:

1. Computer Vision and AI-Based Neurological Symptom Analysis
2. Machine Learning and Longitudinal Symptom Monitoring
3. Clinical Dashboard Development and Data Visualisation
4. Explainable AI and Human–AI Interaction
5. Human-Centred Design and Clinical Integration

Projects will be tailored to the students' educational level, technical background and interests. Access to clinical data will depend on relevant approvals and data availability.

Required qualifications/prerequisites:

The project is relevant for students within Biomedical Engineering, Medicine and Technology, Computer Science, Artificial Intelligence, Data Science, Human–Computer Interaction, Design and Innovation or related disciplines.

Depending on the selected subproject, relevant competencies may include:

- Programming (e.g. Python), machine learning, deep learning and computer vision.
- Image and video processing, pose estimation, signal processing and statistical analysis.
- Data visualisation, software development, user-interface design or interactive dashboard development.
- Human-centred design, usability testing and Explainable AI.

Responsible institution/department:

Department of Health Technology, Technical University of Denmark (DTU Health Tech), and DTU Electro in collaboration with the Department of Neurology, Bispebjerg-Frederiksberg Hospital, and the Department of Neurology, Zealand University Hospital.

Contact information:

Trine Hørmann Thomsen, RN, PhD

Senior Researcher, Department of Neurology, Bispebjerg-Frederiksberg Hospital

Assistant Professor, DTU Health Tech

Email: trine.hoermann.thomsen@regionh.dk

Allowed no. of students per report (1-4):

1–4 students, depending on project scope and educational level.

KU/DTU supervisor:

DTU supervisor: To be confirmed according to the technical focus of the student project.

Trine Hørmann Thomsen, Assistant Professor, DTU Health Tech / Senior Researcher, Bispebjerg-Frederiksberg Hospital

Is the project TUH (Technical University Hospital) affiliated (yes/no):

Yes.

Project Title: *Air For Life: Development and Technical Validation of Digital Monitoring for Home Mechanical Ventilation*

Description: (n.a. if confidential)

Home mechanical ventilation (HMV) enables people with severe chronic respiratory failure to live in their own homes. Some individuals require continuous respiratory monitoring by trained respiratory assistants, which can restrict privacy, autonomy and flexibility in everyday life.

Air For Life is an interdisciplinary research project between Respiratory Centre East at Copenhagen University Hospital – Rigshospitalet and DTU(TUH). The project aims to develop and evaluate a digital monitoring solution that can supplement current respiratory monitoring in the home while maintaining patient safety.

The project is currently moving towards the technical development and pilot phase. The initial concept involves integrating alarms and data from existing home ventilators with physiological data from wearable sensors and making relevant information available on a mobile device. Several technical questions remain open, providing opportunities for student projects within areas such as device integration, wireless data transmission, physiological sensing, user-interface development, signal processing and technical validation.

The specific project will be defined according to the student's interests and academic level and may include development, implementation and/or experimental evaluation of individual components of the monitoring system. Multiple students may work on complementary parts of the overall system.

Required qualifications/prerequisites:

Students should have a background in biomedical engineering, health technology or a related field and an interest in digital health and medical technology. Depending on the specific subproject, experience with programming, signal processing, sensors, wireless communication or data integration may be relevant. Specific technical prerequisites will be adapted to the individual project.

Responsible institution/department:

Neurological Department- Bispebjerg Hospital & Respiratory Centre East, Copenhagen University Hospital – Rigshospitalet, in collaboration with DTU Health Technology

Contact information:

Marcus A. Behnke Hjorth, PhD.-fellow, Respiratory Centre East, Copenhagen University Hospital – Rigshospitalet

marcus.andreas.behnke.hjorth@regionh.dk, Tlf: +45 21 77 94 50

Trine Hørmann Thomsen, Assistant professor, Senior Researcher, Neurological Department- Bispebjerg Hospital,

trine.hoermann.thomsen@regionh.dk,

Allowed no. of students per report (1-4):

1-4

KU/DTU supervisor:

Trine Hørmann Thomsen, TUH/DTU/KU (PI)

Søren Straarup Rasmussen, TUH (co-supervisor)

Marcus A. Behnke Hjorth, RH, KU (co-supervisor)

Is the project TUH (Technical University Hospital) affiliated (yes/no):

Yes.

Project Title: Analyzing oxygen concentrations in 3D cell and tissue cultures with deep learning

Description:

A sufficient and controllable oxygen supply is essential for high-density in vitro 3D cell and tissue cultures, requiring volumetric in situ oxygen analysis methods to quantitatively assess oxygen distribution [1]. We have developed a method to measure oxygen concentrations in 4D using embedded oxygen microsensor beads that produce a phosphorescence lifetime signal (Fig. 1d). This signal can be converted into an oxygen concentration (Fig. 1e). However, the conversion is far from trivial because the signal is weak and is influenced by several known factors, such as bead size, while other contributing factors remain unknown. This complicates the fitting of experimental data with an analytical model.

In this project, the goal is to develop a machine learning model for analyzing the experimental data while incorporating prior knowledge of the specific experimental system. You will work on real oxygen data from our advanced human liver and human follicle cultures.

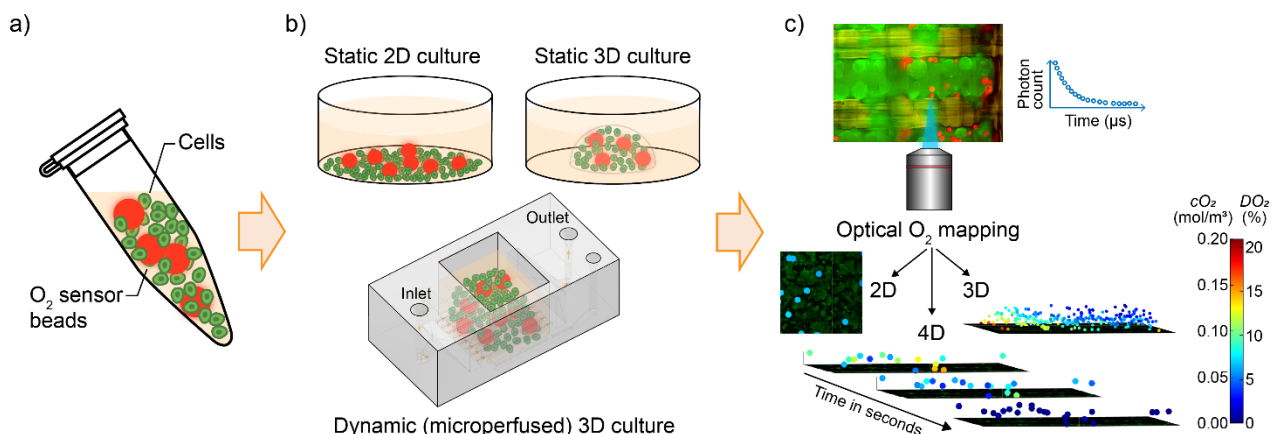


Figure 1. (a) 3D dynamic culture with beads within a chip supporting microperfusion. (b+c) Confocal phosphorescence lifetime microscopy mapping. (d) The oxygen-dependent phosphorescence decay profiles of the embedded sensor beads can be converted to calibrated oxygen concentration and dissolved oxygen maps in 2D, 3D, or 4D (e).

[1] *Optical 4D oxygen mapping of microperfused tissue models with tunable in vivo-like 3D oxygen microenvironments*, M.F. Wesseler, (...), Niels B. Larsen, Lab Chip, 2022, 22, 4167

Required qualifications/prerequisites:

An interest in data analysis, signal analysis, and basic programming skills in Python or Matlab. Knowledge of deep-learning/neural networks is an advantage, but not required.

Responsible institution/department:

DTU Health Tech

Contact information:

Niels Bent Larsen (nibl@dtu.dk) and

Jonas Nyvold Pedersen (jnpe@dtu.dk)

Allowed no. of students per report: 1-4

DTU supervisor:

Niels Bent Larsen (nibl@dtu.dk) and

Jonas Nyvold Pedersen (jnpe@dtu.dk)

Project Title: Automating proteomics sample preparation with the Opentrons robot

Description:

Background

Our team uses state-of-the-art mass spectrometry-based proteomics to map the molecular build-up of the heart and to uncover the protein remodeling that drives cardiac disease. Recent advances in instrumentation have transformed what is possible -we can now measure far more samples than before, which means real biological replication, properly powered study designs, and the statistical confidence to make claims about disease mechanisms. But every sample that is measured must first be prepared. Manual sample handling has become a rate-limiting step -and also a source of technical variation - in large-scale proteomics. Solving this ultimately determines the scale and the quality of the biology we can do next.

The project

The student will take ownership of implementing and benchmarking an Opentrons liquid-handling robot, programmed in Python, as a core part of our proteomics sample-processing pipeline. The robot handles pipetting, reagent distribution, magnetic bead handling and wash steps in 96-well format. The goal is a validated, documented and genuinely trusted automated workflow. The work is staged so that each step builds the confidence needed for the next.

Work package 1: Establishing the platform -protein concentration measurements

The entry point is protein quantification, a step performed in nearly every experiment we run. The student will implement colorimetric protein assays on the robot and benchmark them rigorously against manual pipetting: accuracy across the standard curve, well-to-well and plate-to-plate precision, carry-over, and the behaviour of viscous and detergent-containing lysates. This work package establishes the robot's performance envelope and the student's command of the platform, and it delivers something the group uses immediately.

Work package 2: Scalable immunoprecipitation for proximity ligation proteomics

Proximity ligation proteomics lets us map protein interaction networks and subcellular neighbourhoods in situ. Our team perform proximity ligation proteomics in stem cell derived cardiomyocytes. The proteome readout depends on affinity enrichment: bead-based capture followed by many stringent wash steps, where small inconsistencies in bead handling or wash volume translate into background, missing interactors and irreproducible networks. The student will develop and validate automated bead-based immunoprecipitation on the Opentrons, benchmarking enrichment efficiency, background and reproducibility against the manual protocol. Success here unlocks interaction proteomics at a scale enabling multiple baits, conditions and timepoints processed in parallel with uniform handling.

Work package 3: Automated sample preparation for cardiac tissue proteomics

Finally, the student will move core sample-preparation steps in the sample processing for cardiac tissue proteome measurements onto the robot. Cardiac tissue is precious and tissue amounts are very limited, so uniform, traceable, low-variance processing is a requirement. Automating sample processing steps means every sample in a cohort is treated identically, and that differences we see between samples are true biology, and not affected by technical handling variations.

What we are looking for:

This project suits a student who is meticulous, structured and patient with detail. The experiments the workflow will feed into use valuable biological material and costly reagents, and a workflow is only useful to us if it can be trusted completely. We therefore expect careful method development on surrogate material before precious samples are touched, systematic benchmarking with proper controls and replicates, clearly defined acceptance criteria, and thorough documentation of both protocols and code.

A background in biomedical engineering is ideal -the project sits at the interface of engineering and biology.

The student will be embedded in an active proteomics research group and will see their workflow put to use in ongoing cardiac disease projects.

Required qualifications/prerequisites:

A strong academic performance during your studies, and an ambition to do excellent work.

Responsible institution/department:

Department of Biomedical Sciences

Contact information: Prof. Alicia Lundby, Alicia.lundby@sund.ku.dk (www.lundbylab.com)

Allowed no. of students per report: 1

KU/DTU supervisor: KU supervisor

Project Title:

Bacterial growth quantification from optical microscopy

Description:

The monitoring of bacterial growth has several applications in research and industry. It is routinely performed by colony counting on agar plates, a process that is the golden standard for many applications but is difficult to automatize. Other approaches are therefore needed to miniaturize, then parallelize and automatize assays. Some recent examples such as this one [1] are based on the combination of microfluidics and label free imaging.

The overall goal of the proposed project is to use an existing home-made microscope to perform a series of experiments and quantify bacterial growth using bright field microscopy. You will participate in developing a microfluidic platform to compare different growth conditions.

You will be trained in working in the lab and become an expert in optical microscopy, single cell tracking/counting, and experiment microfluidics. The extend of the project depends on the level (BSc or MSc) and the number of ECTS dedicated to this project.

Reference:

[1] Tiwari, Anuj, et al. "Label-Free Analysis of Bacterial Growth and Lysis at the Single-Cell Level Using Droplet Microfluidics and Object Detection-Oriented Deep Learning." *Frontiers in Lab on a Chip Technologies*, vol. 2, 2023, <https://doi.org/10.3389/frlct.2023.1258155>.

Required qualifications/prerequisites:

An interest in lab work, microscopy and image analysis.

Responsible institution/department: DTU Health Tech

Contact information: rcwm@dtu.dk

Allowed no. of students per report: 1-3

DTU supervisor: Rodolphe Marie

Project Title: Biocompatible Batteries for Ingestible Devices

Description:

Ingestible devices, such as smart capsules, can sense, sample or deliver drugs inside the gastrointestinal (GI) tract. Most of them use commercial coin-cell or silver-oxide batteries. These contain toxic materials and can cause serious injury if the capsule gets stuck or breaks. Safer batteries are needed. They should be made from materials the body can tolerate, such as zinc, manganese oxide, magnesium or food-grade components.

In this project, you will build and test small biocompatible batteries for use in ingestible devices. You will:

- Prepare electrodes from safe, low-cost materials
- Test different electrolytes, including gel-based and biocompatible ones
- Measure battery performance with electrochemical methods (galvanostatic discharge, cyclic voltammetry, EIS)
- Test the batteries in simulated gastric and intestinal fluids
- Study how pH, temperature and current load affect performance and stability
- Optionally, integrate a battery into a 3D-printed capsule prototype and power ingestible electronics

The project is part of ongoing research on ingestible bioelectronics in the IDUN group at DTU Health Tech. You will work in an active lab alongside PhD students and postdocs. The scope can be adjusted to fit a bachelor's, master's or special-course project.

Required qualifications/prerequisites: Basic knowledge of chemistry, materials science or physics. An interest in batteries, electrochemistry or medical devices. Lab experience is an advantage but not required. Training in all methods will be provided.

Responsible institution/department: Technical University of Denmark (DTU), DTU Health Tech, IDUN Section

Contact information: Santanu Patra (sanpa@dtu.dk)

Allowed no. of students per report: 1-2

KU/DTU supervisor: Santanu Patra and Anja Boisen

Project Title: Biofuel Cells for Ingestible Devices

Description:

Ingestible devices, such as smart capsules, can sense, sample, or deliver drugs inside the gastrointestinal (GI) tract. Most of them run on small coin-cell batteries. These batteries limit device lifetime and size, and they carry a risk of toxic leakage. Biofuel cells offer a safer alternative. They produce electricity from substances already present in the gut, such as glucose, or from enzymes and microbial activity.

In this project, you will build and test small biofuel cells for use in ingestible devices. You will:

- Prepare and modify electrodes with enzymes or microorganisms
- Measure power output with electrochemical methods (open-circuit potential, polarization curves, cyclic voltammetry, EIS)
- Test the cells in simulated gastric and intestinal fluids
- Study how pH, temperature, and fuel concentration affect performance
- Integrate a cell into a 3D-printed capsule prototype and test it for ingestible biosensing

The project is part of ongoing research on ingestible bioelectronics in the IDUN group at DTU Health Tech. You will work in an active lab alongside PhD students and postdocs. The scope can be adjusted to fit a bachelor's, master's or special-course project.

Required qualifications/prerequisites: Basic knowledge of chemistry or biochemistry. An interest in electrochemistry, biosensors or medical devices. Lab experience is an advantage but not required. Training in all methods will be provided.

Responsible institution/department: Technical University of Denmark (DTU), DTU Health Tech, IDUN Section

Contact information:

Santanu Patra (sanpa@dtu.dk)

Gohar Soufi (gohsoo@dtu.dk).

Allowed no. of students per report: 2

DTU supervisors:

Santanu Patra, Gohar Soufi and Anja Boisen

Project Title: Bladder-SENSE project: Developing Wearable Technology for Predictive and Person-Centred Bladder Care in Neurological Patients

Description: (n.a. if confidential)

Bladder dysfunction is a common and often overlooked consequence of neurological diseases, including stroke, Parkinson's disease, multiple sclerosis and spinal cord injury. It may significantly affect patients' quality of life, independence, dignity and participation in everyday activities. Current bladder management relies primarily on intermittent bladder scanning, patient-reported symptoms and predefined toileting schedules. These approaches provide only snapshots of bladder function and may not adequately capture individual variations in bladder filling and the need for timely intervention.

The Bladder-SENSE project aims to develop and evaluate a wearable solution for continuous bladder monitoring, supporting a transition from reactive bladder management towards predictive, individualised and person-centred care.

The project is embedded in an interdisciplinary research collaboration between the Department of Neurology at Bispebjerg-Frederiksberg Hospital and DTU Health Tech, bringing together engineers, clinicians, nurses, researchers and patients.

Students may contribute to one or several aspects of the Bladder-SENSE development process, depending on their educational background, interests and technical qualifications. Depending on the selected project, students may deliver a technical prototype, sensor validation study, data analysis pipeline, predictive model, user-interface concept, usability evaluation or implementation recommendations.

Required qualifications/prerequisites:

The project is relevant for students within Biomedical Engineering, Medicine and Technology, Health Technology, Design and Innovation, Computer Science, Data Science or related disciplines.

Depending on the selected subproject, relevant competencies may include sensor technology, signal processing, programming (e.g. Python or MATLAB), data analysis, product development, user-centred design or qualitative research methods. An interest in interdisciplinary collaboration, clinical research and developing technologies with direct relevance to patients and healthcare professionals is essential. Prior clinical experience is not required.

Responsible institution/department:

Department of Health Technology, Technical University of Denmark (DTU Health Tech), in collaboration with the Department of Neurology, Bispebjerg-Frederiksberg Hospital, Copenhagen University Hospital.

Contact information:

Trine Hørmann Thomsen, RN, PhD

Senior Researcher, Department of Neurology, Bispebjerg-Frederiksberg Hospital

Assistant Professor, DTU Health Tech

Email: trine.hoermann.thomsen@regionh.dk

Allowed no. of students per report (1-4):

1–4 students, depending on project scope and educational level.

KU/DTU supervisor:

Alireza Dolatshahi-Pirouz, Associate Professor, DTU Health Tech (Biosensing)

Trine Hørmann Thomsen, Assistant Professor, DTU Health Tech / Senior Researcher, Bispebjerg-Frederiksberg Hospital

Is the project TUH (Technical University Hospital) affiliated (yes/no):

Yes.

Can automated tests improve the reliability of EEG statistical analysis?

Description:

Reliable neuroscience depends on analysis software producing correct results across different datasets and experimental designs. This project will strengthen unit and integration tests for the MATLAB-based LIMO EEG toolbox.

Students will extend existing tests using synthetic EEG data with known effects and a selected real-data example. Unit tests will verify individual functions against independently established expectations; integration tests will check complete workflows from model specification to group results. Selected cases will include trial rejection, contrasts, channel ordering and invalid inputs. The effectiveness of the tests will be evaluated by introducing controlled coding errors and measuring which errors they detect.

Deliverables will include an automated MATLAB test suite, reusable example datasets and a report evaluating test effectiveness and remaining gaps. BSc scope will focus on one model and a small number of workflows; MSc scope can add simulations assessing statistical performance.

Required qualifications/prerequisites:

- **02002 or 02003 — Programming**, preferably with MATLAB experience.
- **02402 — Statistics**, or **02403 — Introduction to Mathematical Statistics**.
- **22051 — Signals and Linear Systems in Discrete Time**.
- **22052 — Applied Signal Processing** is particularly useful for MSc students.
- **22062 — Introduction to Medical Data Science** is an additional advantage.

Prior experience with unit testing is welcome but not required.

Responsible institution/department: DTU – Hearing Systems

Contact information: Dr Cyril Pernet cyrpe@dtu.dk

Allowed no. of students per report: 2-3

KU/DTU supervisor: Cyril Pernet

Can revised statistical figures improve users' interpretation of EEG results?

Description:

EEG analyses produce complex results across electrodes, time and frequency. How these results are visualised can influence users' understanding of effect sizes, uncertainty and statistical significance. This project will investigate whether redesigned figures and interactive tools improve interpretation within the MATLAB-based LIMO EEG toolbox.

Students will review existing figures, identify interpretation difficulties with researchers, and implement selected improvements in MATLAB. A small user study will compare existing and revised visualisations using interpretation accuracy, task completion time and usability ratings. Deliverables will include working visualisation tools, documented code and an evaluation of their effectiveness.

Required qualifications/prerequisites: MATLAB programming, introductory statistics, and an interest in biomedical signals and user-centred design. Relevant DTU Health Tech courses include:

- 22062 — Introduction to Medical Data Science
- 22051 — Signals and Linear Systems in Discrete Time, or 22052 — Applied Signal Processing
- 22449 — Introduction to Biomedical Product Development, or 22450 — Applied Biomedical Product Development

Equivalent experience is welcome; completion of all listed courses is not required.

Responsible institution/department: DTU – Hearing Systems

Contact information: Dr Cyril Pernet cyrpe@dtu.dk

Allowed no. of students per report: 2-3

KU/DTU supervisor: Cyril Pernet

Project Title:

Comparison of Forced Oscillation Technique and Impulse Oscillometry: Effects of Lung Size, Disease Phenotype and Clinical Confounders

Description:

Respiratory oscillometry measures respiratory-system mechanics during quiet breathing and provides information that complements spirometry, body plethysmography and diffusion-capacity testing. Forced oscillation technique (FOT) is the general methodological principle, whereas impulse oscillometry (IOS) is a specific implementation using repeated pressure impulses. Although both measure respiratory-system impedance, differences in forcing signals, frequency content, hardware and signal processing may lead to systematic differences between measurements.

The aim of this project is to compare FOT and IOS in the same healthy individuals and patients and determine which physiological and clinical factors influence agreement between the two techniques. Particular attention will be given to lung size, age, height, BMI, breathing pattern and disease severity.

The student(s) will assess agreement and systematic bias between FOT and IOS and investigate whether differences vary across normal, obstructive, restrictive and mixed physiological patterns. The project will also examine whether either technique is more sensitive to airway obstruction, peripheral mechanical heterogeneity, airway closure or altered respiratory-system compliance.

Statistical methods may include regression analysis, Bland–Altman analysis, mixed-effects modelling and subgroup comparisons. Depending on scope, the project may be extended to multivariable modelling of confounders and development of practical recommendations for interpreting and selecting FOT and IOS in different clinical populations.

Required qualifications/prerequisites:

Basic knowledge of statistics and some programming experience in R and/or Python. Familiarity with regression analysis is an advantage. The project is particularly suitable for students interested in biomedical engineering, lung physiology, respiratory measurements and statistical modelling. Prior experience with oscillometry is not required.

Responsible institution/department:

University of Copenhagen (KU), Department of Biomedical Sciences – Integrative Circulation in collaboration with Department of Clinical Medicine / Clinical Physiology and Nuclear Medicine, Rigshospitalet.

Contact information:

Associate Professor Henrik H. El Ali, MSc, PhD – helali@sund.ku.dk, +45 29354867. Professor Jann Mortensen – jann.mortensen@regionh.dk, +45 35 45 17 16.

Allowed no. of students per report: 1–4

KU/DTU supervisor:

Associate Professor Henrik H. El Ali (KU, Department of Biomedical Sciences) and Professor Jann Mortensen (KU, Department of Clinical Medicine / Rigshospitalet).

Project Title:

Designing Peptide Binders for Cancer Targets with AI — Can We Trust the Predictions?

Description:

This project explores the use of BindCraft and related state-of-the-art AI methods for designing peptide binders against cancer-relevant protein targets. Depending on the student's interests, the work can focus on generating and evaluating new AI-designed peptides, benchmarking different structure-prediction approaches, and/or analyzing our existing data on AI-designed peptides and associated experimental binding-affinity data.

A key goal is to understand what makes an AI-predicted binder plausible and why some predictions succeed while others fail. The project will therefore combine computational predictions with structural and existing experimental data to critically assess the capabilities, limitations, and failure modes of current AI-based binder-design methods.

Required qualifications/prerequisites:

- **Understanding of proteins and molecular interactions** — including familiarity with protein structures and structural data (e.g. PDB/mmCIF files) and visualization (e.g. pymol)
- **Basic computational skills and interest in protein design** — some experience with Python, data analysis, structural modelling, or related tools; prior experience with AlphaFold, docking, BindCraft, etc. is a plus but not required.
- **Curious, self-driven, and independent** — able to learn new computational tools, read documentation, troubleshoot, and make progress independently with guidance when needed.

Responsible institution/department: Department of Biomedical Sciences, Department of CHemistry

Contact information: njc@chem.ku.dk

Allowed no. of students per report: 1-3

KU/DTU supervisor: Niels Johan Christensen, Knud Jensen, Andreas Kjaer

Project Title:

Development of Local Reference and Baseline Values for Respiratory Oscillometry Using IOS/FOT

Description:

Respiratory oscillometry is a non-invasive lung-function method that measures respiratory mechanics during quiet tidal breathing. Because the technique requires only limited active cooperation, it can complement conventional lung-function tests such as spirometry, particularly in patients who have difficulty performing forced respiratory manoeuvres. Reliable interpretation, however, depends on reference values that are appropriate for the population, device and measurement protocol.

Impulse oscillometry (IOS) and forced oscillation technique (FOT) measure respiratory-system impedance, including resistance and reactance. Commonly used indices include R5, R20, R5–R20, X5, resonant frequency and area of reactance. These measurements are influenced by factors such as age, sex, height, body size, breathing pattern, lung volume and device technology. Published reference equations have been derived from different populations and systems and may therefore not be directly applicable to local measurements.

The aim of this project is to establish preliminary local baseline values for clinically relevant IOS/FOT parameters in healthy adults and to identify the main physiological and demographic factors influencing these measurements.

The student(s) will recruit approximately 50–80 healthy adults and perform repeated IOS/FOT measurements together with spirometry and basic clinical measurements. The project will assess within-session and between-day repeatability, investigate associations with age, sex, height, BMI, respiratory frequency and tidal volume, and compare observed values with selected published reference equations.

Statistical analyses may include descriptive modelling, multivariable regression, intraclass correlation coefficients, coefficients of variation, Bland–Altman analysis and calculation of predicted values, residuals and z-scores. The project may also contribute to the development of a standardised local protocol for measurement, quality control and reporting of respiratory oscillometry..

Required qualifications/prerequisites:

Basic knowledge of statistics and some programming experience in R and/or Python. Familiarity with regression analysis is desirable. The project is particularly suitable for students interested in biomedical engineering, lung physiology, respiratory measurements, reference equations and clinical data analysis. Prior experience with IOS/FOT is not required.

Responsible institution/department:

University of Copenhagen (KU), Department of Biomedical Sciences – Integrative Circulation in collaboration with Department of Clinical Medicine / Clinical Physiology and Nuclear Medicine, Rigshospitalet.

Contact information:

Associate Professor Henrik H. El Ali, MSc, PhD – helali@sund.ku.dk, +45 29354867. Professor Jann Mortensen – jann.mortensen@regionh.dk, +45 35 45 17 16.

Allowed no. of students per report: 1–4

KU/DTU supervisor:

Associate Professor Henrik H. El Ali (KU, Department of Biomedical Sciences) and Professor Jann Mortensen (KU, Department of Clinical Medicine / Rigshospitalet).

Project Title: Evolution of *Pseudomonas aeruginosa* under human host-defense peptides

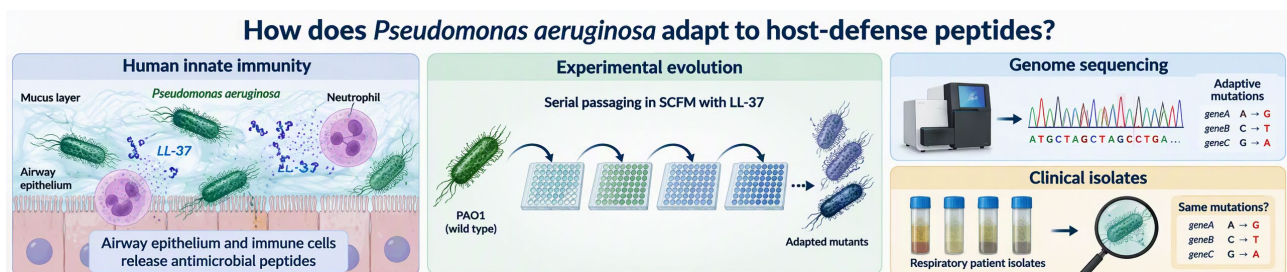
Description:

Pseudomonas aeruginosa causes chronic respiratory infections in patients with cystic fibrosis (CF), Chronic Obstructive Pulmonary Disease (COPD) and other chronic lung diseases. During these infections, bacteria are continuously exposed not only to antibiotics but also to antimicrobial peptides produced by the host innate immune system. However, the evolutionary consequences of this selective pressure remain poorly understood.

In this project, the student will use experimental evolution to investigate bacterial adaptation to human host-defense peptides (e.g. LL-37) under physiologically relevant conditions using Synthetic Cystic Fibrosis Sputum Medium (SCFM). Evolved populations will be characterized by whole-genome sequencing to identify adaptive mutations and resistance mechanisms.

The project will further explore the clinical relevance of these findings by screening a longitudinal collection of *P. aeruginosa* isolates from patients with chronic respiratory infections to determine whether the same genetic adaptations emerge during infection and their functional consequences. Depending on project progress, additional phenotypic characterization may include infection assays in advanced airway epithelial models.

The project combines microbiology, bacterial evolution, genomics and host-pathogen interactions, and is suitable for students interested in infectious diseases and microbial adaptation.



Required qualifications/prerequisites:

- Enrolment in a study program in Biology, Biotechnology, Biomedicine, Microbiology or a related field.
- Interest in microbiology, infectious diseases and bacterial evolution.
- Basic laboratory experience is advantageous.
- Motivation to learn molecular biology, microbial cultivation and genomic data analysis.
- Experience with bioinformatics is a plus but not essential.

Responsible institution/department:

DTU HealthTech / Department of Clinical Microbiology, Rigshospitalet

Contact information: Pablo Laborda (esmceb@dtu.dk), Ruggero La Rosa (rugros@dtu.dk)

Allowed no. of students per report: 1

Supervisors:

Ruggero La Rosa (rugros@dtu.dk), Associate professor, DTU Health Tech

Helle Krogh Johansen (hkj@dtu.dk), MD, DMSc, Professor – Rigshospitalet, KU

Pablo Laborda (palama@dtu.dk), Postdoctoral researcher, Rigshospitalet

Esmeralda Cebrián (esmceb@dtu.dk), Postdoctoral researcher, Rigshospitalet

Project Title:

Fabrication of a **Biomimetic Mouse Stomach Model** for In Vitro Evaluation of Oral Drug Delivery Devices

Description:

The development of oral drug delivery systems and vaccine administration devices for mice is becoming increasingly important in preclinical research. However, device development often requires extensive animal testing during the early design stages, leading to increased costs, time consumption, and the potential loss of experimental animals.

This project aims to develop a transparent biomimetic mouse stomach model that can serve as an in vitro platform for evaluating the mechanical performance and functionality of oral delivery devices before animal studies. The model will be fabricated by creating a mould from an excised mouse stomach and subsequently reproducing its anatomical structure using transparent silicone materials.

Students will participate in the design, fabrication, and characterization of the biomimetic stomach model. The project may also involve designing supporting fixtures, developing a temperature-controlled testing setup operating at 37°C, and establishing imaging methods for device visualization during testing. The developed platform will enable assessment of device deployment and functionality but will not be intended for drug absorption or release studies.

The project combines biomedical engineering, anatomical modelling, rapid prototyping, and experimental design, providing students with hands-on experience in developing alternative in vitro models that can support and reduce animal experimentation during device development.

Required qualifications/prerequisites:

Interest in biomedical engineering, design thinking, anatomical modelling, CAD design, and experimental development. Experience with 3D design or prototyping is beneficial but not required.

Responsible institution/department:

DTU Health Tech

Contact information:

Johnson Ebenezer Rajendran (joera@dtu.dk)

Allowed no. of students per report: For BSc. 1-2 | MSc. 1

DTU supervisor:

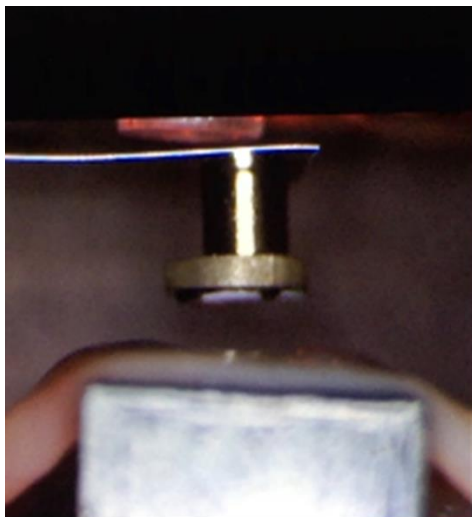
Anja Boisen (aboi@dtu.dk)

MSc project for students in Biomedical Engineering and/or relevant fields

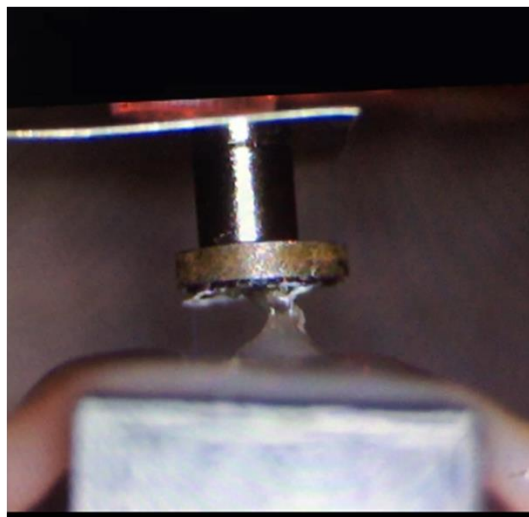
Project Title: Surface-modified nanostructured μ particles for increased intestinal retention

Description: Rapid clearance of the drug and the drug delivery system from the gastrointestinal (GI) tract is a major barrier to oral delivery and intestinal absorption. While mucus can act as a barrier to effective drug delivery, it can also assist with improved intestinal residence with anchoring mechanism. Special muco-adhesive micro/nano drug delivery systems can enable longer residence time, improving the efficacy of oral drug delivery.

In this project, we aim to design, fabricate and validate a special drug delivery system based on muco-adhesive nanoparticles covering a μ particle structure. We will perform in vitro, ex vivo and (if possible) in vivo studies to evaluate our drug delivery system from muco-adhesive, mucus-penetrating, and mucolytic aspects.



Hydrophobic polymer sheet



Surface modified hydrophobic polymer sheet

Responsible institution/department: Department of Health Technology (DTU)

Contact information: Fatemeh Ajalloueiian (faaj@dtu.dk)

Allowed no of students per report (1-4): 2 students

About IDUN

IDUN is a center of excellence funded by the Danish National Research Foundation and the Villum Foundation. The center is divided into two parts: IDUN Drug and IDUN Sensor, focusing on drug delivery and nanomechanical sensors, respectively.

MSc Project: From €15 to Less Than €1 per Sample

Can a Cheaper IgG Purification Method Enable Affordable Raman Diagnostics for Identifying Women at Risk of Delivering Infants with Gestational Alloimmune Liver Disease?

Are you interested in combining antibody purification, optical sensing, machine learning, and clinical diagnostics to solve a real healthcare challenge? Then this MSc project may be for you.

Background

Gestational Alloimmune Liver Disease (GALD) is a rare but severe antibody-mediated disease that can cause fetal and neonatal liver failure. Our recent work has shown that Raman spectroscopy combined with machine learning can identify women at risk of delivering infants affected by GALD by analyzing purified IgG antibodies from maternal blood samples (Jensen et al., 2026).

The current workflow relies on a commercial IgG purification kit costing approximately €15 per sample. While suitable for research, this cost may become a barrier for implementation in the clinic.

Caprylic acid precipitation is a simple, inexpensive, and scalable purification strategy that could reduce the purification cost to less than €1 per sample. However, its suitability for Raman-based diagnostics depends critically on whether sufficiently pure IgG can be isolated while maintaining diagnostic performance.

Project Objectives

The project consists of two closely linked tasks:

1. Development and Optimization of a Low-Cost IgG Purification Workflow

You will develop and optimize a caprylic acid precipitation protocol for human plasma samples with the goal of obtaining IgG preparations that are sufficiently pure for Raman spectroscopic analysis.

This includes:

- Optimization of precipitation conditions and process parameters.
- Evaluation of IgG yield and purity.
- Identification and mitigation of contaminating plasma proteins.
- Development of a robust and reproducible sample preparation workflow.

2. Benchmarking Against the Current Workflow

The optimized caprylic acid protocol will be benchmarked against the currently used Melon™ Gel purification method.

You will investigate:

- Differences in Raman spectral quality.
- Effects on downstream machine-learning performance.
- Classification accuracy for identifying women at risk of GALD-affected pregnancies.

- Trade-offs between purification cost, sample purity, and diagnostic precision.

The key question is:

Can a purification method costing less than €1 per sample achieve diagnostic performance comparable to a €15 commercial purification kit?

What You Will Learn

This project provides hands-on experience with:

- Biomedical optics and Raman spectroscopy.
- Antibody purification and bioanalytical methods.
- Machine learning for biomedical data analysis.
- Technology development for medical diagnostics.
- Translational research in collaboration between DTU and a clinical diagnostic laboratory.

Potential Impact

If successful, the project could reduce sample-preparation costs by more than an order of magnitude while preserving diagnostic accuracy. Such a development would help move Raman-based antibody diagnostics closer to routine clinical implementation and may enable screening approaches for diseases where the causative antigen remains unknown.

Supervisors:

Anders Kristensen, DTU Health Tech

Martin Dufva, DTU Health Tech

Morten Hanefeld Dziegiel, Department of Clinical Immunology, Rigshospitalet

Anne Todsén Hansen, Department of Clinical Immunology, Rigshospitalet

How the heart chambers crosstalk – an electrocardiographic study in patients with prior myocardial infarction

Description:

After a myocardial infarction in the ventricles, ventricular arrhythmias often occur, and the underlying mechanisms have been studied. Still, atrial arrhythmias also manifest after a myocardial infarction, and the mechanisms here are yet to be explored. We will use long-term (min. 24 hours) EKG recordings from patients with prior myocardial infarction to study the interplay between the atria and ventricles. Our results will pave the path for a new way of thinking arrhythmias in the heart.

Required qualifications:

Independent and motivated student(s) with excellent knowledge in human biology and signal processing, motivated to work with real-life data. If interested, please send CV, study record incl. grades, and short motivational letter mentioning a bit about yourself and your future professional ambitions. This project involves a lot of data processing and is therefore most suitable for project +20 ECTS points.

Responsible institution/department:

Department of Biomedical Sciences (BMI), KU

Contact information:

Lisa A. Gottlieb gottlieb@sund.ku.dk, MD PhD assistant professor

Allowed no of students per report: 1-4

KU and/or DTU supervisor:

Dr. Lisa A. Gottlieb, BMI, KU

Dr. Dan Eik Høfsten, Rigshospitalet

Dr. Nicolai Spicher, DTU

Project Title: Immune response measured with nanodiamond-based quantum sensing

Motivation

When macrophages engulf bacteria, one of the responses of the macrophage is formation of reactive oxygen species. Many reactive oxygen species are paramagnetic, and these can be measured with very high spatial precision using so-called diamond quantum sensing.

Goal of the project

In this project we aim to apply intracellular nanodiamond sensing of reactive oxygen species produced by the macrophage cells as they interact with bacterial cells.

Research plan and learning outcomes

First, you will explore how to use fluorescence microscopy to determine coupling of nanodiamonds with bacteria, and study the interaction between macrophages and bacteria. If you are not familiar with cell cultures, we will teach you how to culture the macrophages and to let the two cell types interact. You will learn how to apply nanodiamond magnetometry to measure presence of paramagnetic species, using fluorescent nanodiamonds (FNDs) with nitrogen vacancy centers as probes.

Required qualifications/prerequisites

Insight in cell biology and/or in optical microscopy and image analysis with python or MatLab - alternatively, background in optics/physics and a sincere interest in learning the required cell biology.

Responsible institution/department

DTU Health Technology

Contact information: kibs@dtu.dk

Allowed no. of students per report: 1-2

KU/DTU supervisor: Kirstine Berg-Sørensen, DTU

Impact of Obstructive Sleep Apnea on Cardiac Electrophysiology and Cardiac Disease Development in a Danish Patient Cohort

Description:

Obstructive sleep apnea associates with heart failure and arrhythmia in patients. Still, the patho(physiological) processes of how apnea leads to disease are unknown. In this project, we will analyze polysomnography data (EKG, oxygen saturation, blood pressure recordings during an entire night) from patients with and without obstructive sleep apnea and thereby establish biological patterns during apnea associated with arrhythmia formation.

Required qualifications:

Independent and motivated student(s) with excellent knowledge in human biology and signal processing, motivated to work with real-life data with the potential to improve diagnosis in patients with obstructive sleep apnea. If interested, please send CV, study record incl. grades, and short motivational letter mentioning a bit about yourself and your future professional ambitions. This project involves a lot of data processing and is therefore most suitable for project +20 ECTS points.

Responsible institution/department:

Department of Biomedical Sciences (BMI), KU

Contact information:

Lisa A. Gottlieb gottlieb@sund.ku.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor:

Dr. Lisa A. Gottlieb, BMI, KU

Dr. Nicolai Spicher, DTU

Prof. Poul Jennum, Rigshospitalet

Project Title:

Linking Cortical Network Organization to Brainstem Integrity in Parkinson's Disease: A 7T MRI Study of Cortical Morphometric Similarity Networks and Substantia Nigra and Locus Coeruleus Imaging Features

Description:

Parkinson's disease involves brainstem alterations alongside changes in cortical organization. This project will investigate whether individual cortical morphometric similarity networks are associated with MRI features of the substantia nigra (SN) and locus coeruleus (LC), using existing 7T MRI and clinical data.

Students will assess cortical morphometry, construct or refine individual similarity networks, and relate selected network measures to SN MTw, QSM and R2* features and LC MTw features. Associations with motor and non-motor symptoms may be explored. Existing pipelines provide a starting point, and the project can focus on a subset of network measures or imaging features. If the project goes smoothly, we hope the students will be able to publish a journal paper.

This project offers a valuable opportunity to gain hands-on research experience and build a strong foundation for a future research career.

Required qualifications/prerequisites:

Basic statistics and programming in Python or R. Interest in neuroimaging and network analysis. Familiarity with cortical morphometry or graph theory is helpful but not essential. A proactive attitude and patience when working through technical challenges are highly valued.

Responsible institution/department:

Danish Research Centre for Magnetic Resonance (DRCMR), Department of Radiology and Nuclear Medicine, Copenhagen University Hospital, Hvidovre, Denmark.

Contact information:

Weijian Liu, MD, PhD, Postdoctoral Researcher, weijian.liu@regionh.dk

Day-to-day supervision: Dr Weijian Liu and Senior Researcher David Meder.

Allowed no. of students per report: 1

KU supervisor: Prof. Hartwig R. Siebner, University of Copenhagen (KU).

Project Title: Marauder's Patient Map: Designing a Real-Time Location System (RTLS) to Minimize Search Times and Optimize Care in Stroke Units

Description:

Inspired by the mythical map that reveals everyone's exact whereabouts in real-time, the "Marauder's Patient Map" project addresses a major real-world bottleneck in healthcare logistics: the significant amount of time clinical staff waste searching for mobile patients. Hospital staff spend unnecessary amounts of time walking up and down the hospital corridors trying to locate patients. Either the doctor trying to locate them for rounds, physiotherapists getting them to rehabilitation training or nurses during patient care. In neurological rehabilitation units, stroke patients have many commitments and often move around a lot. This administrative fiction of trying to locate patients directly reduces the valuable "touch time" available for face-to-face patient care, stalls doctors' rounds, and erupts clinical efficiency.

Project objective: This project aims to design, deploy, and evaluate a lightweight, low-cost real-time location system (RTLS) feasibility study. The project will investigate how a digital "live ward map" at a hospital workstation can eliminate daily searching friction and provide a data-driven cost-benefit analysis to support long-term hospital investments.

Scope of work: The student team will lead a feasibility study inside an active clinical hospital setting:

- *User-centric field research:* Conduct interviews and shadow nursing/medical staff, and map current operational bottlenecks and measure actual time spent locating patients.
- *Interface and map interaction design:* Develop and test the user-facing "Marauder's Patient Map" dashboard for hospital workstations, ensuring it's intuitive, functional so that the clinical staff can easily locate the patients of interest while respecting patient privacy constraints.
- *Feasibility study execution:* Deploy a lightweight tracking ecosystem (e.g. patient wristbands and wall beacons in each room of interest) to log precise spatial coordinates during a live trial phase on the ward.
- *Data analysis:* Do an analysis of indicators (e.g. search times, room utilization) and conduct a cost-benefit analysis. Moreover, assess possible additional applications for use.

Required qualifications/prerequisites:

We are seeking a highly motivated team of 2 master's students, ideally from the Biomedical Engineering Program or Design and Innovation program, who has an interest in healthcare operations, socio-technical design, and data-driven service innovation. The ideal candidate should have:

- A solid foundation in user-friendly design methodologies
- Strong analytical skills with an interest or experience in translating raw tracking data into operational metrics in real-time.
- Communication skills, empathy, and collaboration abilities required to work directly with clinical staff and patients in a complex hospital environment.
- A creative, solution-oriented mindset that can create an intuitive user interface design.

Responsible institution/department:

Stroke Unit, Department of Neurology
Copenhagen University Hospital, Bispebjerg
Nielsine Nielsens Vej 13, Entrance 1
2400 Copenhagen NV

Contact information:

Karina Siewers Christensen
karina.siewers.christensen@regionh.dk

Allowed no. of students per report: 2

KU/DTU supervisor:

Trine Hørmann Thomsen, RN, MScN, PhD
trine.hoermann.thomsen.01@regionh.dk

Professor Hanne Christensen, MD, PhD, DMSci
hanne.krarup.christensen@regionh.dk

Project Title: Metabolic Adaptation of Bacteria Evolved in an In Vivo Lung Infection Model

Description:

Chronic lung infections place bacteria under multiple selective pressures, including nutrient limitation, host immune responses, and antibiotic treatment. Over time, bacteria can adapt to these conditions through genetic and metabolic adaptations that improve survival. Understanding these changes in bacterial metabolism is important because they may contribute to persistence and antibiotic resistance and could reveal new vulnerabilities that can be targeted therapeutically.

In this project, we collaborate with the group of Oana Ciofu at the Biofilm Center, University of Copenhagen. We will investigate a collection of bacterial strains that evolved during repeated passages in an experimental lung infection model with and without antibiotic treatment. Previous genomic and metabolomic analyses have shown that the evolved strains differ substantially from their ancestral strain and suggest that metabolic adaptation plays an important role in the evolutionary process.

The aim of this project is to investigate how nutrient availability influences the metabolic phenotype of evolved bacterial strains. The bacteria will be cultivated in both a defined minimal medium and a medium designed to mimic conditions encountered in the lung. Growth characteristics and metabolic activity will be compared to identify metabolic adaptations associated with evolution in the host environment. Furthermore, antibiotic susceptibility will be determined for each strain under the different growth conditions to investigate whether metabolic state influences susceptibility to antimicrobial treatment.

The project will include bacterial cultivation, determination of antibiotic susceptibility, growth curve analysis, and ¹H NMR-based metabolomics. The resulting data will be used to identify metabolic differences between evolved and ancestral strains and determine how growth conditions influence bacterial metabolism.

Responsible institution/department: DTU, Department of Health Technology

Contact information: Email: peroje@dtu.dk

Allowed no. of students per report: 1-2 students

KU/DTU supervisor: Associate Professor Pernille Rose Jensen, Department of Health Technology, DTU

Project Title: Method development for Magnetic Resonance Imaging (MRI)

Description: Magnetic Resonance Imaging and Spectroscopy techniques (MRI/MRS) are challenging, but also safe and extremely flexible providing non-invasive and detailed tissue characterization. Magnetic fields of typically 1.5 to 3 tesla are used for humans. The state-of-the-art 3 tesla human scanner at DTU is open for experimentation, for example, and a 7-tesla human scanner is available at Hvidovre Hospital as a result of a national collaboration involving DRCMR, DTU and other partners.

New innovations give more possibilities but also challenges that need to be overcome. There are hundreds of magnetic resonance imaging and spectroscopy techniques, and more are constantly being developed, refined, validated and employed for clinical or research uses at Danish MRI sites operating at different field strengths. Students with relevant skills are invited to express interest, so project options can be discussed. There are possibilities for projects that are oriented toward physics, electronics, method development, image analysis, statistics, medical applications, brain function and more.

Required qualifications: Different competences are of interest, and projects matching your background can likely be proposed. It is an advantage to have one or preferably more of the courses 22481, 22485, 22506, 22610 or 22508 (see <https://www.cmr.healthtech.dtu.dk/education/mr-courses-and-their-connection>). MRI can be quite challenging, and some projects are therefore only suited for MSc students.

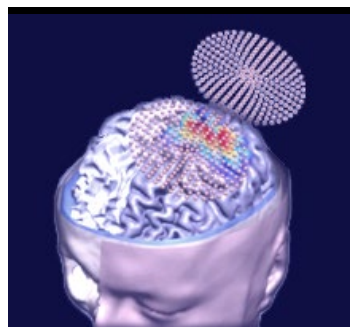
Responsible institution/department: DTU Health Tech / DTU Compute and/or Danish Research Centre for MR, DRCMR, <http://www.cmr.healthtech.dtu.dk>, <http://www.compute.dtu.dk>, <http://drcmr.dk/>

Contact information: Lars G. Hanson, lgan@dtu.dk or people mentioned below.

Allowed no of students per report (1-4): 1-4

KU and/or DTU supervisor: For example Axel Thielscher (neurophysics), Mathilde Hauge Lerche (brain metabolism), Henrik Lundell (microstructure & ultra-highfield MRI), Kristoffer Hougaard Madsen (machine learning), Tim Dyrby and Marco Pizzolato (microstructure), Vitaliy Zhurbenko (coil technology) or Lars G. Hanson (measurement design). See web for their mail addresses and interests (only examples are given).

Is the project TUH (Technical University Hospital) affiliated: May be



BSc/MSc project for students in Biomedical Engineering and/or Health Technology relevant fields, DTU/KU

Project Title: Microporous Nanostructures and nanofibrous microparticles for smart drug delivery and tissue engineering applications

Description: Nanofibrous structures (e.g. electrospun sheets) mimicking the ECM fibrous structure of native tissue play an important role in drug delivery and tissue engineering applications. On the other side, micro particles have demonstrated a profound role as carriers of drugs/bioactive agents in oral drug delivery systems (DDS). Both these systems, in their conventional form, suffer from deficiencies preventing them from efficient clinical applications. Whilst Nanofibers suffer from limited cell infiltration due to their small pore sizes (against their high total porosity), micro particles have appeared inferior to nanoparticles (in several studies) due to their incapability in passing through mucus barrier in order to deliver their drug. In this project, we use our fabrication knowledge to design and develop nanofibers with regular micro-pores for improved cell adhesion and infiltration, as well as fabricating nanostructured micro particles with possibility of delivering nanocarriers to pass through mucus barrier. In this project, you will work on either of these structures, and will learn how to fabricate them, and use them for cell culture studies or for drug loading and oral delivery. You will also learn several characterization techniques including imaging, drug release and cell-scaffold interactions.

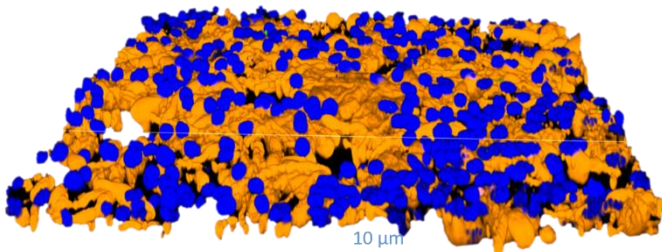
Required qualifications: None

Responsible institution/department: Department of Health Technology, DTU

Contact information: Fatemeh Ajalloueiian (faaj@dtu.dk)

Allowed no of students per report (1-4): 4

Supervisors: Anja Boisen, Fatemeh Ajalloueiian



Project Title:

Modelling the Relationship Between Transcriptomic Signatures and Multidimensional Lung Function in COPD

Description:

COPD is a heterogeneous disease in which FEV1 captures only part of the underlying physiological impairment. Hyperinflation, small-airway dysfunction and impaired gas exchange may reflect different biological mechanisms and contribute differently to disease phenotype. This project will investigate how transcriptomic pathway signatures relate to multidimensional lung physiology in a literature-grounded synthetic COPD cohort.

The student(s) will work with or generate a synthetic cohort of approximately 500–1,000 individuals, including healthy controls, smokers without COPD and patients with varying degrees of COPD severity. The dataset may include spirometry, lung volumes (TLC, RV and RV/TLC), diffusion capacity (DLCO and KCO), oscillometry, smoking history and other clinical characteristics, together with omics-derived pathway scores representing inflammation, oxidative stress, epithelial dysfunction, extracellular-matrix remodelling and tissue destruction. The main modelling objective is to identify biological processes associated with distinct patterns of physiological impairment rather than simply classify individuals according to COPD status.

The main aim is to identify which omics-derived biological pathways are most strongly associated with different patterns of lung-function impairment in COPD. The students will first define physiological phenotypes using spirometry, lung volumes, diffusion capacity and oscillometry, and then model how these phenotypes relate to inflammatory, oxidative-stress, epithelial and tissue-remodelling pathway scores.

The analysis will primarily use multivariable regression and dimension-reduction methods such as PCA or factor analysis. Depending on the scope, the project can be extended with clustering, nonlinear modelling or validation against publicly available datasets. For larger groups, students can divide the work between data generation, physiological phenotyping, omics modelling and validation.

Required qualifications/prerequisites:

Basic knowledge of physiology, linear models and statistical inference. Experience with R and/or Python is desirable. Interest in respiratory physiology, multivariate statistics, machine learning or omics is an advantage. No prior COPD or transcriptomics specialization is required.

Responsible institution/department:

University of Copenhagen (KU), Department of Biomedical Sciences – Integrative Circulation in collaboration with Department of Clinical Medicine / Clinical Physiology and Nuclear Medicine, Rigshospitalet.

Contact information:

Associate Professor Henrik H. El Ali, MSc, PhD – helali@sund.ku.dk, +45 29354867. Professor Jann Mortensen – jann.mortensen@regionh.dk, +45 35 45 17 16.

Allowed no. of students per report: 1–4

KU/DTU supervisor:

Associate Professor Henrik H. El Ali (KU, Department of Biomedical Sciences) and Professor Jann Mortensen (KU, Department of Clinical Medicine / Rigshospitalet).

Project Title:

MRI Signal Entropy in the Substantia Nigra and Locus Coeruleus and Its Relationship with Clinical Symptoms in Parkinson's Disease: A 7T MRI Study

Description:

Parkinson's disease affects the substantia nigra (SN) and locus coeruleus (LC), but average MRI signal values may not fully capture the variation within these nuclei. This project will explore whether MRI signal entropy—a measure of the diversity and unpredictability of image intensities—provides additional information about brainstem alterations and their relationship with motor and non-motor symptoms.

Using existing 7T MRI and clinical data from patients with Parkinson's disease and healthy controls, students will quantify entropy in SN MTw, QSM and R2* images and LC MTw images. They will compare entropy between groups and examine its associations with clinical symptoms, alongside conventional mean signal measures. Existing data and analysis tools provide a starting point, and the scope can be adapted to the student's interests and experience. The project offers an opportunity to develop skills in quantitative MRI, image analysis and clinical research, with the potential to contribute to a journal publication.

This project offers a valuable opportunity to gain hands-on research experience and build a strong foundation for a future research career.

Required qualifications/prerequisites:

Students with a background in biomedical engineering, medicine, physics, mathematics, computer science or related fields are welcome. Basic knowledge of statistics and programming experience in Python, R or MATLAB are expected. An interest in neuroimaging and quantitative image analysis is important; prior experience with MRI, information theory or texture analysis is helpful but not essential. A proactive attitude and patience when working through technical challenges are highly valued.

Responsible institution/department:

Danish Research Centre for Magnetic Resonance (DRCMR), Department of Radiology and Nuclear Medicine, Copenhagen University Hospital, Hvidovre, Denmark.

Contact information: Weijian Liu, MD, PhD, Postdoctoral Researcher, weijian.liu@regionh.dk

Day-to-day supervision: Dr Weijian Liu and Senior Researcher David Meder.

Allowed no. of students per report: 1

KU supervisor: Prof. Hartwig R. Siebner, University of Copenhagen (KU).

MSc project for students in Biomedical Engineering and/or Health Technology relevant fields

Project Title: Nanofibrous microparticles for nasal drug delivery

Description:

Chronic rhinosinusitis is a disease case requiring improved nasal delivery. Liquid nasal sprays deposit mainly in the anterior nasal cavity and are removed by mucociliary clearance within about 15 minutes, whereas high-volume irrigations improve distribution but suffer from poor patient adherence (~45%). Preservative-free dry powders are therefore a rational next step, offering better physicochemical stability, longer mucosal residence and versatile drug loading.

In this project we use our fabrication knowledge to design nanofibers that are converted, by micro-cutting, into discrete and geometrically defined nanofibrous microparticles, and to formulate them as a dry powder for targeted nasal delivery. The work is related to our dry-powder nasal delivery platform for sinonasal therapy, and you will learn how to fabricate these structures, how to load them with drugs or bioactive agents, and how to evaluate their release and functionality.

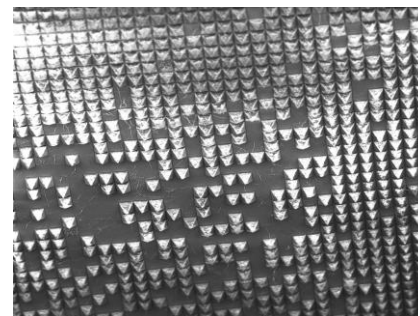
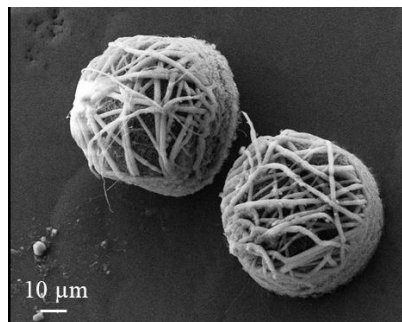
Required qualifications: None

Responsible institution/department: Department of Health Technology, DTU (DTU Health Tech)

Contact information: Fatemeh Ajalloueian (faaj@dtu.dk)

Allowed no of students per report (1-4): 4

Supervisors: Fatemeh Ajalloueian



Project Title:

Multimodal Classification of Lung Disease Using Physiology, Clinical Phenotypes and Omics

Description:

Modern respiratory medicine generates several complementary descriptions of the same patient, including clinical characteristics, physiological phenotypes and molecular endotypes. This project will investigate whether integrating these data sources can identify clinically meaningful patient subgroups that are not captured by conventional lung-function measurements alone. The project will contribute to the development of the LungOmics-Sim framework for multimodal modelling.

The student(s) will analyse or generate a synthetic cohort of approximately 800–1,200 subjects representing healthy individuals and selected obstructive, restrictive and/or malignant lung conditions. The dataset will integrate spirometry, lung volumes, DLCO, oscillometry, clinical variables and transcriptomic or pathway-level omics features. The main analysis will compare patient patterns derived from physiology alone, omics alone and integrated multimodal data.

The central aim is to determine whether molecular endotypes correspond to, complement, or reveal subgroups beyond conventional physiological phenotypes. Statistical methods may include PCA, clustering, Gaussian mixture models and regularised classification. Depending on the scope, the project can be extended with multimodal feature integration, cluster-stability analysis, explainable machine learning or validation against publicly available datasets. For larger groups, the work can be divided into cohort simulation, physiological phenotyping, omics modelling and multimodal integration.

Required qualifications/prerequisites:

Basic statistics and programming experience in R and/or Python. Familiarity with regression or multivariate analysis is desirable. The project is particularly suitable for students interested in biomedical engineering, machine learning, lung physiology, data integration or omics. Prior omics experience is not required.

Responsible institution/department:

University of Copenhagen (KU), Department of Biomedical Sciences – Integrative Circulation in collaboration with Department of Clinical Medicine / Clinical Physiology and Nuclear Medicine, Rigshospitalet.

Contact information:

Associate Professor Henrik H. El Ali, MSc, PhD – helali@sund.ku.dk, +45 29354867. Professor Jann Mortensen – jann.mortensen@regionh.dk, +45 35 45 17 16.

Allowed no. of students per report: 1–4

KU/DTU supervisor:

Associate Professor Henrik H. El Ali (KU, Department of Biomedical Sciences) and Professor Jann Mortensen (KU, Department of Clinical Medicine / Rigshospitalet).

Project Title:

Nanodiamond-based quantum sensing for correlation of free radical generation with viscoelastic properties of cells

Motivation

Understanding of mechanoregulated free radical generation by cancer cell models would enhance the usefulness of the model system as predictive drug screening platforms. Free radicals (FRs), a class of reactive molecules with a free electron, have emerged to be crucial for intracellular signalling, cancer cell migration and therapeutic resistance. It is also well known that tumor mechanical properties are changing depending on the disease stage. However, we do not understand what the correlation between these two factors is and how we could manipulate them to decrease therapeutic resistance. **Goal of the project** In this project we aim to reveal the correlation between changes in FR concentration and mechanical properties of cancer cell models using a nanodiamond magnetometry (quantum sensing technique) combined with optical tweezers.

Research plan and learning outcomes

You will learn how to apply nanodiamond magnetometry to simultaneously measure FRs generation and local viscoelastic properties in living cells. In this method you will use fluorescent nanodiamonds (FNDs) with nitrogen vacancy centers as probes. You will learn how to culture the cell type chosen. Further you will explore how to use fluorescent microscopy to determine nanodiamonds penetration inside cells and determine how cell heterogeneity may influence the nanodiamonds uptake.

We imagine that your project can take different directions, such as:

- 1) You will study nanodiamonds uptake by cells. You will simultaneously track nanodiamonds within the cell and measure free radical concentration using nanodiamond magnetometry technique. You will calculate cell viscoelastic properties based on parameters obtained from tracking and correlate them with FRs concentration in response to the stiffness the cell. Further, you will explore how to use optical tweezers to obtain complementary information about cell viscoelasticity.
- 2) You will focus on nanodiamonds coated such that they are targeted mitochondria in the cells. With these nanodiamonds, you will study the uptake by confocal microscopy. Further you will measure free radical concentration using the nanodiamond magnetometry technique, correlated with optical tweezers measurements of the stochastic motion of the mitochondria-coupled nanodiamonds.

Required qualifications/prerequisites: Insight in cell biology and/or in optical microscopy and image analysis with python - alternatively, background in optics/physics and a sincere interest in learning the required cell biology.

Responsible institution/department: DTU Health Technology

Contact information: kibs@dtu.dk

Allowed no. of students per report: 1-2

KU/DTU supervisor: Kirstine Berg-Sørensen

Project Title: New Organ-on-Chip technology compatible with NMR

Description:

Organ-on-chip (OOC) technologies provide physiologically relevant models for studying human biology, drug absorption, toxicity, and disease mechanisms. Combining OOC systems with nuclear magnetic resonance (NMR) spectroscopy enables non-invasive, real-time monitoring of metabolism, providing insights that are difficult to obtain using conventional endpoint assays. Metabolic activity is a key indicator of cell health, function, and response to external stimuli, and changes in metabolic profiles can reveal alterations in barrier integrity, nutrient uptake, drug efficacy, and disease progression.

This project aims to investigate and compare different chip architectures that can be accommodated within a standard 10 mm NMR tube format. Building on our existing prototype design, the student will explore alternative architectures and evaluate their suitability for NMR-compatible OOC applications. The student will design, fabricate, and characterize several microfluidic layouts with emphasis on NMR performance in standard cell culture media, cell culture compatibility, and manufacturability. Rapid prototyping methods and insights from the scientific literature will be used to develop and evaluate the concepts.

The developed designs will be assessed using NMR measurements of cell culture media to evaluate spectral quality and detection sensitivity. This work will contribute to the development of advanced in vitro models with integrated metabolic readouts for drug testing and disease research.

Required qualifications/prerequisites:

Familiarity with CAD modelling and an interest in rapid prototyping and microfluidic device development.

Responsible institution/department: DTU, Department of Health Technology

Contact information: peroje@dtu.dk

Allowed no. of students per report: 1-2 students

DTU supervisor: Associate Professor Pernille Rose Jensen

Optical coherence tomography-derived biomarkers for diagnosis and monitoring of diseases

This project comprises a range of possible projects working with optical coherence tomography. Optical coherence tomography is a non-invasive optical imaging modality that provides volumetric images of tissue microstructure without the need for contrast agents. OCT is most commonly used in ophthalmology, however, our research group aims to expand the use of OCT to other diagnostics, including in dermatology and oncology. The project can be more engineering focused, image processing, or application focused depending on the student. Some opportunities could include:

- Quantitative analysis of microvasculature using OCT
- Analyzing optical attenuation from OCT images in bone
- OCT imaging and analysis of tumor spheroids and co-cultures
- Identifying biomarkers of small fiber neuropathy using OCT
- Design and fabrication of fiber optic catheters for OCT
- Building and characterizing OCT systems
- Acquiring and analyzing OCT data from in vitro samples, animal models, and human patients
- Optical imaging for women's health

Required qualifications/prerequisites:

Project description can be adjusted to reflect the background and interest of individual students

Responsible institution/department:

DTU Health Tech

Contact information:

Gavrielle Untracht: greun@dtu.dk

Allowed no. of students per report:

The project can be adjusted to reflect the number of students

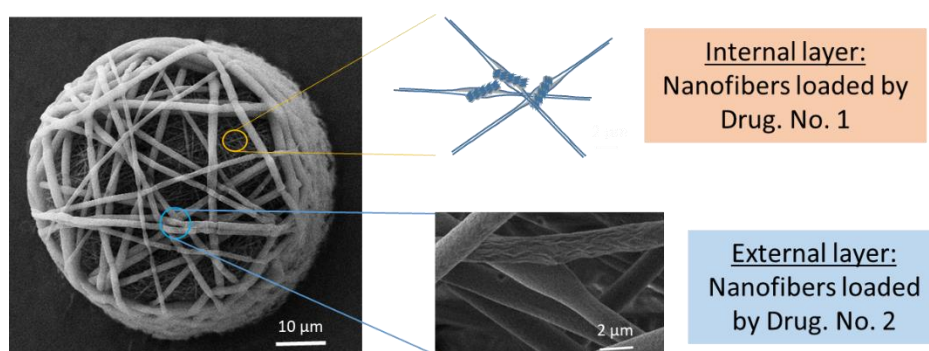
KU/DTU supervisor:

Gavrielle Untracht and Peter Andersen

MSc project for students in Biomedical Engineering and/or Health Technology relevant fields

Project Title: Orally administered Multilayer Nanostructured microparticles containing natural compounds for combinatorial treatment of breast cancer

Description: Traditional chemotherapeutics are effective, but suffer from low therapeutic efficiency and harmful side effects. Recently, it has been reported that some natural compounds possess a wide range of biological activities including anti-inflammatory, anti-atherosclerotic, and anti-cancer properties. The drawback with such natural compounds is usually their low bioavailability. Nanoformulations could enhance their solubility and bioavailability, and therefore we aim for loading two to three natural compounds in a monodisperse nanostructured microparticle system and study how this combination can assist with enhanced cancer therapy relating to suppression of tumor initiation, progression and metastasis.



Required qualifications: None

Responsible institution/department: Department of Health Technology, DTU

Contact information: Fatemeh Ajalloueian (faaj@dtu.dk)

Allowed no of students per report (1-4): 4

Supervisors: Fatemeh Ajalloueian

Project Title: Particle transport in the eye with laser light

Description:

Chronic diseases of the retina and optic nerve (CDRON) result in irreversible vision loss and eventual blindness, affecting millions of people worldwide. Treatment involves direct injection of large quantities of drugs into the vitreous humor, but most of the drugs never reach the retina at the back of the eye. This is due to the fluid flow in the eye that runs from the back to the front (Fig. 1a).

Recently, laser-induced counterflows have been described as a mechanism to counteract the natural flow and induce particle transport towards the retina (Fig. 1b) [1]. The flows are induced by a thermal hotspot moving across the liquid. In one implementation, the hotspot is created by a focused infrared (IR) laser. The IR light is absorbed by water, increasing the local temperature and leading to particle transport.

Measuring and quantifying such flows and the resulting particle transport is challenging. Therefore, the goal of the project is to use an existing setup to perform a series of experiments on model systems to induce and visualize flows in liquids or hydrogels using laser light. Several physical mechanisms affecting particle transport must be understood for a correct interpretation of the results, including diffusion, thermophoresis [2], and viscophoresis [3].

The main experimental technique in the project is fluorescence microscopy, which will be used to detect fluorescent tracer particles. So, you will be trained in general lab work and on the necessary equipment for creating and measuring flows in solutions, and you will become an expert in fluorescence microscopy.

The extent of the project depends on the level (BSc or MSc) and the number of ECTS dedicated to this project.

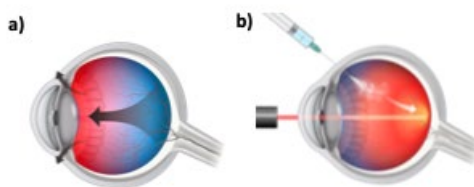


Figure 1. a) The retina is located at the back of the eye. A natural flow from the back to the front of the eye pushes, e.g., drugs away from the retina. b) Drugs are injected into the front of the eye and pushed to the back with a laser beam.

References:

[1] Guerassimoff, Léa, et al. "Photothermal Transport for Guiding Nanoparticles Through the Vitreous Humor." *Advanced Science*, vol. 13, no. 16, 2026, p. e16534, <https://doi.org/10.1002/advs.202516534>.

[2] Pedersen, Jonas Nyvold, et al. "Thermophoretic Forces on DNA Measured with a Single-Molecule Spring Balance." *Physical Review Letters*, vol. 113, no. 26, 2014, p. 268301, <https://doi.org/10.1103/PhysRevLett.113.268301>.

[3] Benjamin Wiener and Derek Stein. Electrokinetic Current Driven by a Viscosity Gradient. 2018, <https://doi.org/10.48550/arXiv.1807.09106>

Required qualifications/prerequisites:

An interest in lab work.

Responsible institution/department:

DTU Health Tech

Contact information:

rcwm@dtu.dk and jnpe@dtu.dk

Allowed no. of students per report: 1-3

DTU supervisor:

Rodolphe Marie and Jonas Nyvold Pedersen.

Project Title: PD-TRIAGE

Developing a Data-Driven Clinical Triage Algorithm to Optimise Telephone and Physical Consultations in Parkinson's Disease Care

Description

People living with Parkinson's disease frequently contact specialised neurological outpatient clinics by telephone regarding medication, symptom fluctuations, treatment-related concerns, appointments and other aspects of disease management. These telephone consultations are an important part of clinical care but also represent a considerable workload for nurses and other healthcare professionals.

Currently, telephone inquiries are primarily managed through clinical assessment and existing workflows, with limited systematic use of historical call data to identify patterns, predict patient needs or optimize the allocation of clinical resources.

The PD-TRIAGE project aims to develop and evaluate a data-driven clinical triage algorithm to support more efficient, safe and individualised management of telephone inquiries from people living with Parkinson's disease.

The project will use existing clinical data on telephone call categories and patterns from a specialised Parkinson's outpatient clinic. Through close collaboration between students, clinical researchers, nurses and neurologists, the project will investigate how data analytics, machine learning and clinical decision-support principles can be applied to distinguish between inquiries requiring direct clinical assessment and those potentially manageable through alternative pathways.

The overall ambition is to reduce avoidable telephone contacts and unnecessary clinical workload while maintaining patient safety, timely access to care and high-quality patient–clinician communication.

Potential student projects

Students may contribute to one or several development activities depending on their technical background and interests.

1. Data Analysis and Identification of Telephone Consultation Patterns

- Analyse existing datasets containing telephone call categories and characteristics.
- Identify the most frequent reasons for patient inquiries and their distribution across categories.
- Explore patterns in call frequency, recurrence and potential associations with available clinical or organisational variables.
- Identify call categories potentially suitable for alternative management strategies.
- Develop data visualisations illustrating call patterns and opportunities for workflow optimisation.

2. Development of a Data-Driven Triage Algorithm

- Develop a rule-based or machine learning-supported algorithm for categorising and prioritising telephone inquiries.
- Investigate methods for distinguishing between urgent clinical needs, routine clinical questions and administrative inquiries.
- Explore the feasibility of predicting appropriate care pathways based on available call information.

- Compare algorithm-generated recommendations with clinical assessments and predefined triage criteria.
- Evaluate algorithm performance, including classification accuracy, sensitivity for high-priority inquiries and potential misclassification risks.

3. Clinical Decision Support and Explainable AI

- Develop an interpretable decision-support model to assist nurses in telephone triage.
- Investigate how algorithm-generated recommendations can be presented transparently and understandably.
- Explore methods for communicating uncertainty and identifying situations requiring additional clinical assessment.
- Design a simple clinical interface or dashboard presenting call categories, suggested pathways and relevant decision-support information.
- Evaluate usability, clinical relevance and trust through iterative feedback from healthcare professionals.

4. Workflow Optimisation and Alternative Patient Pathways

- Map existing telephone consultation workflows and identify opportunities for improvement.
- Explore which types of inquiries may be managed through structured patient information, digital self-management support, administrative pathways or planned clinical follow-up.
- Develop and simulate alternative triage workflows using historical call data.
- Estimate the potential reduction in avoidable telephone contacts and time spent on telephone management.
- Investigate how algorithm-supported triage may influence clinical workload, response times and resource allocation.

Expected student outcomes

Depending on the selected subproject, students may deliver a structured analysis of telephone call patterns, a prototype triage algorithm, a machine learning classification model, a clinical dashboard, an explainability framework or a simulated workflow optimisation model.

Required qualifications/prerequisites

The project is relevant for students within Biomedical Engineering, Medicine and Technology, Health Technology, Design and Innovation or related disciplines. Both bachelor and master students.

Relevant competencies may include data analysis, statistics and programming (Python or R), machine learning, classification algorithms and predictive modelling., data visualisation, dashboard development and user-interface design, and human-centred design, workflow analysis and usability evaluation.

An interest in interdisciplinary collaboration, clinical decision support and developing technologies with direct relevance to healthcare is essential.

Responsible institution/department

Department of Neurology, Bispebjerg-Frederiksberg Hospital, Copenhagen University Hospital, in collaboration with the Department of Health Technology, Technical University of Denmark (DTU Health Tech).

Contact information

Trine Hørmann Thomsen, RN, PhD

Senior Researcher, Department of Neurology, Bispebjerg-Frederiksberg Hospital

Assistant Professor, DTU Health Tech

Email: trine.hoermann.thomsen@regionh.dk

Allowed no. of students per report (1–4)

1–4 students, depending on project scope and educational level.

KU/DTU supervisor

Trine Hørmann Thomsen, Assistant Professor, DTU Health Tech / Senior Researcher, Bispebjerg-Frederiksberg Hospital.

Additional technical DTU supervision may be arranged according to the specific project focus.

Clinical collaboration with nurses and neurologists from the specialised Parkinson's outpatient clinic.

Is the project TUH (Technical University Hospital) affiliated?

Yes.

Project Title:

Physiology and Transcriptomic Endotypes for Predicting Corticosteroid Response in Asthma

Description:

Asthma is physiologically and molecularly heterogeneous, and patients with apparently similar lung function may respond differently to inhaled corticosteroids. This project will develop and analyse a literature-grounded synthetic cohort integrating lung physiology, clinical characteristics, biomarkers and transcriptomic pathway scores. The overall aim is to determine whether molecular endotyping provides predictive information beyond conventional lung-function measurements.

The student(s) will generate or refine a synthetic cohort of approximately 400–800 patients containing spirometry (FEV1, FVC and FEV1/FVC), measures of small-airway function and oscillometry, FeNO, blood eosinophils, treatment exposure and omics-derived inflammatory pathway scores. Statistical models will be developed to predict treatment response, for example change in FEV1 or responder/non-responder status. Depending on the project scope, methods may include multiple or logistic regression, penalised regression such as LASSO or elastic net, PCA or PLS, interaction modelling and selected machine-learning approaches. Model performance, calibration, uncertainty and biological interpretability will be evaluated using appropriate validation strategies.

The project scope can be tailored to the background, interests and number of students. Possible extensions include more detailed synthetic-data generation, advanced feature selection, nonlinear or multilevel modelling, interaction analyses, sensitivity analyses, benchmarking against publicly available datasets, and more detailed simulation of transcriptomic profiles.

Required qualifications/prerequisites:

Basic knowledge of physiology and statistics. Experience with R and/or Python is desirable. Interest in lung physiology, biomedical data analysis, statistical modelling or omics is an advantage. Prior experience with transcriptomics is not required.

Responsible institution/department:

University of Copenhagen (KU), Department of Biomedical Sciences – Integrative Circulation in collaboration with Department of Clinical Medicine / Clinical Physiology and Nuclear Medicine, Rigshospitalet.

Contact information:

Associate Professor Henrik H. El Ali, MSc, PhD – helali@sund.ku.dk, +45 29354867. Professor Jann Mortensen – jann.mortensen@regionh.dk, +45 35 45 17 16.

Allowed no. of students per report: 1–4

KU/DTU supervisor:

Associate Professor Henrik H. El Ali (KU, Department of Biomedical Sciences) and Professor Jann Mortensen (KU, Department of Clinical Medicine / Rigshospitalet).

Project Title: Statistical Shape Modeling and Deep Learning of the Human Labyrinth from Large-Scale CBCT

Description: (n.a. if confidential)

Background and Motivation

The human labyrinth—comprising the cochlea and semicircular canals—is a highly complex inner ear structure responsible for hearing and balance. Characterizing the subtle anatomical variations of the labyrinth across a large population is critical for advancing personalized medicine. High-resolution 3D Statistical Shape Models (SSMs) provide a mathematical framework to map these variations, serving as a cornerstone for cochlear implant planning, high-precision surgical navigation, and deep morphometric studies. Furthermore, mapping these structures offers valuable insights into pediatric craniofacial development and growth trajectories.

By analyzing an unprecedented, large-scale clinical dataset, this project operates at the cutting edge of advanced medical image processing, statistical shape analysis, and deep learning, translating raw radiological data into actionable clinical intelligence.

Project Aims & Structure

This project investigates automated, high-throughput workflows by establishing a robust, atlas-based baseline and exploring deep learning extensions. The work is modular and can be adapted into multiple Bachelor or Master's thesis topics for Medicin og Teknologi students, focusing on:

- **Part I: Pipeline Fine-Tuning & Validation**
Fine-tuning an existing atlas-based segmentation workflow using deformable registration (SlicerElastix). Students will rigorously evaluate the accuracy, boundary precision, and robustness of the method across different sub-structures of the inner ear.
- **Part II: High-Throughput Segmentation & Data Curation**
Deploying the validated atlas pipeline to process hundreds of scans. This creates a massive, high-quality curated dataset of segmented labyrinths, which serves as the foundation for subsequent statistical modeling and deep learning training.
- **Part III: Statistical Shape Modeling (PCA)**
Building a Principal Component Analysis (PCA) framework to decode the mean geometry and structural variance of the labyrinth. Students will investigate key clinical questions:

Does inner ear morphology exhibit sexual dimorphism (gender differences)? How do the size and shape change across childhood and adolescence?

- Part IV: Deep Learning Proof-of-Principle (3D U-Net & MONAI)
Developing a state-of-the-art 3D U-Net using medical-image-specific frameworks like MONAI (Medical Open Network for AI) built on PyTorch. Using the datasets generated in Parts I & II, students will evaluate AI model performance, estimate optimal training set sizes, and implement data augmentation strategies to combat clinical imaging noise.

Material & Available Data

The project leverages an exceptionally large and rich clinical dataset consisting of between 500 and 1,000 Cone-Beam Computed Tomography (CBCT) scans, providing an ideal statistical power rarely available in academic projects.

Expected Deliverables

- An automated, validated atlas-based segmentation pipeline.
- A large-scale, curated 3D dataset of segmented inner ear structures.
- A quantitative performance evaluation of the registration and segmentation accuracy.
- A statistical shape model detailing anatomical variations (PCA components).
- A trained proof-of-principle 3D deep learning model (optional/dependent on project scope).

Required qualifications/prerequisites:

We are looking for students who can work systematically and independently, while collaborating effectively with our interdisciplinary team of engineers and clinical specialists.

- Teamwork: You will participate in semi-daily interactions and feedback loops within our research environment.
- Technical Skills: Basic familiarity with medical imaging concepts or 3D Slicer is an advantage. Programming skills in Python are highly beneficial—particularly experience with libraries like PyTorch, MONAI, or scikit-learn for students targeting the PCA modeling or deep learning components. However, tasks can be tailored based on the project focus and student level.

Responsible institution/department:

Technical University of Denmark
Department of Applied Mathematics and Computer Science
Section for Visual Computing

Contact information:

Research Engineer, PhD, Tron Darvann, 3D Craniofacial Research Laboratory (KU/DTU/RH)

Tel. +45 28 20 03 12

E.mail: trd@sund.ku.dk

Allowed no. of students per report (1-4):

- Maximum number of students: Up to 4 students can be accommodated.
- Group work: Groups are accepted. The modular design allows a team to split the workload seamlessly.

KU/DTU supervisor:

Main supervisor: Professor Vedrana Andersen Dahl, DTU Compute

Daily supervision: Research Engineer, PhD, Tron Darvann, 3D Craniofacial Research Laboratory (KU/DTU/RH)

KU supervisor: Associate Professor Nuno Hermann, Pediatric Dentistry and Clinical Genetics, Department of Odontology, University of Copenhagen

Additional central project members:

Professor emeritus Sven Kreiborg (KU/RH).

Research Assistant Anna Vaskova Krygermeier (3D Craniofacial Research Laboratory (KU/DTU/RH)

Is the project TUH (Technical University Hospital) affiliated (yes/no):

no

Project Title: Analysis of 3D Craniofacial Growth in a Pediatric Population using MRI and Advanced Image Analysis

Description: (n.a. if confidential)

Background and Motivation

Congenital and acquired craniofacial malformations (such as craniosynostosis and syndromic conditions) significantly alter normal head shape and cranial symmetry. Accurate characterisation of these structural deviations is essential for clinical diagnostics, long-term monitoring, and treatment outcome assessments. This project aims to establish robust, automated workflows to define "typical" morphology, growth trajectories, and structural variability within a specific pediatric cohort. By moving away from traditional 2D metrics, this research leverages advanced 3D neuroimaging to capture complex, multi-dimensional changes in the growing cranium, directly supporting the development of objective, data-driven clinical tools.

Project Aims

The primary goal is to refine, extend, and validate an advanced image analysis framework for pediatric craniofacial assessment. The project focus areas include:

- **Pipeline Optimization:** Fine-tuning an existing pipeline for atlas creation and non-rigid registration of 3D T1 MRI to accurately quantify growth.
- **Multimodal Integration & Quality Control:** Developing methods to co-register Black Bone (BB) MRI sequences to T1 structural images and overcoming severe multi-center scanner heterogeneity and variable scan quality.
- **Visual & Statistical Quantification:** Generating average population data at 2 and 4 years of age, mapping 3D growth vectors (e.g., via color-coded surface models or volume rendering), and quantifying anatomical variability.
- **Methodological Validation:** Evaluating registration accuracy and precision against expert-defined manual landmarks.

Material & Technical Challenges

The study utilizes a longitudinal pediatric dataset tracking 30+ individuals scanned at two critical developmental milestones: 2 and 4 years of age. For each subject, 3D T1-weighted MRI (soft-tissue) and Black Bone MRI (non-ionizing cranial bone visualization) are available.

A primary engineering challenge is multi-center data heterogeneity, as the scans originate from different scanner types and centers. While the T1 data is stable, the Black Bone MRI data varies drastically, ranging from poor to excellent quality.

Possible Split Into Sub-Project Focus Areas

Due to its modular nature, this project can be tailored to individual student interests or split into distinct Bachelor and Master's thesis topics for Medicin og Teknologi students:

- **Sub-Project A: Core Growth Registration & Atlas Creation**

Focuses on the SlicerElastix non-rigid registration pipeline, template/atlas creation at ages 2 and 4, growth vector computation, and statistical quantification of population variability.

- **Sub-Project B: Black Bone Processing & Advanced Visualization**

Focuses on the artifact and data-quality challenges of the BB scans. The student(s) will develop preprocessing and artifact mitigation techniques to robustly extract, segment, and visualize craniofacial structures (via volume rendering or surface modeling) despite varying scan quality.

- **Sub-Project C: Atlas-Based Auto-Landmarking & CT Deformation**

Focuses on accelerating the clinical workflow by non-rigidly deforming a high-quality, "ideal" reference CT scan onto the T1 and/or BB MRI scans. The student will evaluate how accurately landmarks set in the reference CT propagate to the target MRI scans compared to expert manual landmarks. This can be developed as a fully automated landmarking tool or an interactive "smart-assist" pipeline to speed up expert validation.

Required qualifications/prerequisites:

We are looking for students who can work systematically and independently, while also collaborating closely within a multidisciplinary environment.

- **Teamwork:** You will interact with our research team of clinicians and engineers on a semi-daily basis.
- **Technical Skills:** Experience with 3D Slicer or basic image processing concepts is beneficial. Programming skills in Python are an advantage but not a requirement.

Responsible institution/department:

Technical University of Denmark
Department of Applied Mathematics and Computer Science
Section for Visual Computing

Contact information:

Research Engineer, PhD, Tron Darvann, 3D Craniofacial Research Laboratory (KU/DTU/RH)

Tel. +45 28 20 03 12

E.mail: trd@sund.ku.dk

Allowed no. of students per report (1-4):

Maximum number of students: Up to 4 students in total can be accommodated across the different focus areas.

- **Group work:** Groups are accepted and encouraged, allowing students to collaborate closely on complementary parts of the pipeline (e.g., combining Sub-Project A and Sub-Project C).

KU/DTU supervisor:

Main supervisor: Professor Vedrana Andersen Dahl, DTU Compute

Daily supervision: Research Engineer, PhD, Tron Darvann, 3D Craniofacial Research Laboratory (KU/DTU/RH)

KU supervisor: Associate Professor Nuno Hermann, Pediatric Dentistry and Clinical Genetics, Department of Odontology, University of Copenhagen

Additional central project members:

Professor emeritus Sven Kreiborg (KU/RH).

Research Assistant Anna Vaskova Krygermeier (3D Craniofacial Research Laboratory (KU/DTU/RH)

Is the project TUH (Technical University Hospital) affiliated (yes/no):

no

Project Title: Research Projects in Hearing, Auditory Neuroscience, and Hearing Technology

Description:

Hearing loss affects millions of people worldwide and remains a major clinical and societal challenge. DTU Hearing Systems and the Copenhagen Hearing and Balance Center (CHBC) offer a range of research opportunities within hearing science, auditory neuroscience, hearing technology, and clinical audiology.

Depending on the interests and background of the student(s), projects may involve experimental studies, data analysis, signal processing, electrophysiology (e.g., EEG, ECoG, auditory evoked potentials), hearing aid and cochlear implant research, auditory perception, speech understanding, balance and vestibular function, machine learning applications, or development and validation of clinical assessment tools.

Projects will be tailored to the interests, skills, and level of the student(s) and may include collaboration with clinicians, engineers, and researchers across DTU and CHBC.

Required qualifications/prerequisites:

Interest in biomedical engineering, neuroscience, audiology, signal processing, data science, or related fields. Basic programming and data analysis skills are an advantage but not required for all projects.

Responsible institution/department:

DTU Health Tech, Hearing Systems in collaboration with Copenhagen Hearing and Balance Center (CHBC), Rigshospitalet.

Contact information:

Abigail Anne Kressner
akress@dtu.dk

Allowed no. of students per report: 1-4

KU/DTU supervisor:

Abigail Anne Kressner (DTU Health Tech)
(Additional or alternative DTU/KU co-supervisors may be assigned depending on the specific project.)

Project Title

Smart Capsules for Daily Health Monitoring in Patients with Intestinal Inflammation

Description

This project aims to develop a smart capsule for monitoring biomarkers associated with intestinal inflammation, with the long-term goal of supporting routine disease monitoring in patients. The proposed platform will combine miniaturized electrochemical sensors, low-power electronics, and wireless communication to monitor local changes in the intestinal environment.

The project will focus on electrode fabrication, sensor functionalization, and electrochemical characterization in buffer and simulated intestinal fluid. It will also involve designing a capsule housing to integrate the electrode array and circuit board. The student will assist in fabricating and modifying electrodes to detect selected inflammation-related biomarkers. Sensor performance will be evaluated in terms of sensitivity, detection range, selectivity, reproducibility, response time, and operational stability.

The expected outcome is an in vitro proof of concept demonstrating the feasibility of capsule-based monitoring of selected intestinal biomarkers. Where feasible and subject to the necessary approvals, the platform will also be evaluated in animal studies. Through this project, you will gain hands-on experience in screen-printed electrode fabrication and bioelectronic device development, including electrode array design and capsule integration, with potential opportunities to participate in animal experiments.

Required qualifications/prerequisites

Background in biotechnology, chemistry, electrochemistry, biomedical engineering, materials science, or a related field. Interest in biosensors and experimental laboratory work is essential. Experience with electrochemistry, enzyme handling, or data analysis is an advantage but is not required; relevant training will be provided.

Responsible institution/department

Technical University of Denmark (DTU), Department of Health Technology, IDUN research group.

Contact information

Yu Gao, PhD student, DTU Health Tech
Email: ygao@dtu.dk

Allowed no. of students per report: Proposed: 1–2 students, subject to supervisor confirmation.

DTU supervisor

Yu Gao, Dr. Santanu Patra, Asst. Prof. Gohar Soufi, and Prof. Anja Boisen, DTU Health Tech

Project Title: Spasticity Diary for the care team

Description:

Spasticity and dystonia cause involuntary muscle overactivity. Spasticity often follows stroke or brain injury, which can affect cognition and vision. Many receive botulinum toxin every three months and physiotherapy outside the hospital. Treatment is judged against personal goals, largely from memory at the next visit.

Based on an earlier paper diary, we have developed the Spasticity Diary, where patients suggest goals, the clinic approves them, and patient and physiotherapist rate progress between injections. The patient perspective has been evaluated in an earlier project, but now we extend the work to the whole care team, aiming for a version ready for a clinical pilot. Students can take one or several subprojects, depending on group size. The interface subprojects start from the existing app: interview or observe users, define their needs, redesign within the app's design system, test in think-aloud sessions with test data, and deliver implementable specifications.

Clinician interface. What does the clinician need to see and enter at the visit, and how can three months of patient and physiotherapist ratings be read at a glance? Output: a tested cycle overview.

Physiotherapist interface. What should physiotherapists receive from the clinic (goals, treatment notes) and send back (ratings, training, observations)? Output: functional requirements and a tested prototype.

Patient interface. How should the patient interface work for users with reduced working memory, visual field loss or neglect, building on the previous project? Output: a revised prototype and design principles.

Regulation and product development. Is the app a medical device under the EU MDR, and what do MDR and GDPR require for a pilot and a product? Output: draft intended purpose, risk analysis, roadmap. Students work with real clinical users, an app in active development and medical software regulation.

Required qualifications:

Interest in UX, user research, health technology or medical device regulation. Coding is optional (the app is built in React/TypeScript). At least one student must speak Danish for the interface subprojects.

Responsible institution/department:

Department of Neurology, Bispebjerg Hospital and Hvidovre Hospital

Contact information:

Nikolaj Karottki: nikolaj.folke.la.cour.karottki.01@regionh.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor:

Bo Biering Sørensen, Associate Professor, Department of Public Health, University of Copenhagen. Clinical co-supervisor: Nikolaj la Cour Karottki.

Project Title: SurfPrompt: Click-to-Correct Cortical Surface Reconstruction with Deep Learning

Background. Deep learning methods can reconstruct the white and gray matter surfaces of the cortex from MRI in about a second. These models are fully automatic, however, when they fail there is no good way to fix the result. Manual editing in classical pipelines is slow and indirect. For voxel segmentation, interactive methods let a user refine a prediction with a few clicks or scribbles, but nothing comparable exists for surface meshes.

Aim. Develop and evaluate an interactive deep learning method for cortical surface reconstruction, where a few user corrections update the surfaces within seconds while preserving topology.

Approach. Building on an existing surface reconstruction network and its synthetic training pipeline, you will (1) define surface-appropriate interactions, such as points and scribbles on the true boundary; (2) make the model iterative by refining the previous surface; (3) train with simulated user interactions derived from prediction errors; and (4) add losses that keep corrections local and avoid self-intersections.

Evaluation. Surface and cortical thickness error as a function of the number of interactions, locality of edits, and mesh quality, compared against the non-interactive model.

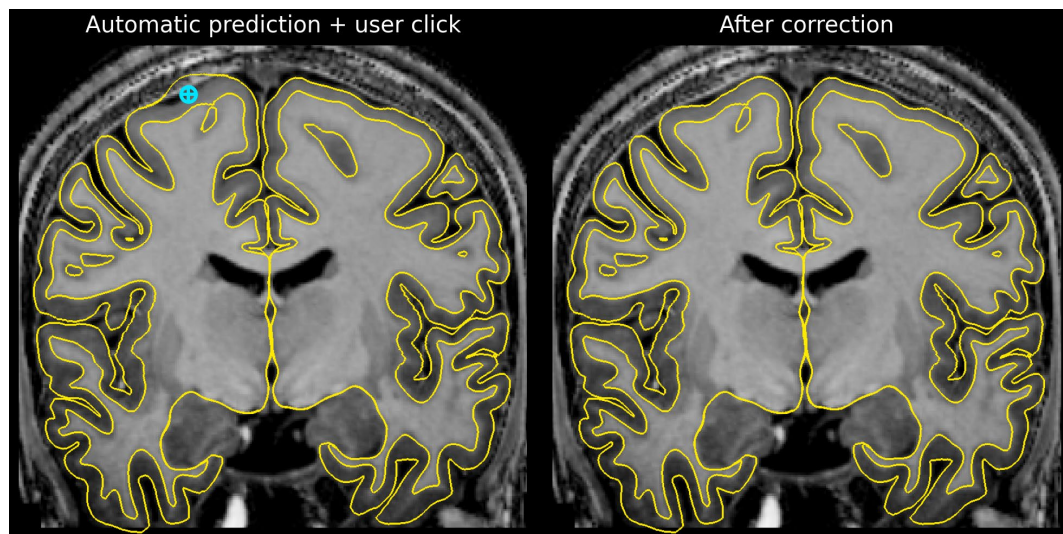


Illustration of the idea: white and pial surfaces (yellow) on an MP2RAGE scan. Left: the pial surface leaks into non-brain tissue (simulated error), and the user clicks on the correct boundary. Right: the corrected surfaces.

Required qualifications/prerequisites: Solid Python and PyTorch programming skills; background in deep learning and image analysis. Interest in geometric deep learning or 3D/mesh data is a plus but not required.

Responsible institution/department: DTU Health Tech, Section for Magnetic Resonance.

Contact information: Oula Puonti, oupu@dtu.dk

Allowed no. of students per report: 1-3

DTU supervisor: Oula Puonti

Project Title: Tackling Multidrug-Resistant *Mycobacterium abscessus* Infections using an Air-Liquid Interface (ALI) model

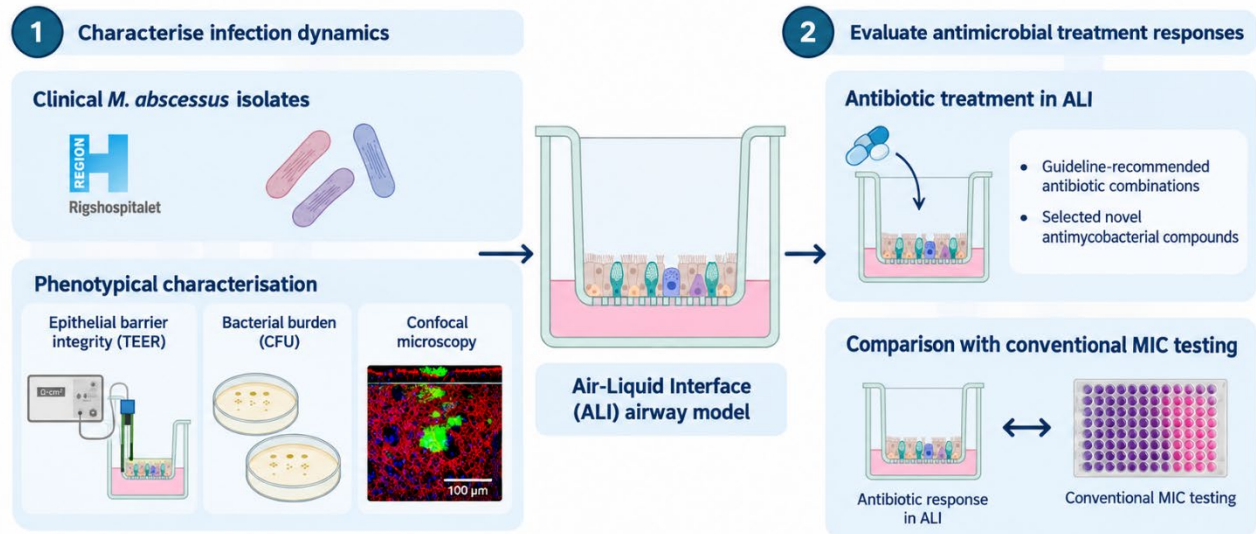
Description:

Nontuberculous mycobacterial (NTM) infections represent a growing global health concern, particularly in people with chronic airway diseases. Among these pathogens, *Mycobacterium abscessus* has emerged as a prominent species associated with severe respiratory disease and poor clinical outcomes. Its intrinsic and acquired resistance to multiple antibiotics makes infections difficult to treat, often requiring prolonged multidrug regimens associated with substantial toxicity and cure rates below 50%. Despite its clinical relevance, many aspects of *M. abscessus* infection biology remain poorly understood, and optimal treatment strategies have yet to be established. Currently, therapeutic decisions are informed by antimicrobial susceptibility testing, although they are not solely determined by these results. However, conventional minimum inhibitory concentration (MIC) testing has important limitations, as it is typically performed using planktonic bacterial cultures grown in standard laboratory media that do not reproduce the conditions encountered in the airways. There is therefore a clear need for improved experimental models that better reflect the infection environment and support the development of more effective treatment strategies.

In our laboratory, we have established an airway air–liquid interface (ALI) model that provides a physiologically relevant and translational platform for studying bacterial–epithelial interactions and antibiotic responses. In this project, we will characterise *M. abscessus* infection dynamics in the ALI model and evaluate antimicrobial treatment strategies using a collection of clinical isolates obtained from patients followed at Rigshospitalet. We will investigate both guideline-recommended antibiotic combinations and novel antimycobacterial compounds whose activity against *M. abscessus* under infection-relevant conditions remains unclear. Antibiotic responses observed in the ALI model will be compared with MIC values determined by conventional antimicrobial susceptibility testing.

Throughout the project, the student will receive hands-on training in a range of microbiological and cell biology techniques, including the preparation of culture media, bacterial culture, antimicrobial susceptibility testing (MIC determination), quantification of bacterial survival, airway epithelial cell culture, and confocal microscopy. In addition, the student will be involved in experimental planning and will develop skills in data analysis and interpretation, critical evaluation of scientific literature, and communication of research findings through scientific presentations and written reports.

Tackling Multidrug-Resistant *Mycobacterium abscessus* Infections using an Air-Liquid Interface (ALI) model



Required qualifications/prerequisites:

- BSc in Biotechnology, Biology, Biochemistry, Biomedical Sciences, or a related field.
- Currently enrolled in an MSc program at DTU or KU.
- Interest in molecular microbiology, infectious diseases and host-pathogen interactions.
- Previous laboratory experience, particularly in microbiology or cell culture techniques, is an advantage.

Responsible institution/department: DTU Health Tech, Rigshospitalet

Contact information: Esmeralda Cebrián Sastre (esmceb@dtu.dk), Ruggero La Rosa (rugros@dtu.dk)

Allowed no. of students per report: 1

KU/DTU supervisor:

- **Esmeralda Cebrián Sastre**, PhD, Postdoctoral researcher – Rigshospitalet
- **Ruggero La Rosa**, PhD, Associate Professor – DTU Health Tech
- **Helle Krogh Johansen**, MD, DMSc, Professor – Rigshospitalet, KU

Project Title:

Thalamic Subnucleus–Cortical Structural Covariance and Its Relationship with Motor Symptoms in Parkinson's Disease: A 7T MRI Study

Description:

The thalamus contains distinct nuclei whose relationships with cortical anatomy may help explain motor symptom variation in Parkinson's disease. This project will use existing 7T structural MRI and clinical data from patients and healthy controls to examine structural covariance between thalamic subnucleus volumes and cortical morphology.

Students will assess segmentation quality, extract regional measures, and test whether thalamic–cortical associations differ between groups and vary with motor symptom severity, accounting for relevant covariates. The focus is on subnucleus–cortical relationships rather than whole-network construction. Existing analysis pipelines provide a starting point, with scope adapted to the students' experience. If the project goes smoothly, we hope the students will be able to publish a journal paper.

This project offers a valuable opportunity to gain hands-on research experience and build a strong foundation for a future research career.

Required qualifications/prerequisites:

Basic statistics and programming in Python or R. Interest in neuroimaging and Parkinson's disease. Familiarity with MRI or image segmentation is helpful but not essential. A proactive attitude and patience when working through technical challenges are highly valued.

Responsible institution/department:

Danish Research Centre for Magnetic Resonance (DRCMR), Department of Radiology and Nuclear Medicine, Copenhagen University Hospital, Hvidovre, Denmark.

Contact information:

Weijian Liu, MD, PhD, Postdoctoral Researcher, weijian.liu@regionh.dk

Day-to-day supervision: Dr Weijian Liu and Senior Researcher David Meder.

Allowed no. of students per report: 1

KU supervisor: Prof. Hartwig R. Siebner, University of Copenhagen (KU).

Project Title: MRI guided reconstruction on dynamic PET data

Description:

Positron emission tomography combined with simultaneous magnetic resonance imaging (PET/MRI) has evolved significantly with recent hardware and software advances. Recent hardware and software advancements in PET/MRI enable improved PET spatial resolution and MRI signal-to-noise ratio (SNR), motivating the development of new reconstruction methods to further push image quality. MRI-guided (MRlg) PET reconstruction integrates the anatomical information of the MRI as a prior to the PET reconstruction potentially enhancing SNR and image resolution in the final images

We propose a project working on dynamic PET data, implementing MRlg PET reconstruction, on a variety of clinical indications. We have showed that it is possible and seek assistance to look into which indications would benefit the most from MRlg.

Required qualifications/prerequisites:

- KU181 - Radioactive Isotopes and Ionizing Radiation (preferred)
- 02502 – Image analysis (preferred)
- General programming skills in Python

Responsible institution/department:

Department of Clinical Physiology & Nuclear Medicine, Rigshospitalet.

Contact information:

Emil Christensen

Emil.christensen@sund.ku.dk

Allowed no. of students per report: 1-2

KU/DTU supervisor:

Thomas Lund Andersen, PET & MR physicist, Ph.D., MPE, Assoc. Professor

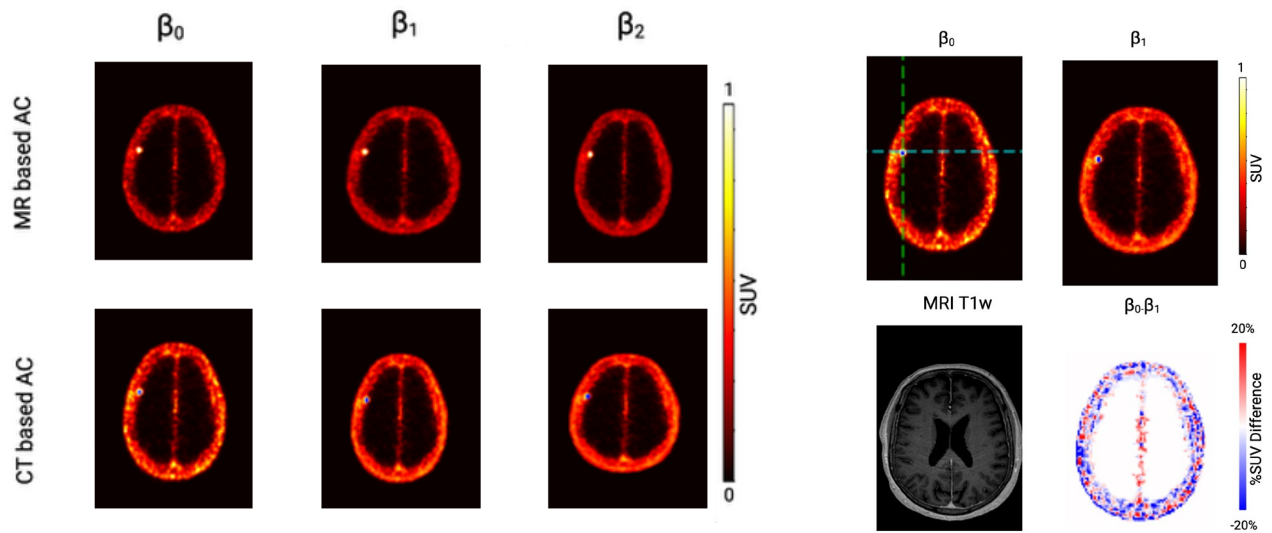


Figure 1: Example images of MRlg PET reconstruction, using a T_{1w} image as prior. This indication is a meningioma, with a static PET scan using $[^{68}\text{Ga}]\text{Ga-DOTATOC}$.

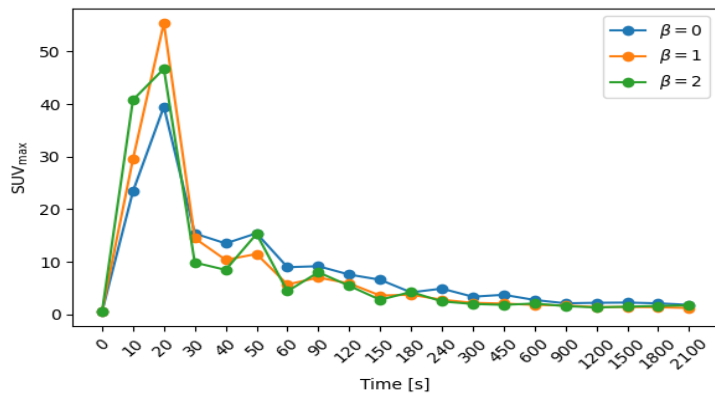


Figure 2: $\text{SUV}_{\max}$ of a pituitary adenoma patient, extracted from the pituitary gland, the $\text{SUV}_{\max}$ is extracted for reconstructions using β_0 , β_1 and β_2 .

Project Title: Motion correction in PET and MRI and its influence on clinical interpretation

Description:

PET/MRI has evolved due to recent advances in both hardware and software. These developments have enabled improved PET spatial resolution, higher MRI signal-to-noise ratio (SNR), and faster image acquisition. Despite these improvements, patient motion during scanning remains a challenge and can degrade image quality if not properly corrected. The latest generation of PET/MRI systems provides time-of-flight (TOF) information, enabling direct histogram-based reconstruction methods that are computationally faster than conventional iterative approaches.

We propose a project focusing on motion correction using combined PET and MRI data. Specifically, we aim to compare an established motion correction algorithm with a direct histogram-based reconstruction approach, for which we have already demonstrated feasibility. As this approach is computationally efficient and compatible with TOF information, it has the potential to enable more effective motion correction while maintaining clinically feasible reconstruction times.

Required qualifications/prerequisites:

- KU181 - Radioactive Isotopes and Ionizing Radiation (preferred)
- 02502 – Image analysis (preferred)
- General programming skills in Python

Responsible institution/department:

Department of Clinical Physiology & Nuclear Medicine, Rigshospitalet.

Contact information:

Emil Christensen

Emil.christensen@sund.ku.dk

Allowed no. of students per report: 1-2

KU/DTU supervisor:

Thomas Lund Andersen, PET & MR physicist, Ph.D., MPE, Assoc. Professor

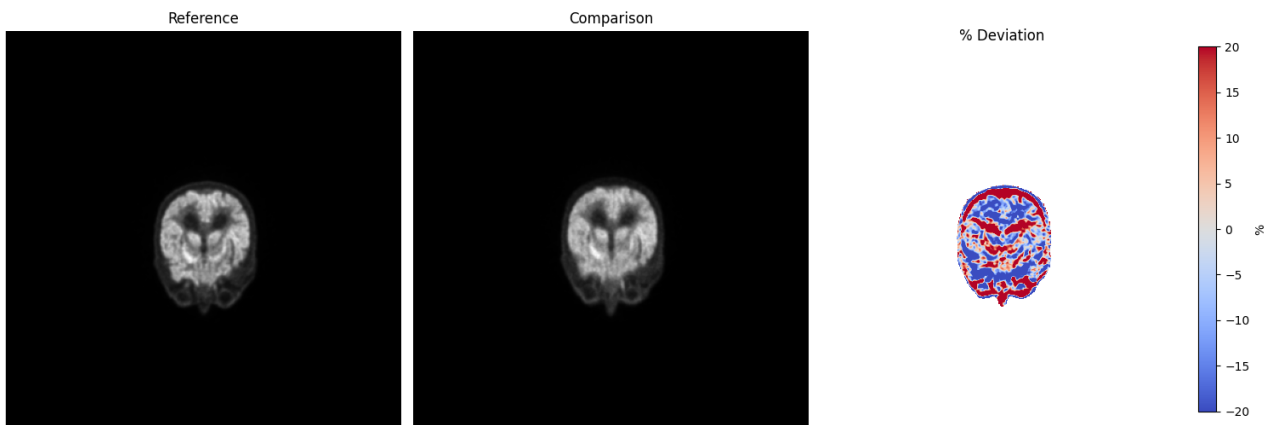


Figure 1: Example images a $[^{18}\text{F}]$ FDG image with and without motion correction, and the difference between the two.

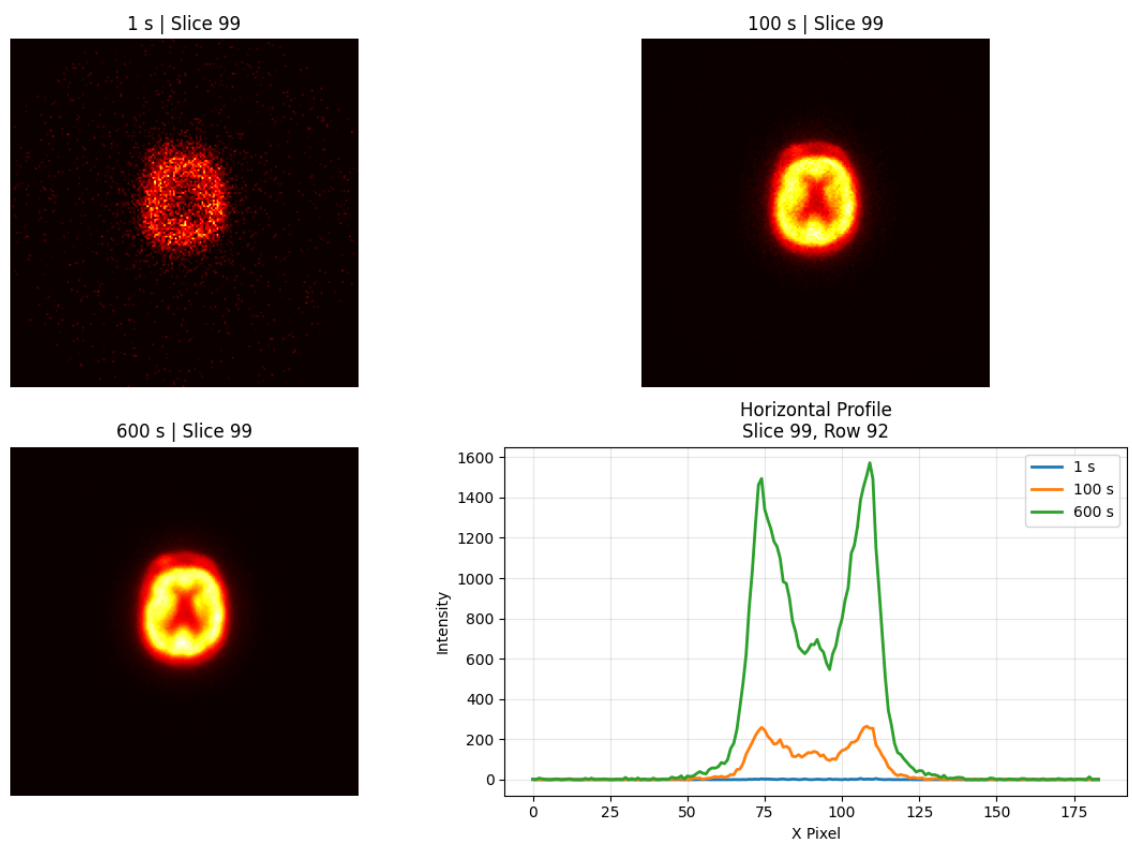


Figure 2: Example of histogram based reconstructions for different frame durations, with a corresponding line profile, through the same coordinates of the brain.

Project Title: Motion Correction of 4D PET using External Markerless Motion Tracking Data

Description:

Positron Emission Tomography is a highly sensitive technique for visualizing metabolism or receptor-based tracers in-vivo. The time course of tracer uptake after injection is essential to understand the tissue response which can be modelled using pharmacokinetic modelling. Due to the temporal evolution of some of the physiological processes being slow, data acquisition often extends up to one hour. Though instructed to keep still, patients often move during acquisition, which degrades the quality and the clinical usefulness of the data.

In this project motion correction will be applied to 4D PET data to improve image quality and clinical usefulness. Comparison of correction methods will be evaluated.

Responsible institution/department:

Department of Clinical Physiology and Nuclear Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Contact information:

Thomas Lund Andersen, thomas.lund.andersen@regionh.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor: Thomas Lund Andersen / Ulrich Lindberg

Project Title: Novel pharmacokinetic model development

Description:

Positron Emission Tomography is a highly sensitive technique for visualizing metabolism or receptor-based tracers in-vivo. The time course of tracer uptake after injection is essential to understand the tissue response which can be modelled using pharmacokinetic modelling.

With new high-resolution, high sensitivity scanners novel model approaches are possible, extracting physiological parameters not previously possible. You will work on PET data

In this project you will work on the novel microvascular compartment model extracting flow, PS product, cellular volume and capillary volume

Required qualifications:

22485 Medical Imaging Systems (preferred)

KU005 Modelling of physiological systems (preferred)

General programming skills in Python

Responsible institution/department:

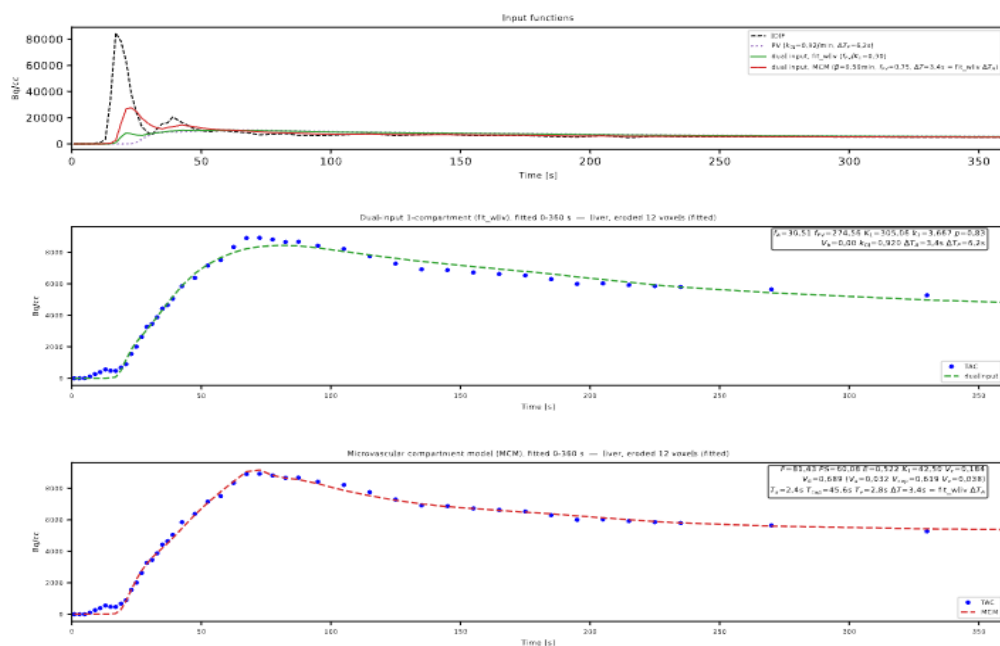
Department of Clinical Physiology and Nuclear Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Contact information:

Thomas Lund Andersen, thomas.lund.andersen@regionh.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor: Thomas Lund Andersen / Ulrich Lindberg



Project Title: Monte Carlo simulations of dose deposition

Description:

Positron Emission Tomography (PET) provides exceptional sensitivity and quantitative accuracy for visualizing biochemical pathways, metabolic processes, and receptor-targeted radiotracers in vivo. In systemic radiopharmaceutical therapy and diagnostic dosimetric evaluations, understanding patient-specific radiation absorbed doses to tumors and organs at risk (OARs) is critical for optimizing treatment efficacy while avoiding normal tissue toxicity.

Standard clinical dosimetry frequently relies on simplified organ-level S-values (MIRD formalism), which assume standardized organ geometries and homogeneous activity distributions. By utilizing sequential, multi-timepoint PET imaging, it becomes possible to capture individual spatial-temporal clearance dynamics and map accumulated activity (time-integrated activity) at the voxel level.

Required qualifications:

22485 Medical Imaging Systems (preferred)

KU005 Modelling of physiological systems (preferred)

General programming skills in Python

Responsible institution/department:

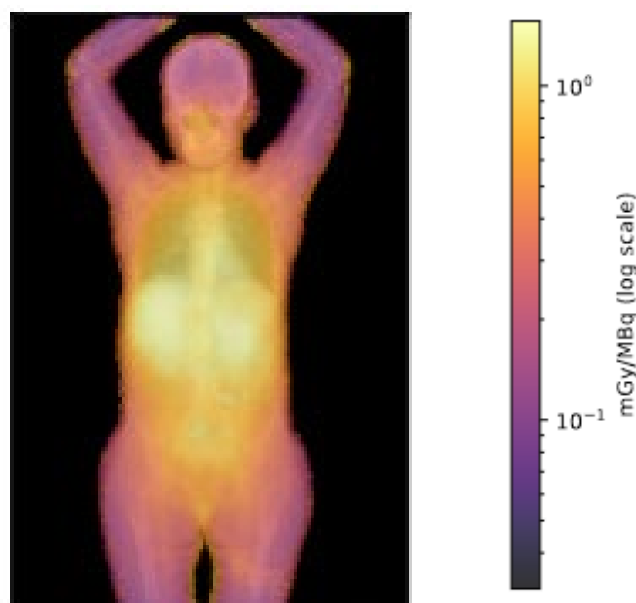
Department of Clinical Physiology and Nuclear Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Contact information:

Thomas Lund Andersen, thomas.lund.andersen@regionh.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor: Thomas Lund Andersen



Project Title: Fractional tissue perfusion

Description:

Positron Emission Tomography (PET) is a highly sensitive technique for visualizing metabolism or receptor-based tracers in-vivo. Perfusion, that is the passage of fluid from the circulatory system to an organ or tissue, can be quantitatively measured with PET using a radioactive isotope of oxygen bound in water, i.e. [^{15}O]- H_2O . The measurement across typically 3 minutes due to the short half-life ^{15}O of two minutes. With new high-sensitive scanners the measurement time can now be expanded to and beyond 12 minutes. Such measurements offer a unique insight into the physiology of more slowly perfused tissue which can be measured on longer time scales. Longer measurement times also open up for more advanced model to estimate the perfusion components of the underlying tissue.

In this project novel models for perfusion imaging calculation should be investigated, implemented, and characterized tested on long time scale [^{15}O]- H_2O scans.

Required qualifications:

22485 Medical Imaging Systems (preferred)

KU005 Modelling of physiological systems (preferred)

General programming skills in Python

Responsible institution/department:

Department of Clinical Physiology and Nuclear Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Contact information:

Thomas Lund Andersen, thomas.lund.andersen@regionh.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor: Thomas Lund Andersen

Project Title: Complementary PET Reconstruction on Low Dose Dynamical PET data

Description:

Dynamic Positron Emission Tomography (PET) enables in vivo quantification of physiological and pharmacokinetic parameters through tracer kinetic modelling. To resolve rapid vascular transit and early tracer exchange, dynamic protocols divide acquisitions into short time frames—often lasting only a few seconds each.

In these early frames, and particularly in low-dose protocols with reduced injected activity, detected photon counts are extremely low. This low-count regime presents substantial challenges for iterative reconstruction (e.g., OSEM) and standard scatter correction methods such as Single Scatter Simulation (SSS), typically leading to:

- High noise levels and unstable scatter scaling.
- Local convergence artifacts and positive bias in early reconstructed frames.
- Distorted Time-Activity Curves (TACs), which propagate errors into estimated kinetic parameters (e.g., K_1 , VT , or Patlak K_i).

Complementary reconstruction frameworks offer viable routes to stabilize low-count frames and preserve quantitative accuracy.

The objective of this B.Sc. project is to investigate, implement, and evaluate complementary/regularized reconstruction strategies tailored for low-count dynamic PET acquisitions, focusing specifically on mitigating scatter-induced bias and noise in short time frames.

The student will work with simulated, phantom, or clinical dynamic PET datasets and assess the trade-offs between image noise, spatial resolution, and kinetic parameter reliability.

Required qualifications:

22485 Medical Imaging Systems (preferred)

KU005 Modelling of physiological systems (preferred)

General programming skills in Python

Responsible institution/department:

Department of Clinical Physiology and Nuclear Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Contact information:

Thomas Lund Andersen, thomas.lund.andersen@regionh.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor: Thomas Lund Andersen / Ulrich Lindberg

Project Title: Denoising MRI DCE data using AI

Description:

T1-weighted contrast enhanced imaging (DCE) in Magnetic Resonance Imaging (MRI) has an inherent low contrast-to-noise (CNR), especially pronounced in areas of low blood volume – leading to less confidence in the tracer kinetic model estimates from those areas. DCE data is measured with a pre-contrast baseline of typical 20s. From this period, we can establish the signal-to-noise (SNR) ratio. Given the SNR the goal of this project is to denoise the entire DCE time-series using artificial intelligence. Evaluation of the performance of such denoising algorithm is then by comparing individual time-activity-curves (TAC) to that of a larger average.

Required qualifications:

22485 Medical Imaging Systems (preferred)

KU005 Modelling of physiological systems (preferred)

General programming skills in either MATLAB or Python

Responsible institution/department:

Department of Clinical Physiology and Nuclear Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Contact information:

Ulrich Lindberg, ulrich.lindberg@regionh.dk

Allowed no of students per report: 1-2

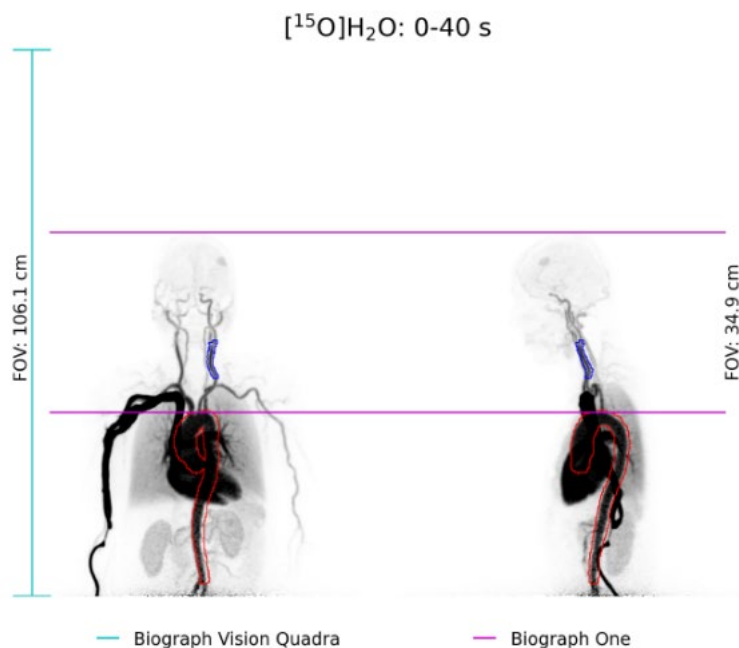
KU and/or DTU supervisor: Thomas Lund Andersen / Ulrich Lindberg

Project Title: Image Derived Input Function estimation from carotid arteries

Description:

Accurate pharmacokinetic modelling relies on a correct arterial input function (AIF). For Long-Axial Field of View (LAFOV) scanners the AIF is extracted from the descending Aorta. With Short-Axial field of view (SAFOV) scanners the aorta is not in the imaging field when scanning the brain. The AIF is therefore often extracted from the carotid arteries, however this impose a problem due to partial volume effects and the recovery constant not being ideal.

This project seeks to investigate if a correct AIF can be determined from the carotid arteries by using the AIF found in the aorta as ground truth.



Required qualifications:

22485 Medical Imaging Systems (preferred)

KU005 Modelling of physiological systems (preferred)

General programming skills in either MATLAB or Python

Responsible institution/department:

Department of Clinical Physiology and Nuclear Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Contact information:

Ulrich Lindberg, ulrich.lindberg@regionh.dk

Allowed no of students per report: 1-2

KU and/or DTU supervisor: Thomas Lund Andersen / Ulrich Lindberg

Tracking how the heart pumps by clinical medical imaging

Description:

Heart disease, incl. myocardial infarction and heart failure, is the most common cause of death in the world. To overcome the clinical challenge of heart disease, research in disease progression and diagnostics is essential. In this study, we perform image processing of computer tomography (CT) scans (dynamics, multi-slide covering the entire heart) in living pigs with and without heart disease. We aim to develop machine learning tools for (semi)-automatic assessment of 4D cardiac scans and thereby understand how heart disease impacts the heart's pumping functions.

Required qualifications:

Independent and motivated student(s) with excellent knowledge in human biology and image processing, motivated to work with real-life data and translational science. If interested, please send CV, study record incl. grades, and short motivational letter mentioning a bit about yourself and your future professional ambitions. This project involves a lot of data processing and is therefore most suitable for project +20 ECTS points.

Responsible institution/department:

Department of Biomedical Sciences (BMI), KU

Contact information:

Lisa A. Gottlieb gottlieb@sund.ku.dk, MD PhD assistant professor

Allowed no of students per report: 1-4

KU and/or DTU supervisor:

Dr. Lisa A. Gottlieb, BMI, KU

Prof. Rasmus Paulsen, DTU

Dr. Martin Nørgaard, DIKU KU

Two-photon microscopy for diagnosis and monitoring of diseases

This project comprises a range of possible projects working on two-photon fluorescence microscopy. The project can be more engineering focused, image processing, or application focused depending on the student. Some opportunities could include:

- Investigation of metabolic biomarkers using 2D and 3D cultured cells and cancer models
- Beam shaping through multi-core and multi-mode optical fibers
- Imaging and analysis of pancreatic cancer samples with two-photon light sheet microscopy
- Imaging and analysis of autofluorescence and/or exogenous biomarkers with two-photon microscopy
- Analysis of laser damage to cells using two-photon microscopy
- Comparison of benchtop and fiber probe-based two-photon imaging systems
- Applications of two-photon fluorescence imaging in neuroscience

Required qualifications/prerequisites:

Project description can be adjusted to reflect the background and interest of individual students

Responsible institution/department:

DTU Health Tech

Contact information:

Henry Sansom: [hgosa@dtu.dk](mailto:hgos@dtu.dk)

Peter Andersen: peta@dtu.dk

Allowed no. of students per report:

The project can be adjusted to reflect the number of students

KU/DTU supervisor:

Henry Sansom and Peter Andersen

Project Title: Virtual brain scans: how microscopic tissue changes alter what we measure on clinical MRI

Description:

Diseases like multiple sclerosis, dementia and vascular disease cause small changes in the brain tissue, for example by reducing myelin, adding iron or changing the water content. Clinical MRI scans do not measure these properties directly. They show image contrast, and software tools then estimate things like cortical thickness from that contrast. As a result, we do not really know which tissue changes a clinical scan can pick up, or whether some of them change the measured thickness even when the brain has not shrunk.

In this project you will answer that question with a fully controlled virtual experiment. Starting from high-resolution 7 Tesla quantitative MRI maps of healthy brains, you will build a digital model of the cortex, change its tissue properties in a controlled way at different cortical depths, and simulate how the brain would look on the two most common clinical brain scans, T1-weighted MPRAGE and FLAIR. You then run standard cortical thickness software on the simulated scans and measure how much the measured thickness changes as the tissue properties are modulated.

You will write your own MRI signal simulator in Python/PyTorch, validate it against an established open-source simulator, and work with widely used neuroimaging tools. The results will help us understand what clinical MRI can and cannot measure about the brain tissue.

Required qualifications/prerequisites: Solid Python programming. Basic knowledge of MRI physics or medical image analysis (e.g. an introductory course) is a plus. Interest in neuroscience. Experience with PyTorch or neuroimaging tools such as FreeSurfer is an advantage but not required.

Responsible institution/department: DTU Health Tech, Section for Magnetic Resonance.

Contact information: Oula Puonti, oupu@dtu.dk

Allowed no. of students per report: 1-2

DTU supervisor(s): Oula Puonti (DTU Health Tech), Henrik Lundell (DTU Health Tech).

Project Title:

Hjerneskolen (The Brain School)

Wearable Sensor Data Analysis in Patients with Minor Stroke: A Cross-Sectoral Rehabilitation Study

Background

Patients with a minor stroke or transient ischemic attack (TIA) are at increased risk of recurrent stroke, cardiovascular disease, reduced quality of life, and long-term health complications. Despite these risks, many patients receive limited rehabilitation after hospital discharge.

The Hjerneskolen project is a feasibility study investigating whether a 12-week supervised exercise and education program can improve physical fitness, health-related outcomes, and reduce stroke risk factors in patients with minor stroke or TIA.

As part of the intervention, participants continuously wear a Garmin Vivosmart 4 activity tracker for three months. The device collects large amounts of physiological and activity-related data that may provide valuable insights into exercise adherence, physical activity patterns, heart rate responses, recovery, and autonomic function.

Aim

The purpose of this project is to explore and analyze wearable sensor data collected from stroke patients participating in the Hjerneskolen study.

The student will investigate how data from wearable devices can be used to monitor rehabilitation, quantify physical activity, and potentially identify markers of cardiovascular or autonomic dysfunction.

Clinical Intervention

Participants complete a 12-week rehabilitation program consisting of:

- Supervised aerobic interval training twice weekly (60 minutes/session).
- High-intensity interval training performed as 4 × 4-minute cycling intervals.
- Exercise intensity corresponding to 80-90% of individual maximum heart rate (HRmax).
- Active recovery periods at approximately 70% of HRmax.
- Home-based aerobic exercise at least once weekly.

Training intensity is individually prescribed based on results from a Cardiopulmonary Exercise Test (CPET) and monitored using heart rate recordings from Garmin Vivosmart 4 devices.

Available Data

Data are collected from approximately 13 patients.

Each participant wears a Garmin Vivosmart 4 continuously (24 hours/day, 7 days/week) for a period of three months.

Data are uploaded through the Fitrockr platform and can be exported as Excel files for analysis.

Additional available information includes:

- Individual maximum heart rate (HRmax)
- Personalized heart rate zones (70%, 80%, and 90% HRmax)
- Dates of active monitoring periods for each participant

Training logs and exercise diaries

Proposed Research Questions

1. Heart Rate Variability (HRV)

Can heart rate variability be used as an indicator of autonomic dysfunction following stroke?

Potential analyses:

- HRV during exercise sessions
- HRV during resting periods
- HRV during sleep
- Changes in HRV over the 12-week intervention period

2. Physical Activity Behavior

How physically active are participants during rehabilitation?

Potential analyses:

- Daily step counts
- Weekly activity patterns
- Changes in activity levels over time

3. Exercise Intensity and Adherence

Do participants achieve the prescribed exercise intensity?

Potential analyses:

- Time spent in prescribed heart rate zones
- Minutes of moderate-to-vigorous physical activity (MVPA)
- Compliance with exercise recommendations (WHO-guidelines)

4. Sleep Analysis

How does sleep develop during rehabilitation?

Potential analyses:

- Daily sleep duration
- Sleep consistency
- Relationship between sleep, activity levels, and recovery

Additional Activity Metrics

Other wearable-derived measures include:

- Number of floors climbed
- Daily calorie expenditure
- Resting heart rate
- Activity intensity profiles

Required qualifications:

The student is expected to:

1. Export data from the Fitrockr platform
2. Clean and preprocess wearable sensor data from Fitrockr exports.
3. Develop analytical methods for extracting relevant activity and physiological metrics.
4. Perform statistical analyses and data visualizations.
5. Investigate trends and associations between physiological measures and rehabilitation participation.

6. Present results in a written technical report.

The project provides a unique opportunity to work with real-world health data, wearable technologies, and clinical rehabilitation research.

Responsible institution/department:

Herlev Gentofte hospital, department of neurology

Contact information:

Rikke Steen Krawcyk, PhD
Research and Development Physiotherapist
Department of Neurology and Department of Occupational Therapy and Physiotherapy
Herlev and Gentofte Hospital
Borgmester Ib Juuls Vej 29, Building 8
2730 Herlev, Denmark

Email: rchr0102@regionh.dk

Phone: +45 3868 6159

Allowed no of students per report:

1-2

KU and/or DTU supervisor:

Christina Kruuse, KU

