



MSc Thesis Opportunity

Projectome-Aware Selectivity: Cardiac Off-Target Risk Mapping in Cervical VNS

Introduction

Are you motivated to advance neuromodulation technologies and help improve the safety of next-generation therapies? The **Center for Medical Physics and Biomedical Engineering** and the **Department of Psychiatry and Psychotherapy** at the **Medical University of Vienna** are offering an exciting Master's Thesis opportunity. Join our team to explore how electrode placement and nerve anatomy shape cardiac side effects in vagus nerve stimulation (VNS). This project combines high-resolution anatomical imaging with cutting-edge computational modeling to produce the first maps of cardiac off-target risk in right cervical VNS.

Project Overview

Vagus nerve stimulation is used to treat epilepsy, depression, and heart failure. However, stimulation on the **right cervical vagus** can inadvertently activate the **superior cardiac branch (SCB)**, causing bradyarrhythmias. Despite the clinical importance, there are currently no anatomy-grounded models linking electrode *placement* and *rotation* to SCB recruitment risk.

This project builds on a high-resolution **human right vagus micro-CT reconstruction** (capturing fascicular branching down to the SCB) and an existing **3D COMSOL electrode model** with clinical cuff configurations. The goal is to quantify safe vs. risky electrode positions and generate compact **selectivity heatmaps** for VNS.

Your Responsibilities

- Construct a **fascicle graph** to trace trajectories from cervical fascicles to the SCB.
- Generate **synthetic axon bundles** inside fascicles and simulate their activation.
- Perform **electromagnetic field sweeps** across electrode rotations and positions.
- Calculate **activation thresholds** and design **selectivity heatmaps** showing safe/danger zones.
- Explore parameter sensitivity (e.g., perineurium conductivity, cuff fit).

Required Background

- Master's student in Biomedical Engineering, Physics, Electrical Engineering, Neuroscience, or related field.

- Strong interest in **neurostimulation, computational modeling, and clinical translation**.
- Experience with **Python/MATLAB** is required; familiarity with COMSOL or FEM is an advantage.

What We Offer

- A unique opportunity to work with a **one-of-a-kind human vagus nerve dataset**.
- Hands-on training in **computational neurostimulation modeling** and axon activation theory.
- Close supervision and collaboration in an interdisciplinary research environment.
- The chance to contribute to manuscript for journal submission.
- Insight into **clinical aspects of invasive neuromodulation**, including patient selection, surgery, and programming in individuals with severe psychiatric disorders (e.g., depression, OCD).

Application

Interested students are invited to send a brief motivation statement to max.haberbusch@meduniwien.ac.at and christoph.kraus@meduniwien.ac.at with the subject line: *Master Thesis – Cervical VNS Selectivity*. Applications will be reviewed on a rolling basis until the position is filled. **Preferred start date:** October 2025.