MSc Thesis Opportunity

How Much Do Simple Cylinders Get Wrong?

Longitudinal Branching vs. Simplified Nerve Models in VNS

Introduction

Are you curious about how simplified models shape our understanding of nerve stimulation? The **Center for Medical Physics and Biomedical Engineering** and the **Department of Psychiatry and Psychotherapy** at the **Medical University of Vienna** are offering a Master's Thesis opportunity to benchmark realistic versus simplified vagus nerve models.

Most computational VNS studies use homogeneous cylinders or constant cross-section fascicle models, ignoring the complex longitudinal branching and perineurial heterogeneity observed in real human anatomy. This project asks a simple but important question: **When do simplified models get it wrong?**

Project Overview

This project leverages a high-resolution **human right vagus micro-CT model** (from nodose ganglion to superior cardiac branch) and a **3D COMSOL electrode setup** with clinical cuff geometries.

You will compare the realistic reference model against simplified surrogates:

- A homogeneous cylinder model (matched outer diameter and cuff fit).
- A multi-fascicle constant cross-section model (extruded fascicles, no longitudinal branching).

The aim is to quantify threshold and selectivity errors introduced by these simplifications, and to identify when reduced models are adequate versus misleading.

Your Responsibilities

- Build comparator meshes and enforce **scenario parity** (same electrode, pulse, placements, rotations).
- Run **simulation sweeps** across electrode positions and rotations for all three models.
- Extract **activation thresholds**, compute selectivity indices, and analyze ranking errors between models.
- Perform **error analysis** (mis-ranking rate, Bland–Altman, correlation, selectivity error).
- Explore sensitivity to **perineurium properties**, cuff fit, and optional thin tissue layers.

Required Background

- Master's student in Biomedical Engineering, Physics, Electrical Engineering, Neuroscience, or related field.
- Strong interest in **computational modeling and neurostimulation**.
- Experience with **Python/MATLAB** is required; familiarity with COMSOL or FEM tools is a plus.

What We Offer

- Experience working with a **unique human vagus nerve dataset**.
- Training in **comparative neurostimulation modeling** and error analysis methods.
- Close supervision and interdisciplinary collaboration.
- Opportunity to contribute to a manuscript for publication.
- 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 – Simplified VNS Models*. Applications will be reviewed on a rolling basis until the position is filled. **Preferred start date:** October 2025.