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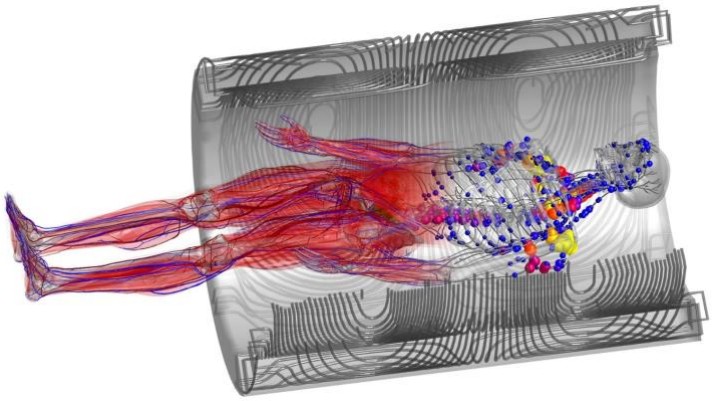
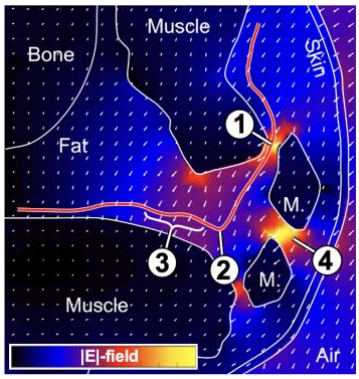
Postdoctoral fellowship: Biophysical modeling of the interactions between electromagnetic fields and nerves

I am looking for highly accomplished and motivated candidates to work in my laboratory located in the Athinoula A. Martinos Center for Biomedical Imaging in Charlestown, Massachusetts, on electromagnetic and neurophysiological modeling. The laboratory is part of the Massachusetts General Hospital. The ideal candidate will have a PhD in mathematics, physics and/or engineering. Excellent coding skills is crucial for this position. Previous experience with electromagnetic or neurophysiological modeling is required. A proven track record of publications is essential.

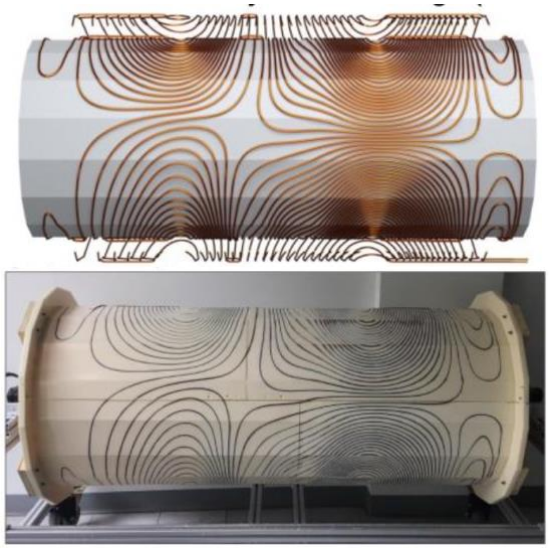
In the last few years, my group has developed computational methods for modeling and prediction of peripheral nerve stimulation (PNS) as well as cardiac stimulation (CS) by MRI. The rapidly switched gradients using for MR image formation induce electric fields in the body via Faraday induction that can stimulate nerves. This modeling work has led to new insights into PNS and CS during coil design. For example, we proposed a modified boundary element modeling method that incorporates explicit PNS constraints, which led to gradient designs with intrinsically low PNS propensity. We are now exploring a number of projects building on this success, including creation of realistic anatomical/nerve body models, fast PNS monitoring via deep learning and linear models, gradient design and optimization, and more.



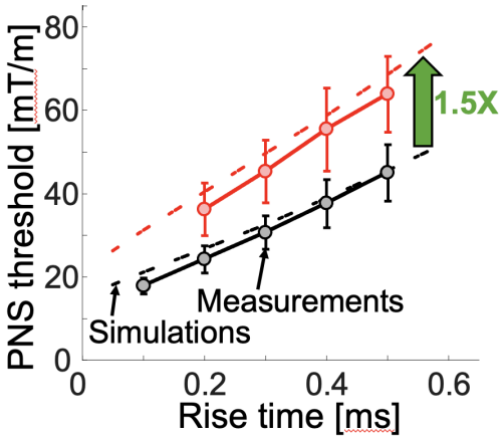
View of one of our detailed anatomical/nerve model inside an MRI gradient coil. The color 'blobs' on the right show activation areas indicating strong probabilities of PNS.



Four typical scenarios: 1) The nerve passes through a E-field hotspot. 2) High curvature in uniform E-field. 3) Low curvature in uniform E-field. 1) and 2) typically lead to activation.



Designed and constructed prototype of a PNS-optimized Y-axis body gradient coil.



*Comparison between measured (solid) and simulated PNS thresholds (dash). **Black**: Conventional design. **Red**: PNS-optimized design. Our optimization yields a 50% increase of thresholds compared to the conventional design.*

My laboratory is part of the Magnetic Resonance Physics and Instrumentation Group (MRPIG) at the A. A. Martinos Center for Biomedical Imaging. The MRPIG houses 12 Principal Investigators and dozens of postdocs and graduate students who develop instrumentation and computational methods to bring new levels of understanding of disease and biology using non-invasive imaging. Our goal is to bridge experimental and computational areas by developing new hardware methodology and expanding image acquisition and reconstruction methods to exploit newly generated capabilities. Some of our projects include: Ultra-high field neuro-MRI (UHF), methods for functional brain imaging and connectomics, RF coil detector and transmit arrays, parallel imaging acquisition and reconstruction methods for speeding up MRI and motion mitigation, parallel transmit pulse design, RF safety for patients with deep brain stimulators, portable MR technology, developing Magnetic Particle Imaging (MPI) for studying brain function.

The A. A. Martinos Center for Biomedical Imaging is a large research institute home to more than 350 investigators, postdocs and graduate students with deep ties to the Massachusetts General Hospital, the Massachusetts Institute of Technology and Harvard Medical School. It is an internationally renowned center with unique scanning capabilities including three 3T MRI scanners, two PET-MRI scanners, two 7T MRI scanners, one ‘Connectome’ high-gradient strength 3T system as well as machine shops, an RF laboratory, a maker space and extensive computational capabilities. Members of the center animate regular science and social events including the weekly ‘Brainmap’ science seminars, ‘Science on Tap’ and ‘Why & How’ events, Martinnovate (entrepreneurship talks and events) and the Molecular Imaging speaker series, which makes it an ideal environment to learn and grow scientifically and personally.

Please contact me directly for more information if interested in this position.