REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RHD-26-07

Modeling Neural Action Potential Response to Infrared Stimulation

PROJECT DESCRIPTION: Infrared exposure can functionally impact the electrochemical activity of neuronal networks resulting in stimulation or inhibition of action potential. The fundamental mechanics of the neuron's response are not fully understood, and effect optimization is an active area of research. Experimental approaches to study these effects have limitations due to the complex nature of the interaction and difficulty in making direct and repeatable measurements. Numerical modeling can be a useful tool for hypothesis testing, and previous efforts worked to combine laser-tissue thermal modeling with temperature dependent neuronal action potential modeling to create an end-to-end analysis tool. Simulating accurate neural response may require incorporating molecular dynamics to resolve behavior of membrane response to temperature and pressure. This project will investigate predictive performance of several numerical neuron models against experimental data evaluating parameter sensitivity and predictive uncertainty.

LEARNING OBJECTIVES: Participants will engage in research activities such as simulation using a finite-volume heat equation solver, high performance computing, briefings to diverse audiences (i.e. skills, education, rank), and neural inhibition/stimulation modeling using NEURON.

ACADEMIC LEVEL: Undergraduate; Doctoral; Masters

DISCIPLINES NEEDED: Biomedical Engineering, Neuroscience, Physics

RESEARCH LOCATION: JBSA-Fort Sam Houston, San Antonio, Texas

RESEARCH MENTOR: Chad Oian, MS
Mechanical Engineering, University of Texas at San Antonio, 2017

Chad Oian is a research engineer in the Air Force Research Laboratory's Optical Radiation Bioeffects Branch (711 HPW/RHDO). He has worked as a computational physics and simulation researcher for 8 years on the Bioeffects Division's modeling and simulation team. He transitioned to civil service through the Palace Acquire program in 2018 after completing a M.S. in mechanical engineering focusing on continuum mechanics modeling of laser-induced neuronal inhibition. His other research areas include laser safety tool development, vision effects modeling, and expanding multiphysics capabilities in the area of directed energy bioeffects.

Photo courtesy of the U.S. Air Force Research Laboratory