

# REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RHD-21-10

## ELECTRO-PHYSICAL PROPERTIES OF CELL MEMBRANES - MODEL REFINEMENT

**PROJECT DESCRIPTION:** Critical to the understanding of how electromagnetic waves interact with biological structures (molecules, cells, tissues) are advanced modeling techniques that predict where energy is absorbed. These models rely on electrical properties of the biological structures to enable accurate predictions. Novel approaches to measuring these properties, specifically dynamically during electromagnetic interrogation, is a critical need within the field of bioelectromagnetics. Our project's goal is to extract fundamental electro-physical parameters using advanced microscopy systems and to refine existing electromagnetic models of biological structures. Currently, the microscopy system has been engineered and tested showing the ability of our team to resolve MHz responses within cells. Our goal is to use this setup to test a wide range of electromagnetic interrogations (waveforms and frequencies) across a wide variety of cell types to better understand the dynamic properties of biological systems. These results will build the next generation of dynamic electromagnetic models of single and multiple cells systems. Such models will likely answer questions posed over 30 years ago about the basis for electropermeabilization, electroporation, and electrical stimulation in complex systems such as the brain.

**ACADEMIC LEVEL:** Bachelors, Masters, PhD

### DISCIPLINE NEEDED:

- Engineering
  - Bioengineering and Biomedical Engineering
- Life Health and Medical Sciences
  - Biophysics
  - Microbiology
- Physics
  - Acoustics
  - Applied Physics
  - Astronomy and Astrophysics
  - Atmospheric Sciences/Meteorology
  - Atomic and Molecular
  - Condensed Matter Physics
  - Neutron Scattering
  - Nuclear
  - Optics
  - Particle Physics
  - Physics (General)
  - Physics of Fluids
  - Plasma
  - Polymer Physics
  - Solid State Physics
  - Theoretical Physics

**PREFERRED QUALIFICATIONS:**

- A near completion bachelor's or an early graduate student.
- Students should have some knowledge of a programming language (python/matlab/mathematica/c/c#/etc) and an interest in mathematical modeling.
- Students should have at least some experience in experimental work (upper level bachelor's course work in an experimental science is fine).

**RESEARCH LOCATION:** JBSA, Fort Sam Houston, San Antonio, TX

**RESEARCH ADVISER:** Allen Kiester

Allen Kiester joined the Air Force Research Laboratory in 2020 as a research physicist focused on the interaction between electromagnetic waves and cells/tissues. His primary interest is developing high speed imaging systems to resolve the rapid biophysics occurring at the plasma membrane/cell surface in real time. His current research efforts include modeling of electric stimulus of mammalian cells, developing apparatus to observe nsEP and AC stimulus, modeling laser tissue interactions, and developing high speed imaging systems. His educational background is in physics and his graduate school research was dedicated to the physics of confining defuse non-neutral plasmas and the manipulation of plasma using electromagnetic fields.