# REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RHD-26-08

## Machine Learning Surrogate Models for Laser-Tissue Interactions

**PROJECT DESCRIPTION:** Physics-level simulations provide a high-fidelity prediction of the effects resulting from laser-tissue tissue interaction but require high performance computational hardware and relatively long simulation times to numerically solve the governing equations. In higher-level DoD simulations, a near-real-time requirement to calculate effects necessitate development of engineering libraries that provide a realistic answer informed by experimental and high-fidelity simulations without burdensome resource requirements. Physics Informed Neural Network (PINN) surrogate models are an active area of research to meet this requirement by replacing numerical methods with networks to solve the mapping between input parameters and solutions that conform to the equations governing the system. Exploring other viable approaches using operator networks and neural operator networks have shown that tradeoffs in complexity and performance are highly dependent on the specific application and fine-tuning of system parameters. This opportunity will seek to develop approaches for surrogating physics-level numerical solvers with trained networks that can be deployed in engineering and mission-level simulation frameworks.

**LEARNING OBJECTIVES:** Participants will engage in research activities such as simulating laser-tissue interactions with finite-volume and finite-difference heat equation solvers, high performance computing techniques, briefings to diverse audiences (i.e. skills, education, rank), and machine learning.

**ACADEMIC LEVEL:** Undergraduate; Master's; Doctoral

**DISCIPLINES NEEDED:** Mathematics, Physics, Biomedical Engineering

**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*