Quantum-Classical Pathfinder for Directed Energy Bioeffect Attribution

PROJECT DESCRIPTION: Directed energy (DE) systems produce complex biological effects, but a critical challenge for assessment and forensics is solving the "inverse problem": given a known effect, what were the exact source parameters (e.g., frequency, pulse width, and power) of the signal that caused it? The parameter space of modern waveforms is nearly infinite, and classical computational search methods often fail, becoming trapped in local minima or requiring infeasible amounts of time. This project will serve as a pathfinder for a novel solution: a Quantum-Classical (Q-C) hybrid generative model.

This project will focus on developing the crucial classical component of this hybrid architecture. As an ORISE participant, you will select a well-documented interaction to serve as a "ground-truth" test case. You will then develop a physics solver that acts as the "loss function," mathematically scoring how well a given set of waveform parameters reproduces the target effect. The core of the project will involve building the "translator" code that maps a hypothetical quantum seed to the continuous physical parameters required by the solver. Finally, under the guidance of a mentor, you will integrate these components and test the entire pipeline. The resulting validated pipeline will be ready to interface directly with quantum hardware, forming the foundation of a new DE bioeffect attribution tool.

LEARNING OBJECTIVES: Under the guidance of a mentor, you will gain hands-on experience to complement your education and support your academic and professional goals. Along the way, you will engage in activities and research in several areas, including but not limited to:

1. Gain a deep, interdisciplinary understanding of DE bioeffects, computational physics, and the architecture of hybrid quantum-classical algorithms.
2. Develop practical, hands-on skills by creating a physics-based simulation and a machine learning data pipeline.
3. Learn to translate abstract concepts from quantum information science into tangible code.
4. Build a modular and scalable research tool.
5. Practice communicating complex, multidisciplinary findings to a diverse team of physicists, biologists, and computer scientists.

ACADEMIC LEVEL: Undergraduate**;** Master's, Doctoral
DISCIPLINES NEEDED: Physics, Engineering (Quantum)
RESEARCH LOCATION: JBSA Fort Sam Houston, Texas
RESEARCH MENTOR: Clint Lanham
Master's of Science in Physics, Virginia Tech, 2023

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Clint Lanham is a research physicist in the Air Force Research Laboratory's Optical Radiation Branch (711 HPW/RHDO). In his current role, he works on the Bioeffects Division's modeling and simulation team, applying his computation and theory background as a subject matter expert. He focuses on scoping new research initiatives and leading technical discussions to develop physics-based projects and implement component library integration towards directed energy risk assessments. Prior to his work with the Air Force, Clint was a Health Physicist at UCLA, where he managed comprehensive radiation safety programs for university facilities. His research background is rooted in nuclear, particle, and condensed matter physics, with a focus on data analysis, physics-based modeling, and Monte Carlo simulations. His current research pursuit areas include modeling high-energy laser-particle interactions, condensed matter theory for advanced protective equipment, reflectance modeling for vision effects, and digital engineering.

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