REPPERGER RESEARCH INTERN PROGRAM  
RESEARCH PROJECT #: AFRL-RHD-20-02

ULTRAFAST IMAGING: STREAK CAMERA PHOTOGRAPHY FOR VISUALIZING ULTRAFAST CELLULAR DYNAMICS

PROJECT SYNOPSIS: For many full-field imaging techniques, such as fluorescence-based microscopy, imaging speeds are often limited by the read-out rate of the CCD or CMOS detector used. While advances in these technologies have allowed for faster image acquisition rates over time, fundamental physical limits in these devices prevent this technology from further increasing imaging speed. With the recent development of Compressed Ultrafast Photography (CUP), single-shot images at up to 100 billion frames per second have been demonstrated. We have incorporated CUP detection into an inverted microscope through the use of a high dynamic range streak camera to allow for microscopic scale imaging of biological phenomena at unprecedented frame rates. In this project, we seek to further utilize both streak photography and CUP-based imaging to enable the direct observation of directed energy interacting with biology. Phenomena of interest include laser tissue interaction and extraction of dynamic tissue optical properties, and membrane voltage imaging via a voltage sensitive fluorescent dye. Opportunities include laboratory based imaging experiments as well as software development to enhance image processing speeds via GPU processing.

ACADEMIC LEVEL: Masters, PhD

DISCIPLINE NEEDED: Biomedical Engineering, Computer Science, Physics

RESEARCH LOCATION: Fort Sam Houston, TX

RESEARCH ADVISER: Joel N. Bixler, PhD
Biomedical Engineering, Texas A&M University, 2015

Joel Bixler is a Research Biomedical Engineer in the Optical Radiation Branch at the Air Force Research Laboratory, Airman Systems Directorate. He joined AFRL in 2014 as a Pathways student, and currently works as a principle investigator on an AFOSR funded effort to develop ultrafast imaging systems. He is also the PI on a grant to develop advanced image processing tools for studying retinal laser damage, including the use of machine learning to automate detection and classification of laser damage. Dr. Bixler additionally works with the modeling, simulation, and analysis team to develop improved methods for modeling laser-tissue interaction and measuring tissue optical properties.