JOHNS HOPKINS
BIOMEDICAL ENGINEERING

BME SPECIAL SEMINAR

Meng Cui, PhD

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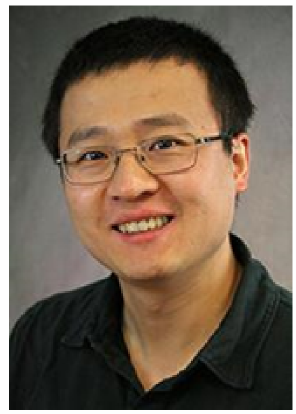

Tuesday, April 11, 2023
10:00am-11:00am
Clark 110 and via zoom:
https://bit.ly/3K9Tl3w

Faculty Host: Sri Sarma

New generation of technologies for multiscale imaging of mammalian brain

Abstract: The brain as the center of the nervous system controls our physiology, consciousness, and behavior. Its function relies on the interactions of tens of billions of neurons through tens of trillions of synapses. Gaining precise knowledge of neural circuits relies on innovative and transformative tools for quantitative measurement of cellular dynamics in the live brain across multiple spatiotemporal scales. My team works at the interface of optical engineering, device fabrication, and image processing to deliver enabling tools for neuroscience. In this talk, I will introduce several new capabilities. First, the combination of genetically encoded fluorescence indicators and two-photon microscopy has provided a paradigm shift in neuroscience by enabling cellular resolution functional imaging in mammalian brains. However, current technologies have severe scale limitations, far from achieving whole-brain coverage. Recently, my team developed the NeuroDome technology for ultra-large-scale cellular-resolution imaging of mammalian brains. I will discuss the applications of NeuroDome for in vivo calcium imaging. Second, a major challenge of cellular resolution recording is the superficial access depth. Current methods are limited to ~ 1 mm depth, insufficient to access deep brain regions. My team has developed the Clear Optically Matched Panoramic Access Channel Technique (COMPACT) for the deep-brain large-scale neurophotonic interface. I will present the results of applying COMPACT for deep-brain multi-region functional imaging. Third, high-performance fast genetic indicators are on the horizon. Seeing information flow at a millisecond time scale among neural circuits in the live mammalian brain is about to become a reality. However, current imaging tools are insufficient to keep up with the sensor response. We have developed an optical gearbox that can convert existing imaging systems for high-speed measurement. I will present the results of in vivo kHz imaging. Fourth, cellular resolution recording has been limited to animal models. In comparison, fMRI and ultrasound can be applied to the human brain. Can we leverage the advance of cellular resolution recording to address the key challenges of human brain measurement modalities? I will discuss the latest progress in the multimodal imaging of the mammalian brain.

Bio: Meng Cui obtained his M.S. in Electrical Engineering and Ph.D. in Physics both from the University of Michigan in Ann Arbor. He started his research career as a lab head at HHMI Janelia Research Campus in Ashburn Virginia, where he developed his strong research interest in leveraging optical and mechanical design to solve biomedical challenges. Currently, he is an associate professor of ECE and Biology at Purdue University. The research focus of his lab is neural imaging technologies, the synergy of optical and mechanical design, device fabrication, robotic control, machine vision, and image processing. Many of the ongoing research projects have benefited greatly from the deep and sometimes bold collaboration with neuroscientists from many institutes. Through collaborations, Meng aims to overcome the scale and depth limitations of current technologies and transform the study and understanding of brain functions.