Professor Elizabeth Hillman, Columbia University

Real-time Imaging of Whole-brain Activity

Abstract: The past decade has seen dramatic improvements in optical reporters of neural activity and technologies capable of imaging them in-vivo. As a result, the number of neurons that can be recorded has increased from hundreds to thousands across increasingly large brain regions. Dr. Hillman's lab has contributed several imaging techniques to this field, including swept confocally aligned planar excitation (SCAPE) microscopy for high-speed 3D microscopy, which we are applying to imaging awake, behaving organisms such as the freely crawling Drosophila larva, the whole brain of behaving adult Drosophila, zebrafish brain and the awake mouse cortex. We have also developed wide-field optical mapping (WFOM) for imaging both neural activity and hemodynamic over the entire dorsal cortical surface in awake, behaving mice. Both techniques are providing new high-speed, real time views of brain-wide activity in awake, behaving animals, providing fundamentally new views of spontaneous activity and behavior that permit the application of new modeling and analysis methods including machine learning. She will present our latest progress on high-speed imaging technique development, and showcase her work applying these techniques to understand whole-brain activity in the context of awake behavior, as well as studies linking spontaneous brain-wide neural activity to resting state functional magnetic resonance imaging (fMRI).

Bio: Dr. Elizabeth Hillman is a Professor of Biomedical Engineering and Radiology at Columbia University, and a member of the Zuckerman Mind Brain Behavior Institute and Kavli Institute for Brain Science. Dr. Hillman develops novel approaches to in-vivo optical imaging and microscopy for studying living tissues, most recently SCAPE microscopy – a technique for very high-speed 3D imaging of cellular activity. Her lab also applies these imaging tools to studying the relationship between neural activity and blood flow (neurovascular coupling) in the healthy, diseased and developing brain. These studies offer to improve use and interpretation of fMRI data, whose signal detects dynamic changes in brain blood flow. Dr. Hillman received undergraduate and graduate degrees in Physics and Medical Physics at University College London and completed post-doctoral training at the Martinos Center for Biomedical Imaging at Massachusetts General Hospital. She has been the Director of the Laboratory for Functional Optical Imaging at Columbia University since 2006. Dr. Hillman is a Fellow of OSA, SPIE and AIMBE, has received young investigator awards from the HFSP and Coulter Foundation as well as an NSF CAREER award, two NIH BRAIN initiative awards and the Optical Society of America's Adolph Lomb medal for contributions to optics at a young age.