High-throughput optical neuroimaging

Laser Biomedical Research Center

The brain is arguably the body's most complex organ, and understanding it requires imaging at scales from nanometers to centimeters. Just mapping neural connectivity requires each synapse to be identified and located while tracing the neuron's extent across the brain; additionally, activity mapping requires temporal resolutions from milliseconds to minutes. To image the brain at synaptic resolution, in collaboration with Dr. Ed Boyden, LBRC researchers are developing a 3D super-resolution instrument capable of several hundred megapixels per second throughput; this instrument is projected to be able to image a complete mouse brain at 50nm XYZ resolution within a year. The LBRC is also developing tools for neural activity monitoring in collaboration with Dr. Elly Nedivi to determine how neurons perform computation based on their synaptic inputs. This instrument can image all ~10^5 synapses in a neuron at 10-100Hz within a mouse brain, based on random-access holographic multiphoton microscopy. Both of these instruments will be discussed, along with their design choices, further applications, and opportunities for future development and collaboration.