ALL-OPTICAL PHYSIOLOGY WITH FAST VOLUMETRIC IMAGING IN A LIVING DROSOPHILA BRAIN

Chiao Huang,[1] Chu-Yi Tai,[2] Kai-Ping Yang,[1] Wei-Kun Chang,[3] Kuo-Jen Hsu,[1,3] Yen-Yin Lin,[3] Ann-Shyn Chiang,[3,4,5,6] and Shi-Wei Chu[1,7]
[1]Department of Physics, National Taiwan University [2]Institute of Biotechnology, National Tsing Hua University [3]Brain Research Center, National Tsing Hua University[4]Institute of Systems Neuroscience, National Tsing Hua University [5]Institute of Physics, Academia Sinica [6]Kavli Institute for Brain and Mind, University of California, San Diego [7]Molecular Imaging Center, National Taiwan University
1, Sec 4, Roosevelt Rd, Taipei 10617, Taiwan
E-mail : swchu@phys.ntu.edu.tw

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ABSTRACT

How the brain works is based on its complex neuron network. To study functional connection among neurons, compared to conventional electrophysiology, all-optical physiology [1], which uses light to stimulate and record neurons, provides attractive advantages of non-invasiveness and high spatial resolution. Although several all-optical physiology setups, including stimulation and recording techniques, have been demonstrated, the recording designs are mostly limited to single-depth imaging. Nevertheless, due to 3D distribution and fast responses of neurons, the combination of all-optical physiology and fast volumetric imaging is highly desired. In this work, simultaneous single-photon stimulation and high-speed two-photon 3D imaging is demonstrated, where the latter is achieved by integrating a tunable acoustic gradient-index (TAG) lens [2, 3]. Fully resolved functional responses are achieved within a densely distributed neuropils in a living *Drosophila* brain, as shown in Fig. 1. With precise stimulation and high spatiotemporal resolution recording, this work paves the way toward non-invasive investigation on 3D brain functional connectome *in-vivo*.

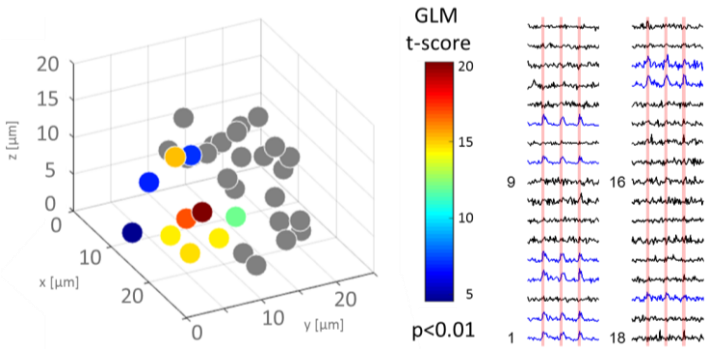

Figure 1: All-optical physiology in 3D living *Drosophila*. The functional responses in 3D coordinate are shown and activated responses are identified by generalized linear model (GLM).

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