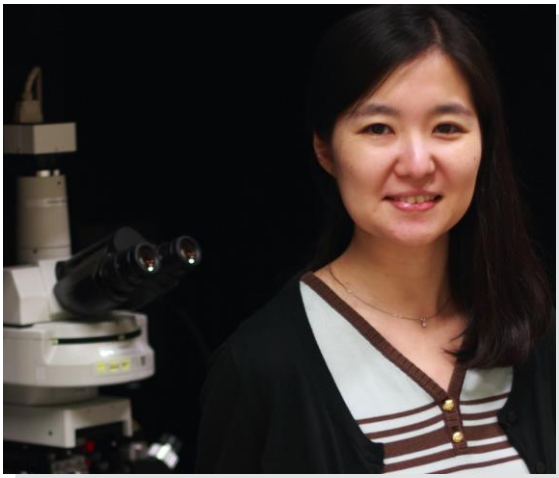
Prizmatix *Innovative Application*

High-power LED system allows photostimulation of multiple neurons



Research led by Dr. Sachiko Tsuda of the Duke-NUS Graduate Medical School in Singapore is directed at better understanding the functional organization of neuron circuits in the brain. She and her colleagues in the lab of Prof. George Augustine recently developed an all-optical approach to study how groups of neurons collectively communicate within brain networks.

"Our optogenetic approach enables both the control and detection of the activity of entire populations of neurons simultaneously by using light, which makes it easier to map the connections between different neuron populations," said Dr. Tsuda, the lead author of their recently published paper. The researchers achieved photostimulation of multiple neurons via the light-sensitive cation channel, channelrhodopsin-2, using the Prizmatix UHP-Mic-LED-460 as the light source and the Andor Mosaic digital micromirror device to create arbitrary spatial patterns of illumination. They simultaneously detected the postsynaptic responses via voltage sensitive dye imaging.

"Since voltage-sensitive dye imaging enables observation of synaptic inhibition as well as excitation, we can visualize inhibitory circuits that largely remain to be elucidated," Dr. Tsuda said.

"The strong output of UHP-Mic-LED-460 solved this problem very effectively. As a bonus, the simple control of its LED via TTL signals also helped us to simplify synchronization of our optical and electrophysiological instruments."

Because they were photostimulating multiple neurons, it was challenging to get enough light power to efficiently activate each neuron. “The strong output of UHP-Mic-LED-460 solved this problem very effectively,” Dr. Tsuda said. “As a bonus, the simple control of its LED via TTL signals also helped us to simplify synchronization of our optical and electrophysiological instruments.”

The Prizmatix UHP-Mic-LED-460 provides more than 1.5 W of collimated light, with a peak excitation of 460 nm, and is optimal for photostimulating a large number of neurons. Prizmatix LEDs all feature a direct TTL input for fast switching with a rise/fall time of microseconds, much faster than the millisecond pulses required for optogenetic applications.

As a proof-of-principle, the researchers used their technique to control the activity of cerebellar interneurons while simultaneously recording inhibitory responses in multiple Purkinje neurons, which are the postsynaptic targets for the interneurons. The results demonstrated that their all-optical technique allows rapid and quantitative analysis of the spatial organization of neuronal circuits.

“We believe that this approach will greatly aid understanding of the functional organization of neuronal circuits,” Dr. Tsuda said.

The researchers are now working to increase the resolution of photostimulation mapping by optimizing the detection of neuronal responses, and they plan to try the approach with genetically encoded fluorescent indicators to achieve cell-type specificity for the neuronal responses. Dr. Tsuda adds that their approach could be used to analyze neuronal circuits in intact brains, and for such in vivo applications, the UHP-Mic-LED-460 would be a key component because of its high power and simple control.

Research Paper: Tsuda S, Kee MZ, Cunha C, Kim J, Yan P, Loew LM, Augustine GJ.. Probing the function of neuronal populations: combining micromirror-based optogenetic photostimulation with voltage-sensitive dye imaging. Neurosci Res. 2013 Jan;75(1):76-81. dx.doi.org/10.1016/j.neures.2012.11.006

Read more:

Prizmatix UHP-Mic-LED-460: www.prizmatix.com/uhp/uhp-mic-led-460.htm

Ultra-High Power LED Light Source for Microscopy in Electrophysiology Setups: http://www.prizmatix.com/LEDUHP/LED-UHP-TEP.aspx

Optogenetics Toolbox:

http://www.prizmatix.com/optogenetics/Optogenetics-LED-Light-Sources-and-Fiber-Optics.htm

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