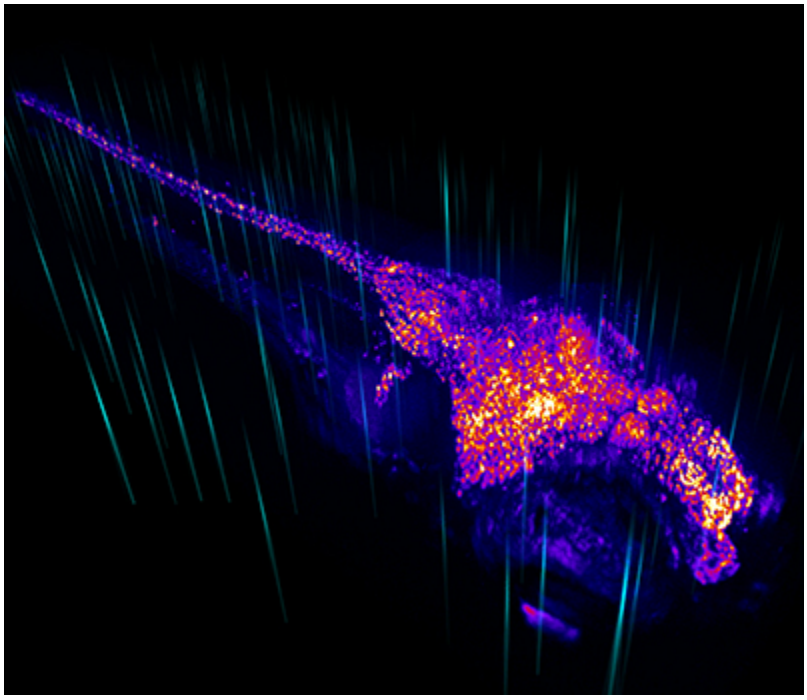
Docket #: S15-366

SPED microscopy – high-speed, cellular-resolution volumetric imaging

Dr. Raju Tomer and Prof. Karl Deisseroth have developed “SPED” (Spherical-aberration-assisted Extended Depth-of-field) light sheet microscopy that combines a large volumetric field-of-view, via extended detection depth-of-field, with the optical sectioning of light sheet microscopy to enable high-speed functional and structural mapping of entire vertebrate nervous systems and CLARITY cleared intact brains at sub-cellular resolution. This system eliminates the need to physically scan the detection objective for volumetric imaging, therefore breaks a fundamental volumetric imaging speed barrier to enable potential scanning speeds of several thousand volumes per second. SPED-light sheet microscopy provides a fundamentally new approach for high-speed mapping of cellular activity in neural networks, with potentially broad applications for research and diagnostics.



*The image shows an example 3D volume rendering from **SPED high-speed functional imaging of an entire zebrafish larval nervous system**, overlaid on SPED detection point spread functions across the field-of-view.*

Stage of Research
The inventors have demonstrated the capabilities of SPED microscopy by performing sub-cellular resolution imaging of CLARITY mouse brains. They have also performed functional imaging of the entire zebrafish larval nervous system up to 12 volumes (40 planes) per second. Furthermore, they used their data to analyze neuronal activity spanning the entire naturally functioning nervous system.

Applications

- **Neuroscience research** - ultra fast functional and structural imaging of living nervous systems
- **Diagnostic** - fast imaging of biopsies or other pathological samples

Advantages

- **Fast** - up to 1000 volumes/second, limited only by camera acquisition rate
- **High-resolution functional imaging** - cellular-level resolution

- **Large field of view** - for imaging networks of neurons or other cells, including entire vertebrate nervous systems (e.g., brain and full longitudinal extent of spinal cord in zebrafish larva)
- **Automated** image segmentation and quantitative analysis pipelines

Publications

- Tomer, Raju et al., SPED Light Sheet Microscopy: Fast Mapping of Biological System Structure and Function *Cell*, Volume 163 , Issue 7 , 1796 - 1806
- PCT Published Patent Application WO2017075275A1, "Methods and systems for imaging a biological sample".

Patents

- Published Application: WO2017075275
- Published Application: 20190056581

Innovators

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