Docket #: S15-390

FIP microscope for simultaneous multi-site measurement of neuronal circuit dynamics

Researchers in Dr. Karl Deisseroth's Lab have developed a microscope and methods to allow simultaneous recording of multiple different brain regions in a freely moving and behaving animal. Brain research is growing rapidly. Simultaneous real-time access to activity signals within specific cell populations and projections will be important for understanding brain function. However, systems to allow such measurement are lacking. To help meet this need the inventors have developed this frame-projected independent-fiber photometry (FIP) microscope that allows users to perform calcium imaging or fluorescence measurement from multiple brain regions simultaneously in the same animal. The microscope allows simultaneous dual-color imaging so multiple genetically-defined neuronal populations can be imaged using calcium indicators with separable emission wavelengths. The FIP microscope and methods may be used for global identification of neural circuits recruited during various behaviors; for studying the brain as an intact dynamic system; and for understanding brain-wide joint statistical relationships that represent sensation, cognition and action.

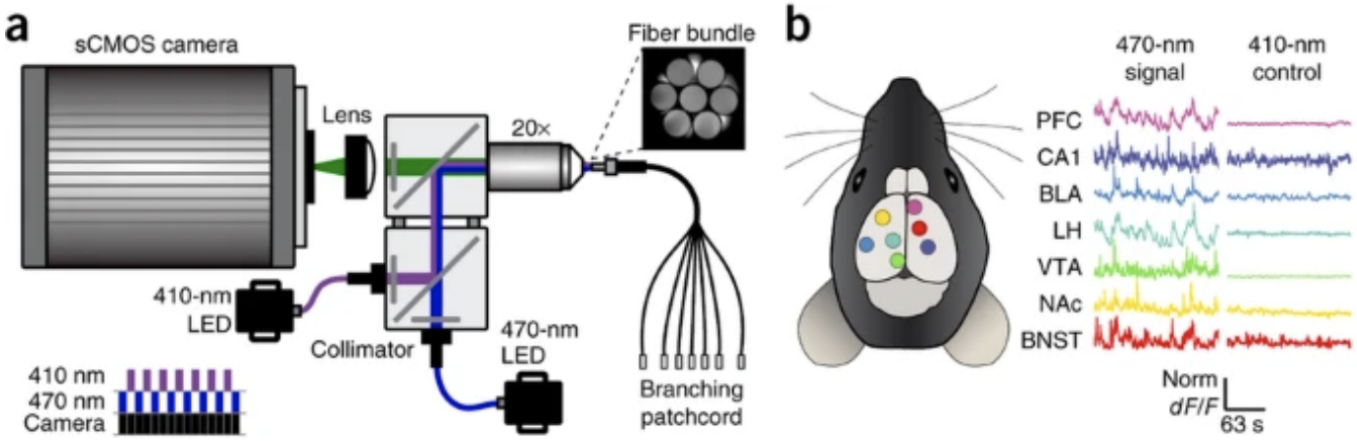

Figure 1 a) Microscope schematic used for simultaneous FIP Ca+2 recording
b) Mouse brain region fiber placement with example Ca2+ traces and freely moving mouse control traces
(Image courtesy the Deisseroth Lab)

Stage of Development - Prototype
The inventors have demonstrated the performance and sensitivity of this system with simultaneous recording of multiple axonal activity signals during distinct sensory experiences.

Applications

- Scientific research in neuroscience:
  - Measure brain activity during behavioral tasks
  - Measure fluorescence in different brain regions
  - Use with genetically-encoded voltage indicators

Advantages

- First integrated system to allow:
  - Simultaneous recording from 7 different brain regions in the same animal
  - Simultaneous dual-color imaging
  - Simultaneous optogenetic stimulation and calcium imaging
- Simple integrated design requiring only one camera and optional image splitter
- Easy to scale
- Easy to build and align
- Easy to use software that doesn't require lock-in amplification of signal

Publications

- Deisseroth, K. A., & Kauvar, I. V. (2022). *U.S. Patent No. 11,234,599*. Washington, DC: U.S. Patent and Trademark Office.
- Deisseroth, K. A., & Kauvar, I. V. (2021). *U.S. Patent No. 11,147,457*. Washington, DC: U.S. Patent and Trademark Office.

- Kim, C. K., Yang, S. J., Pichamoorthy, N., Young, N. P., Kauvar, I., Jennings, J. H., Lerner, T. N., Berndt, A., Lee, S. Y., Ramakrishnan, C., Davidson, T. J., Inoue, M., Bito, H., & Deisseroth, K. (2016). Simultaneous fast measurement of circuit dynamics at multiple sites across the mammalian brain. *Nature methods, 13*(4), 325-328. https://doi.org/10.1038/nmeth.3770

Patents

- Published Application: WO2017087542
- Published Application: 20180228375
- Published Application: 20200187780
- Issued: 11,147,457 (USA)
- Issued: 11,234,599 (USA)

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