



## Presentation Abstract

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Presentation Title: High channel-count silicon neural recording probes for 3d characterization of optogenetically modulated neural dynamics

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Authors: **\*J. SCHOLVIN**<sup>1</sup>, A. N. ZORZOS<sup>1</sup>, G. TALEI FRANZESI<sup>1</sup>, S. B. KODANDARAMAIAH<sup>1,2</sup>, B. D. ALLEN<sup>1</sup>, J. KINNEY<sup>1</sup>, C. MOORE-KOCHLACS<sup>1,3</sup>, A. C. SINGER<sup>1</sup>, S. WASSERMAN<sup>1</sup>, C. WENTZ<sup>1</sup>, M. YAMAGUCHI<sup>1</sup>, C. FOREST<sup>2</sup>, N. KOPELL<sup>3</sup>, C. G. FONSTAD<sup>1</sup>, E. S. BOYDEN<sup>1</sup>;  
<sup>1</sup>MIT, Cambridge, MA; <sup>2</sup>Georgia Inst. of Technol., Atlanta, GA; <sup>3</sup>Boston Univ., Boston, MA

Abstract: Optogenetics is commonly used for precision modulation of the activity of specific neurons within neural circuits, but assessing the impact of optogenetic neuromodulation on millisecond-timescale local and global circuit neural activity remains difficult. We here present a novel strategy for designing and fabricating silicon-based microelectrode arrays with customizable electrode locations, targetable to defined neural substrates distributed in a 3-D pattern throughout a neural network in the mammalian brain, and compatible with simultaneous use of a diversity of existing light delivery devices. Our design of these 3-D electrode arrays provides for both easy electrical and mechanical assembly, and provides for scaling of arrays to up to 1000 neural recording channels and beyond. Our approach relies upon a number of innovations at the material, structural, electrical, and data acquisition levels. First, typical silicon-based electrodes that are arranged in a 1-dimensional linear array, or 2-dimensional comblike fashion, often use linear or tetrode-style electrode locations along the comb's fingers, with stereotyped spacing and pad sizes. Our software-driven approach enables variable spacing and pad sizes, so that electrode geometries can be customized to the cellular

properties of the brain circuits under investigation. Second, to support the assembly of such electrode arrays into a 3-dimensional array, we have developed novel electrical and mechanical connector strategies to make the assembly as automated and reliable as possible. Third, we have developed strategies for amplifying and acquiring data that simplify the use of these probes in an intact, in vivo, mammalian context. Fourth, we have implemented hybrid electrodes that contain both a low-impedance metallic pad for recording of spike activity, as well as an indium tin oxide (ITO) pad that can report local field potentials (LFPs) without the photoelectrochemical artifacts common in optogenetics. Finally, these 3-D probes are designed to be easy to use, from design to surgery. We have developed a user-friendly interface that enables neuroscientists to specify probe geometries based upon neural target geometries and coordinates, and are developing supporting surgical and behavioral strategies for use of such arrays in vivo.

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