# Large Scale Multielectrode Recording and Stimulation of Neural Activity

*Presenter:* Alexander Sher[1]

*Authors:* A. Sher[1], E. J. Chichilnisky[2], W. Dabrowski[3], A. A. Grillo[1], M. Grivich[1], D. Gunning[4], P. Hottowy[3], S. Kachiguine[1], A. M. Litke[1], K. Mathieson[4], D. Petrusca[1].

[1]Santa Cruz Institute for Particle Physics, University of California, Santa Cruz, CA
[2]Systems Neurobiology, Salk Institute, La Jolla, CA
[3]AGH University of Science and Technology, Kraków, Poland
[4]University of Glasgow, Glasgow, UK

Large circuits of neurons are employed by the brain to encode and process information. How this encoding and processing is done is one of the central questions in neuroscience. Since individual neurons communicate with each other through electrical signals (action potentials), recording of neural activity with arrays of extracellular electrodes is uniquely suited for the investigation of this question. In addition to being able to detect simultaneous activity of multiple neurons, such recordings provide the combination of the best spatial (individual neurons) and temporal (individual action-potentials) resolution compared to other large scale imaging methods. Electrical stimulation of neural activity in turn has two very important applications; it enhances our understanding of neural circuits by allowing active interactions with them, and it is a basis for a large variety of neural prosthetic devices.

Until recently, the state-of-the-art neural activity recording systems consisted of 64 electrodes spaced at hundreds of microns. Using silicon microstrip detector expertise acquired in the field of high energy physics, we created a unique neural activity readout and stimulation framework that consists of high density electrode arrays, multi-channel custom-designed integrated circuits, a data acquisition system, and data processing software.

Using this framework we developed a number of neural readout and stimulation systems; 1) a 512-electrode system for recording simultaneous activity of hundreds of neurons in retinas and brain tissue slices, 2) a 61-electrode system for electrical stimulation and readout of neural activity in retinas and brain-tissue slices, 3) a system with telemetry capabilities for recording of neural activity in the brain of awake-behaving animals.

We will report on these systems and novel neurobiology results obtained with some of them, and we will discuss future directions.