

## Second Network Physiology Symposium New Orleans, SFN 2003

### “Exploring Synaptic Interactions and Network Plasticity with Multi-Electrode Devices”

Nathan R. Wilson  
MIT

My talk will preview efforts to develop a new set of technologies for exploring synaptic plasticity from the perspective of the neural network. Recent advances in multi-electrode devices (MEDs) are now permitting the traditional accessibility of tissue culture to be augmented by the presence of dozens of micro-electrodes that can be utilized to observe, activate, or alter the network's properties. Here I hope to show how traditional tools for examining synapses in small circuits might be applied in conjunction with multi-electrode devices to explore interactions between defined subsets of neurons.

First, the addition of confocal imaging to the MED permits the high-precision localization of synaptic proteins or uptake of functional dyes in response to evoked activity. Quantitative immunostaining can be applied to study the structural changes associated with applied stimulation, while functional dyes such as FM1-43 can be utilized to directly visualize synaptic efficacy and dynamic changes in vesicle cycling.

Similarly, traditional electrophysiological techniques such as intracellular recording can be introduced to the MED to explore how a specific cell's output contributes to network dynamics, how various regions of a network map their input into a specific cell, and how these mappings change in response to specific patterns of stimulation. Interesting experiments along this avenue involving synaptic scaling and synaptic pairing will be discussed.

Third, a lingering barrier to producing a one-to-one correspondence between neurons in a cultured network and electrodes in an underlying MED resides in the uncertainty of a network's structure: while the MED electrodes are quite ordered in space, dissociated neurons tend to disperse at will, and often do not contact electrodes at all. To work on this problem we have attempted a micropatterning technique that allows neurons to be positioned with micron-scale resolution. Neurons can be arbitrarily configured while still forming functional neural networks with robust properties.

The final part of the talk will discuss potential clinical applications of multi-electrode devices, and preliminary work in which we have fashioned analogous arrays of electrodes out of a biocompatible conductive polymer, introduced the arrays into live mammalian brain, and fostered some integration. It is likely that many of the methodologies for observing and stimulating spatiotemporally across multiple electrodes, will have additional relevance to a number of applications *in vivo*, further motivating their firm establishment *in vitro*.

