Bursting and synaptic plasticity in neuronal networks

Networks of neonatal cortical neurons, cultured on multi electrode arrays (MEAs) exhibit spontaneous action potential firings. The electrodes embedded in the glass surface of a MEA can be used to record and stimulate activity at 60 sites in a network of ~50.000 neurons. Such *in-vitro* networks enable studies of neuron-neuron interactions within the non-trivial setting of a surrounding, active network.
Cultured networks exhibit spontaneous firing patterns in which many or all neurons fire action potentials in a short timespan (~100 ms) interleaved with quiescent periods spanning from seconds to minutes. The neuron-specific firing rate during such bursts is statistically stable on a timescale comparable to ongoing network growth. This is also confirmed using other methods of analysis, such as conditional firing probabilities which reveal functional connections between neurons.
Although changes in bursting patterns have been observed by many researchers, the experimental induction of such changes by means of electrical stimuli is still subject of some controversy. Evidence is mounting that (spontaneous) bursts interfere with experimentally induced changes, obscuring the results and necessitating many repetitions of a stimulus.
Tetani (trains of stimuli) are more effective when bursts are suppressed using frequent 'background' stimuli (~10 /s). We will describe how slow (4Hz) rhythmic background stimuli, delivered randomly to 10 or more electrodes, have a profound effect on changes occurring in network firing patterns. We applied tetani made out of 4 pulses at 5 ms intervals, phase-locked to either the peak or trough of oscillatory RBS. When delivered at the peak, tetani result in changes in burst patterns and facilitate the response to probe stimuli. When delivered to the through, no statistically significant differences were found in either bursts or probe responses. We will discuss the implications and possibilities of this new stimulation method.