UCLA NEUROENGINEERING PROGRAM

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The UCLA NeuroEngineering Research Laboratory is focused on several efforts to make use of state-of-the-art engineering technology to develop and execute projects that address problems that have a neuroscientific base. The following three projects are examples of the type of research in this laboratory.

UCLA Neuroengineering Project 1: Transcutaneous RF-Powered Neural Recording Device (a collaboration with Dr. Istvan Mody, Neurology, UCLA). The study of complex neuroscientific phenomena, such as fear, epilepsy, and aggressive behavior, is currently being limited by the physical and psychological effect of the test environment itself. In such studies it is necessary to have a means of observing electrophysiological activity, without interfering with its environment, so the test subject does not know that it is being studied. Examples include the dynamic electrophysiological features of emotion, the behavioral interactions of multiple interacting animals in their natural environment, and the real-time continuous monitoring of brain activity in epileptic animals enabling the analysis of seizure activity during awake and sleep periods. This research effort has designed, fabricated, and is testing a miniature, implantable, remotely powered, and wirelessly transmitting recording device. Specifically, an inductively powered single-channel
neural recording device has been designed, fabricated, and tested. This device amplifies the recorded signal, which is then used to regulate a voltage-controlled oscillator about a 3.1 GHz carrier wave. This FM wave is sent through a power amplifier that drives a 50 W antenna load and transmits the signal into free space. The signal is picked up by a similar antenna and demodulated using off-the-shelf equipment. The demodulated signal has a high degree of correlation with the original input signal for inputs as small as 5 mV and as great as 1.5 mV. The device has a 0.5 m transmit range allowing for continuous recordings from animals in their
natural environments.

UCLA Neuroengineering Project 2: Multielectrode Microprobes to Deep-Brain Stimulation (a collaboration with Dr. Marie-Françoise Chesselet, Neurology, UCLA). Although deep-brain stimulation (DBS) can be used to eliminate the severe side effects of Parkinson's disease (e.g., muscle tremors), it does not prevent neurodegeneration that leads to dementia or death. A combination of DBS and drug treatment might be capable of halting these degenerative processes by altering the response of neural tissue to drugs. In order to fully investigate this hypothesis, a comprehensive long-term stimulation study in an animal model is needed. We have designed, fabricated, and tested a novel micromachined probe that is able to accurately stimulate the subthalamic nucleus (STN) while minimizing damage to the surrounding tissue. The probe is coated with gold and insulated with silicon nitride for biocompatibility, has four platinum electrodes to provide a variety of stimulus patterns, and is formed in a novel 3-D plating process that results in a microwire-like geometry (i.e., smoothly tapering diameter) with a corresponding mechanically stable shank.

UCLA Neuroengineering Project 3: Development of High Density Electrode Arrays for Retinal Prostheses (a collaboration with Dr. Bob Greenberg, Second Sight, LLC). Electrically stimulating the retinas of blind patients suffering from macular degeneration can illicit visual perceptions. High-density arrays of electrodes can induce increasingly higher resolution images. However, the area of the retina to be simulated
is small (3×imes;3 mm2) and each electrode must be capable of delivering sufficient charge to activate deep

retinal neurons. Simple flat electrodes cannot supply the required current density reliably without electrode corrosion. Our approach is to enhance the effective electrode area by micromachining the electrode surface, and investigating materials with higher charge injection density capability.