CIMIT MEETING SUMMARY 5/14/02

The meeting was combined with the Lester Wolfe Workshop in Laser Biomedicine, organized jointly by MIT and MGH Wellman Laboratories, and devoted to the topic: "Looking at the Brain Optically". Matthew Wilson, Department of Brain and Cognitive Sciences, MIT spoke on: "From Single Neurons to Brains: In the Big Picture Do the Details Matter?". His investigation of the relationship between the behavior of individual neurons and brain function utilizes microelectrodes arrays implanted in the rat hippocampus and is attempting to understand what the latter does. The microelectrode are arranged in tetrodes, with a total of over 100 sites monitored. Sampling is of a layer of cells about 100 micrometers deep and has a spatial resolution of about 15 micrometers. The tetrode arrays allow localization of electrical signals to a particular cell. Mapping of neural voltages was performed as the rat explored a square grid, with measurements taken for each square. The signal patterns differed for each square and corresponded to a spatial resolution of about 1" of animal movement. These experiments were interpreted to indicate the hippocampus maps the rat's spatial experience. Further experiments were aimed at exploring memory function by measuring the animal's hippocampus firing maps while having the animal run a specific pattern on a circular track; these patterns were then compared with the firing pattern during REM sleep. The experiments indicate macroscopic correlates of REM sleep patterns with the prior patterns evoked by running the track .

Britton Chance, Department of Biochemistry and Biophysics, University of Pennsylvania, discussed "Optical Tomography and Functional Measurements", focusing more specifically on brain activity of the prefrontal cortex during anagram tests. The hypothesis being explored was that brain activity correlates with changes in brain blood volume and oxygenation. Diffuse optical tomography (photon migration measurements) was performed using light-emitting diodes operating at three different near-infrared wavelengths as sources together with silicon detectors in 16-channel headband system. Differential measurements of localized changes in blood volume and blood oxygenation were made on a large number of student volunteers as they solved anagrams ranging from 3 to 8 letters. The measurements were correlated with improvements in anagram-solving ability and showed localization to certain regions of the brain. Localization appears to be linked with changes in blood oxygenation rather than blood volume. The measurement system was also used compare the impact of violent versus pastoral images on brain oxygenation; single voxel peaks were found in differential measurements of the oxygenation patterns. Future plans include Bluetooth™ wireless output from the measurement system, allow a much wider range of activities to be monitored.

Theodore H. Schwartz, Weill Medical College of Cornell University, discussed "In vivo Optical Imaging of Neocortical Epilepsy-From the Lab to the Clinic". Electrophysiology is currently the gold standard in epilepsy mapping but is limited in spatial resolution. Optical measurements of blood volume and oxygenation together with light scattering were performed in an animal model using reflectance measurements at about 707 nm. A CCD camera was used to detect changes in reflectance of 0.1% or greater on the brain surface. "Angle maps" of brain reflection response to patterns of stripes of varying

orientation were obtained and showed that specific spatial regions responded to specific orientational patterns. A model in which epilepsy is locally induced by iontophoresis was used and the spatial and temporal change of reflectivity compared to that obtained with electrical measurements. A focal change in reflectivity which correlated with the electrical signal was observed. The temporal progression of an induced seizure was mapped and found to start focally and spread. In addition, the reflectivity increased in the event focus while decreasing in the surround. "Angle maps" showed that the pre-event orientation patterns were destroyed in the epileptic focus. Finally, mapping was performed on one patient whose skull was open for other reasons; optical mapping of the sensory cortex showed different changes in reflectivity for stimulation of the upper and lower regions of the face.

Thomas F. Deutsch 5/17/02