Title: Scanning Electron Microscopy of Intracortical Microelectrode Arrays after Five Years in Human Neocortex

Authors: S. Kellis[1,2], L. Rieth[3,4], B. Baker[3], L. Bashford[1], K. Pejsa[1], B. Lee[1,2], C. Liu[1,2], R. Andersen[1]

[1]T&C Chen BMI Center, Caltech, Pasadena, CA; [2]USC Neurorestoration Center, Keck School of Medicine of USC, Los Angeles, CA; [3]Department of Electrical & Computer Engineering, University of Utah, Salt Lake City, UT; [4]Center for Bioelectronic Medicine, The Feinstein Institute for Medical Research, Manhasset, NY

Abstract: Stable, sensitive electrodes are fundamental to the robust operation of brain-machine interfaces (BMI), devices which read out brain activity to control assistive devices and write feedback information back into the brain. In this work we examined two microelectrode arrays, which had been implanted in human neocortex for five years, under scanning electron microscopy (SEM). We implanted "Utah" microelectrode arrays (NeuroPort Array, Blackrock Microsystems, Salt Lake City, UT) in anterior intraparietal area (AIP), an area with specialization for grasp, and Brodmann's area 5 (BA5), an area with specialization for reaching. While implanted, both arrays showed similar trends in terms of impedance measurements, with initially high values descending quickly into a gradually downward sloping trend over the remaining implant lifetime. The number of units recorded from the two arrays could be very different, both across sessions and between arrays. Five years after implant, the arrays were explanted intact. The purpose of this work is to understand the effects of long-term implantation in the human cortex by visually examining defects in the electrode metallization and insulation. We found a variety of conditions for the electrode tips and insulation; most electrodes suffered some form of damage to either or both. As we continue to assess these data, we will attempt to correlate the post-explant condition with data recorded while the electrodes were still implanted. This work is especially important as multi-year clinical trials of BMIs in human are becoming more common. These data could potentially lead to new information about improved manufacturing practices, appropriate signal processing routines, or novel electrode designs that will improve the overall experience and long-term performance of BMIs.