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Presentation Abstract

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Presentation Title:	Toward development of a wireless implant for investigating in vivo brain activity: Evaluation of a miniaturized electrode-coupled neural recording chip.
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Authors: ***B. D. WINSLOW**[1], M. NAGARAJU[2], T. MORRISON[2], F. ZHANG[2], T. NGUYEN[1], H. A. ZARIWALA[3], A. R. JONES[1], C. KOCH[1], B. OTIS[2], A. BERNARD[1];
[1]Allen Inst. For Brain Sci., Seattle, WA; [2]Univ. of Washington, Seattle, WA; [3]Seattle Children's Res. Inst., Seattle, WA

Abstract: Microelectrode recording technology has had significant impact in the characterization of the mechanisms underlying neurological activity as well as in the restoration of function to patients with sensory or motor deficits in the clinic. Wireless transmission of neural spiking information and miniaturization of instrumentation is desirable as these approaches, reduce movement-induced artifacts, decrease the risk of infection by not crossing epithelial layers, allow for investigation of behavior in unrestrained environments, and likely will increase recording longevity. Ultimately, miniaturized wireless neural recording capability will be a key technology to advance chronically-implanted neuroprosthetics devices. In this study, the cerebral cortex of an adult mouse was implanted with a microwire electrode array coupled to a miniature custom radio frequency integrated circuit (RFIC) measuring 2 x 2 mm, designed to amplify, digitize, packetize, and wirelessly transmit single unit neural signals. The RFIC comprises a 4-channel low noise neural interface with a 15 kHz sample rate and a 400/433 MHz MICS/ISM-band RF transmitter. The system weighs only 300 mg including antenna and battery, and continuously streams spike data for up to 3 days. Data transmission can be recorded at distances up to 10 m with a USB-PC receiver interface, eliminating the need for rack-mounted instrumentation. In anesthetized, head-fixed mice, sensory-evoked neural spiking data recorded wirelessly was found to be qualitatively comparable to data recorded in a conventional wire-tethered recording system. Electrophysiological spike recordings were evaluated over time and activity state. Additionally, the physiological impact of the miniaturized recording and transmission system on local tissue integrity was assessed immunohistochemically. The foreign body response elicited by the miniature wireless system was compared to the response generated by a conventional wired setup using the same implanted electrodes, to evaluate hallmarks of cellular damage such as activated macrophages/microglia, astrocyte hypertrophy, and neuronal loss in the recording zone. Ongoing chip design is focused on increasing the number of recording channels, integrating stimulation ability, and exploring a wirelessly-powered architecture to eliminate the battery altogether. The future goal of such an electrode-coupled chip is to realize wireless, miniaturized recording and stimulating systems for wide scale deployment to researchers in neuronal sensing, recording, and stimulation paradigms.

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