Contribution ID: **14** Type: **poster**

Instrumentation of high-density sensors and electronics for brain recordings

Our goal is to demonstrate a high spatio-temporal resolution system to record neural activity >1000 channels that could be translatable to humans, and directly scaled to >10000 channels. Current state-of-the-art systems have electrodes with many mm spacing, and discrete electronics, or integrated circuits with ⊠100 channels per chip. Microfabrication techniques allow very high-density electrode arrays, but without correspondingly dense readout electronics. In Year 1 we developed a ~2,000 "pixel"system (E-Chip), with an electrode pitch of 100 μm (33% better than proposed) covering an area of roughly 5 mm2. Each pixel has a gain and bandwidth programmable front end, and will is multiplexed to high-speed analog readout (20kHz) and has 9-wires. The E-Chip is designed to work as a cortical surface sensor (e.g. micro-electrocorticography, ECoG), but the same basic technology could be used to design multi-electrode depth recording electrodes (E-Shanks), which could be combined with the E-Chip surface recordings. Indeed, we have begun fabrication of such multi-channel depth recorders. The data acquisition (DAQ) system is a clone of those we have developed for high-speed imaging: based on a high-reliability Advanced Telecommunications Computing Architecture (ATCA) platform, the system as is can handle >10000 pixels at 20 kHz, with simple extensions to higher channel counts.

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