Wireless, implantable neuroprostheses:
Applying advanced technology to untether the mind

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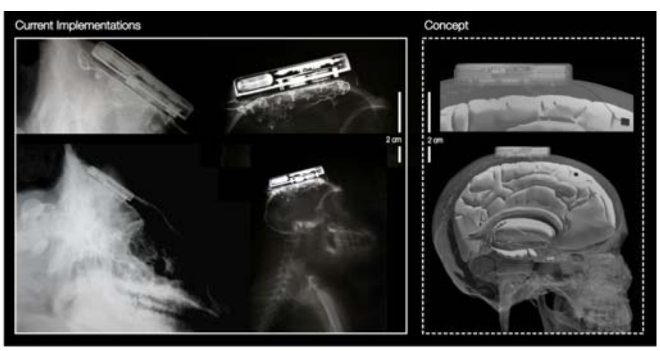
The average neuron in the human brain maintains roughly 10^4 synapses [1] and rests among 10^{11} co-inhabitants. Neurons communicate with each other over synaptic links, which helps them accomplish tasks not only in their immediate cortical neighborhoods, but also across the vast landscapes of the nervous system to control, *e.g.* the movement of a toe. The dynamics of the 1.3 liters of semi-transparent neuronal goo consisting of 10^{15} interconnections are exceedingly complex. How do we observe these dynamics? How much can we expect to "hear"? How does one neuron affect the entire system?

With such a complicated, interwoven system comes the potential for serious communication failure. Neuromotor disease and insult affect the lives of millions of people worldwide. In severe cases, such as the locked-in syndrome, a completely functional central nervous system is disconnected from a completely functional body. The birth of the neuroprosthetics field came from the idea of "unlocking" this state by building devices to bridge the nervous system gap, detecting individual thoughts and translating them into actions. Recent successes in human clinical trials [2] have shown how accessing the human motor cortex by intracortical Si-based multielectrode array (MEA) implants provides important cues to function in the cortex and, more importantly, the underlying neural communication codes.

We discuss the development of an implantable, ultra-low power, neural recording microsystem with integrated and active microelectronics performing wireless data collection and telemetry. This is a critical component to advance human neuroprostheses to wider clinical use. Ongoing brain-sensing research offers tantalizing hints as to the importance of accessing cortical circuits at individual neuron resolution [3, 4]. Presently, these technologies are cumbersome, percutaneous, and limited in their scalability for larger cortical coverage. We have developed a new type of fully-implantable, hermetically sealed, wireless neural recording device for primate use and show its chronic performance and utility.



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