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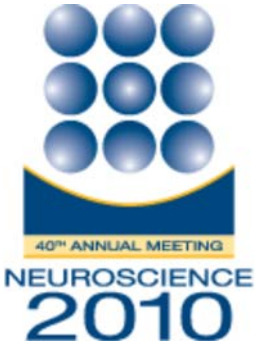

Presentation Abstract

Program#/Poster#:	106.5/MMM12
Title:	Wireless optical control of neural circuits in freely-moving animals
Location:	Halls B-H
Presentation Time:	Saturday, Nov 13, 2010, 1:00 PM - 2:00 PM
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Abstract:	The ability to control specific cell types or pathways with optical neural control methods, utilizing 'optogenetic' sensitizers that make specific cellular functions controllable by light, is enabling the parsing of the causal substrates of normal and pathological brain functions. In order to enable such studies in complex behaviors, longitudinal studies, and multi-animal studies, wireless control of and power delivery to implanted light sources would be of great use. We below describe a system that fulfills this need, and present the use of this technology. We here present a headborne device featuring multiple LEDs (which can be used in raw-die form or fiber coupled; see Bernstein et al., SFN 2009) and the electronic circuits for power capture and bidirectional information telemetry. The design is modular and utilizes primarily off-the-shelf components; as a result, the system can reliably function for many months in a ~3 gram package, easily carried by a mouse. The headborne device is capable of delivering 2 watts of continuous power, enough to power 2 700um x 700um Cree blue LEDs at maximum output power of ~500mW/mm^2. (Note that this is a very high level of power; for surface LEDs atop the cortex, dozens can be run indefinitely). Furthermore, an on-device supercapacitor can store energy and sustain drives of more LEDs in short bursts (e.g., 5 LEDs at max power all on for 1 second, or 10 LEDs at max power all on for 1/2 second, etc., with a 2 second recharge time after such bursts). The power transmitter (custom designed by Ferro Solutions, Inc.) is a large tile-able coil placed under-cage, which delivers a low strength oscillating magnetic field optimized for power efficiency over a wide range of animal head orientations. During a behavioral experiment, high-speed data and control telemetry is handled

by a TI microprocessor and a 2.4 GHz data telemetry chip on the head, and a custom USB-compatible microprocessor radio card up to 10 meters away that can be interfaced to a standard PC or laptop. The headborne device can additionally record neural activity off of 4 implanted electrodes (signals processed by two-stage amplifier, low pass filtered at 10 kHz, and sampled at 25 ksps by the microprocessor).
We have also implemented a system for monitoring and control of dozens of implants simultaneously (in theory, up to ~80 continuously, with potentially 65,536 via a polled addressing strategy, using short bursts of information transfer), making this system suitable for institution-scale high-throughput optogenetic screening. Finally, we have implemented real-time remote triggering of light delivery, allowing for closed-loop perturbation, e.g. upon behavioral event detection.

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