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Development of Brain-Computer Interface Translational Research Platform in Canine Models

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Introduction: Brain-Computer Interface (BCI) applications require expertise in hardware, software, neurophysiology and signal processing, limiting their widespread use. To lower the entry barrier and to encourage potential clinical BCI applications, we are developing an open-source ecosystem in canine models combining the BCI2000 software environment and CorTec's Brain-Interchange (BIC) platform (see Fig.1). This ecosystem enables real-time signal visualization, analytical online processing pipelines for BCI applications, as well as both open & closed-loop stimulation paradigms across all 32 channels independently [1].

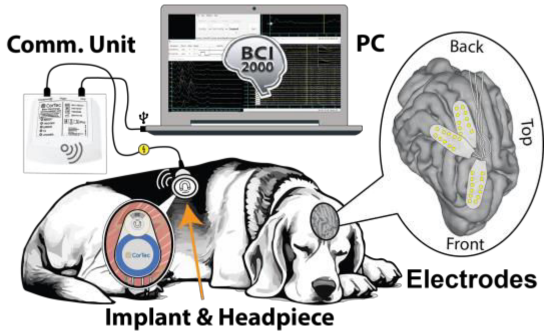

Figure 1: *CorTec BIC–BCI2000 recording setup. Implant is powered inductively by a magnetically attached headpiece. Data are transferred wirelessly to a communication unit and visualized on a PC running BCI2000 software.*

Methods and Results: We have implanted three canines with cortical or deep brain stimulation (DBS) electrodes. Following surgical recovery, canines were monitored on daily basis for over 23 months (in total), during which we evaluated in-vivo capabilities of the BIC, including the device's noise floor, packet loss rate and impedance fluctuations. We recorded signals during various brain states, including task-based movement & multi-sensory behavior, rest or sleep in all three canines. We triggered closed-loop stimulation based on different brain oscillations (see Fig.2). After almost a year post implant, we conducted series of simple functional tasks in one canine and successfully decoded brain activity by capturing broadband spectral changes associated with local neuronal activation [2]. Additionally, we recorded and quantified evoked response potentials triggered by single-pulse stimulation in all three of the canines and captured epileptic activity during sleep in the canine with natural occurring epilepsy.

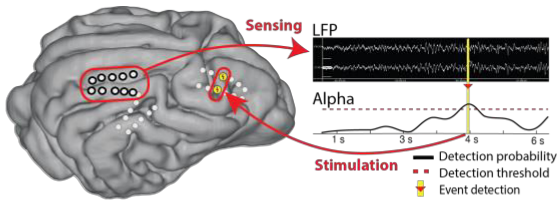

Figure 2: *Schematic figure of the closed-loop stimulation. Local field potentials (LFPs) are streamed to PC and signal power in band is calculated. After exceeding a threshold, stimulation is triggered.*

Conclusion: We are developing a powerful open-source ecosystem that will bridge research and clinical settings, enabling closed-loop neuromodulation or BCI applications therapies for patients with various neurological disorders, such as ALS, stroke or epilepsy.

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