In Vivo Recording of Epileptiform Neural Activation using a Novel Fully-Passive Implantable System

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High-resolution systems for monitoring neural activation is crucial for studying different neural disorders. This is especially true when diagnosing and treating epilepsy, as it has been reported that about 80% of surgeons use these systems to identify seizure origin site for surgical removal. These neuropotential acquisition systems are typically highly-invasive as they require the use of wires that are left protruding from the scalp. This leaves the subject exposed to infections, is detrimental to the quality of life and often limits recordings to a clinical setting thereby limiting the physician's analysis. Many implantable devices have been designed, however, they typically require the use of a power source, which can generate tissue-damaging heat.

To address these pitfalls, we proposed a novel fully-passive and fully-implantable neurosensing system. This device consists of an implant and interrogator antenna, neural probes along with a demodulation circuit designed with a very low noise figure of 3.8 dB (C. Lee, A. Kiourti, J. Volakis, IEEE Antennas and Wireless Propagation Letters, Vol. 16, 2017). The antennas in this system radiate at 2.4 and 4.8 GHz ± f_{neuro}, which allows us to use the interrogator antenna to provide the implant with a 2.4 GHz carrier signal and then receive the harmonically modulated signal backscattered by the implant. Experiments proved an RF sensitivity of ~-135 dBm alsong with an ability to detect emulated neural signals with amplitude in the microvolt scale, implying the system is capable of sensing the signals generated by the brain. Previously, we performed the *in vivo* validation of this device. This entailed a series of electrophysiological recordings of spontaneous cardiac activity and later evoked neural activity. A major contributor to achieving these recordings was the low-impedance neural probes specially designed for the neurosensing system C. Moncion, S. Bojja-Venkatakrishnan, J.R. Diaz and J.L. Volakis, IEEE IMBioC, pp. 76 – 78, 2018).

To build on the completed *in vivo* validation of the neurosensing system we set out to conduct a study focusing on the intended application of this device, continuous monitoring of epilepsy. Using the pilocarpine model, we induced temporal lobe epilepsy (TLE) in several Wistar rats, in compliance with the Institutional Animal Care and Use Committee (IACUC) at Florida International University (Approval No. 17-042). Currently, we are performing experiments to evaluate the system's ability to sense and transmit with minimal distortion the characteristic components found in epilepsy between periods of seizure activity, namely interictal epileptiform discharges (IEDs). At the conference, we will present results from a series of *in vivo* epileptic rat experiments. The neurosensing system will greatly impact future neurological research, as it offers a novel and unobtrusive option.