2017 NSF CYBER-PHYSICAL SYSTEMS PRINCIPAL INVESTIGATORS' MEETING

A Signal-Aware-Based Low-Power, Fully Human Implantable Brain-Computer Interface System to Restore Walking after Spinal Cord Injury
NSF Award: 1446908

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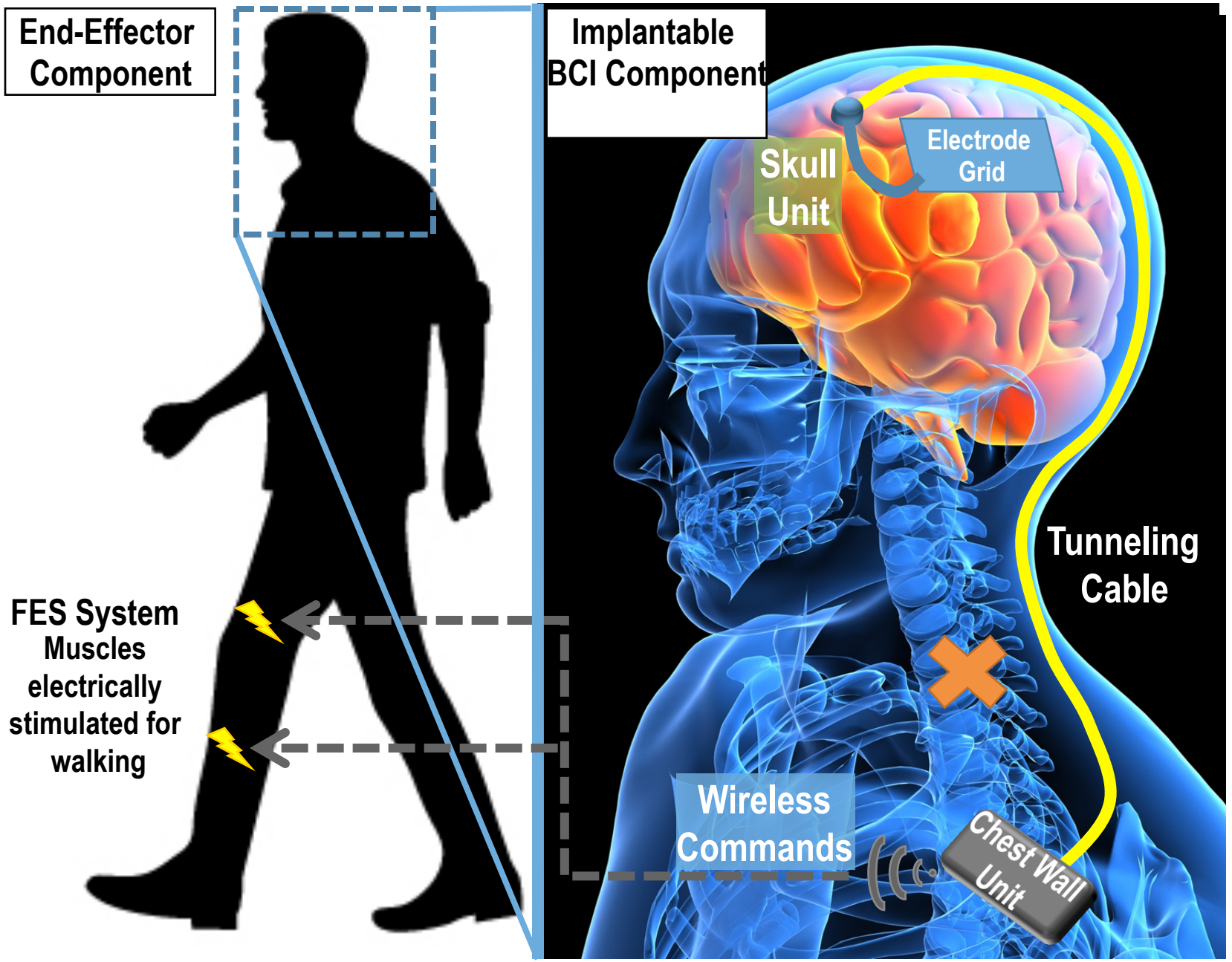
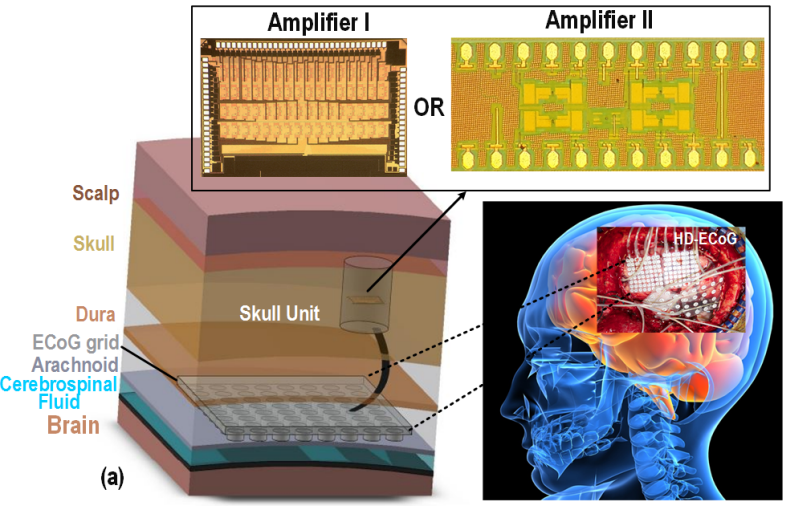
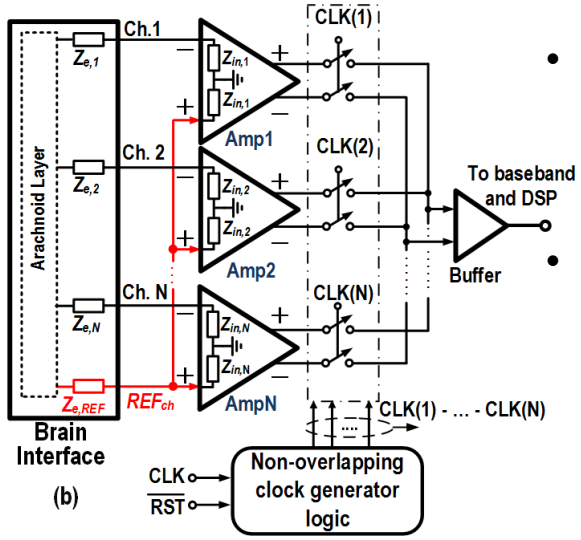
Proposed Fully Implantable BCI System

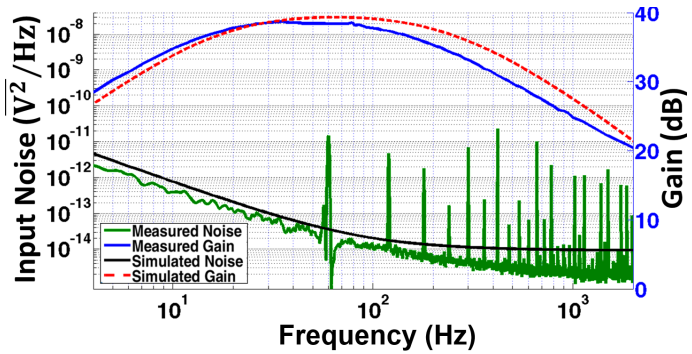


Ultra Low-Power Brain Signal Acquisition Front-Ends

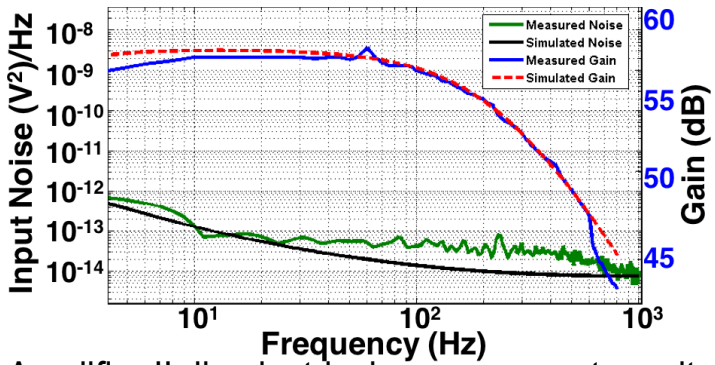




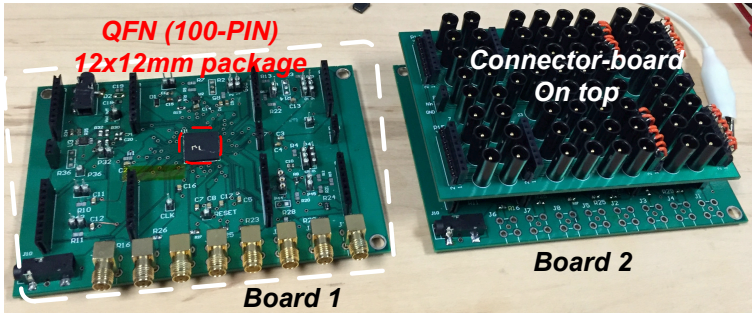
- Front-end system architecture and die micrographs of Amplifier I in 130nm and Amplifier II on 180nm CMOS.
- Amplifier I and II consume 0.21/0.69 µW from 0.4/0.6 V supply, with less than 2.3 μV_{RMS} input noise



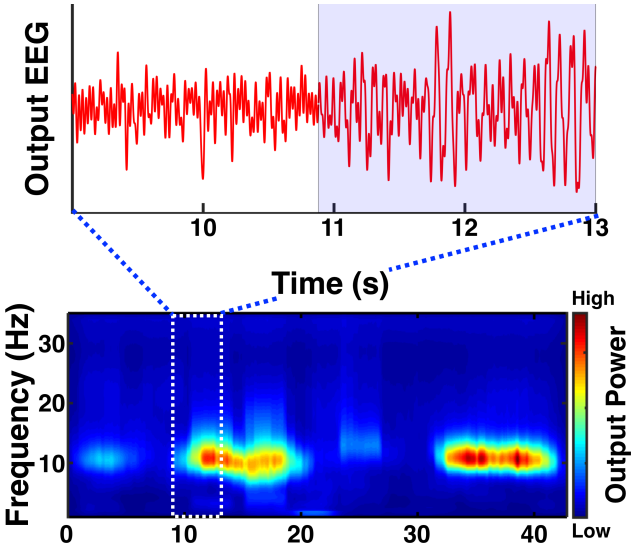
Amplifier I die electrical measurement results



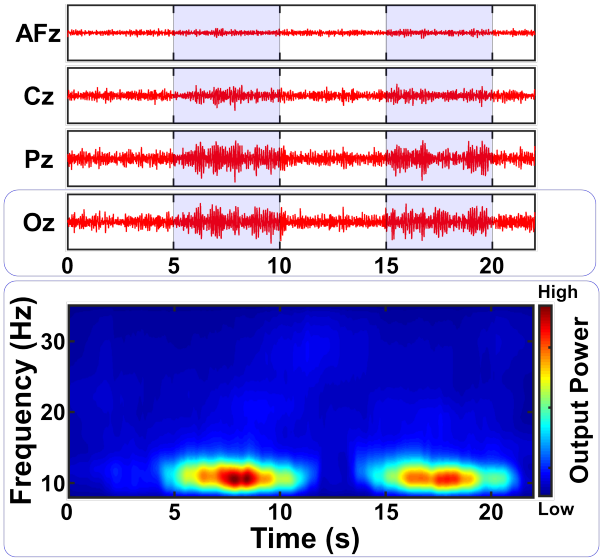
Amplifier II die electrical measurement results



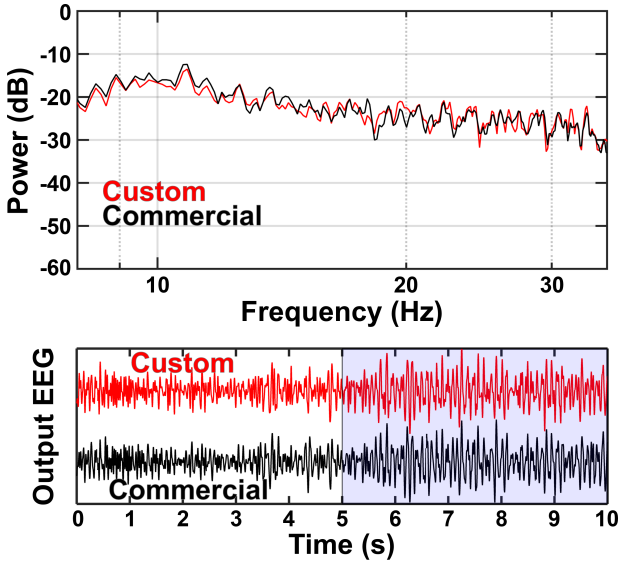
Ultra Low-Power Brain Signal Acquisition Front-Ends



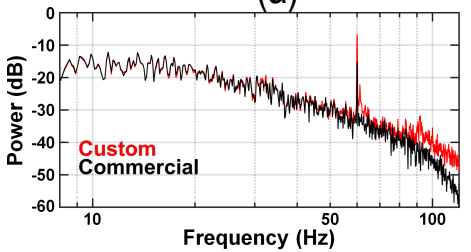
(a)

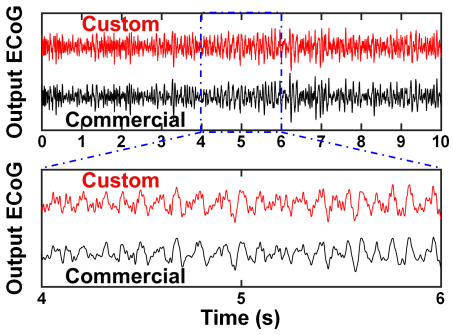


(b)



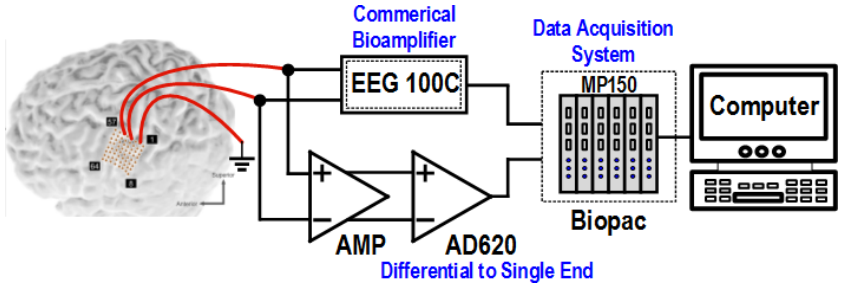
(c)





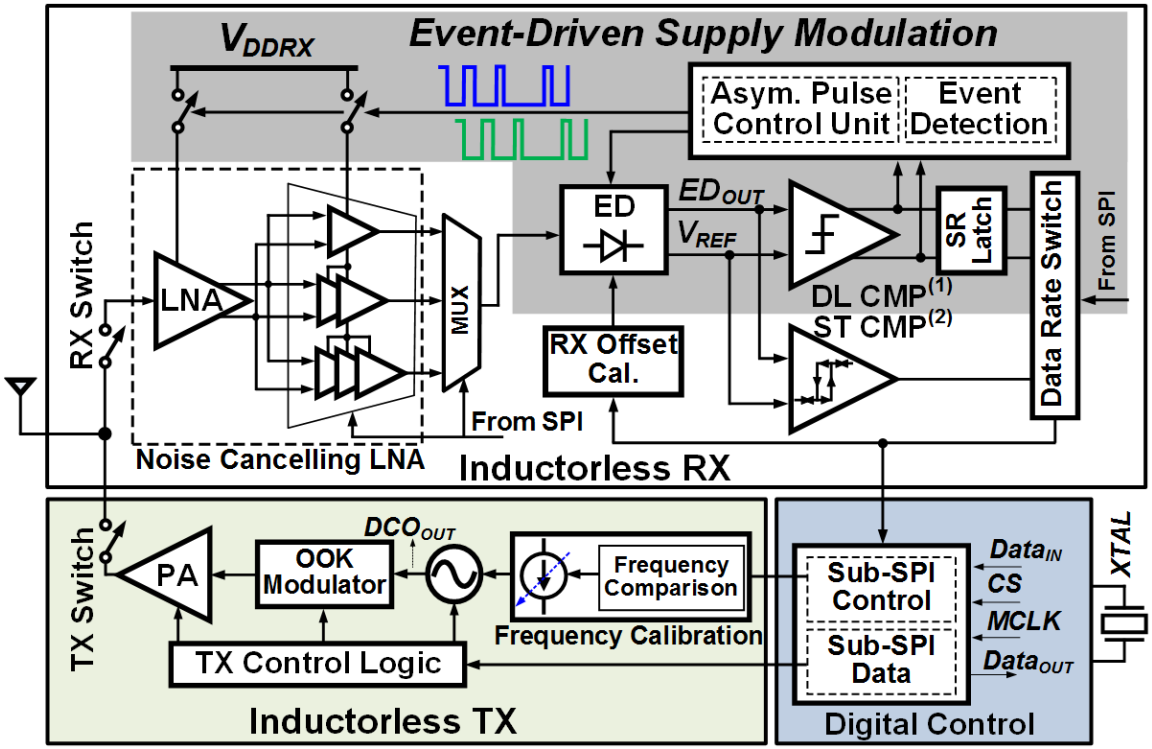
(d)

(a) Amplifier I and (b) Amplifier II EEG time series and spectrogram with increase in α rhythm amplitude when the subject closed his eyes. Power spectral density and time series of the Amplifier II and commercial bioamplifier for (c) EEG and (d) ECoG signals



Measurement setup for concurrent signal recording through commercial and custom-designed amplifiers

Inductorless Low Power Transceiver



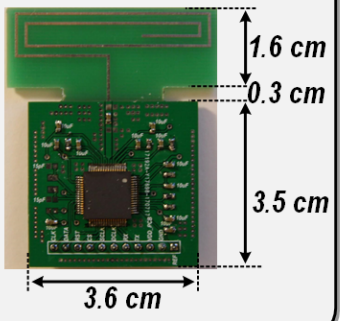
(1) DL CMP: Dynamic-Latch Comparator (2) ST CMP: Schmitt Trigger Comparator

System Features

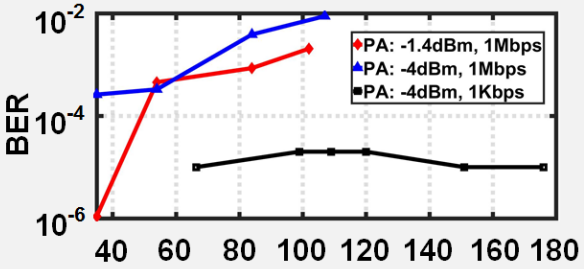
- Inductorless TRX
- Dual Mode Operation
- Frequency Calibration
- Wide Dynamic Range
- Supply Mod. Techn.
- Full TX Power-Cycling

Phantom Measurement

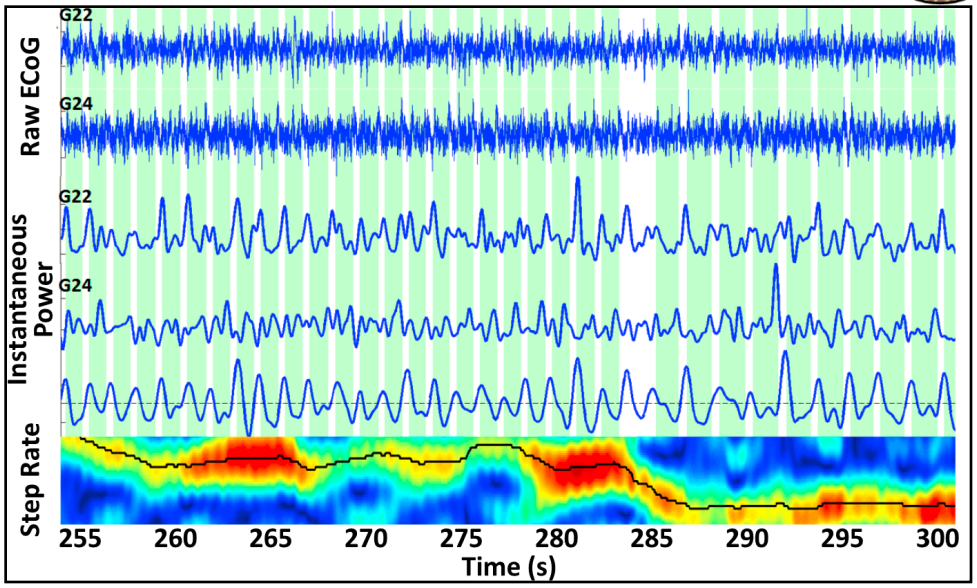
PCB and Antenna

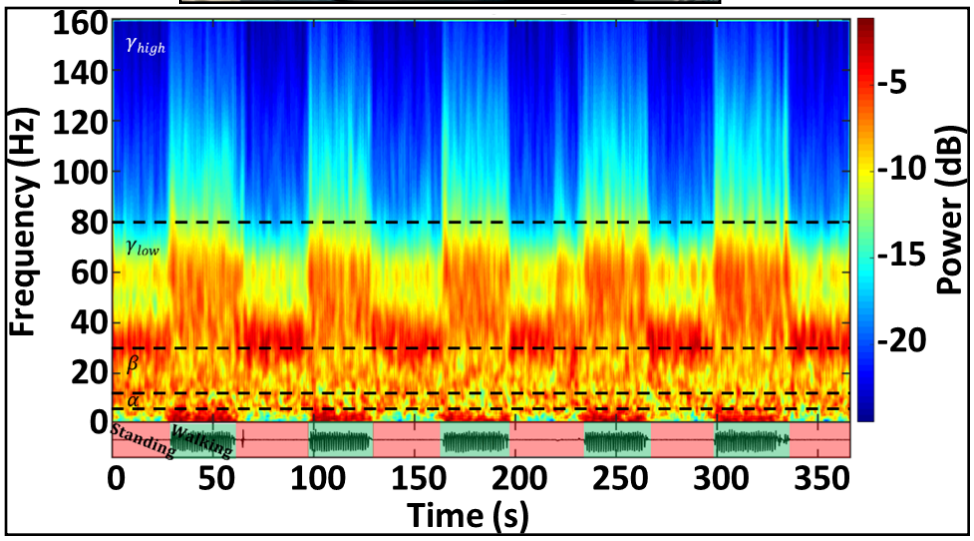


Phantom BER Measurement

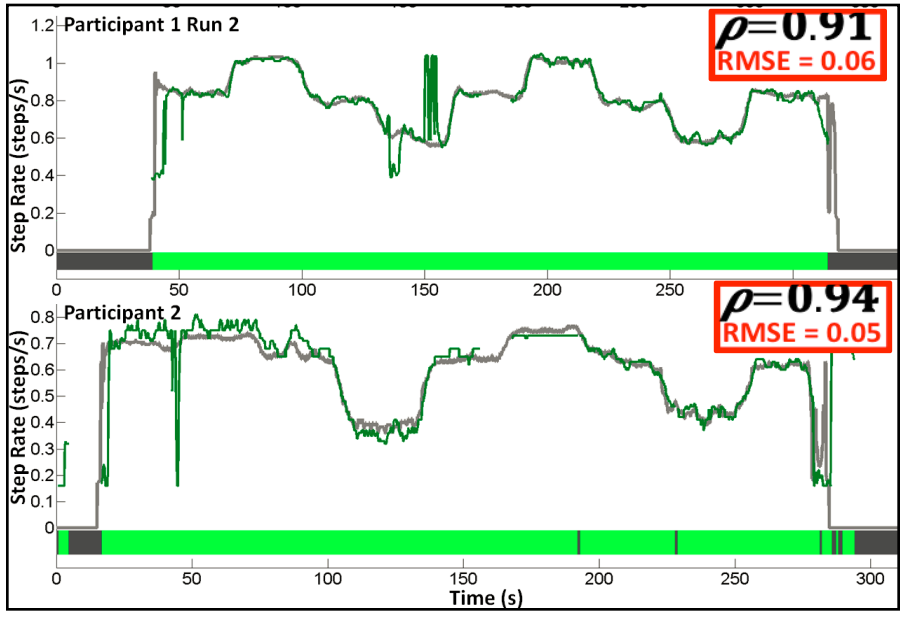


Neurophysiological Study of Walking





McCrimmon et al., *Cerebral Cortex*, 2017



Wang et al., (in preparation)