neurocare

Temporal Interference (TI) Stimulation with neuroConn tES Technology

A new type of transcranial Electrical Stimulation (tES) has been described in the study by N. Grossman, et al. (2017) [1]: **Temporal Interference (TI) Stimulation**. The aim of this new stimulation is to non-invasively stimulate deep brain areas.

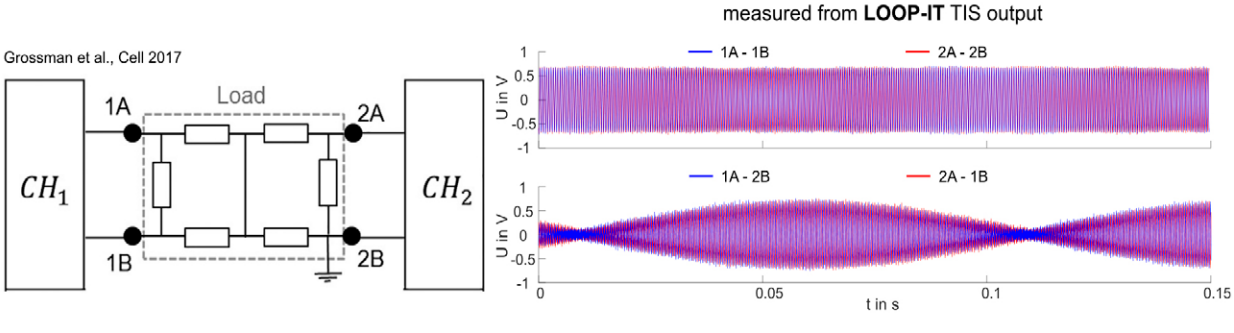
The stimulation consists of two high kilo-hertz frequency sine signals whose frequency difference is comparatively small, for example: 2 kHz and 2.01 kHz, to drive neural activity (in this case 10 Hz). The two input signals are thus injected to the head surface. The applied current waveforms superimpose to a waveform with beating amplitude at the slower difference frequency. The proposed stimulation focusses on the site where the superimposed electric fields constructively interfere, and neural stimulation occurs where the amplitude of the electric field envelope, at the difference frequency, is of great magnitude [1].

Low frequencies generated by TI stimulation have been shown to effectively drive neural activity in anesthetized living mice [1]. Neurons follow the low-frequency envelope of the interfering electric fields (10 Hz) but not the highfrequency carrier (2 kHz).

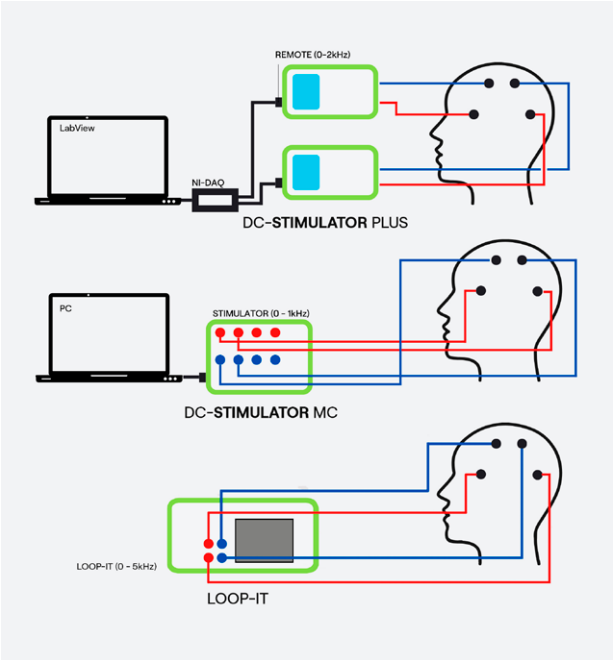
Preliminary finite element modeling stimulation of TI fields in human anatomical models show that the locus of TI stimulation is comparable in size with large subcortical structures (e. g. the hippocampus) but cannot be localized to very small deep brain structures (e. g. the subthalamic nucleus) [2, 3].

However, further work refining the invention is required to optimize it for human use and future trials should aim at understanding TI stimulation outcomes in specific disease states. Regions that are deep but not too small as a fraction of total volume (e. g. those in stroke, OCD, epilepsy, depression, and spinal cord injury) may be attractive initial indications [2].

LOOP-IT with interface for TI stimulation



TI stimulation with LOOP-IT



neuroConn modalities for TI stimulation with DC-STIMULATOR PLUS, DC-STIMULATOR MC and LOOP-IT

neuroConn offers 3 modalities to achieve TI stimulation:

- using two DC-**STIMULATOR** PLUS with a modified REMOTE circuit board (frequency resolution up to 2 kHz) [4, 5, 7, 8, 9]
- using the DC-**STIMULATOR** MC (frequency resolution up to 1 kHz) [6]
- using the LOOP-IT (frequency resolution up to 5 kHz or 200 kHz)

In the neuroConn TI systems, the electrical reference points ("ground") of both stimulation channels are galvanically isolated but the current sources are running synchronously.

Literature:

[1] **Grossman N. et al.,** Noninvasive Deep Brain Stimulation via Temporally Interfering Electric Fields. Cell (2017)

[2] **Grossman N et al.,** Translating Temporal Interference Brain Stimulation to Treat Neurological and Psychiatric Conditions. JAMA Neurol. **(2018)**

[3] **Fernandez-Corazza M. et al.,** Temporal interference transcranial electrical stimulation in humans: actual doses and streerability. Poster at NYC Neuromodulation Conference and NANS summer series **(2018)**

[4] **Hunold A. et al.,** Simulating the superposition of transcranial electric stimulation targeting the visual cortex. Poster at BIOMAG **(2018)**

[5] Iszak K et al., Why Temporal Inference Stimulation May Fail in the Human Brain: A Pilot Research Study. Biomedicines (2023)

[6] Ahtiainen A. et al., Stimulation of Neurons and Astrocytes via Temporally Interfering Electric Fields. bioRxiv (2023)

[7] Ilvær J. & Thommesen A., The Effect of Transcranial Temporal Interference Stimulation (tTIS) on Pavlovian Bias (2022)

[8] Vieria P. G. et al., Temporal interference stimulation disrupts spike timing in the primate brain. bioRxiv (2023)

neuroConn's electrode cable for using TI stimulation within MSR (MEG / MRI)

[9] von Conta J. et al., Interindividual variability of electric fields during transcranial temporal interference stimulation (tTIS). Sci Rep 11 (2021).

[10] Violante I. R. et al., Non-invasive temporal interference electrical stimulation of the human hippocampus. Nat Neurosci (2023)

[11] Savvateev I. et al., Multipair phase-modulated temporal interference electrical stimulation combined with fMRI. bioRxiv (2023)

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