Improving responsiveness to non-invasive brain stimulation in minimally conscious state patients: a closed-loop approach

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Introduction

- Transcranial direct current stimulation (**tDCS**) over left dorsolateral prefrontal cortex (**DLPFC**) efficient for *recovery of conscious awareness* in patients in minimally conscious state (**MCS**) [1].

- Vigilance cycles of ~70 min measured by **EEG spectral entropy** in MCS [2].

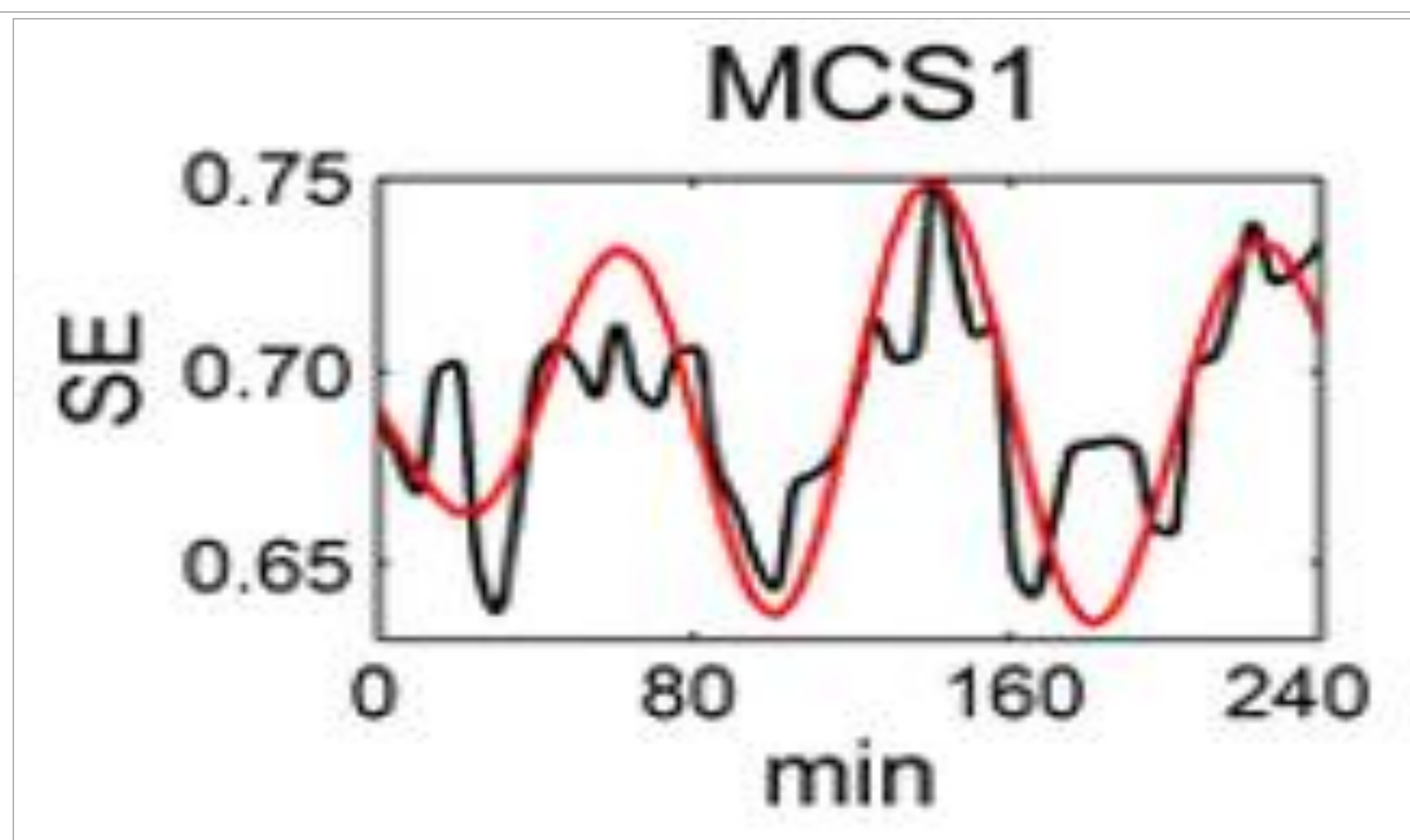- Selectively stimulating at **high** and **low vigilance** states (closed-loop) to improve **tDCS response**.

Fig. 1: Spectral entropy time course (in black) and time course of the main oscillation identified by wavelet analysis (in red) of a MCS patient [2] (*Piarulli et al. 2016)*

Methods

- 12 patients
- Randomized controlled crossover
- Preliminary 4-hour EEG recording
- 3 tDCS sessions (bilateral DLPFC 20 min. 2 mA (*4 mA total*)
    - active tDCS – high vigilance
    - active tDCS – low vigilance
    - sham tDCS – random vigilance
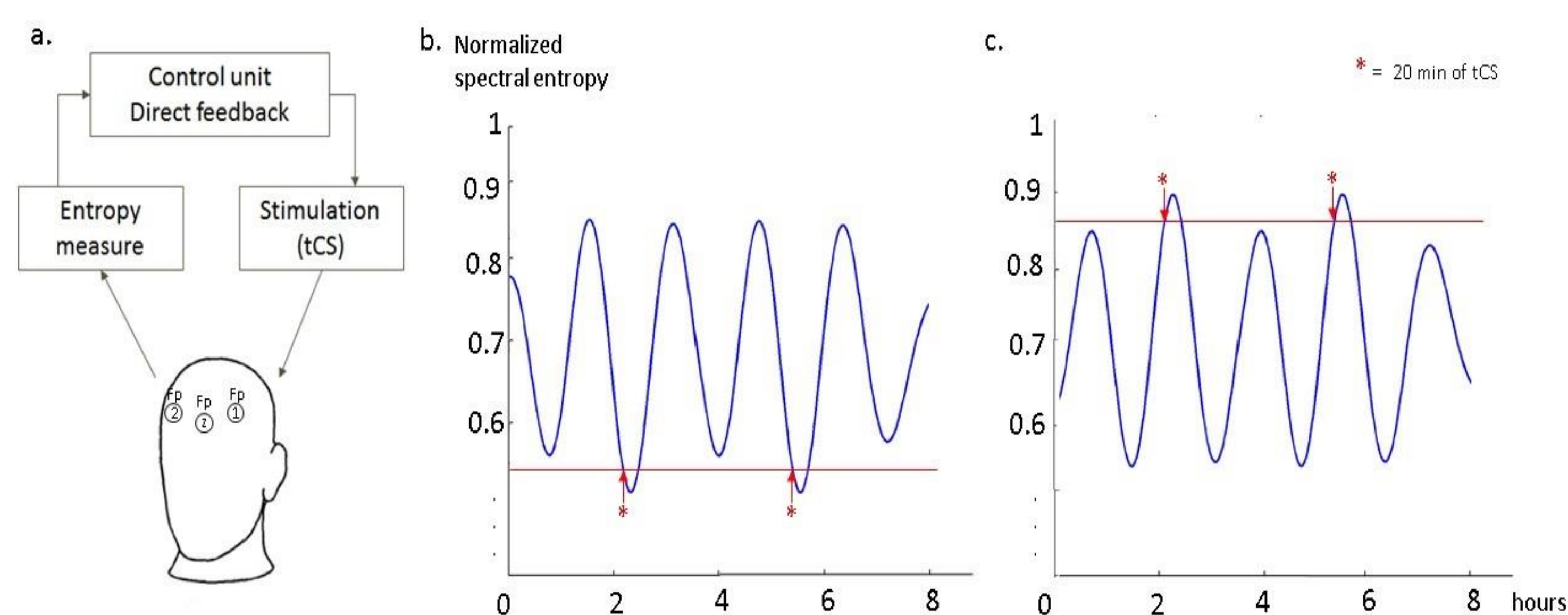- Baseline CRS-R + after tDCS

Fig. 2: tDCS-EEG Closed-loop model based on individual vigilance thresholds measured by spectral entropy
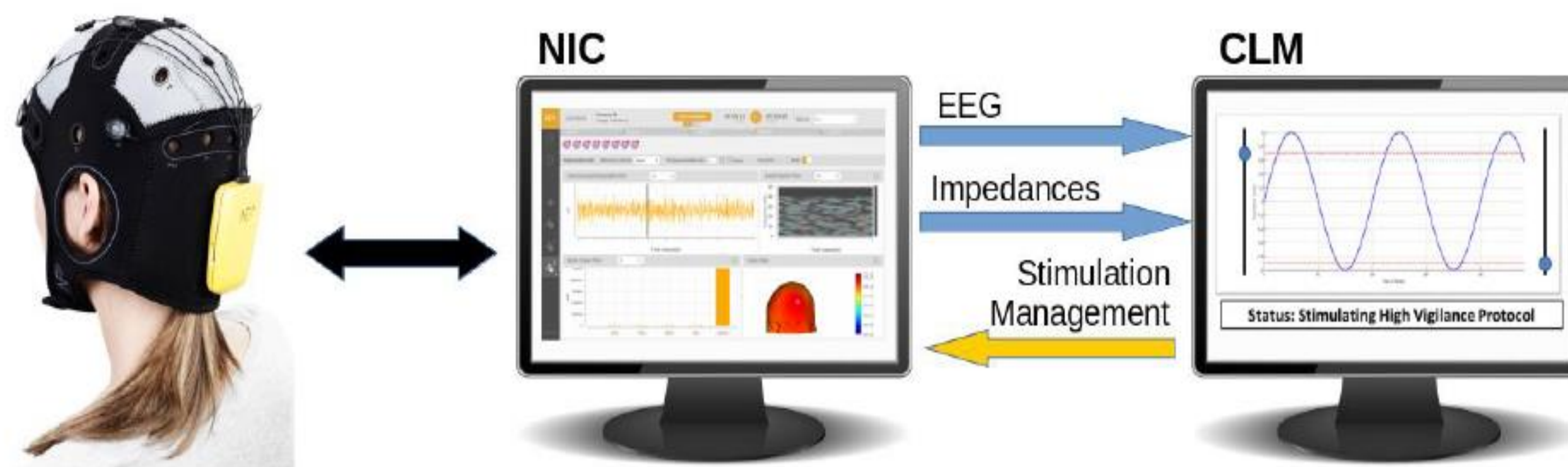

Fig. 3: Closed-loop architecture (left) and closed-loop model (right) as developed by Starlab Barcelona. NIC= software interface for Startsim8® control; CLM= Closed-loop manager for EEG monitoring and tCS management

Conclusion

This unique and novel approach will provide new insights for the identification of tDCS responders and provide treatment options for the challenging population of patients with disorders of consciousness.

References
1. Thibaut et al. tDCS in patients with disorders of consciousness: sham-controlled randomized double-blind study. Neurology, 2014
2. Piarulli et al. EEG ultradian rhythmicity differences in disorders of consciousness during wakefulness. Journal of neurology, 2016

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