



Modelling Non-Invasive Electric and Magnetic Stimulation of the Cervical Spinal Cord

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Why Non-invasive stimulation?

Devices are more affordable
Do not involve surgical procedures

Modulates sensorimotor spinal functions
(Hubli et al., 2013; Niu et al., 2018)

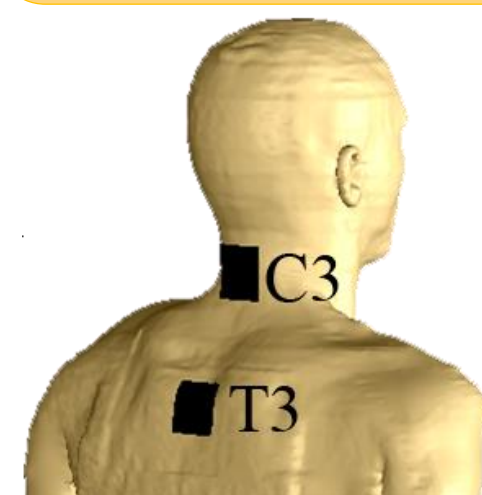
How?

\vec{E} calculation using Finite Element Analysis in MRI-based human models

Optimization of electric field at spinal target

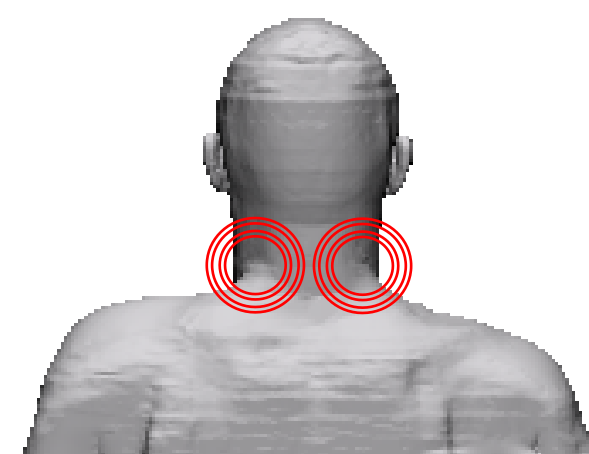
Electric field changes spinal neurons excitability

Transcutaneous Spinal Direct Current Stimulation - **tsDCS**

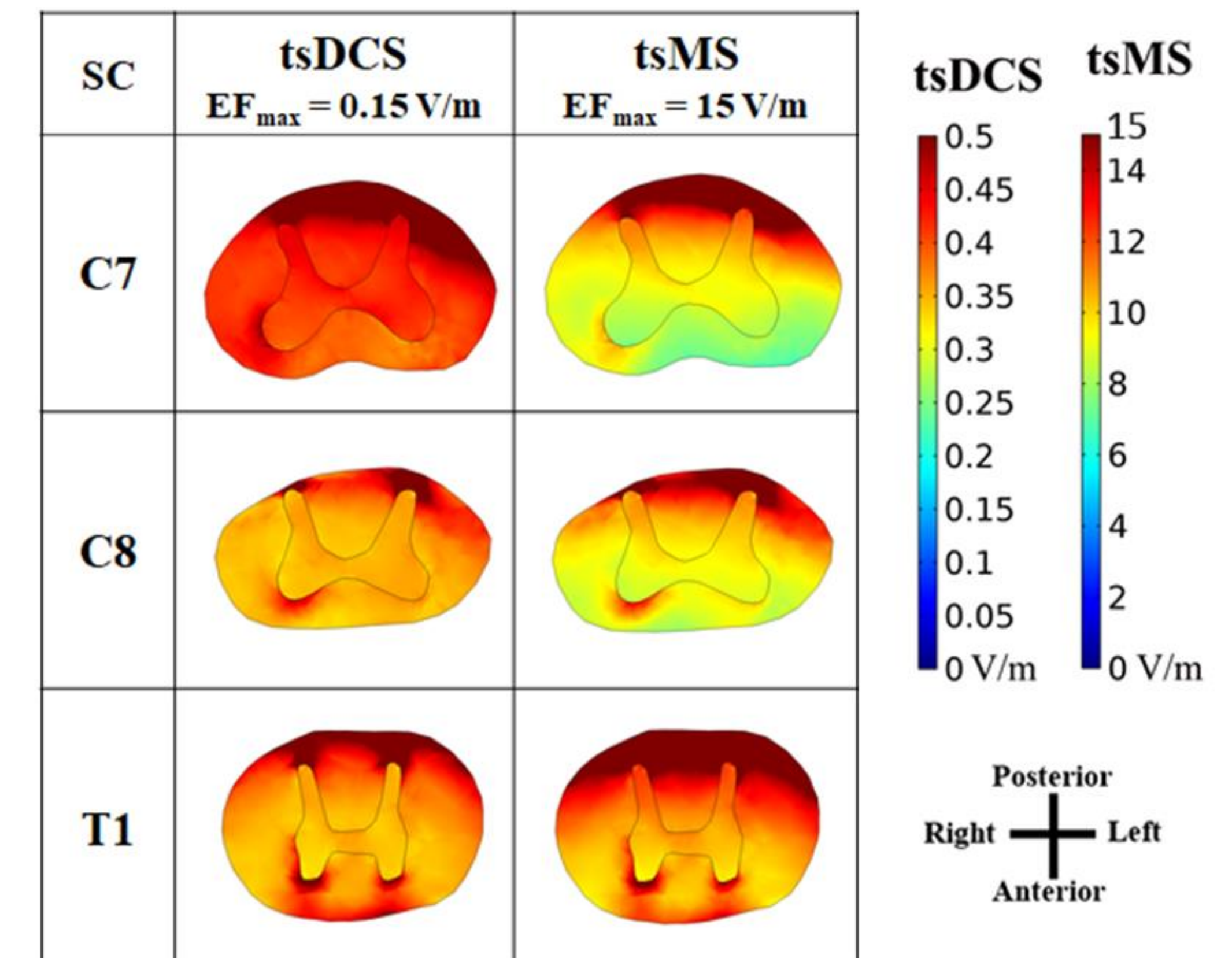
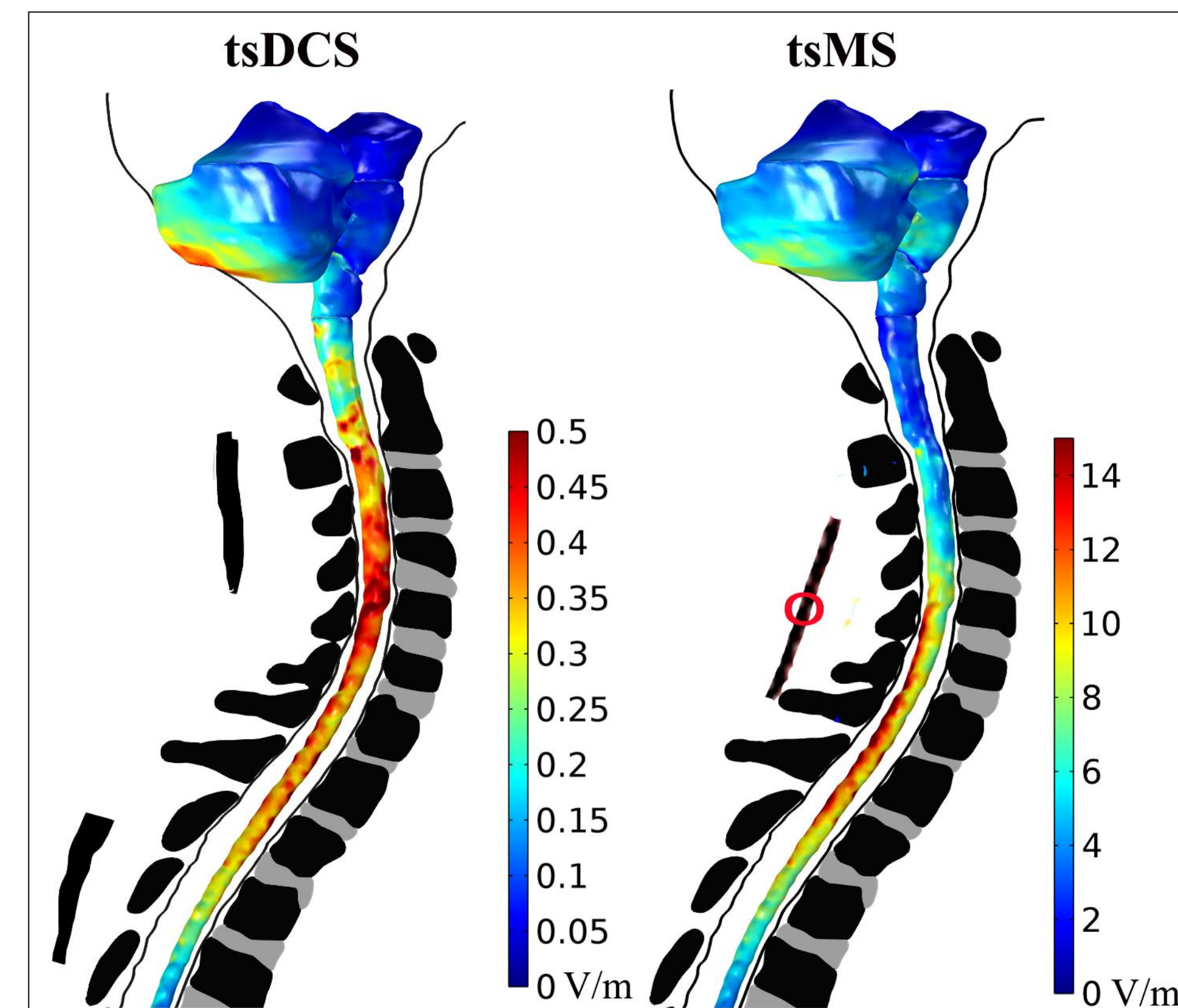


$I = 2.5 \text{ mA}$
DC stimulation

Transcutaneous Spinal Magnetic Stimulation - **tsMS**



Sinusoidal current $f = 3.5 \text{ kHz}$
61% maximum output
 $I_{\max} = 2.8 \text{ kA}; \frac{dI}{dt} = 61.54 \text{ A}/\mu\text{s}$



EF > 0.15 V/m at cervical SC:
→ neuromodulation of upper limb functions
EF ~ 30 times larger in tsMS:
→ effects may be more pronounced in tsMS

Same EF magnitude distribution features:
→ Influence of anatomical properties
Stepper decrease of EF with distance from coil:
→ Larger focality in tsMS

References

- Fernandes SR et al. Modelling Studies of Non-invasive Electric and Magnetic Stimulation of the Spinal Cord. In: Brain and Human Body Modeling 2020, Springer.
- Hubli M et al.. Modulation of spinal neuronal excitability by spinal direct currents and locomotion after spinal cord injury. Clin Neurophysiol 2013, 124(6):1187-1195.
- Niu et al. A Proof-of-Concept Study of Transcutaneous Magnetic Spinal Cord Stimulation for Neurogenic Bladder. Sci Rep 2018 8(1):12549.