Magnetic Stimulation of the Human Brain with Low-Intensity Field

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Project overview

- **Theory**
  - LFMS model
  - Head model

- **Stimulator**
  - Hardware
  - Software
  - Coil set

- **Trials**
  - HRV

→ Motivation: WHO reports, under-researched area
→ Novelty: hand-held device, new ways of modeling
First stage: materials and methods

Objective: model → technical specification

Underlying theory
1. E/M field
2. FE-analysis
3. Segmentation

Implementation
1. TMS in COMSOL
2. LFMS in COMSOL
3. Head in Simpleware
4. Validation in phantom
Transcranial magnetic stimulation

- Coils: circular, eight-shaped
- Sites: frontal and temporal lobes
- $I_{\text{peak}} = 5$–$10$ kA at $100$ $\mu$s
- $B_{\text{coil}} = 1$–$5$ T
- $E_{\text{head}} = 100$ V/m average
- $J_{\text{brain}} = \text{up to } 1$ A/m$^2$
TMS model

130μs: |J| in brain, A/m²

130μs: |J| in head, A/m²

Server farm, 9 Gb RAM, ~2m linear mesh, >2m DOFs, 8 hours
Low-field magnetic stimulation

- Several small coils
- Frontal and temporal lobes
- $I_{\text{peak}} = 1–10 \text{ A at 1 kHz}$
- $B_{\text{coil}} = 1–5 \text{ mT}$
- $E_{\text{head}} = 100 \text{ mV/m average}$
- $J_{\text{brain}} = \text{up to 1 mA/m}^2$
LFMS model

Induced current density, mA/m²

Server farm, 26 Gb RAM, ~50k quadratic mesh, ~400k DOFs, 19.5 hours
Head model

- MRI/CT
- PREPROCESSING
- SEGMENTATION
- EMBED COILS
- SURFACE/MESH

8x2.4GHz CPU, 15Gb RAM, 2mm³ voxel, ~7m linear mesh, >8m DOFs

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Stimulator prototype

The work of Daniel Laqua [7]
Conclusion

• **Literature review:** no models of LFMS, worth it

• **Obtained results:** TMS and LFMS models

• **Work in progress:** human head model

• **Contributions:** technical specification draft

• **Future plans:** inverse study and validation
Thank you for your attention!

Photo by Dominic Kamp
References


