Effect of Brain Tissue Segmentation Pipelines on Simulated tDCS Electrical Field Measures

Hanieh Ghaempanah[1,2], Guy Nagels[1,3], Miguel D'haeseleer[3,4], Jeroen Van Schependom[1,2]

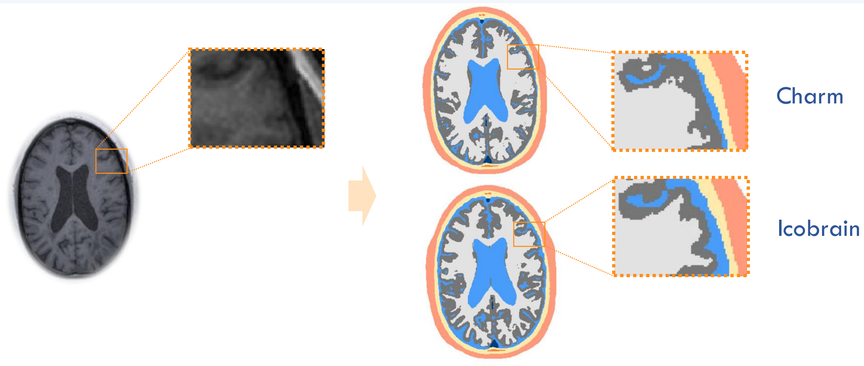
[1] AIMS lab, Vrije Universiteit Brussel, Belgium, [2] Department of Electronics and Informatics (ETRO), Vrije Universiteit Brussel, Belgium, [3] UZ Brussel, Department of Neurology, Brussels, Belgium,[4] National MS Center Melsbroek, Melsbroek, Belgium

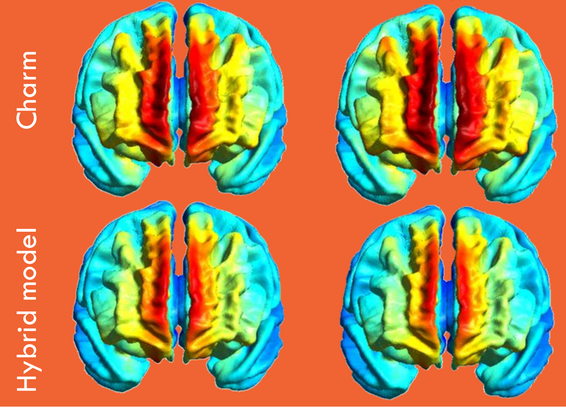
Background

- Individualized **tDCS simulations** rely on MRI-based head models.
- **Segmentation pipelines** may classify brain tissues differently, especially near tissue boundaries.
- Because these tissues have distinct conductivities, label differences can alter simulated **electric-field strength and focality**.
- This issue is particularly relevant in multiple sclerosis (**MS**), where lesions and atrophy can complicate **GM**, **WM**, and **CSF** classification.

Aim

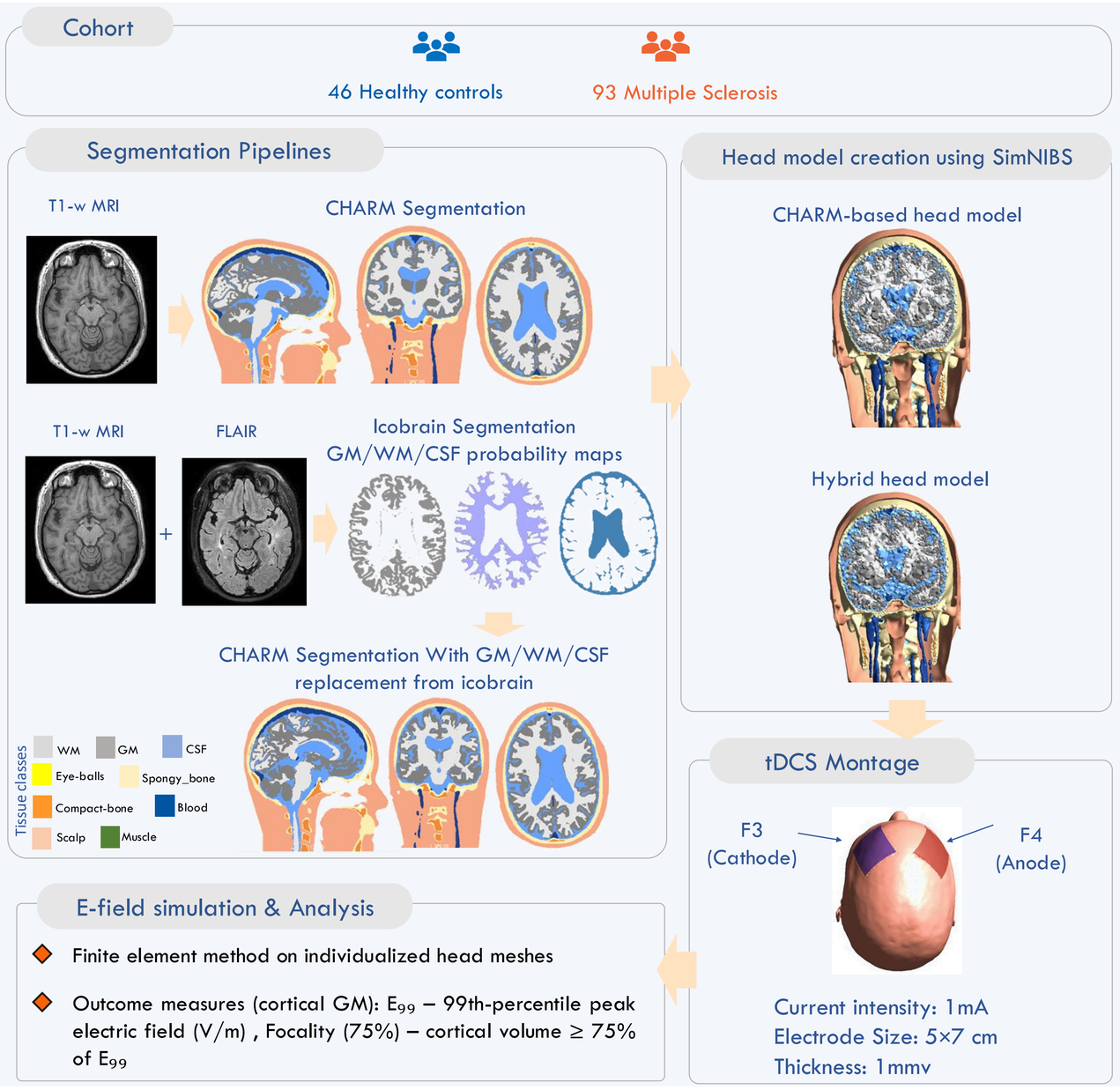
- To quantify how differences in intracranial **tissue segmentation** between a whole-head FEM-oriented pipeline (**charm**) and a clinical MS brain-volumetry pipeline (**icobrains**) propagate to simulated tDCS **E-field outcomes** in people with **MS** and **HC**.





Brain tissue segmentation differences can meaningfully change simulated tDCS E-field metrics, even when all other modelling steps are kept constant. The effect was strongest for focality and influenced the observed pattern of HC - MS differences.

Methods



Results

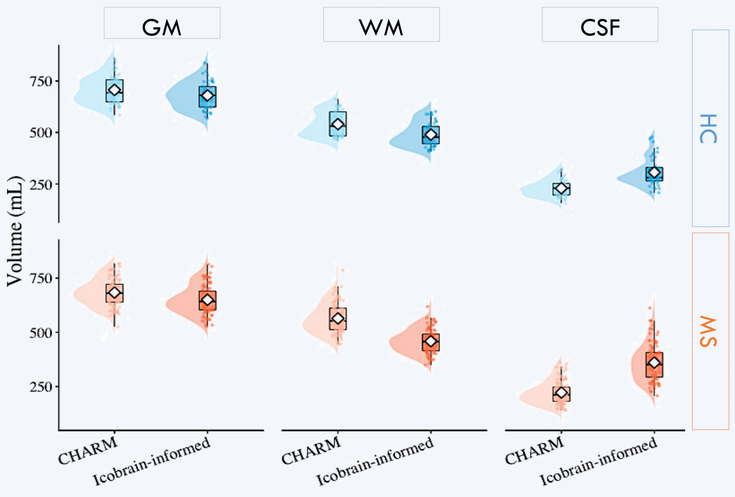
- Segmentation significantly influenced both E99 and focality-75, with stronger effects on focality.
- Two-way mixed-effects ANOVA result:

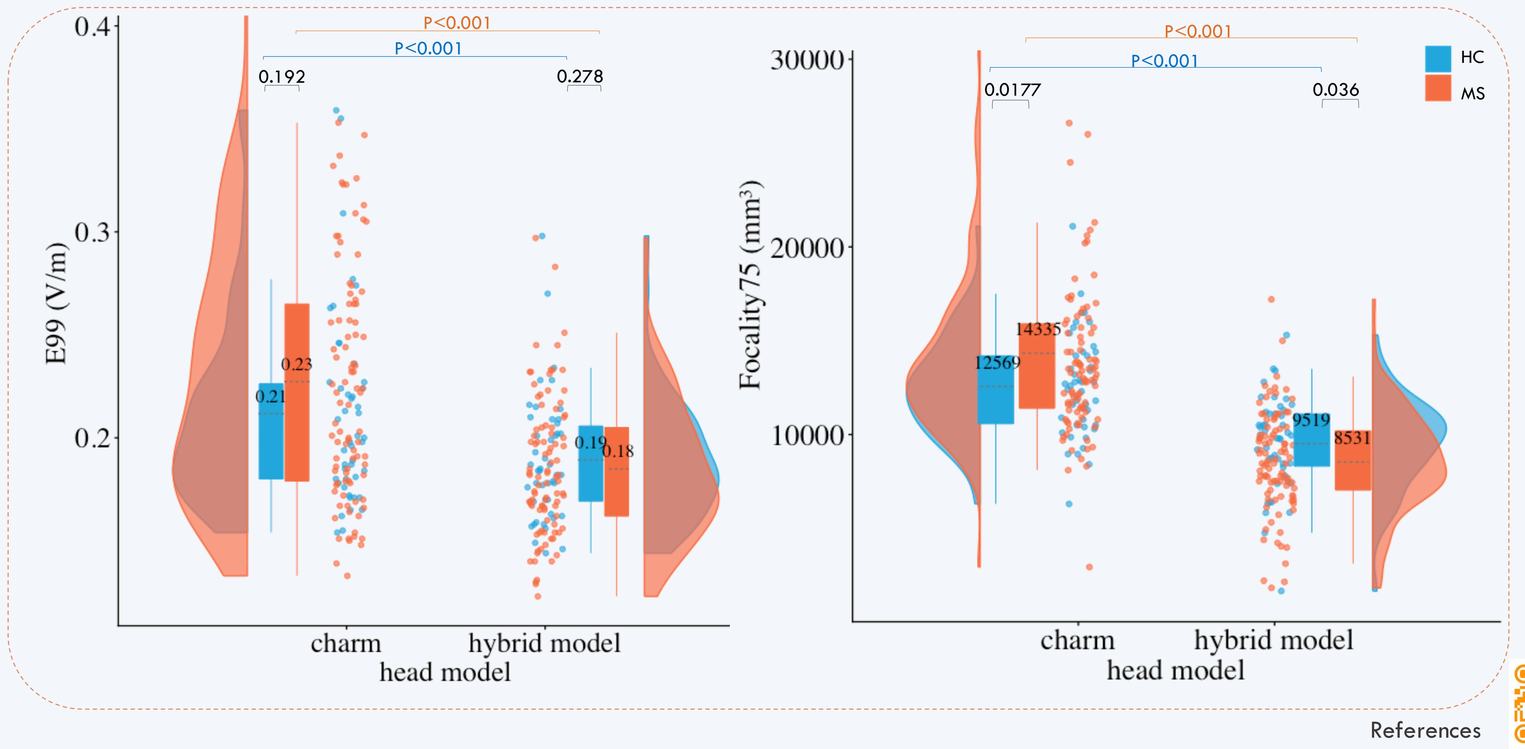
E99:

- Significant effect of Head model: $F(1,137) = 133.27$, $p < 0.001$, $\eta p^2 = 0.5$
- No main effect of Group: $F(1,137) = 0.55$, $p = 0.46$, $\eta p^2 = 0.004$
- Significant effect of Group × Model: $F(1,137) = 9.12$, $p = 0.003$, $\eta p^2 = 0.06$

Focality-75

- Significant effect of Head model : $F(1,137) = 137.32$, $p < 0.001$, $\eta p^2 = 0.5$
- No main effect of Group : $F(1,137) = 0.63$, $p = 0.43$, $\eta p^2 = 0.0046$
- Significant effect of Group × Mode: $F(1,137) = 9.64$, $p = 0.00232$, $\eta p^2 = 0.0657$





References

AI-SUPPORTED MODELLING IN CLINICAL SCIENCES RESEARCH GROUP

ETRO ELECTRONICS & INFORMATICS

Hanieh.Ghaempanah@vub.be