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# Peripheral nerve stimulation thresholds in human exposed to extremely low-frequency magnetic fields : a simulation study

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## 01 INTRODUCTION

▶ Extremely-Low Frequency Magnetic Fields (**ELF-MF**; <300 Hz) induce Electric fields in biological structures, which **can modulate neurophysiological signals**<sup>1-2</sup>.

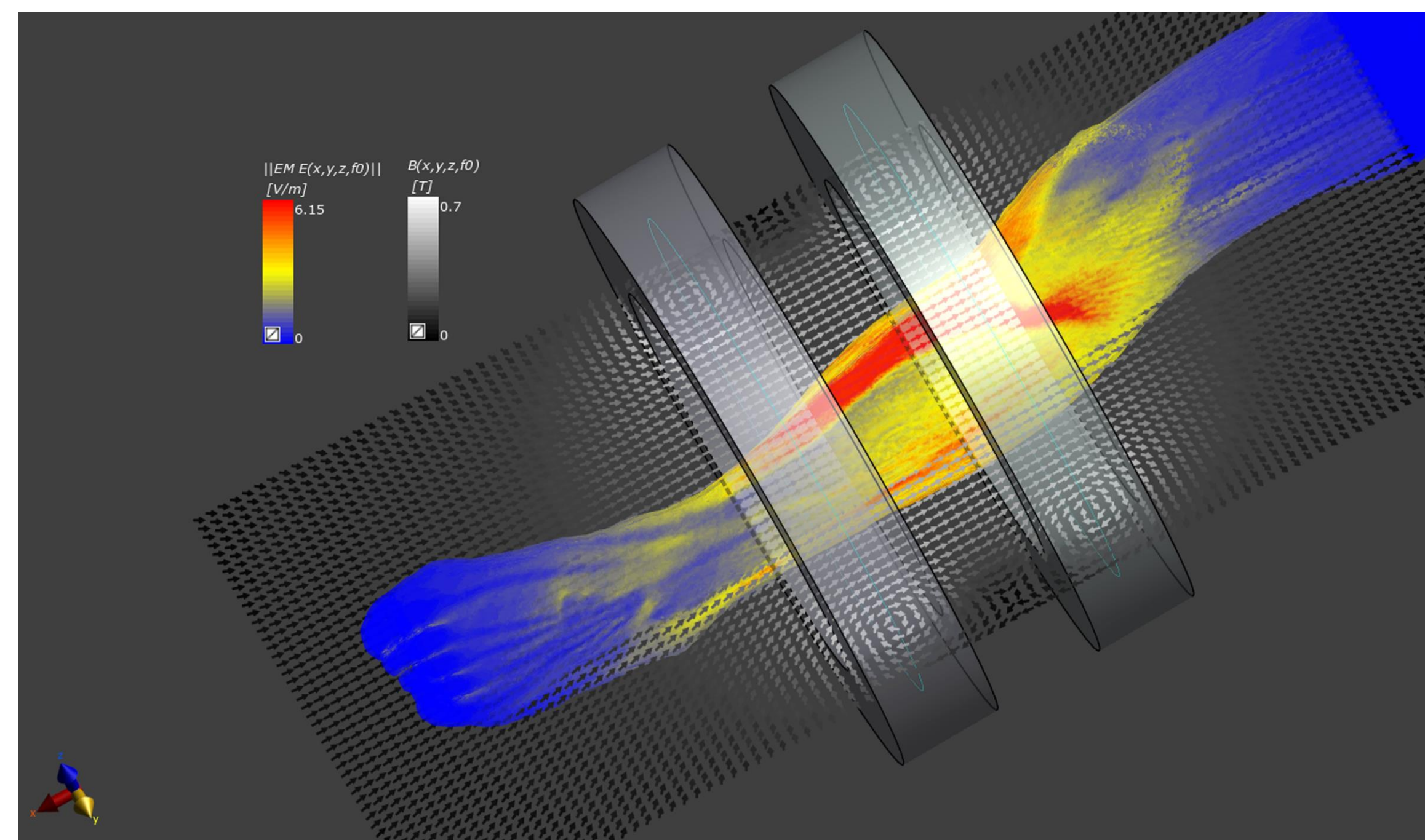
▶ International organisations (ICNIRP & IEEE-ICES) establish **guidelines and standards**<sup>3,4</sup> protection humans against potential adverse effects for both the central and peripheral nervous systems (CNS and PNS).

▶ But, PNS **thresholds estimations are still uncertain** (2.5 to 6.3 V/m<sub>PEAK</sub>)<sup>5-7</sup> and before new human studies are initiated, **dosimetry of a new exposure system is needed**.

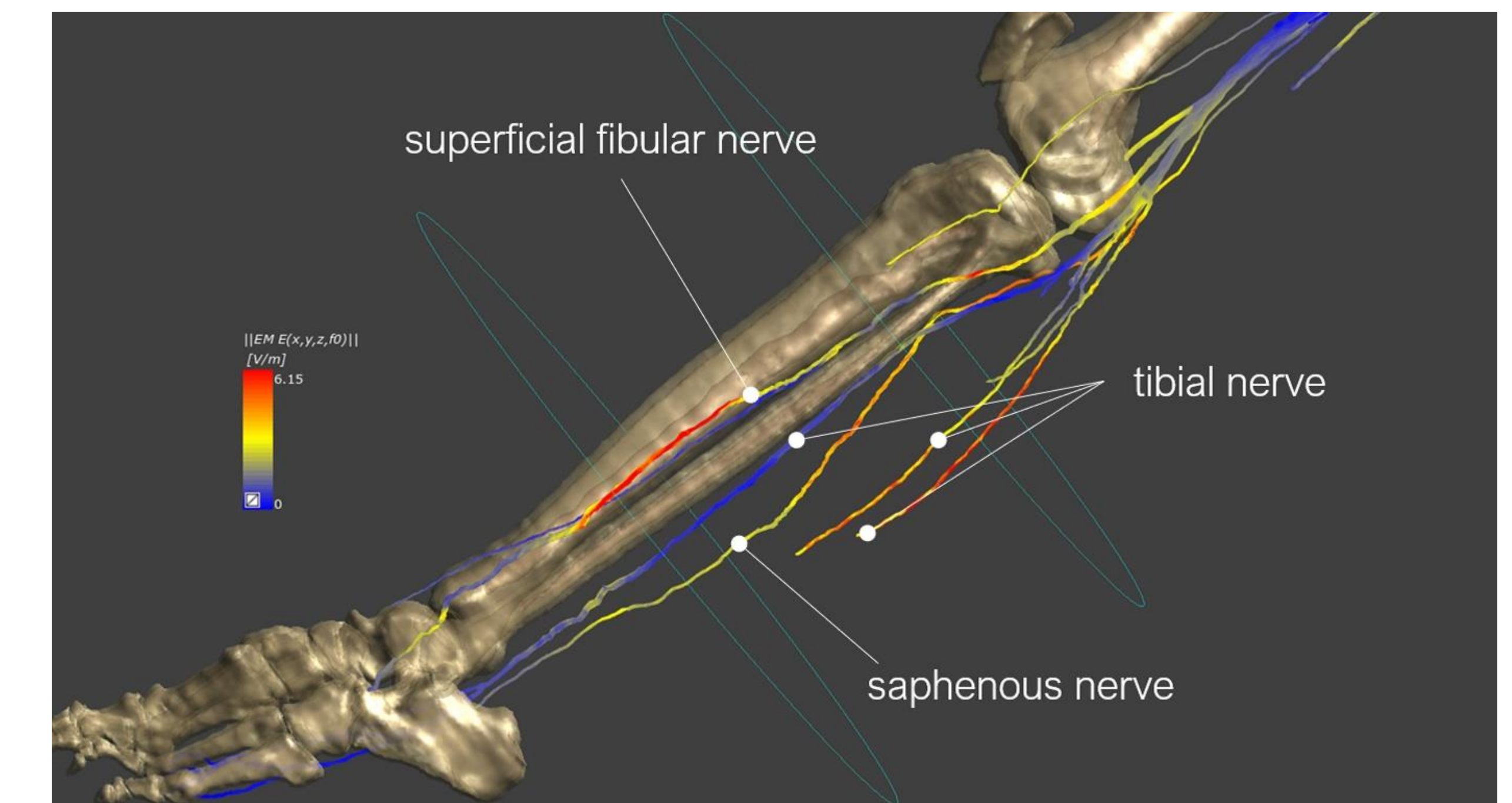
### PURPOSE

Elaborate a theoretical model allowing estimations of high PNS stimulations at power-line frequencies (60 Hz)

## 03 RESULTS



**Fig 2.** Representation of the leg stimulated by Helmholtz-like coils. The colors represent the level of induced E-fields in the leg, with red indicating an E-field equal to or greater than 6.15 V/m<sub>PEAK</sub> and blue equal to 0 V/m<sub>PEAK</sub>. The B-field is represented by arrows, the dark ones corresponding to 0 T and the lighter ones to 0.7 T.



**Fig 3.** Representation of the nerves' leg stimulated (lateral view). Colors represent the simulation of the induced E-field in the nerves with red indicating an E-field equal to or greater than 6.15 V/m<sub>PEAK</sub> and blue equal to 0 V/m<sub>PEAK</sub>

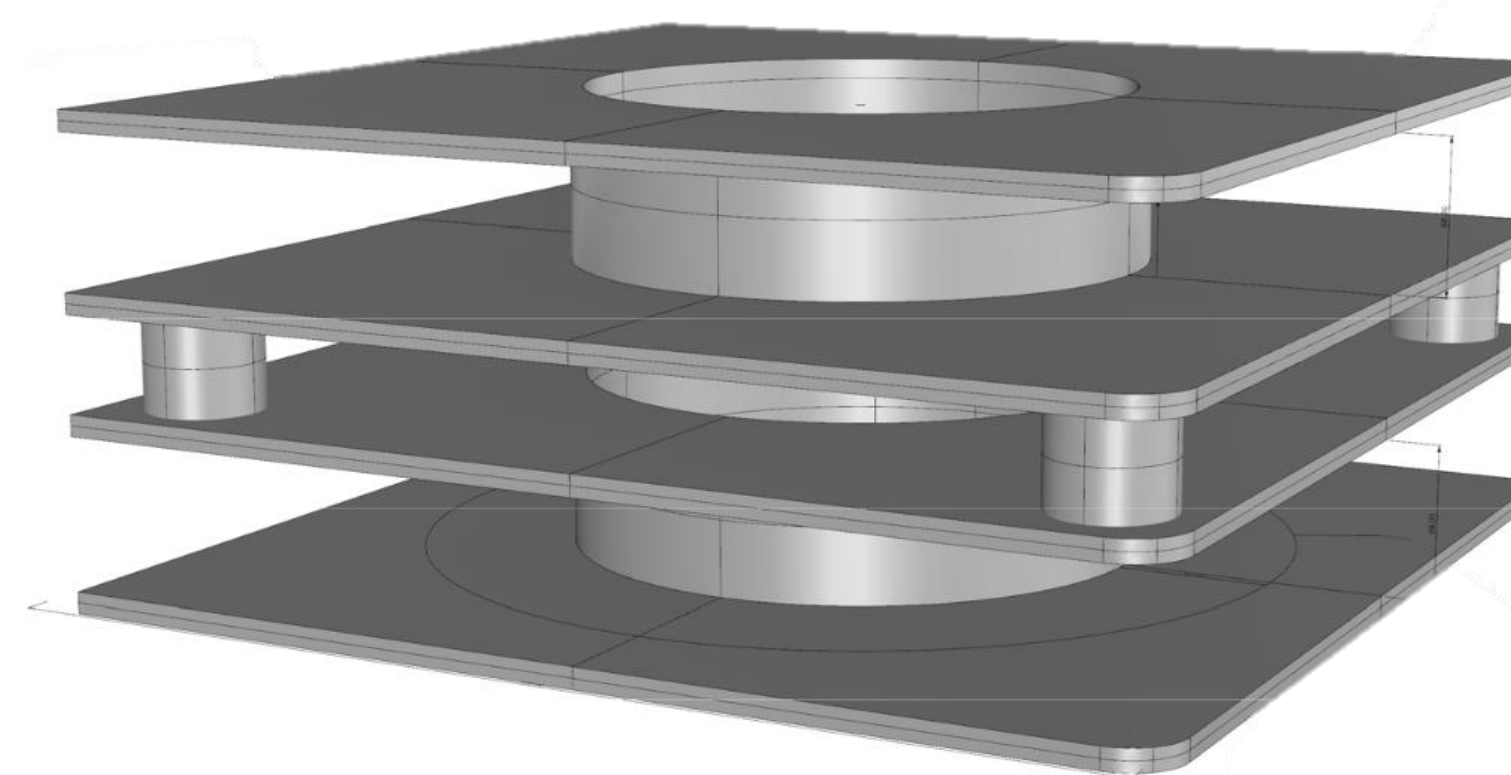
## 02 METHODS

### COILS

- ▶ Helmholtz-like coils : 400 turns of copper wire (Fig. 1)
- ▶ Max current available at 60 Hz = 180 A

### Model Simulation E-field

- ▶ Sim4Life Version 6.2 (ZurichMedTech AG, Zurich, Switzerland)
- ▶ Human anatomical model JEDUK (male, 33y, 1.62m, 64.5kg) from the Virtual Population family
- ▶ Simulation of E-field in the tissues and nerves of the calf (Fig. 2 and 3)



**Fig 1.** Coils model

## 04 CONCLUSION

The simulation model shows **3 sensitive nerves** stimulated at or above 6.15 V/m<sub>PEAK</sub> : it corresponds to the theoretical PNS threshold used to date by ICNIRP and IEEE-ICES<sup>4,5</sup>.

This is encouraging, and it is a strong argument in favour of moving forward with **real human data collection, aiming to establish an experimental perception threshold**.

In conclusion, this work further explores ELF-MF exposure levels capable of inducing acute perceptual PNS responses in humans, with the future experimental study it will contribute to the literature supporting ELF-MF **safety exposure guidelines and standards**.

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### Acknowledgements



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