Study of the effects of human exposure to 5G millimeter-wave electromagnetic fields: development of an exposure system

Vatovez, B.[1], Ledent, M.[2], Schettino, F.[3], D'Silva, C.[3], Spirito, M.[4], Bogdanova, A.[5]

1. Institut Scientifique de Service Public, Liège, Belgium
2. Risk and Health Impact Assessment, Sciensano, Brussels, Belgium
3. University of Cassino and Southern Lazio, Cassino, Italy
4. Delft University of Technology, Delft, Netherlands
5. University of Zurich, Zurich, Switzerland

Introduction

- The deployment of 5G mobile networks has raised some concerns among the population in relation to potential health risks and Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF), particularly in the FR2 mm-wave band (from 24.25 GHz to 71 GHz).
- In order to improve knowledge on these two topics, **an exposure system** is being developed in order to take part to two separate but complementary research projects:
  - **NextGEM** (https://www.nextgem.eu/), a EU-funded research project focusing on the mechanism of interaction of the RF EMF with the human body and tissues therein within the 5G frequency bands;
  - **5GINC**, an ongoing study aimed at developing a method for assessing the exposure levels generated by 5G antennas (via simulations and on-site measurements) and contributing to IEI-EMF study at the frequencies used by 5G.

One exposure system under controlled environment

- Exposure sessions and any collection of biological samples will take place in a dedicated room at ISSeP. The exposure room is designed to reduce environmental electromagnetic field levels (from both inside and outside the building) to below 0.1 V/m for RF EMF, and below 0.05 µT for magnetic field at 50 Hz.
- Temperature and humidity will be controlled so as to remain within standard levels: ≥ 18°C for very light work, ideally 20°C, and 30-70%, ideally ≤ 50%.
- The volunteer sits on a comfortable armchair. On both sides, their arms will lay on an armrest. Each box contains an antenna which may or may not be transmitting a 26-GHz 5G signal (i.e. located after a switch selected randomly from the instrument control).
- The modulated OFDM 5G signal at 26.5 GHz will be realized using a software defined radio (SDR) unit or employing a vector signal generator at an intermediate frequency (IF). The IF signal is moved to the FR2 band, employing a custom designed up-converter and filtered for out of band unwanted signals. The up-converted signal will be amplified using a linear amplification stage. A controllable switch will be placed to allow selection between the two transmitting antennas located just a few centimeters from the exposed area.
- The field strength is still under discussion but will remain below the regulatory limit values in Belgium. The exposure system will be tested for correct operation before each session.

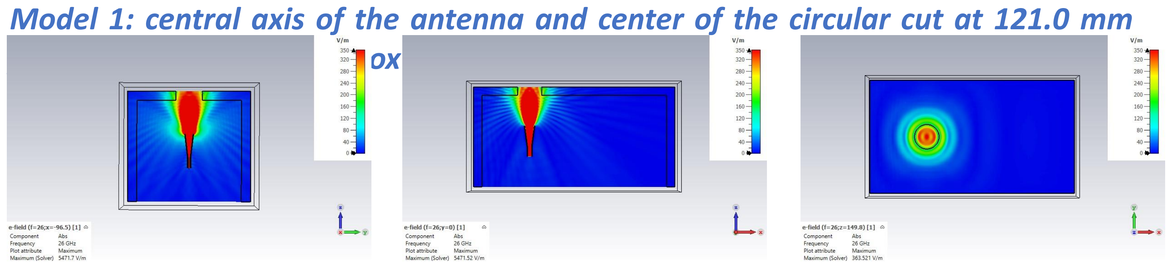
NextGEM: WP3 and WP4

- Studies possible **effects of 5G radiation on human red blood cells in the FR2 frequency band**, specifically at 26.5 GHz.
- Two double-blind exposure sessions.
- Exposure of the area close to the wrist of one arm, which has been chosen for its proximity of the blood vessels. Such a design allows multiple short-duration exposure of blood cells once a minute in average.
- 45-minute exposure per session with no interruption.
- Volunteers: 15 men and 15 women aged between 18 and 25.
- Blood samples will be taken by a qualified nurse and prepared on site. Part will be directly analyzed on-site, part in a nearby private lab (for complete blood count), and a part will be frozen and analyzed in our partners' premises (UZH) (travel time < period deemed critical for sample preservation).

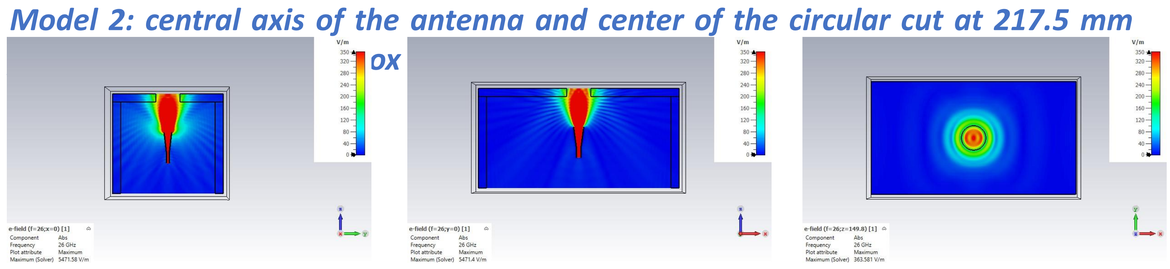
Dosimetry: preliminary simulation results

Results of simulation modelled in CST Microwave Studio based on PE9851B/2F-15 horn antenna from Pasternack (15 dBi, 26 GHz, P_{in} = .5 W) and comparison by horizontal position of the circular cut (ϕ = 52 mm) under the wrist area. The top aperture of the antenna is at 84 mm from the top surface of the box (far-field exposure). The coefficient of variation of S_{inc} is 51% at R=26mm and 29.5% at R=20.5mm, for both models.

Model 1: central axis of the antenna and center of the circular cut at 121.0 mm



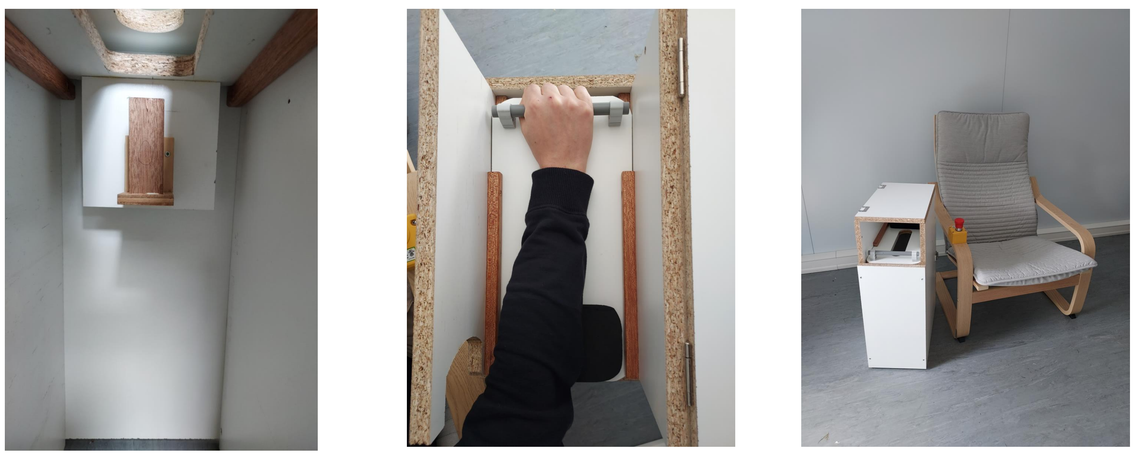
Model 2: central axis of the antenna and center of the circular cut at 217.5 mm



5GINC: WP4

- **A double-blind provocation study focusing on EHS people** reporting skin symptoms such as perception of heat, redness, tingling or itching, when exposed to 26-GHz EMF.
- One habituation session followed by two double-blind exposure sessions on the forearms, one real and one sham (one per week).
- Both forearms will be exposed. The field strength could be adjustable in order to take individual variability and needs into account.
- Two consecutive periods of exposure during each session: a first period of 4 minutes, followed by a second period of 30 minutes. These periods correspond respectively to the average duration of telephone calls (implying acute exposure) and a period considered long. A control button allows the volunteer to pause the exposure (real or sham).
- Volunteers: 10 EHS reporting skin symptoms when exposed, 10 EHS reporting no such symptoms and 20 non-EHS volunteers.
- Objective measurements: skin characterization measurements will be carried out following exposure such as electrodermal response, temperature and transepidermal water loss. Mutations in a gene known to cause sensitivity to environmental agents will be analyzed from a sample of cells taken from the inside of the cheek (buccal swab).

From right to left : overall view of the exposure setting prototype, the horizontal movable armrest and the position of the horn antenna



Conclusions & perspectives

→ Simulations show that the coefficient of variation of incident power density decreases from 51% at R=26mm (aperture) to 29.5% at R=20.5mm.
→ Ongoing characterization of the box material under 26-GHz EMF radiation in order to verify the relevance of adding an absorbing inner layer.
→ Dosimetry results will be scaled according to actual input power.

BioEM

BioEM 2024 CRETE GREECE

NextGEM
Funded by the European Union
5GINC funded by ISSeP Institut scientifique de service public

065A