PhD Offer - Deterministic and stochastic exposure assessment of children and pregnant women at emerging 5G frequencies (CHILD_5G)

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Key words: dosimetry, millimeter-wave (mmWave), ageing, deterministic and stochastic analysis.

Context: With the upcoming massive deployment of 5G, new frequency bands have been introduced for wireless networking. According to the International Telecommunication Union (ITU), the mobile data traffic is expected to reach 5 zettabyte/month by 2030 and the number of devices connected to internet will exceed 75.4 billion by 2025. 5G exploits a large spectrum, ranging from frequencies below 1 GHz and the mid-band range (up to 6 GHz) to millimeter-wave (mmWave) frequencies. The adoption of the mmWave frequencies for mobile communications is a point of discontinuity with respect to legacy 2G/3G/4G generations. This results in the need to assess and analyse the exposure of the users to 5G technologies, particularly for potentially more sensible subjects, like children and pregnant women.

Objective of the PhD project: This project will contribute to improvement of the existing knowledge regarding the exposure of the whole population to one or multiple electromagnetic (EM) sources operating in the 5G bands positioned in the near- or far- field with respect to the user. This will include the study of the power absorption and resulting heat rise as a function of age as well as during pregnancy. The main objective of the project is to develop deterministic and stochastic computational methods, to cope with the high complexity and variability of the exposure scenarios, including thermal analysis. EM and thermal analysis will be performed on human models of increasing complexity accounting for the interindividual variability (skin thickness, humidity, physiological condition, etc.), the age dependence of the EM and thermal properties, and anatomy. This multifaced approach will allow providing accurate children and pregnant women exposure assessment considering both realistic and representative 5G exposures scenario and use cases. This project will be carried out at Institut dElectronique et des Technologies du numéRique (IETR), Centre National de la Recherche Scientifique (CNRS) (France) in collaboration with the Institute of Electronic, Information Engineering and Telecommunications of the National Research Council of Italy (IEIIT CNR) (Italy).

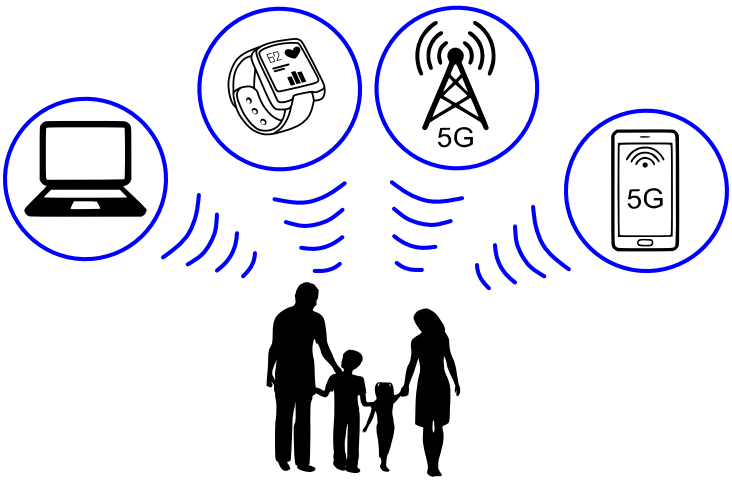

Figure 1: Example of sources of exposure in 5G scenarios.

Candidate

- Education: MS or equivalent degree in biomedical engineering, electrical engineering, or physics.
- Background: knowledge in antenna design, electronics, bioelectromagnetics, numerical modelling. Experience with commercial or open-source numerical solvers (e.g., CST, Ansys, SIM4LIFE, COMSOL Multiphysics) and programming skills (e.g., MATLAB, Mathematica) are welcome but not mandatory.
- Fluency in English: the candidate should be conversant and articulate in English and must have strong writing skills. Knowledge of French is not required but would be appreciated.

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Research environment: The PhD student will join Electromagnetic Waves in Complex Media Team (eWAVES) of the IETR/CNRS. IETR is one of the leading EU research laboratories in electronics, wireless communications, and digital technologies. Our research activities in biomedical electromagnetics cover a wide spectrum of fundamental and applied research spreading from multi-physics and multi-scale modelling to biomedical radars and advanced technologies for body-centric wireless communications. The team was at the origin of pioneering innovations in biomedical electromagnetics, including the first mmWave tissue-equivalent phantoms, novel reflectivity-based surface phantom concept, new broadband multi-physics characterization technique for Debye-type materials, innovative mmWave textile antennas for smart clothing, ultra-robust miniature implantable UHF antennas, first mmWave reverberation chamber.

Duration: 36 months

Funding: Full 3 years scholarship provided.

Application deadline: May 15, 2024

Starting date: flexible (from October 2024 till December 2024)

How to apply: please provide your CV, transcripts, motivation letter, and reference letters (optional) to:

- Giulia SACCO, CNRS (giulia.sacco@cnrs.fr)
- Maxim ZHADOBOV, CNRS (maxim.zhadobov@univ-rennes.fr)

References:

[1] G. Sacco, D. Nikolayev, R. Sauleau, and M. Zhadobov, "Antenna/human body coupling in 5G millimeter-wave bands: Do age and clothing matter?" *IEEE Journal of Microwaves*, vol. 1, no. 2, pp. 593–600, Apr. 2021.

[2] G. Sacco, S. Pisa, and M. Zhadobov, "Age-dependence of electromagnetic power and heat deposition in near-surface tissues in emerging 5G bands," *Scientific Reports*, vol. 11, no. 1, p. 3983, Feb. 2021, ISSN: 2045-2322.

[3] G. Sacco, S. Pisa, and M. Zhadobov, "Impact of textile on electromagnetic power and heating in near-surface tissues at 26 GHz and 60 GHz," *IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology*, vol. 5, no. 3, pp. 262–268, Dec. 2020, ISSN: 2469-7249, 2469-7257.

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