

PhD Project in BioElectroMagnetics at University of Bordeaux 36 months starting autumn 2018

RF signals and electrical activity of neuronal networks: characterization of the underlying mechanisms

Research Unit	<i>Bioelectronics group, IMS Laboratory, CNRS UMR 5218, University of Bordeaux, Bat. A31, 351 cours de la Libération, 33405 Talence Cedex, France</i>
Supervisors	<i>N. Lewis (Pr, Electronics) - I. Lagroye (DE, Cellular biology)</i> Contacts: noelle.lewis@ims-bordeaux.fr , isabelle.lagroye@ims-bordeaux.fr
Collaborations	<i>Mnemosyne INRIA project team, Andre Garenne (As. Pr, Neuroscience)</i> <i>XLIM Laboratory, University of Limoges, P. Lévêque (DR, Physics)</i>

Scientific context



The rapid development of wireless communications has raised questions about potential health risks. Up to now, the only identified biological effects of radiofrequency (RF) fields are caused by heating and the threshold of this thermal effect is never reached by exposure to mobile phones and their networks (regulatory limitation of the Specific Absorption Rate or SAR). Today the research is oriented towards the exploration of potential nonthermal biological effects, at low levels of SAR, and especially on the central nervous system (CNS), given the proximity between the mobile phone and the brain, and the excitability of neurons. In this context, several human electroencephalography (EEG) studies have reported variations in the EEG power spectrum during or after RF exposure, suggesting that RF exposure may directly influence brain dynamics. However, the mechanisms underlying these effects on the EEG are still unknown.

Experimental approach Preliminary results

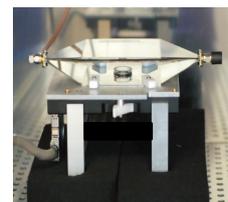
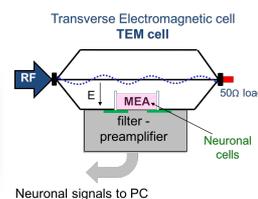
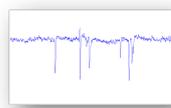
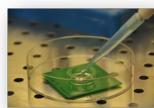


Figure 1

Figure 2

Figure 3

Thanks to a multidisciplinary collaboration mixing Electronics, Physics, Cellular Biology and Neuroscience, we developed a unique experimental bench allowing to acquire the electrical activity of neuronal cells exposed *in vitro* to RF signals. Cultures of cortical neurons are grown on multi-electrode arrays (MEAs) (Fig.1) and after a few weeks *in vitro* they spontaneously emit spikes (Fig.2) and bursts of spikes. These cultures are then exposed to RF fields by inserting the MEA in a specific exposure system, a Transverse ElectroMagnetic cell (Fig.3). The electrical activity of the neurons is pre-amplified and digitized in a PC for data processing. This processing utilizes classical detection algorithms and custom pre-filtering steps developed in Matlab. We have shown a clear decrease in firing and bursting rates of neuronal cultures exposed for 3-min to a GSM RF field at 1800 MHz [Moretti *et al.*, 2013]¹.

¹ Moretti D, Garenne A, Haro E, Poullietier de Gannes F, Lagroye I, Lévêque P, Veyret B, Lewis N. (2013) In-vitro exposure of neuronal networks to the GSM-1800 signal. Bioelectromagnetics 34: 571–578.

PhD project

We obtained a grant co-funded by ANSES², Region Nouvelle Aquitaine and Bordeaux University to further characterize the decrease of neuronal activity under RF exposure and to understand the interaction mechanism involved. The PhD student will contribute to these objectives by carrying out 3 types of exploration:

- (1) Characterization of the effect versus the nature, modulated or continuous, of the RF signal, at the GSM carrier frequency.
- (2) Comparison of the RF observed effect and reported effects of direct electrical stimulation.
- (3) Research of an eventual effect in other frequency bands of interest.

Exploration (1) will use the current experimental bench, the challenge being to implement an adequate filter stage in the post-processing Matlab software, able to eliminate an artifact generated at the level of recording electrodes. Exploration (2) will require to develop a new part of the bench, thanks to a stimulator already designed in the group³. Exploration (3) will require to adapt the exposure system and characterize it in terms of dosimetry (electromagnetic propagation and temperature elevation), in collaboration with XLIM group.

These explorations will contribute to understand the mechanism involved in the interaction between RF and neuronal cells and also investigate the role of RF exposure in therapeutic applications where direct stimulation through surface or implanted electrodes are used.

Candidate profile

We are looking for a candidate graduated in Electronics, Electrical Engineering, Applied Physics or Neurosciences, interested in biomedical applications, with minimal knowledge and practice in Matlab for signal processing. Knowledge in electromagnetics and RF signals will be appreciated. Knowledge and practice in primary cell culture will be part of the doctoral teaching.

² Agence Nationale de Sécurité Sanitaire Alimentation Environnement Travail

³ Castelli, J., Kölbl, F., Siu, R., N'Kaoua, G., Bornat, Y., Mangalore, A., Hillen, B., Abbas, J.J., Renaud, S., Jung, R. and Lewis, N., An IC-based controllable stimulator for respiratory muscle stimulation investigations, IEEE International Conference In Engineering in Medicine and Biology Society (EMBC), 2017.