CHAMPS ÉLECTROMAGNÉTIQUES :
DE LA DOSIMÉTRIE À LA SANTÉ HUMAINE

# Le projet ERNAM : exposition de réseaux de neurones à des signaux GSM-1800

# The ERNAM project: exposure of neuronal networks to the GSM-1800 signal

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## Introduction

During the last years, several articles have been published on the effects of the radiofrequency fields (RF) of mobile telephony on sleep and EEG. These studies showed effects of GSM signals on the intensity of the alpha band of the EEG [1].
The ERNAM project lies within the scope of the 2010 RF research agenda of WHO. It will contribute to the understanding of the phenomena evoked by the use of a well-characterized exposure system on neuronal networks.
In the ERNAM project we developed a new RF exposure system (TEM cell, GSM-1800 signal) in which neuronal networks (from the cortex of rat embryos) are cultured in MEAs (multiple electrode arrays). The neurons are exposed on top of electrodes which allow the acquisition of the spontaneous extracellular electrical activity of the neurons under RF exposure.

## Material and methods

The culture protocol was optimized and the quality of the neuronal networks obtained was excellent in terms of growth and electrical activity of the neurons. The embryos are taken from anaesthetized Sprague Dawley rats at the 18th day of gestation. A suspension of cells is obtained by dissection followed by enzymatic and mechanical dissociation of the cortex; $10^6$ cellules/ml are placed on the MEA (micro-electrode arrays, Figure 1) coated with coated with PEI and laminin or Poly-D-Lysine and laminin. The networks cultured in the MEAs are then placed in an incubator (100% humidity, 5% $CO_2$ at 37°C) awaiting exposure. Medium renewal is performed twice a week. In the MEA, the neurons are in contact with sixty electrodes (Fig.1). Ad-hoc MEAs are manufactured by the Qwane Biosciences company.

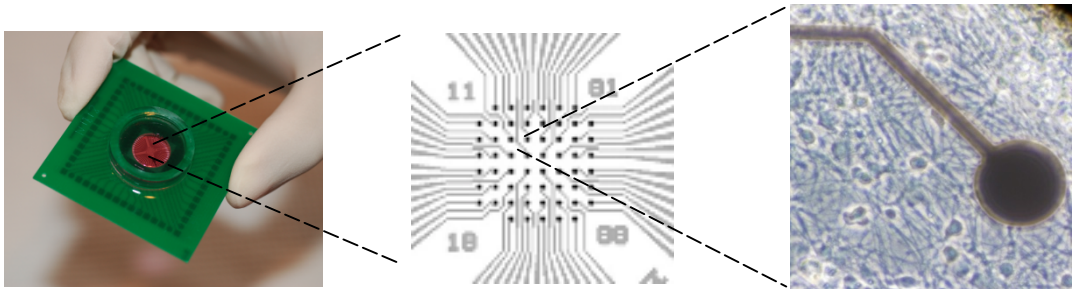


*Figure 1: from left to right: MEA; a zoom of the recording area with 60 electrodes (electrode diameter: 40 µm, electrode spacing centre to centre: 200 µm); neurons in culture at 10 DIV (days in vitro) around an electrode.*

## Exposure system

A real-time acquisition device was developed in the gigahertz range to expose the neuronal networks. A preliminary project had been launched by the group of Gimsa in Rostock, Germany, but was discontinued [2]. The MEAs are placed inside a TEM cell (transverse electromagnetic) in which the GSM-1800 signal is propagating (Figure 2). A dosimetric modelling of this exposure system was carried out in collaboration with the team of P. Lévêque in Limoges (Xlim Laboratory) and was published [3]. A rise in temperature of 0.3°C for an input power of 1 W was calculated and measured which corresponds to a DAS of 3.5 W/kg. The GSM modulation was selected as it makes it possible to detect the neuronal activity during the 7 empty timeslots out of 8, in case exposure induces interferences in the detection of the neuronal signals.

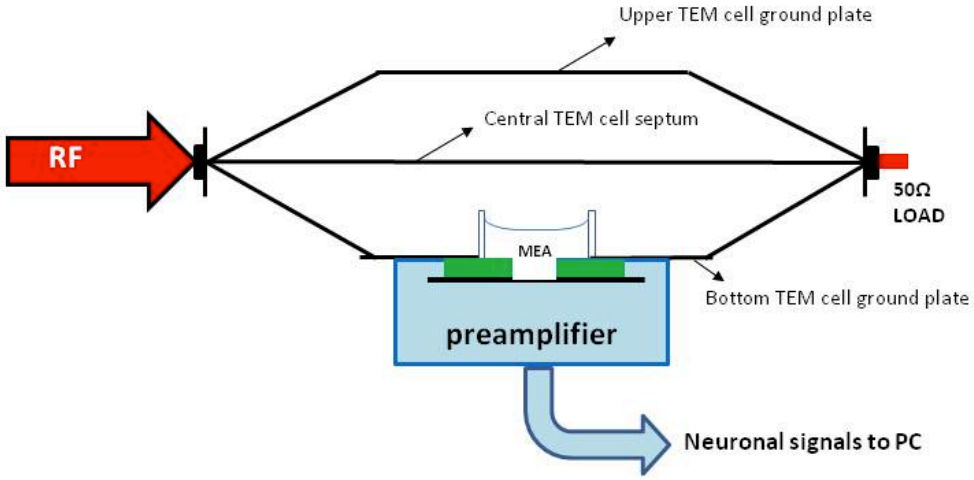


*Figure 2: Exposure system. TEM cell with MEA inside.*

## Signal processing

The neuronal cells will be exposed from the 3rd week of culture, at the onset of action potentials. The neuronal electric activity will be recorded during 3 minutes, before, during, and after the 3 minute exposure. Sham exposures will also be carried out. The signal processing of the neuronal action potentials (spikes) will allow the assessment of potential effects of GSM-1800 exposure, as a function of SAR. It will comprise an analysis of the spikes rate, spike-sorting, and burst rate.

Spikes are detected when the signal exceeds a 5:1 signal-to-noise ratio. The noise is estimated, respectively for each electrode, as the standard deviation calculated in a time interval of 500 ms that does not present an electrical activity. The first step is to compare the spontaneous spikes frequency before and after the exposure.

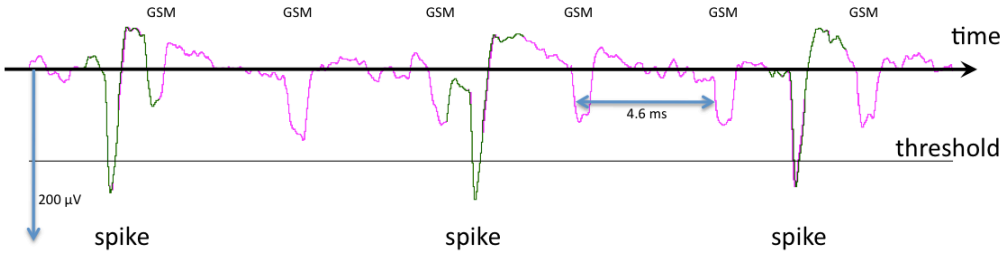


*Fig. 3. Example of neuronal electric activity recorded during GSM signal exposure. The age culture was 40 DIV.*

Results of the analysis will be presented at the meeting.

Later studies will address (i) the influence of RF signal modulation by using both GSM continuous signals (CW) at 1800 MHz, (ii) possible effects of RF exposure on the plasticity of the neurons, by using a stimulation within a closed-loop real-time system and (iii) the effect of the GSM-1800 signal as a function of the age of the culture and of the duration exposure.

## References

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