Magnetophosphenes and associated brain activation: a study protocol in humans exposed to up to 50 milliTesla 50/60 Hz magnetic fields.

[1,2]Alexandre Legros, [1,2]Julien Modolo, [3]Daniel Goulet, [3]Michel Plante, [4]Martine Souques, [5]François Deschamps, [1,2]Frank Prato, [4]Jacques Lambrozo, [1,2]Alex W Thomas

[1]Bioelecrtromagnetics Group, Lawson Health Research Institute, London, ON, Canada, [2]Department of Medical Biophysics, University of Western Ontario, London, ON, Canada, [3]Hydro-Québec, Montréal, QC, Canada, [4]Service des Études Médicales, EDF, Paris, France. [5]Réseaux de Transport d'Électricité, Paris, France.
*Corresponding author e-mail: alegros@lawsonimaging.ca

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ICNIRP guidelines regarding low frequency (LF) electric and magnetic fields (EF and MF) are mainly based on the best estimate of an acute biological effect in humans, i.e. magnetophosphenes: "ICNIRP now considers the effect on the retina as a model of effects in the brain and the phosphene threshold provides a basis for limiting exposure" [1].

The estimated threshold for magnetophosphene perception in humans is associated with exposure levels above 5 mT at frequencies in the order of 20 Hz [1, 3-6]. However, these levels at 20 Hz are still not clearly established, the methods used thirty years ago do not seem entirely described, which makes these studies "difficult to evaluate" [7]. Moreover, the threshold for magnetophosphene perception at 50 and 60 Hz is extrapolated from values reported at 20 Hz: "the guidelines are based upon very limited data and assumptions regarding phosphenes" [8]. There is thus a need to clearly establish the threshold for magnetophosphene perception in humans at 50 and 60 Hz experimentally.

Since 2005, our group from has studied the effects of 60 Hz MFs in humans at levels reaching 1.8 mT (2005-2007), then 3 mT (2008-2010) [9-11]. We are now initiating a new research project with the primary objective of establishing a MF threshold at which magnetophosphenes are systematically perceived in humans. With this project, we are willing to experimentally address the question of the magnetophosphene detection threshold in humans exposed to MF levels between 0 and 50 mT at 50 and 60 Hz.

This project also aims to objectively characterize the neurophysiological responses associated with magnetophosphene perception: we are analyzing brain electrical (using electroencephalography – EEG) and metabolic (using functional Magnetic Resonance Imaging - fMRI) activity in two distinct experiments testing for magnetophosphene perception. Experimental results will be completed with mathematical modeling [12]. Computational neuroscience uses mathematical equations to predict neuronal electrical activity, both from single neurons and

neuronal networks, when exposed to a magnetic or electric stimuli [13]. This approach offers another perspective on the potential mechanisms involved.

Here, we are proposing to summarize our results at 1.8 and 3 mT and to report on the protocol of our new project in humans aiming to overcome a limit explicitly mentioned in the ICNIRP guidelines, i.e. the need to support, with experimental data collected in humans, the current reference values.

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