

# **PRECIS TO FINAL REPORT: A FERROMAGNETIC TRANSDUCTION MECHANISM FOR RADIO FREQUENCY BIOEFFECTS - *H.G. Wieser and Jon Dobson***

## **1. Research activities performed, milestones and deliverables accomplished**

Work began on the project in September, 2000. The following milestones were achieved:

- Culture of magnetotactic bacteria from bacterial stock
- Testing and calibration of the BacLight fluorescence assay for bacterial viability
- Evaluation of video capture microscopy system for motility assays
- Attachment of magnetic microparticles to astrocyte cell lines
- Design and construction of a coil system for pulsed field exposure (i.e. simulation of battery current bursts)
- Design and construction of a cell phone holder for preliminary experimental analysis
- Experimental analysis of bioeffects on magnetotactic bacteria mortality due to exposure from standard mobile phones [1,2,3].
- Installation, calibration and testing of the REFLEX RF exposure system.
- Culturing of control (non-magnetic) CC-26 bacteria.
- Experimental analysis of bioeffects on magnetotactic bacteria mortality due to GSM-type radiofrequency (RF only) exposure [3,4].
- Experimental analysis of bioeffects on magnetite-loaded astrocyte mortality due to GSM-type radiofrequency (RF only) exposure.
- Final coding and compilation of LabView drivers for the coil system to simulate low frequency magnetic field components from mobile phones.
- Presented results at the 2<sup>nd</sup> International Workshop on Biological Effects of EMFs, Rhodes, Greece. October, 2002.

## **2. Findings**

The findings can be divided into two groups, reflecting the different nature of the two experimental systems. In the experiments on magnetotactic bacteria mortality using standard mobile phones transmitting in both talk and DTX mode, there was some evidence of increased mortality in the exposed groups [1,3]. Though the statistical significance of the individual experiments varied, when all experimental data were pooled, the results were significant ( $p=0.037$  – ANOVA).

Experiments on bacteria mortality using the REFLEX system were not consistent. There was some significant evidence of increased mortality in individual experiments, however, there were also individual experiments in which mortality in the sham group was significantly higher. None of the control experiments using a similar, non-magnetic bacterial strain (CC-26) showed any significant effect on either the exposed or the sham groups. When all data on *M. magnetotacticum* were pooled and examined, no consistent and significant effects were seen. REFLEX analysis of the magnetite-loaded astrocytes also showed no significant trend.

These results seem to indicate that if the effect seen in the mobile phone experiments is verified, it is likely the result of low frequency magnetic field components of the mobile phone signal. These include battery current pulses associated with discontinuous transmission (DTX – 2 Hz) and the frame structure of Time Division Multiple Access (TDMA – 8 Hz).

### **Publications:**

1. Cranfield, CG, HG Wieser, JM Al Madan and J Dobson (2003) Evaluation of ferromagnetic transduction mechanisms for mobile phone bioeffects. *IEEE Transactions on NanoBioscience* In Press.
2. Al Madan, J (2002) Experimental examination of ferromagnetic transduction models and design of a magnetic coil system for cell phone bioeffects. *M.Sc. Thesis (Biomedical Engineering), Keele University*, 102 pp.
3. Dobson, J, C Cranfield, J Al Maddan, HG Wieser (2003) Cell mortality in magnetite-producing bacteria exposed to GSM radiation. *Proceedings of the 15<sup>th</sup> International Symposium on Electromagnetic Compatibility*, Zurich, Switzerland. In Press.
4. Cranfield, C, HG Wieser, J Dobson (2003) Exposure of magnetic bacteria to simulated mobile phone-type RF radiation has no impact on mortality. *IEEE Transactions on NanoBioscience* In Preparation.