# A Comparative Study of the Physical Effects of Third Generation Cellular Phone Radiation on Organic Tissues

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## Abstract

*In this work, it is shown that the microwave radiation emitted from third generation cellular phones causes clearly detectable physical changes on muscle and nerve tissues. The changes, caused by a warming effect, are shown to be larger than those measured previously, and relatively independent of many paramaters related to the transmission of radio signal. The results show that in addition to nerve tissues, cell phones are, in general, deterious to muscles. Although the results are yet to be confirmed with clinical studies, it is probable that cellular phones are dangerous to a formerly unpredictable extent.*

## 1 Introduction

Electromagnetic radiation has been shown to cause various physical effects on organic tissues [4, 7, 8]. Although ethical issues prevent performing these experiments on human subjects, there is evidence indicating that human tissues could be affected as well [2].

Mobile phone and wireless local area networks (WLAN) are suspected to impact human beings in various ways. An analysis of the effects of electromagnetic and thermal radiation from modern cellular phones and WLAN antennas has been recently conducted by Yioultsis *et al.* [9]. Although no direct evidence was found in this or any other study, it has been hypothetized that cell phones can cause even cancer, not to mention several less severe symptoms [3, 5, 7, 6].

In this study it is shown that the thermal effects produced by third generation cellular phone radiation are significantly larger than those measured in previously, causing clearly detectable physical effects on organic tissues. These effects are proved to be practically independent on the physically measurable parameters of the radiation source.

## 2 Experiments

### 2.1 Instrumentation

The measurements were performed in an electrically and thermally insulated container. A Faraday cage was built in a VMKY calorimeter with special electrically conducting aluminium foil equalized with the electrical potential of the ground. Inside the calorimeter, the Hewlett Packard Official Nonionizing Electromagnetic Radiation Analyzer was used in measuring the electromagnetic flux originating from the radiation source placed inside the calorimeter. Furthermore, the calorimeter contained a probe of an external, absolutely calibrated digital thermometer. As radiation sources, different types of second and third generation cellular phones were utilized. The measurement system is shown in Fig. 2.

Table 1: Measurement parameters

| Parameter | $P_{\min}$ | Scale ($10^x$) | $P_s$ | Scale | Unit |
|---|---|---|---|---|---|
| Measurement interval | 0.0 | 0 | 5.0 | 3 | s |
| Spatial separation | 1.1 | -3 | 1.029 | 1 | m |
| Temperature | 2.6685 | 2 | 1.04 | 2 | K |
| Temporal separation | -3.60 | 3 | 7.20 | 3 | s |
| Tissue mass | 5.61 | -1 | 0.0 | 0 | kg |
| Transmission power | 3.0 | -4 | 8.0024 | 2 | W |

### 2.2 Measurement Method

In the beginning of the measurements, a sample of muscular tissue was placed in the calorimeter. At this time, the internal temperature of the tissue was measured to be 266.85 K. The temperature of the calorimeter was normalized with respect to the constants represented in Table 1. To reduce the possibility of systematic errors, measurements were performed in uniformly distributed pseudo-randomized intervals.

The radiation and type of the cellular phones tested were systematically varied as indicated by the radiation parameters listed in Table 1. The radiation levels were ensured not to exceed the limits imposed by the ANSI/IEEE electromagnetic radiation safety standard [1].

To make the measurements commensurate with previously reported data, a standardized normalization scheme was applied. Each measurable parameter was scaled as shown by Eq. 1:

$$P_n = \frac{P_m - P_{\min}}{P_{\max} - P_{\min}}, \tag{1}$$

where $P_m$ denotes the actual measurement, and $P_n$ the normalized value. $P_{\max}$ and $P_{\min}$ stand for the maximum and minimum value for a parameter, respectively. The denominator $P_{\max} - P_{\min}$ is later denoted with $P_s$ in Table 1 for brevity.

### 2.3 Close-Range Radiation Effects

In the first experiment, cellular phones where placed in a close proximity with the tissue sample. Since all other sources of variation were carefully eliminated with respect to the normalization constants, all physically measured short-term changes in the tissue were due to the electromagnetic radiation. The temperature change of the tissue was measured as a function of time. The temperature curve shown in Fig. 1 displays the actual non-normalized temperature values for visualization purposes. It can be quite easily seen that the change is significant. Due to the radical temperature change, anti-annealing effects in the tissue soon become apparent. In about two hours, the physical state of the cellular solutions in the tissue has been irreversibly changed. The magnitude of this effect is clearly larger than formerly thought.

### 2.4 Varying Radiation

To investigate the effects of changing electromagnetic fields, the parameters of radiation sources were subjected to a multitude of different transformations. The magnitude of radiation power was varied from the level of background radiation to a level slightly exceeding the limits imposed by safety standards. In addition, the spatial as well as the temporal separation of the tissue and the radiation source were varied within the range of [0,1], normal-

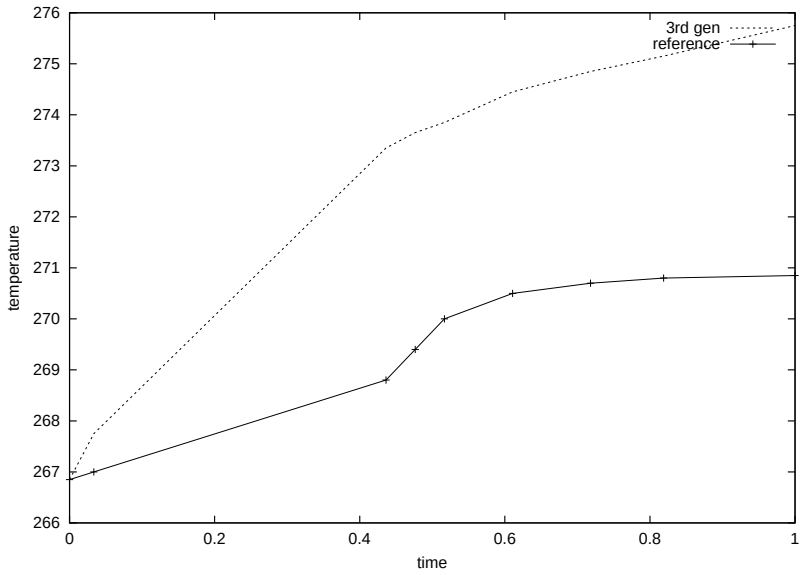


Figure 1: Temperature change over time

ized with respect to the measurement parameters. Also, reference results were obtained with second generation cellular phones.

It was noted that the derivative of the temperature curve measured from the muscular tissue was completely invariant with respect to frequency, magnitude and type of the conducted transformation. Moreover, it seems that third generation mobile phones cannot be expected to cause less severe damage than their second generation counterparts.

# 3 Conclusions

The results clearly indicate that the electromagnetic radiation emitted by third generation cellular phones causes irreversible changes in organic tissues. This confirms the concern of the effects of cellular phone radiation on human beings. Furthermore, the effects were shown to be not only of local type, but changes in tissues were detected with large spatial or temporal, and even spatio-temporal separations between a tissue and a radiation source.

Since the results have not yet been confirmed by a clinical study, it would be too drastic to draw definite conclusion on whether the use of third generation cellular phones should be avoided. The problem is not too critical as the phones are not yet widely used. It is however important to verify the results before they are commonplace.

# References

[1] ANSI/IEEE. IEEE standard for the safety levels with respect to human exposure to radio frequency electromagnetic fields 3 kHz to 400 GHz. The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.

Figure 2: Measurement system


[2] S.L. Arber and J.C. Lin. Microwave enhancements of membrane conductance: effects of EDTA, caffeine and tetracaine. *Physiol. Chem. Physics Med. NMR*, 16:469–475, 1984.

[3] K.R. Foster and J.E. Moulder. Are mobile phones safe? *IEEE Spectrum*, 37(8):23–28, August 2000.

[4] K. Fritze, C. Wiessner, N. Kuster, C. Sommer, P. Gass, D.M. Hermann, M. Kiessling, and K.-A. Hossmann. Effect of global system for mobile communication microwave exposure on the genomic response of the rat brain. *Neuroscience*, 81(3):627–639, September 1997.

[5] J.C. Lin. Research on health effects from cell phone radiation. *IEEE Antennas and Propagation Magazine*, 42(4):142–144, August 2000.

[6] J.C. Lin. Cell phone testing and fundamental scientific research. *IEEE Antennas and Propagation Magazine*, 43(4):156–158, August 2001.

[7] J.C. Lin. Health effects: the blood-brain barrier, cancer, cell phones, and microwave radiation. *IEEE Microwave Magazine*, 2(4):26–30, December 2001.

[8] Z. Weinberger and E.D. Richter. Cellular telephones and effects on the brain: the head as an antenna and brain tissue as a radio receiver. *Medical Hypotheses*, 2002. in press.

[9] T.V. Yioultsis, T.I. Kosmanis, E.P. Kosmidou, T.T. Zygiridis, N.V. Kantartzis, T.D. Xenos, and T.D Tsiboukis. A comparative study of the biological effects of various mobile phone and wireless LAN antennas. *IEEE Transactions on Magnetics*, 38(2):777–780, March 2002.