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Preface

Dear Participants,

Confronted with the ever-increasing complexity of technical processes and the growing demands on their efficiency, security and flexibility, the scientific world needs to establish new methods of engineering design and new methods of systems operation. The factors likely to affect the design of the smart systems of the future will doubtless include the following:

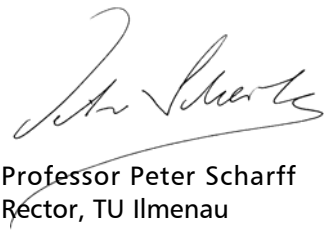
- As computational costs decrease, it will be possible to apply more complex algorithms, even in real time. These algorithms will take into account system nonlinearities or provide online optimisation of the system's performance.
- New fields of application will be addressed. Interest is now being expressed, beyond that in "classical" technical systems and processes, in environmental systems or medical and bioengineering applications.
- The boundaries between software and hardware design are being eroded. New design methods will include co-design of software and hardware and even of sensor and actuator components.
- Automation will not only replace human operators but will assist, support and supervise humans so that their work is safe and even more effective.
- Networked systems or swarms will be crucial, requiring improvement of the communication within them and study of how their behaviour can be made globally consistent.
- The issues of security and safety, not only during the operation of systems but also in the course of their design, will continue to increase in importance.

The title "Computer Science meets Automation", borne by the 52nd International Scientific Colloquium (IWK) at the Technische Universität Ilmenau, Germany, expresses the desire of scientists and engineers to rise to these challenges, cooperating closely on innovative methods in the two disciplines of computer science and automation.

The IWK has a long tradition going back as far as 1953. In the years before 1989, a major function of the colloquium was to bring together scientists from both sides of the Iron Curtain. Naturally, bonds were also deepened between the countries from the East. Today, the objective of the colloquium is still to bring researchers together. They come from the eastern and western member states of the European Union, and, indeed, from all over the world. All who wish to share their ideas on the points where "Computer Science meets Automation" are addressed by this colloquium at the Technische Universität Ilmenau.

All the University's Faculties have joined forces to ensure that nothing is left out. Control engineering, information science, cybernetics, communication technology and systems engineering – for all of these and their applications (ranging from biological systems to heavy engineering), the issues are being covered.

Together with all the organizers I should like to thank you for your contributions to the conference, ensuring, as they do, a most interesting colloquium programme of an interdisciplinary nature.
I am looking forward to an inspiring colloquium. It promises to be a fine platform for you to present your research, to address new concepts and to meet colleagues in Ilmenau.



Professor Peter Scharff
Rector, TU Ilmenau

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Head of Organisation

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Effects of Mm-Wave Electromagnetic Radiation on Sensitivity of Human Lymphocytes to Ionizing Radiation and Chemical Agents *in Vitro*

TOOLS FOR DIAGNOSIS AND THERAPY

INTRODUCTION

Research into effects of mm-wave electromagnetic radiation (EMR) on human health has attracted considerable interest in recent years. Mm-wave EMR is a component of electromagnetic pollution, on the one hand, and one of key mechanisms in adjusting vital functions [1, 2], on the other. Apoptosis of human peripheral blood lymphocytes represents a suitable test system for assessing harmful environmental impact on human body [3] and may be used for biological dosimetry of ionizing radiation (IR) [4]. In view of this, metabolic activity of peripheral blood lymphocytes is a convenient indicator of mm-wave EMR effects on human body. The impact of low-intensity mm-wave EMR on blood corpuscles and peripheral blood plasma has been researched recently [5]. However, no research is yet available of the EMR effects on lymphocytes *in vitro*, although, as noted above, lymphocyte cellular preparations may present a suitable test system to assess harmful environmental impact on vital human functions.

In this paper a technique and results of research into effects of mm-wave EMR on vitality of human lymphocytes *in vitro* and an possibility of EMR use for prophylaxis or regeneration of the damages caused by ionizing radiation and chemical agents are presented.

RESEARCH AND RESULTS

The research was conducted on donor lymphocytes separated from heparinized peripheral blood by centrifugation. The selected lymphocytes were subsequently placed in culture medium and subjected to the 38.0-55.0GHz EMR. For this purpose sterile capsules, which have been made of radiotransparent polyethylene, were filled with the prepared cells suspension and airproofed. Then the capsules were located in a pyramidal horn aperture in the sizes 10×20 mm^2, which corresponds to the sizes of the

capsules. The EMR exposure varied between 5 and 45 minutes. The EMR power flow density employed in the research amounted to 1-2 mW/cm^2, which corresponds to a low-intensity or 'informative' EMR impact. The cellular suspension was subjected to ionizing radiation in total doses of 0.17, 2.0 and 5.0 Gy. Effects of the EMR and ionizing radiation were investigated using different sequences: X-rays followed by EMR or vice versa. Chemical agents such as Dexamethazonum and Cladribine were added in the culture medium to research into a toxic action on lymphocytes of the chemical agents with ionizing radiation also. The lymphocytes, following their irradiation by EMR and X-rays, were incubated for 44 hours in the same culture medium. Irradiation results were assessed using a biochemical technique of MTT testing to evaluate variations in cellular metabolic activity. The level of metabolic activity in cells not subjected to EMR was taken as reference at 100 %. Figures 1 and 2 show the lymphocytes metabolic activity dependences on the EMR exposure.

The mm-wave low-intensity EMR effect results in increase of peripheral blood normal lymphocytes metabolic activity (the solid line at fig. 1 and 2). The expressed stimulation is observed only at short-term five-minute exposure. Statistically proved distinctions in comparison with not irradiated cells are not revealed at longer EMR exposure.

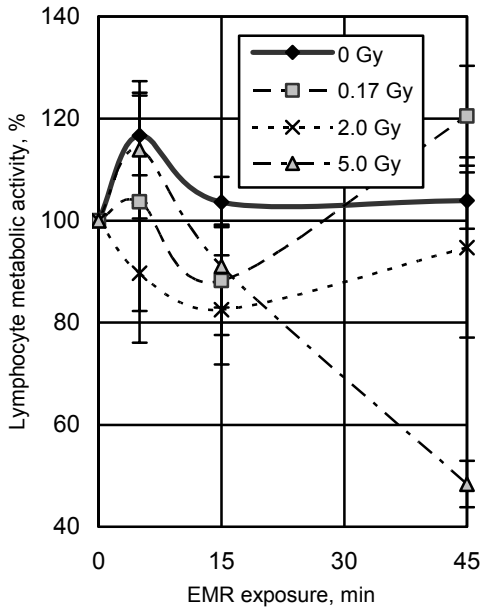

Fig. 1. Metabolic activity of lymphocytes previously subjected to various doses of ionizing radiation dependences on the EMR exposure

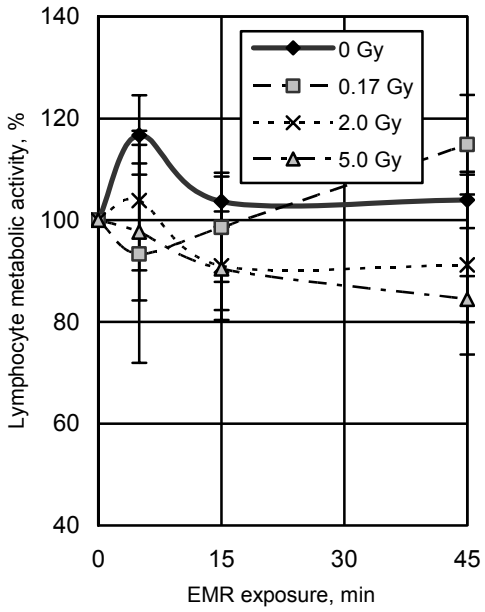

Fig. 2. Metabolic activity of lymphocytes subsequently subjected to various doses of ionizing radiation dependences on the EMR exposure

The effect of the low-intensity EMR on the lymphocytes in a combination with IR is selective. It is observed both protective and regenerative impact, and the effect of EMR is determined by the dozes and the order of application of the external factors.

The "therapeutic" effect of EMR within 5-15 minutes on the lymphocytes following their irradiation by X-rays *in vitro* does not result in a significant change of its metabolic activity (fig. 1). The increase of the EMR exposure up to 45 minutes results in the strongly pronounced change of the lymphocytes viability. The effect of EMR in the combination with IR by a small doze (0.17 Gy) is stimulating, with IR by a doze 2.0 Gy – regenerating, with IR by a doze 5.0 Gy – oppressing.

The research of the "therapeutic" effect of EMR on the cells damaged by X-rays has confirmed a "cumulative" character of its action. The significant effect of EMR by a small exposure (5-15 minutes) on the lymphocytes, irradiated by IR, it is not revealed (fig. 1). The expressed cellular reactions are observed when the EMR exposure increase up to 45 minutes.

In a case of the "preventive" effect of EMR there is no a statistically significant decrease in the lymphocytes metabolic activity (fig. 2). The preliminary effect of EMR within 5-45 minutes promotes practically full recovery of the peripheral blood lymphocytes viability after irradiative on them IR in dozes 0.17-5.0 Gy.

The effect of EMR prevents a damage of the lymphocytes by X-rays. Probably, the preliminary irradiation on the lymphocytes *in vitro* by EMR results in an increase of biological processes intensity in the lymphocytes that prepares the cells to stress – reactions before the subsequent X-ray irradiation.

The low intensity mm-wave EMR effect at the wide frequency band can prepare an organism for the subsequent adverse impacts, for example, to effect of IR and to make an organism less susceptible to it. The adaptation to the subsequent adverse impact can be compared to the effect which is being given by training, but is being carried out during short time. The informative EMR impact provides a correction at a level of physiological functions.

The research of the combined effect of the low-intensity EMR, IR and the chemical agents on the normal lymphocytes has revealed a various character of their viability changes (fig. 3 and 4). A effect of Dexamethazonum and Cladribine in the concentration close to therapeutic, results in a suppression of the peripheral blood lymphocytes viability up to the level 90,98±5,6 % and 56,5±2,4 % in comparison with the reference values, accordingly.

The irradiative on the blood cells by EMR within 15 minutes in a combination both with Dexamethazonum, and with Cladribine raises its metabolic activity up to 20 % and more in comparison with the reference level, and practically does not effect with other intervals of exposure.

The effect of EMR within 45 minutes, an irradiation of IR by a small doze (0.17 Gy) in a combination with the both chemical agents restores the lymphocytes viability.

The irradiation of IR in doze 2.0 Gy in a combination with Dexamethazonum and EMR within 15 minutes reduces the lymphocytes metabolic activity. The increase of the EMR exposure time up to 45 minutes practically restores the cells viability up to the initial size.

In part restoring effect of EMR on the cells, which are exposed by IR in a doze 2.0 Gy and Cladribine is observed. However, the initial level of the cells metabolic activity is not achieved by the increase of EMR exposure time up to 45 minutes.

The low-intensive EMR increases the damaging effect of IR in doze 5.0 Gy in a combination with the chemical agents. The increase of the EMR time exposure up to 45 minutes results in a reduction of the cells metabolic activity in the case.

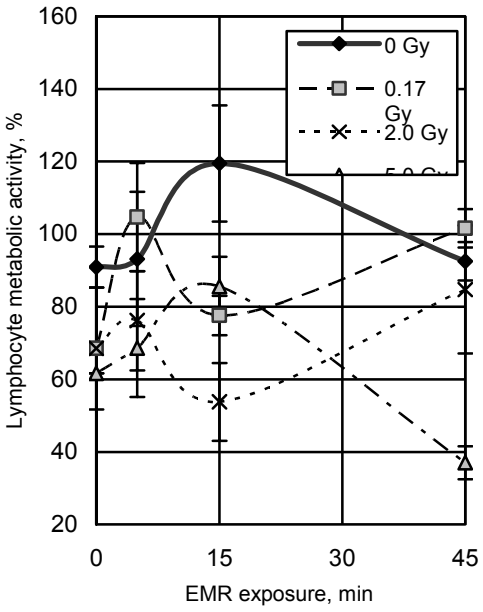

Fig. 3. Metabolic activity of lymphocytes previously subjected to various doses of ionizing radiation in combination with Dexamethazonum dependences on the EMR exposure

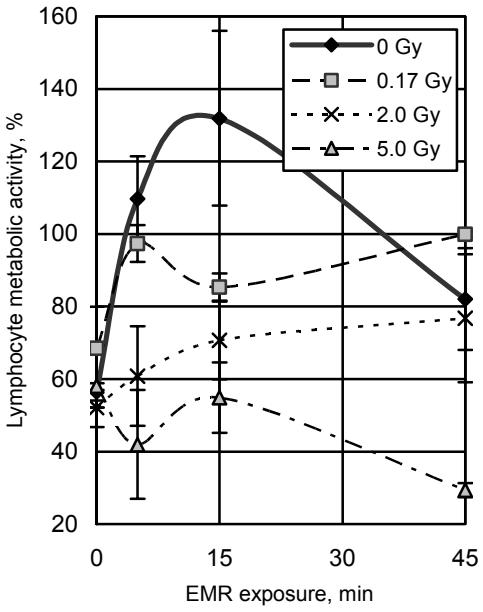

Fig. 4. Metabolic activity of lymphocytes previously subjected to various doses of ionizing radiation in combination with Cladribine dependences on the EMR exposure

CONCLUSION

The low-intensity mm-wave EMR produces stimulating effect on peripheral donor blood lymphocytes *in vitro*. Damages of lymphocytes caused by small doses of ionizing radiation and the chemical agents are compensated by long EMR exposures. Preventive exposure of lymphocytes by EMR provides protective effect against ionizing radiation. The fixed effects can be used both for protective, and for the combined therapy of various nature diseases.

The low intensity mm-wave EMR is the physical factor which changes the viability of the healthy persons peripheral blood lymphocytes are damaged by the impact of IR and chemical agents *in vitro*. The reaction of the lymphocytes to the effect of EMR in a combination with IR and the chemical agents is defined by duration of its exposure, the sequence of the factors impact and a doze of IR.

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