Research of Interactions of EM Field and Biological Systems

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Abstract: Paper deals with new results obtained by several research projects in the field of interactions of EM field and biological systems.

1. Introduction: In present time 4 research institutions in the Czech Republic run research projects focused on studies of interactions between EM field and biological systems. In this contribution we would like to give more details about that projects and obtained results —both technical (i. e., developed exposition systems) and biological as well.

Three of that projects (1 in Germany and 2 in Czech Republic) are basic research for simulation of the microwave hyperthermia treatment. Other two project are focused on simulation of the case of exposition by mobile phone.

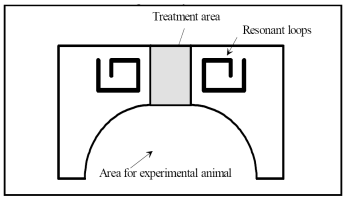

Figure 1: Arrangement of discussed microwave hyperthermia applicator.

2. Applicator for German Project: The main goal of the planned biological experiment is a hyperthermia treatment of the experimentally induced pedicle tumours of the rat to verify the feasibility of ultrasound diagnostics and magnetic resonance imaging respectively to map the temperature distribution in the target area of the treatment. That means to heat effective volume of approximately cylindrical shape (diameter approx. 2 cm, height approx. 3 cm). Temperature to be reached is $41°C$ or more (i. e., temperature increase of at least $4°C$ from starting point $37°C$), time period of heating is 45 minutes.

Considering the necessary effective heating depth for the planned experiments, we have found 915 MHz to be suitable frequency. As an excellent compatibility of the applicator with non-invasive temperature measurement system (ultrasound or NMR) is a fundamental condition for our project, we should have to use non-magnetic metallic sheets of minimised dimensions to create the conductive elements of the applicator. Therefore the applicator itself (see Fig. 1) is created by two inductive loops tuned to resonance by capacitive elements [4, 5]. Dimensions of these resonant loops were designed by our software, developed for this purpose. Coupling between coaxial feeder and resonant loops (not shown in Fig. 1) as well as a mutual coupling between resonating loops could be adjusted to optimum by microwave network analyser.

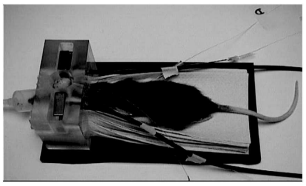

Figure 2: Photograph of the discussed applicator.

The position of the loops is fixed by perspex holder. There is a special cylindrical space for experimental animal in lower part of this perspex holder. As the heated tissue has a high dielectric losses, both loops are very well separated and so no significant resonance in heated area can occur. From this follows, that either the position of the loops with respect to heated area or the distance between the loops is not very critical.

First measurements to evaluate the basic properties of the discussed applicator were done on agar phantom of muscle tissue:

- evaluation of basic microwave properties (transfer of EM energy to the ?
- evaluation of compatibility with US and NMR,
- calculation and measurement of SAR and temperature distribution and its homogeneity.