

Electromagnetic Pollution

The **objective** of the Project is investigation of the effects of non-ionizing radiation of radio-frequency and microwave range on the biological structures and systems through creation and analysis of realistic models of their electromechanical impact interaction considering freedom of the movement of elements of the structure and creation of the applied program package for the maximum comprehensive study of the biological impact of this radiation.

The **topicality** of the Project objectives is provoked by all-round and fast growing penetration of radiofrequency and microwave radiating devices into everyday and occupational life of population that stimulates the problem of providing the safety of these devices for the human health and environment. This need has given rise to the numerous research studies focused on various aspects of electromagnetic effects of this radiation on the biological systems.

Up to recently, analysis of non-ionizing radiation effects upon the biological systems was restricted mainly to the macroscopic evaluation of induced electromagnetic field and electric currents in various tissues and organs of individuals and animals. More recent studies have however shown, that microscopic knowledge of internal fields and currents induced inside the elementary biological structures is also of great importance to evaluate the biophysical consequences of electromagnetic exposure. As such the structures, tissue cells, neurons, erythrocytes and other elementary biological structures were considered. Moreover, it is of great interest to analyze also the biological systems consisting of assembles of elementary biological structures.

Nowadays, in view of complexity of the structure of real biological systems, analysis of interaction of the external electromagnetic radiation with biological structures is conducted mainly with their simplified, spherical stratified models. This doesn't allow to properly evaluate the influence of their real shape and internal structure on the electromagnetic behavior. Moreover, the problems of influence of direct surroundings upon the electromagnetic response of different biological structures have not yet analyzed in detail. Also, the organic, protein nature of the biological structures resulting in their complex (chiral) material properties is not usually taken into account.

This Project **aims** to fill in the existing gap in this area by suggesting and analyzing the generalized, complex shape, multi-layer model of biological structures, which allows to realistically describe the internal configuration of the most elementary biological structures. Furthermore, the Project aims to take into account the real material properties of the biological structures. Moreover, the Project intends to analyze the mutual effects of single-type and multi-type biological structures on their electromagnetic behavior, considering the systems built of these structures.

The **expected results** of the Project are following:

- creation of the generalized realistic model of the external non-ionizing radiation effects on the biological structures and systems;
- development of the effective numerical methods for calculation of electromagnetic behavior of the created biological model under the external electromagnetic exposure in radio and microwave region;
- creation of effective algorithms for the comprehensive study of the given external radiation on the biological structures and systems;
- development of the user-friendly program package of general use for the comprehensive study of bio-electromagnetic impact of non-ionizing electromagnetic radiation;
- obtaining the detailed information about electromagnetic behaviour of elementary biological structures and systems in dependence of their shape, internal structure and direct environment.

The **scientific significance** of the expected Project results consists in development of the effective methods, creation of the flexible programs and obtaining of the specific results of the study of the given external radiofrequency and microwave radiation effects on the biological structures and systems.

The commercial and ecological significance of the expected Project results consist in creation of the competitive production having a broad area of potential applications in design of professional and domestic radio equipment and facilities to bring them into compliance with national and international claims to the ecological safety and electromagnetic compatibility.

To perform the Project objectives, first of all, a flexible algorithm will be developed to evaluate an effective distribution of electromagnetic fields induced inside the investigated biological tissues due to the given microwave non-ionizing radiation. Further, a generalized, multi-layer, realistic model of fundamental biological structures will be created, and an effective algorithm will be developed to calculate the electromagnetic field and electric current distributions inside these structures under various frequencies of external exposure and their internal structure and shape. At the last stage, a generalized realistic model of the complex biological structure under the external electromagnetic exposure will be created and algorithmised. As a result, an optimized program package will be created for the comprehensive study of external microwave non-ionizing radiation impact on the biological structures and systems.

As a technical approach, a combination of different numeric-analytical methods and techniques with empirical analysis, numerical simulation and optimisation will be used.

At the first stage of the Project, a flexible technique will be developed to determine electromagnetic fields induced inside the different biological tissues and organs. This technique will incorporate the use of volume-oriented methods and techniques [Finite Element Method (FEM), Finite-Difference Time-Domain method (FDTD), method of volume integral equations and so on], to describe the internal heterogeneous properties of biological objects, and surface-oriented methods and techniques [Method of Moments (MoM), method of singular (surface) integral equations, Method of Auxiliary Sources (MAS) and so on], to properly describe the object boundaries and external excitation, with empirical analysis. Further, modeling of the induced electromagnetic field interaction with generalized multi-layer model of elementary biological structures will be carried out, and a package of optimized programs will be developed to calculate the electromagnetic field and electric current distributions inside these structures. At the last stage, modeling, algorithmization and development of the created program package in the case of complex biological system will be carried out.