

## List of the research projects of the German Mobile Telecommunication Research Programme

The German Mobile Telecommunication Research Programme includes 53 projects in the scientific fields biology (22 projects), dosimetry (15 projects), epidemiology (9 projects) and risk communication (7 projects). From the original planned 54 projects three projects valued with priority III were not assigned in aid of projects valued with priority I and II. Three projects with high priority could not be assigned as proposed. The reasons are elucidated in the speech of the president of the Federal Office for Radiation Protection ([http://www.emf-forschungsprogramm.de/veranstaltungen/p\\_rede\\_3fg.html](http://www.emf-forschungsprogramm.de/veranstaltungen/p_rede_3fg.html) – German language). Compared to this several new projects were assigned as necessary completion of this programme, for example the second project concerning the sleep quality and the project regarding the phenomena tinnitus.

### List of the research projects of the German Mobile Telecommunication Research Programme:

<b>Biology</b>
<p><b>Investigation of mechanisms of action in cells exposed to the high frequency electromagnetic fields of mobile telephone technology</b></p> <p><b>A. Demodulation / Communication</b></p> <p>The electrical field distribution under the influence electromagnetic fields of is calculated and experimentally verified on and in the cell membrane. On neural networks single nerve cell activity and signal transduction between nerve cells will be investigated.</p>
<p><b>Investigation of mechanisms of action in cells exposed to the high frequency electromagnetic fields of mobile telephone technology</b></p> <p><b>B. Pineal gland</b></p> <p>The hormone melatonin is produced according to the diurnal rhythm in the pineal gland. In this study clarification shall be provided whether the function of isolated pineal organs of laboratory rodents is influenced by high frequency, GSM-modulated or continuous wave (1800 MHz) electromagnetic fields.</p>
<p><b>Investigation of mechanisms of action in cells exposed to the high frequency electromagnetic fields of mobile telephone technology</b></p> <p><b>C. Functions</b></p> <p>In this in vitro study, the influence of GSM mobile transmissions on cell type specific functions such as phagocytosis activity, free radical production and interleukin formation will be studied in different immune cells. In addition, the possible influence of protein patterns will be studied.</p>

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<b>Biology</b>
<p><b>Influence of low and high frequency electromagnetic fields on spontaneous leukaemia in AKR/J mice</b></p> <p>AKR/J mice will be exposed over their lifetime to a modulated GSM field of 900 MHz and mean SAR value of 0,4 W/kg. Survival rate, body weight, blood samples (haematology) and histological analysis of relevant organs will be selected as endpoints. Likewise the influence of low frequency 50 Hz magnetic fields will be studied.</p>
<p><b><i>in vivo</i> experiments on exposure to the high frequency fields of mobile telecommunication</b></p> <p><b>A. Long-term study</b></p> <p>The objective of this project is to examine possible effects of chronic exposure to EMF of commercial mobile telecommunications systems (GSM and UMTS) on learning and memory. In order to assess the possible effects on the developing organism, laboratory rodents will be exposed over the course of three generations. Possible influences on the blood-brain barrier as well as stress and immune response are examined in litter siblings of animals used for the experiment.</p>
<p><b><i>in vivo</i> experiments on exposure to the high frequency electromagnetic fields of mobile telecommunication</b></p> <p><b>B. Carcinogenesis</b></p> <p>The objective of this research project is to investigate whether chronic exposure to fields from UMTS mobile telecommunication technology influence either the leukaemia rate or the production of solid tumours in a leukaemia animal model, the AKR/J mouse. This study is being carried out in close connection to the project on "Influence of low and high frequency electromagnetic fields on spontaneous leukaemia in AKR/J mice".</p>
<p><b><i>in vitro</i> experiments on exposure to the high frequency fields of mobile telecommunications</b></p> <p><b>C. Blood-brain barrier</b></p> <p>The objective of this research project is to investigate whether the gene expression pattern of cells of the blood-brain barrier is affected by the high frequency fields of mobile communication technology. Primary capillary endothelium cells from rats are used as a model for the blood-brain barrier.</p>
<p><b>Influence of mobile telecommunication fields on the permeability of the blood-brain barrier in laboratory rodents (<i>in vivo</i>)</b></p> <p>The task of this project is to determine the influence of high frequency electromagnetic fields used in mobile telecommunications (GSM and UMTS) on the permeability of the blood-brain barrier <i>in vivo</i>. In particular, the dependence of changes in permeability on specific absorption rates (SAR), duration of exposure as well as possible introduction of delayed damage will be clarified. In addition possibly pathological processes on neurons shall be detected.</p>

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<b>Biology</b>
<b>Possible genotoxic effects of GSM signals on isolated human blood</b> Possible genotoxic effects of RF-Signals used in mobile communication are investigated. To this purpose, PHA-stimulated peripheral lymphocytes from 20 donors (adults and children) will be exposed to mobile telecommunications signals. DNA strand breaks, chromosomal aberrations, micronuclei and sister chromatid exchanges are investigated as endpoints. The samples are scored in parallel by three independent laboratories.
<b>Influence of GSM signals on isolated human blood</b> <b>B. Differential gene expression</b> The aim of the study is a broad examination of possible influences of GSM Signals on differential gene expression detected on mRNA-level in a study meeting quantitative and qualitative requirements. Microarrays covering the human genome will be used, significant changes will be verified by RT-PCR and - if possible - further analyzed on the protein level. As in the study "Influence of GSM signals on isolated human blood. A. Genotoxicity" peripheral lymphocytes from healthy donors (adults and children) will be used.
<b>Influence of high frequency electromagnetic fields of mobile telecommunications on sensory organs</b> <b>A. The auditory system</b> The objective of this project is to describe the possible physiological effects of high frequency electromagnetic fields on the auditory system and to investigate their mechanisms of action in order to evaluate their relevance to health.
<b>Possible influence of high frequency electromagnetic fields of mobile communication systems on the induction and course of phantom auditory experience (tinnitus)</b> As an extension of the project "Influence of high frequency electromagnetic fields of mobile telecommunications on sensory organs A. The auditory system" here it will be investigated, if and at which intensity high frequency electromagnetic fields of mobile phones can induce tinnitus.
<b>Influence of high frequency electromagnetic fields of mobile telecommunications on sensory organs</b> <b>B. The visual system</b> The objective of this project is to describe the possible physiological effects of high frequency electromagnetic fields on the optical system and to investigate their mechanisms of action in order to evaluate their relevance to health.

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<b>Biology</b>
<b>Feasibility study on age dependent effects of RF electromagnetic fields on the basis of relevant biophysical and biological parameters</b>
The aim of the study is to clarify, whether from the analysis of existing scientific information a plausible hypothesis regarding to an enhanced vulnerability of young children and teenagers to RF-electromagnetic fields (RF-EMF) can be postulated. Possible critical biological target structures shall be identified as a basis for the main study. The feasibility study is finished.
<b>Investigation of age-dependent effects of high frequency electromagnetic fields based on relevant biophysical and biological parameters (main study)</b>
Within the framework of the study children's heads and the source of RF-radiation will be modelled as realistic as possible. Amount and the distribution of energy absorption and the temperature increase will be examined in anatomically correct head phantoms of children. Age dependent differences of physiological, biophysical or anatomic parameters will be taken into account as far as possible. Target structures such as the pineal organ, hippocampus, hypothalamus and bone marrow will be included in the model.
<b>Studies of the effects of exposure to electromagnetic fields emitted from mobile phones on volunteers</b>
The objective of this project is to clarify whether high frequency electromagnetic fields emitted from mobile telephones influence brain activity (sleep and cognitive performance).
<b>Investigation of sleep quality in persons living near a mobile base station - Experimental study on the evaluation of possible psychological and physiological effects under residential conditions</b>
The objective is to examine the influence of high frequency electromagnetic fields of mobile telecommunication base stations on residents' quality of sleep.
<b>Investigation of sleep quality of electrohypersensitive persons living near base stations under residential conditions</b>
As an extension of the project "Investigation of sleep quality in persons living near a mobile base station - Experimental study on the evaluation of possible psychological and physiological effects under residential conditions" the reaction to the cancellation of the electromagnetic exposure will be investigated in the flats of the concerned persons.

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### **Biology**

#### **Investigation of the phenomenon of 'electromagnetic hypersensitivity' using an epidemiological study on 'electrosensitive' patients including the determination of clinical parameters**

The objective of this project is to examine the phenomenon of 'electromagnetic hypersensitivity' in patients believing themselves to be hypersensitive to the electromagnetic fields of mobile telecommunications. The study should clarify whether the self-diagnosis of electromagnetic hypersensitivity is based on a particular sensitivity to or perception of electromagnetic fields and how the 'electrosensitive' group is characterised in psychological and laboratory-clinical parameters.

#### **Investigation of electrosensitive persons with regard to accompanying factors or diseases, such as allergies and increased exposure or sensitivity to heavy metals and chemicals**

By means of objective medical tests it has to be clarified if there is a correlation between electrosensitivity against the electromagnetic fields of mobile communication and various accompanying factors such as allergies or an elevated exposure or sensitivity to heavy metals or chemicals. Moreover it has to be examined if these accompanying factors have an effect on the type or intensity of the impairment to health of the affected persons.

#### **Long-term study on the effects of UMTS signals on laboratory rodents**

The study will answer the question whether long term exposure to RF-fields of mobile communication systems according to the UMTS standard do influence the parameters fertility and development. In vivo experiments will be performed with male and female mice.

#### **Influence of high frequency electromagnetic fields of mobile telecommunications on the metabolic rate in laboratory rodents**

The study shall clarify whether the detected weight gain in AKR/J mice exposed to EMF of the GSM-standard at SAR values below the threshold of adverse thermal effects (see the results of project "Influence of low and high frequency electromagnetic fields on spontaneous leukaemia in AKR/J mice") is caused by an influence on the metabolic rate of laboratory animals.

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<b>Dosimetry</b>
<p><b>Analysis of the SAR-distribution in test animals exposed to electromagnetic radiation</b></p> <p>High-resolution anatomical models of laboratory animals have been generated and used for calculating the distribution of specific absorption rates (SAR) within them when exposed to electromagnetic fields.</p>
<p><b>Development of measurement and calculation methods for the determination of the public exposure due to electromagnetic fields in the vicinity of mobile phone base stations</b></p> <p>Subject of this project was to develop measurement standards and numerical methods in order to quantify the exposure of the general public in the vicinity of cellular base stations.</p>
<p><b>Determination of the exposure of groups of people that will be investigated within the scope of the project 'Cross-sectional study for ascertainment and assessment of possible adverse effects by the fields of mobile phone base stations'</b></p> <p>Goal of this project was to develop and to test a procedure for HF dosimetry in epidemiological studies.</p>
<p><b>Determination of exposure distribution from high frequency fields in the human body with regard to small structures and relevant thermo-physiological parameters</b></p> <p>Based on current scientific, documented knowledge with regard to the absorption of high frequency electromagnetic fields in the human body, extensive investigations, particularly with regard to the anatomically small and delicate organ structures of the head (e.g. eyes, inner ear, pineal gland) should be carried out.</p>
<p><b>Determination of the specific absorption rate (SAR values) occurring during day-to-day mobile phone use</b></p> <p>The objective of this project is to discuss possible methods to determine the actual exposure of mobile phone users. Furthermore, the project will point to variability over time and the relationship between burden and mobile phone use, network structure and environmental influences.</p>
<p><b>Determination of human exposure caused by indoor wireless communication technologies applied in homes and offices</b></p> <p>Objective of this research project was to give a detailed overview of current and future wireless communication devices for home and office use and to develop measurement standards and numerical methods in order to quantify the exposure produced by them.</p>

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<b>Dosimetry</b>
<b>Determination of the field distribution of radio frequency electromagnetic fields of wireless LAN-applications in urban environments</b>
Within this project the actual field distribution in the vicinity of wireless LAN transmitters in urban environments will be determined in order to quantify the exposure of the general public caused by them.
<b>Determination of the real RF field distribution in the surrounding of UMTS base stations</b>
In addition to the project „ Development of measurement and calculation methods for the determination of the public exposure due to electromagnetic fields in the vicinity of mobile phone base stations” measuring and numerical methods of electromagnetic fields in the near of UMTS base stations will be developed.
<b>Determination of the real exposure from using mobile phones in partly shielded rooms compared to the exposure occurring under advantageous conditions in free space</b>
Within this project the hypothesis, that wireless telecommunication in partly shielded rooms causes increased exposure with HF-EMF, will be proved and quantified.
<b>Exposure from transmitters worn near the trunk of the body</b>
This research project will answer the questions, whether the torso has distinct, sensitive areas which, in light of increased exposure under the conditions discussed, need to be more extensively examined and whether an effective radiation protection concept needs to be addressed.
<b>Determination of the public exposure due to electromagnetic fields of digital broadcast transmitters</b>
Subject of this project is to analyse relevant types of digital broadcast transmitters (DVB-T – and DAB – transmitters), and to evaluate the different supply concepts (analog, digital, transmitter distribution) regarding the exposure of the general public caused by them.
<b>Studies on the issue, if macroscopic dielectric properties of tissues have unlimited validity in both cellular and subcellular dimensions</b>
Goal of this project is to carry out studies concerning the issue, how dielectric parameters of different cell types behave at cellular, subcellular and molecular dimensions. Based on the project’s findings, consequences regarding the distribution of electromagnetic fields and energy absorption have to be derived and discussed.
<b>Development of a practicable computational procedure for the determination of the actual exposure in complex exposure scenarios with several different RF-sources</b>
The goal of this research project is the development of a practicable computational procedure for the determination of the actual SAR values in complex exposure scenarios with several different RF-sources.

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### **Dosimetry**

#### **Study on the influence of antenna topologies and topologies of entire devices of wireless communication terminals operated near the body on the resulting SAR values**

The goal of this project is to examine, how the SAR values of wireless communication terminals operated near the body are influenced by e.g. the antenna topology, the topology of the entire device or by the choice of the transmitter frequency.

#### **Determination of exposure to ultra-wideband technologies**

With upcoming Ultrawideband (UWB) a new technology will be introduced into market, that will cause exposures covering outstanding broad frequency ranges- very much different to ordinary used narrow-band transmission techniques. At present no suitable and accepted procedure is available for assessment of exposures to this new technology. Therefore, the goal of this project is to work on the question, how immissions can be addressed suitably.



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### **Epidemiology**

#### **Feasibility study for a cohort study: the cohort study should investigate highly exposed (occupational) groups to estimate the risk associated with high frequency electromagnetic fields**

The objective of this project was to examine by means of a feasibility study whether a cohort study of highly exposed groups can be carried out in Germany. Altogether, 30 occupational groups could be identified as exposed to high-frequency electromagnetic fields. After evaluation of these groups it turned out that a study protocol for a cohort study could not be defined that would allow for an unbiased estimate of the health risk due to exposure to high frequency electromagnetic fields. The BfS decided not to carry out any cohort studies on persons highly exposed to high frequency.

#### **Feasibility study for a prospective cohort study on mobile phone users**

An international prospective cohort study including about 250.000 mobile phone users, the so-called COSMOS study (COHORT STUDY ON MOBILE PHONE USE AND HEALTH) has been initiated to investigate the long-term health effects related to mobile phone use. The aim of the feasibility study was to test whether a cohort study consisting of 50.000 persons can be established in Germany. In principal the feasibility of conducting a cohort study in Germany was successfully demonstrated. However, the major limitation was the low response rate of about 5 %. In order to build up a cohort of 50.000 people the time, effort and costs would be tremendous. Therefore the BfS had to decide not to fund the cohort study in Germany at the moment.

#### **Addendum to a case control study on uveal melanoma and radio frequency radiation (RIFA Study)**

Objective of the case-control study is to examine whether published results of an increased eye tumor risk from electromagnetic fields can be confirmed. In order to increase the statistical power by means of increasing the number of cases and controls, the BfS financially contributed to this study. Overall a total of 458 cases and 1.210 controls were interviewed. The statistical analyses of this study, which had not been subject of the BfS project, are in preparation.

#### **Cross-sectional study to record and evaluate possible adverse health effects due to electromagnetic fields from mobile-phone base stations**

The objective of this project is to investigate the hypothesis that cell-phone base stations fields can lead to adverse health affects of local residents. In a nation-wide, cross-section of some 40,000 persons health complaints and subjective perception of exposure had been surveyed. In addition a rough estimate of the fields of the cell-phone base stations has been performed. In-depth investigations of health complaints and measurements of high frequency fields will be carried out for a selected sub-group of 3.200 persons (see also project addendum to the cross-sectional study).

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<b>Epidemiology</b>
<b>Extension of an international epidemiological study on the association between high-frequency electromagnetic fields and the risk of brain cancer (INTERPHONE)</b> WHO initiated an international case control study to investigate the key question whether the use of mobile phones could cause brain cancer. This study is carried out in 13 countries according to a standardised protocol. Within the German Mobile Telecommunication Research Programme a study addendum is financed which will improve the significance of the German part and the transfer of the results of the international study to the situation in Germany.
<b>Estimation of RF-exposure in INTERPHONE Study subjects</b> The estimation of RF-exposure in INTERPHONE Study subjects is an important and critical step which is now partly funded by the German Mobile Telecommunication Research Programme.
<b>Epidemiological study on childhood cancer and proximity to radio and television transmitters</b> The objective of the project is to investigate in a nation-wide case-control study in Germany the hypothesis of an increased risk of childhood leukaemia in the proximity of powerful radio and television transmitters.
<b>Addendum to the cross-sectional study on adverse health effects by fields of mobile phone base stations</b> Within the framework of the project "Cross-sectional study on possible adverse health effects due to the electromagnetic fields of cell phone base stations" for a sub-group of about 1.500 people individual measurements of the fields of mobile phone basestations are planned by means of personal dosimetry.
<b>Acute health effects by mobile telecommunication among children</b> The objective of this project is to investigate in a population-based cross-sectional study the association of acute subjective health effects with individually measured and self-assessed exposure levels of fields of mobile telecommunication among children and adolescents. The study will include 1.500 children aged 8 to 12 years and 1.500 adolescents aged 13 to 17 years. The exposure to high frequency electromagnetic fields will be measured by means of personal dosimeters.

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<b>Risk Communication</b>
<b>Identifying the general public's fears and anxieties with regard to the possible risks of high frequency electromagnetic fields of mobile telecommunications (annual survey)</b> Within this project the general public's fears and anxieties of the possible risks of high frequency electromagnetic fields of mobile telecommunications will be investigated within the scope of a representative annual survey.
<b>Knowledge-based database of literature describing the effects of electromagnetic fields on the organism and implants</b> The objective of this project was to create a substantive, objective and impartial source of information on which to base factual discussions on the possible adverse effects of electromagnetic fields and to give interested citizens the chance to objectively assess actual or alleged risks from electromagnetic fields. An improved understanding of scientific risk assessment should be reached.
<b>Innovative methods of conflict mediation when determining the location for mobile phone base stations</b> This project shall present innovative procedures for settling disputes with respect to the siting of mobile phone transmitters in order to encourage a constructive debate on mobile phone transmitters and to contribute to the improvement of communication and information, a reduction of conflicts and a reduction of the public's fears in particular in local processes.
<b>Analysis of target groups for differentiated information</b> The objective of this project is to define main target groups and, on the basis of these findings, make recommendations in respect to dissemination, content and language for optimal information and communication measures for these groups.
<b>Supplementary information about electromagnetic hypersensitive persons</b> The objective of this project is to compile further descriptive information on electrosensitive persons from the point of view of sociodemographic characteristics and other personality traits.
<b>Examination of the knowledge and effects of information activities in the field of mobile telecommunications and determination of further approaches to improve information of different population groups</b> The objective of this project is to investigate the numerous information and communication activities undertaken in the field of mobile telecommunications with regard to public awareness of such measures and their effects on the public.

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### **Risk Communication**

#### **Support of the co-operation between the mobile telecommunication actors by the local agenda 21**

The objective of this research project is to evaluate the experience gained from and potentials found in Local Agenda 21 processes so that recommendations can be made for the co-operation between mobile telecommunication players.