

EMF Research needs and priorities

Static magnetic fields

Use of static magnetic fields in medicine can lead to exposures to patients and workers at levels well above those where the science has any information to determine safety (4 to 8 Teslas). Yet there are only few informative studies using exposures above 2 T and so more information about exposures above this level is needed. This lack of information resulted in the EU Directive 2004/40/EC₂ not containing recommendations on static magnetic fields. Thus the following research is urgent and should have very high priority: Human studies are needed to determine any short-term effects on CNS functions and cardiovascular effects. Long-term and acute studies on experimental animals are needed using endpoints such as life-span, cancer, development, cardiovascular, immune system and CNS responses. In vitro studies should investigate interaction mechanisms such as radical pair reactions and enzymatic activity, as well as effects on gene expression, mutagenicity and cell transformation. Theoretical and computational studies are needed to investigate the magnitude and direction of induced currents and fields under various magnetic field exposure conditions. There is a great need for high quality epidemiological studies since none exist at present. Large epidemiological studies should focus on workers involved in high exposure areas and address endpoints such as cancer and pregnancy outcomes in occupational situations.

Extremely Low Frequency (ELF) fields

- Experimental studies and interaction of fields : studies investigating plausible biophysical and biological mechanisms that might provide support to epidemiological results suggesting carcinogenic effects of magnetic fields; investigation of combined exposure to magnetic fields and other physical, chemical or biological agents; studies on developmental and cognitive effects of prenatal exposures and on effects on the nervous system and behavior; studies on the role of exposure duration and characteristics such as intermittency and transients in the development of effects; replication and extension of key in vitro studies, such as those related to genotoxic effects; high quality multigenerational animal studies and use of appropriate transgenic models are needed determine if low-level ELF magnetic field exposures can initiate or influence leukemia..
- Epidemiological studies and human exposure: studies capable of clarifying the nature of the association between ELF and childhood leukaemia and neurodegenerative diseases are needed, including population-based studies using different epidemiological designs (in particular cohort studies) less prone to selection bias than are case-control studies. In addition, large studies of highly exposed populations (such as workers) are desirable , as are methodological investigations of the possible influence of selection and other bias on epidemiological findings and investigations on the possible association with neurodegenerative diseases and pregnancy outcome.

Radiofrequency Radiation (RFR)

Exposure of the general population to mobile telecommunications signals is the main driver of public concern. However, mobile phones produce significantly higher RF exposures, especially among children, and should be the focus of research rather than their base station exposures. Research should also use occupational settings where high RF exposures would

be expected to workers. Moreover, studies should also address exposures at frequencies at the two ends of the RFR band (i.e. Intermediate Frequencies from 300 Hz to 10 MHz and the THz band, respectively), because of the rapidly growing usage of these frequencies by modern technologies. High priority research includes both experimental studies and epidemiological studies:

- Experimental studies and interaction of fields: volunteer studies are needed to determine if RFR exposure influences cognition, EEG and sleep in both children and adults. Multigenerational animal studies are needed to address the effect of RF exposure on development and maturation of the CNS, behavior and effects on the blood-brain barrier from prenatal exposures. With rapid changes in technology, research is needed to document the changing patterns of mobile phone use (SMS, email, talk mode, etc) and exposure to different parts of the body for adults, children and the fetus. In vitro studies are also needed to replicate genotoxic effects. Research should also focus on possible effects of prolonged exposure to RFR during early life, especially in immature animals, and on effects on the nervous system and behavior in humans and animals. Experimental studies should, whenever possible, use precise micro-dosimetry at cellular or sub-cellular levels.
- Epidemiological studies and human exposure: studies of the risk of brain and CNS tumors associated with RF exposures in children and adolescents (who are potentially more sensitive than adults but could not be included in the current FP5 INTERPHONE project due to the low mobile phone use in these age groups when the project started in 2000) are urgently needed. In addition there is a need for large-scale cohort studies of mobile phone users to follow up and complement the FP5 EC Project INTERPHONE by providing a tool for surveillance of risk of other diseases. Large-scale cohort studies of highly exposed workers, as well as studies on the potential long-term effects of environmental and occupational whole-body exposure to RF from mobile phone base stations and other sources (taking into account exposure to ELF fields), would also be useful, provided adequate personal dosimeters are available, the study end-points are carefully defined and the feasibility and informativity of such studies can be adequately demonstrated. Again, epidemiological and human studies should, whenever possible, evaluate associations with exposure metrics other than average field strength, such as field variability in time and in space, variability of the investigated individuals, etc

Dosimetric studies for experimental, human and epidemiological studies

Development of precise micro-dosimetry at cellular or sub-cellular levels for experimental studies, especially for RF; methods and tools for reliable assessment of human body exposure levels taking into account exposure metrics other than average field strength; criteria, methods and tools for reliable exposure assessment, specially for children; improvement of dosimetric techniques to estimate exposures from body-worn or hand-operated devices placed in the vicinity of other sites of the body than the head; development of dosimetric models for children and pregnant women, extending dosimetry to intracorporal temperature changes, developing exposure monitoring strategies both in the ELF and RFR range for complex and inhomogeneous exposure situations and for personal exposure assessment (personal dosimeters).