

Health protection and RF exposure assessment : engineering aspects.

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Guest editors

The last few ten years have seen a tremendous increase in the use of electromagnetic fields in the daily life; for instance, the microwave oven is a common cooking device in the domestic environment, but the most important evolutions have been in the telecommunications area. Electromagnetic Fields (EMFs) are used in telecommunications since a long time. The first complete wireless system was patented by Marconi in 1897, but the system required high power transmitters and long antennas. The development of applications continued, and in the mid 1900s the first public radio broadcast was done in the US. In the early 1920s, the Michigan police carried out pioneering experiments to broadcast radio messages to receivers in police cars. The wireless telegraphy was used at larger scale after the Second World War, since the vulnerability of cables was demonstrated. In 1945, the first US public mobile telephone system was inaugurated in St. Louis, Missouri. But we have to wait until the 1960s to leave the push-to-talk approach, and enter into the cellular network one. In 1979, the World Administrative Radio Conference set up a research group to define a common international standard.

Since the mid of the 1980s, cellular networks have increased the use of wireless systems to the well-known situation we have today. The huge developments in technology have allowed the reduction in the size of the handsets that are now intensively used in our daily life. For instance, in 2007 in France, mobile phone users are more than 50 millions, while there were only some thousands in 1993. Since ten years now, telecommunications systems using EMFs are not limited to cellular networks (such as UMTS or GSM), but encompass others like WiFi, Bluetooth or RFID, just to mention a few, and new systems based on NFC (Near Field Communications) appeared recently.

The rapid expansion of these technologies has fostered a “fear of the unknown”, i.e., the concern of the population about the possible health hazards coming from exposure to EMFs. Since many years, various national and international scientific bodies have analyzed the problem of exposure to EMFs. In order to protect people against overexposure, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) or the Institute of Electrical and Electronic Engineers (IEEE) have developed guidelines and recommended exposure reference levels. In 1999, the European Council has established a Recommendation based on ICNIRP levels.

Even if reference levels have been established and compliance methods developed, questions still exist about the possible health impact of EMF exposure. In 1996, the World Health Organization (WHO) has setup the International EMF Project to promote and coordinate the worldwide research. Since the beginning, it has

emphasized the importance of exposure assessment related to biomedical studies; "in vivo", "in vitro", and "human studies", as well as epidemiological studies, request a well designed dosimetry in order to allow conclusions.

The tremendous development and success of wireless systems has been supported by the deployment of thousands of base stations or access points. Because of that, the general public is looking for information about exposure. Although broadcast systems may radiate more than one thousand times the values of base stations, the attention of the media, and of the public, has been focused on wireless systems, due to their massive penetration, already surpassing 100% of the population in many countries, namely in Europe.

In order to achieve the three objectives of assessment, study and information, the engineering aspects of RF exposure assessment are fundamental. The last years have seen a large effort to develop tools and methods that can be used to check the compliance to the reference levels. In the experimental domain, probes have been developed to measure the Specific Absorption Rate (SAR), which is an index of the safety guideline of exposure to RF fields, namely used in cellular phones. Studies are still on going to take new technologies that are using different frequency bands into account. Efforts have also been carried out in numerical dosimetry; the well known FDTD (Finite Difference in Time Domain) approach has been improved and adapted to allow for an accurate SAR estimation. New methods, able to take multi-physical phenomena into account, e.g., temperature elevation due to RF power absorption, have also been developed. These engineering aspects of RF exposure assessment and health protection have been fundamental to develop compliance methods: based on these engineering works, standards have been developed, being under improvement in some cases; for instance, European bodies, like CENELEC and IEC, have developed standards that are used to check the compliance of handsets. Moreover, worldwide efforts have also been developed to improve the personal exposure analysis and a dosimetry that can be used in epidemiology.

This special issue of Annals of Telecommunications aims at providing the reader with a few articles on the latest developments in the engineering aspects of RF exposure assessment and health protection. It starts with a brief overview of two important projects established within the European frameworks of COST and of the European Commission, which have been invited for this special issue. A. McKinlay presents the main ideas to be addressed by COST BM0704, "Emerging EMF Technologies Action on Possible Health Risks", which is expected to gather (it is about to start by the time this note is being written) many of the European experts in the several areas crossing this matter, ranging from engineering to medicine. Another European initiative, under the Framework Programme 6, is the Coordination Action EMF-NET, "Effects of the Exposure to Electromagnetic Fields: from Science to Public Health and Safer Workplace", also including many European participants from a broad range of expertise, which main results are presented by P. Ravazzani.

The issue follows with the remaining papers, coming from the open call. M. Cueille et al. address the development of a numerical model connecting electromagnetism, thermal and hydrodynamics in order to analyse in vitro exposure, by presenting a numerical model to provide a complete dosimetry for exposure systems, using the FDTD approach. J. Silly-Carette et al. deal with the analysis of the numerical one-step

method in the time domain, including lossy media and absorbing boundary conditions, for studies on bio-electromagnetics. C. Person et al. present a study on the design and optimization of E-field probes for SAR evaluation, including a comparison between simulations and measurements. Afterwards, some papers address the problem of SAR assessment by using numerical methods: F. Lacroux et al. look at the exposure near a base station, analyzing the relationship between the antenna input powers required to reach the SAR basic restriction values and ones that are required to reach the power density reference levels; N. Varsier et al. investigate SAR characterization inside intracranial tumors for case-control epidemiological studies on cellular phones, results being found to be highly dependent on phone categories; A. Pradier et al. evaluate the SAR induced in a multilayer biological structure and compare with the one in homogeneous tissues, in a wide range of frequencies.

Then, another group of papers present measurement results for exposure around transmitters: G. Thuróczy et al. show results for personal RF exposimetry in urban areas from broadcast and mobile cellular systems; F. Troisi et al. present the Italian national EMF monitoring network, which includes also actions of risk communication targeting the population; and A. Gotsis et al. introduce the EMF monitoring networks in Greece, with a detailed analysis of the results obtained so far. Finally, still in the same are, but with a slightly different perspective, T. Alanko et al. deal with occupational exposure to EMF from base station antennas on rooftops, having in mind the European Directive 2004/40/EC regarding the exposure of workers.