ICES

International Committee on Electromagnetic Safety

Technical Program

IEEE/ICES Workshop on Current Status of LF Dosimetry Modeling

0830 – 1640 h
Sunday, 14 June 2015
Chapel Hall, Asilomar Conference Center
Pacific Grove, California, USA

Organizers & Chairs: Akimasa Hirata (Nagoya Institute of Technology)
and
J. Patrick Reilly (Metatec Associates)

1. **0830 – 0840: Opening Remarks**

2. **0840 – 0910: "Rationale behind EMF Compliance Assessment Protocols," Andreas Christ (*Research Consultant, Cabo Frio (RJ), Brazil*) and Jafar Keshvari (*Microsoft Corporation, EMF Research and Standards, Espoo, Finland*)**
   This work discusses the scientific principles for the development of procedures for the quantification of the EM fields induced in the human body regarding both purely experimental and combined numerical and experimental approaches. As a main aspect the concept of conservativeness is introduced by reviewing the design criteria that were applied on the development of the Specific Antrhopometric Mannequin (SAM) used in cell phone compliance testing. In addition, the requirements on the applicable experimental instrumentation and numerical techniques as well as on the development of evaluation protocols and methods for the assessment of the experimental and numerical uncertainty are presented.

3. **0910 – 0940: "Measurement of dielectric characteristics of biological tissues from ELF to MMW frequencies," Kanako Wake, Kensuke Sasaki, and Soichi Watanabe (*National Institute of Information and Communications Technology, Tokyo, Japan*)**
   The dielectric property values of biological tissues are used for the safety analysis and development of medical applications. A previous study conducted by Gabriel et al. has provided reference dielectric databases. To the best of our knowledge, no other databases have been constructed that allow a comprehensive measurement to be conducted with such a large number of tissues and organs. To this end, we present the development of a novel database for adaptation to recent research, permitting the validation of measured dataset by Gabriel et al. In this paper, we

introduce measurement systems for further developing the database and summarize our findings with a discussion on the remaining challenges.

4. **<u>0940 – 1020:</u> "The role of skin modelling in ELF/LF magnetic field exposure assessment based on IEEE C95.6 and ICNIRP 2010," Schmid Gernot (*Seibersdorf Laboratories, Austria*)**

In ELF/LF magnetic field exposure scenarios maximum in situ field strengths usually appear in spots of skin-to-skin or skin-to-metal contact. For the computational dosimetric analysis of such exposure scenarios it is essential to use an appropriate skin model in order to avoid substantial assessment errors with respect to the in situ electric field strengths inside skin and subcutaneous tissues. However, due to computational limitations only a highly simplified representation of the complex layered structure of the human skin can be used in practice. In this presentation latest results of systematic comparisons of different skin models (homogeneous vs. layered) will be shown and consequences with respect to present exposure limits will be discussed.

<u>Break: 1020 – 1040</u>

5. **<u>1040 – 1110:</u> "Review of ELF/LF dosimetry for magnetic field exposure in Japan," Kenichi Yamazaki (*CRIEPI, Yokosuka, Japan*)**

Numerical calculation of internal electric fields caused by ELF/LF magnetic fields is one of the key issues in addressing the biological effects. In Japan, scientific committees have been successively organized in IEEJ (Institute of Electrical Engineers in Japan) and have conducted investigations focused on the issue since early 2000's. This presentation focuses on the results of an intercomparison of the internal electric field calculations conducted by several research groups using the same anatomical human model.

6. **<u>1110 – 1140:</u> "Modeling of transcranial Electrical Stimulation (tES): Implications for Safety and Efficacy," Dennis Truong and Marom Bikson (*City College New York, USA*)**

Transcranial electric stimulation (tES) is a noninvasive neuromodulation technique that encompasses low intensity current stimulation (typically 1 to 2 mA) via skin electrodes. Common applications being investigated include therapeutic use as well as cognitive enhancement and physiological research. Computational models have become an increasingly popular method of assessing focality and intensity as a result of electrode configuration. Individualized modeling has allowed similar analysis between subjects and even populations. Examples of these models and their implications to safety and efficacy are discussed. Present limitations are presented.

7. **<u>1140 – 1210:</u> "Survey of Electrostimulation models," J Patrick Reilly (*Metatec Associates, USA*)**

This paper presents the results of a survey of electrostimulation models of myelinated nerve. Participants were asked to determine thresholds of excitation for 18 cases involving different characteristics of the neuron, the stimulation waveform, and the electrode arrangement. Responses were received by various investigators using different models of myelinated nerve. The results reveal significant differences among the models for some of the test cases. The differences in reported results point to the need for experimental verification. Additional efforts need to be directed to development of computational models for unmyelinated C-fibers, A-delta fibers, CNS neurons, and CNS Synapses.

Break: 1210 – 1330

8. **1330 – 1400: "Magnetophosphene perception threshold in humans exposed to ELF MF up to 50 mT – experimental data and a modelling approach," Alexandre Legros (*Lawson Health Research Institute, Canada*)**

   Although magnetophosphene perception is the most reliable reported effect on acute human neurophysiological responses to ELF MF exposure, current knowledge is based on small sample sizes and non-replicated experiments. This works aims to study the impact of 20/50/60/100 Hz MF of up to 50 mT on magnetophosphene perception and associated electroencephalographic (EEG) activity in humans. A modeling approach is also used to characterize the interaction between the induced E-fields and retinal cells. Preliminary results indicate a magnetophosphene perception threshold at 15 mT at 50/60 Hz (n=51), and decreased EEG alpha (8-12 Hz) activity above. The full results will be discussed at the workshop.

9. **1400 – 1430: "Insights on human response to EMF exposure obtained by combining detailed anatomical induction models and modern neuronal dynamics models," Esra Neufeld (*IT'IS Foundation, Switzerland*)**

   By functionalizing detailed anatomical models with realistic neuronal dynamics models, insights into EM induced neural stimulation can be gained that are relevant with regard to intended and unintended stimulation. The focus of the presented study will be on the assessment of low frequency exposure safety using MRI gradient coil switching as an application example. Assumptions underlying current safety standards will be identified and critically examined. Investigated aspects include neuronal dynamics models, field inhomogeneity, field and trajectory smoothing, thermal and tissue interface effects, and stimulation mechanisms.

10. **1430 – 1500: "Multi-scale induction and electrostimulation model with experimental validation," Ilkka Laakso and Akimasa Hirata (*Nagoya Institute of Technology, Japan*)**

    Magnetic stimulation enables us to investigate the function of the human nervous system non-invasively. However, it is difficult to determine which internal sites are actually affected by it. Here we describe a computational model that combines a finite-element induction model with electrostimulation models. The model predictions are compared with responses recorded experimentally for magnetic spinal nerve root stimulation. We show that the model can quantitatively reproduce experimental data, leading to improved understanding of the physics and basic mechanisms of non-invasive stimulation. Our work shows that computer-based modeling is a promising new approach to evaluate and improve the accuracy of non-invasive stimulation.

Break: 1500 – 1520

11. **1520 – 1640: Discussion on Future Research Topics**