



# **Commission E**

## **2008-2011 Triennial Report**

Chair: Prof. Christos Christopoulos

Vice Chair: Prof. A P J van Deursen

### I. Terms of Reference

During the General Assembly in Chicago, the name of the Commission and its terms of reference were changed to better reflect current scientific and industrial practice.

Commission E promotes research and development in:

- a) Terrestrial and planetary noise of natural origin, seismic associated electromagnetic fields;
- b) Man-made electromagnetic environment;
- c) The composite noise environment;
- d) The effects of noise on system performance;
- e) The effects of natural and intentional emissions on equipment performance;
- f) The scientific basis of noise and interference control, electromagnetic compatibility;

g)Spectrum management.

## **II. Commission E Working Groups**

A number of Working Groups have been established to provide a focus for a number of activities relevant to the theme of Commission E. These are outlined below, together with the contact person and where appropriate a brief summary of its activities during the three year period.

### E1. Terrestrial and Planetary Electromagnetic Noise Environment

Co-Chairs: M.Hayakawa (Japan), A.P. Nickolaenko (Ukraine), C. Price (Israel), Y. Hobara (Japan), K. Hattori (Japan)

This working group deals with the electromagnetic noise environment on the Earth and on other planets. The main interests and activities of E1 during the last three years is summarised as follows: (1) study of the characteristics and generation mechanisms of ionospheric/magnetospheric electromagnetic noise by means of satellite observations; (2) study of global and local lightning distributions and characteristics by means of ground- and satellite-based observations; (3) study of electromagnetic and plasma phenomena associated with earthquakes and volcano eruptions.

Especially a lot of progress has taken place in the field of lightning. Lightning is recently regarded as a new and fundamental topic in physics because it includes particle acceleration and its significant effects onto the mesosphere (transient luminous events) and ionosphere. In addition, a lot of convincing evidence has accumulated on seismo-electromagnetics effects. In particular, a statistically significant correlation between the ionospheric perturbations as detected by sub-ionospheric VLF/LF propagation and earthquakes (large magnitude and shallow) was obtained from long-term data.

### E2. Intentional Electromagnetic Interference

Co-Chairs: M. Bäckström (Sweden), and W. Radasky (U.S.A)

This working group studies the area of intentional electromagnetic interference (IEMI), which is defined by the IEC as the “Intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes.” In particular, this working group focuses on the electromagnetic threat weapons, the coupling to electronic systems, the vulnerability of systems to these types of transients, and the protection of systems from the IEMI threat.

### E3. High Power Electromagnetics

Co-Chairs: C.E. Baum (U.S.A) (deceased), and R.L. Gardner (U.S.A)

The subject of this working group is the physics and engineering associated with electromagnetic sources for which nonlinear effects associated with high-field regions must be avoided or included in the analysis and design. This includes (but is not limited to) EMP simulators, high-power narrowband and mesoband sources and antennas, and hyperband (impulse) sources and antennas. It also includes the environment near lightning channels and in nuclear EMP source regions. In some cases it includes the high-field regions on, or in targets.

First, it is with great regret that the Commission E community reports that the long time chairman of the High-Power Electromagnetics Working Group, Dr. Carl E. Baum passed away early this year. Those working in the field will miss his leadership and his pioneering work.

The purpose of the High-Power Electromagnetics Working Group is to encourage research in electromagnetics, which is of sufficient power to show nonlinear effects in at least part of the problem. Such problems often involve the response of air or surrounding dielectrics subject to breakdown level fields. Consequently, Maxwell's Equations are often augmented by various plasma physics equations in addition to the usual boundary value problems. Working Group efforts are informal and are often in cooperation with the Permanent NEM Committee, US National Committee Commission E and other similar organizations supporting the general subject of electromagnetic compatibility.

Much of the work associated with the EUROEM and AMEREM series of meetings was dedicated to the understanding of high-power electromagnetics and applications. During this triennium, meetings were held in Lausanne, Switzerland in 2008 and Ottawa in 2010. These meetings, along with all other NEM, AMEREM and EUROEM Meetings were held in formal cooperation with URSI.

Sessions on HPE were also organized at the URSI General Assembly in Chicago in August 2008 and at the US National Radio Science Meetings in 2009, 2010 and 2011. Contributions in the form of lightning papers and related coupling papers were given at PIERS 2009 in Hangzhou and will be given at PIERS 2011 in Marrakech.

Each of the International Conferences on Electromagnetics in Advanced Applications has had a session dedicated to the understanding of high-power electromagnetics. While these sessions were labelled "Intentional Electromagnetic Interference", the subject matter was that of high-power electromagnetics. During this triennium, sessions were held in Turin in September 2009 and in Sydney in 2010. Finally, members of this working group have held a series of short courses on high-power electromagnetics. During the triennium a course was held in Chateau d'Oex, Switzerland in 2009. During that course, 26 new scientists were introduced to high-power electromagnetics.



#### E4. Lightning Discharges and Related Phenomena

Chair: Z. Kawasaki (Japan), V. A. Rakov (USA)

#### E5. Interaction with, and Protection of, Complex Electronic Systems

Co-Chairs: F Sabath (Germany) and J-P. Parmentier (France)

#### E6. Spectrum Management

Chair: T.Tjelta (Norway).

The spectrum management working group has since the last GA in 2008 organised one session on spectrum management at a conference and planned a session at the upcoming general assembly.

An URSI Comm. E spectrum management session was organised as part of the EMC Europe conference held 13-17 September 2010 in Wroclaw, Poland. The session included five presentations addressing general spectrum management in the context of market mechanisms and free utilisations, called “commons”, the recent interest in “white space” in the UHF bands, a study showing almost negligible interference from new mobile systems in the 800 MHz bands for TV households in lower bands, an introduction to spectrum management for radio systems dealing with climate data addressing climate change issues, and radiowave propagation and utilisation of spectrum in West Africa.

The planned spectrum management session at URSI GA addresses effective utilisation of the radio spectrum. It covers presentations on sound scientific spectrum management methods such that services are available in an interference-free environment, collaboration and interoperability between various spectrum users, and more recent ideas of sharing spectrum in a dynamic manner. There will be presentations on the following themes:

- Spectrum needed to fulfil ambitions of broadband access for everyone in the world
- Modern approaches to spectrum sharing
- Broadband mobile and fixed convergence and traditional ITU-R radio regulations
- Perspectives and problems of opportunistic and dynamic spectrum management
- Conservation of spectrum for scientific services
- Overview: physical, technical/practical, economical, and regulatory approaches to spectrum management

#### E7. Geo-Electromagnetic Disturbances and their Effects on Technological Systems

Chair: A. Viljanen (Finland)

#### E8. Electromagnetic Compatibility in Wire and Wireless Communication Systems

Co-Chairs: J. Gavan (Israel), and A.Zeddami (France)

Commission E: Joint Working groups

Inter-Commission working group on Solar Power Satellites

Chair: H. Matsumoto (Japan)

Co-Chair for Commission E: J. Gavan (Israel)

EGH. Seismo Electromagnetics (Lithosphere-Atmosphere-Ionosphere Coupling)

Co-Chair for Commission E: M. Hayakawa (Japan)

### **III. Commission E Related National Activities**

During the triennial period a large number of events linked to Commission E took place in many cases directly sponsored by URSI. Listed below is a selection of national activities to show the breadth of Commission E-based events:

**France:**

For the last two three years, the scientific activities of the Commission E have been represented during the 15<sup>th</sup> international and exposition symposium on EMC which took place at Limoges (April 7-9 2010). There was an increase to the number of participants (260); 107 communications were presented during three sessions in parallel and a poster session (22 posters). This large number of articles and the growing number of PhDs underlines the importance and the interest of academic, industrial and young scientists in EMC problems. The success of this symposium was amplified by the participation of about fifteen exhibitors (private companies) which indicates strong partnerships with the EMC research teams.

Many communications addressing advanced numerical models and new characterization methods were presented on the topic of "EMC interaction on complex systems" (more than 34 papers), with a focus on cable networks and applications in aerospace and automotive systems. Numerical modeling for EMC applications represents again an important activity of the research teams. The other topics presented were measurement techniques (12 papers and 4 papers about MSRC), communication systems (4 papers), power systems (5 papers), and integrated circuits (10), protection systems (4 papers). It can be noted that the biological effects community (Commission K) shows good interaction with Commission E, in particular for the study of exposure systems (12 papers).

**Italy:**

During the past triennium, the Italian contribution to the URSI Commission E scientific activities can be summarized as follows.

The members of the Department of Electrical Engineering of La Sapienza (M. D'Amore, S. Greco, M.S. Sarto, A. Tamburrano) work on the technology of EM shields transparent at optical frequencies, on numerical modelling and on transient waveforms of electric and magnetic fields.

The Telecom Lab TILAB (M. Giunta) works on the evaluation of coupling between Power Line Communication and VDSL2 links and on VDSL2 simulation parameters. In order to ensure reliable operation in the distribution of broadband services around homes, suitable noise models were developed.

A joint activity which brings together the Department of Information Engineering of the University of Padova, the Industrial Electronic Research Centre and the National Institute of Metrology Research, is currently analyzing in depth and developing improved adapters for the accurate calibration of LISN input impedance, and studying the uncertainty evaluation and reduction in air electrostatic discharge tests.

The main activity of the EMC Group of the Politecnico di Torino includes the creation of modelling tools and verification techniques for the Electromagnetic Compatibility of transportation systems, the modelling of cable networks and the study of parameter variability effects on the performance of electronic devices. A statistical assessment of good-but-imperfect Reverberation Chambers has also been conducted.

The members of the "Department of Biomedical Engineering, Electronics and Communications" and the "Antennas and EMC Group" of the Università Politecnica delle Marche provide expertise in reverberation chambers, in particular in FDTD technique analysis, in the efficiency of cable shielding and in techniques of electronic stirring. Their contributions also include the study of the simulation of cardiac stimulators on the human body and the study of plasma columns.

The activity of the EMC Group at Politecnico di Milano is mainly focused on the characterization of interference effects in wiring structures (lines and cables), and development of innovative experimental procedures and optimized setups for EMC assessment at the unit/system level. In particular, Group activity over the past three years includes development of statistical EMC prediction models for field-to-wire coupling and crosstalk, analysis of noise effects in time-domain measurement systems, development of optimized measurement systems for EMC assessment of high-speed railway systems, and characterization of the power-line communications (PLC) channel frequency-response for different channels and different applications of the PLC technology.

An URSI Italy meeting was held in Parma in June 2009, where the activities of all Commissions were illustrated. Commission E presented an overview of the activities of

various research groups and Prof. Paolo Corona of Parthenope University in Naples delivered an invited speech on “Digital telecommunications and Electromagnetic Compatibility” which focused on the need for having new procedures, parameters and evaluation methods which take into account the frequency impact of new multiple access systems.

#### **Netherlands:**

Commission E related activities include, three annual joint conferences with NERG (Dutch Institute of Electronic and Radio Engineers), yearly joint symposium with the Belgian national URSI committee, EMC project research funded by Ministry of Economic affairs IOP-EMVT and EU FP7 (ILDAS, Marie Curie, HIRF-SE), Lightning related research funded by the Dutch Technology Foundation STW ([www.stw.nl](http://www.stw.nl)) and various activities sponsored by the Dutch EMC Foundation ([www.emc-esd.nl](http://www.emc-esd.nl)) such as knowledge market, EMC on Tour etc.

#### **Portugal:**

Relevant activities include the 2<sup>nd</sup> Congress of the Portuguese Committee of URSI (20-21 Nov 2008) devoted to the theme of “Electromagnetic Compatibility and New Radio Communications Services” <http://www.anacom.pt/render.jsp?contentId=704949&languageId=1>; the 3<sup>rd</sup> Congress of the Portuguese Committee of URSI (3-4 Nov 2009) with several papers presented on the topics of Commission E <http://www.anacom.pt/render.jsp?contentId=704949&languageId=1>; the 4<sup>rd</sup> Congress of the Portuguese Committee of URSI (23-24 Sept 2010) with several papers presented on the topics of Commission E <http://www.anacom.pt/render.jsp?contentId=1048655&languageId=1>

#### **South Africa:**

Several activities related to Commission E business are organised in collaboration with other scientific societies. In June 2009 an IEEE joint EMC chapter along with AP/MTT were started. The 2011 South African IEEE combined AP/MTT/EMC chapter conference will be held in Stellenbosch on **14 and 15 April 2011**. Engineers from both the South African industry and academia in the fields of Antennas and Propagation, Microwave Theory and Techniques and Electromagnetic Compatibility will be brought together. The conference will host approximately 40 technical papers, *all invited*, which will cover the whole spectrum of antennas, microwave and radar engineering activity in South Africa. This includes research activities centred around the South African Square Kilometre Array (SKA) radio-astronomy project, active and passive microwave devices, computational modelling, and Electromagnetic Compatibility. The department of EE Engineering at Stellenbosch has an extensive group tackling RFI mitigation and EMC for SKA demonstrator systems. South Africa's TC73 has made sustained submissions to CISPR sub-committee concerning PLT systems and legislation. In expressing extreme caution, South Africa promoted the inclusion of the “in some countries” clause. South Africa's electricity utility, ESKOM, has meanwhile been contemplating its own response to PLT and is drafting a standard, NRS 094, which is a code of practice for utilities to use in their engagement with third party PLT operators wishing to use their 'last mile' infrastructure. In its present final draft form it does not deal with EMC issues directly, but alerts the electricity utility to the co-existence /lack of

co-existence issues that can arise. This is particularly relevant because of the evolving applications in 'smart metering' where many electricity utilities need to communicate with their customers' electricity meters (e.g. through PLC over the LV networks).

ESKOM has also produced the NRS083 standard which is a comprehensive code of practice for the application of EMC standards and guidelines in electricity networks – its part 2 concerns substation design and equipment installation practices.

#### **Sweden:**

Commission E in Sweden holds two meetings per annum a total of six over the triennium. Of these, three meetings are held jointly with the IEEE EMC Chapter. The attendance at these meetings ranges between 10 and 50. The Swedish Commission E has 28 members.

Of the many publications on international conferences and in scientific journals that were published by commission members we would like to highlight one that received the "2009 Richard Schultz Transaction Paper Award" for the best paper during 2008 in the IEEE Transactions on EMC. The title of this paper is "Vulnerability of European Rail Traffic Management System to Radiated Intentional EMI".

#### **United Kingdom:**

International collaboration in Radio Science:

In September 2008 the UK representative for Commission E gave the invited lecture *Partial discharge: noise or signal?* at the Recife headquarters of Companhia Hidro Eletrica do Sao Francisco in Recife, Brazil. This lecture outlined the potential information available in the noisy electromagnetic environment of an electricity substation and how this information may be used for condition monitoring of power system plant. The UK Commission E member was subsequently appointed under a 12-month sabbatical arrangement to the full-time post of CAPES Visiting Professor of Radio Science at the Universidade Federal de Campina Grande (UFCG), Brazil. This international collaboration in Radio Science resulted in several further outputs and activities related to Commission C, E and F activities:

UK Festival of Radio Science:

Commission E played a full role in IET-URSI UK Festivals of Radio Science held at the University of Birmingham on 15 December 2009 and the University of Leicester on 12 January 2011. These events organised by the UK URSI panel cover all URSI commissions and are specifically designed to promote Radio Science by giving an opportunity for Research Students and early career researchers to present their work to an audience consisting of senior Radio Scientists. Commission E related work was well-represented at both events.

#### **United States of America:**

The US National Committee (USNC) of URSI Commission E has promoted new organized and special sessions since Jan. 2009 and this resulted in increased attendance (more than double) compared to three years ago. The sessions were organized at the US National Radio Science meeting, which occurs every year in the month of January, and at the joint IEEE International Symposium on Antennas and Propagation with USNC/URSI.

In particular, in Jan. 2010 it was the turn of USNC/URSI Comm. E to organize one of the plenary talks at the National Radio Science Meeting. The title of the talk was “Computer modeling tools for EMC engineers” and the presenter was Prof. Todd Hubing of Clemson University.

The following sessions relevant to Commission E were organised: 2009 National Radio Science meeting, Boulder, Colorado, USA (High Power Electromagnetics); 2009 IEEE Intl. AP-S Symposium/USNC-URSI, Charleston, SC, USA (Electromagnetic Environments and Interference: High-Power, Transients, and Spectrum Management); 2010 National Radio Science meeting, Boulder, Colorado, USA (High-Power Electromagnetics: Environments and Sources; EM Interference: Effects and Cyber Threats); 2010 IEEE Intl. AP-S Symposium/CNC/USNC-URSI, Toronto, Ontario, Canada (Research directions for future radar systems: perspectives from the DoD R&D community; EMI modeling, interference and coupling); 2011 National Radio Science meeting, Boulder, Colorado, USA (Waveform Diversity: Multidisciplinary Approaches to Different Sensing Modalities; Radar-Communication Spectrum Issues: Management, Allocation, and Compatibility; Radio Frequency Interference Mitigation and Spectrum Usage)

#### IV. Meetings

A large number of meetings took place in the review period as outlined in section III. In addition, Commission E sponsored a number of international meetings which are listed in the attached table which also indicates expenditure.

##### Balance sheet of Commission E

Budget 2008-2011: EUR 9,000

code	details meeting	mode	allocation in Euro
090112EK	EMC Zurich 2009 - 20th International Zurich Symposium on Electromagnetic Compatibility, Zurich, Switzerland, 12-16 January 2009	A	EUR 0
090611E	EMC Europe Workshop "Materials in EMC Applications", Athens, Greece, 11-12 June 2009	B	EUR 500
090622BCE	ISTET'09 - International Symposium on Theoretical Electrical Engineering, Luebeck, Germany, 22-24 June 2009	A	EUR 0
090720CE	EMC'09 Kyoto, 2009 International Symposium on Electromagnetic Compatibility, Kyoto, Japan, 20-24 July 2009	A	EUR 0
090912BCDEFH	ICEAA'09 - International Conference on Electromagnetics in Advanced Applications, Torino, Italy, 14-18 September 2009	A	EUR 0
100329JE	RFI 2010 - RFI Mitigation Workshop, Groningen, The Netherlands, 29-31 March 2010	A	EUR 0
100412BE	Asia Pacific EMC Symposium, Beijing, China, 12-16 April 2010	A	EUR 0
100621BEF	OCOSS 2010 - Ocean and Coastal Observation: Sensors and observing systems, numerical models and information systems, Brest, France, 21-23 June 2010	A	EUR 0
100817BCEG	Nordic Shortwave Conference HF10 and Longwave Symposium LW10, Farö (north of the island of Gotland in the Baltic), 17-19 August 2010	A	EUR 0
100920BDEFGJ	ICEAA'10 - International Conference on Electromagnetics in Advanced Applications, Sydney, Australia, 20-24 September 2010	A	EUR 0
100922ABCDEFHJK	AP-RASC'10: 3rd Asia-Pacific Radio Science Conference, 22-25 September 2010, Toyama, Japan	B	EUR 500
100913E	EMC Europe, Wroclaw, Poland, 13-17 Sept. 2010		
110912ACEFGHJK	ICEAA-APWC 2011, Torino, Italy, 12-17 September 2011	A	EUR 0
110926EB	EMC Europe 2011, York, UK, 26-30 September 2011	A	EUR 0
Total :			EUR 1,000
Balance :			EUR 8,000
Budget (fixed in Euro) :			EUR 9,000

## **V. Reviews of Radio Science**

The following papers were contributed to the Radio Science bulletin:

1. "EMC in Space Systems: Current Practices and Future Needs-The ESA Perspective", A. Ciccolella, F. Marliani, Radio Science Bulletin, No 328, March 2009, pp 9-19.
2. "Man-made Noise in Our Living Environments", F. Leferink, F. Silva, J. Catrysse, SA. Batterman, V. Beauvois, A. Roc'h, Radio Science Bulletin, , No 334, Sept. 2010, pp 49-57.

## **VI. Website**

Further information about Commission E may be found in the web links below:

<http://www.ursi.org/en/commission.asp?com=E>

<http://ursi-test.intec.ugent.be/files/E/Homepage.htm>

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