

Commission E
on
Electromagnetic Environment and Interference

2011-2014 Triennium Report

Chair: Dr. A P J van Deursen

Vice Chair: Prof. D. Giri

I. Terms of Reference

During the General Assembly in Chicago in 2008, 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, including lightning and 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: C. Price (Israel), Y. Hobara (Japan) , A.P. Nickolaenko (Ukraine), and K. Hattori (Japan)

This WG deals with the study on the characteristics of electromagnetic noises taking place not only in the terrestrial, but also in the planetary environment. The most well-known noise is the atmospheric radio noise from the lightning discharges (so-called sferics in a wide frequency range

from ULF to VHF). Some examples of topical subjects on sferics are (1) monitoring of global lightning activity as studied by high frequency noise and Schumann resonance phenomena in the ELF band and (2) ELF transients related with the optical emissions in the mesosphere due to the lightning. Higher frequency lightning emission provides us with the information on the fine structure of lightning electrical structure, while lower frequency noise provides us with the macroscopic nature of lightning. The noise coming from the ionosphere/magnetosphere will be discussed as well; micro pulsations in the ULF range, VLF/ELF emissions and HF emissions due to the plasma instabilities in the space. Also, our recent topic is the radio emission from the lithosphere, which covers again a wide frequency range from DC to VHF (or even more). The characteristics and generation mechanisms of those effects and also the seismic effect onto the ionosphere will be discussed. Finally, the radio noise environment on other planets (like Jupiter) will be our topic as well. The interaction of these natural noises with artificial noises due to human activity is also another subject. Power line harmonic radiation penetrates into the ionosphere/magnetosphere and induces the particle precipitation into the lower ionosphere (this is a kind of pollution of the natural environment by human activity). Also, we discuss the interaction of natural environment with human activity

During the years between 2011 and 2014, following international symposiums/conferences related to the subjects of our working group were held.

-International Symposium on Monitoring and Prediction of Earth's Environment by Using Electromagnetic Methods was organized by Prof. Hobara in The University of Electro-Communications (UEC) Tokyo, Japan in May 2012.

-JpGU (Japan Geoscience Union Meeting) (Japan): International session of Atmospheric Electricity was chaired by WG member in 2012-2013.

-COSPAR 2012 (India): Session (Ionospheric Disturbances Observed Through Very Low Frequency Radio Waves) was chaired by WG member.

-EMSEV (Inter Association Working Group on Electromagnetic Studies of Earthquakes and Volcanoes) in 2012 and 2014: Sessions were chaired by WG members.

-WG members actively presented the papers in the various international scientific meetings such as EGU, AGU, IAGA and Isradynamics.

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.

Over the 2011-2014 period a large number of conferences dealt with IEMI, along with other aspects of HPEM:

- Joint IEEE APS and URSI Meeting in Spokane, Washington, July 3-8, 2011. Dr. Giri and Prof.

Uslenghi organized an "In Memoriam " special session to remember Dr. Carl Baum (11 papers).

- URSI General Meeting in Istanbul, Turkey, August 15-19, 2011. There was a session organized by Dr. Sabath and Dr. Radasky entitled, "High Power EM and IEMI" with 11 papers presented.
- A weeklong short course HPE 201-2011 was presented in Schloss Noer, Germany, September 18-24, 2011. Dr. Dave Giri served as Lecturer and Course Director.
- IEC SC 77C (High Power Transient Phenomena) Project and Plenary Meetings in Seoul, South Korea, October 19-21, 2011. Work continued on IEMI and HEMP standards for protecting civil systems from these threats. Dr. Radasky chairs IEC SC 77C and the Secretary is Dr. Hoad.
- USNC URSI Conference in Boulder, Colorado, January 4-7, 2012. Several papers were presented dealing with IEMI.
- A weeklong short course HPE 201-2013 was presented in Lohas Park, South Korea, 26 May-1 June 2013. Dr. Dave Giri served as Lecturer and Course Director. APEMC in Singapore, May 21-24, 2012. A special session on HEMP and IEMI was organized by Dr. Radasky. Another regular session on HPEM was also held. A total of 8 papers were presented.
- EUROEM Symposium held in Toulouse, France from July 2-6, 2012. This symposium is dedicated entirely to HPEM topics and had 218 papers and 312 participants. There were a significant number of papers dealing with IEMI.
- IEEE EMC Symposium held in Pittsburgh, Pennsylvania from August 4-10, 2012. A workshop was held dealing with Intentional EMI (IEMI), and 15 papers were submitted dealing with HPEM and also EM Information Leakage.
- Joint ICEAA 2012 - IEEE APWC 2012 - EEIS 2012 (URSI Commission E) Conference held in Cape Town, South Africa from September 2-7, 2012. Eleven papers were presented dealing with various aspects of HPEM, including IEMI.
- Conference on Environmental Electromagnetics (CEEM) held in Shanghai, China from November 6-9, 2012. Several sessions were organized with IEMI papers.
- Directed Energy Professional Society (DEPS) Symposium Conference held in Albuquerque, New Mexico from November 26-30, 2012. While this conference is aimed mainly at source development, there was a session that included papers covering HEMP and IEMI.
- National Radio Science Meeting sponsored by the USNC-URSI held in Boulder, Colorado from January 9-12, 2012. There were a few papers dealing with HPEM and IEMI at this meeting.
- An IET Seminar entitled, "Extreme Electromagnetics – The Triple Threat to Infrastructure," held in London, England on January 14, 2013. Ten papers were presented dealing with impacts of HPEM (HEMP, IEMI and severe geomagnetic storms) on the critical infrastructures.
- Asia-Pacific EMC (APEMC) Symposium held in Melbourne, Australia from May 18-23, 2013. There was a workshop on the protection of commercial facilities from HEMP and IEMI, and there was a special session on HPEM with 8 papers presented.
- IEEE EMC Symposium held in Denver, Colorado from August 4-8, 2013. There was a workshop on EM Information Leakage, and a special session on IEMI with 6 papers presented.
- A session entitled, "Intentional EMI (IEMI) and EMC" was organized at PIERS 2013, 12-15 August 2013 in Stockholm with 8 papers.
- EMC Europe Symposium held in Brugge, Belgium from September 2-6, 2013. There was a workshop presented on the impact of IEMI on the critical infrastructures in Europe reviewing the work of three special EU-funded projects. Also a special session on EM Information Leakage was held.
- 8th Future Security Research Conference in Berlin, September 17 – 19, 2013. One Session "Electromagnetic Threats And Countermeasures", consisting of 7 papers, and also a Panel

- Session with the same title, i.e. “Electromagnetic Threats and Countermeasures”.
- IEC SC 77C (High Power Transient Phenomena) Project and Plenary Meetings held in Ottawa, Canada from September 23-27, 2013. Work continued on IEMI and HEMP standards for protecting civil systems from these threats.

E3. High Power Electromagnetics

Co-Chairs: F. Sabath (Germany), and R.L. Gardner (U.S.A)

The objective is to encourage research in high power electromagnetics (HPE). The technical area of HPE consists of the physics and engineering associated with electromagnetic sources where nonlinear effects associated with high-field regions (and air breakdown) must be 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 because of local field enhancement.

E4. Lightning Discharges and Related Phenomena

Chair: V. A. Rakov (USA) and S. Yoshida (Japan)

The lightning discharge is one of the two natural sources of electromagnetic interference (EMI), the other one being the electrostatic discharge. Electric and magnetic fields generated by lightning represent a serious hazard to various systems, particularly those containing sensitive electronics. This WG focuses on the characterization of lightning and its interaction with engineering systems and with the environment, as well as on lightning detection and testing. It covers all aspects of lightning research, including observations, field and laboratory experiments, theoretical studies, and modeling.

Sessions on lightning discharges and related phenomena were organized at PIERS 2011 in Marrakesh, ICAE 2011 in Rio de Janeiro, ICLP 2012, in Vienna, GROUND/LPE 2012 in Bonito, SIPDA 2013 in Belo Horizonte, GROUND/LPE 2014 in Manaus, and ICAE 2014 in Norman, Oklahoma.

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

Co-Chairs: F. Gronwald (Germany), J-P. Parmentier (France) and H. Reader (South Africa)

This working group studies the various electronic and electromagnetic aspects related to the interaction with, and protection of, complex electronic systems. The focus is the analysis of the various coupling paths and their associated transfer functions into complex electronic systems, as formalized in the framework of electromagnetic topology. Analytical, numerical, and measurement techniques are used to characterize the electromagnetic fields and currents in a complex environment. In the analysis, special attention is placed on the emergence of new technologies, and the inclusion of advanced materials and communication systems.

Professor Reader announced that he will no longer be able to contribute to this working group because of a new position. Commission E thanks Professor Reader for his great contribution to the URSI in general, and this working group in particular.

E6. Spectrum Management

Chair: T.Tjelta (Norway) and R. Struzak (Poland).

The E6 focus is on sound scientific spectrum management for improved utilization of the radio frequencies for protection wireless communications service and radio sciences. The goal is to assure further development of radio sciences and communication services, unobstructed by potential radio interference due to unwanted energy in the form of out-of-band and in-band encroaching and deleterious in-band and out-of-band emissions. The electromagnetic spectrum is treated as a limited natural resource with a multitude of competing demands for access to it and use of it. Spectrum management seeks innovative means and technologies for adequate co-existence of all of them taking into account the need of protection of new and incumbent wireless and wired communication services, systems and equipment, with special focus on science services and those that use passive technologies.

Two of the papers presented at the previous GASS was revised and submitted to the Radio Science Bulletin, published in No 340 on the topics:

- Spectrum management overview.
- Opportunistic secondary spectrum access: Opportunities and limitations.

The WG than planned a session at the first Comm. E Electromagnetic Environment and Interference Symposium (EEIS 2012), in Cape Town, but very limited response and in the end no session on spectrum management. It was seen as a good opportunity to deal with the spectrum issues in between the GAs.

A session on spectrum management topics have been planned together with Comm. J for the GASS 2014. Some papers were received, and the session will be held.

It appears difficult to engage the community in between GAs to address spectrum management topics: either it is to improve spectrum utilization, or to ensure acceptable "interference free" environment for radio science services.

Dr Tjelte and Professor Struzak indicated that they would stop their activities for working group E6. Commission E thanks both for their contributions over the long period they held this position. Dr. J.P. Borrego will take the position in the next triennium. The commission actively looks for a second chair/member of this workgroup.

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

Chair: A. Viljanen (Finland)

E8. Electromagnetic Compatibility in Wired and Wireless Systems

Co-Chairs: A. Zeddami (France), F. Rachidi (Switzerland) and F. Gronwald (Germany)

The intensive use of the electromagnetic spectrum for communications has resulted in issues of compatibility and interoperability between different users. In addition the continual increase in operating frequency of products and higher frequency sources of disturbances (such as Ultra-Wide Band systems) resulted in an increase of potential EMC problems in communication systems and the use of power lines for carrying data is adding to interference problems. This session will focus on theoretical and experimental EMC aspects in both wire and wireless communication systems. Potential remedies will be also addressed.

Professor Gronwald becomes the new vice-chair for commission E at the 2014 GA in Beijing and is also a member of working group E5. He decided to be no longer an official chair for this working group.

E9. Stochastic Techniques in EMC

Co-chairs: L. Arnaut, S. Pignari, R. Serra

The EMC community is increasingly interested in the development of analysis and design techniques which take account of the inherent uncertainty of system parameters. In fact, the system response is affected by the statistics of such parameters, and varies widely within a distribution. Typical areas of interest include effects due to unknown wave parameters of interfering signals, statistical nature of fields inside metallic enclosures, uncertainty in the location of conductors inside multiwire structures and routing of bundles in metallic enclosures, values of termination impedances, values of stray parameters and material parameters, etc.

This new working is group proposed on the commission meeting during URSI GASS 2014

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)

Different kinds of electromagnetic precursors have been accumulated during the last few decades. Especially, geoelectric signals, ULF (ultra low frequency) and ELF (extremely low frequency) electromagnetic emissions, etc are the direct signature of seismic activity. Also, there have been observed perturbations in the atmosphere and ionosphere in possible association with earthquakes. The final goal is to understand different kinds of electromagnetic phenomena in the context of lithosphere-atmosphere-ionosphere coupling.

Activity during the last three years (2012-2014)

There have been accumulated a lot of evidence that electromagnetic phenomena do appear prior to an earthquake (EQ) on the basis of extensive ground-and satellite- based measurements. Especially, geoelectric signals are found to be associated with EQs, and ULF (ultra-low-frequency) electromagnetic emissions have been studied in numerous countries, and have been found to be statistically correlated with EQs. Ionospheric perturbations both in the bottom and the upper parts have been extensively studied by means of subionospheric VLF/LF signals and ionosonde data respectively, and a statistical correlation of those ionospheric perturbations with EQs has been recently established. Further, the satellite, Demeter has contributed a lot to the study of seismo-electromagnetics. Finally, in order to understand such seismo-atmospheric and -ionospheric perturbations, these have been proposed a few hypotheses of lithosphere-atmosphere-ionosphere coupling mechanism. A few monographs on seismo electromagnetics and EQ prediction have been published, and also there have been several workshops and many sessions in international conferences.

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:

China:

During last three years, the China national Commission E Chair (Dr. Yinghong Wen) has organized the special session “EMC and ITS Technologies” for 2012 International Conference on Electromagnetics in Advanced Applications which was held in South Africa from September 2 to September 7, 2012, and the special session “EMC and other Related Technologies for Rail Transportation” for 2014 International Conference on Electromagnetics in Advanced Applications which will be held in Aruba from August 3 to August 9, 2014.

The researchers in EMC laboratory of Beijing Jiaotong University have been studying the EM environment of China railway, the characteristics of EM disturbance sources in China high-speed railway system and EM interference protection technologies for the high-speed EMUs and the train control system. They have solved many train driving faults induced by EM interferences.

France:

During the past triennium, the activities of the commission E have been presented in 2012 and 2014, at the occasion of the 16th and 17th international symposiums on EMC which took place in Rouen (2012 april 25-april 27) and Clermont-Ferrand (2014 june 30-july 3).

For both symposiums, about 100 communications were presented during three sessions in parallel. In 2014, the organization committee of this symposium tried to increase the international participation in inviting the professor Christos Christopoulos to give an invited conference on the “challenges for experimenters and modelers in EMC analysis and design”. The effort was also to stimulate the relation with the activities of other domain of the URSI, in inviting a professor in optic domain who gave a presentation entitled “emission and radiation: the view of the physicist”.

Israel:

The Israel contributions to the URSI Commission E scientific activities are connected with the Israel IEEE EMC chapter activities. We organize a chapter on EMC in the yearly conferences organized by the Israel national electrical Engineering society with the Israel IEEE society, where are participating also members of URSI commission E and distinguished guest lecturers from abroad. This year we have organized the 30.01.14 a national conference in EMC, radio systems interference and radiation effects in HIT Holon with more than 120 participants and a scientific exhibition was included. The description of this conference and abstracts of the 14 presentations are included in the appendix.

In December 2014 are organized in Israel two EMC related conferences:

1. An international conference in Tel Aviv leded by Bill Radasky cochairman of the URSI committee E2 Intentional EMC Interference and Elya Joffe ex president of the worldwide IEEE EMC society.
2. A chapter on EMC at the joint national conference of the Israel association of electrical engineers and the Israel IEEE society, where will also participate lecturers from abroad. The chapter is leded by Jacob Gavan. Jacob is cochairman of the URSI committee E8 EMC in wired and wireless communication systems and the inter commission WG on SPS and Moshe Netzer ex chairman of the Israel IEEE EMC chapter.

Italy:

During the past triennium, the Italian contribution to the URSI Commission E scientific activities included the technology of EM shields, Power Line Communication, modelling tools and verification

techniques for the Electromagnetic Compatibility of transportation systems, reverberation chambers, statistical EMC, development of optimized measurement systems for EMC assessment of high-speed railway systems.

An URSI Italy meeting is held every other year in conjunction with the national symposium of Electromagnetics Society. In this meeting, the activities of all Commissions are illustrated. Commission E presented an overview of the activities of various research groups and in 2014 Prof Valter Mariani Primiani and Franco Moglie of Università Politecnica delle Marche delivered an invited speech on "Applications and optimization of reverberation chambers".

Netherlands:

Commission E related activities include

- Three annual joint conferences with NERG (Dutch Institute of Electronic and Radio Engineers)
- A yearly joint symposium with the Belgian national URSI committee,
- EMC PhD research funded by Ministry of Economic affairs IOP-EMVT and EU FP7
- Lightning related research funded by the Dutch Technology Foundation STW (www.stw.nl) with substantial contribution from industry
- Various activities sponsored by the Dutch EMC Foundation (www.emc-esd.nl) such as an EMC knowledge market and EMC on Tour.
- Organization of the EMC session in EUMW, November 2012.

Portugal:

In the last triennium (2011-14), the Portuguese Commission E has collaborated with the National Committee organising the URSI Annual Congress. During these events, significant scientific contributions, on the topics addressed by Commission E, have been received, such as invited talks, papers or posters. The national congresses also intend to stimulate a close relationship between industry, academia and society, by promoting scientific exhibitions to show new projects, demonstrators, and industrial and commercial products, most of them related to the Commission E activities.

- 2011: 5th Congress of Portuguese Committee of URSI, devoted to the theme: "Detection and measurement of radio signals in the future of radio communications", Programme: <http://www.anacom.pt/render.jsp?contentId=1093180>
- 2012: 6th Congress of Portuguese Committee of URSI, theme: "Electromagnetic wave applications: from energy efficiency to bioengineering", Programme: <http://www.anacom.pt/render.jsp?contentId=1130476>
- 2013: 7th Congress of the Portuguese Committee of URSI, theme: "An ocean without borders: technological challenges", Programme: <http://www.anacom.pt/render.jsp?contentId=1168130>

South Africa:

In September 2012, the South African Commission E was actively involved in the International Conference on Electromagnetic Advanced Applications (ICEAA-offshore, Cape Town, September 2012). This was in parallel with the first Electromagnetic Environment and Interference Symposium (EEIS) for Commission E. This URSI mid-term engagement was discussed at the last URSI GA in Turkey.

The local Commission E was also represented at the URSI BEJ meeting which ran in parallel with IEEE Africon 2013 in Mauritius Sept 9 -12. The URSI meeting was entitled: "LARGE SCALE SCIENCE PROJECTS: EUROPE-AFRICA CONNECTS". A plenary paper was given on: "New robust approaches to designing large radio research instruments" by H C Reader. The paper explored the challenges to

engineers, radio-astronomers and construction teams in their collaboration throughout the design process of large radio telescopes.

In other activities, Eskom, South Africa's national utility, is involved with the CIGRE national and international committee with regards to EMC. Eskom is involved with the following working groups addressing EMC in the power industry:

- CIGRE WG C4.30 – EMC of wind energy system
- CIGRE WG C4.31 - EMC between communication circuits and power systems
- CIGRE WG B4.61 – General guidelines for HVDC electrode design

EMSS South Africa, recently acquired by Altair, and its computational electromagnetics code, FEKO, is used extensively in EM & EMI simulations for research activities; a contemporary focus is allied to MeerKAT.

Various Engineering Departments were polled at main universities in South Africa to ask after 2014 activities in URSI E:

The University of Witwatersrand has strong lightning research interests led by Professor Ian Jandrell and Dr John Van Coller. Prof Ivan Hofsaier reports that their group has been involved with: measurement and mitigation of conducted EMI from power electronics; off-line switching ballasts for LED lighting applications; modelling, measurement and mitigation of capacitively conducted EMI across transformers isolated supplies. More recently, research has been active on: Multipath conductive structures consisting of multiple parallel paths of differing materials offer intrinsically EMI immune conductors. The physics of these multipath conductors has been investigated and results are already useful.

Geomagnetically induced currents (GIC) continue to be studied by the group led by Professor Trevor Gaunt at Cape Town University, in collaboration with Dr Pierre Cilliers at South Africa's National Space Agency in Hermanus. This work is linked to ESKOM.

The EMRIN Group at the Department of EE Engineering at Stellenbosch continues with its research on RFI mitigation and EMC for the SKA pre-cursor, MeerKAT. Signal propagation, shielding, reverberation chamber, common mode current coupling and time domain impulse metrology form part of the research focus. As a final note from the Stellenbosch group, Dr P Gideon Wiid is taking over the South African Commission E Chair as Professor Reader takes early retirement after years of involvement in the South African URSI committee.

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 29 members.

Topics areas for meetings in the period include "EMC and railways"; "Smart Grid: future electric power distribution and EMC"; "EMC in naval applications" and "EMC in space applications".

Members of commission E have been active in the arrangement of national and international conferences, notably "EMC Europe 2014" which will be held in Sweden in September 2014.

Members have also been giving lectures, plenary talks and papers at national and international meetings and conferences, published articles in scientific journals, and been acting as opponents or members of the evaluation committee of doctoral dissertations.

Switzerland:

Recent activities of the Commission E (in cooperation with Commission C) in Switzerland include the design, test and installation of a lightning current measurement system at the Säntis telecommunication tower in the Appenzell region of Switzerland. The site is operational since June 2010 and more than 400 flashes are successfully measured. The obtained data constitute the largest dataset available to this date for upward negative flashes.

United Kingdom:

The UK commission E started to join the scattered forces associated with the Institute of Physics and the Royal Meteorological Society which are genuinely associated with the work of the URSI commission E in the UK. A series of annual meetings was started in 2013, now known as the Wilson meetings which are held on an annual basis at the University of Bath. These meetings bring together UK experts working in the general area of atmospheric electricity and its applications. For example, topics range from cosmic rays, cluster ions, charged aerosols and current flow in fair weather conditions, to disturbed weather electrification, rain electricity, thunderstorm electrification, lightning, corona discharges, transient luminous events and even to Space Weather. The meetings were attended by scientists and representatives of companies working in the areas of lightning detection and location, applications of static electric fields in production processes and high voltage power line surveying. The next meeting is planned for November 5, 2014, at the University of Bath. The long term aim of the Wilson meetings is to establish a 'CTR Wilson Centre' as a communication portal to respond to requests by the government, the general public and to provide scientific expertise upon request.

UK Festival of Radio Science:

Commission E participates in the IET-URSI UK Festivals of Radio Science which will be held this year at the University of Manchester on December 16, 2014. These events are organised by the UK URSI panel and cover all URSI commissions. The meetings 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.

United States:

During the 2011-2014 triennium the US National Committee of URSI Commission E participated in four series of conferences. First, we participated in the USNC-URSI National Radio Science Meetings held in Boulder in January of 2013 and 2014. Particularly strong areas of interest included spectrum management, lightning, and wireless power transfer.

Second, we participated in the Antennas and Propagation / URSI conferences held in July of 2012 (Chicago), 2013 (Orlando), and 2014 (Memphis). Of particular note was a memorial session held in Chicago to celebrate the life of Dr. Carl Baum, who contributed so much to high power electromagnetics and related areas. It was moving to see so many of his colleagues from around the world talk about how Carl had mentored their work, and helped them to build HPEM programs in far-off places.

Third, we participated in the EUROEM/AMEREM series of conferences in July of 2012 (Toulouse) and 2014 (Albuquerque). The focus of this conference is high-power electromagnetics. Finally, we participated in the 2014 URSI GASS in Beijing.

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.

TBD with URSI Office

V. Reviews of Radio Science

The Radio Science bulletin 2012-3 was devoted to Commission E issues, with Dr. D.V. Giri as guest editor. The following papers were contributed:

D.V. Giri and F.M. Tesche, Energy Patterns of Pulsed Antennas Illustrated with a Reflector Type of an Impulse-Radiating Antenna (IRA) , RSB 340 (2012-3), pp 14-24.

Terje Tjelta and Ryszard Struzak, Spectrum Management Overview, RSB 340 (2012-3), pp 25 - 28

Jens Zander and Ki Won Sung, Opportunistic Secondary Spectrum Access : Opportunities and Limitations, RSB 340 (2012-3), pp 29-33

Etienne Sicard, Mohamed Ramdani, Samuel Akue Boulingui, Recent Advances in Integrated Circuit Immunity to Radio-Frequency Interference, RSB 340 (2013-3) pp 34 – 52

James C. Lin, Radio-Frequency Radiation Safety and Health. Are Radio-Frequency or Mobile-Phone Electromagnetic Fields Possibly Carcinogenic to Humans? RSB 340 (2012-3), pp 53-54

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>