Commission E (Electromagnetic Environment and Interference)

1. Results of Election of Vice Chair

There were three candidates for the position of Vice Chair available: Dr. Virginie Deniau (France), Dr. Martin Fullekrug (United Kingdom), and Prof. Yasuhide Hobara (Japan). After a careful vote count, yielding an almost even vote distribution amongst the three candidates, Dr. Virginie Deniau was declared elected as the Vice Chair of Commission E for the upcoming triennium.

2. Results of Election of Early Career Representative

For the position of second Early Career Representative, two candidates were available: Dr. Chaouki Kasmi (France) and Dr. Nicolas Mora (Switzerland). After the voting, Dr. Chaouki Kasmi was declared elected as the second Early Career Representative of Commission E for the upcoming triennium.

The Early Career Representative of the last triennium, Dr. Gabriele Gradoni, agreed to also serve as Early Career Representative for the upcoming triennium.

3. Appointment of Associate Editor for *Radio Science Bulletin*

The Vice Chair elect, Dr. Virginie Deniau, was appointed as the Associate Editor for the *Radio Science Bulletin*.

4. Updates/Status of Working Groups

The subject of Electromagnetic Environment and Interference is of concern within many disciplines of Radio Science. This is reflected in a number of working groups with focus on particular topics. These are outlined below with the names of contact persons and, where available, a brief description of the relevant topics. Typical activities of the working groups involve the organization of sessions for various conferences, workshops, and meetings.

4.1. 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 natural electromagnetic noise taking place not only in the terrestrial, but also in the planetary environment. The most well-known EM noise is the atmospheric radio noise from the lightning discharges (so-called sferics in a wide frequency range from DC to VHF). Some examples of topical subjects on sferics are (1) monitoring of global lightning activity as studied by high frequency noise and Shumann 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. The radio noise environment on other planets is also of interest to this group. We are particularly interested in using natural EM observations in monitoring, detecting, and forecasting natural hazards, such as thunderstorms, severe weather, space weather and seismic events.

4.2. E2. Intentional Electromagnetic Interference

Co-Chairs: M. Bäckström (Sweden) and W. Radasky (USA)

This WG 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 WG 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.

4.3. E3. High Power Electromagnetics

Co-Chairs: R.L. Gardner (USA) and F. Sabath (Germany)

The objective of this WG 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 meso-band 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.

4.4. E.4. Lightning Discharges and Related Phenomena

Co-Chairs: 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.

4.5. E.5. Interaction with, and Protection of, Complex Electronic Systems

Co-Chairs: F. Gronwald (Germany) and J-P. Parmantier (France)
This WG studies the various electronic and electromagnetic aspects related to the interaction with, and protection of, complex electronic systems. The focus is on 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.

4.6. E.6. Spectrum Management

Co-Chairs: J. P. Borrego (Portugal) and R. Struzak (Poland)

The focus of this WG 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.

4.7. E.7. Electromagnetic Compatibility in Wired and Wireless Systems

Co-Chairs: F. Rachidi (Switzerland), A. Zeddam (France), 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. Within the framework of this WG, we have regularly organized special sessions at URSI GASS This session focusing on theoretical and experimental EMC aspects in both wire and wireless communication systems. Potential remedies are also addressed.

4.8. E.8. Stochastic Techniques in EMC

Co-Chairs: L. Arnaut (UK), S. Pignari (Italy), and R. Serra (Netherlands)

4.9. Joint Working Groups

4.9.1. EB Chaos and Complexity in EM

Co-Chairs: G. Gradoni (UK), and A. Sihvola (Finland)

Wave complexity underpinned by fully developed, partial and transient chaos is becoming permanent in multi-component electromagnetic systems operating at electrically large scales. Statistical methods have been developed to tackle those systems and their specific engineering structures occurring in electromagnetic compatibility, electronics circuits as complex sources of radiated emissions, wireless communications including massive MIMO systems, etc. Recent studies in wave chaos have attracted researchers in electromagnetic theory and universal statistical properties have been used to study large electromagnetic systems without solving the full-wave problem. Hybrid methods combining full wave algorithms with newborn statistical methods are emerging in the EM wave modeling arena. System specific components need detailed treatment while deformed and irregular parts of EM environments can be treated statistically because of their mixing behavior. Furthermore, statistical sources can be treated through semi-classical as well as random matrix theories. Novel theoretical models have been developed describing fields through complicated electromagnetic environments - including electromagnetic reverberation chambers - also accounting for coupling through apertures and including losses at both microwave and mmWave regimes, as well as complex placement of wires and cables within EM environments. Uncertainties arising within cabling and radiating systems can be described through the polynomial chaos method.

4.9.2. EHG Solar Power Satellite

Chair: H. Matsumoto (Japan), Co-Chair for Commission E: J. Gavan (Israel), Co-Chair for Commission H: K. Hashimoto (Japan)

4.9.3 GEH Seismo Electromagnetics (Lithosphere-Atmosphere-Ionosphere Coupling)

Co-Chair for Commission G: S. Pulinets (Russia), Co-Chair for Commission E: M. Y. Hobara (Japan), Co-Chair for Commission H: H.Rothkaehl (Poland)

4.9.4. Interdisciplinary Space Weather

Co-Chair for G: I. Stanislawska (Poland), Co-Chair for J: R. Fallows (Netherlands)

4.9.5. URSI/IAGA VLF/ELF Remote Sensing of the Ionosphere and Magnetosphere (VERSIM)

Chair for URSI (Commissions E,G,H): M. Clilverd (UK), IAGA Chair: J. Bortnik (USA)

5. Updates to Terms of Reference of Commission

There were no updates to the Terms of Reference. The current Terms of Reference are as follows:

"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."

6. Meetings proposed to be supported in the coming triennium

Commission E will support the following meetings in the current triennium:

• Second URSI Atlantic Radio Science Conference (URSI AT-RASC), May 28th – June 1st, 2018, to be held in the ExpoMeloneras Convention Centre, Gran Canaria, Spain.

• Asia-Pacific Radio Science Conference (URSI AP-RASC), March 9th – 15th, 2019, to be held in the India Habitat Centre, New Delhi, India.

• XXXIIIrd URSI General Assembly and Scientific Symposium (URSI GASS), August 2020, to be held on the Sapienza University Campus, Rome, Italy, 2020.

7. Report and comments on the scientific program of the Commission for the current GASS

Commission E offered 11 sessions at the URSI GASS in Montreal (2017), most of them consisting of several parts. In addition, there were seven more sessions, organized and co-organized with other Commissions. All of the sessions were well attended. It is intended to have a similar session structure for the next GASS.

Commission E also offered a "Short Course on IEMI and Cyber threats for Wireless Communications", an "ECR Tutorial on Wave Chaos and Complexity in Electromagnetic

Environments", and a "Tutorial on EMC Aspects in Smart Grids". Commission E also was involved in the well-received "One-Day Workshop on RFI Mitigation and Characterization".

8. Proposed sessions for the next GASS

It is proposed to use the successful session structure of the last URSI GASS in Montreal (2017) as a basis for the next URSI GASS in Rome (2020). Of course, in particular the special sessions, short courses, tutorials, and workshops will be updated according to current topics of interest. Proposed sessions, at the time of writing, include the following:

Sessions of Commission E only:

E.1: EMC in Complex Systems

E.2: High-Power Electromagnetics

E.3: Stochastic/Statistical Techniques in EMC

E.4: Geomagnetic Disturbances (GMD) and Effects

E.5: Time Reversal in Electromagnetics

E.6: EMC for PCB and Package

E.7: Lightning and Related Phenomena

E.8: Measurement Techniques

E.9: EMC in Wired and Wireless Systems

E.10: New Concepts in Wireless Communications

E.11: Open Session

Joint Sessions led by Commission E:

EB: Chaos and Complexity

ECJ: Spectrum Management

EFGH: Natural Electromagnetic Noise and Radio Sensing Applications in Terrestrial and Planetary Environments

Joint Sessions led by other Commissions:

AE: SI Units

GEH: Seismo Electromagnetics (Lithosphere-Atmosphere- Ionosphere Coupling)

HGE: Atmospheric, Ionospheric, Magnetospheric and High Energy Effects of Lightning Discharges

KBE: Uncertainty Management and Stochastic Methods in Experimental and Numerical Electromagnetism, Environmental Exposure Assessment and Dosimetry

9. Proposed sessions for the AT-RASC

The sessions planned for AT-RASC 2018 are given below. Depending on the number of submitted papers it might be meaningful to eventually merge several sessions.

E.1: EMC Analytical and Numerical Modeling

E.2: EMC Measurements and Standards

E.3: Communication in the Presence of Noise

E.4: HPEM, Intentional EMI, Radiation Hazards, Lightning and other Noise of Natural Origin

E.5: Stochastic and Statistical Methods in EMC

E.6: Other

S-EABK: Wave Chaos of Complex Systems

S-EACFJ: Spectrum Management and Utilization

S-EE: Time Reversal in Electromagnetic Environments: Theory and Applications

S-EF: Understanding Microwave Processing on Materials

S-AE: Mode stirred chambers

S-GEH: Seismo-electromagnetics (lithosphere-atmosphere-ionosphere coupling)

S-JACEFG: Applications for pattern recognition methodologies

10. Other business

None.

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