Commission Report
2017-2021

Commission Triennial Report

Commission B

1. Commission B Activities (Terms of Reference)

The interest of Commission B is fields and waves, encompassing theory, analysis, computation, experiments, validation and applications. Areas of emphasis are:

- Time-domain and frequency-domain phenomena;
- Scattering and diffraction;
- General propagation including waves in specialized media;
- Guided waves;
- Antennas and radiation;
- Inverse scattering and imaging.

The Commission fosters the creation, development, and refinement of analytical, numerical, and measurement techniques to understand these phenomena. It encourages innovation and seeks to apply interdisciplinary concepts and methods.

2. Commission B Officers

At the URSI Council meeting held during the "XXXIInd URSI General Assembly and Scientific Symposium" (URSI GASS 2017), Montreal, Canada, August 19–26, 2017, the URSI Council approved the election of Kazuya Kobayashi as Commission B Chair, John Volakis as Commission B Vice-Chair, and Andrea Michel as ECR (Early Career Representative) for the period 2017–2020.

The "XXXIIIrd URSI General Assembly and Scientific Symposium" (URSI GASS 2020) was going to be held in Rome, Italy on August 29–September 5, 2020. Due to the COVID-19 pandemic, however, the GASS 2020 Local Organizing Committee (LOC) and the URSI Board decided to cancel the organization of the GASS 2020 as a physical event. The GASS 2020 LOC and the URSI Board also decided, in view of the record number of submitted papers and in order to value the work of all our fellow researchers, to publish the Proceedings of the GASS 2020, available through the URSI website. Subsequently there was a decision by the URSI Board and the GASS 2020 LOC that "XXXIVth URSI General Assembly and Scientific Symposium" (URSI GASS 2021) be held in Rome, Italy during August 28–September 4, 2021. The GASS 2021 will be held onsite, with provision for online participation and presentations. All the Commission Officers were asked by the URSI Board that they continue to stay as the Commission Officers until the end of GASS 2021.

The Commission B Officers for 2017–2021 are as follows:

- Chair:
  Professor Kazuya Kobayashi
  Department of Electrical, Electronic, and Communication Engineering
  Chuo University
  1-13-27 Kasuga, Bunkyo-ku
  Tokyo 112-8551, Japan
  Email: kazuya@tamacc.chuo-u.ac.jp
- Vice-Chair:
  Professor John Volakis
  Dean, College of Engineering and Computing
  Florida International University
  10555 W. Flagler Street

Miami, FL 33174, USA
Email: jvolakis@fiu.edu

- ECR1:
  Professor Lianlin Li
  School of Electronics Engineering and Computer Science
  Peking University
  Beijing, 100871, China
  E-mail: lianlin.li@pku.edu.cn
- ECR2:
  Andrea Michel
  Department of Information Engineering
  University of Pisa
  Via G. Caruso, 16
  I-56122 Pisa, Italy
  Email: andrea.michel@unipi.it
- Past Chair
  Professor Ari Sihvola
  Department of Electronics and Nanoengineering
  Aalto University School of Electrical Engineering
  Box 15500
  00076 Aalto, Finland
  Email: ari.sihvola@aalto.fi

During this triennium, Chair Kazuya Kobayashi appointed Shinichiro Ohnuki of Nihon University, Tokyo, Japan as the Commission B Secretary for assistance in his work as Commission B Chair.

3. Election of New Commission B Officers for 2021–2023

At the Commission B Coordination Activities Meeting to be held during GASS 2021 (Rome, Italy, August 28– September 4, 2021), the new Commission B Vice-Chair and ECR for 2021–2023 will be elected. We received three nominations for Vice-Chair and two nominations for ECR. The candidates for Vice-Chair are:

- Debatosh Guha (India)
- Ahmed A. Kishk (Canada)
- Henrik Wallén (Finland)

and the candidates for ECR are:

- Dimitrios Tzarouchis (USA)
- Okan Yurduseven (UK).

According to the rule, the voting process runs in the following two steps:

- Email voting until June 1, 2021
- Final voting at the Commission Coordination Activities Meeting (formerly Commission B Business Meeting) in Rome

Since we have already passed the first round of voting (i.e., email voting), the second round of voting (i.e., final voting at the Commission B Coordination Activities Meeting) is now left. The new Vice-Chair and ECR will begin their career as Commission B Officers from the end of GASS 2021. In addition, current Vice-Chair (John Volakis) will take the position of Chair, and Chair Kazuya Kobayashi will step down to become Past Chair as of the last day of GASS 2021. The final voting will take place at the Commission B Coordination Activities Meeting during GASS 2021. Commission B Official Members of all URSI Member Committees can vote for this election.

4. Associate Editors for the Radio Science Bulletin

During this triennium (2017–2021), John Volakis (Vice-Chair) and Andrea Michel (ECR1) have served as Associate Editors for the *Radio Science Bulletin* (RSB). They have worked together to contribution to publication of articles in the RSB. They have done a good job. The EMTS 2019 report (authored by Sembiam Rengarajan and Kazuya Kobayashi) has been published in No. 370 of RSB (September 2019). In addition, the "Special Issue of the Best Papers from the EMTS 2019 Young Scientist Award" (Guest Editors: Kazuya Kobayashi and Sembiam Rengarajan) is also planned to be published in the RSB. Incidentally John Volakis is involved in the "Special Issue of the 2019 URSI International Symposium on Electromagnetic Theory" for the journal *Radio Science* as Guest Editor.

The new Associate Editors for the next triennium (2021–2023) will be appointed at the Commission B Coordination Activities Meeting that will take place during GASS 2021 in Rome.

5. Commission B Technical Advisory Board (B-TAB)

Commission B consists of

- Commission B Officers (Chair, Vice-Chair, two ECRs);
- Commission B Official Members (Commission B representatives from the URSI Member Committees);
- Commission B Technical Advisory Board (B-TAB),

among which the B-TAB was established in order to strengthen Commission B activities. The structure of the B-TAB is the following (as of August 16, 2021):

Matteo Albani	Italy
Makoto Ando	Japan
Francesco Andriulli	Italy
Amir Boag	Israel
Salvatore Campione	USA
Deb Chatterjee	USA
Thomas Eibert	Germany
George Eleftheriades	Canada
Nader Engheta	USA
Levent Gürel	Turkey
Susan Hagness	USA
Ehud Heyman	Israel
Jiro Hirokawa	Japan
David Jackson	USA
Ludger Klinkenbusch	Germany
Kazuya Kobayashi	Japan
Gerhard Kristensson	Sweden
Lianlin Li	China
Giuliano Manara	Italy
Andrea Michel	Italy
Juan Mosig	Switzerland
Paolo Nepa	Italy
Shinichiro Ohnuki	Japan
Matteo Pastorino	Italy
Yahya Rahmat-Samii	USA
Sembiam Rengarajan	USA
Magdalena Salazar-Palma	Spain
Giuseppe Schettini	Italy
Lotfollah Shafai	Canada

Yury Shestopalov	Sweden
Ari Sihvola	Finland
Daniel Sjöberg	Sweden
Paul Smith	Australia
W. Ross Stone	USA
Donglin Su	China
Anton Tijhuis	Netherlands
Piergiorgio L. E. Uslenghi	USA
John Volakis	USA
Henrik Wallén	Finland
Don Wilton	USA
Amir Zaghloul	USA
Richard Ziolkowski	Australia

6. URSI Flagship Meetings

During this triennium, the following three URSI Flagship Meetings were held:

- 2nd URSI Atlantic Radio Science Conference (URSI AT-RASC 2018), May 28–June 1, 2018, Gran Canaria, Spain
- 2019 URSI Asia Pacific Radio Science Conference (URSI AP-RASC 2019), March 9–15, 2019, New Delhi, India
- XXXIVth URSI General Assembly and Scientific Symposium (URSI GASS 2021), August 28–September 4, 2021, Rome, Italy

Commission B has contributed significantly to the success of all these conferences.

URSI AT-RASC 2018

The "2nd URSI Atlantic Radio Science Conference" (URSI AT-RASC 2018) was held at ExpoMeloneras Convention Centre, Gran Canaria, Spain on May 28–June 1, 2018. Listed below are the suggested topics (general and special topics) for Commission B, indicated in the Call for Papers.

General topics:

B.1 Antenna arrays
B.2 Antennas: recent advances and future outlook
B.3 Antenna theory, design and measurements
B.4 Cognitive radio
B.5 Complex media (bandgap structures, biological and geophysical media, metamaterials, and others)
B.6 Educational methods and tools
B.7 Electromagnetic interaction and coupling
B.8 Guided waves and waveguiding structures
B.9 High-frequency techniques
B.10 Imaging, inverse scattering and remote sensing
B.11 Mathematical modeling of electromagnetic problems
B.12 Microstrip antennas and printed devices
B.13 Multiphysics electromagnetics
B.14 Nanoscale electromagnetics
B.15 Nonlinear electromagnetics
B.16 Numerical methods (differential- and integral-equation based, hybrid and other techniques)
B.17 Optical phenomena
B.18 Optimization techniques in electromagnetics

B.19 Propagation phenomena and effects
B.20 Rough surfaces and random media
B.21 Scattering and diffraction
B.22 Theoretical electromagnetics
B.23 THz antennas and propagation
B.24 Transient fields, effects, and systems
B.25 Ultra-wideband electromagnetics
B.26 Wireless communications

Special topics:
S-B1 Advanced algorithms in computational electromagnetics
S-B2 Antennas: limitations, optimizations and realizations
S-B3 Fundamental aspects of high-frequency EM wave propagation in the ionosphere
S-B4 Inverse scattering and high/super-resolution imaging: theory, algorithm and applications
S-B5 Metasurfaces
S-B6 Novel mathematical methods in electromagnetics
S-B7 Periodic structures
S-B8 Direct and inverse scattering methods for complex environments
S-B9 Stochastic electromagnetic field theory
S-BD Advanced electromagnetics for short-range wireless systems
S-CBD Radar target detection, positioning, and collision avoidance
S-DB Advances in leaky wave antenna technologies
S-EABK Wave Chaos of Complex Systems
S-JB Polarimetry of advanced antenna systems in radio astronomy
S-KB1 EMF hyperthermic therapeutic applications
S-KB2 Electromagnetic inversion and imaging
S-KBCDF Radio sciences and E health

Based on the above topics, 17 sessions and 5 joint sessions were formed in the Commission B scientific program, which led to a great success. Figure 1 shows the Program at a Glance of the Conference.

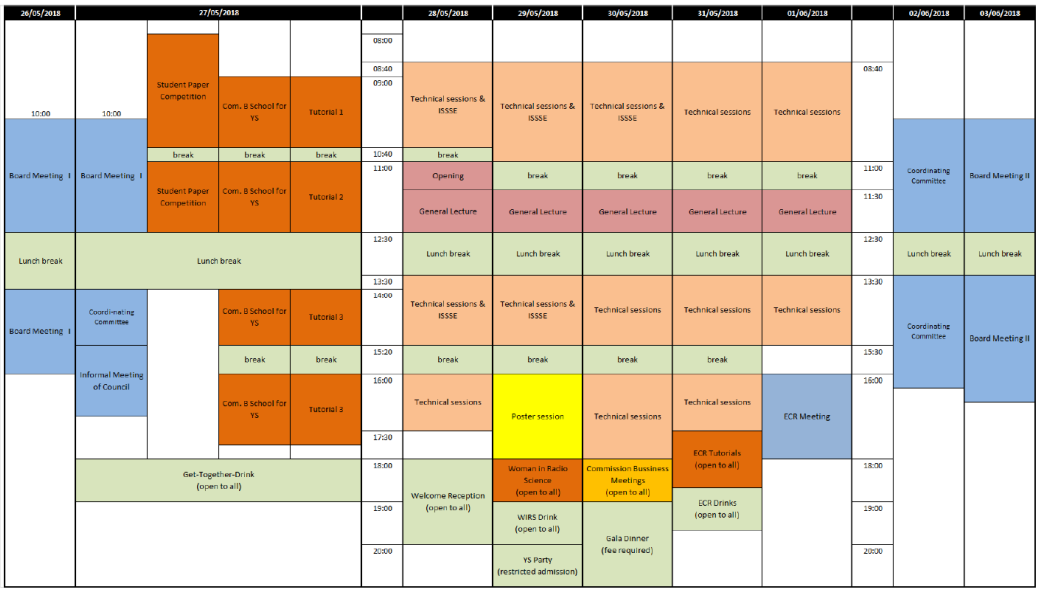

Fig. 1. AT-RASC 2018 Program at a Glance.

Three typical statistics (number of participants, number of paper submissions, number of applications for the Young Scientist Award) are shown in Figs. 2–4.

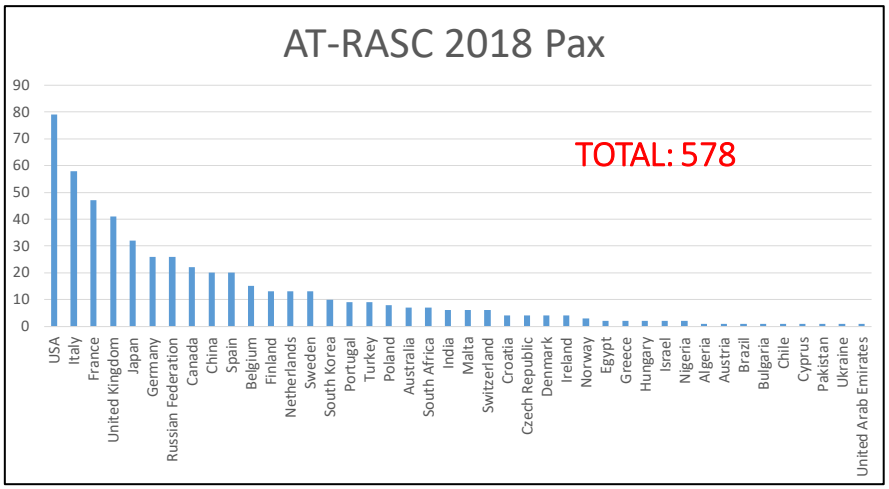

Fig. 2. Number of participants in terms of country/region.

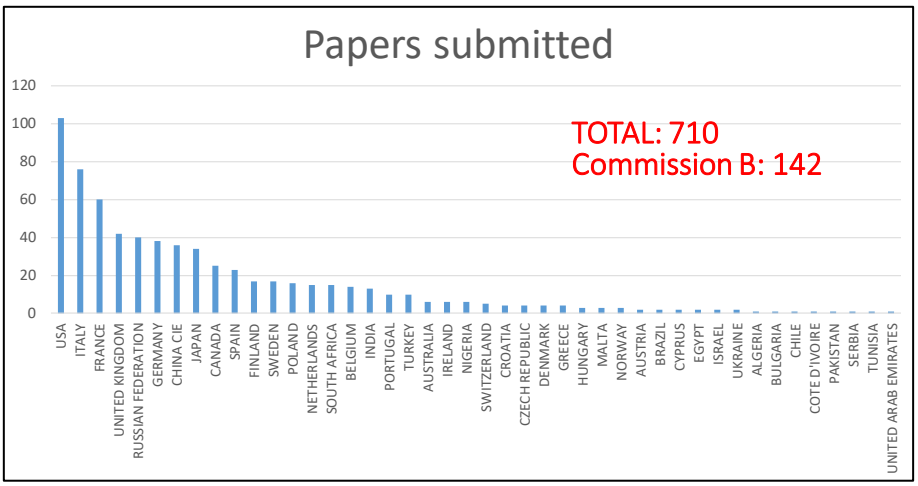

Fig. 3. Number of paper submissions in terms of country/region.

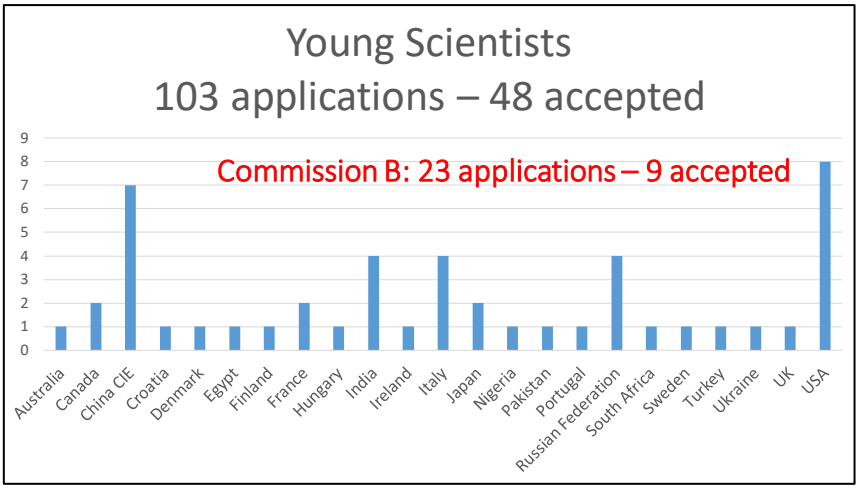

Fig. 4. Number of YSA (Young Scientist Award) applications in terms of country/region.

AP-RASC 2019

History of AP-RASC

The "Asia-Pacific Radio Science Conference" (AP-RASC) was established based on initiatives by the Japan National Committee of URSI, and was held for the first time in Tokyo, Japan during August 1–4, 2001. The AP-RASC was thereafter held in Qingdao, China (August 24–27, 2004), Toyama, Japan (September 22–26, 2010), Taipei, China (SRS) (September 3–7, 2013). All these AP-RASC meetings were a great success.

In 2016, AP-RASC was renamed as the "URSI Asia-Pacific Radio Science Conference" (URSI AP-RASC), and became an URSI Flagship Meeting. The first URSI AP-RASC after this renaming was held as "URSI AP-RASC 2016" in Seoul, South Korea. During this triennium, URSI AP-RASC 2019 was held in New Delhi, India on March 9–15, 2019. Since 2016, URSI has been involved in organization of URSI AP-RASC meetings from various aspects, and the Conference has been expanding rapidly and attracting more international participants. All the AP-RASC meetings held in the past are shown in Table 1.

Table 1. Past AP-RASC and URSI AP-RASC meetings.

- Name of Conferenc	- Dates	- Venue	- Statistics
- (1st) AP-RASC 2001	- August 1–4, 2001	- Korakuen Camp Chuo Univers Tokyo, Japan	- 601 papers; 7 participants from countries/regions
- (2nd) AP-RASC 2004	- August 24–27, 2004	- Qingdao, China	- not known
- (3rd) AP-RASC 2010	- September 22–2010	- Toyama International Conference Center, Toyar Japan	- 566 papers; 6 registrants from countries/regions
- (4th) AP-RASC 2013	- September 3–7, 201	- Howard International House, Taip Taiwan	- 618 papers; 5 registrants from countries/regions
- (5th) URSI AP-RA 2016	- August 21–25, 2016	- Grand Hilt Seoul, Seoul, Sou Korea	- 687 papers; 7 registrants from countries/regions
- (6th) URSI AP-RA 2019	- March 9–15, 2019	- India Habi Centre, New De India	- 952 papers; 6 registrants from countries/regions

AP-RASC 2019

The "2019 URSI Asia-Pacific Radio Science Conference" (URSI AP-RASC 2019) was held at India Habitat Centre, New Delhi, India on March 9–14, 2019. Figure 5 shows India Habitat Centre.

Fig. 5. India Habitat Centre (AP-RASC 2019 venue).

The key structure of the Committees is as follows:

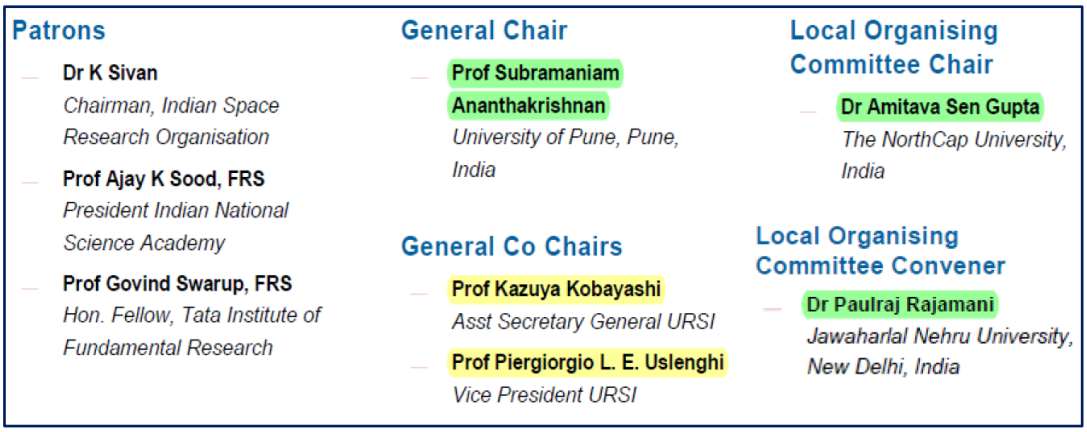

Fig. 6. Key structure of the Committees.

Depicted below is the Program at a Glance of the Conference.

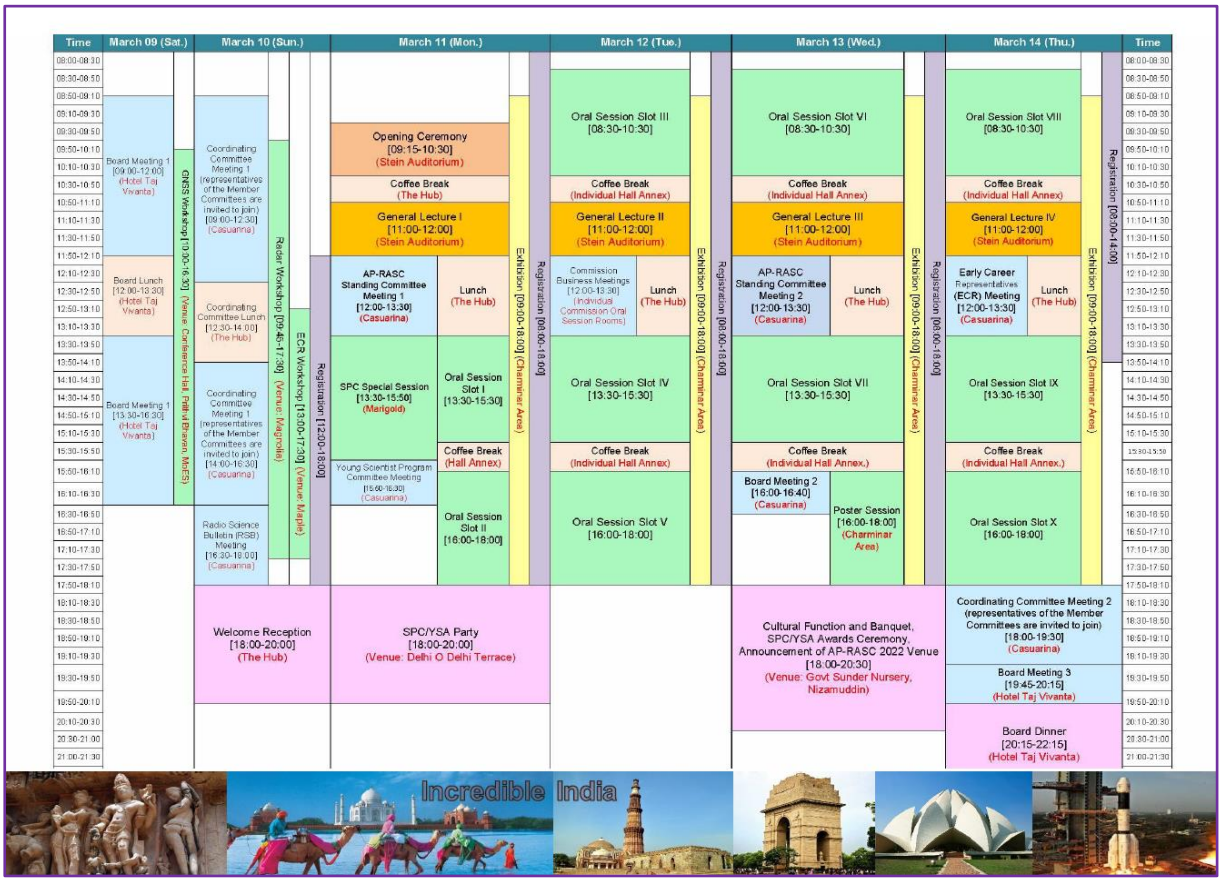

Fig. 7. Program at a Glance.

Figure 8 shows a photo taken at the Opening Ceremony on March 11, 2019, the first day of the core scientific program.

Fig. 8. Opening Ceremony.

The AP-RASC 2019 scientific program consists of the following:

- General Lectures 1–4 (4 lectures)
- Commission Keynote Lectures A–K (10 lectures)
- Regular oral and poster sessions (oral: 571 papers, poster: 320 papers)
- Young Scientist Award (YSA) (20 awardees from 129 applicants)
- Student Paper Competition (SPC) (3 Winners and 3 Honorable Mentions from 34 applicants)

Fig. 9. General Lectures.

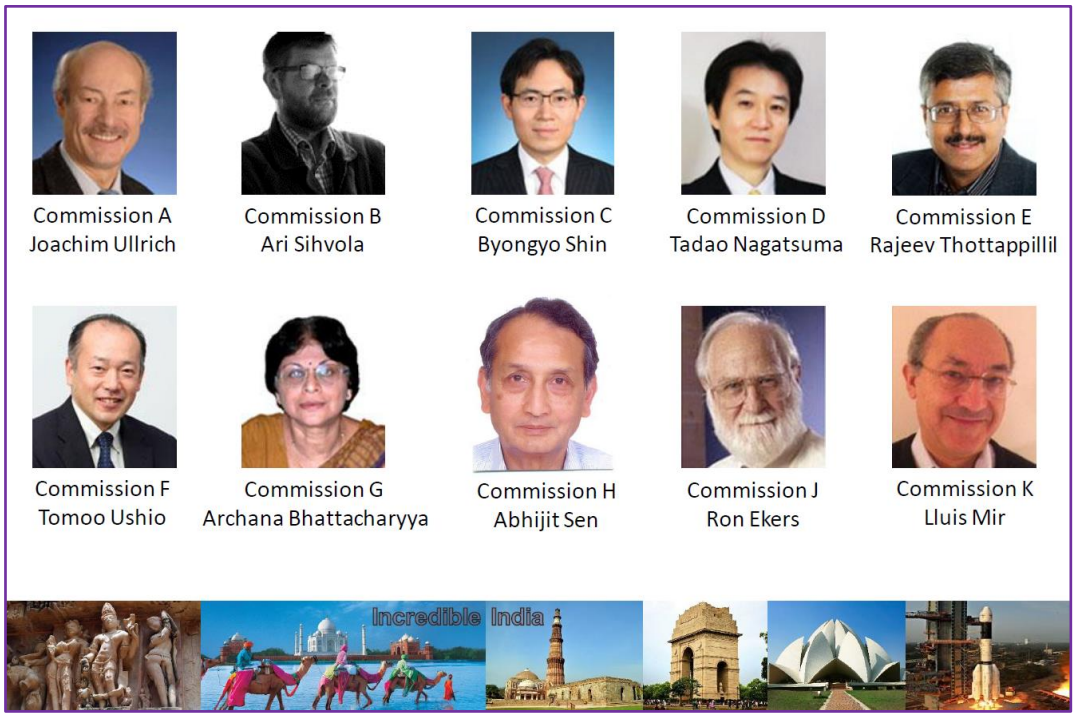

Fig. 10. Invited speakers of Commission Keynote Lectures.

Commission B created the following 11 sessions:

B01	Antenna Theory, Design, and Measurement
B02	Computational Methods in Electromagnetics
B03	Electromagnetic Theory
B04	Optical and THz Waves and Applications
B05	High-Frequency and Hybrid Methods
B06	Inverse Scattering and Imaging
B07	Materials and wave-material interaction
B08	Novel Mathematical Methods in Electromagnetics
B09	Advanced Antenna concepts including Antennas for RFID
B10	Scattering and Diffraction
BOS	Any Other Aspect of Fields and Waves

All these sessions were successful.

Some statistics are given in Tables 2–5.

Table 2. Paper submission statistics in terms of country/region.

Country	Number of Submissions
Australia	18
Austria	1
Belgium	7
Canada	4
China	50
Cote d'Ivoire	1
Croatia	1
Cyprus	2
Czech Republic	2
Egypt	1
Finland	5
France	17
Germany	11
Hong Kong	1
Hungary	2
India	587
Iraq	1
Ireland	2
Italy	23
Japan	79

Country	Number of Submissions
Luxembourg	2
Malaysia	1
Mexico	3
Myanmar	1
Netherlands	4
Nigeria	3
Pakistan	1
Poland	3
Russia	19
Singapore	3
South Africa	6
South Korea	15
Sweden	2
Switzerland	4
Taiwan	4
Thailand	2
Turkey	1
Ukraine	2
UK	10
USA	51
TOTAL	**952**

Table 3. Paper submission statistics in terms of Commission.

Commission	Number of Submissions
A	50
B	143
C	87
D	76
E	48
F	180
G	120
H	68
J	119
K	61
TOTAL	**952**

Table 4. Registration statistics in terms of country/region.

Country	Number of Delegates
Australia	14
Austria	1
Belgium	4
Canada	5
China	33
Croatia	1
Czech Republic	2
Finland	2
France	10
Germany	9
Hong Kong	1
Hungary	1
India	442
Ireland	2
Italy	12
Japan	70

Country	Number of Delegates
Luxembourg	1
Mexico	1
Myanmar	1
Netherlands	3
Nigeria	2
Poland	2
Russia	16
Singapore	1
South Africa	6
South Korea	11
Sweden	3
Switzerland	3
Taiwan	3
UAE	2
UK	9
USA	40

Total Delegates: 713 from 32 countries

Table. 5. YSA/SPC application statistics in terms of Commission.

Commission	YSA	SPC	Total
A	4	1	5
B	32	3	35
C	19	2	21
D	10	4	14
E	3	1	4
F	24	11	35
G	18	2	20
H	5	7	12
J	3	2	5
K	11	1	12
TOTAL	**129**	**34**	**163**

The AP-RASC 2019 Young Scientist Program Committee (YSPC) selected a total of 20 recipients from the 129 applicants in advance of the Conference. All the YSA recipients were given free registration and free accommodations. They were invited to the Banquet where each of them received a certificate.

The AP-RASC 2019 YSPC also reviewed all the 34 SPC applications and selected seven finalists before the Conference. Subsequently the SPC special session was organized during the Conference, where the finalists made oral presentation. The AP-RASC 2019 YSPC judged the presentations by the finalists and selected the 1st, 2nd, and 3rd Prize Winners and three Honorable Mentions, where the prize money for the 1st, 2nd, and 3rd Prizes were $1000, $750, and $500, respectively. Six awardees (three Winners and three Honorable Mentions) were invited to join the Banquet, where each of the Winners received a certificate together with the prize money, and each of the Honorable Mentions received a certificate.

Figures 11 and 12 show the Award Ceremony held during the Banquet for the SPC and YSA, respectively.

Fig. 11. SPC awardees at the Award Ceremony during the Banquet.

Fig. 12. YSA awardees at the Award Ceremony during the Banquet.

AP-RASC 2019 Special Issues

Two special issues have been published based on the papers from AP-RASC 2019, which has proved a great success of the Conference. Short descriptions are provided below.

Special Issue in *Radio Science* (RS)

- Title: Special Issue of the 2019 URSI Asia-Pacific Radio Science Conference
- Guest Editors:
  Subra Ananthakrishnan, URSI AP-RASC 2019 General Chair
  Amitava Sen Gupta, URSI AP-RASC 2019 LOC Chair
  Kazuya Kobayashi, URSI Assistant Secretary-General (AP-RASC), URSI AP-RASC 2019 General Co-Chair
- Aims and Scope:
  - This special issue publishes a collection of papers presented at URSI AP-RASC 2019 (*already published*).

Special Issue in *Radio Science Bulletin* (RSB)

- Title: Special Issue on URSI AP-RASC 2019
- Guest Editors:
  - Amitava Sen Gupta, URSI AP-RASC 2019 LOC Chair
  - Subra Ananthakrishnan, URSI AP-RASC 2019 General Chair
  - Kazuya Kobayashi, URSI Assistant Secretary-General (AP-RASC), URSI AP-RASC 2019 General Co-Chair
- Aims and Scope:
  - This special issue consists of two parts and publishes papers from General Lectures, Commission Keynote Lectures, and the Student Paper Competition at URSI AP-RASC 2019 (*already published; see the RSB issues below*).
    - No. 370 (September 2019): https://www.ursi.org/content/RSB/RSB_370_2019_09.pdf
    - No. 371 (December 2019): https://www.ursi.org/content/RSB/RSB_371_2019_12.pdf

URSI GASS 2021

The "XXXIIIrd URSI General Assembly and Scientific Symposium" (URSI GASS 2020) was scheduled to be held in Rome, Italy on August 29–September 5, 2020, but it was canceled as a physical event due to the COVID-19 pandemic. However, the URSI Board and the GASS 2020 Local Organizing Committee (LOC) decided, in view of the record number of submitted papers and in order to value the work of fellow researchers, to run GASS 2020 partially and virtually. The virtual GASS 2020 was over with the following results:

- GASS 2020 Proceedings;
- GASS 2020 Young Scientist Award;
- GASS 2020 Student Paper Competition.

The URSI Board and the GASS 2020 LOC have also decided to postpone GASS 2020 to the year 2021 as the 34th GASS (GASS 2021), which will be held in the hybrid form in Rome, Italy during August 28–September 4, 2021. The GASS 2021 is organized based on resubmissions of GASS 2020 papers and submissions of new papers.

The Commission B scientific program for GASS 2021 consists of Commission B Tutorial, 29 Commission B sessions, and 5 Commission B-led joint sessions as follows:

Commission B Tutorial:
Physical bounds for functional surfaces and materials, Daniel Sjöberg, Lund University (Sweden)

Commission B sessions:

B01	Antenna theory, design, and measurement
B02	Memorial session for Prof. Thomas B. A. Senior
B03	Propagation and scattering: advances, trends and new applications
B04	Advanced algorithms in computational electromagnetics
B05	Memorial session for Prof. Jean Van Bladel
B06	Inverse scattering and imaging
B07	Integral equation, hybrid, and fast methods
B08	Novel mathematical methods in electromagnetics
B09	Mathematical modelling of EM problems
B10	Scattering and diffraction
B11	Electromagnetic theory
B12	Materials in electromagnetics
B13	Electromagnetics of time-varying scatterers and materials
B14	Waves in nonlinear and inhomogeneous media
B15	Forward scattering and propagation

B16 Antennas and microwave devices inspired by electromagnetic band gap
B17 Optimization techniques in electromagnetics: new trends and novel applications
B18 Millimeter-wave antennas/5G communications
B19 Women's contributions in inverse electromagnetic problems
B20 High-frequency and hybrid methods
B21 International Union of Radio Science: 100 years of history and achievements of Commission B
B22 Advanced metamaterial concepts for electromagnetics
B23 Spatial correlation estimation and channel modelling for massive MIMO and near-field communication systems
B24 Electromagnetic methods for direct and inverse scattering involving stratified media
B25 Semi-analytical modeling techniques in electromagnetics and photonics
B26 Electromagnetics at the nanoscale and quantum effects
B27 Inverse problems in antenna and scattering in complex environments: Theory, challenges, and applications
B28 Innovative Electromagnetic Solutions for Modern Sensing and Information Systems
B29 Open session

Commission B-led joint sessions:
BD1 Symmetries in artificial materials: theory and applications
BE1 Near field coupling in wireless communications
BE2 Reconfigurable Intelligent Surfaces for Wireless Communication and Sensing
BG1 High frequency wave propagation in highly disturbed ionosphere
BK1 Innovative methods and devices for microwave medical applications

As seen from the above list, Commission B has created a very attractive program. Based on the papers submitted to the above sessions, we prepared the Commission B Program at a Glance as shown in Fig. 13. Commission B's entire scientific program will run in terms of four parallel sessions.

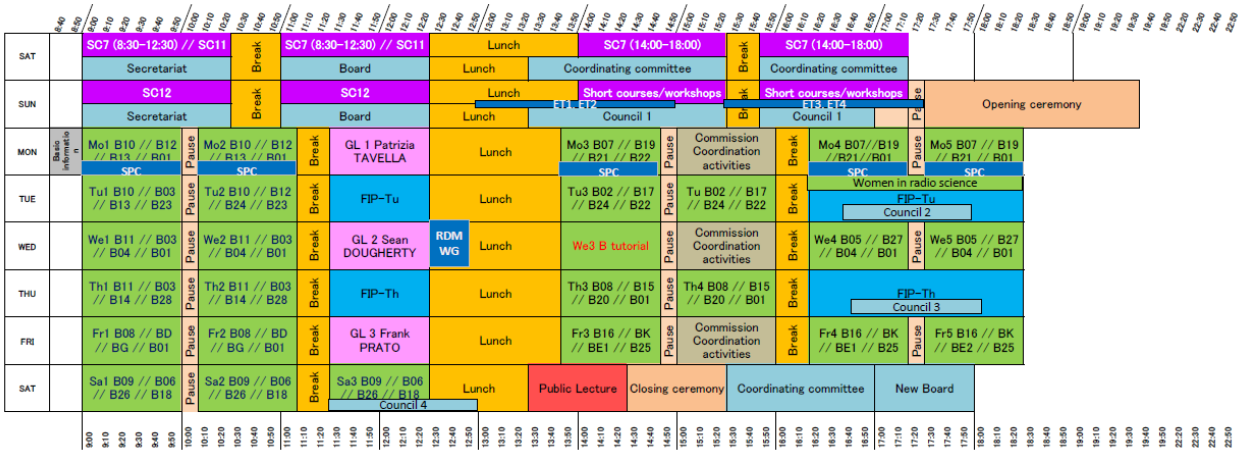

Fig. 13. Program at a Glance for Commission B.

Submission statistics are shown in Table 6 below.

Table 6. Paper submission and YSA/SPC application statistics.

Commission	All categories (regular, YSA, SPC)			YSA			SPC		
	Number of submissions	Rejected	Accepted	Number of applications	Rejected	Accepted	Number of applications	Rejected	Accepted
A	89	1	88	9	0	9	4	0	4
B	409	9	400	53	0	53	20	1	19
C	66	3	63	9	0	9	1	0	1
D	139	0	139	17	0	17	8	0	8
E	82	2	80	5	0	5	1	0	1
F	143	4	139	27	0	27	6	0	6
G	314	0	314	18	1	17	2	0	2
H	140	0	140	17	0	17	2	0	2
J	203	2	201	9	0	9	2	0	2
K	137	1	136	17	1	16	1	0	1
TOTAL	1722	22	1700	181	2	179	47	1	46

7. URSI Commission B International Symposium on Electromagnetics Theory (URSI EMTS)

History of EMTS meetings

In addition to the triennial URSI Flagship Meetings (URSI GASS, URSI AT-RASC, URSI AP-RASC), an important triennial meeting within URSI Commission B is the “URSI Commission B International Symposium on Electromagnetic Theory” (URSI EMTS). This meeting was held for the first time in 1953 in Montreal, Canada. Since then, a total of 23 symposia were held and every time the Conference attracted a large number of participants and receives a high reputation in electromagnetic theory. The history of EMTS is provided in Table 7.

Table 7. Venues of past EMTS meetings.

	Year	Place (Country)
I	1953	Montreal (Canada)
II	1956	Michigan (USA)
III	1959	Toronto (Canada)
IV	1962	Copenhagen (Denmark)
V	1965	Delft (Netherlands)
VI	1968	Stresa (Italy)
VII	1971	Tbilisi (USSR)
VIII	1974	London (UK)
IX	1977	Stanford (USA)
X	1980	Munich (Germany)
XI	1983	Santiago de Compostela (Spain)

XII	1986	Budapest (Hungary)
XIII	1989	Stockholm (Sweden)
XIV	1992	Sydney (Australia)
XV	1995	St. Petersburg (Russia)
XVI	1998	Thessaloniki (Greece)
XVII	2001	Victoria (Canada)
XVIII	2004	Pisa (Italy)
XIX	2007	Ottawa (Canada)
XX	2010	Berlin (Germany)
XXI	2013	Hiroshima (Japan)
XXII	2016	Espoo (Finland)
XXIII	2019	San Diego (USA)
XXIV	2023	Moscow (Russia), *planned*

At the Commission B Business Meetings held during EMTS 2019 (San Diego, California, USA), Moscow, Russia was selected as the venue of the 2022 EMTS. Due to the COVID-19 pandemic, however, the Moscow EMTS, originally scheduled to be held in 2022, was shifted to 2023.

EMTS 2019, San Diego, USA

The EMTS 2019 symposium was held at the Westin San Diego Hotel, in downtown San Diego, California, USA May 27–31, 2019. The Conference provided an international forum for researchers to present papers on current topics in fields and waves in radio science. Radio science covers the study, understanding, and application of electromagnetics and electronics in natural and man-made environments. The impact and importance of radio science for modern technology and society cannot be overstated. Telecommunications, nanotechnology, radio astronomy, and remote sensing for monitoring of the environment and global change are but some of the fields that rest on the foundations of radio science. We believe that the foundations of radio science rest on electromagnetics – the study of fields and waves – which is the domain of URSI Commission B.

Fig. 14. Opening Ceremony.

The four days of the Symposium started with the Opening Ceremony on the May 28 morning (see Fig. 14). The Symposium covered a wide range of topics in Commission B, consisting of 52 technical sessions and four General Lectures. The list of general sessions and convened sessions is shown below.

General Sessions

G01 Analytical and semi-analytical methods
G02 Canonical problems
G03 Integral equation methods
G04 Partial differential equation methods
G05 Fast solvers and high-order methods
G06 Time-domain techniques
G07 Computational algorithms
G08 Metamaterials and metasurfaces
G09 Plasmonics and nanoelectromagnetics
G10 Electromagnetic bandgaps and other periodic structures
G11 Optical devices
G12 EMC and EMI
G13 Bioelectromagnetics
G14 Antenna theory
G15 Antenna measurements
G16 Multi-band and wideband antennas
G17 Antenna arrays and MIMOs
G18 Wireless communication systems
G19 Guided waves and structures
G20 Random media and rough surfaces
G21 Millimeter-wave antennas
G22 MIMO for 5G communication

Convened sessions

C01 Advanced algorithms in computational electromagnetics
C02 High-frequency wave propagation in highly disturbed ionosphere
C03 Inverse scattering and imaging
C04 Integral equation, hybrid, and fast Methods
C05 Novel mathematical methods in electromagnetics
C06 Mathematical modelling of EM problems
C07 Scattering and diffraction
C08 Education in electromagnetics
C09 History of electromagnetics
C10 Electromagnetic theory
C11 Near-field coupling in wireless applications
C12 Materials in electromagnetics
C13 Analytical and canonical solutions for metamaterials and metasurfaces
C14 Waves in nonlinear media
C15 Exotic EM wave-matter interaction phenomena empowered by complex material platforms
C16 Forward scattering and propagation
C17 Antennas and microwave devices inspired by electromagnetic band gap
C18 Recent advances in optimization techniques in electromagnetics
C19 Millimeter-wave antennas/5G communications
C20 Theory and applications of characteristic modes
C21 High-frequency and hybrid methods
C22 International Union of Radio Science: 100 years of history and achievements of CommissionB
C23 Memorial session for Prof. Dennis P. Nyquist
C24 Electromagnetics at the nanoscale and quantum effects
C25 Advanced metamaterial concepts for electromagnetics
C26 Analytical methods in antennas, scattering and wave propagation
C27 Chaos and complexity in electromagnetism

One of the highlights was a historical session on the “International Union of Radio Science: 100 years of history and achievements of Commission B”, which had 11 interesting papers. The papers submitted to the Symposium were evaluated by the review board, which consisted of 44 experts in electromagnetics. The final program included 308 presentations from 31 countries. EMTS 2019 was a perfect platform for scientific interactions after the presentations and during coffee breaks.

The Program at a Glance for the Conference is shown in Fig. 15.

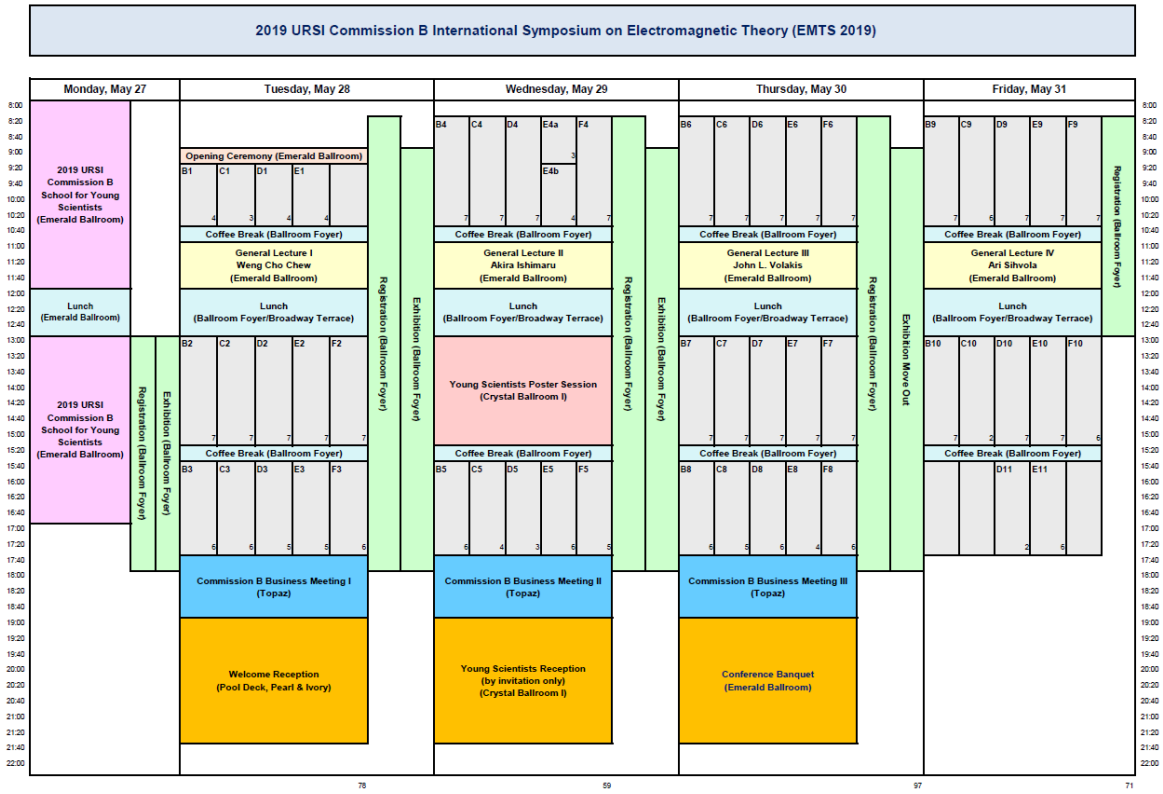

Fig. 15. Program at a Glance.

In the best of URSI traditions, a strong emphasis was put on young scientists. The EMTS 2019 Young Scientist Program Committee, chaired by Kazuya Kobayashi, selected a total of 20 recipients of the Young Scientist Award (YSA) from 42 applicants in advance of the Conference. They were all given free registration to the Conference, free accommodations, and banquet tickets. At the Award Ceremony during the Banquet, the certificates were presented to the YSA recipients (see Fig. 16).

Fig. 16. Recipients of the Young Scientist Award (YSA) at the Award Ceremony during the Banquet.

A poster session was further arranged particularly for the 20 YSA recipients onsite during the Conference, and they gave a poster presentation in addition to their talk in one of the oral sessions. Based on the submitted papers and poster presentations, the Young Scientist Program Committee selected three winners of the Young Scientist Best Paper Award. The 1st, 2nd, and 3rd Prizes were given to Viktar S. Asadchy (Aalto University, Espoo, Finland, $1000), Younes Ra'di (Advanced Science Research Center, New York, NY, USA, $750), and Yakir Hadad (Tel-Aviv University, Tel-Aviv, Israel, $500), respectively. Honorable Mention was conferred on Miguel Camacho (University of Exeter, Exeter, UK) and Mariana Dalarsson (Linnaeus University, Vaxjo, Sweden). The awardees who received the Prizes and the Honorable Mention are shown in Fig. 17.

The Welcome Reception and the Banquet were enjoyed by the participants (see Fig. 18).

Fig. 17. Awardees (1st, 2nd, and 3rd Prizes and Honorable Mention) of the Young Scientist Best Paper Award at the Award Ceremony during the Banquet.

Fig. 18. Banquet.

EMTS 2019 Special Issues

Two special issues have been scheduled based on the papers presented at the EMTS 2019, which provide a great success of the Conference. Short descriptions are given below.

Special Issue in *Radio Science* (RS)

- Title: Special Issue of the 2019 URSI Commission B International Symposium on Electromagnetic Theory
- Guest Editors:
  Kazuya Kobayashi, Chuo University, Tokyo, Japan (Commission B Chair)
  John Volakis, Florida International University, Miami, FL, USA (Commission B Vice-Chair)
  Yury Shestopalov, University of Gävle, Gävle, Sweden
  Paul Smith, Macquarie University, Sydney, Australia
- Aims and Scope:
  - This special issue publishes a collection of papers presented at EMTS 2019 (*to be published in 2021*).

Special Issue in *Radio Science Bulletin* (RSB)

- Title: Special Issue of the Best Papers from the EMTS 2019 Young Scientist Award
- Guest Editors:
  - Kazuya Kobayashi
  - Chair, EMTS 2019 Technical Program Committee
  - Chair, URSI Commission B
    Sembiam Rengarajan
    Chair, EMTS 2019 Local Organizing Committee
    Chair, U.S. National Committee for the International Union of Radio Science (USNC-URSI)
- Aims and Scope:
  - This special issue publishes papers from the EMTS 2019 Young Scientist Award (*planned to be published in 2021*).

8. URSI Commission B School for Young Scientists

The "URSI Commission B School for Young Scientists" is organized by URSI Commission B and usually arranged at the following three URSI conferences:

- URSI Commission B International Symposium on Electromagnetic Theory (URSI EMTS);
- URSI General Assembly and Scientific Symposium (URSI GASS);
- URSI Atlantic Radio Science Conference (URSI AT-RASC).

The School is a one-day event and offers a short, intensive course, where a series of lectures are delivered by leading scientists in the Commission B community. Young scientists working in all the Commissions A–K are encouraged to learn the fundamentals and future directions in the area of electromagnetic theory and its applications from these lectures. Recipients of the Young Scientist Award (YSA) and finalists of the Student Paper Competition (SPC) from all Commissions are invited to join the School with free registration.

At the Commission B Business Meetings held during GASS 2011 (Istanbul, Turkey), there was a discussion on establishing the "School" where young scientists can learn the fundamentals and the latest progress in electromagnetics. The Working Group was subsequently formed and the name of the School was fixed in October 2011 as "URSI Commission B School for Young Scientists". The School was organized for the first time on the occasion of EMTS 2013 in Hiroshima, Japan.

Commission B Schools held until the last triennium (2014-2017)

Past Schools organized until 2017 are as follows:

- 1st School (during EMTS 2013, Hiroshima, Japan)
  Course title: Fundamentals of Numerical and Asymptotic Methods
  Course Instructors: Prof. Donald R. Wilton, University of Houston, USA
  Prof. Prabhakar Pathak, The Ohio State University, USA
- 2nd School (during GASS 2014, Beijing, China)
  Course title: Fields and Waves in Metamaterials
  Course Instructor: Prof. Nader Engheta, University of Pennsylvania, USA
- 3rd School (during AT-RASC 2015, Gran Canaria, Spain)
  Course title: Integral Equations, Fast Algorithms, and Parallelization Strategies for the Solution of Extremely Large Problems in Computational Electromagnetics
  Course Instructor: Prof. Levent Gürel, ABAKUS Computing Technologies, Turkey, and University of Illinois at Urbana-Champaign USA
- 4th School (during EMTS 2016, Espoo, Finland)
  Course title: Electromagnetic Fields and Waves: Mathematical Models and Numerical Methods*
  Course Instructor: Prof. Yury Shestopalov, University of Gävle, Sweden
  Course tutor: Dr. Eugen Smolkin, University of Gävle, Sweden

Commission B Schools held during 2017-2021

During this triennium (2017-2021), the following Schools have been organized up to present:

- 5th School (during AT-RASC 2018, Gran Canaria, Spain)
  Course title: Multiscale Computational Electromagnetics in Time Domain
  Course instructor: Prof. Qing Huo Liu, Duke University, USA
- 6th School (during EMTS 2019, San Diego, CA, USA)
  Course title: Field and Potential Based Methods in Anisotropic and Bianisotropic Electromagnetics
  Course instructor: Prof. Michael J. Havrilla, Air Force Institute of Technology, USA

There will be another School during this triennium that is scheduled on the occasion of GASS 2021 in Rome, Italy as follows:

- 7th School (GASS 2021, Rome, Italy)
  Course title: Wireless Data and Power Transfer: Approaching Antenna Near-field Region from Far Field
  Course instructors: Prof. Giuliano Manara, University of Pisa, Italy
  Prof. Paolo Nepa, University of Pisa, Italy

9. Commission B Budget Status

During the period 2017-2021, a total of 30,202.73 Euros were transferred to Commission B from URSI Central as an initial budget. The budget has been used for the following purposes:

- Expenses of Commission Officers (Vice-Chair John Volakis, ECR1 Lianlin Li, ECR2 Andrea Michel) for participation in the URSI Flagship Meetings (AT-RASC 2018, AP-RASC 2019, GASS 2021): travel and accommodation expenses, registration fees.*
- Expenses for the EMTS 2019 Young Scientist Program: registration fees, accommodation expenses, banquet, prize money for Young Scientist Best Paper Award
- Support for invited speakers of four General Lectures at EMTS 2019: registration fees
- Support for Prabhakar Pathak, distinguished scientist (retired): registration fees for AP-RASC 2019 and EMTS 2019
- (*planned*) Support for instructors (Giuliano Manara, Paolo Nepa) at 2021 URSI Commission B School for Young Scientists, GASS 2021, Rome, Italy: registration fees and banquet

For details of the Commission B expenditure, please refer to Fig. 19.

* Expenses of Chair Kazuya Kobayashi for his participation in the URSI Flagship Meetings have been covered by URSI central in his capacity of Assistant Secretary-General (AP-RASC).

Commission B Budget: 2017-2021 30.202,73 €

	AT-RASC 2018	AP-RASC 2019	GASS 2021	EMTS 2019	Total
Chair Kazuya Kobayashi	**0,00 €**	**0,00 €**	**0,00 €**	**0,00 €**	**0,00 €**
travel	0,00 €				
reg fee	0,00 €	expenses paid	0 € (President's award)		
hotel	0,00 €	from Central funds			
per diem	0,00 €				
Vice-Chair John Volakis	**0,00 €**	**0,00 €**	**2.500,00 €**	**0,00 €**	**2.500,00 €**
travel	0,00 €				
reg fee	0,00 €	did not attend	0 € (Booker medal)		
hotel	0,00 €				
per diem	0,00 €				
ECR1 Lianlin Li	**2.120,00 €**	**0,00 €**	**2.500,00 €**	**0,00 €**	**4.620,00 €**
travel	1.130,00 €				
reg fee	590,00 €	did not attend	650,00 €		
hotel	400,00 €				
per diem	0,00 €				
ECR2 Andrea Michel	**1.635,39 €**	**2.907,90 €**	**2.500,00 €**	**0,00 €**	**7.043,29 €**
travel	205,39 €	758,90 €			
reg fee	590,00 €	629,00 €	650,00 €		
hotel	560,00 €	part of per diem			
per diem	280,00 €	1.520,00 €			
Prabhakar Pathak (distinguished scientist; retired)	**0,00 €**	**760,00 €**	**0,00 €**	**620,00 €**	**1.380,00 €**
Young Scientist Award	**0,00 €**	**0,00 €**	**0,00 €**	**6.000,00 €**	**6.000,00 €**
General Lecture speakers (4 persons)	**0,00 €**	**0,00 €**	**0,00 €**	**2.480,00 €**	**2.480,00 €**
reg fee (GL speaker 1)				620,00 €	
reg fee (GL speaker 2)				620,00 €	
reg fee (GL speaker 3)				620,00 €	
reg fee (GL speaker 4)				620,00 €	
	3.755,39 €	**3.667,90 €**	**7.500,00 €**	**9.100,00 €**	**24.023,29 €**
				Balance	6.179,44 €
hotel block reservation EUR/day	80,00 €	170,00 €			

Fig. 19. Commission B budget for 2017–2021.

10. Meetings supported by Commission B

Commission B provided technical support to various international conferences during 2017–2021 as shown in Table 8.

Table 8. List of Commission B-supported meetings.

Dates	Location	Title	Description
19-22 October 2021	Taipei, Taiwan	ISAP 2021	2021 International Symposium on Antennas and Propagation
2-5 August 2021	New York, NY, USA	Metamaterials 2021	15th International Congress on Artificial Materials for Novel Wave Phenomena
19-21 April 2021	Brno, Czech Republic	MAREW 2021	Microwave and Radio Electronics Week 2021
25-28 January 2021	Osaka, Japan	ISAP 2020	2020 International Symposium on Antennas and Propagation
28 September - 1 October 2020 (in an online format)	New York, NY, USA	Metamaterials 2020	14th International Congress on Artificial Materials for Novel Wave Phenomena
5-6 September 2019	Tokyo, Japan	URSI-JRSM 2019	2019 URSI-Japan Radio Science Meeting
7-8 March 2019	New Delhi, India	SPIN 2019	6th Int. Conference on Signal Processing and Integrated Networks
12-13 November 2018	Loughborough , UK	Loughborough Antennas and Propagation Conference	
6-9 November 2018	Kyoto, Japan	APMC 2018	Asia-Pacific Microwave Conference 2018
14-15 December 2017	Madrid, Spain	IWMbD2017	Third International Workshop on Metamaterials by Design - Theory, Methods and Applications to Communications and Sensing
30 October – 2 November 2017	Phuket, Thailand	ISAP 2017	2017 International Symposium on Antennas and Propagation
25-28 September 2017	Cape Town, South Africa	RADIO 2017	IEEE Radio and Antenna Days of the Indian Ocean 2017
28-31 August 2017	Marseille, France	Metamaterials 2017	The Eleventh International Congress on Advanced Electromagnetics Materials in Microwaves and Optics The Eleventh International Congress on Artificial Materials for Novel Wave Phenomena