

## Radio Science in Czechoslovakia and Czechia

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### Predecessors of Radio Science in Czechia

Development of science, education, and industry in the geographical region of Czechia (the western part of Czechoslovakia from 1918 to 1992, the north-western part of Austro-Hungarian Empire before 1918) took place in parallel with the overall development in Europe well before URSI was founded. The first scientific societies were established in this region in 1784. At that time, Czechia was the most industrialized part of the Austro-Hungarian Empire. The most important higher education and scientific institutions were Charles University founded in 1348 [1], the Czech Technical University in Prague founded in 1707 [2], and Brno University of Technology founded in 1899 [3].

However, the very first Czech scientist interested in electricity was a catholic priest Prokop Diviš (1698 – 1765). In order to prevent thunderstorms and lightning to occur in his parish he erected in 1754 a 40 m high pole in Přímětice (Czechia), on which he mounted several tin boxes and more than 400 metallic spikes. The pole was secured by conductive chains that grounded it and thus it became the first operational lightning rod, being better grounded than Franklin's experimental lightning rods at that time. He published his findings in 1762 [4].

One of the first Czech pioneers in the field of radio engineering was Prof. Augustin Žáček (1886 – 1961). He published a number of articles in the journal named "Časopis pro pěstování matematiky a fyziky". In the most important one [5] he described a new method for exciting very short electromagnetic waves by a magnetron. He also contributed significantly to the development of the magnetron theory [6].

Another Czech scientist, explorer, and writer Prof. František Běhounek (1898 – 1971) was a scientific member of the Norge (1926) and Italia (1928) Airship crews serving as an expert on cosmic rays being recommended by Marie Curie. He flew as the first Czech over the North pole in 1928 and he obtained important results from his measurements of electric conductivity of the atmosphere and ionic mobility conducted on the Italia airship [7].

### History of the Czechoslovak and Czech National Committee of URSI

After the foundation of independent Czechoslovakia in 1918, the international relationships of Czechoslovak research institutions were officially set by their affiliation with the International Research Council (IRC) through the Czechoslovak National Research

Council (CNRC). This organization, in Czech “Československá národní rada badatelská”- established in 1923 became a regular member of CIR in 1925 when the statutes of CIR were accepted by the Czechoslovak government. CNRC provided Czechoslovak research institutions with technical assistance in networking and establishing international scientific collaborations.

During World War II, activities of the Czechoslovak National Research Council stopped and after the war, the internal structure of CNRC was changed to accommodate an increasing number of scientific committees. The National Committee for Radio Science was among these newly established committees. It became a member of URSI immediately after its foundation in 1948 and has been later renamed to Czechoslovak National Committee of URSI.

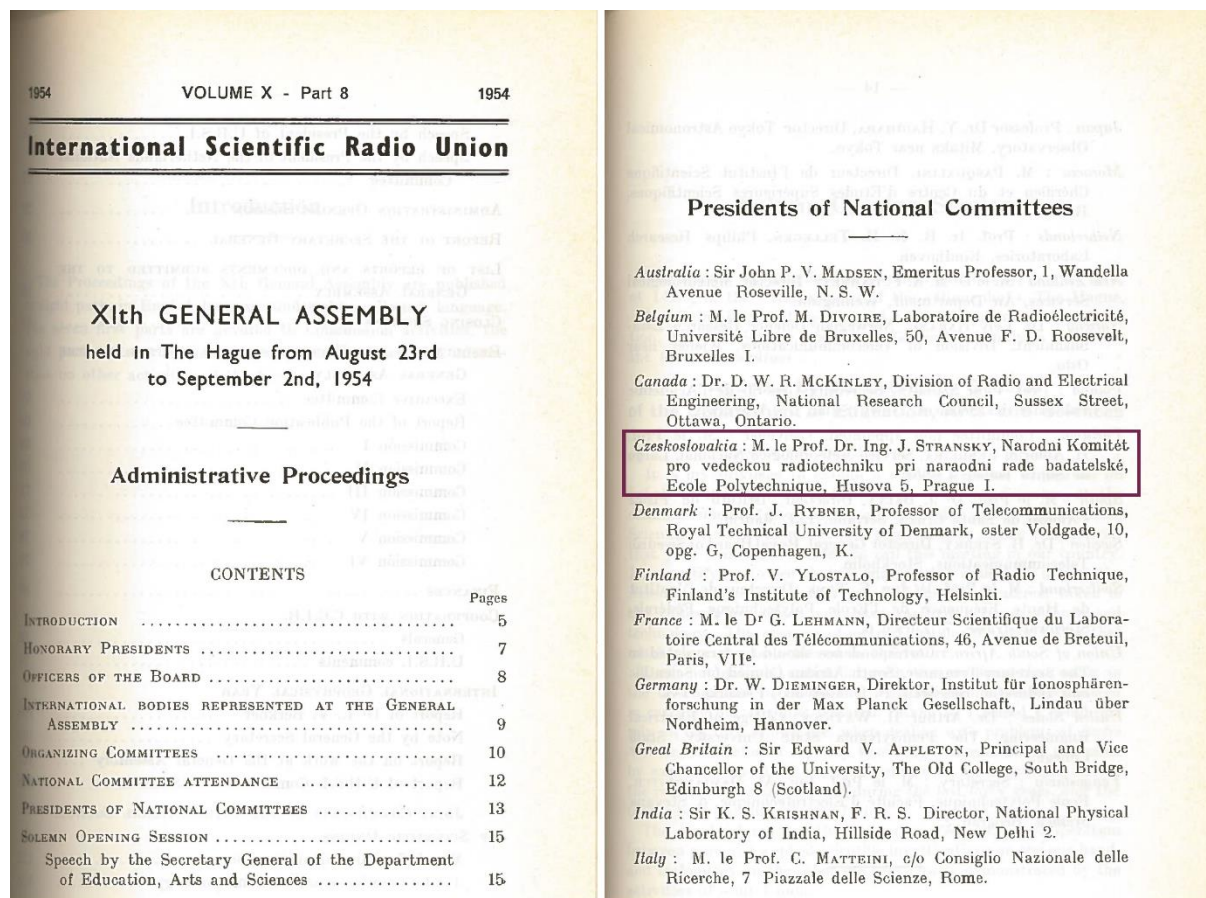
In 1953 the newly established Czechoslovak Academy of Sciences took over the responsibility for all national committees originally supported by CNRC, including the Czechoslovak National Committee of URSI. After January 1, 1993, when Czechoslovakia split into two independent states, Czechia and Slovakia, the Czechoslovak National Committee of URSI worked another seven years as a common committee for both countries (Czech and Slovak National Committee of URSI). Independent committees of the two countries were set up only in 1999.

The Czech National Committee of URSI was supported by the Czech Academy of Sciences up to the end of 2017 when the support was terminated due to changes in the Czech national legislation. These changes resulted in an action of the Czech Supreme Audit Office which banned the Czech Academy of Sciences from paying the yearly membership dues to URSI. Fortunately, the Institute of Atmospheric Physics of the Czech Academy of Sciences agreed to legally take over the agenda of the Czech National Committee of URSI. The institute appointed a new committee composed of active members of the former Czech National Committee of URSI, which allowed them to continue to represent the Czech radio science community both at national and international levels.

### **Presidents of the Czechoslovak and Czech National Committee of URSI**

The first appearance of the Czechoslovak National Committee (NC) of URSI in the URSI archives is documented in Fig.1. This figure shows the name of the first president of the Czechoslovak NC of URSI Prof. Dr. Ing. Josef Stránský among the names of presidents of other National Committees attending the XI. General Assembly in Haag in 1954. Prof. Stránský (1900-1983) has finished his studies at the Czech Technical University in 1923, then he continued at the Ecole Superior de Electricite, section radio in Paris, France. After graduation he worked at the technical department of the Post and Telegraph directory in Prague, Czechoslovakia and also spent several years in Western Electric Company and Bell Telephone Labs in the USA. He was appointed the first Professor of Radio Engineering at the Czech Technical University in 1937. He was an author of many monographs and textbooks

on principles of radio science and taught many future radio specialists who continued their careers in science and industry.



**Fig. 1** The first appearance of the Czechoslovak National Committee of URSI in the URSI archive

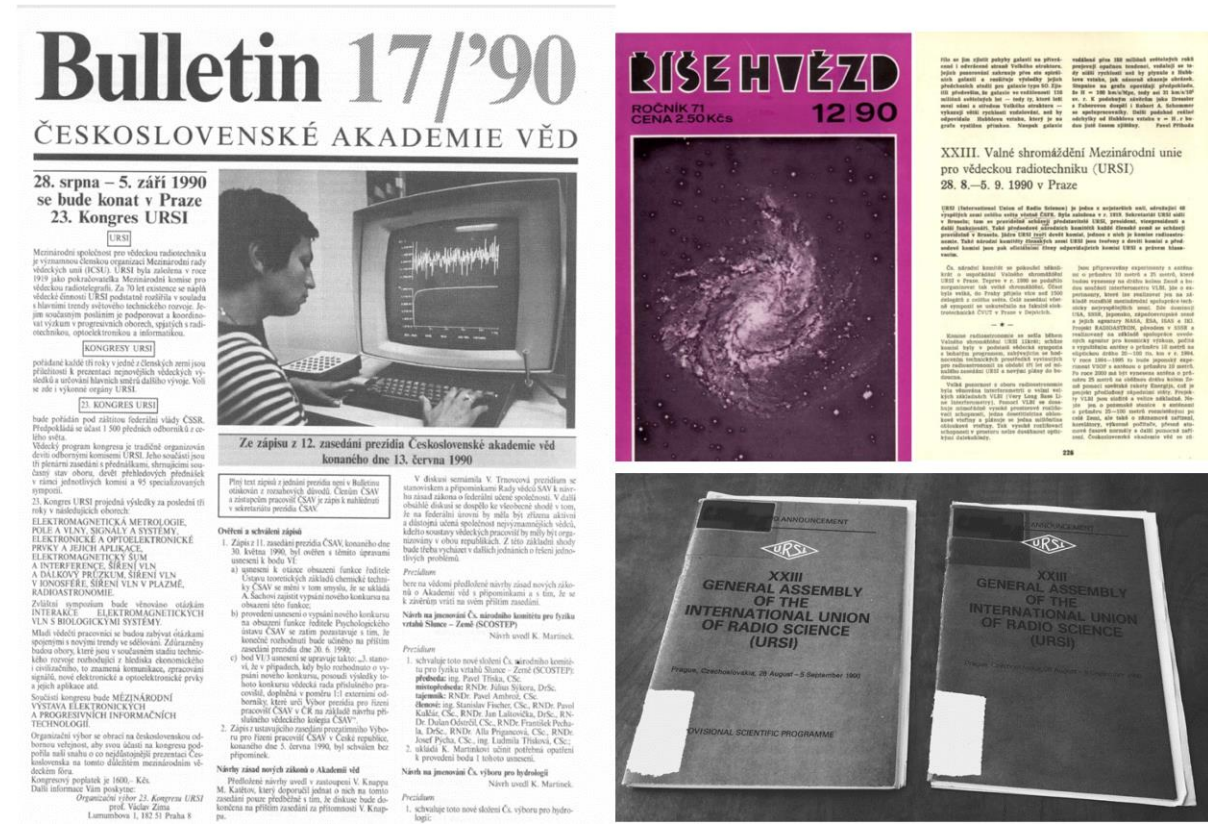
Prof. Stránský was one of the founders of the Czechoslovak National Committee for Radioscience and has been serving as its president for 35 years. He was followed in this service by Prof. Václav Zima, at that time the director of the Institute of Radio Engineering and Electronics of the Czechoslovak Academy of Sciences. He served as a president of the Czech NC of URSI from 1984 to 1991. Prof. Zima was very active in preparations of the XXIIIrd URSI General Assembly which was held in the Czech capital Prague and was hosted by the Czechoslovak NC of URSI in 1990. Dr. Václav Čížek from the same institute (the current name of the institute is the Institute of Photonics and Electronics of the Czech Academy of Sciences) replaced Prof. Zima in 1991 and served as a president up to 1999, when the common Czech and Slovak NC of URSI was split into two independent national committees.

The first president of the Czech NC of URSI was Dr. Vladimír Fiala from the Institute of Atmospheric Physics of the Czech Academy of Sciences (1999-2008), followed by Prof. Miloš Mazánek from the Czech Technical University (2008 – 2016). The current president of

the Czech NC of URSI, Dr. Ivana Kolmašová from the Department of Space Physics of the Institute of Atmospheric Physics of the Czech Academy of Sciences, recently led the efforts to maintain the continuity of the legal existence of the Czech NC of URSI. Members of the NC of URSI represented Czechoslovakia and later Czechia as official members in individual commissions of URSI; many of them have been serving for more than 20 years.

### International activities of the Czechoslovak and Czech National Committee of URSI

Several members of the Czechoslovak or Czech NC of URSI participated or participate in URSI activities at the international level. Prof. Václav Zima worked as a Vice Chair and Chair of the international Commission C from 1975 to 1980.



**Fig. 2** Announcements of 23rd URSI General Assembly in Prague in the 1990. Left: in the bulletin of the Czechoslovak Academy of Sciences, top right: in the popular astronomical magazine “Realm of stars”, bottom right: the first and the second official announcement by the organizing committee. (Photos in the figure were collected from the archive of the Institute of Photonics and Electronics of the CAS, which co-organized the XXIIIrd GA in Prague (that time bearing the name Institute of Radio Engineering and Electronics of the Czechoslovak Academy of Sciences))

Dr. Vladimír Fiala served as a Vice Chair and Chair of the international Commission H - Waves in plasma from 1993 to 1999. Prof. Ondřej Santolík worked as a Vice Chair and Chair of Commission H from 2006 to 2017. The international visibility of the Czech “Waves in plasma” community has been recently strengthened by the election of Assoc. Prof. Dr. František Němec for the position of the Early Career Representative of the international

Commission H for two trienniums starting 2017. As regards the Czech or Czechoslovak representation in the URSI board, Prof. Václav Zima worked as the Vice-President of URSI for two trienniums from 1984 to 1990. Prof. Ondřej Santolík has been elected Vice-President of URSI in 2017.

The XXIIIrd General Assembly of URSI was held in Prague, Czechoslovakia from August 28 to September 5, 1990 (Fig. 2). Prof. Václav Zima, the president of the Czechoslovak NC of URSI and the vice-president of URSI chaired the Organizing Committee of this General Assembly. A number of 1176 contributions included in the abstract book exceeded the number of abstracts submitted to previous General Assemblies of URSI. Prague hosted more than 1500 radio scientists from different countries all over the world. For many Czechoslovak radio scientists this congress became the first opportunity to personally meet foreign colleagues whose names they previously knew only from scientific papers.

### **Current activities of the Czech National Committee of URSI**

The Czech NC of URSI regularly provides technical sponsorship to conferences “Radioelektronika” and “MAREV” organized by Czech and Slovak technical universities. The Czech NC of URSI supported many international conferences when organized in the Czechia, like e.g. PIERS 2007 (Progress in EM Research), ISMOT 2011 (International Symposium on Microwave and Optical Technology), EuCAP 2012 (European Conference on Antennas and Propagation), PIERS 2015 and EuMCE 2019 (European Microwave Conference in Central Europe).

It also supports other conferences, workshops and seminars which are related to scientific topics of URSI commissions and are not organized at regular base. The Czech NK of URSI supports publication of the journal “Radioengineering - Proceedings of Czech and Slovak Technical Universities” which publishes original scientific and engineering papers from the area of wireless communication and application of wireless technologies. Members of NK URSI were also serving in the editorial board of the Radioengineering journal.

Representatives of the Czech NC of URSI regularly attend the URSI flagship conferences, participate in meetings held during these conferences and inform the Czech radio science and radio engineering communities about the outcomes of these meetings. NC of URSI also encourage young scientists to participate in URSI competitions organized for young scientists during URSI flagship meetings.

The Czech NC of URSI cooperates with the other NC of URSI. The members of the NC occasionally attend the conferences organized by the German, French or American NCs of URSI. We also closely cooperate with NCs of URSI from Austria, Poland, Hungary and Slovakia. In 2018, the Czech and Slovak National Committees of URSI organized a one-day Czech and Slovak National Radio Science Meeting in order to remind 70 years of URSI in Czechia and Slovakia. Representatives of National Committees of neighboring European

countries were invited. As a part of this meeting we arranged a student poster competition with participation of fourteen students. The first, second, third prizes and two fourth prizes were awarded to Barbora Bezděková from the Charles University (Fig. 3), Andrea Kolínská from the Czech Technical University, Jan Záhlava from the Charles University, Marek Novák from the Brno University of Technology, and Michaela Poplová from the Czech Technical University. International guests Prof. Frank Grohnwald from Germany, chair of international Commission E of URSI, Prof. Janos Lichtenberger, chair of the international Commission H of URSI and Prof. Piotr Słobodzian, Chair of Commission E of the Polish NC of URSI took part in the meeting and helped with the evaluation of student posters.



**Fig. 3** The student poster competition organized during the „Czech and Slovak National Radio Science meeting -70 years of URSI in Czechia and Slovakia“ (left to right): Ondřej Santolík – the vicepresident of URSI, Barbora Bezděková – winner of the competition, Ivana Kolmašová – the President of the Czech NC of URSI, Vladimír Štofánik – the President of the Slovak NC of URSI

### **Czech institutions active in the area of Radio Science**

Nowadays the research in the area of Radio Science is mainly concentrated in several institutes of the Czech Academy of Sciences (Institute of Atmospheric Physics, Institute of Photonics and Electronics and Astronomical Institute), in Charles University in Prague (The Faculty of Mathematics and Physics), and in five technical universities in Prague, Brno, Liberec, Plzeň and Ostrava. Czech scientists and engineers participate in many international

research programs and projects, which are related to the area of Radio-Science. For example, Prague is now the administrative center of European GNSS Agency (Galileo – Global Navigation Satellite System).

*Czech Academy of Sciences, Institute of Atmospheric Physics (IAP)*

IAP, established in 1964, is oriented toward basic research of the atmosphere, ionosphere and magnetosphere of the Earth, ionospheres and magnetospheres of planets of the Solar system, and of the solar wind. Two of the four departments of the institute (Department of Space Physics and Department of Ionosphere and Aeronomy) and one working group (Group of Numerical Simulations of Heliospheric Plasmas) are close to URSI topics, in the domains of space plasma physics and space weather, including design and development of scientific instruments, in situ experimental measurements, data analysis, theory, and numerical simulations. Researchers and technicians at IAP takes advantage of a strong heritage originating from scientists and engineers from the team led by Dr. Pavel Tříška and Ing. Jaroslav Vojta who designed, built, and operated a series of five Magion spacecraft (1978 – 2002). The Department of Space Physics (<http://okf.ufa.cas.cz/en/>) lead by Prof. Ondřej Santolík is active in areas of research related to scientific topics of URSI Commission H (Waves in Plasma). The research consists of experimental studies of processes in heliospheric plasmas via analysis of data from spacecraft and ground observatories, large scale numerical simulations of space plasma processes, and design and development of scientific instruments for future spacecraft missions. Nowadays the data analysis is largely focused on the study of waves and oscillations in various plasmas in the magnetosphere of the Earth, Jupiter, Saturn and in the solar wind. Main field of interest of the Department of Ionosphere and Aeronomy lead by Dr. Jan Laštovička is the physics of the ionosphere including the International Reference Ionosphere activities lead by Dr. Vladimír Truhlik, forcing the ionosphere by atmospheric waves and by space weather, and global changes in the upper atmosphere and ionosphere.

*Czech Academy of Sciences, Institute of Photonics and Electronics (IPE)*

IPE (former Institute of Radio Engineering and Electronics) of the Czech Academy of Sciences has a long tradition in the research in several areas of URSI activities and various applications. Among many historical achievements, it was where the first maser in Czechoslovakia was constructed in 1963 (Dr. Jan Blabla, Dr. Viktor Trkal). In the current era, IPE carries out fundamental and applied research in the scientific fields of photonics, optoelectronics and electronics. In these fields, IPE generates new knowledge and develops new technologies. In the field of photonics, the primary focus at IPE is the research and development of optical biosensors (Prof. Jiří Homola), high-power fiber lasers (Dr. Pavel Honzátko), generators of coherent radiation in middle IR, and special optical fibers (Dr. Vlastimil Matějec, Dr. Ivan Kašík, Prof. Jiří Čtyroký). In the field of optoelectronics, IPE

investigates electrical and optical phenomena occurring on the surfaces and interfaces of nanomaterials. These phenomena are induced by photons, ions, electrons, and the adsorption of atoms and molecules, and are used for applications in sensing, light generation and advancement of analytical techniques (Dr. Jan Grym, Dr. Petar Gladkov, Dr. Karel Ždánský). In the field of electronics (with extensions to photonics), the main research activities of IPE are the study of electrodynamic properties of biological systems and the development of detection systems (Dr. Jiří Pokorný, Dr. Michal Cifra). In addition to these activities, IPE runs the Laboratory of the Czech Etalon of Time and Frequency (Dr. A. Kuna).

#### Czech Academy of Sciences, Astronomical Institute

The Radio Astronomy Observations in Czechoslovakia started at the Ondřejov observatory (nowadays belonging to the Astronomical Institute (<http://www.asu.cas.cz/en/>)) in 1955 with acquisition of a 7.5m Würzburg Riese Radar previously used by the German Luftwaffe during the World War II. The antenna was used for continuous measuring the Solar Radio Flux at 260, 536 and 808 MHz until 1994, when the main bearing broke down. Later the antenna was moved to the Military Museum. Nowadays we operate a 3m dish for measuring the Solar Radio Flux at 3 GHz, a 10m dish for Solar Radio Spectrograph 0.8-2.0 GHz, and another 3m dish for Solar Radio Spectrograph 2.0-5.0 GHz. All instruments are fully automated, acquiring data with 10 ms time resolutions.

#### Charles University, Faculty of Mathematics and Physics, Department of Surface and Plasma science

The scientific group at the Department of Surface and Plasma Science (<https://physics.mff.cuni.cz/kfpp/>) (formerly Department of High Frequencies and Vacuum Technics, later Department of Electronics and Vacuum Physics) has a long history in development of spacecraft instruments, going back to early seventies (Prof. Zdeněk Němeček, Prof. Jana Šafránková). The instrument development was naturally accompanied by the data analysis, and the space physics group was formed. Although the main scientific focus was originally on space plasma properties, a significant aim on electromagnetic wave phenomena in space is apparent in the new millennium (Prof. Ondřej Santolík, Assoc. Prof. František Němec). Multicomponent wave measurements and detailed analyses of wave properties, propagation, and growth are used to understand the wave and particle dynamics in space, in particular in the Earth's inner magnetosphere.

#### Czech Technical University in Prague, Faculty of Electrical Engineering (Department of Electromagnetic Field and at the Department of Radio Engineering), and Faculty of Biomedical Engineering

Faculty of Electrical Engineering (<https://www.fel.cvut.cz/en/>) is doing basic and applied research and educating students in overall scientific scope of URSI: Radio-technology (receivers and transmitters), signal processing, electronics, physics, theory of



electromagnetic fields, antennas, radio-wave propagation, radio frequency and microwave circuits and systems, radio frequency and microwave measurements, biological effects of electromagnetic fields, medical applications, beam and fiber optics, electromagnetic compatibility, 5G, navigation, etc. The research activities related to URSI are concentrated at the Department of Electromagnetic Field and at the Department of Radio Engineering. Department of electromagnetic field (founded in 1972) (<https://elmag.fel.cvut.cz/>) had several important radio-science related scientists in its history - above all Prof. Václav Tysl, Prof. Jaroslav Vokurka, Prof. Jaroslav Prokop and Prof. Karel Novotny. In the period 1977-1992 this department was involved in the Earth's Remote Exploration program (in cooperation with the Institute of Physics of the Czechoslovak Academy of Sciences). The project was related to participation in the INTERKOSMOS program. The research was focused on microclimate and millimeter radiometry and Earth imaging in these bands (Prof. Miloš Mazánek). The work coincided with the electromagnetic wave propagation program and grew into applications in radiometry for biomedical effects (Assoc. Prof. Přemek Hudec). In parallel there were some other research projects done at this department, like e.g. parametric amplification for implementation of low noise receivers, microstrip circuits (Prof. Ján Zehentner, Prof. Jan Macháč), measurement systems for cm and mm waves (Prof. Karel Hoffmann) and last, but not least since 1981 development of hyperthermia technology and its clinical applications in hospital in Prague (Prof. Jan Vrba).

Nowadays there are at this department several research groups with topics related to URSI activities, e.g.: Theory of EM Field (Prof. Jan Macháč, Prof. Zbyněk Škvor), Antennas and EMC (Prof. Miloš Mazánek, Assoc. Prof. Pavel Hazdra), Radio-wave Propagation (Prof. Pavel Pechač), Free-space and Fiber Optics (Prof. Stanislav Zvánovec), Microwave Circuits, Systems and Measurement (Prof. Karel Hoffman, Assoc. Prof. Přemek Hudec), RFID (Assoc. Prof. Milan Polívka), Computational Electromagnetics (Assoc. Prof. Lukáš Jelínek, Assoc. Prof. Miloslav Čapek), Biomedical Applications of EM Field (Prof. Jan Vrba).

Department of Radio Engineering (<http://poseidon2.feld.cvut.cz/>) works on wireless analog and digital communication and multimedia technology. The department has specialized laboratories for teaching and carrying out research on signal broadcasting, receiving and processing, audiovisual technology, radioelectronic measurements, RF circuits analysis and design, radar and satellite navigation, and space technologies. It cooperates with universities, scientific institutions and industry, mostly on R&D projects and in teaching support. Department of Radio Engineering has several research activities related to URSI field of interest, eg.: 5G Technologies and Applications of RF and multimedia Internet of Things (Assoc. Prof. Václav Žalud), Implementation of the European Galileo satellite positioning system in the Czech Republic (Prof. František Vejražka), Development of quality evaluation methods for calomel optical elements (Prof. Miloš Klíma), Participation in preparation of payloads for space missions of ESA (Prof. Petr Páta), Analysis and Optimization of RF circuits using computer-aided design (Assoc. Prof. Josef Dobeš).

Faculty of Biomedical Engineering (<https://www.fbmi.cvut.cz/en>) is doing basic and applied research and educating students in overall biomedical engineering. There is a research group with topics related to URSI activities: Bio-electromagnetic team from the Department of Biomedical Technology (head Prof. Peter Kneppo), where research is being conducted on the use of electromagnetic field in radio microwave frequency bands for medical diagnostics, like e.g. cancer diagnostics and stroke recognition (Assoc. Prof. Jan Vrba jr.), MTM (Metamaterial) technology for cancer treatment (Assoc. Prof. David Vrba) and non-invasive temperature measurement (Dr. Ondřej Fišer jr.).

*Brno University of Technology, Faculty of Electrical Engineering and Communication,  
Department of Radio Electronics (DREL)*

The Department of Radio Electronics (DREL) (<http://www.urel.feec.vutbr.cz/>) has been established in 1959 and this year celebrates 60 years of teaching students in radio electronics and communications, of outstanding research and development in future communication technologies and also of Czech radio-science community networking. Former heads of the DREL were Prof. Jan Kalendovský (1959 - 1970), Prof. Kamil Vrba (1970 - 1981), Prof. Vladimír Mikula (1981 - 1990), prof. Jiří Svačina (1991 – 2006) and Prof. Zbyněk Raida (2006 – 2013). Since 2013, head of the DREL is Prof. Tomáš Kratochvíl. The main research activities of the DREL are radio and wireless communication systems (Prof. Roman Maršálek), mobile communications (Prof. Stanislav Hanus) including traffic and vehicle-to-vehicle communications (Prof. Aleš Prokeš), applied electromagnetism including wearable antennas and electronics (Prof. Zbyněk Raida), satellite communications including communication transponders and their design for various Space missions (Prof. Miroslav Kasal), hybrid radio and optical communication systems for free space optics links and networks (Prof. Otakar Wilfert), design of the radio electronics and communication systems (Prof. Zdeněk Kolka) and digital video and audio broadcasting and coexistence of the radio and wireless systems (Prof. Tomáš Kratochvíl). Each mentioned radio-science topic has professors' leadership and individual research working groups include also master and Ph.D. students. In last 10 years, 567 electrical engineers specialized in radio electronics and communications have successfully finished their master degree study at the DREL and almost all of them are working in the electronic and communication R&D field. In advance, from 2007 the DREL is a publishing department of the Radioengineering Journal (ISSN 1210-2512), which is Proceedings of Czech and Slovak Technical Universities and URSI Committees, listed in WoS and Scopus. In 2019, the DREL team consisting of 37 academicians, 20 Ph.D. students, and 8 technician assistants teaching and researching in 14 modern and well-equipped laboratories.

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