



**INSTITUTE OF RADIOELECTRONICS
AND MULTIMEDIA TECHNOLOGY**

WARSAW UNIVERSITY OF TECHNOLOGY

FACULTY OF ELECTRONICS AND INFORMATION TECHNOLOGY



ANNUAL REPORT

2023

Warsaw, January 2024

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Edited by:

K. Bąk
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J. Marzec

From the Director

Dear Friends and Colleagues,

Looking back at the past year, I can say with full confidence that the tasks set before the institute in January 2023 have been mostly successfully completed. The COVID-19 pandemic is slowly fading in our memory, and its main remnants are online meetings and teleconferences, which have proved to be very useful and time-saving tools. War just beyond our borders has not disrupted our activities, though our thoughts and feelings are with the brave nation of Ukraine as they defend against the Russian threat. However, as we are looking into the future with an increasing optimism, it's also the time for the brief summary of the past period.

Scientifically, our institute has been steadily growing. This is evidenced by the significant number of solid publications in the JCR list, evaluated between 100 and 140 points by Polish Ministry of Science. Additionally, the five monographs authored or co-authored by our most active researchers summarize long-term research findings. An important achievement is the publication of nine patents, some of which have the potential for practical application in the commercial operations of the startup companies created by our employees as the results of research and development projects. We hope these endeavors will be fruitful in increasing the economic assets of the Institute.

Scientific activities include participation in conferences, which, although less frequent this year, remain significant. Our staff was involved in organization of the International Symposium on Sound Engineering and Tonmeistering, held in Warsaw in October. Congratulations are in order for prof. Jan Żera and his team for making this event successful. Additionally, we were involved in the Radiocommunication and Teleinformatics Conference held in Cracow in September.

A significant part of the Institute's activities involves participating in and leading research grants. The past year has been particularly successful for us, as we were able to continue the existing endeavors and initiate new ones, such as "Infostrateg" program, financed by the National Centre of Research and Development. Thanks to Dr. Marcin Ziembicki leadership his team's achieved astounding success with the "Super-Kamiokande to Hyper-Kamiokande" project under the Horizon 2020 program. The similar project, the "Hyper-Kamio-kande" (funded by the National Centre of Research and Development) was started last year. Furthermore, prof. Yevhen Yashchyshyn initiated the European project "Novel Technologies and Materials for TeraHertz Radiation Control". We hope that these successes will inspire other researchers to redouble their efforts secure financing for their projects.

This year, our academic staff was significantly strengthened. Congratulations are due to Dr. Derzakowski, for being awarded his DSc degree. Our institute maintains steady stream of new PhD graduates, with six persons completing their degrees (three with honors), five of whom are now employed in the institute. The number of PhD students exceeds 30, ensuring the rich resource for the potential new research staff in the future.

In terms of didactic activities, our contributions to the Faculty operations have been strong, as usual. This includes managing multiple courses across three levels of study, including the PhD school, with main focus primarily in Electronics, Cybersecurity and Internet of Things Engineering specializations.

Many long-time staff members have been awarded medals and distinctions, including the medal of the National Education Committee. We extend our sincere congratulations to all awarded colleagues. Additionally, multiple students had been recognized by the Rector for their outstanding achievements at the BSc and MSc levels.

We brace for the year filled with both changes but continuations. Upcoming University elections may result in transition of responsibility to new authorities for various organizations, potentially including Institute or Faculty, besides University itself. Our Institute awaits these events with confidence, believing that any changes will not hinder but rather foster our organization's advancement and expansion, both scientifically and didactically.



Professor Józef Modelski

Warsaw, January 2024

Classification of publications presented in this Report
is in accordance with the rules in force in 2023

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1. GENERAL INFORMATION

1.1. Mission of the Institute

In defining its mission, the Institute of Radioelectronics and Multimedia Technology is amenable to contemporary needs of academia, industry, and society. Therefore, it aims at the three measurable objectives: to provide teaching of societal relevance; to seek excellence in scientific research; and to run projects meeting the international standards. Technically, we focus on the well-defined specializations: radioelectronics, multimedia, nuclear and medical electronics. These are very well perceived by our students and partners in national and international activities.

As educators, our staff performs sterling work and exhibit immense stamina. The effects are directly measurable in terms of quality and numbers of supervised diplomas. Our graduates prove competitive on the demanding job market in Poland and abroad. They find employment in telecommunication services, mobile communications, information technology, television, and also in public services. We reach further into these sectors through the successful scheme of continuing education. The offer of courses including Radioelectronics and Multimedia Technology attracts an increasing number of participants.

As researchers, we are faithful to the highest standards of the Faculty and the University. We also feel quite unique due to an extremely broad spectrum of addressed subjects, which comprise:

- In Radioelectronics

We are interested in all theoretical and practical aspects concerning transmitting and receiving parts of radio systems. As radio systems we understand radio broadcasting systems, telecommunication systems including various configurations from point-to-point to multiple input-multiple output systems as well as the radio-location and radio-navigation systems. These systems can operate in narrow band, wide band or ultra-wide band. Special attention has been recently put on reconfigurable and software-defined radio systems (incl. smart and reconfigurable antennas).

The frequency range of our interest spans from kHz range (for high efficiency energy conversion) through all ranges used in classical telecommunication up to the terahertz and optical range.

In our applied research we have a vast experience in designing up-to-date, ready to use parts of the radio systems including various types of antennas, power amplifiers, modulators and even entire TR modules for radar systems.

We also specialize in physical aspects of the propagation of electromagnetic and acoustic waves. The waves are interested in as the means of transmission of the telecommunication information but also as the means of transmitting high power and/or means of investigating the properties of materials (incl. semiconductors, ferroelectrics, graphene, composites etc.).

- In Multimedia

Multimedia at our Institute assembles various lines of research in visual and audio technology. The Multimedia branch comprises people working in two major research and teaching groups: the Television Division and the Electroacoustics Division. Activities of the Television Division focus on media compression, object recognition in images, and digital processing for measurement signals. Moreover, media security, extracting 3D models from video streams, the augmented reality for TV applications, and novel multimedia applications based on deep, convolution, and recurrent artificial neural networks - extend the traditional area of research and teaching in the Television Division.

The Electroacoustics Division, in its research and teaching, focuses on fundamental and applied issues in acoustics, electroacoustics, design of sound systems, signal processing for audio as well as various aspects of perception of sound including noise control and its effects on people.

- In Nuclear and Medical Electronics

Nuclear and Medical Electronics assemble designing of the detectors and front-end electronics for high energy physics and neutrino experiments (e.g. AMBER, WCTE – CERN, T2K, HyperK – Japan), software and hardware developments in Magnetic Resonance Imaging (MRI), like studies of hyper-polarization (DNP) with RF and processing methods in functional and structural neuroimag-

ing, data analysis in proteomics, software and hardware developments in Electrical Capacitance Tomography and Nanoparticle Magnetic Tomography.

It is also our ambition to implement the new scientific knowledge into a good engineering practice. The Institute covers the full process of technological development, from innovative ideas up to the construction of prototypes.

The Foundation for Development of Radiocommunications and Multimedia Technology plays a special role in perpetuating scientific research within our Institute and the whole Faculty. The Foundation subsidizes undergraduate and graduate scholarships. It monitors and awards the progress of young Polish researchers. Its generous support helps us face the socio-economical obstacles, and compete with commercial opportunities awaiting the young people on the open market.

1.2. Board of Directors

Director of the Institute

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Deputy Director for Research

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Secretariat

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Director's Representative for Economy & Administration

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1.3. Organisation of the Institute

The Institute of Radioelectronics and Multimedia Technology consists of the following research and teaching divisions:

- Electroacoustics Division;
- Nuclear and Medical Electronics Division;
- Radiocommunications and Radiolocation Engineering Division;
- Subterahertz Technology Division;
- Multimedia Engineering Division.

The structure of the Institute includes, Accounting Department, Supply Section.

1.3.1. Electroacoustics Division

Head of Division

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Senior academic staff

Piotr Bilski, D.Sc., Associate Professor
 Piotr Bobiński, Ph.D., Assistant Professor
 Marcin Lewandowski, Ph.D., Assistant Professor
 Robert Łukaszewski, Ph.D., Assistant Professor
 Grzegorz Makarewicz, Ph.D., Assistant Professor (0.5)
 Agnieszka Pietrzak, Ph.D., Assistant Professor
 Krzysztof Mroczek, Ph.D., Assistant Professor

Junior academic staff

Maciej Jasiński, Ph.D., Assistant

Technical staff

Grzegorz Makarewicz, Ph.D., Research Support Engineer (0.5)

Ph.D. Students

Dina Al-Daloo, M. Sc., from Oct. 2023
 Piotr Czarnecki, M.Sc., from Oct. 2019
 Krzysztof Dowalla, M.Sc., from Feb. 2017, till Oct. 2023
 Salomea Grodzicka, M.Sc., from Oct. 2019
 Maciej Jasiński, M.Sc., from Feb. 2018, till Dec. 2023
 Bartosz Kościąg, M.Sc. from Feb. 2021
 Ary Kurniadi Irawan, M.Sc., from Oct. 2023
 Zinelabidine Leghelimi, M.Sc. from Oct. 2023
 Jacek Majer, M.Sc., from Oct. 2018
 Tomasz Markowski, M.Sc., from Feb. 2018
 Łukasz Popek, M.Sc., from Oct. 2023
 Bartosz Połok, M.Sc., from Oct. 2015
 Karolina Pondel-Sycz, M.Sc., from Oct. 2021
 Jakub Tkaczuk, M.Sc., from Oct. 2020

Retired

Zbigniew Kulka, Prof. D.Sc.,
 Ewa Kotarbińska, Ph.D.,
 Andrzej Leszczyński, Ph.D.,
 Maria Tajchert, Ph.D.

The activities of the Division concern electroacoustics and digital audio techniques, including investigations, measurements and applications. They are focused on:

- fundamentals of acoustics;
- electroacoustics;
- psychoacoustics;
- digital audio;
- design and measurements of electroacoustic transducers;
- investigation and modeling of acoustic field distribution;
- noise control and active noise reduction;
- architectural and industrial acoustics;
- sound studio techniques;
- hearing protection.

Current research topics include:

- digital audio signal processing;
- low-level acoustic signals measurements and analysis;
- objective and subjective methods of sound quality evaluation;

- detection of auditory warning signals in the presence of industrial noise;
- elaboration of computation methods for acoustic field radiated in free space by surface acoustic sources and their implementation on a PC.

The other field of interest concerns fundamental and applied research associated with metrology, instrumentation and measuring systems. It is focused on design of automated computer-based measuring systems. Current research topics include:

- modern information technologies, e.g. LabVIEW, Java, XML, and modern communication technologies, e.g. the Internet, GSM, Bluetooth, ZigBee in distributed control and measuring systems;
- virtual instrumentation, plug-in boards for data acquisition, IEEE-488 equipment;
- artificial intelligence methods in diagnostics of analog systems;
- non-invasive methods for monitoring and analysis of electricity consumption around the end users.

The Division is equipped with an anechoic chamber and sound studio with two control rooms.

1.3.2. Nuclear and Medical Electronics Division

Head of Division

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Senior academic staff

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 Piotr Bogorodzki, D.Sc., Associate Professor
 Waldemar Smolik, D.Sc., Associate Professor
 Grzegorz Domański, Ph.D., Assistant Professor
 Bogumił Konarzewski, Ph.D., Didactic Assistant Professor
 Jacek Kryszyn, Ph.D., Assistant Professor, till Sep. 2023
 Robert Kurjata, Ph.D., Assistant Professor
 Dariusz Radomski, Ph.D., Research Assistant Professor
 Tymon Rubel, Ph.D., Assistant Professor
 Andrzej Rychter, Ph.D., Assistant Professor
 Damian Wanta, Ph.D., Assistant Professor, from Jul. 2023
 Marcin Ziembicki, Ph.D., Assistant Professor (0.7)
 Piotr Brzeski, Ph.D., Didactic Assistant Professor (0.3)

Junior academic staff

Krzysztof Dygnarowicz, M. Sc., Assistant (0,5) from May 2023
 Kamil Lipiński, M. Sc., Assistant (0,5)
 Wojciech Obrębski, M.Sc., Assistant (0.5)
 Tomasz Olszewski, M.Sc., Didactic Assistant (0.5)
 Damian Wanta, Ph.D., Assistant (0.5), till Jun. 2023
 Michał Wieteska, M.Sc., Assistant (0.5)
 Przemysław Wróblewski, M.Sc., Assistant

Technical staff

Tomasz Olszewski, M.Sc., R&D Engineer (0.5)
 Andrzej Wasilewski, Worker

Administrative staff

Yuliya Hoika, M.Sc. from Apr. 2023

Ph.D. students

Monika Drabik, M.Sc. from Oct. 2016

Krzysztof Dygnarowicz, M.Sc., from Feb. 2021
 Mikhail Ivanenko, M.Sc., from Oct. 2023
 Paweł Kazulo, M.Sc., from Feb. 2022
 Kamil Lipiński, M.Sc., from Oct. 2019
 Mateusz Midura, M.Sc., from Oct. 2019
 Katarzyna Orzechowska, M.Sc., from Oct. 2019
 Przemysław Wróblewski, M.Sc., from Oct. 2021

Retired

Zdzisław Pawłowski, Prof. D.Sc.,
 Ewa Piątkowska-Janko, Ph.D.,
 Roman Szabatin, Ph.D.

The research and teaching activities carried out in the Nuclear and Medical Electronics Division are concentrated on two areas: biomedical engineering and nuclear electronics. Research in the interdisciplinary area of biomedical engineering covers a broad range of topics and integrates sophisticated electronics and information technology with elements of medical knowledge. The activity in the area of nuclear engineering is concentrated on the design of electronics systems and data processing software for high energy physics experiments. The Division's research is focused on the following topics:

- nuclear medicine (emission tomography: SPECT, PET);
- magnetic resonance imaging (MRI), functional MRI, advanced applications of MRI;
- quantitative computer-aided tomography;
- tomographic dynamic studies;
- process tomography, impedance tomography;
- analogue and digital radiography;
- medical image processing and recognition;
- methods and instrumentation for electrocardiography;
- medical applications of isotope techniques;
- telemedicine;
- design of apparatus and software for high energy physics experiments;
- data analysis in genetics and proteomics;
- mathematical modeling of physiological and disease processes.

Areas of recent studies include:

- advanced applications of MRI and CT imaging systems, covering: dynamic scanning protocols, a new methodology and instrumentation for functional MRI, fMRI image analysis methods;
- a new contrast media for MRI: functional lung imaging with hyper-polarized agents;
- multi-modal imaging of topographic, tomographic and functional studies in medicine;
- electrical instability of heart study research, high resolution ECG systems;
- digital structural radiography, modeling of radiographic imaging systems;
- optical tomography applications in medicine;
- algorithms for image reconstruction for electrical and process tomography;
- construction of capacitance tomographs and sensors for medical and industrial applications;
- study of a bioelectrical activity of a pregnant uterus and using EHG for telemetric monitoring of upcoming labor;
- application of nonlinear predictive algorithms to control of insulin dosing in diabetic patients;
- algorithms for the data analysis in genomics and proteomics;
- characterization and modeling of photosensor for high-energy physics and astronomy experiments;

- development of detectors, front-end electronics, and test devices for high energy physics experiments;
- applications of "soft-computing" methods.

1.3.3. Radiocommunications and Radiolocation Engineering Division

Head of Division

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Senior academic staff

Józef Modelski, Prof. D.Sc., Full Professor
 Wojciech Wojtasiak, D.Sc., Associate Professor
 Jacek Cichocki, Ph.D., Didactic Assistant Professor (0,5)
 Vitomir Djaja-Joško, Ph.D., Assistant Professor
 Daniel Gryglewski, Ph.D., Assistant Professor
 Wojciech Kazubski, Ph.D., Assistant Professor
 Jerzy Kołakowski, Ph.D., Assistant Professor
 Marcin Kołakowski, Ph.D., Assistant Professor, from Oct. 2023
 Przemysław Korpas, Ph.D., Assistant Professor
 Sebastian Kozłowski, Ph.D., Assistant Professor
 Karol Kuczyński, Ph.D., Assistant Professor (0,5)
 Krzysztof Kurek, Ph.D., Assistant Professor
 Przemysław Miazga, Ph.D. Didactic Assistant Professor
 Mirosław Mikołajewski, Ph.D., Assistant Professor
 Tomasz A. Miś, Ph.D., Assistant Professor (0,4) from Nov. 2023
 Dawid Rosołowski, Ph.D., Assistant Professor

Junior academic staff

Marcin Kołakowski, Ph.D., Assistant (till Sep. 2023)

Technical staff

Mirosław Lubiejewski, Foreman

Ph.D. students

Marcin Kołakowski, M.Sc., from Oct. 2016, till Jul. 2023
 Tomasz A. Miś, M.Sc., from Oct. 2017, till Sep. 2023
 Łukasz Nowicki, M.Sc., from Oct. 2021
 Marcin Wiśniewski, M.Sc., from Oct. 2021

Temporary Staff

Dariusz Kołodziej, M.Sc., Support Enginner (0.5)

Retired

Jan Ebert, Prof. D.Sc.,
 Wojciech Gwarek, Prof. D.Sc.,
 Stanisław Rosłonec, Prof. D.Sc.
 Tomasz Kosito, Ph.D.,
 Karol Radecki, Ph.D.
 Henryk Chaciński, M.Sc.

The Radiocommunications and Radiolocation Engineering Division conducts scientific and applied research around microwave theory and techniques, radio communication systems and networks, radar systems, and measurement techniques in the field of microwaves and millimeter waves. This includes the subjects of computer-aided design and signal processing. Specific research topics included:

- radiocommunication systems and networks – cellular networks, satellite systems and broadband access

- networks, and propagation channel analysis and modeling,
- Internet of Things technology and applications – methodologies for the antenna design and embedded software for the Single Board Computer-based systems,
- UWB – wireless ultra-wideband systems – methods and systems for communication and localization,
- re-configurable and software-defined radio systems,
- design of front-ends for wireless systems with power amplifiers linearized using signal processing such as digital pre-distortion techniques,
- design of transmitter/receiver modules for radar applications,
- development of high-power high-frequency stability sources for microwave heating,
- methods of synthesis and computer-aided design of passive and active microwave circuits and devices (couplers, power combiners and dividers, switches, transistor circuits, oscillators, synthesizers, modulators, amplifiers) and microwave semiconductor device modelling,
- design of accurate Q-Factor determination equipment applicable in material characterization using resonant techniques,
- development of high-efficiency resonant power amplifiers (class D, DE, E, F and G), linear wide-band HF amplifiers, high-power amplitude modulators, high-efficiency power supplies, power factor correctors, and high-efficiency AC-DC and DC-DC converters.

1.3.4. Subterahertz Technology Division

Head of Division

Yevhen Yashchyshyn, Prof. D.Sc., Full Professor
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Senior academic staff

Yevhen Yashchyshyn, Prof. D.Sc., Full Professor
 Krzysztof Derzakowski, D.Sc., Associate Professor
 Paweł Kopyt, D.Sc., Associate Professor
 Bartłomiej Salski, D.Sc., Associate Professor
 Peter Tokarsky, D.Sc., Associate Professor, till Sep. 2023
 Paweł Bajurko, Ph.D., Assistant Professor
 Grzegorz Bogdan, Ph.D., Assistant Professor
 Konrad Godziszewski, Ph.D., Assistant Professor
 Tomasz Karpisz, Ph.D., Assistant Professor
 Adam Pacewicz, Ph.D., Assistant Professor, (0,5) from Feb. 2023
 Jakub Sobolewski, Ph.D., Assistant Professor, from. Apr. 2023
 Maciej Sypniewski, Ph.D., Didactic Assist. Professor 0.5

Junior academic staff

Mateusz Krysicki, M.Sc., Research Assistant

Technical Staff

Adam Pacewicz, Ph.D., Senior R&D Engineer, (0,5)

Ph.D. students

Jerzy Cuper, M.Sc., from Oct. 2019
 Piotr Czekala, M.Sc., from Oct. 2021
 Maciej Soszka, M.Sc., from Oct. 2018

The most important research topics of the Division include analysis, development and investigation of:

- sub-terahertz technology;
- antenna measurements;
- antenna design and fabrication;
- accurate, repeatable measurements on-wafer up to 500 GHz;

This includes of measurements in the wide frequency range thanks to a unique set consisted of four-port PNA-X Vector Network Analyzers from Agilent Technologies and six pairs of Frequency Extenders for measurements up to 500 GHz. Each pair of Frequency Extenders is designed for single band of standard rectangular waveguide and allows to measure full two-port scattering matrix (amplitude and phase) with a very high dynamic range (above 100 dB). The wide frequency range and large number of measurement points (up to 32001 points) enables further processing of the measured data in the time domain. This set is used for measurements of antenna parameters, and is a part of the quasi-optical setup for the characterization of materials in the millimeter-wave and sub-terahertz ranges.

The research and teaching activities are also performed at the Antenna and Sub-terahertz Technology laboratory. The laboratory was partly funded by European Development Fund (ERDF) in scope of Operational Programme Innovative Economy (POIG) as a part of the Faculty Research Centre FOTEH (Photonics and Terahertz Technologies). The Antenna Laboratory enables research on spatial distributions of the electromagnetic field up to sub-terahertz range to develop and study of antennas, characterization of materials and designing of communication, imaging and radar systems.

The research topics of the Laboratory of Field Methods in the Microwave and Sub-Terahertz Techniques include characterization of low-loss dielectric materials and conductive materials in the range 1–110 GHz by various resonance methods, including the use of a Fabry-Perot open resonator, and ferromagnetic materials in the range 1–30 GHz by resonance methods, electromagnetic modeling of problems related to microwave heating, propagation of electromagnetic waves in the atmosphere, electromagnetic modeling and measurements of the effective reflection surface of absorption panels, designing frequency synthesizers operating in the microwave and millimeter bands, and frequency multipliers operating in the microwave and millimeter bands.

1.3.5. Multimedia Engineering Division

Head of Division

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 Grzegorz Pastuszek, D.Sc., Associate Professor
 Kajetana Snopek, D.Sc., Associate Professor
 Andrzej Buchowicz, Ph.D., Assistant Professor
 Xin Chang, Ph.D., Assistant Professor
 Grzegorz Galiński, Ph.D., Assistant Professor
 Krystian Ignasiak, Ph.D., Didactic Assistant Professor
 Paweł Mazurek, Ph.D., Assistant Professor
 Andrzej Miękina, Ph.D., Assistant Professor, till Sep. 2023

Jakub Wagner, Ph.D., Assistant Professor

Junior academic staff

Grzegorz Gwardys, M.Sc., Assistant (0.5)

Technical staff

Tomasz Krzymień, M.Sc., Administrative Clerk for Health and Safety

Ph.D. students

Michał Daniluk, M.Sc., from Oct. 2020
 Szymon Kruszewski, M.Sc., from Oct. 2022
 Daniel Mostowski, M.Sc., from Oct. 2020
 Rafał Protasiuk, M.Sc., from Oct. 2016
 Mikołaj Wieczorek, M.Sc., from Oct. 2020

Retired

Andrzej Miękina, Ph.D., from Oct. 2023
 Marek Rusin, Ph.D.

Scientific and teaching activities of the Division cover most of the modern television aspects, beginning with the basics to the leading and fastest developing areas: digital image processing in multimedia, high resolution TV (HDTV), cable TV (CATV), industrial television. Besides basic television courses, the division teaches microcontrollers, PLD and the selected aspects of the microwaves. Multimedia aspects such as compression, object recognition, hardware technologies (MPEG coders) and software technologies (Java, Python) are gaining recently more attention.

Division consists of 3 groups:

- Deep Neural Network in Digital Media;
- Hardware Algorithms in Digital Media;
- Digital Processing and Measurement Systems.

1.4. Evening Studies and Continuing Education

1.4.1. Postgraduated Studies “Deep Neural Networks – Application in Digital Media”

Head

Władysław Skarbek, Prof. D.Sc., Full Professor.

Secretariat

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1.5. Other Institute’s Units

1.5.1. Accounting Department

Head

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Staff

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[Edu3], [Edu29], [Edu58], [Edu70], [Edu74], [Edu85], [Edu117], [Pro2], [Pro24], [Pro37], [Pro41], [Pro42], [MSc20], [MSc29], [BSc14], [Pub16], [Pub18], [Pub79], [Pat3], [Pat9].

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[Edu16], [Edu22], [Edu44], [Pro8], [PhD1], [MSc6], [MSc17], [MSc18], [MSc22], [BSc56], [Pub17], [Pub19], [Pub24], [Pub26], [Pub27], [Pub29], [Pub63], [Pub75], [Pat4].

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[Edu1], [Edu9], [Edu46], [Edu65], [Edu69], [Edu117], [Pro8], [MSc21], [BSc28], [BSc29], [BSc38], [BSc49], [BSc53], [BSc55].

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[Edu29], [Edu47], [Edu58], [Edu66], [Edu67], [Edu87], [Pro27], [Pro34], [Pro40], [MSc1], [Pub11], [Pub18], [Pub64], [Pat6].

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lecommunications ('14-); Member of the Programme Board of High Field Resonance Imaging ECOTECH-COMPLEX Center ('15-); Member of the Scientific Council for Biom. Engineering, WUT ('19-).

[Edu75], [Edu83], [Edu92], [Edu116], [Pro10], [Pro17], [Pub2], [Pub5], [Pub22], [Pub56], [Pub82], [Pub85].

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[Edu5], [Edu6], [Edu12], [Edu24], [Edu99], [Edu116], [Pub91].

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[Edu7], [Edu9], [Edu10], [Edu24], [Edu33], [Edu37], [Edu78], [Edu81], [Edu82], [Edu113], [Edu117], [Pro1], [Pro4], [Pro8], [BSc21].

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[Edu4], [Edu32], [Edu41], [Edu55], [Edu70], [Edu72], [Pro6], [Pro7], [Pro35], [Pub91].

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[Pub34], [Pub35], [Pub36], [Pub46], [Pub72].

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[Edu81], [Edu82], [Pro35], [Pro38], [PhD3], [PhD4], [Pub34], [Pub35], [Pub36], [Pub49], [Pub72], [Pub73].

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[Edu13], [Edu30], [Edu43], [Edu52], [Edu114], [Edu116], [Pro28], [Pub70], [Pub84].

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[Edu31], [Edu56], [Pro9], [Pro20], [Pub37], [Pub39], [Pub40], [Pub47], [Pub48], [Pub69], [Pub83], [Pub86], [Pub87], [Pub89].

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[Edu7], [Edu37], [Edu64], [Edu65], [Edu89], [Edu102], [Edu117], [Pro8], [MSc3], [BSc9], [BSc44], [Pub74].

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M.Sc. ('06), Ph.D. ('10), D.Sc. ('15); microwave technique; **Associate Professor**, Sub-Terahertz Technology Division.

Member of CLEO ('14-), Reviewer of journals: *IEEE Trans. on Antennae and Propag.* ('10-), *Micro. Theory and Techniques* ('10-), *IEEE Micro. & Wireless Compon. Letters* ('12-); Member of Sect. of Microwaves and Radiolocation of the Electronics and Telecommunication Comm. of the Polish Academy of Sciences ('15-); Founder and President of the Board Council of the Microwave and Radiolocation Foundation ('15-); Tutorial assistance of Electromagnetic Modelling Students Scientific Group ('16-); Member of the Scientific Council for Automatic Control, Electronics, and Electrical Engineering, WUT ('19-).

[Edu31], [Edu56], [Pro9], [Pro11], [Pro14], [Pro19], [Pro20], [Pub37], [Pub39], [Pub40], [Pub47], [Pub48], [Pub69], [Pub83], [Pub86], [Pub87], [Pub88], [Pub89], [Pub90].

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M.Sc. ('72), Ph.D. ('77), D.Sc. ('94); Prof. Title ('03); information technology, image processing, digital media; **Full Professor**.

Member of the Editorial Board of *Fundamenta Informaticae* ('03-), *International Journal of Electronics and Telecommunication* ('13-); Member of the Programme Committee of the National Conference of Radiocommunications and Broadcasting ('01).

[Edu73], [Edu80], [Edu93], [Edu105], [Edu109], [Edu117], [MSc10], [MSc23].

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M.Sc. ('91), Ph.D. ('97), D.Sc. ('14); computer engineering, biomedical engineering, computer tomography; **Associate Professor**, Nuclear and Medical Electronics Division.

Head of the Laboratory of Information Acquisition and Processing Systems in the Nuclear and Medical Electronics Division ('15-); Member of the Faculty Council Committee on Education ('16-); Member of the Scientific Council for Biomedical Engineering, WUT ('19-); Member of the Steering Committee - *Intelligent Decision Support System based on the Algorithmic Image Analysis in the Operations of the Justice System* - BIO10 Programme; Member of the Education Committee of the Council of the Faculty of Electronics and

Information Technology; Member of the Scientific Council of the Discipline of Biomedical Engineering; Head of the field of study "Biomedical Engineering" at the Faculty of Electronics and Information Technology; Member of the WUT Doctoral School Council.

[Edu24], [Edu75], [Edu90], [Edu116], [Pro17], [Pro18], [Pro43], [MSc7], [BSc57], [Pub21], [Pub25], [Pub55], [Pat2], [Pat5].

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M.Sc. ('91), Ph.D. ('02), D.Sc. ('14); signal and system theory and applications; **Associate Professor**, Multimedia Engineering Division.

Head of the Multimedia Engineering Division ('20-); Head of the "WUT Eagle School" Project at the Faculty of Electronics and Information Technology (POWER Program ('19-); Head of the Scholarship Commission of the Foundation for the Development of Radiocommunications and Multimedia Technology ('21-); Member of the Scientific Council for Technical Informatics and Telecommunications, WUT ('21-); Member of the Steering Committee - *Intelligent Decision Support System based on the Algorithmic Image Analysis in the Operations of the Justice System* - BIO10 Programme ('20-22); Expert of the Telecommunications Section of KEIT PAS ('22-23); Editor in chief (with W. Wojtasiak and G. Pastuszak) of Special Issue Electronics (mdpi) – "Wireless Communication and Multimedia Technology – Theory and Applications" ('22); Coordinator of the 5th edition of the Engineer 4 Science 2022 engineering diploma thesis competition at FEIT, WUT (Biomedical Engineering) ('22); Session Chair - *23rd Foundation Scholarship Holders Seminar*;

[Edu24], [Edu37], [Edu62], [Edu66], [Edu116], [Pub91].

Jakub Sobolewski

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M.Sc. ('16), Ph.D. ('23); microwave technique; **Assistant Professor**, Sub-Terahertz Technology Division.

[Edu3], [Edu74], [Edu85], [Pro2], [Pro24], [Pro34], [Pro37], [Pro40], [Pub16], [Pub18], [Pub62], [Pub78].

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M.Sc. ('83), Ph.D. ('96); microwave technique; **Didactic Assistant Professor**, Sub-Terahertz Technology Division.

[Edu31], [Edu56], [Edu66], [Edu77].

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Ph.D. ('05), D.Sc. ('07); information and communication technology, **Assistant Professor**, Sub-Terahertz Technology Division.

[Pub49], [Pub50].

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M.Sc. ('11), Ph.D. ('20); measurement and instrumentation, **Assistant Professor**, Multimedia Engineering Division.

[Edu13], [Edu52], [Edu62], [BSc37], [Pub52], [Pub80].

Wojciech Wojtasiak*room: 549, phone: +48 22 2345886**e-mail: wojciech.wojtasiak@pw.edu.pl*

M.Sc. ('84), Ph.D. ('98), D.Sc. ('15); microwave technique; **Associate Professor**, Radiocommunications and Radiolocation Division, Head of Division ('20-). Member of IEEE ('96-); Member of the Scientific Council for Automatic Control, Electronics and Electrical Engineering, WUT ('19-).

[Edu24], [Edu26], [Edu61], [Edu101], [Edu117], [Pro13], [Pro21], [BSc15], [Pub23], [Pat8].

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M.Sc. ('16), Ph.D. ('23); medical and nuclear engineering; **Assistant Professor**, Nuclear and Medical Electronics Division.

[Edu6], [Edu14], [Edu53], [Edu75], [Edu90], [Pro18], [Pro23], [Pro29], [Pub21], [Pub25], [Pat2], [Pat5].

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M.Sc. ('79), Ph.D. ('86), D.Sc. ('06), Prof. Title ('16); telecommunications; **Full Professor**, Sub-Terahertz Technology Division.

Head of Division ('20-). Member of the Com. on Electronics and Telecommunications PAN ('19-); Member of the Organizing Committee of the International Conference *TCSET- Modern Problems of Radio Engineering, Telecommunications and Computer Science* ('98-); Reviewer of the *IEEE Transactions on Micro Theory and Techniques* ('04-), *IEEE Trans on Antennas and Propagation* ('06-) and *IEEE Microwave and Wireless Components Letters* ('04-); Member of Editorial Board of *Izvestiya Wuzow Radioelektronika* ('09-); Member of the Microwave and Radiolocation Section of the Electronics and Telecommunication Committee of the Polish Academy of Sciences ('07-); TPC Member of the ('09-), TPC Member of the European Wireless Conference EW ('10-), Member of the Programme Committee of the National Conference of Radiocommunications and Broadcasting ('09-); Member of the Faculty Council Committee on Scientific Researches ('16-); Member of the Scientific Council Automatic Control, Electronics, and Electrical Engineering, WUT ('19-).

[Edu3], [Edu70], [Edu74], [Edu85], [Edu117], [Pro2], [Pro3], [Pro33], [Pro37], [PhD5], [MSc31], [MSc32], [BSc11], [BSc18], [BSc32], [Pub16], [Pub18], [Pub28], [Pub53], [Pub54], [Pub77], [Pat3], [Pat6].

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M.Sc. ('81), Ph.D. ('90), D.Sc. ('03), Prof. Title ('12), biomedical engineering, nuclear electronics; **Full Professor**, Rector of the WUT ('20-); Nuclear and Medical Electronics Division.

Member of CERN ('89-); Member of the Programme Board of the Institute of Applied Researches, WUT ('14-); Member of the Editorial Advisory Board of the *Polish Journal of Medical Physics and Engineering* ('07-), Deputy Chairman of the Board of the Center for Imaging and Biomedical Research ('06-); Member of the Scientific Board of the Automotive Industry Institute ('17-); Member of the Scientific Board of the Institute of the Nuclear Chemistry and Technology ('17-); Member of the Scientific Council for Automatic Control,

Electronics and Electrical Engineering, WUT ('19-); Head of the Committee on Education, the Conf. of Rectors of Academic Schools in Poland, ('20-); Member of the Plan for Work and Development Council (21-).

[Pro1], [Pro4], [Pro5], [Pub6], [Pub7], [Pub8], [Pub9], [Pub10], [Pub11], [Pub12], [Pub13].

Marcin Ziembicki*room: 62, phone: +48 22 2347643**e-mail: marcin.ziembicki@pw.edu.pl*

M.Sc. ('02), Ph.D. ('20); nuclear and medical electronics; **Assistant Professor**, Nuclear and Medical Electronics Division.

[Edu18], [Edu27], [Edu35], [Edu42], [Pro1], [Pro4], [Pro5], [Pro22], [Pub6], [Pub7], [Pub8], [Pub9], [Pub10], [Pub11], [Pub12], [Pub13], [Pub14], [Pub15].

Jan Żera*room: 131, phone: +48 22 2347999**e-mail: jan.zera@pw.edu.pl*

M.Sc. ('76), Ph.D. ('90), D.Sc. ('04); acoustics, Prof. Title ('17); electroacoustics, psychoacoustics, noise control; **Full Professor**, Electroacoustics Division, Head ('13).

Member of Polish Acoustical Society ('78-), European Acoustics Association ('01-), Acoustical Society of America ('90-); Member of the Technical Committees of the Polish Committee for Standardization ('09-); Vice-President of the Scientific Council of Central Institute for Labour Protection – National Research Institute ('21-); Member of the Scientific Council for Automatic Control, Electronics, and Electrical Engineering, WUT ('19-).

[Edu48], [Edu89], [Edu114], [Edu117], [Pro25], [PhD2], [MSc28], [BSc30], [Pub3], [Pub67].

2.2. Junior academic staff

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Mateusz Krysicki, M.Sc., Research Assistant

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Kamil Lipiński, M.Sc., Assistant (0.5)

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Wojciech Obrębski, M.Sc., Assistant (0.5)

*room: 71, phone: +48 22 2346087**e-mail: wojciech.obrebski@pw.edu.pl*

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*room: 59, phone: +48 22 2347577**e-mail: tomasz.olszewski2@pw.edu.pl*

Michał Wieteska, M.Sc., Assistant (0.5)

*room: 71, phone: +48 22 2346087**e-mail: michal.wieteska@pw.edu.pl*

Przemysław Wróblewski, M.Sc., Assistant

*room: 5, phone: +48 22 2345786**e-mail: przemyslaw.wroblewski@pw.edu.pl*

2.3. Ph.D. students (the third-level studies)**Ph.D. Student (tutor)**

Dina Al.-Daloo, M.Sc. (P. Bilski)
 Jerzy Cuper, M.Sc. (P. Kopyt)
 Piotr Czekala, M.Sc. (B. Salski)
 Piotr Czarnecki, M.Sc.^{*)} (P. Bilski)
 Michał Daniluk, M.Sc.^{*)} (G. Pastuszak)
 Monika Drabik, M.Sc. (P. Bogorodzki)
 Krzysztof Dygnarowicz, M.Sc. (J. Marzec)
 Salomea Grodzicka, M.Sc. (P. Bilski)
 Ary Kurniadi Irawan, M.Sc. (P. Bilski)
 Mikhail Ivanenko, M.Sc. (W. Smolik)
 Paweł Kazulo, M.Sc. (P. Bogorodzki)
 Bartosz Kościug, M.Sc. (P. Bilski)
 Szymon Kruszewski, M.Sc. (R. Z. Morawski)
 Zinelabidine Leghelimi, M.Sc. (P. Bilski)
 Kamil Lipiński, M.Sc. (P. Bogorodzki)
 Jacek Majer, M.Sc. (J. Żera)
 Tomasz Markowski, M.Sc.^{*)} (P. Bilski)
 Mateusz Midura, M.Sc. (W. Smolik)
 Daniel Mostowski, M.Sc.^{*)} (G. Pastuszak)
 Łukasz Nowicki, M.Sc. (W. Wojtasiak)
 Katarzyna Orzechowska, M.Sc. (K. Zaremba)
 Karolina Pondel-Sycz, M.Sc. (P. Bilski)
 Bartosz Połok, M.Sc. (P. Bilski)
 Łukasz Popek, M.Sc.^{*)} (P. Bilski)
 Rafał Protasiuk, M.Sc. (W. Skarbek)
 Maciej Soszka, M.Sc.^{*)} (Y. Yashchyshyn)
 Jakub Tkaczuk, M.Sc.^{*)} (P. Bilski)
 Mikołaj Wieczorek, M.Sc.^{*)} (W. Skarbek)
 Marcin Wiśniewski, M.Sc. (W. Wojtasiak)
 Przemysław Wróblewski, M.Sc. (W. Smolik)
 Minyu Zhang, M.Sc. (Y. Yashchyshyn)

^{*)} implementation doctorate

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 e-mail: miroslaw.lubiejewski@pw.edu.pl
 Grzegorz Makarewicz, Ph.D., Res. Support Eng.(0.5)
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 e-mail: grzegorz.makarewicz@pw.edu.pl
 Tomasz Olszewski, R&D Engineer (0.5)
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 e-mail: tomasz.olszewski2@pw.edu.pl
 Andrzej Owczarek, M.Sc., Maintenance Eng. (0.5)
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 Adam Pacewicz, Ph.D., Senior R&D Eng.^{*)}
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 Andrzej Wasilewski, Worker
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^{*)} temporary research staff for the projects: OPUS 16, ^{**)} WidePOWER

2.4. Technical and administrative staff

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 Izabela Dudek, Administrative Clerk for Teaching
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 Monika Feluś, M.A., Administrative Clerk for Teaching
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 Zdzisława Fenikowska, M.A., Accounting Clerk
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 Yuliya Hoika, M.A., Administrative Clerk
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 Aleksandra Jefimowicz, M.A., Accounting Clerk
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 Dariusz Kołodziej, M.Sc., Research Support Eng.**
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 Tomasz Krzymień, M.Sc., Administrative Clerk for Health and Safety
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3. TEACHING ACTIVITIES

(the summer semester of the academic year 2022/2023 and the winter semester of the academic year 2023/2024)

3.1. Regular studies – main fields of study:

<p>Electronics Specialization: Electronics and Computer Science in Medicine Head Andrzej Rychter, Ph.D., Assistant Professor <i>room: 64, phone: +48 22 2347916</i> <i>e-mail: andrzej.rychter@pw.edu.pl</i></p>	<p>[Edu5] <i>Basics of Medical Imaging</i> (Podstawy obrazowania medycznego – POMED); 45 h/sem.; P. Brzeski.</p>
<p>Informatics Specialization: Computer Science in Multimedia Head Grzegorz Pastuszek, D.Sc., Associate Professor <i>room: 451, phone: +48 22 2347840</i> <i>e-mail: grzegorz.pastuszek@pw.edu.pl</i></p>	<p>[Edu6] <i>Basics of Medical Imaging Techniques</i> (Podstawy technik obrazowania w medycynie – PTOM); 60 h/sem.; P. Brzeski.</p> <p>[Edu7] <i>Basics of Multimedia</i> (Podstawy multimediów – PMUT); 43 h/sem.; A. Buchowicz.</p> <p>[Edu8] <i>Basics of Programming</i> (Podstawy programowania – PPR); 60 h/sem.; R. Kurjata.</p> <p>[Edu9] <i>Basics of Programming 1</i> (Podstawy programowania – PRM1T); 60 h/sem.; A. Buchowicz.</p> <p>[Edu10] <i>Basics of Programming 2</i> (Podstawy programowania – PRM2T); 55 h/sem.; K. Ignasiak.</p>
<p>Biomedical Engineering Specialization: Biomedical Apparatus Head Grzegorz Domański, Ph.D., Assistant Professor <i>room: 61, phone: +48 22 2347626</i> <i>e-mail: grzegorz.domanski@pw.edu.pl</i></p>	<p>[Edu11] <i>Basics of Radiolocation and Radionavigation</i> (Podstawy radiolokacji i radionawigacji – PRIR); 45 h/sem.; D. Gryglewski.</p> <p>[Edu12] <i>Biomedical Accelerators</i> (Akceleratory biomedyczne – ABM); 30 h/sem.; S. Wronka.</p>
<p>Telecommunications Specialization:</p> <ul style="list-style-type: none"> • Radiocommunications and Multimedia Techniques • Wireless and Multimedia Technologies (I⁰ studies) <p>Head Jacek Kryszyn, Ph.D., Assistant Professor <i>room: 59, phone: +48 22 2347577</i> <i>e-mail: jacek.kryszyn@pw.edu.pl</i></p>	<p>[Edu13] <i>Computing in Engineering</i> (Obliczenia inżynierskie – OINT); 30 h/sem.; R. Z. Morawski.</p> <p>[Edu14] <i>Computer Graphics</i> (Grafika komputerowa – GRK); 30 h/sem.; T. Rubel.</p> <p>[Edu15] <i>Construction of High Quality Audio Equipment</i> (Konstrukcja urządzeń audio wysokiej jakości – KUA); 45 h/sem.; G. Makarewicz.</p>
<p>Specialization:</p> <ul style="list-style-type: none"> • Wireless and Multimedia Techniques (II⁰ studies) <p>Andrzej Buchowicz, Ph.D., Assistant Prof. <i>room: 451, phone: +48 22 2347840</i> <i>e-mail: andrzej.buchowicz@pw.edu.pl</i></p>	<p>[Edu16] <i>Data Analysis Methods</i> (Metody analizy danych – MADAN); 80h/sem.; P. Bilski.</p> <p>[Edu17] <i>Data Security in Medical Information Systems</i> (Bezpieczeństwo medycznych systemów informacyjnych – BEMSI); 45 h/sem.; R. Kurjata.</p> <p>[Edu18] <i>Detection of Ionizing Radiation</i> (Detekcja promieniowania jonizującego - DEPJO); 30 h/sem.; J. Marzec.</p>
<p>3.1.1. Basic courses</p>	<p>[Edu19] <i>Detection of Nuclear and Biomedical Signals</i> (Detekcja sygnałów biomedycznych i jądrowych – DSBJ); 60 h/sem.; J. Marzec.</p>
<p>[Edu1] <i>Acquisition and Data Processing Using LabVIEW</i> (Akwizycja i przetwarzanie danych z wykorzystaniem LabVIEW – LABV); 30h/sem.; P. Bobiński.</p>	<p>[Edu20] <i>Digital Circuits – EDC1</i>; 60 h/sem.; P. Miazga (English-medium studies).</p>
<p>[Edu2] <i>Analysis of Measurement Data in Medicine</i> (Analiza danych pomiarowych w medycynie – ADP); 45 h/sem.; B. Konarzewski.</p>	<p>[Edu21] <i>Digital Circuits</i> (Technika cyfrowa – TECY), 30 h/sem.; K. Mroczek (Faculty coordinator: the Institute of Telecommunications).</p>
<p>[Edu3] <i>Antennas</i> (Anteny – ANT); 45 h/sem.; Y. Yashchyshyn.</p>	<p>[Edu22] <i>Digital Communications – EDICO</i>; 60 h/sem.; P. Bilski (English-medium studies).</p>
<p>[Edu4] <i>Basics of Cellular Systems</i> (Podstawy systemów komórkowych – PSK); 45h/sem.; J. Kołakowski.</p>	<p>[Edu23] <i>Digital Systems</i> (Systemy cyfrowe – SYCYF), 30 h/sem.; K. Mroczek (Faculty coordinator: the Institute of Telecommunications).</p>

TEACHING ACTIVITIES

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| <p>[Edu24] <i>Diploma Seminar for Undergraduate Students</i> (Seminarium dyplomowe inżynierskie – SDI); 30 h/sem.; A. Buchowicz,</p> <p>[Edu25] <i>DC/DC Power Converters Supply</i> (Zasilanie układów elektronicznych - ZUE); 45 h/sem.; M. Mikołajewski.</p> <p>[Edu26] <i>Electronic Circuits</i> (Układy elektroniczne – ULET); 60h/sem.; W. Wojtasiak.</p> <p>[Edu27] <i>Electronic Circuits</i> (Układy elektroniczne – UEL); 60 h/sem.; W. Obrębski.</p> <p>[Edu28] <i>Electronic Circuits and Systems</i> (Elementy i układy elektroniczne – UKEL); 60 h/sem.; D. Gryglewski.</p> <p>[Edu29] <i>Evolutionary Algorithms</i> (Algorytmy ewolucyjne – AE); 45 h/sem.; G. Bogdan, P. Miazga.</p> <p>[Edu30] <i>Ethical Aspects of Research and Engineering</i> – EEARE; 30 h/sem; R. Z. Morawski, (English-medium studies).</p> <p>[Edu31] <i>Fields and Waves</i> (Pola i fale – POFAT); 56 h/sem.; B. Salski.</p> <p>[Edu32] <i>Fundamentals of Wireless Communication</i> (Podstawy transmisji bezprzewodowej – PTB); 57 h/sem.; J. Kołakowski.</p> <p>[Edu33] <i>Image Techniques</i> (Technika obrazowania – TO); 60 h/sem.; G. Galiński.</p> <p>[Edu34] <i>Influence of Electromagnetic Waves on Living Organisms</i> (Oddziaływanie fal elektromagnetycznych na organizmy żywe – OFE); 30 h/sem.; K. Derzakowski.</p> <p>[Edu35] <i>Ionizing radiation detectors</i> (Detektory promieniowania jonizującego – DETPJ); 60h/sem.; J. Marzec.</p> <p>[Edu36] <i>Introduction to Medical Science</i> (Wprowadzenie do nauk medycznych – WNM); 45 h/sem.; K. Szopiński.</p> <p>[Edu37] <i>Introduction to Multimedia</i> (Wstęp do multimedialności – WMM); 72 h/sem.; G. Pastuszek.</p> <p>[Edu38] <i>IoT Radio Interfaces</i> (Interfejsy radiowe systemów internetu rzeczy – IRI); 45 h/sem.; J. Kołakowski.</p> <p>[Edu39] <i>IoT Systems in Healthcare</i> (Urządzenia IoT w opiece medycznej – UIOM); 45h/sem.; R. Kurjata</p> <p>[Edu40] <i>Measurement Systems</i> (Systemy pomiarowe – SPOM); 60 h/sem.; R. Łukaszewski.</p> <p>[Edu41] <i>Measurements in Radio Electronics</i> (Pomiary w radioelektronice – POR); 45h/sem.; J. Cichocki.</p> <p>[Edu42] <i>Medical Electronic Instrumentation</i> (Elektroniczna aparatura medyczna – EAME); 60 h/sem.; A. Rychter.</p> <p>[Edu43] <i>Methodological Aspects of Engineering Practice</i> (Metodyczne aspekty działalności inżyniera) – MADI; 30 h/sem; R. Z. Morawski (Institute of Telecommunications).</p> | <p>[Edu44] <i>Microcontrollers and Programmable Circuits</i> (Mikrokontrolery i układy programowalne – MUP); 60h/sem.; P. Bilski.</p> <p>[Edu45] <i>Microprocessor Technique</i> (Technika mikroprocesorowa – TEMI); 45 h/sem.; G. Domański.</p> <p>[Edu46] <i>Multimedia applications</i> (Aplikacje multimedialne – APEM); 54h/sem.; P. Bobiński.</p> <p>[Edu47] <i>Multi-service and Multimedia Networks</i> – EMSMN; 60 h/sem.; S. Kozłowski (English-medium studies).</p> <p>[Edu48] <i>Musical Acoustics</i> (Akustyka muzyczna – AM); 45 h/sem.; J. Żera.</p> <p>[Edu49] <i>Neural Networks in Biomedical Applications</i> (Sieci neuronowe w zastosowaniach biomedycznych – SNB), 45 h/sem.; P. Mazurek.</p> <p>[Edu50] <i>Nuclear Medicine Techniques</i> (Techniki medycyny nuklearnej – TMENU); 30 h/sem.; T. Olszewski.</p> <p>[Edu51] <i>Numerical Methods</i> (Metody numeryczne – MNUB); 45 h/sem.; P. Mazurek.</p> <p>[Edu52] <i>Numerical Methods</i> – ENUME; 60 h/sem.; R. Z. Morawski, (English-medium studies).</p> <p>[Edu53] <i>Object-oriented Programming</i> (Programowanie obiektowe – PROBI); 60 h/sem.; J. Kryszyn.</p> <p>[Edu54] <i>Object-oriented Programming of Multimedia Applications in Java</i> (Java – obiektowe programowanie aplikacji multimedialnych – OPA); 45 h/sem.; K. Ignasiak.</p> <p>[Edu55] <i>Orientation</i> (Orientacja - ORIT); 8 h/sem.; J. Cichocki.</p> <p>[Edu56] <i>Physics 2</i> – EPHY2; 60 h/sem.; B. Salski, (English-medium studies).</p> <p>[Edu57] <i>Programming of Geoinformation Applications</i> (Programowanie aplikacji geoinformacyjnych – PAG); 30 /sem.; K. Ignasiak (for Faculty of Geodesy and Cartography).</p> <p>[Edu58] <i>Radio Transmission</i> (Transmisja radiowa – TRRA); 57 h/sem.; K. Godziszewski.</p> <p>[Edu59] <i>Radiological Apparatus in Medical Diagnostics</i> (Aparatura radiologiczna w diagnostyce medycznej – ARDM); 30 h/sem.; G. Domański.</p> <p>[Edu60] <i>Radiology and Nucleonics</i> (Radiologia z nukleoniką – RN); 45 h/sem.; B. Konarzewski.</p> <p>[Edu61] <i>RF & Microwave Engineering in Telecommunications</i> (Technika mikrofalowa w telekomunikacji – TMT); 45 h/sem.; W. Wojtasiak.</p> <p>[Edu62] <i>Signals and Systems</i> (Sygnały i systemy – SYGSY); 60 h/sem.; K. Snopek.</p> <p>[Edu63] <i>Software Defined Radio in Telecommunications</i> (Radio programowalne w telekomunikacji – RAPT); 48h/sem.; D. Rosołowski.</p> |
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TEACHING ACTIVITIES

- [Edu64] *Sound Recording Technique* (Dźwiękowa technika studyjna – DTS); 42 h/sem.; M. Lewandowski.
- [Edu65] *Sound Technique* (Technika dźwiękowa – TD); 45 h/sem.; P. Bobiński.
- [Edu66] *Team Project 1* (Projekt grupowy 1 – PROJ1); 13 h/sem.; P. Korpas.
- [Edu67] *Team Project 2* (Projekt grupowy 2 – PROJ2); 30 h/sem.; P. Korpas.
- [Edu68] *User Interface Design* (Projektowanie interfejsu użytkownika – PIU); 45 h/sem.; K. Ignasiak.
- [Edu69] *Web Applications* (Programowanie aplikacji internetowych – PAINT); 45 h/sem.; R. Łukaszewski.
- [Edu70] *Wireless Transmission and Antennas* (Transmisja bezprzewodowa i anteny – TBAT); 60 h/sem.; K. Godziszewski.
- [Edu71] *Wired and Wireless Communication* (Komunikacja przewodowa i bezprzewodowa – PBL3); 180h/sem.; P. Korpas.
- [Edu72] *4th and 5th Generation Cellular Systems* (Systemy komórkowe 4 i 5 generacji – SYK45); 45h/sem.; J. Kołakowski.
- 3.1.2. Advanced courses**
- [Edu73] *Adaptive Image Recognition* – EADIR; 60 h/sem.; W. Skarbek (English-medium studies).
- [Edu74] *Antennas* (Anteny – EANTE); 54 h/sem.; Y. Yashchysyn (English-medium studies).
- [Edu75] *Computed Tomography* (Tomografia komputerowa – TOM); 60 h/sem.; W. Smolik.
- [Edu76] *Computer - Aided Medical Image Diagnostics* (Komputerowe wspomaganie obrazowej diagnostyki medycznej – KWOD); 45 h/sem.; A. Przelaskowski.
- [Edu77] *Computational Electromagnetics for Telecommunications* – ECOET; 60 h/sem.; P. Korpas (English-medium studies).
- [Edu78] *Data Compression* (Kompresja danych – KODA); 45 h/sem.; G. Pastuszek.
- [Edu79] *Data Science Product Management* (Zarządzanie produktami data science – ZPDS); 45h/sem.; G. Gwardys.
- [Edu80] *Deep Neural Networks for Digital Media* (Głębokie sieci neuronowe w mediach cyfrowych – GSN); 60 h/sem.; W. Skarbek.
- [Edu81] *Diploma Seminar for Graduate Students 1* (Seminarium dyplomowe magisterskie 1 – SDM1); 30 h/sem.; A. Buchowicz.
- [Edu82] *Diploma Seminar for Graduate Students 2* (Seminarium dyplomowe magisterskie 2 – SDM2); 30 h/sem.; A. Buchowicz.
- [Edu83] *Dynamic Medical Image Data Analysis* (Analiza medycznych obrazowych danych dynamicznych – AMDD); 45 h/sem.; P. Bogorodzki.
- [Edu84] *Electromagnetic Compatibility* – EEMC; 45 h/sem.; P. Kopyt (English-medium studies).
- [Edu85] *Electronic devices of wireless systems* (Układy systemów bezprzewodowych – USYB); 60h/sem.; Y. Yashchysyn.
- [Edu86] *Embedded Programming for Medical Devices* (Programowanie wbudowane w urządzeniach medycznych – PWUM); 45 h/sem.; G. Domański.
- [Edu87] *Evolutionary Algorithms* – EEVAL; 60h/sem.; P. Miazga.
- [Edu88] *Genetic Engineering* (Inżynieria genetyczna – INGE); 15 h/sem.; T. Rubel.
- [Edu89] *Hearing and Sound Perception* (Słyszenie i percepcja dźwięku – SPD); 45 h/sem.; J. Żera.
- [Edu90] *Information Systems in Medicine* (Systemy informatyczne w medycynie – SIM); 60 h/sem.; W. Smolik.
- [Edu91] *Machine Learning in Bioinformatics* (Uczenie maszynowe w bioinformatyce – UMB); 60 h/sem.; T. Rubel.
- [Edu92] *Magnetic Resonance Imaging* (Tomografia rezonansu magnetycznego – TRM); 45 h/sem.; P. Bogorodzki.
- [Edu93] *Mathematics in Multimedia* (Matematyka w multimediach – MATMU); 60 h/sem.; W. Skarbek.
- [Edu94] *Medical IT Systems* (Informatyczne systemy medyczne – ISMED); 45 h/sem.; R. Kurjata.
- [Edu95] *Methodological and Ethical Issues of Technoscientific Research* – EMET; 30h/sem.; P. Mazurek (English-medium studies).
- [Edu96] *Microcontrollers in Wireless Transmission Systems* (Mikrokontrolery w systemach transmisji bezprzewodowej – MSTB); 45 h/sem.; J. Kołakowski.
- [Edu97] *Neural Network Compression with Applications* – ENNCA; 60h/sem.; X.Chang (English-medium studies).
- [Edu98] *Noise and Electromagnetic Interference in Electronic Devices* (Szumy i zakłócenia w aparaturze elektronicznej – SZAE); 45 h/sem.; J. Marzec.
- [Edu99] *Nuclear Medicine Techniques* (Techniki medycyny nuklearnej – TMN); 60 h/sem.; G. Domański.
- [Edu100] *Radiocommunication System Design* (Projektowanie systemów radiokomunikacyjnych – PSRK); 60 h/sem.; K. Kurek.
- [Edu101] *Security of the Internet of Things* (Bezpieczeństwo internetu rzeczy – BIR); 180h/sem.; W. Wojtasiak.
- [Edu102] *Spatial Audio System* (Systemy dźwięku przestrzennego – SDP); 60 h/sem.; M. Lewandowski, A. Pietrzak.

[Edu103] *SRD Technology in Applications* (Techniki radia programowalnego w zastosowaniach – TRPZ), 60 h/sem.; D. Rosołowski.

[Edu104] *Telemedical Systems* (Systemy telemedyczne - TELM); 60 h/sem.; R. Kurjata.

3.2. Special courses

3.2.1. Post-graduated studies: “Deep neural networks at digital media”

[Edu105] *Compression and Immersion of Digital Objects* (Kompresja i zanurzenie obiektów cyfrowych – KZO); 12 h/sem.; W. Skarbek.

[Edu106] *3D Modeling – Face and Body Image Analysis* (Modelowanie 3D – analiza obrazu twarzy i sylwetki osoby – M3D), 24 h/sem.; G. Gwardys.

[Edu107] *Deep Networks in the Design of Computer Games - Content and Strategy Aspects* (Sieci głębokie w projektowaniu gier komputerowych – aspekty treści i strategii) – SGS); 24 h/sem.; Z. Nasarzewski.

[Edu108] *Deep Networks in the Design of Computer Games – Aspects of Player Intelligent Interface* (Sieci głębokie w projektowaniu gier komputerowych – aspekty inteligentnego interfejsu gracza – SGI); 24 h/sem.; R. Pilarczyk.

[Edu109] *Deep Neural Networks-Basics* (Głębokie sieci neuronowe – podstawy – GSP); 24 h/sem.; W. Skarbek.

[Edu110] *Digital Objects Indexing* (Indeksowanie obiektów cyfrowych – IOC); 24 h/sem.; R. Protasiuk.

[Edu111] *Digital Objects Recognition* (Rozpoznawanie obiektów cyfrowych – ROC); 24 h/sem.; R. Pilarczyk.

[Edu112] *Programming deep neural networks* (Programowanie głębokich sieci neuronowych – PGS); 24h/sem. ; K. Ignasiak.

[Edu113] *Security in Digital Media* (Bezpieczeństwo w mediach cyfrowych – BMC); 12 h/sem.; A. Buchowicz.

3.3. International co-operation

[Edu114] Within the Advanced Technology Higher Education Network / Socrates (ATHENS), the course "*Ethical Aspects of Research and Engineering*" was given by **Roman Z. Morawski**, and the course "*Sound: Hearing and Acoustical Measurements*" was given by **Jan Żera**. The students who attended this course were from the following EU institutions of higher education:

- Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης (Aristotle University of Thessaloniki, Greece) – 1 person;
- École nationale supérieure d'arts et métiers (Paris, France) – 2 persons;
- École des Ponts ParisTech (France) – 3 persons ;
- Telecom ParisTech (France) – 5 persons;

- Mines ParisTech (France) – 7 persons;
- České vysoké učení technické v Praze (Czechia) – 6 persons;
- Instituto Superior Técnico (Lisbon, Portugal) – 5 persons;
- İstanbul Teknik Üniversitesi (Turkey) – 1 person;
- Katholieke Universiteit Leuven (Belgium) – 6 persons;
- Politecnico di Milano (Italy) – 7 persons;
- Technische Universität München (Germany) – 2 person;
- Technische Universiteit Delft (Netherlands) – 3 persons;
- Budapest University of Technology and Economics (Hungary) – 1 person;
- Universidad Politécnica de Madrid (Spain) – 1 person
- Universitatea Politehnica din București (Romania) – 1 person.

[Edu115] **Collaboration between the Warsaw University of Technology and the University of Western Australia. Agreement on joint supervision and joint doctoral conferment process.** 2020-2023

The agreement allows to undertake a joint Ph.D. subject to **Jerzy Cuper** M.Sc., candidate from WUT who was registered as a doctoral student at the Doctoral School no. 3.

3.4. Educational projects

[Edu116] **Modification M.Sc. Studies: Biomedical Engineering in the frame of Knowledge – Education – Development - Cooperation Project** (Modyfikacja studiów drugiego stopnia na kierunku „Inżynieria Biomedyczna” w ramach projektu NERW2 PW: Nauka – Edukacja - Rozwój - Współpraca). **Waldemar Smolik**, J. Marzec, R. Z. Morawski, P. Bogorodzki, K. Snopek, P. Brzeski, G. Domański, B. Konarzewski, R. Kurjata, E. Piątkowska-Janko, D. Radomski, T. Rubel, J. Kryszyn, W. Obrębski; Mar. 01, 2019 – Feb. 28, 2023

Funded by the National Centre for Research and Development EU Operational Programme Knowledge – Education – Development - Cooperation 2014-2020

The main goal of this project is to modify Biomedical Engineering M.Sc. studies, by means of introducing two specializations: Electromedical Equipment and Systems, and Biomedical Informatics. Research team taking part in this project includes scientists from the Faculty of Electronics and Information Technology and the Faculty of Mechatronics, WUT.

[Edu117] **Modification M.Sc. Studies: Telecommunications in the frame of Knowledge – Education – Development - Cooperation Project** (Modyfikacja studiów drugiego stopnia na kierunku „Telekomunikacja” w ramach projektu NERW2 PW: Nauka – Edukacja - Rozwój - Współpraca).

Andrzej Buchowicz (head from Institute of Radioelectronics and Multimedia Technology), P. Bajurko, P. Bobiński, K. Godziszewski, K. Ignasiak, M. Jasiński, J. Kołakowski, P. Kopyt, P. Korpas, S. Kozłowski, M. Lewandowski, R. Łukaszewski, G. Makarewicz, A. Pietrzak, D. Rosołowski, W. Skarbek, W. Wojtasiak, Y. Yashchyshyn, J. Żera.

Mar. 01, 2019 – Feb. 28, 2023

EU Operational Programme Knowledge – Education – Development - Cooperation 2014-2021

Funded by the National Centre for Research and Development

The project is realized in the frame of EU The main goal of this project is to modify Telecommunications M.Sc. academic programme by means of introduction two new specializations: Teleinformatics and Wireless and Multimedia Technologies using new teaching methods.

4. RESEARCH ACTIVITIES

4.1. International projects

[Pro1] **Super-Kamiokande to Hyper-Kamiokande (SK2HK)**

Marcin Ziembicki, J.Marzec, K.Zaremba, A.Rychter, R. Kurjata, K.Dygnarowicz, W.Obrębski, G.Pastuszak, A.Buchowicz, G.Galiński;

Nov. 01, 2019 – Apr. 30, 2025

Horizon 2020 EU Framework Programme **MSCA-RISE Action**

The study of the neutrino properties and interactions has been key in the development of the Standard Model of fundamental interactions and it is providing first clues on the understanding of its deeper foundations. In this aspect the Super-Kamiokande (SK) detector (ICRR, U. Tokyo, Japan) for many years has played a crucial role. It contributed to the discovery of oscillations of atmospheric neutrinos, thus establishing their 'massive' character. Because of this discovery, Takaaki Kajita, the "person in charge of this proposal" from our main Third Country partner ICRR, was awarded with the Nobel Prize in Physics 2015. With SK2HK we aim to continue the very successful SKPLUS, through extension of participation of European institutes in the state-of-the-art experimental program related to the SK, the SK-Gd and the Hyper-Kamiokande (HK) experiments. We want to gain insight and even discover the hypothesized charge-parity violation in the leptonic sector with SK and the future HK. We want to discover the "Diffuse Neutrino Supernova Background" with SK-Gd and to explore in depth the Grand Unification with SK and the future HK. Those measurements are key to the complete understanding of the most fundamental concepts of Physics.

An important aspect of this proposal is significant amount of hardware R&D related to HK, especially given the decision to start HK construction in 2020. Timely finalization of these activities is crucial to the success of HK and requires even closer cooperation with our partners. Given the uniqueness of the technologies that are being developed, it is efficient to do some work at the location where most of the infrastructure needed for the R&D is. In this project those are the ICRR of the Univ. of Tokyo and the TRIUMF laboratory in Canada, as well as several European laboratories, incl. the applying institutions. The proposed secondment program offers a unique opportunity to fulfil these goals while working with World leading experts.

[Pro2] **Innovation optical/quasioptical technologies and nano-engineering of anisotropic materials for creating active cells with substantially improved energy efficiency** (Innowacyjne optyczne/quasi optyczne techniki oraz inżynieria nanomateriałów i materiałów anizotropowych dla opracowania struktur czynnych z zasadniczo poprawioną efektywnością energetyczną).

Yevhen Yashchyshyn, P. Bajurko, J. Sobolewski;

Feb. 01, 2018 - Jul 31, 2023

IMAGE, Horizon 2020, EU Framework Programme for Innovative Training Networks.

The principal goal of the project is to combine research expertise in optics, crystallography and material science with efforts in material engineering to go beyond state-of-the-art in the development of highly efficient energy saving optical cells based on electro-acousto- and nonlinear optical effects and designed to operate in optical and quasi-optical (sub-THz) ranges. The idea of the project arises from recent advances in nano engineering combined with our technology.

[Pro3] **Novel Technologies and Materials for TeraHertz Radiation Control** (Nowoczesne technologie i materiały do kontroli promieniowania terahertwowego).

Yevhen Yashchyshyn,

Jan. 01, 2023 – Dec. 31, 2026

TeraHertz, HORIZON, EU Framework Programme

The project focuses on developing novel technologies and materials characterization that are to be used synergistically to create advanced possibilities for terahertz radiation control. International team expertized in materials synthesis and terahertz science will direct its efforts towards the development of innovative quasi-optical technologies which will help finding the solution for efficient use of dielectric and semiconductor crystalline materials, including nanocomposites and coplanar structures, and their application as functional elements in terahertz radiation control devices, ultimately targeting market-ready innovative products. A range of such materials will be considered for thorough investigations of potential application in electro/acousto-quasioptical devices to control THz radiation. Optimization of transmission, absorption, refraction indexes, loss tangent, the dielectric constant will be made based on experimental measurements and computer simulations. The project's scope will include semiconductor materials in which light-induced photogeneration of charge carriers is possible. The effect of photogeneration on the parameters of these materials will be used to develop efficient quasi-optical cells, which are key elements of control devices. The project brings together an international multidisciplinary network of organizations from academia and industry that will work coherently on the innovative research program on quasi-optical technologies and related material engineering. Participants will exchange skills and share knowledge, strengthening links between countries and promoting interaction between involved economics sectors. Reaching the goals related to the implementation of advanced quasi-optical technologies will open new market possibilities for engaged non-academic project participants, ultimately becoming beneficial for European society globally.

4.2 Projects granted by the Ministry of Science and Higher Education (National Centre for Research and Development, and National Science Centre)

4.2.1. International grants

[Pro4] **Hyper-Kamiokande (HK)**
Marcin Ziembicki, Andrzej Rychter,
J.Marzec, K.Zaremba, R.Kurjata,

K.Dygnarowicz, W.Obrębski, G.Pastuszak, A.Buchowicz, G.Galiński;
Dec. 01, 2022 – Nov. 30, 2027

Programme: **"Support for the participation of Polish research teams in international research infrastructure projects"**.

Hyper-Kamiokande is a next-generation neutrino experiment currently under construction in Japan and scheduled to launch in 2027. One of the key components of this experiment will be two new underground water detectors of Cherenkov radiation: a far detector with a mass of 250 kt (the world's largest man-made object of this type) and an intermediate detector. The physics program of the Hyper-Kamiokande experiment will address the most important unsolved issues in physics, such as the violation of charge-space symmetry of CP in neutrino oscillations and the decay of nucleons. The WUT team is responsible for the preparation of multi-PMT photodetection modules, which consist of 19 3-inch photomultipliers, high-voltage power supply systems and readout electronics, and the whole is enclosed in a pressurized housing. These modules are being developed together with partners from Italy, Canada, Japan, the Czech Republic and Mexico. The project also includes a test experiment at CERN (Water Cherenkov Test Experiment), which is scheduled to be launched in 2024

[Pro5] **T2K experiment (Tokai-to-Kamioka)** (Eksperyment T2K) (Tokai-to-Kamioka).

Andrzej Rychter, K. Zaremba, R. Kurjata, M. Ziembicki, K. Dygnarowicz

2023/WK/04, International project is realized in collaboration with the National Center for Nuclear Research, Department Basic Research BP3, University of Warsaw, Faculty of Physics University of Silesia in Katowice, Faculty of Science and Technology, University of Wrocław, Faculty of Physics, Institute of Nuclear Physics of the Polish Academy of Sciences;

Mar. 01, 2023 – Dec. 31, 2027

Funded by the Ministry of Science and Higher Education

This application concerns the participation of Polish groups in the T2K experiment in the period March 1, 2023 - December 31, 2027 and is a continuation of the project for financing participation in this experiment in the period October 1, 2017 - September 30, 2022. Further participation in the T2K experiment will be carried out in parallel with the construction of the Hyper-Kamiokande detector. The tasks to be carried out in the submitted application are related to supporting the participation of Polish groups in measurements carried out in the T2K experiment as research infrastructure.

[Pro6] **Integrated Care Platform Based on the Monitoring of Older Individual Intrinsic Capacity for Inclusive Health (CAREUP)**

(Zintegrowana platforma inkluzywnej opieki nad osobami starszymi oparta na monitorowaniu zdolności wewnętrznych).

Jerzy Kołakowski, V. Djaja-Joško J. Cichocki, M. Kołakowski

May, 1, 2022 – Nov. 30, 2024

Ambient Assisted Living (AAL)

Funded by the National Centre for Research and Development

The CAREUP project objective is to design and implement an ICT platform to preserve older adults' intrinsic capacity and functional ability through continuous monitoring and application of preventive measures. To do so, CAREUP will compensate for their decline (due to aging) through the development of a customized and personalized care plan with multi-component interventions whose implementation focuses on the fulfillment of the person-centered goals, uses principles of self-management support, community engagement, caregiver support and shared decision making with support caregivers.

[Pro7] **Personalized ICT solution to reduce re-hospitalization rates in heart failure elderly patients suffering from comorbidities** (Zmniejszanie ryzyka hospitalizacji osób w starszym wieku z niewydolnością serca i chorobami współistniejącymi z wykorzystaniem technologii informacyjno-komunikacyjnych (ICT)).

Jerzy Kołakowski, V. Djaja-Joško J. Cichocki, M. Kołakowski;

Sept. 01, 2020 – Dec. 31, 2023

ERA PerMed

Funded by the National Centre for Research and Development

The PerHeart project employs Information and Communication Technology to reduce re-hospitalization rates in heart failure patients. The PerHeart ICT platform integrates modular design functionalities dedicated to patients and their professional caregivers. The underlying artificial intelligence software will adapt to the patient's needs. Data collected with sensors and medical devices will help elucidate specific risk factors for readmission while taking gender and socio-economic aspects into account and help interpret and predict complex multifactorial diseases.

[Pro8] **Intelligent speech processing system for doctors** (Inteligentny system przetwarzania mowy dla lekarzy).

Piotr Bilski; A. Buchowicz, P. Bobiński, P. Gawrysiak, M. Jasiński, M. Lewandowski, G. Makarewicz, P. Mazurek, A. P. Pietrzak;

Mar. 01, 2023 – Nov. 30, 2025

INFOSTRATEG IV

Funded by the National Centre for Research and Development

The aim of the project will be to develop tools for speech processing (consisting of phrases spoken by the doctor and possibly the patient) and extracting relevant information from the text which will be then be classified semantically in order to, for example define the topic of the conversation and the diagnosis. Critical technologies to be developed in the project will include artificial intelligence methods for Natural Language Processing (NLP): extracting words from the record audio stream (so-called text to speech) and semantic analysis of the extracted text using deep natural networks. The results of the processing will be output to the forms and databases developed for this purpose. The former will be flexible, so that they can be able to automatically generate documents: prescriptions, exemptions or referrals for further diagnostic tests.

4.2.2. Research grants

[Pro9] **Correlations between electromagnetic and magnetoelastic properties of ferromagnetic thin films** (Korelacje pomiędzy właściwościami elektromagnetycznymi i magnetosprężystymi cienkich warstw ferromagnetycznych).

Jerzy Krupka (the Institute of Microelectronics and Optoelectronics), **P.** (head on behalf of the Institute of Radio-electronics and Multimedia Technology, WUT), A. Pacewicz, B. Salski;

Jun. 18, 2019 - Dec. 17, 2023

OPUS 16

Funded by the National Science Centre

The project is realized in collaboration between the Warsaw University of Technology and the Institute of Physics, Polish Academy of Science. The main goal of the project is to find out correlations between magnetoelastic and magnetic damping properties of several groups of magnetic thin films. Rigorous quantitative study of various contributions to the magnetic damping occurring in thin films will be undertaken in a broad electromagnetic spectrum. Another goal will be to find the conditions for the excitation of a magnetic plasmon in the planar structures.

[Pro10] **Coma and consciousness disorders – new prognostic and diagnostic indicators based on EEG and MRI** (Śpiączka i zaburzenia świadomości – nowe wskaźniki prognostyczne i diagnostyczne oparte o EEG i MRI).

Piotr J. Durka (Warsaw University, Faculty of Physics), **P. Bogorodzki** (head on behalf of the Institut of Radioelectronics and Multimedia Technology, WUT), **P. Bogorodzki**, **E. Piątkowska-Janko**, **K. Lipiński**;

Jul. 16, 2019 - Jul. 15, 2024

OPUS 16

Funded by the National Science Centre

Awareness-raising mechanisms are one of the greatest mysteries. Among the leading directions to their cognition are the study of patients in states of impaired consciousness (disorders of consciousness, DoC) - both in terms of hopes of broadening the basic knowledge of these processes, as well as the high demand for a method of diagnosis based on the results of these studies. Existing research in this area has shown promising results in the use of methods of Magnetic Resonance Imaging (MRI) and electroencephalography (EEG). However, the existing use of both methods in assessing the DoC are based on relatively weak methodological analyses of EEG and MRI signals, resulting in suboptimal sensitivity and less than achievable specificity. Furthermore, the absence of a combination of these two methods in the previous literature in longitudinal studies, conducted by all stages of the evolution of consciousness disorder, from the beginning of coma. The completion of these gaps in modern research is the basis of this project.

[Pro11] **Research and simulations of effects of HPM impulses** (Badania i symulacje skutków oddziaływania impulsów HPM).

Bartłomiej Salski, **M. Kryszicki**, **P. Kopyt**;

Feb. 13, 2019 - Dec. 28, 2023

Strategic research and development program.

Funded by the National Centre for Research and Development

The project aims at developing an electromagnetic simulation platform dedicated to the analysis of the attack with high power microwave pulses.

[Pro12] **Development and implementation of an artificial intelligence system for virtual characters allowing simulation of their realistic behavior and interaction with the player on the basis of autonomous image analysis of game participants in real time** (Opracowanie i implementacja system sztucznej inteligencji wirtualnych postaci pozwalającego na symulację ich realistycznych zachowań i interakcji z graczem na podstawie autonomicznej analizy obrazu uczestników gry w czasie rzeczywistym).

Maciej Lasocki (WA PW), **G. Galiński** (IRTM), **P. Garbat** (IMiO), **M. Bieniek** (WMEiL), **M. Żakowski**, **M. Szymkowski** (ImiO);

Aug. 01, 2020 – Jun. 30, 2023

Funded by the National Centre for Research and Development

Operational Programme Intelligent Development 2014-2020

The aim of the project is to create a platform for creating multiplayer AR games using cloud rendering and machine learning. The result of the project, i.e. the new Pirxon platform, will be implemented directly in the consortium leader's business. The platform will be based on algorithms developed together with the consortium partner – the Warsaw University of Technology – and equipped with the first vision system supporting multiplayer games in augmented reality in real time.

[Pro13] **Project implemented for the defence and security of the state of code name GRANIT**

Wojciech Wojtasiak, **D. Gryglewski**;

May, 19, 2021 – Oct. 31, 2023

Funded by the National Centre for Research and Development

Detail of this project cannot be published due to non-disclosure agreement with the contractor. Leader of this project – PIT – Radwar.

[Pro14] **Standardize the measurement of dielectric properties of materials for 5G** (Standaryzacja pomiaru własności dielektrycznych materiałów na potrzeby technologii 5G)

Bartłomiej Salski;

Jul. 12, 2022 - Jul. 11, 2024

PolishMetrology

The main goal of this project is to elaborate an error budget of the complex permittivity measurement with a Fabry-Perot open resonator in the 20-110 GHz range. In addition, a new type of a dielectric resonator applicable to the characterization of ceramic pills above 20 GHz will be developed.

4.2.3. Grants for young researchers

[Pro15] **Accurate methods of materials spectroscopy in mm-wave and sub-THz frequencies** (Dokładne metody spektroskopii materiałów w paśmie milimetrycznym i sub-

terahercowym).

Jerzy Cuper, P. Kopyt;
Jul. 30, 2019 – Feb. 29, 2024

Diamond Grant

Funded by the Ministry of Science and Higher Education

The purpose of this project was to develop new, accurate and reliable methods for material characterization in mm-wave and sub-THz frequencies, where most of the high-tech industry was carrying out researches for 5G and IoT. Work would be focused on resonant methods, especially on Fabry-Perot open resonator structure. Firstly, a dedicated setup for both low-loss materials and conductive samples would be considered at 50-110 GHz frequencies. Second task assumes coupling such resonator with 300-4000 GHz THz time-domain spectrometer (THz TDS) and perform measurements with unprecedented accuracy. Both setups would be designed, fabricated partly at the Warsaw University of Technology, and tested within this project.

[Pro16] **Novel autonomous measurement system for characterization of dielectric materials at microwave and millimeter-wave frequencies** (Nowy autonomiczny system pomiarowy do charakteryzacji materiałów dielektrycznych w zakresie mikrofal i fal milimetrowych).

Tomasz Karpisz;

Jan. 01, 2022 – Dec. 31, 2024

LIDER XII

Funded by the National Centre for Research and Development

The proposed project is devoted to research on the creation of new systems for measuring the electromagnetic properties of materials in the field of mycophagus and millimeter waves. There are solutions on the market that allow you to determine these values, but each of the methods has its limitations discussed in more detail in the project description.

4.3 Projects granted by the University

4.3.1 Priority Research Area Grants

[Pro17] **The combined NMR-MPS method for studying application of magnetic nanoparticles for hyperthermia** (Skojarzona metoda NMR-MPS do badania nanocząstek w hipertermii).

Piotr Bogorodzki, W. Smolik, T. Płociński, G. Domański, J. Kryszyn, P. Wróblewski;

Jan. 26, 2021 – Mar. 31, 2023

Project granted by the Scientific Council for Biomedical Engineering, WUT.

In this project, we propose a two-stage measurement. The first stage involves broadband (2 kHz – 1 MHz) measurement of complex magnetic susceptibility by Magnetic Particle Spectroscopy (MPS) method. For this purpose the system for measuring complex magnetic susceptibility in function of frequency will be created. In the second stage measurement of the diffusion coefficient by Nuclear Magnetic Resonance (NMR) method will be conducted. The third part includes imaging of nanoparticles samples using electron microscopy methods (TEM, SEM). Nanoparticle diameter distribution will be determined on the basis of image segmentation.

[Pro18] **Capacitively coupled electrical tomography for anatomical and functional imaging** (Elektryczna tomografia ze sprzężeniem pojemnościowym do obrazowania anatomicznego i funkcjonalnego).

Waldemar Smolik, J. Kryszyn, M. Wanta, P. Wróblewski;

Jan. 26, 2021 – Mar. 31, 2023

Project granted by the Scientific Council for Biomedical Engineering, WUT.

Electrical tomography allows to visualize a spatial distribution of electrical parameters of tested objects. Until now, electrical impedance tomography (EIT) with sinusoidal excitation was considered to have the greatest potential for application in diagnostic medical imaging, but impedance of electrode-skin contact, which is a major challenge in this imaging technique, limits the practical use of EIT. In this project, an alternative approach with non-contact electrodes and pulse excitation will be investigated.

The aim is to verify the properties of capacitively coupled electrical tomography in the context of diagnostic medical imaging. Studies will be performed using numerical and physical lung phantom, taking into account regional ventilation distribution. Measurement sensitivity, contrast and spatial-temporal resolution of images could be assessed.

[Pro19] **Light-matter interaction of dielectric micro-resonators with microwave photons in a Fabry-Perot open resonator** (Oddziaływanie światło-materia mikrorezonatorów dielektrycznych z fotonami mikrofalowymi w otwartym rezonatorze Fabry-Perot).

Bartłomiej Salski, T. Karpisz, P. Czekala;

Jan. 27, 2020 – Mar. 31, 2023

Project granted by the Scientific Council for Automatics, Electronics and Electrical Engineering, WUT.

The goal of this project will be at first to develop a rigorous electromagnetic model of the Fabry-Perot open resonator with a dielectric micro-resonator located inside. The model will combine a newly proposed model of the Fabry-Perot open resonator based on the scattering matrix approach and a mode matching method that will be applied to solve the micro-resonator.

[Pro20] **Frequency extenders integrated electronically with a vector network analyzer in a single-sweep mode operating in the 50-120 GHz frequency band** (Ekstendery częstotliwości zintegrowane elektronicznie z wektorowym analizatorem obwodów do pracy w trybie single-sweep w paśmie 50-120 GHz).

Bartłomiej Salski, T. Karpisz; P. Kopyt, A. Pacewicz, J. Cuper;

Nov. 08, 2021 – Dec. 20, 2023

Project granted in the competition for projects aiming to purchase equipment.

Excellence Initiative, Research University.

The competition aims to enhance the research potential of the Warsaw University of Technology through the purchase of specialist research equipment. The aim of this project is the purchase of dedicated frequency extenders that allow expanding the operating range of the existing VNA analyzer in such a way that

it will be possible to work in single-sweep mode over the entire measuring frequency range, i.e. from 10 MHz to 120 GHz. The purchase of this equipment will enable the characterization of dielectric materials in the previously unavailable frequency range, i.e. 20-120 GHz.

[Pro21] **Chemical reactor vessel using intelligent microwave source** (Reaktor chemiczny z wykorzystaniem inteligentnego źródła mocy mikrofalowej).

Przemysław Korpas, K. Jankowski, W. Wojtasiak, D. Gryglewski, S. Kozłowski; Mar. 01, 2021 – Feb. 28, 2023
Excellence Initiative, Research University

Two processes have been planned to be examined in the project: synthesis of nanofertilizer and separation of nanohybrid. The first selected process consists in a 2-step synthesis of a nanofertilizer based on metal oxides (copper, manganese, iron, zinc) in the presence of microwave energy. First, a dispersion of metal hydroxides is obtained, which is then dehydrated. The second process is a 1-step preparation of nanohybrid composed of hydroxyapatite and urea, characterized by a long period of nitrogen release to the soil. The chemical reactor vessel proposed in the project works in a double feedback loop to control the current temperature in the reactor and to track the minimum return loss depending on the frequency.

[Pro22] **Specialized support from the Electronics and Detectors laboratory „Electronics and Detectors for High Energy Physics – ELHEP”** (Wsparcie specjalistycznej pracowni Elektroniczno-Detektorowej "Electronics and Detectors for High Energy Physics – ELHEP").

Marcin Ziembicki
Jun. 01 – Dec. 31, 2023

The aim of the project " Electronics and Detectors for High Energy Physics - ELHEP " is to provide manpower, material and logistical support for currently ongoing and planned research activities related to the IDUB-POB-FWEIE project. The activities implemented within the scope of this project include: supporting the design work in related to equipment, modules and complete systems, including detector modules and specialized electronics for physics experiments; supporting the maintenance of experimental equipment; preparation of "proof of concept" experiments; performing comprehensive feasibility studies (concept, visualizations); support for bachelor, masters and doctoral students participating in high-energy projects realized by the institute.

[Pro23] **Reconstruction of three-dimensional images in electrical capacitance tomography using deep neural networks** (Rekonstrukcja obrazów trójwymiarowych w elektrycznej tomografii pojemnościowej z użyciem głębokich sieci neuronowych).

Damian Wanta,
Apr. 03, 2023 – Apr. 31, 2025
YOUNG, WUT

Electrical capacitance tomography is an imaging technique that enables obtaining a spatial distribution of electric permittivity based on the mutual capacitances measured using a set of electrodes surrounding investigated area. ECT allows for obtaining a very large number of images per second and so can be

used to image dynamic processes, like multiphase flow, widely used in the pharmaceutical, petrochemical, and food industries. Due to the limited number of electrodes used, the spatial resolution of the images obtained is low. Increasing the number of electrodes would mean reducing their surface area, and thus limiting measured capacitances to values of the order of hundreds of attofarads. The measurement of such low values would be a significant challenge.

In three-dimensional tomography, data acquisition is performed using electrodes located in several rings. Based on one set of excitations, it is possible to reconstruct the three-dimensional distribution of permittivity in the entire volume of interest. Obtaining good quality images based on three-dimensional data acquisition is possible with the use of non-linear iterative reconstruction algorithms. These algorithms require repeated solving of a forward problem consisting in simulation of electric field distribution. Achieving an accurate simulation of a three-dimensional electric field requires the use of a very large number of discretization mesh elements, which results in a large computational load. As a result, the time needed to reconstruct a single 3D image with the use of modern personal computers can range from a few to several dozen minutes.

Image reconstruction using deep neural networks is much faster than non-linear inverse problem-solving methods, allowing for many images per second. The aim of this project is to develop a neural network architecture that will allow for obtaining better quality images than in classical reconstruction methods, such as the Lovenberg-Marquard algorithm. It is planned to generate large and diverse training data using both numerical simulation and real measurements. We want to check whether a neural network trained with simulated data will cope well enough with real measurements. The obtained images will be compared with images obtained using non-linear algorithms. For this purpose, a new test object will be proposed for the assessment of spatial resolution, enabling the determination of the modulation transfer function. We want to investigate how the neural network deals with stability when imaging fast-changing processes and whether it is possible to obtain images of better quality in real time measurement.

4.3.2. Internal grants

[Pro24] **Development and examination of improved antenna circuits for field-effect transistor-based subterahertz detectors** (Opracowanie i badanie udoskonalonych obwodów antenowych do detektorów subterahercowych na bazie tranzystorów polowych).

Paweł Bajurko, J. Sobolewski;
May 18, 2022 – Dec. 31, 2023

Project granted by the Scientific Council for Automatics, Electronics and Electrical Engineering, WUT.

The subject of the project is the design of THz detectors with improved efficiency by using new types of antennas and improved circuits for coupling the antenna to the semiconductor structure.

[Pro25] **Application of modern techniques in sound recording with the use of ambisonic microphones in determining the interaural cross correlation (IACC).** (Zastosowanie nowoczesnych technik reje-

stracji dźwięku mikrofonami ambisonicznymi do wyznaczenia międzyusznej korelacji skośnej sygnału IACC).

Jan Żera, M. Jasiński;

May 06, 2022 – Dec. 31, 2023

Project granted by the Scientific Council for Automatics, Electronics and Electrical Engineering, WUT.

The aim of the project is to explore application of the binaural room impulse response (BRIR) in determining quantities describing acoustic conditions in room, with the focus on the interaural cross correlation (IACC) characterizing the spatial features of sound field. Method considers spatial impulse response recorded with an ambisonic microphone combined with the head-related impulse response (HRIR) related to the presence of the listener in the acoustic field. The accuracy of this novel method is assessed in reference to standard measurements carried out using an acoustic manikin.

[Pro26] **Performance comparison of HL7, FHIR and openEHR standards** (Porównanie wydajności standardów HL7 FHIR oraz openEHR)

Jacek Kryszyn

Apr. 26, 2022 – Oct. 31, 2023

Project granted by the Scientific Council for Biomedical Engineering, WUT.

The aim of the project is to perform load tests of several selected open-source solutions compliant with the openEHR and HL7 FHIR standards. The collected data will be analyzed in terms of the speed of operation and the ability to handle large network traffic of each solution. This will make it possible to determine whether one of the standards has an advantage over the other in terms of the tested parameters. Based on the technical details of the solutions, an assessment of what has a key impact on performance in this type of system will be made.

[Pro27] **Direct Antenna Modulation in 4-D Antenna Arrays** (Bezpośrednia cyfrowa modulacja w szyku antenowym 4D).

Grzegorz Bogdan;

May. 26, 2023 – Dec. 31, 2023

Project awarded by the Scientific Council of Automation, Electronics, Electrical Engineering and Space Technologies, WUT.

Four-dimensional (4-D) antenna arrays, introduce time as an additional dimension for generating ultra-low sidelobes at fundamental component and realizing beam scanning by harmonic components. The goal of the project was to enhance functionality of a 4-D antenna array with the direct antenna modulation by adjusting the switching times of periodic sequences activating the antenna elements. Developed device features generation of BPSK, QPSK, 8PSK, 16PSK and 16APSK signals. Simplicity, cost, and energy efficiency of the resulting transmitter were achieved by the following key features: no phase shifters in the feed network, no mixers for frequency conversion, no digital-to-analog converters, and post-amplifier modulation. The first three features significantly reduce the circuitry complexity while the third one allows the usage of nonlinear, however highly efficient, power amplifiers.

[Pro28] **Detection of persons' falls by means of a monitoring system based on impulse-radar sensors** (Wykrywanie upadków osób w systemie monitoringu opartym na impulsowych czujnikach radarowych).

Roman Z. Morawski;

Jun. 1, 2023 – Nov. 30, 2024

Project awarded by the Scientific Council of Biomedical Engineering, WUT.

The project is aimed at developing methods for processing measurement data acquired by means of impulse-radar sensors – the methods enabling the analysis of the movement of monitored persons, as well as the prediction and detection of events that threaten their health or life, such as falls. The developed methods are intended for use in non-invasive monitoring of elderly persons. The results of the project will be included into the Ph.D. thesis prepared by Szymon Kruszewski under supervision of Roman Z. Morawski.

[Pro29] **Method for determining the electrode-skin contact capacitance in medical electrical capacitive tomography measurements** (Metoda wyznaczania pojemności kontaktu elektrody ze skórą w pomiarach medycznej elektrycznej tomografii pojemnościowej).

Damian Wanta;

Jun. 1, 2023 – Nov. 30, 2024

Project awarded by the Scientific Council of Biomedical Engineering, WUT.

The project aims to develop a method for determining the electrode-skin contact capacitance during Electrical Capacitance Tomography (ECT) measurements. As part of the project, measurements will be performed using the pulse excitation method, in which the distribution of permittivity and conductivity in the examined space can be determined based on the shape of the measured signal. Changes in the electrode's insulation capacitance, resulting from improper adhesion to the skin, strongly influence the nature of the measured pulse, making it impossible to analyze its shape correctly. Precise determination of the contact capacitance value will enable the determination of the components of the tested impedance and thus will allow the practical use of dry electrodes in tomographic measurements.

[Pro30] **Methods for determining the ratio of bound superparamagnetic nanoparticles (MNPs) using Magnetic Nanoparticle Spectroscopy (MPS)** (Metody wyznaczania za pomocą Spektroskopii Magnetycznej Nanocząstek (MPS) stosunku związanych nanocząstek superparamagnetycznych (MNP)).

Przemysław Wróblewski;

Jun. 1, 2023 – Nov. 30, 2024

Project awarded by the Scientific Council of Biomedical Engineering, WUT.

The aim of this project is to use multi-frequency magnetic particle spectroscopy (MPS) to develop a method for estimating the ratio of immobilized and free magnetic nanoparticles (MNPs) in the tested samples based on the difference in the complex magnetic permeability at selected frequencies when only one mode of nanoparticle relaxation (Brown or Neal) dominates. It can be used to quantitatively track MNP-labeled cells in MPI magnetic nanoparticle imaging.

4.4. Other projects

[Pro31] **Performing R&D tasks and creating a prototype of an innovative handset equipped with predictive active noise reduction (pANC) technology, which automatically adjusts to the working environment** (Przeprowadzenie prac B+R and stworzeniem prototypu innowacyjnej słuchawki wyposażonej w technologię predykcyjnej aktywnej redukcji hałasu (ANC), która automatycznie dostosowuje się do środowiska pracy).

Grzegorz Makarewicz;

Jun. 01. 2021 – Aug. 31, 2023

Funded by the AXEL sp.z.o.o.

The topic of the project is to perform Research and Development tasks in the field of active noise reduction/compensation (ANC) to create the prototype of innovative headphones equipped with predictive Active Noise Reduction/Compensation (pANC) technology, which automatically adjusts the parameters of the active headphones to the changing parameters of the operating environment.

The idea of the project is to develop new algorithms for the synthesis of the compensating signal by predicting its parameters on the basis of already measured values. It should then be possible to use systems with lower computing powers for calculations and to apply more complex and efficient adaptive algorithms, increasing the effectiveness of active reduction. This will meet the expectations of the target group (consumers interested in high-quality ANC-equipped headphones), who expect more effective noise isolation to improve the quality of sound reproduced in the headphones. Optimizing the process of parameters' calculation to compensate signal will allow for functional improvements, such as inclusion in the algorithm implemented in the control system of signals and messages with an important informative role, e.g. warning signals, in order to extract them from the active reduction operation. During the project, subsequent versions of the headphones prototype will be developed along with the software to achieve the highest possible noise reduction parameters.

[Pro32] **Designing RF circuits for LTE 450 MHz base station for critical applications** (Projektowanie obwodów RF do stacji bazowej LTE 450 MHz do zastosowań krytycznych).

Daniel Gryglewski;

Jul. 01, 2020 – Dec. 31, 2023

Funded by IT Partners Telco sp.z.o.o.

The aim of this work is to design and test RF circuits for the newly developed LTE base station intended for critical applications. The system is to operate in the LTE 450 MHz band (B31).

The Institute of Radioelectronics and Multimedia Technology acts as a sub-contractor of IT Partners Telco. The contract is carried out as a part of the National Centre for Research and Development project "LTE -Advanced 450 MHz Micro Base Station for Critical – Mission Systems", implemented under the "Path for Mazovia" program.

[Pro33] **BST/polymer composites tunability studies in the frequency range up to 500 GHz** (Badania przestrajalności

kompozytów BST/polimer w zakresie częstotliwości do 500 GHz).

Yevhen Yashchshyn, K. Godziszewski;
Oct. 19, 2020 – Jun. 30, 2023

Funded by the Faculty of Chemistry, WUT.

The project is carried out as part of NCN's project **SHENG 1 – Polish-Chinese Funding Initiative**. SHENG-1 is focused on the cooperation between Warsaw University of Technology and Northwestern Polytechnical University to jointly elaborate BST/polymer dielectric tunable functional composites by tape casting. The main emphasis is put on the influence of BST particles, polymer type, BST/polymer interactions and composite structure on the microstructure and dielectric properties of materials. The important parameter will be the dielectric tunability of composite materials in sub-THz frequencies. Dielectric tunability theoretical model of ceramics/polymer functional composites is the key issue of the project. It allows to design and test high dielectric tunable composites. Testing BST/polymer composites under the microwave and sub-THz frequencies is the main goal of the part of the project that is done in Antennas and sub-THz Technology Group as the subtask.

[Pro34] **Experimental investigation of planar antenna arrays in X-band** (Badania planarnych szeregów antenowych w paśmie X).

Grzegorz Bogdan, Jakub Sobolewski

Feb. 8 – Dec. 31, 2023

Funded by Eycore Sp. z o.o.

Electrical parameters of planar antenna arrays were measured in the frequency range of 9-10.5 GHz with various methods and configurations. Fundamental characteristics as the radiation pattern and the impedance matching were determined separately for individual components (i.e. antennas and feeding networks) and assembled arrays. This involved measurements of scattering matrices of 9-port networks and measurements of the absolute gain in two orthogonal planes with an angular step as low as 0.6 degree.

[Pro35] **Analysis of technical documentation and preparation of the report describing the impact of qualitative requirements, defined in the auction procedure for 3.6 GHz band, on the investment** (Analiza dokumentacji technicznej i przygotowanie ekspertyzy dotyczącej wymagań jakościowych w postępowaniu rezerwacji częstotliwości w paśmie 3.6 GHz i ich wpływu na inwestycje)

Krzysztof Kurek, Józef Modelski, Jacek Cichocki

Apr. 26 – May 31, 2023

Funded by Polkomtel Sp. z o.o.

The aim of the project was to technical analysis of the requirements associated with the frequency auction announced by the Office of Electronic Communications (UKE) for operation of the mobile system in C band. Based on 3GPP propagation models, the number of base stations necessary to cover the assumed area of Poland with the assumed data transmission speed was estimated.

[Pro36] **Implementation of digital signal processing algorithms in embedded systems – consultancy** (Implementacja algorytmów cyfrowego przetwarzania

sygnałów na mikrokontrolerach jednokomputerowych)

Przemysław Korpas

May 8-19, 2023

Funded by Tedee Sp. z o.o.

The aim of the project was to provide consultancy on selected topics of digital signal processing in embedded systems, i.e. A/D and D/A conversion principles, signal conditioning, MCU selection criteria, review of selected algorithms (filtration, compression, etc.) and code optimisation techniques in implementations on embedded systems.

[Pro37] **Design of monopole antenna for 4.7 MHz band and measurement of antenna prototype** (Projekt anteny monopolowej na pasmo 4,7 GHz i wykonanie pomiarów prototypu anteny).

Paweł Bajurko, Yevhen Yashchyshyn, Jakub Sobolewski

Apr. 14 – May 25, 2023

Funded by Vortex Sp. z o.o.

The aim of this work was to design a monopole antenna for the 4.7 MHz band and measurement examination of the prototype antenna.

[Pro38] **Developing an analysis of executive possibilities, so-called feasibility study for the project of the Polish telecommunication satellite** (Opracowanie dokumentu analizy możliwości wykonawczych tzw. Stadium wykonalności dla projektu pt. "Polski satelita telekomunikacyjny")

Krzysztof Kurek, Józef Modelski, Sebastian Kozłowski

May 25 – Nov. 21, 2023

Funded by Polish Space Agency

The aim of the project was to analyse the preliminary version of the feasibility study of building the Polish telecommunication satellite, which will be placed in a geostationary orbit and will operate in the Ka band. The possible structure of the satellite, ground segment and services for the users were described. The project was realized in cooperation with the Institute of Communications - National Research Institute, TTComm and Thorium Space.

[Pro39] **Evaluation of noise produced by iGuzzini Laser Fixed Round Minimal QA48 and QA49 Lighting Fixtures** (Ocena hałasu generowanego przez oprawy oświetleniowe iGuzzini Laser Fixed Round Minimal QA48 i QA49)

Maciej Jasiński

Sep. 25-29, 2023

Funded by Spectra Lighting Sp. z o.o.

The aim of the project was to evaluate the noise emitted by iGuzzini lighting fixtures belonging to the Laser Fixed Round Minimal QA48 and QA49 families. It was shown that the noise produced by these luminaires does not exceed the background noise level recorded in an anechoic chamber. Additionally, the noise emitted does not exceed the NR10 noise curve criterion, thereby permitting the utilization of these lamps in acoustically protected environments.

[Pro40] **Experimental investigation of a phased antenna array in the frequency range from 26 to 30 GHz** (Badania modułu nadawczo-odbiorczego z fazowanym szykiem

antenowym w zakresie częstotliwości od 26 do 30 GHz)

Grzegorz Bogdan, Jakub Sobolewski

Oct. 23-24, 2023

Funded by Innofin Sp. z o.o.

The goal of this work was to characterize a phased antenna array transceiver in the frequency range from 26 to 30 GHz. The scanning range and the scanning resolution were determined by means of the radiation pattern measurements. Equivalent isotropically radiated power (EIRP) and relative received signal power were measured in the transmit and receive modes, respectively.

[Pro41] **Probe station measurements of adjustable-gain amplifiers** (Wykonanie pomiarów ostrzowych wzmacniaczy o regulowanym wzmacnieniu)

Paweł Bajurko

Oct. 25 – Nov. 30, 2023

Funded by SIRC Sp. z o.o.

The scope of work included measurements of adjustable-gain RF amplifier chips using a probe station. Several types of amplifiers were examined with varying control voltages at frequencies up to 18 GHz.

[Pro42] **Vector network analyzer S-parameter measurements of antenna-optical system in WR-5.1, WR-3.4 and WR-2.2 bands** (Pomiary parametrów S układu antenowo-optycznego za pomocą vector network analyzer w pasmach WR-5.1, WR-3.4, WR-2.2.)

Paweł Bajurko

Nov. 27 – Dec. 27, 2023

Wojskowa Akademia Techniczna (Funded by Military University of Technology)

The antenna-optical system was experimentally examined in WR-5.1, WR-3.4 and WR-2.2 bands (the combined band from 140 GHz to 500 GHz). The dependence of S-parameters on the position of the antennas has been studied.

[Pro43] **Research and development works in the area of developing and implementing an integrated modern breakthrough trading platform in terms of performance and capacity parameters as well as innovative communication protocols and transaction algorithms** (Usługi badawcze i eksperckie w celu realizacji projektu pt. "Przeprowadzenie prac badawczo-rozwojowych w zakresie opracowania oraz implementacji zintegrowanej nowoczesnej Platformy Transakcyjnej przełomowej pod względem parametrów wydajnościowych i pojemnościowych oraz nowatorskich protokołów komunikacyjnych oraz algorytmów zawierania transakcji")

Waldemar Smolik

Dec. 6-31, 2023

Funded by Giełda Papierów Wartościowych w Warszawie S.A. (Warsaw Stock Exchange).

Details of this project cannot be published due to non-disclosure agreement with the contractor.

4.5. Other activities

4.5.1 Partnership

4.5.1.1. International Co-operation

CC-Link

Since 12 May 2005 the Institute of Radioelectronics and Multimedia Technology has been a formal member of the CC-Link Partner Association the world-wide organization of industrial and research institutions working on the development and applications of CC-Link (Control & Communication Link) – a field network system that processes both the control and information data at high speed, to provide efficient integrated factory and process automation. The collaboration with the Association is realized by the Division of Nuclear and Medical Electronics.

China – Poland Exchange Program

The Institute of Radioelectronics and Multimedia Technology (Nuclear and Medical Electronics Division) in collaboration with the Institute of Engineering Thermophysics (IET), Chinese Academy of Sciences, China, realized the new exchange program: “Advanced process monitoring technologies for multiphase flows”. The aim of this program is to explore how to investigate the multiphase flows based on process tomography and process CFD simulation to analyze the complex flow characteristics. Exchange plan includes scholars from IET visiting the Institute of Radioelectronics and Multimedia Technology, Warsaw University of Technology (WUT). Head of the research group: **Waldemar Smolik**

4.5.1.2. National Co-operation

IUSER

The new established science and technology platform: “Intelligent Devices and Systems for Distributed Power Generation” is carried out at Institute of Radioelectronics and Multimedia Technology, Military University of Technology, National Institute of Telecommunications, Military Communication Institute, National Chamber of Electronics and Telecommunications, TP SA., Institute of Electron Technology. The main aim of this project is to conduct the research on technologies and products, the implementation of which will create a market opportunity for the development of distributed generation based on renewable energy sources.

Intelligent Transport

The new established science and technology platform is carried out at Faculty of Electronics and Information Technology (Institute of Radioelectronics and Multimedia Technology, Institute of Telecommunications), Faculty of Transport, Faculty of Administration and Social Sciences, Faculty of Automotive and Construction Machinery Engineering. The main aim of this project is to realize the scientific researches in the field of telecommunication and information systems and methods of information in an intelligent transport.

CentriX

The new established science and technology platform CentriX is funded by European Regional Operation Fund 2014 – 2020 for Mazovian Voivodeship. This project is carried out at National Center for Nuclear Research, Institute of Radioelectronics and Multimedia Technology with co-operation of Imagine RT Ltd., and Eastern Wall Technologies Ltd. The main goal of

this project is to establish the innovation and scientific center and realize researches in the field of industry radiation techniques. Head of the research group: **Waldemar Smolik**

Outstanding industrial project – co-operation with IT Partners Telco Ltd.

The Institute of Radioelectronics and Multimedia Technology (Microwave and Radiolocation Engineering Division) in collaboration with IT Partners Telco Ltd., realized the project called “Innovative at global level microcell LTE-Advanced working with high RF power in 3.4-3.8 GHz frequency range” funded from EU Innovative Development Operation Program. Institute of Radioelectronics and Multimedia Technology making the equipment available for IT Partners Telco Ltd. to conduct the research activities possible through this project.

Microwave Microscopy for Advanced and Efficient Materials Analysis and Production

Przemysław Korpas;

MMAMA Project - research and innovation programme under European Union **Framework Programme - HORIZON 2020**
2017-2021

Cooperation with QWED company focused on development of accurate microwave Q-Meter device for 10 GHz Split-Post Dielectric Resonators and algorithms for special resolution improvements of scans performed with such a resonator.

4.5.2. Scientific networks

Subsystem Developed Through IMWP for Wireless Communication and Radar Functionalities – WG2 work group, IMWP for 5G – WG3 work group.

Yevhen Yashchychyn;

COST – European Cooperation in Science & Technology supported by **EU Framework Programme HORIZON 2020**
2018 - 2022

The WG2 and WG3 are realized in frame of the European Network for High Performance Integrated Microwave Photonics Project.

WG2: The goal is to define the main requirements for implementing IMWP communication and radar subsystems in terms of PIC models and monolithic integration.

WG3: The goal is to identify the IMWP opportunities in terms of generation, SWaP, bandwidth, and integration to unlock the future 5G communications.

Polish Network of Neutrino Physics (Polska Sieć Neutrinowa)

In 2006, the Faculty of Electronics and Information Technology joined the Polish Network of Neutrino Physics. The network comprises several institutes and laboratories working in the field of development of experimental neutrino physics. The Faculty is represented in the network by the Division of Nuclear and Medical Electronics, which has a long-term experience in collaboration with high energy physics (NMC, SMC, COMPASS) and neutrino physics (ICARUS, T2K) experiments.

Polish Network of Particle Astrophysics (Polska Sieć Astrofizyki Cząstek)

In 2006 the Faculty of Electronics and Information Technology joined the Polish Network of Particle Astrophysics. The main goal of the organization is to

create a frame for the research collaboration of several institutes and laboratories in the field of development of advanced experimental methods for particle astrophysics. The Faculty is represented in the network by two research groups: from the Institute of Electronics Systems and from Institute of Radioelectronics and Multimedia Technology – namely from the Division of Nuclear and Medical Electronics.

HyperMR - European Network for Hyperpolarization Physics and Methodology in NMR and MRI – TD1103

In 2012 the Faculty of Electronics and Information Technology, Institute of Radioelectronics and Multimedia Technology (the Division of Nuclear and Medical Electronics) joined the project realized in the frame for the research collaboration of several Polish and foreign institutes. The main aim of this Action is to stimulate and accelerate collaborations and joint research efforts between European groups into hyperpolarization physics and methodology with the goal to develop robust strategies for sensitivity enhancement in NMR and MRI. Coordinated short-term scientific missions (STSMs) will make it possible to fully exploit the potential of unique scientific instrumentation which already exists in few European groups. The scientific programme is organised into 5 different working groups that focus on key issues related to the topic of the Action. The scientific programme is supported by a wide range of research groups thus generating a high added value for the European research landscape.

4.5.3. Student research groups

Space Engineering Student Research Group

Krzysztof Kurek – tutor.

Space Engineering Student Research Group – SKIK (in Polish: Studenckie Koło Inżynierii Kosmicznej) was formed in 2004. Members of SKIK participated in different international and internal educational space projects. i.e. ESEO, PW-Sat, BOBAS balloon missions. Now, the group start activity with new members, preparing the next balloon mission. Now activity of the Group is focused on realization of stratospheric balloon missions to measure air pollution.

Biomedical and Nuclear Engineering Student Research Group

Grzegorz Domański – tutor.

Biomedical and Nuclear Engineering Student Scientific Group (in Polish: Studenckie Koło Inżynierii Biomedycznej i Jądrowej “Biomedyczni”) was formed in Dec. 2005 by a group of students from Biomedical Engineering. The group worked on software enabling determination of longitudinal relaxation time based of a series of images with different inversion time (TI). The "Arduino for biomedical applications" project has been initiated to develop student interests in the design of new electronic systems, software, and use them in biomedicine. The main objective of the project group is to get acquainted with the electronic platform Arduino programming environment for creating low-cost, flexible and easy-to-use devices. The acquired knowledge and skills will be use at a later stage of the project to develop and implement a multi-functional system for biomedical use, based on the Arduino platform and additional electronic components.

Innovative Information Technologies Student Scientific Group

Przemysław Miazga – tutor.

The scope of interest of the Students' Circle for Innovative Informatics Technologies (KNITI) is the application of .NET technologies in mobile devices programming. KNITI organized courses for students of our university, two courses on basics of C# programming language, and one course on advanced Windows 8 programming for mobile devices. Students of the Group participated in many programming events and contests eg. in Microsoft Imagine Cup, hackatone Night of The Living Devs. The Circle is the organizer of K-Night LAN Party programming marathon.

Radio Localization Student Research Group

Jerzy Kołakowski – tutor.

Radio Localization Student Research Group LORAD was established in 2016 at the Warsaw University of Technology. It brings together undergraduate and postgraduate students from Institute of Radioelectronics and Multimedia Technology. LORAD's main field of interest are radio localization systems, especially those intended for indoor localization. LORAD focuses mostly on ultrawideband localization techniques, however it is interested in inertial localization techniques and SLAM systems as well.

Members of the Radio Localization Student Research Group carry out various tasks, starting from PCB design and assembly, through microcontroller and PC applications programming ending with localization algorithms design and implementation. Additionally, unmanned, self-localizing indoor flying and driving vehicles are developed.

In its projects LORAD cooperates with IoT Systems Research group.

Electromagnetic Modelling Student Research Group

Bartłomiej Salski - tutor

Members of the Electromagnetic Modelling Student Research Group have realized the project: “System for characterization of materials at millimeter spectrum”. One of the hurdles in the development of devices and systems working in the millimeter-wave band is that the electromagnetic properties of the materials used for their construction should be well known at the design stage. The goal of the project is to develop a practical and portable test-bench for free-space characterization of planar samples in the frequency range 18-40 GHz. Strengths of the chosen characterization method include a broad analysis bandwidth and non-destruction of the sample. It is hoped that students and faculty members will benefit from both building and utilizing the test-bench for research purposes.

3Z5PW Experimental Amateur Radio Station

Dawid Rosołowski – tutor.

The 3Z5PW is the callsign of the amateur radio club station set up in 2015 with the goal of developing interest in RF and microwave technology among students of The Faculty of Electronics and Information Technology and of the whole WUT. Due to the interdisciplinary character of the contemporary amateur radio, the Experimental Station activities focus on the practical use of the knowledge in the field of analog radio electronics - development of components for transceivers, designing simple and more complicated radio circuits and antennas for educational and experi-

mental purposes, as well as applications of SDR technology and uC programming. All efforts allow the club members to make long distance wireless contacts with other stations in faraway places on the HF, VHF and SHF bands in more conscious way.

Current activities are concentrated on education and training of young radio operators (two editions of amateur radio courses), promotion of ham radio and the development of the radio shack. 3Z5PW station operators: Dawid Rosołowski (SQ5JQI), Grzegorz Grochowski (SP5QWG), Przemysław Korpas (SQ7JHV).

Electroacoustics Scientific Student Research Group

Agnieszka Paula Pietrzak – tutor.

Electroacoustics Scientific Club of Warsaw University of Technology, is affiliated with the Electroacoustics Department of the Institute of Radio electronics and Multimedia Techniques at the Faculty of Electronics and Information Technology. The area of activity of the Electroacoustics Scientific Club includes: design and construction of electroacoustic devices, design of electroacoustic systems, studio recording sessions and mastering, surround sound, development of software for processing and measuring sound signals, application of Artificial Intelligence (AI) to sound signals, speech acoustics, electroacoustic measurement systems.

Members of the Electroacoustics Scientific Club conduct projects, give speeches at scientific conferences, and support the organization of conferences and fairs (e.g. Audio Video Show Warsaw, polish conferences on acoustics: ISSET, OSA and OSKA). Scientific Club also cooperates with other scientific clubs and student organizations, organizing joint initiatives (e.g. realization of radio studio concerts in the recording studio of the Electroacoustics Department in cooperation with the WUT radio station - Radio Aktywne). The scientific supervisor of the club is Agnieszka Paula Pietrzak, PhD. Board: chairman - Karolina Pondel-Sycz, M.Sc.; vice-chairman - Andrzej Budny, Eng.; treasurer/secretary - Kamil Drzewiecki

4.6. Instrumentation Investments

4.6.1. Centre for Biomedical Technology and Medical Physics

Nuclear and Medical Electronics Division
(**Krzysztof Zaremba** – head)

2008 - 2021

Founded by European Regional Development Fund (ERDF) in scope of Operational Programme Innovative Economy (POIG).

The project is a part of the CePT (Centre for Preclinical Research and Technology), the biggest biomedical and biotechnological undertaking in Central and Eastern Europe. The CePT project is coordinated by the Medical University of Warsaw in partnership with the University of Warsaw, the Warsaw University of Technology and seven research institutes of the Polish Academy of Sciences. The main objective of the Centre is to establish the network of biomedical engineering and biomaterial technology laboratories which will form the base for scientific research and technology implementation. In this Project participates 8 faculties of Warsaw University of Technology.

4.6.2. Panda 2 Project

2016 – 2021

The Institute of Radioelectronics and Multimedia Technology together with the partners of the CePT Project participates in the implementation of the contract for the execution and financing of the Panda 2 Project, which aims to support the cost of maintaining the readiness of the research infrastructure. The contract was concluded in 2016 with a period of 4 years. According to The National Centre for Research and Development (NCBR) roles the program is aimed at supporting the costs of maintaining R & D infrastructure built or rebuilt thanks to the implementation of projects within the second axis of the Innovative Economy Programme (POIG), for which the final eligible costs was at least 50 million PLN.

4.6.3. Sub-terahertz Technology and Antenna Laboratory

Yevhen Yashchyshyn, P. Bajurko;

2010 – 2021

Funded by European Regional Development Fund (ERDF) in scope of Operational Programme Innovative Economy (POIG).

The project is a part of the Faculty Research Centre FOTEH (Photonics and Terahertz Technologies). The project encompasses modernizing of infrastructure of the Antenna Laboratory that enables research on spatial distributions of the electromagnetic field in the millimetre-wave and sub-terahertz range to develop and study of antennas, characterize parameter of materials and designing of the communication, imaging and radar system.

4.6.4. Fast-X Laboratory: Electrical Capacitance Tomograph (Laboratorium Fast-X: Elektryczny tomograf pojemnościowy).

Waldemar Smolik, J. Kryszyn, R. Szabatin (em.), M. Krzewski, T. Olszewski, B. Radzik, P. Wróblewski, D. Wanta, M. Stosio;

2019-2021

Funded by European Regional Development Fund (ERDF) in scope of Regional Operational Programme for Mazovian Voivodeship – PRO-WM

The project is elaborated in the co-operation with the National Center for Nuclear Research in Świerk, where has been set up a research and implementation centre for CentriX industrial radiation techniques. One of the key equipments, which is established at the National Centre for Research and Development, is the most modern modular accelerator capable of speeding up electrons up to energy of 30 MeV. The accelerator is a part of the Fast-X Laboratory within the CentriX project.

5. TITLES AND DEGREES AWARDED

5.1. D.Sc. Degrees

[DSc1]

Krzysztof Derzakowski: "Mikrofalowe struktury wielowarstwowe o symetrii obrotowej zawierające materiały dielektryczne i magnetyczne" (Microwave multilayered axisymmetric structures containing dielectric and magnetic materials), Warsaw, May. 23, 2023

5.2 Ph.D. Degrees

[PhD1]

Krzysztof Dowalla: "Rozpoznawanie stanów odbiorników energii elektrycznej z wykorzystaniem analizy zniekształceń w obrębie jednego okresu sygnału prądu" (Identification of electricity consumers states using analysis of distortions within one period of the current signal), Assoc. Prof. **P. Bilski** (supervisor), Warsaw, Oct. 17, 2023.

[PhD2]

Maciej Jasiński: "Wyznaczanie parametrów akustycznych pomieszczeń z zastosowaniem przestrzennych odpowiedzi impulsowych" (Determination of room acoustic parameters using spatial impulse responses), Prof. **J. Żera** (supervisor), Warsaw, Dec. 12, 2023.

[PhD3]

Marcin Kołakowski: "Adaptive Method for Indoor Positioning of Moving Objects", Prof. **J. Modelski** (supervisor), Ph.D. degree with honours, Warsaw, Sep. 19, 2023.

[PhD4]

Tomasz A. Miś: "Electrostatic Analysis of Transmitting System and Investigation on Fully-Airborne Emissions on Very Low Frequencies", Prof. **J. Modelski** (supervisor), Ph.D. degree with honours, Warsaw, Sep. 19, 2023.

[PhD5]

Jakub Sobolewski: "Wybrane zagadnienia integracji układów sub-terahercowych" (Selected issues of sub-terahertz circuits integration), Prof. **Y. Yashchyshyn** (supervisor), Ph.D. degree with honours, Warsaw, Feb. 21, 2023.

[PhD6]

Damian Wanta: "Czasowo-przestrzenne próbkowanie danych w trójwymiarowej elektrycznej tomografii pojemnościowej" (Spatio-temporal data sampling in three-dimensional electrical capacitance tomography), Assoc. Prof. **W. Smolik** (supervisor), Warsaw, Mar. 21, 2023.

5.3 M.Sc. Degrees

[MSc1]

Wojciech Borowski: "Wyznaczanie charakterystyk kanału radiowego za pomocą radia programowalnego" (Determination of radio communication channel response using software defined radio), Assist. Prof. **G. Bogdan** (supervisor).

[MSc2]

Wojciech Brodowski: "Modelowanie w środowisku Matlab działania radarów lotniskowych na potrzeby analiz wpływu środowiska propagacyjnego na błędy lokalizacji" (Modeling the performance of airport

radars for analysis of the propagation environment impact on localization errors), Assist. Prof. **K. Kurek** (supervisor).

[MSc3]

Michał Daniluk: "Ocena jakości mowy syntezowanej" (Assessment of the quality of synthesized speech), Assist. Prof. **A. Pietrzak** (supervisor).

[MSc4]

Adam Dobrowolski: "Analiza i porównanie różnych typów przedwzmacniaczy korekcyjnych" (Analysis and comparison of different types of preamplifiers with equalization), Assist. Prof. **G. Makarwicz** (supervisor), M.Sc. degree with honours.

[MSc5]

Roberto Del Giudice: "Klasyfikacja zachowań szczurów laboratoryjnych na podstawie analizy sekwencji wideo i skojarzonej mapy głębi" (Classification of laboratory rats' behaviour based on analysis of video sequence and associated depth map), Assist. Prof. **G. Nieradka** (supervisor).

[MSc6]

Mahmoud Hamdan: "Energy-Efficient Configuration of Antennas and Users in The Uplink Massive MIMO System" (Energoszczędna konfiguracja anten i użytkowników w systemie Uplink Massive MIMO), Assoc. Prof. **P. Bilski** (supervisor), studies in English.

[MSc7]

Mikhail Ivanenko: "Zastosowanie sieci neuronowych do rekonstrukcji obrazów tomografii elektrycznej" (Neural network usage in electric tomography image reconstruction), Assoc. Prof. **W. Smolik** (supervisor).

[MSc8]

Andrzej Łukasz Kiernich: "Wpływ czynników występujących w procesie produkcyjnym na niezawodność elastycznych obwodów drukowanych" (The influence of factors present in the production process on the reliability of flexible printed circuits), Assist. Prof. **J. Kalenik** (supervisor), M.Sc. degree with honours.

[MSc9]

Patryk Krajewski: "Analiza wybranych parametrów rentgenowskich tomografów komputerowych na podstawie danych z kontroli fizycznych parametrów urządzeń radiologicznych w jednostkach ochrony zdrowia" (Analysis of selected parameters of X-ray computer tomographs on the basis of data from the control of physical parameters of radiological devices in health care units), Assoc. Prof. **P. Tulik** (supervisor).

[MSc10]

Stanisław Krześniak: "Segmentacja budynków na zdjęciach lotniczych z wykorzystaniem głębokich sieci neuronowych" (Segmentation of buildings in aerial images using deep neural networks), Prof. **W. Skarbek** (supervisor).

[MSc11]

Jintong Li: "MIMO system performance degradation in spatially correlated channel", Assist. Prof. **S. Kozłowski** (supervisor), studies in English.

TITLES AND DEGREES AWARDED

- [MSc12] Oliwia Makowiecka: *"Pomiar pojemności zespolonej z wykorzystaniem wymuszenia impulsowego w elektrycznej tomografii pojemnościowej"* (Complex capacitance measurement using pulse excitation in electrical capacitance tomography), Assist. Prof. **J. Kryszyn** (supervisor).
- [MSc13] Krzysztof Mazurek: *"Opracowanie i wykonanie elementów emulatora dla systemu "slow control" w eksperymencie PANDA"* (Preparation and implementation of emulator elements for the "slow control" system in the PANDA experiment), Prof. **S. Wronka** (supervisor).
- [MSc14] Karolina Sylwia Michalska: *"Algorytmy dopasowania sekwencji w bioinformatyce – oprogramowanie do analizy i prezentacji sekwencji DNA i RNA"* (Sequence alignment algorithms in bioinformatics - software for the analysis and presentation of DNA and RNA sequences), Assist. Prof. **R. Kurjata** (supervisor).
- [MSc15] Andrzej Musiał: *"Modelowanie transmisji sygnałów standardu JESD204B w wielowarstwowych obwodach drukowanych"* (Modeling of signals transmission of JESD204B interface in multilayer printed circuits), Assist. Prof. **P. Korpas** (supervisor).
- [MSc16] Igor Muško: *"Monitor dziennej aktywności ruchowej z wykorzystaniem technologii Bluetooth Smart"* (Daily physical activity monitor using Bluetooth Smart technology), Assist. Prof. **R. Kurjata** (supervisor).
- [MSc17] Gabzachew Ayele Negatu: *"Mu-massive Mimo-ofdma based channel capacity enhancement with constant bw and transmitting power"*, Assoc. Prof. **P. Bilski** (supervisor), studies in English.
- [MSc18] Filip Paczkowski: *"System do znajdowania podobieństwa utworów muzycznych na podstawie analizy cech akustycznych"* (A system for finding the similarity of music tracks based on the analysis of acoustic characteristics), Assoc. Prof. **P. Bilski** (supervisor).
- [MSc19] Michał Papiewski: *"Wieloparametryczny rejestrator parametrów biomedycznych z kolektorem danych"* (Multi-parametric recorder of biomedical parameters with data collector), Assist. Prof. **R. Kurjata** (supervisor).
- [MSc20] Agnieszka Piwowar: *"Badania parametrów elektrycznych podłoży krzemowych o różnym stopniu domieszkowania na częstotliwościach subterahercowych"* (Study of electrical parameters of silicon substrates with different levels of doping at subterahertz frequencies), Assist. Prof. **P. Bajurko** (supervisor).
- [MSc21] Oskar Mikołaj Słoń: *"Projekt i realizacja aplikacji wyszukującej słowa w nagraniach dźwiękowych z wykorzystaniem metod uczenia maszynowego"* (Project and realization of an application that searches for words in audio recordings with usage of machine learning methods), Assist. Prof. **P. Bobiński** (supervisor).
- [MSc22] Jędrzej Michał Synowiec: *"Analiza modeli klasyfikacji sentymentu na podstawie danych tekstowych"* (Analysis of sentiment classification models based on text data), Assoc. Prof. **P. Bilski** (supervisor).
- [MSc23] Roshani Thaware: *"Fine Grained Image Retrieval"*, Prof. **W. Skarbek** (supervisor), studies in English.
- [MSc24] Jan Tuchowski: *"System do lokalizowania osób w pomieszczeniach z wykorzystaniem czujników podczerwieni"* (Infrared sensors-based indoor localisation system), Assist. Prof. **V. Djaja-Joško** (supervisor), M.Sc. degree with honours.
- [MSc25] Jakub Turliński: *"Miernik poziomu dźwięku – realizacja i porównanie implementacji programowej i sprzętowej"* (Sound level meter – development and comparison of software and hardware implementation), Assist. Prof. **G. Makarewicz** (supervisor).
- [MSc26] Kamil Wojtczyk: *"Internetowy System do wspomaganie opieki nad pacjentami"* (Internet system to support patient care), Assist. Prof. **R. Kurjata** (supervisor).
- [MSc27] Piotr Wójtowicz: *"Ocena słuchowa i parametry obiektywne formatów dźwięku w serwisach strumieniowych"* (Objective and subjective evaluation of audio streaming services), Assist. Prof. **M. Lewandowski** (supervisor).
- [MSc28] Aleksandra Wrzesień: *"Zastosowanie sekwencyjnego testu Walda w psychoakustycznych procedurach adaptacyjnych"* (Application of Sequential Wald Test in psychoacoustic adaptive procedures), Prof. **J. Żera** (supervisor).
- [MSc29] Mateusz Wrzesiński: *"Wykorzystanie technik kalibracji w pełnofalowych symulacjach elektromagnetycznych obwodów planarnych na częstotliwościach subterahercowych"* (Implementation of calibration techniques in full-wave electromagnetic simulations of planar circuits at subterahertz frequencies), Assist. Prof. **P. Bajurko** (supervisor).
- [MSc30] Bartosz Zabołotny: *"Sprzętowo-programowa realizacja funkcjonalności enklaw bezpieczeństwa dla urządzeń IoT"* (Hardware-software implementation of secure enclaves' functionalities for IoT devices) Assoc. Prof. **M. Rawski** (supervisor), M.Sc. degree with honours.
- [MSc31] Minyu Zhang: *"Optimized design of small eight-unit MIMO smartphone antenna array system"*, Prof. **Y. Yashchysyn** (supervisor), studies in English.
- [MSc32] Mikołaj Żebrowski: *"Projekt szyku antenowego z elektronicznym przestrajaniem wiązki na pasmo milimetrowe"* (Design of electronically scanned antenna array for

- millimeter band), Prof. **Y. Yashchysyn** (supervisor).
- 5.4 B.Sc. Degrees**
- [BSc1] Maciej Adamski: „*Wielokanałowe urządzenie do pomiaru przyspieszeń na powierzchni skóry*” (Multi-channel device for measuring acceleration on the skin surface), Assist. Prof. **G. Domański** (supervisor).
- [BSc2] Maedot Bahran Ayenew: „*Pomiar zajętości kanału w paśmie ISM 433 MHz z wykorzystaniem techniki SDR*” (Channel Occupancy Measurement in 433 MHz ISM Band Using SDR Technique), Assist. Prof. **S. Kozłowski** (supervisor), studies in English.
- [BSc3] Sylwia Beata Bakalarz: „*Układ do wielopunktowego pomiaru temperatury z wykorzystaniem pirometrów*” (System for multi-point temperature measurement using pyrometers), Assist. Prof. **P. Korpas** (supervisor).
- [BSc4] Anna Berent: „*Zasilana bateryjnie, wisząca waga hakowa wyposażona w moduł automatycznego pomiaru i radiowej transmisji danych*” (Battery-powered, hanging scale incorporating automatic measurement and radio data transmission module), Prof. **G. Cybulski** (supervisor).
- [BSc5] Michał Ryszard Bober: „*Rekonstrukcja Obrazów w Elektrycznej Tomografii Pojemnościowej z Użyciem Sieci Neuronowych Głębokich*” (Reconstruction of Images in Electrical Capacitance Tomography With Use Of Deep Neural Network.), Assist. Prof. **J. Kryszyn** (supervisor).
- [BSc6] Albert Bogdanovič: „*Monitor promieniowania tła z funkcją IoT*” (Natural background radiation monitor with IoT functionality), Assist. Prof. **A. Rychter** (supervisor).
- [BSc7] Luiza Bojczuk: „*Sztuka, wizja i maszyna: Design i implementacja generowanych komputerowo grafik 3D w demoscenie*” (Art, vision and machine: Design and implementation of computer-generated 3D graphics within the demoscene), Prof. **A. Przelaskowski** (supervisor).
- [BSc8] Michał Bojke: „*Algorytmy detekcji, lokalizacji i separacji źródeł dźwięku za pomocą matryc mikrofonowych*” (Algorithms of sound source detection, localization and separation using microphone matrices), Assist. Prof. **M. Lewandowski** (supervisor).
- [BSc9] Julia Borysławska: „*Oprogramowanie do prowadzenia oceny jakości dźwięku metodą ABX i AB*” (Software for Conducting Sound Quality Assessment Using ABX and AB Methods), Assist. Prof. **A. Pietrzak** (supervisor).
- [BSc10] Justyna Budzyńska: „*Zastosowanie standardu openEHR w szpitalnym systemie informacyjnym*” (Use of the openEHR stand-ard in hospital information system), Assist. Prof. **J. Kryszyn** (supervisor).
- [BSc11] Zhuoer Che: „*Antenna of Automotive Radar*”, Prof. **Y. Yashchysyn** (supervisor), studies in English.
- [BSc12] Paulina Cieloch: „*Zastosowanie standardu openEHR w szpitalnym systemie informacyjnym*” (Application of the openEHR standard in the hospital information system), Assist. Prof. **J. Kryszyn** (supervisor).
- [BSc13] Kamil Gałązka: „*Opracowanie modułu komunikacyjnego zgodnego ze standardem sieci LTE-M*” (Development of a communication module compatible with the LTE-M network standard), Assist. Prof. **J. Kołakowski** (supervisor).
- [BSc14] Jakub Grądziel: „*Modelowanie cienkich warstw w symulacji elektromagnetycznej metodą momentów*” (Modeling of thin layers in electromagnetic simulation using the method of moments), Assist. Prof. **P. Bajurko** (supervisor).
- [BSc15] Piotr Gryglewski: „*Wzmacniacz sterujący o mocy 15 W na pasmo 5.5-6GHz do nadajnika stacji bazowej LTE-A*” (15 W Driver for the 5.5-6GHz band for LTE-A base station transmitter), Assoc. Prof. **W. Wojtasiak** (supervisor).
- [BSc16] Song Haiyang: „*Wireless M-BUS to WiFi gate*”, Assist. Prof. **M. Rupniewski** (supervisor), studies in English.
- [BSc17] Jarosław Jabłoński: „*Impulsowy wzmacniacz audio z przetwornikiem sigma-delta*” (Switching-mode audio amplifier based on a sigma-delta A/D converter), Assist. Prof. **M. Lewandowski** (supervisor).
- [BSc18] Changyuan Ji: „*Antenna design for RF energy collection*”, Prof. **Y. Yashchysyn** (supervisor), studies in English.
- [BSc19] Karolina Joachimczyk: „*Wielokanałowy system do pomiaru sygnałów EMG*” (Multi-channel EMG signal measuring device) Assist. Prof. **G. Domański** (supervisor).
- [BSc20] Maciej Kaczkowski: „*Implementacja sieci neuronowej do estymacji dysparycji w obrazach stereowizyjnych*” (Implementacja sieci neuronowej do estymacji dysparycji w obrazach stereowizyjnych), Assoc. Prof. **G. Pastuszak** (supervisor).
- [BSc21] Monika Kaczmarek: „*Kodowanie i dekodowanie sekwencji wizyjnych z wykorzystaniem sprzętowego kodera na karcie graficznej NVIDIA*” (Coding and decoding video sequences using hardware encoder on NVIDIA graphic card), Assist. Prof. **A. Buchowicz** (supervisor).
- [BSc22] Ada Kawala: „*System do obsługi e-recept*” (E-prescription system), Assist. Prof. **J. Kryszyn** (supervisor).
- [BSc23] Dmytro Kirshev: „*Układ do bezkontaktowego pomiaru temperatury ciała*” (System for non-contact body temperature

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- measurement) Assist. Prof. **K. Godziszewski** (supervisor).
- [BSc24] Karol Kosowski: „Przetwornica impulsowa do ładowania akumulatorów” (Impulse converter for charging batteries), Assist. Prof. **M. Mikołajewski** (supervisor).
- [BSc25] Jakub Kowalczyk: „Urządzenie do pomiaru rozproszenia światła w roztworach” (Device for measuring light dispersion in solutions), Assist. Prof. **G. Domański** (supervisor).
- [BSc26] Bartłomiej Krzesiński: „Wirtualny multimetr z interfejsem sieciowym” (Virtual multimetr based on LXI interface), Assist. Prof. **R. Łukaszewski** (supervisor).
- [BSc27] Maria Kujawa: „System do obsługi e-recept” (E-prescription system), Assist. Prof. **J. Kryszyn** (supervisor).
- [BSc28] Karolina Kuna: „Projekt, realizacja i ocena nagrań muzycznych w różnych warunkach akustycznych” (Design, realisation and evaluation of music recordings in various acoustic conditions), Assist. Prof. **P. Bobiński** (supervisor).
- [BSc29] Katarzyna Latos: „Projekt i realizacja systemu webowego wspomagającego monitoring stanu zdrowia pacjenta” (Design and implementation of a web-based system to support patient health monitoring), Assist. Prof. **P. Bobiński** (supervisor).
- [BSc30] Mateusz Leszczyński: „Opracowanie stanowiska pomiarowego do badania aerofonów” (Development of a demonstration setup for examining aerophones), Prof. **J. Żera** (supervisor).
- [BSc31] Zuzanna Lewandowska: „Jednokanałowy system do pomiaru i analizy sygnału EKG” (Single-channel system for ECG signal measurement and analysis), Assist. Prof. **G. Domański** (supervisor).
- [BSc32] Xiaoxiao Li: „A dual-band microstrip antenna design for 5G applied to mobile communications”, Prof. **Y. Yashchynshyn** (supervisor), studies in English.
- [BSc33] Maksymilian Liśkiewicz: „Częściowy egzozoszkieleł pasywny wspomagający przy pracach z uniesionymi rękami. Projekt oraz budowa prototypu” (Partial-passive exoskeleton for support during work with raised arms. Project and prototype construction), Assist. **H. Hawlas** (supervisor).
- [BSc34] Magdalena Ładogórska: „Analiza parametrów krążeniowo-oddechowych na podstawie rejestracji interwałów RR w trakcie testu Yo-Yo w grupie piłkarzy w wieku 8-18 lat” (The analysis of cardio-respiratory parameters based on the registration of RR intervals during the Yo-Yo test among footballers aged 8-18 years old), Assoc. Prof. **M. Młyńczak** (supervisor), B.Sc. degree with honours.
- [BSc35] Damian Łaguna: „Aplikacja internetowa do obsługi e-recepty” (e-prescription web application), Assist. Prof. **J. Kryszyn** (supervisor).
- [BSc36] Arkadiusz Majkowski: „Aplikacja mobilna "Dzienniczek diabetyka"” (Mobile application "Diabetes diary”), Assist. Prof. **R. Kurjata** (supervisor).
- [BSc37] Sofiya Makarenka: „Ocena asymetrii chodu człowieka na podstawie danych pozyskiwanych za pomocą czujnika głębi” (Evaluation of gait asymmetry based on data from a depth sensor), Assist. Prof. **J. Wagner** (supervisor).
- [BSc38] Konrad Malinowski: „Projekt i implementacja kompresora dynamiki w technologii wtyczek VST” (Project and Implementation of a dynamic range compressor in VST technology), Assist. Prof. **P. Bobiński** (supervisor).
- [BSc39] Franciszek Milczarski: „Skuteczne rozpoznawanie dokumentów tekstowych za pomocą narzędzi OCR dostępnych w środowisku UiPath” (Effective recognition of text documents using OCR tools available in the UiPath environment), Prof. **A. Przelaskowski** (supervisor).
- [BSc40] Martyna Muszyńska: „Przeglądarka obrazów medycyny nuklearnej” (Nuclear Medicine Image Viewer), Assist. Prof. **J. Kryszyn** (supervisor), B.Sc. degree with honours.
- [BSc41] Jeremi Olejnik: „Trójwymiarowa wizualizacja ultradźwiękowa przy wykorzystaniu inercyjnych czujników ruchu” (Three-dimensional ultrasound visualisation with the use of inertial motion unit sensors), Assist. Prof. **B. Leśniak-Plewińska** (supervisor), Ph.D. Norbert Żołek IPPT PAN (co-supervisor).
- [BSc42] Adam Piszczek: „Oprogramowanie do klasyfikacji obrazów medycznych z wykorzystaniem wybranych narzędzi sztucznej inteligencji” (Medical image classification software using selected artificial intelligence tools), Assist. Prof. **A. Rychter** (supervisor).
- [BSc43] Weronika Rokita: „Modelowanie dynamiki pracy mięśni dla wybranych czynności ruchowych” (Modelling of the muscle work dynamics for selected motor activities), Assoc. Prof. **M. Kwacz** (supervisor).
- [BSc44] Jan Rozwadowski: „Realizacja nagrania w technice ambisonicznej” (Production of an ambisonic sound recording), Assist. Prof. **A. Pietrzak** (supervisor).
- [BSc45] Dawid Ruciński: „Metody sztucznej inteligencji w ekstrakcji zespolonej przenikalności elektrycznej próbek medycznych przy pomocy otwartego rezonatora Fabry-Perot” (The methods of artificial intelligence in extraction complex permittivity of medical samples with usage of Fabry-Perot open resonator), Assist. **M. Kryszyn** (supervisor), B.Sc. degree with honours.

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- [BSc46] Mateusz Rutkowski: „*Układ do pomiaru temperatury z bezprzewodową transmisją danych*” (Temperature measurement system with wireless data transmission), Assist. Prof. **V. Djaja-Joško** (supervisor).
- [BSc47] Ivan Ryzhankow: „*Metoda rozpoznawania twarzy z wykorzystaniem fuzji danych z różnych sensorów*” (Face recognition method using fusion of data from different sensors), Assist. Prof. **M. Trokielewicz** (supervisor).
- [BSc48] Katarzyna Sendek: “*Wielokanałowy system do pomiaru fali PPG*” (The multi-channel system for measuring the pulse wave using the photoplethysmography method (PPG)), Assist. Prof. **G. Domański** (supervisor).
- [BSc49] Aleksandra Sidor: „*Projekt i realizacja webowej aplikacji wspomagającej współpracę laboratoriów, lekarzy i pacjentów*” (Project and implementation of web application supporting cooperation between laboratories, doctors and patients), Assist. Prof. **P. Bobiński** (supervisor).
- [BSc50] Michał Siek: „*Moduł sterujący klawiaturami muzycznymi MIDI*” (MIDI keyboard controlling module), Assist. Prof. **M. Lewandowski** (supervisor).
- [BSc51] Filip Socha: “*Sieć czujników zbliżeniowych z bezprzewodową transmisją wyników*” (Laser proximity sensors network with wireless transmission of data), Assist. Prof. **V. Djaja-Joško** (supervisor).
- [BSc52] Mateusz Szewczyk: “*Aplikacja na urządzenia mobilne do rejestrowania przebytej trasy*” (Application for mobile devices to record the traveled route), Assist. Prof. **G. Galiński** (supervisor).
- [BSc53] Łukasz Szopa: “*Projekt i realizacja aplikacji mobilnej monitorującej stan zdrowia pacjenta*” (Design and implementation of a mobile app monitoring the patient's health), Assist. Prof. **P. Bobiński** (supervisor).
- [BSc54] Tomasz Szuster: “*Oprogramowanie NILM do modułu IoT*” (NILM software for IoT module), Assist. Prof. **R. Łukaszewski** (supervisor).
- [BSc55] Paweł Tydelski: “*Projekt adaptacji oraz symulacje warunków akustycznych w wybranym wnętrzu*” (Adaptation project and simulation of acoustic conditions in the selected room), Assist. Prof. **P. Bobiński** (supervisor).
- [BSc56] Chuanzhao Wang: “*Implementation of the multilayered perceptron for the ASK symbol detection in the presence of noise*”, Assoc. Prof. **P. Bilski** (supervisor), studies in English.
- [BSc57] Aleksandra Wiedeńczyk: “*Rekonstrukcja obrazów płuc w elektrycznej tomografii pojemnościowej za pomocą sieci neuronowych głębokich*” (Reconstruction of lung images in electrical capacitance tomography using deep neural networks), Assoc. Prof. **W. Smolik** (supervisor).
- [BSc58] Kinga Wszolek: “*Częściowy egzoskielet pasywny odciążający przy pracach w pozycji stojącej - projekt oraz budowa prototype*” (Partial passive exoskeleton for relieving strain during standing work - project and prototype construction), Assist. **H. Hawlas** (supervisor).
- [BSc59] Xiaorui Xie: “*Application for generation and visualization of a ray -tracing-based MIMO channel model*”, Assist. Prof. **S. Kozłowski** (supervisor), studies in English.
- [BSc60] Jakub Zduński: “*Projekt i realizacja internetowego systemu 'video na żądanie'*” (Project and implementation of 'video on demand' web system), Assist. Prof. **G. Galiński** (supervisor).
- [BSc61] Wiktoria Oliwia Zych: “*Oprogramowanie do automatycznej segmentacji zmian nowotworowych w obrazach magnetycznego rezonansu jądrowego z wykorzystaniem wybranych narzędzi sztucznej inteligencji*” (Software for automatic segmentation of cancerous lesions in nuclear magnetic resonance images using selected artificial intelligence tools), Assist. Prof. **A. Rychter** (supervisor).
- [BSc62] Radosław Żelazo: “*Oprogramowanie do analizy obrazów medycznych pod kątem zmian nowotworowych z wykorzystaniem technik sztucznej inteligencji*”, (Software for the analysis of medical images for neoplastic changes using artificial intelligence techniques) Assist. Prof. **R. Kurjata** (supervisor), B.Sc. degree with honours.

6. PUBLICATIONS

6.1. Scientific and technical books, chapters in books

- [Pub1] P. Garbat, G. Galiński, M. Żakowski, M. Bieniek, M. Lasocki: „Image Analysis System for Augmented Reality Games”, in: *Progress on Pattern Classification, Image Processing and Communication*, R. Burduk, M. Choraś, R. Kozik, P. Ksieniewicz, T. Marciniak, P. Trajdos (eds), part of book series: *Lecture Notes in Networks and Systems*, Springer 2023, ISBN: 978-3-031-41629-3, pp. 93-100.
- [Pub2] N. Hryniewicz, R. Rola, K. Lipiński, E. Piątkowska-Janko, P. Bogorodzki: „Optimization of the BOLD Hemodynamic Response Function for EEG-fMRI Studies in Epilepsy” in. *The Latest Developments and Challenges in Biomedical Engineering*, P. Strumiłło, A. Klepaczko, M. Strzelecki, D. Baciąga (eds), part of book series: *Lecture Notes in Networks and Systems*, Springer 2023, ISBN 978-3-031-38429-5, pp. 131-146.
- [Pub3] T. Rogala, J. Szczepańska-Antosik, A. Miśkiewicz, J. Żera, J. Majer: „Identification of Environmental Sounds: Auditory Abilities of Musicians and Non-Musicians” in *Professional Acoustics 2*, A. Rosiński (eds), *Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego w Olsztynie (Wydawnictwo UWM)*, 2023, ISBN 978-83-8100-364-3, pp. 135-156.
- [Pub4] S. Rosłonec: „Fundamentals of the Radio-location and Radionavigation”, in. *Springer International Publishing*, 2023, ISBN 9783031106309, 453 pp.
- [Pub5] M. Sińczuk, J. Rogala, E. Piątkowska-Janko, P. Bogorodzki: „Application of Un-suppressed Water Peaks for MRS Thermometry”, in: *The Latest Developments and Challenges in Biomedical Engineering*, P. Strumiłło, A. Klepaczko, M. Strzelecki, D. Baciąga (eds), part of book series: *Lecture Notes in Networks and Systems*, Springer 2023, ISBN 978-3-031-38429-5, pp. 407-420.

6.2. Scientific and technical papers in journals

6.2.1. Part A

This subsection contains the list of papers published in the journals indicated on the list of the Ministry of Education and Science including those listed in the Thomson-Reuters Journal Citation Reports. Papers authored by more than 10 persons from outside of the Faculty of Electronics and Information Technologies, WUT, have been specified in a simplified way, viz.: only the first author and all the authors from the Faculty have been listed and the number of other authors has been provided in brackets.

- [Pub6] K. Abe (...), K. Dygmarowicz, R. Kurjata, R. Rychter, K. Zaremba, M. Ziembicki (395 external authors): “Measurements of neu-

trino oscillation parameters from the T2K experiment using 3.6×10^{21} protons on target”, *European Physical Journal C*, vol. 83, no. 9, 2023, doi: 10.1140/epjc/s10052-023-11819-x, pp. 1-50.

- [Pub7] K. Abe (...), K. Dygmarowicz, R. Kurjata, A. Rychter, K. Zaremba, M. Ziembicki (399 external authors): “First measurement of muon neutrino charged-current interactions on hydrocarbon without pions in the final state using multiple detectors with correlated energy spectra at T2K”, *Physical Review D*, vol. 108, no. 11, 2023, doi: 10.1103/physrevd.108.112009, pp. 1-32.
- [Pub8] K. Abe (...), K. Dygmarowicz, R. Kurjata, A. Rychter, K. Zaremba, M. Ziembicki (378 external authors): “Measurements of the $\nu\mu$ and $\bar{\nu}\mu$ -induced coherent charged pion production cross sections on C12 by the T2K experiment”, *Physical Review D*, vol. 108, no. 9, 2023, doi: 10.1103/physrevd.108.092009, pp. 1-15.
- [Pub9] K. Abe (...), K. Dygmarowicz, R. Kurjata, A. Rychter, K. Zaremba, M. Ziembicki (399 external authors): “Updated T2K measurements of muon neutrino and antineutrino disappearance using 3.6×10^{21} protons on target”, *Physical Review D*, vol. 108, no. 7, 2023, doi: 10.1103/physrevd.108.072011, pp. 1-10.
- [Pub10] G. D. Alexeev (...), R. Kurjata, J. Marzec, A. Rychter, K. Zaremba, M. Ziembicki (186 external authors): “Collins and Sivers transverse-spin asymmetries in inclusive muon production of ρ^0 mesons”, *Physics Letters B*, vol. 843, 2023, doi: 10.1016/j.physletb.2023.137950, pp. 1-10.
- [Pub11] G. D. Alexeev (...), R. Kurjata, J. Marzec, A. Rychter, K. Zaremba, M. Ziembicki (188 external authors): “Double J/ψ production in pion-nucleon scattering at COMPASS”, *Physics Letters B*, vol. 838, 2023, doi: 10.1016/j.physletb.2023.137702, pp. 1-8.
- [Pub12] G. D. Alexeev (...), R. Kurjata, J. Marzec, A. Rychter, K. Zaremba, M. Ziembicki (185 external authors): “Spin density matrix elements in exclusive ρ meson muon production”, *European Physical Journal C*, 2023, vol. 83, art. no. 924, 2023, doi: 10.1140/epjc/s10052-023-11359-4, pp. 1-25.
- [Pub13] G. D. Alexeev (...), R. Kurjata, J. Marzec, A. Rychter, M. Ziembicki, M. Ziembicki (192 external authors): “Transverse-spin-dependent azimuthal asymmetries of pion and kaon pairs produced in muon-proton and muon-deuteron semi-inclusive deep inelastic scattering”, *Physics Letters B*, vol. 845, 2023, doi: 10.1016/j.physletb.2023.138155, pp. 1-8.
- [Pub14] L. Ambrosi, K. Dygmarowicz, R. Kurjata, W. Obrebski, A. Rychter, M. Ziembicki (90 external authors): “Characterization of Charge

- Spreading and Gain of Encapsulated Resistive Micromegas Detectors for the Upgrade of the T2K Near Detector Time Projection Chambers”, *Nuclear Instruments & Methods in Physics Research Section A Accelerators, Spectrometers, Detectors and Associated Equipment*, vol. 1056, 2023, doi:10.1016/j.nima.2023.168534, pp. 1-40.
- [Pub15] D. Attie, K. Dygmarowicz, R. Kurjata, A. Rychter, M. Ziembicki (80 external authors): “Analysis of test beam data taken with a prototype of TPC with resistive Micromegas for the T2K Near Detector upgrade”, *Nuclear Instruments & Methods in Physics Research Section A Accelerators, Spectrometers, Detectors and Associated Equipment*, vol. 1052, art. no. 168248 2023, doi: 10.1016/j.nima.2023.168248, pp. 1-15.
- [Pub16] P. Bajurko, J. Sobolewski, Y. Yashchishyn, P. Sai, S. L. Rumyantsev, T. Narynyk, G. Cywiński: „AlGaIn/GaN Distributed Schottky Barrier Single-Pole Single-Throw Millimeter-Wave Switches”, *IEEE Access*, vol. 11, 2023, doi: 10.1109/access.2023.3331222, pp. 125909-125917.
- [Pub17] P. Bilski, I. Antoniuk, R. Łabędzki: „Method for the Player Profiling in the Turn-based Computer Games”, *International Journal of Electronics and Telecommunications*, 2023, vol. 69, no. 3, doi: 10.24425/ijet.2023.144384, pp. 461-468.
- [Pub18] G. Bogdan, J. Sobolewski, P. Bajurko, Y. Yashchishyn, J. Oklej, D. Ostaszewski: „A Wire-Bonded Patch Antenna for Millimeter Wave Applications”, *Electronics*, 2023 vol. 12, no. 3, doi: 10.3390/electronics12030632, pp. 1-14.
- [Pub19] K. Dowalla, P. Bilski, R. Łukaszewski, A. Wójcik, R. Kowalik: “A Novel Method for Detection and Location of Series Arc Fault for Non-Intrusive Load Monitoring”, *Energies*, 2023 vol. 16, no. 1, doi: 10.3390/en16010171, pp. 1-23.
- [Pub20] D. A. Drecka, M. T. Lipiński, A. Z. Sarwiński, A. Sowa, J. K. Turliniński, R. Romaniuk: “Students’ View of Quantum Information Technologies”, *International Journal of Electronics and Telecommunications*, vol. 70, no. 3, 2023, doi: 10.24425/ijet.2023.146503, pp. 627-633.
- [Pub21] M. Ivanenko, W. Smolik, D. Wanta, M. Midura, P. Wróblewski, X. Hou, X. Yan: „ Image Reconstruction Using Supervised Learning in Wearable Electrical Impedance Tomography of the Thorax”, *Sensors*, 2023, vol. 23, no. 18, 2023 doi: 10.3390/s23187774, pp. 1-21.
- [Pub22] E. Kolada, K. Bielski, M. Wilk, K. Rymarczyk, P. Bogorodzki, P. Kazulo, B. Kossowski, M. Wypych, A. Marchewka, L. Kaczmarek: “The Human Centromedial Amygdala Contributes to Negative Prediction Error Signaling during Appetitive and Aversive Pavlovian Gustatory Learning”, *Journal of Neuroscience* 2023, vol. 43, no. 14, doi: 10.1523/jneurosci.0926-22.2023, pp. 3176-3185.
- [Pub23] A. Korpas, D. Rosołowski, M. Kajczuk, D. Gryglewski, W. Wojtasiak: „ A Universal Hardware Platform for an LTE-Advanced Base Station Prototyping”, *Electronics*, 2023, vol. 12, no. 5 doi: 10.3390/electronics12051069, pp. 1-18.
- [Pub24] B. Kościug, P. Bilski: “Energy Saving Chaotic Sequence Based Encryption, Authentication and Hashing for M2M Communication of IoT Devices”, *International Journal of Electronics and Telecommunications*, vol. 69, no. 2, 2023, doi: 10.24425/ijet.2023.144358, pp. 253-259.
- [Pub25] J. Kryszyn, W. Smolik, D. Wanta, M. Midura, P. Wróblewski: “Comparison of OpenEHR and HL7 FHIR Standards”, *International Journal of Electronics and Telecommunications*, vol. 69, no. 1, 2023, doi: 10.24425/ijet.2023.144330, pp. 47-52.
- [Pub26] K. Kuczyński, M. Lisicki, P. Bilski, J. Szymanski, A. Bilski: “Magnetolectric ring sensor—modelling and experimentation”, *Microsystem Technologies*, vol. 29, no. 7, 2023, doi: 10.1007/s00542-023-05472-3, pp. 905-917.
- [Pub27] K. Kuczyński, P. Bilski, A. Bilski, J. Szymański: „Testing and modeling of constant magnetic field cylindrical magnetolectric sensors output characteristics”, *Bulletin of the Polish Academy of Sciences, Technical Sciences*, vol. 71, no. 1, 2023, doi: 10.24425/bpasts.2023.144583, pp. 1-12.
- [Pub28] H. Ling, Z. Li, K. Li, R. Zhao, P. Ma, Y. Zhou, J. Li, X. Xu, Y. Yashchishyn: „ Terahertz Electromagnetically Induced Transparency with Electric-Field-Coupled Inductor-Capacitor Resonators on LCP Substrate”, *Crystals*, 2023, vol. 13, no. 2, doi: 10.3390/cryst13020283, pp. 1-12.
- [Pub29] P. Marszałek, P. Bilski: “Steganography in Audio Files – COTS Software Analysis”, *International Journal of Electronics and Telecommunications* 2023, vol. 69, no. 1, doi: 10.24425/ijet.2023.144340, pp.121-126.
- [Pub30] P. Mazurek, S. Kruszewski: “Applicability of multiple impulse-radar sensors for the recognition of a person’s action”, *Acta IMEKO*, vol. 12, no. 2, 2023, doi: 10.21014/actaimeko.v12i2.1346, pp. 1-7.
- [Pub31] P. Mazurek: “Application of Feedforward and Recurrent Neural Networks for Fusion of Data from Radar and Depth Sensors Applied for Healthcare-Oriented Characterisation of Persons’ Gait”, *Sensors* 2023, vol. 23, no. 3, doi: 10.3390/s23031457, pp. 1-18.
- [Pub32] P. Miazga: „ Generalized Linear Network Analysis Method Based on the Transfer Scattering Approach”, *IEEE Transactions on Microwave Theory and Techniques*

- 2023, doi: 10.1109/tmtt.2023.3322543, pp. 1-9, early access.
- [Pub33] M. Mikołajewski: "An Off-Nominal Class E Amplifier—Design Oriented Analysis", *Electronics* 2023, vol. 12, no. 10, doi: 10.3390/electronics12102203, pp. 1-16.
- [Pub34] T. A. Miś, J. Modelski: "Electrical Phenomena on Fully Airborne Vertical Electric Antennas in Extreme Weather Conditions", *Energies* 2023, vol. 16, no. 1, doi: 10.3390/en16010052, pp. 1-13.
- [Pub35] T. A. Miś, J. Modelski: "Risk Assessment and Experimental Light-Balloon Deployment of a Stratospheric Vertical VLF Transmitter", *Sensors* 2023, vol. 23, no. 3, doi: 10.3390/s23031073, pp. 1-30.
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6.4. Abstracts, Posters and presentations

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- [Pub84] R. Z. Morawski: "Ethical & educational implications of the development of AI-supported technologies", ENHANCE workshop "Artificial Intelligence in Higher Education" (June 22, 2023), presentation composed of 13 slides.
- [Pub85] K. Lipiński, P. Bogorodzki: "Evaluation of Intra Voxel Incoherent Motion (IVIM) Methodology in the Context of Perfusion Clinical Protocols", 1 Red Hot Fluorine 19F MRI & SAMS meet Kraków MRI Workshop 2023 (Kraków, Poland, Dec. 4-7, 2023), 1 pp.
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6.5. Books and special issues edited by the staff

- [Pub91] J. Cichocki, A. Czarnecka, K. Snopek, P. Mazurek, P. Brzeski (Eds.): "50 lat Instytutu Radioelektroniki (i Technik Multimedialnych)"; (50 Years of the Institute of Radioelectronics and Multimedia Technology), Wyd. Fundacja Wspierania Rozwoju Radiokomunikacji i Technik Multimedialnych PW (2022), 281 pp.

7. RESEARCH REPORTS

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- [Rep2] B. Salski, T. Karpisz, P. Czekala: “Oddziaływanie światło-materia mikrorezonatorów dielektrycznych z fotonami mikrofalowymi w otwartym rezonatorze Fabry-Perot” (Light-matter interaction of dielectric micro-resonators with microwave photons in a Fabry-Perot open resonator), Final report for the Scientific Council for Automatics, Electronics and Electrical Engineering, WUT, Warsaw, Mar. 2023.
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- [Rep5] M. Lasocki, G. Galiński, P. Garbat, M. Bieniek, M. Żakowski, M. Szymkowski, “Opracowanie i implementacja system sztucznej inteligencji wirtualnych postaci pozwalającego na symulację ich realistycznych zachowań i interakcji z graczem na podstawie autonomicznej analizy obrazu uczestników gry w czasie rzeczywistym” (Development and implementation of an artificial intelligence system for virtual characters allowing simulation of their realistic behavior and interaction with the player on the basis of autonomous image analysis of game participants in real time), Final report for the National Centre for Research and Development, Warsaw, Jun. 2023.
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- [Rep14] P. Bajurko, J. Sobolewski: “Opracowanie i badanie udoskonalonych obwodów antenowych do detektorów subterahercowych na bazie tranzystorów polowych” (Development and examination of improved antenna circuits for field-effect transistor-based subterahertz detectors), Final report for the Scientific Council for Automatics,

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8. PATENTS AND PATENT APPLICATIONS

- [Pat1] R. Łukaszewski, A. Wójcik, W. Winięcki, R. Kowalik; „Sposób identyfikacji w sieci zasilania włączanego odbiornika i urządzenie do identyfikacji w sieci zasilania włączanego odbiornika” (Method of identification of the switched receiver in the power supply network and device for identification of the switched receiver in the power network), Jan. 17, 2023.
- [Pat2] D. Wanta, W. Smolik, J. Kryszyn, G. Domański, P. Wróblewski, M. Midura; „Sposób pomiaru pojemności międzyelektrodowych w sondzie tomograficznej z wieloma elektrodami za pomocą tomografu wielokanałowego” (Method of measuring inter-electrode capacitances in multi-electrode tomographic probe using multi-channel tomograph), Mar. 23, 2023.
- [Pat3] G. Cywiński, S. Rumiantcev, P. Bajurko, Y. Yashchyshyn; „A high frequency switch with field effect transistor”, May 3, 2023.
- [Pat4] R. Łukaszewski, K. Dowalla, R. Kowalik, P. Bilski; „Urządzenie do detekcji zmiany trybu pracy oraz identyfikacji odbiorników elektrycznych i sposób detekcji zmiany trybu pracy oraz identyfikacji odbiorników elektrycznych” (Device for detecting changes in the operating mode and identifying electrical receivers and method of detecting a change in the operating mode and identifying electrical receivers), Jun. 14, 2023.
- [Pat5] D. Wanta, W. Smolik, J. Kryszyn, P. Wróblewski, M. Midura; „Sonda pojemnościowa elektrycznego tomografu pojemnościowego do pomiaru mieszanin z fazą ciągłą przewodzącą i nieprzewodzącą i sposób pomiaru” (Capacitive probe of an electric capacitive tomograph for measuring mixtures with a continuous conductive and non-conductive phase and method of measurement), Jul. 14, 2023.
- [Pat6] Y. Yashchyshyn, G. Bogdan; „Antena elektrycznie mała” (Small electric antenna and the way of its tuning), Oct. 2, 2023.
- [Pat7] S. Kozłowski, K. Kurek; „Sposób korekcji przesunięcia Dopplera w odbiorniku radiowym” (Method of correcting the Doppler shift in a radio receiver), Nov. 13, 2023.
- [Pat8] W. Gwarek, K. Jankowski, W. Wojtasiak, M. Borowska, P. Korpas, S. Kozłowski, D. Gryglewski, D. Kołodziej; „Aplikator mikrofalowy do przeprowadzania reakcji chemicznych” (Microwave applicator for carrying out chemical reactions), Dec. 19, 2023.
- [Pat9] P. Bajurko; „Sposób detekcji terahercowej oraz obwód elektryczny półprzewodnikowego detektora terahercowego” (Method of terahertz detection and electrical circuit of semiconductor terahertz detector), patent application no. P.447179, Dec. 20, 2023.

9. SCIENTIFIC EVENTS

9.1. Scientific events co-organized by the Institute

- [Con1] *International Symposium on Sound Engineering and Tonmeistering 2023* (Warsaw, Oct. 12-14, 2023), J. Żera (chair of the Programme Committee), A. P. Pietrzak, M. Lewandowski (members of the Organizing Committee), A. P. Pietrzak, K. Pondel-Sycz, M. Jasiński, M. Lewandowski (speakers).

9.2. International scientific events

- [Con2] IEEE/MTT-S International Microwave Symposium - IMS 2023, (San Diego, USA, Jun. 11-16, 2023), J. Modelski (MTT-S observer), B. W. Salski (speaker), P. Kopyt, M. Kryszicki, P. Czekala (participants).
- [Con3] ENHANCE on-line workshop "Artificial Intelligence in Higher Education" (June 22, 2023), R. Z. Morawski (speaker).
- [Con4] *30th International Conference on Mixed Design of Integrated Circuits and System (MIXDES 2023)*, 2023, (Cracow, Poland, Jun. 29-30, 2022) P. Bajurko (participant/speaker).
- [Con5] *International Travelling Summer School on Terahertz Science and Technology: ITSS-TSaT 2023* (Eindhoven, Niderlandy Jul. 9-13, 2023), Y. Yashchyshyn (speaker).
- [Con6] *XXXVth General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS)*, 2023, (Sapporo, Japan, Aug. 19-26, 2023), J. Modelski (Member Committee), G. Bogdan, T.A. Miś (speakers).
- [Con7] *Technology & Instrumentation in Particle Physics (TIPP2023)*, (Cape Town, South Africa, Sep. 4-8, 2023), K. Dygnarowicz (speaker).
- [Con8] *Immersive and 3D Audio: from Architecture to Automotive (I3DA) 2023*, (Bologna, Italy, Sep. 5-7, 2023), M. Jasiński (speaker).
- [Con9] *12th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, 2023* (Dortmund, Germany, Sept. 7-9, 2022), P. Bilski, S. Kruszewski, J. Wagner (speakers).
- [Con10] *10th Convention of the European Acoustics Association, Forum Acusticum 2023*, (Turin, Italy, Sep. 11-15, 2023), A. P. Pietrzak (speaker/ participant).
- [Con11] *European Microwave Week 2023* (Berlin, Germany, Sep. 17-22, 2023), J. Modelski (member of the Programme Committee).
- [Con12] *19th IMEKO TC10 Conference 2023 MACRO meets NANO in Measurement for Diagnostics, Optimization and Control* (Delft, Netherlands, Sep. 21-22, 2023), P. Bilski (speaker).

- [Con13] *12th International Conference on Microwave Materials and their Applications (MMA 2023)*, (Mainz, Germany, Sep. 25-28, 2023), A. Pacewicz (speaker), B. W. Salski (participant).

- [Con14] *50 Międzynarodowa Konferencja I Wystawa PIKE 2023 (50th International Conference and Exhibition PIKE)* (Łódź, Poland Oct. 2-4, 2023), J. Modelski (President of the Programme Council).

- [Con15] *International Symposium and Exhibition on Electromagnetic Compatibility (EMC Europe 2023)*, (Cracow, Poland, Oct. 4-8, 2023), P. Kopyt (Member of the International Board of Reviewers).

- [Con16] *22nd International Workshop on Next Generation Nucleon Decay and Neutrino Detectors (Procida, Italy, Oct. 11-13, 2023)*, A. Rychter (participant).

- [Con17] *IEEE International Conference on Imaging Systems & Techniques (IST 2023)* (Copenhagen, Denmark, Oct. 17-19, 2023), D. Wanta (participant).

- [Con18] *Autumn School Series in Acoustics: ASSA 2023* (Eindhoven, the Netherlands, Nov. 5-10, 2023), A. P. Pietrzak (participant).

- [Con19] *Microwave Workshops and Exhibition (MWE 2023)* (Pacifico Yokohama, Japan, Nov. 29 – Dec. 1, 2023), P. Kopyt, B. Salski (speaker).

9.3 National scientific events

- [Con20] *Konferencja Radiokomunikacji i Teleinformatyki: KRiT 2023 (Radiocommunication and Teleinformatics Conference)*, (Cracow, Poland, Sep. 20-22, 2023), J. Modelski, G. Pastuszak, K. Snopek, Y.Yashchyshyn (members of the Programme Committee), V. Djaja-Joško, J. Kołakowski, M. Kołakowski, J. Sobolewski (speakers).

10. AWARDS AND DISTINCTIONS

State Medals

**Piotr Bilski, D.Sc.,
Robert Kurjata, Ph.D.**

Medal Komisji Edukacji Narodowej (Medal of the National Education Committee).

Awards of the Rector

Janusz Marzec, Prof. D.Sc.

Individual award for all the achievements.

Jan Żera, Prof. D.Sc.

Individual II^o award for the teaching achievements.

**Jakub Wagner, Ph.D.,
Paweł Mazurek, Ph.D.,
Roman Z. Morawski, Prof. D.Sc.,**

Team I^o award for the scientific achievements.

**Jacek Kryszyn, Ph.D.,
Waldemar Smolik, D.Sc.,
Damian Wanta, M.Sc.,
Mateusz Midura, M.Sc.,
Przemysław Wróblewski, M.Sc.**

Team I^o award for the scientific achievements.

**Augustyn Wójcik, Ph.D.,
Robert Łukaszewski, Ph.D.,
Piotr Bilski, D.Sc.,
Ryszard Kowalik, D.Sc.,
Bartosz Połok, M.Sc.,
Krzysztof Dowalla, Ph.D.**

Team II^o award for the scientific achievements.

**Jacek Cichocki, Ph.D.,
Jerzy Kołakowski, Ph.D.,
Vitomir Djaja-Joško, Ph.D.,
Marcin Kołakowski, Ph.D.**

Team II^o award for the teaching achievements.

**Piotr Krawiec, Ph.D.,
Jordi Mongay Batalla, D.Sc.,
Kajetana Snopek, D.Sc.,
Zuzanna Mazek
Anna Czarnecka, M.Sc.,**

Team I^o award for the organizational achievements.

**Jakub Wagner, Ph.D.,
Paweł Mazurek, Ph.D.,
Piotr Bilski, D.Sc.,**

Team I^o award for the organizational achievements.

Awards of the Foundation for the Development of Radiocommunications and Multimedia Technologies for the Best Ph.D. Thesis.

Jakub Sobolewski, Ph.D.

Degree with honours for the dissertation titled: "Selected issues of integration of sub-terahertz systems" (Wybrane zagadnienia integracji układów sub-terahercowych), supervisor: **Yevhen Yashchyshyn, Prof. D.Sc.**

Scholarships of the Foundation for the Development of Radiocommunications and Multimedia Technologies granted in 2023.

Jerzy Cuper

For preparing Ph.D. thesis.

**Mateusz Wrześniński
Agnieszka Piwowar
Aleksandra Krawczyk
Michał Papiewski
Aleksander Augustyniak**
For preparing M.Sc. thesis.

**Jan Sosulski
Piotr Baprawski
Piotr Polnau
Julia Szymła
Michał Kamiński
Michał Twarowski
Wojciech Hrycenko
Jakub Jędryś
Aleksandra Fabrycy
Kazimierz Roman
Krystian Mandecki
Andrzej Budny
Dominik Nuszkiewicz
Łukasz Słowik**
For preparing B.Sc. thesis.

11. STATISTICAL DATA (as of Dec. 31st of each year)

SPECIFICATION	2020	2021	2022	2023
academic staff [posts]				
total	56	54,5	58,75	58,9
Full professors	5,5	5,5	6,5	6,5
University professors	8	8	7	7
associate professors	1	1	1	2
assistant professors	30,5	31,5	38,25	39,4
readers	1	0	0	0
senior lecturers	2,5	0	0	0
assistants	7,5	9,5	7	6
Ph.D. students [persons]				
total	39	26	24	31
technical and administrative staff [posts]				
total	13,3	14,7	12,5	12,5
senior R&D associates	1	2	0	0
R&D associates	3,5	3,5	2	1
administrative associates	6,8	5,2	8	9
service workers	2	2	2	2
temporary staff [persons]	4	2	0,5	0,5
teaching activities				
basic courses	57	75	81	72
advanced courses	27	40	36	32
other courses	15	13	8	9
international projects, courses and lectures	1	2	6	4
research projects				
total	51	42	33	43
International granted by EU	4	3	2	3
granted by the Ministry	22	14	13	13
granted by the University	7	13	12	14
other	18	12	6	13
titles and degrees awarded				
Prof. titles	0	0	1	0
D.Sc. degrees	0	0	0	1
Ph.D. degrees	6	5	2	6
M.Sc. degree (regular studies + evening studies)	43+1	26	32	32
M.Sc. degree (studies in English)	0	0	0	5
B.Sc. degrees (regular studies + evening studies)	63+5	71	51+1	62
B.Sc. degrees (studies in English)	0	0	2	7
publications				
total	131	71	101	91
sci.-tech. books and chapters in books	2	1	5	5
sci.-tech. papers in journals - total	62	42	62	57
JCR-ICI list (IF>0)	52	37	59	57
in other journals	10	5	3	0
sci.-tech. papers in conference proceedings	59	17	32	18
other publications	8	11	2	11
patents and patent applications	2	3	3	9
international	0	3	1	1
national	2	0	2	8
research reports	24	19	3	16
scientific events attended by the staff	20	19	23	20

APPENDIX:

EXPLANATORY NOTE ON POLISH ACADEMIC AND PROFESSIONAL TITLES, DEGREES AND POSTS

This note contains the definitions of academic and professional titles, degrees and posts held by the staff of the Institute of Radioelectronics and Multimedia Technology.

The following professional titles are awarded by Polish higher-education institutions:

- the *inżynier (inż.)* title, translated here as **B.Sc.**, is awarded to the students completing undergraduate studies in the fields of study related to engineering and technology;
- the *magister (mgr)* title, translated here as **M.Sc.**, is awarded to the students completing graduate studies in the fields of study related to sciences;
- the *magister (mgr)* title, translated here as **M.A.**, is awarded to the students completing graduate studies in arts and humanities;
- the *magister inżynier (mgr inż.)* title, translated here as **M.Sc.**, is awarded to the students completing graduate studies in the fields of study related to engineering and technology.

The academic degrees, the *doctor* and *doctor habilitowany* degrees, are awarded by the scientific councils of higher-education institutions or other scientific institutions.

The degree of *doktor (dr)*, translated here as **Ph.D.**, is conferred on a person who:

- is the holder of the professional title of *magister* or *magister inżynier*;
- has successfully passed doctoral examinations in a selected research discipline;
- has submitted and successfully defended a doctoral thesis, favorably assessed by two reviewers.

The doctoral thesis, prepared under the supervision of a research adviser, should provide an original solution of a research problem and demonstrate general theoretical knowledge of the candidate in a given research discipline, as well as confirm his/her skills to conduct research work autonomously.

The degree of *doktor habilitowany (dr hab.)*, translated here as **D.Sc.**, is conferred on a person who:

- is the holder of the academic degree of *doktor*;
 - has remarkable scientific achievements;
 - has significantly contributed to the development of a given research discipline;
- and his/her contribution has been favorably assessed by four reviewers and approved by the scientific council of a higher-education institution or other scientific institution. The holder of the *doktor habilitowany* degree is authorized to be the advisor of Ph.D. students.

The academic title of *profesor (prof.)* is conferred by the President of the Republic of Poland. This title may be conferred on a person who:

- is the holder of the degree of *doktor habilitowany*;
- has scientific achievements significantly exceeding those required of *doktor habilitowany*;
- has remarkable academic achievements, including formation of academic staff.

The combination of the *profesor* title and the *doktor habilitowany* degree (**professor doktor habilitowany – prof. dr hab.**) is translated here as **Prof. D.Sc.**

The minimum requirements concerning the academic posts are as follows:

- for the post of *asystent*, translated here as **Assistant** – the professional title of *magister* or *magister inżynier*;
- for the post of *wykładowca*, translated here as **Lecturer** – the professional title of *magister* or *magister inżynier*;
- for the post of *starszy wykładowca*, translated here as **Senior Lecturer** – the *doktor* or *magister inżynier* degree;
- for the post of *docent*, translated here as **Reader** – the *doktor* degree;
- for the post of *adiunkt*, translated here as **Assistant Professor** – the *doktor* degree;
- for the post of *profesor uczelni*, translated here as **Associate Professor** – the *doktor habilitowany* degree;
- for the post of *profesor*, translated here as **Full Professor** – the professor title.

More details concerning academic and professional titles, degrees and posts may be found in the Act on Higher Education from 2018 (with further addendments)

