FACULTY
OF BIOMEDICAL
ENGINEERING
CTU IN PRAGUE

IEP On-Site Visit 2025
Excellence and Strategic Advancements at **Faculty of Biomedical Engineering**

Kladno, June 25, 2025

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Assoc. Prof. Ing. Jiří Hozman, Ph.D.

Vice-Dean for Development and External Relations, head of research team

Clinical applications of imaging systems and methods

prof. Ing. Karel Roubík, Ph.D.

Vice-Dean for International Relations and PR, head of Non-conventional Ventilatory Team, main inventor of CoroVent

Assoc. Prof. Roman Matějka, Ph.D.

Head of Bioreactors for tissue and organ replacements research team, PI at FBME of four reaserch projects supported from Czech Health Research Council

Václav Petrák, Ph.D.

Head of Nanosensors for Biomedicine research team, PI of bilateral Czech-American (USA) project

prof. Dr.-Ing. Jan Vrba, M.Sc.

Vice-Dean for Science and Research and Doctoral Studies, head of Bio-Electromagnetics research group, founder of CTU spin-off Tonagena

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IEP on-site visit schedule

1. FBME in numbers
2. FBME Evaluation Summary & Implementation of IEP Recommendations
3. Overview of our laboratories
4. Visit of selected labs

Appendix SWOT and selected R&D results and achievements of our faculty

Our motto: „From Engineering Principles to Biology and Medicine“

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

…was born as 7th faculty…

FBME at a Glance

FBME founded on 27th May 2005, 20th anniversary in 2025, 7th faculty within the CTU, young and dynamically growing → well established

The only one Faculty of Biomedical Engineering within the Czech Republic and Slovak Republic

One of the four technical university faculties accredited by the Ministry of Health to provide education for the professions of Biomedical Technician and Biomedical Engineer in the Czech Republic

From 2022 - Institutional accreditation in the field of education – healthcare disciplines

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Study programmes: Bc.-3 years, M.Sc.-2 years, Ph.D. – 4 years

Bachelor

- Biomedical Technology (CZ, EN)
- Informatics and Cybernetics in Health Care
- Medical Laboratory Diagnostics
- Optics and Optometry
- Paramedics
- Physiotherapy
- Radiological Assistance
- Safety and Population Protection

Follow-up Master

- Applied physiotherapy
- Biomedical and Clinical Informatics
- Biomedical Engineering (CZ, EN)
- Biomedical Laboratory Methods
- Civil Emergency Planning
- Systematic Integration of Processes in Healthcare (CZ, EN)

Doctoral

- Assistive Technology (CZ, EN)
- Biomedical Engineering (CZ, EN)
- Civil Emergency Preparedness

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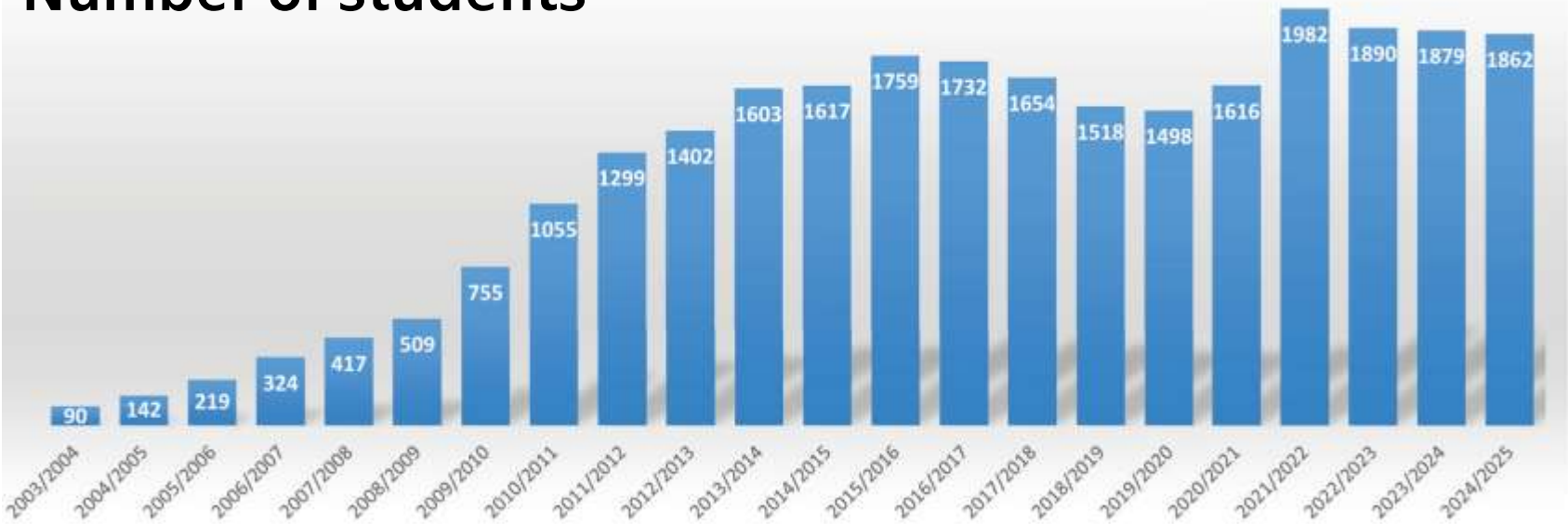
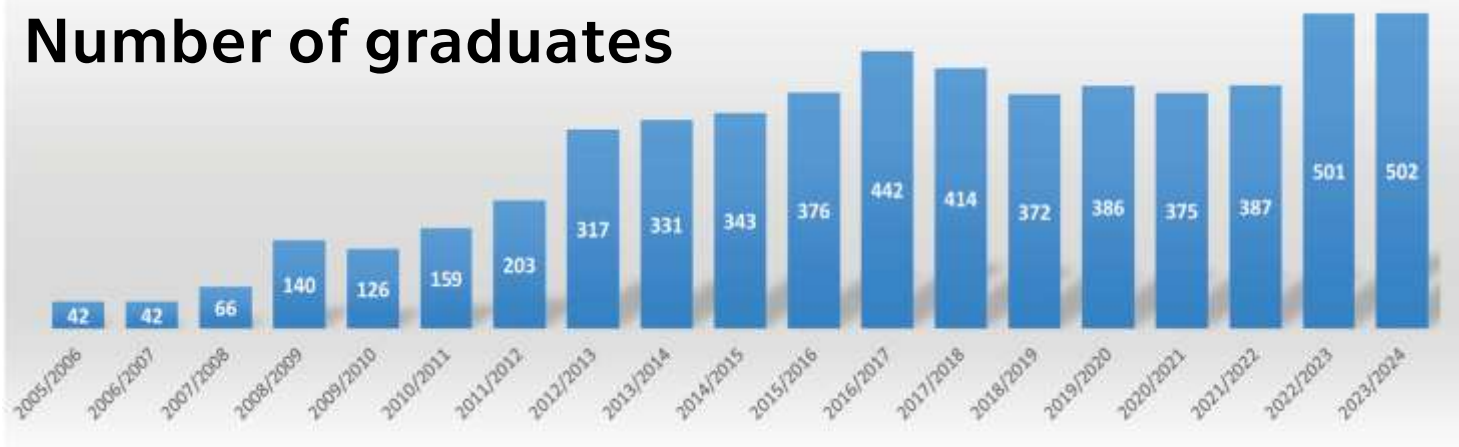
Number of students



Number of graduates



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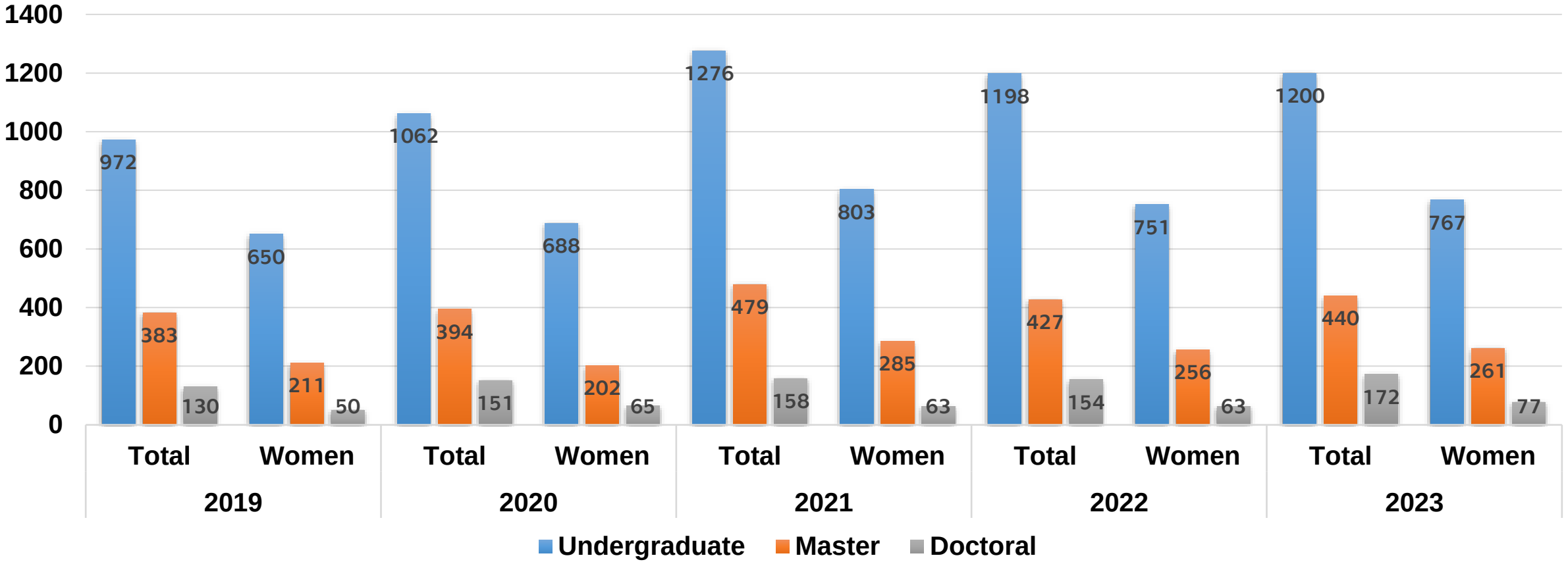
No. of FBME students in 2019-2023



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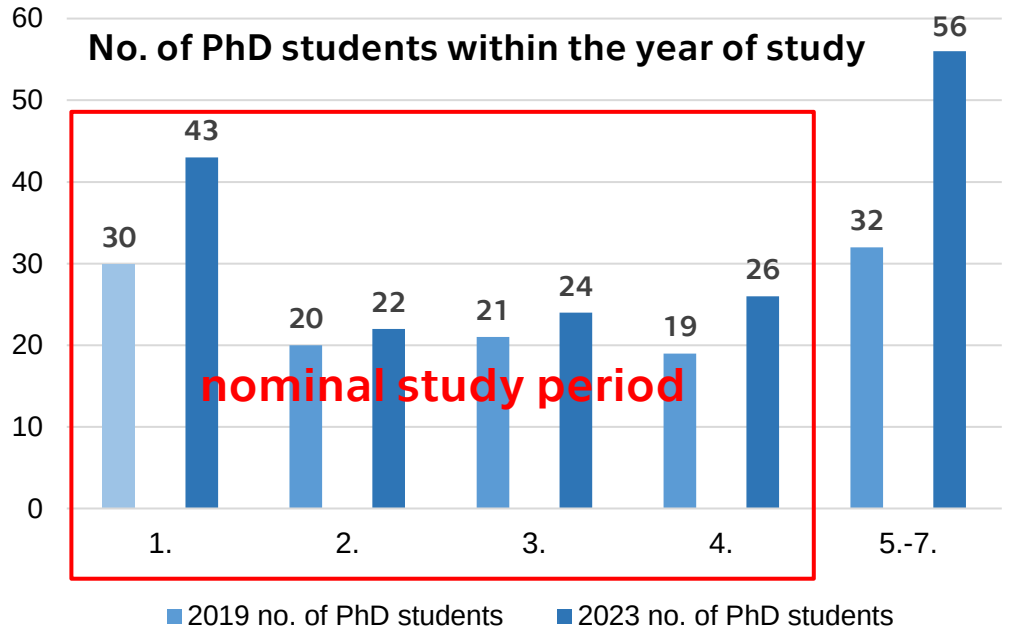
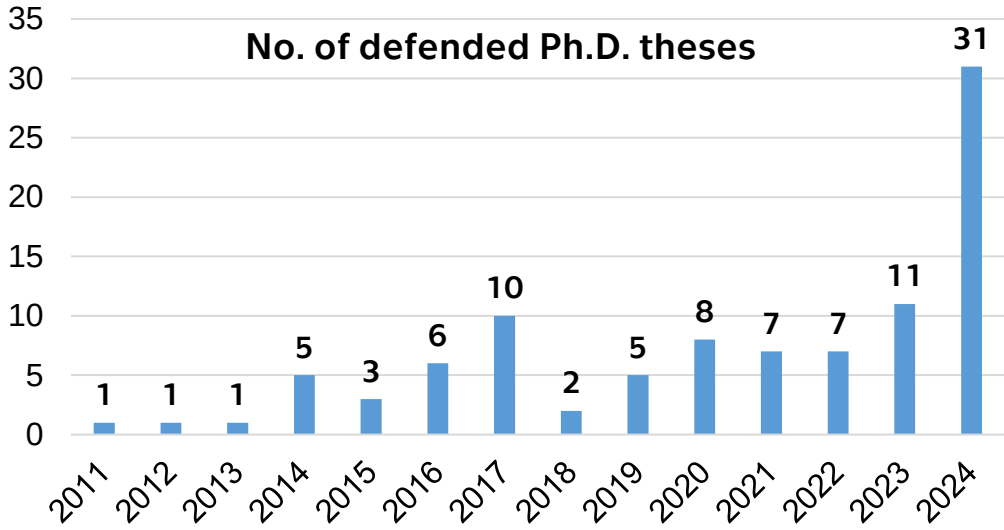
Doctoral Studies at FBME

- Around 9% of all FBME students, currently 172
- 2/3 programs also in English (EN)
- Full-time and part-time study
  - 40% in full-time
- Supported from ESF projects (infrastructure)
- Supported by research teams and projects
- More then 30 well-equiped research labs
- **Motivation system supporting publication activity**





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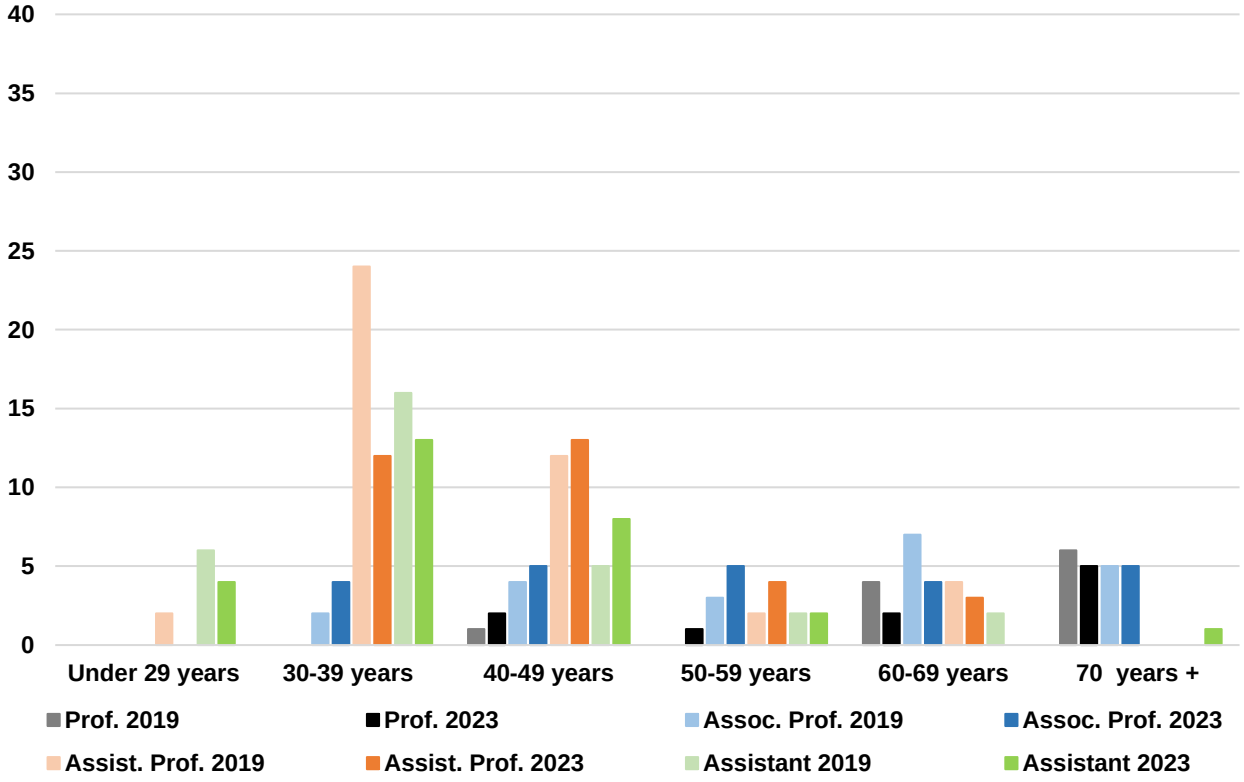
Academic Staff ≈172 FTE

FBME Departments:

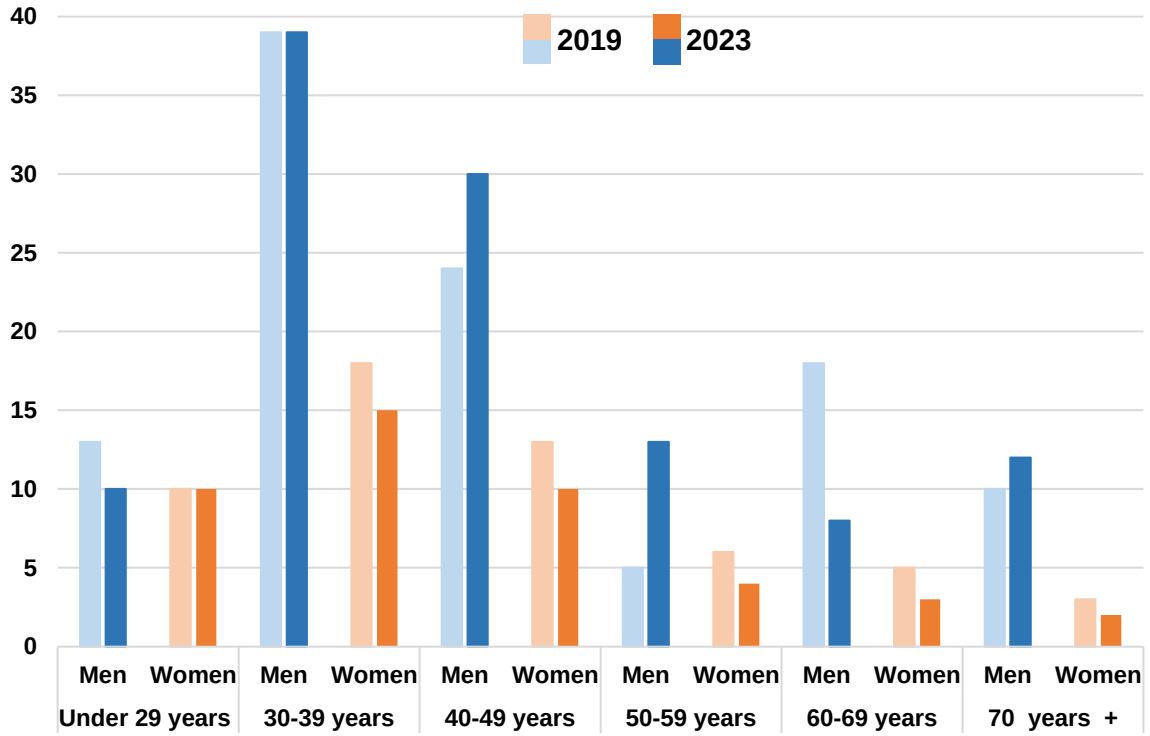
- Dept. of Biomedical Technology
- Dept. of Health Care and Population Protection
- Dept. of Natural Sciences
- Dept. of Biomedical Informatics
- Dept. of Information and Communication Technologies in Medicine

Academic Staff

FBME staff structure



FBME Staff and Gender Ratio



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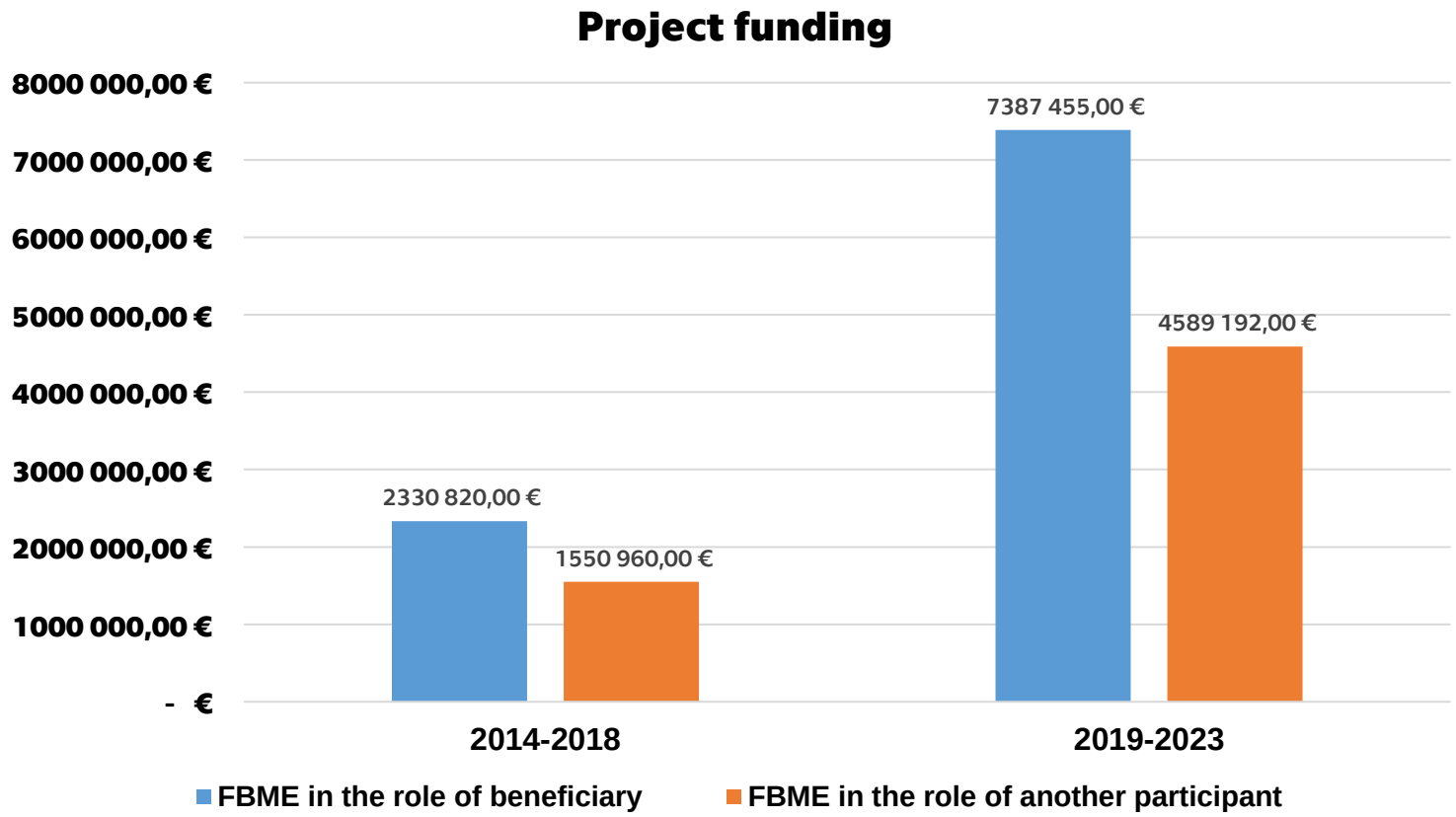
Research Funding Overview (2019–2023)

- Total projects: 62
- Total funding:
  11.98 million EUR

- Previous period total funding:
  3.88 million EUR



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GAČR CZECH SCIENCE FOUNDATION

Nationally Funded Projects

AZV ČR CZECH HEALTH RESEARCH COUNCIL

- Majority funded by Czech national agencies
- Key bodies: Czech Science Foundation (GACR), Czech Health Research Council (AZV)
  - **Acceptance rate: ~15%**
  - **Czech Science Foundation: 6 projects, 542,000 EUR**
  - **Czech Health Research Council: 8 projects, 523,000 EUR**

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Applied Research Projects

- Funding by Technology Agency, Ministries, and Municipalities:
  - **Prague Municipality: 2.37 mil. EUR**
  - **Technology Agency: 2.17 mil. EUR**
  - **Ministry of Interior: 1.95 mil. EUR**
  - **Ministry of Industry: 1.80 mil. EUR**
  - **Ministry of Education: 0.35 mil. EUR**

PRAHA PRAGUE PRAGA PRAG

T A C R
Technology Agency of the Czech Republic

MINISTRY OF THE INTERIOR OF THE CZECH REPUBLIC

MINISTRY OF INDUSTRY AND TRADE

MŠMT
MINISTRY OF EDUCATION, YOUTH AND SPORTS

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Development Projects

- Success in development grants
- Modern equipment for researchers and students
- Total funding: 2.03 mil. EUR

- Funding into research infrastructure (2025 - 2028): 3 mil. EUR

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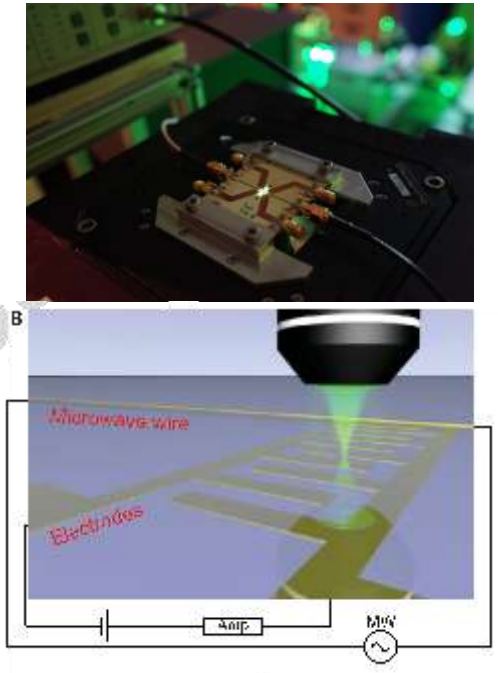
International Research Projects

FBME participats(ed) in:

- 1. H2020 Fast Track to Innovation (2019–2022): development of innovative cardiac implant
- 2. H2020 Marie Curie EMERALD (2018–2022): 14 PhD students, internships [msca-emerald.eu]
- 3. ERASMUS+ ITEM (2018–2022): math teaching innovation [item.uni-pr.edu]
- 4. COST Action CA17115 (2018–2023): hyperthermia [cost.eu]
- 5. Euramet (2023–2025): LF MRI systems [euramet.org]
- 6. Ministry of education of Czech Republic (2024-2026): Inter-Excellance II. Czech-USA: non-invasive correction of implanted intraocular lenses
  - **400 thous. EUR**
- 7. Interreg Central Europe (2024-2026): Microwave medical imaging
  - **2,5 mil. EUR/250 thous. EUR**
- 8. Horizon Europe: Diamond for Industry REady Quantum Technologies (2025-2029)
  - **25 mil. EUR/1.5 mil. EUR**



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2. FBME Evaluation Summary & Implementation of IEP Recommendations

- IEP Rating 2018-2022:
- - Excellent: 5 Categories
- - Very Good: 6 Categories
- Overall Rating: High end of 'Very Good'
- FBME implemented IEP recommendations to the maximum extent
- Focus on staff conditions and R&D support

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IEP Recommendations Overview

1. Increase publications in prestigious journals
2. Expand cardiovascular research
3. Focus research on selected topics
4. Broaden research scope & recruit staff
5. Encourage spin-offs
6. Intensify EU research cooperation
7. Collaborate with other CTU faculties

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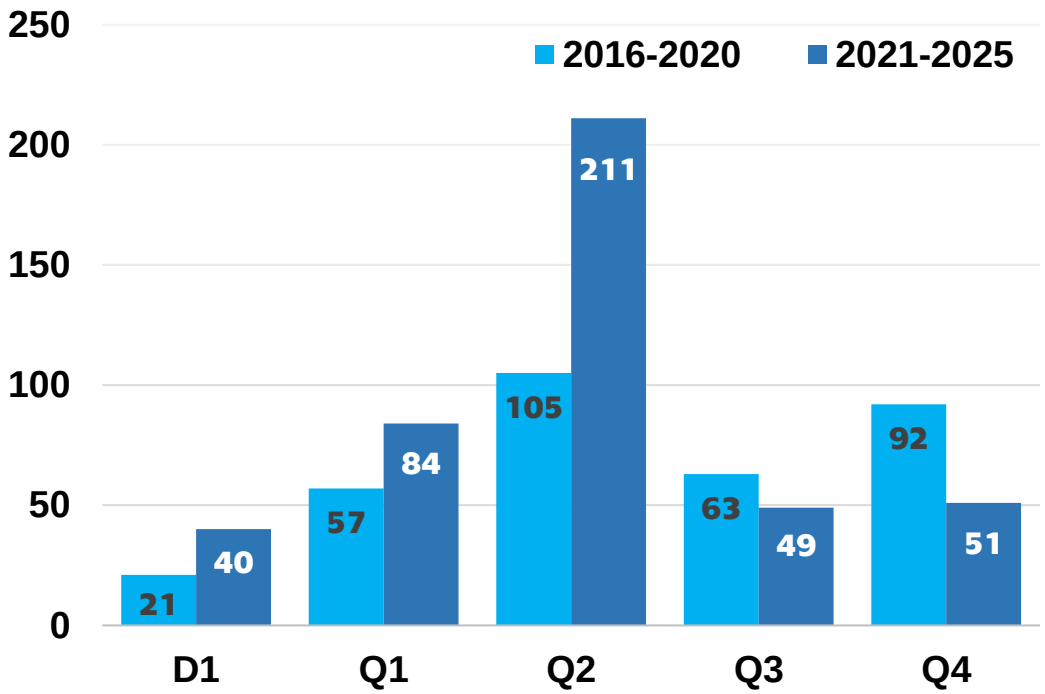
Implementation – 1: Publications

- Motivation System Introduced: Transparent rewards for R&D/publication
- Results:
- - WoS publications: 224 ➡ 465
- - Q1+Q2 journal share:

  46.9% ➡ 70.1%
- Staff Development (2014-18 and 2019-23):
- 6 ➡ 12 habilitations, 1 ➡ 2 professorships
  - Prof. Pavla Bojarová (2025)
- PhD Incentives: Better support and increased publication activity



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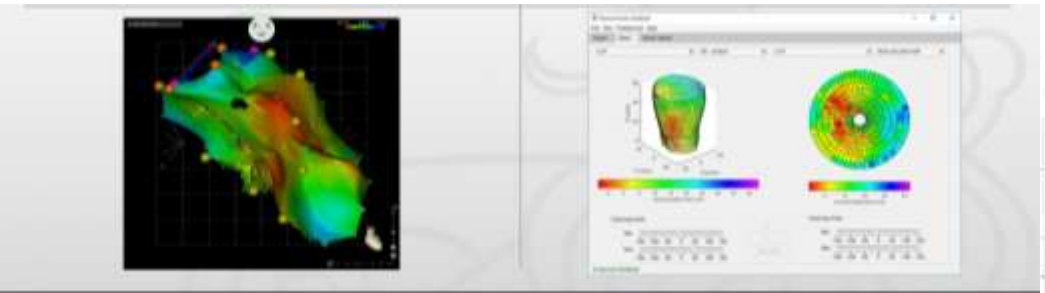
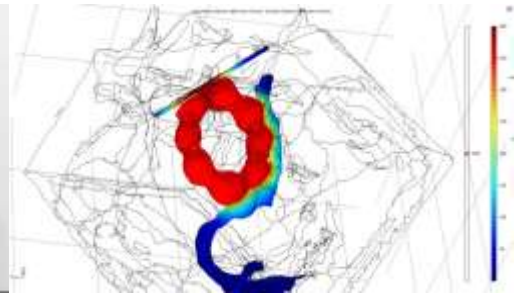
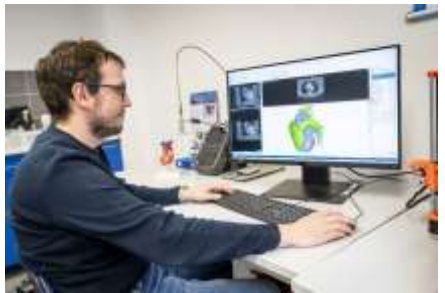
Implementation – 2: Expansion Cardiovascular Research

- 8 Research Teams and 10 activities
- Projects:
  - **LAA-Start H2020 with AuriGen Medical**
  - **Collaboration with Královské Vinohrady Hospital**
  - **Blood flow simulations with Faculty of Mechanical Engineering**
  - **…**







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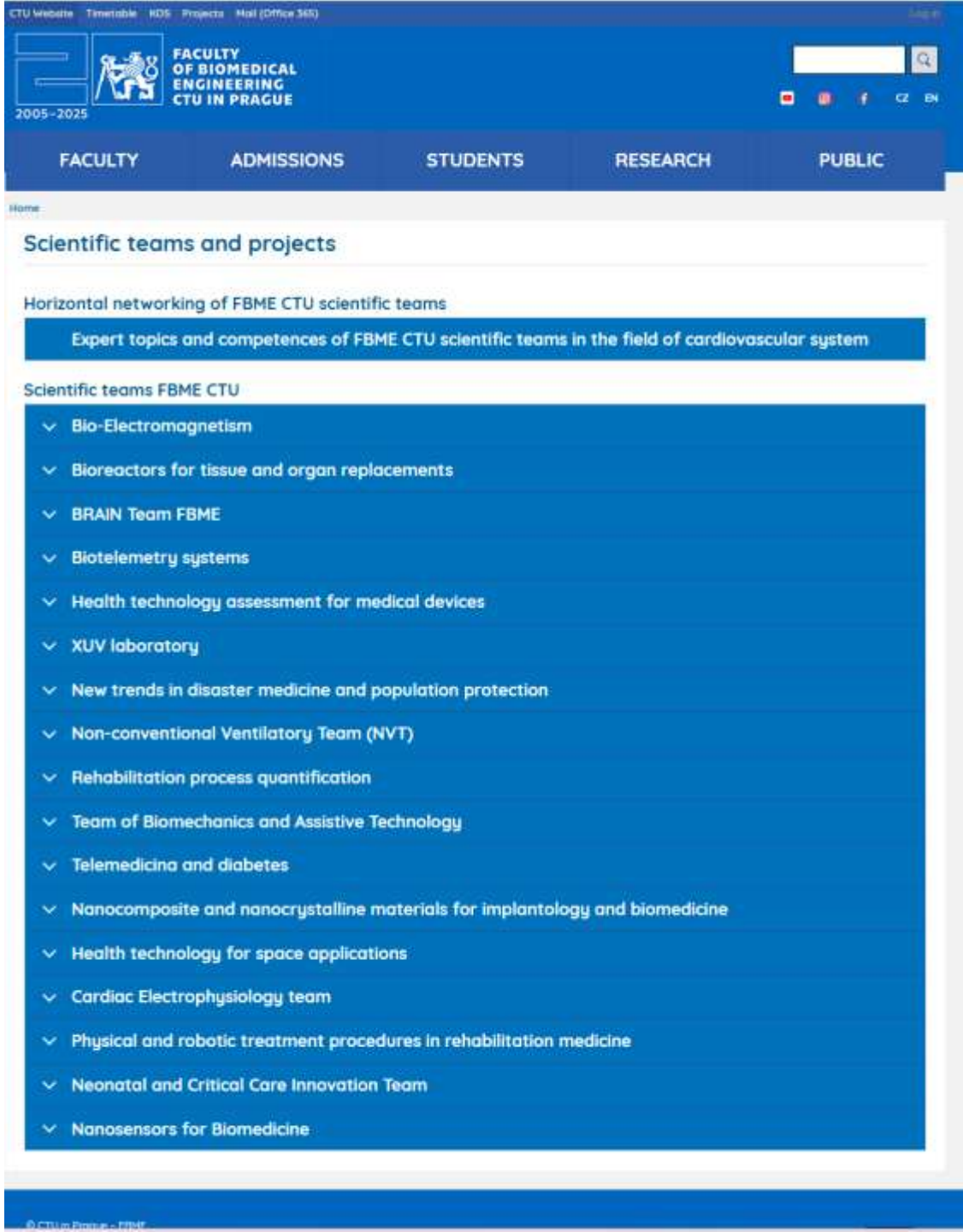
Implementation – 3: Focused Research Topics

- 17 research teams with different smart specialisations
- Challenge: Narrowing focus limited by current expertise
- Solution: Hire new experts to refocus research



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Implementation – 4: Staff Recruitment

- CTU received HR Excellence in Research award (2019)
- Ongoing recruitment aligned with CTU HR strategy
  - **Assoc. Prof. Aleš Tichopád**
    - **New research team**
    - **New research projects**
    - **Potentional new spin-off**
  - **Prof. Pavla Bojarová**
    - **Guarantor of the new follow-up master's degree program "Biomedical Laboratory Methods"**

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Implementation – 5: Spin-Off Support

- New CTU spin-off framework (2023)
  - **FBME contributed to framework development**
  - **CTU/FBME spin-off Tonagena founded as the first spin-off according to the new CTU framework**
- In August 2025
  - **CTU/FBME Start-up G-REC**

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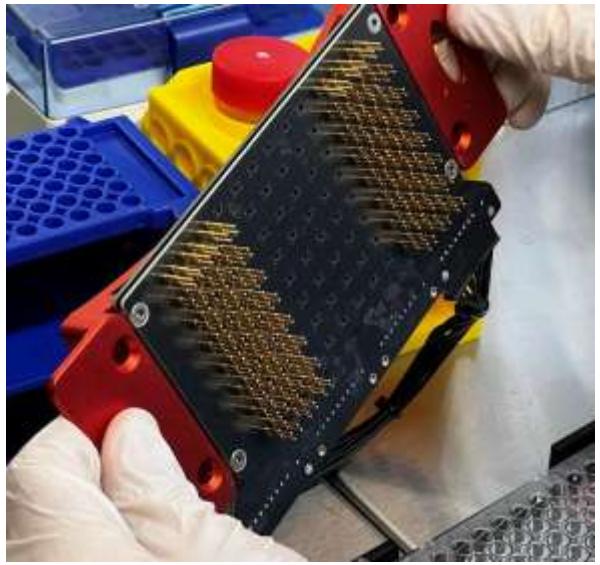
CTU Spin-off

Tonagena

- Established in 2023 by the Bioelectromagnetism team at FBME CTU as a hardware spin-off to commercialize advanced technologies
- **Product portfolio:**
  - **TonaPulse® system for in vitro electroporation of adherent cell cultures**
  - Radar and optical sensing for people counting and detection
- Early adopters and customers:
  - **3rd Faculty of Medicine, Charles University** – electroporation in cardiology
  - **Motol University Hospital** – electroporation for gene therapy research
  - **ADASTRA s.r.o.** – delivery of 30+ radar-based people counters with trajectory sensing for retail analysis
- Further capabilities
  - Custom development of microwave applicators and radar solutions – first deliveries of specialized hardware to medical device manufacturers.



https://www.tonagena.com/

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CTU Start-up G-REC

Who We Are

A start-up emerging from FBMI CTU.

A team of experts in biomedical engineering, signal analysis, and measurement system design.

Our Mission

To bring into practice an affordable, high-quality, and non-invasive solution for long-term monitoring of stomach and intestinal activity, complemented by the measurement of other biosignals such as ECG and EEG.

Why?

- Non-invasive measurement of gastrointestinal (GIT) signals is currently unavailable or of low quality.
- Clinical devices are expensive, difficult to access, and often involve uncomfortable procedures.
- We aim to enable broader research and clinical use of these valuable data.

What We Offer

- A multimodal device for monitoring GIT and other biomedical signals — at a fraction of the cost of clinical systems, while maintaining signal quality suitable for scientific research.
- Support for researchers: experiment design, measurement optimization, and data analysis.

G-rec aims to deliver a tool that enables researchers and clinicians to better understand the interactions between the function of the digestive tract and the nervous system.

Tonagena

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Implementation – 6: EU Research Participation

Staff encouraged to join COST projects

Key Projects:

- 1. H2020 Fast Track to Innovation (2019–2022): development of innovative cardiac implant
- 2. H2020 Marie Curie EMERALD (2018–2022): 14 PhD students, internships [msca-emerald.eu]
- 3. ERASMUS+ ITEM (2018–2022): Math teaching innovation [item.uni-pr.edu]
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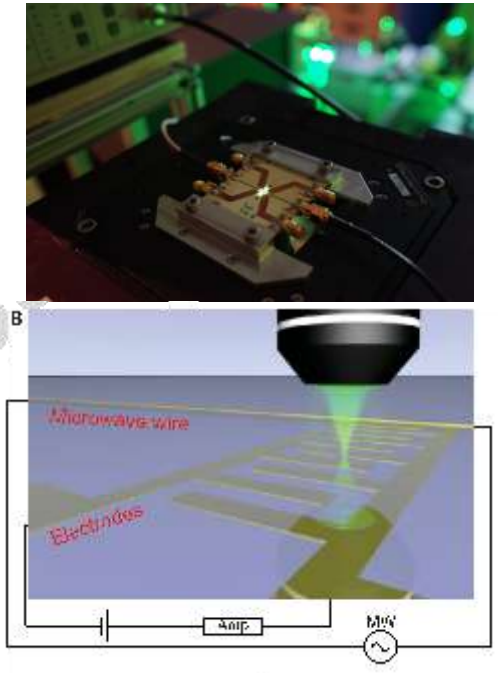

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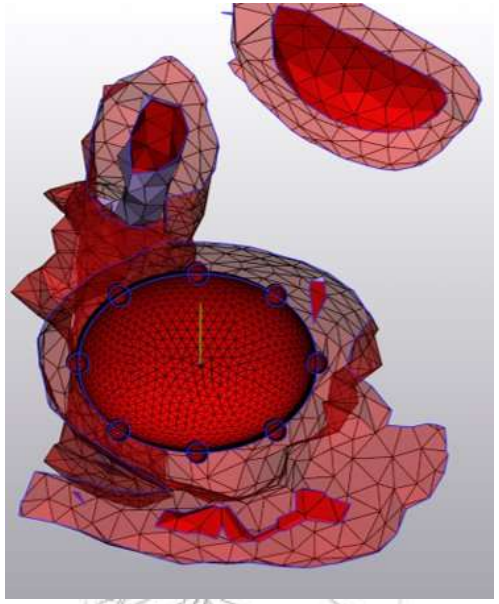
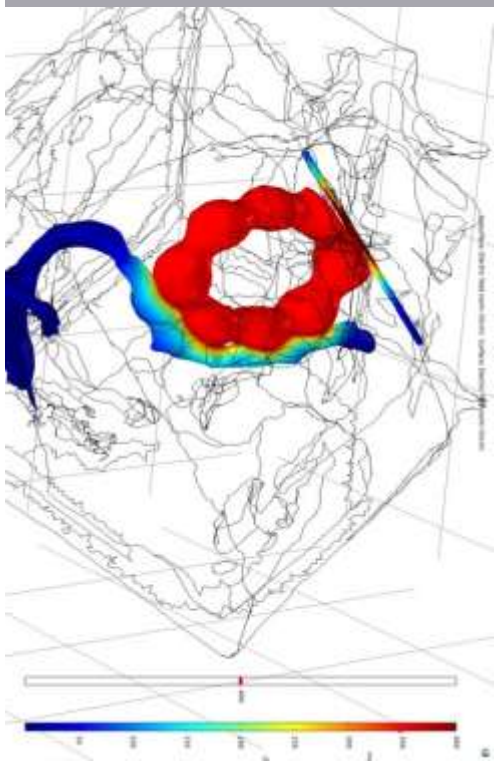
Left Atrial Appendage Electrical Isolation via Bio-photonic Optical Confirmation to Treat Persistent Atrial Fibrillation

European Project by Horizon 2020, Fast Track to Innovation,

ID: 831117, 2019-2022





Project Overview:

- International consortium of companies and universities from 3 countries
- Medical Objective: Target Condition: Atrial Fibrillation (AF) – affects 10M+ patients in EU/US
- Goal: Prevent stroke and heart failure by reducing clot formation in the Left Atrial Appendage (LAA)

Technological Innovation: Minimally invasive cardiac implant

- Electrically & mechanically isolates LAA
- Single-procedure permanent treatment

Academic Contribution (FBME Team): Designed & optimized RF ablation applicator geometry

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EURAMET

Low-field Magnetic Resonance Imaging (2023 +)

European Project by EURAMET: A4IM Affordable Low-Field MRI Reference System (2023-2025)

Project Overview

- Development of cost-effective MRI systems with B_0 = 50 mT.
- Collaboration with leading research institutions.

System Capabilities

- Designed for imaging the human head and limbs.
- Utilizes a Halbach magnet with ~2500 neodymium permanent magnets.

Key Advantages

- Compact and Lightweight compared to traditional MRI.
- Fully Passive Operation → low energy & maintenance costs.
- Implant-Safe → increased safety for more patients.

Global Impact

- Ideal for resource-limited settings, Offers a more accessible diagnostic solution worldwide.

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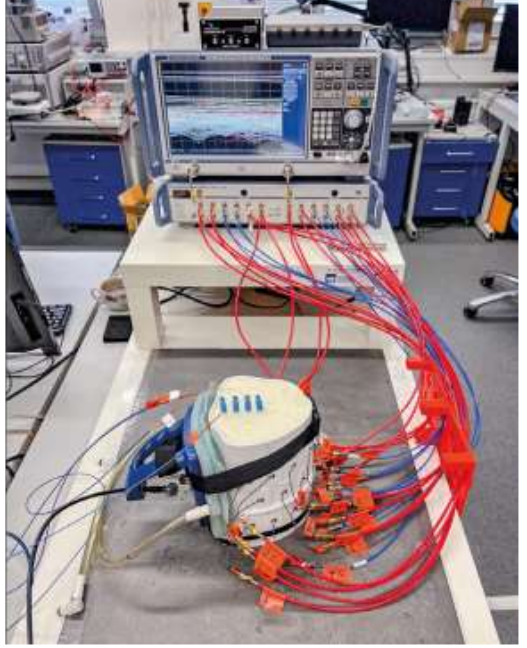
Interreg CENTRAL EUROPE

Co-funded by the European Union

MedWaveImage

Microwave imaging technology transfer to innovate the medical sector **(2024-2026)**



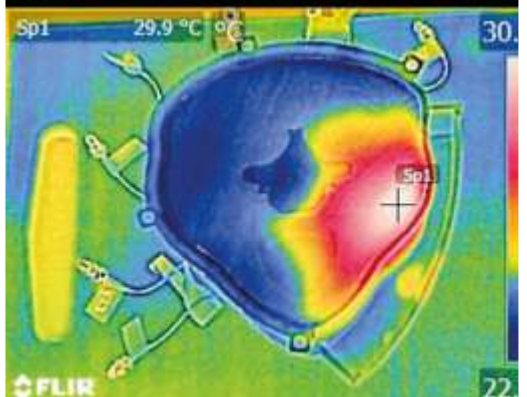
European Project by Interreg Central Europe: MedWaveImage

Transfer of cutting-edge technologies from universities to hospitals

Focus on microwave imaging and development of portable and cost-effective devices for:

- Breast cancer diagnostics
- Brain tissue monitoring after stroke
- Real-time Non-invasive Monitoring of Hyperthermia

Devices to be tested in hospitals



Lead partner

Polytechnic of Turin

Project partner

- Czech Technical University in Prague
- Technical University of Ilmenau
- Motol University Hospital
- Bulovka University Hospital
- Jena University Hospital
- Ilmsens GmbH
- E.P.F. ELETTROTECNICA SRL

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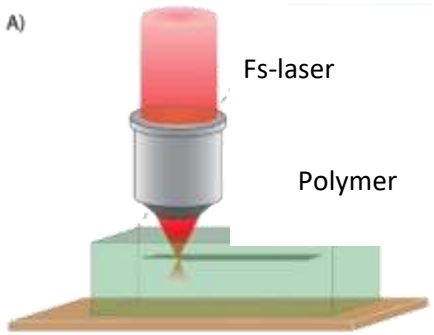
Fluorescence in femtosecond laser modified polymer materials

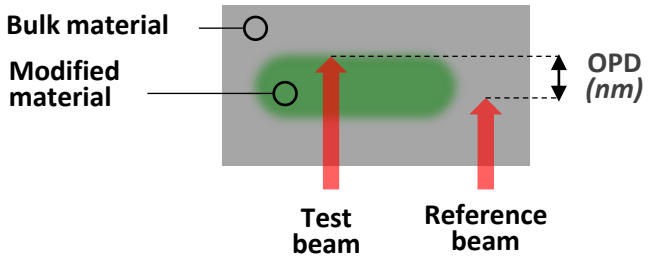
Fs-laser locally interacts with polymers

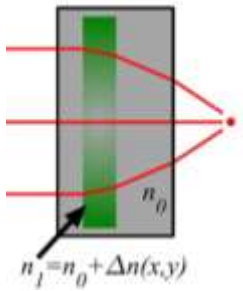
UNIVERSITY of ROCHESTER

The writing takes place within the material via multi-photon absorption



The interaction changes RI index, and allows for writing optical elements





The interaction induces fluorescence in exposed areas

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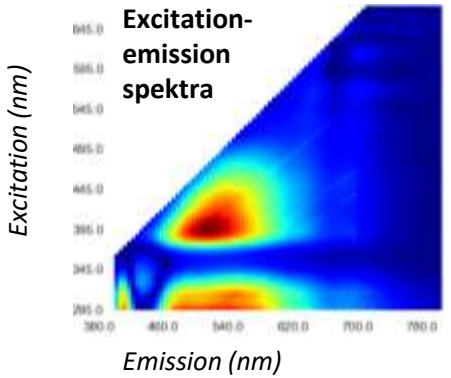
Fluorescence patterin of inscribed Fresnel lens



What we know

- The modified area exhibits changes in RI.
- There is an increase in water content.
- Free monomers are present after depolymerization.
- Fluorescence properties are altered following the modification

What we do not know:

- Which specific monomers are present after the modification?
- Is the modification stable, and when does it reach stability?
- What processes occur within the material after the modification?
- What causes the change in refractive index?

Why we should care? Fundamental understanding of a process with broad implications in ophthalmology; additional potential applications include memory devices, labeling, and calibration standards.

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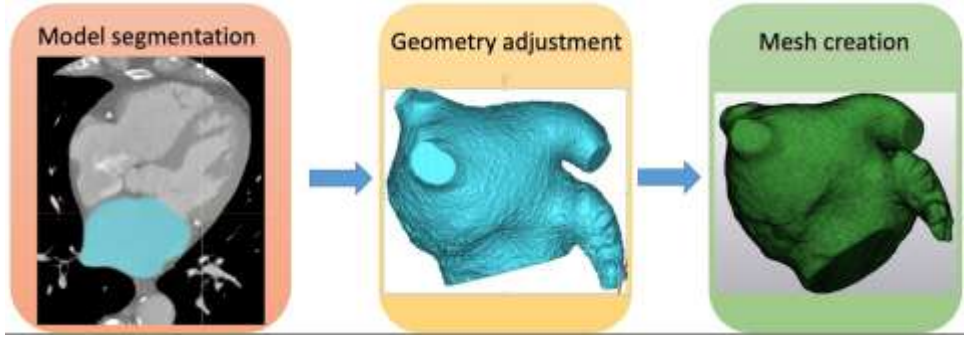

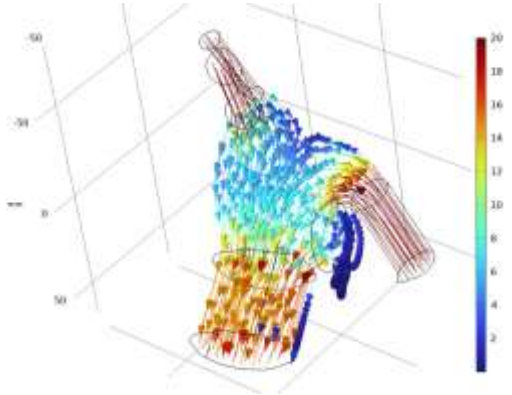

Implementation – 7: CTU Collaborations

- Collaboration with Faculty of Mechanical Engineering: Cardiovascular modeling
- Goal:
  - To investigate the relationship between cardiac hemodynamics and thrombus formation in the left atrial appendage (LAA) using patient-specific simulations.
  - Improve understanding of stroke risk in atrial fibrillation and support personalized treatment strategies.
- **Approach:**
  - Development of **numerical models** of blood flow in the heart of patients with arrhythmias.
  - Focus on flow patterns in the **LAA**, a key site for thrombus formation in atrial fibrillation.
- **Validation:**
  - **3D-printed heart models** are used for experimental validation at the **Faculty of Mechanical Engineering, CTU**.
  - Flow dynamics measured and compared with simulation outputs.
- **Clinical Collaboration:**
  - **Cardiology Clinic of the University Hospital Královské Vinohrady** provides:
  - Patient-specific data (e.g. imaging, rhythm characteristics).
  - Clinical interpretation of simulation results.

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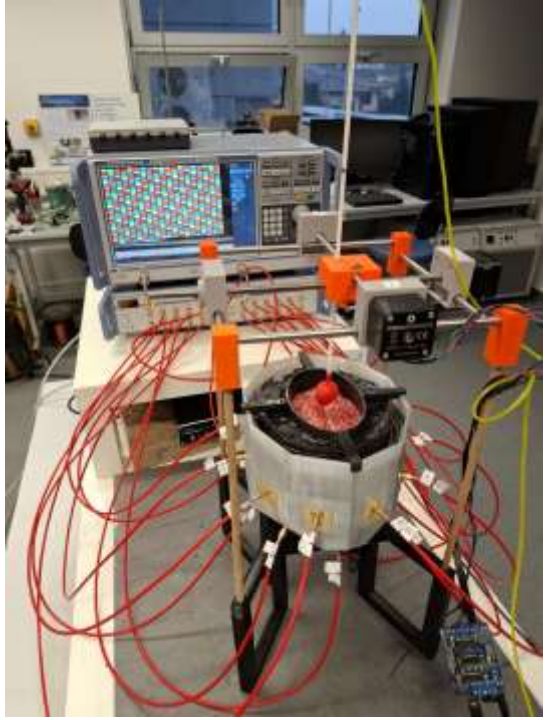
Implementation – 7: CTU Collaborations

- Collaboration with Faculty of Architecture:
- Goal:
  - **Joint development of a microwave helmet for pre-hospital stroke detection**
- **Design Contributions:**
  - Industrial Design students are creating a **functional prototype** with focus on **aesthetics** and **ergonomics**
- **Progress Update:**
  - **Design & sketching phase completed**
  - **Mechanical prototype (non-electrical)** in preparation
  - Prototype to aid in **custom coaxial cable fabrication**
- **Next Steps:**
  - Development of a **fully functional microwave system**
  - Planned **clinical trials** (e.g., during **TAVI procedures**) with at-risk patients



FACULTY
OF BIOMEDICAL
ENGINEERING
CTU IN PRAGUE

3. Modern Labs for FBME Students and Researchers

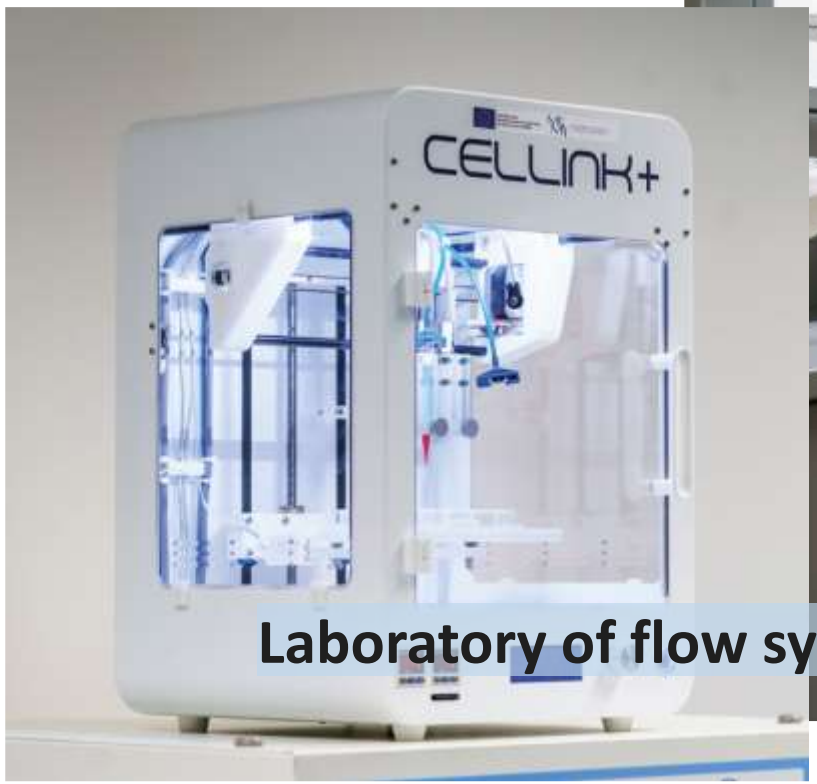
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Nanotechnology Laboratory

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

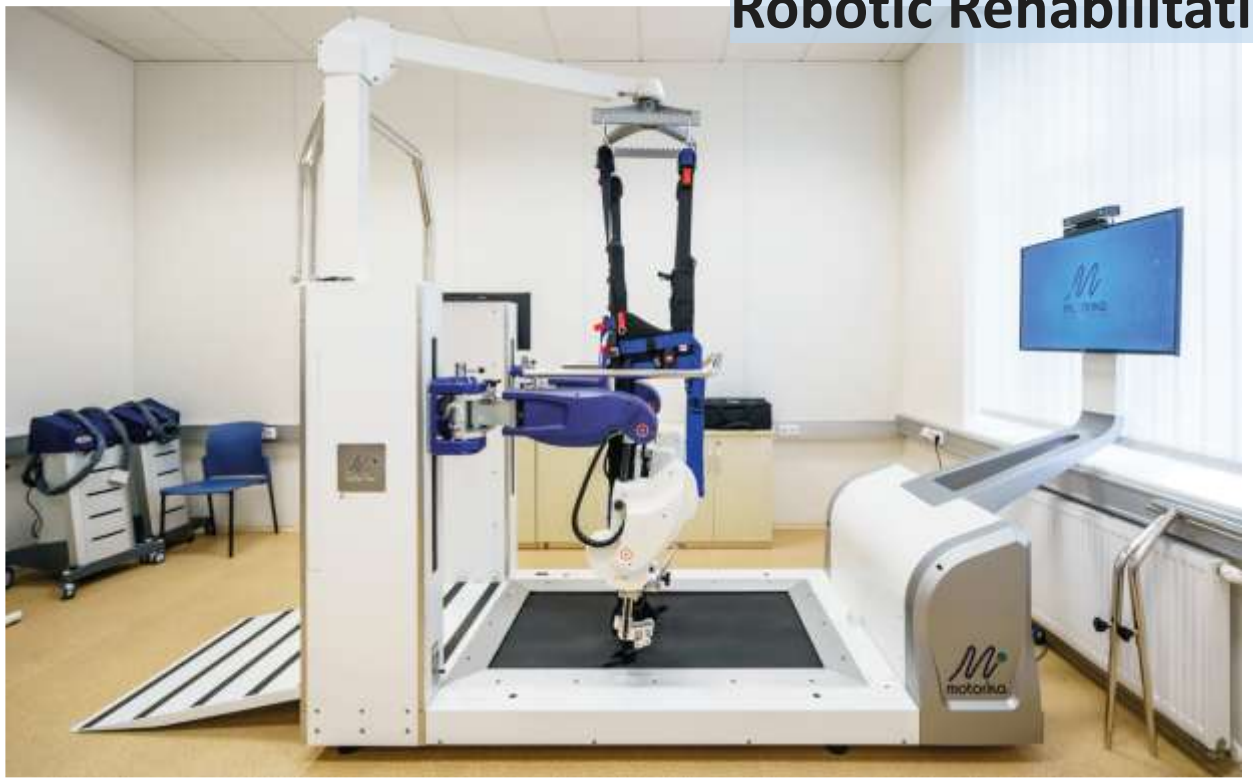


Laboratory of flow systems for tissue engineering and organ perfusion

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Robotic Rehabilitation Laboratory



FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Laboratory of anatomical models

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Laboratory of the unconventional artificial lung ventilation team

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

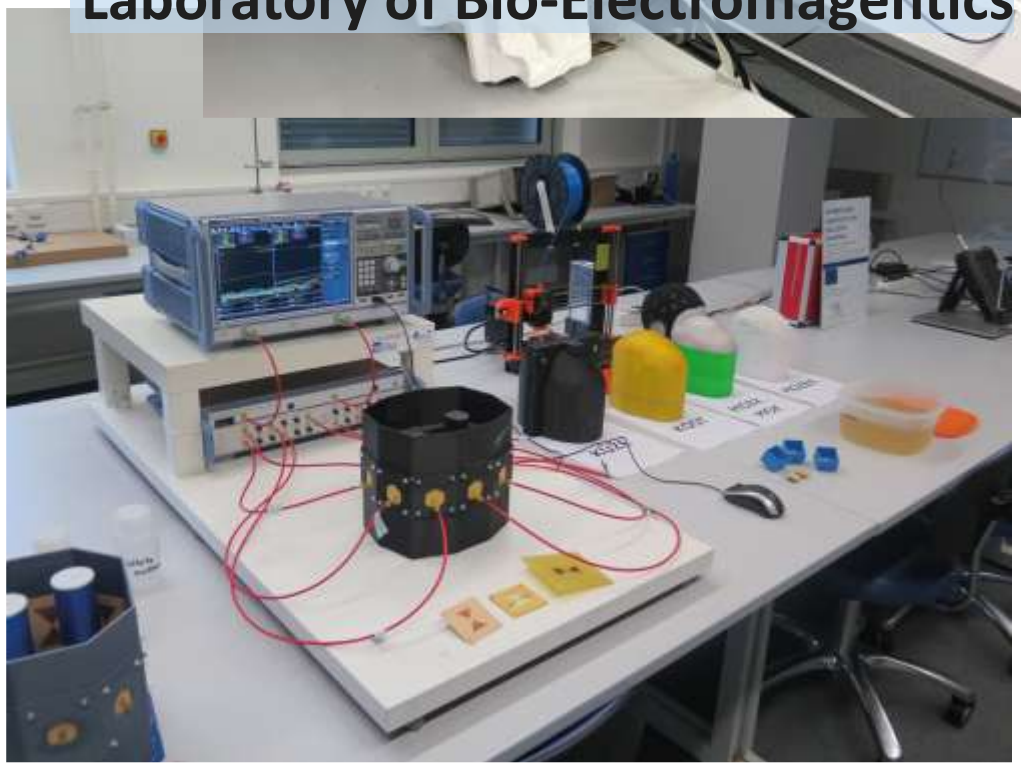
Simulated ICU and Patient Simulation Laboratory

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Laboratory of Bio-Electromagentics

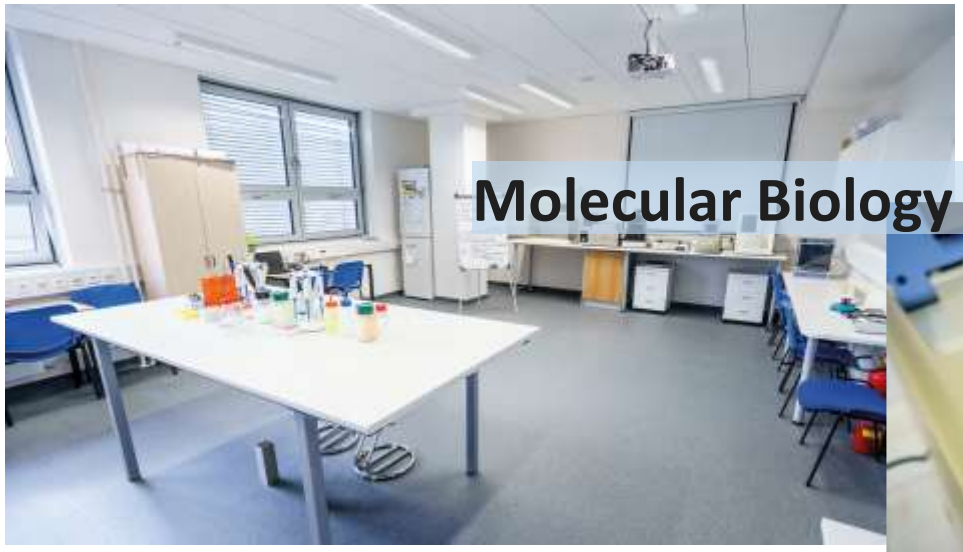
UVX Laboratory



FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Clinical laboratory



Molecular Biology Laboratory

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

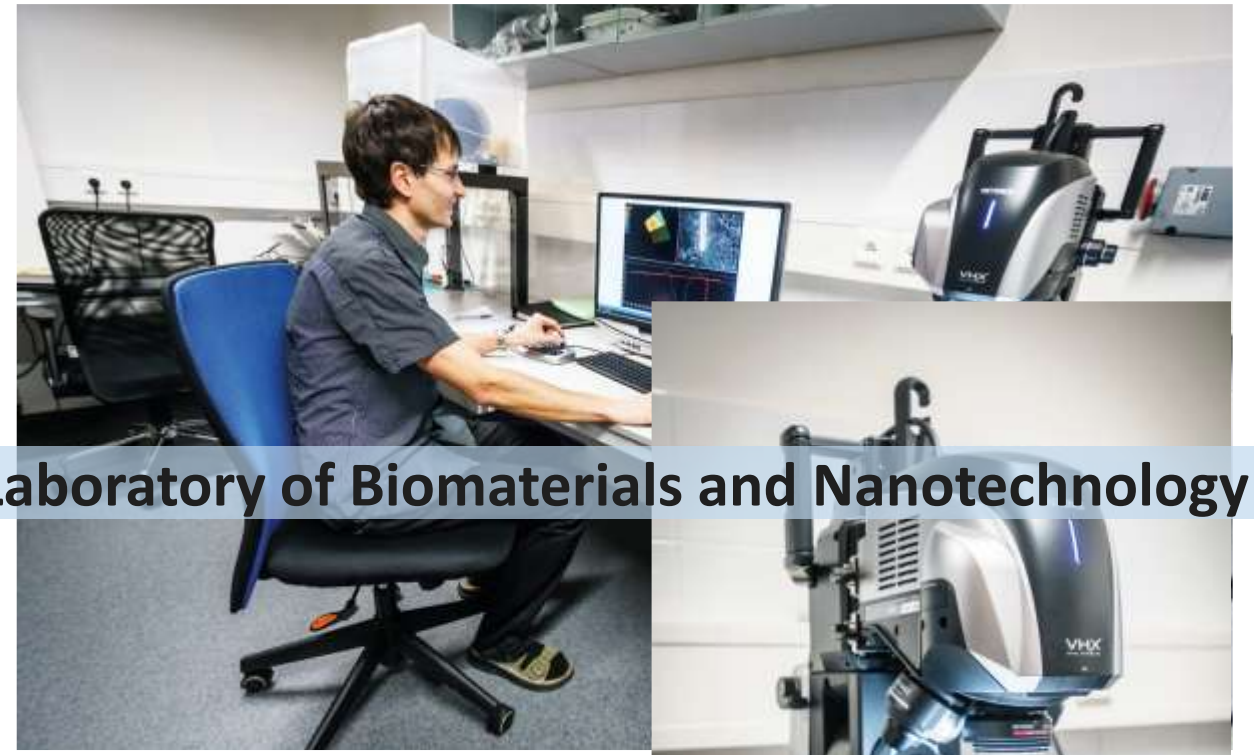
MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Professional classroom ambulance

Nursing professional classroom

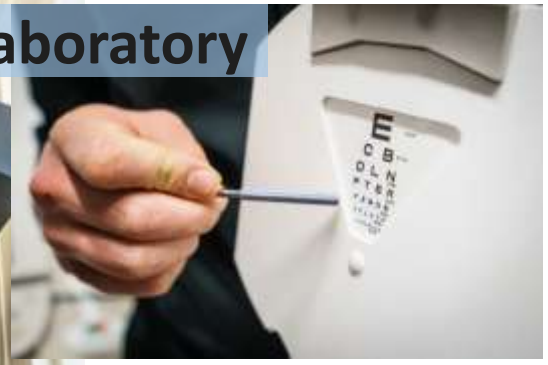
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS



Laboratory of Biomaterials and Nanotechnology

Contact lens laboratory



FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

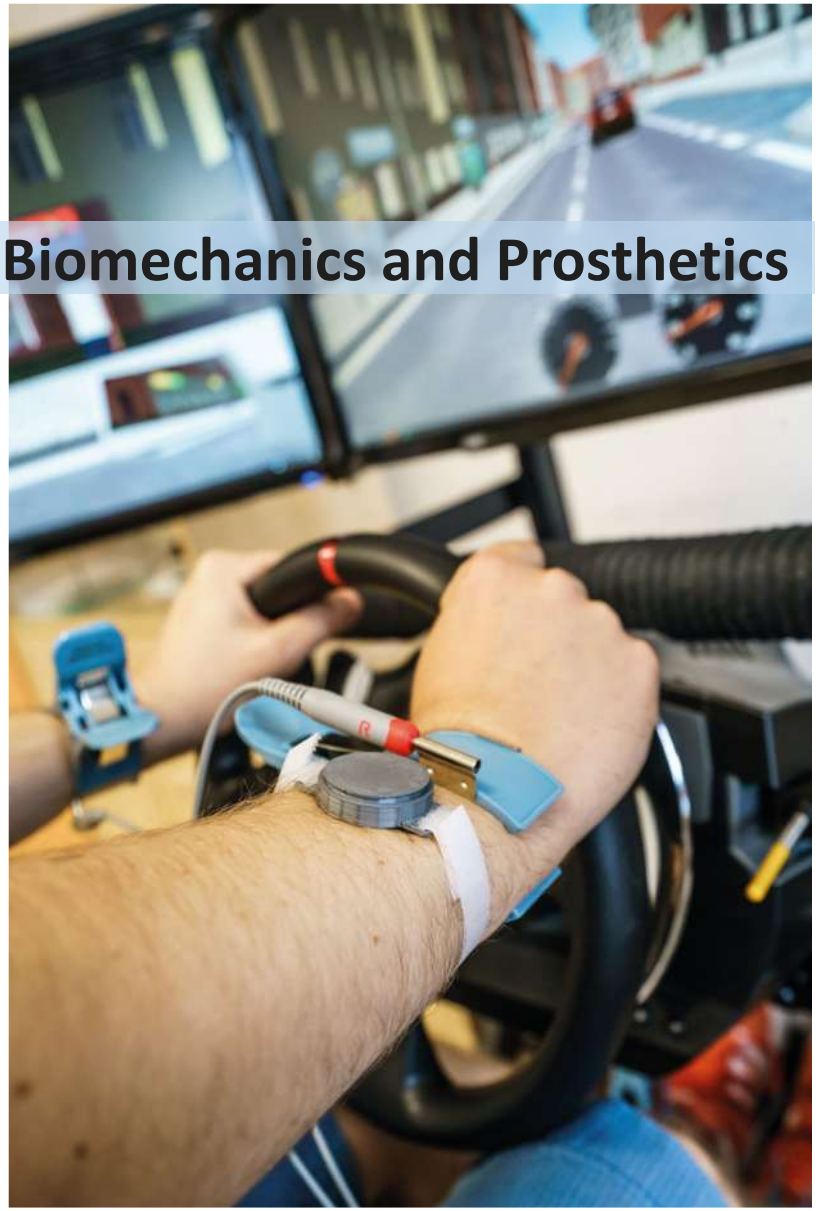
MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

Laboratory of simulation and practical methods for population protection

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

MODERN LABS FOR FBME STUDENTS AND RESEARCHERS

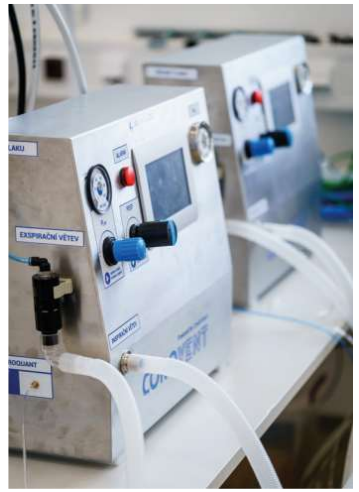
Laboratory of Biomechanics and Prosthetics

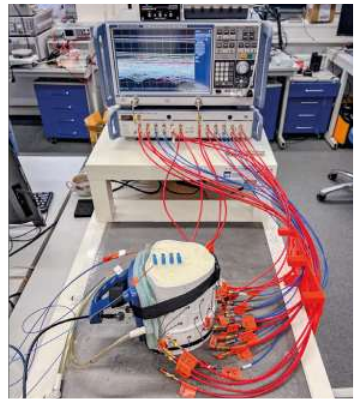


FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Invitation to visit selected labs

- **Laboratory of the unconventional artificial lung ventilation (CoroVent)**
- **Laboratory of flow systems for tissue engineering and organ perfusion**
- **Laboratory of Bio-Electromagentics**
- **Laboratory of Low-field Magnetic Resonance Imaging**





FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

...was born as 7th faculty...

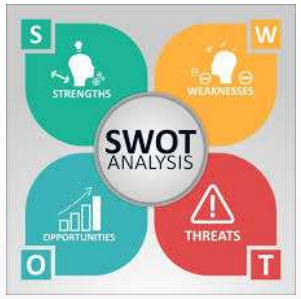
Appendix

SWOT and selected R&D results and achievements of our faculty

Our motto: „From Engineering Principles to Biology and Medicine“

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

...was born as 7th faculty...



SWOT Analysis of FBME

	HELPFUL (to achieve the objective)	HARMFUL (to achieve the objective)
INTERNAL ORIGIN (attributes of environment)	**STRENGHTS** • Faculty is very important part of the oldest and the high-quality technical university in CR • Quality academic and administrative staff • Sufficiency of young academic staff • New labs with modern and up-to-date technologies • Relatively stable and high number of applicants • Very good Kladno district geographical position support in EU projects competition • Faculty solutions highlights during covid-19 pandemic with long-term benefits for society • Clear faculty vision and strategy • The majority of study programmes with amount of practical and project oriented teaching • International cooperation • Aesthetics of the study environment, social meetings and students activities support	**WEAKNESSES** • A few aged professors • Low effectiveness of the selected staff self management • Lower motivation and discipline of selected students • Staff additional effort assessment with low financial motivation
EXTERNAL ORIGIN (attributes of environment)	**OPPORTUNITIES** • Wide faculty and relevant successes PR and communication • Higher number of applications of information and communication technologies in education • Strengthening teamwork • Projects with all departments included • High demand for our graduates • Very good conditions for applied research supported by projecst, labs, spin-off and HR	**THREATS** • New faculty accreditaion with the same scope • Decreasing of applicants number • Outflow of high-quality teachers and reseachers • Lower faculty budget • Legislation regulations changes affect faculty development

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

COROVENT - Emergency mechanical lung ventilator for COVID-19 pandemic

by the **„Ventilation Team“**, **led by Prof. Karel Roubík and his** PhD, MSc and Bc students

Produced and distributed by MICo Medical, ltd., company **(Třebíč, CZ)**
The design patented (patent pending) at the „Industrial Property Office“

United States Food and Drug Administration approval (Emergency Use Ventilators)

FDA U.S. FOOD & DRUG ADMINISTRATION

Approved for Use in the Czech Republic by Ministry of Health

Hack the crisis – 2nd prize: 80 000 EUR for further research

HACK THE CRISIS

Dept. of Anesthesia and CCM, Masarykova nemocnice, Ústí n. Labem

COROVENT

46 ventilators distributed to 15 hospitals (as of November 13)

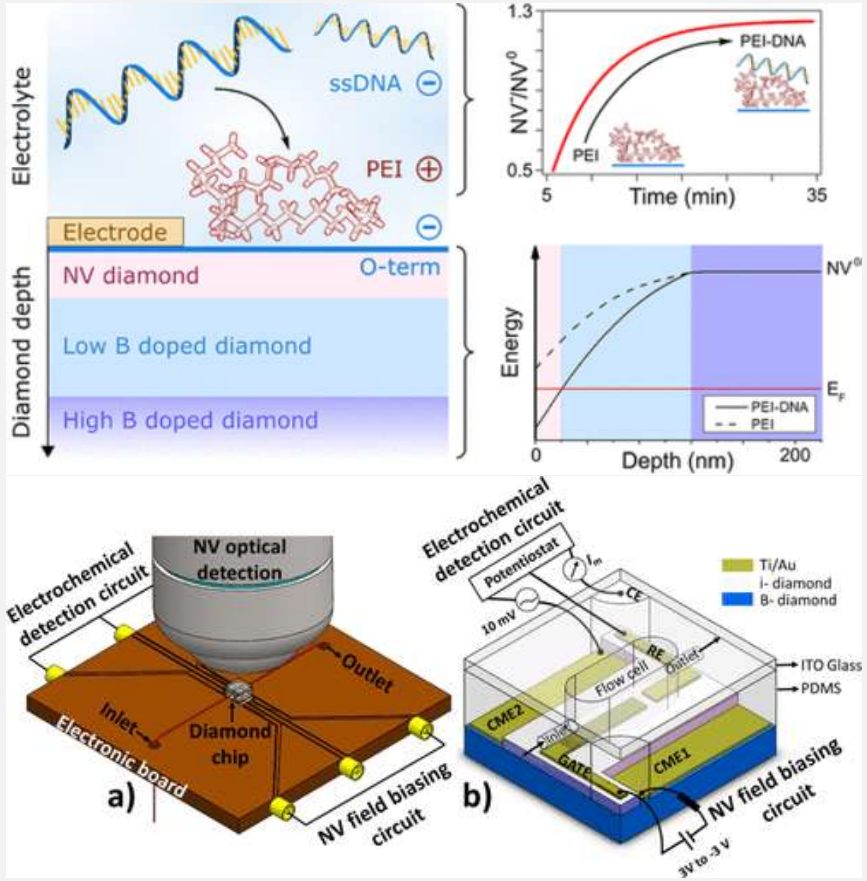
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

A Label-Free Diamond Microfluidic DNA Sensor Based on Active Nitrogen-Vacancy Center Charge State Control

by the Nano Group, Prof. M. Nesladek

A label-free biosensors are devices with a large potential in biochemistry and medical diagnostics. Especially, devices that can be integrated with electronic readout and semiconducting chips as of high interest. The bottleneck of such devices is often their selectivity to target molecules. The paper proposes a concept of ultrasensitive quantum sensor, based on the charge state manipulation of nitrogen-vacancy (NV) quantum color centers in diamond, combined with an electrochemical microfluidic flow cell sensor, constructed on boron-doped diamond. The proposed device allows an electrochemically tunable selectivity. We demonstrate the functionality of the device by performing label-free optical detection of DNA molecules. In this experiment, a monolayer of strongly cationic charged polymer polyethylenimine is used to shift the charge state of near surface NV centers from negatively charged NV– to neutral NV0 or dark positively charged NV+. Immobilization of negatively charged DNA molecules on the surface of the sensor restores the NV centers charge state back to the negatively charged NV–, which is detected using confocal photoluminescence microscopy. The use of the developed electrochemical device can also be extended to nuclear magnetic resonance spin sensing in which several or just single target molecules can be detected, opening a novel field of single molecular biosensors



Krečmarová, M.; Gulka, M.; Vandenryt, T.; Hrubý, J.; Fekete, L.; Hubik, P.; Taylor, A.; Mortet, V. et al. A Label-Free Diamond Microfluidic DNA Sensor Based on Active Nitrogen-Vacancy Center Charge State Control *ACS Applied Materials & Interfaces.* 2021, 13(16), 18500-18510. ISSN 1944-8244.

The paper has received 26 citations according to Web of Science and has 2991 full text views. The journal was at the time of publication Q1 in MATERIALS SCIENCE, MULTIDISCIPLINARY according both IF and AIS and Q1 in NANOSCIENCE & NANOTECHNOLOGY according both IF and AIS.

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

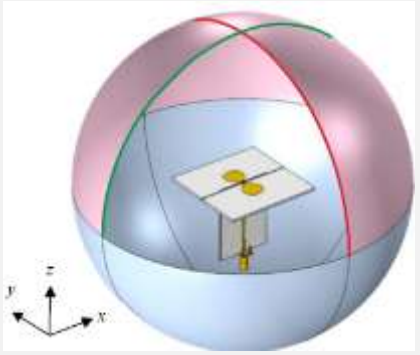
Selected excellent R&D results and achievements of our faculty

UWB Bowtie Antenna for Medical Microwave Imaging Applications

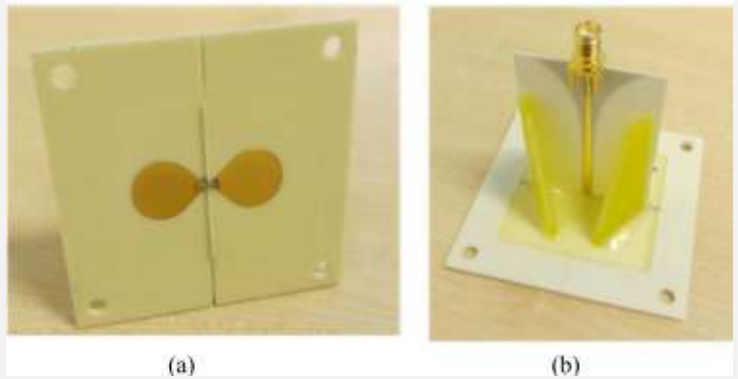
by the „Bio-Electromagnetism“ Research Team

Microwave imaging (MWI) is a non-destructive set of methods that use electromagnetic waves at microwave frequency band to obtain information about the distribution of the dielectric properties within the object being imaged. As dielectric properties of different biological tissues and their pathologies differ as well as they are frequency and temperature dependent, MWI could provide anatomical images or detect strokes, tumors, local heating of tissue, or inserted catheters. Antenna elements play a crucial role in MWI systems, as they are directly responsible for transmitting and receiving the electromagnetic waves that interact with biological tissues. The design, configuration, and performance of these antenna elements significantly impact the resolution, sensitivity, and SNR of the microwave imaging system. The paper “UWB Bowtie Antenna for Medical Microwave Imaging Applications” presents the design and experimental validation of a miniaturized ultrawideband (UWB) bowtie antenna paired with a UWB balanced-to-unbalanced (balun) circuit, optimized for medical microwave imaging (MWI) applications within the 1-6 GHz frequency band which provides sufficient resolution for most biomedical application of microwave imaging. The antenna demonstrates high radiation efficiency (over 80%) and minimal backward radiation, operating across an ultra-wide frequency band that enhances resolution and enables multi-frequency microwave tomography. The antennas with high effectivity are able to transmit higher energy and thus detect lower dielectric changes. Bowtie arms (crucial parts of antenna) were miniaturized by edge rounding which is beneficial in MWI systems with higher number of antennas. Smaller dipole arms dimensions have a positive influence on the antenna impulse response. Additionally, the compact size of the UWB bowtie antenna makes it suitable for integration into wearable devices, further expanding its potential applications in continuous patient monitoring and diagnostic tools.

Acknowledgment: This work was supported in part by Czech Science Foundation (GACR) through the project 21-00579S



Numerical model for calculation of antenna power efficiency and SAR simulation



Photograph of the fabricated antenna element: (a) front view and (b) top view.

Fišer, O.; Hrubý, V.; Vrba, J.; Dřížďal, T.; Tesařík, J.; Vrba, J.; Vrba, D.
UWB Bowtie Antenna for Medical Microwave Imaging Applications
IEEE Transactions on Antennas and Propagation. 2022, 70(7), 5357-5372.
ISSN 0018-926X.

JIF (2022) = 5.7 ENGINEERING, ELECTRICAL & ELECTRONIC = 80.2 Q1, TELECOMMUNICATIONS = 75.6 Q1, the paper has so far (3,5 years after publication) received 56 citations in Web of Science. It has 4750 full text views.

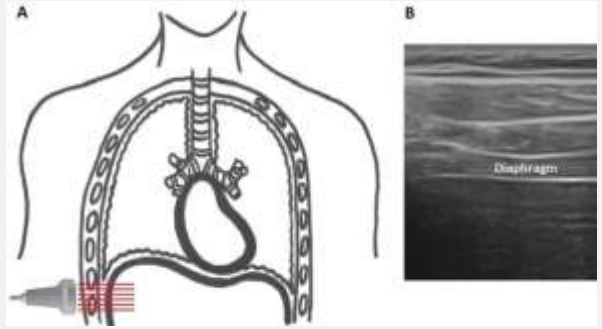
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

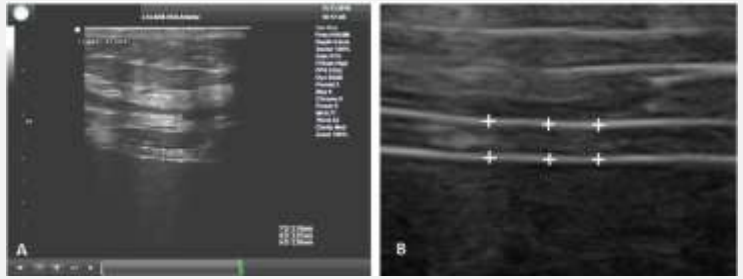
Phrenic Nerve Stimulation Prevents Diaphragm Atrophy in Patients with Respiratory Failure on Mechanical Ventilation

by the „Non-Conventional Ventilatory Team“ Research Team

The original research presented in this article demonstrates that induced contraction of the diaphragm by pacing the phrenic nerve not only reduces the rate of its atrophy during mechanical ventilation but also leads to an increase in its thickness, that is the main determinant of the muscle strength required for spontaneous ventilation and successful ventilator weaning. The presented result is part of a broad multidisciplinary and long-term research that combines technical and medical sciences. By its very nature, the project is a fusion of technical and medical disciplines. The technical disciplines implemented at CTU FBMI include the design of electrode systems, their manufacture, design of electrical circuits generating stimulation pulses, design and monitoring of correct electrode insertion using a newly designed ultrasound imaging system and other related issues. The medical disciplines within the project address the anatomical problems of the phrenic nerve stimulation method, safety, ensuring sterility, determining the level and timing of stimulation ensuring on the one hand enhancing function and averting diaphragm atrophy and on the other hand not causing adversarial effects in the form of muscle fatigue of the diaphragm, electrochemical effects to discomfort for the stimulated patient in case of limited sedation. For the above reasons, the project could not have been carried out without the cooperation of technical and medical departments. In addition to the above-mentioned collaboration of research departments focused on both technical and medical fields, the research is based on the cooperation of academic departments with the commercial sector represented by the American company Stimdia Medical (1355 Mendota Heights Road, Suite 300, Mendota Heights MN 55120), where both parties participate in the provision of research both financially and in terms of personnel, and last but not least in terms of experience, competence and technical and material equipment of the departments



Ultrasound linear probe orientation (a) and view of the diaphragm (b) identifed as a 3-layer structure comprised of two hyperechoic lines representing the pleural and peritoneal membranes and a middle hypoechoic layer representing the diaphragm muscle itself



Ultrasound measurement of the right side of the diaphragm, linear probe, 10 MHz (a), measurement was made from the middle of the pleural line to the middle of the peritoneal line (b) detail

Soták, M.; Roubík, K.; Henlin, T.; Tyll, T., Phrenic nerve stimulation prevents diaphragm atrophy in patients with respiratory failure on mechanical ventilation, ***BMC Pulmonary Medicine***. 2021, 21(1), ISSN 1471-2466.

This article has already received 37 citations in the Web of Science database and led to two other research studies and related publications.

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Agreement between the GAITRite (R) System and the Wearable Sensor BTS G-Walk (R) for measurement of gait parameters in healthy adults and Parkinson's disease patients by the Dept. of Biomedical Informatics

This study investigates the agreement between the GAITRite system, a well-established electronic walkway for gait analysis, and the G-Walk, a portable wearable sensor, in measuring spatiotemporal gait parameters in both healthy individuals and Parkinson's disease (PD) patients. The research addresses the increasing demand for wearable technology in clinical and everyday settings, especially for the continuous monitoring of gait, which is crucial for assessing mobility and progression in neurodegenerative disorders. The results indicate a high level of agreement between the two systems for parameters such as cadence, stride length, and speed, suggesting that the G-Walk system has potential utility in non-laboratory environments. However, systematic errors were noted in specific gait phases (stance, swing, double support, and single support), particularly among PD patients, which may limit the interchangeability of the two systems for these parameters. The study concludes that while the G-Walk sensor shows promise for capturing general gait characteristics in both healthy individuals and PD patients, caution is warranted when interpreting certain gait cycle phases. These findings underscore the need for further algorithmic refinement in wearable technology to ensure accurate phase detection and support expanded applications in remote patient monitoring. The research thus provides a solid foundation for future studies aimed at enhancing wearable sensor reliability for diverse clinical applications. The article offers significant contributions to the field of biomedicine by rigorously evaluating the compatibility and accuracy of wearable inertial sensors for gait analysis, particularly in the context of neurodegenerative diseases such as PD. This study addresses a critical gap in validating wearable technologies against established gold-standard systems like the GAITRite, traditionally confined to laboratory settings. By directly comparing the G-Walk sensor's measurements of spatiotemporal gait parameters to those of the GAITRite, the study provide valuable evidence supporting the potential of portable, non-invasive devices for monitoring gait in both clinical and everyday settings. The findings emphasize the promise of wearable sensors to accurately capture key gait metrics outside of controlled environments. However, the systematic errors observed in gait cycle phase detection for PD patients highlight an essential area for further refinement. This limitation opens avenues for subsequent research, particularly in enhancing sensor algorithms to address motion artifacts and improve the reliability of wearable technology in detecting subtle gait anomalies characteristic of neurological disorders. The implications of this research are considerable: it not only paves the way for increased patient autonomy through remote health monitoring but also sets the stage for developing tailored therapeutic interventions based on real-time data. By expanding the application of wearable sensors beyond laboratory settings, this research holds promise for worthwhile longitudinal patient tracking, early diagnosis, and precision medicine in neurology and rehabilitation.

Acknowledgment: The study was supported by Ministry of Health of the Czech Republic (AZV) [grant number 17-32318A]..

Vítečková, S.; Horakova, H.; Polakova, K.; Krupička, R. et al., Agreement between the GAITRite (R) System and the Wearable Sensor BTS G-Walk (R) for measurement of gait parameters in healthy adults and Parkinson's disease patients, ***PeerJ.*** 2020, 8 ISSN 2167-8359.

PeerJ is prestigious journal in the field [JIF (2020) = 2.98; MULTIDISCIPLINARY SCIENCES, JIF Percentile = 63.19, JIF Rank = 27/72, JIF Quartile = Q2;]. The paper has so far received 37 citations in Web of Science.

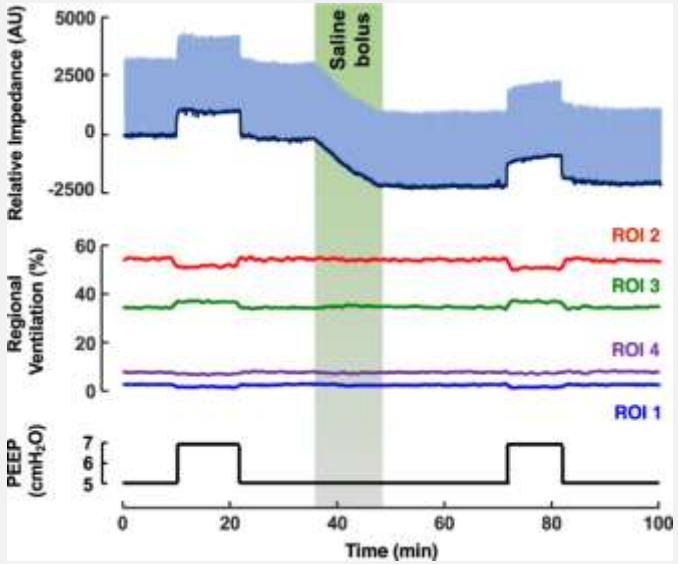
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Intravenous administration of normal saline may be misinterpreted as a change of end-expiratory lung volume when using electrical impedance tomography

by the „Non-Conventional Ventilatory Team“ Research Team

Electrical impedance tomography (EIT) is a noninvasive imaging modality that allows real-time monitoring of regional lung ventilation. The aim of the study is to investigate whether fast saline infusion causes changes in lung impedance that could affect the interpretation of EIT data. Eleven pigs were anaesthetized and mechanically ventilated. A bolus of 500 mL of normal saline was administered rapidly. Two PEEP steps were performed to allow quantification of the effect of normal saline on lung impedance. The mean change of end-expiratory lung impedance (EELI) caused by the saline bolus was equivalent to a virtual decrease of end-expiratory lung volume (EELV) by 227 (188-250) mL and decremental PEEP step of 4.40 (3.95-4.59) cm H2O (median and interquartile range). In contrast to the changes of PEEP, the administration of normal saline did not cause any significant differences in measured EELV, regional distribution of lung ventilation determined by EIT or in extravascular lung water and intrathoracic blood volume. In conclusion, EELI can be affected by the changes of EELV as well as by the administration of normal saline. These two phenomena can be distinguished by analysis of regional distribution of lung ventilation.The objective of this study was to design and validate a temperature-dependent numerical model of the cortex for assessing the heating that occurs during the novel ESM paradigm developed in the Motol Epilepsy Center, Prague. The model was optimized using data obtained through actual intraoperative thermographic measurements. The simulation results confirm that the thermal impact of the novel ESM method is non-destructive and thereby corroborate the safety of the protocol.



Typical changes of end-expiratory lung impedance and regional ventilation during the animal trial. Top graph: End-expiratory lung impedance (EELI) trend (dark blue) was determined as local minima of the relative impedance waveform (light blue). Middle graph: distribution of ventilation in the pre-defined regions of interest (ROIs). Bottom graph: time course of positive end-expiratory pressure (PEEP) during the trial.

Sobota, V.; Müller, M.; Roubík, K.
Intravenous administration of normal saline may be misinterpreted as a change of end-expiratory lung volume when using electrical impedance tomography
Scientific Reports. 2019, 9 ISSN 2045-2322.

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

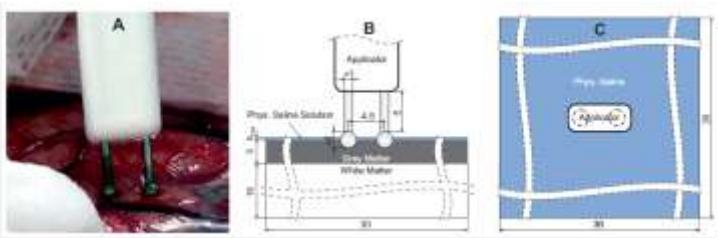
Assessing the Risk of Thermal Damage of Brain Tissue during Direct Cortical Stimulation

by the „Bio-Electromagnetism“ Research Team

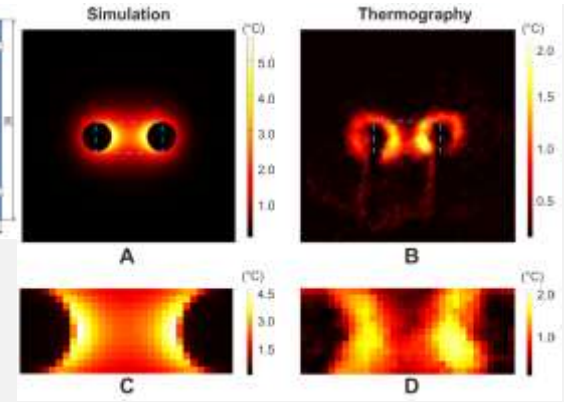
To assess the risk of thermal damage to brain tissue during electrical stimulation (e.g., during cortical mapping in epilepsy surgery), no current method allows temperature measurement under stimulation electrodes with sufficient temporal and spatial resolution. The only viable approach is multiphysics numerical simulations, developed by the Bio-Electromagnetism team at FBMI CTU. In this study, a comprehensive anatomically, dielectrically, and thermally realistic numerical model of the brain surface and stimulation electrodes was created in collaboration with the Faculty of Electrical Engineering, CTU in Prague, and Motol University Hospital.

This model enables coupled electro-thermal simulations to evaluate the risk of thermal damage. A methodology using the Arrhenius integral was applied to assess the time-dependent spatial temperature distribution in brain tissue. The model was used to analyze a novel paradigm of electrical stimulation mapping (ESM) applied during neurosurgery in pediatric epilepsy patients, where conventional ESM methods failed. The new ESM approach uses short, high-intensity, high-frequency pulses.

The model was optimized using measured electrode resistances and validated by comparing simulated and intraoperatively measured brain surface temperatures. Results showed that the thermal impact of the new ESM paradigm is non-destructive. The simulations aligned with prior thermographic and histopathological data, confirming the safety of the method. The goal of the study was to develop and validate a temperature-dependent numerical model to assess heating during this novel ESM protocol, which was verified using intraoperative thermographic data.



(A) Photograph of Ojemann's stimulation electrode during ESM, (B) and (C) side and top view of the computational domain (the grip of the applicator is not included in the numerical model).



Maximum differential temperature comparison of the simulation (A, C) and the thermographic measurement (B, D) of cortex surface after applying 100mA ESM. (C) Average in 33 ms time-window in simulation and resolution downsampling simulated the thermo-camera subsampling (30 fps, 0:15 0:15mm=pixel). Dotted blue squares mark region of detail.

Acknowledgment: This work was supported by a grant of the Czech Health Research Council, Czech Republic, project no. 15-30456A.

J. Vrba, D. Vrba *et al.*, Modeling of Brain Tissue Heating Caused by Direct Cortical Stimulation for Assessing the Risk of Thermal Damage, ***IEEE Transactions on Neural Systems and Rehabilitation Engineering***, vol. 27, no. 3, pp. 440–449, Mar. 2019.

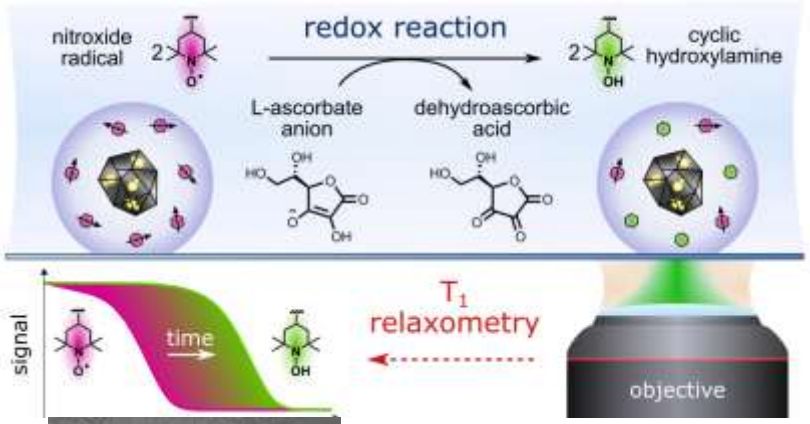
J. Vrba, J. D. Vrba, et al., Novel Paradigm of Subdural Cortical Stimulation Does Not Cause Thermal Damage in Brain Tissue: A Simulation-Based Study ***IEEE Transactions on Neural Systems and Rehabilitation Engineering***. 2021, 29(1.3.2021), 230-238. ISSN 1534-4320.

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Nano Group, Prof. M. Nesladek

Nanodiamonds for quantum detection in cells



SCIENTIFIC REPORTS
nature research

Simultaneous label-free live imaging of cell nucleus and luminescent nanodiamonds

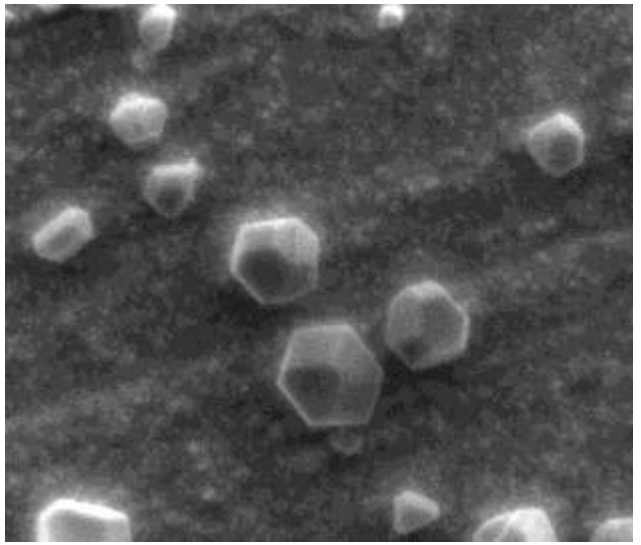
2020

Michal Gulka[1,2,12], Hamideh Salehi[3,9], Bela Varga[1,4], Elodie Middendorp[3], Orsolya Pall[5], Helena Raabova[6], Thierry Cloitre[6], Frederic J. G. Cuisinier[3], Petr Cigler[5], Milos Nesladek[1,7] & Csilla Gergely[8]

Development of NMR methodology for ultrasensitive molecular detection in nano-resolution cells

Fig. Nanodiamonds prepared by the Chemical Vapor Deposition (CVD) method

Cooperation with the University of Hasselt, Belgium



ACS NANO

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Nanoscale Dynamic Readout of a Chemical Redox Process Using Radicals Coupled with Nitrogen-Vacancy Centers in Nanodiamonds

Jan Barton,◆ Michal Gulka,◆ Jan Tarabek, Yuliya Mindarava, Zhenyu Wang, Jiri Schimer, Helena Raabova, Jan Bednar, Martin B. Plenio, Fedor Jelezko, Milos Nesladek, and Petr Cigler*

Cite This: https://dx.doi.org/10.1021/acsnano.0c04010 Read Online

2020

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

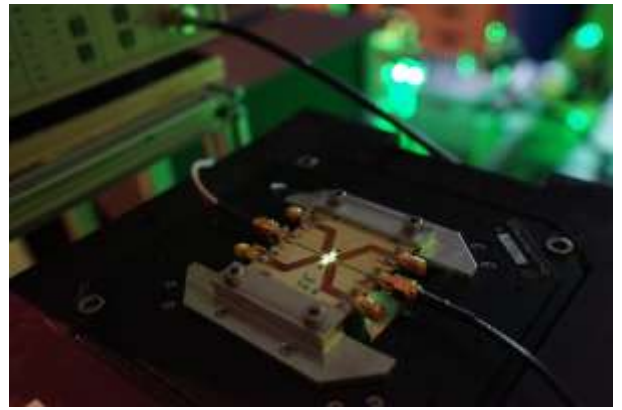
Nano Group, Prof. M. Nesladek

Development of quantum chips for ultrasensitive detection of spin states

Application:

- Nanodiamond - based in - vitro cell sensors
- Quantum chips for nanoscale NMR (pharmaceutical applications, medical diagnostics)
- Applications for quantum bits in quantum computing

Experimental realization of a quantum chip based on artificial diamond

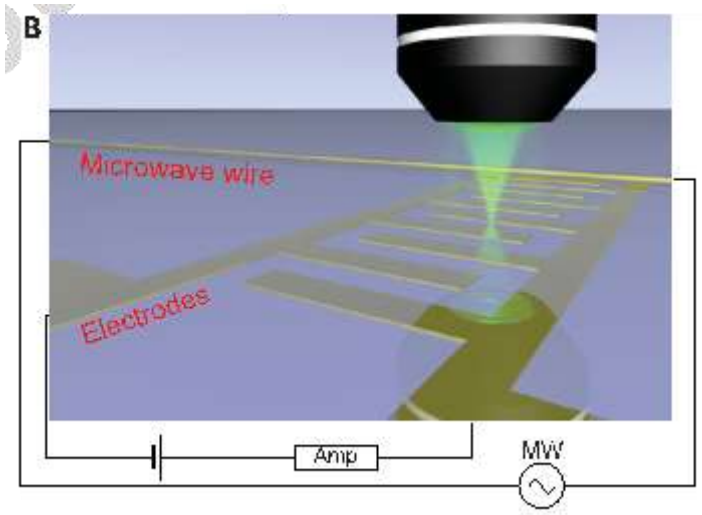


Science 363, 728–731 (2019)

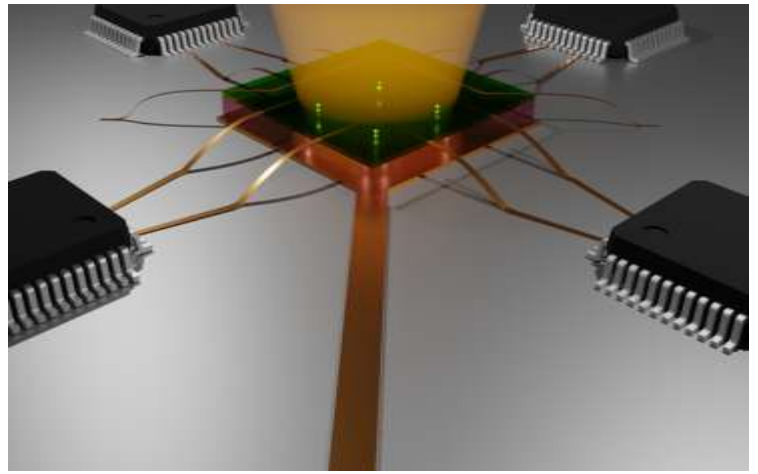
QUANTUM OPTICS

Photoelectrical imaging and coherent spin-state readout of single nitrogen-vacancy centers in diamond

Petr Siyushev[1,2*†], Milos Nesladek[3,4,5*†], Emilie Bourgeois[3,4], Michal Gulka[3,4,5], Jaroslav Hruby[3,4], Takashi Yamamoto[3,4‡], Michael Trupke[6], Tokuyuki Teraji[7], Junichi Isoya[8§], Fedor Jelezko[1]



Schematic arrangement of the principle of the method of photoelectric detection of spin states

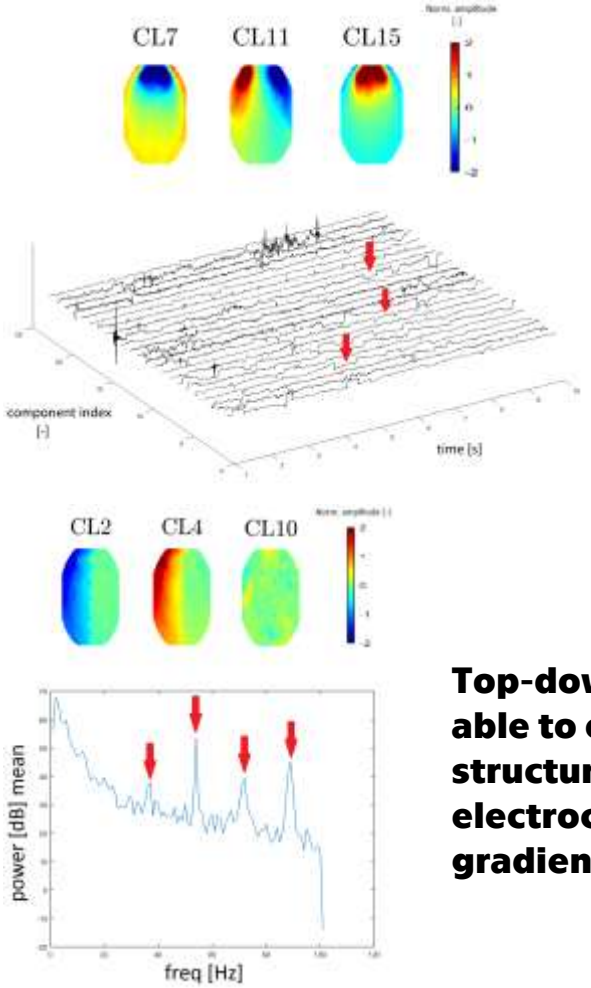


Future use of the method for quantum computer construction

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Universal automated EEG artifacts detection method.



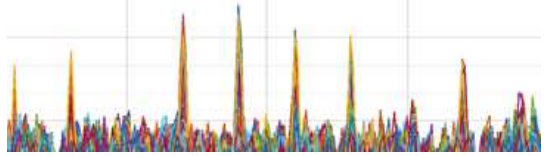
improve brain signals analysis

Top-down strategy based on machine learning is able to extract information from the data structure regarding electrooculographic, electrocardiographic, electromyographic and gradient artifact's residua.

BRAIN Team FBME
Biosignal Recognition & Artificial Intelligence in Neuroscience

Universal approach
(dry / water / gel electrodes).

Evaluation - model with signal simulation possibility.



PIORECKY, Marek, Vlastimil KOUDELKA, Jan STROBL, Martin BRUNOVSKY a Vladimir KRAJCA. Artifacts in Simultaneous hdEEG/fMRI Imaging: A Nonlinear Dimensionality Reduction Approach. Sensors, 2019, 19(20), ISSN 1424-8220. doi:10.3390/s19204454

STROBL, Jan, Vlastimil KOUDELKA, Vojtech VIKTORIN, Vladimir KRAJCA a Marek PIORECKY. The Stimulus Transduction Artifact from Headphones in hdEEG during the ASSR Experiments: a Phantom Study. In: 2020 International Conference on Biomedical Innovations and Applications (BIA) , IEEE, 2020, s. 29-32, ISBN 978-1-7281-7073-2. doi:10.1109/BIA50171.2020.9244505

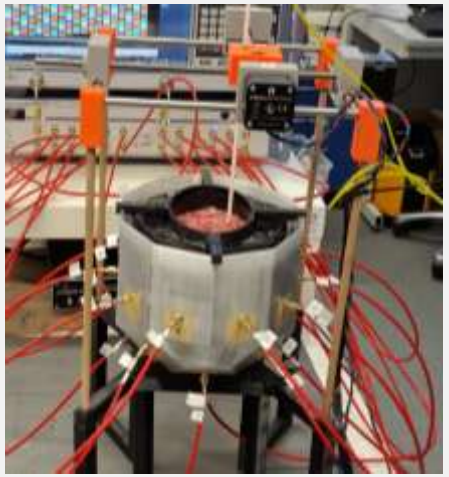
PIORECKÝ, Marek, Jan ŠTROBL a Vladimír KRAJČA. AUTOMATIC EEG CLASSIFICATION USING DENSITY BASED ALGORITHMS DBSCAN AND DENCLUE. Acta Polytechnica , 2019, 59(5), 498-509, ISSN 1805-2363, doi:10.14311/AP.2019.59.0498

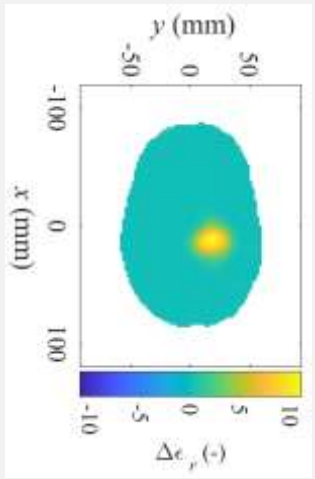
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

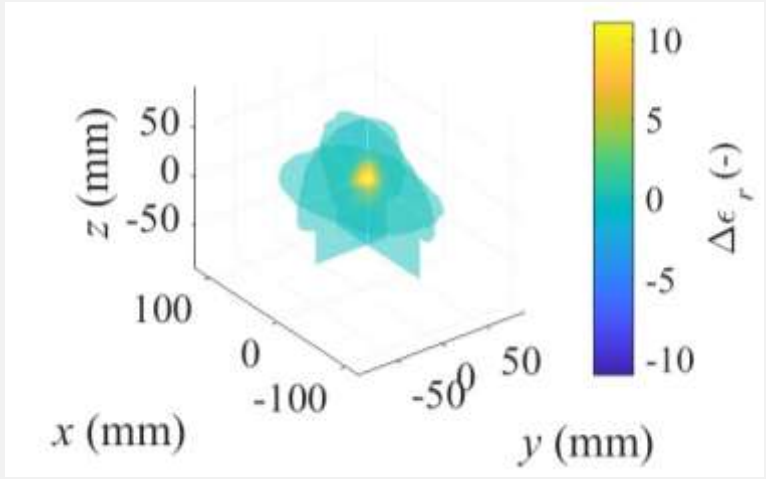
Selected excellent R&D results and achievements of our faculty

Microwave Imaging Systems for Stroke Monitoring and Anatomically and Dielectricall Realistic Solid Head Phantoms

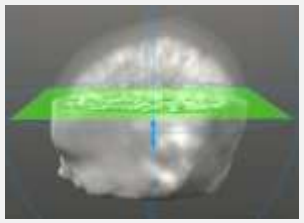
by the „Bio-Electromagnetism“ Research Team

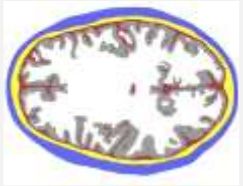




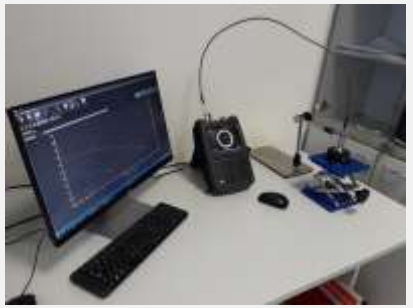


Microwave Imaging Sysem, Reconstructed Images and Antenna Elements





Anatomically and Dielectricall Realistic Solid Head Phantoms



Further Information in Journal Publications

- Salucci, M. Gelmini, A. Vrba, J. Merunka, I. et al., "Instantaneous brain stroke classification and localization from real scattering data," Microwave and Optical Technology Letters. 2019, 61(3), 805-808. ISSN 0895-2477.
- Merunka, I. Massa, A. Vrba, D. Fišer, O. Vrba, J., "Microwave Tomography System for Methodical Testing of Human Brain Stroke Detection Approaches," International Journal of Antennas and Propagation. vol. 2019, Article ID 4074862, 9 pages, 2019.
- Pokorný, T., Vrba, D., Tesařík, J., Rodrigues, D.R., Vrba, J., "Anatomically and Dielectrically Realistic 2.5D 5-Layer Reconfigurable Head Phantom for Testing Microwave Stroke Detection and Classification," International Journal of Antennas and Propagation, vol. 2019, Article ID 5459391, 7 pages, 2019.
- Tesařk, J., Pokorný, T., and Vrba, J., "Dielectric Sensitivity of Different Antennas Types for Microwave-Based Head Imaging: Numerical Study and Experimental Verification," International Journal of Microwave and Wireless Technologies, 2020.
- Pokorný, T.; Vrba, D.; Fišer, O.; Salucci, M.; Vrba, J., Systematic Optimization of Training and Setting of SVM-Based Microwave Stroke Classification: Numerical Simulations for 10 Port Systém, IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. 2024, 8(3), 273-281. ISSN 2469-7249.

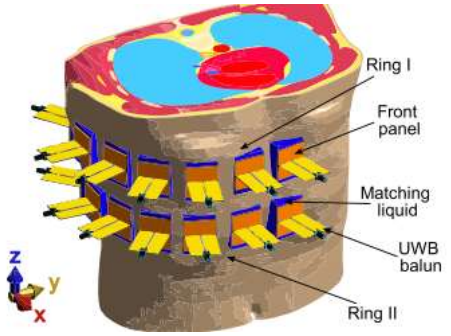
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

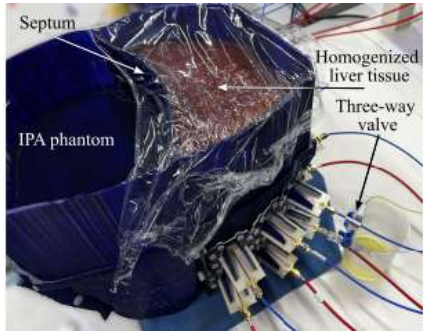
Selected excellent R&D results and achievements of our faculty

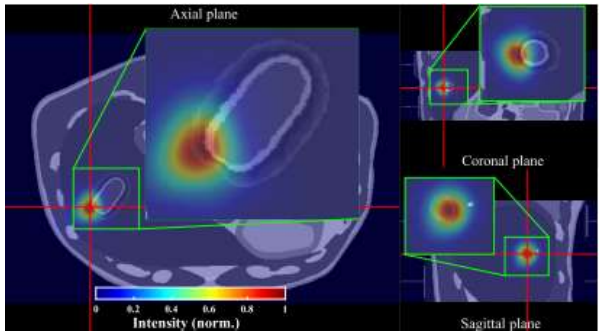
Microwave Diagnostics by the „Bio-Electromagnetism“ Research Team

Ph.D. Students as first authors of publications in prestigious scientific journals

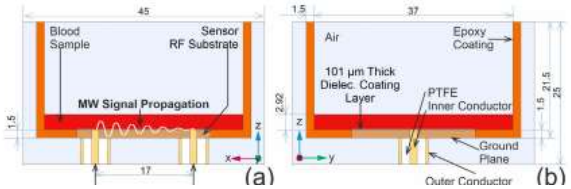
- Kollár, J.; Novák, M.; Babák, M.; Dřížďal, T.; Vrba, J.; Vrba, D.; Pokorný, T.; Linha, Z. et al. **Potential of UWB Radar Systems in Monitoring Liver Ablation: A Phantom Model Study, IEEE Transactions on Antennas and Propagation**. **2025**, 73(5), 3202-3216. ISSN 0018-926X.

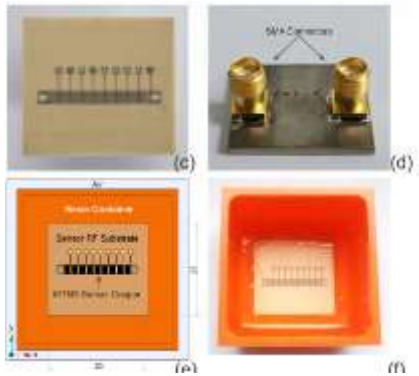


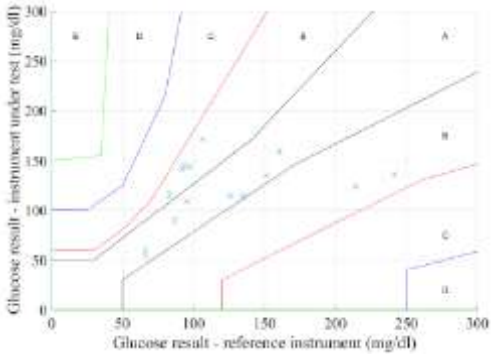




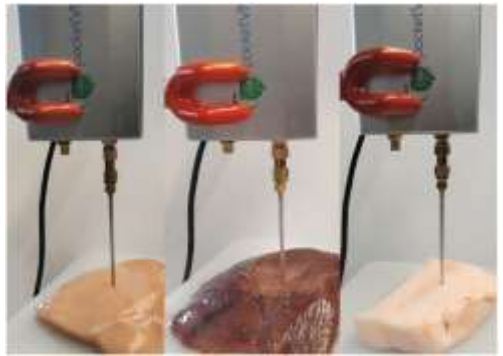
- Malena, L.; Fišer, O.; Dřížďal, T.; Pokorný, T.; Novák, M.; Vrba, J.; Vrba, D. **Feasibility of Glucose Concentration Estimation in Whole Blood Samples Using Noninvasive Metamaterial Microwave Sensor IEEE Sensors Journal**. **2025**, 25(5), 8259-8268. ISSN 1530-437X.







- Linha, Z.; Vrba, J.; Kollár, J.; Fišer, O.; Pokorný, T.; Novák, M.; Dřížďal, T.; Vrba, D. **An Inexpensive System for Measuring the Dielectric Properties of Biological Tissues Using an Open-Ended Coaxial Probe, IEEE Transactions on Instrumentation and Measurement**. **2025**, 74 ISSN 0018-9456.



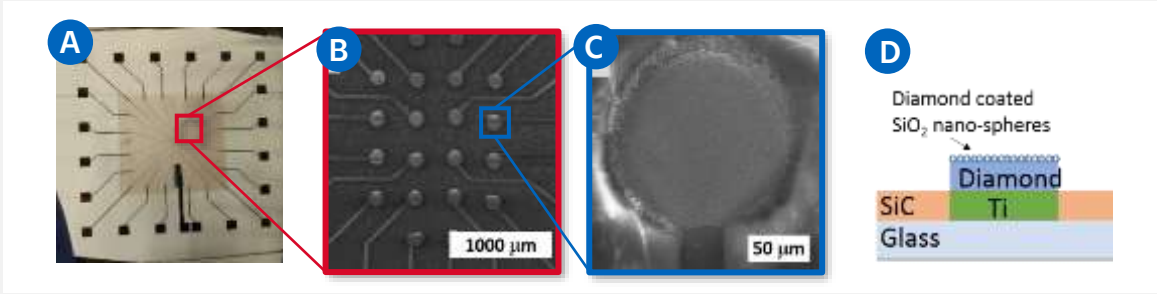
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

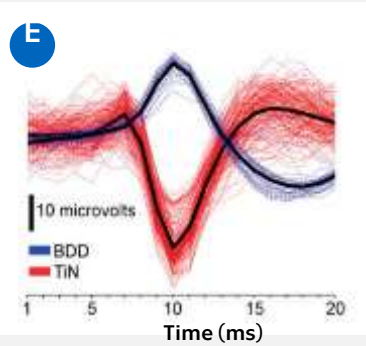
Diamond based microelectrode arrays for dual mode neural recording

by “Nanosensors for Biomedicine“ research team

In a multidisciplinary collaboration with the Academy of Sciences of the Czech Republic, we developed a nanodiamond-based microelectrode array system for dual recording of neuron electrical (action potentials) and chemical signals (dopamine release). We have developed a spike sorting algorithm for the processing of the recoded signals.



(A) optical image of nanodiamond coated MEA, (B) SEM image showing measuring region of nanodiamond MEA, (C) measurement pad and (D) schematic showing conductive diamond measurement pad.



(E) An example of recorded spikes from neural cells

Selected publications

- Klempíř et al. "Application of Spike Sorting Algorithm to Neuronal Signals Originated from Boron Doped Diamond Micro-Electrode Arrays." Physiological Research 69.3 (**2020**): 529-536.
- Krůšek, et al. "Molecular Functionalization of Planar Nanocrystalline and Porous Nanostructured Diamond to Form an Interface with Newborn and Adult Neurons." physica status solidi (b) 256.3 (**2019**): 1800424.

Acknowledgment

This work was supported by the Czech Science Foundation Grant No. 17-15319S

GAČR
CZECH SCIENCE FOUNDATION

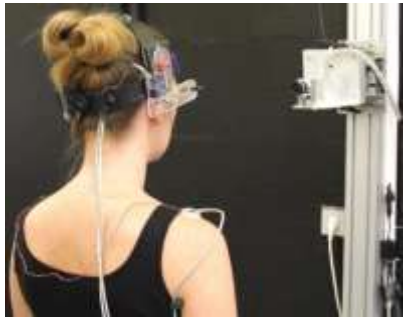
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Methods for Motion Capture and Kinematic Analysis of Human Movement

by the Team of Biomechanics and Assistive Technology






Further Information and Related Publications:

- Zarkovic, D., Sorfova, M., Tufano, J.J., Kutilek, P., Viteckova, S., Groleger-Srsen, K., Ravnik, D.; Effect of Robot-Assisted Gait Training on Selective Voluntary Motor Control in Ambulatory Children with Cerebral Palsy (2020) Indian Pediatrics, 57 (10), pp. 964-966.
- Hourova, M., Kutilek, P., Hejda, J., Viteckova, S., Janura, M., Bizovska, L., Hamrikova, M., Volf, P., Svoboda, Z.; Evaluation of postural stability differences in the elderly through recurrent analysis (2020) Studies in Health Technology and Informatics, 273, pp. 197-202.
- Volf, P., Kutilek, P., Hejda, J., Viteckova, S., Smrcka, P., Hana, K., Svoboda, Z., Krivanek, V.; Methods for kinematic analysis of human movement in military applications: A review of current and prospective methods (2020) Lekar a Technika, 49 (4), pp. 125-135.
- Kutilek, P., Volf, P., Cerny, R., Hejda, J.; The application of accelerometers to measure movements of upper limbs: Pilot study (2017) Acta Gymnica, 47 (1), pp. 24-32.

Related Research Projects

Simulation of real force effects during shooting on a shooting simulator and influence on shooting accuracy, Project No. TJ04000176, Principal investigator: M.Hourova, **2020-2022**.

MIHRIL (Multi Impact Hybrid Layers) - protection against street threats, Project No. FW01010463, Principal investigator for CTU: P.Kutilek, **2020-2022.**

Intelligent Senior Care System, Project No. TL03000611, Principal investigator for CTU: P.Kutilek, **2020-2023.**

Enhancing Robotic Physiotherapeutic Treatments using Machine Learning, Project no. LTAIZ19008, Principal investigators: P. Kutilek. INTER-EXCELLANCE, **2019-2022**.

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Monitoring the Mental State of Persons Controlling Transport Means such as Cars or Planes

by the Team of Biomechanics and Assistive Technology

Further Information and Related Publications:

- Kutilek, P., Volf, P., Sedova, K., Hejda, J., Krivanek, V., Stehlík, M., Rusnakova, K., Kozlova, S., Braunova, M.; Heart rate variability during fighter pilot training (2019) ICMT 2019 - 7th International Conference on Military Technologies, Proceedings, art. no. 8870071.
- Volf, P., Stehlik, M., Kutilek, P., Kloudova, G., Rusnakova, K., Kozlova, S., Braunova, M., Hejda, J., Krivanek, V., Doskocil, R.; Brain electrical activity mapping in military pilots during simulator trainings (2019) ICMT 2019 - 7th International Conference on Military Technologies, Proceedings, art. no. 8870112.
- Kutilek, P., Volf, P., Hejda, J., Smrcka, P., Adolf, J., Krivanek, V., Lhotska, L., Hana, K., Doskocil, R., Kacer, J., Cicmanec, L.; Non-contact measurement systems for physiological data monitoring of military pilots during training on simulators: Review and application (2019) ICMT 2019 - 7th International Conference on Military Technologies, Proceedings, art. no. 8870115.
- Kacer, J., Krivanek, V., Cicmanec, L., Kutilek, P., Farlik, J., Hejda, J., Viteckova, S., Volf, P., Hana, K., Smrcka, P.; Physiological data monitoring of members of air forces during training on simulators (2019) IFMBE Proceedings, 68 (3), pp. 855-860.

Related Research Projects

Reserch and development of synthetic device with artificial intelligence focused on pilot preselection and screening, Project No. FW01010444, Principal investigator: P. Kutilek, **2020-2022**.

Back behind the Wheel - Diagnostic and rehabilitation tool for people after brain injury, Project No. TJ02000036, Principal investigator for CTU: P.Kutilek, **2019-2021.**

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FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Portable and Wearable Assistive Devices

by the Team of Biomechanics and Assistive Technology





Further Information and Related Publications:

- Lema, D.S.M., Karavaev, A., Hybl, J., Hejda, J., Volf, P., Kutilek, P.; Control system of a lower-extremity exoskeleton based on the artificial neural network (2020) Studies in Health Technology and Informatics, 273, pp. 91-96.
- Volf, P., Hejda, J., Hájková, S., Kutílek, P. Cooling module for orthosis (2020) Advances in Intelligent Systems and Computing, 1044, pp. 445-452.
- Kutilek, P., Volf, P., Hejda, J., Viteckova, S., Krivanek, V., Doskocil, R., Kotolova, V., Smrcka, P., Havlas, V.; Determining the upper limb's intensity of movement using a smart orthosis for rehabilitation at the clinic and home (2020) Advances in Intelligent Systems and Computing, 1044, pp. 397-405.
- D'Angeles Mendes de Brito, A.C., Kutilek, P., Hejda, J., Kotolova, V., Havlas, V.; Methods of motion assessment of smart orthosis of upper limb for rehabilitation at the clinic and at home (2018) IFMBE Proceedings, 68 (2), pp. 779-783.

Related Research Projects

Orthosis with controlled electronic cooling, Project No. TG02010033 – InovaFOND, Sub-project Principal investigator P.Kutilek, **2018-2019**.

MIHRIL (Multi Impact Hybrid Layers) - protection against street threats, Project No. FW01010463, Principal investigator for CTU: P.Kutilek, **2020-2022.**

Intelligent Senior Care System, Project No. TL03000611, Principal investigator for CTU: P.Kutilek, **2020-2023.**

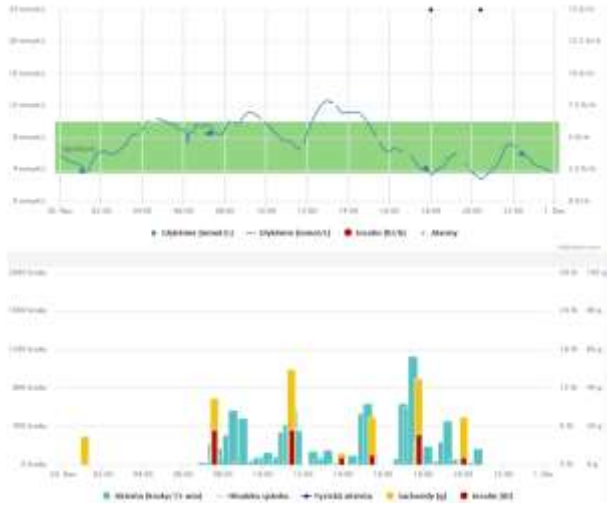
Enhancing Robotic Physiotherapeutic Treatments using Machine Learning, Project no. LTAIZ19008, Principal investigators P. Kutilek. INTER-EXCELLANCE, **2019-2022**.

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Telemedicine and diabetes research team – main results

Design of the Diani telemedicine system for patients with chronic diseases – primarily diabetes and hypertension – in cooperation with Mobas s.r.o. company



Diabetesdagboka mobile app and a companion app for Pebble

World's first smartwatch application for patients with diabetes – in cooperation with NSE Tromsø

Team in numbers

Publications	**100+**
Patents and utility models	**10+**
Funded projects	**10+**
Clinical studies	**6**

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

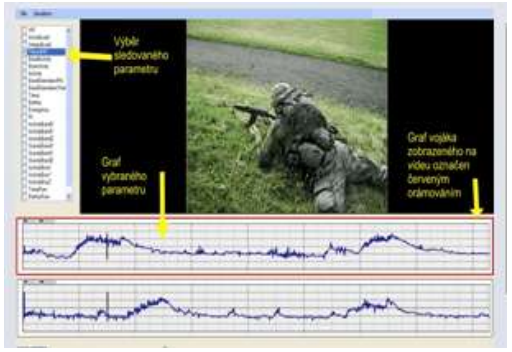
Personal Security System to Support Training and intervention of Integrated Rescue System units

by the „Bio-telemetry systems“ Research Team

The system **FlexiGuard** Enables long-term telemetric monitoring of health-physiological data and the environment in real time – heart rate, body and environmental temperature, physical activity, humidity, body position, breath frequency, GPS position. **Can monitor up to 30 persons simultaneously and transfer the data up to 2 km.**

The system is actively used in various real security, survillance and research applications and in cotractual research projects, more than 40 system installations have already been implemented, for example on:

- CASRI company, a.s., in cooperation with Czech Army – security monitoring of soldiers during anti-teroristic training
- Fire and Rescue Service of Czech Republic – security monitoring on training Polygon Zbiroh
- National institute of biological, chemical and radiation protection (SÚJCHBO) – personal monitoring in climatic chamber



The solution is protected by 2 valid patents and several utility samples

- **Supervision device for monitoring people, especially in difficult conditions and a sensor allocation system on the human body, CZ Patent No. 307930**
- **A monitoring and transport system in particular for transporting infectious patients. CZ Patent No. 307932**

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

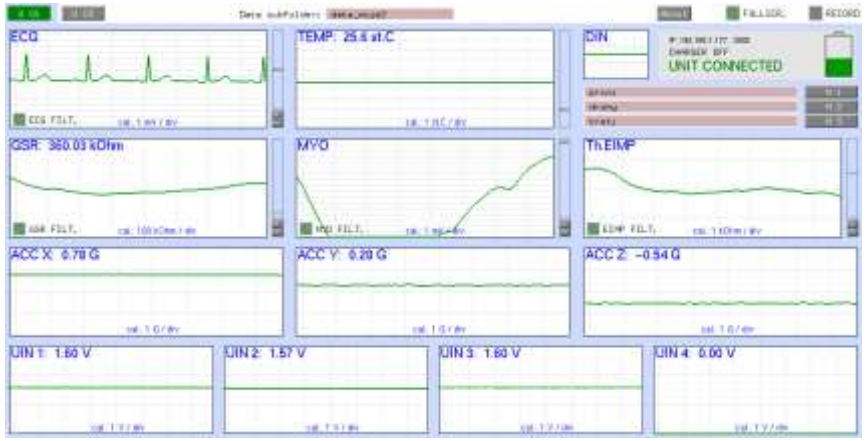
Wireless portable medical polygraphic unit VLV3 for research of psycho-physiological states

by the „Bio-telemetry systems“ Research Team

Portable polygraphic unit **VLV3** for personal biotelemetry – measuring and on-line wireless streaming of medical grade ECG, breath curve, activity, body temperature, skin resistance from up to 12 persons simultaneously.

The system was applied on more than 2000 probands during various research experiments and contract research projects, for example on:

- Skoda auto, a.s., Wolkswagen Group, CZ & D
- Faculty of Natural Scinces, Charles University, CZ
- University of Palacky, Olomouc, CZ
- University of Defence, Brno, CZ
- Faculty of Aviation, Technical University Kosice, SK – monitoring of pilots during training both on simulators and real planes.



Unique solution protected by 2 valid patents

- A biotelemetric system for the support of monitoring the psychophysiological state of a human being, CZ Patent No. 306895
- Method of detection and signalization of the drivers fatigue during the driving task and the method of it's realization. CZ Patent No. 300170

FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Homebalance – Interactive telerehabilitation system for home-based therapy of balance disorders

by the „Rehabilitation process quantification“ Research Team

Produced and distributed by Homebalance, s.r.o., spin-off company (Prague, CZ)

Compatible with Health 4.0

Links and patents

- https://www.homebalance.cz/en.html; http://www.clevertech.cz/en/iso-certifikace.html; https://www.protectu.cz/?lng=en
- Hana, K., Kaspar, J., Kucera, L., Muzik, J., Smrcka, P., Vesely, T., Viteznik, M.: Method of wireless connection of an intelligent house with a rescue system patrol and a system for its implementation. Patent 308531, 16.9.2020, Industrial Property Office in Czech Republic, 2020
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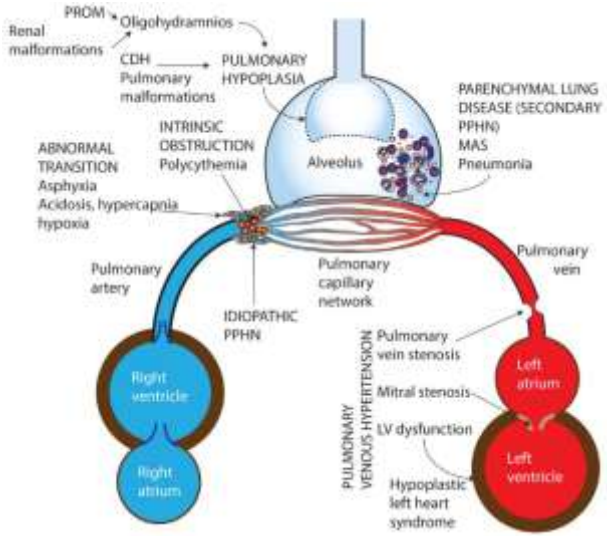
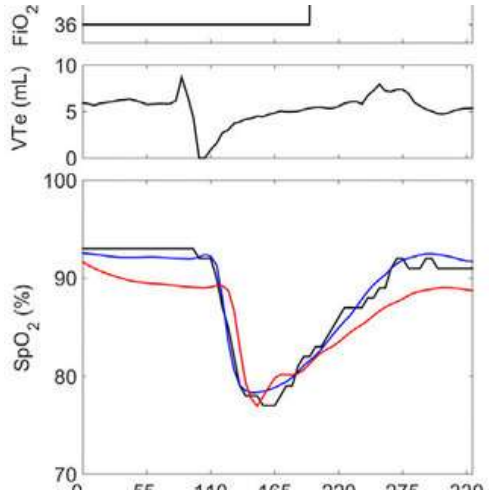
FACULTY OF BIOMEDICAL ENGINEERING CTU IN PRAGUE

Selected excellent R&D results and achievements of our faculty

Computer Model of Oxygenation in Neonates

by the „Patient Simulation “ Research Team





Optimized mathematical model of oxygenation of the neonate with implemented diffusion resistance, variable oxyhemoglobin dissociation relationship and the bias between arterial and peripheral oxygen saturation.

Model reliably simulate episodes of oxygen desaturation and describe the relation between ventilation, FiO_2 and SpO_2 .

Related Journal Publications:

- Rafl, J., Huttova, V., Möller, K., Bachman, T. E., Tejkl, L., Kudrna, P., ... & Roubik, K. (2019). Computer model of oxygenation in neonates: A demonstration of utility. *Current Directions in Biomedical Engineering*, *5*(1), 73-76.
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- Huttova, V., Rafl, J., Möller, K., Bachman, T. E., Kudrna, P., Rozanek, M., & Roubik, K. (2019). Model of SpO2 signal of the neonate. Current Directions in Biomedical Engineering, 5(1), 549-552.

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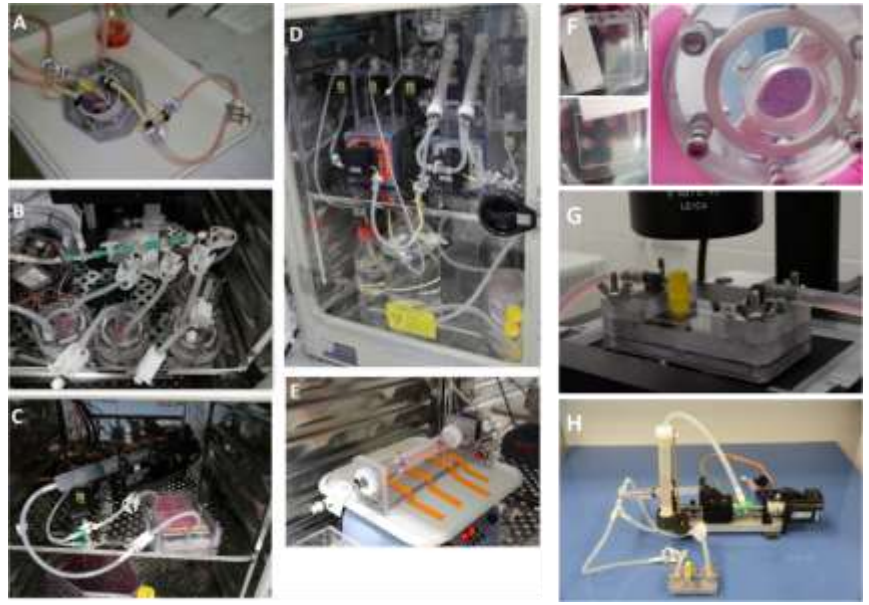
Selected excellent R&D results and achievements of our faculty

Bioreactors for tissue and organ replacements



Dynamic culture system design and development

- **Mimicking physiological conditions**
- **Mechanical stimulation**
- **Maintaining living conditions**
- **Non-toxic and sterile**

Automation and instrumentation of culture systems

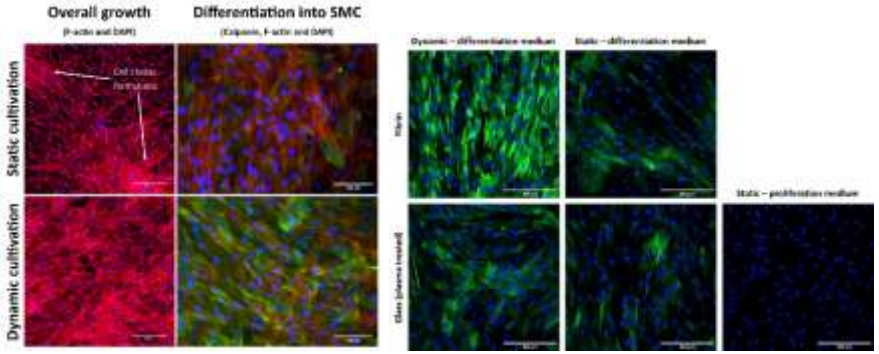
- **Optimization for 24/7 running**
- **Remote access**
- **Suitable for normal CO2 incubators**

Systems for tissue decellularization

- **Vessels, pericardium and peripheral nerves**

Involving 3D printed parts in system design (with new biocompatible materials)

3D bioprinting of cells in hydrogels onto nanofibrous or decellularized substrates – providing homogenous and reproducible initial seeding



MATĚJKA, R., M. KOŇAŘÍK, J. ŠTĚPANOVSKÁ, J. LIPENSKÝ, J. CHLUPÁČ, D. TUREK, Š. PRAŽÁK, A. BROŽ, Z. ŠIMŮNKOVÁ, I. MRÁZOVÁ, S. FOROSTYAK, P. KNEPPO, J. **ROSINA, L. BAČÁKOVÁ a J. PIRK** Bioreactor Processed Stromal Cell Seeding and Cultivation on Decellularized Pericardium Patches for Cardiovascular Use. Applied Sciences, 2020a, 10(16).

BACAKOVA, L., J. PAJOROVA, M. TOMKOVA, R. MATEJKA, A. BROZ, J. STEPANOVSKA, S. PRAZAK, A. SKOGBERG, S. SILJANDER a P. KALLIO Applications of Nanocellulose/Nanocarbon Composites: Focus on Biotechnology and Medicine. Nanomaterials (Basel), Jan 23 2020, 10(2)

KUMOREK, M., O. JANOUSKOVA, A. HOCHERL, M. HOUSKA, E. MAZL-CHANOVA, N. KASOJU, L. CUCHALOVA, R. MATEJKA a D. KUBIES Effect of crosslinking chemistry of albumin/heparin multilayers on FGF-2 adsorption and endothelial cell behavior. Applied Surface Science, JUL 31 2017 2017, 411, 240-250.

Recent grant and projects:
Ministry of Health of the Czech Republic grants No. NV18-02-00422 and NV19-02-0006; Technology Agency of Czech Republic, project no. TM01000046; Ministry of Education, Youth and Sports of CR projects CZ.02.2.69/0.0/0.0/16_018/0002242 and CZ.02.1.01/0.0/0.0/16_017/0002244

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Selected excellent R&D results and achievements of our faculty

Automated tissue decellularization

Automated and reproducible method for tissue decellularization

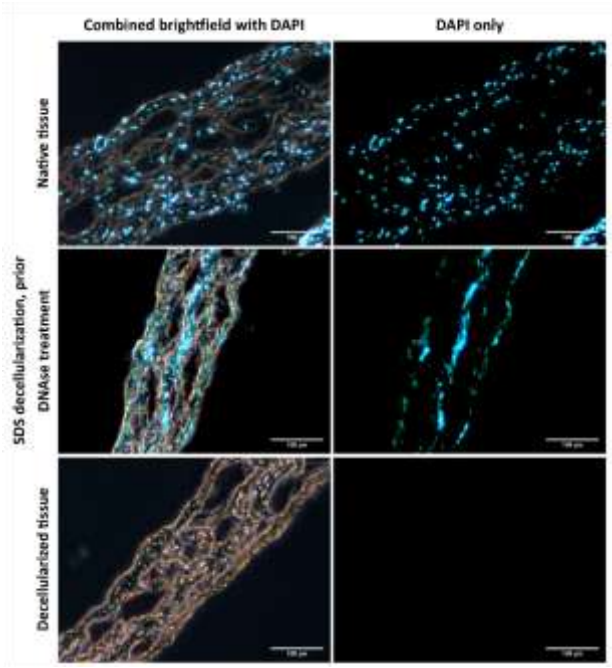
Optimized processes for tubular and planar tissues

Result - sterile completely decellularized tissue for further processing

Recolonization with cells in designed bioreactors

- **Cardiovascular patches**
- **Vessel replacements**
- **Valve replacements**
- **Skin grafts**

Optimization according ATMP regulations and translation into GMP/GLP facility



Industrial partner

primecell

MUSILKOVA, J., E. FILOVA, J. PALA, R. MATEJKA, D. HADRABA, D. VONDRASEK, O. KAPLAN, T. RIEDEL, E. BRYNDA, J. KUCEROVA, M. KONARIK, F. LOPOT, P. JAN a L. BACAKOVA Human decellularized and crosslinked pericardium coated with bioactive molecular assemblies. Biomed Mater, Dec 9 2019, 15(1), 015008.

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Tissue engineered vessel replacements

Pilot animal study with 1 and 6 month observation

Procedures optimized according ATMP

Using of decellularized allo- (porcine) and xenogeneic tissues (ovine) – as for porcine animal model

Harvesting of adipose derived stromal (stem) cell prior surgery – autologous recolonization

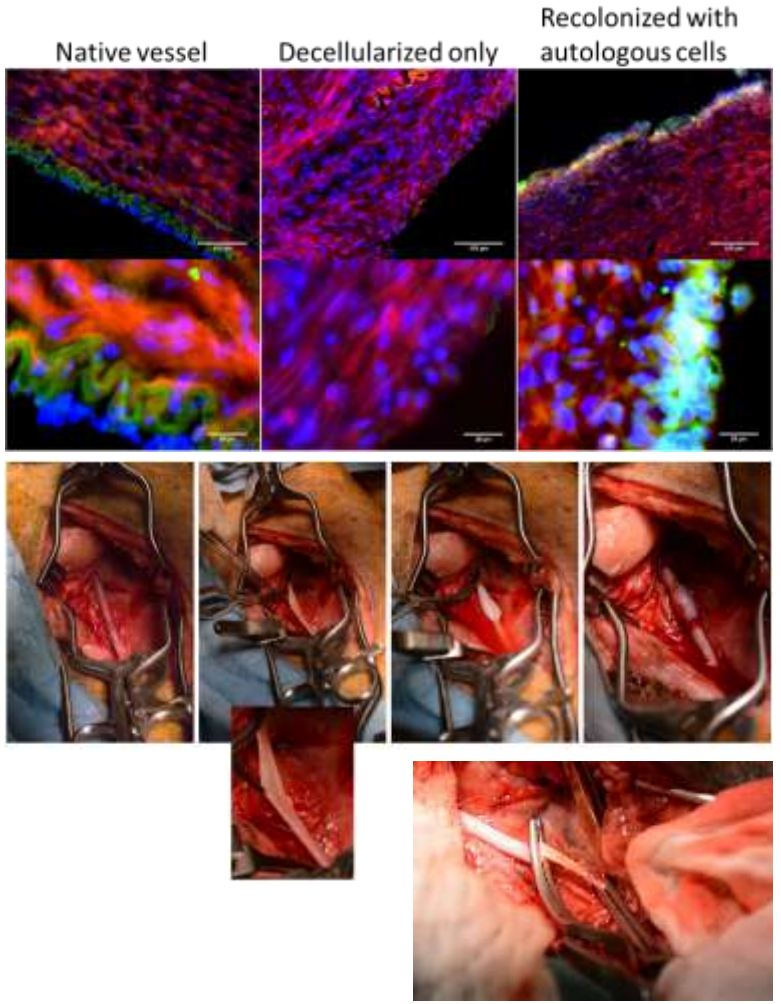
Wharton's Jelly Stem Cells – allogenous pooled

Cultivation of cells and seeding / printing on planar substrates (patches) and impregnation of tubular grafts (vessel replacements)

Implantation in experimental pig (Prestice black pied breed) onto carotid

- **Artificial defect**
- **Replacement**

Formation of new endothelial layer and tunica intima



CHLUPAC, J., E. FILOVA, J. HAVLIKOVA, R. MATEJKA, T. RIEDEL, M. HOUSKA, E. BRYNDA, E. PAMULA, M. RÉMY, R. BAREILLE, P. FERNANDEZ, R. DACULSI, C. BOURGET, L. BACAKOVA a L. BORDENAVE The gene expression of human endothelial cells is modulated by subendothelial extracellular matrix proteins: Short-term response to laminar shear stress. Tissue Engineering - Part A, 2014 2014, 20(15-16), 2253-2264.

MAŤĚJKA, R., M. KOŇAŘÍK, J. ŠTĚPANOVSKÁ, J. LIPENSKÝ, J. CHLUPÁČ, D. TUREK, Š. PRAŽÁK, A. BROŽ, Z. ŠIMŮNKOVÁ, I. MRÁZOVÁ, S. FOROSTYAK, P. KNEPPO, J. ROSINA, L. **BAČÁKOVÁ a J. PIRK** Bioreactor Processed Stromal Cell Seeding and Cultivation on Decellularized Pericardium Patches for Cardiovascular Use. Applied Sciences, 2020a, 10(16).

Research partners:

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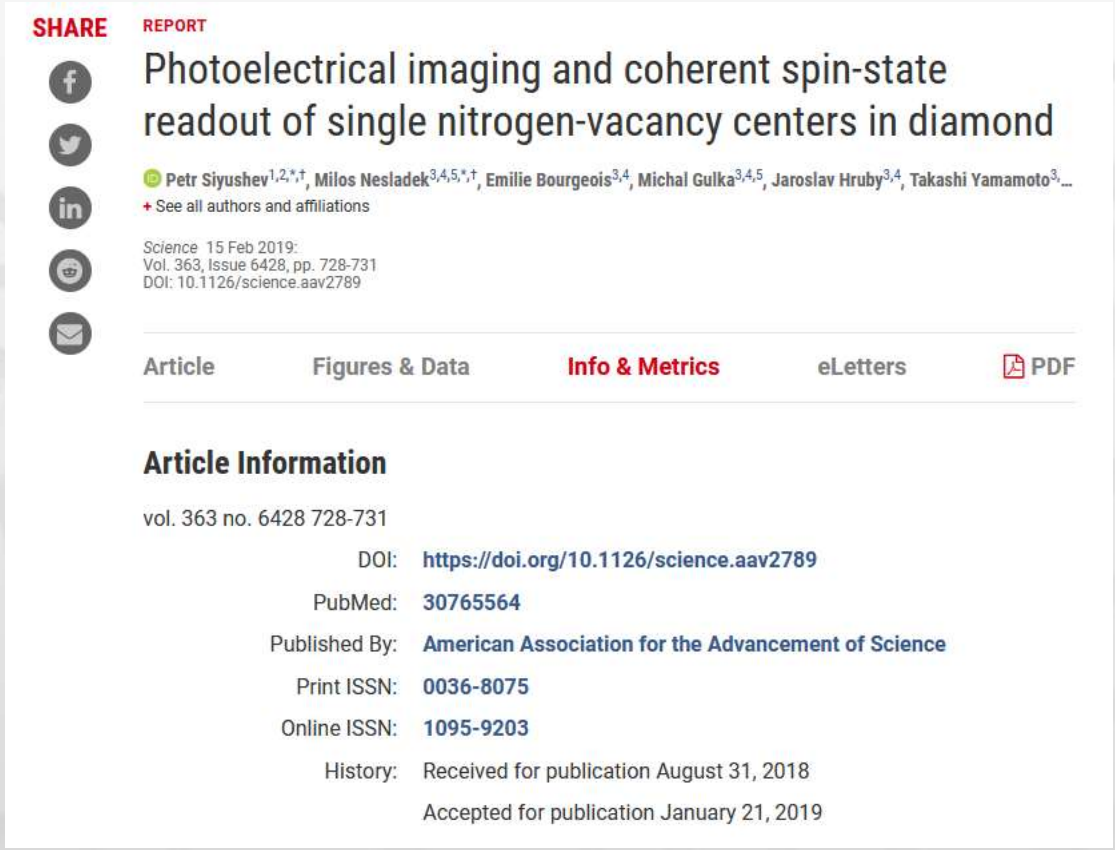
Scientific paper in Science

https://science.sciencemag.org/content/363/6428/728/tab-article-info



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REPORT

Photoelectrical imaging and coherent spin-state readout of single nitrogen-vacancy centers in diamond

Petr Siyushev[1,2,*,†], Milos Nesladek[3,4,5,*,†], Emilie Bourgeois[3,4], Michal Gulka[3,4,5], Jaroslav Hruby[3,4], Takashi Yamamoto[3,...]

+ See all authors and affiliations

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Article | Figures & Data | Info & Metrics | eLetters | PDF

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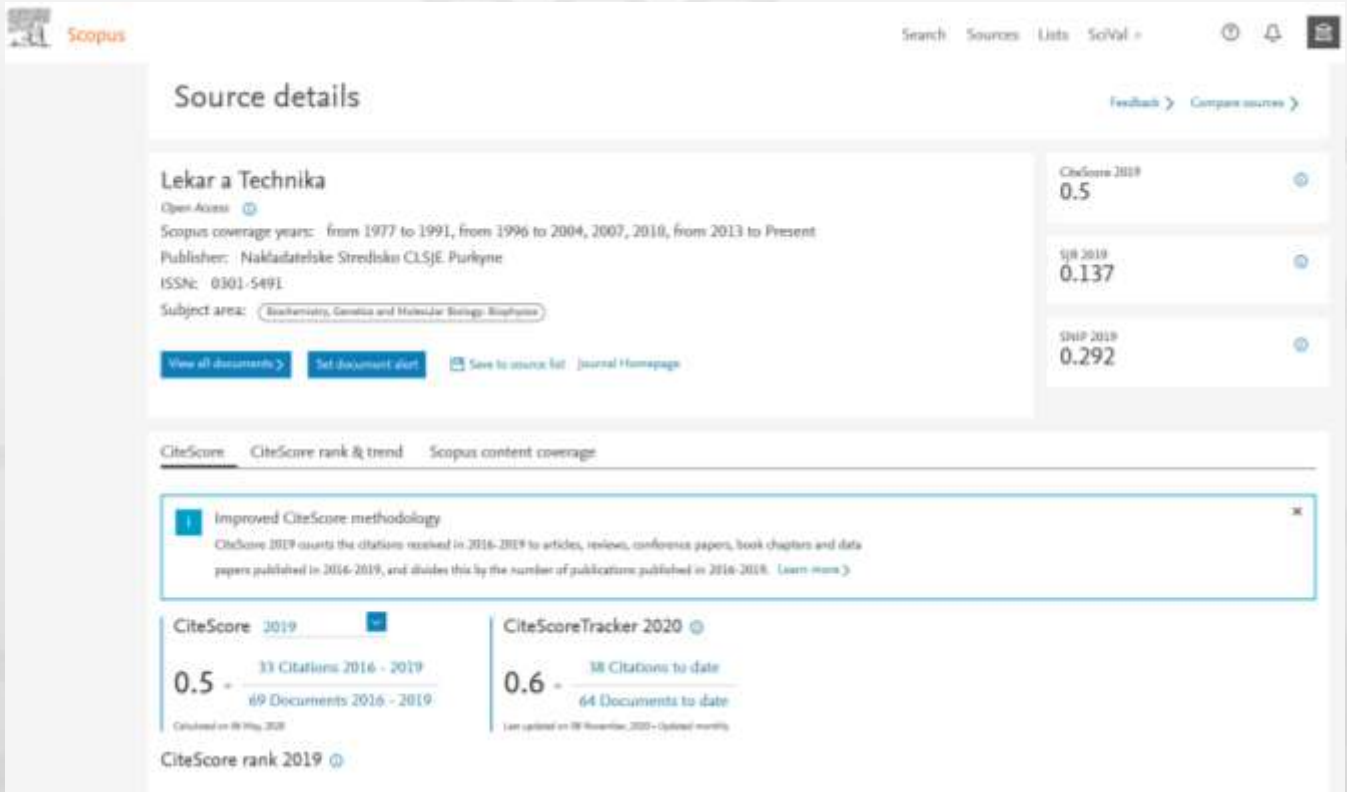
Scientific journal Lékař a technika – Clinician and Technology (published by CMA JEP and CTU FBME, indexed in Scopus, including DOI)

https://ojs.cvut.cz/ojs/index.php/CTJ/



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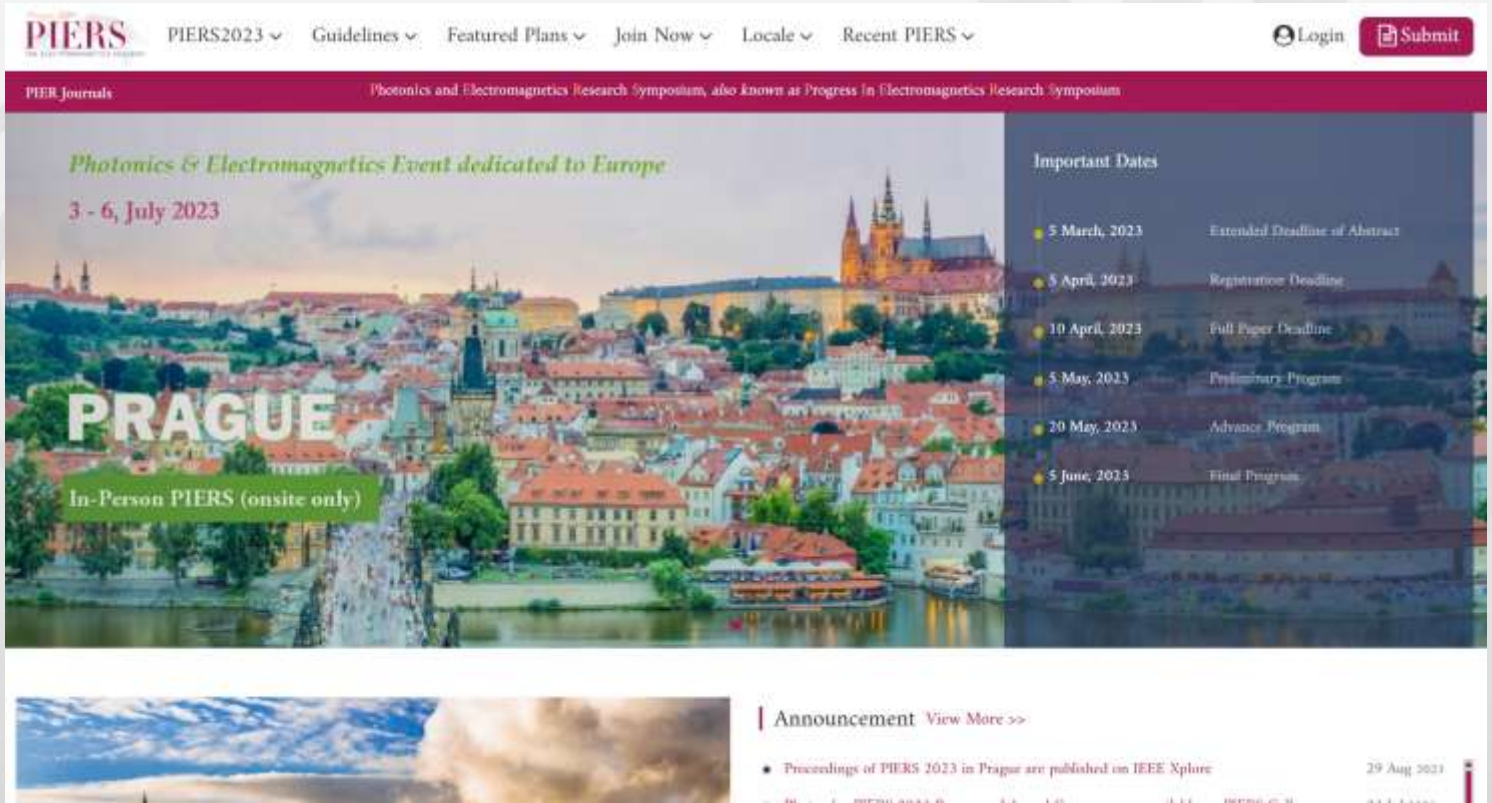
1200+ participants from 80+ countries. Technical committee members and local organizers from among FBME academics and students https://prague2023.piers.org/



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IFMBE

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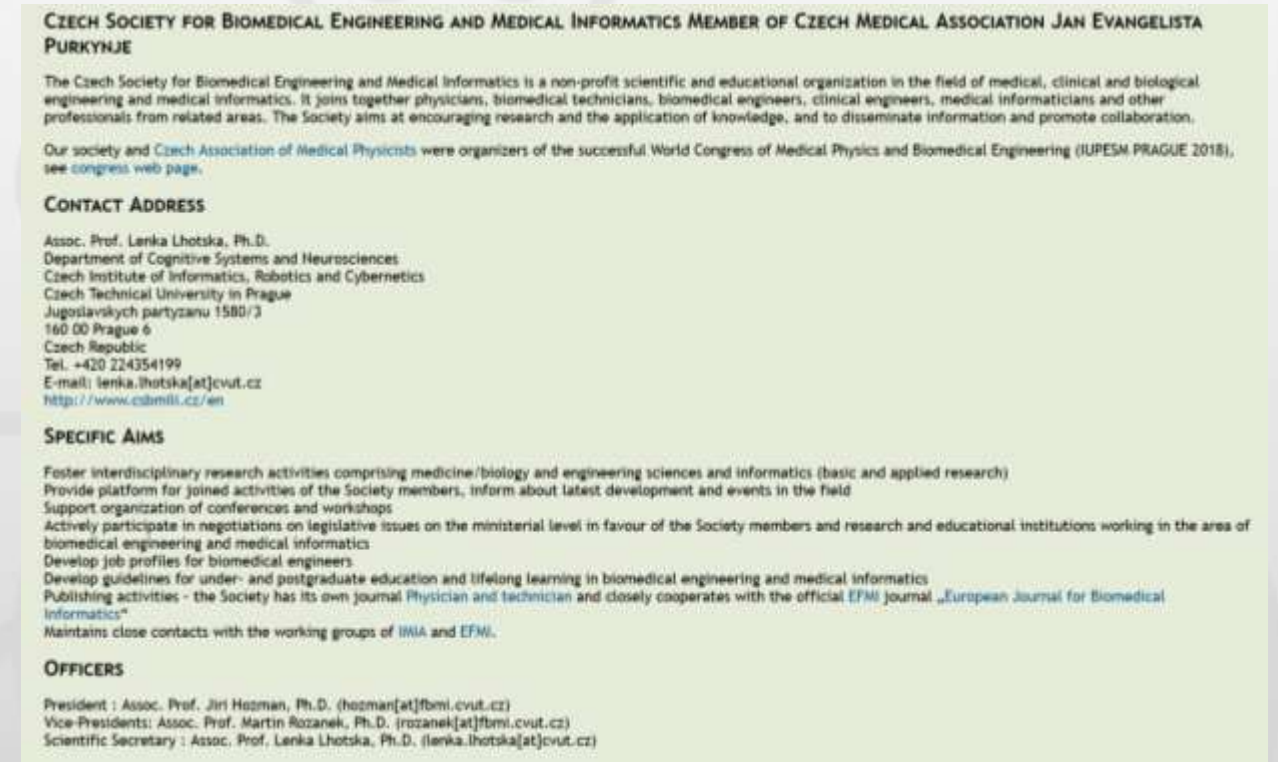
Czech Society for Biomedical Engineering and Medical Informatics – a lot members from FBME including committee members

http://www.csbmili.cz/en

EFMI European Federation for Medical Informatics

ISfTeH



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The Czech Society for Biomedical Engineering and Medical Informatics is a non-profit scientific and educational organization in the field of medical, clinical and biological engineering and medical informatics. It joins together physicians, biomedical technicians, biomedical engineers, clinical engineers, medical informaticians and other professionals from related areas. The Society aims at encouraging research and the application of knowledge, and to disseminate information and promote collaboration.

Our society and Czech Association of Medical Physicists were organizers of the successful World Congress of Medical Physics and Biomedical Engineering (IUPESM PRAGUE 2018), see congress web page.

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Provide platform for joined activities of the Society members, inform about latest development and events in the field
Support organization of conferences and workshops
Actively participate in negotiations on legislative issues on the ministerial level in favour of the Society members and research and educational institutions working in the area of biomedical engineering and medical informatics
Develop job profiles for biomedical engineers
Develop guidelines for under- and postgraduate education and lifelong learning in biomedical engineering and medical informatics
Publishing activities - the Society has its own journal Physician and technician and closely cooperates with the official EFMI journal „European Journal for Biomedical Informatics“
Maintains close contacts with the working groups of IMIA and EFMI.

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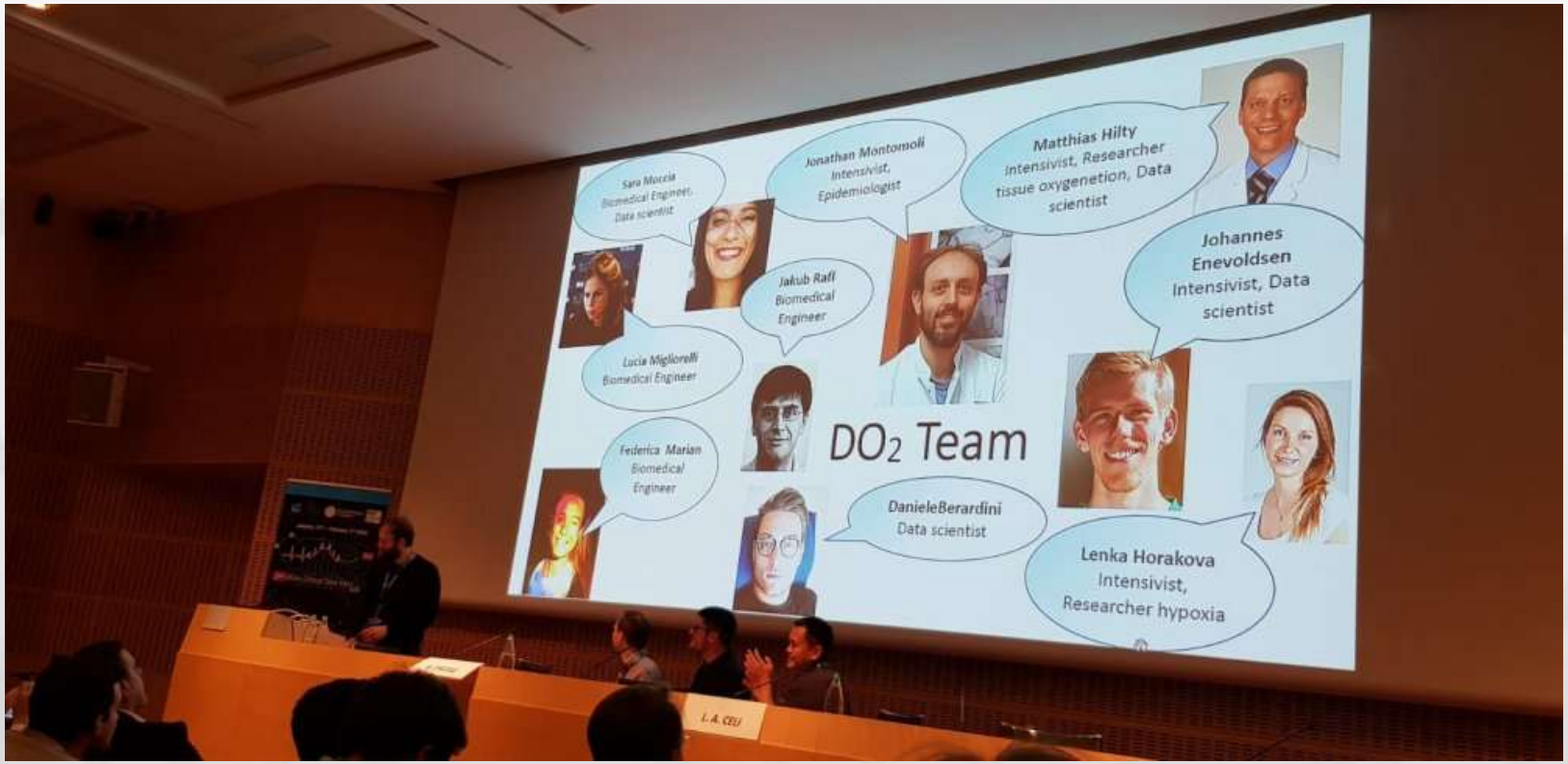

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Roubik, K., „We are helping in Cambodia“

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https://www.fbmi.cvut.cz/cs/verejnost/fotogalerie/pomahame-kambodzi
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